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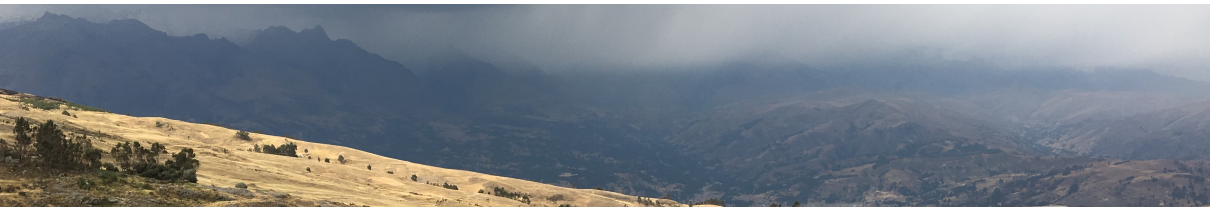

Drivers of rainfall variability and change in the central tropical Andes, Rio Santa Basin

AgroClim Huaraz Project

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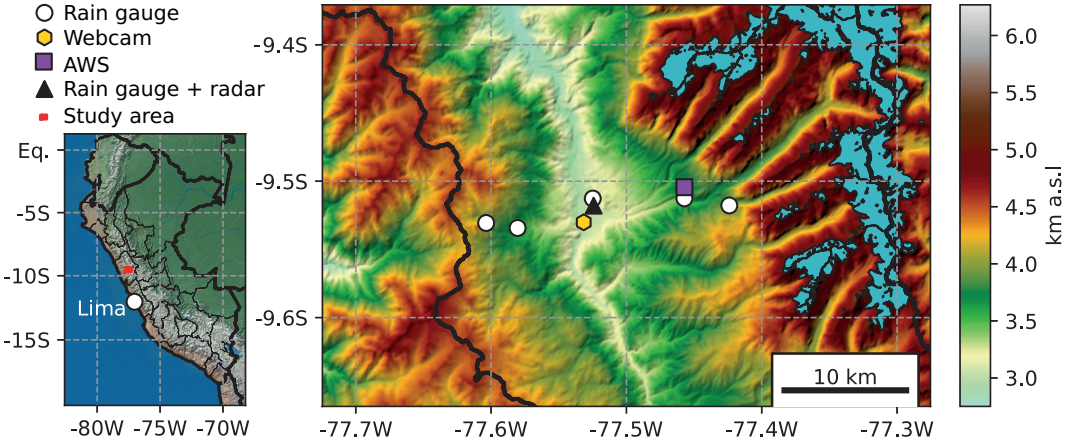
Project context

- Small-scale Farmers' Vulnerability to Climate Change in the Peruvian Andes
- Climate trends and glacier retreat in the Cordillera Blanca, Peru, revisited
- Comparison of perceptions of precipitation change with precipitation records
- Stay tuned for more on our in-situ measurements from Hänchen et al. (click)
- **Check out our website: https://agroclim-huaraz.info**

- **Climate**: have the spatial patterns and seasonality of climate variables relevant for rain-fed farming changed over the last decades, and if yes, how?
- **Human influence**: how does the choice of crops and agricultural management practices affect plant water demand?

Study region



https://agroclim-huaraz.info/region

Focus here: Local climate drivers

Objectives

1. improve our understanding of the local to large scale drivers of climate variability (with a focus on precipitation processes) in the Rio Santa Basin.
2. assess and detect potential changes in climate with a focus on precipitation type, amounts and seasonality in the central tropical Andes during the last three decades.

