RV POSEIDON 516
Cruise Report / Fahrtbericht

Ponta Delgada (Azores) 29.07.2017

Ponta Delgada (Azores) 18.08.2017

POS516 – ENERGY TRANSFER

Maren Walter & the scientific party of POS516:

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Table of Contents

1. Cruise summary / Zusammenfassung

Summary
The RV Poseidon cruise 516 (POS516) is part of the observational program of the TRR 181 'Energy Transfers in Atmosphere and Ocean', and focussed on the energy transfer by low-mode internal waves. The goals of the cruise were to deploy a mooring to record the temporal variability of the internal wave field and associated energy fluxes, and to use time series CTD/LADCP stations to assess locally the temporal variability of mixing, dissipation, and internal wave fluxes. The region south of the Azores in the east Atlantic is ideally suited for this kind of process study, because it is an area of a strong internal tide signal radiating away from the islands. The cruise track is located along a convergence of tidal beams south of the archipelago, crossing a chain of sea mounts as well as the critical latitude for parametric subharmonic instability (PSI). During the cruise, we collected CTD/LADCP time series between 39h and 52h length on 7 stations in up to 5000 m water depth along the tidal beam between 27°30'N and 37°N latitude, a total of 92 casts. The mooring equipped with of 7 current meter/temperature logger pairs and an acoustic Doppler current profiler was deployed along the track at 30°29.04'N, 30°11.7'W in a water depth of 4500 m (to be retrieved in 2018). All anticipated goals of the cruise were accomplished.

Zusammenfassung
Die RV Poseidon Fahrt 516 (POS516) ist Teil des Beobachtungsprogramms des TRR 181 'Energy Transfers in Atmosphere and Ocean', und beschäftigt sich mit dem Energieaustausch durch niedrig-modige interne Wellen. Die Ziele der Fahrt waren die Auslegung einer Verankerung zur Beobachtung der zeitlichen Veränderlichkeit des internen Wellen Feldes sowie die Messung von Zeitreihen mit CTD/LADCP Stationen zur Erfassung der räumlichen und zeitlichen Variabilität der von internen Wellen hervorgerufenen Energieflüssen, sowie deren Dissipation. Die Region südlich der Azoren ist für diese Art von Prozessstudie ideal geeignet, da dort interne Gezeiten zu einem fokussierten Strahl überlagert werden.
Das Arbeitsgebiet befand sich entlang diese Strahls zwischen 27°30'N und 37°N Breite. Es wurden insgesamt 92 CTD/LADCP Profile auf 7 Stationen mit einer Wassertiefe von bis zu 5000 m gesammelt, die Dauer der einzelnen Zeitreihen variierte zwischen 36 und 52 Stunden. Eine Verankerung bestehend aus 7 Strömungsmesser/Temperatur Logger Paaren sowie einem akustischen Doppler Profilstrommesser wurde auf der Position 30°29.04'N, 30°11.7'W in 4500 m Wassertiefe ausgelegt. Die Wiederaufnahme ist für 2018 geplant. Alle geplanten Ziele der Fahrt wurden erreicht.

2. Participants / Teilnehmer

1	Walter, Maren	Chief Scientist	Univ. Bremen/MARUM
2	Böke, Wolfgang	Technician, Mooring	Univ. Bremen
3	Köhler, Janna	CTD, LADCP, Mooring	Univ. Bremen/MARUM
4	Löb, Jonas	CTD, Mooring	Univ. Bremen/MARUM
5	Münzner, Florentina	CTD, Maps	Univ. Bremen
6	Quinn, Brenda	CTD	Univ. Hamburg
7	Rümmler, Simon	CTD	Univ. Bremen
8	Stiehler, Jan	CTD	Univ. Bremen
9	Sukhikh, Natalia	CTD, ADCP	Univ. Bremen/MARUM

Participating institutions: Univ. Bremen/MARUM: Zentrum für Marine Umweltwissenschaften, Universität Bremen; Univ. Hamburg: Institut für Meereskunde, Universität Hamburg.

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Figure 1. *Scientific party POS516, left to right: Maren Walter, Jonas Löb, Janna Köhler, Wolfgang Böke, Florentina Münzner, Jan Stiehler, Brenda Quinn, Simon Rümmler, Natalia Sukhikh*

3. Research Program

The RV Poseidon cruise POS516 is part of the observational program of the TRR 181 'Energy Transfers in Atmosphere and Ocean', and focusses on the energy transfer by low-mode internal waves (TRR project W2). The aim of the TRR 181 is to establish an energetically consistent framework of mechanical energy conversions in the climate system to develop consistent models. In the project W2 specifically a combination of observations and modelling is used to improve the understanding of internal waves and energy fluxes in the ocean. W2 aims to quantify the generation and propagation of internal waves in the global ocean, study the pathways of radiated low-mode internal waves including processes operating along the pathways, identify regions of sources and sinks, and to quantify the contribution to local dissipation and identify the involved processes.

In this context, the goals of the cruise were the following:

- Conduct a mooring study to record the temporal variability of the internal wave field and associated energy fluxes.
- Use time series CTD/LADCP stations to assess locally the temporal variability of mixing, dissipation, and internal wave fluxes.
- Observe internal wave energy fluxes along paths where satellite altimetry shows beams of converging low-mode internal waves to study the processes operating along specific beams using shipboard measurements in combination with model data and satellite altimetry.
- Estimate the contribution of radiated internal wave energy to local mixing.

The region south of the Azores in the east Atlantic is ideally suited for this kind of process study, because it is an area of a strong internal tide signal radiating away from the islands. The cruise track is located along a convergence of tidal beams south of the archipelago, crossing a chain of sea mounts as well as the critical latitude for parametric subharmonic instability (PSI). This enables us to investigate both the effect of topography/wave interaction as well as wave/wave interaction on the internal wave energy flux and dissipation and mixing.

The work program consists of two parts, a series of CTD/LADCP stations with repeated casts, and the deployment of the mooring:

CTD/LADCP time series stations

The time series stations of stratification (Conductivity, Temperature, Depth probe, CTD) and flow (Lowered Acoustic Doppler Current Profiler, LADCP) serve a dual purpose: (I) Estimate the dissipation rate at the respective locations, and (II) determine the internal wave energy flux. The measurement sites are located along a beam away from the generation site south of the Azores on a line in direction of the energy flux and cross the critical latitude for PSI 28.9°N, where potentially abrupt attenuation of the internal wave energy takes place (Fig. 2). On each station, the time series stations of top-to-bottom CTD and LADCP profiles are occupied for periods longer than 36 hours (depending on water depth and latitude) to capture semidiurnal to diurnal and inertial signals (the inertial period increases from 20 h to 26 h along the proposed cruise track). That timeframe ensures a minimum of 10 individual profiles obtained on each station.

