“High-quality” climate data ...

... *“accurate and representative”* measurements

... *“efficient and reliable”* data quality control

... *“standardized and relevant”* metadata

... “*rational and efficient”* homogenization procedures

... *„???“* grid datasets

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Federal Department of Home Affairs FDHA
Federal Office of Meteorology and Climatology MeteoSwiss

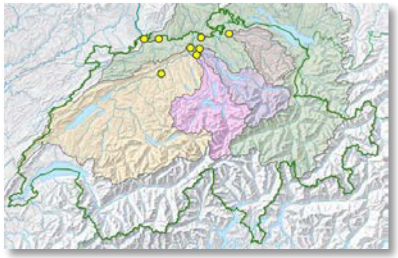
What does „high quality“ mean with regard to spatial climate datasets?
Practice and experience at MeteoSwiss

Christoph Frei and Francesco Isotta

Rebekka Erdin, Denise Keller, David Masson, Reinhard Schiemann, Raphaela Vogel, Bettina Weibel, Marco Willi (former collaborators)

Data Management Workshop 28.-30.10.2015, St. Gallen, Switzerland

Application and Users



Hydrology

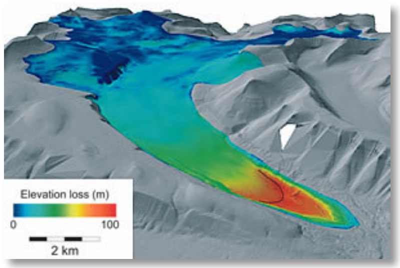
Runoff forecasting,
Flood protection,
Land slide risks, …

Agriculture

Crop suitablity maps,
Crop desease and pests,
Subsidies, …

Energy & Construction

Renewable energy,
Heating/cooling design, …



Snow & ice

Avalange risk,
Slope stability,
Glacier monitoring, …

Research

ETH, Univ., FHS
Univ. outside CH

Agencies

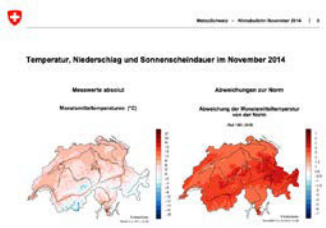
Federal,
Regional

Private Sector

Insurance
Engineering

Internal

Climate monitoring
Model verification
Local forecasts
CC-Scenarios, …



User Requirements

high accuracy (small random errors)

fine spatial resolution (km)

high temporal resolution (1 day, 1 hour)

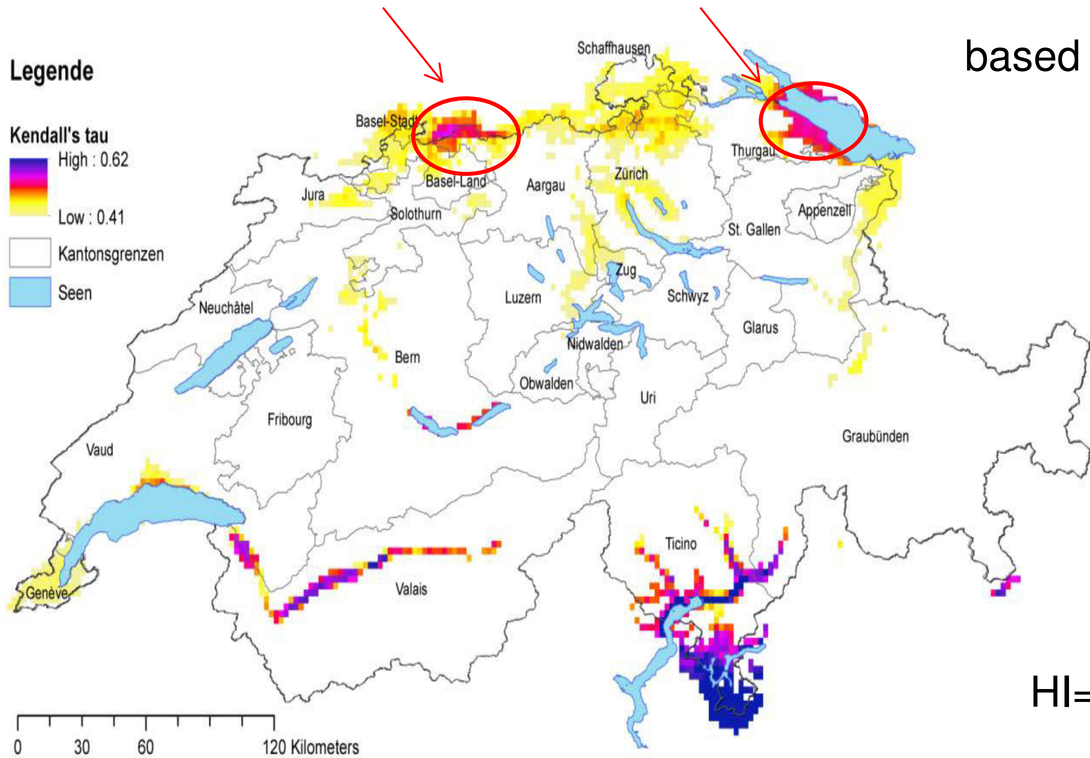
multi-parameter – physically consistent

multi-decadal – climate consistent

timely – possibly real-time

Trends in Viticulture

change in station network



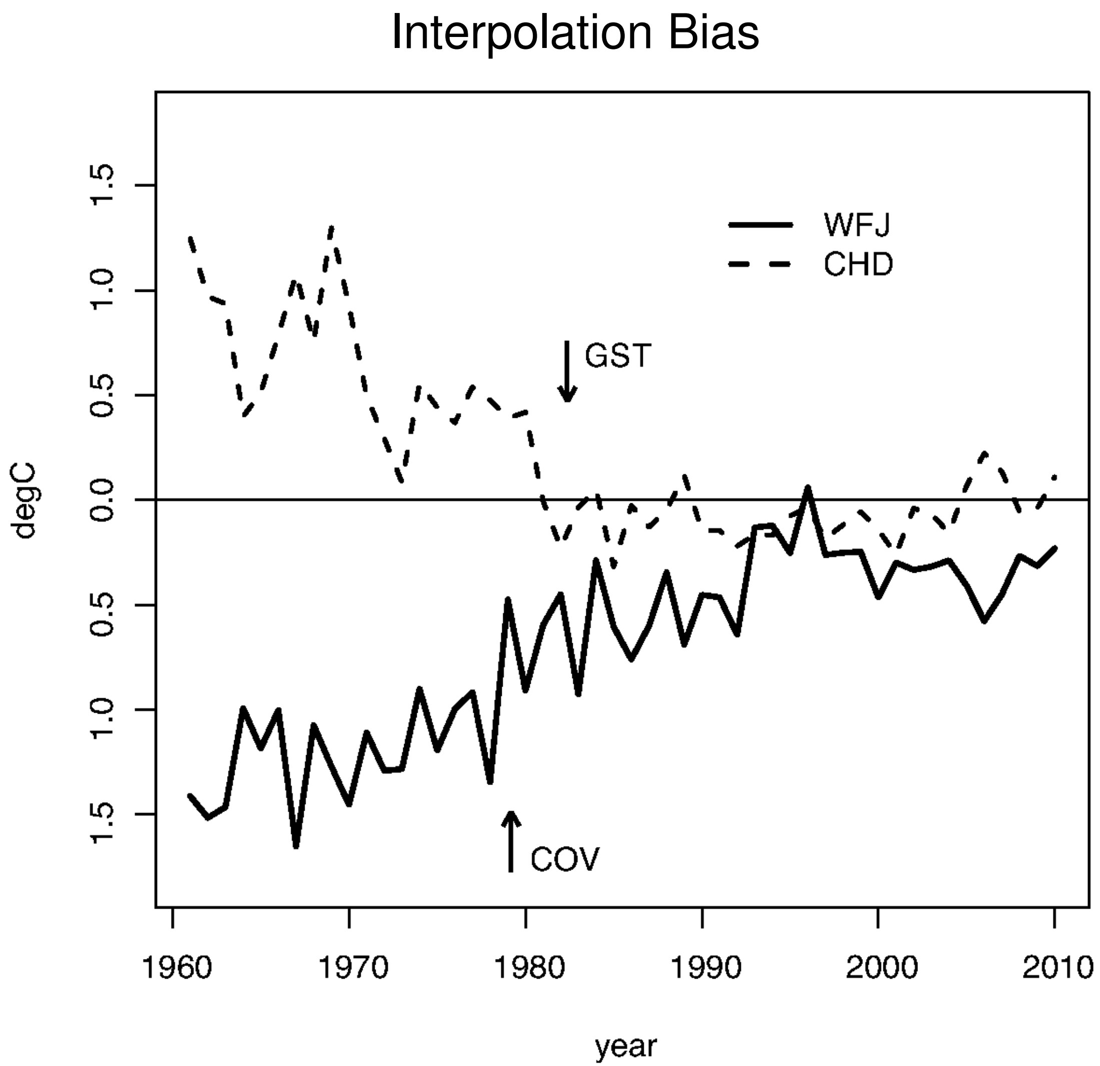
1981-2010 Trend in Huglin Index

based on high-res daily grid data

$HI=sum((T_m+T_x)/2 – 10degC)$

April – September

Effects from network changes



Frei 2014

Purpose-Design Philosophy

Data products targeted to application groups

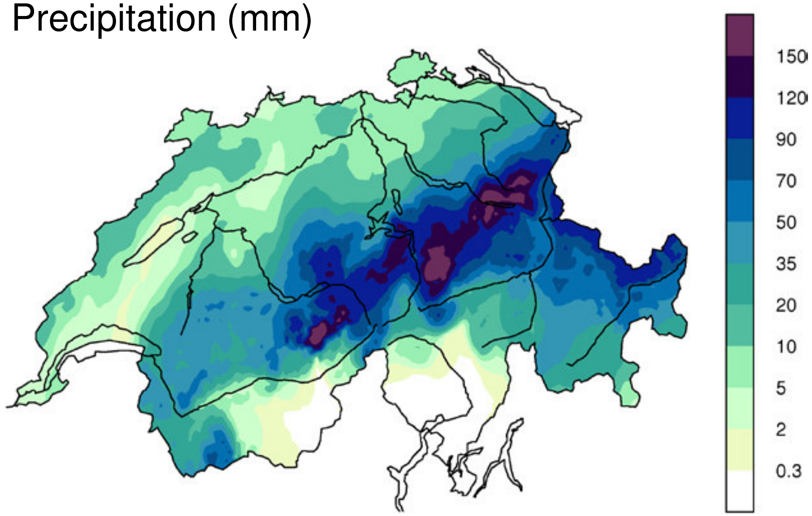
Methods depend on intended application

Individual balance between method and data

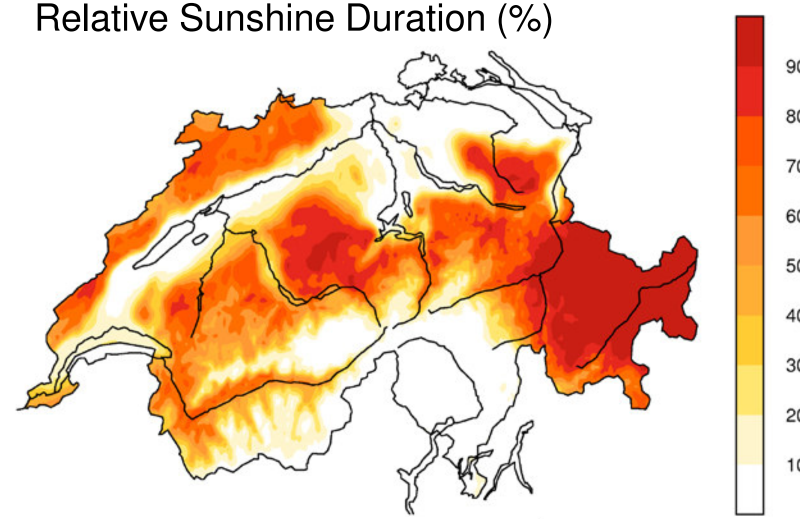
Limitations / uncertainties are openly cummunicated

The MCH Grid-Data Suite

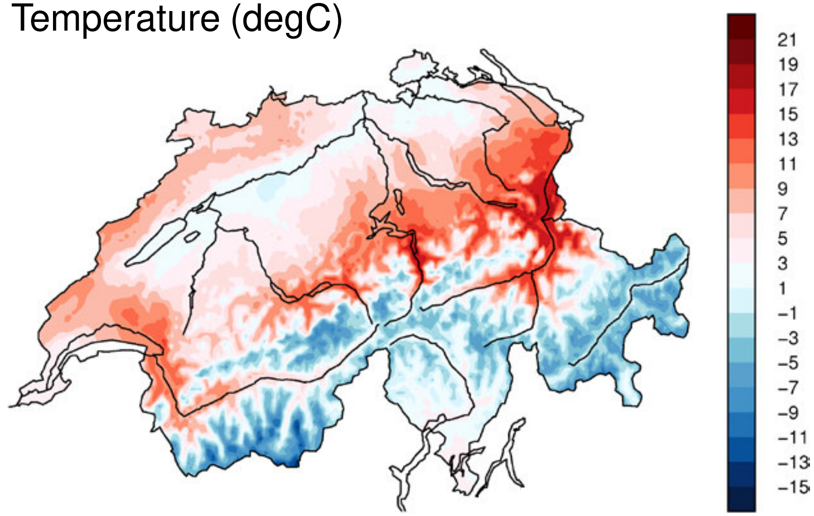
Precipitation (mm)



Relative Sunshine Duration (%)



Temperature (degC)



~ 40 products,

Temp (m, n, x), Precip, Sun, Radiation

territory of Switzerland, 2 km

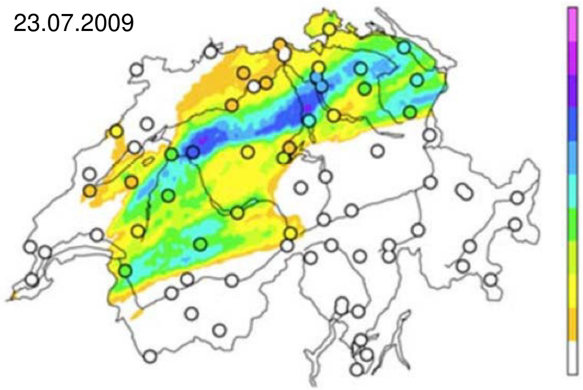
norm, monthly, daily, (hourly), anomaly

1961-actual, 2004-actual (radar-gauge)

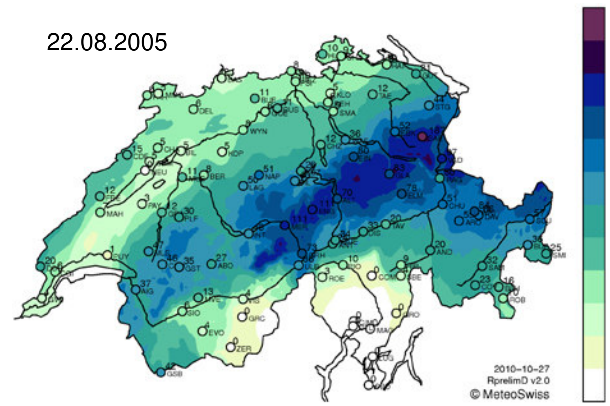
automatic production and delivery

web, reports

Precipitation – Products

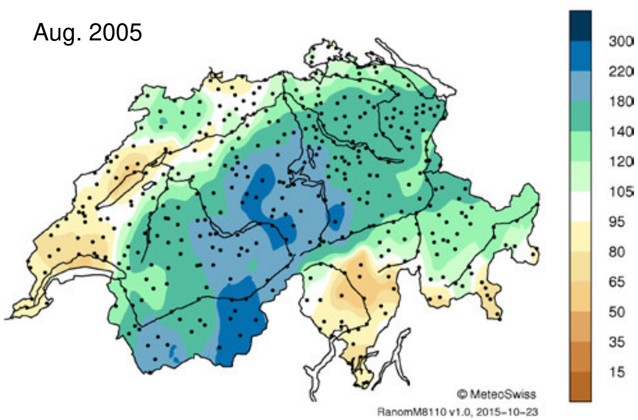


Real-time (hourly)
Radar-Gauge combination, t-KED
Erdin et al. 2012, Sideris et al. 2014

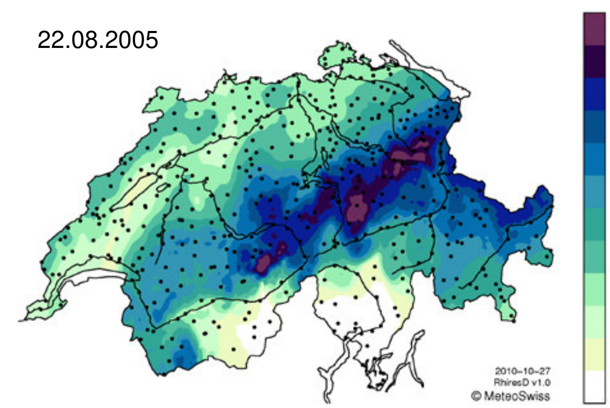


Real-time (daily)
Statistical reconstruction (RSOI)
Schiemann et al. 2012

-> talk by Francesco on Friday

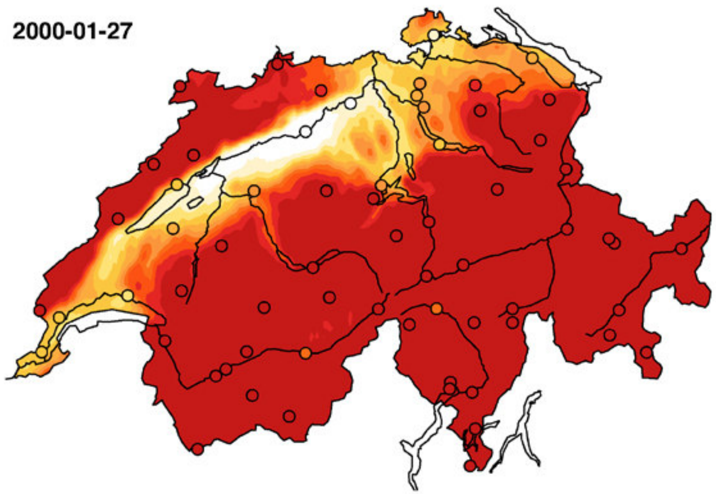


Anomaly wrt Norm
>1960, SYMAP
Shepard 1984, Frei et al. 1998



High-resolution (daily, monthly, ...)
PRISM & SYMAP
Schwarb et al. 2001, Frei et al. 1998, 2004

Relative Sunshine Duration



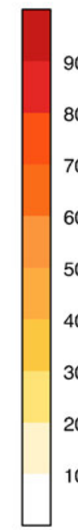
High-resolution SSD

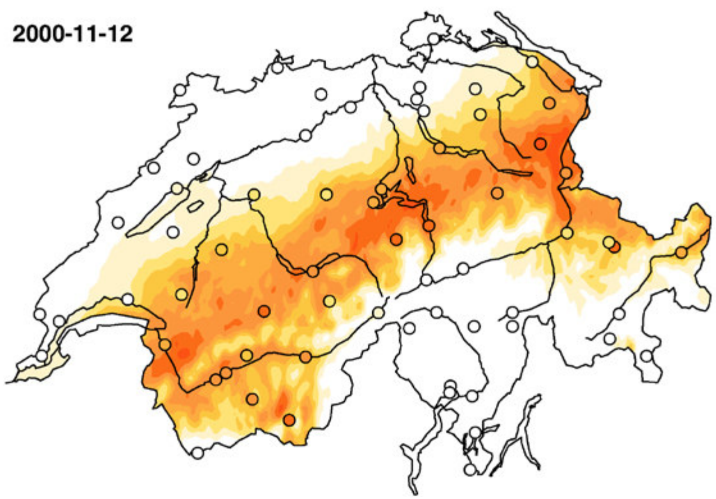
Merging satellite (MSG Clear-sky index)

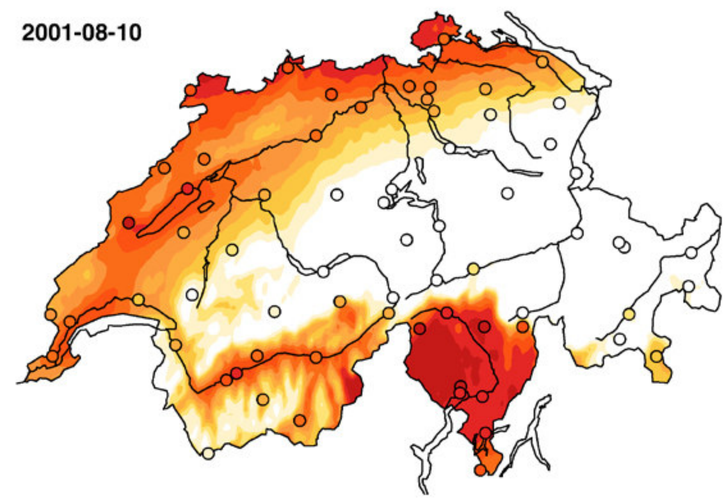
and in-situ data (Heliometer, ~75 stations)

Non-contemporaneous, PCA & KED

Frei et al. 2015, Stöckli 2013



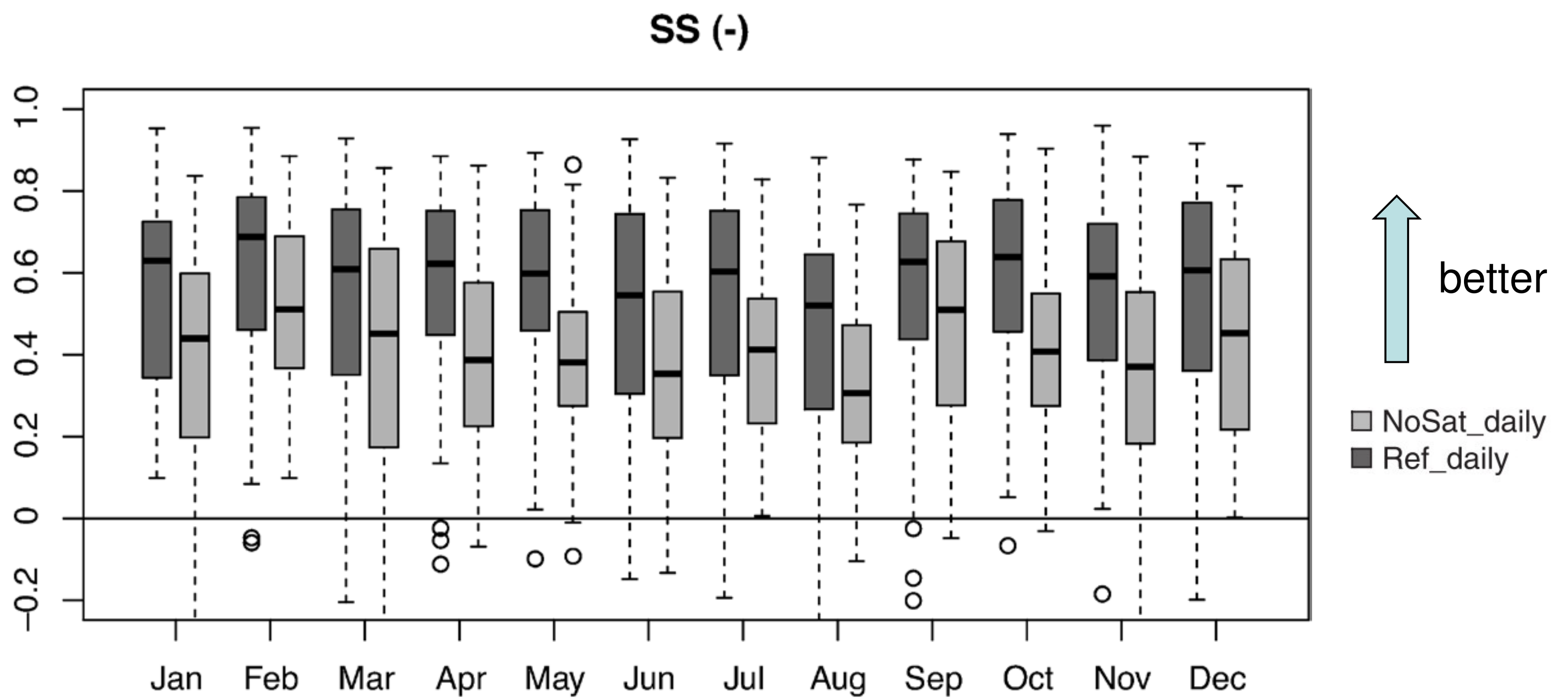




Frei et al. 2015

Relative Sunshine Duration

SS : Fraction of explained spatial variance
(spatial Nash-Sutcliffe efficiency)

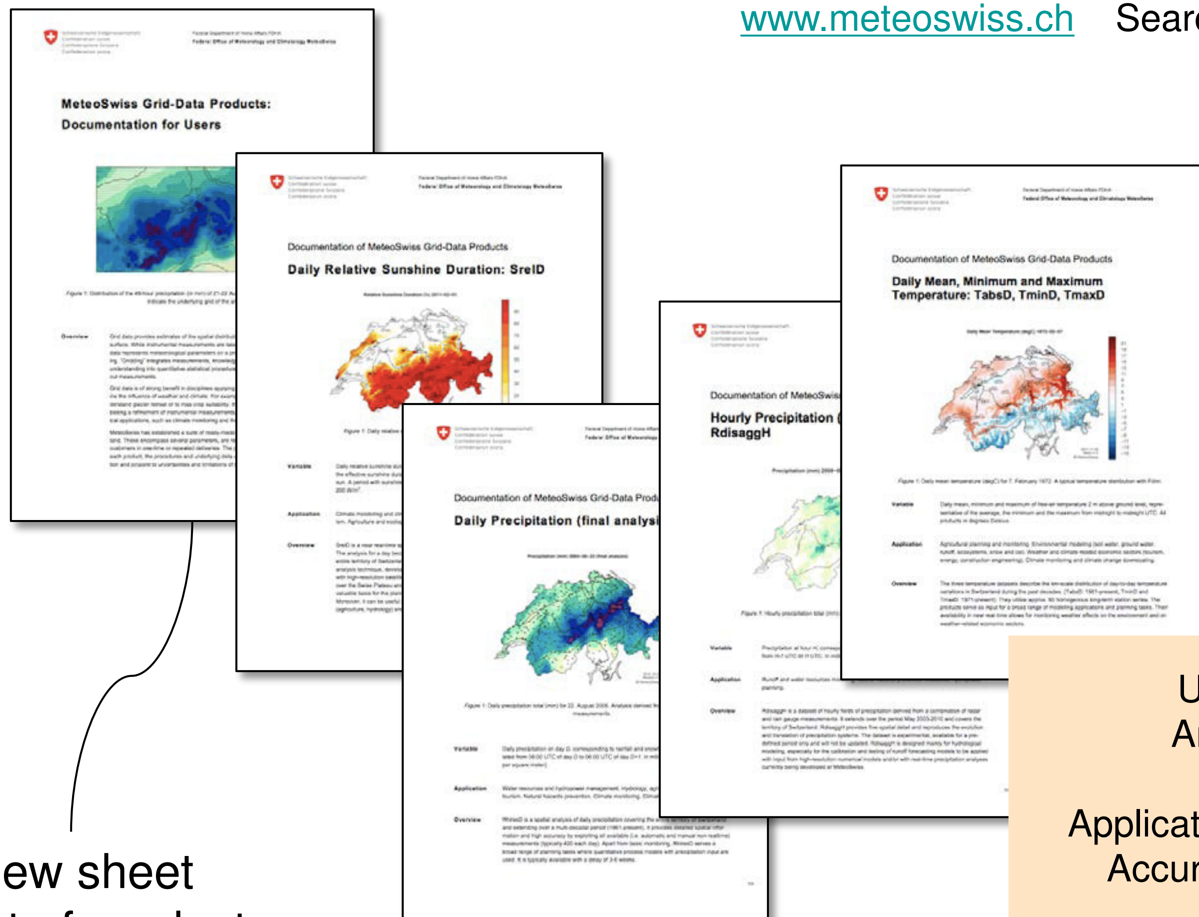


Leave-one-out crossvalidation all days 1998-2001

Frei et al. 2015

Documentation for Users

www.meteoswiss.ch   Search for „Gitterdaten“



Overview sheet
with list of products

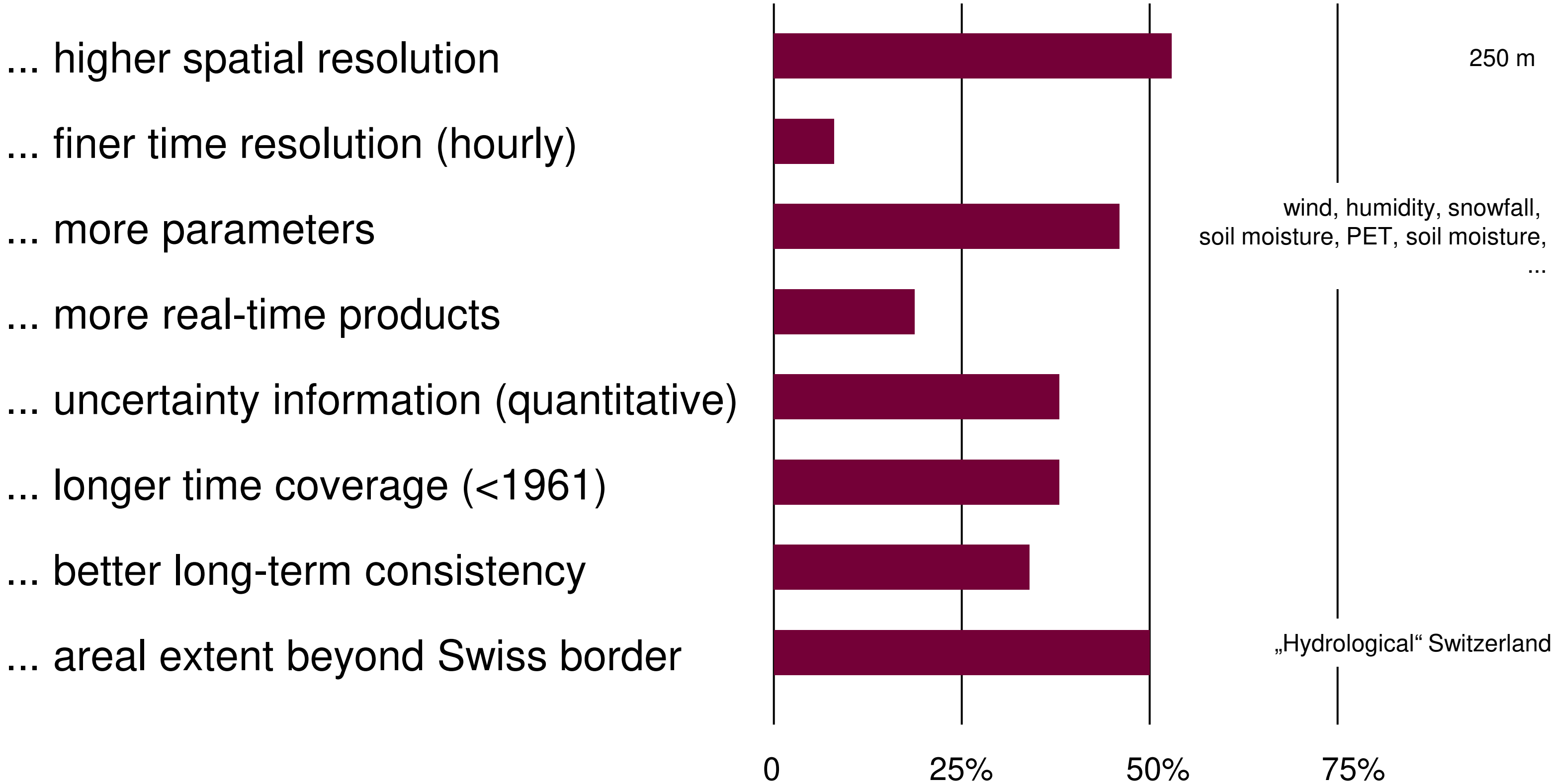
Underlying data
Analysis method

Applications and target users
Accuracy and limitations

Grid structures
Update cycle
Versions

User Wishes (2013)

Your applications could benefit from new products/developments with priority on ...



Number of responses: 26

Our Experience

- “High quality” = USEFUL. Meeting the requirements of applications.
- Requirements are diverse. Products tailored for applications.
- There is not “a best method”.
- Users need to grapple with requirements and specifications. User-friendly product information.
- Be honest about limitations.
- Improving through collaboration. Bridging producer – user gap.
- “High-quality climate services” is about sharing thought, not just data.

Publications

Erdin, R., C. Frei, and H. R. Künsch, 2012: Data transformation and uncertainty in geostatistical combination of radar and rain gauges. J. Hydrometeorol., 13, 1332–1346, doi:10.1175/JHM-D-11-096.1.

Frei, C., 2014: Interpolation of temperature in a mountainous region using nonlinear profiles and non-Euclidean distances. Int. J. Climatol., 34, 1585–1605, doi:10.1002/joc.3786.

Frei, C., M. Willi, R. Stöckli, and B. Dürr, 2015: Spatial analysis of sunshine duration in complex terrain by non-contemporaneous combination of station and satellite data. Int. J. Clim., doi:10.1002/joc.4322.

Hiebl, J., and C. Frei, 2015: Daily temperature grids for Austria since 1961 - concept, creation and applicability. Theor. Appl. Clim., doi:10.1007/s00704-015-1411-4.

Isotta, F. A. and Coauthors, 2014: The climate of daily precipitation in the Alps: Development and analysis of a high-resolution grid dataset from pan-Alpine rain-gauge data. Int. J. Clim., 34, 1657–1675, doi:10.1002/joc.3794.

Isotta, F. A., R. Vogel, and C. Frei, 2015: Evaluation of European regional reanalyses and downscalings for precipitation in the Alpine region. Meteorol. Z., 24, 15-37.

Masson, D., and C. Frei, 2014: Spatial analysis of precipitation in a high-mountain region: Exploring methods with multi-scale topographic predictors and circulation types. Hydrol. Earth Syst. Sci., 18, 4543–4563, doi:10.5194/hess-18-4543-2014.

Masson, D., and C. Frei, 2015: Long-term variations and trends of mesoscale precipitation in the Alps: Recalculation and update for 1901-2008. Int. J. Clim., (in press).

Vogel, R., 2013: Quantifying the uncertainty of spatial precipitation analyses with radar-gauge observation ensembles. Scientific Report MeteoSwiss, 95, 80 pp.

Willi, M., 2010: Gridding of daily sunshine duration by combination of station and satellite data. Technical Report MeteoSwiss, 232, 89 pp.

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Free access to climate observations from Germany:

An overview of recent activities of DWD's Climate Data Center (CDC)

Frank Kaspar, Andrea Kaiser-Weiss, Elsbeth Penda, Frank Kratzenstein

Deutscher Wetterdienst

Data policy: „Geodatennutzungsverordnung“

- ➔ Since 2014 DWD freely provides a much greater selection of climate data (national and international data).
- ➔ This was possible based on the so-called „Geodatennutzungsverordnung“ (for govermental data).
- ➔ Data is protected by copyright, but may be used without any restrictions, provided that the source is indicated (“Deutscher Wetterdienst”). For details see the “terms_of_use.txt”.
- ➔ Data can be accessed here:

ftp://ftp-cdc.dwd.de/pub/CDC/

CDC FTP-Server (1): Station data

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Index von ftp://ftp-cdc.dwd.de/pub/CDC/

In den übergeordneten Ordner wechseln

Name	Größe	Zuletzt verändert	
Change_log_CDC_ftp.txt	13 KB	15.10.2015	13:30:00
Error_log_CDC_ftp.txt	5 KB	19.08.2015	06:44:00
Liesmich_intro_CDC-FTP.pdf	222 KB	15.10.2015	10:48:00
Liesmich_intro_CDC-FTP.txt	7 KB	15.10.2015	10:48:00
Nutzungsbedingungen_German.pdf	34 KB	30.06.2014	00:00:00
Nutzungsbedingungen_German.txt	2 KB	30.06.2014	00:00:00
Readme_intro_CDC_ftp.pdf	315 KB	15.10.2015	10:50:00
Readme_intro_CDC_ftp.txt	7 KB	15.10.2015	10:50:00
Terms_of_use.pdf	252 KB	02.07.2014	00:00:00
Terms_of_use.txt	3 KB	02.07.2014	00:00:00
derived_germany		06.06.2014	00:00:00
grids_europe		19.06.2015	11:18:00
grids_germany		12.05.2015	08:52:00
help		08.10.2015	17:26:00
observations_germany		19.08.2015	08:58:00
observations_global		23.07.2014	00:00:00
regional_averages_DE		10.07.2014	00:00:00

→ observations_germany: Observations from German stations

CDC FTP-Server (2) Station data

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Index von ftp://ftp-cdc.dwd.de/pub/CDC/observations_germany/

In den übergeordneten Ordner wechseln

Name	Größe	Zuletzt verändert
climate		02.06.2014 20:13:00
phenology		02.06.2014 20:23:00

Observations at German stations

Historical and recent data:

Air temperature, soil temepraturе, pressure, wind (speed and dierction), sunshine duration, cloudiness and radiation

Temporal resolution:

hourly, daily, monthly, long-term (1961-90, 1971-2000, 1981-2010)

Phenology

approx. 1200 active stations where the state of development of selected plants (e.g., apple, birch, snow drops, goose berry, wheat, wine etc) is reported.

Reporting:

Annual and immediate reporters

Remarks on provision of station data

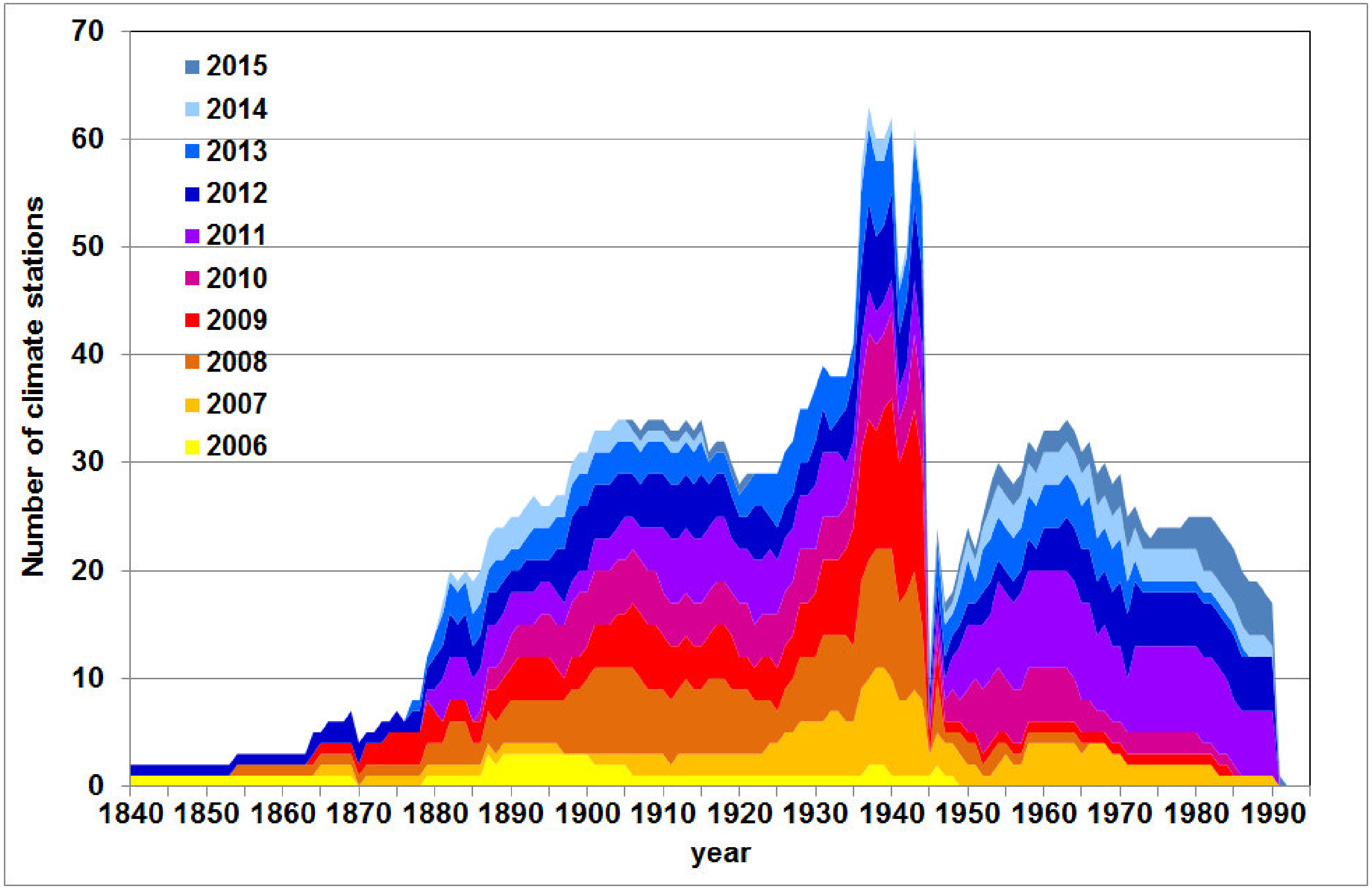
Historic data in the data base might change due to quality control or data rescue activities.

Historic time series on the public server are therefore updated once a year.

‚Recent data' include approx. the data of the last year (until yesterday). These packages are updated daily.

Data rescue

Deutscher Wetterdienst
Wetter und Klima aus einer Hand



Annual number of **climate** stations digitized by the KLIDADIGI project in the period 2006-2015 (colors)

Selected examples of station-related metadata (in German, station ‚Kassel'):

Top: details on daily average wind speed;

Bottom: instrumentation used for precipitation measurements.

Stations_ID	Stationsname	Parameter	Parameter-beschreibung	Einheit	Von_Datum	Bis_Datum	Datenquelle	Zusatz-Info	Besonderheiten	Literaturhinweis
2532	Kassel	FM	Tagesmittel der Windgeschwindigkeit m/s Messnetz 3	m/sec	19540101	19741231	Winddaten (Stundenmittel, maximale Windspitze 00:00-23:59 MEZ) generiert aus analogen Registrierungen. Richtungsangaben in der 32-teiligen Windrose.	arithm.Mittel aus mind. 21 Stundenwerten		
2532	Kassel	FM	Tagesmittel der Windgeschwindigkeit m/s Messnetz 3	m/sec	19750101	19990831	Winddaten (Stundenmittel, maximale Windspitze 00:00-23:59 MEZ) generiert aus analogen Registrierungen. Richtungsangaben in der 36-teiligen Windrose.	arithm.Mittel aus mind. 21 Stundenwerten		
2532	Kassel	FM	Tagesmittel der Windgeschwindigkeit m/s Messnetz 3	m/sec	19980201	20030831	Winddaten (Stundenmittel, maximale Windspitze 23:51-23:50 UTC) generiert aus 10-Minutenmittel von automatischen Stationen der 1.Generation (MIRIAM/AFMS2), Richtungsangaben in 36-teiliger Windrose	arithm.Mittel aus mind. 21 Stundenwerten		
2532	Kassel	FM	Tagesmittel der Windgeschwindigkeit m/s Messnetz 3	m/sec	20011001	20020530	Winddaten (Stundenmittel, maximale Windspitze 23:51-23:50 UTC) generiert aus SYNOP-Meldungen, Richtung als 10-Minutenmittel aus SYNOP-Termin, Richtungsangaben in 36-teiliger Windrose	arithm.Mittel aus mind. 21 Stundenwerten		
2532	Kassel	FM	Tagesmittel der Windgeschwindigkeit m/s Messnetz 3	m/sec	20030901	20131031	Winddaten (Stundenmittel, maximale Windspitze 23:51-23:50 UTC) generiert aus 10-Minutenmittel von automatischen Stationen der 2. Generation (AMDA), Richtungsangaben in 36-teiliger Windrose	arithm.Mittel aus mind. 21 Stundenwerten		

Stationsgeschichte der Geräte für Niederschlagsmessungen

Stations_ID	Stationsname	Geo. Laenge [Grad]	Geo. Breite [Grad]	Stations-hoehe [m]	Von_Datum	Bis_Datum	Geraetetyp Name	Messverfahren
2532	Kassel (West)					30.04.1951	Gerätetyp unbekannt	Niederschlagsmessung, Hellmann
2532	Kassel (West)	9.45	51.31	187	01.05.1951	24.09.1953	Niederschlagsschreiber (unbeheizt)	Niederschlagsmessung, Hellmann
2532	Kassel (West)	9.45	51.31	187	01.05.1951	24.09.1953	Niederschlagsmesser	Niederschlagsmessung, Hellmann
2532	Kassel (Süd)	9.48	51.31	158	25.09.1953	30.09.1969	Niederschlagsschreiber (unbeheizt)	Niederschlagsmessung, Hellmann
2532	Kassel (Süd)	9.48	51.31	158	01.09.1969	19.07.1977	Niederschlagsschreiber (beheizt)	Niederschlagsmessung, Hellmann
2532	Kassel (Süd)	9.48	51.31	158	25.09.1953	19.07.1977	Niederschlagsmesser	Niederschlagsmessung, Hellmann
2532	Kassel	9.44	51.3	231	20.07.1977	19.10.2003	Niederschlagsschreiber (beheizt)	Niederschlagsmessung, Hellmann
2532	Kassel	9.44	51.3	231	20.07.1977	19.10.2003	Niederschlagsmesser	Niederschlagsmessung, Hellmann
2532	Kassel	9.44	51.3	231	18.04.2000	12.07.2006	PLUVIO-OTT	Niederschlagsmessung, Hellmann, elektr.
2532	Kassel	9.44	51.3	231	18.04.2000	12.07.2006	Niederschlagsgeber Kroneis	Niederschlagsmessung, elektr.
2532	Kassel	9.44	51.3	231	01.11.2008	31.10.2013	Laser-Niederschlagsmonitor LNM	Niederschlagsmessung, elektr.
2532	Kassel	9.44	51.3	231	13.07.2006	31.10.2013	Niederschlagsgeber Kroneis	Niederschlagsmessung, elektr.
2532	Kassel	9.44	51.3	231	13.07.2006	02.11.2013	PLUVIO-OTT	Niederschlagsmessung, Hellmann, elektr.

generiert: 22.05.2014 -- Deutscher Wetterdienst --

ftp://ftp-cdc.dwd.de/pub/CDC/observations_germany/climate/daily/kl/historical/

CDC FTP-Server (3) Rasterdaten

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Index von ftp://ftp-cdc.dwd.de/pub/CDC/

In den übergeordneten Ordner wechseln

Name	Größe	Zuletzt verändert	
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Error_log_CDC_ftp.txt	3 KB	20.01.2015	11:10:00
Liesmich_intro_CDC-FTP.pdf	207 KB	22.10.2014	14:02:00
Liesmich_intro_CDC-FTP.txt	7 KB	22.10.2014	14:02:00
Nutzungsbedingungen_German.pdf	34 KB	30.06.2014	00:00:00
Nutzungsbedingungen_German.txt	2 KB	30.06.2014	00:00:00
Readme_intro_CDC_ftp.pdf	333 KB	07.11.2014	14:56:00
Readme_intro_CDC_ftp.txt	6 KB	07.11.2014	15:01:00
Terms_of_use.pdf	252 KB	02.07.2014	00:00:00
Terms_of_use.txt	3 KB	02.07.2014	00:00:00
derived_germany		06.06.2014	00:00:00
grids_germany		26.06.2014	00:00:00
help		04.02.2015	12:05:00
observations_germany		11.02.2015	09:01:00
observations_global		23.07.2014	00:00:00
regional_averages_DE		10.07.2014	00:00:00

Gridded products for Germany

CDC FTP-Server (4) Gridded data for Germany

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Gridded fields covering Germany at different temporal resolutions (not every parameter is given at all resolutions).

Following **precipitation data** are available: *RADOLAN* precipitation fields are derived from radar together with station data (hourly, daily).

REGNIE precipitation fields are derived from precipitation stations only (daily). Precipitation fields derived from climatological stations only are given with monthly resolution.

Soil moisture, soil temperature at 5cm depth, potential and real evaporation are available at daily, monthly, and multi-annual resolution

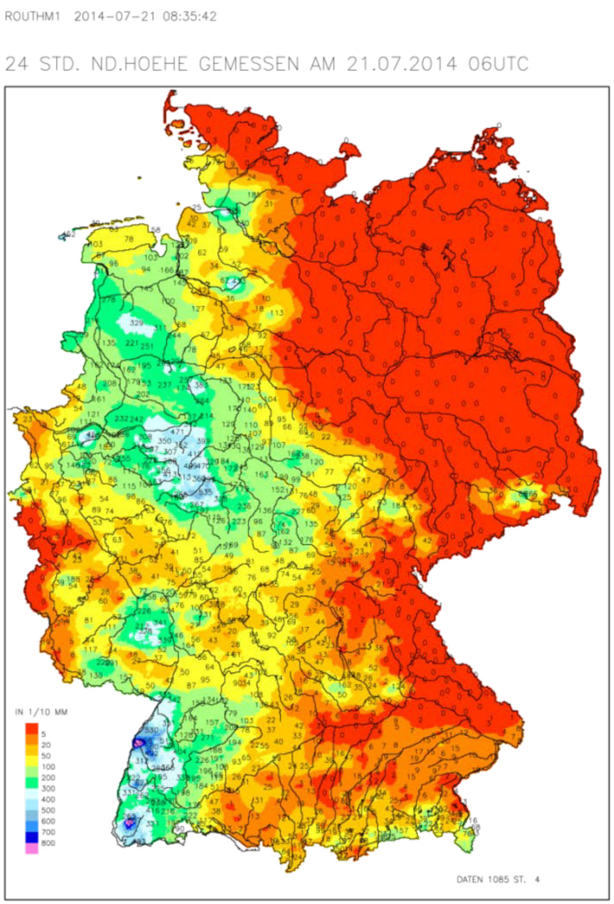
Air temperature (mean, max, min), sunshine duration, drought index, as well as the **numbers of days with snow, frost days, or exceeding certain thresholds for temperature or for precipitation** are given at monthly or multi-annual resolution.

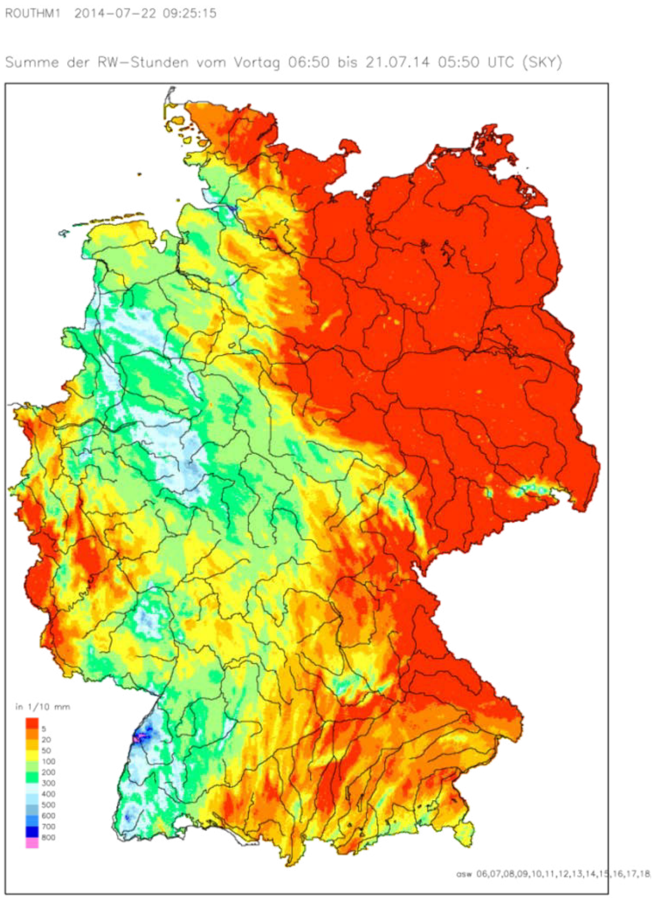
Solar irradiance fields are derived from satellite data and ground-based stations at monthly, annual and multi-annual resolution.

Wind energy related parameters derived from station measurements are given as multi-annual mean.

Examples: gridded daily precipitation products:

Deutscher Wetterdienst
Wetter und Klima aus einer Hand





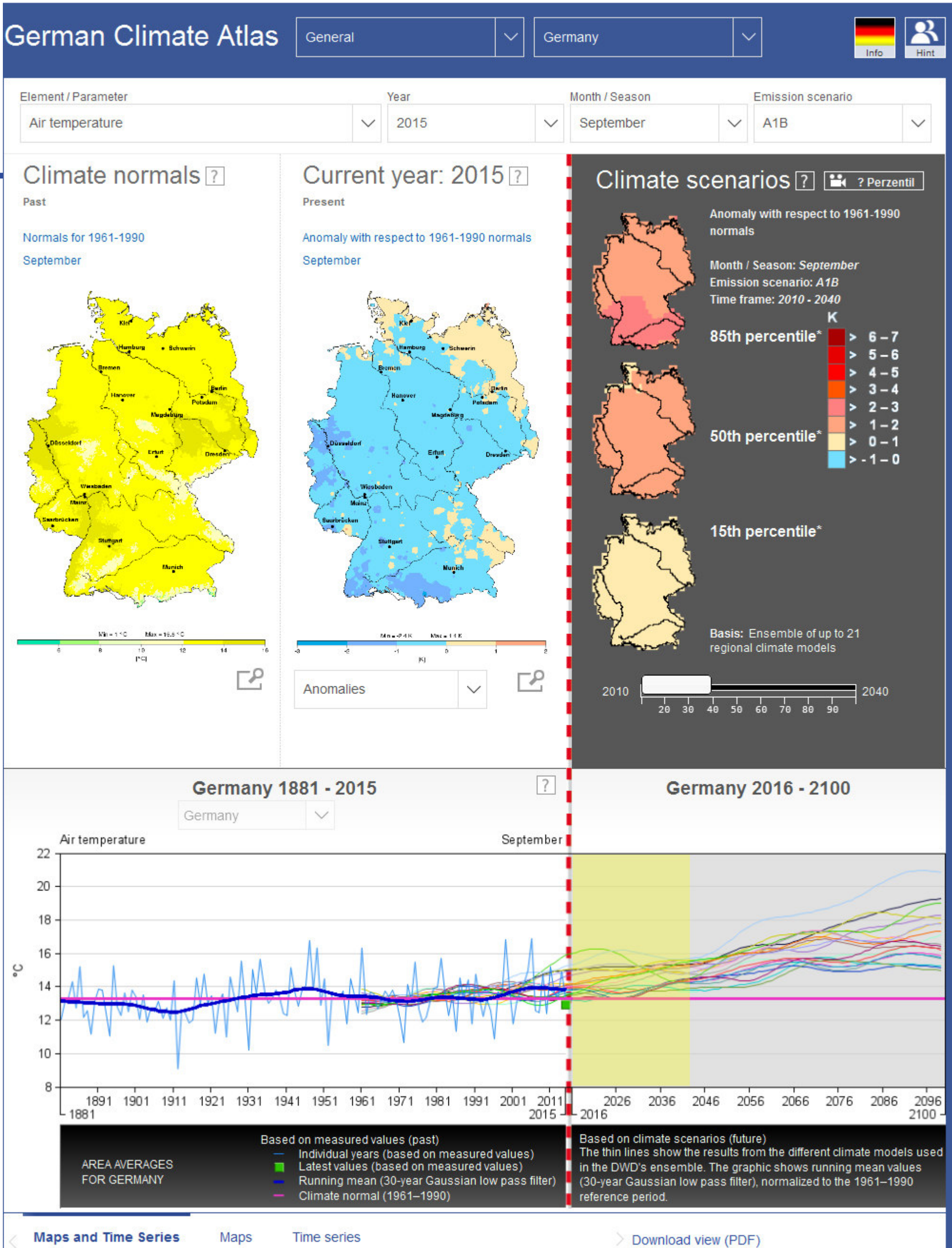
→ *derived from station measurements (REGNIE)* *ftp://*

→ *derived from radar observations combined with station data (RADOLAN).*

ftp://ftp-cdc.dwd.de/pub/CDC/grids_germany/daily/regnie/
ftp://ftp-cdc.dwd.de/pub/CDC/grids_germany/daily/radolan/

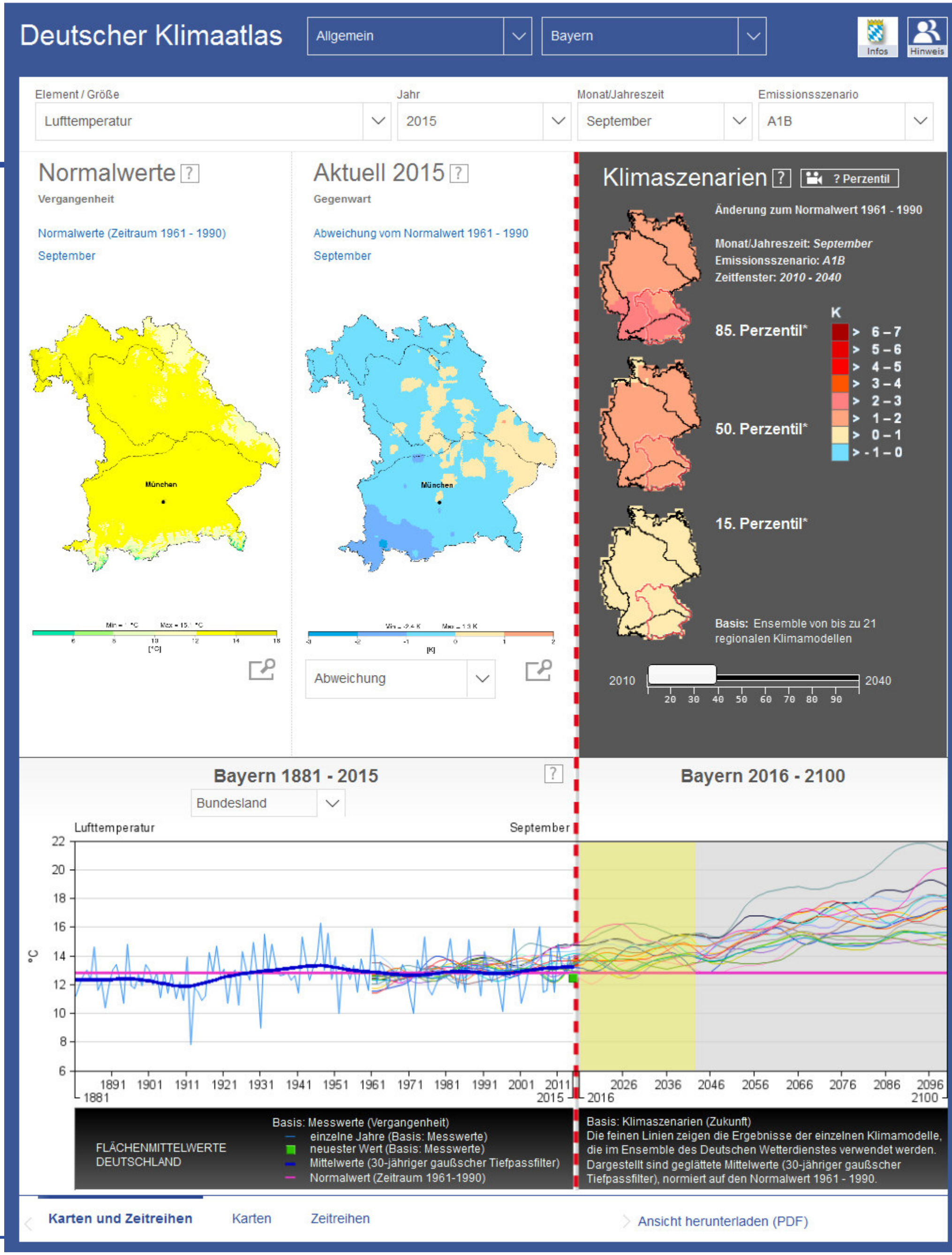
German Climate Atlas

- ➔ Allows visualisation of monthly gridded climate montoring products.



➔ Recent development:

Information for Germany‘s federal states.



CDC FTP-Server (5) Derived data

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

DWD

Index von ftp://ftp-cdc.dwd.de/pub/CDC/

In den übergeordneten Ordner wechseln

Name	Größe	Zuletzt verändert	
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Liesmich_intro_CDC-FTP.txt	6 KB	31.07.2014	16:43:00
Nutzungsbedingungen_German.pdf	34 KB	30.06.2014	19:51:00
Nutzungsbedingungen_German.txt	2 KB	30.06.2014	20:11:00
Readme_intro_CDC_ftp.pdf	327 KB	30.06.2014	21:16:00
Readme_intro_CDC_ftp.txt	5 KB	30.06.2014	21:16:00
Terms_of_use.pdf	252 KB	02.07.2014	13:32:00
Terms_of_use.txt	3 KB	02.07.2014	13:32:00
derived_germany		06.06.2014	10:07:00
grids_germany		26.06.2014	16:46:00
help		24.09.2014	10:49:00
observations_germany		09.06.2014	10:58:00
observations_global		23.07.2014	12:36:00
regional_averages_DE		10.07.2014	07:19:00

derived data

Derived parameters at station locations

→ **Soil parameters** include
the potential and real evaporation over grass and sandy clay,
the soil moisture below sand and sandy clay,
the calculated soil temperatures at 5cm, 10cm, 20 cm, 50 cm and 100cm depth below bare soil,
and the maximal frost penetration depth.

Available resolution: daily, monthly and multi-annual. The soil parameters are calculated for about 320 stations since 1991.

Data set descriptions

- ➔ Metadata are provided by the internal experts for each data product (-> Excel)
- ➔ Automatic procedure to generate ‚data set description (PDF).
- ➔ INSPIRE-XMLs for GISC or DOI-registration can also be automatically (and consistently) generated.

www.dwd.de

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

DATA SET DESCRIPTION

Phenological observations of crops from sowing to harvest (immediate reporters)

Version v0.x

Cite data set as: DWD Climate Data Center (CDC): Phenological observations of crops from sowing to harvest (immediate reporters), Version v0.x, 2015.

INTENT OF THE DATASET

This describes the freely available data of the DWD Climate Data Center (CDC). The phenological data are quality controlled and flagged with a quality byte.

POINT OF CONTACT

Deutscher Wetterdienst
CDC - Vertrieb Klima und Umwelt
Frankfurter Straße 135
63067 Offenbach
Tel.: + 49 (0) 69 8062-4400
Fax.: + 49 (0) 69 8062-4499
Mail: klima.vertrieb@dwd.de

DATA DESCRIPTION

Spatial coverage Germany

Temporal coverage 01.01.1979 - current year

Temporal resolution annually

Format(s) Ascii. Each file PH_Sofortmelder* contains the observation of a certain species (e.g., oat), with fixed object_id (e.g., 208). The rows are sorted according to Stations_id, reference year, phase_id. Each row corresponds to one observation. The list with all phenological stations (immediate reporters) and corresponding meta-data can be found here: ftp://ftp-cdc.dwd.de/pub/CDC/help/stations_list_pheno_immediate_reporters.txt .

Parameters permanent grassland, winter wheat, winter rye, winter barley, winter oilseed rape, summer wheat, spring barley, oat, sunflower, maize, potato, beet, fodder beet.

Qualitaetsniveau	see	Quality_flags
Stations_id	see	station list
Referenzjahr		year corresponding to phase
Objekt_id	see	definition crops
Phase_id	see	pheno_phase_id.txt
Eintrittsdatum	date of joining	yyyymmdd
Eintrittsdatum_QB	see	Quality_flags
Jultag	date of observation	year to date

Uncertainties Factors for uncertainties include: (1) change of observer (2) change of plants.

Quality information The Qualitaetsniveau describes the data control. The individual dates are flagged with a quality byte (Ereigniedatum_QB).
Qualitaetsniveau:
1 - only formal control
2 - controled on individual criteria

-1-

Datasets from externally funded activities

- ➔ Gridded products for Europe
- ➔ Homogenized radiosonde data

daily grids temp./wind for Europe 2001-2010

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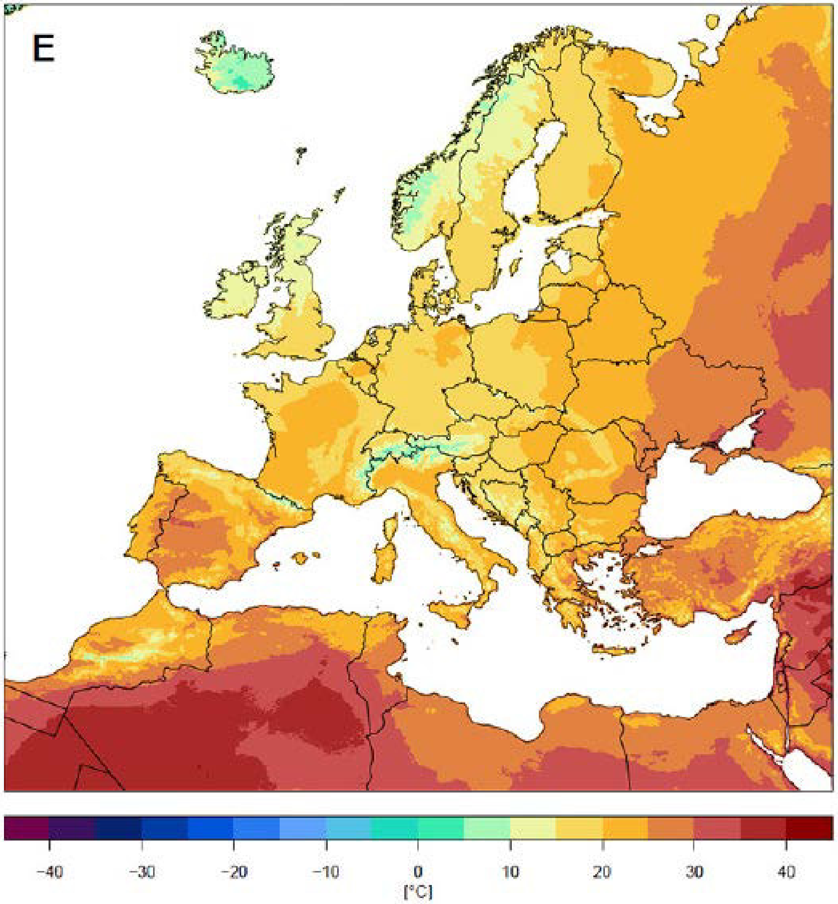
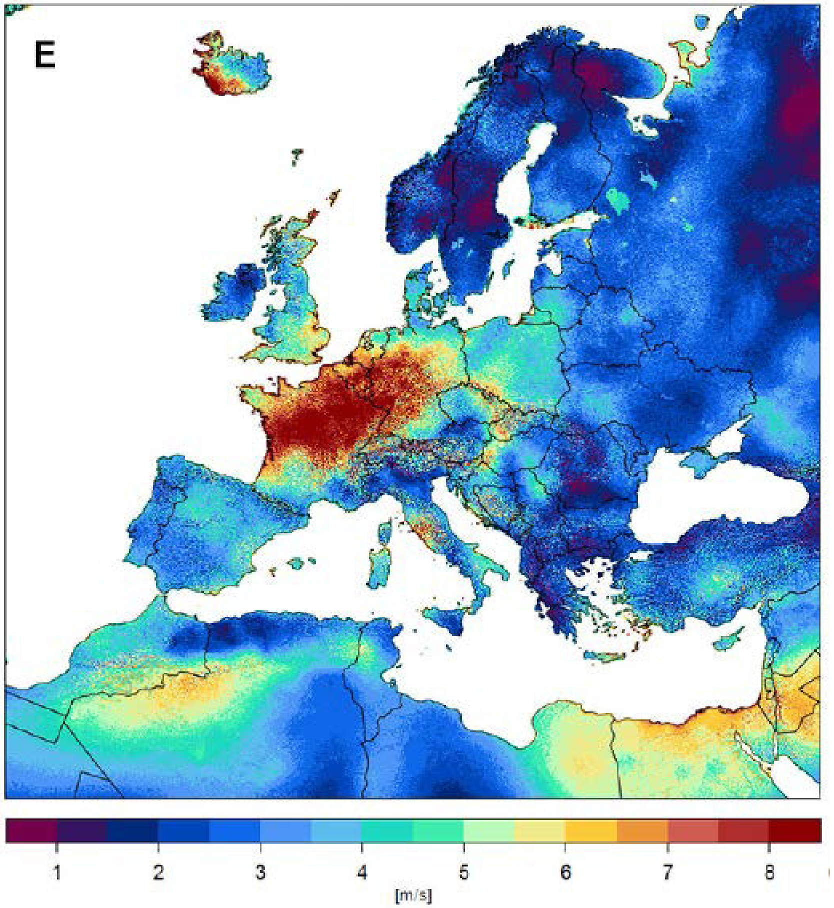


Daily mean temperature 31 July 2010



Daily wind speed 28 February 2010

doi: 10.5676/DWD_CDC/DECREG0110v1

High-resolution daily gridded datasets of air temperature and wind speed for Europe: doi:10.5194/essdd-8-649-2015 (ESSD)

Earth Syst. Sci. Data Discuss., 8, 649–702, 2015
www.earth-syst-sci-data-discuss.net/8/649/2015/
doi:10.5194/essdd-8-649-2015

Open Access Earth System Science Data Discussions

This discussion paper is/has been under review for the journal Earth System Science Data (ESSD). Please refer to the corresponding final paper in ESSD if available.

High-resolution daily gridded datasets of air temperature and wind speed for Europe

S. Brinckmann[1], S. Krähenmann[2], and P. Bissolli[1]

[1]Climate Monitoring, Deutscher Wetterdienst, Frankfurter Strasse 135, 63067 Offenbach, Germany
[2]Central Climate Office, Deutscher Wetterdienst, Frankfurter Strasse 135, 63067 Offenbach, Germany

Received: 30 June 2015 – Accepted: 8 July 2015 – Published: 12 August 2015

Federal Ministry of Transport and Digital Infrastructure

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Homogenized historical German radiosonde measurements (project MOSQUITO/MiKlip)

Always quote citation when using data!

DOI for Scientific and Technical Data
10.5676/DWD_CDC/PAST-RS-H

Title
Homogenized historical German radiosonde measurements (project MOSQUITO/MiKlip)

Citation
Pattantyus-Abraham, Margit: Homogenized historical German radiosonde measurements (project MOSQUITO/MiKlip). Version v001, 2014, DWD Climate Data Center (CDC), DOI:10.5676/DWD_CDC/PAST-RS-H.

Creators
Pattantyus-Abraham, Margit (Deutscher Wetterdienst)

Publisher
DWD Climate Data Center (CDC)

Publication Year
2015

Version
v001

Summary
This homogenized monthly radiosonde data had been prepared within the project MOSQUITO/MiKlip, in order to generate dataset for decadal climate model validation. The data is based on 12 German radiosonde stations. Monthly means are only taken if more than 8 data per month (separately for day-time and night-time soundings) is available. The temporal coverage of the dataset ranges from January 1950 until November 2014.

Summary

Current status:

- ➔ Since last year, DWD significanlty extended free access to climate data
- ➔ These data are currently provided with a FTP-Server
- ➔ Academic users are very enthusiastic about that; others would like to have more interactive access to the data.
- ➔ An interactive portal is currently in preparation („CDC-2.0“)

Extending southeastern Australia's instrumental climate record: data quality and availability 1788–1859

Linden Ashcroft, David Karoly and Joëlle Gergis

10th EUMETNET Data Management Workshop
28 October 2015

SEARCH South Eastern Australian Recent Climate History
THE UNIVERSITY OF MELBOURNE
Centre for Climate Change
UNIVERSITAT ROVIRA I VIRGILI

Why do we need historical climate data?

Context

Ballarat, Victoria, 2000

Susan Gordon-Brown, State Library of Victoria (SLV)

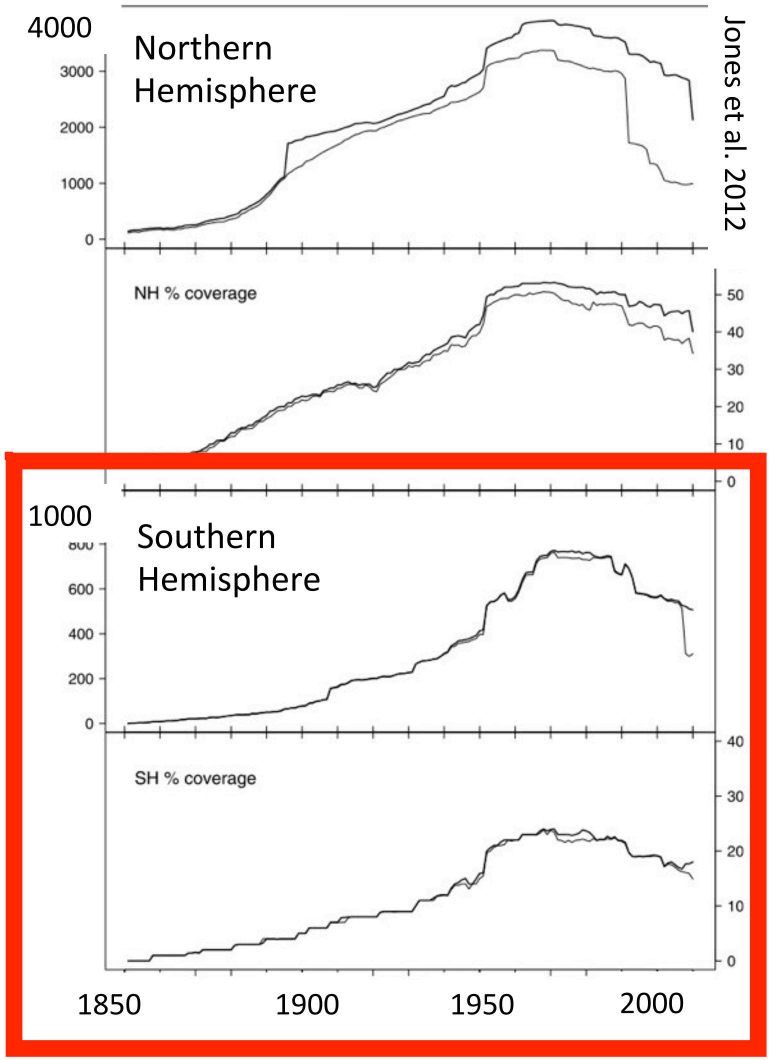
Northern South Australia, 1865

Robert Bruce, SLV

Calibration

University of Wisconsin

Coverage



What exists in Aust. for 1788–1860?

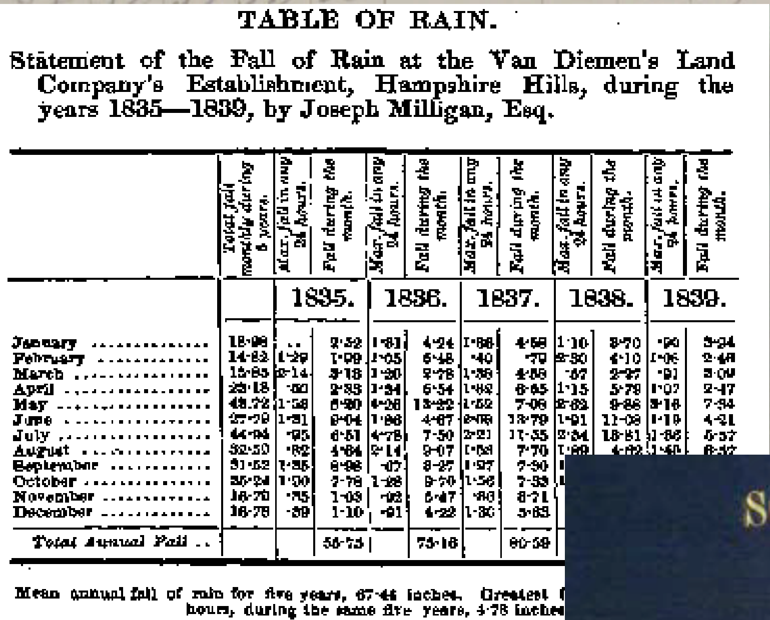
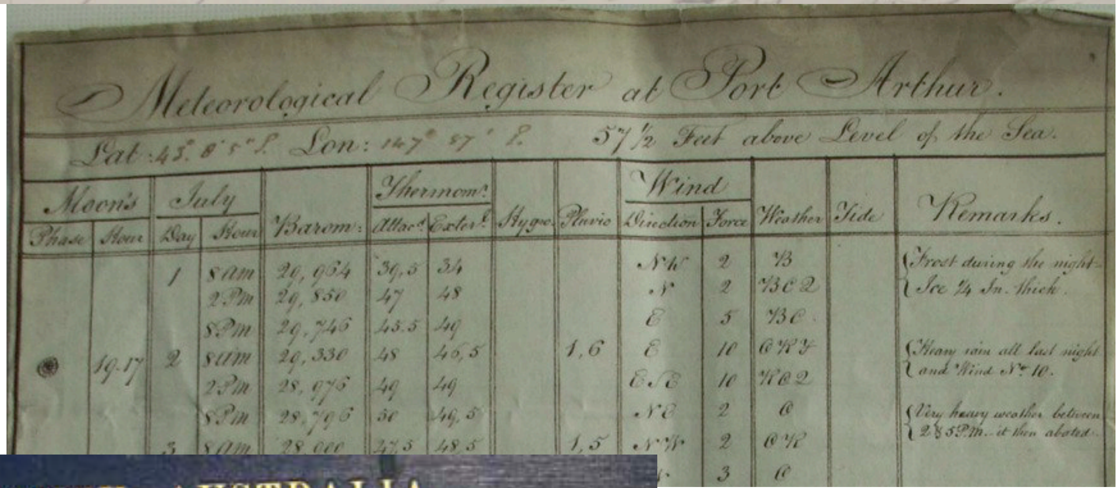


TABLE OF RAIN.

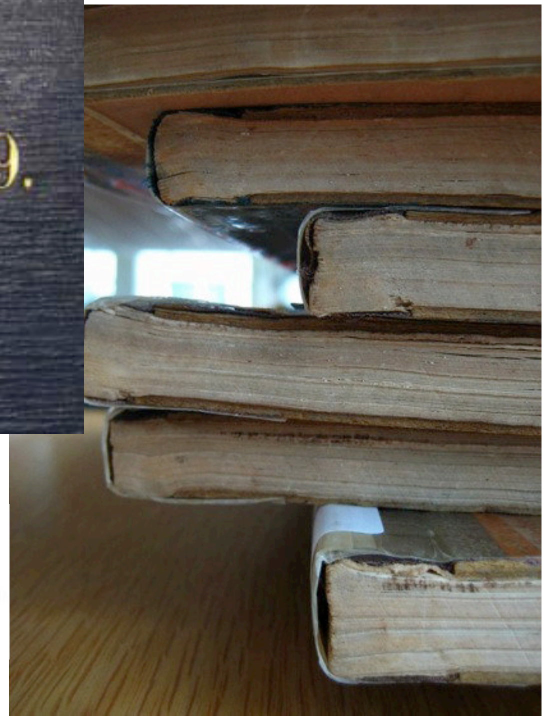
Statement of the Fall of Rain at the Van Diemen's Land Company's Establishment, Hampshire Hills, during the years 1835—1839, by Joseph Milligan, Esq.

	Total fall monthly during 5 years.	1835. Max. fall in any 24 hours.	1835. Fall during the month.	1836. Max. fall in any 24 hours.	1836. Fall during the month.	1837. Max. fall in any 24 hours.	1837. Fall during the month.	1838. Max. fall in any 24 hours.	1838. Fall during the month.	1839. Max. fall in any 24 hours.	1839. Fall during the month.
January	18·98	..	2·52	1·81	4·24	1·86	4·58	1·10	3·70	·90	3·24
February	14·82	1·29	1·99	1·05	6·48	·40	·79	2·50	4·10	1·06	2·48
March	15·85	2·14	3·18	1·20	2·78	1·38	4·88	·67	2·97	·91	3·09
April	25·18	·80	2·35	1·34	6·54	1·42	6·65	1·15	5·78	1·07	2·47
May	48.72	1·58	6·80	4·26	13·22	1·52	7·06	2·82	9·86	3·16	7·34
June	27·79	1·31	2·04	1·86	4·67	2·69	13·79	1·91	11·08	1·19	4·21
July	44·94	·95	6·51	4·78	7·50	2·21	11·35	2·34	13·51	1·86	5·57
August	32·50	·82	4·84	2·14	9·07	1·53	7·70	1·89	4·92	1·40	6·57
September	31·52	1·35	6·98	·07	8·27	1·97	7·30	[illegible]	[illegible]	[illegible]	[illegible]
October	35·24	1·90	7·78	1·28	9·70	1·56	7·33	[illegible]	[illegible]	[illegible]	[illegible]
November	16·70	·75	1·09	·92	6·47	·80	8·71	[illegible]	[illegible]	[illegible]	[illegible]
December	16·78	·39	1·10	·91	4·22	1·30	5·83	[illegible]	[illegible]	[illegible]	[illegible]
Total Annual Fall ..			56·73		75·16		80·59	[illegible]	[illegible]	[illegible]	[illegible]

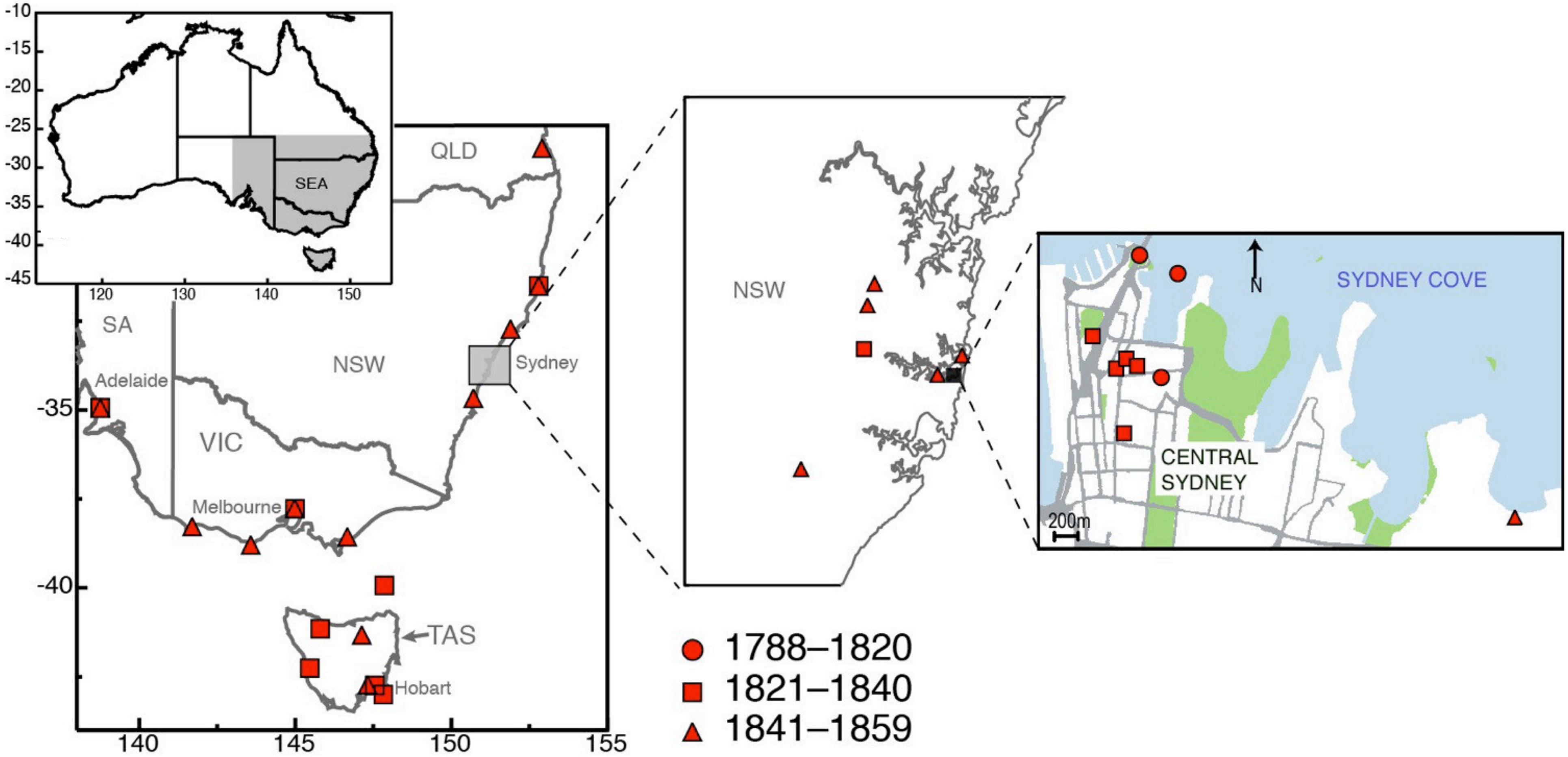
Mean annual fall of rain for five years, 67·46 inches. Greatest [illegible] hours, during the same five years, 4·78 inches



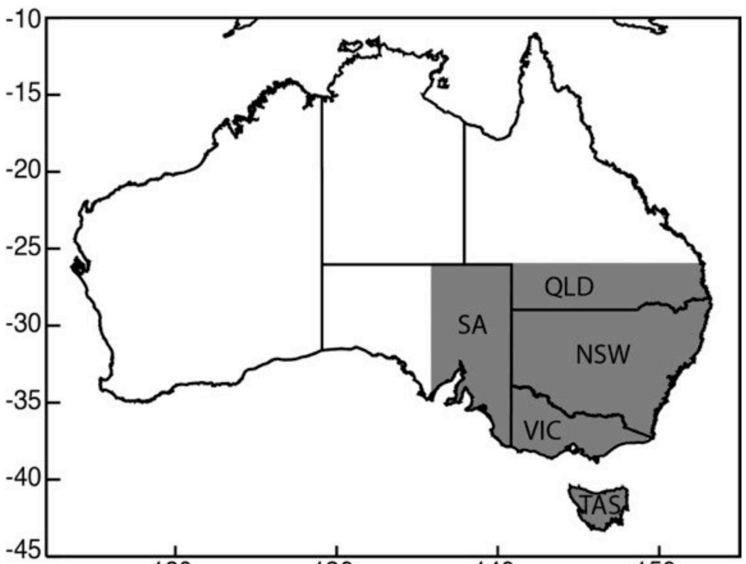
Trove

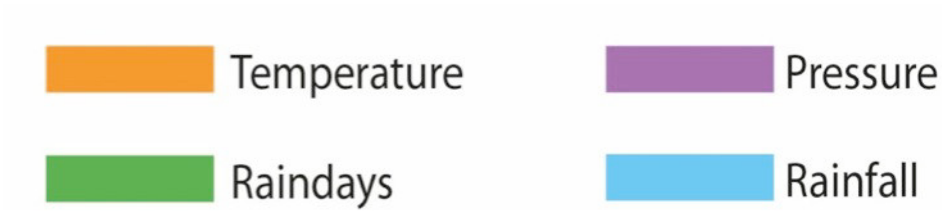


Stations are confined to the coast

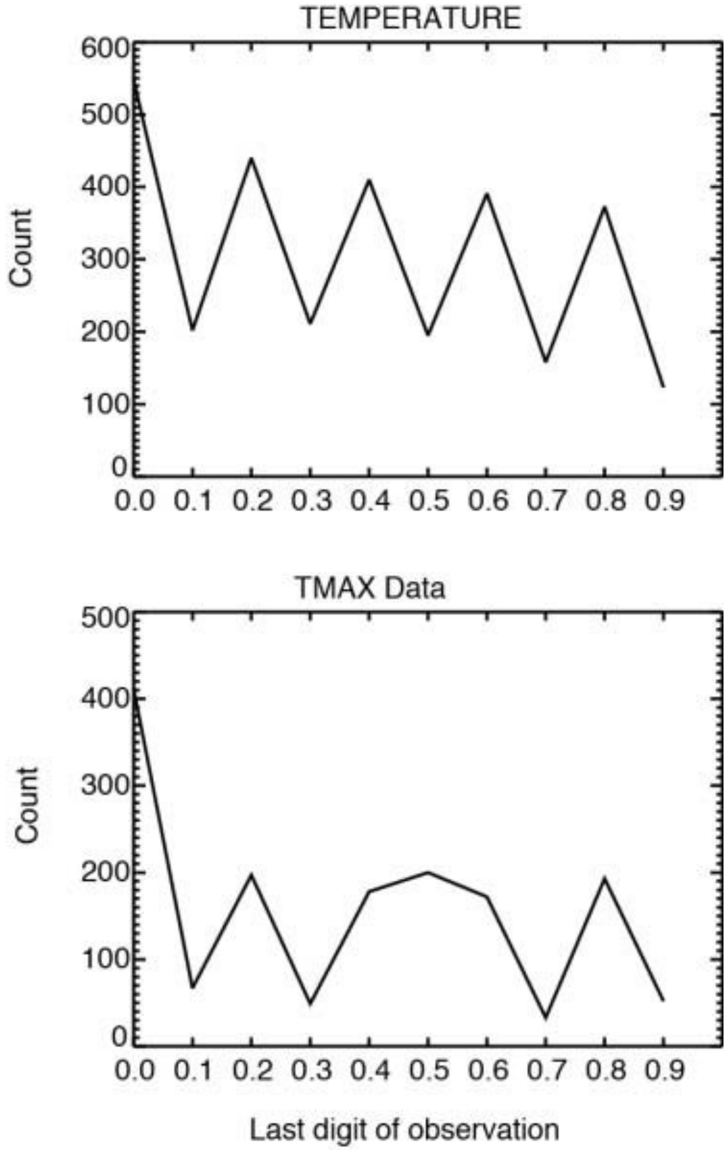


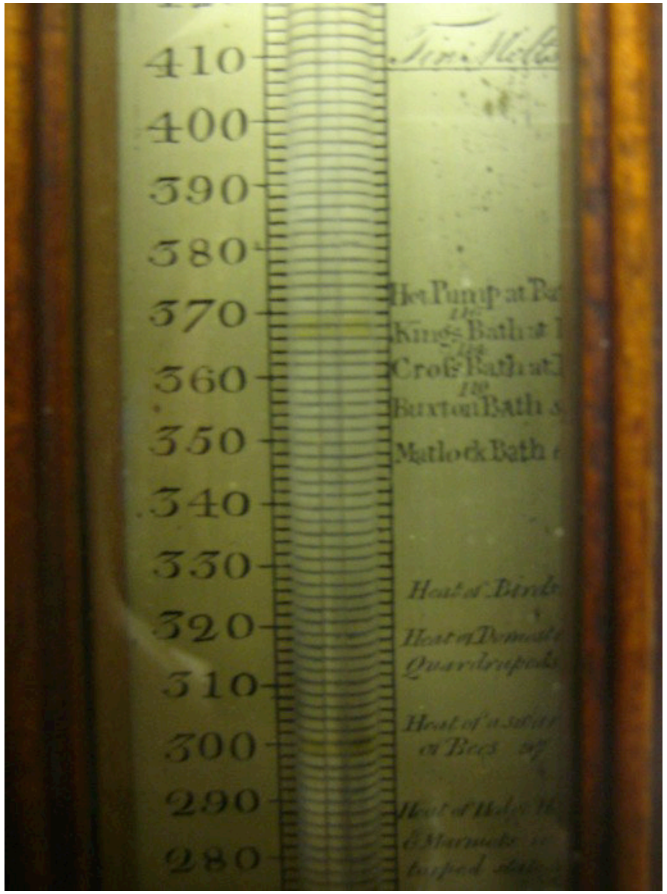
Data are available from 1788!

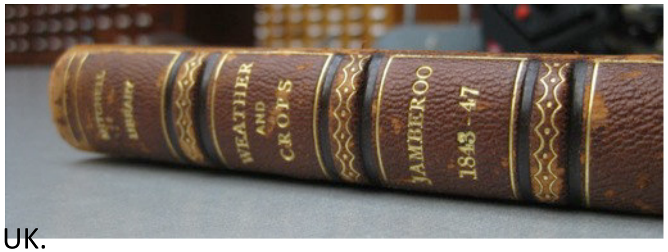


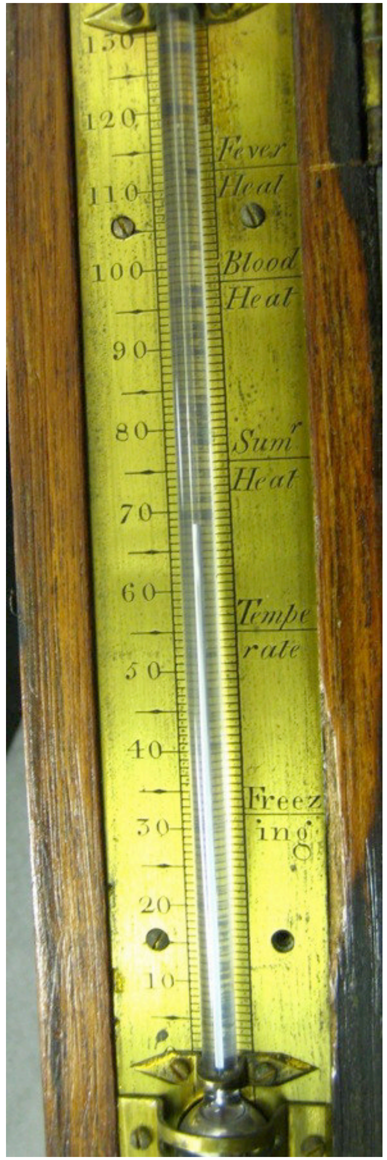


Some observations have biases



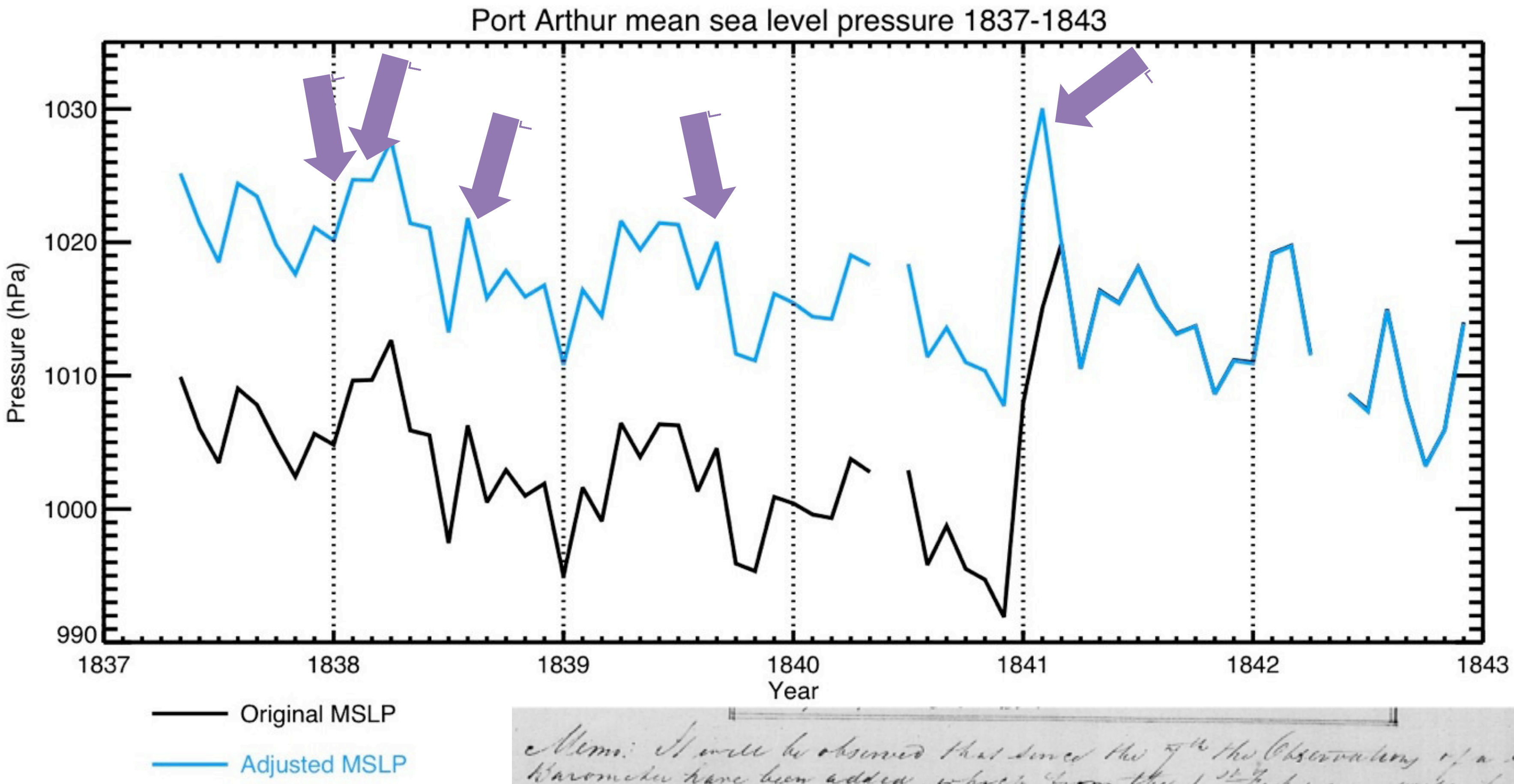


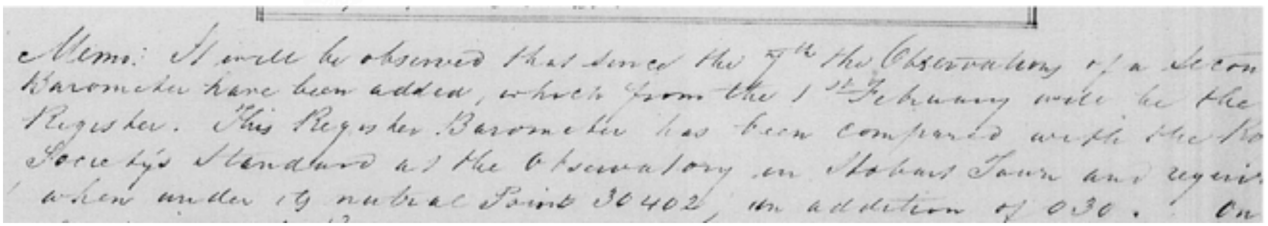




Images used with permission from SLNSW, Science Museum UK.

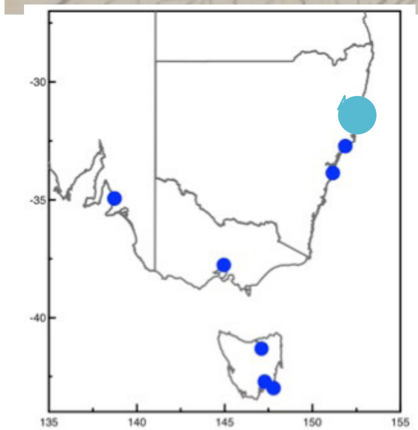
Others have reliability issues

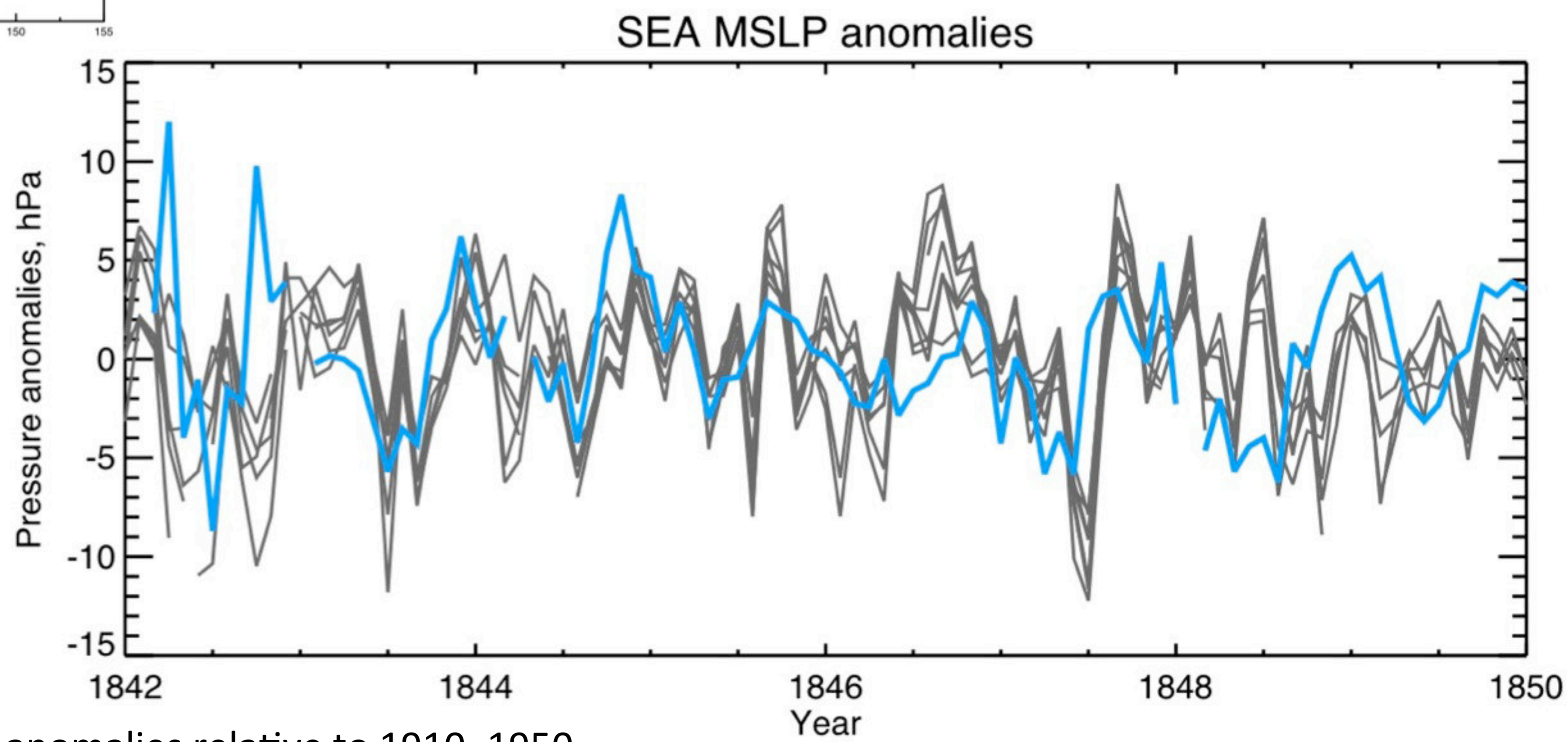




Memo: It will be observed that since the 7th the Observations of a Second Barometer have been added, which from the 1st February will be the Register. This Register Barometer has been compared with the Ro[yal] Society's Standard at the Observatory in Hobart Town and requires when under its neutral Point 30.402, an addition of .030. On

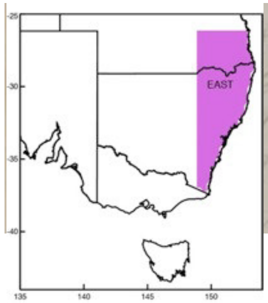
But overall are surprisingly good

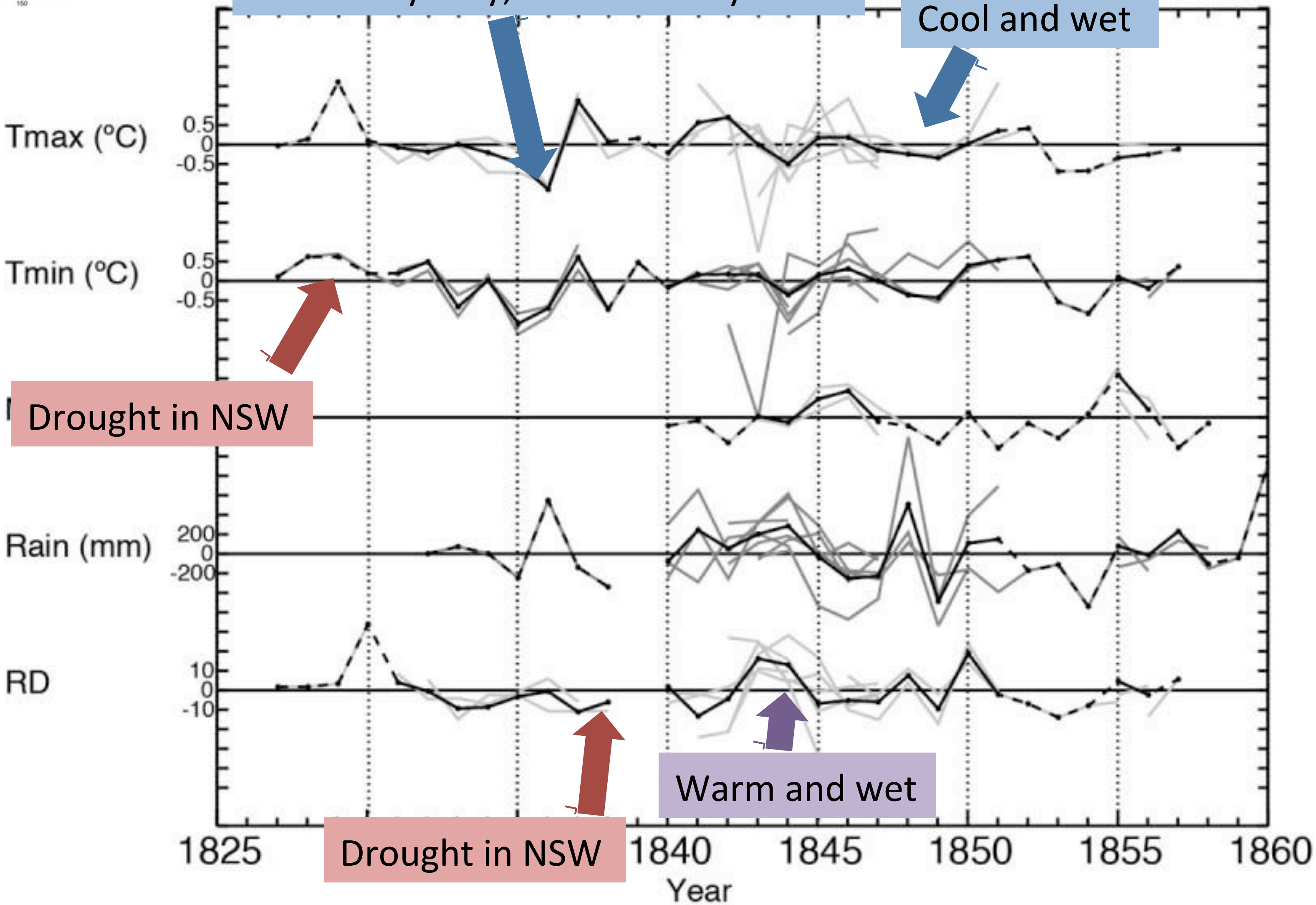




anomalies relative to 1910–1950

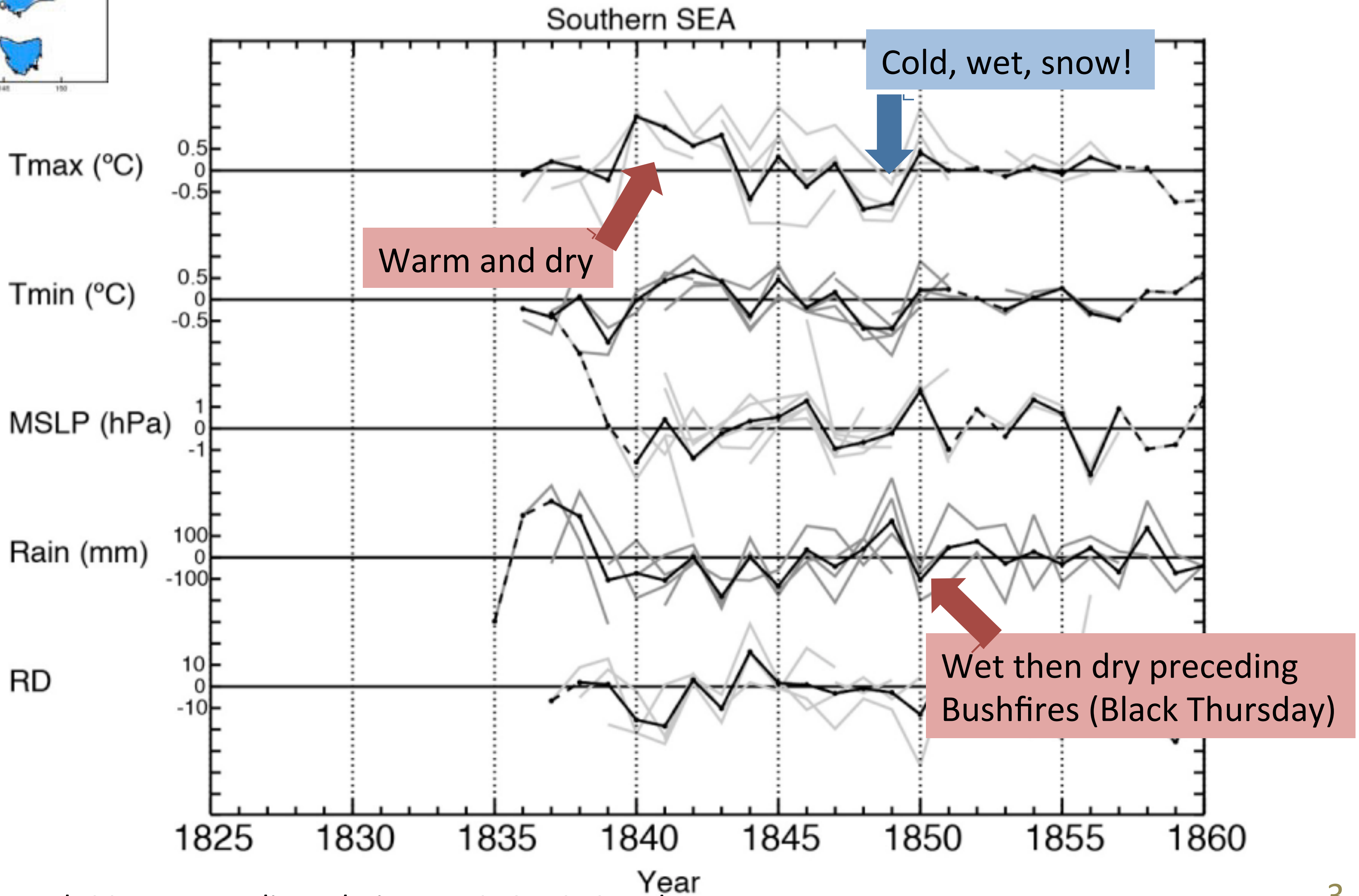
East coast, 1826–1860





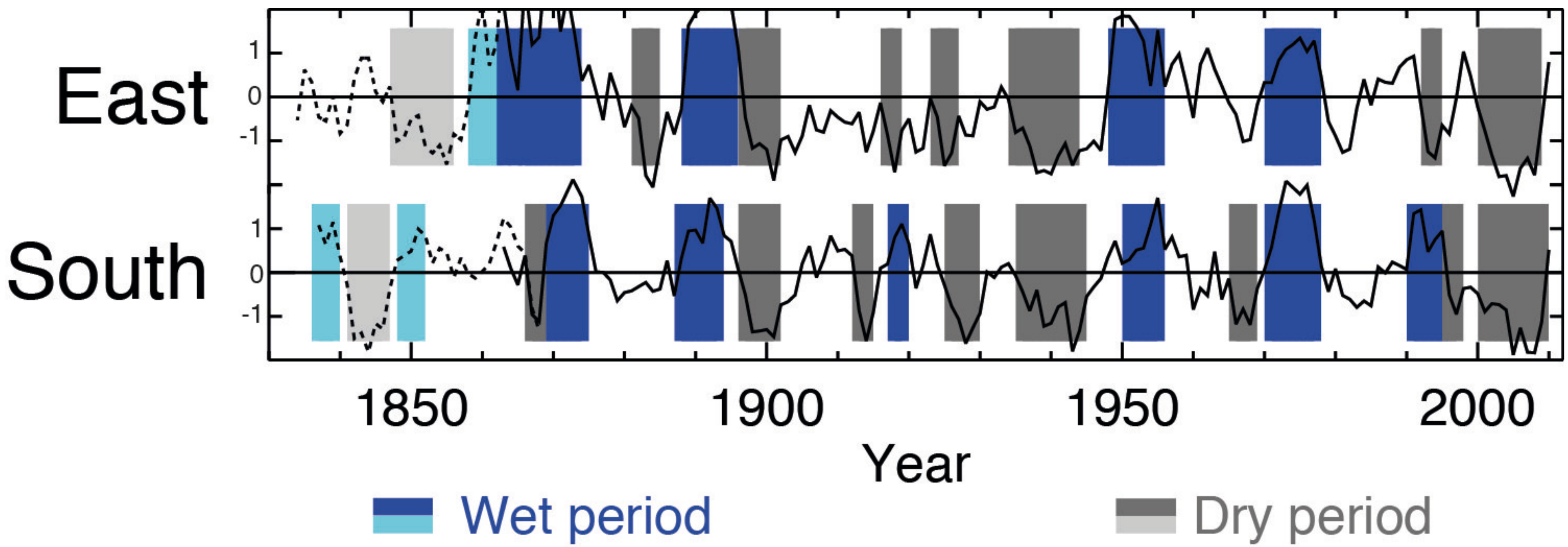
Ashcroft et al. 2014. anomalies relative to 1910–1950 and reset to zero

South, 1825–1860



Ashcroft et al. 2014. anomalies relative to 1910–1950 and reset to zero

Prolonged wet and dry periods, 1835–2012



Ashcroft et al. 2015.

The data are now publicly available

Ashcroft, Gergis and Karoly. 2014. A historical climate dataset for southeastern Australia, 1788–1859. *Geoscience Data Journal*, 1(2): 158–178, DOI: 10.1002/gdj3.19.

Ashcroft, Gergis and Karoly. 2015. Long-term stationarity of El Niño–Southern Oscillation teleconnections in southeastern Australia. *Climate Dynamics*, DOI: 10.1007/s00382-015-2746-3

Conclusions

1. To improve our understanding of past, present and future climate

2. Continuous data back to 1828, patchy observations back to 1788

3. They are good enough to look at year-to-year climate variability

4. Lots!

5. Explore regional and hemispheric teleconnection stability, extreme events, agreement with proxy data, find more data, etc., etc…

Any and all questions welcome!

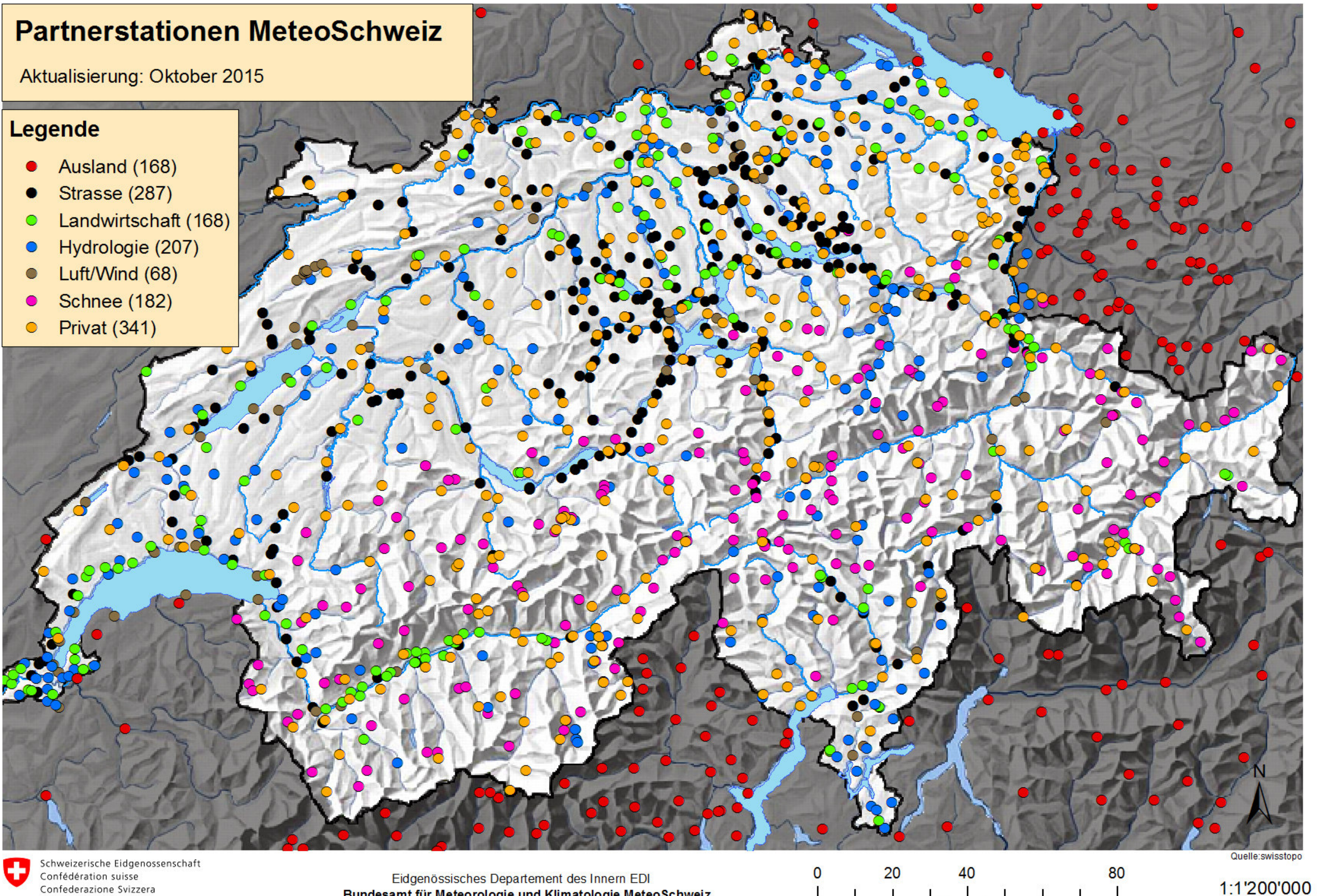
lindenclaire.ashcroft@urv.cat | @lindenashcroft

METEO-Cert: Acceptance Procedure for Automatic Weather Stations

Joël Fisler, Marlen Kube &
Bertrand Calpini (MeteoSwiss)

10th EUMETNET Data Management Workshop

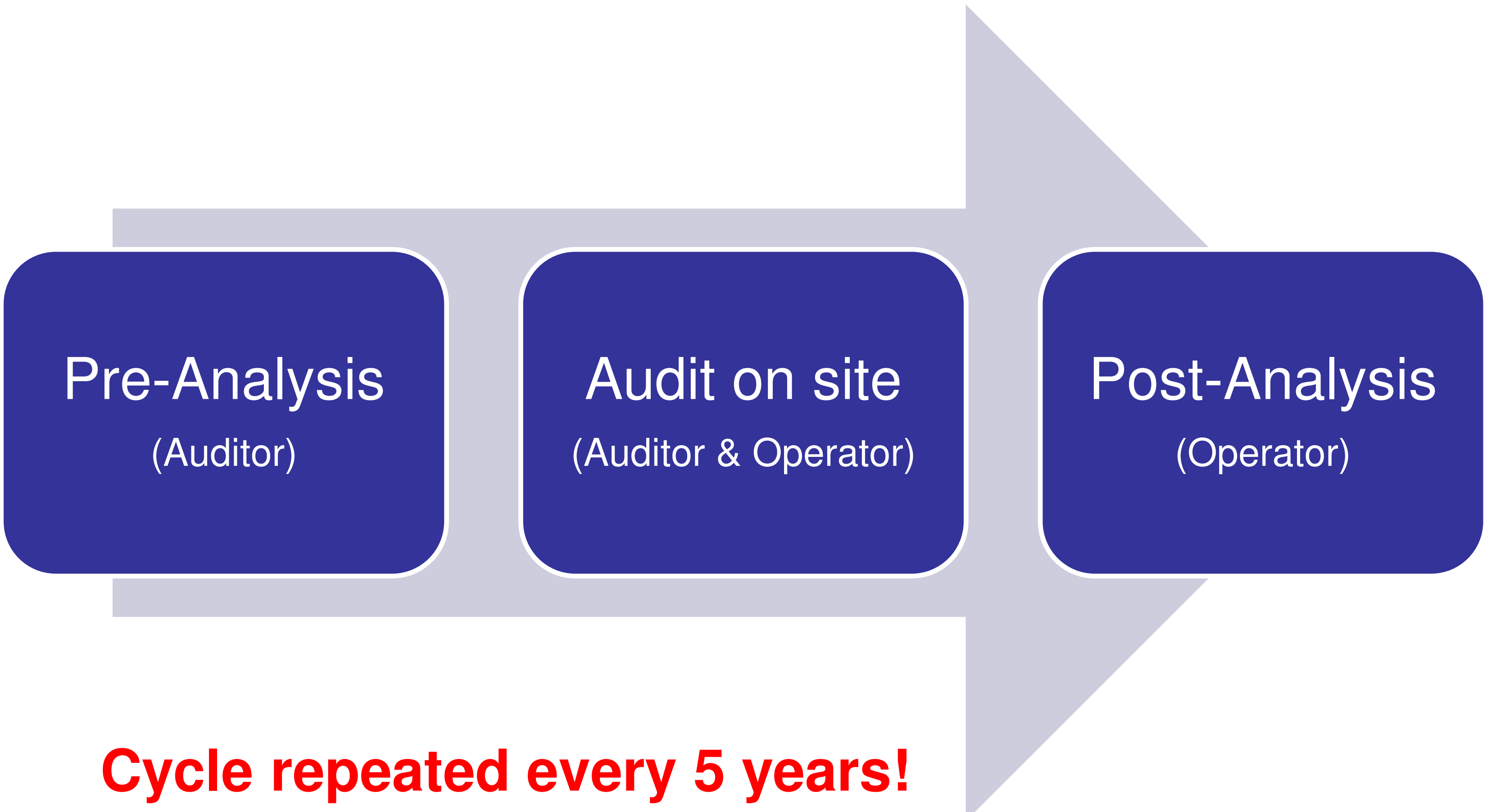
St. Gallen | October 28th 2015



Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Eidgenössisches Departement des Innern EDI
Bundesamt für Meteorologie und Klimatologie MeteoSchweiz

Procedure



Cycle repeated every 5 years!

Auditor = Neutral third-party organization conducting assessment

Quality Labels

Fully compliant
All WMO requirements fulfilled

Compliant
Most requirements fulfilled

Not compliant / Special Site
Some important WMO requirements not fulfilled! Be aware of the limitations and use data with caution.

METEO-Cert: Report

Information about the installed instruments

What assessed instruments are installed?	T, RH , p, Wind, Precipitation, Radiation	
Comments about the station or non-assessed instruments	-	

Temperature and Humidity	Not Compliant	
Sensor	Davis: Vantage Pro2 (6153, with fan)	
Is the sensor correctly ventilated?	Yes	2
Is the sensor protected and weather-proof?	Yes	2
Accuracy of instrument at 20C	0.50 K	1
Accuracy of relative humidity instrument	3.00%	2
Measurement height	2.0 m	2
Is the sensor correctly exposed?	No	0
Leroy site classification	5	0
Station supervision [points]	6	2
Frequency of calibration in lab or replacement? [years]	never	0
Frequency of comparison measurements or controls on site by ope	24 months	2
Frequency of maintenance by Keeper? [week]	2 weeks	2
Is there a parallel measurement with a second instrument?	No	0
Is there automatic data control or monitoring?	Yes	2
Post-Analysis: Effective data availability	96%	2
Post-Analysis: Effective max. downtime of an instrument in 80% of c	3 days	2
Comments	Sensor is between buildings	

Pressure	Compliant	
Sensor	Davis: Vantage Pro2 (6153, with fan)	
Is the sensor protected and weather-proof?	Yes	2
Accuracy of instrument at 20 °C	1.00 hPa	1
Altitude of pressure sensor [m]	705.0 m	
Accuracy of measurement altitude [cm]	100 cm	1
Is the sensor correctly exposed?	Yes	2
Station supervision [points]	3	1
Frequency of calibration in lab or replacement? [years]	never	0
Frequency of comparison measurements or controls on site by ope	24 months	1
Is there a parallel measurement with a second instrument?	No	0
Is there automatic data control or monitoring?	Yes	2
Post-Analysis: Effective data availability	96%	2
Post-Analysis: Effective max. downtime of an instrument in 80% of c	3 days	2
Comments		

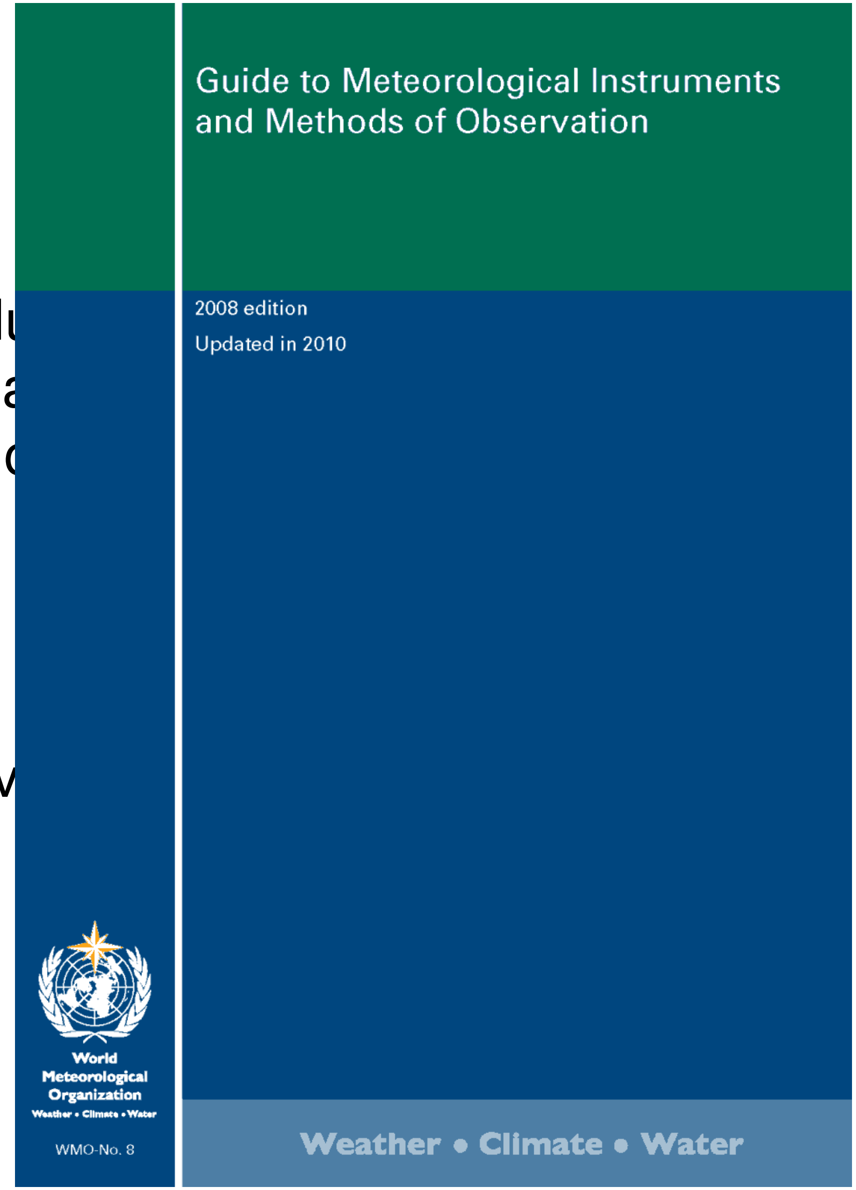
Wind	Not Compliant	
Sensor	Davis: Vantage Pro2 (6153, with fan)	
Accuracy of wind speed instrument [%]	5%	2
Accuracy of wind direction instrument [°]	3.0 °	2
Is instrument heating site-appropriate?	No	1
Does the sensor measure up to 180km/h?	Yes	2
Is the sensor correctly exposed?	No	0
Error dependent on roughness and measurement height	25%	0
Measurement height (from ground)	14.0 m	
Wind class according to Davenport	8	City cer
Leroy site classification	5	0
Station supervision [points]	5	1
Frequency of calibration in lab or replacement? [years]	never	0
Frequency of comparison measurements or controls on site by ope	24 months	1
Frequency of maintenance by Keeper? [week]	4 weeks	2
Is there a parallel measurement with a second instrument?	No	0
Is there automatic data control or monitoring?	Yes	2
Post-Analysis: Effective data availability	96%	2
Post-Analysis: Effective max. downtime of an instrument in 80% of c	3 days	2
Comments	The sensor is on the roof, 2m above the top	

Precipitation	Not Compliant	
Sensor	Davis: Vantage Pro2 (6153, with fan)	
Is instrument designed to work under snow and hail conditions?	No	0
Is instrument heating site-appropriate?	No	0
Is instrument based on tipping-gauge pricinple?	Yes	
Accuracy [%]	4%	2
Collector size	214 mm2	1
Measurement height	2.4 m	1
Is the sensor correctly exposed?	Yes	2
Leroy site classification	4	0
Is the instrument on a roof?	No	2
Station supervision [points]	5	1
Frequency of calibration in lab or replacement? [years]	never	0
Frequency of comparison measurements or controls on site by ope	24 months	1
Frequency of maintenance by Keeper? [week]	2 weeks	2
Is there a parallel measurement with a second instrument?	No	0
Is there automatic data control or monitoring?	Yes	2
Post-Analysis: Effective data availability	96%	2
Post-Analysis: Effective max. downtime of an instrument in 80% of c	3 days	2
Comments	Very close to the house (2.3 m)	

Criteria assessed

The quality of a station is infl
METEO-Cert does take into a
summarized in the following c

1. Instrument
2. Siting and Exposure
3. Maintenance and Observ
4. Post-Analysis



Criteria 1

1. **Instrument**
2. Siting and Exposure
3. Maintenance and Observer
4. Post-Analysis

In order to be «fully compliant» an instrument has to meet all the requirements listed in the CIMO guide including:

- Achievable measurement uncertainty (CIMO Guide, Annex 1D)
- Ventilation
- Heating
- Protection
- and more…

Criteria 2

METEO-Cert includes the following criteria:

- CIMO Siting Classification (CIMO Guide, Annex 1B)
- Measurement Height
- Correct station exposure (CIMO Guide, Annex 1C)
- Rain gauge not mounted on roof
- and more…

Criteria 3

1. Instrument
2. Siting and Exposure
3. **Maintenance and Observer**
4. Post-Analysis

METEO-Cert includes the following criteria:

- How often are instruments calibrated (in lab)
- How often does operator do control measurements on site
- How often is maintenance by warden done
- Is there an automatic data control?
- Is there a parallel measurement?

(At least three criteria should be fulfilled to be fully compliant)

Criteria 4

1. Instrument
2. Siting and Exposure
3. Maintenance and Observer
4. **Post-Analysis**

Using one year of data two criteria are assessed:

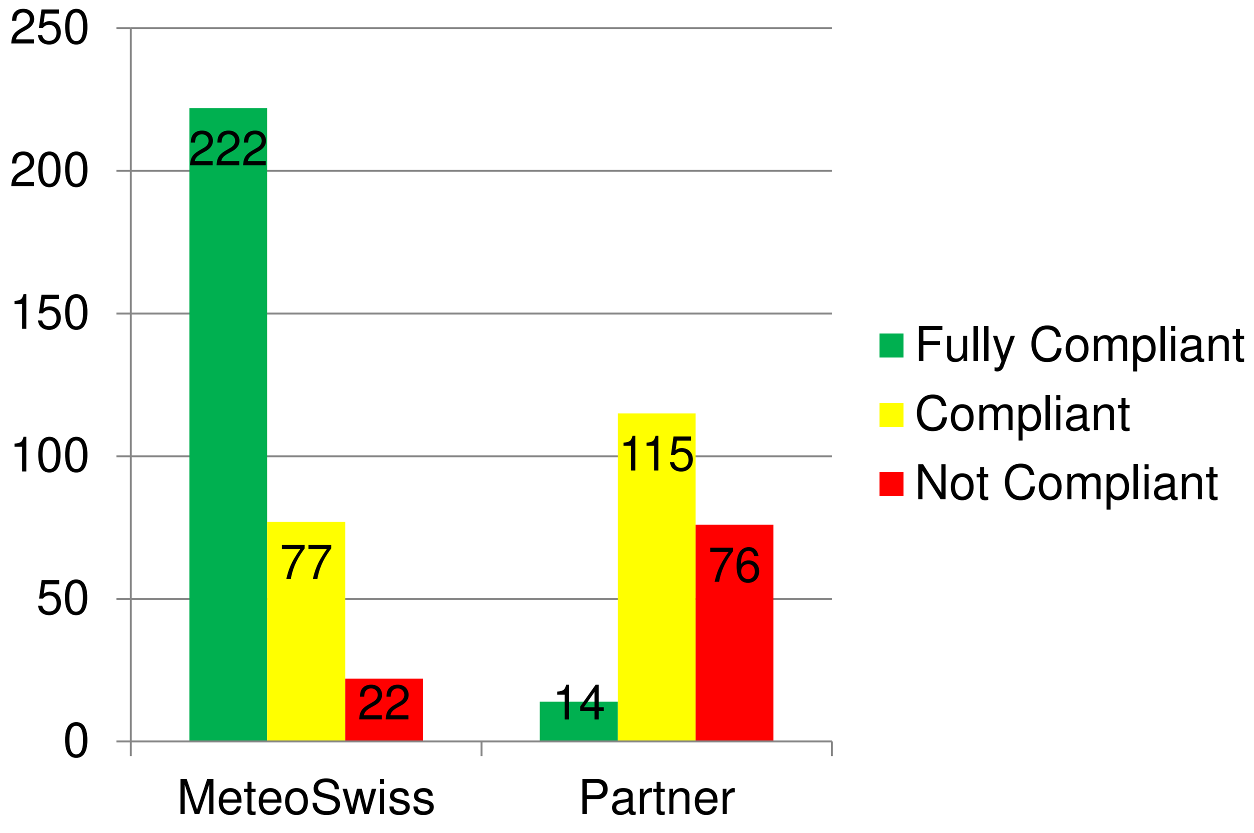
1. Data availability: How complete is the data?
2. Timeliness: How fast is the data delivered?

Results

A total of 526 instruments (mounted on 113 stations) were inspected by METAS from 2013 to July 2015:

Operator	2013	2014	2015	Total
MeteoSwiss	101	148	72	321
Partner	90	102	13	205
				526

Results: Overall for 526 instruments



Example 1 “Not Compliant”: Temperature and Wind at PSI

Example 2 "Not Compliant": Rain, Wind and Radiation in Stabio

Example 3 “Not Compliant”: Temperature at Weissfluhjoch

Example 4 “Fully Compliant”

Conclusions

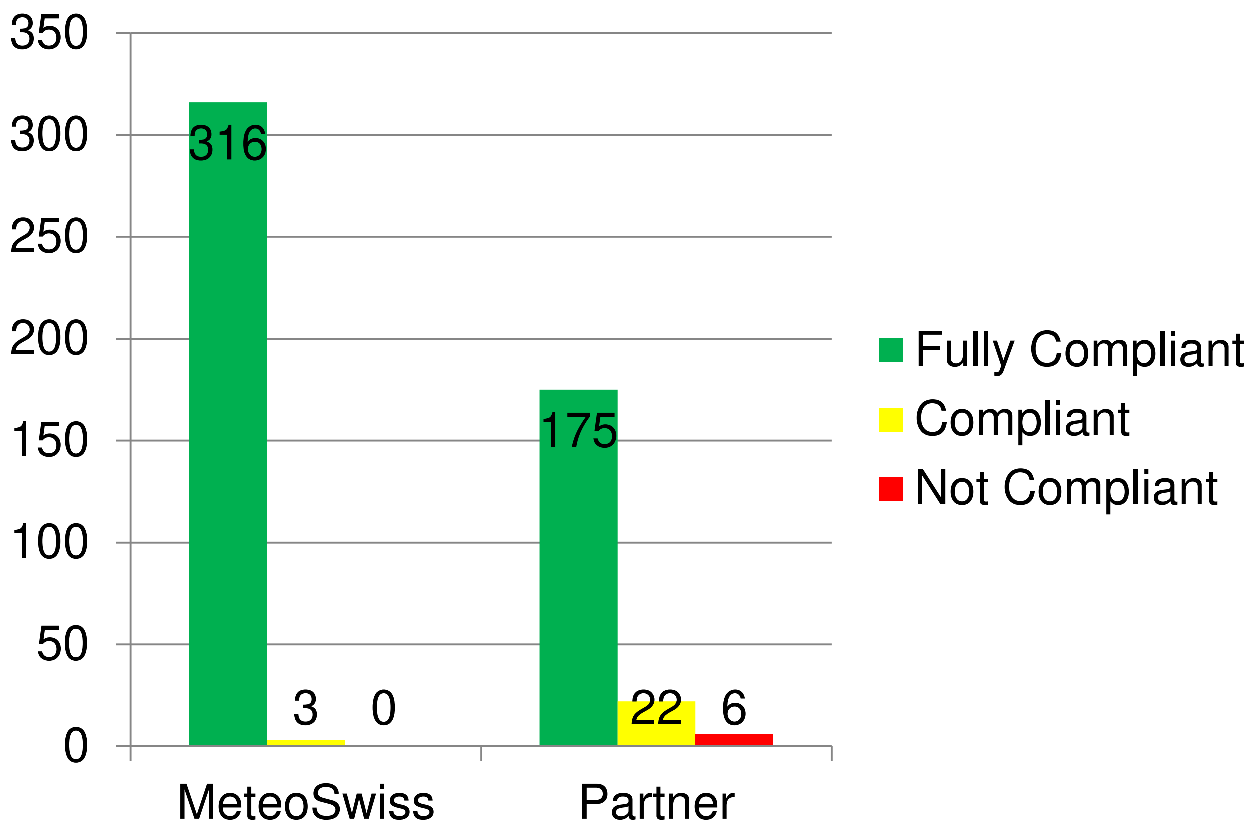
The acceptance procedure METEO-Cert…

- works! → Meaning: It delivers meaningful results
- is objective and reproducible
- led to the improvement/relocation of MeteoGroup stations
- generates metadata that is stored in the MeteoSwiss DataWareHouse (DWH) and can be used by applications
- will be integrated in the MeteoSwiss data retrieve tools
- will be an important source of information for future generations if 5-year-cycle is kept up ☺

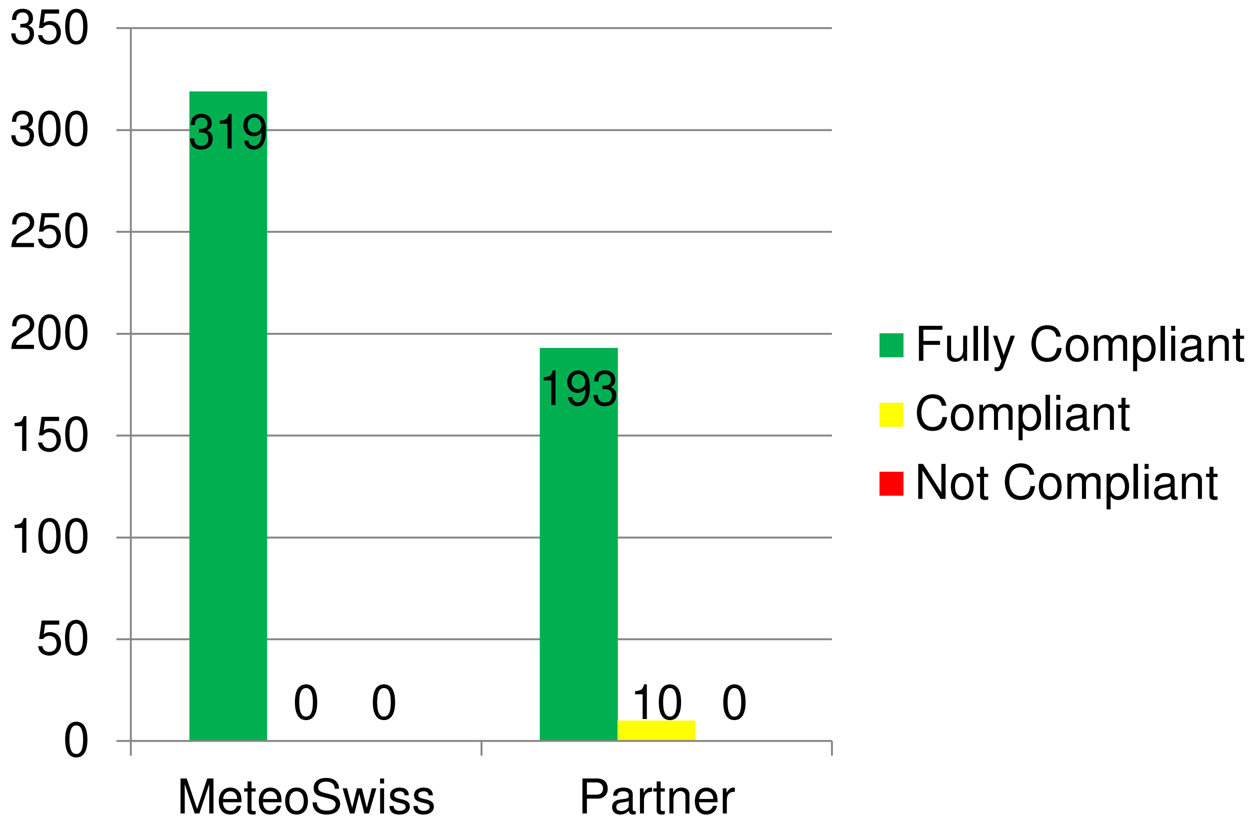
Appendix

Additional results

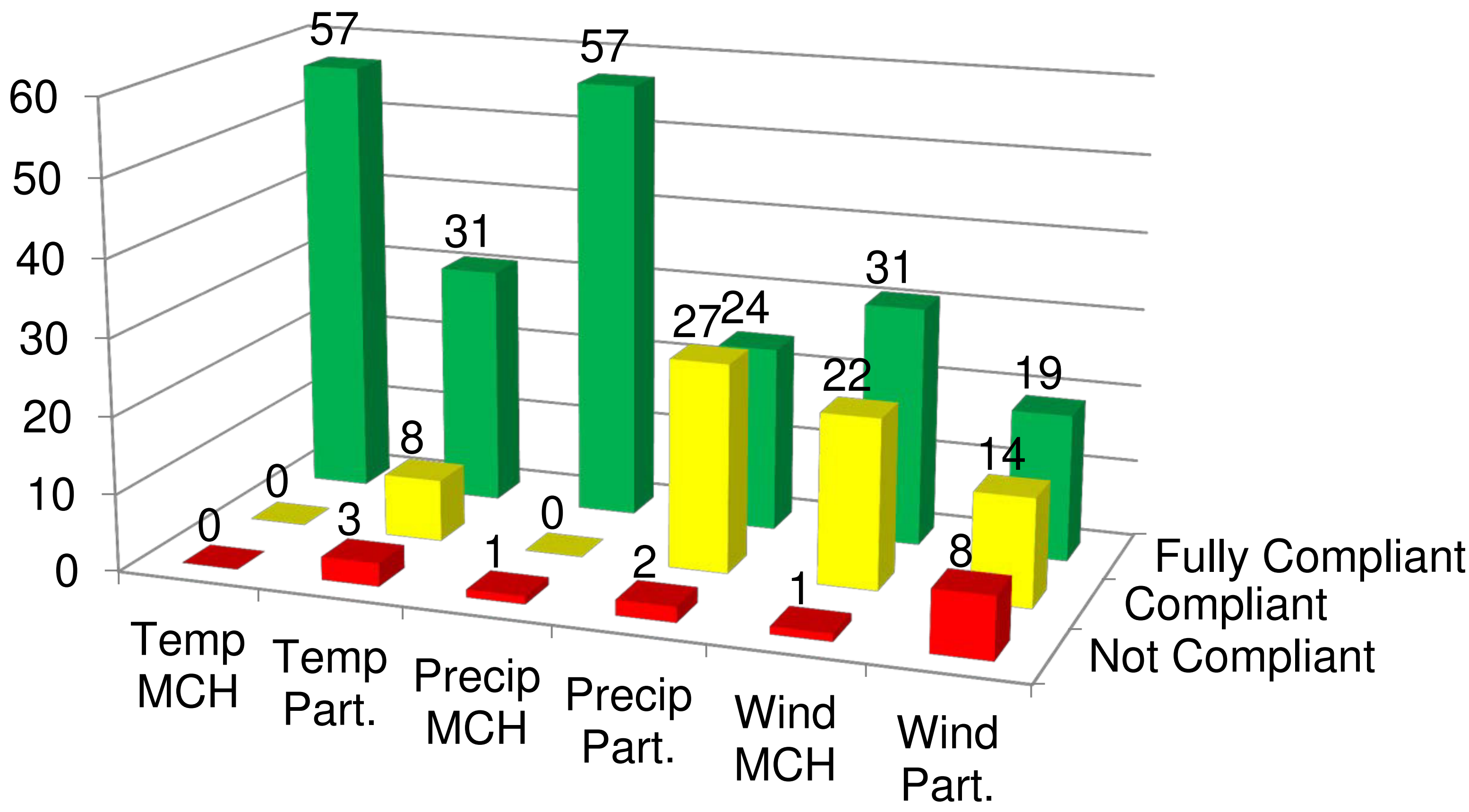
Results: Data availability



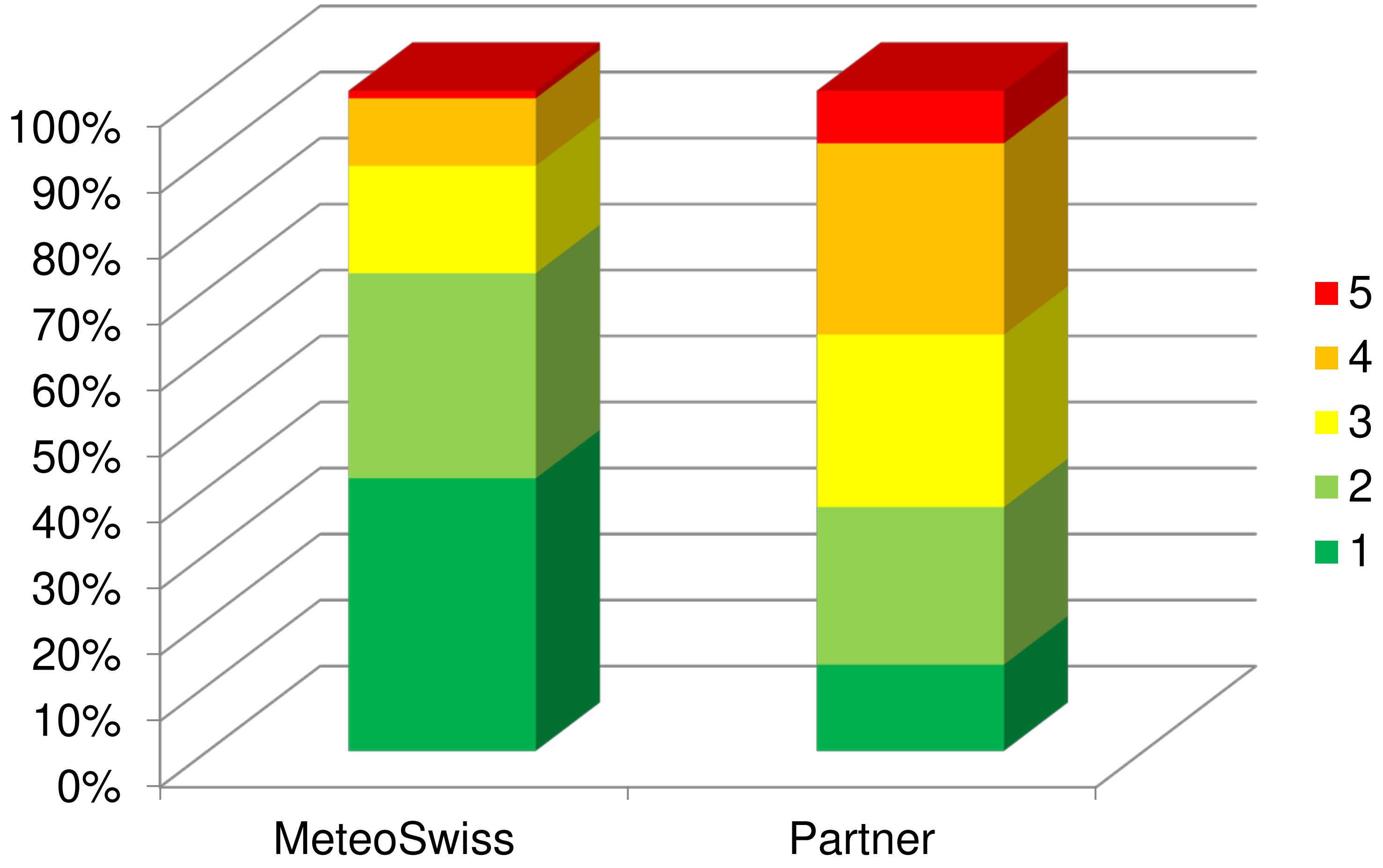
Results: Timeliness



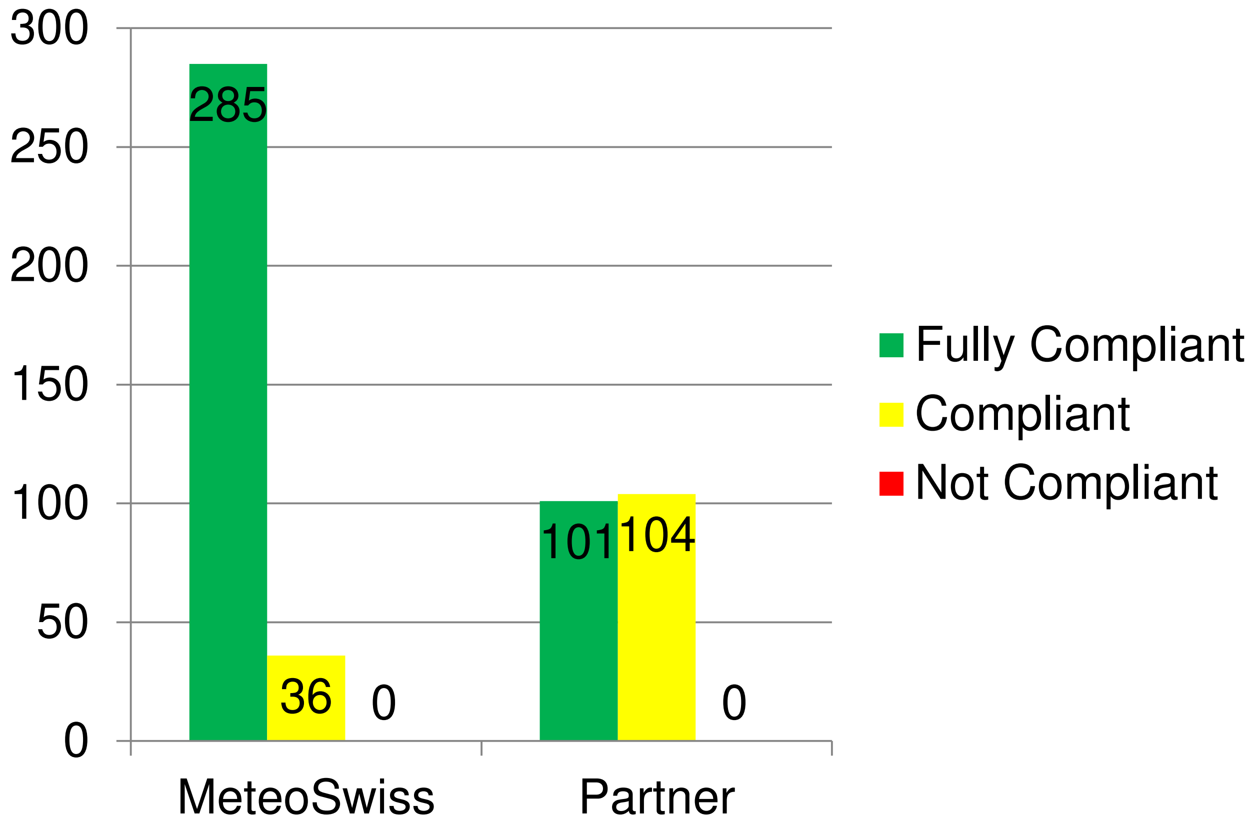
Results: Measurement Height



Results: CIMO Siting Classes

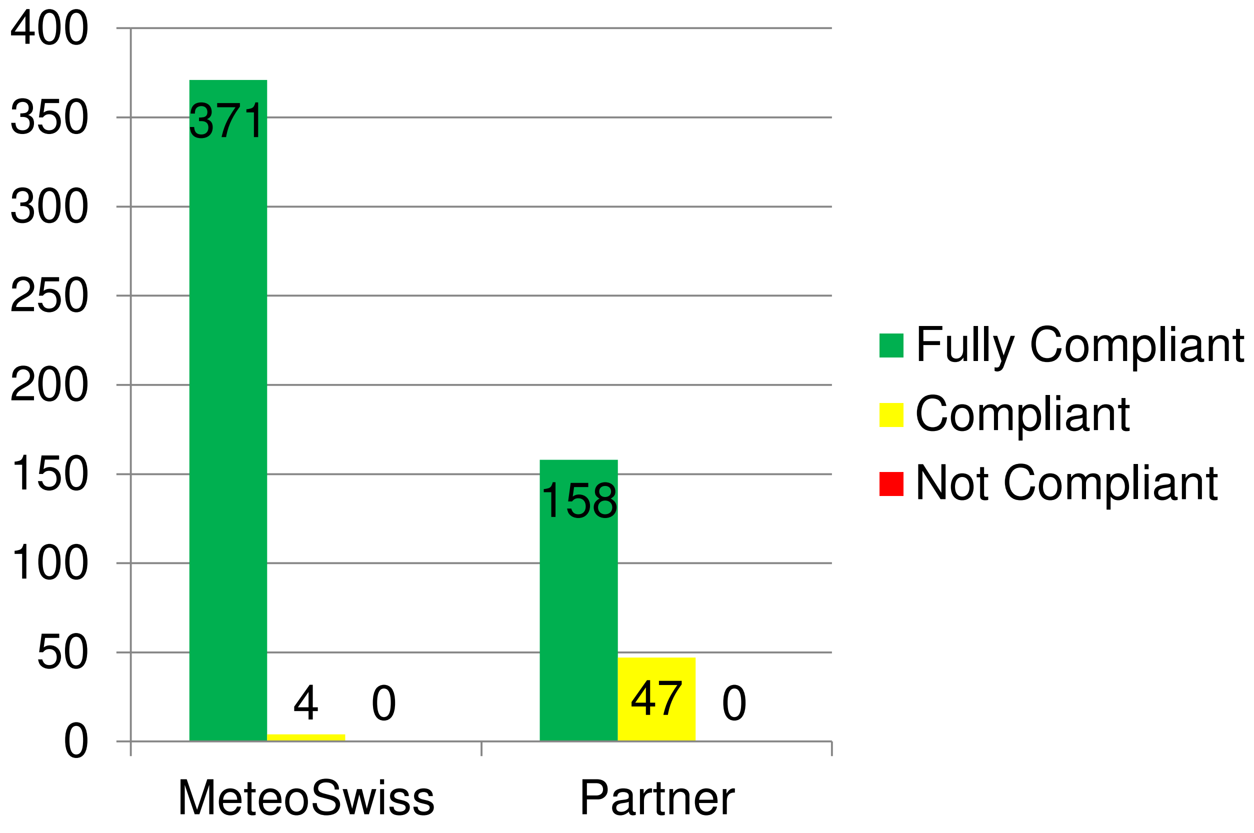


Results: Instrument accuracy (according to manufacturer)



*But **correct heating** is sometimes an issue with partner stations!*

Results: Maintenance and Observer



Austrian‘s Developments during the last two years!

***Adler** Silke, Auer Martin, **Lipa** Wolfgang*

Albenberger Joachim, Fritz Alexandra, Fürst Hermine, Galavics Hermann, Jensen Michael, Lang Gerald, Lechner Wolfgang, Mandl Alexander, Rubin Verena, Teuschler Daniela, Zach-Hermann Susanne

ZAMG
Zentralanstalt für
Meteorologie und
Geodynamik

Overview

- Annual data report = Yearbook

YEARBOOK

- KSE – Klima-Synop-Entry – meteorological observation

KSE

- DCT – Data Correction Tool – historical data

DCT

- AQUAS – Austrian Quality Service – online data

AQUAS

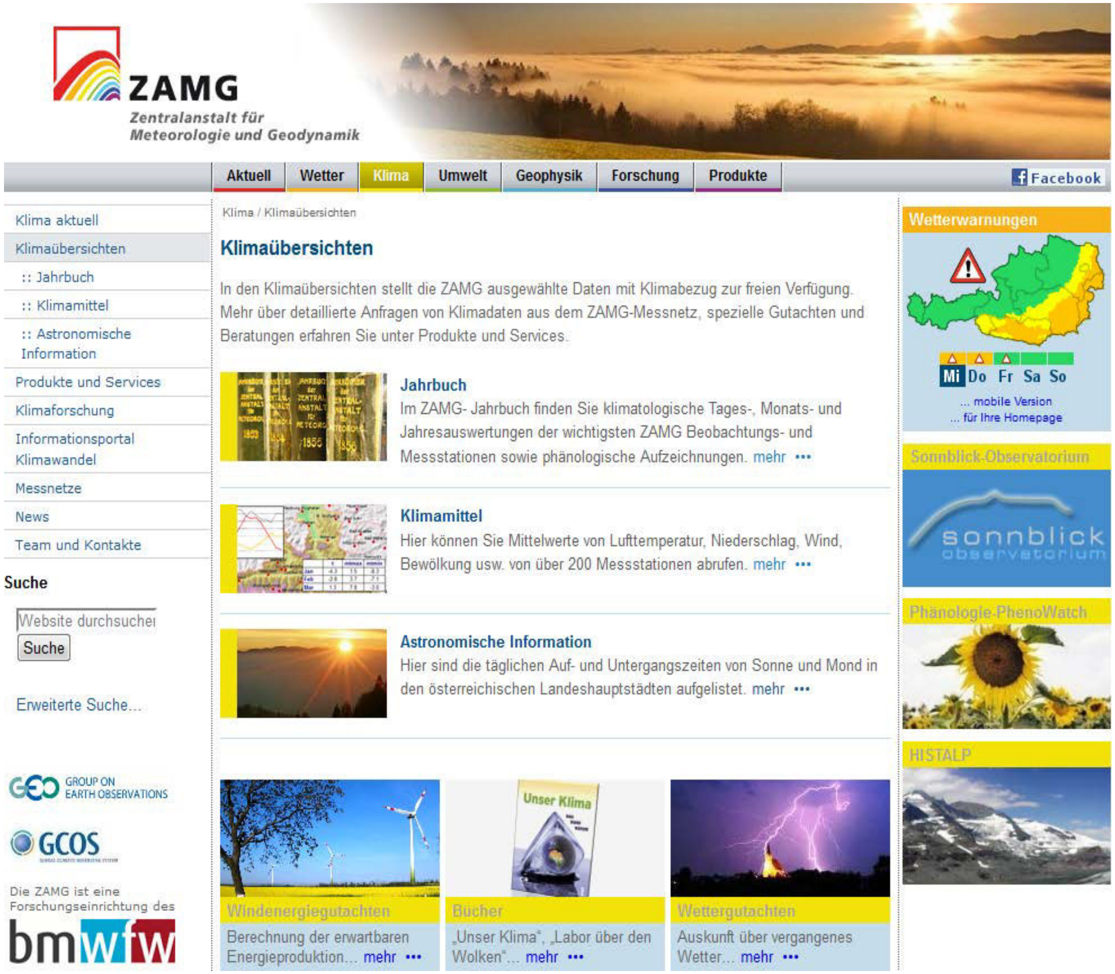
Yearbook

Old version:

- manual , many individual programs, very time consuming
- Excel VBA
- start of programs until whole datasets of all stations of a year were checked
- delay of two-three years

New version:

- runs automatically, only five minutes
- Python
- program runs twice a year or as necessary
- use data of all stations end level checked (typ=6 for 365 days)
- daily report, monthly report, annual report, phenological report
- currently data are available from 1992 until 2014



www.zamg.ac.at/Klima/Klimaübersicht/Jahrbuch

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Zentralanstalt für Meteorologie und Geodynamik

Yearbook

2014 ▾ | Monatsauswertung ▾ | Stationssuche

- ☑ Jänner
- ☑ Februar
- ☑ März
- ☑ April
- ☑ Mai
- ☑ Juni
- ☑ Juli
- ☑ August
- ☑ September
- ☑ Oktober
- ☑ November
- ☑ Dezember

Alle

- ☐ Globalstrahlung
- ☐ Luftdruck und Bewölkung
- ☑ Lufttemperatur
- ☐ Luftfeuchte
- ☑ Niederschlag
- ☐ Wind
- ☐ Erdbodentemperatur
- ☐ Besondere Erscheinungen
- ☐ 5 cm Lufttemperatur
- ☐ Sonnenscheindauer

Alle

Burgenland
- Andau (T)
- Bad Tatzmannsdorf (T)
- Bernstein (T)
- Bruckneudorf (T)
- Eisenstadt/Nordost (T)
- Güssing (T)
- Kleinzicken (T)
- Lutzmannsburg (T)
- Mattersburg (T)
- Neusiedl/See (T)
- Rechnitz (T)
- Wörterberg (T)

Niederösterreich
- Allentsteig (T)

TAWES (T): Teilautomatische Wetterstation

Beobachtung (B): manuelle Klimabeobachtung

(Bewölkung, Niederschlag, Schnee)

Doppelte Einträge weisen auf Übergänge durch

Stationsverlegung oder Sensorenumrüstung hin!

