Dezember 22, 2017
Edition 6

ENERGY INFLOW

www.trr-energytransfers.de

♫♫ It's beginning to look a lot like ♫♫ TRR 181 ♫♫

by Jennifer Fandrich

♫♫ Soon the bells will start, And the thing that will make them ring is the carol that you sing, Right within your heart.♫♫

Dear colleagues,
Starting our last newsletter for this year with a little song on the lips might be a good way to end this exciting year ☺.
But first we want to give you some new information on our project and especially thank everyone who helped realizing the TRR 181 vision!

What is inside this time?

There is a lot to explore in the ocean, as you can read in our cruise report. Furthermore we provide you as usual with information on new publications and upcoming events as well as **new reports from the scientific front**!

Let me introduce to you..

Content

...our new colleague Marion Timpf.

Marion will assist the TRR in supporting the maintenance of the media technology, especially the web conferences as well as updating the webpage and administrative tasks.

Marion Timpf

We wish all readers happy holidays and the best possible start to the New Year!

Fair Winds and Following Seas - A TRR Cruise Report

by Maren Walter

The Poseidon cruise Pos516 is part of the observational program of the Transregio. During the three week cruise in July/August 2017 starting and ending in Ponta Delgada on the Azores, we were nine people on board, scientists and students from Bremen and Hamburg working in the TRR projects W2 and W1.

left2right: Maren Walter, Jonas Löb, Janna Köhler, Wolfgang Böke, Florentina Münzner, Jan Stiehler, Brenda Quinn, Simon Rümmler, Natalia Sukhikh

The interior of the ocean is not at rest. Instead, there is movement and motion in all direction and on scales spanning from the thousands of kilometres of basin wide current systems to the millimetres of turbulence. The movements are driven mainly by tides and wind. The interaction between these different scales and the exchange of energy is not well understood. For example, tidal forcing at

Mooring deployment: (left) The yellow top float houses an acoustic current profiler. It will be monitoring the currents in the upper 250 m. (centre) The smaller current meters are combined with temperature loggers to obtain time series of current velocity and temperature at the same depths. (right) The current meter/temperature logger packages are attached to orange floatation. The floatation holds the mooring upright in the water and brings it back to the surface at the end of the deployment period. To the left of the instruments is the 1,4t anchor made of massive steel sheets.

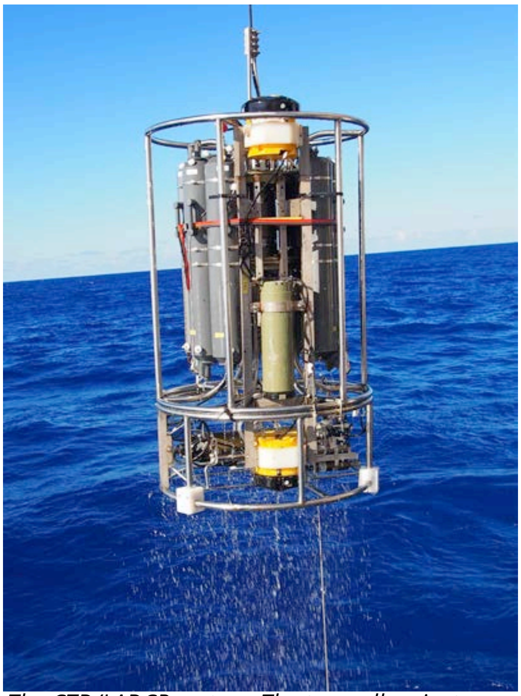
seamounts and continental shelves generates internal waves that could travel over hundreds of kilometres through ocean basins before finally disintegrating and dissipating. Their loss of energy is determined by a number of different processes and interactions, but the where and how of these processes is largely unknown. In W2, we aim to better understand the propagation and dissipation of tidal energy in the oceans' interior with the goal to better implement these processes in climate models.

To this end, the objective of the Poseidon cruise was to observe the energy fluxes along a tidal beam emanating from the seamounts south of the Azores southward towards the Cape Verde Islands. The main instrument used for these observations is the CTD, a Conductivity-Temperature-Depth probe. The CTD is mounted to frame, the water sampling carousel, which is additionally equipped with bottles to take water samples (sic!) and two lowered acoustic Doppler current profilers (LADCP). This instrument package is lowered from the ship on a cable to the seafloor, thus obtaining full depth profiles of the parameters recorded by the CTD as well as the ocean currents. The data from the CTD are received and displayed in real time in the lab on the ship. From the conductivity, temperature and pressure recordings the depth, the density, and hence the stratification of the seawater can be calculated. The internal waves we are looking for are apparent as periodic oscillations in the stratification.

The second instrument is the LADCP. It measures the ocean currents with the aid of the Doppler frequency shift of an emitted acoustic pulse reflected back to the instrument. Our system consists of two instruments, one mounted at the top of the water sampling unit and one at the bottom. During lowering and heaving of the system, these two instruments collect current profiles over the whole water column. The shear of the flow on vertical scales between 10 and several hundreds of meters (the so-called finestructure) gives us information about the energy of the internal wave field and its variability.

For the calculation of the internal wave energy fluxes we occupied several time series stations along the beam. Each station lasted between 36 and 48 hours, to observe variability associated with the semidiurnal as well as the diurnal tidal forcing, and possible the effect of inertial oscillations. The inertial period is determined by the coriolis frequency at the respective latitude and varies between 20 and 26 hours in our working area. During each of the time series stations we carried out between 10 and 15 CTD/LADCP profiles over a depth of up to 5000 m. Each of the individual profiles covers approximately 4 hours, depending on the depth. First results from our time series stations show a clear signal of the internal waves with an M2 tidal frequency. The amplitude of the waves has a maximum between 800 m and 1300 m water depths, where the isopycnal excursions are exceeding 100 m.

