Waves to Weather

Newsletter Jan/Mar 2022

Welcome to the Spring edition of the W2W newsletter. To go with the birds and flowers, new research results are sprouting everywhere and we've highlighted a bunch of them here. As always, we report on our ongoing activities, this time including links to video recordings of two lectures.

Please enjoy, and let us know if you have any comments or questions!

George Craig

Contents

Upcoming events

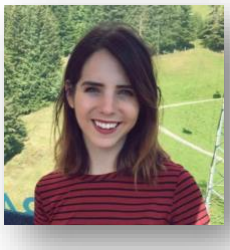
- A **W2W ECS workshop on improving writing skills** will take place online on 22 April 2022 and will last half a day. A panel of W2W PIs and external guests will provide feedback to the participants. To learn more, visit: https://www.wavestoweather.de/meetings/ecs-writing-workshop2022a
- A **W2W ECS workshop on scientific writing**, including setting priorities in the writing process, developing a clear main message, and structuring the text will take place on 5-6 May 2022 online. To learn more, visit: https://www.wavestoweather.de/meetings/ecs-writing-workshop2022b
- A **W2W hands-on workshop** will take place on 4 September 2022, on the Sunday before the EMS Annual Meeting in Bonn, Germany, to showcase the tools developed in W2W to the scientific and operational communities. Save the date and stay tuned! Visit: https://www.wavestoweather.de/meetings/hands-on-workshop-sep2022
- The **Mathematics of the Weather conference** will take place from 4-6 October 2022 in Bad Orb with the support of W2W and in collaboration with the HIWeather programme of WMO. Registration opens on 1 March 2022 and deadline for abstract submission is 30 June 2022. For more information, visit: https://www.wavestoweather.de/meetings/mow2022
- The **review meeting for Phase 3 of W2W** will take place in Mainz from 23-24 February 2023.

Additional information on upcoming events can be found here: http://www.wavestoweather.de/meetings

News

Bettina Wiebe (A2 project, JGU) defended her PhD on 10 December 2021. Congratulations, Bettina! We wish you all the best for your career developments!

Since 15 January 2022, **Tijana Janjic-Pfander** (B6 project) is a Heisenberg Professor of data assimilation at the Mathematical Institute for Machine Learning and Data Science in the Faculty for Mathematics and Geography of the KU Eichstätt-Ingolstadt, in Germany. Congratulations, Tijana, for this new position! We look forward to continuing working with you!



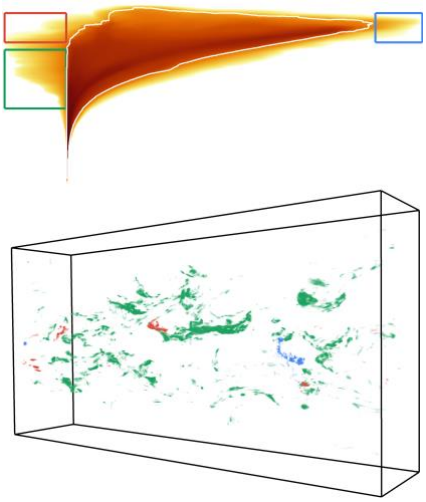
Maria Madsen did her PhD at the University of Wisconsin-Madison and is now part of project A8 where she investigates the dynamics of weather regimes with a linear inversed model as a Postdoc at JGU Mainz and closely with the A8 project partners at KIT.
Welcome in W2W, Maria!

Joshua Dorrington did his PhD in Oxford and is now starting his Postdoc in the transfer project T2 at KIT where he identifies long range precursors to extreme weather events for the next two years.
Welcome in W2W, Josh!

Research Highlights

Here are some examples of recently published research from W2W.

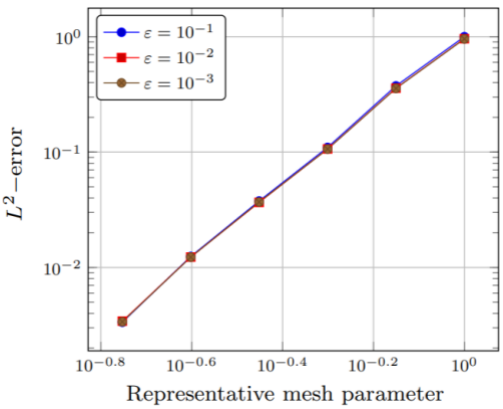
1. Uncertainty in Continuous Scatterplots, Continuous Parallel Coordinates, and Fibers (B. Zheng and F. Sadlo)



This work introduces uncertainty to continuous scatterplots, continuous parallel coordinates, and fibers of bivariate fields. Scatterplots and parallel coordinates are probably the most widely used visualization techniques for bivariate and multivariate discrete data, and their extension to the continuous case made them applicable for fields. Our contribution extends these powerful tools to the uncertain continuous domain, and thus enables analysis of, e.g., averages of measured data or simulated ensembles.

