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CR5.7 Proglacial Lakes

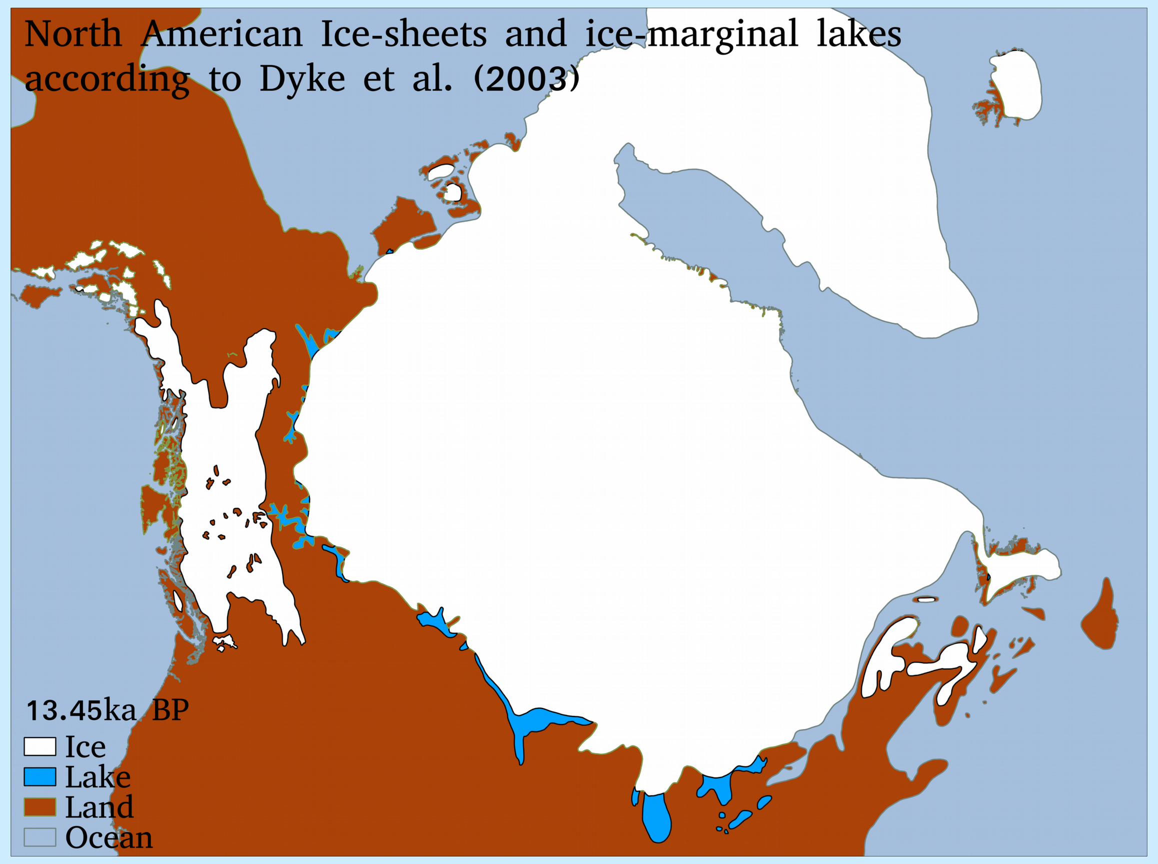
ALFRED-WEGENER-INSTITUT
HELMHOLTZ-ZENTRUM FÜR POLAR- UND MEERESFORSCHUNG

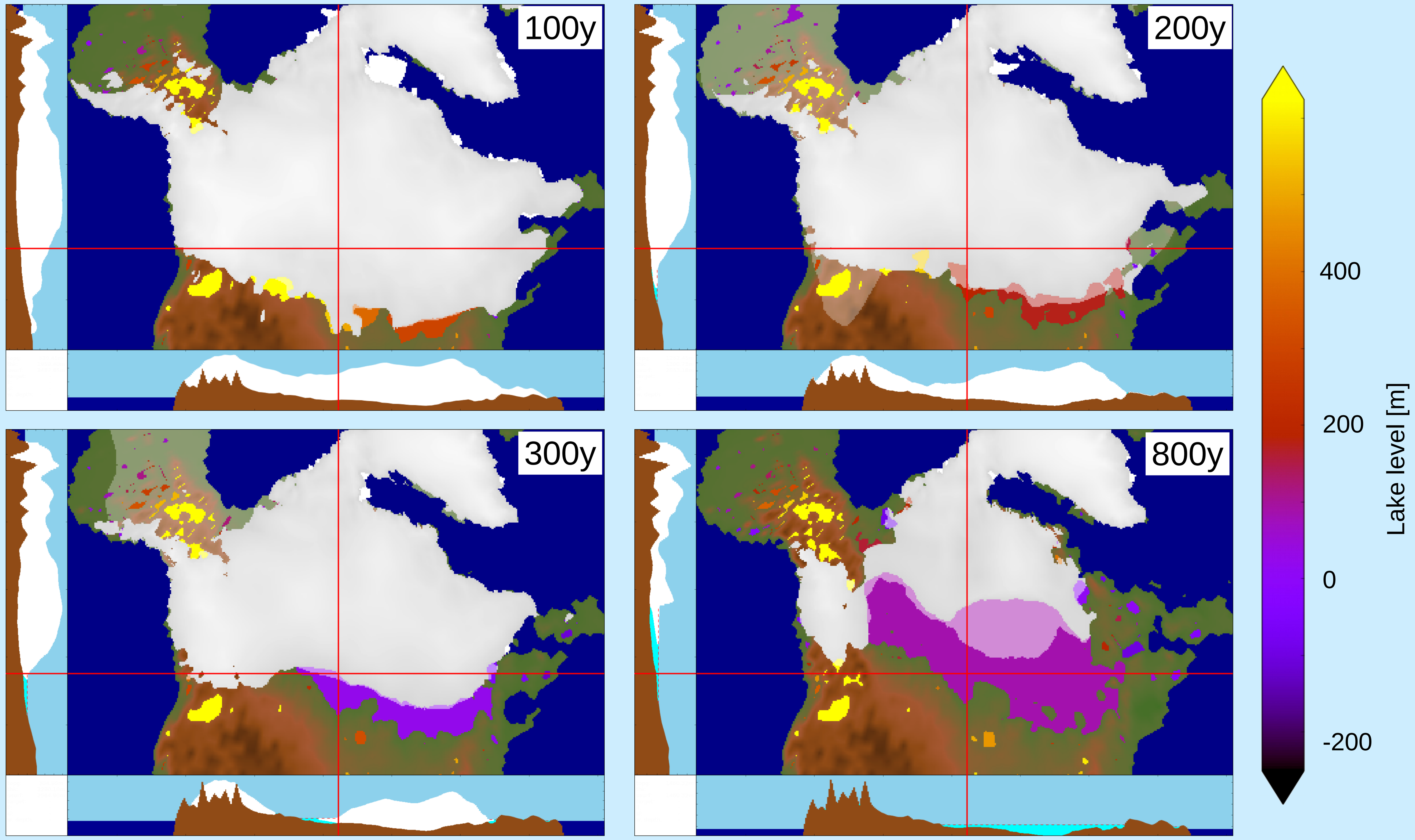
Sebastian Hinck[1] (sebastian.hinck@awi.de), Evan Gowan[1], Lu Niu[1], Gerrit Lohmann[1]
(1) Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research, Bremerhaven, Germany

Studying the impact of proglacial lakes on ice sheet dynamics

Motivation

Paleo-lake shorelines are evidence of huge lakes that existed along the continental margins of past ice sheets (see reconstruction of Dyke et al).
As marine boundaries, lake boundaries trigger complex ice dynamics (Carrivick and Tweed (2013)).





