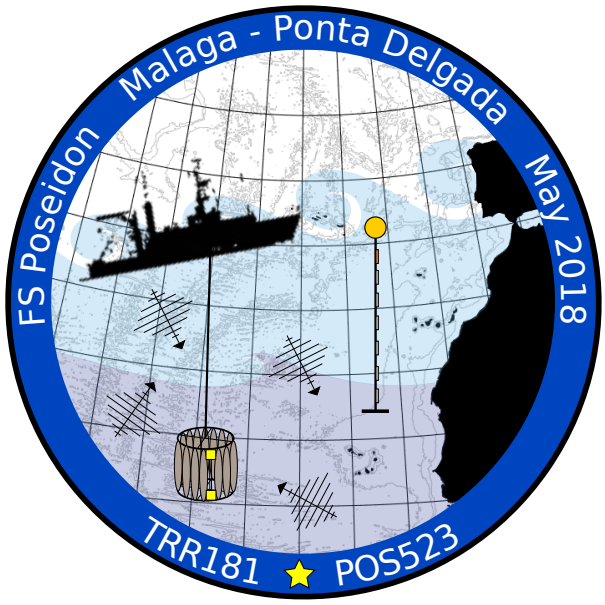
RV POSEIDON 523
Cruise Report / Fahrtbericht

Malaga (Spain) 02.05.2018

Ponta Delgada (Azores) 23.05.2018

POS523 – ENERGY TRANSFER II



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1. Cruise summary / Zusammenfassung

Summary
The RV Poseidon cruise 523 (POS523) is the second cruise to the work area as 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 recover and redeploy a mooring to record the temporal variability of the internal wave field and associated energy fluxes, and to use time series CTD/LADCP/microstructure 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 south of a chain of seamounts in a tidal beam formed by constructive interference of internal tides, and crosses the critical latitude for parametric subharmonic instability (PSI). During the cruise, we collected time series of CTD/LADCP and microstructure between 36 h and 52 h length on 5 stations in up to 4600 m water depth along the tidal beam between 29°20’N and 32°N latitude. In total 64 CTD/LADCP casts and 18 microstructure data sets were measured. The mooring equipped with current meter/ temperature logger pairs and acoustic Doppler current profiler was successfully recovered and later redeployed along the track at 30°29’N, 30°12’W in a water depth of 4500 m (to be retrieved in 2019). All anticipated goals of the cruise were accomplished.

Zusammenfassung
Die RV Poseidon Fahrt 523 (POS523) ist die zweite Fahrt ins Arbeitsgebiet als Teil des Beobachtungsprogramms des TRR 181 'Energy Transfers in Atmosphere and Ocean’. Sie beschäftigt sich mit dem Energieaustausch durch niedrig-modige interne Wellen. Die Ziele der Fahrt waren die Aufnahme und Wiederauslegung einer Verankerung zur Beobachtung der zeitlichen Veränderlichkeit des internen Wellen Feldes, sowie die Messung von Zeitreihen mit CTD/LADCP/Mikrostruktur Stationen zur Erfassung der räumlichen und zeitlichen Variabilität der von internen Wellen hervorgerufenen Energieflüssen und 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 29°20’N und 32°N Breite. Es wurden insgesamt 64 CTD/ LADCP Profile und 18 Mikrostruktur Datensätze auf 7 Stationen mit einer Wassertiefe von bis zu 4600 m gesammelt, die Dauer der einzelnen Stationen variierte zwischen 36 und 52 Stunden. Eine Verankerung aus Strömungsmesser/ Temperatur Logger Paaren und einem akustischen Doppler Profilstrommesser wurde auf der Position 30°29’N, 30°12’W in 4500 m Wassertiefe geborgen und dort später wieder ausgelegt. Die Wiederaufnahme ist für 2019 geplant. Alle geplanten Ziele der Fahrt wurden erreicht.

2. Participants / Teilnehmer

1	Adam, Lia	CTD	Univ. Bremen
2	Fandrich, Jennifer	CTD, Outreach	Univ. Hamburg
3	Gemmrich, Helen	Microstructure	Univ. Victoria
4	Köhler, Janna	Mooring, LADCP	Univ. Bremen/MARUM
5	Liu, Yuqing	CTD	Univ. Bremen
6	Löb, Jonas	Mooring	Univ. Bremen/MARUM
7	Loureiro, Clara	CTD, Bio	Univ. Azores
8	Reitz, Thomas	CTD	MPI Hamburg
9	Stiehler, Jan	CTD, ADCP	Univ. Bremen
10	Walter, Maren	Chief Scientist	Univ. Bremen/MARUM

Participating institutions: Univ. Bremen/MARUM: Zentrum für Marine Umweltwissenschaften, Universität Bremen; Univ. Hamburg: Center for Earth System Research and Sustainability, Universität Hamburg; MPI Hamburg: Max-Planck-Institut für Meteorologie, Hamburg; Univ. Victoria: University of Victoria, Canada; Univ. Azores: University of the Azores Horta, Portugal.
Chief Scientist: Dr. Maren Walter, Univ. Bremen/MARUM, Otto-Hahn-Allee 1, 28357 Bremen +49 421 218 621467, maren.walter@uni-bremen.de

Figure 1. *Scientific party POS523, left to right: Jennifer Fandrich, Helen Gemmrich, Jonas Löb, Clara Loureiro, Jan Stiehler, Lia Adam, Thomas Reitz, Yuqing Liu, Janna Köhler, Maren Walter*

3. Research Program

The RV Poseidon cruise POS523 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 seamounts south of the islands.. The cruise track is located along a convergence of tidal beams south of the archipelago, crossing a chain of seamounts 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 recovery and redeployment 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 chosen to complement the stations along the center of the tidal beam that were occupied during POS516 in 2017 (Fig. 2). The positions of the five stations were chosen to give insights into variability of energy fluxes in the cross-beam direction, to closer study the patterns at the critical latitude, and in one case to repeat a station during neap tide that was occupied during spring tide in 2017.

