TRR 181 NEWSLETTER

ENERGY INFLOW

HAPPY NEW YEAR

This year it is a “new year” and not “end of the (last) year” newsletter - hopefully you all had a good start into 2022 and look confidently towards the new year. We wish that we can finally have more offline events where everyone can feel comfortable again. To make it even more desirable to meet again: We ordered and received new TRR merchandise that we would like to spread all over Bremen, Hamburg, Rostock and Frankfurt.

In this Newsletter you find:

- a **report of the M-Day in Bremen**
- a **report of the Warnemünde Turbulence Days**
- a **report of a research stay in the US**
- **reports** from our new PhD and Postdoc in M5 in L4
- as usually 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

M-Day in Bremen: Probably the last meeting in person some of us had last year!

REPORT - M-DAY IN BREMEN: IT´S ALL ABOUT MATHEMATICS!

Text by Rüdiger Brecht, Postdoc in M2

The M-Day took place on Monday, November 15th, 2021. On that day we met to exchange ideas on new mathematical concepts and new numerical methods. The low Corona Warnstufe in Bremen made it possible to meet in person and experience a normal conference-like retreat.

The M-Day started with a presentation from the subgroups M1, M2, M3, M5 and M7, where the Ph.Ds., Postdocs and PIs gave an overview of the ongoing research projects in Area M. Especially for the newcomers, this was a great opportunity to obtain an overview of the ongoing research projects.

The core part of the M-Day was that members of the M projects get to know each other. Furthermore,

to have in-person meetings with all the members of one each sub project, since not all members are at the same city or institution.

The presentations were followed by two talks given by Camilla Nobili and Florian Noethen, where we learned about the Batchelor scale and Lyapunov exponents.

After all these presentations we had a Q&A session, where questions from the earlier talks and presentations could be asked. Moreover, this gave a great opportunity to discuss more general research related problems concerning all M-Projects.

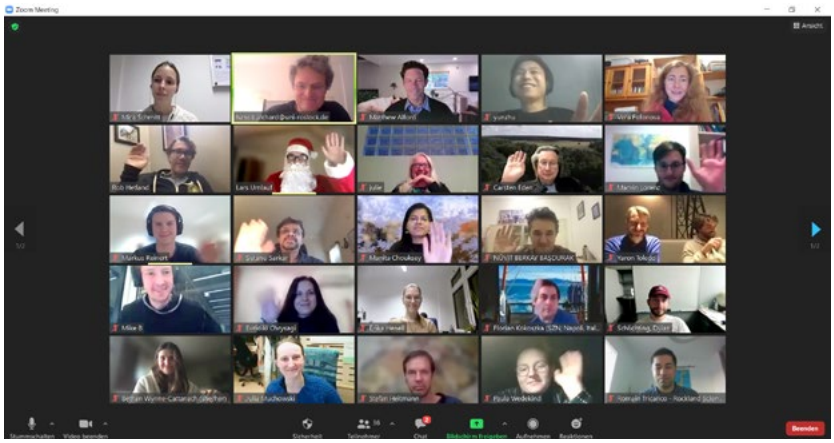
Finally, we ended the retreat with a forward-looking discussion: M-projects and TRR “From theory to practice”.

REPORT - 10. WARNEMÜNDE TURBULENCE DAYS (WTD)

Text by Lars Umlauf, Project leader in L4 (psssst: And Secret Santa)

From December 6-9, 2021 the Warnemünde Turbulence Days took place as an International Virtual Conference, partly funded by the TRR 181.

It was meant to be a small anniversary: From December 6 to 9, 2021, turbulence experts from all over the world were to meet on the tiny island of Vilm near Rügen to discuss their favorite topic in a relaxed atmosphere on the occasion of the 10th Warnemünde Turbulence Days (WTD). The WTD, which has been held every two years since 2003, had become one of the most important international workshops for turbulence and mixing in the ocean over the last two decades. This was to be celebrated together with the more than 60 registered participants from all over the world in the great meeting rooms of the International Conservation Academy on the island of Vilm. Unfortunately, the steeply increasing corona numbers at the beginning of December put a spanner in the works. The workshop, this time focusing on “Interfaces and Turbulent Boundary Layers,” had to be switched to an online-only format at the last minute, which presented some challenges, especially in program planning, with speakers and audiences spread across 16 time zones. To give participants at least a hint of a workshop and island feel, a virtual island was set up especially for people to meet for informal conversation during workshop breaks. In any case, the switch to a virtual format did little to dampen the enthusiasm of the participants. The discussions remained exciting and engaging right to the end - and the number of participants stable. And at the very end, everyone was even rewarded by the appearance of Santa Claus (see photo)!



