15 years of TERENO: The initiative has installed numerous large and small measuring instruments in the observatories over the years, for example man-sized lysimeters sunk into the ground to investigate the water and matter balance.

© DLR

TERENO
TERRESTRIAL ENVIRONMENTAL OBSERVATORIES

Newsletter 2/2024

CONTENTS

SUCCESS STORY

Since its inception, TERENO has not only built up a Germany-wide environmental observation network. The initiative provides impetus for methodological and technological advances as well as for international cooperation. Today, it is considered a key pillar for environmental modeling and forecasting in Germany.
See page 3.

HELMHOLTZ ASSOCIATION

EXTENSIVE MEASUREMENT CAMPAIGN IN THE HARZ

For five months, scientists from the DFG research group CosmicSense collected a large amount of measurement data in the Selke catchment area at TERENO's Harz/Mid-German Lowland observatory. The aim of the campaign from June to November 2023 was to test how soil moisture monitoring using a dense network of cosmic ray sensors can improve hydrological models. To determine soil moisture, the Cosmic-Ray Neutron Sensing (CRNS) method uses cosmic radiation that hits the Earth from space and interacts with the atmosphere to generate neutron radiation. Another aim of the campaign was to to facilitate and validate new methods for upscaling local data.

Ready for take-off: Mobile CRNS measurements were carried out with a hot-air airship.

Following the two intensive measurement campaigns at the TERENO site Fendt in 2019 and the TERENO site Wüstebach in 2020, the researchers had to deal with a much larger study area this time: The previous campaigns only investigated very small areas (1-2 square kilometer), whereas the catchment area of the Selke covers an area of around 456 square kilometers. The area is not only very large, but also geographically and geopmorphologically very diverse. It ranges from the Central German Lowland to low mountain ranges and is characterized by different topography, land use and meteorology. There are several intensive study areas in the catchment area, where TERENO has been carrying out long-term environmental monitoring for many years.

Additionally, the eight research partners of CosmicSense, including four of the Helmholtz centers involved in TERENO, temporarily installed 18 CRNS stations in the Selke region. The measurements were supplemented with hydrogravimetry, remote sensing, groundwater levels, further soil moisture measurements as well as modeling and measurements with mobile CRNS sensors. In order to find suitable locations for the measurement sensors and to coordinate with local authorities and farmers, the research group explored the measurement area in advance on a joint bicycle tour. Particular highlights were the joint sensor calibration on a nearby lake, the mobile hydrogravimetric measurements along the river Selke and mobile CRNS measurements with the Selke tourist train and in a hot-air airship. The measurement data is currently being processed and will be published in the near future.

More photos

▶ https://www.uni-potsdam.de/en/cosmicsense/about/field-sites/selke

EDITORIAL

Our work is far from over

At the end of May/beginning of June, heavy rainfall caused severe flooding in southern Germany. Brazil, Kenya and, on the Arabian Peninsula, Oman and the United Arab Emirates also experienced devastating floods after rainfall this year. The Intergovernmental Panel on Climate Change (IPCC) has been warning for some time that global warming could lead to an increase in heavy rainfall events. With global warming of just 1.5 degrees Celsius, such events are likely to occur 1.5 times as often and be around 10 percent more intense. With an increase of 4 degrees Celsius, the frequency is likely to rise to 2.7 and the intensity to 30 percent. Forests in Germany are also a cause for concern. The forest condition survey in 2023 was just as bleak as in the previous year: Only one in five trees is healthy.

It is important that such developments and events are analyzed in order to draw the right conclusions. To do this, many factors and processes must be considered, for example the water and matter cycles or the interactions between the atmosphere and soil surfaces. TERENO was launched in 2008 to collect such data over the long term in order to record the regional consequences of climate change. We have achieved a great deal since then (see article on page 3). But our work is far from over. Current developments show how necessary it is to continue integrated environmental monitoring programs like TERENO in the future.

Happy reading!

Your Harry Vereecken
TERENO Coordinator

EXPECTATIONS MORE THAN FULFILLED

TERENO was founded over 15 years ago - the most comprehensive research project to investigate the long-term regional effects of climate change on terrestrial ecosystems and their socio-economic consequences in Germany. In an article for the open access journal “Earth's Future”, 36 scientists from the TERENO network have summarized the most important findings of the initiative.

Closing a gap, giving a new impetus - the advance praise was not small when the TERENO initiative was launched at the end of 2008. In fact, TERENO was something new: the largest project in Germany to record the regional consequences of climate change. The Helmholtz centers involved not only brought together a broad spectrum of disciplines: Together, they established a Germany-wide network of observatories that were extensively equipped with measuring instruments.

