



Past changes in climate and hydrology

Anders Moberg

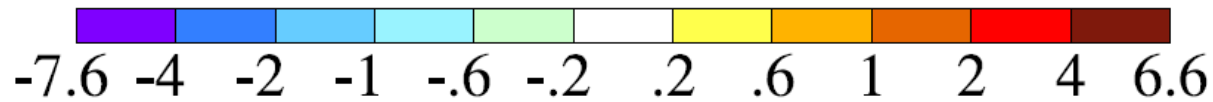
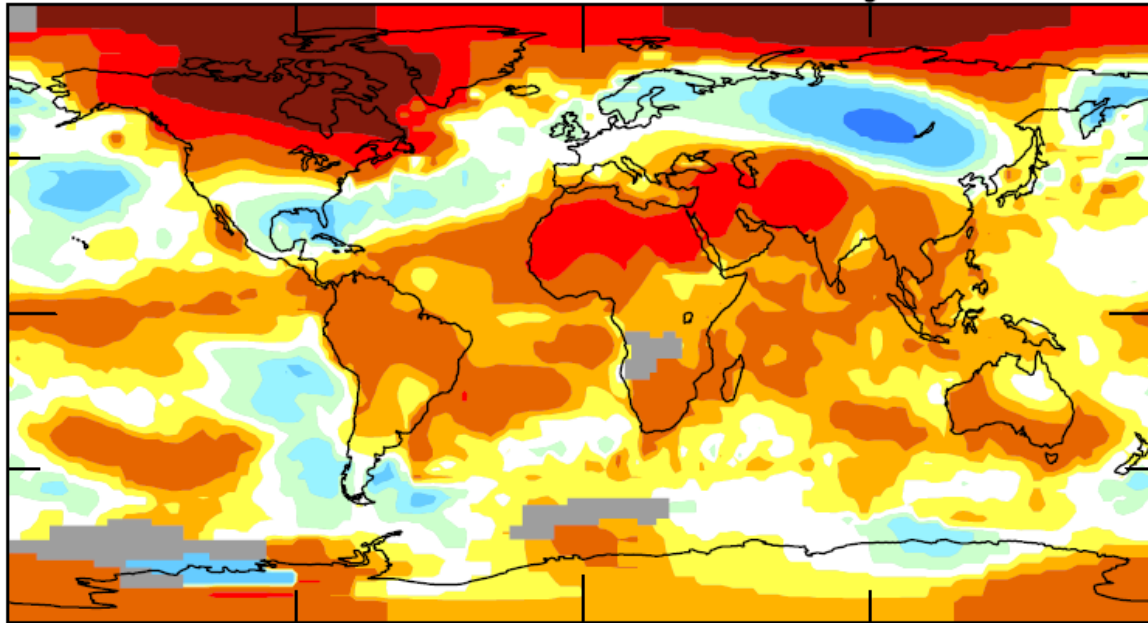
Department of Physical Geography and Quaternary Geology
Stockholm University

Conference on Future Climate and Renewable Energy:
Impacts, Risks and Adaptation

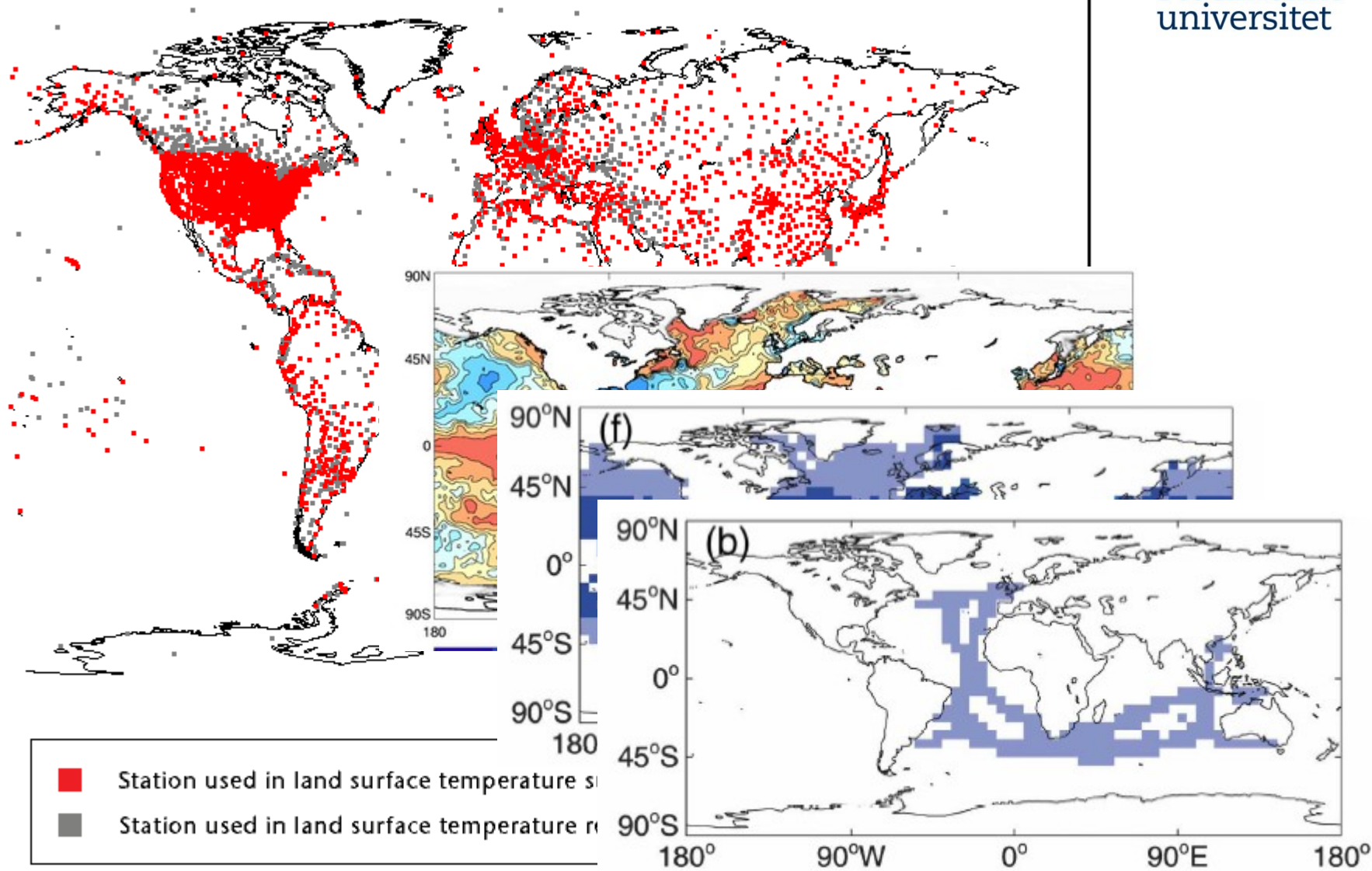
Oslo, 31 May 2010

This year so far (Jan – Apr) ...

