Meteor 60-5: Weekly Report #4

The fourth week of Meteor 60-5 saw fewer stations being occupied in part due to a long transit southwards in order to resume our eastward transect along about 33°N. This planned gap was followed later by an enforced ~24-hour halt to stations due to strong winds and high seas. The transit time was used by the various chemical measurement groups on board to make adjustments to their systems, perform more extensive calibrations, and work up data. It also allowed our CTD operators to take a much-needed break. Despite the bad weather, we managed to sample at, or close to, all planned TTO stations and we are still on schedule. At the time of writing we have just completed a re-occupation of TTO station 49 at 33° 46'N 25° 8'W. Immediately after this we will make a biological CTD and particle-catching station in about 280m of water on top of the nearby Atlantis Seamount.

Photo 1: A small ceremony was held to honour our CTD operators, Jens Schafstall and Christopher Smarz when the thousandth water sample was collected. (photo by Sylvia Walter).

We also took the opportunity of the long transit at the beginning of the week to hold our 'Bergfest'. This included the cultural highlight of the cruise with the awarding of prizes for the Meteor 60-5 photo contest. Twenty excellent entries were submitted in the categories: 'Science', 'Life on Board', and 'Art: Hands or Feet'. Upon examination of the entries, the judges were forced to add an additional category: 'uncategorisable'. One of the winning photos (under 'uncategorisable') was of a seaman riding a cow on deck. We are still looking for the cow. Captain Jakobi awarded the prizes to the winners. Later in the week, on April 1, the Chief Scientist was the victim of an extraordinarily elaborate hoax that some people found quite amusing.

A major activity during Meteor 60-5 is the analysis of a wide range of dissolved gases and volatiles. In addition to measurement systems for dissolved CO_2 and O_2, we have a total of 5 gas chromatographs on board that are measuring a wide range of trace compounds both in deep ocean profiles and the air. The compounds range from man-made chlorinated and fluorinated compounds that can be used as circulation tracers, through a variety of naturally-produced chlorine-, bromine- and iodine-containing compounds that are potentially important for atmospheric chemistry, to the important greenhouse gas N_2O.

Photo 2: with so many different analyses being made on the same sample, there is strong competition for water from the sampling bottles. (photo by Sylvia Walter)

The circulation tracers that we are measuring include the chlorofluorocarbons 11 and 12 (CCl_3F and CCl_2F_2), together with CCl_4 and SF_6. CFC-11 and CFC-12 have been measured worldwide since the 1980's. We have already re-sampled some stations where the very first North Atlantic measurements of these compounds were made, during TTO, in 1981. Not surprisingly, our data reveal a large increase in the concentrations of these compounds, at all depths, since that time. Much less commonly measured are CCl_4 and SF_6. Both compounds are also exclusively man-made, but have very different time-histories of input to the oceans compared to the CFCs. CCl_4 has been used widely as a solvent since the early 1900's, and has had significant environmental concentrations since the late 1920's. SF_6 in contrast has increased rapidly in the environment since the 1960's. Taken together, the suite of compounds covers input timescales of <80 years (CCl_4), <60 years (CFCs 11 and 12) and <40 years (SF_6). We can refer to these timescales, perhaps optimistically, as: 'senior', 'middle-aged' and 'young'. The distributions of the tracers that we have measured so far in the western basin reveal the impact of ventilation of the interior ocean over these three distinct timescales.

In the deep waters of the western basin we have seen some striking variations in the relative distributions of CFC11 and CCl_4. On some density horizons we have found relatively high levels of CCl_4 in the near-absence of CFC11. This signals tracer associated with a water mass component that was ventilated at a time when CCl_4 was already present in surface waters but CFC levels were still low: this is the 'senior' water. At other density surfaces and locations we have found similar levels of CCl_4 associated with much higher CFC11 levels. This water therefore includes a 'middle-aged' component that was ventilated when both CCl_4 and F11 were present in surface waters. Only in the upper 1000-2000m and in North Atlantic-derived deep water masses along the boundaries do we find evidence of a 'young' component containing detectable SF_6. The 'senior' water contains no detectable SF_6. The deep water distribution of SF_6 shows some strong similarities with the distribution of CFC11 as it was at the time of TTO.

One of our goals is to employ this diverse tracer information to help us interpret the patterns of increase of CO_2 that we measure through our comparison with TTO data. The tracer data should also help us with the interpretation of the distribution of other halocarbon compounds that we are measuring on board. More about these and N_2O in next week's report.

As is usual on Meteor we are being very well looked after by the stewards department and able to concentrate on our measurements. Next week sees us following the footsteps of Larry Armi's TTO Leg 3 into the Canary Basin. The 'bioassay group' will start another of their experiments at our southernmost point.

Then we make a northwards transect, to the east of the Azores, and start the final transect eastwards towards Lisbon along 37°N, following the path of TTO Leg 4 (Chief Scientists: Wally Broecker and Claes Rooth).

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