Today, more than 15 years later, the initiative can look back on very successful work. Hundreds of thousands of environmental data are publicly available in the TERENO data portal, hundreds of publications have been produced and dozens of national and international events have been organized. "TERENO data was and is important: for example, to test new remote sensing technologies, to calibrate and validate models and to enable data products such as the German Drought Monitor. The close link between in-situ measurements and remote sensing data on the one hand and between observation and modeling on the other has greatly advanced all sides,” reports Prof. Irena Hajnsek from the German Aerospace Center. TERENO has also supported large-scale experiments, provided impetus for methodological and technological advances and promoted international cooperation - for example in the eLTER RI research infrastructure. The effect on follow-up projects should also not be underestimated - for example, research projects funded by the German Research Foundation that use TERENO infrastructure and data.

Measuring tower in the middle of the forest: the TERENO site Hohes Holz

© Eric Thurm

© Chris Taube

Kick-off: the TERENO Science Steering Committee at the 2008 kick-off meeting

All in all, TERENO has more than fulfilled expectations. “TERENO is now a key pillar for environmental modeling and forecasting in Germany and serves as an information hub for practitioners and policy stakeholders in agriculture, forestry, and water management at regional to national levels,” states Prof. Harry Vereecken from Forschungszentrum Jülich.

From the point of view of the 36 authors of the paper, TERENO has shown how valuable such comprehensive environmental monitoring systems are. “Only with such systems can the data be collected which is necessary to distinguish long-term trends from short-term fluctuations and develop appropriate adaptation measures,” emphasizes Dr. Theresa Blume from the Helmholtz Centre Potsdam - GFZ German Research Centre for Geosciences. However, planning, construction and operation require considerable effort - both in terms of resources and funding, which the participating centers largely raise themselves.

Other important findings: In order to adapt to changing research requirements and ensure long-term data collection, a research infrastructure must be designed flexibly. The necessary interdisciplinarity does not arise by itself either. "The culture of institutions is crucial. There must be a willingness to deal with the different views and requirements of the various scientific disciplines and also the user communities and ultimately to make compromises, for example with regard to locations or measurement methods. In TERENO, this has been achieved in an exemplary manner,” says Prof. Peter Dietrich from the Helmholtz Centre for Environmental Research. "All this shows that such integrated environmental monitoring programs must be continued in the future,” adds Prof. Hans Peter Schmid from the Karlsruhe Institute of Technology.

Steffen Zacharias et al. (2024). *Fifteen Years of Integrated Terrestrial Environmental Observatories (TERENO) in Germany: Functions, Services, and Lessons Learned.* Earth's Future, Vol. 12, Issue 6.

▶ DOI: 10.1029/2024EF004510

GERMAN HYDROLOGY AWARD GOES TO HARALD KUNSTMANN

Prof. Harald Kunstmann, a member of the Scientific Steering Committee since the start of TERENO, has been awarded the German Hydrology Prize 2024. With this award, the German Hydrological Society (DHG) recognizes individuals who have distinguished themselves through pioneering research and special commitment.

Harald Kunstmann is Deputy Director of the Institute for Meteorology and Climate Research Atmospheric Environmental Research (IMK-IFU) at the Karlsruhe Institute of Technology and Professor and Chair of Regional Climate and Hydrology at the University of Augsburg. He is also the founding director of the newly established Center for Climate Resilience. His research focuses in particular on water availability - such as analyses of uncertainties in precipitation and runoff data - climate change and extreme events such as floods, droughts and heat. His and his team's work enjoys high national and international recognition and has made a decisive contribution to the understanding and improved management of water resources, according to the DHG in its award rationale. Kunstmann has also done important work through his involvement in national and international expert commissions, but also in the public arena to raise awareness of the consequences of the climate crisis on our water resources.

“I am delighted to receive this award. What is important to me is that this award has a lot to do with TERENO,” says the prize-winner. The Helmholtz initiative has made it possible to equip different locations all over Germany with highly complex instruments. The resulting extensive observational data has significantly helped to expand and extensively validate Earth system models and thus decisively improve our understanding of climate, water and ecosystems. There is also a personal concern that is important to him: “We are passing on the experience gained from TERENO and the infrastructure to countries that do not have the same resources as we do - in other words, to countries in the global South, such as in West Africa. This was also only possible in this form through TERENO. I am very grateful to TERENO for this,” emphasizes Harald Kunstmann.

