Meteor 55: 2nd Weekly Report (21.10.2002-27.10.2002)

By the end of the 2nd week we have settled into some sort of routine. The initial excitement of sampling the Amazon plume waters, with theit surprisingly low pCO_2 and a bloom of nitrogen-fixers, has receded in our minds as we concentrate on the more regular section work that is the core of our cruise.

We continue to have two stations per day. The early station, which starts at 05.00, is the more extensive with a minimum of 2 separate CTD casts. On many days, we have added 1 or 2 additional CTD casts in order to collect large volumes of water for on-board experiments. At tbis station we also conduct two casts with Go-Flo sampling bottles specially suited for contamination-free sampling of trace metals. Sampling at this station extends to a maximum depth of 600m with a major emphasis on the waters at, and overlying, the chlorophyll maximum. The afternoon station is usually less extensive, with a single CTD cast as well as measurement of light and fluorescence profiles. The afternoon sampling is also usually to 600m but this has, on occasion, been replaced by a full-depth CTD cast.

In order to satisfy the needs of all groups, several of whom require several liters of water from each depth, we developed a carefully controlled sampling protocol. The high diversity of samples being collected from the CTD casts also threatened to become a nightmare of record-keeping and data management. We have adopted a sample identification system that was initially developed by the Bedford Institute of Oceanography in Canada. This system assigns, to each separate water sample, an identification number that is consecutive throughout the entire cruise. This identification number uniquely identifies the station, cast, depth and sample bottle from which the water sample was collected. The identification numbers are pre-printed onto special sheets of sticky labels that are proven to stick securely to all sample containers, wet or dry. Each sub-sample drawn from a water-sampling bottle (e.g. a nutrient sample) is then labelled with one of these stickers that displays the unique identification number for the sample. Despite some initial skepticism, the advantages of this system for a cruise of this nature are now appreciated by all sampling groups. We wholeheartedly recommend it!

As well as the water column sampling, the underway sampling of surface water and air has also continued at fast pace. Collection of these samples is coordinated on the basis of common sampling times during the day. Underway samples are also collected for a set of on-board nutrient enrichment experiments.

We have suffered few equipment failures. We had one short-lived scare with the CTD which turned out to be software-related, and we had a potentially major problem with our multi-channel fluorometer whose pressure-housing leaked slightly on one deployment. Heroic efforts from the Meteor's excellent electronics team allowed a damaged circuit-board to be repaired, and it is now fully operational again. Otherwise problems have been limited to the usual intense, almost personal, battles of chemists with recalcitrant, sensitive gas chromatographs or the struggles of biologists to carry, manipulate and filter vast quantities of water on a moving vessel. In other words: absolutely nothing out-of-the-ordinary.

Progress

During the 2nd week we have steamed steadily east along 10°N. Altogether, for the period covered by this report we travelled almost 1000 miles to the east. On the evening of the 26th we turned south for a transit to the equator along 26°W. The equator transit is designed to allow air sampling along the steepest gradient of the ITCZ, and we will also recover a sediment trap mooring belonging to the University of

Bremen at 0 N, 23W. Seawifs images have been showing a clear biomass signal that is associated with equatorial upwelling so we will conduct a limited amount of station work at the equator. On the Saturday evening, just as we started to head south, the staff and crew enjoyed a barbecue on deck accompanied by tropical sunset, warm weather and calm seas. A very welcome break from the constant filtration, experiments, analyses and fighting with complex instrumentation of the previous two weeks.

Results

Here follow brief highlight reports from a few of the groups on board. Other groups and themes will be covered in next week's report.

- Dissolved oxygen and nutrients have been measured at all stations and all depths. Chlorophyll has been measured at most stations in the upper 150m. The section to-date shows nitrate and phosphate to be below detection limit in surface waters throughout the section, however the depth of the nutricline has risen steadily towards the east. Nitrate to phosphate ratios show a distinct maximum, exceeding the Redfield ratio, immediately below the chlorophyll maximum. The chlorophyll maximum was deep and weak throughout most of the eastern part of the section, but has became shallower and stonger towards the east. At the easternmost stations occupied immediately prior to our southward turn, we started to encounter the shallow oxygen minimum with concentrations as low as 40 uM. This will become more pronounced when we resume our section and sail further eastwards following our brief equatorial excursion.

