Hydroclimate variability in the Tropical Andes (Perú – Bolivia) during the last 1000 years inferred from stables isotopes and trace elements in Speleothems

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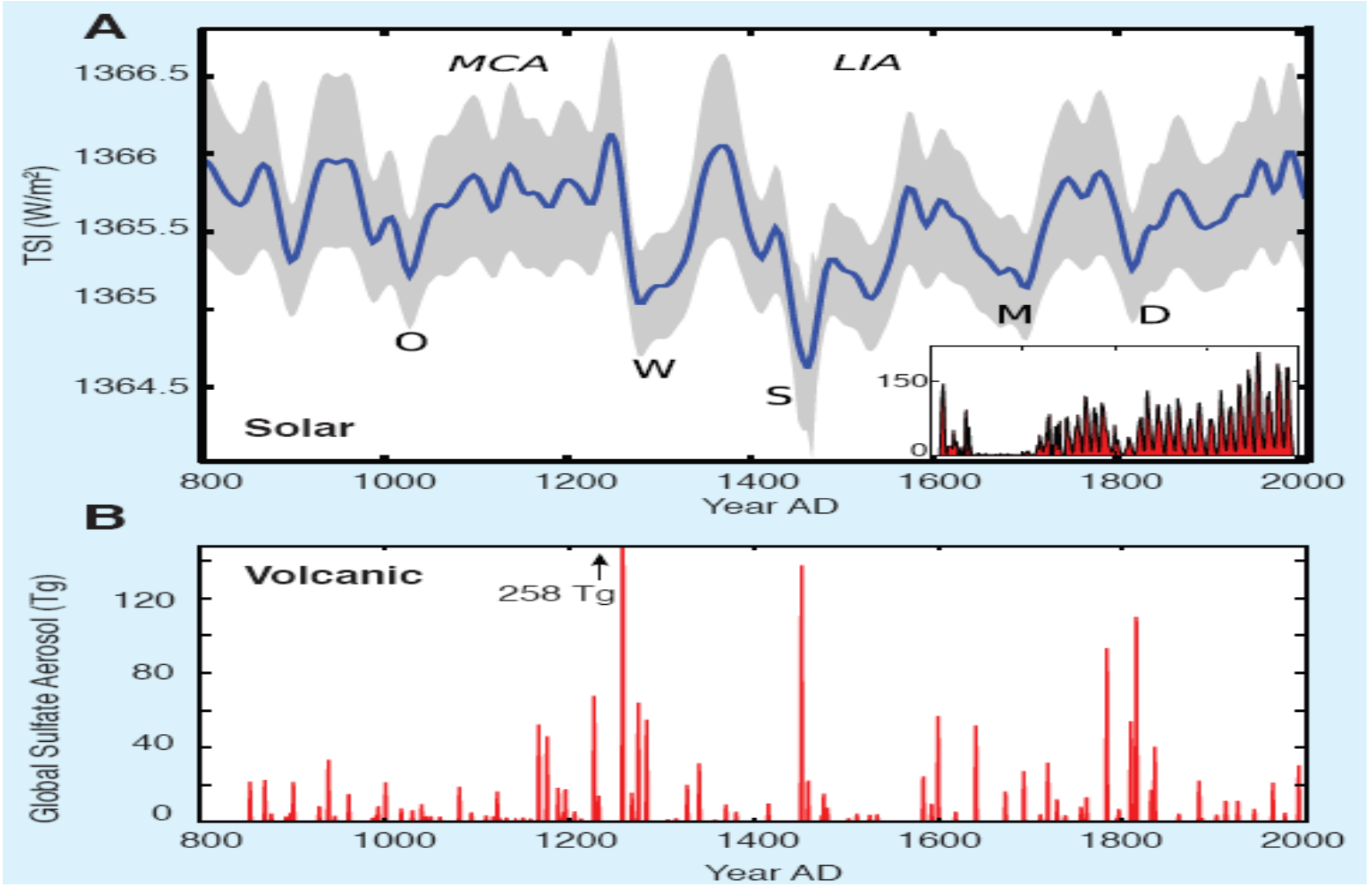
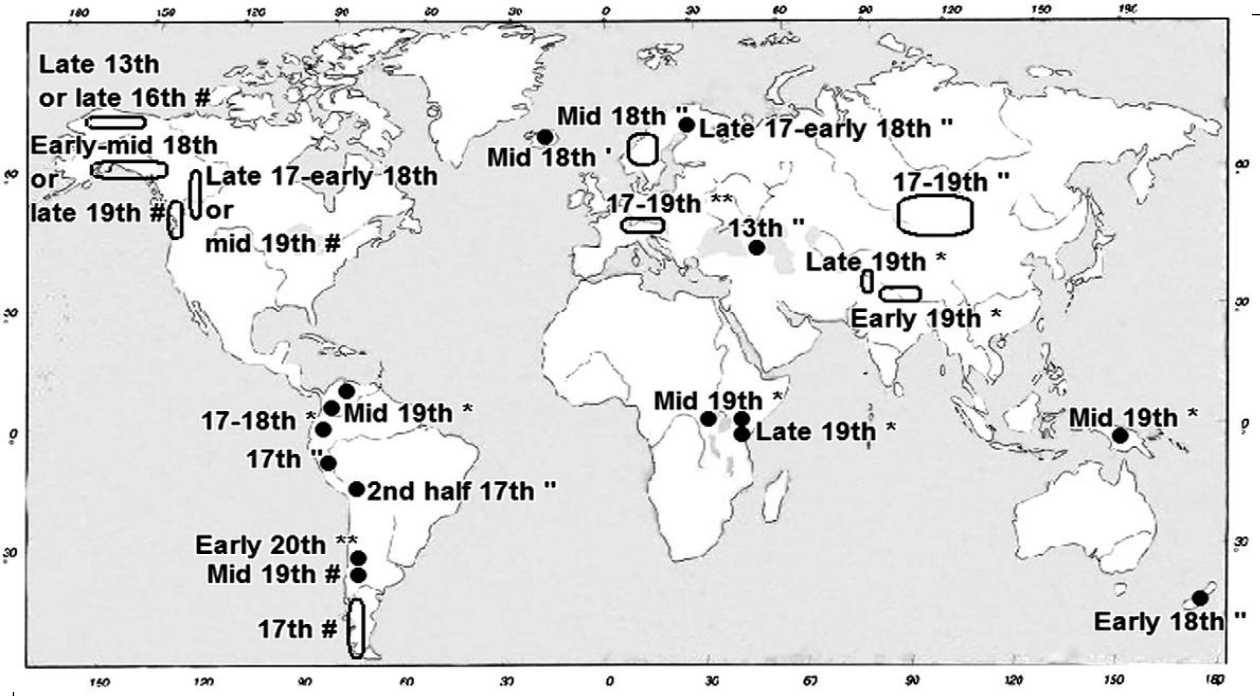
Introduction

- Global Climate Events in the last millennium (MCA – LIA)
- South American Monsoon System (SAMS)
- Speleothems and enviromental Paleoclimate
- How calcite $\delta^{18}O$ reflects rainfall in the tropical Andes
- Study Area
- Preliminary results and discussion
- Conclusions and future remarks

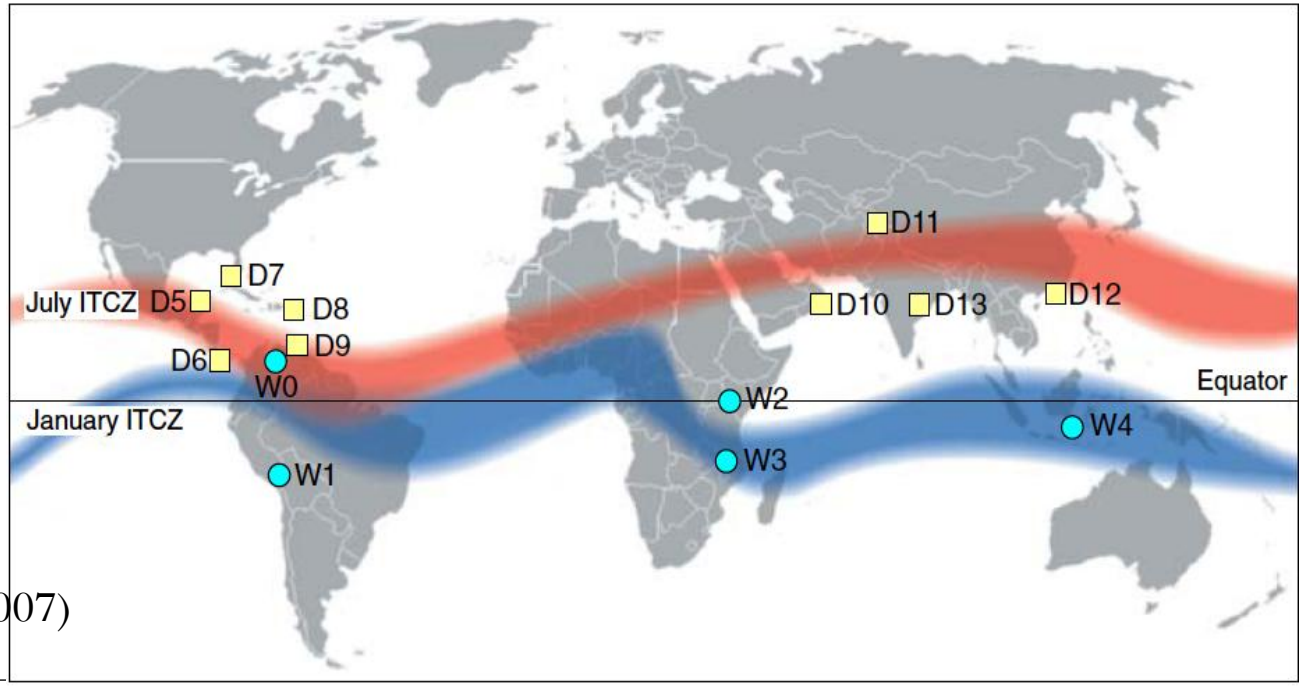
Climate Variability in the last Millenium

