Hydrography, current and turbulence moorings and SPM modelling

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Abstract

This account of OMEX II-II work at POL relates to planned POL contributions to the following elements of the Technical Annex:

- Task II.1 (moorings, currents, circulation and flow fields) and specifically Task II.1.2 (deployment of moorings)
- Task II.2.1 (classical hydrography and water masses), specifically the collection of CTD and water sample data
- Task III.1.2 (spatial and temporal variability of the benthic boundary layer dynamics), specifically deployment of a lander measuring near-bed turbulence
- Task III.1.6 (benthic model), specifically continued use of a simple diffusion model to investigate observed distributions of suspended matter, including application to a cross-slope section over Goban Spur, and initial application of a prognostic model to SPM in the cross-slope section
- Work Package IV in respect of tasks IV.1 (water budget and circulation), IV.2 (carbon sources, cycling and fates), IV.6 (integrated margin exchange model) and IV.7 (Work Package IV coordination).

Introduction

For Work Package II, in OMEX II-I work was carried out to draft an OMEX synthesis paper *Physical structures, advection and mixing at the Goban Spur* (Huthnance *et al.* 1998). This paper has now been submitted for the planned volume of OMEX I synthesis papers. The physical context for ocean margin exchange at the Goban Spur is described. Observations adjacent to, prior to and during the Ocean Margin EXchange (OMEX) experiment of 1993-1996 are used. They include currents measured on moorings, drogued-buoy tracks; temperature and other data from CTD profiles, especially as indicators of vertical mixing; evidence from models, particularly for turbulence causing vertical mixing. These data are combined in estimates of (seasonally-dependent) mean flow, tidal currents, other current variability, exchange and mixing, over the main cross-slope section studied in OMEX and in nearby and contrasted locations (aided by the use of earlier and adjacent measurements). Causative physical processes are discussed.

For Work Packages II and III, preparations were made in OMEX II-I for swath bathymetry, coring, mooring deployments, CTD and water sampling stations (especially for nutrients and primary production) on the first cruise (RRS *Charles Darwin* 105) of OMEX II-II off NW Iberia. Application was made for subsequent cruises; in all, OMEX cruises CD105 (29 May to 23 June 1997), CD110 (23 December 1997 to 19 January 1998) and CD114 (29 July to 24 August 1998) have been secured.

The mooring array plans recognised ongoing Portuguese nationally funded moorings at 40°N and plans to supplement them with others at 41°N. Thus the UCG current meter moorings, IfM current and sediment trap moorings and POL Sediment Transport and Boundary Layer Equipment (STABLE) were all planned for one cross-slope section. This was chosen near 42°40′N to come under the regularly-occurring upwelling filament near Cape Finisterre and on a slight ridge indicated on charts, as a secure base for the moorings.

The CTD/sampling station grid for CD105 was chosen in conjunction with those for the following *Belgica* cruise to take account of

- nearshore waters off the mouths of the rias
- oceanic waters up to 100 km offshore
- fine resolution offshore across the slope to detect effects of processes in the narrow confines of the steep slope
- the possibility of along-shore variability associated with topographic features, upwelling filaments and

eddy features.
This resulted in seven planned sections common to the two cruises between 42°N and 43°N, each section have stations at a spacing O(10km) (some closer over the steep slope). "Reference" stations were defined (100, 200, 1000, 2000 m water depths) on three sections, for all cruises to attempt to construct a best seasonal sequence.

For Work Package III, a model of diffusion and settling (only) in the cross-slope section was used in OMEX II-I to investigate steady-state distributions of SPM (Amin and Huthnance, 1998). It is found that the strongest factors are effective horizontal and vertical diffusivities, the relation of vertical diffusivity to settling velocity × depth, and the distribution of "sources" including sea-bed resuspension. Resuspension is suggested as the usual reason for increased deposition recorded by sediment traps near the bottom. Observed thin, near-horizontal intermediate nepheloid layers put bounds on the vertical diffusivity and settling velocity, O($10^{-4} m^2/s$, $10^{-5} m/s$) over Goban Spur.