- Dust and rain sampling. Dust and rain samples are being collected along the cruise track to investigate how much nitrogen, phosphorus and iron are deposited into the ocean from the atmosphere. Model predictions of dust transport that we have been receiving on board show that we have been sailing directly along the axis of the main transport route for Saharan desert dust across the Atlantic. We are particularly interested in how much iron is carried by this dust. Dust has shown up on our filters on almost very day of the cruise so far. We were fortunate to intercept and sample one particularly spectacular dust transport event that we had previously seen (in Seawifs satellite imagery) leaving the West African coast on October 23rd. The large amount of dust in the air was easily noticed: visibility dropped significantly and the sunset had an unusual pale yellow colour. Rainfall collection success has far exceeded our expectations. Useful amounts of rainfall have been collected on 3 of the past 7 days and it is looking like the M55 cruise will contribute an extensive data set for the chemical characterization of tropical marine rainfall.

- Canister sampling. A significant component of the air chemistry program is the regular collection of cartridge and canister samples for subsequent analysis in the laboratory. The Meteor 55 cruise has attracted the interest and participation of a number of groups due to interest in the region we are studying and the ancillary and related programs that are being conducted on board. Canisters and cartridges are being collected every 6-12 hours for the following groups: the National Center for Atmospheric Research in Boulder (Elliot Atlas), the NOAA Climate Monitoring and Diagnostics Laboratory in Boulder (Jim Butler), the Max Planck Institut für Chemie in Mainz (Jonathan Williams), the Institut für Meereskunde in Kiel (Birgit Quack), and the University of East Anglia (Adele Chuck and Peter Liss). The samples will be analysed for a wide range of halogenated trace gases and other trace organics. The collection strategy allows for high resolution sampling but also, very importantly, for direct intercomparison of data.

- Protein Transfer Mass Spectrometry (PTRMS). A PTRMS system suitable for measuring a range of organic compounds in seawater has been set up in the Geo Labor. This instrument is brand-new and is now making the very first measurements of their kind on seawater samples. At present the instrument is used to investigate the distribution of acetonitrile, isoprene and acetone in surface waters and in depth profiles. A separate system is installed in the Luftchemie Labor and is making measurements of the same species at 2 minute frequency in boundary layer air. The goal is to investigate source-sink behaviour for these compounds along the cruise track. Initial results suggest that no regions with significant oceanic emissions or oceanic production of these compounds were crossed last week. This was confirmed by very low gas-phase concentrations. The first profile measurements show evidence for within-ocean destruction of these species: acetone, acetonitrile and isoprene were all below detection limit in a sample collected at 200m.

- Nutrient Addition Bioassays: in addition to characterization of biomass and productivity along the cruise track, an intensive program of biological experimentation is being conducted. These experiments are designed to determine which nutrients limit primary production. The growth and physiological response of phytoplankton is monitored during incubations following addition of different combinations of N, P and Fe. The large number of possible combinations of these nutrients together with the need to avoid contamination of the incubation bottles, means that these experiments are extremely difficult and time-consuming. So far, 2 separate experiments have been completed. Each experiment has involved about 10 separate nutrient treatments requiring almost 120 separate incubations. Preliminary results of the first experiment show a significant response after the addition of Saharan dust that contained Fe and P. The second experiment, made further to the east where surface water iron levels were high, showed the strongest response to combined additions of N and P. These experiments are conducted every 3-4 days. The next one is scheduled for our southward transit to the equator.

Stay tuned for more reports next week on other groups' activities, notably the results of the various trace gas investigations that are being conducted on board.

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Note: Short photoessays from the Meteor 55 cruise should be viewable on www.meeresforschungonline.de at regular intervals.