Waves to Weather

Newsletter Apr/Jun 2022

Welcome to an optimistic W2W Newsletter! We are entering the final year of our second 4-year funding phase, the early career scientists are all actively producing new results, and we are starting to meet again in person and really feel like we are part of a community. We have a full range of activities to tell you about, and some especially interesting scientific results, so please read on...

George Craig

Contents

If you have any questions or comments about this newsletter or W2W in general, we would be happy to hear from you!

Upcoming events

- The **ECS Annual Meeting** will take place from 6-8 July 2022 in Speyer. Visit: https://www.wavestoweather.de/meetings/ecs-annual-meeting-2022
- The **RA-B meeting** will take place on 14 July 2022 in Munich. For more information, visit: https://www.wavestoweather.de/meetings/ra-b-meeting-2022
- The **RA-A meeting** will take place on 19 July 2022 in Mainz. For more information, visit: https://www.wavestoweather.de/meetings/ra-a-meeting-2022
- 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 **W2W Annual Meeting** will take place from 28-30 November 2022 in Würzburg. For more information, visit: https://www.wavestoweather.de/meetings/w2w-ann-meet-2022

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

News

Congratulations to Mirjam Hirt and her coauthors for the article "**Cold-pool-driven convective initiation: using causal graph analysis to determine what convection-permitting models are missing**", which was among the **top-cited papers** in the Quarterly Journal of Royal Meteorological Society (QJRMS)! https://doi.org/10.1002/qj.3788

The article "**Extreme precipitation events over northern Italy. Part I: A systematic classification with machine-learning techniques**" (https://doi.org/10.1002/qj.3635) was also one of the **top-cited papers** in QJRMS over the period 2020-2021. Congratulations to all the coauthors!
Federico Grazzini writes: "I think this is a nice result of fruitful work within W2W, and in particular between the LMU and the collaborating partner ARPAE. I'm looking forward to implementing the EPE classification scheme operationally in ARPAE in the framework of the new transfer project T2."
https://www.wavestoweather.de/research_areas/phase2

Maicon Hieronymus (Z2) received an "**Outstanding Poster Award**" at the first MeteoXchange ECS Conference on 17-18 March 2022 for his poster on "Algorithmic Differentiation as Sensitivity Analysis in Cloud Microphysics". Congratulations, Maicon!

Andreas Fink is one of this year's **Fellows of the American Meteorological Society**. With this award, the AMS recognizes "outstanding contributions to the atmospheric or related oceanic or hydrologic sciences or their applications during a substantial period of years". Congratulations, Andreas!

Thank you, **Bernhard Mayer** for having coordinated the Research Area B "Cloud-scale Uncertainties" during Phase 2 of W2W! Thank you, **Christian Keil** for taking the lead during Phase 3 preparations, and hopefully beyond!

Yuhuan Yuan started as a Postdoctoral fellow in the A2 project in Mainz. She says:
"I did my PhD at Peking University in China, and was a postdoctoral fellow in Maria Lukacova's group at JGU Mainz supported by the CSC and DAAD. Now I am working in the A2 project."
Welcome, Yuhuan!

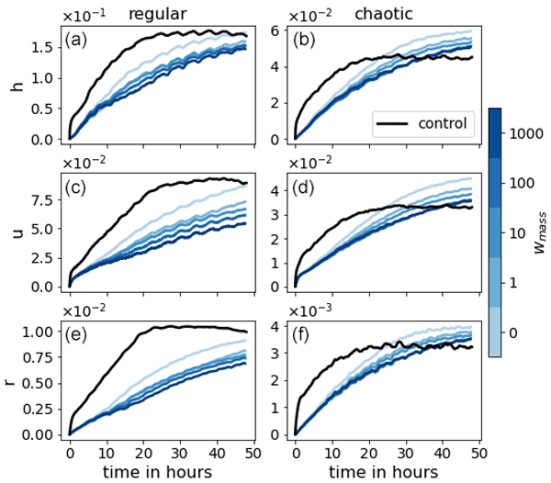
Linda Schlemmer (DWD) has agreed to join the W2W Scientific Advisory Board, with special interest in RAB and as a representative of DWD. We are looking forward to her comments and advice, starting at the RAB meeting in July! Welcome in W2W, Linda!

Susanne Eri (Z1 project, LMU) left W2W to start a new career in the private sector. Thank you for your friendly and efficient support with the W2W finances, Susanne! We wish you good luck with your new career steps and exciting challenges ahead!
Olena Furlan (Z1 project, LMU) is the successor of Susanne Eri. She will support the Z1 team with the finances. Welcome to the team, Olena!

Research Highlights

Here are some examples of recently published research from W2W.

