TERENO
TERRESTRIAL ENVIRONMENTAL OBSERVATORIES

NEWSLETTER

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HELMHOLTZ | ASSOCIATION

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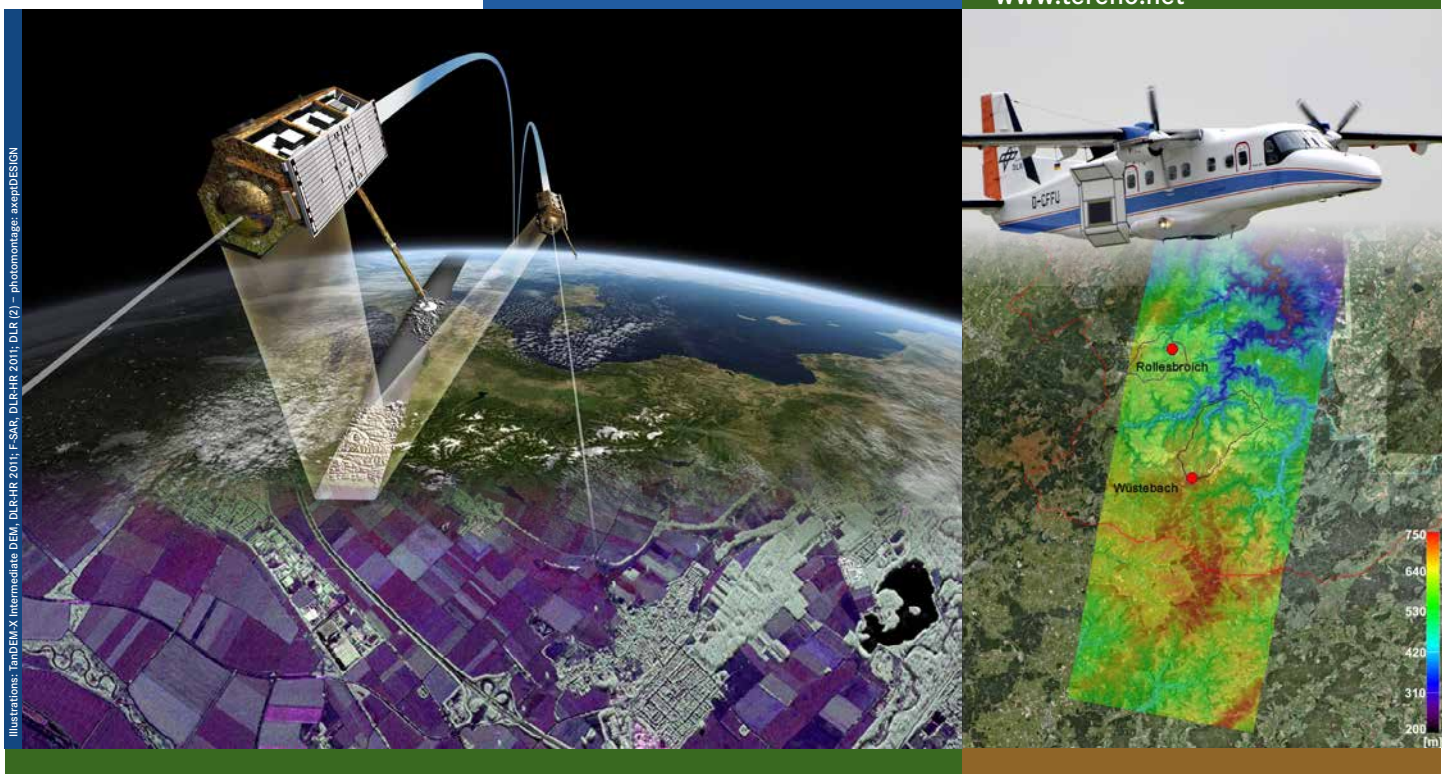


Satellite missions and research flights collect comprehensive environmental data. The German Aerospace Center (DLR) is contributing its radar satellites TanDEM-X (left) and TerraSAR-X as well as the airborne F-SAR system (right) to TERENO

REMOTE SENSING – THE VIEW FROM ABOVE

AN INDISPENSABLE TOOL

Remote sensing has become an indispensable tool in global climate and environmental research. Planes and satellites send back images that provide important information about the Earth's surface. With these data we can better understand relevant processes and develop climate change solutions and adaptation strategies. The field has made great strides in recent years. Germany, in particular, the German Aerospace Center (DLR), has made a significant contribution, as illustrated by the interview with Professor Johann-Dietrich Wörner, Chairman of the DLR's Executive Board. Remote sensing is also an important tool for TERENO. The long-term initiative serves as an excellent validation platform for satellite data (see page 3).

CONTENTS

NASA TO MEASURE GLOBAL SOIL MOISTURE

TERENO observatory selected for Cal/Val support to SMAP Mission

The American space agency NASA plans to provide global soil moisture measurements, taken from space, in the near future. The Soil Moisture Active & Passive (SMAP) Mission will deliver joint active and passive L-band microwave records. These data will make an important contribution to our understanding of the global water cycle, and will help to enhance weather and climate prediction models. NASA has selected the TERENO observatory "Eifel/Lower Rhine Valley" for the SMAP calibration and validation program (Cal/Val). Activities in this phase of the mission include the calibration, testing, and improvement of models and algorithms for processing the collected data. It also validates the accuracy of the science data products.

