

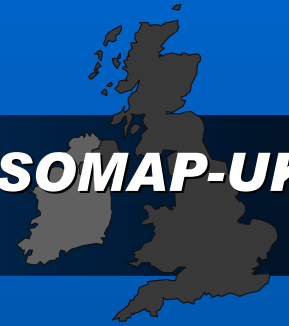
ISOMAP-UK

**A combined data – modelling
investigation of water isotopes and their
interpretation during rapid climate-
change events**

*Jonathan A. Holmes
Environmental Change Research Centre
University College London*

INTRODUCTION

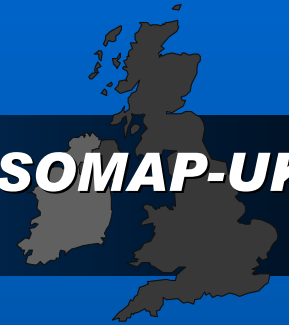
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- **ISOMAP-UK Co-investigators**
- **Isotopes in precipitation**
- **The PAGES ISOMAP Project**
- **ISOMAP-UK**
 - Aims and objectives**
 - Palaeoarchives**
 - Modelling**
- **Potential links with other projects**

PROJECT CO-INVESTIGATORS

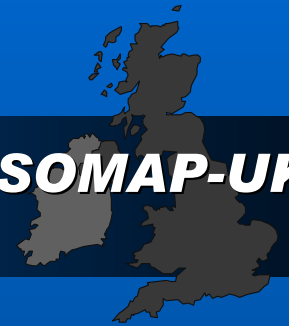
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- Dr Tim Atkinson (UCL and UEA)
- Prof Keith Barber (Southampton)
- Dr Jim Marshall (Liverpool)
- Dr Peter Rowe (UEA)
- Prof Alayne Street-Perrott (Swansea)
- Prof Paul Valdes (Reading)
- Dr Eric Wolff (BAS)

ISOTOPES IN PRECIPITATION

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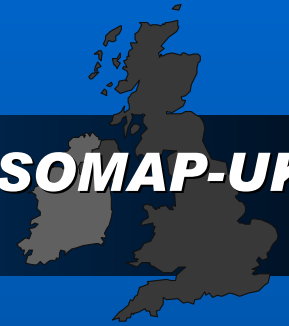
- The distribution of the heavy isotopes of oxygen and hydrogen in palaeoprecipitation provides a quantitative link to past climate and hydrology
- Incorporation of water isotopes into atmospheric GCMs allows simulation of past global climate under a range of different forcing conditions

HOWEVER...

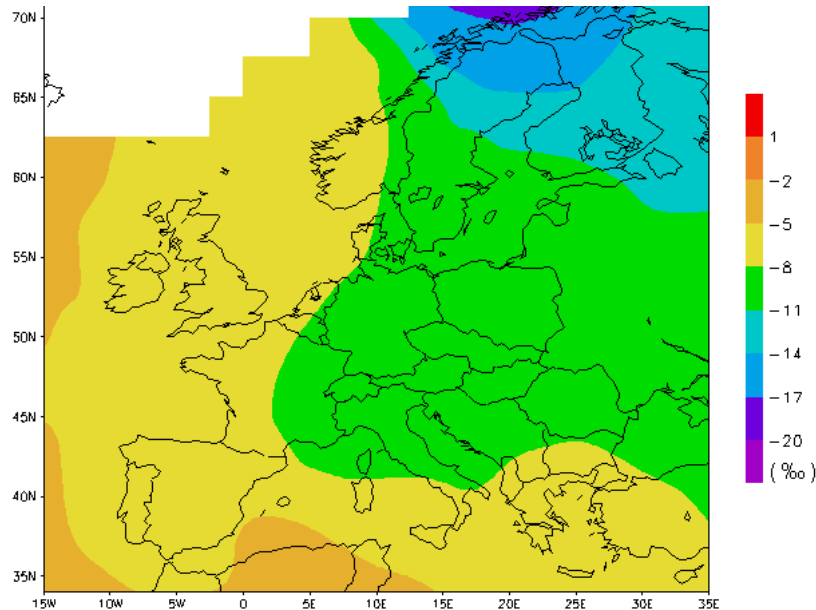
- Because of the scarcity of palaeo-data, only basic 'ground-truthing' of modelled scenarios has been undertaken

ISOTOPES IN PRECIPITATION

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Weighted annual $\delta^{18}\text{O}$ in precipitation, Europe