Honored for pioneering research and special commitment: Harald Kunstmann
© KIT/IMK-IFU/Harald Kunstmann

NEW COORDINATOR FOR TERENO-NORDOST

Since July 15, 2023, Melanie Burns has been coordinator of the TERENO's Northeast German Lowland observatory (TERENO-Nordost), succeeding Dr. Markus Schwab, who has held this position since 2021.


© Kate Longley

Melanie Burns, who has been at the Helmholtz Centre Potsdam - GFZ German Research Centre for Geosciences since 2020, is an experienced scientific coordinator with a broad range of experience, including managing large third party funded projects, such as the EU Horizon2020 project PAGER. Prior to this, she held similar positions at the Max Planck Institute for Chemical Ecology and the Charité University of Medicine. She also has particular experience in organizing field campaigns as well as expertise in event and people management. The Australian had worked in the management of non-profit organizations in her home country and specialized in science management after moving to Germany in 2015. "In my new role, I will focus, among other things, on expanding science communication around TERENO-Nordost and thus promoting the outstanding work that TERENO scientists have achieved over more than a decade and a half," says Melanie Burns.


© privat

Markus Schwab, senior scientist in the Climate Dynamics and Landscape Development department at the GFZ, will remain active in TERENO, for example as a member of the TERENO-Nordost Scientific Steering Committee of the GFZ. The expert in utilizing lake sediments for reconstructing climate history through proxy data will continue to contribute his extensive experience and expertise in geoarchives.

MODEL PREDICTIONS IMPROVED BY UP TO 60 PERCENT

CRNS measuring station in the TERENO's Eifel/Lower Rhine Valley observatory

TERENO researchers are are among those increasingly using the Cosmic-Ray Neutron Sensing (CRNS) method to estimate soil moisture. The method closes the gap between local measurements and large-scale remote sensing, for example satellite measurements. It also helps to improve model predictions. Scientists at Forschungszentrum Jülich were able to reduce model errors in the hydrological model Terrestrial System Modeling Platform (TSMP) by up to 60 percent using CRNS data from the TERENO's Eifel/Lower Rhine Valley observatory.

The Cosmic-Ray Neutron Sensing (CRNS) method utilises cosmic radiation that continuously hits our Earth from space and interacts with the atmosphere to generate neutron radiation. Depending on the amount of water in the soil or in the plants, this neutron radiation is reflected differently at the land surface. Measuring the reflected radiation reveals how much water is stored in the landscape. An important advantage of CRNS: Instead of laboriously burying a large number of individual sensors, only one CRNS detector is set up on the land surface. The detector provides a contact-free representative measurement of the neutrons for the area within a radius of 150 to 200 metres around the sensor.

CRNS provides an accurate estimation of soil moisture at the field scale and thus valuable information about soil moisture in the root zone on the typical scale of a model grid cell.

The results of the Jülich CSC PhD student Fang Li show how valuable the information is: The model error of TSMP in the prediction of soil moisture was reduced by up to 60 percent, while model errors in the prediction of monthly evaporation were reduced by 15 percent in the wet year and by 9 percent in the dry year. For the study, the team used CRNS data from 12 TERENO sites in the Rur catchment area - from a wet year (2016) and a dry year (2018) verified with an independent year (2017).

Fang Li et al. 2024. *Can a Sparse Network of Cosmic Ray Neutron Sensors Improve Soil Moisture and Evapotranspiration Estimation at the Larger Catchment Scale?* Water Resources Research, Vol. 60, Issue 1.

▶ DOI: 10.1029/2023WR035056

THE FINGERPRINT OF GREENHOUSE GASES

Forests and soils can absorb large quantities of CO_2. However, they only store the greenhouse gas for a certain period of time before releasing it back into the atmosphere. Accurate measurement data on greenhouse gas emissions is important in order to understand, but also to mitigate global warming caused by humans. In the ISOMONEAE project, researchers want to monitor the exchange of the greenhouse gases CO_2, nitrous oxide (N_2O) and methane (CH_4) as well as water vapor between the atmosphere and ecosystems with high temporal resolution. They also use the measurement of stable isotope ratios for this purpose.

