Palaeoclimate evidence in the Mediterranean area; climate variability and extremes Part I

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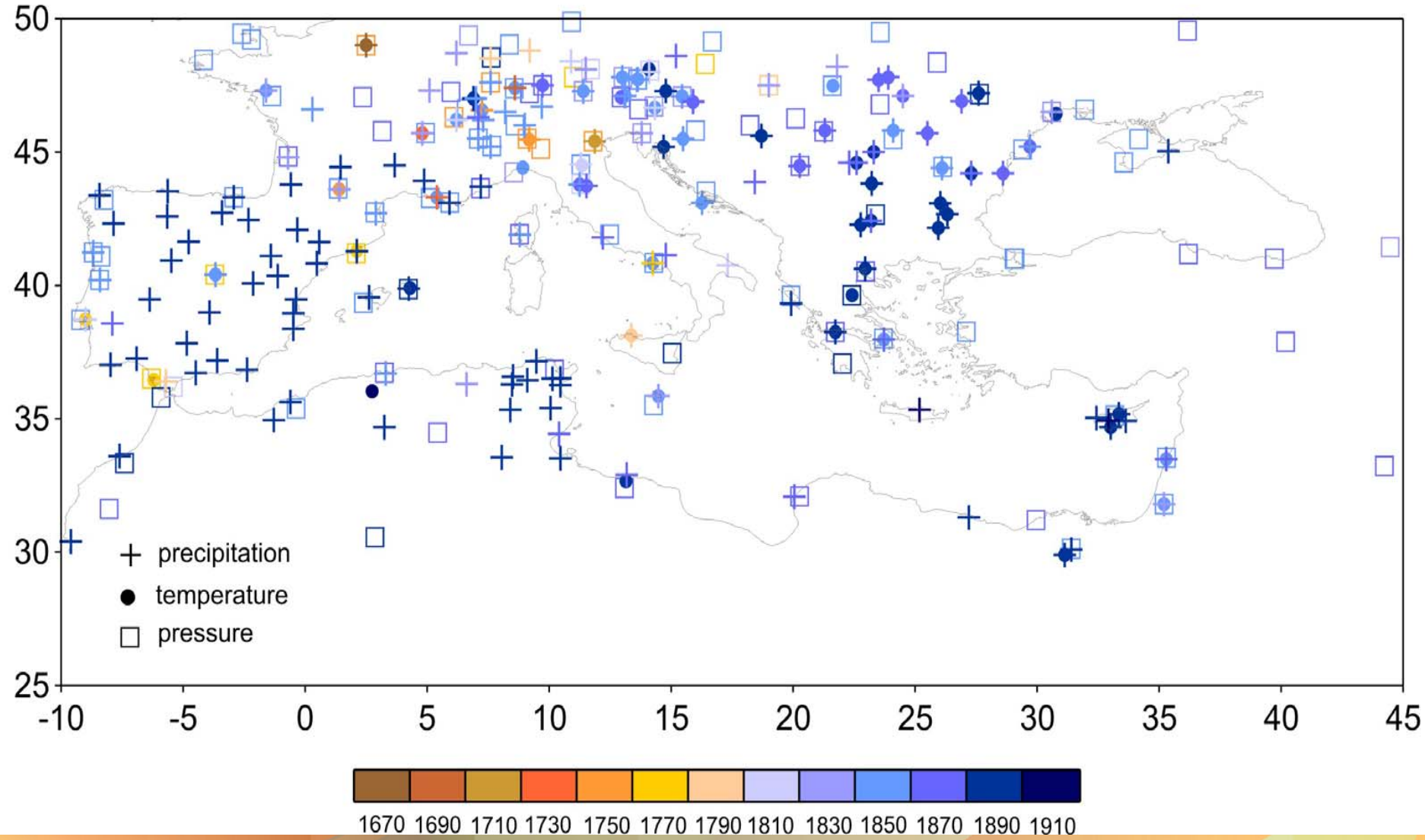
Outline

- Introduction, importance of Palaeoscience for global change research
- Past climate information from terrestrial and marine archives; examples from Greece and other Mediterranean regions
- Conclusions, future challenges and needs

