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WFP Ref. No.: AR12
Project: VIVALDI '91
Principal Scientists: R. T. Pollard
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Ship name: RRS Charles Darwin
Cruise No.: Cruises 58 & 59
Dates: 25 Apr-16 May; 18 May-10 Jun 1991.

ABSTRACT

Vivaldi was conceived as a series of seasonal surveys of the NE Atlantic. The Vivaldi '91 trial combined the high spatial resolution of SeaSoar surveys with deep CTD stations spaced every 3 degrees of latitude on the tracks 300 km apart. These primary measurements were complemented by a shipboard acoustic Doppler current profiler, chlorofluorocarbon tracer chemistry, Oxygen, nutrient and chlorophyll measurements, and mean surface meteorology.

The aims of Vivaldi are to:

* calculate seasonal upper ocean heat and fresh water budgets* map isopycnic potential vorticity variations from the sub-tropical gyre to the subpolar gyre* map interannual changes in the properties of water masses formed by deep convection* calculate statistics of upper ocean parameters and air sea fluxes* investigate the role of eddies

Scientific Personnel

Cruise No.: 58

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Cruise No.: 59

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NARRATIVE

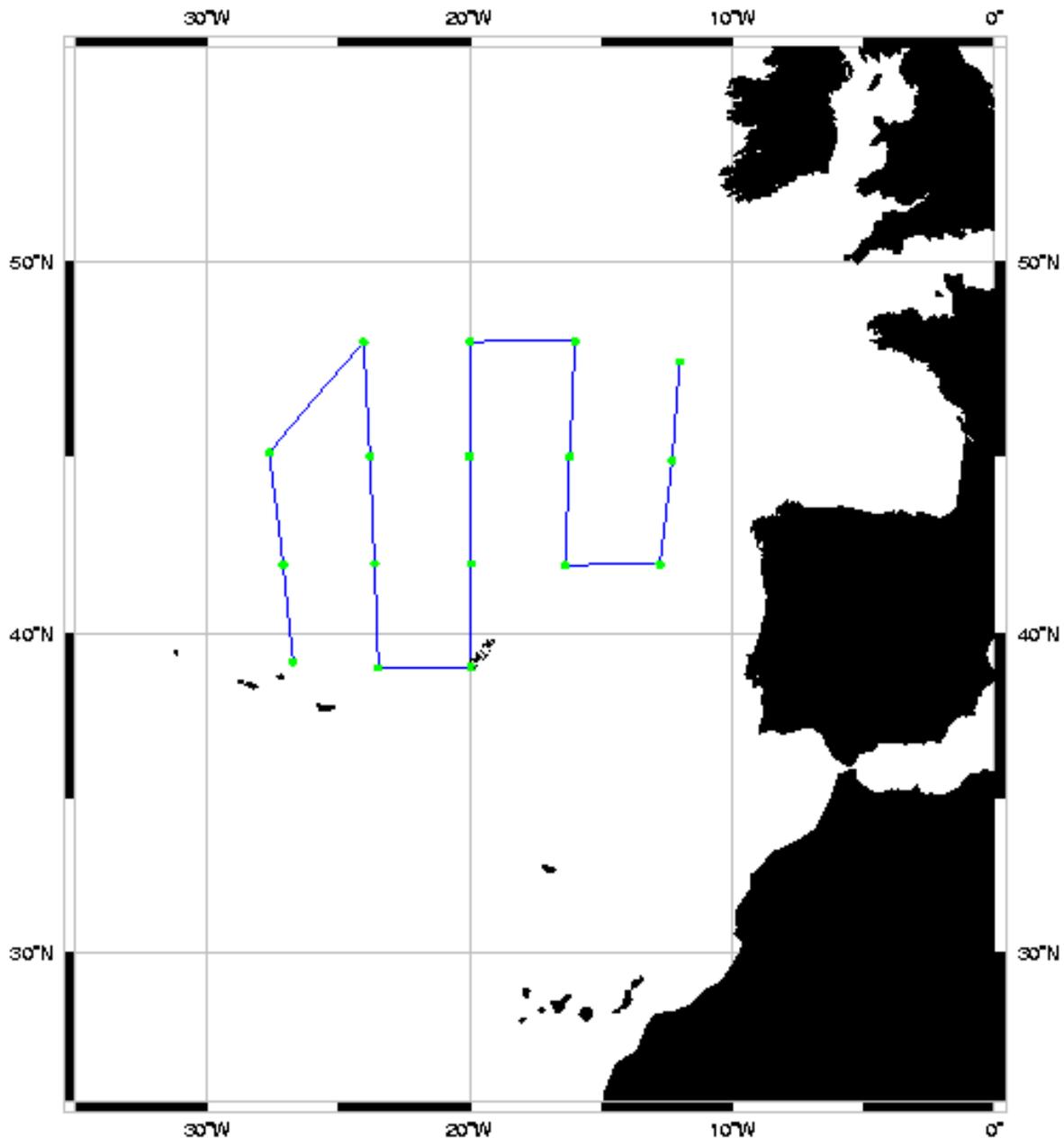
As a major contribution to the UK WOCE effort Vivaldi was conceived as a series of seasonal surveys covering the NE Atlantic. In order to obtain both spatial coverage and high resolution a plan was developed in which nearly