On each station, repeated top-to-bottom CTD and LADCP profiles were measured 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

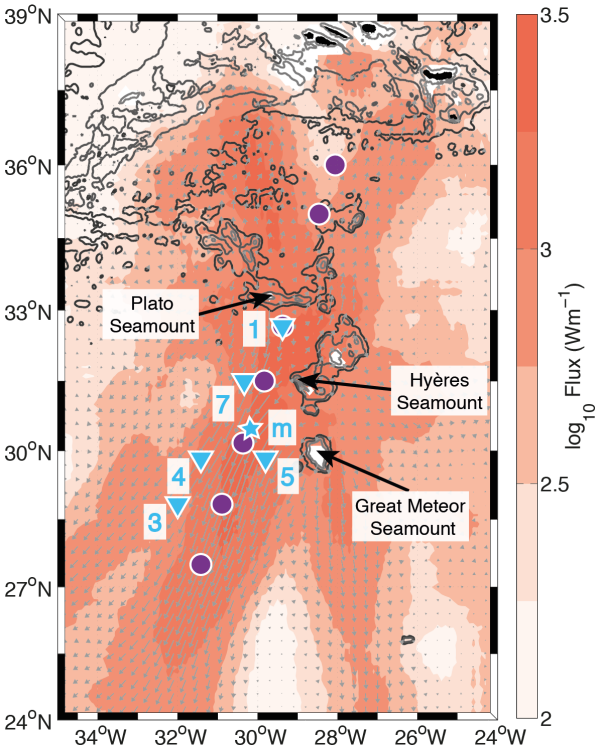

Figure 2. *Map and position of stations during POS523. Blue triangles denote CTD/ LADCP/microstructure stations , the blue star marks the position of mooring ET1/ET2. Also shown (purple dots) are the positions of previous cruise POS516. Background color is M2 energy flux from satellite altimetry (data: Z. Zhao).*

26 h along the cruise track). That timeframe ensured a minimum of 10 individual profiles on each station.

CTD/LADCP data will be decomposed into mean, inertial, 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 repeated casts at the stations using the shear/strain variance of finestructure (Gregg et al., 2003; Kunze et al., 2006), and the overturn or Thorpe scale method (Thorpe, 1977).

Microstructure measurements

In addition to the CTD/LADCP profiles, microstructure measurements of the upper ocean turbulence have been conducted during the time series stations. The sampling was done with a free-falling probe with a slowly drifting ship, and covered approximately the upper 500m. Microstructure measurements were alternated with the CTD/LADCP profiles, with 2 to 5 blocks of microstructure during one time series station, each block containing 3 to 6 individual profiles. The data will be used to obtain energy dissipation rates in that depth range, and to compare a possible tidal cycle in this property with the energy fluxes and finescale dissipation estimates from the CTD/LADCP data.

Mooring work

The second part of the program for this cruise was the recovery and re-deployment of a long-term mooring (to be recovered in 2019), 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 POS523 will complement the data obtained during POS516,. The two data sets are combined with 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 Málaga, Spain, on May, 2 at 9:00 (local time = UTC-2) with 10 scientists from the MARUM-Center for Marine Environmental Sciences/IUP-Institute of Environmental Physics at the University of Bremen, the Center for Earth System Research and Sustainability, University of Hamburg, the Max-Planck-Institute for Meteorology, Hamburg, the University of Victoria, Victoria, B.C., Canada, and the University of the Azores Horta, Azores, Portugal.

The working area south of the Azores afforded a six day transit from Málaga, during which a short CTD/rosette test was performed on May, 5, at 8:00 (local time). Underway current measurements (shipboard ADCP) were started on Saturday, May 5, well after leaving the Spanish waters. During transit, we shifted the ships' time to UTC which coincides with the Azores time zone. The first station was reached on Tuesday, May 8 at 7:00 UTC (Fig. 2).

During the cruise, 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. Initially, the instrument package was lowered and heaved with a velocity of 1 m/s. After a first analysis of the current meter data, we decided to reduce the lowering and heaving velocity to 0.8 m/s below 3000 m depth to increase the signal-to-noise ratio in the data. This measure was implemented after CTD profile 17, and kept throughout the rest of the cruise. Batteries for the ADCPs were changed between stations, and the last cast of each station was used to take water samples for later on-board filtration and salinity calibration in the home lab.

On the first station, the water depths was around 3500 m. A total of 11 CTD/LADCP casts and 4 microstructure data sets were acquired over a time of 36 h. During the third cast, the two releaser for the mooring work were lowered down with the CTD system and successfully tested. The station was finished on May 9, at 18:45 UTC.

The position of the mooring ET1 that had been deployed during the previous POS516 cruise in 2017 (30° 29' N, 030° 12' W) was reached on May 10, at 8:28 UTC. The mooring was released and subsequently successfully recovered. All instruments were on deck at 11:41 UTC, and the station ended.