Read the full article: https://ieeexplore.ieee.org/document/9222253

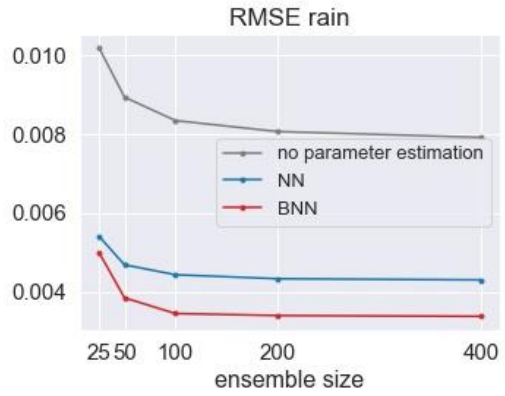
2. Asymptotic properties of a class of linearly implicit schemes for weakly compressible Euler equations (V. Kučera, M. Lukáčová-Medvid'ová, S. Noelle and J. Schütz)



As atmospheric flows are weakly compressible, efficient numerical schemes need to be developed to handle large scale differences between the acoustic and advective waves. We analyzed two well-known numerical schemes that have been successfully used in the literature to approximate low Mach number flows. Although different in type, numerically, both schemes perform very well in a singular limit as the Mach number (ε) tends to 0. We developed a unified theoretical framework for a class of linearly implicit schemes which are based on time implicit approximation of the underlying acoustic system. We proved that our class of linearly implicit schemes are asymptotic preserving, i.e. they yield consistent and convergent approximation of the limiting system, the incompressible flow equation.

Read the full article: https://doi.org/10.1007/s00211-021-01240-5

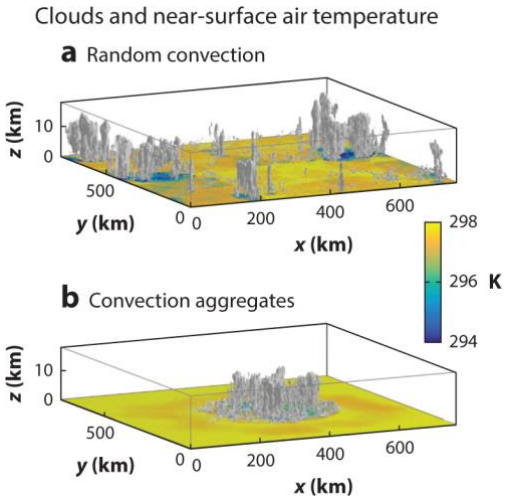
3. Combining data assimilation and machine learning to estimate parameters of a convective-scale model (S. Legler and T. Janjić)



We train a Bayesian neural network (BNN) and an ensemble of point estimate neural networks (NN) to estimate several model parameters and their uncertainty as a function of the atmospheric state. Experiments with the one-dimensional modified shallow water model show that the BNN and the NN are able to estimate the model parameters and their relevant statistics. In addition, once combined with data assimilation for the state estimation, the state errors decreased even when assimilating sparse and noisy observations.

Read the full article: https://doi.org/10.1002/qj.4235

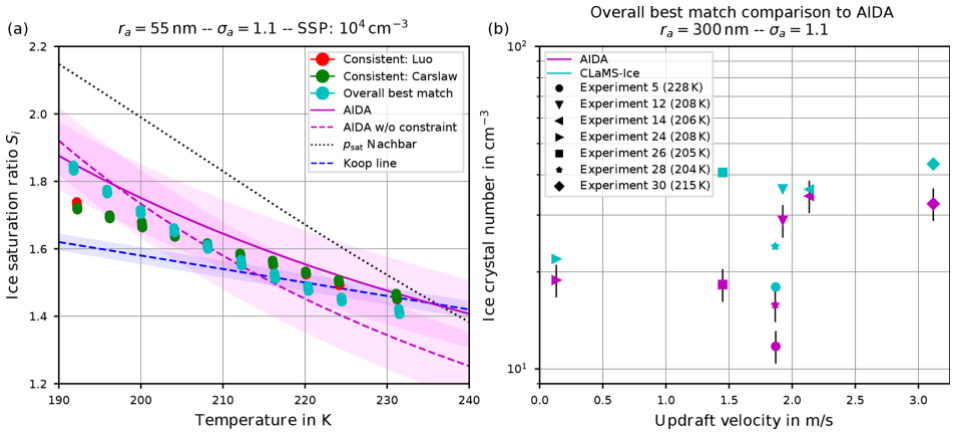
4. Spontaneous Aggregation of Convective Storms (C. Muller, D. Yang, G. Craig, T. Cronin, B. Fildier, J. O. Haerter, C. Hohenegger, B. Mapes, D. Randall, S. Shamekh, and S. C. Sherwood)



Idealized simulations of the tropical atmosphere have predicted that clouds can spontaneously clump together in space, despite perfectly homogeneous settings. This phenomenon has been called self-aggregation, and it results in a state where a moist cloudy region with intense deep convective storms is surrounded by extremely dry subsiding air devoid of deep clouds. We review the main findings from theoretical work and idealized models of this phenomenon, highlighting the physical processes believed to play a key role in convective self-aggregation. We also review the growing literature on the importance and implications of this phenomenon for the tropical atmosphere, notably, for the hydrological cycle and for precipitation extremes, in our current and in a warming climate.

