

Weekly report no. 1 EIFEX ANT XXI/3 RV "Polarstern" 25th January 2004

RV "Polarstern" departed from Cape Town punctually at 8 pm on the 21st January with 96 persons on board of which 43 are crewmembers and 53 are involved with carrying out the scientific mission of this research cruise. The latter represent 14 institutes and 3 companies from 7 European countries and South Africa. It had been a hot day and we sailed into a glorious sunset watching the twinkling lights of Cape Town gradually merge with the starry sky. Everything had gone according to plan and even the weather has been in our favour all along so we are in excellent spirits. The first few days were spent unpacking the innumerable boxes and setting up the multifarious instruments that, thanks to the efficiency of the logistics department of the AWI, are all on board so everybody is happy and grateful. The aim of the cruise – the European Iron Fertilisation Experiment (EIFEX) – is to study the growth and demise of a phytoplankton bloom that we will induce by fertilising a patch of ocean some tens of kilometres in diameter with some tens of tonnes of iron sulphate. Our experiment will be the eighth in a series of similar experiments – 2 in the Equatorial Pacific, 3 in the Southern Ocean and 2 in the Subarctic Pacific – that have been carried out so far. Phytoplankton blooms were induced in all these experiments so we are convinced that the same will happen during EIFEX. In contrast to earlier experiments including our own EisenEx that we carried out 3 years ago, we now have 9 weeks, which is enough time to also study the fate of the bloom adequately.

We intend conducting the experiment in an eddy south of the Antarctic Polar Front which is located at about 50°S, because the silica concentrations to its north will be low at this time of the year. Our first task is to locate a promising eddy and map it in order to ascertain its suitability for the experiment. Satellite images of sea surface height reveal the presence and characteristics of eddies and we have been observing the eddy field south of Africa since December. There are several to choose from, so we decided to head for the closest one due south of Africa at about 51°S.

In order to gain an overview of the hydrographical field we commenced measurements at the position of the Subantarctic Front at 46°S which we reached at dawn of Saturday (Jan. 24). The station started with a vertical zooplankton net to calibrate the acoustic instruments with which we measure the populations of these tiny animals below the ship. The microstructure sonde, which measures the degree of layering of the surface layer, was deployed next, followed by a deep cast of the CTD rosette. This instrument is the backbone of our cruise: it records vertical profiles of salinity, temperature, chlorophyll fluorescence and turbidity and is equipped with 24 bottles of 12-litre capacity that can be closed at desired depths. The water samples are divided up amongst the chemists and biologists on board who measure various properties of the water including the organisms living in it. This CTD cast was used to calibrate the towed undulating instrument Scanfish that was deployed at the end of the station. Scanfish is towed behind the ship at a speed of about 15 km an hour. It undulates between the

surface and 220 m depth every few kms and so records the large-scale structure of the water masses in the study region.

After a day of satisfactory performance in calm seas we lost Scanfish because the wire snapped suddenly for unknown reasons. Scanfish is about 2 m long, buoyant and brilliant yellow so we searched for it with our helicopter but unfortunately to no avail. The wire had snapped some 150 m from the instrument so its weight more than sufficed to drag Scanfish down to the bottom. We are now continuing the southerly transect with CTD "dips" (i.e. no bottle sampling) down to 500 m every 5 miles. We will reach our eddy on Monday and by midweek will either have started fertilisation or moved to the next eddy.

Fertilisation experiments have received a lot of publicity because of their climate relevance, which will be dealt with in greater detail in later reports. Our overarching goal is to further our understanding of how open ocean ecosystems function and how the organisms of the plankton interact with one another and with the environment to drive the biogeochemical cycles of our planet.

The quality of the insights we will gain from this experiment can best be communicated with a science fiction story. Imagine an intelligent life form that evolved on a planet similar to ours but which was covered entirely with a single continuous ocean, just as Mars is covered by a single land mass. A hundred of these aliens visit planet Earth (just prior to the advent of humans) with the same motivation (and funding) that will be focussed on the manned Mars mission if President Bush has his way. Being aquatic organisms the aliens would "land" on the ocean in a space ship filled with water and find a familiar environment inhabited by organisms whose way of life and hence evolution they would soon understand. They would be baffled by the air-breathing marine animals (turtles, birds and mammals) but they would be totally bewildered (and presumably excited) by life on the continents.

Assume the aliens choose Africa as their study site and, since they would have invented propellers but not the wheel, use helicopters to explore its length and breadth. They would wonder at the patterns of forest, savannah, semi-desert and desert and after analysing their pictures and samples, formulate what for them would be a strange hypothesis: water evaporating from the ocean falling as rain on the continent determines its vegetation and life forms. How would they test this hypothesis? By sprinkling patches of land in the different regions with water, of course. They would get no response in the equatorial rain forests where it rains all the time anyway, but also none, at least for a long time, in the centre of the arid deserts where it never rains and there is no soil (meaning nutrients). The response would be strongest in the savannah, particularly if it happened to be the middle of the dry season. Within days the parched brown land would acquire a green sheen, and the grass would grow till it reached its maximum height and further irrigation would have no effect. However, in the meantime,

herds of herbivores (from elephants to antelopes) would move in from the surroundings and swarms of insects (from aphids to locusts) would proliferate, all grazing on the lush vegetation. The amount of vegetation surviving the onslaught of the grazers would depend on the size of the irrigated patch relative to the parched surroundings and the zoologist aliens would claim that the animals determine the amount of vegetation. The nutrient chemist aliens on the other hand would take another view and so on. But they would all have to agree that the supply of water is the primary factor determining how much life can be sustained in a particular terrestrial environment.

To come back to our own cruise: yes, we belong to the terrestrial aliens who have recently discovered that the supply of iron is the primary determinant of how much life can be sustained in the ocean. Dust whipped off the continents by winds supplies iron to the land- far open ocean and the productive regions receive more "iron rain" than the unproductive regions such as those around the ship. Our experiment will show us how the anemic plankton reacts to this "manna from heaven" and what the fate of the induced vegetation will be. The various teams on board covering different aspects of the plankton and its environment will be introduced in subsequent reports.

Polarstern is a secure life-supporting system and we are fortunate in that many members of the crew who looked after us so well during EisenEx are again on board. They are doing their best to make our stay profitable and comfortable. The food is delicious and all the more enjoyable because the winds have been calm so far. We would rather be here than on Mars. With our best wishes from the purring forties,

Victor Smetacek