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MAP-NWS – an Optional EUMETNET Programme in Support of an Optimal Research Programme

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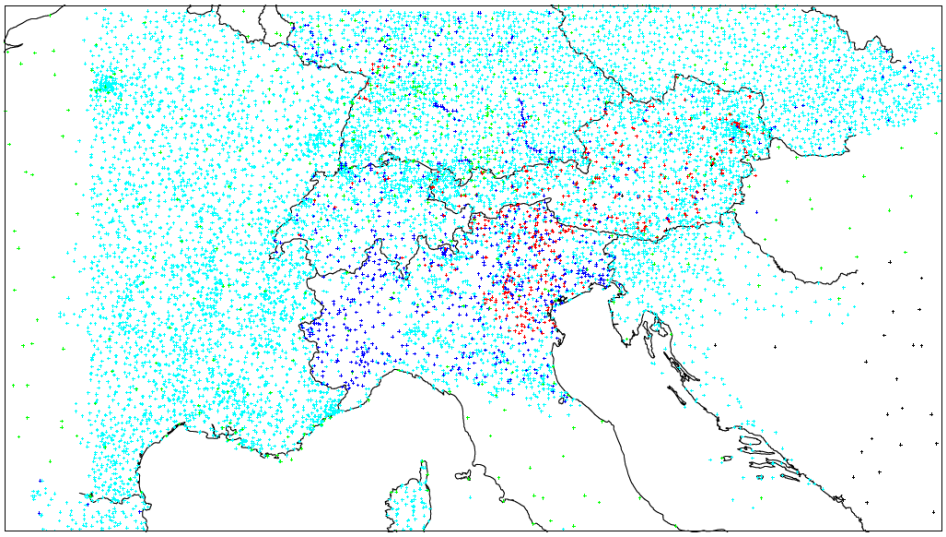

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The figure on the front page shows the coverage of the greater Alpine area with meteorological surface stations, and rain gauge stations in particular. One achievement of MAP consists in collecting and analyzing such a comprehensive data set for the entire Alpine region, i.e. providing a proof of concept for the feasibility of high-resolution trans-national observing networks. MAP-NWS funded DAQUAMAP, data quality effort of MAP, has compiled an inventory of more than 15’000 surface stations in the Alpine area.

Optional EUMETNET Programme MAP-NWS – The Mesoscale Alpine Programme of the National Weather Services

Final Report

Author: Andrea M. Rossa, Programme Manager

Table 1: Fact sheet of the optional EUMETNET Programme MAP-NWS, Mesoscale Alpine Programme of the National Weather Services.

Duration of the Programme:	1. Phase: 1996 – 1999 2. Phase: 2000 – 2002 3. Phase: 2003 – 2005
Members	EUMETNET: A, CH, D, E, F, GR, I, UK Non-EUMETNET: HR, HU, SI, SK, CAN, USA
Responsible Member	MeteoSwiss, Switzerland
Programme Manager	Andrea M. Rossa
Overall financial volume	2.15 MEUR (see section 4.3 on page 20)
Overall balance	26.6 kEUR (1.2%) remaining capital (see section 4.7 on page 24)
Estimated economic dimension	~42 MEUR, important promotion of next-generation high-resolution NWP and advanced observation technologies
Societal impact	Launching of 2nd WMO/WWRP Forecast Demonstration Project D-PHASE (planned for 2007; (see section 3.6.1 on page 16)
Main scientific results	Concerted publication of 9 overview articles in a special issue of the Quarterly Journal of the Royal Meteorological Society will appear 2007. A comprehensive list of peer-reviewed MAP publications is included in section 7.4.

Table of Contents

1 Preface

MAP: An internationally successful cooperation between Meteorological Services, Research Laboratories and University Institutes – a two-part preface.

The research part – **Hans Volkert**[1]

Meteorology possesses the chance and the curse of being viewed by the general public day-by-day and all-year long. Since decades Meteorological Service undertake the public service tasks of monitoring the atmospheric states and organizing weather forecasts through more and more realistic calculations from initial conditions faster then the wall clock can progress. University Institutes experiment with novel techniques and provide young, well trained staff. Publicly financed research laboratories have an intermediate position to provide, e.g., high-tech instrumentation on airborne platforms. International cooperation has a long tradition in operational meteorology, but underwent a significant upsurge in Europe after 1980.

These various strands helped to set the scene for the largest research programme ever conducted over a major mountain range, the Mesoscale Alpine Programme (MAP). While the planning, conduct and achievements of MAP are well documented, it is less known which significant background initiative was carried by the first optional EUMETNET project MAP-NWS led by the Swiss Federal Office of Meteorology and Climatology (former Swiss Meteorological Institute, now MeteoSwiss).

This report summarizes the development, the investment and the out-come of MAP from the MAP-NWS perspective. As participant and observer of this unique undertaking at the developing interface of basic and applied research and technology with a growing societal and economic impact I commend the secretary of The MAP Programme Office, Dr. Andrea Rossa, for the compilation of this useful document.

I conclude by referring to Dr. Stephan Nelson, a US-NSF program director, who mentioned as key elements during the phase A of MAP the visibility of a *complete research programme*, a *strong programme office* (set up at MeteoSwiss in January 1995; regularly informing the community via the *MAP newsletter*) and the early establishment of a *first rate data centre* (starting at ETH during summer 1995; making wide use of the internet from the beginning). He concluded: “I guess success came from good planning from both the sponsoring agencies and the scientists. MAP was an extremely well organized and well-run program. It could serve as a model for any large, atmospheric sciences program.”

[1] Chair of the ad-hoc working group of ALPEX-Regional to establish an Alpine research initiative 1992-1995, and Chair of MAP Steering Committee 2004-2006)

The operational part – **Peter Binder**[2]

MAP is an outstanding example of the successful cooperation between the scientific research and the operational meteorological communities. The generous and steady support from the very beginning of the programme by the network of the European National Meteorological Services (EUMETNET) by financial and technical means as well as by extended provision of the operational data allowed MAP to build on a solid basis and to develop into the largest atmospheric research initiative ever conducted in the European Alps.

EUMETNET through its optional programme MAP-NWS secured the organizational and operational backbone of MAP by financing the central management element, the MAP Programme Office, and the still running data platform, the MAP Data Centre. Furthermore, by investing into data quality efforts of the observational data and a high-resolution reanalysis, just to mention the most prominent projects, lessons learnt from the former large mountain meteorology research programme ALPEX (1982) have been realized.

The initiative of Dr. Thomas Gutermann, former director of MeteoSwiss, his convincing power and his tenacity were the key factors to initiate and maintain the MAP-NWS programme. Dr. Andrea Rossa of MeteoSwiss skillfully led the MAP Programme Office. Prof. Hans Richner and Dr. Hans Hirter of ETH built up, developed and operated the MAP Data Centre with great dedication. These key people in the context of MAP-NWS deserve highest appreciation for their contribution to the success of MAP-NWS.

[2] Chair of the MAP Coordination and Implementation Group 1995 – 2001, MAP Operations Director during the MAP SOP 1999, Vice-chair of the MAP Steering Committee 2001-2003

2 Management Summary

The Mesoscale Alpine Programme of the National Weather Services (MAP-NWS) started as the first EUMETNET Programme (after the Co-ordination Office) in 1996, with optional participation of the member countries, to support MAP. Its main goal was to sustain the administrative and technical backbone of this international research programme in the Alpine countries, i.e. the Programme Office (PO) and the MAP Data Centre (MDC). It also included a data quality effort (DAQUAMAP) and a state-of-the-art reanalysis of the entire 70-day Special Observing Period (SOP) from 7 September to 15 November 1999.

MAP-NWS was managed by Responsible Member MeteoSwiss, Switzerland, and lasted from 1996 to 2005 during which it was renewed twice, in 2000 and 2003, respectively. The membership slightly varied over the three phases of the Programme and comprised 14 NWSs, eight of which EUMETNET members and two non-European (Canada and USA, see Table 3 on page 19).

The overall financial volume of MAP-NWS amounts to 2.15 MEUR (see section 4.3 on page 20 and Table 11 on page 35), 79% of which was devoted to human resources, 27% for the PO, 39% for the MDC, 9% for DAQUAMAP, and 4% for the Reanalysis Project. Travel of the PO and MDC staff used 3% of the budget, while the remaining 18% were part of the in-kind contributions of the PO and MDC host institutions. MDC host ETH Zürich contributed an additional approximately 12% of the budget in-kind for hard- and software. A more detailed description is given in section 4.4 on page 20, while the overall expenditures are reported in section 7.2.1, Table 10, on page 34.

The overall balance leaves approximately 26.6 kEUR in the MAP-NWS account. The MAP Steering Committee and the Programme Manager propose to transfer this money to the WMO/WWRP Forecast Demonstration Experiment MAP D-PHASE, the societal impact component of MAP (see section 3.6.1 on page 16, section 6 on page 30, and the Written Procedure on page 63).

It is difficult to quantify the return on investment of a research and development initiative such as MAP. Volkert and Gutermann (2007) made an attempt to quantify the overall investments into MAP, from the planning to the field and evaluation phase, with roughly 42 MEUR, which would correspond to a leverage factor of 20. The overall economic dimension (see section 4.7), however, should be substantially larger, as MAP anticipated the development of the next-generation high-resolution NWP (Numerical Weather Prediction) with an, at the time, unprecedented real-time experiment during the SOP, providing an important test- and comparison-bed for the major limited area NWP consortia and centres in Europe and Canada. Similarly, modern observing technologies were pushed, e.g. airborne LIDAR (DLR), and the feasibility of the Alpine radar composite was demonstrated along with considerable progress in radar-based quantitative precipitation estimation. Finally, an important Alpine-wide collaboration experience in forecasting high-impact phenomena was possible thanks to MAP, a collaboration that was continued in an INTERREG Alpine Space project.

3 The Mesoscale Alpine Programme

3.1 Brief History of MAP (following J. Kuettner 2005)

The MAP effort constitutes an important step directed towards a better understanding of the multi-scale effects of mountains on atmospheric flow and was conceived, in seed form, in Sveti Stefan (Montenegro) in 1976, at a conference proposed by Fedor Mesinger and colleagues, chaired by Jule Charney, and attended by a remarkable group of scientists, such as Eliassen, Oboukhov, Wiin-Nielsen, and others. One thing this conference achieved was to get the mountain meteorological science objective, with the Alps as the experimental site, incorporated into GARP, the Global Atmospheric Research Program. This assured widespread support for a field experiment by ICSU, WMO and its more than, at that time, 150 member countries.

Jule Charney, who said “We do not know and we do not understand how air flows over or around mountains”, was the inspiration behind ALPEX, the major international field experiment carried out in the Alps in Spring 1982, as Charney was behind all of GARP. MAP did not have the type of backing that ALPEX enjoyed, and it took more than 15 years of tireless persistence to make MAP a reality. MAP may not have happened if nature had not cooperated so effectively with one of the main objectives of ALPEX: the lee cyclogenesis, a prime example of scale interaction. Instead of the climatologically expected two lee cyclones over the Mediterranean, it provided seven cases during March/April 1982. This resulted in the prevalence of northerly flow across the Alps at the expense of another primary objective of ALPEX; namely, the “deep South Foehn” and its related lee waves and Foehn storms. Ironically nature provided what was called by some the “Foehn of the Century” three days after the closure of the ALPEX field phase. There was a high interest in this specific problem in the Alpine countries like Austria, which, historically, had pioneered Foehn research, for example by the classical Foehn theory of von Hann and the daring balloon flights of von Ficker from Innsbruck. This led to the creation of “ALPEX Regional”, an informal group formed by ALPEX participants from Switzerland, Austria, Germany and Italy to keep alive the scientific cooperation achieved during ALPEX and to plan another field project with emphasis on the Foehn problem. There is little doubt that without the ALPEX Regional effort and the tenacity of its members, the plans for MAP would never have survived.

3.2 The Objectives and Structure of MAP

The Mesoscale Alpine Programme (MAP) constituted a measured response of the international atmospheric and hydrologic scientific community to the foregoing challenges and developments. It was conceived as a coordinated and integrated programme of basic research to have direct practical applications in the realm of numerical weather prediction and river runoff forecasting. The programme's coupled overall aim is to further our basic understanding and forecasting capabilities of the physical and dynamical processes that govern precipitation over major complex topography, including hydrological aspects, and determine three-dimensional circulation patterns in the vicinity of large mountain ranges, and the strategy is to focus on key orographic-related mesoscale effects that are exemplified in

the Alpine region. On a more detailed level, the MAP objectives, published in the MAP Design Proposal (Binder and Schär 1996), read:

1a. To improve the understanding of orographically influenced precipitation events and related flooding episodes involving deep convection, frontal precipitation and runoff.

1b. To improve the numerical prediction of moist processes over and in the vicinity of complex topography, including interactions with land-surface processes.

2a. To improve the understanding and forecasting of the life-cycle of Foehn-related phenomena, including their three-dimensional structure and associated boundary layer processes.

2b. To improve the understanding of three-dimensional gravity wave breaking and associated wave drag in order to improve the parametrization of gravity wave drag effects in numerical weather prediction and climate models.

3. To provide data sets for the validation and improvement of high-resolution numerical weather prediction, hydrological and coupled models in mountainous terrain.

The field phase of MAP took place 7 September – 15 November 1999, was a very large experimental effort over a mountain range of the size of the Alps. Thanks to the active international cooperation, a number of high-tech atmospheric and hydrological probing facilities were available. In order to facilitate the planning process, the numerous MAP goals were structured into eight broad projects (P1 to P8, see MAP Science Plan, Bougeault et al. 1998). Three of these projects came in direct support to the so-called "wet" part of MAP, i.e. the primary scientific objectives 1a and 1b. These are P1: Orographic precipitation mechanisms; P2: Incident upper tropospheric PV anomalies; P3: Hydrological measurements for flood forecasting. Four projects came in direct support of the "dry" part of MAP, i.e. the primary scientific objectives 2a and 2b. These are P4: Dynamics of gap flow; P5: Unstationary aspects of Foehn in a large valley; P6: Three-dimensional gravity wave breaking; and P7: Potential vorticity banners. Finally, project P8 on the planetary boundary layer structure, came in support of both wet and dry scientific objectives.

There was a great synergy between the eight projects: the upper tropospheric PV anomalies (P2) influence the intense rainfall location (P1) and vice versa; the hydrological program (P3) benefited directly from the rainfall measurements provided by (P1) and the surface evaporation measurements made under (P8); the dynamics of Foehn in a large valley (P5) have close a relationship to the gap flow (P4), and to the study of the planetary boundary layer (P8).

To tackle a research programme as complex as MAP, a three-body structure was established right from the beginning, along with a Programme Office (PO) and a Data Centre (MDC).

The International Governing Panel (IGP) consists of representatives of the national meteorological services and of the science funding agencies. The IGP carries the final responsibility for the implementation of the overall Mesoscale Alpine Programme. It approves the recommendation on the structure and implementation of MAP, particularly with respect to the necessary financial and technical support.

The Scientific Steering Committee (SSC) consists of leading atmospheric scientists and technologists. It is responsible for the formulation of well defined objectives and of a coherent scientific programme for MAP. The SSC will ensure the scientific integrity and coherence of the scientific objectives of MAP.

The responsibilities of the Coordination and Implementation Group (CIG) are the general planning and coordination of MAP in accordance with the scientific and technical goals set forth in the MAP Design Proposal document and in accordance with the decisions of the SSC and IGP.

3.3 The Planning Phase

The first phase of MAP, the planning phase, was intense, well structured, and was pushed on three distinct levels by the three MAP bodies, which proved essential in the setup of this complex research venture. Milestones in the planning of the field phase comprised the formulation of the MAP Data Policy. It took almost two years and a major effort to find a trade-off between protecting the data from misuse and keep the access to the data for research as open as possible. It led to the concept of ‘required’ and ‘supplemental’ data. Access to supplemental data is granted by way of an account which can be requested by filling in a pre-agreement form.

Two dedicated planning meetings were organized in Boulder, CO, USA in February 1998, and in Ascona, Switzerland, in October 1998. The former served to convince the US funding agencies of the solidity of the MAP objectives and planning, while the latter was dealing with many down-to-earth issues of the field experiment. This planning activity was carefully documented and made available to every participating scientist in form of the MAP Implementation Plan (Binder et al. 1999).

One peculiarity of the MAP field phase was the distributed character of the Operations Centres. What first started as friendly competition muted into a distributed planning with the MAP Operations Centre in Innsbruck, Austria, the Project Operations Centre for radar in Milano Linate, Italy, and the Foehn in the Rhine Valley Operations Centre in Bad Ragaz, Switzerland.

3.4 The Field Phase of MAP

3.4.1 SOP facts and figures

The overall success of the Special Observing Period of MAP was largely determined by the following factors:

- the weather was very favourable to the MAP scientific objectives;
- the key equipment, including all the observing platforms and the aircraft, worked reliably with no major failures;
- the cooperation between the numerous groups of scientific, technical, and operational staff was remarkably smooth, even with the geographically separated operations centres, where the professional help of the U.S. Joint Office of Science Support merits a particular mention.

Seventeen Intensive Observing Periods (IOP) grouped in a total of 34 days of operations occurred during the 70 days of Special the Observing Period (SOP) that lasted from 7 September to 15 November1999, which was well above average referred to the ten preceding years.