Isotopes are variants of an atom that differ from each other only in the number of neutrons. Most isotopes decay very quickly, but stable isotopes have an unlimited lifetime. The chemical elements that make up greenhouse gases also occur as different stable isotopes. For example, carbon exists as a light (^{12}C) and a heavy variant (^{13}C). The light isotope variant dominates in all these gases, but there are variations in the proportions, that means in the ratios between heavy and light isotopes, which are caused by natural processes. This is because the rates at which the different isotope variants are converted in nature depend on the physical, chemical or biological processes on site. In the case of water vapor, for example, both the temperature and the relative humidity of the air have a strong impact on the isotope ratios. In the case of CO_2, N_2O and CH_4, it is mainly the production and consumption processes that exert the strongest influence on the isotopic signatures. “This means that we can determine specific patterns of stable isotopes - a kind of fingerprint that we can use to trace matter fluxes and thus precisely determine sources and sinks,” explains Prof. Nicolas Brüggemann from Forschungszentrum Jülich.

The researchers are conducting isotope-specific monitoring at two sites – the agricultural TERENO/ICOS site in Selhausen, which is supervised by Jülich, and the Fluxnet forest site in Leinefelde, which is supervised by the project partners from the University of Göttingen: Prof. Alexander Knohl, member of the TERENO Advisory Board, and Dr. Christian Markwitz. The results of ISOMONEAE will be incorporated into the “Integrated Greenhouse Gas Monitoring System for Germany” (ITMS). The ITMS partners, which also include TERENO members Jülich and Karlsruhe Institute of Technology, are currently developing a demonstrator system for a nationwide system for monitoring and verifying CO_2, nitrous oxide and methane emissions.

One of the two test sites: the TERENO site in Selhausen

HOW GOOD ARE SOIL MOISTURE ESTIMATES?

UFZ researcher Toni Schmidt wants to improve soil moisture estimates.

Accurate soil moisture estimates are crucial for understanding the Earth's water cycle and ecosystem dynamics. For these estimates, scientists use so-called soil moisture products, which are based, for example, on satellite measurements or model calculations. Assessing their quality at relevant scales has remained a challenge – because conventional in-situ measurements used for comparison are high-resolution, whereas the soil moisture products provide results on a coarser resolution of several square kilometers.

To evaluate various soil moisture products, researchers from the Helmholtz-Centre for Environmental Research (UFZ) and the University of Potsdam used a special data set: They used hectare-scale soil moisture data from the Cosmic-Ray Soil Moisture Observation System (COSMOS) in Germany as a reference.

Generally, model-based products demonstrate higher correlations and lower errors. But the team found out, that some purely satellite-based products performed comparably well – especially, the products from ESA's Climate Change Initiative and NASA's SMAP mission. However, the researchers observed seasonal variations in performance, with correlations and biases peaking during the summer months. The bias variability can be attributed to the limitations of microwave-based satellite sensors, which can only measure the upper few centimeters of soil. But during prolonged droughts, the subsurface layers can be much drier. Estimates based on satellite sensors could therefore indicate wetter soil conditions. The Cosmic Ray Neutron Sensing (CRNS) method, on the other hand, also detects deeper soil volumes, as cosmic ray neutrons can penetrate much deeper into the soil.

"This study has deepened our understanding of COSMOS data as a reference for coarse-scale soil moisture products," summarizes Toni Schmidt, PhD student at the Helmholtz Centre for Environmental Research - UFZ and the study's lead author. The researchers want to use their findings to develop a large-scale soil moisture product that leverages the benefits of both satellite and cosmic-ray neutron sensor data. "By combining the strengths of different measurement techniques, we aim to provide more accurate and comprehensive soil moisture estimates, which are essential for various applications, including drought monitoring or flood prediction," says Schmidt.

Toni Schmidt et al. 2024. *Comprehensive quality assessment of satellite- and model-based soil moisture products against the COSMOS network in Germany*. Remote Sensing of Environment, Vol. 301, 1.

▶ DOI: 10.1016/j.rse.2023.113930

TERENO-WORKSHOP „TERENO research in the Critical Zone“

5 – 7 November 2024 in Leipzig, Germany

The TERENO workshop hosted this time by the Helmholtz Centre for Environmental Research - UFZ will focus on topics relating to the Critical Zone, the uppermost layer of our planet. Key issues will be “Microbial life in soil and water”, “Land management and water quality” and “Carbon in the Critical Zone”. Contributions are still welcome on TERENO-related research activities, model applications at site, catchment and national level, and the translation of observation results into data products. In addition to workshops, lectures and poster presentations, there will also be an excursion: on November 7 to Holzhausen to the Meteorological Observatory of the German Weather Service.

