Unraveling South American spatial precipitation patterns, intensity and variability through a multi-proxy approach for the past 2 kyr

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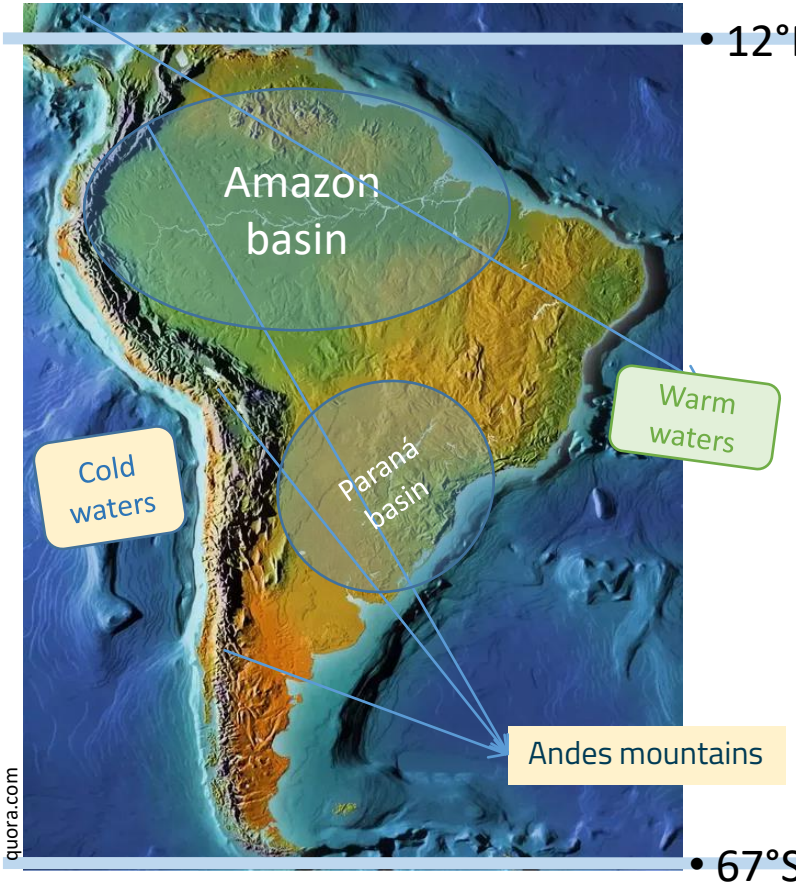
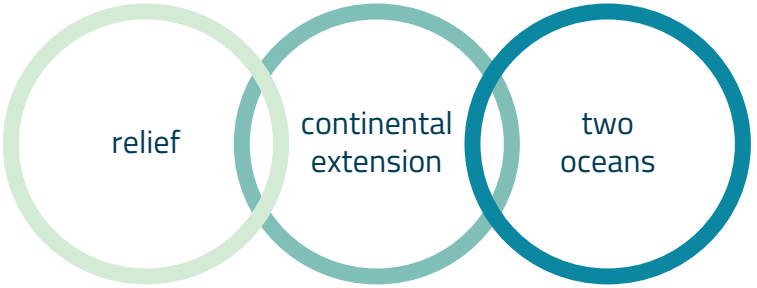
South America characteristics





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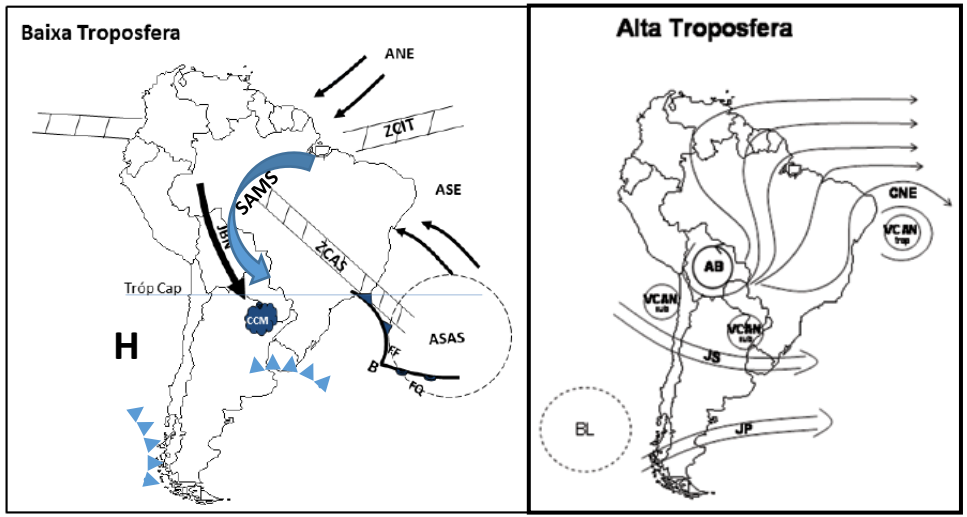
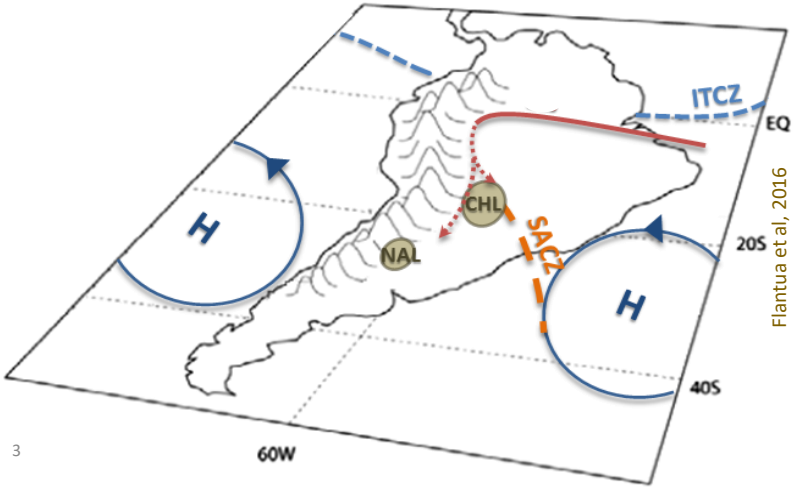
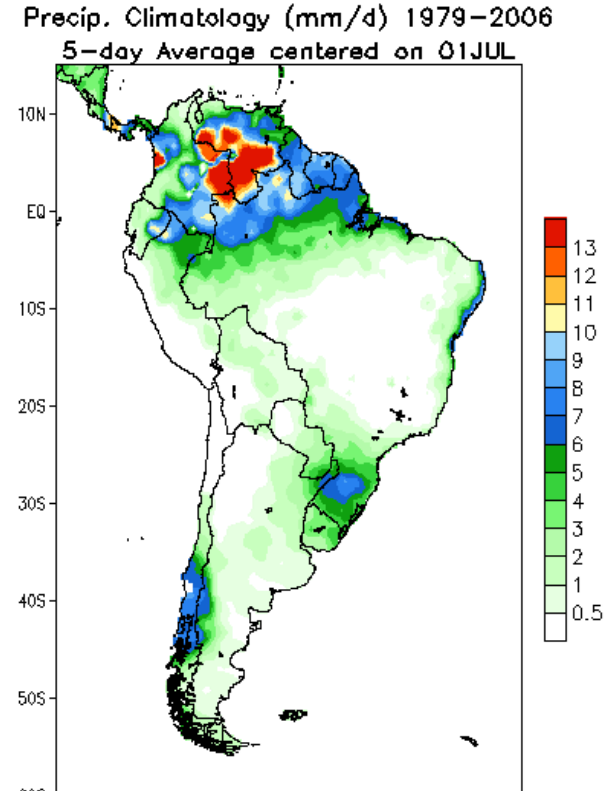
Mechanisms of precipitation in South America



