TERENO
TERRESTRIAL ENVIRONMENTAL OBSERVATORIES

NEWSLETTER

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Photo: KIT / IMK-IFU

Aiming high: Christian Chwala from the Karlsruhe Institute of Technology (KIT) installs a self-developed measuring device at the Fendt test site that uses microwave radiation to test new methods for collecting precipitation and humidity data

INNOVATIVE APPROACHES

RESEARCH MAKES STRIDES

The search for new approaches is always a worthwhile one – especially in research. In a bid to collect more accurate precipitation data, partners in the PROCEMA project are making use of microwave links run by mobile network operators, in particular the effect on transmission power which even light drizzle can cause. Tests are currently underway at the TERENO observatory “Bavarian Alps/Pre-Alps”. At the TERENO observatory “North-East German Lowlands” a method is being developed to measure the concentration of greenhouse gases directly above the soil with high spatial resolution, something which has not been possible up to now. The new method relies on a combination of infrared absorption spectroscopy and tomography. Just two examples that highlight the research gains that are being made as the four TERENO observatories are expanding.

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PH.D. STUDENTS ON THE WAY TO THE TOP

TERENO observatory "Bavarian Alps/Pre-Alps" provides infrastructure for new Helmholtz Research School

Good news for prospective climate and environmental researchers: the new Helmholtz Research School on Mechanisms and Interactions of Climate Change in Mountain Regions (MICMoR) will offer places for up to 25 Ph.D. students to research the effects of climate change at the interfaces of atmosphere, biosphere and pedo-/hydrosphere. The programme is set to receive six years of funding from the Helmholtz Association of German Research Centres, and will provide both an interdisciplinary training and a cross-disciplinary skill-set.

MICMoR is located at the Institute of Meteorology and Climate Research (IMK-IFU) at the Karlsruhe Institute of Technology (KIT). The programme's infrastructure is provided by the TERENO observatory in the Bavarian Alps and Alpine foothills that is operated by the IMK-IFU and the Helmholtz Center Munich (HMGU). The thesis projects of future Ph.D. students will sustain the momentum of the observatory's current research programme, ensuring that data series are not discontinued when any given research project ends.

Fit for international research

Summer schools and workshops will equip Ph. D. students with essential capabilities and methods. "These skills will help them go on to successfully pursue research at an international level" says MICMoR spokesman Professor Hans Peter Schmid from the IMK-IFU. The range of offers includes mentoring programmes, which foster leadership qualities and team skills. Research forums provide both experienced and young scientists with a platform for scientific exchange.

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PARTICIPATING INSTITUTIONS

Central Partners
- Karlsruhe Institute of Technology (KIT)
- Ludwig Maximilian University of Munich (LMU Munich)
- Technical University of Munich (TUM)
- University of Augsburg

Associated Partners
- German Aerospace Center (DLR)
- Helmholtz Center Munich - German Research Center for Environmental Health (HMGU)
- University of Bayreuth
- University of Würzburg

Photo: KIT/IMK-IFU

Students from Munich visit the Fendt test site in the TERENO observatory "Bavarian Alps/Pre-Alps", where future Ph.D. students of the new Helmholtz Research School MICMoR will conduct their research

EDITORIAL

Photo: Chris Taube

A collaborative effort

Dear Readers,

Terrestrial research in Germany is joining its forces. This is an important step forward. We have to pool our know-how in order to fully understand the regional effects of climate change with its wide-reaching consequences. Only then is it possible to develop viable forecasting models. TERENO is making a significant contribution to this process – in particular through collaboration with the Helmholtz Climate Initiative Regional Climate Change (REKLIM) and the German Water Science Alliance. At the four TERENO observatories we are committed to intensive long-term monitoring of all components of the terrestrial system: soil, groundwater, plants and atmosphere. Accordingly, the project was, from its inception, intended to serve as a platform for various disciplines and different institutes to come together. That doesn't just apply to institutes in the Helmholtz Association, but also to universities, Leibniz Institutes and public authorities. We are extending our collaborations further, for example our collaboration with the Leibniz Centre for Agricultural Landscape Research (ZALF) – also at a European level with ICOS (Integrated Carbon Observation System). At the same time, we are working to complete the instrumentation of the observatories by the end of 2011. Some very promising projects are currently in progress: In this Newsletter you will find out more about activities such as CarboZALF, PROCEMA and the SPEAR Indicator.