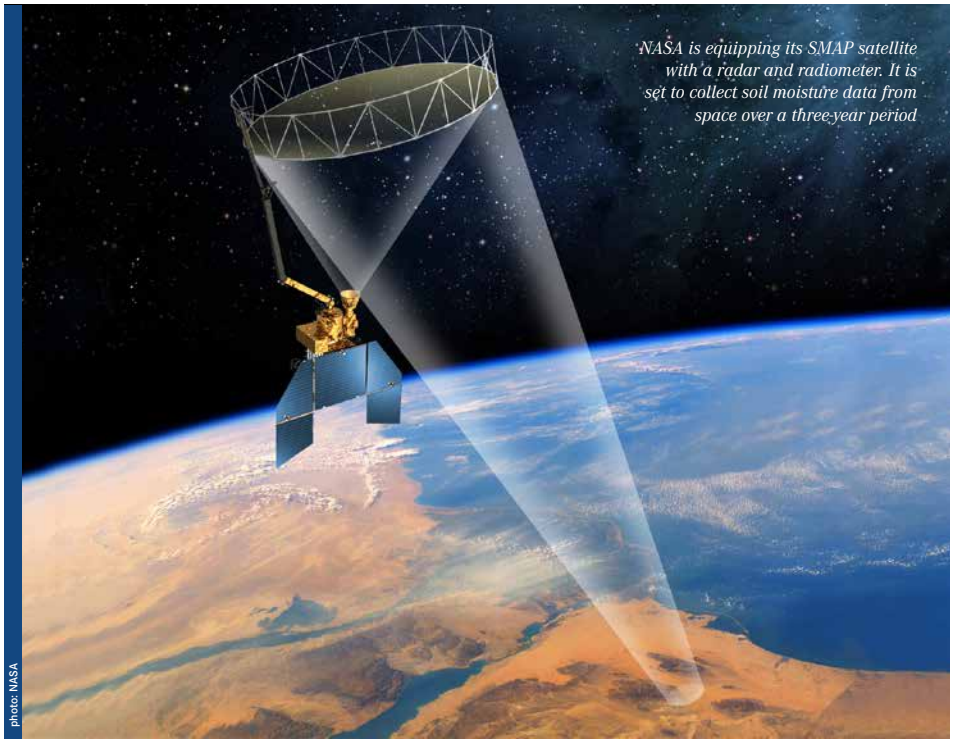
Precise estimate

SMAP measures at L-band frequency with multiple polarizations, which makes it possible to correct for vegetation, surface roughness, and other perturbing factors. The result is a precise global estimate of soil moisture. The radar and radiometer share a single rotating reflector with a diameter of 6 meters, providing a conically scanning antenna beam with a fixed surface incidence angle of 40 degrees. Several data products will be delivered, for example a surface soil moisture product with a spatial resolution of 9 km, fused from radiometer (36 km) and radar (3 km) data.

Benefiting from German expertise

Of particular value to the NASA-Mission are data recorded by the wireless soil moisture network SoilNet at the Wüstebach and Rollesbroich test sites. Information obtained by Cosmic Ray Probes after detailed calibration is also highly useful. In addition, data recorded by the microwave platform developed by the Agrosphere Institute at the Forschungszentrum Jülich (FZJ) and the German Aerospace Center (DLR) for the DLR research aircraft Dornier 228 can be used to process SMAP data. To this end, the active radar DLR F-SAR and the passive radiometer PLMR2 (Polarimetric L-band Multi-beam Radiometer 2) have been jointly installed in order to investigate improved fusion methods of active/passive microwave data. The TERENO database TEODOOR is able to provide required data in near real-time. NASA has scheduled a validation test for spring 2013 in order to check the operational readiness of all selected database systems throughout the world.

SMAP calibration and validation



NASA is equipping its SMAP satellite with a radar and radiometer. It is set to collect soil moisture data from space over a three-year period

photo: NASA

EDITORIAL

Photo: Chris Taube

Observations from a distance

Air- and satellite-based remote sensing technology is a central component of the four TERENO observatories. The expertise in optic and active remote sensing that the German Aerospace Center (DLR) brings to TERENO–for example, through measurement flights, the provision of satellite data, and development of measuring platforms–is therefore extremely important. At the same time, remote sensing still has many untapped opportunities. The satellite mission Tandem-L, currently in the planning stage, will provide 3-D maps of the Earth's surface with unprecedented precision. A new satellite mission has also been scheduled by the American space agency NASA called SMAP (Soil Moisture Active Passive). The field of remote sensing is also being advanced by the newly launched Helmholtz Alliance "Remote Sensing and Earth System Dynamics" and the ACROSS network, recently established through an association of nine Helmholtz Centres. TERENO is actively involved in these projects. These research collaborations demonstrate the importance of developing national and international cooperation. This has inspired us to introduce a new section to our newsletter, titled "Networks". Readers can turn to this section for information on associations and events, which, in participation with TERENO, bring the international scientific community closer together. One such event is the International Soil Moisture Network, which is setting up a world-wide databank for in-situ soil moisture measurements.

Wishing you enjoyable reading and a wonderful start to the New Year,

Harry Vereecken
TERENO Coordinator

Johann-Dietrich Wörner

PROGRESS THROUGH AEROSPACE

New vistas for environmental and climate research – an interview with Johann-Dietrich Wörner, Chairman of the DLR's Executive Board

Civil engineer Professor Johann-Dietrich Wörner has served as Chairman of the Executive Board of the German Aerospace Center (DLR) since March 2007. The DLR unites German research and development work in aeronautics, space, and in selected areas of energy and transport. In addition, the DLR is tasked with the planning and implementation of Germany's space programme.

Professor Wörner, where does Germany stand today with regards to radar satellites on the international stage?

Germany is certainly one of the leading countries in this field. Germany's radar satellite TerraSAR-X, which was launched in June 2007, is considered one of the most modern satellites of its kind throughout the world. The mission—a collaborative project between the DLR and EADS Astrium GmbH—has been the focus of much attention and respect from the US space agency NASA and other national space agencies as well as the European Space Agency ESA.

Why is the mission so successful?

Regardless of the weather and lighting conditions, TerraSAR-X provides extremely reliable radar data at a very high resolution and with precision positioning. The more than 35,000, often exceptional, images have benefitted science, politics, society, and business. Time-lapse images are particularly sought after, to help track changes in glaciers and volcanoes, for example. June 2010 saw the launch of an almost identical satellite, TanDEM-X. The aim is to use this combination of satellites to generate high-precision 3D-elevation models of the Earth. The TanDEM-X mission is a milestone in remote radar sensing and carries a huge number of challenges with it, such as the first close formation flight of two satellites.

What next? What are the challenges of the future?

Despite state-of-the-art technology, the recording capacity of TerraSAR-X won't be sufficient to meet the demands of future environmental and climate research. In order to provide global and systematic measurements of dynamic processes on the Earth's surface, we will need high-resolution images covering large areas at short time intervals. That is what is necessary to answer current questions about the biosphere, geosphere, hydrosphere, and cryosphere and to plug existing holes in climate research—such as research into the global carbon cycle. What is more, the satellites recording capabilities are limited by the X-band wavelength.

What part can the DLR play?

Back in 2008 we started work on a new satellite mission: Tandem-L. The aim is to provide 3-D images of the Earth's surface with unprecedented accuracy. In addition, the longer L-band wavelength will make it possible to record biomass. This aeronautical innovation provides climate research and environmental observation with new opportunities: for example, global monitoring of forest conditions and forest change.

What are the mission's concrete plans?

The plan is to assemble two satellites, equipped with cutting edge technology and methodology. To this end, the DLR Institute for High Frequency Technology and Radar Systems in Oberpfaffenhofen has developed and patented a new, revolutionary recording technique. This technique makes it possible to create high-resolution images of the entire Earth, twice a week. In comparison, TanDEM-X would need a whole year to achieve the same results. The innovation was recently nominated for the 2012 German Future Award. The mission itself is still in the planning stage. If everything goes well, the satellites could be launched in 2019. With this mission, Germany will be able to build on its international leadership role in the radar field.

