1. Motivation

Arctic flaw polynyas are considered to be highly productive areas for the formation of sea ice throughout the winter season. In addition, heat and moisture fluxes are strongly modulated by open water fractions associated with polynyas, having important consequences e.g. for the atmospheric boundary layer and ocean processes. Our geographical focus is on the Laptev Sea area of the Siberian Arctic (Fig.1, Fig.2), which is a key area for arctic sea ice production (Dmitrenko et al. 2009).

2. Models and methods

We present results of dynamical downscaling using simulations of the NWP model COSMO (15 and 5km resolution) for the Laptev Sea of the Siberian Arctic. COSMO is the non-hydrostatic operational weather prediction model of the German Meteorological Service (Deutscher Wetterdienst, DWD). COSMO is forced by ERA-Interim data (ECMWF, 2002-2009) and GME data (DWD, 2007-2009), and the sea ice module of Schröder et al. (2011) is used to simulate the sea ice surface temperature. Sea-ice concentration is taken from AMSR-E passive microwave satellite data with about 6 km. Polynya area is either assumed to be open water or covered by 10 cm thin ice.

While the resolution of reanalyses and most regional climate models is too coarse to include the impact of polynyas on the atmosphere, our data allows for studies of the boundary layer modification and associated large-scale impacts. Using the energy balance equation we are able to estimate the potential ice production for the polynyas.

3. Polynya effects on the ABL

Fig.3. 2m temperature for 0700UTC 4 Jan 2008 (COSMO forced by GME). Left: open water polynya, right: run without polynya. The white line marks a cross-section.

Fig.4. Cross-section along the line marked in Fig.3 for differences between the runs with and without polynya: temperature (colour shaded), wind speed (black isolines every 5 m/s) and cloud coverage (blue)

4. Comparison with forcing data

Fig.5: Sea ice concentration for 8 Jan 2009. Left: ERA-I, right: COSMO. A threshold of 70% is used in COSMO to define the polynya area. In ERA-I, fast ice areas are incorrectly represented as areas with ice concentration of 75-90%, and polynyas are smoothed out.

5. Ice production in Laptev polynyas

Fig.7. Ice production for Laptev polynya for winters 2002-2009. Blue: COSMO nested in ERA-Interim, green: satellite-based estimate after Wilmes et al. (2011). The mean for COSMO is 39.3 km³/a, and the mean satellite estimate is 46.2 km³/a. This is equivalent to about 5-10% of total Laptev sea ice production, and is much lower than previous studies (e.g. Tamura and Oshima (2011) estimate 152 km³/a for 1992-2007).

References


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