Venue:

KUBUS Leipzig
Helmholtz-Zentrum für Umweltforschung - UFZ
Permoserstraße 15
04318 Leipzig
Germany

Contact and to register:

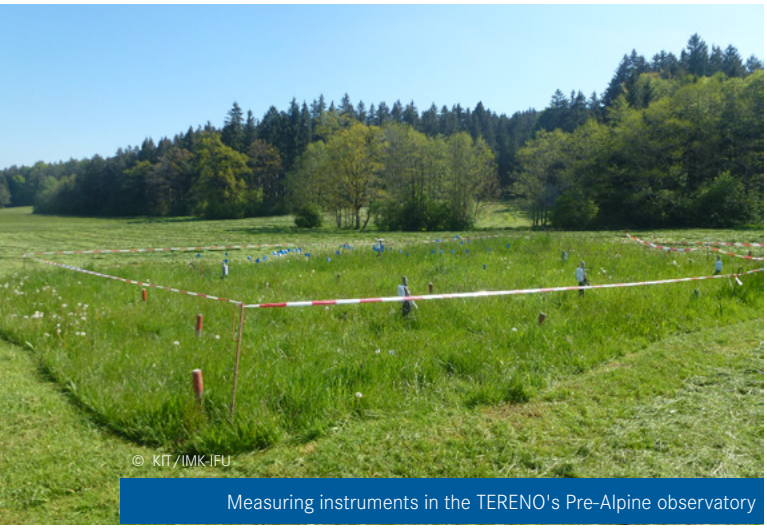
Dr. Steffen Zacharias
Department Monitoring- und Erkundungstechnologien
Helmholtz-Zentrum für Umweltforschung – UFZ

▶ Tel.: +49 341/235-1381
▶ E-mail: steffen.zacharias@ufz.de

CUMULATIVE KNOWLEDGE

The General Assembly of the European Geosciences Geosciences Union (EGU) is the largest annual geoscientific annual geoscientific conference in Europe. Around 18,000 participants traveled to Vienna in mid-April 2024 for the event. Almost 19,000 scientific presentations and posters were presented there. TERENO researchers also presented their work together with cooperation partners.

Soil functions at risk



Measuring instruments in the TERENO's Pre-Alpine observatory

One of TERENO's main goals is to is to record the regional effects of global change. Long-term data from grassland soils in the TERENO's Pre-Alpine observatory show the consequences of the moderate climate change of plus 2 degrees Celsius since 2012. Although plant growth has increased during this period due to increased nitrogen uptake, the soil is paying the price. The increased decomposition of nitrogen - and therefore also carbon - in the soil has a negative impact on soil fertility, the exchange of greenhouse gases and the soil's filtering function of the soil to protect water bodies. This development poses risks to important soil functions in the long term.

▶ DOI: 10.5194/egusphere-egu24-11233

Better understanding dew formation

In order to be able to assess the consequences of changes, environmental processes must be understood, such as water input into ecosystems. Precipitation is the most important factor here. However, other, significantly smaller inputs are also important for the survival of fauna and flora, especially during drier periods. But dew, hoar frost, rime, fog, and adsorption of water vapour in the soil are often neglected in studies. Data from the TERENO site in Selhausen show that dew accounts for the largest proportion of non-rainfall water inputs there. However, the rate and frequency of dew formation differs significantly between vegetation types. The analysis showed that, depending on the height of the vegetation, different parameters correlated with dew formation for grassland and arable land during dry downs. This information is important for better predicting dew formation for different land cover types with models in the future.

▶ DOI: 10.5194/egusphere-egu24-7308

Data quality must be right

In order to obtain accurate and reliable results from sensor data, one thing is particularly important: efficient quality control. Deep Learning (DL) methods are becoming increasingly important here. TERENO researchers have developed a model that uses DL to detect anomalies in time series data. The detected irregularities can be used to determine whether they are unusual events, or faults or disturbances within the data. The researchers tested their model with 2.5 million samples. They used data from commercial microwave links which are used for rainfall estimation as well as soil moisture data from the SoilNet sensor network at the TERENO site Hohes Holz.

▶ DOI: 10.5194/egusphere-egu24-8410

Forest in transition

TERENO researchers are also monitoring other changes, such as the transformation of a spruce monoculture into a mixed deciduous forest in the Eifel National Park, which corresponds to the local climate and soil conditions. The area is part of the TERENO site Wüstebach, which is equipped with numerous measuring devices. The data show that the area cleared by the national park initially became a source of atmospheric CO_2. Eight years later, the regrowing vegetation has turned it back into a CO_2 sink. The dominant tree species is now rowan, followed by spruce and birch - with rowan and birch growing about twice as fast as spruce.

