Skill of user-tailored seasonal temperature and precipitation forecasts for agriculture in Peru

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MOTIVATION

Prediction of user relevant indices may be more beneficial for specific applications than predicting mean values at the seasonal scale. In this study, the skill of two selected indices, tailored for applications in the agricultural sector, is assessed:

- Optimum temperatures dependent on crop phenological phase
- Onset of rainy season

The study is part of the project CLIMANDES aiming at developing climate services for the agricultural sector in the Peruvian Andes.

DATA

Variables: daily mean temperature and precipitation

Seasonal forecasts: ECMWF system 4 seasonal prediction system (1° grid and interpolated to stations)

Verification data: Station data and PISCO gridded dataset (only for precipitation: 5km resolution, interpolated to 1° grid). Both datasets from SENAMHI.

Niño 3.4: sea surface temperature (SST) anomalies [2]

Time period: 1981-2012

VERIFICATION METRICS

Skill is assesed using the **Generalized discrimination score** for tercile forecasts [1]. Values higher than 0.5 indicate skill.

Potential predictability: A perfect model approach is employed. The generalized discrimination score is calculated as the mean over the individual scores using all ensemble members one by one as observations.

CHALLENGES

- Quality and availability of observational and reanalysis data for verification
- Representation of precipitation in climate models (see Fig.C1)
- Insufficient knowledge about specific user needs

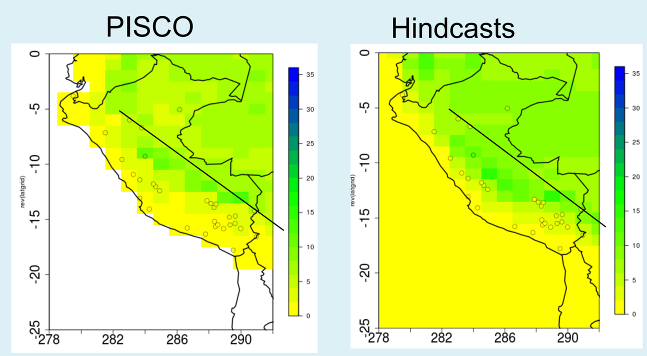

Fig. C1: Climatology (1981-2012) of November precipitation of PISCO-dataset and hindcasts (Ensemble mean, initialized in October). Black line: guide to the eye. Model precipitation is shifted westwards. ERA-Interim Reanalysis data shows a similar shift (not shown).

Crop-specific optimal temperature ranges

Definition

Percent of days within crop-specific optimal temperature range for respective growing stage.
(Tab. T1; all results for maize)

Tab. T1 Thresholds for different phenological phases of maize [3]

Maize		
Mean temperature [°C]	Optimum	
	Min	Max
I.Germination	15	25
II.Growth	15	21
III.Flowering	15	20

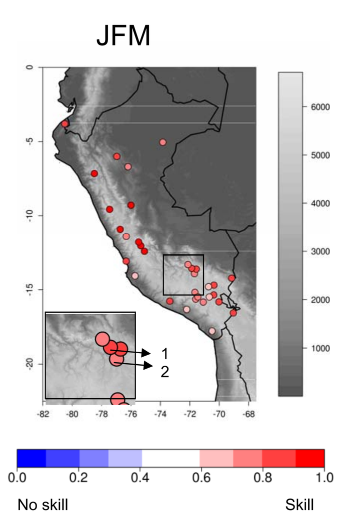

Fig. T1: Skill of seasonal temperature means. Inset in left figure shows the two stations for which results are shown.