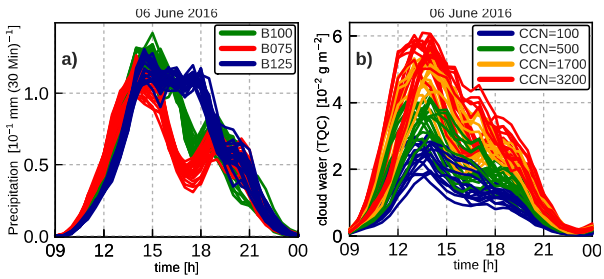
1. Using neural networks to improve simulations in the gray zone (R. Kriegmair, Y. Ruckstuhl, S. Rasp and G. Craig)



Our regional numerical weather prediction models run at kilometer-scale resolutions. Processes that occur at smaller scales not yet resolved contribute significantly to the atmospheric flow. We use a neural network (NN) to represent the unresolved part of physical process such as cumulus clouds. We test this approach on a simplified, yet representative, 1D model and find that the NN corrections vastly improve the model forecast up to a couple of days.

Read the full article: https://doi.org/10.5194/npg-29-171-2022

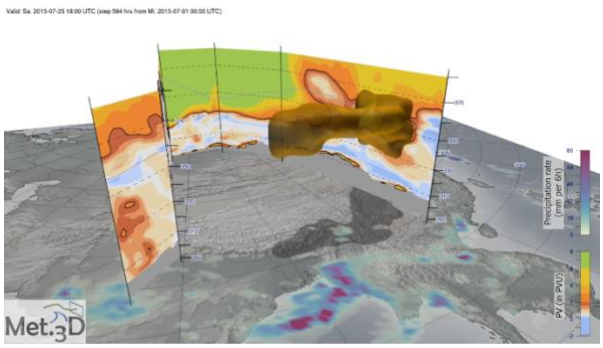
2. Combined effects of soil moisture and micro-physical perturbations on convective clouds and precipitation for a locally forced case over Central Europe (F. Baur, C. Keil and C. Barthlott)



While the homogeneous soil moisture bias primarily controls the timing of convection initiation and the amount of precipitation, the number of cloud condensation nuclei and the width of the cloud droplet size distribution mainly control the number, size, and lifetime of convective clouds. Since microphysical process rates depend systematically on the sign of the perturbations, but rainfall does not, there are compensating effects buffering microphysical perturbations directly and impacting the cloud condensate amount and surface precipitation.

Read the full article: https://doi.org/10.1002/qj.4295

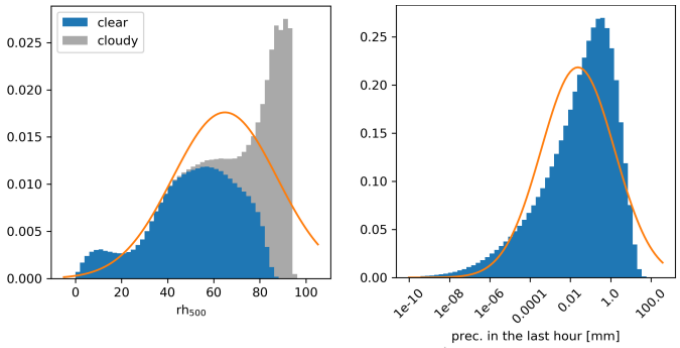
3. A novel method for objective identification of 3-D potential vorticity anomalies (C. Fischer, A. H. Fink, E. Schömer, R. van der Linden, M. Maier-Gerber, M. Rautenhaus and M. Riemer)



Potential vorticity (PV) analysis plays a central role in studying atmospheric dynamics. For example, anomalies in the PV field near the tropopause are linked to extreme weather events. In this study, an objective strategy to identify these anomalies is presented and evaluated. As novel concept, it can be applied to three-dimensional (3-D) data sets. Supported by 3-D visualizations, we illustrate and showcase upsides and potential of this new analysis over existing studies along a case study.

Read the full article: https://gmd.copernicus.org/articles/15/4447/2022/

4. Distributions and convergence of forecast variables in a 1000-member convection-permitting ensemble (G. Craig, M. Puh, C. Keil, K. Tempest, T. Necker, J. Ruiz, M. Weissmann, T. Miyoshi)



A large number of forecast variables at different lead times were examined, and their distributions could be classified into three categories: quasi-normal (e.g. tropospheric temperature), highly skewed (e.g. precipitation), and mixtures (e.g. humidity). Dependence on ensemble size was examined in comparison to the asymptotic convergence law that the sampling error decreases proportional to $N^{-1/2}$ for large enough ensemble size N, independent of the underlying distribution shape. The asymptotic convergence behaviour was observed for the ensemble mean of all forecast variables, even for ensemble sizes less than 10. For the ensemble standard deviation, sizes of up to 100 were required for the convergence law to apply. In contrast, there was no clear sign of convergence for the 95th percentile even with 1000 members. Methods such as neighbourhood statistics or prediction of area-averaged quantities were found to improve accuracy, but only for variables with random small-scale variability, such as convective precipitation.