The position of the third station, again a CTD/microstructure station, was reached on 4:02 UTC on May, 11. A total of 14 CTD/LADCP casts and 2 microstructure data sets were acquired over a time of 46 h, in a water depth of 4350 m. The station was finished on May 13, at 02:16 UTC. The fourth station was occupied from May 13, 10:38 UTC, to May 15, 12:53 UTC, with 13 CTD/LADCP casts and 3 microstructure data sets over a time of 50.5 h, in a water depth of 4600 m. The fifth station was reached at May 16, at 01:19 UTC. 12 CTD/LADCP casts and 4 microstructure data sets over a time of 47.5 h, in a water depth of 4400 m. The station was ended at May, 18, at 0:42 UTC.

On May 18, the starting position for the mooring deployment (30° 26.23' N, 030° 16.15' W) was reached at 8:00 UTC. The mooring (ET2) was deployed from 8:30

UTC onwards in ideal conditions in a water depth of 4530 m at the same position as ET1; the anchor was slipped at 11:48 UTC and the top floatation was observed to dive shortly afterward. After the successful deployment, a microstructure survey of 5 profiles was conducted close to the mooring position.

After finishing the mooring work, the seventh and last station was reached on May 19, 0:10 UTC. Here, 14 CTD/LADCP casts were measured over 44 h, in a water depth of 4200 m, as well as 4 blocks of microstructure measurements. The last cast of the station, microstructure, was finished on May 21, at 00:12 UTC. This was the conclusion of the station work during the cruise POS523; the recording of shipboard ADCP was stopped after that station on May, 21, 16:12 UTC; all underway measurements were stopped before reaching the Portuguese 12-mile zone. On May 23, Poseidon arrived in the port of Ponta Delgada at 9:00 local time.

5. Scientific report and first results

5.1 CTD (M. Walter)

Conductivity-temperature-depth (CTD) casts were carried out using the ships carousel water sampler, fitted with the ships Sea-Bird Electronics, Inc. SBE911plus system provided by GEOMAR. The SBE911plus was equipped with two parallel sensor sets consisting of two temperature probes (SN 4547 and 4867, both calibrated in June 2016), two conductivity probes (SN 3379/Jun 2016; SN 2443/Dec 2016), and two SBE 43 oxygen sensors (SN 2589/Jul 2017; SN 0631/May 2016), plus a WETLabs combined Fluorometer and Turbidity meter (SN 2928/Nov 2012), a Digiquarz pressure sensor (SN 0615/Sep 2017), and an altimeter (SN 42106). Additionally, an additional custom build Seapoint Turbidity Meter (5x normal gain, SN 14143) was mounted. This setup worked flawless for the entire 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). 36 salinity samples, at least 7 on one cast at each of the five stations, were collected for later analysis at home and post-cruise salinity calibration. In total 64 CTD casts were carried out.

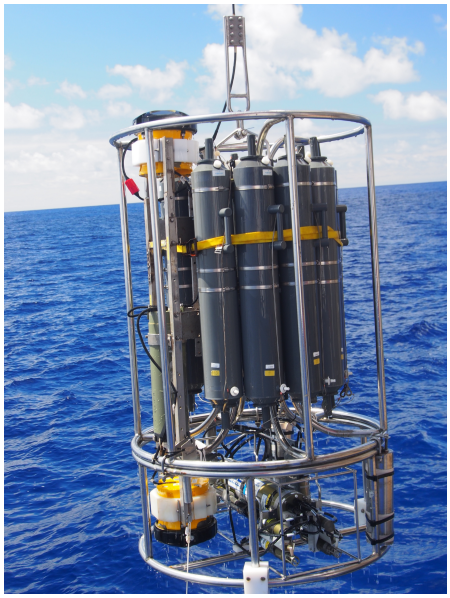

Figure 3. *CTD setup with 10 water sampling bottles and Lowered ADCP system.*

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 synchronized configuration in which the downward looking instrument (S/N 1973) triggers the upward looking instrument (S/N 7915). Both instruments were used in narrowband mode with a ping rate of 1 Hz and a 10 m depth cell size. Power for the instruments was supplied by 35 commercial quality 1.5V batteries, externally assembled in a modified Aanderaa pressure housing. A compass calibration was carried out in Bremen, Germany, before the cruise. CTD pressure profiles were used for exact depth information.

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 at depths below 3000 m from profile 17 onwards in order to increase the number of shear estimates in each depth bin. Especially at the southernmost station (28.8°N) scatterers are sparse (Fig. 4).

No or incomplete LADCP data exist for profiles 43 to 47 due to a partial flooding of

