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Katabatic winds and polynya dynamics in the Weddell Sea region (Antarctica)

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The Antarctic surface wind field is dominated by a persistent katabatic flow from the interior towards the coast. Downslope winds are a result of mainly two forcing components: (1) the katabatic force (KF), which contains the forcing from a temperature inversion over sloping terrain and (2) the synoptic force (SF), which is the superimposed pressure gradient force in the free atmosphere above the inversion layer. If the slope ends close to the coastline and/or if appropriate synoptic forcing is present, wind of katabatic origin can contribute to the formation of coastal polynyas. These coastal polynyas are frequent in the Weddell Sea Region even in winter and have a strong impact on ice-ocean-atmosphere interactions. Through the enhanced energy exchange between ocean and atmosphere, these areas are known as strong sea ice producers. In consequence, polynyas have a substantial impact on bottom water formation through the production of new cold and saline water masses during the whole winter season.

To investigate the polynya dynamics associated with katabatic winds, high-resolution (5km) atmospheric simulations have been performed for 6 months for the Weddell Sea Region, comprising the autumn and winter season in 2008. The simulations have been carried out using the non-hydrostatic numerical weather prediction model COSMO (Consortium for Small-scale modeling) of the DWD (German Meteorological Service) using GME (Global model extended) analysis from DWD as initial and boundary fields. Daily sea ice coverage is taken from AMSR-E (Advanced Microwave Scanning Radiometer - EOS) data. A thermodynamic sea ice model is used to simulate the sea ice surface temperatures in the COSMO model. This high-resolution atmospheric dataset was then provided for forcing the sea ice ocean model FESOM (Finite element sea ice ocean model).

Linkages between pressure gradient force, composed of its katabatic and synoptic components, offshore wind regimes and polynya area are identified. The surface offshore wind component of Coats land is mainly steered by the katabatic force term. A good correlation between polynya area change and offshore wind is found.