

Quantitative applications of high-resolution late Holocene proxy data sets: estimating climate sensitivity and thermohaline circulation influences

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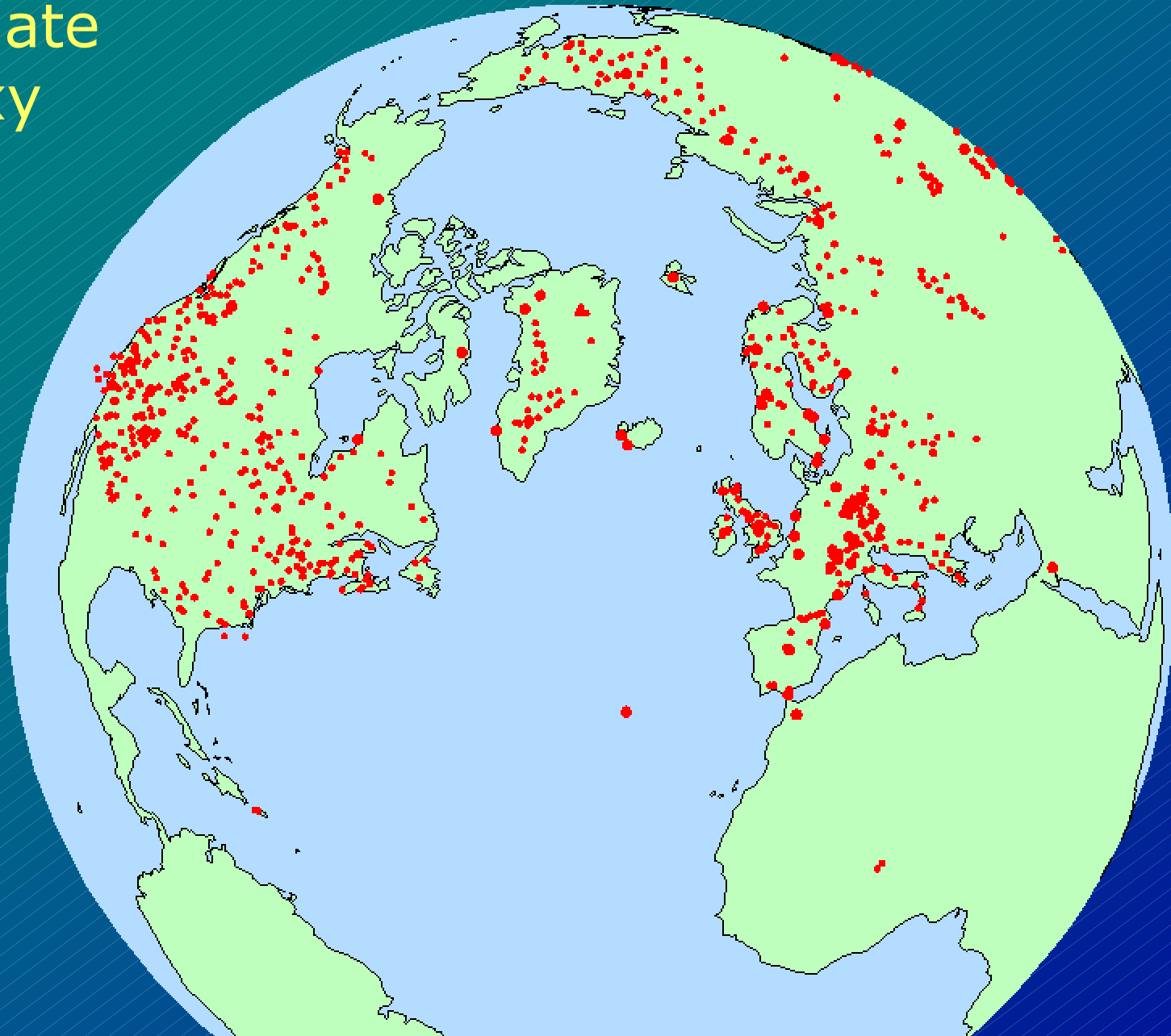
NERC thematic programme on Rapid Climate Change

Principal objectives

Assess the capability of, and then use, late-Holocene climate proxies for:

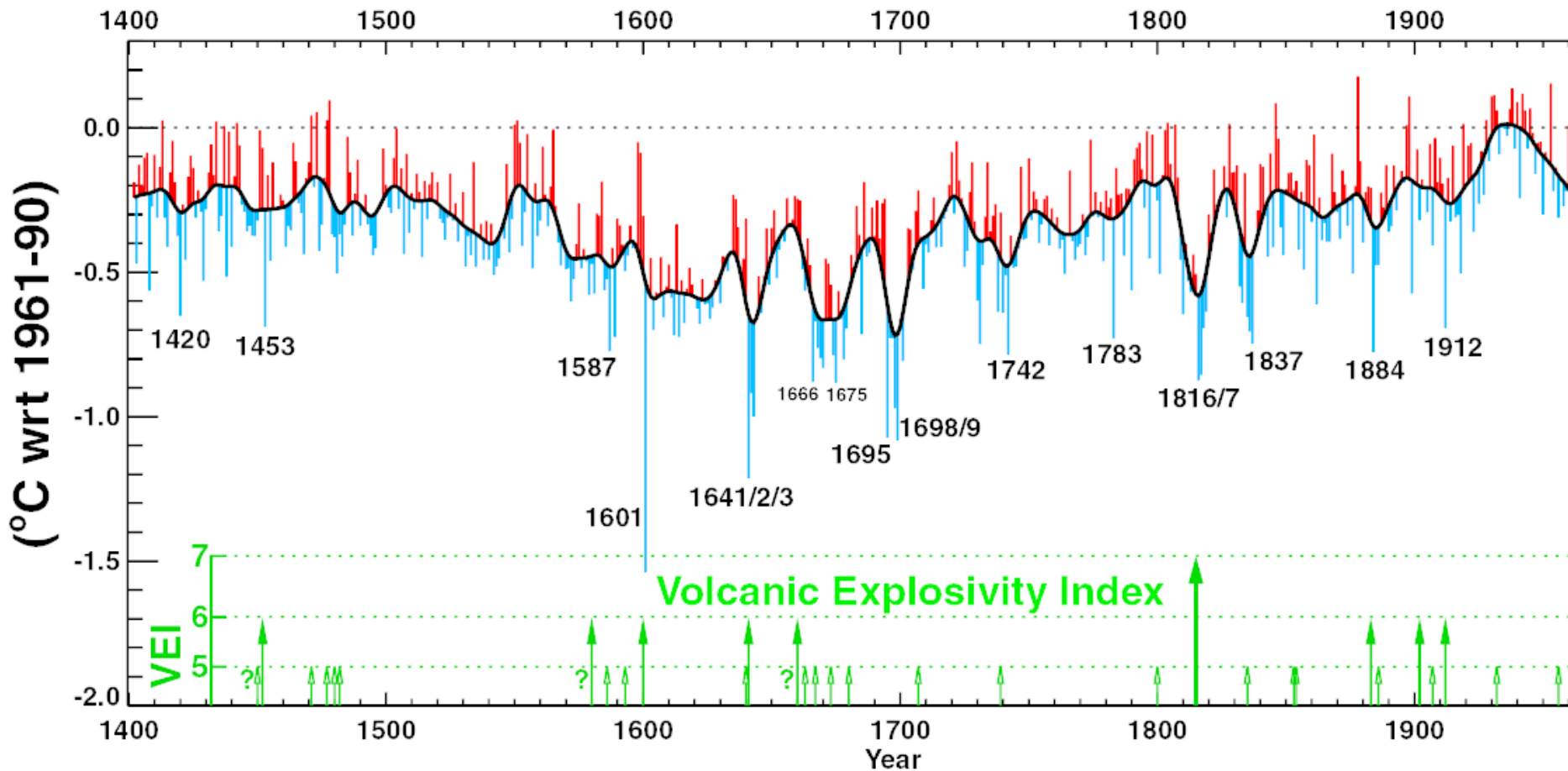
- (1) Quantitative **climate reconstructions** with optimal seasonal & spatial representation
- (2) Identifying **role of NAO and Atlantic MOC** as drivers of circum-Atlantic variability
- (3) Providing constraints on estimates of the **sensitivity of climate** to external forcings

