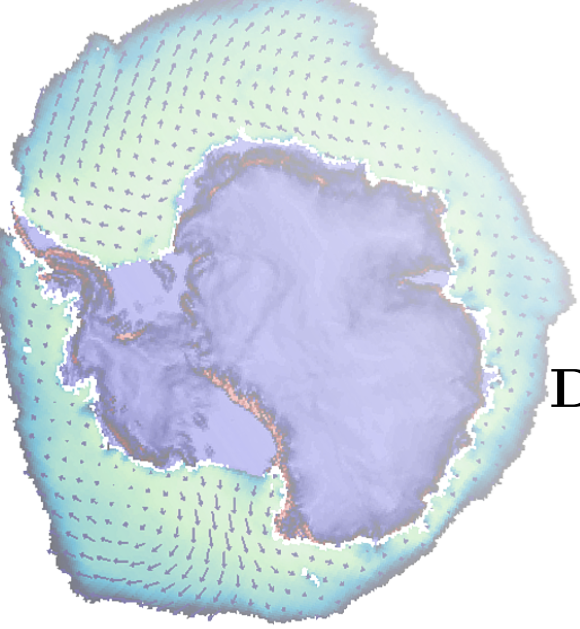

Dynamical Interaction between Atmosphere and Sea Ice in Antarctica

Master's Thesis

by

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Abstract

Sea ice that covers large parts of the polar oceans throughout most of the year responds to changes in the atmosphere or the ocean within a short period of time. The rapid decrease of the Arctic sea ice cover in the past decades has led to a fundamental discussion of the role of sea ice in the climate system. Surprisingly, in contrast to the northern hemisphere, the sea ice in the Southern Ocean has been slightly increasing over the last decades. This is owing to essentially different processes that take place around Antarctica. There, the ice is not confined to a basin as in the Arctic Ocean but can move rather freely around the Antarctic continent which results in a strong response to changes in the wind field.

In this Master's thesis I examined the impact of the variations in the coastal Antarctic atmospheric boundary layer on the sea ice. By studying wind driven sea ice transport in the Southern Ocean and temporal and spatial variabilities in the period 1989 to 2006, I have revealed important characteristics of the sea ice cover and processes that determine its growth and decay. The near surface wind field over the coastal continent and ocean as well as its forcing mechanisms were described in detail by using output from a regional atmospheric climate model. This showed strong relations to key parameters that I have deduced from a satellite record of sea ice concentration and sea ice motion.

The regions of the largest sea ice extent, the Ross and Weddell Seas, are also those areas where most of the sea ice transport takes place and where its variability is the largest. Interannual variations and trends of transport are associated with varying sea ice concentration just north of these areas in the Ross and Weddell Seas. Comparing the wind field and the sea ice motion, I found out that spatial patterns of persistent southerly or south-easterly winds coincide with those of ice drift. The winds in these regions result from combined effects of the large-scale pressure distribution, cold air that accumulates over the ice shelves, and large topographic barriers that alter the flow. Adjacent to the large Ross and Ronne-Filchner Ice Shelves constant outflow of cold air takes place almost year-round. Here, sea ice is constantly exported from the coastal region, and large polynyas and leads form. As the cold winds not only lead to sea ice transport but also support refreezing of the open water, these areas are associated with strong sea ice formation. I have defined an index that captures the outflow of cold continental air from the ice shelves. The long-term variations in outflow correlate well with variations of the sea ice cover and meridional sea ice transport in the Ross and western Weddell Seas. Further, the results suggest that the positive trend of sea ice cover in western Ross Sea and the negative trend in the western Weddell Sea are related to a respective seasonal increase and decrease of cold air outflow. Overall, in my thesis, I showed that the dynamical interaction between the atmospheric boundary layer and the sea ice is a regional key element in the interannual variability and the long-term changes of the sea ice cover in the Southern Ocean.

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