Work Package II

Methods

POL led RRS Charles Darwin cruise 105 leg B (10 June 1997 Vigo to 23 June 1997 Southampton).

(Task II.1.2)

A UGC bottom-mounted ADCP mooring was deployed on 10th June at 42°40.94′N 9°28.58′W in a water depth of 156m, being lowered into the water and released using a quick-release hook. (It would have been preferable to have lowered the mounting to close to the seabed and released the package with an acoustic release instead of the slip hook; however, weather conditions did not allow this). Interrogation of the mooring 11 days later proved successful when stationed at the release site. The range indicated by the release indicated little movement from the release site due to drift in the free-fall descent. A conventional UCG sub-surface mooring with four current meters was deployed satisfactorily on 10th June (like the ADCP) in a water depth of 686m. Release location was 42°40.1′N 9°34.4′W. Both these moorings were close to their planned depths and near 42°40′N where two more moorings with sediment traps were subsequently deployed by IfM in July 1997.

The ship-borne ADCP was run using 4 m bin lengths and a 5-minute ensemble.

(Task II.2.1)

On leg A (29 May to 9 June) thermosalinograph and PAR light sensors were recorded underway. On leg B, transmissometer and fluorometer sensors were also recorded.

The main activity was a grid of CTD stations, typically 10 km apart, on cross-slope sections at 43°N, 42°50′N, 42°40′N, 42°30′N, 42°20′N, 42°09′N, 42°N, 41°48′N and 41°25′N, recording profiles of temperature, salinity, fluorescence, dissolved oxygen, up- and down-welling radiance, transmittance and optical backscatter. Water samples were taken at many of these stations, by partners from UCamb, UCG, PML, UVigo, SOC and CFR to analyse for nutrients, biogenic silicate and calcite, primary production (phytoplankton and "new" production, ammonia regeneration and nitrification), pigments, DOC, bacteria, microzooplankton, natural radio-nuclides, SPM and POC. These stations included all the standard "reference" stations, the SEFOS lines - although a few stations were omitted - and pre-dawn casts for primary production incubation samples on nine days. Night and day plankton net hauls were taken (100m depth to surface with a 20 micron mesh net) for phytoplankton samples at 22 stations. A Longhurst-Hardy Plankton Recorder was towed on six occasions, night and day. CTD casts were repeated a week later at two stations, and after a short interval to 100-200m at several more; these may give some estimate of (tidal) displacements of the thermocline; the aggregate of CTD casts shows diurnal heating effects although no 12hr CTD series were performed. Samples from the three designated positions on 42°09′N were exchanged with *Belgica* for intercalibration between analyses by scientists on the two ships, in Vigo and at PML. A CTD cast with water sampling was carried out at 42°30′N close to one by *Belgica*, also for intercalibration. Very little time was lost to adverse conditions.

Satellite infra-red images for sea-surface temperature were received for June 4 and June 8 prior to leg B, for the afternoons of June 14 and June 17 and for the early morning of June 18. These were e-mailed to the ship from PML (having been received from the NERC-sponsored satellite receiving station at Dundee).

The images, together with visual and thermosalinograph observations of the plume and its offshore front, encouraged underway nutrient sampling, especially on 15 June, for subsequent correlation with sea-surface temperature. Their lack of other structure encouraged a decision to dispense with diagonal ship's tracks between the cross-shelf sections; diagonals had been envisaged to give denser surface coverage along-shore.

(cf. Work Package III)
POL also led cruise CD110 Leg A (23 December 1997 to 9 January 1998) which deployed STABLE, attempted mooring recovery and carried out systematic mapping of water properties.