modified from REBOITA et al., 2012; Reboita et al., 2010

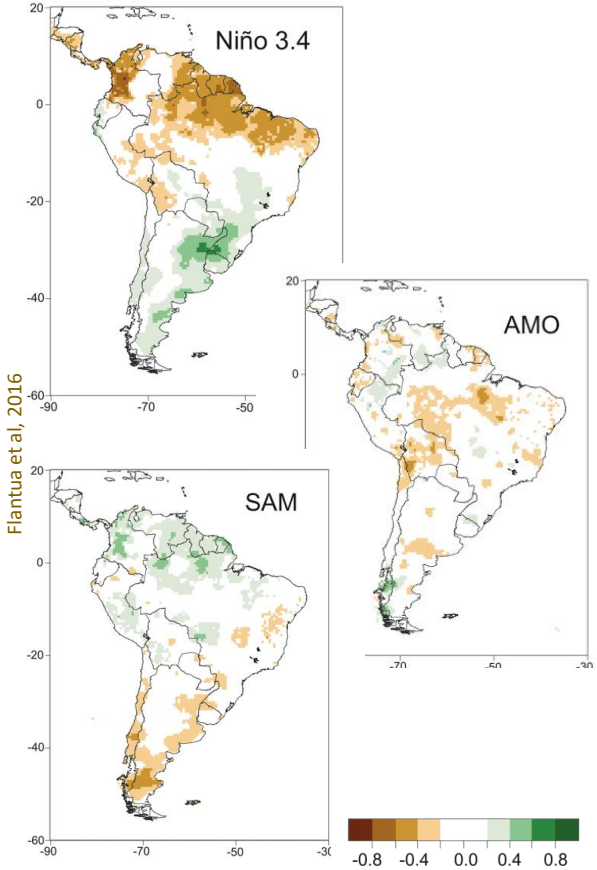


Flantua et al, 2016



Created by NOAA/Climate Prediction Center 9 May 2006

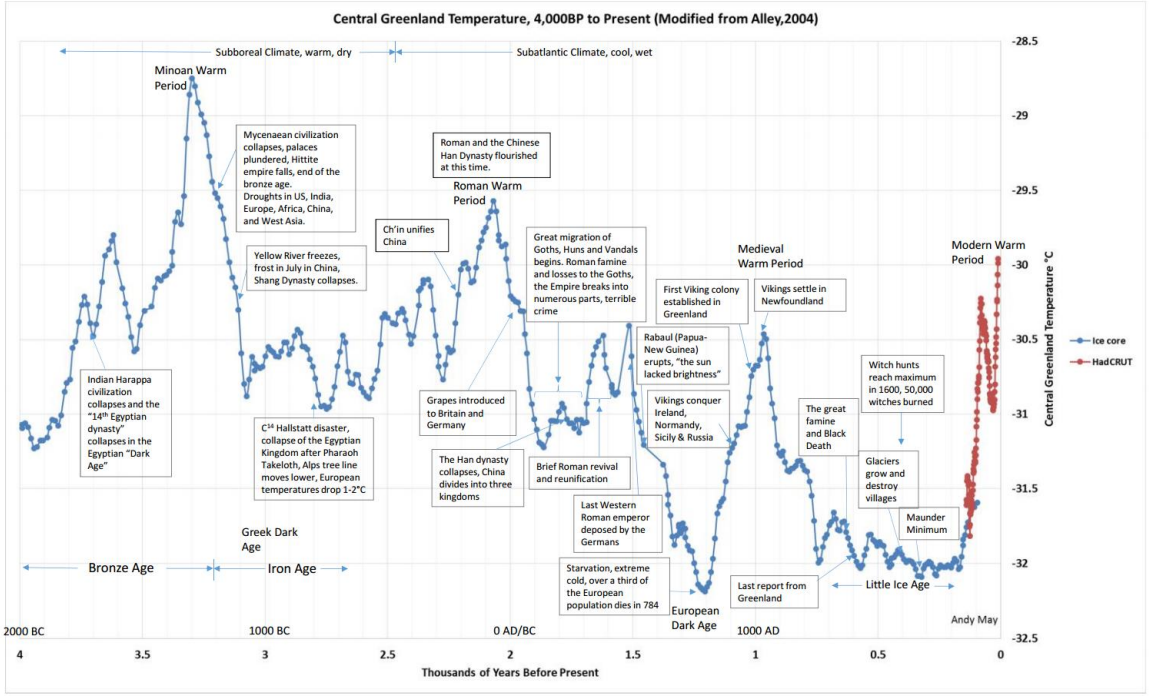
Climate modes variability in South America

