

Newsletter 2/2016

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At TERENO's Wüstebach site, researchers use special chambers to measure CO₂ fluxes from the soil.

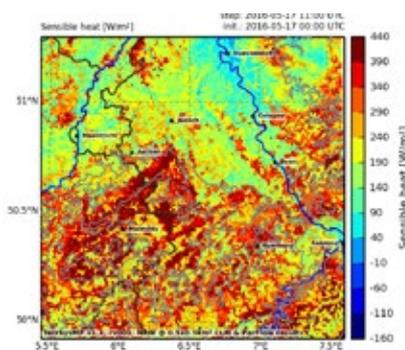
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The TERENO model

With its four observatories across Germany, TERENO has established extensive measurement networks, such as the Wüstebach site in the Eifel region (image above). Data gathered at these sites make it possible to forecast future developments and develop appropriate measures as needed. These networks are taking root in other countries as well. In the Mediterranean region, for example, a new network of hydrologic observation platforms in Italy, Spain and Greece has modeled itself on TERENO observatories.

DAILY UPDATES ON YOUTUBE

The Centre for High-Performance Scientific Computing in Terrestrial Systems (HPSC TerrSys) publishes current simulations of the terrestrial water cycle on its dedicated YouTube channel on a daily basis – both for North Rhine-Westphalia and Europe as a whole. Aside from typical meteorological diagnostics, the videos show, e.g. forecasts of the diurnal cycles of changes in groundwater levels, plant available water, or discharge. The simulations are performed with the Terrestrial Systems Modeling Platform (TerrSysMP), which was developed as part of the DFG Collaborative Research Centre/Transregio 32 (see TERENO Newsletter 1/2016). ■



► [The HPSC TerrSys YouTube channel](#)

ICOS GERMANY ANNUAL MEETING: STRENGTHENING COLLABORATION



© GEOMAR / Jan Steffen

Participants in the 2016 ICOS-D annual meeting in Kiel.

ICOS Germany (ICOS-D), the German chapter of the international Integrated Carbon Observation System (ICOS), has nearly completed construction of its measurement networks and laboratories. Focus will now shift to current data and results as well as a long-term strategy for greenhouse gas observations; these were also the main topics at the national network's 4th annual meeting held this year in Kiel, Germany. Numerous experts were on hand from May 18-20 at the GEOMAR Helmholtz Centre for Ocean Research to discuss the current status of Germany's contribution to ICOS and future strategies. Participants included researchers from the three ICOS observation networks Atmosphere, Ecosystems and Oceans, employees from ICOS' two central laboratories in Germany, as well as representatives from the Federal Ministry of Transport and Digital Infrastructure, the Federal Ministry of Education and Research, and the responsible project sponsor at the German Aerospace Center (DLR).

An important point of discussion was the role of ICOS in relation to other national and international measurement networks and research infrastructures. Already today ICOS and TERENO, which share the use of several measurement stations, enjoy a close collaborative relationship characterized by active dialogue and exchange. In terms of international cooperation, participants agreed that ICOS and other ground-based measurement networks, along with remote sensing data, should form a major part of the planned comprehensive verification system for greenhouse gas emissions reporting. They also agreed that such a system should include strong atmospheric inversion modelling and data assimilation components. ■

► [ICOS-D annual meeting presentations](#)

EDITORIAL

Sharing knowledge



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Networking and sharing knowledge are very important aspects of our work. This applies not only to the work with our partners in the TERENO observatories, but also to the scientific community worldwide. With TERENO we have created a network from which other countries can benefit as well. Scientists from around the world can exchange data and share experiences, for example, within the European network for Long Term Ecological Research (LTER-Europe), the international Integrated Carbon Observation System (ICOS), or the recently established International Soil Modeling Consortium (ISMC, see p. 5). And it's just as important for us to learn from others. Only by exchanging and sharing knowledge will we be able to understand complex processes, such as those between earth, atmosphere and land-use, and to develop solutions to address the effects of global environmental change.

The Mediterranean region is already feeling these effects. Agriculture's growing demand on fresh water reserves, for example, has led to lower groundwater levels and a decline in water quality. At the same time, heavy rains are causing floods and landslides. But before we can develop efficient management strategies we must first gather sufficient data. Through the Helmholtz initiative ACROSS, TERENO researchers are helping establish the necessary observation platforms (see p. 3). Here, existing TERENO observatories serve as useful models. The data gathered is then shared with the larger scientific community through TERENO's data portal TEODOOR – and everyone benefits.

I hope you enjoy this issue of the TERENO Newsletter.

Sincerely,

Harry Vereecken
TERENO Coordinator

LEARNING FROM TERENO

ACROSS establishes observatories in the Mediterranean

While agricultural production remains an important economic factor in the Mediterranean region, the combination of climate change and the growing demand on freshwater reserves poses significant challenges. Efficient management strategies will be key to ensuring agricultural production over the long term. These strategies, in turn, depend on access to key environmental data. Jülich scientists have responded by establishing observation platforms in selected regions, for which TERENO observatories serve as a model.

