



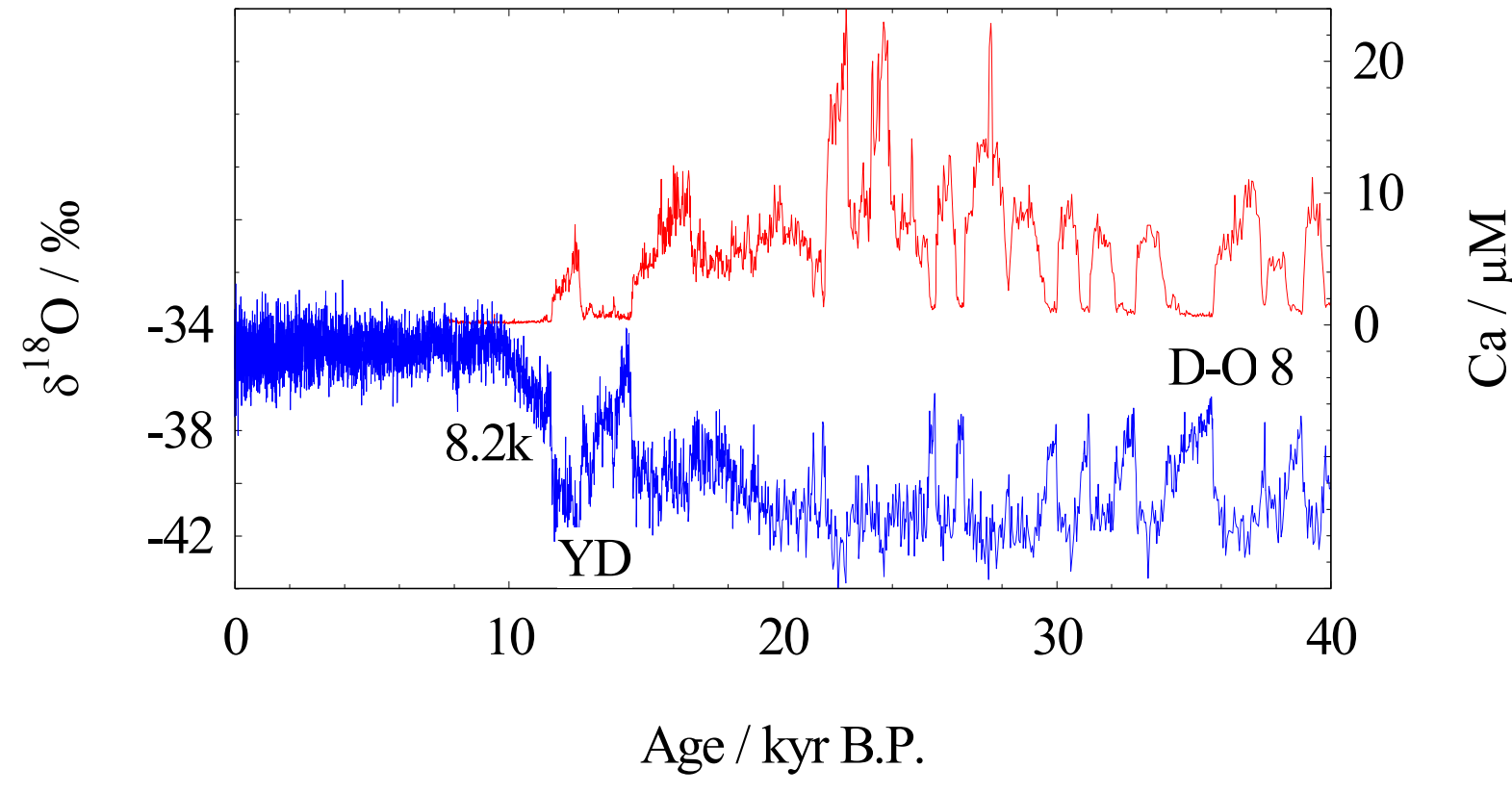
High resolution anatomy of rapid climate transitions from a Greenland ice core

