TRR 181 NEWSLETTER

ENERGY INFLOW

All new in May

Our wish for the new year of more offline events is slowly coming true: We started with hybrid seminar meetings and a lot of TRR members even spent 52 days together on research vessel METEOR - you can read more about the expedition in this newsletter. Finally we will now have the Spring School for the Early Career scientists offline in Plön - we are looking forward to see a lot of non-virtual faces there :) With this, we wish everyone a happy spring time. To quote a German saying: Alles neu macht der Mai (translated freely: See title).

In this Newsletter you find:

- a **report of Digital RTG Winter School**
- a **report of Expedition SONETT**
- a **report of the last two Art&Science events**
- **reports** from our new PhD and Postdoc in M2
- as usual the new publications and and outlook on what will happen in the next weeks

If you want to contribute to the newsletter, don´t hesitate to get in touch with me.

All the best,
Jennifer

Group Picture of the SONETT Cruise Team on research vessel Meteor

REPORT - DIGITAL RTG WINTER SCHOOL 2022

Text by Katharina Holube, PhD

From Monday to Wednesday, January 31 to February 2, the first part of the RTG spring school took place online. The second part is planned to take place in person in Plön in May.

On Monday afternoon, we started with a round of personal introductions, where we shared experiences from the weekend. After that, Knut Klingbeil taught the second part of the Numerics course. He combined the theory with hands-on programming exercises. The day concluded with teams competing in a Geotastic game as a social activity.

On Tuesday morning, every PhD and post-doc gave an ultra-short presentation about their work. To boost attention, this was combined with a game of bingo. In the following breakout sessions, any suggested topic could be discussed in groups. On this occasion, we have exchanged ideas about, for example, the SONNETT cruise, scientific writing, machine learning and activities in Plön.

A course on Good Scientific Practice by Ingenuin Gasser took place on Tuesday afternoon and Wednesday morning. It contained lively discussions about reliability and reproducibility of research results. A subsequent group discussion addressed challenges that we PhD students face. Most took the opportunity to discuss time management issues.

Finally, we held the RTG assembly and elected Florian, Ekaterina, Mariana and Ankit as PhD and Postdoc representatives in the TRR Vorstand and the RTG board.

We thank Lea Diederichsen and Jennifer Fandrich for organizing this informative school, and we are looking forward to offline scientific and social conversations in later spring!

REPORT FROM EXPEDITION M180 SONETT

by Manita Chouksey, Young PL in W2

A key part of the ocean observations in the second phase of TRR181 has been the M180 SONETT Expedition, which stands for Synoptic Observations - a Nested approach to study Energy Transfer & Turbulence in the ocean. The expedition has been recently completed amidst the pandemic on board RV METEOR in South Atlantic Ocean, with the aim to observe multiple processes that affect energy fluxes in the ocean and the ocean's exchange with the atmosphere.

TRR181 researchers from MARUM - Center for Marine and Environmental Sciences at the University of Bremen, the University of Bremen, the University of Hamburg, the Institute for Baltic Sea Research Warnemünde (IOW) and the Helmholtz Center Hereon participated in the expedition.

The working area for this expedition was the eastern South Atlantic Ocean, southeast of the Walvis Ridge, rife with internal tides and the so-called Agulhas eddies, which are formed at the southern tip of

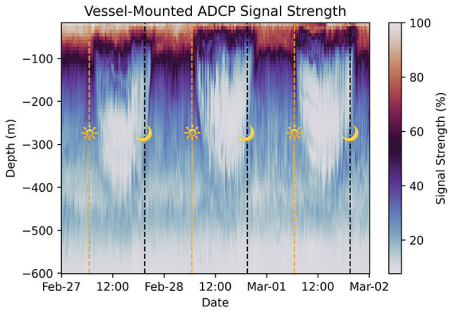
Africa and migrate northward through the Atlantic Ocean. In this region, these eddies interact with the internal tides generated at the Walvis Ridge, and affect the propagation and dissipation of internal tidal waves. Further, the eddies can also form fronts and so-called filaments at their edges, these processes occur at smaller scales referred to as the submesoscales. The observations included large to small scales and from the upper to the deeper ocean: the surface fluxes and waves, surface layer processes, mesoscale and submesoscale variability, horizontal mixing, internal wave energy fluxes, the interaction between internal waves and eddies, and the energy dissipation in the ocean interior.