Read the full article: https://doi.org/10.1146/annurev-fluid-022421-011319

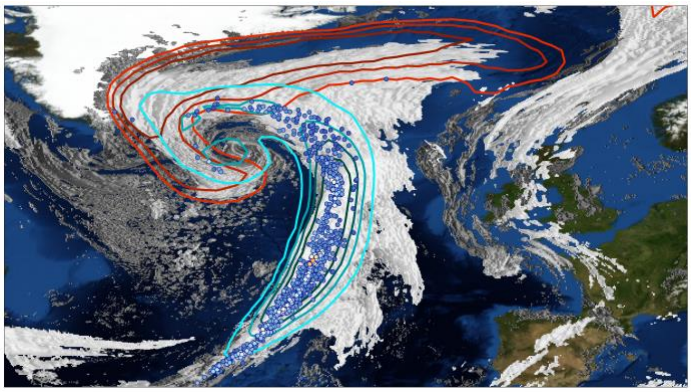
5. New investigations on homogeneous ice nucleation: the effects of water activity and water saturation formulations (M. Baumgartner, C. Rolf, J.-U. Grooß, J. Schneider, T. Schorr, O. Möhler, P. Spichtinger and M. Krämer)



Laboratory measurements at the AIDA cloud chamber and airborne in situ observations suggest that the homogeneous freezing thresholds at low temperatures are possibly higher than expected from the so-called “Koop line”. This finding is of importance, because the ice onset relative humidity affects the cirrus cloud coverage and, at the very low temperatures of the tropical tropopause layer, together with the number of ice crystals also the transport of water vapor into the stratosphere. Both the appearance of cirrus clouds and the amount of stratospheric water feed back to the radiative budget of the atmosphere. We re-examine the entire homogeneous ice nucleation process, ice onset, and nucleated crystal numbers, by means of a two-moment microphysics scheme embedded in the trajectory-based model (CLaMS-Ice). We present extensive sensitivity simulations testing the influence of three different formulations for the water activity and four for the water saturation on homogeneous ice nucleation.

Read the full article: https://acp.copernicus.org/articles/22/65/2022/

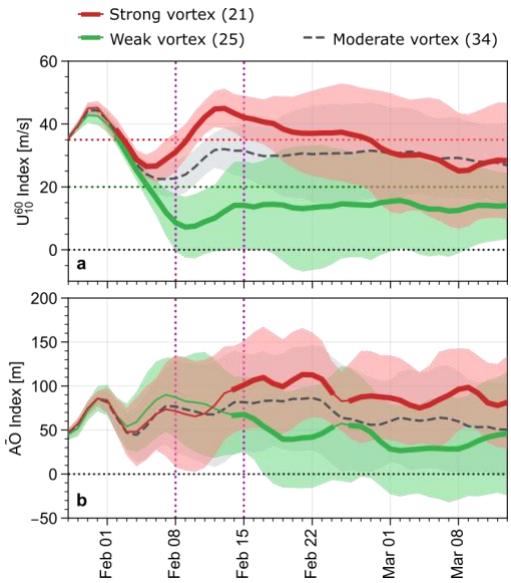
6. EuLerian Identification of ascending AirStreams (ELIAS 2.0) in numerical weather prediction and climate models (J. Quinting, C. Grams, A. Oertel and M. Pickl)



Warm conveyor belts (WCBs) are rapidly ascending coherent airstreams in midlatitude low pressure systems. The physical processes embedded therein importantly affect the midlatitude large-scale circulation and are a source of forecast uncertainty. In Part I, we introduce an artificial intelligence-based diagnostic which successfully identifies footprints of WCB inflow, ascent, and outflow at comparably low computational costs and from data at low spatial and temporal resolution. The diagnostic thus newly enables the systematic investigation of WCBs in large data sets such as ensemble reforecasts and climate model projections. In the companion paper Part II, we highlight the versatility of the diagnostic by applying it to reanalysis data, a large set of operational ensemble forecasts and a convection-permitting simulation with the ICOsahedral Nonhydrostatic (ICON) model (see Figure). Overall, we aim to demonstrate how deep learning methods can be used efficiently to support process-oriented understanding of forecast error and model biases.

Read the full articles: https://doi.org/10.5194/gmd-15-715-2022 and https://doi.org/10.5194/gmd-15-731-2022

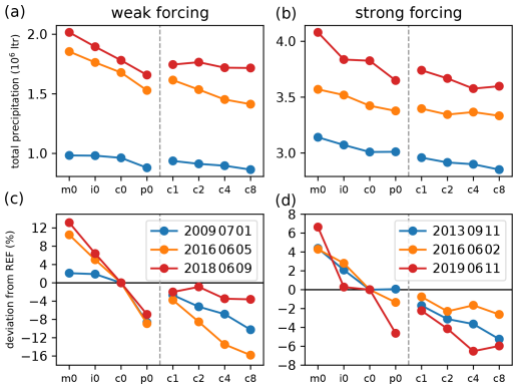
7. Potential links between tropospheric and stratospheric circulation extremes during early 2020 (P. Rupp, S. Loeffel, H. Garny, X. Chen, J. G. Pinto and T. Birner)



We study the connection between periods marked by extreme strength of the Atlantic jet and the stratospheric polar vortex during early 2020. Employing sets of numerical ensemble simulations we find the extreme vortex strength to be linked to the reflection of upward propagating planetary waves and a generally robust coupling between tropospheric and stratospheric anomalies: ensemble members with anomalously strong polar vortex tend to exhibit a stronger tropospheric jet and vice versa. Despite indications for vertical coupling, our simulations underline the role of internal variability within each atmospheric layer.