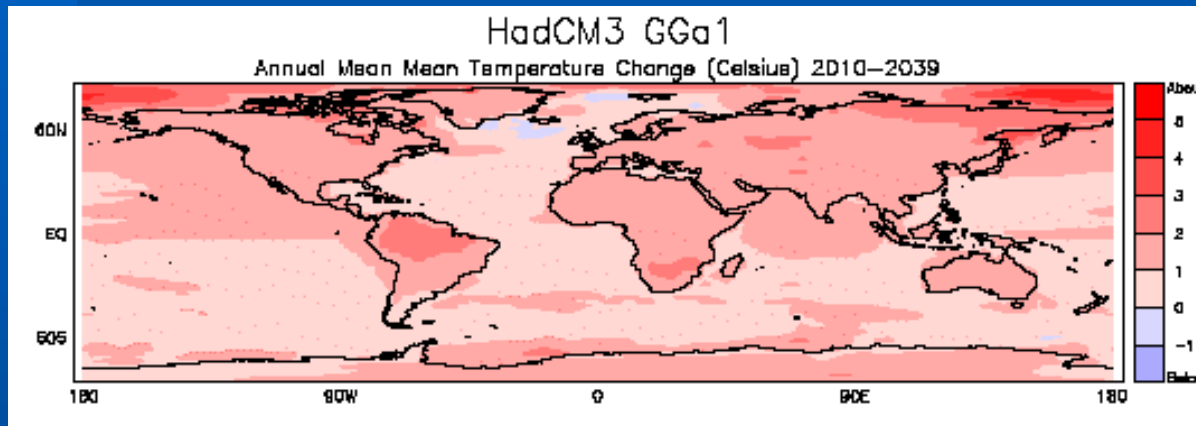
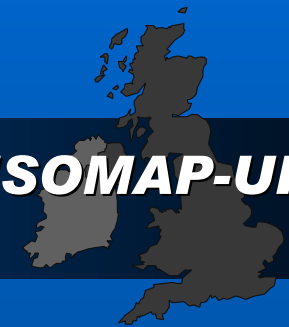
Palaeotemperature
inferences

$$\delta = aT_s + b$$

Source: http://sciborg.uwaterloo.ca/research_groups/eilab/gnip/maps&animations

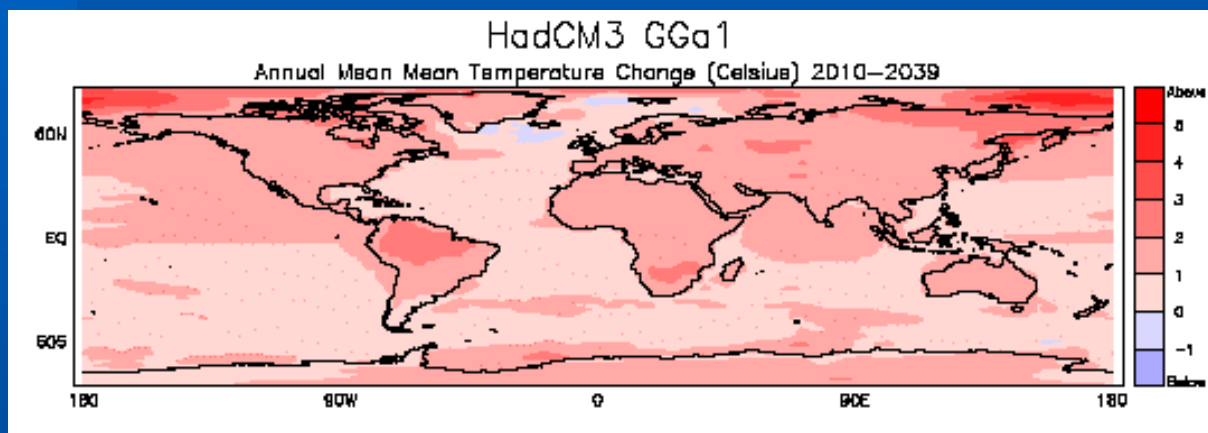
MODEL OUTPUT

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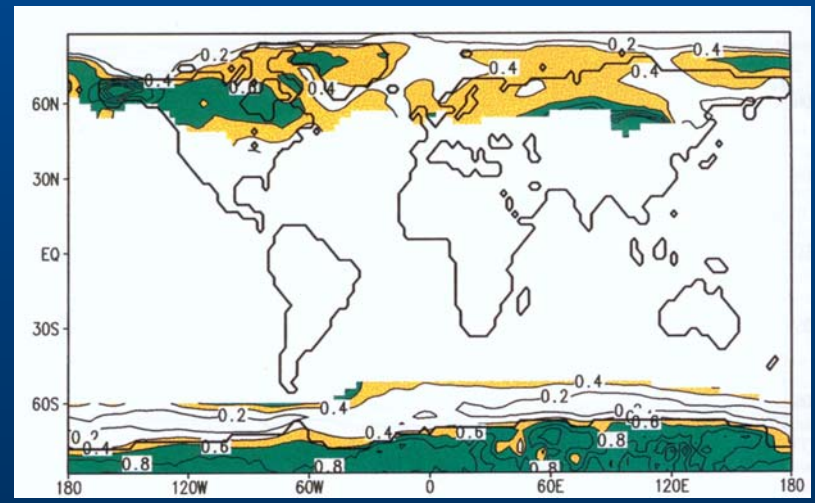
Source: www.cru.eua.ac.uk/link

MODEL OUTPUT



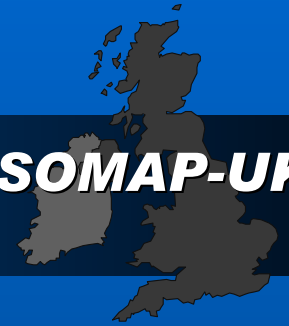
Source: www.cru.eua.ac.uk/link

Slope of the $\delta^{18}\text{O}/T_s$ relationship LGM - control ($\text{‰}/^\circ\text{C}$) from ECHAM simulation (Jouzel *et al.*, 2000)



The **PAGES** ISOMAP Project

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Isotope calibration and mapping study

Concerned with the mapping and modelling of the global isotope climate at key times and intervals in the past