A MEMORY OF PRE-PANDEMIC TIMES AND A GLIMPSE AT THE HOPEFULLY SOON-TO-BE FUTURE: MY VISIT AT MIT AND THE AGU FALL MEETING 2021

Text by Georg Sebastian Voelker, Postdoc in W1, S2

Having been in the home office for a long time during the last two years I am sure everyone wonders: Remember how things were before the virus hit? And how things will be afterwards? I was asking myself the very same questions while having a travel grant available I had won mid 2020 from the DFG research unit MS-GWaves which was still sitting in the accounts waiting to be used. My visit had been planned for a long time but had also been delayed by the pandemic. So when the US started opening up to foreign visitors in late summer 2021 I decided to try to move forward with the plan we had been setting aside for so long. And despite the restrictions and insecurities linked to long distance travel I should very soon be rewarded. On November 8 I boarded an airplane to Cambridge, Massachusetts to visit the long research partner of out group, Prof. Triantaphyllos Akylas at the Massachusetts Institute of Technology.

Our former and ongoing research project with T. R. Akylas is concerned with the background-modulated wave-wave interaction of internal gravity waves. In a previous manuscript we had been able to show that wave modulation by a sheared mean flow can significantly inhibit the energy exchange through a near-resonant triadic interaction. However, the assumptions of Boussinesq dynamics and a constant stratification limited the applicability of the findings to the atmospheric context. We thus took on the task to extend the theory to semi-incompressible dynamics with both a variable stratification and sheared mean winds. Having derived the theory beforehand we used the 5 weeks together

at MIT to explore the combined effects of the modulation by the wind and the stratification on the wave interaction. Interestingly the two modulation mechanisms can counteract each other opening up the possibility of strong interactions in regions with both changing stratification and strong shear. As the tropopause region typically exhibits these features it is of particular interest to be studied. A manuscript is now in preparation and planned to be submitted later this year.

Having already traveled to the US another possibility opened for me: the in-person attendance of the fall meeting of the American Geophysical Union in New Orleans. Traveling to conferences has always been one of my favorite parts of being a scientist. I am particular fond of getting to know places and people, exchanging ideas about our research, networking among peers and like-minded people and making friends throughout the world. The idea of attending a conference on site for the first time in two years was therefore especially tempting for me. Even though it came with the huge insecurity of sharing the venue with another 10,000 people during a pandemic the stringent health policies helped keeping the participants safe and the number of infections low.

With two successful talks, one on my research at the CRC181 and one on my science policy activities, I am more than happy with the received exposure and appreciation of our work. Fostering existing connections and forging new ones additionally rendered the conference experience as a very positive one. But maybe most importantly, I also realized what I had been missing out in the past months. Even though video conferences can account for the majority of the scientific collaboration it will not be able to replace the experience of and the human relationships associated to a person to person contact. Partnerships are build on these relationships and I am hoping that there will be a time soon where

we can find a way to get back together. Personally I feel motivated to move forward and make progress in ways that I had not expected when I boarded that airplane on November 8. I would therefore like to particularly thank the CRC181, the research group MS-GWaves, the Wilhelm-Heraeus Visiting Professorship program and not at last Prof. Ulrich Achatz and Prof. Triantaphyllos Akylas for enabling this collaboration and the conference participation for me.

AN IN-DEPTH STUDY OF DIURNAL WARM LAYERS: QUANTIFICATION OF AIR-SEA INTERACTIONS

by Mira Shevchenko, Postdoc, L4

In July 2021 I joined the TRR 181 as a postdoctoral researcher in the project L4, "Energy-Consistent Ocean-Atmosphere Coupling". Within this project I am studying the

phenomenon of diurnal warm layers (DWLs) in the ocean. It describes the warming of the sea surface in certain areas during daytime (by up to 2K, though in particular cases also higher fluctuations have been observed) compared to the surrounding ocean that usually keeps an almost constant surface temperature.

From the point of view of air-sea interactions the appearance of DWLs is of particular interest, since such differential heating can promote a sea breeze like convective movement and, as a result, serve as a cloud building mechanism. Moreover, as such warm spots appear due to solar radiation, one can also expect a feedback behaviour caused by an increase in the cloud cover.