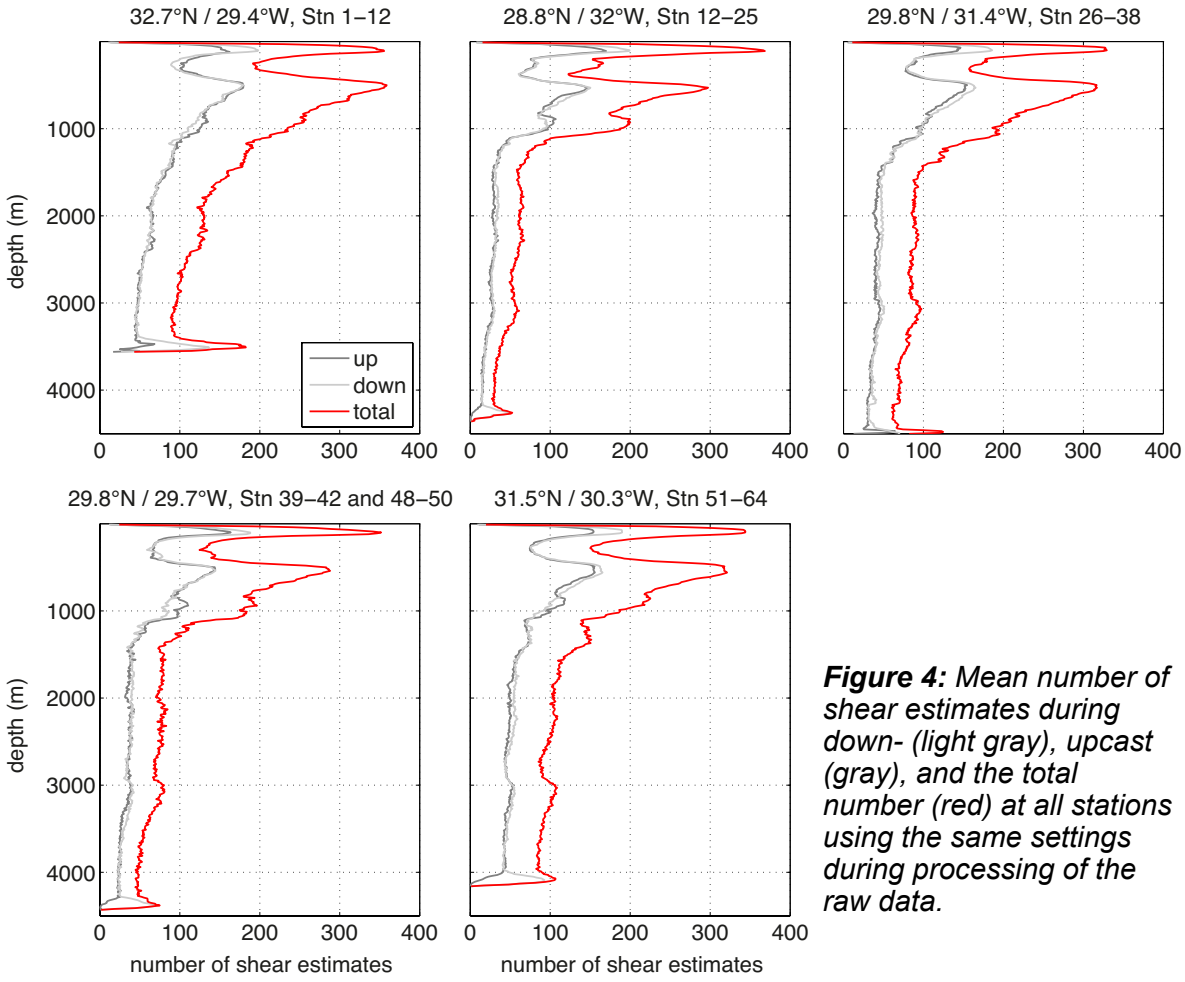

Figure 4: *Mean number of shear estimates during down- (light gray), upcast (gray), and the total number (red) at all stations using the same settings during processing of the raw data.*

the batterie housing that was caused by a loose connector. Thanks to the ships electrician, the batterie housing could be used again from profile 48 onwards.

5.2.2 Vessel mounted ADCP (J. Stiehler)

The vessel-mounted ADCP device used for this cruise was a 75 kHz Ocean Surveyor by Teledyne RD. It uses single pings to measure the velocities in the upper layer of the ocean and was mounted directly into the hull of the ship at a depth of 4.5 m. The data was acquired via a PC with VMDAS (Real-Time Vessel-Mount Data Acquisition Software by Teledyne RD, version 1.46.3). The measurements were started on 05.05.2018 at 17:00 and finished on 21.05.2018 at 16:12. VMDAS was set to collect the data in 100 bins with 8 m bin size and a blanking distance of 8 m in files with a maximum size of 10 Mb to prevent data loss due to program errors. The ADCP was programmed to use a narrow-band mode to achieve maximum depth. For the attitude data a ship navigation program was used which provided pitch, roll and heading as a simulated COM-port. There were two averaging settings, one for short-term and one for long-term. The settings used were 60 s and 1200 s respectively.

5.3 Microstructure (H. Gemmrich)

Microstructure measurements during POS523 were conducted using a Rockland Scientific VMP-250, which is a vertical microstructure profiler designed to measure micro-scale turbulence in the marine environment. The VMP used on POS523 has a maximum depth rating of 1000 m, and is fitted with two shear probes, two thermistors, a compact CT sensor, and a fluorometer (Fig. 5). The shear probes contain a piezo-ceramic beam that measures fluctuations in the water flow, used to characterize the dissipation of kinetic energy in micro-scale turbulence. The VMP is an internally recording instrument, meaning that all data is stored on a memory card within the instrument during the deployment, as opposed to being transmitted directly to a computer on deck. This equally eliminates the need for a deck side power supply - the VMP battery allows for approximately 10 h of continuous operation before needing to be recharged. The data is then downloaded via a USB connection after deployment.

During POS523, the measuring strategy was to deploy the VMP for blocks in between CTD casts during the time series stations. The deployments occur in 2 h segments between sets of CTD rosette deployments, where the slots were varied to avoid bias with regard to the tidal phase. For a deployment, the VMP is lowered over the stern of the ship, where it then falls freely to its maximum depth, typically around 500-700m. The instrument is recovered using a mechanical winch and then directly re-deployed. As the VMP is designed for continuous autonomous operation, it is not necessary to bring the VMP back on deck between deployments; separate profiles can be extracted in post-processing. Each 2 hour time block is sufficient time to complete 4 or 5 profiles, each profile taking about 20-30 minutes. The deployments are done by a three person team - one person is in charge of operating the winch, helped by the second person, who leads the tether from the spool and passes it to the third person. The third team member's task consists of ensuring that enough line is in the water at any given time, as the VMP must be deployed on a slack line. The VMP data were post-processed using the Rockland Scientific software package.