north-south SeaSoar sections, spaced 300 km apart relative to longitude 20 W as origin, would be complemented by deep CTD stations every 3 degrees of latitude.

Vivaldi'91, Charles Darwin Cruises 58 and 59 together, represents the first attempt to carry out a systematic survey as suggested by the Vivaldi concept. It was decided to carry out the survey given the time and season available in two parts, first a southeastern part from Barry to Ponta Delgada (Cruise 58) and then a western and northern part (Cruise 59) from Ponta Delgada back to Barry. The position of the deep CTD stations was in theory defined by the formula enunciated above. However because some of the theoretical positions were in untypically shallow water it was decided to move these into adjacent deeper water so that the deep water would also be sampled.

Cruise 58

Station locations for AR12 POLLARD : AR12_C



Sailing from Barry was delayed by over 12 hours because of an RVS management ban on weekend working. RRS Charles Darwin passed through the lock at 0600Z/25 April (all times will be expressed in GMT) and

set course for the first station position. The ADCP was calibrated from 0230-0600/26 April by a series of 90 course changes at 20 minute intervals with the ADCP in bottom track mode on the continental shelf. A trial CTD cast at 1030 revealed a number of problems, most serious of which was that the lanyards supplied with the new 10 litre water bottles were the wrong length. A second trial cast was therefore undertaken at 1400. The casts were numbered CTD 11v01 and 11v02. The first '1' signifies the year 1991 and the second '1' signifies the first Vivaldi cruise in that year. Thus the second leg (Cruise 59) will have numbers in the series CTD12...

After each of the CTD stations, a zoological net was cast on the starboard side using a small kevlar winch and with the block held on the crane. Minor problems were corrected after the first cast and the procedure was followed after every CTD cast throughout the cruise. Later in the day (1836/26 April) the SeaSoar was deployed for a two-hour trial run, using the RVS-supplied block.

Vivaldi leg B

The first full depth CTD (11v03) in the Vivaldi series was begun at 0252/27 April at position B48. The numbering scheme signifies a cast online B at 48N. Five sections were to be occupied on Cruise 58. The sections were nearly north-south runs, parallel in the sense of being 300 km apart, with the third leg along 20W exactly north-south. Each leg was identified by a letter of the alphabet, with the first leg being leg B. CTD positions were nominally at 3 intervals of latitude, at 39, 42, 45 and 48 N. The exact positions were adjusted usually by no more than a few miles to maximise the water depth available and avoid known seamounts. The first cast was moved more than a few miles from its nominal position at 48 N however, to 47.5 N, to reach deep water well south of the Celtic Shelf edge.

After the CTD cast, the SeaSoar was deployed for the passage from B48-B45 (SS11001). The block was changed to the IOS supplied U-shaped sheave so that (a) a length of chain could be removed, (b) the RVS block could be built up on its cheeks to ensure that the wire could not jam down the sides of the cheeks. The SeaSoar run was historic, with the SeaSoar profiling for the first time to 500 m. It ended at 0222/28 April when course was altered downwind to recover SeaSoar. With the IOS block outboard, quite a few individual fairings snapped.

During deployment of the CTD (CTD 11v04, B45) the roller fitted to the A-frame was not freed from its stowed position. It sprang free suddenly, which jarred the CTD and led to poor quality data on casts 11004 and 5. After changing the stern block back to the RVS one, the SeaSoar was deployed from 1829 for run B45-B42 (SS11002). Good speeds were attained, the SeaSoar preferring speeds of 8.5 - 9 knots to provide the lift needed to raise the extra weight of cable. This compensated for the time on station, which was rather longer than had been allowed.