I wish you enjoyable reading!

Harry Vereecken

TERENO-Coordinator

GERMAN WATER RESEARCH POOLS ITS FORCES

Water Science Alliance develops common goals and strategies – An interview with Georg Teutsch

More than 200 German water experts and several invited experts from all over the world met in Berlin at the beginning of June for the second Water Research Horizon Conference. The conference was organized by the Helmholtz Centre for Environmental Research (UFZ). Professor Georg Teutsch, Scientific Managing Director at the UFZ, talks about the global challenges in water research and the goals of the Water Science Alliance.

Experts warn that we are facing a water crisis. What problems must we confront?
In recent decades global water consumption has surged. Given the global changes we are experiencing – from a growing world population to climate change and changes in land use – this is a trend that is set to continue. Another confounding factor is the pollution of groundwater and surface water. The effects impact on a wide variety of areas such as food production, ecology and energy supply. Solutions are needed to secure water supplies and ensure water quality.

What does this mean for research?
It is important that we continue to develop our understanding of individual processes. At the same time, it is vital that we get a better handle on the complex interactions involved. For example, every year, millions of chemicals and pollutants are transported through water into the environment. We still don't know enough about what happens next. How are they dispersed? Are they broken down or do they accumulate over time? What effects do they have in the long-term? In particular, what can be done to minimize extensive release of these substances? In addition to finding answers to these questions we need better model systems so that we can make future projections covering large areas, in the same way that climate researchers do. To achieve these goals, German water research will have to pool its forces, which are available in many subdisciplines, and develop solution strategies that go beyond individual subjects. It is for this reason that the Water Science Alliance was initiated, organized by the UFZ.

What is the Water Science Alliance?
The initiative is a communication and cooperation platform for over 150 university and non-university research groups, as well as federal and state institutions which carry out water research in Germany, or else fund it and make use of its results. Our White Paper outlines key research fields and sets the foundations for relevant thematic clusters to be built around the development of common research objectives and strategies (see box). We hope that these efforts will also help to raise the international profile of German water research on these issues.

What role does the Water Research Horizon Conference play?
The conference provides a forum for the Alliance's partners to discuss and collaborate. At the first conference in 2010 we put forward and decided upon the key challenges in the White Paper. This year the focus was on the management of matter fluxes in river catchments and the development of complex system models for better projections. Up to now, many of the issues have been approached or analyzed by compartment specific, monocausal models. However, the new big challenges in water research require a much more complex tool box, which will have to be developed on a collaborative basis.

What was the outcome of the conference? What are the next steps?
The very open and positive exchange among the German experts as well as the international experts helped us to make significant progress. These discussions provided the basis for a whole series of new common initiatives, including, for example, a "Benchmarking Initiative" to test and compare different model systems in water research. We are currently compiling the proceedings and will offer targeted workshops in order to clarify and discuss these topics in detail.

What is TERENO's role?
TERENO plays a very important role. For one thing, it isn't possible to understand complex systems by theory alone, or on the basis of a few simplified laboratory experiments. What is needed are field sites that are adequately instrumented so that they can deliver the necessary information redundancy for identifying the relevant processes and parameters. In addition, we are increasingly required to scale up our detailed understanding of the interactions of processes at, for example, the catchment or river basin level. The methods used for upscaling these processes to a regional level are necessarily reliant on intelligent simplifications which can only really be verified at test sites such as those operated by TERENO. To this end we intend to extend TERENO's mission to include a priority focus on complex remote sensing methods.