Figure 5. *Sensor head of Rockland Scientific VMP-250*

5.4 Mooring Energy Transfer, Deployments ET1 & ET2 (J. Löb)

5.4.1 ET1

On Thursday, May 10th, the mooring ET1 (deployed during POS516 in May 2017) was successfully recovered. It consisted of a total number of 7 current meter/ temperature logger pairs, made up of 7 Nortek Aquadopp current meters, 3 Sea-Bird SBE56 temperature loggers, and 5 Sea-Bird SBE39plus temperature loggers (Fig. 6), plus 19 Nautilus 17" spheres, 2 acoustic releasers and an upward looking 150 kHz TRDI ADCP Quartermaster mounted in a 32" float with Radio and Iridium Beacon. All instruments were retrieved in good condition and measured as planned. Unfortunately, the range of the near-surface ADCP (Quartermaster), which was designed to provide time series of current velocity between the top of the mooring

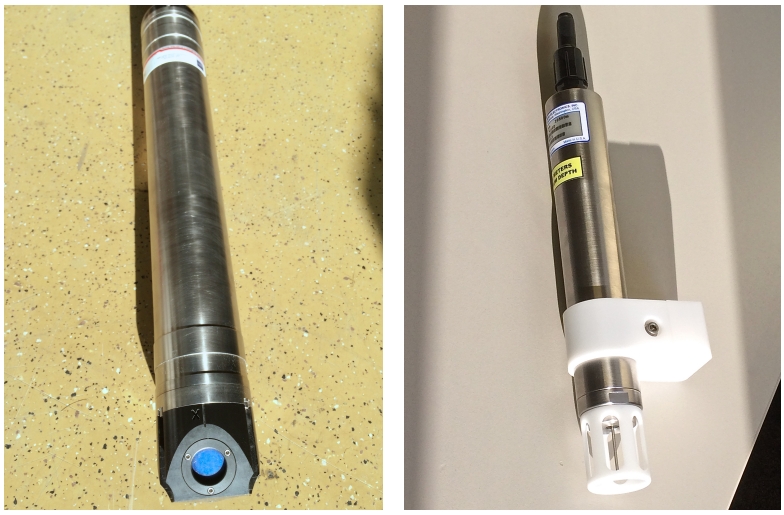

Figure 6. *(left) Nortek Aquadopp current profiler, (right) Sea-Bird SBE56 Temperature logger.*

and the sea surface, was not sufficient to see the surface. After recovery and data retrieval, all instruments were serviced and reprogrammed.

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. The nine month time series of raw data (Fig. 7) show both a seasonal signal as well as a strong influence of the spring-neap cycle of currents and stratification.

5.4.2 ET2

The mooring, now called ET2, was redeployed for a second period at the same position as ET1, with an additional downward looking DVS current profiler directly below the head buoy. It consists of a total number of 8 current meter/temperature logger pairs, made up of 7 Nortek Aquadopp with either a Sea-Bird SBE56 temperature logger or a Sea-Bird SBE39plus temperature logger plus 1 DVS current meter with a SBE56 temperature logger, the upward looking 150 kHz TRDI ADCP mounted in a 32” float with radio and iridium beacon, and the DVS current profiler, with 17 Nautilus 17” spheres as floatation and 2 acoustic releasers moored to a bottom weight (total length: 4300 m). The mooring was elongated by 200 m to ensure that the surface is within range for the head buoy ADCP. Buoyancy was adjusted by removing two of the buoyancy spheres and moving more floatation to the upper part of the mooring. One of the releasers was exchanged to for maintenance. Due to consistency in the data, the settings and the position of the instruments within the mooring were kept the same. In particular these were:

ADCP (RDI Workhorse Quartermaster)

The TRDI Workhorse Quartermaster is an Acoustic Doppler Current Profiler (ADCP), mounted in the head buoy of the mooring, the nominal depth of the instrument is 190 m. The instrument settings are: frequency: 153600 Hz, sampling interval: 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.