Full advantage of favourable weather can only be taken if the equipment is available and working, the right decisions are made, and circumstances permit the decisions to be carried out. The PO coordinated and worked in the office of the Facility Status Coordinator, serving the Mission Selection Team with currently updated information on all observing platforms. Figure 1 shows that nearly all projects were able to use the allocated flight hours (right bars). The relatively low percentage for P7 is due to the fact that P7 had a low number of favourable weather events, but those which occurred were good cases. The bars in the middle put the aircraft resources used in proportion to the largest project P1 on heavy precipitation. Finally, the left bars give the relative numbers of days of the 70 SOP days on which each individual project had operations. The heavy precipitation project conducted the most IOP days, followed by the gap flow and Foehn in the Rhine Valley.

The additional radio sounding resources contributed by the National Weather Services, the Swiss Army, and other research institutions, were entirely used, finishing on the last day of the SOP. This means 30 days with generally four ascents per day, three days of which were increased to eight ascents per day. With a rough total of 6'800 launched sondes as opposed to the routinely deployed roughly 2'800, the number of soundings during the SOP was more than doubled. Table 2 shows a few more significant numbers with respect to radars, lidars and last but not least the METEOSAT rapid scanning exercise.

From this one may conclude, that in spite of occasional competition between projects, the missions were managed in such a way, that in the overall experiment every project was well served and able to make use of its allocated resources.

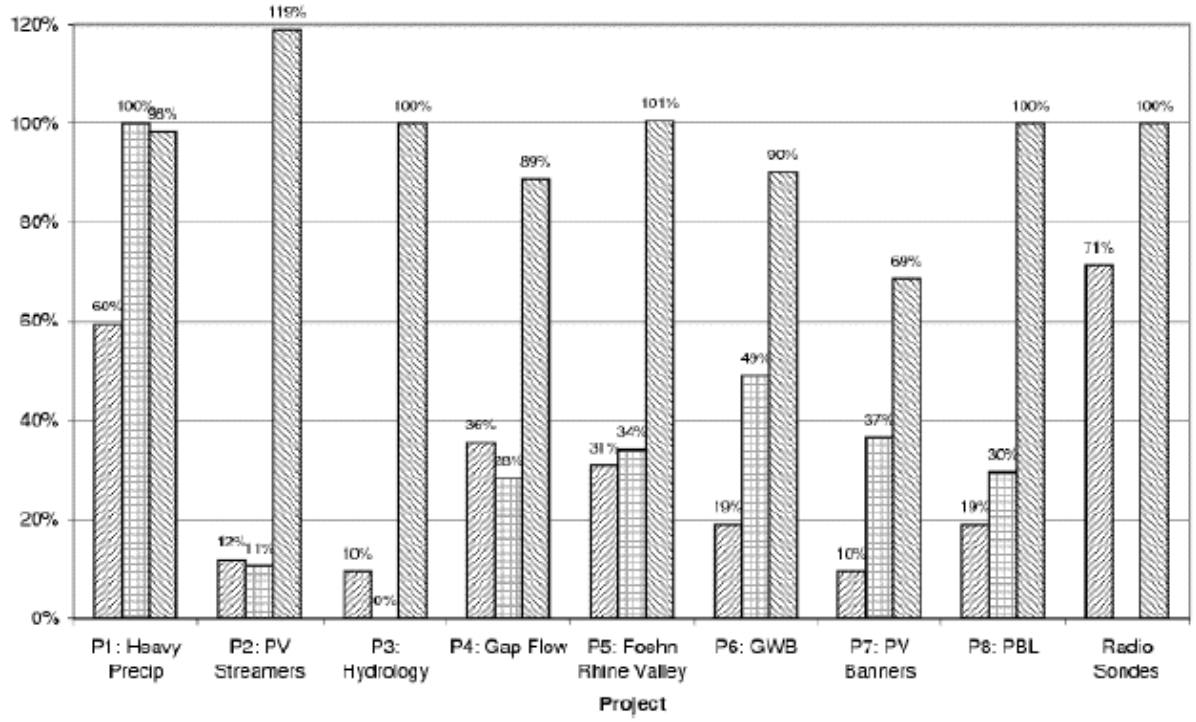

Figure 1 IOP activities, aircraft and radio sonde resource usage. Relative usage in % of the allocated resources (right column), absolute usage in % of the Heavy Precipitation project P1 (middle column). The left columns show the number of days on which a major facility has been deployed for a project (in % of the total 42 IOP days).

Table 2 Overview on the deployment of some major facilities during the SOP.

number of IOPs	17
number of IOP days	42
number of SOP days	70
number of flights	107
total flight hours	480
approx. number of total radio soundings	6’800
approx. number of additions radio soundings	4’000
number of METEOSAT rapid scan sequences	17
METEOSAT rapid scan hours	406
research radar hours	864
research lidar hours	187

3.4.2 Daily Planning Process and Weather Forecasting

The daily planning process which included weather forecast and briefing was carefully prepared ahead of the SOP and is described in detail in the MAP Implementation Plan (Dirks et al. 1999). The Mission Selection Team (MST), constituted of four rotating leading scientists, the Scientific, and the Operations Directors decided on the missions to be conducted, after thorough discussions, including voice communication with the POC.

An international team of bench forecasters, coming from national and regional weather services around the Alps and from Canada, provided guidance for the Mission Selection Team. The equipment of the forecast office was unique for 1999 in that it disposed of real-time products from a number of European weather services. The output of Aladin (nested in Arpège, MétéoFrance), SM (nested in GM/EM, MeteoSwiss), LM (nested in GME, DWD), IFS and EPS (ECMWF), and a high-resolution version of MC2 (grid size 3km, nested in SM, RPN-ETH-MeteoSwiss). In addition, an unprecedented variety of real-time observations was transmitted to the MOC, including an Alpine-wide radar composite featuring northern Italian radars, and the European windprofiler network data.

It should be emphasized that all these data and products were channelled through the MAP Network Centre (MNC), the real-time component of the MAP Data Centre (MDC). The MNC was also the node interconnecting the three Operations Centres in Innsbruck, Milano-Linate, and Bad Ragaz. The specific knowlegde acquired at the MDC during the Preparation Phase of MAP, turned out to be absolutely crucial, and well reflects the importance of the investment EUMETNET programme MAP-NWS in financing the MDC.

Air Traffic Control, both in the Innbruck and the Milano area, was an issue in dealing with the quite unusual research flight patterns touching several airspaces which concerned various centres around the Alps. Only very rarely was it necessary to accept compromises in the flight tracks, also thanks to the outstanding job of the experienced individuals involved. In particular, MAP-NWS co-funded Heinz Finkenzeller's mission for ATC support to Innsbruck.

From the organizational point of view, MAP was certainly at the limit of complexity of what can be handled with the means at hand: three operations centres, eight aircraft, three target areas heavily equipped with ground-based instrumentation, a large number of groups operating in the field, and a wealth of data connections to the operational world of weather services. The MAP-NWS co-sponsored telecommunication capability was a crucial element in the undertaking, for data as well as for human interaction.

3.5 The Evaluation Phase

Scientific output is often measured in terms of peer reviewed publications. The full inventory of the decade arching the SOP of MAP, i.e. 1997 – 2006, tracked so far, comprise as many as 220 publications in 30 journals (see sections 5 and 7.4). Systematic browsing through all the papers reveals different kinds of contributions. Early ones deal with general aspects as the Alpine-wide precipitation characteristics or new technical procedures, the bulk of middle ones discusses in depth case-studies from IOPs during MAP-SOP, while recently generalizations are attempted regarding lessons from MAP for high-resolution numerical weather prediction techniques. A comprehensive list of MAP publications is given in section 7.4.

MAP placed particular emphasis on the dissemination process. An annual scientific meeting was established from the very beginning and broadly publicized. This steadily growing event with up to more than 200 participants in 1999 was well appreciated by the community. In the years 2002-2005 this meeting was jointly held with two long established conferences in mountain meteorology, i.e. the AMS MMC (American Meteorological Society Mountain Meteorology Conference) in 2002 and 2004, and the ICAM (Int. Conf. on Alpine Meteorology) in 2003 and 2005.

Furthermore, a substantial effort was made to harvest the main MAP results and publish them in a form in which they could be made available to the upcoming scientific generation in an effective way. The results of this harvest process include progressively maturing solicited overview presentations at the AMS MMC 2004 and ICAM 2005, and a concerted publication of peer-reviewed overview articles in the Quarterly Journal of the Royal Meteorological Society to appear early 2007. The MAP-NWS Final Report is not the place to dive into the scientific aspects and results of MAP in any depth, so that reference is made to these publications.

3.6 The MAP Spinoffs

3.6.1 MAP D-PHASE

D-PHASE (**D**emonstration of **P**robabilistic **H**ydrological and **A**tmospheric **S**imulation of flood **E**vents in the Alpine region) started as MAP's response to WWRP's encouragement to include a societal impact component to the Programme and aims at establishing a real-time end-to-end forecasting system for heavy precipitation and subsequent flood events in the Alpine region. It will be based on the following items (in chronological order):

Probabilistic forecast of rain intensity and spatial distribution for lead times between 2 and 5 days, with possible pre-alerts (based on amount and probability) for different target regions. These pre-alerts will be sent out to all the participants including atmospheric and hydrological modellers, forecasters, and end users.

In the days following a pre-alert, the warnings may be re-iterated, refined, or discontinued.

For pre-alerts maintained up to two days ahead of the potential event, short-range (up to 48 hours lead time) *high-resolution deterministic forecasts* are performed using all the atmospheric models covering the likely affected region, and possibly, a poor man's ensemble constructed from these simulations. The simulations will use a wide range of data-assimilation systems as used by the participating institutions, further be supported by adaptive observations (extra soundings performed by or in collaboration with the EUCOS program of EUMETNET). Also, surface analysis fields from the VERA (Vienna Enhanced Resolution Analysis) analysis will be provided for assimilation and online monitoring purposes.

For the pre-alerted events, the output of the high-resolution deterministic atmospheric models is used to drive *hydrological models* if the event affects an impact area. Output goes to the concerned hydrological forecasters and end user(s) and is tailored towards their specific needs. Possibilities of performing hydrological *ensemble* predictions (based on an atmospheric ensemble prediction system, different atmospheric models, stochastic techniques, or parameter perturbations in hydrological models) will be explored.

Nowcasting (0 to 6 hours lead time) will be done with existing nowcasting tools at the various involved forecasting centres. This includes, where available, nowcasting based on high-quality radar data (e.g., automatic tracking of convective cells and automatic short-term alerts for heavy precipitation), and specific warnings by forecasters. Additionally, quantitative radar estimates of surface precipitation may be used as input for hydrological models. Real-time provision of latest high-resolution observations will complete the system, and may be used as input for hydrological models.

Figure 2 gives a graphical impression of the foreseen forecasting procedure. Observational input data will be required for data assimilation and to drive the nowcasting tools. These will be obtained from the existing networks to demonstrate *operational* forecasting capabilities. In collaboration with EUCOS, D-PHASE hopes to establish a supplemental network of radio sounding stations, which can be activated in case of a pre-alert.

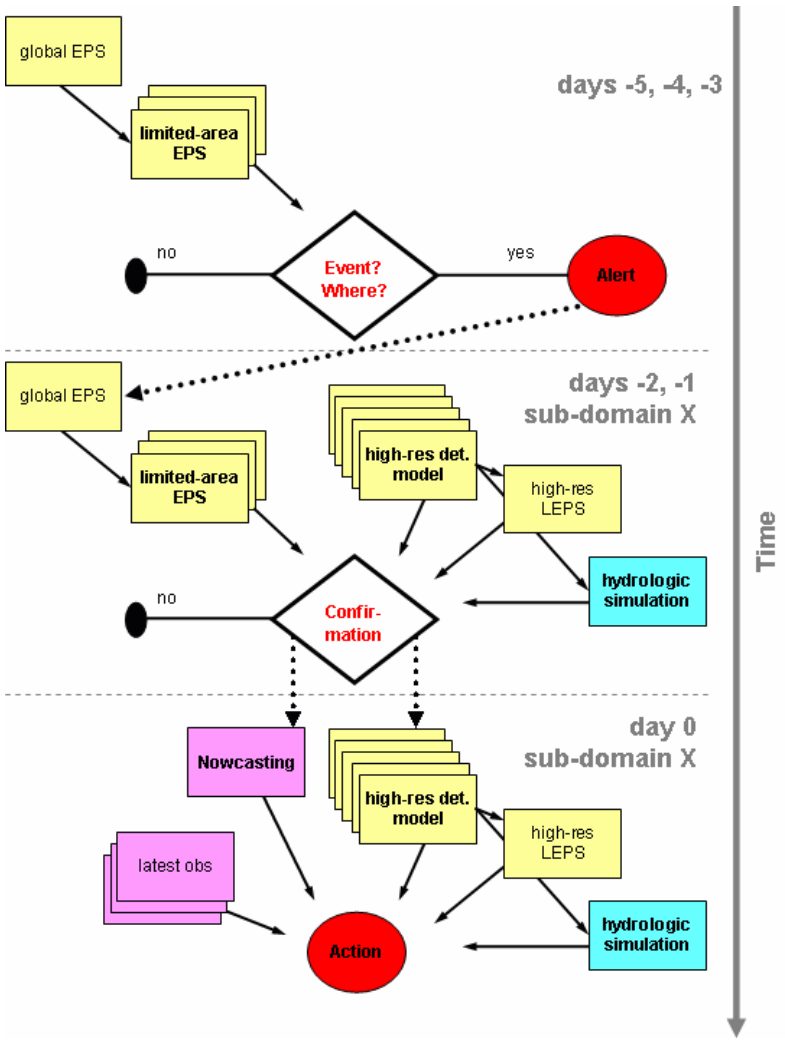

Figure 2: Conceptual sketch of the real-time end-to-end forecasting system for MAP D-PHASE. Not depicted are the forecasters and the end users.

3.6.2 Meteorisk as indirect initiative

Meteorisk was an Alpine-wide project to coordinate weather forecasting in case of extreme meteorological events. It was run as an INTERREG project in the Alpine Space Programme with Austrian, Italian, Slovenian, and Swiss participation. The spirit of Meteorisk certainly was inspired by the Working Group of Forecaster established in preparation of the MAP SOP with the goal to provide weather forecasts and mission guidance to the scientists. After the field phase an attempt was made to maintain the acquired collaboration within a forum called FACT (Forecasting in Alpine and Complex Terrain). This initiative was based on the belief that the Working Group could serve as an important and effective trigger for extended collaboration of the Alpine NWSs on the rapidly growing and changing level of operational forecasting. The main targets of FACT were meant to be:

- Education and training in Alpine forecasting
- Assessment of Numerical Weather Prediction models
- Real time co-operation during severe weather events

A part of these goals was implemented in Meteorisk, including the setup of the web service www.meteorisk.info which collects data from a specifically established network of automatic weather stations. These data are interpreted by the experts based on their personal experience of the local weather in their regions and compare these with the “larger” prevailing weather models for their country and for Europe as a whole. The platform www.meteorisk.info also serves to substantially ease communication between meteorologists, encouraging that this be made on a regular basis and across boarders. The overall goal is to supply in this way the public, as well as civil protection services and disaster relief workers with more reliable weather forecasts and the necessary warnings. Carefully analyzing and evaluating the disasters and dangerous weather situations of the past will prepare us for the demands of the future.

4 The MAP-NWS Programme

This section deals with the financial aspects of MAP-NWS and constitutes the final and overall financial audit of the Programme. In particular, sections 4.3 and 4.4 report the overall financial contributions and expenditures, which are further detailed in section 7.2. The MAP-NWS Board is asked to approve this audit by Written Procedure (see section 7.6).

4.1 Importance of the administrative and technical backbone

Throughout the entire MAP it was repeatedly stated that the existence of the MAP Programme Office (PO) and the MAP Data Centre (MDC) from the very beginning of MAP was a decisive factor for the success encountered. Especially in the early planning stages the PO provided the necessary momentum and cohesion between the participating groups, while the MDC was present as information and early data collection platform. The latter included meteorological data of MAP-relevant cases which otherwise would not have been easily available neither to the research community nor to the National Weather Services. The PO and the MDC constitute the basis of the MAP-NWS Programme (for more details see section 0), while two data related efforts were supported as well, i.e. a quality control (see section 4.5.3) and a reanalysis project (see section 4.5.4).

Table 3 Membership to the optional EUMETNET Programme MAP-NWS (Mesoscale Alpine Programme of the National Weather Services). 'X' denotes adhesion to the Programme, '(X)' financial contribution without formal membership.

Members	Phase 1	Phase 2	Phase 3
EUMETNET Members	1996-1999	2000-2002	2003-2005
Austria	X	X	X
France	X	X	X
Germany	X	X	X
Greece	X	X	
Italy	X	X	X
Spain	X	X	X
Switzerland	X	X	X
UK	(X)	(X)	X
Non-EUMETNET Members			
Croatia	X	X	X
Hungary	X	X	
Slovakia	X	X	X
Slovenia	X	X	X
USA		X	
Canada		X	X

4.2 Participating Members

Membership in the optional EUMETNET Programme was variable over the three phases of MAP-NWS (Table 3). It included eight EUMETNET, four European non-EUMETNET countries, as well as Canada and USA.

4.3 Financial Contributions

Table 4 reports overall the MAP-NWS Members' financial contributions which add up to 2.14 MEUR. The detailed revenues, given in Annex 7.2.2, show in addition that the interests matured on the capital amount to 8 kEUR, while an approximate accounting of the currency fluctuation between EUR and CHF resulted in a net gain of about 7 kEUR.