Long > 100 years of monthly Temperature, Precipitation and Pressure series

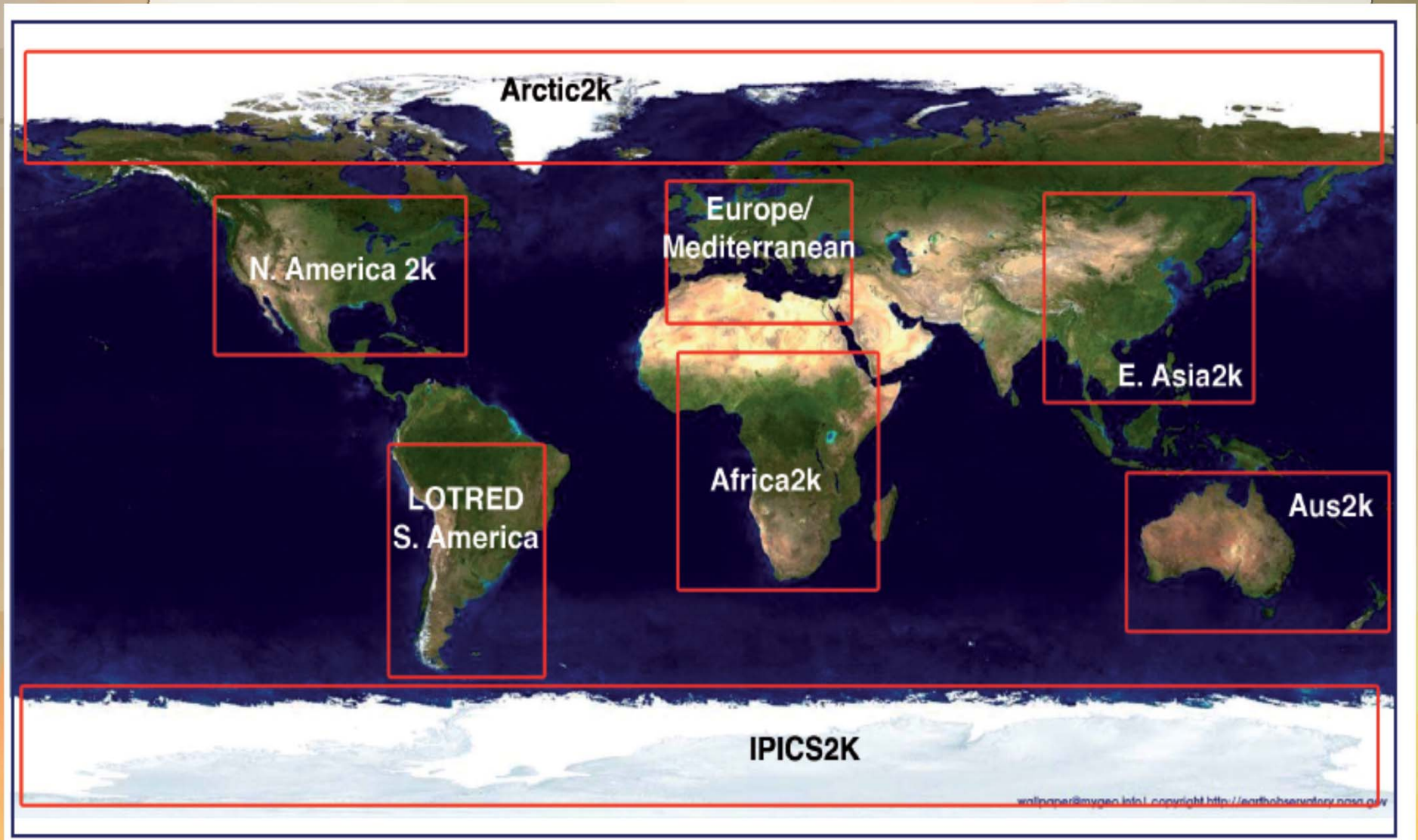


Importance of Palaeoscience for Global Change Research

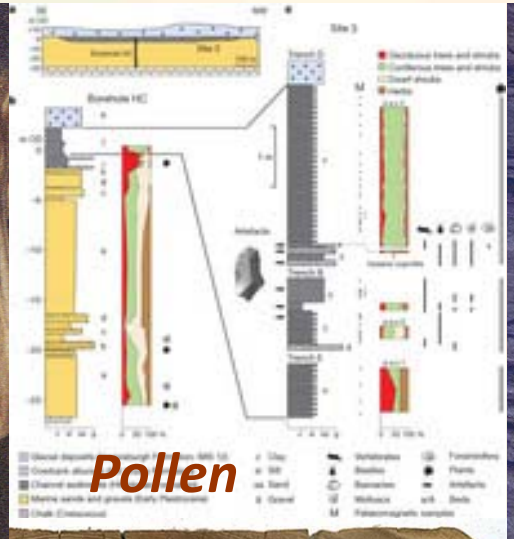
- **Palaeoscience is the study of climate and environmental processes in the recent past prior to the existence of instrumental records**
- **The palaeorecord evidence together with modelling of the past provides a quantitative understanding of past Earth System variability and the underlying processes**
- **In order to better understand current global changes and to project future scenarios, knowledge of the past is imperative**
- **The past does not provide a prescriptive guide to the future but can form the basis for an evaluation of present day trends, future probabilities and likely human consequences**

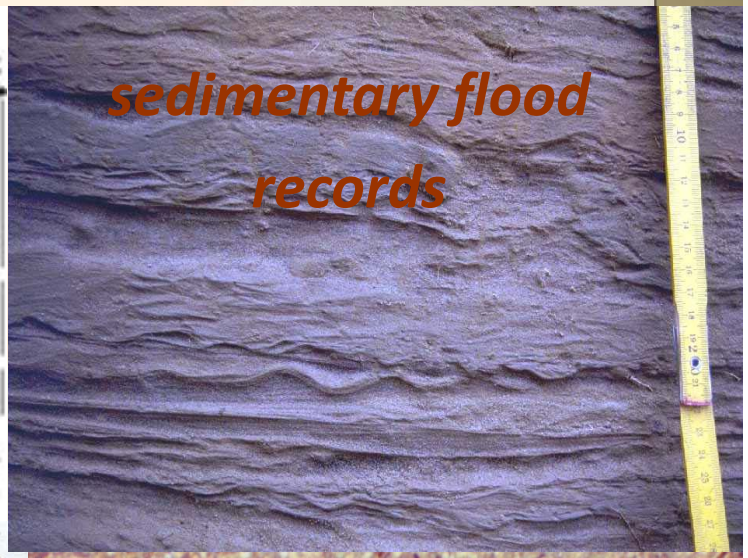
(PAGES 2009)

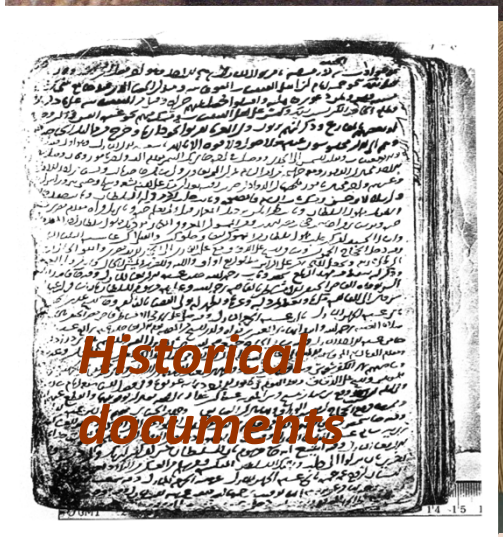
PAGES/MedCLIVAR Initiative, 2000 years high resolution continental climate reconstructions