Setup & Results

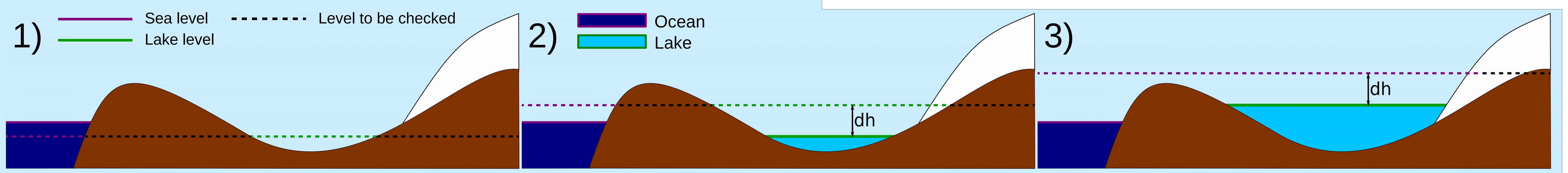
- -Studying deglaciation of of the north American continent (20km resolution)
- -Initial LGM ice sheet and topography from ICE-6G (Peltier et al. (2015))
- -Climatic forcing: monthly mean pre-industrial temp. and precipitation fields from earth system model COSMOS (Zhang et al. (2013)). Surface Mass Balance from Positive degree day (PDD) scheme.
- -Sea level reconstruction from Imbrie et al. (2006)
- -Iso-static rebound: Lingle-Clark (Bueler et al. (2007))
- -Thickness threshold calving: ocean 200m, lake 50m

-Snapshots show evolution of lake levels and ice retreat
→complete deglaciation within ~2000y

Algorithm

-Very simple approach:
lakes filled to top, no water budget
-iteratively check successive levels:
Fill if not connected to sink (ocean)

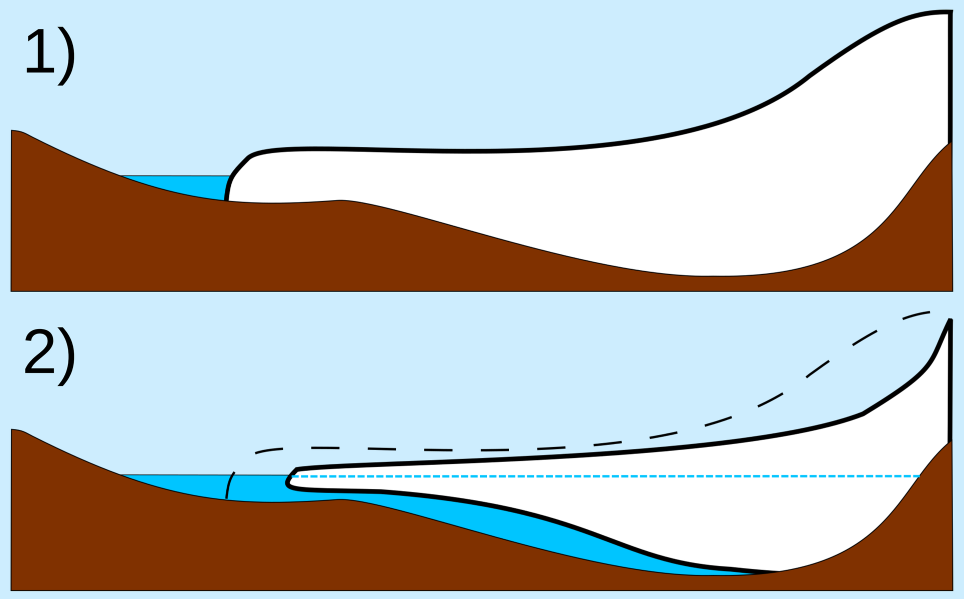
-Implementation into Parallel Ice Sheet Model (PISM)
→treated as locally elevated sea-level



Instability

Bed and ice sheet undergo constant change
→lake level may instantaneously rise or fall
→Sudden changes in boundary conditions might destabilize the ice sheet which can lead to failure of the numerical solver

Gradual filling of the lakes can prevent these problems in some cases



Conclusions

-Rapid deglaciation due to extreme forcing
→Also cause for huge lakes

-Lake formation depends strongly on resolution

Still some open questions…
-How to choose the threshold thickness for the calving mechanism?
-What sub-shelf water temperatures to use?

References
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ALFRED-WEGENER-INSTITUT
HELMHOLTZ-ZENTRUM FÜR POLAR- UND MEERESFORSCHUNG
BREMERHAVEN
Am Handelshafen 12
27570 Bremerhaven
Telefon 0471 4831-0
www.awi.de