Over the last several decades, agricultural production has continued to grow and expand across the Mediterranean region,

placing greater demand on the sources of freshwater used to irrigate fields and other cultivated lands. In many regions the impact of this has been noticeable; consequences include lower groundwater levels, a decline in water quality, and, in coastal regions, sea water intrusion into groundwater. Climate change only exacerbates the situation. Over the last several years, longer droughts and episodes of heavy rainfall have occurred more frequently, resulting in increased risk of flooding and landslides throughout the Mediterranean region.

For individual countries in the region it is important to be able to predict future de-

velopments as accurately as possible and to develop appropriate countermeasures. The problem is that the required environmental data – including data on precipitation, soil moisture or water drainage – is by no means complete. Jülich scientists from the Agrosphere Institute are working together with local partners to establish observation platforms in selected regions with funds from the Helmholtz initiative ACROSS. The platforms are modeled on the four observatories within Germany's TERENO network. Data gathered in the Mediterranean region is then shared with the scientific community via TERENO's data portal TEODOOR.



Picassent Study Site

Cooperation with the Polytechnic University of Valencia



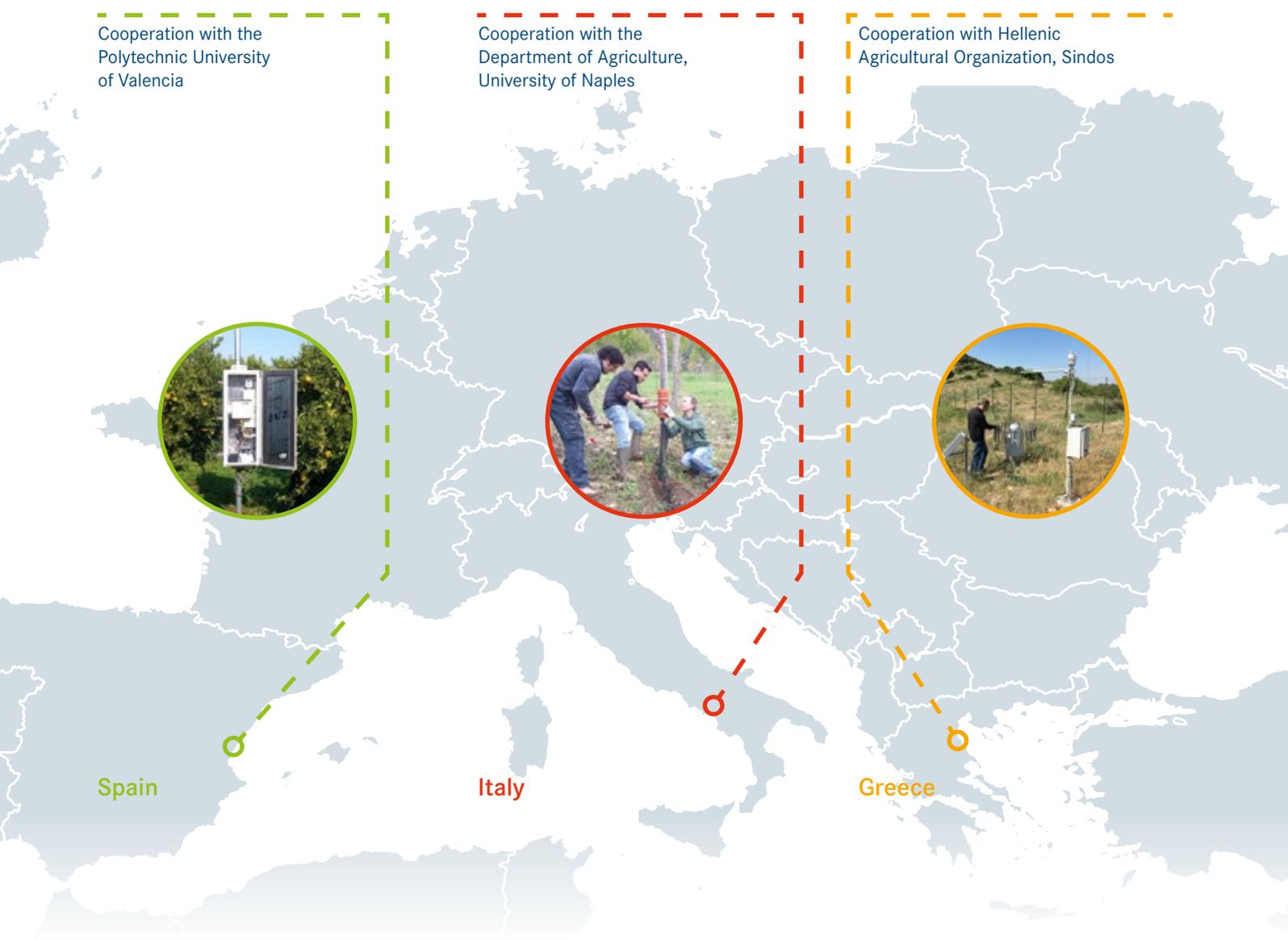
Alento River Catchment

Cooperation with the Department of Agriculture, University of Naples



Thessaly Basin

Cooperation with Hellenic Agricultural Organization, Sindos



Spain

Italy

Greece

► ACROSS establishes observatories in the Mediterranean

Picassent Study Site

In Spain researchers are investigating a test area within an irrigated citrus plantation near Valencia. Here Jülich researchers are working closely with the Institute for Water and Environmental Engineering based at the Technical University of Valencia with the goal of minimizing the use of water resources for irrigation. Researchers installed a network of soil moisture sensors and a cosmic-ray sensor. Additional support was also received from the EU project AGADAPT. All data is available in real-time and has already been used for automatically regulating the irrigation system. Initial results indicate potential water savings of up to 20%. In addition, researchers plan to



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Spain: Cosmic-ray soil moisture sensor at the citrus plantation

install measurement instruments in a forested catchment area to enable a detailed investigation of water exchange between soil and atmosphere in a pine forest.

Alento River Catchment

In Italy researchers selected a 400 km area south of Naples within the Alento River catchment. This includes the Piano della Rocca dam reservoir, which is also used for irrigation. Three smaller research/testing areas will be used to investigate environmental processes in an agricultural field, a tree plantation and a natural forest. Among other things, researchers want to learn how agriculture impacts nitrate levels in the reservoir. Another important aspect is the impact of forest fires, the risk of which has increased due to climate changes and more frequent drought periods. Already last year, researchers equipped the test areas with wireless sensor networks for measuring soil