After CTD 11v05 (B42) it had been intended to continue south to 39N, but with time lost before sailing, a slight underestimate of the meantime between stations, and the need to allow at least a day for bad weather, it was reluctantly decided that stations B39 and A39 would have to be abandoned for this Vivaldi trial. The SeaSoar was therefore deployed to run west towards A42, but had to be recovered after little over an hour because of electronics failure. The problem was quickly shown to be leakage in a blanking plug, but it was decided not to redeploy the SeaSoar, but to steam on to the next station. It was a blow to have to lose this 42 N section, which would have repeated a section occupied in the two previous years. However, in the context of Vivaldi it was the right decision, as it enabled the CTD to be fully checked out during the passage run. It had given very noisy data on cast CTD 11v05. Although no fault was found, aboard must have been shaken loose when the frame was jarred, as the noise disappeared after disassembly and reassembly.

Vivaldi leg A

Stations A42, A45 and A48 (CTD 11v06-8) were occupied between 30 April and 2 May, with SeaSoar runs (SS11003-5) in between. During this period problems in both CTD and SeaSoar systems were gradually traced and corrected, but the consequent strain, particularly on the senior electronics engineer, Pat Gwilliam, was high.

During SS11003 (A42-A45) the SeaSoar was recovered because of a noisy signal, traced to a noisy fluorometer lead. The ship steamed on during repair (1337-1448/30 April). After deployment for run A45-A48 the SeaSoar would not respond to command and leaky hydraulics were stripped off at either the stem block or the roller at the lead onto the winch. The former was caused by swinging of the stem sheave, which was reduced by welding a bar across it to give greater control. The latter was caused by the metal stoppers on the

cable catching on the edge of the roller when the cable lead was at angle. This happened when the wire was full out as the winch was mounted somewhat to port of the centre line of the ship. On recovery at A48 brooms were used to turn the fairing upwards as it led onto the blocks. The A-frame was held inboard so that the stern block could be reached. A great reduction in fairing damage was noted. Once inboard, it was found that the bottom tail-plane was missing and the impeller blades bent. The loss was most probably due to fatigue, and explained the rather poor maximum depths attained during the preceding run.

Vivaldi leg Z-20 W

Leg Z was completed between 3 May and 6 May from 48 N to 39 N. CTD casts were CTD 11v09 -11v12, and SeaSoar runs SS11006-8. Weather was good throughout. Because 20 W was the 'master' section, some extra time was allowed to run up to each CTD position before recovering SeaSoar and to position the ship prior to deployment so that the SeaSoar would be deployed and profiling by the time the CTD position was reached again. This added about 30 minutes to manoeuvring time at each station.

During leg A, careful examination of salinities, oxygens and nutrients from the 101 24 bottle multisampler had led to the definite conclusion that the bottles were not firing consistently at the depths at which they were triggered according to the deck unit. Salinities provided the most accurate evidence, so from CTD 11v10 (Z45) onwards salinities were drawn from every bottle (previously samples had been drawn from alternate bottles for CTD calibration). This proved that two bottles were firing at some depths and none at others. After CTD11v11 the multisampler was stripped down, minor seawater damage repaired, and the firing pin position retarded. Double firing was still apparent. After CTD11v12, the multisampler was again stripped down and the firing pin advanced carefully to the midpoint between firing positions. thereafter, near-perfect firing was achieved for the rest of the cruise. The conclusion is that, on a 24 bottle multisampler, with only 15 between firing positions, setup is critical, given that there is some play in the pin turning mechanism.

At the end of SeaSoar run SS11007 (45-42 N) there was some swell and the nose of the SeaSoar slammed into the stern in the final moments during recovery. The fibreglass nose was squashed and the bolts holding the weight sheared off, but no further damage was apparent. Recovery at Z39 at

the end of the next run was much easier running with the wind but kept a little on the quarter to reduce pitching. Ideally, both deployment and recovery should be made running with the wind and the ship speed should be quite high, 4 quickly increasing to 7-8 knots on deployment and 6 knots dropping at a late stage to 4 knots on recovery. For run SS11009 (Z39-Y39), the course was westward running into wind. Considerable pitching made deployment difficult when the faired cable went slack and threatened to foul the safety rails. During run SS11009 trials with varying cable went slack and threatened to foul the safety rails. During run SS11009 trials with varying cable lengths were done which confirmed previous calculations. A sea anchor was also tested for drag efficiency.