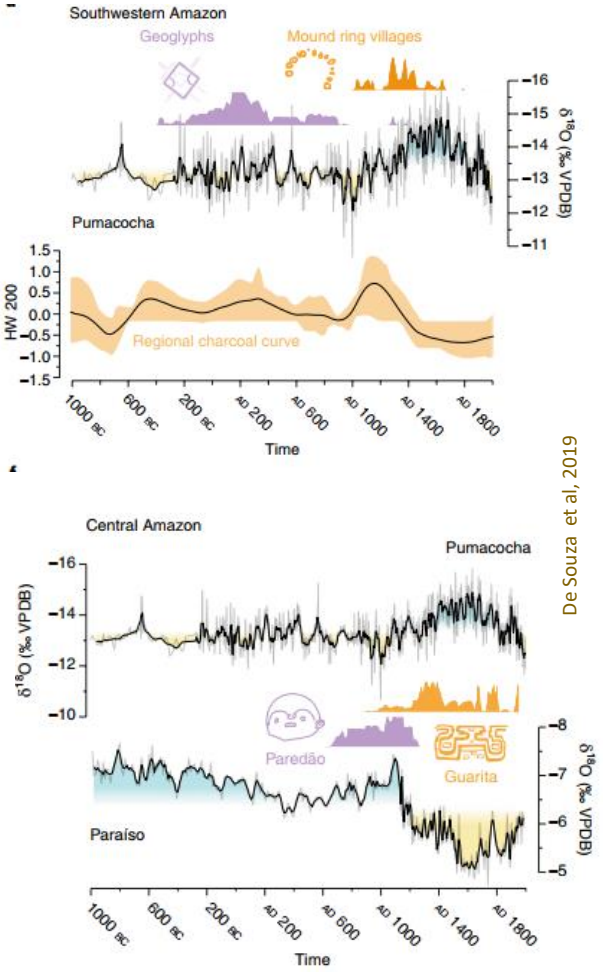


Flantua et al, 2016

- El Niño: Variations in crop yield; decrease in river flow; increased risk of forest fires; water supply.
- IPO: Like ENSO patterns in low frequency
- AMO: Positive mode affect precipitation in Amazon basin.
- SAM: Affect precipitation in south of South America.

Why 2k is important?