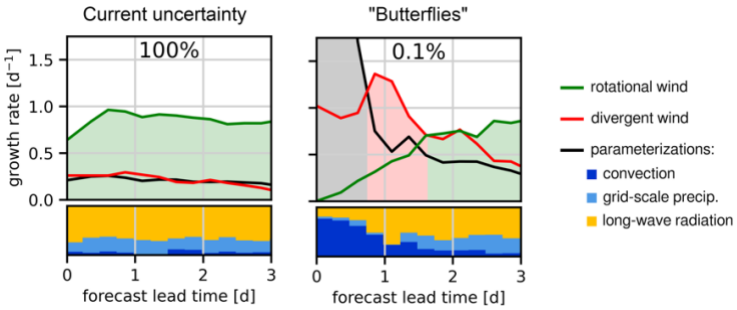
Read the full article: https://doi.org/10.1002/qj.4305

5. Evaluating ensemble post-processing for wind power forecasts (K. Phipps, S. Lerch, M. Andersson, R. Mikut, V. Hagenmeyer and N. Ludwig)

Multiple strategies for ensemble post-processing in the context of wind power prediction are systematically evaluated and compared. Results show that post-processing the final wind power ensemble constitutes a crucial step and improves forecast performance regarding both calibration and sharpness whilst only post-processing the weather ensembles does not necessarily lead to increased forecast performance.

Read the full article: https://doi.org/10.1002/we.2736

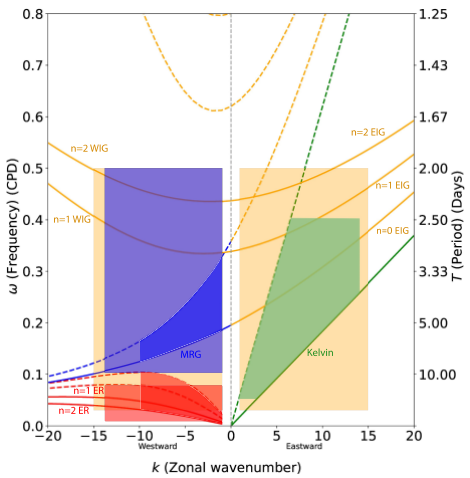
6. The transition from practical to intrinsic predictability of midlatitude weather (T. Selz, M. Riemer and G. Craig)



Although weather forecasts have been continuously improving over the past 50 years, there is an intrinsic, physical limit to weather prediction even if perfect observations and simulations were available. This phenomenon arises from scale-interactions in the atmosphere and is commonly known as the “butterfly effect”. Our study investigates how far we are currently away from this limit and finds that there is a remaining future improvement potential of 4-5 forecast days, which requires an about 90% error reduction in the initial conditions. We further demonstrate that transitioning to the intrinsic limit is accompanied by a pronounced change in the processes that dominate the initial forecast error growth. Currently forecast mainly degrade because of error growth in synoptic, high- and low-pressure systems, while the intrinsic limit is characterized by error growth related to convection and precipitation which eventually propagates upscale.

Read the full article: https://doi.org/10.1175/JAS-D-21-0271.1

7. The intricacies of identifying equatorial waves (P. Knippertz, M. Gehne, G.N. Kiladis, K. Kikuchi, A. Rasheeda Satheesh, P.E. Roundy, G.-Y. Yang, N. Žagar, J. Dias, A.H. Fink, J. Methven, A. Schlueter, F. Sielmann and M.C. Wheeler)



This paper is the first to systematically compare different methods developed to isolate equatorial waves from satellite or model data. While one class of methods sets strong constraints on temporal evolution, others use broad filters combined with 2D or 3D single- or multi-variate spatial projection to isolate wave signals. In addition, the influence of different input fields (e.g. winds, geopotential, rainfall) is investigated. Based on the results, we generally recommend employing a combination of wavenumber-frequency filtering and spatial-projection methods (and of different input fields) to check for robustness of the identified signal.