Water Science Alliance
Water Research Horizon Conference:


Photo: UFZ

Georg Teutsch

THE WATER SCIENCE ALLIANCE'S SIX THEMATIC CLUSTERS:

A) Generic water problems of global dimension:
1. Challenges Emerging from Global and Climate Change: Food and Water, Mega-Urbanisation, Risk and Vulnerability
2. Managing Water Beyond Integrated Water Resources Management (IWRM): Target Setting, Instrument Choice and Governance

B) Strengthening methodological key competences:
3. Understanding Matter Fluxes at the Catchment Scale: Safeguarding our Health and the Environment
4. New Approaches to Observation, Exploration and Data Assimilation in Water Research
5. A Community Effort Towards Model Development and Data Integration for Water Science

C) Complex water management in a priority region:
6. Water Scarcity: New Perspectives for a Circum-Mediterranean Research Case

White Paper

BRINGING TOGETHER TERRESTRIAL RESEARCH

Positive progress report at the TERENO Workshop 2011

"TERENO is already more than an infrastructure project" explained TERENO Coordinator Professor Harry Vereecken from the Forschungszentrum Jülich (FZJ) at the TERENO Workshop held at the beginning of 2011. Two years in, and the participating institutions report positive progress. More than 60 scientists as well as representatives from German government, public authorities and other institutions attended the meeting in Bonn. They came to find out more about the progress made so far, exchange experiences and to take a look into the future.

Professor Vereecken reminded attendees of the situation Germany faces. According to the Federal Environment Agency (UBA), over the next 100 years, Germany could see its average temperature rise by 2.5 to 3.5 degrees Celsius, while precipitation could fall by up to 30 percent. Droughts and heat waves, winter storms, floods and loss of biodiversity all threaten to occur more frequently.Professor Vereecken called for terrestrial research in Germany to make a more concerted effort to monitor the regional consequences of climate change and to develop future models. He extended his appeal to various disciplines as well as to different institutions.

Instrumentation to be completed by 2011

"TERENO links up activities which have, up to now, often been run separately – and not just within the Helmholtz Association", stressed Professor Georg Teutsch, Scientific Managing Director at the Helmholtz Centre for Environmental Research (UFZ). For example, TERENO works intensively together with the Transregional Collaborative Research Centre 32 (TR32) run by the German Research Foundation (DFG). This collaboration was an important factor in the extension of TR32 and its increase in funding (see Newsletter No 1/2011 and Newsletter No 1/2009). This is the type of synergy effect that TERENO initiators as well as the Federal Ministry of Education and Research (BMBF) as investors had hoped for. Scientists from numerous universities and a Leibniz Institute already make use of the equipment in the four TERENO observatories for their research. The instrumentation of the observatories is set to be completed by the end of 2011.

National and international connections

For Professor Vereecken, the parallel development of TERENO is vital. Linking up to national and international networks is part of that process. For example, TERENO is a partner of ICOS Germany, the national component of the European observation platform that researches the carbon cycle and greenhouse gas emissions. A proposal for BMBF-funding is currently pending (see page 12). There are also plans to work closer together with the DFG-run "Biodiversity Exploratories". In addition, the Helmholtz Association hopes to extend its international focus. One project in preparation is "TERENO-Med", an observation network for the Mediterranean area that researches the long-term effects of climate change on the region.

Dr. Rainer Müssner from the BMBF called for increased efforts to raise TERENO's public profile. Products, key publications and other service offerings can showcase TERENO's extensive scope while at the same time highlighting the great benefits it brings to society.

Exceeding expectations: TERENO Coordinator Professor Harry Vereecken (top right) discussed the project's progress with participants at the TERENO Workshop 2011

Hans Papen

NEW COORDINATOR

Professor Hans Papen is the new coordinator of the TERENO observatory "Bavarian Alps/ Pre-Alps". Professor Papen is the Deputy Director of the Institute for Meteorology and Climate Research (IMK-IFU) at the Karlsruhe Institute of Technology (KIT) since 1999 and also heads up the research group "Ecosystem Matter Fluxes". He takes over the position from his colleague, Professor Harald Kunstmann, who was appointed Chair of Regional Climate and Hydrology at the University of Augsburg, a chair established jointly with the KIT.

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A GUIDE TO CLIMATE KNOWLEDGE

A new internet portal pools knowledge on climate change. The "Climate Navigator" serves as a guide through the German research landscape and provides an overview of the current state of research on issues such as the climate, climate consequences and adaptation to climate change. For example, detailed dossiers give background information on important issues in an easily accessible format. In additional, visitors to the portal will find portraits and current press releases of the more than 30 member institutions, including TERENO. Further institutions and alliances are set to follow. There are also plans to provide scientists with a forum for international networking and career opportunities. The portal is oriented to science, politics and management as well as business and society. It was initiated by the Climate Service Center in Hamburg, which is part of the Helmholtz-Zentrum Geesthacht Centre for Materials and Coastal Research.

www.klimanavigator.de

TEODOOR IS LIVE

The TERENO data portal TEODOOR (see TERENO Newsletter No 1/2011) is now fully searchable. Users can navigate the site to search for, display and download every piece of data which is collected over the course of the TERENO project.