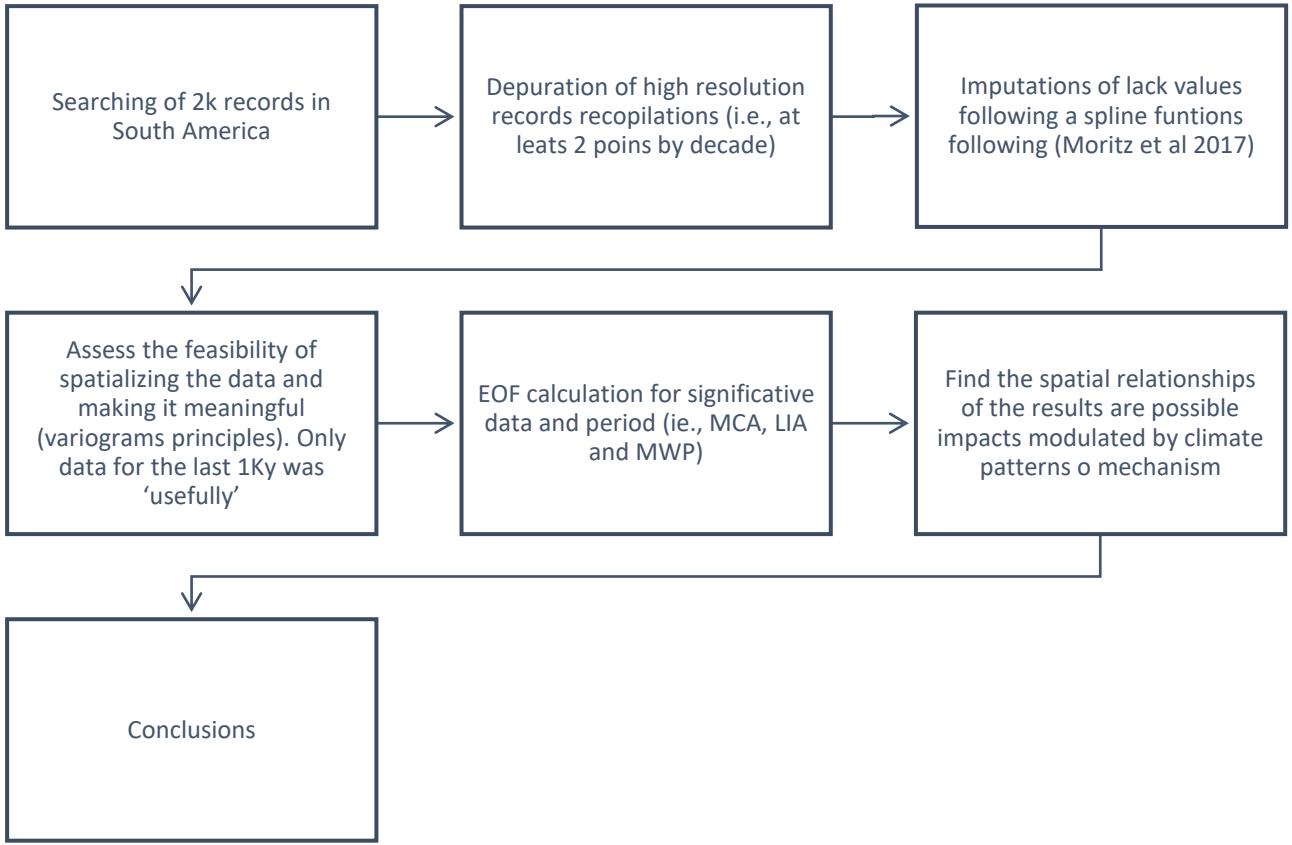


De Souza et al, 2019

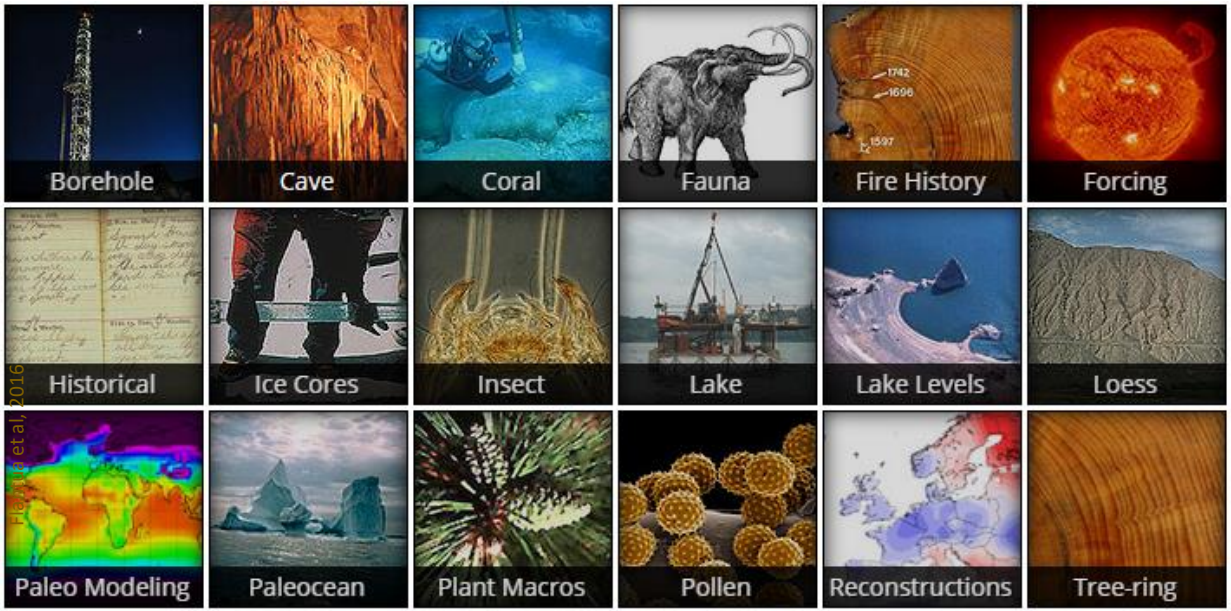
Objetive

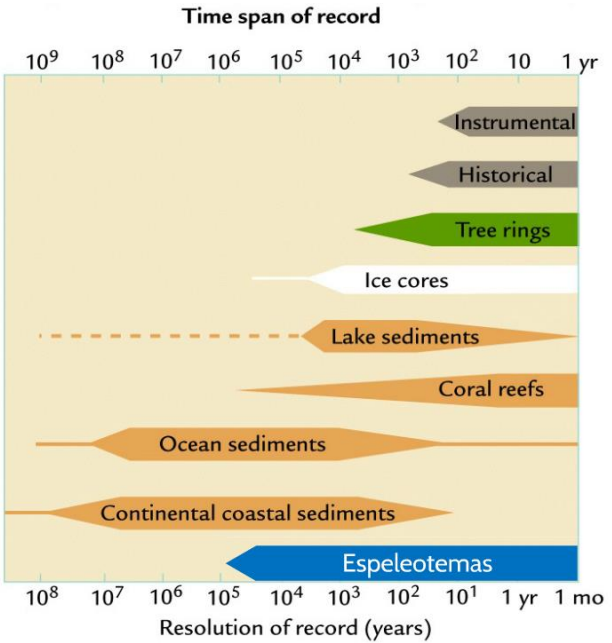
Here we present an effort of the PAGES/LOTRED-SA paleo-community to explore the South American hydro-climate reconstruction selecting from more than 360 South American databases, some with high resolution for the last 2 kyr timescale. Following a multi-proxy approach we expect to better describe duration and location of wet and dryer climate regimes at most important climate domains of South America; as well as their predominant variability and trends.

