Modeling the post-LGM deglaciation of the Scandinavian-Barents Sea Ice Sheet; a model intercomparison approach

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Abstract

We aim at simulating the last deglaciation of the Scandinavian-Barents Sea (SBS) ice sheet. In particular, we focus on the Storfjorden and Bear Island ice streams, for which marine geological evidence suggests that they played an important role in the retreat of the ice sheet from the continental shelf edge during the last deglaciation, e.g., Rebesco et al. 2014, Lucchi et al. 2013, Ingólfsson and Landvik (2013). Two hybrid SIA/SSA numerical ice sheet models are employed, GRISLI, Ritz et al. 2001, and PSUI, Pollard and DeConto 2012. These models differ mainly in the complexity with which grounding line migration is treated.

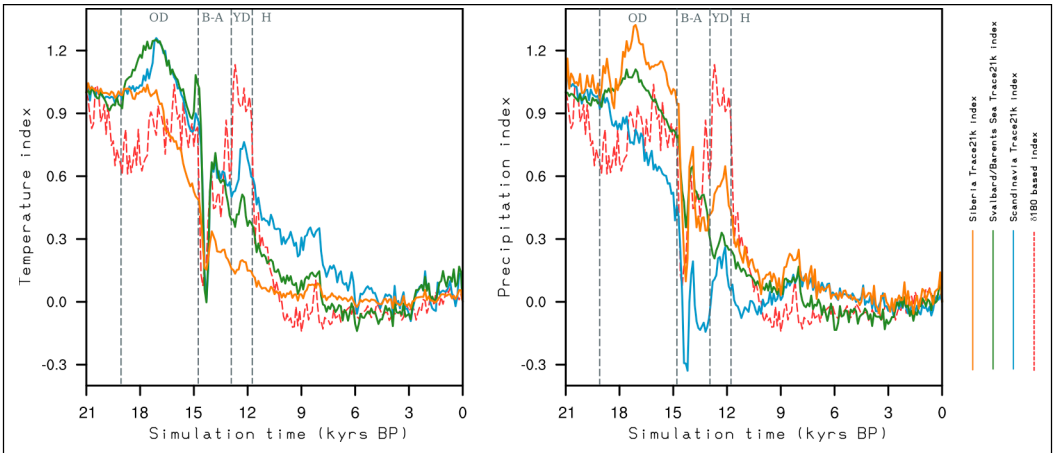

Figure 1: *Plot of the three macro-regional indexes for air temperature (left) and precipitation (right) derived from, respectively, the average temperature and precipitation showed in Figure FINAL_trace21ka_climate_evolution.pdf. In dashed red the index based on NGRIP d18O values is showed.*

The ice models are forced, from a spun-up initial condition, with spatially and temporally variable precipitation, surface air temperature, ocean temperature and ocean salinity fields. Climate forcing is interpolated by means of climate indexes between the Last Glacial Maximum (LGM) and the pre- Industrial (PI) climate. Regional climate indexes are constructed based on the non-accelerated deglaciation transient experiment carried out with CCSM3, Liu et al. 2009. Several indexes representative of the climate evolution over Siberia, Svalbard and Scandinavia are employed. The impact of such refined representation as opposed to the common use of the NGRIP _18O index for transient experiments is analysed.

In this study, the ice-ocean interaction is crucial to reconstruct the deglaciation scenario in the area of the Storfjorden and Bear Island ice streams. To investigate the sensitivity of the ice shelf/stream retreat to ocean temperature, we allow for a temporal and a (vertical) spatial variation of basal melting under the ice shelves, using an implementation based on Martin et al. 2011 and simulated ocean temperature and salinity from the TraCE-21ka coupled climate simulation.

In this presentation, we will show work in progress, address open issues, and sketch future work. In particular, we invite the community to suggest possibilities for model-data comparison and integration.

