

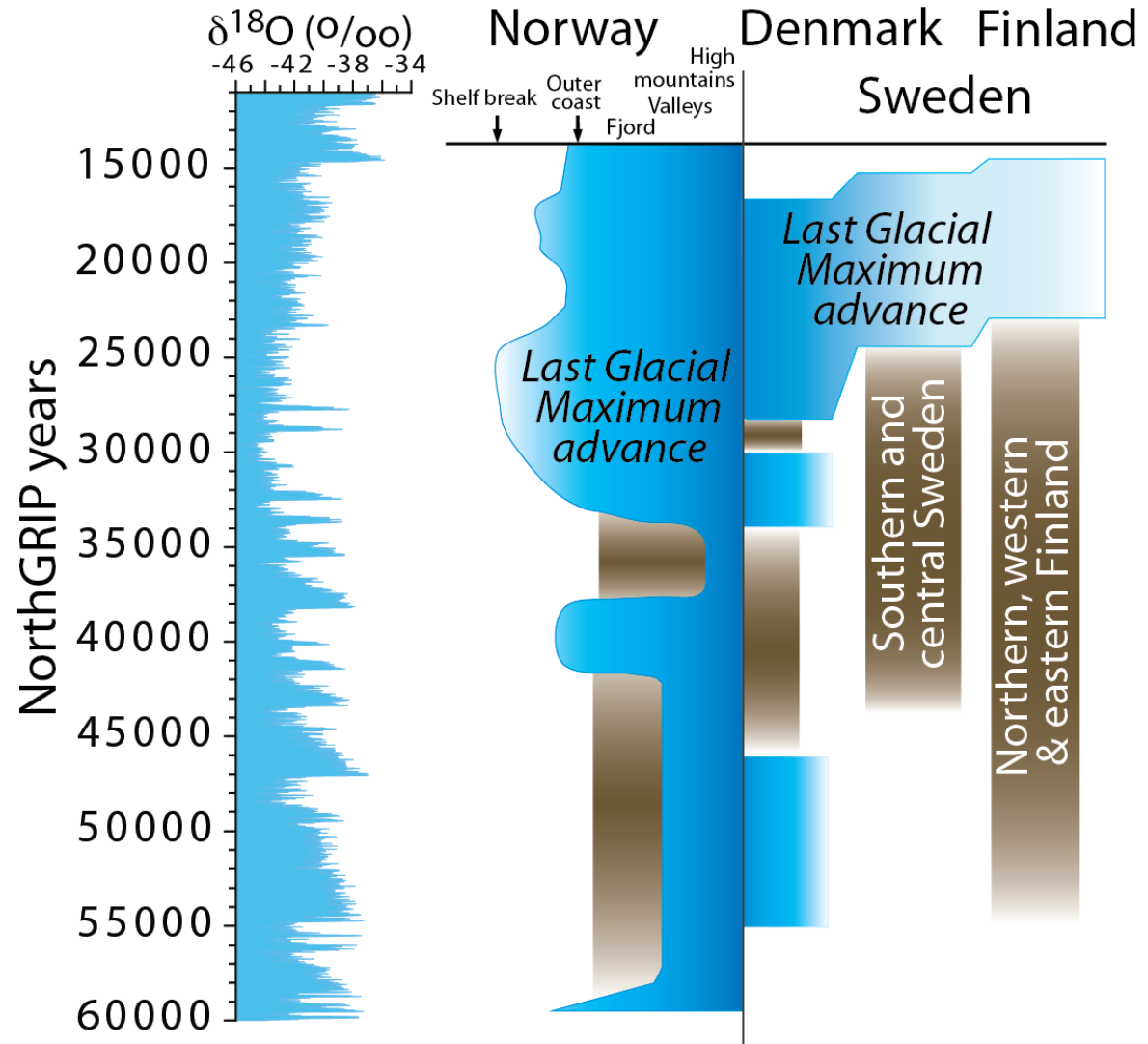
Ice-free conditions in Sweden during Marine Oxygen Isotope Stage 3!?