2010 (the warmest out of 131 years) .75



Temperature anomaly (°C) from 1951-80 mean

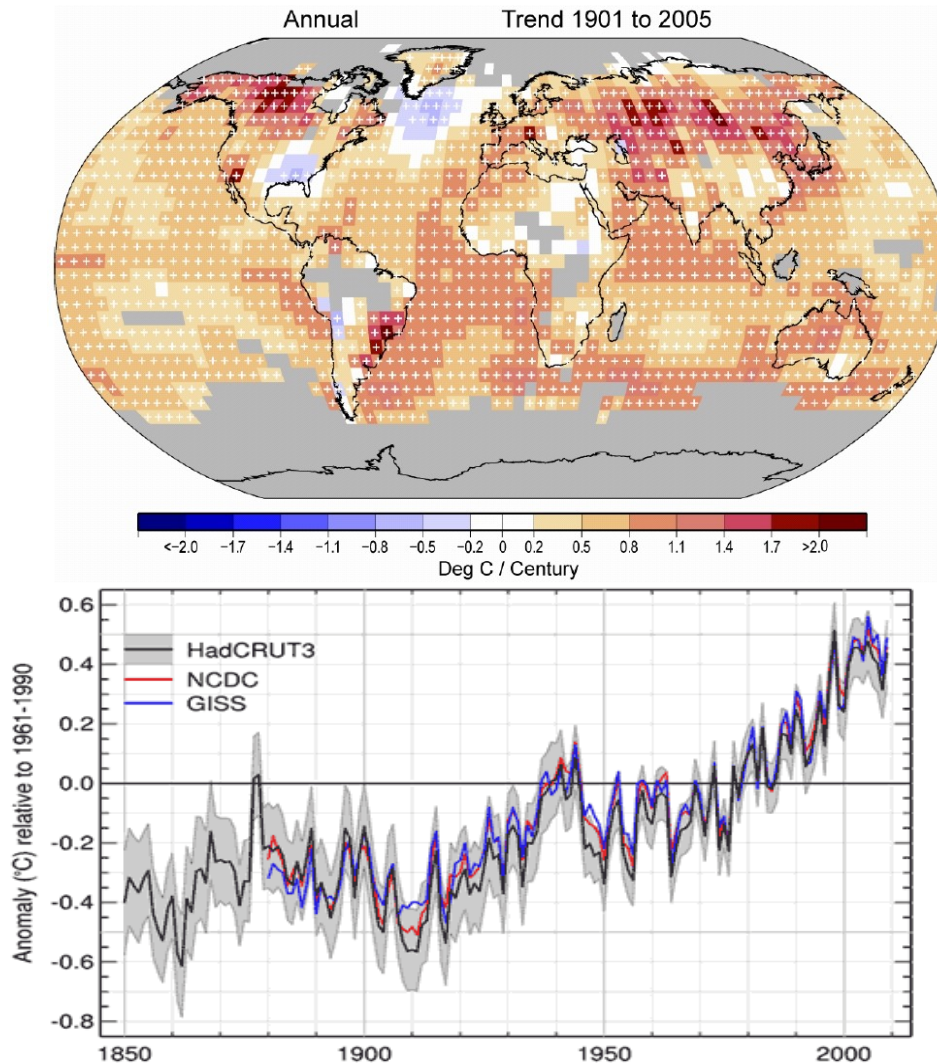


Global mean temperature since 1850

– warming in most places, but not everywhere



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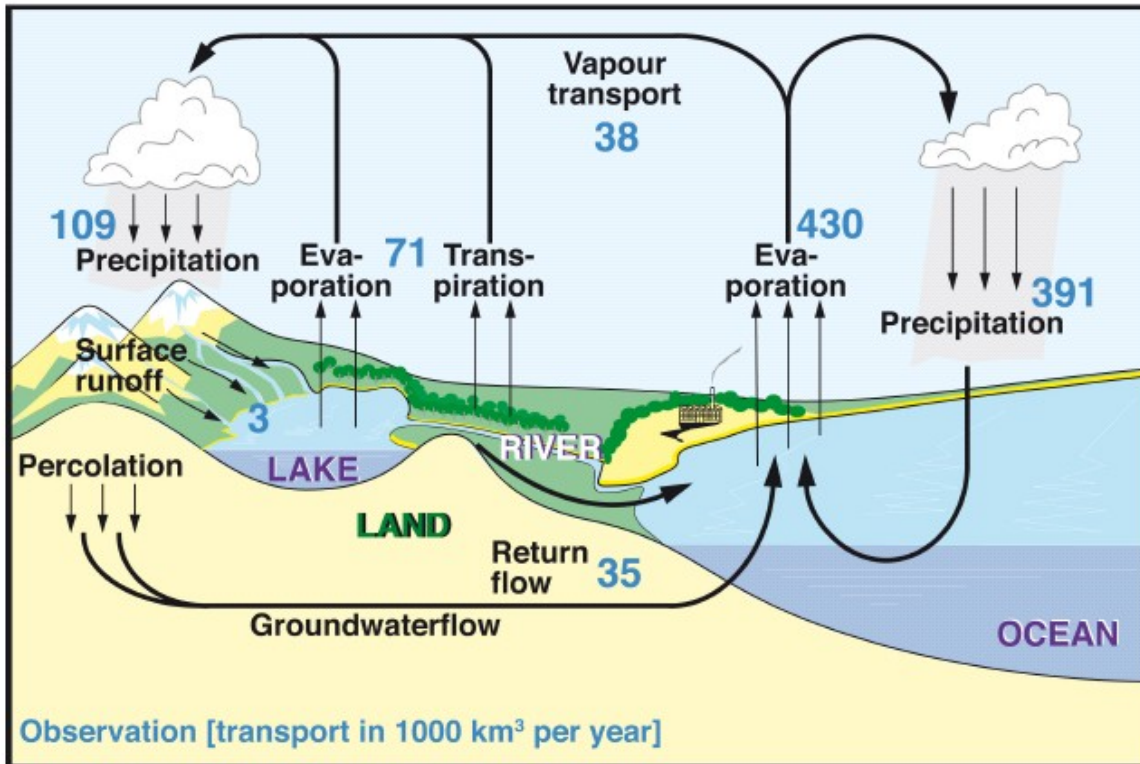


The global water cycle

- changes when temperature change



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A warmer atmosphere can hold more water
(c. 6-7% per 1°C)

Global mean precipitation and evaporation increase
(c. 1-2% per 1°C)