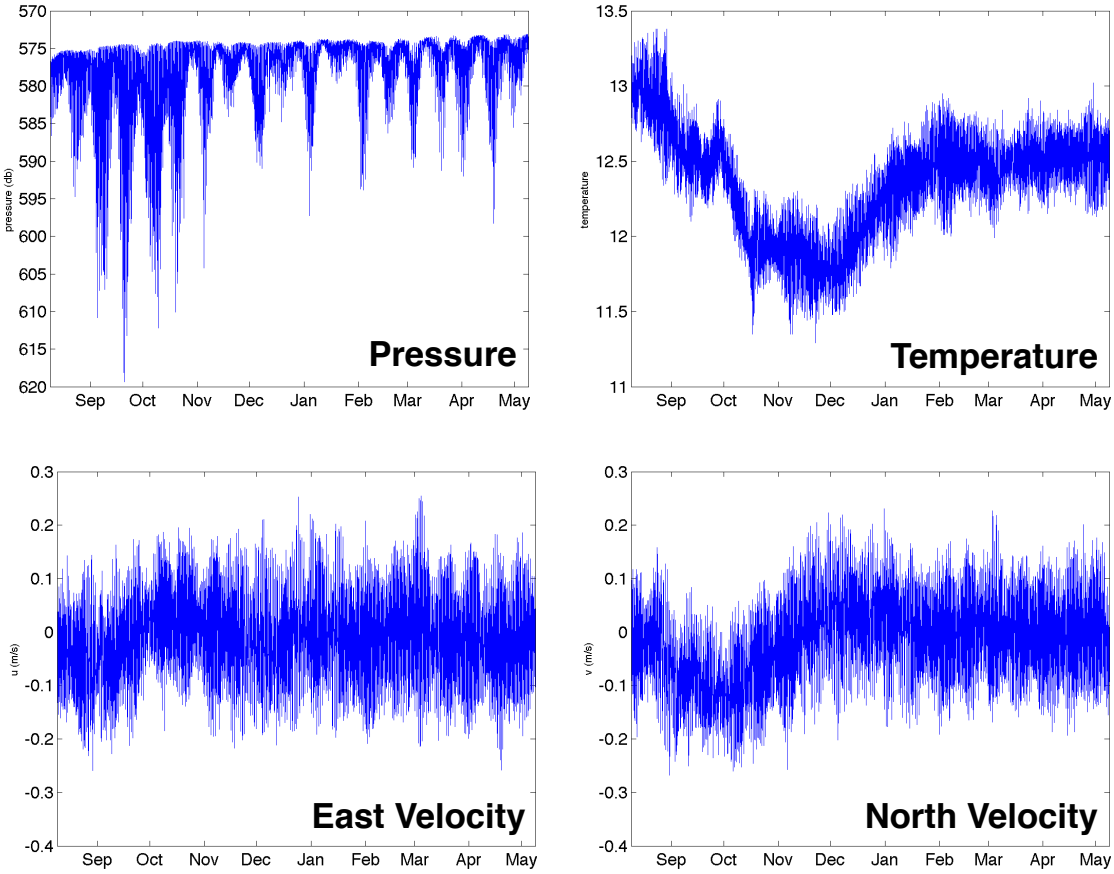

Figure 7. *Raw data (pressure (dbar), temperature (°C), u (m/s), and v (m/s)) from mooring ET1, Aquadopp current meter at a nominal depth of 575 m.*

Doppler Volume Sampler (RDI DVS) with pressure sensor

The TRDI doppler volume sampler is a high frequency current profiler, used to get a better understanding of wave induced shear events in the system. The starting time was set to 18.05.2018 at 08:00, the nominal depth of the instrument is 195 m. The instrument settings are: frequency: 2457.6 kHz, sampling interval: 600 s, pings per ensemble: 19, number of depth cells: 5, depth cell size: 0.8 m, blanking distance: 0.3 m, first cell range: 1.13 m, last cell range: 4.33 m, max range: 4.73 m, standard deviation: 0.5 cm/s.

Nortek Aquadopp current profilers with pressure sensor

The current meter/temperature logger pairs were mounted at nominal depths of respectively 610 m, 1030 m, 1445 m, 2070 m, 2900 m, 3735 m, and 4550 m.

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 are the same. The starting time was set to 18.05.2018 at 08:00. 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.

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

longterm, 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 five SBE39plus and three SBE56 are the same. The starting time was set to 18.05.2018 at 08:00. The measurement interval was set to 60 s.

Acoustic releaser
Two IxSea releasers were set in parallel so that in the event of an instrument or communication failure of one of the instruments the mooring can still be recovered. Both releasers have successfully passed dry testing in the lab as well as an in-situ test fitted onto the CTD carousel during a regular CTD station prior to deployment.

5.5 Biology sampling (C. Loureiro)
During the POS523 cruise, microplanktonic community characterization (in terms of prokaryotes- bacteria and archaea) was performed through in situ seawater sampling at 5 stations. At each station, a maximum of 5 different depths were chosen due to storage and filtration system limitation. These depths were chosen according to water column characteristics (through the real time CTD profile): surface, deep chlorophyll maximum (DCM), Mediterranean outflow, maximum & minimum oxygen saturation and bottom. Seawater samples were taken for:

Nutrients: 50 ml of seawater were directly collected to white containers from the Niskin bottle and immediately frozen at -20ºC. A total of 27 samples were collected. The nutrients concentration will be determined using a San++ Automated Chemistry Analyzer which is based on a continuous flow analysis (CFA) technique.

Photosynthetic pigments: 1000ml of seawater was vacuum filtered onto a 0.47mm glass microfiber filter (Whatman GF/F, 0.45 mm Æ). The filtered was blotted dried, folded several times, and stored dry, protected form the sunlight, in Eppendorfs at -20ºC. The main pigment to be analyzed will be chlorophylla which will be extracted with acetone according to the Turner Fluorometer method using a LS55 fluorescence spectrometer in order to determined its concentration.

Microplanktonic community: two times 2500ml of well mixed water was collected at each depth (total of 25 samples) and filtered under low vacuum pressure conditions through a filtration system onto to a 47mm (Æ) cellulose acetate filter (Sartorius Biolab, 0.2mm pore Æ) in order to produce two replicas (DNA1 and DNA2) plus in two depths, two times 5000ml of well mixed water was collected and filtered under the same conditions onto a sterivex unit (Millipore, 0.2mm pore size). The filter with the immobilized cells was folded and stored into sterilized Eppendorfs and immediately frozen at -20ºC. These samples will be analyzed through the extraction of the genomic DNA and further sequencing for bacteria and archaea.

6. Outreach

(J. Fandrich) During the cruise the project coordinator of the TRR181, Jennifer Fandrich, collected material for outreach activities, e.g. pictures and video interviews with the scientists, as well as for Social Media activities e.g. Twitter to inform the general public and science-interested people about the work of scientists on a research vessel.

The idea behind this was to produce photo material for the website and other outreach events and to have movie material to produce videos for the TRR181 Youtube Channel. These can be used for educational events and to inform interested adults about the work on a research vessel carried out within the project. The videos can also be included in other outreach activities like science events for the general public or schools.