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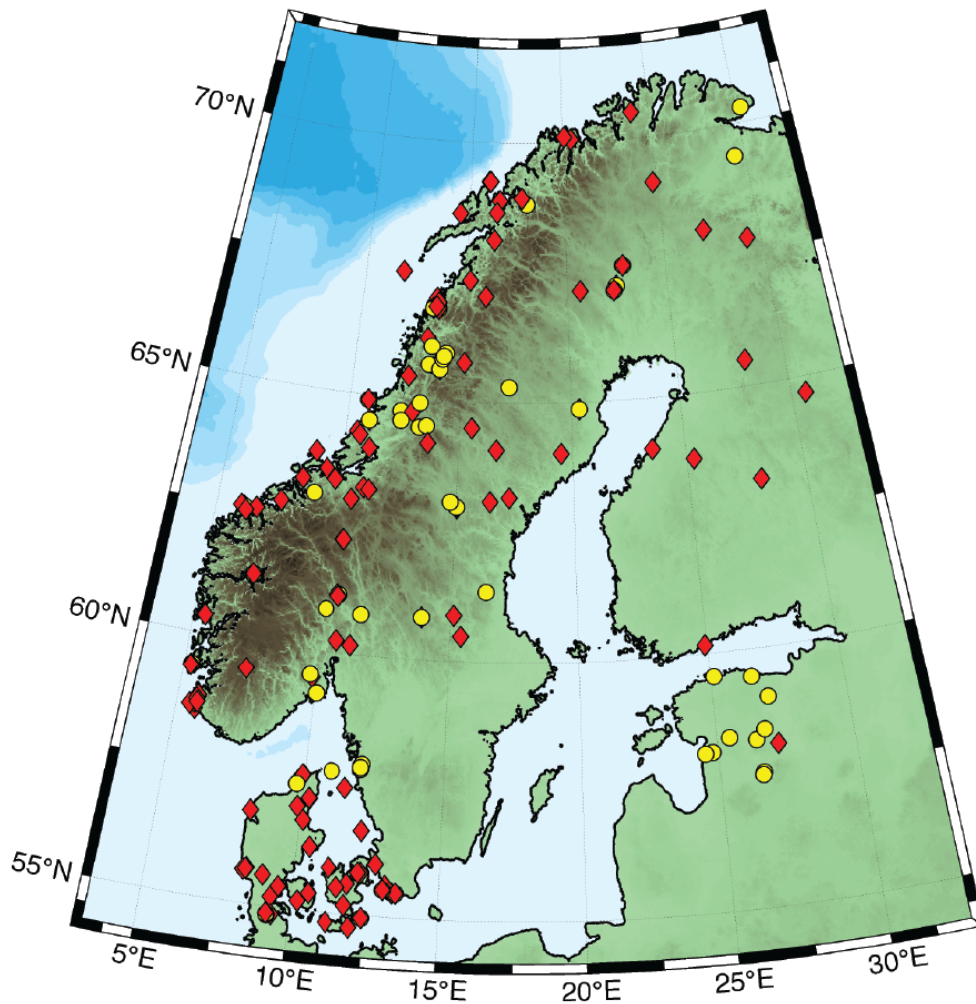


Conflicting ideas



Based on data from Krogh Andersen et al. 2006; Vorren & Mangerud 2008, Mangerud 2004, Mangerud et al. 2003, 2009; Houmark-Nielsen 2007, 2009; Kjaer et al. 2006; Ukkonen et al. 2007; Mäkinen 2005; Helmens et al. 2007; Lunkka et al. 2008.

Re-evaluation of published ^{14}C dates



- Group 1: ^{14}C ages are not acceptable
- ◆ Group 2: ^{14}C ages are possibly acceptable

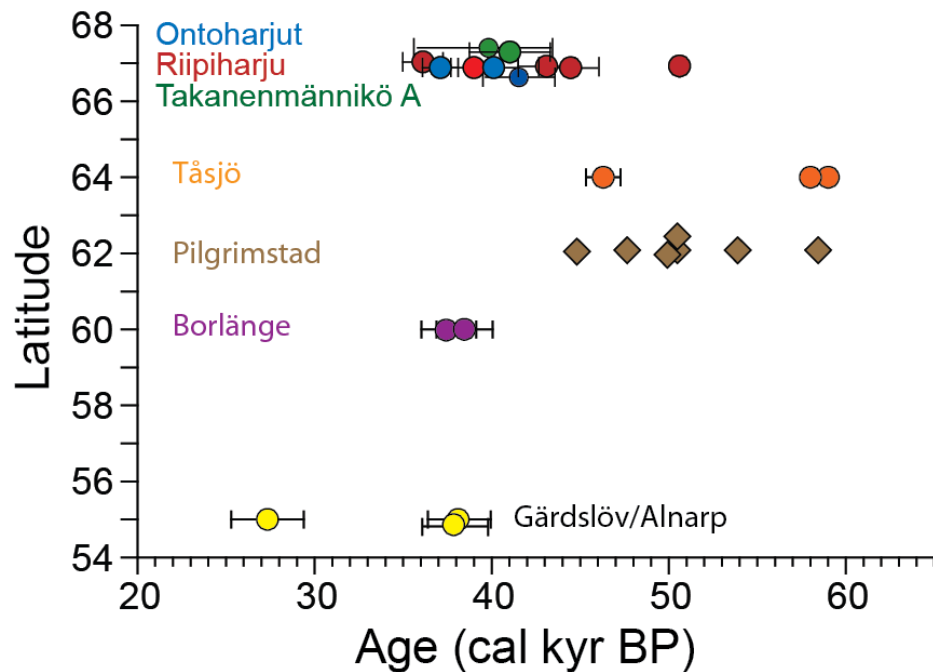
Group 2 ^{14}C samples

- In situ and/or reworked bulk organic marine or lacustrine sediments, marine shells, bones, foraminifera, terrestrial plant material, terrestrial bones
- SOL/INS fraction of bulk organic material