Eric Wolff and Robert Mulvaney

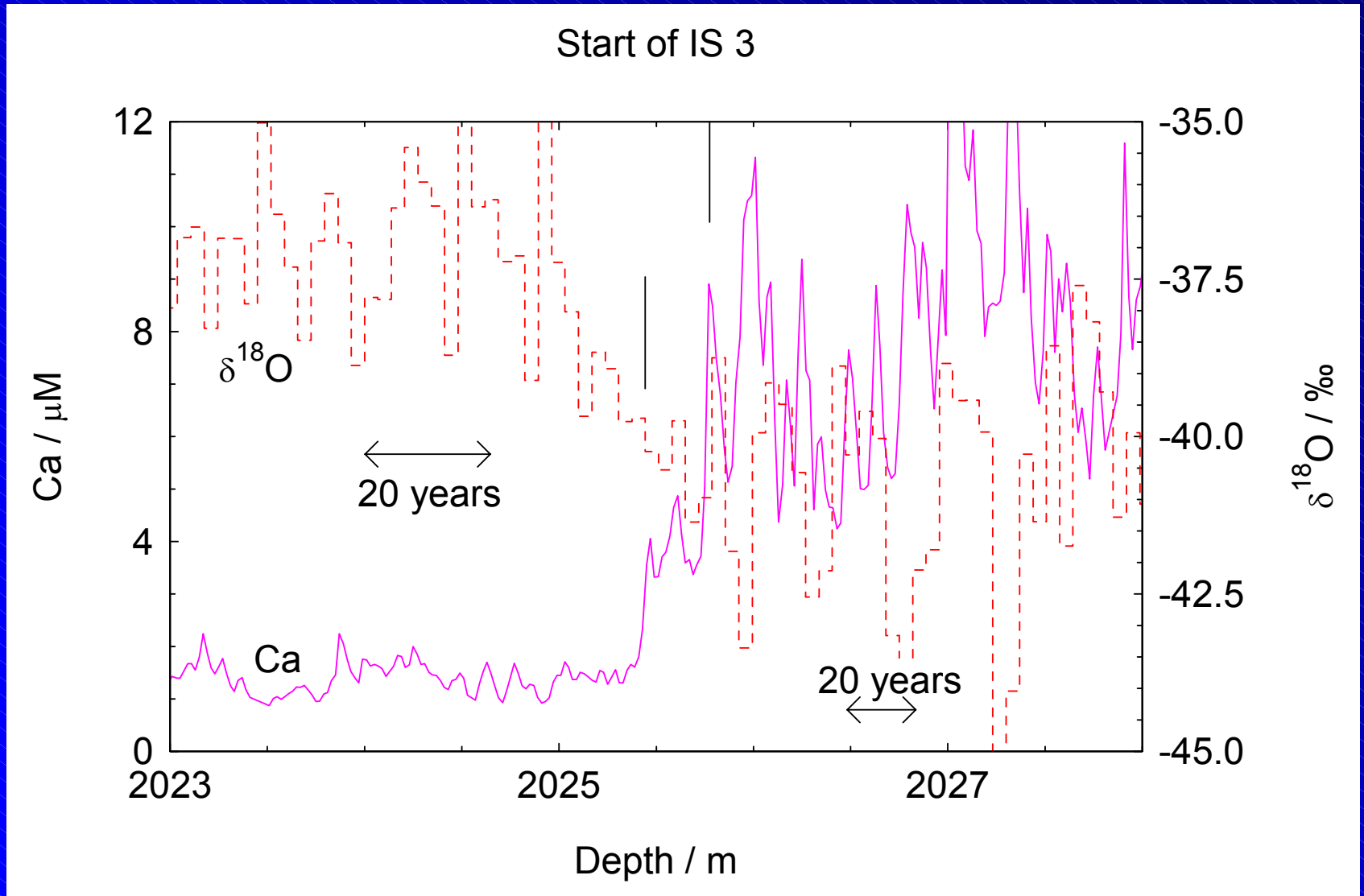
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Greenland ice cores raised the alarm about rapid climate changes