Mediterranean climate proxies





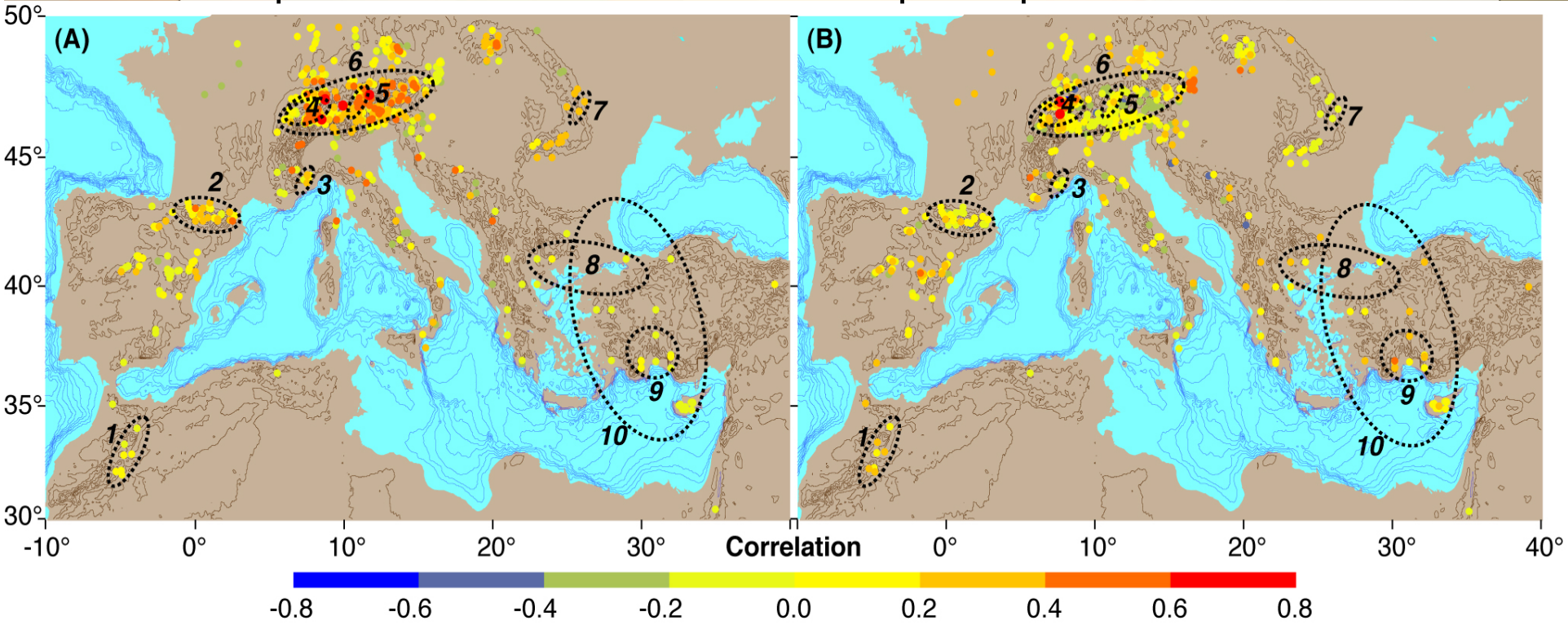


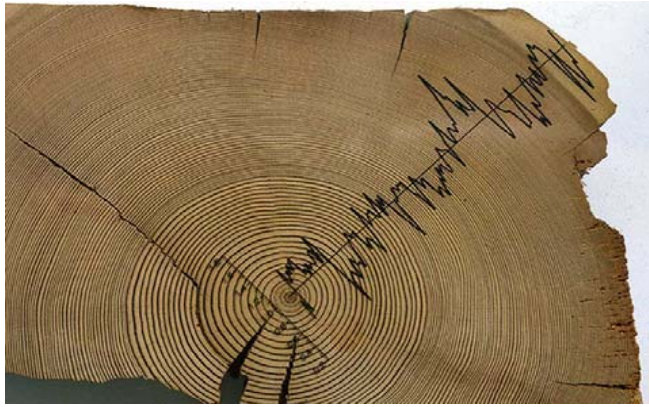
Bradley 1999

tree ring sites > 600 years
annual temperature & precipitation

temperature

precipitation





→ Alpine sites reflect summer temperatures
→ Sites in the south reflect hydroclimatic evidence
→ Late spring/early summer precipitation in Greece & the Middle East

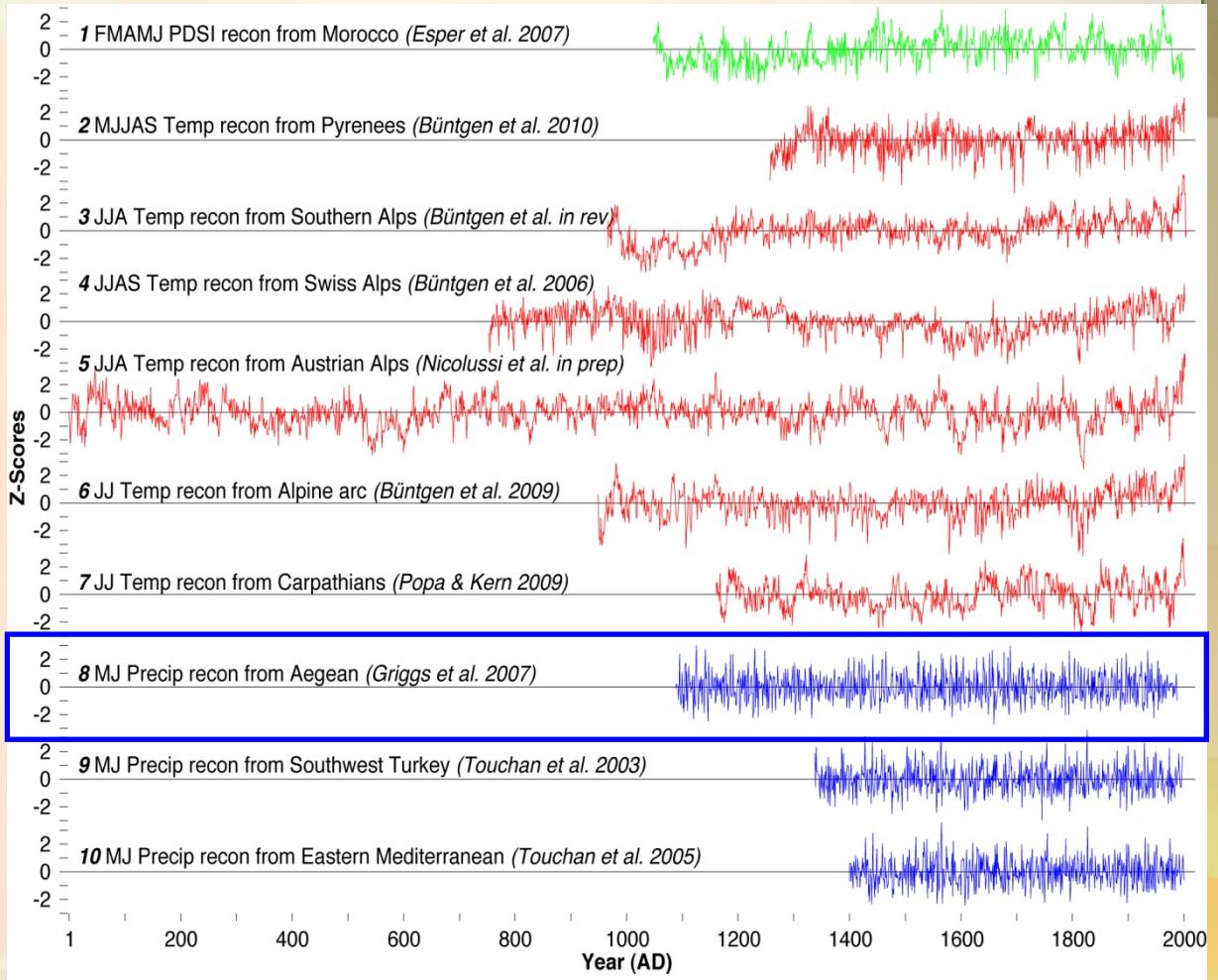
Luterbacher, Xoplaki, Zerefos et al. 2012

Tree ring based climate reconstructions (>600 years), no spring/early summer trends in the Aegean region

‚Drought'