(Task II.1.2)
The UCG ADCP mooring deployed in June 1997 on CD105 and intended for redeployment was not found. It was subsequently learned that it had been recovered by a Spanish trawler just prior to the cruise.

The UCG current meter line mooring deployed in June 1997 on CD105 was located but not recovered or replaced. Its release was interrogated at a position 42°40.00′N, 9°36′11″W with a positive contact made at a range of 2581m, consistent with the cut away position during deployment in June. The following day at the site the C/R was asked to release the anchor weight and contact was made at a range of 727m. However, the mooring did not rise. Closest contact was made at 42°40′10.5″N, 9°34′21.8″W (at a range of 628m), about 0.15nm to the north east of the cut away deployment site. Weather and sea conditions during CD110 were not good enough for deployment of a replacement 700m mooring or for dragging.

The POL rig STABLE (Sediment Transport and Boundary Layer Equipment), a pop-up benthic-landing instrument package, was deployed in 202m water, position 42°40′41′N, 09°30′30″W at 1117 GMT on 27th December 1997. It measures near-bed turbulent phenomena using electromagnetic current meters and a pressure sensor. Mean transport phenomena and near-bed shear are measured using a rotor stack and a vane. (STABLE was successfully recovered on CD110 leg B). Tidal analysis of the current time series has commenced.

Underway recording included monitoring by ship-borne ADCP, recording at 10-minute intervals with a bin depth of 4m in the vertical.

(Task II.2.1)
The near-surface sampling system comprised a thermosalingraph, light meters, transmissometer and fluorometer. Data from the various sensors were collected approximately every two seconds and averaged over thirty seconds before being logged by the computing system. The system was run continuously at sea.

39 CTD profiles were obtained and (in poorer conditions) 60 XBT profiles (two probe types: T-5 for 760 metres to 1830 metres of depth; T-7 for less than 760 metres). With the CTD were transmittance ($\times$ 2), optical backscatter, fluorescence and dissolved oxygen; also irradiance on some profiles. Water bottles were taken for salinity (only).

Clouds prevailed, so that the only relevant satellite image was obtained eight days before the cruise.

22 plankton net hauls were taken by UCG. There was some bias towards the shelf and slope rather than deep-water locations. Vertical hauls in the upper 100 m of the water column with a 40 micron mesh phytoplankton net were made. Several stations were repeats of June stations to investigate possible seasonal variability in certain species.

The cruise CD110 was adversely affected by poor conditions: mooring work (or coring) were only possible on three days out of 12 in the working area; CTD profiling less than half of the time.

Results

(Task II.2.1)

For the period 29 May to 13 June 1997 the weather was predominantly cloudy with winds from between south-east and west (strong on 5-7 June, otherwise light or moderate only). These conditions did not favour upwelling. Winds became northerly on 14 June, but were only light and became variable or westerly until 17-18 June. Then a spell of (upwelling-favourable) northerlies built up to force 6 but subsided again. Winds were westerly again thereafter.

The overall oceanographic situation in leg B was a thermocline typically at 50 m depth, sharpest in the deep ocean offshore, more diffuse over the slope and spanning a depth range typically 40-80 m, and more or less mixed waters in depths less than 130 m over the shelf. Surface nutrients were largely depleted (despite the storm on 5-7 June). There was a chlorophyll maximum at typically 60 m, just below the sharpest part of the seasonal thermocline (ie. at a depth where some vertical mixing was indicated) and accompanied by a maximum of SPM as indicated by the CTD transmissometers. Other SPM maxima were often recorded in depths down to several hundred metres, especially near to the steep slope. There was consistently a maximum salinity at a depth 850-1200m indicating Mediterranean water; at two stations there was a double maximum; possibly trends to lower values of the salinity maximum to the west and north.