© University of Naples / Nunzio Romano

Italy: Installation of the soil moisture sensor network at the tree plantation in 2015

moisture, cosmic-ray sensors and numerous groundwater gauges. The installation of the measurement instruments in the Alento River catchment is in close cooperation with the Institute of Agricultural, Forest and Biosystems Engineering, University of Naples.

Thessaly Basin

In Greece researchers chose the Agia region to conduct their research – an area in the Thessaly basin with intensive agricultural use. Farming here is largely dependent on irrigation, which draws down significantly on groundwater reserves. One important goal is to adjust groundwater extraction so that it corresponds to the amount of groundwater actually available. This requires a better understanding of how groundwater is formed in the region. Along with local groundwater recharge, groundwater in the basin is presumably replenished by runoff from the surrounding mountains. To learn more about this, researchers installed climate stations and sensor networks, which allow them to



© FZ Jülich / Frank Herrmann

Greece: Meteorological station in the Agia region

accurately determine soil water content and groundwater levels – even given significant spatial variation of these levels. The measurement instruments in the Agia region were installed in close cooperation with the Institute of Soil and Water Resources of the Hellenic Agricultural Organization. ■

eLTER H2020: Data platform to launch in 2016

The EU project European Long-Term Ecosystem & Socio-Ecological Research Infrastructure (eLTER H2020) continues to make rapid progress. Approximately one year after the project's kick off in 2015 (see TERENO Newsletter 1/2015) the first parts of the planned data portal are already up and running. The "eLTER Data Integration Platform" (DIP) is scheduled to be online in its entirety by the end of 2016, as announced at the second annual meeting of eLTER H2020 held in mid June in Latvia's capital city Riga. DIP will enable access to data from 162 different eLTER research sites, including various TERENO sites, all of which belong to the European network for Long Term Ecological Research (LTER-Europe).

The two-day meeting in Riga focused among other matters on planned DIP functions and requirements. Participants also discussed how data collected via the portal will be used – intended primarily to supply climate and vegetation models to help investigate climate change and its impact on ecosystems. As part of a test study over the summer, data was collected from the 162 research areas and uploaded onto the portal. The subsequent evaluation will provide a first look at what will be possible with DIP.

Research grants for eLTER sites

Project partners attending the annual meeting also discussed selection of the most urgent research topics, the close association with critical zone research, as well as researcher training and mobility. Summer 2016 saw the first researchers visiting selected eLTER research areas as part of the eLTER Transnational Access program. One of these 16 areas is the TERENO site Siptenfelde overseen by the Helmholtz Centre for Environmental Research – UFZ. An additional topic was the planned communications strategy, which is designed to help create as much transparency as possible vis-à-vis the scientific community and the public.