Table 4 Overall contributions [kEUR] to the MAP-NWS for the entire Programme Period 1996-2005. Note that for the percentages only the cash contributions are accounted for, i.e. the Swiss in-kind contributions are not counted.

Overall contributions to MAP-NWS [kEUR]		
MAP-NWS Member	total contr.	%
Austria	194.00	11%
France	151.00	8%
Germany	207.50	12%
Greece	28.00	2%
Italy	256.00	14%
Spain	142.00	8%
Switzerland kind	356.89	
Switzerland cash	529.63	30%
UK	109.97	6%
Croatia	18.00	1%
Hungary	15.00	1%
Slovakia	20.00	1%
Slovenia	18.00	1%
USA	45.31	3%
Canada	47.05	3%
Total	2138.34	100%

4.4 Financial Accounting

Table 5 summarizes the overall expenditures of the MAP-NWS Programme and reveals that most of the available funding was invested in human resources. More specifically, the PO used 27%, the MDC 39%, DAQUAMAP 9%, and the Reanalysis project 4% of the available money. Travel took 3% of the overall budget, while most of the resources used for publication were in-kind contributions by MeteoSwiss. Note that the Swiss in-kind contribution is accounted for as several budget items (e.g. facilities or telecommunications) indeed were not accounted for explicitly. The detailed financial audit, included in Annex 7.2., constitutes, upon approval by the MAP-NWS Board, the official and overall audit of the Programme.

Table 5 Overall expenditures of the MAP-NWS Programme for Phases I to III in kEUR. Percentages are relative to the the overall financial contributions as reported in Table 2, including the in-kind contributions of Switzerland. The main part of these cover the budget items 'facilities', 'communication', 'telefone/mail', and 'publications'.

Overall expenditures [kEUR] Budget item			%
Salaries	PO I	538.83	25%
	PO II	47.55	2%
	DBM I	424.01	20%
	DBM II	220.79	10%
	DBM III	166.47	8%
	DBM IV	29.79	1%
	DAQUAMAP	153.90	7%
	DAQUAMAP II	39.28	2%
	Reanalysis	75.00	4%
Salaries Total		1695.61	79%
Facilities		189.00	9%
Communication		28.85	1%
Travel		57.82	3%
Meetings		3.68	0%
Telefone/Mail		22.00	1%
Fees/Charges		4.16	0%
Publications		124.82	6%
Varia		3.29	0%
Grand Total		2129.24	100%

4.5 How was the money spent

In this section a short description is given for what the human resources were used. An overview is given in section 7.1 on page 33 in Table 9, while the following subsections contain a more detailed report.

4.5.1 Programme Office (PO)

Even before the official start of MAP a scientific secretariat with the Programme Officer (PO I, Andrea Rossa) was set up at MeteoSwiss starting 1 January 1995 and operating through to the end of MAP-NWS, with a steadily decreasing work load after the SOP. For the intense years from 1998 to 2002 a deputy (PO II, Martin Bolliger) was hired to help the PO. The main tasks of the PO comprised:

- Organizing and supporting the meetings of the MAP bodies CIG, SSC, IGP, and later the MSC, including writing the minutes;
- Proposing and managing the EUMETNET Programme MAP-NWS, including the yearly financial accounting and the Final Report;
- Assistance and technical editing of the major planning documents, i.e. the MAP Design Proposal (Binder and Schaer, 1996), the MAP Science Plan (Bougeault et al. 1997);
- Co-authoring the MAP Implementation Plan (Dirks et al. 1999) with a major focus on the observational facilities;
- Serving as Facility Status Coordinator during the SOP at the MOC in Innsbruck, including the set up of the monitoring and messaging system for all the observational platforms involved;
- Co-editing the MAP newsletter along with writing progress and status reports on the MAP affairs to the MAP community.

4.5.2 MAP Data Centre (MDC)

As early as in 1995 it was decided that a Data Centre was necessary to prepare the main channels for the large variety of meteorological data that MAP would have to deal with. The main Data Base Manager (DBM I, Hans Hirter 1996 – 2003, and Claudia Schmengler until the migration) had the task to design the overall architecture of the MDC. Quickly it became clear that the technical aspects and user support required more personnel. As a response to this need, a deputy was hired from 1998 to 2005 (DBM II, Thomas Kistler), in the intense period from 1999 to 2003 with a third person (DMB III, Esther Scharnhorst-Häller) in the team, and 1999 to 2000 even a forth (DBM IV, Anne Guy).

In the year prior to the SOP the MAP Network Centre, the real-time component of the MDC which served to channel the real-time data flow to the Operations Centres took a special effort, and proved to be absolutely necessary. The years around and after the field phase assistance needed to be given to the numerous institutions delivering data sets to the MDC.

The final effort undertaken by the MDC was its migration from the original host institution ETH Zurich to MeteoSwiss. The migration was prepared by the DBM I and realized with the help of a consultant in 2005. The permanent address of the MDC reads www.map.meteoswiss.ch and assistance can be requested under map@meteoswiss.ch.

4.5.3 DAQUAMAP

A lesson that was direly learnt in ALPEX was that a lacking data quality effort could obstacle the field phase data set of being available quickly after the experiment. MAP-NWS, upon recommendation of the SSC, decided to fund such a data quality effort within MAP, i.e. DAQUAMAP[3]. This project took the burden to compile an inventory of the order of 15’000

[3] http://www.univie.ac.at/IMG-Wien/daquamap/

meteorological surface stations, predominantly of non-GTS type, help setting up a data flow, and assess the quality of the basic meteorological parameters (temperature, pressure, wind, humidity) measured by these stations. The effort was carried out at the University of Vienna under the lead of Prof. Steinacker. An evaluation of the performance of the surface observation network during MAP has been published in Häberli et al. (2004).

The quality control was extended to the radio soundings in 2003 and dealt with the dry bias problem encountered with a number of Vaisala radio sondes deployed during the SOP. Last effort was a redo of the entire quality control procedure based on the 'best SOP surface data set' as collected by 2004. This was carried out at MeteoSwiss. The available reports include the DAQUAMAP final report (Steinacker et al. 2003), published papers on the method (Steinacker et al. 2004), Häberli et al. (2006) on the dry bias problem and a EUMETNET flyer.

4.5.4 SOP Reanalysis

After the SOP the MAP Steering Committee (MSC) decided to produce a best depiction of the atmospheric state for the period of the SOP, i.e. they formulated the need for a "reference reanalysis" of the MAP SOP, taking benefit of all the additional observations with the most recent version of a state-of-the-art global data assimilation system. A tendering was published in July 2001 and was calling for offers to produce two kinds of deliverables:

- Quality-controlled special observations of MAP, under a format well adapted to data assimilation (such as BUFR);
- A standard reanalysis of the whole MAP-SOP, to be made available to research groups via the MDC.

The ECMWF offer was selected by the MSC in November 2001, for the following reasons:

- guarantee of rapid delivery of the products;
- maximum use of satellite data over the Mediterranean area;
- familiarity of ECMWF formats and procedures for the MAP community.

The reanalysis was performed with ECMWF's global data assimilation system 4D-Var (T511/159L60, horizontal resolution approximately 40km) combined with special MAP observations to provide a new reference description for studies on mountain related atmospheric phenomena. In the Alpine region, three times more humidity observations from radiosondes and five times more humidity observations at surface stations than in operations in 1999 have been assimilated. A control analysis excluding the MAP special observations is available, too. The main results of the reanalysis effort are documented in (Keil and Cardinali 2003).

4.5.5 SOP Contributions

The setup of the operational infrastructure was a major effort, especially as the dry and wet MAP objectives had a complementary focus. This led in practice to a distributed Operations Centre as described in section 3.4. Most of the Operations was financed, both in-cash as well as in-kind, by the hosting countries, i.e. Austria, Italy, and Switzerland, and in a major way by the USA who sent two experienced scientists of the Joint Office of Science Support to Innsbruck, and one more to Milano. MAP-NWS contributed to the SOP in strengthening the

MDC, and contributing to the air traffic control, more specifically to the support of Heinz Finkenzeller, DLR Oberpfaffenhofen, Germany, at the MOC in Innsbruck.

4.5.6 MDC Migration (see also section 4.5.2)

One of the main goals of the third and final phase of MAP-NWS consisted in migrating the MDC from the university setting of ETH to an operational environment to grant for permanent access to the MAP data set. This migration was prepared by the MDC staff and the data warehouse group of MeteoSwiss. The technical realization was supported by an external consultant, and necessitated some changes in the technical architecture, which do not affect users. They were necessary to allow smooth operation of the MDC within the standardised MeteoSwiss environment in the years to come.

4.6 In-kind contributions

All participating countries have contributed, through their funding of the scientific groups, to the overall success of MAP. From a MAP-NWS perspective, the host institutions for the PO and the MDC provided most all of the infrastructure, including IT equipment (hardware and software licences as ORACLE for instance), as well as communications and printing. A rough estimate of the PO and MDC in-kind contributions amounts to 350 kEUR or 17% of the overall budget (see Table 4). Hard- and software in-kind contributions, not accounted for in Table 5, amount to 100 kEUR for hardware (file and web server, DB server, development and staff systems), and 15 kEUR/yr for software (operating systems, DB and web server [Oracle]), i.e. another 12% of the overall budget. In summary, the total in-kind contribution of the host institutions of the PO and the MDC contributed roughly 30% over the total financial volume of the MAP-NWS Programme.

4.7 Overall balance

The overall balance of MAP-NWS evens to approximately 25 kEUR on a total financial volume of over 2.15 MEUR, i.e. to about 1%. The MAP-NWS Contract foresees that the Board decide upon how to proceed with the assets of the Programme, once it ended. In section 6 it is proposed to transfer these leftover funds to the societal component of MAP, i.e. D-PHASE. In order to document what effort this is for every member Table 6 reports the repartition of the remaining funds in proportion of the overall contributions.

Table 6 Member repartition of remaining funds [kEUR]of the MAP-NWS Programme on the basis of their overall contributions. Note that the Switzerland in-kind contributions are not accounted for.

potential repayment of remaining capital [kEUR]		
MAP-NWS Member	%	26.63
Austria	11%	2.90
France	8%	2.26
Germany	12%	3.10
Greece	2%	0.42
Italy	14%	3.83
Spain	8%	2.12
Switzerland cash	30%	7.92
UK	6%	1.64
Croatia	1%	0.27
Hungary	1%	0.22
Slovakia	1%	0.30
Slovenia	1%	0.27
USA	3%	0.68
Canada	3%	0.70
Total	1.00	26.63

5 Was it worth the effort?

The obvious question to a research programme that lasted for a decade and benefited from the direct EUMETNET contribution of about 2MEUR is 'was it worth the effort? The PO is probably not the most objective source to answer this question with a simple yes or no. An attempt is made nevertheless to make the overall significance of this EUMETNET effort plausible.

Table 7 Investments for MAP made by countries and international bodies broken up by project funds, extra investments (mostly for infrastructure during the SOP), and estimated in-kind investments from the base budgets of the participating institutions. Investments made for MAP broken up by group of sponsors, project funds (for number of projects), extra investments and estimated in-kind investments from the base budgets of the participating institutions. 1) basic contribution to run the operation centre in Innsbruck during SOP; 2) enhancement of routine measurements; 3) basic costs for radar system and two research aircraft; 4) basic costs for research aircraft and enhanced observations; 5) basic contribution for the precipitaion operation centre (POC) in Milano and for enhanced measurements ; 6) deployment of research aircraft; 7) USA figures where provided in US$; 1 US$ = 1 Euro is used as average conversion for the MAP period; 8) basic costs for US MAP-office and field deployments (e.g. two research aircraft, Doppler radar); 9) many national meteorological services contributed to basic infrastructure (e.g. Programme Office, Data Centre) via EUMETNET administered by MeteoSwiss; 10) ECMWF contribution to reanalysis costs in addition to EUMETMET payment.

Country/International body	Sponsoring agencies	Project	Extra	In-kind	Sum
Austria	FWF, ZAMG	1.4	0.3 [1]	0.7	2.4
Canada	MSC, NRC	0.1		0.2	0.3
Croatia	DHMZ	0.1	0.1 [2]	0.1	0.3
France	CNRS, MétéoFrance, CNES, EDF	1.3	2.4 [3]	8.5	12.2
Germany	DLR, DFG, DWD	0.4	0.4 [4]	1.3	2.1
Italy	CNR, AeroMil	1.1	0.6 [5]	0.6	2.3
Slovenia	ARSO	0.1	0.1 [2]	0.1	0.3
Switzerland	SNF, MeteoSwiss	3.3		1.5	4.8
United Kingdom	MetOffice		0.3 [6]	0.7	1.0
United States[7]	NSF, NCAR	7.2	1.4 [8]	3.8	12.4
National Met. Services	EUMETNET		2.2 [9]		2.2
European bodies	EU, ECMWF	1.4		0.2 [10]	1.6
Sum		**16.4**	**7.8**	**17.7**	**41.9**

Apart from the direct 30% in-kind contributions of the PO and MDC host institutions, the Programme leveraged a roughly twenty-fold direct investment in the participating countries, e.g. through research projects funded by national funding agencies. Table 7, taken from Volkert and Gutermann (2007), attempts to inventory the main scientific and supportive activities which were a direct part of MAP. By virtue of its incompleteness it is bound to underestimate the monetary value of the real efforts that went into the Programme.

Analysis of Table 7 reveals that Considerable investments were made by major funding agencies, as FWF (Austria), CNRS-INSU (France), SNF (Switzerland), and NSF (United States). Similar figures for Canada, Italy, and Slovenia are hopefully available for the final version of this report. France and the United States made the largest overall contributions, followed by the central Alpine countries Austria and Switzerland. Remarkable are the significant contributions from international bodies (EUMETNET, EU, ECMWF). Three different kinds of support are distinguished: funds for specialized research projects (mainly for groups at universities; ~35%), financial support for large instrument platforms as aircraft and portable radars (~20%) and in-kind support through the base budgets of all the participating institutions (~45%). In a conservative fashion, the latter were estimated from average factors provided by funding managers. One of them, a NSF program director, mentioned as key elements during the phase A of MAP the visibility of a complete research programme, a strong Programme Office (set up at MeteoSwiss in January 1995, regularly informing the community via the MAP newsletter) and the early establishment of a first rate Data Centre (starting at ETH in summer 1995; making wide use of the internet from the beginning). He concluded: “I guess success came from good planning from both the sponsoring agencies and the scientists. MAP was an extremely well organized and well-run program. It could serve as a model for any large, atmospheric sciences program.”

Scientific output is often measured in terms of peer reviewed publications. The full inventory of the decade spanning 1997 – 2006, tracked so far, comprises 220 publications in no less than 30 journals (see Table 8 and section 7.4). For a paper to be counted it needs to make explicit reference to MAP, make use of relevant data or document techniques for subsequent SOP data processing. For the sake of comparison it can be noted that in the five post-SOP years of MAP 33% more papers came out from MAP than in the respective post-GATE quinquennium (121, GATE was a large-scale meteorological research programme conducted in the 1970-ies), where the peak lies at least one year earlier. Specific to MAP is the unifying rôle of special issues in established research journals [as M.A.P. 72 (2-4) for project HERA and HESS 7 (6) for project RAPHAEL during phase A of MAP, QJ 129 (588) dedicated to MAP-SOP results, and Met.Z. 13 (1-3) for results presented at ICAMMAP-03 conference in Brig]. A systematic browsing through all the papers reveals different kinds of contributions. Early ones deal with general aspects as the Alpine-wide precipitation characteristics or new technical procedures, the bulk of middle ones discusses in depth case-studies from IOPs during MAP-SOP, while recently generalizations are attempted regarding lessons from MAP for high-resolution NWP techniques. A comprehensive list of MAP publications is given in section 7.4. Moreover, 42 PhD thesis were concluded in the framework of MAP, highlighting a the considerable educational impact of this Programme.