On the inner shelf, there was a surface plume of varied extent, typically 10m deep with fresher, greener water that was also warmer during the day. Satellite images prior to 9 June 1997 showed that the storm on 5-7 June had largely removed the sea-surface temperature patterns of 4 June (when scales of order 20 km were evident offshore) to leave just a consistent band of warmer water within O(20km) of the coast. Images for the afternoons of June 14 and June 17 showed warmer surface water in a continuous coastal band, width O(20km, 30 km respectively) and "bulging" somewhat further offshore in some places than others. *In situ* measurements suggested that this was associated with fresher "greener" water, *ie.* a plume. A subsequent image for the early morning of June 18 showed a thin O(5km) band of water close inshore, the warm band O(40km) wide and the ocean beyond. The thin inshore band was at a similar temperature to the ocean, especially north of Porto in association with the coastline trending west of north. It may have been the result of further freshwater input or forcing of the warm plume offshore by the northerly winds of the previous day and evening (more probably, in view of the association with coastal trend).

In December 1997, the pre-cruise satellite image showed SST 14-15°C close to the coast and the "Navidad" condition offshore with SST about 18°C; a broad (~ 100 km) band of warmer waters advected apparently from the south along the slope as far as Cape Finisterre. It is worth noting that during the cruise the corresponding SST was about 16°C.

For the period 23 December 1997 to 5 January 1998, the upper mixed layer varied from about 70 to 120m depth, bounded below by a pycnocline that existed in all water of depth 150m or more. The data tended to suggest some deepening during the cruise. There was just a hint of reduced mixed-layer depth over the mid-slope (600m and 1000m stations) suggesting some erosion by increased mixing below the mixed layer. Transmittance was less and fluorescence was enhanced in the mixed layer, suggesting continuing production.

Near the coast there was usually a plume of fresher, cooler water with lower transmittance and higher fluorescence. Exceptionally, on one "O" line this extended out to the 1000m station (1/1/1998). More often, the signal remained in deeper water as a slight salinity deficit throughout the depth of the mixed layer compared with the salinity just beneath.

The usual (Mediterranean water) salinity maxima were apparent between 900 and 1200 m; one profile (T2000) had two distinct maxima, at 930 and 1200 m. Below that, dissolved oxygen increased to

2000m indicating Labrador water.

Transmittance was usually reduced and optical backscatter increased near the bottom.

The temperature records from STABLE for 27 December 1997 to 14 January 1998 show a near-bed warming during the second half of the period. This indicates that the remaining previous summer's thermocline, above the bottom rig at the time of deployment, was mixed down to the bottom at this time.

The cruise period experienced poor weather and especially swell from a near continuous succession of storms over the Atlantic further north. The period from Christmas Eve 1997 to the first week of January 1998 was remarkable for the persistence of intense low pressure around Iceland and high pressure south of the Azores. Winds were therefore very strong in the whole northern north Atlantic. Hence the working area suffered very heavy swell from a spread of directions not usually aligned with the local winds. These conditions may well have contributed to the thermocline deepening.

(Task II.1.3)
The pressure sensor on STABLE shows a regular spring-neap tidal cycle, but this is not matched by analysis of the currents. The amplitude of the semi-diurnal tides is irregular through the record, and may reflect the rapidly changing stratification as the deepening thermocline neared the sea bed.

Discussion
The swath bathymetry from CD105 leg A proved very valuable for the choice of mooring sites, and in the subsequent P700 mooring deployment by enabling the ship to be steered towards an exact position for releasing the mooring. This bathymetry was far superior to other information available, which was found to be seriously inaccurate (by hundreds of metres) in some CTD station locations.

The UCG current meter line mooring may have been moved by fishing activity and it appeared that either a) the release mechanism jammed or the mooring was held down by damaged wire/instruments, or b) the mooring had too little buoyancy remaining for it to rise to the surface.

The pre-upwelling condition with depleted surface nutrients appears to have been well characterised.