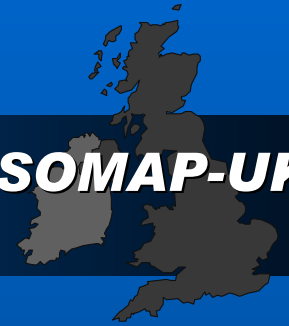
ISOMAP-UK forms a UK contribution to the PAGES ISOMAP Project

ISOMAP-UK Aims

- **To compile high-resolution isotope records from a range of terrestrial archives in Northwest Europe**
- **To compare the archives with model simulations of isotopes in precipitation**
- **To undertake model validation**
- **To investigate the role of different forcing factors in rapid climate change during the late glacial and Holocene**

ISOMAP-UK Objectives

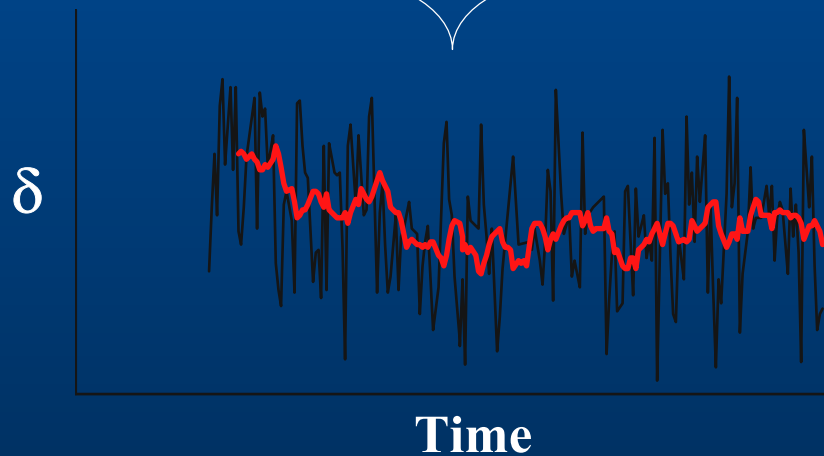
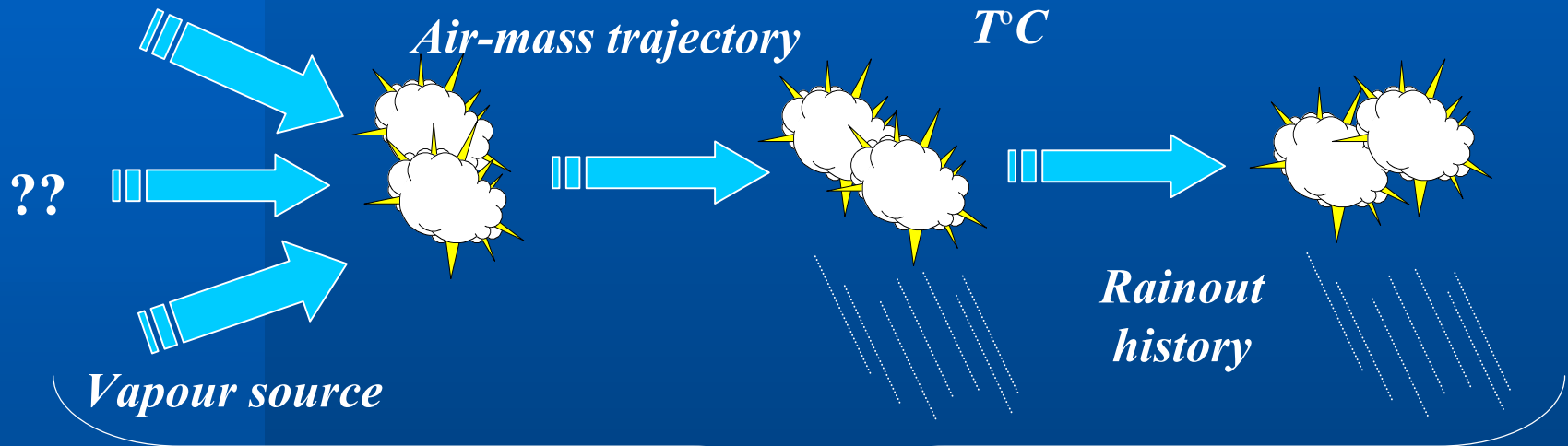
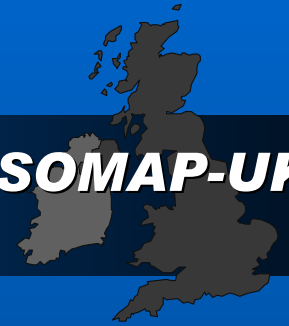
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- Configuration of the Hadley Centre Model (HadCM3) to provide numerical simulations of $\delta^{18}\text{O}$ and δD in precipitation
- Model validation, through comparisons with the GNIP database and recent measurements of isotopes in precipitation; comparison of performance with other models
- Reconstruction of the isotopic composition of precipitation for the late glacial and Holocene using a range of different archives (lake sediments, speleothems, peat) over the British Isles and Europe based on primary research and existing data
- Comparisons of the reconstructed isotope composition of palaeoprecipitation with model output for periods of rapid climate change to assess whether the palaeodata are consistent with the postulated forcing as simulated by the model