- Medieval Climate Anomaly (MCA)
- Little Ice Age (LIA)



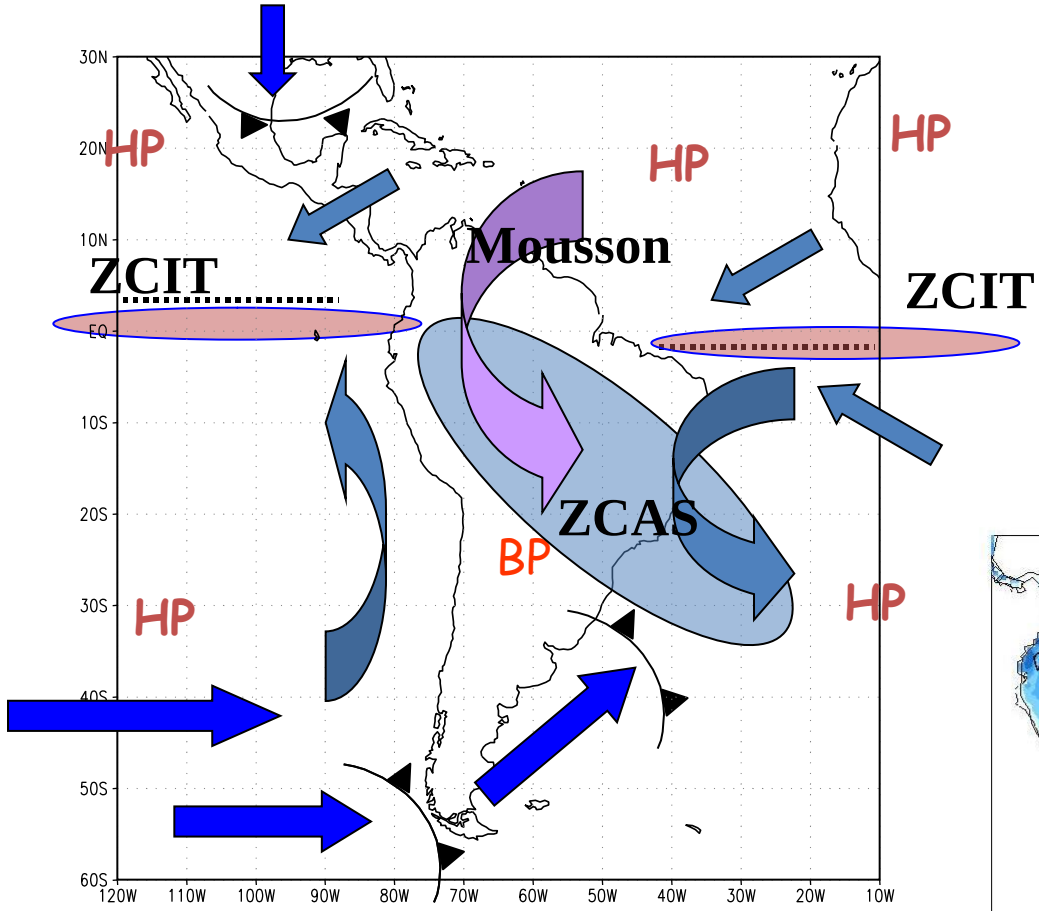


(Rabatel *et al.*, 2008)



(Newton *et al.*, 2006; Kirkby, 2007)