Read the full article: https://doi.org/10.1029/2021JD035667

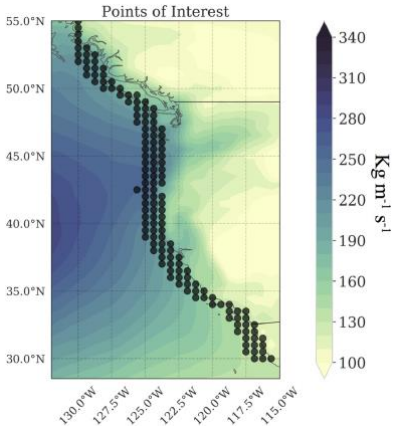
8. Importance of aerosols and shape of the cloud droplet size distribution for convective clouds and precipitation (C. Barthlott, A., Zarboo, T., Matsunobu, C. Keil)



The relative impact of cloud condensation nuclei (CCN) concentrations and the shape parameter of the cloud droplet size distribution is evaluated in realistic convection-resolving simulations. We find that an increase in the shape parameter can produce almost as large a variation in precipitation as a CCN increase from maritime to polluted conditions. The choice of the shape parameter may be more important than previously thought for determining cloud radiative characteristics.

Read the full article: https://doi.org/10.5194/acp-22-2153-2022

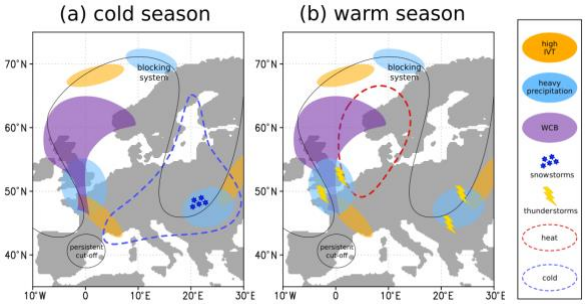
9. Probabilistic Predictions from Deterministic Atmospheric River Forecasts with Deep Learning (W. E. Chapman, L. Delle Monache, S. Alessandrini, A. C. Subramanian, F. M. Ralph, S.-P. Xie, S. Lerch and N. Hayatbdini)



Post-processing methods for predicting integrated vapor transport over the North American West Coast based on convolutional neural networks (CNNs) are proposed and compared to an analog ensemble approach. The deep learning methods allow for generating well-calibrated and accurate probabilistic forecast from deterministic inputs, and can be efficiently estimated from around 10 years of reforecast data.

Read the full article: https://doi.org/10.1175/MWR-D-21-0106.1

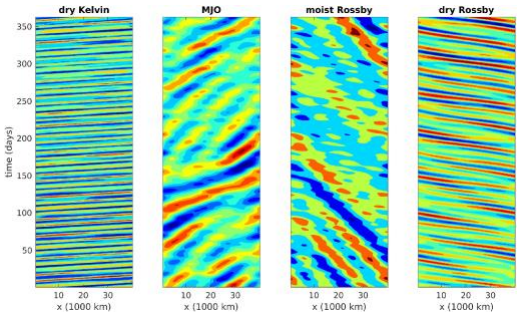
10. Atmospheric Blocking and Weather Extremes over the Euro-Atlantic Sector - A Review (L.A. Kautz, O. Martius, S. Pfahl, J.G. Pinto, A.M. Ramos, P.M. Sousa and T. Woollings)



Atmospheric blocking is associated with stationary, self-sustaining and long-lasting high-pressure systems. They can cause or at least influence surface weather extremes, such as heat waves, cold spells, heavy precipitation events, droughts or wind extremes. The location of the blocking determines where and what type of extreme event will occur. These relationships are also important for weather prediction and may change due to global warming.

Read the full article: https://doi.org/10.5194/wcd-3-305-2022

11. Ensemble Kalman filter based data assimilation for tropical waves in the MJO skeleton model (T. Gleiter, T. Janjić and N. Chen)



The Madden-Julian oscillation (MJO) is the dominant component of tropical intraseasonal variability with wide reaching impacts even on extratropical weather and climate patterns. However, predicting the MJO is challenging. Since the memory of initial conditions is long in the tropics, it could be beneficial for the MJO prediction to improve on standard data assimilation (DA) approaches that are typically based on filtering methods with Gaussian approximations and do not consider physical properties. In this paper, a constrained ensemble DA method is applied to study the impact of different physical constraints on the state estimation and prediction of the MJO and associated tropical waves. We show that a constraint to the truth's nonlinear total energy, statistically improves forecasts and can in certain situations even prevent filter divergence.