And showed that they happened very fast



Significance of past rapid changes to future

- D-O events are not an analogue for future changes in THC because other conditions were so different
 - Large or residual ice sheet in North America
- But they do offer a chance to test in a general sense whether models are capable of simulating effects of THC change, and to understand the possible extent of such changes


Signatures for the mechanism of D-O events

- Periodicity (Why 1500 years?)
- Spatial pattern (where are they seen most strongly?)
- Detailed events at transitions (resolution probably available only in ice cores)
 - True speed of transitions
 - Phasing between different ice core signals
 - Seasonality of changes

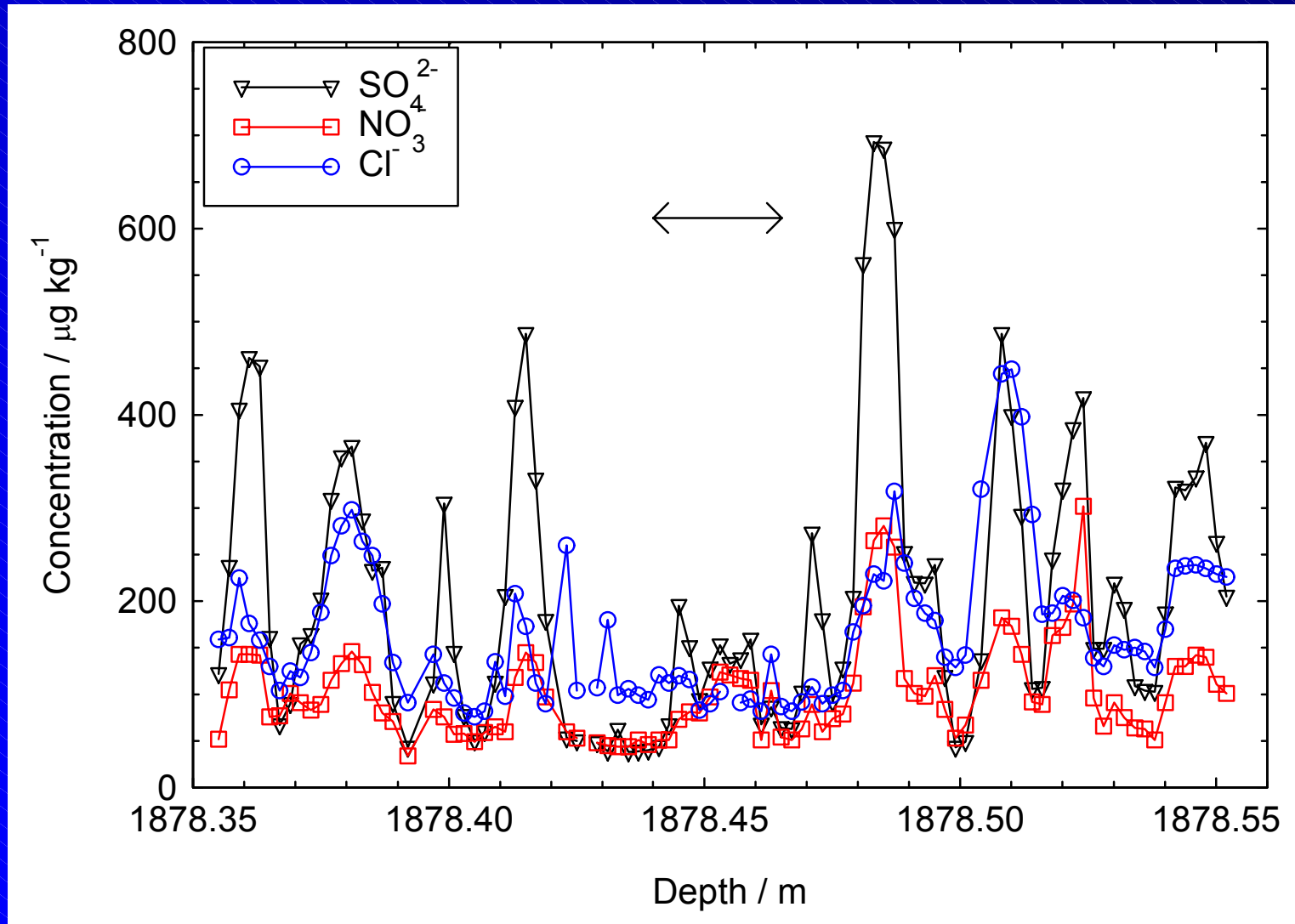
Our project

- Study, in Greenland ice cores, transitions into and out of
 - D-O event 8