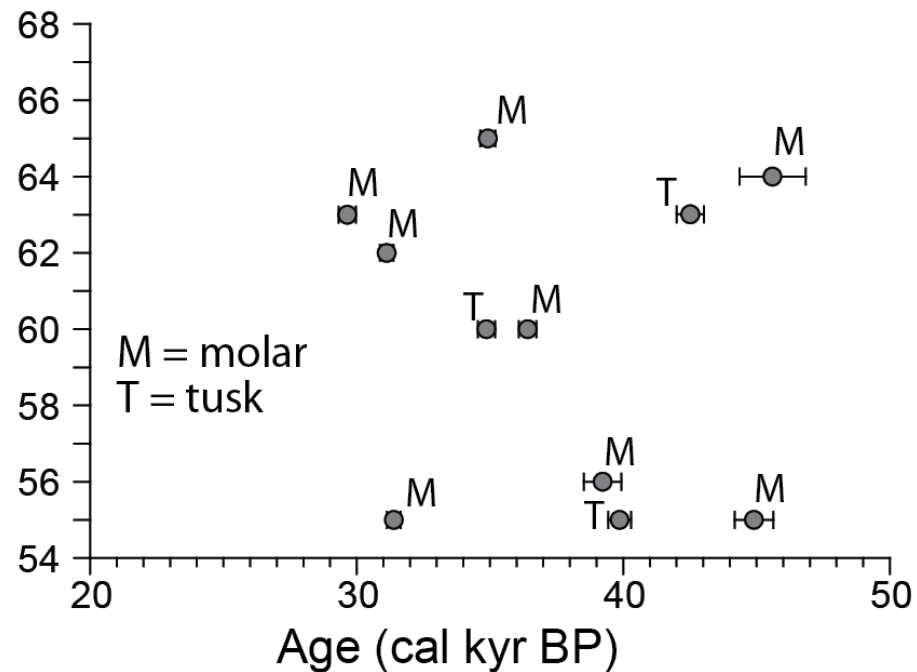
Wohlfarth 2010, Fig. 3B

Acceptable ^{14}C dates for Sweden

Group 2 dates on organic matter

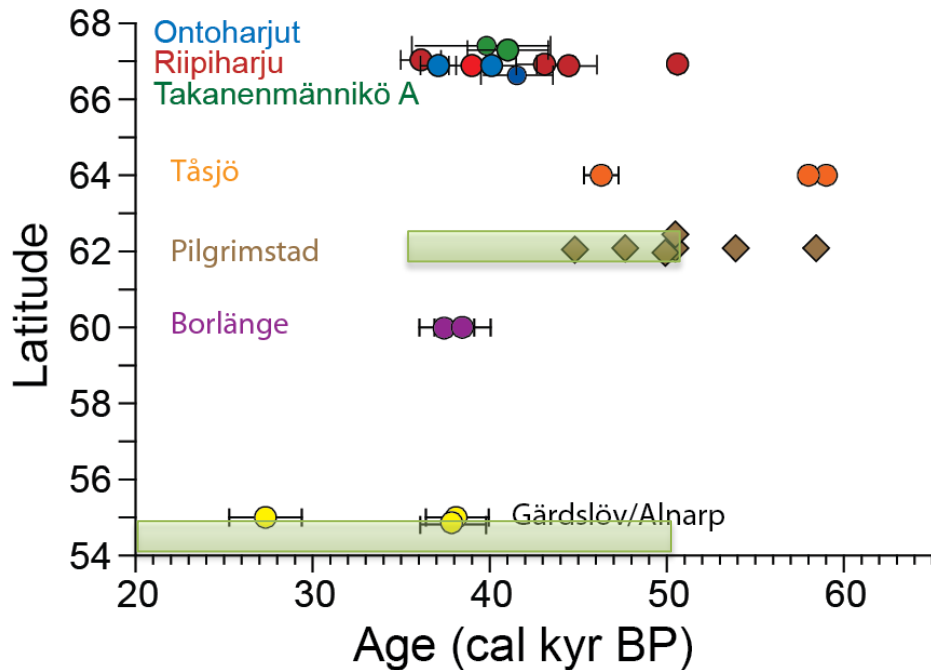


Group 2 dates on mammoth remains

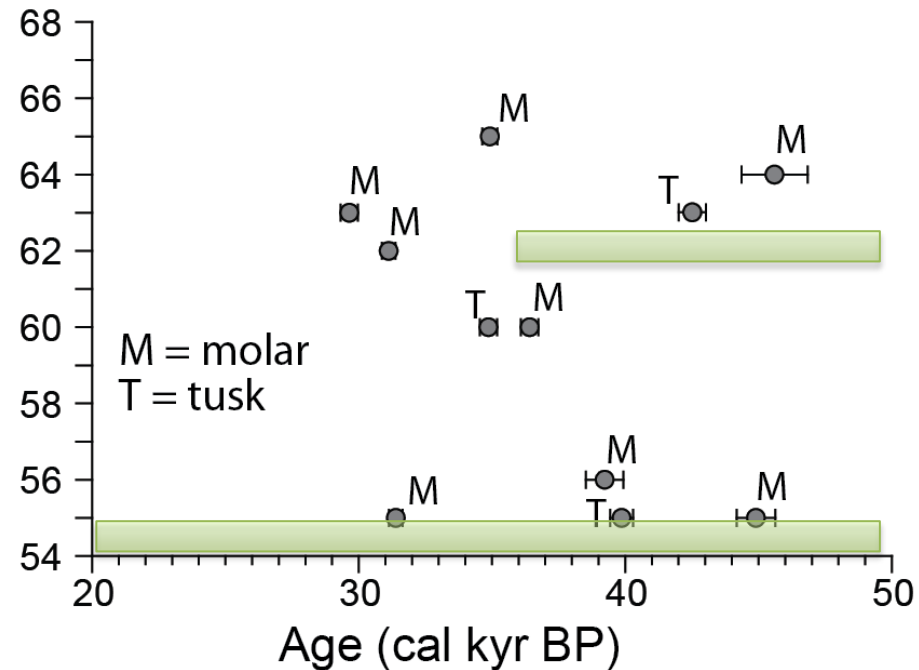


^{14}C dates & OSL dates (Sweden)