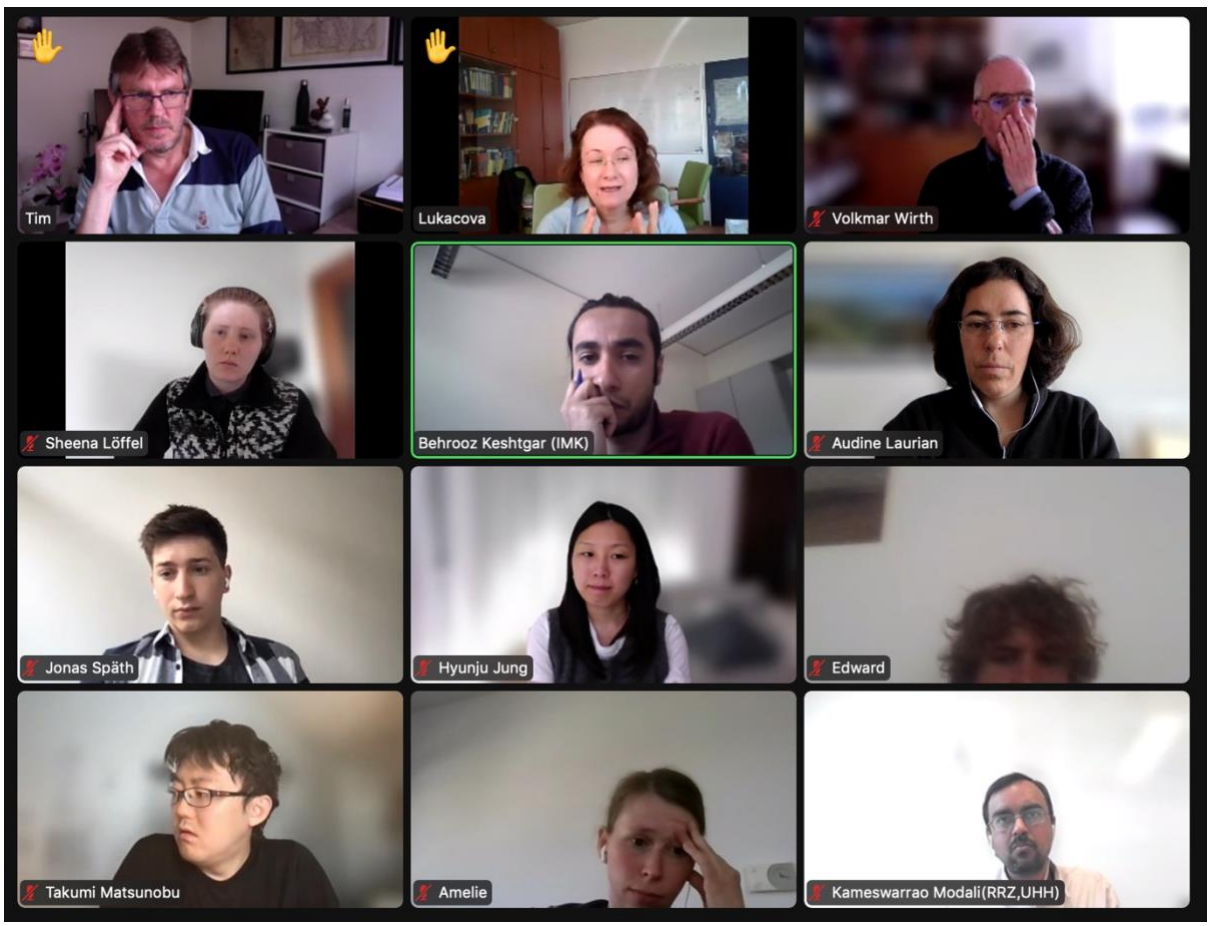
Read the full article: https://doi.org/10.1002/qj.4338

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

Past activities

W2W ECS workshop on improving writing skills

A workshop on improving writing and communication skills, in particular regarding the introduction part of scientific articles took place online on 22 April 2022. Eight ECS from all locations presented their written texts to a panel of W2W PIs and external guests who provided constructive feedback and insightful tips. The participants learnt about how to look at their own work from different perspectives, and how to get the reader interested in their work. Thank you to Volkmar Wirth for giving a short introduction, and to Maria Lukacova, Michael Riemer, Annette Miltenberger and Tim Hewson for the many fruitful contributions!
To learn more, visit:
https://www.wavestoweather.de/meetings/ecs-writing-workshop2022a



Some participants of the writing workshop

Research Data Management Workshop

On May 4, 2022 Jörg Steinkamp presented the Research Data Management in terms of the archive tool iRODS to eight W2W ECS located in Mainz. The workshop consisted of a short presentation with motivation and tips on data storage and archiving, and was followed by some hands-on practice. In the end everybody was able to use iRODS to archive and publish their data, which will hopefully help to increase the reproducibility of results in the future and improve collaborations with our colleagues.
Thank you, Jörg!
Read more here: https://www.wavestoweather.de/meetings/ecs-data-manag-2022

