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## **CRUISE REPORT FOR THE SUBDUCTION EXPERIMENT**

Chief Scientist: Robert A. Weller, Woods Hole Oceanographic Institution  
Cruise: Oceanus 240 leg 3  
Dates: June 17, 1991 to July 5, 1991  
Ship: R/V oceanus  
Port of call: Funchal, Madeira to Ponta Delgada, Azores

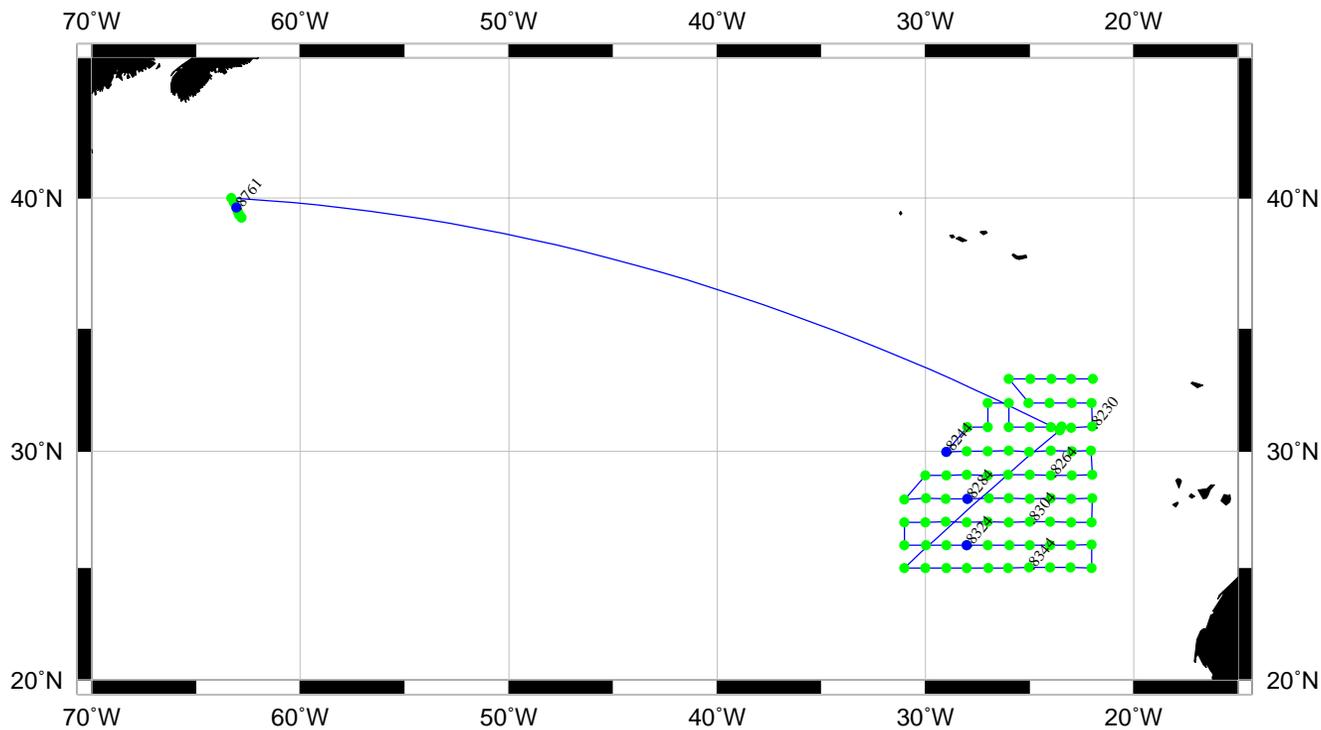
### **OVERVIEW**

R/V Oceanus cruise number 240, leg 3 departed Funchal, Madeira on 17 June 1991 to deploy five surface moorings as part of the Office of Naval Research (ONR) funded Subduction and ASTEX Experiments. This cruise involved both personnel and equipment from the Woods Hole Oceanographic Institution (WHOI) and Scripps Institution of Oceanography (SIO). While transiting between moorings sites hourly XBTs and half hourly meteorological observations were taken. The five surface moorings that were deployed are intended to stay on station for a period of eight months at which time they will be recovered and replaced with new moorings. Table 1 contains the mooring positions and deployment times. A total of 88 recording instruments were deployed on the five Subduction moorings. There are 9 meteorological packages, 32 current meters, 54 temperature data loggers, one Acoustic Doppler Current Profiler and one conductivity data logger. The schedule is to replace the moorings in February and October 1992 and then recover them in June 1993.