How is TERENO involved?

In addition to the Helmholtz Alliance "Remote Sensing and Earth System Dynamics" (see page 4) and the ACROSS project (see page 8), TERENO will participate in the intensive preparation of data usage. The information captured at the regional level will also be of great benefit for the researchers at the TERENO observatories. The data will help to map regional changes in land-use and their effects on the global cycle. On the other hand, the TERENO observatories, with their excellent instrumentation, are also ideal calibration and validation sites for the development, testing, and improvement of algorithms. The more accurate the algorithms, the easier it will be to extrapolate concrete information about, for example, soil moisture, from the radar images. These activities are a successful example of collaboration between different Helmholtz research areas.

Were these opportunities for collaboration one of the decisive factors in the DLR's participation in TERENO?

Of course. As I have outlined, the extensive opportunities afforded by TERENO benefit all participating research areas. It was therefore only logical that the DLR Institute for High Frequency Technology and Radar Systems assume responsibility for TERENO's remote sensing activities. In addition to its expertise and the satellite missions, it also contributes the DLR research plane Dornier Do228-212, which is equipped with an F-SAR-system. This year, for example, a comprehensive flight campaign was conducted over the four observatories. Plans are already underway for next year's new campaign. The focus will be on recording changes in agricultural areas with plant growth. We are already very excited about the results. ■

TARGETING NEW SATELLITE PRODUCTS

Launch of Helmholtz Alliance "Remote Sensing and Earth System Dynamics"

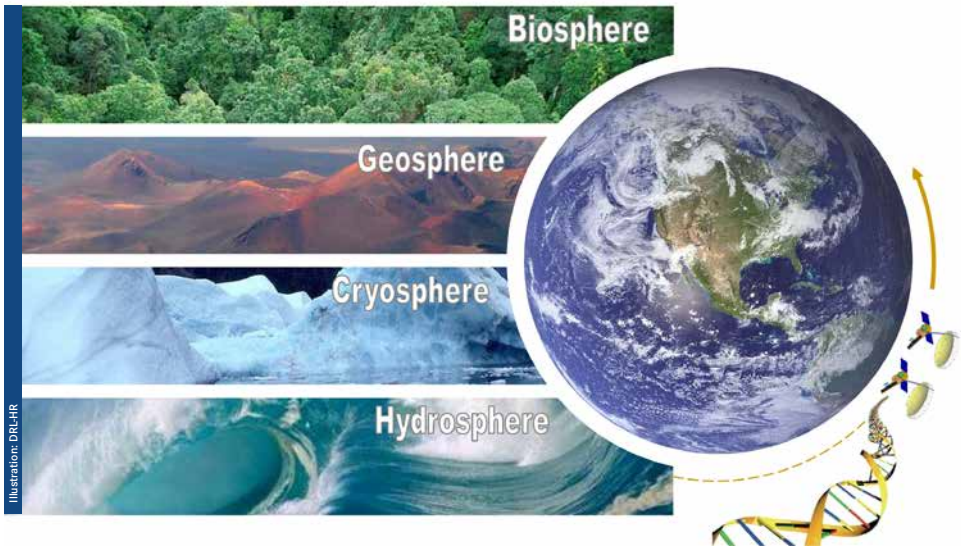
Innovative global biophysical and geophysical satellite products are set to provide new insights into the Earth system and its dynamics. The aim of the new Helmholtz Alliance "Remote Sensing and Earth System Dynamics" is to develop just such products. The TERENO observatories have been designated as calibration and validation sites. Members of the alliance met mid-October for a kick-off meeting held at the German Aerospace Center (DLR) in Oberpfaffenhofen.

The Earth system comprises a vast array of separate components which are linked to one another through complex dynamic processes, such as global water and carbon cycles. Given the acceleration in global climate change, it is crucial that these dynamic processes are more accurately quantified and understood. To this end, future space-based remote sensing systems, such as the planned Tandem-L German radar mission, offer to provide data files and products at higher spatial and temporal resolution than ever before. Integrating these new products into Earth system models is the project's main objective. Armed with these insights, participating scientists want to gain a better understanding of environmental and climate models. The Helmholtz Association is providing the new alliance with 20 million euros of funding over the next five years to develop these types of products.

International collaboration

An important objective of the alliance is to develop a network that brings together Helmholtz Centres as well as national and international competence centres. The list of partners include eight Helmholtz Centres, eleven universities, and three non-university research institutions. The DLR is coordinating the project. Research within the alliance will focus on four main areas: the biosphere, the geosphere, the hydrosphere, and the cryosphere. Climate-relevant goals include determining global forest biomass and monitoring its temporal changes, as well as gaining a better understanding of the carbon cycle. In the biodiversity area, for example, the spotlight is on global forest structure, while in Earth dynamics the main focus is on improving understanding of earthquake and volcano activities. ■

The Helmholtz Alliance will focus on four main areas: the biosphere, the geosphere, the hydrosphere, and the cryosphere



Promoting innovation

Helmholtz Alliances run for five years and offer participating scientists an opportunity to conduct research on new topics or to develop current research topics in innovative ways. Helmholtz Alliances don't just bring together Helmholtz Centres; universities, other non-university research institutions, and companies both from Germany and abroad are also partners. The aim is for research to continue once the funding has ended.

More about Helmholtz Alliances

ESKP: Gaining new insights into risks such as extreme hydrological events (above: the town of Meissen following flooding of the Elbe river, August 2002)

MASTERING GLOBAL CHANGE

Earth System Knowledge Platform: pooling knowledge and support

The Helmholtz Association is currently developing a comprehensive knowledge platform which aims to provide information on global changes in the environment. The "Earth System Knowledge Platform" (ESKP) will pool knowledge on topics such as natural catastrophes, climate change, soil degradation, and water pollution. "Our aim is to use the platform to set up a dialogue with policy makers, business, and society in general, on global change – providing information on its risks and impacts and communicating possible adaptation strategies – with tailored suggestions for individual economic sectors and social groups", explains Professor Jürgen Mlynek, President of the Helmholtz Association. The scientific organization will invest around 13 million euros in establishing the platform over the next four years.

The project is coordinated by the Helmholtz Centre Potsdam - GFZ German Research Centre for Geosciences and the Helmholtz-Zentrum Geesthacht Centre for Materials and Coastal Research (HZG). In total, there are eight participating Helmholtz Centres, representing the two Helmholtz Research Fields "Earth and Environment" and "Aeronautics, Space and Transport". The six centres involved in the TERENO project are included in this number. In addition, six universities, the research alliances Geoverbund GEO.X in the Berlin-Potsdam region and Geoverbund Aachen-Bonn-Cologne-Jülich are external partners.