To observe set of varied instruments were onboard RV METEOR to measure different quantities: CTD-LADCP-Rosette system, Vertical Microstructure Profiler (VMP), Microstructure Probe (MSS), Scanfish, Catamaran, Echolot, Gliders, Drifters, Wave radar, and Argo floats. The observations are complemented by high-resolution ICON SMT-WAVE simulations, an ocean circulation model with tidal forcing from the Max Planck Institute for Meteorology in Hamburg, Germany, which will allow to further understand the processes and characterize the energy balance of this ocean region, in combination with the observations.
The expedition started on February 23, 2022 in Montevideo (Uruguay) and ended on April 14, 2022 in Cape Town (South Africa), after sailing across the entire South Atlantic Ocean for 51 days, making it the longest research cruise so far on the research vessel RV METEOR. More information can be found in the logbook of the M180 SONETT Expedition and can be accessed here: https://www.marum.de/en/Discover/Logbuch-M180.html#section4981

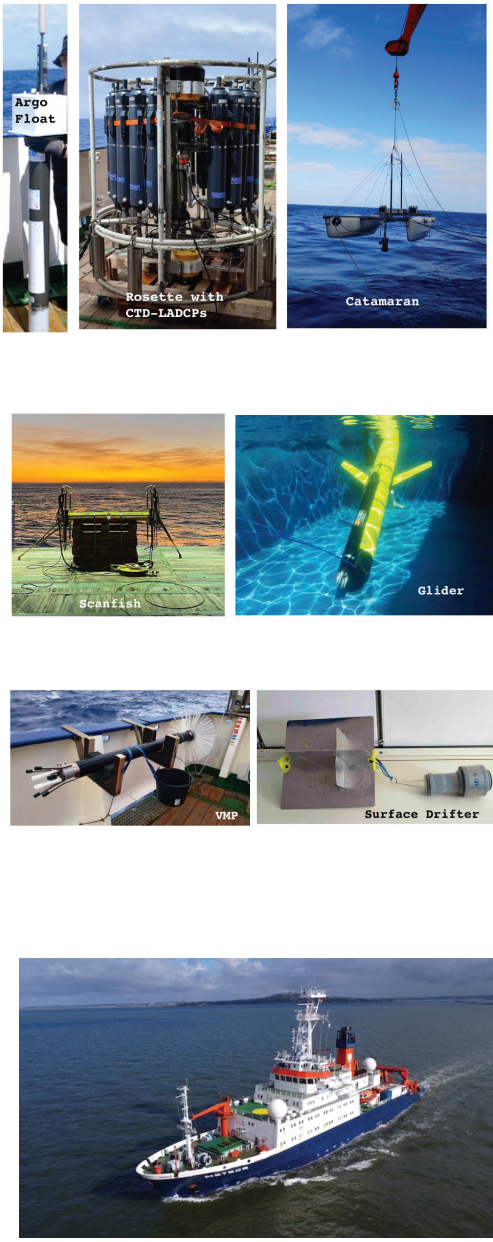
This is one example log entry by Ryan Mole:

11 March 2022: Little Things, Big Impacts

One of our instruments is attached to the bottom of the ship and runs almost constantly: the vessel-mounted ADCP fires pulses of sound down into the ocean and listens for any echoes coming back. When we know how long an echo took to return, and if the sound of it changed on its journey, we can calculate the speed and direction of water movements at different depths below the ship. Unfortunately, this means we get no measurements if there isn't anything in the water to return an echo.



When we look at the strength of the signal from this instrument since leaving Uruguay, a strange pattern emerges. During the night, we get information from all the way down to 600 metres where the echo becomes too quiet to hear. During the day, a gap in our signal starts to emerge just after sunrise and closes just after sunset. The strength of our signal increases near the surface whilst at the same time we get no echoes bouncing back from deeper waters, particularly around 300 metres.



Instruments used during the SONETT expedition, RV METEOR in the South Atlantic Ocean during the SONETT expedition

UPCOMING EVENTS

May 13, 2022
TRR 181 Seminar
The TRR 181 seminar is held by Fabien Roquet (University of Gothenburg).

May 16-20, 2022
TRR 181 RTG Spring School 2022
Offline event in Herberge Koppelsberg, Plön for all PhDs, Postdocs and Young PLs of the TRR.

May 23-27, 2022
EGU 2022, Vienna

June 2, 2022
TRR 181 Seminar
The TRR 181 seminar is held by Alberto Vela Martín (University Bremen).