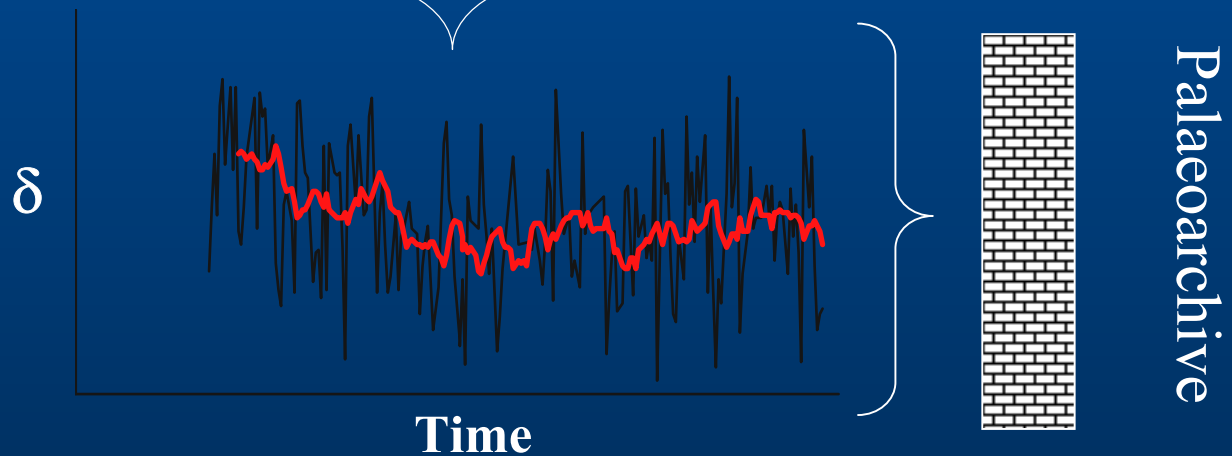
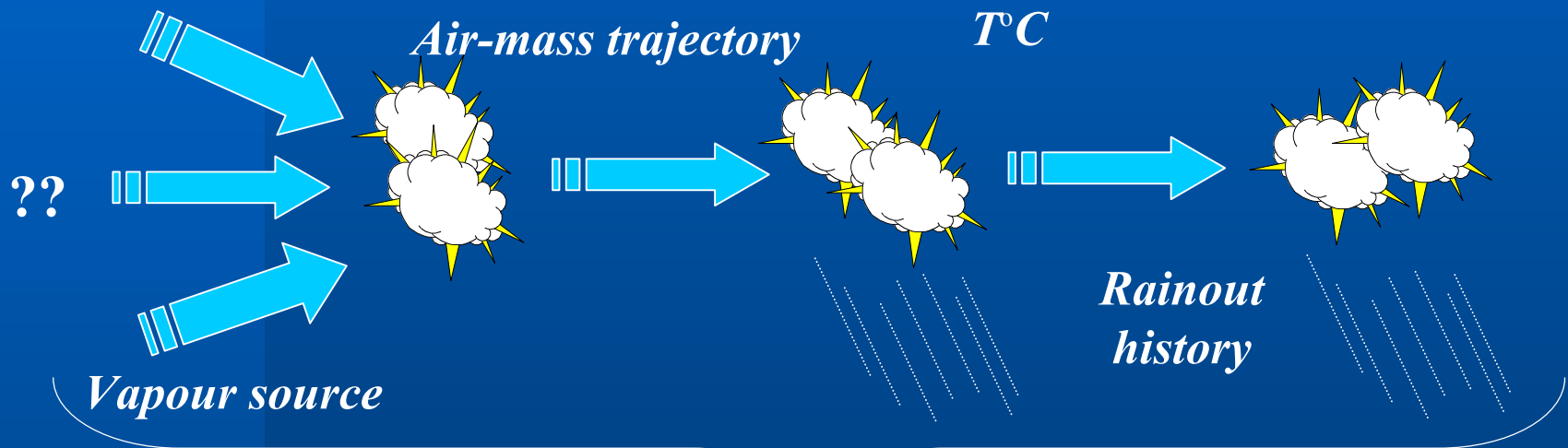
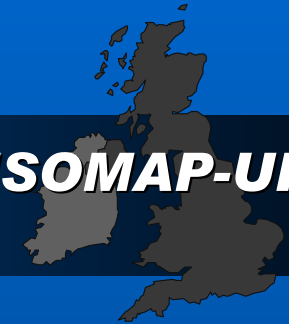
ISOTOPES IN PAST PRECIPITATION

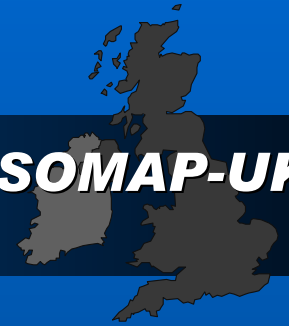
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ISOTOPES IN PAST PRECIPITATION

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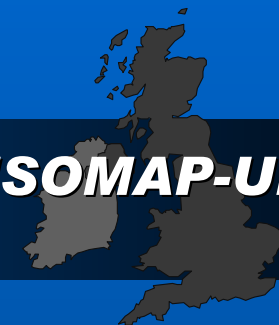


PALAEORECORDS

- Instrumental records
- Ice cores
- Lake sediments
 - Carbonate*
 - Organic matter*
- Peat bogs
- Speleothems
 - Carbonate*
 - Fluid inclusions*

