Past changes in climate and hydrology

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This year so far (Jan – Apr) ...

2010 (the warmest out of 131 years) .75

Temperature anomaly (°C) from 1951-80 mean

http://data.giss.nasa.gov/gistemp/
Global mean temperature since 1850
– warming in most places, but not everywhere

IPCC 2007, Fig. 3.9
http://www.metoffice.gov.uk/climatechange/science/
The global water cycle 
- changes when temperature change

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

Observation [transport in 1000 km³ per year]
Global land precipitation since 1900
– strong regional differences, insignificant global trend
Drought Severity Index since 1900
– dry areas drier, wet areas wetter

IPCC 2007, FAQ 3.1, Fig. 1
Dynamic circulation modes – cause regional differences in weather and climate

Positive Phase of NAO and NAM

With higher than normal atmospheric pressure over the central Atlantic, strong westerly winds push warmth and precipitation toward northern Europe.

- Warmer than normal
- Cooler than normal
- Drier than normal
- Wetter than normal

© IPCC 2007, WG1 AR4
Dynamic circulation modes
– cause regional differences in weather and climate
Climate Proxy Data
– our source of knowledge before
the meteorological observations

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

Mann et al. Science 2009, 326, p.1257, Figs. 1-2
Stockholm winter/spring temperatures last 500 years

Background image: "Swiddetavlan" showing central Stockholm c. 1720.
http://www.stockholmskallan.se/php/fupload/SMF/SSM0030900.jpg
European floods last 500 years

European floods last 500 years

North American droughts last 1200 years

Cook et al. JQS 2010, 25(1), p.48-61, Figs. 4&7
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

Mann et al. Science 2009, 326, p.1257, Fig. 1
IPCC 2007, Fig. 6.13
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

Mann et al. Science 2009, 326, p.1257, Fig. 1

IPCC 2007, SPM Fig. 5