Methodology



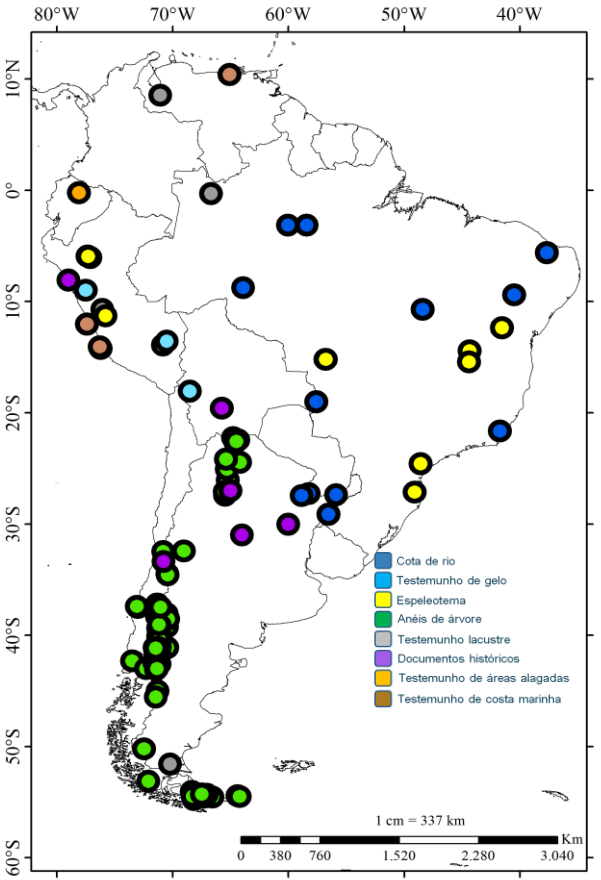
Methodology: South American records

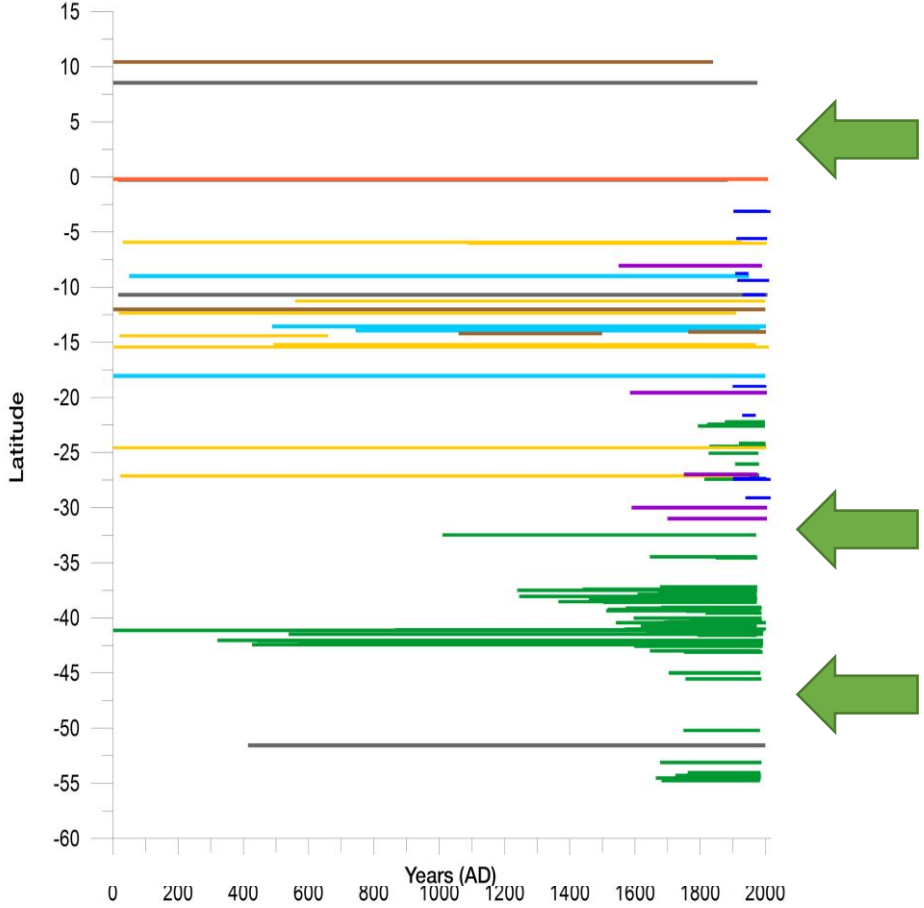




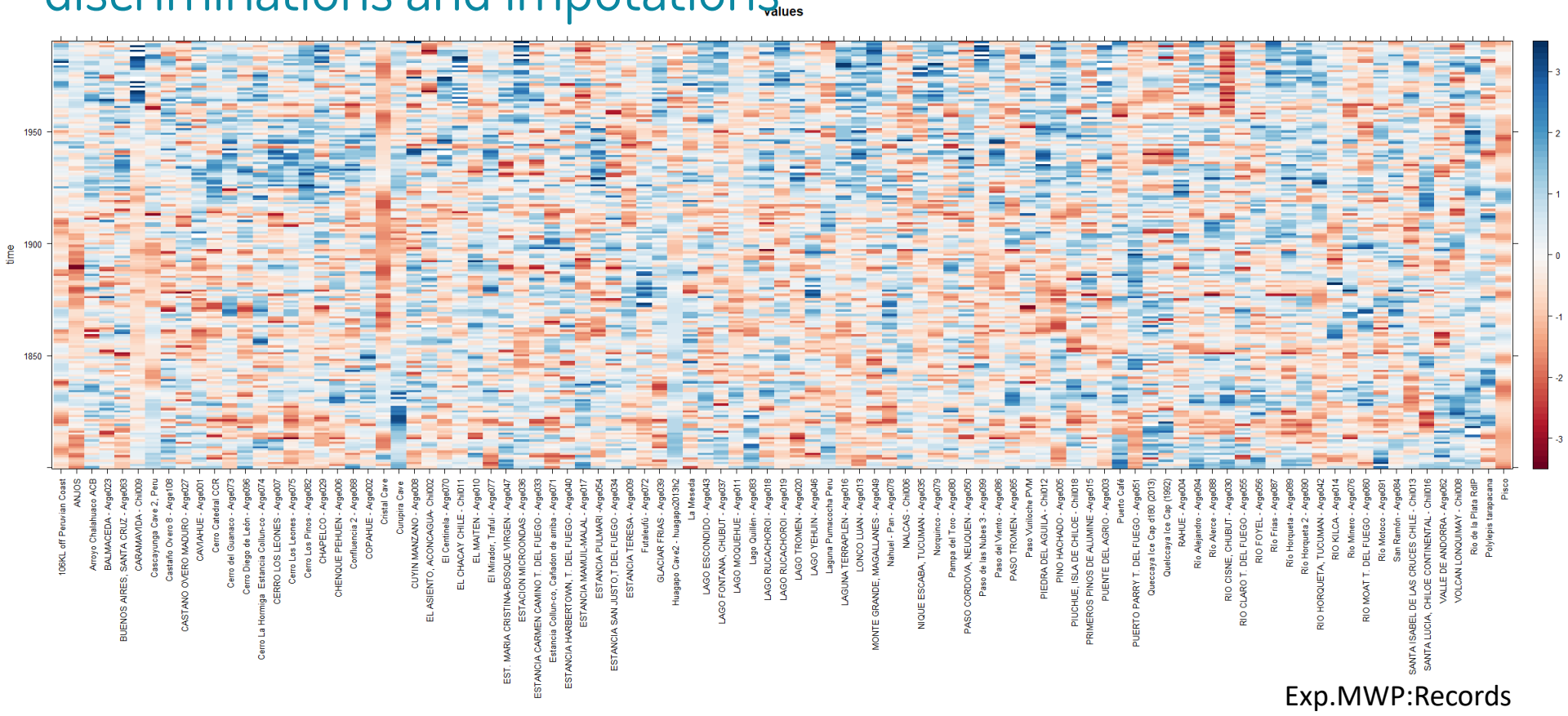
365 records between: Ice cores (THOMPSON ET AL., 1986), Lake cores (BIRD ET AL., 2012), speleothems (REUTER ET AL, 2009; KANNER ET AL., 2013; APAÉSTEGUI ET AL., 2014, marine cores (GUTIERRES, 2009,2010, 2012; SALVATECCI, 2010,2012,2014), tree rings (VILLALBA, 2012), among others.