- ◉ HTML Darstellung
- ○ Excel CSV Datei
- ○ PDF Datei

Erstellen

Yearbook

HTML-format

Stationsinformationen Wien Hohe Warte

Stationsname	Stationstyp	Bundesland	Geogr. Breite (°)	Geogr. Länge (°)	Höhe (m)	Aktiv seit	Lage (grob) - Lage (fein)
Wien Hohe Warte	Tawes	W	48.2486	16.3564	198	01 1993	Anhöhe - Ebene

2014 Wien Hohe Warte Niederschlag [Stationsinformationen]

Niederschlag
Sonnenscheindauer
Besondere Erscheinungen
Wind

Parameter / Monat	ugust	September	Oktober	November	Dezember	Gesamtjahr
Monatssumme des Niederschlags (mm)	110	109	37	34	43	753
maximale 24h-Niederschlagssumme (mm)	40	30	12	14	10	62
maximale Tagesschneehöhe (cm)	0	0	0	0	6	6
Tag der maximalen Niederschlagssumme	23	11	17	7	1	-

2014 Wien Hohe Warte Sonnenscheindauer [Stationsinformationen]

Parameter / Monat	Jänner	Februar	März	April	Mai	Juni	Juli	August	Septe
Monatssumme der Sonnenscheindauer (h)	62	87	218	203	231	304	268	216	1
Summe der Sonnenscheindauer (% der maximal möglichen)	24	32	61	52	51	67	58	51	4

Yearbook

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1																		
2	Monatsauswertung																	
3																		
4																		
5	Station	Breite	Länge	Höhe	Lage (grob)	Lage (Fein)	Kapitel	Parameter	Jän.14	Feb.14	Mär.14	Apr.14	Mai.14	Jun.14	Jul.14	Aug.14	Sep.14	Okt.14
6	Wien Hohe \	48,2486	16,3564	198	Anhöhe	Ebene	Niederschlag	Monatssumr	8	21	12	66	189	33	91	110	109	37
7	Wien Hohe \	48,2486	16,3564	198	Anhöhe	Ebene	Niederschlag	maximale 24	4	6	5	17	62	16	25	40	30	12
8	Wien Hohe \	48,2486	16,3564	198	Anhöhe	Ebene	Niederschlag	maximale Ta	2	1	0	0	0	0	0	0	0	0
9	Wien Hohe \	48,2486	16,3564	198	Anhöhe	Ebene	Niederschlag	Tag der maxi	21	12	23	24	24	29	30	23	11	17
10	Wien Hohe \	48,2486	16,3564	198	Anhöhe	Ebene	Sonnenschei	Monatssumr	62	87	218	203	231	304	268	216	154	95
11	Wien Hohe \	48,2486	16,3564	198	Anhöhe	Ebene	Sonnenschei	Summe der S	24	32	61	52	51	67	58	51	42	29
12	Wien Hohe \	48,2486	16,3564	198	Anhöhe	Ebene	Besondere E	Tage mit Nie	2	5	4	10	12	4	11	9	7	7
13	Wien Hohe \	48,2486	16,3564	198	Anhöhe	Ebene	Besondere E	Tage mit Nie	0	0	0	2	6	1	3	4	5	1
14	Wien Hohe \	48,2486	16,3564	198	Anhöhe	Ebene	Besondere E	Tage mit Sch	3	0	0	0	0	0	0	0	0	0
15	Wien Hohe \	48,2486	16,3564	198	Anhöhe	Ebene	Besondere E	Tage mit Sch	1	0	0	0	0	0	0	0	0	0

ZAMG_Jahrbuch

Bereit 100 %

XLS-File

or

PDF-File

ZAMG **2014**

Wien Hohe Warte **Monatsauswertung**

Niederschlag													
Parameter / Monat	Jänner	Februar	März	April	Mai	Juni	Juli	August	September	Oktober	November	Dezember	Jahr
Monatssumme des Niederschlags (mm)	8	21	12	66	189	33	91	110	109	37	34	43	753
maximale 24h-Niederschlagssumme (mm)	4	6	5	17	62	16	25	40	30	12	14	10	62
maximale Tagesschneehöhe (cm)	2	1	0	0	0	0	0	0	0	0	0	6	6
Tag der maximalen Niederschlagssumme	21	12	23	24	24	29	30	23	11	17	7	1	-

Sonnenscheindauer													
Parameter / Monat	Jänner	Februar	März	April	Mai	Juni	Juli	August	September	Oktober	November	Dezember	Jahr
Monatssumme der Sonnenscheindauer (h)	62	87	218	203	231	304	268	216	154	95	55	75	1968
Summe der Sonnenscheindauer (% der maximal möglichen)	24	32	61	52	51	67	58	51	42	29	21	30	46

Besondere Erscheinungen													
Parameter / Monat	Jänner	Februar	März	April	Mai	Juni	Juli	August	September	Oktober	November	Dezember	Jahr
Tage mit Niederschlag >= 1 mm	2	5	4	10	12	4	11	9	7	7	4	11	86

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KSE: climatological observation

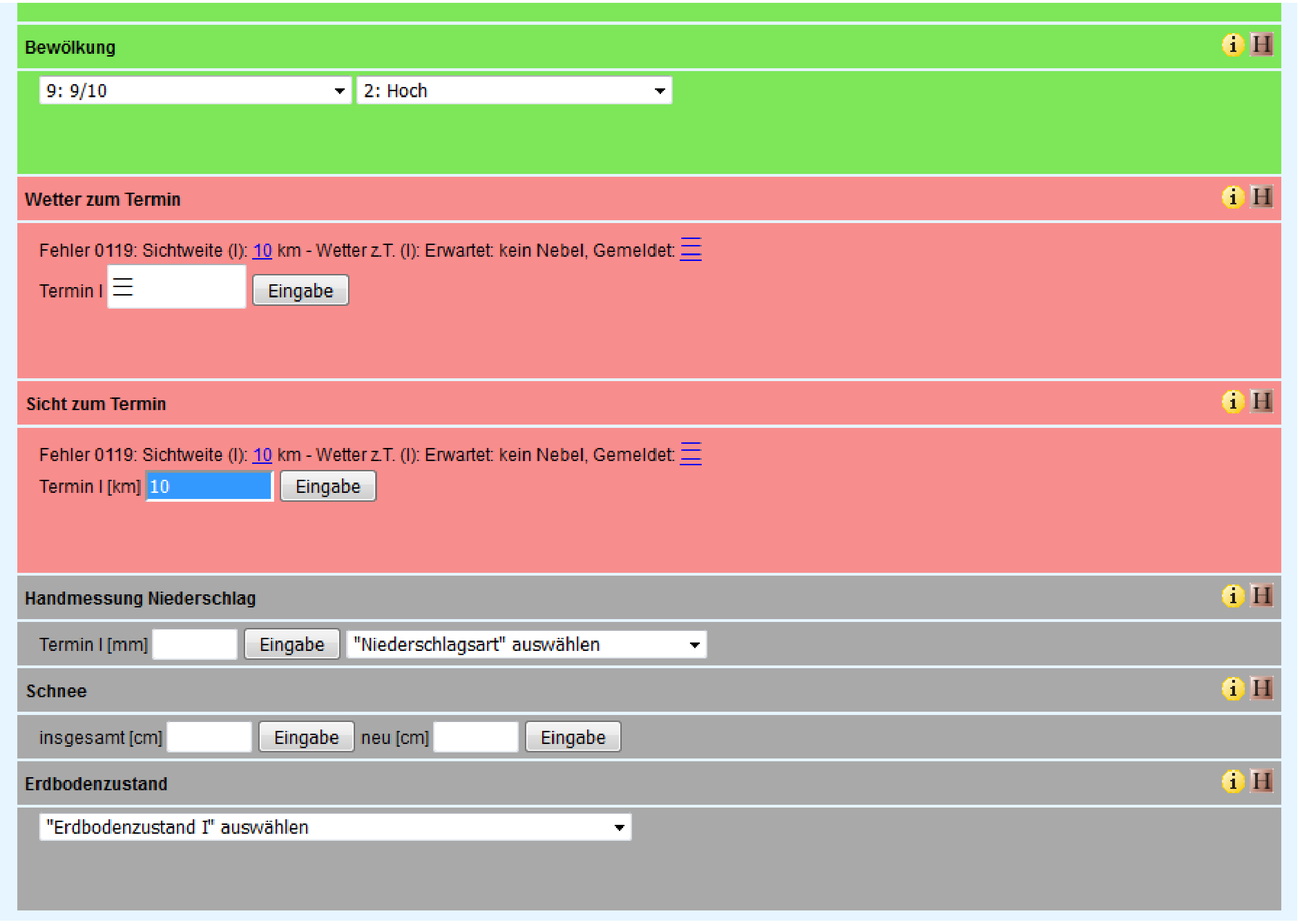
requirements

KSE

- Online form for climatological observations
- Observation pre-check
  - Inner consistency
  - Consistency with measurements
- Feedback for corrections or confirmations
- Substitution of paper reports

KSE: climatological observation

Example: checking for inner consistency



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Austrian Development

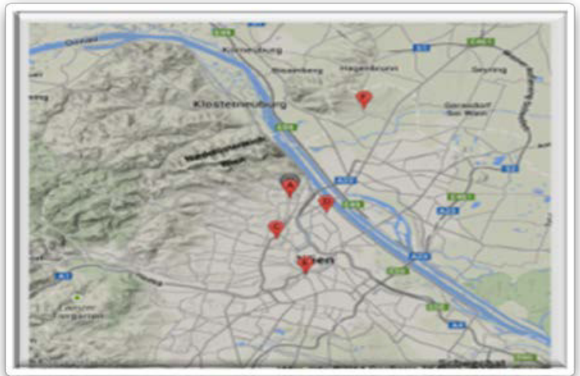
DCT

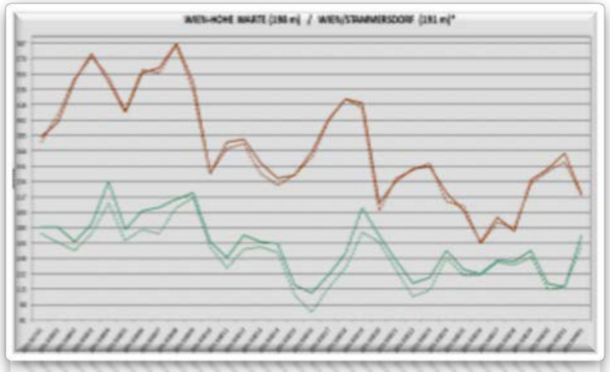
DATA CORRECTION TOOL

tmin	erdmin	t7	t14
-72	-79	-70	-20
-108	[illegible]	[illegible]	-40
-134	[illegible]	[illegible]	-69
-80	[illegible]	[illegible]	-88
-117	[illegible]	[illegible]	-85
-103	-101	-101	-67
-131	-134	-129	-80
-111	-110	-110	-89
-111	-124	-110	-53

Fehler:
|F07| tmin > t7

~ Bitte korrigieren!





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DCT – Data Correction Tool

- Development started November 2012 -> operational since November 2013
- database-editor for checking offline data (correct hourly and daily values)
- makes realtime calculations (monthly values)
- control- and informationsystem
- displays graphics and station map
- includes station quality control
- check and learn control
- 130 checking criteria separated in 6 processes (completeness check, climatological check, temporal consistency check, inner consistency check, spatial consistency check, statistical check)
- oberserved data also be checked with DCT

DCT

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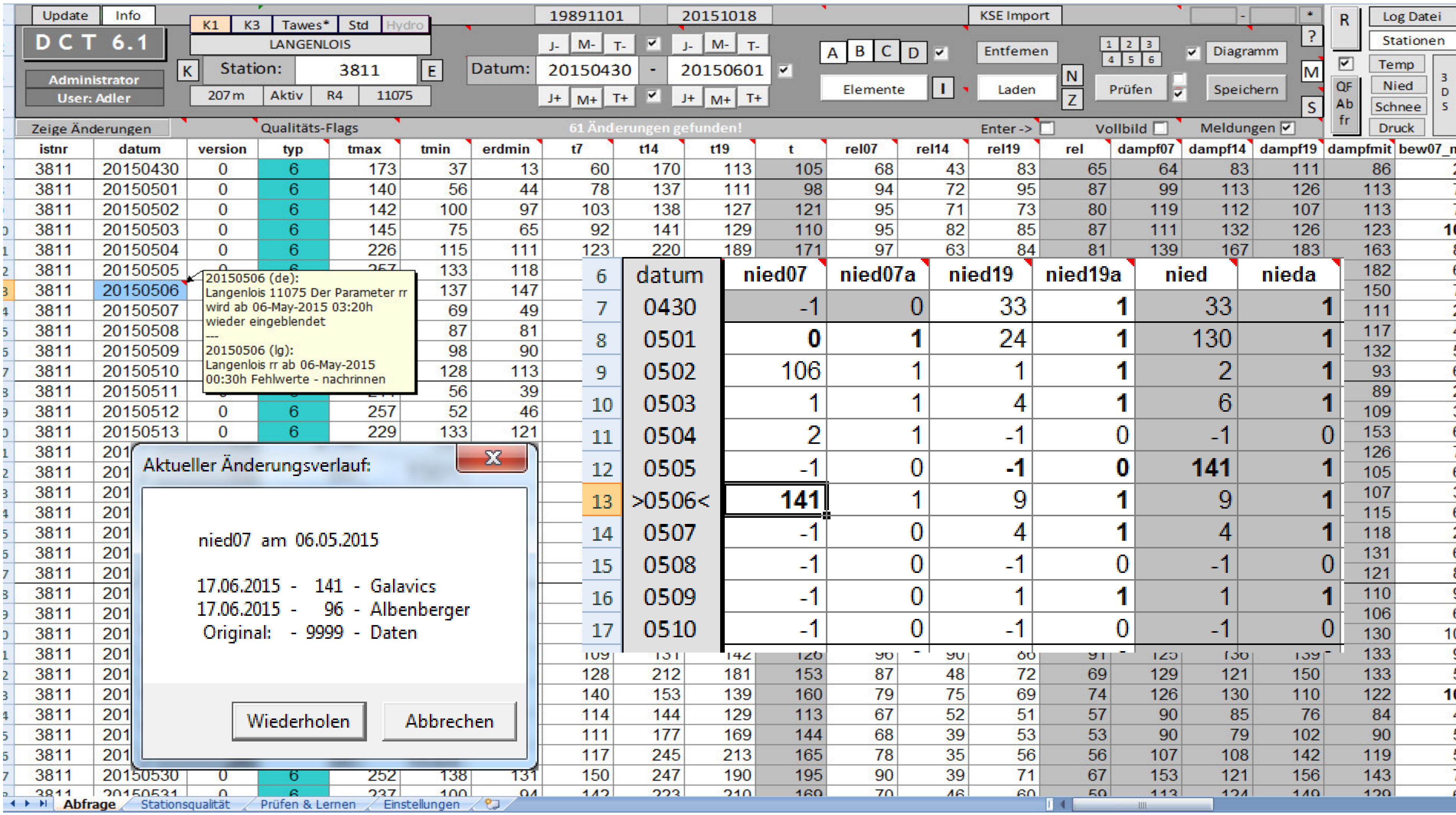
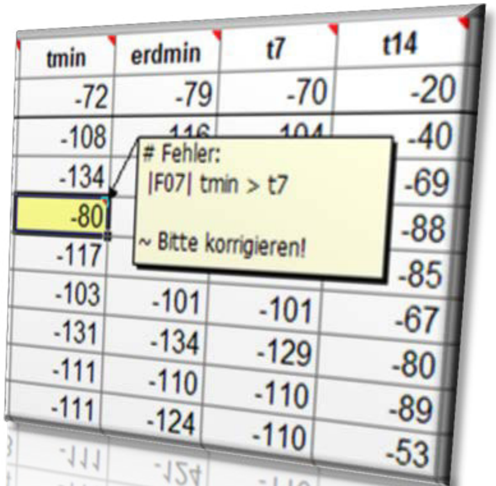
Austrian Development

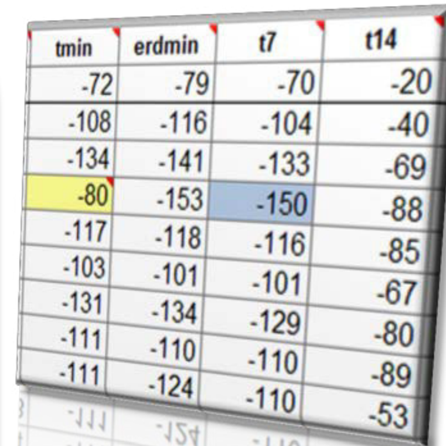
DCT – Data CorrectionTool



• DCT – Data Correction Tool



- failures and warnings
- Extensive description of errors
- notification of the values of neighbourhood
- shows relationship between error value and other values
- shows detailed information of the parameter
- displays the history of the failure value



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DCT - station quality control

Stationsqualität

<-- | Entfernen | Bewerten | 201504 | Liste

QF prüfen ☑

Daten:
- wird nicht beobachtet
- keine Einträge vorhanden
- weniger als ganzes Monat

Bewertung:
- wird nicht bewertet
- schlechte Bewertung
- Bewertung nicht vorhanden
- keine Bew. möglich
- bereits DCT geprüft / Bewertung vorhanden

28.10.2015

13

Tir/Vbg - 201504 | Bearbeiter | P | DATEN | BEWERTUNG

Stationsnummer	Name	Bund	Bearbeiter / Region	Qualitäts-Flags (Typ)	DCT geprüft (ab 2015)	Anzahl Daten	Anzahl T	Anzahl Bew	5 cm Erdbodentemp.	Temperatur	Relative Feuchte	Sichtweite	Bewölkung	Windgeschwindigkeit	Windrichtung	manueller Niederschlag	Niederschlagsart	Nied. Zusatzbeob.	autom. Niederschlag	Schneehöhe	Neuschnee	Erdbodenzustand	Druck	Zusatzbeobachtungen	Sonnenscheindauer	Globalstrahlung	Diffusstrahlung	Verdunstung	Bewertung
8805	ACHENKIRCH	1	Tirol	6	E	30	30	30	3	3	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3	0			2,94
12015	ALPBACH	1	Tirol	5		30	30			3	3			3	3				3				3		3	3			3,00
12016	ALPBACH	1	Tirol	5		30		0				2	2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3	3	2		2					2,22
14801	BRENNER	1	Tirol	2		30		0				1	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1	1	1		1					1,00
14802	BRENNER	1	Tirol	6	E	30	30			3	3			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3				3		3	3			3,00
17320	BRUNNENKOGEL	1	Tirol	5		30	30			3	3			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0										3,00
11602	EHRWALD	1	Tirol	5		30		30				3	3	[illegible]	[illegible]	2	3	3		3	3	2		3					2,78
11603	EHRWALD	1	Tirol	5		30	30			3	3			3	3				3				3		3	0			3,00
17002	GALTUER	1	Tirol	5		30	30			3	3			3	3				3				3		3	0			3,00
17003	GALTUER	1	Tirol	5		30		30				3	3			2	3	3		3	3	3		3					2,89
14305	GALZIG	1	Tirol	6	E	30	30	30	0	3	3	2	2	3	3		3		3	3	3		3		3	0			2,83
15005	GERLOS/DURLASSBODEN (MT)	1	Tirol	5		30	30			3	3								3										3,00
12215	HAHNENKAMM-EHRENBACHHOEHE	1	Tirol	6	E	30	30			3	3			3	3				1	3	3		3		3	0			2,78
14602	HAIMING	1	Tirol	5		30		30				3	3			3	3	3		3	3	2		2					2,78
14603	HAIMING	1	Tirol	5		30	30		3	3	3			3	3				3				3		3	0			3,00
14912	HINTERTUX (OE3)	1	Tirol	5		30	30		0	3	3			3	3				3						3				3,00
12351	HOCHFILZEN	1	Tirol	5		30	30			3	3			3	3				3				3		3	0			3,00
12352	HOCHFILZEN	1	Tirol	5		30										3	3			3	3								3,00
11401	HOLZGAU	1	Tirol	5		30		30				3	3			2	3	3		3	3	2		3					2,78
11402	HOLZGAU	1	Tirol	5		30	30		3	3	3			3	3				3				3		3	0			3,00
14512	IMST	1	Tirol	5		30		30				3	3			3	3	3		0	0	2		2					2,71
14513	IMST	1	Tirol	5		30	30		3	3	3			3	3				3				3		3	0			3,00
11800	INNSBRUCK-FLUGPLATZ	1	Tirol	5		30		30				3	3			3	3	3		3	3	3		3					3,00
11804	INNSBRUCK-FLUGPLATZ	1	Tirol	5		30	30	30	3	3	3			3	3				3				3		3	0			3,00
11803	INNSBRUCK-UNIV.	1	Tirol	5		30	30	30	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	0			2,94

beobachtet nicht mehr - neuer B. gesucht

Stationsqualität | Prüfen & Lernen | Einstellungen

Austrian QUAlity Service

Current status and Motivation

Data source →	Data quality control →	Data Use
Met. Network TAWES	NWP or Nowcasting Systems	synoptic
Met. Network TAWES	QualiMet (DWD)	climatology
Climatological observations	KSE + manual control	climatology
???	???	???

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Austrian QUAlity Service

Current status and Motivation

Data source →	Data quality control →	Data Use
Met. Network TAWES	AQUAS	synoptic
Met. Network TAWES		climatology
Climatological observations		climatology
???		???

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Austrian Quality Service

New requirements

- Real-time testing
- Arbitrary data structures (non-standard networks)
- Adaptable check-ups
- Traceable and reversible data changes
- Centralized testing
- Distributed Correction (local experts)
- Web editor for manual data corrections

AQUAS

Solution for a small NMS with decreasing human resources

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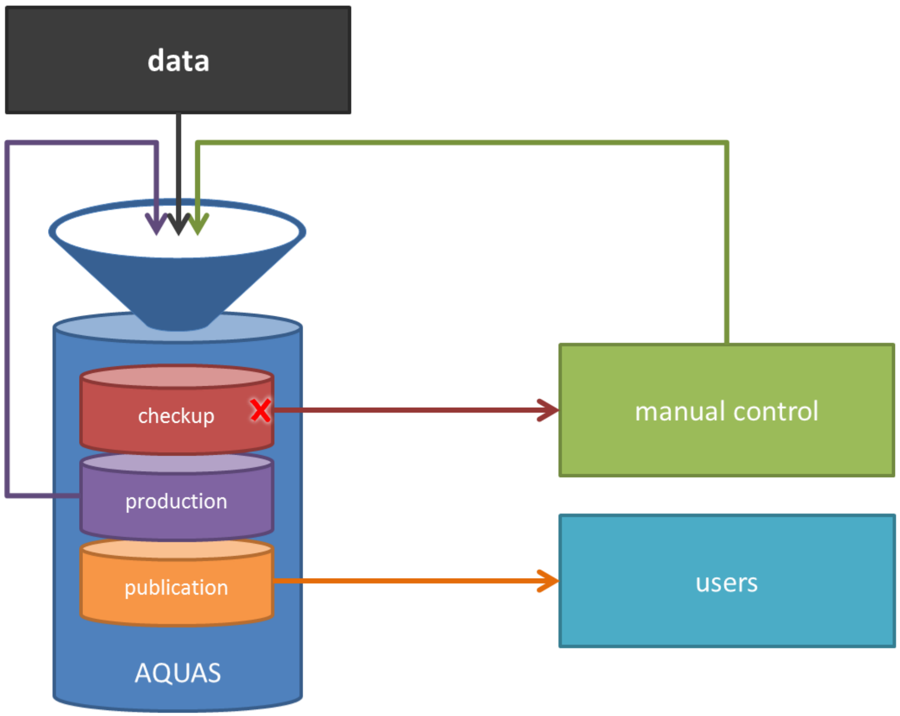
Austrian Quality Service

System specifications



- data base: PostgreSQL
- Kernel: C++
- check-up: PYTHON3 functions
- production: PYTHON3 functions
- manual control: play! framework

Austrian Quality Service

timetable

2012 Requirements analysis, System specifications ✓

2014 Prototype ✓

2015 Prototype enhancements ✓

2016 Beta Testing, Configuration

2017 Operational Service

AQUAS

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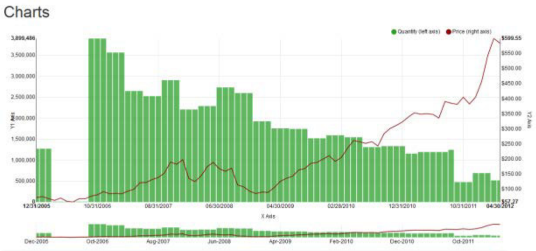
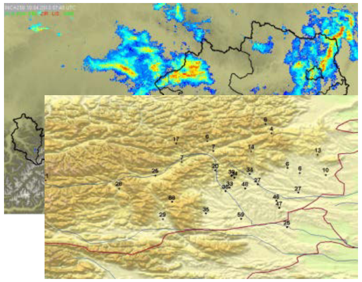
Austrian Quality Service

web editor (work in progress)





Datum	RR [mm] Hirschenkogel	RRM [bool] Hirschenkogel
10.10.2015 15:06	0.0	0
10.10.2015 15:07	0.0	0
10.10.2015 15:08	0.1	0
10.10.2015 15:09	0.0	0
10.10.2015 15:10	0.0	0
10.10.2015 15:11	0.0	0
10.10.2015 15:12	0.0	0
10.10.2015 15:13	0.0	0
10.10.2015 15:14	0.0	0
10.10.2015 15:15	0.0	0
10.10.2015 15:16	0.0	0
10.10.2015 15:17	0.0	0
10.10.2015 15:18	0.0	0
10.10.2015 15:19	0.0	0

History | Werte Bestaetigen

- Multi window elements:
  - Data tables
  - Data time series
  - Data maps
  - Radar, Satellite, …
- Synchronized display

keep it small & simple

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Outlook

AQUAS:

- 2016 Beta Testing, Configuration
- **2017 Operational Service**

Meta Data:

- Consolidation of meta data

Climate DataRescue:

- step by step

Thanks for your attention!

QualiMET 2.0

The new Quality Control System of Deutscher Wetterdienst

Reinhard Spengler
Deutscher Wetterdienst
Department Observing Networks and Data
Quality Assurance of Meteorological Data

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D-14473 Potsdam
Tel.: +49 (0)69 8062-5200
E-mail: reinhard.spengler@dwd.de

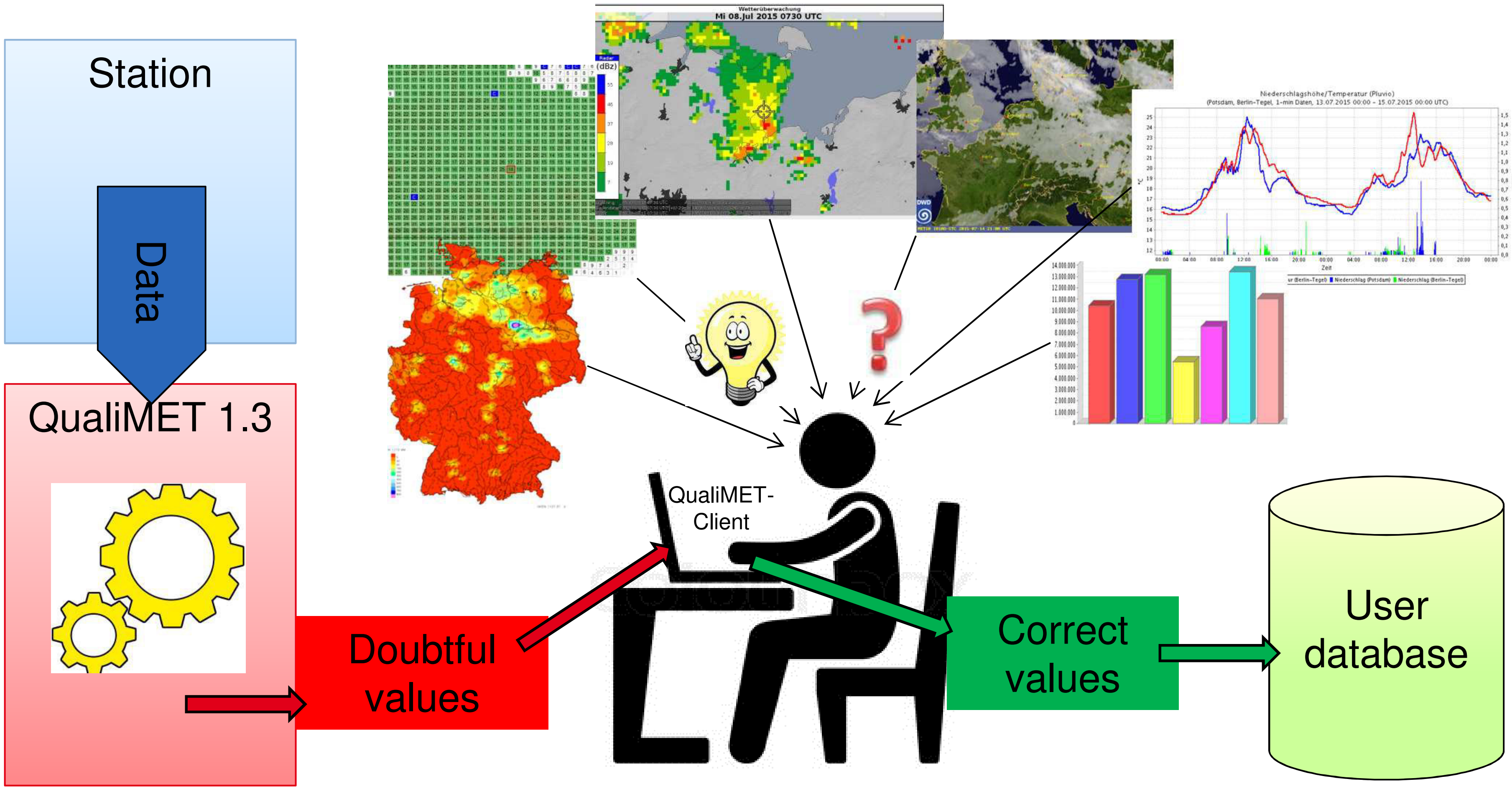
Overview

1. Background of planning and creating QualiMET 2.0
2. Difference between QualiMET 1.3 and QualiMET 2.0
3. Decision tree & usage of remote sensing data / nowcasting data
4. Calculation of climatological values
5. Co-operation with other NMSs

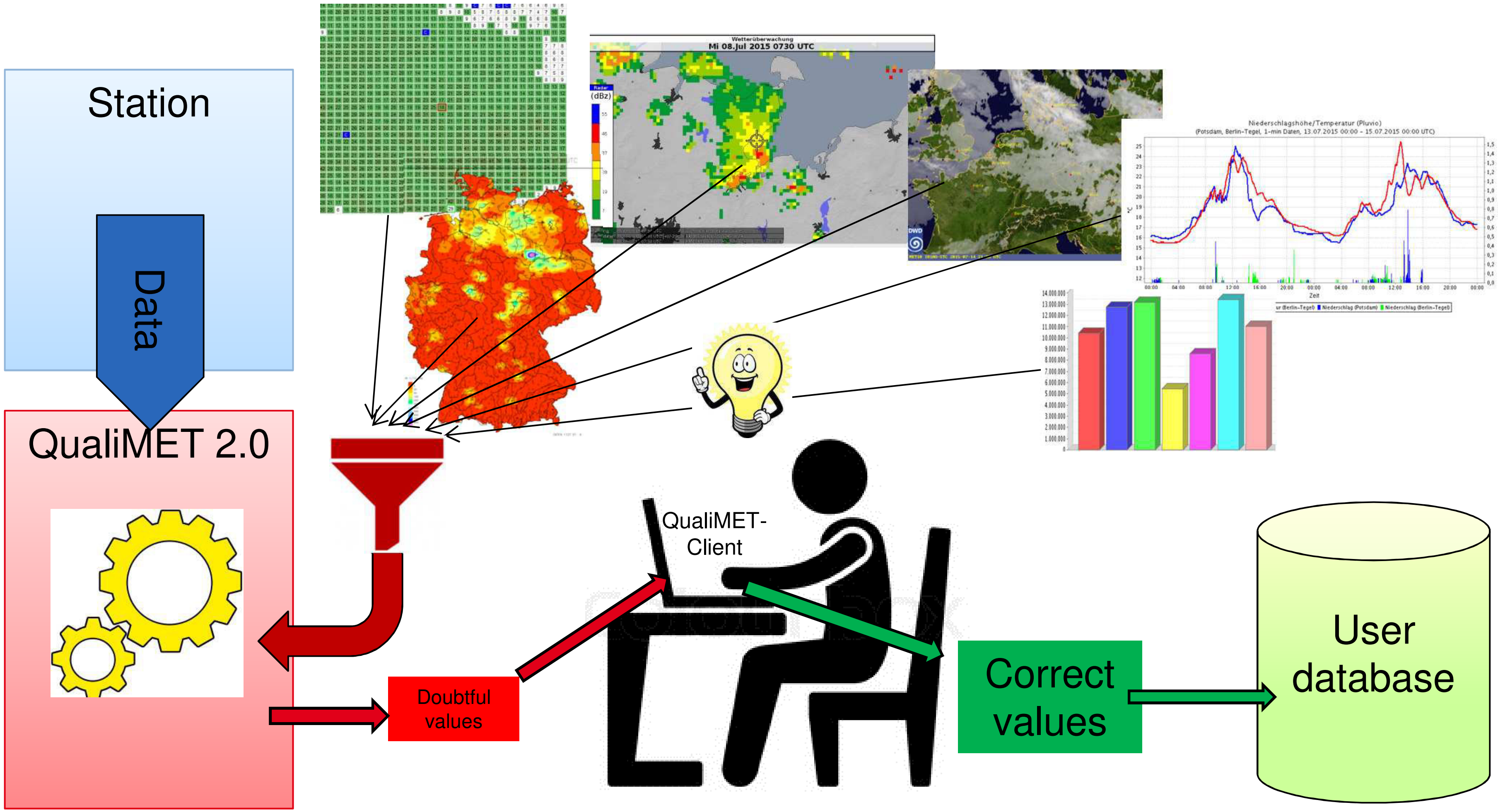
Background of planning and creating QualiMET 2.0

- The previous system has been in operation for about 15 years.
- We had many human resources for visual observations and for operating interactive QC procedures.
  → DWD decided to run a fully automated observing network as of 2020.
- Interactive QC is currently distributed to seven regional offices
  → Future: one central QC group
- Human QC takes to much time and is often biased by subjective judgement.

The previous system QualiMET 1.3



The new system QualiMET 2.0



Decision tree & usage of remote sensing / nwc data (1/6)

➔ **To be continued: 4 levels of Quality Control**

1. Real-time at station site (fully automated)
2. Real-time at central office (24/7, semi-automated)
3. Non real-time at central office (→ max. 3 days)
4. Climatological Quality Control (→ 1 year)

➔ **To be continued: 5 steps of Quality Control**

1. Completeness, availability
2. Climatological limits
3. Temporal consistency
4. Internal consistency
5. Spatial consistency

Decision tree & usage of remote sensing / nwc data (2/6)

→ Usage of satellite data (cloud cover, cloud type, cloud mask, radiation, sunshine duration, etc.) at levels 2, 3 and 4 to check **hourly, daily** and **monthly** values

- to decide if available data is acceptable
- to get substitute data to correct inaccurate data
- to get substitute data to close gaps in time series

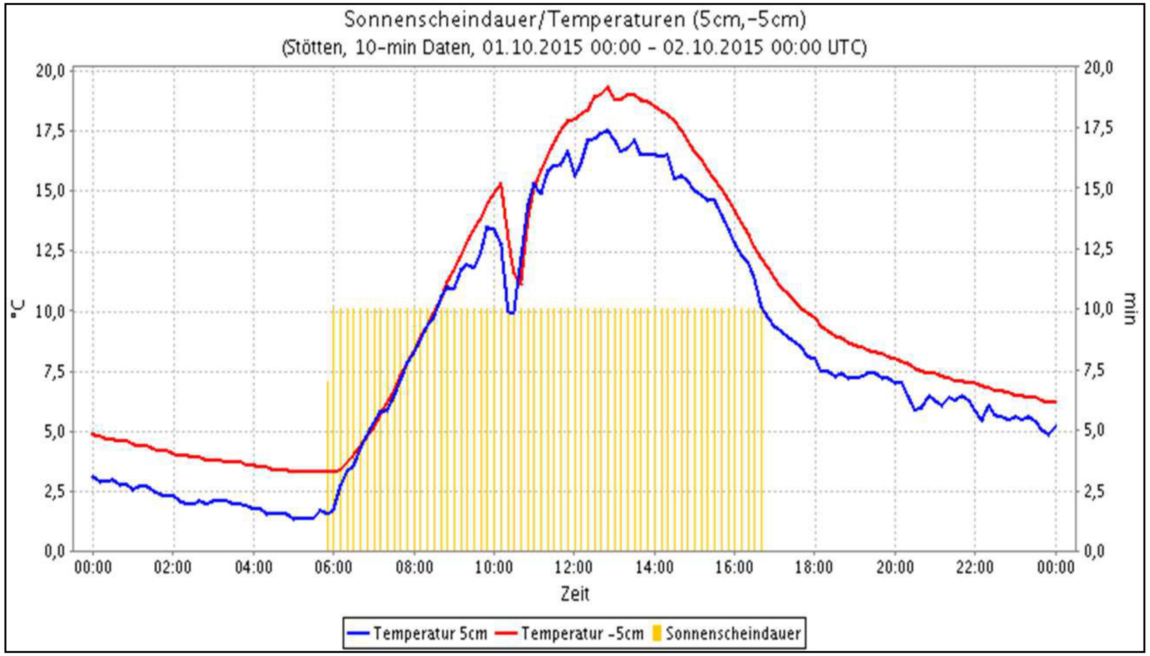
→ Usage of radar products at levels 2 and 3 to check **hourly** and **daily** values

- in the same way as satellite data …

→ Usage of station site classification (CIMO) and other metadata

→ example on following slide

Decision tree & usage of remote sensing / nwc data (3/6)
- Example: sudden drop in temperature 5cm above ground



<u>Weather conditions</u>
- no clouds
  → full sunshine
- no precipitation
- nearly calm
- …

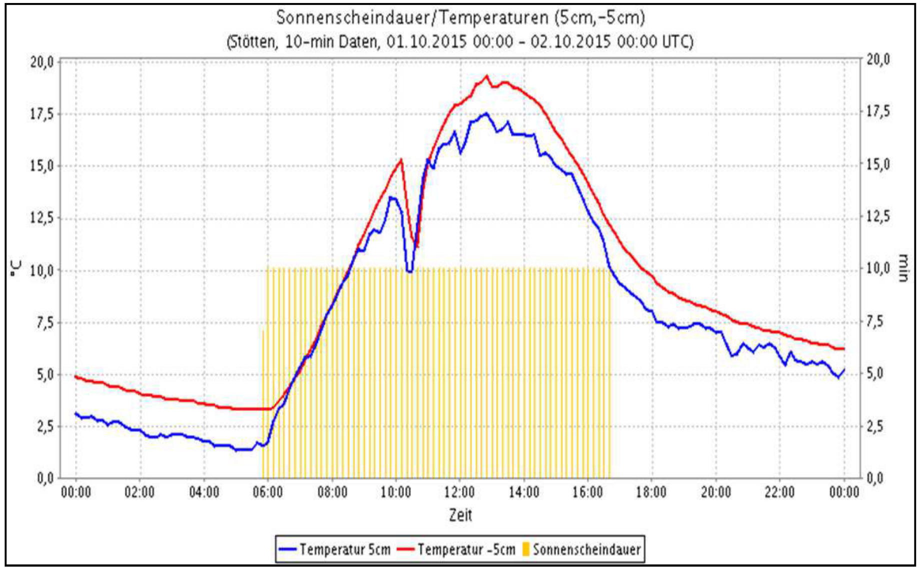
Decision tree & usage of remote sensing / nwc data (4/6)

- Example: sudden drop in temperature 5cm above ground

Decision tree in **previous system**

➔ Drop of temperature too large!

precipitation (gauge)?
- yes → data correct → flagging (end)
- no → full sunshine?
  - yes → operator has to decide → result??
  - no → data correct → flagging (end)



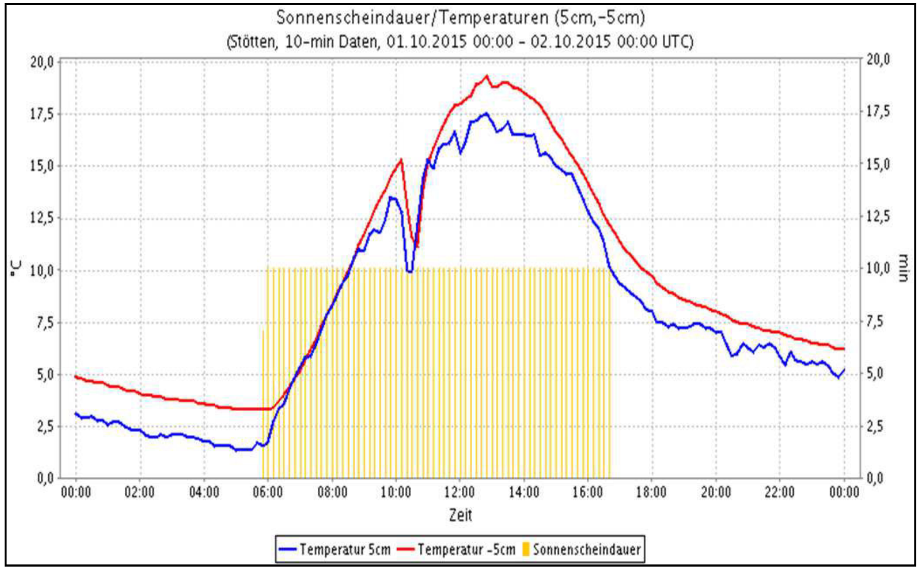
Decision tree & usage of remote sensing / nwc data (5/6)

- Example: sudden drop in temperature 5cm above ground

<u>Decision tree in **future system**</u>

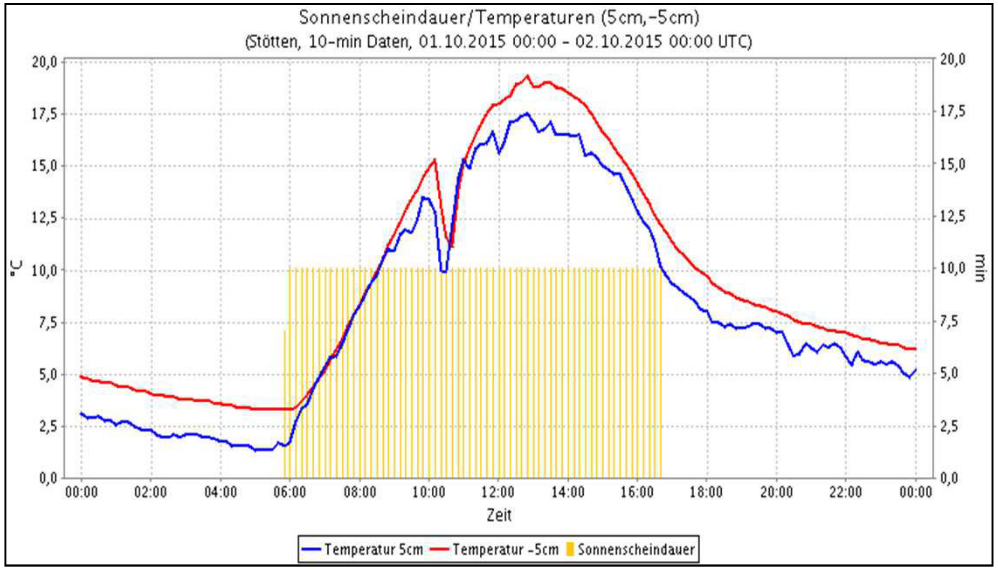
➔ Drop of temperature too large!

precipitation (gauge)?
- yes → data correct → flagging (end)
- no → precipitation (radar)?
  - yes → data correct → flagging (end)
  - no → full sunshine?
    - yes → other influence ? (search in meta data)
      - yes → automatic correction → flagging (end)
      - no → decision of operator …
    - no → data correct → flagging (end)



Decision tree & usage of remote sensing / nwc data (6/6)

- Example: sudden drop in temperature 5cm above ground

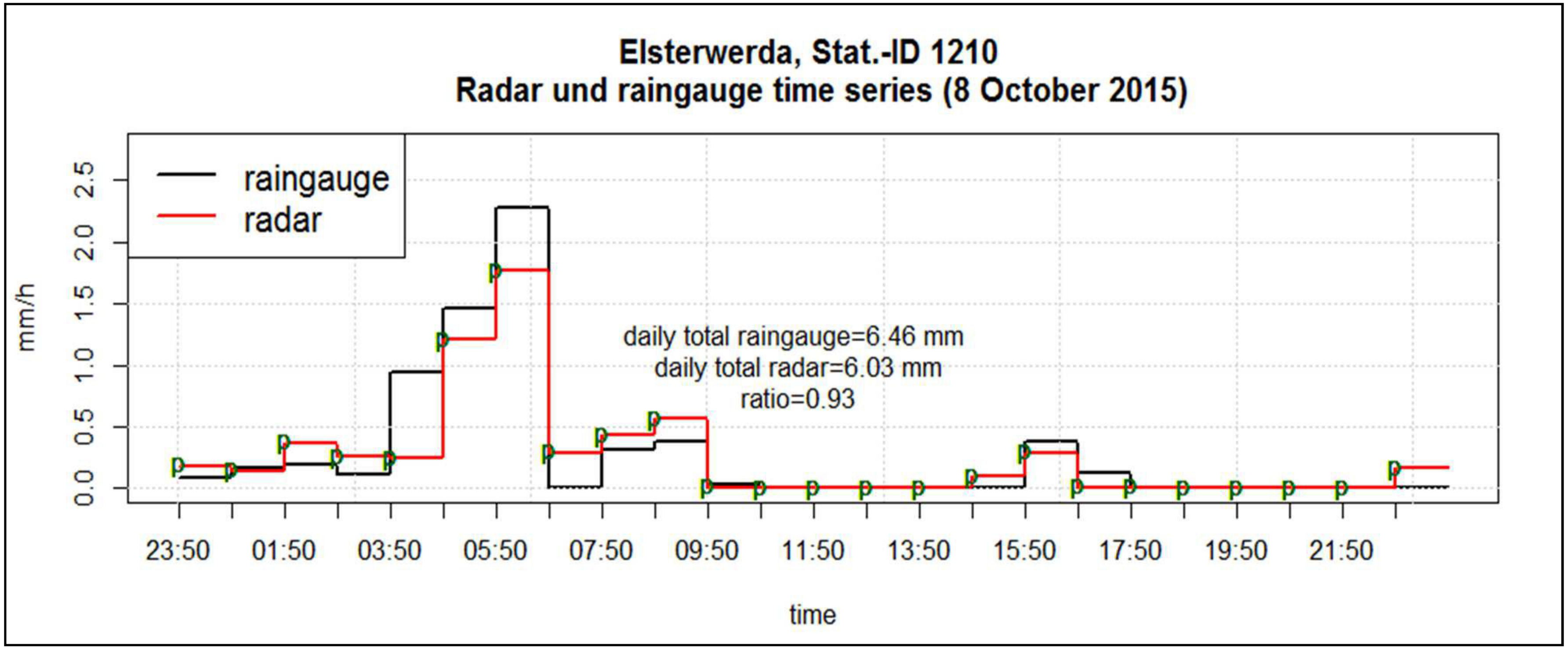


<u>Result</u>

- Drop in temperature was caused bei shadow of a radio tower (see picture)

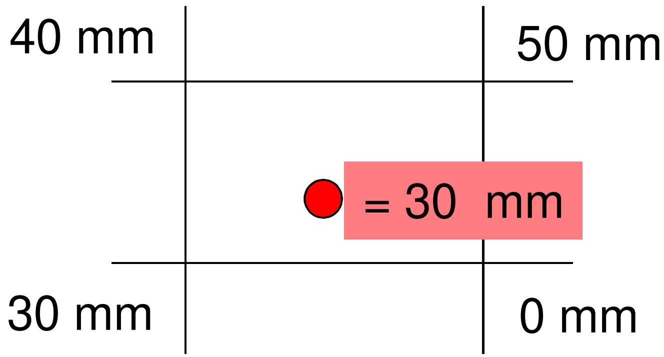
Remote sensing / model data

- Check-algorithms for precipitation by using radar products



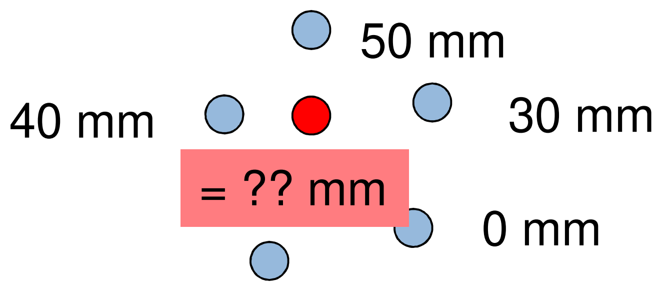
Remote sensing / model data

- spatial check of daily precipitation with a new linear model



- Information from neighboring station (considering dataset of the last 10 years)
- Search / identify of suitable predictors

- Interpolation of Data into a grid of 1km



Results from Sensor calibration checks
- should these data be considered in QA of time series?

- ➔ Maintanance interval of wind-sensor is 12 months
- ➔ The re-calibration check detects an non-acceptable deviation in wind-speed
- ➔ How should we deal with such a result relating to the time series, especially of climatological data ???

Calculation of climatological values

- ➔ All climate data are calculated using data sets from the synoptic stations.
- ➔ This means that QC is based on data with the highest possible temporal resolution: 1-minute data, 10-minute data, ...
- ➔ Any change in high temporal resolution data will automatically lead to adaptation of the climate data (possible for up to 30 days back)
- ➔ A quality flag is assigned to each measurement value. During the calculation of climate data, this information is passed on to the condensed values.
- ➔ The concept of data condensation and quality flagging will be expanded until 2017 to be applicable to the new procedures by using remote sensing and model data.
- ➔ In future, all users of the data will see whether the values are original data or have been corrected or added.

Co-operation with other NMSs

- ➔ The new developments to the method and software require intense co-ordination, also at international level.
- ➔ For this reason, we have intensified our contacts to MeteoSwiss and ZAMG during 2014.
- ➔ I would be very pleased if we could work together on improving our procedures for the quality control of meteorological data and data management.


Thank you very much
for your attention
Are there any
questions ?

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Swiss Confederation

Federal Department of Home Affairs FDHA
Federal Office of Meteorology and Climatology MeteoSwiss

Three Information Sources for Quality Control

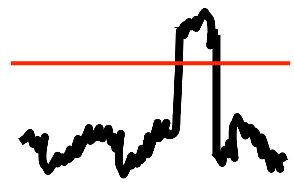
Christian Sigg – christian.sigg@meteoswiss.ch
Valentin Knechtl – valentin.knechtl@meteoswiss.ch

10th EUMETNET Data Management Workshop, 2015

In a Nutshell

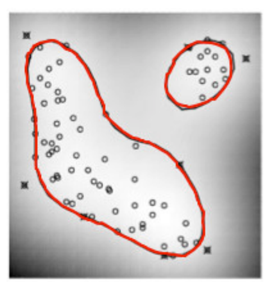
We build QC tests from three sources of information:

1. **Relative frequency of occurrence**
   Principle: “Rough errors are rare”
   Classical rule: magnitude limit tests



   Model: outlier detection based on density estimation

Schölkopf et al. (2001)

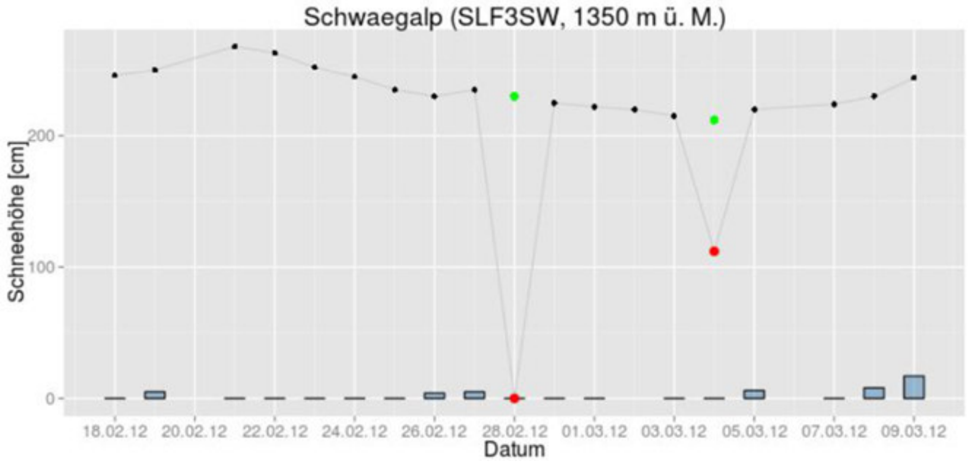


$$\hat{p}\left(\mathbf{x}\right) < \varepsilon$$

\+ efficient and low FDR for *p(x)* or *p(**x**)* – high FDR for *p(x,y)*

In a Nutshell

2. **Historical treatment**
   Principle: "Model imitates expert"
   Model: classifier that predicts discrete quality flags

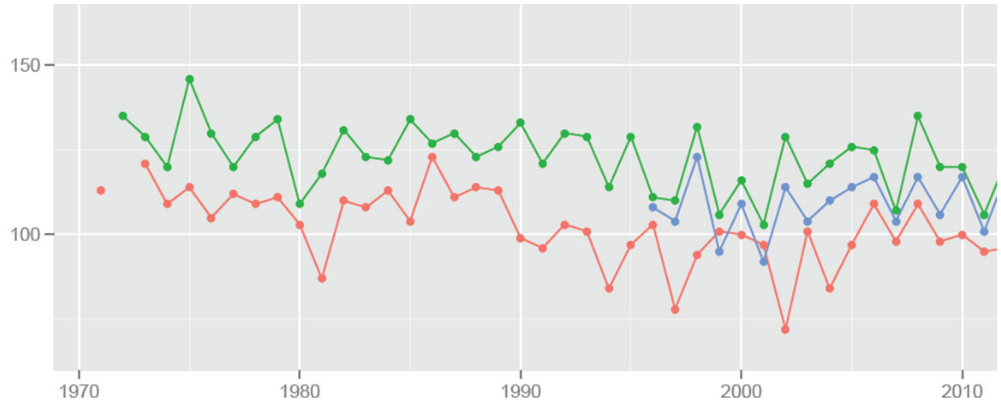


$$\hat{p}(q \mid x, \mathbf{y})$$

- \+ Identifies erroneous measurements
- – Label scarcity problem

In a Nutshell

3. **Relationship to other measurements**
   Principle: “Errors deviate from prediction”
   Model: predictive model based on context



$$\hat{p}(x \mid \mathbf{y})$$

+ no labels needed
! erroneous or missing context

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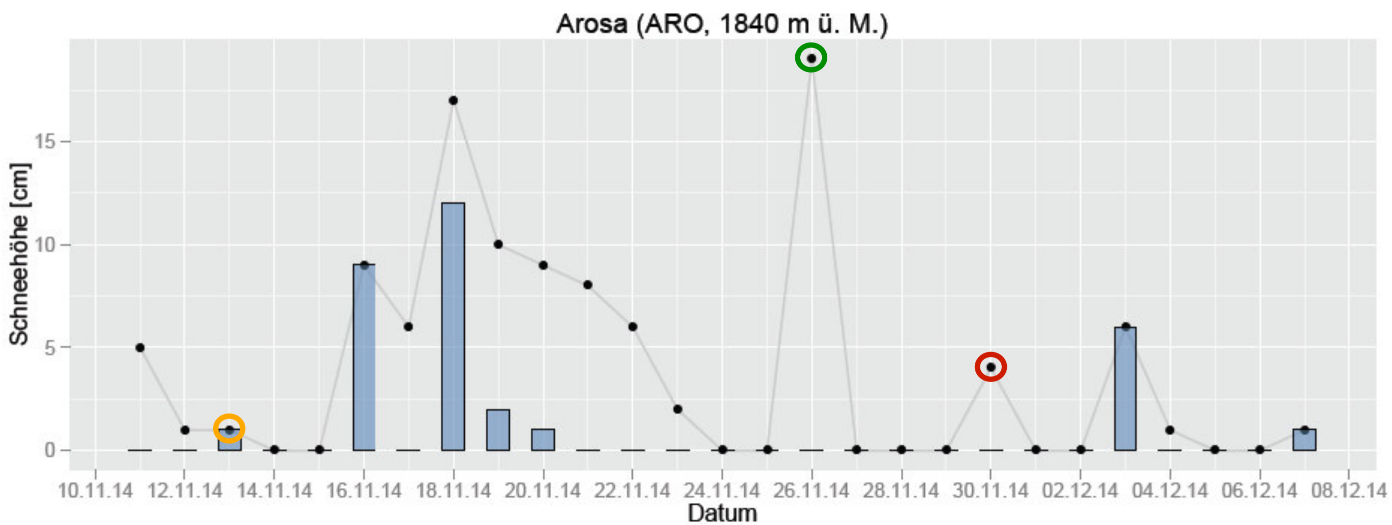
Federal Department of Home Affairs FDHA
Federal Office of Meteorology and Climatology MeteoSwiss

Evaluating a QC System

Poster: V. Knechtl, D. van Geijtenbeek and C. Sigg "A Quantitative Approach to Optimize the Quality Control System for Surface Data at MeteoSwiss"

Measuring QC System Performance

	Value not flagged	Value flagged
Value correct	True negative (TN)	False positive (FP)
Value not correct	False negative (FN)	True positive (TP)



Trade-off necessary between benefit (TP) and cost (FP + FN)

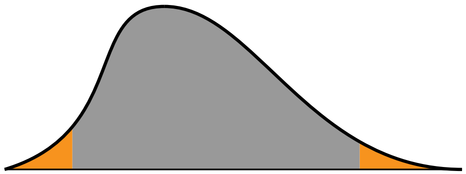
False discovery rate (FDR): *E[FP/(FP+TP)]*

1. Relative Frequency of Occurrence

"Rough errors are rare"

Outlier Detection: *p(x)*

Our distributions are typically unimodal -> lower and upper limits:



“Hard” limits:

- Nonsensical: negative precipitation measurements
- Physically impossible: 2m surface temperature > 50 °C

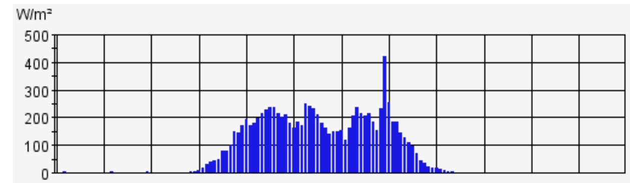
“Soft” limits:

- Monthly limits based on climatology of station
- Derived from inter-quantile range

Both achieve a low FDR, but have significant number of FNs

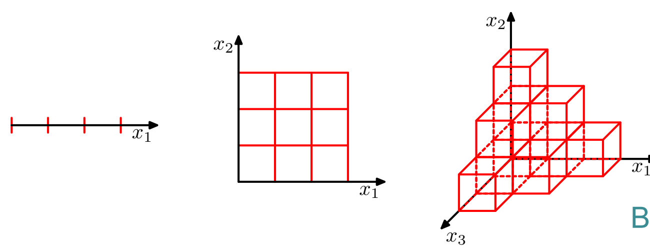
Outlier Detection: *p*(***x***)

Inherently multi-dimensional observations



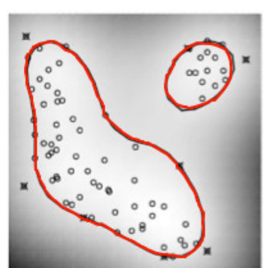
Time series data

Multi-variate density estimation is hard due to the "curse of dimensionality" Bellman (1961)



Bishop (2006)

One-class classification (OCC) based on SVM Schölkopf et al. (2001)



Schölkopf et al. (2001)

$$\hat{p}(\mathbf{x}) < \varepsilon$$

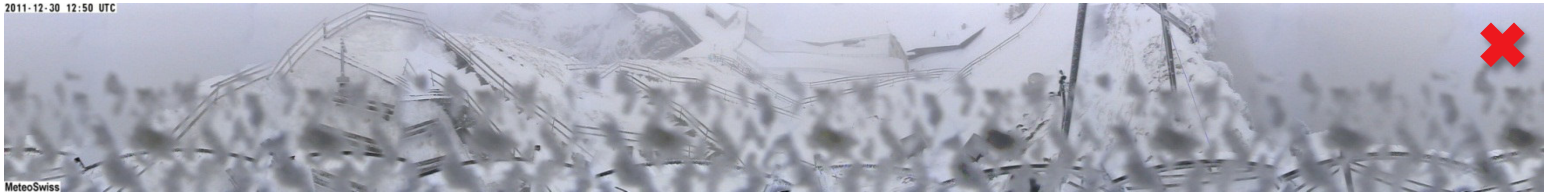
p(***x***) Example: Regular Case

Margin: 0.30

Margin: 0.13

Margin: 0

p(***x***) Example: Outliers



Margin: -0.42

Margin: -0.14

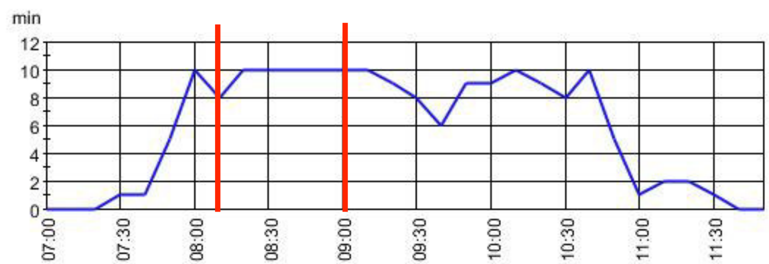
Margin: -0.11

Outlier Detection: *p(x,y)*

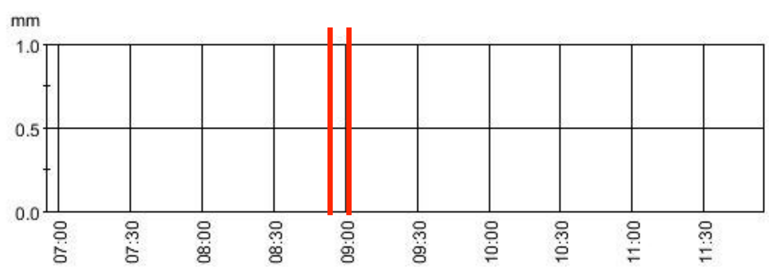
Rule based: Consistency of different but related measurements

$$\sum_{60\,\text{min}} rco > 50\text{ min} \wedge rre < 0.1\text{ mm}$$

Rule seems plausible, but reality is more complex:



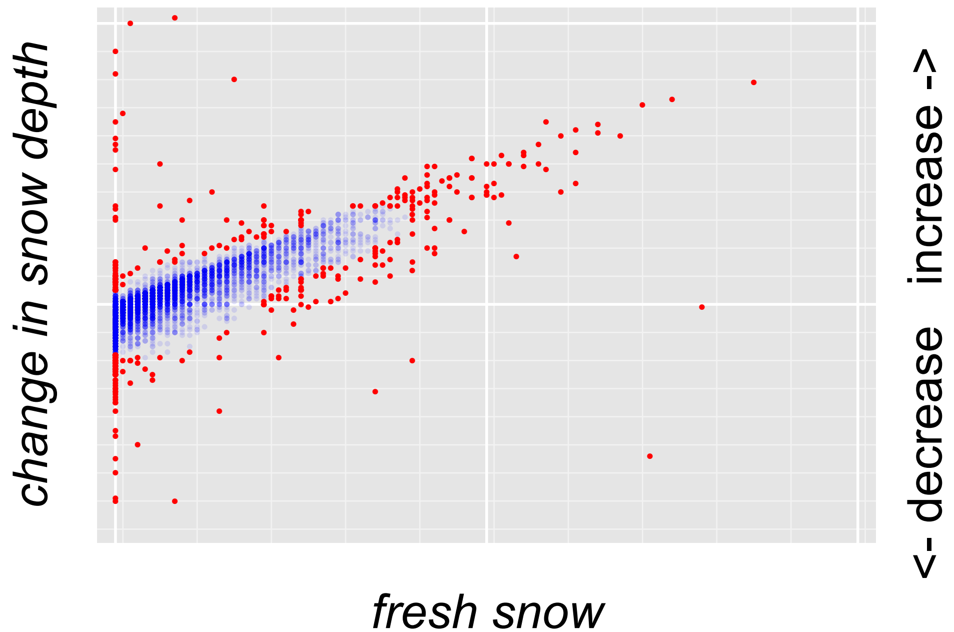
Precipitation activity (rco)



Precipitation sum (rre)

Outlier Detection: *p(x,y)*

Model based: one-class classification of daily change in snow depth and fresh snow (2 years, 109 stations)

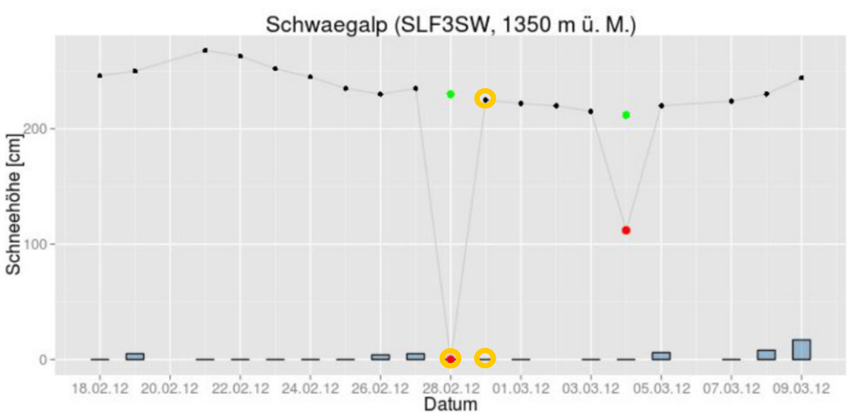


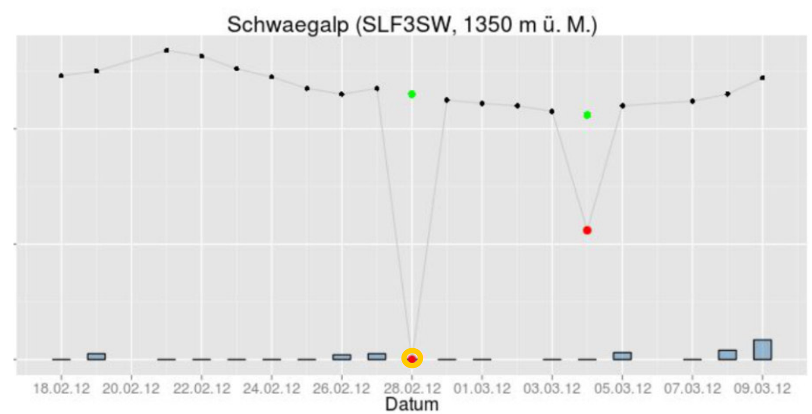
Treatment of QC Cases

Both consistency rules and density estimators flag all involved values and produce a QC case.

1. Automatic QC
2. Treatment of cases

Only Automatic QC





Consistency tests were developed for this scenario

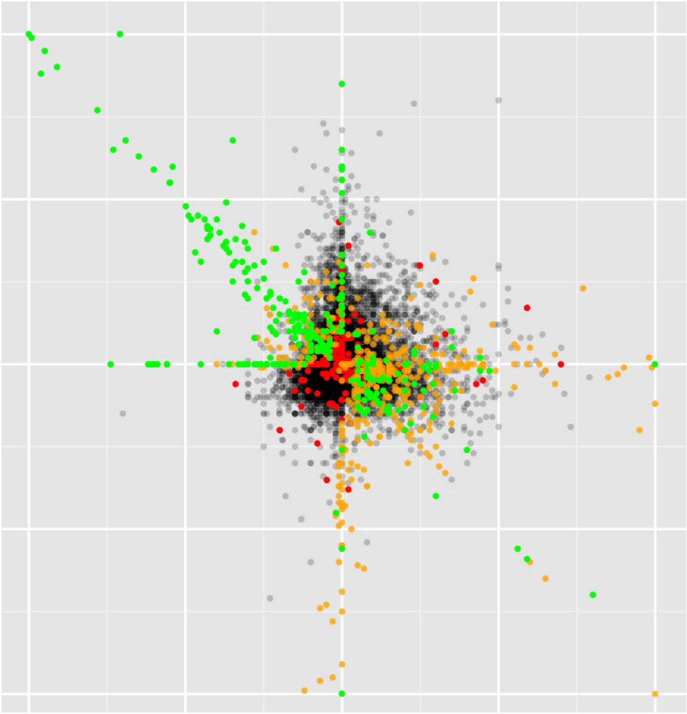
Automatic QC has to identify the erroneous measurement

2. Historical Treatment

“Model imitates expert”

Bi-Classification: *p(q|x,**y**)*

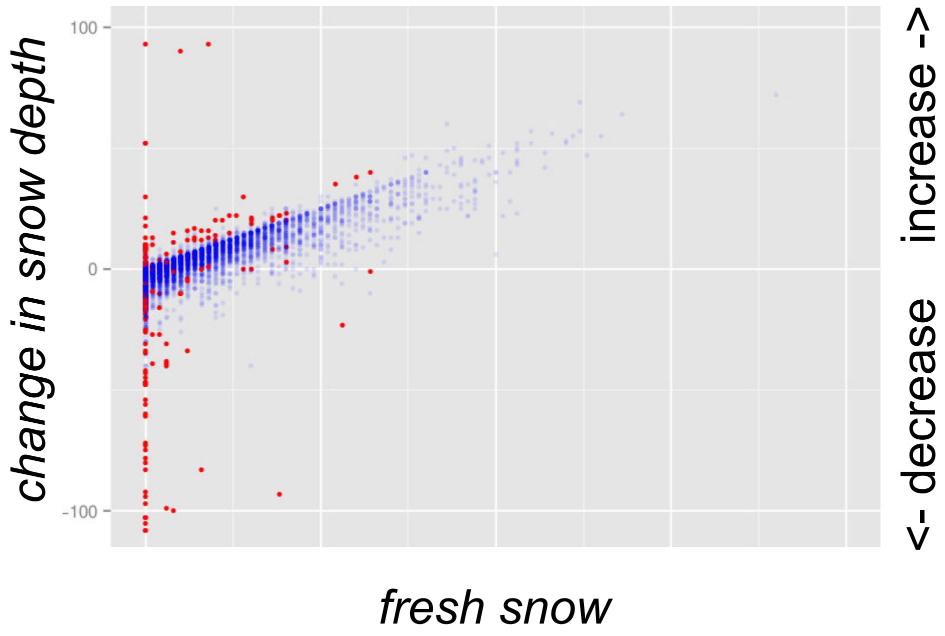
SVM classifier Cristiannini & Shawe-Taylor (2000) trained on labels provided by the Institute for Snow and Avalanche Research (SLF):



- *true negative*
- *true positive*
- *false negative*
- *false positive*

Bi-Classification: *p(q|x,**y**)*

Applied to the same dataset as before:



SVM correctly identifies regions of erroneous measurements.

Label Scarcity Problem

Data is plentiful, but expert labels are scarce.

Two years of labels for snow depth and fresh snow are

- Enough to train a generic model with a good FDR
- Not enough to train station-specific models

3. Relationship to other measurements

"Errors deviate from prediction"

Prediction: $p(x|\mathbf{y})$

Regression: point-wise best estimate, e.g. $E[x|\mathbf{y}]$

1. Train regression model based on context **y**

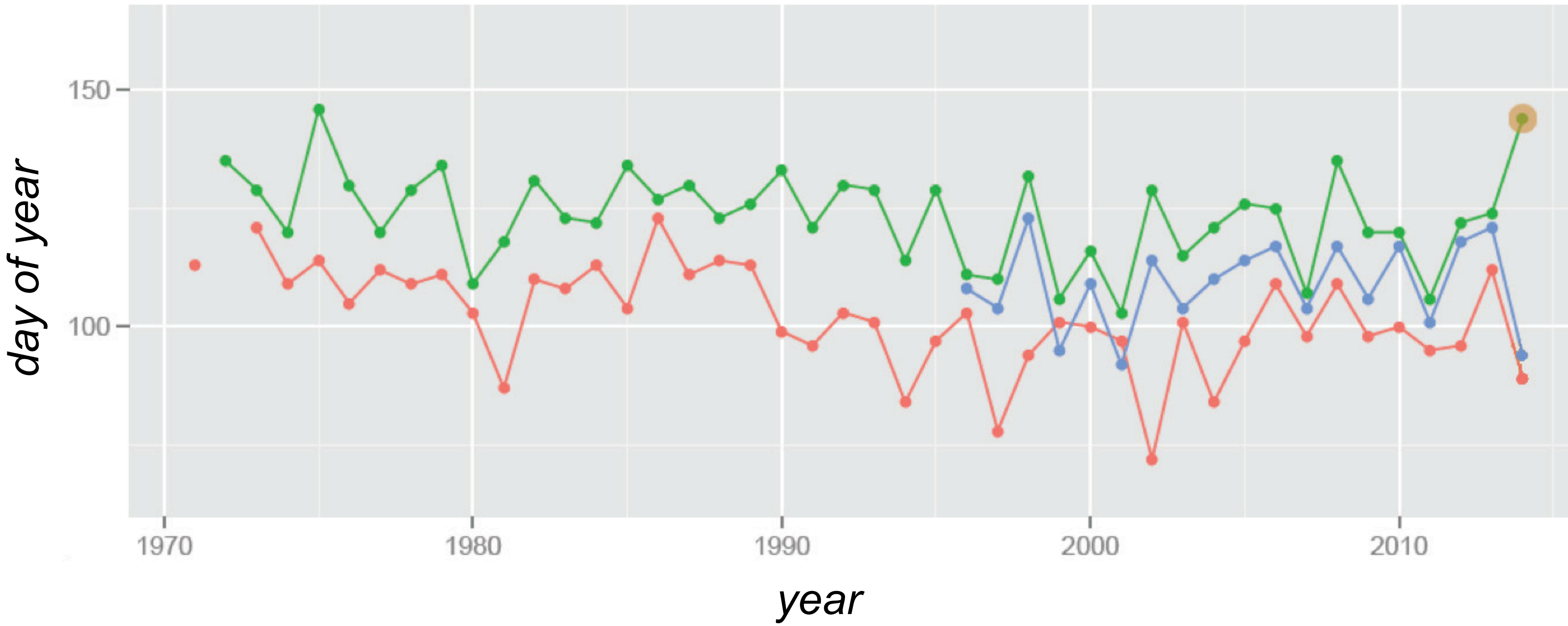
$$x \approx f(\mathbf{y})$$

2. Flag based on difference to observation

$$\varepsilon < x - f(\mathbf{y}) < \varepsilon'$$

Phenology Example

Horse chestnut tree at station „Villnachern“:



leaf unfolding *start of flowering* *full flowering*

Choice of Context

Trade-off:

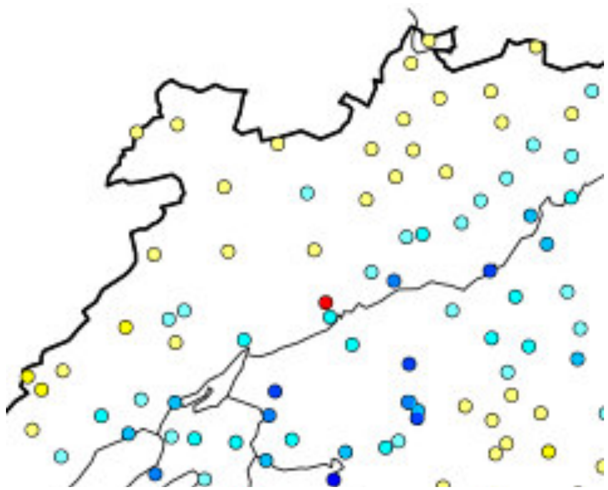
- Predictiveness: which measurements show a strong statistical relationship
- Timeliness: which measurements are available at the time of measurement
- Robustness: data problems in context impair prediction

-> Employ multiple models:

1. Based on climatology only
2. Based on context available at time of measurement
3. Based on most predictive context

Data Problems with Context

- How to deal with missing values in context:
  - Skip test entierely
  - Impute missing predictor
- Errors in context generate FPs:



daily precipitation sums

flagged values

Errors in the Context

Three approaches to deal with errors in the context:

1. Split the context Gandin (1988)

$$x \approx f(y,z) \rightarrow x \approx g(y), x \approx h(z)$$

x can be validated either by *y* or *z*:

+ An error in either predictor can be detected

– predictors are treated as independent
-> loss of power for the test

Errors in the Context

2. Train OCC for the predictors

$$\hat{p}(y,z)$$

Apply test if the predictors are accepted by the OCC

$$\hat{p}(y,z) > \delta \rightarrow \varepsilon < x - f(y,z) < \varepsilon'$$

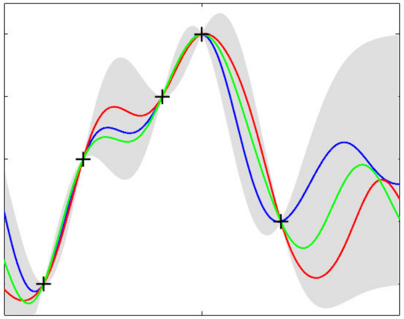
+/– OCC is a separate step, independent of the regression model

Errors in the Context

3. Predict the full distribution instead of a point estimate:

$$\mathrm{E}\left[x \mid y,z\right] \rightarrow \hat{p}\left(x \mid y,z\right)$$

For example using Gaussian process regression



Rasmussen and Williams (2006)

- \+ Posterior variance is high for unlikely (*y*,*z*)
- \+ Single integrated model
- – Model complexity

Conclusions

Summary

We use three information sources for quality control:

1. **Relative frequency of occurrence:** density estimation
   \+ low FDR for $p(x)$ or $p(\mathbf{x})$ – high FDR for $p(x,y)$
2. **Historical treatment:** classification
   \+ identifies erroneous measurement – label scarcity
3. **Relationship to other measurement:** regression
   \+ no labels needed ! erroneous or missing context

Thank you for your attention.

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Identifying and attributing common data quality problems: temperature and precipitation observations in Bolivia and Peru

S. Hunziker [1], S. Gubler [2] J. Calle [3], I. Moreno [3], M. Andrade [3], F. Velarde [3], L. Ticona [3], G. Carrasco [4], Y. Castellón [4], C. Oria Rojas [5], S. Brönnimann [1], M. Croci-Maspoli [2], T. Konzelmann [2], M. Rohrer [2]

[1] *Oeschger Centre for Climate Change Research and Institute of Geography, University of Bern, Bern, Switzerland*

[2] *Federal Office of Meteorology and Climatology MeteoSwiss, Zürich, Switzerland*

[3] *Laboratorio de Física de la Atmósfera, Instituto de Investigaciones Físicas, Universidad Mayor de San Andrés, La Paz, Bolivia*

[4] *Servicio Nacional de Meteorología e Hidrología de Bolivia, SENAMHI*

[5] *Servicio Nacional de Meteorología e Hidrología del Perú, SENAMHI*

Challenges

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- Data availability
- Sparse station network
- Metadata is fractional or missing
- Often severe data quality problems

Challenges

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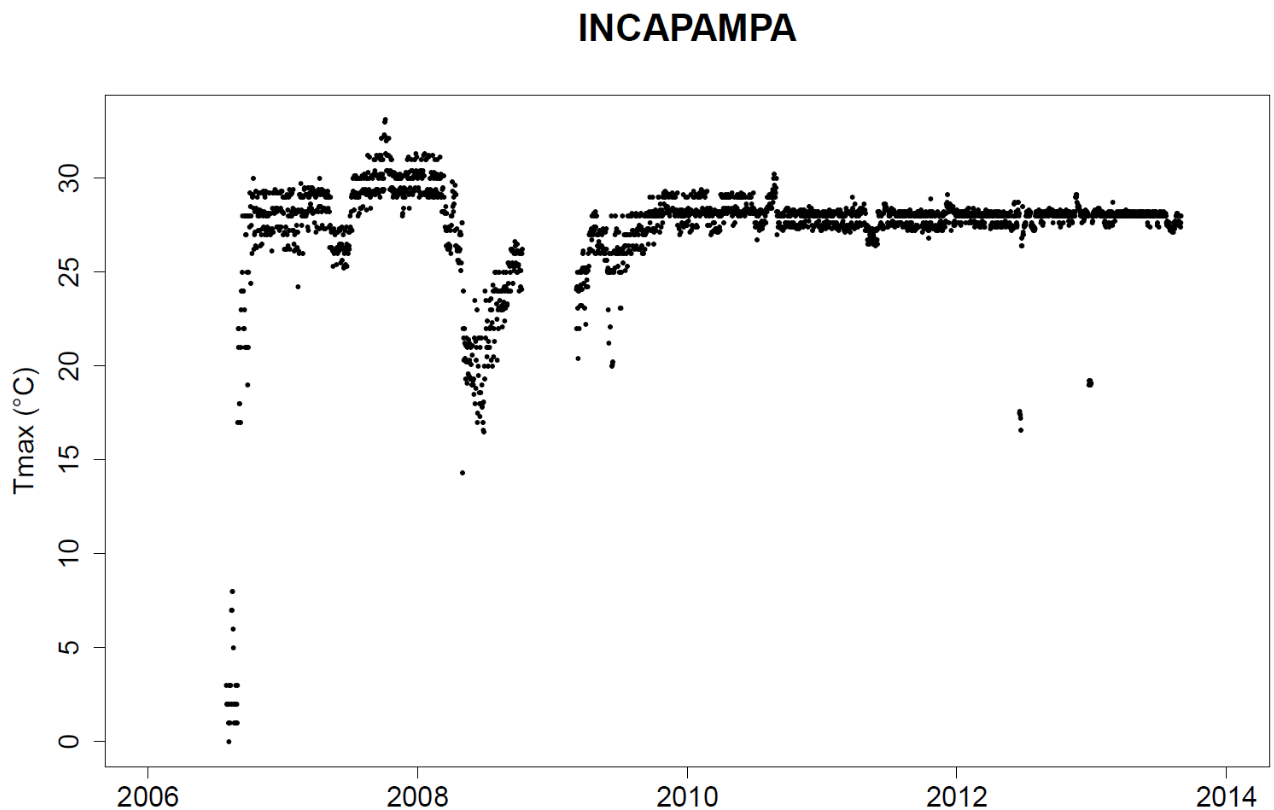
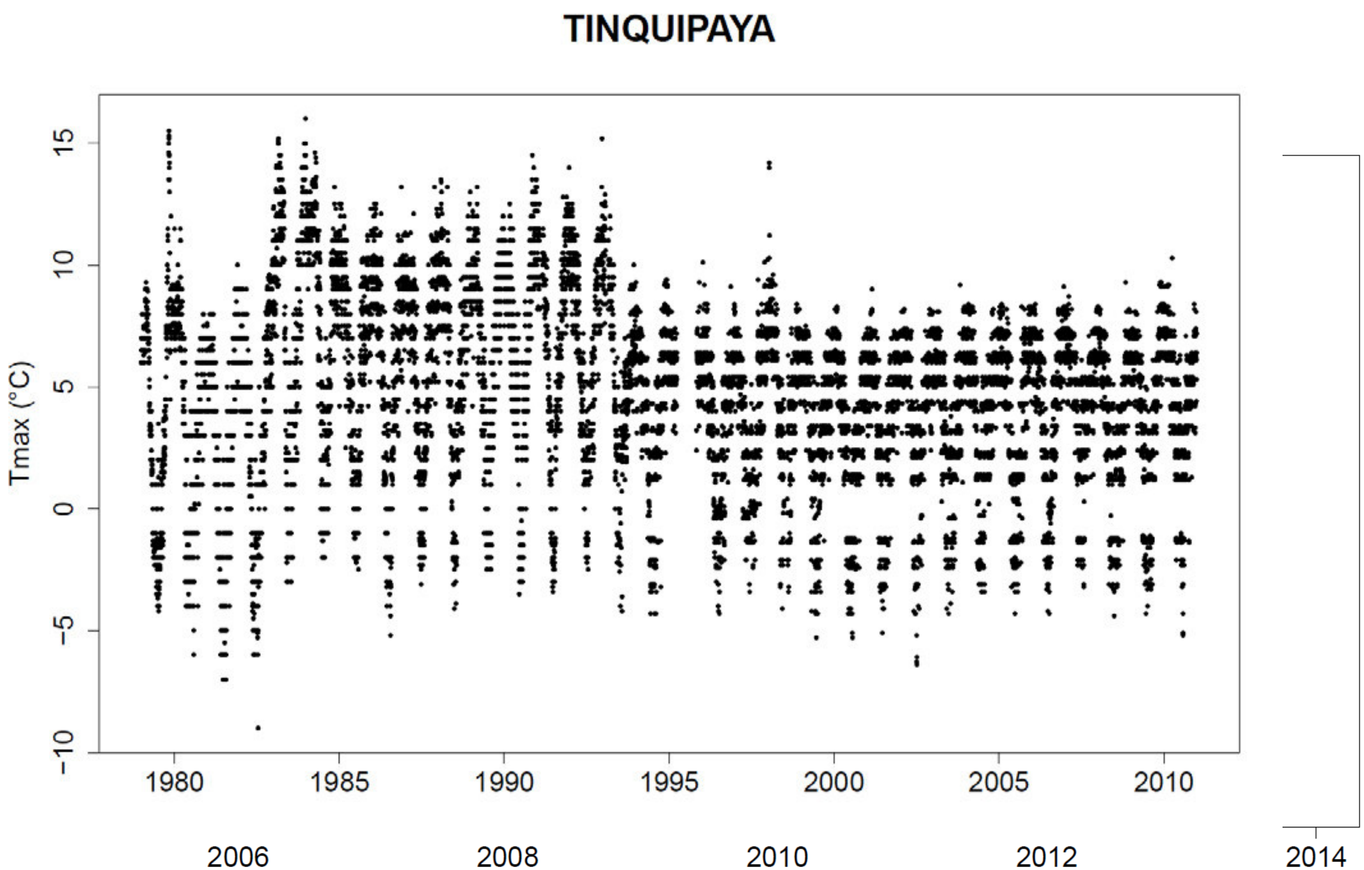
- Data availability
- Sparse station network
- Metadata is frac
- Often severe da



Challenges

- Data availability
- Sparse stati
- Metadata is
- Often sever



Challenges

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- Data availability
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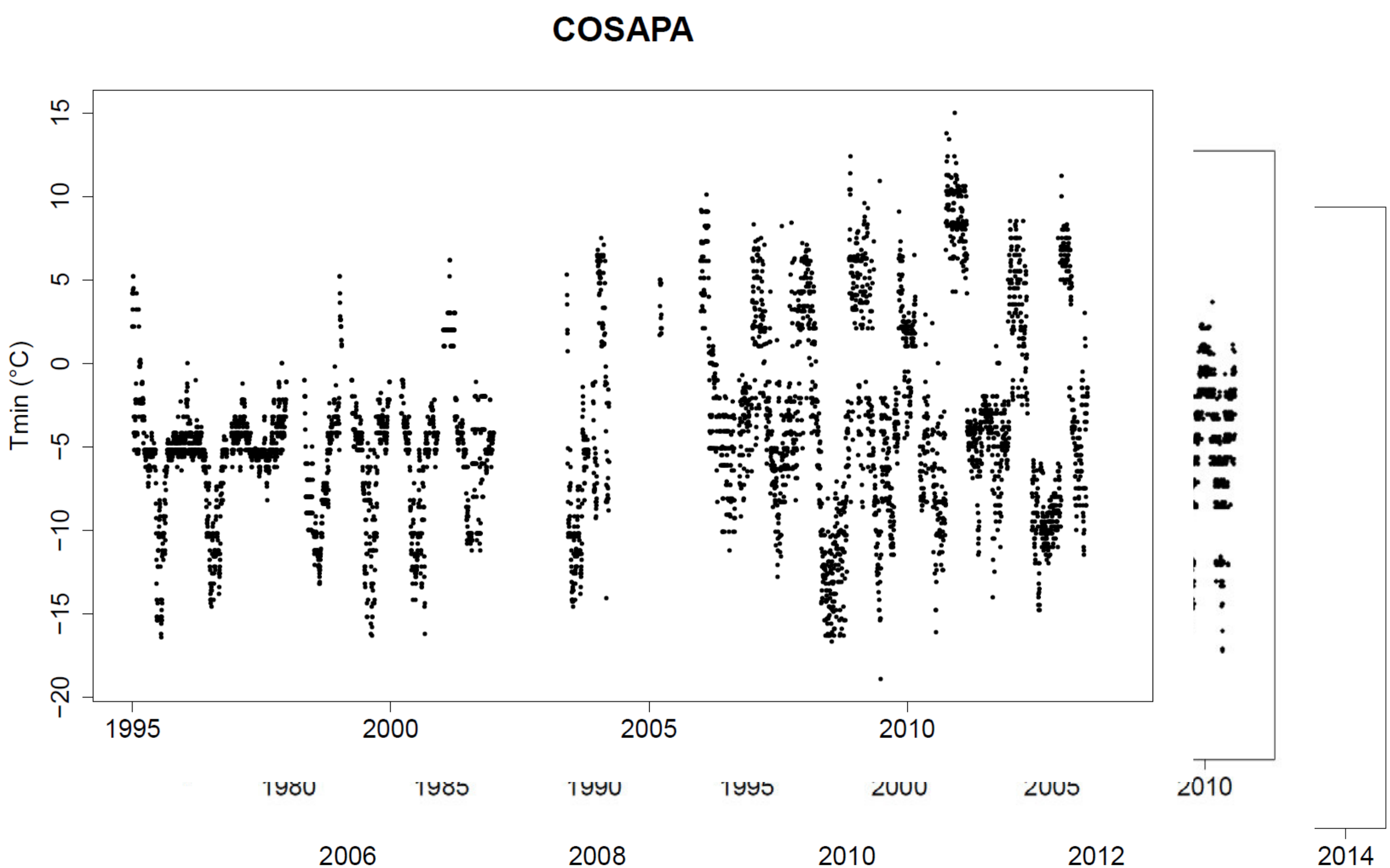
- Metac
- Often



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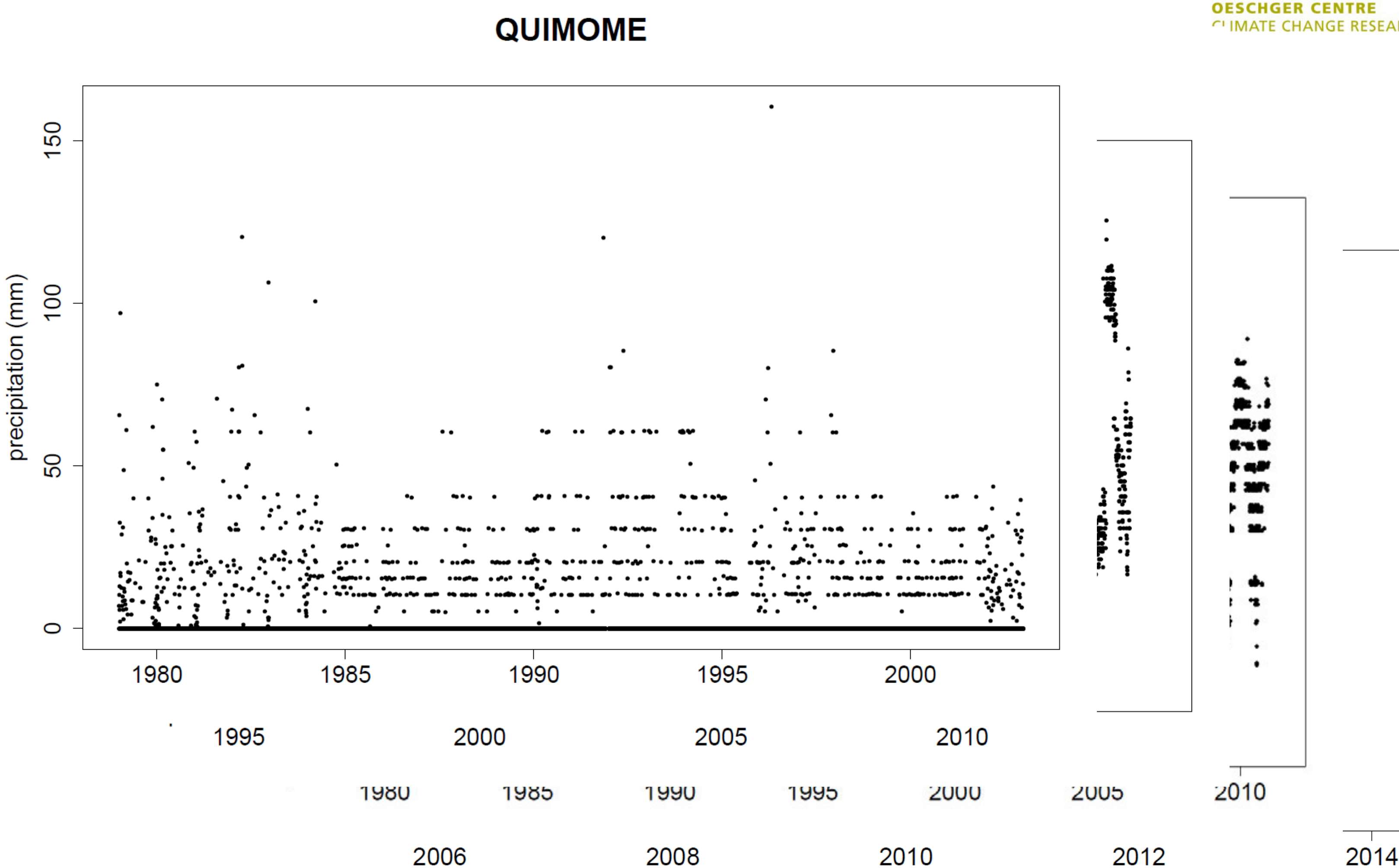

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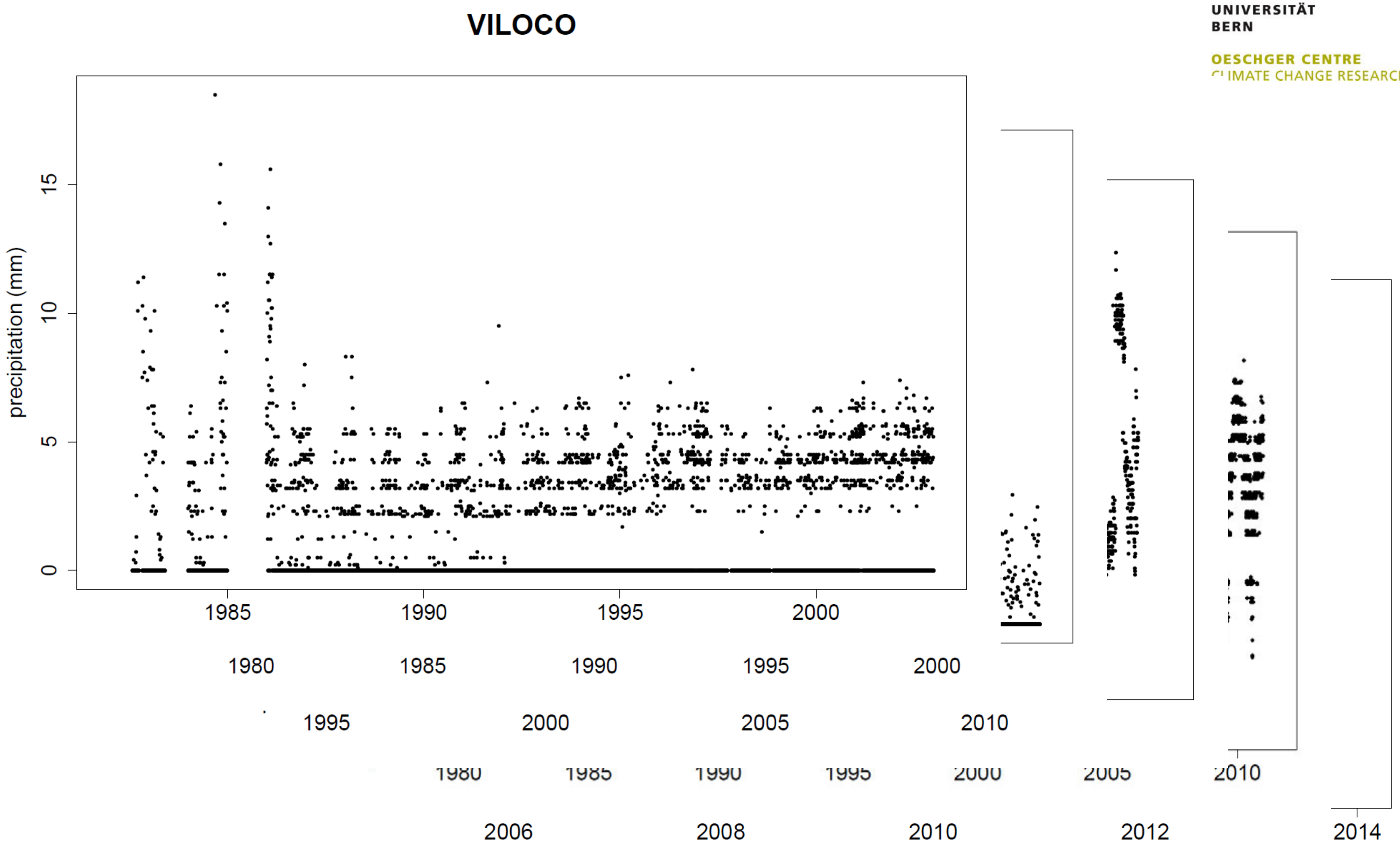

Challenges

- Data availability
- Sparse station network
- Metadata is fractional or missing
- Often severe data quality problems

Frequently found errors:

- missing temperature intervals
- reduction of variability
- rounding inconstancies
- 20mm precipitation cut
- missing low precipitation values
- untagged rainfall accumulations
- transcription errors

Challenges

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CLIMATE CHANGE RESEARCH

- Data availability
- Sparse station network
- Metadata is fractional or missing
- Often severe data quality problems

Frequently found errors:

- missing temperature intervals
- **reduction of variability**
- **rounding inconstancies**
- **20mm precipitation cut**
- **missing low precipitation values**
- **untagged rainfall accumulations**
- transcription errors

Metadata

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Station visits to

1. report and assess the actual state of the station
2. reconstruct the station history
3. detect sources of data errors

Metadata

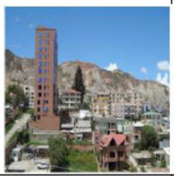
Metadata

FORMULARIO DE RECOLECCIÓN DE METADATA ESTACIONES METEREOLÓGICAS			
Nombre de la estación	Cota Cota	Alias	
Código(s)		Tipo de estación	Automática (datalogger CR200X SN: 13809) Campbell Scientific.
Institución a cargo	Instituto de Investigaciones Físicas		
Persona de contacto	Lic. René Torrez Santalla		
Rotación del personal	Actual	Lic. René Torrez Santalla	
	Previa	No hubo nunca rotación del personal	
Cada cuanto se reporta a la oficina	Cada 2 semanas se descargan los datos		

Ubicación	Actual	Previa	Inicio de la serie de datos
Latitud	16°33´20.893´´		Se inicia en tre 1998 y 1999
Longitud	68°03´59.297´´		
Elevación	3445.73 m		

Fotografías desde la estación

Vista al Sur



Vista al Norte

Foto de la estación

Vista al Este

Vista al Oeste

Obstáculos	Existen materiales como maderas y fierros que perjudican el transito
Infraestructura	La estación está instalada en una Torre de fierro de aproximadamente 3.33 m de altura.
Observaciones	El techo podría perjudicar la medición de la radiación solar.

BITACORA DE LA ESTACIÓN

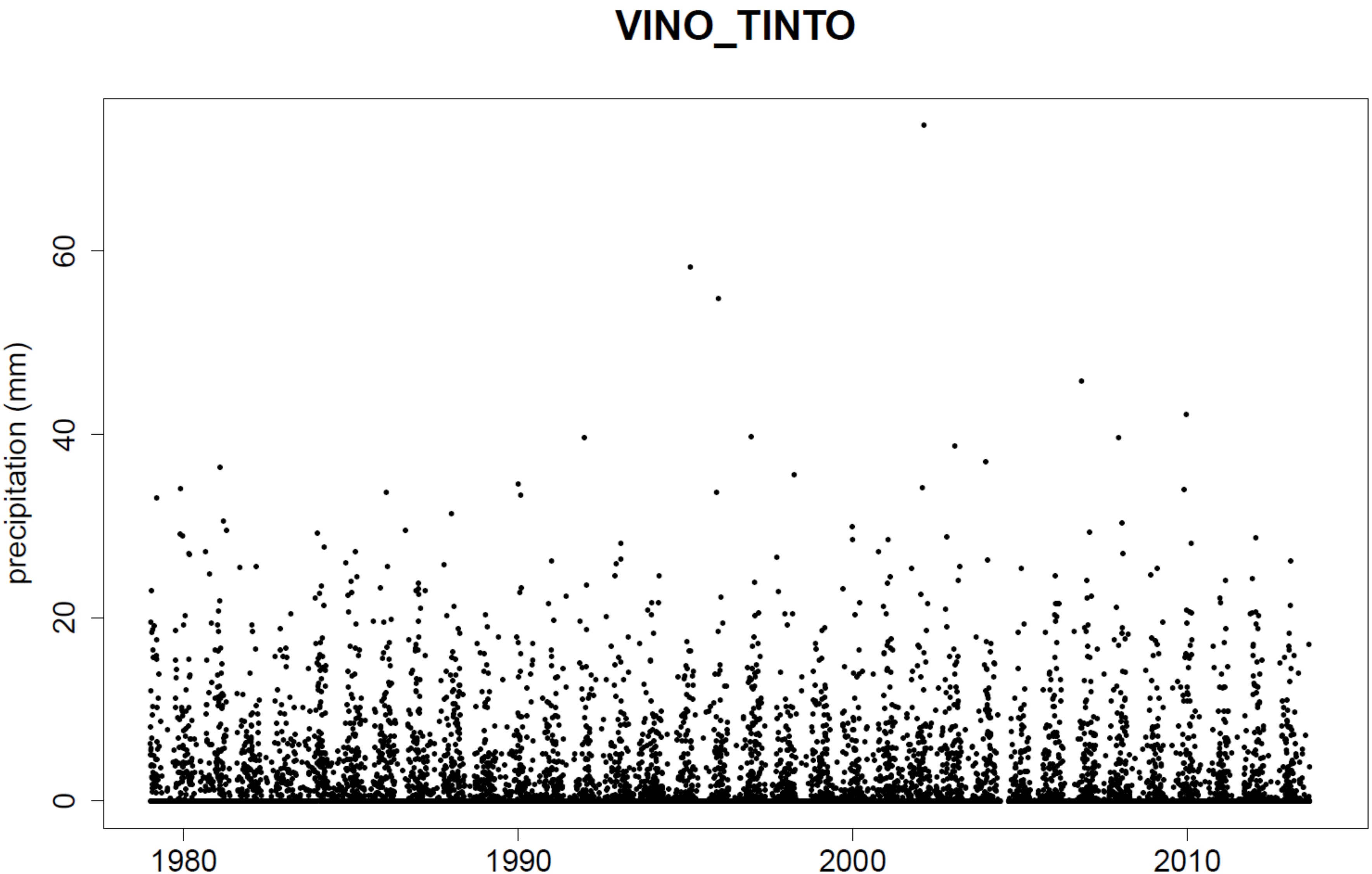
#	Fecha	Participante(s)	Acción ejecutada	Descripción
1	12/03/2014	Decker Guzman Zabalaga	Recojo de bitacora	No exite bitácora de la estación.
2	No existe fecha exacta	Lic. Rene Torrez Santalla	Retiro de radiómetro eppley	Aproximadamente hace un año y medio se hizo el retiro de radiómetro .
3	20/02/2014	Lic. Rene Torrez Santalla	Descarga de datos	Se descargaron los datos de la estación por medio de una computadora conectada al Datalogger

Variables que se miden	Unidades	Instrumento Marca/Modelo	Altura	Intervalo de medición	Calibración	Observaciones
Temperatura	ºC	Licor 200	3,33[m]	5 [min]	No se realiza	No se realiza calibraciones,solo intercomparaciones con la estación de Patacamaya Variación de 2ºC actualmente . 13/03/2014
Presión						
Humedad relativa	%	Met one instruments	3,33[m]	5 [min]	No se realiza	No se realiza calibraciones,solo intercomparaciones con la estación de Patacamaya
Velocidad del viento	m/s	Met one instruments	3,07[m]	5 [min]	No se realiza	No se realiza calibraciones,solo intercomparaciones con la estación de Patacamaya
Dirección del viento	(º)	Met one instruments	3,07[m]	5 [min]	No se realiza	No se realiza calibraciones,solo intercomparaciones con la estación de Patacamaya
Precipitación						
Radiación solar	mV		3,01[m]	5 [min]	No se realiza	No se realiza calibraciones,solo intercomparaciones con la estación de Patacamaya

***Notas:**

- No se tiene un periodo determinado para realizar la intercomparación
- La estación meteorológica fue armada por partes y no se tiene el número del modelo de cada parte.

Metadata



Metadata

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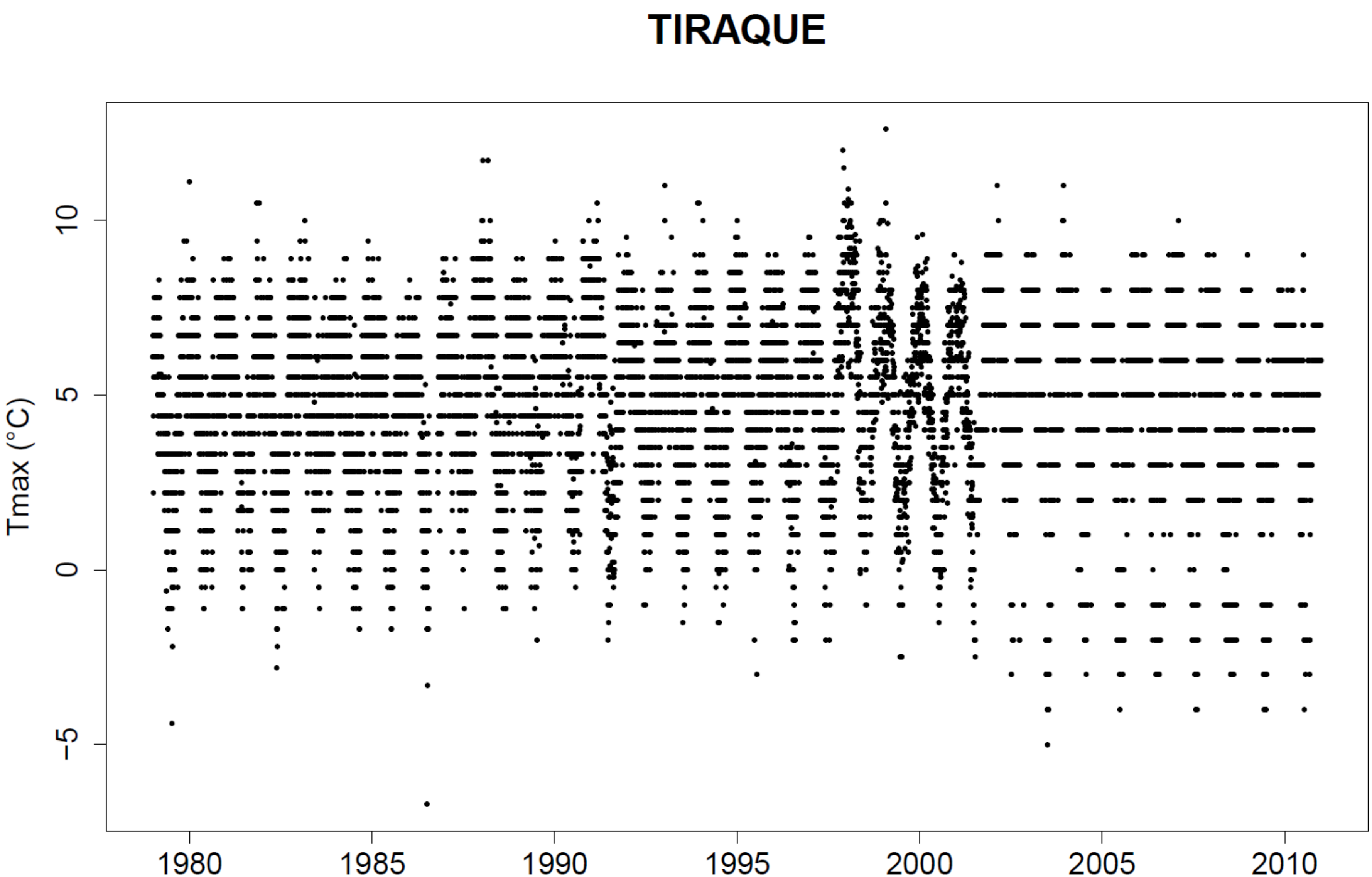
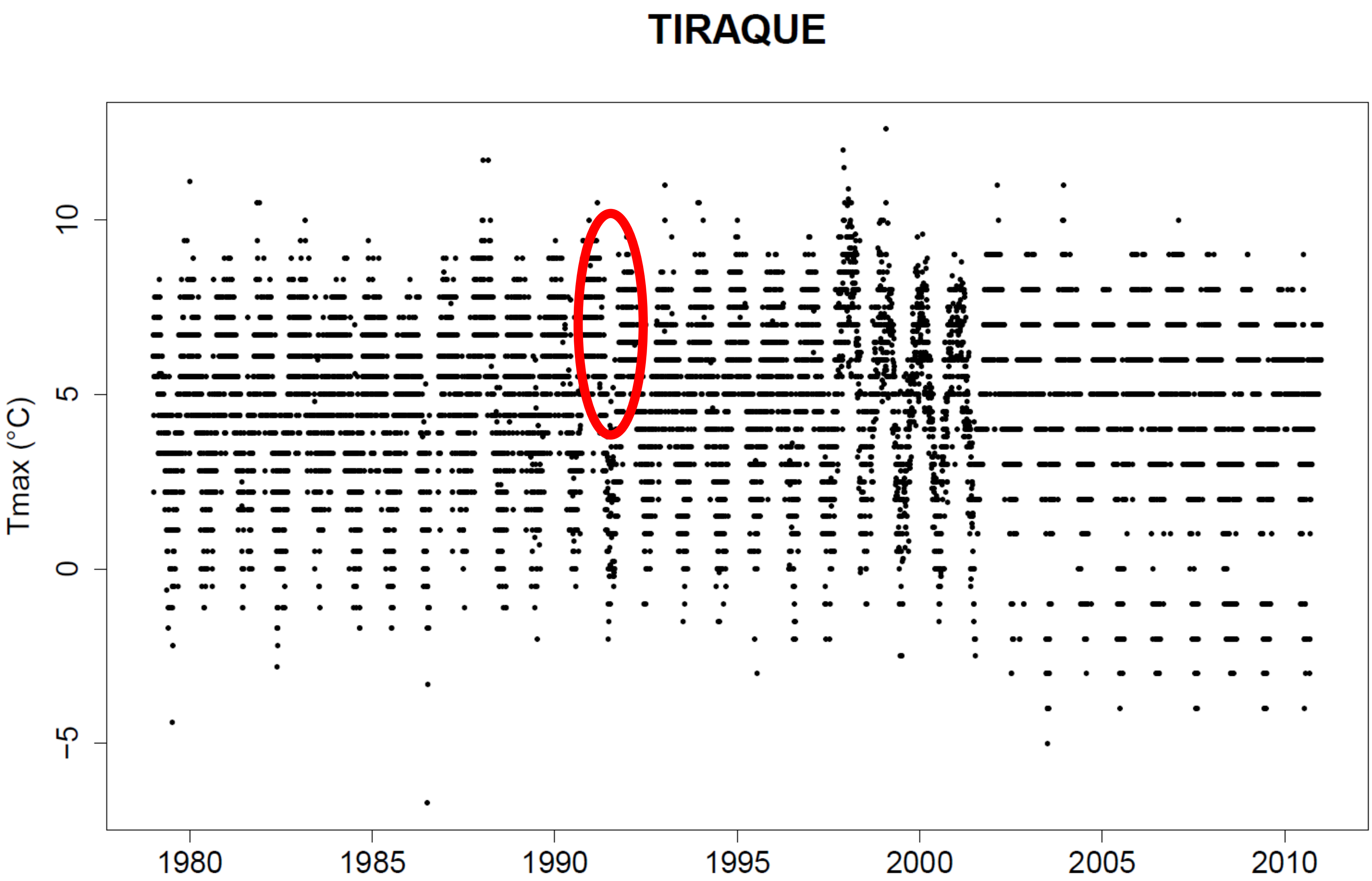
Rounding inconstancies



Rounding inconstancies



Reduced variability in all variables

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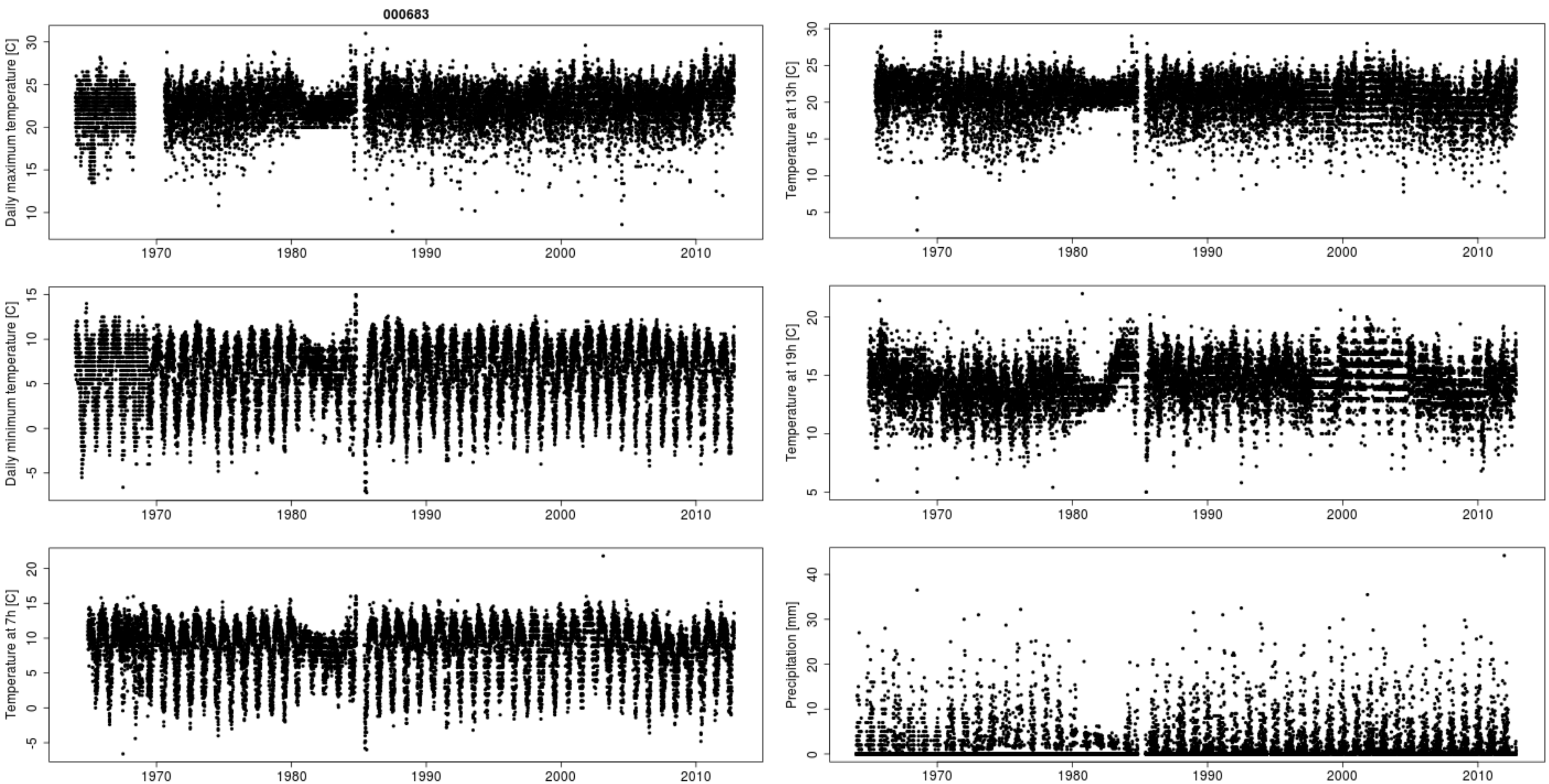
Urubamba, Peru



Reduced variability in all variables

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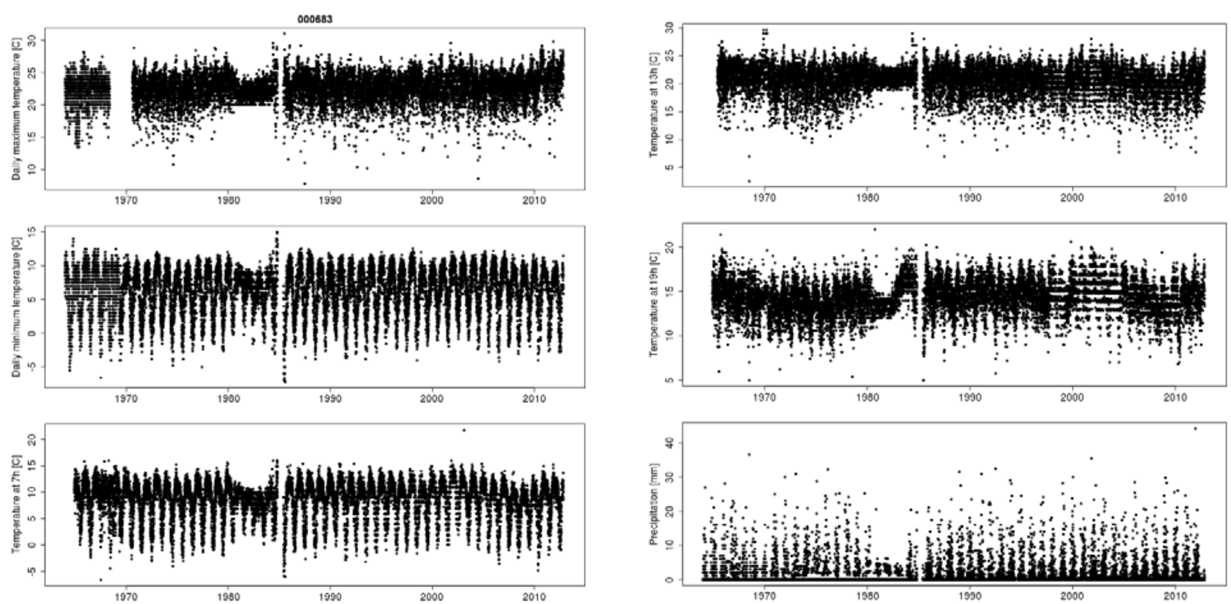
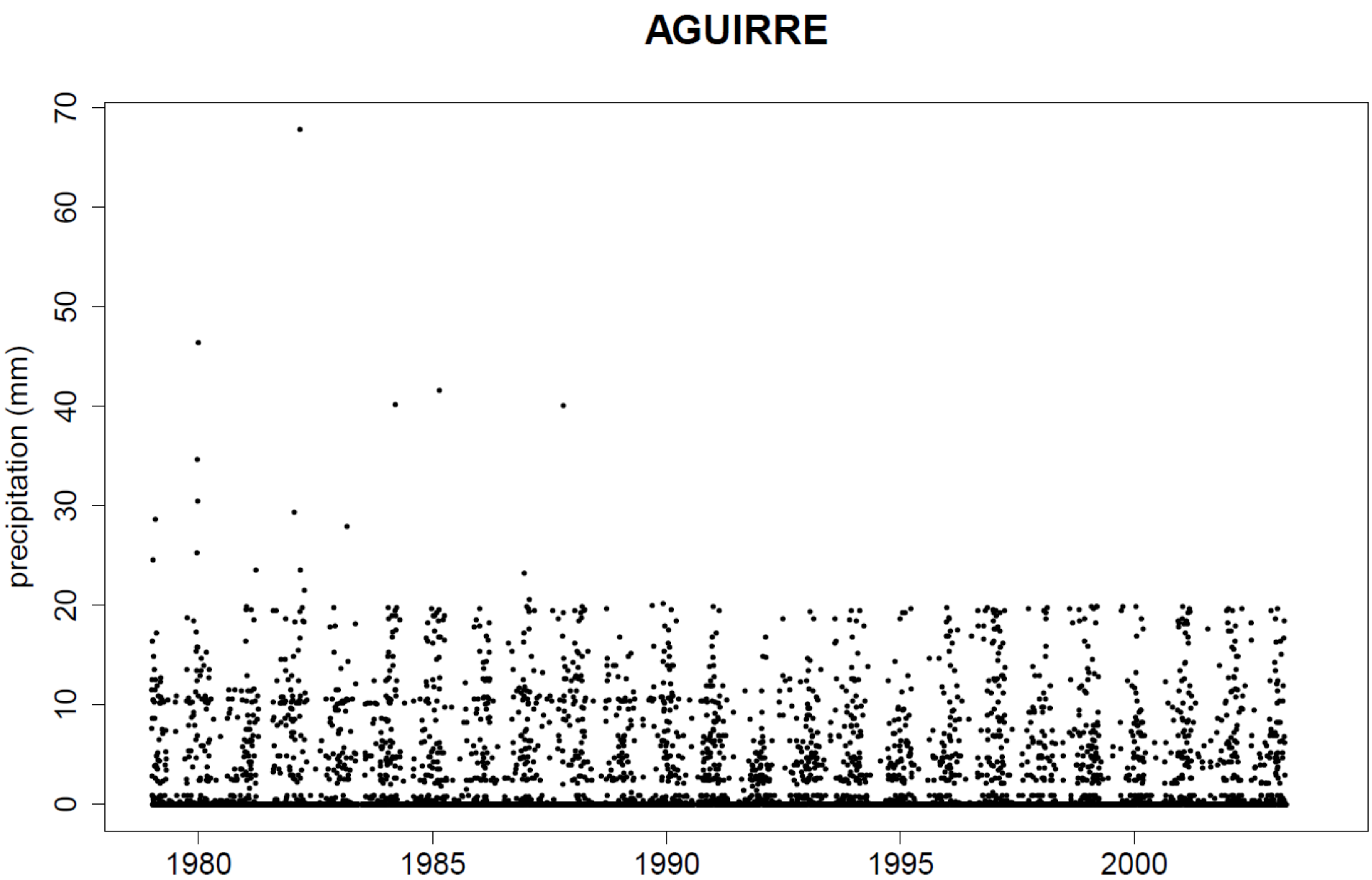
Urubamba, Peru

- Rebellion of the Sendero Luminoso against the Peruvian state (escalating in the early 80s)
- Data gaps and errors are found in many stations in that time
- All parameters affected → observer error
- Exact source of error source is unknown



20mm precipitation cut



20mm precipitation cut

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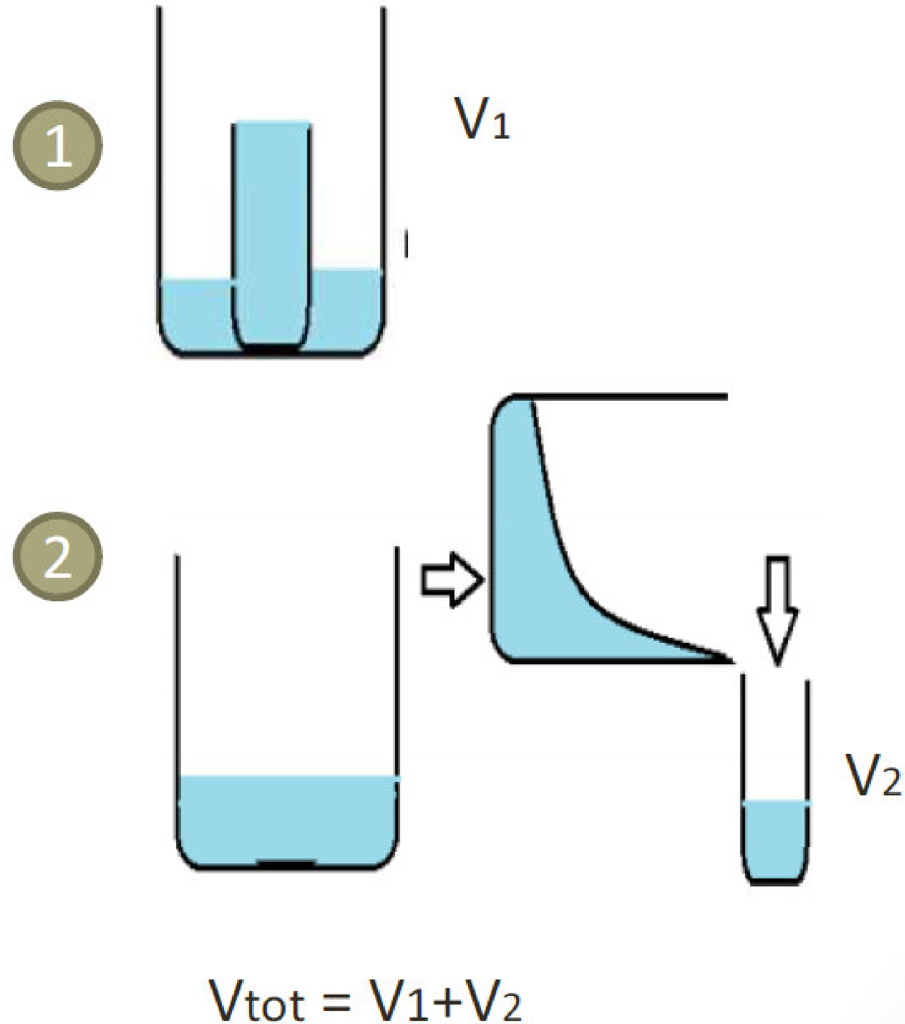
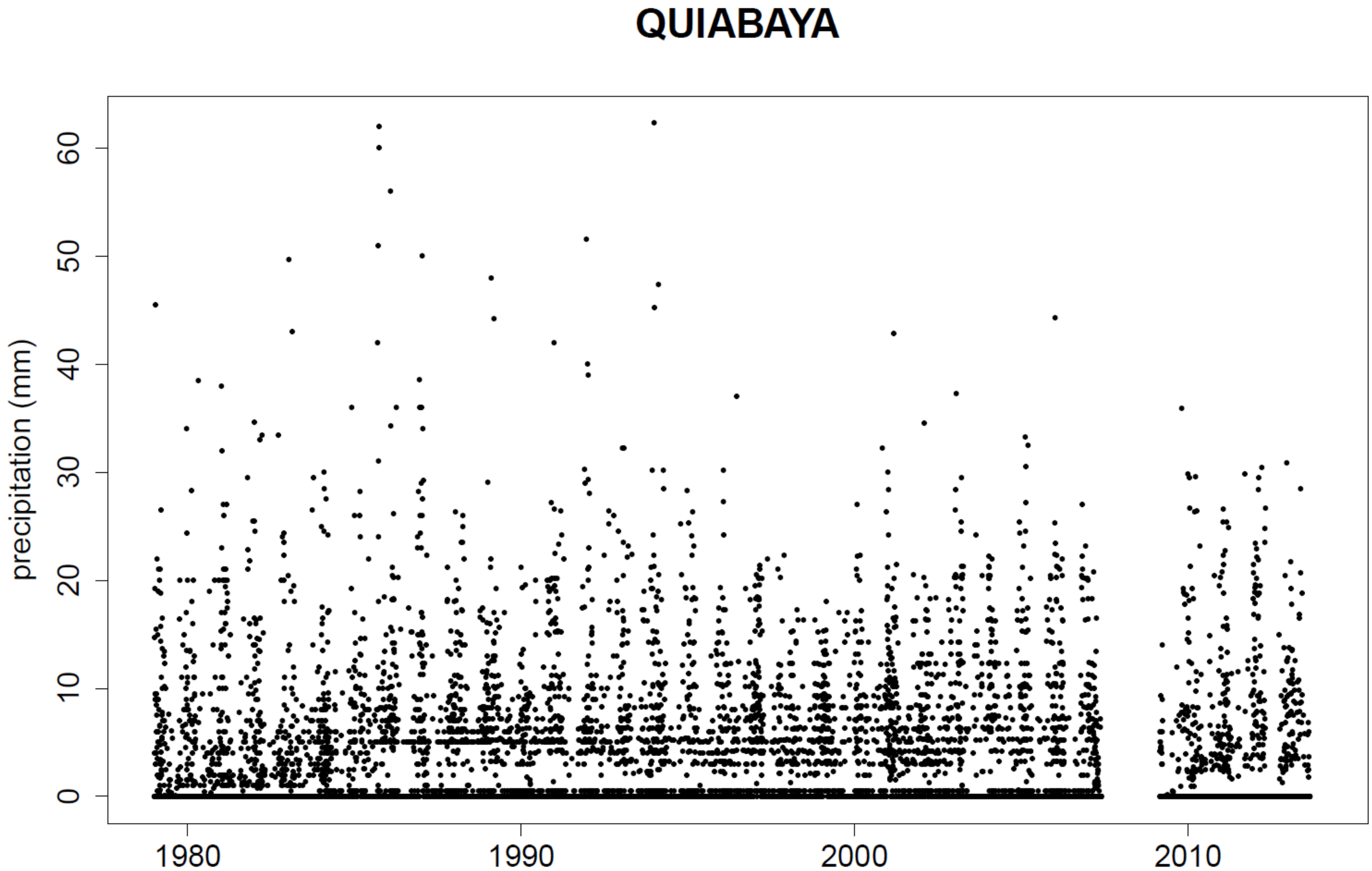


Low precipitation gap



Low precipitation gap

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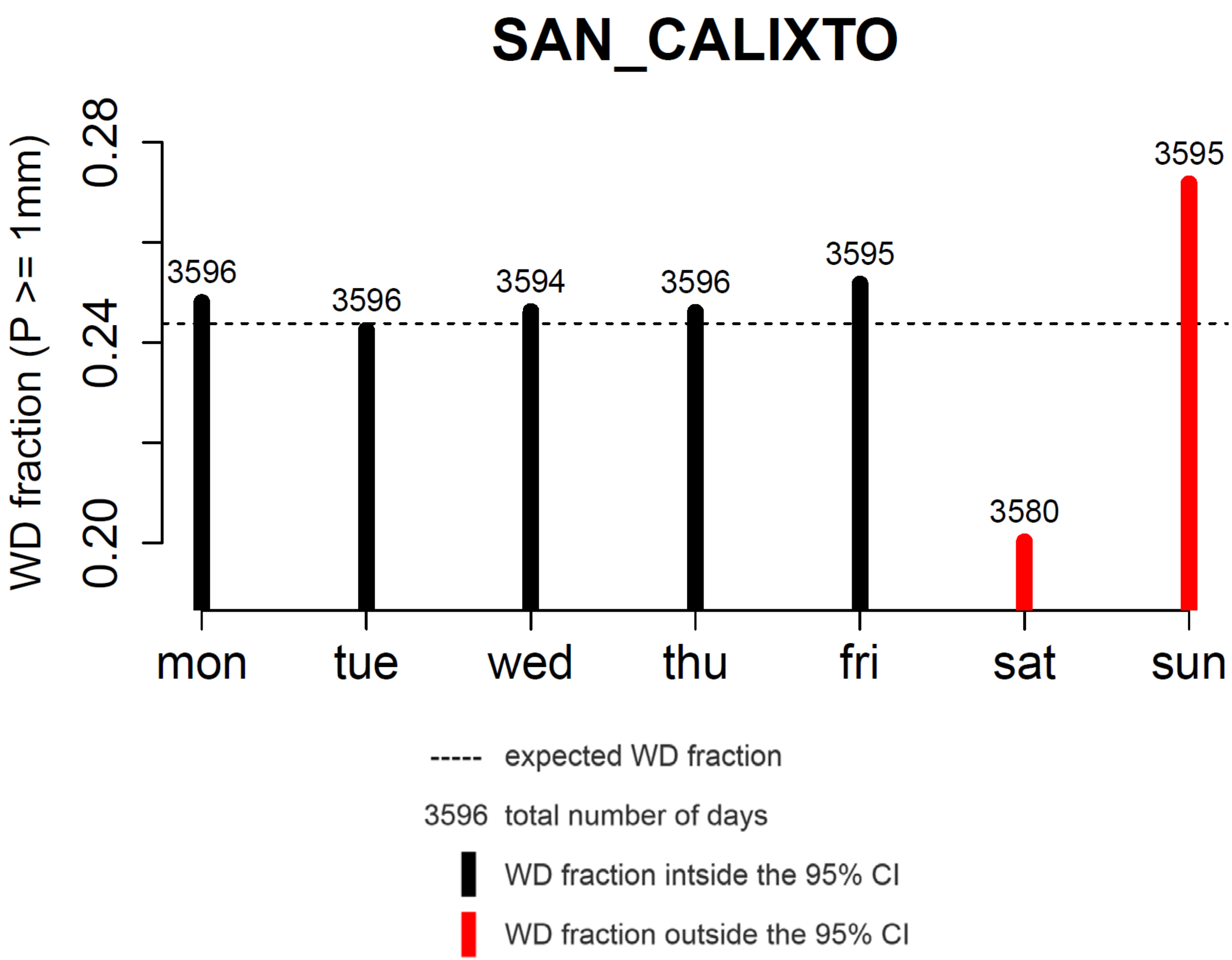
Untagged rainfall accumulations



Untagged rainfall accumulations

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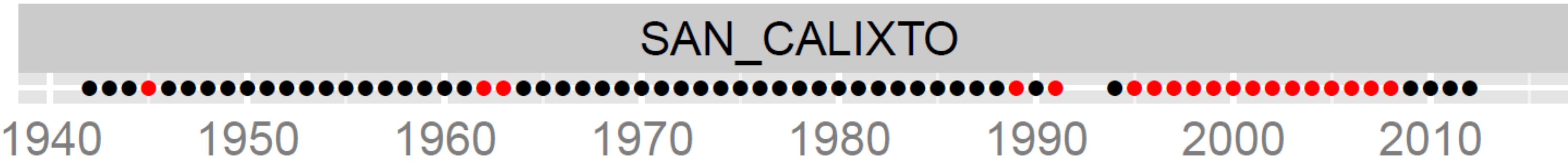
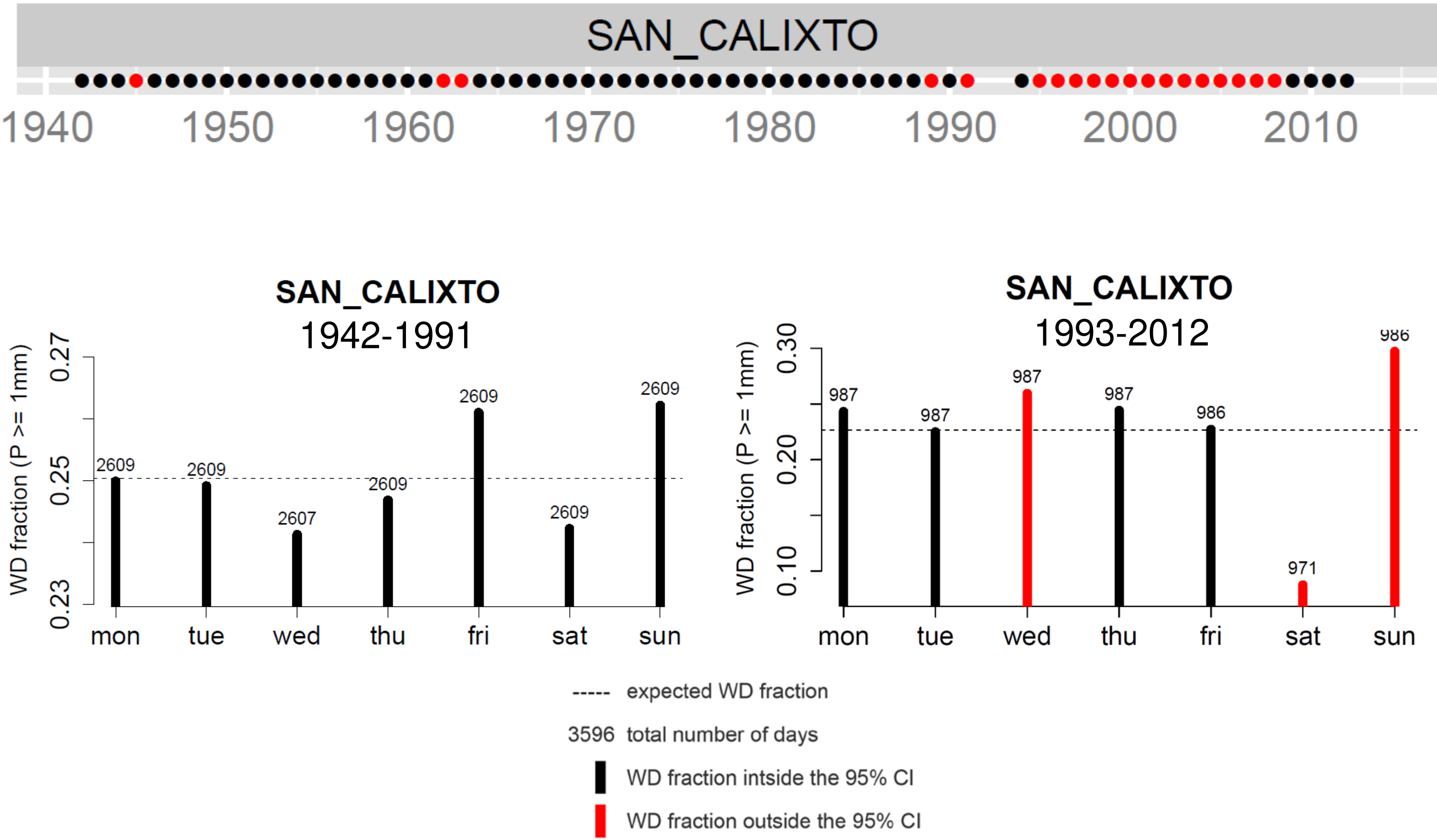


Untagged rainfall accumulations



Untagged rainfall accumulations

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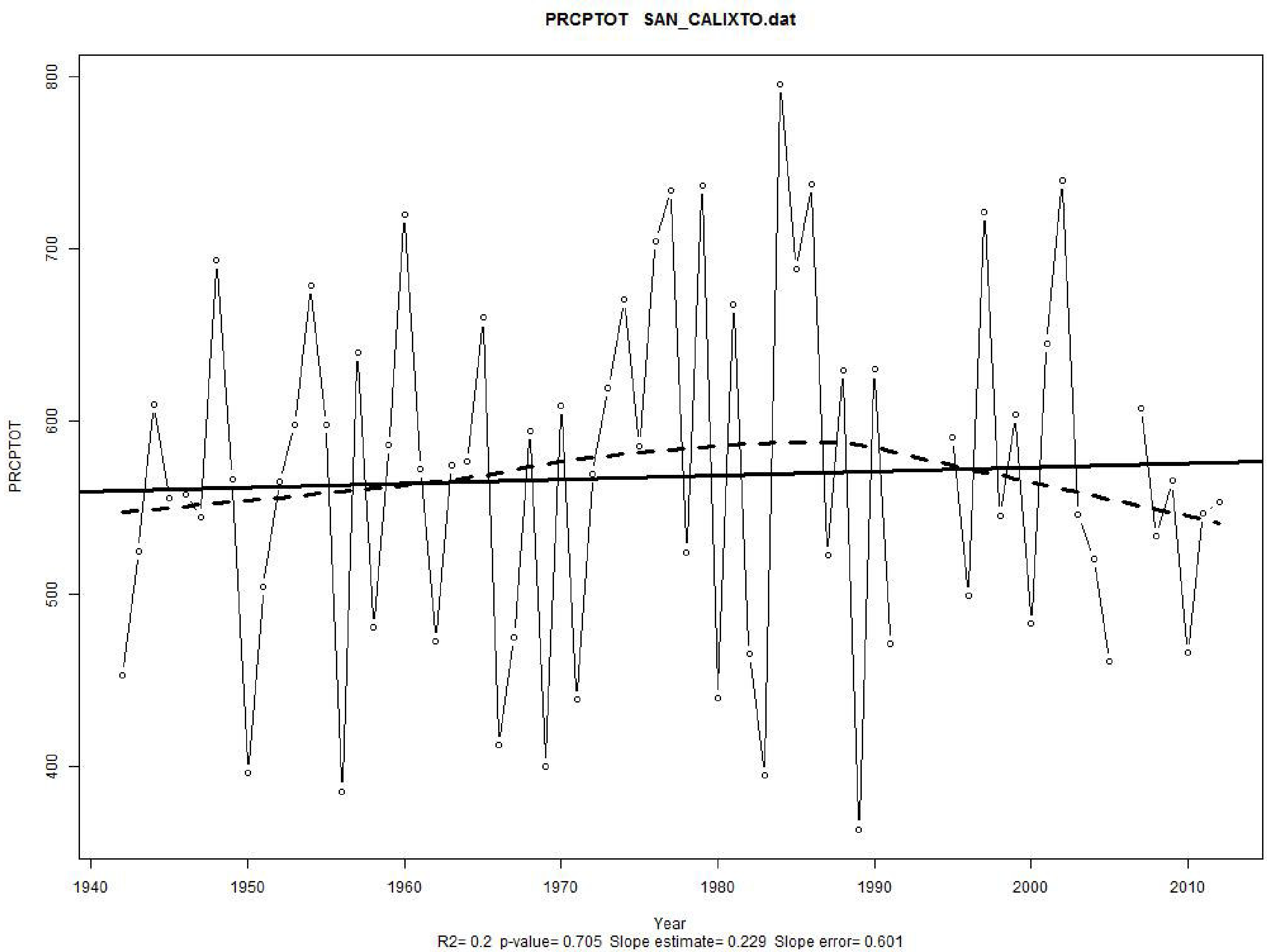
PRCPTOT: annual total wet-day precipitation



Untagged rainfall accumulations

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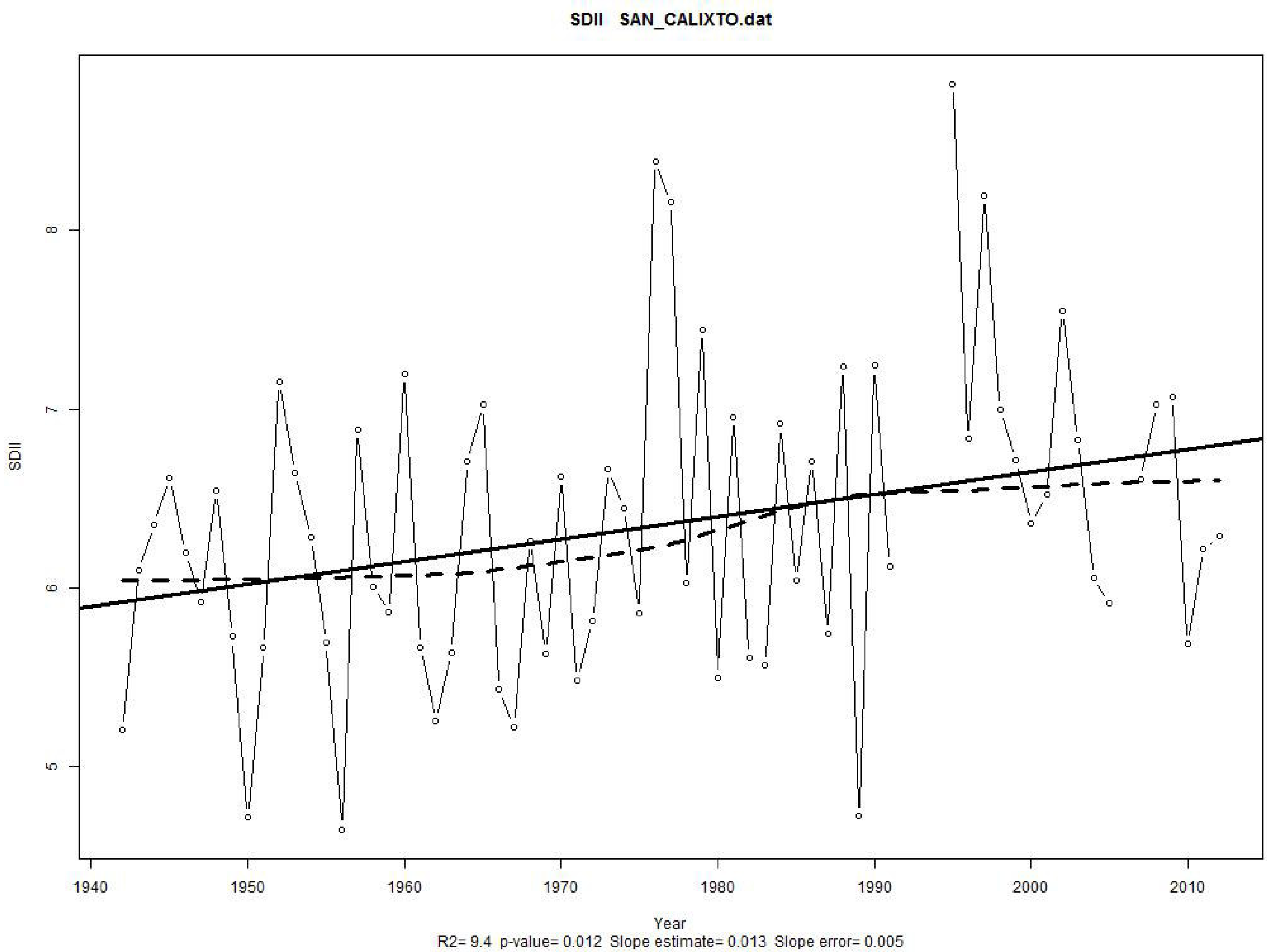
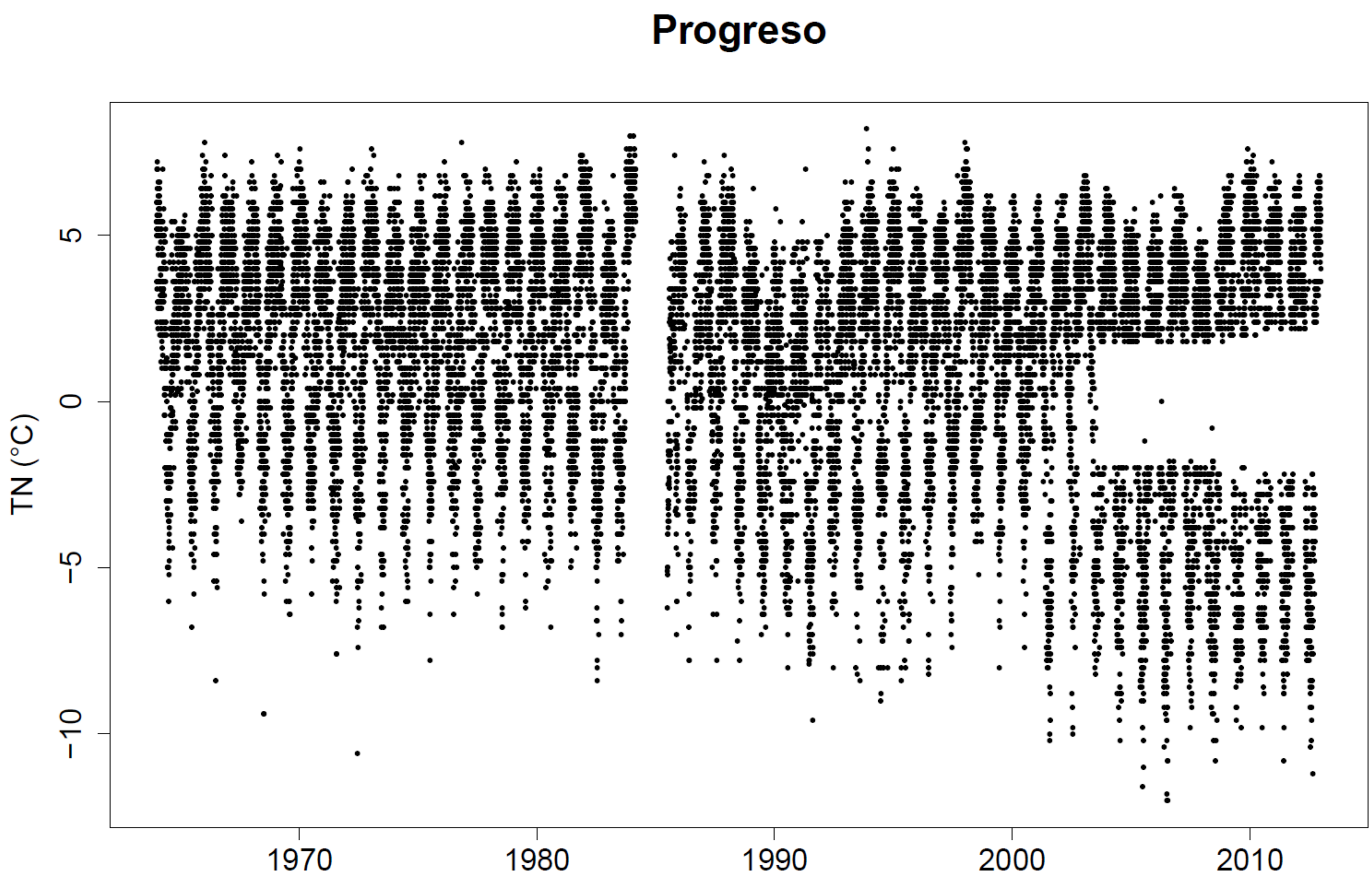
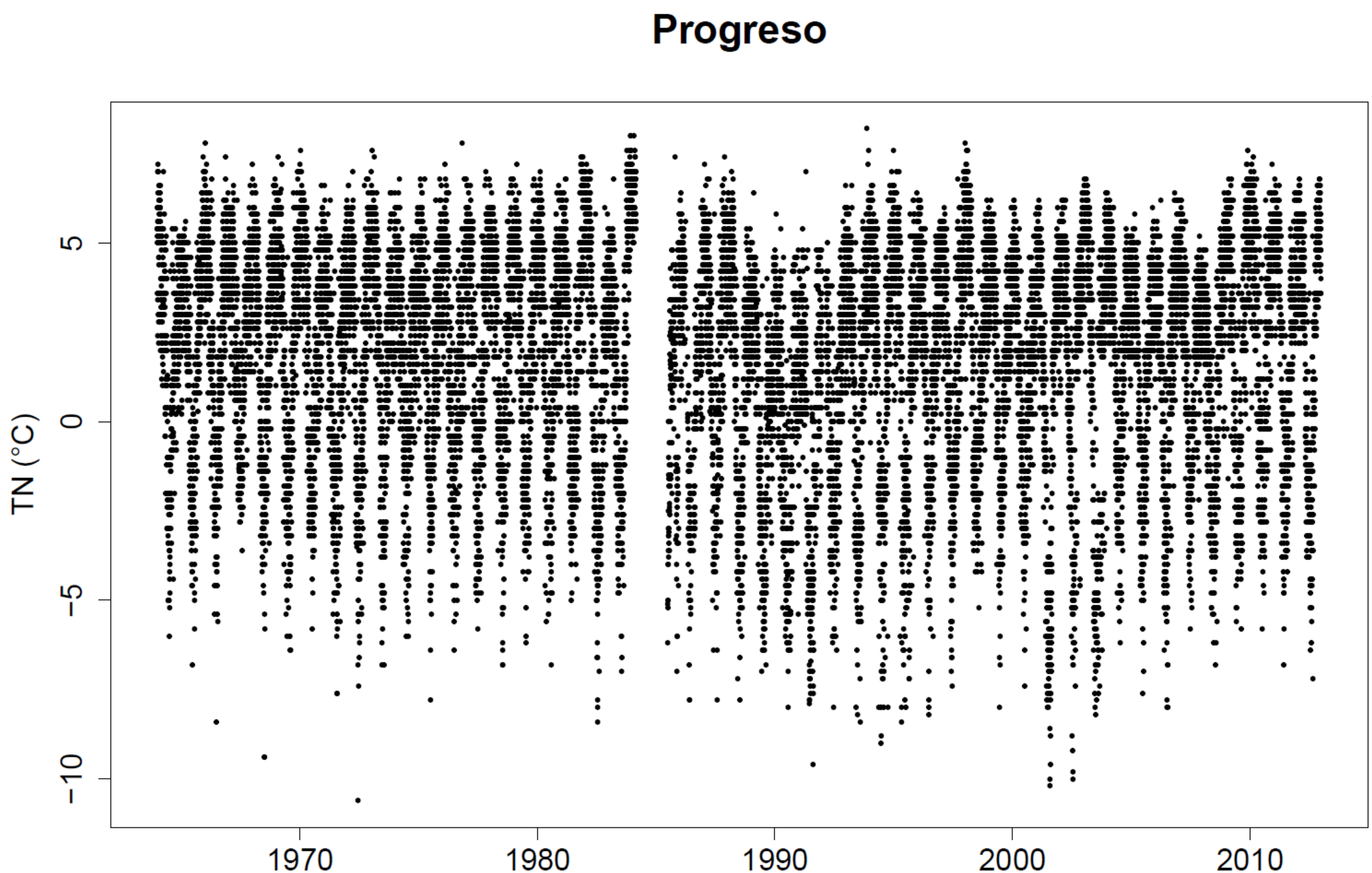
SDII (Simple Daily Intensity Index): annual total precipitation divided by the number of wet days in the year



Error correction



Error correction



Error detection

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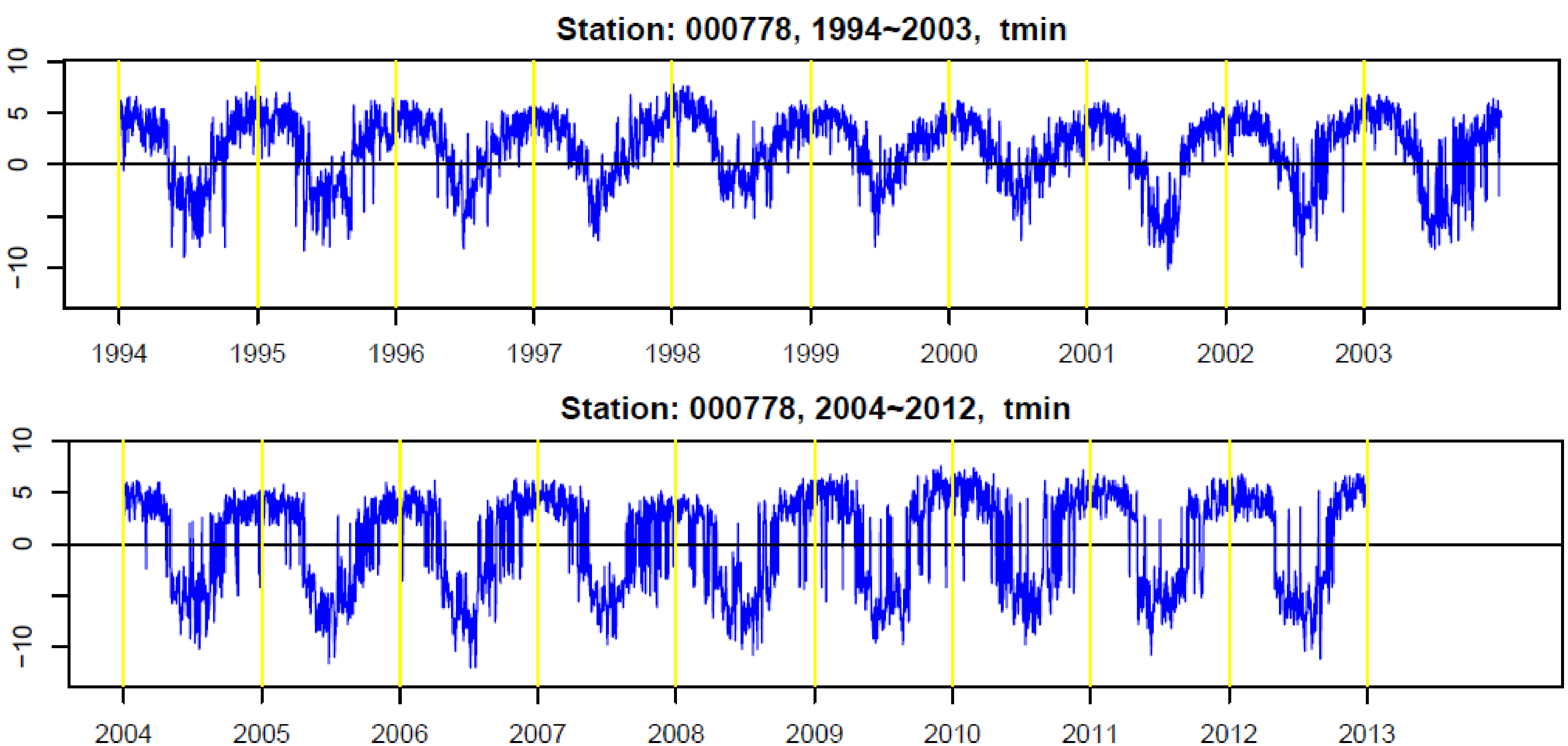
- QC is included in many programs
- Programs often create plots for visual quality control, e.g. RClimDex:



Error detection

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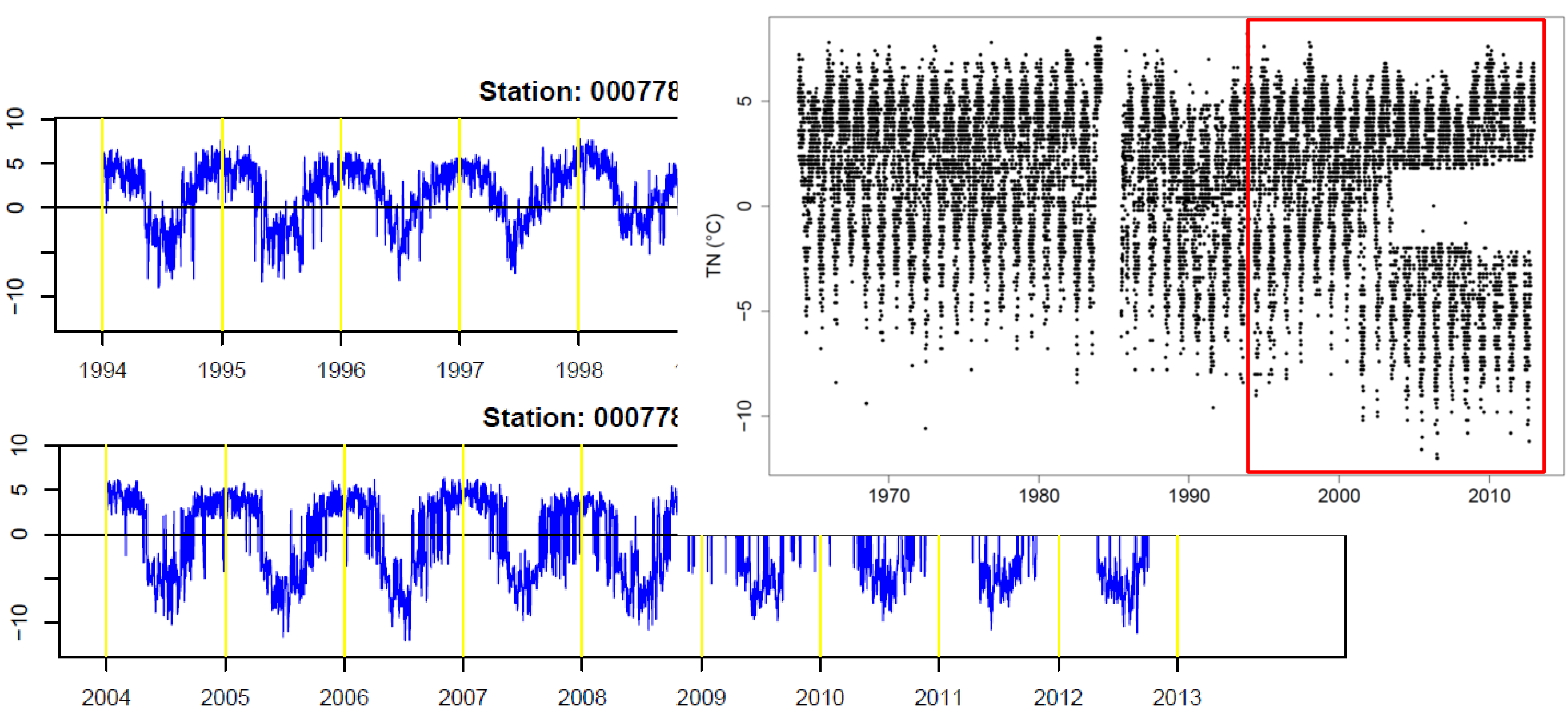

Conclusions

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- High priority to QC before analyzing data from Bolivia and Peru
- Ideally, metadata should be checked before using the data
- Visual QC is very helpful to detect patterns

  → use point instead of lines plots

- Reporting errors and observations in data

  → create additional metadata

- Knowing the source of the error allows to
  - possibly correct the error
  - decide if the error affects the data application of interest

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Thank you!

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Confederation

Federal Department of Home Affairs FDHA
Federal Office of Meteorology and Climatology MeteoSwiss

The challenge of porting scientific results to operational applications

Rebekka Posselt*, Rebecca Hiller, Mark A. Liniger

*rebekka.posselt@meteoswiss.ch

Schweizerische Eidgenossenschaft
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The challenge of porting scientific results to operational applications

Rebekka Posselt*, Rebecca Hiller, Mark A. Liniger

Thanks to work by: Christoph Frei, Sophie Fukutome

*rebekka.posselt@meteoswiss.ch

In the beginning

The task:

- Analyze the past climate
- Monitor the current climate
- Predict the future climate

Therefore, climate researchers

- Develop new methods
- Create new visualizations

to deliver climate products

- Understandable
- Usable

by the climate information customer.