The CTD/LADCP data will be decomposed into mean, diurnal, and semidiurnal components by harmonic analysis of velocity and displacement at each depth and the energy flux is then computed following Nash et al. (2005). Vertical diffusivities K_ρ will be calculated from the time series stations using the finestructure shear/strain variance (Gregg et al., 2003; Kunze et al., 2006), and the overturn or Thorpe scale method (Thorpe, 1977).

Mooring work

The second part of the program for this cruise was the deployment of a long-term mooring (to be recovered in 2018), equipped with current meters and temperature loggers. The measured time series of current velocity and temperature from the mooring will be used to calculate time series of internal wave energy fluxes in the near-inertial and tidal frequency bands. A near-surface ADCP will provide time series of current velocity between the top of the mooring and the sea surface suitable to estimate the energy input into the mixed layer by the wind.

The data gathered during POS516 will be complemented by historical mooring data, satellite altimetry, and high resolution ocean circulation modelling to produce the best estimate of the global distributions of sources and sinks of internal wave energy.

4. Narrative of the cruise

POSEIDON left the port of Ponta Delgada, Azores, on July 29 at 10:00 (local time = UTC) with 9 scientists from the MARUM-Center for Marine Environmental Sciences/ IUP-Institute of Environmental Physics at the University of Bremen, and one scientist from the Institut für Meereskunde, University of Hamburg. A short CTD/rosette test was performed and underway measurements (shipboard ADCPs, thermosalinograph) were started shortly after leaving the twelve-mile zone. The first and southernmost station was reached on the August 1 at 9:00 UTC (Fig. 2).

To begin with, we used the ships' CTD/water sampling system with 10 out of 12 water samplers, with the LADCP system taking up the remaining two spaces. During the first two casts at this position, the data from the CTD showed an irregular offset between the two sensor pairs. We switched to a different secondary sensor pair and pump after the first profile, and because of continuing problems, changed the whole CTD to our own instrument. This setup worked fine, and was used throughout the rest of the cruise. The pump problem of the ships' system was identified as a faulty tube connection afterward in the lab and subsequently fixed.

On the first station, the seafloor was irregular with water depths between 4900 and 5200 m. We limited the maximum profile depth to 5000 dbar because of the pressure rating of the two LADCPs. A total of 12 profiles was acquired over a time of 52h. After a first analysis of the current meter data, we decided to reduce the lowering and heaving velocity from initially 1 m/s to 0.8 m/s below 1500 m depth to increase the signal-to-noise ratio in the data, and possibly to reduce the spinning of the CTD wire. This measure was implemented after profile 7, and kept throughout the rest of the cruise. For similar reasons, mainly the easier identification of the semidiurnal signals in the LADCP data with a weak signal-to-noise ratio, we decided early on in the

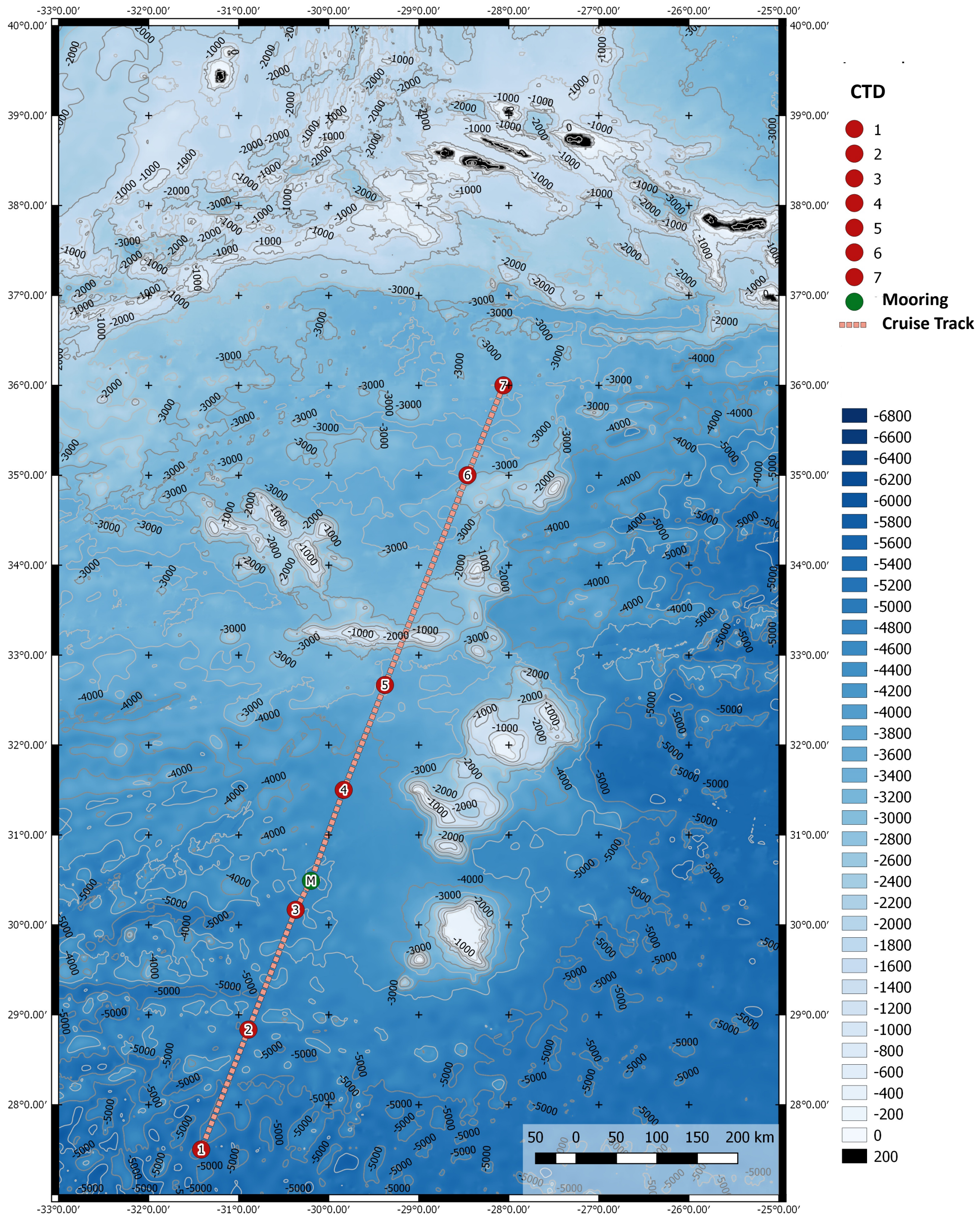

Figure 2. *Map of working area with positions of CTD stations and mooring.*

cruise to skip two of the nine originally planned stations in favour of longer time series (39+) at the remaining stations, reducing the total number to seven stations.