Participants of the iRODS workshop

W2W ECS workshop on scientific writing

The W2W ECS workshop on writing scientific articles took place online on 5-6 May 2022. The instructor, Carsten Rohr presented an overview of the steps to create a paper draft, and the eighteen participants from all W2W institutes created their first draft paper based on their results during a hands-on session.
On the first day, the focus of the workshop was on the five key parts of the paper (title, abstract, figures, captions, conclusions) and the participants practiced their main messages, building their paper argumentation points, and improving their graphics and caption to convey their messages in the clearest way.
On the second day, the participants practiced principles for text writing including building paragraphs, revision, writing abstracts, and writing in active form. The last session of the workshop was dedicated to notes regarding the writing process and article submission. The online learning platform set up by the instructor also provided a nice environment for getting feedback and more learning materials.

Some participants of the workshop

Thank you to the ECS committee for organizing this workshop!
To learn more about this workshop, visit:
https://www.wavestoweather.de/meetings/ecs-writing-workshop2022b

Research Area C meeting

Twenty-six W2W scientists from five different institutes (KIT, LMU, JGU, UHH, Env. Canada) participated in the RA-C meeting in Karlsruhe on 22 June 2022 (20 in person, 6 online). The ECS presented their latest results and the discussions were lively. The quality of the presentations was excellent.
Thank you to the ECS at KIT, Christoph Fischer, Athul Satheesh, Eva-Maria Walz and Benedikt Schulz, for organizing and chairing the meeting!
For more information, visit:
https://www.wavestoweather.de/meetings/ra-c-meeting-2022

Participants of the RA-C meeting on 22 June 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

Outreach

Café Météorologique

Four W2W scientists will give short presentations to the general public within the framework of the Café Météorologique organized during the EMS annual meeting in Bonn from 5-9 September 2022. Learn more about the W2W participation to the EMS annual meeting:
https://www.wavestoweather.de/meetings/hands-on-workshop-sep2022

Interview in the "Badischen Neuesten Nachrichten"

Andreas Fink gave an interview to the "Badischen Neuesten Nachrichten" on 15 June 2022 about the recent heat wave in Germany, and extreme events in the context of climate change. Read the interview (in German) here:
https://www.wavestoweather.de/communication/outreach-activities/press-releases/interviewbnn2022

Deutsches Museum

Christian Grams will give a presentation at the Deutsches Museum on 21 September 2022 within the seminar series "Wissenschaft für jedermann". To read about similar past presentations, visit:
https://www.wavestoweather.de/communication/outreach-activities/presentations-general-public

Dissemination

Past issues of this newsletter

Past issues of this newsletter are available here:

https://www.wavestoweather.de/communication/dissemination-activities/publications/quarterly_newsletter

Equal opportunity (EO) activities

Girls' Day

Girls' Day is a countrywide event to introduce school girls to disciplines and careers in which women are usually underrepresented. On 28 April 2022, W2W scientists and their colleagues offered workshops at the LMU in Munich and at the JGU in Mainz.

At the meteorological institute in Munich, nine participants between 11 and 14 years old started by playing a Monte Carlo game to learn about solar radiation, clouds, and the weather. Each participant played the role of a photon, starting from to the top of the atmosphere and aiming at reaching the ground. The photon was slowed down by clouds, and giving a wrong answer to a quiz question led the photon to being absorbed, i.e. "losing a life". The participants then played the Forecast Factory (https://doi.org/10.1002/wea.670), a game in which the participants play the role of a numerical model forecasting the temperature in Germany. Each participant is a model grid point and computes the temperature at this grid point for several time steps, communicating with neighbors to exchange information about boundary conditions. The resulting temperature forecast is then compared to the "real" model forecast. This excellent team work highlights the challenges of NWP and the effects of error growth on a forecast. The school girls then visited the instruments on the roof of the institute. After the lunch break, they visited an exhibition about role models in STEM fields. They read the inspiring stories featured in the comic book "Of course!" that were printed on posters. Hella Garny was there in person to talk about her own inspiring story. The day ended by a visit of the institute and the interview of a few scientists about their everyday life at work. A participant wrote: "I have learned a lot about the weather today, but also that you have to go your own way, no matter what others say and no matter whether you are a man or a woman."

Girls' Day at the LMU. Top left: Forecast Factory, bottom left: Monte Carlo game, center: participants on the roof of the institute, top right: Hella Garny talking about her inspiring career path, bottom right: interview of scientists in their office.