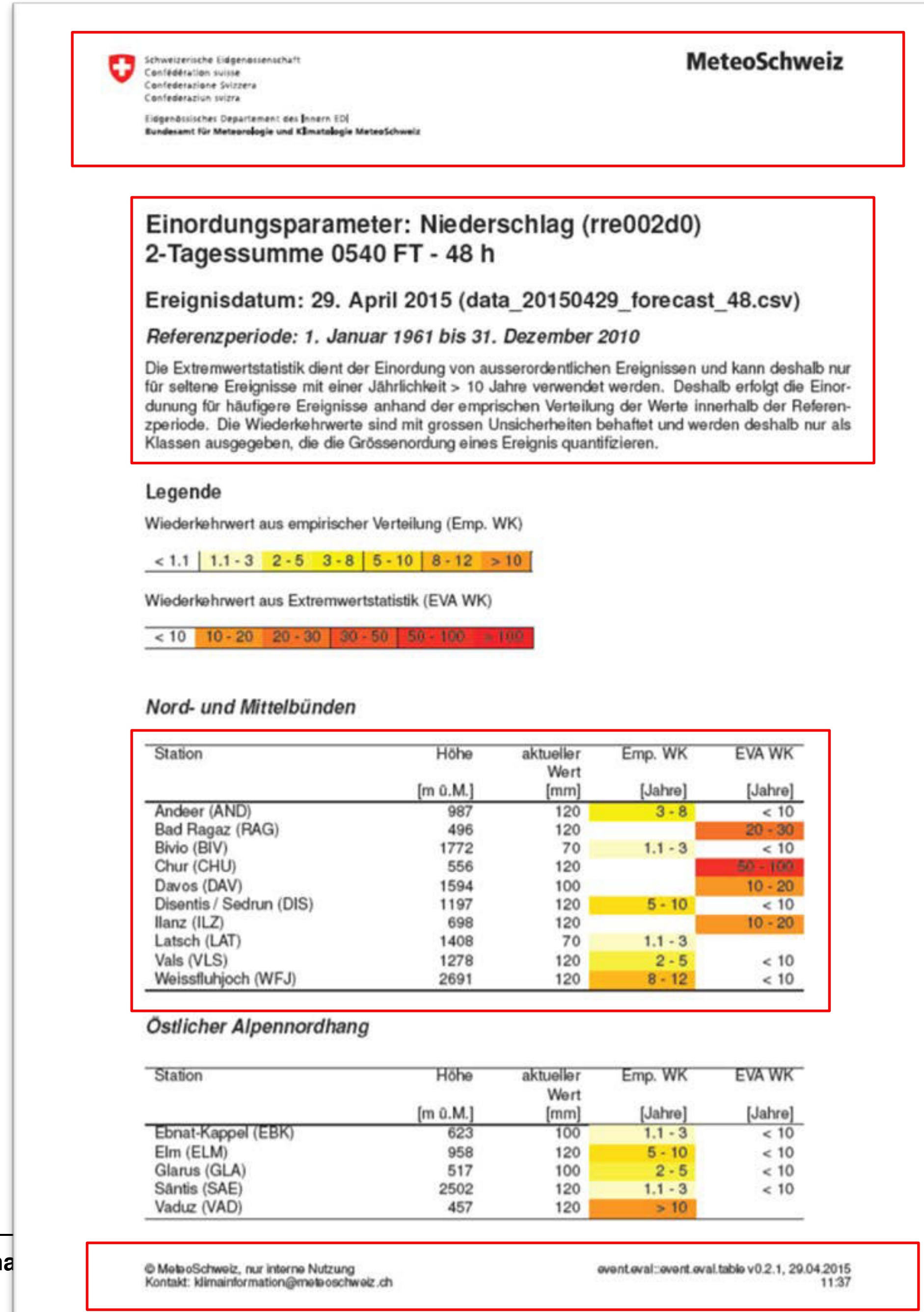
And then?

- «Leave it on the shelf to gather dust»?
- Port it to operational applications

Report generation

- Direct, automatic output
- Uses Sweave (→LaTeX) with embedded R-Code

- Implementation of the official layout (Latex class)
- Statistical analysis via embedded R-Code
- Customizable (heading, text, contact info, ...)
- Automatic formatting (header, footer, …)


Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Eidgenössisches Departement des Innern EDI
Bundesamt für Meteorologie und Klimatologie MeteoSchweiz

MeteoSchweiz

Einordungsparameter: Niederschlag (rre002d0)
2-Tagessumme 0540 FT - 48 h

Ereignisdatum: 29. April 2015 (data_20150429_forecast_48.csv)

Referenzperiode: 1. Januar 1961 bis 31. Dezember 2010

Die Extremwertstatistik dient der Einordung von ausserordentlichen Ereignissen und kann deshalb nur für seltene Ereignisse mit einer Jährlichkeit > 10 Jahre verwendet werden. Deshalb erfolgt die Einordunung für häufigere Ereignisse anhand der emprischen Verteilung der Werte innerhalb der Referenzperiode. Die Wiederkehrwerte sind mit grossen Unsicherheiten behaftet und werden deshalb nur als Klassen ausgegeben, die die Grössenordung eines Ereignis quantifizieren.

Legende

Wiederkehrwert aus empirischer Verteilung (Emp. WK)

< 1.1	1.1 - 3	2 - 5	3 - 8	5 - 10	8 - 12	> 10

Wiederkehrwert aus Extremwertstatistik (EVA WK)

< 10	10 - 20	20 - 30	30 - 50	50 - 100	> 100

Nord- und Mittelbünden

Station	Höhe [m ü.M.]	aktueller Wert [mm]	Emp. WK [Jahre]	EVA WK [Jahre]
Andeer (AND)	987	120	3 - 8	< 10
Bad Ragaz (RAG)	496	120		20 - 30
Bivio (BIV)	1772	70	1.1 - 3	< 10
Chur (CHU)	556	120		50 - 100
Davos (DAV)	1594	100		10 - 20
Disentis / Sedrun (DIS)	1197	120	5 - 10	< 10
Ilanz (ILZ)	698	120		10 - 20
Latsch (LAT)	1408	70	1.1 - 3	
Vals (VLS)	1278	120	2 - 5	< 10
Weissfluhjoch (WFJ)	2691	120	8 - 12	< 10

Östlicher Alpennordhang

Station	Höhe [m ü.M.]	aktueller Wert [mm]	Emp. WK [Jahre]	EVA WK [Jahre]
Ebnat-Kappel (EBK)	623	100	1.1 - 3	< 10
Elm (ELM)	958	120	5 - 10	< 10
Glarus (GLA)	517	100	2 - 5	< 10
Säntis (SAE)	2502	120	1.1 - 3	< 10
Vaduz (VAD)	457	120	> 10	

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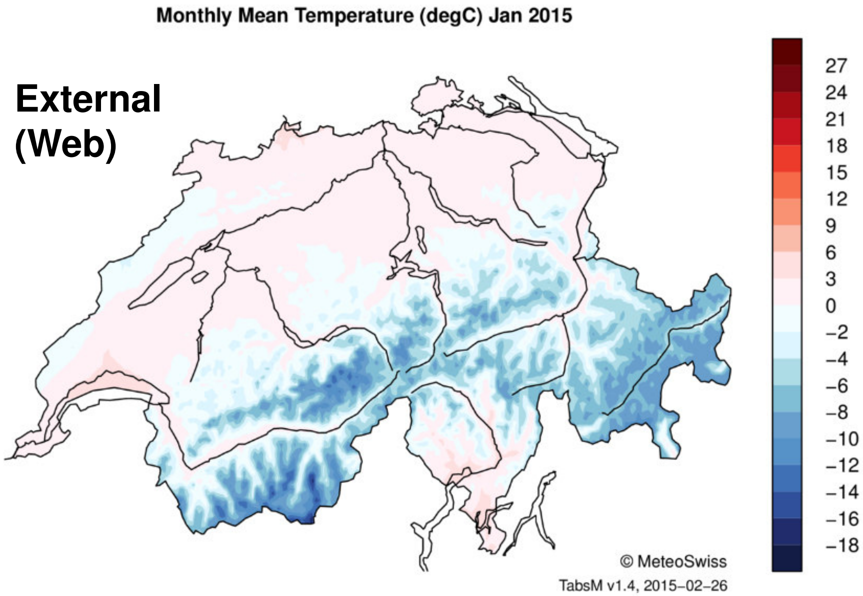
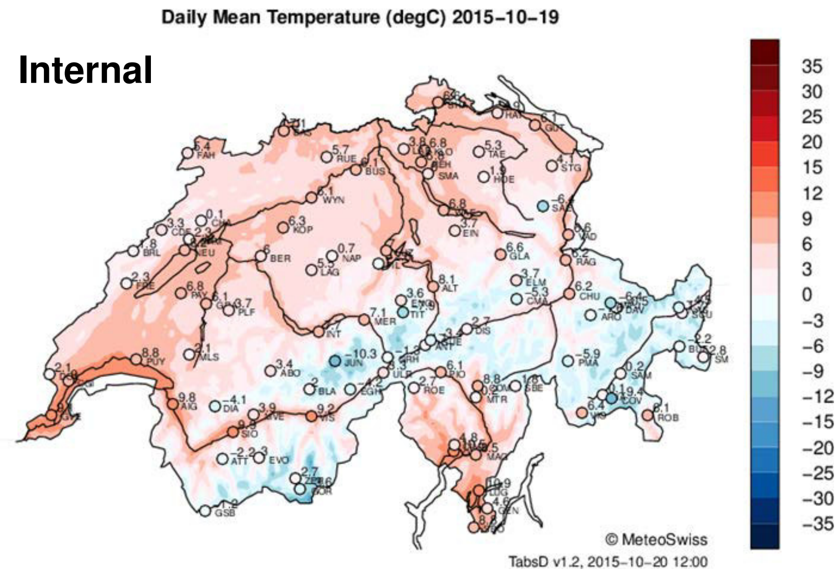
Kontakt: klimainformation@meteoschweiz.ch

event.eval::event.eval.table v0.2.1, 29.04.2015 11:37

Gridded Datasets



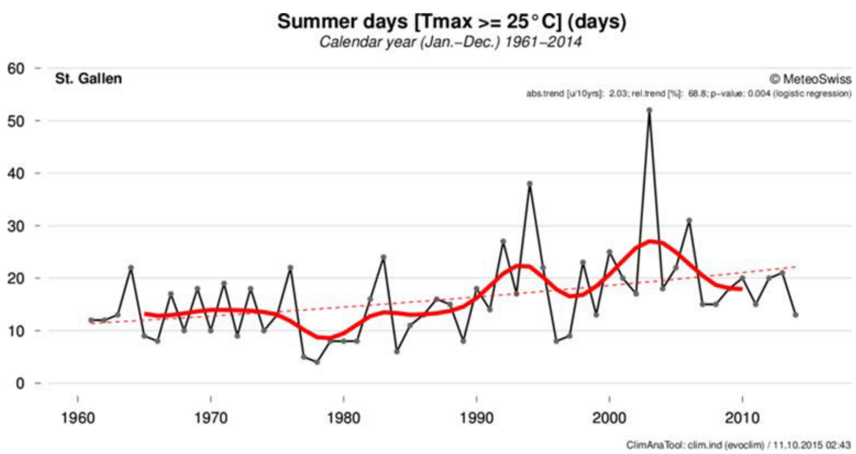


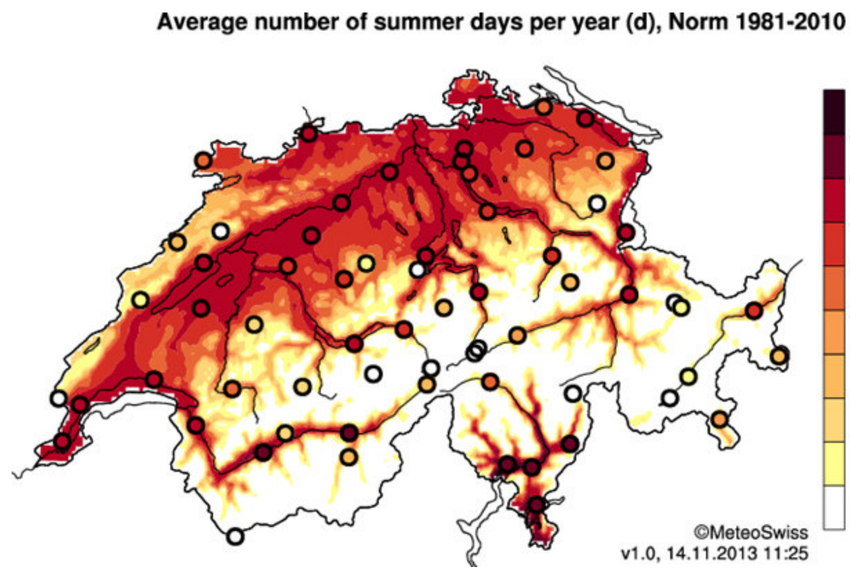
http://www.meteoschweiz.admin.ch/home/klima/gegenwart/monats-und-jahreskarten.html

- User-dependent visualizations
  - Less information for Internet → Common user
  - Additional information for internal use (e.g., used for quality control) → Expert user

Climate Indices: Ongoing work

- Need for unification!
- Several tools @ MeteoSwiss used to calculate climate indices for station data, gridded data, climate scenarios





- CRAN-package “climdex.pcic”: contribution and collaboration

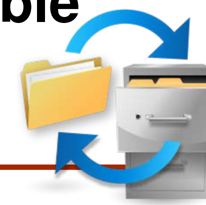
And then?

- «Leave it on the shelf to gather dust»
- Port it to operational applications

Requirements on operational tools

Reliable

Reproducible

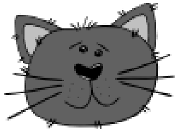


Maintainable

Automated

User friendly

The solution @ MeteoSwiss

CATs → Climate Analysis Tools 

CATs → collection of «R»-packages

= open-source statistical software

CATs provide the framework for

- Coordinated development
- Automatic and/or individual production
- Easy maintenance

of a wide variety of climate products.

Common structure

Programm call (→ argument names and formatting)

- Easy to use, understood one → understood all

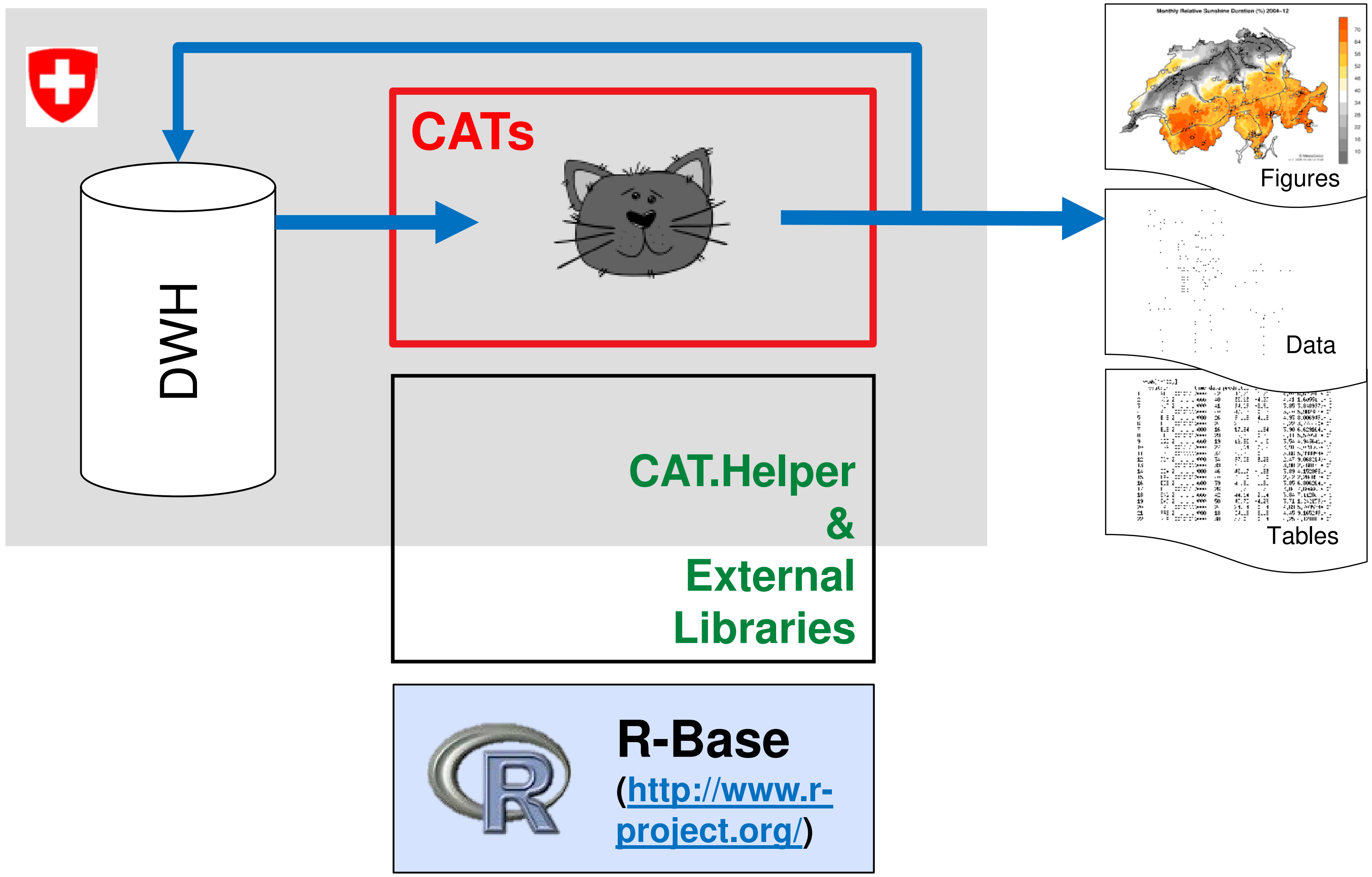
CAT/Package structure (→Input preparation, Data retrieval, Data analysis, Output)

- Enables coordinated and easy development
- Easy maintenance

General functionalities in CAT.Helper Libraries

- Basic functionality (data retrieval, color tables, labeling)
- Advanced, more scientific functionality (climate indices, Verification Skill scores)

Common Structure



Documentation

pheno.longts {phenopoll} R Documentation

Long phenological records

Description

Create a plot of long phenological records

Usage

```
pheno.longts(
  parameter = "kjaesc09",
  station = "PGE",
  datafile = "dwh",
  bgimage = "aesculus",
  start.year = 1800,
  end.year = "current",
  ylim = c(-5, 120),
  title = NULL,
  add.years=TRUE,
  filter.col = "red",
  filter.max.gap=5,
  line.col = "darkblue",
  outpath="current",
  languages = "G"
)
```

Arguments

`parameter`	character string parameter name as in dwh for text file data input, the parameter will be used in the output datafile
`station`	character string station nat_abbr as in dwh for text file data input, the station will be used in the output datafile
`datafile`	character string "dwh" to derive data from dwh or the path and datafile of the input file the file must contain two columns separated by white spaces or tabs the columns do not have a header the first column defines the observation year in the format YYYYmmddMMHHSS the second column the observation date in the format YYYYmmdd
`bgimage`	character string datafile of the background image NULL to omit the background image "prunus" and "aesculus" for default pictures of the two plants provided as part of the package
`start.year`	numeric start year of the analysis YYYY e.g. start.year=2012
`end.year`	numeric end year of the analysis YYYY, e.g. end.year=2012 or end.year="current" for the current year, or end.year="last" for the year preceding the current year
`ylim`	numeric vector of length 2, min and max value on the y-axis, xlim=NULL for autoscaling

- Comprehensive documentation required
- Meaningful examples and Tests necessary
- Recommended packages:
  - «roxygen» for Documentation
  - «testthat» for Testing

Git – A version control system

- Change tracking:
  - Who changed What, Where, and When
  - Supports collaboration between developers
- Code archive
- Trigger for automatic installation on the servers

Automated production & monitoring

- Job scheduling via Linux-intern «crontab»
  - Manage the automatic production for Internet, Intranet, Archive, …
  - ~20 CATs run as «cronjobs» at different times (daily, monthly, seasonal, yearly, special, …)

- Monitoring by capturing «errors»
  - Within the «cronjob» scripts

  → Trigger of Fail-Emails

Server architecture

- Development server
  → Reserved for developing CATs
- Interactive server
  → Accessible by all interested employees
  → Individual production
- Production server
  → Reserved for automated production
  → Redundant layout (Main + FailOver)

- All servers provide the same environment (OS, libraries)
- Maintenance and administration by IT-Department

Requirements on operational tools

Reliable
- Tested
- Redundant system
- Monitored

Reproducible
- Code archive
- Scriptable
- Documented

Maintainable
- Common structure
- Standardization
- Single implementation

Automated
- Scheduled
- Monitored

User friendly
- Documented
- Customizable
- Easy access

Is the global mean temperature trend too low?

Victor Venema, Phil Jones,
Ralf Lindau, Tim Osborn and
numerous collaborators

@VariabilityBlog
variable-variability.blogspot.com

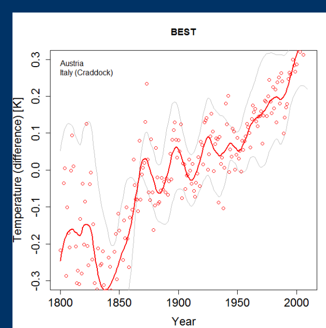
Content

1. Comparison trend in national datasets & global collections
2. Global temperature datasets
3. Statistical homogenization
4. Physical understanding historical transitions
5. Other changes in the climate system

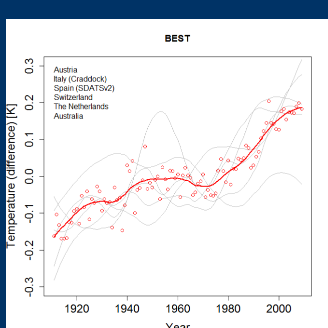
Well-homogenized national datasets

- Australia, Austria, France, Hungary, Netherlands, Israel, Italy, Slovenia, Spain and Switzerland
- Compared global collection
  - Annual mean averaged over same countries
    - Berkeley Earth Surface Temperature (BEST)
    - GHCNv3, GISS
    - CRUCY, CRUTEM4
- National datasets are expected to be better
  - More data: better correlated references
  - More metadata: station history
  - More care and better methods

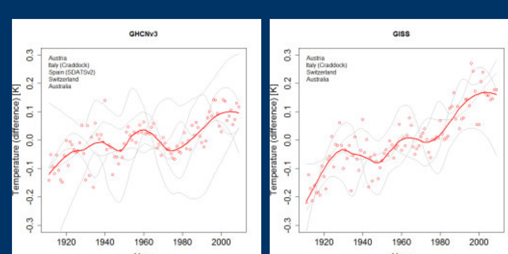
Difference (national – global) BEST (1800)



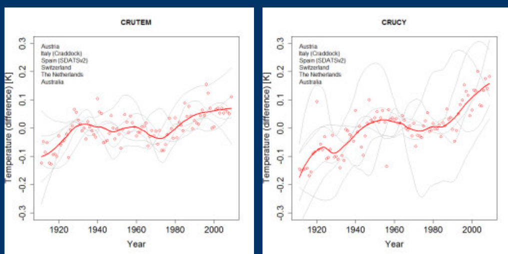
Difference – BEST (1911)



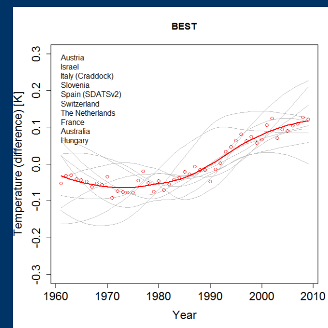
Difference – GHCN & GISS (1911)



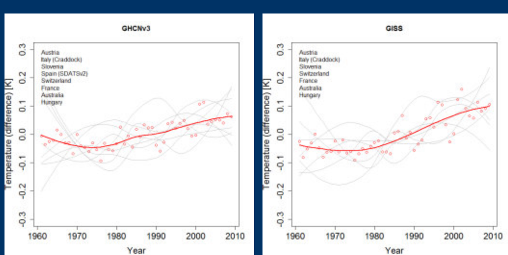
Difference CRUTEM & CRUCY (1911)



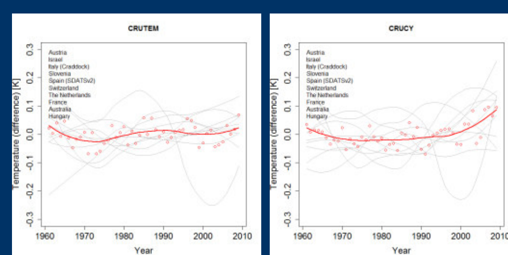
Difference – BEST (1961)



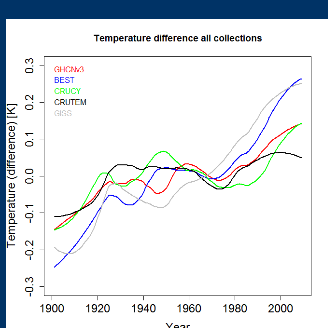
Difference – GHCN & GISS (1961)



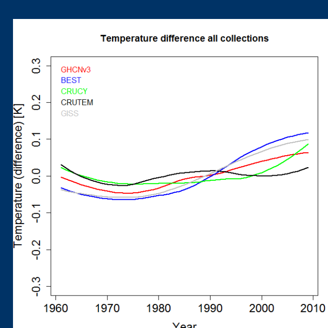
Difference – CRUTEM & CRUCY (1961)



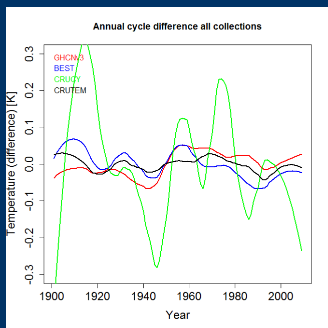
All collections 1901-2009



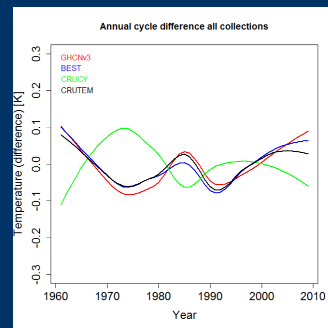
All collections 1961-2009



Seasonal cycle – all collections (1901-2009)



Seasonal cycle – all collections (1961-2009)



Content

1. Comparison trend in national datasets & global collections
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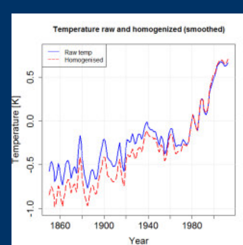
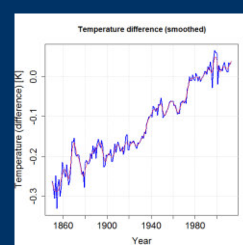
Inhomogeneities in GHCNv3

Global Land Surface Temperature



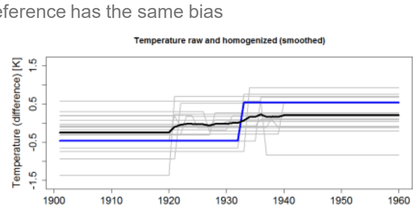
Adjustments



Averaging: Zeke Hausfather
Data: GHCNv3

Regional trend bias correction

- A small bias in breaks can lead to large-scale temperature trend errors
- Correction with composite reference
  - Reference has the same bias

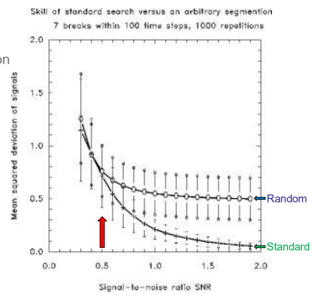


Undercorrecting trend biases

- ANOVA decomposition
  - Regional climate signal for all stations
  - Step function per stations
  - Noise to be minimized
- Computing the adjustments is a regression
  - Predictors: break positions (+ station temps)
  - Predictands: adjustments (+ regional signal)
- Numerical test (all breaks are known)
  - ANOVA adjustments are unbiased (but noisy)
- Imperfect predictors (break positions)
  - Break variance is underestimated
    - Trend biases will be undercorrected
  - All breaks detected, but error in position of 2 year:
    - 18% of trend bias remains
    - Artificial, but gives idea of the order of magnitude

Break detection and SNR

- RMS skill for:
  - 0 Random segmentation
  - \+ Standard search
- Mean square deviation of signals
  - Inserted (true signal)
  - Computed adjustments
- Lindau & Venema (2015) submitted IJC.



Trend uncertainties

- Benchmarking gives qualitative idea of uncertainties
  - HOME: 10%, NOAA: 90%
    - HOME: no explicit large-scale trend bias (thus very small)
  - Several caveats of unknown importance
    - HOME: size of the breaks 2x too large
    - NOAA: breaks implemented as random walk
- High network density USA & Europe
  - Much of the world and periods SNR will be smaller
- ➢ Need better validation (ISTI) and numerical studies

Conclusions

- Trend difference between well-homogenized datasets and global collections
  - Land surface temperature
- If there is a cooling bias in raw observations:
  - Trend error likely undercorrected
- Physical understanding of cooling bias poor
  - Transition to Stevenson screens seems undercorrected
- Many other changes in climate system fast

Future research – Comparison national & global data

- Quality categorisation is subjective
  - Ask multiple scientists to make a categorisation
- Understand physical reasons for cooling bias
  - Also compare seasonal/monthly series
  - Timing of changes
- Study the adjustments applied in GHCN
  - Timing, station density and climates
- Compare national adjustments to GHCN adjustments
- Comparison on a station level

Future research – Comparison national & global data

- Understand trend differences adjustments
  - Homogenization methods
    - Detection or correction
  - Data available as reference / station density
    - Break frequency
  - Metadata
    - Precise date, significance level
    - Physical adjustments, adjustment size
    - Percentage of confirmed breaks
  - Selection of stations
  - Averaging:
    - Mean reference stations, interpolation, gridding
    - National stations or also neighbouring countries

Future research – Comparison national & global data

- More datasets (of any quality level)
  - Australia, Austria, Canada, Catalonia, Catalonia, China (MASH, CMA), Croatia, Czech Republic, Estonia, Ecuador, Finland, France, Germany, Greece, Hungary, Ireland, Israel, Italy (Craddock, Toretti), Latvia, Netherlands, Central Netherlands, Norway, Ukraine (long and short), United Kingdom, Portugal, Romania, Russia, Serbia, Slovakia, Slovenia, Spain (AEMET, SDATSv2, ACMANT, MOTEDAS), Sweden, Switzerland
  - Greater Alpine Region, Carpathian basin, Central England Temperature, Catalonia.
- More variables
  - Precipitation, extreme temperatures

Future research - Homogenization

- Need better mathematical understanding of how well large-scale trend biases can be removed
  – Numerical understanding: ISTI global benchmarking
- Need better homogenization methods
  – Multiple breakpoint methods
    - Low signal to noise ratio
    - Determination of optimal number of breaks
    - Joint detection
    - Noise reduction of difference time series
  – Apply them to global datasets
- Need to exchange more data & metadata

Future research – Physical reasons

- Understanding of cooling biases is poor
  – Reduction radiation errors
  – Relocations, better siting
  – Irrigation and watering near weather stations
- Large global parallel dataset can help
  – ISTI-POST side meeting at 15.00
  – Transition to AWS
  – Transition to Stevenson screen
  – Relocations
  - Changes in weather variability and extreme weather
    - Poster
  - Precipitation, humidity, wind(?)

Questions?

Victor.Venema@uni-bonn.de
http://variable-variability.blogspot.com/

Description of the bias introduced by the transition from Conventional Manual Measurements to Automatic Weather Station through the analysis of European and American parallel datasets. (+ Australia, Israel & Kyrgyzstan)

E. Aguilar , P. Stepanek , V.K.C. Venema, R. Auchmann, F.D. dos Santos Silva, E. Engström, A. Gilabert, Z. Kretova, J.A. Lopez-Díaz, Y. Luna Rico, C. Oria Rojas, M. Prohom, D. Rasilla, M. Salvador, G. Vertacnik, and Y. Yosefi

Presenting Author: E. Aguilar (enric.aguilar@urv.cat) Center for Climate Change, C3,URV, Tarragona, Spain. See acknowledgements for full institutions list

October-2015. Saint-Gallen.

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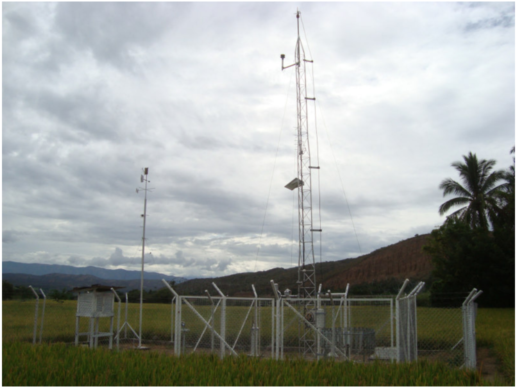
IN THIS TALK

- Motivation.
- POST & the AWS-Manual transition dataset.
- Results: networkwide; per country; some particular cases.
- Summary, further work.



Jaen Station (Peru)

MOTIVATION

- We have inhomogeneities.
- Daily data homogenization needs to be improved.
- Parallel measurements help us to empirically compare the effect of transitions between systems.
- Their analysis contributes to : create realistic benchmarks; validate homogenization; evaluate uncertainty.

- This talk AWS-Manual temperatures < POST-AWS < POST < ISTI
- **POST is a Working Group of the International Surface Temperature Inititative (ISTI)**, which intends to contribute to the creation and delivery of reliable climate services produced with an open and transparent procedures: www.surfacetemperatures.org
- POST works to **create a global parallel dataset** to enable the **study of systematic biases** in the national, regional and global records of different Essential Climate Variables (ECVs).

NUMBER OF STATIONS FOR EACH DATASET (TEMPERATURE, TX, TN, TM, DTR)

COUNTRY	STATIONS	DETAILS ON AWS STATIONS
Argentina	9	No info available at this point
Australia	13	Stevenson shelters; AWS are relocations
Brazil	4	AWS sensors in Young screens
Israel	5	AWS Campbell/Rotronic (repl. 2005) in Stevenson
Kyrgyztan	1	Vaisala HMP45C in non-stevenson shelter
Peru	31	AWS sensors in multiplate shelters
Slovenia	3	iButton probes in same Stevenson Screen than LIG
Spain	35	Mixture of Stevenson and non-Stev. (Young type)
Sweden	8	AWS in multiplate screens (Young Type)
USA	6	AWS in fan aspirated solar radiation shields

- POST is preparing a metadata template to distribute to partners

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- More than 300,000 values checked.
- Set to **error**: $|t| > 60º$, $|AWS\text{-}CON| > 10ºC$, value of $|t| > 40Cº$ & $|AWS\text{-}CON| > 5$, TX > TN.
- Set to **very suspect**: outliers in temperature and difference (4 IQR).
- Set to **suspect**: outliers either in temperature or difference (4 IQR).

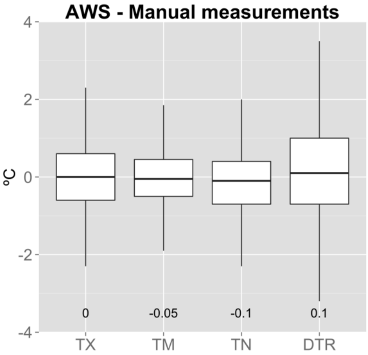
	1	2	3	4	9
tx	1.19	0.01	0.02	97.80	0.98
tn	0.60	0.02	0.02	98.59	0.77

Percentage of values flagged during QC.

1.- Error; 2.- Very Suspect ; 3.- Suspect ; 4 Passed QC; 9 NA.

BIAS ANALYSIS. FULL DATASET

- This analysis is run using all the data which was not labelled as error in QC (level > 1).
- The median bias in TX and TM is 0.0ºC, meanwhile it is -0.1 in TN and +0.1ºC in DTR.
- Wishkers indicate spread (1.5 times IQR).



- Even though these results are not representative (different years, different number of values, uneven area coverage, etc.), they show to some extent the cancellation exerted by different sign biases.

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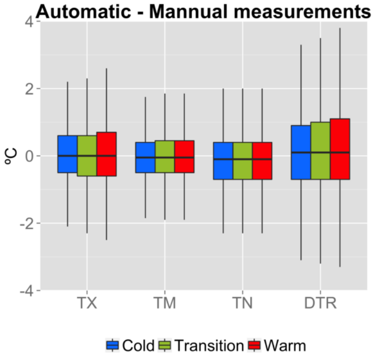
BIAS ANALYSIS. FULL DATASET. SEASONS

- **Cold** and **Warm** seasons have been adapted to each hemisphere (DJF for HS, JJA for HN).
- MAM and SON are labelled as **Transition**.



- Values are **similar to** those found for the **year-round** analysis.
- **Warm season** shows slightly **larger dispersion**.

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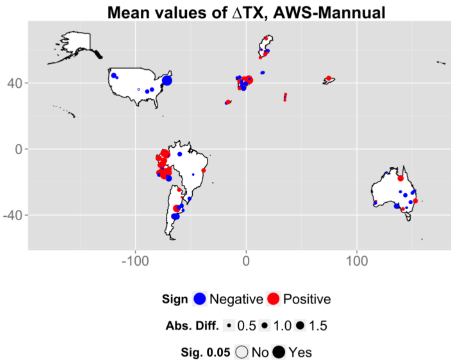
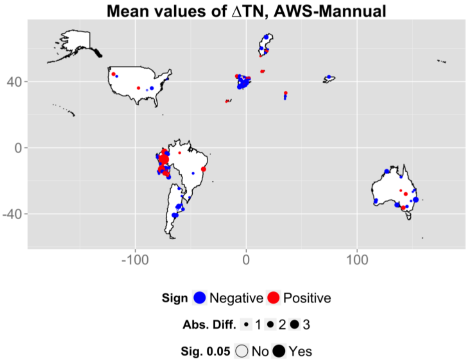
MEAN BIAS (AWS-Manual) PER STATION. TX, TN.



	Negative	Positive
No	3	4
Yes	51	58

Significance and Sign



	Negative	Positive
No	6	5
Yes	70	35

Significance and Sign

- Most diff. **significant**. In **TN** 2/3 of the series show **cooler AWS**.

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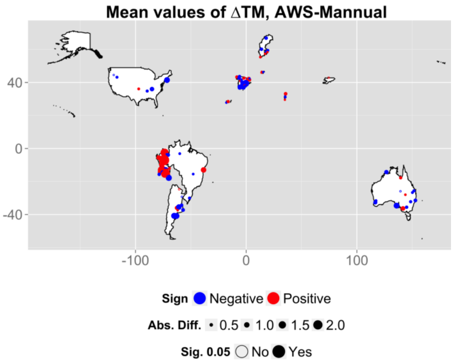
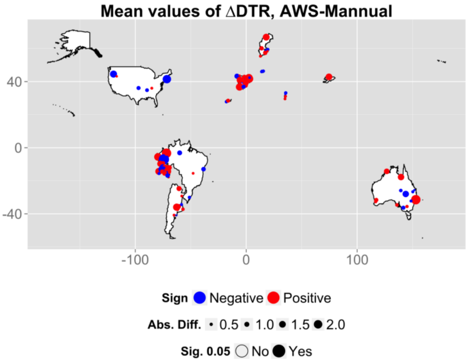
MEAN BIAS (AWS-Manual) PER STATION. TM and DTR



	Negative	Positive
No	5	2
Yes	55	54

Significance and Sign



	Negative	Positive
No	5	2
Yes	41	68

Significance and Sign

- Most diff. **significant**. More than 60% of **AWS show larger DTR**.

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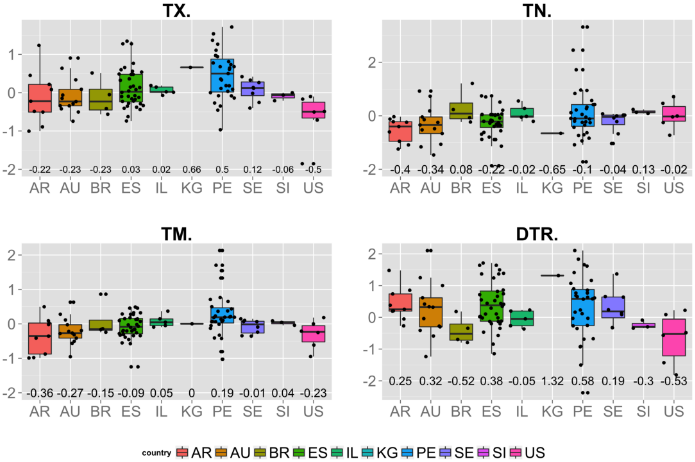
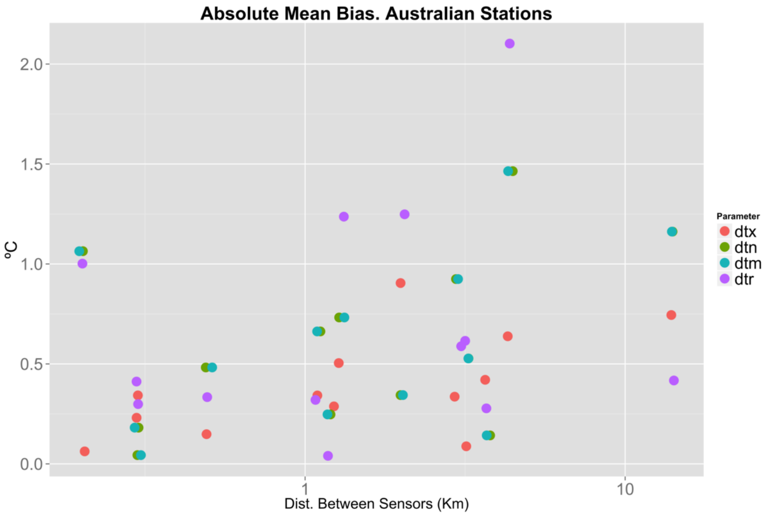
BIAS (deg. C) AWS-MANUAL PER COUNTRY



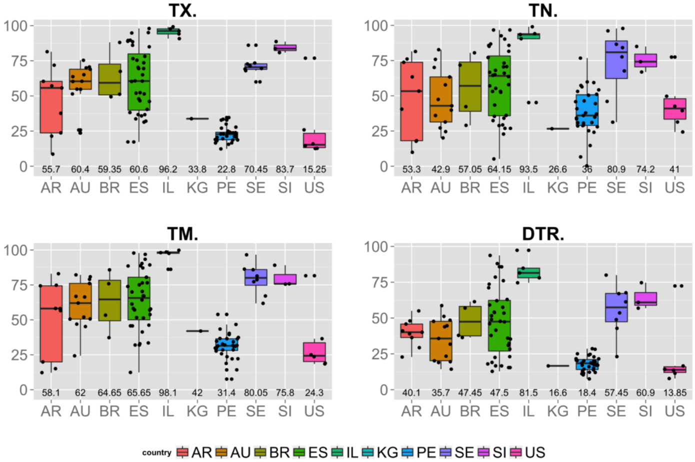
- **Different countries = different results**. Eg. Peru shows larger bias in Tx than other countries and Irael shows no bias in DTR.
- **More data is necessary** to reach more solid conclusions.

INFLUENCE OF OTHER FACTORS. AUSTRALIA .



- The plot shows a tendency of the **absolute mean bias to grow with increasing distance** between sensors.

PERCENTAGE ABS. AWS-MANUAL < 0.5



- **Israel** (nearly 100%), **Slovenia and Sweden** show the larger % of diffs in a |0.5| range. Notice **larger spread in TN, specially Sweden and Peru**.

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EFFECT OF INTERNAL INHOMOGS. **ISRAEL** (METADATA)

Israel made available detailed metadata:

Station	Code Man/AWS	Parallel Period	AWS Type
Eilat	9972/9974	01/05/2001-08/07/2002	Campbell 107
Eilat	9972/9974	09/07/2002-31/05/2008	Rotronic-MP101
Zefat	4640/4642	01/02/2003-30/06/2008	Rotronic-MP101
Jerusalem	6770/6771	01/01/1996-31/08/2005	Campbell 107
Jerusalem	6770/6771	01/09/2005-29/02/2008	Rotronic-MP101
Kefar Blum	8471/8472	01/07/2005-31/03/2009	Rotronic-MP101
Sedom	9570/9571	01/01/2003-30/04/2009	Rotronic-MP101

- Even more detailed information and pictures was made available by Israel Meteorological Service.

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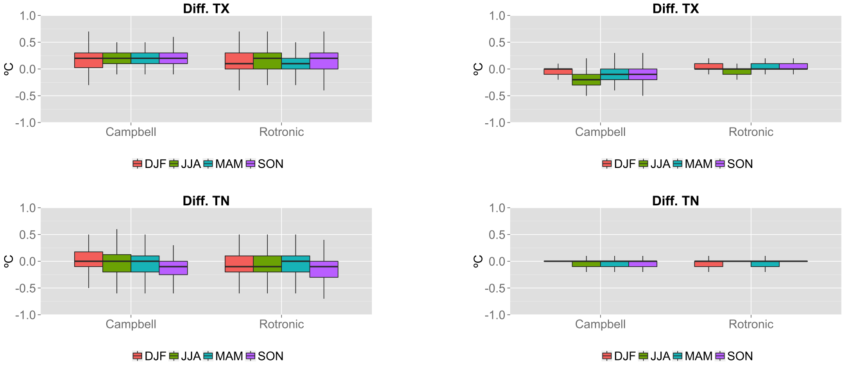
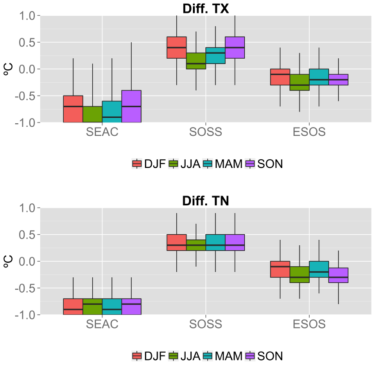
EFFECT OF INTERNAL INHOMOGS. EILAT (left), JERUSALEM (right), **ISRAEL**



- The effect of the sensor change is relatively small in absolute magnitude.
- But some seasons (eg. Eilat, winter, DTN) reverse sings of the median difference after the replacement.

- The **Observatorio del Ebro, near Tortosa (Tarragona, Spain) is the longest paralell record** we have available for Spain.
- The AWS sensors are **always located inside the same Stevenson Screen** of the LIG manual measurement.
- DTX and DTN bias changes **up to 1ºC, reverses sign and alters seasonality** with sensor changes



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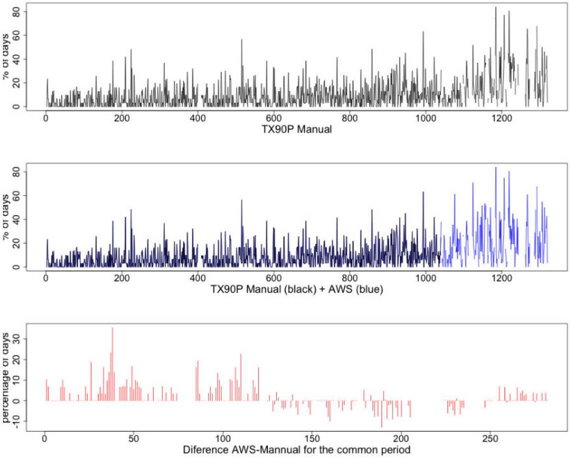
EFECT OVER ETCCDI INDICES.TX90p. OBSERVATORIO-EBRO, SPAIN

- Introduction of AWS affects mean values and also ETCCDI indices. Sensor changes are evident.



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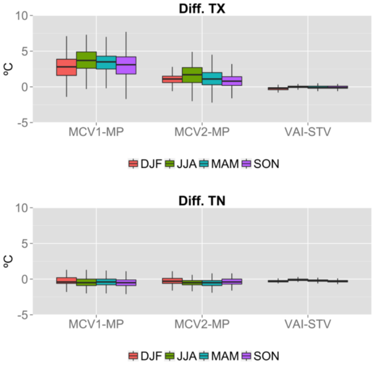
INTERNAL INHOMOGENEITIES. BARCELONA-FABRA, **SPAIN**

- Internal changes in Fabra station have a **strong effect in the relation between the AWS and the Manual** measurements, specially in DTX. (Notice the change in y-axis scale)
- When the AWS sensor is sheltered inside the **Stevenson screen**, the **differences are much smaller** and even **reverse sign in DTX**.
- For **DTN, the changes are less dramatic** and do not imply a change in sign, but the dispersion of the difference series becomes much smaller.



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STRATIFICATION OF THE DIFFERENCES WITH OTHER VARIABLES IN BARCELONA-FABRA

Median differences AWS-CON for the third period (AWS in Stevenson)

	TX	TN
sun <= 03 hours	-0.2	-0.2
sun >= 10 hours	0.0	-0.2
wind sp. <= 2 m/s	-0.2	-0.3
wind sp. >= 6 m/s	0.0	-0.2
precip <= 1 mm	-0.1	-0.1
precip >= 5 mm	-0.2	-0.2

- We intend, if data is available, to stratify the results with other variables / weather types.

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SUMMARY

- We have presented a dataset of temperature observations for the study of the transition between AWS and Manual observations.
- Although averaged biases over the whole dataset are not remarkable, most individual stations show significant differences.
- These differences vary much between countries and within countries.
- Differences affect not only the mean, but also extremes and ETCCDI indices.
- Instrumentation and sheltering plays a very important role, easily identificable.
- At this point we cannot determine whether different climates imply different biases.
- Other factors such as internal inhomogeneities and distance between the parallel measurements must be taken into account.
- The more data we have, the more solid conclusions we will be able to reach.

ACKNOWLEDGEMENTS AND FURTHER WORK

- This study has been possible thanks to the kind contributions of many coauthors and their institutions.
- It will continue under the guidance of POST.
- POST intends compile the largest possible dataset of transition (including AWS - Manual) to understand their effect on climate series.
- POST is your playground. Come and play!

- More info about POST: `http://tinyurl.com/ISTI-Parallel`.
- Interested in joining us? Contact chair, Victor Venema, after EMS at `Victor.Venema@uni-bonn.de`.

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Thanks for your atention and thanks to:

Universitat Rovira i Virgili, Center for Climate Change, C3, Tarragona, Spain, Global Change Research Centre,Czech Academy of Sciences, Brno, Czech Republic, Czech Hydrometeorological Institute, Brno Regional Office, Brno, Czech Republic, University of Bonn, Meteorological Institute, Bonn, Germany, University of Bern, Institute of Geography, Bern, Switzerland, Instituto Nacional de Meteorologia, INMET, Brazil, Swedish Meteorological and Hydrological Institute, Norrköping, Sweeden, Main Hydrometeorological Administration, Bishkek, Kyrgizstan, Agencia Estatal de Meteorología, AEMET, Madrid, Spain, Servicio Nacional de Meteorología e Hidrología del Perú(SENAMHI), Lima, Perú, Servei Meteorològic de Catalunya, Barcelona, Spain, Universidad de Cantabria, Santander, Spain, Slovenian Environment Agency, Ljubljana, Slovenia, Israel Meteorological Service, Tel-Aviv, Israel and Servicio Meteorológico Nacional, Buenos Aires, Argentina, Bureau of Meteorology, Australia for their contributions in terms of data and human resources.

With the support of Grant **CGL2012-32193**, Ministerio de Economía y Competitividad, **MINECO**, España and FP7-SPACE-2013-1 grand 607193, Uncertainties in Ensembles of Regional Reanalyses (UERRA).

Biases in precipitation records found in parallel measurements

Petr Stepanek (1,2), Enric Aguilar (3), Victor Venema (4), Renate Auchmann (5), Fabricio Daniel dos Santos Silva (6), Erik Engström (7), Alba Gilabert (1), Zoia Kretova (8), Jose Antonio Lopez-Díaz (9), Yolanda Luna Rico (9), Clara Oria Rojas (10), Marc Prohom (11), Domingo Rasilla (12), Mozar Salvador (6), Gregor Vetacnik (13), Yzhak Yosefi (14), Maria de los Milagros Skansi (15)

(1) Global Change Research Centre, Czech Academy of Sciences, Brno, Czech Republic., (2) Czech Hydrometeorological Institute, Brno Regional Office, Brno, Czech Republic, (3) Universitat Rovira i Virgili, Center for Climate Change, C3,Tarragona/Tortosa, Spain., (4) University of Bonn, Meteorological institute, Bonn, Germany., (5) University of Bern, Institute of Geography, Bern, Switzerland. , (6) Instituto Nacional de Meteorologia, INMET, Brazil. , (7) Swedish Meteorological and Hydrological Institute, Norrköping, Sweeden. , (8) Main Hydrometeorological Administration, Bishkek, Kyrgizstan, (9)Agencia Estatal de Meteorología, AEMET, Madrid, Spain, (10) Servicio Nacional de Meteorología e Hidrología del Perú (SENAMHI), Lima, Perú, (11) Servei Meteorològic de Catalunya, Barcelona, Spain, (12) Universidad de Cantabria, Santander, Spain. (13) Slovenian Environment Agency, Ljubljana, Slovenia, (14) Israel Meteorological Service, Bet-Dagan, Israel., (15) Departamento Climatología, Servicio Meteorológico Nacional, Buenos Aires, Argentina.

Content

- Motivation / POST initiative
- The conventional - automatic precipitation measurements dataset
- Results
- Summary

Motivation

- For studying climatic changes it is important to accurately **distinguish non-climatic from climatic signals**
- This can be achieved by **studying the differences between two parallel measurements**. These need to be sufficiently close together to be well correlated
- One important ongoing worldwide **transition** is the one **from manual to automated measurements**. We need to study the impact of automated measurements urgently because sooner or later this will affect most of the stations in individual national networks
- Similar to temperature series, we study the transition from **conventional manual measurements (CON)** to **Automatic Weather Stations (AWS)**, using several parallel datasets distributed over EuroAsia and America

Instrumentation, example from CZ

The METRA 886 rain-gauge

MR3H automatic
tipping bucket rain-gauge

Parallel Observations Scientific Team (POST)

- In this talk we deal with the **transition from conventional (manual) to automatic precipitation measurements (AWS)**
- This is another study in the framework of The Parallel Observations Scientific Team (POST, http://www.surfacetemperatures.org/databank/parallel_measurements)
- **POST is a Working Group of the International Surface Temperature Inititative (ISTI)**, which intends to contribute to the creation and delivery of reliable climate services produced with an open and transparent procedures: www.surfacetemperatures.org
- POST works to **create a global parallel dataset** to enable the **study of systematic biases** in the national, regional and global records of different Essential Climate Variables (ECVs)

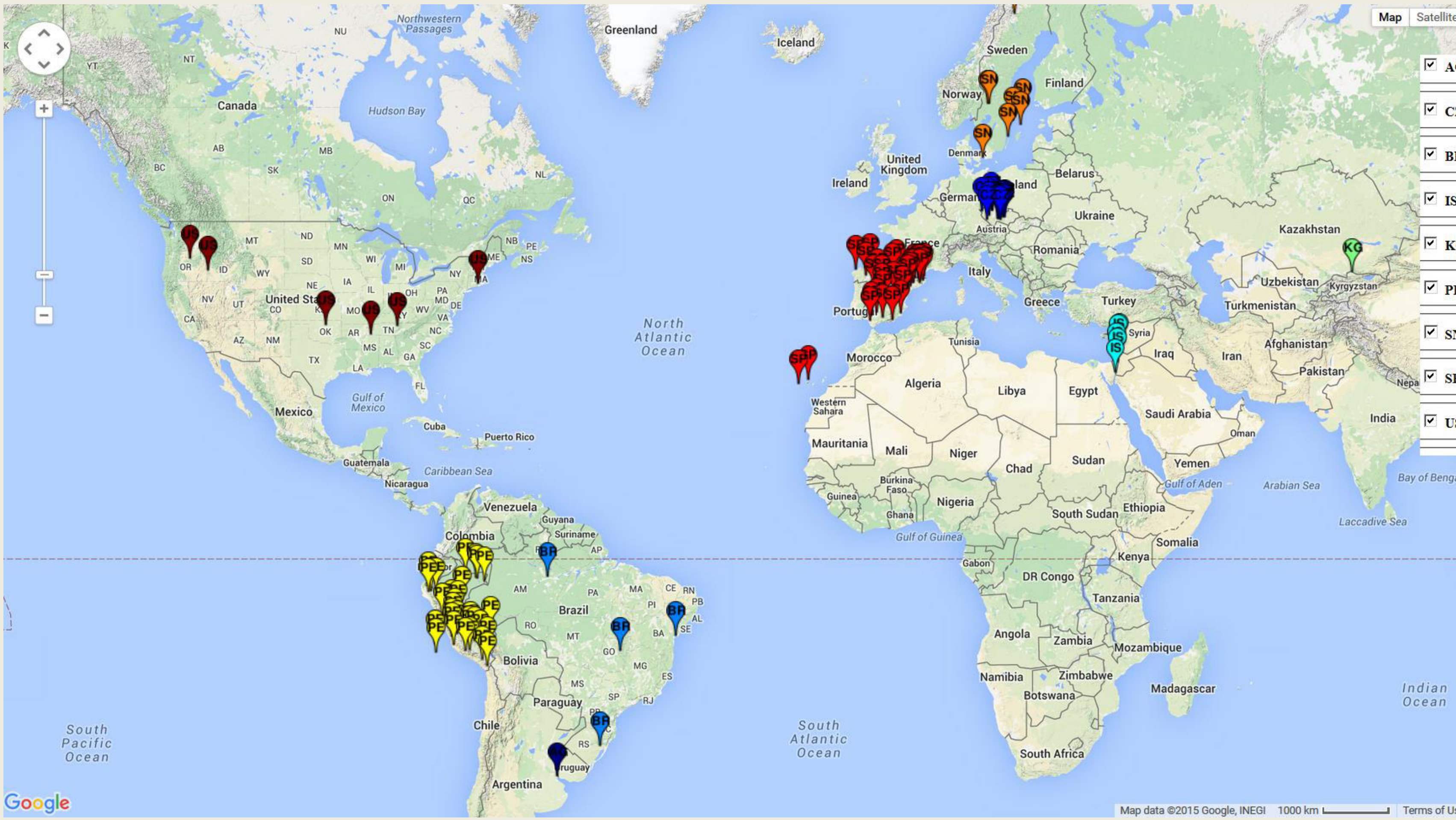
Available datasets for transition between CON and AWS

- **Only a few datasets are available** so far, so our data base is not global. In this analysis, we will present series from America (Argentina, Brazil, Peru, USA), Asia (Israel, Kyrgyztan) and Europe (Slovenia, Spain, Sweden, Czech Republic).
- Data have been kindly provided by local scientists (see co-authors list). New contributions are expected and more are most welcome.

Available datasets for transition between CON and AWS

Country	*Name*	*Count*
AG	Argentina	1
BR	Brazil	4
CZ	Czech Republic	19
IS	Israel	5
KG	Kyrgyzstan	1
PE	Peru	31
SN	Sweden	8
SP	Spain	33
US	United States	6

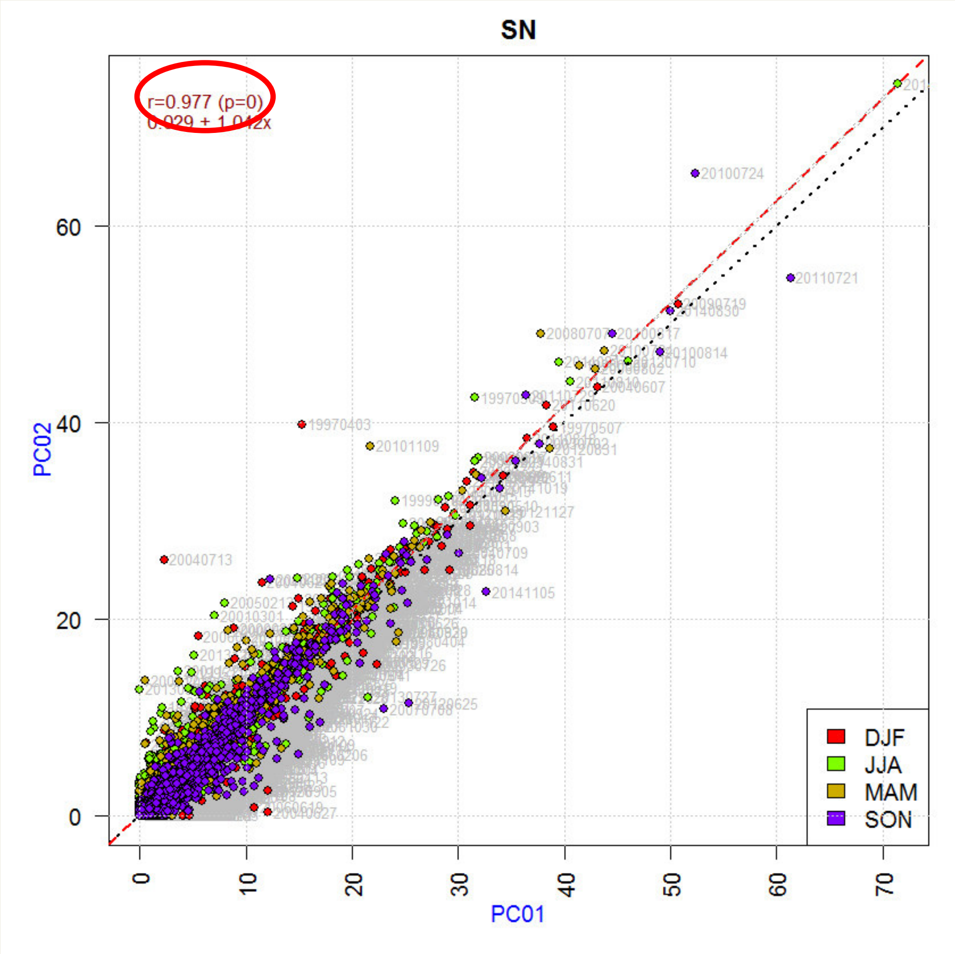
Available datasets for transition between CON and AWS



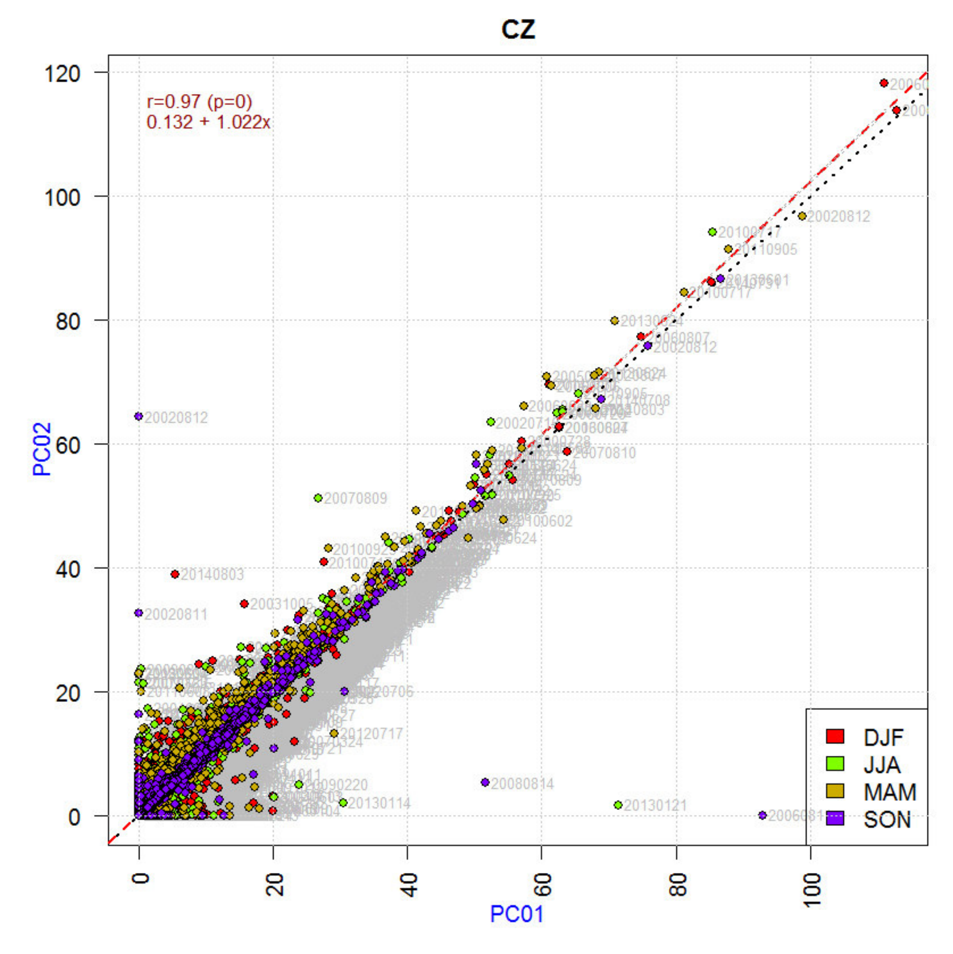
Data pre-processing

- The ratio series AWS-CON are subject to quality control, and before the analysis obvious errors are removed
- Further, the series are inspected for internal inhomogeneities and– if necessary –the records are split into two or more homogeneous segments

Different quality of datasets in individual countries

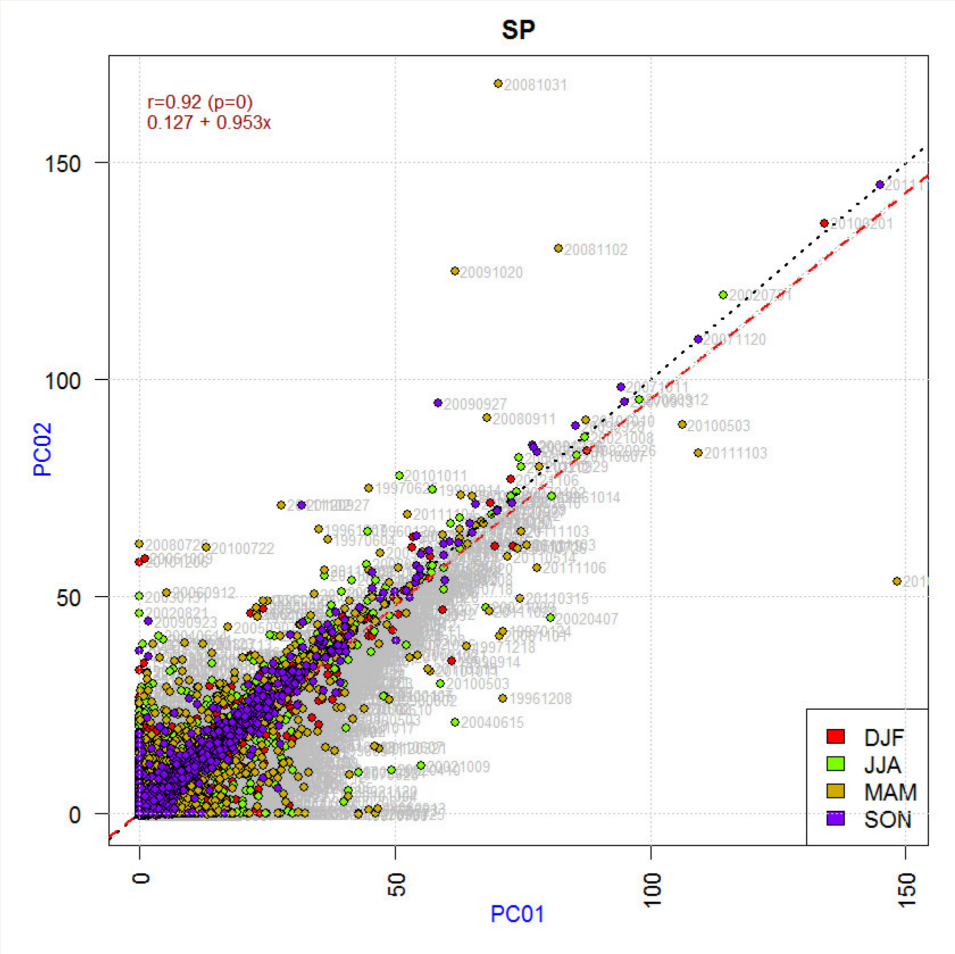


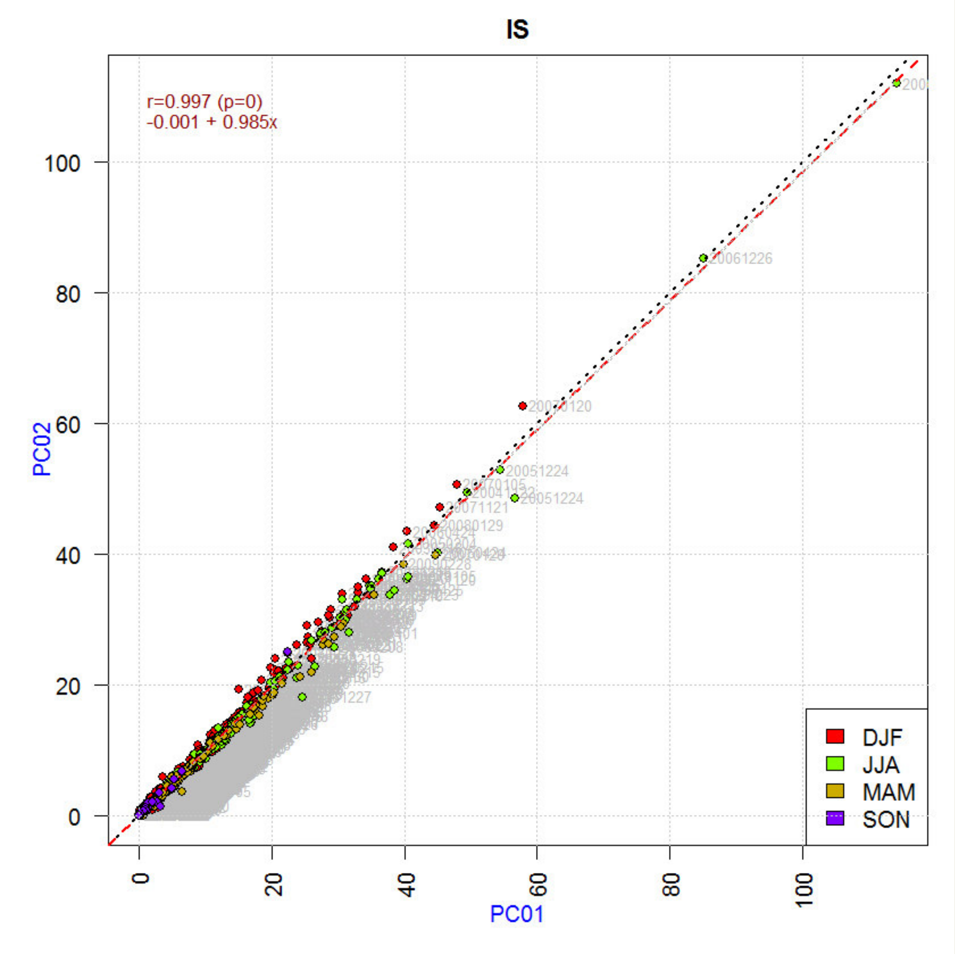
Daily sums for AWS (PC01) and CON (PC02) measurements



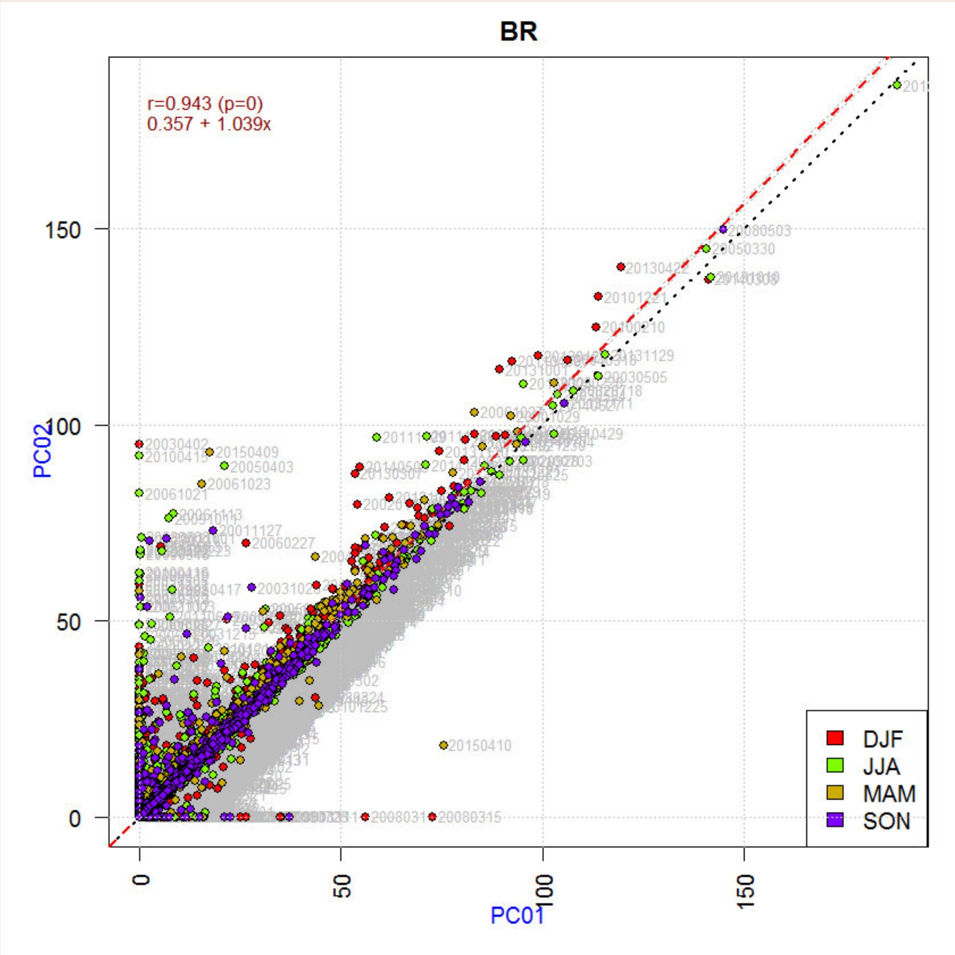
Different quality of datasets for individual countries

Daily sums for AWS (PC01) and CON (PC02) measurements

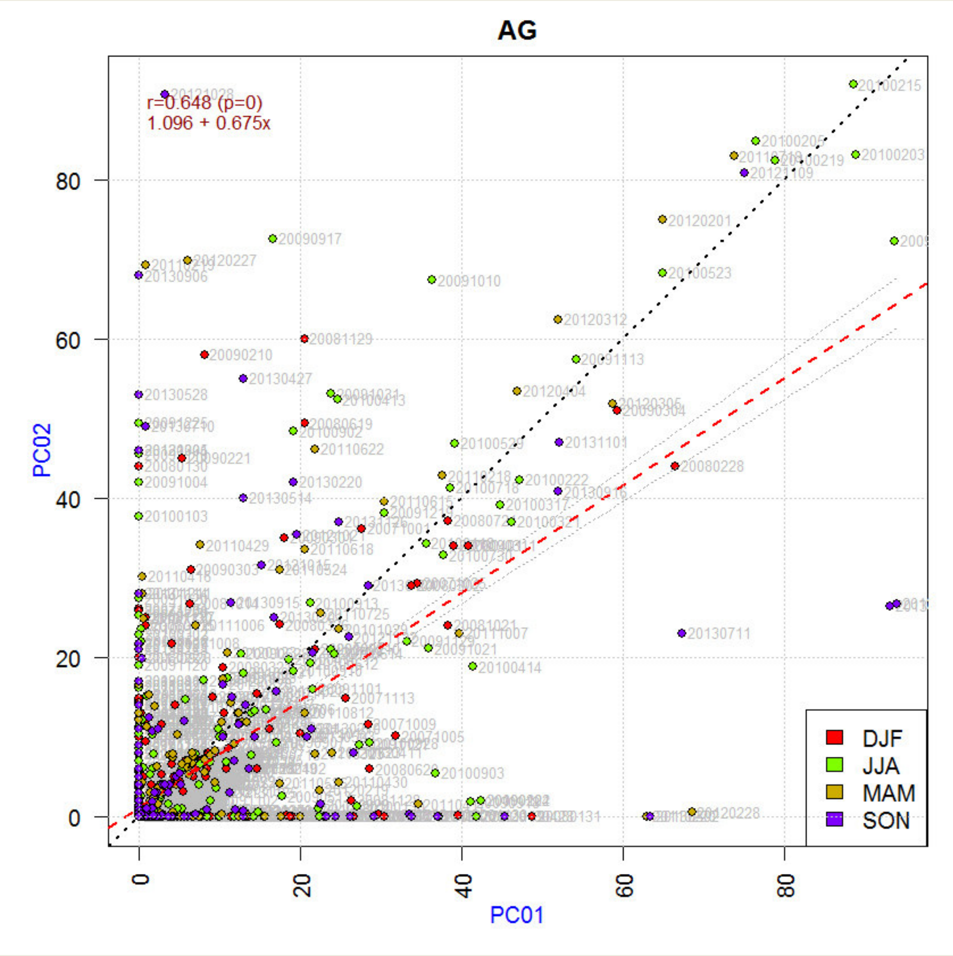




Different quality of datasets for individual countries

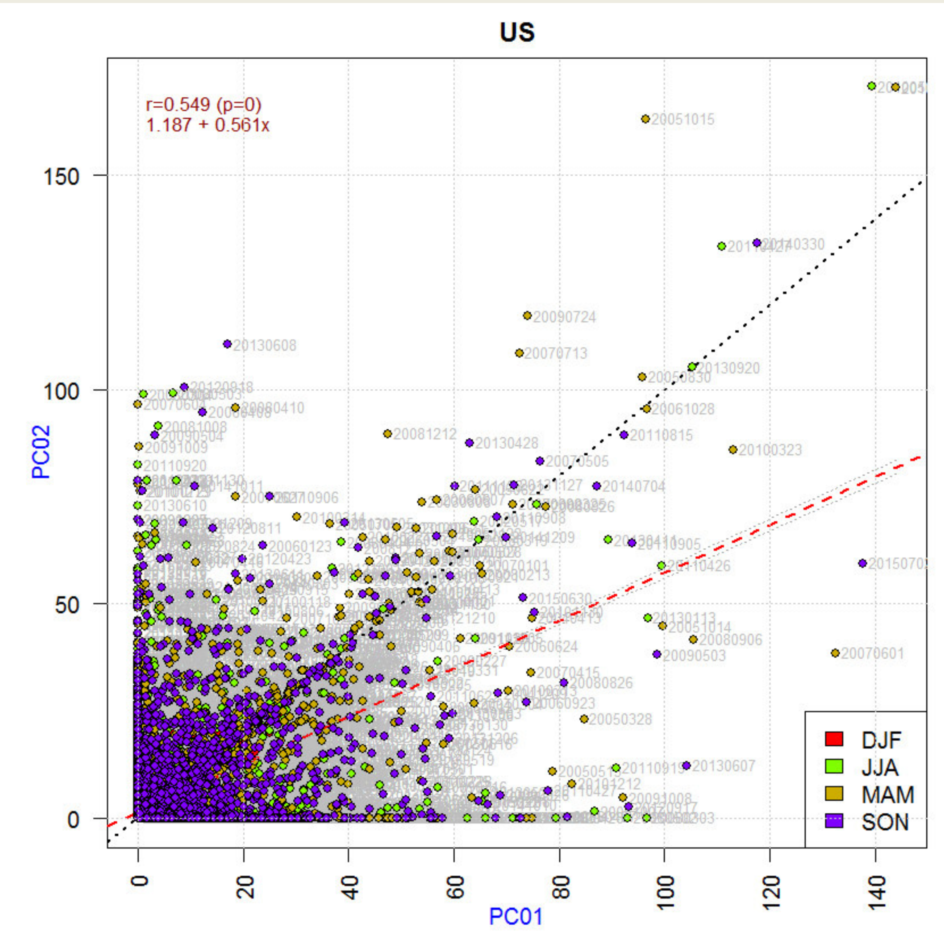


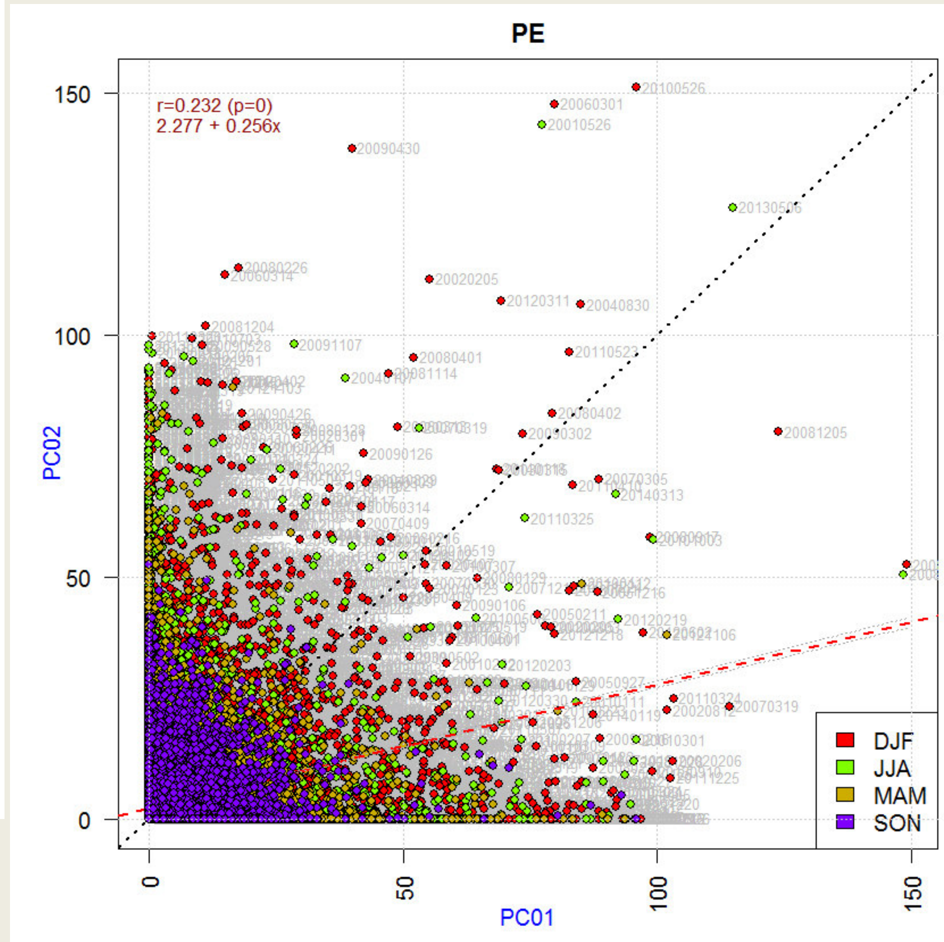
Daily sums for AWS (PC01) and CON (PC02) measurements



Different quality of datasets for individual countries

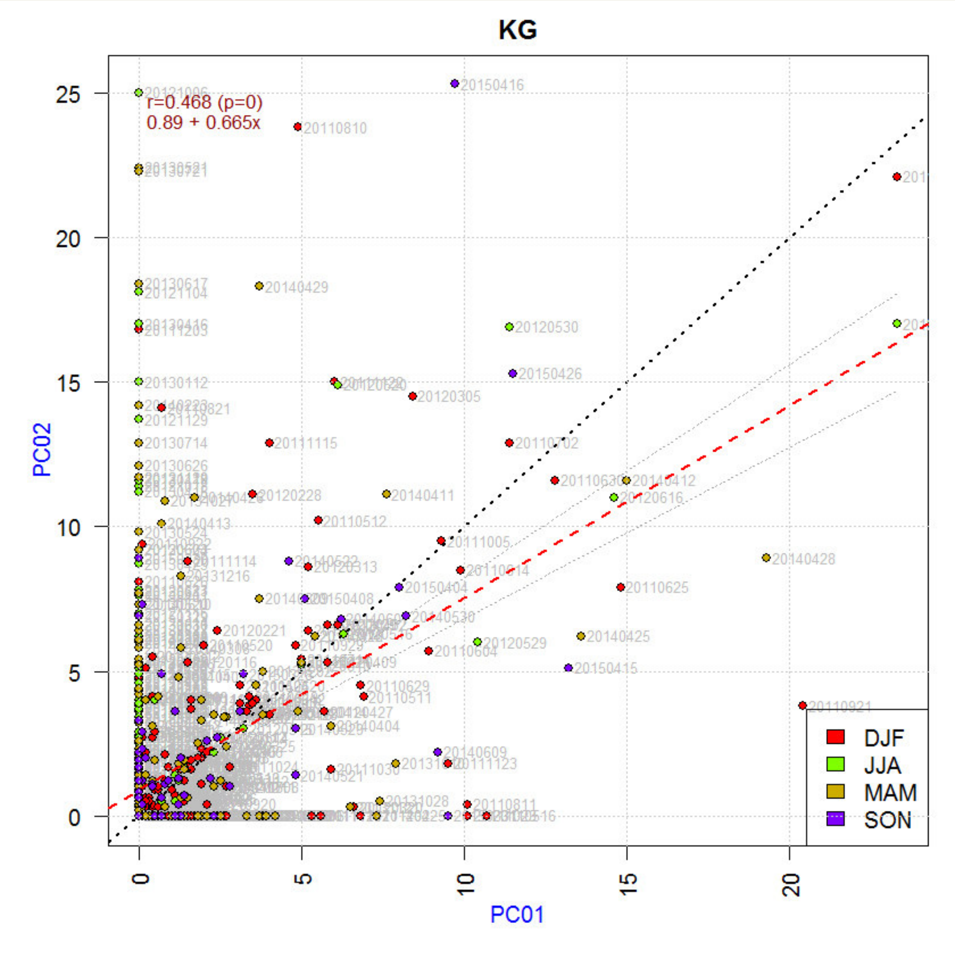
Daily sums for AWS (PC01) and CON (PC02) measurements



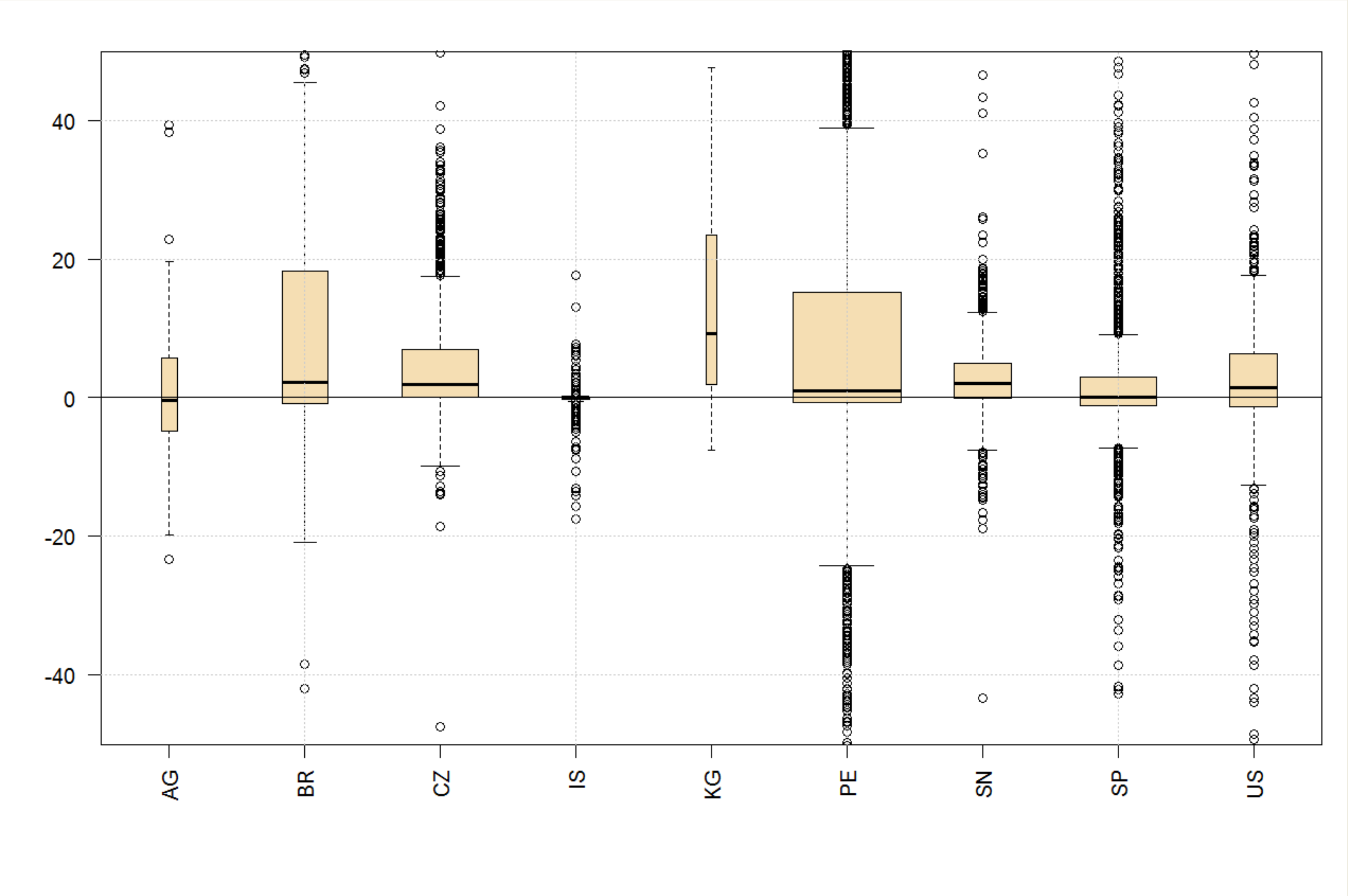


Different quality of datasets for individual countries

Daily sums for AWS (PC01) and CON (PC02) measurements

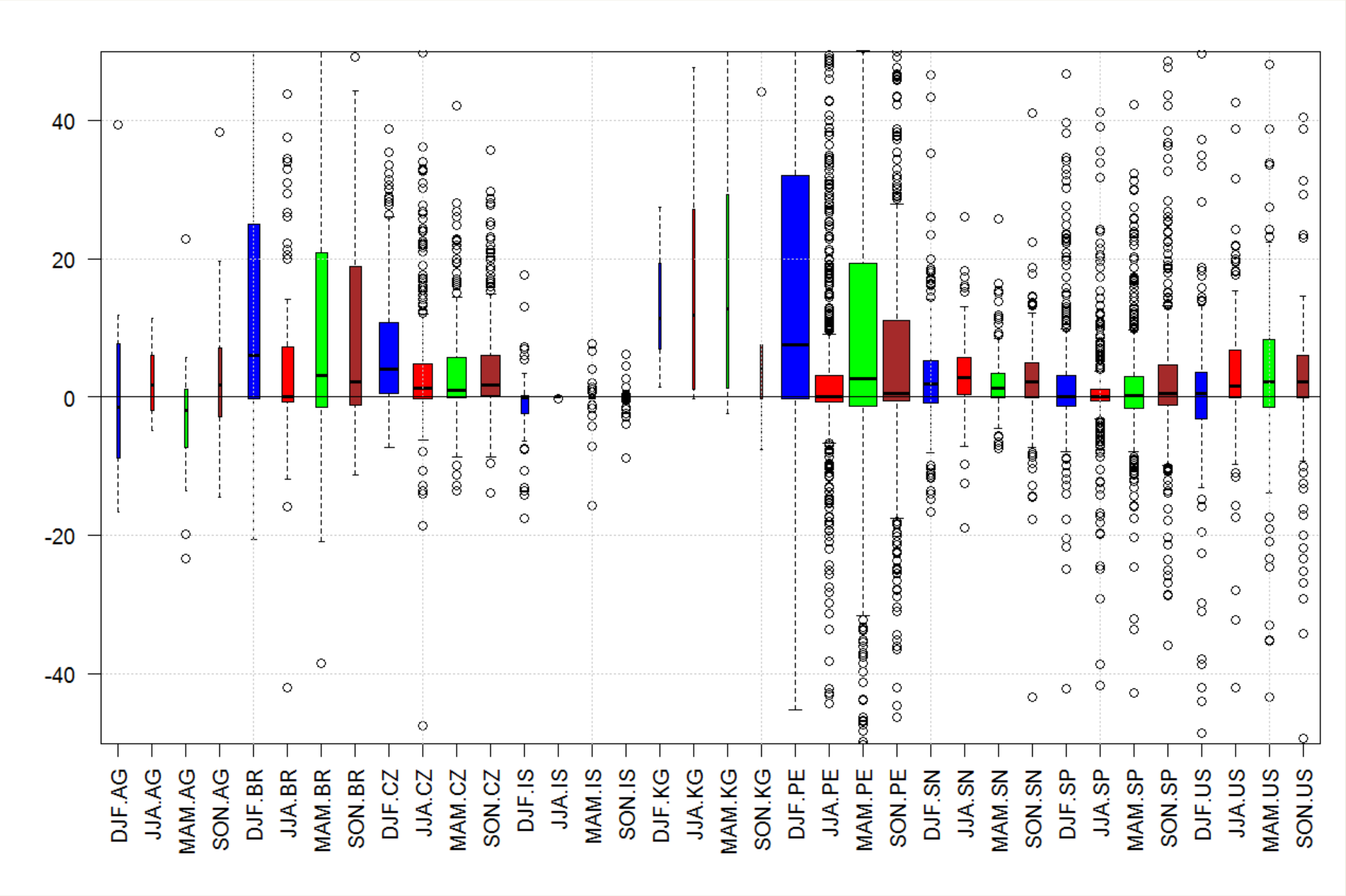


Differences in CON-AWS Monthly Sums for individual regions

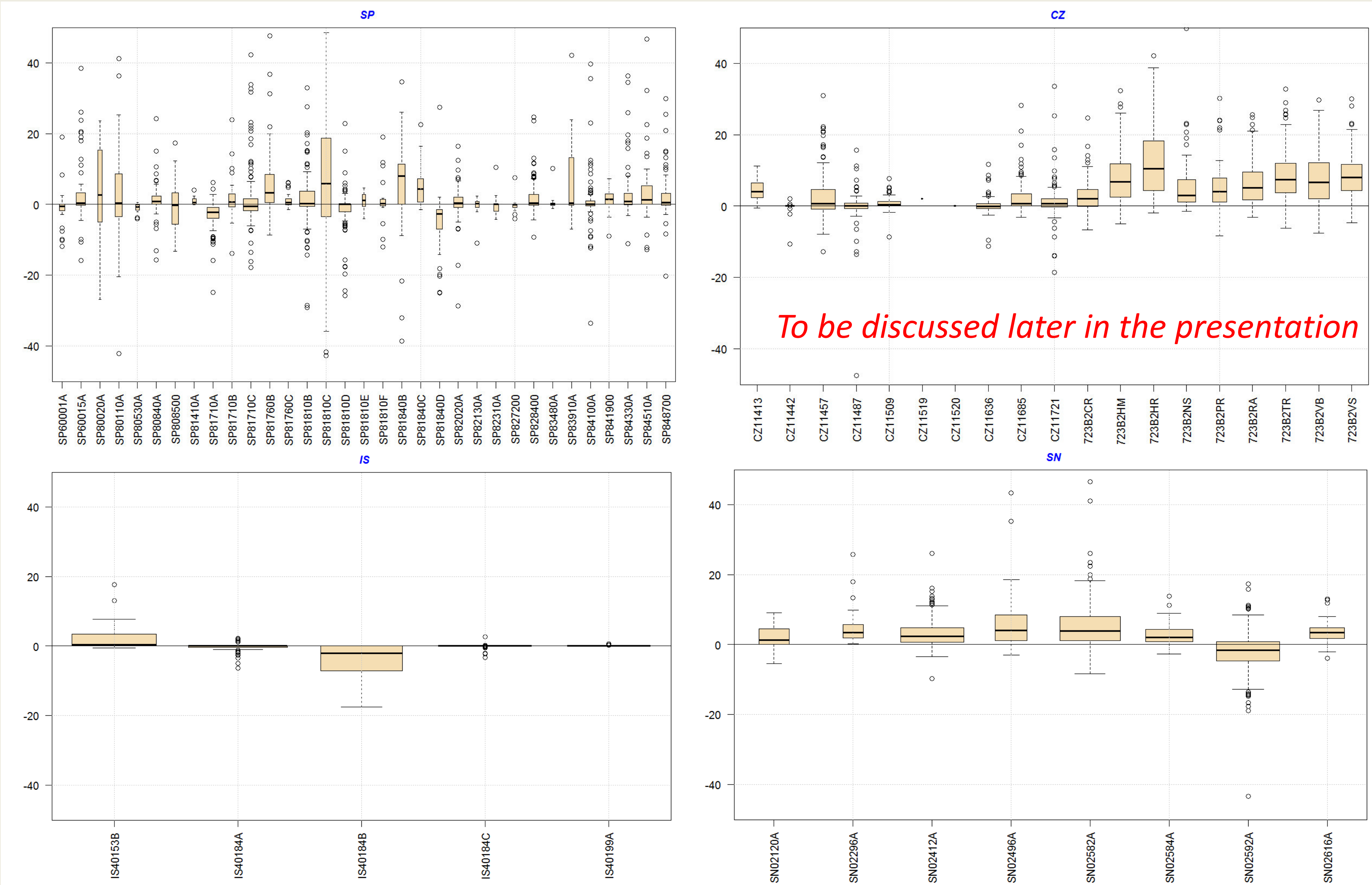


Note: boxplot width differs with number of available stations

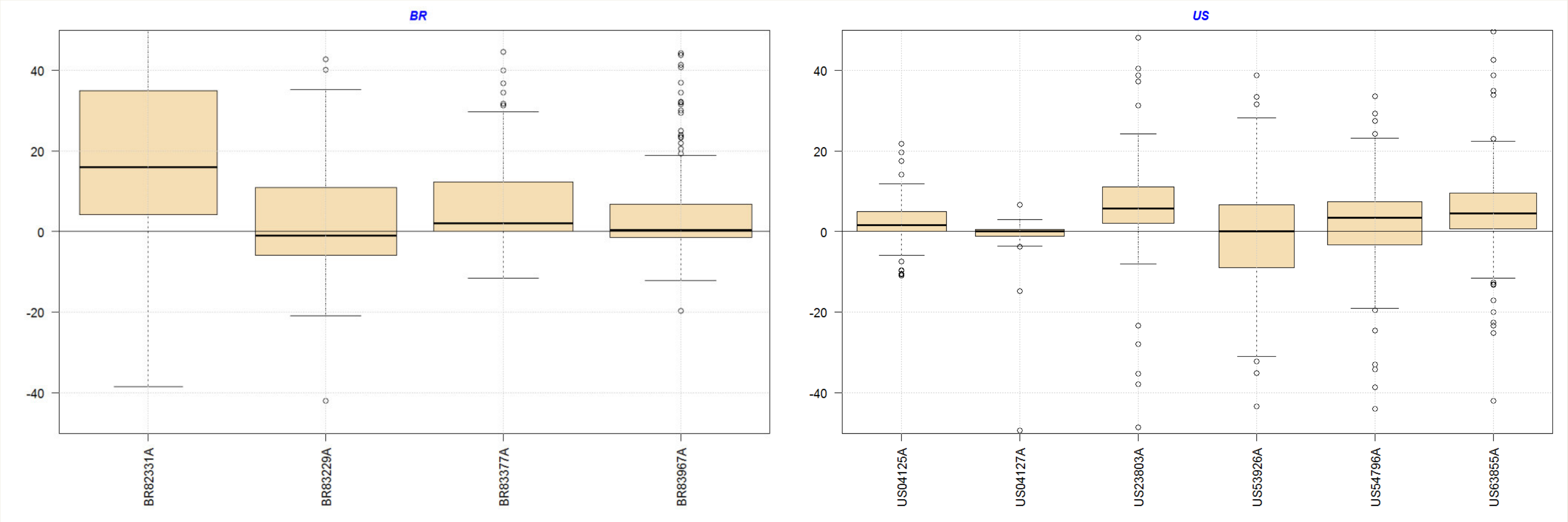
Differences in CON-AWS Monthly Sums for individual regions and seasons



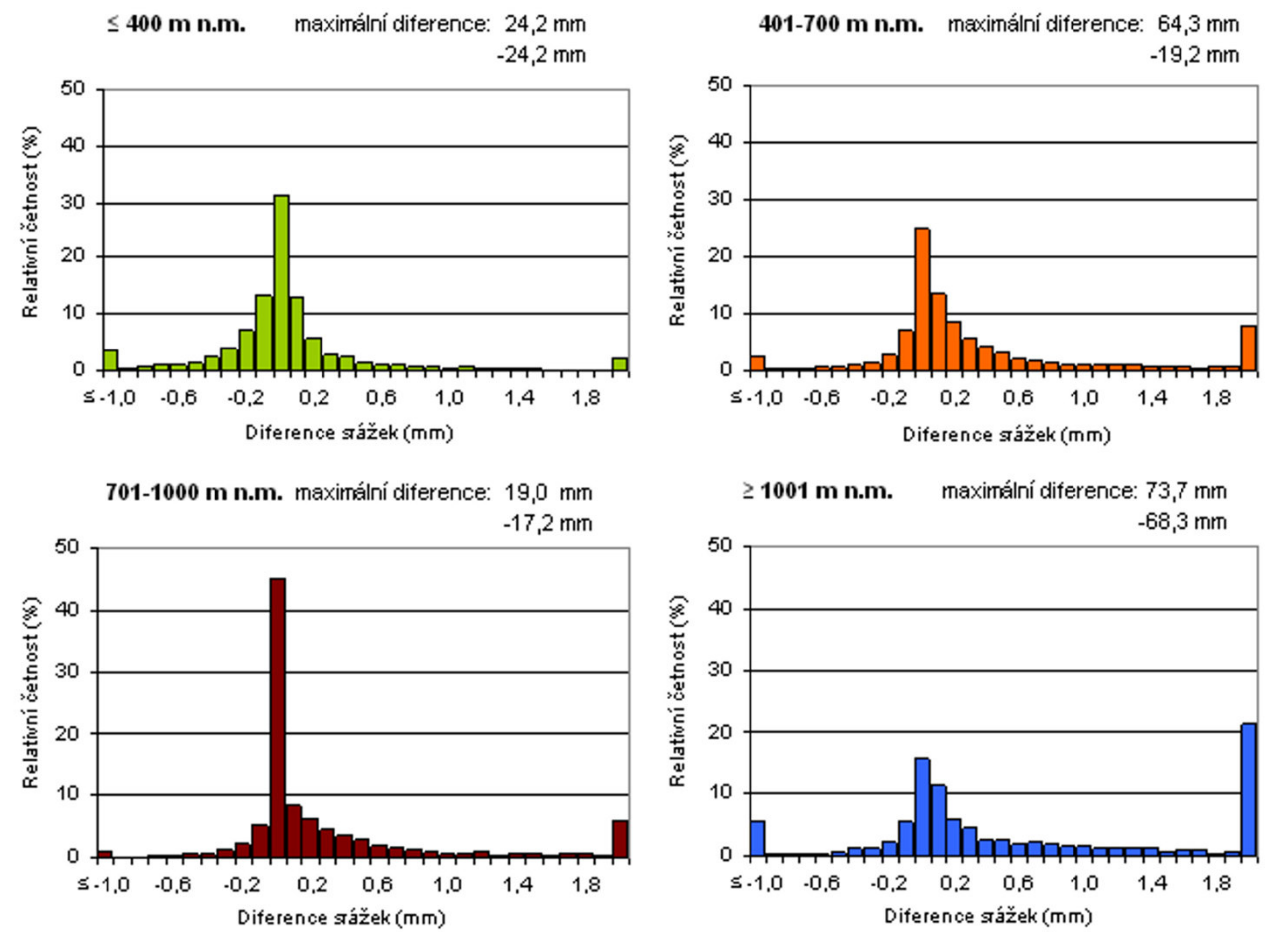
Differences in CON-AWS Monthly Sums for individual stations, by countries



Differences in CON-AWS monthly sums for individual stations, by countries

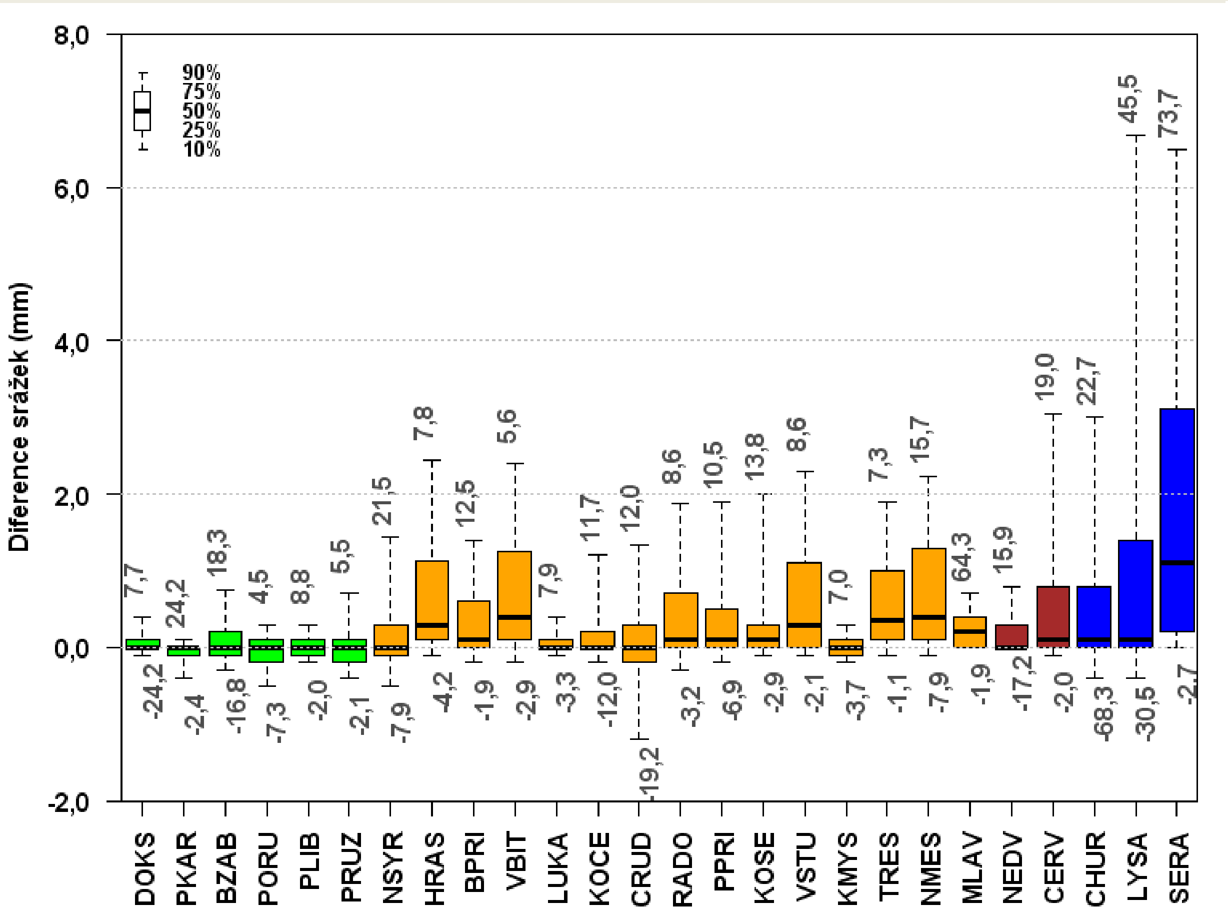


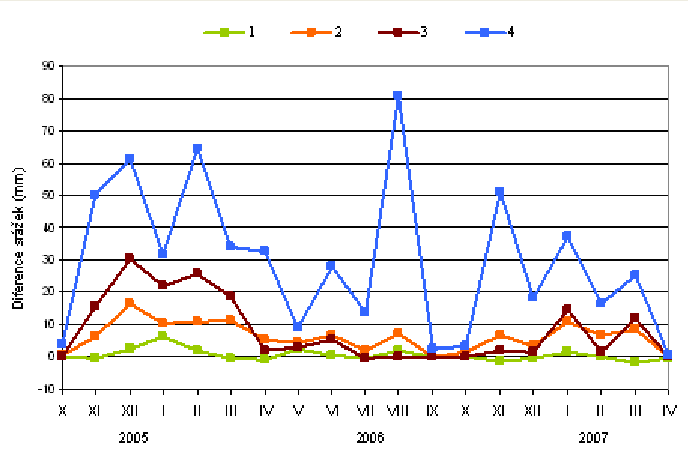
Differences in CON-AWS montly sums for different altitudes, example from CZ



Relative frequencies (%) of the distribution of ***differences*** *in* ***daily*** *precipitation totals measured by* ***CON*** *(METRA 886) and* ***AWS*** *(MR3H) rain-gauges for groups of stations at* ***different altitudes*** *in the period 1999–2007.*

Differences in CON-AWS montly sums for different altitudes, example from CZ

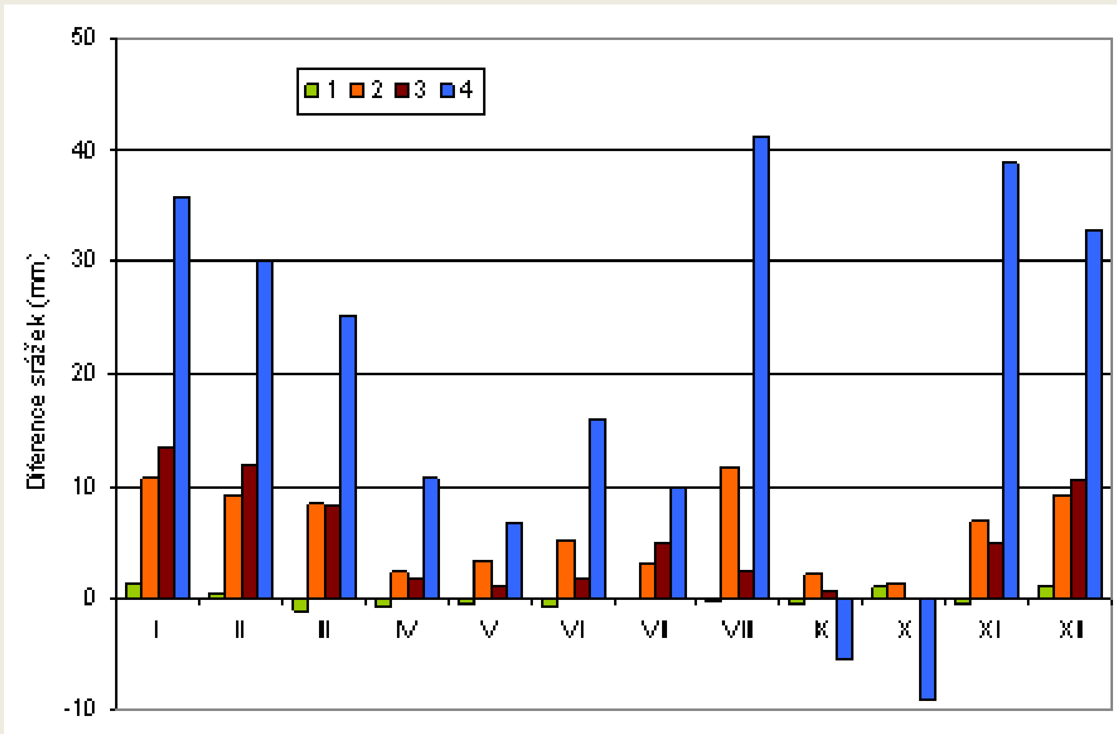




*Variation of mean **differences** in **monthly** precipitation totals (mm) for groups of stations at **different altitudes**:*
1 – ≤400 m; 2 – 401–700 m, 3 – 701–1000 m, 4 –≥1001 m a.s.l.

*Groups of stations at **different altitudes**:* ≤ 400, 401–700, 701–1000, ≥ 1001 m a.s.l.

Differences in CON-AWS montly sums for different altitudes, example from CZ



Annual variation of ***differences*** *in* ***monthly*** *precipitation totals (mm) measured by* ***CON*** *(METRA 886) and* ***AWS*** *(MR3H) rain-gauges for groups of stations at* ***different altitudes***
1 – ≤400 m; 2 – 401–700 m; 3 – 701–1000 m; 4 – ≥1001 m) in the period 1999–2007.

Summary

- Different datasets poses different data quality (compare e.g. PE vs. BR)
- AWS generally underestimate precipitation compared to CON, this effect can be seen throughout the world
- There are differences between individual seasons
- Additional variables helps to understand seasonal differences
- Higher differences (biases) occur in connection with: solid precipitation, higher wind speeds (winter), thunderstorms (summer)

Acknowledgements And Further Work

- This study has been possible thanks to the kind contributions of many coauthors and their institutions.
- It will continue under the guidance of POST. More info about POST:

  http://tinyurl.com/ISTI-Parallel
- Interested in joining us? Please Contact Victor Venema (Victor.Venema@uni-bonn.de)
- Can you contribute with dataset? Please contact Enric Aguilar (Enric.Aguilar@urv.cat)

General mathematical formulation of homogenization of climate data series

Tamás Szentimrey

Hungarian Meteorological Service

Content

Mathematics of homogenization of climate data series?

Critical remarks

Mathematical formulation of homogenization

- Definition of inhomogeneity of series
- Unconditional homogenization, theorems
- Relation with Quantile Matching methods
- Conditional homogenization, theorems
- Mathematical questions to be solved
- Special but basic case: Normal Distribution

What is in the practice?

- A popular procedure
- Relation of parallel observations and extremes
- An alternative procedure for mean and st. deviation
- Homogenization of standard deviation in MASH!

Mathematics of homogenization of climate data series?

There are several methods and software in meteorology but

- **there is no exact mathematical theory of homogenization!**

Moreover,

- the mathematical formulation is neglected in general,
-"mathematical statements" without proof are in the papers,
- unreasonable dominance of the practice over the theory.

No solution without advanced mathematics!

Theoretical questions

Mathematical formulation of homogenization of climate data series?

What are the mathematical problems to be solved? And what is the solution?

Evaluation of the mathematical base of the methods applied in practice?

The following contradiction is an often phenomenon at the methods:

good heuristic ideas **versus** poor mathematics

The ratio of the problems to be solved: 90% mathematics, 10% meteorology

But at the methods applied in practice: 10% mathematics, 90% meteorology

Mathematical formulation of homogenization

Distribution problem, not regression!

Let us assume we have daily or monthly data series.

$Y_1(t)\ \left(t=1,2,..,n\right)$: candidate series of the new observing system

$Y_2(t)\ \left(t=1,2,..,n\right)$: candidate series of the old observing system

$1 \le T < n$: change-point

Before T: series $Y_2(t)\ \left(t=1,2,..,T\right)$ can be used

After T: series $Y_1(t)\ \left(t=T+1,..,n\right)$ can be used

Theoretical (!) cumulative distribution functions (CDF)

$$F_{1,t}(y) = \mathrm{P}\big(Y_1(t) < y\big) \quad , \quad F_{2,t}(y) = \mathrm{P}\big(Y_2(t) < y\big)$$

$$y \in (-\infty, \infty) \ , \ t = 1,2,..,n$$

Natural change (annual cycle, climate change)

Functions $F_{1,t}(y)$, $F_{2,t}(y)$ $(t = 1,2,..,n)$ change in time!

Definition of inhomogeneity

The merged series

$Y_2(t)$ $(t = 1,2,..,T)$, $Y_1(t)$ $(t = T+1,..,n)$ is inhomogeneous,

if identity $F_{2,t}(y) \equiv F_{1,t}(y)$ $(t = 1,2,..,T)$ is not true.

Homogenization

Adjustment, correction of values $Y_2(t)$ $\left(t = 1,2,..,T\right)$

in order to have the corrected values $Y_{1,2h}(t)$ $\left(t = 1,2,..,T\right)$

with the same distribution as the elements

of series $Y_1(t)$ $\left(t = 1,2,..,T\right)$ have, i.e.:

$$\mathrm{P}\left(Y_{1,2h}(t) < y\right) = \mathrm{P}\left(Y_1(t) < y\right) = F_{1,t}(y) \qquad t = 1,2,..,T$$

Theorem for (unconditional) homogenization

i, Existence:

If $Y_{1,2h}(t) = F_{1,t}^{-1}\left(F_{2,t}\left(Y_2(t)\right)\right)$ then

$$P\left(Y_{1,2h}(t) < y\right) = F_{1,t}(y) \qquad \left(t = 1,2,..,T\right).$$

ii, Unicity:

If $h(s)$ is a strictly monotonous increasing function and $P\left(h(Y_2(t)) < y\right) = F_{1,t}(y)$, then $h(s) = F_{1,t}^{-1}\left(F_{2,t}(s)\right)$.

Quantile Matching (QM) methods

The basis of these methods can be integrated into the general theory since the transfer function,

$Y_{1,2h}(t) = F_{1,t}^{-1}\left(F_{2,t}\left(Y_2(t)\right)\right)$ is equivalent with,

$$Y_{1,2h}(t) = Y_2(t) + \left(F_{1,t}^{-1}(p) - F_{2,t}^{-1}(p)\right)$$

where $F_{1,t}^{-1}(p)$, $F_{2,t}^{-1}(p)$ are the quantile functions

and $F_{2,t}\left(Y_2(t)\right) = p$.

However the QM methods developed in practice mainly for daily data are very weak empiric methods. It is not real mathematics! (good heuristics with poor mathematics; brave people!)

Conditional homogenization based on given events

Let $B = \{B_j : j = 1,2,..,M\}$ be a complete system of events:

$$B_i \cap B_j = \varnothing, \quad \sum_{j=1}^{M} P(B_j) = 1 \qquad \text{(e.g. macrosynoptic weather situations)}$$

Conditional homogenization of $Y_2(t)$ on given events B,

$$Y_{1,2h}(t,B) = F_{1,t,B_j}^{-1}\left(F_{2,t,B_j}\left(Y_2(t)\right)\right) \quad \Leftrightarrow \quad B_j \text{ occurs at } t \qquad (t = 1,2,..,T)$$

where $F_{1,t,B_j}(y)$, $F_{2,t,B_j}(y)$ are the conditional distribution functions of $Y_1(t)$, $Y_2(t)$, given B_j, that is

$$F_{1,t,B_j}(y) = \mathrm{P}\left(Y_1(t) < y \mid B_j\right), \; F_{2,t,B_j}(y) = \mathrm{P}\left(Y_2(t) < y \mid B_j\right)$$
$$y \in (-\infty, \infty), \quad t = 1,2,..,T$$

Then as a consequence of Bayes and total probability theorems:

$$\mathrm{P}\left(Y_{1,2h}(t,B) < y\right) = F_{1,t}(y) \qquad y \in (-\infty, \infty), \; t = 1,2,..,T$$

Mathematical questions to be solved

The simpler case: unconditional homogenization

The merged series are given: $Y_2(t)\ \left(t = 1,2,..,T\right)$, $Y_1(t)\ \left(t = T+1,..,n\right)$

The transfer function is: $Y_{1,2h}(t) = F_{1,t}^{-1}\left(F_{2,t}\left(Y_2(t)\right)\right) \quad \left(t = 1,2,..,T\right)$

Problems:

Estimation, detection of change point(s) T ?

Estimation of distribution functions $F_{1,t}(y)$, $F_{2,t}(y)$ $\left(t = 1,2,..,T\right)$?

i, $F_{1,t}(y)$, $F_{2,t}(y)$ change in time (annual cycle, climate change)

ii, No sample for $F_{1,t}(y)$ $\left(t = 1,2,..,T\right)$

The problem is insolvable in general case!
Only relative methods can be used with some assumptions.
In addition some simplifications are necessary.

Special but basic case: Normal Distribution (e.g. temperature)

Theorem.

Let us assume normal distribution,

$$Y_1(t) \in N\left(E_1(t), D_1(t)\right), \quad Y_2(t) \in N\left(E_2(t), D_2(t)\right) \quad (t = 1,2,..,n)$$

$E_1(t), E_2(t)$: means $\quad D_1(t), D_2(t)$: standard deviations

Then the transfer function of homogenization:

$$Y_{1,2h}(t) = F_{1,t}^{-1}\left(F_{2,t}\left(Y_2(t)\right)\right) = E_1(t) + \frac{D_1(t)}{D_2(t)}\left(Y_2(t) - E_2(t)\right) \quad (t = 1,2,..,T)$$

Remarks:

i, A simple linear function and there is no "tail distribution" problem!

ii, Only the mean (***E***) and standard deviation (***D***) must be homogenized!

What is in the Practice?

A popular procedure

1. Homogenization of monthly series:

   Break points detection, correction of mean

   Assumption: homogeneity of higher order moments (e.g. st. deviation)

2. Homogenization of daily series:

   Trial to homogenize also the higher order moments

   (Quantile Matching (HOM, RHtests), Spline (SPLIDHOM))

   Used monthly information: only the detected break points

Contradiction

- Inhomogeneity of higher moments: **daily**: yes versus **monthly**: no ?

  It is not adequate mathematical model for st. deviation!

- Why are not used the monthly correction factors for daily homogenization?

What is the reason of this “popular procedure”?

An observed phenomenon at extremes

The differences of parallel observations are larger in case of extremes.

What is this? Inhomogeneity in the tails of the distributions?

No, this observed phenomenon has a simple and logical reason.

The reason is that the extremes may be expected at different moments in case of parallel observations. It is a natural phenomenon.

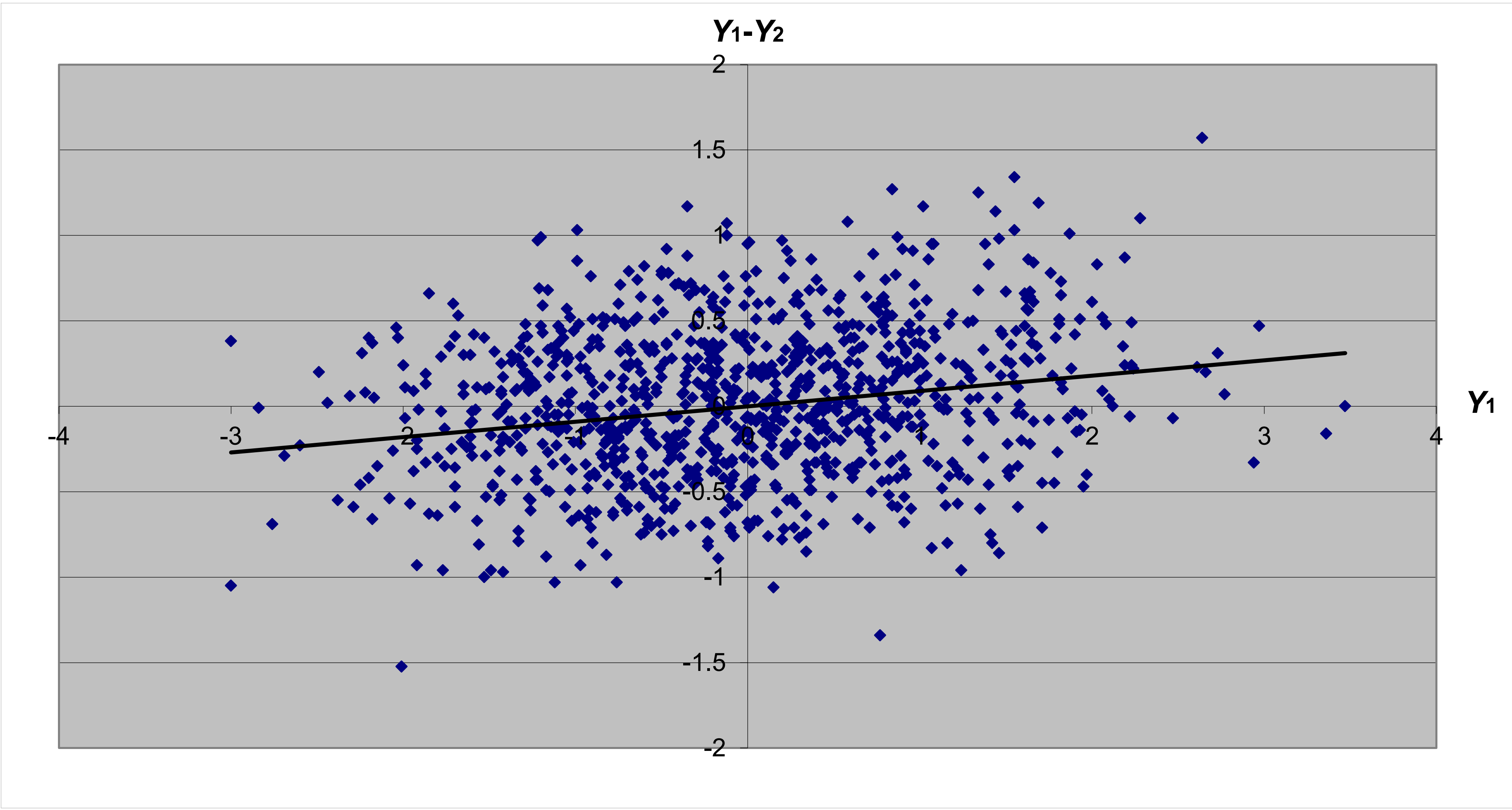
Or with other words, there maybe systematic biases in rank order!

An example is presented.

Example by Monte-Carlo method for natural dependence of $Y_1 - Y_2$ on Y_1

Generated series: $Y_1(t) \in N(0,1)$, $Y_2(t) \in N(0,1)$, $\operatorname{corr}(Y_1(t), Y_2(t)) = \rho = 0.9 \quad (t = 1,..,1000)$

Difference series: $Y_1(t) - Y_2(t)$, $\quad \mathrm{E}(Y_1(t) - Y_2(t) \mid Y_1(t)) = (1-\rho) \cdot Y_1(t) = 0.1 \cdot Y_1(t)$



An alternative procedure

1. Homogenization of monthly series:

Break points detection, correction of the mean and standard deviation.

The correction is based on the normal distribution transfer function.

Assumption: homogeneity of higher order (>2) moments.

This assumption is always right in case of normal distribution!

2. Homogenization of daily series:

Homogenization of mean and standard deviation on the basis of the monthly results. The used monthly information are the break points and the monthly corrections of the mean and standard deviation.

Developing of MASH for homogenization of Standard Deviation

(Multiple Analysis of Series for Homogenization; *Szentimrey, T.*)

Order of steps

1. Homogenization of Standard Deviation of data series
2. Homogenization of Mean of data series

Principles of Methodology

Multiple break points detection procedures for Mean and St. Deviation.

Procedures based on **Test of Hypothesis.**

Confidence Intervals are also given for the break points.
(make possible automatic use of metadata).

Estimation of the correction factors for Mean and St. Deviation.

Estimation is based on **Confidence Intervals.**

15 Hungarian Annual Mean Temperature Series 1901-2014

Test Statistics for St. Deviation Before Homogenization

Critical value (significance level 0.05): 26.8

Series	TSB	Series	TSB	Series	TSB
7	141.13	11	50.79	14	33.13
6	28.19	12	26.07	13	24.93
5	22.69	2	22.11	4	21.54
1	20.87	3	19.44	10	17.46
9	15.31	8	11.74	15	10.26

AVERAGE: 31.04

Test Statistics for Mean Before Homogenization

Critical value (significance level 0.05): 21.76

Series	TSB	Series	TSB	Series	TSB
12	1262.47	5	926.31	10	831.81
7	637.72	6	558.66	3	506.91
15	500.07	8	463.98	11	320.14
13	288.51	14	249.40	9	197.54
1	166.10	4	134.41	2	88.90

AVERAGE: 475.53

17 Annual mean Maximum Temperature Series 1950-2007
(Network real 000005 of COST Benchmark)

Test Statistics for St. Deviation Before Homogenization
Critical value (significance level 0.05): 21.00

Series	TSB	Series	TSB	Series	TSB
6	41.27	5	21.28	7	20.34
12	13.23	13	12.69	4	12.01
1	11.06	14	9.89	11	9.17
8	9.15	17	7.53	2	6.78
15	6.62	9	6.24	16	5.29
10	5.07	3	4.14		

AVERAGE: 11.87

Test Statistics for Mean Before Homogenization
Critical value (significance level 0.05): 20.91

Series	TSB	Series	TSB	Series	TSB
4	351.61	14	245.58	12	227.40
16	189.04	2	183.80	3	168.03
8	138.70	5	130.57	6	108.53
1	96.95	17	80.80	15	56.89
7	47.16	10	37.68	11	24.90
13	21.09	9	18.47		

AVERAGE: 125.13

15 Hungarian Annual Mean Temperature Series 1901-2014

Test Statistics for St. Deviation After Homogenization

Critical value (significance level 0.05): 26.8

Series	TSA	Series	TSA	Series	TSA
7	28.19	12	27.66	14	26.34
5	24.13	2	22.11	4	21.54
1	20.87	3	20.54	10	18.92
6	18.18	11	15.61	13	14.96
9	14.85	15	12.53	8	11.74

AVERAGE: 19.88

Test Statistics for Mean After Homogenization

Critical value (significance level 0.05): 21.76

Series	TSA	Series	TSA	Series	TSA
11	32.81	13	31.46	9	29.11
12	27.27	8	25.37	7	25.29
5	22.93	1	21.91	4	21.85
10	21.45	14	21.04	3	19.12
6	18.96	2	18.52	15	17.23

AVERAGE: 24.09

There is no royal road!

Thank you for your attention!

The International Surface Temperature Initiative – progress, future developments and how countries can contribute

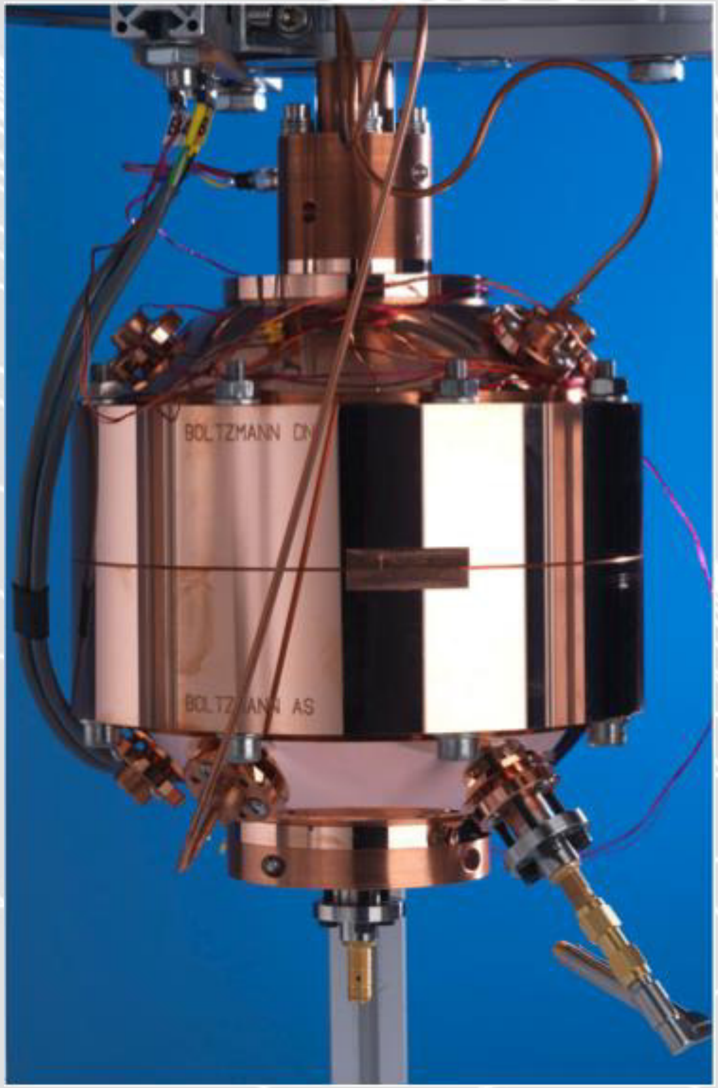
29 October 2015

Peter Thorne, **Blair Trewin**, Victor Venema, Jay Lawrimore, Kate Willett, with thanks to many initiative participants

History and purpose of ISTI

- ISTI was created following a CCl resolution in 2010
- Goal is to have an open, transparent and traceable data set with maximum global coverage
- Aiming for data at a range of timescales (monthly, daily, sub-daily)
- Governance through a steering committee and subject-matter working groups
- Not a formal WMO program, but has considerable involvement from NMHSs, as well as other institutions, and experts from other relevant fields (e.g. statistics, metrology)

The real world observing system is not the lab … we are not dealing with 10^{-N}K



Michael de Podesta's 'Instrument of real beauty'

Image courtesy Michael de Podesta, NPL

It's not, in general, these either …

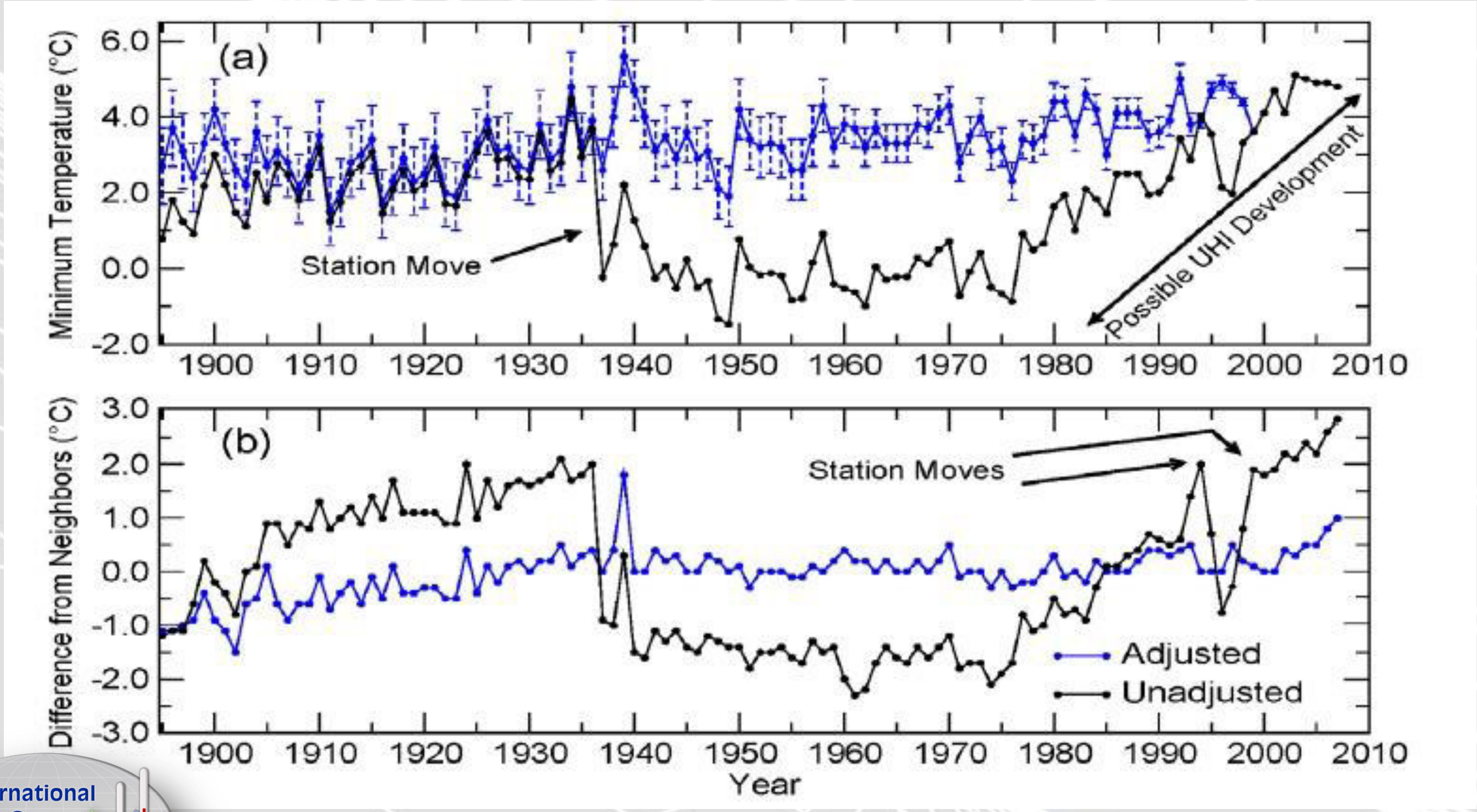
US Climate Reference Network website

It's more like these ...

Huge range of instrument types, siting exposures etc. regionally, nationally and globally with many changes over time.

Various sources online

Inhomogeneities: annual mean minimum temperature at Reno, Nevada, USA



(Matt Menne and Claude Williams, NOAA National Climatic Data Center)

International Surface Temperature Initiative

The long list of issues to be considered …

- Station moves
- Instrument changes
- Observer changes
- Automation
- Time of observation biases
- Microclimate exposure changes
- Urbanization
- And so on and so forth …

Underlying which are two absolutely fundamental issues …

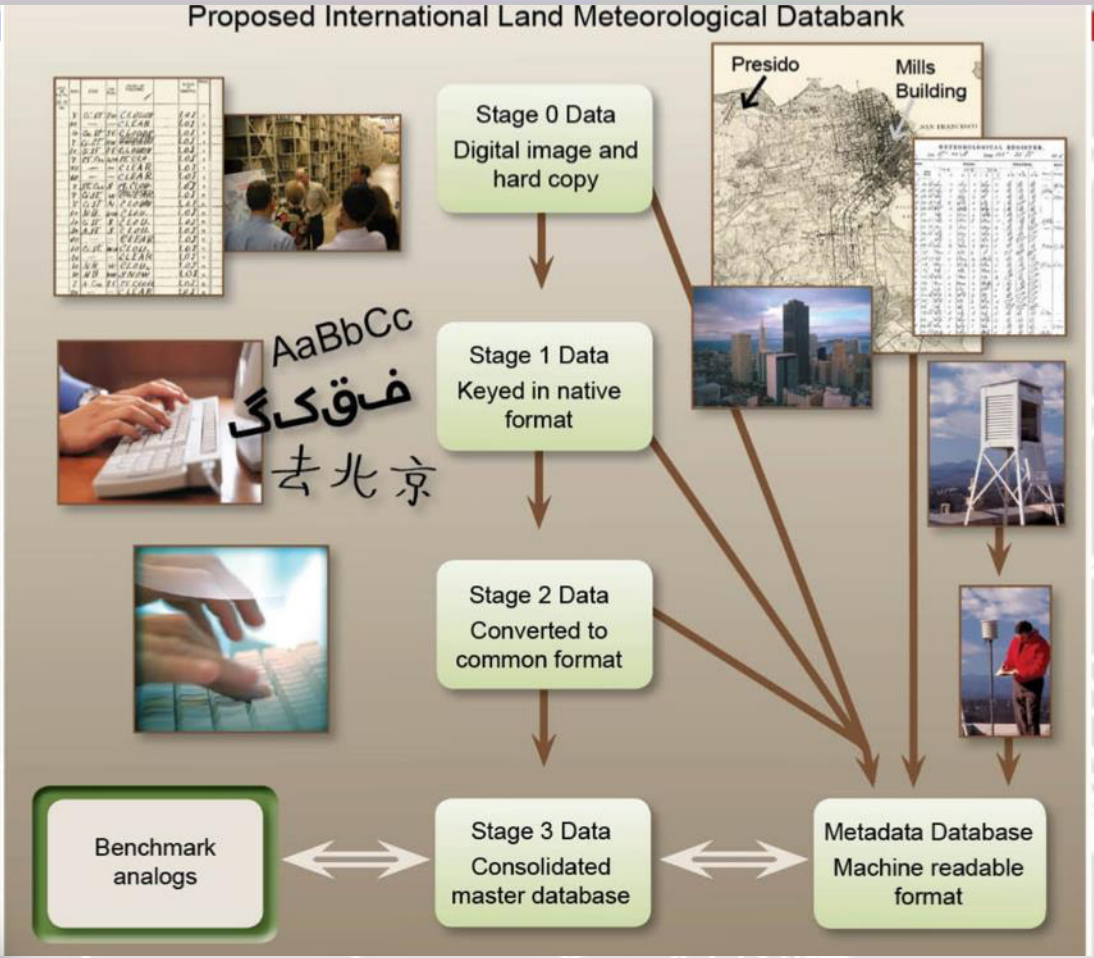
- A lack of traceability to absolute or relative standards for most, if not all, of the historical records
- A lack of adequate documentation of the (ubiquitous) changes sufficient to characterize on a station by station basis in an absolute sense their changing measurement characteristics.

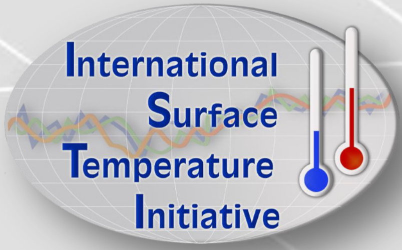
ISTI: Creating a framework to enable advances

- The International Surface Temperature Initiative can put in place certain structures to enable science advances
  1. Basic environmental data provision
  2. Creation of independent means to benchmark and assess
  3. User advice
- The rest is down to the global science community ….

International Surface Temperature Initiative

Step 1: Data rescue and provision





Jay Lawrimore, Jared Rennie and Peter Thorne (2013) Responding to the Need for Better Global Temperature Data, EOS, 94 (6), 61–62

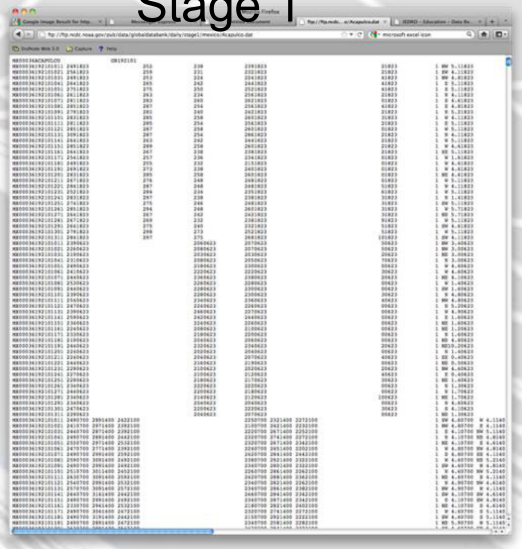
DOI: 10.1002/2013EO060002

Stage 0 / Stage 1 Overview and Metadata

- Stage 0: Original observation
  - Scanned Images of paper record (PDF / JPG)
  - Not always available
  - Conversely, a lot of data <u>only</u> exist on paper (or as scanned images) – still a great need for data rescue

- Stage 1: Native keyed format.
  - Databank policy encourages data be provided in its rawest form; that closest to the measurements that were first reported by the observer.
    - Ideally no quality control or homogenization should be applied prior to submission
  - Other Requirements
    - Any time scale (monthly / daily / hourly)
    - Metadata: latitude, longitude, elevation, name
    - Other metadata: ID, country of origin, instrumentation

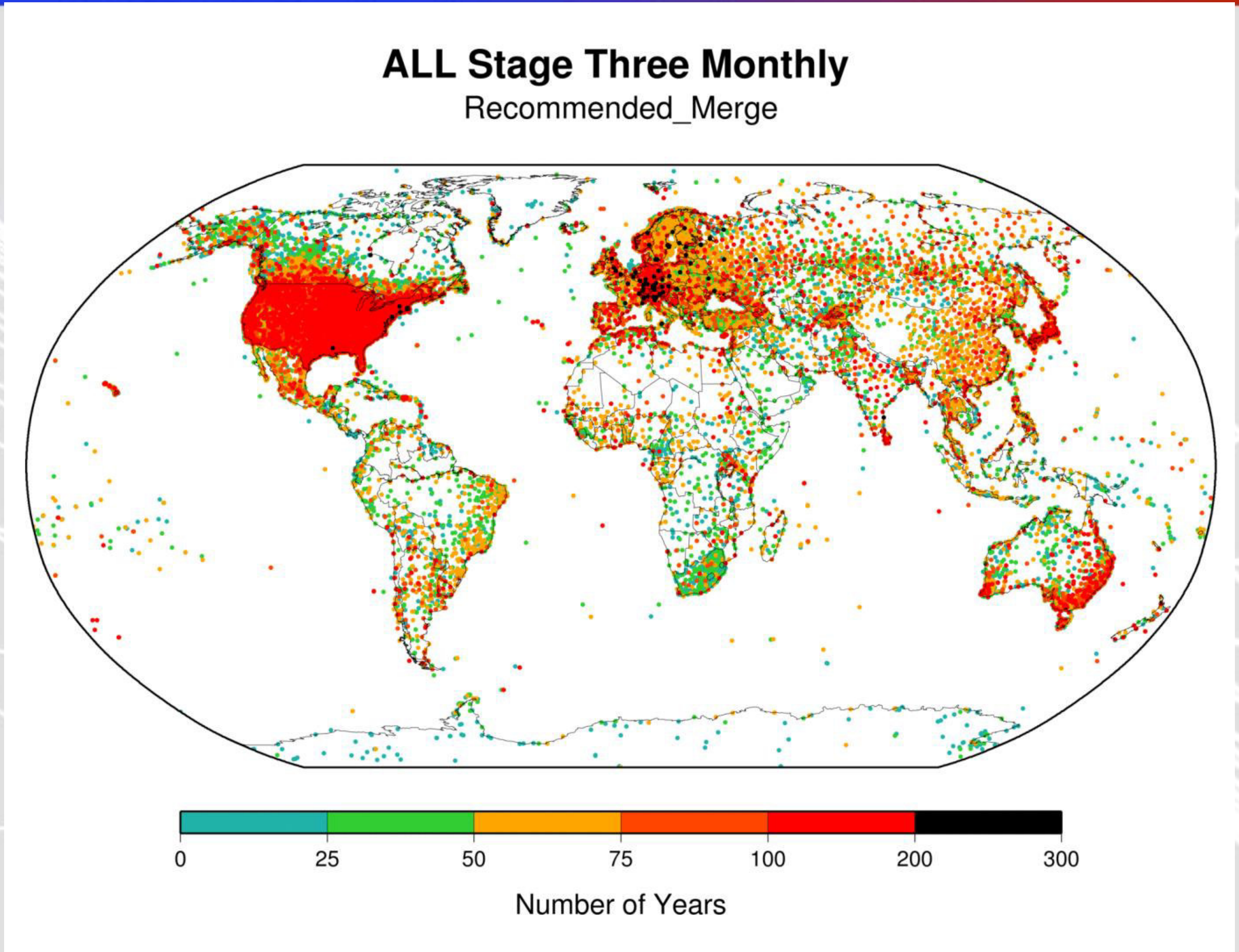
Stage 1



Data Provenance Tracking Flags

- Data source for Stage 0 Files
  - NCDC, JMA, BOM
- Data source for Stage 1 Files
  - NCDC, NMA's, other international organizations
- Type of data sent by source
  - Raw, quality controlled, bias corrected
- Mode of Digitization
  - SourceCorp, CDMP, Local Originator
- Mode of converting hourly data into daily data
  - Main standard synoptic times, intermediate synoptic times, other
- Method of converting daily data into monthly summaries
  - How many days used to calculate monthly average

The version 1.1.0 databank (released 15 October 2015)



Stage 3 merging program

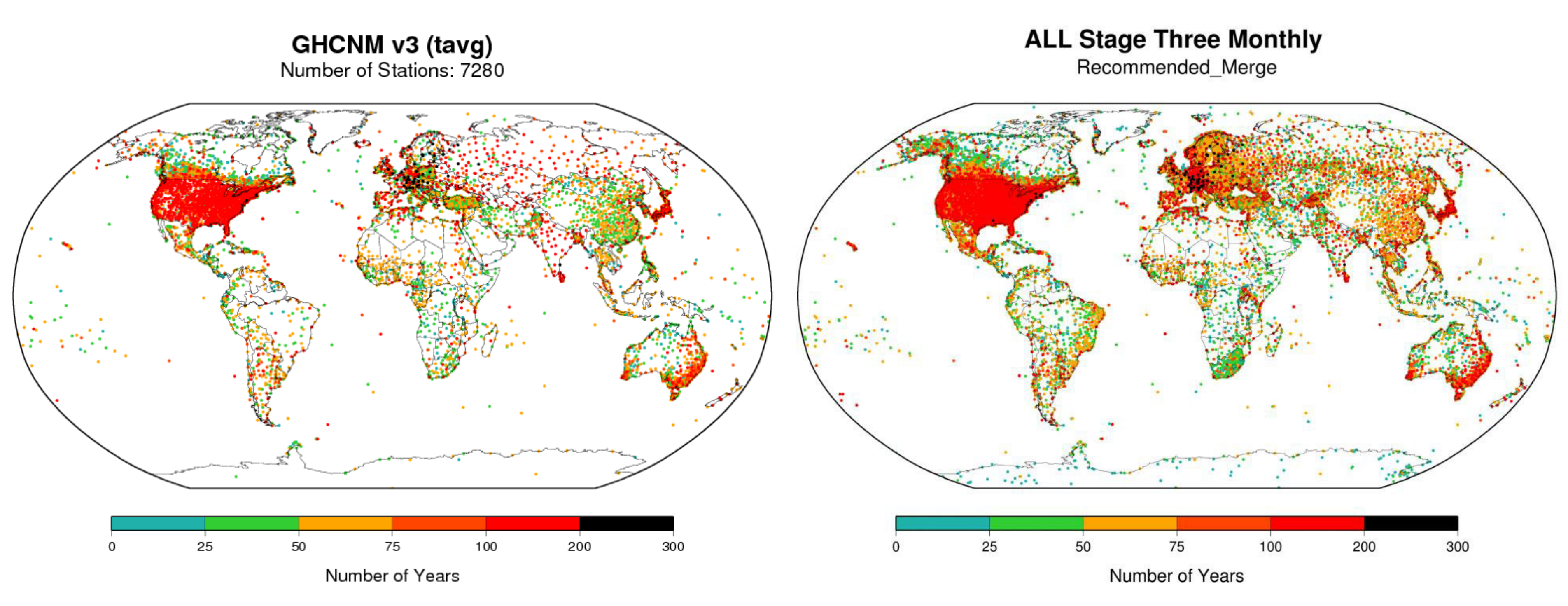
- Take all ***monthly*** sources and combine them into one complete global dataset
- Metadata matching and data equivalence criteria
- Code is readable, portable, and modular – need an automated method due to large number of stations
- Recommended product, along with several variants to characterize uncertainty
- Results placed on FTP
  - ftp://ftp.ncdc.noaa.gov/pub/data/globaldatabank/monthly/stage3

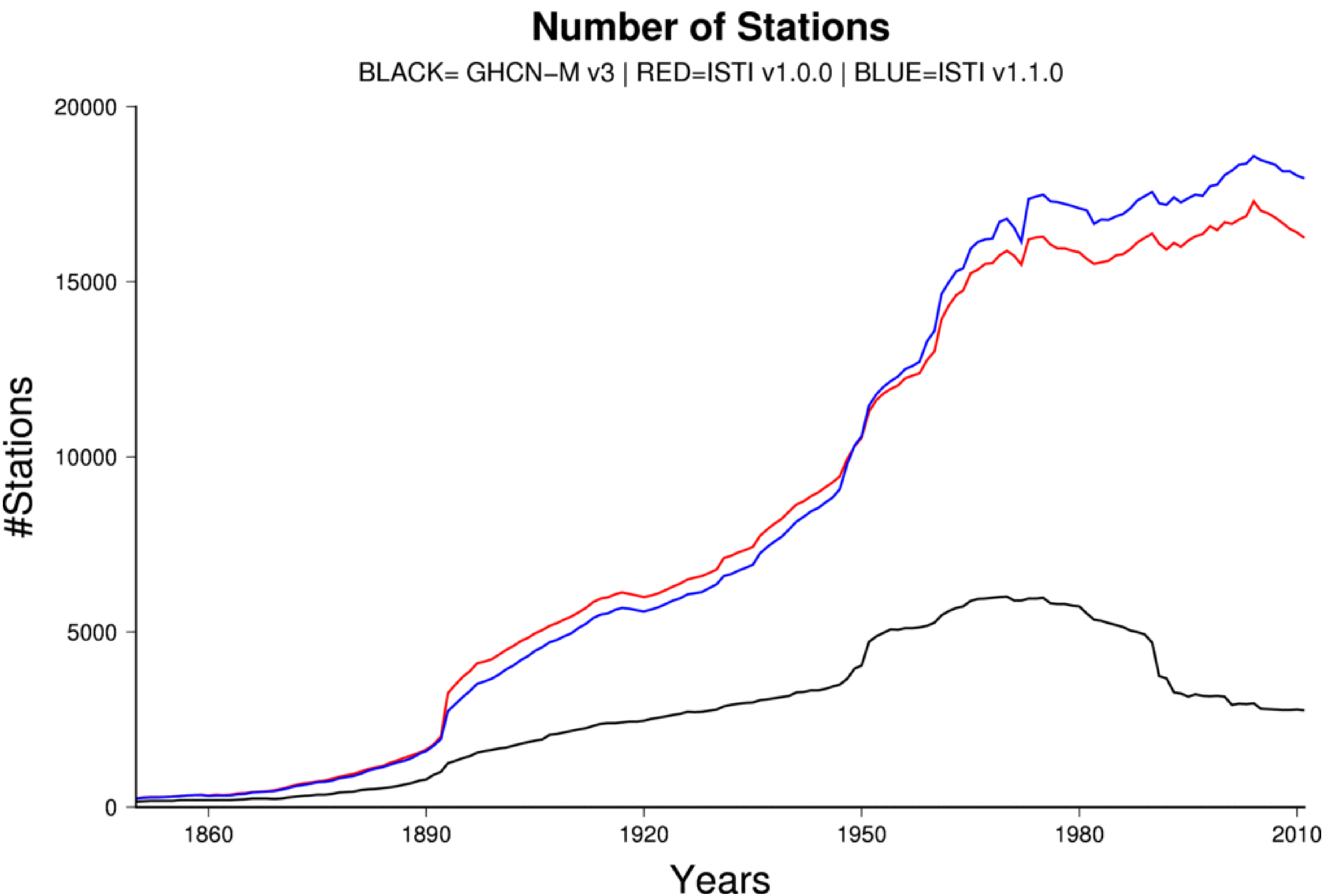
International Surface Temperature Initiative

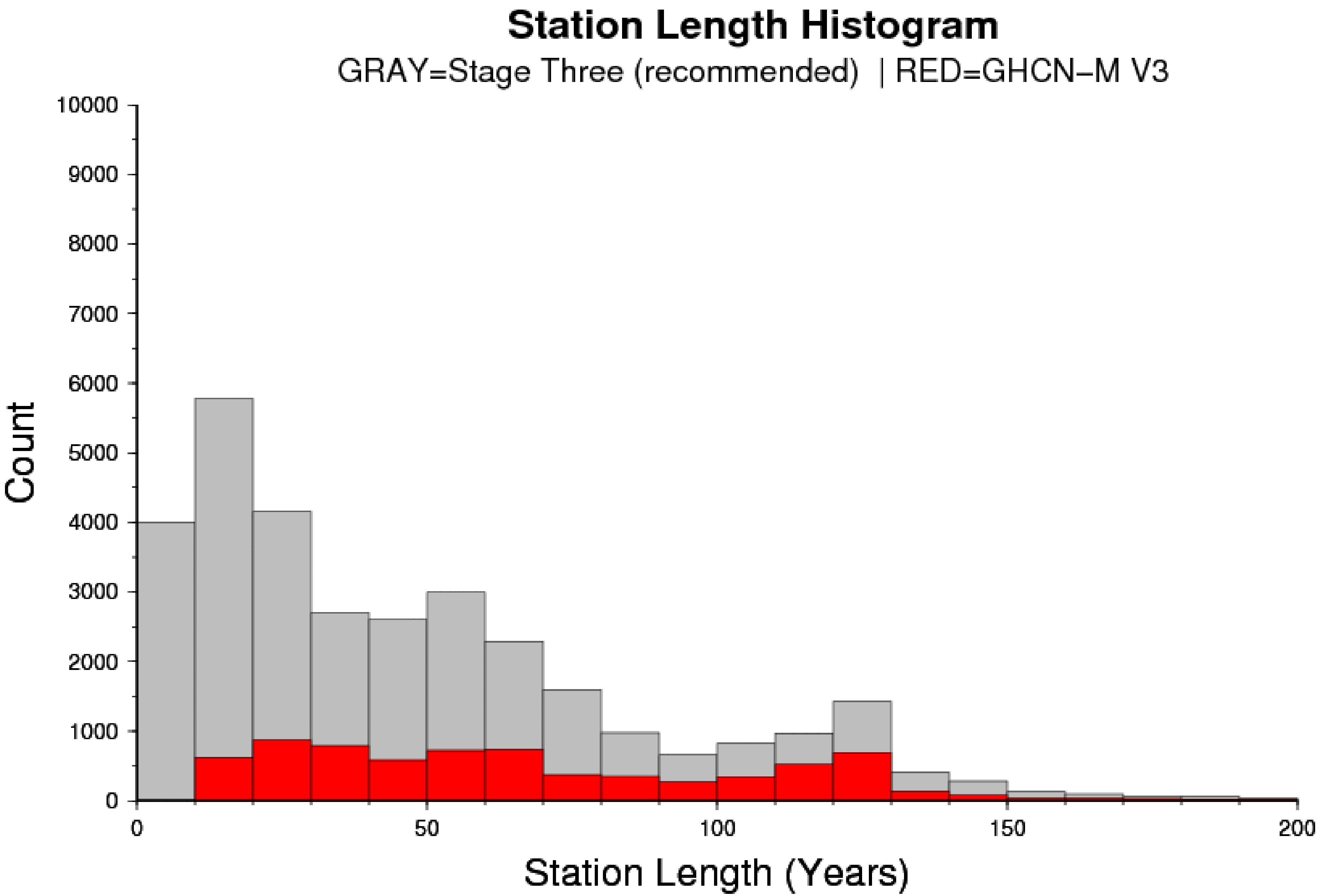
Source hierarchy

- More than 100 sources received
- Certain sources need to be given a higher preference, so that no valuable information is lost
- ISTI has developed a set of criteria that dictates the hierarchy for the recommended merge
- In addition, some grossly overlapping sources aren’t considered, to avoid excess duplication

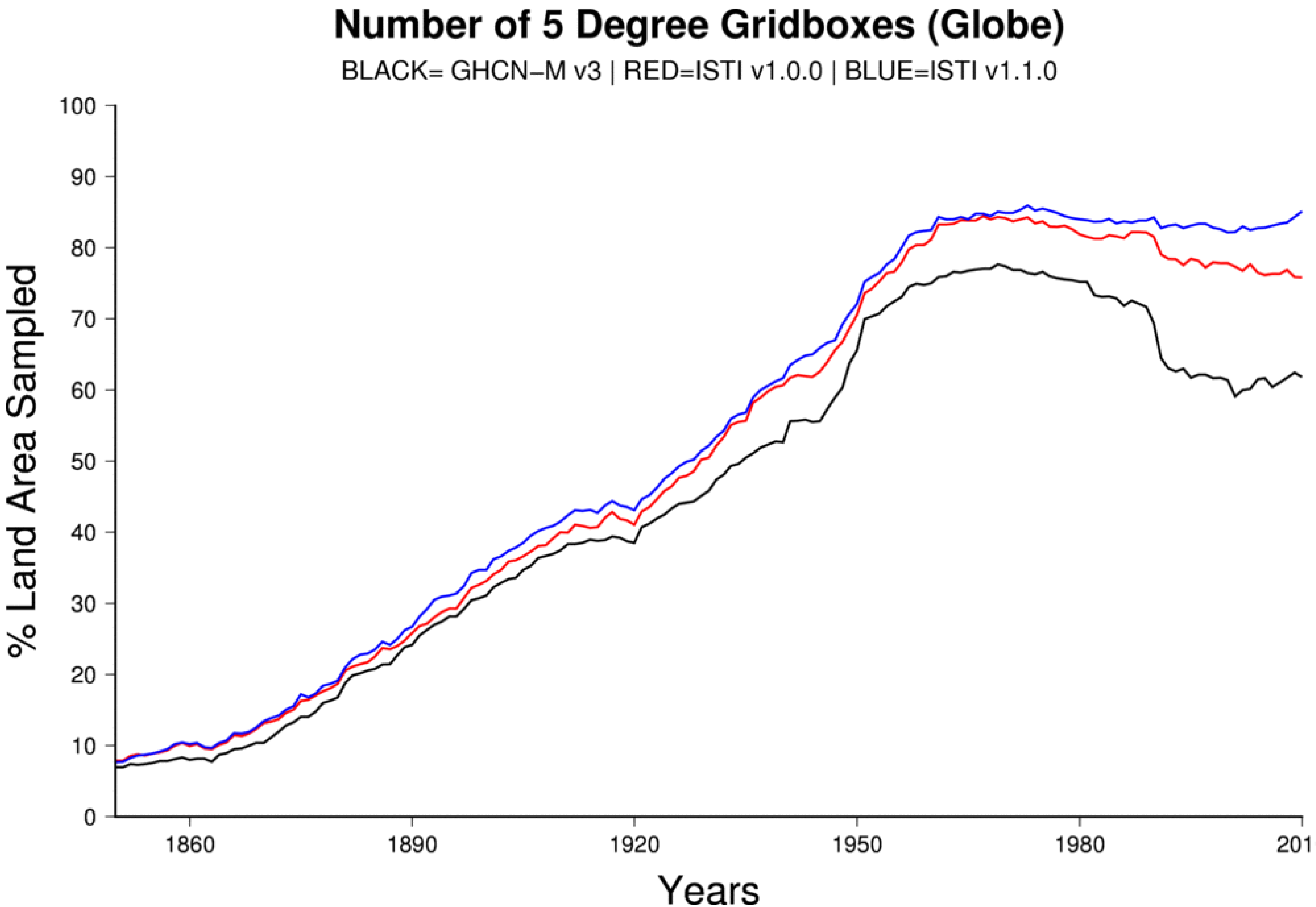
How does ISTI coverage compare with other global data sets?




Number of Stations
BLACK= GHCN–M v3 | RED=ISTI v1.0.0 | BLUE=ISTI v1.1.0
20000
15000
10000
5000
0
#Stations
1860
1890
1920
1950
1980
2010
Years



Station Length Histogram
GRAY=Stage Three (recommended) | RED=GHCN-M V3
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Count
0
50
100
150
200
Station Length (Years)


Number of 5 Degree Gridboxes (Globe)
BLACK= GHCN−M v3 | RED=ISTI v1.0.0 | BLUE=ISTI v1.1.0
% Land Area Sampled
100
90
80
70
60
50
40
30
20
10
0
1860
1890
1920
1950
1980
2010
Years

Homogenisation and benchmarking

- A major part of ISTI is providing a platform for benchmarking homogenisation methods.
- With real world data we do not have the luxury of knowing the truth – we CANNOT measure performance of a specific method or closeness to real world truth of any one data-product.
- We CAN focus on performance of underlying algorithms (AKA software testing) - consistent synthetic test cases, simulating real world noise, variability and spatial correlations potentially enable us to do this.

International Surface Temperature Initiative

Benchmarks

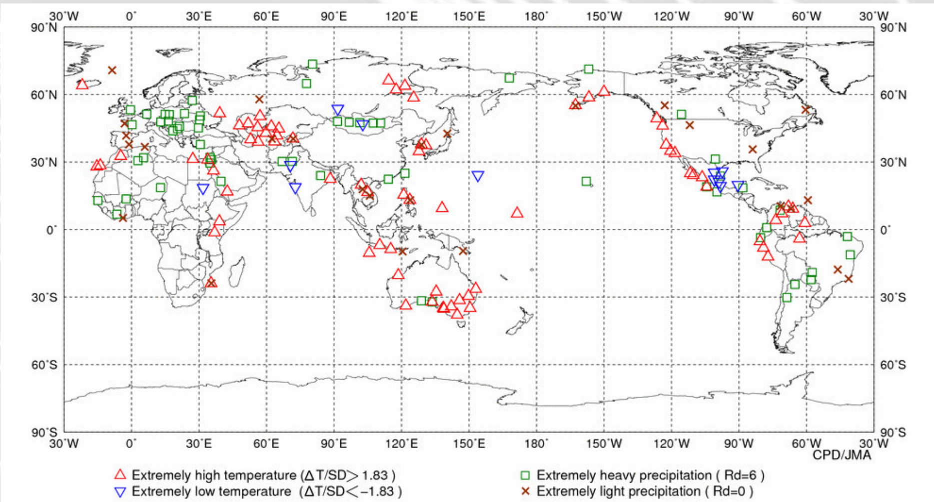
- Global benchmarks that mirror the databank holdings will be made available in 2016
  - 8-10 versions, with a subset open but most closed
  - Realistic intra- and inter-station statistics for each but distinct added data artefacts to be removed
- Benchmarks will be available for c.2 years for analysis
- Then the closed benchmarks will be unveiled and different algorithms assessed by benchmarking group.