During the last cast of station 1, the LADCPs battery failed, and the profile was lost. Generally, batteries for the ADCPs were changed between stations, and the last cast of each station was used to take salinity samples for later calibration. The first station was finished on August 3, at 12:48 UTC. Between stations one and two, one of the LADCPs was changed to see whether a slight hysteresis offset between the two instrument compasses could be improved. The new configuration showed however a similar performance, and was kept for the rest of the cruise.

The position of the second station was reached on 23:58 on the same day. During the first cast, the two releaser for the mooring were lowered down with the CTD system and successfully tested at 4850 m depth. The fifth cast on this position was used to calibrate five of the mooring temperature loggers. A total of 10 casts was acquired over a time of 44h on this position. Afterwards, we carried out a shallow (1400 m) CTD cast at the same position to calibrate the remaining temperature loggers that had only a 1500 dbar pressure rating. The station was finished on August 5, at 20:27 UTC. The third station was occupied from August 6, 6:54 UTC, to August 8, 1:25 UTC, with 11 casts over 40h, in a water depth of 4600 m.

On August 8, the mooring position was reached at 6:30 UTC. The water depth and smoothness of the bathymetry was determined by carrying out three crossing tracks of approximately 5 km length across the planned mooring position. Afterwards, the ships' drift was tested to determine the best start position for the deployment. The mooring was deployed from 9:00 UTC onwards in ideal conditions; the anchor was slipped at 13:04 UTC and the top floatation was observed to dive shortly afterward.

After finishing the mooring work, the fourth CTD/LADCP station was occupied from August 9, 0:00 UTC, to August 10, 15:31 UTC, with 12 casts over 39h, in a water depth of 4200 m. The fifth station was occupied from August 11, 0:07 UTC, to August 12, 21:03 UTC, with 15 casts over 45h, in a water depth of around 3500 m. Station six lasted from August 13, 13:32 UTC to August 15, 7:52 UTC. 15 casts were measured over 45h, in a water depth of again 3500 m. During the fourth casts on this station, we stopped heaving the CTD system 100 m above the seafloor for 30 minutes to allow the wire to loose some of its spin.

The seventh and last CTD/LADCP station was reached on August 15, 18:05 UTC. Here, 16 casts were measured over 41h, in a water depth of 3200 m. The last cast of the station was finished on August 17, at 10:52 UTC. This was the conclusion of the station work during the cruise Pos516; the recording of shipboard ADCP was stopped after that station at 23:42 UTC; all underway measurements were stopped before reaching the Portuguese 12-mile zone. The cruise was concluded with a barbecue on deck the evening of the day. On August 18, Poseidon arrived in the port of Ponta Delgada at 9:00 local time.

5. Work details and first results

5.1 CTD (M. Walter)

Conductivity-temperature-depth (CTD) casts were carried out using the ships carousel water sampler, initially equipped with the ships SBE911plus system. This setup showed issues with the pump system (handling error, later resolved in the lab), therefore the CTD was replaced after the first two profiles by the Univ. Bremen CTD, a Sea-Bird Electronics, Inc. SBE911plus system, equipped with a temperature probe (SN 4145; calibrated in Feb 2017), a conductivity probe (SN 2643; calibrated in Feb 2017), a Digiquarz pressure sensor (SN 0675, calibrated in Feb 2017), an SBE 43 oxygen sensor (SN 0267, calibrated in Feb 2017), and an altimeter (SN 70933). Additionally, an additional custom build Seapoint Turbidity Meter (5x normal gain, SN 14143) was mounted. This setup worked flawless for the rest of the cruise. The underwater unit was attached to the ships Sea-Bird carousel water sampler equipped with 10 10L Hydro-Bios bottles. The two remaining spaces for bottles were taken up by the lowered acoustic Doppler current profiler system (LADCP, Fig. 3).

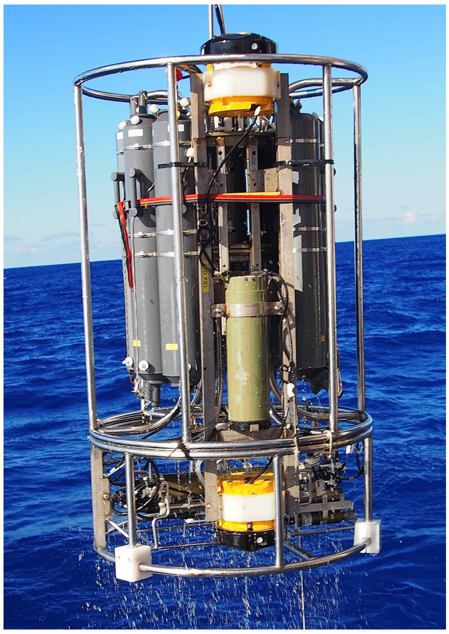

Figure 3. *CTD setup with 10 water sampling bottles and Lowered ADCP system.*

In total 59 salinity samples, typically 7 to 9 on one cast at each of the seven stations were collected for later analysis at home and post-cruise salinity calibration. In total 92 CTD casts were carried out.