▶ DOI: 10.5194/egusphere-egu24-9455

Open data for better science

After measuring and monitoring, the data needs to be made available to others. This becomes a challenge when enormous amounts of data are generated, as is the case with the infrastructures of the seven centers of the Helmholtz Research Field Earth and Environment, which includes TERENO. In order to streamline and standardize the usage of data, the centers have initiated the STAMPLATE project. Essentially, the aim is to establish a joint, networked research data infrastructure for environmental time series data. This includes a standardized interface as well as tools for visualizing data or managing monitoring systems.

▶ DOI: 10.5194/egusphere-egu24-20127

TIME FOR A BROADER SPATIAL SCALE

A new international network aims to advance Critical Zone (CZ) research: CZInt. The network was initiated by US researchers Prof. Elizabeth Boyer from Penn State University, Dr. Bhavna Arora from Lawrence Berkeley National Laboratory, and Prof. Jeffrey Munroe from Middlebury College. The US National Science Foundation is funding it through its "AccelNet" program. In this interview, Jeff Munroe explains the background and goals of CZInt in which TERENO is also involved.

Prof. Munroe, what is this new initiative about?
CZ research, whether at the level of individual projects, integrated observatories, or connected national networks, has been quite successful as a way to understand processes and feedbacks operating within the CZ. But the time is right to integrate study of the CZ at a broader spatial scale, bringing the observatories and programs at the national level together into an organized, international entity.

Why?
Each network and observatory is a valuable research entity itself, but they often exist as isolated islands, e.g., with site specific instrumentation, goals, and research teams. These efforts exhibit an inherent level of redundancy, and different protocols for observatory design, field sampling, and data sharing complicate the global discoverability of data sets. Furthermore, CZ exhibits tremendous diversity in terms of climate, geology, and ecosystems. Limiting CZ research to individual sites or networks within individual countries inherently means that the full range of Earth's diversity cannot be studied by any one network. As a result, the full potential of what these networks could achieve remains unrealized. The aim of CZInt is to change that.

How is this to be achieved?
We outlined two primary goals. The first is to establish a robust and cohesive international "Network of Networks" focused on the CZ, bringing together researchers from different countries and disciplines across established and emerging networks to accelerate scientific research. Knowing who is who, and who is doing what, is hugely important for building a network of networks in which the whole is greater than the sum of the parts.

And second?
We would like to create a framework that not only addresses existing research gaps but also proactively identifies and leverages synergies among CZ networks, fostering cross-disciplinary collaboration and innovation in CZ science. It is a coordinated effort to share the lessons learned, to integrate results, and to more effectively share research expertise. CZInt will leverage the environmental settings of each individual CZ network, allowing researchers to explore heterogeneity in the CZ more thoroughly, gaining insights that would contribute to a more robust understanding of complex processes.

Does this mean that there is already a concrete idea of how CZ research should be carried out?
Beth, Bhavna, and I are certainly not saying we have a rigid plan or idea for what international CZ research should be – far from it! This is exactly the point that should be discussed. And CZInt will give us the chance to do that, with as many voices at the table as possible.

As the first network partner, you have selected SITES from Sweden, OZCAR from France, and the German TERENO initiative. Why these three?
All three are model programs that have been in successful operation for many years. Frankly, it was an easy decision to select them as initial partners to the US CZ community in this starting phase of CZInt. Of course, it is a major goal of CZInt - indeed a major requirement of the AccelNet program overall - to further expand the group. To me this will be one of the most exciting aspects, seeing what new connections can develop or be strengthened.

What is specifically planned?
At the core of the initiative will be day-long meetings for members of the international CZ community at meetings of the American Geophysical Union (AGU) and the European Geosciences Union. These gatherings will provide a platform for face-to-face interactions, enabling participants to make new connections, forge new collaborations, share insights, and discuss future directions for CZ science. A significant component of these meetings will be guided conversations about collective visioning for international CZ research, and identification of prominent CZ knowledge gaps.


© privat

Jeffrey Munroe is Philip Battell Stewart and Sarah Frances Cowles Stewart Professor of Geology at the Department of Earth and Climate Sciences of Middlebury College, USA. He is active in the CZ research community in the US and expert for mountain geomorphology and paleoclimate.

When will CZInt start and what needs to be done by then?
The project will officially start in September, 2024. Between now and then, Beth, Bhavna, and I will be busy planning our strategy for rolling out the project and making contacts. The first few months will be a soft start as we build a website, launch the seminar series, begin compiling a newsletter, and work to get the word out about the new project. In December, the AGU meeting in New Orleans, USA will provide the opportunity for a higher-profile official launch.