To observe long-term temporal variability, we also deployed a mooring within the tidal beam. It is equipped with current meters and temperature logger, to record energy fluxes and their variations over the course of one year. It will be recovered next May during the next cruise.



The CTD/LADCP system. The two yellow instruments are the current meters (LADCP), the grey tubes the bottles for water sampling. The CTD instrument is mounted transversely in the lower part of the frame.

Publications

Have you also published your work, but cannot find it here? Please get in touch with me.

Pollmann, F. & **Eden, C., Olbers, D.** (2017). Evaluating the Global Internal Wave Model IDEMIX Using Finestructure Methods. *American Meteorological Society*. doi: 10.1175/JPO-D-16-0204.1

Ovsyannikov, I. I., & Turaev, D. V. (2016). *Analytic proof of the existence of the Lorenz attractor in the extended Lorenz model.* Nonlinearity, 30(1), 115.

Upcoming events

January 16, 2018: TRR 181 seminar "Atmospheric Gravity Waves: Challenges and Solution Strategies"
The seminar is held by Dr. Ulrich Achatz (Goethe-Universität Frankfurt)

January 22, 2018: Parallel Programming Workshops
Introduction to parallel programming with MPI and OpenMP on January 22-26 at Jacobs University, Bremen.

January 25, 2017: TRR 181 seminar "Resolving the horizontal direction of internal tide generation"
The seminar is held by Friederike Pollmann (Universität Hamburg).

February 26 March 3, 2017: TRR 181 Winter school
The school is held at Tagungszentrum Hotel Hessenkopf in Goslar (Harz).

Reports from the scientific front

Each newsletter will contain short reports from the project scientists on their work and the progress they made. So everyone can keep up on new findings in the project. Enjoy!

Progress on CLVs in PUMA

By Sebastian Schubert, Postdoc in M1

I am Sebastian Schubert and I am a postdoc in sub project M1 “Instabilities across scales and statistical mechanics of multi-scale GFD systems”.

We would like to understand the multi-scale behaviour that is observable in the atmosphere using a spectral primitive equations models. For this, we use PUMA, a spectral primitive equation model, that is the dynamical core of PLASIM (Planet Simulator). For this purpose, we are studying instability of linear perturbations in a generalized framework which develop on chaotic backgrounds.

" *We would like to understand the multi-scale behaviour that is observable in the atmosphere using a spectral primitive equations model.*"

For this, we make use of the splitting of tangent linear space into a covariant Lyapunov basis as described by Osedelecs theorem.

Recently, we have studied the existence of a large fluctuation theorem for the Lyapunov exponents. The investigation is difficult because the computational effort only allows “short” time series of about 25 years. Our results show that there is convergence towards a rate function which describes the behavior of large fluctuations. Nevertheless, we did not find a growth dependent variation of the rate function. This means in order to find discriminating

properties that are growth dependent we really have to study the scale dependency of the CLVs. As a first step, we are investigating the fastest growing instabilities in comparison to their presence in the actual non-linear background state. We see a clear detachment of the scales present in the first CLVs after going to a resolution of T85 (128x256, 1.39° at the equator). Our objective is now to expand this analysis to leading linear instabilities (the CLVs) and see if there are trends of the dominating waves towards larger scales.

Gravity Wave Parameterisation for the Atmosphere

By Matthäus Mai, PhD W1

Gravity waves are an important part of the energy cycle of the atmosphere. They exchange momentum and energy with the mean flow due to wave breaking and wave refraction. In the subproject W1, we propose a new, energetically consistent gravity wave parameterisation, based on the radiative transfer equation for a field of waves.

Conventional parameterisations for gravity waves base on the assumption of stationary mean flow and a superposition of monochromatic waves launched at a certain level. The new scheme describes the wave field continuously in physical and wave number space. The IDEMIX concept (previously used for

" *The focus of W1 will be on the wave-mean flow interactions, i.e. the energy deposition and the gravity wave drag.*”

mixing by internal waves in the ocean) enables to simplify the radiative transfer equation with a few assumptions (propagation into a particular azimuth direction, single column approximation). The focus of W1 will be on the wave-mean flow interactions, i.e. the energy deposition and the gravity wave drag. This drag contributes strongly to drive the residual circulation in the middle atmosphere and to induce the quasi-biennial oscillation in the tropical stratosphere.

My part of the project is the derivation of realistic force functions of gravity waves (spatially and temporally continuous). These functions will contain gravity waves caused by flow over rough terrain, and convection and frontal activity. Another task will be the derivation of a vertical diffusion coefficient, which considers dynamical instability criterion. At last, this parameterisation has to be implemented in KMCM (Kühlungsborn Mechanistic general Circulation Model) and compared with the conventional schemes routinely used in KMCM and ICON.

Main content created by
Jennifer Fandrich
other authors are credited respectively

Telephone:
+49 (0)40 42838 5094

E-Mail:
trr181.cen@uni-hamburg.de

Web:
www.trr-energytransfers.de

Twitter:
@TRREnergy

Youtube:
TRR 181 Energy transfers in Atmosphere and Ocean

Something funny at the end ...