Following the eLTER meeting, the European network LTER-Europe also met in Riga for their annual meeting. Here the focus was on a planned project entitled "Advance_eLTER" which is designed to strengthen and expand LTER in Europe. ■

► [More on eLTER H2020](#)

WHAT HYPERSPECTRAL IMAGES CAN TELL US ABOUT PLANTS

EnMAP to provide even more detailed ecosystem data starting in 2018

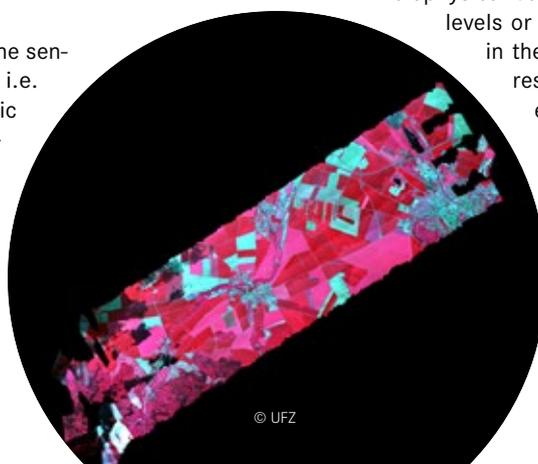
An additional German satellite program – EnMAP (Environmental Mapping and Analysis Program) – is scheduled to launch in 2018. The earth observation satellite will provide high-resolution spectral data which scientists can then use to analyze and describe geochemical, biochemical and biophysical properties of ecological systems in greater detail. The TERENO member Helmholtz Centre for Environmental Research – UFZ is among the program participants. One of the main challenges when evaluating hyperspectral images is deriving biophysical properties through the inversion of radiative transfer models.

As part of the preparatory program, UFZ is involved in modeling vegetation spectra and deriving biophysical and biochemical vegetation parameters such as chlorophyll content, leaf area index or water content. The vegetation parameters were derived mainly from agricultural crops wheat, barley and corn. Beginning in 2011 UFZ researchers gathered airborne hyperspectral images several times per year from TERENO's Harz/Central German Lowland observatory with the help of the airborne hyperspectral imaging system AISA Dual.

On the way from the earth's surface to the sensor, the energy emitted by an object, i.e. its radiance, is modified by atmospheric constituents like water vapor and aerosols. Researchers can use atmospheric radiative transfer models to determine the impact of such factors. UFZ scientists were able to simulate at-sensor radiance by combining two models: the vegetation radiative transfer model SLC and the atmosphere radiative transfer model MODTRAN. With the

help of complex statistical methods, researchers were able to assign fix values to model parameters – a process known as inversion. This allows researchers to work with signals received directly at the sensor, which makes it easier to identify vegetation parameters. Furthermore, this procedure reduces the number of variables for inversion and the overall computational effort required.

The method used by UFZ researchers allows them to assign biophysical vegetation properties, such as chlorophyll levels or leaf area index, for each individual pixel in the hyperspectral image data set. This way researchers were able to derive reliable vegetation properties for the agricultural areas of the TERENO observatory. Results were verified by conducting corresponding in-situ field measurements parallel to the airborne measurements. Consequently EnMAP, from the very start of the program, can rely on methods for the thematic evaluation of satellite data. ■



Color Infrared (CIR) image based on hyperspectral airborne data from early summer 2014 (Falkenstein/Harz) using the AISA-Dual system. The agricultural fields are clearly recognizable. Red areas indicate active green vegetation; blue areas indicate either soil signatures (post harvest), senescent vegetation or urban areas.

NEWLY ESTABLISHED INTERNATIONAL SOIL MODELING CONSORTIUM

The International Soil Modeling Consortium (ISMC) was established at the end of March 2016 in Austin, USA as part of a three-day inaugural conference held at the University of Texas and attended by more than 110 scientists from over 25 countries. The mission of the newly-formed consortium is to integrate and advance soil systems modeling and improve data gathering and observational capabilities. Participants elected TERENO Coordinator Prof. Harry Vereecken from Forschungszentrum Jülich to chair the ISMC for a two-year term.



During the conference more than 40 presentations and over 80 posters provided the focus for intensive discussions on a broad range of soil modelling activities. Four working groups addressed the following key topics: mission and governance of the ISMC

and outreach, model development and intercomparison, linking data with models, and cross-cutting topics on soil research and modelling. The last day of the conference also featured the first working meeting of the ISMC during which the executive board, a scientific advisory board and five science panels were appointed.

► [Additional information on the ISMC](#)

CARBON TRANSFER THROUGH SOIL EROSION



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Runoff measurements in the Northeastern German Lowland TERENO Observatory

Soils, which can both capture and release carbon, play an important role in the carbon cycle. Soil erosion can cause substantial carbon transfer within the landscape. Researchers disagree on the significance of this lateral transfer and its impact on the carbon budget; some consider it a global source, others a global sink. In addition, several sub-processes involve reciprocal interactions that are not yet fully understood. This is where the “TERENO Erosion Observation System” comes into play. As part of the project, scientists from different institutions are investigating carbon transfer in selected fields in TERENO’s Northeastern German Lowland observatory.

Agricultural fields play a key role in lateral carbon fluxes at the landscape level. Not only is soil erosion due to water at its highest levels here, there is also additional erosion due to soil tillage. To gather data on both of these processes and investigate the interactions with vertical carbon fluxes, researchers have conducted continuous measurements in four smaller representative field watersheds since the beginning of 2015. This enables runoff samples to be taken automatically, whenever surface runoff occurs. Laser precipitation monitors (distrometers) also gather data on the spatial distribution of precipitation intensity, along with drop size and velocity. With the help of a terrestrial laser scanner research-

ers can assess gradual changes to the land surface. Various additional measurements further supplement the erosion monitoring. “Because water erosion is event-based and yearly changes due to tillage erosion are so minimal, both processes can only be understood through long-term observation,” explains Prof. Peter Fiener from the University of Augsburg.