At the Institute for Atmospheric Physics in Mainz, 12 girls between 11 and 13 years old took part in a workshop called "What do you need do forecast the weather?". The workshop

started with a presentation by Volkmar Wirth about the "Fascination of Meteorology" featuring many surprising pictures and movies of storms, hurricanes and tornadoes. A short weather discussion afterwards highlighted the variables that need to be measured to produce a weather prediction. To measure these variables, the participants built their own thermometer, wind mill, and wind vane. The calibration of the thermometers with ice and hot water was more challenging than expected, but it worked out as best as possible. After lunch the girls tried their self-made wind mills and wind vanes in the wind channel. During this experiment they experienced wind speeds exceeding 25m/s! Finally, they visited the instruments on the roof and touched clouds produced by the cloud chamber.

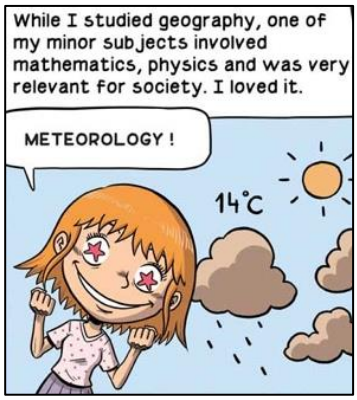
Girls' Day at the JGU. Top and center left: construction and calibration of a thermometer, top right: visit of the instruments on the roof, bottom left and center: cloud chamber, bottom right: wind channel.

Thank you to the volunteers for your time and enthusiasm, and for making this day a success!

Read more here: https://www.wavestoweather.de/equal_opportunity/activities/girlsday-2022

Update on the "Of course!" comic book

Read the latest **interview of Ulrike Lohmann** (ETH):
https://www.wavestoweather.de/equal_opportunity/activities/comic-book/ulrike
Thank you, Ulrike, for taking part in the project and for sharing your personal story!



Poster exhibition for Girls' Day and for "Diversity4Research@LMU"

The interviews featured in the comic book "Of course!" were presented as posters at an exhibition during Girls' Day (see previous paragraph) and during the initiative "Diversity4Research@LMU" from 30 May – 01 July 2022 in the main building of the LMU in Munich. Below are some impressions. To learn more, visit:
https://www.wavestoweather.de/equal_opportunity/activities/diversity4research/

Exhibition in the building of the meteorological institute for Girls' Day (28 Apr. 2022)

Exhibition in the Thomas-Mann Halle in the main building of the LMU (30 May-01 Jul. 2022)

Eunice Foote (1819-1888) and the discovery of the warming effect of CO_2 (by Federico Grazzini)