Group 2 dates on organic matter



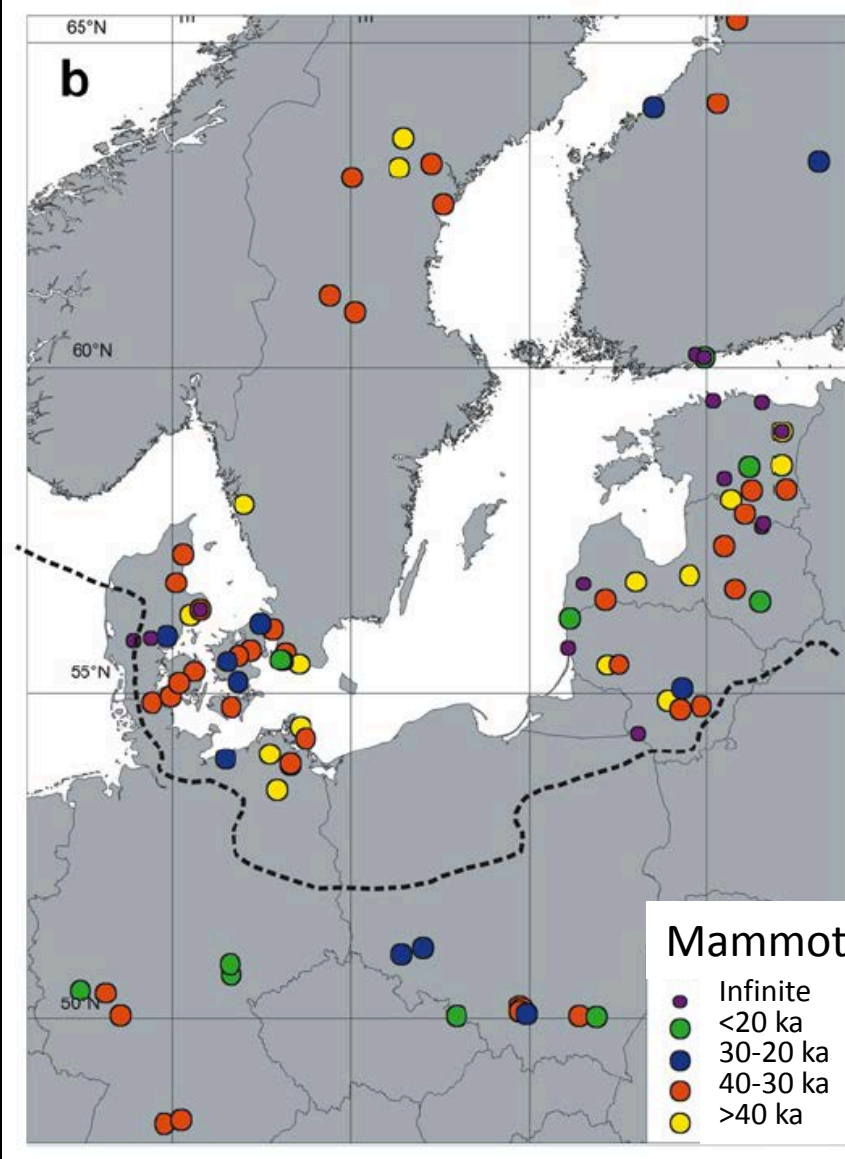
Group 2 dates on mammoth remains



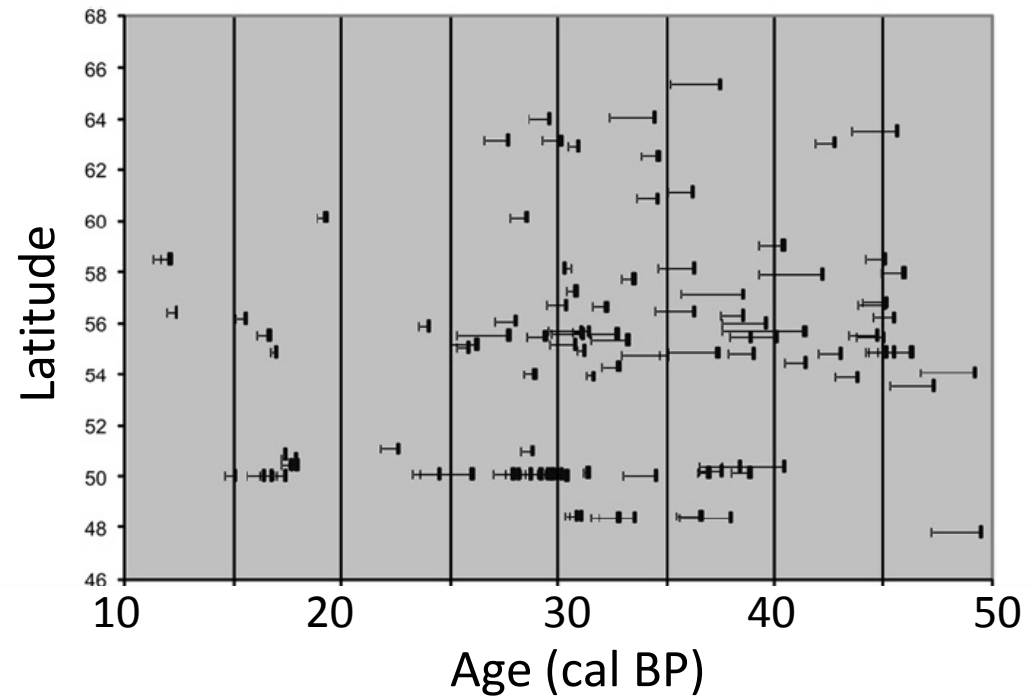