Vivaldi leg Y

The fourth leg was occupied from 7 May to 11 May, with CTD casts 11v13-16 at Y39, Y42, Y45 and Y48. The SeaSoar runs inbetween were numbered SS11010-12. With so little time lost to bad weather, it was possible to continue the manoeuvring described above to avoid any gaps in SeaSoar data just before and after each CTD cast.

Before recovery at position Y42 a metal guide (ploughshare) was fitted to the travelling arm of the SeaSoar winch which laid the fairing correctly so that it could not foul the next turn. In addition to being safer and reducing by one the number of people needed during recovery, the guide saves time, avoiding the two or three occasions on each recovery when wire has to be paid out to clear fouled turns.

With so little bad weather, it was possible to make time for the main trawling warp, damaged on a previous cruise, to be ditched after CTD11v16 (Y48). This took 5.5 hours (0533-1105/11 May), including the time needed to draw all samples from the multisampler, strip and stow the bottles and cover the multisampler to avoid damage or grease contamination during the wire cutting operation using the starboard A-frame.

Vivaldi leg X

After the main warp had been ditched, the SeaSoar was deployed (1105-1131/11 May) to run west from Y48 to X48. During this run, the wind increased to force 6 overnight. By 1000/12 May it was decided that it would be impossible to hold station for the next CTD cast at X48, so there was no

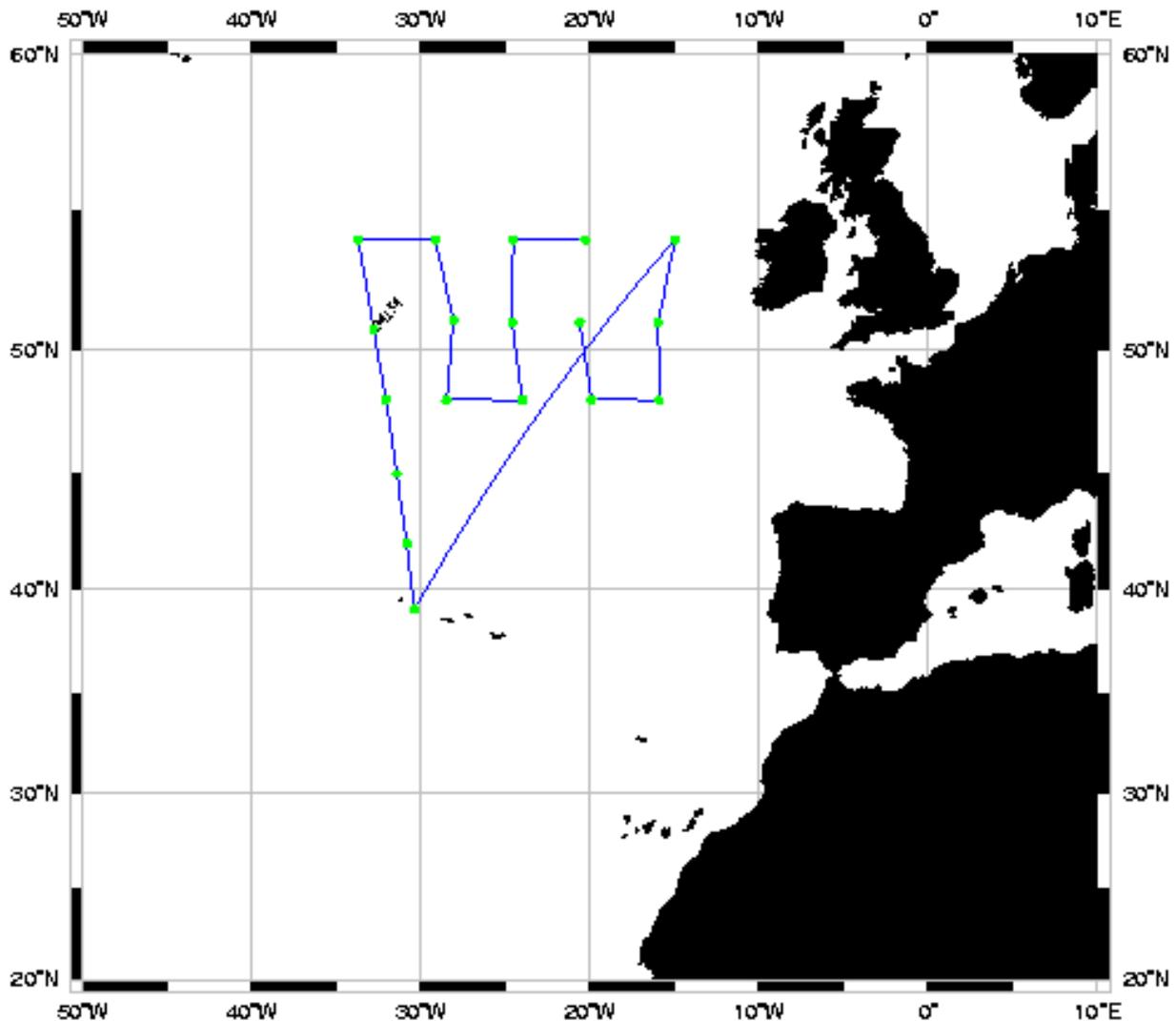
point in risking damage to the SeaSoar by recovering it in marginal conditions. The wind was southwest, putting it on the port side during the westward run, but the starboard side after turning south. The multisampler was therefore made more secure, the bottles removed and all gear stowed or lashed before the course change at 1122/12 May.

