Reconstruct Past Climate

Data Source, Proxies

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Large-scale climate variability, 13.11.2006

Outline

Parameter and Resolution

Parameter

- temperature
- precipitation
- wind
- ...

Resolution

- daily
- monthly
- seasonal
- annual

Data Source

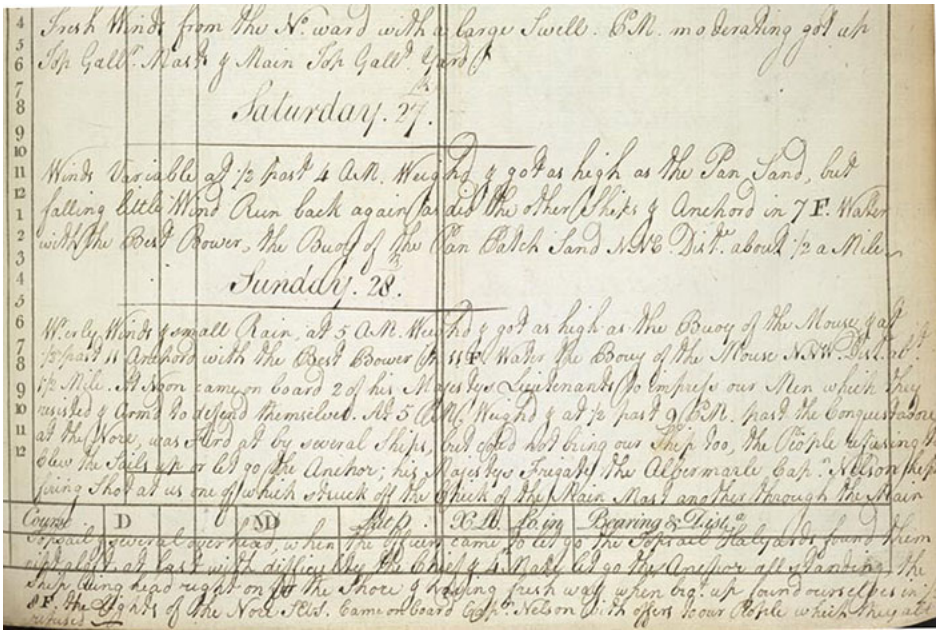
- instrumental records (since 18 cent.)
- documentary data
  - descriptive
  - proxy
- speleothems
- tree rings
- corals
- boreholes
- vermetids
- ice cores
- sediments (lake, ocean,...)

Descriptive Documentary Data

Weather Observations

- reports from chronicles
- daily weather reports
- travel diaries
- ship logbooks

Example of a Ship Logbook



Saturday. 27.

Sunday. 28.

▸ Transcript

Parameter and Resolution

Resolution

- daily or more

Parameter

- Wind: force and direction
- General accounts of the weather
- After 1850 most ships provided instrumental data

Documentary Proxy Data

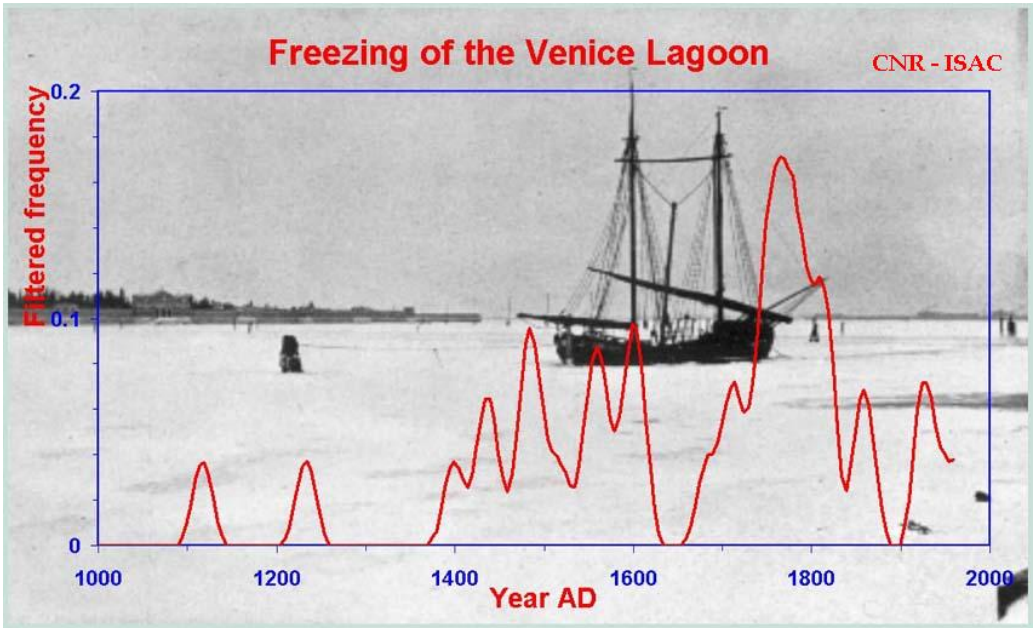
More indirect evidence that reflects weather events or climate conditions

- agricultural activites e. g. grape-harvest (Swiss German: Wümmet)
- time of freezing and opening up of waterways
- religious ceremonies
- tax e. g. tithe (German: der Zehnte)
- . . .