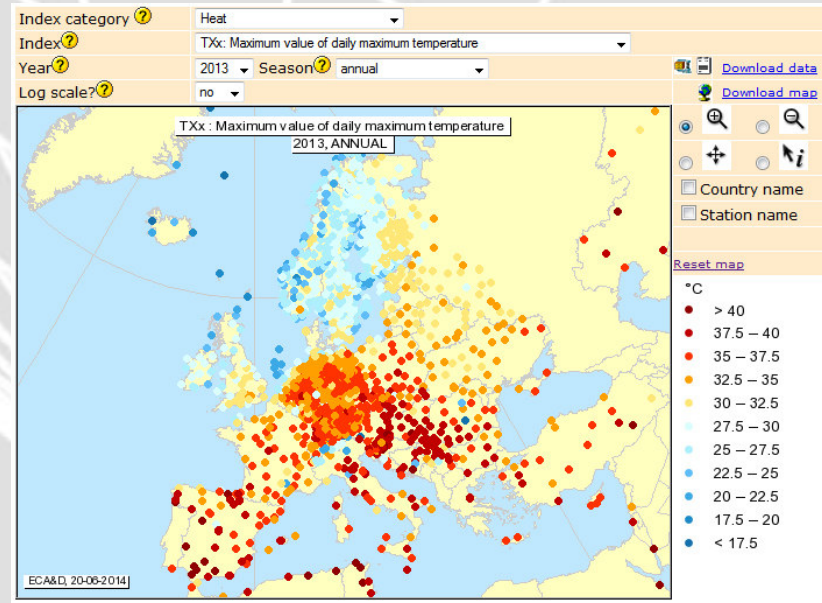
International Surface Temperature Initiative

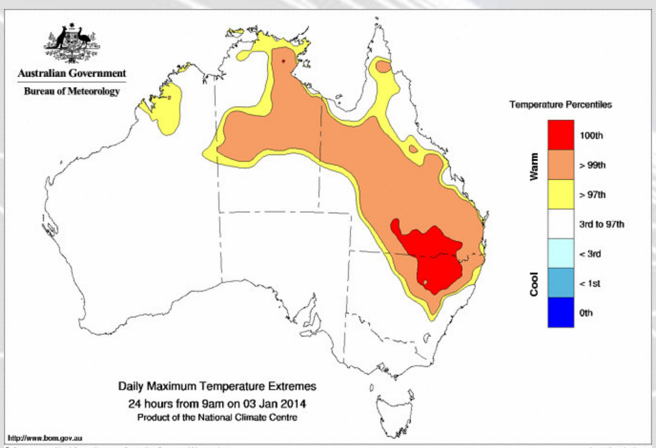
Some of the challenges facing ISTI

- Needs countries to make data available – data policy is moving slowly towards open data at both national and WMO levels, but still a long way to go.
- ISTI has virtually no resources of its own.

ISTI – potential to be a basis for global and regional data products?







How countries can contribute

- Making data (especially daily data) available to ISTI
- Participating in data rescue activities
- Participating in the benchmarking project

To make arrangements for data submissions (in any reasonable format), contact data.submission@surfacetemperatures.org

Questions and Answers

www.surfacetemperatures.org

Bull. Amer. Met. Soc. doi: 10.1175/2011BAMS3124.1

https://www2.image.ucar.edu/event/summerprog.surfacetemps

Peter.thorne@nersc.no

Data.submission@surfacetemperatures.org

Efficiency tests for automatic homogenization methods of monthly temperature and precipitation series "MULTITEST"

Peter Domonkos[1] and José A. Guijarro[2]

[1]Centre for Climate Change, University Rovira i Virgili, Tortosa, Spain, e-mail:dpeterfree@gmail.com

[2]Spanish Meteorological Agency (AEMET)

Aims of MULTITEST

- Testing of monthly homogenization softwares with larg test datasets of varied climatic and inhomogeneity properties and identifying the best performing methods;
- Clarifying the relations between efficiencies and test dataset characteristics;
- Finding the minimum conditions for automatic methods in terms of the number of comparable time series, their length and their spatial correlations;
- Providing a large size benchmark dataset for the climatological community characterizing the observed climate of various geographical regions;

Scope of MULTITEST

- Efficiency tests for the homogenization of monthly temperature and monthly precipitation datasets;
- Only automatic methods or semiautomatic methods with default parameterization will be tested;
- Wide range of test dataset properties:
  - climate,
  - network density,
  - inhomogeneity properties,
  - length of time series,
  - missing data fields.

Important and timely (?)

- Variability of monthly and annual means is still an important issue;
- Methodology is better developed for monthly and annual scale data and the potential improvement of data quality is the clearest with the homogenization of annual and monthly data;
- The HOME benchmark with its 15 networks was too small and could not include the examination of the impact of various dataset properties;
- There are new softwares, which should be tested;
- Most inhomogeneities cannot be quantified with parallel measurements.

Evaluation of efficiency

- Centred RMSE of monthly values;
- Centred RMSE of annual values;
- RMSE of trend bias;
- RMSE of network mean trend bias.

Principles of methodology

- Parent networks of at least 100, spatially well correlating time series are built, then subsets of pre-set size are randomly selected;
- Both real data based and synthetic test datasets are used;
- Forms of inhomogeneities: shift, trend, platform;
- True frequency of inhomogeneities is usually higher than that of the detected frequency;
- Inhomogeneity properties are widely varied.

Homogeneous benchmark

- Regional differences of climate is more important for precipitation than for temperature;
- Real data based section of benchmark:
  – advantage: it characterizes best the spatial – temporal structures of observed data;
  – drawback: presence of residual inhomogeneities;
- Synthetic section:
  – advantage: fully homogeneous;
  – drawback: imperfect spatial-temporal structures

Homogeneous benchmark

- Temperature, real data based section
  - USA data, Rachel Warren's dataset
  - Spanish data (AEMET)
- Temperature, synthetic section
  - Spatially correlated white noise, 3 versions of predominating spatial correlations

Homogeneous benchmark

- Precipitation, real data based section
  - Mediterranean climate: Mallorca (AEMET)
  - oceanic climate: Ireland (Met Éireann)
  - continental climate: CARPATCLIM gridded observational data (www.carpatclim-eu.org)
- Precipitation, synthetic section
  - Climate of northern Spain, two versions of predominant spatial correlations
  - Monsoon climate, modelling climate of India, two versions of predominant spatial correlations

Parameterization

- Length of time series: 30yr, 60yr, 120yr
- Number of time series in network: 4, **5**, 7, **10**, **25**, 40
- Missing data: **0%**, 10%, 30%; 25 series & 70% missing data
- Form of inhomogeneities: shift, trend, platform
- Three kinds of standard dev. of inhomogeneities (low, medium, high)

	Temperature	Precipitation
• Frequency in 100yr		
• Frequency of shift	3 **5** 7	1 **3**
• Frequency of trend	1	1
• Frequency of platform	1 3 10	1 3
• Seasonality of biases:	- semi-sinusoid - other	- no seasonality - winter biases differ

Interactive contact and transparency

- New softwares are accepted for testing until the end of 2016
- Parent benchmark will be published at the beginning of 2017
- Datasets of selected experiments will be published

Thank you for your attention!

Homogenization of daily peak wind gust series from Spain and Portugal

José A. Guijarro[1], Cesar Azorin-Molina[2]

[1]State Meteorological Agency (AEMET), Palma de Mallorca, Spain
[2]Instituto Pirenaico de Ecología (IPE-CSIC), Zaragoza, Spain

EUMETNET Data Management Workshop
St. Gallen, Switzerland, 28-30 October 2015

Outline

Introduction

Homogenization strategies

Impact on extreme wind indexes

Conclusions

Introduction

- Homogenization of daily series is difficult, due to their lower noise/signal ratio.
- Yet the study of the variability of extreme weather events requires homogeneous and quality controlled daily series.
- Here we apply different strategies to homogenize daily maximum gust speeds from Portugal and Spain, and analyze their impact on the evaluation of the trends of mean and maximum gusts, the number of days over the 90 percentile and maximum expected gusts for return periods of 50, 100 and 200 years.
- Question:
  Do we really need to homogenize the daily series?

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- Question:
  Do we really need to homogenize the daily series?

Methodology

- The data set consisted of 80 series (7 Portuguese and 73 Spanish) of daily maximum peak wind gusts spanning 54 years (1961-2014).
- Corresponding daily series from MM5 simulations at 10 km resolution were available until 2007 (Murcia University).
- Homogenization was performed with Climatol 2.2 (multiplicative model) on:
  - Average monthly values, using MM5 series as references when available, and adjusting the daily series with interpolated monthly correction factors.
  - Direct homogenization of daily values, using MM5 series as references when available.
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  - Annual values of maximum and average wind peak gusts and number of days over the 90 percentile.

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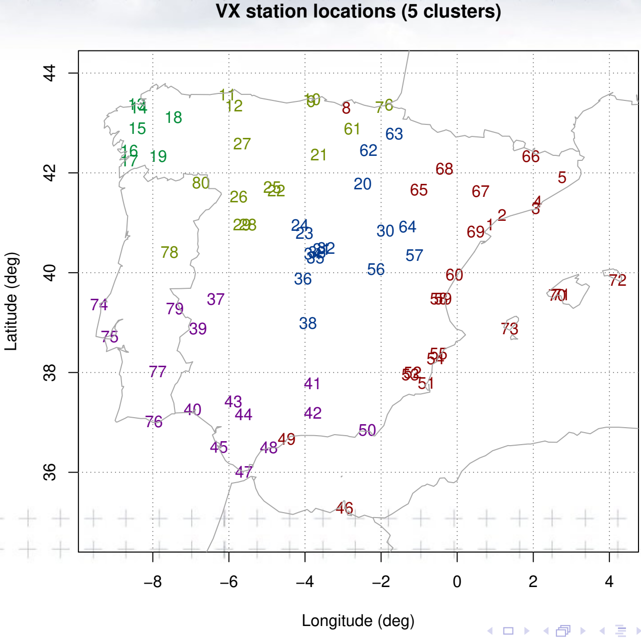
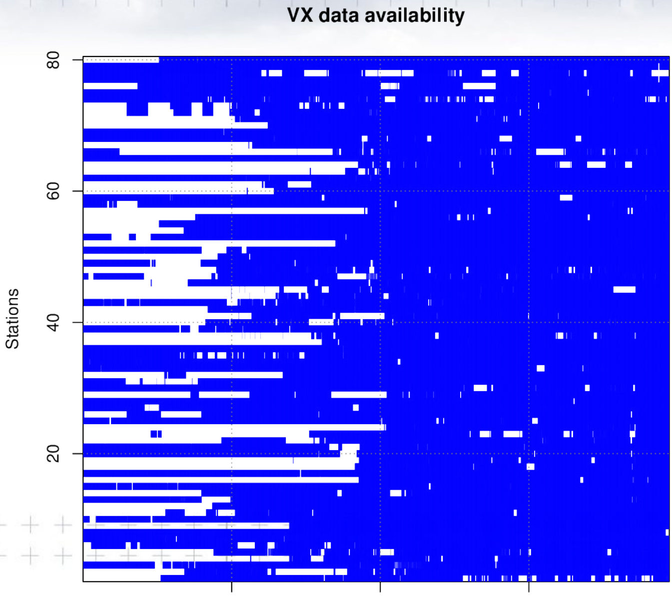
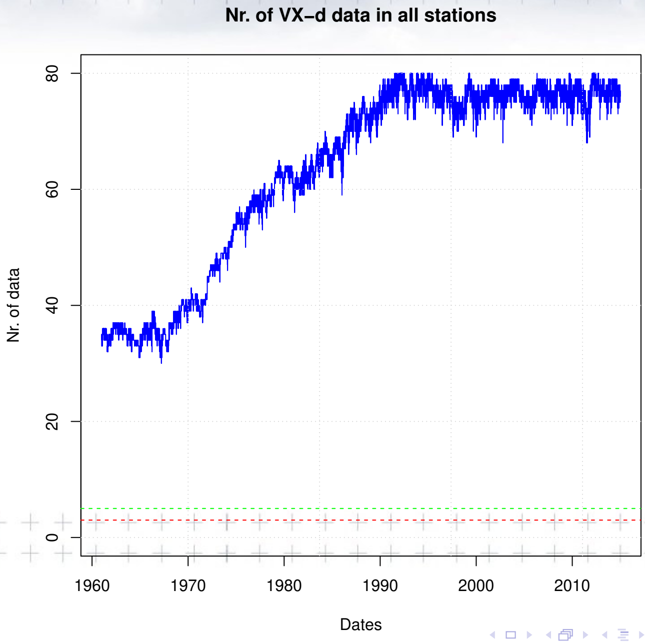
Station locations



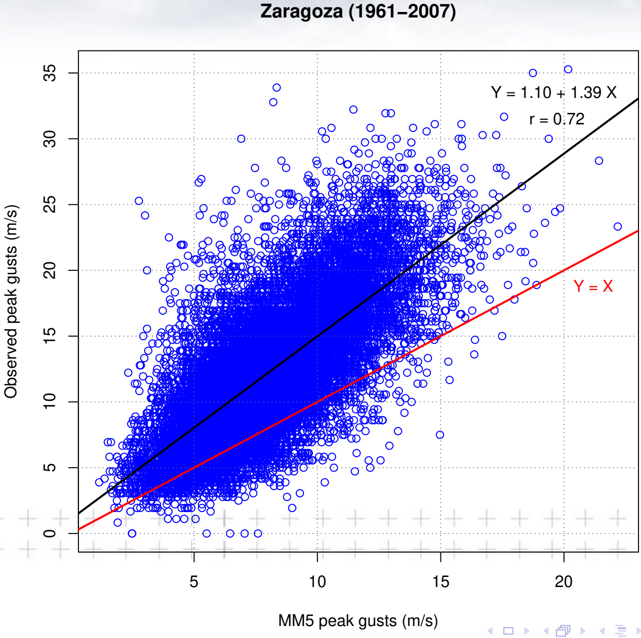
Data availability



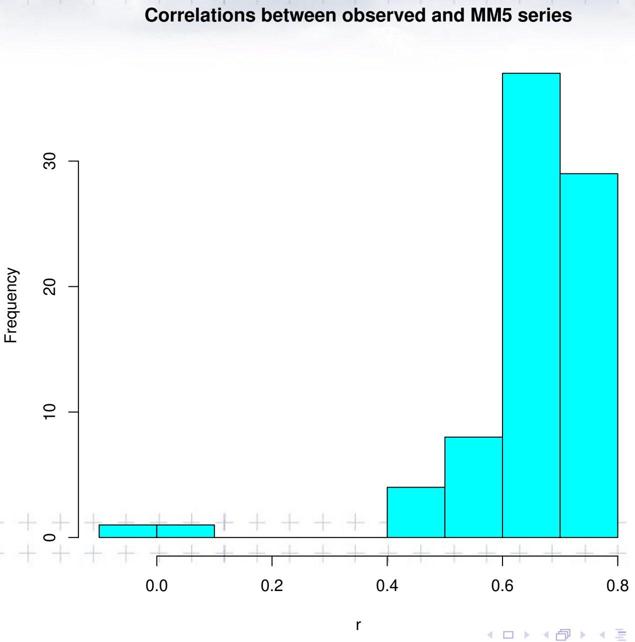
Data availability



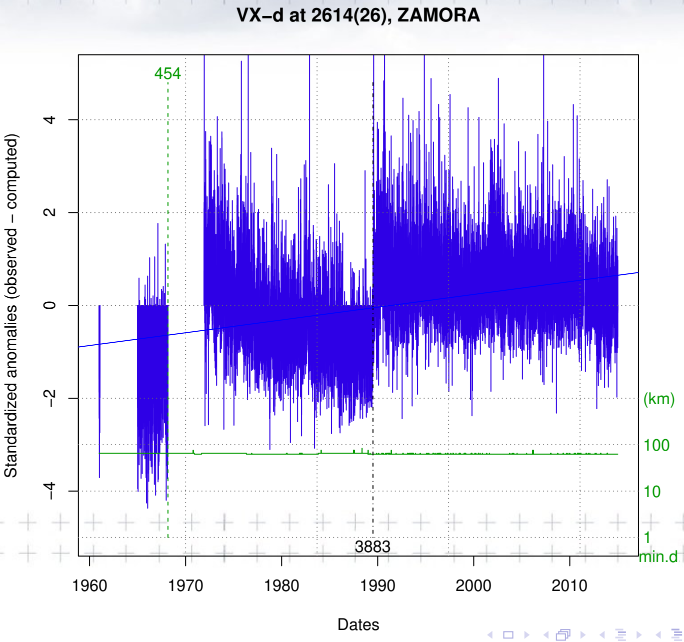
Regression observations vs MM5



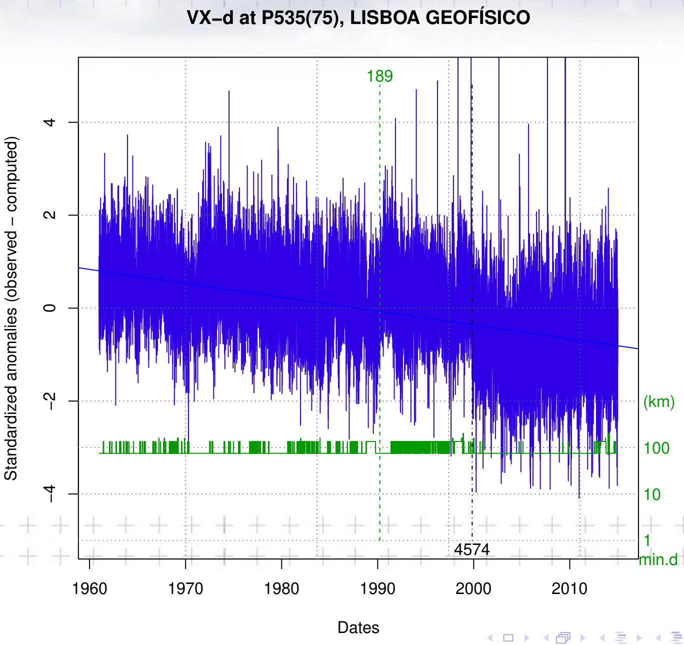
Correlations observations vs MM5



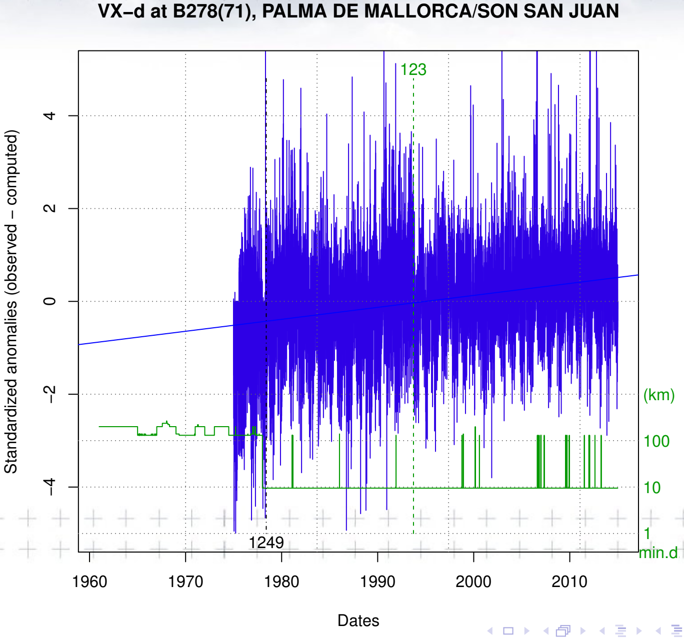
Inhomogeneities



Shift

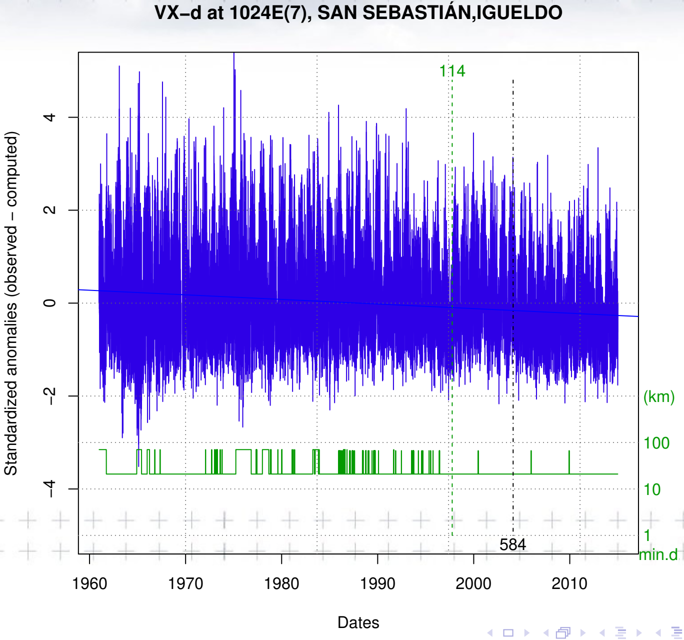

VX–d at P535(75), LISBOA GEOFÍSICO
189
4574
Standardized anomalies (observed – computed)
4
2
0
−2
−4
(km)
100
10
1
min.d
1960
1970
1980
1990
2000
2010
Dates

Trend

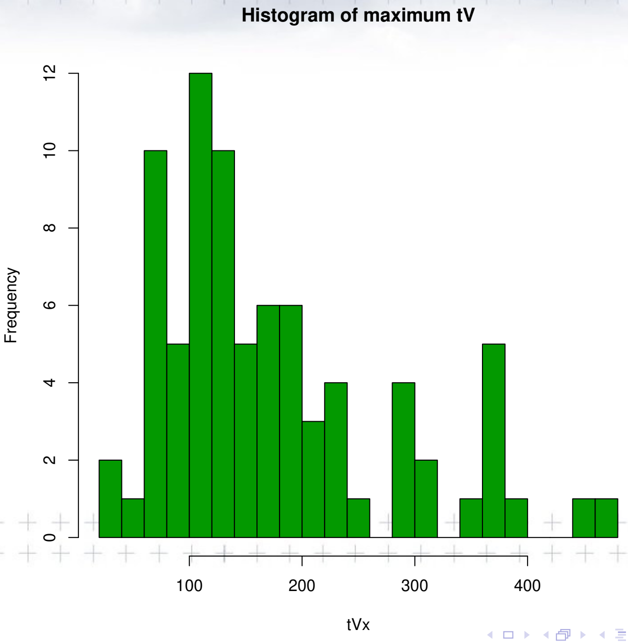


VX–d at B278(71), PALMA DE MALLORCA/SON SAN JUAN
Standardized anomalies (observed – computed)
Dates
123
1249
(km)
100
10
1
min.d
4
2
0
−2
−4
1960
1970
1980
1990
2000
2010

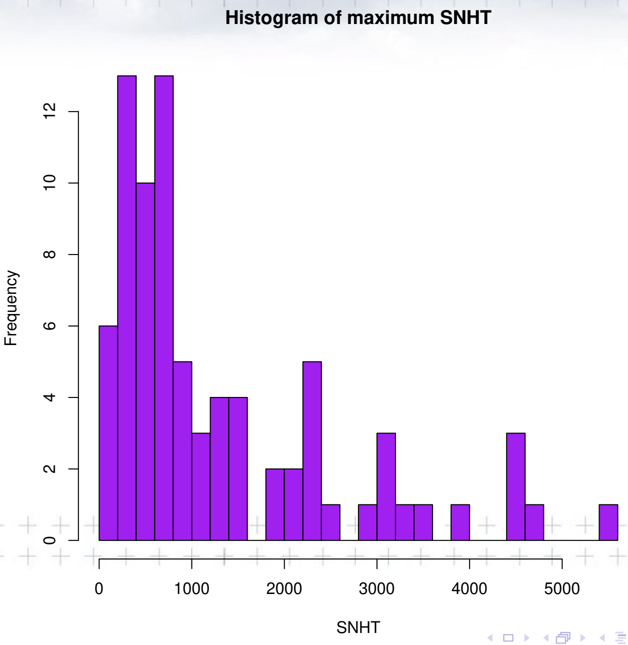
Relative homogeneity



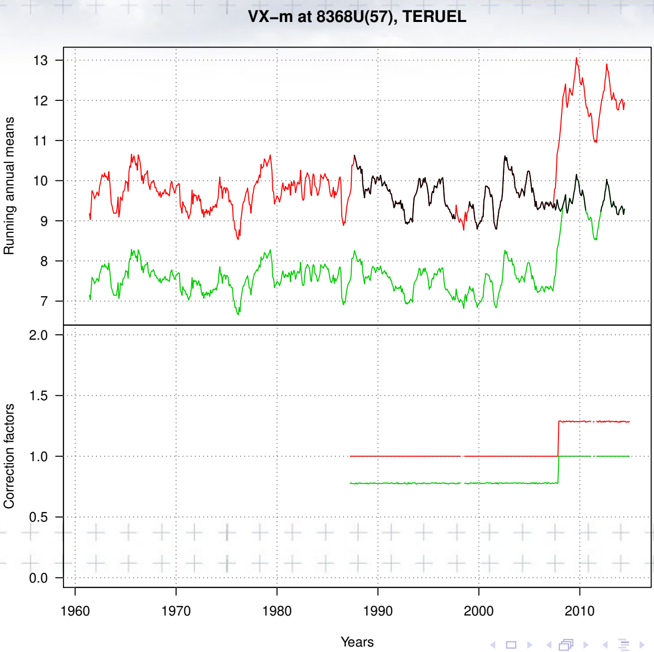
Windowed SNHT histogram



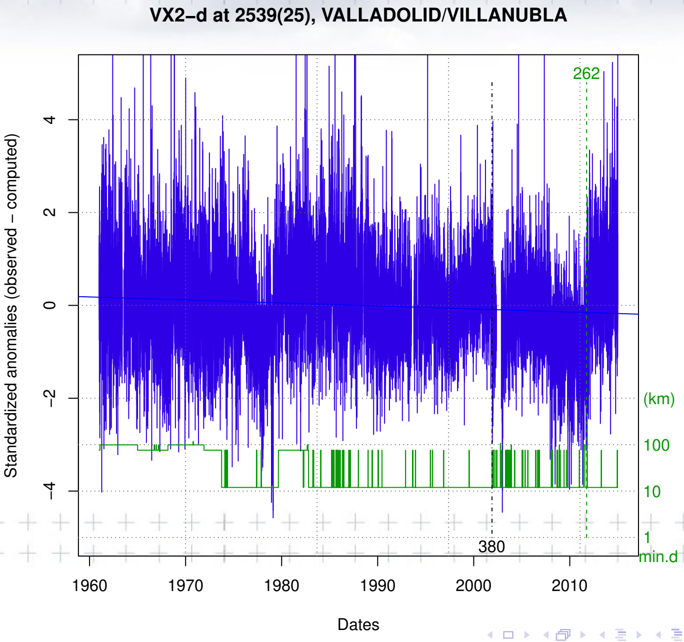
Complete SNHT histogram



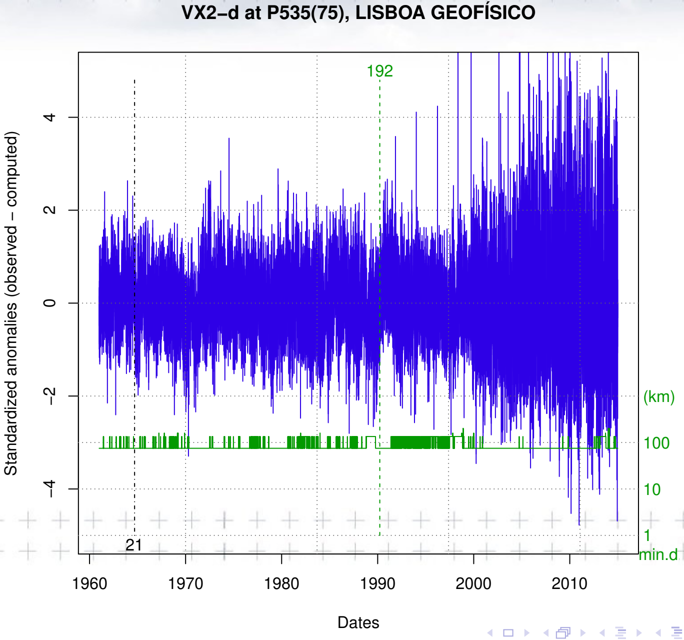
Abnormal series reconstruction



Residual inhomogeneities



Change of variance

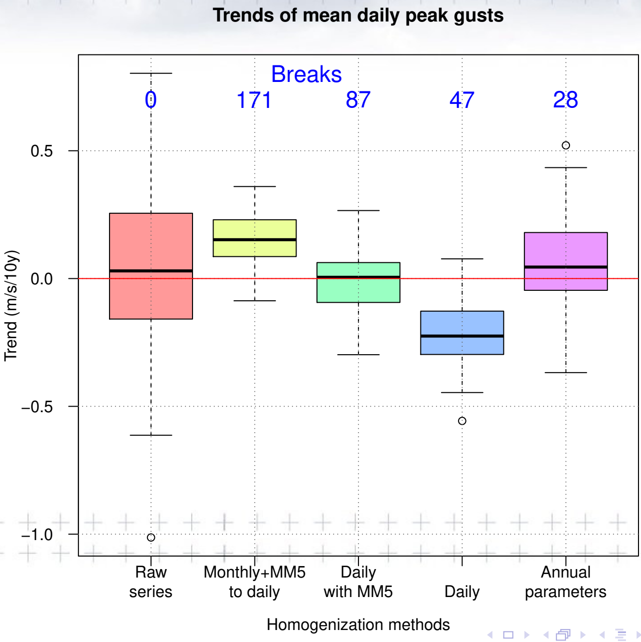


Other homogenizations

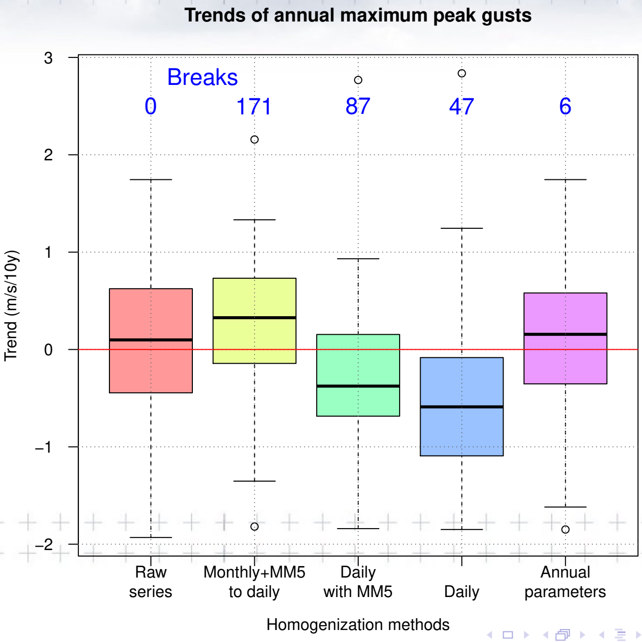
Due to these unsatisfactory results, further homogenizations were performed either directly on the daily data or on annual extreme wind indexes, which led to decreasing levels of break detection when compared to the monthly homogenization:

Series		Breaks	
Raw (filled)		–	
Monthly+MM5 to daily		171	
Daily+MM5		87	
Daily		47	
Annual indexes:	Averages	Maximums	Days>90%
	28	6	25

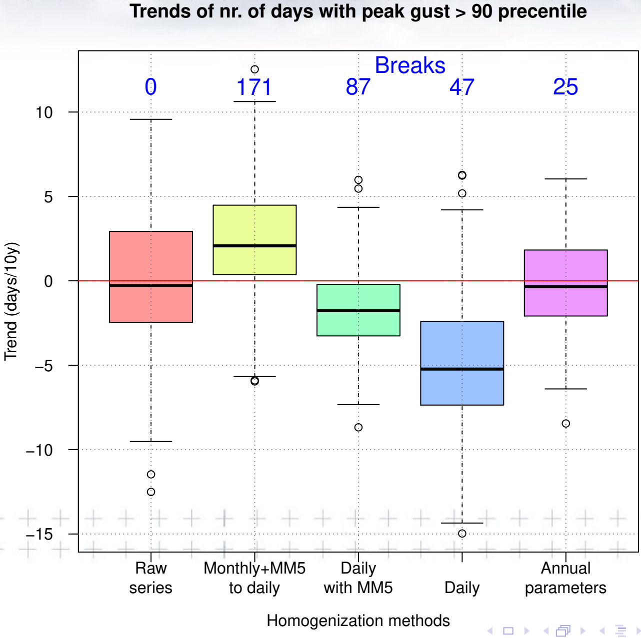
Trends of mean peak gusts



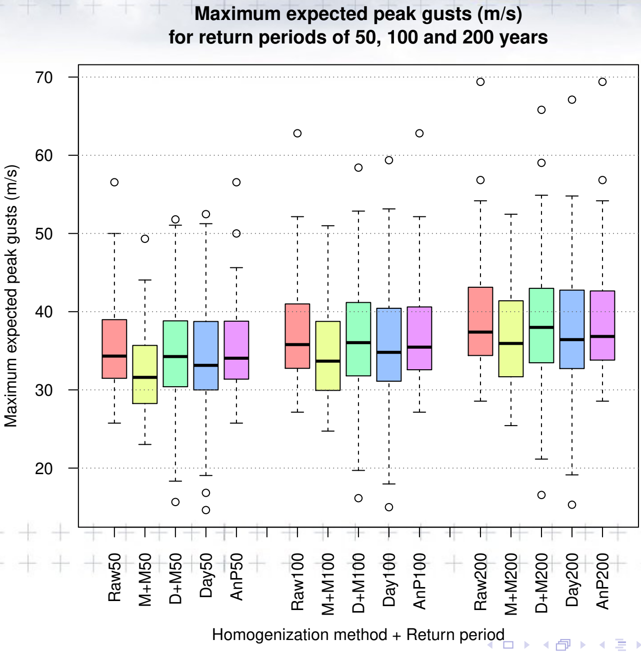
Trends of annual peak gusts



Trends of days > 90%



Max. expected peak gusts



Conclusions

- In many cases, there is no clear evidence suggesting that the homogenization of the daily series is needed (especially for computing trends of average values).
- But these results, derived from real data, cannot be conclusive, since we do not know the true solution.
- $\Rightarrow$ Further experiments should be performed with synthetic data.

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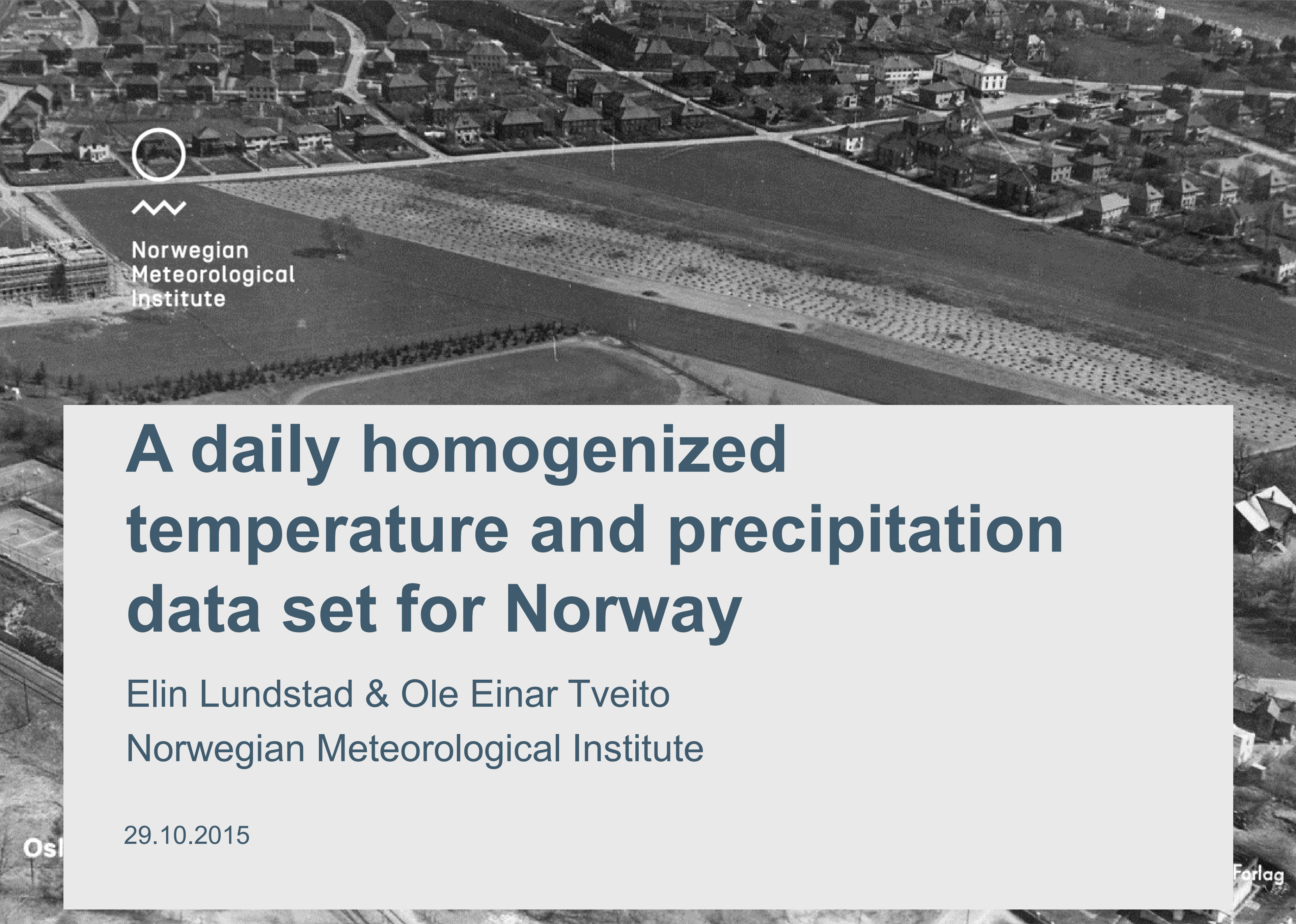


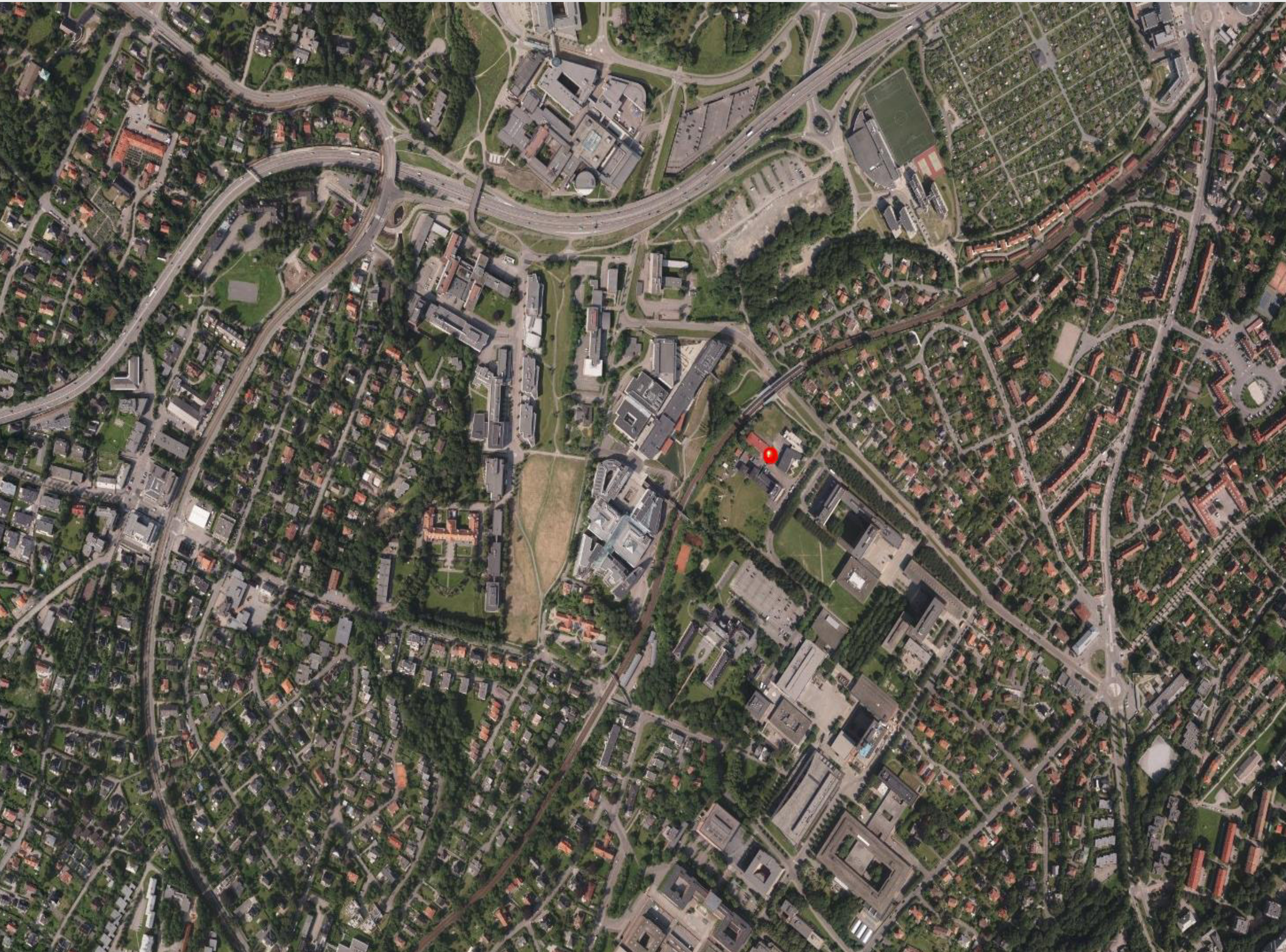
Norwegian Meteorological Institute

A daily homogenized temperature and precipitation data set for Norway

Elin Lundstad & Ole Einar Tveito
Norwegian Meteorological Institute

29.10.2015

Foto: Harstad, Karl



Objectives

- Establish a quality assurance tools to identify and adjust for homogeneity violation

- Producing homogenized daily values of temperature and precipitation for a number of long climate series.

- Develop methodology to generate "homogenized" daily values of precipitation and temperature for given locations / catchments based on gridded (1x1 km) map.

- Facilitate homogenized daily values and analysis for homogenization so that it is available to external users, such as Statkraft.

Challenges with the methods

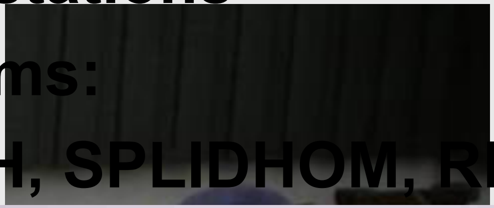
HOMER

Adapted Caussinus-Mestre Algorithm for Networks of Temperature Series (ACMANT)

Multiple Analysis of Series for Homogenization
Tamás Szentimrey

What is new?

- Former homogenization of monthly values
- Mostly temperature data of some stations
- Now homogenization of daily data
  - and all the precipitation stations
- New methods and programs:
  - SNHT → HOMER, MASH, SPLIDHOM, RHtest

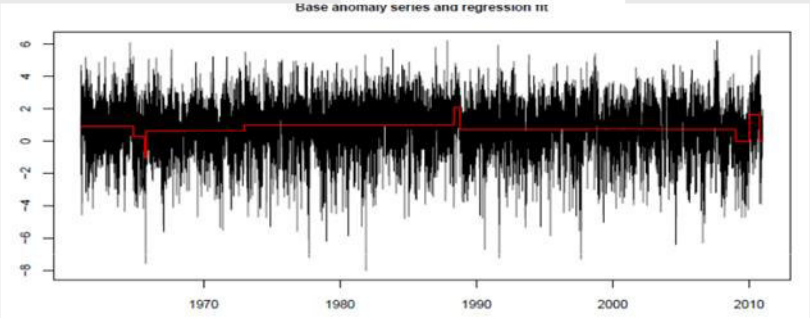


Methods

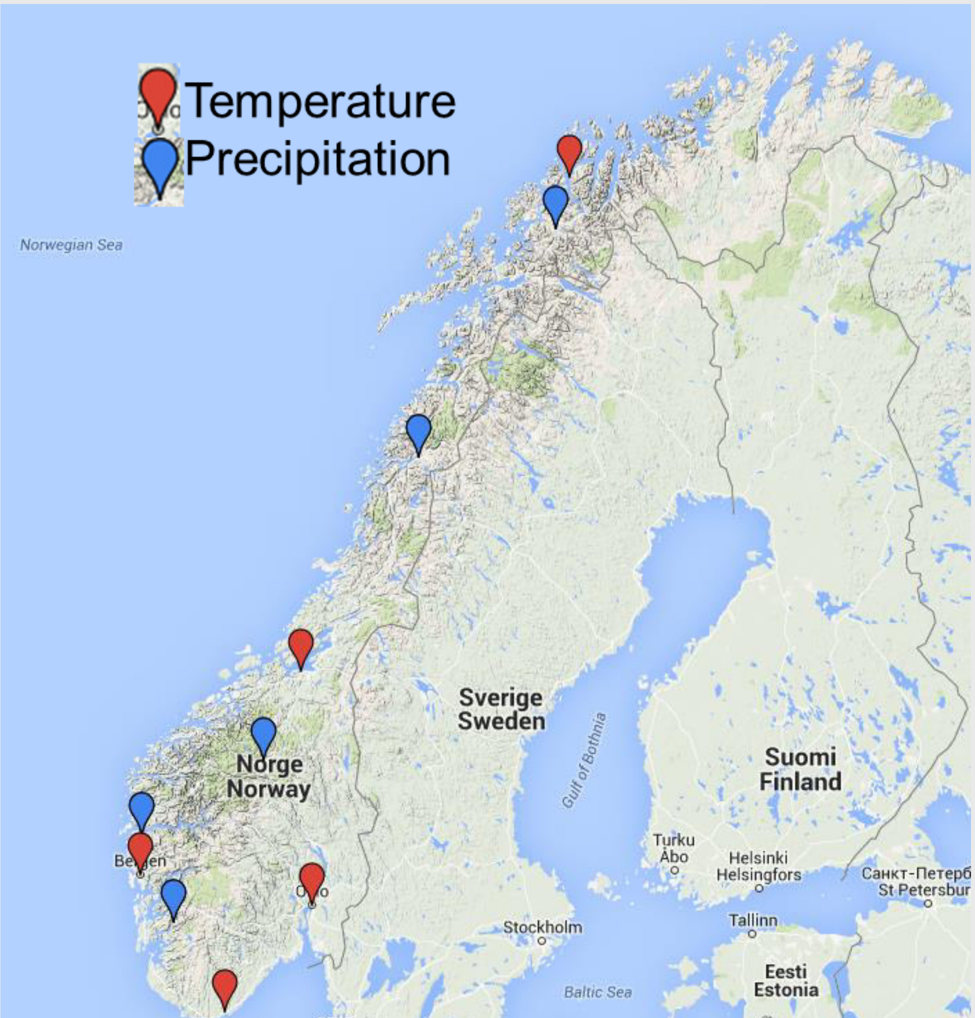
SPLIDHOM

```
--------------------------------------------------------------------
    Station: 00018700 has no break. No need to homogenize!
    Returning to main menu.
--------------------------------------------------------------------
```

Rhtests V4



Locations/Network

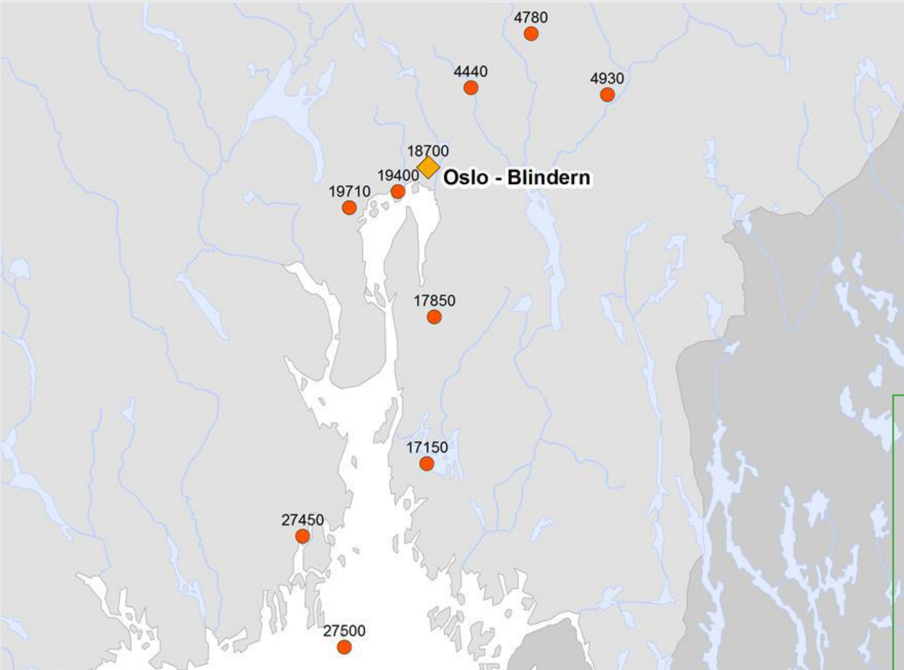


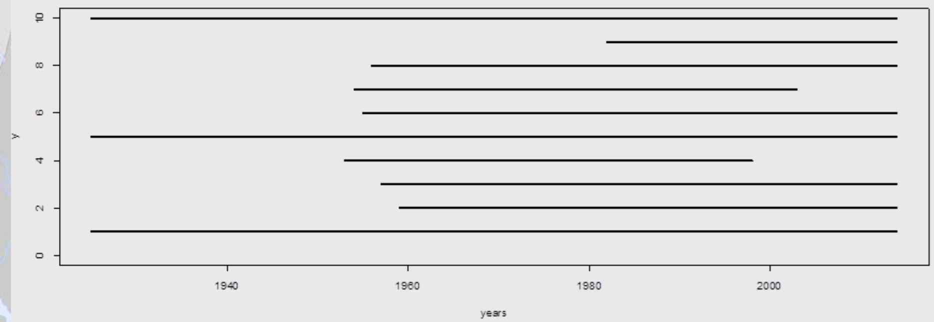
Network	**Breaks**
Temperature	
· 7 stations @Tromsø	1
· 7 @ Trondheim	7
· 12 @ Bergen	3
· 10 @ Kristiansand	3
· 10 @ Oslo	3 or 4?
Precipitation	
· 1 @ Bardufoss	0
· Mo i Rana	0
· Fokstua	8
· Takle	1
· Sauda	0

Norwegian
Meteorological
Institute

Challenges

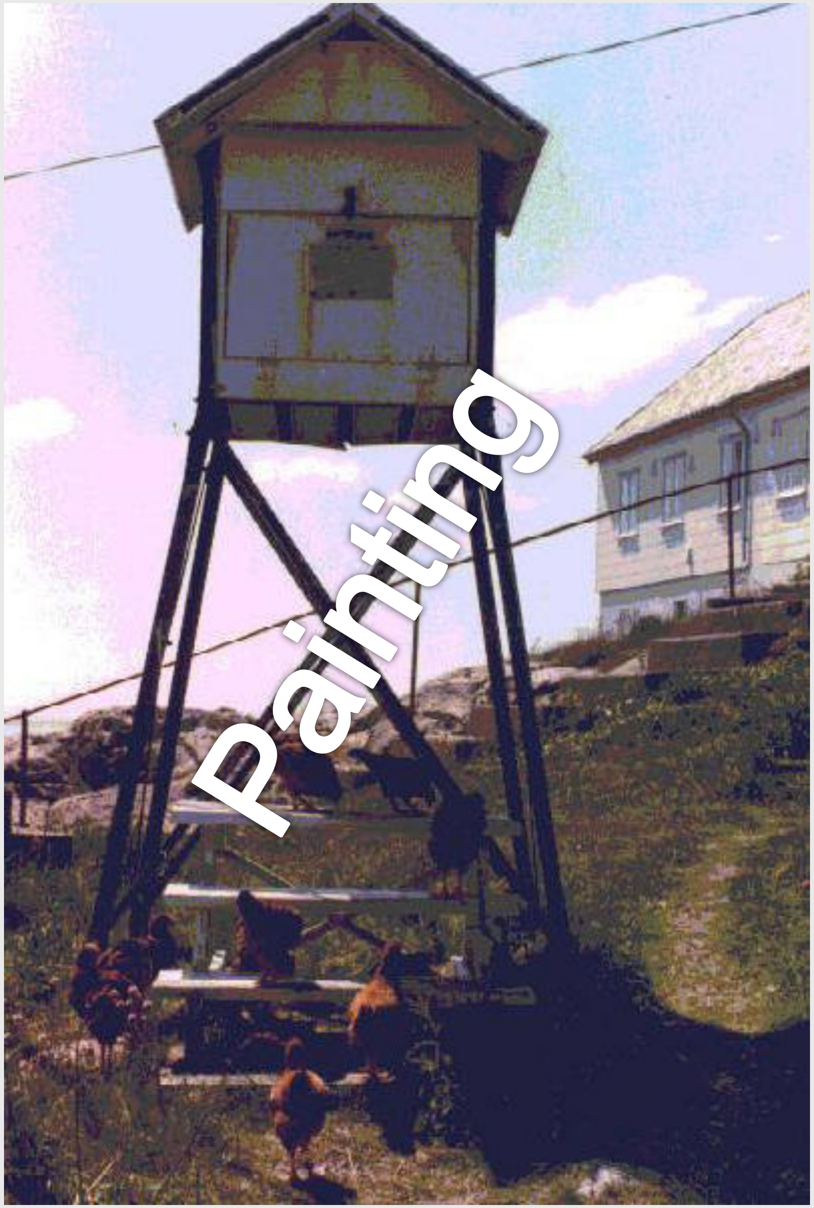
Network



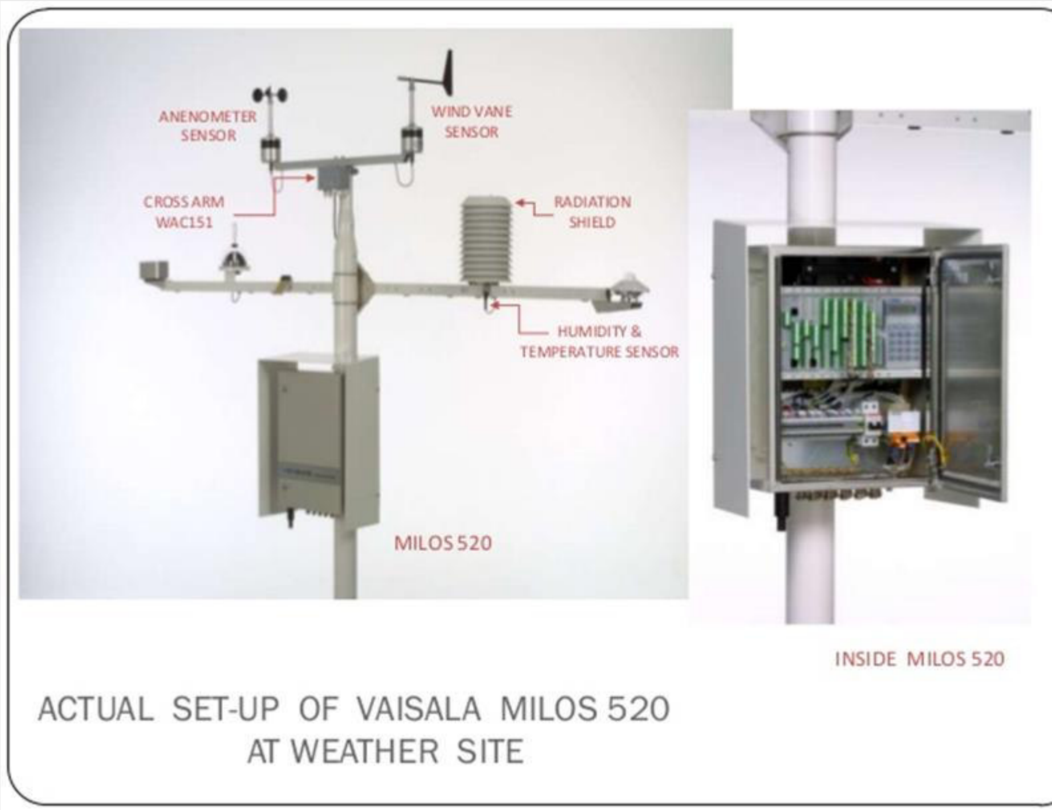


	18700	04440	04780	04930	17150	17850	19400	19710	27450	27500
18700	1.000	0.991	0.993	0.987	0.988	0.899	0.996	0.994	0.988	0.879
04440	0.991	1.000	0.994	0.991	0.981	0.989	0.991	0.986	0.983	0.954
04780	0.993	0.994	1.000	0.993	0.984	0.991	0.991	0.989	0.985	0.960
04930	0.987	0.991	0.993	1.000	0.986	0.991	0.986	0.980	0.984	0.954
17150	0.988	0.981	0.984	0.986	1.000	0.995	0.986	0.983	0.994	0.977
17850	0.899	0.989	0.991	0.991	0.995	1.000	0.992	0.988	0.993	0.972
19400	0.996	0.991	0.991	0.986	0.986	0.992	1.000	0.991	0.986	0.967
19710	0.994	0.986	0.989	0.980	0.983	0.988	0.991	1.000	0.986	0.973
27450	0.988	0.983	0.985	0.984	0.994	0.993	0.986	0.986	1.000	0.976
27500	0.879	0.954	0.960	0.954	0.977	0.972	0.967	0.973	0.976	1.000

What causes the breaks?



From manual to automatic WS



MI-46 ➡ MI-74 ➡ MI-2001

New buildings

Vegetation grows

Norwegian
Meteorological
Institute

Results of the homogenization

Code for intepretation of breaks - Metadata

A = Change from manuel to automatic station

E = Environment

H = Change of instrument height

I = Inspection

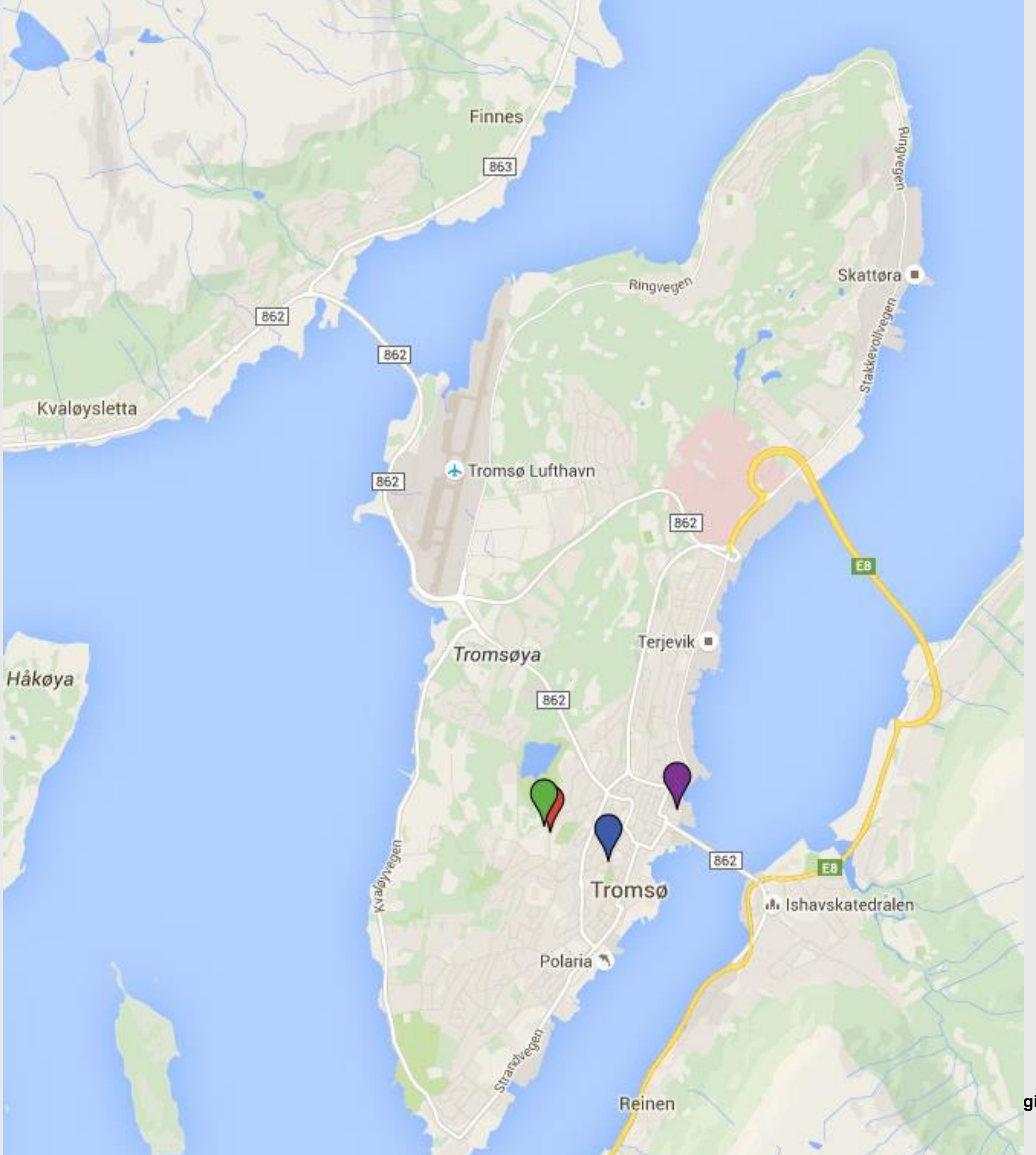
N = New instrument

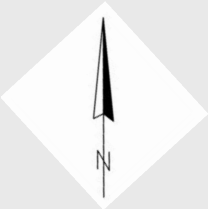
O = Shift of observer

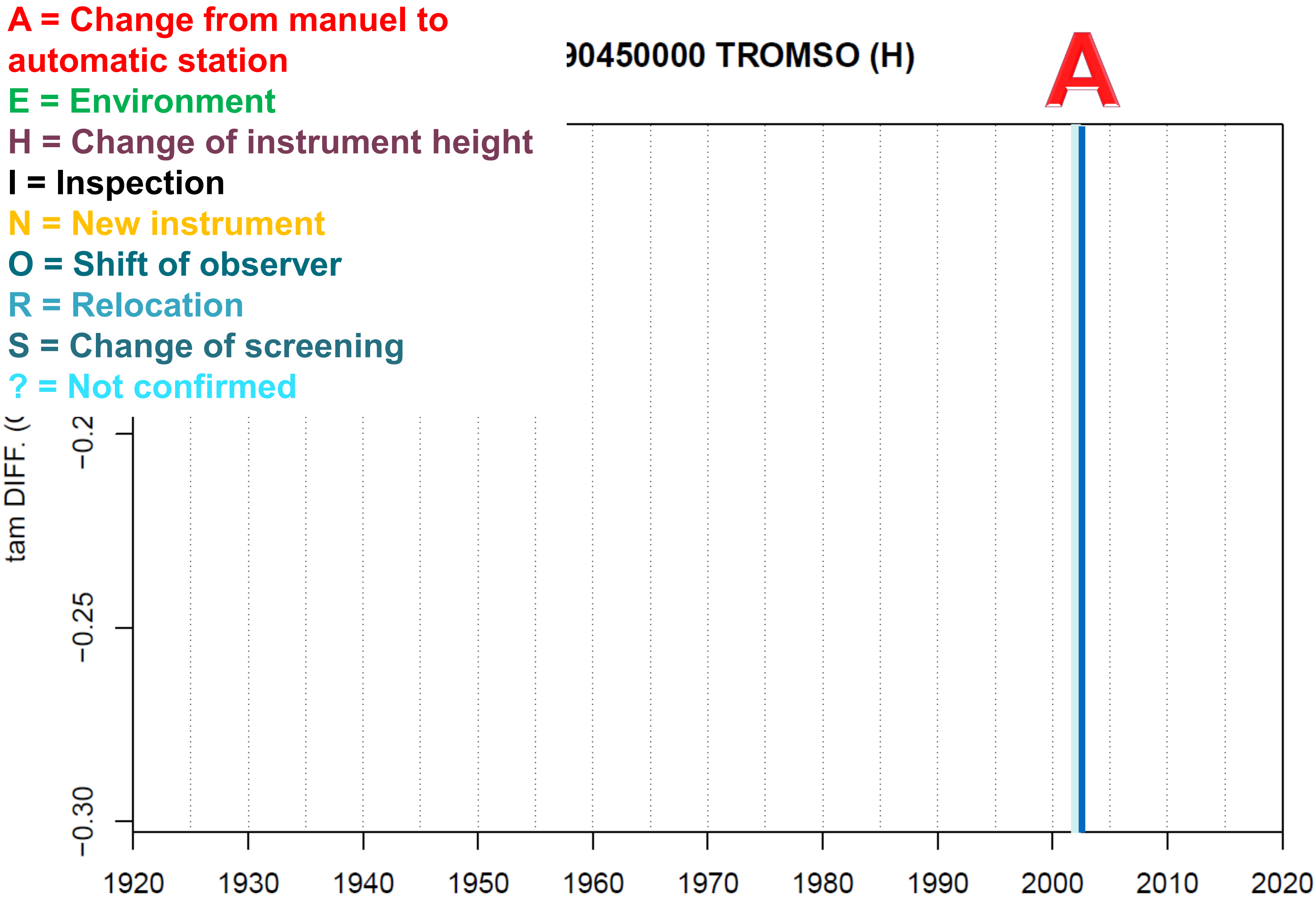
R = Relocation

S = Change of screening

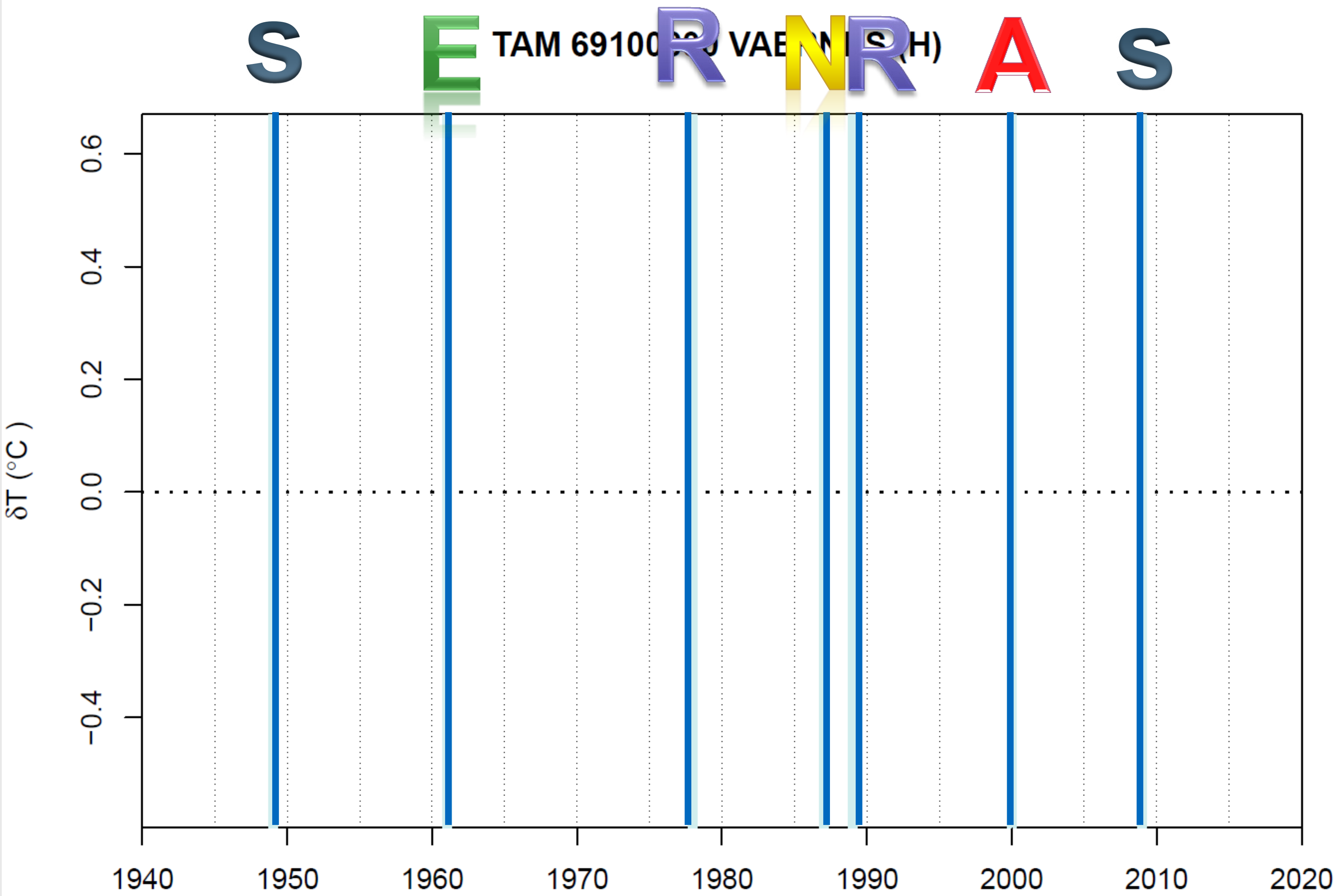
? = Not confirmed


Finnes
863
862
862
Kvaløysletta
Tromsø Lufthavn
862
862
Ringvegen
Ringvegen
Skattøra
Stakkevollvegen
E8
Terjevik
Tromsøya
Håkøya
862
862
E8
Tromsø
Ishavskatedralen
Kvaløyvegen
Polaria
Strandvegen
Reinen


N


A = Change from manuel to automatic station
E = Environment
H = Change of instrument height
I = Inspection
N = New instrument
O = Shift of observer
R = Relocation
S = Change of screening
? = Not confirmed
90450000 TROMSO (H)
A
tam DIFF. (
-0.2
-0.25
-0.30
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020

TRONDHEIM

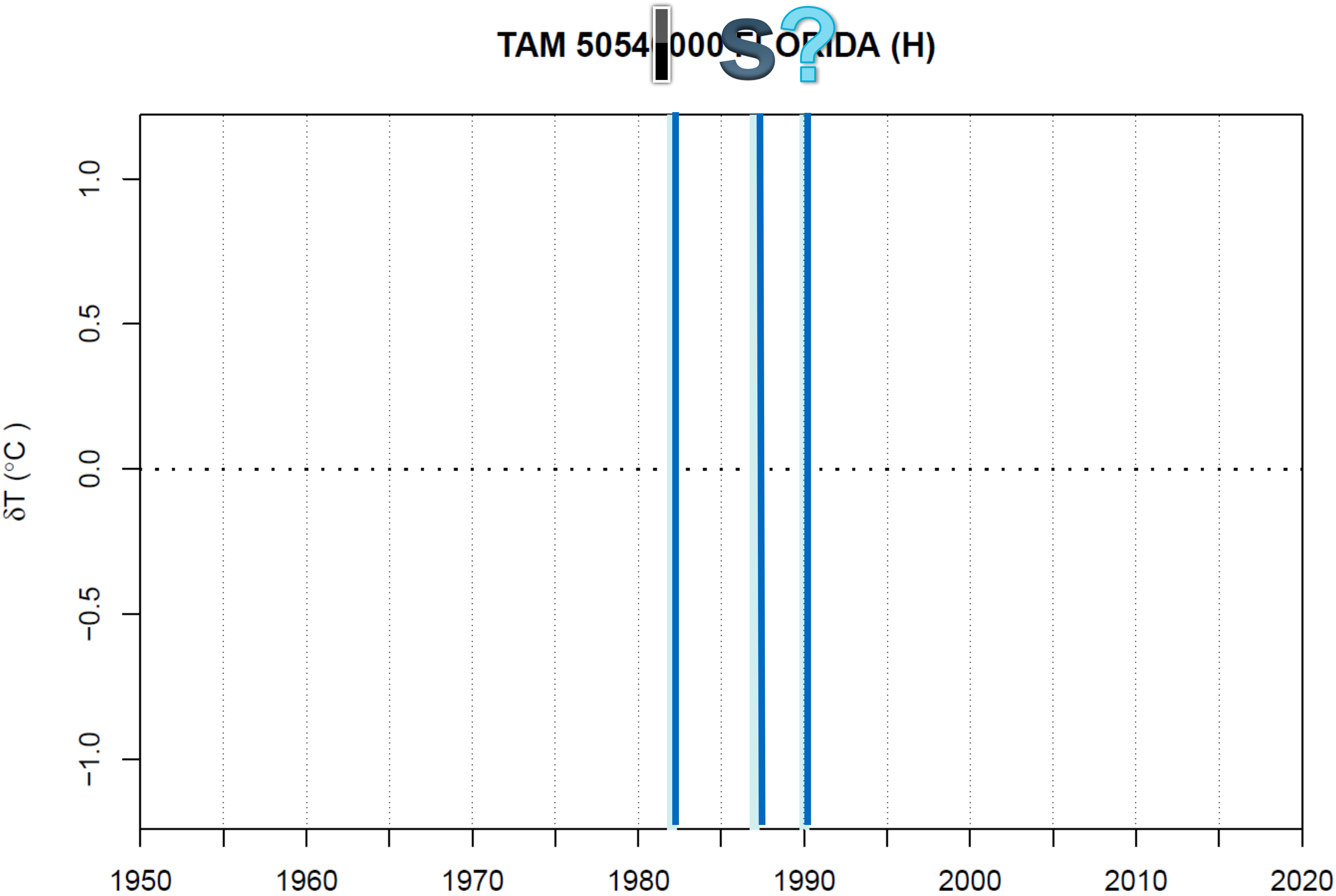


S
E
R
N
R
A
S
1940
1950
1960
1970
1980
1990
2000
2010
2020
0.6
0.4
0.2
0.0
−0.2
−0.4
δT (°C)

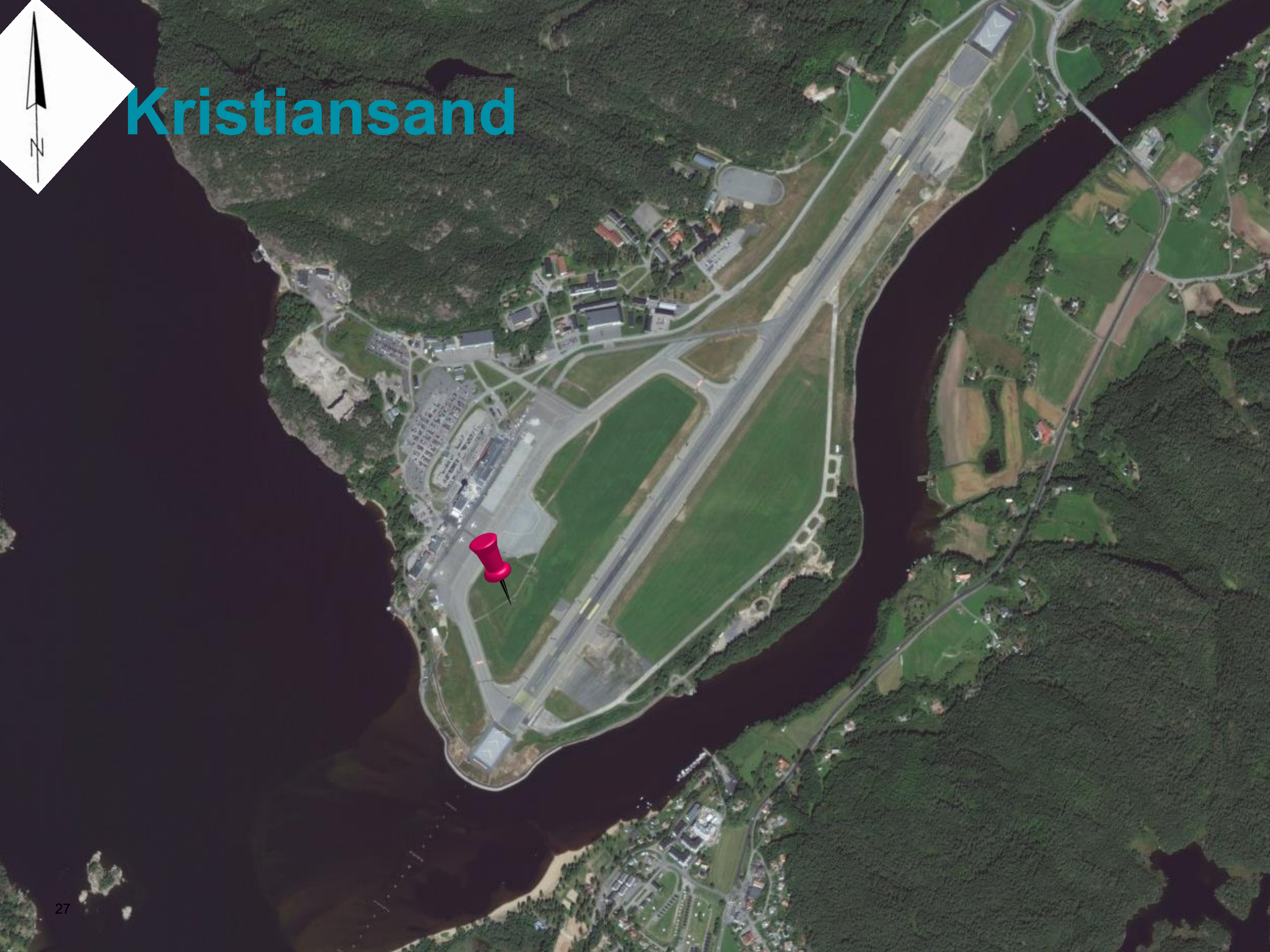
Bergen

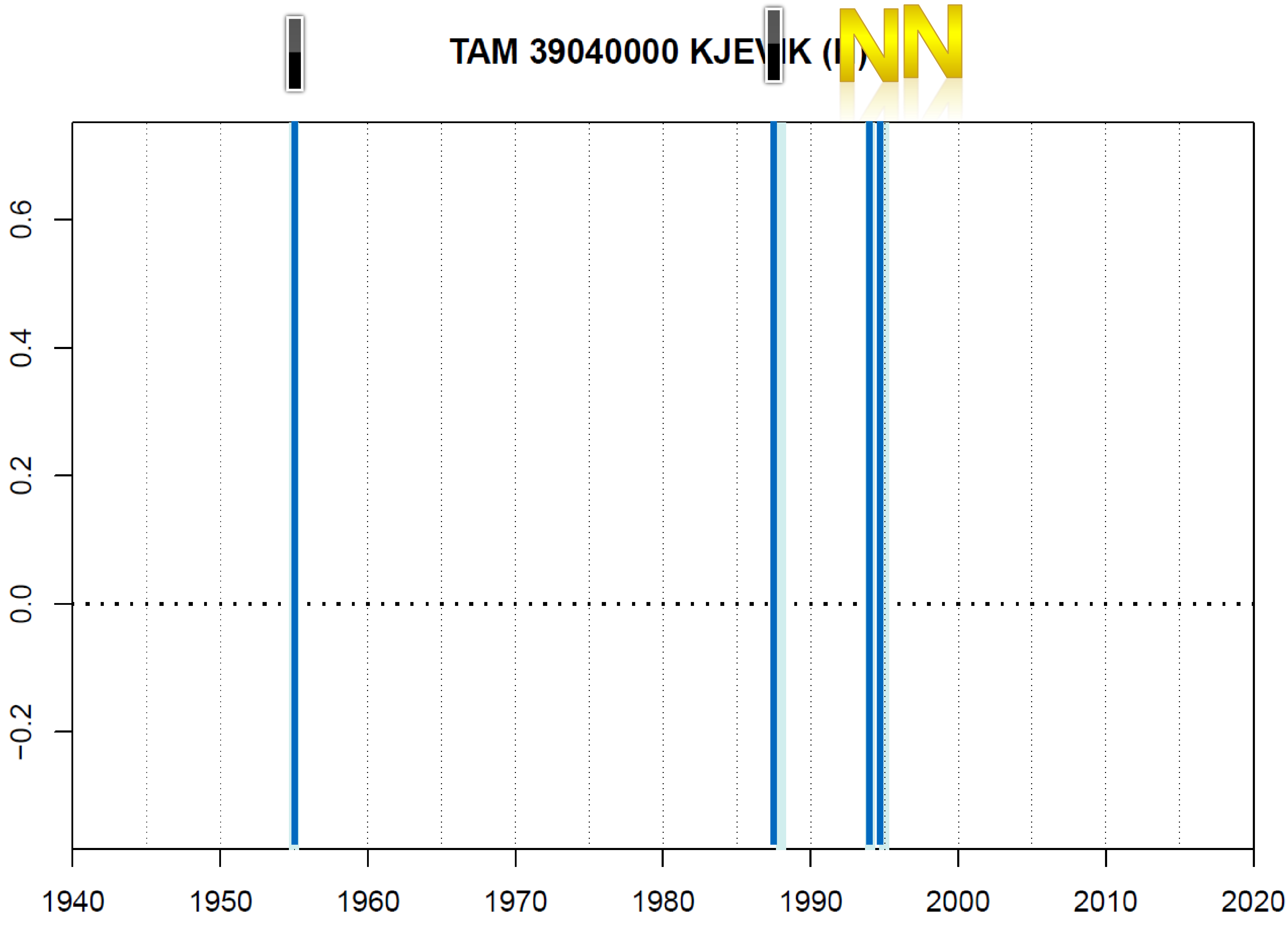
FLORIDA

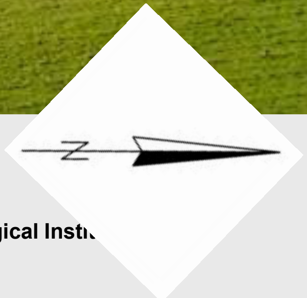
Nordnespynten
Nordnes
270 Nordnesbakken
Nordnes
270 Strandgaten
270 C. Sundts gate
Tollbodkaiene
Bergen-
Festningskaien
Vågen
hus
Sverresborg
Bergenhus
585 Bontelabo
Nykirkekaien
Nykirken
Bradbenken
264 Nye Sandviksveien
585 Bryggen
Vågen
Fredriksberg
Fredriksberg
Georgernes
270 Haugeveien
270 Østre Murallmenningen
263 Kong Oscars gate
Vindeggen
Skansen
Nøstet
Nøstet
Nøstebukten
270 Markeveien
555 Jonsvollsgaten
585 Småstrandgaten
585 Olav Kyrres gate
585 Christies gate
Domkirken
Sydnes
555 Nøstegaten
271 Teatergaten
Bergen
270 Starvhusgaten
Bergen
Fjellveien
Sydnes
Puddefjorden
257 Vaskerelven
585 Strømgaten
Jekteviken
E16
Busstasjonen
Dokkeskjærskaien
Kirkebukten
Dokken
555 Olav Kyrres gate
Nygård
Dokken
555 Christies gate
555
260 Agnes Mowinckels gate
582 Carl Konows gate
Damsgård
Damsgård
280 Fyllingsveien
Møhlenspris
272 O.J. Brochs
Damsgård
582 Michael Krohns gate
Damsgårdsveien
Nygårdsparken
256 Nygårdsgaten
Damsgårdssundet
Frydenbø
280 Svingen
555
540 Fyllingsdalsveien
272 Thormøhlens gate
Florida
E39

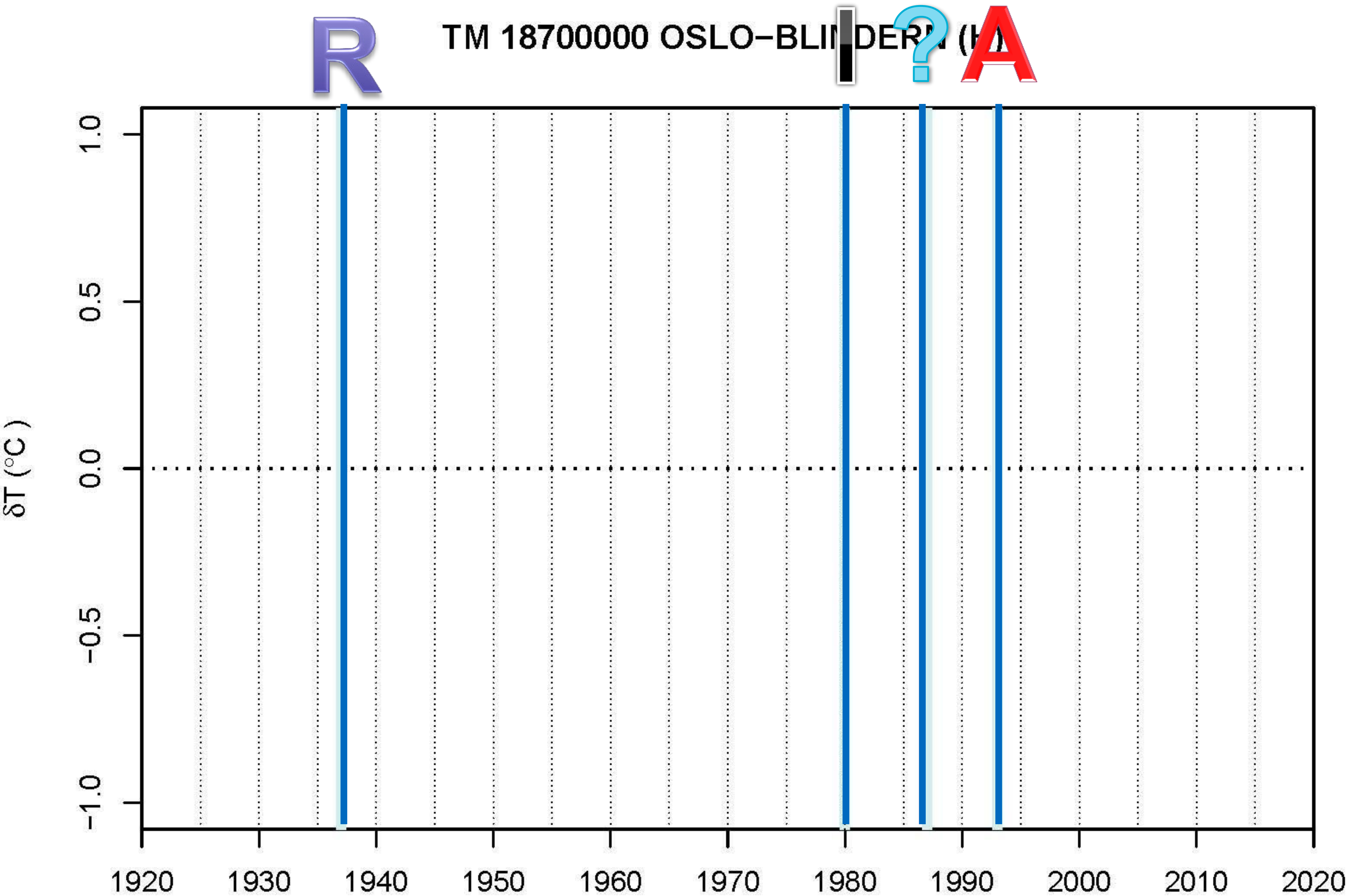

TAM 5054[redacted]000 FLORIDA (H)
δT (°C)
1.0
0.5
0.0
−0.5
−1.0
1950
1960
1970
1980
1990
2000
2010
2020

Kristiansand

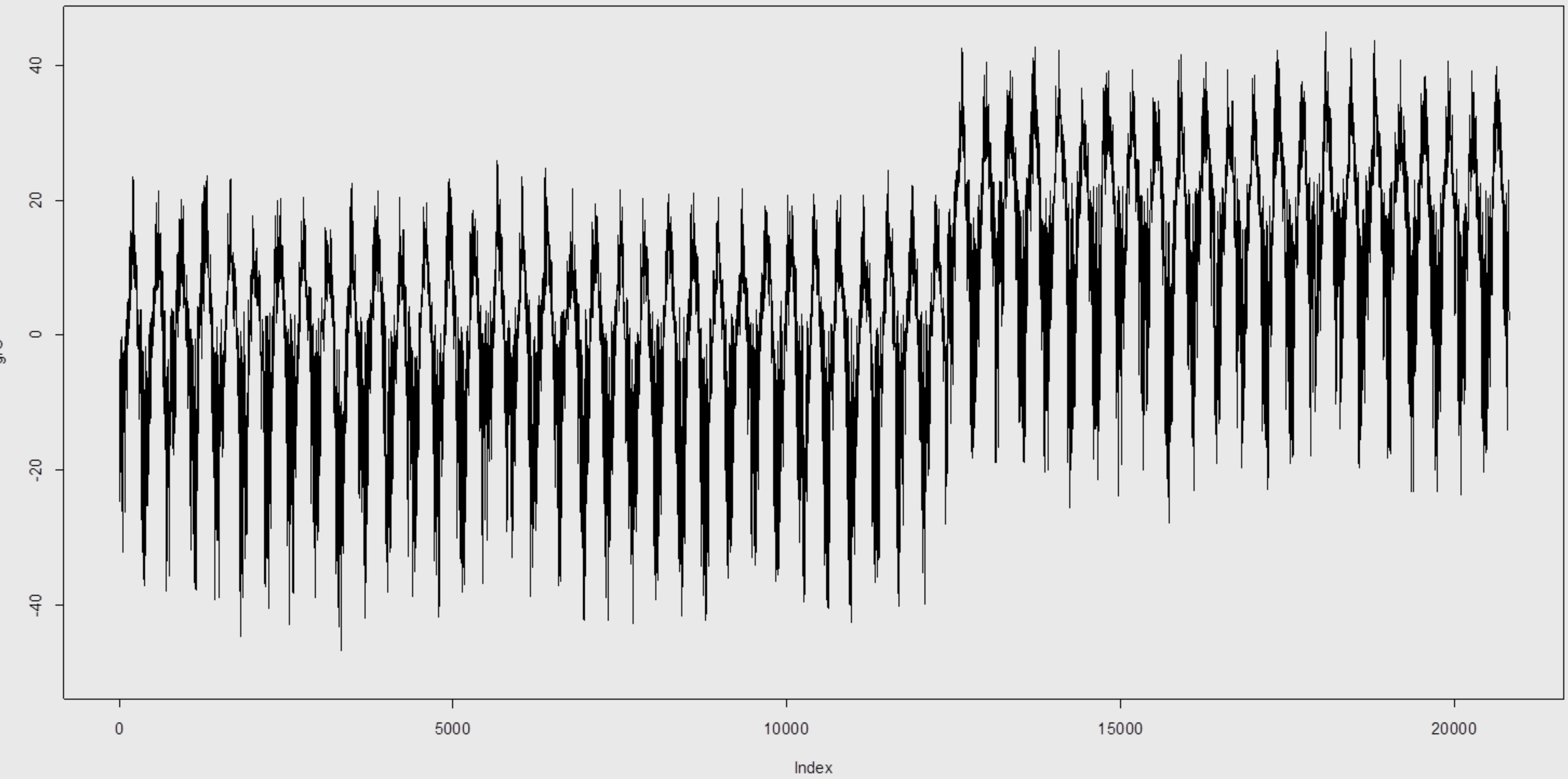



TAM 39040000 KJEVIK
0.6
0.4
0.2
0.0
−0.2
1940
1950
1960
1970
1980
1990
2000
2010
2020

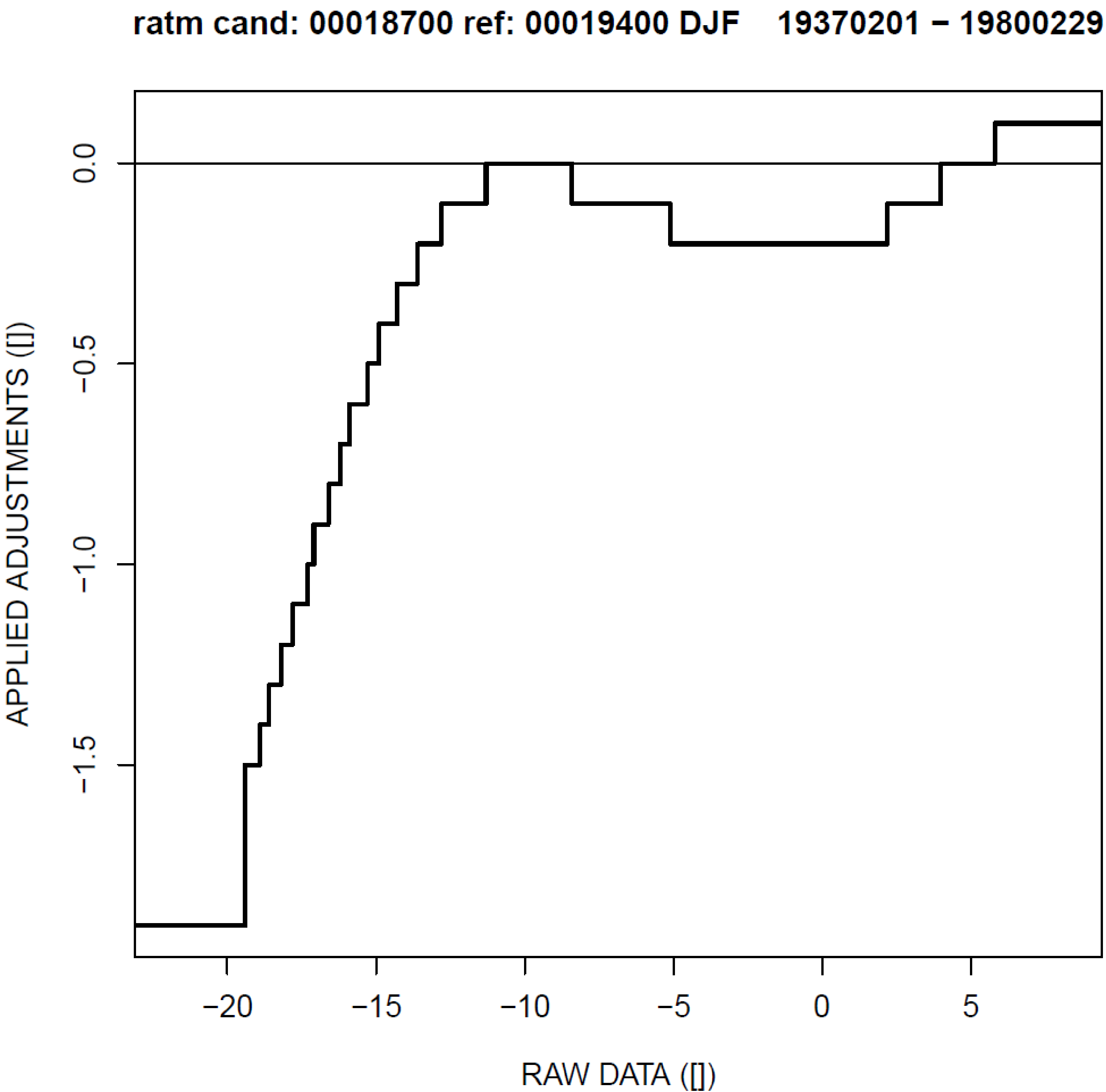


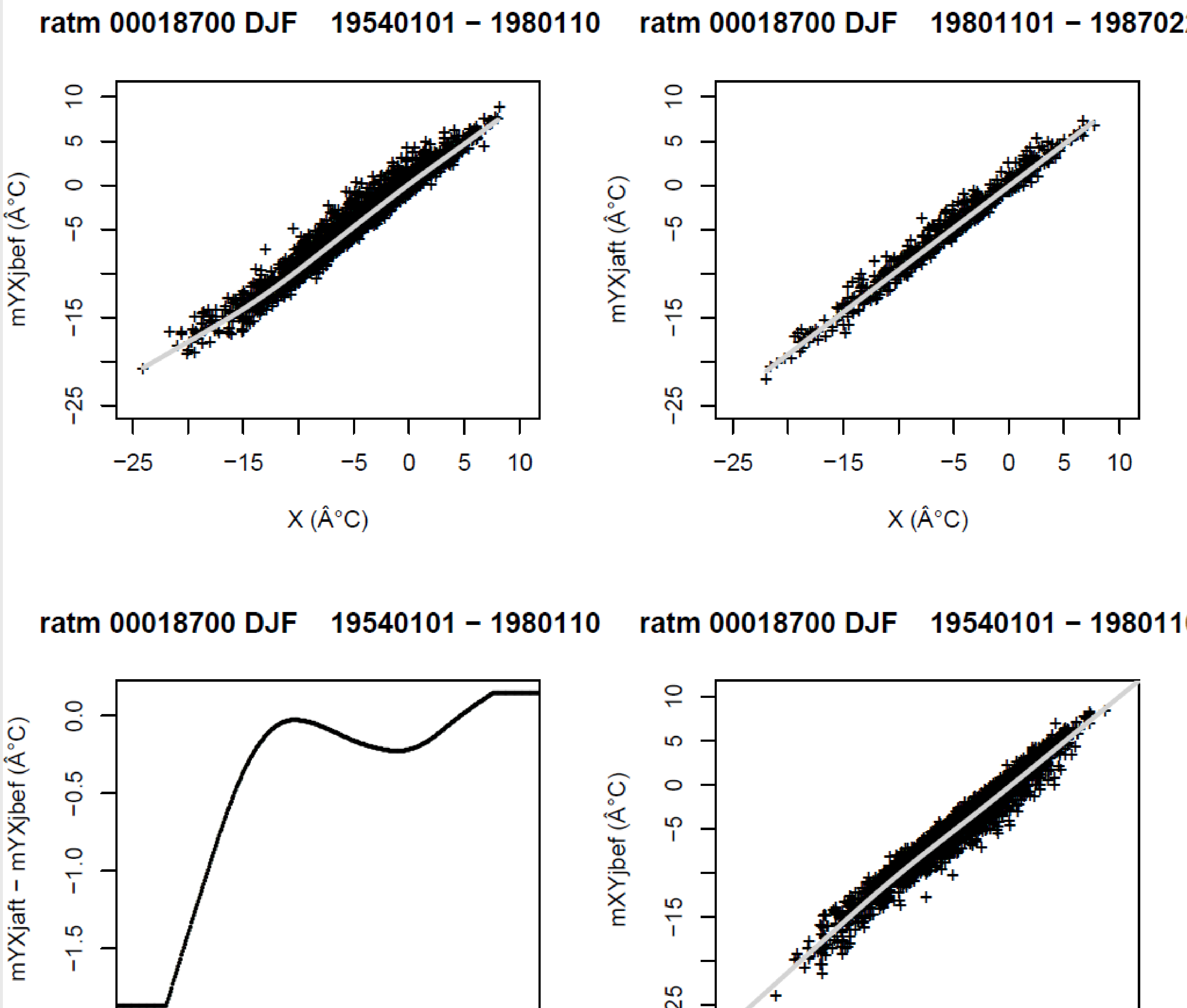

TM 18700000 OSLO−BLINDERN (H)
R
?
A
δT (°C)
1.0
0.5
0.0
−0.5
−1.0
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020

What happen in 1988?



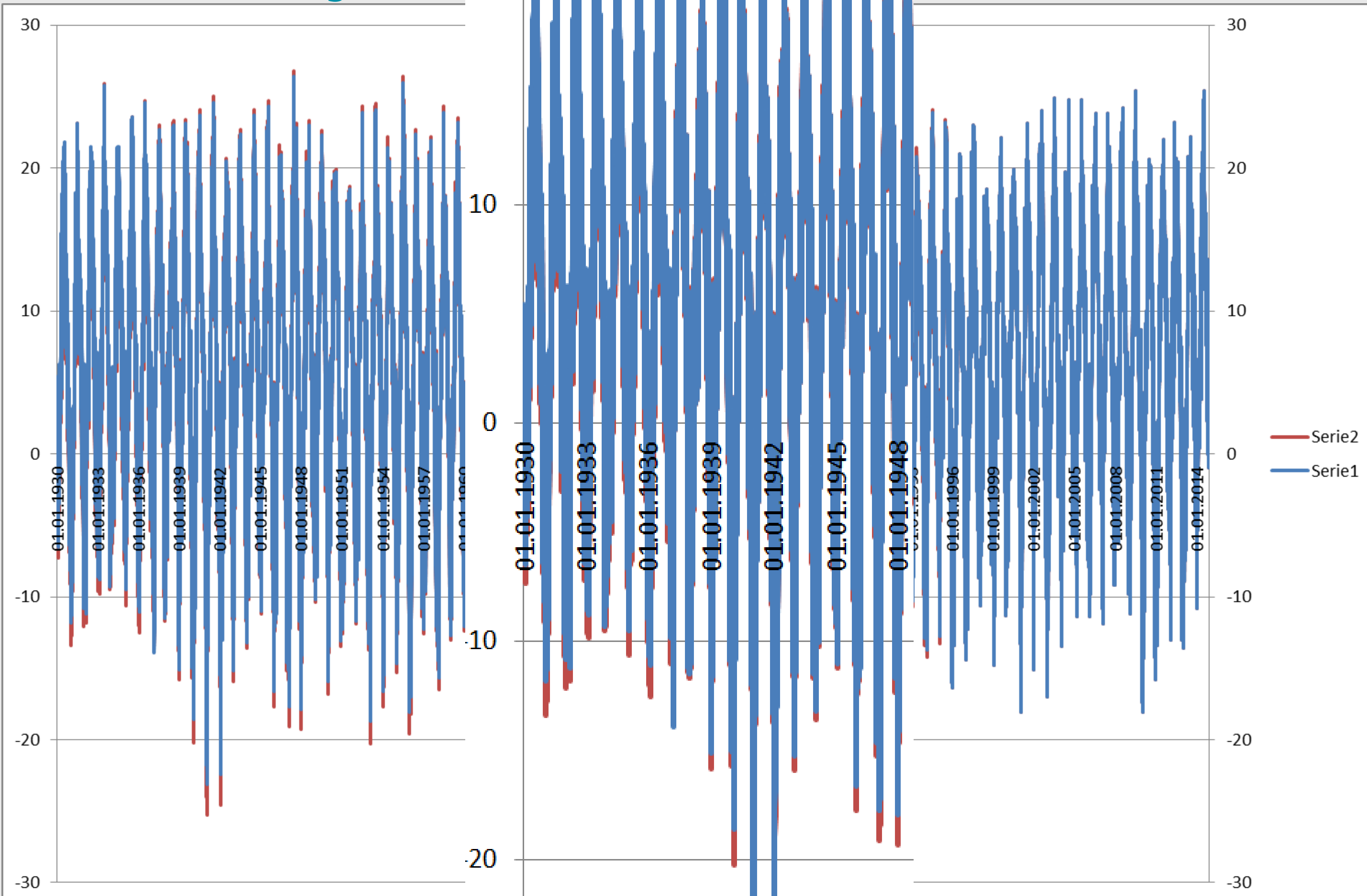
What happ


ratm cand: 00018700 ref: 00019400 DJF 19370201 − 19800229
APPLIED ADJUSTMENTS ([])
0.0
−0.5
−1.0
−1.5
−20
−15
−10
−5
0
5
RAW DATA ([])



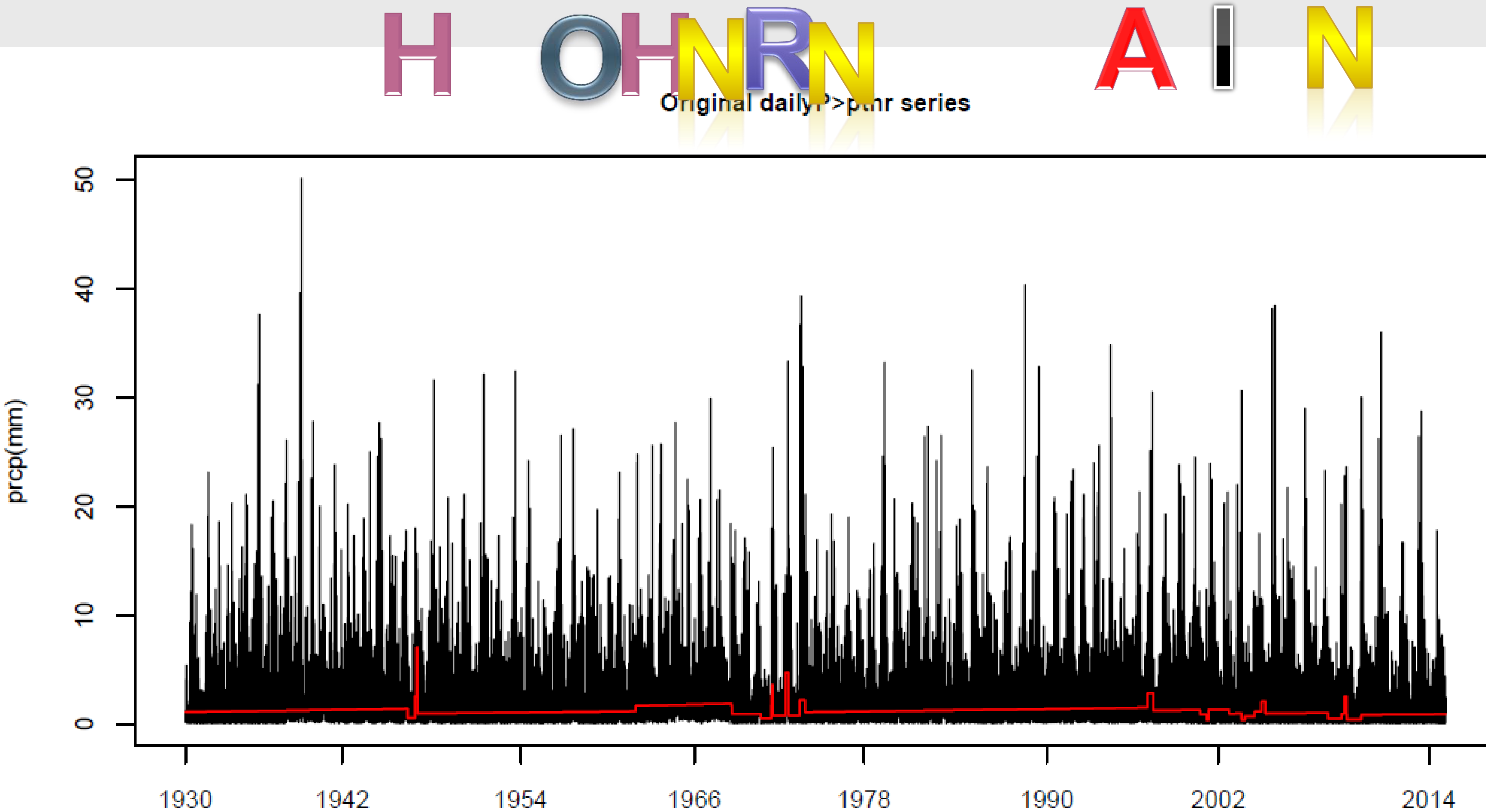
ratm 00018700 DJF 19540101 – 1980110
ratm 00018700 DJF 19801101 – 1987022
mYXjbef (Â°C)
mYXjaft (Â°C)
X (Â°C)
X (Â°C)
−25 −15 −5 0 5 10
ratm 00018700 DJF 19540101 – 1980110
ratm 00018700 DJF 19540101 – 1980110
mYXjaft – mYXjbef (Â°C)
mXYjbef (Â°C)
0.0 −0.5 −1.0 −1.5

The adjust

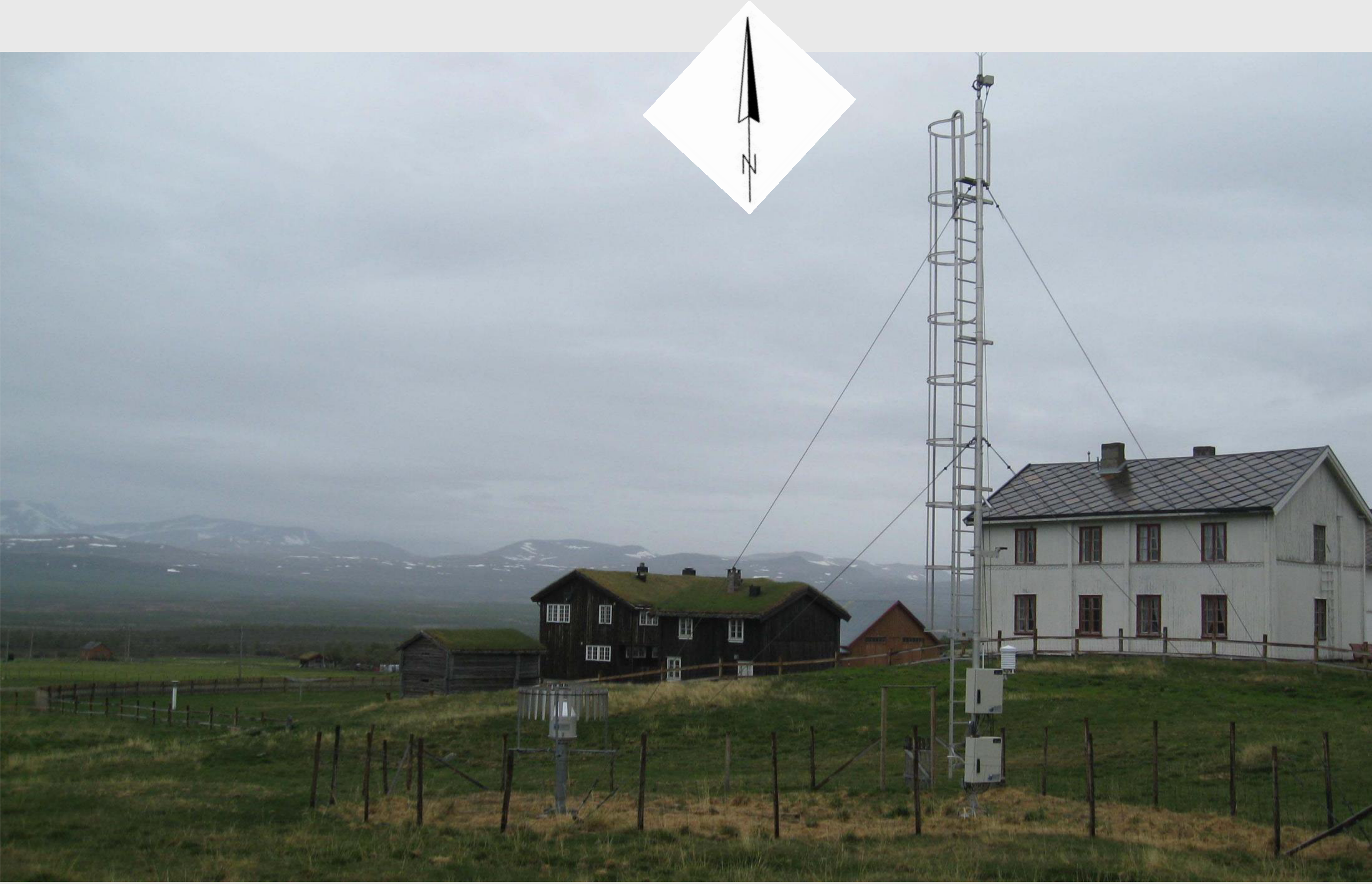


30
20
10
0
-10
-20
-30
01.01.1930
01.01.1933
01.01.1936
01.01.1939
01.01.1942
01.01.1945
01.01.1948
01.01.1951
01.01.1954
01.01.1957
01.01.1996
01.01.1999
01.01.2002
01.01.2005
01.01.2008
01.01.2011
01.01.2014
30
20
10
0
-10
-20
-30
Serie2
Serie1
20
10
0
-10
-20
01.01.1930
01.01.1933
01.01.1936
01.01.1939
01.01.1942
01.01.1945
01.01.1948

Precipitation: RHtestsV4

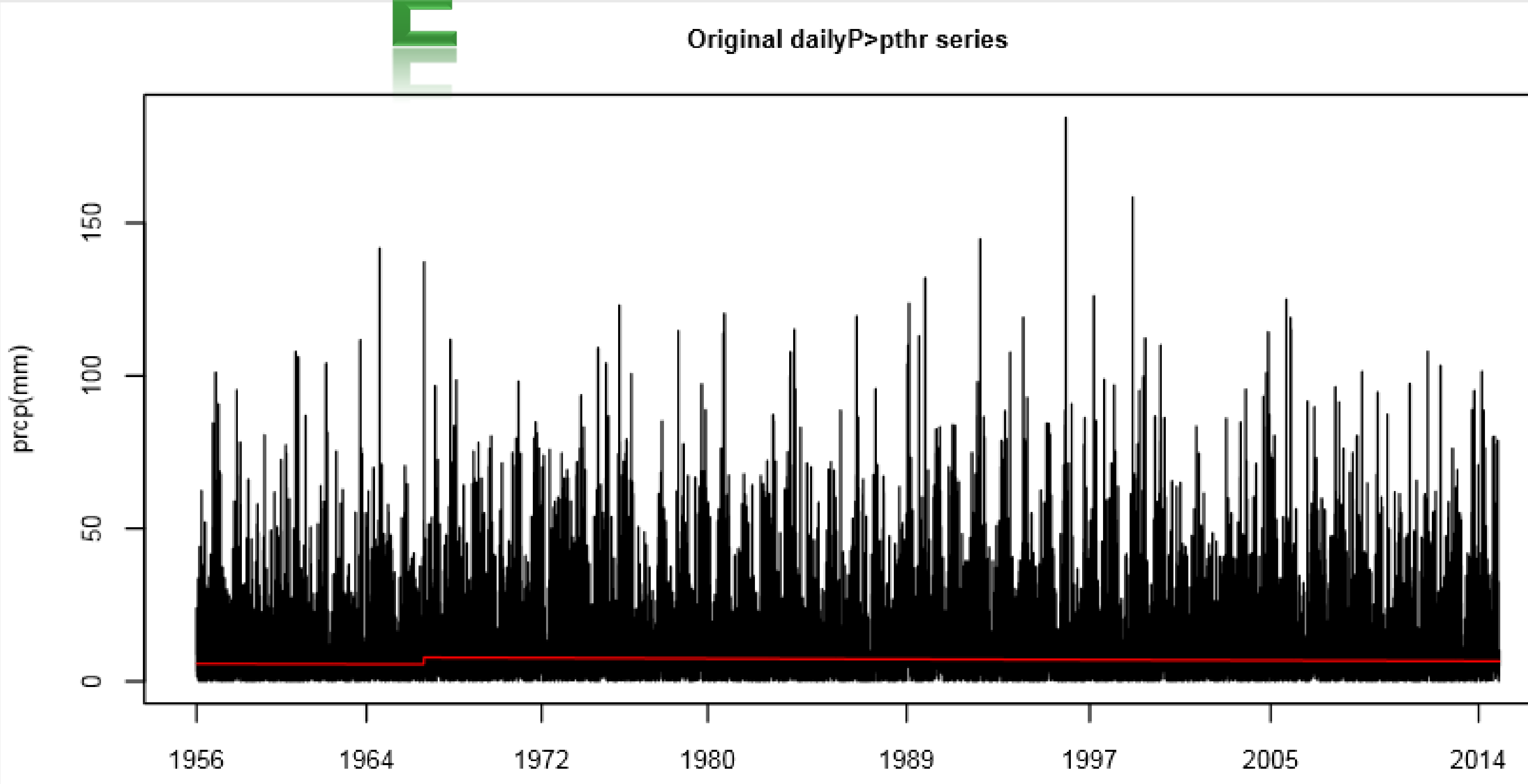


Fokstua



N

Takle


Original dailyP>pthr series
prcp(mm)
0
50
100
150
1956
1964
1972
1980
1989
1997
2005
2014

Experiences so far..

- For temperature, we follow the recommendations of COST HOME:
- Homer for monthly temperature
- Software: SPLIDHOM for daily temperature

- Homogeneity Software precipitation is problematic:
  Seasonal challenges are not covered by "standard" applications.
  We use several Homer, MASH, ...
  One method of day P.T. (RHtests_dlyPrcp4 @ Wang)

  Have access to other methods (MASH, ACMANT, ...) for comparison (monthly data)

  Open source can be a challenge:
- lack of standardization maintenance and repairs


Foto: Ørnelund, Leif
Oslo Museum

Norwegian
Meteorological
Institute

Thanks for your attention!

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E. elinl@met.no
Twitter. @nile_2011

Norwegian
Meteorological
Institute

Homogenisation of Maximum and Minimum Air Temperatures in Ireland

Mary Curley* and Seamus Walsh

Homogenisation of monthly maximum and minimum temperature series

HOMER 2.6

MET éireann

MET éireann

Number of stations homogenised

- 17 years or more of data

  Minimum: 99 stations

  Maximum: 100 stations

- Less than 17 years of data

  Minimum: 35 stations

  Maximum: 34 stations

- Total number of stations homogenised

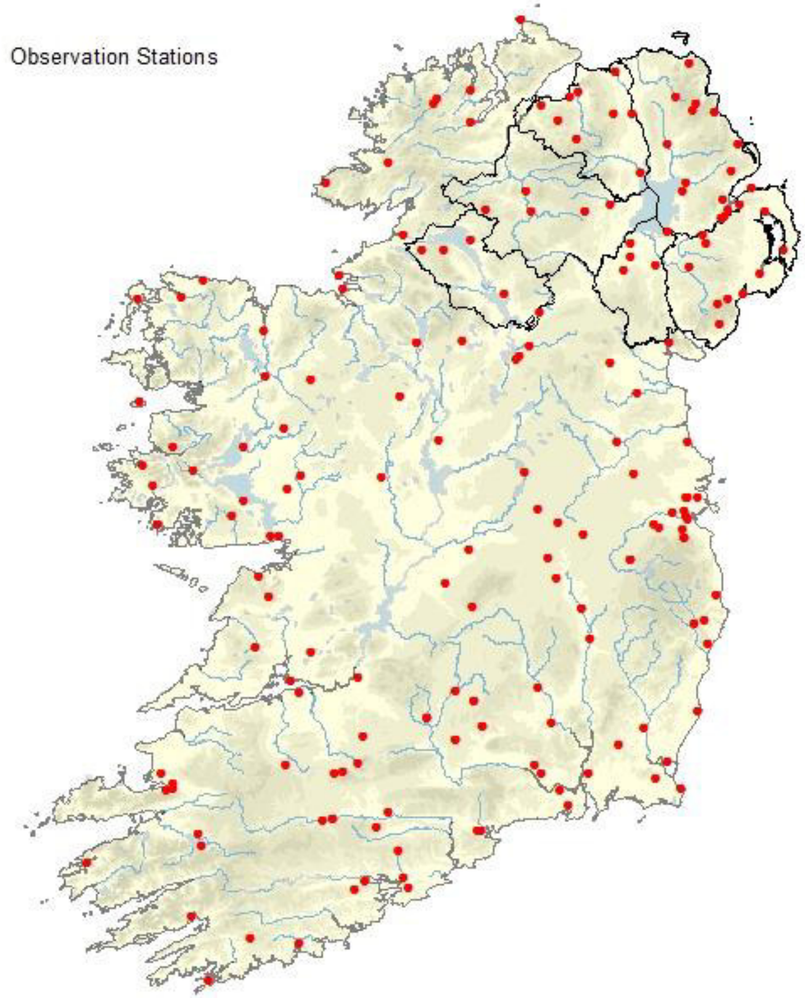
  Minimum and Maximum: 134 stations

Number of stations homogenised

17 years or more of data

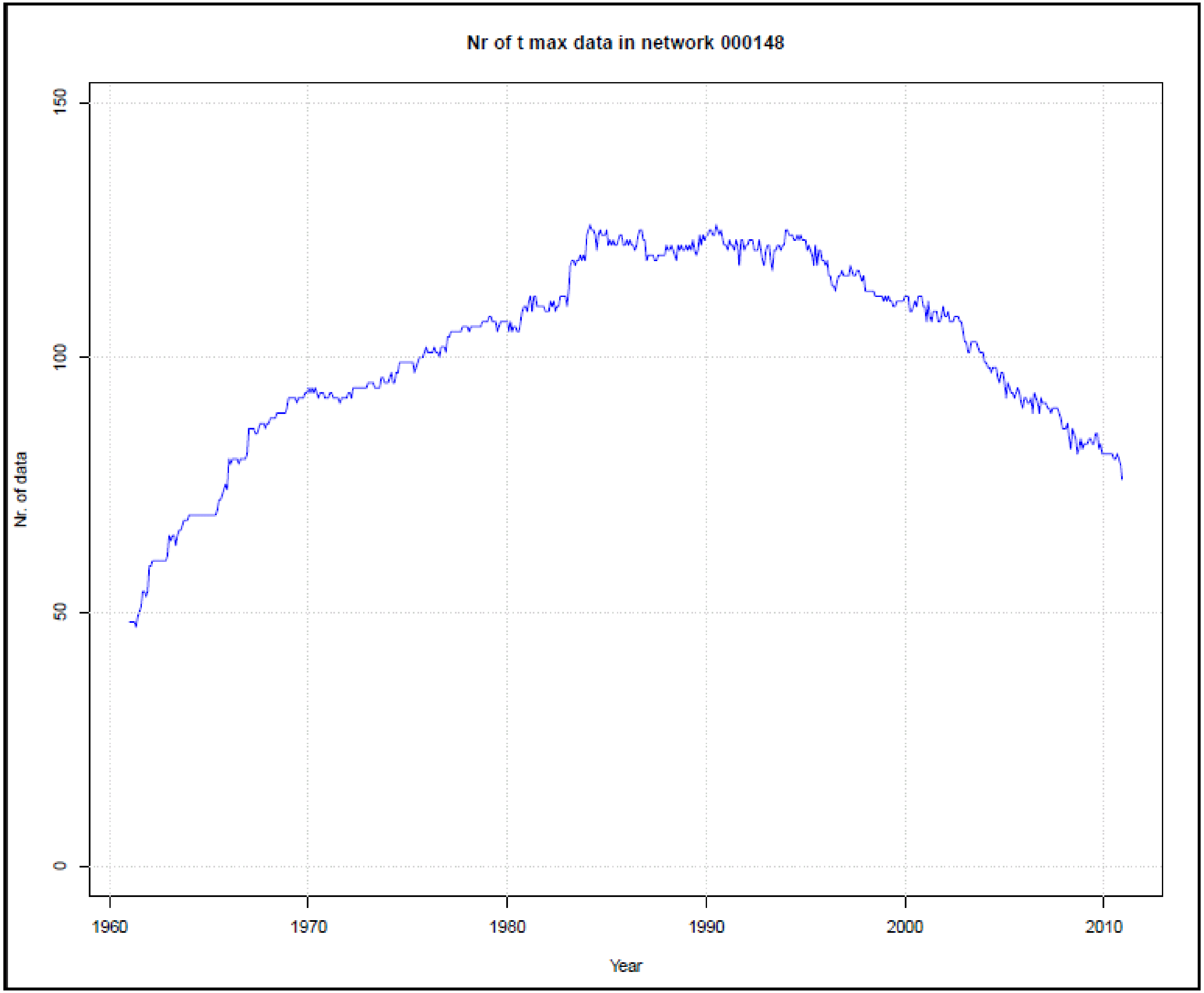
- Minimum temperature
- 99 stations (+48 N. Ireland reference stations)
- Maximum temperature
- 100 stations (+48 N. Ireland reference stations)

17 years or more of data

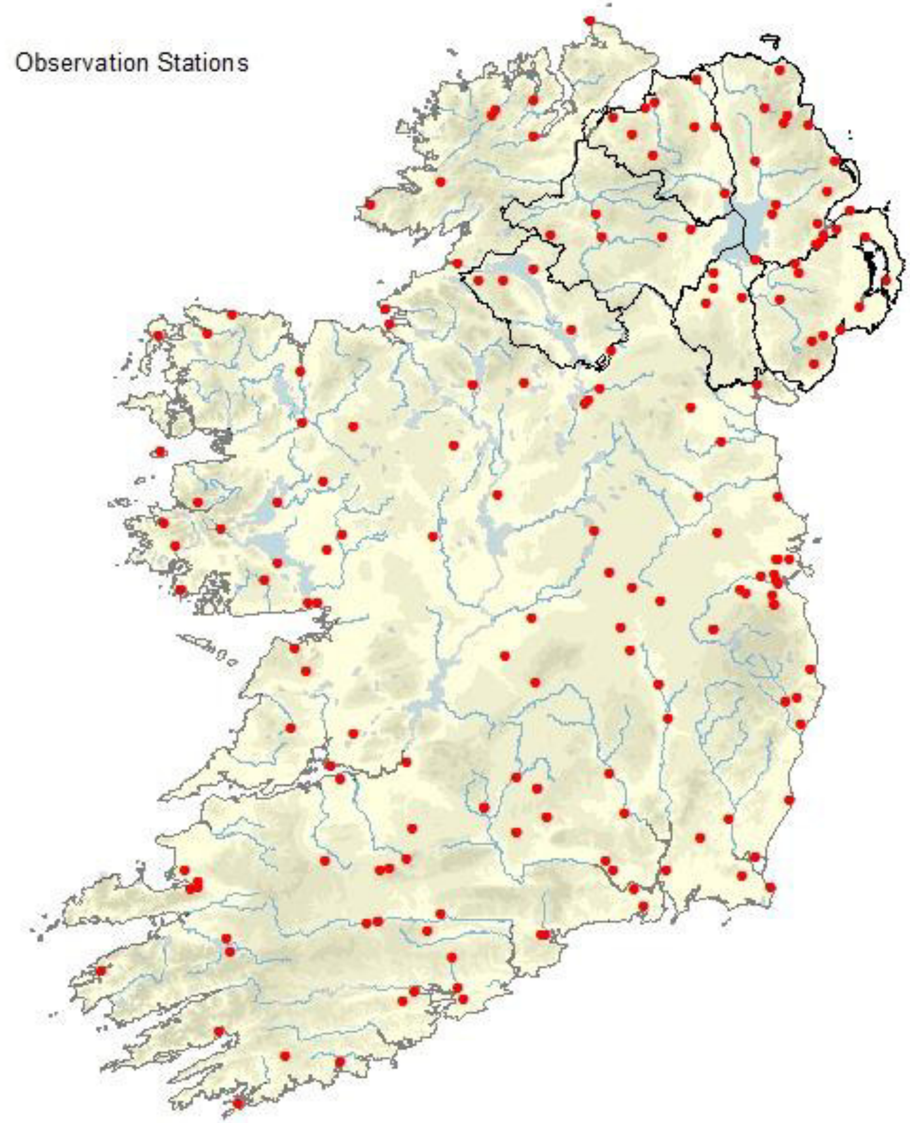


Irish stations with 17 years or more of data

50 years of data:	22 stations
40-49 years of data:	19 stations
30-39 years of data:	19 stations
<30 years data:	~40 stations



Nr of t max data in network 000148
Nr. of data
0
50
100
150
1960
1970
1980
1990
2000
2010
Year


Observation Stations

Number of Breaks

17 years or more of data

	Minimum	Maximum
Total number of breaks	108	111
% of stations with breaks	69	63
% verified breaks	37	37

Verified breaks

	Minimum	Maximum
New site %	35	41
Screen replaced %	25	17
New observer %	15	12
Degrees C thermometer %	5	5
New thermometer %	5	15
AWS %	5	-
Other %	10	10

Non-verified breaks

	Minimum	Maximum
No metadata %	28	30
No reason %	47	47
Possible reason/no exact date %	25	23

Example of some minimum monthly data detected breaks

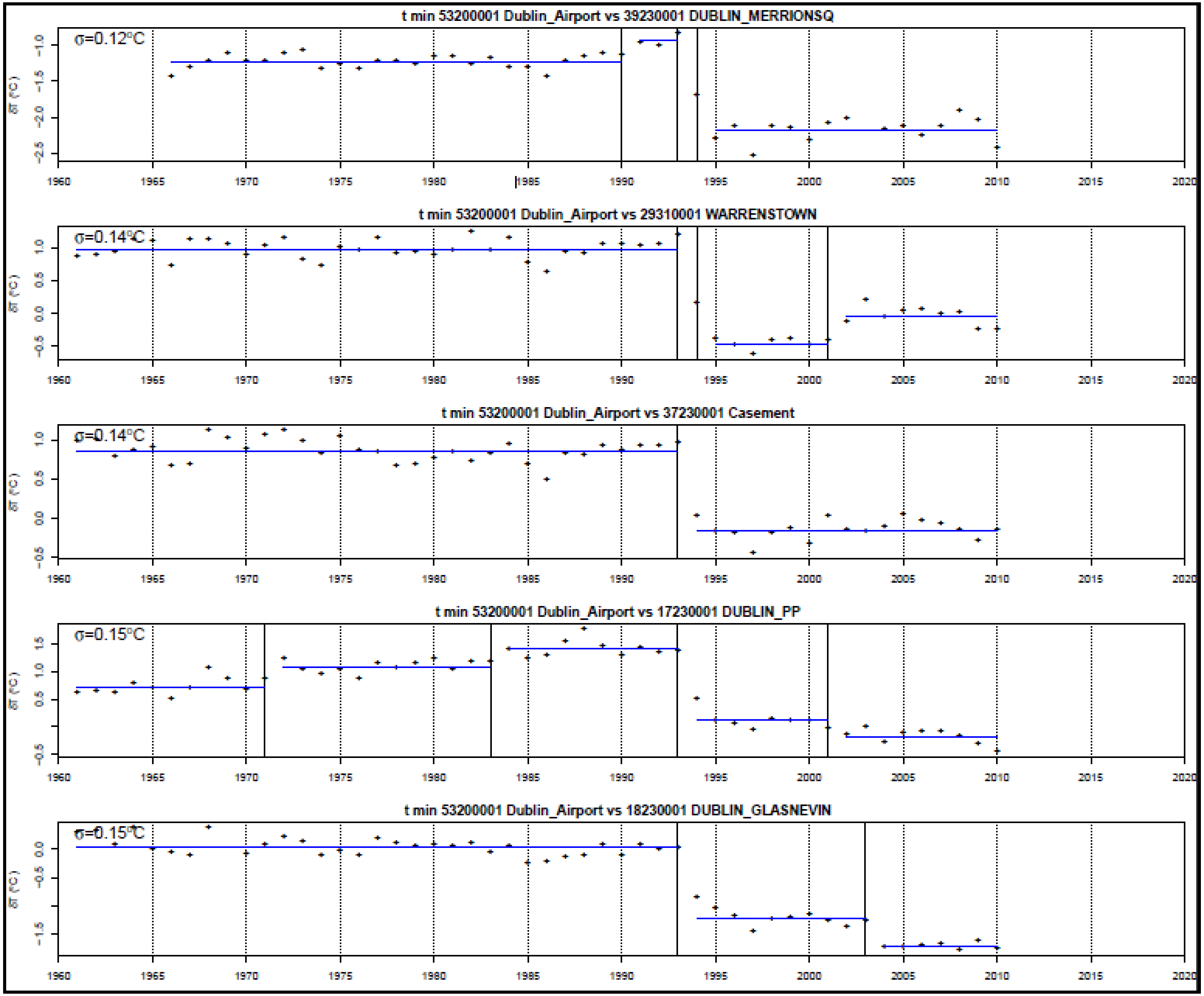
	Year	month		Reason
TRALEE_CLASH	1982	5	v	degrees c thermometer
TRALEE_CLASH	1993	12	v	new site
BALLINACURRA	1972	1	v	new obs
TUAM_AIRGLOONEY	1963	1	n	no metadata
GLENAMOY	1984	2	v	site move
MILFORD_VOCSCH	1975	5	n	no metadata
KINSALEY_AGRRES	1993	8	v	new screen
LETTERKENNY_MAGHERENAN	2005	5	n	no metadata
LETTERKENNY_MAGHERENAN	1968	12	n	observer poor around this time
DUNGARVAN_CARRIGLEA	2005	3	v	screen replaced and new fence
DUNGARVAN_CARRIGLEA	1976	8	n	replacement screen sent
CLOOSH_FORSTN	2004	9	n	no reason
CLOOSH_FORSTN	2007	7	n	no metadata

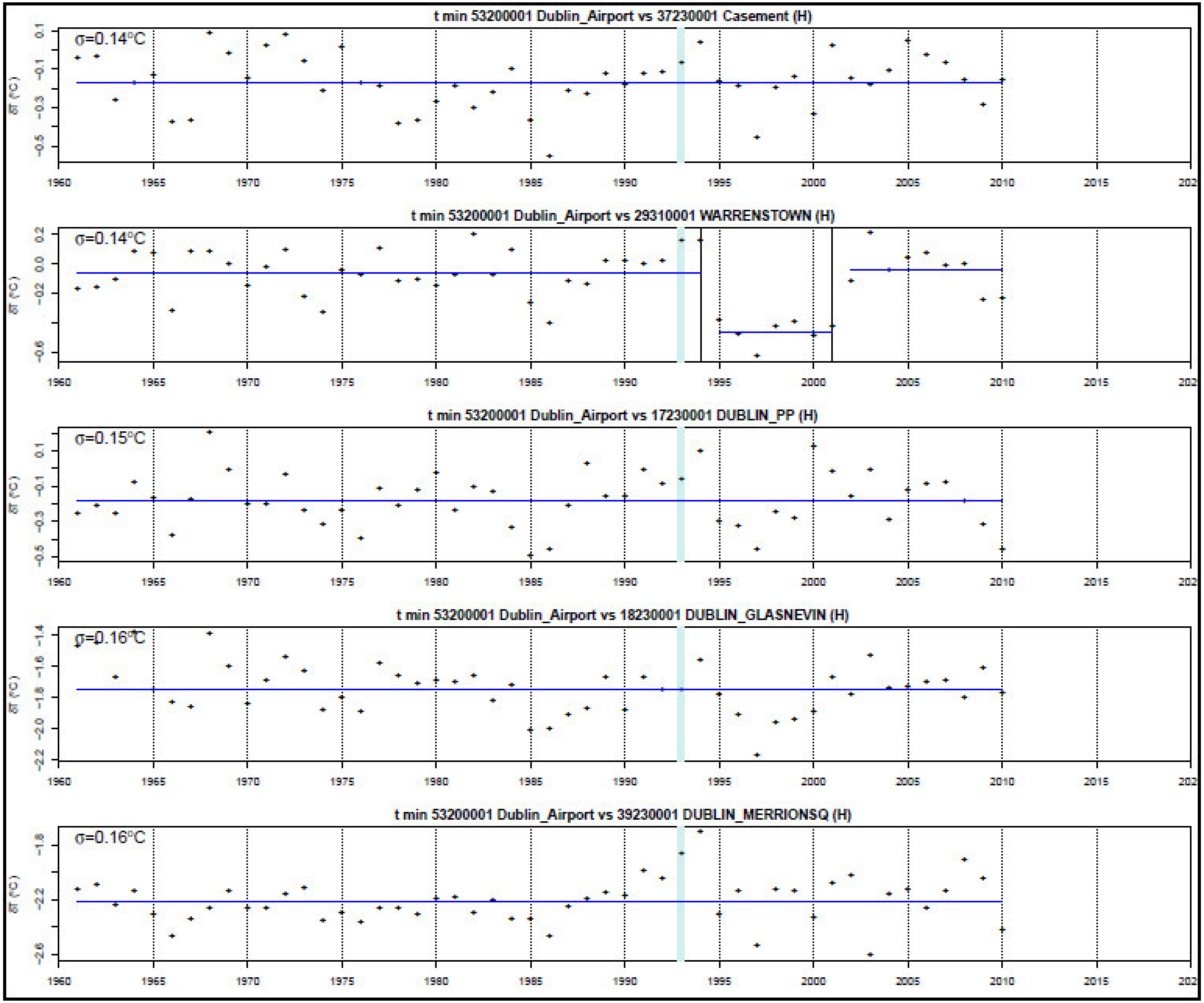
Number of breaks in stations

	Minimum	Maximum
# stations with breaks	68	63
# stations with 1 break	39	31
# stations with 2 breaks	19	23
# stations with 3 breaks	9	5
# stations with 4 breaks	1	2
# stations with 5 breaks	-	2

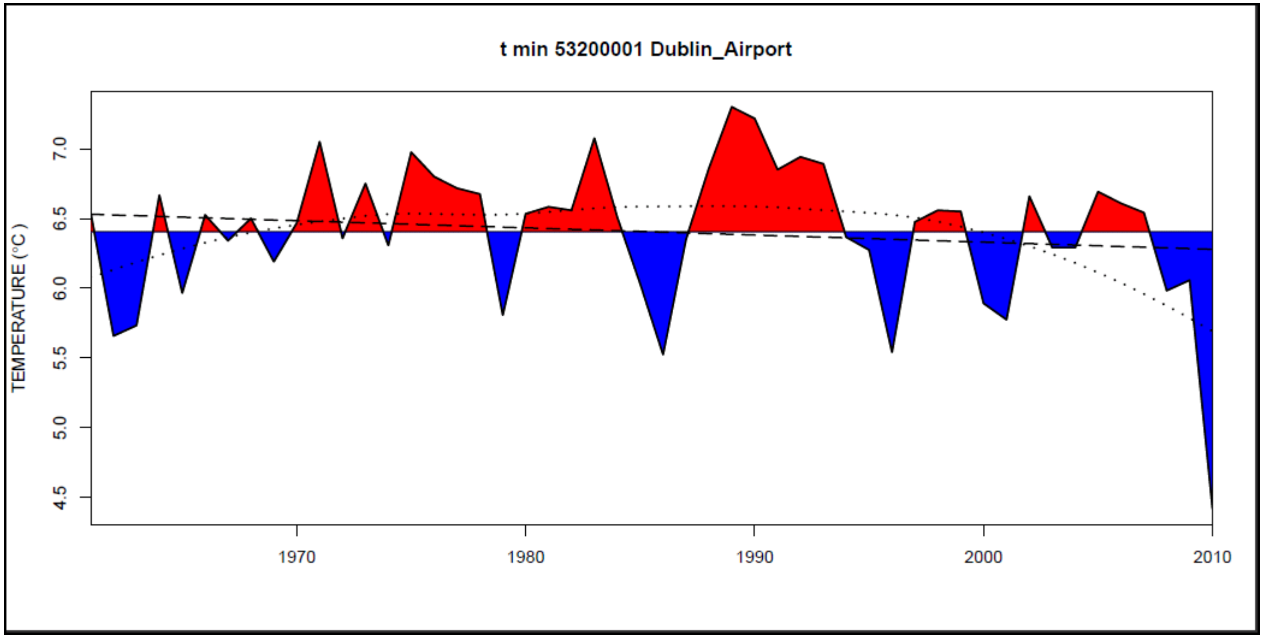
Dublin Airport
site move

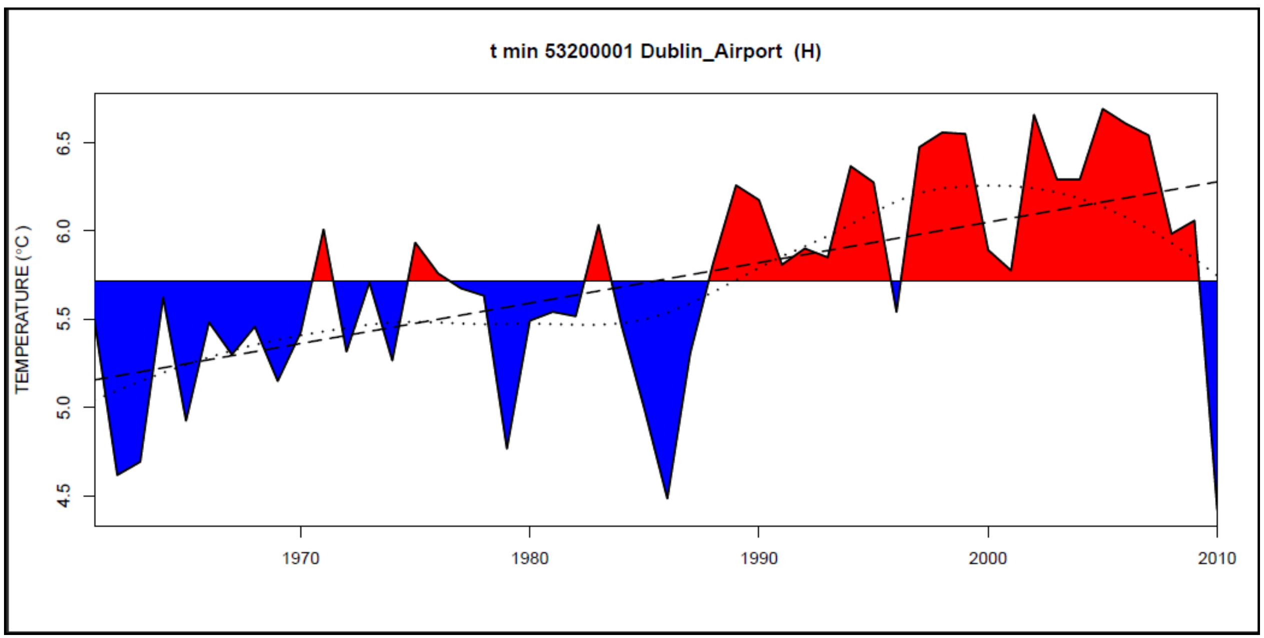
	Break amplitude	Annual correction	Monthly correction
Minimum	-1.03	-1.0	-0.9 to -1.3
Maximum	-0.28	-0.3	-0.1 to -0.4

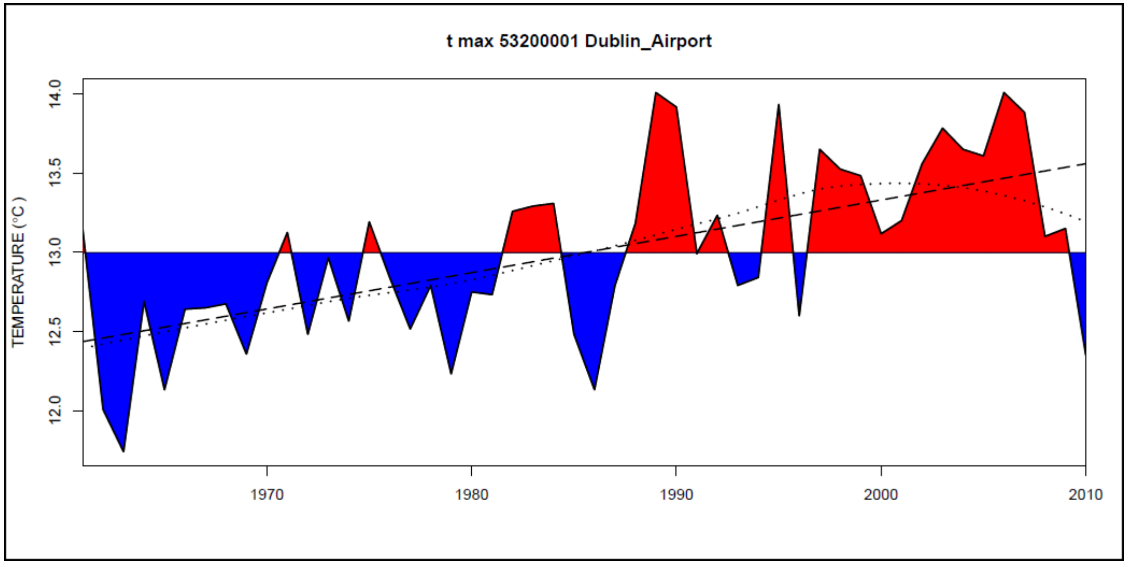

t min 53200001 Dublin_Airport vs 39230001 DUBLIN_MERRIONSQ
σ=0.12°C
t min 53200001 Dublin_Airport vs 29310001 WARRENSTOWN
σ=0.14°C
t min 53200001 Dublin_Airport vs 37230001 Casement
σ=0.14°C
t min 53200001 Dublin_Airport vs 17230001 DUBLIN_PP
σ=0.15°C
t min 53200001 Dublin_Airport vs 18230001 DUBLIN_GLASNEVIN
σ=0.15°C

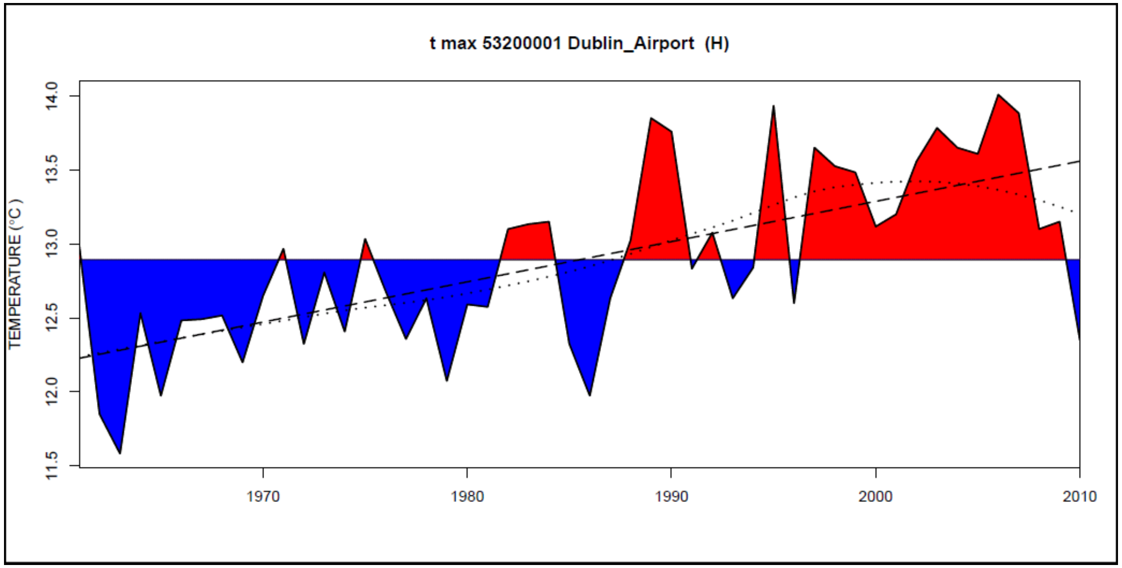


t min 53200001 Dublin_Airport vs 37230001 Casement (H)
σ=0.14°C
t min 53200001 Dublin_Airport vs 29310001 WARRENSTOWN (H)
σ=0.14°C
t min 53200001 Dublin_Airport vs 17230001 DUBLIN_PP (H)
σ=0.15°C
t min 53200001 Dublin_Airport vs 18230001 DUBLIN_GLASNEVIN (H)
σ=0.16°C
t min 53200001 Dublin_Airport vs 39230001 DUBLIN_MERRIONSQ (H)
σ=0.16°C


t min 53200001 Dublin_Airport
TEMPERATURE (°C)
7.0
6.5
6.0
5.5
5.0
4.5
1970
1980
1990
2000
2010


t min 53200001 Dublin_Airport (H)
TEMPERATURE (°C)
6.5
6.0
5.5
5.0
4.5
1970
1980
1990
2000
2010

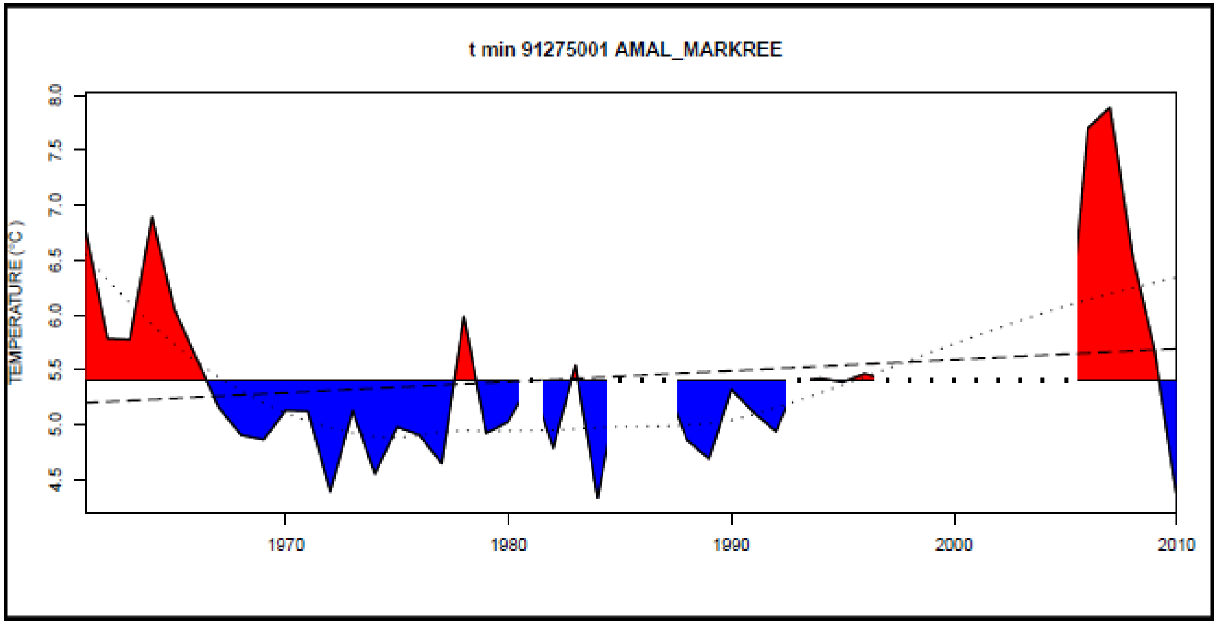

t max 53200001 Dublin_Airport
TEMPERATURE (°C)
12.0
12.5
13.0
13.5
14.0
1970
1980
1990
2000
2010

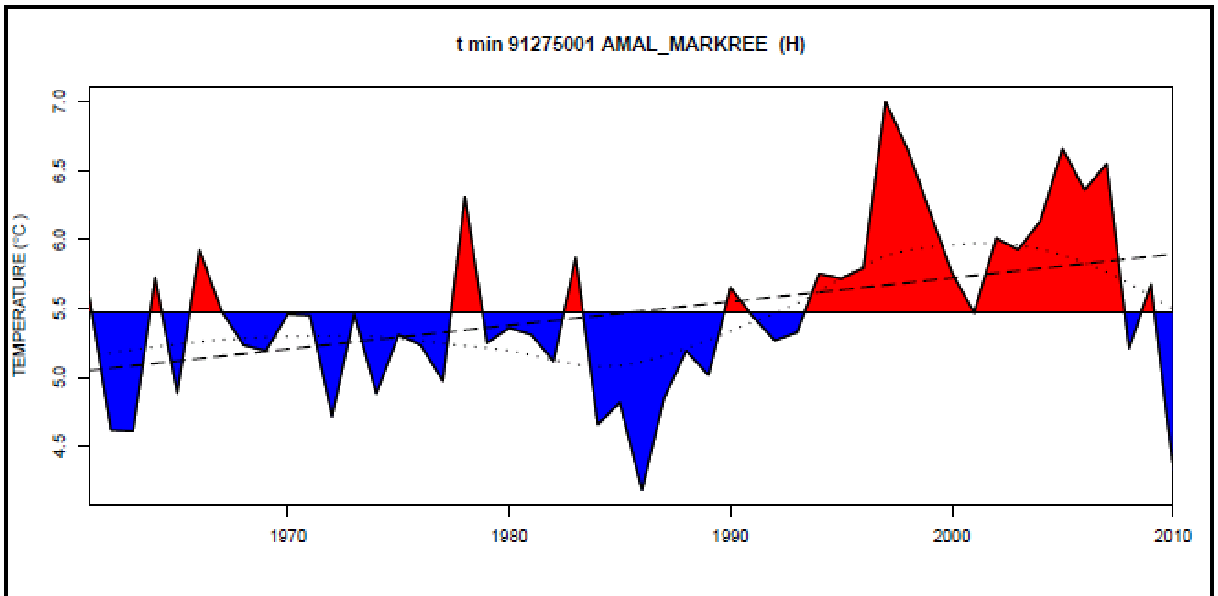

t max 53200001 Dublin_Airport (H)
TEMPERATURE (°C)
11.5
12.0
12.5
13.0
13.5
14.0
1970
1980
1990
2000
2010

Markree Castle

reason for breaks unknown

	Year	Break amplitude	Annual correction	Monthly correction
Minimum	1961-1965	-1.52	-1.2	-0.7 to -1.8
	1966-1998	1.62	0.4	0.2 to 0.6
	1998-2008	-1.26	-1.3	-0.9 to -1.8
Maximum	1961-1965	-1.01	-1.7	-1.2 to -2.0
	1966-1984	-0.27	-0.6	-0.2 to -1.1
	1984-1995	-0.48	-0.4	0 to -0.9
	1995-2007	-1.42	-1.4	-1.3 to -1.6


t min 91275001 AMAL_MARKREE
TEMPERATURE (°C)
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
1970
1980
1990
2000
2010


t min 91275001 AMAL_MARKREE (H)
TEMPERATURE (°C)
7.0
6.5
6.0
5.5
5.0
4.5
1970
1980
1990
2000
2010

Stations with little metadata but multiple breaks

- Oak Park
  - Min: 3 breaks 1967, 1997 & 2006
  - Max: 5 breaks 1967, 1977, 1991, 1997 & 2006
- Derrygreenagh
  - Min: 3 breaks 1973, 1982 & 2007
  - Max: 4 breaks 1964, 1974, 1990 & 2002

HOMER 2.6

- Outliers which were extreme events were reinserted after homogenisation
- In general interactive mode was used. A lot more breaks when non-interactive mode used

Comparison with MASH

- Some stations compared well for others there was a big difference

HOMER v MASH

		Jan	Feb.	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Min T Dublin Airport		0.2	-0.2	-0.3	-0.2	0	0.7	-0.3	0	0.2	0	-0.1	0
Max T Dublin Airport		-0.1	0.2	0	-0.1	0	0	0	-0.3	-0.1	0.1	0.1	-0.1
Min T Markree	1961	-1.1	0.1	-1.7	-1.1	-1.3	-1.7	-1.1	-1	-0.5	-1.6	-1.1	-0.7
	1983	-0.5	0.1	-0.8	-0.2	-0.5	-0.6	-0.5	-0.5	0.5	-0.5	-0.4	-0.8
	2002	-0.7	0.2	-1.4	-1.1	-0.8	-1.4	-0.9	-0.7	-0.4	-1.1	-0.6	-0.3

Stations with less than 17 years of data

- Minimum temperature

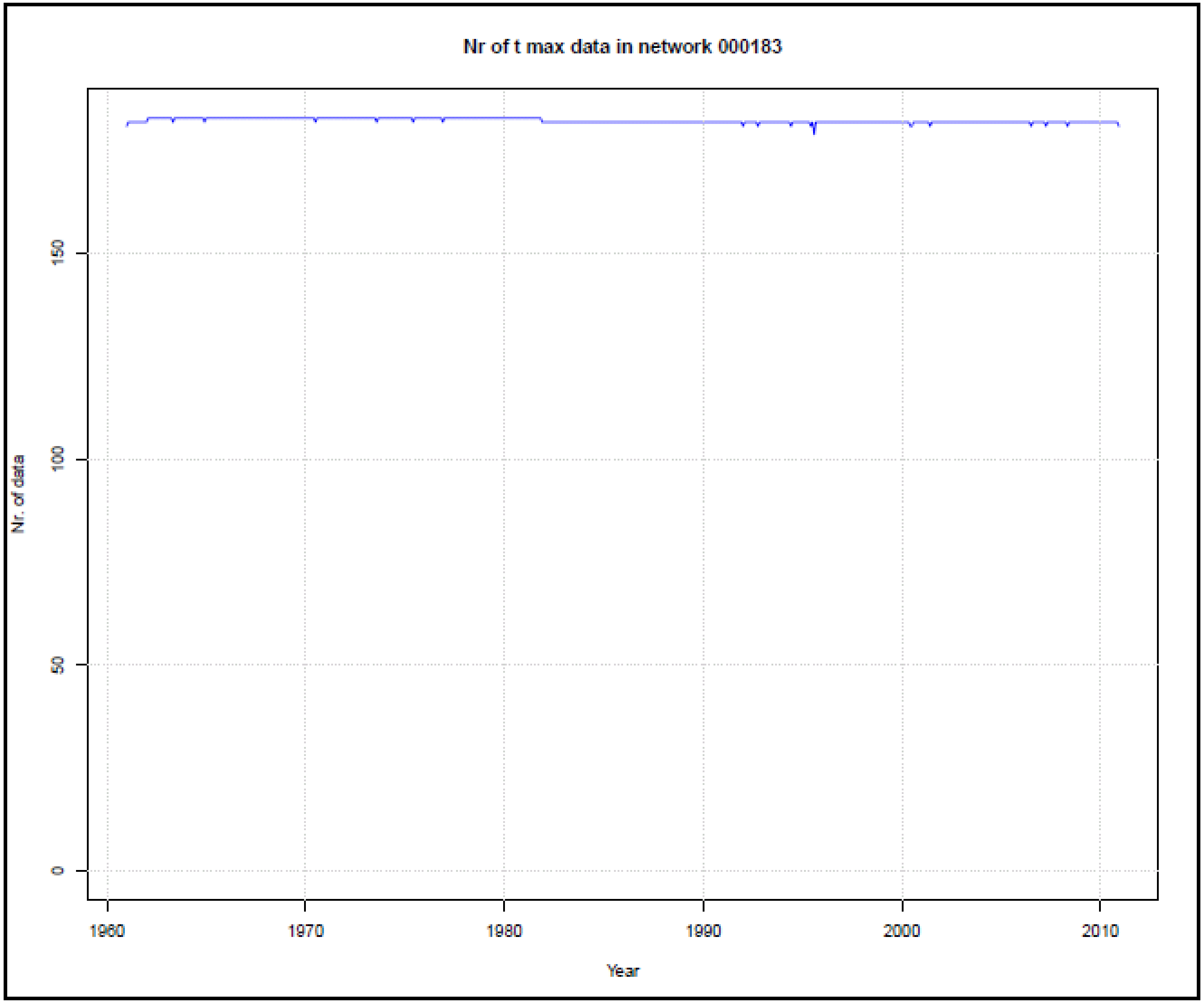
  35 stations

- Maximum temperature

  34 stations

Less than 17 years of data

- Infilled the series which had less than 17 years of data prior to homogenisation
- Used the homogenised data series from stations with 17 years or more of data as reference


Nr of t max data in network 000183
Nr. of data
0
50
100
150
1960
1970
1980
1990
2000
2010
Year

Number of Breaks

Less than 17 years of data

	Minimum	Maximum
Total number of breaks	47	46
% of stations with breaks	80	82
% verified breaks	34	37

Number of breaks in stations

	Minimum	Maximum
# stations with breaks	28	28
# stations with 1 break	13	24
# stations with 2 breaks	11	8
# stations with 3 breaks	4	2

Daily data

Daily data series

- Looking at parallel data series
- SPLIDHOM

Parallel data series

- When stations where automated we had parallel measurements for a number of months.
- Mullingar
- Valentia
- Belmullet
- Malin Head
- Sherkin Island

Parallel data series

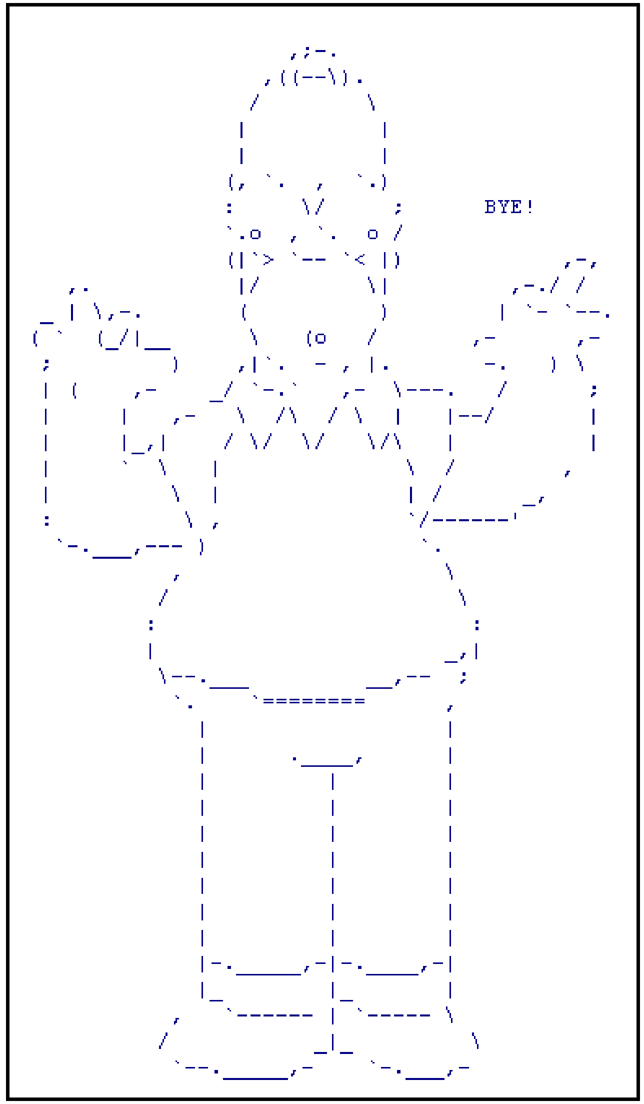
- In general the difference seems bigger between minimum temperatures however for Sherkin Island the maximum temperature is more affected.
- The difference in the maximum thermometers can range from 0.5 up to 3 degrees C whilst for the minimum it is generally less than a degree.