The data show an increasing signal of the Mediterranean outflow at a depth slightly below

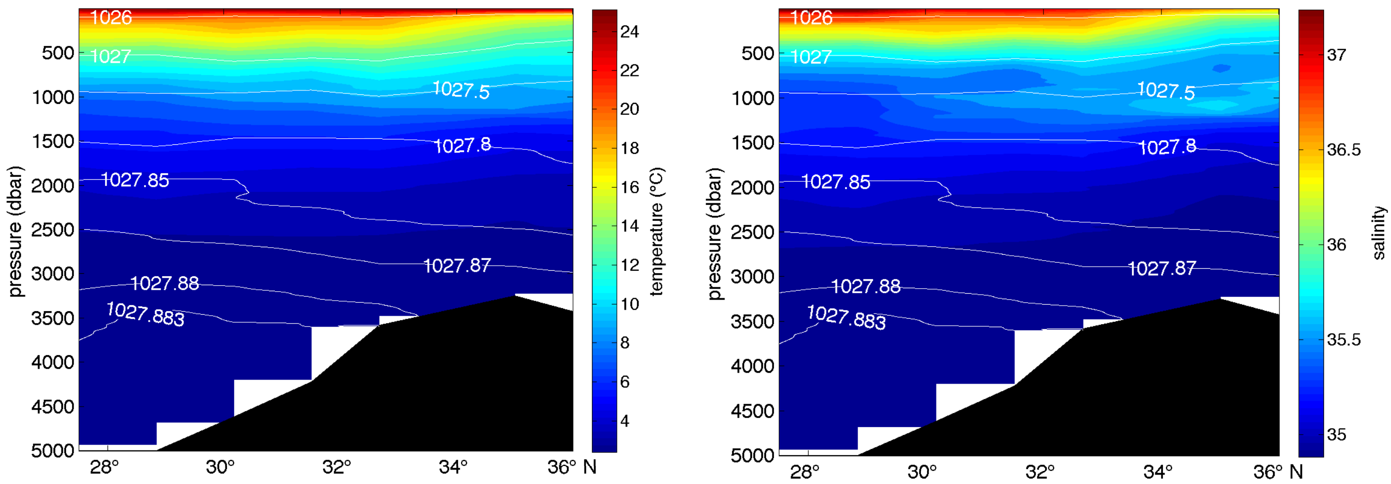

Figure 4. *Along track section of potential temperature (left) and salinity (right) at CTD stations; isopycnals are shown in white.*

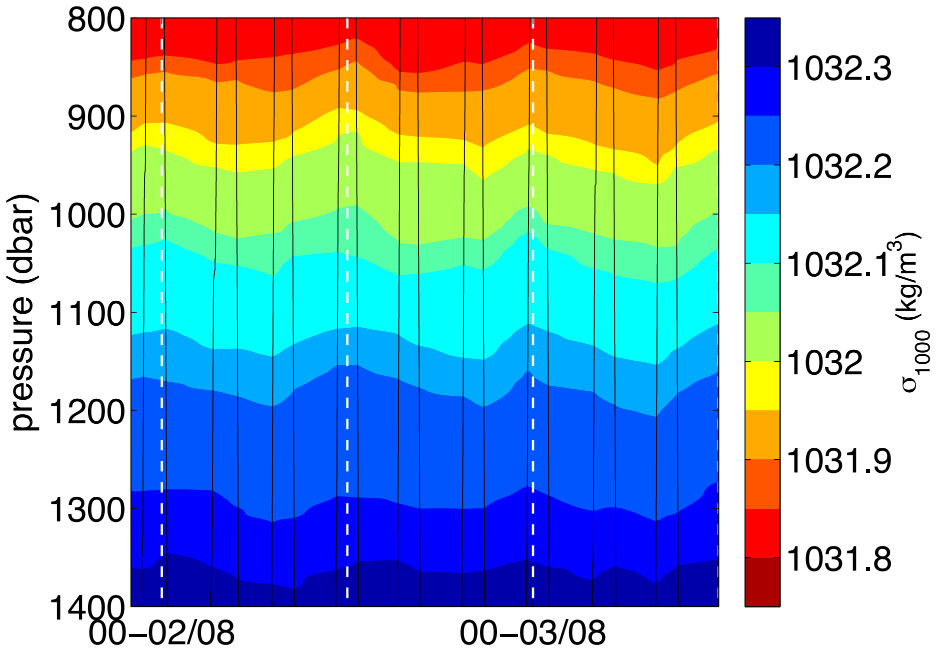

Figure 5. *Internal wave signal with tidal frequency (white lines) in the density field from CTD data (Station 1). Black lines indicate position of CTD.*

1000 m form south to north (Fig. 4). During each of the time series stations, clear internal wave signals of varying amplitude were observed. The signals were dominantly of semidiurnal tidal frequency, and baroclinic in structure, with the maximum around 1000 m depth (Fig. 5).

5.2 Current measurements

5.2.1 Lowered ADCP (J. Köhler)

Two RD Instruments 300 kHz Workhorse Monitor ADCPs were attached to a carousel water sampler and operated in a synchronised configuration in which the downward looking instrument triggers the upward looking instrument. Both instruments were used in narrowband mode with a ping rate of 1Hz, 1.6 seconds as interval between data collection cycles and a 10 m depth cell size. Power for both instruments was supplied by 35 commercial quality 1.5 V batteries, externally assembled in a modified Aanderaa pressure housing. A compass calibration was carried out in Bremen, prior to the cruise. CTD pressure data were used for exact depth information.
During the cruise three different ADCPs were used. Two of the instruments were calibrated as downward looking instruments (serial numbers 1973 and 7915), one as upward looking (serial number 2161). After the first station (casts 1-12) instrument 1973 was exchanged with instrument 7915 to test the compass calibration. No difference between the two instruments was found.
On the first station profiles end at 5000 dbar (100 m - 200 m above the seafloor) due to the maximum pressure rating of the ADCPs. Because of insufficient power supply no LADCP data were collected for cast 12 at station 1.

As the number of scatterers strongly decreased with depth, the lowering and heaving velocity of the water sampler carousel was lowered from 1 m/s to 0.8 m/s in depths below 1500 m from station 1, cast 7 onwards in order to increase the number of shear estimates in each depth bin. With the lowered winch speed the number of