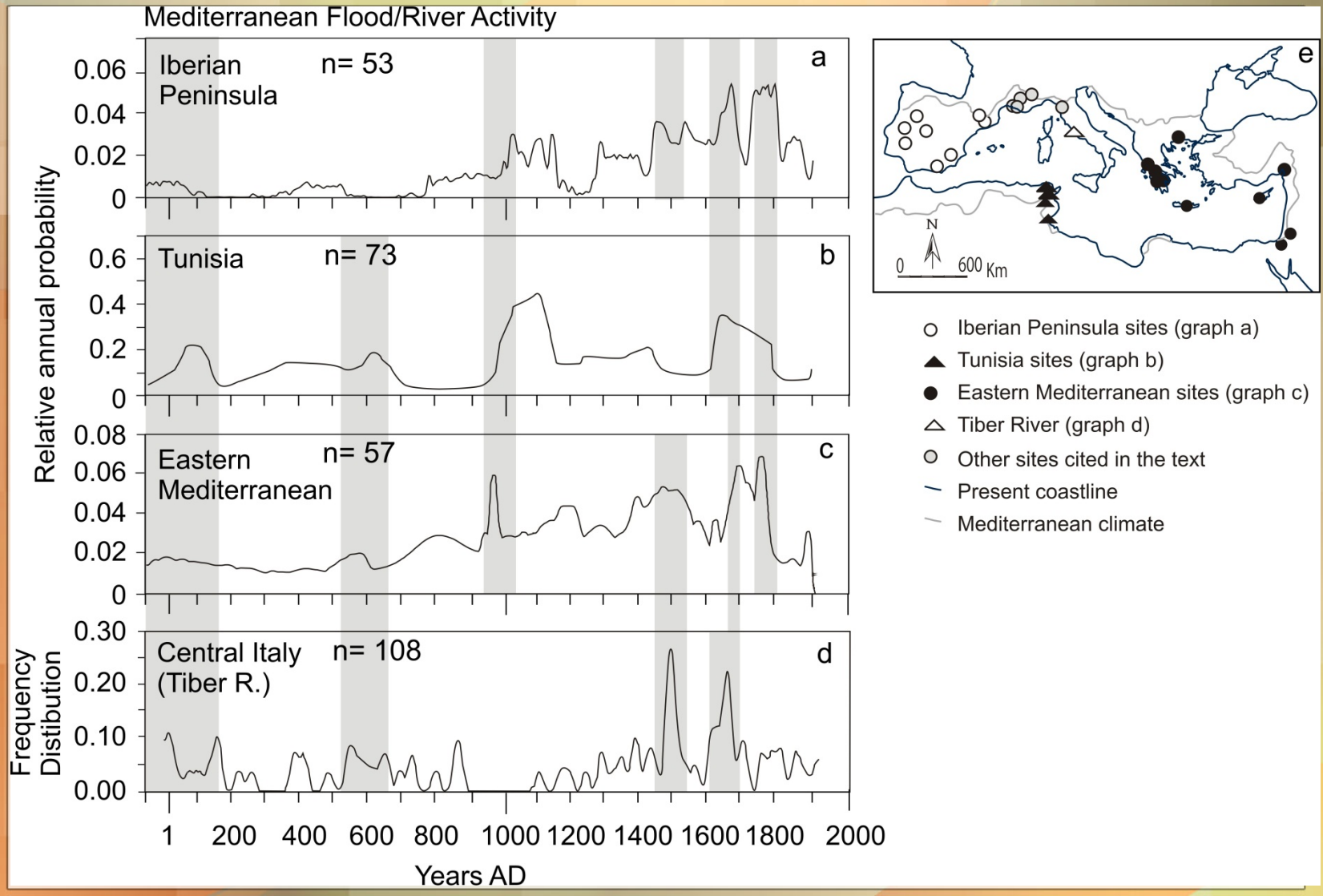
Summer temperature

Spring/summer precipitation



Büntgen et al. 2011, Luterbacher, Xoplaki, Zerefos et al. 2012

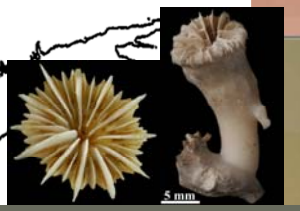
Flood/fluvial activity based on flood deposits, sediments and documentary archives



G. Benito et al. in Luterbacher, Xoplaki, Zerefos et al. 2012

Spatial distribution of marine proxies

Vermetids



Desmophyllum dianthus

(Deep-water corals)

Serpulid
overgrowth on submerged speleothems

Cladocora caespitosa

- *Cladocora caespitosa*
(SST, pH - monthly to fortnightly resolution – last two centuries plus windows in the past 2 ka)

- Serpulids
(SST, SL – multi-centennial resolution – last 2 ka BP)

- Vermetids
(SST, SL, pH? – decadal resolution – last three millennia)

- Deep water corals
(water chemistry, temperature, ventilation age – monthly to annual resolution - last two centuries plus windows in the past 2 ka)

S. Silenzi, pers com.

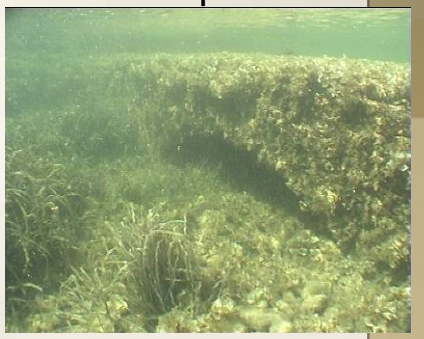
Collection of sea level proxies for the last 2 ka

Roman fish tanks

Sluice gate

Harbors

Crepidinae



Archeological remains
[Typical error ±0.2 m]