Work Package III
Methods
POL led RRS Charles Darwin cruise 105 Leg A (29 May 1997, Lisbon to 9 June 1997, Vigo) which carried out multi-beam echo-sounding, associated side-scan and 3.5kHz sounding between 41°45′N and 43°5′N. This extended from the upper slope (typically 200-500m depth from 42°20′N to 42°40′N) to 10°6′W (typically 2500-3000m depth). Thus the intended coverage was achieved except for the uppermost slope and an extension west along 42°20′N towards Galicia Bank.

The Simrad EM12 Multibeam system used is a low-frequency multibeam echo sounder with full ocean depth capability. It has an angular coverage of up to 120° giving a maximum swath width of 3.5 times the water depth. The system is run with the 81 beams set for equidistant horizontal range. A sound velocity profile using the svp16 probe was carried out at the beginning of the cruise and, weather permitting, XBTs were carried out each day (eight in total were possible). The surface sound velocity probe (OTS) was installed prior to the cruise.

The multi-beam data were processed using the Neptune processing software suite, as supplied by SIMRAD and Geomatic. The software was used to remove spikes and erroneous sounding from the data set before it was processed to produce gridded depth files. Processed navigation from the RVS ABC was also fed in as part of the processing procedure. A 100m grid file was produced to cover the whole of the survey area; 50m grid files of shallower subsections in the eastern part of the survey area were also generated. A two times SD (standard deviation) statistical filter was used as part of the gridding process. The grids were then statistically smoothed using a custom regridding algorithm. The final smoothed 100m gridded files were then used to produce a variety of contour plots. The data were transferred to BODC who have produced a further variety of plots on request.

The 3.5kHz echo sounder uses a chirped pulse between 3 and 4 kHz. The return echo is then correlated to produce a paper record, annotated with the cruise number and the time. The sounder was run throughout most of Leg A, being switched on 0600 JD150 (30th May). Few problems were experienced.

Box cores involving scientists from UCamb and CFR were taken at various depths along 41°48′N and 42°20′N; Kasten cores at depths ~ 1100, 1600, 2700m along the former line and 1800m on the latter; no core was obtained on Galicia Bank. No suitable coring site near Canyon de Porto was identified. A NIOZ box corer was used. Initially, it over-penetrated; its travel length was reduced to prevent this re-occurring. On a couple of occasions, samples of rock were in the mud being cored; this caused some leakage in the seal at the bottom of the corer bucket. The Kasten corer was used with a four-metre barrel for most deployments.

Both corers oscillated in the vertical by a considerable amount on many deployments. Stopping and allowing the corer to stabilise close to the bottom did not cure these oscillations. The only practical option to overcome this problem was to lower the corer to the bottom slowly and to increase the payout speed to about 50 m/min as soon as the weight started to come off the cable. As soon as all the weight was removed the payout speed was reduced to 15 m/min for about 15 s and then the corer was immediately recovered. This procedure was tedious but necessary to prevent multiple penetrations or being pulled out of the bottom before it had fully penetrated.

Three days of adverse weather reduced the number of successful cores taken but had less effect on the bottom surveying.

(cf. Work Package II)
POL also led cruise CD 110 Leg A (23 December 1997 to 5 January 1998) which carried out sea-bed work. Four sets of multi-cores were obtained (from the five stations undertaken). The tubes obtained were apportioned: three to the University of the Algarve who carried out the work on board, one to the University of Bordeaux. Except for one of the cores that was immediately sectioned into 1-cm slices and frozen for aminoacids studies, the others were stored in the cold room at 5°C. The only successful Kasten core station was W90, where a 77 cm core was obtained. It was described and sub-sampled on board, being cut at the middle into two equal parts; half of the core was stored at 5°C, for X-ray analyses of internal structures (University of Bordeaux). The other half was sampled in the following way: a small amount, for humidity calculations from each cm down to 20 cm and below that each 5 cm until the end of the core (Univ. Bordeaux). For aminoacids and granulometric and compositional studies of the sedimentary column (Univ. Algarve) samples were taken each 5 cm.

