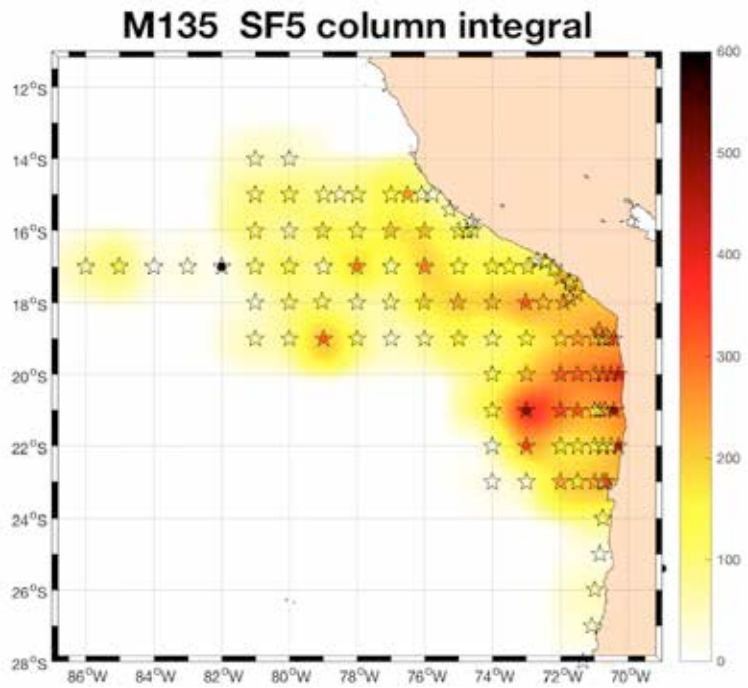
POSTRE-II

M135

(01.03. – 08.04.2017)

5. weekly report 2. April 2017

The fifth week of scientific work in the Peruvian sector of the South Pacific ocean was largely successful. We covered three zonal sections with the CTD survey along 16°S, 15°S and today completed the 14°S section. The mapping of the tracer that we released in October 2015 worked out very well and we see the first interesting patterns emerging. On the one hand the Peru-Chile under current transported the tracer southward along the coast. From there eddies and zonal flows disperse the tracer into the ocean interior. The precise rates of mixing, transport and dispersal will be computed back home in Kiel and then compared to ocean models.



Vertical integral of observed tracer concentration.

Another objective of the cruise are the distribution of transient tracers. Transient tracers are trace substances in the ocean that has time information, either from surface concentrations that change with time, or from substances that decay with time. Transient tracers can then be used to determine the “age” of a water sample. With age we normally mean the time since that particular water sample was in contact with the atmosphere, or rather since the water was in the very upper part of the ocean called the “mixed layer” where exchange with the air takes place. For instance it is in the surface ocean that oxygen is exchanged between water and air.

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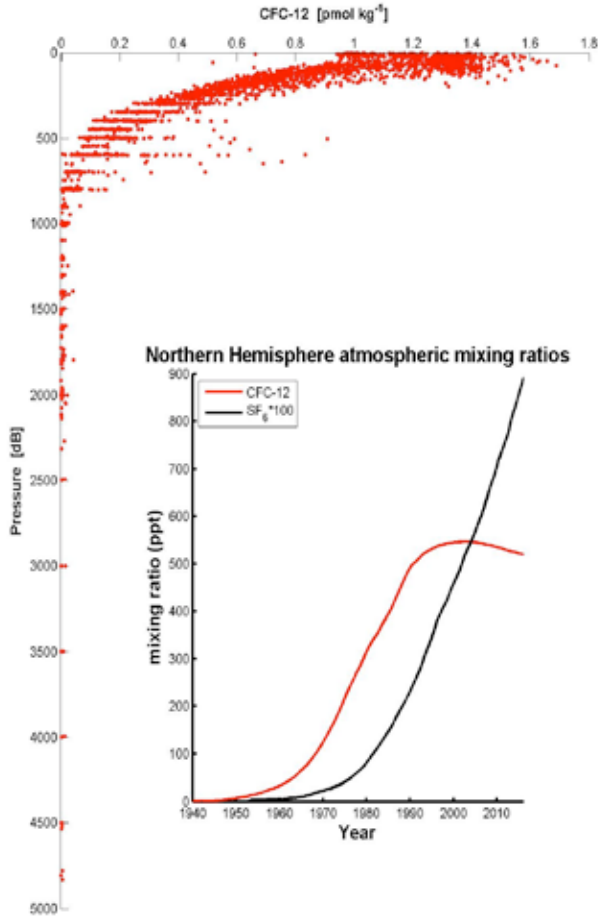
During the M135 cruise Toste Tanhua measured the transient tracers SF_6 and CFC-12 simultaneously to the deliberately released tracer. These are inert compounds (they do not react with other compounds easily) that are entirely man-made. We know the concentration of SF6 and CFC-12 in the atmosphere over time, see figure, and we know how much of the tracer it must have been in the surface waters at a certain time. By measuring the tracer concentration in the water column, we can estimate the time since this water was at the surface.

