Weekly report no. 2 GLOBEC II (ANT XXI/4) RV „Polarstern“ 8 April 2004

Biological processes in the surface ocean may affect deeper water layers and the underlying sediments. In the last report, we mentioned EIFEX, an iron enrichment experiment performed in an ocean eddy located in the Polar Front. On our way south, we performed another sampling station in and 30 nautical miles (nm) south of the same eddy that kept geographical position in the otherwise eastward flowing Antarctic Circumpolar Current. The plankton bloom in the eddy had disappeared and chlorophyll had decreased from 3 down to 0.5 µg per litre. To test if the organic material had sunken out to deeper water layers, the physical oceanographers deployed their CTD probe. CTD stands for conductivity, temperature and depth that are measured and transmitted back into the lab on-line while the probe is lowered with one meter per second. In addition a fluorometer measures algal pigments and a turbidity sensor records light attenuation from particles (e.g. dead or live algal cells and zooplankton or detritus) passing a 25 cm long, and few millimetres wide light beam. 24 bottles holding 11 litres of water each can be closed remotely in distinct depth layers by the operator to retrieve water to be analysed for plant nutrients like phosphate, nitrate or silicate, for chlorophyll, oxygen, species composition and abundance of plankton cells and the amount of total organic carbon. The depth profile from the EIFEX station still clearly showed sinking plankton particles down close to the bottom at 3960 m water depth. Also the benthic boundary layer was still present, as it was when Polarstern left the area 2 weeks ago. Sinking of plankton biomass was still ongoing in the Polar Frontal Zone.

The geochemists on board had not dared to wish that they would be able to closely follow such a sedimentation event. The group was busy to get their complex instrumentation ready to be deployed. Most geochemical reactions on such sedimentation events take place in the first few millimetres or centimetres of the sediment surface. As soon as rich organic matter reaches the otherwise nutrient poor deep-sea floor, the additional load of organic carbon, nitrogen and phosphorus will heavily be consumed by the deep-sea benthos, mostly comprising of bacteria, protozoa and a few tube dwelling polychaetes. The more the metabolic activity will increase the more decrease will occur in oxygen concentration, while nutrient concentrations and pH will also change accordingly in the sediments. In reverse, the depth profile of these parameters will indicate the intensity of the respective turnover rates.

The special deep-sea technology of the three sampling devices on board: the Lander, the Multicorer MUC and the Bottom Water Sampler BWS is adapted to retrieve samples from an unaltered sediment surface as gently as possible, as often the sampling gear itself disturbs the location of sampling. The Lander has the shape of a space robot landing on moon. Three legs with heavy weight attached reach out from about 2m. In the middle of the instrument a metal cylinder is attached near to the bottom with tiny glass needles, the micro-probes, sticking out. The tips of these sensors have 0.025mm diameter and are used to determine oxygen concentration and pH changes in the sediments with high vertical resolution. The Lander is deployed as free falling instrument. Once released from the chips crane, it sinks to the sea floor with a speed of 1m/sec. There it will rest for 30 min. to let the cloud of fine sediment produced by the Lander's legs by the touch down, drift away. Thereafter a stepping motor drives a spindle that lowers the microprobes slowly into the underground recording the parameters in 0.5mm intervals. Salinity of the pore water and sediment porosity is measured also, as are speed and directions of bottom currents to reconstruct advection processes. After sampling time has passed, the ship will transmit an acoustic signal that triggers the releaser to unhook the bottom weight. Due to the uplift of 16 pressure resistant glass spheres the instruments surfaces again and transmits its position back to the ship via radio beacon, Argos GPs position and during nighttime also by flashlight.

The 6-hour deployment time of the Lander is used to deploy the other two instruments. The MUC looks like a big spider with its 8 long but thin legs sticking out. In the centre of the MUC heavy lead plates are attached over 8 tubes made of Plexiglas that in turn face downwards. Lowered by the deep-sea winch, the ends of the legs will eventually touch the sea floor well outside the designed sampling spot. After standing on the sediment, a hydraulic driven by the heavy weights will very gently, slowly but steadily lower the tubes30 cm into the sediments. While pulling up the cable and lifting the MUC, flaps close the tubes on both sides, protecting the sediment to slide out and the overlying water to be mixed with water on the instruments way to sea surface. The BWS also is deployed via heavy cable to the seabed, where it sits for ten minutes to let the clouds in the bottom water drift away. A time-controlled release will than the horizontal water bottles attached to the BWS between 20 cm and 2m. Oxygen, nutrients are determined from the water samples retrieved and nutrients are determined in the pore water of sediment slices cut from the MUC cores to obtain parameters to determine geochemical processes and pathways in the sediments. Time series over days on the oxygen profiles will indicate the half-life time of the organic matter in the sediments.

Two out of 4 geochemical sampling stations were conducted in and 30 nm south of the EIFEX area, respectively. On both stations, the surface layer was covered with a fluff layer comprised of remains of diatoms and other unicellular organisms of the plankton. Also the oxygen and pH values dropped drastically in the upper millimetre of the sediment surface. We assume that the end of the EIFEX plankton bloom with subsequent sinking happened simultaneously to similar events all along the Polar Front. The autumn is the natural end in the growing season for many plankton species. The crash of the EIFEX bloom added only little organic matter flux to the sea floor in the respect to the huge area of the Polar Front but with the iron addition we nonetheless added additional but jet to determined quantity of carbon to that downward flux, although a great shared of the iron bloom was grazed beforehand by the zooplankton. On our way back, from the Lazarev Sea krill area, we will revisit the Polar front and investigate the fate of the organic matter burial into its underlying sediments.

Since a few days we are truly in Antarctic waters as we have crossed 60°South. We now catch for krill in shifts 24 hours a day, but this is the topic for the next weekly report.

We wish happy eastern to the beloved and friends at home
From a busy fishing Polarstern
Uli Bathmann