Bitts

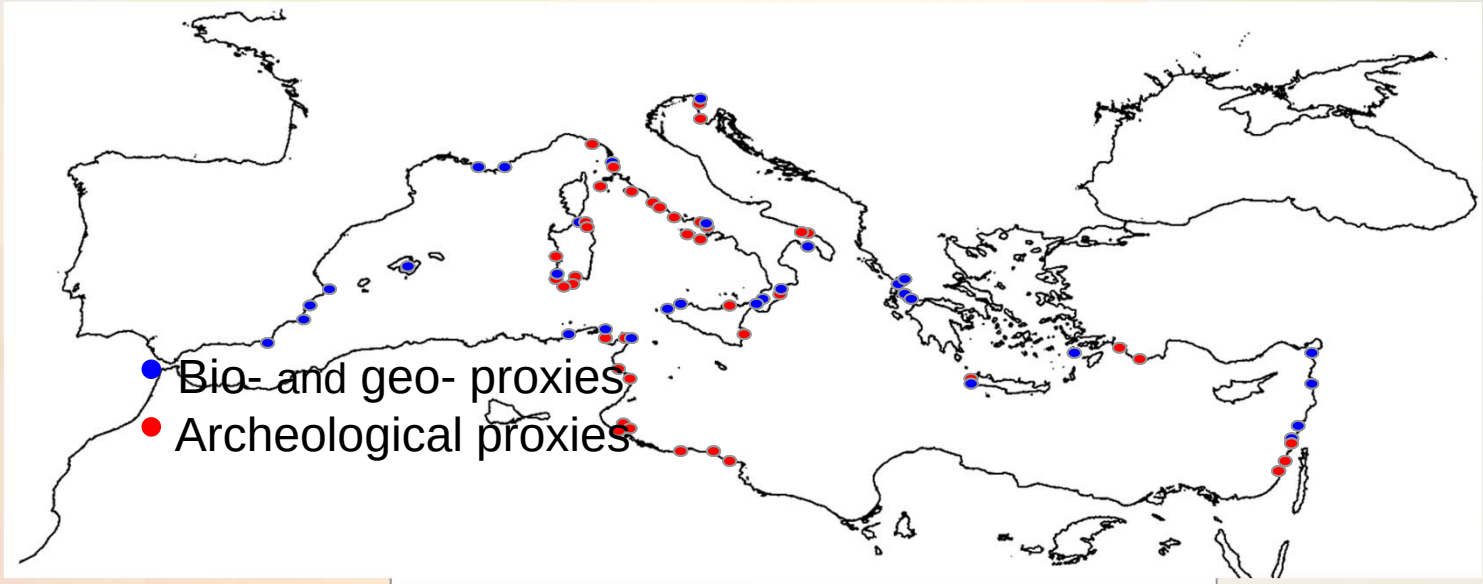
Cerastoderma glaucum

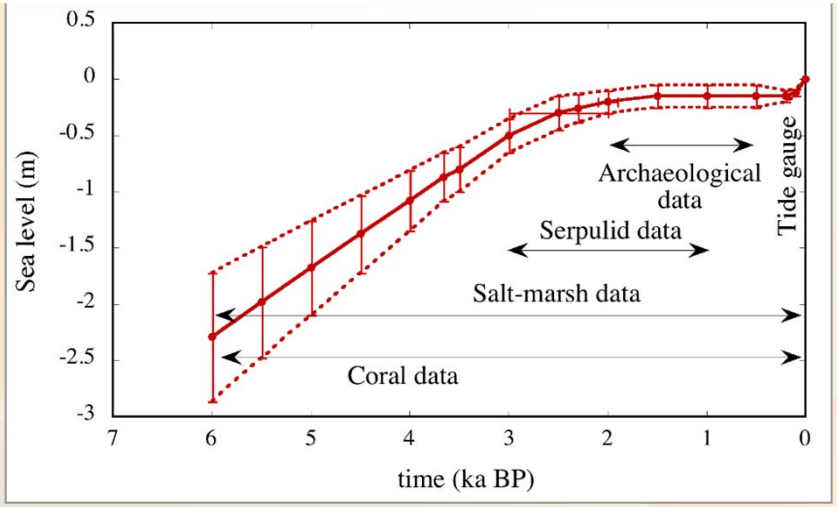
Sea-level

Coastal (lagoonal) deposits
[Typical error ±0.5 m]

S. Silenzi, pers com.

Mediterranean Sea-level variations





Lambeck et al. 2004, 2009; Silenzi et al. 2009

Spatial distribution of climate proxies

- **Greece**: tree rings, lake sediments, pollen, documentary evidence, marine sediments, vermetids, deep water corals, sea level markers
- proxies reflect different climate information (temperature, precipitation, sea level changes, sea water temperature, etc.)
- documentary data density limited due to turkish occupation
- Currently no information on winter and autumn precipitation; seasonal temperature!
- More efforts needed to obtain data from archives in Greece, Turkey, Egypt, etc, mainly related to daily to seasonal climate and weather extremes!

Luterbacher, Xoplaki, Zerefos et al. 2012

Arabic documentary information Middle East and NE Africa back to 800

At Wednesday morning the [07.10.573 = 29.03.1178] there had been a very strong sand storm, afterwards it hailed.
This lasted for one hour. The wind changed from strong to normal until the late morning, afterwards it kept strong. The sky kept yellow until late in the afternoon.
At 10 *Schawwal* the water level of the Tigris was rising above the normal level by 20 *Thira'a* [9,24 m]. After three days the water was falling.
Ibn al-Jawzi, Vol. 10., p. 545.

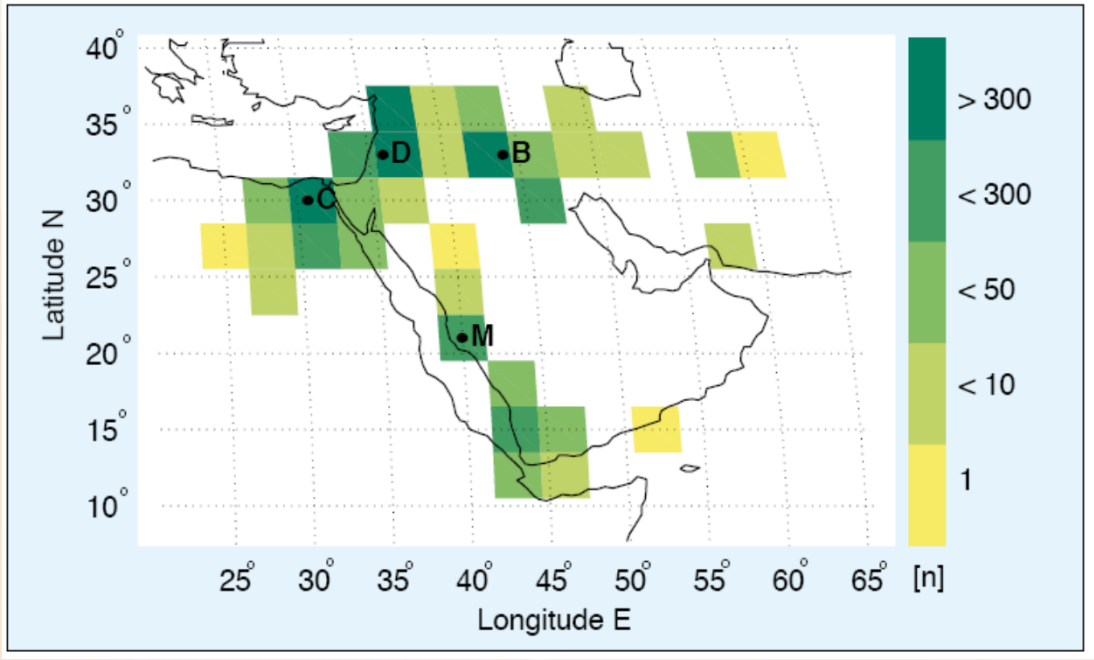
[note that al-Athir for the very same day 29.03.1178 notes a strong wind associated with an earthquake!
Ibn al-Athir, al-Kamil, Vol. 9, 446]