Good dating control and high temporal resolution

Documentary Proxy Data

Documentary Proxy Data



Speleothem

Secondary Cave Deposits such as

- stalactites
- stalagmites

Speleothem

From the Greek for "cave deposit".
German: Speläotheme (sekundäre Mineralablagerungen in Höhlen)

Stalactites and Stalagmites

Memory hook

English

Stala**g**mites grow from the **g**round, stala**c**tites grow from the **c**eiling

German

Stalagmiten haben schon viel „mitgemacht“ sind daher „müde“ und deswegen am Boden, während Stalak**t**iten **t**ropfen und an der Decke hängen.
Children: Die Stalak**t**iten kommen von der „**T**“ecke, und die Stalag**mit**en wachsen **mit** dir mit.
Adult: Die Mi(e)ten steigen und die (Stalak)tit(t)en hängen.

French

La Stalag**m**ite **m**onte, la stalag**t**ite **t**ombe

Development of Speleothems

Reaction

$$\begin{aligned} CaCO_3 + H_2O + CO_2 &\Longrightarrow Ca_2^+ + 2\,HCO_3^- \\ Ca_2^+ + 2\,HCO_3^- &\Longrightarrow CaCO_3 + H_2O + CO_2 \end{aligned}$$

Parameter

Example: Stalagmite Q5 from a Oman Cave (Fleitmann et. al., 2003)

Age

- Thorium-Uran (Th-U)
- 18 measurements

Precipitation

- $\delta^{18}O$
- more negativ $\delta^{18}O \rightarrow$ more precipitation

▸ Location of Oman

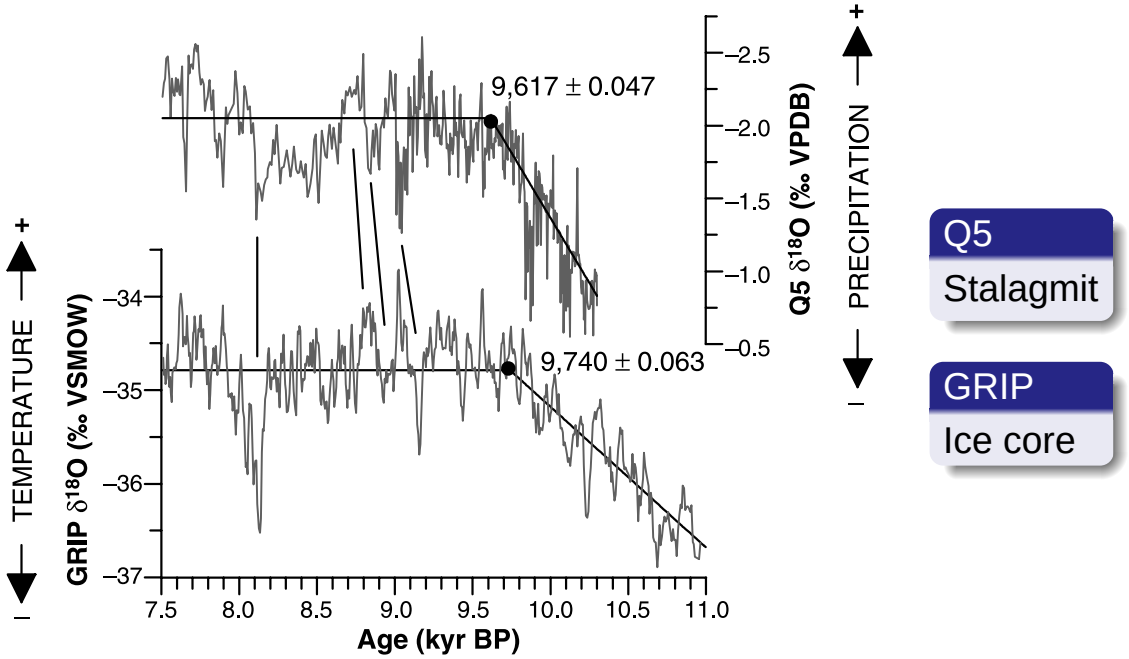
Resolution

Percipitation

- 1405 $\delta^{18}O$ measurements every $\approx$0.7 mm
- 10.3 to 2.7 ky B. P.[a] and 1.4 to 0.4 ky B. P. Total 8.6 ky
- Resolution $\approx$ 6 year