Table 8 Distribution of 207 MAP related articles in peer-reviewed journals over the years 1997-2006 and 27 research journals. The journals are grouped by the publishing learned societies (AMS: American Meteorological Society; AGU: American Geophysical Union; RMS: Royal Meteorological Society; D-A-CH: consortium of meteorological societies of Germany, Austria, Switzerland; EGU: European Geophysical Union; IMI: International Meteorological Institute, Stockholm) or companies (Springer, Elsevier). The journal abbreviations are explained in section 7.4 alongside with the complete inventory of counted articles. Entries in bold contain the MAP related articles of the special issues in Meteo. Atmos. Phys. 72, issue no. 2-4, 2000; Q. J. R. Meteorol.Soc. 129, issue no. 588, 2003; Hydrol. Earth System Sci. 7, issue no. 6, 2003; Meteorol. Z. 13, issues no. 1-3, 2004.

publisher	journal(s)	97	98	99	00	01	02	03	04	05	06	Sum
AMS	JAS. MWR		2		2	2	5	1	8	5	6	31
	JAOT, WF				3	6	3		1			13
	others (BAMS,				2	4	2	1	1	1	3	14
AGU	GRL, JGR		1					4	1			6
RMS	QJ					4	5	**30**	11	7	8	65
	IJCli, MA		1		1		1				1	4
D-A-CH	BPA, MZ			2		4	1	3	**12**			22
EGU	ACP, AG, **HESS**				1			**9**		1		11
IMI	Tellus-A				1	1		1	1		1	5
Springer	BLM, EFM, **MAP**	1			**11**	3	1	4	7	3	3	33
Elsevier	AE, JHyd, PCE				2	2	1	2	1			8
others	AsGs, Geof, HydP						1	2				3
Sum		**1**	**4**	**2**	**23**	**26**	**20**	**57**	**43**	**19**	**25**	**220**

Taking it one step further still, the overall Economic Dimension of the Programme, however, is probably significantly larger, as important investments were made by the National Weather Services in the area of high-resolution numerical weather prediction, to name but one major field of progress to which MAP contributed. Here is a list, not necessarily complete, of facts related to MAP which can be taken as an indicator to the overall value of such an experience:

- MAP was the first international research initiative to receive official WMO/WWRP endorsement for a field programme;
- It was WWRP to encourage a societal impact component, an effort that was difficult to get started. MAP eventually responded with the D-PHASE (**D**emonstration of **P**robabilistic **H**ydrological and **A**tmospheric **S**imulation of flood **E**vents in the Alpine region, see sections 3.6.1 and 6, and note the intended double meaning of the acronym);

- MAP led in high-resolution modelling providing a unique data set and a common focus which led quicker progress:
  - the real-time MC2 experiment (mesh size 3 km) was unprecedented in 1999 and served to collect first operational experiences with an NWP model of that resolution;
  - all new-generation NWP models, both European and Canadian:, were extensively tested on the well documented MAP cases;
  - in particular, the physics packages of the French research model Meso-NH were transferred to the next-generation operational NWP model Arome;
  - early attempts of limited area ensemble prediction were tested on MAP cases;
  - effectual test environment for critical evaluation of several (5-6) high-resolution NWP models (this was novel and needful);
- observing technologies were pushed, e.g. lidar (DLR), Falcon partly funded by NSF;
- unique airborne observing effort which led to unprecedented documentation of mountain induced mesoscale phenomena (e.g. gravity waves);
- the feasibility of the Alpine radar composite was demonstrated, and considerable progress in QPE (quantitative precipitation estimation) was made (e.g. with the MeteoSwiss Mt. Lema radar);
- the INTERREG project Meteorisk followed a concept that emerged from the collaboration of the international MAP SOP Forecasting Office.

Moreover, J. Kuettner, very experienced in meteorological field experiments, and honorary member of the MAP committees, pointed out some of the scientific achievements. “In my (very personal) opinion the following accomplishments stand out:

- our ‘Wet MAPPERS’ have elucidated the complex mechanism of heavy orographic precipitation and flooding over the Southern Alps;
- for the first time the flow through a mountain gap has been systematically explored in the Brenner Pass area by multilevel flight traverses and ground based observations;
- the theoretically postulated ‘Potential Vorticity Banners’ were verified on both sides of the Alps and over the Dalmatian coast;
- modelling of orographic flow and precipitation has made impressive advances;
- in a more general context the combined ALPEX-MAP exploration effort has stimulated the whole field of mountain meteorology and hydrology.”

“Let me conclude”, he goes on to say, “with an observation on the human relations aspect of MAP: long experience in international field projects has convinced me that the best technical/scientific plans are useless if the human relations are not functioning. To accomplish this requires a sensitive balance between tolerance and decisiveness on the side of the Scientific and Operations Field Directors. Several of my American colleagues have told me after MAP that they have never enjoyed a field project as much as MAP. May the international friendships formed during MAP last a lifetime!”

6 Proposal for the remaining funds of MAP-NWS

As detailed in section 4.4 and Annex 7.2 the overall MAP-NWS balance yields approximately 26.6 kEUR. The Contract foresees that the Board decide upon the usage of any assets or money. The MAP Steering Committee, at its last meeting in Santa Fe, NM, USA, 1 September 2006, decided to support the MAP D-PHASE initiative and formulated the following Proposal:

Recommendation to the MAP-NWS Board concerning the financing of the MAP D-PHASE Visualisation Platform. Petitioner is Mathias Rotach, chair of the MAP D-PHASE Steering Committee.

- MAP D-PHASE, the **MAP Forecast Demonstration Project**, aims at demonstrating some of the many achievements of MAP, in particular the ability of forecasting heavy precipitation and related flooding events in the Alpine region. The MAP FDP will address the entire forecasting chain ranging from limited-area ensemble forecasting, high-resolution atmospheric modelling (km-scale), hydrological modelling, and nowcasting to decision making by the end users, i.e., it is foreseen to set up a distributed end-to-end forecasting system.
- A detailed description of the D-PHASE Project can be found on the MAP D-PHASE website[4], in the proposal to the WWRP[5], or in the MAP D-PHASE Implementation Plan[6].
- The distributed end-to-end forecasting system will encompass **two centralised elements, the data interface (DI) and the visualisation platform (VP)**. The DI is realised in collaboration with **COPS** ('Convective and Orographically-induced Precipitation Study, the field experiment of the German Priority Programme PQP[7], and will store all data and alerts. **Financing of the DI is secured through funding of COPS by the German Research Foundation.**
- The visualization platform (VP) is designed to visualize pre-defined atmospheric and hydrological model products, nowcasting tools, and alerts of all components of the end-to-end forecasting system as well as to serve as feedback platform where forecasters and end-users can subjectively evaluate all the products available through D-PHASE. The visualization platform is planned to be realized in collaboration with **Meteorisk[8]**. **In contrast to the DI, the VP is not yet firmly financed.**

[4] http://www.map.meteoswiss.ch/d-phase

[5] http://www.map.meteoswiss.ch/map-doc/dphase/wwrdp_fdp_proposal_20051012_corr.pdf

[6] http://www.map.meteoswiss.ch/map-doc/dphase/ip_v1.0_20060425.pdf

[7] http://www.uni-hohenheim.de/spp-iop

[8] http://www.meteorisk.info

- Specification of the technical realisation of the DI is already partly available and is being revised by the responsible for the DI (a 50% position has been financed by COPS to take care of the DI) and the chair of the D-PHASE Working Group ‘data interface’. For the VP, detailed specifications are presently being worked on. A very general picture of how the VP should look like and what functionalities it should have is available from the D-PHASE Implementation Plan and will be further developed by the D-PHASE working groups.

The MAP Steering Committee is requested to make the following recommendations to the MAP-NWS Board:

- Attribution of the surplus money from the MAP-NWS budget to MAP D-PHASE to finance the MAP D-PHASE visualisation platform.
- In case the funds needed to finance the MAP D-PHASE visualisation platform should be smaller than the surplus money from the MAP-NWS budget, the extra money may be spent for any other D-PHASE-related purpose.
- The surplus amount of the MAP-NWS budget is transferred to MeteoSwiss.

7 Annexes

7.1 Overview of human resources and expenditures sustained by MAP-NWS

Table 9 Overview of the human resources deployed during MAP-NWS. Note that the PO and the MDC were operational prior to the formal establishing of MAP-NWS. Colour shading denotes approximate period of operation.

Sum of Amount [EUR]		year											
Budget Item	sub item	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Salaries	PO I	Continuous operation of the Programme Office starting 1 Jan 1995, with progressively decreasing activity after the Special Observing Period											
	PO II				additional support to the PO in preparation of the SOP, as well as post-SOP activities								
	DBM I	Continuous operation of the MAP Data Centre (MDC) starting Aug 1995, with a culmination of activities in preparation of and after the SOP											
	DBM II			additional support to the MDC in preparation of the SOP									
	DBM III					additional support to the MDC for the setup of the real-time Data centre during the SOP; Migration of							
	DBM IV						additional MDC support						
	DAQUAMAP			data quality effort for surface observing networks in the entire Alpine area									
	DAQUAMAP II										DQ or radio sounding; final processin		
	Reanalysis								reanalysis of SOP data at ECMWF				
Facilities		in-kind contributions of MeteoSwiss and ETH Zurich (Offices, computer hardware and software well above declared value)											
Communication		in-kind contributions of MeteoSwiss and ETH Zurich; telecommunication costs during SOP, especially for MOC-POC link											
Travel		travel costs of PO and MDC staff				SOP air traffic control support							
Meetings													
Telefone/Mail		in-kind contributions of MeteoSwiss and ETH Zurich											
Fees/Charges		predominantly bank charges (counterbalances by interests)											
Publications		Design Proposal, Science Plan, Implementation Plan, newsletters (20 issues, contained the extended abstracts of Annual Meeting contributions until 2001) all in-kind MeteoSwiss; cash for BAMS overview article and QJ Special Issue											
Varia				DCW for NWP	translation	Field Catalog CDs							

7.2 Detailed financial audit tables MAP-NWS Contributions

7.2.1 Expenditures

Table 10: Overall expenditures of the MAP-NWS Programme in kEUR (negative numbers are revenues, positive numbers expenditures). The percentages in the last column are based on the total contributions to the Programme, 2.15MEUR (see Table 3 on page 19 and Table 11 on page 35), including the in-kind contribution of Switzerland.

Expenditures [kEUR]		year													
Budget Item	sub item	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Grand Total	percentage
Salaries	PO I	55.75	66.43	66.80	66.13	76.35	79.91	44.14	26.28	19.45	18.46	10.65	8.50	538.83	25%
	PO II	0.00	0.00	0.00	10.41	13.26	9.47	11.22	3.20	0.00	0.00	0.00	0.00	47.55	2%
	DBM I	61.03	59.83	65.68	34.21	30.60	31.30	35.47	39.99	16.16	32.37	16.13	1.22	424.01	20%
	DBM II	0.00	0.00	17.32	45.20	26.79	40.35	43.74	25.71	10.70	5.31	5.67	0.00	220.79	10%
	DBM III	0.00	0.00	0.00	0.00	23.74	12.62	43.92	25.55	31.88	0.00	28.76	0.00	166.47	8%
	DBM IV	0.00	0.00	0.00	0.00	0.00	6.45	23.34	0.00	0.00	0.00	0.00	0.00	29.79	1%
	DAQUAMAP	0.00	0.00	8.00	20.00	31.10	31.10	31.10	32.60	0.00	0.00	0.00	0.00	153.90	7%
	DAQUAMAP I	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	25.00	14.28	0.00	39.28	2%
	Reanalysis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	50.00	25.00	0.00	0.00	0.00	75.00	4%
Salaries Total		116.78	126.27	157.79	175.95	201.83	211.20	232.93	203.33	103.18	81.14	75.49	9.72	**1695.61**	79%
Facilities		18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	15.00	15.00	15.00	0.00	189.00	9%
Communication		1.00	2.00	2.00	2.00	9.85	2.00	2.00	2.00	2.00	2.00	2.00	0.00	28.85	1%
Travel		2.00	5.87	2.42	3.59	22.14	2.20	2.43	8.77	1.91	2.54	1.27	2.68	57.82	3%
Meetings		0.20	0.00	0.00	0.00	0.00	0.00	0.00	1.19	0.00	1.24	0.00	1.05	3.68	0%
Telefone/Mail		2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	0.00	22.00	1%
Fees/Charges		0.04	0.06	0.66	0.63	0.73	0.72	0.60	0.33	0.17	0.13	0.10	0.00	4.16	0%
Publications		15.10	13.11	13.00	12.00	12.00	21.84	21.00	7.00	3.78	3.00	3.00	0.00	124.82	6%
Varia		0.96	0.00	1.61	0.20	0.50	0.02	0.00	0.00	0.00	0.00	0.00	0.00	3.29	0%
Grand Total		156.08	167.30	197.48	214.37	267.04	257.98	278.96	242.62	128.05	107.06	98.86	13.45	**2129.24**	100%

7.2.2 Revenues

Table 11: Overall revenues of the MAP-NWS Programme in kEUR (negative numbers are revenues, positive numbers expenditures). The percentages in the last column are based on the cash contributions only, i.e. the Switzerland in-kind contribution is not accounted for here.

Revenues [kEUR]		year													cash
Budget Item	sub item	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Grand Total	percentage
NWS	Austria	-8.00	-30.00	-35.00	-35.00	-35.00	-20.00	-15.00	-10.00	-2.00	-2.00	-2.00	0.00	-194.00	11%
	France	0.00	-30.00	-15.00	-15.00	-15.00	0.00	-30.00	-10.00	-12.00	-12.00	-12.00	0.00	-151.00	8%
	Germany	-22.12	-10.38	-30.00	-30.00	-30.00	-20.00	-20.00	-15.00	-10.00	-10.00	-10.00	0.00	-207.50	12%
	Greece	0.00	-4.00	-4.00	-4.00	-4.00	-4.00	-4.00	-4.00	0.00	0.00	0.00	0.00	-28.00	2%
	Italy	0.00	-25.00	-30.00	-35.00	-35.00	-35.00	-35.00	-25.00	-12.00	-12.00	-12.00	0.00	-256.00	14%
	Spain	0.00	0.00	-20.00	-18.00	-25.00	-20.00	-20.00	-15.00	-8.00	-8.00	-8.00	0.00	-142.00	8%
	Switzerland ki	-38.95	-39.97	-36.98	-34.00	-34.00	-35.00	-43.00	-29.00	-22.00	-22.00	-22.00	0.00	-356.89	
	Switzerland ca	-81.38	-66.43	-99.63	-53.07	-62.78	-60.81	-30.53	-20.00	-25.00	-15.00	-15.00	0.00	-529.63	30%
	UK	-10.00	-9.97	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	0.00	-109.97	6%
	Croatia	0.00	0.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	0.00	-18.00	1%
	Hungary	0.00	0.00	-1.00	-2.00	-3.00	-3.00	-3.00	-3.00	0.00	0.00	0.00	0.00	-15.00	1%
	Slovakia	0.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	0.00	-20.00	1%
	Slovenia	0.00	0.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	0.00	-18.00	1%
	USA	0.00	0.00	0.00	0.00	-10.00	-10.00	-13.29	-12.02	0.00	0.00	0.00	0.00	-45.31	3%
	Canada	0.00	0.00	0.00	0.00	0.00	0.00	-9.05	-10.00	-10.00	-9.00	-9.00	0.00	-47.05	3%
NWS Total		-160.46	-217.74	-287.60	-242.07	-269.78	-223.81	-238.86	-169.02	-117.00	-106.00	-106.00	0.00	**-2138.34**	100%
revenues	dcw selling	0.00	0.00	0.00	-0.52	0.00	-0.06	0.00	0.00	0.00	0.00	0.00	0.00	-0.58	
	Interest	-0.04	-0.12	-1.08	-1.68	-1.44	-1.67	-1.33	-0.43	-0.03	-0.04	-0.05	0.00	-7.91	
revenues Total		-0.04	-0.12	-1.08	-2.20	-1.44	-1.73	-1.33	-0.43	-0.03	-0.04	-0.05	0.00	-8.49	
Grand Total		-160.49	-217.87	-288.68	-244.27	-271.23	-225.54	-240.20	-169.44	-117.03	-106.04	-106.05	0.00	**-2146.84**	

7.2.3 Accumulated balance

Table 12: Overall accumulated balance of the MAP-NWS Programme in kEUR (negative numbers are revenues, positive numbers expenditures). The total revenues are as in Table 11 while total costs as in Table 10. The uncovered costs correspond to the yearly balance, while the accumulated uncovered costs correspond to the accumulated balance, which at the end of the Programme correspond to the left over capital. The exchange rate of the EUR (ECU at the beginning of the Programme) to the CHF was such as to yield an approximate overall gain of 6.8kEUR. The difference to the net available capital at the end of the Programme is imputed to the exchange rate variability which was not accounted for and corresponds to ½‰ of the total volume.

accumulated balance [kEUR]	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Total
Total Revenues	-160.49	-217.87	-288.68	-244.27	-271.23	-225.54	-240.20	-169.44	-117.03	-106.04	-106.05	0.00	-2146.84
Total Costs	156.08	167.30	197.48	214.37	267.04	257.98	278.96	242.62	128.05	107.06	98.86	13.45	2129.24
Uncovered Costs yearly	-4.41	-50.56	-91.21	-29.90	-4.19	32.44	38.76	73.18	11.01	1.02	-7.19	13.45	
Uncovered Costs accumulated	-4.41	-54.98	-146.18	-176.08	-180.27	-147.83	-109.07	-35.89	-24.88	-23.86	-31.04	-17.59	**-17.59**

balance EUR audit	-17.59
approximate accumulated currency gain CHF-EUR [EUR]	-6.79
total	-24.38
available CHF capital [EUR]	**-26.63**
difference (exchange rate variability)	-2.25

7.3 References

Binder P, C. Schär (Eds). 1995. Mesoscale Alpine Programme – Design Proposal. MeteoSwiss, Zurich, 63 pp. (2nd edition, 1996, including hydrological applications, 77 pp. online available at http://www.map.meteoswiss.ch/map-doc/proposal.htm)

Bougeault P., P. Binder, A. Buzzi, R. Dirks, R. J. Houze, J. Kuettner, R. B. Smith, R. Steinacker, and H. Volkert, 2001. The MAP Special Observing Period. *Bull. Amer. Meteorol. Soc*., **82**, 433-462.

Bougeault P, P. Binder, and J. Kuettner, 1998. The MAP Science Plan, available at MeteoSwiss, http://www.map.meteoswiss.ch/map-doc/splan/spindex.htm, 64pp.

Binder P., A. Rossa, Ph. Bougeault, J. Moore, and D. Jorgensen (1999): MAP Implementation Plan, 300 pp., online available at MeteoSwiss, http://www.map.meteoswiss.ch/map-doc/mip.htm.