First results are one published interview with Janna Köhler and Jonas Löb on the Youtube channel. Still in progress is the interview with Maren Walter as well as a short interview with Helen Gemmrich about the microstructure profiling process. This material have already successfully be used for outreach events and activities. We would like to thank everyone who helped realizing these outreach activities during the work on the POSEIDON, especially the crew of the POSEIDON.

7. Data management

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

8. Acknowledgements

We thank Captain Matthias Günther 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’, project ID 274762653.

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10.Station List POS523

Station	Gear	Date	Time (UTC)	Latitude	Longitude	Depth (m)	Samples, Remarks
POS523_1-1	CTD 1	2018-05-08	07:00:31	32° 39.992' N	029° 22.515' W	3561	
POS523_1-2	CTD 2	2018-05-08	09:45:27	32° 39.986' N	029° 22.476' W	3563	
POS523_1-3	µStruct 1	2018-05-08	12:17:26	32° 39.962' N	029° 22.380' W	3563	
POS523_1-4	CTD 3	2018-05-08	14:26:55	32° 40.017' N	029° 22.499' W	3561	Releaser test
POS523_1-5	CTD 4	2018-05-08	17:10:54	32° 39.977' N	029° 22.497' W	3561	
POS523_1-6	µStruct 2	2018-05-08	19:35:41	32° 39.992' N	029° 22.456' W	3562	
POS523_1-7	CTD 5	2018-05-08	21:39:38	32° 39.964' N	029° 22.531' W	3562	
POS523_1-8	CTD 6	2018-05-09	00:03:53	32° 39.923' N	029° 22.488' W	3563	
POS523_1-9	µStruct 3	2018-05-09	02:15:56	32° 40.055' N	029° 22.465' W	3563	
POS523_1-10	CTD 7	2018-05-09	04:31:06	32° 39.964' N	029° 22.488' W	3562	
POS523_1-11	CTD 8	2018-05-09	06:58:13	32° 40.034' N	029° 22.486' W	3561	
POS523_1-12	µStruct 4	2018-05-09	09:27:46	32° 40.165' N	029° 22.666' W	3560	
POS523_1-13	CTD 9	2018-05-09	11:31:01	32° 39.959' N	029° 22.500' W	3562	
POS523_1-14	CTD 10	2018-05-09	13:52:22	32° 40.045' N	029° 22.615' W	3561	
POS523_1-15	CTD 11	2018-05-09	16:20:35	32° 39.889' N	029° 22.426' W	3564	Salinity, Bio
POS523_2-1	Mooring	2018-05-10	08:28:48	30° 28.805' N	030° 11.983' W	4531	Recovery
POS523_3-1	µStruct 5	2018-05-11	04:02:02	28° 50.002' N	032° 00.119' W	4308	
POS523_3-2	CTD 12	2018-05-11	06:22:30	28° 49.990' N	032° 00.013' W	4324	
POS523_3-3	CTD 13	2018-05-11	09:19:14	28° 50.049' N	032° 00.057' W	4302	
POS523_3-4	CTD 14	2018-05-11	12:16:58	28° 50.064' N	032° 00.026' W	4307	
POS523_3-5	CTD 15	2018-05-11	15:08:14	28° 50.037' N	031° 59.948' W	4313	
POS523_3-6	CTD 16	2018-05-11	18:06:23	28° 50.001' N	032° 00.009' W	4308	
POS523_3-7	CTD 17	2018-05-11	20:59:19	28° 49.996' N	032° 00.007' W	4340	
POS523_3-8	CTD 18	2018-05-12	00:07:35	28° 49.921' N	032° 00.000' W	4280	
POS523_3-9	CTD 19	2018-05-12	03:16:53	28° 49.969' N	031° 59.937' W	4304	
POS523_3-10	CTD 20	2018-05-12	06:21:56	28° 49.964' N	031° 59.897' W	4292	
POS523_3-11	CTD 21	2018-05-12	09:23:35	28° 50.042' N	032° 00.050' W	4305	
POS523_3-12	CTD 22	2018-05-12	12:26:50	28° 50.007' N	031° 59.939' W	4297	
POS523_3-13	CTD 23	2018-05-12	15:32:50	28° 50.036' N	031° 59.976' W	4306	
POS523_3-14	CTD 24	2018-05-12	18:34:21	28° 50.081' N	031° 59.983' W	4295	
POS523_3-15	CTD 25	2018-05-12	21:33:07	28° 49.973' N	032° 00.022' W	4369	Salinity, Bio
POS523_3-16	µStruct 6	2018-05-13	00:42:23	28° 49.809' N	031° 59.496' W	4282	