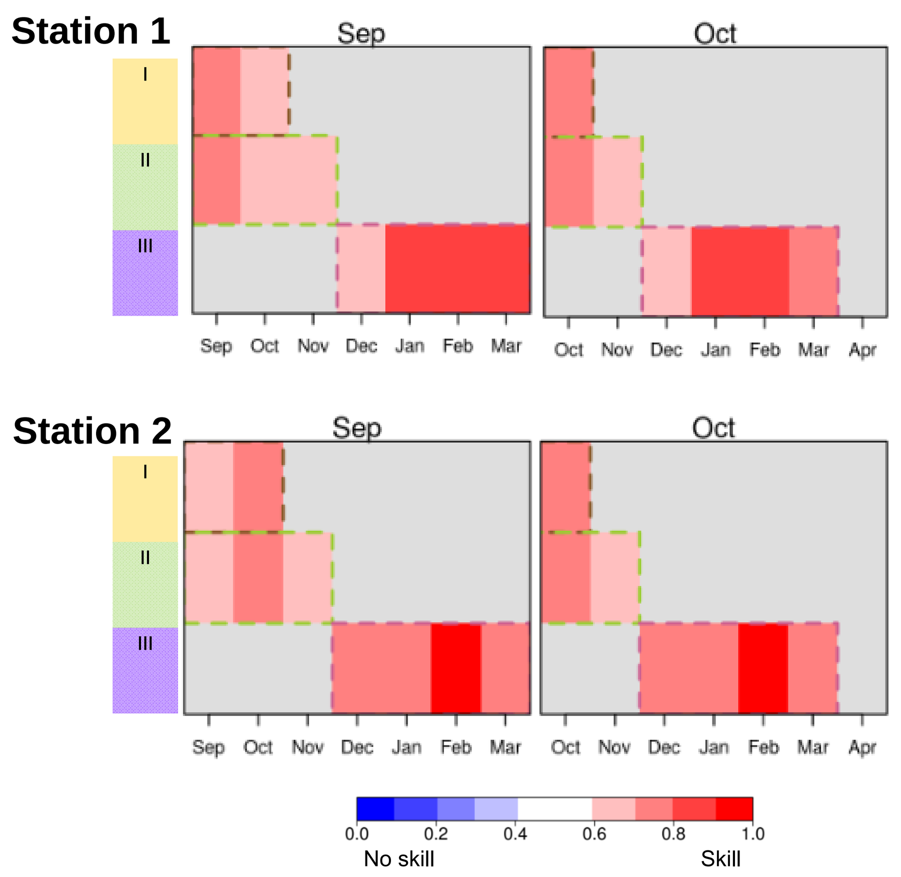

Fig. T3 Skill at stations 1(top row) and 2 (bottom row) shown in Fig. T1. Hindcasts initialized in September (left) and October (right). Rows indicate different growing stages (see Tab T1).

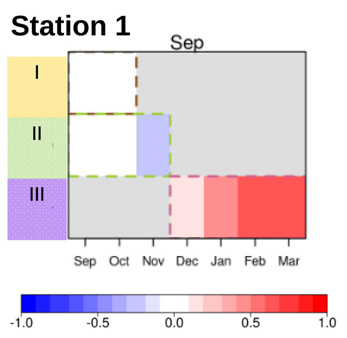

Fig. T2: Correlation between observed temperature-based index and Niño 3.4 SST anomalies at station 1. The rows indicate different growing stages (see Tab T1). Results at station 2 are similar for Jan-Mar.

⇒ Index shows skill at both stations. Highest skill during January — March.

⇒ Highest skill is observed during months of strongest correlations with Niño 3.4 SST.

Onset of rainy season

Definition

Onset as days after 1 of August
P(d)>0 and P(d : d +6)>10mm and N(P(d : d +30)>0)>10 [4]