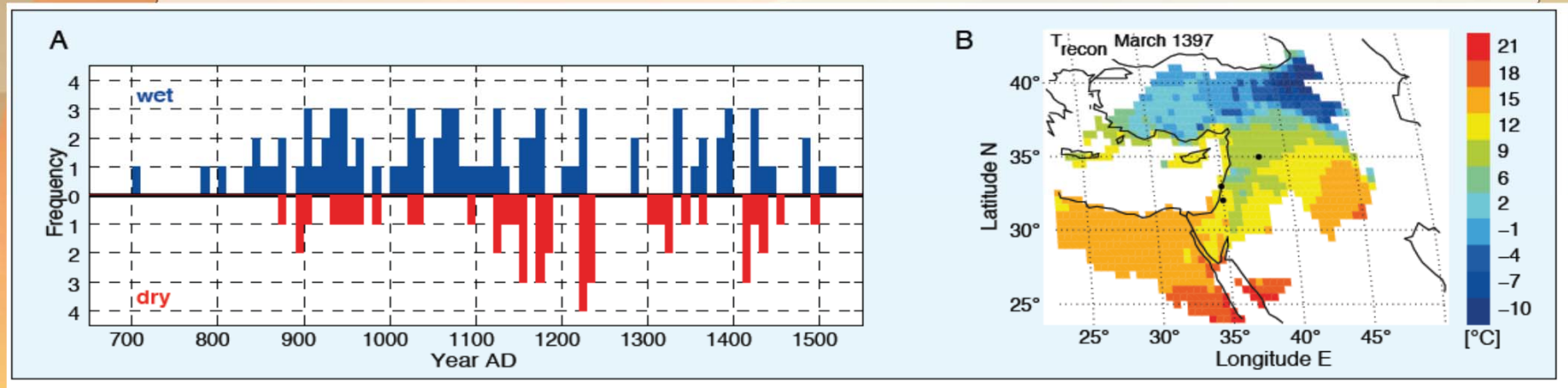
وفي سحرة يوم الأربعاء سابع شوال: هبت ريح عظيمة فزلزلت الدنيا بتراب عظيم حتى خيف ان تكون القيامة، ثم جاء فيها برد، ودام ذلك ساعة طويلة، ثم انجلت وقد وقعت حيطان وتهدمت مواضع على أقوام مات منهم وارتث منهم، ووقع سقف متصل بمنظرة الخليفة التي عند باب الحلبة، وكانت الريح تقوى ساعة وتخف ساعة إلى وقت الضحى، ثم اشتدت وملأت الدنيا تراباً فصعد إلى عنان السماء، فتبين السماء منه مصفرة إلى وقت العصر، وزادت دجلة في عاشر شوال زيادة عشرين ذراعاً على المعتاد، وخاف الناس واشغلوا بالعمل في القورج، ثم نقص الماء بعد ثلاثة أيام.

وفي يوم الجمعة سلخ شوال: بعد أذان الجمعة صعد غيم وجاء مطر شديد من جامع السلطان إلى الرصافة فما فوق، فكانت ثم غدران، وامتلأت الصحارى والشوارع به، ولم يأت بنهر معلى إلّا اليسير، وورد حاج كثير من خراسان فاستأذن الوزير ابن رئيس الرؤساء في الحج فأذن له، فعمل بركاً جميلاً،

Vogt, Glaser, Luterbacher et al. 2011; work in progress

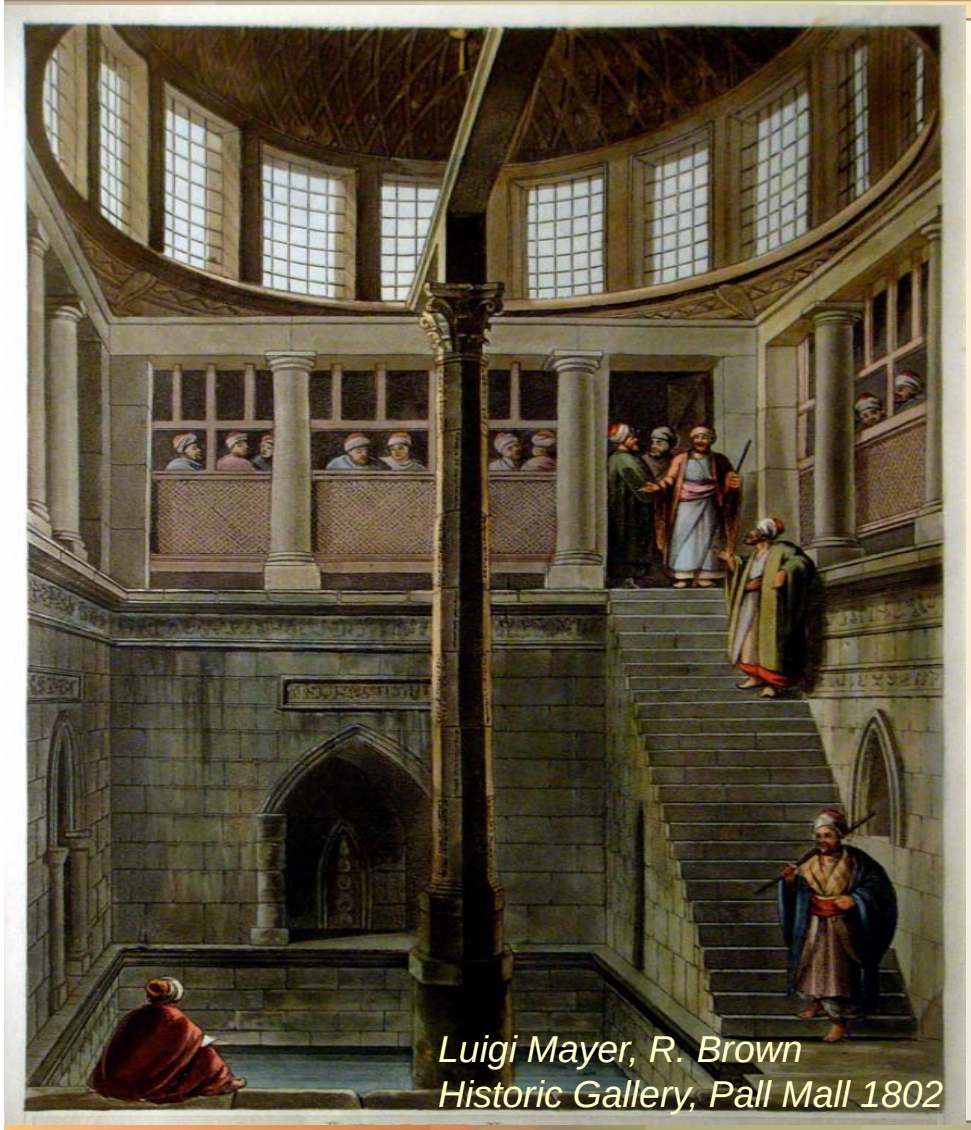
Spatial distribution of information AD 800 to 1500 & frequency of wet and dry winter/decade for Iraq