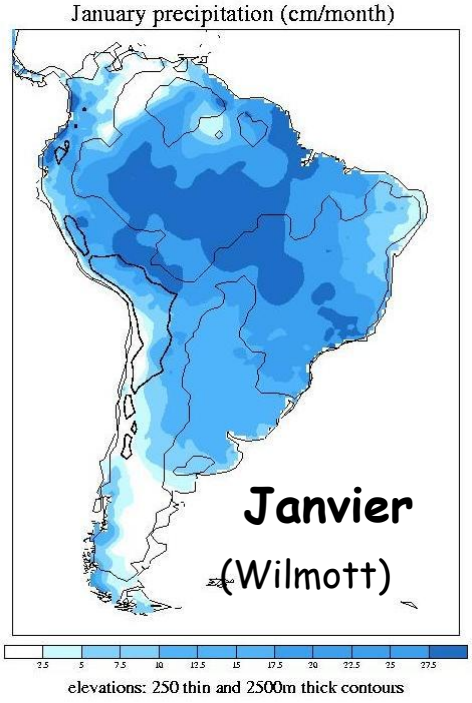
Circulacao e Chuvas no verao austral



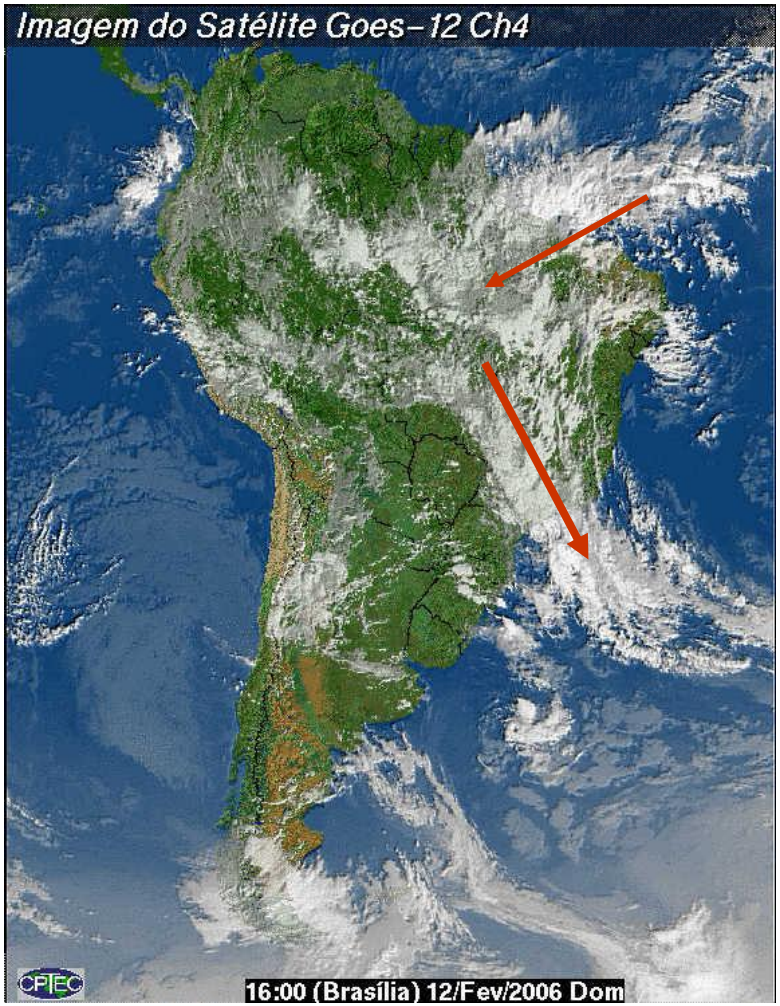
Circulation extra-tropicale

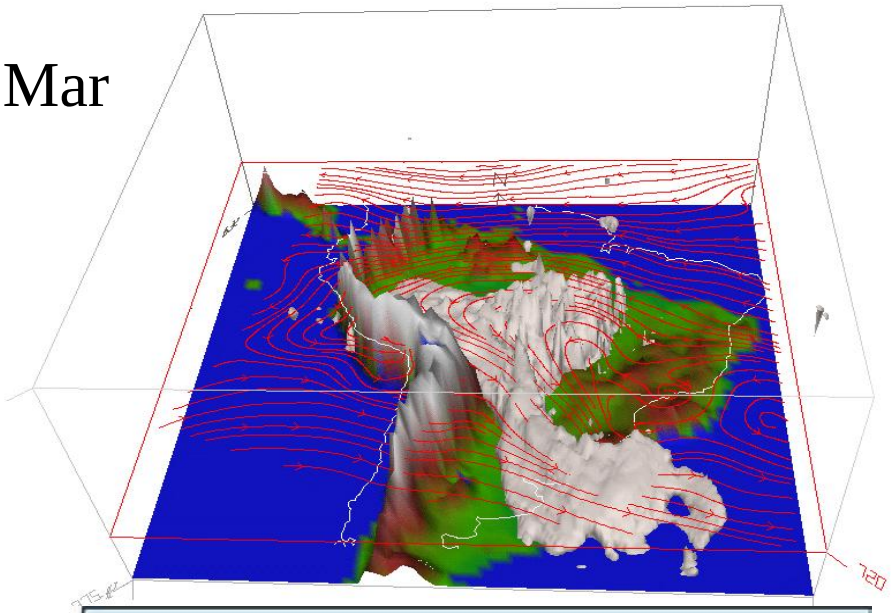
Alizés

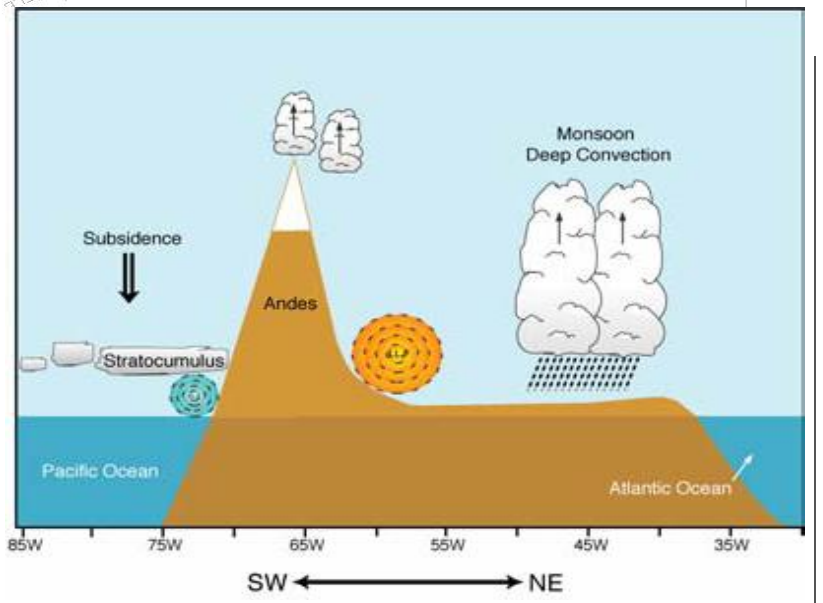
Mousson



Mecanismo: Δ T = Continente - Sup. Mar

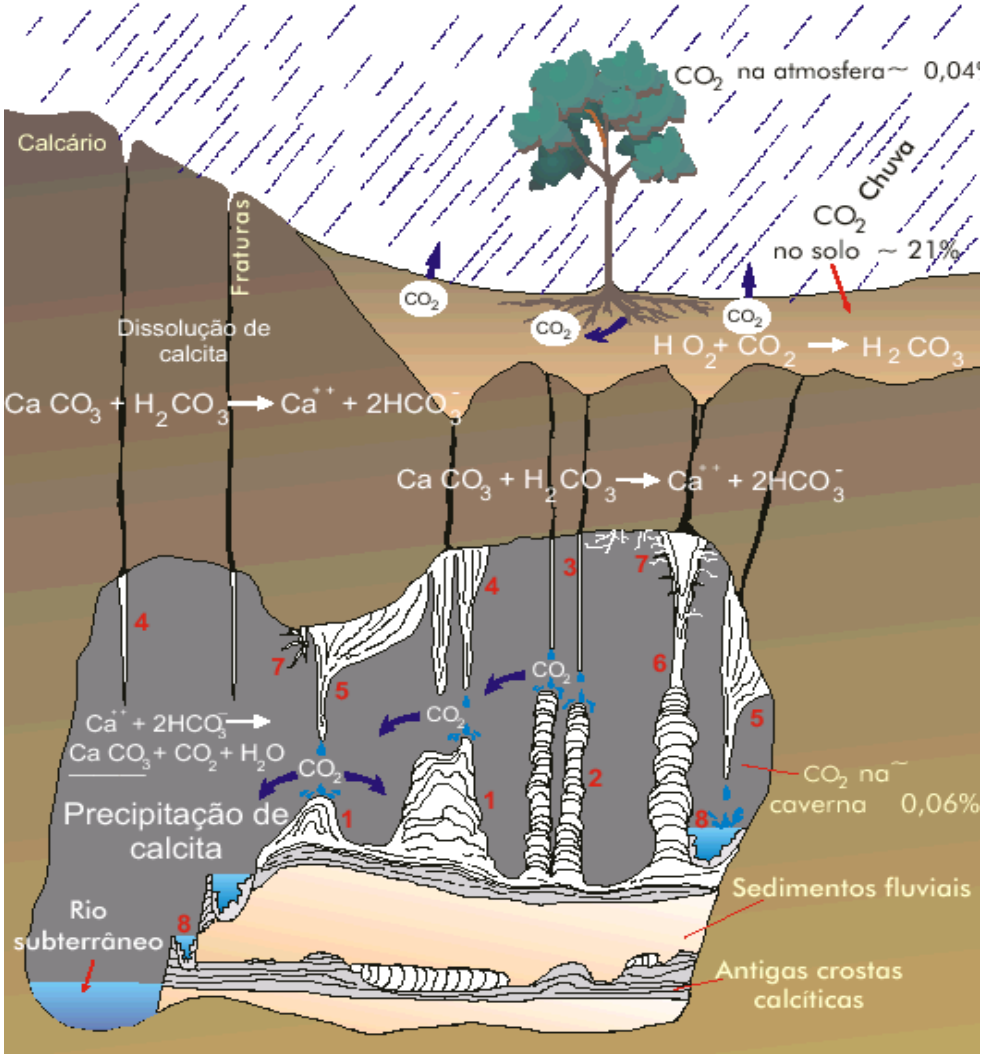


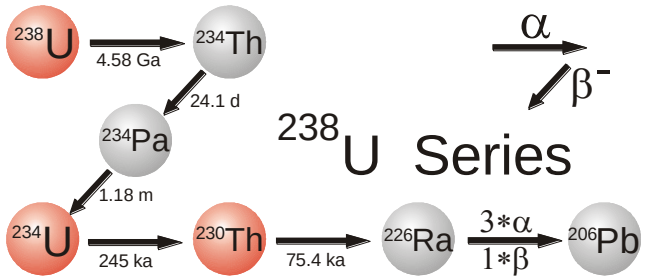




No particular, o gradiente termico entre a superficie e oceano, gera uma serie de depressoes e ascendencas do vento alimentadas por um fluxo de ar humido trans equatorial provenente do oceano produzindo precipitacoes intensas ate latitudes Subtropicais **(Monção = Sul Americano).**

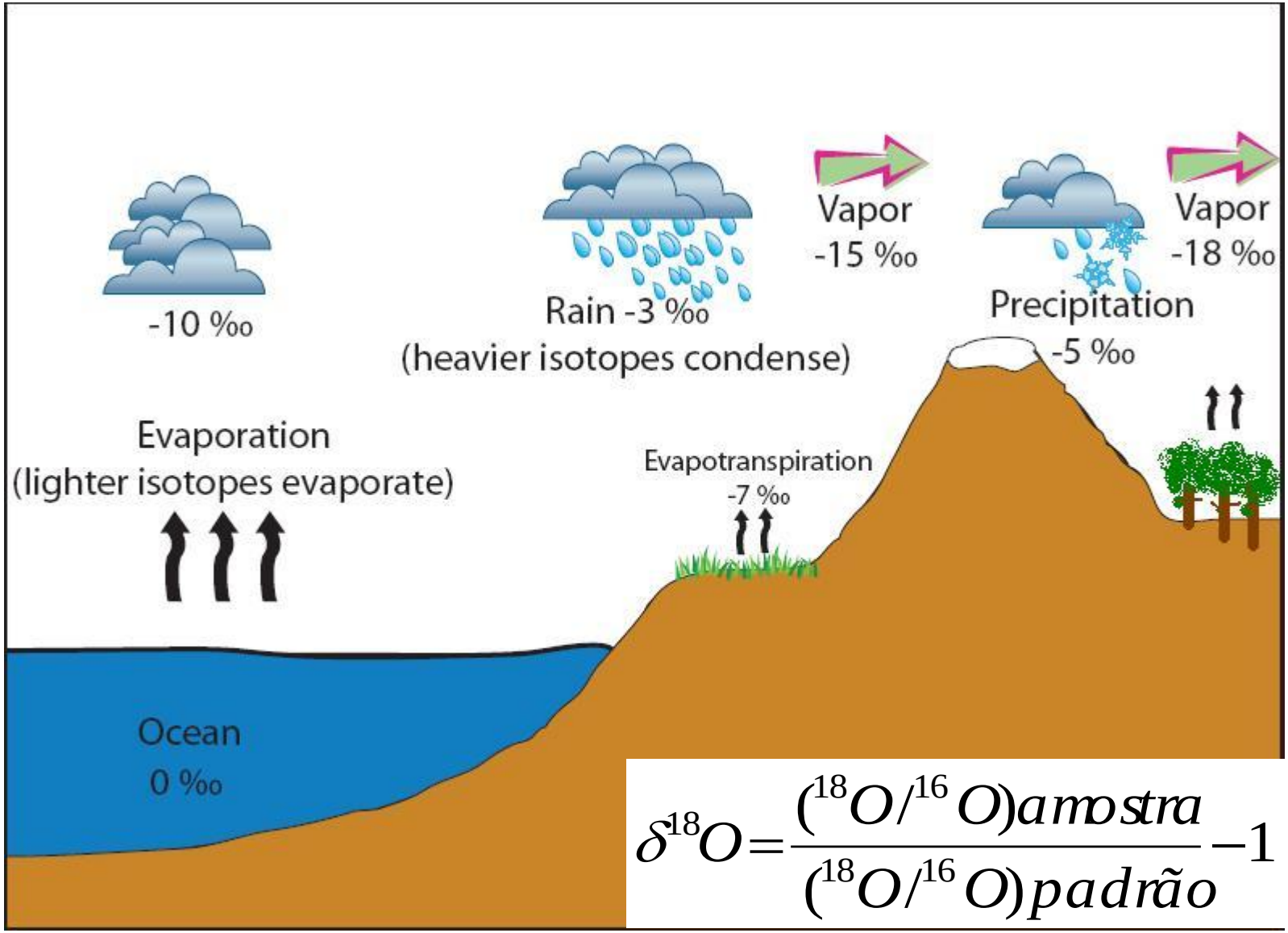
Speleothems and enviromental Paleoclimate