TEODOOR Online Data Portal


Photo: Achim Brauer

THE CLIMATE PUZZLE

A climate and water balance archive in the new TERENO observatory: the Müritz National Park

In order to predict the future one must first examine the past. That is especially true when predicting the effects of climate change. It is difficult to ascertain whether changes in the climate are responsible for changes in the landscape and in the water balance, or whether they are the result of agriculture and forestry practices. One example is the decades-long decline in the water table and in lake levels at the Müritz National Park. Is the downwards trend a result of climate change? "Not necessarily", cautions Dr. Knut Kaiser, a researcher at the GFZ German Research Centre for Geosciences. "Water levels have gone up and down repeatedly over the last thousand years".

Dr. Kaiser is part of a team of experts who are tracking down these types of historical developments at the Müritz National Park. The area they are covering is a core part of the TERENO observatory "North-East German Lowlands" (see Newsletter No 1/2011). It is also a unique component of the TERENO project as a whole. The research focus at the other three observatories is almost exclusively on contemporary change. Retrospectives reaching far back into the past are currently not on the agenda.

Almost untouched nature

The Müritz National Park was founded in 1990. With its extensive forests, lakes and moors it offers an unspoiled landscape. As there is relatively little agriculture and forestry in the region it serves as an ideal "yardstick" for climate researchers, hydrologists and biologists. The majority of changes in this area have not been wrought by human hands, at least that is the current assumption, but are, in the main, due to natural causes. As a result, researchers are better able to understand the causes of climate change and to separate out natural and anthropogenic factors.

Some of the researchers based at the GFZ are also collecting data on regional landscape changes spanning some 15,000 years. Different methods are applied depending on the time frame in question. For example, dendrochronology – the analysis of annual tree rings – is used to provide interesting information relating to past climate and water balance. For the national park, this record goes back 300 years, as that is how old many of the trees there are.

Dr. Kaiser and his colleagues are particularly interested in the Great Fürstenseer Lake and its catchment area. Sediment samples retrieved from probes sent deep down to the lake bottom and soil profiles of lake terraces above and below water provide insights into the historical water balance. Taken by themselves, these data are not particularly meaningful, "but when as many of these individual indicators or pieces of the puzzle as possible are taken together, they help to give a more detailed picture", says Kaiser.

A lake under observation

The plan is to set up a monitoring area on the lakeshore, where many indicators can be analyzed simultaneously. One question is how trees respond to weather and climate, and what conclusions can be drawn for the hydrology of the lake catchment area. Preparations have been underway for two years; the measuring instruments are scheduled to be installed at the end of 2011. Hydrologist Dr. Theresa Blume is one of the researchers working on the project. She is particularly interested in the lake's water balance, as the lake does not have a surface water tributary but is totally dependent on ground water. She hopes that the measurement data will help to answer a number of questions, including where water flows in to the lake, how the forest influences the water balance and when exactly in summer trees switch from soil water to ground water. To this end Dr. Blume will work together with GFZ-based dendrochronologists Dr. Gerd Helle and Dr. Ingo Heinrich. They will use annual tree ring data to gain a better understanding of the contemporary dynamic with regards to fluctuations in the water balance over the last few centuries.

Researchers will have many sophisticated new measurement methods at their disposal:

- **GPS reflectrometry**
  GPS satellite signals, which are reflected from the Earth's surface and whose properties are consequently altered. These measurement errors are especially interesting for hydrologists, as they have to the potential to assess soil moisture of the Earth's surface in real-time.
- **Gravimeters**
  They are used to measure the Earth's gravitational force, although changes in the water storage capacity of groundwater or soil in the areas surrounding the gravimeters influence the measurements taken. For geodesists this constitutes an unwelcome distortion, for hydrologists on the other hand, it is a very useful side-effect that provides insights into the amount of water stored underground.