Vogt, Glaser, Luterbacher et al. 2011; work in progress

Nilometer

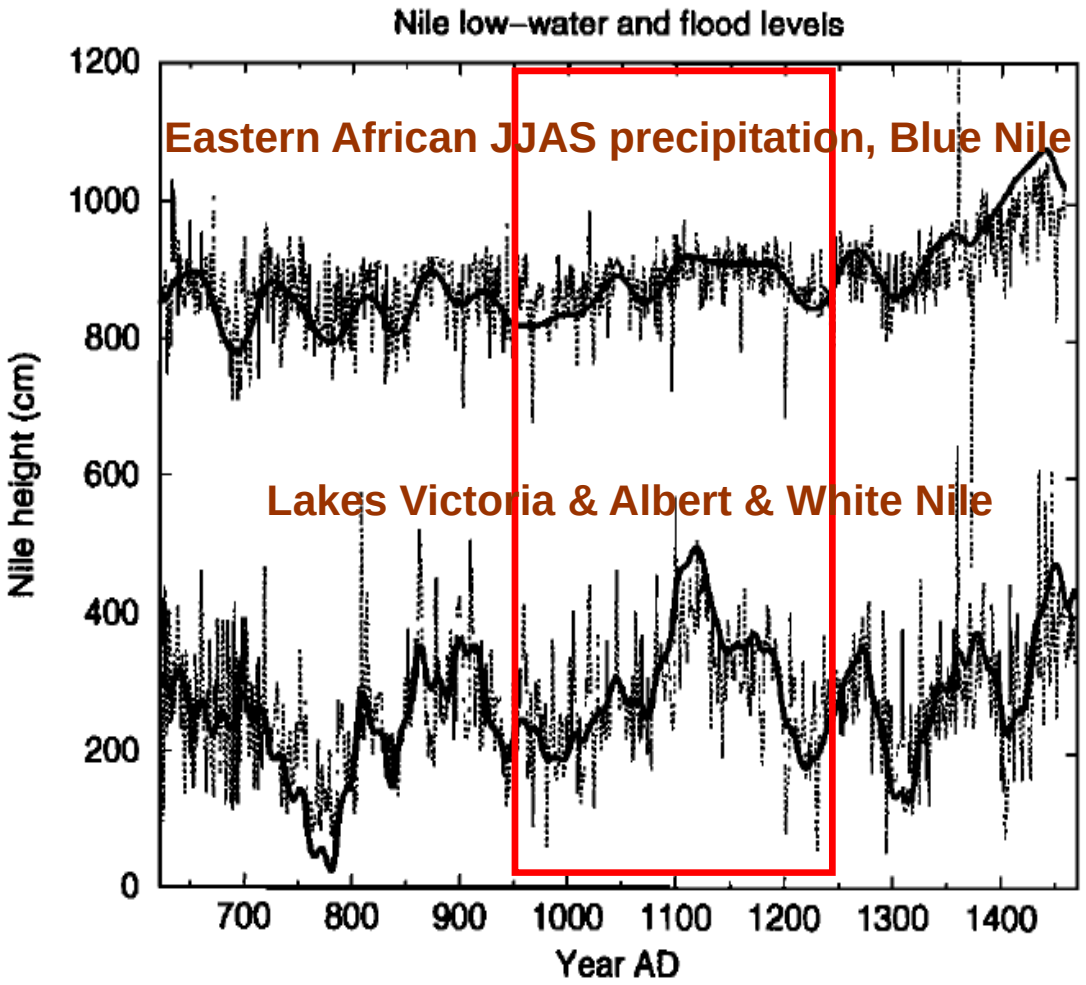


Luigi Mayer, R. Brown
Historic Gallery, Pall Mall 1802

Pharaonic and medieval Egypt depended solely on winter agriculture and hence on summer floods. The rise of the waters of the Nile was measured regularly from the earliest times.

compiled the annual maxima and minima of the water level recorded at nilometers, back to the 7th century.

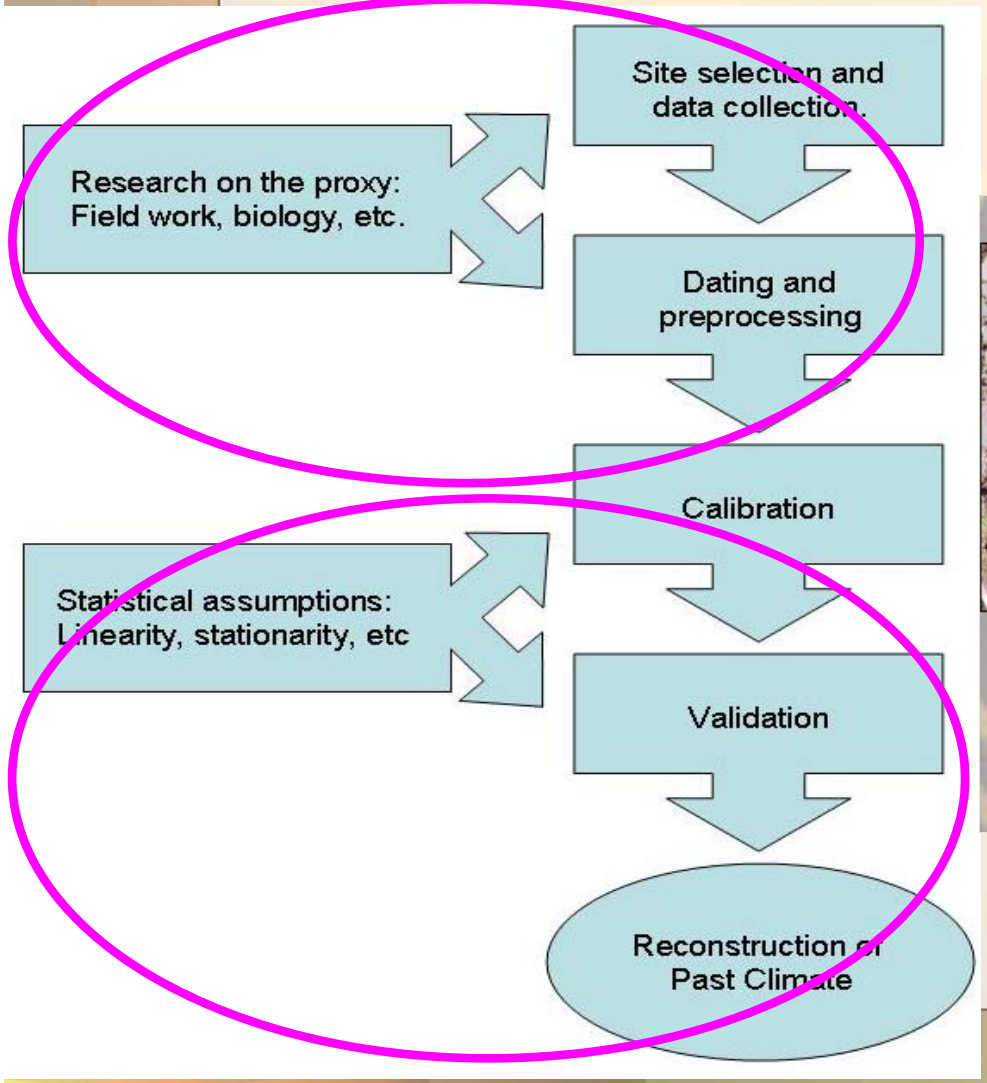
Annual record of flood and low-water at Roda Island, Cairo