SPLIDHOM

- Starting with Dublin stations
  - long series with generally not too many breaks in monthly data
  - dense network

Thanks to the Met Office, particularly Dan Hollis for providing Northern Ireland monthly maximum and minimum data

Thank you



Norwegian
Meteorological
Institute

Influence of outliers in homogeneity testing of seasonal precipitation data in Norway

Herdis M. Gjelten, Ole Einar Tveito and Elin Lundstad

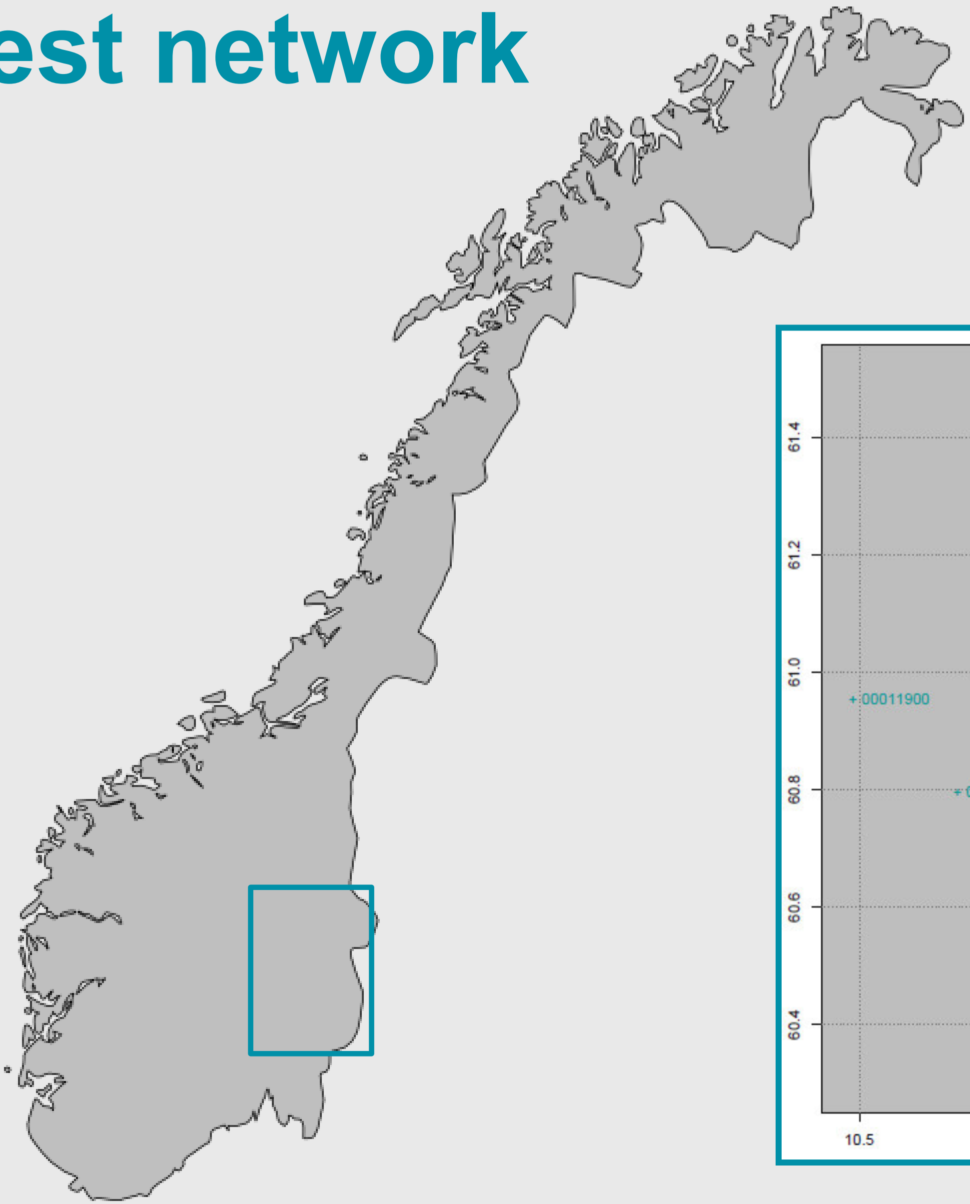
29.10.2015

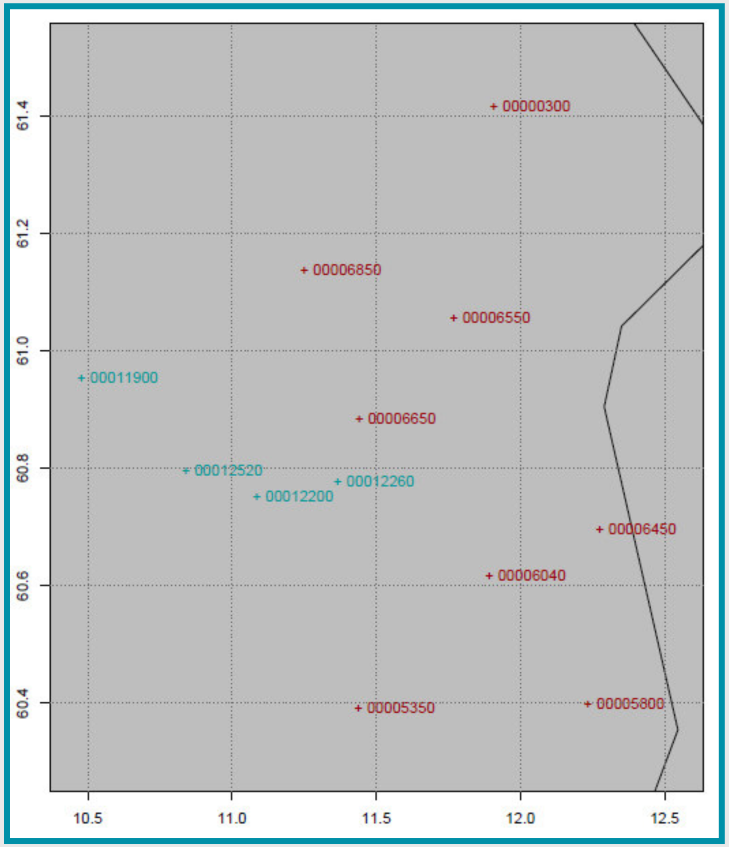
Typical test result

Break year	Adjustment factor
1961	1.08
1963	0.94
1964	1.08
1974	0.91
1979	1.08
1980	0.94
1981	1.04

Test network

- 12 stations
- Seasonal data
- 1957-2014





Norwegian Meteorological Institute

Removal of outliers

Station	Daily value	Percentile	New value
300	2.5	53	
5350	3.2	54	
5800	30.7	99	
6040	9.0	87	
6460	**32.1 mm**	**99 %**	**2.0 mm**
6550	2.3	41	
6650	1.3	29	
6850	0.3	13	
11900	2.4	47	
12200	11.4	93	
12260	0.7	22	
12520	2.9	61	
Average		**54.5 %**	

Removal of outliers - result

	Number of breaks	
	Before	After
MASH	26	21
HOMER	34	33

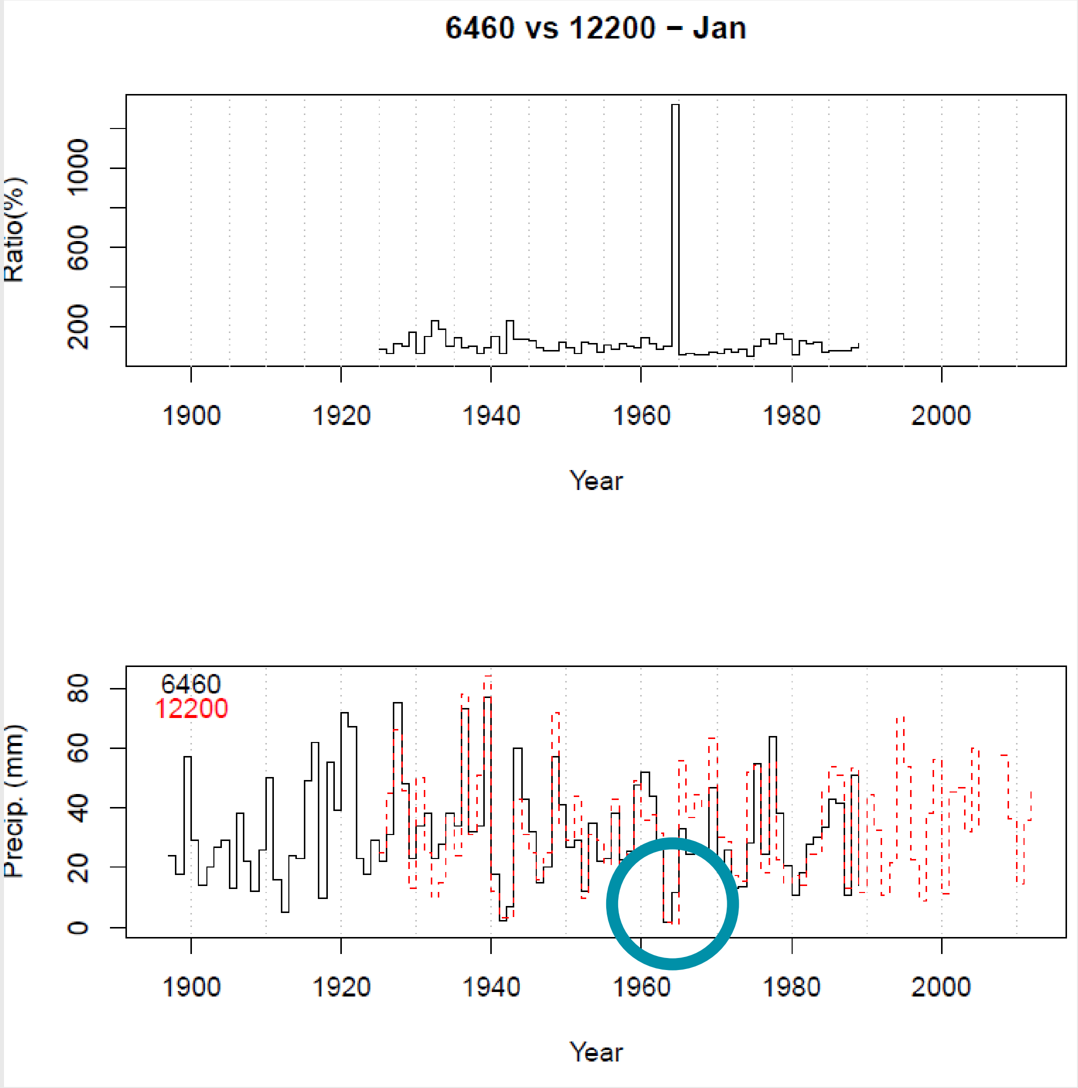
Typical test result - again

Break year	Adjustment factor
1961	1.08
1963	0.94
1964	1.08
1974	0.91
1979	1.08
1980	0.94
1981	1.04

Ratios


Ratio(%)
1000
600
200
1900
1920
1940
1960
1980
2000
Ratio(%)
250
150
50
Ratio(%)
300
100
Ratio(%)
200
100
50
Ratio(%)
180
140
100
60
Ratio(%)
1200
800
400
0
Ratio(%)
150
100
50
Ratio(%)
1000
600
200

Ratios

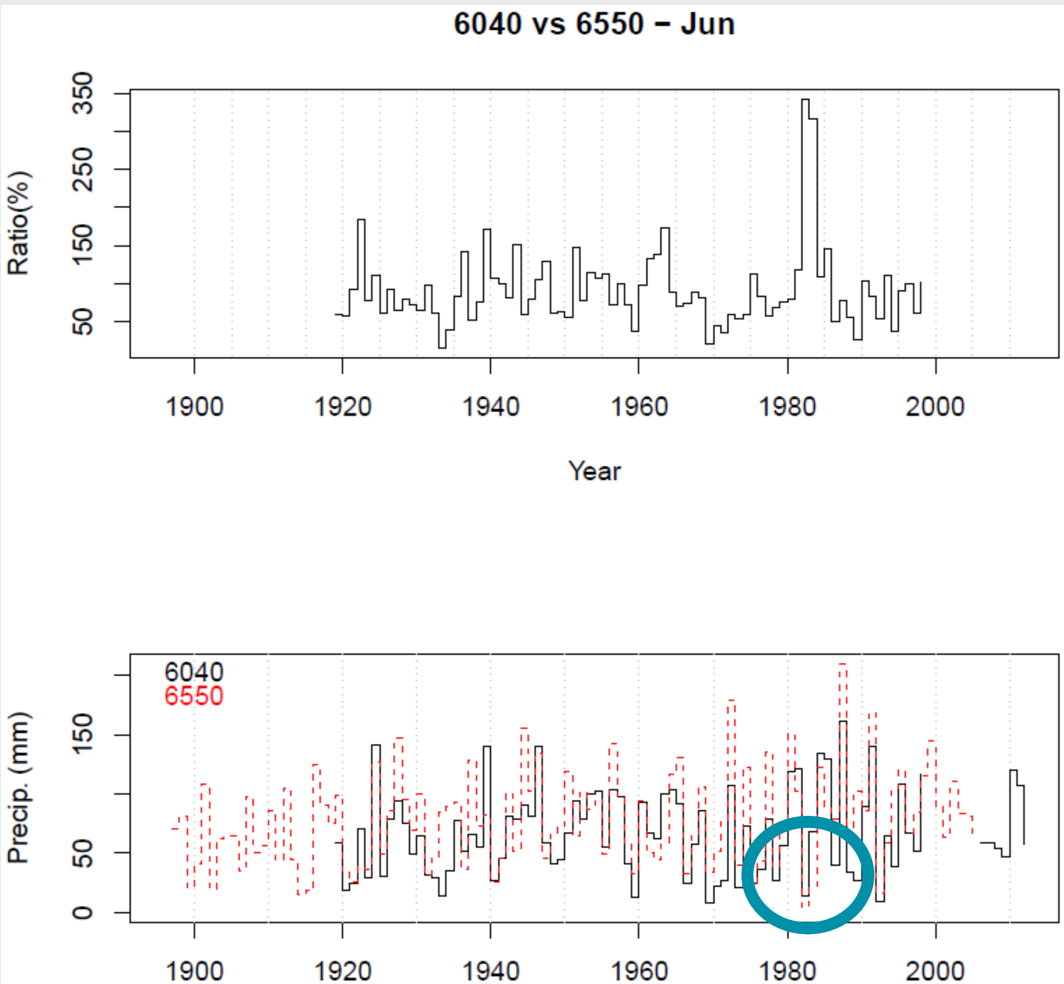


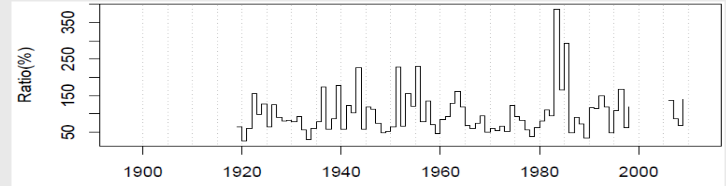
Monthly sum January:
6460 = 11.9 mm
12200 = 0.9 mm

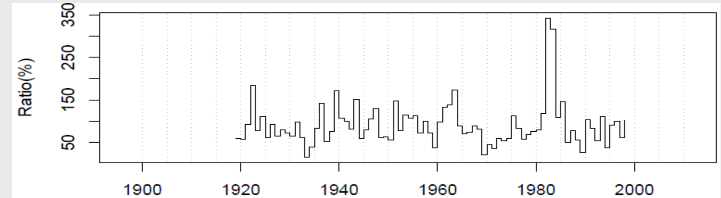
→ large ratio

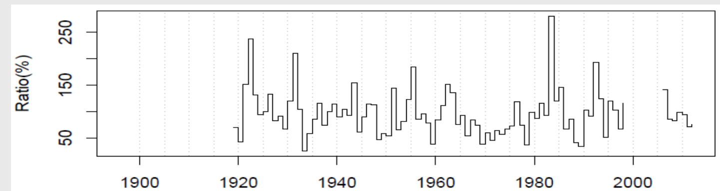
Ratios

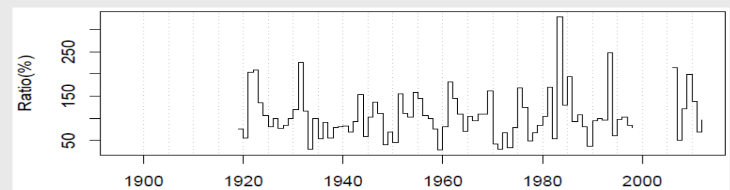
Breaks	
1983	1.11
1985	0.90

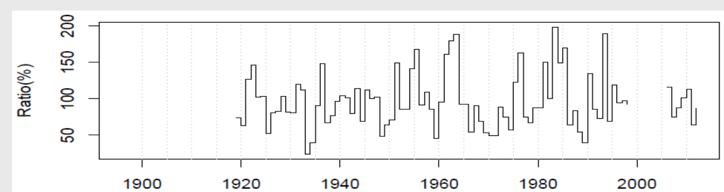


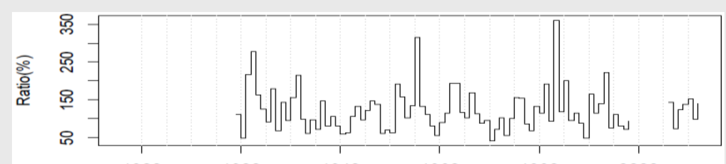












Conclusions?

Norwegian
Meteorological
Institute

Thank you for your attention!

Adjustment of new daily data from thermograph and pluviograph to a conventional series: the case of Fabra Observatory, Barcelona (1904-1913)

10th EUMETNET Data Management Workshop – 28/30 October 2015, St. Gallen

***Marc Prohom*, Enric Aguilar and Germán Solé**

meteo.cat Servei Meteorològic de Catalunya

C3 Centre for Climate Change

Observatori de l'Ebre
Universitat Ramon Llull

Layout

1. **Background and objectives**

2. **Digitalization process**

3. **Reference series and quality control**

4. **Homogeneity analysis – Break point detection (HOMER)**

5. **Homogeneity analysis – Daily adjustment on temperature (SPLIDHOM)**

6. **Homogeneity analysis – Monthly adjustment on precipitation (HOMER)**

7. **Results and conclusions**

1. Background and objectives

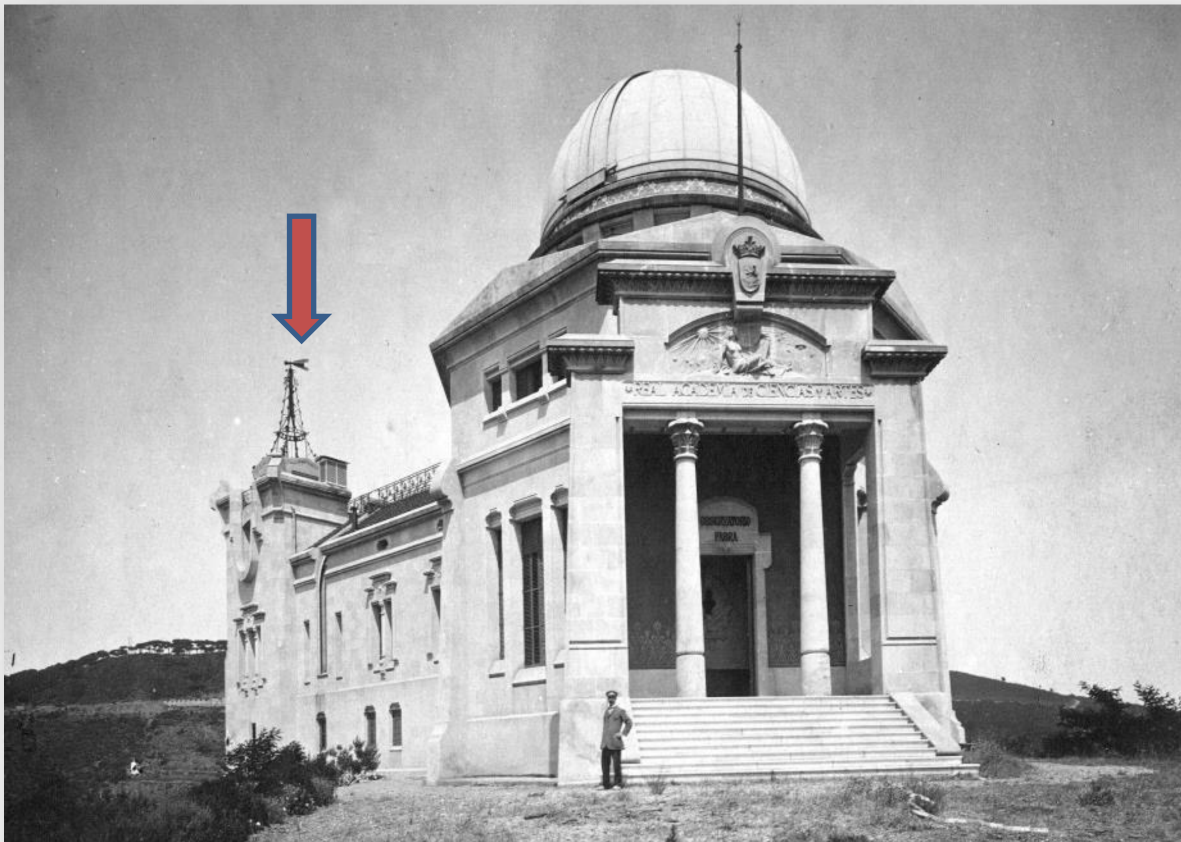
Fabra Observatory (in Barcelona, 412 m asl) has one of the longest, continuous and unchanged location series of Iberia.

Meteorological field at Fabra Observatory: 1920s (left image) – present day (right image)

For years it was believed that meteorological observations began in August 1913. In 2012, evidence of previous observations appeared and the data and metadata was detected and recovered from the archives of the Royal Academy of Sciences and Arts of Barcelona.

1. Background and objectives

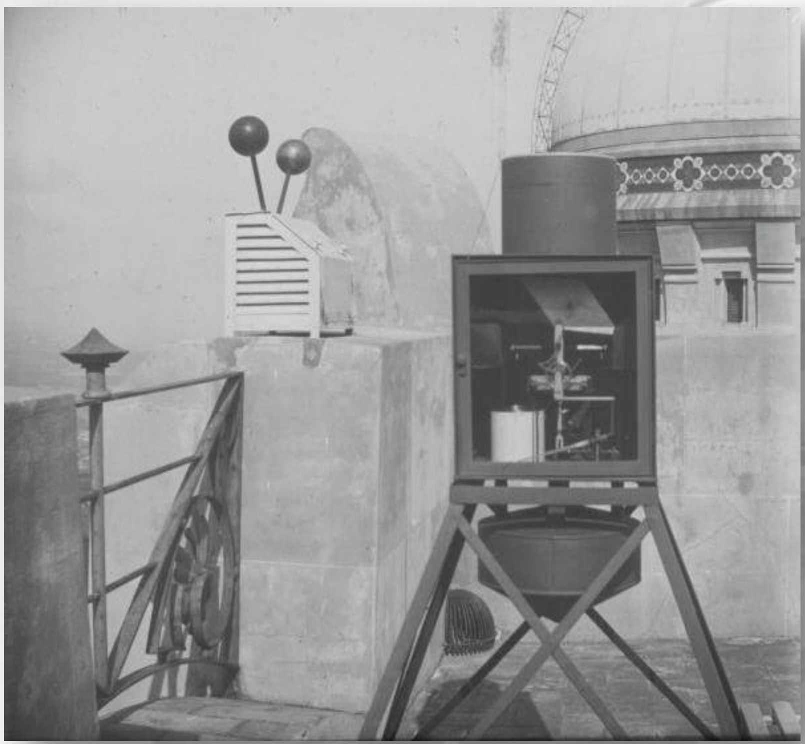
- New data covered the period from 1905(Dec) up to 1914(June).
- Was recorded by weekly thermographs and pluviographs.
- The site was located at the roof of the observatory.



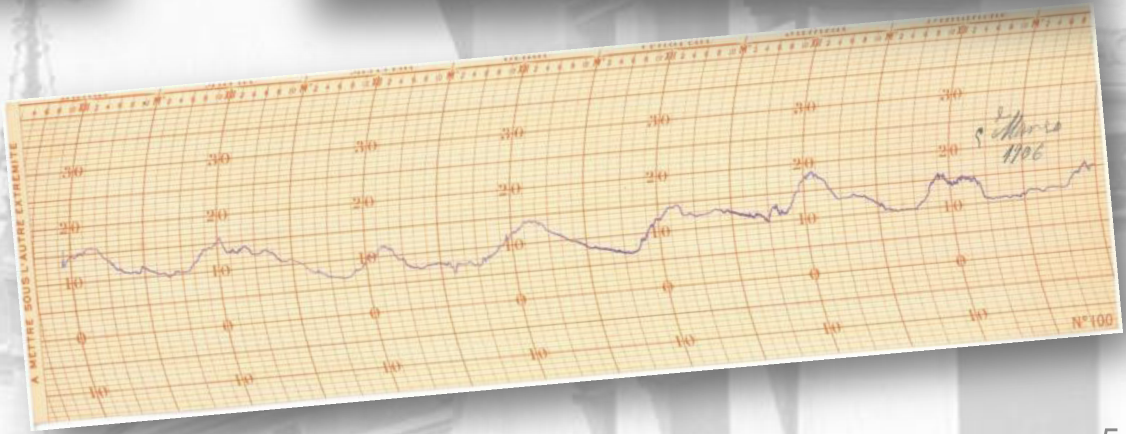
Location of the undocumented observatory

1. Background and objectives

Weekly thermograph and tipping-bucked rain gauge, both Richard manufacturers

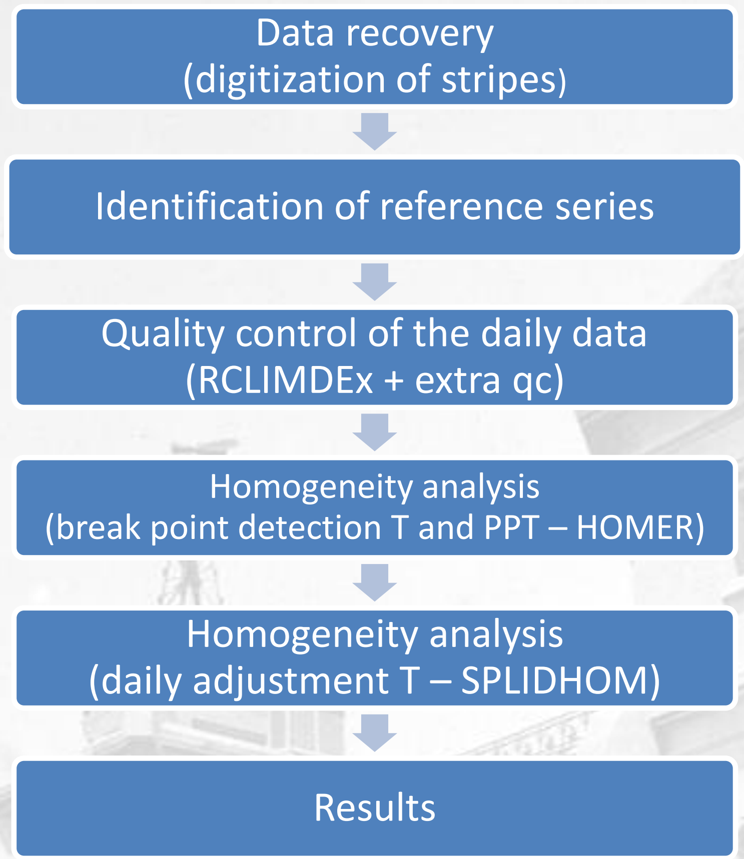


15/12/1904 up to 30/06/1914
97.9% data recovered for T and **100%** for precipitation (hourly and daily)



1. Background and objectives

MAIN OBJECTIVE: adjust the daily T data (Tx and Tn) and the monthly PPT data to the conventional series.
ACHIVEMENT: the longest and more continuous series of Catalonia, located in a single point.



2. Digitalization process

Several steps:

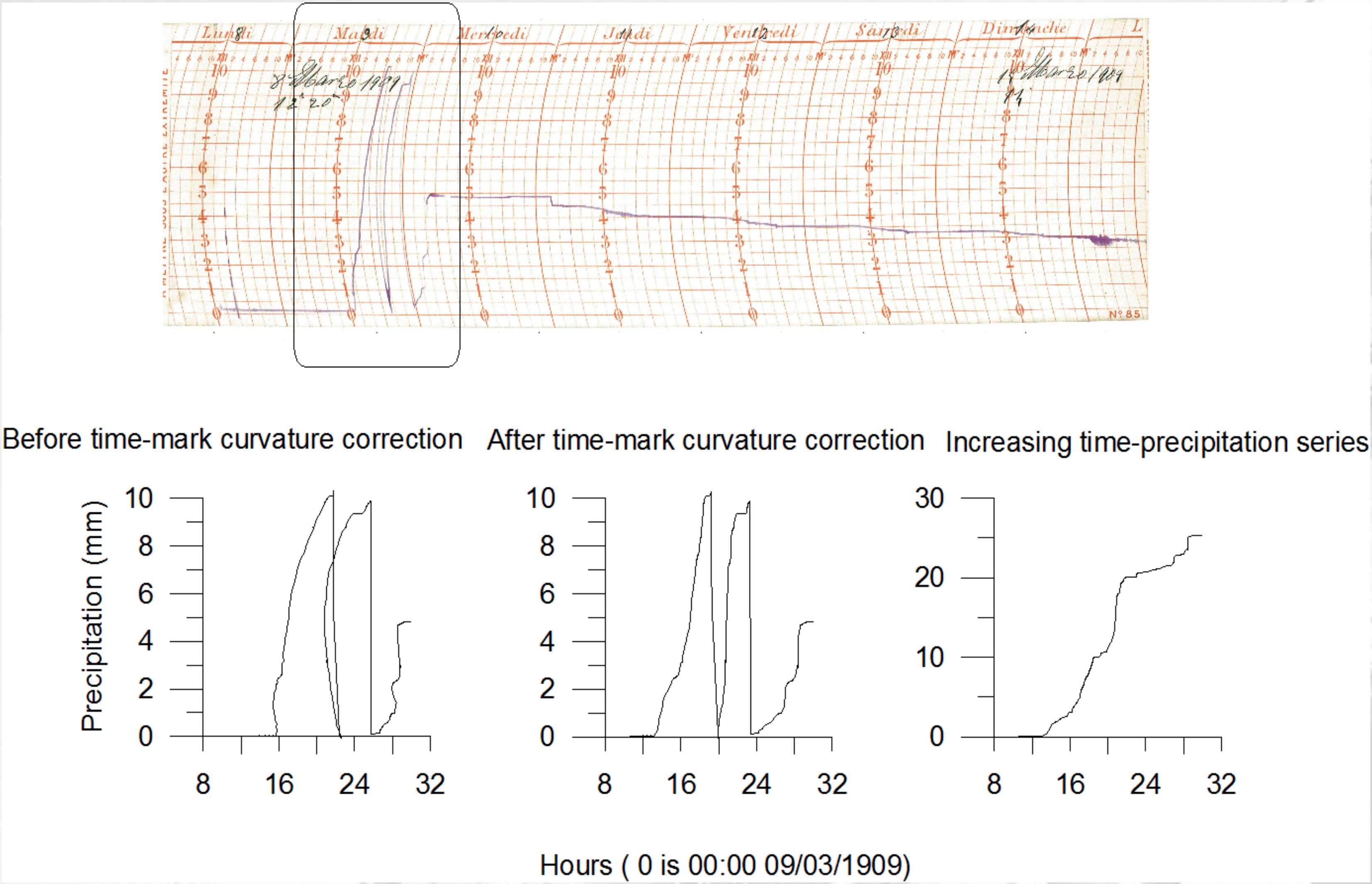
a) Scanning of the thermograph and pluviograph stripes.
b) To obtain the digitized values (time, variable) according to WINDIG methodology.
c) Applying algorithms for the required corrections:

- **T**: correction due to time marks curvature and determination of hourly and daily Tmax and Tmin.
- **PPT**: determination of 0 level at the beginning of the record, Determination of the time and values of the maxima and minima due to the discharge process, evaluating the precipitation during this interval, and creating a new increasing time-precipitation series.

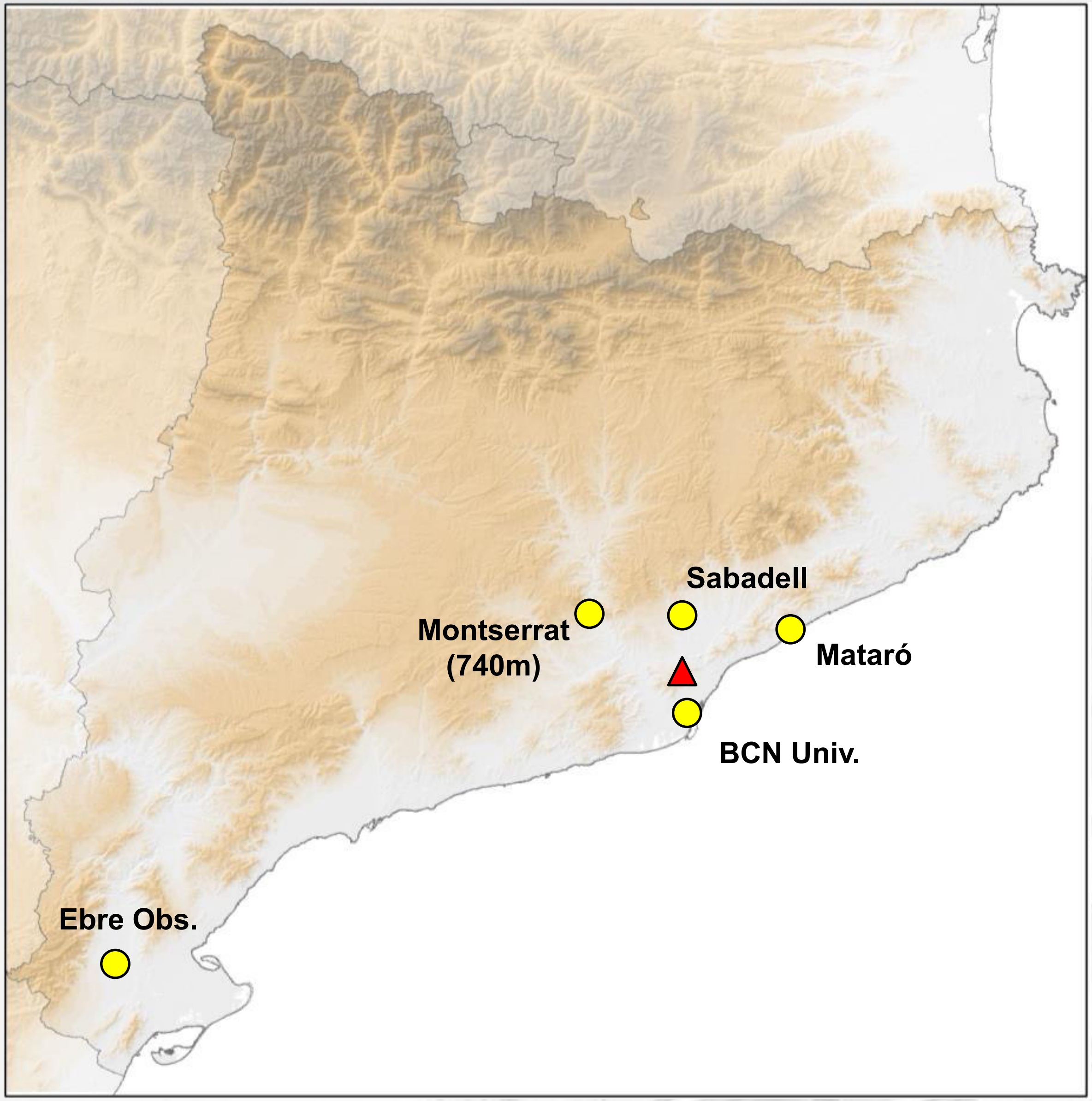
d) Quality control: coherency controls.

e) Main difficulties: determination of time and likely malfunctions, especially for rain gauge data.

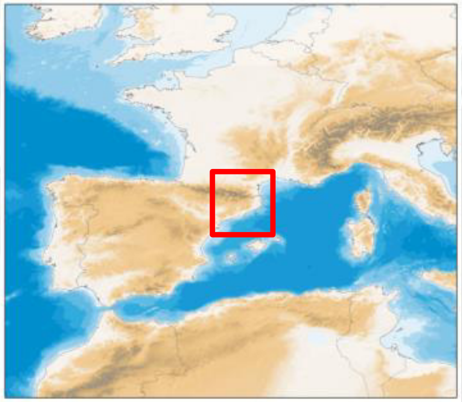
2. Digitization process



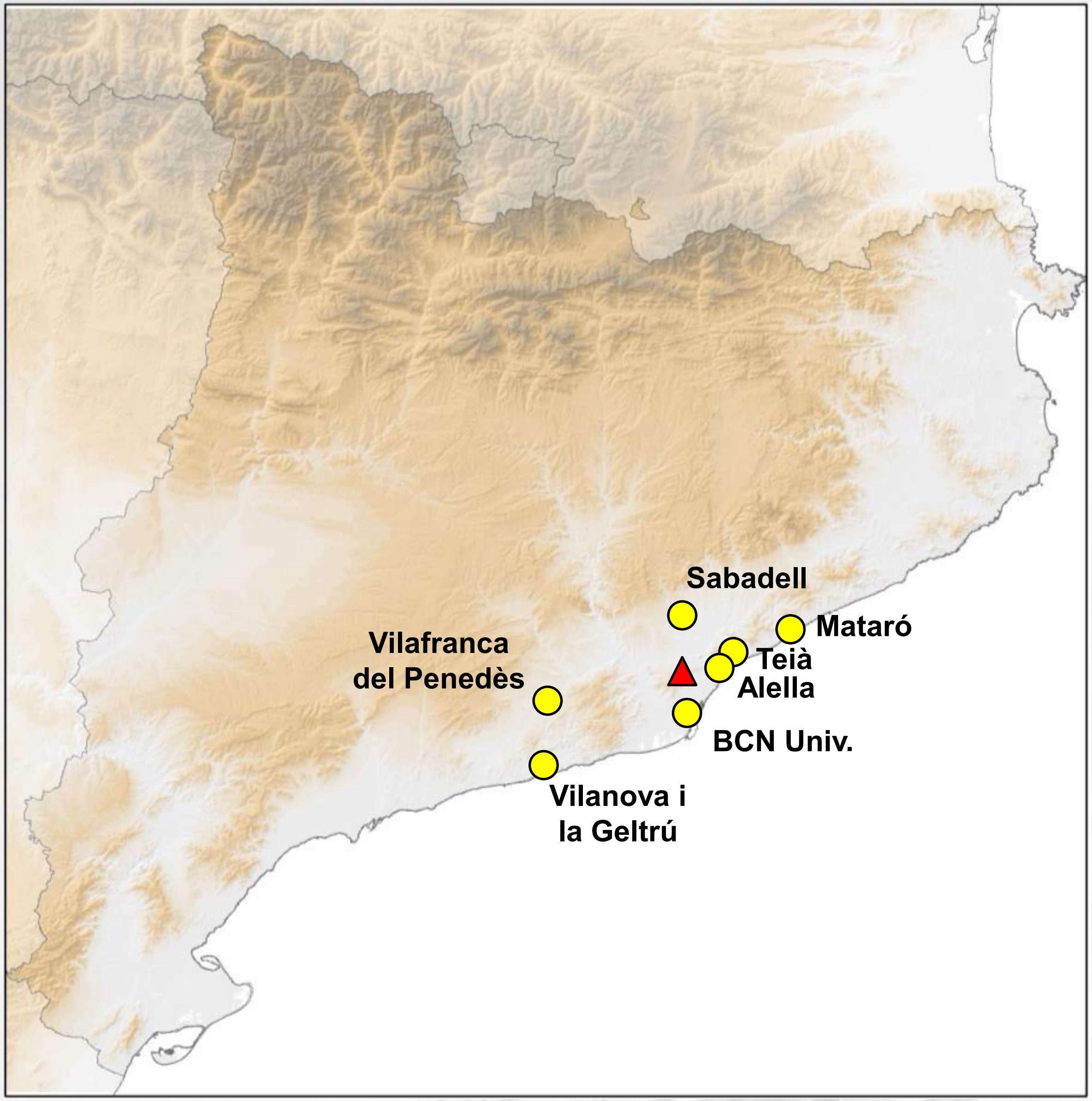
2. Reference series (T)



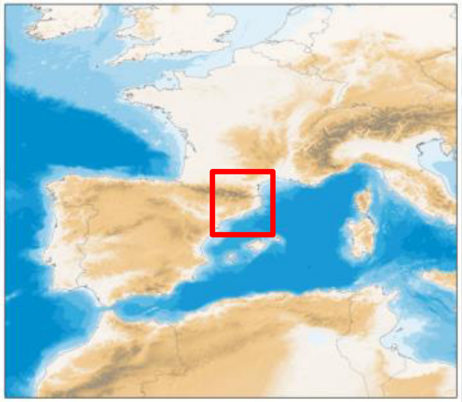
5 daily Tx and Tn series were detected with >80% of data (1904-1930)



2. Reference series (PPT)



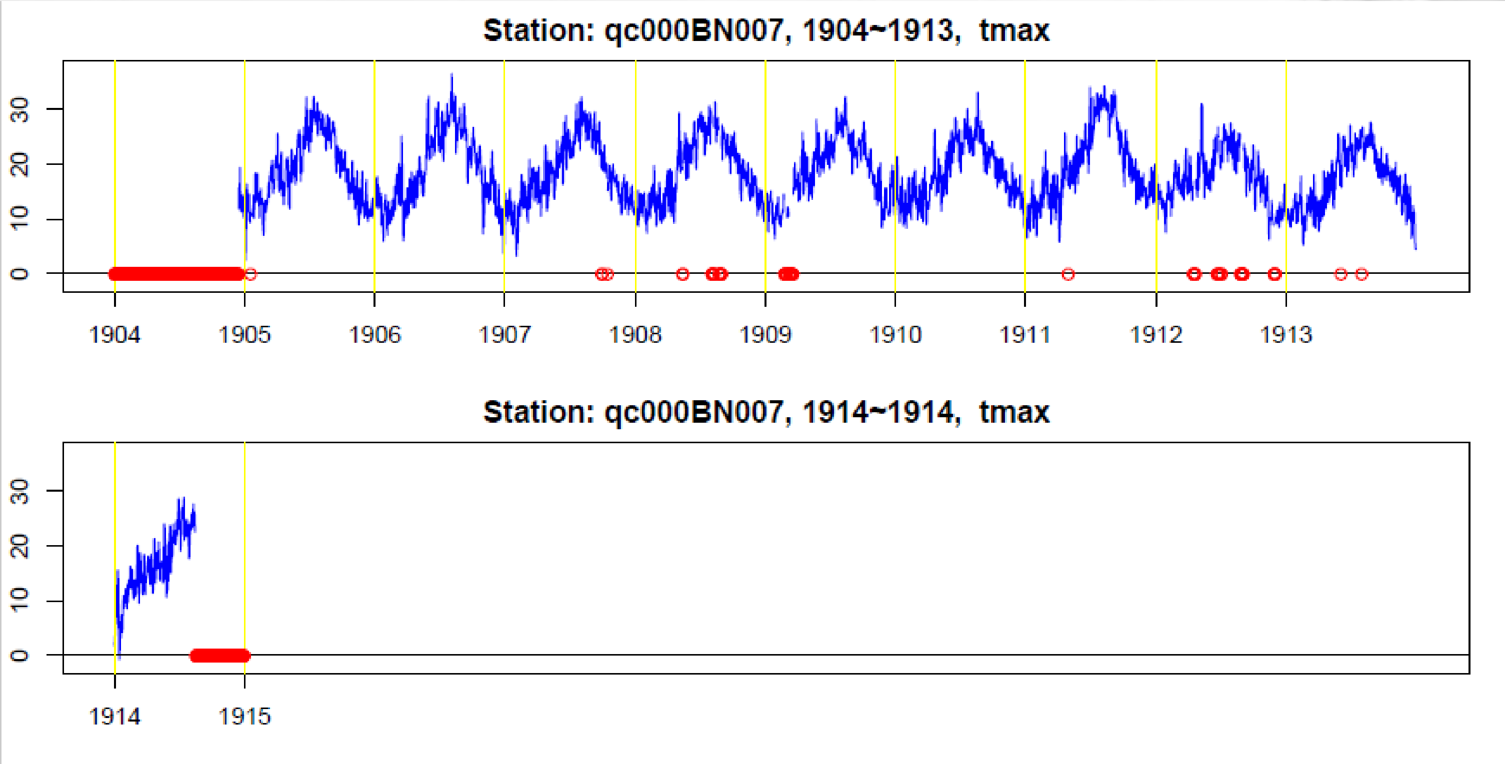
7 monthly PPT series were detected with >80% of data (1904-1930)



3. Quality control

RCLIMDEX (+extraqc) was applied to daily TN and TX candidate (Fabra) and reference series.

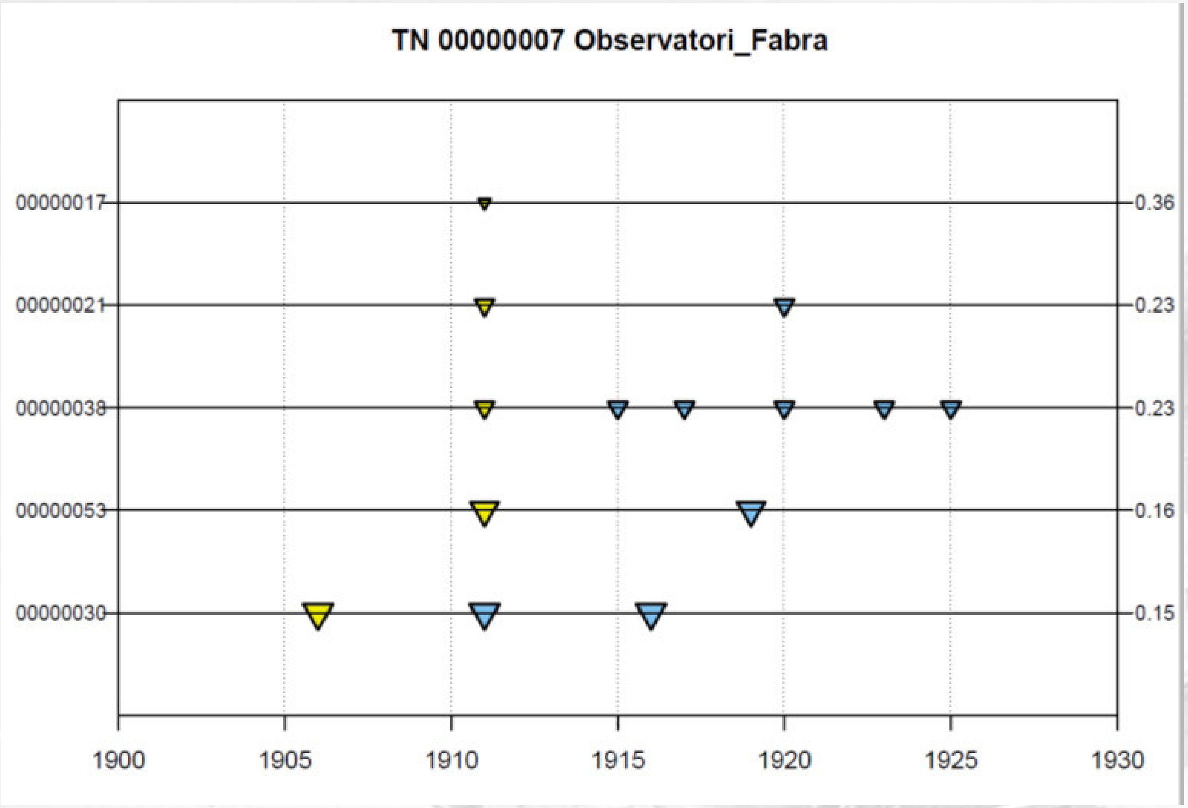
- 13 daily TN and 14 daily TX anomalous values were detected
- No anomalous data were detected for PPT



4. Break point detection (HOMER)

HOMER approach (COST ES0601) was used for break-point detection: the whole set of series were used.

A clear BP was detected in **1911/12** at the end of “thermograph” period.



5. Adjustment of daily TX and TN (SPLIDHOM)

SPLIDHOM was used to adjust the daily series, taking into account 1913 BP.

The most well correlated series from the set were:

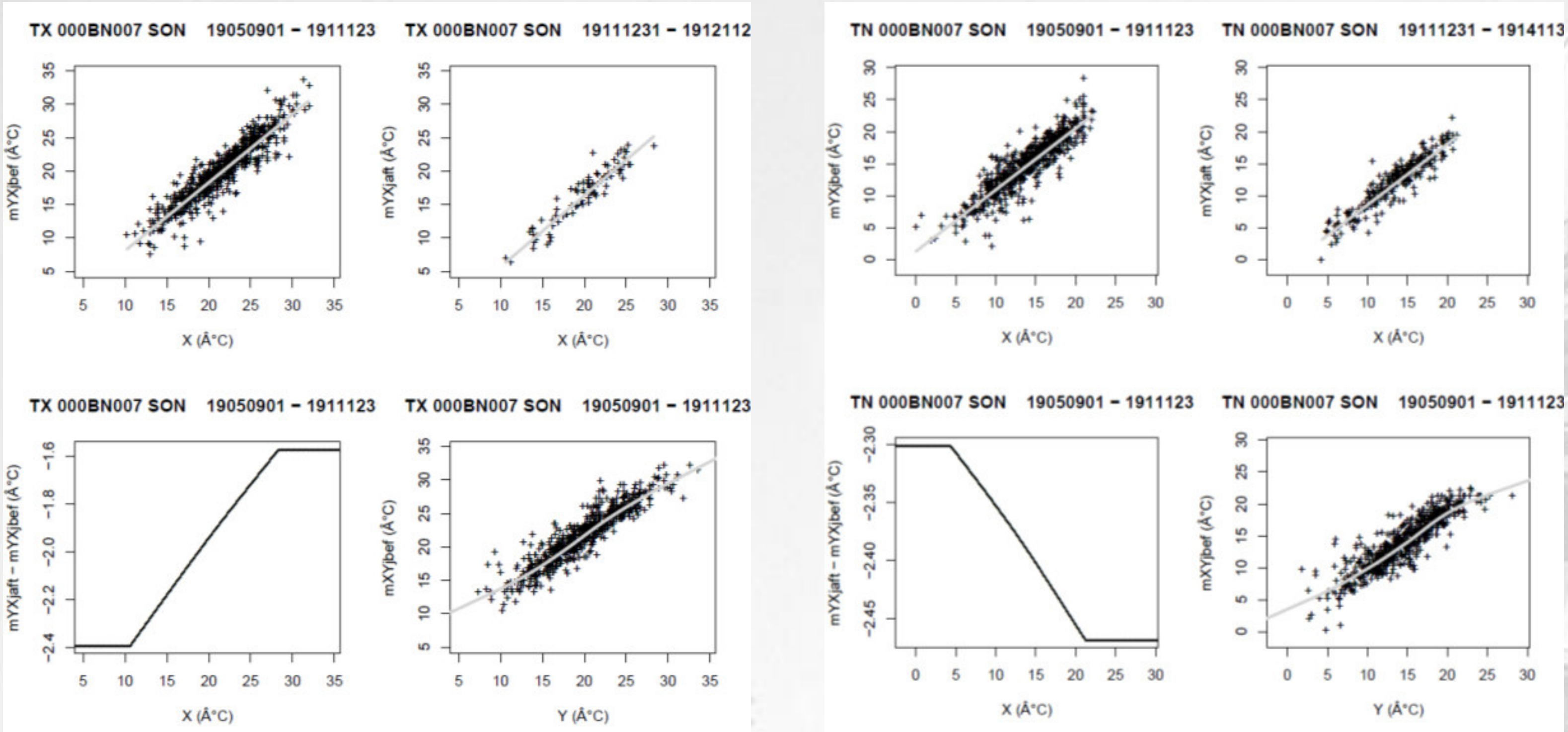
	DJF Bef/Aft	MAM Bef/Aft	JJA Bef/Aft	SON Bef/Aft
Mataró	0.85/0.80	0.86/0.80	0.82/0.79	0.92/0.94
Sabadell	0.85/0.85	0.77/0.79	0.84/0.79	0.92/0.92

TX

	DJF Bef/Aft	MAM Bef/Aft	JJA Bef/Aft	SON Bef/Aft
Mataró	0.79/0.80	0.85/0.79	0.82/0.80	0.90/0.93
Montserrat	0.83/0.83	0.87/0.75	0.79/0.87	0.90/0.93

TN

6. Adjustment of daily TX and TN (SPLIDHOM)

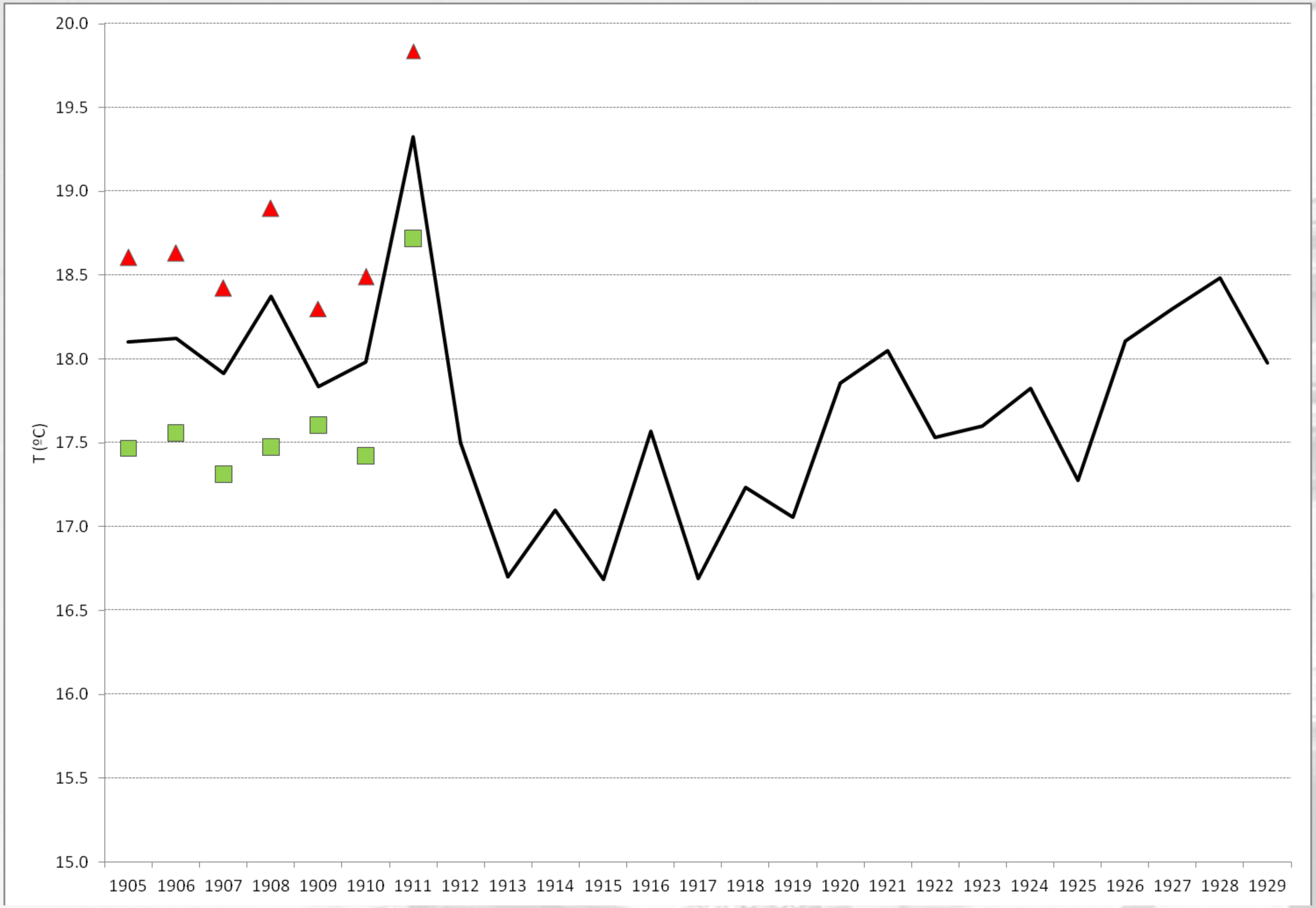


Correction of HSP between 01/09/1905 and 19/11/1911, for Fabra Observatory daily TX (left panel) and TN (right panel) for the autumn season (SON), and using Mataró (X) as reference.

Corrections are always negative and quite large, for both TX and TN, confirming the warming effect of the roof (summer) and wind damping effect (TN, in winter).

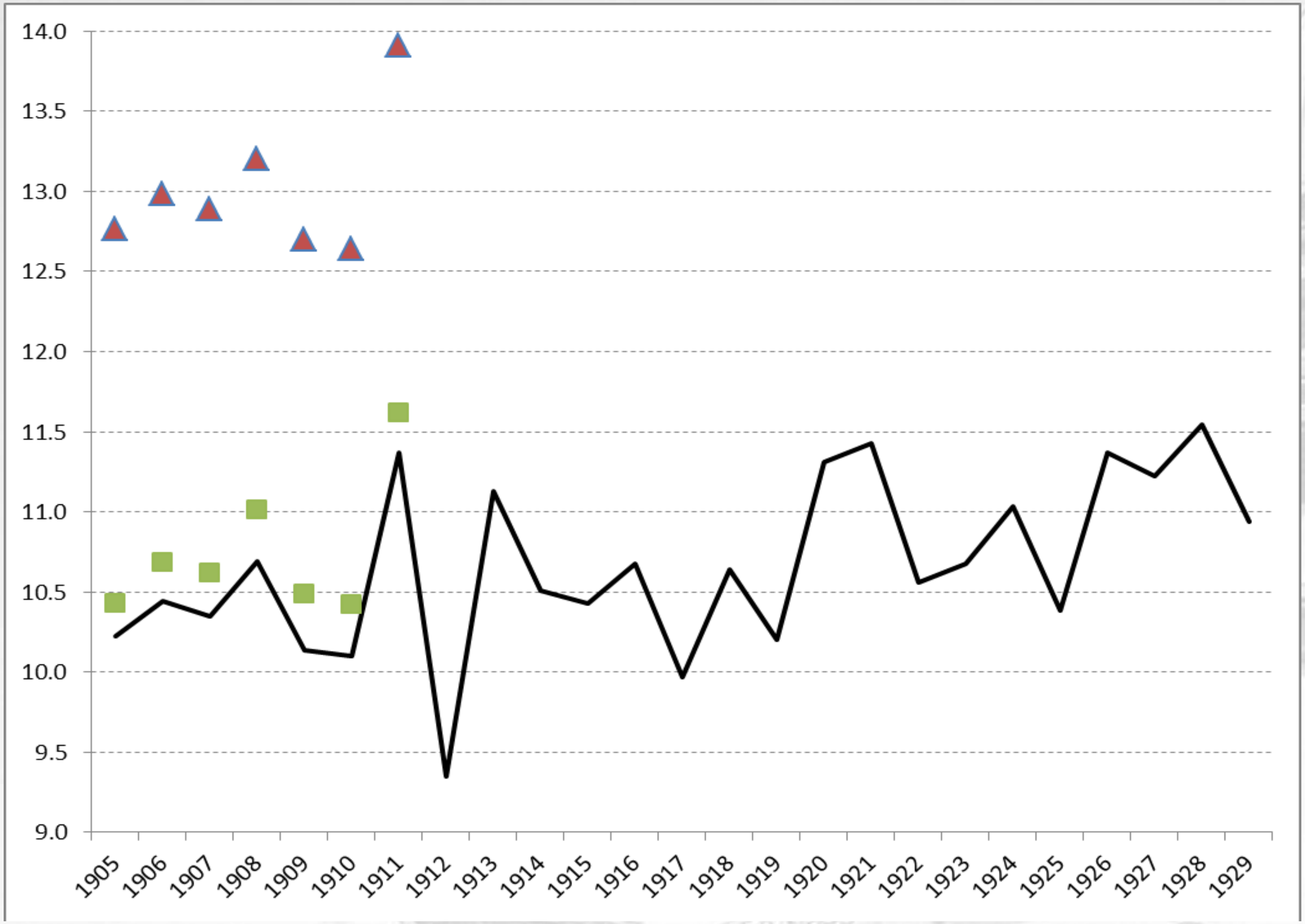
Summer: -2.1/-2.4ºC (TX) -2.7/-3.7ºC (TN)
Winter: -0.9/-0.6ºC (TX) -1.5/-3.5ºC (TN)

6. Adjustment comparison: SPLIDHOM vs. HOMER (TX)



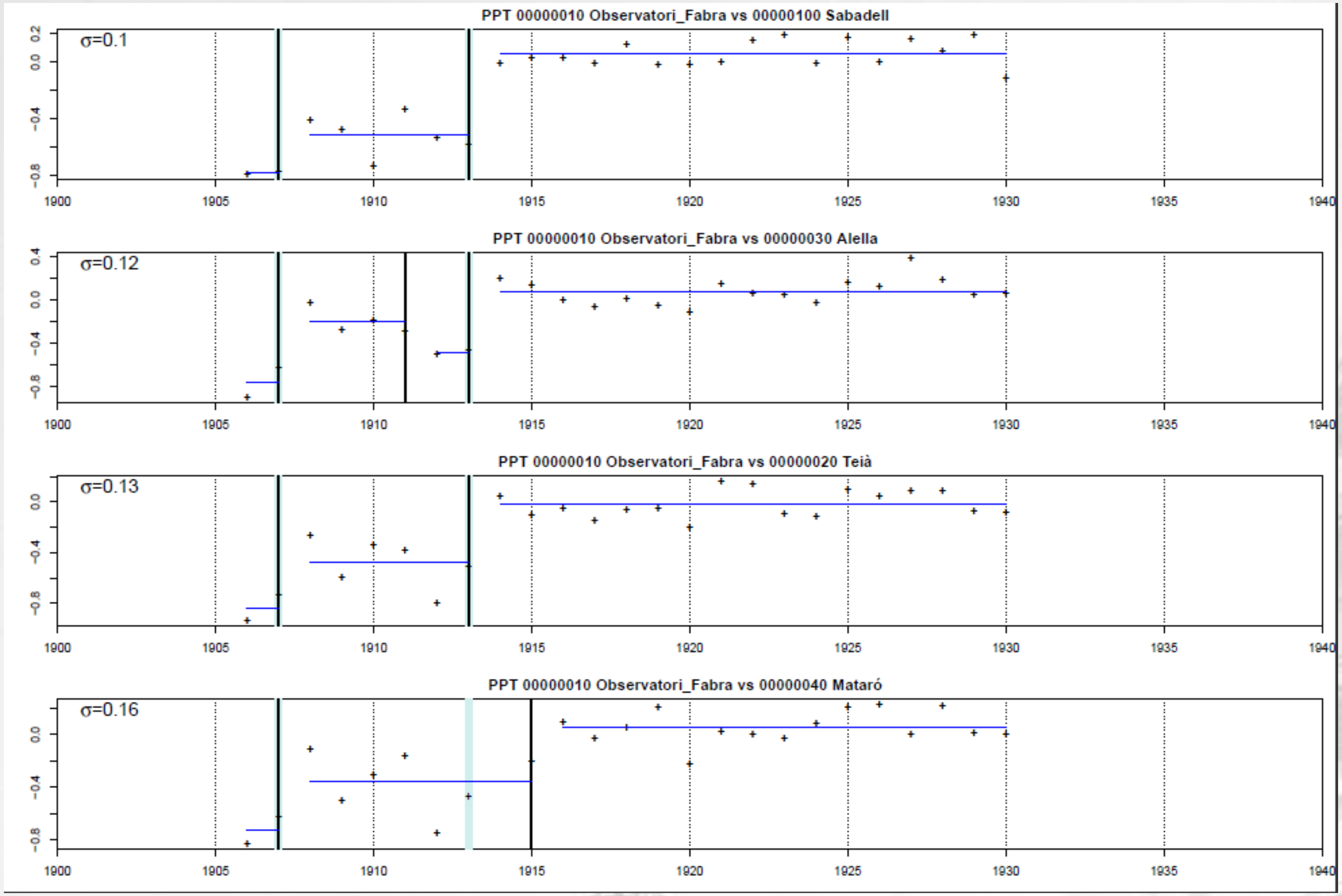
Annual averages of daily corrected TX series( ) compared to raw ( ) and monthly homogenized series by HOMER (solid line).

6. Adjustment comparison: SPLIDHOM vs. HOMER (TN)



Annual averages of daily corrected TN series(■) compared to raw (▲) and monthly homogenized series by HOMER (solid line).

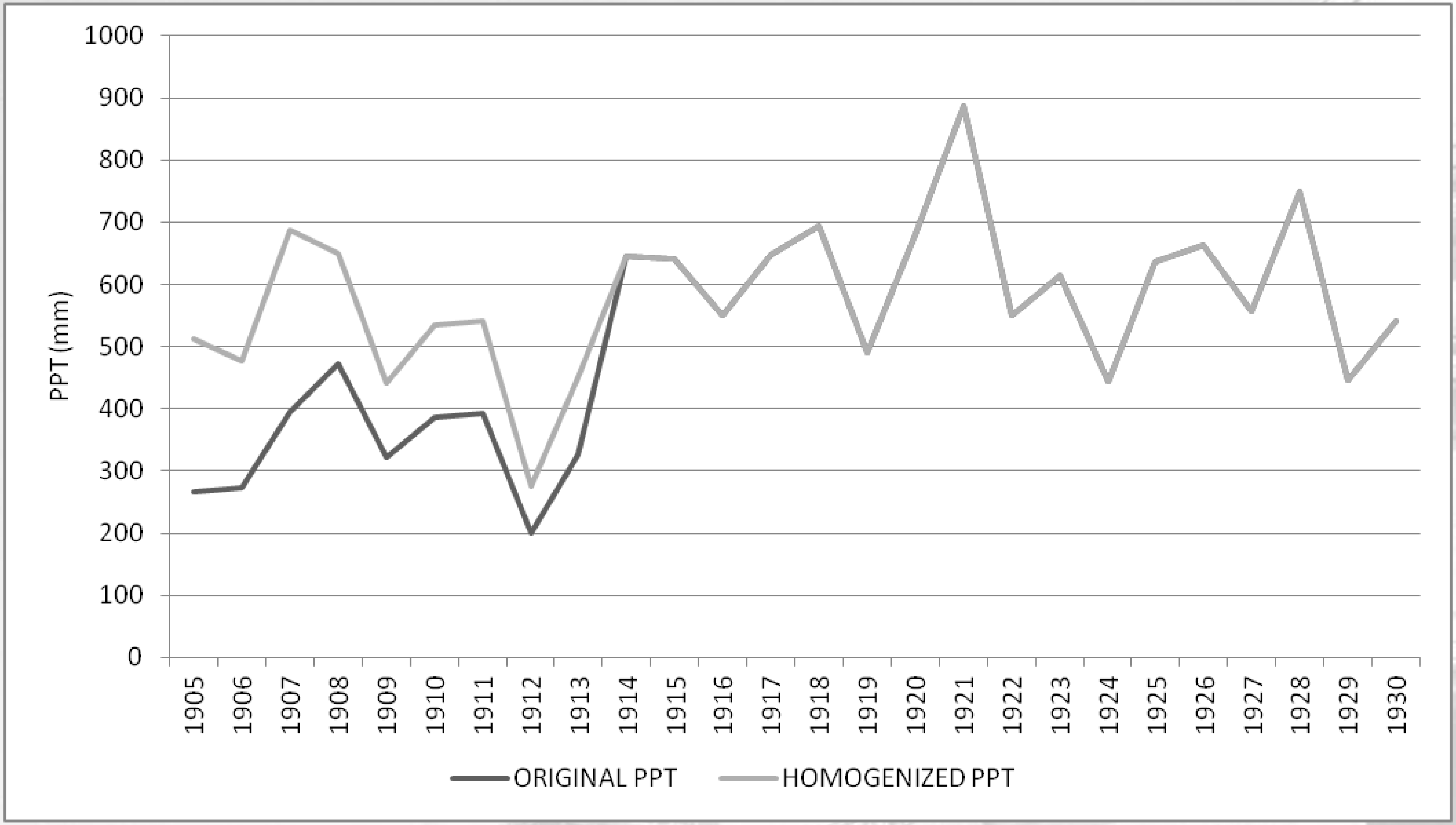
6. Adjustment of monthly PPT (HOMER)



Two breakpoints were detected: 1907 (unknown) and 1913.

A clear underestimation of rainfall totals was detected, probably due to exposition and/or instrumental problems.

6. Adjustment of monthly PPT (HOMER)



7. Some conclusions…

- **Early daily and sub-daily undocumented data from Fabra Observatory (Barcelona) has been digitized and recovered.**

- **HOMER succeeds in detecting the “new” period recovered.**

- **Adjustment results differ if we apply a daily (SPLIDHOM) or monthly (HOMER) approach… why?**

    - HOMER works with 5 stations while SPLIDHOM just 1
    - The correlation is not good enough (around 0.8) for daily adjustments in some seasons.

- **Data rescue activities:** completing existing series and digitizing unknown ones = improves break-point detection and adjustment.

- **To be done:** contrasting SPLIDHOM findings with other methods as percentile-matching (PM) algorithm (Trewin, 2012).

- **Breaking news!**

7. Some conclusions…

		Terrasa						Calle					
Fecha	hora	Max	Min.	Seco.	Hum.	Evap.	Pluv.	Max	Min.	Pluv.	Clase	Cantid.	Observaciones
1º Dbre	8	13.4	8.8	8.7	8.5	1.5	12.9	12.7	9.0	11.7	Nb.	10	T y
2 "	8	9.6	5.0	9.4	8.1	1.0	41.3	9.0	5.3	44.7	St cu	6	
3 "	8	11,2	7,9	8,4	7,7	1,8	—	10.8	7,8	—	Ci	4	a 19.30
4 "	8	12.8	7,5	8.5	5,5	3.0	—	11.1	7.1	—	St	3	1930
5 "	8	8.6	3.9	4.7	-0.3	3.5	—	8.2	3.9	—	St	2	
6 "	8	8,2	1.3	2.6	-2.0	8.1	—	7.1	1.2	—	St cu	4	
7 "	8	6.2	1.2	2.3	-0.7	3.9	—	5.6	0,6	—	Alt cu	3	
8 "	8	7.4	2,5	3,3	2,2	4,2	—	7,0	2,0	—	St cu	5	
9 "	8	7.7	2,4	3,4	2.0	3,3	—	7.3	2.5	—	Ci	3	
10 "	8	8.0	2.6	3.5	2,4	3.0	—	7.7	2.5	—	St	8	SE a 19h 30m
11 "	8	8.2	3,4	6.0	2.6	5.0	—	7.6	3.3	—	St	7	
12 "	8	8,1	5,2	7.6	6.2	7.8	—	8.0	5.2	—	St	10	
13 "	8	11.2	7,0	7,5	3,2	5.0	—	11.3	7.0	—	St cu	7	
14 "	8	8,3	3,0	4,7	1,5	6.3	—	8.1	2.9	—	Ci	3	22h T
15 "	8	9,2	2,4	4,4	2,0	5.5	2.7	9.3	2.6	4.0	St	2	
16 "	8	8.0	2.1	5.0	1.6	5,2		7.6	2.1	—	Ci	4	13h

Parallel measurements were taken in the roof and the garden, from **July 1913 up to October 1920.**

THANKS FOR YOUR ATTENTION !

Climate Data Records of ECVs from the CM SAF

-

Current Status and application examples

Martin Werscheck, Rainer Hollmann,

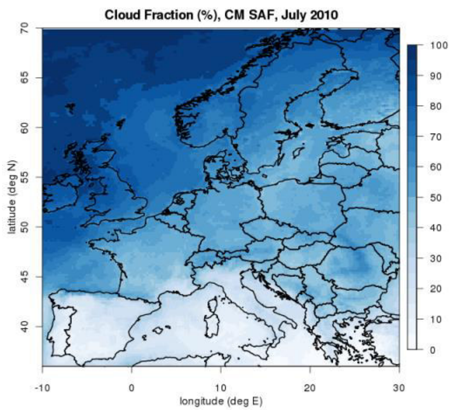
Jörg Trentmann, Frank Kaspar

Overview:

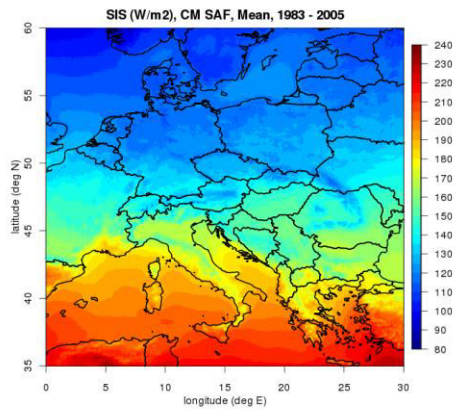
- Short introduction to CMSAF products
- Using CMSAF products to evaluate quality of ground based radiation measurements
- Analysing requirements of in-situ networks for Germany (surface radiation, sunshine duration).

CM SAF

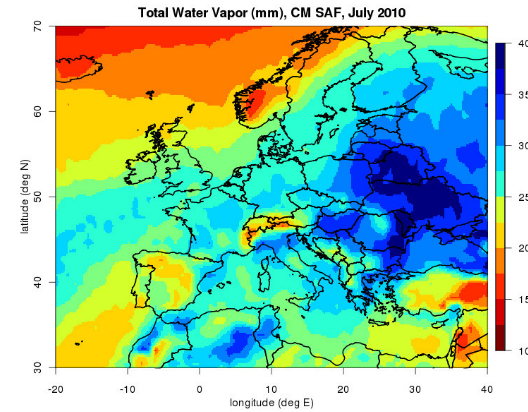
Clouds



Radiation



Water Vapor

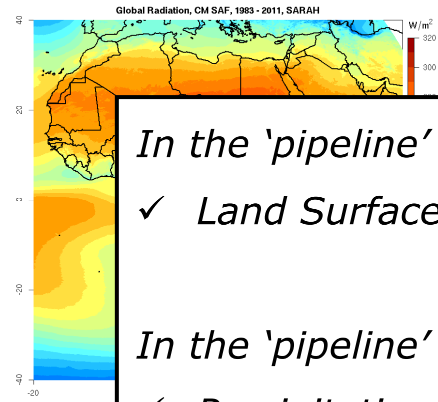


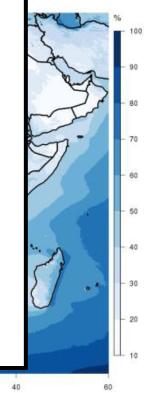
- *EUMETSAT Satellite Application Facility on Climate Monitoring* www.cmsaf.eu
- Provides satellite-derived climate data of geophysical variables
- Regional, up to global coverage
- Currently, data available from Jan 1982 to October 2015
- Spatial resolution: 0.03° to 1°

- Data freely available in netcdf-format
- User-friendly data access via the Web User Interface: www.cmsaf.eu/wui
- Toolkit (example data + software): www.cmsaf.eu/tools
- CM SAF Community Site available via EUMETSAT: training.eumetsat.int

CM SAF data

- ✓ ***Cloud Information***
- ✓ ***Surface and ToA Radiation***
- ✓ ***Surface Albedo***
- ✓ ***Water Vapour***
- ✓ ***Precipitation, wind, surface fluxes (ocean only)***
- ✓ ***Free Tropospheric Humidity***



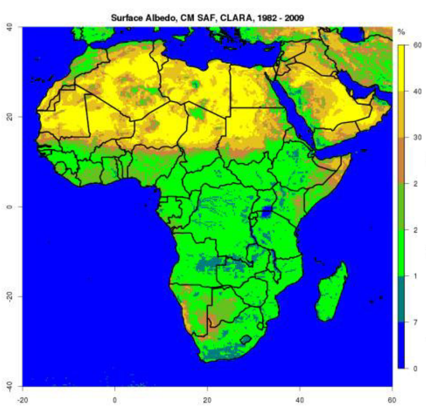


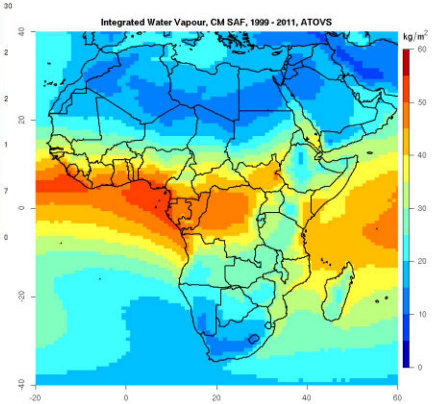
In the 'pipeline' (2016)

- ✓ *Land Surface Temperature*

In the 'pipeline' (2020ff)

- ✓ *Precipitation (land)*
- ✓ *Evapotranspiration*



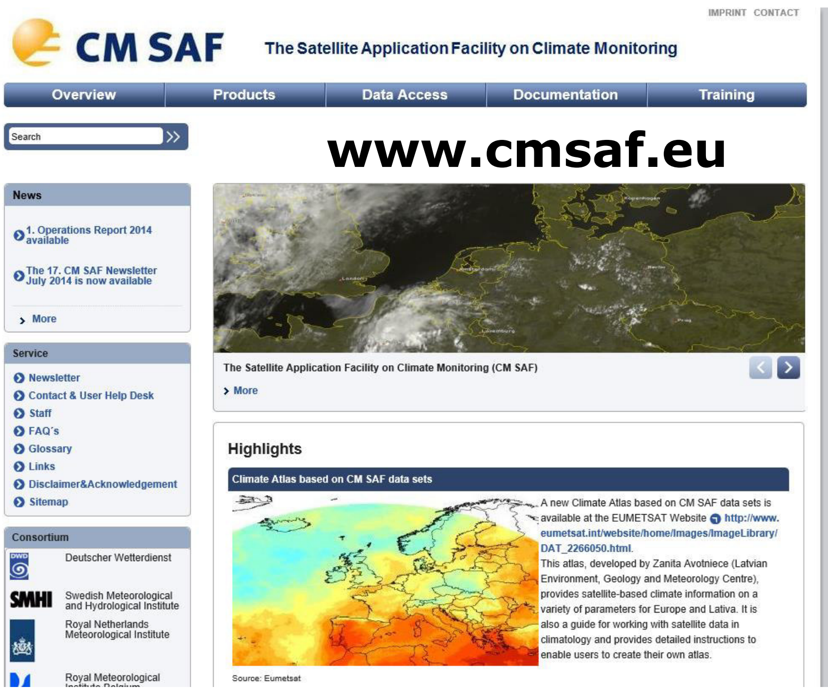


Satellites used to generate CM SAF data sets and operational products:

- ➢ ***Meteosat (SARAH / CLAAS)***
- ➢ ***AVHRR (CLARA)***
- ➢ ***ATOVS / SSMI (HOAPS, FCDRs (=radiances))***

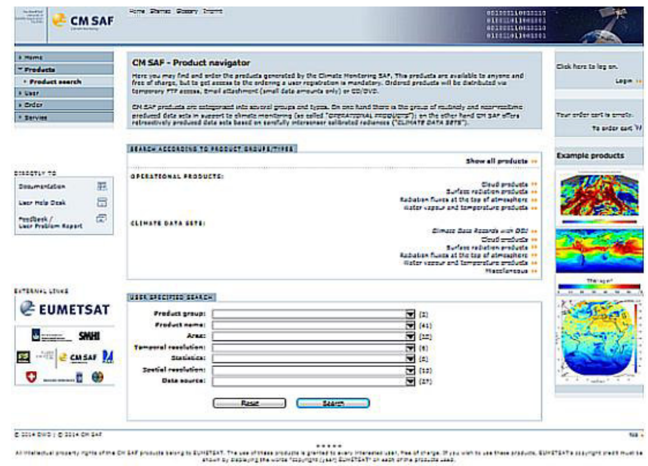
Data Access

CM SAF data is freely available without restrictions!

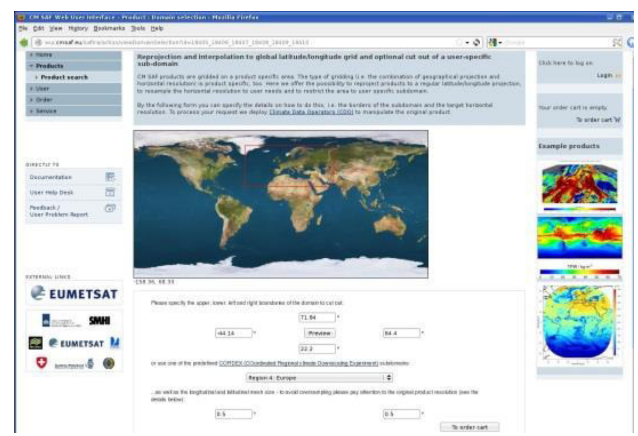


www.cmsaf.eu

Web User Interface



www.cmsaf.eu/wui

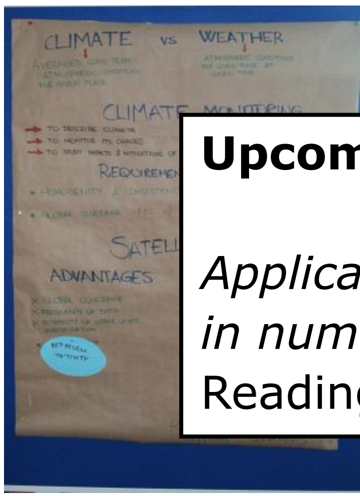


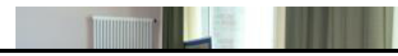
- Registration required
- Data will be delievered in 1 hr to 1 day to an ftp server in hdf / netcdf format

CM SAF Workshops

CM SAF conducts annual workshops / online events to support the use of CM SAF data

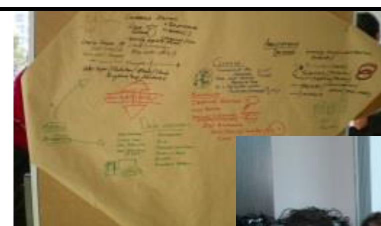




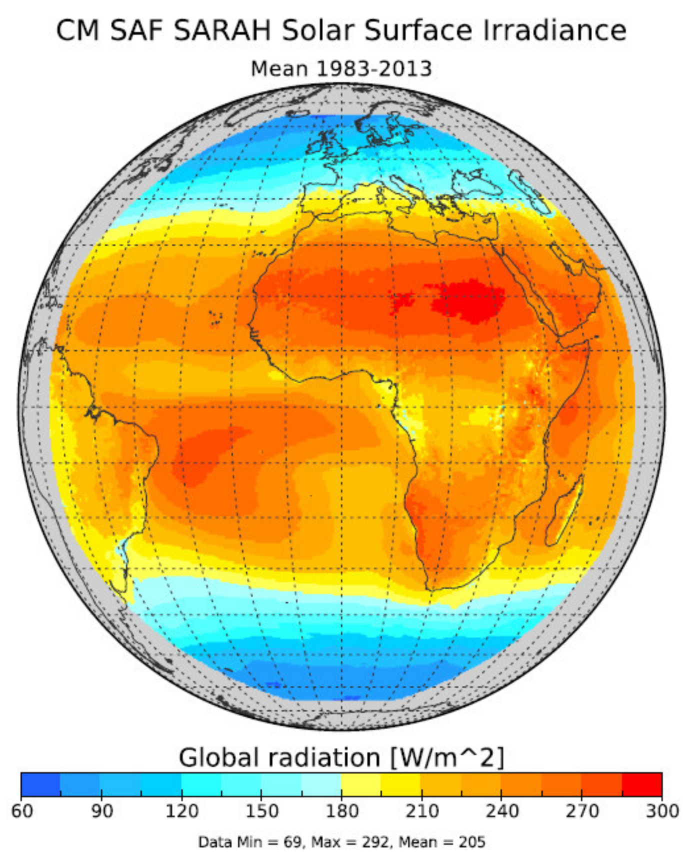

Upcoming Event:

Applications of satellite-based data sets from the CM SAF in numerical modeling, 14 to 17 November 2016, ECMWF, Reading, UK

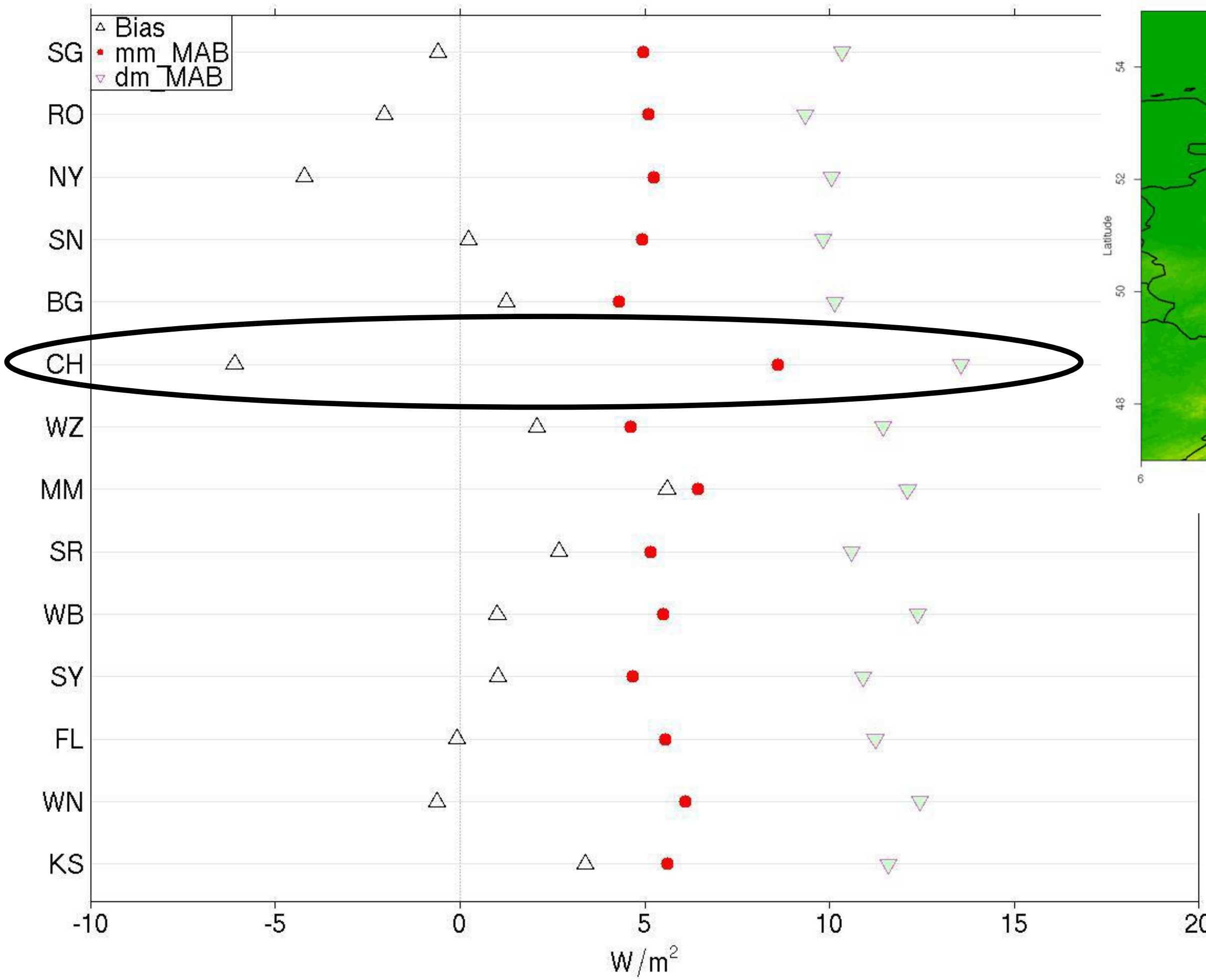



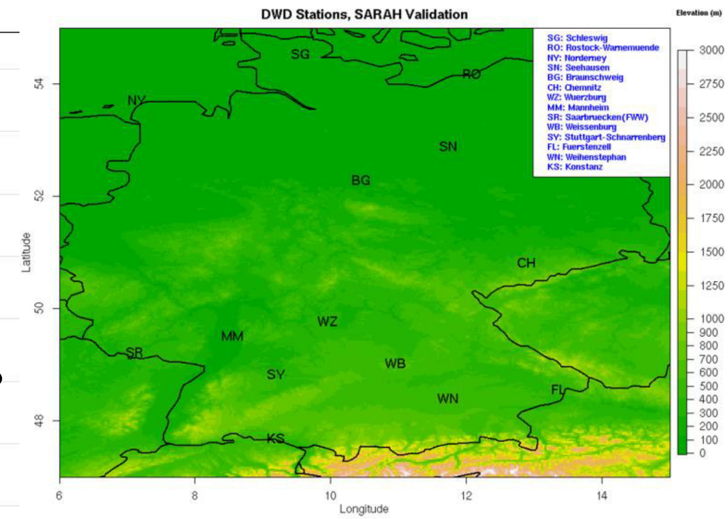
Surface Solar Radiation Dataset – Heliosat (SARAH)

- **Variables**
  - Global irradiance (SIS)
  - Direct normalized irradiance (DNI)
  - Effective cloud albedo (CAL)
- **Resolution**
  - Spatial: 0.05° × 0.05°
  - Temporal: hourly, daily, monthly means
- **Coverage**
  - Spatial: Meteosat disk
  - Temporal: 1983 to 2013
- **Satellites**
  - Meteosat 2 to 10 (MVIRI/SEVIRI)
- **Freely available at www.cmsaf.eu**



Validation of SARAH daily mean irradiance with DWD network



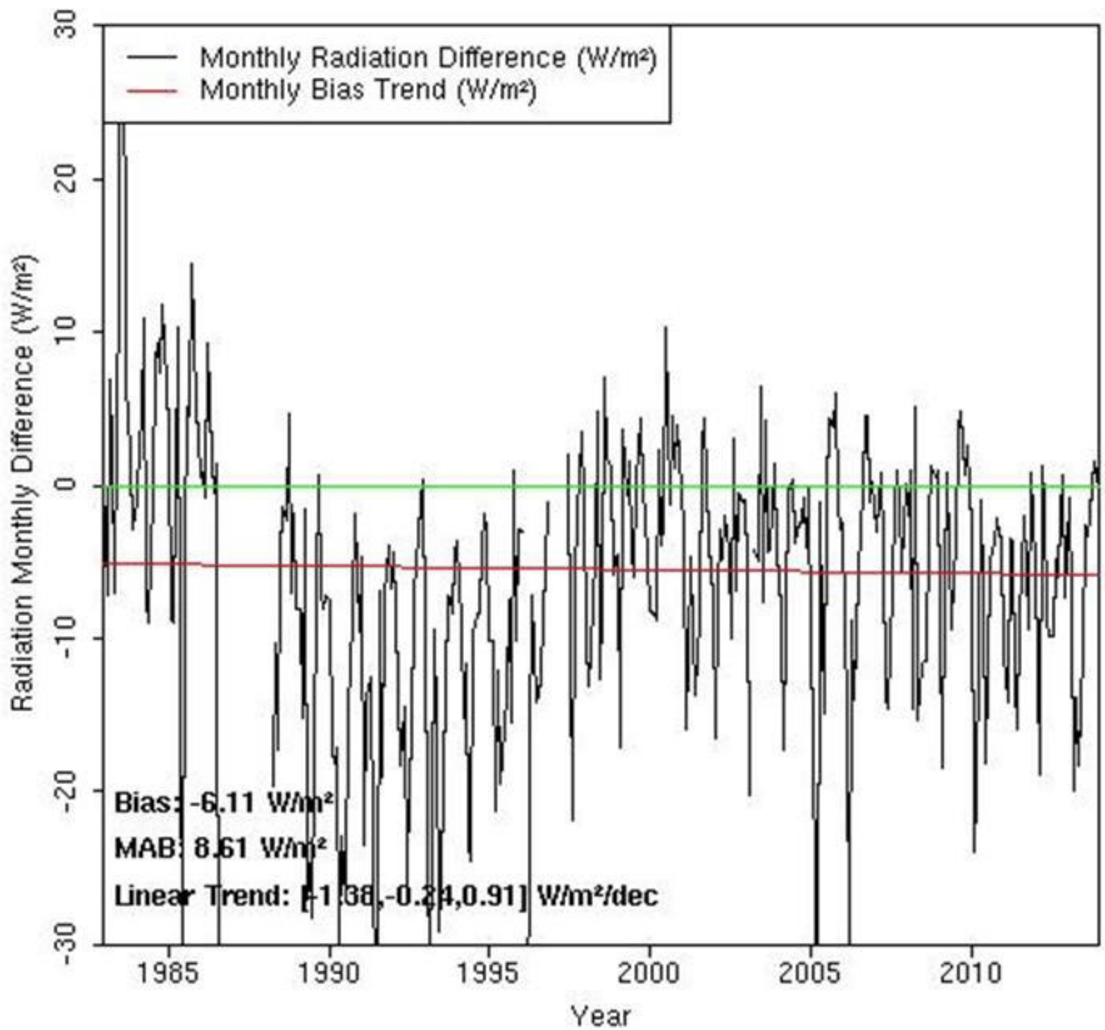


BSRN:

Bias: 1.1 W/m2
MAB: 12.1 W/m2

Comparison Chemnitz

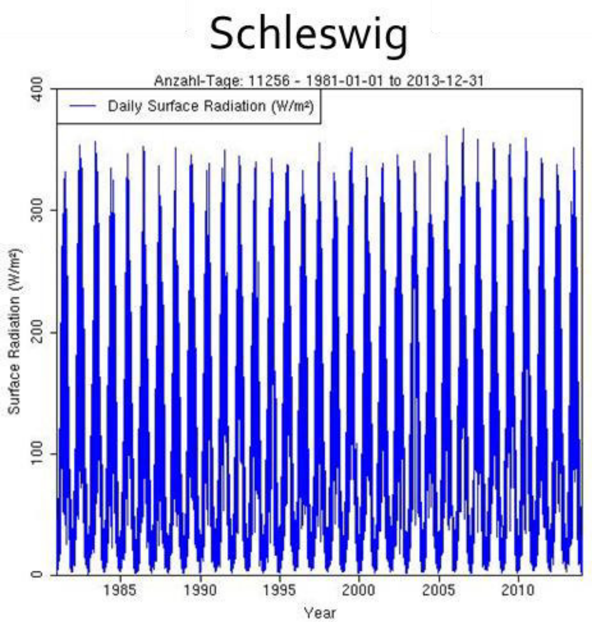
Time series of differences between SARAH SIS and station measurement

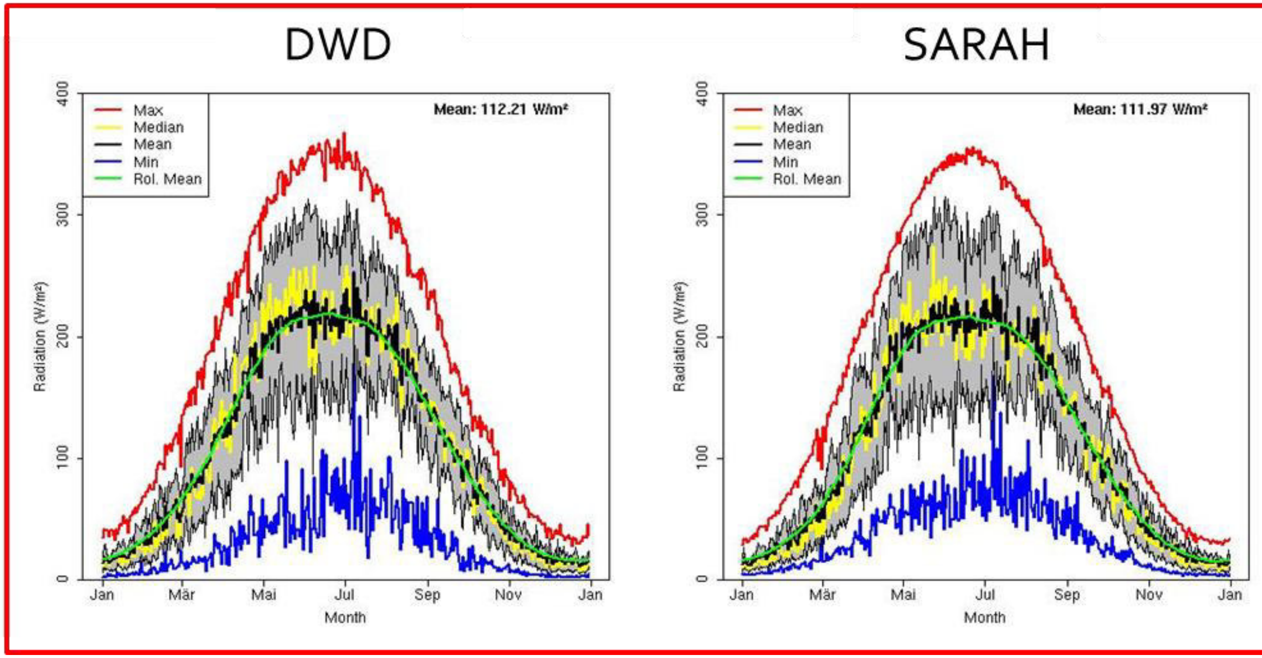


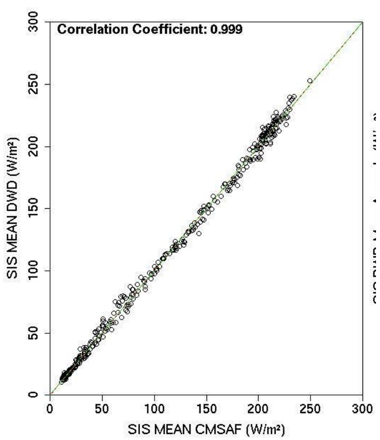
Obvioues jumps in 1989 and 1997 / 98 ….

Inhomogenities in station data?

Climatology: Schleswig





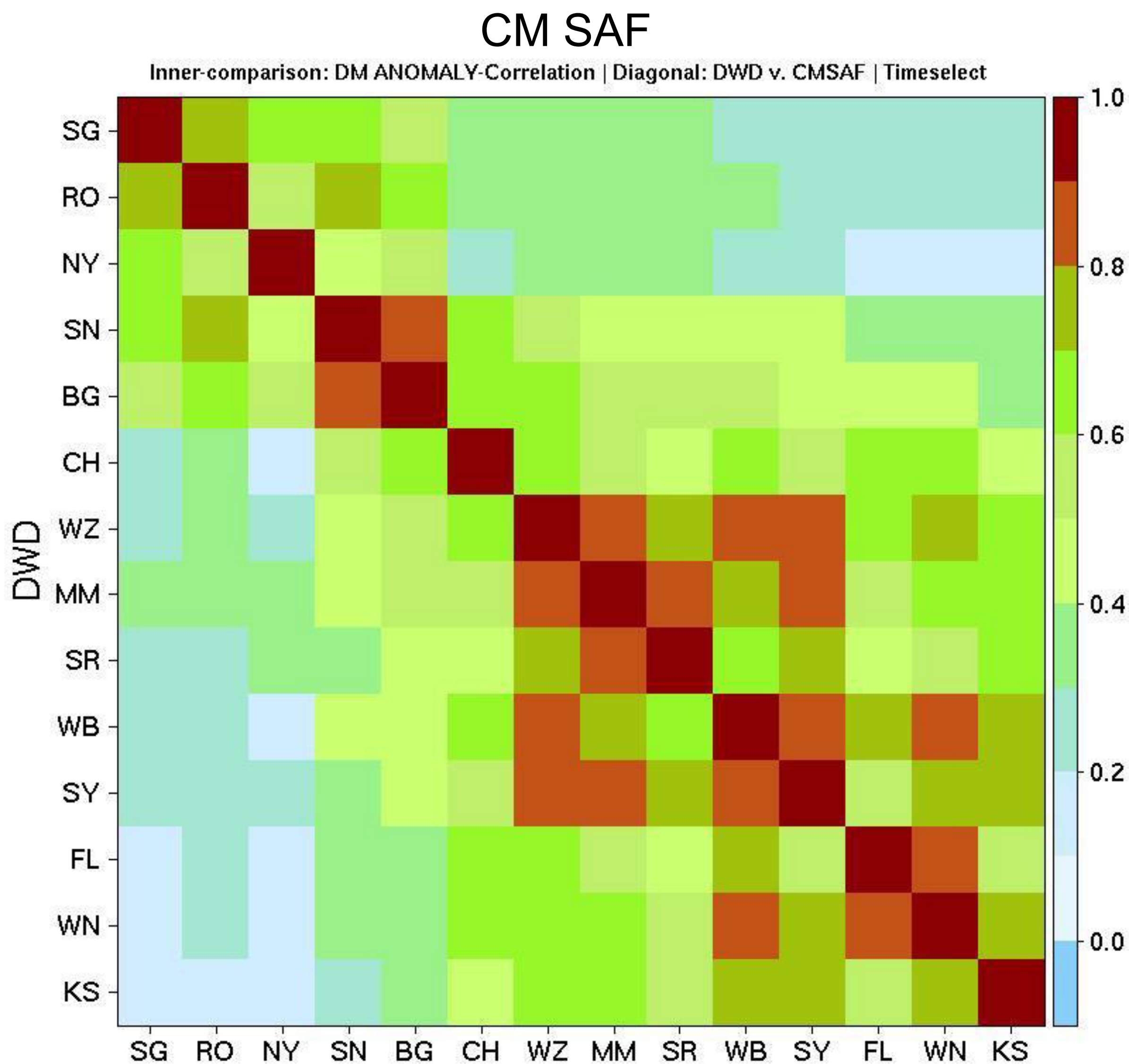


Multi-year daily averages

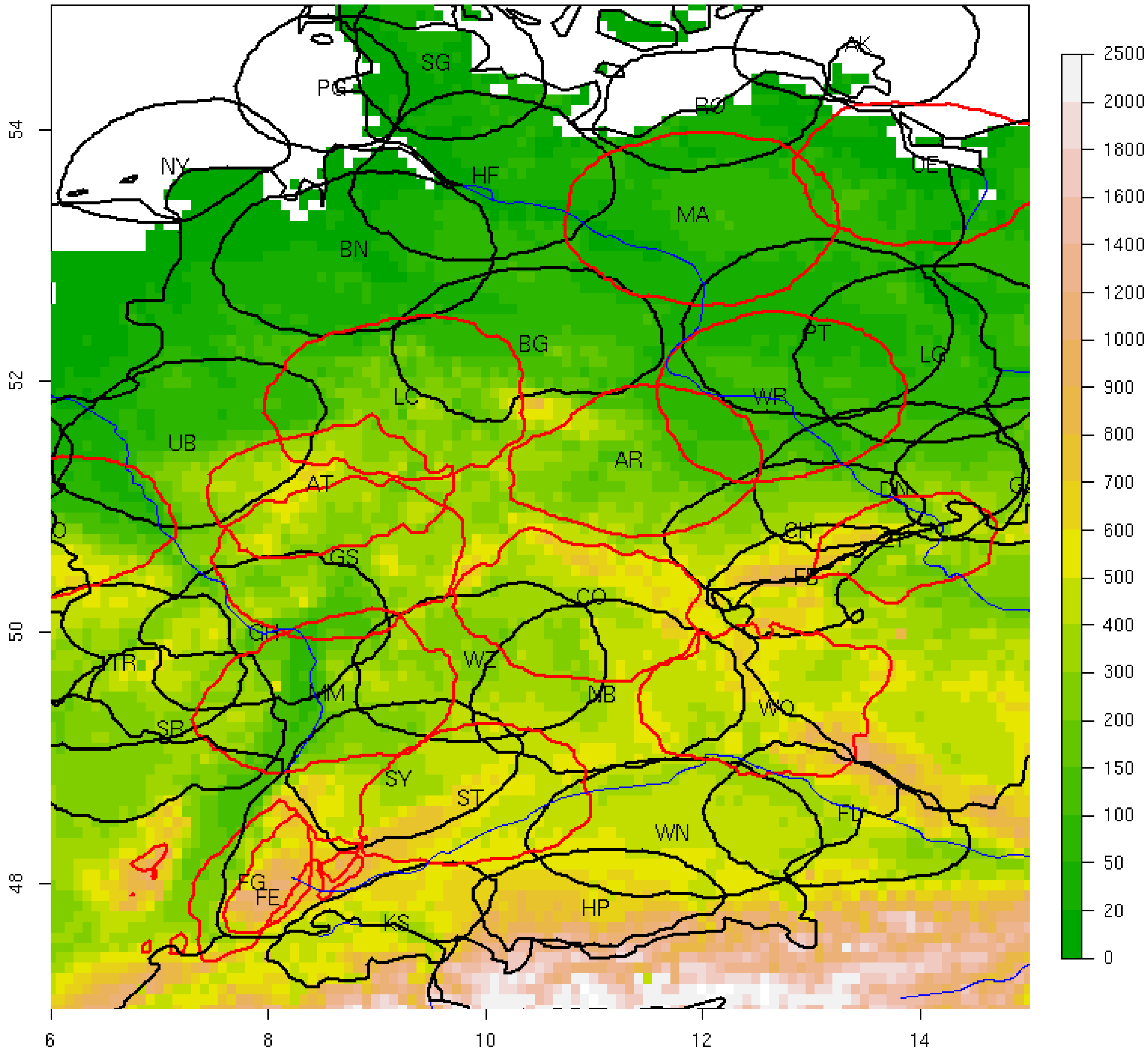
- Very high correlation

Correlation: dm- anomaly

- CM SAF data provide good representation of the spatial structure of daily variability
- Correlation decreases with distance of stations.

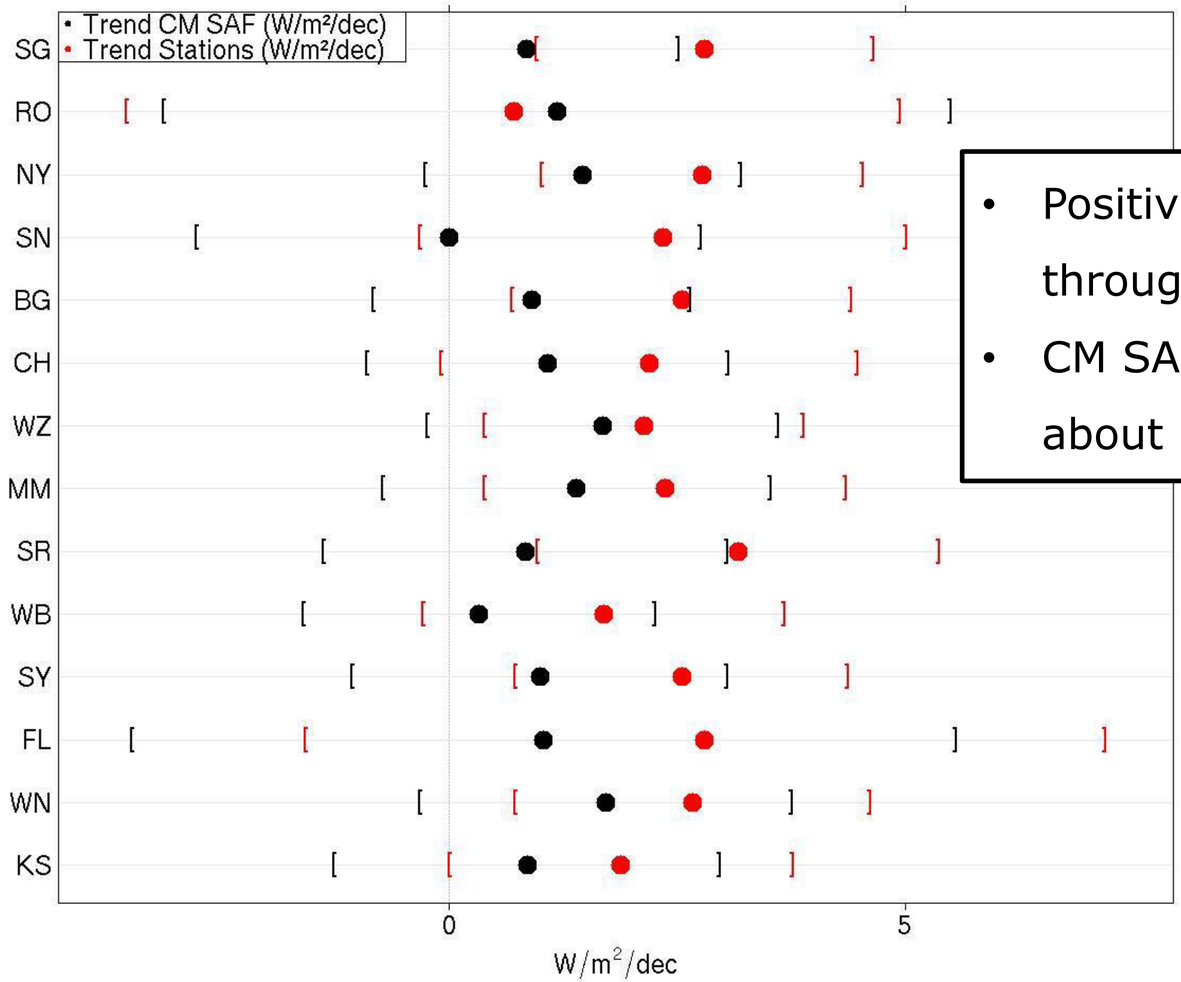


New DWD observation network



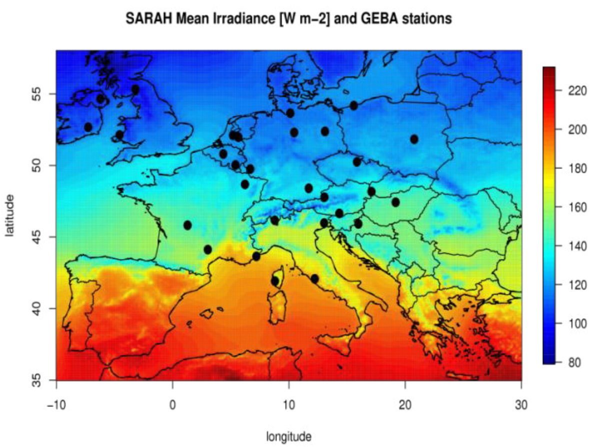
- The suggested new DWD observation network for surface radiation covers almoste completely Germany with a correlation of >0.9 (based on SARAH)

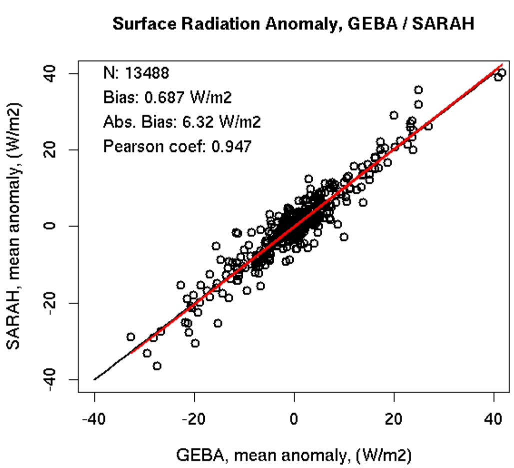
Radiation Trends in D

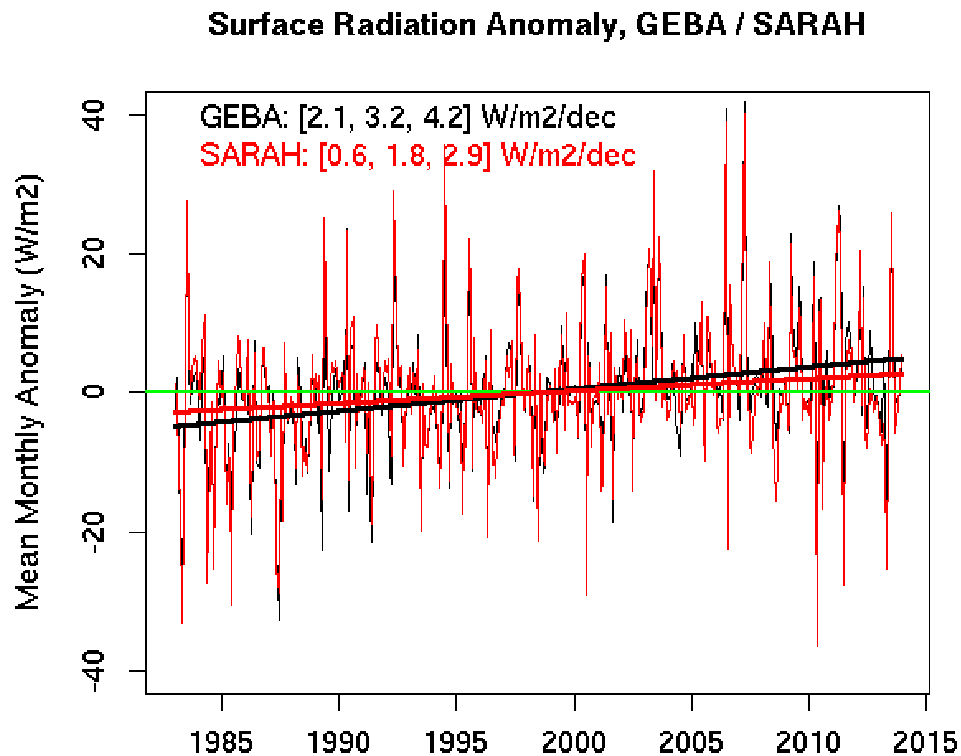


- Positive trend in radiation throughout D
- CM SAF underestimates trends by about 1 W/m2/dec

Trend assessment, evaluation with GEBA







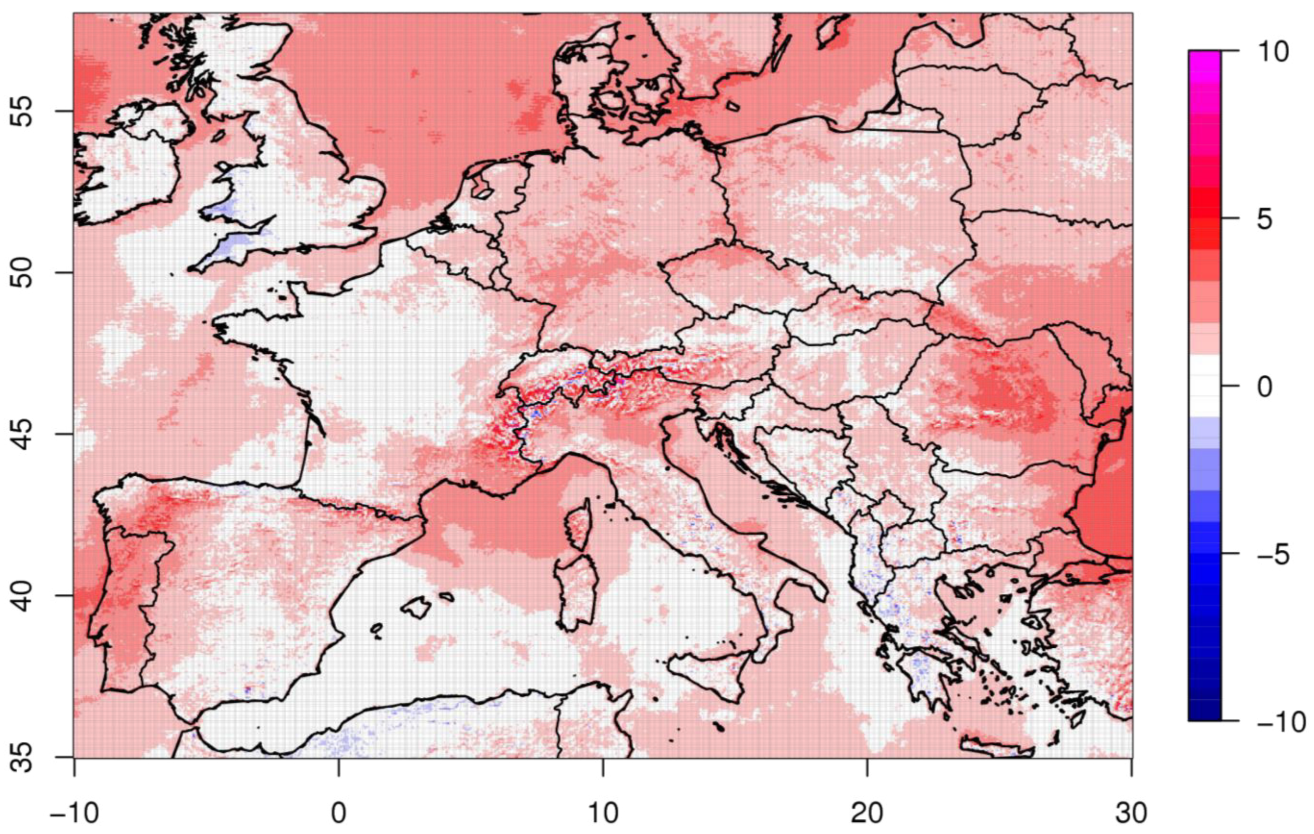
Consistent linear trend;
underestimated by about 1.5 W/m²/dec

GEBA data provided by Arturo Sanchez-Lorenzo, IPE-CSIC, Zaragoza

Spatial Trends

- Mainly positive trends
- Substantial spatial variability

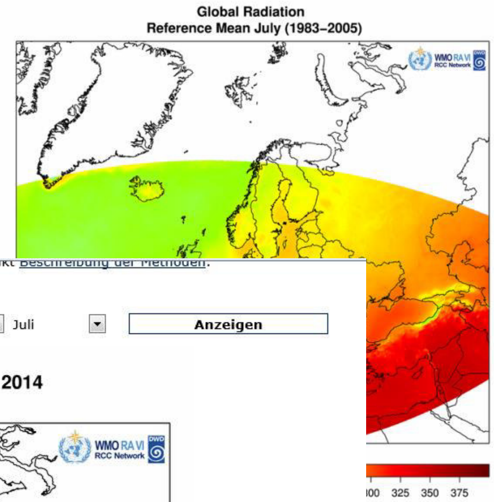
Trend in SIS [W m−2/dec], 1983 – 2013

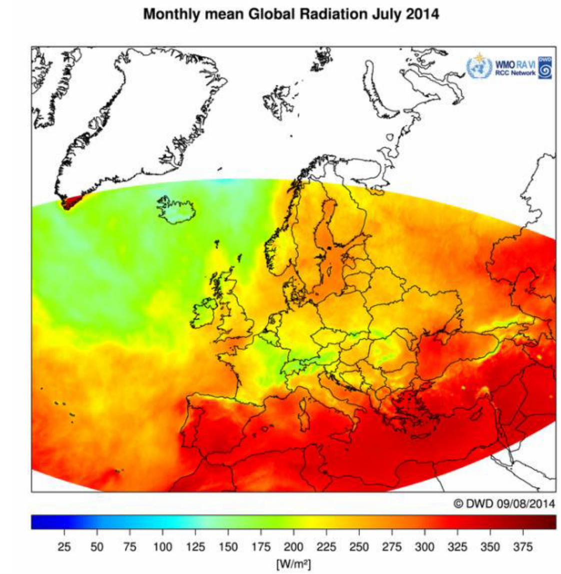


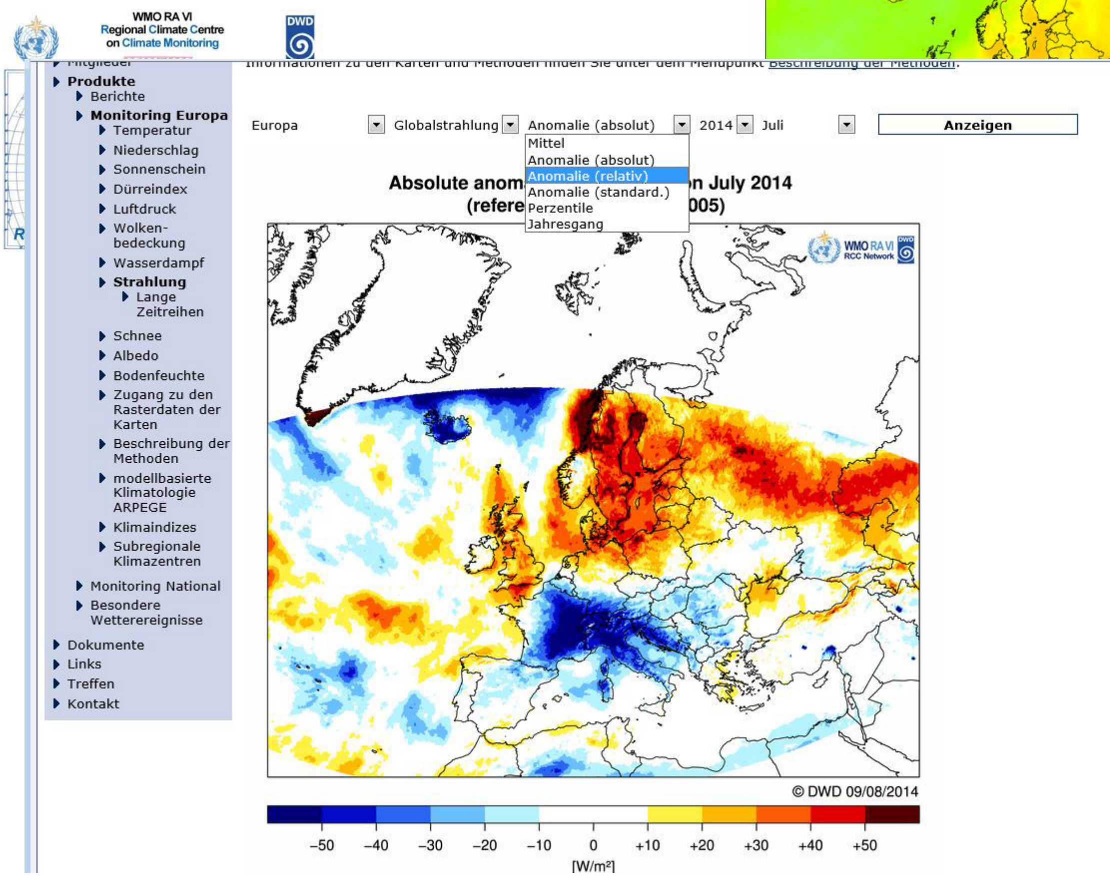
Application: WMO RCC, KU23

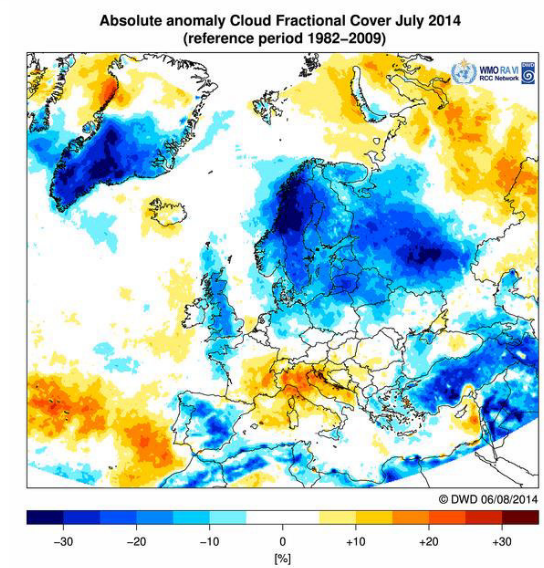
WMO RA VI Regional Climate Centre on Climate Monitoring (http://www.dwd.de/rcc-cm)

Climatology

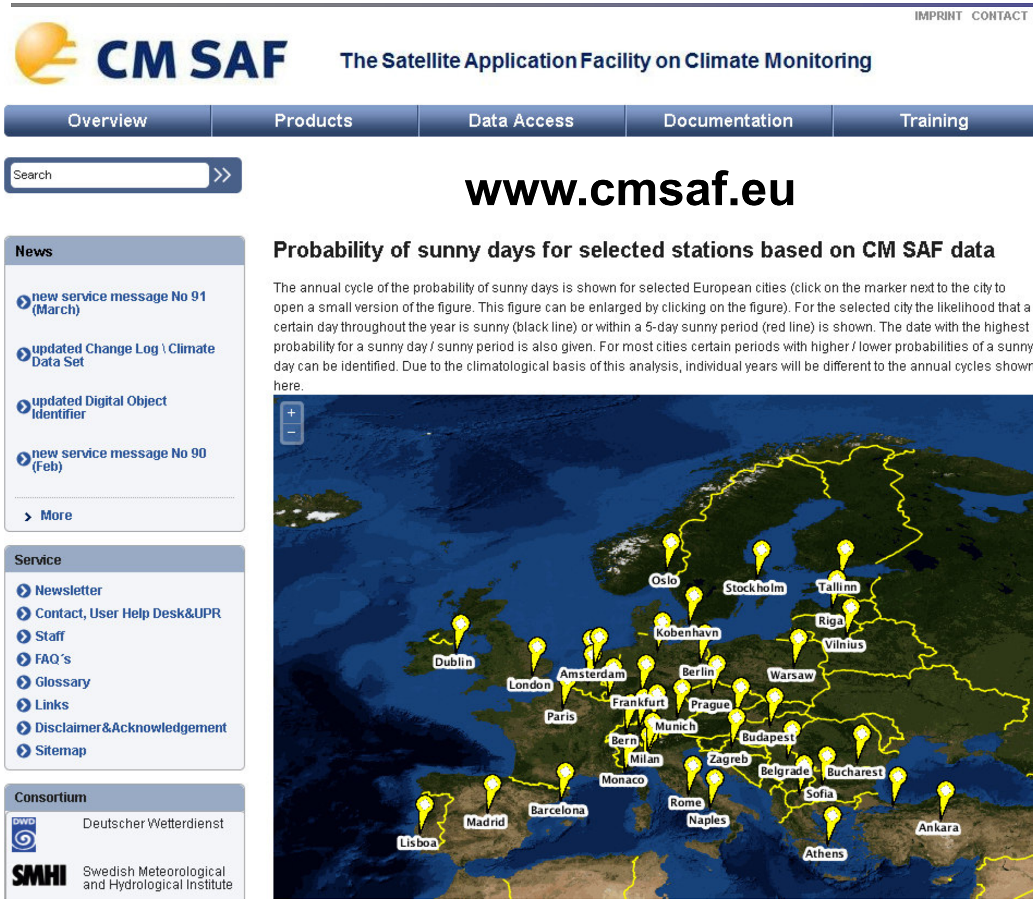








Sunny days in Europe



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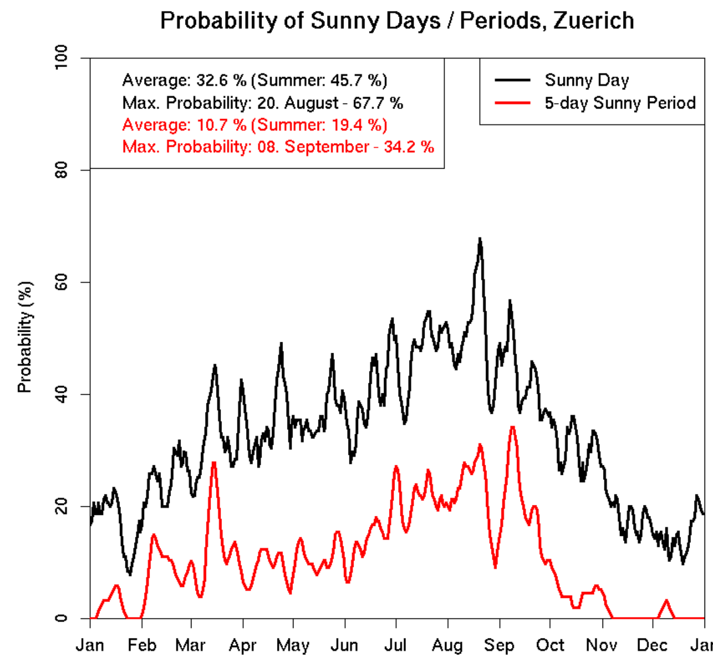
Consortium

Deutscher Wetterdienst

Swedish Meteorological and Hydrological Institute

Probability of sunny days for selected stations based on CM SAF data

The annual cycle of the probability of sunny days is shown for selected European cities (click on the marker next to the city to open a small version of the figure. This figure can be enlarged by clicking on the figure). For the selected city the likelihood that a certain day throughout the year is sunny (black line) or within a 5-day sunny period (red line) is shown. The date with the highest probability for a sunny day / sunny period is also given. For most cities certain periods with higher / lower probabilities of a sunny day can be identified. Due to the climatological basis of this analysis, individual years will be different to the annual cycles shown here.



28.10.2014

RP ONLINE

NRW POLITIK WIRTSCHAFT SPORT KULTUR PANORAMA GUT LEBEN REISEN

Für die Reiseplanung

Wann in Europa wie lange die Sonne scheint

SPIEGEL ONLINE WISSENSCHAFT

Politik | Wirtschaft | Panorama | Sport | Kultur | Netzwelt | Wissenschaft | Gesundheit | einestages | Karriere | Uni | Reise | Auto | Stil

21.10.2014

Langzeitanalyse: Wo und wann in Europa länger die Sonne scheint

DWD Solar Radiation Product for Germany:

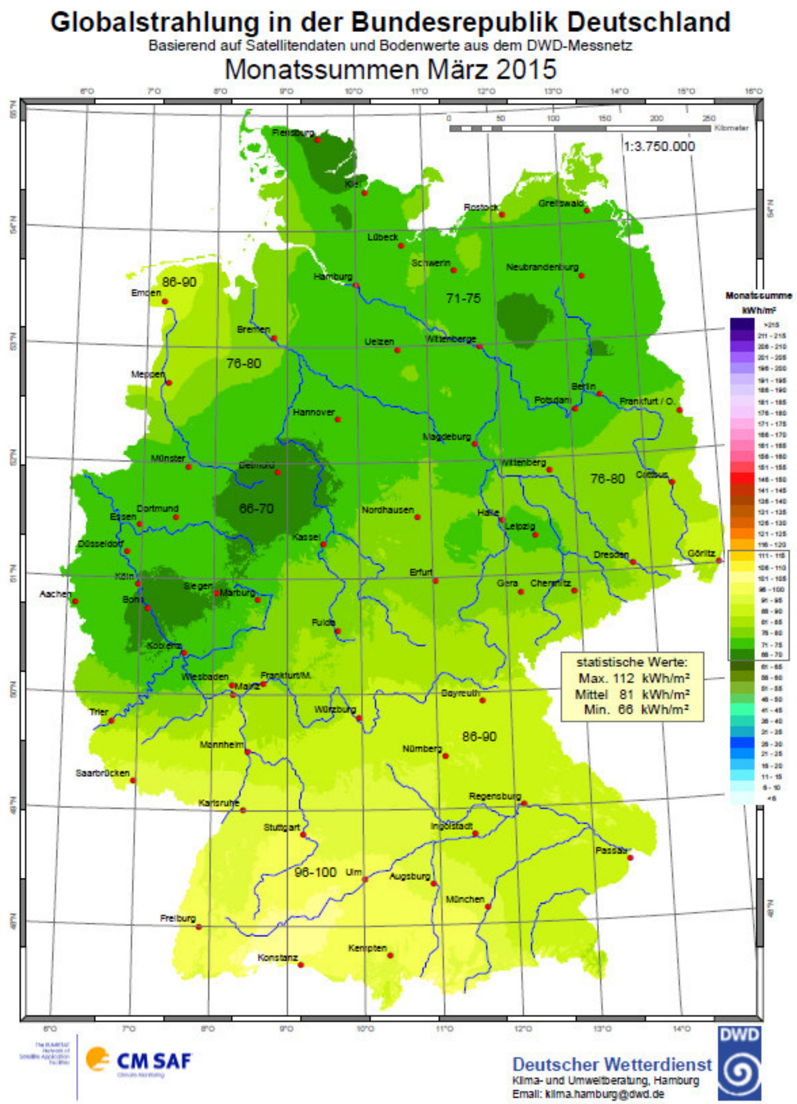
www.dwd.de/solarenergie

- Combined product using the CM SAF SIS operational product and surface measurements
- Generated on a monthly basis

Available online at www.sciencedirect.com
SciVerse ScienceDirect
Solar Energy 86 (2012) 3561–3574
SOLAR ENERGY
www.elsevier.com/locate/solener

Solar resource assessment in the Benelux by merging Meteosat-derived climate data and ground measurements

Michel Journée [a,*], Richard Müller [b], Cédric Bertrand [a]



Application: Sunshine Duration

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Eidgenössisches Departement des Innern EDI
Bundesamt für Meteorologie und Klimatologie MeteoSchweiz

Arbeitsbericht MeteoSchweiz Nr. 232

Gridding of Daily Sunshine Duration
By Combination of Station and Satellite Data

Marco Willi

Adv. Sci. Res., 10, 15–19, 2013
www.adv-sci-res.net/10/15/2013/
doi:10.5194/asr-10-15-2013

Advances in Science & Research

Sunshine duration climate maps of Belgium and Luxembourg based on Meteosat and in-situ observations

M. Journée, C. Demain, and C. Bertrand
Royal Meteorological Institute of Belgium, Brussels, Belgium

Remote Sens. **2013**, *5*, 2943-2972; doi:10.3390/rs5062943

OPEN ACCESS
Remote Sensing
ISSN 2072-4292
www.mdpi.com/journal/remotesensing

Article

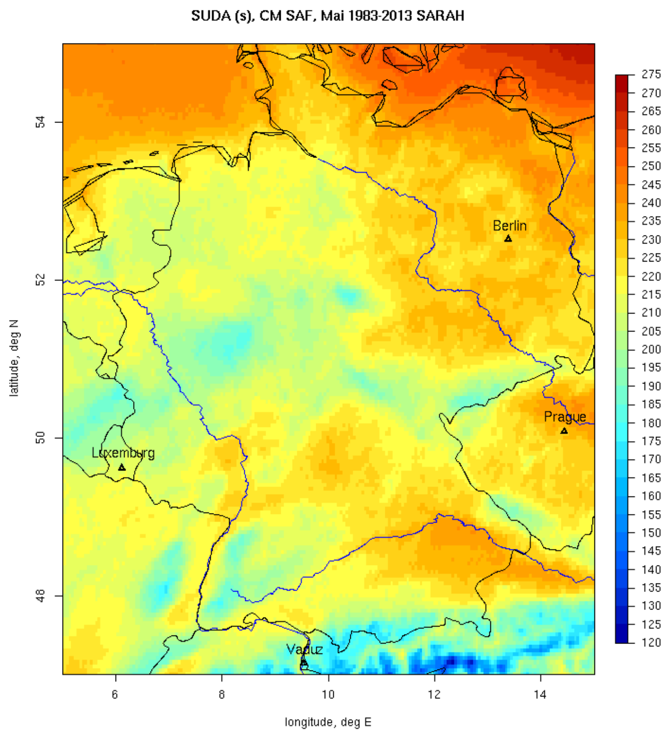
Satellite-Based Sunshine Duration for Europe

Steffen Kothe [1,*], Elizabeth Good [2], André Obregón [3], Bodo Ahrens [1] and Helga Nitsche [3]

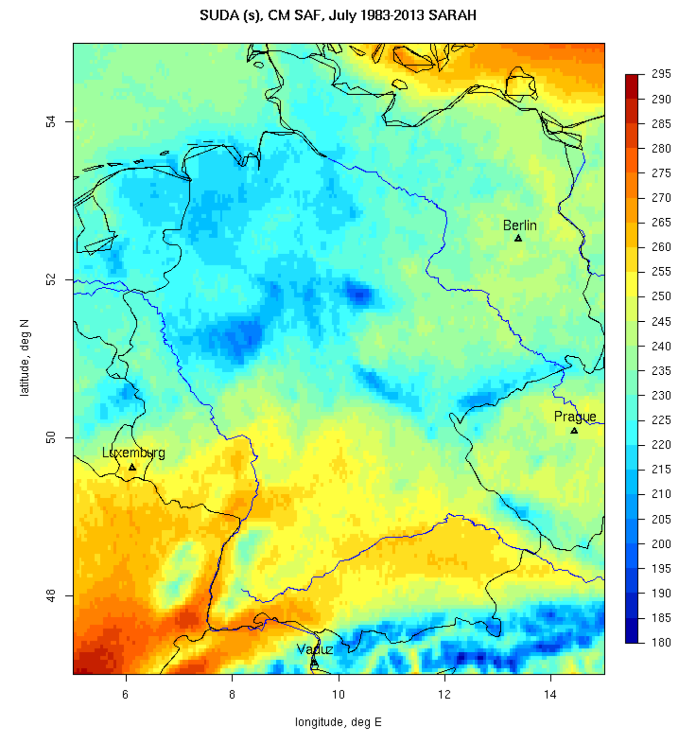
Sunshine Duration from DNI

(SDU if DNI > 120 W/m2)

May

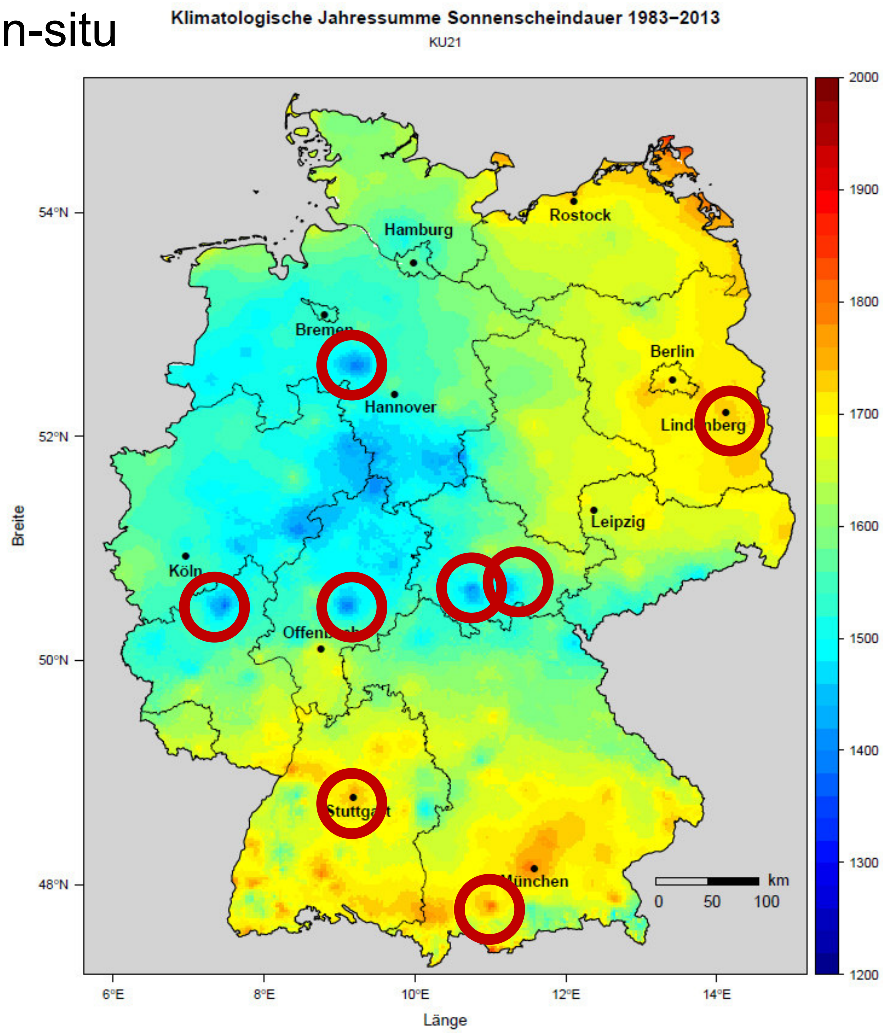


July

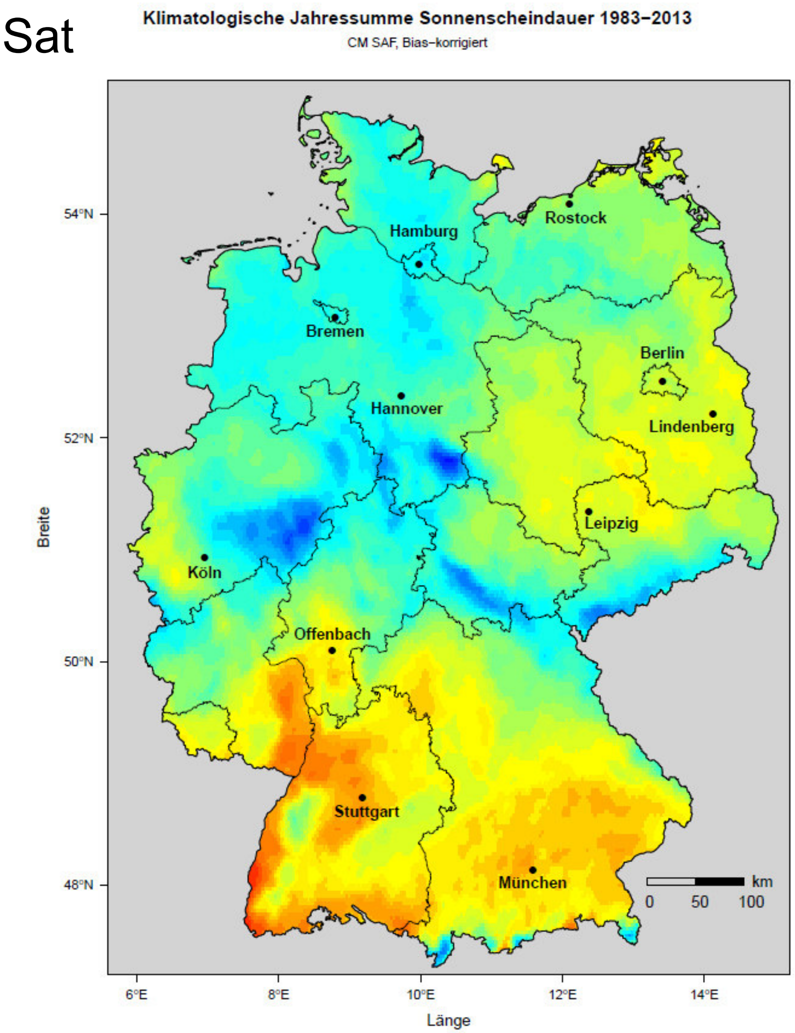


Sunshine duration: in-situ vs. satellite

In-situ

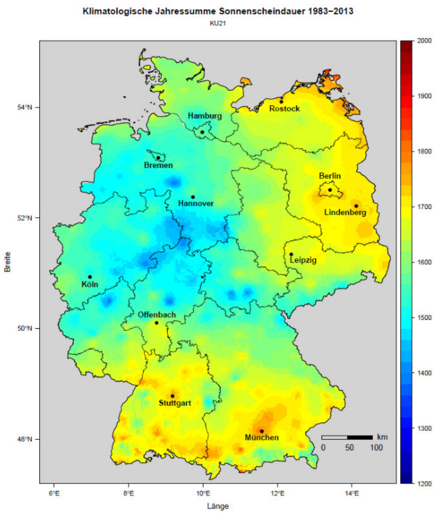


Sat

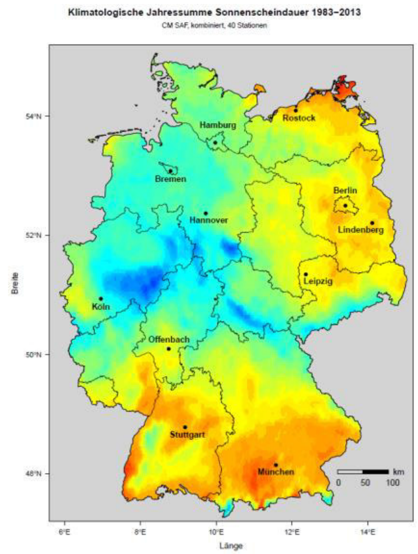


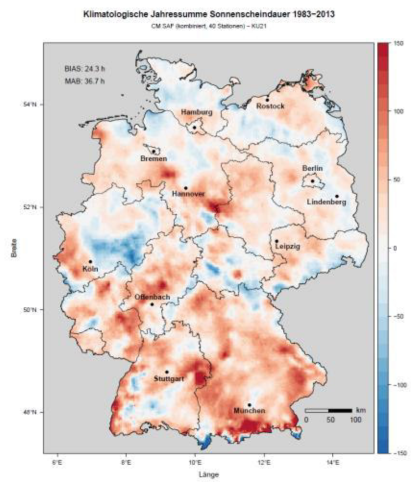
Which product provides best representation of the real conditions?

in-situ vs. satellite

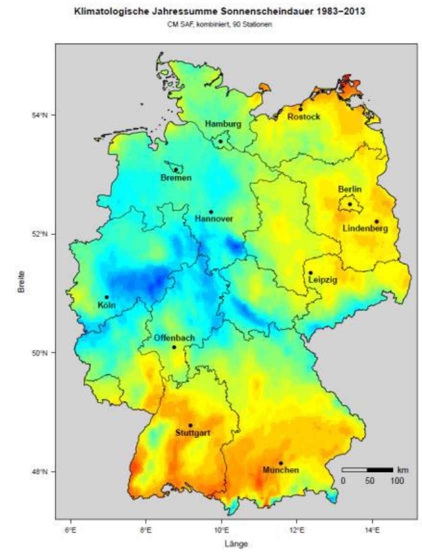


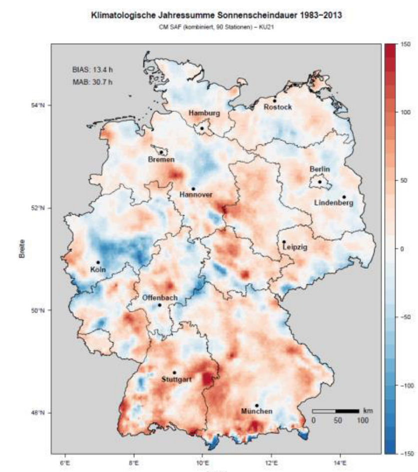
In situ only





sat + 40

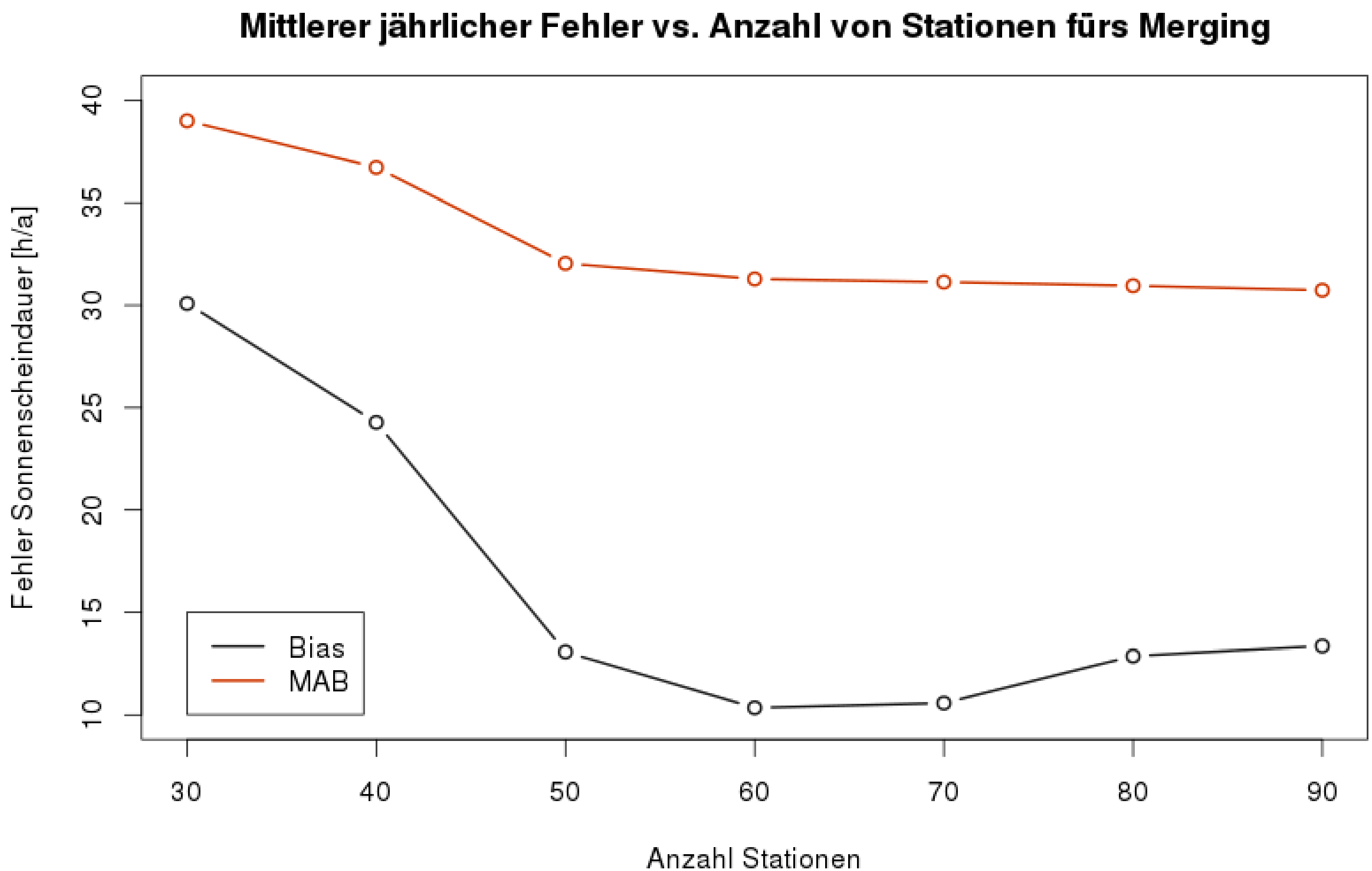




sat + 90

CM SAF Climate Monitoring

Deutscher Wetterdienst
Wetter und Klima aus einer Hand



Error in sunshine duration vs. number of stations used for merging

Summary:

- CMSAF provides satellite-based datasets of several parameters
- These datasets can be used to evaluate quality and homogenity of in-situ observations
- DWD has analysed requirements for the in-situ network based on CMSAF radiation data.

ČESKÝ
HYDROMETEOROLOGICKÝ
ÚSTAV

Global solar radiation: comparison of satellite and ground based observations

Petr Skalak[1,2], Piotr Struzik[3], Aleš Farda[2,1], Pavel Zahradníček[2,1], Petr Štěpánek[2,1]

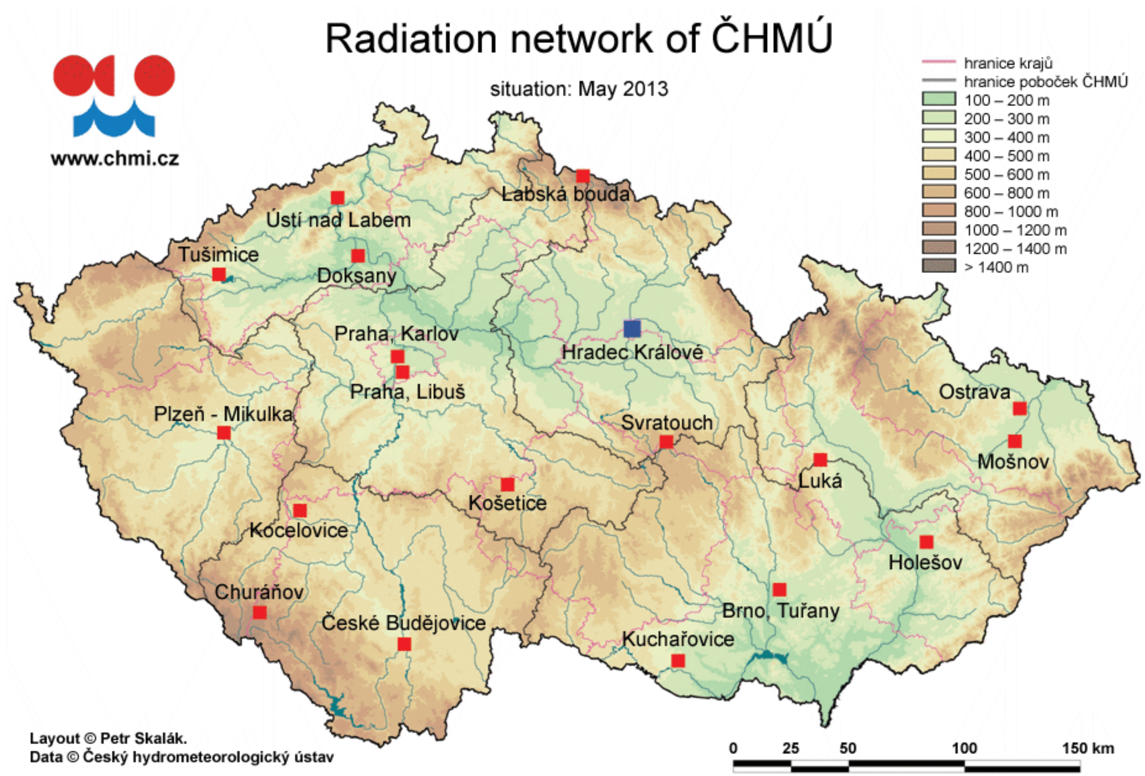
1) Czech Hydrometeorological Institute, Praha, Czech Republic
2) Global Change Research Centre AS CR, Brno, Czech Republic
3) Institute of Meteorology and Water Management, Krakow, Poland

skalak@chmi.cz

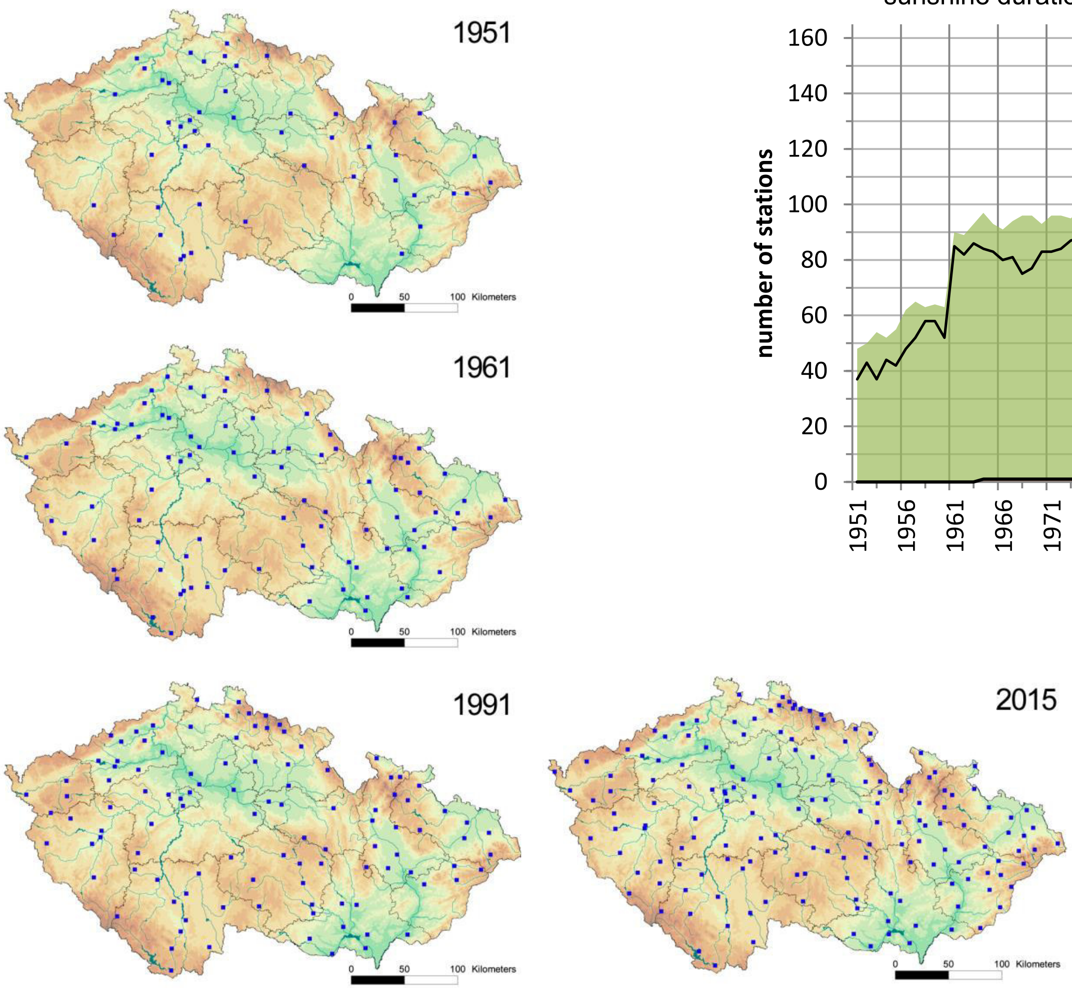
CHMI Radiation Network

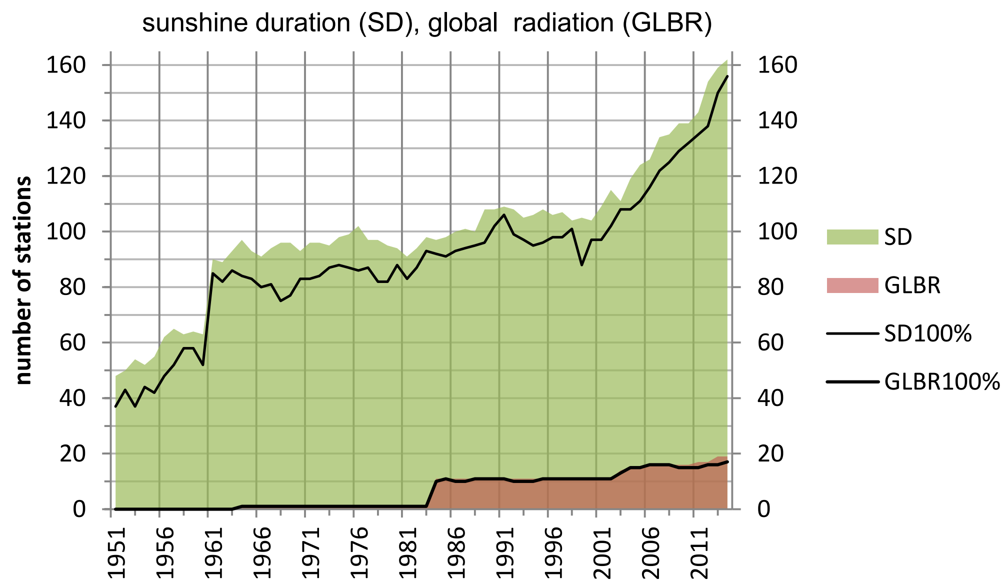
- **19** stations in total
- established in 1984 with 11 stations (the oldest records since 1953)
- monitoring of solar radiation (global radiation + components, UV radiation)
- equipped with Kipp&Zonen CM11 and CMP 11 pyranometers

Q: ***How can we get information on solar radiation at other locations?***



Sunshine duration at CHMI stations





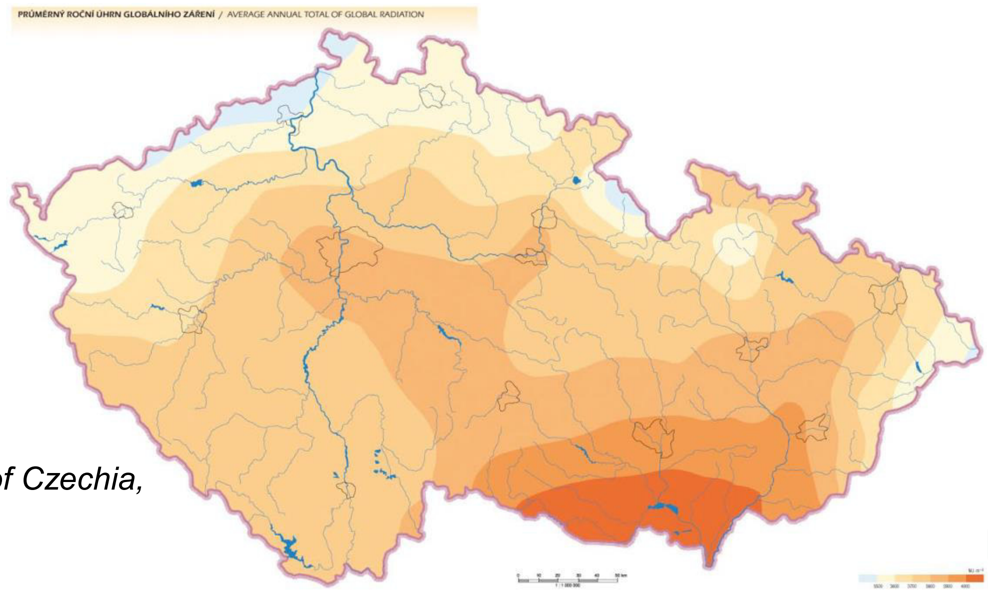
Campbell Stokes heliograph replaced by SDx series of sunshine detectors from Meteoservis Vodňany

Applicability of sunshine duration

Sunshine duration (SD) can be recalculated into global radiation (GLBR) but detailed metadata are needed:

- changes of instrumentation and its location
- the real horizon at the station and its changes in time (tree growth, new buildings…)

→ not often well documented at voluntary (i.e., majority of) stations

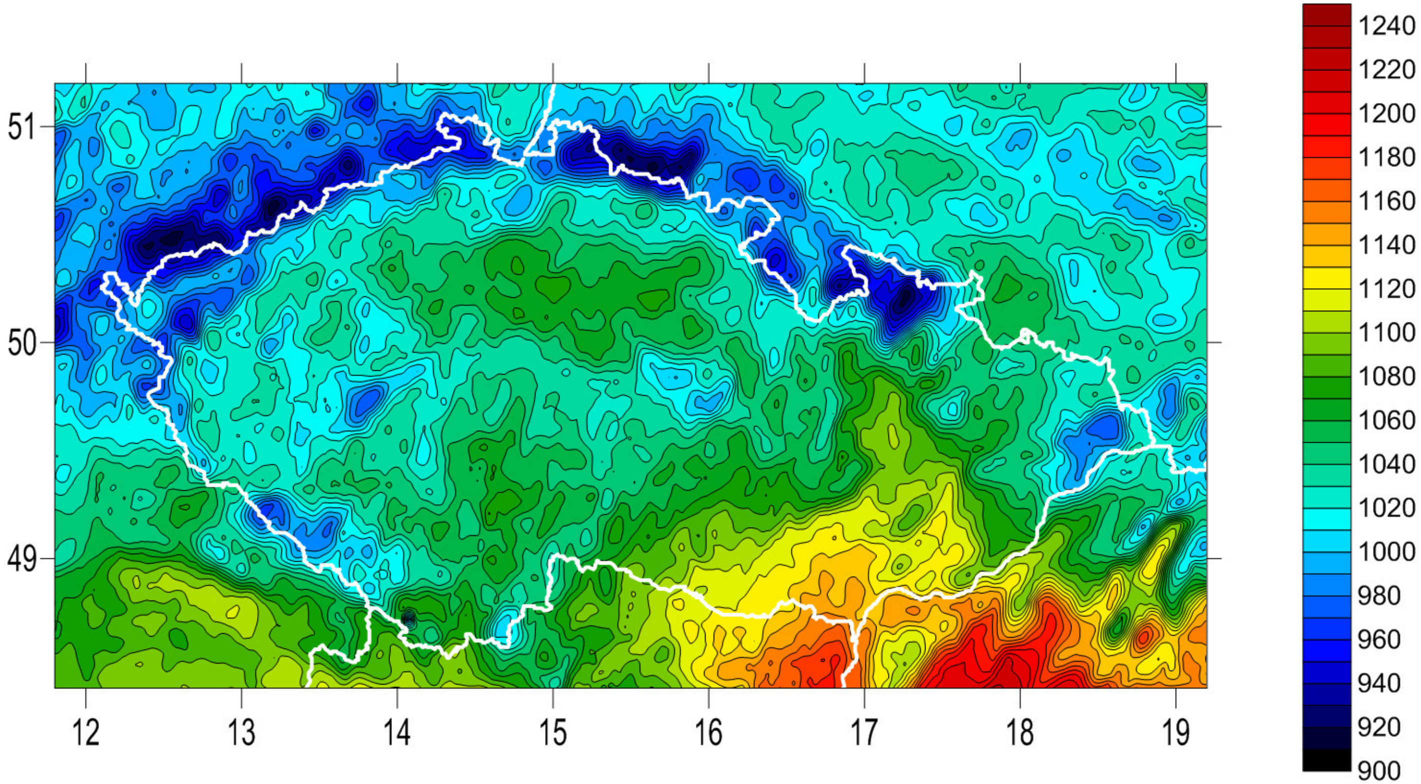


Annual sum of GLBR [MJ/m^2] over the Czech Republic in the period 1961-2000.