Methodology: South American records





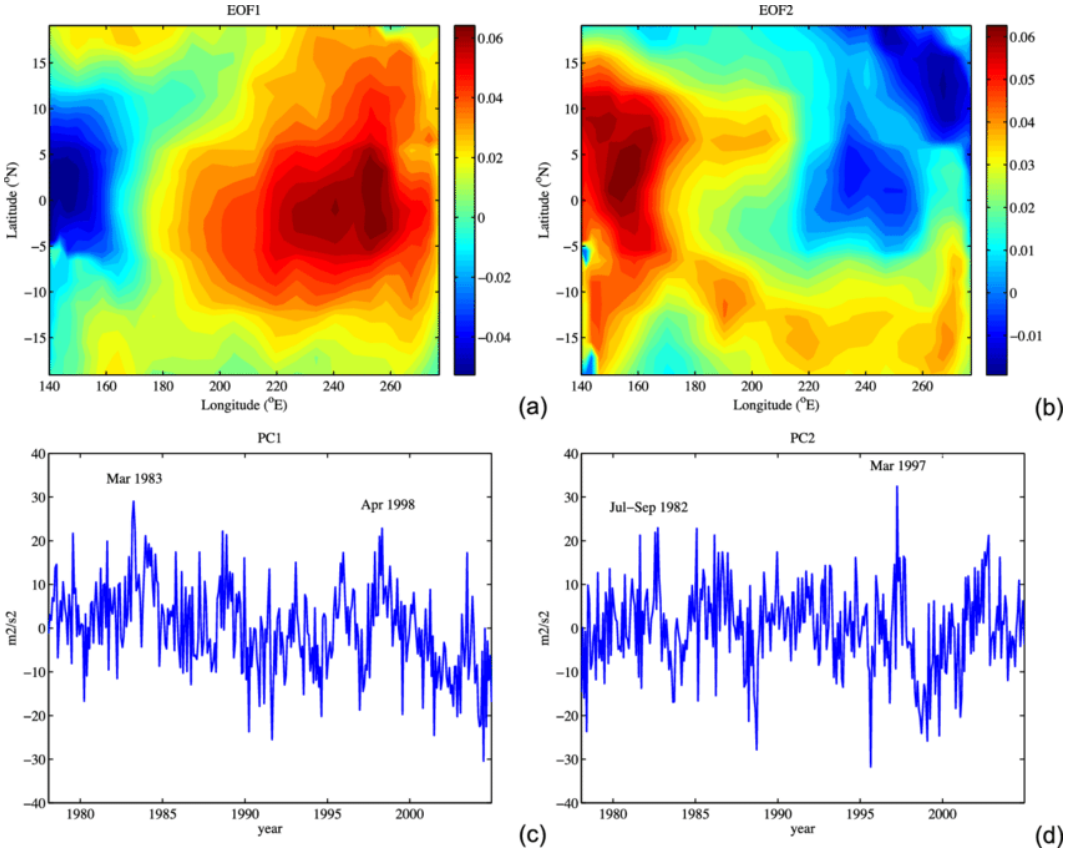
Methodology: Higth resolution records discriminations and imputations



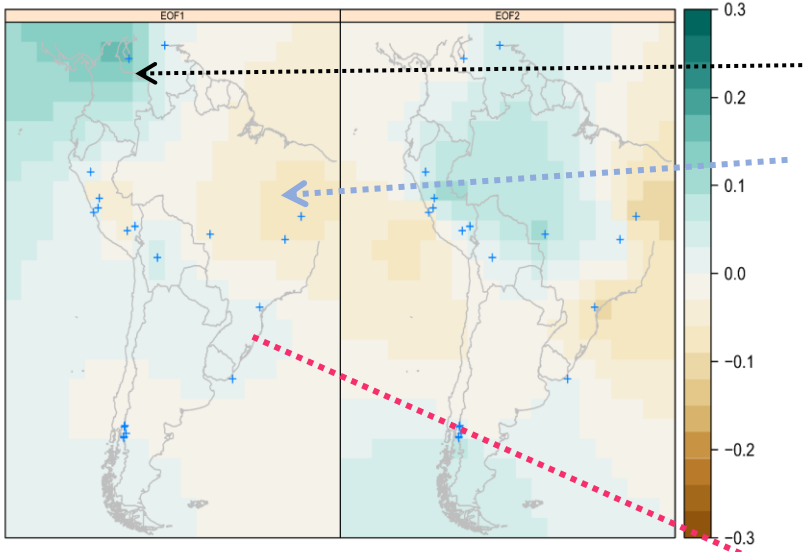
Exp.MWP:Records

Empirical Orthogonal Function

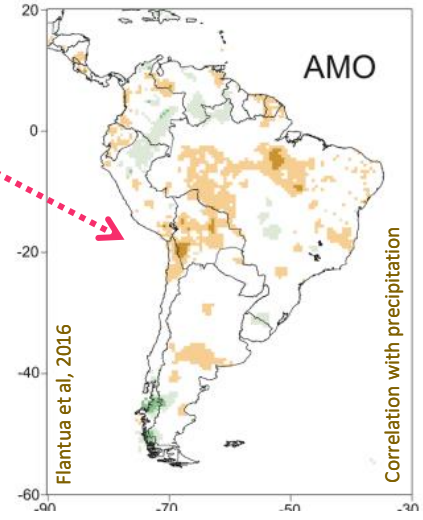
Empirical Orthogonal Function Analysis (EOF) is used in climate science to describe, reconstruct, and predict highly dimensional data fields. EOF provides us with spatial and temporal patterns of the dominant modes of variability.