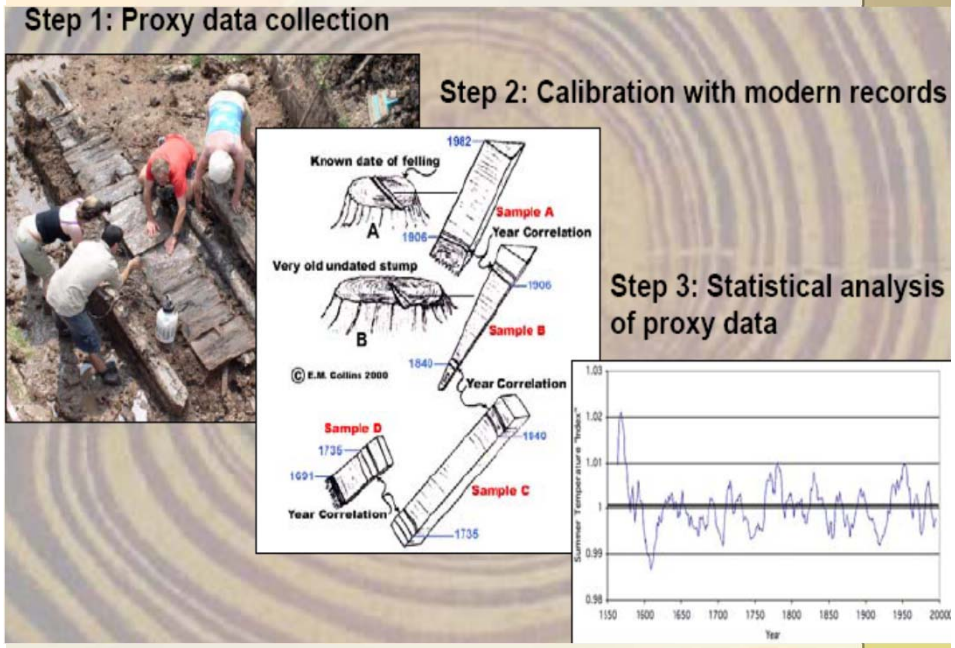


MCA (~950-1250) characterised by a low variability in flood record and strong variations of low-water

De Putter et al. 1999; Hassan 2011

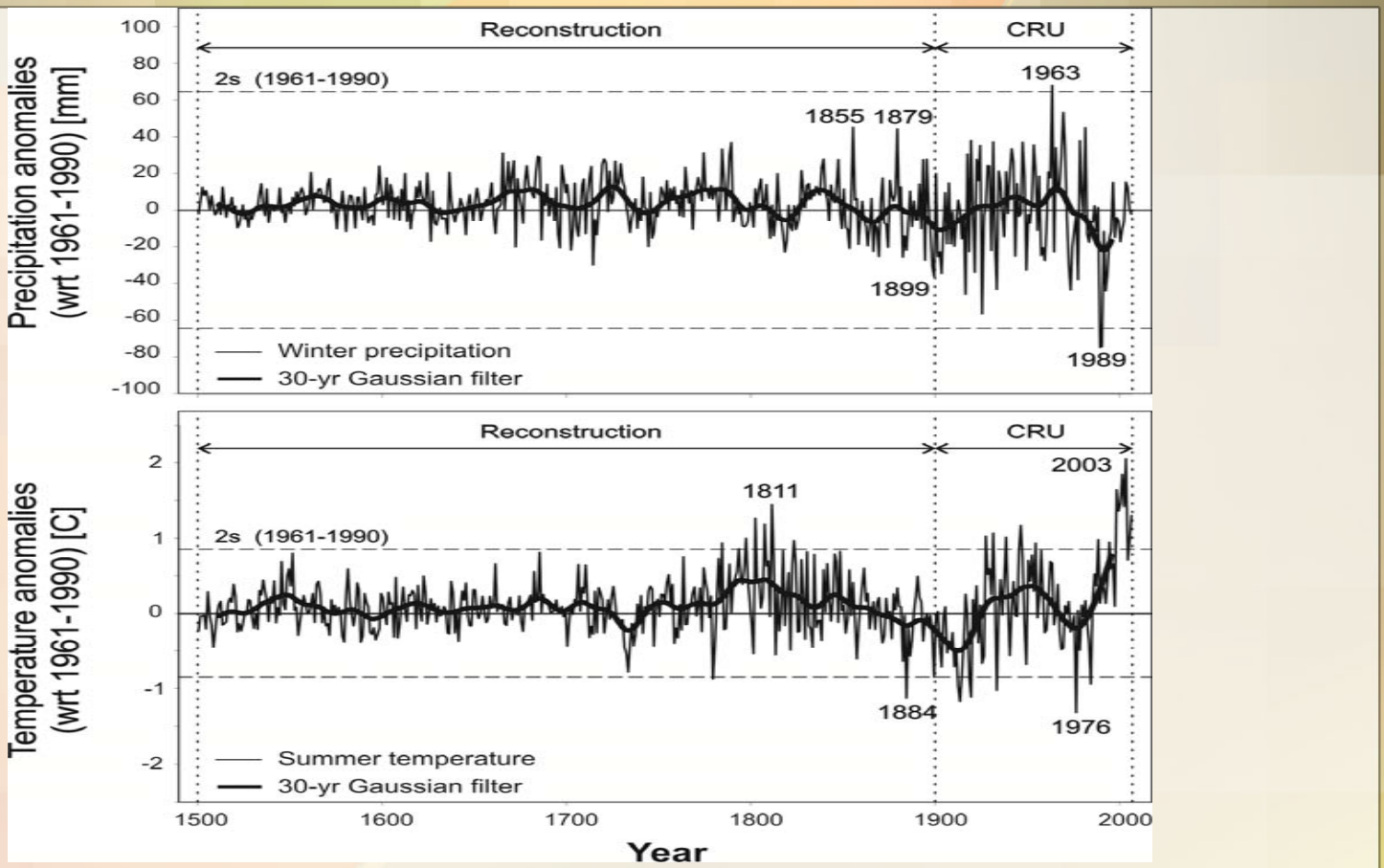
Schematic diagram to reconstruct past climate





NRC 2006

Winter precipitation and Summer temperature reconstructions in the SE Mediterranean (incl. Greece) back to 1500



→ 1980s & 1990s winters were exceptional dry in the context of the past

→ Current summer warmth exceptional in the context of the past

→ but large uncertainties, no information from Greece! Need for more high temporal resolved information from different archives!

Conclusions

- The Mediterranean offers a broad spectrum of terrestrial and marine proxy data
- Most information related to changes in the hydrological cycle
- limitations to reconstruct the full range of climate variations including short duration and extensive drought and flood periods, extremes
- Only limited information available from Greece that provide information on daily to seasonal extreme weather and climate

Challenges and future needs

- → more emphasis on data generation from different proxy archives
- → need to study proxy archives in an integrative way and disentangle the complex relationships between climate, land use, sea level changes, human interactions, fire, vegetation and forests
- → more early instrumental data from different libraries (effort to digitise weather and climate information) and libraries (Turkey, Greece, Egypt)
- → better understanding and analysis of weather and climate extremes (heatwaves, floodings, droughts, storms), etc in Greece in the past
- → Study of impacts of climate variations and extremes on past societies, economy and ecology and link to the present and to the future


Thank you very much for
your attention!