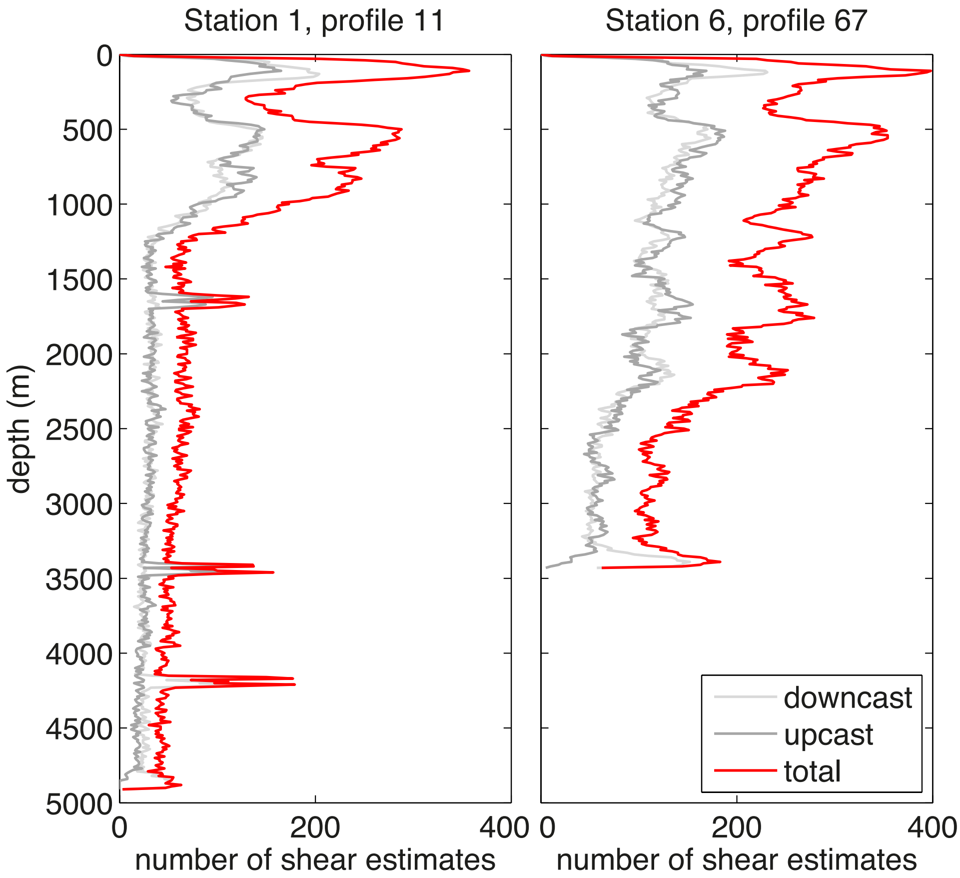

Figure 6. *Number of shear estimates during down- (light gray), upcast (gray) and total (red) in cast 11 (station 1, left) and in cast 67 (station 6, right). Below 1500 m sparse scatterers resulted in 40-70 estimates per bin with winch speed of 0.8 m/s at station 1; the number of shear estimates increased steadily at stations towards the north.*

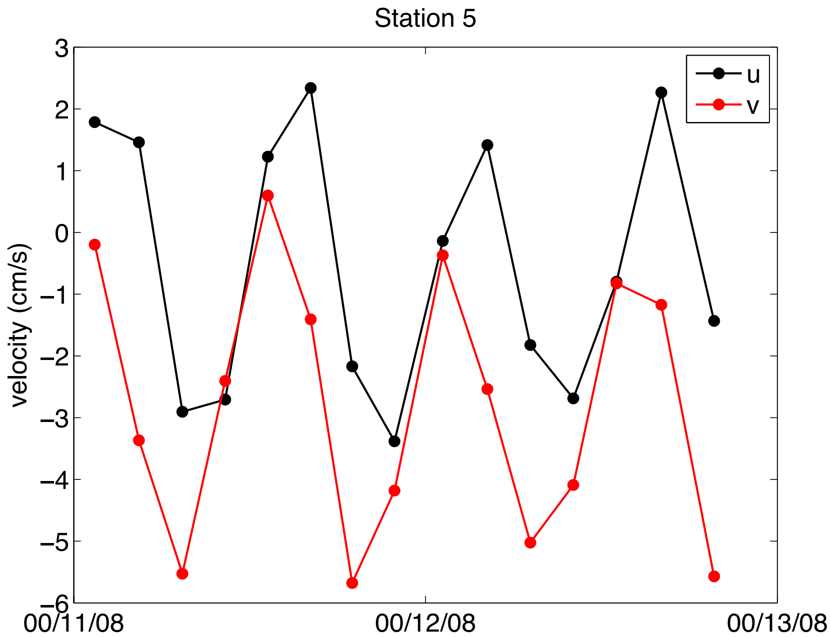

Figure 7. *Barotropic (mean) velocity (cm/s) from Lowered ADCP during Station 5 (15 profiles).*

shear estimates increased but for most profiles at the first station only 40 - 70 shear estimates per bin below 1200 m could be achieved. The number of shear estimates increased steadily during the succeeding stations (Fig. 6).

Similar to the CTD data, the LADCP signal was dominated by semidiurnal tidal frequencies (Fig. 7).

5.2.2 Vessel mounted ADCP (N. Sukhikh)

During the cruise vessel-mounted ADCP measurements of sea current velocity were performed. The shipboard acoustic Doppler current profiler by Teledyne RD Instruments with flat phased-array transducer was used to record single-ping velocity data in the upper ocean. The 75 kHz Ocean Surveyor (OS 75) was mounted into the hull of the ship. The transducer depth was 4.5 m. The ship PC was used to control the receiving of the ADCP data via comport with the help of VMDAS (Real-Time Vessel-Mount Data Acquisition Software by Teledyne RDI, version 1.46). The measurements started on 29.07.17 14:30 (UTC). The SADCP was switched off during the mooring operations on 8th of August.