### **SCIENTIFIC GOALS**

Subduction is the mechanism by which water masses formed in the mixed layer and near surface layer of the ocean through air-sea interactions find their way into the upper thermocline. The basic idea that fluid in the ocean's interior originates at the sea surface is an old one, dating from Iselin and Montgomery in the late 1930's, but only recently have simple models begun to provide a framework for a dynamical understanding of the processes involved in subduction. In essence, the study of the subduction processes and mechanisms involved an understanding of the complete three-dimensional circulation in the upper ocean and the coupling of the mixed layer to the interior of the ocean. The work proposed under the auspices of the Subduction ARI will attempt to understand subduction and its underlying mechanisms through a combination of Eulerian and Lagrangian measurements of velocity, measurements of the tracer distributions and hydrographic properties and modelling. Measurements will be made on synoptic scales in frontal

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regions as well as on larger scales appropriate to the structure of the quasi-steady wind-driven and thermohaline circulation.

The large scale structure of the surface wind and thermal forcing and the upper ocean response will be observed by a moored array of surface meteorological packages, current meters and acoustic doppler profilers. The meteorological data collection is supported jointly by the Subduction and Atlantic Stratocumulus Transition Experiment (ASTEX) programs.

**TABLE 1:** Subduction Mooring Deployment and Positions

Buoy	Mooring #	Deployment	Time (UTC)	Position (GPS)	
NE	914	18-JUN-1991	16:42	33 00.07N	21 59.75W
C	915	23-JUN-1991	00:26	25 31.90N	28 57.17W
SW	916	25-JUN-1991	13:12	18 00.03N	33 59.96W
SE	917	29-JUN-1991	01:37	18 00.13N	22 00.00W
NW	918	03-JUL-1991	13:23	32 54:61N	33 53.50W

## PERSONNEL

<b>Robert A. Weller,</b>	<b>Chief Scientist (WHOI)</b>
Jeff Sherman	(SIO design engineer)
Richard P. Trask	(WHOI research specialist)
Nancy J. Pennington	(WHOI senior research assistant)
Gennaro H. Crescenti	(WHOI meteorologist)
Bryan S. Way	(WHOI engineering assistant)
Paul R. Bouchard	(WHOI engineering assistant)
William Ostrom	(WHOI senior research assistant)
Neil McPhee	(WHOI engineering assistant)
Stephen Abbott	(SIO development technician)
Glenn S Pezzoli	(SIO development technician)
Christine Murray	(SIO development technician)

## WATER SAMPLING AND UNDERWAY MEASUREMENTS

Water samples were collected near the Central mooring position for Jim Ledwell (WHOI). Since there was no hydro wire on board the ship a reel of 1/4" kevlar was wound on the TSE mooring winch. Nine depths had previously been marked on the kevlar where Niskin bottles were to be placed. The Kevlar was deployed with a weight off the stern and Niskin bottles were attached at the appropriate depths (50, 100, 150, 100, 250, 300, 350, 400 and 450 meters). The Niskin bottles were tripped at 0135 UTC on 23 June 1991 at

position 25°32.817' N, 28°55.498' W. The surface wire angle at the time the samples were collected was measured to be approximately 30 degrees.

Meteorological observations of air temperature, relative humidity, relative wind speed and direction, ship's speed and direction, barometric pressure and sea surface (bucket) temperature were recorded every 30 minutes while underway.

After leaving Madeira on June 19, while enroute to the Central mooring site and throughout the remainder of the cruise hourly XBTs were taken. The data was logged on a PC using a Spartron of Canada Ltd. XBT processor card. The type of XBTs were Sippican T-7 probes, which provide temperature data to a depth of 750 meters. XBTs were not launched when within approximately 10 miles of a mooring site.

## **CRUISE TRACK AND MOORING STATIONS**

Leg 3 of Oceanus cruise number 240 departed Funchal, Madeira on June 17th, 1991 at 0714 UTC to deploy five surface moorings for the ONR funded Subduction and ASTEX Experiments.

During the transit to the NorthEast mooring meteorological observations were recorded every 30 minutes. The first mooring to be deployed was the NorthEast mooring at position 33N, 22W. Upon arrival at the site a depth survey was conducted. The bottom was found to be relatively flat with the mooring site having a corrected depth of 5264 meters. (Throughout the depth surveys, mooring deployments, and subsequent acoustic release/anchor surveys, GPS was used for all navigation.) The mooring deployment began 7 nautical miles downwind (southeast) of the target. The near-surface instrumentation were deployed first followed by the surface buoy and the remainder of the mooring. Careful attention was paid to the target site so as to get the anchor as close to it as possible. The anchor was deployed at 1642 UTC on 18 June 1991. Following the 7.5 hour deployment an acoustic release/anchor survey was conducted. Based on this survey the GPS anchor position for the NorthEast Subduction mooring (WHOI mooring number 914) is 33°00.07'N, 21°59.75'W. During the anchor survey the ship was positioned 1/4 mile downwind of the surface buoy and measurements of sea surface temperature, air temperature, relative humidity, barometric pressure, wind speed and direction were made every 5 minutes for 30 minutes. The ship's position at the start of the meteorological observations was 32°59.362'N, 22°00.151'W.