Longer residence time for H₂O in the atmosphere

Changes in statistical distributions including precipitation extremes

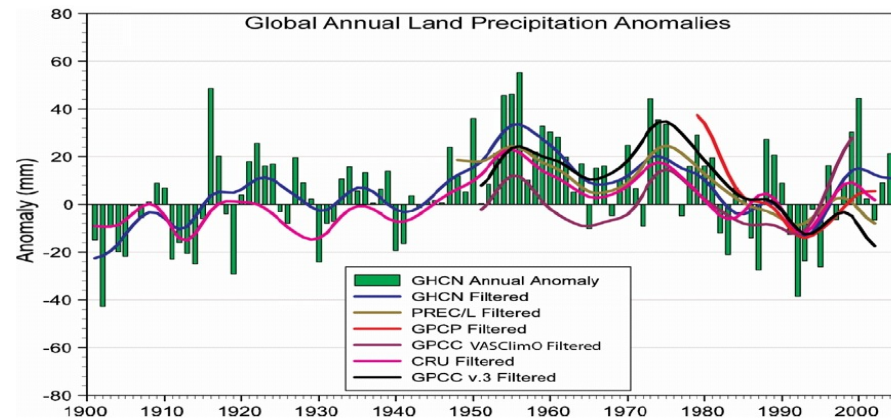
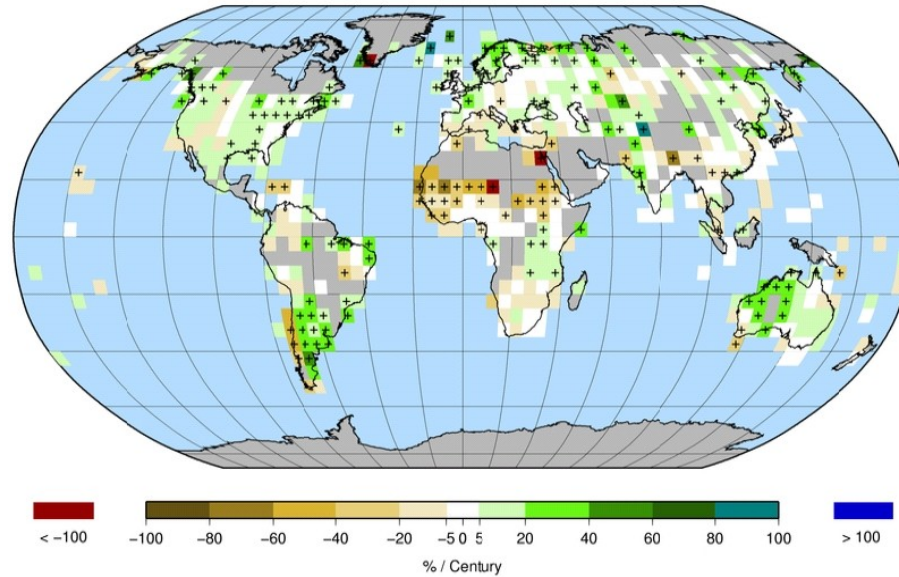
Global land precipitation since 1900

– strong regional differences, insignificant global trend



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Trend in Annual PRCP, 1901 to 2005

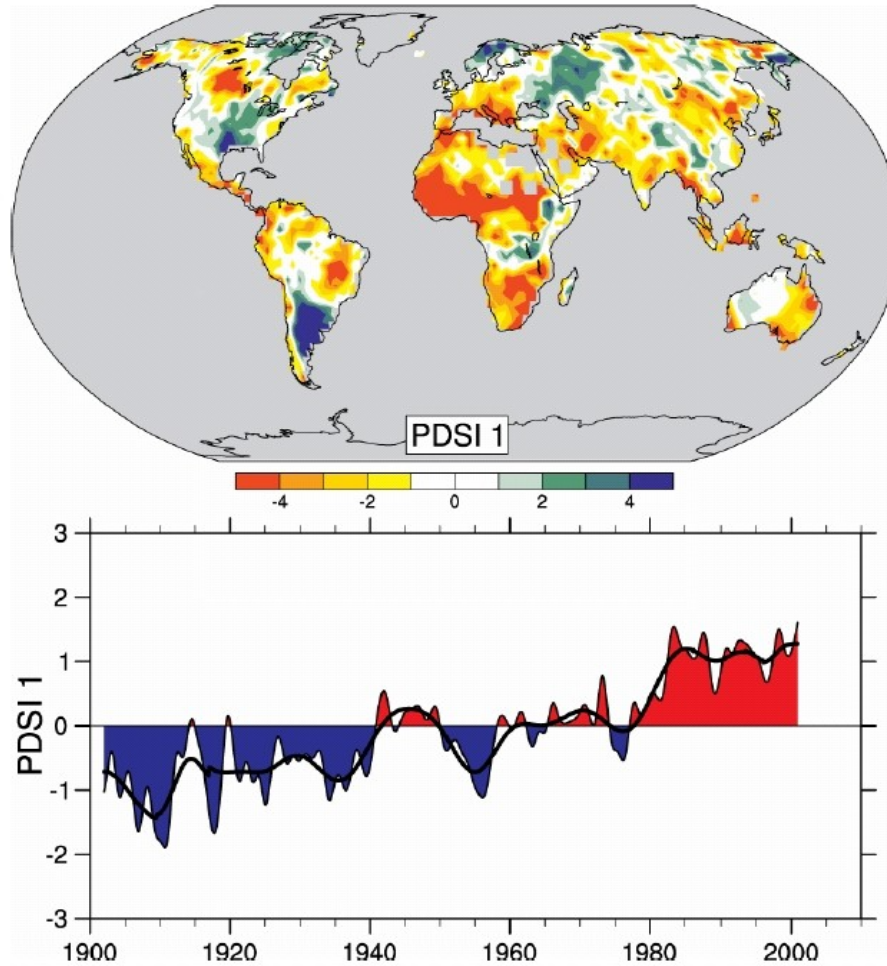


Drought Severity Index since 1900

– dry areas drier, wet areas wetter



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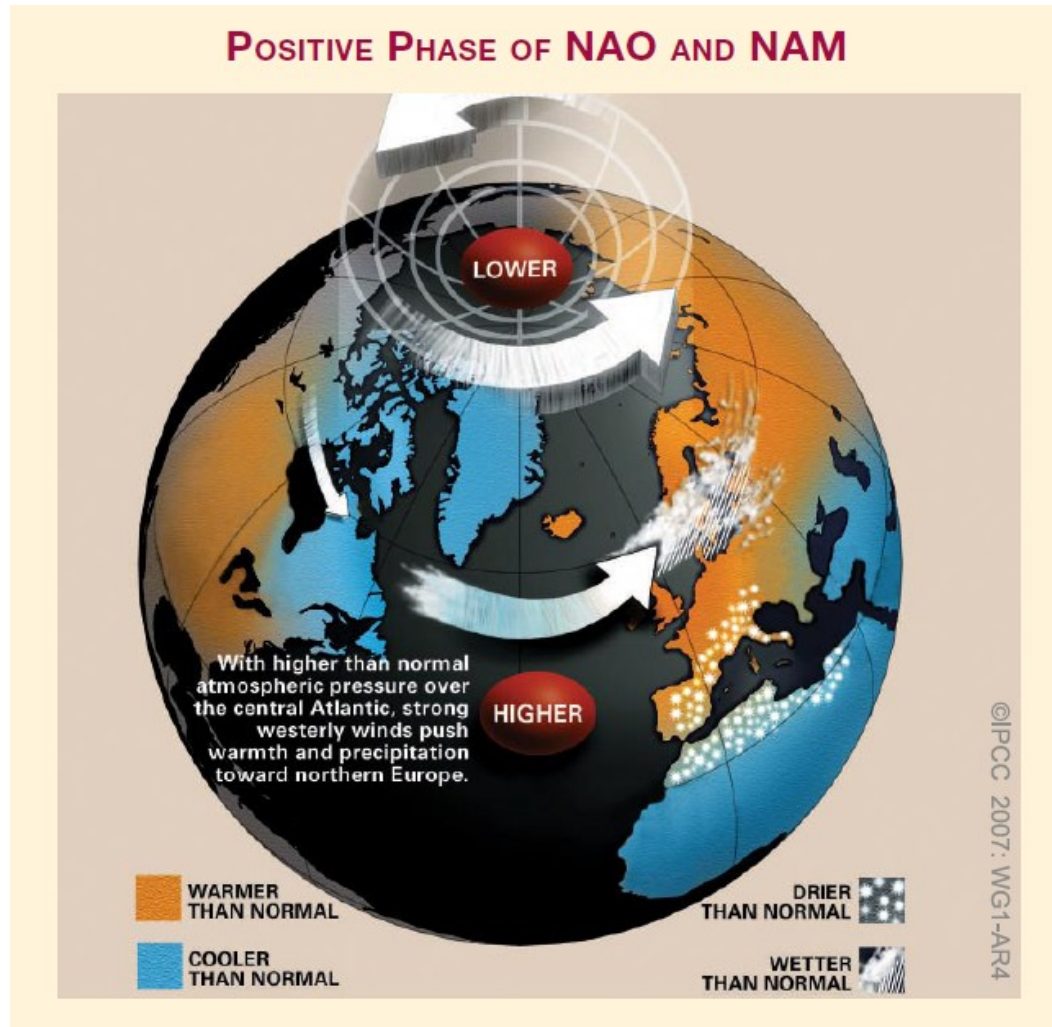