Climate proxy data

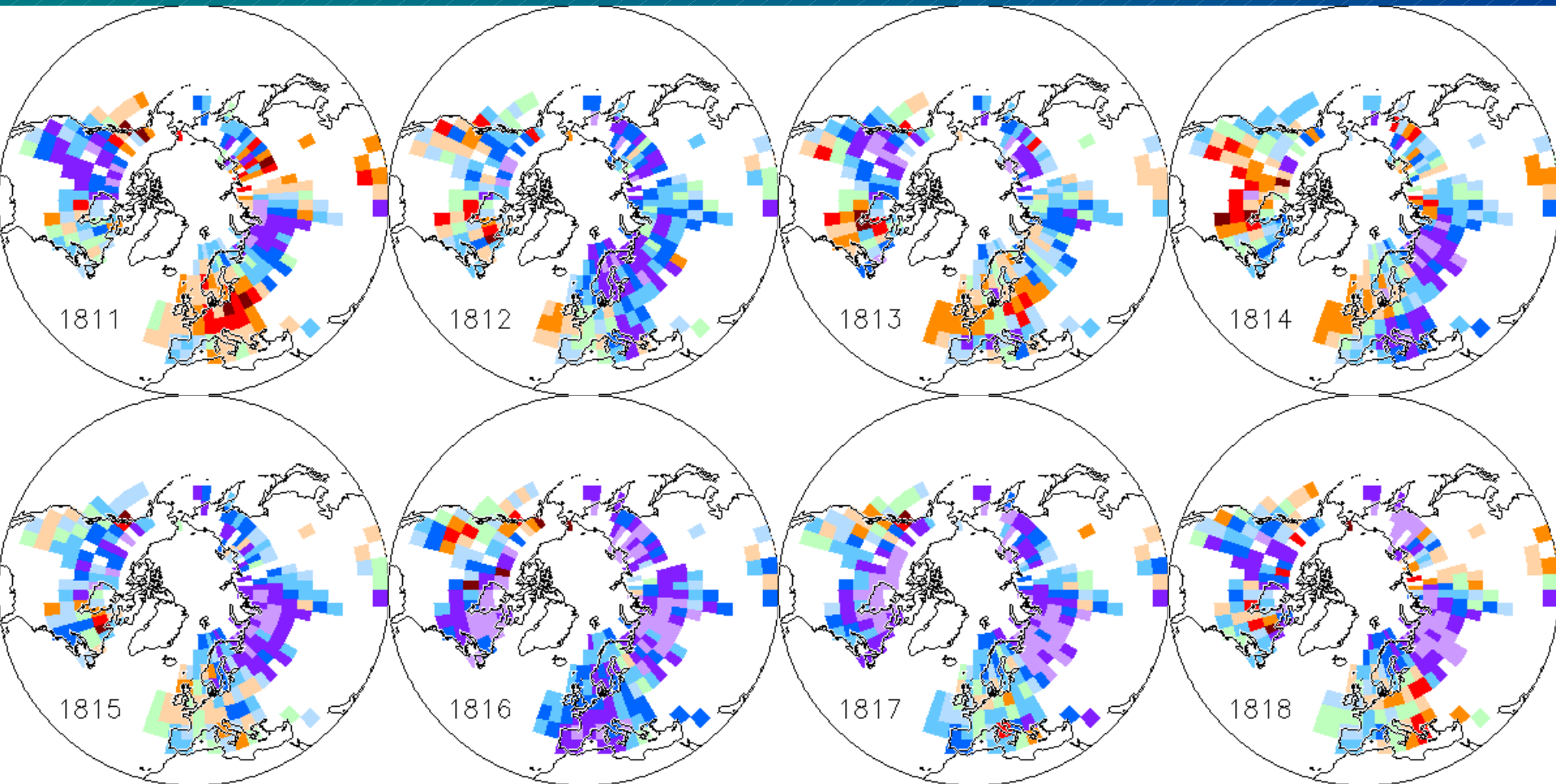
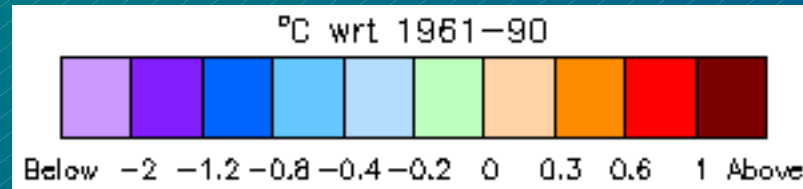