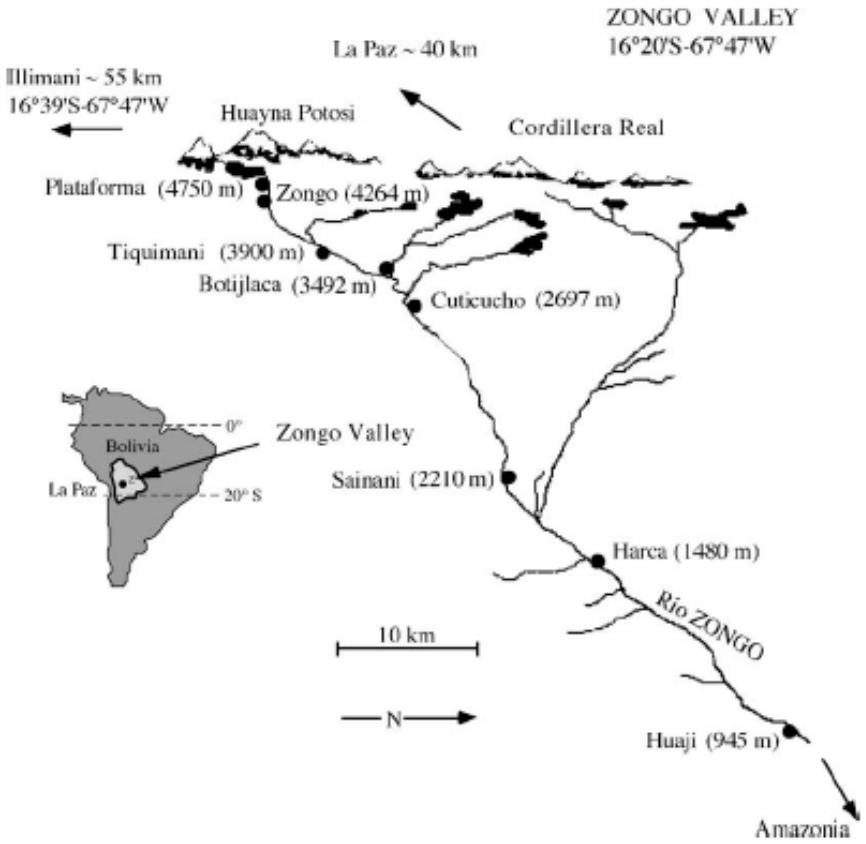
$$\delta^{18}O = \frac{(^{18}O/^{16}O)_{sample} - {}^{18}O/^{16}O)_{VPDB}}{(^{18}O/^{16}O)_{VPDB}}$$

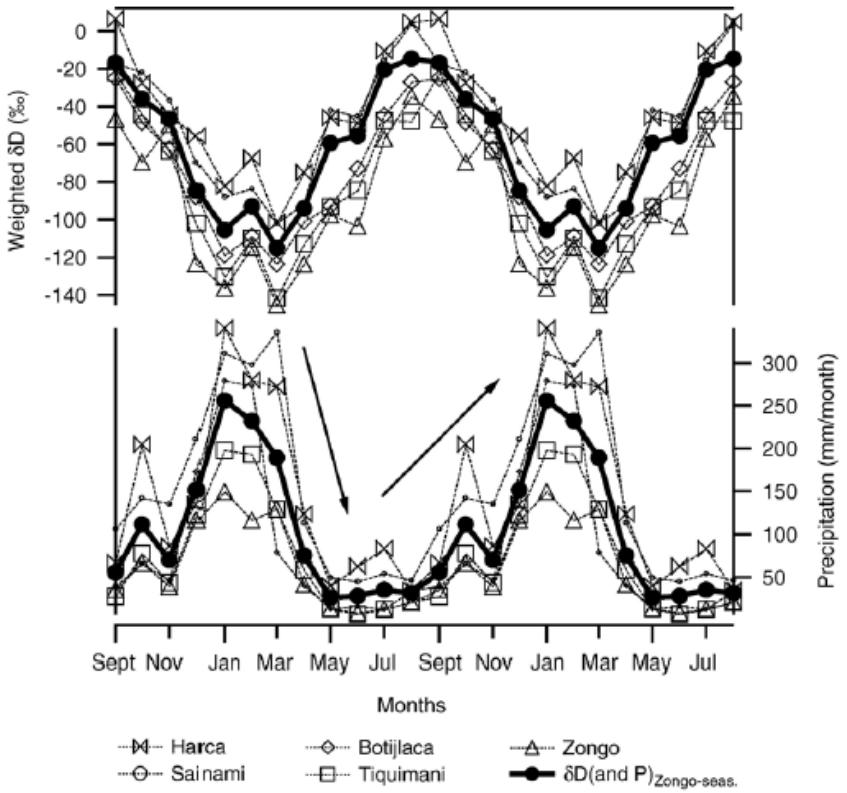
“Rain fall amount” effect



$$\delta^{18}O = \frac{(^{18}O/^{16}O)amostra}{(^{18}O/^{16}O)padrão} - 1$$

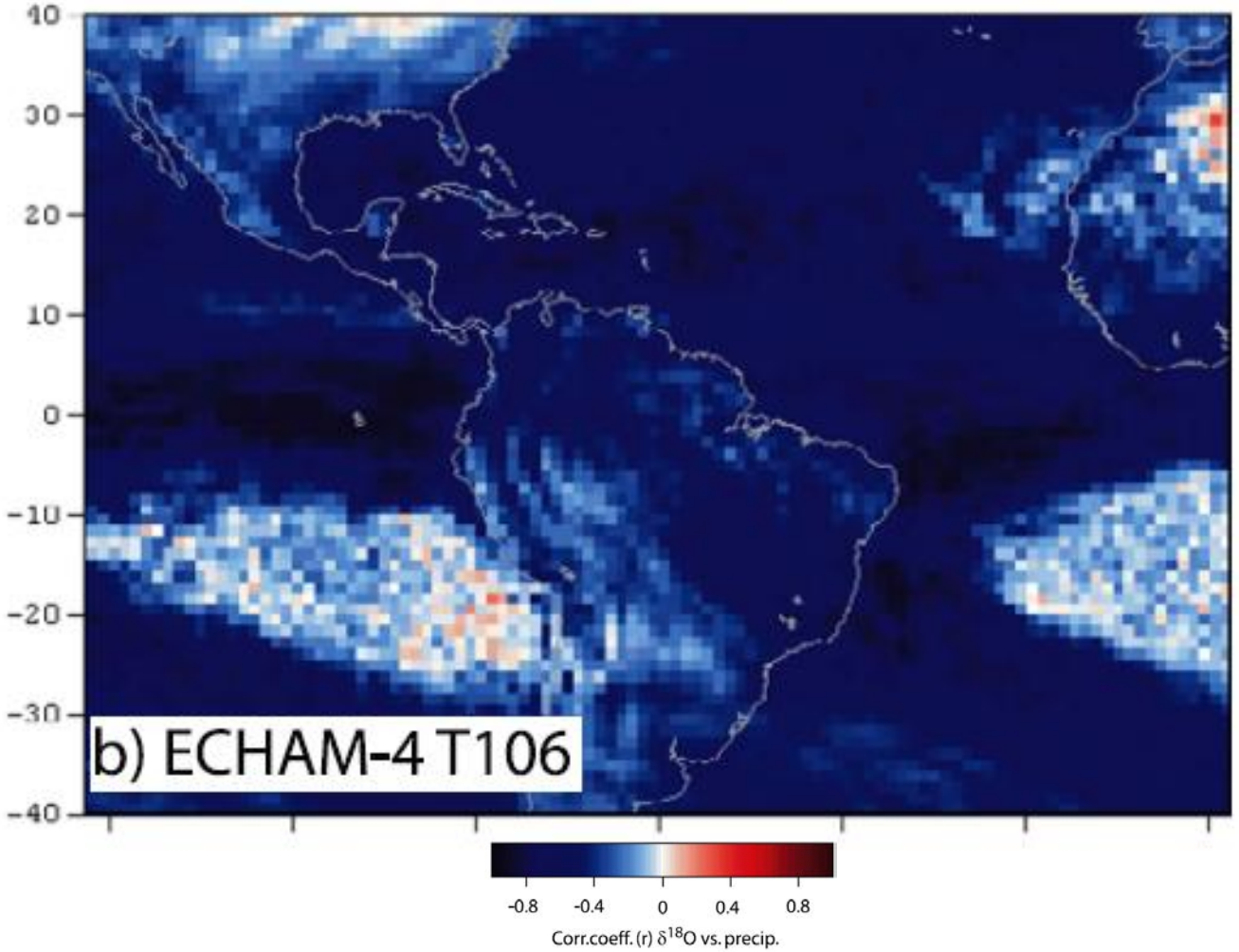
Altitude effect





o Valley (Bolivia) with the locations of the 8 pluviometers at Huaji (945 m), Harca (1480 m), Sainami (2210 m), Cuticucho
92 m), Tiquimani (3900 m), Zongo (4264 m) and Plataforma (4750 m).