Häberli, C., 2006. Assessment, correction and impact of the dry bias in radiosonde humidity data during the MAP SOP. *Quarterly Journal of the Royal Meteorological Society*, **132**, 2827–-2852.

Häberli, C.; Groehn, I.; Steinacker, R.; Pцttschacher, W. & Dorninger, M., 2004. Performance of the surface observation network during MAP. *Meteorologische Zeitschrift*, **13**, 109--121.

Kuettner, J. 2005. Editorial. MAP newsletter, available online at http://www.map.meteoswiss.ch/map-doc/newsletter20.htm, **20**, 1-2.

7.4 Comprehensive list of peer-reviewed MAP publications

In the following a comprehensive list of references to peer-reviewed publications are reported which can be considered as outcome of MAP. The formal requirement for an article to be included in the inventory is that it refers to the MAP Design Proposal (1995, 1996) or the MAP-SOP overview by Bougeault et al. (2001). Concerning the content it is checked whether the study helped the preparation of MAP-SOP, used data from MAP-SOP, or took inspiration from MAP-SOP observations for theoretical investigations. At present, as many as 220 articles appeared in print during the decade 1997-2006 are listed by year and alphabetically by lead author. The page range eases a first judgement about the size of the investigation. The journal abbreviations used in Table 8 are:

- ACP Atmospheric Chemistry and Physics, EGU
- AE Atmospheric Environment, Elsevier
- AG Annales Geophysicae, EGU
- AsGs Annals of Geophysics, Inst. Nat. di Geofisica, I
- BAMS Bulletin of the American Meteorological Society, AMS
- BLM Boundary Layer Meteorology, Springer
- BPA Beiträge zur Physik der Atmosphäre, DMG
- EFM Environmental Fluid Mechanics, Springer
- Geof. Geofizika, Geophysical Institute, Zagreb

- GRL Geophysical Research Letters, AGU
- HESS Hydrology and Earth System Sciences, EGU
- HydP Hydrolociacl Processes, Wiley InterScience
- IA Intergrated Assessment, Springer
- IJCli International Journal of Climatology, RMS
- JAM Journal of Applied Meteorology, AMS
- JAOT Journal of Atmospheric and Oceanic Technology, AMS
- JAS Journal of the Atmospheric Sciences, AMS
- JC Journal of Climate, AMS
- JGR Journal of Geophysical Research, AGU
- JHyd Journal of Hydrology, Elsevier
- JHyM Journal of Hydrometeorology, AMS
- MA Meteorological Applications, RMS
- MAP Meteorology and Atmospheric Physics, Springer
- MZ Meteorologische Zeitschrift (N. Folge), D-A-CH
- MWR: Monthly Weather Review, AMS
- PCE Physics and Chemistry of the Earth, Series B, Elsevier
- QJ Quarterly Journal of the Royal Meteorological Society, RMS
- Tellus Tellus, Series A, International Meteorological Institute, Stockholm
- WF Weather and Forecasting, AMS

1997

Heimann, D., 1997. Foehn signals detected by sodar wind and turbulence measurements in the Rhine Valley, Austria, during the MAP field phase. *Meteorology and Atmospheric Physics*, **62**, 49--70.

1998

Aebischer, U. & Schaer, C., 1998. Low-level potential vorticity and cyclogenesis to the lee of the Alps. *Journal of Atmospheric Sciences*, **55**, 186--207.

Buzzi, A.; Tartaglione, N. & Malguzzi, P., 1998. Numerical simulations of the 1994 Piedmont flood: Role of orography and moist processes. *Monthly Weather Review*, **126**, 2369--2383.

Frei, C. & Schaer, C., 1998. A precipitation climatology of the Alps from high-resolution rain-gauge observations. *International Journal of Climatology*, **18**, 873--900.

Massacand, A.; Wernli, H. & Davies, H., 1998. Heavy precipitation on the Alpine southside: An upper-level precursor. *Geophysical Research Letters*, **25**, 1435--1438.

1999

Morgenstern, O. & Davies, H., 1999. Disruption of an upper level PV streamer by orographic and cloud diabatic effects. *Beiträge zur Physik der Atmosphäre*, **72**, 173--186.

Schmid, H. & Dörnbrack, A., 1999. Simulation of breaking gravity waves during the south Foehn of January 7-13, 1996. *Beiträge zur Physik der Atmosphäre*, **72**, 287--301.

2000

Buzzi, A. & Foschini, L., 2000. Mesoscale meteorological features associated with heavy precipitation in the southern Alpine region. *Meteorology and Atmospheric Physics*, **72**, 131--146.

Cacciamani, C.; Cesari, D.; Grazzini, F.; Paccagnella, T. & Pantone, M., 2000. Numerical simulation of intense precipitation events south of the Alps: Sensitivity to initial conditions and horizontal resolution. *Meteorology and Atmospheric Physics*, **72**, 147--159.

Chong, M. & Cosma, S., 2000. A formulation of the continuity equation of MUSCAT for either flat or complex terrain. *Journal of Atmospheric and Oceanic Technology*, **17**, 1556--1564.

Chong, M.; Georgis, J.; Bousquet, O.; Brodzik, S.; Burghart, C.; Cosma, S.; Germann, U.; Gouget, V.; Houze Jr, R.; James, C.; Prieur, S.; Rotunno, R.; Roux, F.; Vivekanandan, J. & Zeng, Z., 2000. Real-time wind synthesis from Doppler radar observations during the Mesoscale Alpine Programme. *Bulletin of the American Meteorological Society*, **81**, 2953--2962.

Doyle, J.; Durran, D.; Chen, C.; Colle, B.; Georgelin, M.; Grubisic, V.; Hsu, W.; Huang, C.; Landau, D.; Lin, Y.; Poulos, G.; Sun, W.; Weber, D.; Wurtele, M. & Xue, M., 2000. An intercomparison of model-predicted wave breaking for the 11 January 1972 Boulder windstorm. *Monthly Weather Review*, **128**, 901--914.

Fehlmann, R. & Quadri, C., 2000. Predictability issues of heavy Alpine south-side precipitation. *Meteorology and Atmospheric Physics*, **72**, 223--231.

Fehlmann, R.; Quadri, C. & Davies, H., 2000. An Alpine rainstorm: Sensitivity to the mesoscale upper-level structure. *Weather and Forecasting*, **15**, 4--28.

Ferretti, R.; Lownam, S. & Rotunno, R., 2000. Numerical simulations of the Piedmont flood of 4--6 November 1994. *Tellus A*, **52**, 161--179.

Frei, C.; Davies, H.; Gurtz, J. & Schär, C., 2000. Climate dynamics and extreme precipitation and flood events in Central Europe. *Integrated Assessment*, **1**, 281—299.

Georgis, J.; Roux, F. & Hildebrand, P., 2000. Observation of precipitating systems over complex orography with meteorological Doppler radars: A feasibility study. *Meteorology and Atmospheric Physics*, **72**, 185--202.

Germann, U. & Joss, J., 2000. Spatial continuity of Alpine precipitation. *Physics and Chemistry of the Earth, Series B*, **25**, 903--908.

Hagen, M.; Schiesser, H. & Dorninger, M., 2000. Monitoring of Mesoscale Precipitation Systems in the Alps and the Northern Alpine Foreland by Radar and Rain Gauges. *Meteorology and Atmospheric Physics*, **72**, 87--100.

James, C.; Brodzik, S.; Edmon, H.; Houze Jr, R. & Yuter, S., 2000. Radar data processing and visualization over complex terrain. *Weather and Forecasting*, **15**, 327--338.

Jansa, A.; Genoves, A. & Garcia-Moya, J., 2000. Western Mediterranean cyclones and heavy rain. Part 1: Numerical experiment concerning the Piedmont flood case. *Meteorological Applications*, **7**, 323–-333.

Keil, C. & Volkert, H., 2000. Precipitation in the northern Alpine region: Case-study-type validation of an operational forecast model. *Meteorology and Atmospheric Physics*, **72**, 161--173.

Mladek, R.; Barckicke, J.; Binder, P.; Bougeault, P.; Brzovic, N.; Frei, C.; Geleyn, J.; Hoffman, J.; Ott, W.; Paccagnella, T. & others, 2000. Intercomparison and evaluation of precipitation forecasts for MAP seasons 1995 and 1996. *Meteorology and Atmospheric Physics*, **72**, 111--129.

Pellarin, T.; Delrieu, G.; Creutin, J. & Andrieu, H., 2000. Hydrologic visibility of weather radars operating in high-mountainous regions: A case study for the Toce catchment (Italy) during the Mesoscale Alpine Programme. *Physics and Chemistry of the Earth, Series B*, **25**, 953--957.

Petitdidier, M.; Tabary, P.; Bigorgne, J.; Scialom, G. & Klaus, V., 2000. Integration of the VHF wind profiler data within dual Doppler wind synthesis. *Physics and Chemistry of the Earth, Series B*, **25**, 1195--1199.

Schneidereit, M. & Schär, C., 2000. Idealised numerical experiments of Alpine flow regimes and southside precipitation events. *Meteorology and Atmospheric Physics*, **72**, 233--250.

Stein, J.; Richard, E.; Lafore, J.; Pinty, J.; Asencio, N. & Cosma, S., 2000. High-resolution non-hydrostatic simulations of flash-flood episodes with grid-nesting and ice-phase parameterization. *Meteorology and Atmospheric Physics*, **72**, 203--221.

Steinacker, R.; Häberli, C. & Pцttschacher, W., 2000. A transparent method for the analysis and quality evaluation of irregularly distributed and noisy observational data. *Monthly Weather Review*, **128**, 2303--2316.

Vignal, B.; Galli, G.; Joss, J. & Germann, U., 2000. Three methods to determine profiles of reflectivity from volumetric radar data to correct precipitation estimates. *Journal of Applied Meteorology*, **39**, 1715--1726.

Volkert, H., 2000. Heavy precipitation in the Alpine region (HERA): Areal rainfall determination for flood warnings through in-situ measureme nts, remote sensing and atmospheric modelling. *Meteorology and Atmospheric Physics*, **72**, 73--85.

2001

Baumann, K.; Maurer, H.; Rau, G.; Piringer, M.; Pechinger, U.; Prevot, A.; Furger, M.; Neininger, B. & Pellegrini, U., 2001. The influence of south Foehn on the ozone distribution in the Alpine Rhine valley-results from the MAP field phase. *Atmospheric Environment*, **35**, 6379--6390.

Bougeault, P.; Binder, P.; Buzzi, A.; Dirks, R.; Houze, R.; Kuettner, J.; Smith, R.; Steinacker, R. & Volkert, H., 2001. The MAP special observing period. *Bulletin of the American Meteorological Society*, **82**, 433--462.

Caccia, J.; Aubagnac, J.; Bethenod, G.; Bourdier, C.; Bruzzese, E.; Campistron, B.; Candusso, J.; Cherel, G.; Claeyman, J.; Conrad, J.; Cordesses, R.; Currier, P.; Nederrien, S.; Despaux, G.; Dole, J.; Durbe, J.; Frappier, A.; Ghio, F.; Girard-Ardhuin, F.; Jacoby-Koaly, S.; Klaus, V.; Ney, R.; Pages, J.; Petitdidier, M.; Pointin, Y.; Richard, E.; Seloyan, I.; Smaոni, L. & Wilson, R.,

2001. The French ST-radar network during MAP: Observational and scientic aspects. *Meteorologische Zeitschrift*, **10**, 469--478.

Chong, M. & Bousquet, O., 2001. On the application of MUSCAT to a ground-baseddual-Doppler radar system. *Meteorology and Atmospheric Physics*, **78**, 133--139.

Drobinski, P.; Dabas, A.; Haeberli, C. & Flamant, P., 2001. On the small-scale dynamics of flow splitting in the Rhine Valley during a shallow Foehn event. *Boundary-Layer Meteorology*, **99**, 277--296.

Drobinski, P.; Dusek, J. & Flamant, C., 2001. Diagnostics of hydraulic jump and gap flow in stratified flows over topography. *Boundary-Layer Meteorology*, **98**, 475--495.

Frei, C. & Schär, C., 2001. Detection probability of trends in rare events: Theory and application to heavy precipitation in the Alpine region. *Journal of Climate*, **14**, 1568--1584.

Furger, M.; Drobinski, P.; Prévôt, A.; Weber, R.; Graber, W. & Neininger, B., 2001. Comparison of horizontal and vertical scintillometer crosswinds during strong Foehn with lidar and aircraft measurements. *Journal of Atmospheric and Oceanic Technology*, **18**, 1975--1988.

Germann, U. & Joss, J., 2001. Variograms of radar reflectivity to describe the spatial continuity of apline precipitation. *Journal of Applied Meteorology*, **40**, 1042--1059.

Houze, R.; James, C. & Medina, S., 2001. Radar observations of precipitation and airflow on the Meditteranean side of the Alps: Autumn 1998 and 1999. *Quarterly Journal of the Royal Meteorological Society*, **127**, 2537--2558.

James, C. & House, R., 2001. A real-time four-dimensional doppler dealiasing scheme. *Journal of Atmospheric and Oceanic Technology*, **18**, 1674--1683.

Lin, Y.; Chiao, S.; Wang, T.; Kaplan, M. & Weglarz, R., 2001. Some common ingredients for heavy orographic rainfall. *Weather and Forecasting*, **16**, 633--660.

MARSIGLI, C.; MONTANI, A.; NEROZZI, F.; PACCAGNELLA, T.; TIBALDI, S.; MOLTENI, F. & BUIZZA, R., 2001. A strategy for high-resolution ensemble prediction. II: Limited-area experiments in four Alpine flood events. *Quarterly Journal of the Royal Meteorological Society*, **127**, 2095--2115.

Massacand, A.; Wernli, H. & Davies, H., 2001. Influence of upstream diabatic heating upon an Alpine event of heavy precipitation. *Monthly Weather Review*, **129**, 2822--2828.

Menziani, M.; Pugnaghi, S.; Pilan, L.; Santangelo, R. & Vincenzi, S., 2001. TDR soil moisture measurements at the Lago Maggiore MAP target area: preliminary results. *Physics and Chemistry of the Earth, Series B*, **26**, 431--436.

Miglietta, M. & Buzzi, A., 2001. A numerical study of moist stratified ows over isolated topography. *Tellus, 53A*, 481--499.

Molteni??, F.; Buizza, R.; Marsigli, C.; Montani, A.; Nerozzi, F. & Paccagnella, T., 2001. A strategy for high-resolution ensemble prediction. I: Definition of representative members and global-model experiments. *Quarterly Journal of the Royal Meteorological Society*, **127**, 2069--2094.

Piringer, M.; Baumann, K.; Pechinger, U. & Vogt, S., 2001. Meteorological and ozone sounding experience during a strong Foehn event-a MAP case study. *Meteorologische Zeitschrift*, **10**, 445--455.

Reitebuch, O.; Werner, C. & Leike, I., 2001. Experimental validation of wind profiling performed by the airborne 10-m heterodyne Doppler lidar wind.

2002

Benoit, R.; Schar, C.; Binder, P.; Chamberland, S.; Davies, H.; Desgagne, M.; Girard, C.; Keil, C.; Kouwen, N.; Luthi, D. & others, 2002. The real-time ultrafinescale forecast support during the special observing period of the MAP. *Bulletin of the American Meteorological Society*, **83**, 85--109.

Cassardo, C.; Loglisci, N.; Gandini, D.; Qian, M.; Niu, G.; Ramieri, P.; Pelosini, R. & Longhetto, A., 2002. The flood of November 1994 in Piedmont, Italy: a quantitative analysis and simulation. *Hydrological Processes*, **16**, 1275--1299.

Cherubini, T.; Ghelli, A. & Lalaurette, F., 2002. Verification of precipitation forecasts over the Alpine region using a high-density observing network. *Weather and Forecasting*, **17**, 238--249.

Cosma, S.; Richard, E. & Miniscloux, F., 2002. The role of small-scale orographic features in the spatial distribution of precipitation. *Quarterly Journal of the Royal Meteorological Society*, **128**, 75--92.

Doyle, J.; Volkert, H.; Dцrnbrack, A.; Hoinka, K. & Hogan, T., 2002. Aircraft measurements and numerical simulations of mountain waves over the central Alps: A pre-MAP test case. *Quarterly Journal of the Royal Meteorological Society*, **128**, 2175--2184.

Flamant, C.; Drobinski, P.; Nance, L.; Banta, R.; Darby, L.; Dusek, J.; Hardesty, M.; Pelon, J. & Richard, E., 2002. Gap flow in an Alpine valley during a shallow south fohn event: Observations, numerical simulations and hydraulic analogue. *Quarterly Journal of the Royal Meteorological Society*, **128**, 1173--1210.

Germann, U. & Joss, J., 2002. Mesobeta profiles to extrapolate radar precipitation measurements above the Alps to the ground level. *Journal of Applied Meteorology*, **41**, 542--557.

Germann, U. & Zawadzki, I., 2002. Scale-dependence of the predictability of precipitation from continental radar images. Part I: Description of the methodology. *Monthly Weather Review*, **130**, 2859--2873.

Gheusi, F. & Stein, J., 2002. Lagrangian description of airflows using Eulerian passive tracers. *Quarterly Journal of the Royal Meteorological Society*, **128**, 337--360.

Jasper, K.; Gurtz, J. & Lang, H., 2002. Advanced flood forecasting in Alpine watersheds by coupling meteorological observations and forecasts with a distributed hydrological model. *Journal of Hydrology*, **267**, 40--52.