Dynamic circulation modes

– cause regional differences in weather and climate



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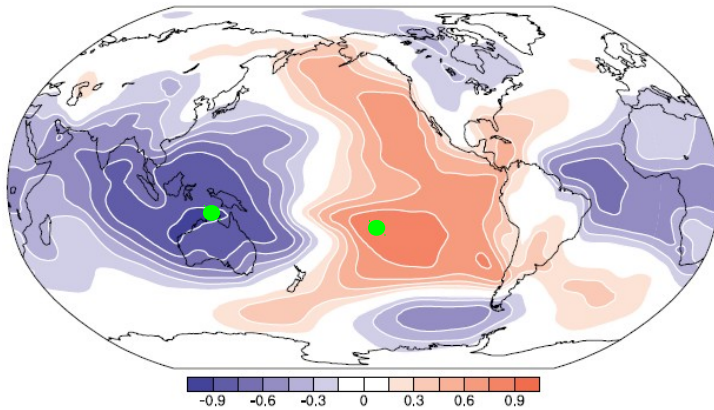
Dynamic circulation modes

– cause regional differences in weather and climate

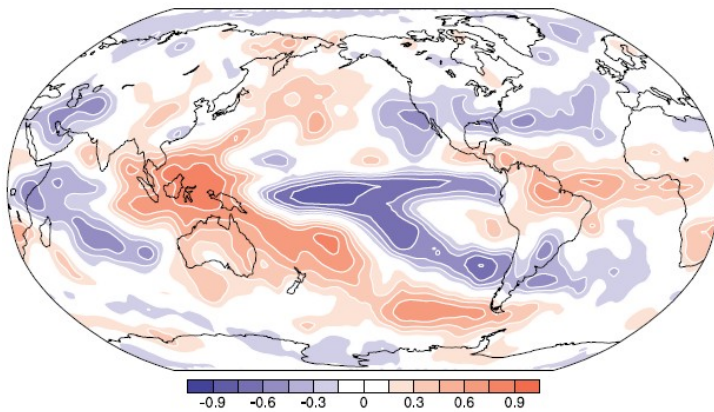
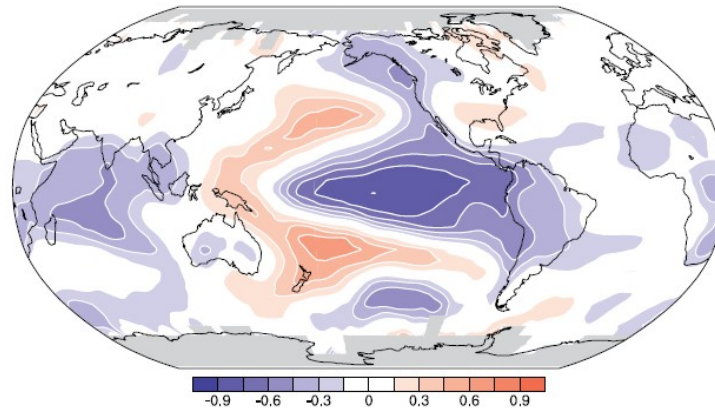


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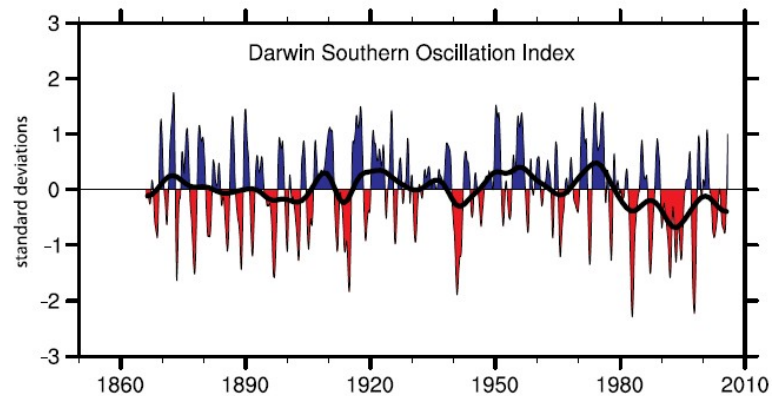
Sea Level Pressure



Surface Temperature



Precipitation

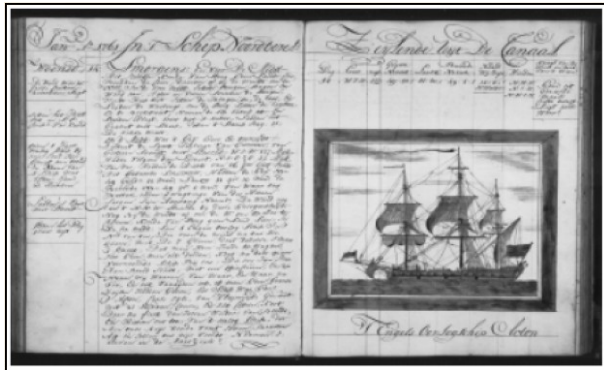


Climate Proxy Data

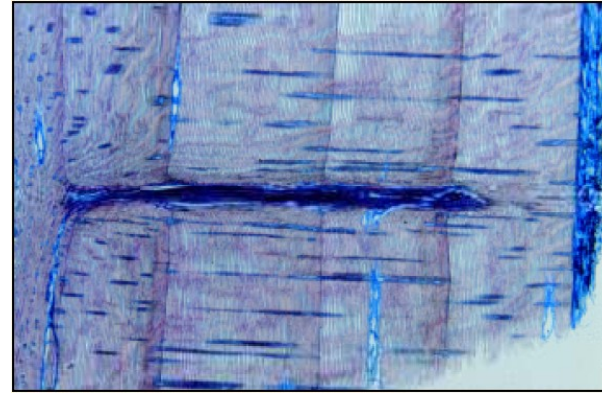
– our source of knowledge before the meteorological observations