Following the anchor survey the ship returned to Madeira to load equipment that could not get during the first part of the cruise. One toroid surface buoy and three anchors with flip plates and seven wire baskets were loaded in Madira. During the loading of the wire baskets the doing they damaged the VAWR and one solar panel on the southeast toroid surface buoy. The wind speed and direction head on the VAWR was replaced with a spare as well as the damaged solar panel. Upon completion of loading and fueling in Madeira the ship departed at 2000 on 19 June 1991 enroute to the Central mooring site.

While enroute to the Central mooring site and throughout the remainder the cruise hourly XBTs were taken starting at position 31,17.67N, 19,16.37W. In addition to collecting XBT data, the half hour meteorological data was again logged. Oceanus arrived at the Central Subduction mooring site at 1030 UTC on June 22, 1991. The depth survey was started upon arrival. The original proposed mooring site (25.5N, 29W) was found to have an irregular sloping bottom and a decision was made to move the site to the northeast about 5 nautical miles where the bottom is flat and uniform. Oceanus moved to a position 7 miles down wind (southwest) of the new mooring site in preparation for starting the mooring deployment. The mooring deployment work lasted 10.5 hours. The anchor was finally deployed at 0027 UTC on June 23, 1991. The acoustic release/anchor survey for the Central mooring (WHOI mooring number 915) was completed. The surveyed GPS anchor position is 25,31.90N, 28,57.17W which has a corrected water depth of 5670 meters. Immediately following the mooring deployment water samples were collected for Jim Ledwell (WHOI). Prior to leaving the Central mooring site the Oceanus was positioned 1/4 mile down wind of the surface buoy. Shipboard meteorological observations were logged every 5 minutes for 30 minutes using the same procedures as were used for the NorthEast mooring. These intensive meteorological observations were made at 25,31.53N. 28,57.91W.

Oceanus arrived at the SouthWest mooring site at 2330 UTC on 24 June 1991. A depth survey of the site was begun immediately. The original mooring site and the area around it was found to be relatively flat with a corrected water depth of 5307 meters. The ship was positioned 6 miles downwind of the proposed mooring site and preparations were made for the deployment of the SouthWest Subduction mooring. The procedure used to deploy the SIO toroid mooring was nearly identical to that used to deploy the discus moorings. The mooring deployment lasted 8.5 hours. An acoustic release/anchor survey was conducted. based on the results of this survey the GPS anchor position for the Southwest Subduction mooring (WHOI Mooring number 916) is 18,00.03N, 33,59.96W.

Oceanus arrived at the SouthEast mooring site at 1835 UTC on June 28,1991. A depth survey was conducted and the bottom was found to be relatively flat with the proposed mooring site (18N, 22W) having a corrected depth of 3295 meters. Following the depth survey the ship was positioned 4 nautical miles down wind/down swell to a position south southeast of the site. the mooring deployment lasted 5.5 hours. The ship remained near the buoy for several hours before moving off to conduct the anchor survey. The results of the survey indicated the GPS anchor position for the Southeast Subduction mooring (WHOI mooring number 917) was 18, 00.13N, 22,00.00W.

While enroute to the North West mooring site the Oceanus passed by the Central discus mooring for a brief inspection and collection of shipboard meteorological observations. The ship arrived at the Central mooring at 0620 UTC on July 1,1991. Prior to getting on station the buoy was detected on radar approximately 7 miles away and the marine lantern could be seen 4 miles away. While on station shipboard meteorological observations were taken every 5 minutes for 45 minutes. Since everything appeared functional the ship was again underway for the NorthWest site by 0730 UTC. The ship arrived at the NorthWest site on 3 July 1991 at 0030 UTC. A depth survey was started as

the ship arrived at the site and it was soon evident that the bathymetry was extremely irregular and considerably shallower than had been expected. After a detailed radiator pattern survey, a new site was chosen. The corrected water depth at the new site was 3607 meters. The ship was then positioned at the site. since there was little weight under the buoy when first deployed it had a greater tendency to rattle than did the other toroids. the anchor was kicked over at 1323 UTC in 5608 meters of water. the final mooring deployment lasted 6 hours. shipboard meteorological observations were every 5 minutes for 30 minutes while the ship remained about 1/4 mile downwind of the buoy. the VAWR data telemetry was compared with shipboard observations and everything appeared operational. the GPS anchor position for the NorthWest Subduction mooring (WHOI mooring number 918) is 32,54.61N, 33,53.50W.

Following the anchor survey the ship headed for the Azores, arriving Ponta Delgada on 5 July 1991 at 0828 UTC.