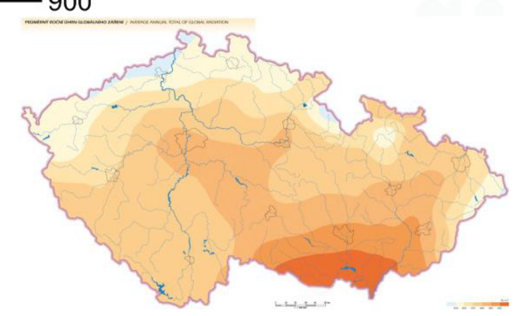
Source: Tolasz R., 2007, Climate Atlas of Czechia, CHMI, Praha

Q: Would it look the same if more stations were available? Aren't we missing some information on the real spatial variability of GLBR?

Solar radiation from satellites



Annual sum of downwelling solar shortwave radiation [kWh/m^2] in 2013 derived by EUMETSAT LSA SAF



EUMETSAT satellite radiation data

EUMETSAT Climate Monitoring Satellite Application Facility (CM SAF)

- http://www.cmsaf.eu
- operational and climate monitoring products including surface incoming solar radiation (SIS)
- **SIS** = irradiance the **200-400 nm** wavelength region
- operational products released 8 weeks after observation at the latest

CM SAF **SARAH** (Surface Solar Radiation Data record – Heliosat) Dataset

- combining Meteosat 1st and 2nd generation data into a single homogenous dataset
- 1983-2013*
- hourly, daily and monthly time resolution
- almost full disc coverage (-65° to 65° in longitude and latitude) in 0.05° spatial resolution

**) extension till 31. 12. 2014 published in October 2015*

EUMETSAT satellite radiation data

EUMETSAT Land Surface Analysis Satellite Application Facility (LSA SAF)

- http://landsaf.meteo.pt
- operational products including Downward Surface Shortwave Flux (DSSF)
- DSSF = irradiance in the wavelength interval 300-4000 nm
- operational products released instantly
- 2009 - today*
- 30 minutes and daily time resolution
- full disc coverage over land in 0.05° spatial resolution

**) based on LSA SAF Web User Interface*

DSSF validation against stations

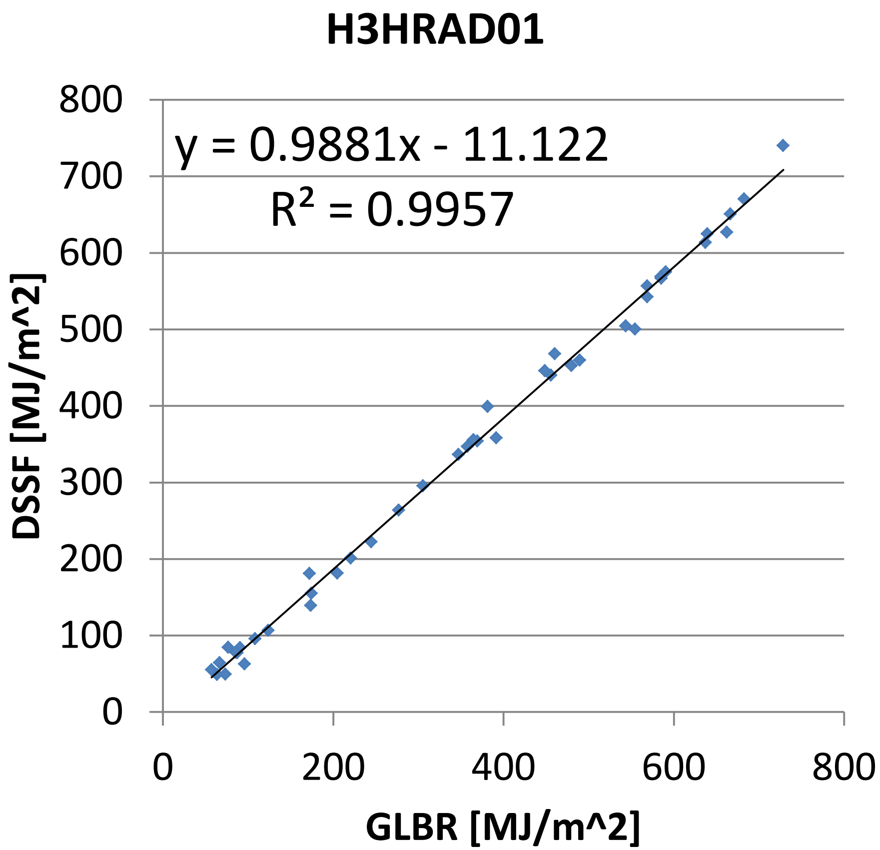
Comparison of monthly sums of LSA SAF DSSF estimates with CHMI stations measurements of global radiation (GLBR) in 2011-2014

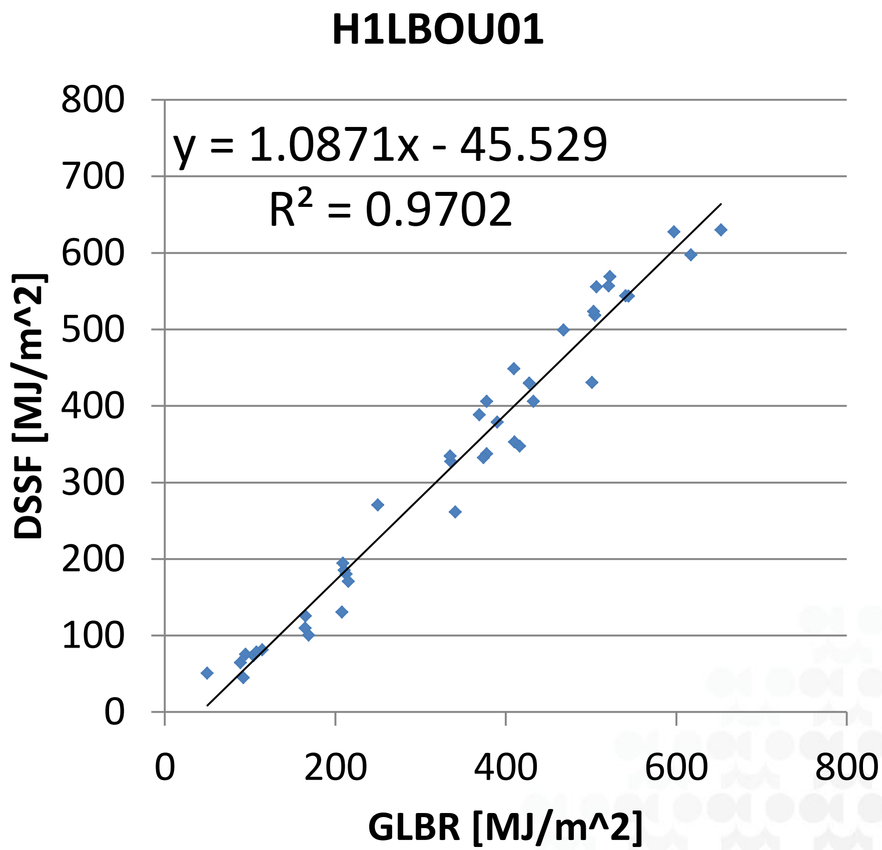
- up to 19 stations versus the nearest grid point (mean distance: 2.1 km)
- DSSF data partly incomplete (Aug 2011, Sep-Dec 2012 missing/omitted)

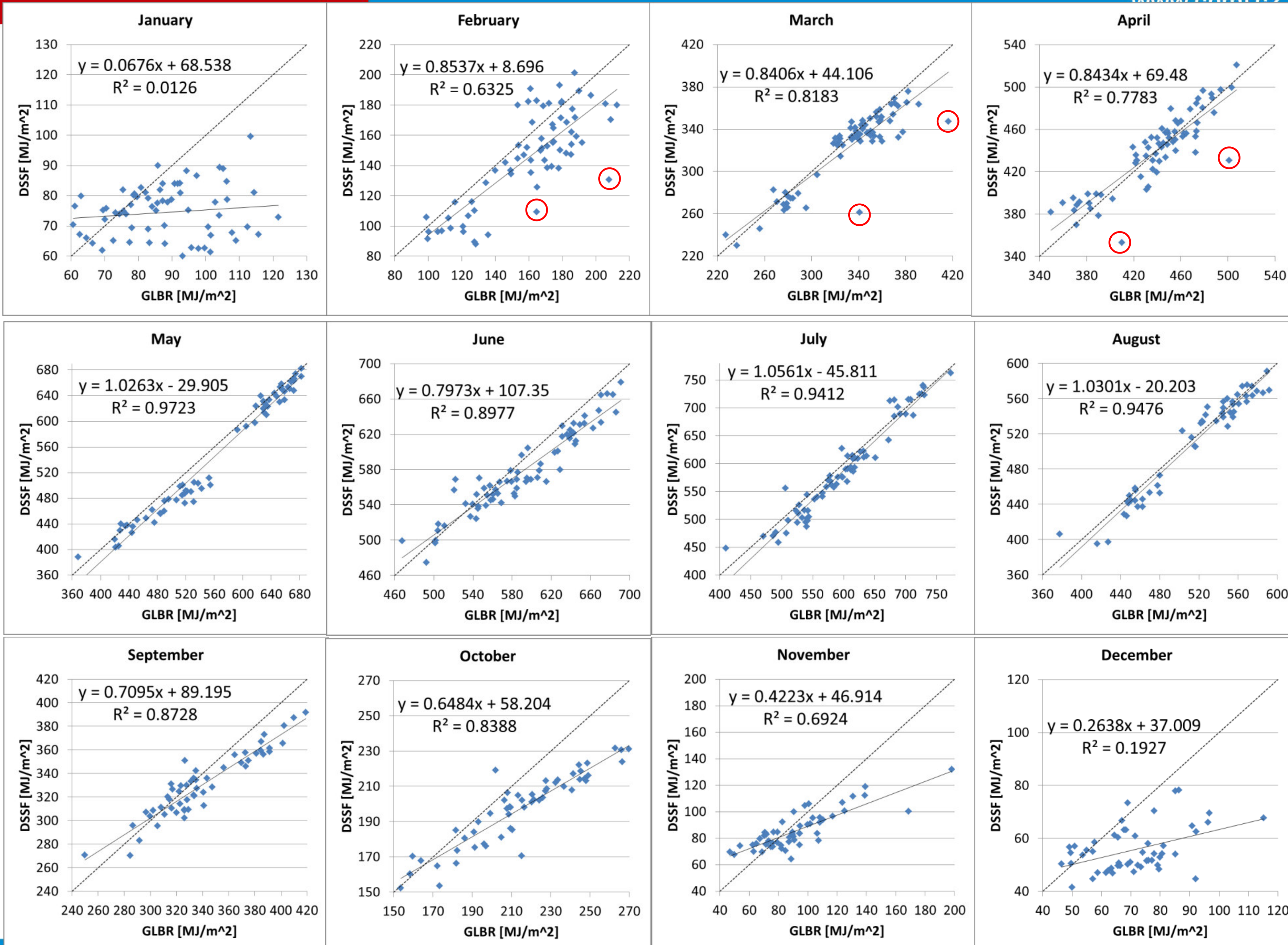
Station ID	LATITUDE	LONGITUDE	ALTITUDE	DISTANCE [km]	AZIMUTH [°]
B1HOLE01	17.57	49.320556	222	2.61	123.8
B2BTUR01	16.688889	49.153056	241	0.73	-152.3
B2KUCH01	16.085278	48.881111	334	2.60	-115.5
C1CHUR01	13.615278	49.068333	1118	1.81	5.9
C1KOCE01	13.838611	49.467222	519	2.87	118.0
C2CBUD01	14.469722	48.951944	395	0.74	-163.1
H1LBOU01	15.544927	50.769883	1315	**3.49**	-72.3
H3HRAD01	15.838452	50.177649	278	2.49	-52.0
H3SVRA01	16.034167	49.735	734	**0.63**	118.3
L1PLMI01	13.378889	49.764722	360	2.87	-73.8
O1MOSN01	18.119167	49.698333	250	0.93	-86.3
O1PORU01	18.1594	49.8253	239	3.08	116.9
O2LUKA01	16.953333	49.652222	510	2.75	-64.1
P1PKAR01	14.427778	50.069167	261	2.48	-120.8
P1PLIB01	14.446944	50.007778	302	2.04	-104.1
P3KOSE01	15.080556	49.573611	532	3.02	76.9
U1DOKS01	14.17	50.45889	158	1.43	60.2
U1KATU01	13.32806	50.37667	322	1.33	163.9
U1ULKO01	14.04111	50.68333	375	1.53	-166.0

DSSF & GLBR monthly sums

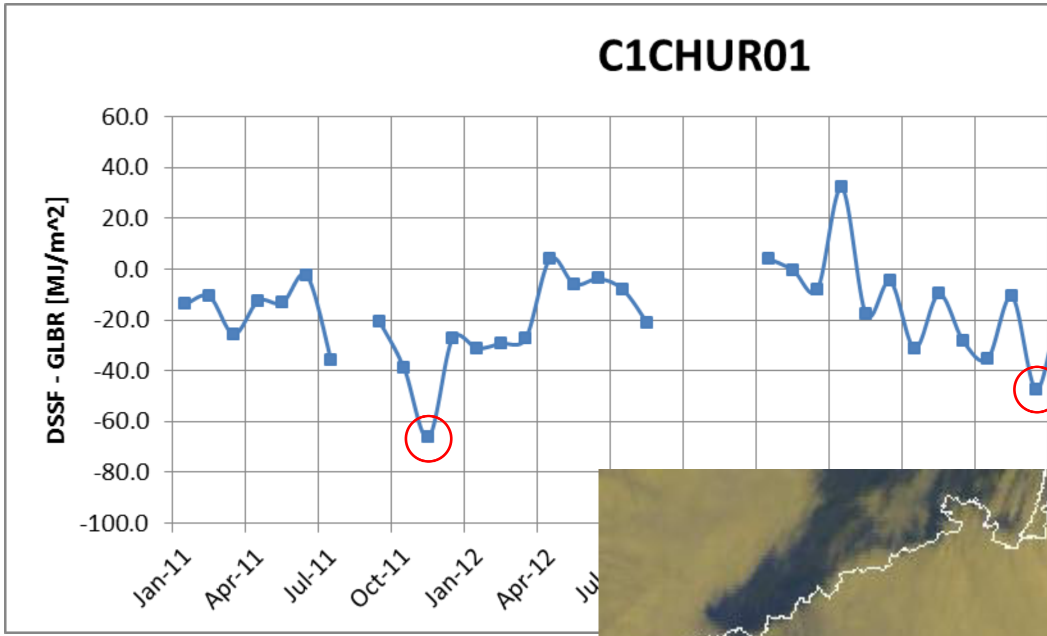
- DSSF estimates against in-situ records over the whole period 2011-2014 at selected two stations

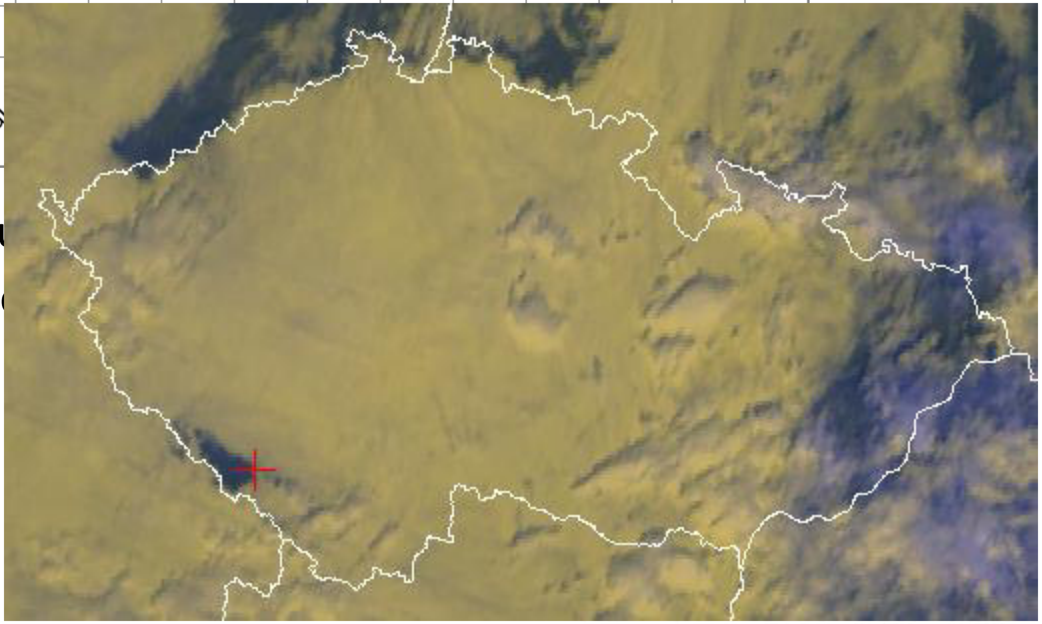





January
y = 0.0676x + 68.538
R² = 0.0126
DSSF [MJ/m^2]
GLBR [MJ/m^2]
February
y = 0.8537x + 8.696
R² = 0.6325
DSSF [MJ/m^2]
GLBR [MJ/m^2]
March
y = 0.8406x + 44.106
R² = 0.8183
DSSF [MJ/m^2]
GLBR [MJ/m^2]
April
y = 0.8434x + 69.48
R² = 0.7783
DSSF [MJ/m^2]
GLBR [MJ/m^2]
May
y = 1.0263x - 29.905
R² = 0.9723
DSSF [MJ/m^2]
GLBR [MJ/m^2]
June
y = 0.7973x + 107.35
R² = 0.8977
DSSF [MJ/m^2]
GLBR [MJ/m^2]
July
y = 1.0561x - 45.811
R² = 0.9412
DSSF [MJ/m^2]
GLBR [MJ/m^2]
August
y = 1.0301x - 20.203
R² = 0.9476
DSSF [MJ/m^2]
GLBR [MJ/m^2]
September
y = 0.7095x + 89.195
R² = 0.8728
DSSF [MJ/m^2]
GLBR [MJ/m^2]
October
y = 0.6484x + 58.204
R² = 0.8388
DSSF [MJ/m^2]
GLBR [MJ/m^2]
November
y = 0.4223x + 46.914
R² = 0.6924
DSSF [MJ/m^2]
GLBR [MJ/m^2]
December
y = 0.2638x + 37.009
R² = 0.1927
DSSF [MJ/m^2]
GLBR [MJ/m^2]

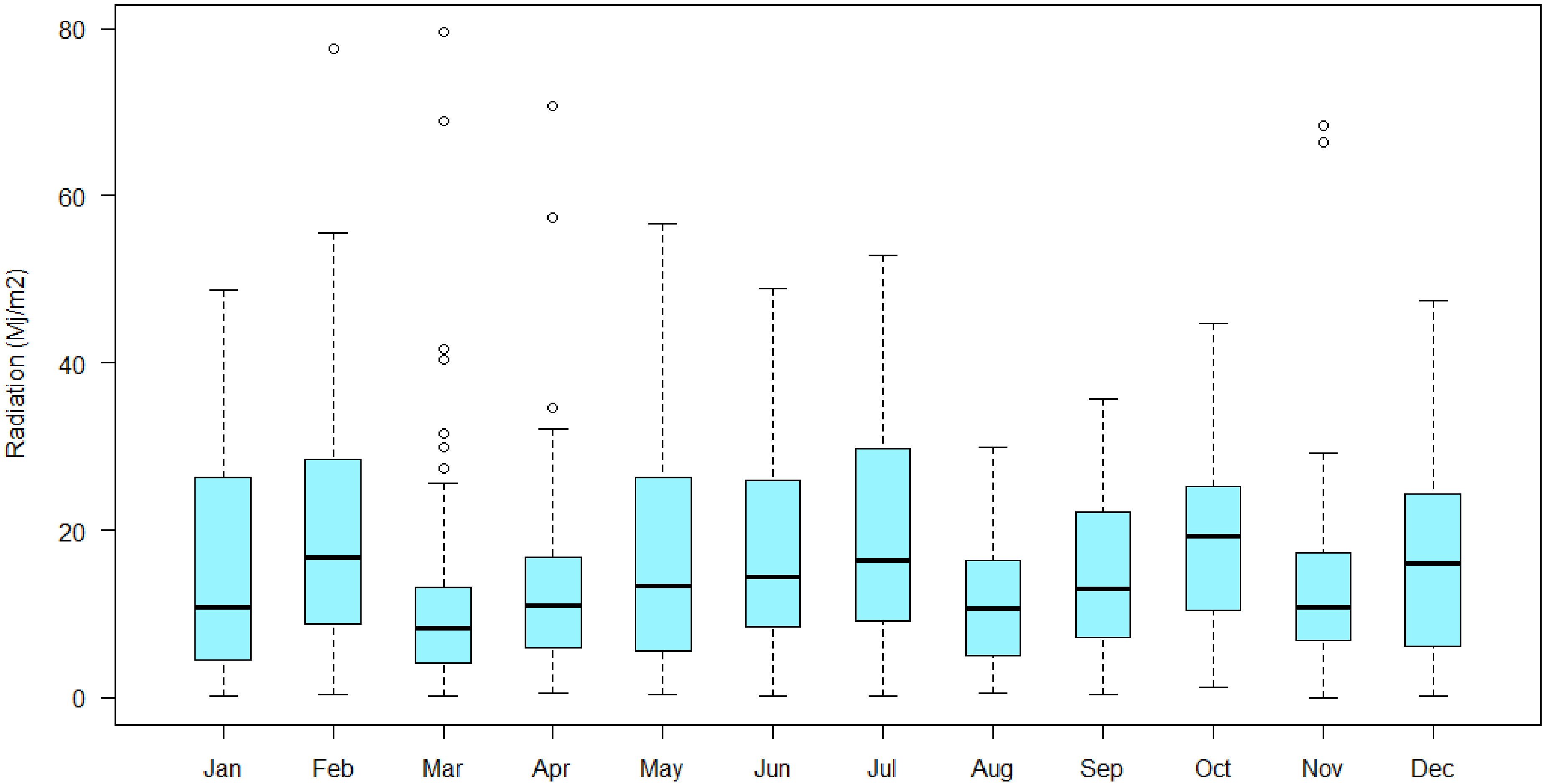
DSSF-GLBR differences in time



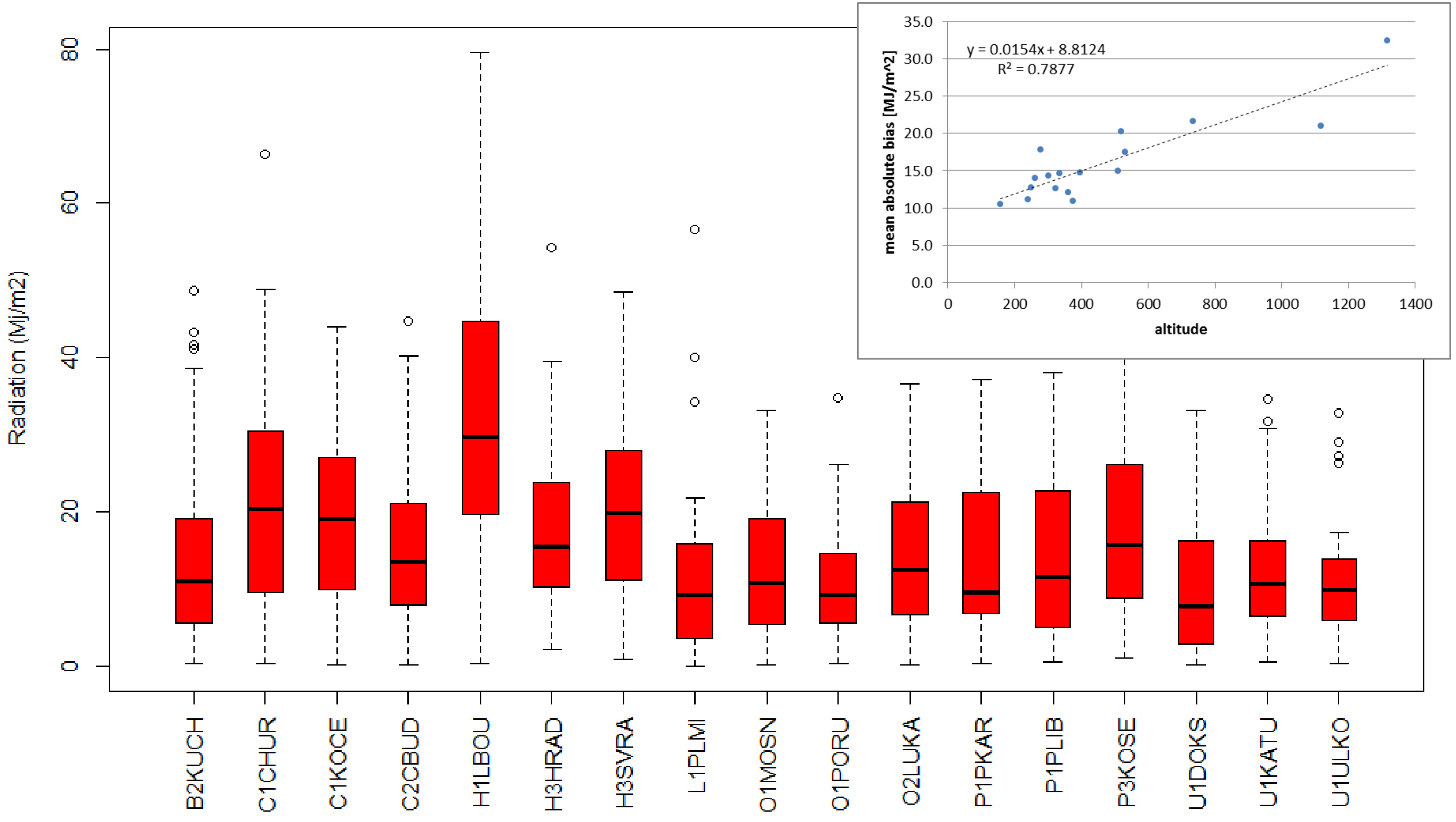


- No apparent similarity of bias evol
- Some biases may be affected by lo

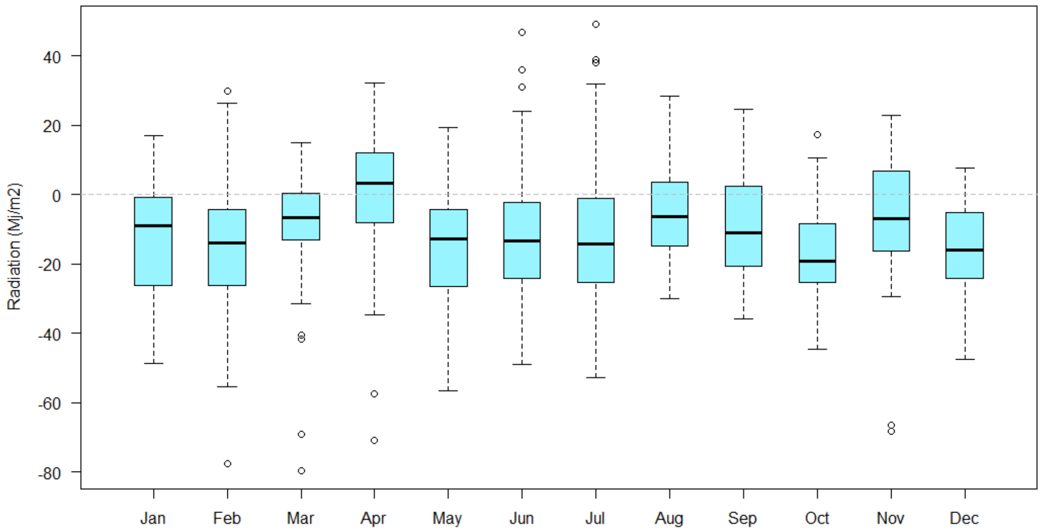
Annual course: bias & absolute bias

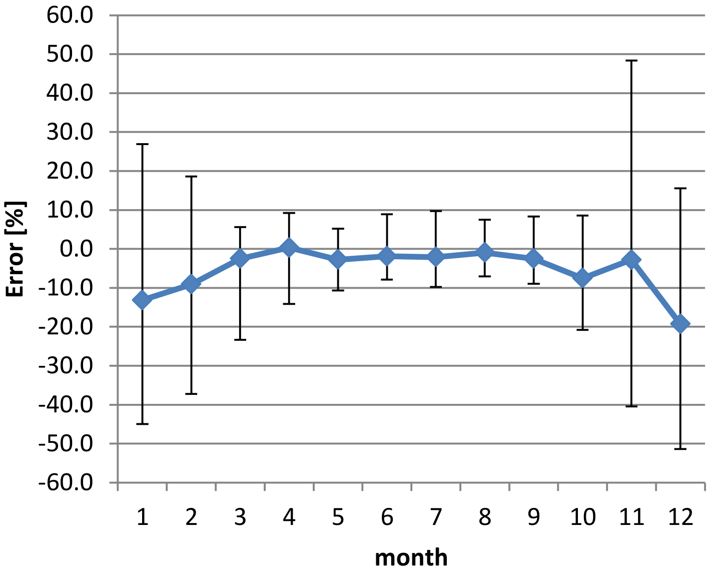


Bias & absolute bias among stations



Size and significance of errors





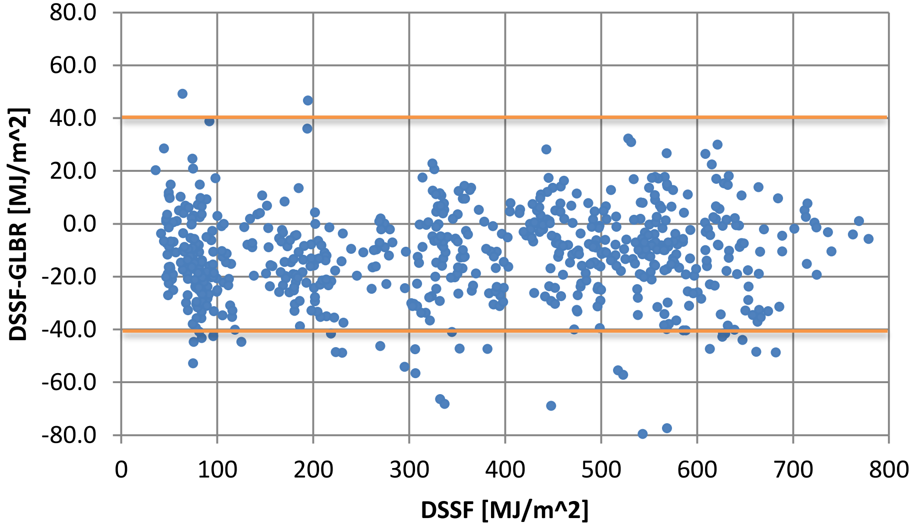
LSA SAF Product Requirements for DSSF at the MSG pixel resolution for 30-min or daily data:

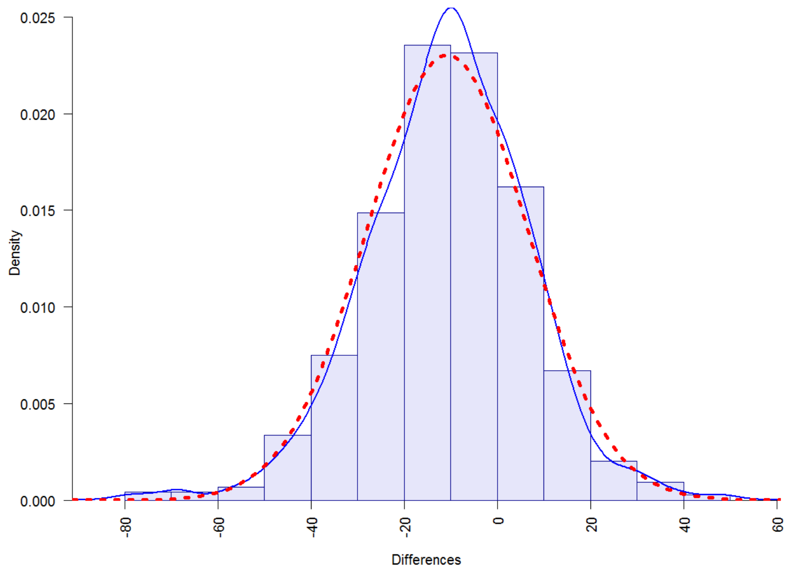
- Accuracy 10% for DSSF > 200 W/m^2
- Accuracy 20 W/m^2 for DSSF < 200 W/m^2

CM SAF Target Accuracy for monthly mean surface solar irradiance (SIS) in SARAH:

- 15 W/m^2 corresponding to ca. 40 MJ/m^2 in monthly sum

Size and significance of errors





- Majority of data points fit within ±40 MJ/m^2 quality target
- In the summer half year ±10% relative error is met

Conclusions & outlooks

- LSA SAF DSSF provides realistic but biased estimates of Downwelling Shortwave Solar Flux and derived monthly totals of irradiance
- Negative bias dominates
- Higher elevated locations (mountains) show bigger errors
- For operational products of CHMI only summer half-year data seems to be suitable (relative error <10%)

- Validation of the CM SAF SARAH dataset on daily/monthly time scale
- Exploring a potential of the SARAH to be used as a reference dataset to correct a bias of climate models → global radiation from GCMs/RCMs often used by models of the climate change impact community)

Thank you for attention

Climatological Atlas of Northeastern Atlantic and Western Mediterranean for the period 1981-2010 based on ERA-Interim Reanalysis

José A. Guijarro, Justo Conde, Joan Campins,
Mª Luisa Orro and Mª Ángeles Picornell

State Meteorological Agency (AEMET), Spain

EUMETNET Data Management Workshop
St. Gallen, Switzerland, 28-30 October 2015

Outline

Motivation

Methodology

ERA-I vs buoy data

Final products

Motivation

- Maritime climate information is very important for the long term planning of a number of activities as maritime transportation of goods and people, fishing, touristic cruises, etc.
- A number of atlas of waves and meteorological conditions on seas have been produced historically (Weather Bureau, 1938; HMSO, 1949; KNMI, 1957; Crutcher, 1969; Young, 1996; Lindau, 2001; Steurer, 1990), one of the most recent developed by KNMI based on ERA-40 reanalysis (Sterl and Caires, 2005).
- Our aim was to update the maritime climate information to the period 1981-2010 for the areas for which the Spanish Meteorological Agency (AEMET) issues predictions of maritime meteorology.

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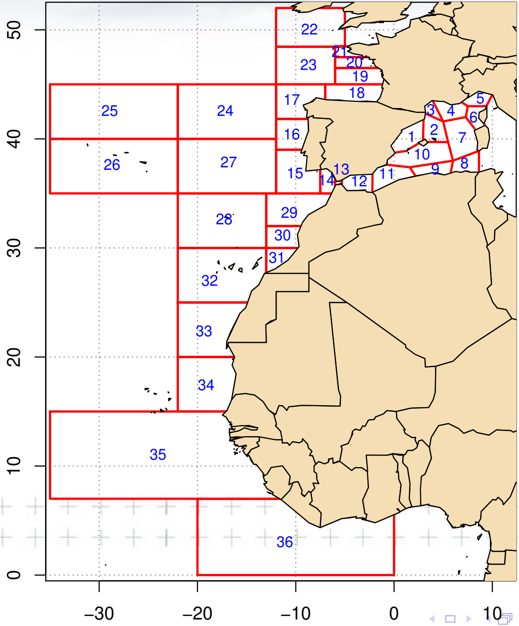
Maritime zones



Methodology

- ERA-Interim reanalysis was used as source of data due to its high quality and resolution (1°).
- Wind and wave variables were downloaded from 35°W to 12°E and 0 to 52°N and for the period 1981-2013.
- Reanalysis data were compared with deep water buoy measurements from the Spanish Agency Puertos del Estado for the five years 2009-2013.
- Maps and graphs of significant wave height, wind speed, mean period and sea surface temperature were developed with programs written in R.
- The final atlas was produced as a PDF document generated with LaTeX.
- An interactive R program allows the production of other maps and graphs not included in the atlas.

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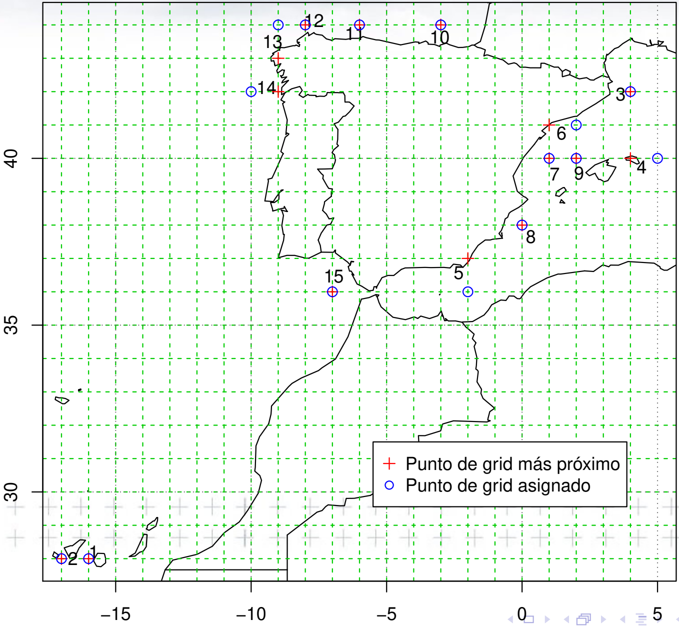
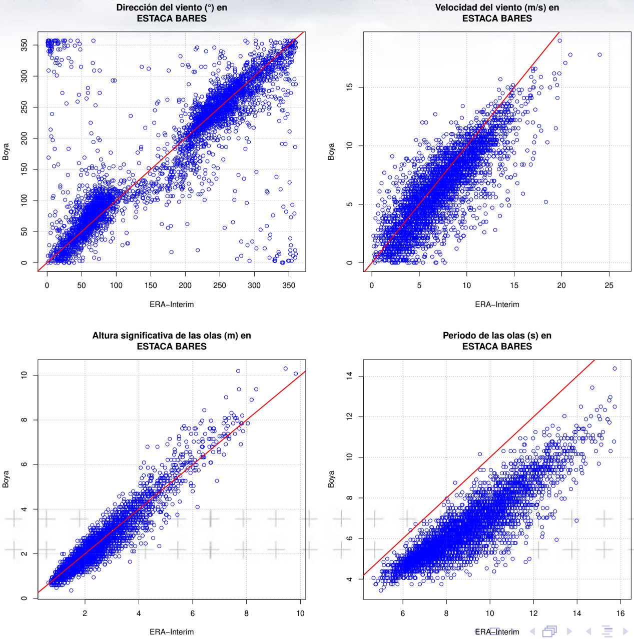


ERA-I vs buoy data



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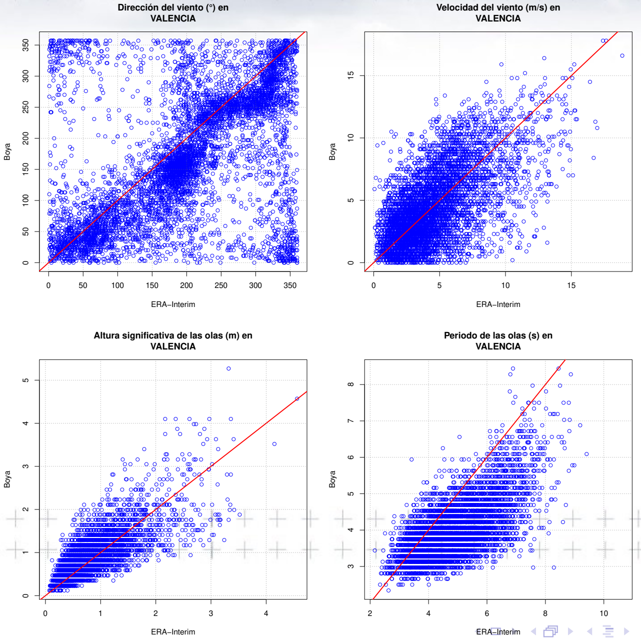
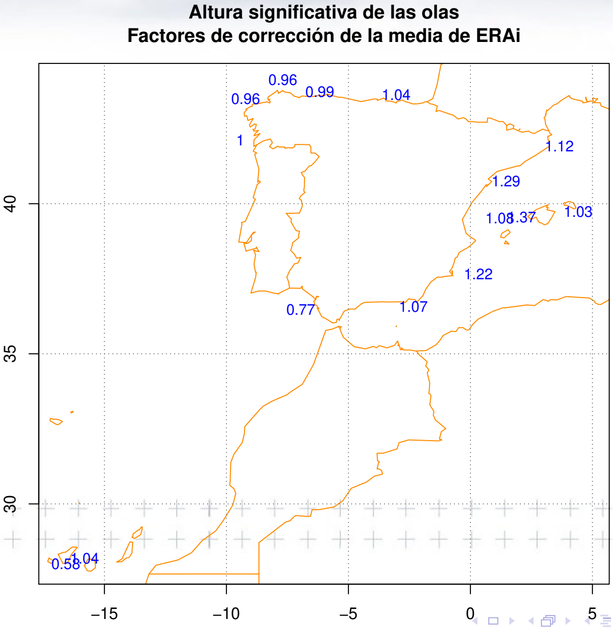
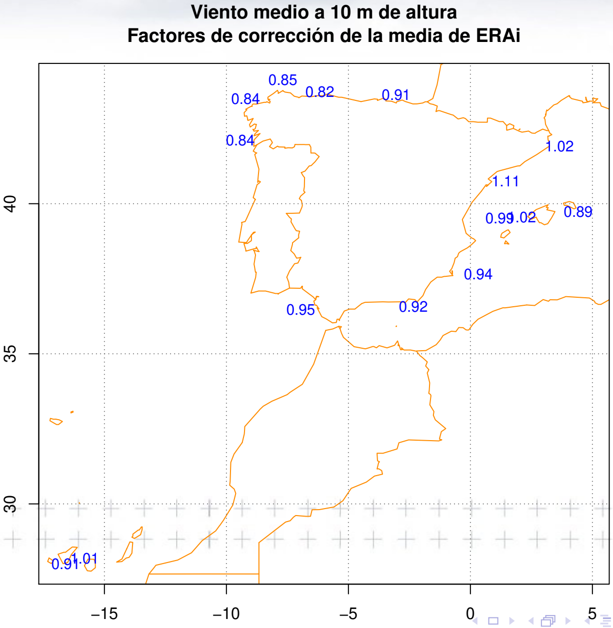


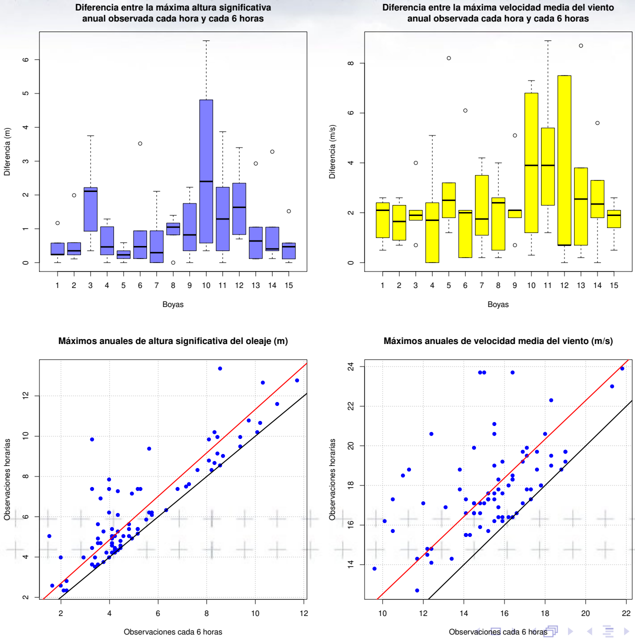
H_s corrections



Wind speed corrections



ERA-I vs buoy extremes



Atlas contents

- Monthly and annual maps of:
  - Percentiles 50, 95 and 100 of significant wave height, wind speed, mean period and sea surface temperature.
  - Wind roses
  - Frequencies of significant wave height over 2.5, 6 y 9 m
  - Frequencies of wind speed over 11.1, 17.3 y 24.4 m/s
- Climatic summaries for selected 1x1° cells with:
  - Frequency tables and boxplots of the above parameters.
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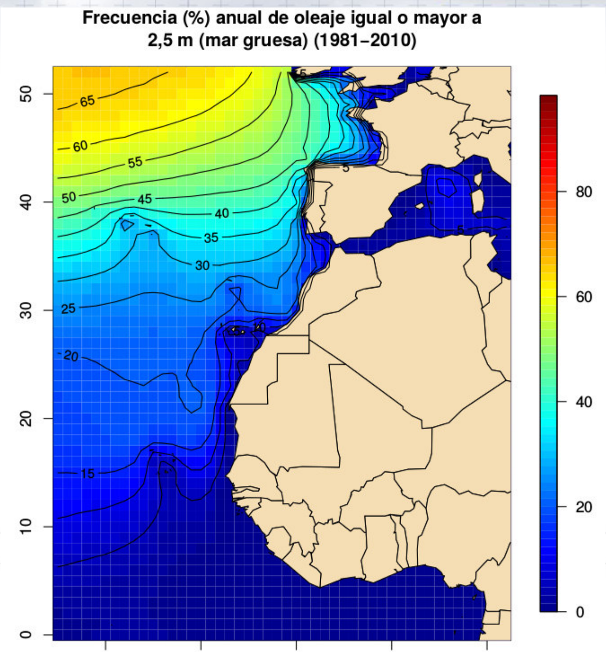
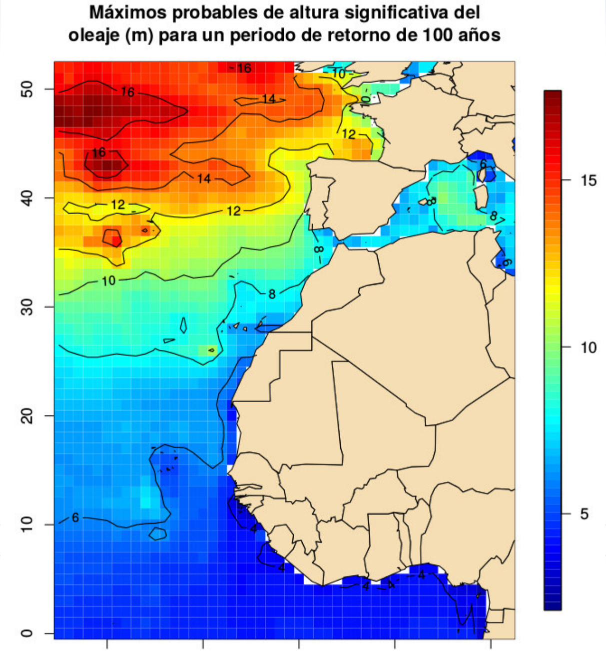
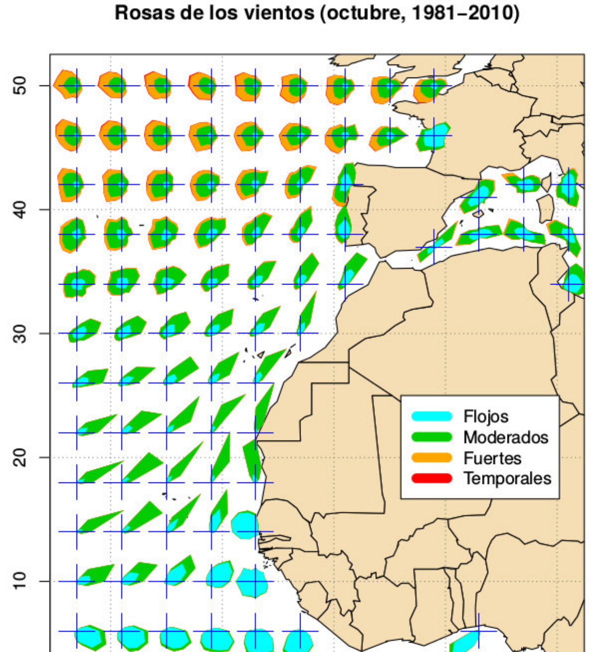
% of $H_s \geq 2.5$ m


Frecuencia (%) anual de oleaje igual o mayor a
2,5 m (mar gruesa) (1981–2010)
65
60
55
50
45
40
35
30
25
20
15
10
5
0
10
20
30
40
50
0
20
40
60
80

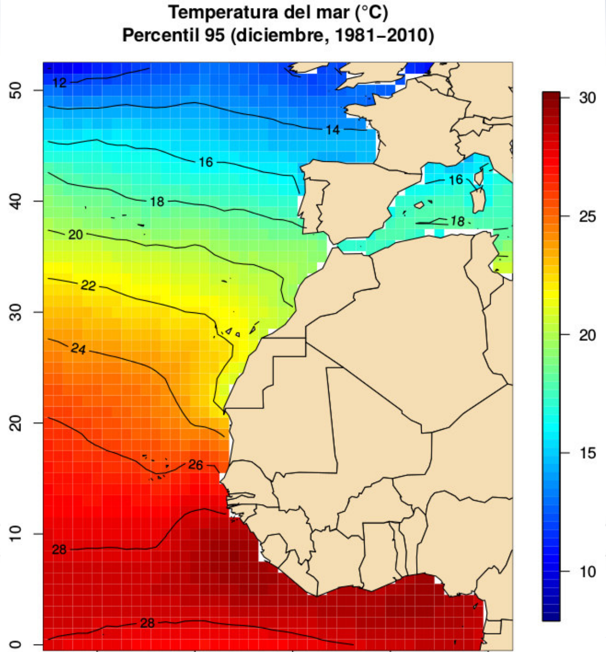
Max. H_s for 100 years R.P.



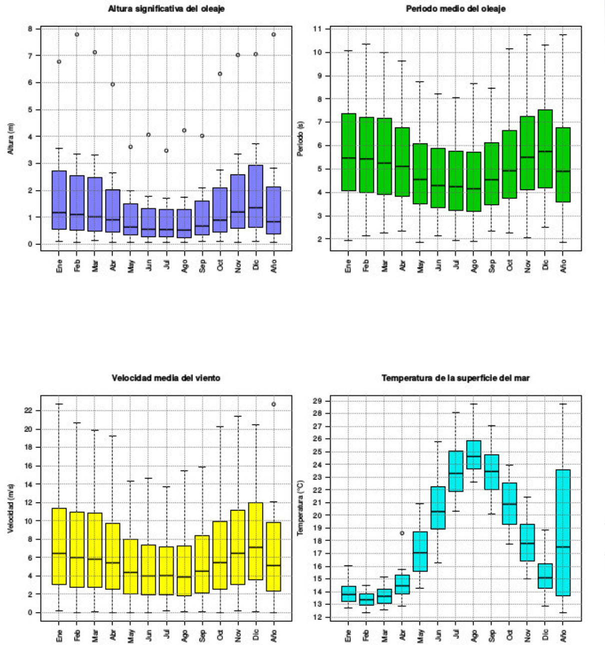
Wind roses


Rosas de los vientos (octubre, 1981–2010)
50
40
30
20
10
Flojos
Moderados
Fuertes
Temporales

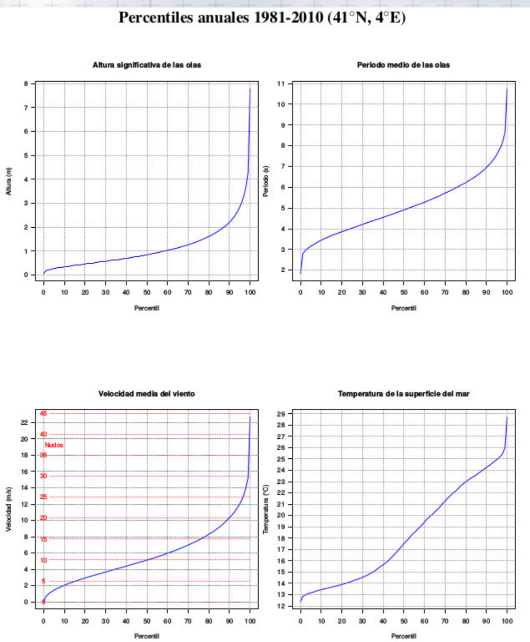
SST (December p.95)



Boxplots

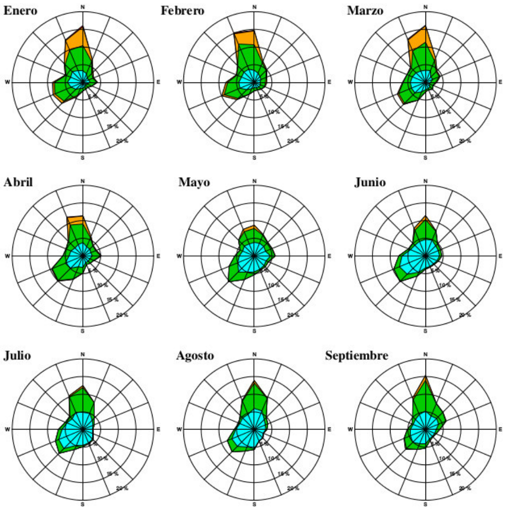

Altura significativa del oleaje
Altura (m)
Periodo medio del oleaje
Periodo (s)
Velocidad media del viento
Velocidad (m/s)
Temperatura de la superficie del mar
Temperatura (°C)
Ene
Feb
Mar
Abr
May
Jun
Jul
Ago
Sep
Oct
Nov
Dic
Año

Accumulated percentiles



Monthly wind roses

Rosas mensuales de los vientos, 1981-2010 (41°N, 4°E)



Final remarks

- This tool is helping our production staff in their work related with the maritime environment.
- The interactive application gives more flexibility for acquiring maps and graphs for locations or thresholds not included in the Atlas.
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Climate Grid

Software for creating national climate data products and services

Dan Hollis, Ian Edwards, Mark McCarthy

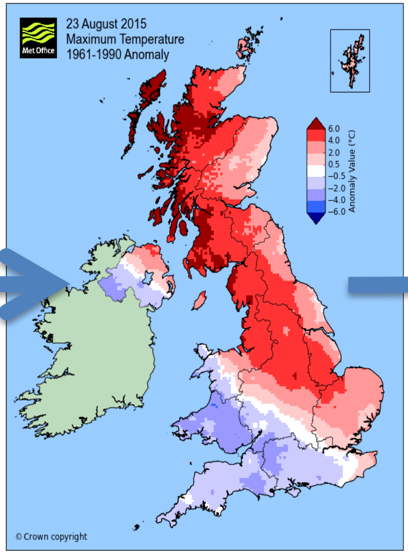
Data Management Workshop, St Gallen, Switzerland, 28-30 October 2015

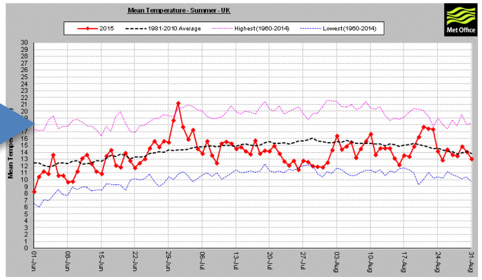
Met Office
Hadley Centre

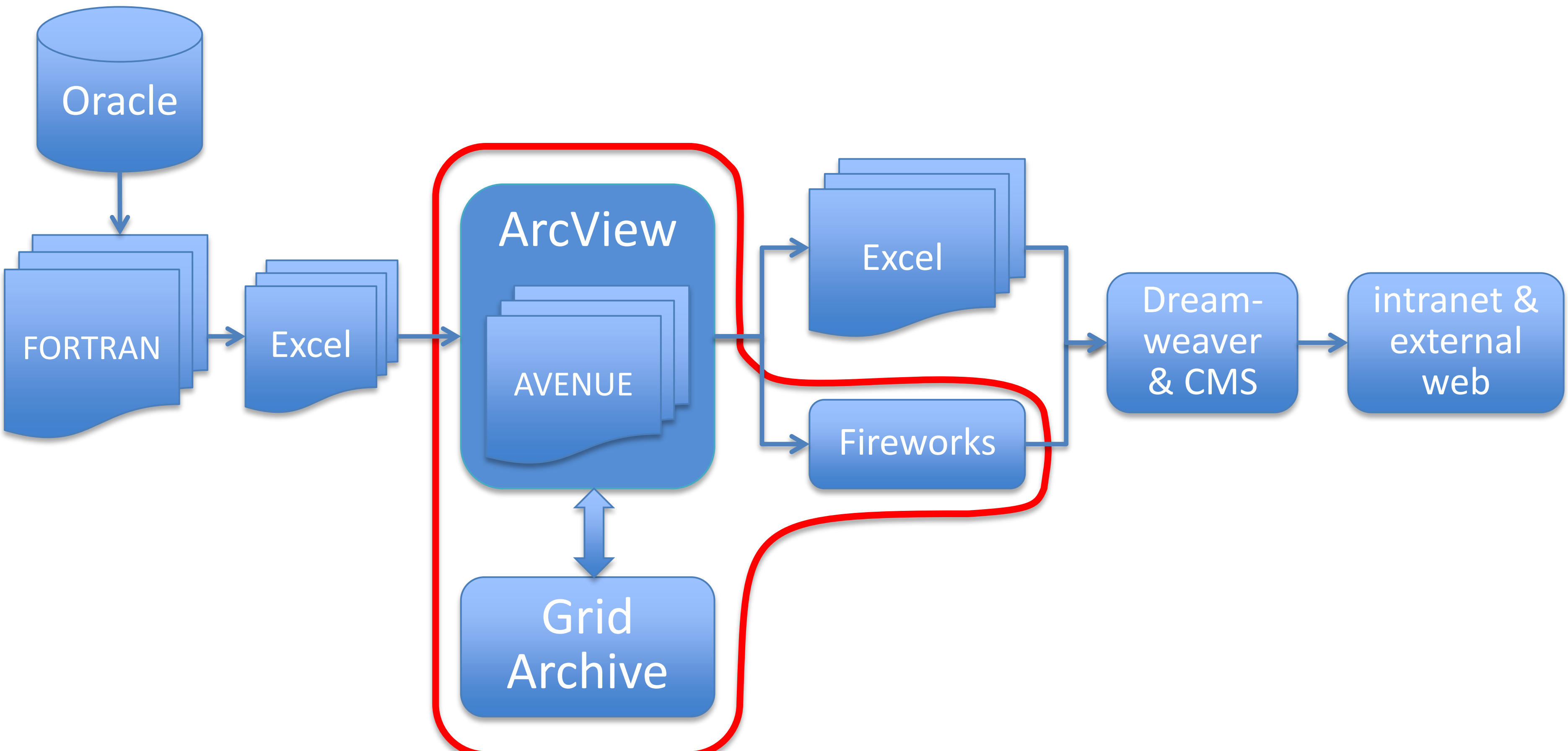
Climate Grid

Aim:

Develop a **portable**, **modular** and **traceable** code base following **open** software standards to provide a tool kit for the generation, exploration and visualisation of UK climate statistics.







Oracle
FORTRAN
Excel
ArcView
AVENUE
Grid Archive
Excel
Fireworks
Dream-weaver & CMS
intranet & external web

Development process

Met Office
Hadley Centre

git

python™

Test-driven
development

Iris 1.8

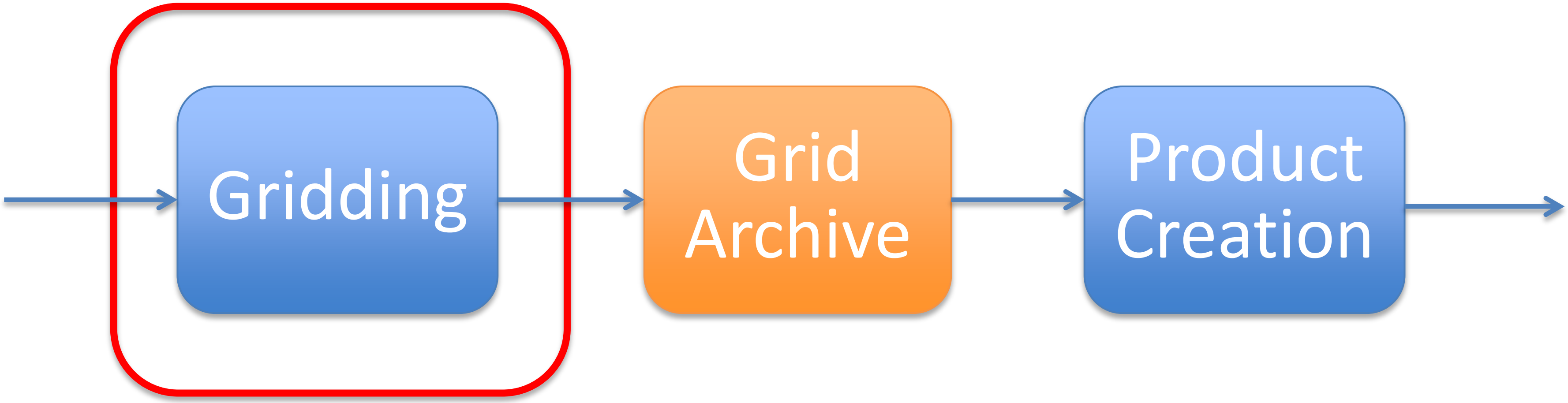
Python library for analysing and visualising meteorological and oceanographic data sets.

http://scitools.org.uk/iris/

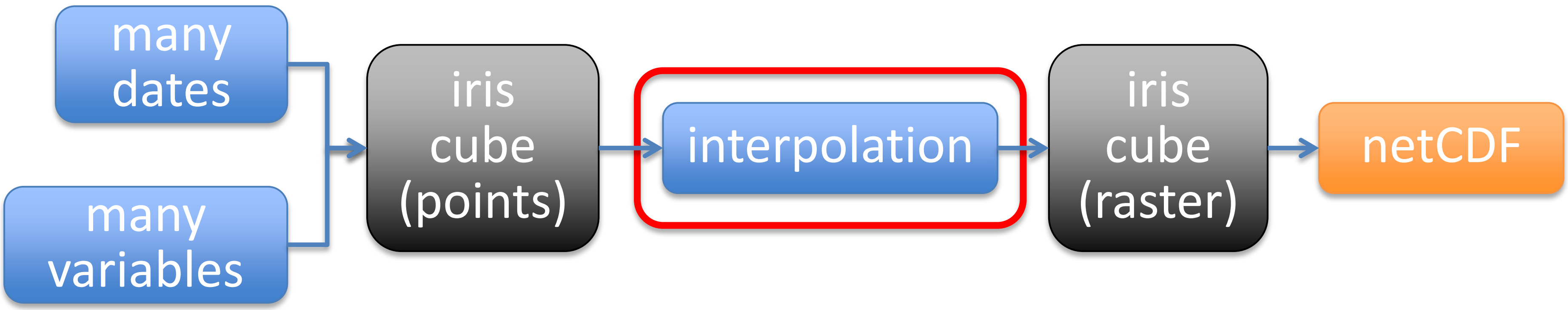
Code refactoring

Met Office
Hadley Centre

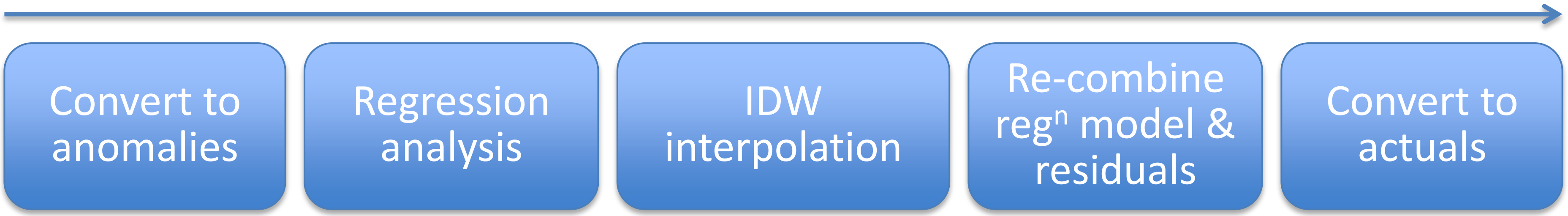
Climate Grid Components



Gridding Overview



Gridding Process



Gridding Process

Convert to anomalies → Regression analysis → IDW interpolation → Re-combine reg^n model & residuals → Convert to actuals

```
idw_actuals()

idw_anomalies()

idw_regression_residual()

idw_regression_residuals_anomalies()
```

Met Office
Hadley Centre

System Configuration

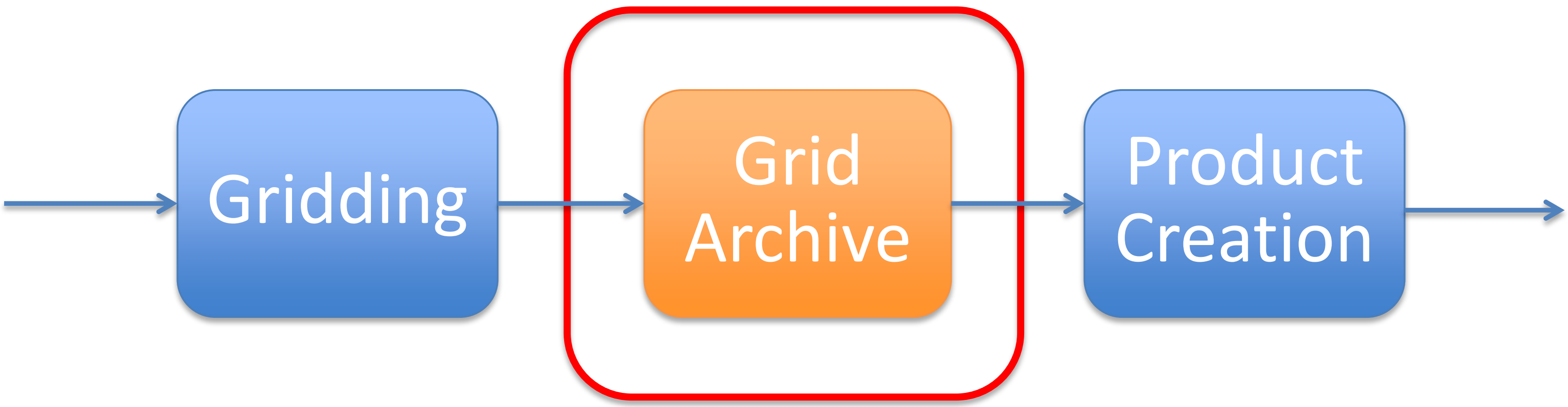
- Paths to system resources
- CF metadata
- Grid definition (extent, projection, resolution etc)
- Gridding method (by variable, month and run type)
- Legends and colours for maps

Indexed via ‘short_name’ = a string combining the temporal resolution and variable name

- e.g. monthly_maxtemp
- e.g. daily_rainfall

- System resources:
  - Station metadata
  - Product templates
  - Region definitions (shapefiles and raster masks)
  - Grids of the independent regression variables

Climate Grid Components



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Grid Archives

Provisional | Final | LTA

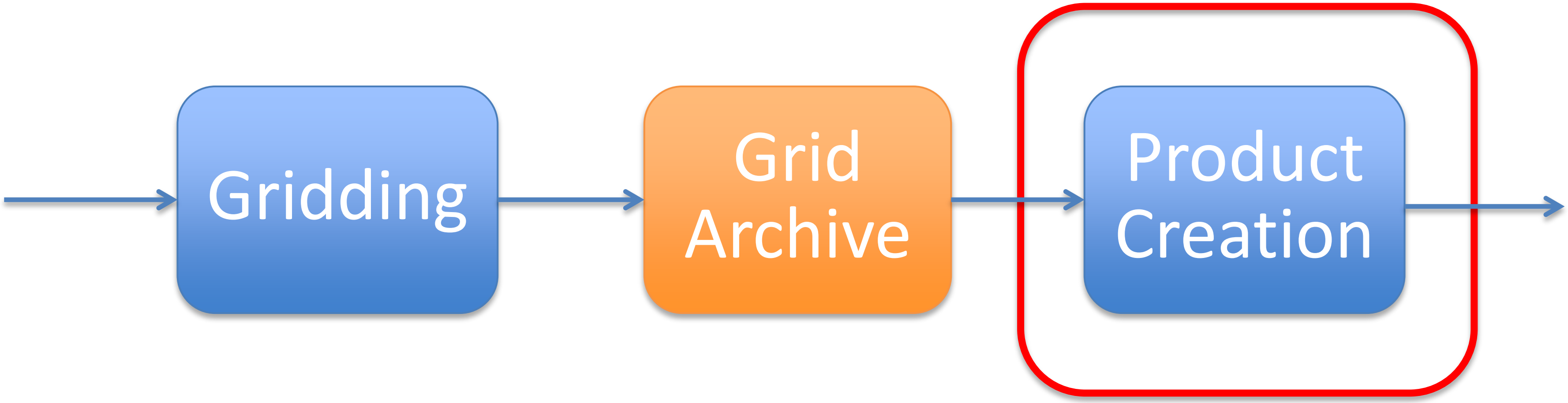
Pre-QC | Test | Historic

```
\grid\variable\year\mm.nc
\station\variable\year\mm.nc
```

```
my_archive = GridArchive(path, ...)

combined_archive = GridArchiveHierarchy(
    final_archive, provisional_archive, historic_archive)
```

Climate Grid Components



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Products and Processes

- Maps
- Regional values
- Grids
- Point values

- Monthly, provisional
- Daily, final
- Services
- Ad hoc products

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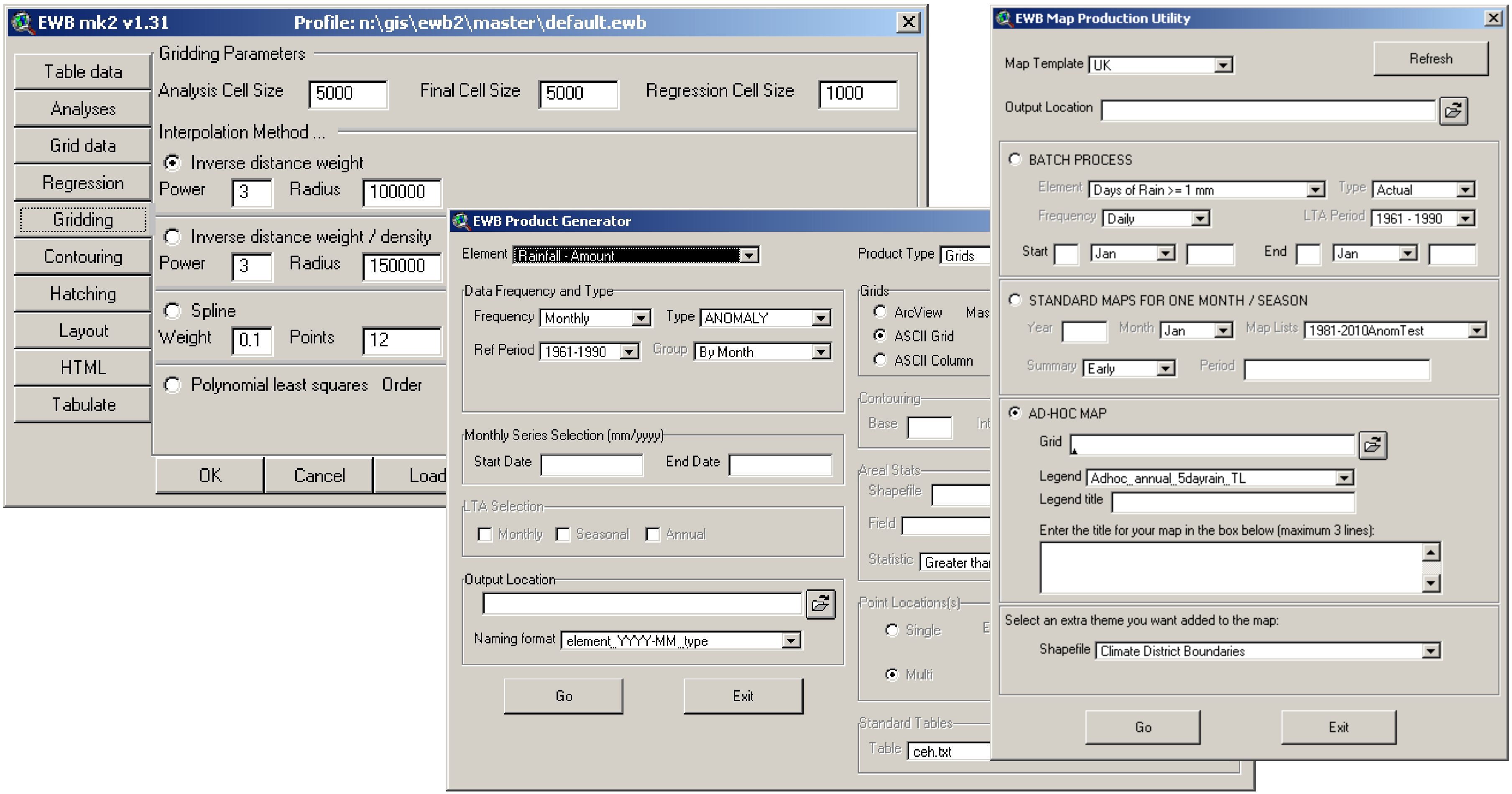
Automation



Automation

`extract_station_data()`

csv file

`gridding()`

netCDF file

`product_creation()`

png file

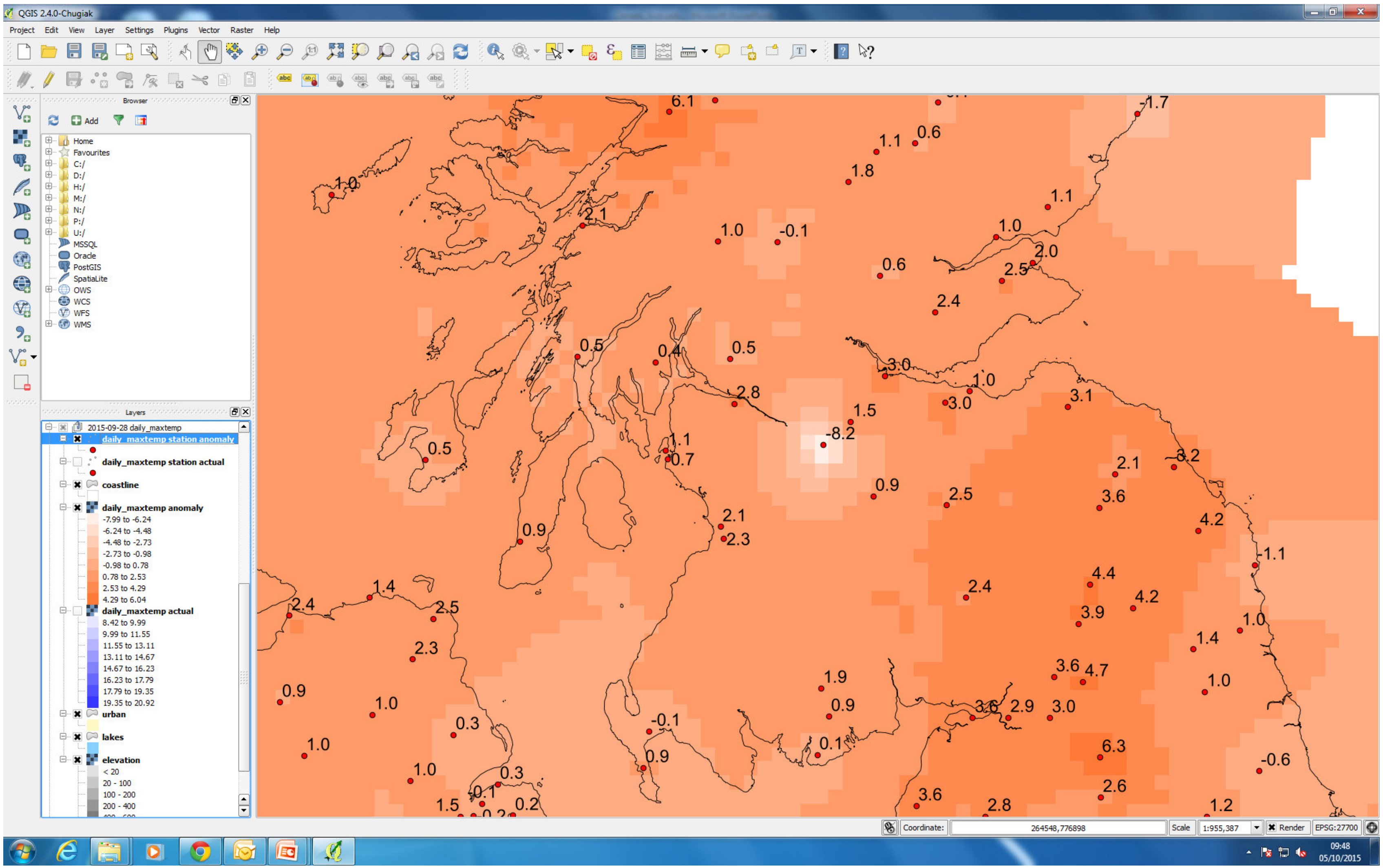
`product_delivery()`

cron

Rose: A framework for managing and running meteorological suites.

http://metomi.github.io/rose/doc/rose.html

Quality Control



Current status

- Software has been used for July, August and September summaries

- No major problems but system is still bedding in (various small issues have needed fixing...)

- Work is ongoing in various areas:
    - Memory issues when working with large networks
    - Automation
    - Quality control
    - Batch processing e.g. multi-month runs
    - Additional system tests
    - Refactoring for open source
    - Documentation

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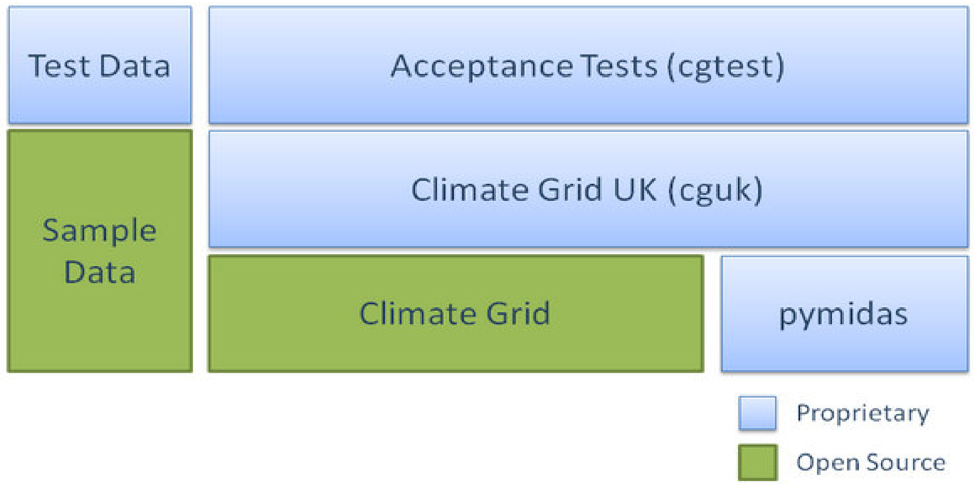
Next Steps: Sharing

Project information



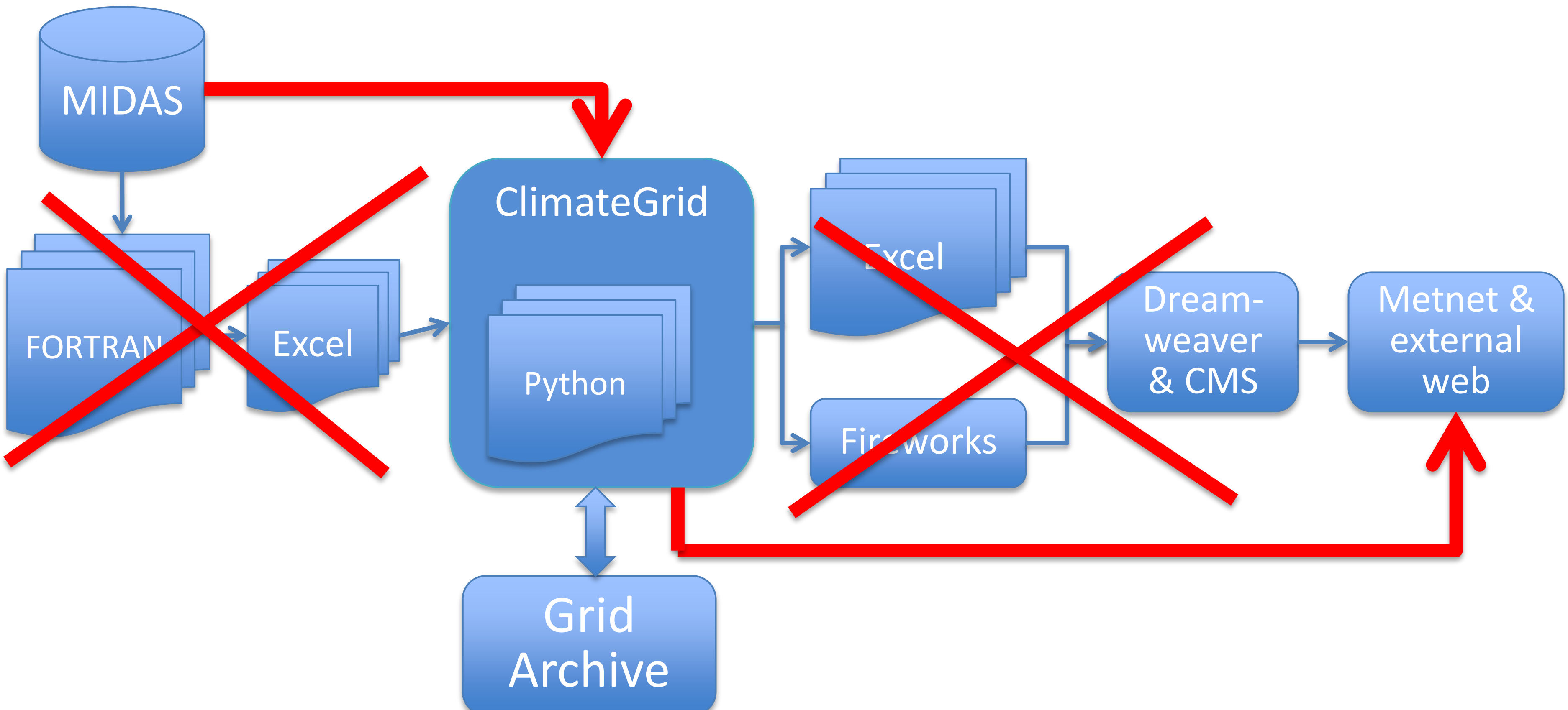
- Transition plan
- Config tables

Documentation

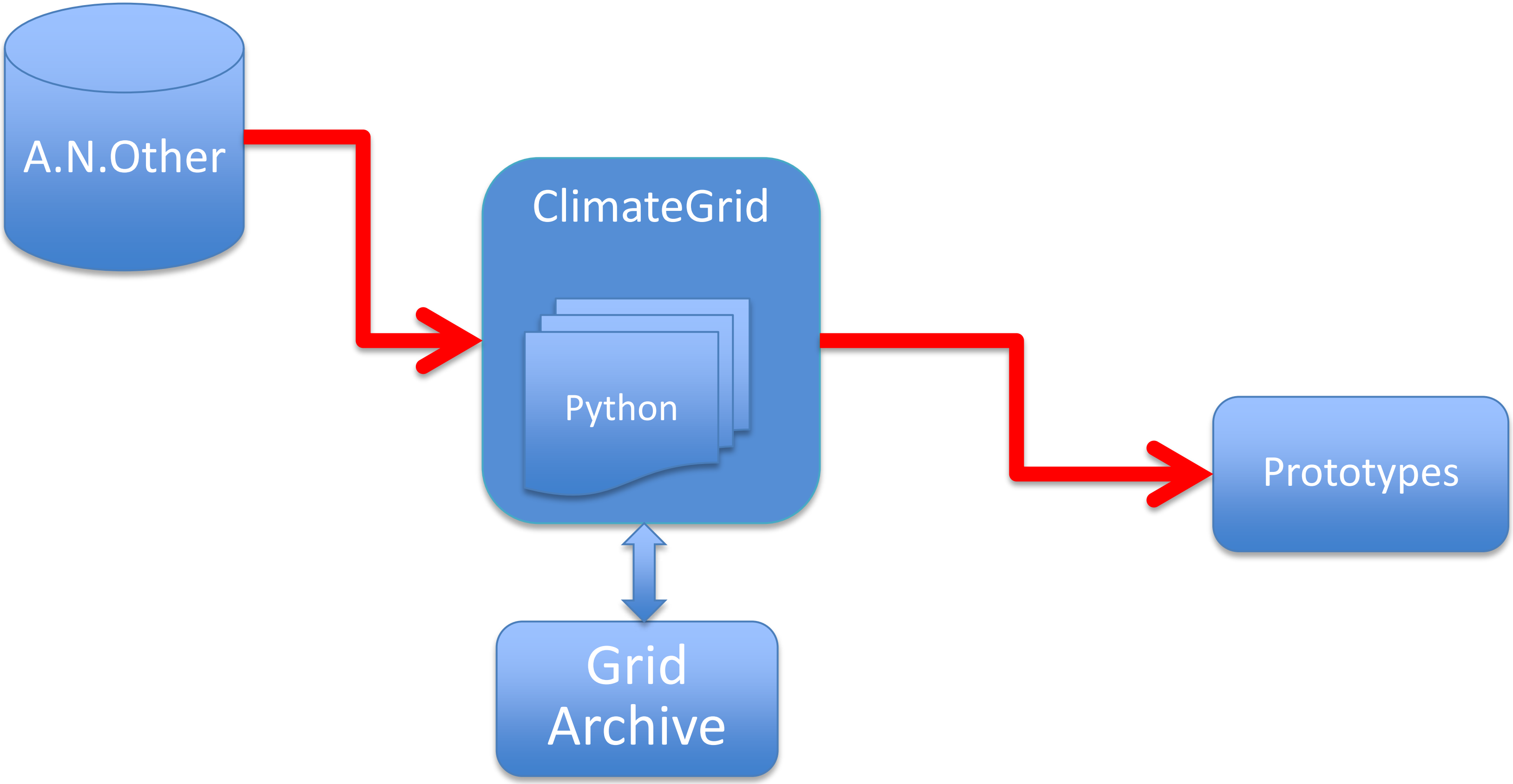
- Climate Grid
- Climate Grid UK
- Climate Grid Acceptance Tests
- pymidas

Climate Grid »

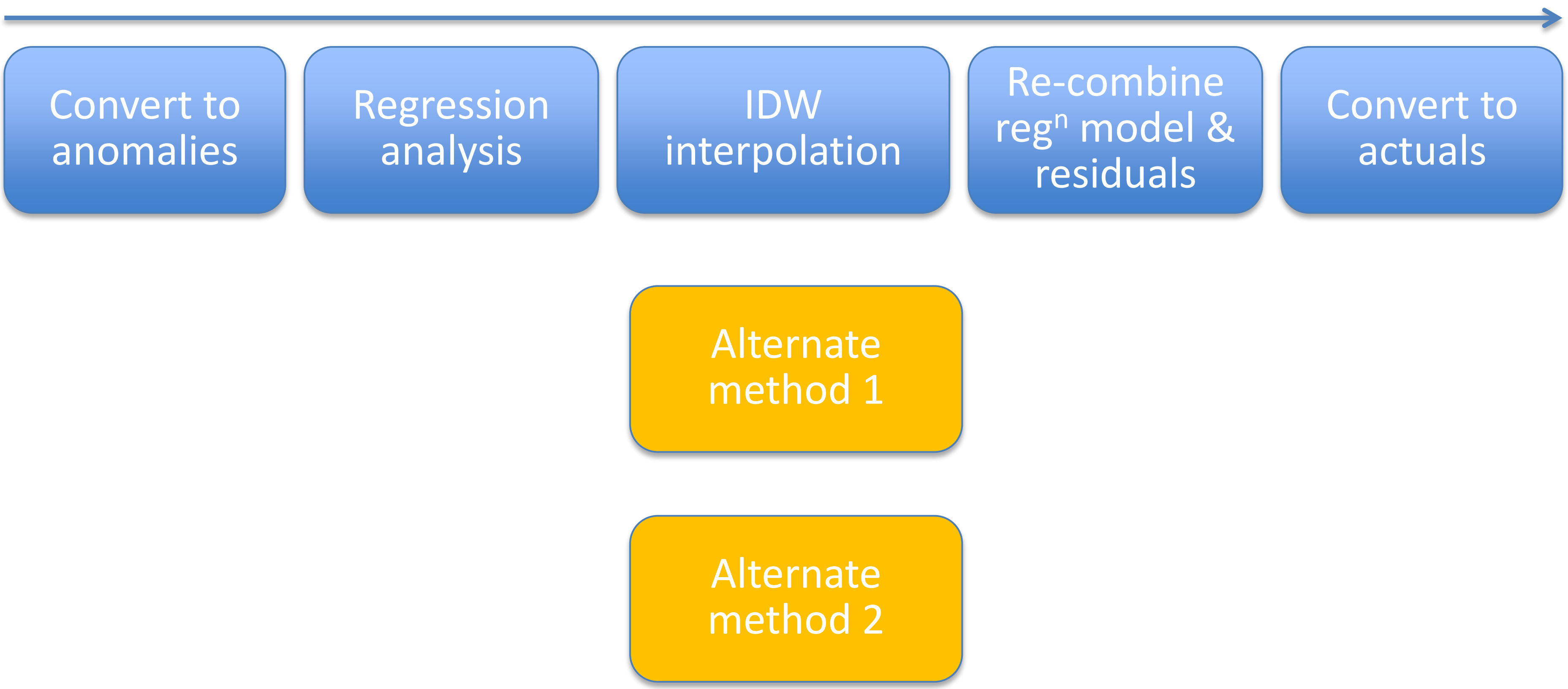
Next Steps: End-to-end



Next Steps: Portability



Next Steps: Methods



Summary

Successful transition

Maintained continuity

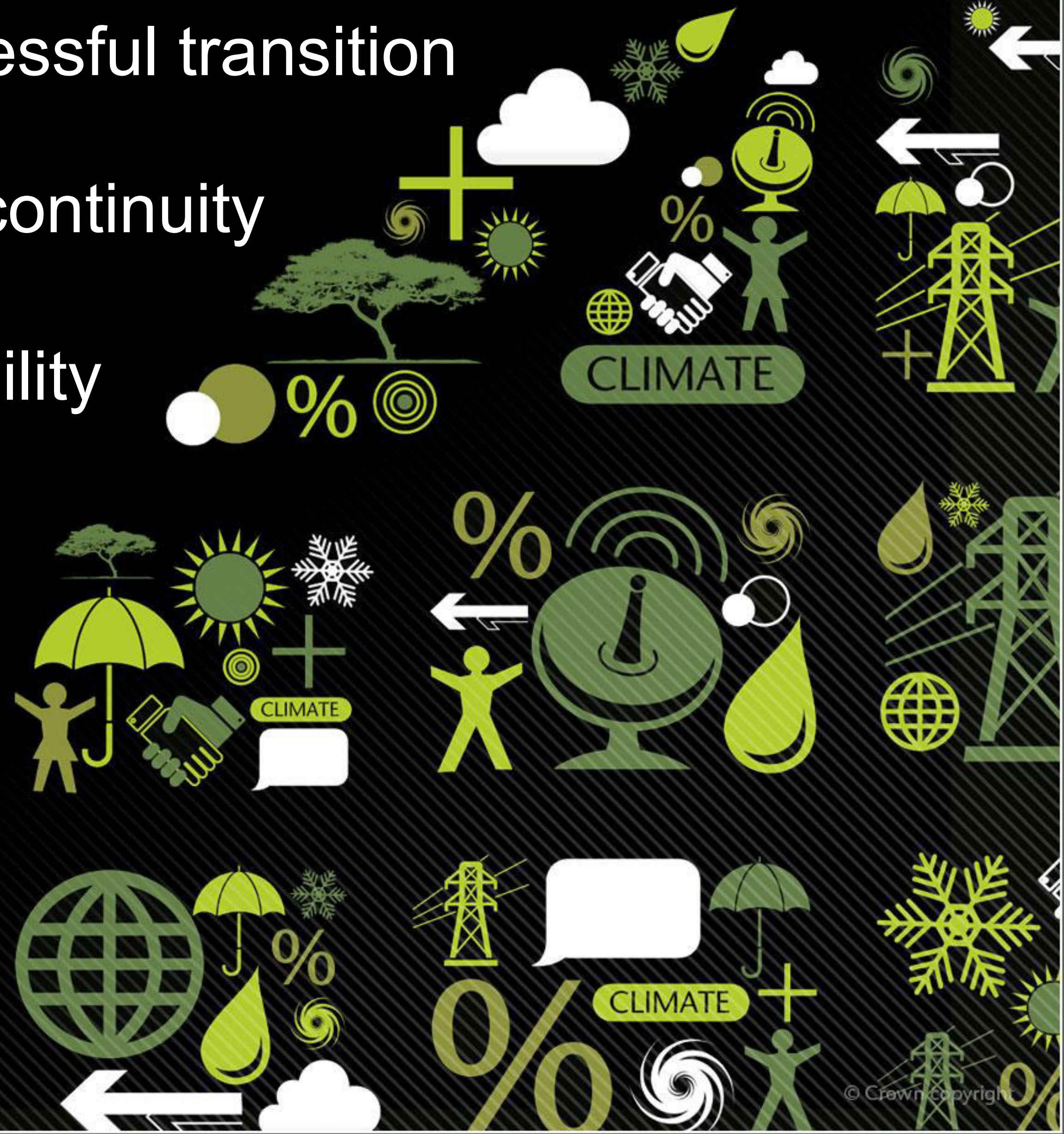
Greater flexibility

Improved skills

Work in progress

Future collaboration

ncic@metoffice.gov.uk



FINNISH METEOROLOGICAL INSTITUTE

Producing a long-term gridded data set in Finland - uncertainty and spatio-temporal trends

Juha Aalto, Pentti Pirinen, Kirsti Jylhä

10th EUMETNET Data Management Workshop,
St. Gallen, Switzerland, 30.10.2015

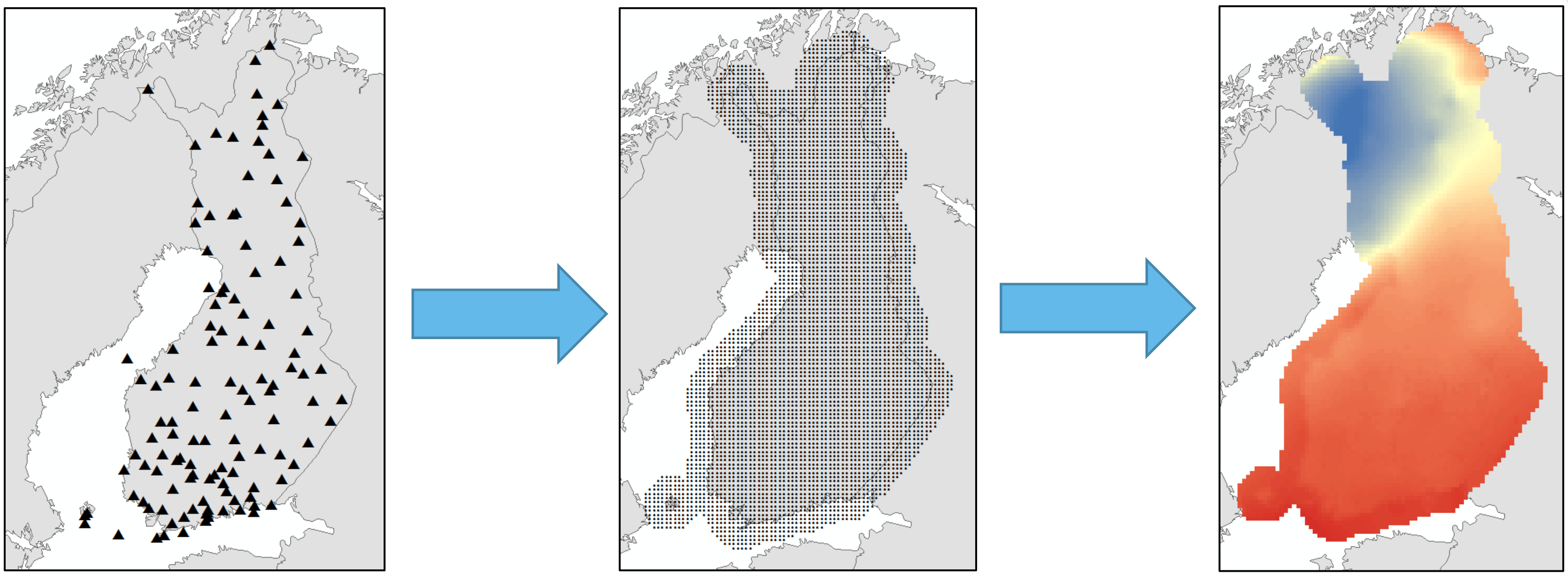
1. Introduction and aims

PLUMES
Pathways linking uncertainties in model projections of climate and its effects

- PLUMES consortium
- **Task: create a high-quality daily gridded climate data set of the key variables across 1961-2010 (”FMI_ClimGrid_1.0”)**
- Focus on interpolation uncertainty
- Use gridded data to investigate temporal trends in climate
- Compare the results with existing data (E-OBS)

1. Introduction – gridded data

- **Spatially continous** data based on a set of observations
- Most often based on a **statistical** model
- Important applications: climate change studies, forest management, agriculture, biosphere modelling, permafrost ….



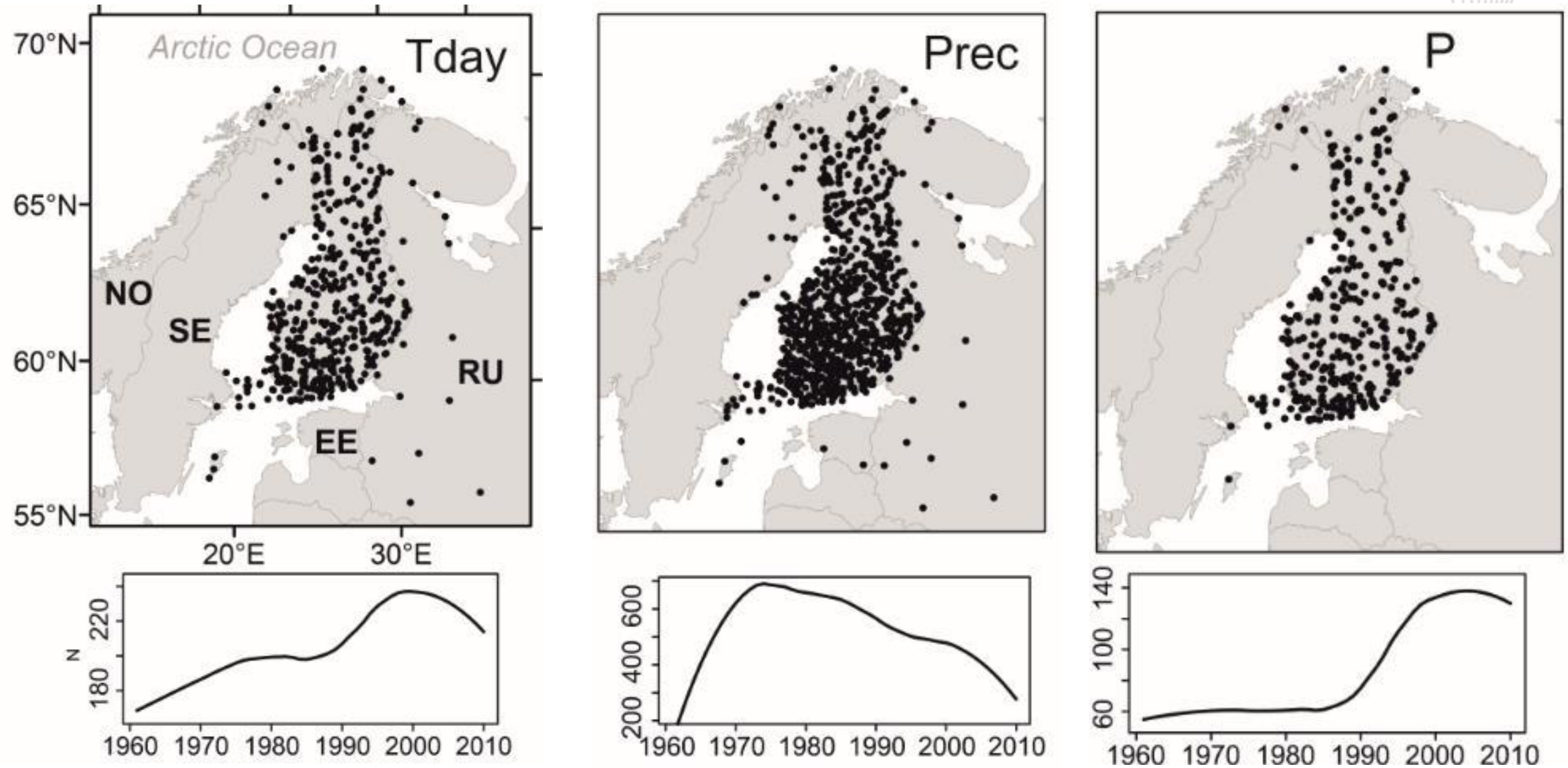
Observations Spatial grid Gridded data

2. Data – observations

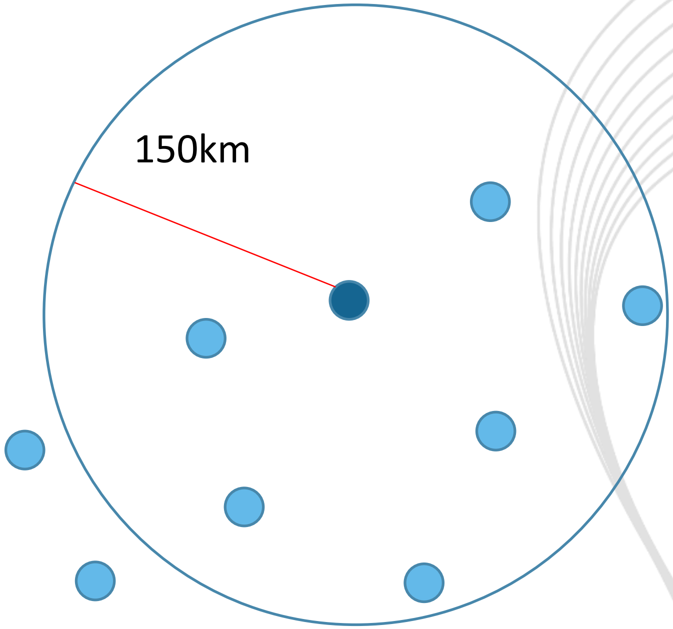
- Seven climate variables:
  - mean temperature (*Tday*)
  - maximum temperature (*Tmax*)
  - minimum temperature (*Tmin*)
  - precipitation sum (*Prec*)
  - mean relative humidity (*RH*)
  - air pressure (*P*)
  - snow depth (*Sn*)

- Data sources:
  - FMI database
  - ECA&D pan-European database
  - Sweden, Norway, Russian and Estonia

2. Data – observations



2. Data – quality control

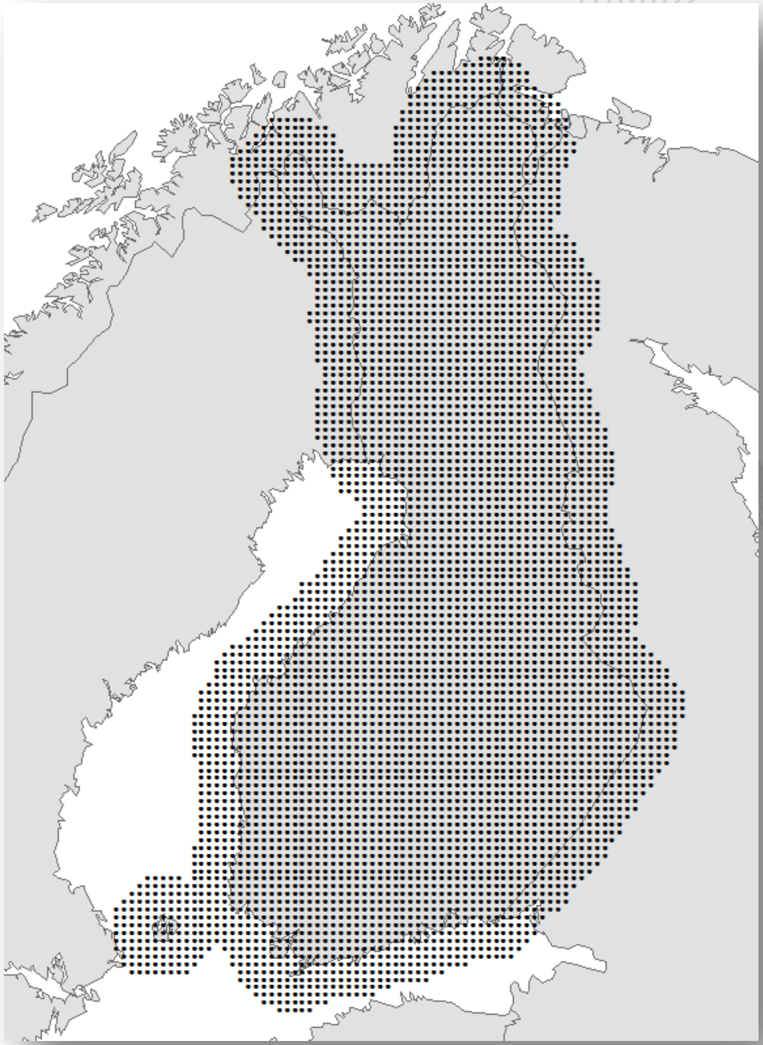


- National operational QC
- ”Non-blended” ECA&D series
- Misscodings, duplicates
- Local outlier detection protocol:

  1. compare each value to local average and stdev (station in turn excluded)
  2. Compare the local stdev to long-term monthly stdev (1961-2010)

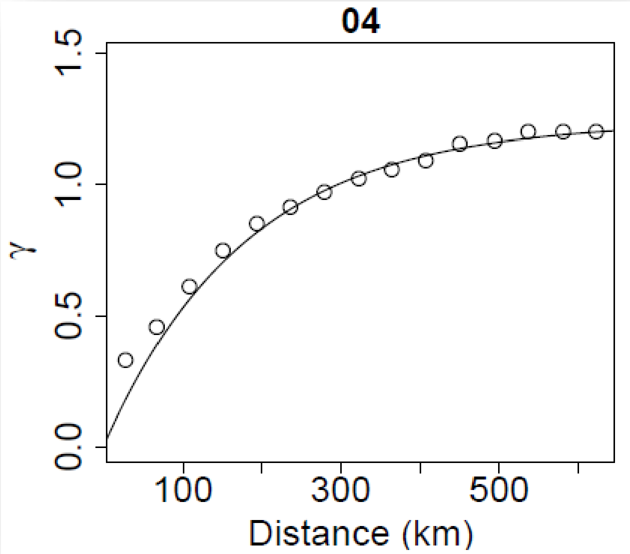
2. Data – grid specifications

- Spatial resolution = 10 km x 10 km
- **Euref-FIN TM35 (epsg: 3067)**
- 5224 points (3364 inside, 1860 outside Finland)



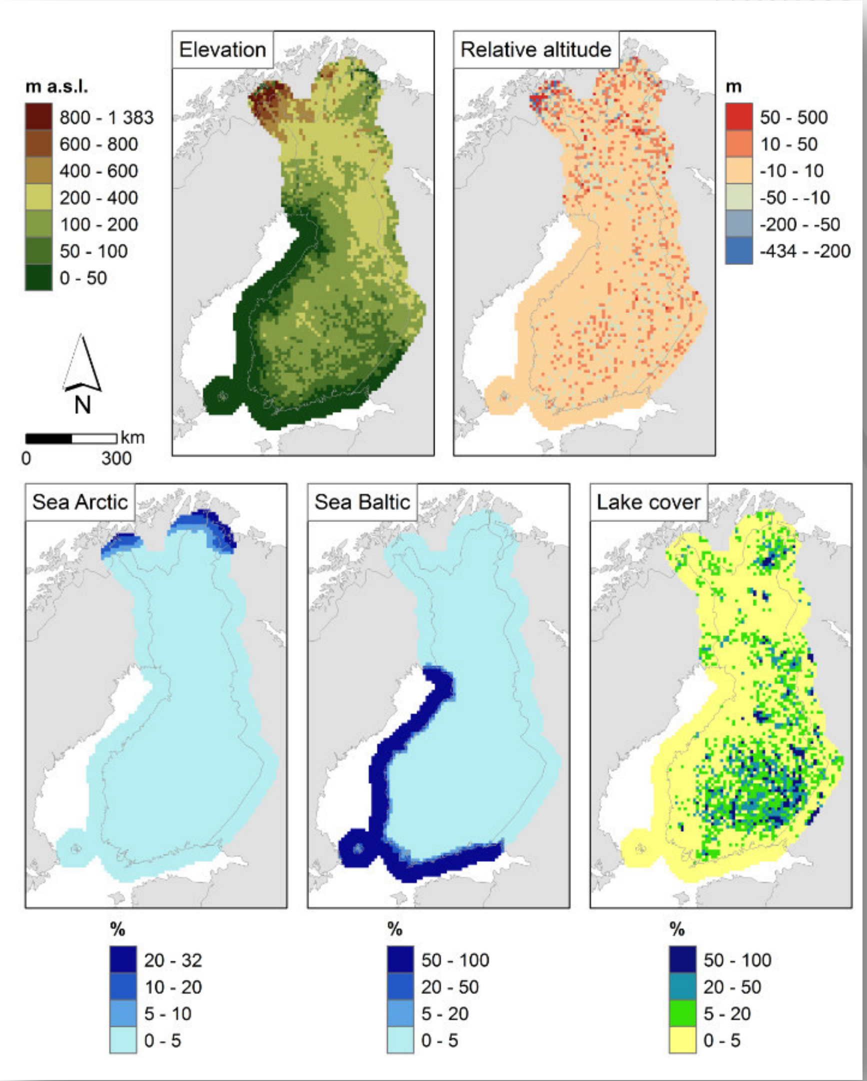
2. Methods – kriging interpolation

- Kriging interpolates the value at given point using **a weighted average of the know values** inside a neighborhood
- Weights are assigned by **(decreasing) function of the distance, based on the spatial covariance structure**
- **Variogram** is used to quantify the spatial dependency in the data



2. Data – background data

- Used as covariates in the interpolation model (i.e. trend model)
- Latitude and longitude

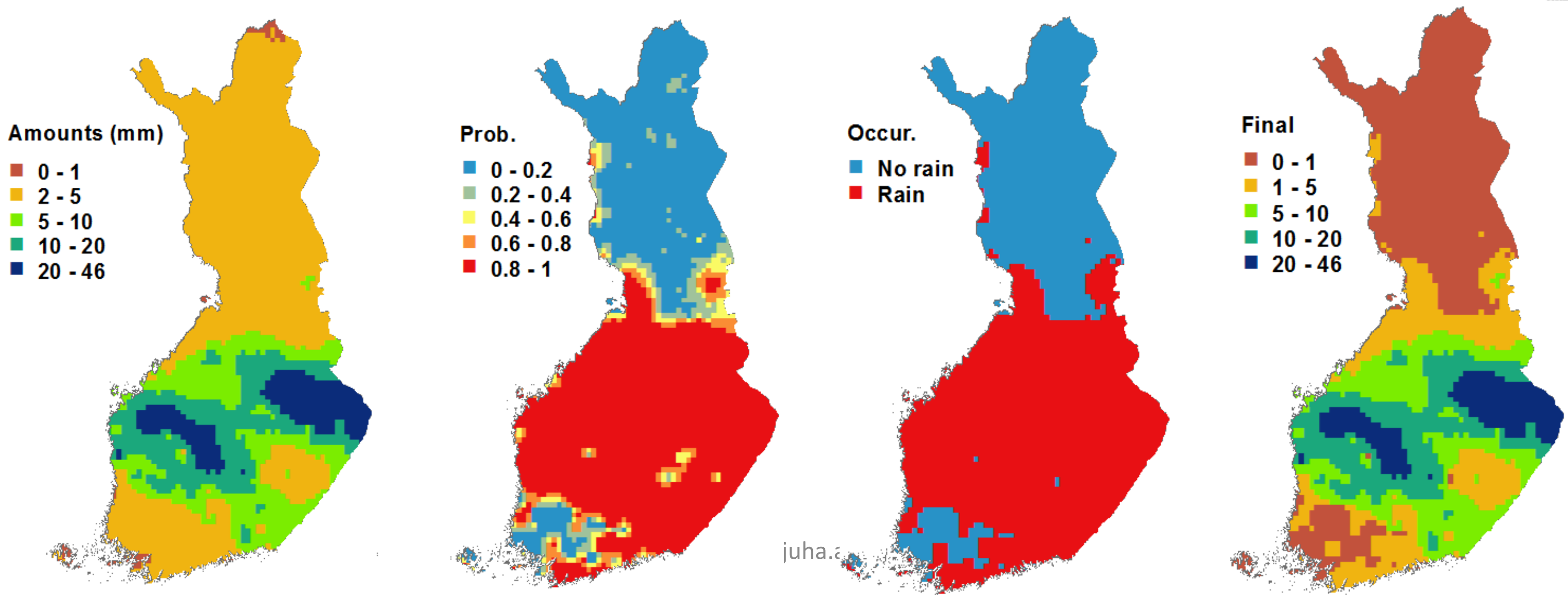


2. Methods – details

- Separate trend model was estimated for each day
- ”Semi” climatological variogram models:
  - Range = monthly means of daily ranges (1961-2010)
  - Separate sill for each day
- Nugget = 30 % of the measurement precision (e.g. 0.03 for Temp)
- Exponential variogrammodels
- Global kriging

2. Methods – interpolating precipitation and snow

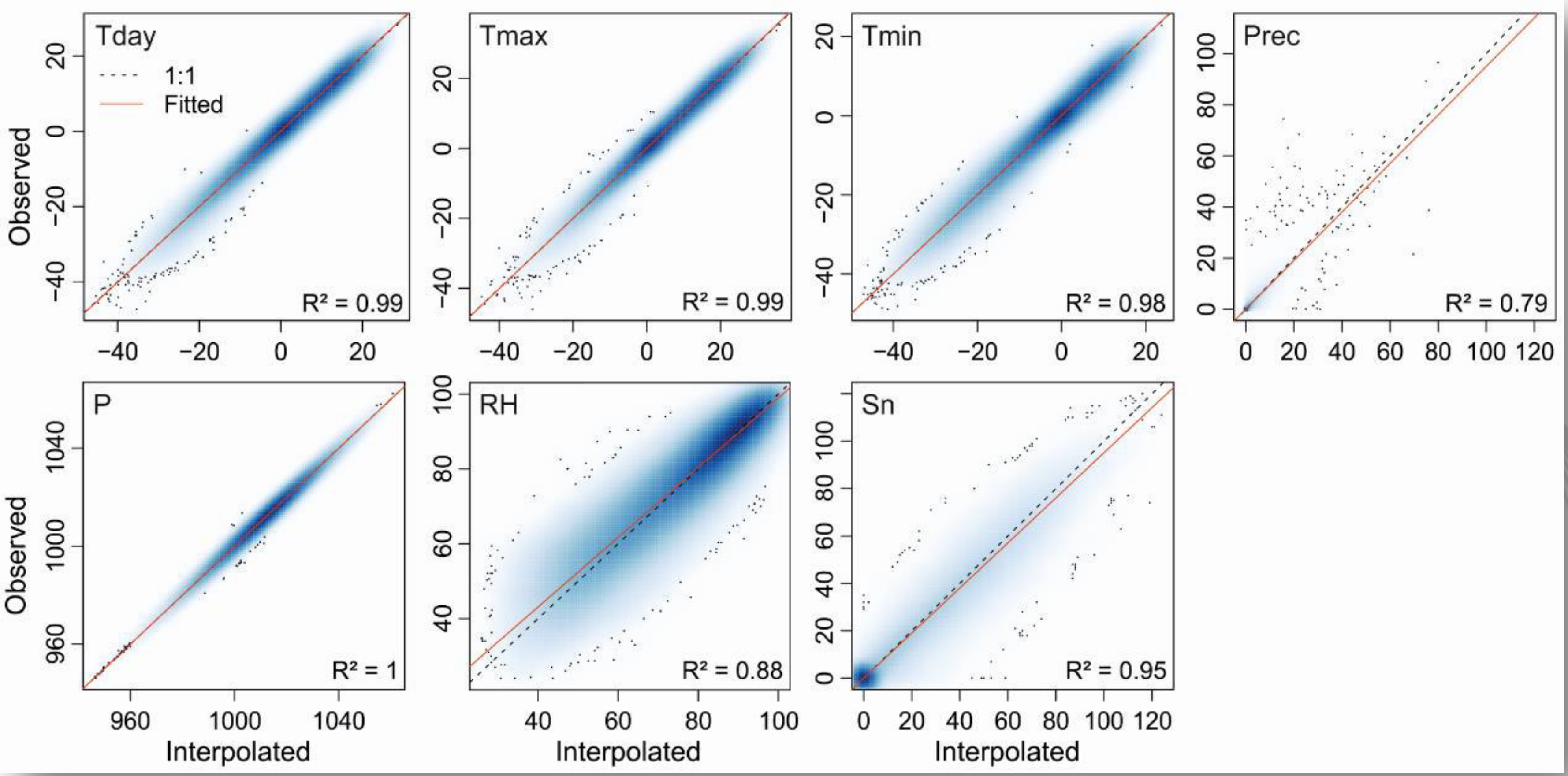
- **High and potentially discrete variation** vs. sparse observation network
- Satellite and radar data might improve
- Solution: **interpolate the probability** of precipitation / snow depth and combine with interpolated amounts



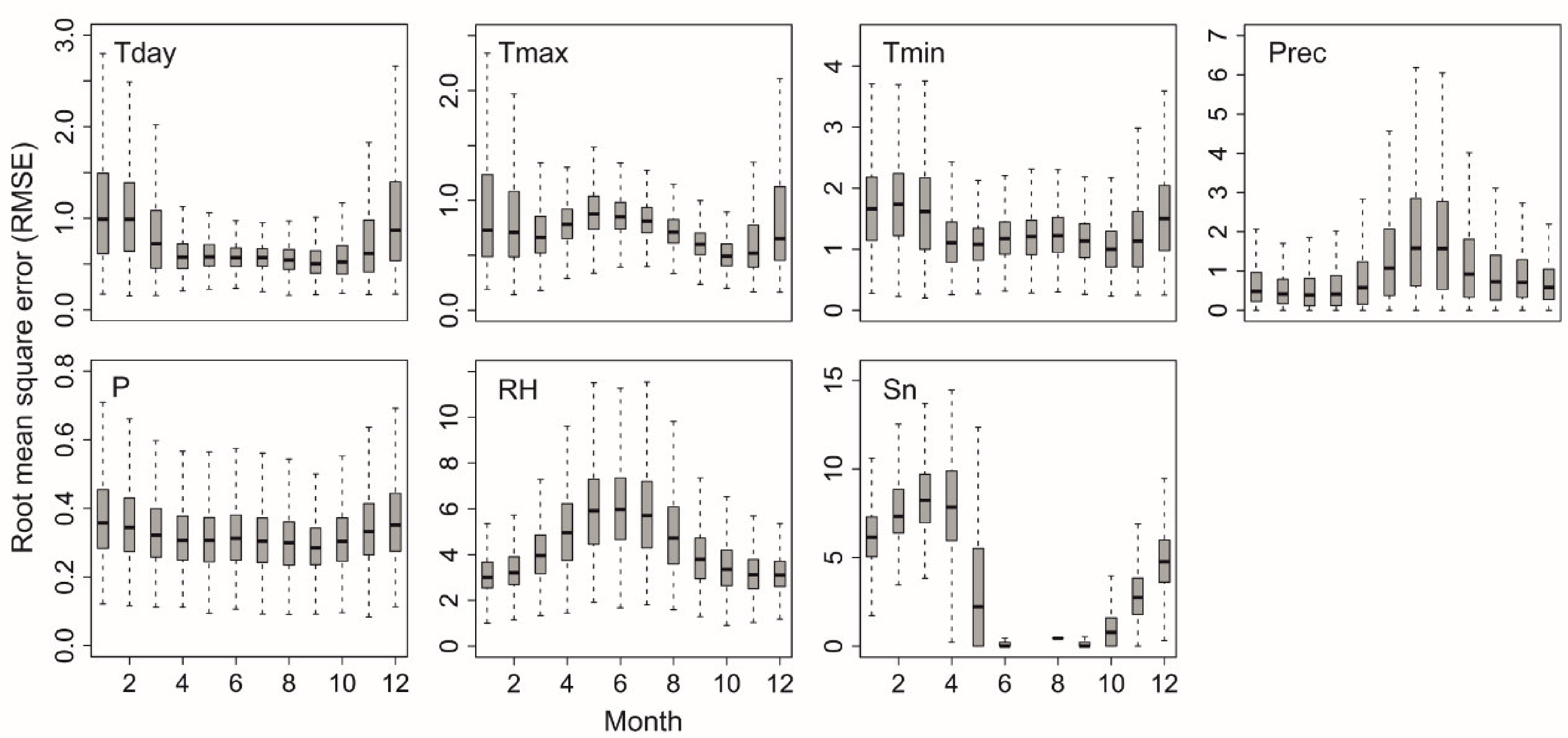
2. Methods - evaluation

- 20 independent evaluation stations
- Compare the observed and interpolated values

3. Results – interpolation accuracy

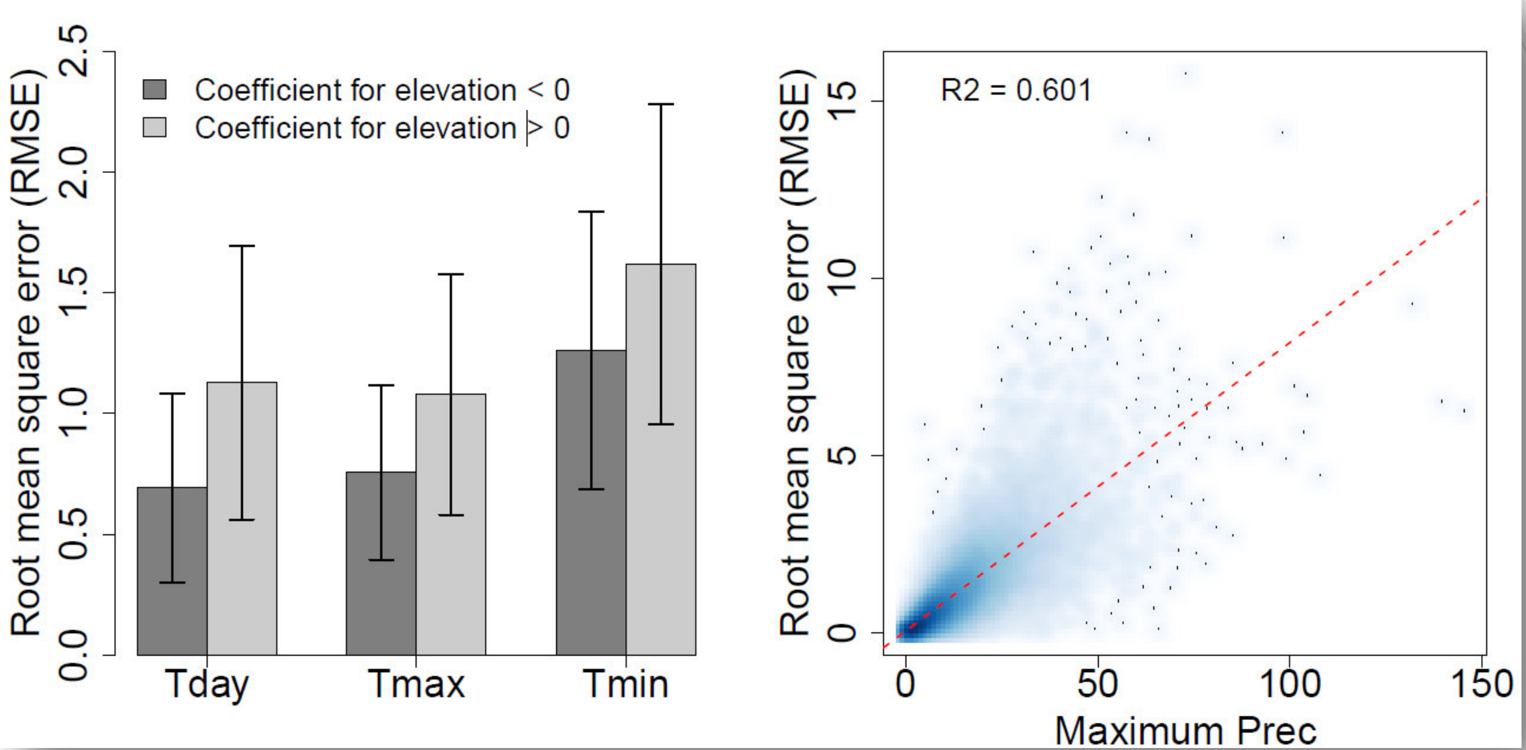


3. Results – seasonal variation in accuracy



3. Results – interpolation accuracy

- Some meteorological conditions are more challenging to interpolate than others…



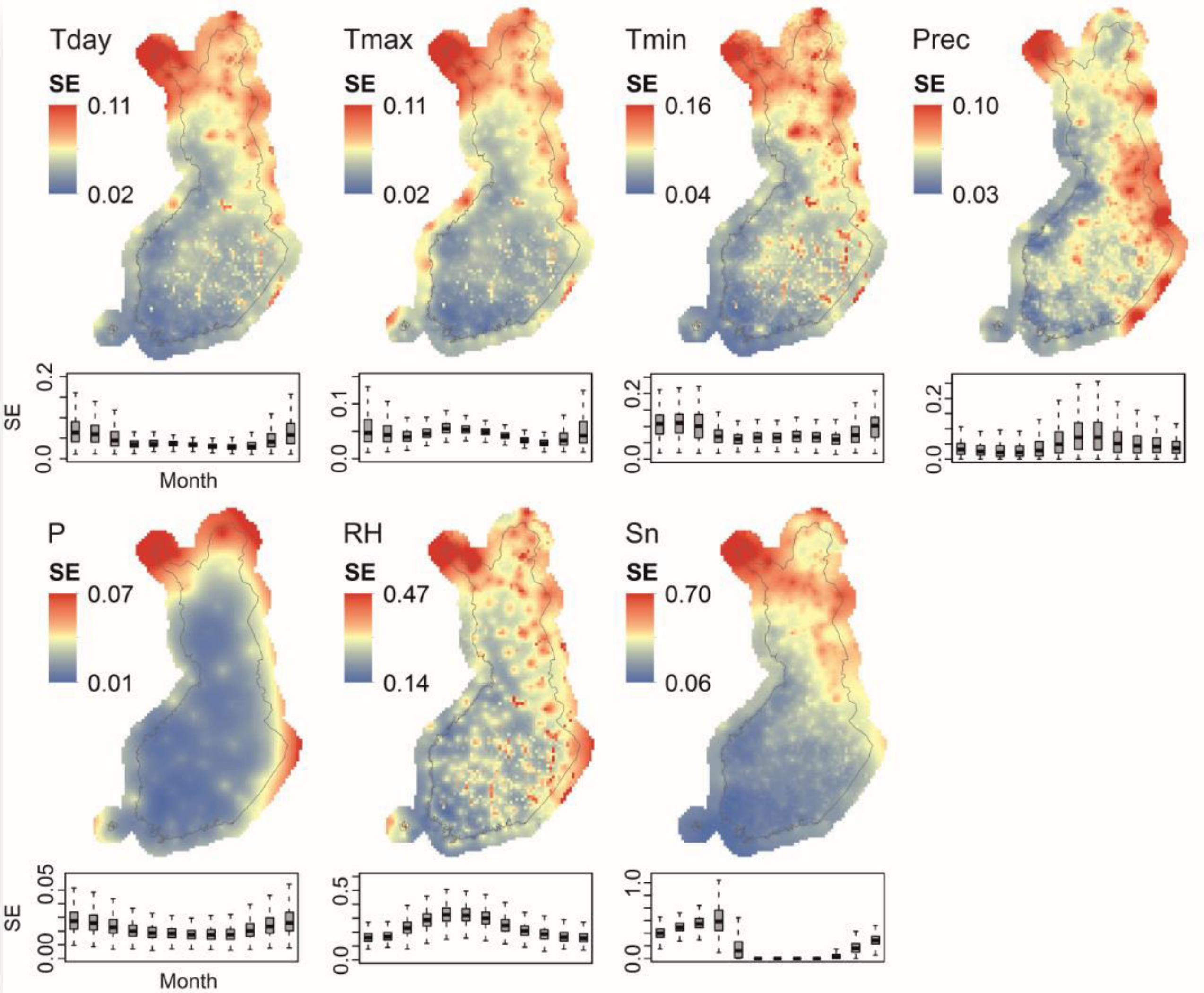
Temperature inversion?

3. Results - uncertainty

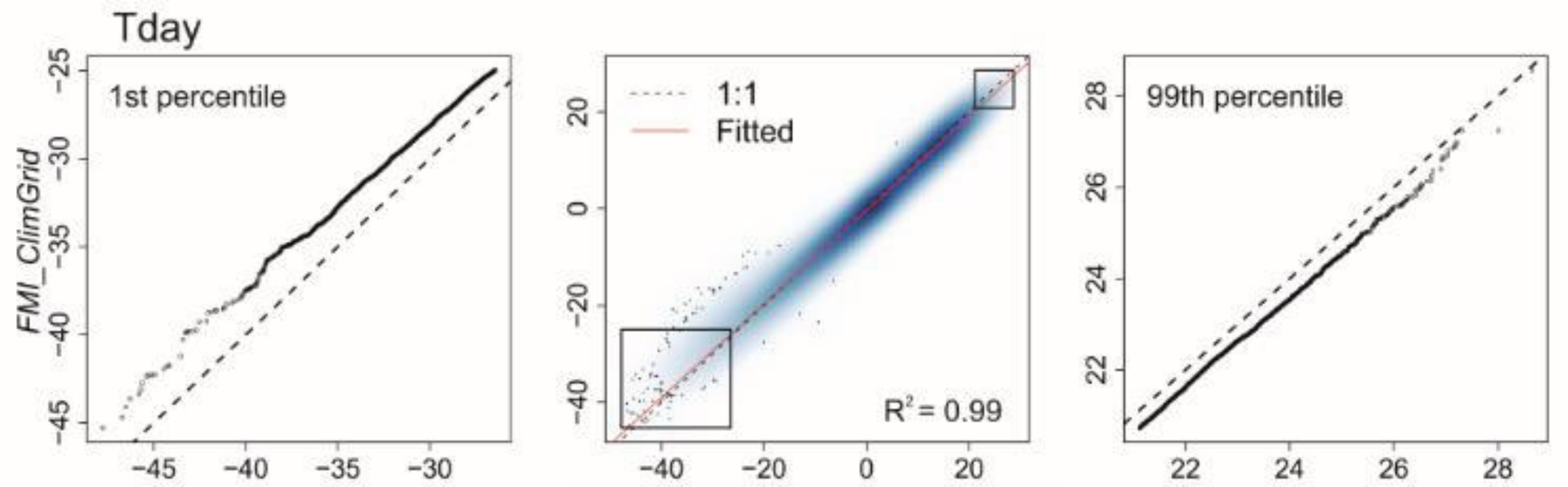
Sources of uncertainty:

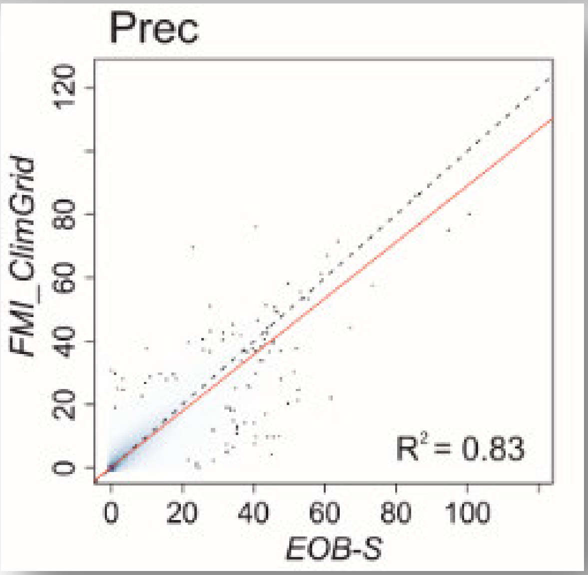
- **Observations** (measurements, network, inhomogeneities …)
- **Background variables** (georeferencing, averaging…)
- **Interpolation method**

- 50 random permutation / day -> 50 different interpolations
- **Daily uncertainty estimate for each variable**

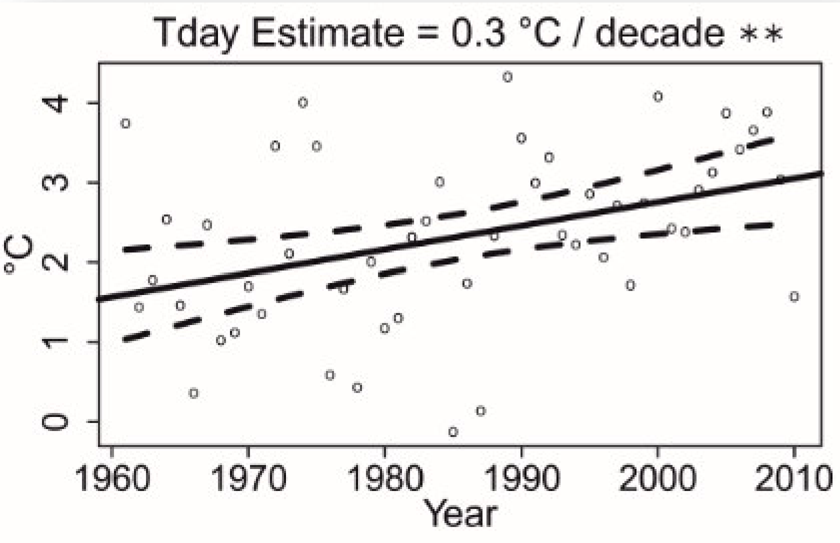


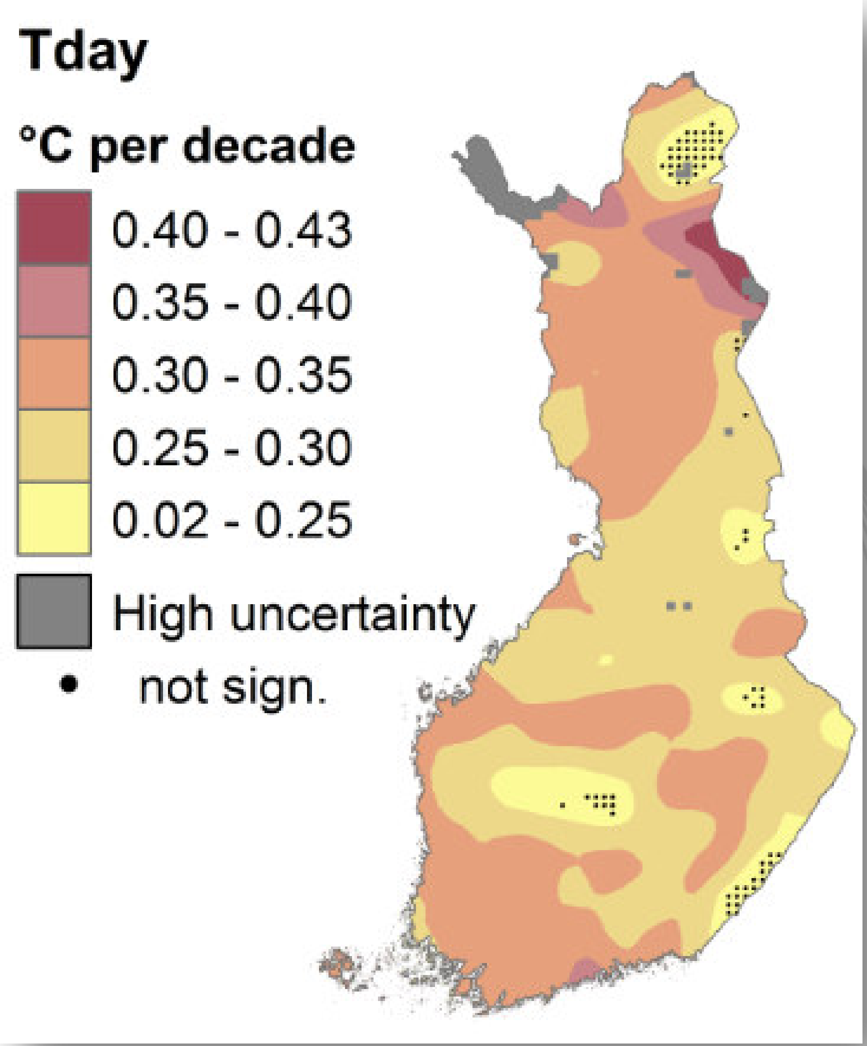
3. Results – a comparison with E-OBS





4. Trends in past climate



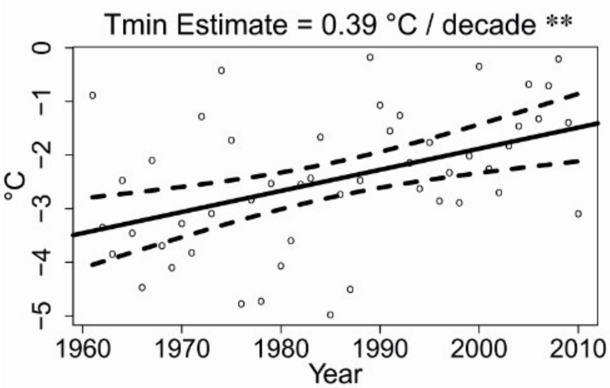


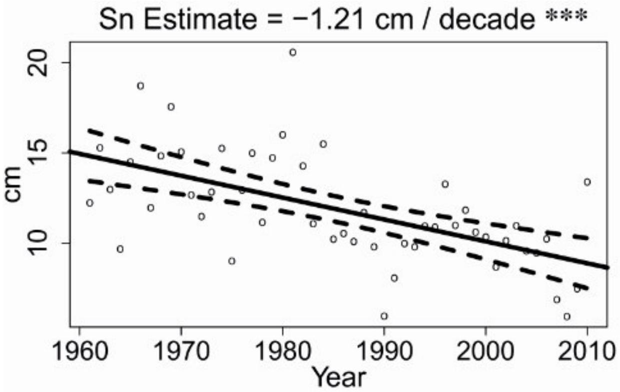
- Daily grid averages

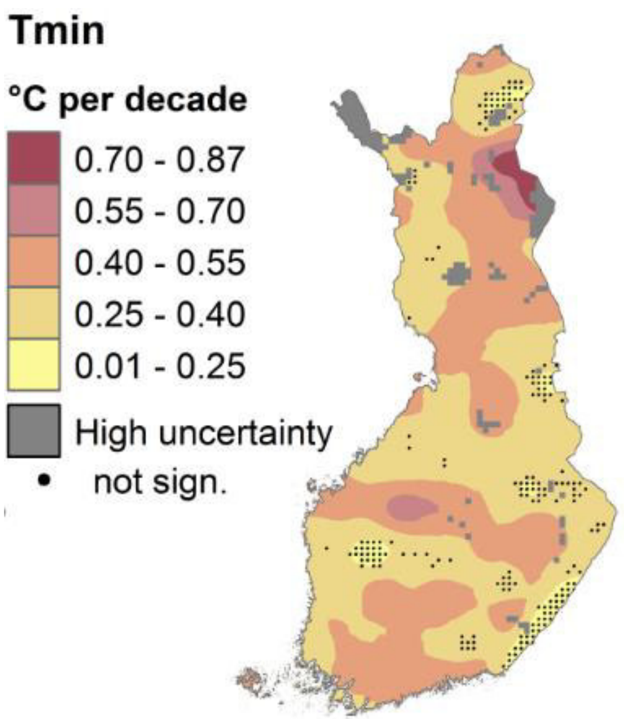
-> seasonal / annual aggregates

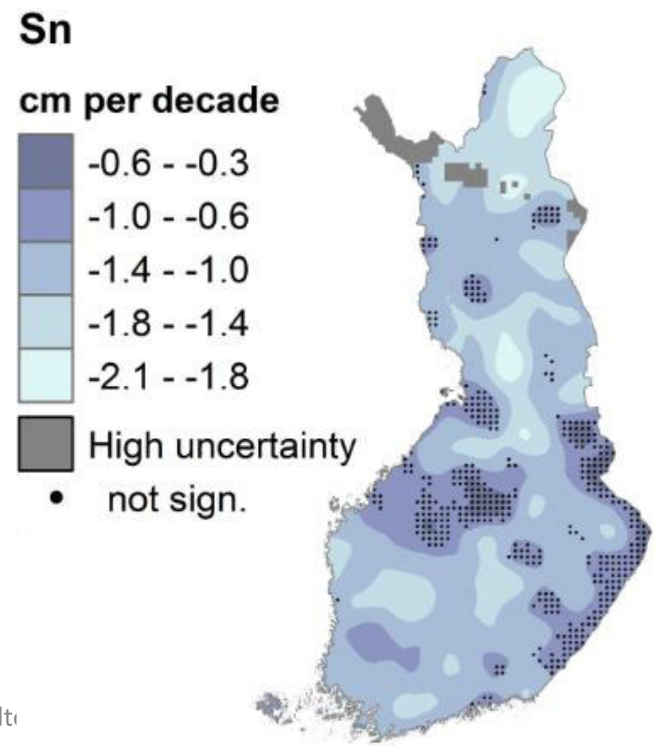
- Most uncertain areas excluded from the trend analysis

4. Trends in past climate









5. Conclusions

- Long-term gridded dataset were succesfully produced
- Daily **permutation-based** uncertainty estimates
- Clear, but locally varying signal of past climate change
- Wind and solar radiation in the future
- The dataset will be made freely available with regular updates
- Manuscript in progress…

Computing environment

- **R** in linux server (FMI supercomputer ”Voima”)
- Required R-packages: **gstat, sp**, rgdal, raster, maptools, PresenceAbsence, Roracle
- Total time of calculations ~ 6 days / per variable

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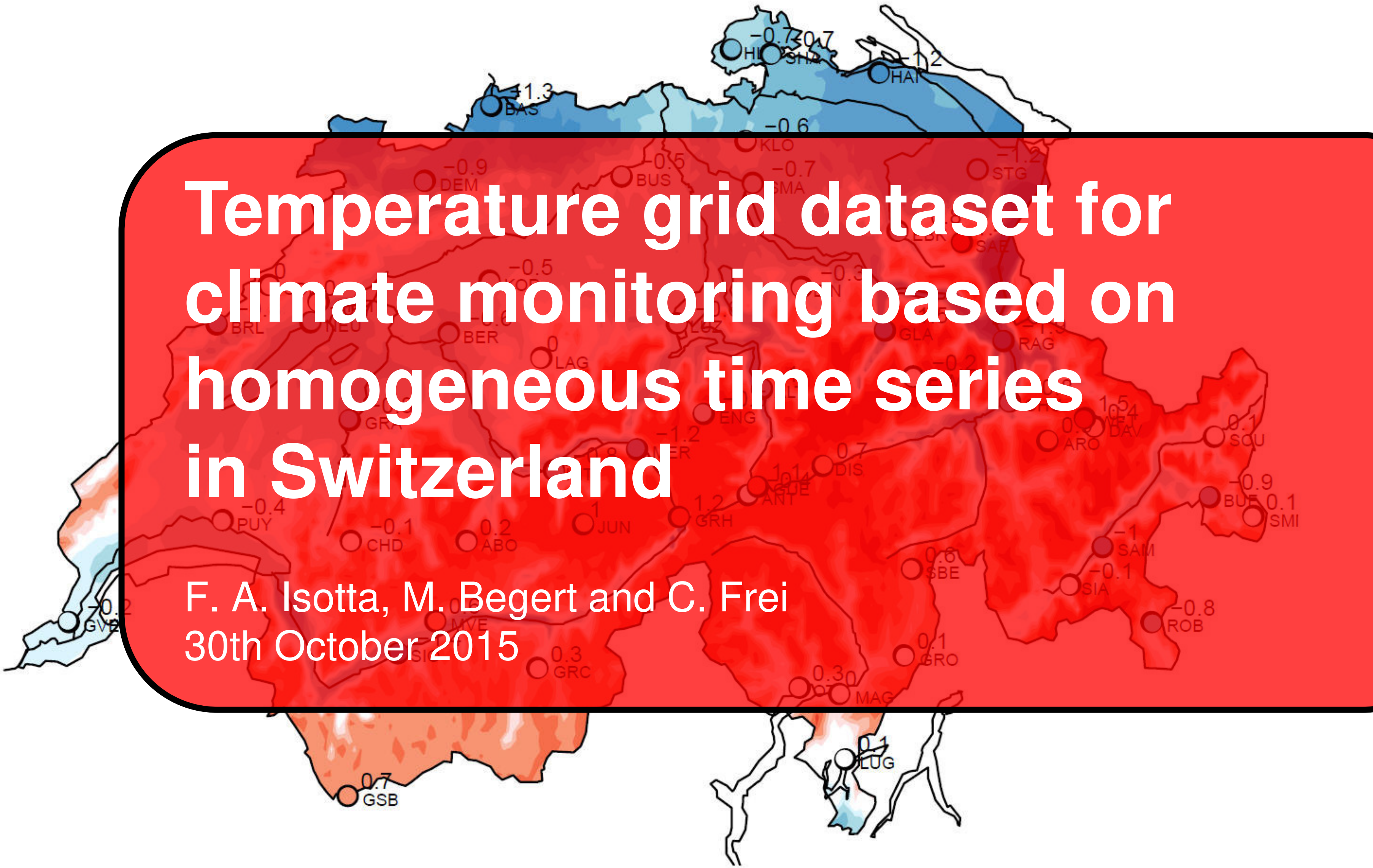
www.fmi.fi

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Confederation

Federal Department of Home Affairs FDHA
Federal Office of Meteorology and Climatology MeteoSwiss



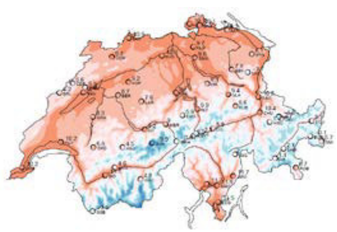
Temperature grid dataset for climate monitoring based on homogeneous time series in Switzerland

F. A. Isotta, M. Begert and C. Frei

30th October 2015

Content

Introduction: motivation, method



Results and evaluation

Conclusion and outlook

Content

Introduction: motivation, method

Results and evaluation

Conclusion and outlook

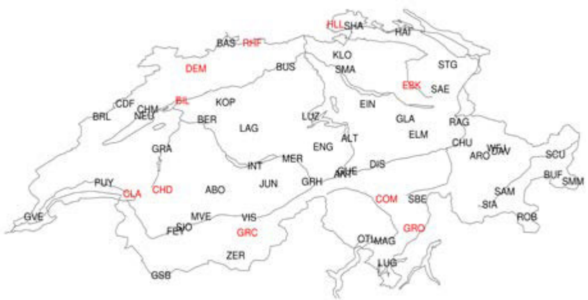
Introduction - Motivation

- Develop new datasets for monthly temperature and precipitation suitable for climate monitoring (regularly updated)
  - (1864-) 1901-2010 (-now) and 1961-2010 (-now)
  - Only with homogenized station data
  - Continuous measurements (no gaps)
  - Constant station density (same stations every time step)

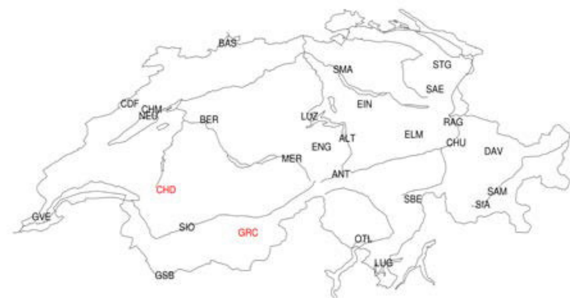
Introduction - Motivation

- The amount of stations fulfilling all requirements is low

	Temperature	Precipitation
1864-2010	18	14
1901-2010	28	39
1961-2010	57	336



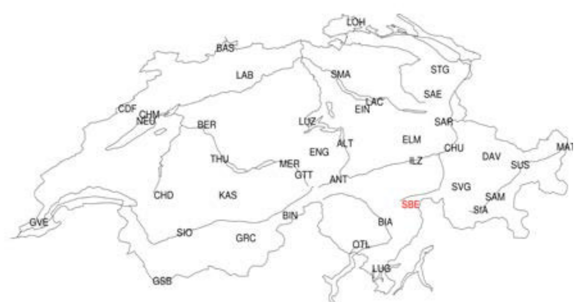
T, 1961-2010, 57 stations



T, 1901-2010, 28 stations

T, 1864-2010, 18 stations

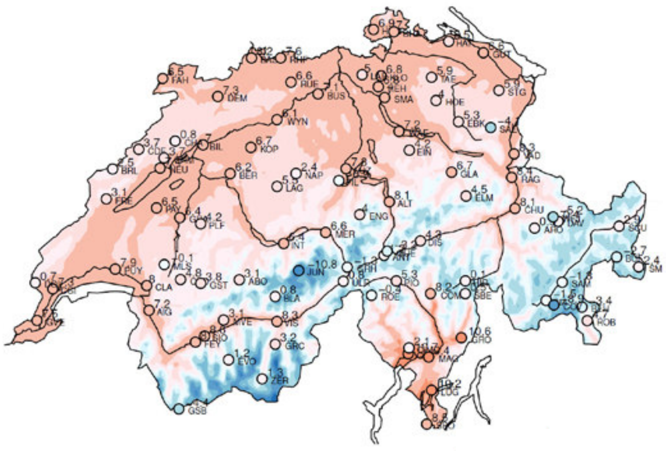
P, 1961-2010, 336 stations



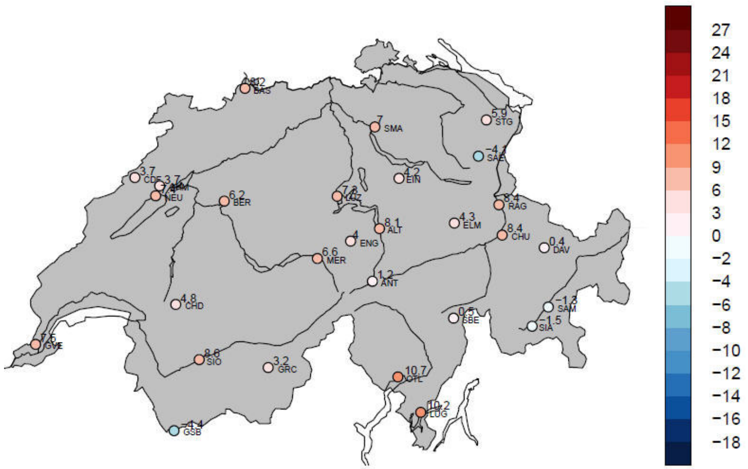
P, 1901-2010, 39 stations

P, 1864-2010, 14 stations

Introduction - Method



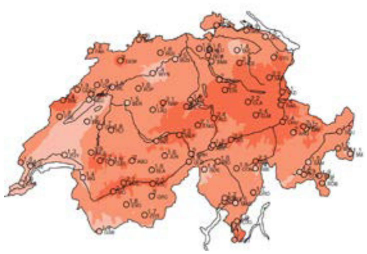
High-resolution component
1981-2010, ~85 stations
2-km grid dataset



Long-term component
1901-2010
28 stations (continuous)

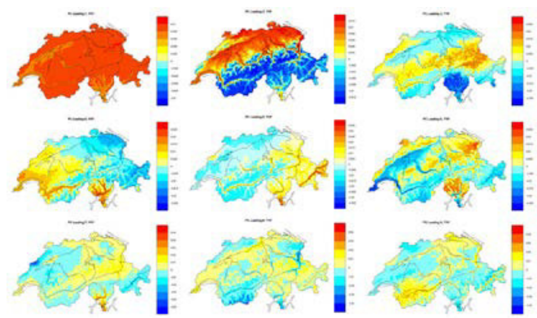
RSOI - Overview

- **<u>R</u>educed <u>S</u>pace <u>O</u>ptimal <u>I</u>nterpolation** (<u>Kaplan et al., 1997</u>; Schmidli et al. 2001, 2002; Schiemann et al., 2010; Masson et al., 2015)



High-resolution component
CALIBRATION PERIOD (1981-2010)
(anomalies, data transformation if needed)

PCA →



PC loadings
Dimensionality reduction (truncation)

\+

$data

	station	time	value
1	ALT	200203010000	2.43
2	ANT	200203010000	1.60
3	BAS	200203010000	1.59
4	BER	200203010000	1.52
5	CDF	200203010000	1.88
6	CHD	200203010000	2.18
7	CHM	200203010000	1.98
8	CHU	200203010000	2.46
9	DAV	200203010000	1.71
10	EIN	200203010000	2.28
11	ELM	200203010000	2.36
12	ENG	200203010000	2.07
13	GRC	200203010000	2.00
14	GSB	200203010000	1.41
15	GVE	200203010000	1.27
16	LUG	200203010000	1.85
17	LUZ	200203010000	1.85
18	MER	200203010000	2.29

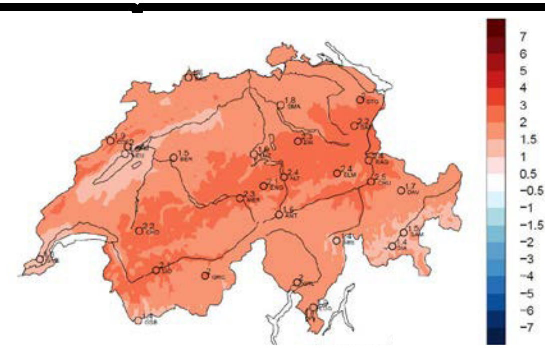
Station data (sparse network)
CALIBRATION PERIOD (1981-2010) (transformed if needed)

Station data (sparse network)
RECONSTRUCTION PERIOD (1901-2010) (transformed if needed)

$data

	station	time	value
1	ALT	200203010000	2.43
2	ANT	200203010000	1.60
3	BAS	200203010000	1.59
4	BER	200203010000	1.52
5	CDF	200203010000	1.88
6	CHD	200203010000	2.18
7	CHM	200203010000	1.98
8	CHU	200203010000	2.46
9	DAV	200203010000	1.71
10	EIN	200203010000	2.28
11	ELM	200203010000	2.36
12	ENG	200203010000	2.07
13	GRC	200203010000	2.00
14	GSB	200203010000	1.41
15	GVE	200203010000	1.27
16	LUG	200203010000	1.85
17	LUZ	200203010000	1.85
18	MER	200203010000	2.29

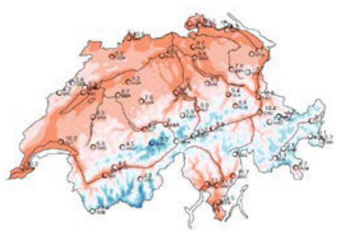
→ OI



Reconstruction (sparse network)
RECONSTRUCTION PERIOD (1901-2010) (back-transformed if needed)

Content

Introduction: motivation, method



Results and evaluation

Conclusion and outlook

RSOI – Results and evaluation

- Calibration period: 1981-2010
- Reconstruction period: 1961-2010, 1901-2010, 1864-2010
- Dimensionality reduction (truncation): 12
- Evaluation:
  - Tests with changing calibration (length and period), truncation, data quality, stations amount
  - Use of crossvalidation (leave-one-out): $x_{i,reconstr}, x_{i,obs}$
  - Mean absolute error (MAE)
  - Mean-Squared Error Skill Score (MSESS)

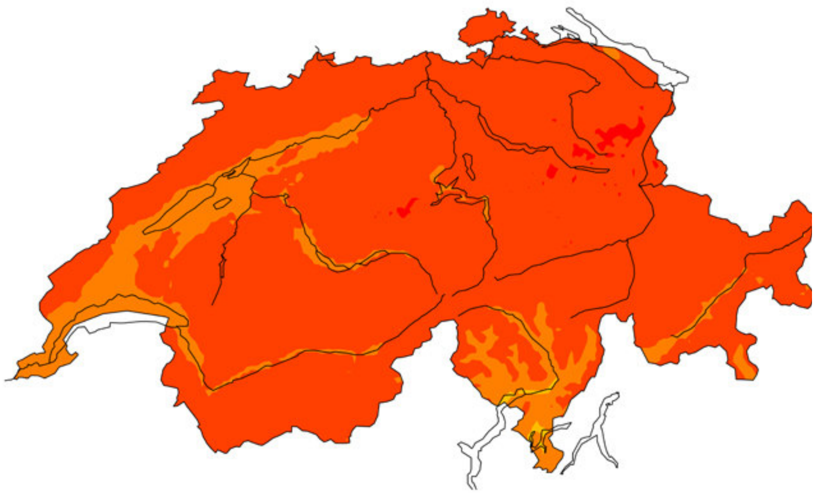
    1= perfect reconstruction, 0=no skill
  - Variance
  - Trend

$$MAE = \frac{1}{n}\sum_{i=1}^{n}\left(\left|x_{i,reconstr} - x_{i,obs}\right|\right)$$

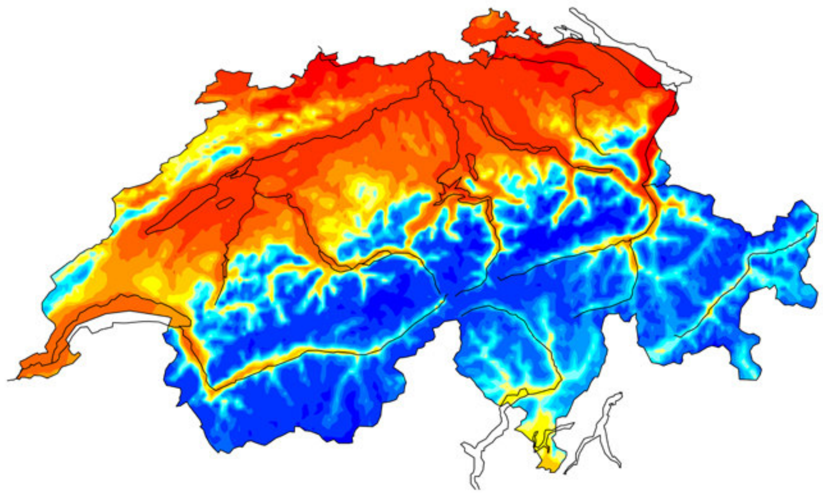
$$MSESS = 1 - \frac{\sum_{i=1}^{n}\left(x_{i,reconstr} - x_{i,obs}\right)^2}{\sum_{i=1}^{n}\left(x_{i,obs} - \overline{x_{i,obs}}\right)^2}$$

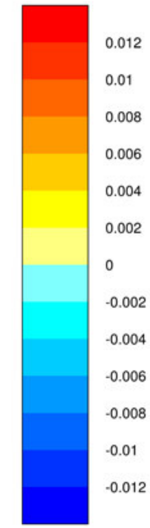
PCA

PC loading 1 – 91%

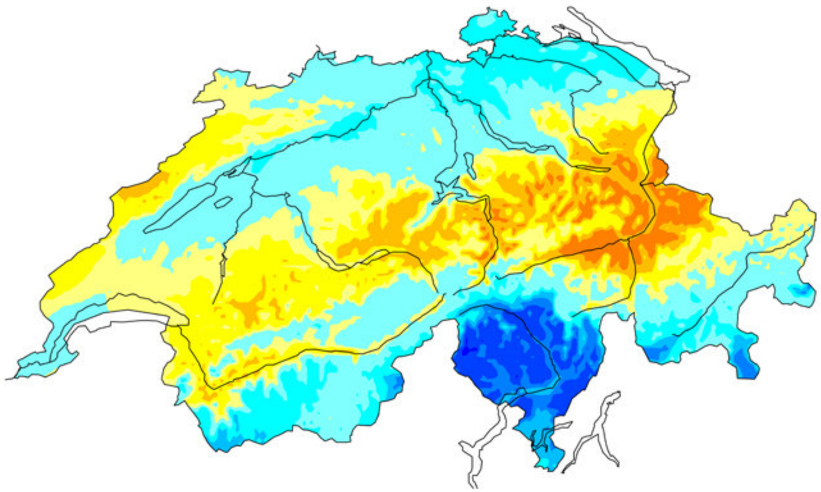


PC loading 2 – 5%

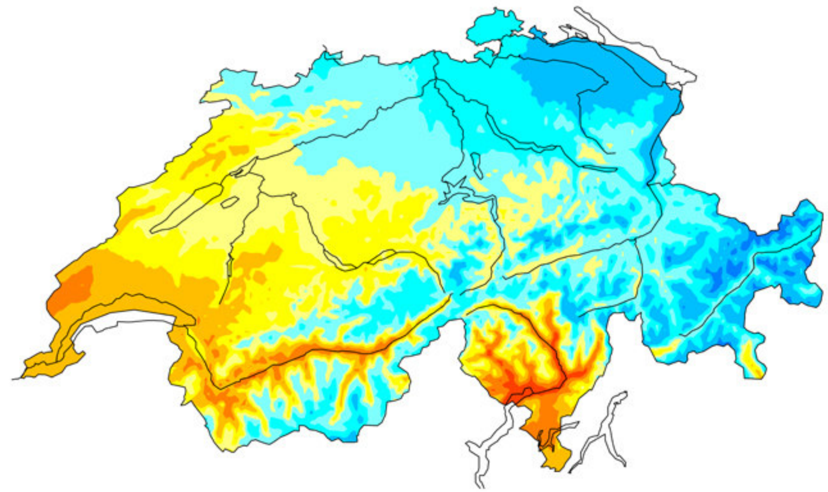


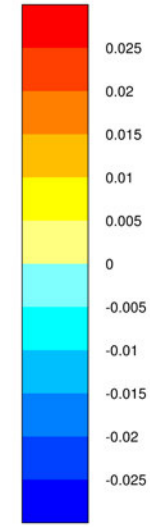


PC loading 3 -1%

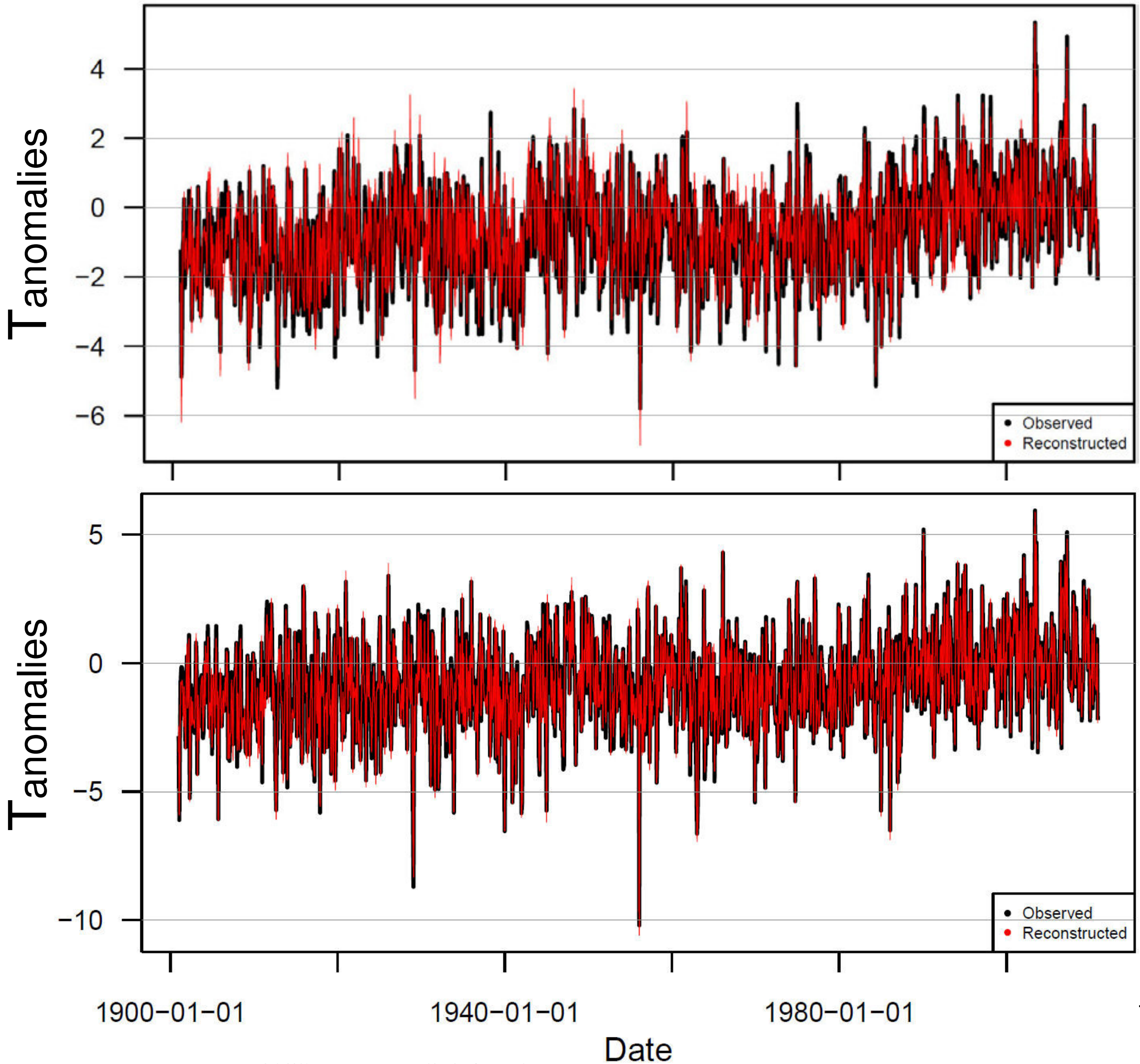


PC loading 4 – 1%





Reconstruction examples (anomalies 1981-2010)