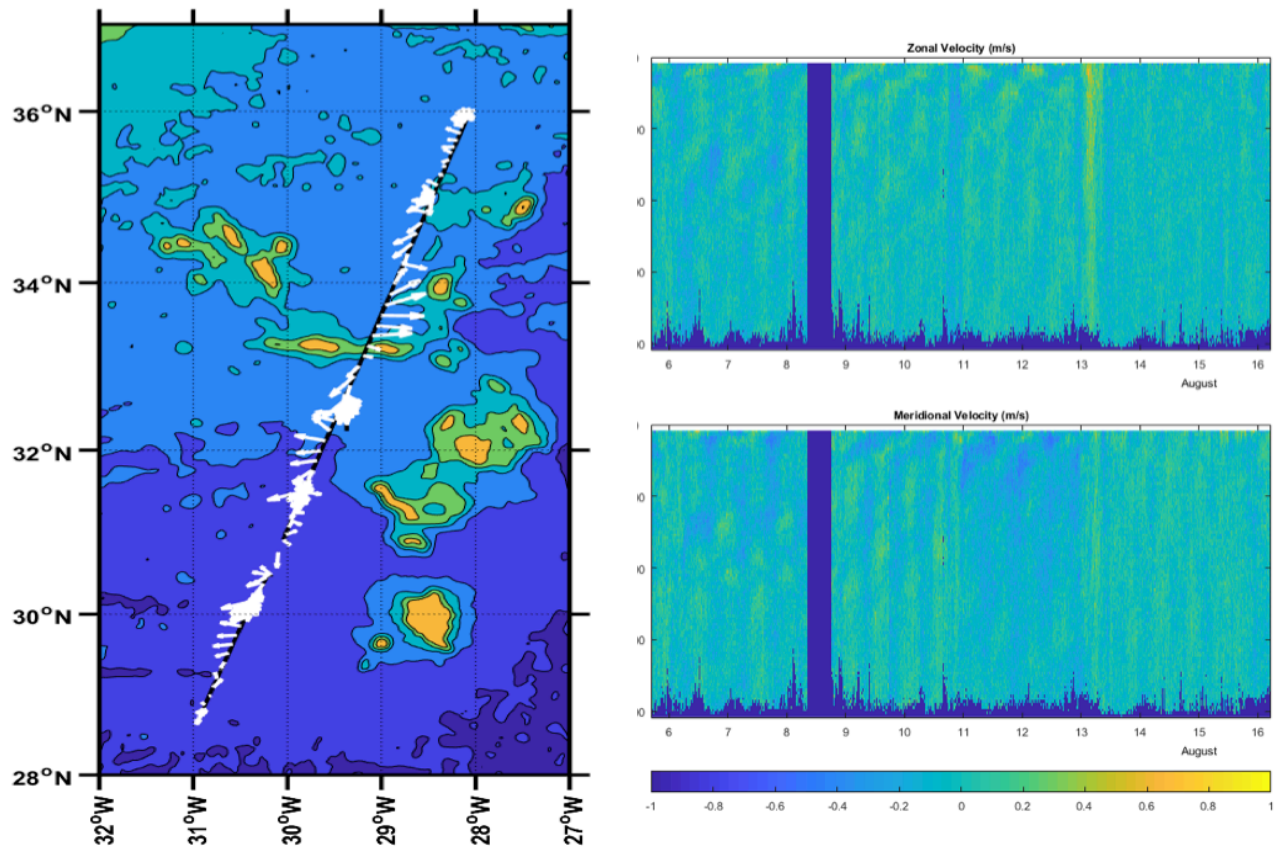

Figure 8. *Currents during the period from 05.08 to 16.08. (left) Depth-averaged (20-748 m) velocity and ship's track. (right) Vertical structure of current velocities (m/s).*

The data were collected in 100 bins with 8 m bin size. Blanking distance was 8 m, bottom track function was switched off. The OS 75 collected the data in narrow-band mode to achieve maximum depth range. The maximum depth range with using the settings was 812.5 m, after post-processing of the data the range was reduced to 748.5 m (Fig. 8). After the averaging the time resolution of the resulting data is 1 minute.

Figure 9. *(left) Nortek Aquadopp current profiler, (right) Sea-Bird SBE56 Temperature logger.*

The water-track calibration was performed. A misalignment angle -1.04˚ and an amplitude factor 1.005 were determined. The post-processing of SADCP data was done with using a MATLAB toolbox OSSI (version 1.9) developed in the GEOMAR Helmholtz Centre for Ocean Research Kiel (kindly provided by Dr. T. Fischer). The dataset consists of data in VMDAS raw data formats (*.ENX, *.ENR, *.ENS, *.VMO, *.LTA, *.STA, *.NMS, *.N1R, *.N2R) and in MATLAB format (*.mat).

During the first part of the cruise (29.07.17 – 05.08.17) it wasn't possible to get the correct pitch, roll and heading data. The exact reason wasn't detect during the cruise. We used fixed heading, pitch and roll for the period. Obtained data will be analysed later with the data from ship navigation system DSHIP (with time resolution 1 second). Additional data of heading and tilt were obtained from the ship's SEAPATH system. The GPS positions were obtained from the ship's GPS. On 05.08.17 the ASHTECH source of heading, pitch and roll data was changed. The correct data were stored in *.N2R files. The system worked correct after the 5th of August till the end of the cruise.

5.3 Mooring Energy Transfer ET1 (J. Löb)

The ET1 mooring is equipped with current meters and temperature recorders to record shear and velocities in the surface ocean. It consist of a total number of 7 current meter — temperature logger pairs, made up of 7 Nortek Aquadopp, 3 Sea-Bird SBE56 temperature logger, and 5 Sea-Bird SBE39plus temperature logger (Fig. 9), plus 19 Nautilus 17" Floats, 2 acoustic releasers and an upward looking 150 kHz TRDI ADCP mounted in a 32" float with Radio and Iridium Beacon. It has a total length of 4500 m.

5.3.1 Nortek Aquadopp current profilers with pressure sensor

The Aquadopp profiler measures three-component (east, north, up) current velocity data using acoustic Doppler technology. The start time and configuration of all 7 Aquadopp current meters were set the same. The starting time was set to 01.08.2017 at 12:00. The instrument settings are: measurement interval: 600 s, average interval: 30 s, blanking distance: 0.5 m, diagnostics interval: 24 h, compass update rate: 1 s, coordinate system: ENU, speed of sound: 1500 m/s. This results in an assumed battery duration of 400 d days.

5.3.2 Sea-Bird SBE56 and SBE39plus temperature recorder

The SBE 39plus and the SBE56 are high-accuracy temperature recorder with internal battery pack and non-volatile memory. They are intended for moorings or other long-term, fixed-site applications and are rated for 10,500 meters with a titanium housing (SBE39plus) and 1,500 m with a plastic housing (SBE56), respectively.

The start time and configuration of all 5 SBE39plus and 3 SBE56 were set the same. The starting time was set to 06.08.2017 at 12:00. The measurement interval was set to 60 s.

For the calibration of the temperature loggers, all instrument were attached to the CTD carousel during two casts (one deep and one shallow for the 1500 m depth-rated). During those casts, the CTD was stopped 3 times for 10 minutes at the anticipated mooring depths of the instruments in order to allow for a complete adjustment.

5.3.3 ADCP (RDI Workhorse Quartermaster):

The TRDI Workhorse Quartermaster is an Acoustic Doppler Current Profiler (ADCP), which is mountain in the head buoy of the mooring. The instrument specifications and settings are: frequency: 153600 Hz, sampling intervall: 18 s, pings per ensemble: 35, ambient temperature: 16.00 °C, first cell range: 12.21 m, last cell range: 332.21 m, max range: 224.36 m, standard deviation: 1.20 cm/s. The settings were chosen to gain the best mix between measurement range and accuracy in the present environment in conjunction with possible battery life.