Sea-bed photographs were taken with a bed-hop camera at three coring sites. The POL 35m bed-hopping camera was used; the films were taken as soon as coring activities finished. Sea-bed exposures were curtailed at W300 because severe ship motion prevented the satisfactory reception of the pinger signals which indicated contact with the sea bed. It had been hoped to use the camera more often, particularly at the STABLE site; however, a heavy swell, at times reaching 8m approximately, precluded over-side activities with heavy equipment for much of the cruise. Instead, there was extensive sampling with a Shipek grab over the Spanish shelf sector. The collected samples were stored in plastic boxes for future compositional and granulometric analysis, in order to identify the origin of the sediments deposited in this shelf, and compare them with the actual supply. In some stations it was necessary to repeat the sampling because the grab came empty or without enough material for the analyses. In several places, due to inappropriate sea conditions, it was not possible to collect any sample even after three attempts.

(Task III.1.2)
Mooring work primarily amounted to deployment of STABLE, in 202m water, position 42°40′41″N,

09°30′30″W at 1117 GMT on 27th December 1997. STABLE measures near-bed turbulent phenomena and associated sediment resuspension using electromagnetic current meters, a pressure sensor and acoustic backscatter sensors. Mean transport phenomena and near-bed shear are measured using a rotor stack and a vane. Four simple settlement tubes collect falling paticles; other sensors measure average water depth, heading, pitch, roll and temperature. (STABLE was successfully recovered on CD110 leg B).

39 CTD profiles were obtained; with the CTD were transmittance (× 2) and optical backscatter (amongst other variables). The cruise was adversely affected by poor conditions: mooring work or coring were only possible on three days out of 12 in the working area; CTD profiling less than half of the time.

Plans are in progress for the second deployment of STABLE during RRS *Charles Darwin* cruise 114 (29 July to 24 August 1998).

(Task III.1.6)
The POL model of SPM diffusion and settling (only) in the cross-slope section (as used in OMEX II-I; Amin and Huthnance, 1998) proceeds by iteration. This numerical procedure is equivalent to discretised time-stepping. The equivalence has been demonstrated in an example calculation with a surface source showing material sinking successively deeper after 5000, 10000, … successive iterative (time) steps.

A 2-D cross-slope form of a 3-D primitive equation model (prognostic with explicit evolution of turbulence parameters; Xing and Davies, 1996) has been used to study processes influencing bottom boundary layer mixing over the continental shelf and slope. Internal tides over a typical shelf edge profile were investigated using both 2-D and 3-D models. In particular, in 2-D form a SPM transport module has been developed and incorporated. For the example runs hitherto, the sediment pick-up function was

$$E_s = \alpha[u_*^2/u_{*c}^2 - 1]^{3/2}$$

with $\alpha = 0.1$, $u_{*c} = 0.0025$ m/s. A settling velocity 0.0001 m/s was used.

Results
The temperature records from STABLE for 27 December 1997 to 14 January 1998 show a near-bed warming during the second half of the period. The amplitude of the semi-diurnal tidal currents is irregular through the record, and may reflect rapidly changing stratification as the deepening thermocline neared the sea bed.

The CTD profiles from CD110 showed that transmittance was usually reduced and optical backscatter increased near the bottom.

The cruise period experienced poor weather and especially swell from a near continuous succession of storms over the Atlantic further north. The period from Christmas Eve 1997 to the first week of January 1998 was remarkable for the persistence of intense low pressure around Iceland and high pressure south of the Azores. Winds were therefore very strong in the whole northern north Atlantic. Hence the working area suffered very heavy swell from a spread of directions not usually aligned with the local winds.

(Task III.1.6)
Comparison of the 2-D model of bottom boundary layer mixing with the results of a 1-D model shows the importance of the coastal boundary condition and the variation of the slope between continental shelf and slope. Upwelling or downwelling bottom flow modifies the density which in turn modifies the along-slope current above the boundary layer significantly, effects omitted in 1D.