The weather had eased considerably by the time SeaSoar was recovered at X45 (0947/13 May) for CTD11v17. The SeaSoar runs from X48 to X39 (SS11014-16) were without incident apart from the poorer minimum depths attainable while the ship speed was reduced to 6-7 knots during the bad weather. The final CTD casts CTD (11v17-19) went smoothly, except that the fluorometer fouled at the start of CTD11v19 during the first minutes of the cast. The CTD was brought to the surface, during which time the fouling cleared, and the cast restarted.

After all bottles had been sampled after the final cast, a zigzag ADCP calibration run was completed from 1740-2042/15 May, before course was set for Ponta Delgada. RRS Charles Darwin berthed at 0915 on Thursday 16 May at the end of a very satisfactory Vivaldi trial cruise.

Cruise 59

Station locations for AR12 LEACH: AR12-D (GBR)



The second leg of Vivaldi '91, Charles Darwin Cruise 59, began in Ponta Delgada, Azores, on Saturday 18 May 1991 when the ship set sail at 1000. We steamed directly to the first station, W39, where at 1110 on the 19th, after the first CTD and net station (CTD 12v01), we began SeaSoaring northwards along section W. Station W51 (CTD12v05) on 23 May seemed to

be positioned directly on the Polar Front, which marks the boundary between the Subtropical and Subpolar Gyres. A peregrine falcon and several housemartins were observed here. At 2131 on 24 May we reached the northern end of Section W at Station W54 (CTD12v06). From there we steamed east to Station X54 and then south to X48. During the section east the SeaSoar conductivity cell 1 finally failed completely explaining the increasingly problematic salinities of the last day or so. At the recovery of the SeaSoar at Station Y48 on 29 May the towing cable was caught in the side of the block and needed reterminating. From there we steamed north again. At Station Y51 (30 May) the very first test of the IOSDL EG&G MKV CTD was made in a double station (CTD12v011 12) in 4002 m of water. From Station Y54 (31 May) we steamed east to Z54 (1 June) and then south along Section Z (20W). Station Z51 many pilot whales and dolphins were observed close to the ship. On the 4th at Station Z48 the bench in the wet laboratory flooded due to surplus water from the non-toxic supply not draining away and damaged the through-flow fluorometer so that it had to be replaced by an older model. On leaving Station A48 (5 June) as the SeaSoar was being deployed in heavy seas the towing cable became jammed in the side of the block and need reterminating. Then we were able to tow off northwards. On the 6th June at Station A51 (CTD12v20) bad weather developed while the CTD cast was in progress. As a result the ship remained hove to until 0400 7 June after which SeaSoaring was resumed and Section A continued northwards. The last station (A54, CTD12v21) was finished by 0530 8 June, after which we set sail for Barry.

Final remarks

For the first time the IOSDL SeaSoar CTD was equipped with two conductivity cells to help with the problem of correcting the salinity when the conductivity cell fouls. Although this modification helped to some extent it did not solve the problem, which was particularly acute in frontal regions with high TS-variability.

At all CTD stations hauls were made with plankton nets from 100 m depth and at most stations on Leg 2 from 300m-450m as well.

During Leg 2 an air sampler mounted forward was used when the wind direction and speed were appropriate to collect aerosols.