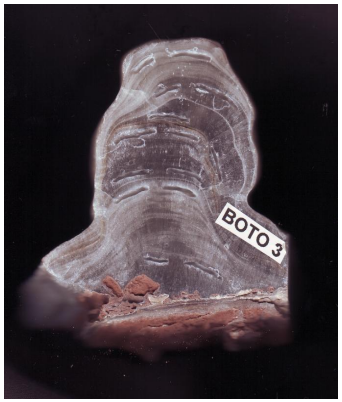
Modelo Geral de Circulação Atmosférica (AGCM)



Global Network Isotope Precipitation (GNIP), IAEA

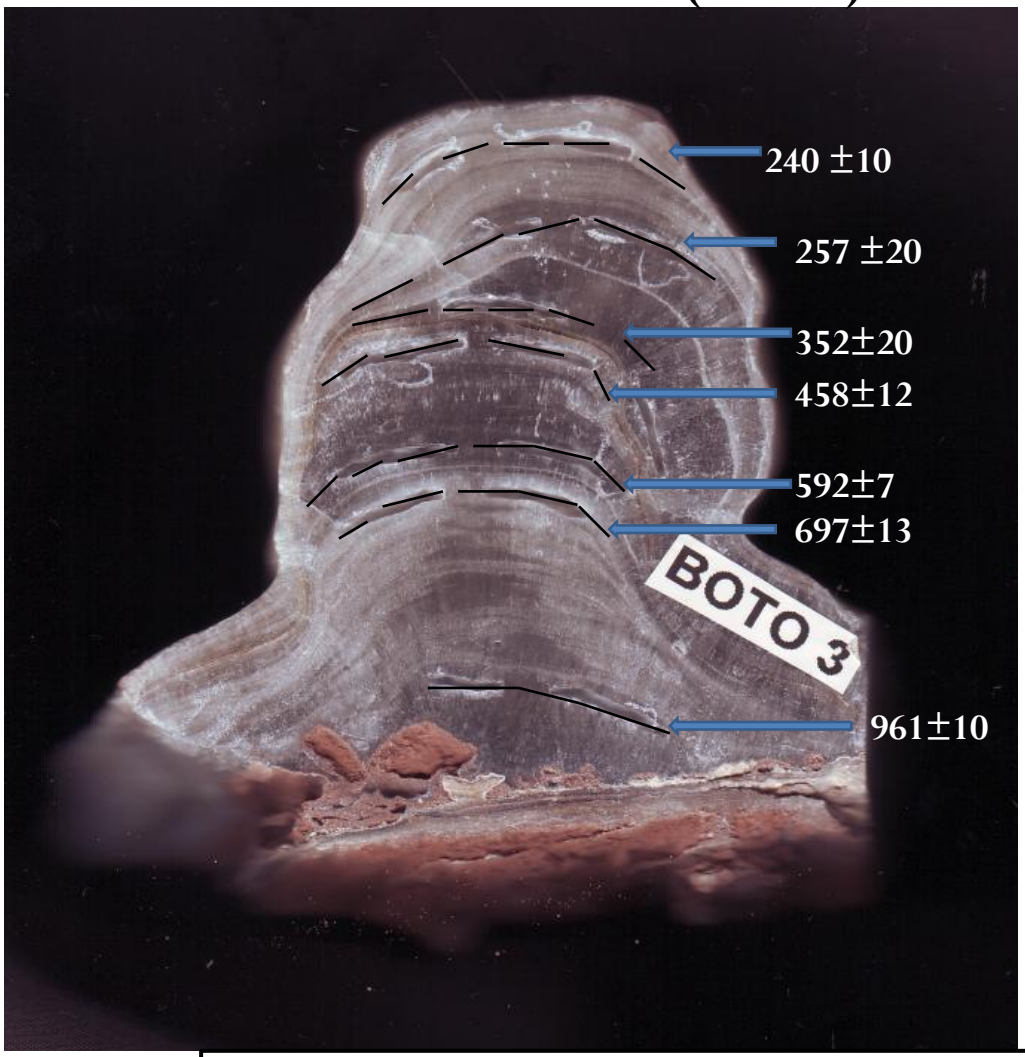
Study Area and caves

Palestina Cave

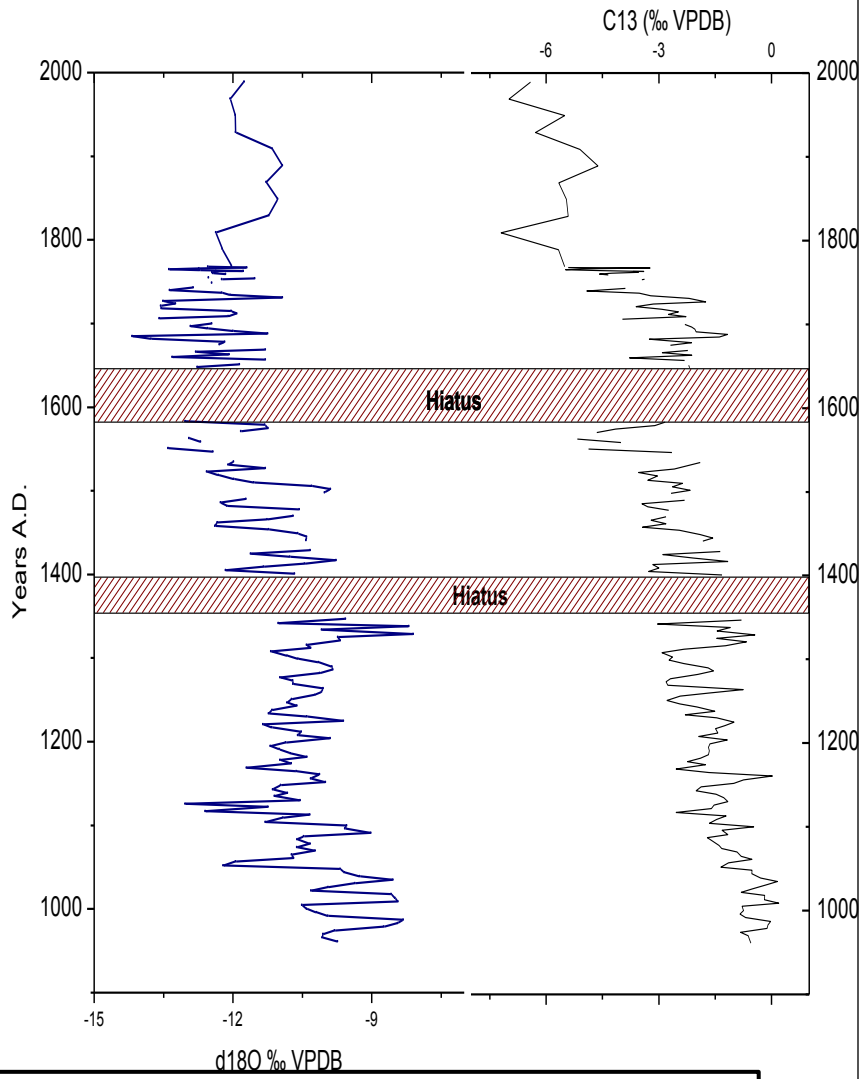


Chiflonkhakha Cave

Bolivian Sample (Chiflonkhakha Cave)
Torotoro National Park (Bolivia)