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Documentary archives



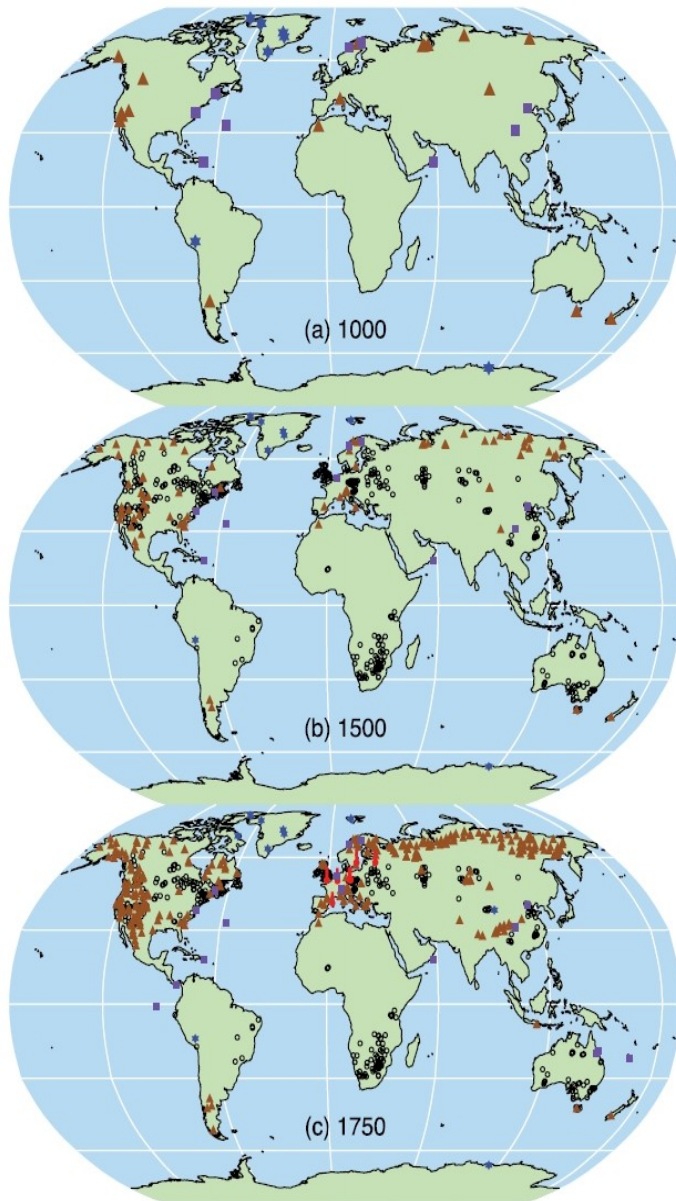
Tree-ring archives



Terrestrial sedimentary archives



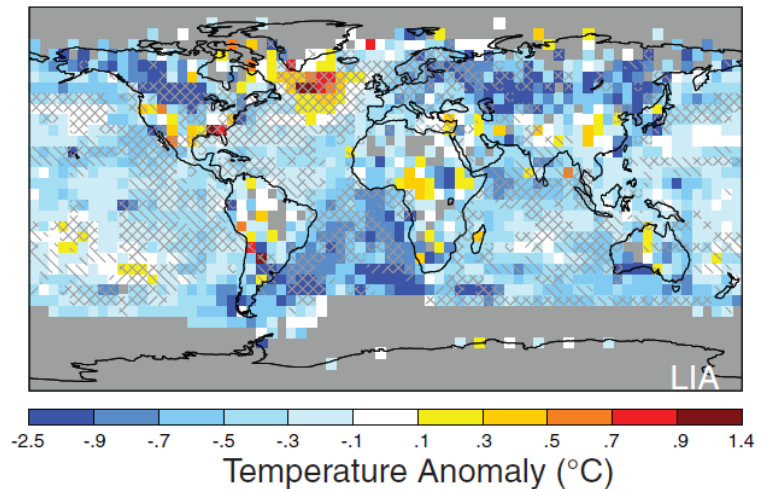
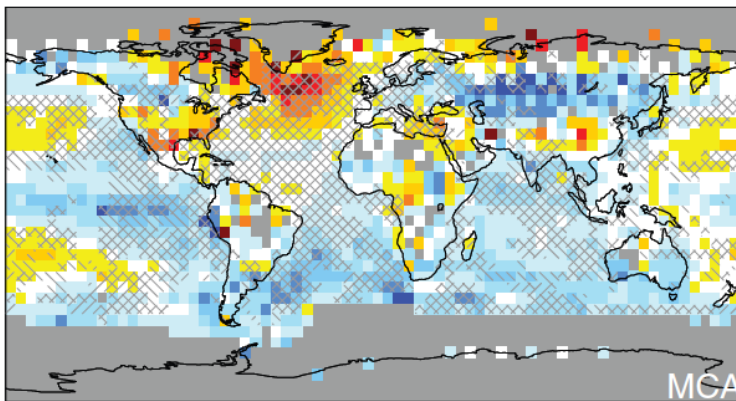
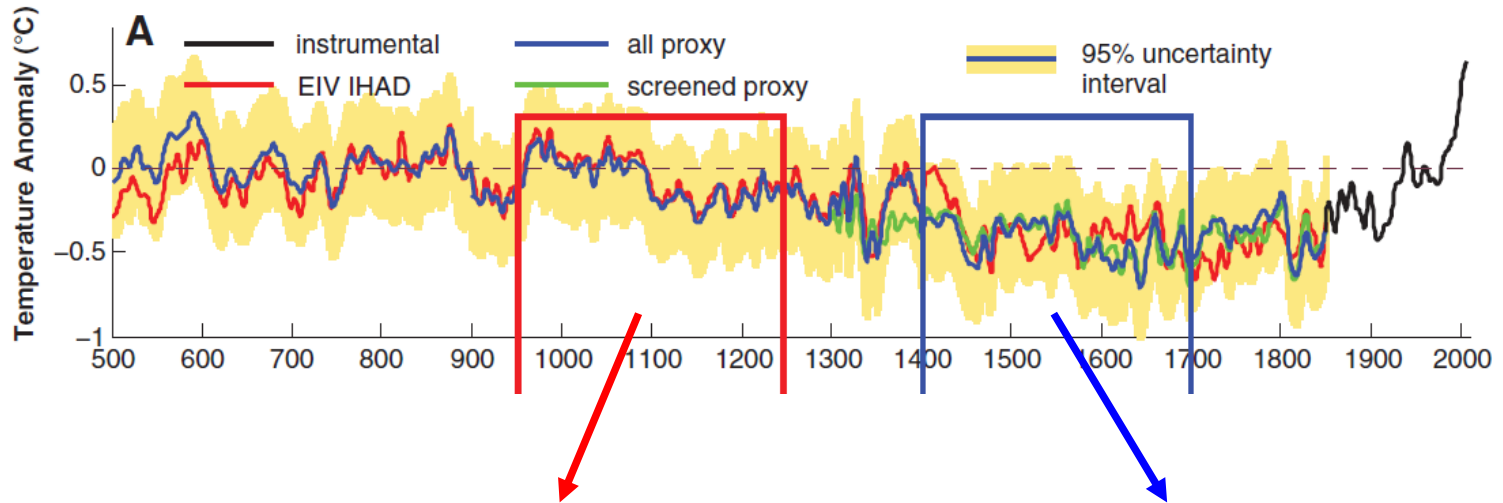
Marine archives



Climate proxy data

- far less accurate than meteorological observations
- decreasing data network back in time
- less information about paleohydrology than paleotemperature

