

## **ANT XXIV-2, Weekly Report No. 8**

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Farewell Antarctica! A week ago we were breaking and shuffling ice. Now back in the blue waters of the open ocean the last icebergs pass the ship and stimulate sentimental feelings as we know the time in Antarctica comes to an end. But we will not finish work before we have accomplished our duties for the 3rd of our big international projects. It is the backbone of the Synoptic Circum-Antarctic Climate-Processes and Ecosystem study (SCACE), a leading project for the International Polar Year (IPY). The projects investigates linkages of physical ocean processes like vertical and horizontal mixing, mixed layer dynamics, to biological processes like primary production, its utilization by zooplankton and krill and the eventual downward transport of organic matter to the deeper ocean and the deep-sea. All these processes in turn impact on the reaction of the carbonate system in seawater and thus on the oceans capacity to uptake carbon dioxide from the atmosphere.

The sampling on the northern bound transect along the Greenwich meridian started on 17 Jan in the morning. In a thirty nautical mile distance, several physical, chemical and biological properties of the upper 1000m water column were recorded. The first instrument to be deployed was the CTD, measuring conductivity, temperature and pressure (depth) to give also salinity and density, with an on-line transmission to the computer and monitor on deck. Blue, red, yellow and green lines appear on the screen as the instrument is lowered. Down to 40 m depth, the green fluorescence line spikes to the right indicating high concentrations of the algal pigment chlorophyll. This maximum is located in the upper mixed layer that always experiences the turbulence created by the wind. At 40m the blue salinity line increases several one thousands units of salinity (e.g. from 33,937 to over 33,961) and shows where the melt water layer ends, which also has warmed to "boiling" temperature of +0.4 °C. Tiny little unicellular algae, the phytoplankton, form the plant biomass in the surface layer. Especially diatoms are very abundant; these are algae surrounded by a transparent wall of silica (glass). But also another algae is rather common and creates a lot of trouble for the scientists filtering water or deploying nets. *Phaeocystis* is the scientific name of the species that occurs in long, large colonies where the 5µm tiny single cells are glued together by some transparent, elastic, rather resistant matrix that works much like a plastic bag. These aggregates are millimetres in size, thus 200 to 1000 times larger than the single cells, and clog the filters and the nets and make it painful for the planktologists to analyse the samples. The explanation for these algal blooms is straight forward. Now in spring, as the ice melts, light conditions become favourable again after a dark winter. And nutrients are plenty in the water. In fact the waters of the Southern Ocean are rather rich in nutrients like phosphorous, nitrate and silicate, but often lack trace elements like iron. The melting ice however releases the iron that accumulated during the previous winter in about ten times higher quantities compared to sea water concentrations. All cell enzymes are fully functional and production is at its maximum. The production and increase in plant biomass in turn also favours the algal grazers, especially small crustaceans such as copepods and krill.

The area of maximum biological productivity stretches between 64°S and 61°S i.e. at the northern flank of the Weddell Gyre, outside the sea ice in the open ocean. Mixed layer depths in this region vary between 30 and 40 m due to the surface temperature increase in combination with melt water induced stability of the upper ocean layer. Thus, phytoplankton finds suitable growing conditions; we recorded the maximum biomass of 1.9 µg chlorophyll a/l in 40 m water depth at 64°S. The uptake of CO<sub>2</sub> by the growing algae has reduced the partial pressure of this gas from 385 units atmospheric value

down to 300 units in the water, indicating the beginning of the CO<sub>2</sub> drawdown effect of the biological carbon pump. Zooplankton and krill do not respond so fast to these high phytoplankton biomasses that should provide suitable feeding conditions. The nets caught some larger krill, and the echo sounder also recorded krill swarms in the surface layers, but not as much as indicated by another measuring device. During a fine, calm sunny day surrounded by at least 20 sculptured ice bergs, we observed large schools of humpback whales performing shallow dives; they were obviously feeding. The whales had detected food, which was not picked up by our measuring gear. Another result of this event was Gigabytes of photos being taken and movies being recorded by many scientists standing outside in the sun and enjoying this spectacular side of Antarctica as well.

The ice bergs at the northern rim of the Weddell Gyre again belong to another category, to the ice berg castles. Recently broken off the shelf, they still carry stiff cliffs some 80 to 150 m above the water. But due to ocean waves and swell, big logs of ice have already broken off, sometimes splitting the bergs above the water in a way that on either side or at the corners, the majestic towers overlook a flat courtyard in the middle under which waves have created castle gates for water to pass through. Talking about ice bergs, I have constantly been asked about the male and female classification of the bergs (report 5) and had some additional thoughts: The male bergs sometimes break and fall apart, spinning off Growlers, little bergs hard to see in a rough sea. This equals a vegetative i.e. asexual reproduction where the offspring is directly produced from the genetic material of only one parent as in aphids. Later when the bergs gain age and experience they become female just like hermaphrodites (first male than female - protandric - or vice versa - protogyne) in some insects or marine invertebrates. The next phase of the continuous cycle of nature is total ice melting. The ice water merges with the ocean and eventually evaporates, being transported in the air and partially snows again over Antarctica in merging water from different sources (i.e. exchanging information just like in genetics) to build up the large polar ice caps. The 1 Million year cycle closes when the continental shelf ice slides north again and reaches the ocean where it will reproduce new, virgin ice bergs. Given the long lasting developmental phase of the continental ice shield, the life of ice as a drifting berg is just a wink of the eye. Berg life dies to fertilise the next generation.

On Jan 23 we passed 60°S going north on our Greenwich meridian transect and this is the legal border for the Antarctic treaty area. We are heading now towards the last deep-sea station, where all gear will be deployed again, weather permitting. As before, weather depression systems travel along the atmospheric polar front at 50°S and one such is expected to create wind force 8 at our sampling position on Sunday. So we are getting ready to develop strong sea-legs again, after all this time in calm ice conditions.

I hope to "see" you next week again

On the latest and final news about our eventful cruise

Uli Bathmann