 - 8.2 kyr eventAt sub-seasonal resolution
- Assess rate of change, phasing, style and seasonality of change in different components
- Assess whether these transitions are representative of others
- Compare with model predictions

Method

- To measure at 8 samples per year for D-O 8, we should aim to cut and analyse at 2 mm resolution
- Continuous flow melting methods are only at ~ 1 cm at present
- We have developed an ion-chromatographic method requiring just 150  L
- Already proved to work
- Very tedious!

Annulars at 18.3 kyr



The proxies

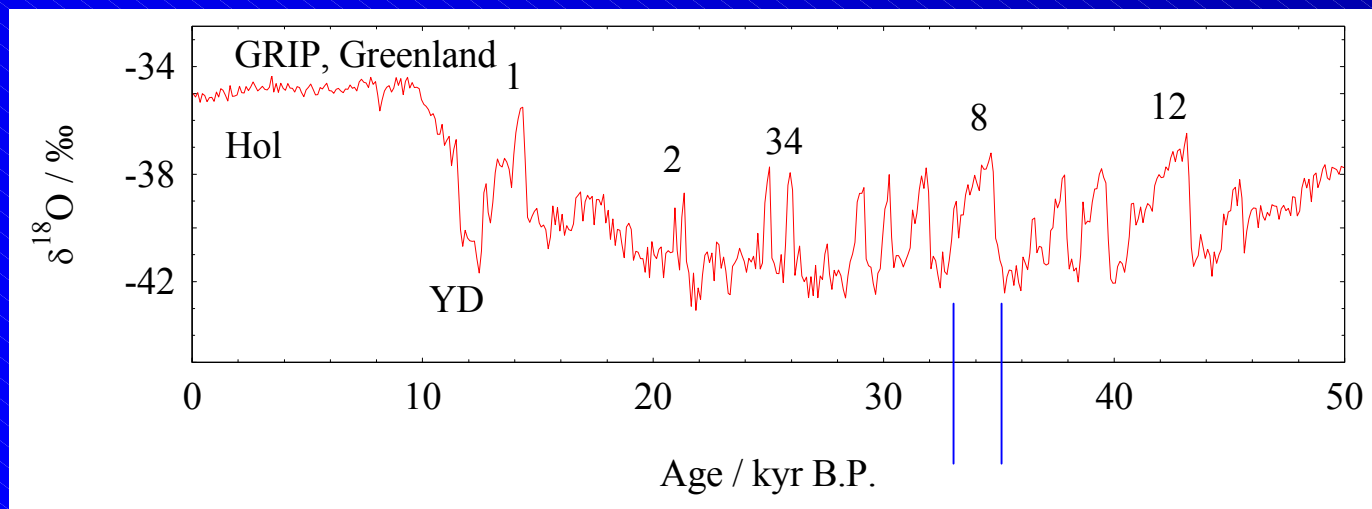
- Oxygen isotopes – essentially Greenland temperature
- Snow accumulation rate – storm tracks
- Sea salt (Na^+) – sea ice extent and high-latitude transport
- Terrestrial dust (Ca^{2+}) – processes at mid latitude Asian source
- Deuterium excess – conditions at water source