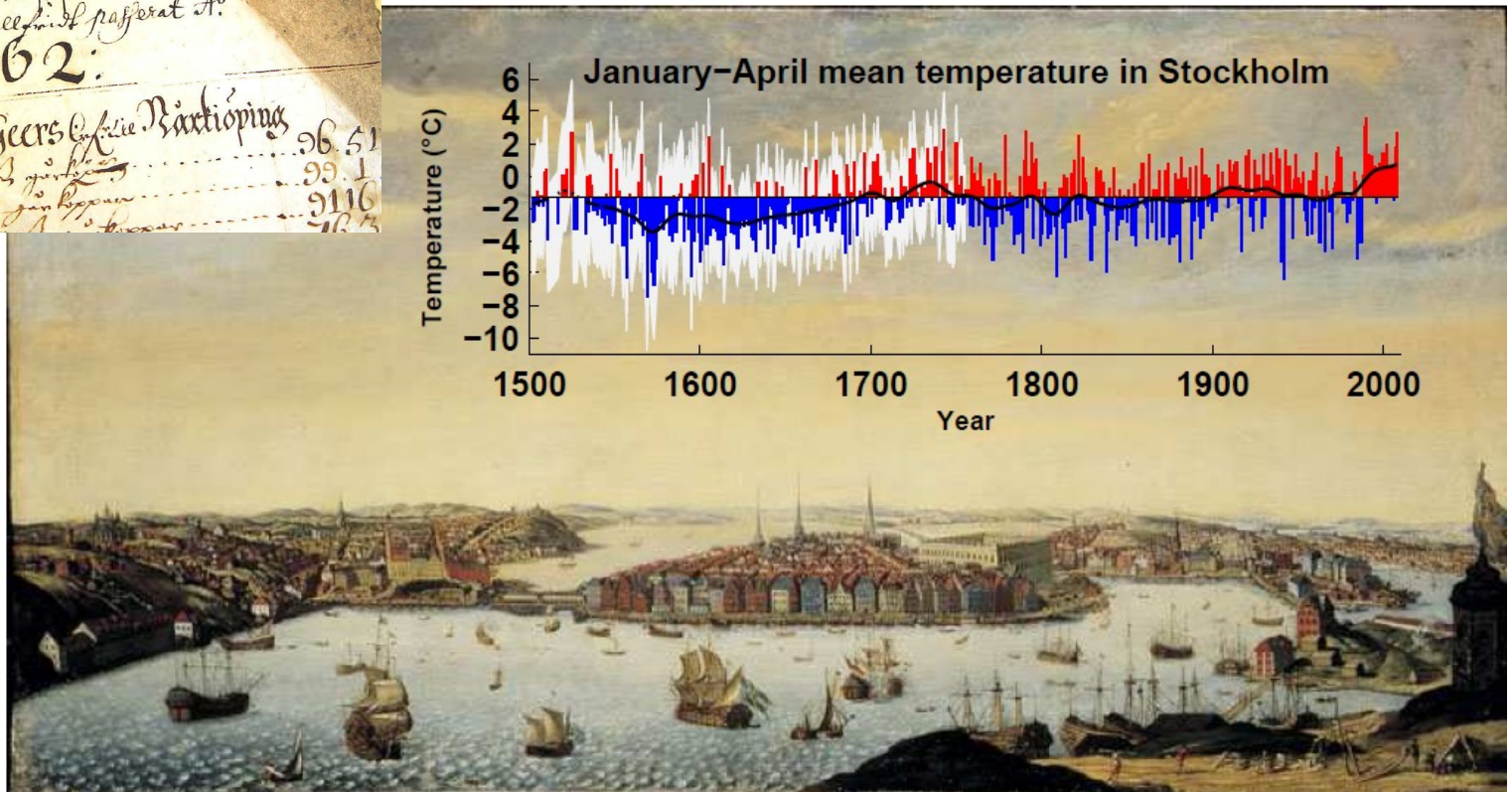
Northern Hemisphere mean temperature last 1500 years



Stockholm winter/spring temperatures last 500 years



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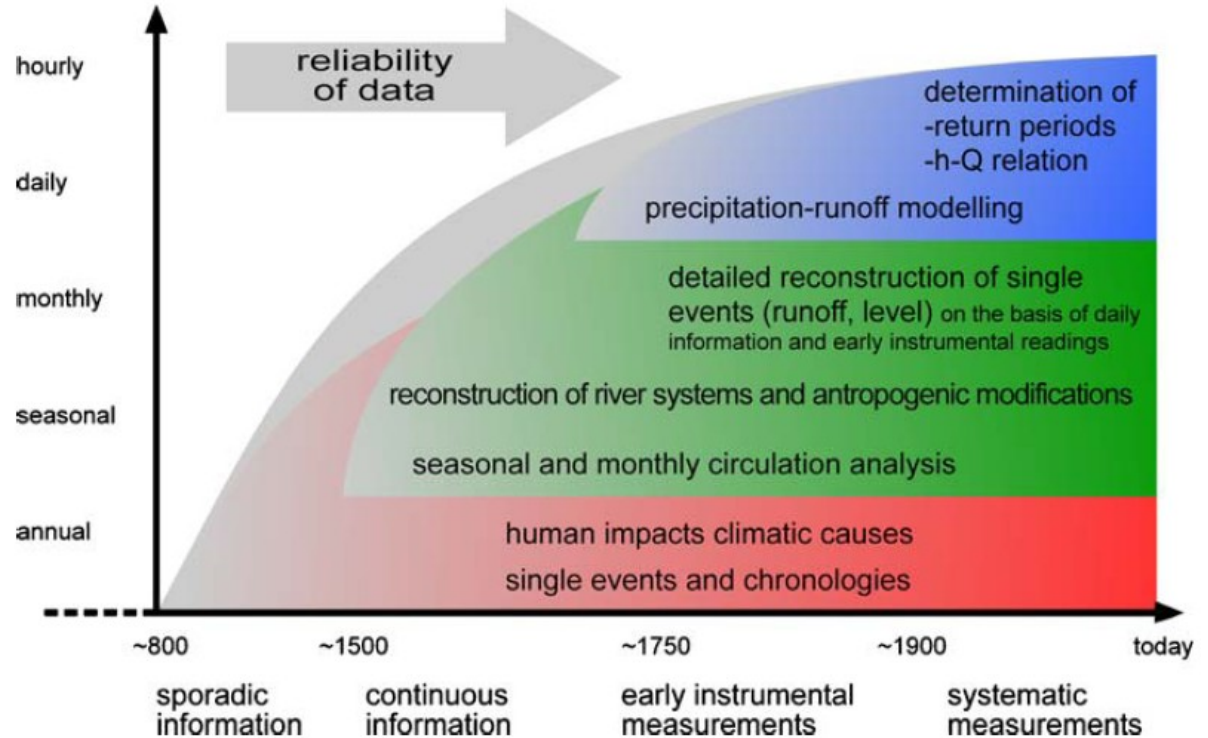
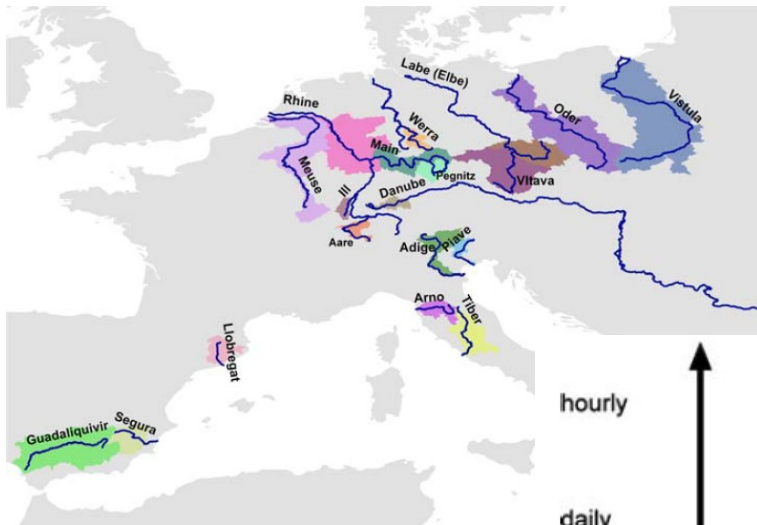