Diverse topics

Once the platform is fully established the ESKP will provide information on numerous relevant topics such as climate change, flooding, biodiversity, megacities, and fragile ecosystems. The ESKP will be able to draw on operational structures already in place at the Helmholtz Centres. In addition to TERENO, the list of resources includes the Helmholtz Association's four Regional Climate Offices and the Center for Disaster Management and Risk Reduction Technology (CEDIM), which is run jointly by the Karlsruhe Institute of Technology (KIT) and the GFZ Potsdam. ■

SIMULATING THE FUTURE

BMBF-project MiKlip: model system for decadal predictions


photo: FZ Jülich

Important data: eddy covariance station at the TERENO Rollesbroich test site records latent and sensitive heat flow

What will our climate look like a decade from now? In what ways will our living conditions have changed, and how will we adapt to them? These questions are of more than scientific interest. There is a need for reliable information on trends in weather and climate for time frames of years to decades for decision-makers in politics, business, and society, mainly because the planning horizon for investments and innovations is often on the order of ten years. In order to meet this growing demand, the Federal Ministry of Education and Research in Germany (BMBF) has established the research programme "MiKlip". The programme also draws on the expertise of the TERENO project.

MiKlip's aim is to create a model system that can provide accurate forecasts on climate and weather, including extreme weather events. The model system to be developed will be novel in several aspects, with great challenges for methodology development. This is particularly true for the determination of processes relevant to decadal predictions (e.g. modelling of the cryosphere and the biosphere), the increase in spatial resolution through regionalisation, and finally the improvement or adjustment of statistical post-processing.

TERENO supplies data

The sub-project MCRA , coordinated by Prof. Stefan Kollet at the Forschungszentrum Jülich (FZJ), addresses this issue with innovative process descriptions. These descriptions can be used to improve forecasts and reduce uncertainty in climate predictions. The forecasting system will play a central role in experiments which, for example, address the influence of climate change on regional water balance. The proposed methods are highly suitable for detailed interpretations of MiKlip forecast results at a local and regional level and for deriving water resource management solutions.

The functionality of the model system will be tested by simulating climate change and variability in past decades. The information this requires will be supplied by the four TERENO observatories, including data on runoff, groundwater levels and soil temperatures, measurements of latent and sensitive heat flow, information on vegetation as well as remote sensing data.

www.fona-miklip.de/en

ON THE ROAD TO A LOW-CARBON ECONOMY

Climate-KIC combines education, innovation and entrepreneurship

Bringing together partners from the private, public and academic sectors to accelerate and stimulate innovation in climate change mitigation and adaptation – that is the aim of Climate-KIC, an initiative of the European Institute of Innovation and Technology (EIT). Currently the Climate-Knowledge and Innovation Community is made up of some 150 European research institutions, universities, government agencies, and companies. The GFZ German Research Centre for Geosciences and the Forschungszentrum Jülich (FZJ) are core partners. "Through the participation of these two Helmholtz Centres, the activities of TERENO are also integrated into this European community", explains Dr. Oliver Bens, Head of the GFZ Scientific Executive Board.

Support for "climate entrepreneurs"

A key area of Climate-KIC's work is the development and promotion of innovative projects with high practical potential for climate protection and mitigation. Projects are organised around various thematic areas, such as "adapting soil and water management", "sustainable city systems", or "climate services". In addition, the initiative provides support to young entrepreneurs and start-ups working on these issues – for example, through scholarships, master classes, and funding technical feasibility studies. The education arm of the Climate-KIC offers programmes covering all relevant areas at masters, doctoral, postdoctoral and professional levels. Five national and six regional co-location centres coordinate and supervise Climate-KIC activities at a local and regional level.

The founding vision is that the synergy between research projects, education, and start-up activities will result in a complete innovation pipeline, resulting in climate-friendly products and processes that meet the challenges of the future. The aim is that these will, in turn, help to optimise consumption and production patterns, accelerating the transition to a low-carbon economy and increasing Europe's competitiveness.

www.climate-kic.org

PROMOTING TERENO INTERNATIONALLY

Advisory Board praises growth in research collaborations


photo: Georg Gerl/HMGU

Annual meeting of the Advisory Board: TERENO scientists and board members met in Scheyern for progress updates and discussions about the long-term project's future development

The first extensive evaluation of the TERENO project is due in spring 2013. The research programmes of the Helmholtz Centres in the research field "Earth and Environment" will then be regularly reviewed at five-year intervals. These evaluations are intended as an opportunity to highlight and draw international attention to the particular importance and great benefits of the new TERENO research platforms. That was the message from the TERENO Advisory Board, which met at the end of October 2012 at the Scheyern test site, located some 40 kilometres north of Munich.

The international panel, which is made up of 12 climate and environmental researchers, reserved particular praise for progress in developing research collaborations. In particular, it welcomed the secured financing of TERENO-MED, an extension of TERENO in the Mediterranean, with potential research stations in Spain, Morocco, Italy, Greece, Cyprus, and other countries. Extending this network was lauded as an important step in developing international cooperation. The common data platform that TERENO is currently developing and making available was also commended. However, once a scientific review of the initial research results has been completed, it will be necessary to review TERENO's aims and objectives, stressed the Chair of the Advisory Board, US hydrology expert Dr. Richard P. Hooper. In a bid to present the results and research collaborations achieved to an international audience, it was recommended that a larger scientific conference be organised for 2014.

Demonstration of new installations

The first day was devoted to outline presentations, talks, and discussions. These included a review of TERENO's role in the Helmholtz Association's new research field "Earth and Environment" by Professor Harry Vereecken from the Forschungszentrum Jülich (FZJ). On the second day, attendees visited the research platform at the Scheyern monastic estate. Located in the TERENO observatory "Bavarian Alps/pre-Alps", researchers at this site are investigating a typical section of an agricultural area in the Bavarian Tertiary Molasse-Hills. Research foci include the recording of nitric oxide emissions from soil and biomass production in agroforestry systems. A soil sensor network that monitors soil temperature and soil moisture – installed beneath a grazed area of grassland as well as under an arable piece of land – was demonstrated as an example of new TERENO installations. The visitors were also invited to a tour of the active Benedictine monastery with a commentary on its cultural and historical significance. ■

NEWS

NEW COORDINATOR


photo: private

In July 2012, Dr. Knut Kaiser from the GFZ German Research Centre for Geosciences, took over as coordinator of the TERENO observatory "Northeastern German Lowland". The 45-year-old researcher joined the GFZ in 2010. He was previously affiliated with the universities of Greifswald and Marburg. The primary focus of his work in northeast Germany to date has been geohistorical research on landscape evolution of lakes, rivers, and peatlands. Kaiser's main scientific interest is the interdisciplinary analysis of soil archives with the aim of establishing long time series of data relating to, for example, variations in lake levels, runoff events, and erosion. As a result of many years of research, he has particular ties to the Müritz National Park – one of the main test sites in the TERENO observatory "Northeastern German Lowland".