Wohlfarth 2010

OSL dates: Kjaer et al. 2006; Alexanderson et al. 2009

^{14}C dates on mammoth remains

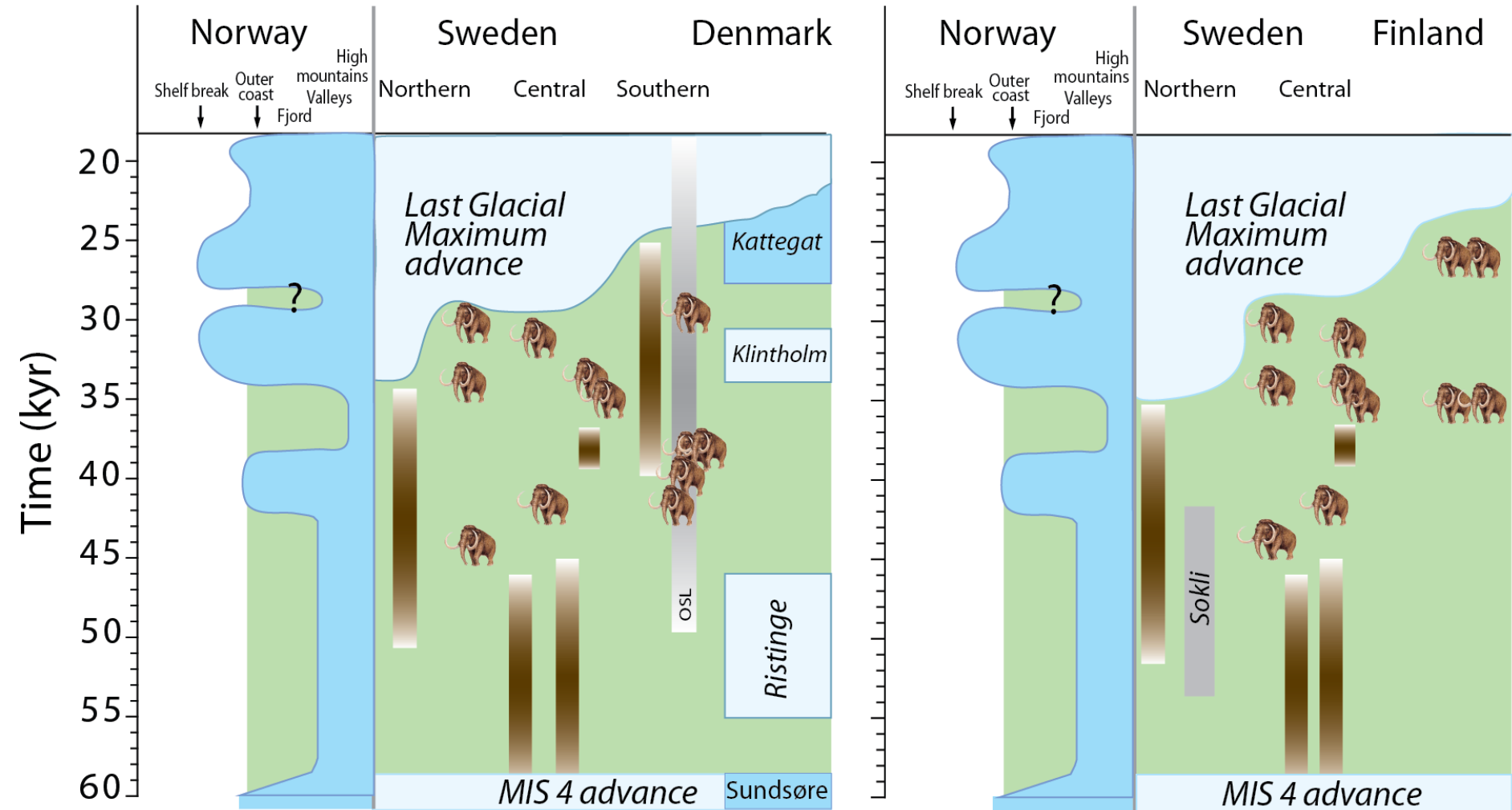