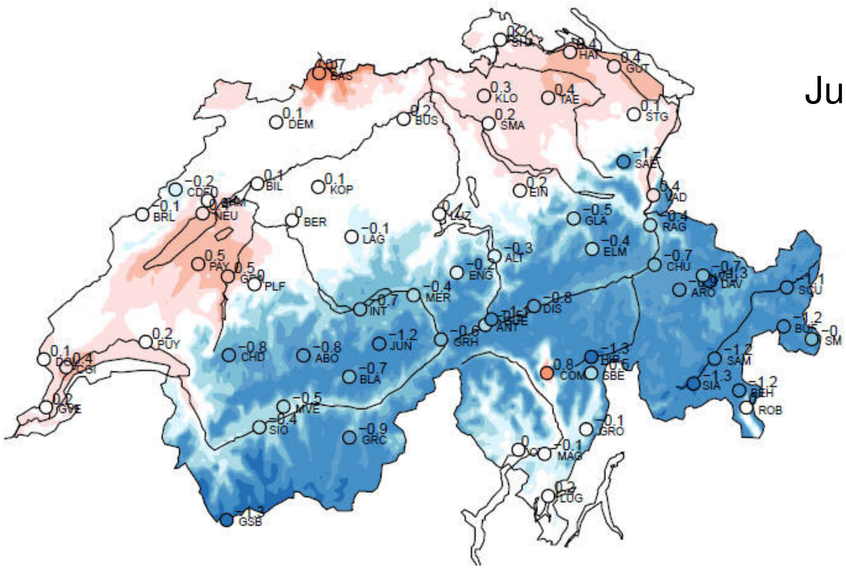


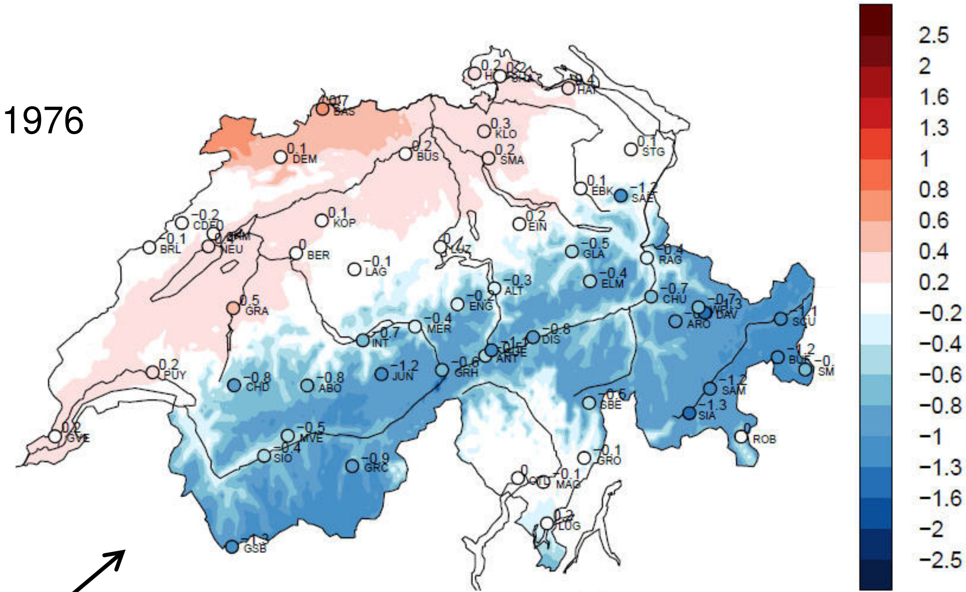
Reconstrucion examples (anomalies 1981-2010)

Direct interpolation

Reconstruction

July 1976

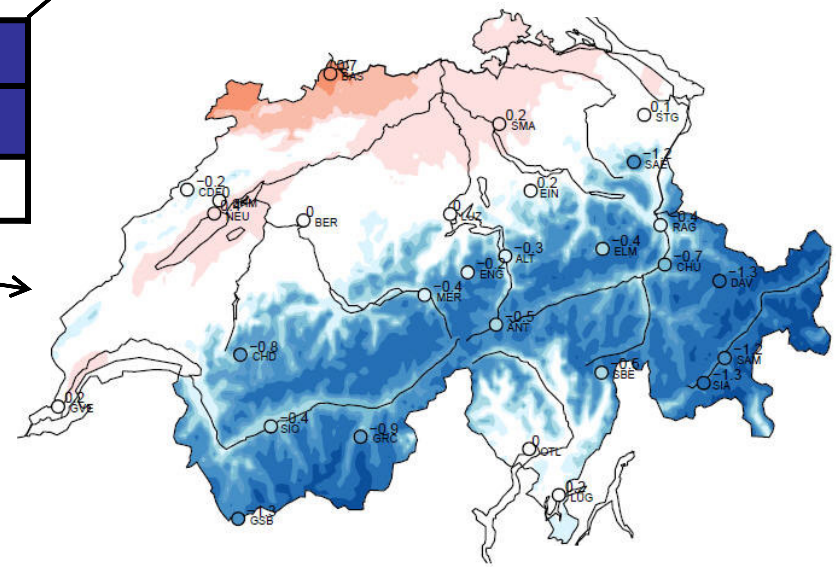




MSESS		
ALL	57 stations	28 stations
0.61	0.64	0.59

MSESS	
57 stations	28 stations
0.72	0.68

MSESS
28 stations
0.64

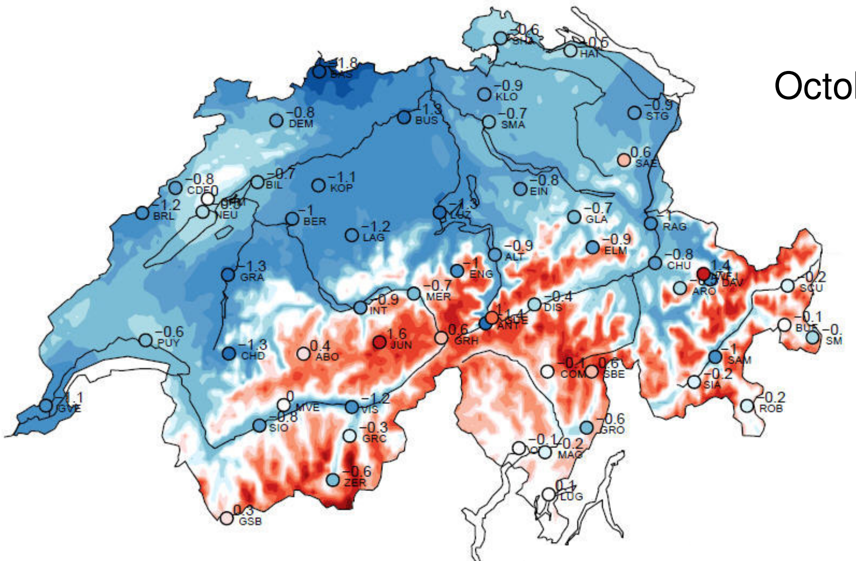


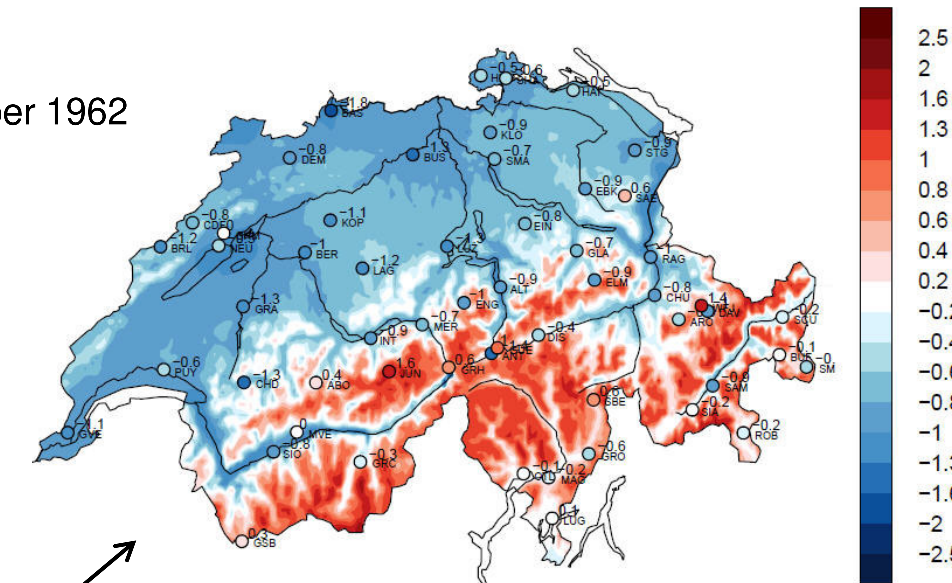
Reconstrucion examples (anomalies 1981-2010)

Direct interpolation

Reconstruction

October 1962

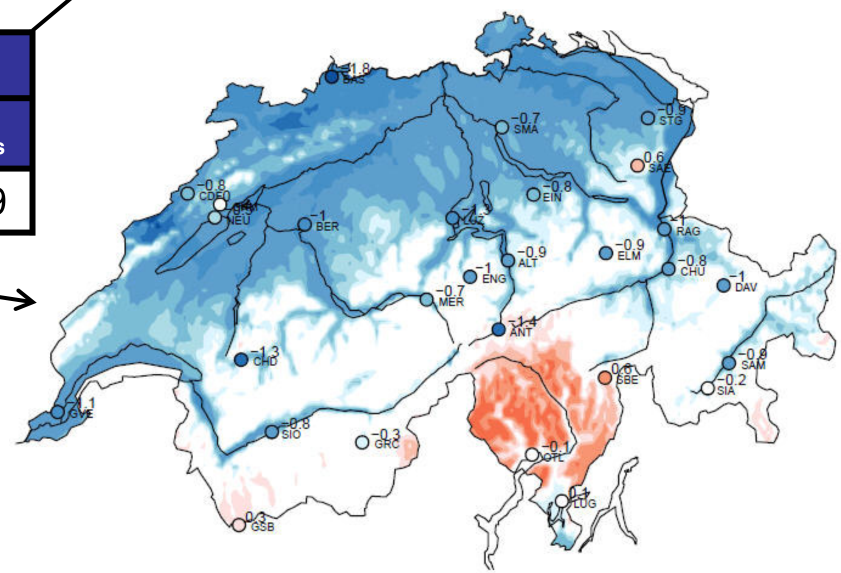




MSESS		
ALL	57 stations	28 stations
0.36	0.36	0.21

MSESS	
57 stations	28 stations
0.26	-0.19

MSESS
28 stations
0.03



Mean absolute error (degC)

$$MAE = \frac{1}{n}\sum_{i=1}^{n}\left(\left|x_{i,reconstr} - x_{i,obs}\right|\right)$$

<table>
<tr><th>t</th><th>Grid</th><th># stat</th><th>ALL</th><th>DJF</th><th>MAM</th><th>JJA</th><th>SON</th><th>#</th></tr>
<tr><td rowspan="3">1961-2010</td><td>Reconstr.</td><td>57</td><td>0.26</td><td>0.35</td><td>0.22</td><td>0.19</td><td>0.27</td><td rowspan="4">28 stat.</td></tr>
<tr><td>Reconstr.</td><td>28</td><td>0.27</td><td>0.36</td><td>0.23</td><td>0.20</td><td>0.27</td></tr>
<tr><td>Direct grid</td><td>~85</td><td>0.28</td><td>0.39</td><td>0.23</td><td>0.21</td><td>0.29</td></tr>
<tr><td rowspan="2">1901-2010</td><td rowspan="2">Reconstr.</td><td rowspan="2">28</td><td>0.32</td><td>0.41</td><td>0.28</td><td>0.26</td><td>0.32</td></tr>
<tr><td>0.33</td><td>0.44</td><td>0.28</td><td>0.26</td><td>0.33</td><td rowspan="2">18 stat.</td></tr>
<tr><td>1864-2010</td><td>Reconstr.</td><td>18</td><td>0.38</td><td>0.50</td><td>0.32</td><td>0.31</td><td>0.39</td></tr>
</table>

Mean absolute error (degC)

$$MAE = \frac{1}{n}\sum_{i=1}^{n}\left(\left|x_{i,reconstr} - x_{i,obs}\right|\right)$$

t	Grid	# stat	ALL	DJF	MAM	JJA	SON	#
1961-2010	Reconstr.	57	0.26	0.35	0.22	0.19	0.27	28 stat.
	Reconstr.	28	0.27	0.36	0.23	0.20	0.27	
	Direct grid	~85	0.28	0.39	0.23	0.21	0.29	
1901-2010	Reconstr.	28	0.32	0.41	0.28	0.26	0.32	
			0.33	0.44	0.28	0.26	0.33	18 stat.
1864-2010	Reconstr.	18	0.38	0.50	0.32	0.31	0.39	

Mean absolute error (degC)

$$MAE = \frac{1}{n}\sum_{i=1}^{n}\left(\left|x_{i,reconstr} - x_{i,obs}\right|\right)$$

t	Grid	# stat	ALL	DJF	MAM	JJA	SON	#
1961-2010	Reconstr.	57	0.26	0.35	0.22	0.19	0.27	28 stat.
	Reconstr.	28	0.27	0.36	0.23	0.20	0.27	
	Direct grid	~85	0.28	0.39	0.23	0.21	0.29	
1901-2010	Reconstr.	28	0.32	0.41	0.28	0.26	0.32	
			0.33	0.44	0.28	0.26	0.33	18 stat.
1864-2010	Reconstr.	18	0.38	0.50	0.32	0.31	0.39	

Mean absolute error (degC)

$$MAE = \frac{1}{n}\sum_{i=1}^{n}\left(|x_{i,reconstr} - x_{i,obs}|\right)$$

t	Grid	# stat	ALL	DJF	MAM	JJA	SON	#
1961-2010	Reconstr.	57	0.26	0.35	0.22	0.19	0.27	28 stat.
	Reconstr.	28	0.27	0.36	0.23	0.20	0.27	
	Direct grid	~85	0.28	0.39	0.23	0.21	0.29	
1901-2010	Reconstr.	28	0.32	0.41	0.28	0.26	0.32	
			0.33	0.44	0.28	0.26	0.33	18 stat.
1864-2010	Reconstr.	18	0.38	0.50	0.32	0.31	0.39	

Mean absolute error (degC)

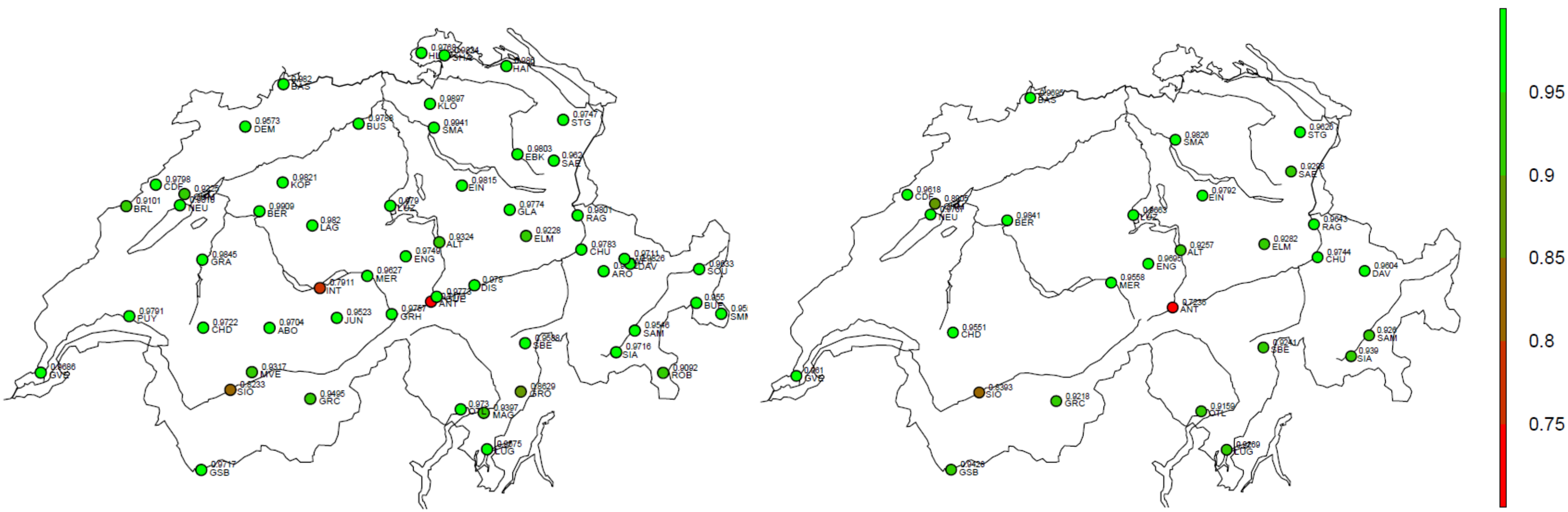
$$MAE = \frac{1}{n}\sum_{i=1}^{n}\left(|x_{i,reconstr} - x_{i,obs}|\right)$$

t	Grid	# stat	ALL	DJF	MAM	JJA	SON	#
1961 - 2010	Reconstr.	57	0.26	0.35	0.22	0.19	0.27	28 stat.
	Reconstr.	28	0.27	0.36	0.23	0.20	0.27	
	Direct grid	~85	0.28	0.39	0.23	0.21	0.29	
1901 - 2010	Reconstr.	28	0.32	0.41	0.28	0.26	0.32	
			0.33	0.44	0.28	0.26	0.33	18 stat.
1864 - 2010	Reconstr.	18	0.38	0.50	0.32	0.31	0.39	

Skill: MSESS 1901/1961-2010

Explained **temporal** variance

- Most of the stations have MSESS > 0.95

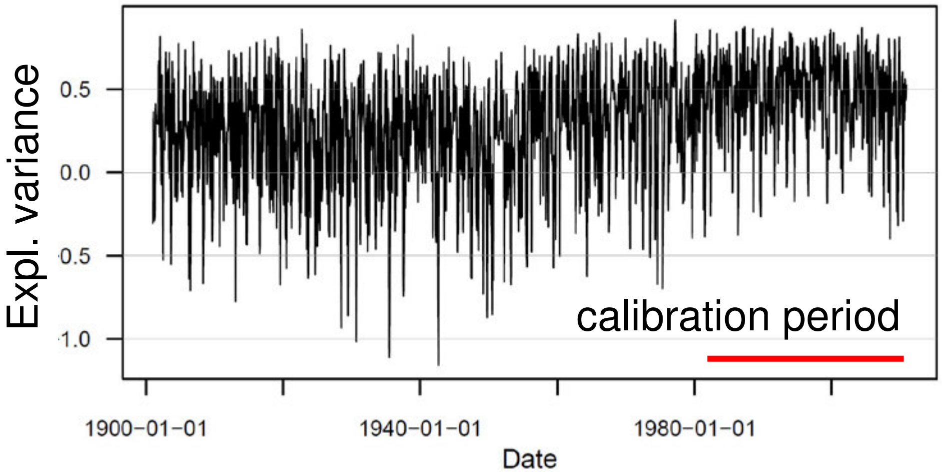


1961-2010, 57 stations

1901-2010, 28 stations

Skill: MSESS 1901-2010

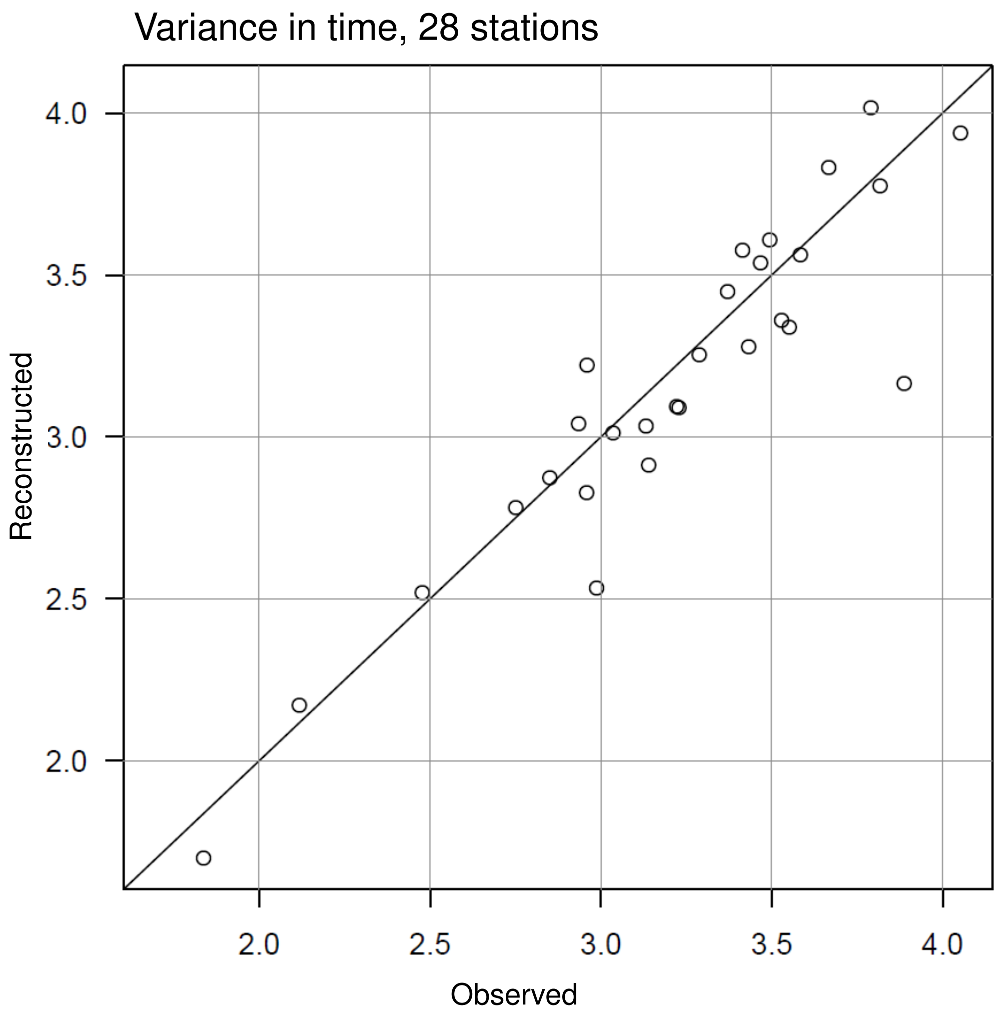
Explained **spatial** variance



Explained variance fraction (28 stations)

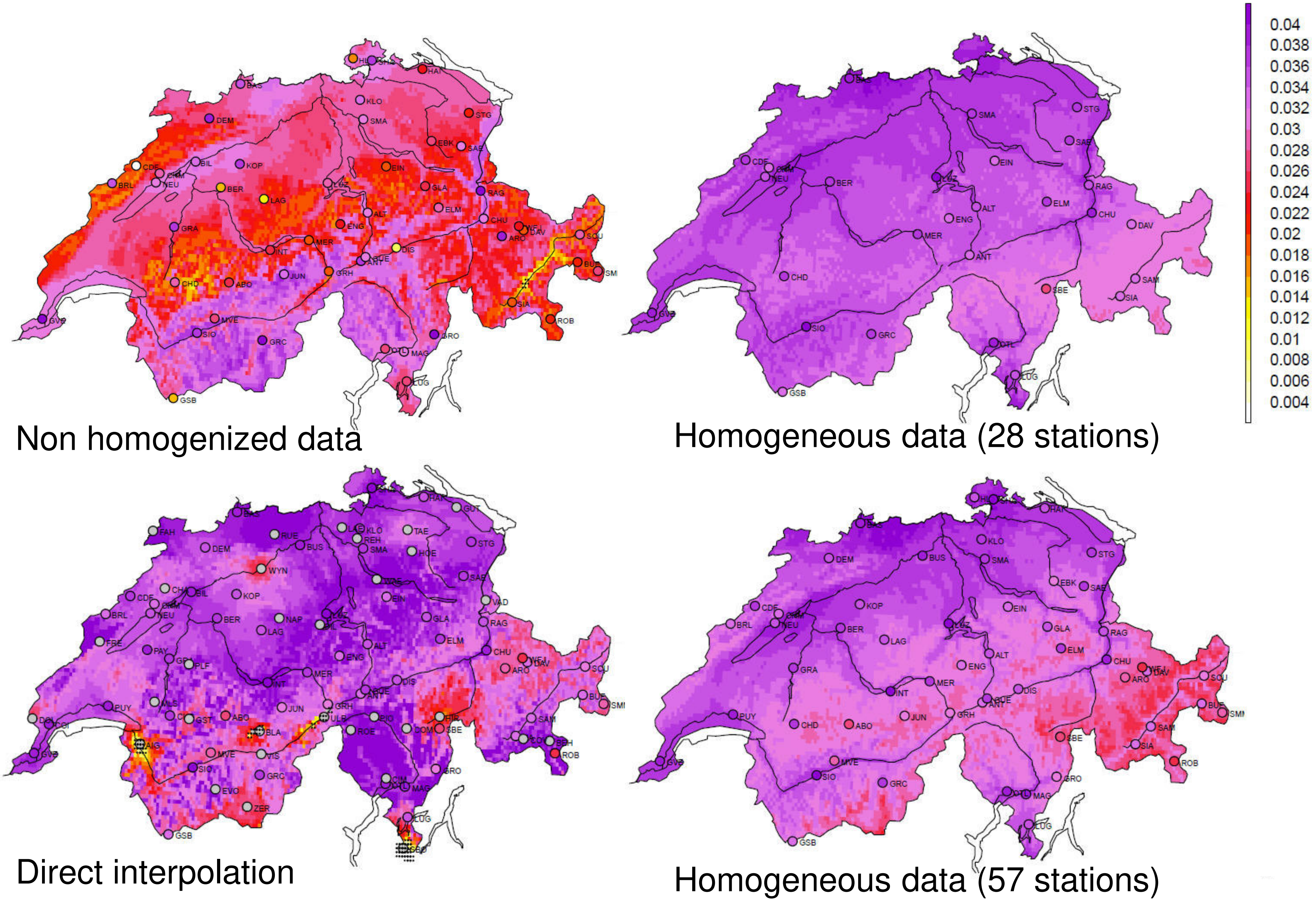
MSESS	ALL	DJF	MAM	JJA	SON
Median	0.36	0.48	0.36	0.19	0.33
q0.9	0.71	0.74	0.73	0.62	0.67
q0.1	-0.20	0.08	-0.25	-0.38	-0.20

Variance 1901-2010



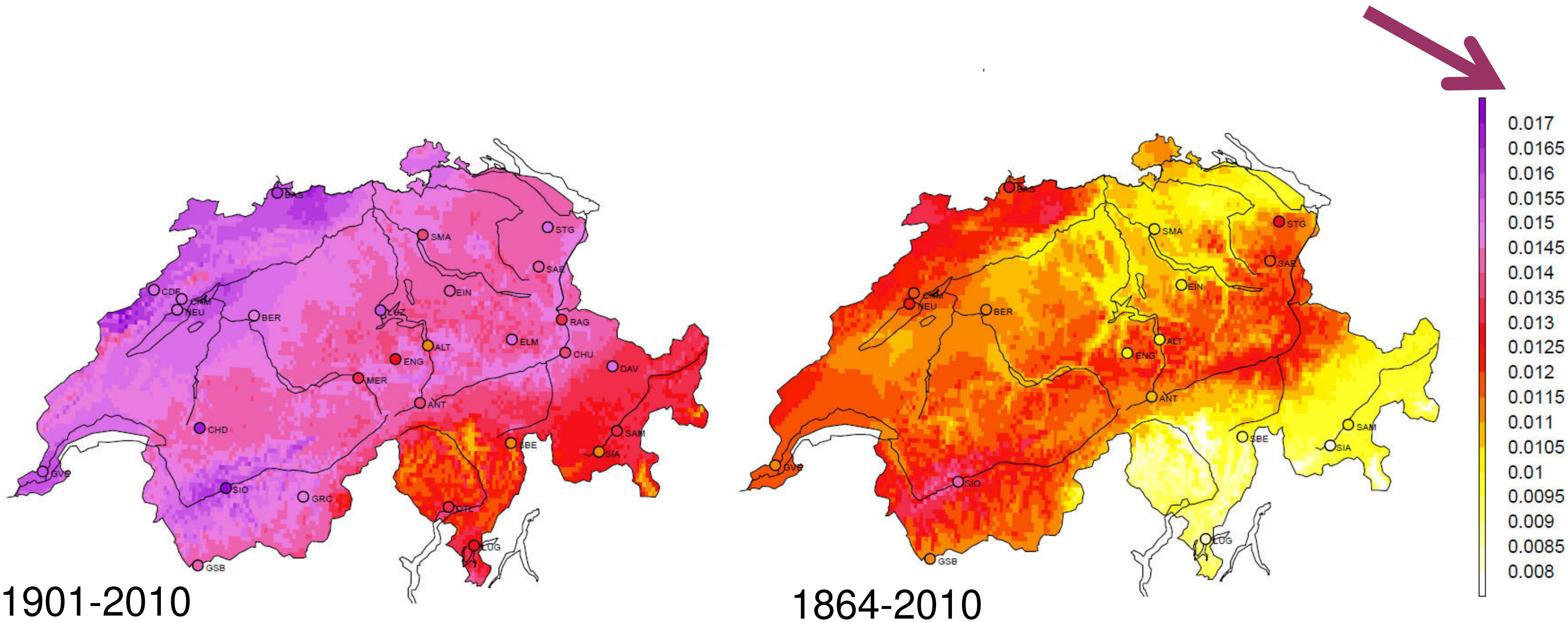
Trend 1961-2010

Theil-Sen trend estimate (degC/y)
Stippling: statistically not significant (0.05, Mann-Kendall)

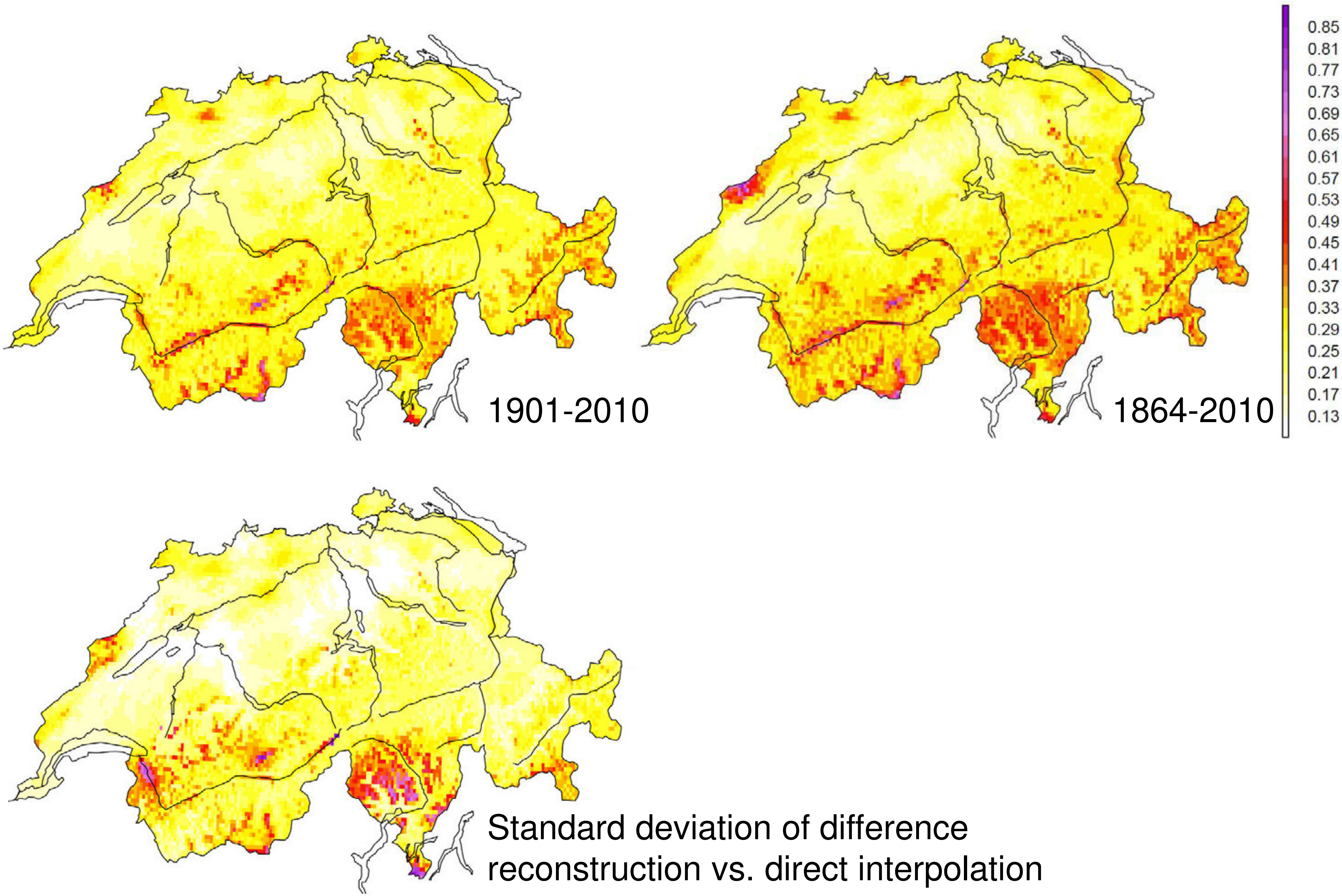


Trend 1864/1901-2010

Theil-Sen trend estimate (degC/y)
Stippling: statistically not significant (0.05, Mann-Kendall)



Standard error



Standard deviation of difference
reconstruction vs. direct interpolation

Content

Conclusion and outlook

RSOI method

- RSOI is an attractive method to benefit of short-term high-resolution information to reconstruct longer time scales with less observations available. Method suitable for complex terrain where variations are spatially anchored.
- Successful reconstruction of time series and spatial distribution of temperature
- The discrepancies between observations and reconstruction are relatively moderate (MAE≈0.25)
- Reconstruction improves long-term consistency

Outlook

- Additional analysis (compare with HISTALP,…)
- Develop a regularly updated climate monitoring product at MeteoSwiss
- Apply same method for precipitation fields (station homogenization ongoing)
- Potential for application in the entire Alpine Region

RSOI – Details

- <u>Optimal interpolation</u>

Find scores $\vec{a}_{t_i}$ (reconstruction period t_i) minimizing the cost function S

Gauge measurement (sparse network k)

Matrix with L eigenvalues of the covariance matrix in the diagonal (from PCA)

$$S(\vec{a}_{t_i}) = (\mathbf{H}\,\vec{a}_{t_i} - \overrightarrow{x^o}_{t_i})^T\,\mathbf{R}^{-1}(\mathbf{H}\,\vec{a}_{t_i} - \overrightarrow{x^o}_{t_i}) + \vec{a}_{t_i}{}^T\,\mathbf{C}^{-1}\,\vec{a}_{t_i}$$

$$= \vec{e}_{t_i}{}^r = \mathbf{H}^o\vec{e}_{t_i}{}^t + \vec{e}_{t_i}{}^o$$

Covariance Matrix of $\vec{e}_{t_i}{}^r$ (estimated from calibration period)

Truncation error (dimension reduction)

Error due to difference between gauge measurement and grid-cell value assigned (H^o)

Guarantee balance between regions with different station density and lowers weight of highly correlated gauges.

Disfavour high scores for high-order PC loadings

RSOI – Details

$\vec{x}_{t_c} = E.\vec{a}_n + \vec{e}_{t_c}{}^{t}$

calibration period t_c

$\vec{x}_{t_c}{}^{o} = H^o.\vec{x}_{t_c} + \vec{e}_{t_c}{}^{o} = H^o.E.\vec{a}_{t_c} + H^o.\vec{e}_{t_c}{}^{t} + \vec{e}_{t_c}{}^{o} = H.\vec{a}_{t_c} + \vec{e}_{t_c}{}^{r}$

Gauge measurement (sparse network k)

Find scores $\vec{a}_{t_i}$ (reconstruction period t_i) minimizing the cost function S

Gauge measurement (sparse network k)

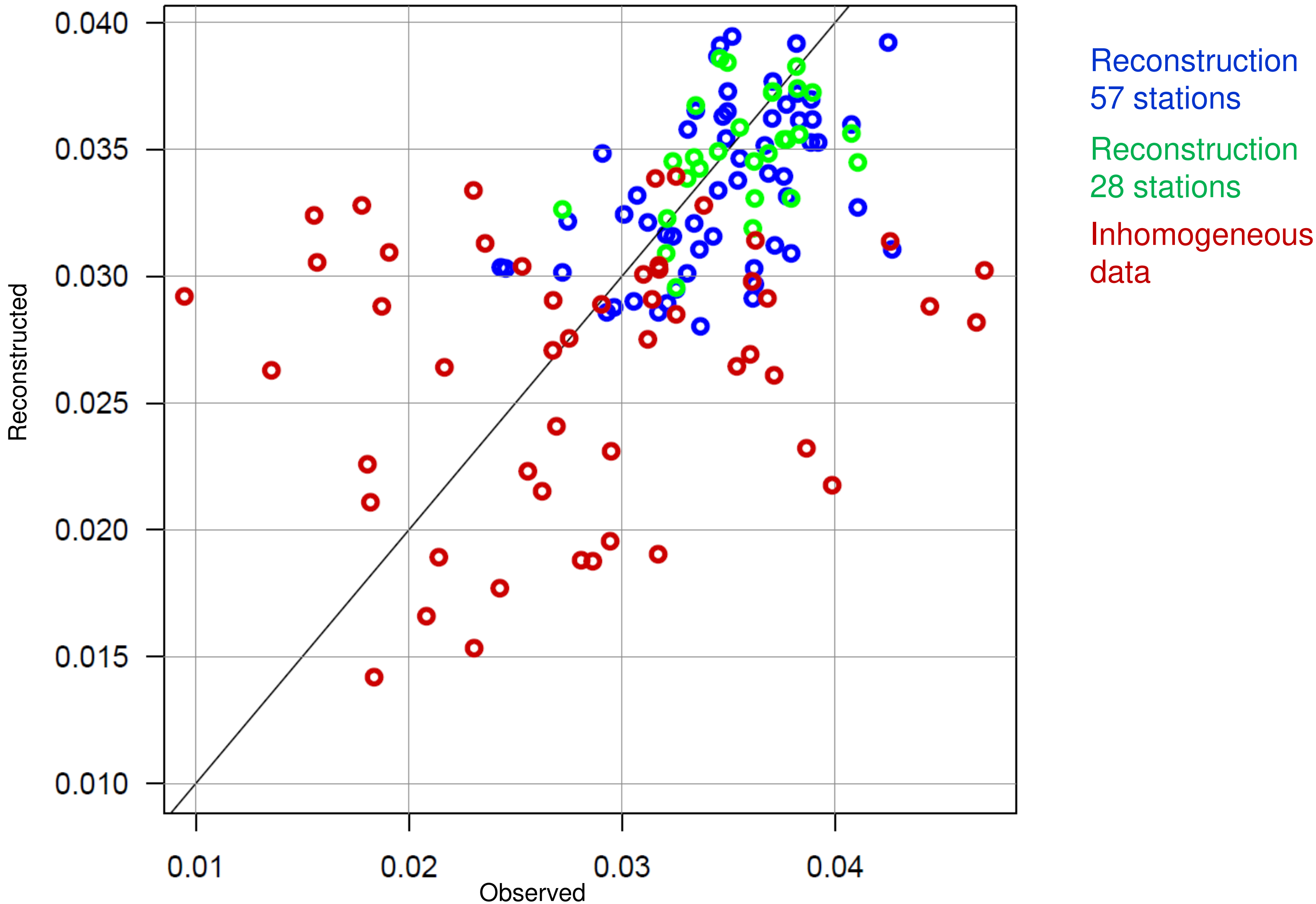
Matrix with L eigenvalues of the covariance matrix in the diagonal (from PCA)

$$S(\vec{a}_{t_i}) = (\mathrm{H}\,\vec{\mathrm{a}}_{\mathrm{t_i}} - \vec{\mathrm{x}}_{\mathrm{t_i}}{}^{\mathrm{o}})^{\mathrm{T}}\,\mathrm{R}^{-1}(\mathrm{H}\,\vec{\mathrm{a}}_{\mathrm{t_i}} - \vec{\mathrm{x}}_{\mathrm{t_i}}{}^{\mathrm{o}}) + \vec{a}_{t_i}{}^{T}\,\mathbf{C}^{-1}\,\vec{a}_{t_i}$$

$$= \vec{e}_{t_i}{}^{r} = \mathbf{H}^{o}\vec{e}_{t_i}{}^{t} + \vec{e}_{t_i}{}^{o}$$

Covariance Matrix of $\vec{e}_{t_i}{}^{r}$ (estimated from calibration period)

Trend 1961-2010 (degC/y)



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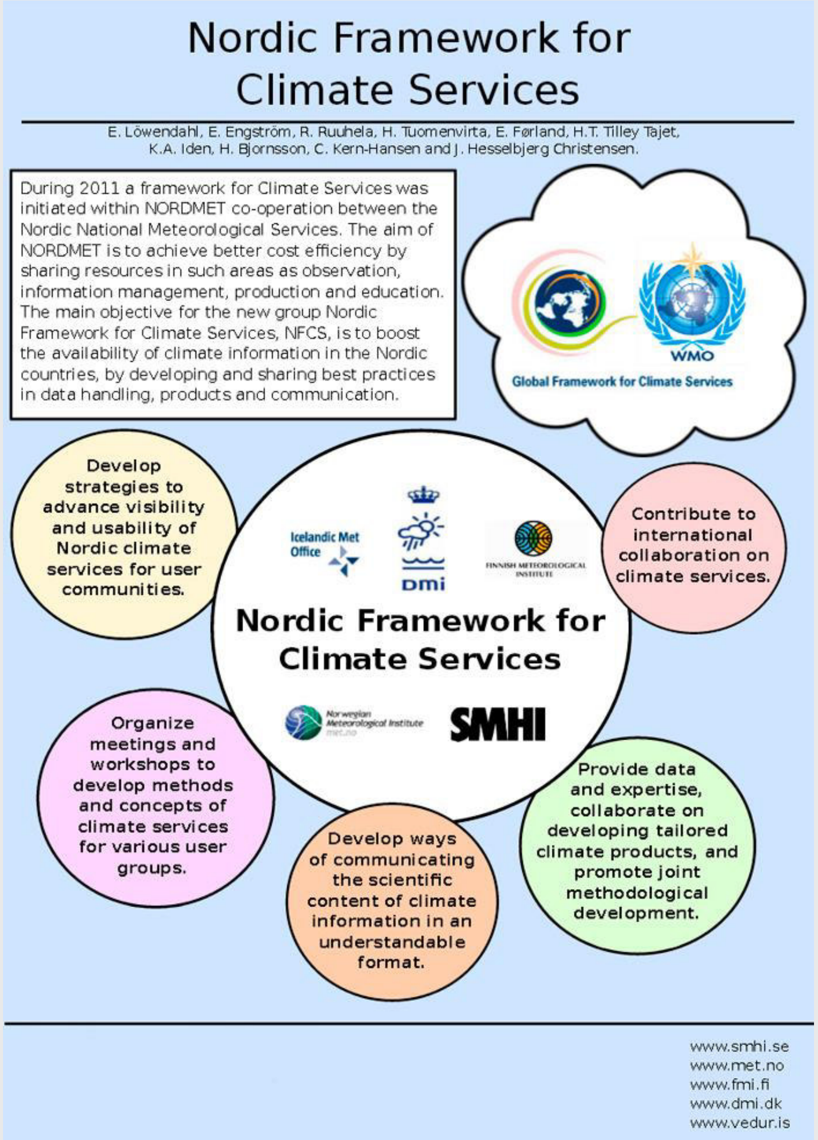
Spatial Interpolation of daily Temperature and Precipitation for the Fennoscandia

Cristian Lussana and Ole Einar Tveito[(1)]

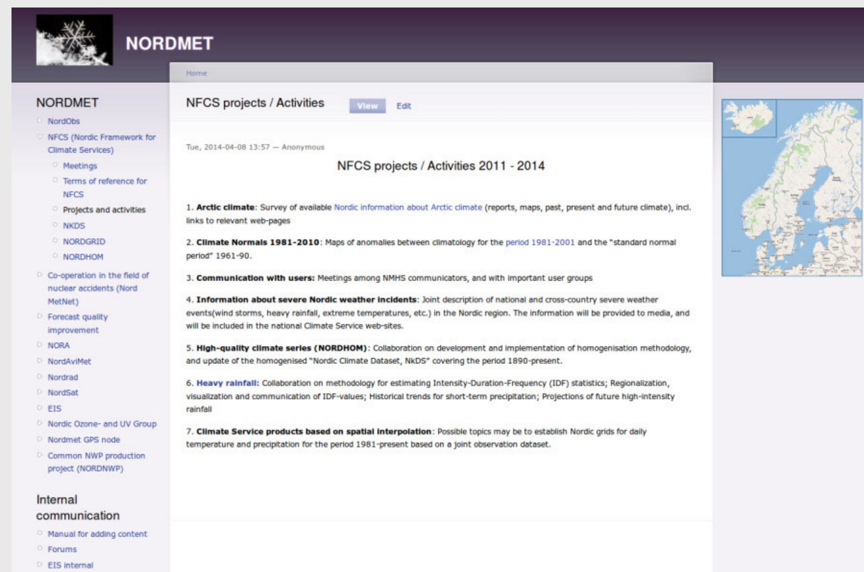
Norwegian Meteorological Institute, Oslo

30.10.2015

10th EUMETNET Data Management Workshop, St. Gallen, Switzerland, 28th – 30th October 2015



http://blog.fmi.fi/nordmet/

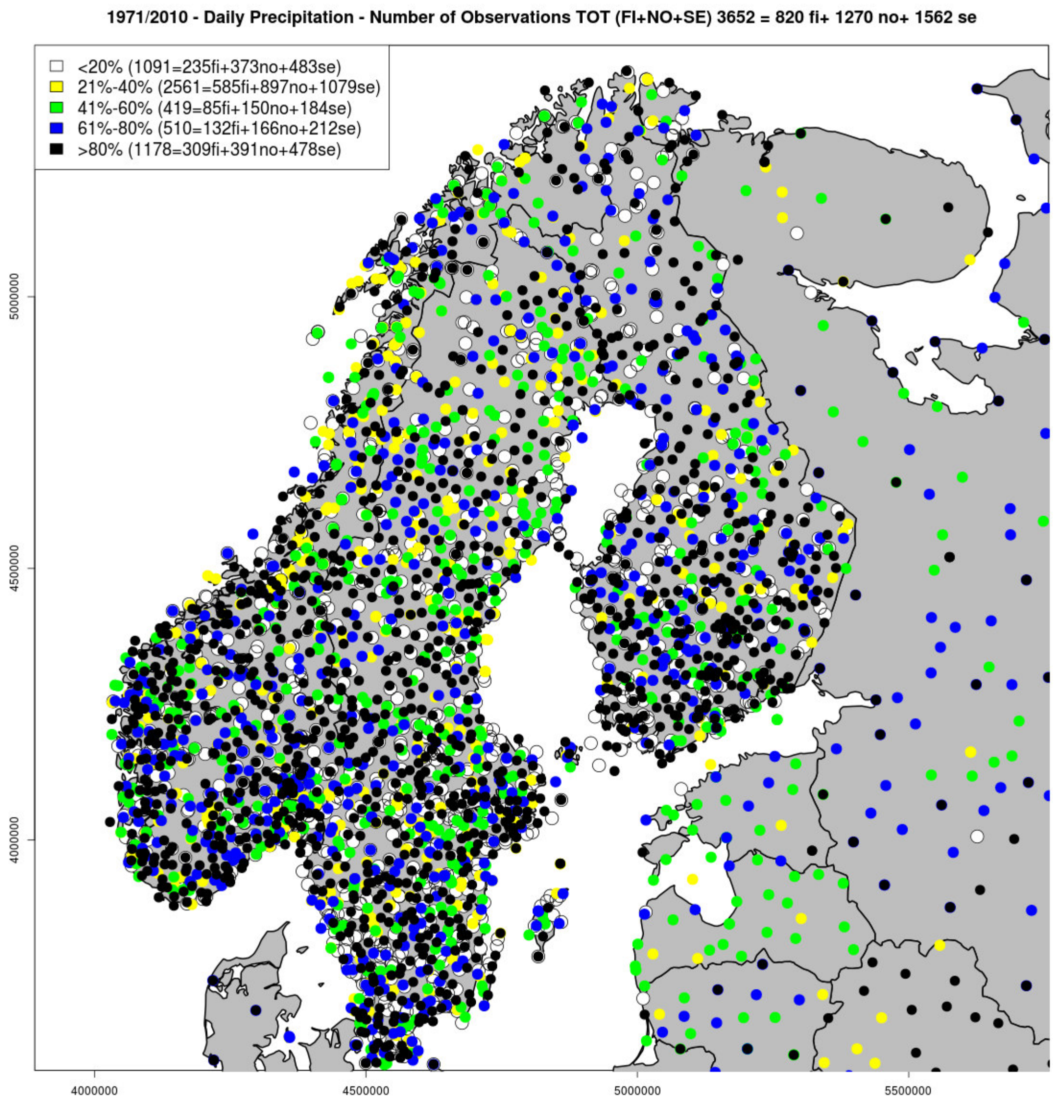


Nordic Gridded Climate Dataset NGCD

- An observation gridded dataset for temperature and precipitation covering Finland, Sweden and Norway.
  - Spatial resolution 1Km x 1Km
  - CRS: EPSG Projection 3035 - ETRS89 / ETRS-LAEA
  - Temporal resolution: daily
  - Time range: 1981 - 2010
  - Data sources: ECA&D, eklima.met.no, SMHI, FMI
- Nordic observation gridded dataset will be an outcome of the Nordic Framework for Climate Services (SMHI, FMI, MI, (DMI,IMO))
- NGCD first versions: 2 from MET Norway, 1 from FMI and 1 from SMHI

RR – daily precipitation

Meteorologisk institutt + ECA&D European Climate Assessment & Dataset



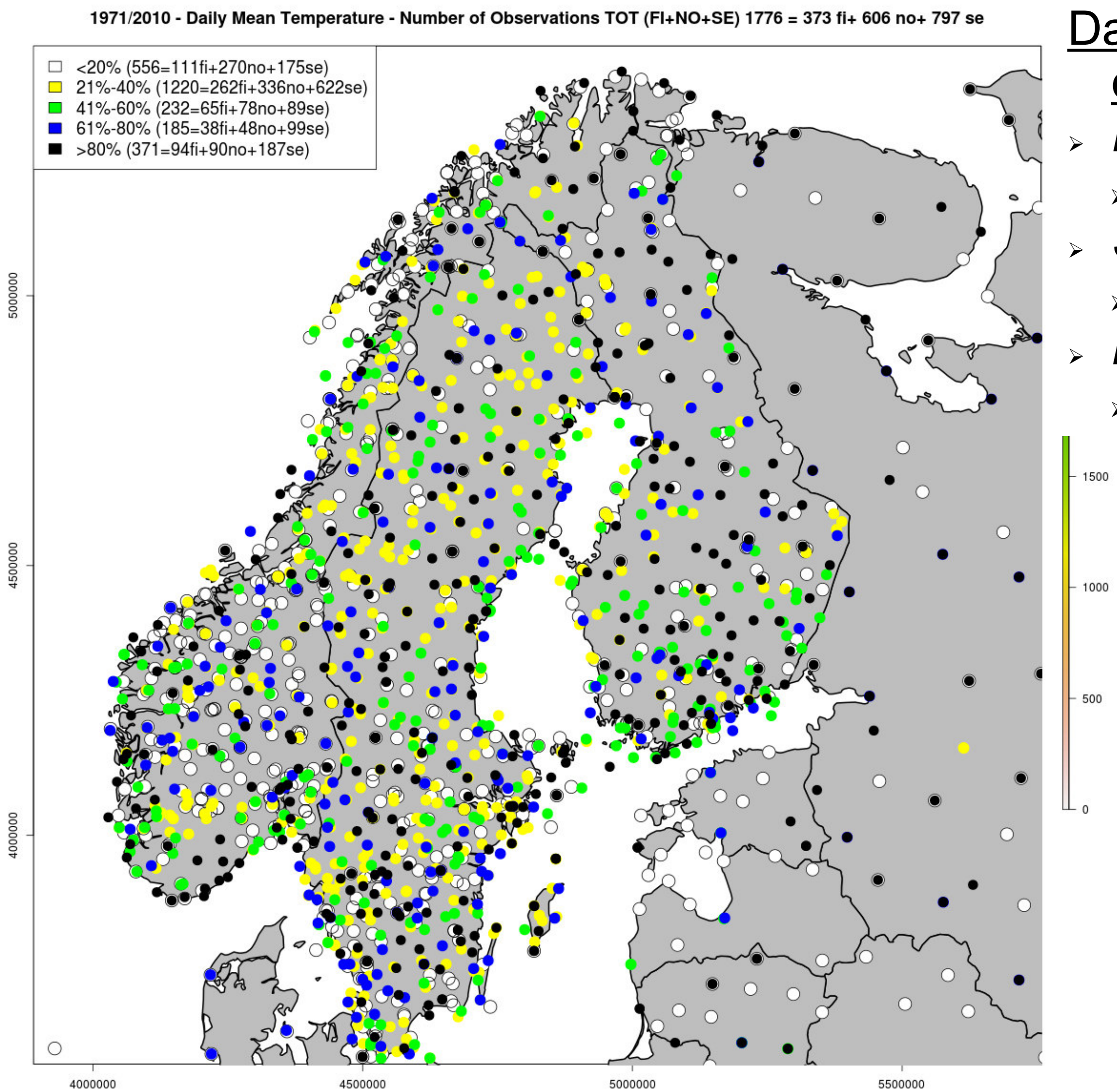
24h PREC, Element descriptions in ECA&D:

- ***Norway***: id=RR2
  - (D-1) 06UTC -> D 06UTC;
- ***Sweden***: id=RR9
  - D 06UTC -> (D+1) 06UTC;
- ***Finland***: id=RR5
  - D 07.30 -> (D+1) 07.30UTC;

TG – daily mean temperature

Meteorologisk institutt + ECA&D

European Climate Assessment & Dataset



Daily mean temperature, Element descriptions in ECA&D:

- ***Norway***: id=TG9
  - (D-1) 6UTC->D 6UTC;
- ***Sweden***: id=TG6
  - average using TN,TX,06,12,18;
- ***Finland***: id=TG6
  - average using 8 observations;

NGCD @ MET Norway

- *Daily mean Temperature*
  - Residual Kriging (RK)
  - Optimal Interpolation (OI)

- *Daily accumulated precipitation*
  - Multi-Scale Optimal Interpolation (MSOI)

Both OI products includes an *automatic data quality control procedure* (described in poster #14, *Data Quality Control of Temperature and Precipitation in-situ observations based on Spatial Interpolation*, Cristian Lussana and Ole Einar Tveito)

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TEMP1d: Residual Kriging

Residual kriging:

Kriging (or any spatial interpolation method)

$$\hat{t}(s_0) = \sum_{i=1}^{n} \text{[illegible]}$$

External trend/drift (linear regression)

- T = TS +TD

- Trend predictors:
    - Altitude (station)
    - Mean altitude within a 20 km circle around the station
    - Minimum altitude within a 20 km circle around the station
    - Longitude
    - Latitude
- Linear stepwise regression is used to define the trend.

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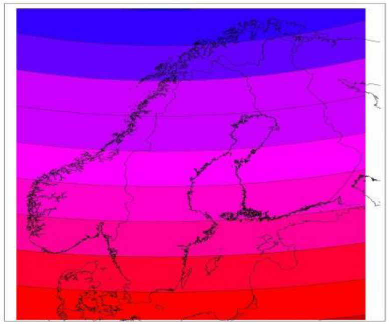
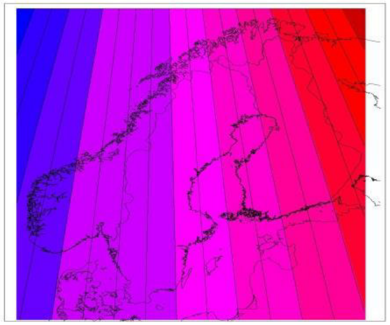
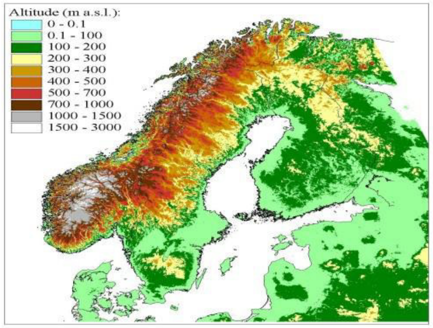
Grids of the independent variables

Latitude

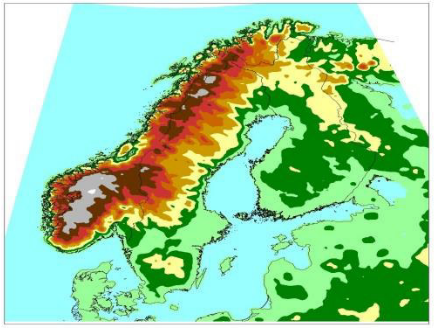


Longitude

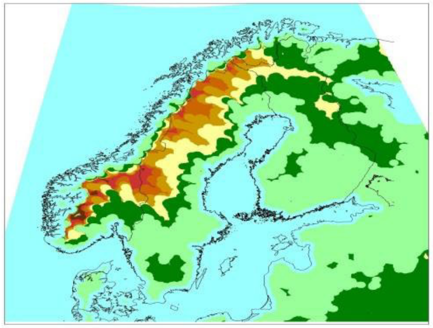




DEM

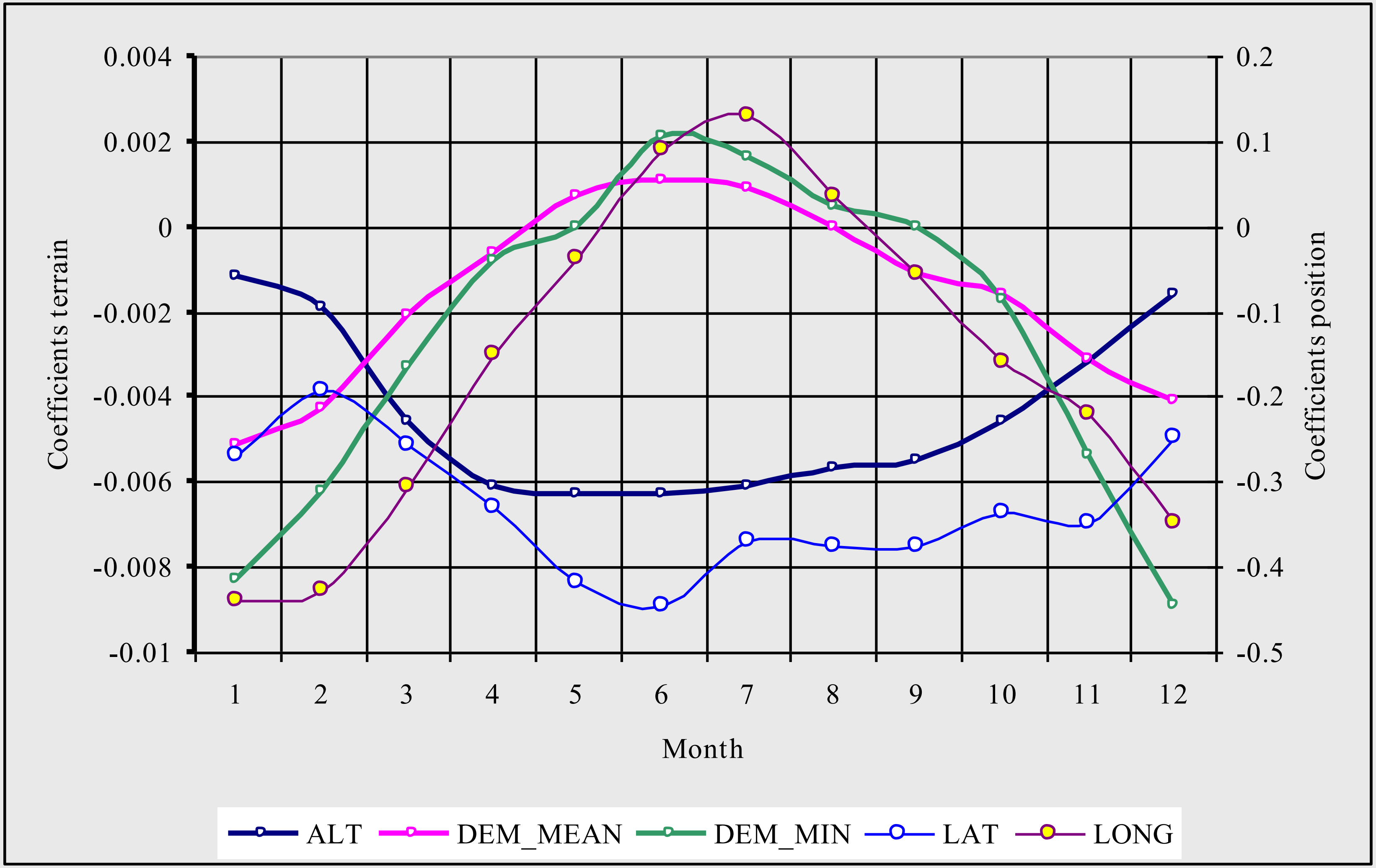


DEM_MEAN



DEM_MIN

Regression coefficients



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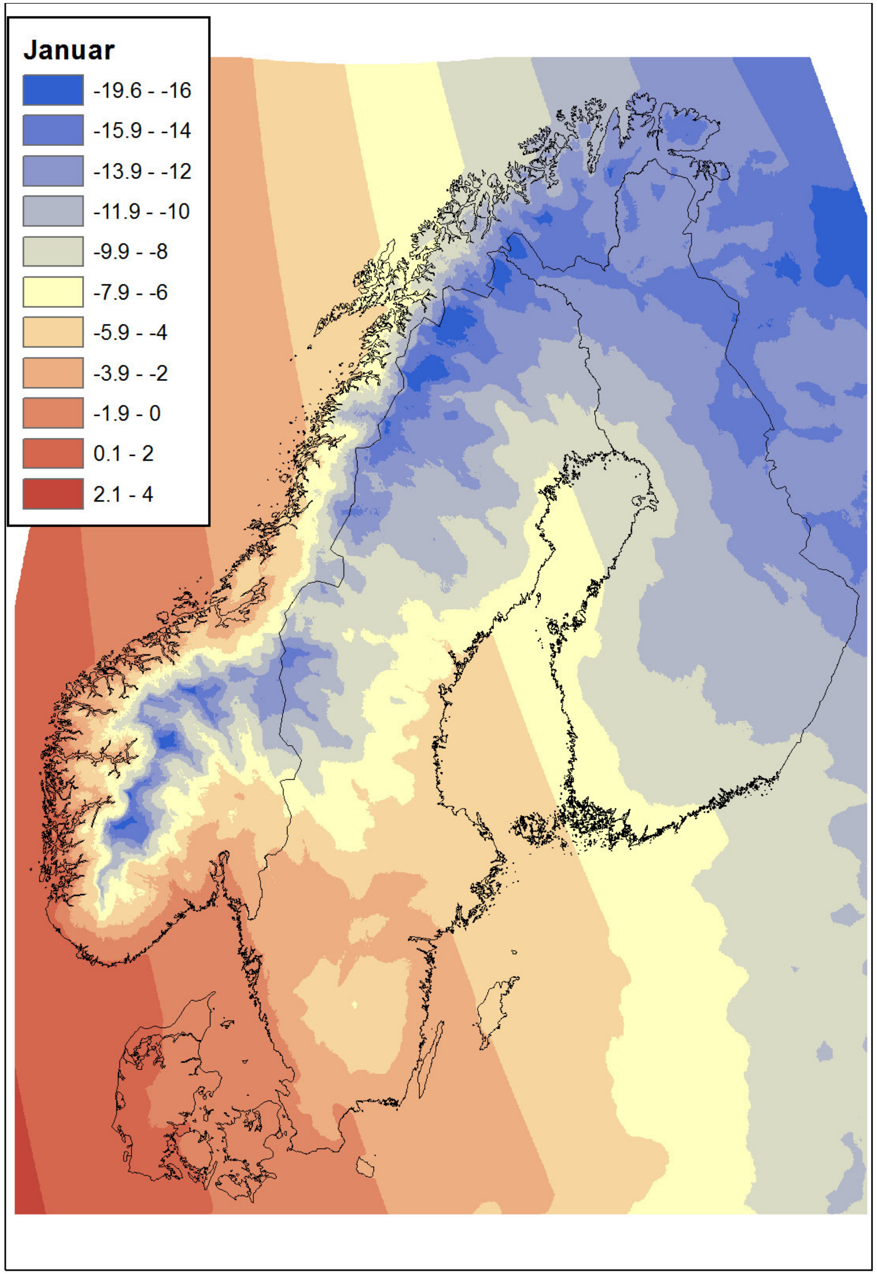
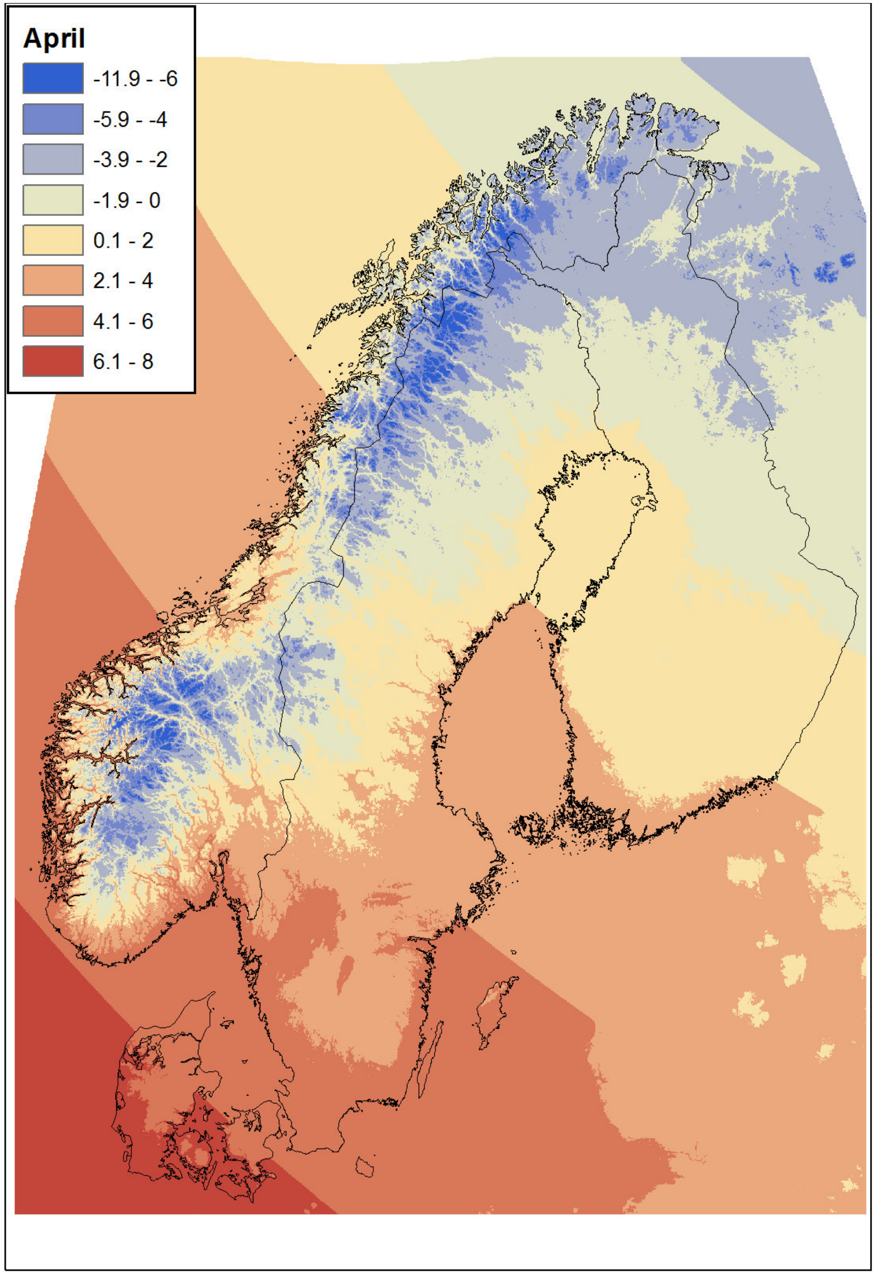
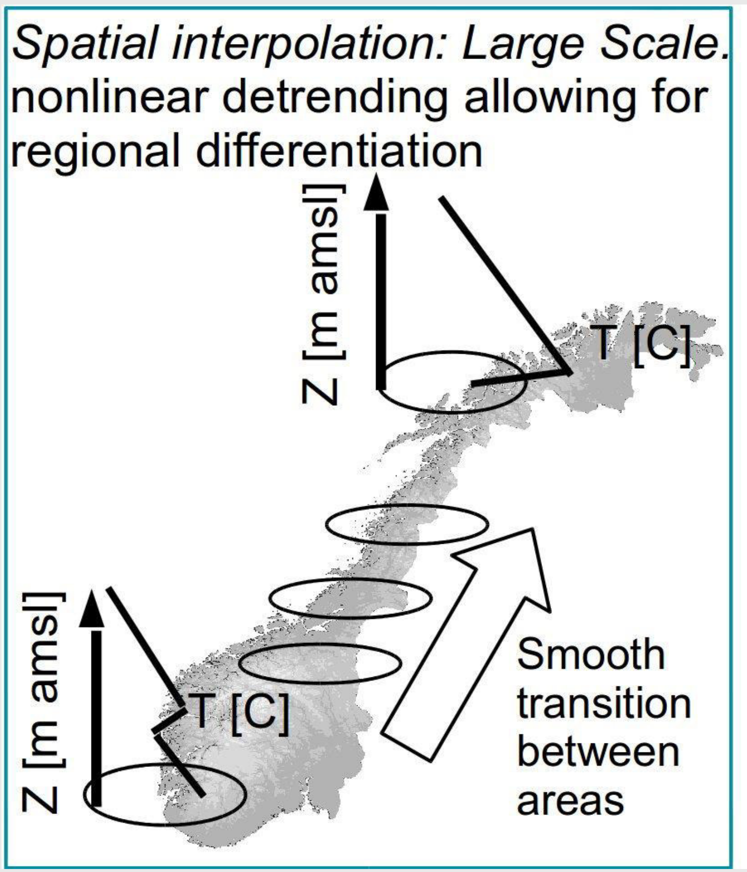
Trend → climatological first guess



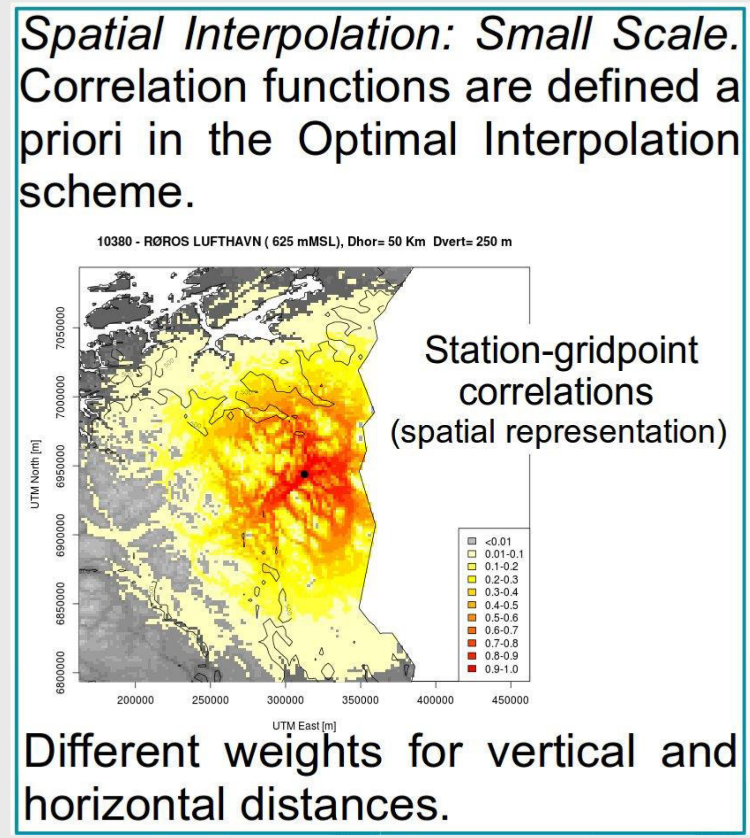


TEMP1d: OI

Large(coarser) scale trend estimation

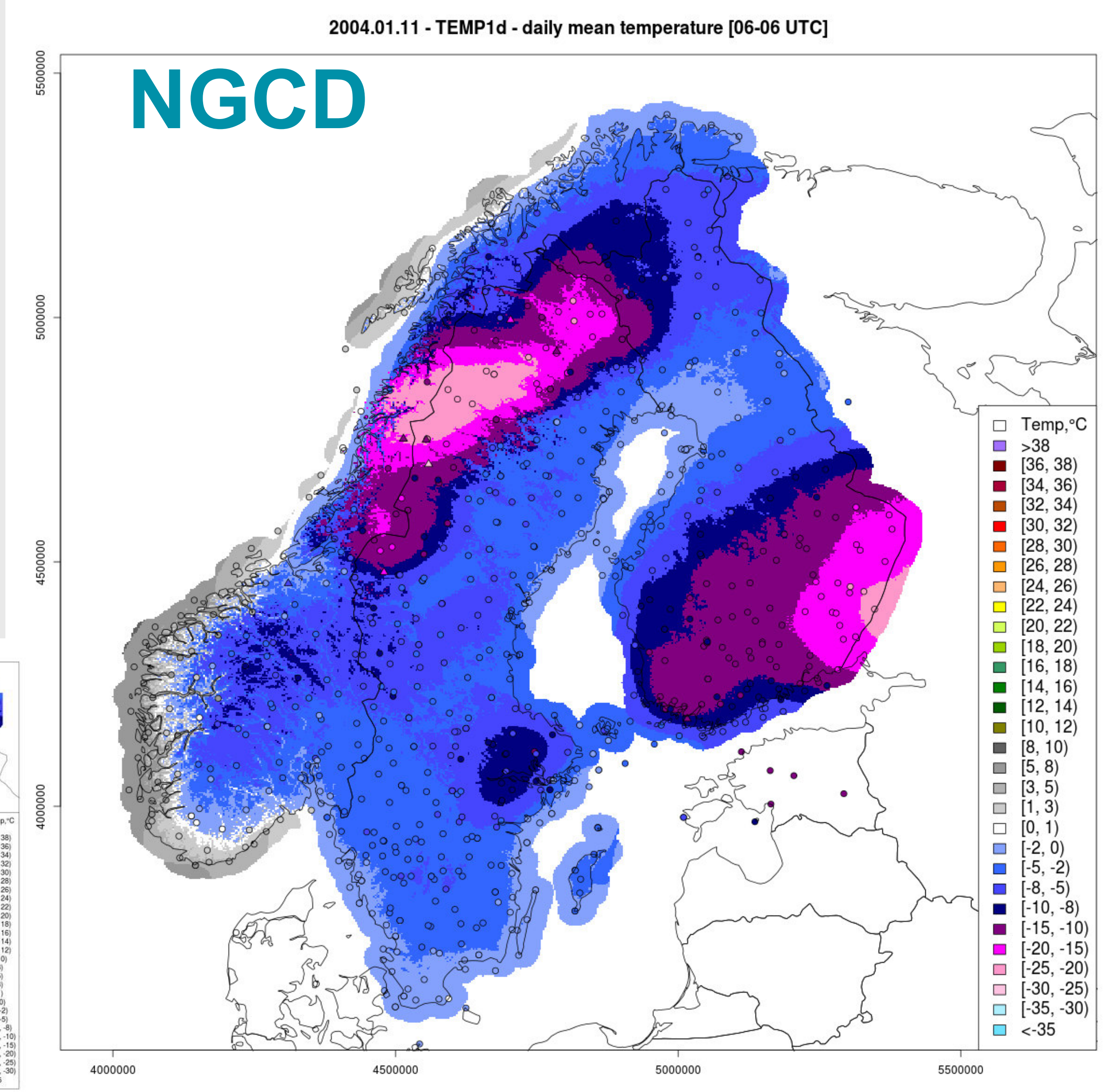


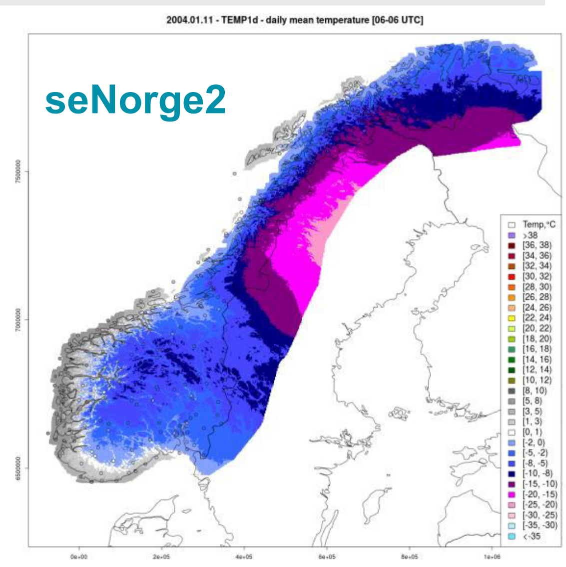
+



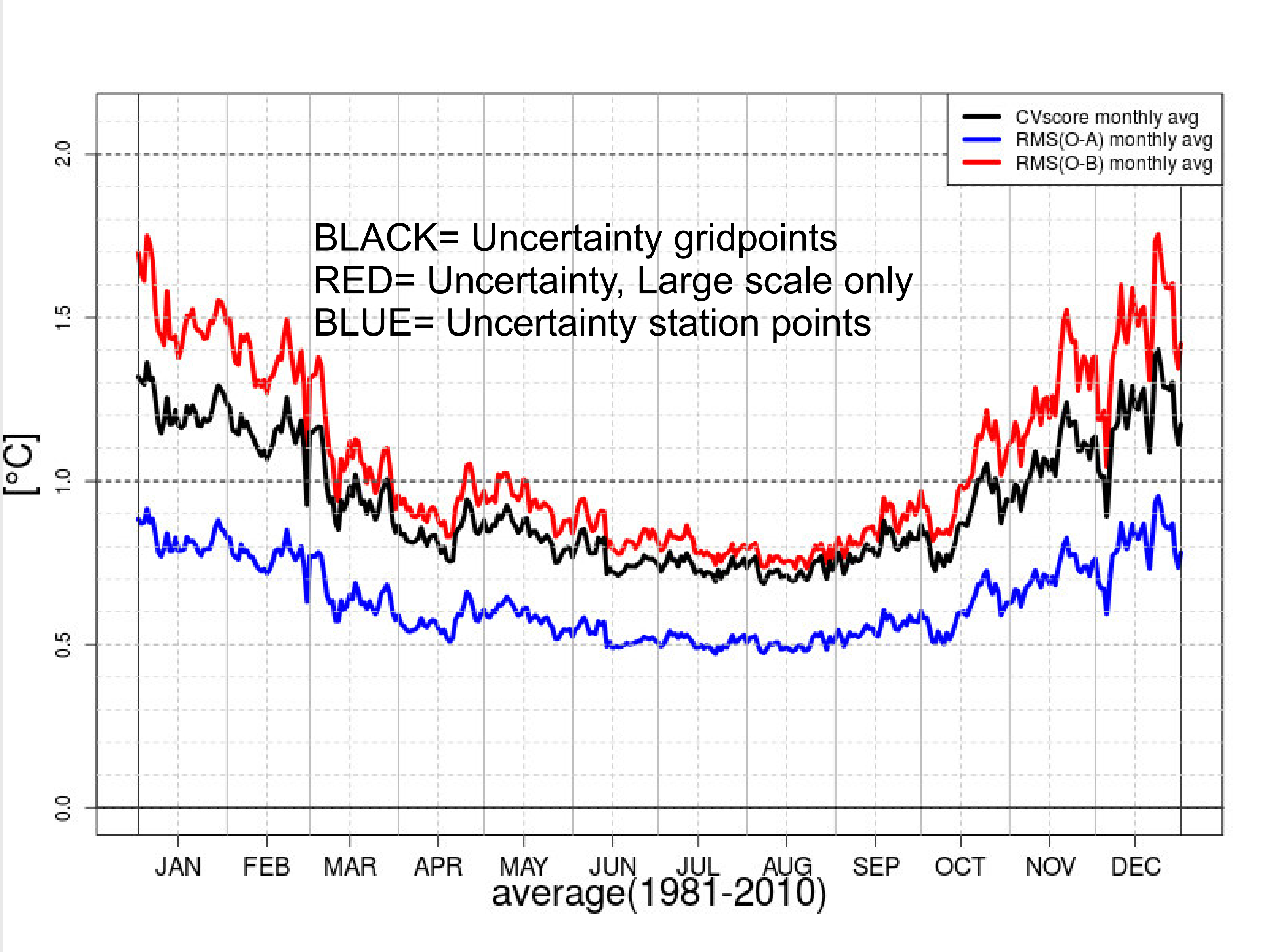
OI introduces the Local(finer) scale

TEMP1d: OI

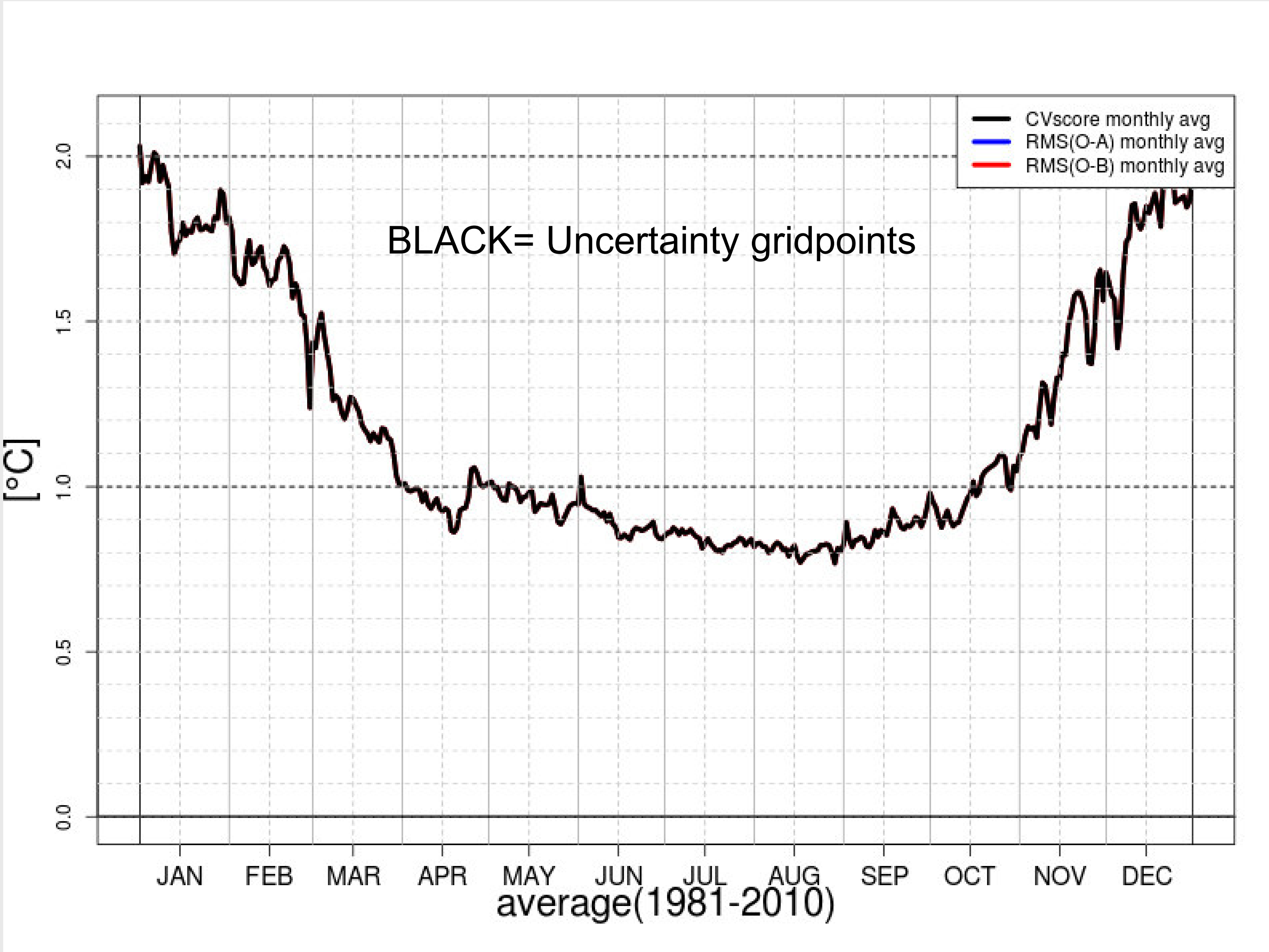

2004.01.11 - TEMP1d - daily mean temperature [06-06 UTC]
NGCD
5500000
5000000
4500000
4000000
4000000
4500000
5000000
5500000
Temp,°C
>38
[36, 38)
[34, 36)
[32, 34)
[30, 32)
[28, 30)
[26, 28)
[24, 26)
[22, 24)
[20, 22)
[18, 20)
[16, 18)
[14, 16)
[12, 14)
[10, 12)
[8, 10)
[5, 8)
[3, 5)
[1, 3)
[0, 1)
[-2, 0)
[-5, -2)
[-8, -5)
[-10, -8)
[-15, -10)
[-20, -15)
[-25, -20)
[-30, -25)
[-35, -30)
<-35


2004.01.11 - TEMP1d - daily mean temperature [06-06 UTC]
seNorge2

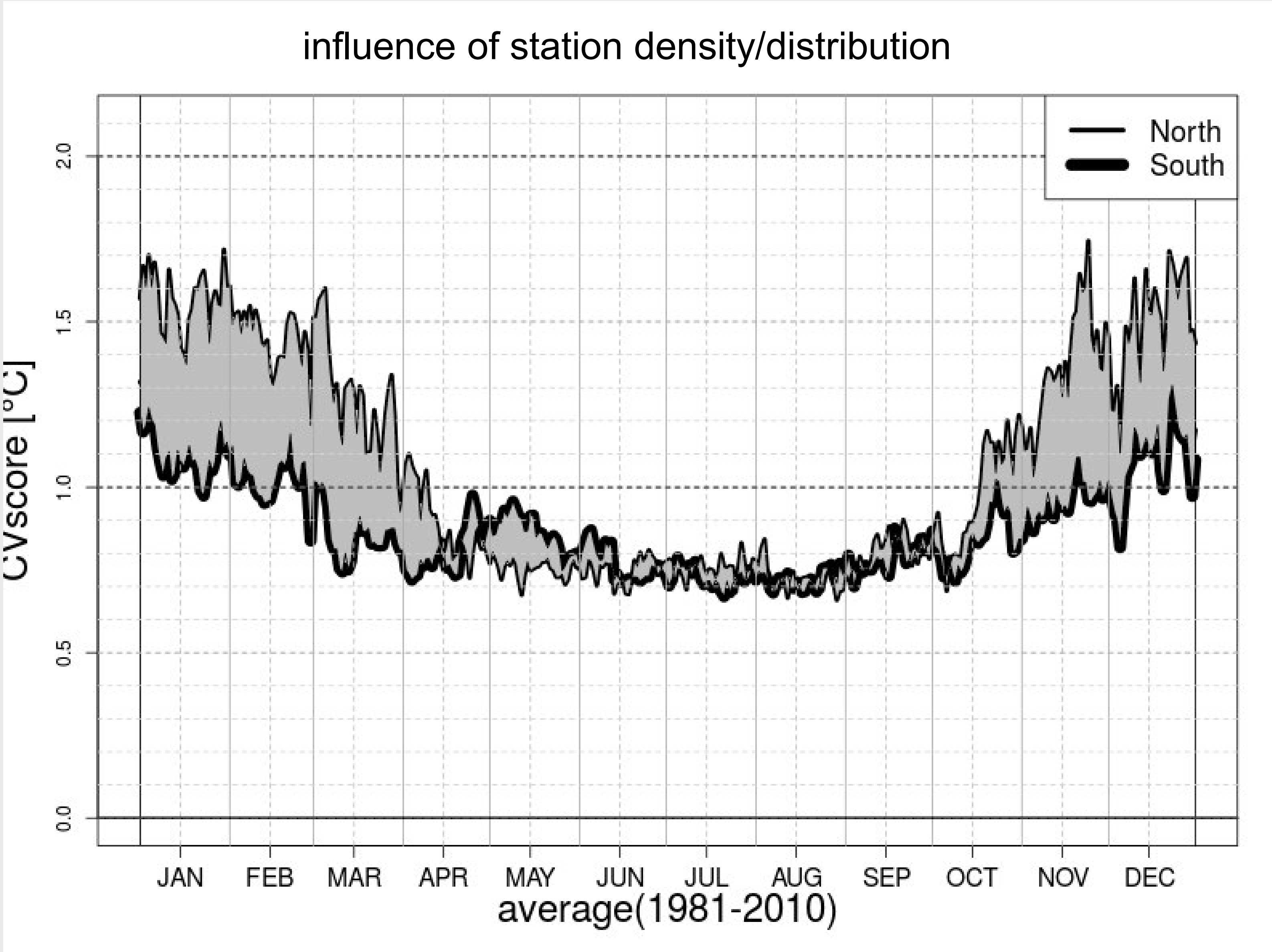
NGCD.OI @ MET Norway – TEMP1d - Evaluation



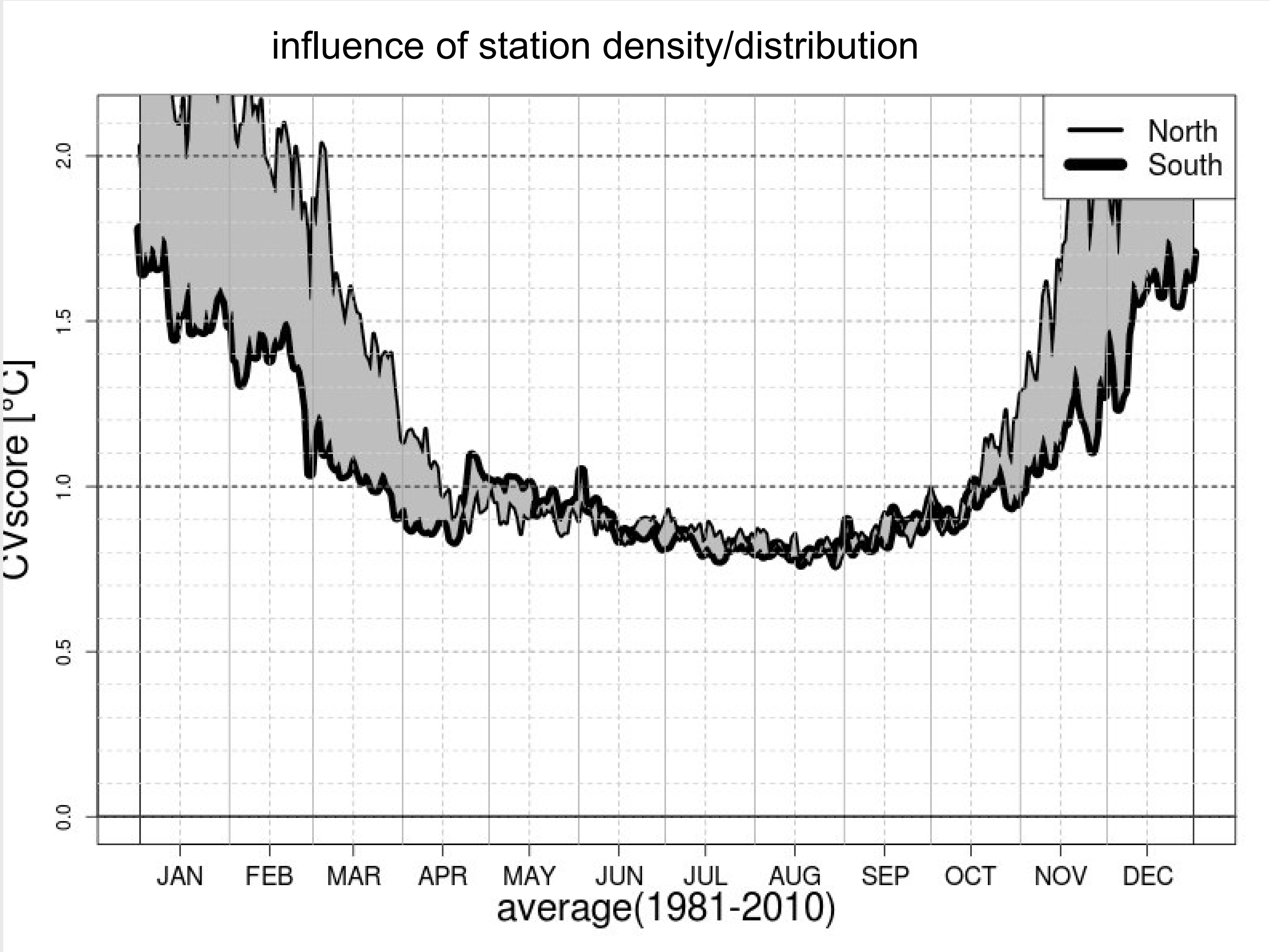
NGCD.RK @ MET Norway – TEMP1d - Evaluation



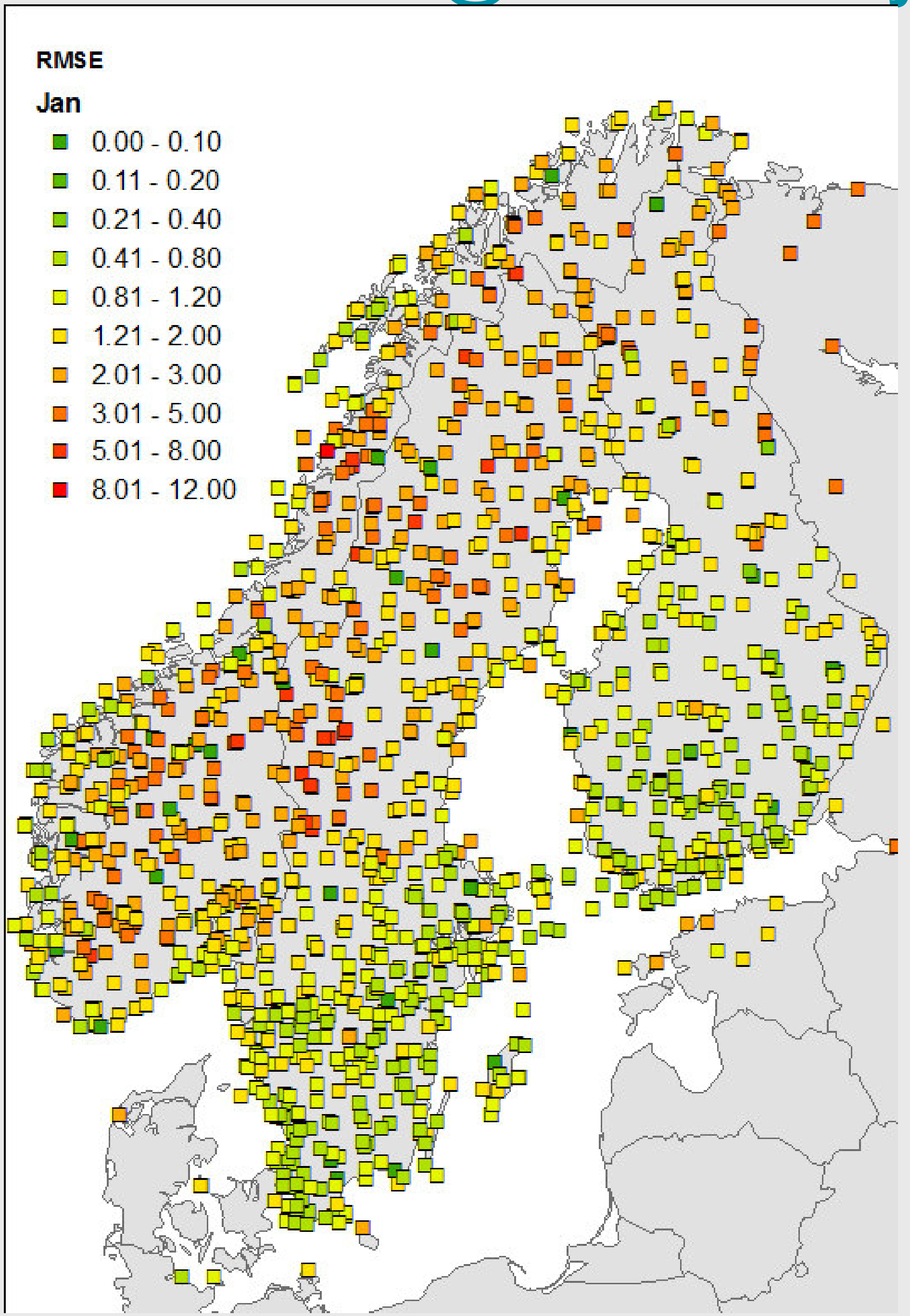
NGCD.OI @ MET Norway – TEMP1d - Evaluation

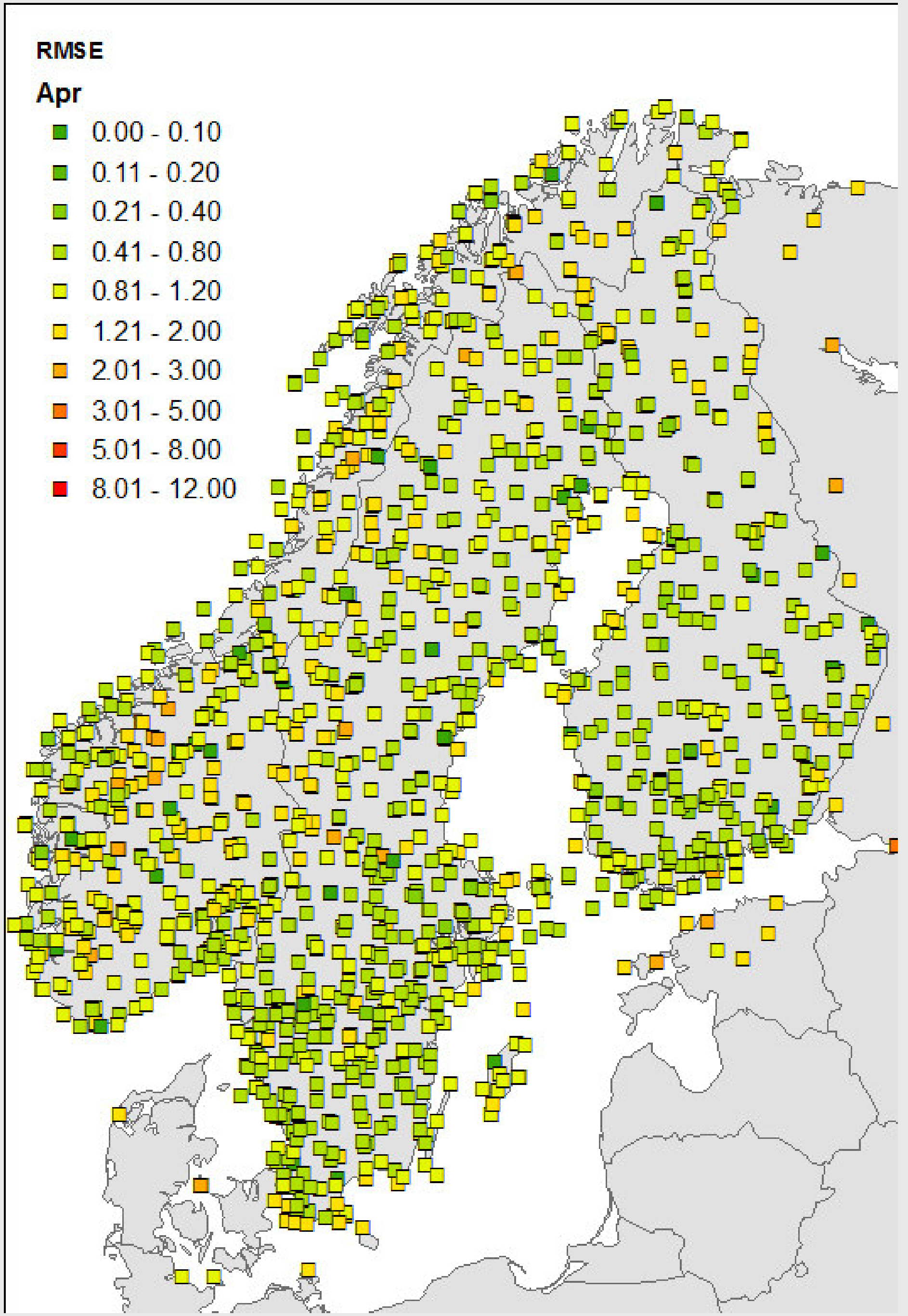


NGCD.RK @ MET Norway – TEMP1d - Evaluation



NGCD.RK @ MET Norway – TEMP1d - Evaluation

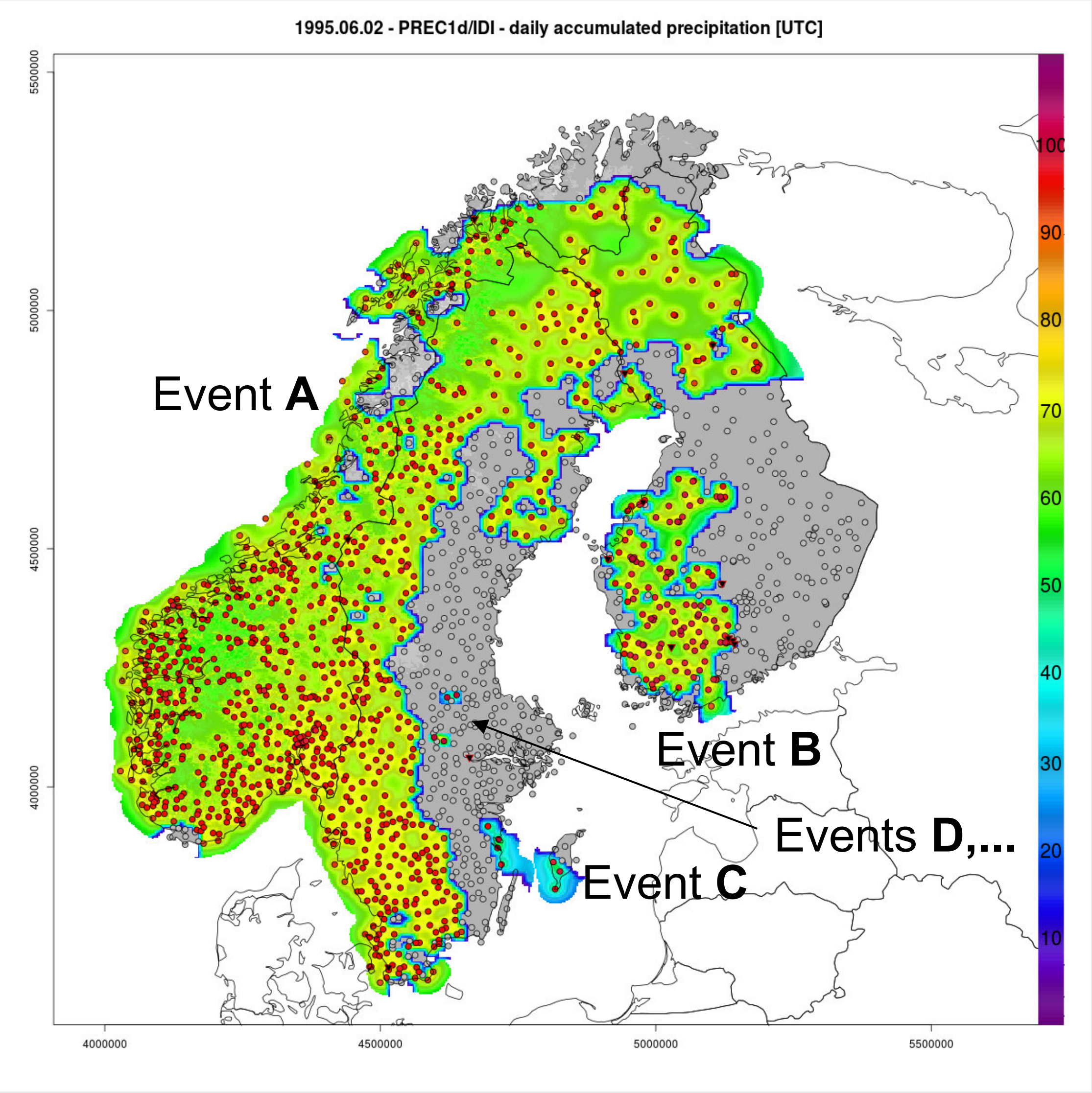




Spatial Interpolation Method based on Multi-scale Optimal Interpolation (Prec)

<u>Step 0:</u> <u>Identification of Precipitation Events (Observed Areas of Precipitation)</u>

(given the Station distribution)



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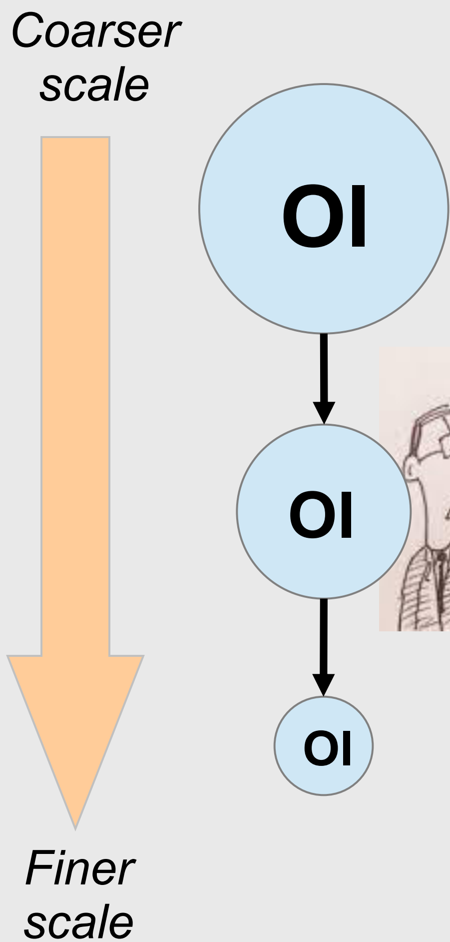
Spatial Interpolation Method based on Multi-scale Optimal Interpolation (Prec)

<u>Given a single Event,</u> the spatial interpolation is based on an *iterative* process:



Given a predefined (horizontal) spatial *scale.*

<u>OI assumptions:</u>

- Additive error model:
  - $obs_{scale} = truth_{scale} + err_{scale}$
  - $back_{scale} = truth_{scale} + err_{scale}$
- Gaussian errors:
  - $err_{scale} = N(0,CovMat)$
- CovMat = f(*scale*,Vertical coord)
- OI (through leave-one-out cross validation) is used to optimize the influence of the vertical coordinate in the error covariance matrix

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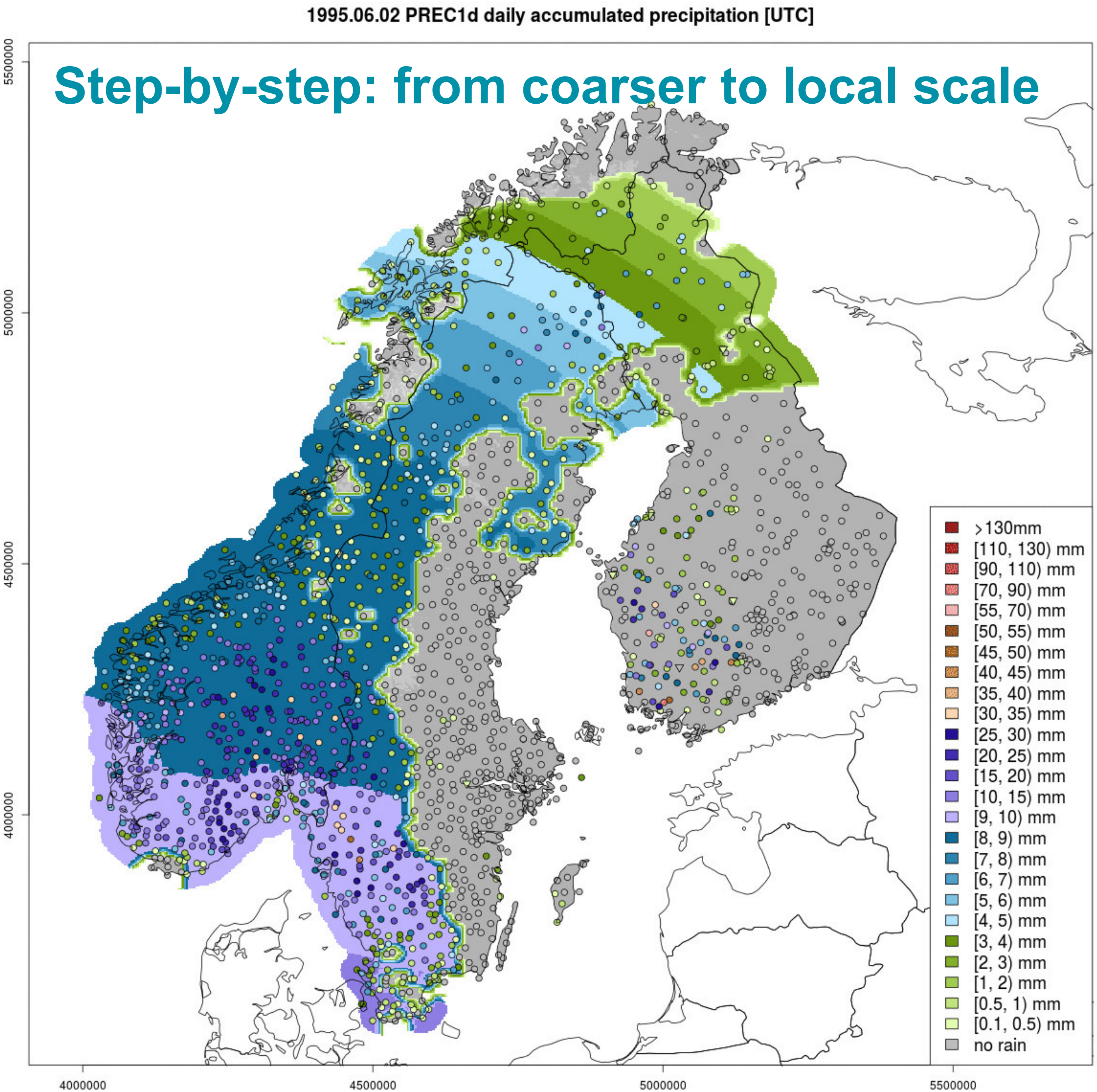
Multi-Scale Optimal Interpolation

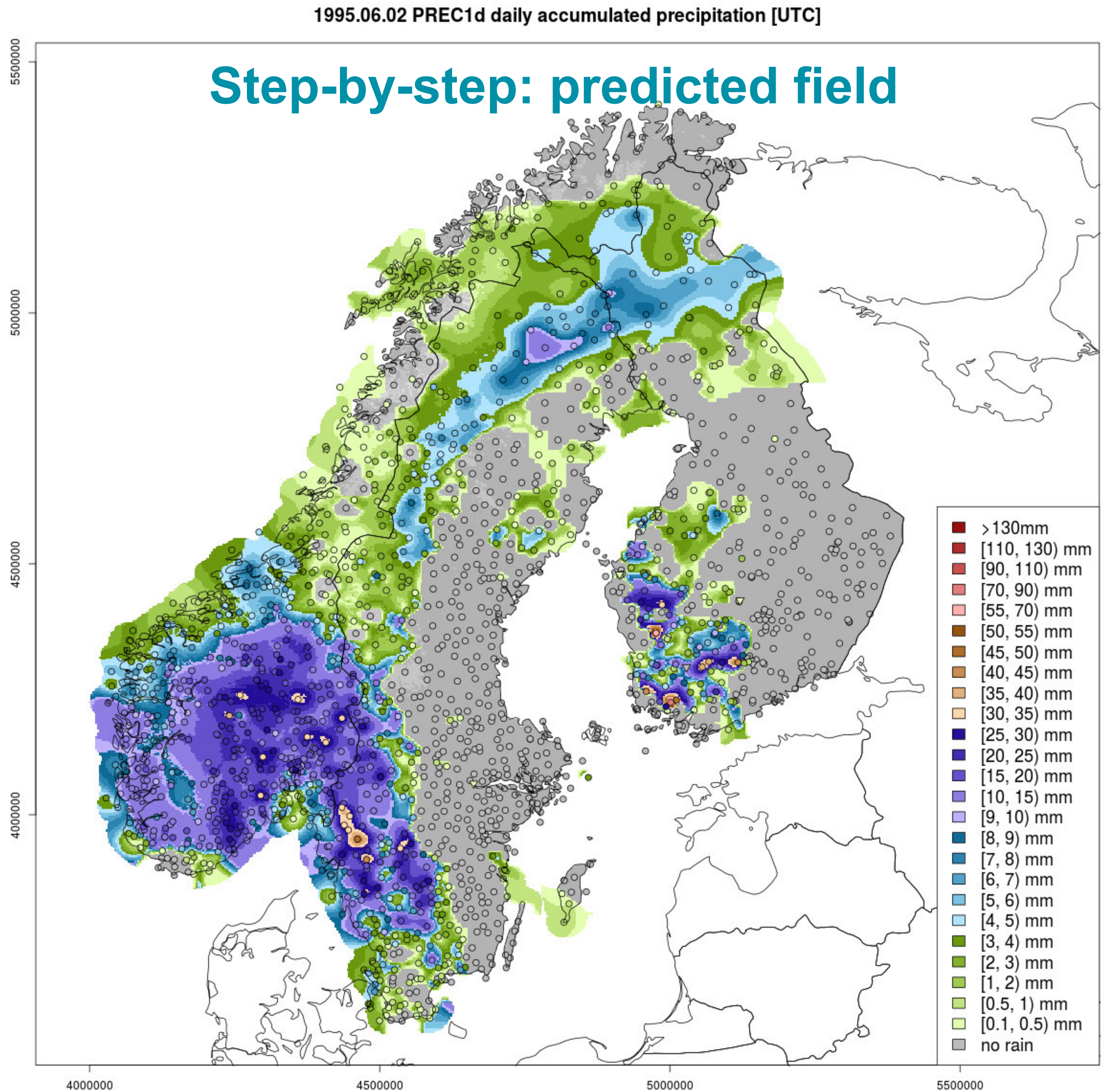
Step-by-step: from coarser to local scale



ical

Multi-Scale Optimal Interpolation

Step-by-step: predicted field



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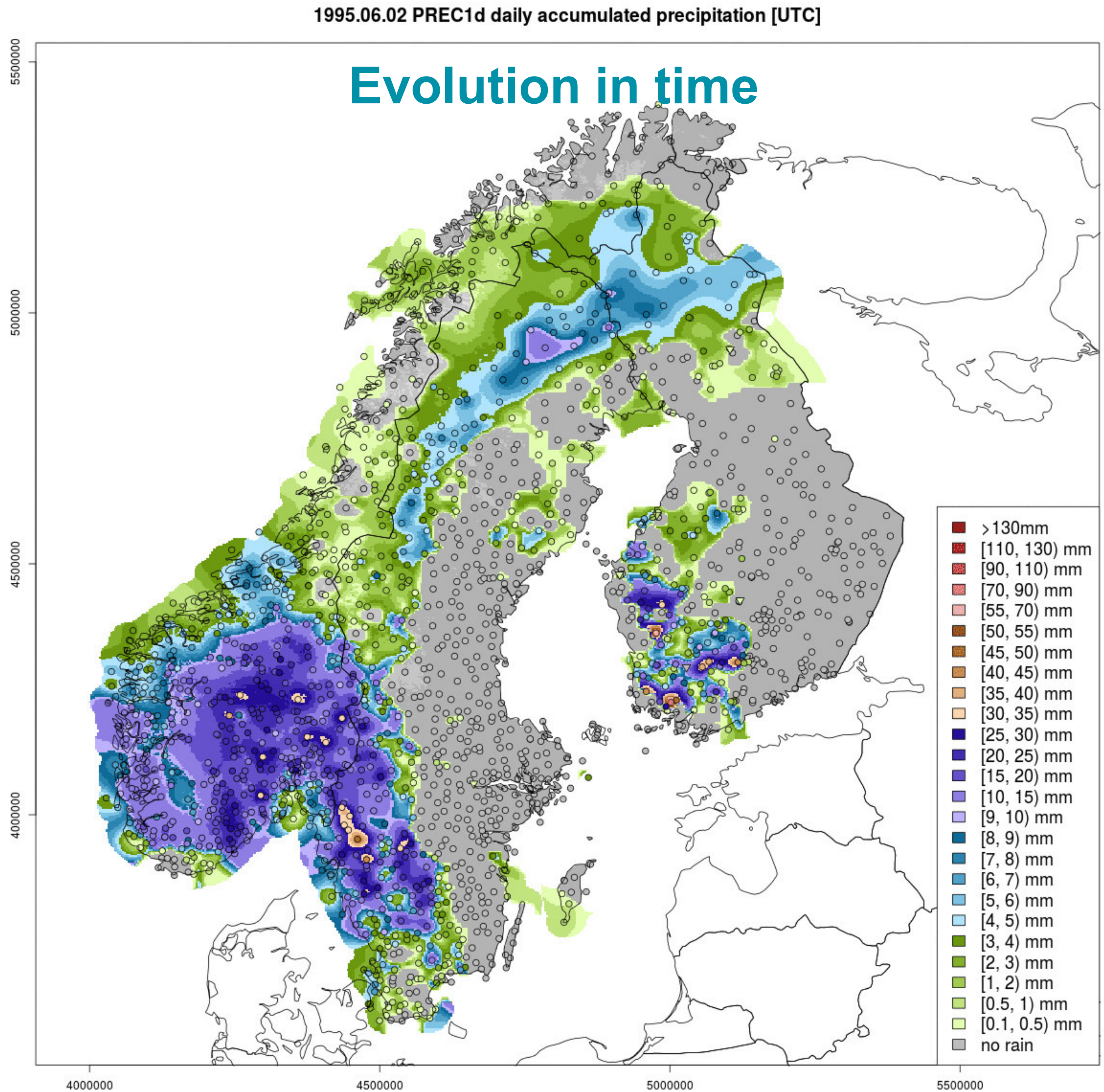
Multi-Scale Optimal Interpolation

Evolution in time



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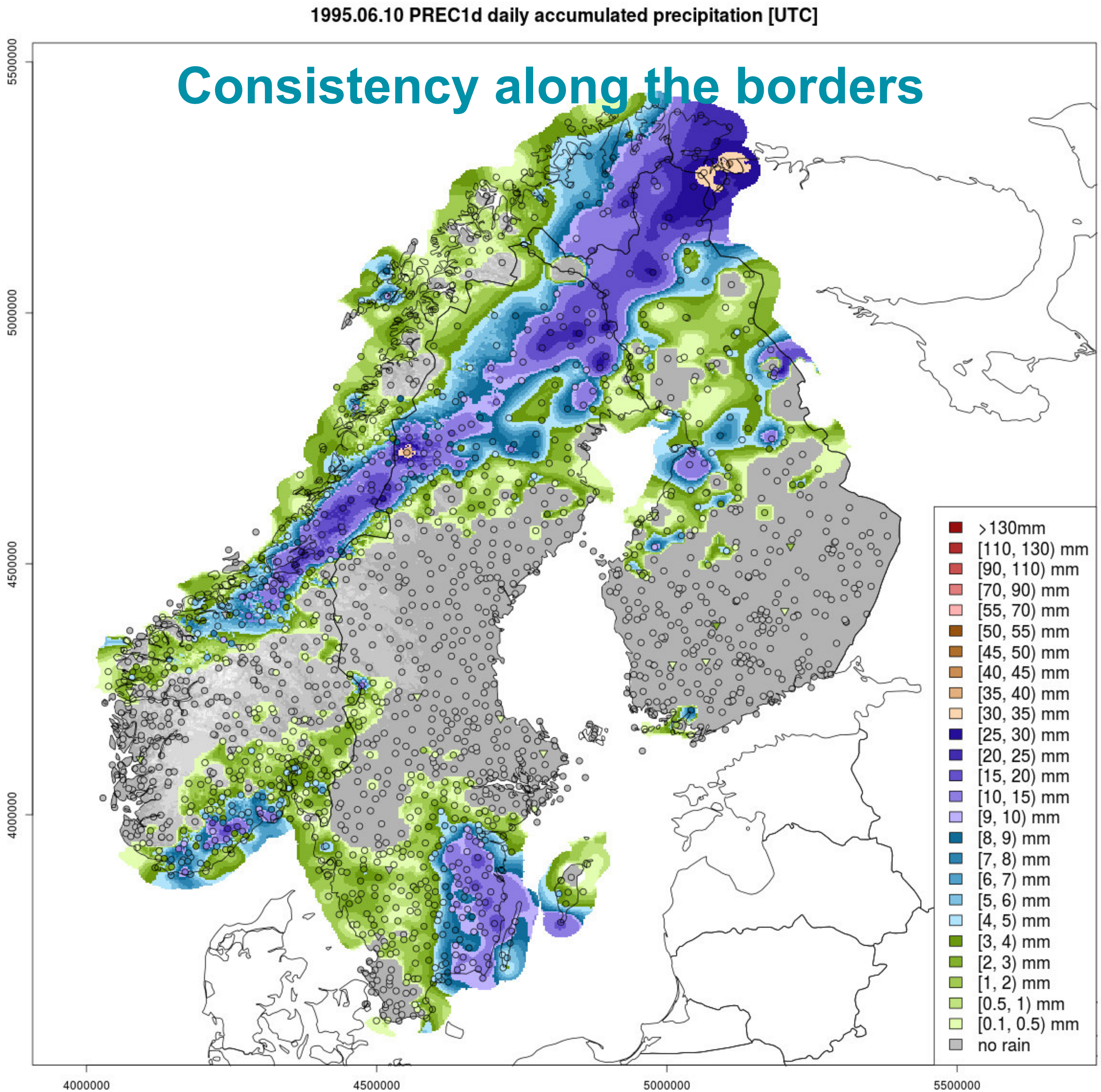
Multi-Scale Optimal Interpolation

Consistency along the borders



Case study: the New Year's Day Storm 1992

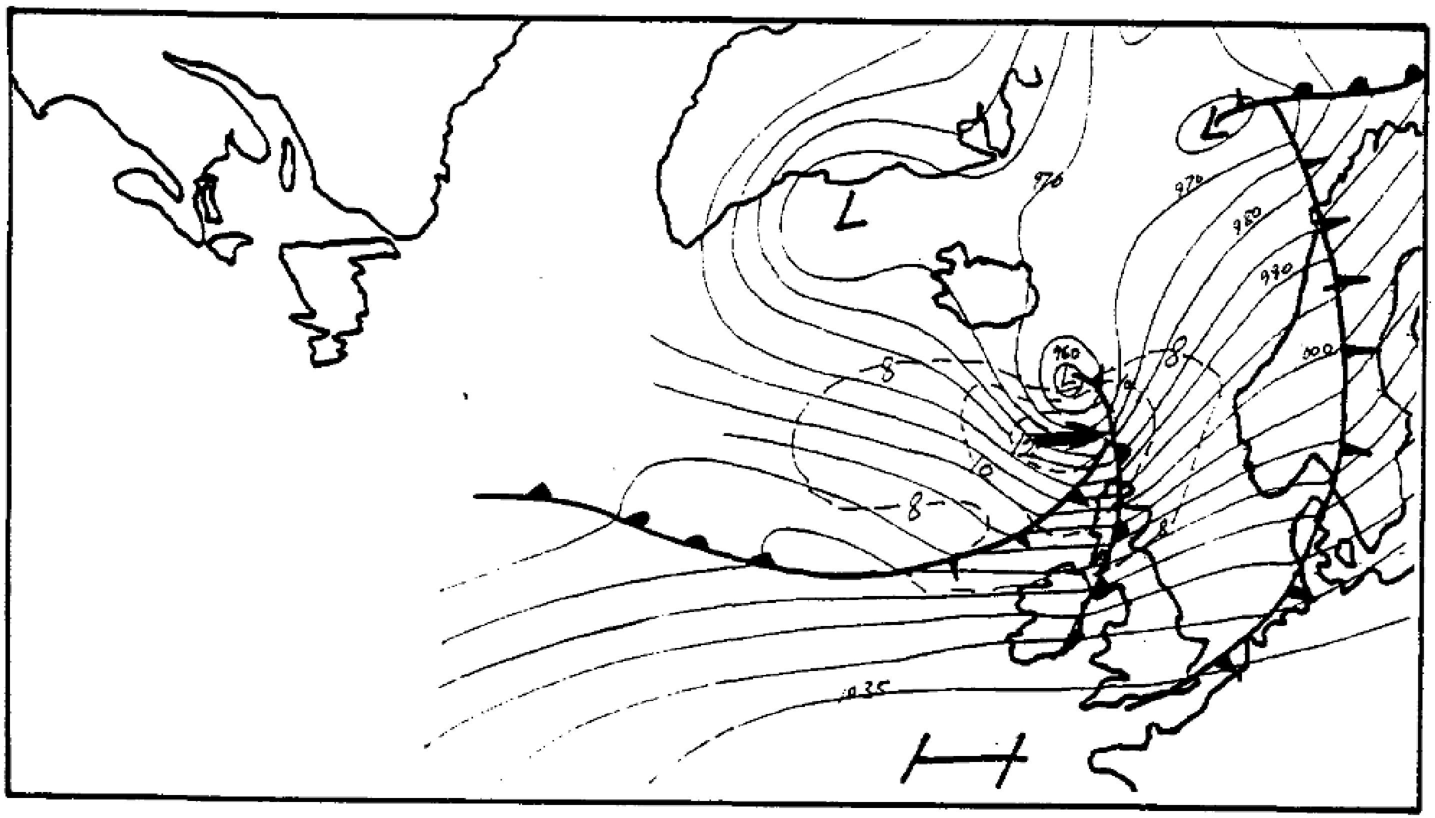
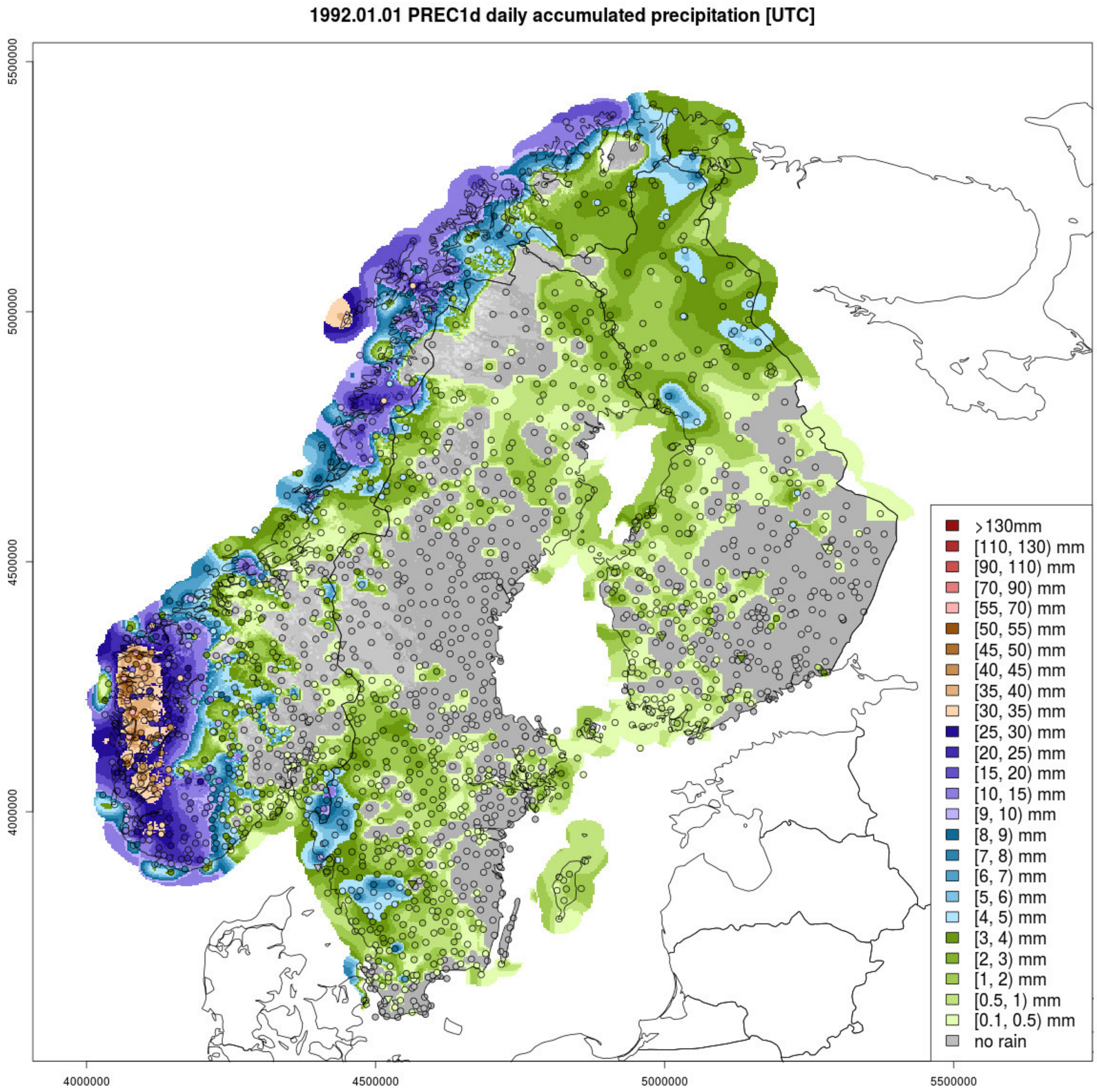


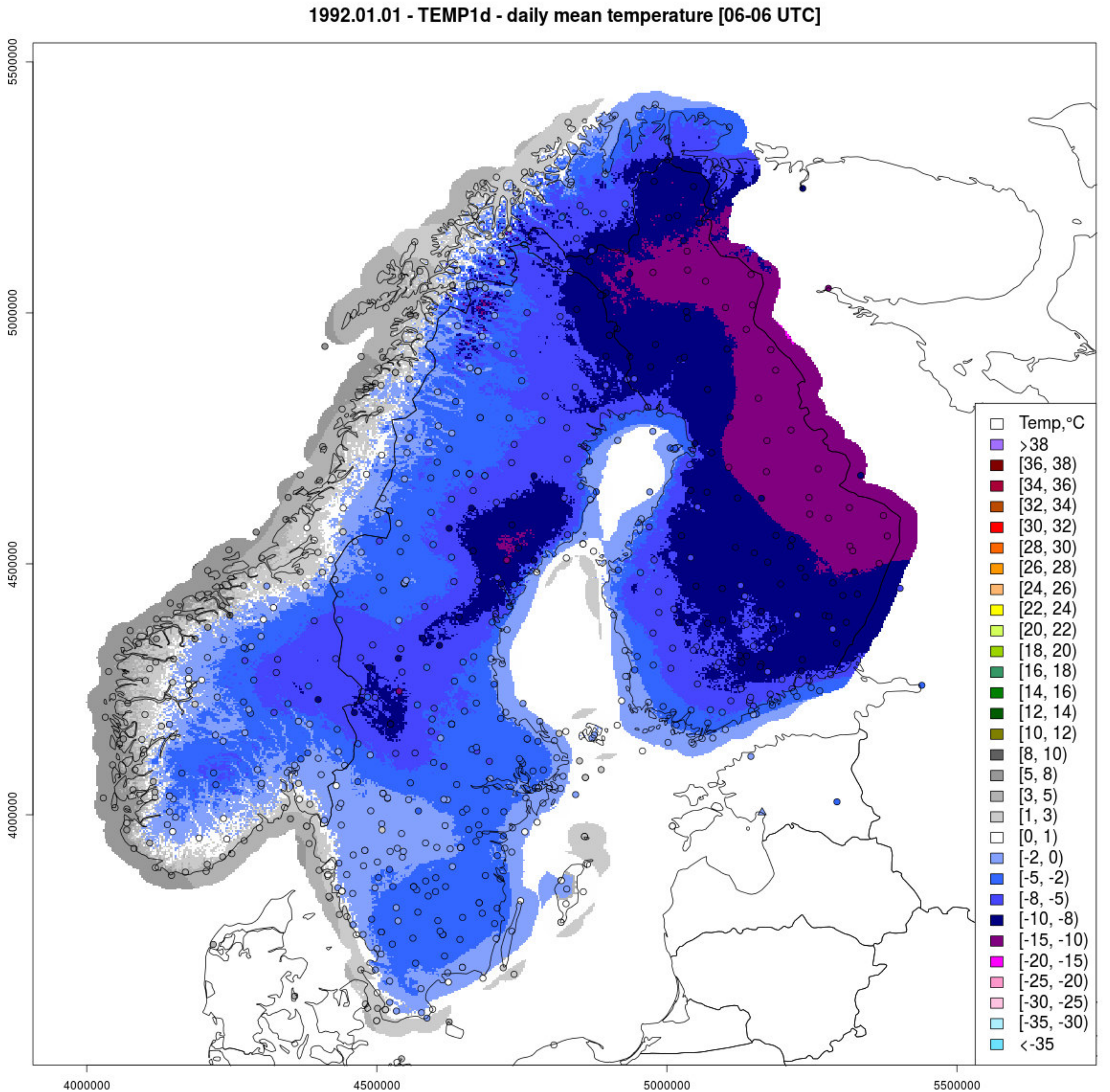
Figure 2. Simplified weather map for 0100 hours NLT 01/01/1992.

Aune, B., and K. Harstveit. "*The storm of January 1st 1992.*" DNMI Rapport NR 23 (1992): 92.

the New Year's Day Storm 1992



the New Year's Storm 1992



Summary

*Within the NFCS, NORDGRID activity, we're establishing several observation-based gridded dataset of **daily precipitation** and **temperature** for the Fennoscandia region covering the period 1981-2010.*

*Given the station distribution we expect to correctly describe the TEMP/PREC state down to the **meso-beta scale** (20-200Km).*

Bayesian/Residual Kriging spatial interpolation of precipitation and temperature show encouraging results.

- *Temp: on the average, Temperature analysis uncertainty is estimated to be between 0.6 ℃ in the summer and 1.5 ℃ in the winter.*
- *Prec: Visual inspection of precipitation fields show realistic feature. Quantitative evaluation needed.*

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10th EUMETNET Data Management Workshop
St. Gallen, Switzerland 28th – 30th October 2015

GOBIERNO DE ESPAÑA

MINISTERIO DE AGRICULTURA, ALIMENTACIÓN Y MEDIO AMBIENTE

AEMet Agencia Estatal de Meteorología

MAPPING MINIMUM DAILY TEMPERATURE IN SPAIN USING KRIGING WITH EXTERNAL DRIFT

Andrés CHAZARRA, José Vicente MORENO, Roser BOTEY

Agencia Estatal de Meteorología (AEMET)

achazarrab@aemet.es

Introduction

• The objective is to describe the methodology that has been applied in the Spanish Meteorological Agency (AEMET) for obtaining **high-resolution gridded fields of daily minimum temperature** in Spain.

• This project began in 2013 when AEMET was requested to generate high-resolution gridded fields of daily minimum temperature for **agricultural applications** for the period **2002-2013.**

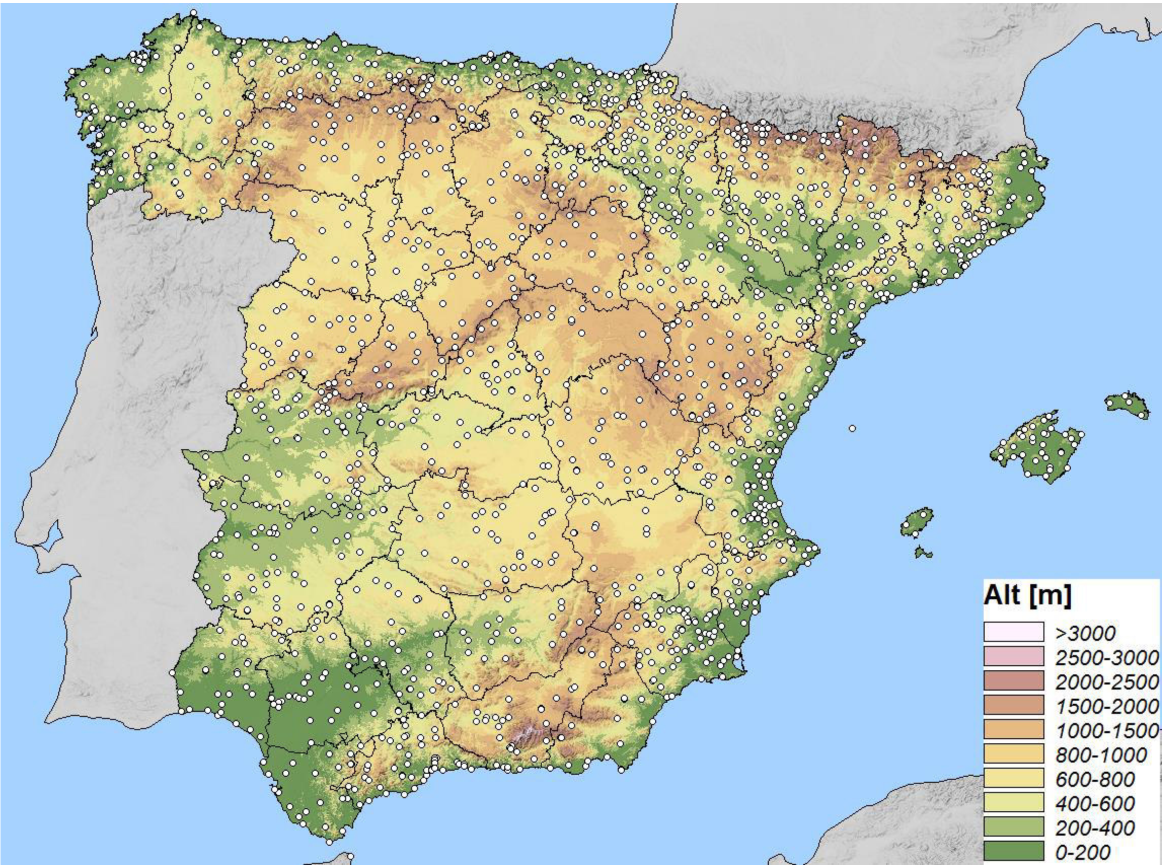
• Spatial interpolation of **daily temperature data** → a more complex problem than the case of monthly or annual mean temperature data. Very often we have to deal with **temperature inversions** and other local phenomena, specially in mountainous regions.

• Mountainous regions are often **data-sparse** in Spain→ it is necessary to consider **external variables**, such as the elevation, in the spatial interpolation process.

• After trying several spatial interpolation methods**, kriging with external drift with elevation and distance to the coast as external variables** was chosen.

Methodology

• **Data**: daily temperature data from Spain - not including the Canary Islands - from the twelve-year period 2002-2013.



Study area and location of the stations (~ 1700 stations)

- **Spatial interpolation method**: Kriging With External Drift (KED) with elevation and distance to the coast as external variables. Exponential semivariogram model.

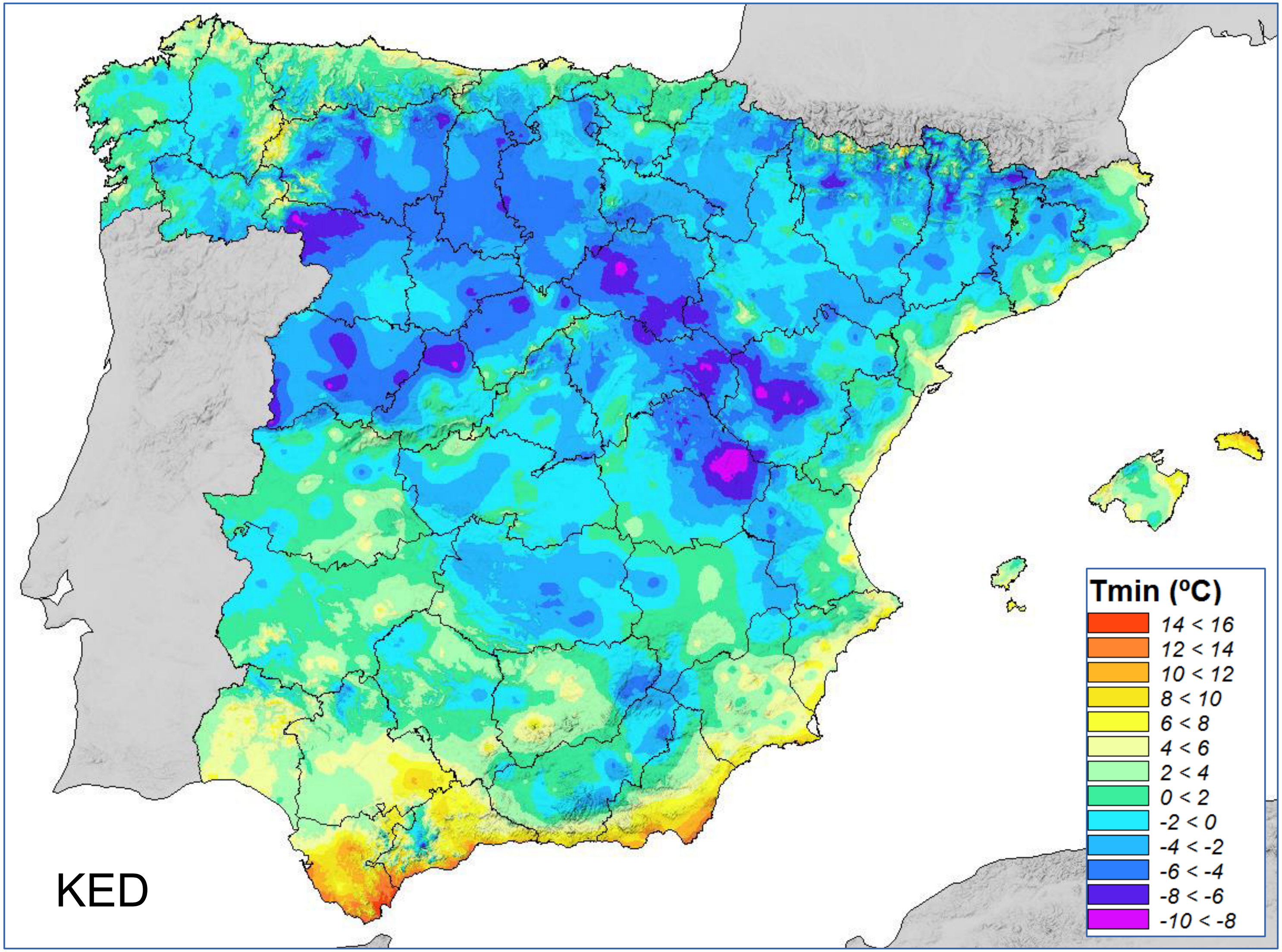
- Other **spatial interpolation methods for comparison**:
  - Inverse Distance Weighted (IDW).
  - Ordinary Kriging (OK).
  - Regression Kriging (RK) with elevation and distance to the coast.

- **Cell size**: 1x1 km.

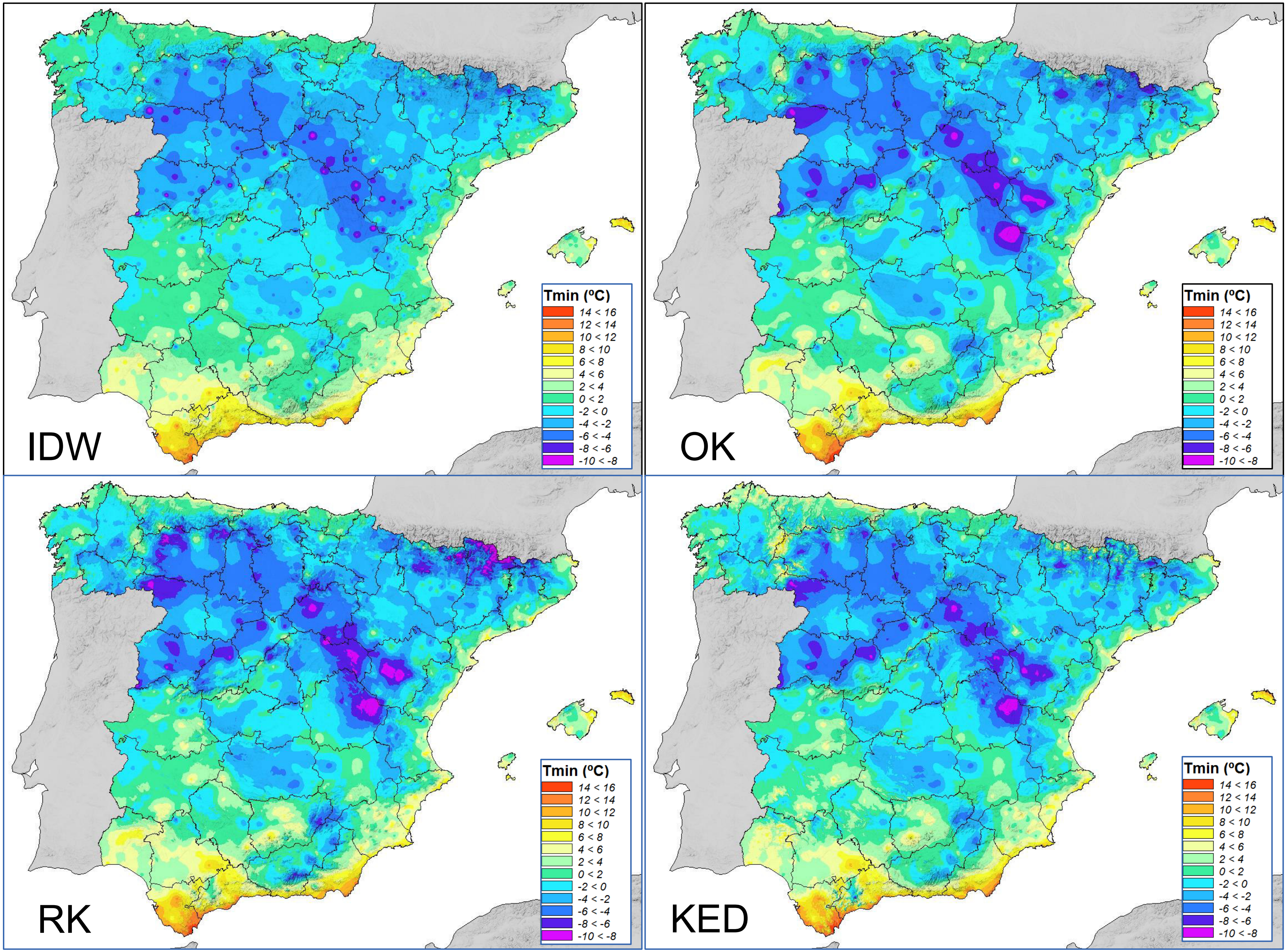
- **Software**: free open source SAGA GIS.

- 365x12+3= **4383** gridded fields of daily minimum temperature were created by KED

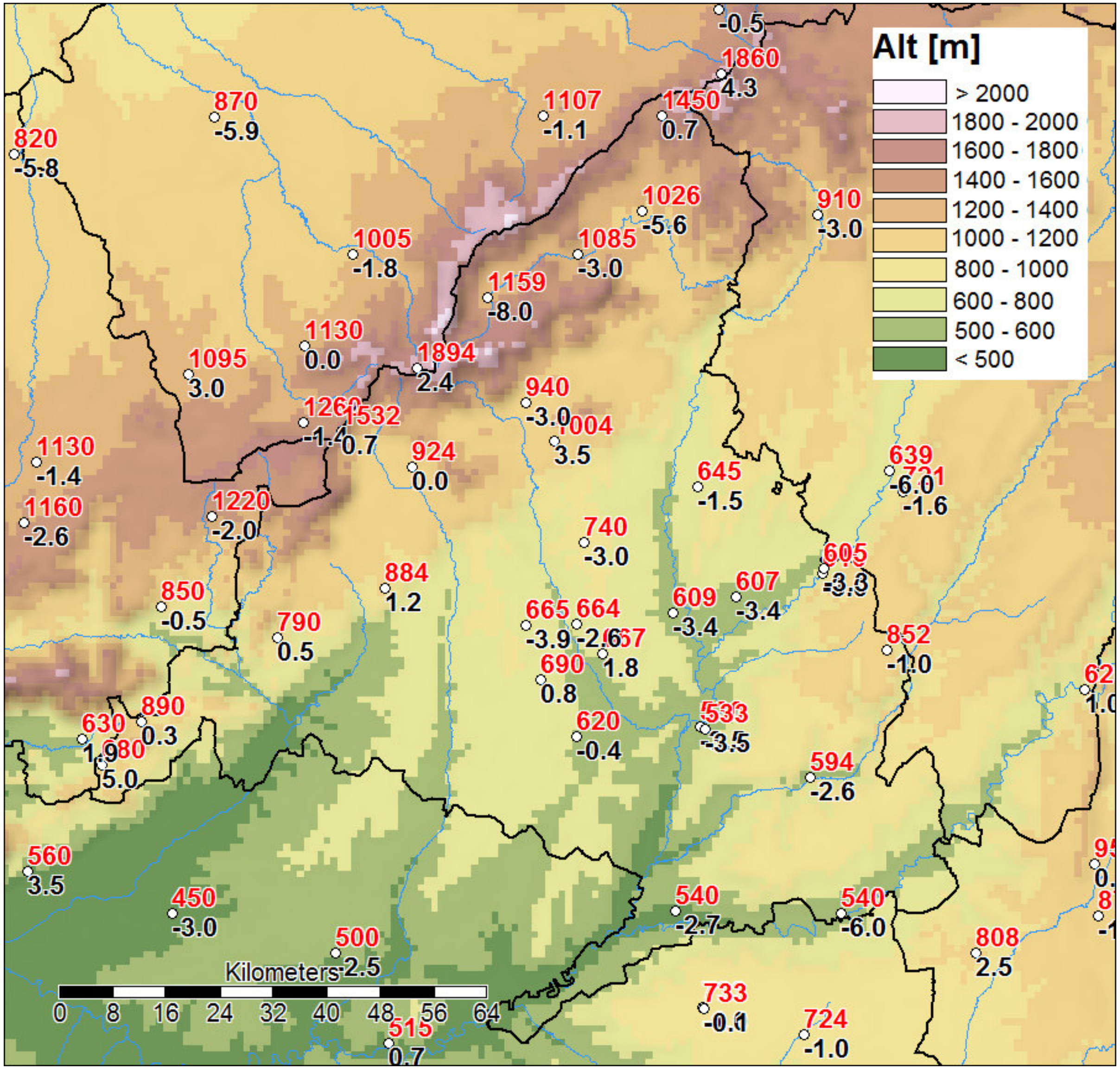
Example: daily minimum temperature 10 January 2012



Visual comparison: daily minimum temperature 10 January 2012



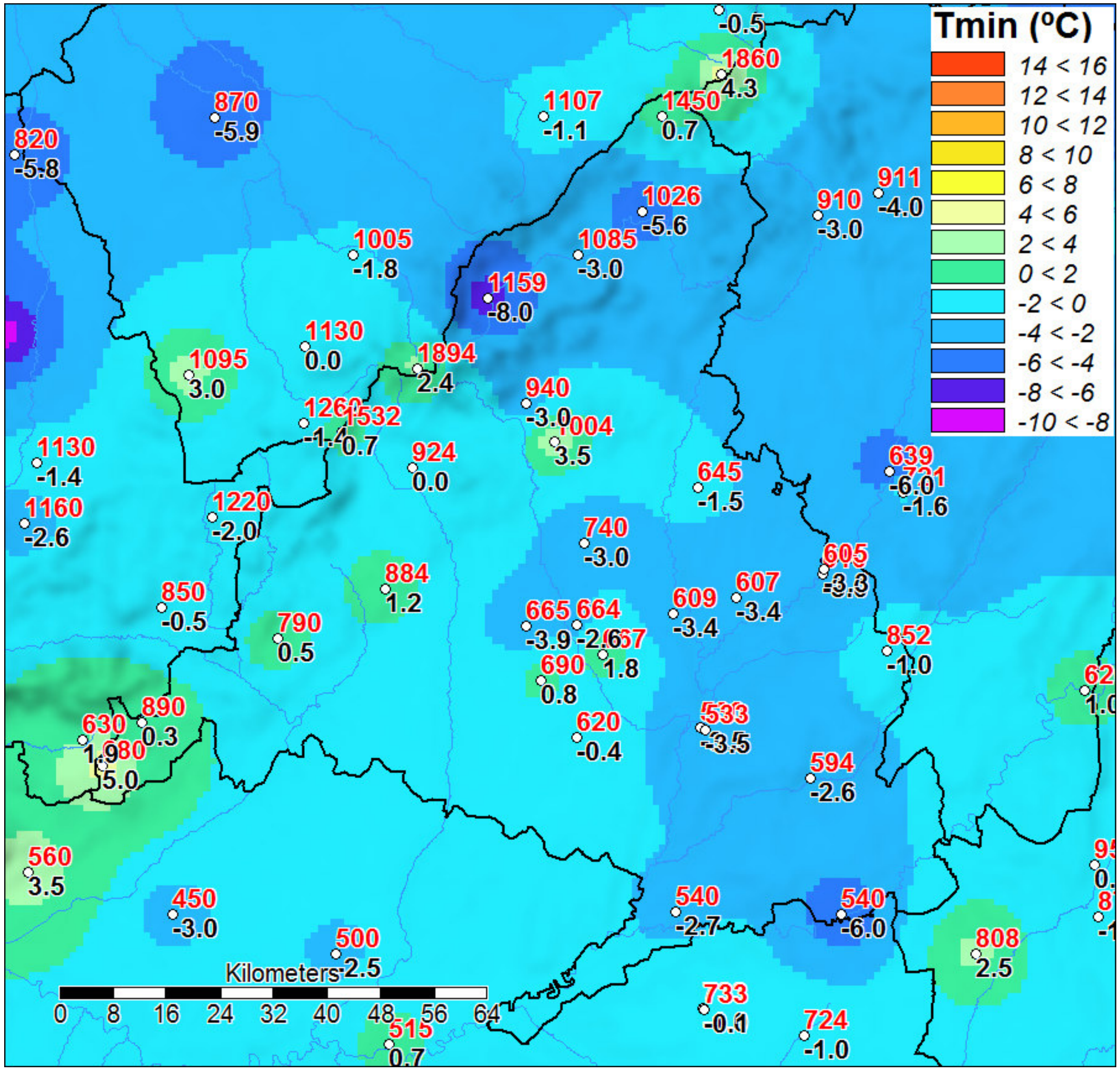
Daily minimum temperature 10 January 2012
Community of Madrid



Minimum temperature data **(black)** and altitude of the stations **(red)**

Daily minimum temperature 10 January 2012

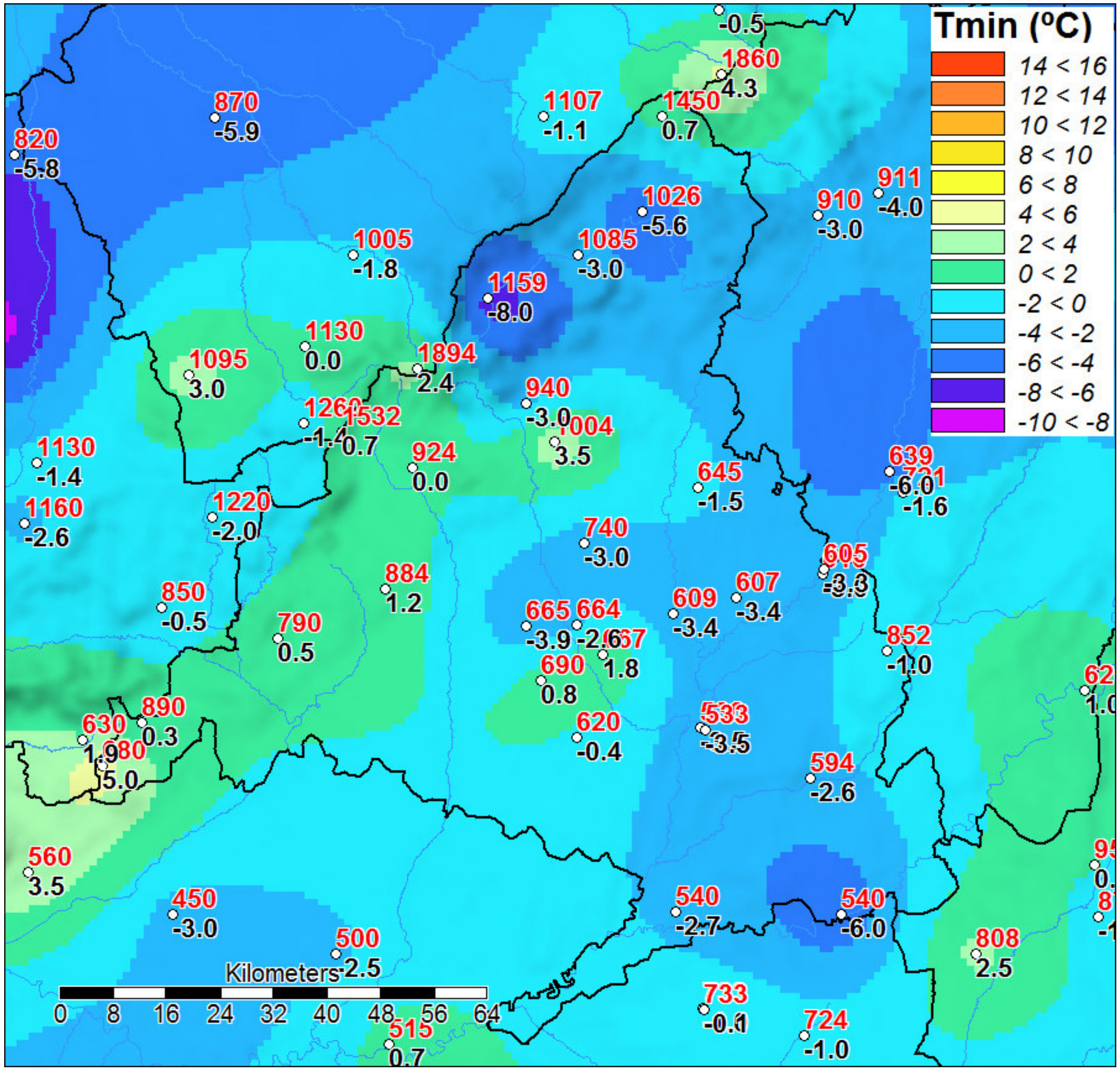
Community of Madrid



IDW

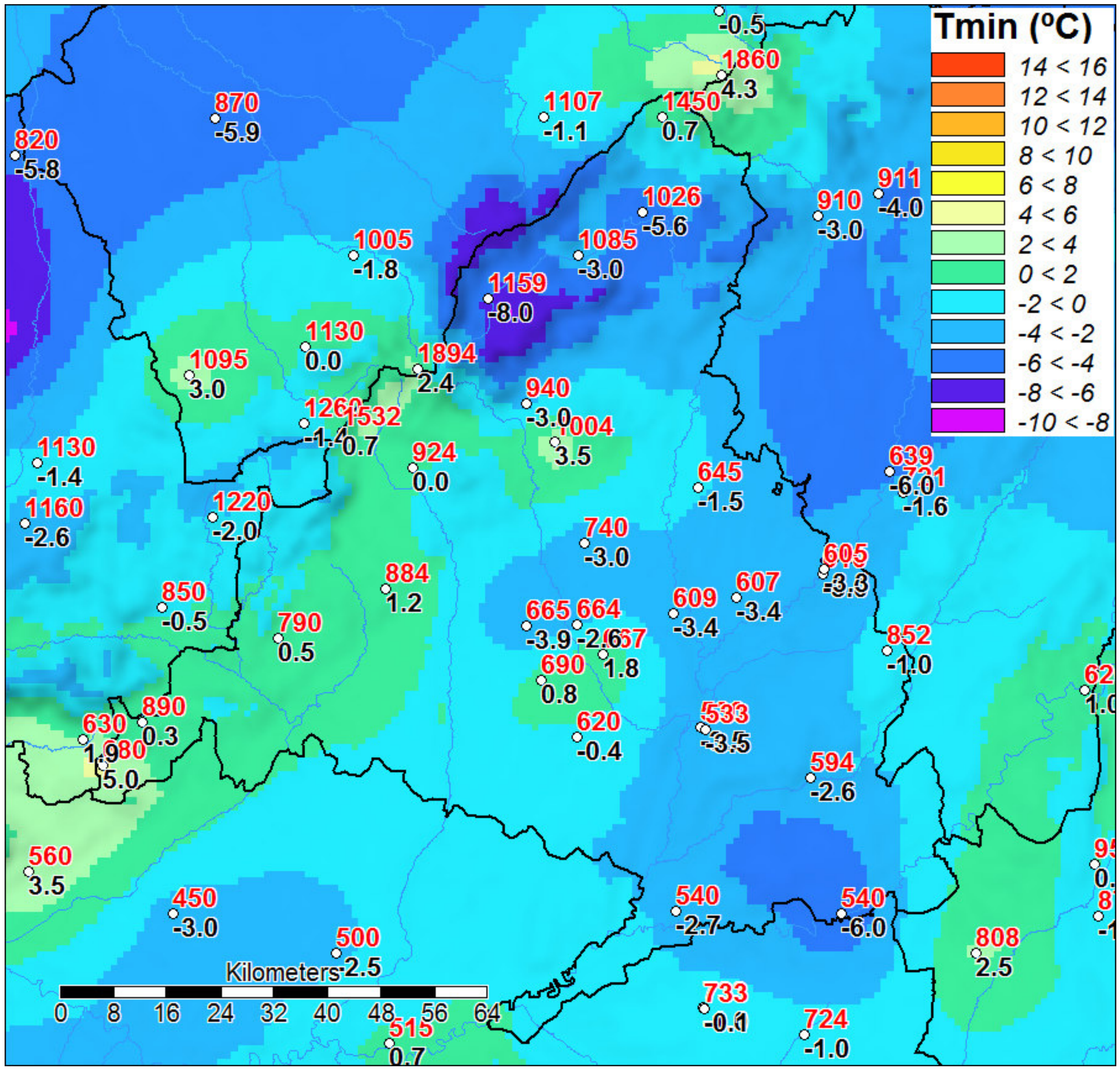
Mapping Minimum Daily Temperature In Spain Using Kriging With External Drift

Daily minimum temperature 10 January 2012
Community of Madrid



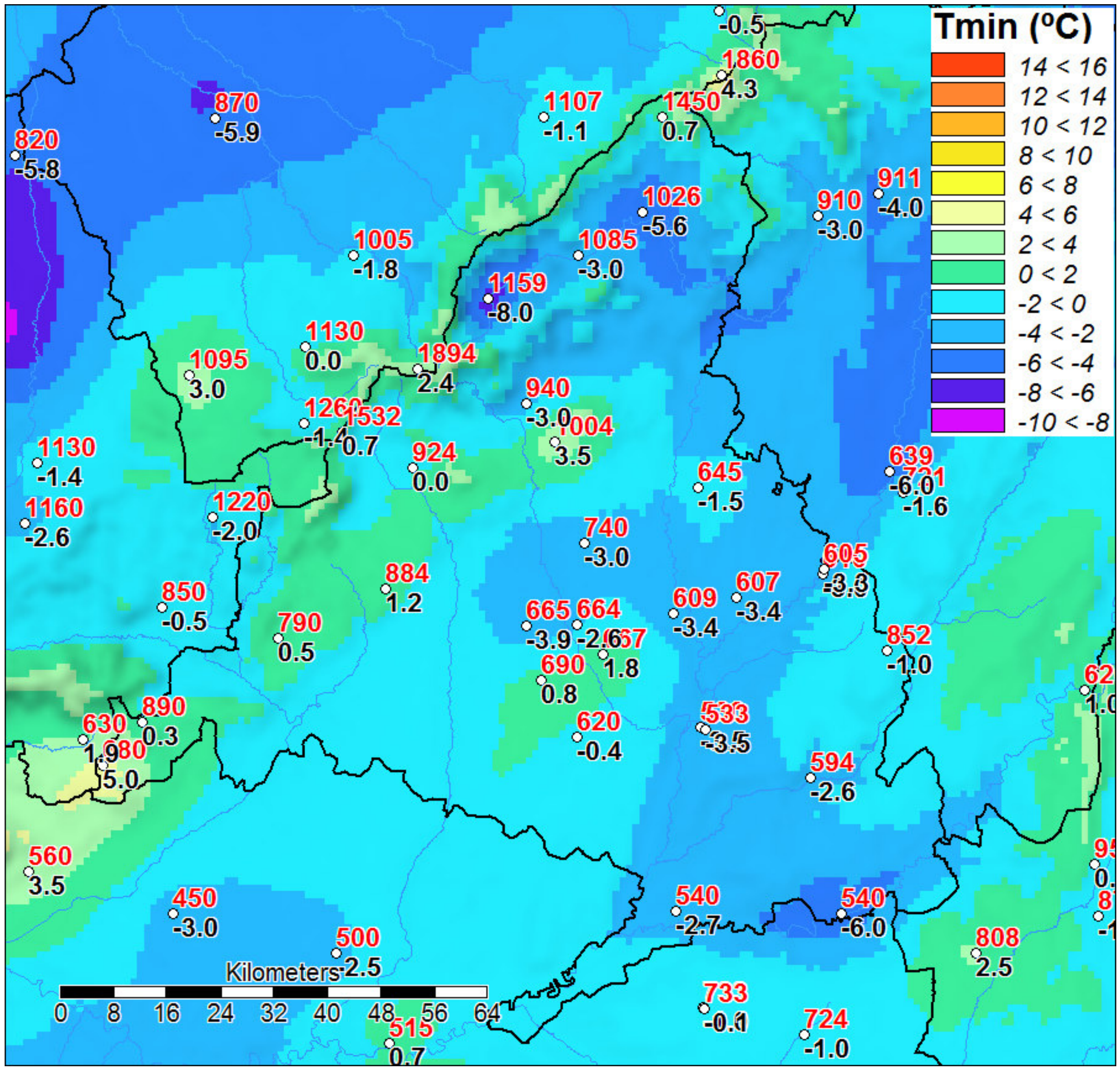
OK

Daily minimum temperature 10 January 2012
Community of Madrid



RK

Daily minimum temperature 10 January 2012
Community of Madrid



KED

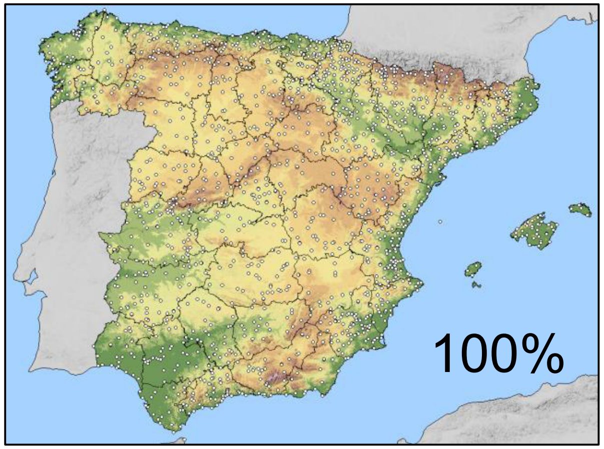
- From a **visual analysis**, we can see that the differences between the methods are generally **small in plain areas**.