The presence of DWLs as well as their influence on the cloud amount is well documented in the literature, at least in the qualitative sense. Moreover, this phenomenon has been confirmed in idealised simulation studies. However, most modern global coupled simulations do not capture this mechanism, since it requires a high vertical resolution of the sea levels in order to correctly represent the heat transport (involving only about 20m in the vertical), but also a high horizontal resolution in the atmosphere that would permit to directly resolve convection. My work in the project consists in implementing a simulation that would incorporate both these features. This has been made possible thanks to recent model development advances for the ICON models at the Max Planck Institute for Meteorology. A subsequent analysis of the output will improve the understanding of the phenomenon itself, in particular permitting to quantify the feedback mechanisms, but it will also clarify how significant of an influence the correct representation of DWLs has on the global cloud amount, and, as a consequence, on the climate described by the simulation. Such results would, moreover, enable a parametrisation of this phenomenon such that it can be included in lower resolution models in order to improve their performance.

Within the project L4 I work under supervision of Cathy Hohenegger at the MPI for Meteorology and collaborate mainly with Nils Brüggemann, Lars Umlauf and Mira Schmitt who already implemented a set of thin layer ocean simulations and contributed significantly to my understanding of the mechanisms involved.

Prior to joining the TRR 181 I spent several years doing research in Probability Theory. After obtaining my Master's degree at the HU Berlin I went on to complete my PhD at the TU Dortmund with a research stay at the University of Lille. During my doctorate I studied stochastic (partial) differential equations driven by random processes or fields with long memory, i.e. such that the increment correlation decays only slowly over time. An example is the fractional Brownian motion. Using techniques from the Malliavin-Stein toolkit (providing a definition for multiple stochastic integrals

with respect to Gaussian processes and many limiting results for those) I proved in several collaborations limit theorems for certain functionals of the solutions of such equations. From the practical point of view, this enabled me to derive results in mathematical statistics and provide estimators for different quantities in such equations as well as show their asymptotic properties.

After defending my dissertation I stayed at the TU Dortmund as a postdoctoral researcher. During this time I studied (in another collaboration) random fields on a sphere. Such objects are used in cosmology to describe cosmic microwave background, but they can also be applied to analyse other random spherical observations such as, for instance, temperature defects.

I am fascinated by such theoretical results but also by their various fields of application. I hope to be able to use some of the models that I studied in order to assess the impact of DWLs and/or to describe other phenomena in the atmosphere and ocean that would help advance the understanding and modelling of physical processes on different scales.

THE IMPACT OF SUBMEOSCALES ON THE AIR-SEA EXCHANGE

by Moritz Epke, PhD, L4

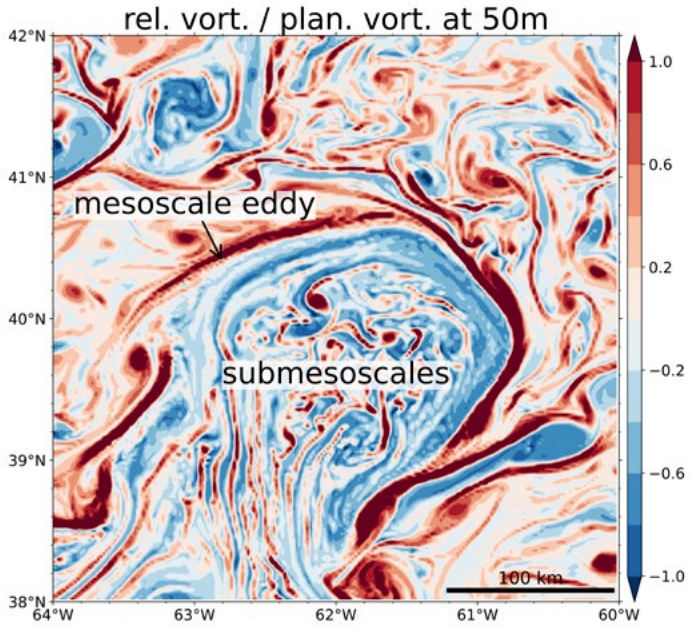
Hello everyone,
my name is Moritz Epke and I am pleased to give you a small impression of my work at TRR. I am part of the subproject L4 „Energy consistent ocean atmosphere coupling", which investigates small scale and balanced processes and their impact on feedback mechanism between atmosphere and ocean. Before I go into more detail, maybe a few words about my background. I moved to Hamburg to study theoretical mechanical engineering at the Hamburg University of Technology. My interest in the physics of fluids grew and grew through my studies and drove me to focus on this topic and related numerical solution approaches. In my thesis I developed and implemented a lattice Boltzmann scheme to efficiently simulate non-isothermal flows, which I benchmarked on standard testcases like Rayleigh-Bénard convection in a cavity and which I used to simulate the internal cooling of a turbine blade by a turbulent flow.