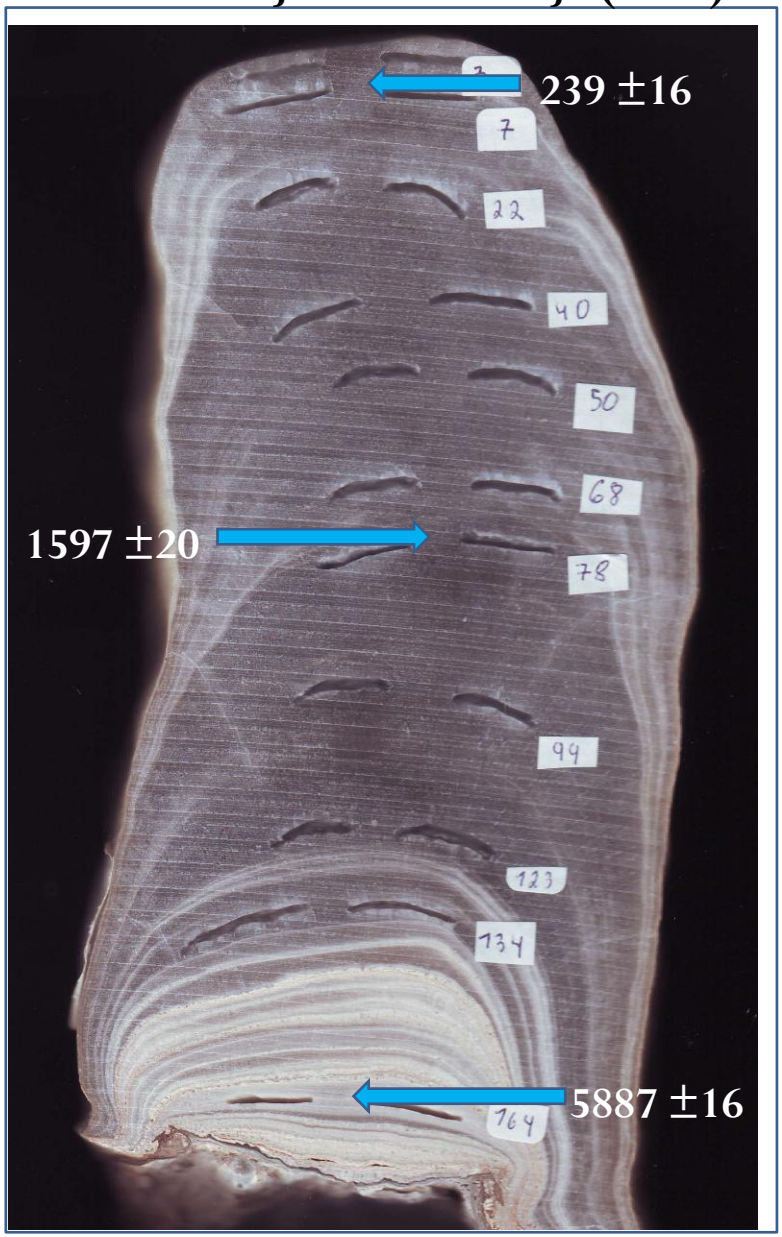
Preliminary results



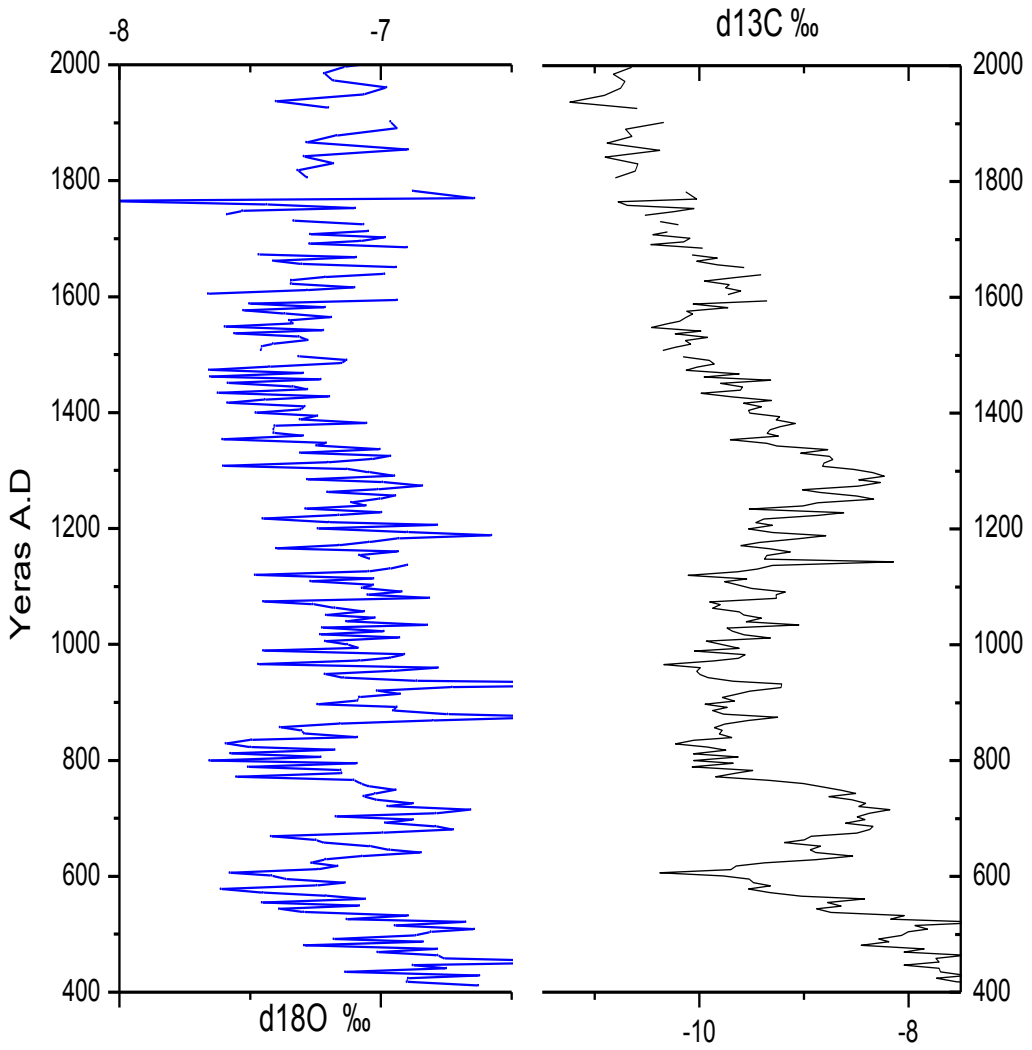
2 hiatus discovered.
(since 1583 to 1645 years A.D) ~64 yrs
(Since 1351 to 1401 years A.D) ~50 yrs

Oxigen Isotope Sampled resolution:
~0.4 mm
Mean temporal resolution of the data obtained:
~ 5 years

Peruvian Sample (Palestina Cave)
Nueva Cajamarca – Rioja (Perú)

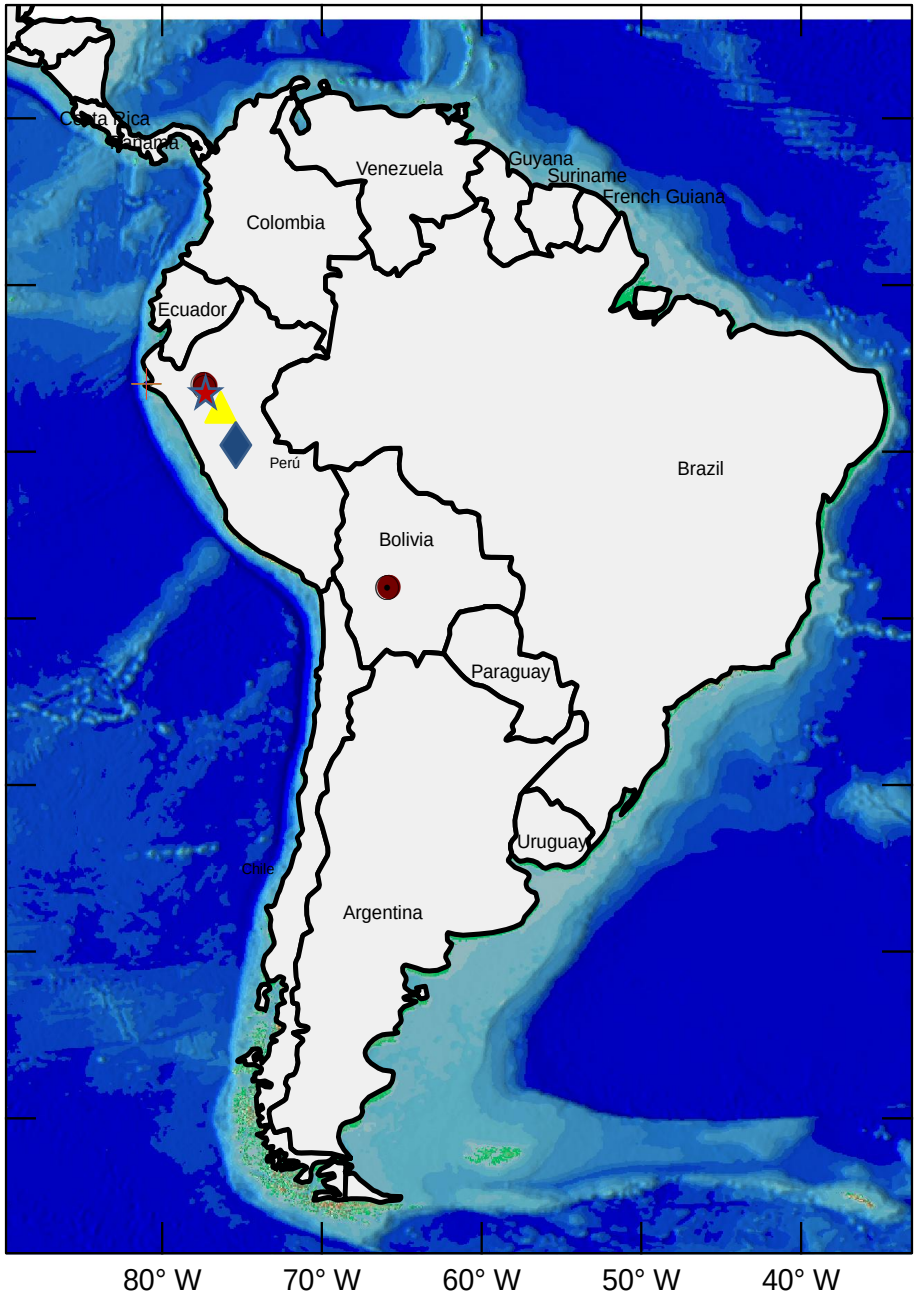


Preliminary results



Future age model:
Include 7 points from the top to the 1597 age.
Sampled resolution for stable Isotopes: 0.3 mm
Mean temporal resolution of threshold data: 8 years