Mayr, G.; Vergeiner, J. & A., G., 2002. An automobile platform for the measurement of Foehn and gap flows. *Journal of Atmospheric and Oceanic Technology*, **19**, 1545--1556.

Poberaj, G., A. Fix, A. Assion, M. Wirth, C. Kiemle, & G. Ehret, 2002. Airborne all-solid-state DIAL for water vapour measurements in the tropopause region: system description and assessment of accuracy. *Applied Physics B*, **75**, 165-172.

Pradier, S.; Chong, M. & Roux, F., 2002. Radar observations and numerical modeling of a precipitating line during MAP IOP 5. *Monthly Weather Review*, **130**, 2533--2553.

Rubel, F.; Skomorowski, P. & Rudolf, B., 2002. Verification scores for the operational GPCP-1DD product over the European Alps. *Meteorologische Zeitschrift*, **11**, 367--370.

Schmidli, J.; Schmutz, C.; Frei, C.; Wanner, H. & Schaer, C., 2002. Mesoscale precipitation variability in the region of the European Alps during the 20 th century. *International Journal of Climatology*, **22**, 1049--1074.

Schär, C.; Leuenberger, D.; Fuhrer, O.; Lüuhi, D. & Girard, C., 2002. A new terrain-following vertical coordinate formulation for atmospheric prediction models. *Monthly Weather Review*, **130**, 2459--2480.

Smith, R.; Skubis, S.; Doyle, J.; Broad, A.; Kiemle, C. & Volkert, H., 2002. Mountain waves over Mont Blanc: Influence of a stagnant boundary layer. *Journal of the Atmospheric Sciences*, **59**, 2073--2092.

Tabary, P. & Petitdidier, M., 2002. Application of a Bayesian wind profile retrieval technique to radar data collected in the Alpine southern upslope region and comparison with upstream wind profiler measurements. *Journal of Atmospheric and Oceanic Technology*, **19**, 875--887.

Zängl, G., 2002. Idealized numerical simulations of shallow fohn. *Quarterly Journal of the Royal Meteorological Society*, **128**, 431--450.

Zängl, G., 2002: An Improved Method for Computing Horizontal Diffusion in a Sigma-Coordinate Model and Its Application to Simulations over Mountainous Topography. *Monthly Weather Review,* **130**, 1423–1432.

2003

Ahrens, B., 2003. Evaluation of precipitation forecasting with the limited area model ALADIN in an Alpine watershed. *Meteorologische Zeitschrift*, **12**, 245--255.

Ahrens, B.; Jasper, K. & Gurtz, J., 2003. On ALADIN precipitation modeling and validation in an Alpine watershed. *Annales Geophysicae*, **21**, 627--637.

Asencio, N.; Stein, J.; Chong, M. & Gheusi, F., 2003. Analysis and simulation of local and regional conditions for the rainfall over the Lago Maggiore Target Area during MAP IOP 2b. *Quarterly Journal of the Royal Meteorological Society*, **129**, 565--586.

Bacchi, B. & Ranzi, R., 2003. Hydrological and meteorological aspects of floods in the Alps: an overview. *Hydrology and Earth System Sciences*, **7**, 785--798.

Balestri, L.; Boccolari, M.; Fazlagic, S.; Pugnaghi, S. & Santangelo, R., 2003. Detection of meteorological inconsistencies by GPS. *Annals of Geophysics*, **46**, 197--203.

Bencetic-Klaic, Z.; Belusic, D.; Grubisic, V.; Gabela, L. & Coso, L., 2003. Mesoscale airflow structure over the norther Croatian coast during MAP IOP 15 -- A major bora event. *Geofizika*, **20**, 23--61.

Benoit, R.; Kouwen, N.; Yu, W.; Chamberland, S. & Pellerin, P., 2003. Hydrometeorological aspects of the real-time ultrafinescale forecast support during the special observing period of the MAP. *Hydrology and Earth System Sciences*, **7**, 877--889.

Bolliger, M.; Binder, P. & Rossa, A., 2003. Tracking cloud patterns by METEOSAT rapid scan imagery in complex terrain. *Meteorologische Zeitschrift*, **12**, 73--80.

Bousquet, O. & Smull, B., 2003. Airflow and precipitation fields within deep Alpine valleys observed by airborne Doppler radar. *Journal of Applied Meteorology*, **42**, 1497--1513.

Bousquet, O. & Smull, B., 2003. Observations and impacts of upstream blocking during a widespread orographic precipitation event. *Quarterly Journal of the Royal Meteorological Society*, **129**, 391--409.

Buzzi, A.; D'Isidoro, M. & Davolio, S., 2003. A case-study of an orographic cyclone south of the Alps during the MAP SOP. *Quarterly Journal of the Royal Meteorological Society*, **129**, 1795--1818.

Corazza, M.; Buzzi, A.; Sacchetti, D.; Trovatore, E. & Ratto, C., 2003. Simulating extreme precipitation with a mesoscale forecast model. *Meteorology and Atmospheric Physics*, **83**, 131--143.

Dabas, A.; Drobinski, P.; Reitebuch, O.; Richard, E.; Delville, P.; Flamant, P. & Werner, C., 2003. Multi-scale analysis of a straight jet streak using numerical analyses and an airborne Doppler lidar. *Geophysical Research Letters*, **30**, 1049--1049.

Doyle, J. & Smith, R., 2003. Mountain waves over the Hohe Tauern: Influence of upstream diabatic effects. *Quarterly Journal of the Royal Meteorological Society*, **129**, 799--823.

Drobinski, P.; Dabas, A.; Haeberli, C. & Flamant, P., 2003. Statistical characterization of the flow structure in the Rhine Valley. *Boundary Layer Meteorology*, **106**, 483--505.

Drobinski, P.; Haeberli, C.; Richard, E.; Lothon, M.; Dabas, A.; Flamant, P.; Furger, M. & Steinacker, R., 2003. Scale interaction processes during the MAP IOP 12 south fohn event in the Rhine Valley. *Quarterly Journal of the Royal Meteorological Society*, **129**, 729--753.

Durran, D.; Maric, T.; Banta, R.; Darby, L. & Hardesty, R., 2003. A comparison of ground-based Doppler lidar and airborne in situ wind observations above complex terrain. *Quarterly Journal of the Royal Meteorological Society*, **129**, 693--713.

Faccani, C.; Ferretti, R. & Visconti, G., 2003. High-resolution weather forecasting over complex orography: Sensitivity to the assimilation of conventional data. *Monthly Weather Review*, **131**, 136--154.

Ferretti, R.; Paolucci, T.; Giuliani, G.; Cherubini, T.; Bernardini, L. & Visconti, G., 2003. Verification of high-resolution real-time forecasts over the Alpine region during the MAP SOP. *Quarterly Journal of the Royal Meteorological Society*, **129**, 587--607.

Frei, C.; Christensen, J.; Déqué, M.; Jacob, D.; Jones, R. & Vidale, P., 2003. Daily precipitation statistics in regional climate models: Evaluation and intercomparison for the European Alps. *Journal of Geophysical Research (Atmospheres*, **108**, 9-1--9-19.

Frioud, M.; Mitev, V.; Matthey, R.; Haberli, C.; Richner, H.; Werner, R. & Vogt, S., 2003. Elevated aerosol stratification above the Rhine Valley under strong anticyclonic conditions. *Atmospheric Environment*, **37**, 1785--1797.

Georgis, J.; Roux, F.; Chong, M. & Pradier, S., 2003. Triple-Doppler radar analysis of the heavy rain event observed in the Lago Maggiore region during MAP IOP 2b. *Quarterly Journal of the Royal Meteorological Society*, **129**, 495--522.

Gheusi, F. & Stein, J., 2003. Small-scale rainfall mechanisms for an idealized convective southerly flow over the Alps. *Quarterly Journal of the Royal Meteorological Society*, **129**, 1819--1840.

Grossi, G. & Falappi, L., 2003. Comparison of energy fluxes at the land surface-atmosphere interface in an Alpine valley as simulated with different models. *Hydrology and Earth System Sciences*, **7**, 920--936.

Hagen, M. & Yuter, S., 2003. Relations between radar reflectivity, liquid-water content, and rainfall rate during the MAP SOP. *Quarterly Journal of the Royal Meteorological Society*, **129**, 477--493.

Hoinka, K.; Richard, E.; Poberaj, G.; Busen, R.; Caccia, J.; Fix, A. & Mannstein, H., 2003. Analysis of a potential-vorticity streamer crossing the Alps during MAP IOP 15 on 6 November 1999. *Quarterly Journal of the Royal Meteorological Society*, **129**, 609--632.

Ivancan-Picek, B. & others, 2003. Analysis and Aladin prediction of a heavy precipitation event on the Eastern side of the Alps during Map IOP 5. *Meteorologische Zeitschrift*, **12**, 103--112.

Jasper, K. & Kaufmann, P., 2003. Coupled runoff simulations as validation tools for atmospheric models at the regional scale. *Quarterly Journal of the Royal Meteorological Society*, **129**, 673–-692.

Jaubert, G. & Stein, J., 2003. Multiscale and unsteady aspects of a deep fohn event during MAP. *Quarterly Journal of the Royal Meteorological Society*, **129**, 755--776.

JIANG, Q., 2003. Moist dynamics and orographic precipitation. *Tellus A*, **55**, 301--316.

Jiang, Q.; Smith, R. & Doyle, J., 2003. The nature of the mistral: Observations and modelling of two MAP events. *Quarterly Journal of the Royal Meteorological Society*, **129**, 857--875.

Kaufmann, P.; Schubiger, F. & Binder, P., 2003. Precipitation forecasting by a mesoscale numerical weather prediction (NWP) model: eight years of experience. *Hydrology and Earth System Sciences*, **7**, 812--832.

Liniger, M. & Davies, H., 2003. Substructure of a MAP streamer. *Quarterly Journal of the Royal Meteorological Society*, **129**, 633--651.

Lothon, M.; Druilhet, A.; Bénech, B.; Campistron, B.; Bernard, S. & Said, F., 2003. Experimental study of five fohn events during the Mesoscale Alpine Programme: From synoptic scale to turbulence. *Quarterly Journal of the Royal Meteorological Society*, **129**, 2171--2193.

Matzinger, N.; Andretta, M.; van Gorsel, E.; Vogt, R.; Ohmura, A. & Rotach, M., 2003. Surface radiation budget in an Alpine valley. *Quarterly Journal of the Royal Meteorological Society*, **129**, 877--895.

Medina, S. & Houze Jr, R., 2003. Air motions and precipitation growth in Alpine storms. *Quarterly Journal of the Royal Meteorological Society*, **129**, 345--371.

Menziani, M.; Pugnaghi, S.; Vincenzi, S. & Santangelo, R., 2003. Soil moisture monitoring in the Toce valley (Italy). *Hydrology and Earth System Sciences*, **7**, 890--902.

Montaldo, N.; Toninelli, V.; Albertson, J.; Mancini, M. & Troch, P., 2003. The effect of background hydrometeorological conditions on the sensitivity of evapotranspiration to model parameters: Analysis with measurements from an Italian Alpine catchment. *Hydrology and Earth System Sciences*, **7**, 848--861.

Pullen, J.; Doyle, J.; Hodur, R.; Ogston, A.; Book, J.; Perkins, H. & Signell, R., 2003. Coupled ocean-atmosphere nested modeling of the Adriatic Sea during winter and spring 2001. *Journal of Geophysical Research*, **108**, 3320.

Ranzi, R.; Bacchi, B. & Grossi, G., 2003. Runoff measurements and hydrological modelling for the estimation of rainfall volumes in an Alpine basin. *Quarterly Journal of the Royal Meteorological Society*, **129**, 653--672.

Reitebuch, O.; Volkert, H.; Werner, C.; Dabas, A.; Delville, P.; Drobinski, P.; Flamant, P. & Richard, E., 2003. Determination of airflow across the Alpine ridge by a combination of airborne Doppler lidar, routine radiosounding and numerical simulation. *Quarterly Journal of the Royal Meteorological Society*, **129**, 715--727.

Richard, E.; Cosma, S.; Benoit, R.; Binder, P.; Buzzi, A. & Kaufmann, P., 2003. Intercomparison of mesoscale meteorological models for precipitation forecasting. *Hydrology and Earth System Sciences*, **7**, 799--811.

Richard, E.; Cosma, S.; Tabary, P.; Pinty, J. & Hagen, M., 2003. High-resolution numerical simulations of the convective system observed in the Lago Maggiore area on 17 September 1999 (MAP IOP 2a). *Quarterly Journal of the Royal Meteorological Society*, **129**, 543--563.

Ross, A. & Vosper, S., 2003. Numerical simulations of stably stratified flow through a mountain pass. *Quarterly Journal of the Royal Meteorological Society*, **129**, 97—115.

Rotunno, R. & Ferretti, R., 2003. Orographic effects on rainfall in MAP cases IOP 2b and IOP 8. *Quarterly Journal of the Royal Meteorological Society*, **129**, 373--390.

Schär, C.; Sprenger, M.; Lüthi, D.; Jiang, Q.; Smith, R. & Benoit, R., 2003. Structure and dynamics of an Alpine potential-vorticity banner. *Quarterly Journal of the Royal Meteorological Society*, **129**, 825--855.

Seity, Y.; Soula, S.; Tabary, P. & Scialom, G., 2003. The convective storm system during IOP 2a of MAP: Cloud-to-ground lightning flash production in relation to dynamics and microphysics. *Quarterly Journal of the Royal Meteorological Society*, **129**, 523—542.

Smith, R., 2003. A linear upslope-time-delay model for orographic precipitation. *Journal of Hydrology*, **282**, 2--9.

Smith, R.; Jiang, Q.; Fearon, M.; Tabary, P.; Dorninger, M.; Doyle, J. & Benoit, R., 2003. Orographic precipitation and air mass transformation: An Alpine example. *Quarterly Journal of the Royal Meteorological Society*, **129**, 433--454.

Smith, S. & Broad, A., 2003. Horizontal and temporal variability of mountain waves over Mont Blanc. *Quarterly Journal of the Royal Meteorological Society*, **129**, 2195--2216.

Soula, S.; Chauzy, S.; Chong, M.; Coquillat, S.; Georgis, J.; Seity, Y. & Tabary, P., 2003. Surface precipitation electric current produced by convective rains during the Mesoscale Alpine Program. *Journal of Geophysical Research Atmospheres*, **108**, 10-1--10-17.

Steiner, M.; Bousquet, O.; Houze Jr, R.; Smull, B. & Mancini, M., 2003. Airflow within major Alpine river valleys under heavy rainfall. *Quarterly Journal of the Royal Meteorological Society*, **129**, 411--432.

Van Gorsel, E.; Christen, A.; Feigenwinter, C.; Parlow, E. & Vogt, R., 2003. Daytime turbulence statistics above a steep forested slope. *Boundary-Layer Meteorology*, **109**, 311--329.

Volkert, H.; Keil, C.; Kiemle, C.; Poberaj, G.; Chaboureau, J. & Richard, E., 2003. Gravity waves over the eastern Alps: A synopsis of the 25 October 1999 event (IOP 10) combining in situ and remote-sensing measurements with a high-resolution simulation. *Quarterly Journal of the Royal Meteorological Society*, **129**, 777--797.

Yuter, S. & Houze Jr, R., 2003. Microphysical modes of precipitation growth determined by S-band vertically pointing radar in orographic precipitation during MAP. *Quarterly Journal of the Royal Meteorological Society*, **129**, 455--476.

Zappa, M. & Gurtz, J., 2003. Simulation of soil moisture and evapotranspiration in a soil profile during the 1999 MAP-Riviera Campaign. *Hydrology and Earth System Sciences*, **7**, 903--919.

Zängl, G., 2003. Deep and shallow south Foehn in the region of Innsbruck: Typical features and semi-idelized numerical simulations. *Meteorology and Atmospheric Physics*, **83**, 237--261.

2004

Baumann-Stanzer, K. & Groehn, I., 2004. Alpine radiosoundings-feasible for mixing height Determination? *Meteorologische Zeitschrift*, **13**, 131--142.

Baumann-Stanzer, K. & Piringer, M., 2004. Foehn signals detected by sodar wind and turbulence measurements in the Rhine Valley, Austria, during the MAP field phase. *Meteorology and Atmospheric Physics*, **85**, 125--139.

Beck, A. & Ahrens, B., 2004. Multiresolution evaluation of precipitation forecasts over the European Alps. *Meteorologische Zeitschrift*, **13**, 55--62.

Beffrey, G.; Jaubert, G. & Dabas, A., 2004. Fo¨ hn flow and stable air mass in the Rhine valley: The beginning of a MAP event. *Quarterly Journal of the Royal Meteorological Society*, **130**, 541--560.

Beffrey, G.; JaubertT, G. & Dabas, A., 2004. Spatial evolution of Foehn flows in the Rhine Valley area: quantification using high resolution simulations. *Meteorologische Zeitschrift*, **13**, 77--82.

Belusic, D. & Klaic, Z., 2004. Estimation of bora wind gusts using a limited area model. *Tellus*, **56**, 296--307.

Bolliger, M.; Binder, P.; Roesli, H. & Wanner, H., 2004. Satellite-and radar-based investigations of heavy precipitation systems on the southern side of the European Alps. *Meteorology and Atmospheric Physics*, **87**, 219--234.

Buzzi, A.; Davolio, S.; D'Isidoro, M. & Malguzzi, P., 2004. The impact of resolution and of MAP reanalysis on the simulations of heavy precipitation during MAP cases. *Meteorologische Zeitschrift*, **13**, 91--97.