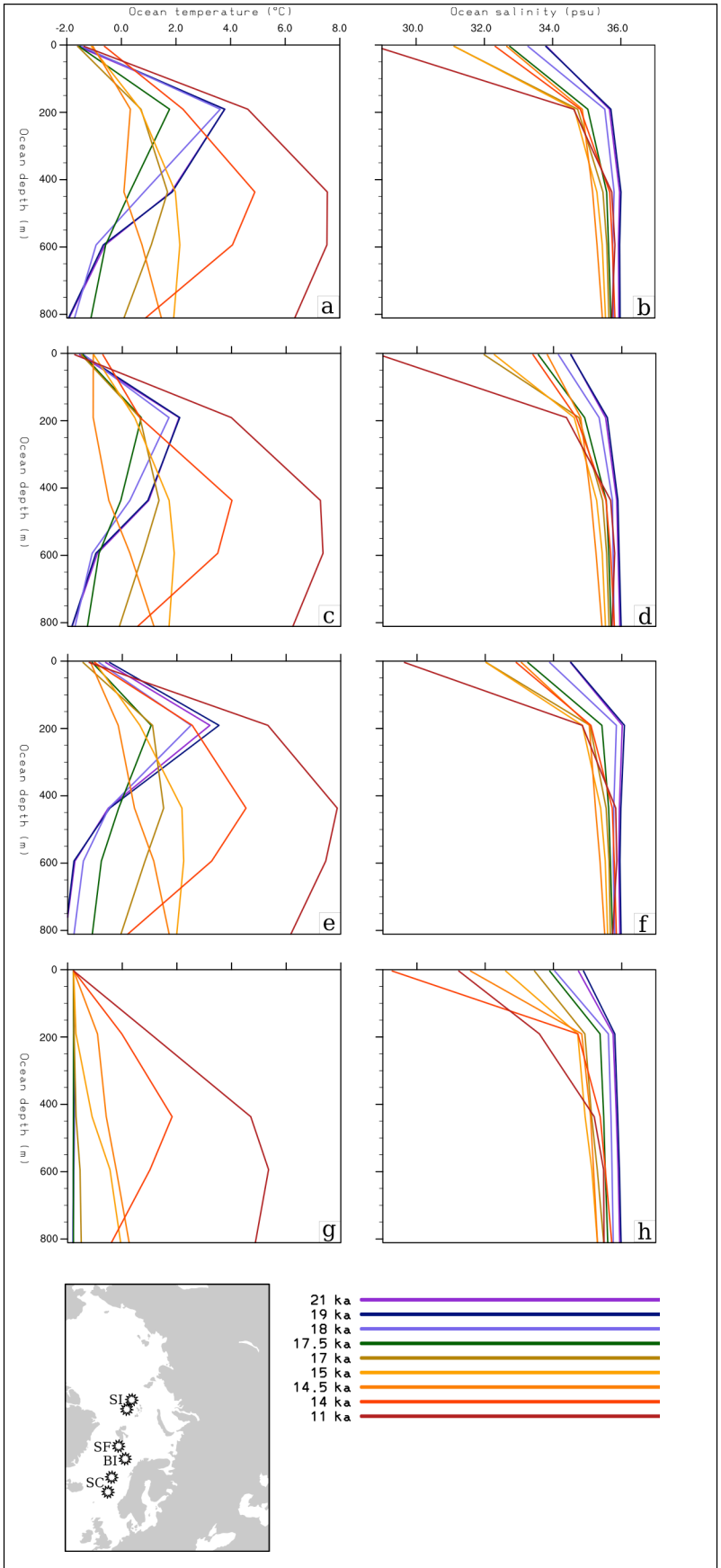

Figure 2: *Vertical profiles of simulated (from TraCE21ka climate, Liu et al., 2009) ocean temperature (left panel) and ocean salinity (right panel) at different time slices for (a) Storfjorden area (SF) (b) Bear Island area (BI) (c) Scandinavia area (SC) (d) North Siberia area (SI).*

References

Ingólfsson, Ó. and Landvik, J. Y. (2013). The Svalbard–Barents sea ice-sheet – Historical, current and future perspectives. Quaternary Science Reviews, 64:33–60.

Liu, Z., Otto-Bliesner, B. L., He, F., Brady, E. C., Tomas, R., Clark, P. U., Carlson, A. E., Lynch-Stieglitz, J., Curry, W., Brook, E., Erickson, D., Jacob, R., Kutzbach, J., and Cheng, J. (2009). Transient Simulation of