Together with data from the TERENO-SOIL-Can project, these long-term monitoring results are then used to develop coupled soil erosion and soil carbon turnover models, which help apply insights gained at the local level to better understanding other similarly structured landscapes. ■

Project partners

- Helmholtz Center Potsdam – German Research Center for Geosciences (GFZ)
- Institute for Soil Landscape Research (BLF), Leibniz Centre for Agricultural Landscape Research (ZALF)
- Institute of Geography, University of Augsburg
- Brandenburg University of Technology Cottbus-Senftenberg

▶ Contact: Professor Peter Fiener, University of Augsburg
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COLLOQUIUM ON LANDSCAPE EVOLUTION AND LONG-TERM OBSERVATIONS IN NORTHEASTERN GERMANY

For the past six years, researchers at TERENO’s Northeastern German Lowland observatory have been investigating the impact of climate and land-use changes on terrestrial ecosystems. At the one day colloquium “Landscape evolution and long-term observations on climate, soils and hydrology in northeastern Germany: TERENO and regional cooperation partners” the Helmholtz Center Potsdam – German Research Center for Geosciences GFZ, which acts as the observatory coordinator, will join with partners to present activities and results. The full-day event is a good chance for interested parties across the region to learn more about TERENO and how they may benefit from it and, ideally, to initiate new partnerships. ■

EVENT NOTE

13 October 2016 | Rostock

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SCIENTISTS FIND ANCIENT VOLCANIC ASH FROM ICELAND IN NORTHEASTERN GERMAN LAKE

An international team of scientists led by the German Research Centre for Geosciences (GFZ) has discovered thousands year old volcanic ash in Lake Tiefer See, a research area within the Northeastern German Lowland TERENO observatory. The ash originates from volcanic eruptions in Iceland. The sediment deposits allow scientists to date climatic changes over the last 11,500 years with greater precision.

Every year layers of minerals and other materials settle at the bottom of lakes; these deposits provide information on climate changes and anthropogenic activities in the vicinity of the lake throughout history. In Lake Tiefer See in Germany's northeastern state of Mecklenburg-Vorpommern researchers discovered something that is not only centuries old, but has also traveled a long way: the vestiges of eight different volcanic eruptions on Iceland more than 2,000 kilometers away. Six of the eruptions could be precisely identified. The oldest occurred 11,400 years ago and the most recent in 1875 – an eruption that is also described in historical documents. From three of these Icelandic eruptions, ash particles were also found in a lake in Poland some 500 kilometers east of Lake Tiefer See. "This means we can, for the



Achim Brauer holding a sediment core from Lake Tiefer See

first time, synchronize both sediment archives down to the year, which allows us to identify even subtle regional differences in past climatic change," says GFZ scientist Prof. Achim Brauer. "This information, in turn, allows us to better anticipate regional aspects of future climate change."

To detect the tiny ash particles, which are only about 50 micrometers across, the researchers use a special combination of chemical and microscopic methods. The geochemical analyses of individual particles were compared with volcanic ash in Iceland. "Ideally we can precisely identify the corresponding volcanic eruption, reconstruct the movement and spread of volcanic ash clouds, and draw conclusions about past wind conditions," explains Dr. Sabine Wulf, who conducted research at GFZ at the time of the study and today works at Heidelberg University. The study was conducted as part of TERENO and the Virtual Institute of Integrated Climate and Landscape Evolution Analyses (ICLEA).

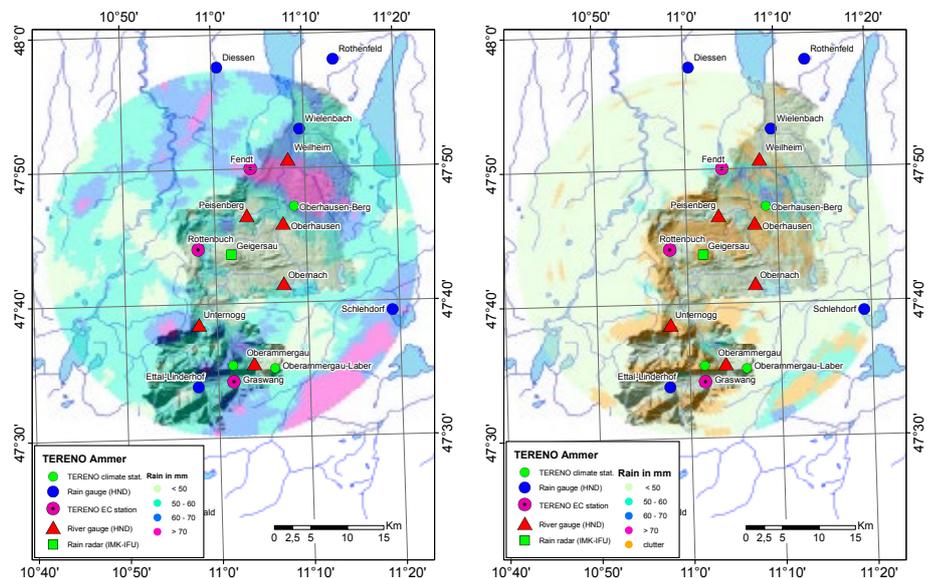
Sabine Wulf et al. *Holocene tephrostratigraphy of varved sediment records from Lakes Tiefer See (NE Germany) and Czechowskie (N Poland).* Quaternary Science Reviews 132 (2016).