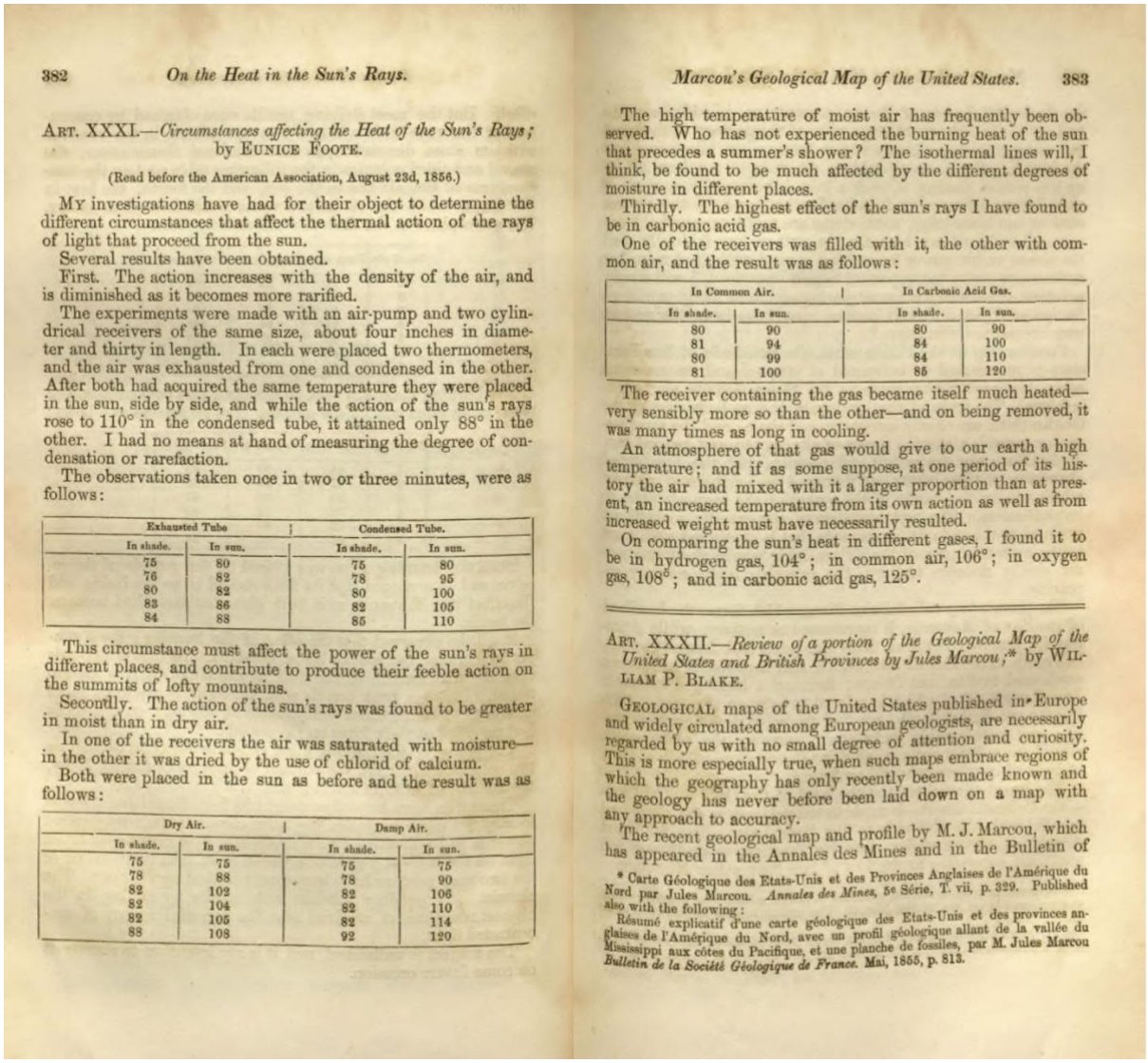
Long before current concerns about global warming, an American woman named Eunice Newton Foote was probably the first person to theorize in 1856 that higher CO_2 levels would lead to a warmer planet. Foote was an amateur scientist, inventor and women's rights campaigner, conducting experiments on the interaction between the sun's rays and various gases. While the economy was growing sustained by the coal-fuel industrial revolution, and the promises of an infinite growth were being postulated, her findings led to the conclusion that there is a connection between the Earth's temperature and the CO_2 concentration in the atmosphere; not only a very important scientific achievement, but potentially the beginning of the discovery of human-made global warming.

Eunice Newton, who later became Foote after marrying the judge and mathematician Elisha Foote, was born on 17 July 1819, in Goshen, Connecticut. After an early education at the Troy Female Seminary, she was introduced to chemistry and biology at a nearby science college. There she was influenced by the textbooks of Almira Hart Lincoln Phelps who was a botany expert and a female pioneer in science.

Both Footes were involved in the women's rights movement and signed the 1848 Declaration of Sentiments, the "Magna Carta of the women's movement", demanding equality with men in social status and legal rights, including the right to vote.

Foote's experiment was simple: she placed two thermometers in identical glass cylinders. Using an air pump, she exhausted air from one cylinder and added air into the other. After the temperatures equalized, she placed the jars next to each other in the Sun and recorded the resulting temperature every two to three minutes. She also conducted the experiment with both jars in the shade. In comparing the temperature changes, she observed that "the [thermal] action increases with the density of the air, and is diminished as it becomes more rarified." She repeated the experiment using moist and dry air by adding water to one cylinder and dehydrating the other using calcium chloride. She discovered that damp air became

significantly hotter than dry air. Last, she measured the effect of different gases against "common air" (the ambient atmosphere) and found "the highest effect of the sun's rays… to be in carbonic acid gas." She noted that after being removed from direct sunlight, carbon dioxide maintained its high temperature much longer than other gases did. The specific result with carbon dioxide and moist air (and with condensed compared to rarefied air) was not known before.



382 *On the Heat in the Sun's Rays.*

ART. XXXI.—*Circumstances affecting the Heat of the Sun's Rays;* by EUNICE FOOTE.

(Read before the American Association, August 23d, 1856.)

MY investigations have had for their object to determine the different circumstances that affect the thermal action of the rays of light that proceed from the sun.

Several results have been obtained.

First. The action increases with the density of the air, and is diminished as it becomes more rarified.

The experiments were made with an air-pump and two cylindrical receivers of the same size, about four inches in diameter and thirty in length. In each were placed two thermometers, and the air was exhausted from one and condensed in the other. After both had acquired the same temperature they were placed in the sun, side by side, and while the action of the sun's rays rose to 110° in the condensed tube, it attained only 88° in the other. I had no means at hand of measuring the degree of condensation or rarefaction.