Example climate reconstructions from tree-ring density

Land north of 20°N temperature anomaly



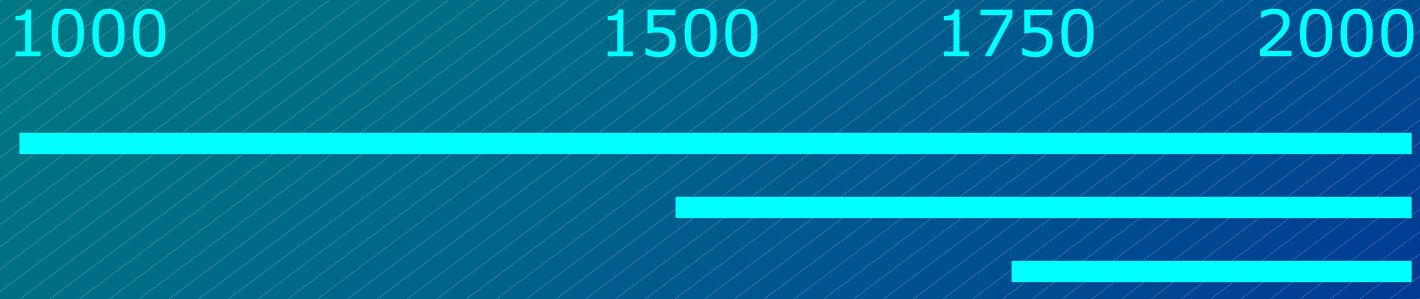
Example climate reconstructions from tree-ring density