Data: Leijonhufvud et al. Climatic Change 2009, doi: 10.1007/s10584-009-9650-y
Background image: "Swiddetavlan" showing central Stockholm c. 1720.
<http://www.stockholmskallan.se/php/fupload/SMF/SSM0030900.jpg>

European floods last 500 years



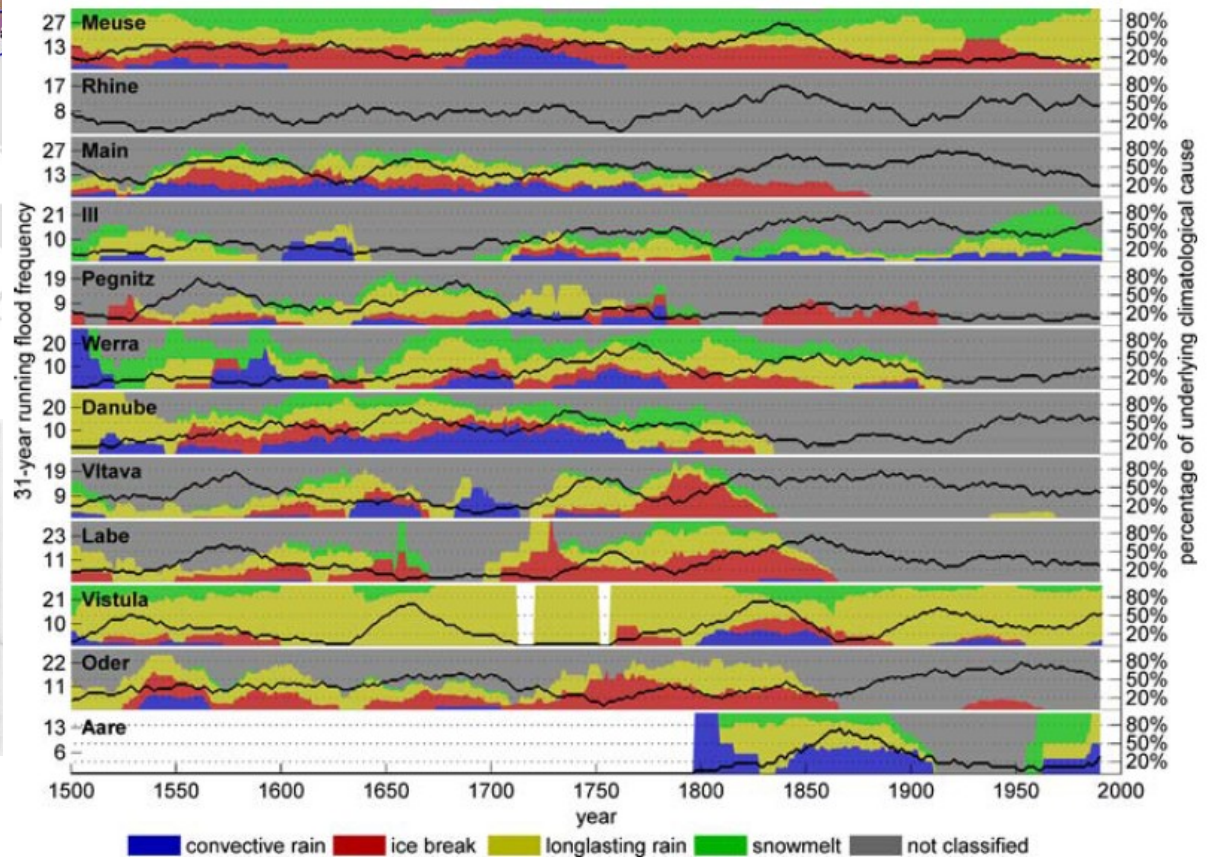
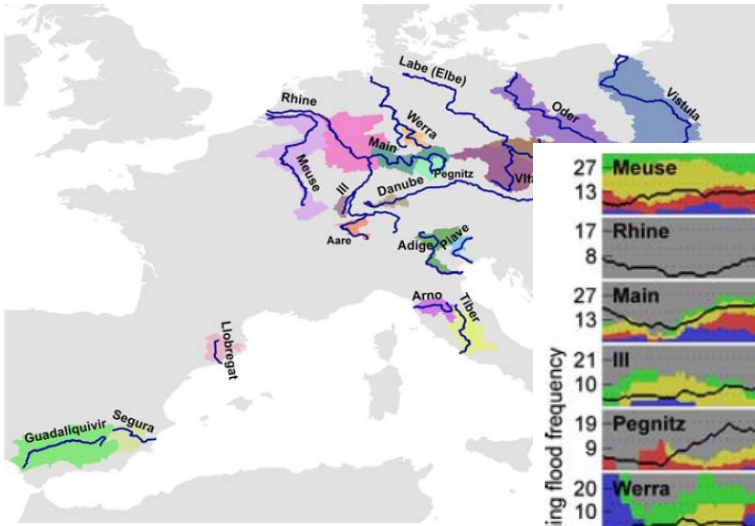
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European floods last 500 years

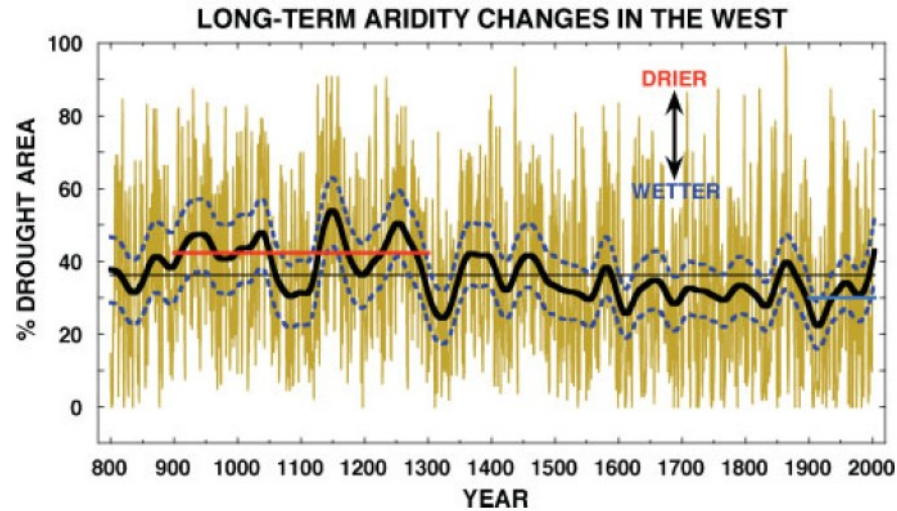
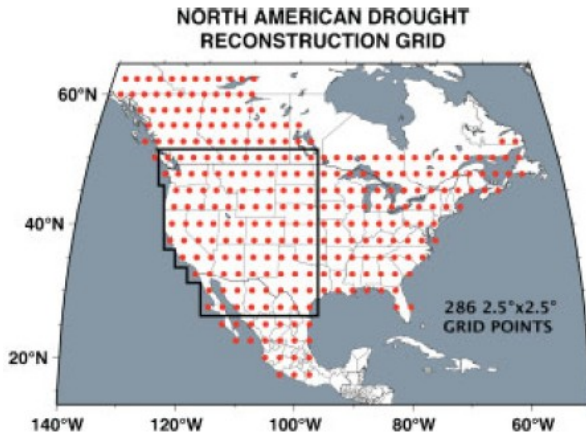