The observations taken once in two or three minutes, were as follows:

Exhausted Tube		Condensed Tube.	
In shade.	In sun.	In shade.	In sun.
75	80	75	80
76	82	78	95
80	82	80	100
83	86	82	105
84	88	85	110

This circumstance must affect the power of the sun's rays in different places, and contribute to produce their feeble action on the summits of lofty mountains.

Secondly. The action of the sun's rays was found to be greater in moist than in dry air.

In one of the receivers the air was saturated with moisture—in the other it was dried by the use of chlorid of calcium.

Both were placed in the sun as before and the result was as follows:

Dry Air.		Damp Air.	
In shade.	In sun.	In shade.	In sun.
75	75	75	75
78	88	78	90
82	102	82	106
82	104	82	110
82	105	82	114
88	108	92	120

Marcou's Geological Map of the United States. 383

The high temperature of moist air has frequently been observed. Who has not experienced the burning heat of the sun that precedes a summer's shower? The isothermal lines will, I think, be found to be much affected by the different degrees of moisture in different places.

Thirdly. The highest effect of the sun's rays I have found to be in carbonic acid gas.

One of the receivers was filled with it, the other with common air, and the result was as follows:

In Common Air.		In Carbonic Acid Gas.	
In shade.	In sun.	In shade.	In sun.
80	90	80	90
81	94	84	100
80	99	84	110
81	100	85	120

The receiver containing the gas became itself much heated—very sensibly more so than the other—and on being removed, it was many times as long in cooling.

An atmosphere of that gas would give to our earth a high temperature; and if as some suppose, at one period of its history the air had mixed with it a larger proportion than at present, an increased temperature from its own action as well as from increased weight must have necessarily resulted.

On comparing the sun's heat in different gases, I found it to be in hydrogen gas, 104°; in common air, 106°; in oxygen gas, 108°; and in carbonic acid gas, 125°.

ART. XXXII.—*Review of a portion of the Geological Map of the United States and British Provinces by Jules Marcou;** by WILLIAM P. BLAKE.

GEOLOGICAL maps of the United States published in Europe and widely circulated among European geologists, are necessarily regarded by us with no small degree of attention and curiosity. This is more especially true, when such maps embrace regions of which the geography has only recently been made known and the geology has never before been laid down on a map with any approach to accuracy.

The recent geological map and profile by M. J. Marcou, which has appeared in the Annales des Mines and in the Bulletin of

* Carte Géologique des Etats-Unis et des Provinces Anglaises de l'Amérique du Nord par Jules Marcou. *Annales des Mines*, 5e Série, T. vii, p. 329. Published also with the following:

Résumé explicatif d'une carte géologique des Etats-Unis et des provinces anglaises de l'Amérique du Nord, avec un profil géologique allant de la vallée du Mississippi aux côtes du Pacifique, et une planche de fossiles, par M. Jules Marcou *Bulletin de la Société Géologique de France*. Mai, 1855, p. 813.

Eunice Foote – "Circumstances affecting the Heat of the Sun's Rays" (1856), American J. of Science and Arts

This groundbreaking discovery soon became forgotten, starting with the fact that she did not present her findings at a meeting of the American Association for the Advancement of Science (AAAS) in Albany (New York). Instead, the eminent Joseph Henry, a family friend presented her results. Neither Foote's paper nor Henry's presentation were included in the conference proceedings. Surrounded by America's elite scientists, she listened as Joseph Henry, secretary of the Smithsonian Institution, presented—and failed to recognize the implications of her research. "An atmosphere of that gas [CO_2] would give to our earth a high temperature," Foote declared in the subsequent paper describing her work. Perhaps because of Henry's fault in not understating the consequences of the discovery, perhaps because of her gender, Foote's groundbreaking conclusions fell into obscurity. For a century and a half, the world has

instead remembered John Tyndall, an Irish physicist, as the person who discovered the warming potential of CO_2 and water vapor—even though he published his findings three years after Foote.

It was not until 2011, when the petroleum geologist and historian Raymond Sorenson stumbled upon an account of Henry's presentation of Foote's work, that Foote began to receive her due. Sorenson immediately realized that Foote's discovery and conclusion about CO_2's effect on climate predated Tyndall's, generating new interest in Eunice life and scientific work. Climate change is strongly connected with atmospheric chemistry and Foote's hypothesis about the effect of CO_2 on Earth's temperature, despite being credited to Tyndall, was crucial for the evolution of the field. Carbon dioxide emissions have significantly risen to dangerous levels since then. If her research, along with that of others colleagues who followed, had been given more credit, the world might have been different.

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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

Spring's highlight

Rape field close to Mainz-Finthen, May 2021. Photo: Volkmar Wirth

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