Climate model simulations

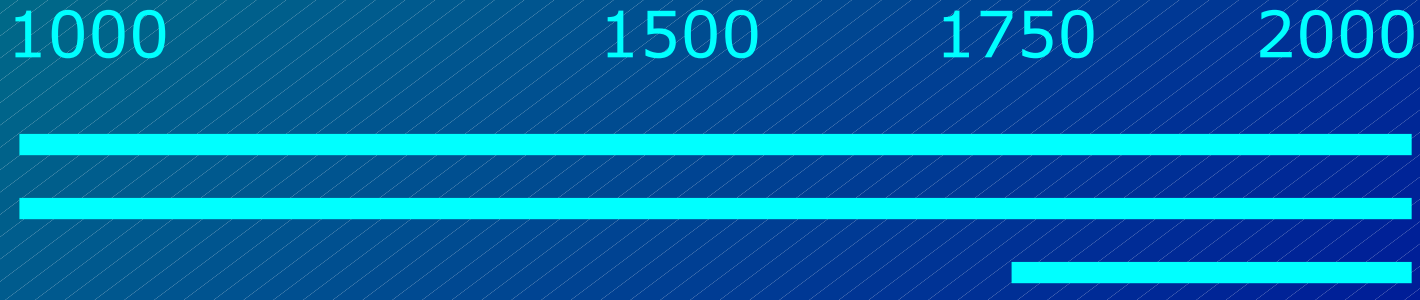
HadCM3

Hadley Centre / Met Office



ECHAM4/HOPE

GKSS & Free University Berlin

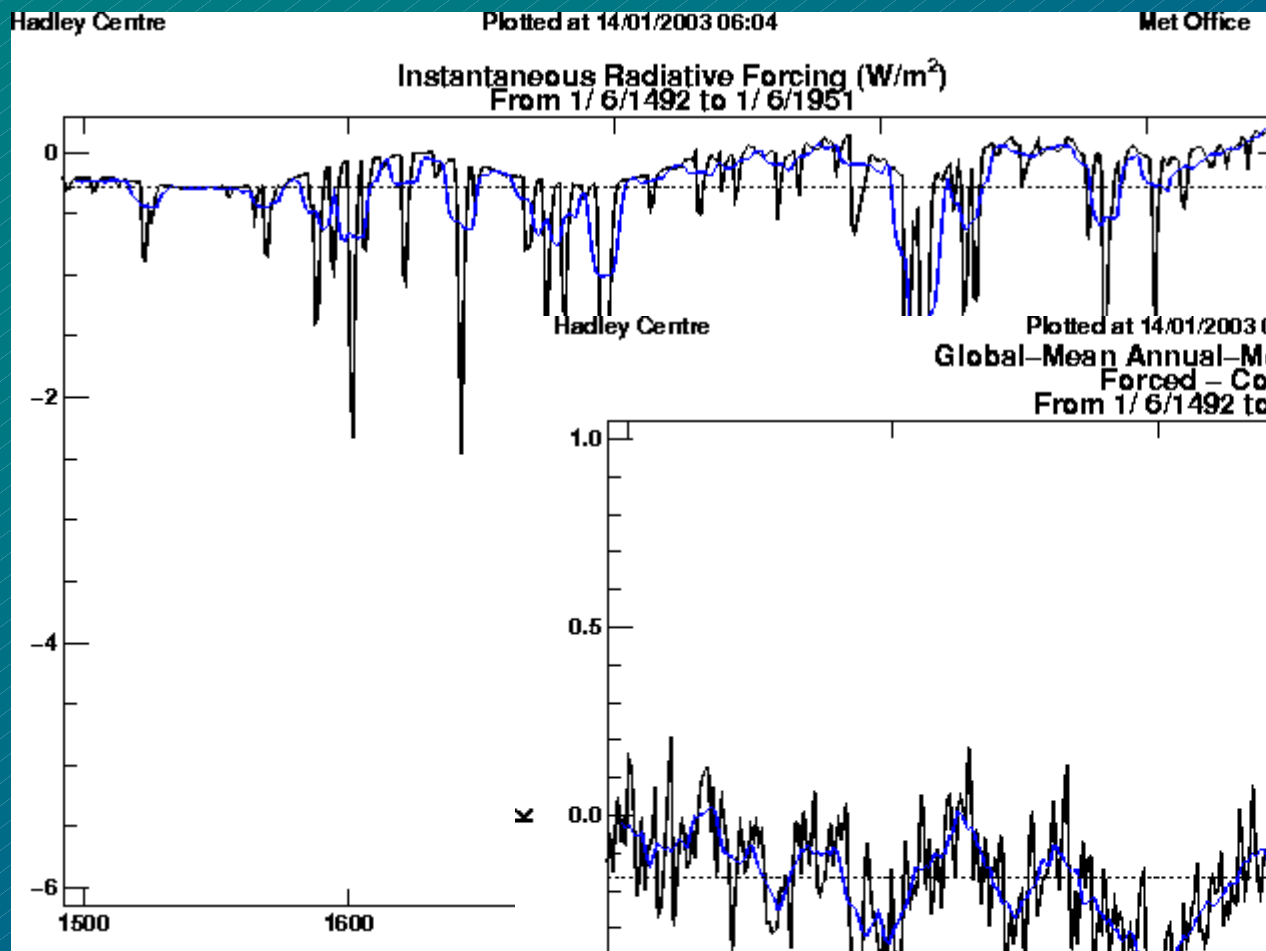


Control: constant external forcings

Natural: volcanic aerosol + solar irradiance + orbital

All: Natural + GHG + SO₄ + O₃ + land-use

HadCM3 natural forcings simulation, 1500-2000



Global
temperature
response

Constraints on the sensitivity of climate

Proxy

Model

$$\mathbf{T}_t + \varepsilon_t = \alpha(\mathbf{F}_t + \zeta_t) + \mathbf{N}_t$$

Unforced climate variability or 'noise'