► DOI: <http://dx.doi.org/10.1016/j.quascirev.2015.11.007>

“GEIGERSAU” RAIN SCANNER ONLINE



Located on the “Geigersau” farm within TERENO’s Bavarian Alps/pre-Alps observatory, the rainfall radar, operated since 2009 by the Institute of Meteorology and Climate Research (IMK-IFU) at the Karlsruhe Institute of Technology, transmits its data to the TERENO data portal TEODOOR for visualization online. Installed on Mount Kimberg at an elevation of 950 meters, the radar operates on a special short-wave frequency known as X-Band. With 12 scans per minute, the radar can scan precipitation



Corrected rainfall data for the Ammer River catchment in TERENO’s Bavarian Alps/pre-Alps observatory (June 2015)

up to a radius of 50 km with a high degree of spatial resolution. Before being published and visualized on TEODOOR, the data undergoes post-processing by IMK-IFU researchers who correct for any ground clutter in the vicinity of the radar and obstacle clutter caused by nearby mountains. These corrections lead to much better agreement

with regional rain gauge measurements provided by TERENO climate stations or Bavarian flood warning service (HND).

► The “Geigersau” rain scanner

NOT ALL BOGS ARE CREATED EQUAL

Natural peatlands, which are some of the earth's most important carbon sinks and water reservoirs, are under threat today. In the northern latitudes this is due mainly to nitrogen inputs and rising temperatures; in temperate zones it is due mainly to drainage and conversion for agricultural use. The Helmholtz International Research Group ArcBiont – a cooperation between the German Research Center for Geosciences (GFZ) and the Arctic University of Norway – has conducted research for over two years on various types of peatlands, including brown moss and Sphagnum peatlands in the high Arctic, Arctic and sub-Arctic as well as in Müritz National Park, a central research area within TERENO's Northeastern German Lowland observatory. Jun.-Prof. Susanne Liebner and her PhD student Andrea Kiss from GFZ are particularly interested in the specific differences between the microbiomes of these peatland types.

Natural peatlands are nutrient poor habitats home to highly specialized flora and fauna. Their vegetation is dominated by mosses, such as Amblystegiaceae (so called “brown mosses”) or Sphagnum moss, commonly referred to as peat moss. Microbial communities, including bacteria, are known to be closely associated with the mosses. Some of these bacteria consume methane for energy, others convert nitrogen. These relationships remain a hot topic of discussion among scientists. It is not yet entirely clear, for example, how much this moss microbiome varies geographically in terms of their diversity and functionality or to what extent their ecology depends on local parameters and the moss itself.

Clear differences

The research group's investigations have now revealed clear structural differences in the bacterial communities associated with Sphagnum and brown mosses mainly resulting from differences in pH. Local distribution patterns can be attributed mainly to water levels. Overall, the results of the team's investigations not only reinforce established knowledge, but also provide new insights. The research team for example learned that peat mosses are not the only ones “engineering” their own habitat, as scientists have known for some time. The microbial communities associated with the mosses, as it turns out, also engage in this process. Also, in the course of peatland succession their bacterial communities become significantly less diverse as certain highly specialized bacteria gain the upper hand. ■



► Helmholtz International Research Group ArcBiont



Samoylov, siberian arctic



Müritz National Park, temperate zone



Neiden, sub-arctic



Svalbard, high arctic

COMBINING MULTI-SCALE SOIL MOISTURE MEASUREMENTS

TERENO scientists are working on transferring information on the exchange processes between soils and the atmosphere from the local and field scale to the regional scale. This includes conducting cosmic-ray measurements in TERENO's Eifel/Lower Rhine Valley observatory. A network of cosmic-ray sensors gathers continuous data on near-surface soil moisture and transmits the information in real time to the TERENO data portal TEODOOR. Data is also gathered using airborne microwave sensors so that near-surface soil moisture can be measured across the full heterogeneity of the area under investigation. This data is also used to validate the results of two satellite missions: SMOS (Soil Moisture and Ocean Salinity)

conducted by the European Space Agency (ESA) and SMAP (Soil Moisture Active Passive) conducted by NASA. Here, particular focus is placed on the quality of algorithms used to create the soil moisture maps from the satellite data. Various methods exist for combining active radar measurements with passive radiometer measurements to improve the accuracy and spatial resolution of the end product. Investigations conducted via TERENO sites in the vicinity of Jülich have shown that spatial disaggregation of the raw radiometer data using radar data with subsequent inversion to soil moisture delivers the most accurate results. This is also the method favored by SMAP. ■