ISOTOPES IN PAST PRECIPITATION

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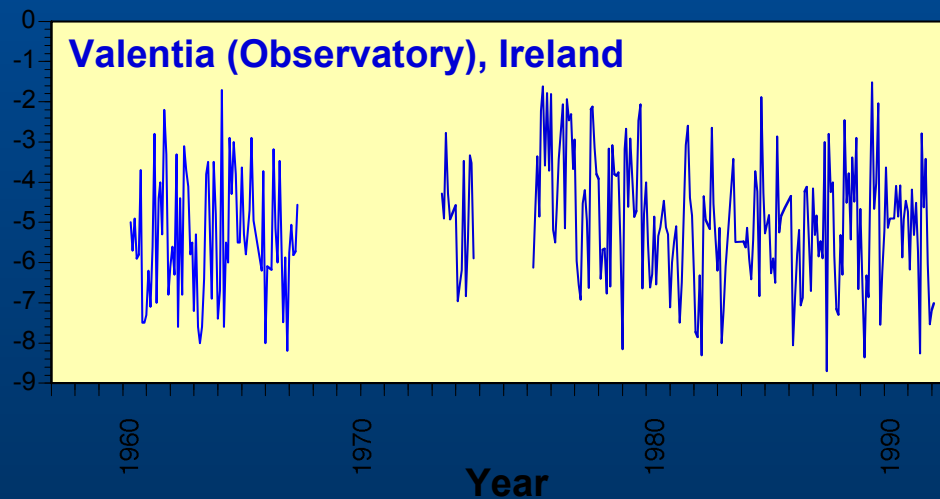


Instrumental records



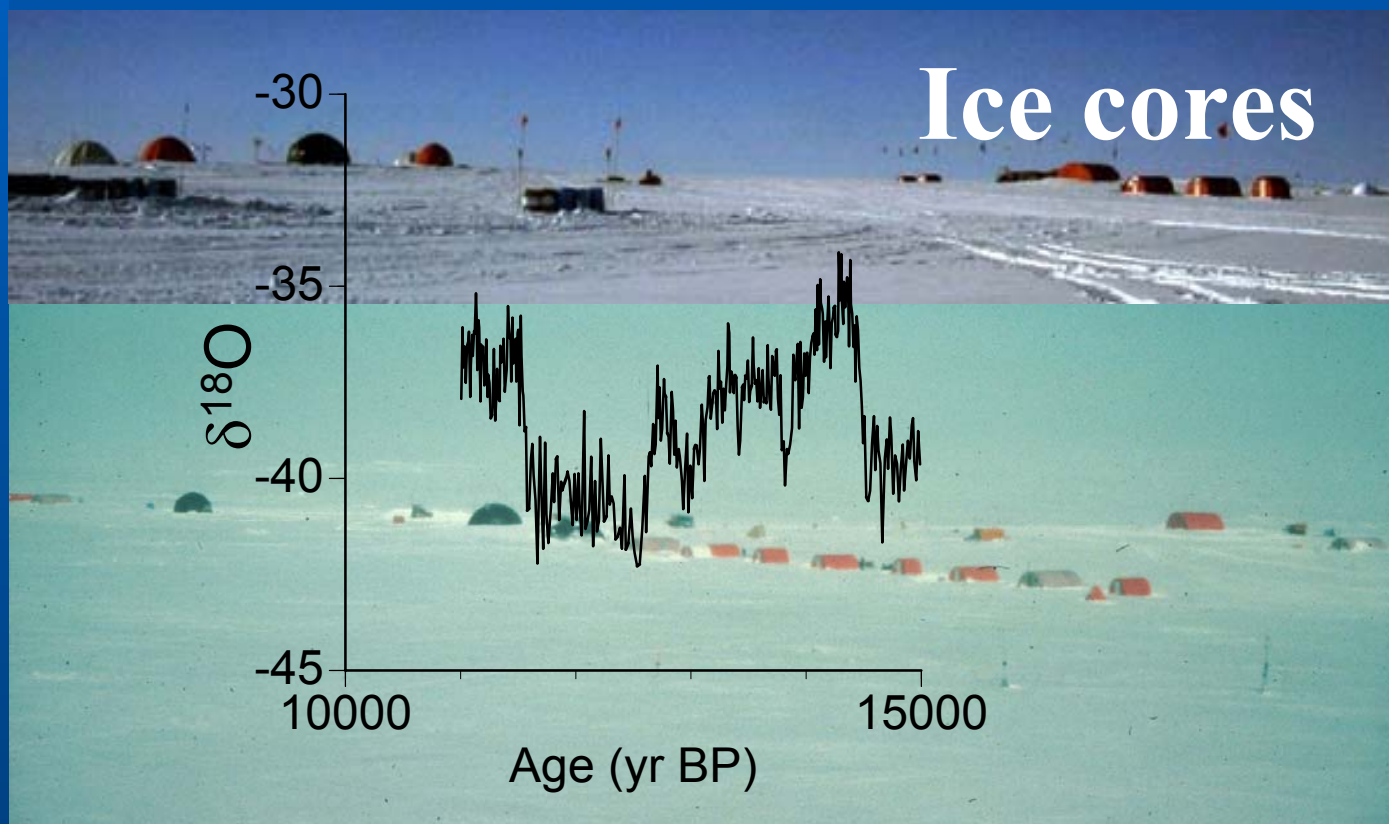
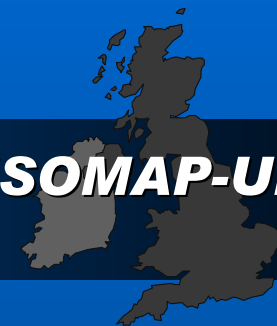
GNIP - Global Network of Isotopes in Precipitation

