Summertime precipitation deficits in the Peruvain highlands for station data, reanalyses and model simulations

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MOTIVATION

- Precipitation deficits are a concern to the rural population in the southern Peruvian highlands as a large share of people practice rainfed subsistence agriculture
- Knowledge about their occurrence is lacking amongst other because of scarce data availability
- Precipitation deficits in the Altiplano have been related to stronger upper-level westerly wind anomalies, which hinder the uplift of moist air from the Amazon (east of the study area) [1]
- Such anomalies can occur during El Niño (EN), but not all El Niño lead to upper-level westerly anomalies.

Within the project Climandes, a GFCS pilot project, two studies were conducted, aiming at better understanding drought events and thereby providing better climate information on droughts:

→ Evaluate total precipitation from global reanalyses to assess their use for drought monitoring and analyses

→ Evaluate the drought events conditional on El Niño focusing on the southern Peruvian highlands (square in first figure below)

EVALUATION OF REANALYSIS

DATA + METHODS

For the evaluation of reanalysis we use two observational datasets as references; a newly generated gridded precipitation dataset and station data. For comparison with stations we use a weighted average of the four closest grid points, for comparison to the gridded dataset, the grid is interpolated to the grid of the respective reanalysis.

Observations:	PISCOpm v2.0 [2] Homogenized Station data [3]
Reanalyses:	ERA20C, ERA-Interim, JRA-55, NCEP/NCAR,
Model:	ERA-20CM

Measures: bias (mean of reanalysis— mean of observation), rank correlation
Period: January—March, 1981—2010

RESULTS

- Higher resolved reanalyses show a large positive bias along the Andes' eastern slopes above 1000 m.a.s.l.
- Correlations are in general low, but higher values occur along the western Andes and the coast of Peru
- NCEP/NCAR shows a low bias and low correlation values

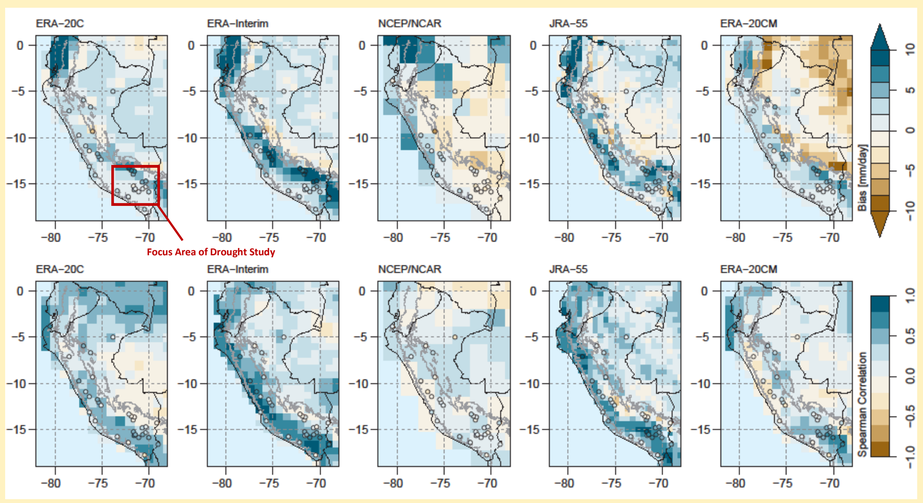

Fig.1 : Evaluation of reanalyses for JFM during 1981 –2010.

DROUGHTS IN THE SOUTHERN PERUVIAN HIGHLANDS

- Drought time series for 1964-2016 based on SPI for 16 stations in the southern Andes of Peru (see first figure above)
- Eight major droughts, of which 7 occured during EN (red stripes in figure below)
- Droughts occured during both flavours central and equatorial Pacific of EN
- The two severest droughts in 1983 and 2016 with severe socio-economic consequences for southern Peru and Bolivia [4]

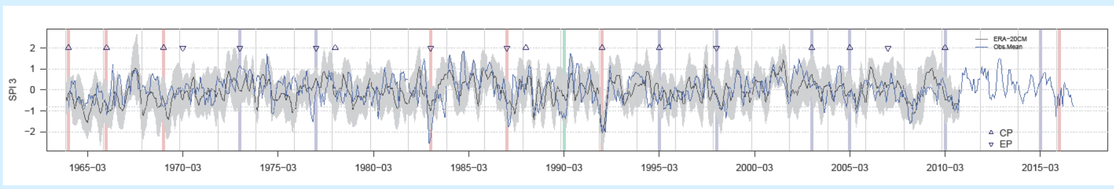

Fig. 2: Time series of 3-monthly SPI for 16 stations and ERA20CM members in the southern Peruvian highlands. EN events based on ONI are marked with colored bars, red for EN with drought, blue for EN without drought and green for drought without EN. Flavours of EN are marked with triangels based on calculations of Yu. et. al. [5]

DATA + METHODS

Atmospheric conditions during JFM precipitation deficits are analysed with two composit studies:

Composite	**1) Years with and without droughts conditional on EN**	**2) Difference between dry and „normal-to-wet" conditions during EP and CP EN**
Period	JFM 1964-2016	JFM 1964 –2010
Data	Precipitation: 16 homogenized stations [3] GPH and wind: JRA-55	Precipitation, GPH and wind: ERA20CM ensemble members
Drought Classification	mean Standardized Precipitation Index (SPI) from station data in southern Peru (drought is a 3-months SPI < -0.8)	SPI calculated for every ensemble member individually (drought is a 3-months SPI < -0.8)
EN Classification	ONI (Oceanic Niño Index)	CP and EP El Niño based on Yu. et. al. 2012
Based on these classifications the following samples for the composites are obtained:		
Samples	EN droughts: 7 EN no droughts: 8	CP droughts/no droughts: 30/70 EP droughts/no droughts: 19/51

1. DROUGHTS DURING EL NIÑO

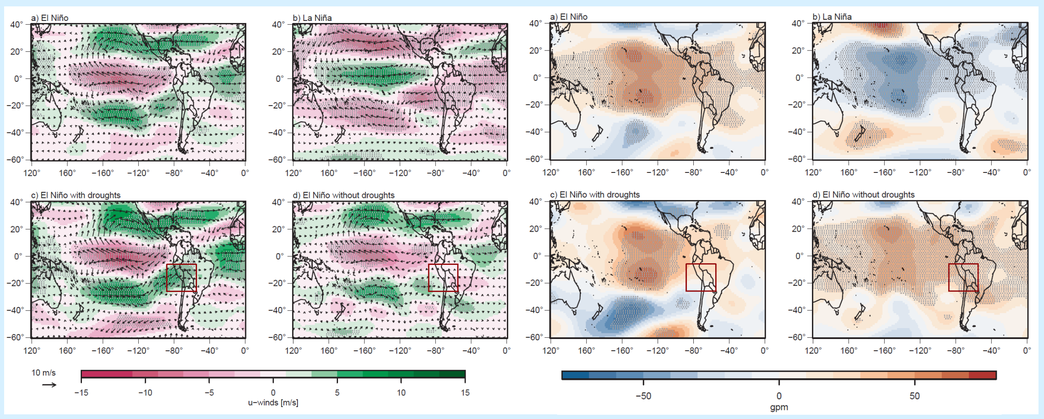

Fig. 3: Composites of winds (left) and geopotential height (right) at 200 hPa for a) El Niño, b) La Niña, c) EN with droughts and d) EN without droughts. Significant differences at 0.95 are dasehd. Data: JRA-55

- All EN events show zonal wind anomaly & a westward extended troposphere over the Central Andes
- EN with droughts show the increased zonal wind anomaly and a steep gradient in the GPH over the Central Andes
- EN without droughts do not exhibit the zonal wind anomaly and the extension of troposphere reaches beyond the Central Andes
- EN with droughts show a distinct PSA Pattern in the southern Pacific

2. DROUGHTS DURING CP AND EP EL NIÑO

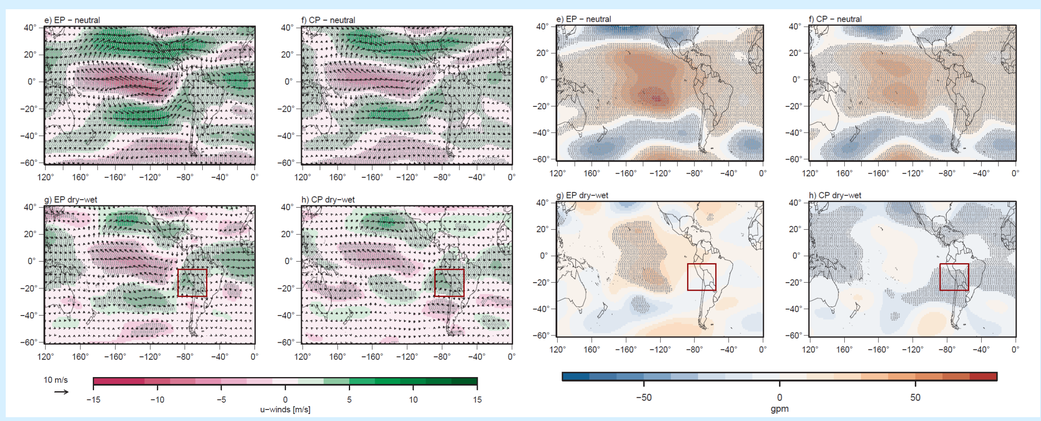

Fig. 4: Composites of winds (left) and geopotential height (right) at 200 hPa for a) EP EN, b) CP EN, c) EP dry minus wet and d) CP dry minus wet. Significant differences at 0.95 are dasehd. Data: ERA20CM

- Westerly wind anomalies for dry periods are of similar magnitude for EP and CP EN over the Central Andes
- A gradient in the GPH over the Central Andes is found in the dry minus wet composite for EP EN, whereas CP EN shows a lower GPH field over the Andes for dry situations

CONCLUSION

- ERA-Interim best represents precipitation for the Andes of Peru, but as other reanalyses shows a positive bias on the Andes' eastern slope, likely due to low resolved model topography
- Composites of EN with droughts confirm increased westerly wind anomalies at 200 hPa and show a stronger gradient in the GPH field over the Central Andes
- Model simulations of ERA20CM show the upper-level westerlies in both flavours of EN, however a gradient in the GPH is only found during EP EN

OUTLOOK

- Higher resolved reanalyses may be able to represent precipitation better (evaluation of ERA5)
- Relation of upper-level westerlies and precipitation bears potential for drought forecast improvements *(see P. 67)*

REFRENCES
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