Ukkonen et al. 2011, Fig. 1B



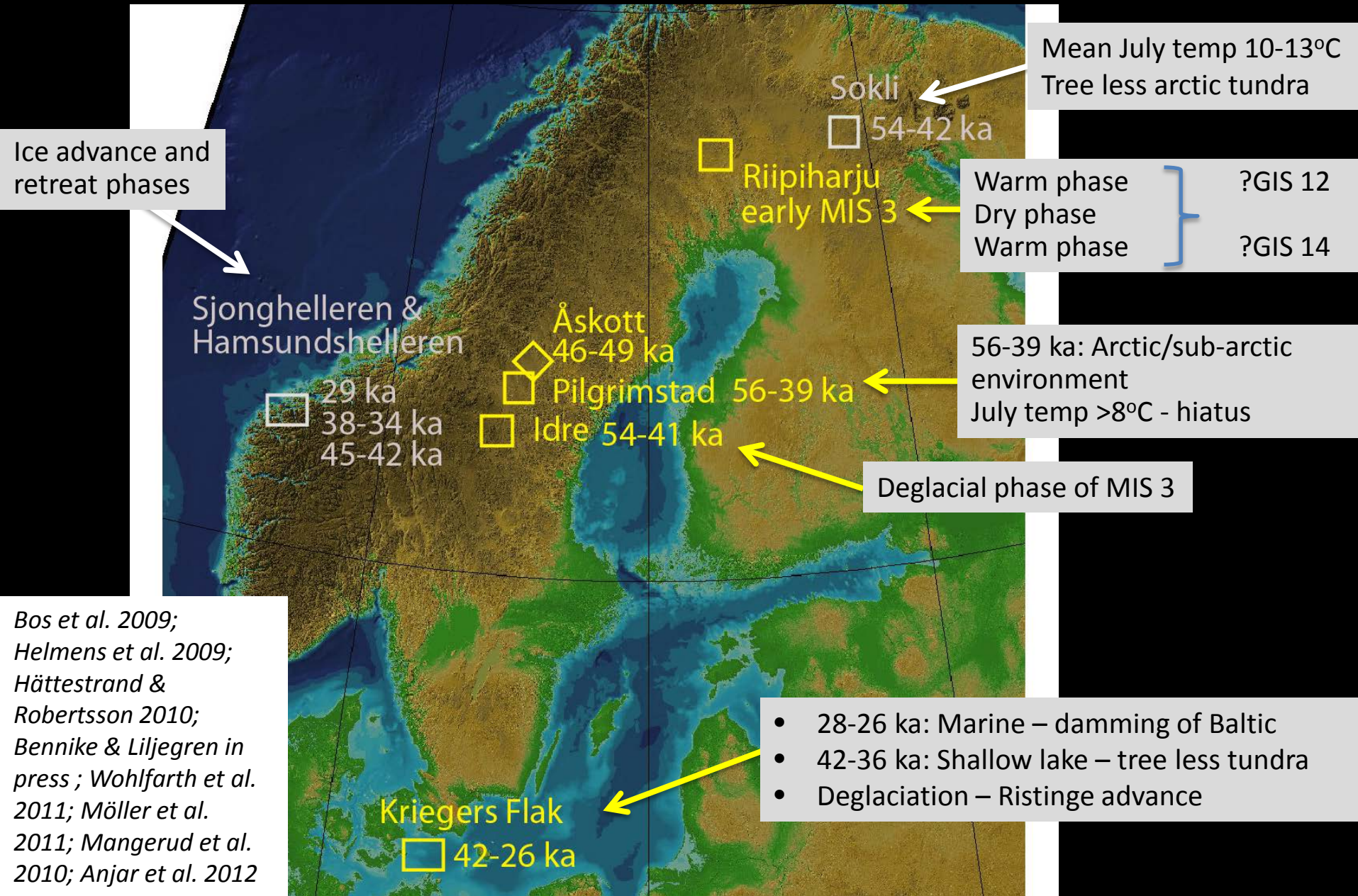
Ukkonen et al. 2011, Fig. 2

Ice free during MIS 3!?