The internal tide enhances the bottom stress, which in turn has a significant effect on the resuspension of bottom sediment and sediment transport over the shelf and slope, for the critical shear velocity value used (corresponding to fine non-cohesive material).

Discussion
Swath bathymetry with coring at the end of the swath lines on CD105 proved to be a good combination with (in this case) an approximately daily cycle being following during the first six days of good working conditions.

The swath bathymetry and 3.5kHz sounder proved very valuable in searching for suitable coring sites with gentle slope and soft deposited sediment. This bathymetry has revealed a very steep upper slope, often exceeding 10% in the depth range 400 to 1000m, indented with many canyons, scale of order 1 km with even steeper sides.

A finding of pinnacles at "P50" (which will have to be omitted from future cruise plans) illustrates a few residual problems of uncertain bathymetry in the area of the OMEX grid.

The "NIOZ" box corer gave several good cores but was not ideal; the circular-cylinder "box" soon lost its shape, although not seriously; the seal by the spade seemed rather prone to disturbance; there was little margin for deploying this large corer (high with a long base) through the slightly offset space available below the starboard gantry on RRS *Charles Darwin*.

The Kasten corer at the bottom of a length of paid-out cable has a natural vertical oscillation which is only slightly damped. There was evidence from basic calculation and the winch tensiometer readings that with 2-3 km of wire out this oscillation had a period of about 4 s and thereby the Kasten corer was exaggerating the vertical motion of the ship. It appeared to "bounce" during several coring attempts. Means of damping the natural oscillation might be considered; it is probably difficult to avoid altogether.

One particular attempt at coring near a corner of the steep upper rim of a canyon exposed the difficulty of sufficiently precise positioning in varying wind and drift when the target area is small - scale O(100m) at 300m depth in this case.

The analysis of STABLE records for near-bed stress should be of interest in the apparent context of variable stratification sufficient to affect the amplitude of the tidal currents so that a spring-neap cycle is not recognisable. This winter period was also notable for large swell which may contribute to near-bed stress.

For the hitherto steady-state SPM diffusion/settling model, plans are to focus on the bottom boundary layer as well as adding time-dependence. For the prognostic bottom boundary model with SPM, plans are to apply to the realistic context of OMEX to explore SPM dynamics, and in due course to extend to including a density effect of SPM and to 3D.

Work Package IV
Hitherto the principal POL contribution has been to co-ordination in a general sense. This includes work preparatory to the two cruises, as outlined in the *Introduction* section: sea-bed mapping (notably swath bathymetry) and the design of mooring and CTD/sampling arrays. By assuming the principal scientist role on the first OMEX II-II cruise, an active part was played in putting these integrating aspects into effect. The first workshops of Work Packages I, II (Paris, November 1997) and III (Faro, April 1998) have all been attended and at the former presentations were made outline WPIV and the role of all OMEX partners therein.

With regard to the substantive work in the six scientific tasks of WPIV, tasks 4 to 6 only commence at month 13 or later, and the work of tasks 2 and 3 in the first year concerned intercalibrations and conclusions about the practical applications of techniques. An overview of progress has been maintained and is summarised in the WPIV overview report.

Task 1 concerns water budget and circulation. Progress with the moorings and water mass analyses is reported here and by UCG, IH and NIOZ-b. A workshop for all the physics partners (ie. those concerned with this task) is being planned for summer 1998, probably at POL or UWB. Hitherto, this is the WPIV task benefiting most directly from the preparatory design of mooring and CTD/sampling arrays.