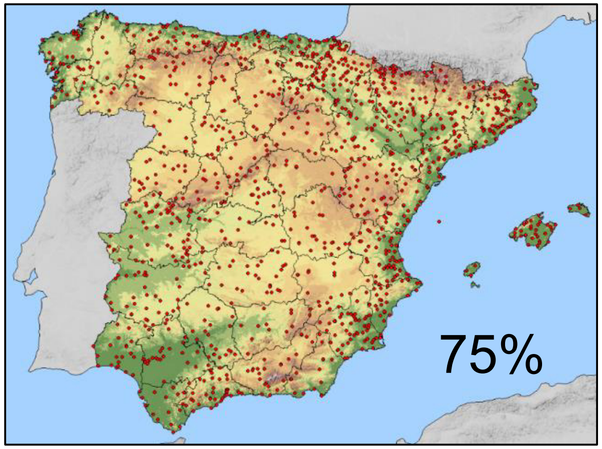
- KED provides better looking interpolations **in mountainous regions with high enough data density**, as it is able to model properly local temperature inversions.

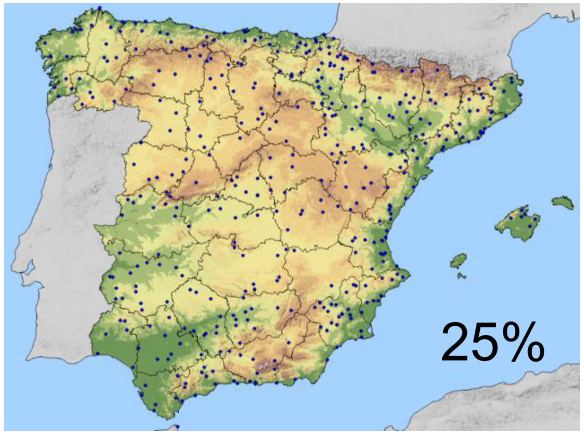
- However, we have detected that KED can lead to some **exaggerated extrapolation effects in areas with scarce and anomalous data** at the same time.

Validation

• A validation process was made by taking apart 25% of the data and repeating the process with the 75% remaining data **for every day of the year 2012** (366 days).







• The mean absolute error (MAE), the root mean square error (RMSE) and the correlation coefficient (R) between the observed and predicted values were used to measure the skill of the interpolation methods.

	R	MAE (ºC)	RMSE (ºC)
IDW	0.859	1.424	1.468
KO	0.858	1.437	1.480
RK	0.858	1.441	1.483
KED	**0.865**	**1.402**	**1.444**

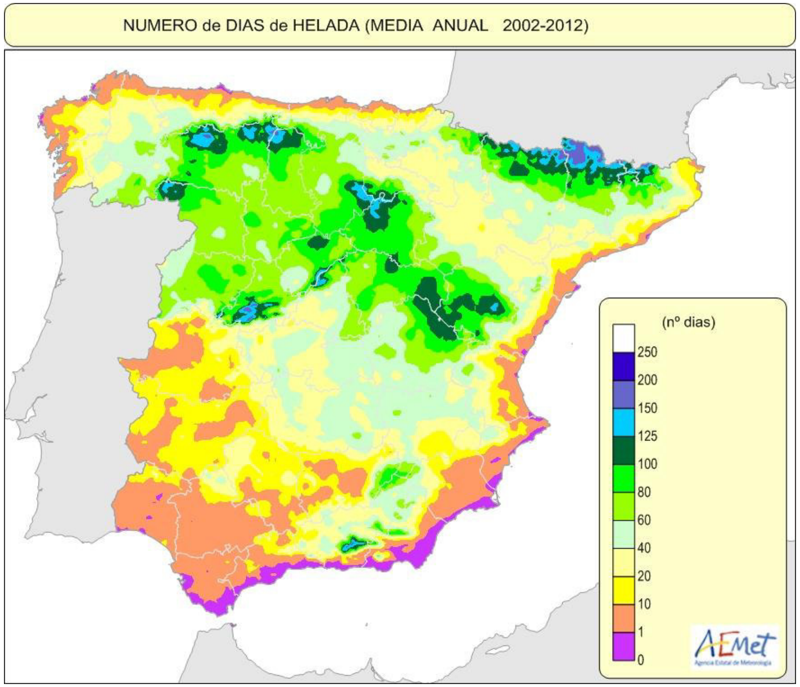
R = Pearson correlation coefficient
MAE = Mean absolute error
RMSE = Root mean square error

- **KED provides the best estimations** for the minimum daily temperature, although the differences with the other methods are small when considering the whole study area.

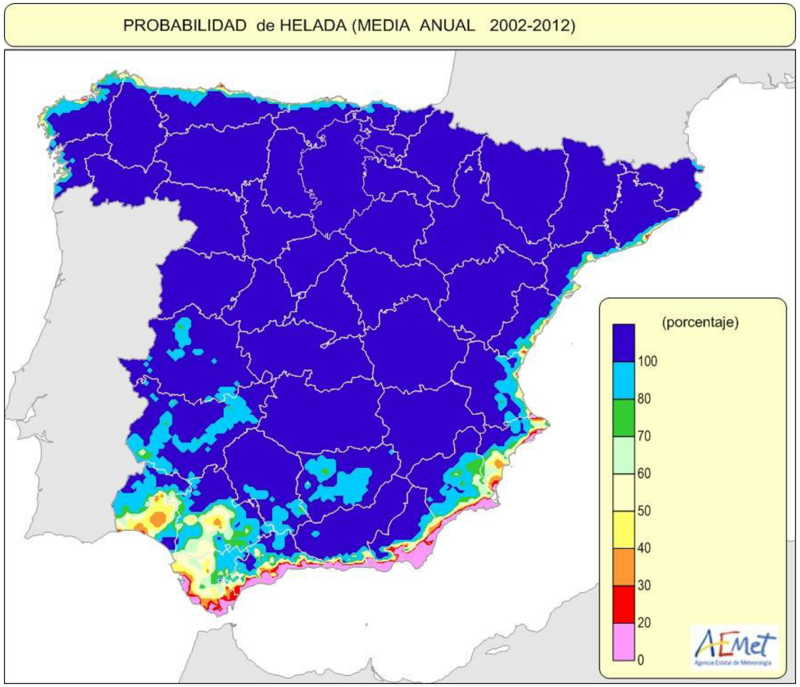
- However, the differences between KED and the other methods **would be greater if only mountainous regions were considered** in the validation.

Some examples of derived products

• Several map products have been generated for agroclimatological purposes by **combining daily gridded temperature fields** from the period 2002-2012

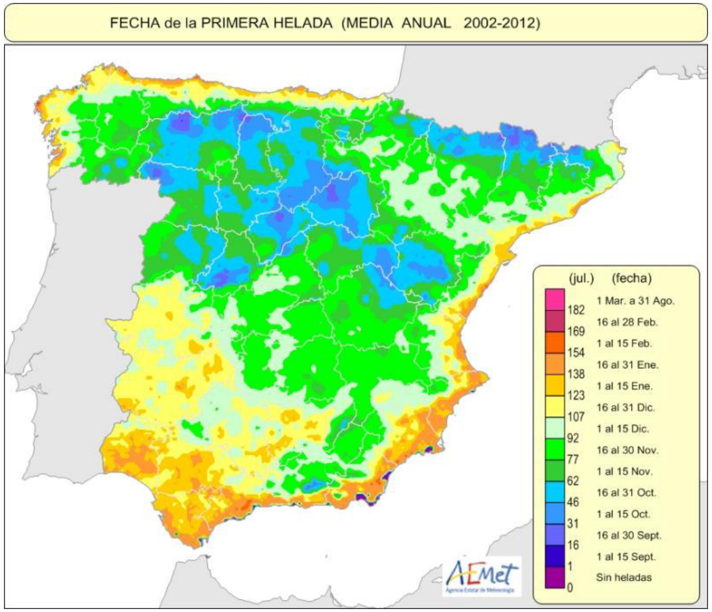


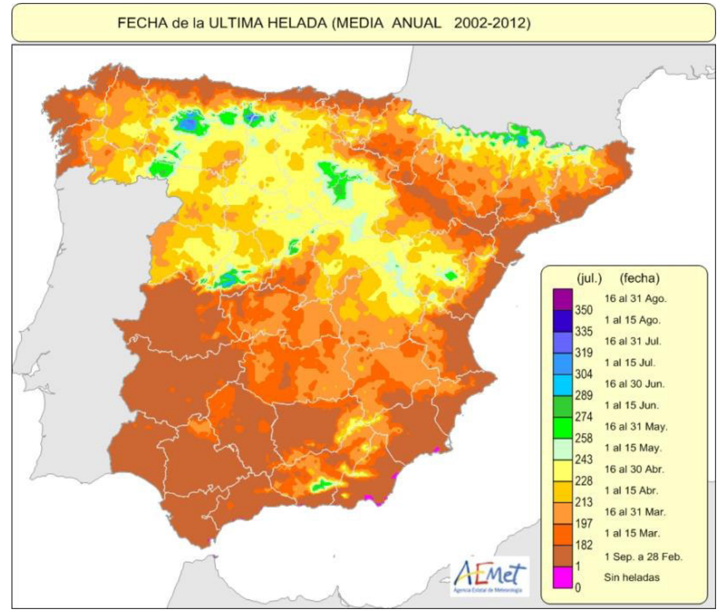
Mean annual number of frost days (2002-2012)



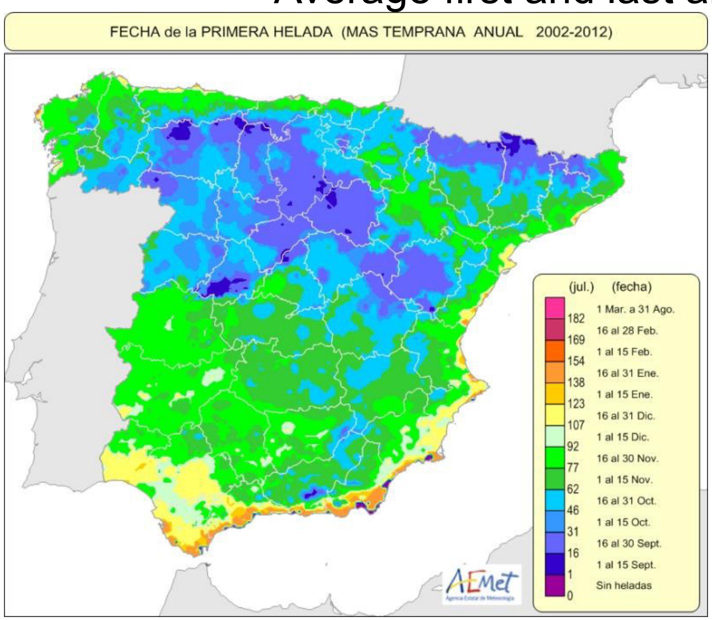
Mean annual probability of reaching temperatures below 0ºC (2002-2012)

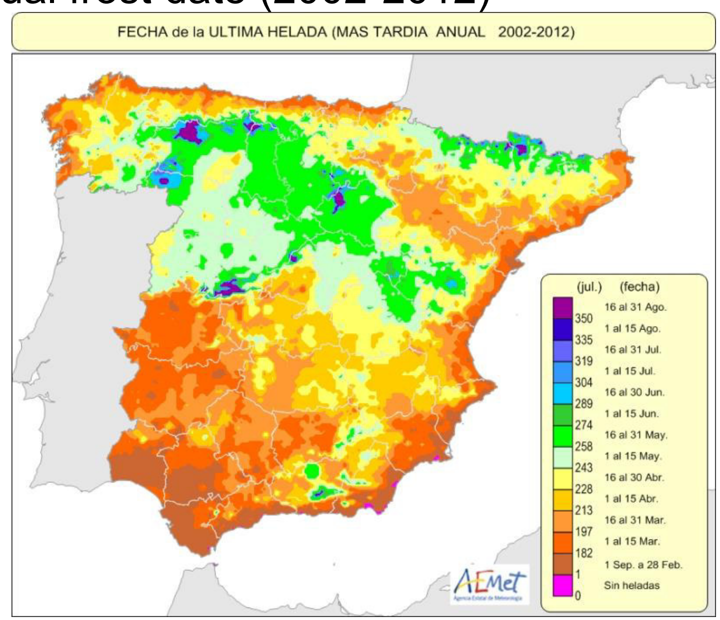
Mapping Minimum Daily Temperature In Spain Using Kriging With External Drift





Average first and last annual frost date (2002-2012)





First and last frost date recorded on the period 2002-2012

Conclusions

• Kriging with External Drift with altitude and distance to the coast as external variables has been proved to be **an appropriate method for obtaining gridded fields of daily minimum temperature data** in Spain.

• However, it must be considered that this method can lead to **exaggerated extrapolation effects in areas with scarce and anomalous data** at the same time.

• The same method has been also applied successfully to **daily maximum temperature data**.

• We are currently generating gridded fields of daily minimum and maximum temperature **over a longer period of time** (1981-2015)

Thank you for your attention!

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PREPARING CLIMATE INDICATORS TO ASSESS THE IMPACT OF EXTREME WEATHER EVENTS ON CRITICAL INFRASTRUCTURES AND ON TOURISM IN HUNGARY

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Thanks for contribution to Annamária Marton, Tamás Kovács, Tamás Szentimrey

10th EUMETNET Data Management Workshop - “High quality climate data – the foundation of Climate Services, St. Gallen, Switzerland, 28-30 October, 2015

Motivation

- 2009-2014 Programme of EEA: Programme for Adaptation to climate change in Hungary - National Adaptation Geo-information System (NAGIS) in Hungary (see poster 43)
- NAGIS: Homogenized gridded dataset from meteorological observations for 1961– 2010 and climate projections for 2021–2050 and 2071–2100
- Extension of the NAGIS for further sectors: KRITéR- CRIGiS project: Vulnerability/Impact Studies with a focus on Tourism and Critical Infrastructures
- For targeted and sustainable adaptation high quality climate information is needed

Objectives

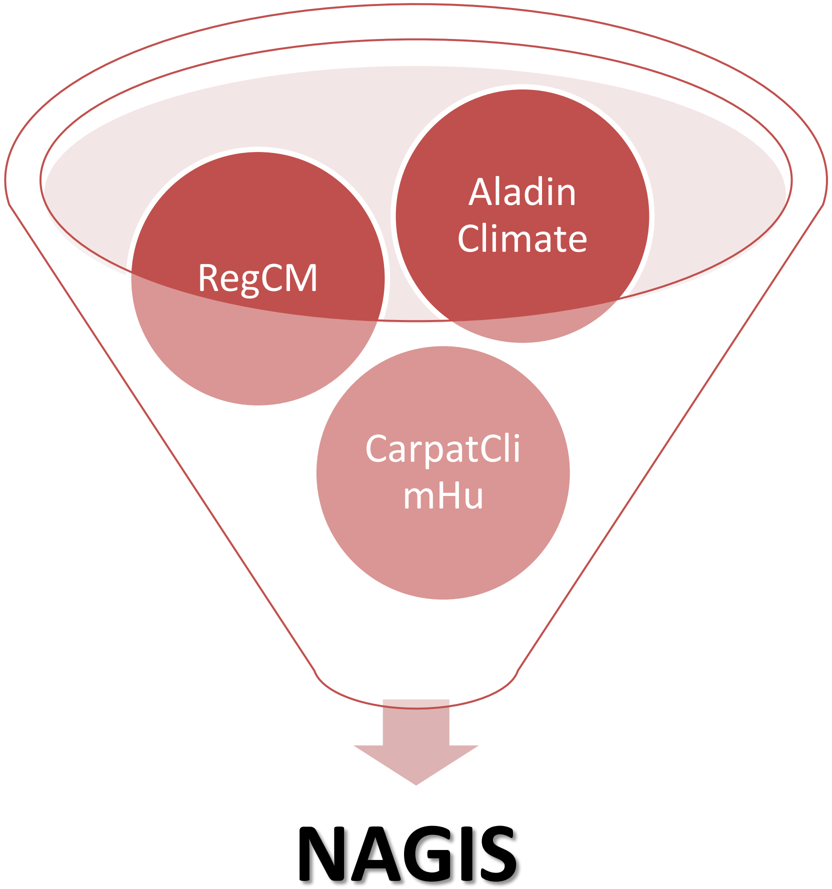
- The KRITéR- CRIGiS project is focusing (i) heatwave-induced excess mortality, impacts of (ii) extreme weather events on road accidents, and (iii) of climatic conditions on tourism
- Identification of climate indicators to assess the impact of

  (ii) extreme weather events on road accidents in winter
  (iii) of climatic conditions on tourism
- Results for observational dataset

National Adaptation Geo-information System (NAGIS)

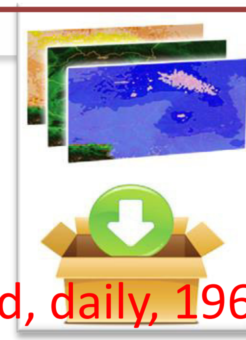
Observations:
1961-2010
CarpatClimHu daily grids
spatial resolution: 0.1°
several basic meteorological variables and climate indicators

Regional Climate model simulations:
2021–2050: „short-term" planning and 2071–2100: long-term strategy

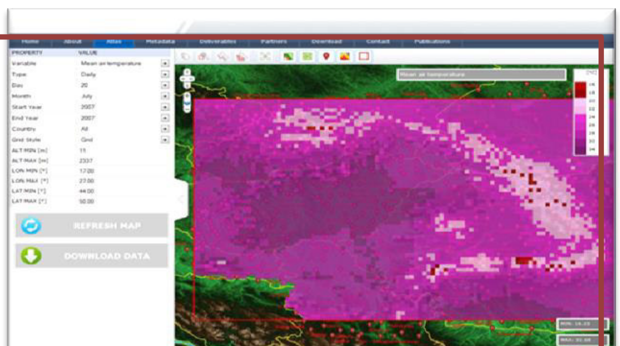


CarpatClim project

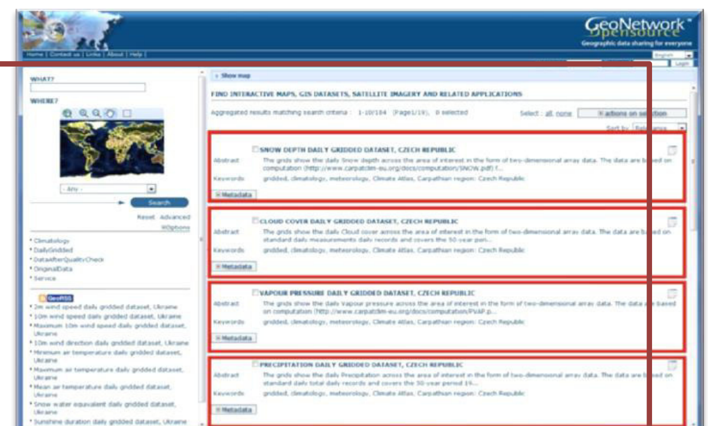
http://www.carpatclim-eu.org



~ 10 km grid, daily, 1961-2010, 13 ECVs, 37 climate indicators, publically available



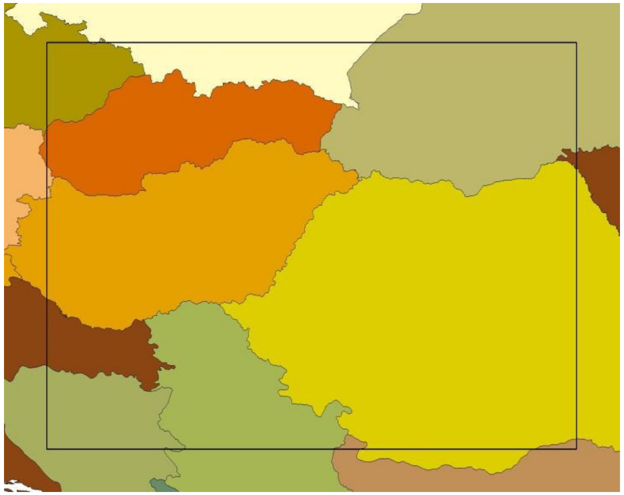
Variable and time period based selection



Searchable Metadata Catalog

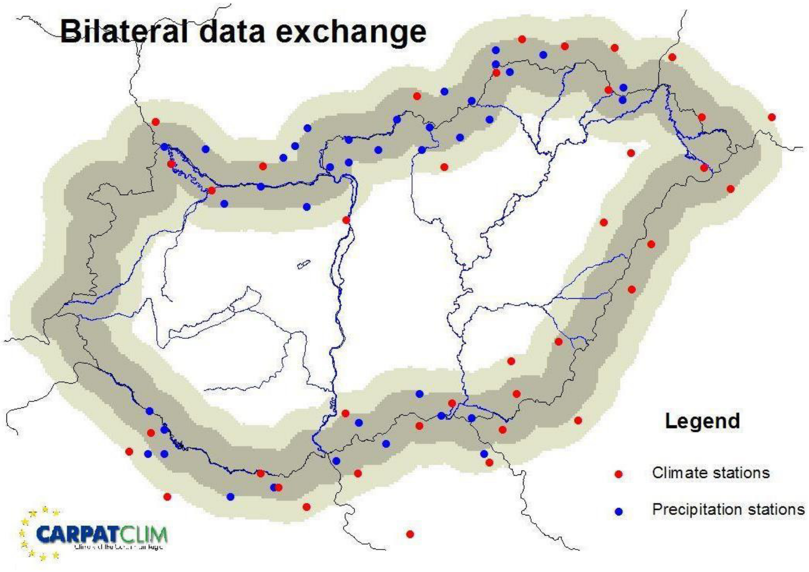
Homogenized and griddded by MASH and MISH

CarpatClim - CarpatClimHu



Variable	Description	units
Ta	2 m mean daily air temperature	°C
Tmin	Minimum air temperature	°C
Tmax	Maximum air temperature	°C
p	Accumulated total precipitation	mm
DD	10 m wind direction, Degrees	0-360
VV	10 m horizontal wind speed	m/s
Sunshine	Sunshine duration	hours
cc	Cloud cover	tenths
Rglobal	Global radiation	J/cm^2
RH	Relative humidity	%
pvapour	Surface vapour pressure	hPa
pair	Surface air pressure	hPa
Snow depth	Snow depth (ZAMG model)	cm

68 climate stations



IDENTIFICATION OF CLIMATE INDICATORS TO ASSESS THE IMPACT OF SEVERE WEATHER ON PUBLIC ROAD ACCIDENTS IN WINTER

Cooperation with Disaster Management – accidents statistics 2011-2014

Identification of severe winter weather parameters

Filtering:

Blizzard, wind, fog, icy roads, snowy, slippery road, strong wind, snowfall, poor vision, large amounts of snow

➡ Daily weather reports

Literature

Media reports

Recent project results: EU FP7 EWENT, RAIN

Warning practices

TMM	Település	Esemény típusa	EOV X	EOV Y	Észlelés dátuma	Helyszín	Káreset fajtája	Megjegyzés
8	Jászberény	Műszaki mentés	240053	712356	2012-01-01 00:10:00.000	Közút	Közúti baleset	A helyszínen, egy szgk. az út r
12	Orosháza	Műszaki mentés	138376	774506	2012-01-01 00:38:00.000	Közút	Közúti baleset	A jelzett helyen egy wartburg
30	Budapest XVIII.	Műszaki mentés	232404	659607	2012-01-01 01:24:00.000	Közút	Közúti baleset	A jh.-en szgk.(KOzma Zoltán :
34	Budapest XIX.	Tűzeset	234192	656013	2012-01-01 01:29:00.000	Közút	NULL	A jh.-en buszmegállóban sárg
95	Lenti	Műszaki mentés	145956	458605	2012-01-01 09:51:00.000	Közút	Közúti baleset	A jelzett helyen egy Peugeot
41	Ku[illegible]	Műszaki mentés	188428	639703	2012-01-01 02:01:00.000	Közút	Közúti baleset	A jelzett helyen egy VW Polo
304	Domony	Műszaki mentés	256972	678527	2012-01-03 11:00:00.000	Közút	Közúti baleset	Jh.SUZUKI SWIFT tip. szgk. (fr
309	Bácsalmás	Műszaki mentés	85411	668434	2012-01-03 11:53:00.000	Közút	Közúti baleset	A jelzett helyen két személya
330	Horvátzsidány	Műszaki mentés	231602	466153	2012-01-03 16:10:00.000	Közút	Közúti baleset	A jelzett helyen egy Suzuki S
337	Sopron	Műszaki mentés	262988	465730	2012-01-03 17:02:00.000	Közút	Egyéb	A jelzett helyen egy MAN típu
360	Piliscsaba	Műszaki mentés	254303	634754	2012-01-03 21:36:00.000	Közút	Közúti baleset	A jelzett helyen egy opel om
375	Nagypáli	Műszaki mentés	176201	482729	2012-01-04 07:01:00.000	Közút	Közúti baleset	A jelzett helyen egy, Renault
369	Hódmezővásárhely	Műszaki mentés	114558	757211	2012-01-04 00:20:00.000	Közút	Közúti baleset	Jelzett helyen egy Toyota Co
399	Székesfehérvár	Műszaki mentés	205771	608802	2012-01-04 10:19:00.000	Közút	Közúti baleset	A jelzett helyen egy Chevrole
383	Zalaegerszeg	Műszaki mentés	172979	482147	2012-01-04 08:00:00.000	Közút	Közúti baleset	EGERSZEG/1, EGERSZEG/2, EG
385	Jászladány	Műszaki mentés	223264	733000	2012-01-04 08:13:00.000	Közút	Közúti baleset	A helyszínen egy Skoda Fabia
426	Budapest XXII.	Műszaki mentés	231405	648178	2012-01-04 13:16:00.000	Közút	Közúti baleset	Jelzett helyen Citroen Saxo ti
455	Csurgó	Műszaki mentés	102088	500253	2012-01-04 17:12:00.000	Közút	Közúti baleset	A jelzett helyen egy Opel Ast
390	Acsád	Műszaki mentés	226037	476638	2012-01-04 08:26:00.000	Közút	Közúti baleset	A jelzett helyen egy Renault
391	Iharosberény	Műszaki mentés	115776	502263	2012-01-04 09:34:00.000	Közút	Közúti baleset	A helyszínen egy SUZUKI SWI
414	Mihályi	Műszaki mentés	242288	501943	2012-01-04 12:35:00.000	Közút	Közúti baleset	A jelzet helyen egy Fiat Punt
430	Balmazújváros	Műszaki mentés	250980	831163	2012-01-04 13:50:00.000	Közút	Veszélyes anyagok	A jelzett helyen, 3316-os út 3
437	Göd	Műszaki mentés	260503	658556	2012-01-04 14:40:00.000	Közút	Közúti baleset	A helyszínen a EBL-612 frsz.-ú
442	Tiszavasvári	Műszaki mentés	292732	822719	2012-01-04 15:56:00.000	Közút	Közúti baleset	A jelzett helyen egy KKG-174
454	Székesfehérvár	Műszaki mentés	201522	599487	2012-01-04 17:21:00.000	Közút	Közúti baleset	A jelzett helyen Ford Fiesta f
###	Debrecen	Műszaki mentés	246236	849123	2012-05-03 15:00:00.000	Közút	Közúti baleset	Jelzett helyen Szlovák forgalı
490	Tiszavasvári	Műszaki mentés	289032	817431	2012-01-05 04:45:00.000	Közút	Közúti baleset	A jelzett helyen egy VW Tran
494	Kaposvár	Műszaki mentés	117861	554601	2012-01-05 07:20:00.000	Közút	Közúti baleset	Toponár és Kaposfüred közti

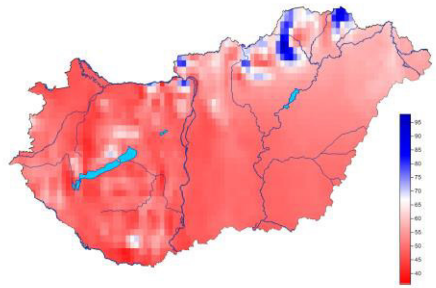
Indicators for sever winter weather situations

TA0: Tmean ≤ 0 °C

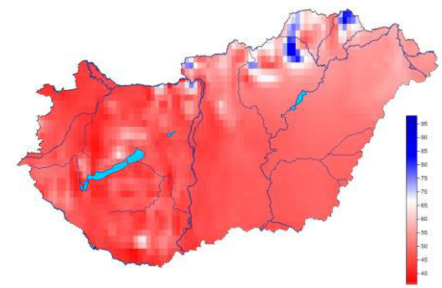
TA-7 Tmean ≤ -7 °C

T0R1: Tmean ≤ 0 °C and Prec ≥ 1mm

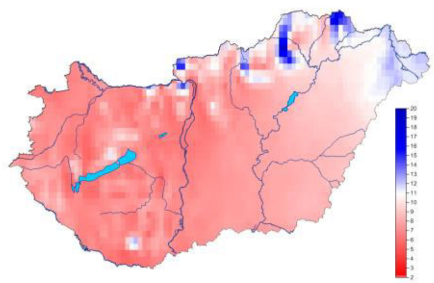
Monthly, sesonal and winter half year



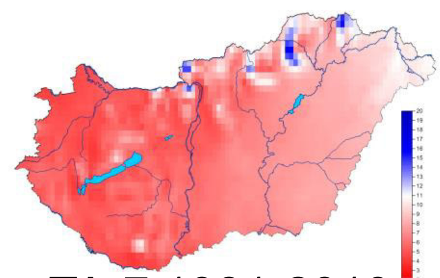
TA0 1961-1990



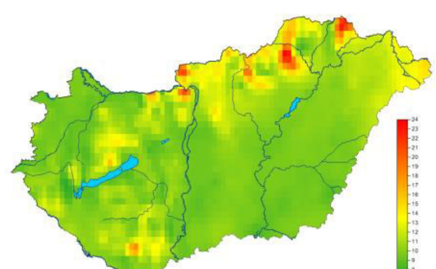
TA0 1981-2010



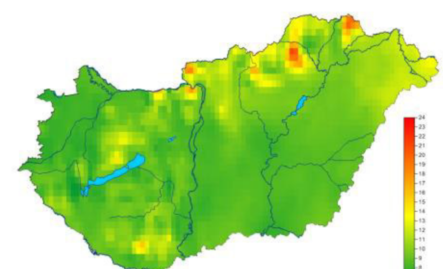
TA-7 1961-1990



TA-7 1981-2010



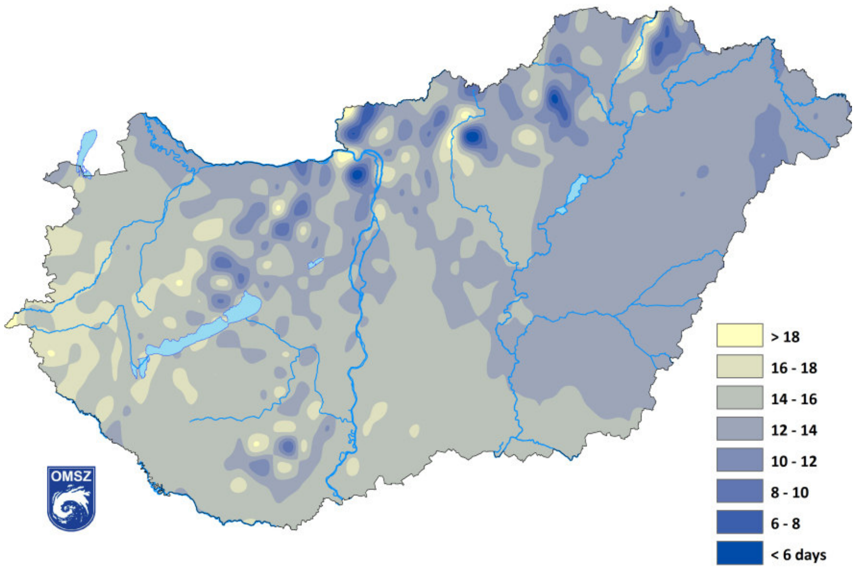
T0R1 1961-1990



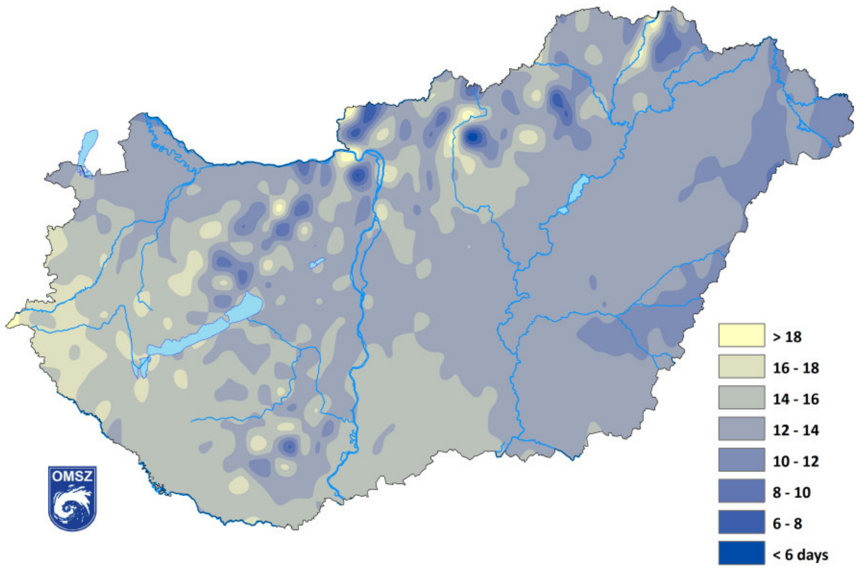
T0R1 1981-2010

Zero crossing days

ZC-JAN, 1961-1990

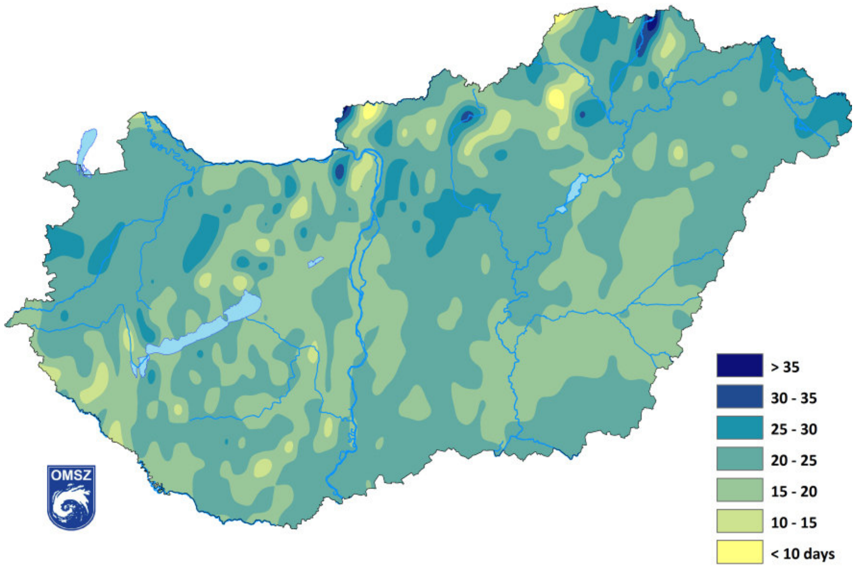


ZC-JAN 1981-2010

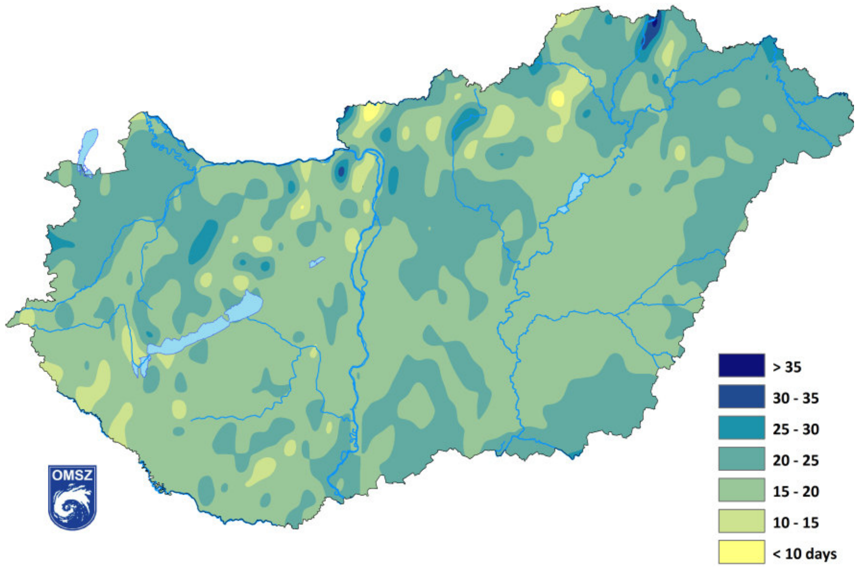


Zero crossing days with precipitation

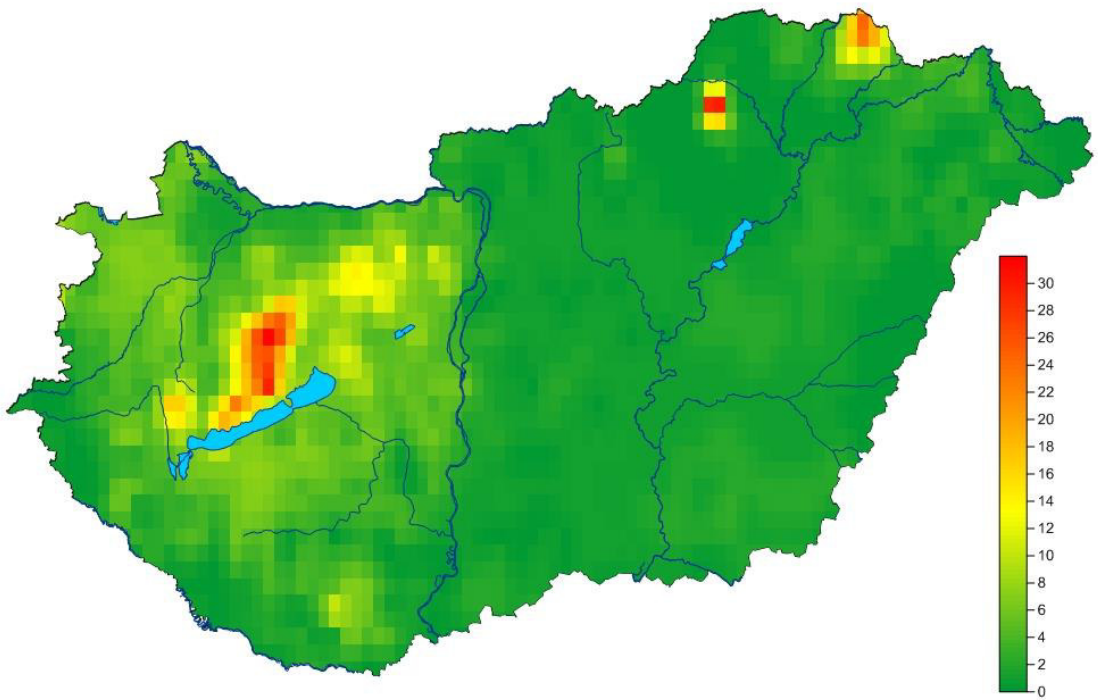
ZCP-DJF 1961-1990



ZCP-DJF 1981-2010



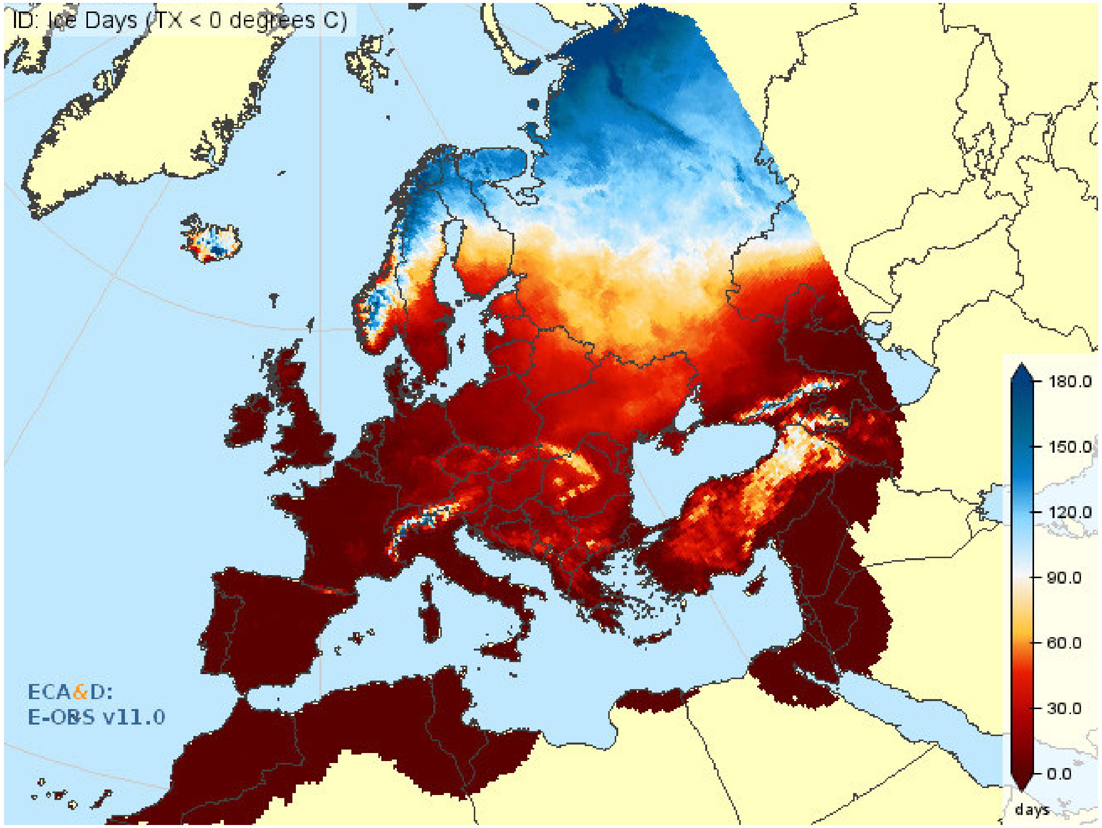
Blizzard 14-15 March 2013



2000-2010

Threshold for blizzard: Ta≤0°C, Snow depth ≥10cm,Fx≥17m/s

E-OBS - Ice days 2000



Smoothed extremes due to interpolation? Not necessarily!

Additive (Linear) Interpolation

Linear Interpolation Formula:

$$\hat{Z}(\mathbf{s}_0, t) = \lambda_0 + \sum_{i=1}^{M} \lambda_i \cdot Z(\mathbf{s}_i, t)$$

where $\sum_{i=1}^{M} \lambda_i = 1$, because of unknown climate change

Optimal Interpolation Parameters :

$\lambda_0, \ \lambda_i \ (i = 1, \ldots, M)$ minimize MSE.

Inadequate formulas - Smoothed extremes

- Inverse Distance Weighting (IDW), $\lambda_0 = 0, \ \lambda_i \left(i = 1,\ldots,M \right)$ not optimal
- Ordinary kriging, $\lambda_0 = 0$

Adequate formulas:

- Universal kriging,
- Regression (residual, detrended) kriging - MISH

TOURISM CLIMATE

Tourism Climate Index (Mieczkowski, Z, 1985)

$$TCI = 8CI_d + 2CI_a + 4R + 4S + 2W$$

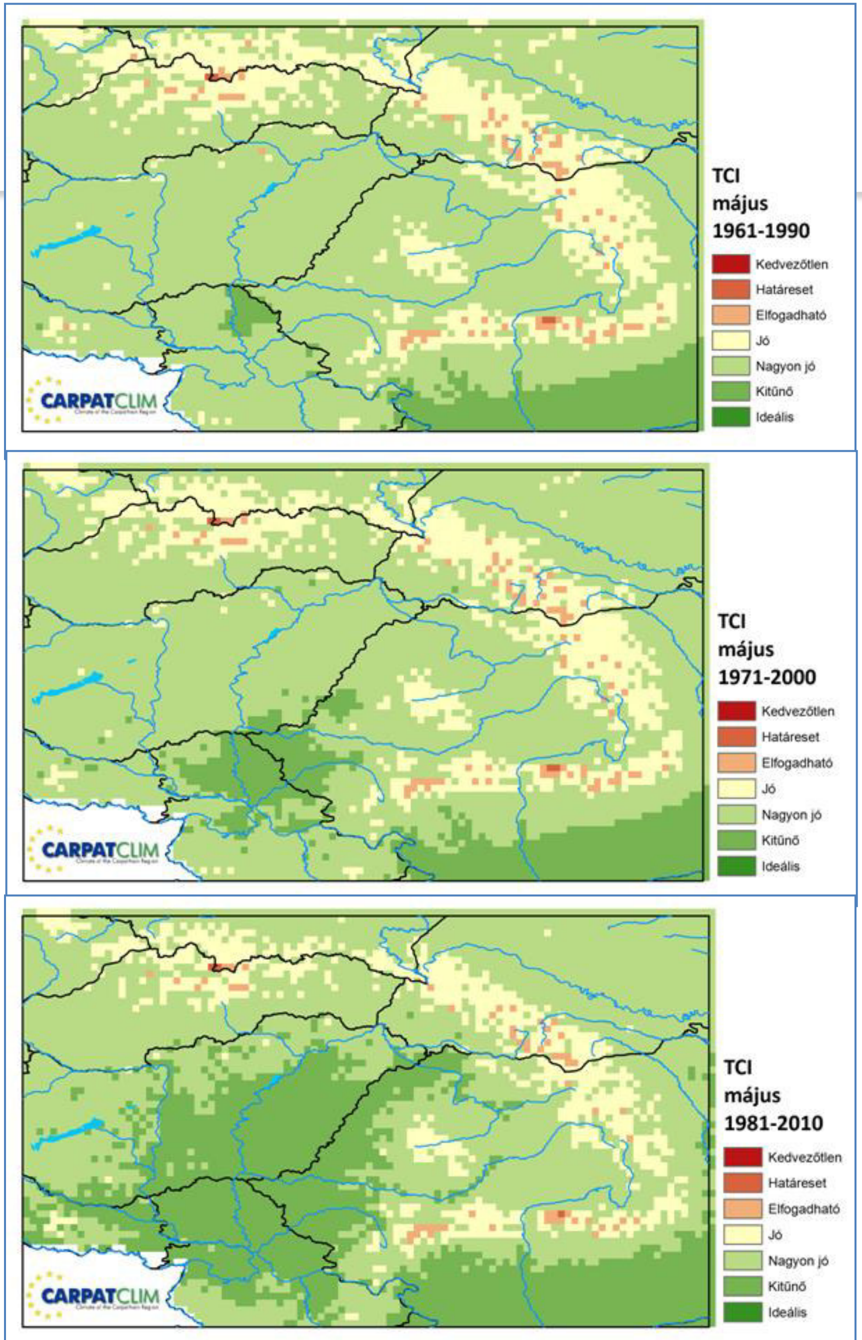
Ci_d daytime comfort index
CI_a daily comfort index
R: precipitation
S: sunshine duration
W: wind speed

$$relhumMin=100 \frac{e}{eSatTmax}$$

Ref: UK Climate Projections NATIONAL CASE STUDY, What could tomorrow's weather and climate look like for tourism in the South West of England?

Additional derived parameter in CarpatClim

TCI May in different standard periods



Increasing „ideal” region in May particularly at South part of the region

- Unfavourable
- Marginal
- Acceptable
- Good
- Very good
- Excellent
- Ideal

Further tasks

- Computation of indicators for the ALADIN-Climate regional climate model outputs for 2021–2050 and 2071–2100
- Modified TCI and computation of the CIT

Thank you for your attention!

New Austrian Climate Scenarios

Downscaled and improved data for key climate parameters and climate indices

Chimani B., Heinrich G., Kienberger S., Leuprecht A., Lexer A., Hofstätter M., Salzmann M., Poetsch M.S., Spiekermann R., Truhetz H.

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Aim

- Concepts to adaption to climate change need high quality, high resolution climatological data
- Federation of Austria and all provinces

- Creation and Interpretation of high resolution climate information on past, present and future and climate changes

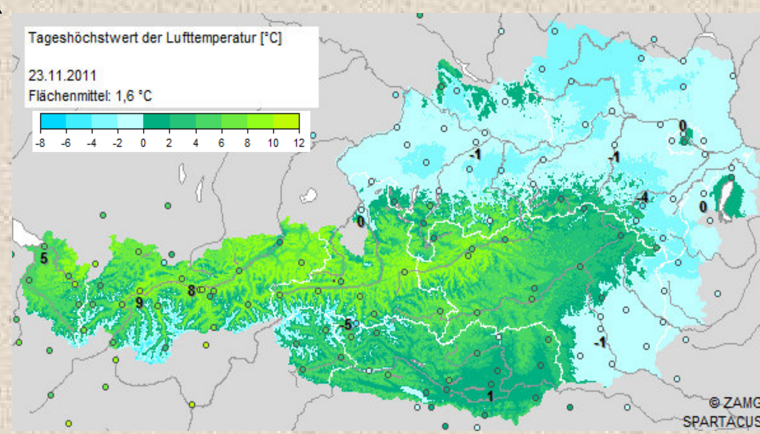
Observational Data

<u>5 Parameters – daily base:</u>

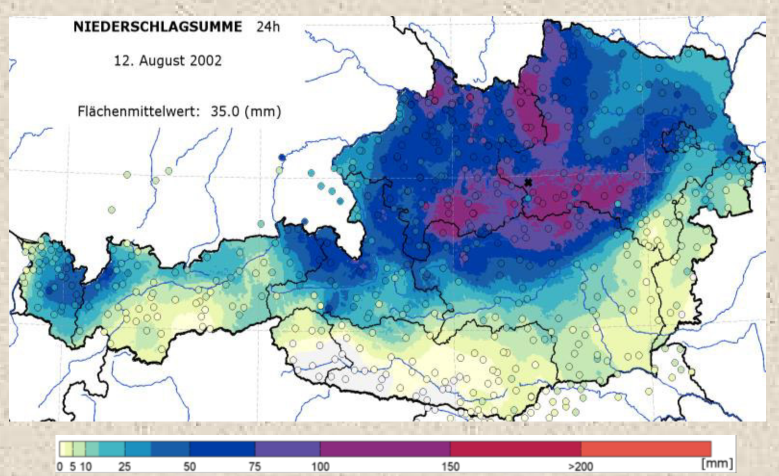
- Temperature min/max
- Precipitation
- Global Radiation
- Sunshine Duration

4-20 „flag-ship“ stations: 1900 – 2015

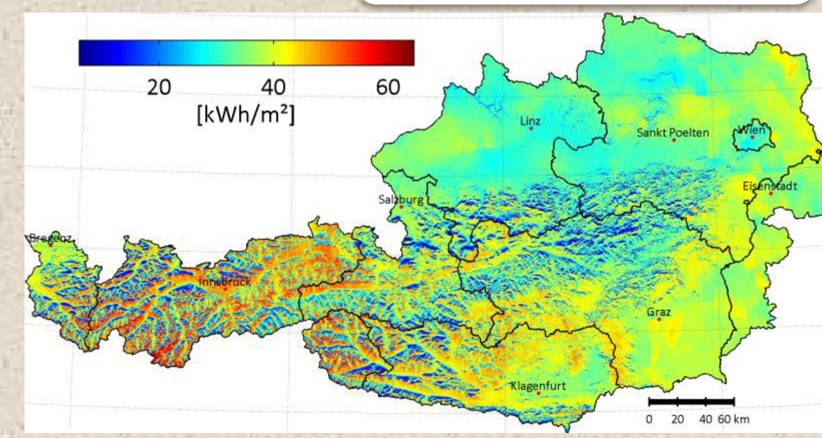
40 weather stations: 1961 – 2015



1km gridded data: 1961 – 2012



1km gridded data: 1981 – 2012



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Climate Model Data

EURO-Cordex:

29 groups, 10 RCMs,13GCMs (from CMIP5) =>

33(available)/79(planned) simulations in 50km resolution

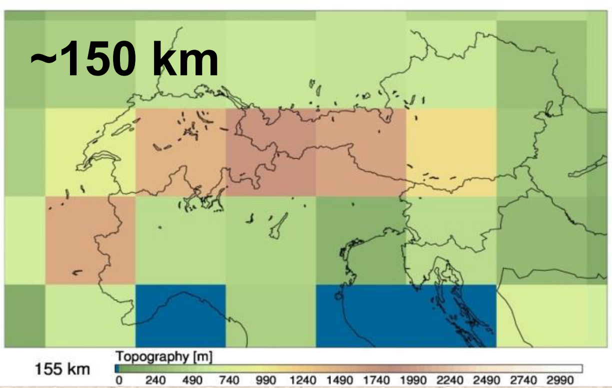
29(available)/63(planned) simulations in 12.5km resolution

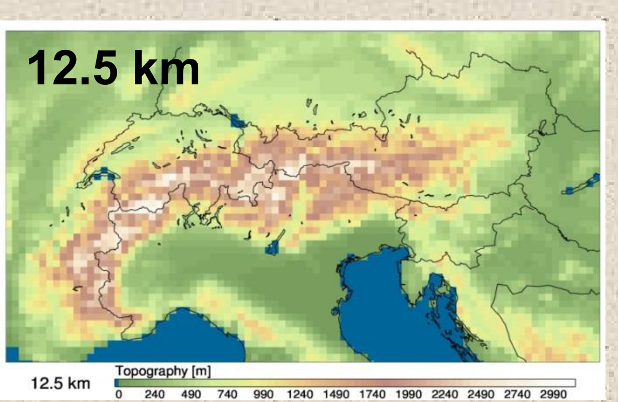
Used in Project:

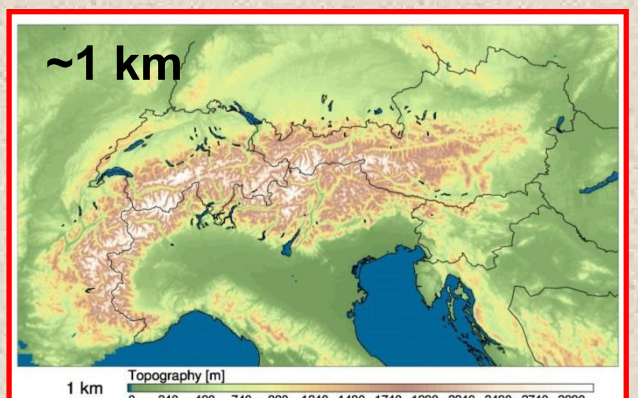
12.5km resolution

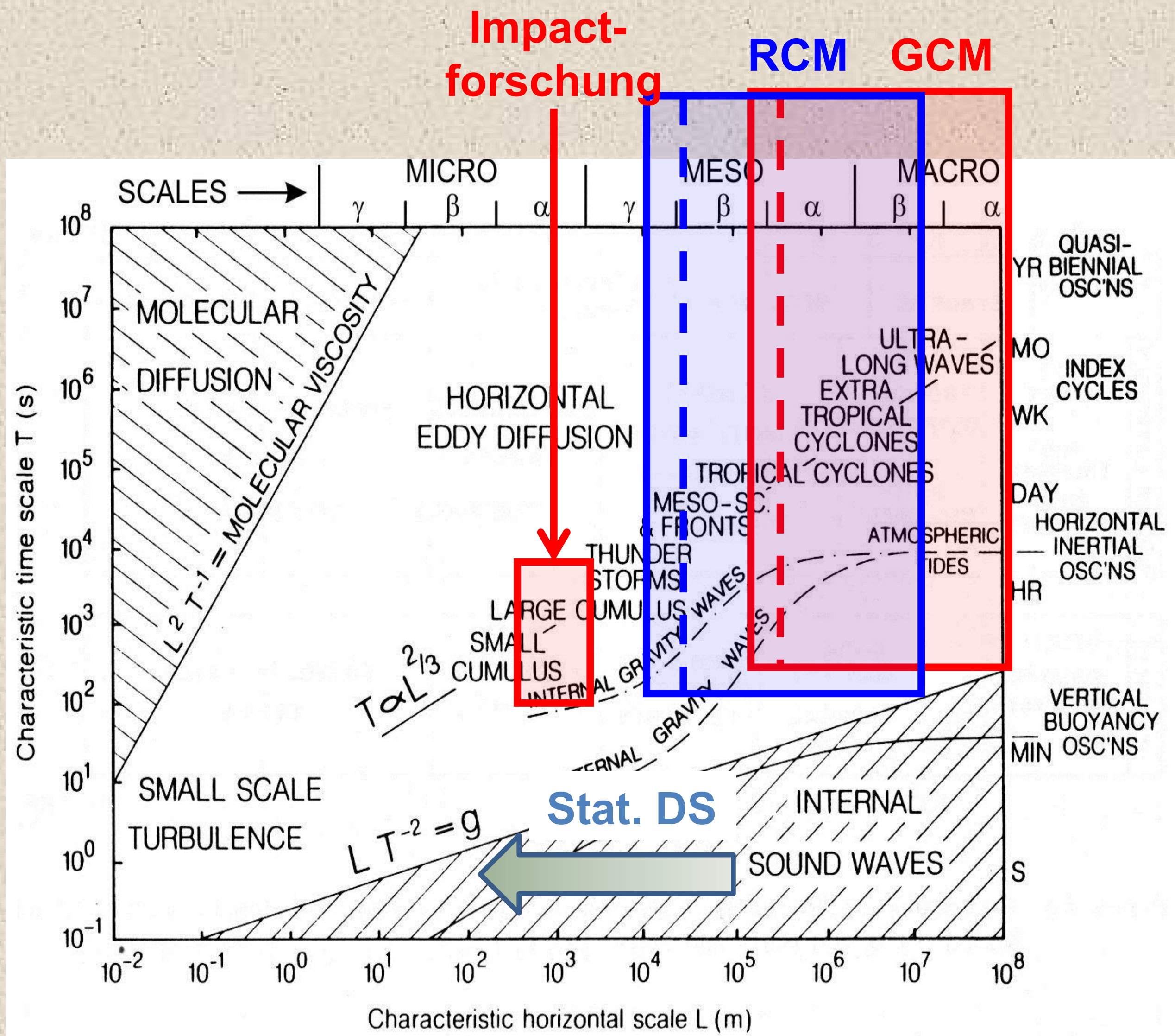
3 representative concentration pathways:

- RCP 2.6: 1 model result
- RCP 4.5: 14 model results
- RCP 8.5: 14 model results









(from Orlanski, 1975; Barry and Carleton, 2001)

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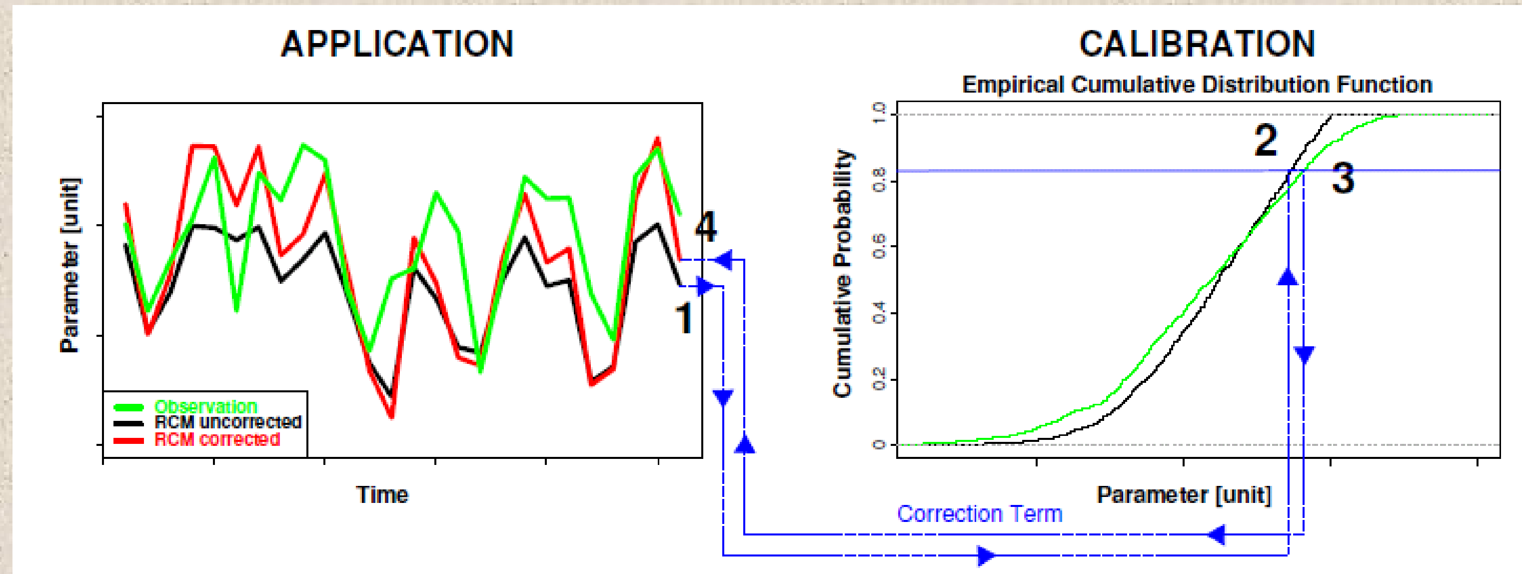
- Downscaling of RCMs to 1km with Quantile mapping (QM)



- Downscaling of RCMs to 1km with Quantile mapping (QM)
- Calibration with observational data in 1km resolution
- Climate model is downscaled using calibration
- => statistical characteristics (bias) are corrected, but physical characteristics of the model do not change

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Climate parameter	resolution	period	quality
Tmin	1 km (12.5 km)	1971 - 2100	Bias corrected (uncorrected)
Tmax	1 km (12.5 km)	1971 - 2100	Bias corrected (uncorrected)
Tmean	1 km (12.5 km)	1971 - 2100	Bias corrected (uncorrected)
Precipitation	1 km (12.5 km)	1971 - 2100	Bias corrected (uncorrected)
Global radiation	1 km (12.5 km)	1971 - 2100	Bias corrected (uncorrected)
Rel. humidity	stations	1971 - 2100	Bias corrected
Wind velocity	stations	1971 - 2100	Bias corrected
Global radiation, Tmin, Tmax, Tmean, precipitation	stations	1971 - 2100	Bias corrected
Rel. humidity	12.5 km	1971 - 2100	uncorrected
Wind velocity	12.5 km	1971 - 2100	uncorrected

Climate Indices

TEMPERATURE INDICES 1

1)	**TM**	*mean temperature*
2)	**ST25**	*summer days*
3)	**HT30**	*heat days*
4)	**KYE**	*kysely heat episode*
5)	**TN20**	*tropical nights*
6)	**HWDI**	*heat wave duration*
7)	**CSDI**	*cold spell duration*
8)	**HHM**	*normalized anomalies*

base period:
daily, monthly, seasonal, annual, special episodes

PRECIPITATION INDICES

16)	**RR**	*total precipitation*
17)	**DD**	*wet days (>1mm)*
18)	**DD#p**	*wet days (> 30/60/90/95 perctile)*
19)	**R#p**	*precipitation intensity on wet days*
20)	**Rx1d**	*maximum daily precipitation totals*
21)	**Rx5d**	*maximum 5-day precipitation totals*
22)	**CDD1**	*consecutive dry days <1mm*
23)	**CWD1**	*consecutive wet days >1mm*

TEMPERATURE INDICES 2

9)	**GSL**	*growing season length*
10)	**GSLt**	*mean temperature in GS*
11)	**GSLrr**	*total precipitation in GS*
12)	**GSLfd**	*frost days in GS*
13)	**FLfd**	*frost days in flowering period*
14)	**FD0**	*frost days (T_{min}<0°)*
15)	**ID0**	*ice days (T_{max}<0°)*

SPECIAL INDICES

24)	**SC05**	*snow cover >5cm days*
25)	**SC20**	*snow cover>20cm days*
26)	**RG**	*global radiation*
27)	**SD**	*sunshine duration*
28)	**ff95d**	*gale wind speed*
29)	**ff98d**	*storm wind speed*
30)	**ff95a**	*gale wind days*
31)	**ff98a**	*storm wind days*

Calculated for observational and model data

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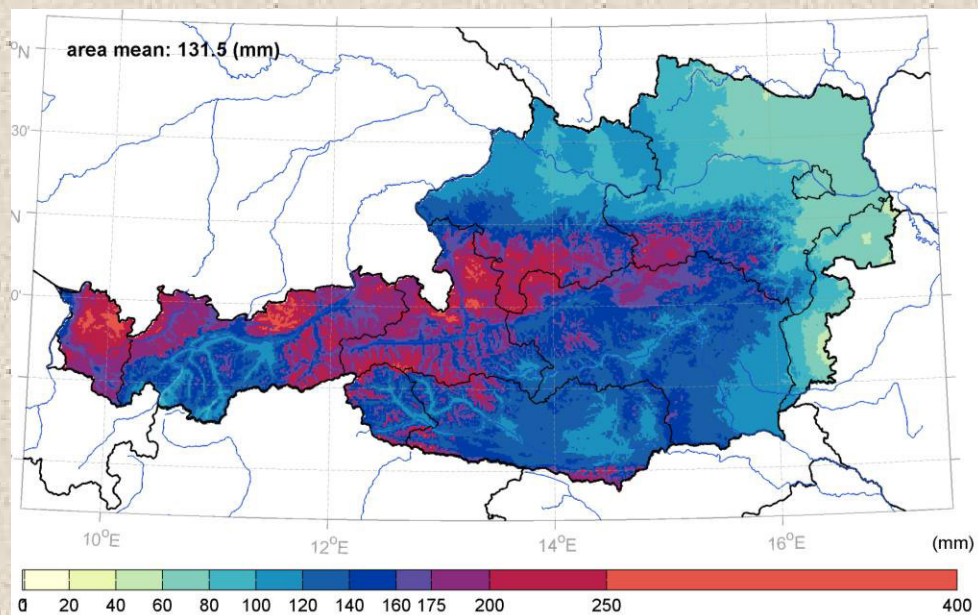

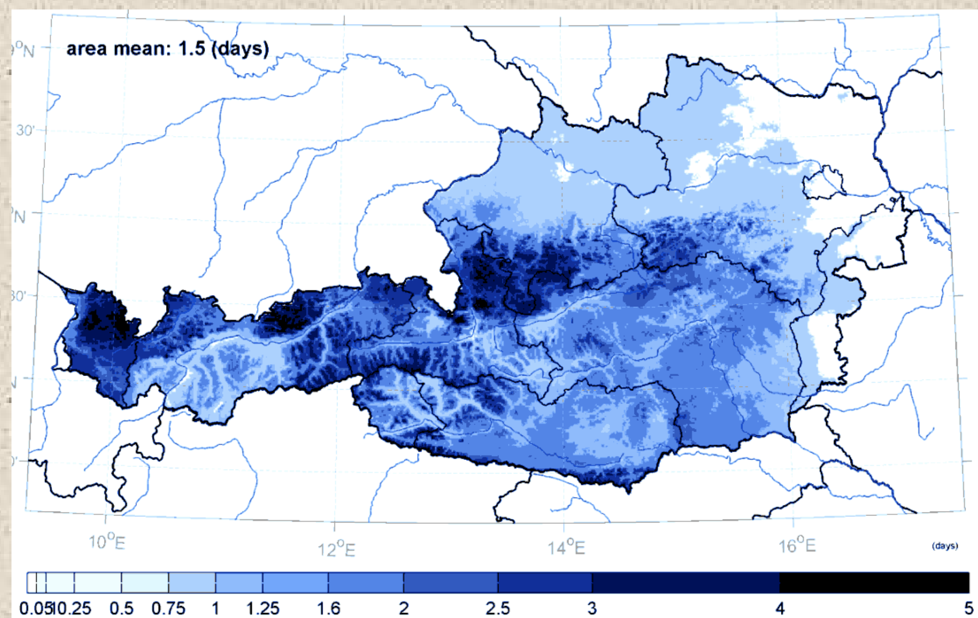

Examples for observational data

1961-2011

(16)
RR

mean seasonal precipitation (JJA)

(18)
DD30p

days with RR> 30pct (JJA)

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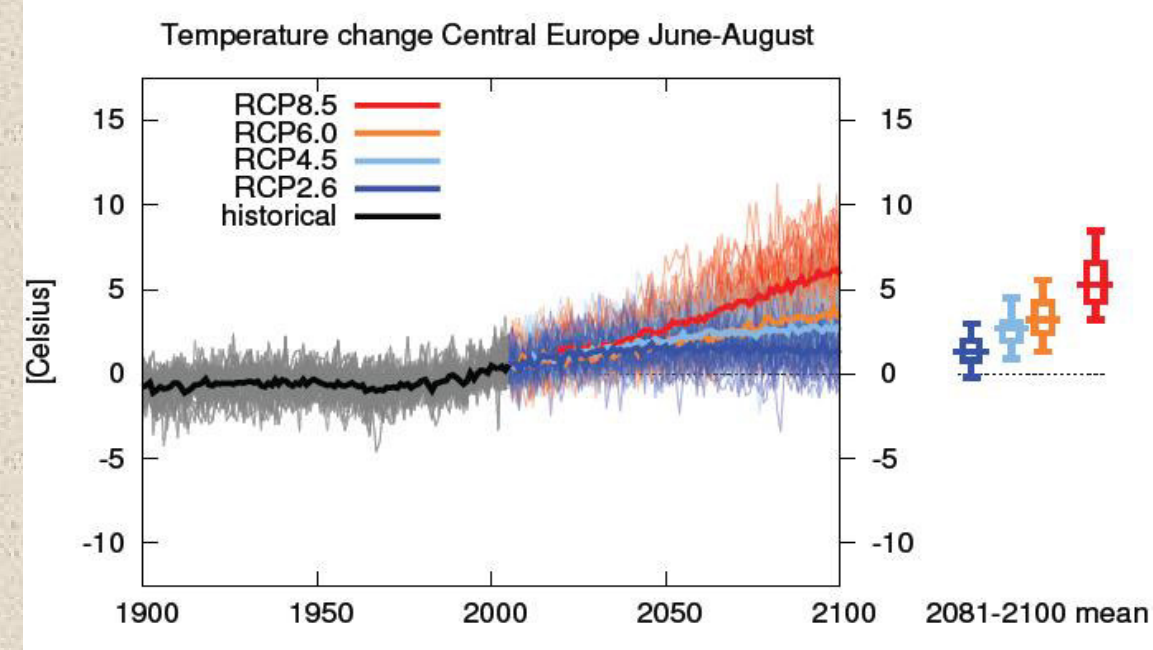
Uncertainties



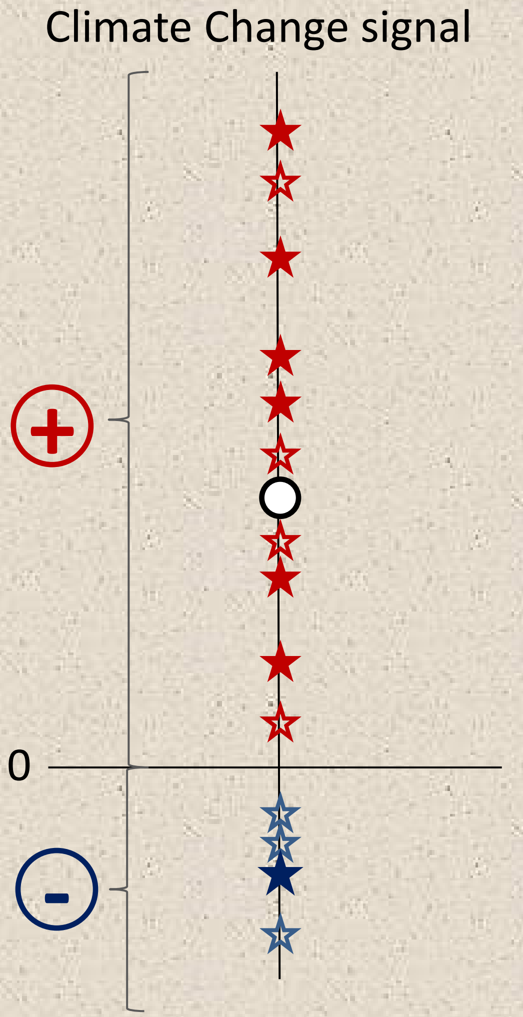
aus: IPCC 2013

Caused by:

- Internal variability
- Future human activities (greenhouse gas emission,..)
- Modell uncertainties

Uncertainty assessment:

for each grid point and RCP



Robustness of signal: percentage of model runs with the same sign as the median [e.g.:10/14 → 71%]

Significance of signal: percentage of statistically significant realisations with the same sign as median [e.g.:6/10 → 60%]

Comparison to Natural Variability: Is median of climate change signals within the standard deviation of the observations?

Climate chance signal of one model realization

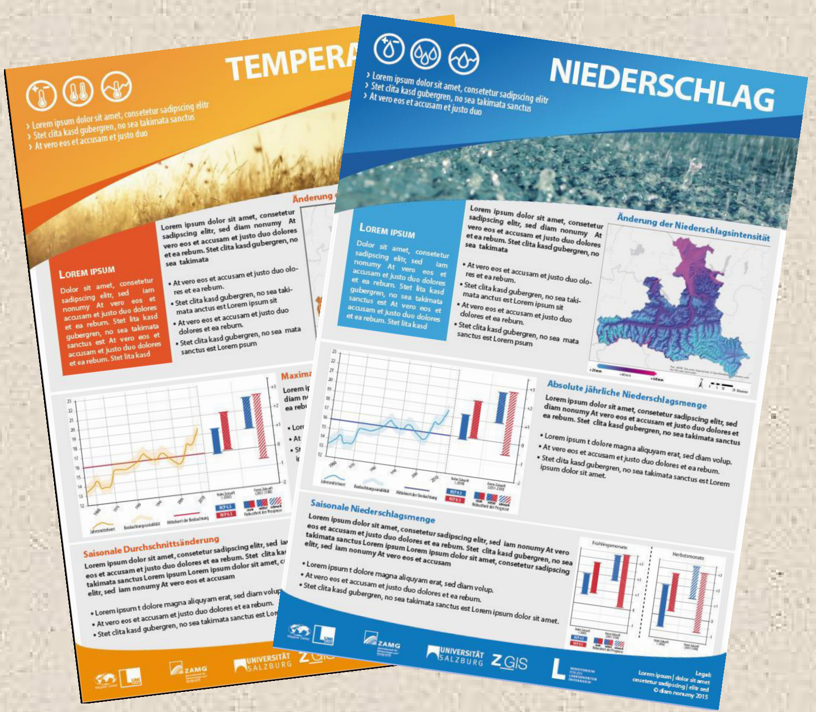
★★ statistically significant

☆☆ statistically insignificant

○ ensemble median (14 model realizations)

Presentation of results

- Factsheets for federal state, provinces and single municipalities including expert assessments



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Availability of Results

– Climate model data (grids/stations)

→Available as ncdf from CCCA-Datacentre (as soon as data and datacentre available, ~March 2016)

– Climate indices

– Climate change signals and uncertainties

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Citizen Science and Phenology a showcase from Austria

Helfried Scheifinger[1], Benjamin Dauth[2], Florian Heigl[2], Thomas Hübner[1], Susanne Käfer[3], **Elisabeth Koch[1]**, Klaus Wanninger[4], Daniel Wuttej[4], Ursula Weiser[1], Johann Zaller[2]
1 ZAMG, 2 Univ. for Natural Resources & Life Sciences, 3 ÖKOLOG, 4 LACON - Landschaftsplanung u. Consulting: all Vienna, Austria

www.naturverrueckt.at
www.phenowatch.at

Overview

- CS definition
- CS history & recent development
- NaturVerrückt
- Farbverrückt
- Lessons learned

CS definition (SOCIENTIZE Consortium, 2013)

- Citizen Science refers to the **general public engagement in scientific research activities** when citizens actively contribute to science either with their intellectual effort or surrounding knowledge or with their tools and resources.
- Citizen scientists **provide experimental data and facilities** for researchers, raise new questions and co-create a new scientific culture
- Citizen scientists **acquire new learning and skills**, and deeper understanding of the scientific work in an appealing way

CS definition (SOCIENTIZE Consortium, 2013)

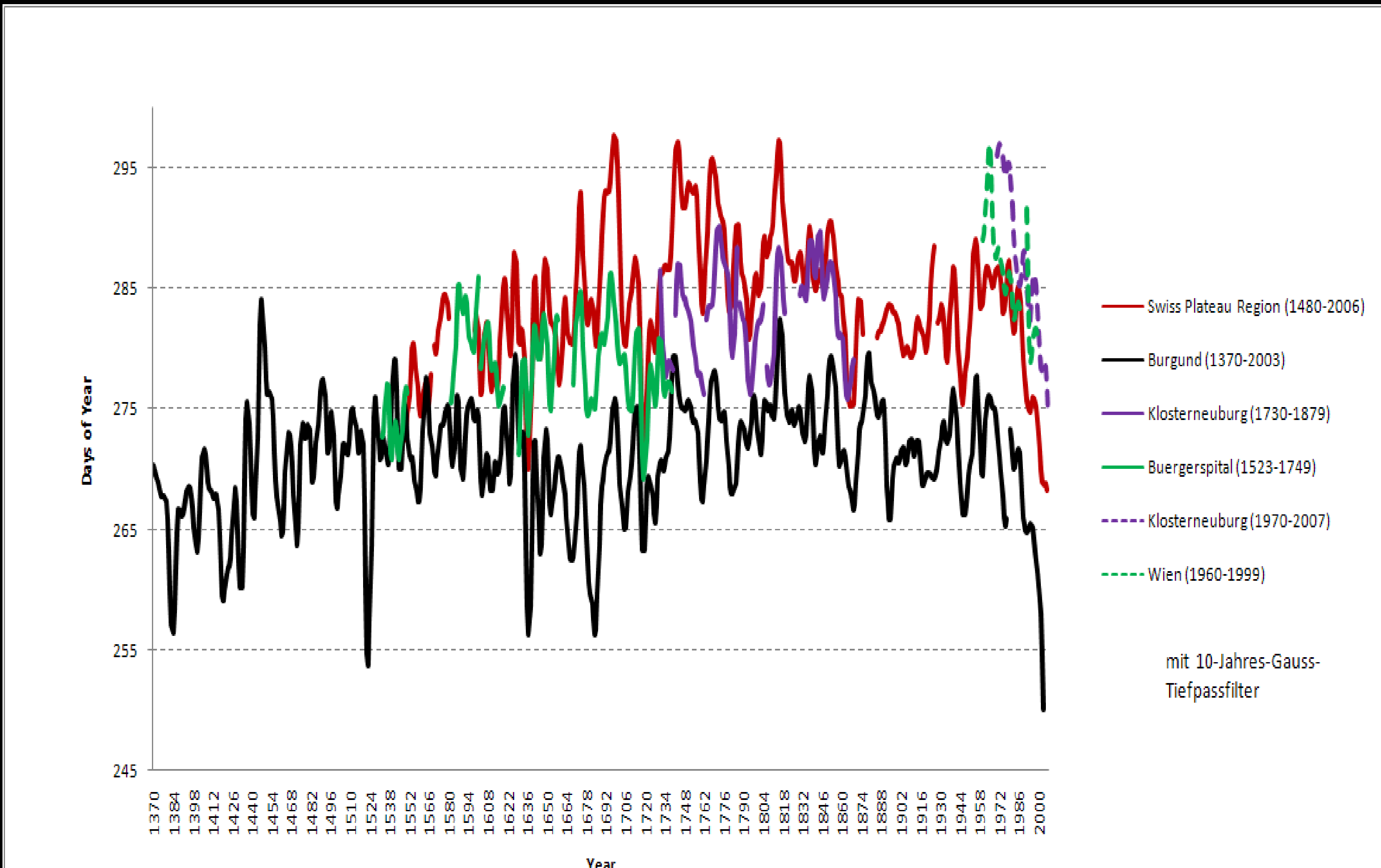
– As a result of this open, networked and trans-disciplinary scenario, **science-society-policy interactions are improved** leading to a more democratic research based on evidence-informed decision making

Citizen Science and Phenology
a showcase from Austria

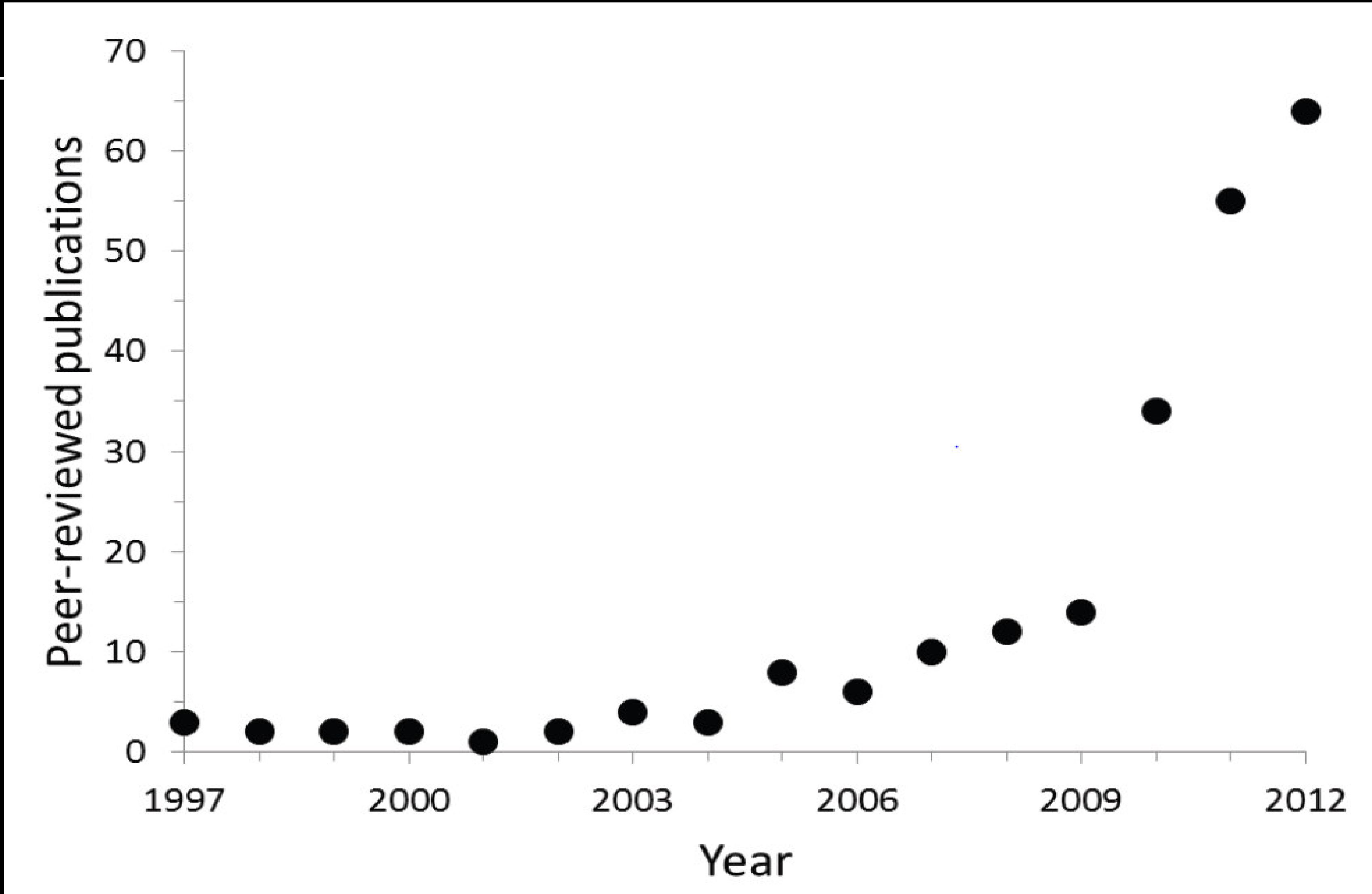
30.10.2015

Folie 5

Some history of CS & phenology



Recent development CS



Recent development CS

Internet & Crowd sourcing

Three factors responsible for the great "explosion" of activity

Easy available technical tools for dissemination of information about projects and gathering data from the public

The increasing realisation among professional scientists that the public represent a free source of labour, skills, computational power and even finance

If we want to continue to spend taxpayers' money, it is in scientists' own interest to make sure that the public appreciates the value of what they are paying for. Undoubtedly the best way for the public to understand and appreciate science is to participate in it.

NaturVerrückt

Impact of weather and climate on the phenology of indigenous woody plants

Students from 5 agricultural schools in Lower Austria track the seasonal development of 11 native plants and its weather/climate dependence.

Main objectives of this project:

- Observation of phenological events from ecological important native plants
- Study of the weather/climate impact on seasonal development
- Development of new methods for data acquisition - Apps

The timing of seasonal activities of animals and plants is perhaps the simplest process in which to track changes in the ecology of species in response to climate change” (IPCC 2007).

NaturVerrückt

Involvement of teachers and students

Planting of the hedge 1 year before

NaturVerrückt

Involvement of teachers and students

Workshop teachers/scientific team

NaturVerrückt

Involvement of teachers and students

Logo competition

NaturVerrückt

Involvement of teachers and students

Weather station

NaturVerrückt

Involvement of teachers and students

Workshop with students twice a semester

NaturVerrückt

Involvement of teachers and students

Workshop with students twice a semester

NaturVerrückt

Involvement of teachers and students

Phenological observations


Faulbaum
Hasel
Liguster
Purpur-Weide
Roter Hartriegel
Linz
Niederösterreich
Pfaffenhütchen
Wolliger Schneeball
Burgenland
Steiermark
Graz
Hundsrose
Schwarzer Holunder
Schlehe
Sal-Weide

Gemeine Hasel

Oder auch: *Haselstrauch, Haselnussstrauch*
Wissenschaftlicher Name: *Corylus avellana*

Hier findet man das Gehölz

Die Hasel ist häufig anzutreffen. Sie wächst in lichten Wäldern, an Waldrändern und in Feldhecken. Sie ist eine Lichtpflanze, verträgt aber auch mäßigen Schatten. Das Areal der Hasel umfasst große Teile Europas und Kleinasiens sowie den Kaukasus. Im Norden Europas reicht das Verbreitungsgebiet bis zum Polarkreis.

Wuchsform

So erkennt man das Gehölz

Im Winter:
- männliche Blüten (Kätzchen) hängen wie Würstchen bereits im Winter von den Zweigen
- Kätzchen strecken sich lange vor dem Laubaustrieb und sind dann gelb
- junge Zweige drüsig behaart, Knospen eiförmig
- vielstämmiger, buschiger Strauch

In der Vegetationsperiode:
- Blätter 6 – 10 cm lang
- Blätter unterseits auf den größeren, Blattnerven behaart
- Herbstaspekt schön gelblich bis gelbbraun

Doppelgänger:
Die baumförmig wachsende Baum-Hasel *(Corylus colurna)* stammt aus Südost-Europa und Westasien und wird gelegentlich als Zierbaum kultiviert.

Eiförmige Knospe und leicht behaarter Zweig

Männliche Kätzchen vor der Streckung

Wer steht drauf?

Die Haselnüsse sind Nahrung für eine Vielzahl verschiedener Tierarten. Gut für die Hasel, denn die Nüsse werden deshalb von Kleinsäugern (Eichhörnchen, Bilchen, Mäusen) und Vögeln (Kleibern und Hähern) verbreitet. Die Haselmaus ist sogar nach ihr benannt. Der Pollen wird auch gerne von Bienen gesammelt, obwohl die Insekten nichts zur Bestäubung beitragen!

Wofür taugt das Gehölz?

- Früchte der Hasel sind essbar
- Zweige sind sehr biegsam, weshalb sich damit tolle Bögen basteln lassen
- Haseln kann man auf Stock setzen (also knapp über dem Boden abschneiden), sie wachsen immer wieder nach

ZWEI MILLIONEN

Die Hasel läutet den Vorfrühling ein. Sie blüht also, wenn die Vegetation eigentlich noch im Wintermodus ist. Warum sie das macht, hat einen besonderen Grund: die Bestäubung der Hasel übernehmen keine Bienen oder andere Insekten – so früh im Jahr sind auch noch fast keine unterwegs. Die Hasel wird vom Wind bestäubt. Und wenn die Blätter der Bäume noch nicht ausgetrieben sind, funktioniert das Verblasen der Pollen wesentlich besser! Das freut die Hasel, beschert vielen allergischen Menschen aber tränende Augen und eine rinnende Nase. Übrigens: Eine einzige Blüte enthält 2 Millionen Pollenkörner. Hatschi!

AUF'S BROT

Ohne Haselnüsse gäbe es keine Nutella, sie sind nämlich eine der Hauptzutaten dieses Aufstriches! ABER: Die meisten Haselnüsse sind von einer nahen Verwandten, der Lambertshasel, Wissenschaftler nennen sie Corylus maxima.

MÄNNCHEN & WEIBCHEN

Anders als bei vielen anderen Gehölzarten gibt es bei der Hasel männliche und weibliche Blüten. Die weiblichen sehen aus wie Blattknospen, aus denen jedoch feine rote Fäden herausschauen.

Gewöhnlicher Liguster

Oder auch: *Rainweide, Tintenbeerstrauch*
Wissenschaftlicher Name: *Ligustrum vulgare*

Hier findet man das Gehölz

Der Gewöhnliche Liguster ist die einzige in Europa heimische Liguster-Art. Er ist relativ anspruchslos und kommt von der Ebene bis in untere Gebirgslagen (1.000 m) vor. Bevorzugte Standorte sind trockenwarme, kalkreiche, gut mit Nährstoffen versorgte Böden. Man findet den Liguster in lichten Wäldern, Auen und Gebüschen ebenso wie in sonnexponierten Hecken.

Wuchsform

So erkennt man das Gehölz

Im Winter:
- buschiger mittelgroßer Strauch (1 bis 3 m) mit aufrechten, rutenförmigen Zweigen
- junge Zweige fein behaart, ältere Zweige kahl
- Knospen nur 5 mm groß, gegenständig angeordnet
- Beeren oft bis in den Frühling am Strauch

In der Vegetationsperiode:
- 3 – 6 cm lange Blätter fühlen sich ledrig an, sind glattrandig und gegenständig angeordnet
- Blattoberseite dunkelgrün und seidig matt glänzend, Unterseite heller und mit deutlicher Mittelrippe
- kleine weiße Blüten in 6 – 8 cm langen Rispen
- traubenähnliche Fruchtstände aus kleinen, schwarz glänzenden Beeren

Blüten-Rispe

Gegenständige lanzettliche Blätter

Traubenähnlicher Fruchtstand

Wer steht drauf?

Die streng duftenden Blüten locken Bienen, Schmetterlinge und andere Insekten zur Bestäubung an. Verschiedenen Schmetterlingsarten dient der Liguster als Futterpflanze. So frisst z.B. die Raupe des Ligusterschwärmers – eine Nachtfalterart – das Laub, und zahlreiche Tagfalterarten, wie z.B. der Kleine Fuchs, laben sich am Nektar der Blüten. Die Früchte werden gerne von Vögeln gefressen, die Samen dann ausgeschieden und dadurch verbreitet. Auch ein paar Nager naschen gerne an den schwarzen Beeren.

Wofür taugt das Gehölz?

- als dichtzweigige, gut schnittverträgliche Art gerne als Sichtschutzhecke gepflanzt
- von Imkern als Bienenweide geschätzt
- wegen intensiven Wurzel- und Ausläuferbildung als Bodenschutzpflanze für Böschungsbefestigungen geeignet

HART UND WEICH ZUGLEICH

Das gelb-braune Holz des Ligusters ist außerordentlich hart. Früher wurden daraus sogar Holznägel oder auch Rechenbögen angefertigt. Die jungen Zweige wiederum sind weich und biegsam und wurden schon in der Römerzeit zum Korbflechten verwendet. Darauf deutet auch der Name hin, denn Liguster kommt vom lateinischen Wort „ligare", was „binden" bedeutet.

FARBGEWALTIG

Die reifen Beeren des Gemeinen Ligusters wurden früher als Farbstoff verwendet. Auf Wolle entsteht ein tiefes Blau, wobei mit Eisen- oder Aluminiumsalzen oder mit Soda vorgebeizt wurde. Neben den reifen Beeren können aber auch die Blätter, die gelben Zweige und die Rinde zum Färben verwendet werden.

FarbVerrückt!

> App downloaden
> Herbstfärbung beobachten
> Insgesamt € 6.000 gewinnen!

Wenn du Bäume und Farben magst, bist du bei unserem **Citizen Science Projekt** goldrichtig und kannst mit deiner Klasse € 1.500,– gewinnen!

Das geht ziemlich easy. Einfach App downloaden und wie verrückt die herbstliche Blattverfärbung beobachten.

Die App wird Mitte September aktualisiert zum Download verfügbar sein!

Wir brauchen eure Augen

Manchmal herbstelt es zeitig und extrem bunt, dann wieder spät und farblich eher fad. Warum das mal so und mal so ist, bestimmen die abnehmende Tageslänge, Temperatur und wahrscheinlich auch die Niederschläge. Wie diese Faktoren jedoch zusammen spielen, wissen selbst die Wissenschaftler/innen der Zentralanstalt für Meteorologie und Geodynamik ZAMG noch nicht genau. Dazu braucht es möglichst viele Beobachtungen an Sträuchern und Bäumen vom Neusiedler See bis zu den Berggipfeln Vorarlbergs. **Und jetzt kommt ihr ins Spiel: Bitte helft uns, dem Zauber des Herbstes auf die Schliche zu kommen, indem ihr Laubverfärbung und Laubfall an möglichst vielen unserer 8 Gehölze beobachtet und an uns meldet. Wie das genau geht, checkt ihr in der App.**

Für die ganze Welt

Eure App-Beobachtungen werden gesammelt und helfen Helfried, Sissi und Thomas von der ZAMG bei der Erforschung von Ursachen der zeitlichen Verschiebung der Laubverfärbung und des Laubfalles. Zusätzlich werden eure Beobachtungen in die internationale phänologische Datenbank eingespielt **und können von Forscher/innen auf der ganzen Welt genutzt werden!**

Insgesamt € 6.000,– gewinnen!

Du bist im Wald, findest eine Rot-Buche und möchtest ihre beginnende Laubfärbung melden. Dazu legst du den Baum in der App als Gehölzstation an und meldest die Phase „beginnende Laubfärbung". So sammelst du Punkte mit jedem Eintrag und jeder Aktualisierung deiner Spots. Jeder weitere Baum oder Strauch, den du als Gehölzstation anlegst und zu dem du eine Meldung absetzt, bringt weitere Punkte. **Je mehr Gehölzstationen du und deine Klassenkolleg/innen beobachten, desto mehr Punkte gibt's und umso mehr steigt eure Chance auf euren € 1.500,–Hauptgewinn!** Die 3 Klassen mit den meisten Beobachtungen gewinnen bares Geld für die Klassenkassa. Dem Sieger winken € 1.500,–, die zweitplatzierte Klasse gewinnt € 1.000,– und die drittplatzierte € 500,–. Das Projekt ist übrigens sowohl für Volksschulen und Unterstufen als auch für Oberstufen geeignet. Es werden Citizen Science-Awards in beiden Kategorien mit insgesamt € 6.000,– vergeben!

FarbVerrückt!

Immer zeitiger Frühling, immer später Herbst

Mit der doppelten Geschwindigkeit als im weltweiten Mittel ist die Jahresmitteltemperatur im Alpenraum während der letzten 100 Jahre um etwa 1.8°C angestiegen. Das wirkt sich nicht nur auf uns Menschen sondern auch auf Pflanzen und Tiere aus. So zieht der Frühling mit der ersten Blüte oder dem Beginn des Laubaustriebs um etwa 7 bis 10 Tage früher ins Land als noch vor 30 Jahren und der Beginn der Herbstverfärbung des Laubes hat sich in manchen Regionen um einige Tage nach hinten verschoben. Insgesamt ist es dadurch zu einer Verlängerung der Vegetationsperiode um bis zu zwei Wochen gekommen.

Wieso ist der Herbst manchmal so bunt?

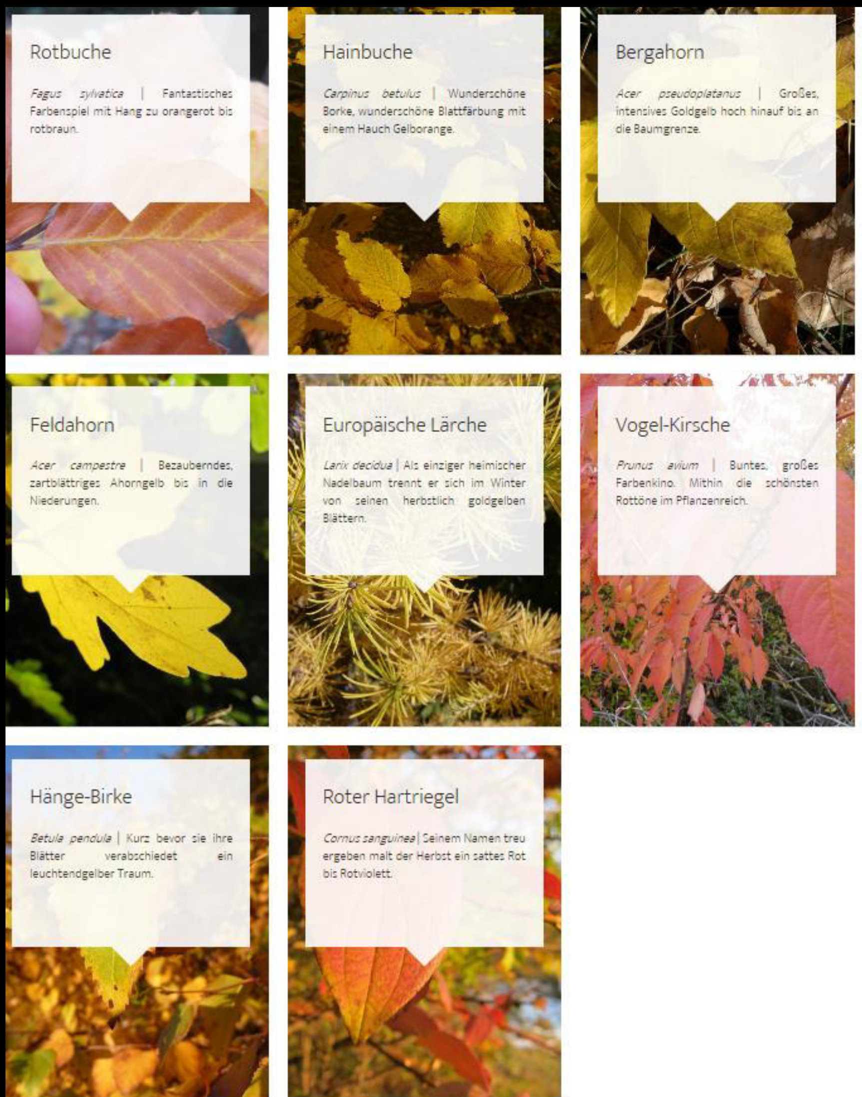
Wann es in der Natur Frühling wird, steuern in unseren Breiten hauptsächlich die Temperaturverhältnisse. Das ist gut erforscht und kann von den Wissenschaftler/innen der Zentralanstalt für Meteorologie und Geodynamik ZAMG gut simuliert werden. Ganz anders sieht es allerdings mit dem Herbst aus. Die Modellierung der Herbstphasen stellt immer noch eine Herausforderung dar. Neben den Temperaturverhältnissen während der Vegetationsperiode und der Photoperiode, so nennt man die Tageslänge, wird auch der Niederschlag als Einflussfaktor vermutet. Um diese Zusammenhänge besser zu verstehen und sagen zu können, wann der Herbst in den vielfältigen Regionen Österreichs in der Natur wirklich ins Land zieht, braucht es möglichst viele Beobachtungen an Sträuchern und Bäumen vom Neusiedler See bis zu den Berggipfeln Vorarlbergs. Damit das gelingt, sind alle Schüler/innen aufgerufen, den Wissenschaftler/innen der ZAMG unter die Arme zu greifen und das Farbenspektakel des einziehenden Herbstes zu beobachten!

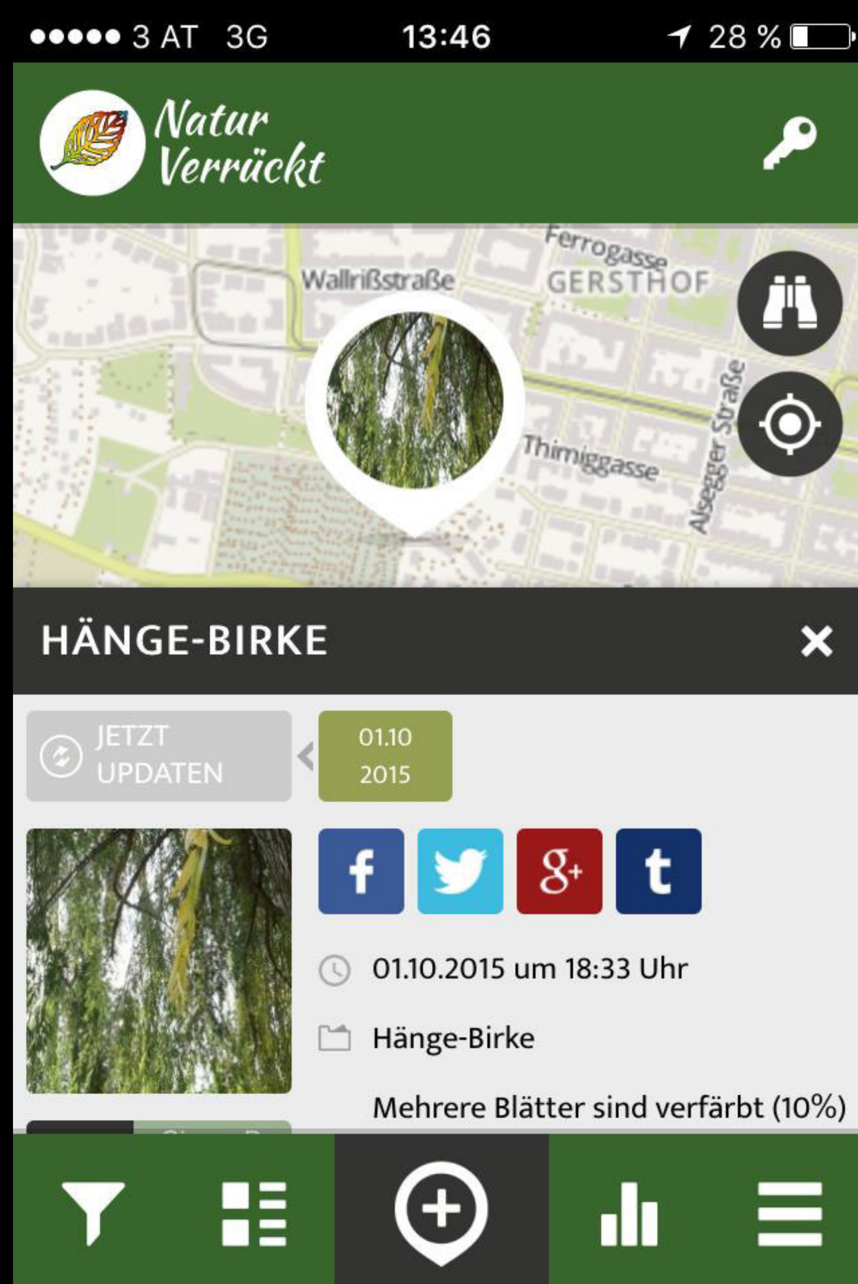
Facts zu FarbVerrückt

Projektbeteiligung: Anmeldung ab Mitte September, Mitmachen von 1. bis 31. Oktober 2015
Zielgruppe: alle Personen, Schüler/innen und Lehrpersonen
Geeignet für: Volksschulen, Unterstufen und Oberstufen
Ort: überall, wo Bäume vorkommen
Tätigkeiten: Bestimmung und fotografieren der herbstlichen Laubverfärbung und des anschließenden Laubfalls
Notwendige Ausstattung: Smartphone mit Kamera
Projektleitende Einrichtung: Zentralanstalt für Meteorologie und Geodynamik
Dr. Helfried Scheifinger, helfried.scheifinger@zamg.ac.at

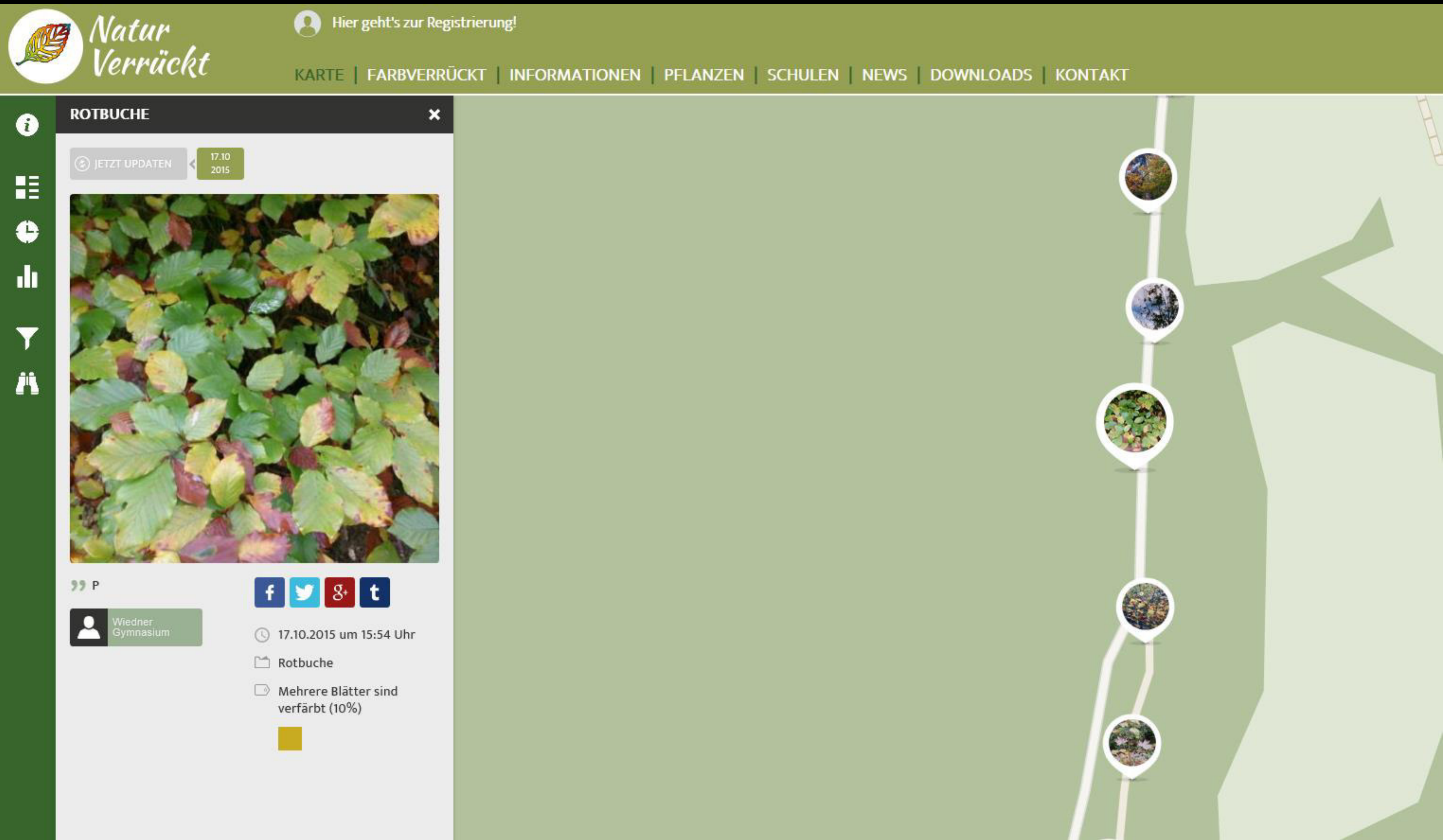
www.naturverrueckt.at/farbverrueckt

FarbVerrückt

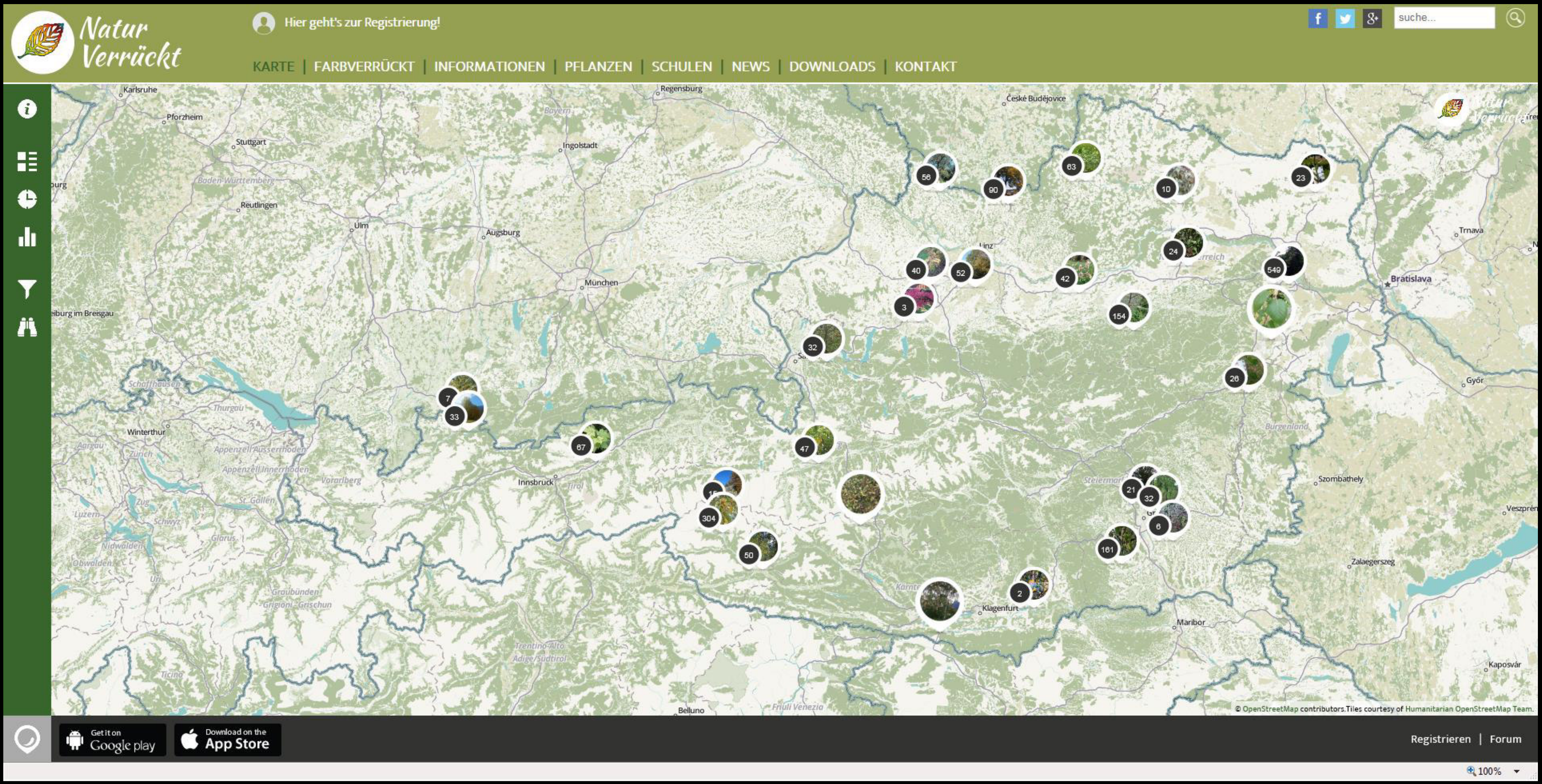




FarbVerrückt



FarbVerrückt



Lessons learned

- Apps much more time needed for development and approval than estimated -> demotivation of students
- Motivation of teachers is essential
- Mass campaign app shoould be more self explaining -> data lack quality
- Other resp. more plants (agricultural schools…), siting of the hedge
- KISS

www.naturverrueckt.at

www.phenowatch.at

Sparkling Science >
Wissenschaft ruft Schule
Schule ruft Wissenschaft
bmwfw

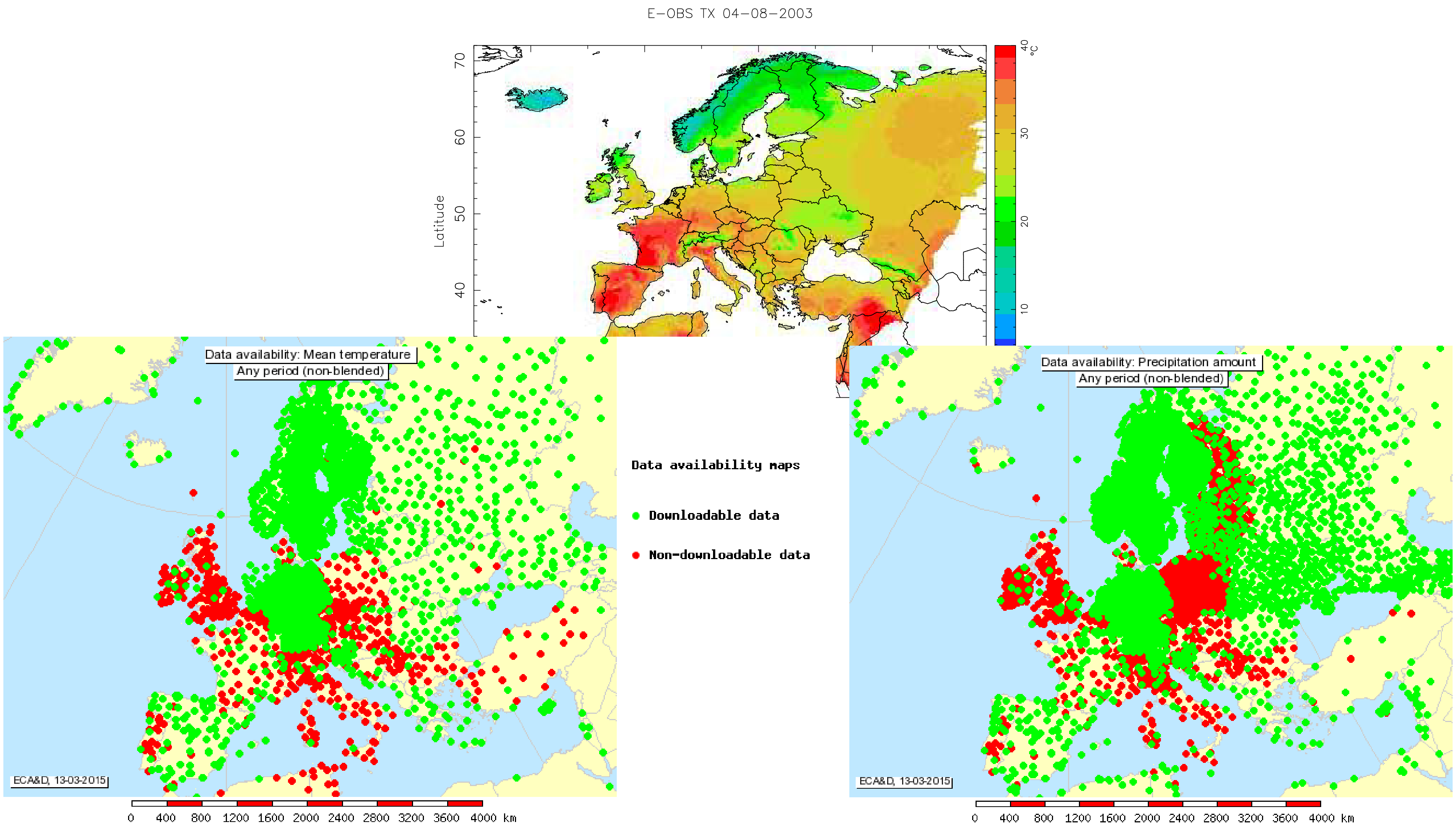
ZAMG

New developments in ECA&D and E-OBS

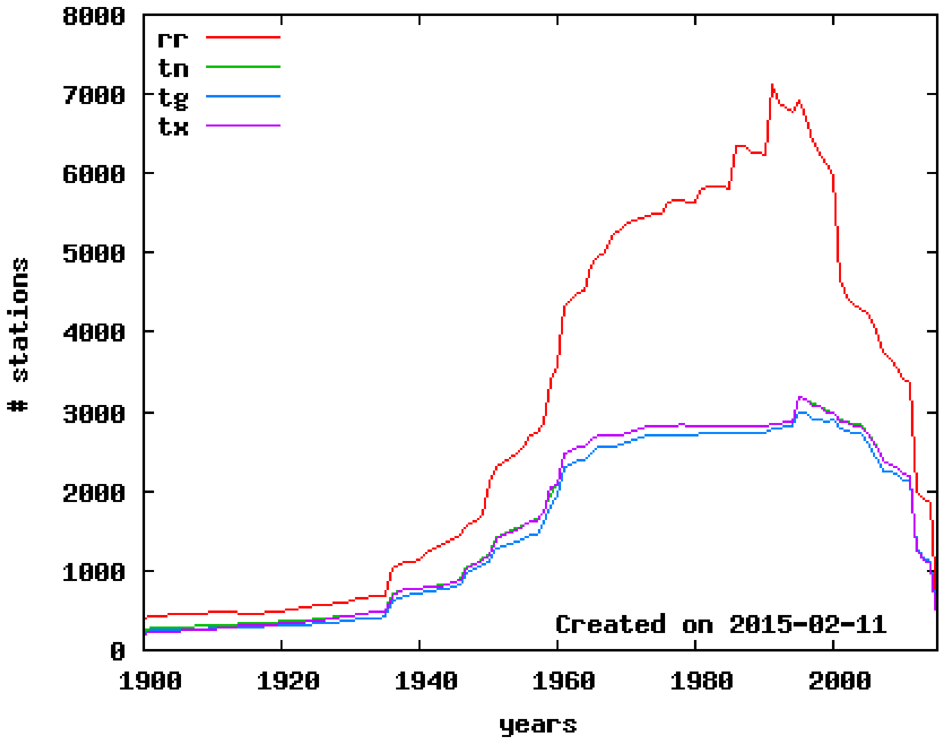
ECA&D Team

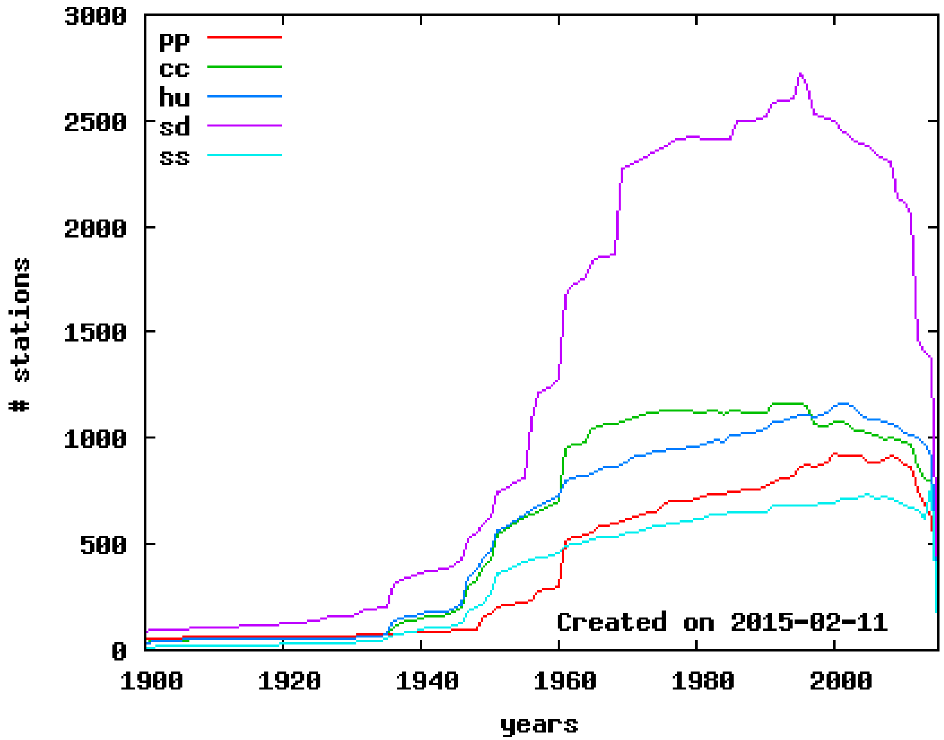
Royal Netherlands Meteorological Institute (KNMI)

What is the European Climate Assessment & Dataset?



What is the European Climate Assessment & Dataset?

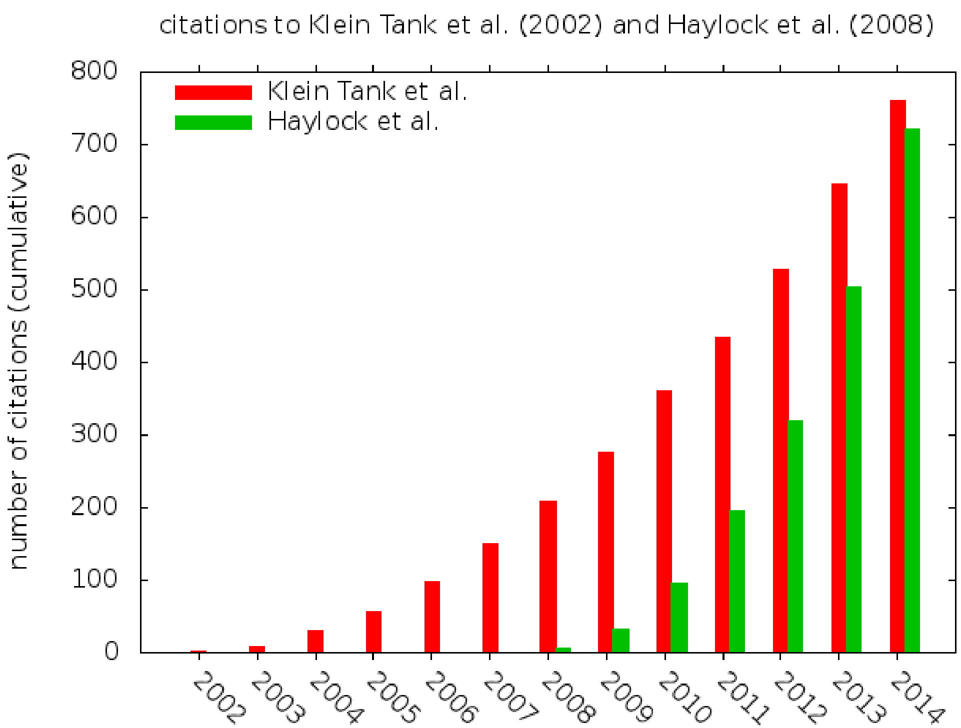


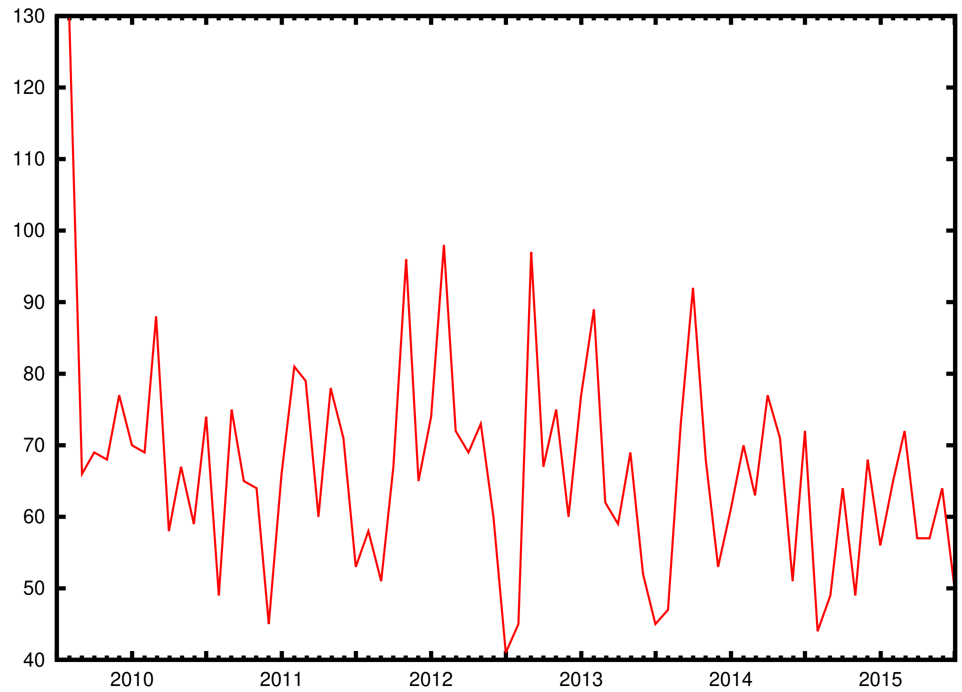


- infrequent data updates from NMHS
- (very) small part of national network
- update of metadata is a challenge

http://www.ecad.eu

Use of ECA&D



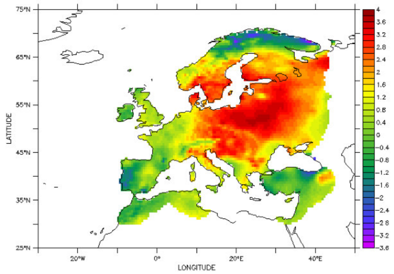


E-OBS is used in: biology (11%), climate science (10%), hydrology (6%), agriculture (5%) and health (3%)

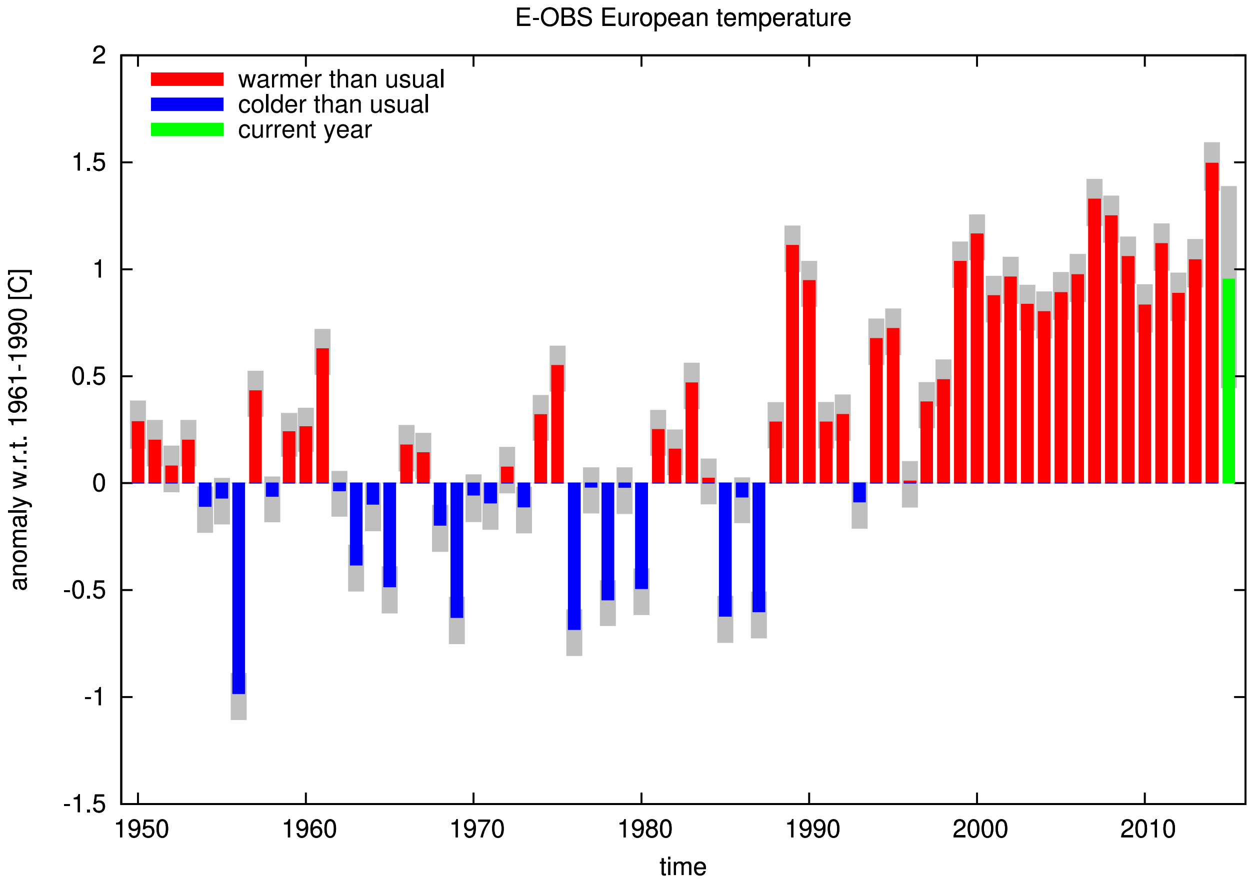
Aim of ECA&D

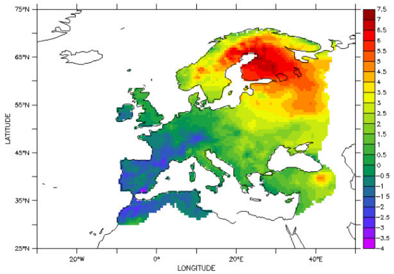
- provide a pan-European view on climate variability and change
- provide dataproducts to
  - scientific research community
  - National Meteorological Services
- complementary to the products provided by the NMHSs
- respects the data policy of the NMHS

Monitoring European climate - temperature

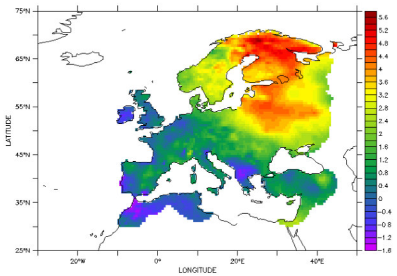


January

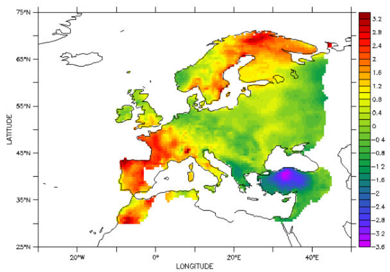




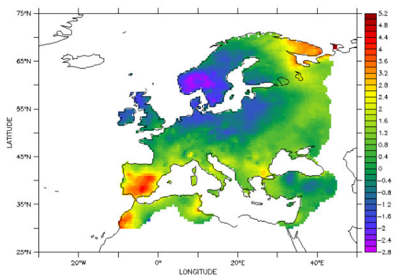
February



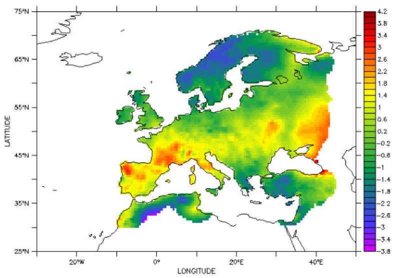
March



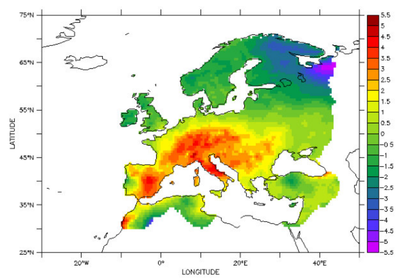
April



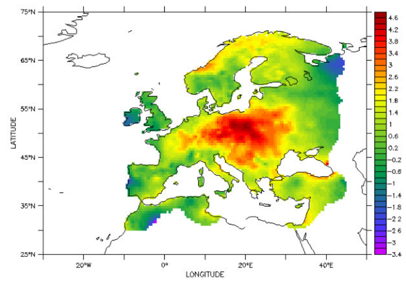
May



June



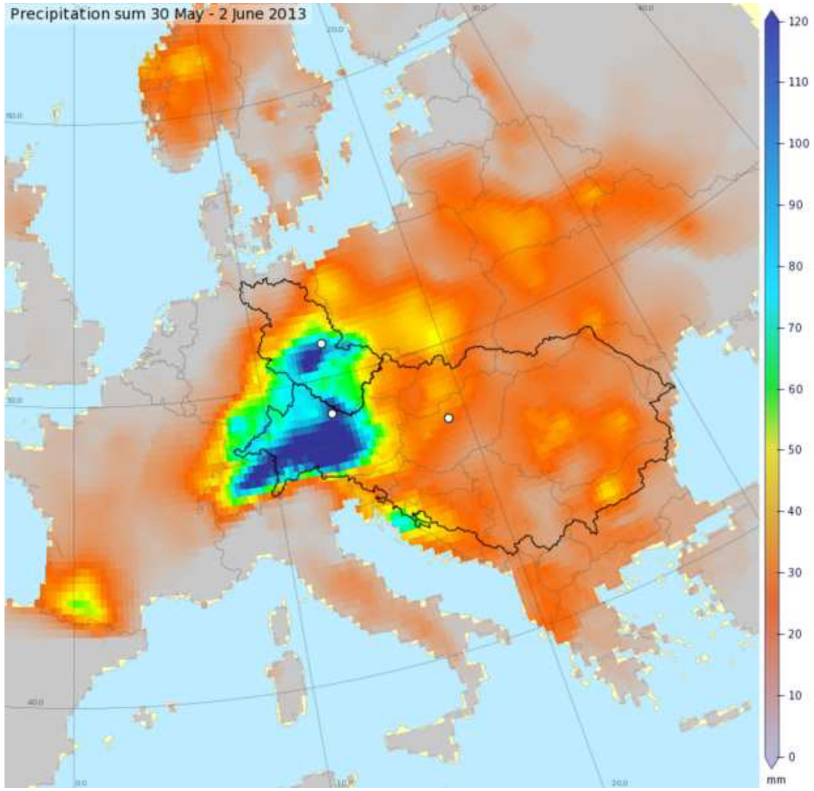
July

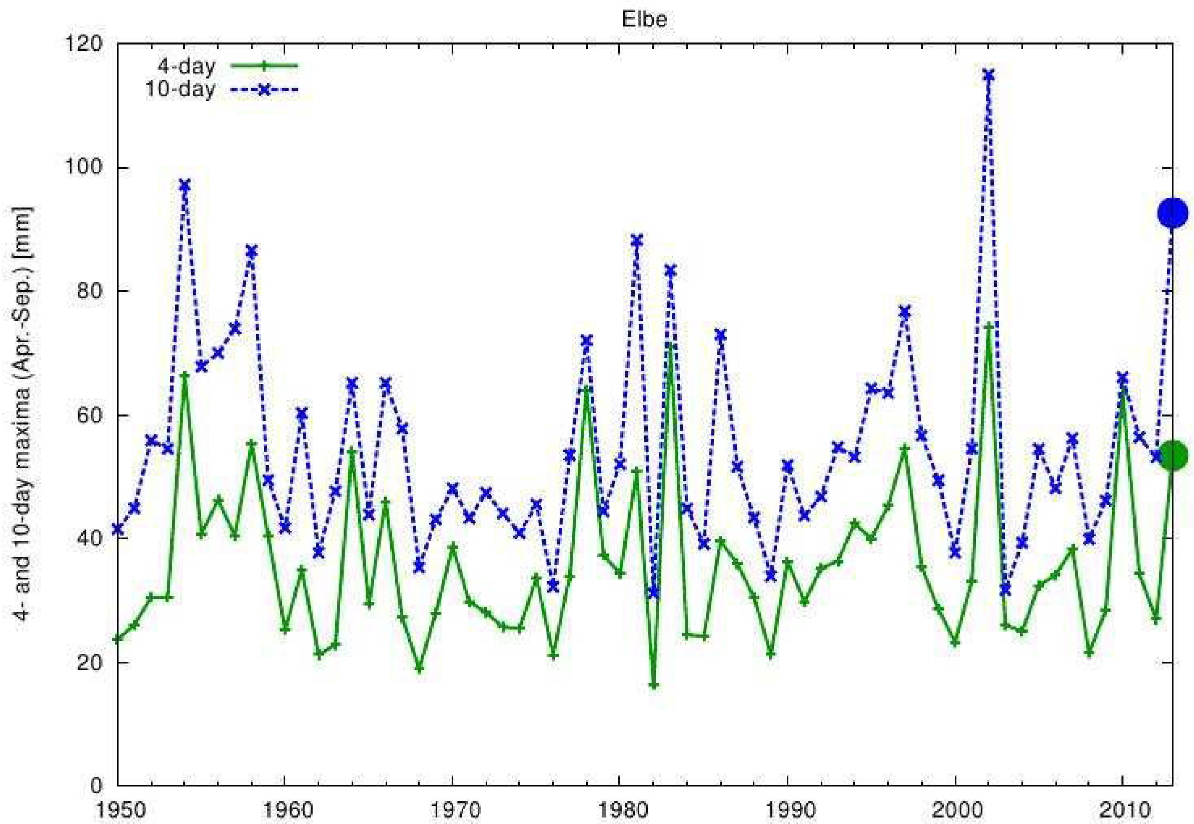


August

Monitoring European climate - extreme events

Central European flooding of 2013





http://cib.knmi.nl

New developments - data update

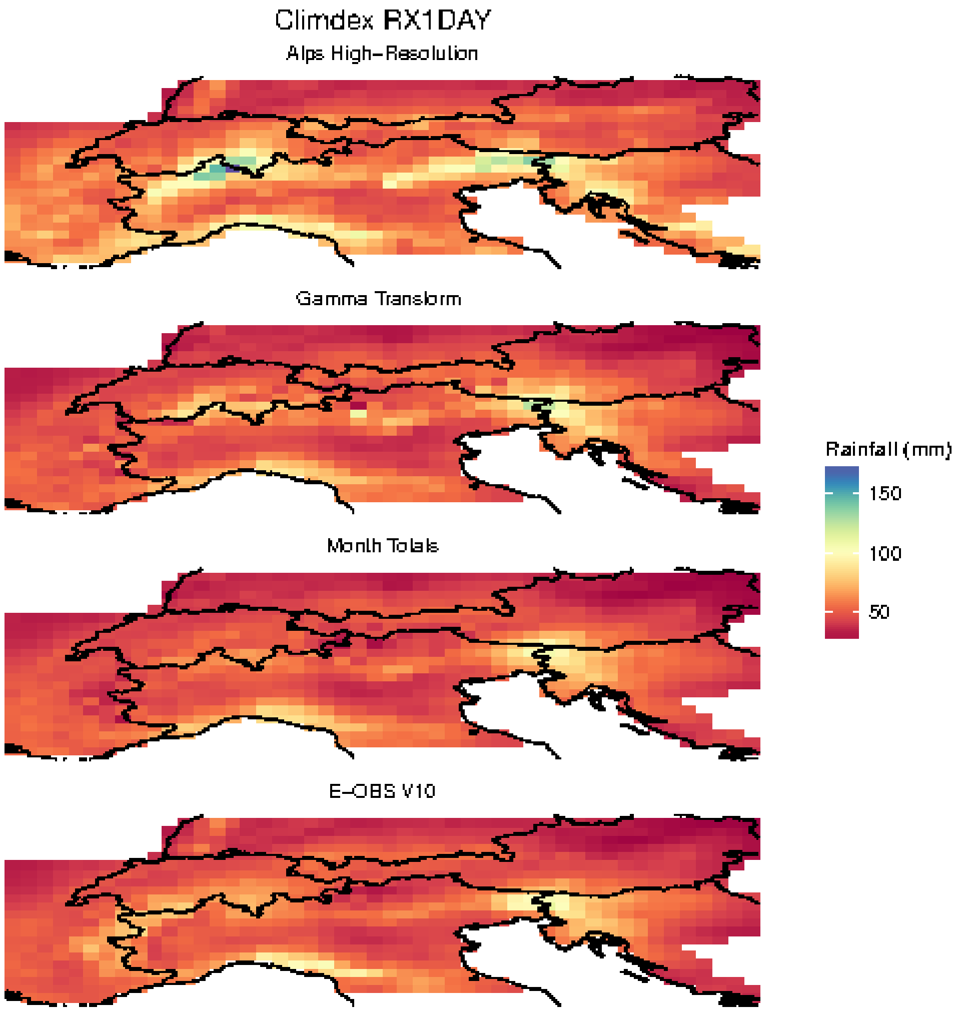
- Sogrape S.A. (Portugal) now contributes data

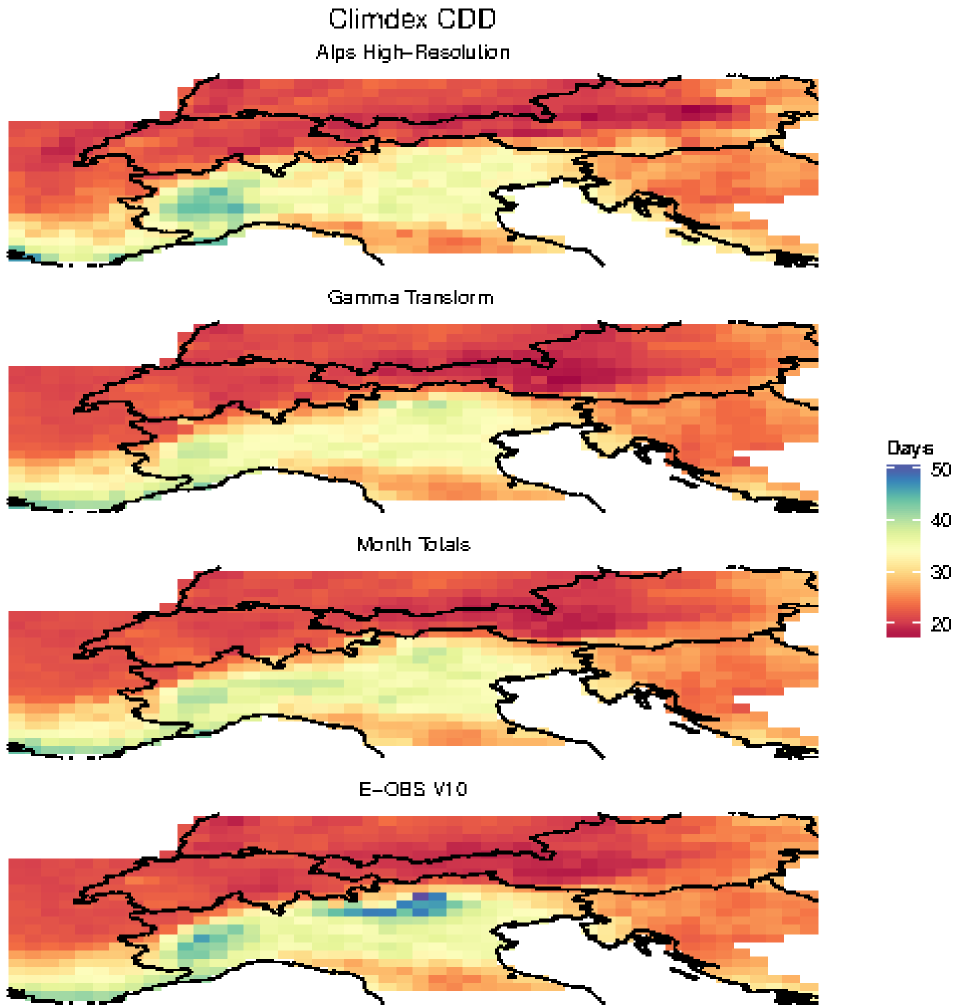
- number of NMSs contributing monthly updates increases
  (ch, cz, de, fi, ie, nl, no, si)

- contacts with regional weather services in Italy
  (ARPA-SIMC, ARPA Valle d'Aosta)

New developments - EOBS improved

gamma-transform technique instead of spline in the monthly value



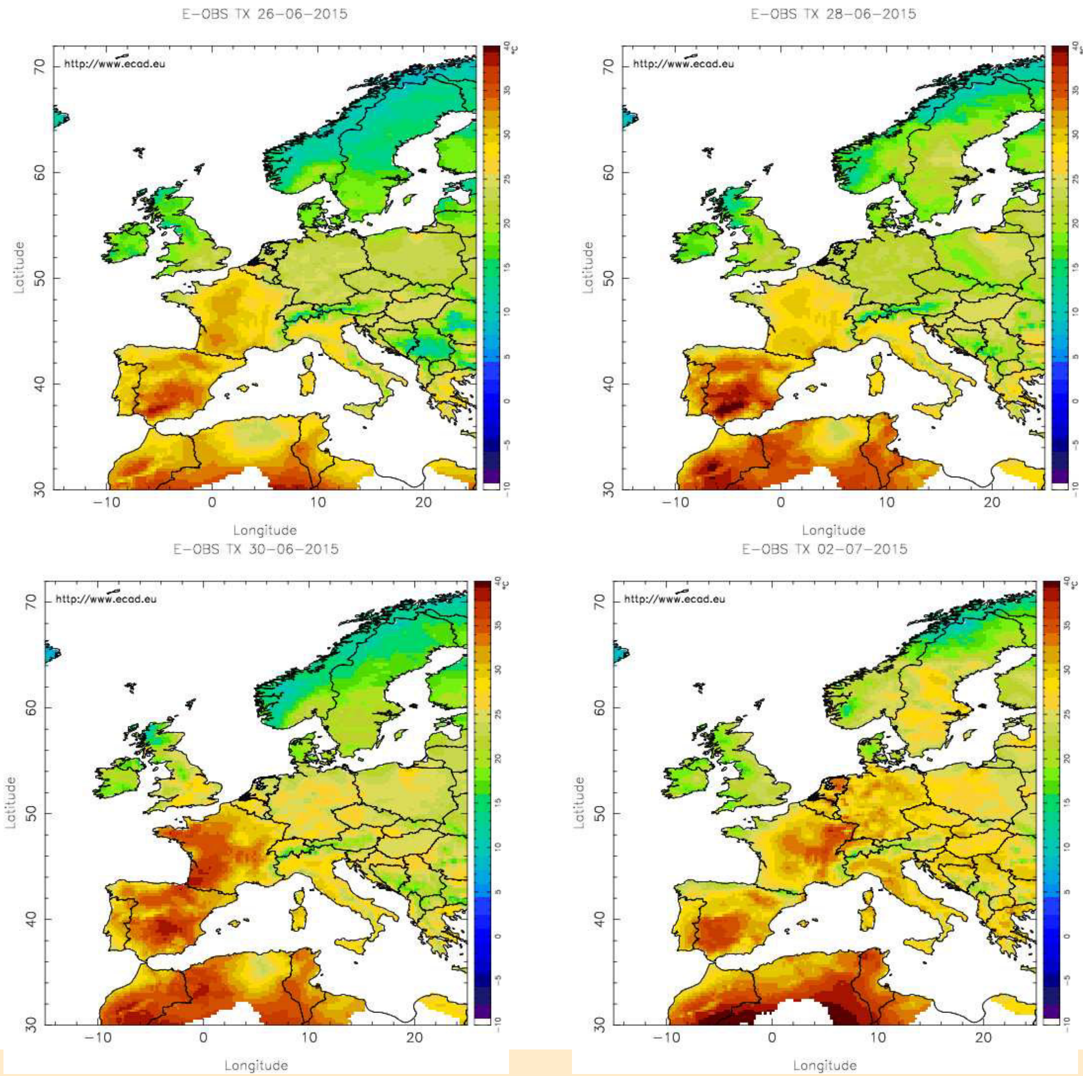


RX1day: somewhat better match

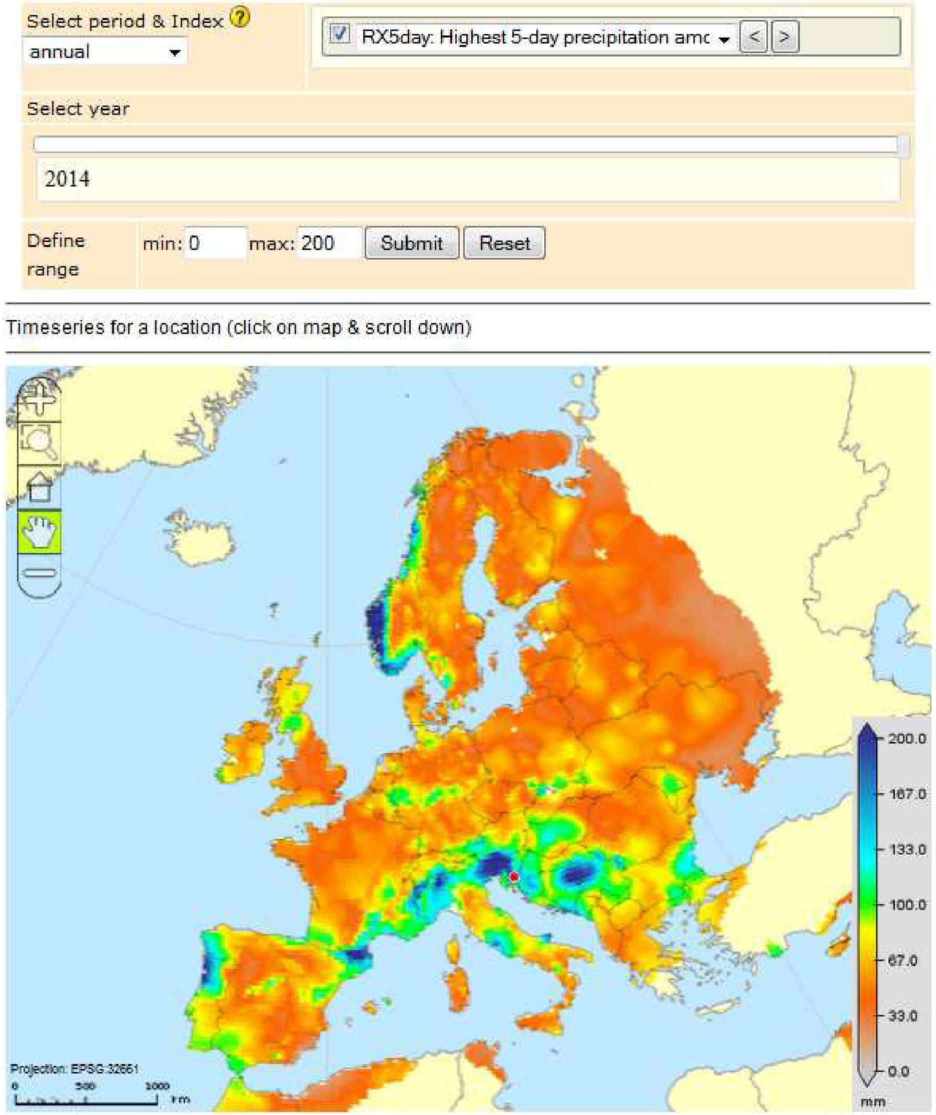
CDD: undershoot corrected

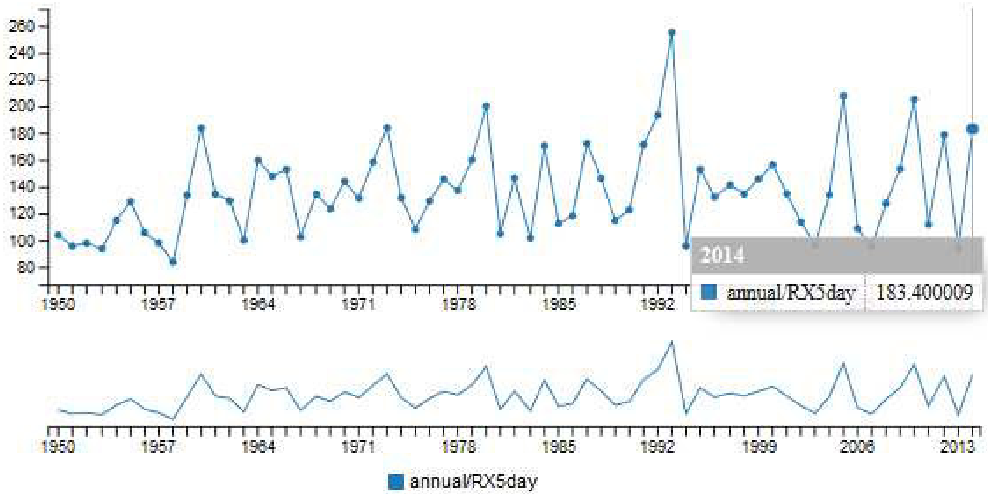
New developments - daily updates

Development of heat wave end of June/start of July 2015



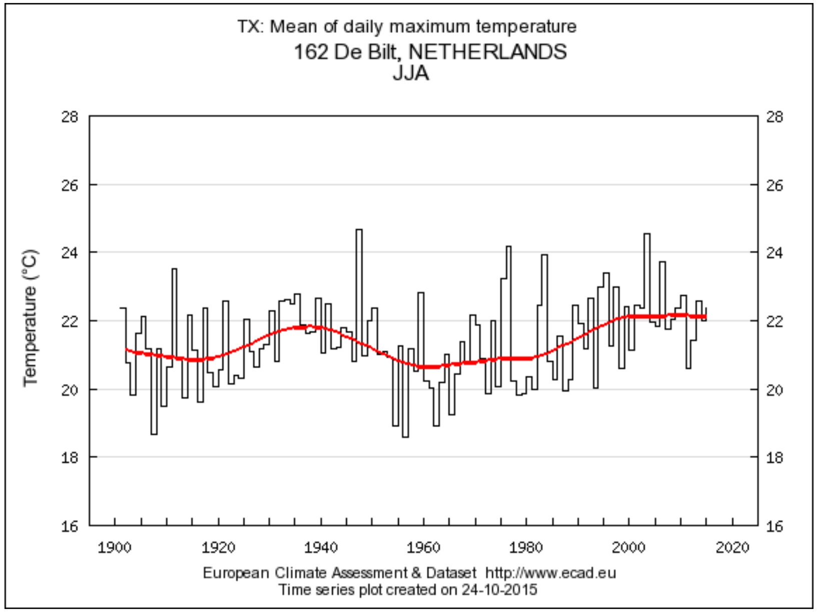
New developments - E-OBS-based indices





funded by EU FP7 - EUPORIAS

Future developments - homogenization of ECA&D data



- how to deal with homogenized data from NMHSs?
  - avoid two homogenized versions of one series
- can we think of a more intelligent way of blending?
  - avoid blending two very distinct (but nearby) stations

funded by EU Horizon2020 - EUSTACE

Conclusions

- give us your feed back
  - how to be more useful for NMHSs
  - how to be more useful for Scientific research community
  - how to avoid being a threat to NMHSs

contact us at: `eca@knmi.nl`