AMT-9

GANGPLANK REPORT

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Grimsby – Montevideo

15 September to 13 October

Atlantic Meridian Transect

The Atlantic Meridional Transect (AMT) programme exploits the passage of the Royal Research Ship, James Clark Ross (RRS, JCR) through the Atlantic Ocean latitudinally from 50 N to 52 S, between the U.K. and the Falkland Islands, a distance of over 13,500 km. In September the JCR sails southward, sampling the N. Atlantic during the boreal fall and the S. Atlantic during the austral spring; the following April it returns to the UK, sampling the S. Atlantic during the austral fall and the spring conditions in the Northern Hemisphere. The ship's track crosses a range of ecosystems and physico-chemical regimes, within which conditions vary from sub-polar to tropical and from eutrophic shelf seas and upwelling systems to oligotrophic mid-ocean gyres. The JCR provides the ideal platform to measure physical, biological and bio-optical properties and processes through these diverse ecosystems of the North and South Atlantic Ocean.

The oceans have a fundamental role in determining global climate, due to their capacity to absorb and emit trace gases (CO_2, CH_4, N_2O, CO, S-compounds, halocarbons), and store and transport heat and organic matter; these processes directly and indirectly affect regional ecosystems and the Earth's radiation budget. The oceans contain approximately 85% of the carbon circulating in the earth's biosphere and provide the main long term control of atmospheric CO_2 and the strength of the natural "greenhouse effect". The ocean biota, particularly phytoplankton, contribute significantly in all these processes. Photosynthetic carbon fixation, leading to the transport of carbon to the deep oceans and sediments (the "biological pump"), increase the capacity of the oceans for CO_2. Dimethylsulphide (DMS) derived from phytoplankton is believed be the major source of cloud condensation nuclei in the marine atmosphere. The absorption and back-scattering of biogenic particles affect the oceanic albedo (surface reflectivity) and the rate of heating of surface waters. All these processes affect the control of the temperature of the Earth's surface.

Satellite remote sensing of water colour provides synoptic, large area, spatially-resolved observations of ocean biology (colour) on a daily basis, subject to cloud-free conditions. The AMT programme has set out to develop the synergistic link of autonomous shipboard, towed measurements and satellite remote sensed observations, as a solution to the under-sampling problem, by extrapolating measurements of the oceans and atmosphere from research ships to basin-scales. Data from the satellite

sensors MOS (launched 19 Mar. 1996 on IRS-1), OCTS (Nov 1996 to June 1997), SeaWiFS (Sept. 1996 – present), can play an important role in defining the present state of the oceans, as a basis for evaluating the role of biology in models of the climate system and for detecting biological feedback responses to climate change. Spatially-extensive bio-optical oceanography on AMT cruises has provided data to develop and validate new bio-optical models and validate and give scientific credibility to remotely sensed imagery of oceanic biology. This is an integral part of the holistic strategy, linking oceanography, remote sensing and modelling in particular the relationships between bio-optical signatures and production parameters.

Narrative

The AMT-9 cruise started in Grimsby on 15 September 1999, with a refuelling stop in Portsmouth on 16-17 September. After Portsmouth, the vessel followed the usual AMT track to 20°W, 47°N. After 20°W meridian was made, the ship followed a southerly course, until to leaving the track for an unscheduled port call in Madeira. The ship then followed the 20°W meridian, through the Canary Current Upwelling to 13°N, after which, the ship altered course to the south-southwest for a waypoint approximately 200 nautical miles east of Montevideo, Uruguay. The ship docked in Montevideo on 13 October. A plot of the ships complete track is shown in figure 1.

Plymouth Marine Laboratory (PML) scientists and other members of the scientific party travelled to Grimsby on, or by, Tuesday 14 September. Scientific equipment from various institutes was unloaded on Tuesday and by the end of the day, most of the equipment had been installed. This unexpectedly good condition was undoubtedly a result of the *old hands* that had come to help their younger charges. The final scientific preparations were completed prior to departure from Grimsby at 0900 GMT Wednesday morning (15 September). The non-toxic supply was turned on at 1200 GMT and extensive testing of underway equipment began. There was no station sampling on Wednesday, but with good progress through the southern North Sea, the straits of Dover and the eastern English Channel, there was sufficient time to conduct a shakedown station at 0830 GMT on Thursday morning. Station 0 produced a successful CTD cast with all bottles firing and deployment of the zooplankton net from the forward starboard crane.

After loading aviation fuel for the BAS Antarctic bases on Thursday afternoon and Friday morning, the JCR departed Portsmouth at 1200 GMT. Underway (2-hourly)

sampling began at 0700 GMT on Saturday 18 September, on sequential day of the year 261. The station planned for the afternoon was cancelled due to bad weather in the western English Channel (force 8/9).

The weather conditions had eased sufficiently for the first station to be performed on Sunday 19 September (1100 GMT). The ship was positioned into with the sun on the port quarter casting a shadow onto the in-water radiometers, due to a large swell.

The following instruments were deployed.

i. SBE CTD system, with Fast Repetition Rate Fluorometer (FRRF) and upwelling and downwelling radiometers attached

ii. Zooplankton nets.

Examination of the secondary T and C sensors on the SBE revealed they were contaminated by noise. The on board BAS electronics engineer believed the cause of the noise was a loose circuit card connection within the body of the CTD. The secondary sensors were left on the SBE to monitor their performance during the duration of the cruise. Deployment of T7 XBT began at 1224 GMT and was scheduled to continue at 4-hourly intervals for the duration of the cruise. The weather deteriorated during the afternoon and all deck work was cancelled on order from the bridge.