June 2 2022
RTG ENERGY Meeting
Every second Thursday at 3 p.m. the TRR PhDs and Postdocs meet online to discuss their research and talk about current TRR issues.

June 14, 2022
Workshop: Gender Equality in Academia
This is the second workshop of the TRR's Career Development Programme, which is open to all female scientists in the TRR, but designed mainly for the female PhDs, postdocs and Young Project Leaders.

June 16 2022
RTG ENERGY Meeting
Every second Thursday at 3 p.m. the TRR PhDs and Postdocs meet online to discuss their research and talk about current TRR issues.

June 28-29, 2022
Scientific writing course
for RTG PhDs with Kimberly Crow

June 30, 2022
TRR 181 Seminar
The TRR 181 seminar is held by Fraser Goldsworth (University of Oxford)

June 30 2022
RTG ENERGY Meeting
Every second Thursday at 3 p.m. the TRR PhDs and Postdocs meet online to discuss their research and talk about current TRR issues.

September 27-29, 2022
TRR 181 Annual Retreat
The Retreat will take place at Dampland (Schleswig-Holstein).

PUBLICATIONS

Have you also published your work, but cannot find it here? Please get in touch with the project coordination. Members of the TRR 181 are printed in bold.

Ovsyannikov, I. (2022): **On the Birth of Discrete Lorenz Attractors Under Bifurcations of 3D Maps with Nontransversal Heteroclinic Cycles.** Regul. Chaot. Dyn. 27, 217–231, doi: https://doi.org/10.1134/S156035472202006X.

Noethen, F. (2022): **Well-Separating Common Complements for Sequences of Subspaces of the Same Codimension are Generic in Hilbert Spaces.** Anal. Math., doi: https://doi.org/10.1007/s10476-022-0124-z.

Ovsyannikov, I. and Ruan, H. (2022): **Classification of Codimension-1 Singular Bifurcations in Low-Dimensional DAEs.** Front. Appl. Math. Stat. 8:756699. doi: https://doi.org/10.3389/fams.2022.756699.

COMBINING THE MULTI-SCALE FINITE ELEMENT WITH STOCHASTIC SUBGRID INFORMATIONS

by Mouhanned Gabsi, PhD, M2

My name is Mouhanned Gabsi and I work as a PhD student at the University of Hamburg under the supervision of Prof. Dr. Jörn Behrens (University of Hamburg). I am part of the TRR subproject M2: Systematic Multi-Scale Modelling and Analysis for Geophysical Flows. M2 aims at systematically deriving new numerical and stochastic methods for the energyconsistent representation of subgrid-scale processes of geophysical flows. Beginning with a bit about myself, I got a bachelor degree in Mathematics and Applications at the University of Monastir (Tunisia), after that I persued a Master degree in Applied Analysis and Mathematical Physics at the University of Toulon (France) that I acquired with an internship of 6 months at the University of Paris Saclay under the supervision of Danielle Hilhorst and Ludovic Goudenège. The goal was to present numerical studies of iterative coupling for solving flow and geomechanics in a porous Medium. I started my work as part of TRR in April 2021. At the beginning, I spent more time in literature and reading papers to dicover the new environment that I am working on. Within this, I started to understand new scientific terms, phenomena and mechanisms related to Oceans, Atmosphere and Climate models and I found RTG course that I took in Mathematics, Oceanography, Meteorology and TRR meeting very helpful to me to acquire new knowledge and skills. After that, I defined my PhD reaserch project within the goal to combine Multi scale numerics with stochastic subgrid informations. Multi-scale numerical methods will address the research questions by providing a framework for coupling small-scale processes to the large-scale. Subgrid-scale parametrization is the mathematical procedure describing the statistical effect of sub-grid- scale processes on the mean flow that is expressed in terms of the resolved-scale parameters. In global atmospheric models, the range of processes which have to be parametrized is large and the characteristics of the different parametrized processes vary, e.g., atmospheric convection, gravity wave drag, vertical diffusion. The resolvedand the subgrid-scale processes in the Earth's atmosphere are the response to mechanical andthermal forcing, associated with the distribution of solar incoming radiation, topography, continents and oceans. There are several methods to improve the process of transferring information from the subgrid-scale to the coarse grid in a mathematically consistent way such as numerical multi-scale methods which are based on homogenization or the multi-scale finite element approach. This method is well established in porous media. The second method is stochastic, and in particular stochastic parametrization exploit the time scale difference between the slow resolved scale and the fast-unresolved scale to model the latter with random noise terms. This has many advantages such gain in computational timecompared to higher resolved simulations, reduction of model errors and systematic representation of uncertainties. A first task is to combine these two methods and to see if this combination inherently address conservation properties, or it pose an unnecessary overhead.