Prof. Munroe, thank you very much!

Interested in CZInt or any questions?

Please contact Jeff Munroe
▶ jmunroe@middlebury.edu

GREENHOUSE GAS EMISSIONS FROM PEATLANDS

Peatland soils store carbon (C) and nitrogen (N). As they bind the greenhouse gas carbon dioxide (CO_2) in the long term, they can be important building elements against climate change. On the other hand, they can also become sources of greenhouse gases. "When streams and rivers drain peatland soils, this can lead to significant emissions of CO_2, methane (CH_4) and nitrous oxide (N_2O)," says Dr. David R. Piatka from the Campus Alpin of the Karlsruhe Institute of Technology (IMK-IFU/KIT). Together with colleagues, he has investigated how the Haselbach, a stream in the TERENO's Pre-Alpine Observatory, drains peatland soils.

The results show that heavy precipitation events in particular can wash out the greenhouse gases dissolved in the surrounding peatland soils and lead to high greenhouse gas emissions from the water systems. In drier periods, the greenhouse gas dynamics were significantly influenced by the metabolism in the water body itself. "Such studies provide an important basis for a better understanding of the temporal variability of greenhouse gas emissions in peatland landscapes and their effects on the climate. They are particularly important for assessing the influence of peatland rewetting projects on global warming on a landscape scale, for example," emphasizes Piatka.

The researchers developed a special measuring system to investigate the temporal variability and dynamics of the greenhouse gases dissolved in the stream water and the associated emissions in more detail: It works with a self-sufficient energy supply and automated, continuous and high-resolution laser measurements. The scientists also measured other environmental parameters and used meteorological data from a nearby weather station to estimate the environmental influences on the greenhouse gas fluxes determined. The work took a total of five months.

David R. Piatka prepares measurements at the Haselbach stream.

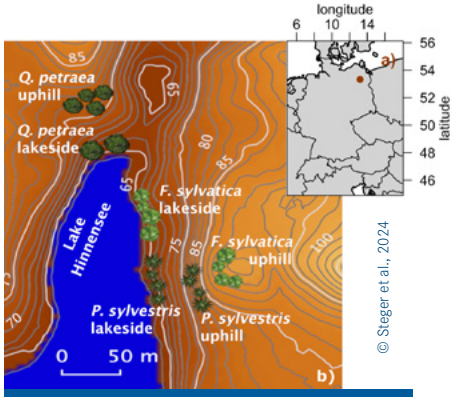
David R. Piatka et al. 2024. *Precipitation fuels dissolved greenhouse gas (CO_2, CH_4, N_2O) dynamics in a peatland-dominated headwater stream: results from a continuous monitoring setup.* Front. Water 5:1321137.

▶ DOI: 10.3389/frwa.2023.1321137

OAK AND BEECH ADJUST MORE TO DROUGHT THAN PINE

Trees can control their water-use by opening and closing their stomata. “This is a critical tool to respond to drought. We have discovered, that European trees also use this ability in the longer term as a mitigation strategy in an increasingly drier environment,” says David N. Steger, PhD student at the University of Basel. Together with colleagues from Basel and from the Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences, he studied trees at lake Hinnensee in the Müritz Nationalpark, a study site of TERENO's Northeast German Lowland observatory.

The scientists collected six years of sap flow and dendrometer data of Pinus sylvestris, Fagus sylvatica and Quercus petraea as well as soil moisture and climate data. And they studied the trees growing under different soil hydrological conditions: One group of each species grows in close proximity to the lake, which creates a wetter environment while the other group grows on top of a terminal moraine, which is characterized by drier soils. “There, the trees are more often subjected to longer periods of soil drought,” explains Steger. The analysis revealed that at the drier site the broadleaved species F. sylvatica and Q. petraea closed their stomata to a higher degree than the conifer species P. sylvestris in comparison to the wet site. “This suggests that the broadleaved species showed a higher level of drought adjustment. The findings of the study highlight the importance of longer-term monitoring to better understand dynamics, composition, and vitality of future temperate forests within a steadily changing environment,” emphasizes Steger. In addition, the study confirms that dendrometer measurements – measurements of growth- and water-related stem circumference dynamics of trees – can be used as proxy for tree-available water.



The Hinnensee study site: at the top are the locations of the oaks, in the middle to the right of the lake are the beech trees and below are the pine trees.

David N. Steger et al. 2024. *Site matters - canopy conductance regulation in mature temperate trees diverges at two sites with different soil water availability.* Agricultural and Forest Meteorology, Vol. 345.