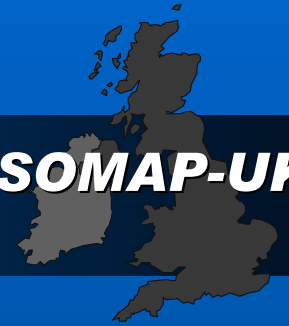
$\delta^{18}\text{O}$



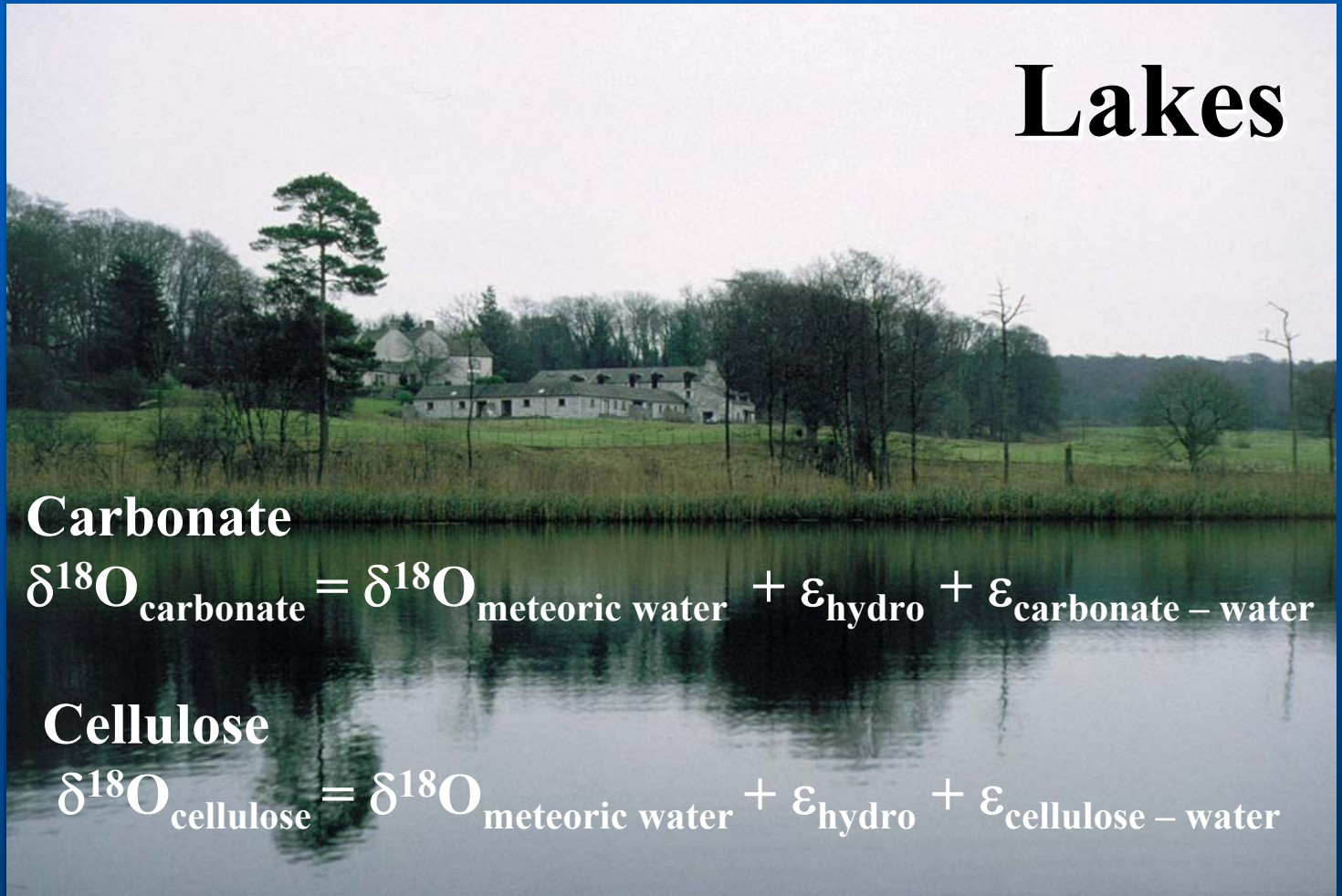
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Lakes



Carbonate

$$\delta^{18}\text{O}_{\text{carbonate}} = \delta^{18}\text{O}_{\text{meteoric water}} + \epsilon_{\text{hydro}} + \epsilon_{\text{carbonate} - \text{water}}$$

Cellulose

$$\delta^{18}\text{O}_{\text{cellulose}} = \delta^{18}\text{O}_{\text{meteoric water}} + \epsilon_{\text{hydro}} + \epsilon_{\text{cellulose} - \text{water}}$$