While most engineering applications have setups with scales from less than a centimeter as in a pipe flow, or up to a few hundred meters as in a large ship, the ocean and the atmosphere have scales that are orders of magnitude higher. Even if we make use of clever approximation techniques to simplify the governing equations in order to reduce the computational effort, we can only carry out coupled climate simulations with roughly ten-kilometer (ocean) grid spacing on a modern supercomputer. In such a simulation an 80km ocean eddy would only be coarsely resolved. The

computational surplus to resolve more scales in long-term simulations is simply too high. What cannot be resolved is usually parameterized or neglected. If parameterized, a model is developed which is based at best on a physical relationship between the relevant parameters. These parameterizations are then tested and optimized in idealized or regional setups. If now such parameterizations or insufficient parameterizations are used, the model is most likely subject to biases. These types of biases might have a strong impact on the energy consistency.

In the first phase of my PhD I am using an ICON submesoscale telescope simulation, which is based on an unstructured grid and allows us (for a short time period) to use an extremely fine spatial resolutions of up to 600m in the focus region. If we look again at an 80km ocean eddy, which is now well resolved, we can see small scale coherent structures that we associate with the submesoscale (see figure) and define to be smaller than the first baroclinic Rossby radius of deformation.
It is an objective to understand

and quantify the impact of submesoscale dynamics like baroclinic and symmetric instabilities on the downward heat and energy transfer and their role for ocean-atmosphere interactions. Here, I will investigate on the potential impact of submesoscale dynamics on the sea surface temperature or the influence of wind on instabilities at ocean fronts. Therewith, I aim to obtain a better understanding of submesoscale dynamics and their role in the coupled ocean-atmosphere system. This improved understanding might ultimately lead to improved parameterizations and therewith less biases in the coupled climate models.



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.

Prugger, A., Rademacher, J. D. M., & Yang, J. (2021): **Geophysical fluid models with simple energy backscatter: explicit flows and unbounded exponential growth.** https://arxiv.org/abs/2105.14728

Merckelbach, L.M. and **Carpenter, J.R. (2021): Ocean Glider Flight in the Presence of Surface Waves.** J. Atmos. Ocean Tech., 38(7), 1265-1275, doi: 10.1175/JTECH-D-20-0206.1.

Funke, C.S., **Buckley, M.P., Schultze, L.K.,** Veron, F., Timmermans, M.E., & **Carpenter, J.R. (2021): Pressure fields in the airflow over wind-generated surface waves.** J. Phys.Oceanogr., doi: 10.1175/JPO-D-20-0311.1.

Eden, C., Olbers, D. & Eriksen, T. (2021): A closure for lee wave drag on the large-scale ocean circulation. J. Phys. Oceanogr., doi: https://doi.org/10.1175/JPO-D-20-0230.1.

Löb, J., Köhler, J., Walter, M., Mertens, C., & Rhein, M. (2021). Time Series of Near-Inertial Gravity Wave Energy Fluxes: The Effect of a Strong Wind Event. J. Geophys. Res.-Oceans, doi: https://doi.org/10.1029/2021JC017472.

UPCOMING EVENTS

January 20, 2022
TRR 181 Seminar
The TRR 181 seminar is held by Manita Chouksey (UHH) on January 20, 11 am.

January 27, 2022
TRR 181 Interview Series
The TRR 181 Interview is held by Manita Chouksey (UHH) and Christian Mertens (UHB) on January 27, 11 am.

January 27-February 4, 2022
RTG Winter School 2022
vent for all PhDs, Postdocs and Young PLs of the TRR

February 10, 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.

February 21 - April 13, 2022
SONETT Cruise

February 24, 2022
TRR 181 Seminar
The TRR 181 seminar is held by Nedjeljka Žagar (UHH) on February 24, 11 am.

February 24, 2022
RTG ENERGY Meeting

March 10, 2022
RTG ENERGY Meeting

March 16-17, 2022
Workshop of "Career Development Programme"
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.

March 24, 2022
RTG ENERGY Meeting

April 3-8, 2022
EGU 2022, Vienna

SOMETHING ARTSY FOR THE END

by AI https://app.wombo.art/

This is a portrait AI WOMBO ART creates when you give the AI the words "Energy transfers in Atmosphere and Ocean"

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