We will also work on improving the interpretation of the proxies

The events: D-O 8

One of the clearest warm events rising out of full glacial conditions

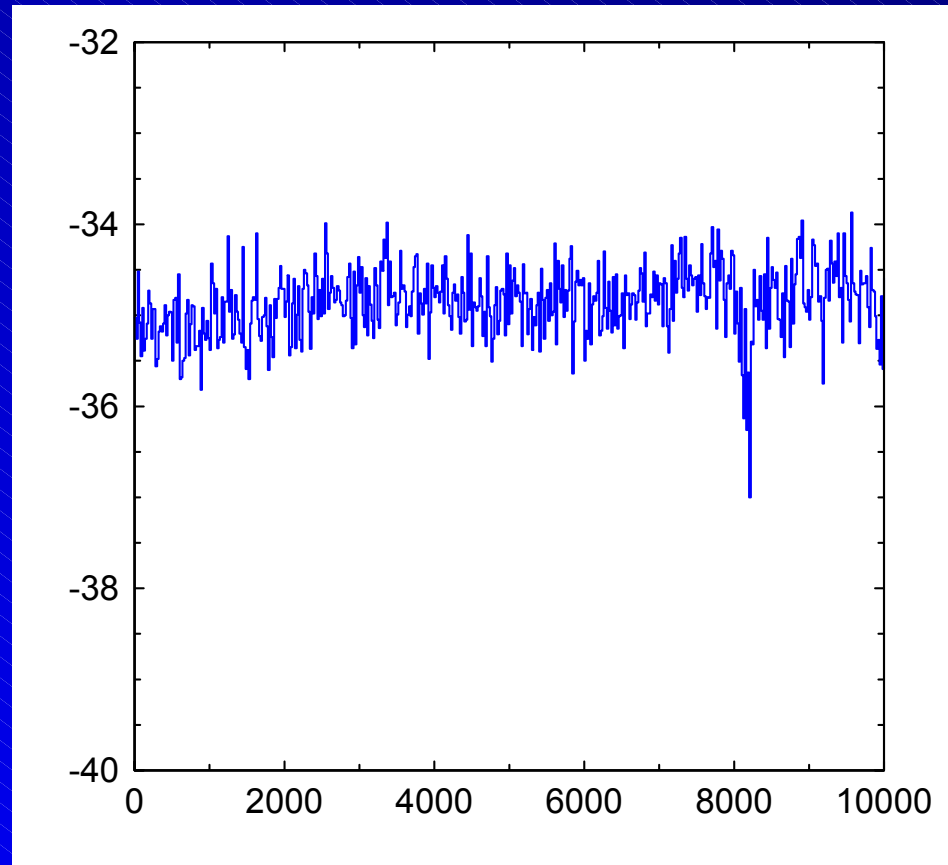
- Starts at 35.7 kyr on GRIP SS09 timescale (but 38.5 kyr on GISP2 Meese/Sowers timescale)
- Lasts about 1800 years
- In N. Atlantic records, this is the event just after Heinrich H4
- We will measure 3 m of ice at each transition at 2 mm resolution



The events: 8.2 kyr

By far the clearest example of a rapid cooling out of the Holocene

- Peak cooling about 6°C
- Beyond “envelope” for about 100 years (10 m of core)
- Peak values last only a decade or two
- We plan to analyse whole event at 5 cm, and transitions at 1 cm



Data-model comparisons

- Greenland temperature
 - Greenland precipitation
 - Conditions in sea salt source areas
 - Conditions in dust source areas
- Existing model runs for freshwater forcing (e.g Renssen et al 2001)
 - HADCM3 and derivatives (Valdes)
 - 8.2 kyr
 - Freshwater from full glacial conditions

Resources

- Dedicated cutter/analyst for 27 months
- Ice cores available in Copenhagen, already promised
- Ion-chromatograph
- Model runs
- Wolff/Mulvaney with agreed collaboration with Copenhagen

Deliverables

- For the 4 transitions, continuous, sub-seasonal chemical record, interpreted as sources and transport
- Annual record of oxygen isotopes and accumulation rate
- A real measurement of the speed at which ?THC changes? can translate into atmospheric effects
- A strong test of rapid climate change mechanisms involving freshwater forcing, as simulated by current models – are they compatible with the speed/pattern we see?