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Warm climate episodes in the subpolar Atlantic caused by large freshwater fluxes at the ocean boundaries

O. Saenko

Canadian Centre for Climate Modelling and Analysis (Oleg.Saenko@ec.gc.ca / Phone: +1-250-363-8267)

In the subpolar Atlantic with extensive sea ice coverage, large fluxes of freshwater could result in warm climate episodes, provided that these fluxes are applied at the ocean boundaries. This is shown using a coupled atmosphere-ocean general circulation model. Two cases are considered wherein a significant freshwater flux is applied either along the cost of Greenland or along the coast of Labrador, and compared to the case wherein the same freshwater flux is applied over the whole subpolar Atlantic. In both former cases, an extensive area in the subpolar west Atlantic becomes free of sea ice and warmer, even when the Atlantic meridional overturning circulation and the associated transport of heat weaken significantly. The warmer climate in this region is associated with major changes in the large-scale wind pattern. Essentially, the massive injection of buoyancy at the ocean boundaries results in a southward shift of the boundary separating the subpolar gyre from the subtropical gyre. This translates into changes in the magnitude of the wind stress curl over the whole subpolar Atlantic, leading to a significant positive Ekman pumping anomaly and favoring an outcrop of subsurface isopycnals. As a result, the near-surface density increases in close proximity to the regions of freshwater input to the ocean, thereby leading locally to a deeper mixed layer. This facilitates the subsurface-to-surface transfer of heat which maintains the warmer climate in the region. The results can be applied for (re)interpreting some of the major shifts in the North Atlantic climate during the last deglaciation seen in paleo-records.