Datasets

1. Rainfall and convection: CHIRPS (1981-2019), GRIDSAT (1985-2017)
2. Atmospheric information: ERA5 reanalysis data (over GRIDSAT period)

Large-scale rainfall drivers in the Rio Santa Basin

Composites of 3-day wet/dry spells in CHIRPS

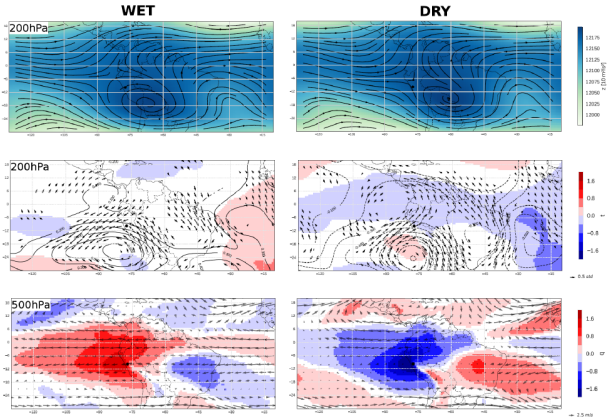


Figure 4: Composite analysis during wet and dry spells. Top: 200hPa winds and geopotential. Middle: 200hPa wind and temperature anomalies (95% confidence). Bottom: 500hPa wind composite and specific humidity anomalies.

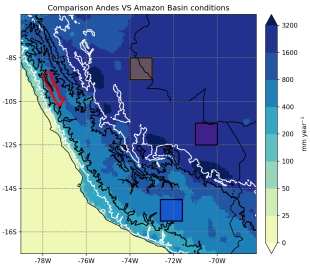
Similar to regions further south such as the Altiplano, Rio Santa Basin rainfall is strongly linked to easterly (wet) or westerly (dry) 200hPa wind conditions during the peak rainy season.

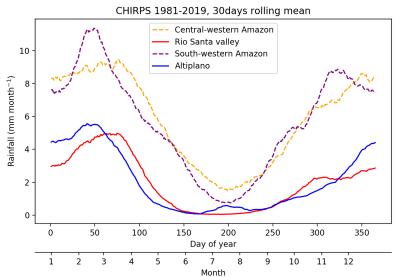
This wind direction is ultimately controlled by the **position and strength of the Bolivian High**, which varies on a daily basis.

Local rainfall & relation to South American monsoon

Indicators of monsoon regime

- Onset of north-easterlies from the tropical Atlantic moving the South American convergence zone (SACZ) inland
- development of Bolivian High (linked to srfc warming and Amazonian convection)



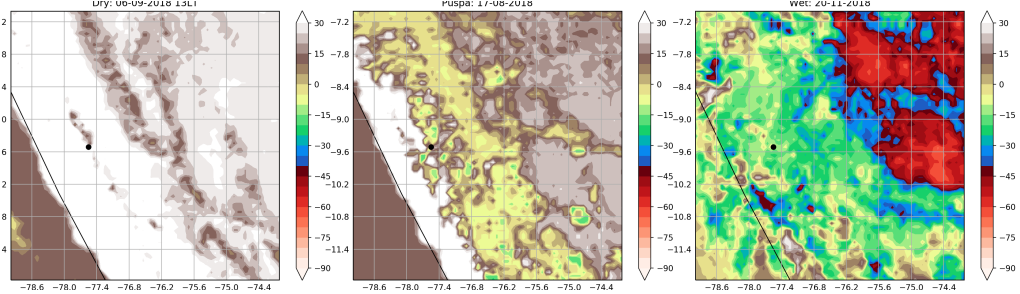


Compared to Altiplano, rainfall peak in central tropical Andes (red contour) is later during northward retreat of SACZ. The seasonal cycle is in phase with Amazon rainfall sampled perpendicular to Andes range.

Analysing clouds from brightness temperature

GRIDSAT -40C cold cloud cover frequency

Left: Dry conditions, **Middle**: local convection, **Right**: Organised convection approaching from Amazon basin

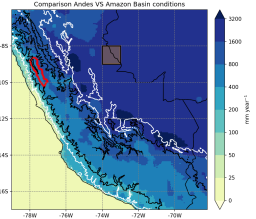


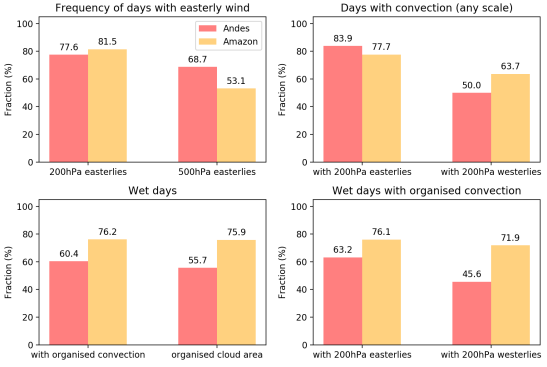
Cloud top temperature is an indicator for the height of the cloud top and therefore for strong vertical updraughts. Hence it tells us something about convective intensity, organisation (cloud scale) and changes in convection over time!