Roland Baatz et al. (2015) *An empirical vegetation correction for soil water content quantification using cosmic-ray probes.* Water Resources Research

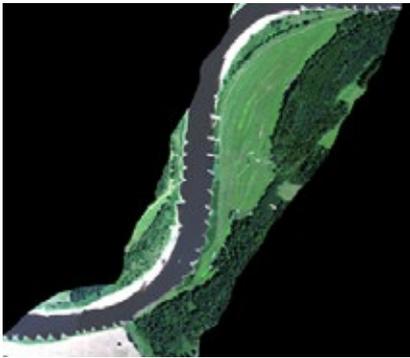
► DOI: [10.1002/2014WR016443](https://doi.org/10.1002/2014WR016443)

Carsten Montzka et al. (2016) *Investigation of SMAP fusion algorithms with airborne active and passive L-band microwave remote sensing.* IEEE Transactions on Geoscience and Remote Sensing

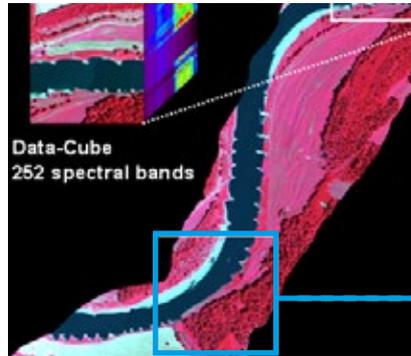
► DOI: [10.1109/TGRS.2016.2529659](https://doi.org/10.1109/TGRS.2016.2529659)

VEGETATION AS BIO-INDICATOR OF SOIL CONTAMINATION

EnviMetal project investigates Elbe River floodplain in preparation for satellite mission



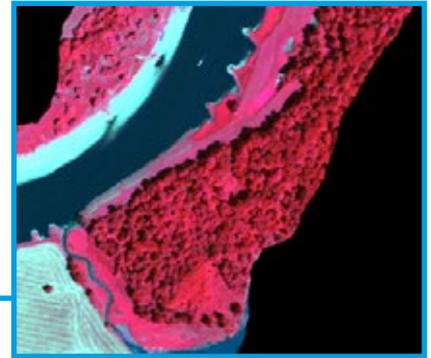
Today many regions throughout the world are experiencing more frequent flood events. And not only the number of flood events is increasing; the flooding has also become more severe. The devastation these floods leave behind is only part of the problem. Flood waters also become enriched with contaminants which spread into the environment and burden ecosystems. Researchers in the “EnviMetal - Vegetation stress as bio-indicator for soil contamination in floodplains” project are analyzing hyperspectral remote sensing data to investigate the level of heavy-metal contamination at TERENO’s Elbe research area.



The project is in preparation for Germany’s satellite mission “Environmental Mapping and Analysis Program – EnMAP” (see p. 5), currently planned for 2018, which will deliver high-quality, hyperspectral image data of the earth with a high degree of spatial and temporal resolution.

Contaminants in flood waters

Industrial, mining and agricultural enterprises are often located in river basins. When flood waters recede, the contaminants remain in the soil and are partly absorbed by plants. To measure the level of



heavy metal contamination in the Elbe River floodplain, EnviMetal project researchers use electromagnetic waves between 350 and 2,500 nanometers in the range of visible, near and shortwave infrared light. Different surfaces reflect these waves and, depending on the type of surface, generate a specific spectral fingerprint, which can then be captured and analyzed. Researchers are developing ways to use these spectral signatures to assess levels of heavy-metal contamination in the soils and plants of the Elbe River floodplain. ■

► EnviMetal – Vegetation stress as bio-indicator for soil contamination in floodplains

ENSURING PRODUCTIVITY AND YIELD OVER THE LONG TERM

BonaRes promotes sustainable soil use and helps safeguard soil functions

Because fertile soils are the most important prerequisite for cultivating crops for food, animal feed, raw materials, and energy production, it is necessary to maintain and enhance the productivity of our soils whenever possible. The “Soil as a sustainable resource for the bioeconomy” (BonaRes) funding programme launched in 2015 supports a number of projects working to achieve this very objective. “Our goal is to better understand soils and their functions,” says BonaRes Centre Coordinator Dr. Ute Wollschläger from the Helmholtz Centre for Environmental Research - UFZ. “Among other aims, we hope to be able to improve the efficiency of water and nutrient use in crop production while, at the same time, preserving other essential soil functions and ecosystem services. All projects have both a natural science and social science component.” A number of TERENO researchers and research sites are involved in BonaRes projects. In all, experts from 48 research institutions and companies work together in ten interdisciplinary consortia and at the BonaRes Centre. The collaborative projects focus on a range of issues related to sustainable soil



© UFZ / André Künzelmann

Site Bad Lauchstädt in Saxony-Anhalt

management. The BonaRes Centre, which is led jointly by UFZ researchers and colleagues from the Leibniz Centre for Agricultural Landscape Research (ZALF), coordinates modeling activities, data provision and public relations activities. In close collaboration with the collaborative projects, model tools are being developed to predict the influence of various agricultural practices on soil functions and ecosystem services. At the same time the Centre facilitates the setup of a permanent, centralized repository for soil data, which consolidates data from long-term field experiments and other soil research data. The tools developed will be made available via a web-based portal.