Chiao, S.; Lin, Y. & Kaplan, M., 2004. Numerical Study of the Orographic Forcing of Heavy Precipitation during MAP IOP-2B. *Monthly Weather Review*, **132**, 2184--2203.

Davolio, S. & Buzzi, A., 2004. A nudging scheme for the assimilation of precipitation data into a mesoscale model. *Weather and Forecasting*, **19**, 855--871.

Flamant, C.; Richard, E.; Schaer, C.; Rotunno, R.; Nance, L.; Sprenger, M. & Benoit, R., 2004. The wake south of the Alps: Dynamics and structure of the lee-side flow and secondary potential vorticity banners. *Quarterly Journal of the Royal Meteorological Society*, **130**, 1275--1303.

Frioud, M.; Mitev, V.; Matthey, R.; Richner, H.; Furger, M. & Gubser, S., 2004. Variation of the aerosol stratification over the Rhine Valley during Foehn development: a backscatter lidar study. *Meteorologische Zeitschrift*, **13**, 175--181.

Gheusi, F. & Davies, H., 2004. Autumnal precipitation distribution on the southern flank of the Alps: A numerical-model study of the mechanisms. *Quarterly Journal of the Royal Meteorological Society*, **130**, 2125--2152.

Gohm, A. & Mayr, G., 2004. Hydraulic aspects of Foehn winds in an Alpine valley. *Quarterly Journal of the Royal Meteorological Society*, **130**, 449--480.

Gohm, A.; Zängl, G. & Mayr, G., 2004. South Foehn in the Wipp Valley on 24 October 1999 (MAP-IOP 10): Verification of High-Resolution Numerical Simulations with Observations. *Monthly Weather Review*, **132**, 78--102.

Grubisic, V., 2004. Bora-driven potential vorticity banners over the Adriatic. *Quarterly Journal of the Royal Meteorological Society*, **130**, 2571--2603.

Hoinka, K. & Zängl, G., 2004. The influence of the vertical coordinate on simulations of a PV streamer crossing the Alps. *Monthly Weather Review*, **132**, 1860--1867.

Häberli, C.; Groehn, I.; Steinacker, R.; Pцttschacher, W. & Dorninger, M., 2004. Performance of the surface observation network during MAP. *Meteorologische Zeitschrift*, **13**, 109--121.

Ivatek-Sahdan, S. & Tudor, M., 2004. Use of high-resolution dynamical adaptation in operational suite and research impact studies. *Meteorologische Zeitschrift*, **13**, 99--108.

Jiang, Q. & Doyle, J., 2004. Gravity wave breaking over the central Alps: Role of complex terrain. *Journal of the Atmospheric Sciences*, **61**, 2249--2266.

Keil, C. & Cardinali, C., 2004. The ECMWF reanalysis of the MAP Special Observing Period. *Quarterly Journal of the Royal Meteorological Society*, **130**, 2827–-2849.

Kirshbaum, D. & Durran, D., 2004. Factors governing cellular convection in orographic precipitation. *Journal of the Atmospheric Sciences*, **61**, 682--698.

Lascaux, F.; Richard, E.; Keil, C. & Bock, O., 2004. Impact of the MAP reanalysis on the numerical simulation of the MAP-IOP2a convective system. *Meteorologische Zeitschrift*, **13**, 49--54.

Mayr, G.; Armi, L.; Arnold, S.; Banta, R.; Darby, L.; Durran, D.; Flamant, C.; Gabersek, S.; Gohm, A.; Mayr, R. & others, 2004. Gap flow measurements during the Mesoscale Alpine Programme. *Meteorology and Atmospheric Physics*, **86**, 99--119.

Miglietta, M. & Buzzi, A., 2004. A numerical study of moist stratified flow regimes over isolated topography. *Quarterly Journal of the Royal Meteorological Society*, **130**, 1749--1770.

Pradier, S.; Chong, M. & Roux, F., 2004. Characteristics of some frontal stratiform precipitation events south of the alpine chain during MAP. *Meteorology and Atmospheric Physics*, **87**, 197--218.

Rakovec, J.; Gabersek, S. & Vrhovec, T., 2004. Relief shapes and precipitation on the south side of the Alps-Part I: Relief characteristics and dry sensitivity simulations. *Meteorologische Zeitschrift*, **13**, 83--90.

Rotach, M.; Calanca, P.; Graziani, G.; Gurtz, J.; Steyn, D.; Vogt, R.; Andretta, M.; Christen, A.; Cieslik, S.; Connolly, R. & others, 2004. Turbulence structure and exchange processes in an Alpine valley: The Riviera project. *Bulletin of the American Meteorological Society*, **85**, 1367--1385.

Smith, S., 2004. Observations and simulations of the 8 November 1999 MAP mountain wave case. *Quarterly Journal of the Royal Meteorological Society*, **130**, 1305--1325.

Soula, S.; Seity, Y.; Feral, L. & Sauvageot, H., 2004. Cloud-to-ground lightning activity in hail-bearing storms. *Journal of Geophysical Research*, **109**, 2101--2101.

Stein, J., 2004. Exploration of some convective regimes over the Alpine orography. *Quarterly Journal of the Royal Meteorological Society*, **130**, 481–-502.

Vogt, S. & JAUBERT, G., 2004. Numerical errors above steep topography: A model intercomparison. *Meteorologische Zeitschrift*, **13**, 165--174.

Vrhovec, T.; Rakovec, J.; Gabersek, S.; Skok, G.; Zabkar, R. & Gegoric, G., 2004. Relief shapes and precipitation on the south side of the Alps-Part II: Heavy-rain cases during MAP and sensitivity to topography modifications. *Meteorologische Zeitschrift*, **13**, 201--208.

Vrhovec, T.; Rakovec, J. & Gregoric, G., 2004. Mesoscale diagnostics of prefrontal and frontal precipitation in the Southeast Alps during MAP IOP 5. *Meteorology and Atmospheric Physics*, **86**, 15--29.

Walser, A.; Lüthi, D. & Schär, C., 2004. Predictability of precipitation in a cloud-resolving model. *Monthly Weather Review*, **132**, 560--577.

Walser, A. & Schär, C., 2004. Convection-resolving precipitation forecasting and its predictability in Alpine river catchments. *Journal of Hydrology*, **288**, 57--73.

Weigel, A. & Rotach, M., 2004. Flow structure and turbulence characteristics of the daytime atmosphere in a steep and narrow Alpine valley. *Quarterly Journal of the Royal Meteorological Society*, **130**, 2605--2627.

Weissmann, M.; Mayr, G.; Banta, R. & Gohm, A., 2004. Observations of the temporal evolution and spatial structure of the gap flow in the Wipp valley on 2 and 3 October 1999. *Monthly Weather Review*, **132**, 2684--2697.

Zagar, M.; Pristov, N. & Rakovec, J., 2004. A diagnostic method for high-resolution precipitation prediction using dynamically adapted vertical velocities. *Meteorology and Atmospheric Physics*, **85**, 187--204.

Zängl, G., 2004. Numerical simulations of the Foehn in the Rhine Valley on 24 October 1999 (MAP IOP 10). *Monthly Weather Review*, **132**, 368--389.

Zängl, G., 2004. The sensitivity of simulated orographic precipitation to model components other than cloud microphysics. *Quarterly Journal of the Royal Meteorological Society*, **130**, 1857--1875.

Zängl, G.; Gantner, L.; Hartjenstein, G. & Noppel, H., 2004. Numerical errors above steep topography: A model intercomparison. *Meteorologische Zeitschrift*, **13**, 69--76.

Zängl, G.; Gohm, A. & Geier, G., 2004. South Foehn in the Wipp Valley--Innsbruck region: Numerical simulations of the 24 October 1999 case (MAP-IOP 10). *Meteorology and Atmospheric Physics*, **86**, 213--243.

2005

Barstad, I. & Smith, R., 2005. Evaluation of an Orographic Precipitation Model. *Journal of Hydrometeorology*, **6**, 85--99.

Bock, O.; Keil, C.; Richard, E.; Flamant, C. & Bouin, M., 2005. Validation of precipitable water from ECMWF model analyses with GPS and radiosonde data during the MAP SOP. *Quarterly Journal of the Royal Meteorological Society*, **131**, 3013–-3036.

Chen, S. & Lin, Y., 2005. Orographic effects on a conditionally unstable flow over an idealized three-dimensional mesoscale mountain. *Meteorology and Atmospheric Physics*, **88**, 1--21.

Chen, S.; Lin, Y.; Chen, S. & Lin, Y., 2005. Effects of moist froude number and CAPE on a conditionally unstable flow over a mesoscale mountain ridge. *Journal of the Atmospheric Sciences*, **62**, 331--350.

De Wekker, S.; Steyn, D.; Fast, J.; Rotach, M. & Zhong, S., 2005. The performance of RAMS in representing the convective boundary layer structure in a very steep valley. *Environmental Fluid Mechanics*, **5**, 35--62.

D'Aulerio, P.; Fierli, F.; Congeduti, F. & Redaelli, G., 2005. Analysis of water vapor LIDAR measurements during the MAP campaign: evidence of sub-structures of stratospheric intrusions. *Atmoapheric Chemistry and Physics*, **5**, 1301--1310.

Faccani, C. & Ferretti, R., 2005. Data assimilation of high density observations: Part I. Impact on Initial Conditions for the MAP/SOP IOP2b. *Quarterly Journal of the Royal Meteorological Society*, **131**, 21--42.

Ferretti, R. & Faccani, C., 2005. Data assimilation of high density observations: Part II. Impact on the forecast of the precipitation for the MAP/SOP IOP2b. *Quarterly Journal of the Royal Meteorological Society*, **131**, 43--62.

Fuhrer, O. & Schär, C., 2005. Embedded cellular convection in moist flow past topography. *Journal of Atmospheric Sciences*, **62**, 2810--2828.

Girard, C.; Benoit, R. & Desgagne, M., 2005. Finescale topography and the MC 2 dynamics kernel. *Monthly Weather Review*, **133**, 1463--1477.

Guenard, V.; Drobinski, P.; Caccia, J.; Campistron, B. & Bench, B., 2005. An observational study of the mesoscale mistral dynamics. *Boundary-Layer Meteorology*, **115**, 263--288.

Houze, R.A., and S. Medina, 2005: Turbulence as a Mechanism for Orographic Precipitation Enhancement. *Journal of the atmospheric sciences,* **62**, 3599–3623.

Jaubert, G.; Bougeault, P.; Berger, H.; Chimani, B.; Flamant, C.; Haeberli, C.; Lothon, M.; Nuret, M. & Vogt, S., 2005. Numerical simulation of meso-gamma scale features of Foehn at ground level in the Rhine valley. *Quarterly Journal of the Royal Meteorological Society*, **131**, 1339--1361.

Jiang, Q., and J. D. Doyle, 2005. Wave breaking induced surface wakes and jets observed during a bora event, *Geophysical Research Letters*, **32**, L17807, 1-5.

Jiang, Q.; Doyle, J. & Smith, R., 2005. Blocking, descent and gravity waves: Observations and modelling of a MAP northerly Foehn event. *Quarterly Journal of the Royal Meteorological Society*, **131**, 675--701.

Lin, Y.; Reeves, H.; Chen, S. & Chiao, S., 2005. Formation mechanisms for convection over the ligurian sea during MAP IOP-8. *Monthly Weather Review*, **133**, 2227--2245.

Medina, S.; Smull, B. & Houze, R., 2005. Cross-barrier flow during orographic precipitation events: Results from MAP and IMPROVE. *Journal of the Atmospheric Sciences*, **62**, 3580--3598.

Nuret, M.; Lafore, J.; Gouget, V. & Ducrocq, V., 2005. Mesoscale analysis and impact on simulation of IOP14 of the MAP experiment. *Quarterly Journal of the Royal Meteorological Society*, **131**, 2769–2793.

Pujol, O.; Georgis, J.; Chong, M. & Roux, F., 2005. Dynamics and microphysics of orographic precipitation during MAP IOP3. *Quarterly Journal of the Royal Meteorological Society*, **131**, 2795–2819.

2006

Asencio, N. & Stein, J., 2006. Origins of the reversed flow over the windward Alpine foothills during MAP IOP3 and IOP8. *Quarterly Journal of the Royal Meteorological Society*, **132**, 297--316.

Boudevillain, B.; Andrieu, H. & Chaumerliac, N., 2006. Evaluation of RadVil, a radar-based very short-term rainfall forecasting model. *Journal of Hydrometeorology*, **7**, 178--189.

Bousquet, O. & Smull, B., 2006. Observed mass transports accompanying upstream orographic blocking during MAP IOP8. *Quarterly Journal of the Royal Meteorological Society*, **132**, 2393--2413.

Chow, F.; Weigel, A.; Street, R.; Rotach, M. & Xue, M., 2006. High-Resolution large-eddy simulations of flow in a steep Alpine valley. Part I: Methodology, verification, and sensitivity experiments. *Journal of Applied Meteorology and Climatology*, **45**, 63--86.

Doyle, J. D., & Q. Jiang, 2006. Observations and numerical simulations of mountain waves in the presence of directional wind shear. *Quarterly Journal of the Royal Meteorological Society*, **132**, 1877-1905.

Drobinski, P.; Bastin, S.; Dusek, J.; Zängl, G. & Flamant, P., 2006. Flow splitting at the bifurcation between two valleys: idealized simulations in comparison with Mesoscale Alpine Programme observations. *Meteorology and Atmospheric Physics*, **92**, 285--306.

Flamant, C., P. Drobinski, M. Furger, B. Chimani, S. Tschannett, R. Steinacker, A. Protat, H. Richner, S. Gubser, & C. Häberli, 2006. Foehn/cold-pool interactions in the Rhine valley during MAP IOP 15. *Quarterly Journal of the Royal Meteorological Society*, **132**, 3035-3058.

Germann, U.; Galli, G.; Boscacci, M. & Bolliger, M., 2006. Radar precipitation measurement in a mountainous region. *Quarterly Journal of the Royal Meteorological Society*, **132**, 1669–-1692.

Guidard, V.; Fischer, C.; Nuret, M. & Dziedzic, A., 2006. Evaluation of the ALADIN 3D-VAR with observations of the MAP campaign. *Meteorology and Atmospheric Physics*, **92**, 161--173.

Guénard, V.; Drobinski, P.; Caccia, J.; Tedeschi, G. & Currier, P., 2006. Dynamics of the MAP IOP 15 severe Mistral event: Observations and high-resolution numerical simulations. *Quarterly Journal of the Royal Meteorological Society*, **132**, 757–-777.

Haeberli, C., 2006. Assessment, correction and impact of the dry bias in radiosonde humidity data during the MAP SOP. *Quarterly Journal of the Royal Meteorological Society*, **132**, 2827–-2852.

Hoggarth, A., 2006. Formation and maintenance mechanisms of the stable layer over the Po Valley during MAP IOP-8. *Monthly Weather Review*, **134**, 3336–-3354.

Hohenegger, C.; Lüthi, D. & Schär, C., 2006. Predictability mysteries in cloud-resolving models. *Monthly Weather Review*, **134**, 2095--2107.

Hoinka, K.; Schwierz, C. & Martius, O., 2006. Synoptic-scale weather patterns during Alpine heavy rain events. *Quarterly Journal of the Royal Meteorological Society*, **132**, 2853–-2860.

Jiang, Q., J.D. Doyle, and R.B. Smith, 2006: Interaction between Trapped Waves and Boundary Layers. *Journal of the Atmospheric Sciences*, **63**, 617–633.

Lascaux, F.; Richard, E. & Pinty, J., 2006. Numerical simulations of three different MAP IOPs and the associated microphysical processes. *Quarterly Journal of the Royal Meteorological Society*, **132**, 1907–-1926.

Martius, O.; Zenklusen, E.; Schwierz, C. & Davies, H., 2006. Episodes of Alpine heavy precipitation with an overlying elongated stratospheric intrusion: A Climatology. *International Journal of Climatology*, **26**, 1149–-1164.

Reeves, H. & Lin, Y., 2006. Effect of stable layer formation over the Po valley on the development of convection during MAP IOP-8. *Journal of the Atmospheric Sciences*, **63**, 2567--2584.

Richner, H.; Baumann-Stanzer, K.; Benech, B.; Berger, H.; Chimani, B.; Dorninger, M.; Drobinski, P.; Furger, M.; Gubser, S.; Gutermann, T. & others, 2006. Unstationary aspects of Foehn in a large valley part I: operational setup, scientific objectives and analysis of the cases during the special observing period of the MAP subprogramme FORM. *Meteorology and Atmospheric Physics*, **92**, 255--284.

Smith, R.B., Q. Jiang, and J.D. Doyle, 2006: A Theory of Gravity Wave Absorption by a Boundary Layer. *Journal of the Atmospheric Sciences*, **63**, 774–781.

Smith, S.; Doyle, J.; Brown, A. & Webster, S., 2006. Sensitivity of resolved mountain drag to model resolution for MAP case-studies. *Quarterly Journal of the Royal Meteorological Society*, **132**, 1467–-1487.

Weigel, A.; Chow, F.; Rotach, M.; Street, R. & Xue, M., 2006. High-resolution large-eddy simulations of flow in a steep Alpine valley. Part II: Flow structure and heat budgets. *Journal of Applied Meteorology*, **45**, 87–-107.