Read the full article: https://doi.org/10.1002/qj.4245

Additional publications relevant to W2W are listed here:
http://www.wavestoweather.de/publications

Past activities

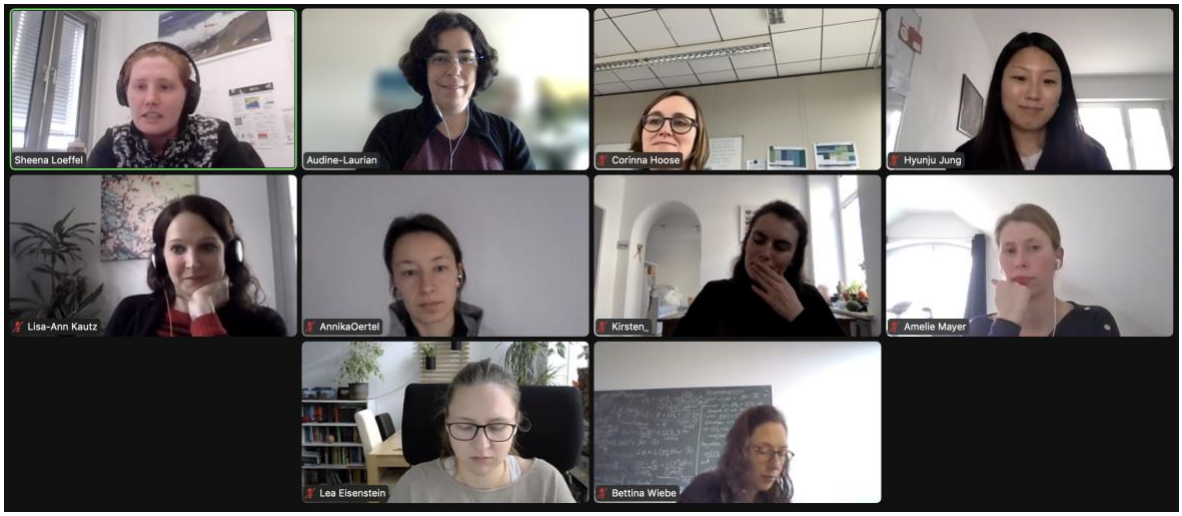
W2W Women Workshop

On 17 January 2022, 15 participants including three PIs took part in a workshop on “Gender Aspects of Communication” covering general strategies such as recognizing, addressing, and reacting to mansplaining, impostor syndrome and biases. The first part of the workshop was a well-structured presentation, which provided a broad perspective on, and many scientific references addressing these issues. The participants were then split in smaller groups to discuss and present the muted group theory and the co-cultural communication theory (https://en.wikipedia.org/wiki/Muted_group_theory, and https://en.wikipedia.org/wiki/Co-cultural_communication_theory). A second round of small discussions focused on the personal experience of the participants regarding the impostor syndrome and mansplaining, manterrupting and manologues. These smaller group discussions provided a forum to exchange personal anecdotes and suggestions on how to react.
By sharing his personal experience, Muriel Aichberger (https://www.murielaichberger.de) was able to create an open and friendly environment that stimulated communication and exchange.

Participants of the workshop on 17 January 2022

On 31 January, 1 and 2 February, thirteen W2W women from Master and PhD students to PIs took part in individual voice trainings. The trainings included breathing and articulation exercises in German or in English. The coach was very experienced and provided honest feedback, as well as exercises to practice at home.

The third and last part of the W2W women workshop consisted in small group discussions about sharing personal experience, exchanging best practice, books, and useful techniques to overcome personal and professional gender-related challenges. Nine women took part in this last session on 8 February 2022. The small group size provided a great opportunity to share personal challenges. In these pandemic times, this opportunity was very welcome. One highlight was to realize that these gender-related issues are not taboo, and that the participants were not alone, having to deal with similar issues at their workplace and in their personal life.



Participants of the workshop on 8 February 2022

Overall, the format of the workshop with three different sessions a few weeks apart from each other was very good, allowing for self-reflection and take-home messages between sessions.
You can read more about the workshop here:
https://www.wavestoweather.de/meetings/women-workshop-2022

Seminars and guest program

Read about the **W2W Fellows program** here:
https://www.wavestoweather.de/guest

Information about previous **guest scientists** invited by W2W is posted here:
http://www.wavestoweather.de/guest

Past and upcoming **W2W seminars** are listed here:
http://www.wavestoweather.de/seminars

