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Analysis of a jet stream induced gravity wave associated with an observed ice cloud over Greenland

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Abstract. A polar stratospheric ice cloud (PSC type II) was observed by airborne lidar above Greenland on 14 January 2000. It was the unique observation of an ice cloud over Greenland during the SOLVE/THESEO 2000 campaign. Mesoscale simulations with the hydrostatic HRM model are presented which, in contrast to global analyses, are capable to produce a vertically propagating gravity wave that induces the low temperatures at the level of the PSC afforded for the ice formation. The simulated minimum temperature is ~8 K below the driving analyses and ~4.5 K below the frost point, exactly coinciding with the location of the observed ice cloud. Despite the high elevations of the Greenland orography the simulated gravity wave is not a mountain wave. Analyses of the horizontal wind divergence, of the background wind profiles, of backward gravity wave ray-tracing trajectories, of HRM experiments with reduced Greenland topography and of several diagnostics near the tropopause level provide evidence that the wave is emitted from an intense, rapidly evolving, anticyclonically curved jet stream. The precise physical process responsible for the wave emission could not be identified definitely, but geostrophic adjustment and shear instability are likely candidates.
In order to evaluate the potential frequency of such non-orographic polar stratospheric cloud events, the non-linear balance equation diagnostic is performed for the winter 1999/2000. It indicates that ice-PSCs are only occasionally generated by gravity waves emanating from spontaneous adjustment.

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