Frühling im Weddellmeer: biologisch-physikalische Wechselwirkungen zwischen Atmosphäre, Eis und Ozean

Go with the floe: biological-physical interactions between atmosphere, ice, and ocean in the Weddell Sea

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The western Weddell Sea is one of the few regions of the Southern Ocean covered by perennial sea ice. Earlier Polarstern expeditions have shown a strong layering of the ice with high algal standing stocks, suggesting that the ice plays an important role for primary production and the Carbon Cycle (Fig. 1). In November 2004, RV Polarstern headed towards the Weddell Sea to conduct the Ice Station POLarstern (ISPOL) experiment. This multidisciplinary project involved leading scientists from eight countries to improve our understanding of physical-biological processes during the sea ice melting season. For five weeks the ship was anchored to an ice floe to conduct biological, chemical, glaciological, meteorological, and oceanographic measurements in the air, ice, and water. During the experiment, the floe drifted 98 kilometers to the North (Fig. 2). Ice thickness measurements showed the presence of two major ice regimes in the study region: two to four meter thick secondyear ice to the West and East covered by up to one meter of snow, and a south-north extending band of thinner first-year ice inbetween. Satellite imagery revealed that this ice originated from the Ronne polynya, and has drifted almost 1000 kilometer into the study region.

Despite spring/summer conditions and the low southern latitude of 67°30'S, ice and snow thickness only decreased by 20 to 30 centimeters. Low atmospheric and oceanic heat fluxes of a few Watts per square meter lead to warming of the ice to –2 to –1°C, resulting in increases of ice porosity (Fig. 1). Chemical measurements showed that this increased the exchange of climatically relevant gases like Carbon Dioxide (CO2) and Dimethyl-Sulfide (DMS) between ocean and atmosphere, even at low increases of algal growth. However, increased algal growth did support large swarms of krill feeding under the ice, and resulted in a continuous flux of dissolved and particulate Carbon into the water.

Observations of vertical temperature and salinity distributions in the water column were performed by means of a new CTD probe deployable by helicopter. Within a region of 60 nautical miles around the Polarstern drift track, the bottom water was 0.5°C colder than observed during the similar Russian-American drift experiment ISW-1 in 1992. Tracer analysis showed for the first time that this water originated from the neighbouring Larsen-C Ice Shelf, and has flown down the continental slope in a sporadic event. During the drift period, surface water salinity decreased only slightly, mainly due to lateral melting of ice floes and brash ice in leads.

The station floe fractured twice during the observation period, but with little consequences for the scientific program. Unfortunately, the long-term Polarstern schedule required a completion of the study in early January 2005. Therefore, we plan to repeat the project to cover the complete summer melting between January and March as part of a future Polarstern drift experiment.

Figure 1: Small ice floe tilted during ice breaking. The ice is strongly inhabited by algae and shows the typical layering of porous summer sea ice.

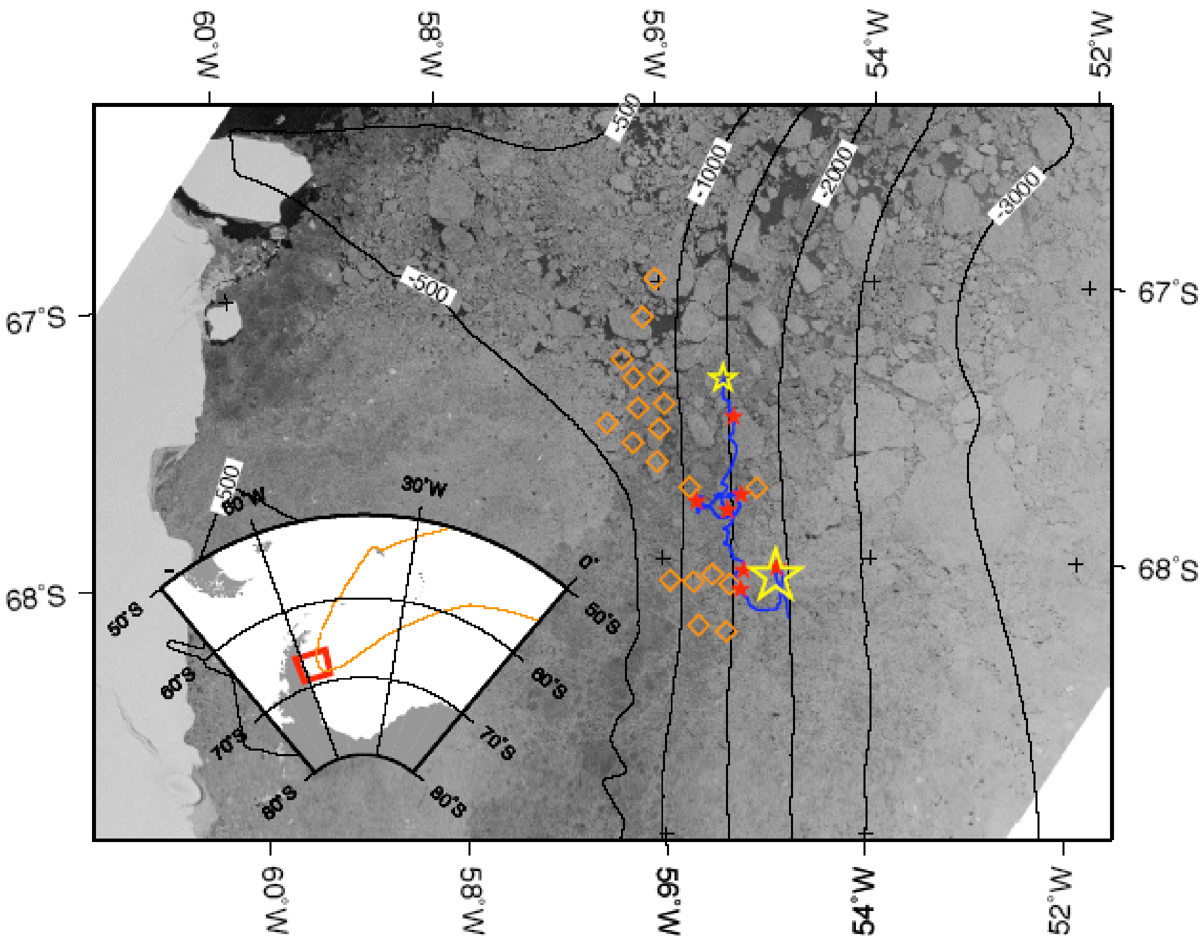

Figure 2: Envisat radar satellite image of the western Weddell Sea and Larsen-C Ice Shelf east of the Antarctic Peninsula. A dark band of first-year ice is visible at 56°W. Black lines show water depth contours. The Polarstern drift track is shown by the blue line, with begin and end of the drift indicated by the large and small yellow stars, respectively. Positions of helicopter measurements of water temperature and salinity are indicated by orange diamonds.