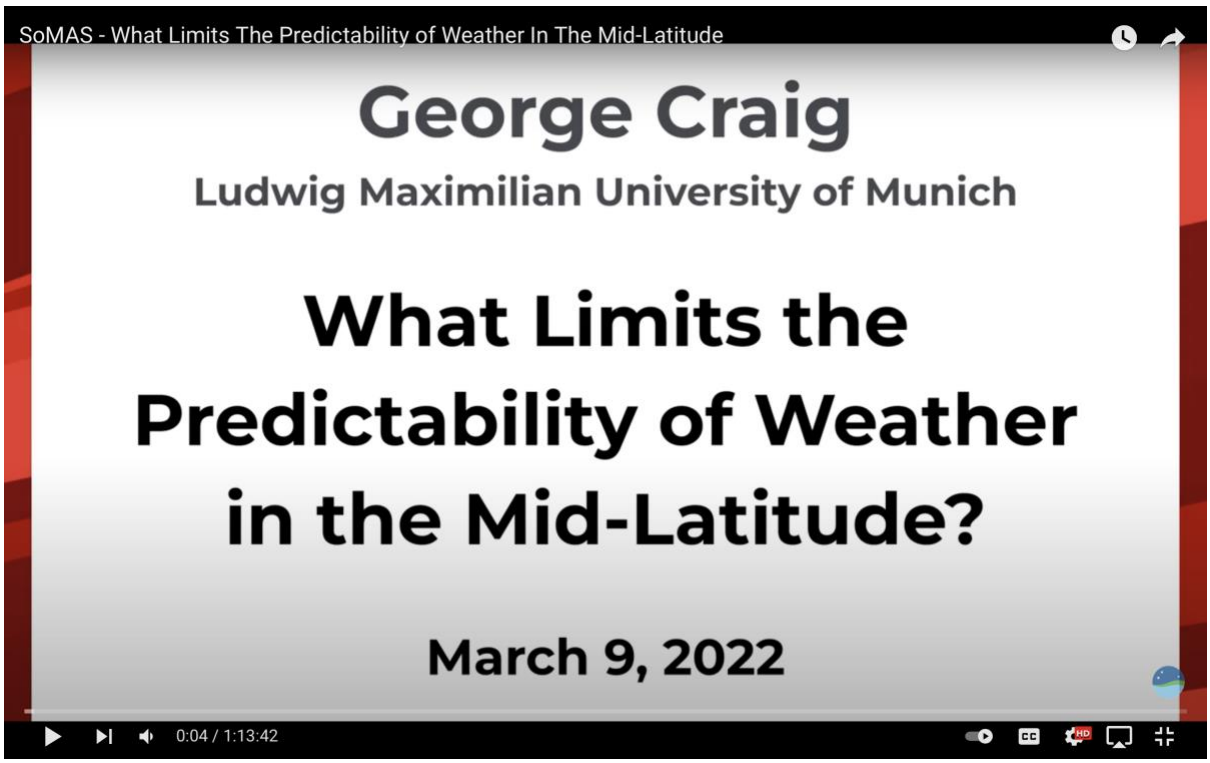
The seminars and colloquium are broadcasted live using **Adobe Connect**. If you would like to receive a link to listen to the presentation, please contact us.

Communication

Dissemination

Presentation at SUNY Stony Brook University

George Craig spoke to the School of Marine and Atmospheric Sciences (SoMAS) at SUNY Stony Brook University on 9 March 2022 at the Topics in Oceanic and Atmospheric Sciences Seminar. You can watch his presentation on "What limits the predictability of weather in the mid-latitudes?" here:
https://www.wavestoweather.de/communication/dissemination-activities/meetings/presentation-at-stony-2022



Screenshot from George's slides

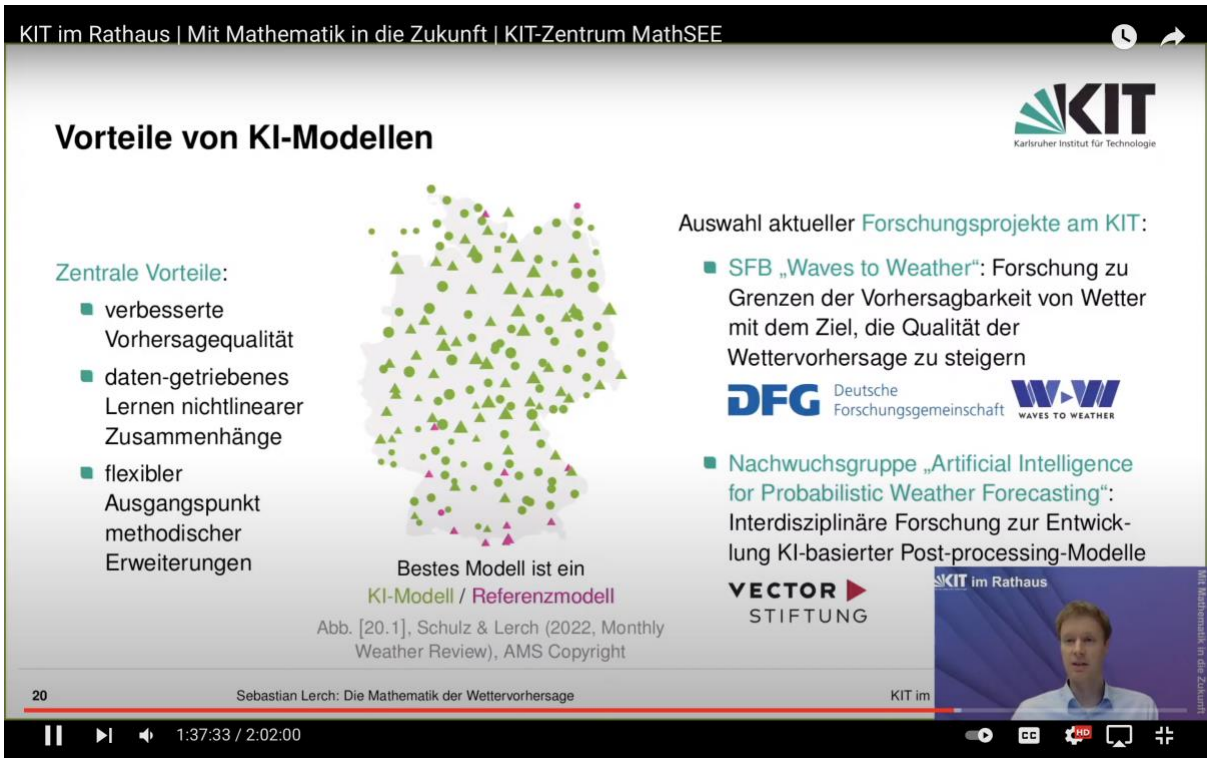
Past issues of this newsletter

Past issues of this newsletter are available here:
https://www.wavestoweather.de/communication/dissemination-activities/publications/quarterly_newsletter