Email: knut.kaiser@gfz-potsdam.de ■

SENSOR NETWORKS INSTALLED

New wireless soil moisture monitoring networks have now been installed at research sites within each of the four TERENO observatories. Networks of this kind are ideally suited for analysing the spatial and temporal distribution of soil moisture and the exchange processes of water between soil, vegetation, and the atmosphere. Working in collaboration with the Transregional Collaborative Research Centre 32, funded by the German Research Foundation (DFG), researchers at the Rollesbroich test site in the "Eifel/Lower Rhine Valley" observatory have set up what is currently the largest soil moisture sensor network in the world. It is made up of 200 measurement nodes with overall 1200 soil moisture probes. The SoilNet sensor network, developed by the Forschungszentrum Jülich (FZJ), has also been installed at other sites: in Scheyern (TERENO observatory "Bavarian Alps/pre-Alps"), in the Schäfertal catchment in the Lower Harz Mountains, and in the forest site "Hohes Holz" (both within the TERENO observatory "Harz/Central German Lowland"). At the DEMMIN test site in the TERENO observatory "Northeastern German Lowland", the GFZ German Research Centre for Geosciences and the German Aerospace Center (DLR), are engaged in a joint project to install a similar network to monitor soil moisture encompassing 64 sites. Further soil moisture monitoring networks are planned. ■

A GLOBAL SOIL MOISTURE DATABASE

International Soil Moisture Network comprises more than 40 sub-networks

Routers from the SoilNet soil moisture sensor network at the TERENO Rollesbroich test site

Only a limited number of measuring stations and systems throughout the world provide continual recordings of soil moisture. Different systems employ different measuring techniques. Data exchange is further complicated by the fact that the data formats are not standardized. These problems are addressed by the International Soil Moisture Network (ISMN), launched in 2009. The initiative aims to establish a global soil moisture database.

Soil moisture is an important parameter in the water cycle and has a great influence on, for example, the weather and flooding. In-situ soil moisture measurements help to calibrate and validate land surface models and satellite observations of soil moisture. This makes it all the more important for these data to be made available to other researchers. Creating a single database is a major step forward. The cooperation already numbers some 35 contributing networks from four continents, with more in the pipeline. TERENO also recently came on board. Its contribution will help strengthen knowledge of soil moisture in temperate climate zones. The unique sample density of TERENO's soil moisture network is just one factor that will make this possible.

All ISMN contributing networks provide their data on a voluntary basis. Data sets are harmonized by automatically converting them into volumetric soil moisture units, and controlling for outliers and improbable values. Individual networks also provide important metadata and additional information, such as precipitation and soil temperature. Consequently, soil moisture data can be easily interpreted by visitors to the site. After filling out a free online registration form, any interested user is able to access the database. Current and historical data can be viewed and downloaded via a graphical user interface. The time series date back as far as 1952. ISMN activities are coordinated by the Global Energy and Water Cycle Experiment (GEWEX) in cooperation with the Group of Earth Observation (GEO) and the Committee on Earth Observation Satellites (CEOS).

www.ipf.tuwien.ac.at/insitu/

TERENO MEASURING CONCEPTS ATTRACT GREAT INTEREST

Hydropedology research in the spotlight at 2nd International Conference held at the UFZ

Some 160 scientists met at the Helmholtz Centre for Environmental Research - UFZ in Leipzig in July, 2012, for the second "International Conference on Hydropedology. The initial conference was held in Pennsylvania, USA, in 2008. The scientific concept of hydropedology aims to create stronger links between various scientific disciplines, particularly the fields of soil and water science. In addition to symposia on the structure and function of soils and their influence on matter fluxes within environmental systems, the main focus of the approximately 70 talks was on the presentation and discussion of new measuring techniques and concepts for monitoring the environment.

Visiting the observatory

Around 50 attendees took part in an organised excursion which included a visit to the Schäfertal, one of the intensive research sites located in the TERENO observatory "Harz/Central German Lowland". One of the research foci at this site is the monitoring of water fluxes at the small catchment scale; a collaborative project between the UFZ and other research institutions. Research findings and various measuring techniques being used in the area were presented by scientists from the GFZ, the University of Applied Sciences Magdeburg-Stendal, the Martin Luther University of Halle-Wittenberg, and the University of Potsdam. The visitors were particularly impressed by the concept for multi-scale monitoring of soil moisture. Demonstrations of the lysimeters installed in the area as part of the TERENO SOILCan network, the wireless sensor network TERENO SoilNet for measuring soil moisture, and Cosmic Ray Moisture Probes, also generated great interest. Visitors also appreciated a tour of the hydrological measuring garden operated by the University of Applied Sciences Magdeburg-Stendal and a presentation on mobile geophysics. Additional excursions were organised to the UFZ Research Station in Bad Lauchstädt and to the CarboZALF project area, run by the Leibniz Centre for Agricultural Landscape Research (ZALF).

www.ufz.de/hydropedology2012

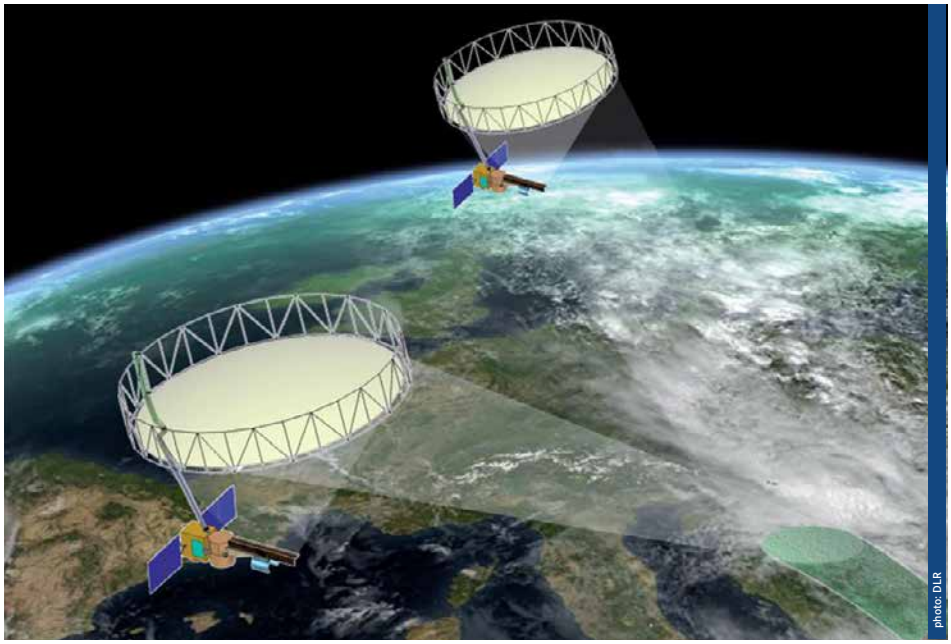
Edoardo Martini (second from left), a doctoral candidate at the UFZ, presents the concept of soil moisture monitoring using wireless sensor networks

MAKING MORE EFFECTIVE USE OF SATELLITE-BASED DATA

ACROSS network delivers new monitoring concepts and high-quality data series

Satellite technology has made an enormous contribution to Earth observation research over the past 10-15 years. There are still a number of obstacles which need to be overcome, however, to ensure the efficient use of satellite-based data. To this end, nine Helmholtz Centres have joined forces in the ACROSS network with the aim of developing innovative monitoring concepts, and generating high-quality data series for the validation of remote sensing data.