Convection in the Rio Santa versus Amazon basin

December-March 1985-2017 statistics from GRIDSAT, CHIRPS, ERA5

Organised convection: contiguous cold cloud $\geq$5000km^2, "wet day": $\geq$ 5 mm day^{-1}

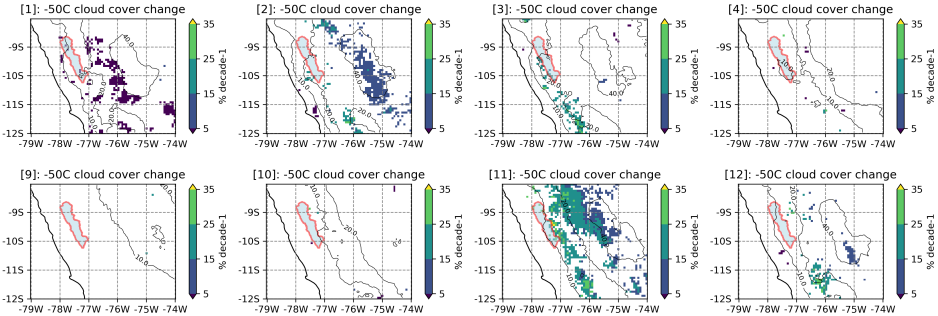




- Compared to Amazon, topography decreases convective organisation.
- Convection still occurs on 50% of westerly "dry condition" days.
- Westerly days make up only 22% during DJFM.
- Convection is less often organised (45% down from 63% with easterlies).

Do we observe trends in convection?

GRIDSAT -50C afternoon cold cloud cover frequency trends (shading) relative to 1985-2017 average (contours).

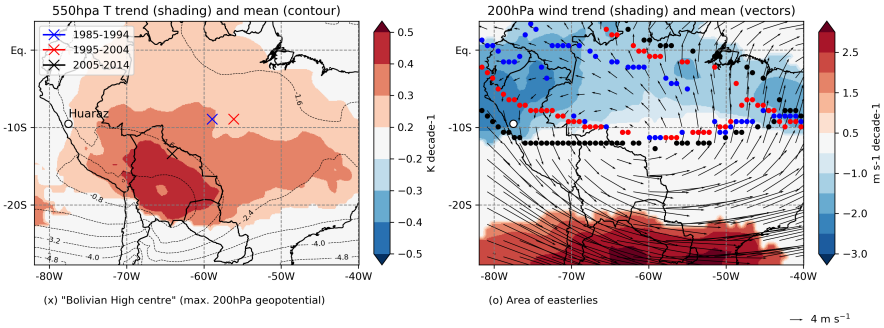


Clear November trend, the monsoon transition month when Bolivian High installs over Bolivia at mid-month.

Are there any large-scale trends linked to this?

November convection trend: potential drivers

ERA5 1985-2017 atmospheric trends.



Since 2005, the centre of the Bolivian High is on average further south co-located with an enhanced warming signal (left). The easterlies of the northern edge of the high extend towards the Rio Santa Basin / Huaraz (right).

Take-home points

- At the seasonal time scale, the south-& north-ward progression of the monsoon/ connected Bolivian High position controls which part of the Andes is in the "wet 200hPa easterly"-wind zone.
- With westerly wind, convection still occurs on about 50% of the days but more localised (drivers to be evaluated)
- Organised convection tends to be associated with easterlies
- An identified positive trend in November convection seems to be linked to earlier southward displacement of the Bolivian High.