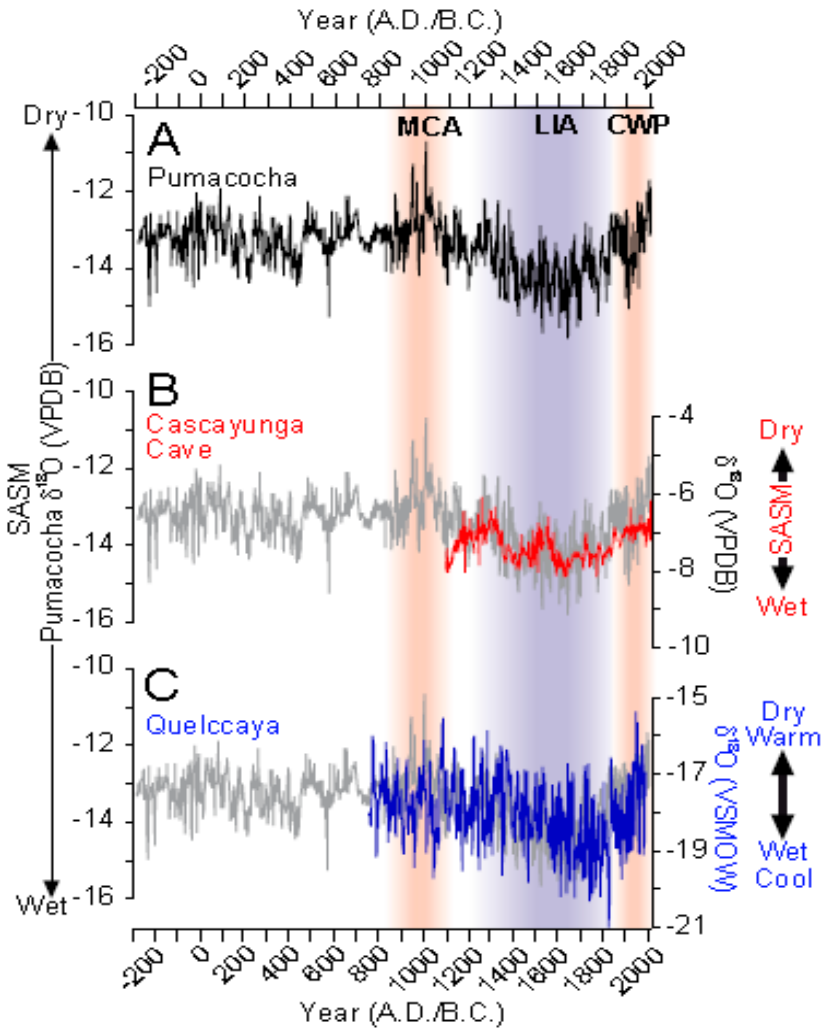
Comparission with other proxis in South America



Pumacocha Lake (Bird et al, 2011) (PNAS)

Quelccaya Ice core (Thompson et al, 1984) (Science)

Cascayunga Cave (Reuter et al, 2009) (GRL)



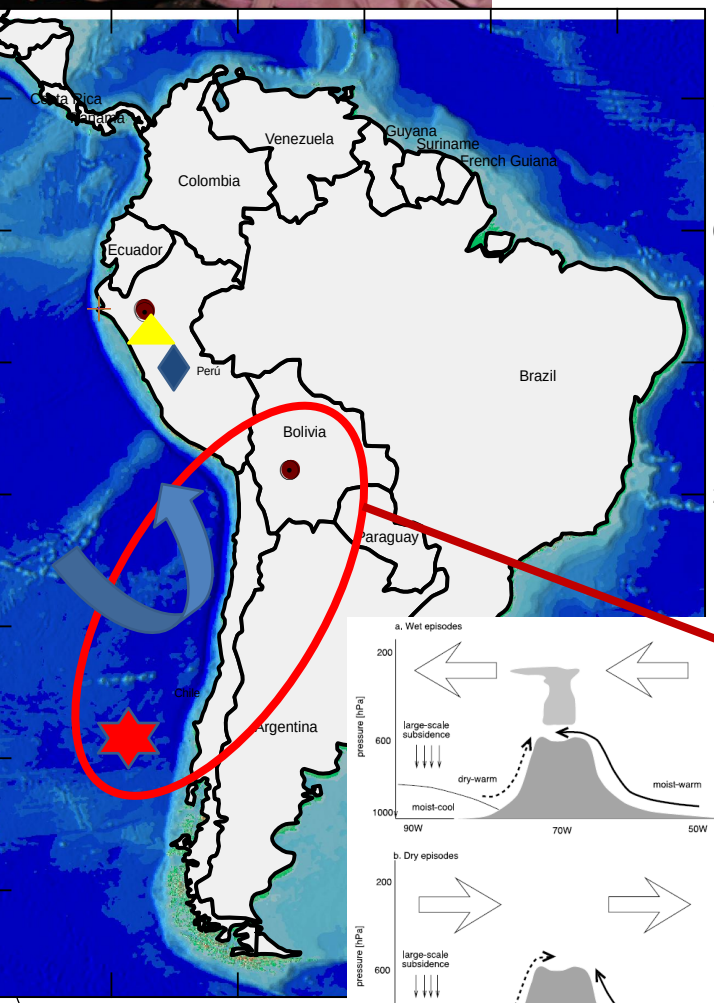
(Bird et al, 2010)

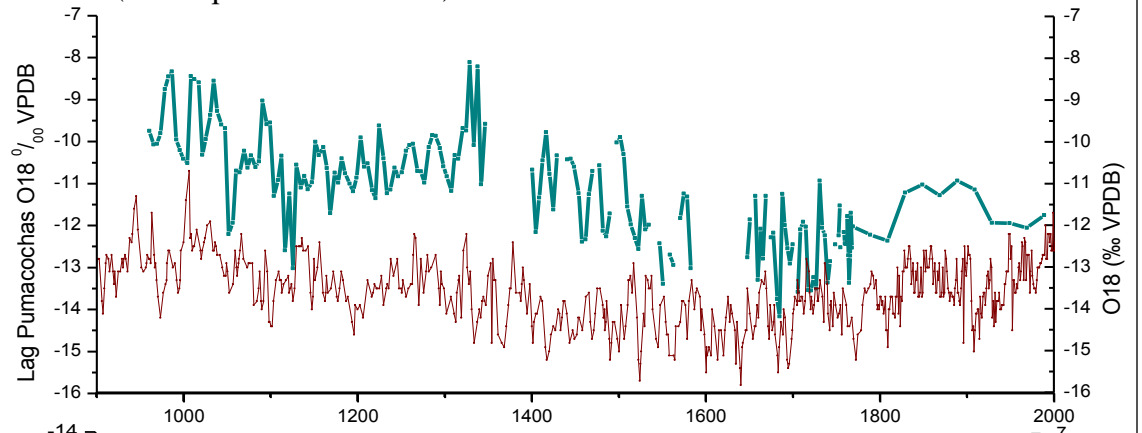
Lamy et al, 2001 . 2002 (EPSL)

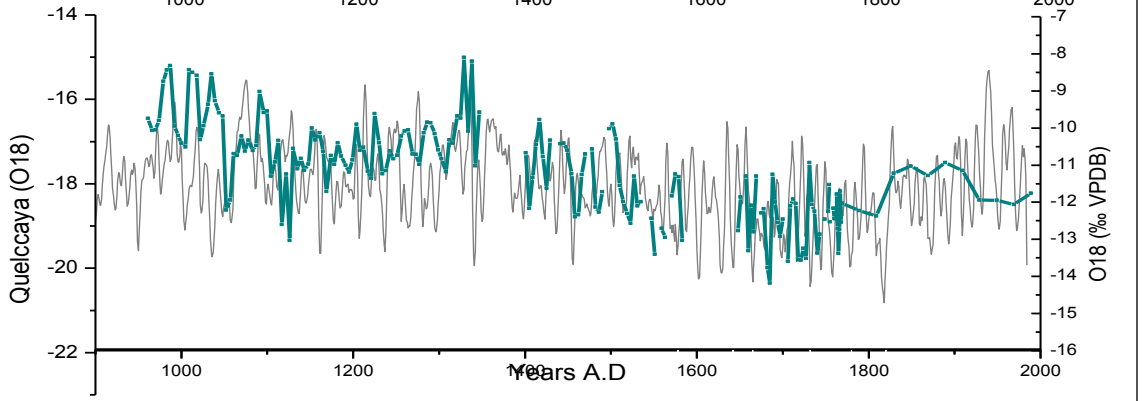
Pumacocha Lake (Bird et al, 2011) (PNAS)

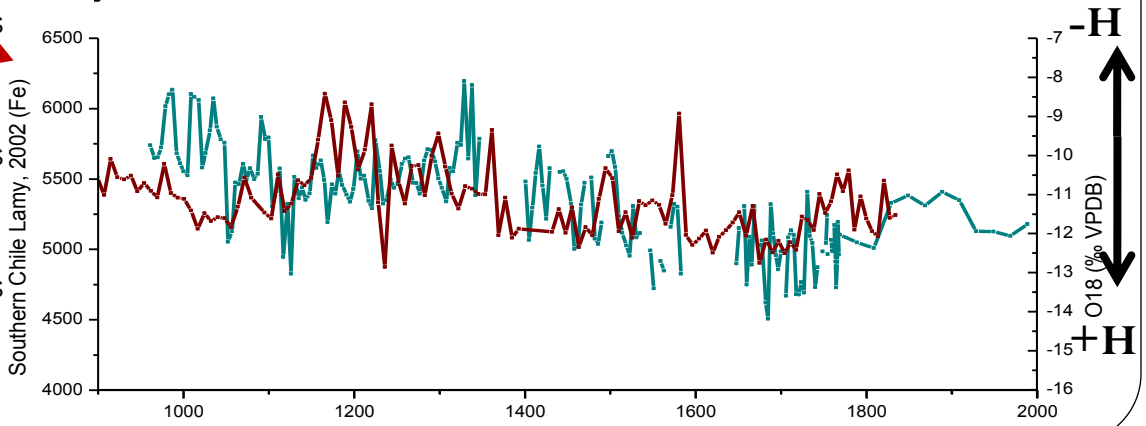
Quelccaya Ice core (Thompson et al, 1984) (Science)