5.3.4 Acoustic releaser:

The releasers were set parallel so that in the event of a failure of one of the instruments the mooring will still be able to be recovered. The releasers have successfully passed both a dry test and a test fitted onto the CTD carousel during a regular CTD station.

6. Data management

Hydrographic and current data from this cruise have been submitted to Pangaea (https://www.pangaea.de) and are available upon request.

7. Acknowledgements

We thank Captain Helge Volland and the entire crew of Poseidon for the friendly and cooperative atmosphere and their professional technical assistance. We are grateful to the Azores and Portuguese authorities for the permission to conduct scientific research in the Exclusive Economic Zones of Portugal. Financial support came from the Deutsche Forschungsgemeinschaft (DFG) TRR 181 ‘Energy Transfers in Atmosphere and Ocean’.

8. References

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9. Station List POS516

Station	Gear	Date	Time (UTC)	Latitude	Longitude	Depth (m)	Samples, Remarks
POS516_1-1	CTD 1	2017/08/01	09:09:23	27° 30.05' N	031° 25.04' W	4931	bad CTD
POS516_1-2	CTD 2	2017/08/01	15:10:02	27° 30.00' N	031° 24.99' W	4942	bad CTD
POS516_1-3	CTD 3	2017/08/01	19:47:19	27° 30.06' N	031° 25.03' W	4964	
POS516_1-4	CTD 4	2017/08/01	23:51:40	27° 29.96' N	031° 24.98' W	5040	
POS516_1-5	CTD 5	2017/08/02	04:25:22	27° 30.04' N	031° 24.92' W	5131	
POS516_1-6	CTD 6	2017/08/02	08:05:09	27° 30.13' N	031° 24.94' W	4979	
POS516_1-7	CTD 7	2017/08/02	12:15:04	27° 30.04' N	031° 25.00' W	4939	
POS516_1-8	CTD 8	2017/08/02	16:15:02	27° 30.09' N	031° 25.06' W	4955	
POS516_1-9	CTD 9	2017/08/02	20:25:50	27° 30.04' N	031° 24.99' W	4960	
POS516_1-10	CTD 10	2017/08/03	00:36:13	27° 29.99' N	031° 24.97' W	5063	
POS516_1-11	CTD 11	2017/08/03	04:54:48	27° 29.93' N	031° 24.98' W	5128	
POS516_1-12	CTD 12	2017/08/03	08:51:43	27° 30.02' N	031° 25.01' W	4939	no LADCP; Salinity samples
POS516_2-1	CTD 13	2017/08/03	23:59:31	28° 49.98' N	030° 53.48' W	4853	Releaser test
POS516_2-2	CTD 14	2017/08/04	04:33:45	28° 49.98' N	030° 53.48' W	4851	
POS516_2-3	CTD 15	2017/08/04	08:29:31	28° 50.06' N	030° 53.48' W	4854	
POS516_2-4	CTD 16	2017/08/04	12:51:00	28° 50.08' N	030° 53.49' W	4851	
POS516_2-5	CTD 17	2017/08/04	16:59:15	28° 50.03' N	030° 53.44' W	4851	T-Logger calibration
POS516_2-6	CTD 18	2017/08/04	21:56:39	28° 49.95' N	030° 53.51' W	4851	
POS516_2-7	CTD 19	2017/08/05	02:34:33	28° 49.93' N	030° 53.59' W	4844	
POS516_2-8	CTD 20	2017/08/05	06:40:39	28° 49.99' N	030° 53.55' W	4854	
POS516_2-9	CTD 21	2017/08/05	10:38:30	28° 50.00' N	030° 53.50' W	4850	
POS516_2-10	CTD 22	2017/08/05	14:58:24	28° 50.05' N	030° 53.53' W	4868	Salinity samples
POS516_2-11	CTD 23	2017/08/05	18:58:12	28° 49.82' N	030° 53.58' W	4853	Shallow T-Logger calibration
POS516_3-1	CTD 24	2017/08/06	06:54:04	30° 09.99' N	030° 22.02' W	4617	
POS516_3-2	CTD 25	2017/08/06	10:49:16	30° 10.11' N	030° 21.90' W	4621	
POS516_3-3	CTD 26	2017/08/06	14:47:05	30° 09.98' N	030° 21.98' W	4620	
POS516_3-4	CTD 27	2017/08/06	18:38:02	30° 09.96' N	030° 21.98' W	4619	Salinity samples
POS516_3-5	CTD 28	2017/08/06	22:39:21	30° 09.98' N	030° 22.05' W	4619	
POS516_3-6	CTD 29	2017/08/07	02:43:21	30° 10.05' N	030° 21.91' W	4621	
POS516_3-7	CTD 30	2017/08/07	06:28:48	30° 10.07' N	030° 22.01' W	4616	