In the Pacific Ocean we find the oldest water in the whole ocean, in excess of 1000 years, so that we would expect to find waters with no CFC-12 (or SF6). During this cruise Toste had the opportunity to sample the oldest water he has ever sampled, after 35+ cruises during 25 years. Interestingly we do find a very small, and nearly constant, signal in the deep (2000 – 4000 meter) water samples. This is most likely artifacts from sampling and outgassing from the PVC water samples. This is thus an excellent opportunity to quantify this background signal – the sampling blank – and it turns out to be 0.003 pmol / kg. This should be compared to the ~1.5 pmol / kg that we see close to the surface; it is thus a very small correction but that increases the quality of the measurements.



The Figure also show all CFC-12 measurements that we have so far on the cruise plotted against depth. One can see that the concentration decreases rapidly with depth, that is the water gets "older" quickly, and at 1000 meters depth there is only a very small signal of CFC-12 left. The samples around 500 m depth with higher CFC-12 concentration is the tell-tale of the Antarctic Intermediate Water that we observed in the southern part of our cruise.

Another program on board is concerned with the distribution of trace metals. A series of 20 stations to date, starting at 18

degrees S, have been completed for collection of contamination sensitive chemical parameters.

A trace metal clean sampling rosette and winch are operated from Meteor's A-frame with the winch container mounted in the central position at the stern of the ship. A pre-fabricated lab container with in-built air filtration is positioned forward and starboard of this for the processing (filtration) of seawater under clean conditions that allow sensitive parameters such as iron (Fe) and dissolved organic phosphatase (DOP) to be collected without the risk of contamination from the ship.

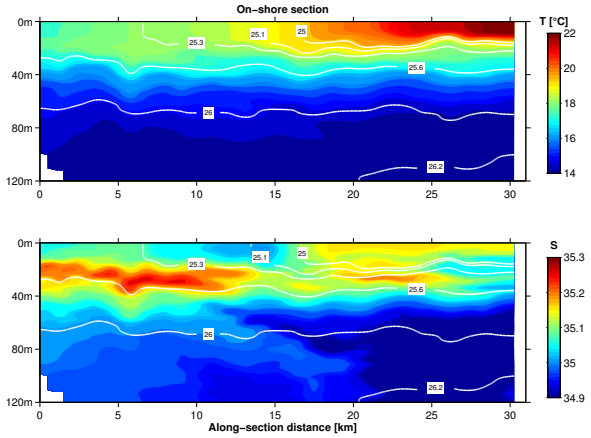
Left: Dr Mark Hopwood explains the trace metal CTD at the back of the METEOR. Right the trace metal CTD comes out of the water at night and back on deck for sampling.

Inside the clean laboratory container, N2 gas is used to overpressure (0.2 atm) all Go-Flo bottles (except 2 at every station which were maintained without N2 and used for O2 collection to calibrate the trace metal CTD). Seawater is being collected for analysis of trace metals, Si isotopes, DOP, H2O2, nutrients and also salinity to calibrate the trace metal clean CTD. H2O2, nutrients and salinity measurements take place onboard, other samples are preserved and will be analyzed upon return to Kiel. In total 500 samples for analysis of trace metals will be collected on M135 (360 have been collected and preserved to date).

Additionally, surface (~2-3 m depth) seawater is sampled at high resolution (every 2-4 hours of steaming time) from a custom-built towed-fish via acid washed 1 cm diameter tubing with suction provided by a peristaltic pump. This water is pumped directly into the purpose-built clean air laboratory container.

The focus of sampling is to investigate the internal cycling of chemical elements within the oxygen minimum zone, thus most stations are conducted only to a depth of 1000 m in order to sample at a high depth resolution (50-100 m). An exception is the shelf-break stations at around the 2000 m contour depth mark where full depth profiles (3 to date) are being conducted in order to contrast the effects of the oxygen minimum zone and benthic supply on trace metals within the water column.

In the middle of the week we inserted a short survey of the ocean's fine structure near the shelf break. We deployed an underway CTD system (RapidCast), that can document the ocean upper 150m with a profile spacing of about 2 km. At the same time we recorded the water reflections from the Parasound echo sounder and velocities from the ship board ADCP system. These small scale signals allow to document the influence of internal waves on the ocean mixing and will be a focus on the next leg.



Highly resolved CTD data from the RapidCast System near the shelf break.

When back at the shelf break we had the opportunity to marvel at the Paracas Candelabra, a well-known prehistoric geoglyph found on the northern face of the Paracas Peninsula at Pisco Bay. Pottery found nearby has been radio carbon dated to 200 BCE, the time of the Paracas culture.

Left: The geoglyph Candelabro de Paracas. Right: Rock formations at Pisco Bay.

The mood on board remains very good, the weather is warm out in the Pacific ocean and cooler in the upwelling zone near the shelf. The food very good and the collaboration with the captain and crew exemplary.

With the best regards from 14° South and 76° 30’ West,

Martin Visbeck and the M135 science crew.