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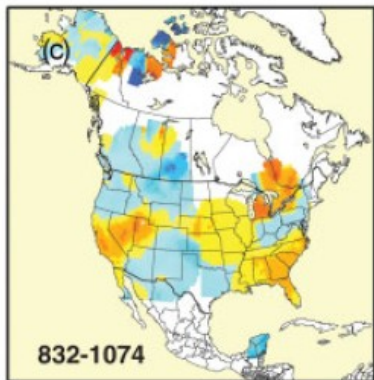


Sum of floods in 31-yr periods

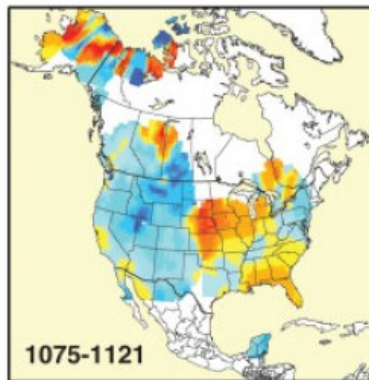
North American droughts last 1200 years



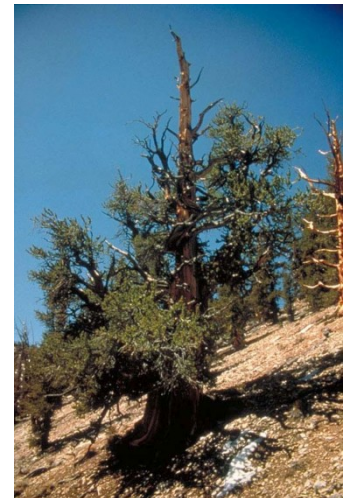
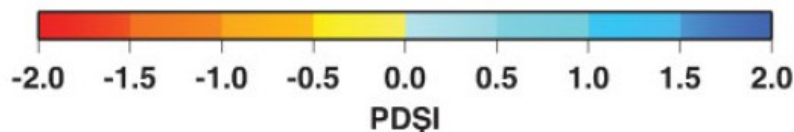
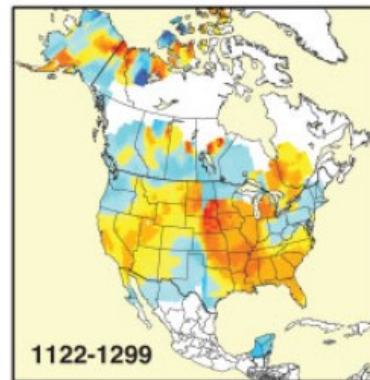
Stine #1 Megadrought



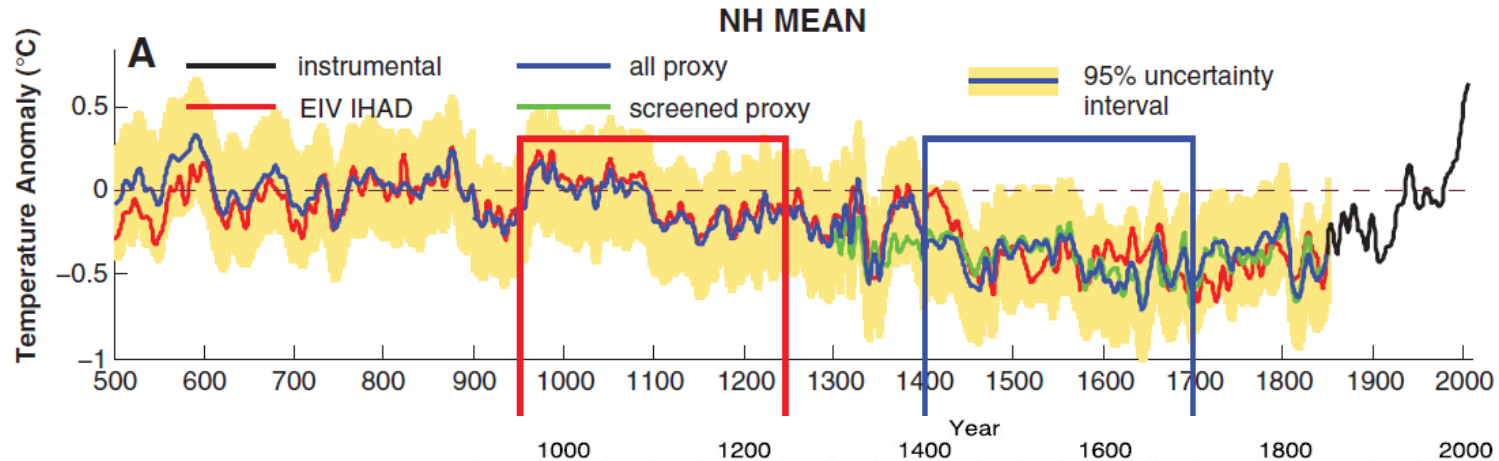
Pluvial



Stine #2 Megadrought



Reasons behind the changes



Volcanic aerosols

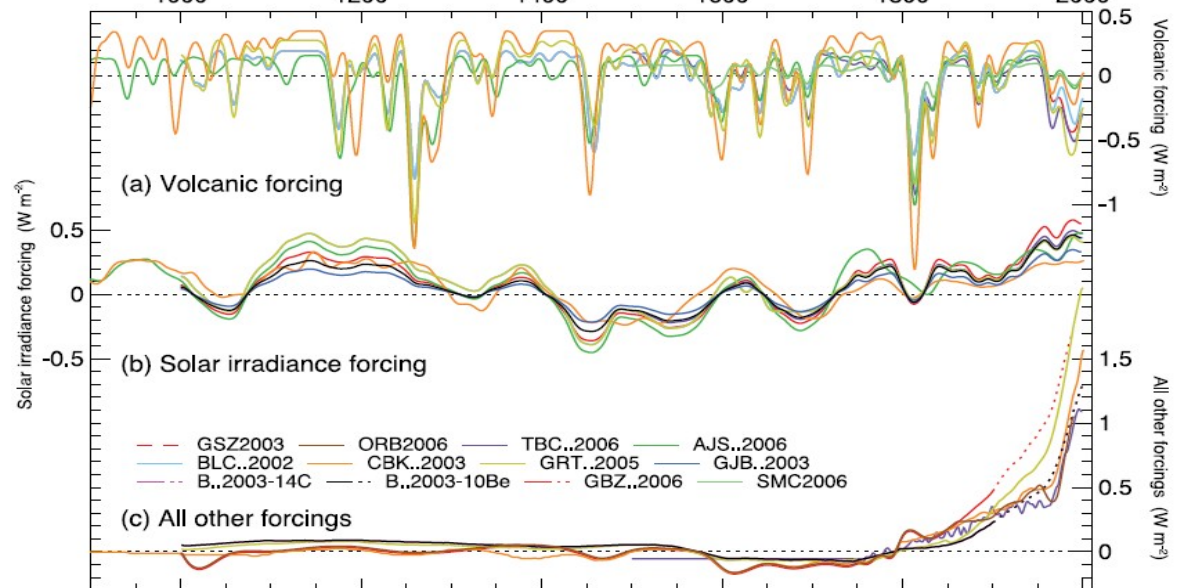
Changing solar radiation

Changing greenhouse gas concentrations – natural and human

Anthropogenic and natural emissions of aerosols

Changed land use

Internal dynamics



Past 1500 years and IPCC future temperature scenarios

- Significant climate changes have occurred in the last millennium – affecting both temperature and hydrology
- Future changes in this century will likely go substantially beyond what we have seen in the recent past