Station	Gear	Date	Time (UTC)	Latitude	Longitude	Depth (m)	Samples, Remarks
POS523_4-1	µStruct 7	2018-05-13	10:38:19	29° 49.993' N	031° 24.927' W	4588	
POS523_4-2	CTD 26	2018-05-13	12:43:17	29° 50.038' N	031° 25.067' W	4021	
POS523_4-3	CTD 27	2018-05-13	16:12:41	29° 49.911' N	031° 25.011' W	4567	
POS523_4-4	CTD 28	2018-05-13	19:39:39	29° 49.974' N	031° 25.061' W	4543	
POS523_4-5	CTD 29	2018-05-13	22:59:34	29° 49.982' N	031° 24.991' W	4562	
POS523_4-6	CTD 30	2018-05-14	02:34:06	29° 49.966' N	031° 25.071' W	4564	
POS523_4-7	CTD 31	2018-05-14	05:44:46	29° 50.054' N	031° 25.127' W	4340	
POS523_4-8	µStruct 8	2018-05-14	08:55:28	29° 49.591' N	031° 24.256' W	4576	
POS523_4-9	CTD 32	2018-05-14	11:49:19	29° 49.943' N	031° 25.028' W	4600	
POS523_4-10	CTD 33	2018-05-14	15:08:06	29° 49.979' N	031° 24.938' W	4570	
POS523_4-11	CTD 34	2018-05-14	18:20:11	29° 50.036' N	031° 25.005' W	4459	
POS523_4-12	CTD 35	2018-05-14	21:37:44	29° 50.038' N	031° 25.013' W	4560	
POS523_4-13	CTD 36	2018-05-15	00:38:37	29° 49.987' N	031° 25.001' W	4613	
POS523_4-14	CTD 37	2018-05-15	03:58:24	29° 49.928' N	031° 24.954' W	4564	
POS523_4-15	CTD 38	2018-05-15	07:12:48	29° 49.933' N	031° 24.926' W	4564	Salinity, Bio
POS523_4-16	µStruct 9	2018-05-15	10:47:34	29° 49.883' N	031° 24.698' W	4573	
POS523_5-1	µStruct 10	2018-05-16	01:19:33	29° 49.990' N	029° 40.091' W	4413	
POS523_5-2	CTD 39	2018-05-16	04:05:56	29° 49.997' N	029° 39.973' W	4412	
POS523_5-3	CTD 40	2018-05-16	07:12:17	29° 50.030' N	029° 40.042' W	4228	
POS523_5-4	CTD 41	2018-05-16	11:43:40	29° 50.048' N	029° 40.058' W	4412	
POS523_5-5	CTD 42	2018-05-16	14:45:59	29° 50.043' N	029° 39.913' W	4411	
POS523_5-6	µStruct 11	2018-05-16	17:36:47	29° 50.100' N	029° 39.965' W	4411	
POS523_5-7	CTD 43	2018-05-16	19:51:19	29° 49.981' N	029° 40.015' W	4412	
POS523_5-8	CTD 44	2018-05-16	23:11:29	29° 49.983' N	029° 39.908' W	4411	no LADCP
POS523_5-9	CTD 45	2018-05-17	02:44:26	29° 50.030' N	029° 40.015' W	4412	no LADCP
POS523_5-10	CTD 46	2018-05-17	05:29:58	29° 49.987' N	029° 39.960' W	4411	no LADCP
POS523_5-11	µStruct 12	2018-05-17	08:12:12	29° 49.995' N	029° 39.980' W	4411	
POS523_5-12	CTD 47	2018-05-17	10:41:41	29° 50.006' N	029° 40.041' W	4413	
POS523_5-13	CTD 48	2018-05-17	13:41:25	29° 50.044' N	029° 39.974' W	4411	
POS523_5-14	CTD 49	2018-05-17	16:44:53	29° 50.097' N	029° 40.046' W	4412	
POS523_5-15	CTD 50	2018-05-17	19:51:34	29° 50.022' N	029° 40.010' W	4580	Salinity, Bio
POS523_5-16	µStruct 13	2018-05-17	23:04:55	29° 50.053' N	029° 39.657' W	4410	
POS523_6-1	Mooring	2018-05-18	08:32:26	30° 26.229' N	030° 16.150' W	4500	Deployment
POS523_6-2	µStruct 14	2018-05-18	12:47:41	30° 28.018' N	030° 11.554' W	4533	
POS523_7-1	µStruct 15	2018-05-19	00:10:26	31° 30.077' N	030° 19.999' W	4135	

Station	Gear	Date	Time (UTC)	Latitude	Longitude	Depth (m)	Samples, Remarks
POS523_7-2	CTD 51	2018-05-19	02:15:32	31° 29.965' N	030° 20.056' W	4151	
POS523_7-3	CTD 52	2018-05-19	05:05:47	31° 30.021' N	030° 20.006' W	4166	
POS523_7-4	CTD 53	2018-05-19	07:57:56	31° 30.004' N	030° 20.021' W	4151	
POS523_7-5	CTD 54	2018-05-19	10:47:40	31° 29.986' N	030° 19.987' W	4143	
POS523_7-6	µStruct 16	2018-05-19	13:22:20	31° 30.033' N	030° 19.978' W	4143	
POS523_7-7	CTD 55	2018-05-19	15:44:45	31° 30.108' N	030° 19.935' W	4144	
POS523_7-8	CTD 56	2018-05-19	18:33:26	31° 30.064' N	030° 19.990' W	4145	
POS523_7-9	CTD 57	2018-05-19	21:24:23	31° 30.001' N	030° 19.955' W	4147	
POS523_7-10	CTD 58	2018-05-20	00:15:31	31° 29.981' N	030° 19.963' W	4145	
POS523_7-11	CTD 59	2018-05-20	03:02:35	31° 30.043' N	030° 19.938' W	4136	
POS523_7-12	µStruct 17	2018-05-20	05:45:36	31° 30.028' N	030° 19.935' W	4139	
POS523_7-13	CTD 60	2018-05-20	07:54:10	31° 29.956' N	030° 20.008' W	4151	
POS523_7-14	CTD 61	2018-05-20	10:46:05	31° 30.040' N	030° 19.967' W	4150	
POS523_7-15	CTD 62	2018-05-20	13:19:01	28° 52.387' N	031° 57.413' W	4474	Salinity, Bio
POS523_7-16	CTD 63	2018-05-20	16:54:30	31° 30.009' N	030° 19.992' W	4152	
POS523_7-17	CTD 64	2018-05-20	19:44:52	31° 30.009' N	030° 20.008' W	4161	
POS523_7-18	µStruct 18	2018-05-20	22:29:11	31° 30.160' N	030° 20.086' W	4129	