The sensors on board modern environmental and Earth system satellites provide a range of important data at different temporal and spatial resolutions. However, the exact relationship between recorded metrics, in particular, is often insufficiently understood. Interpreting satellite data can therefore be fraught with uncertainty. There is a need for new data analysis techniques based on the comprehensive verification of derived environmental data on the basis of ground-based measurements.



State-of-the-art satellite technology: the German Tandem-L mission

Observatories as interfaces

The Helmholtz Association supports numerous integrated Earth system observatories and infrastructures for Earth observation, including TERENO, COSYNA, Ocean Sites and Plate Boundary Observatories. Together, they form an excellent interface for environmental observation via remote sensing. 23 million euros have been allocated to expanding the infrastructure at ACROSS observatories, beginning in 2014. The environmental data collected using the new equipment will make reviewing scientific findings and models significantly more effective. As such, ACROSS marks an important step toward a global initiative for integrated Earth observation.

ACROSS partners include the Helmholtz Centres cooperating in TERENO, the Helmholtz-Zentrum Geesthacht Centre for Materials and Coastal Research (HZG), the Alfred Wegener Institute for Polar and Marine Research (AWI), and the GEOMAR Helmholtz Centre for Ocean Research Kiel. In the long-term, the participating centres plan to set up an integrated multi-parameter system called the Global Earth Monitoring and Validation System (GEMIS). ■

EVENTS

March 11-14, 2013 | Bonn

Patterns in Soil-Vegetation-Atmosphere-Systems: Monitoring, Modelling & Data Assimilation

The exchange of energy, water and carbon between soil, vegetation, and the atmosphere is characterised by extremely complex patterns, structures and processes that act at different time and space scales. Therefore, the quantitative prediction of the systems' behaviour constitutes a major challenge. The international symposium will present novel experimental and theoretical approaches to increase our understanding of the soil-vegetation-atmosphere system. Aims include more reliable climate models, more specific forecasting, and hence, ultimately, better management of natural resources. The event is organised by the Transregional Collaborative Research Centre 32, TR32, and the Danish HOBE Center for Hydrology.

http://tr32meeting.uni-koeln.de/

April 14-18, 2013 | Monte Verità, Switzerland

Soil Systems and Critical Zone Processes – Integrating Life Support Functions across Disciplines

Soil is key to some of the most pressing global challenges, ranging from climate change to food security and improved ecosystem functioning. One of the main objectives of the international conference is to establish a road-map for integrating soil science and "critical zone" research into key Earth Science disciplines. In particular, the aim is to strengthen ties with atmospheric science, hydrology, biogeosciences, and ecology. To this end the conference will foster cross-disciplinary links and platforms for scientific exchange. The conference is being hosted by the Institute of Terrestrial Ecosystems (ITES) at the ETH Zurich.

www.intersoil2013.ethz.ch/

PUBLICATIONS

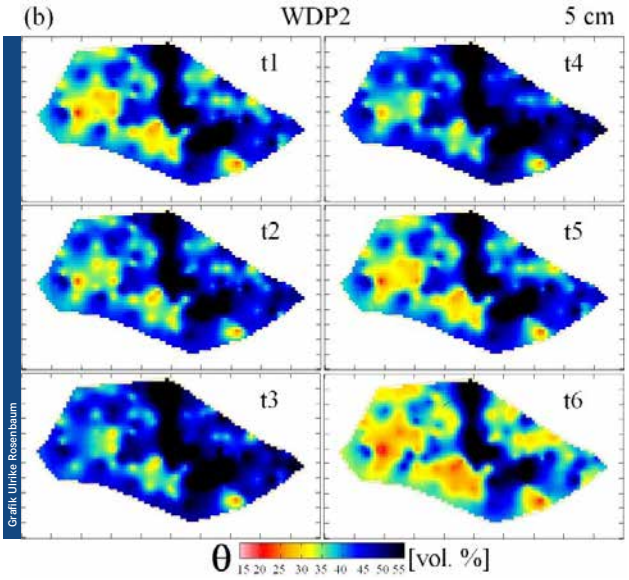
IMPROVED QUALITY AND UNCERTAINTY ASSESSMENT

Long-term monitoring of the exchange fluxes of energy, water, and trace gases between ecosystems and the atmosphere is one of the main objectives of the TERENO project. The generated data contribute to a better understanding of climate-feedbacks. Measurements are often collected using the eddy-covariance method. It is a method which is employed at several hundred permanent sites all over the world. However, the usefulness of these measurements is highly dependent on uncertainty quantification and data quality. Additional information of this kind is essential if the data are to be used in a meaningful way, for example, for the validation and development of computer models. Atmospheric researchers participating in the TERENO network have proposed a comprehensive strategy for uncertainty assessment and data quality. The strategy, which was developed and tested within the framework of TERENO, has a wide range of applications and can be used anywhere in the world. It is particularly suitable for eddy-covariance measurements on a long-term basis. The development of the strategy would not have been possible without the concerted efforts of TERENO researchers working in this field, who contributed their experience and expertise. The scheme has attracted a lot of attention at numerous international conferences. In addition, there is close exchange of information with other ecosystem observatory networks–such as the US National Ecological Observatory Network (NEON) , which is currently developing a similar strategy for its own network.

Mauder, M., M. Cuntz, C. Drüe, A. Graf, C. Rebmann, H. P. Schmid, M. Schmidt, R. Steinbrecher. *A strategy for quality and uncertainty assessment of long-term eddy-covariance measurements.* Agricultural and Forest Meteorology, Vol. 169, 2013, pp. 122-135. Doi: 10.1016/j.agrformet.2012.09.006.