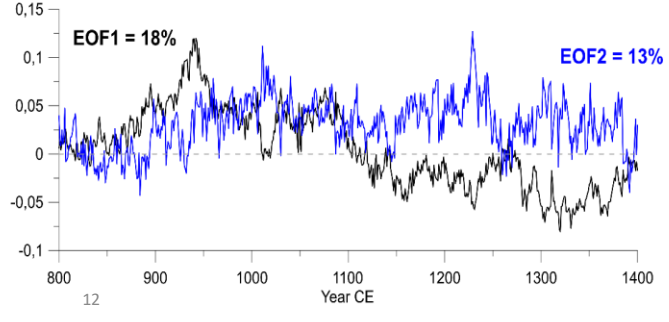


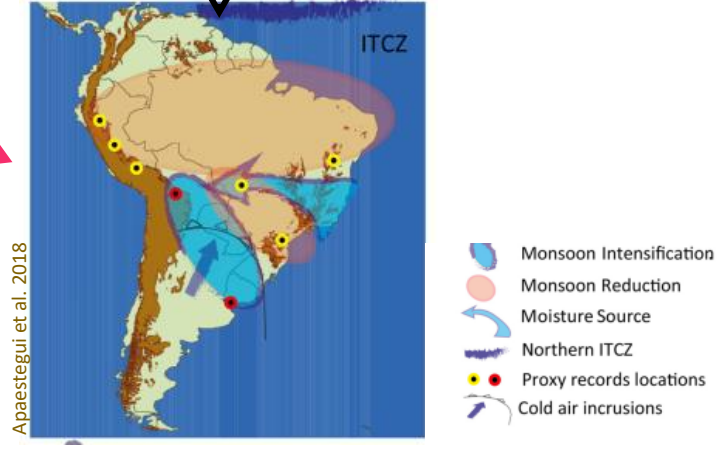
Medieval Climate Anomaly (MCA)



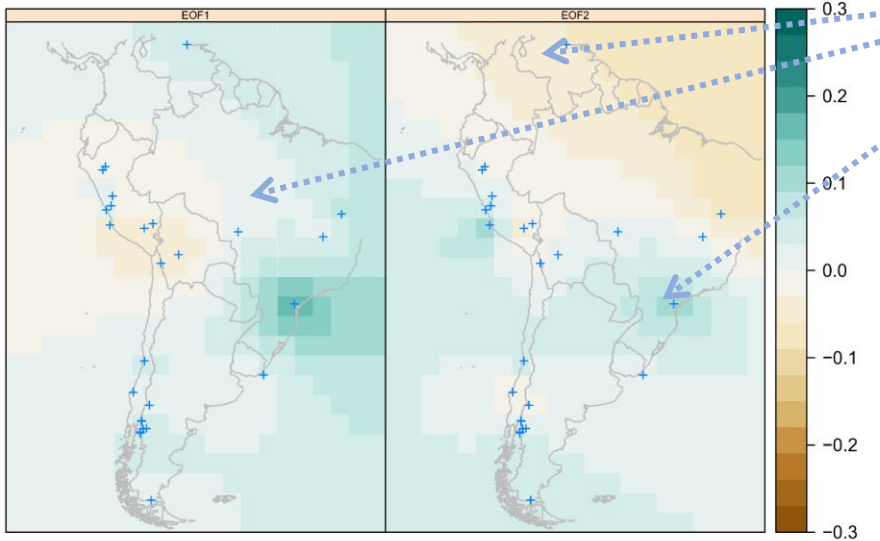
Scenario: AMO (+), Weakening of the South American monsoon / La Niña like conditions / migration of the systems (ZCIT, high) / ZCAS at west/ entry of moisture through the southern Atlantic

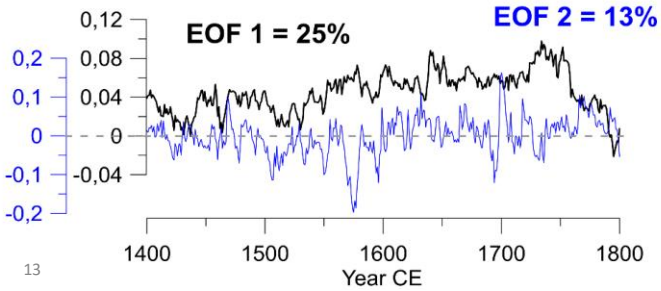




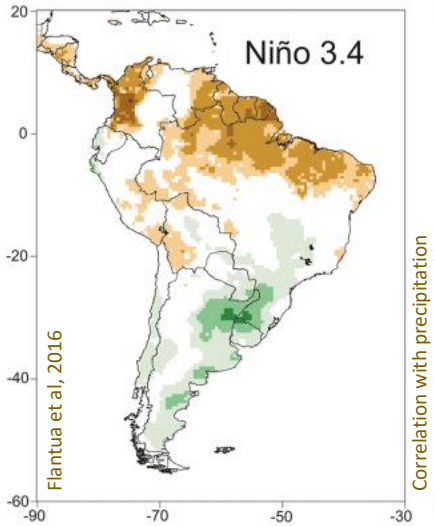


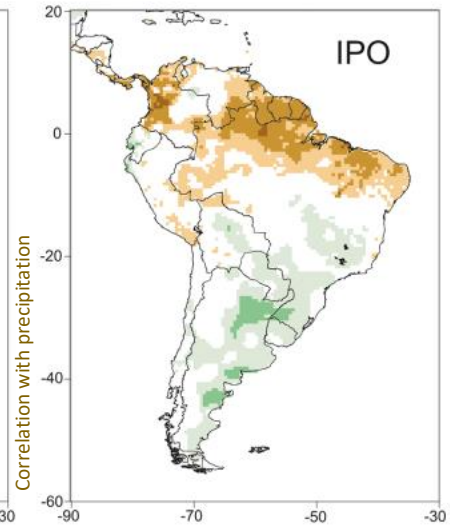
Little Ice Age (LIA)