Station	Gear	Date	Time (UTC)	Latitude	Longitude	Depth (m)	Samples, Remarks
POS516_3-8	CTD 31	2017/08/07	10:28:14	30° 09.99' N	030° 21.99' W	4619	
POS516_3-9	CTD 32	2017/08/07	14:02:52	30° 09.99' N	030° 21.97' W	4642	
POS516_3-10	CTD 33	2017/08/07	17:59:32	30° 09.99' N	030° 21.91' W	4626	
POS516_3-11	CTD 34	2017/08/07	21:55:38	30° 09.99' N	030° 22.02' W	4619	Salinity samples
POS516_4-1	Mooring	2017/08/08	09:13:22	30°29.04'N	30°11.7'W	4530	Deployment
POS516_5-1	CTD 35	2017/08/08	23:59:55	31° 30.06' N	029° 50.04' W	4135	
POS516_5-2	CTD 36	2017/08/09	03:24:22	31° 30.04' N	029° 49.93' W	4140	
POS516_5-3	CTD 37	2017/08/09	06:38:16	31° 30.15' N	029° 50.05' W	4133	
POS516_5-4	CTD 38	2017/08/09	09:51:26	31° 30.02' N	029° 49.98' W	4138	
POS516_5-5	CTD 39	2017/08/09	13:10:00	31° 29.95' N	029° 49.99' W	4145	
POS516_5-6	CTD 40	2017/08/09	16:34:47	31° 29.97' N	029° 49.98' W	4142	
POS516_5-7	CTD 41	2017/08/09	19:42:54	31° 29.99' N	029° 50.04' W	4145	
POS516_5-8	CTD 42	2017/08/09	23:00:51	31° 30.01' N	029° 50.01' W	4140	
POS516_5-9	CTD 43	2017/08/10	02:17:49	31° 30.01' N	029° 49.97' W	4151	
POS516_5-10	CTD 44	2017/08/10	05:35:45	31° 30.02' N	029° 49.90' W	4141	
POS516_5-11	CTD 45	2017/08/10	08:45:10	31° 30.06' N	029° 49.91' W	4139	
POS516_5-12	CTD 46	2017/08/10	12:08:37	31° 29.94' N	029° 49.87' W	4152	2 data files; software restart downcast (3740m) Salinity samples
POS516_6-1	CTD 47	2017/08/11	00:07:31	32° 39.95' N	029° 22.57' W	3560	
POS516_6-2	CTD 48	2017/08/11	03:05:45	32° 39.97' N	029° 22.45' W	3564	
POS516_6-3	CTD 49	2017/08/11	06:11:54	32° 39.98' N	029° 22.51' W	3561	
POS516_6-4	CTD 50	2017/08/11	08:59:40	32° 40.00' N	029° 22.50' W	3564	
POS516_6-5	CTD 51	2017/08/11	12:03:13	32° 40.05' N	029° 22.45' W	3560	
POS516_6-6	CTD 52	2017/08/11	14:54:08	32° 40.04' N	029° 22.52' W	3560	
POS516_6-7	CTD 53	2017/08/11	17:46:15	32° 39.94' N	029° 22.46' W	3562	
POS516_6-8	CTD 54	2017/08/11	20:35:43	32° 40.01' N	029° 22.51' W	3560	
POS516_6-9	CTD 55	2017/08/11	23:49:44	32° 40.00' N	029° 22.50' W	3559	
POS516_6-10	CTD 56	2017/08/12	02:56:10	32° 40.09' N	029° 22.56' W	3562	
POS516_6-11	CTD 57	2017/08/12	05:54:19	32° 39.96' N	029° 22.57' W	3561	
POS516_6-12	CTD 58	2017/08/12	08:44:32	32° 40.04' N	029° 22.50' W	3560	
POS516_6-13	CTD 59	2017/08/12	11:46:36	32° 40.09' N	029° 22.42' W	3560	
POS516_6-14	CTD 60	2017/08/12	14:49:18	32° 40.08' N	029° 22.51' W	3563	
POS516_6-15	CTD 61	2017/08/12	18:19:48	32° 40.08' N	029° 22.44' W	3563	Salinity samples
POS516_7-1	CTD 62	2017/08/13	13:35:16	34° 59.98' N	028° 27.52' W	3438	

Station	Gear	Date	Time (UTC)	Latitude	Longitude	Depth (m)	Samples, Remarks
POS516_7-2	CTD 63	2017/08/13	17:40:44	34° 59.99' N	028° 27.53' W	3441	
POS516_7-3	CTD 64	2017/08/13	19:19:22	34° 59.96' N	028° 27.55' W	3438	
POS516_7-4	CTD 65	2017/08/13	22:07:51	35° 00.13' N	028° 27.57' W	3440	
POS516_7-5	CTD 66	2017/08/14	01:24:41	35° 00.04' N	028° 27.56' W	3439	
POS516_7-6	CTD 67	2017/08/14	04:10:27	34° 59.93' N	028° 27.50' W	3437	
POS516_7-7	CTD 68	2017/08/14	06:47:29	35° 00.03' N	028° 27.50' W	3457	
POS516_7-8	CTD 69	2017/08/14	09:37:07	34° 59.98' N	028° 27.53' W	3437	
POS516_7-9	CTD 70	2017/08/14	12:24:18	35° 00.03' N	028° 27.47' W	3436	
POS516_7-10	CTD 71	2017/08/14	15:07:22	34° 59.95' N	028° 27.53' W	3438	
POS516_7-11	CTD 72	2017/08/14	17:50:18	35° 00.05' N	028° 27.60' W	3440	
POS516_7-12	CTD 73	2017/08/14	20:55:38	35° 00.03' N	028° 27.52' W	3438	
POS516_7-13	CTD 74	2017/08/14	23:53:25	35° 00.05' N	028° 27.52' W	3438	
POS516_7-14	CTD 75	2017/08/15	02:41:32	35° 00.03' N	028° 27.45' W	3436	
POS516_7-15	CTD 76	2017/08/15	05:27:35	35° 00.02' N	028° 27.46' W	3436	Salinity samples
POS516_8-1	CTD 77	2017/08/15	18:06:29	36° 00.03' N	028° 03.52' W	3191	
POS516_8-2	CTD 78	2017/08/15	20:59:51	36° 00.06' N	028° 03.50' W	3188	
POS516_8-3	CTD 79	2017/08/15	23:39:14	35° 59.96' N	028° 03.55' W	3196	
POS516_8-4	CTD 80	2017/08/16	02:10:08	36° 00.08' N	028° 03.45' W	3185	
POS516_8-5	CTD 81	2017/08/16	04:42:42	36° 00.05' N	028° 03.62' W	3210	
POS516_8-6	CTD 82	2017/08/16	07:08:13	35° 59.95' N	028° 03.55' W	3203	
POS516_8-7	CTD 83	2017/08/16	09:41:40	36° 00.00' N	028° 03.49' W	3203	
POS516_8-8	CTD 84	2017/08/16	12:12:10	35° 59.97' N	028° 03.56' W	3203	
POS516_8-9	CTD 85	2017/08/16	14:45:01	36° 00.02' N	028° 03.43' W	3205	
POS516_8-10	CTD 86	2017/08/16	17:21:50	36° 00.05' N	028° 03.49' W	3224	
POS516_8-11	CTD 87	2017/08/16	19:52:14	35° 59.98' N	028° 03.49' W	3192	
POS516_8-12	CTD 88	2017/08/16	22:26:42	36° 00.02' N	028° 03.48' W	3198	
POS516_8-13	CTD 89	2017/08/17	00:54:38	36° 00.00' N	028° 03.49' W	3190	
POS516_8-14	CTD 90	2017/08/17	03:27:23	36° 00.06' N	028° 03.60' W	3199	
POS516_8-15	CTD 91	2017/08/17	06:02:23	36° 00.09' N	028° 03.52' W	3188	
POS516_8-16	CTD 92	2017/08/17	08:29:45	36° 00.00' N	028° 03.53' W	3195	Salinity samples