Outreach

KIT im Rathaus

On 7 February 2022, Sebastian Lerch gave an online presentation to the general public on "The mathematics of weather forecast: from folk sayings to artificial intelligence" in the framework of "KIT im Rathaus". Read more about this event here: https://www.wavestoweather.de/communication/outreach-activities/presentations-general-public/kit_im_rathaus_07feb2022



Screenshot of Sebastian's presentation on 7 Feb.

Press release at KIT

A press release from KIT highlighted the latest article of **Benedikt Schulz and Sebastian Lerch** on "Machine learning methods for postprocessing ensemble forecasts of wind gusts: A systematic comparison". For more information, visit: https://www.wavestoweather.de/communication/outreach-activities/press-releases/press-release-15_03_2022

Movies about the three main institutes involved in W2W

The University Partnership for Atmospheric Sciences (UPAS; https://www.meteo-upas.de) produced movies about the 10 German universities providing consecutive studies in the field of meteorology through both Bachelor (BSc) and Master (MSc) programs. Click on the link below to watch the videos of the meteorological institute in Munich, the Institute for Atmospheric Physics in Mainz and the Institute of Meteorology and Climate Research in Karlsruhe:

https://www.wavestoweather.de/communication/outreach-activities/presentations-general-public/upas-films

Deutsches Museum

Christian Grams will give a presentation at the Deutsches Museum in Munich on 21 September 2022 within the seminar series “Wissenschaft für jedermann”. For past presentations at the Deutsches Museum, visit: https://www.wavestoweather.de/communication/outreach-activities/presentations-general-public

Equal opportunity (EO) activities

Girls' Day

Girls' Day is a countrywide event to introduce schoolgirls to disciplines and careers in which women are usually underrepresented. This year, Girls' Day will take place on **28 April 2022** at the LMU in Munich, at the JGU in Mainz and at KIT in Karlsruhe.
Read more here: https://www.wavestoweather.de/equal_opportunity/activities/girlsday-2022

Joanne Simpson - Pioneer cloud physicist and tropical meteorologist, by Corinna Hoose

Joanne Simpson (1923-2010) was a creative, excellent and versatile scientist. Her work has multiple links to W2W research. She studied the role of tropical convective clouds ("hot towers") in the Hadley cell circulation and within hurricanes, devised one of the first numerical cloud models, flew above and into clouds to study the effects of artificial cloud seeding, and lead the science team of TRMM (Tropical Rainfall Measuring Mission). She has published more than 190 papers (many of the early ones under her first married name, Malkus) and was the first woman in the USA to obtain a PhD in meteorology. For further reading on Joanne Simpson's research, I recommend the comprehensive article by *Tao et al.* (2003) or the short appraisal by *Houze* (2010).
At least as impressive as the science career is the account of Joanne Simpson's personal life and overcoming of obstacles that she encountered as a woman. She studied meteorology in Chicago and started teaching during the Second World War. Despite very good grades, she had difficulties to find any professor to accept her as PhD student, facing open hostility. When she eventually found a supervisor, she concentrated on a topic – tropical clouds – far from mainstream meteorology. During her career, she moved multiple times, with episodes at larger and smaller research institutions, two professorships, and finally more than two decades at NASA Goddard. With three children, three marriages, two divorces and some health issues, she had more than enough personal challenges, but was "generally perceived [...] as calm and collected, a pretty cool character. Her response: `Nothing could be farther from the truth.' " (*Fleming*, 2020). In a reflection on her career (*Simpson*, 1973) at the age of 48, she drew rather bitter conclusions about the institutionalized discrimination she has faced, often in the name of nepotism rules: "My personal and married life and child raising have surely suffered for the professional attainments I have reached, while my career, in turn, has been severely limited by my sex. I am currently not convinced that either the position, rewards or achievements have been worth the cost." (*Simpson*, 1973). In the same essay, she gave three recommendations to young women determined to combine a career in sciences with family: (1) to ("cold-bloodedly") find a niche or a field in which career opportunities are higher because of less competition, (2) to take on unpopular tasks, to network and to accept being disliked by some people ("forgo false pride") and (3) to work at any time and anywhere, shifting the work-life balance substantially to the work side. The recommendations seem extreme and archaic from today's viewpoint, but not only women but also men on the academic career path will recognize some truth in them. Later in her life, Joanne Simpson had a more positive view on her own career-related sacrifices and recognized that the environment for women in meteorology had changed to the positive: "I think I can now retire as a role model, since there are so many really great younger women

meteorologists—many of whom have children, too—who are serving that function extremely well." (*Weier*, 2004).