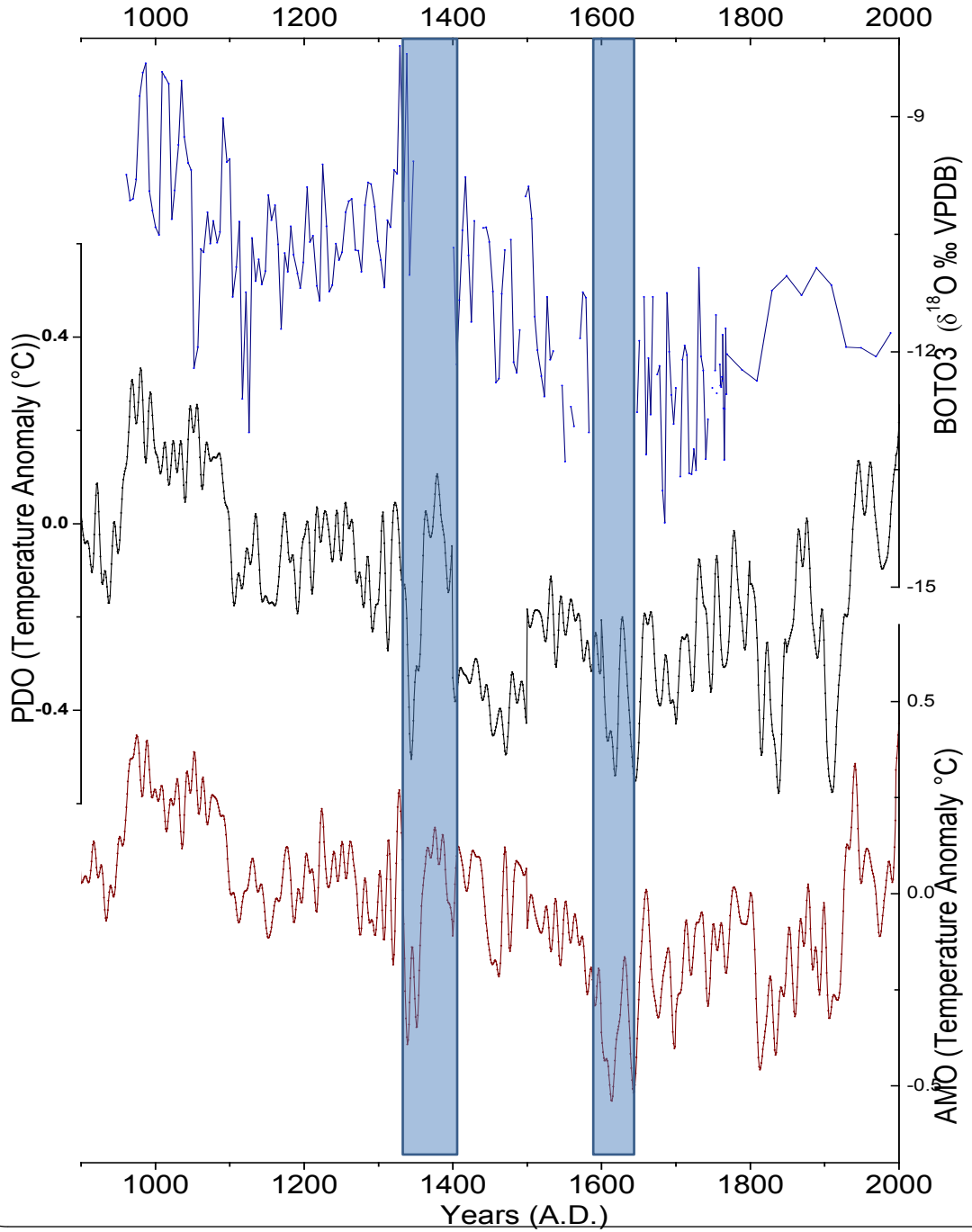
Prelimimary results







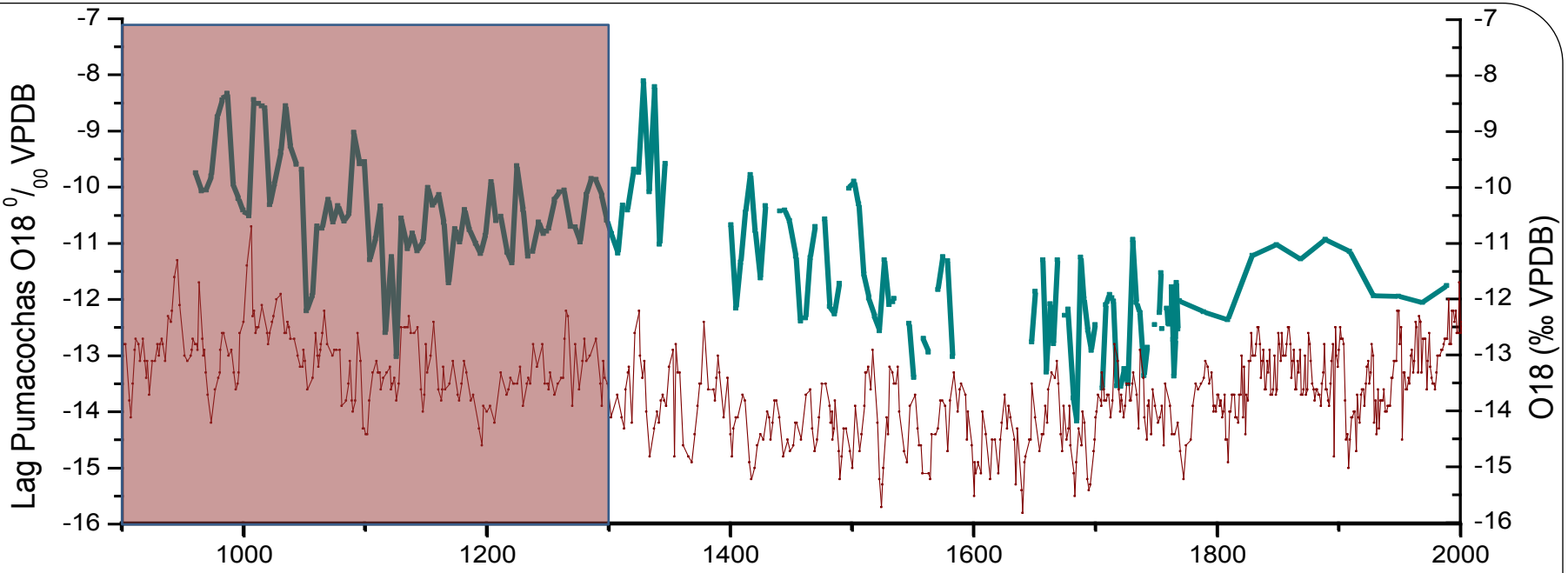


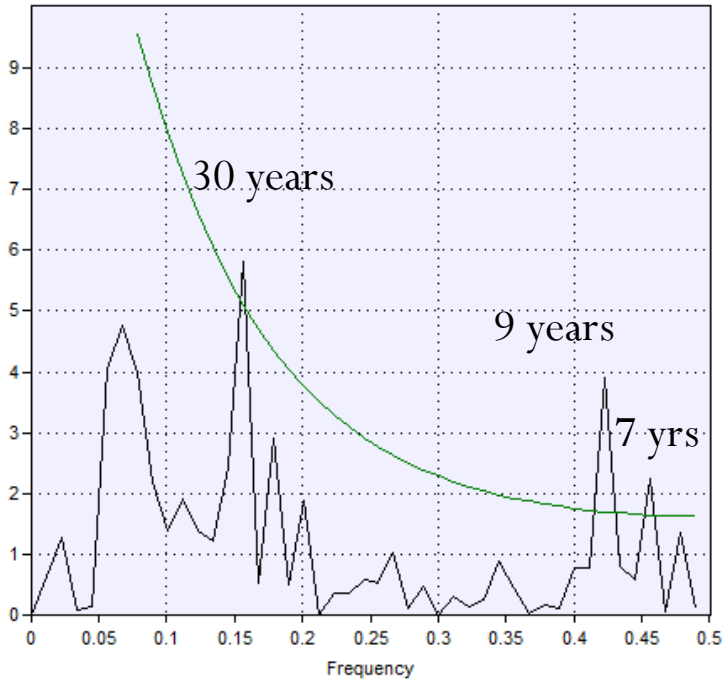


Multidecadal and Centenial Variability
(AMO, PDO - Mann et al, 2009)

Strikling relation to oceanic modes of Variability.

Hiatus discovered in BOTO-3 seems to be related to abrupts wet events:
- Dark Layer at the hiatus suggest inundation events in cave enviroment





MCA (950 – 1350 years A.D.)

Conclusions and future remarks

- Rainfall Variability in the Eastern side of Tropical Andes related to:
South American Monsoon System
Multidecadal Variability (AMO –PDO)
Antartic Gradient?????

- Trace Elements: Mg/Ca, Sr/Ca → Higher resolution

- Monitoring cave enviroment (Palestina Cave)

- Holocene → CAS-1

Gracias

Obrigado

Merci

Thank you