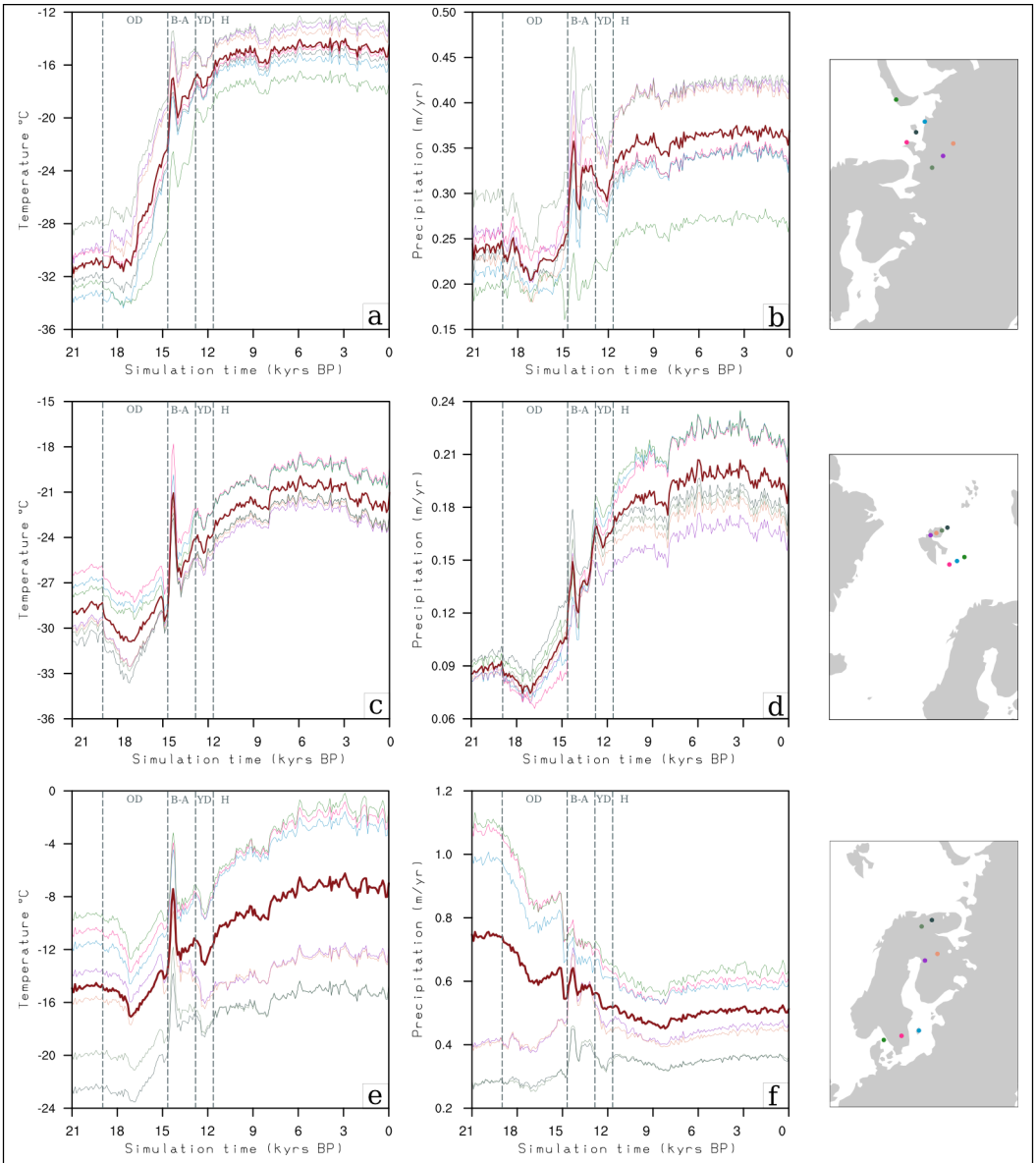

Figure 3: *Plot of simulated (from TraCE21ka climate, Liu et al., 2009) air temperature (left) and precipitation (right) evolution from different locations over Siberia (top), Svalbard (center), Scandinavia (bottom). In dark red the average (between the different locations in each macro-region) evolution is showed.*

Last Deglaciation with a New Mechanism for Bølling-Allerød Warming. Science, 325(5938):310–314.

Lucchi, R. G., Camerlenghi, A., Rebesco, M., Colmenero-Hidalgo, E., Sierro, F., Sagnotti, L., Urgeles, R., Melis, R., Morigi, C., Bárcena, M., and et al. (2013). Postglacial sedimentary processes on the Storfjorden and Kveithola trough mouth fans: Significance of extreme glacimarine sedimentation. Global and planetary change, 111:309–326.

Martin, M. A., Winkelmann, R., Haseloff, M., Albrecht, T., Bueler, E., Khroulev, C., and Levermann, A. (2011). The Potsdam Parallel Ice Sheet Model (PISM-PIK) - Part 2: Dynamic equilibrium simulation of the Antarctic ice sheet. The Cryosphere, 5(3):727–740.

Pollard, D. and DeConto, R. M. (2012). Description of a hybrid ice sheetshelf model, and application to Antarctica. Geoscience Model Development, 5:1273–1295.

Rebesco, M., Laberg, J., Pedrosa, M., Camerlenghi, A., Lucchi, R., Zgur, F., and Wardell, N. (2014). Onset and growth of Trough-Mouth Fans on the North-Western Barents Sea margin–implications for the evolution of the Barents Sea/Svalbard Ice Sheet. Quaternary Science Reviews, 92:227–234.

Ritz, C., Rommelaere, V., and Dumas, C. (2001). Modeling the evolution of Antarctic ice sheet over the last 420,000 years: Implications for altitude changes in the Vostok region. Journal of Geophysical Research: Atmospheres, 106(D23):31943–31964.