Eddy covariance (EC) station at the TERENO Graswang test site

TRACKING DYNAMICS OF SOIL MOISTURE PATTERNS



Spatial distribution of soil moisture within the Wüstebach catchment area at a depth of 5cm (red: dry; blue: moist). A precipitation event occurred at t1, resulting in significant changes in soil moisture patterns: the pronounced contrast between high soil moisture values along the stream and relatively low values in the slope areas at t1 is reduced during precipitation (until t3). The contrast increases again during the ensuing dry period

Noteworthy

The American Geophysical Union (AGU), publisher of the journal "Water Resources Research", selected this paper as an "AGU Research Spotlight". A general summary of the paper was published in WRR online and in the "Research Spotlight" section on the back page of Eos, AGU's online supplement to the weekly newsletter. In addition, the summary was also distributed to interested news media.

In order to increase our understanding of global and local water cycles, more research is needed into the dynamics of soil moisture patterns. The temporal and spatial dynamics of soil moisture are extremely complex and closely linked to the processes of evaporation, transpiration, infiltration and groundwater interaction. However, conventional measurement approaches only supply recordings taken from local points. The wireless sensor network SoilNet developed at the Forschungszentrum Jülich (FZJ) offers new opportunities for the distributed measurement of soil moisture. Within the framework of TERENO, the SoilNet system was installed with 150 nodes and 900 soil moisture probes in the Wüstebach catchment, a forested head water catchment located in the TERENO observatory "Eifel/Lower Rhine Valley". This study showed that the observed soil moisture patterns varied with depth, soil moisture content, and time scale and was controlled by multiple factors including soil properties, topography, meteorological forcing, vegetation and groundwater. Soil moisture variability in the topsoil was mainly related to meteorological forcing, whereas in the subsoil, temporal dynamics were diminished due to soil water redistribution processes and root water uptake. In addition, the analysis of the highly detailed data revealed hysteretic effects, which were not detected by previous measurement systems.

Rosenbaum, U., H. Bogena, M. Herbst, J. A. Huisman, T. J. Peterson, A. Weuthen, A. W. Western, H. Vereecken. *Seasonal and event dynamics of spatial soil moisture patterns at the small catchment scale.* Water Resources Research, Vol. 48, W10544, 22 pages, 2012. Doi:10.1029/2011WR011518.

MEASURING THE EXCHANGE BETWEEN GROUNDWATER AND SURFACE WATER

Streams and groundwater are often closely interlinked. Depending on the season, water temperature or water level, there is constant alternation between water inflow and water outflow from aquifers into streams and back again. The interface between streams and groundwater is therefore a particularly reactive zone. Numerous chemical and microbial reactions take place here, which can have significant effects on water quality. An in-depth understanding of this coupled system and the underlying processes at play is therefore extremely important for modelling water and solute transport in catchment areas and for sustainable water quality management.

Microbial and geochemical gradients which determine matter conversions are controlled by the amount and direction of water flux. In order to fully understand water fluxes and, in particular, their transformation processes and transport, it is necessary to record both the temporal and spatial dynamics of the coupling between groundwater and streams. The metrological recording of these processes is especially challenging. Researchers at the Helmholtz Centre for Environmental Research - UFZ have developed and tested a method to measure and observe temporally resolved water flow in sediments at a test site located in the TERENO observatory "Harz/Central German Lowland".

The method uses electrical conductivity measurements to record variations in travel times and flow velocities in the stream-bed's current. This evaluation method under development will make it possible to define the variability in these types of flow processes with a much higher degree of accuracy in the future.

Schmidt, C., A. Musolff, N. Trauth, M. Vieweg, J. H. Fleckenstein. *Transient analysis of fluctuations of electrical conductivity as tracer in the stream bed.* Hydrology and Earth System Sciences, 2012, Vol. 16, No. 10, pp. 3689-3697. Doi:10.5194/hess-16-3689-2012.

A gravel bank in the Selke catchment area, located within the TEREO observatory "Harz/Central German Lowland": an example of the hydraulic gradient between the river's main channel and side channel

RIVERS, LAKES, AND PEATLANDS IN NORTHEAST GERMANY OVER THE MILLENNIA

To understand current environmental issues, knowledge of long-term landscape developments is essential. Research questions in this area include the causes of hydrologic changes, impacts of land use strategies, and effectiveness of restoration measures. Even the interpretation of model results on future impacts of climatic and land-cover changes on water systems can be improved by using (pre-)historic analogies.

The authors of this study investigated the northeast German lowlands, which bear the marks of the last ice age, and analysed palaeohydrologic findings of the last c. 20,000 years. In geological terms, this period of time belongs to the so-called Late Quaternary, with the subdivisions Glacial (cold stage), and Holocene (warm stage). The research focus was on important water systems in the region, namely rivers, lakes, and peatlands. River development was examined with particular attention to valley formation and depositional changes, including flood dynamics. Lake development was analysed with respect to lake formation, sedimentation, and lake-level change. The overview on peatland development concentrated on hydrological stages in development phases, and on long-term groundwater dynamics.

Until the late Holocene, regional hydrology was predominantly driven by climatic, geomorphic and non-anthropogenic biotic factors. Since late mediaeval times, human activities have strongly influenced the region's drainage pattern and the water cycle, for instance, by the damming of rivers and lakes, construction of channels and dikes, and peatland cultivation. Indeed, the natural changes caused by long-term climatic and geomorphic processes have been exceeded by impacts resulting from short-term human actions in the last c. 50 years, such as discharge regulation, hydromelioration, and the formation of artificial lakes.

Kaiser, K., S. Lorenz, S. Germer, O. Juschus, M. Küster, J. Libra, O. Bens, R. F. Hüttl. *Late Quaternary evolution of rivers, lakes and peatlands in northeast Germany reflecting past climatic and human impact – an overview.* E&G Quaternary Science Journal, 2012, Vol. 61, No. 2, pp. 103-132. http://quaternary-science.publiss.net/issues/69/articles/865.

NEW SIGHTS, NEW INSIGHTS

Crane acts as universal measuring platform

A 40-metre high crane has been erected by a team at the GFZ German Research Centre for Geosciences at the Wendeforst site near Drönnewitz, not far from the town of Demmin. The crane boom extends over a canopy of old trees on one side, to the other side it reaches out over the Trebel river valley peatland, which was only recently re-wetted.

Crane-mounted measurement platform over the Trebel river valley moor

The crane serves as a universally applicable measuring station, which helps to close the gap between data recorded at ground level and from the skies. The Drönnewitz location is part of the DEMMIN test site, situated within the Neustrelitz site of the German Space Center (DLR), an important part of the TERENO observatory "Northeastern German Lowland".