Uncertainty in forcing histories

Forced climate signal

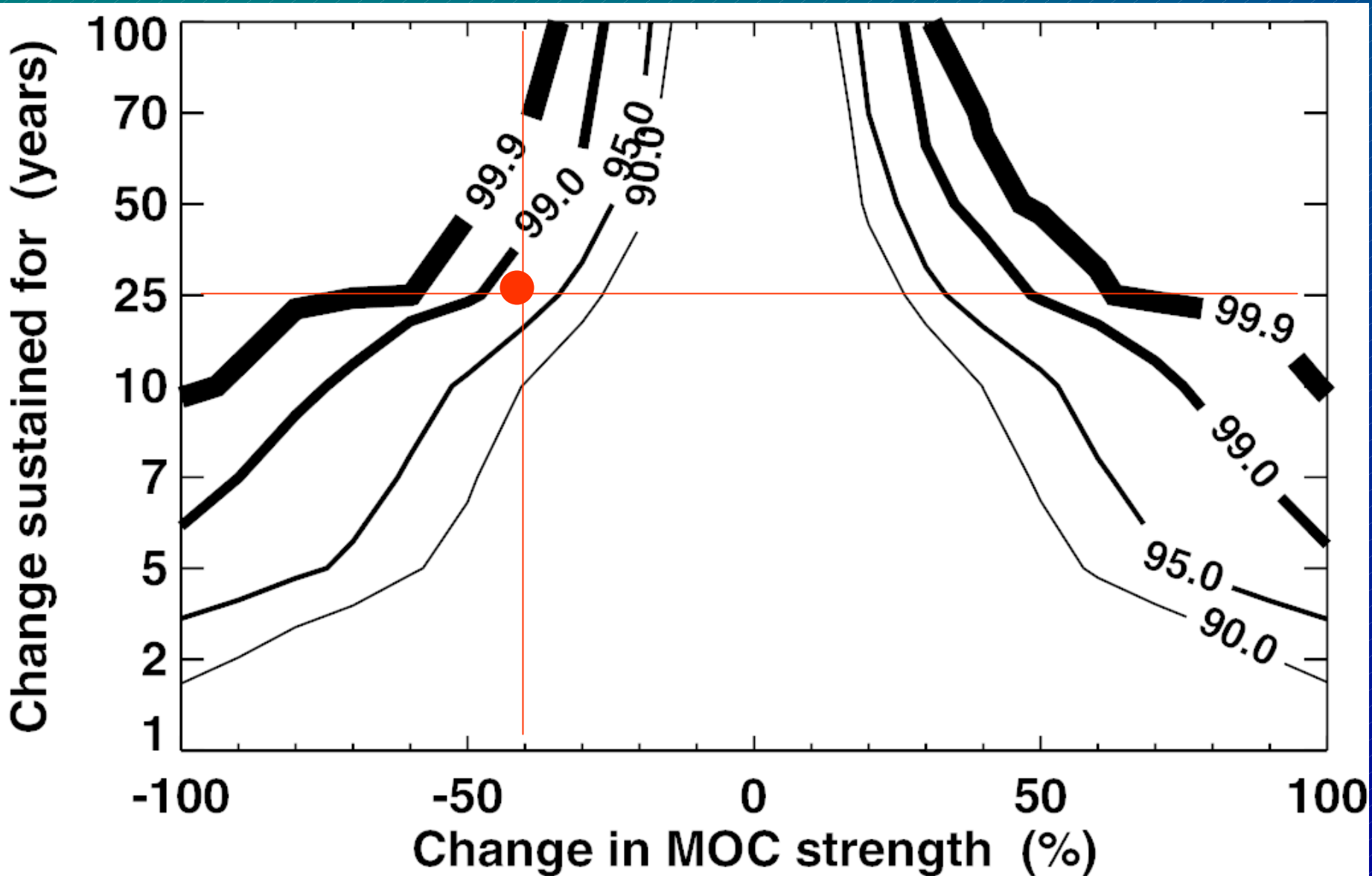
Scaling factor applied to simulated signal from which climate sensitivity can be quantified

Non-climate 'error' in proxy data

Climate reconstruction

Detection likelihood of MOC change

as a function of size of change and length sustained for



Combining tree-ring & early instrumental data

RED LINE = early instrumental temperatures

BLACK LINE = tree-ring density reconstruction,
with **ORANGE** shading to indicate ± 1 and ± 2
standard errors

