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On our route north-east along the sea ice margin we visited the position of the first station of our cruise in the Scotia Sea, which we occupied six weeks ago. Measurements of the same physical and biological parameters in the water column revealed that the phytoplankton biomass had increased twelve-fold, and the spring bloom was well developed, whereas six weeks ago typical winter conditions prevailed.

The development of the phytoplankton had a strong impact on the zooplankton. The animals had left their winter quarters at greater depth returning to the highly productive surface layers. Their metabolism increased three-fold, they were eating and the females have started to lay eggs.

The sea ice biologists were also surprised about the well-developed algal biomass in the ice, which was observed during the entire cruise. Record levels of chlorophyll were measured and also the biomass of the meiofauna (small animals living in the brine channels in the ice) was surprisingly high. This underlines that the production-free winters are not as long as we used to imagine. Moreover, sea slugs and small sea gooseberries were found in the ice, which have not been described in detail before.

Because of the prevailing weather conditions our cruise provided us with the rare opportunity to sample sea ice brines directly in the temperature range of –2 to –8.5°C. Collecting direct brine samples is difficult since in warm ice the ice is too porous and simply floods with seawater. In very cold ice the brines simply do not drain into the sampling holes. Therefore the ice temperature range encountered during this cruise probably provided us with the perfect brine sampling conditions. In the coldest brines we measured salinities of up to 130, and such cryogenic brine samples have not been analysed to our knowledge to date. These brine samples will give us valuable information on the physical and biogeochemical conditions, such as temperature, salinity, dissolved gases, inorganic nutrient content and cryogenic mineral precipitation at cold temperatures. For the first time several types of calcium carbonate crystals have been quantitatively analysed and photographically documented. Their role in the carbon cycle at high latitudes is currently an interesting research question in the context of the increase in atmospheric carbon dioxide content and the subsequent global warming.

During our cruise winter sea ice and snow thicknesses have been determined for the first time through extensive flights with helicopter-borne electromagnetic sensors and with a ground-based radar system. The measurements indicate a strong regional variability with mostly thick ice ranging from 0.8 to more than 4 metres. Especially the region of the former Larsen-A ice shelf has been investigated, which was characterised this year by an extensive coastal polynya (an area blown free of ice by strong winds) and by a large sea ice export towards the north, as documented radar satellite images. Investigation of ice cores an snow samples showed that the 1.4 metre thick sea ice produced in the polynya was nearly snow free and consisted mostly of columnar ice, which is in contrast to the current understanding of turbulent ice production in polynyas. Investigations also reveal that even in winter occasional melting conditions occur with subsequent formation of superimposed ice.

Close to the Larsen-A ice shelf, we found indications of active halogen chemistry in the atmosphere leading to an increase of bromine oxide and a simultaneous decrease of ozone and mercury. Similar events were observed at least two more times: in the marginal ice zone and even over the open water of the South Atlantic. However, it appears that during these events the low atmospheric values of ozone and mercury were rather due to medium- or long-range transport of already depleted air. Additionally, we performed for the first time trace gas measurements on board of a helicopter. The vertical profiles of ozone and mercury obtained during these fights support the idea that depleted air can easily be uplifted to higher elevations.

The main goal of our oceanographers was the acquisition of wintertime hydrographic conditions in the north-western Weddell Sea, a key region for the composition and advection of globally relevant, newly formed water masses. Preliminary results indicate that due to poor knowledge of the sea floor topography, in the past the contribution of Philip Passage (west of the South Orkney Islands) to the Weddell Sea outflow might have been overestimated, emphasizing even more the importance of the South Orkney Passage (east of the South Orkney Islands) for the export of deep and bottom waters across the South Scotia Ridge.

The second region of interest was the continental shelf to the east of the Antarctic Peninsula, which is dominated by high spatial variability in shelf water characteristics. High salinity waters (34.59) in the vicinity of the former Larsen A Ice Shelf might feed a very cold bottom layer (-1.55°C ) on the continental slope (2500 m) just 80 km further to the north. The comparison with stations from the central Powell Basin suggests that these cold bottom waters do not contribute to the Weddell Sea outflow across the South Scotia Ridge. A comprehensive analysis of the hydrographic data at home together with the tracer measurements might confirm these preliminary results, which indicate the north-western Weddell Sea to be highly variable in space and time regarding the formation and spreading of freshly ventilated deep and bottom waters.

Except for the deployment of two bottom pressure sensors, our scientific programme is now finished. Early morning on Saturday we passed through the chain of volcanoes of the South-Sandwich Islands, but much to our regret we could not see these beautiful snow covered volcanoes because of dense fog. A few hours later we traversed the last ice fields and are now steaming east-north-east through calm seas. But our meteorologist has predicted two storms for our passage to Cape Town.

Next Sunday morning we will reach port in Cape Town, and our winter expedition comes to an end in the spring air of South Africa. Fifty-one scientists and technicians (including two helicopter pilots) from 11 countries took part in our cruise. We were ably supported by the excellent cooperation of 43 crew and ship staff, so that our program could be carried out with great success.

In the name of all members of the expedition I send greetings from the South Atlantic, bid you farewell from my position as Chief Scientist, and wish you all the best.

Yours Peter Lemke
Polarstern, 54°30’S, 13°11’W