References

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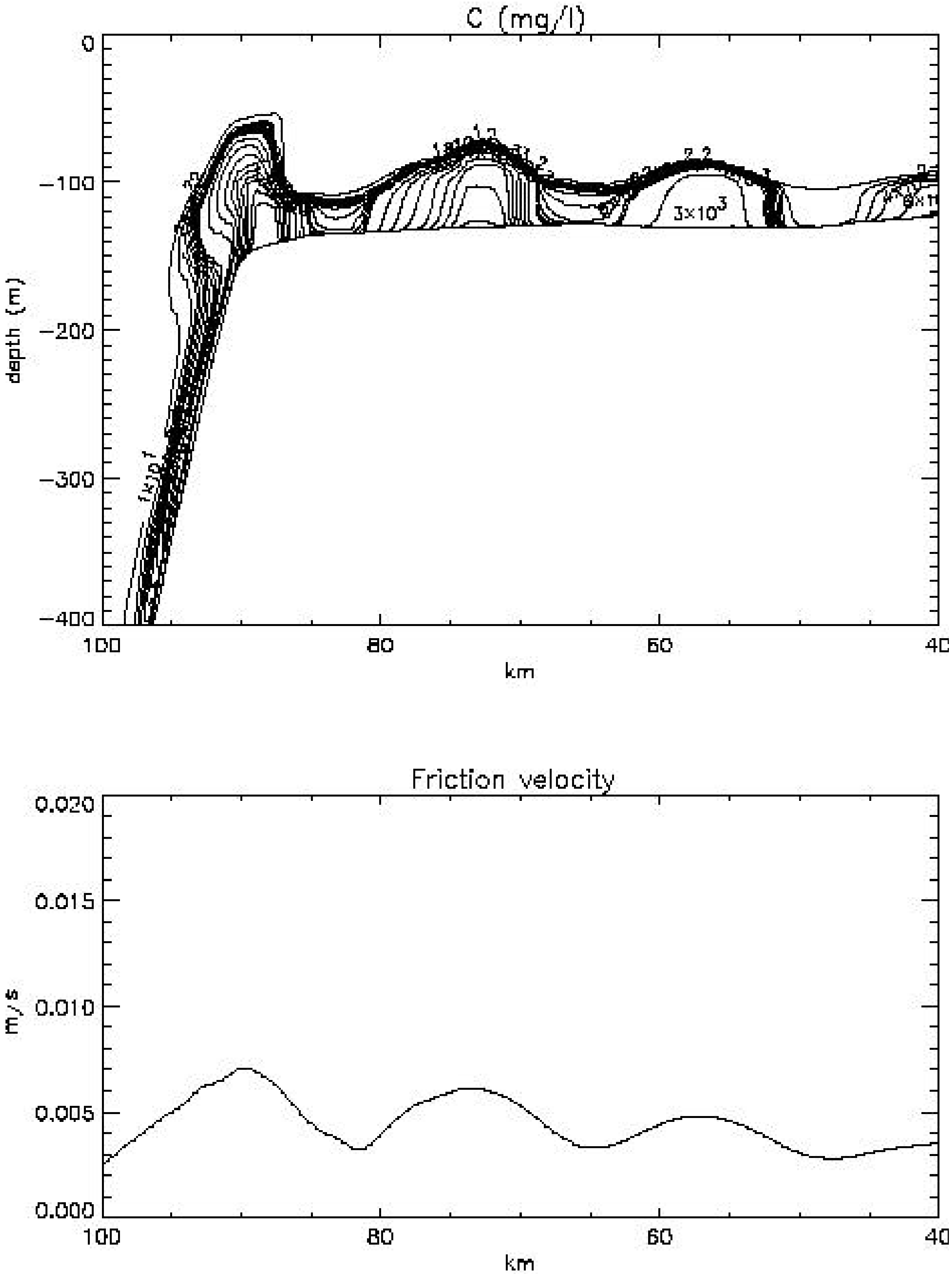

An example 2-D prognostic model calculation showing instantaneous suspended sediment concentration (top) and friction velocity (bottom) in the presence of internal tides over the shelf and upper slope.