Nowadays, three prestigious awards are named after her: The Joanne Simpson Tropical Meteorology Research Award of the AMS, the Joanne Simpson Medal for Mid-Career Scientists

by AGU, and the The Robert H. and Joanne Simpson Mentorship Award of the AMS. Next year will be Joanne Simpson's 100th birthday – a good time for some inspiring reading.

Joanne Simpson bent over reams of images of clouds that she filmed during long flights between islands in the tropical Pacific. Credit: Wikipedia.

Joanne Simpson in 2010. Credit: NASA

References

Fleming, J. R., 2020: First Woman – Joanne Simpson and the Tropical Atmosphere, Oxford University Press.

Houze, R. A., Jr., 2010: Joanne Simpson (1923-2010): Meteorologist who brought the study of clouds to the forefront of Earth science. Nature, 464, 696.

Simpson, J., 1973: METEOROLOGIST. Annals of the New York Academy of Sciences, 208 (1) 41-46, https://doi.org/10.1111/j.1749-6632.1973.tb30819.x

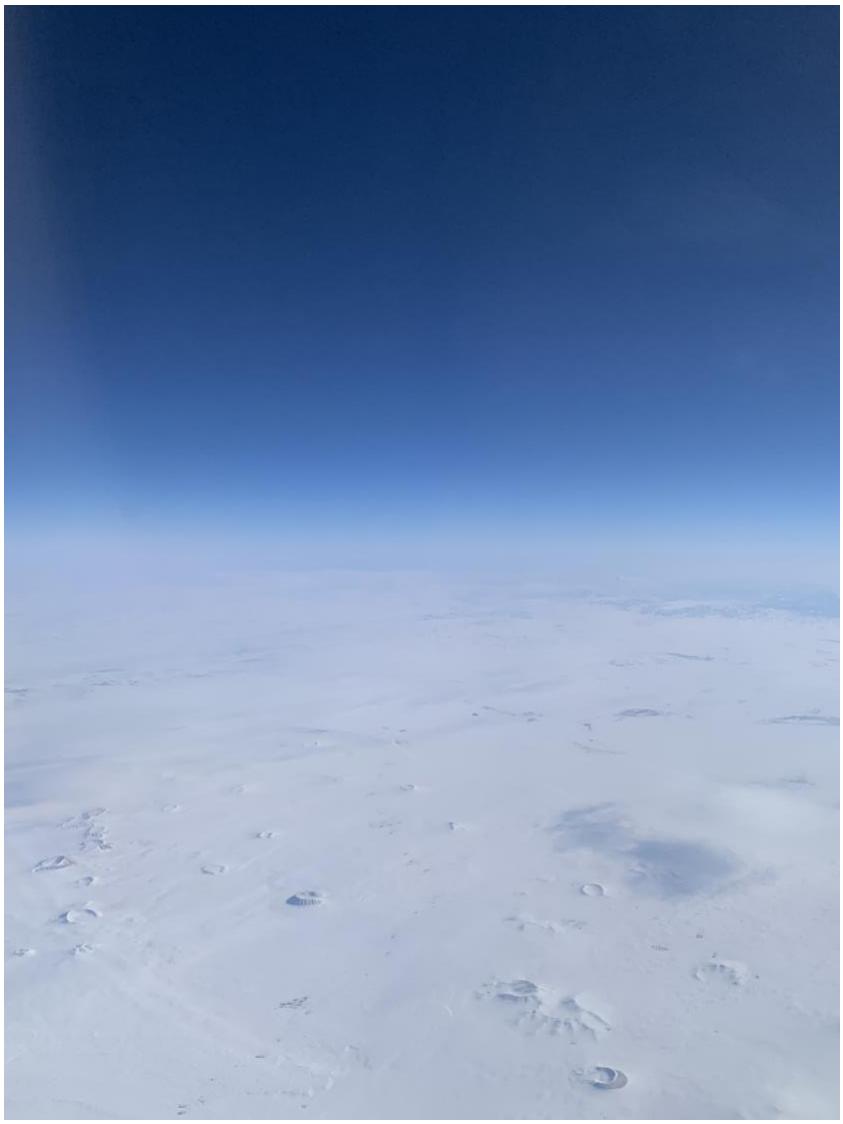
Tao, W.-K., J. Halverson, M. LeMone, R. Adler, M. Garstang, R. A. Houze, Jr., R. Pielke, Sr., and W. Woodley, 2003: The research of Dr. Joanne Simpson: Fifty years investigating hurricanes, tropical clouds, and cloud systems. Cloud Systems, Hurricanes, and the Tropical Rainfall Measuring Mission (TRMM): A Tribute to Dr. Joanne Simpson, Meteorological Monograph, No. 51, American Meteorological Society, 1-16.

Weier, J., 2004: Joanne Simpson (1923-2010), https://earthobservatory.nasa.gov/features/Simpson/simpson.php

EO measures in W2W

- Read about the EO committee:
  http://www.wavestoweather.de/equal_opportunity/contact
- Read about the EO measures offered in W2W:
  http://www.wavestoweather.de/equal_opportunity/eo_measures
- Read about the EO measures and activities already implemented:
  http://www.wavestoweather.de/equal_opportunity/activities

Winter's highlight



Flying over the border of Mongolia, Winter 2022. Photo: Hyunju Jung

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