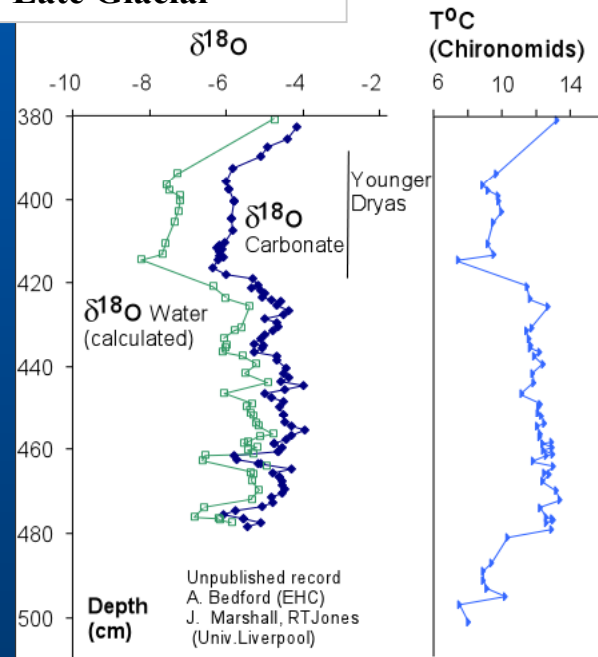
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Lake-sediments

Hawes Water - Late Glacial



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Peat



$$\delta_{\text{cellulose}} = \delta_{\text{meteoric water}} + \epsilon_{\text{hydro}} + \epsilon_{\text{cellulose - water}}$$

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Speleothems

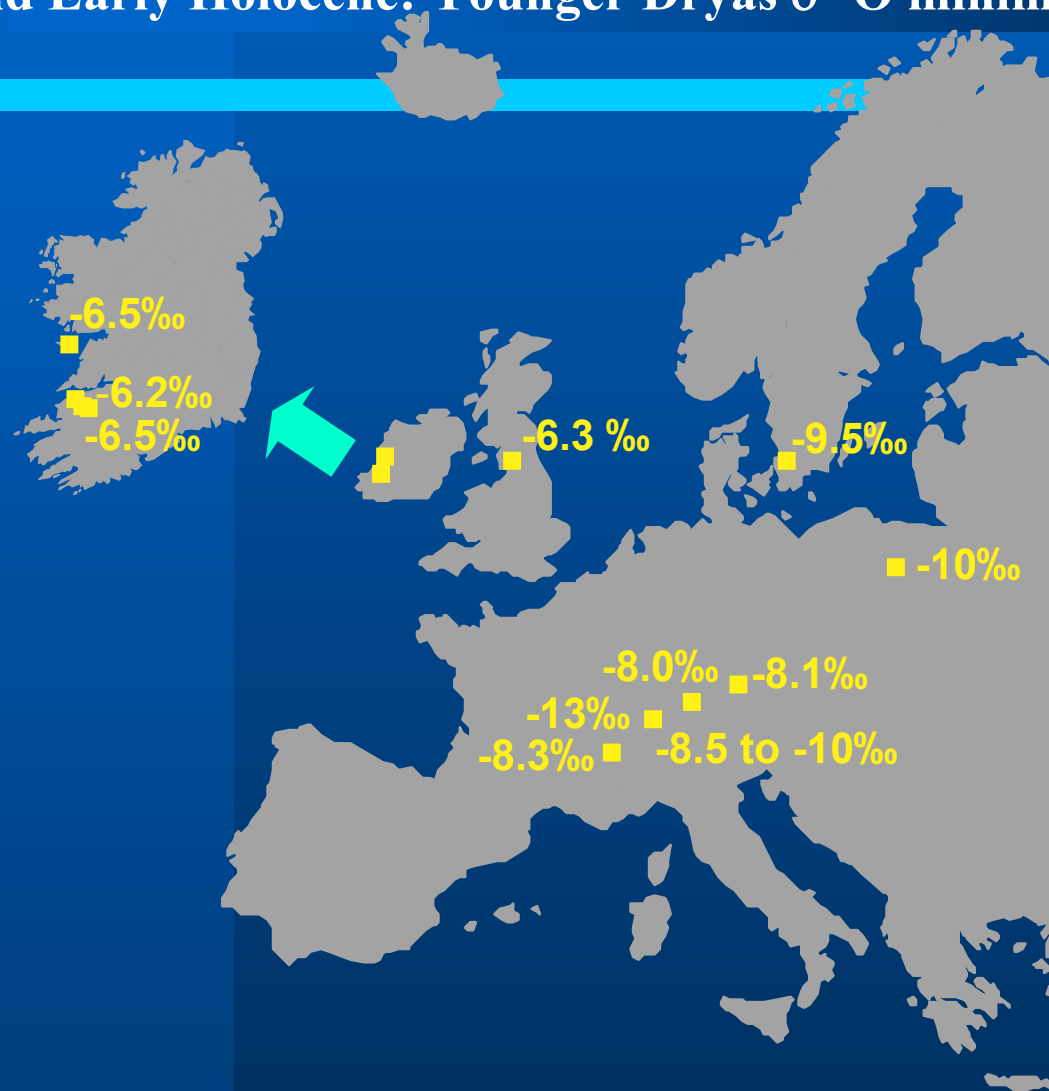
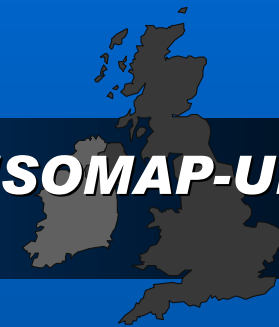


$$\delta^{18}\text{O}_{\text{carbonate}} = \delta^{18}\text{O}_{\text{meteoric water}} + \epsilon_{\text{hydro}} + \epsilon_{\text{carbonate-water}}$$

$$\delta_{\text{fluid inclusions}} = \delta_{\text{meteoric water}}$$

Oxygen-isotope variations in carbonates from the late glacial And Early Holocene: Younger Dryas $\delta^{18}\text{O}$ minima