Zagar, N.; Zagar, M.; Cedilnik, J.; Gregoric, G. & Rakovec, J., 2006. Validation of mesoscale low-level winds obtained by dynamical downscaling of ERA40 over complex terrain. *Tellus A*, **58**, 445--455.

Zängl, G. and A. Gohm, 2006. Small-scale dynamics of the south Foehn in the lower Wipp Valley. *Meteorology and Atmospheric Physics*, **93**, 79-95.

Zängl, G. and R. Vogt, 2006. Valley-wind characteristics in the Alpine Rhine Valley: measurements with a wind-temperature profiler in comparison with numerical simulations. *Meteorologische Zeitschrift*, **15**, 179-186.

References of the MAP overview articles to appear in the Quart. J. Roy. Met. Soc. 2007

Drobinski P, Steinacker R, Richner H, Baumann-Stanzer K, Beffrey G, Berger H, Chimani B, Dabas A, Dorninger M, Urr BD, Flamant C, Frioud M, Grohn I, Gubser S, Gutermann T, Häberli C, Aller-Scharnhorst H, Jaubert G, Lothon M, Mitev V, Pechinger U, Piringer M, Ratheiser M, Ruffieux D, Seiz G, Spazierer M, Tschanett S, Vogt S, Werner R, Zängl G. 2007. Föhn in the Rhine valley during MAP: Reviewing its unstationary aspects in a complex valley geometry. *Q. J. R. Meteorol. Soc.* **133**, 897-916.

Hoinka KP, Davies HC. 2007. Upper-tropospheric flow features and the Alps: An overview. *Q. J. R. Meteorol. Soc.* **133**, 847-865.

Mayr GJ, Armi L, Gohm A, Zängl G, Durran DR, Flamant C, Gaberšek S, Mobbs S, Ross A, Weissmann M. 2007. Gap flows: Results from the Mesoscale Alpine Programme. *Q. J. R. Meteorol. Soc.* **133**, 881-896.

Ranzi R, Zappa M, Bacchi B. 2007. Hydrological aspects of the Mesoscale Alpine Programme: Findings from field experiments and simulations. *Q. J. R. Meteorol. Soc.* **133**, 867-880.

Richard E, Buzzi A, Zängl G. 2007. Quantitative precipitation forecasting in the Alps: The push ahead obtained by the Mesoscale Alpine Programme. *Q. J. R. Meteorol. Soc.* **133**, 831-846.

Rotach MW, Zardi D. 2007. The boundary layer structure over highly complex terrain: Key findings from MAP. *Q. J. R. Meteorol. Soc.* **133**, 937-948.

Rotunno R, Houze RA. 2007. Lessons on orographic precipitation from the Mesoscale Alpine Programme. *Q. J. R. Meteorol. Soc.* **133**, 811-830.

Smith RB, Doyle JD, Jiang Q, Smith SA. 2007. Alpine gravity waves: Lessons from MAP regarding mountain wave generation and breaking. *Q. J. R. Meteorol. Soc.* **133**, 917-936.

Volkert H, Gutermann T. 2007. Inter-domain cooperation for mesoscale atmospheric laboratories: The Mesoscale Alpine Programme as a rich study case. . *Q. J. R. Meteorol. Soc.* **133**, 949-967.

7.5 MAP-NWS Contract Text

7.5.1 Contract for 1. Phase

CONTRACT Mesoscale Alpine Programme of National Weather Services (MAP-NWS)

BETWEEN

Zentralanstalt für Meteorologie und Geodynamik (ZAMG), represented by its Director, P. Steinhauser, Hohe Warte 28, A-1190 Wien, changing to Swiss Meteorological Institute (SMI), represented by its Director Th. Gutermann, after SMI has become EUMETNET member

AND THE NATIONAL METEOROLOGICAL SERVICES

- France, represented by J.-P. Beysson
- Germany, represented by U. Gärtner,
- Greece, represented by G. Nikolakakos,
- Italy, represented by C. Finizio,
- Spain, represented by M. Prieto-Laffargue,
- Switzerland, represented by Th. Gutermann.

Definitions

For the purposes of this Contract the following words and expressions will have the following meaning respectively:

- Member: participants in this development venture of MAP-NWS
- MAP-NWS: Mesoscale Alpine Programme of National Weather Services
- MAP: Mesoscale Alpine Programme
- MPO: MAP Programme Office; co-ordination office of MAP, hosted at the Swiss Meteorological Institute, [one full-time scientist affiliated]
- MDC: MAP Data Centre; central management of MAP-related data, hosted at the Institute of Atmospheric Science, Federal Institute of Technology (ETH) Zurich, [two data managers planned]
- NWS: National Weather Service

WHEREAS

- MAP is an international research venture with strong links to weather forecasting applications and will be based on contributions from research institutions as well as from NWSs. The MAP Design Proposal (January 1995) elaborates on MAP's scientific and technical objectives, and the programme strategy;
- MAP-NWS will be an optional EUMETNET Programme intended to form a part of and to support MAP in operating the MPO and the MDC in terms of well defined and limited financial contributions. MAP-related activities of individual NWSs and contributions in kind to MAP (e.g. field phase) are not included financially in MAP-NWS;
- NOTING the complex interaction of mountains with the atmosphere on the mesoscale and its relevance to regional and global climate and thus the importance of the international research venture MAP;
- NOTING also the important contributions from NWSs in delivering data both from the operational networks as from the climatological data archives and in implementing and evaluating new numerical models;
- WISHING to perform the crucial part NWSs can play within MAP in furthering the knowledge and understanding of atmospheric flow phenomena in mountain regions;
- INTENDING to participate in MAP in contributing financially to infrastructural facilities, and being aware of the important contributions NWSs can make in terms of data supply;
- RECALLING ALPEX the first and successful experience of international collaboration involving NWSs as well as research institutions in the Alpine region, which can and should be succeeded in a more intensive manner;

The Contract participants decide the following:

Section 1. Creation

1 The Members establish a collaboration on the basis of an optional EUMETNET Programme - MAP-NWS defined on the basis of the present contract.

2 MAP-NWS is composed of a group of members supported by the MPO.

3 Austria (Zentralanstalt für Meteorologie und Geodynamik, Wien) is designated as the Responsible Member of MAP-NWS. It will subcontract the tasks necessary for MAP-NWS to SMI Switzerland (Swiss Meteorological Institute, Zurich) until SMI becomes a EUMETNET Member. Then, SMI will take over the role of the Responsible Member.

Section 2. Objectives

1 The MAP-NWS Programme will be supportive to the MAP in supplying

a) funds for the MPO,

b) funds for the MDC.

1 The duties of the MPO and the MDC are listed in Annex II.

2 Research and operational activities of the individual Members related to MAP are welcomed and encouraged. They will have to be financially supported separately of MAP-NWS and co-ordinated through the already applied procedures of MAP.

3 The MAP Data Access Policy, attached in Annex III, regulates the use of the MDC and is a reference document for this contract.

Section 3. Board

1 The Board is composed of the directors, or their designated representatives, of the NWSs of each Member. The Board Members may be assisted by advisers.

2 Meetings of the Board are valid if at least a majority of the Members are represented. Each Member will have one vote. In all votes of the Board abstentions are not counted as votes.

3 A Chairperson and Vice-chairperson are elected by the Board for two years with the possibility of being re-elected.

Section 4. Role of Board

1 The Board is to take all decisions necessary to implement the present understanding.

2 In particular, the Board shall:

a) decide modifications of the MAP-NWS contribution to MAP

b) monitor the execution of MAP-NWS

c) decide the membership of MAP-NWS

d) establish co-operations with entities outside MAP-NWS

e) decide modifications of the present understanding

Section 5. Voting

1 Board decisions are taken unanimously.

2 The Board may decide the exclusion of a Member by a vote with a two-third majority of Members present and voting, not counting the concerned Member.

3 By a vote with a simple majority of Members present and voting, the Board

a) elects the Chairperson and Vice-chairperson of Board,

b) decides the working arrangements of MAP-NWS.

Section 6. Co-ordination

1 The duties of the Co-ordination Office for MAP-NWS shall be taken care of by the MPO (operational since January 1995).

Section 7. Financing

1 The Members contribute to the cost of MAP-NWS according to table of contributions in Annex I.

2 Financial contributions to MAP-NWS will be remitted in ECU on the account:
Union Bank of Switzerland, Branch Zurich-Fluntern
Zürichbergstrasse 80, CH-8044 Zurich, Switzerland
account: 818.126.01B
and managed by the MAP Programme Office under the supervision of the international MAP management.

3 Regarding the time table, a bill for the annual amount is sent on February 1 for payments before April 30 of the respective years.

4 The destination of any asset purchased during the course of MAP-NWS will be decided by the Board upon termination of MAP-NWS.

Section 8. Co-operations

1 NWSs not participating in EUMETNET can co-operate in MAP-NWS by decision of the Board and by signing the MAP-NWS contract. Those NWSs will send a representative to the Board meetings and take part in the Board decisions except those specified in Section 4. c, d, e).

Section 9. Departure of a Member

1 A Member may at any time decide to leave MAP-NWS. His departure takes effect on the 31 December of the year where he notified his decision.

2 A Member remains liable for his commitments made prior to the notification of his decision to leave, unless jointly determined by the remaining Members acting unanimously.

Section 10. Term

1 MAP-NWS has come into operation upon acceptance of the Programme Decision by the EUMETNET Council (May 17, 1996) and will terminate on 31. December 1999, subject to the provision for prior termination acceptable to the Board.

Section 11. Other dispositions

1 A Meteorological Service becoming party to MAP-NWS becomes party to the present contract at the date of its entry into MAP-NWS. In such circumstances the concerned Member contributes according to a revised table of contributions (Annex 1).

2 In the case where part of the contributions of the Members would not be paid, the Responsible Member will not be obliged to incur expenses beyond the amounts received.

3 By 31 January of each year the MAP Programme Office will provide each Member with an annual financial report. A summary of activities of MAP will be periodically provided by means of the MAP Newsletter.

4 At any time a Participating Member may review the accounts relating to the contract and may also request an external audit to be performed at its own expense.

Section 12. Litigation

1 In case of a dispute concerning interpretation or execution of this contract, the parties will make their best efforts to solve it amicably before taking any other action.

2 In case of persisting dispute, it will be, at the initiative of one of the parties, solved through the arbitration procedure foreseen by the EUMETNET Agreement. Failing this the dispute will be brought to the competent court of the Responsible Member's country and the present version of the contract will be the only reference.

7.5.2 Contract Extension for 2. Phase

ANNEX to the Contract `Mesoscale Alpine Programme of National Weather Services (MAP-NWS)', October 31, 1996

Extension of Contract: Mesoscale Alpine Programme of National Weather Services (MAP-NWS)

WHEREAS

- MAP-NWS is an optional EUMETNET Programme focused on supporting the MAP in operating the MPO and the MDC in terms of well defined financial contributions limited to the end of 1999;
- NOTING that the MAP-NWS Contract will formally expire on December 31, 1999;
- NOTING also that the MAP field experiment will take place from September 7 to November 15, 1999, and that a substantial part of the observational data will be available only 12 to 18 months after this period;
- WISHING to make best use of the MAP field experiment data in making it available to the MAP community in an efficient and user-friendly manner;
- INTENDING to provide data handling service and quality assessment through the MDC, and to support scientific meetings, publication of results, and the adaptation of scientific results for operational use through the PO;
- NOTING that the EUMETNET Council accepted an extension of MAP-NWS for three years until December 31, 2002;
- RECALLING the MAP-NWS Contract;

The Contract participants, on the basis of the MAP-NWS Contract accepted on November 26, 1996, decide the following:

Ad Section 10. Term

1 Upon acceptance of the Programme Decision by the EUMETNET Council (September 23, 1998) MAP-NWS has been extended for three years to terminate on 31. December 2002, subject to the provision for prior termination acceptable to the Board.

Ad Section 7. Financing

1 The Members contribute to the cost of MAP-NWS according to the table of contributions in Annex I.

2 The handling of the contributions will remain unchanged.

7.5.3 Contract Extension for 3. Phase

ANNEX to the Contract `Mesoscale Alpine Programme of National Weather Services (MAP-NWS)', October 31, 1996

Follow-up of Contract: Mesoscale Alpine Programme of National Weather Services (MAP-NWS)

WHEREAS

- MAP-NWS is an optional EUMETNET Programme focused on supporting the MAP in operating the MPO and the MDC in terms of well defined financial contributions limited to the end of 2002;
- NOTING that the MAP-NWS Contract Extention will formally expire on December 31, 2002;
- NOTING also that MAP continues as an internation research programme, as the MAP data set, collected from September 7 to November 15, 1999, has been made available to the research community in a revised form only recently;
- EMPHASIZING that the MAP data is unique, and will be explored for years to come;
- INTENDING to make best use of the MAP data set in making it available to the MAP community in an efficient and user-friendly way by providing a reliable operational service for data ingestion and retrieval, data base management, data handling service, user support, system maintenance and upgrade through the MDC, and to support MAP committee meetings, publication of the MAP newsletter PO;
- NOTING that the MAP Steering Committee firmly expressed the need for a continuation of the service provided by the MAP Data Centre, at least until 2004/2005;
- (NOTING that the EUMETNET Council accepted an extension of MAP-NWS for three years until December 31, 2002;)
- RECALLING the MAP-NWS Contract and the MAP-NWS Contract Extension;

The Contract participants, on the basis of the MAP-NWS Contract accepted on November 26, 1996, decide the following:

Ad Section 10. Term

1 Upon acceptance of the Programme Decision by the EUMETNET Council (April 11, 2002) MAP-NWS has been followed-up by INRFA-MAP for three years to terminate on

31. December 2005, subject to the provision for prior termination acceptable to the Board.

Ad Section 2. Objectives

1 The MAP-NWS follow-up project INFRA-MAP will ensure the operational service of the central MAP infrastructure by supplying the salaries of:

a) one full-time manager of the MDC (100%),

b) one part-time administrative support to run the MPO (20%).

2 The duties of the MDC and the MPO are listed in Annex II.

3 The contents of the MDC will be transferred to an operational service (preferably an NMS) by the end of INFRA-MAP, to provide permanent access to the data sets.

Ad Section 7. Financing

1 The Members contribute to the cost of MAP-NWS according to the table of contributions in Annex I.

2 The handling of the contributions will remain unchanged.

7.6 Written Procedure remaining funds

Optional EUMETNET Programme MAP-NWS – The Mesoscale Alpine Programme of the National Weather Services

Written Procedure

Purpose: approval of the MAP-NWS overall audit and Final Report, decision on leftover 26.6 kEUR

Author: Andrea M. Rossa, MeteoSwiss, Programme Manager

Documentation: MAP-NWS Final Report (attached)

Context

The Mesoscale Alpine Programme of the National Weather Services (MAP-NWS) started as the first EUMETNET Programme (after the Co-ordination Office) in 1996, with optional participation of the member countries, to support MAP. Its main goal was to sustain the administrative and technical backbone of this international research programme in the Alpine countries, i.e. the Programme Office (PO) and the MAP Data Centre (MDC).

The overall MAP-NWS Audit is presented in the MAP-NWS Final Report. The overall financial volume amounts to 2.15 MEUR, 79% of which was devoted to human resources, 3% for travel and 18% were part of the in-kind contributions of the PO and MDC host institutions. The overall balance leaves approximately 26.6 kEUR in the MAP-NWS account. The MAP Steering Committee and the Programme Manager propose to transfer this money to the WMO/WWRP Forecast Demonstration Project MAP D-PHASE, the societal impact component of MAP. The share per member of the remaining 26.6 kEUR is as follows:

potential repayment of remaining capital [kEUR]		
MAP-NWS Member	%	26.63
Austria	11%	2.90
France	8%	2.26
Germany	12%	3.10
Greece	2%	0.42
Italy	14%	3.83
Spain	8%	2.12
Switzerland cash	30%	7.92
UK	6%	1.64
Croatia	1%	0.27
Hungary	1%	0.22
Slovakia	1%	0.30
Slovenia	1%	0.27
USA	3%	0.68
Canada	3%	0.70
Total	1.00	26.63

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Decisions

1 Do you approve the overall MAP-NWS audit based on Final Report sections 4, 7.2 and 7.3:

☐ yes ☐ no

comments: ☐ enclosed ☐ none

2 Do you approve the MAP-NWS Final Report:

☐ yes ☐ no

comments: ☐ enclosed ☐ none

3 Do you agree to transfer your share of the balance of 26.6 kEUR to D-PHASE:

☐ yes ☐ no

In case you answer no please specify the bank coordinates for remission of your share:

☐ please remit to _____

MAP-NWS Member/Institution: _____

Representative: _____

Date: _____

Signature: _____

Please return this page duly compiled and signed to MeteoSwiss by Fax +41-44-256 92 78, **not later than 22 January 2007**.

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66 Schär Christoph, Binder Peter, Richner Hans (Eds.): 2003, International Conference on Alpine Meteorology and MAP Meeting 2003, Extended Abstracts volumes A and B, 580pp, CHF 100.

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208 Schmuki D, Schmutz C, Rohling S: 2004, Aeronautical Climatological Information Grenchen LSZG, 73pp, CHF 24.–

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203 Duding O, Schmuki D, Schmutz C, Rohling S: 2004, Aeronautical Climatological Information Geneva LSGG, 104pp, CHF 31.–

202 Bader S: 2004, Tropische Wirbelstürme – Hurricanes –Typhoons – Cyclones, 40pp, CHF 16.-

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