▶ DOI: 10.1016/j.agrformet.2023.109850

EXPERIENCING AND UNDERSTANDING SCIENCE

GFZ researcher Dr. Theresa Blume explains how a SapFlow sensor works. It can be used to quantify the amount of water flowing through a tree stem.

About 6,000 people visited this year's Potsdam Day of Science at the Telegrafenberg campus on May 4, 2024. More than 33 universities, schools and research institutions in Brandenburg presented their work at the event, coordinated this year by the GFZ Research Centre for Geosciences..

The TERENO's Northeast German Lowland observatory (TERENO-Nordost) offered insights into the research of various working groups. "We wanted to inform the visitors in a fun and interactive way about how scientists go about measuring and understanding the environmental processes of global change," reports Melanie Burns, Scientific Coordinator of TERENO-Nordost. At the TERENO-Nordost Zarnekow project, for example, young and old were able to experience how plants breathe. Visitors could use their own breath to influence the CO_2 concentration in the air and then watch how quickly the plant removes the CO_2 from the atmosphere to be used for photosynthesis.

Guests were also able to see something very old: Among the impressive showcase of tree discs was a 1016-year-old juniper disc. Visitors could learn what geoarchives, such as tree discs, tell scientists about the climate of the past: They were able to take samples of tree cores themselves and analyze them. The thickness of the growth rings revealed, for example, how the recent drought caused a sharp decline in growth.

Soil moisture sensors are an important tool in hydrological research. On the Day of Science, sensors made it possible to observe how water moves through the different soil layers. The TERENO scientists also demonstrated equipment for measuring climate parameters and an eddy covariance system for measuring greenhouse gas fluxes, which is used at the GFZ in rewetted peatlands, among other things. "The opportunity to see the technology and equipment up close made it easier to explain and understand the importance of what we measure and why," explains Melanie Burns.

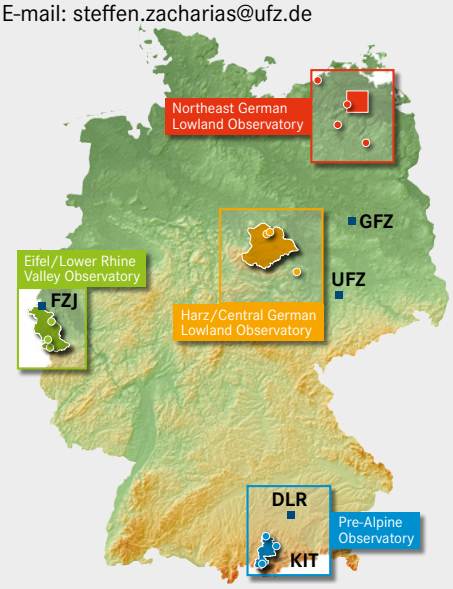
CONTACT | COORDINATION

Dr. Heye Bogena
Institute of Bio- and Geosciences – IBG-3: Agrosphere, Forschungszentrum Jülich, 52425 Jülich, Germany
Tel.: +49 (0) 24 61/61-67 52
E-mail: h.bogena@fz-juelich.de

Dr. Ralf Kiese
Institute for Meteorology and Climate Research, (IMK-IFU), Karlsruhe Institute of Technology
Kreuzeckbahnstrasse 19,
82467 Garmisch-Partenkirchen, Germany
Tel.: +49 (0) 88 21/1 83-1 53
E-mail: ralf.kiese@kit.edu

Melanie Burns
Helmholtz Centre Potsdam – GFZ
German Research Centre for Geosciences,
Telegrafenberg, 14473 Potsdam, Germany
Tel.: +49 (0) 3 31/6264-1725
E-mail: melanie.burns@gfz-potsdam.de

Dr. Steffen Zacharias
Department Monitoring and Exploration Technologies, Helmholtz Centre for Environmental Research – UFZ, Permoserstraße 15, 04318 Leipzig, Germany
Tel.: +49 (0) 3 41/2 35-13 81
E-mail: steffen.zacharias@ufz.de



FZJ Forschungszentrum Jülich (Coordination)

DLR German Aerospace Center

KIT Karlsruhe Institute of Technology

UFZ Helmholtz Centre for Environmental Research

GFZ German Research Centre for Geosciences

IMPRINT

Publisher:
TERENO, www.tereno.net
Editing:
Christian Hohlfeld
(responsible under German Press Law),
Am Brünnchen 21, 53227 Bonn, Germany
Graphic design and layout:
BOSSE UND MEINHARD, Bonn