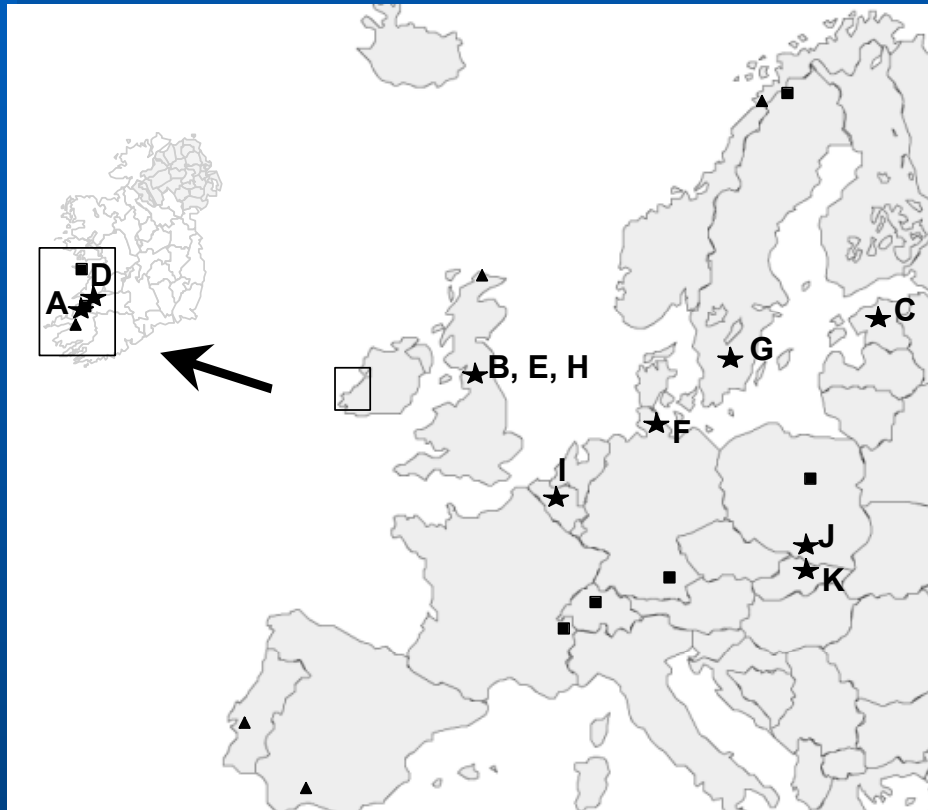
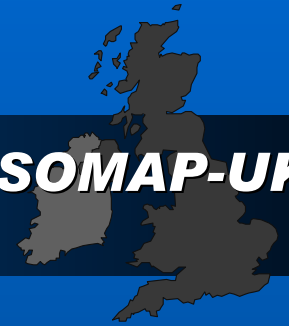
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From published and unpublished sources - data uncorrected for water temperature and other fractionation effects

FIELD SITES

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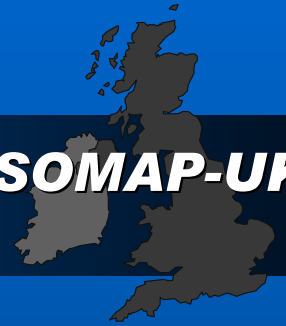
Stars are ISOMAP-UK field sites

Triangles are ASCRIBE sites

Squares are other relevant sites

MODELLING - AIMS

- To include oxygen and deuterium isotope sub-models within version 3 of the Hadley Centre Model
- To use the resulting model to simulate changes associated with freshwater pulses that have been implicated as causes of rapid climate change in the past

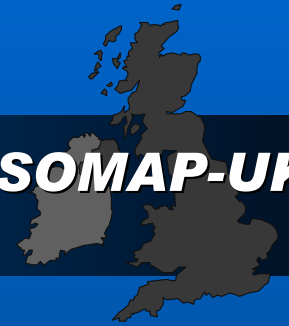


The isotope model will include

- Surface fluxes from ocean and land
- Condensation in clouds, including kinetic effects
- Post-condensation processes such as evaporation of falling precipitation

MODELLING - VALIDATION

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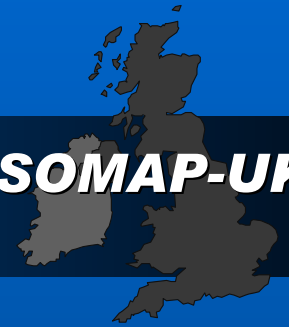


Output from modern simulation “control” runs will be compared with

- (IAEA) global network of isotopes in precipitation (GNIP) database
- Greenland and Antarctic ice-core data
- model-model comparisons with other isotope-enabled GCMs

PROPOSED MODEL SIMULATIONS

- An idealised ‘freshwater hosing’ simulation to examine the isotopic signature recorded in the ice cores and over the European sector
- A quasi-realistic simulation for the 8.2kyr event to understand the basic response of the model.
- A Younger-Dryas type event including an investigation of the sensitivity of isotopic response to different volumes, geographical locations, rates and durations of freshwater input.



- ASCRIBE
- Others?

That's what we're here to discuss!



For further information, contact



j.holmes@ucl.ac.uk