One of the researchers who helped develop plans for erecting the crane is Ph.D. student Anne Clasen, who is currently working on the use of hyperspectral data to characterize forest stands in a project supervised by the Technical University of Berlin and the GFZ. As part of her research, Clasen measures light reflection of tree crown cover approximately every three weeks with the use of a spectrometer. The generated data contribute to understanding of, amongst other things, how the forest is affected by climate change. "While certain readings can be obtained using remote sensing methods, they are not nearly as spatially precise and the temporal resolution is also much lower", explains Anne Clasen. Long-distance images taken by satellite might show parts of the canopy, but – unlike the close-up shots possible from the crane's nacelle – they can't capture details such as leaf area and wood content.

Earth-space connection

Further instrumentation of the crane is planned. One possibility is to install an L-band radiometer. "It's a piece of equipment which would enable us to study local radiation temperature and consequently, changes in soil water content", says former GFZ-researcher Dr. Mike Schwank, who has since joined GAMMA Remote Sensing AG, a Swiss collaborative partner of the GFZ. Drönnewitz is also being considered as a potential calibration site for SMOS satellite missions (Soil Moisture and Ocean Salinity) run by the European Space Agency (ESA).

SIGNIFICANTLY HIGHER ABSORPTION

Bavarian Research Cooperation FORKAST publishes initial results

The effects of climate change on important long-established ecosystems in Bavaria—including grasslands, forests and bodies of water— were investigated over a period of approximately four years by the research association FORKAST. The research agenda included an in-situ climate change experiment at TERENO test sites Graswang and Wielenbach (Fendt). One research finding: climate change affects the level of methane which is absorbed from the atmosphere into soil even within a short period of time.

The experiment was conducted by researchers at the Institute for Meteorology and Climate Research (IMK) at the Karlsruhe Institute of Technology within the framework of the FORKAST subproject "Impact of climate change on alpine grassland ecosystems". Work was carried out at sites within the large lysimeter network located in the Ammer catchment area, an important component of the TERENO observatory "Bavarian Alps/pre-Alps". Small lysimeters were installed alongside the large lysimeters, helping scientists to simulate expected climate developments in this region of Bavaria (increases in temperature, reduced precipitation) and study the short-term effects of climate change on greenhouse gas exchange and the microbiological processes this involves. Of particular note: the methane oxidation rates were significantly higher at the warmer and drier Wielenbach site than at the wetter and colder Graswang site. The lack of differentiation in nitrous oxide (N2O) levels does not necessarily indicate that climate change will have no impact on these processes. It is possible that the microbiological soil processes involved in methane oxidation react more quickly, or more sensitively than those that are active in N2O production or emission. A better understanding of such processes is of vital importance for long-term experiments, such as those foreseen by TERENO.

CLIMATE CHANGE AND LONG-ESTABLISHED ECOSYSTEMS

The Bavarian State Ministry for Science, Research and Arts provided funding for the Bavarian Research Cooperation FORKAST (Impact of climate change on ecosystems and climatic adaptation strategies) from January 2009 to December 2012. Scientists from eleven Bavarian universities and research institutes participated in the project. A brochure highlighting FORKAST research results and findings will be published at the beginning of 2013.

More about FORKAST

Climate simulation with small lysimeters

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PROFILES: YOUNG RESEARCHERS AT TERENO

Tracing trace gases

photo: private

Dr. Daniel Weymann has been investigating trace gas exchange at TERENO sites in the Eifel and Lower Rhine Valley regions since February 2012. His research focus is on the greenhouse gases carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). In addition to monitoring spatial and temporal patterns, the 36-year-old geoecologist, in collaboration with his colleagues at the Agrosphere Institute (IBG-3) at the Forschungszentrum Jülich (FZJ), aims to find out how climate change influences greenhouse gas emissions and the underlying microbial turnover processes. "We can use this knowledge to design more sustainable land-use measures in the future", he explains. In Germany, for example, agriculture is responsible for some 75% of all nitrous oxide emissions.

In order to measure variable trace gas fluxes, the lysimeter-network TERENO-SOILCan has proven invaluable. "SOILCan provides all of the important environmental parameters which control the greenhouse gas balance of soils", enthuses Daniel Weymann. The researchers have developed automated and manual chamber systems, which are used at the lysimeters to monitor trace gases. "It is extremely rare to have access to so many parameters at once. With its instrumentation, comprehensive database, and long-term orientation, TERENO offers excellent prospects for research", he adds. His interest in trace gases developed during his doctorate in Göttingen and as a research associate at the Johann Heinrich von Thünen Institute in Braunschweig. ■

The influence of water


photo: private

Landscapes captivate Dr. Theresa Blume. She is fascinated by how they function, with all their interactions between climate, geomorphology, geology, ecology, and land use. And water plays a crucial role in this system: on the one hand, water forms landscapes, on the other hand, landscapes determine flow paths and flow velocities and consequently flood generation and water quality. The result: "A solid understanding of hydrological processes and interactions is crucial to managing our natural resources in a truly responsible way", says the 38-year-old water expert. In April 2009 she moved from the University of Potsdam on to the GFZ German Research Centre for Geosciences. Working within the framework of TERENO, she and her colleagues are trying to gain a better understanding of the groundwater dominated lake landscapes of northeast Germany. One focus (among others) is to record the spatial patterns of groundwater influx in a lake, and to determine the causes for these patterns. "Before I joined the GFZ I was mostly working on mountainous regions such as the Andes or the Alps. TERENO offered new exciting challenges and opportunities", the hydrologist explains. For Blume, these include interdisciplinary collaborations, for instance through the inclusion of geoarchives, as well as the use of innovative methods, for example new methodologies for the measurement of soil moisture, or the investigation of groundwater-surface water-interactions with the help of temperature measurements along fibre optic cables. ■

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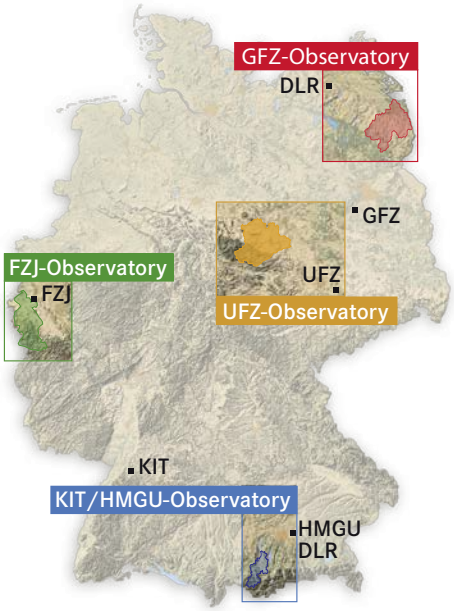

FZJ	Forschungszentrum Jülich (Coordination)
DLR	German Aerospace Center
KIT	Karlsruhe Institute of Technology
HMGU	Helmholtz Zentrum Muenchen, German Research Center for Environmental Health
UFZ	Helmholtz Centre for Environmental Research
GFZ	Helmholtz Centre Potsdam GFZ German Research Centre for Geosciences