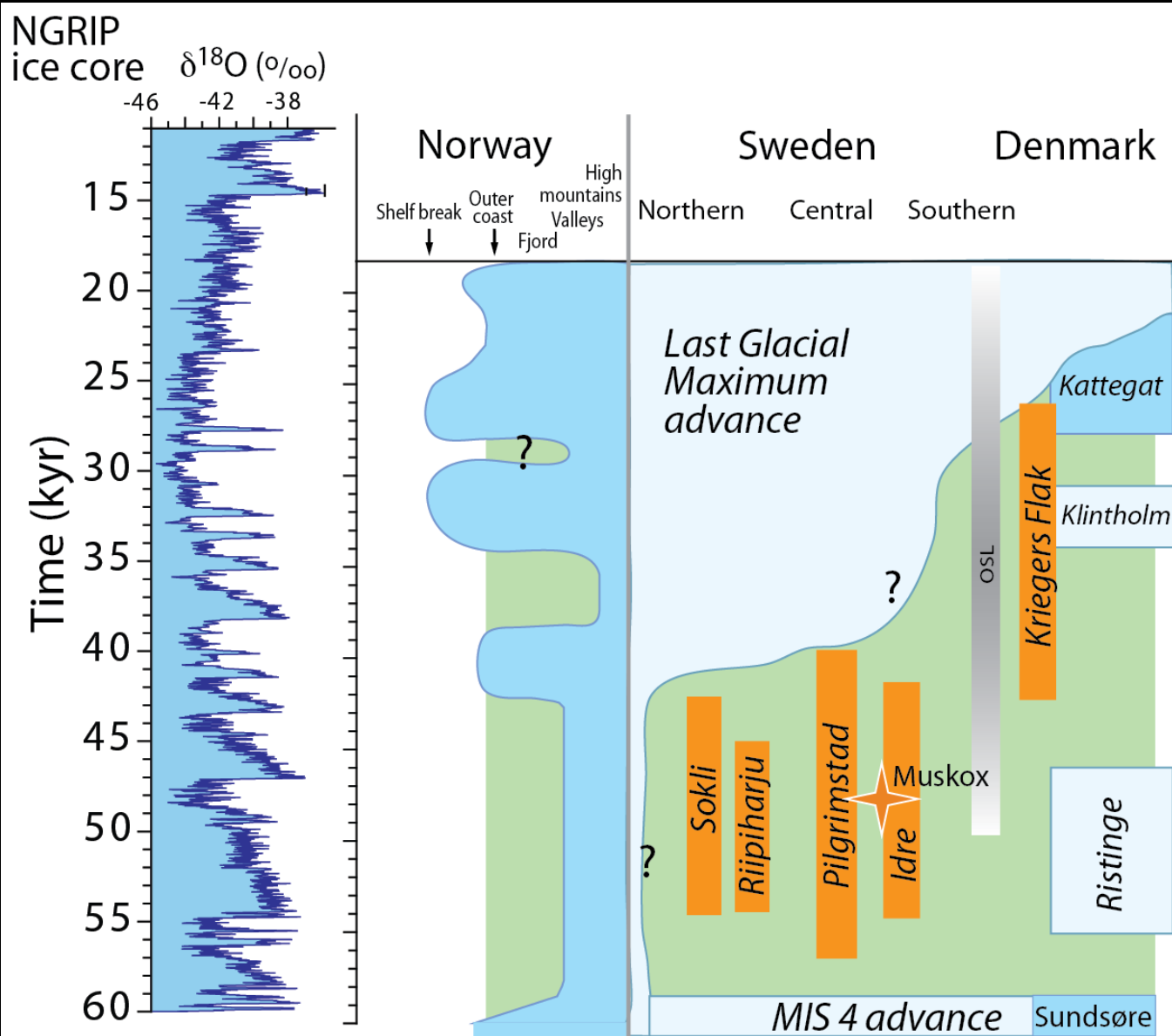


Based on data from Mangerud et al. 2010; Houmark-Nielsen 2007, 2009, 2010; Kjaer et al. 2006; Ukkonen et al. 2007, 2011; Helmens et al. 2009; Bos et al. 2009; Wohlfarth 2010.

New records



New records – an ice free early MIS 3



Data sources:

Sokli: *Bos et al. 2009;*
Helmens et al. 2009

Riipiharju: *Hättestrand & Robertsson 2010*

Åskott (muskox):
Bennike & Liljegren in press

Pilgrimstad: *Wohlfarth et al. 2011*

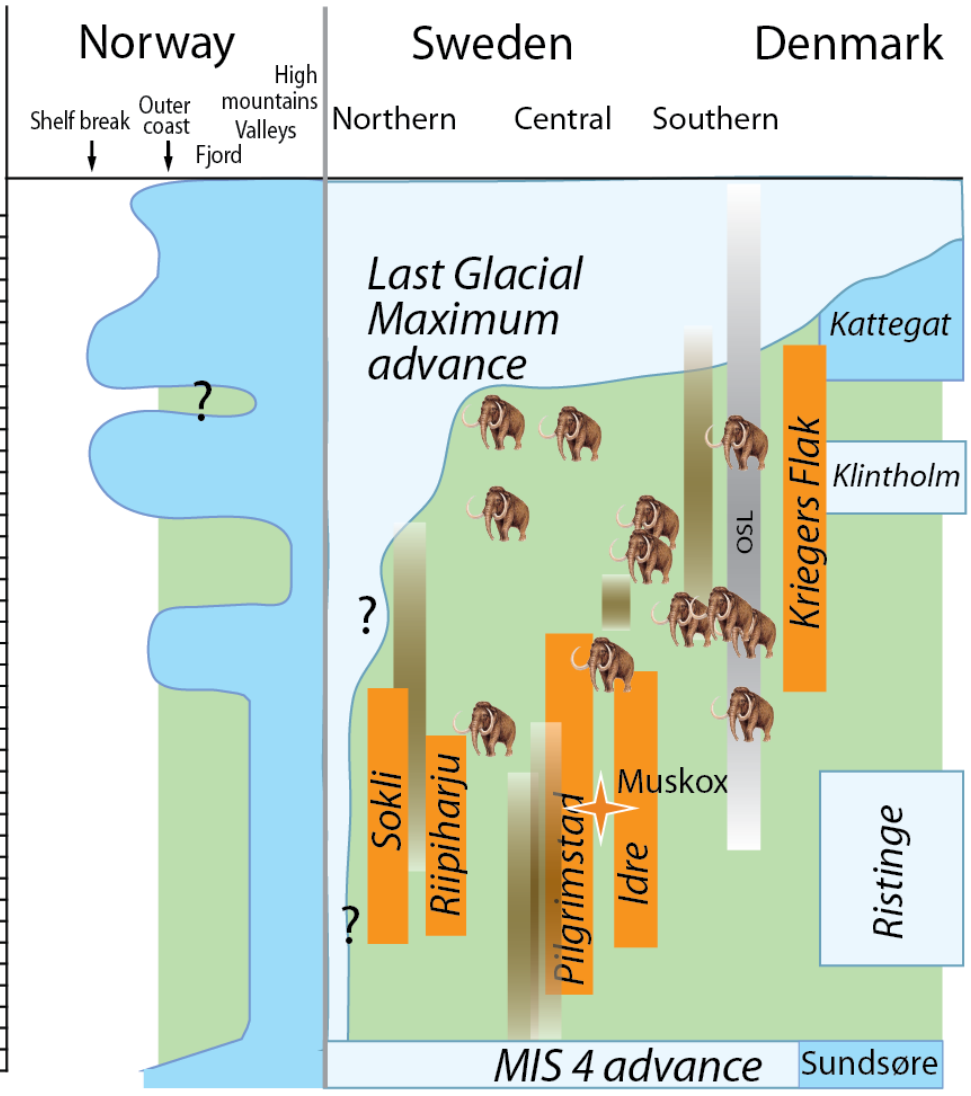
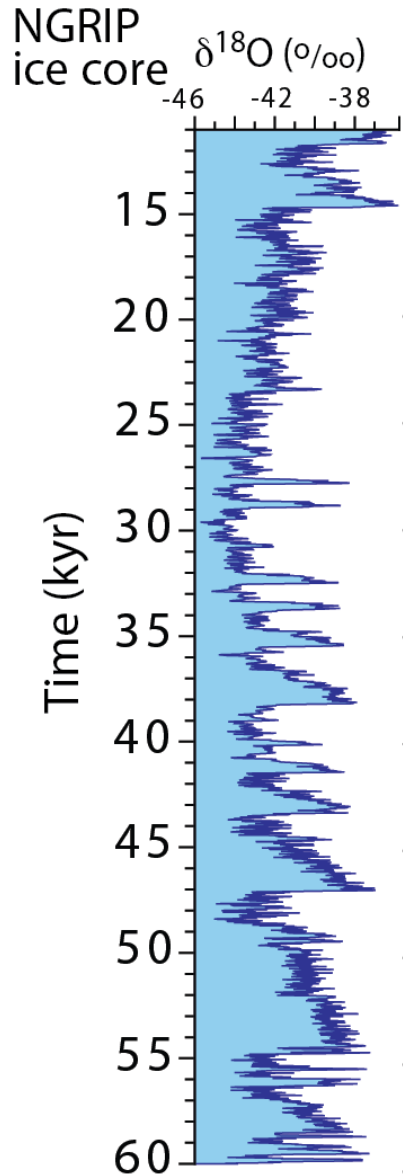
Idre: *Möller et al. 2011*

Norway: *Mangerud et al. 2010*

Kriegers Flak: *Anjar et al. 2012*

NGRIP data: Krogh Andersen et al. 2006; Ice advance Denmark: Houmark-Nielsen 2007, 2009, 2010; OSL: Kjaer et al. 2006

All data sources: Ice free during MIS 3



NGRIP data: Krogh Andersen et al. 2006

Ice advance/retreat Norway: Mangerud et al. 2010

Mammoth dates: Ukkonen et al. 2011

Sokli: Bos et al. 2009; Helmens et al. 2009

Riipiharju: Hättestrand & Robertsson 2010

Pilgrimstad: Wohlfarth et al. 2010

Idre: Möller et al. 2012

Muskox/Åskott: Bennike & Liljegren in press

Re-evaluated organic deposits: Wohlfarth 2010

OSL southern Sweden: Kjaer et al. 2006

Ice advance/retreat Denmark: Houmark-Nielsen 2007, 2009, 2010

What do we actually know?

Most or all of Sweden was ice free during early Marine Isotope Stage (MIS) 3

Ice advanced into central (?) and southern Sweden around 30 ka

Age control too coarse to resolve MIS 3 interstadials/ stadials

Dynamic ice sheet

Ristinge and Klintholm advances difficult to fit into the picture – but check Michael Houmark's poster!