SUBGRID-SCALE PROCESSES OF GEOPHYSICAL FLOWS USING MACHINE LEARNING

by Dr. Rüdiger Brecht, Post-Doc M2

I am a postdoc at Universität Bremen and I work on new sub-grid methods as part of the project M2 . My research focuses on applying machine learning algorithms to geophysical fluid dynamics. Moreover, I organize the TRR Machine Learning Seminar, which takes place Tuesdays at 13:00 Uhr (everyone is welcome to join). Here, experts and newcomers meet to discuss project ideas or research results related to machine learning .

When a numerical simulation or data for a numerical simulation does not resolve the full dynamical scales, we need to simulate these missing dynamics. Unlike landscape or face pictures, geophysical data follows self-similarity such that learning the unresolved dynamics from data is a reasonable task. Especially for geophysical flow simulations an enormous amount of data has been stored in the last decades. Moreover, machine learning performs well when there is enough data available. Thus, I am working on applying machine learning tasks such as image super resolution to geophysical data.

Last year, I completed my PhD at Memorial University of Newfoundland, Canada. For my thesis, I used the shallow water equations to develop structure preserving discretization methods and a stochastic sub-grid model for efficient ensemble forecasting.

SOMETHING SCIENCEARTSY FOR THE END

"Choreatmosphere" at HfMT

"Die weiße Wand" at Thalia Theater

In the last weeks we had two successful presentations of the Art&Science Project. In February there was a first presentation of the music piece "Choreatmosphere: spatial intuitions of energy" by Victor Ernesto Gutiérrez Cuiza aka VictorPiano. The multimedia composer worked closely together with our TRR Phd Valentino Neduhal. This 20 minute piece is divided into five smaller movements. Valentino and Victor created a very atmospheric piece with data from Valentino and his supervisor Nedjeljka Žagar. In a room full of speakers in a 360 degree arragement at Hochschule für Musik und Theater in Hamburg we listened to the composition that also included a live performance of flute player Gabrijela Sušek. Currently victor is working to transfer the piece to a stereo system, so that it´s possible to listen to it also without this

very specialised 360 degree speaker system. The audience was touched and fascinated after each of the three presentations – Nedejljka even said she could hear the gravity waves – that is of course the expert scientist speaking, but it was incredible fascinating to hear the sounds moving through the whole room. We hope now to be able to present this piece to a wider audience again some time.

End of April then there was finally the presentation of theatre play "Die weiße Wand" at Nachtasyl in Thalia Theater in Hamburg – director Woody Mues developed together with writer Peter Thiers and TRR member Luby Bing aka Bing-ying Lu from University Bremen the play: „Die weiße Wand". It was an evening of storytelling. About seaman's yarn, monster waves and the question of whether we meet in fiction or in reality. Increasingly drunk, barmaid and sailor try to find each other. Lies and truth wrestle with each other - until the wave breaks. It was a full success – sold out for the premiere it was a good start into the evening. In a long queue on the stairs to the rooftop club in this beautiful building we waited in line to check in to the event. It was still under corona restrictions, so wearing the mask except while you are drinking was mandatory. Around 80 people gathered in Nachtasyl – that is a place with a bar, where usually plays or club nights take place. Actors Cathérine Seifert and Max Kurth gave an incredible intense and at the same time humorous performance. Director Woody is planning on presenting the play at a festival in northern Germany in summer and Thalia Theater Team is thinking about another presentation in fall. From TRR about 10 scientists have been in the audience – even some who didn´t understand the German text – Luby and Manita Chouksey have already ideas to translate this piece into an English version. This is work in progress.

It was wonderful to finally be able to see the results of these collaborations and also how the fundamental science of our project can be transferred in such new ways and thought patterns. Valentino and Luby told me they enjoyed the working with the artists very much and from what I can tell, the collaborations even may have opened new thought patterns on both sides. I would like to thank everyone and especially the ones I haven´t named in the text for being part of the projects and help realizing these events. We are looking forward to more repetition of these events and of course also new projects.

Main content created by Jennifer Fandrich, other authors are credited respectively
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