The German Federal Ministry of Education and Research sponsors BonaRes as part of the National Research Strategy BioEconomy 2030. ■

► BonaRes

HOT ON THE TRAIL OF GAS EMISSIONS



@ IMK-IFU, KIT/Dario Suppan

Back in 2011, while working on her undergraduate thesis on the energy balance at the earth's surface, Katja Heidbach was surprised to find that all the models being used at the time to determine gas emission source regions were assuming homogeneous surroundings. But in reality landscapes are anything but homogenous – as evidenced in Graswang, a site within TERENO's Bavarian Alps/pre-Alps observatory. "When I measure or calculate gas flows I need to know whether they originate from a field, meadow or forest," says Heidbach, who earned her Diplom degree

in Physical Geography and has since made this the focus of her doctoral work. Today, she conducts field experiments in Graswang to help evaluate and validate such models. "Graswang is situated in a valley so you can forecast wind direction pretty reliably. This is ideal for using a tracer gas to help trace the path of gas emissions," explains Heidbach, who is now a doctoral student at the Institute of Meteorology and Climate Research (IMK-IFU) at the Karlsruhe Institute of Technology. Heidbach uses methane as her tracer gas since there are almost no methane emissions in this area. "Without the TERENO equipment available at the site I would have to raise external funds to finance various measurement instruments, which would not have been possible," says Heidbach. Arguably among TERENO's veterans by now, Heidbach helped establish the Graswang site as part of an internship back in 2009 and has conducted research at IMK-IFU in Garmisch since 2011. Initial analysis has shown that Heidbach's results basically align with the modeling calculations. "But we can still continue to improve the models," says the 29-year-old. "And that's my next goal." ■

THE NEUTRON TRACKER



@ UFZ/André Kinzelmann

Martin Schrön hunts neutrons. But unlike other physicists who might use neutrons to analyze material properties or search for so-called dark energy, Schrön, a researcher at the Helmholtz Centre for Environmental Research – UFZ, uses neutrons to measure soil moisture. These electrically neutral particles rain down upon the Earth in a steady stream. They originate from cosmic rays making their way across the universe, likely a result of star explosions. Many of the neutrons that pass through our atmosphere to the Earth's surface are reflected back, but – and this is the key to measuring soil moisture – not all of

them: "Neutrons that meet up with hydrogen will remain in the soil," explains the 30-year-old Schrön. "If our detector counts a large number of reflected neutrons above the ground then the soil must be dry, if it counts only a few, then the soil must be wet." While knowledge of this relationship dates back some 50 years, only since 2008 have scientists used sensors to measure soil moisture on a larger scale of 10-20 hectares. "In 2013 UFZ acquired its first cosmic-ray sensors along with Europe's only mobile detector, the TERENO-Rover, which can be used to survey entire landscapes," explains Schrön, who studied theoretical astrophysics at university. "For me the job at UFZ is the perfect opportunity to combine theory and practice." Judging by his presentations at numerous Science Slams, this is an area in which Schrön excels. In fact, he even won the German championships in 2015. Schrön provides support to several TERENO sites that use the sensors. "There are still a number of open issues, however, since the measurement signal is also sensitive to water from plants or snow." Currently TERENO researchers are working hard on a way to separate hydrogen pools in snow or biomass from the signal. ■

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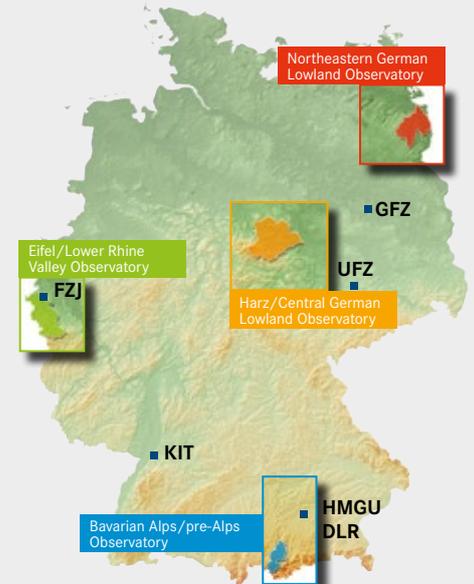
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FZJ Forschungszentrum Jülich
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DLR German Aerospace Center

KIT Karlsruhe Institute of Technology

HMGU Helmholtz Zentrum Muenchen, German Research Center for Environmental Health

UFZ Helmholtz Centre for Environmental Research

GFZ Helmholtz Centre Potsdam GFZ German Research Centre for Geosciences

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TERENO

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