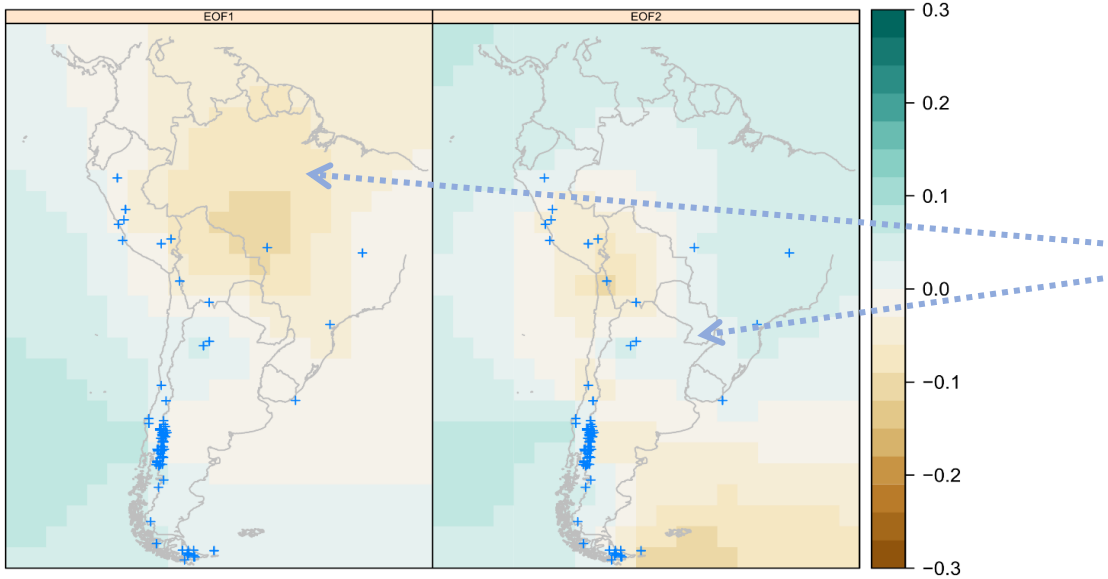


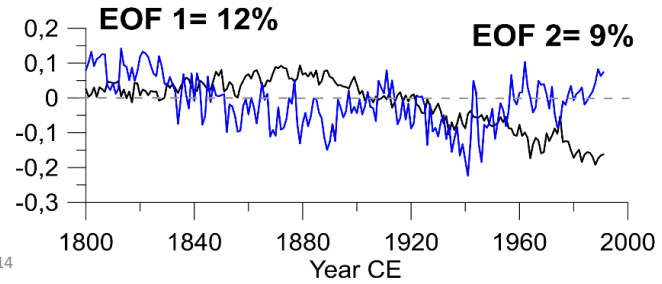
- SAMS +ZCAS strengthened (EOF1)
- ITCZ located to the south
- El Niño like/IPO conditions (EOF2)



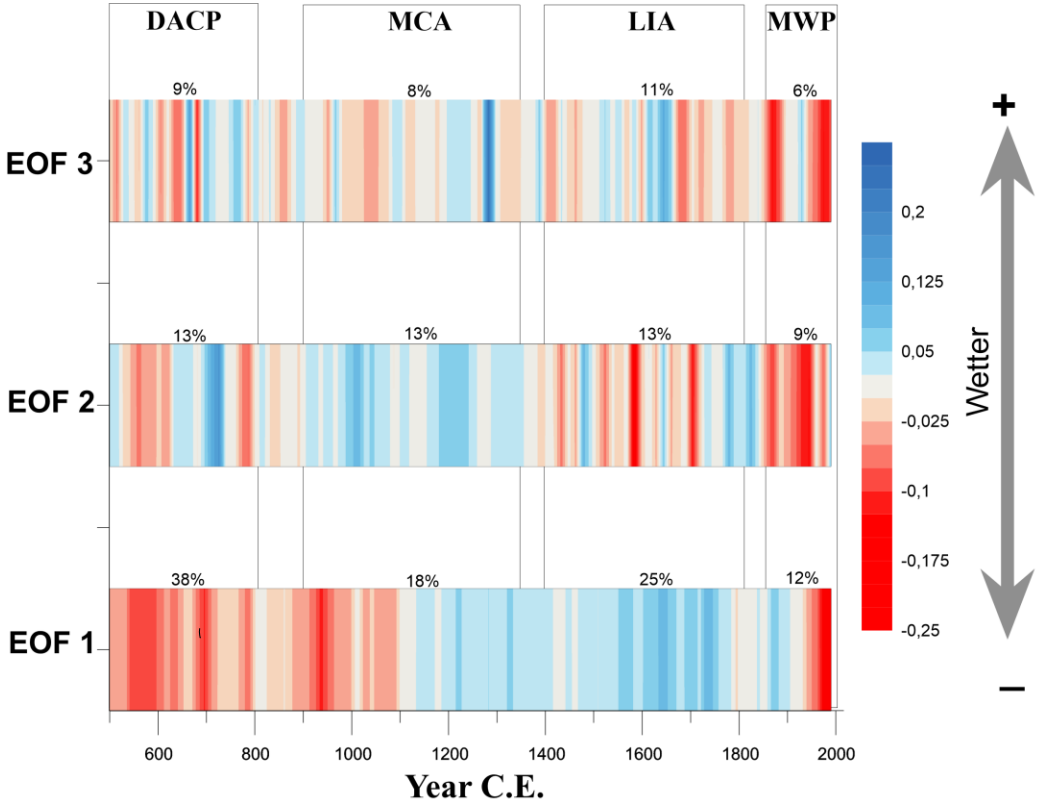


Modern Warm Period (MWP)





- The dominant pattern is more difficult to interpret
- Dominance of systems like SAMS and ZCAS → weakened?
- More El Niño like conditions
- Andes and Amazon basin with less precipitation (EOF1)
- Moisture source in south of continent



We arbitrarily joint the three first EOFs with their respective weights obtaining consistent time variability patters according to South America precipitation reconstructions(at least for the first EOF).

Conclusions

- Even more high-resolution data collection is needed, especially in northern South America and between 0 and 1000 AD where still do not have significant spatial coverage on the continent, which makes interpretation difficult for this period.

- The results show that the variability modes that most affect patterns, as well as the intensity and trend of precipitation, are associated with a multidecadal interplay between the expression of the AMO and IPO impacts, which can sometimes be expressed in tune or not strengthening / weakening precipitation in South America

- The intensity and extension of the periods depend on which mode of variability dominates and how the mechanisms are associated (ITCZ, High Level Pressure, SACZ position).

- There is an excellent match between the anomalies calculated in EOF2 and significant volcanic eruptions (at least V6) suggesting an important role for this mechanism in modulating precipitation in South America (data not shown here). This also strengthens the interpretations based on our EOFs.

Thankyou