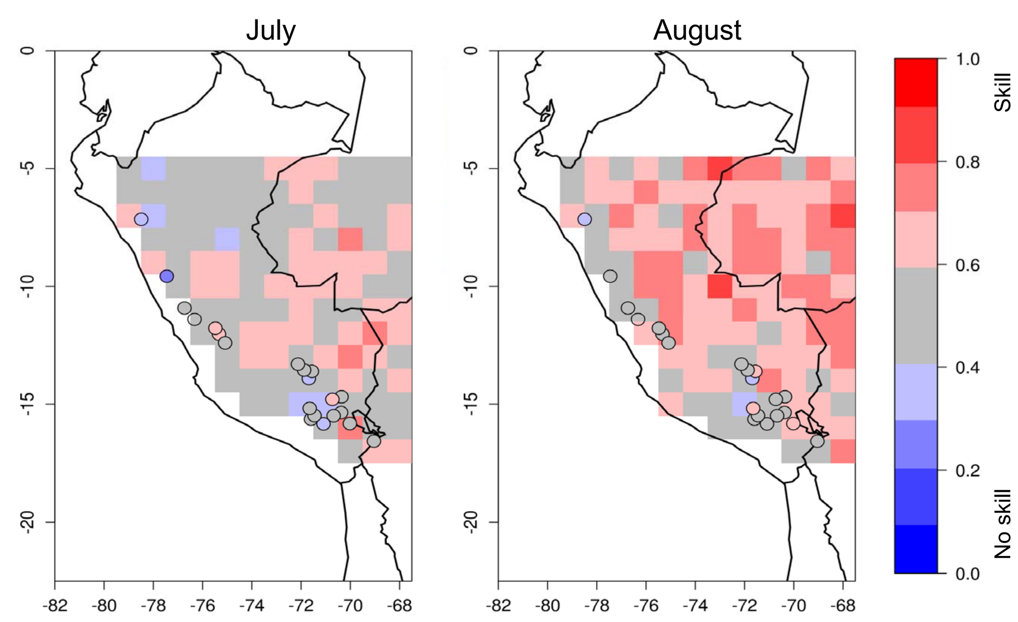

Fig. P1 Skill for hindcasts initialized in July (left) and August (right).

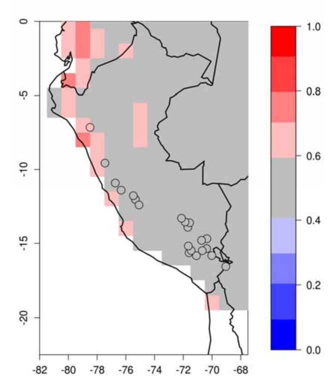

Fig. P2: Potential predictability of precipitation means (SON, initialized in July).

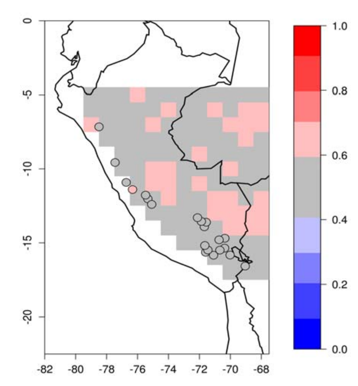

Fig. P3 Potential predictability of onset of rainy season for hindcasts initialized in July.

⇒ No or only little skill and potential predictability, especially in Peruvian Andes. Skill is higher in the west of Andes, a region where the index is not well-defined.

References:
[1] Mason, S. J. & Weigel, A. P., A generic forecast verification framework for administrative purposes, *Monthly Weather Review,* **2009**, *137*, 331-349
[2] Rayner N. A., D. E. Parker, E. B. Horton, C. K. Folland, L. V. Alexander, D. P. Rowell, E. C. Kent, A. Kaplan, Global analyses of sea surface temperature, sea ice, and night marine air temperature since the late nineteenth century, *J. Geophys. Res.,* **2003,** 108 (D14), 4407, doi:10.1029/2002JD002670, .
[3] SENAMHI, Caracterización agroclimática del distrito de Cutervo, departamento de Cajamarca, internal report
[4] Gurgiser, W et al., Comparing peasants' perceptions of precipitation change with precipitation records in the tropical Callejón de Huaylas, Peru, *Earth System Dynamics Discussions,* **2015**, *6*

CONCLUSIONS

- Seasonal predictions of user-tailored temperature indices for the Andes region are skillfull and are promising for climate service products for the agricultural sector in Peru.
- Seasonal precipitation indices are less promising, showing mostly only little skill and potential predictability in the Peruvian Andes.

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