[a] "present" is defined as 1950 A. D. on the ^{14}C absolute age scale

Comparison of $\delta^{18}O$ Record



Discussion

- What proxy do you like best
- Why
- Different proxies and their pros and cons
- Parameters in ship logbooks
- $\delta^{18}O$

List of figures I

- Wümmet
  http://images.gadmin.ch/5145/8331/picbase/1168.jpg
- Freezing of the Venice Lagoon
  http://clima.ictr.pd.cnr.it/immagini/freezing.jpg
- Ship logbook
  http://www.bl.uk/learning/images/texts/ship/Oct-28th-81--lg.jpg
- Cave with Stalactites and Stalagmites
  http://www.ici.ro/romania/images/turism/mc_dambo3.jpg

List of figures II

- Location of Oman
  Google Earth
- Frequency of flooding tides at Venice
  http://clima.ictr.pd.cnr.it/immagini/acqualta.jpg
- Drill to take samples for dendrochronology from trees
  http://en.wikipedia.org/wiki/Image:Dendrochronological_drill_hg.jpg

Bibliography

P. Lionello et. al.
The Mediterranean Climate: An Overview of the Main Characteristics and Issues.
Developments in Earth & Environmental Sciences, 4:27–148, 2006.

D. Fleitmann et. al.
Holocene Forcing of the Indian Monsoon Recorded in a Stalagmite from Southern Oman.
Science, 300:1737–1739, 2003.

Transcript of the logbook

The Halsewell Logbook, 28th October, 1781

Fresh Winds form the Northward with a large swell. PM moderating got up Top gallant Mast and Main Top Gallant Yard

Saturday 27

Winds variable at 12 past 4 AM Weighed and got as high as the Pan Sand, but falling little Wind Run back again as did the other Ships Anchord in 7F Walter with the Best Bower, the Buoy of the Pan Patch Sand NNE Distance about 1/2 a Mile

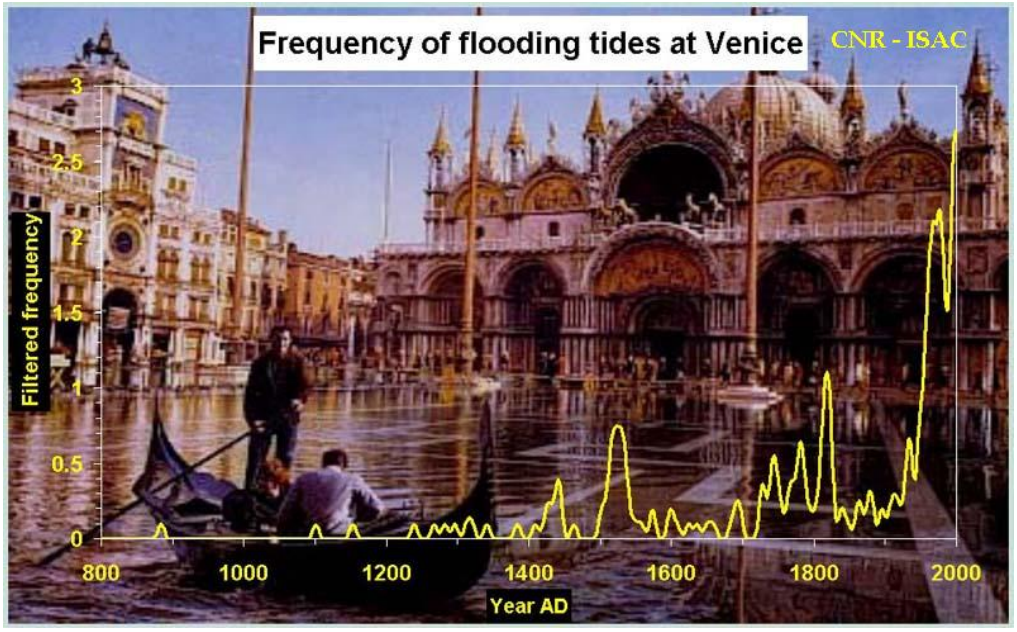
Sunday 28

Northerly winds and small Rain at 5 AM Weighed & got as high as the Buoy. . .

◂ Ship Logbook

Oman

Frequency of flooding tides at Venice



Documentary Proxy Data