The following morning the weather had improved but there was a strong swell, through which slowed the ship to 6-8 knots. XBT deployments recommenced at 1200 GMT. Station A902 was performed at 1330 GMT Sunday 20 September, again the sun was on the port quarter shading the optics cast. After the station the ship set a course for 46°N, 20°W. Fluorometry traces obtained from the first station compared well with chlorophyll extracted by fluorescence, on water filtered from 7 CTD bottle depths.

Station A803 on Monday 21 September (0830 GMT) provided an opportunity to gain additional data on changes to the physical field and a fluorometry trace. The cast was successful, however post cast analysis of the data from the radiometers revealed inconsistent data on the upwelling sensor - caused by seawater corrosion within the connector plug. Optics on the CTD were suspended whilst the situation was appraised. Throughout the day the wind picked up from the west and by 1330 had reached force 7/8, the afternoon CTD station was aborted and all deck work cancelled. A force 9/10 Gale swept across the ship with a low of 984 recorded by the

barometer on the bridge. At 1600 GMT the ship turned into the weather on a course of 250; at a speed of 3.5 knots.

On the 22 September the weather was still poor with strong gusts of up to 40 knots and a large swell, the ship made a south-southeast course (150) at 0830. An afternoon station was possible at 1330 – again the optical sensors were shaded. The ship was approximately 24 hours behind its schedule.

Late in the evening Richard Stanford requested a departure from the vessel for a compassionate return to the UK, arrangements were made for him to disembark at Madeira on the Friday evening.

Station A905 on 23 September (1130 GMT) took place in substantially improved conditions. The optics sensors were reattached before the CTD and the station was the first without ship shading affecting the sensors. Post station the ship took a direct course for Madeira at 14.5 knots.

Station A906 on 24 September (1130 GMT) passed without incident and the ship arrived at Madeira by 1745 GMT and Richard Stanford disembarked.

Stations A907 and A908 both at 1130 GMT on 25 and 26 September respectively passed without incident. The ship recovered the 24 hours lost due to the initial bad weather and a two station per day strategy was implemented. A morning CTD cast to improve the latitudinal distribution of the physical fields and collect additional FRRF flourometery data; the afternoon station typically at 1300 GMT was timed to coincide with SeaWiFS overpass window.

Station A909 on 27 September (0930 GMT) was within the influence of the Canary Current Upwelling, the deep chlorophyll maximum (DCM) was at 45 m, and values of 1.5 ug/L were seen. By the afternoon station, A910 (1400 GMT) the DCM has intensified to 2 ug/L at 35 m. The wind direction and a large swell resulted in the sun on the aft deck for the station. The diffuse light field was caused by wind borne sand from the Sahara. Underway Fluorescence increased throughout the afternoon peaking at 1830 GMT, probably caused by a surface filament from the main upwelling drifting offshore.

Station A911 on 28 September (0930 GMT) and A912 (1300 GMT) were within the influence of the Upwelling with a DCM at 30 m and chlorophyll levels of 1.7 ug/L. On 29 September at 0248 GMT the ship changes course for a waypoint off the River Plate. Station A913 (0930 GMT) and A914 (1300 GMT) were performed in calm seas

with only a breath of wind. The sky conditions were still hazy, but with ship departing the African coast the volume of the Saharan sand in the atmosphere diminished.

Station A915 (0930 GMT) took place north of the Inter Tropical Convergence Zone (ITCZ), storm clouds were evident in the distance to the south. At 1300 GMT the ship entered a large shower. The afternoon station (A916) was delayed 20 minutes (1420 GMT) to allow anther vessel to pass – the station took place in cloudy conditions. A spectacular thunder and lighting show broke out around the vessel at 2200.

Station A917 and A918 on 1 October, passed without major incident, the DCM was down to 50m. During the afternoon the ship approached, the equator the underway Fluorometer measured an increase in fluorescence, indicating activity from the equatorial upwelling.

The equator is crossed at 0647 GMT on 2 October, surface fluorescence had increased overnight. The main station A919 occurred at 1130 GMT. The DCM had risen to 45 m. During the afternoon there is a line crossing ceremony to welcome Neptune on-board, and the 'scurvy dogs' paid homage to him. Always a high point on every AMT, the ceremony was followed by a BBQ.

Station A920 and A921 on 3 October, are performed under clear skies and with a calm seas. The DCM is beginning to deepen to 95 m, as the S. Atlantic Gyre is approached. At 1448 GMT the sun was at its zenith.

Station A922 (1030 GMT) on the 4 October is performed in a torrential downpour, with visibility less than 50 m, shortly after the station the rain stops, and by station A923 at 1500 GMT the ship is in clear blue skies. The transmissometer attached to the SBE system has been giving increasingly noisy signals, but always provided a trace that could be interpreted, however the trace provided for A922 and A923 is unusable.

Stations A925 on 5 October was followed by a tow with the recently developed wide body UOR designed to accommodate the Optical Plankton Counter. The good weather we have enjoyed begins to disappear as we enter a large band of cloud, and the swell picks up.

Station A926 (1030 GMT) on 6 October was conducted in poor conditions with the ship into the swell and the sun on the port beam. The afternoon station passes without incident. A second and final UOR tow passed successfully in the afternoon.

All remaining station passed without incident and the ship docked in Montevideo on the morning of 13 October 1999.

Plots

1. Cruise track.
2. XBT temperature structure.
3. CTD temperature structure.
4. CTD salinity structure.
5. Chlorophyll calculated by fluorescence
6. FRRF Fv/Fm Dark chamber.
7. FRRF Fv/Fm Light chamber.

Logs

1. Station log.
2. Science log.
3. CTD bottle log.
4. XBT log.