Data are not just being collected on-site. GFZ researchers are also searching through archives and conducting interviews. For example, aerial pictures from the 1930s and 1940s give a snapshot of a pre-industrial Müritz region. Dr. Knut Kaiser has sifted through archives and interviewed people from the area to access information about water levels and the construction of drainage ditches or water mills. "That allows us to assess the effect of human activity", explains Matthias Schwabe, who is responsible for research and monitoring at the Müritz National Park. Ideally, once all these assessments have been made, the only factor remaining will be climate change and its' impact on landscape changes.

The Great Fürstenseer Lake is of particular interest to researchers. They want to find out how trees respond to weather and the climate, and how the nature of their response impacts on the hydrology lake catchment area: Sediment samples being retrieved from the Fürstenseer Lake (top), a drill sample being taken from a beech tree (left), and a probe sample being taken from a basin moor at the edge of the lake (right). The strip of sand was formed as a result of the decline in water level since the 1980s (centre)


Photos: Knut Kaiser

The numerous bogs located in the North German Lowlands are substantial CO_2 sources. ZALF-researchers are investigating the viability of flooding bogs to put a lid on emissions

ZALF

The Leibniz Centre for Agricultural Landscape Research (ZALF) in Müncheberg conducts scientific research on ecosysytems in agricultural landscapes and develops land use systems which are both economically and ecologically tenable. ZALF comprises six institutes, each focusing on different aspects of land use, covering basic and applied research questions from the natural sciences to social economics. The centre has almost 300 employees and boasts a research area spanning some 175 hectares.

THE GREAT UNKNOWN

Researchers investigate the carbon balance of landscapes

Climate change is not just something that takes place in the air. Soil and the plants that grow in it also have a decisive role to play in determining how much carbon dioxide (CO_2) is contained in the atmosphere. The CarboZALF project is run by the Leibniz Centre for Agricultural Landscape Research (ZALF) with the aim of investigating the carbon balance of landscapes. TERENO has an important contribution to make to the project, in the shape of a newly developed measurement device, the result of collaboration between scientists at the GFZ German Research Center for Geosciences and the University of Potsdam (see details below). A TERENO SoilCan lysimeter station at the Dedelow test site also provides important information on the water and material balance.

Only around 45% of the CO_2 produced by humans is retained in the atmosphere. The rest is swallowed up by the oceans and absorbed by the earth. “The so-called terrestrial CO_2 sink effect on the continents is a great unknown”, says Professor Michael Sommer, who heads the project together with Professor Jürgen Augustin. Land use in the northern hemisphere plays an important role. Agricultural landscapes are often characterized by a colourful patchwork of fields, woods, meadows, wetlands, open waters and residential areas which are all linked by exchange processes.

Drained bogs pose a problem

“We want to record the source and sink functions of individual landscape elements. Above all, we want to understand the interactions between the individual elements, so that we can gain an overall picture of the carbon balance for a particular landscape”, says Professor Augustin on the goals of CarboZALF. “We also want to understand which processes are responsible for the cycling and transport of carbon so that we can modify landscape elements to increase their functions as carbon sinks”.

Drained bogs are a case in point. Many of these substantial CO_2 sources are located in the North German Lowlands. Flooding a bog can put a stop to CO_2 emissions. It can also lead to the release of large quantities of the carbon-rich greenhouse gas methane. ”We have shown that flooding bogs is akin to building an open-air biogas plant” explains Professor Augustin. In the absence of oxygen, microorganisms break down plant debris, producing methane. If the factors responsible for this process are better understood, it is possible to bypass the methane production stage.

ZALF researchers are also investigating other landscape elements of the North East German Lowlands, such as the moraine landscape characterized by many mounds, which is mostly used as agricultural land. The scientists assess the impact of soil erosion and the increase in cultivation of energy crops on the CO_2 source and sink functions of the “soil-plant” system as well as on the behaviour of small pools of water formed in moraines. There are thousands of these small lakes, which date back to the Ice Age, in the North East German Lowlands. Methane is emitted from their outer edges, but their CO_2 source and sink functions and the impact of their surrounding environments on their carbon balance have yet to be established. “At present, we don’t have a suitable metrological system that can accurately measure CO_2 exchange at smaller spatial scales, for example at the system boundary between farmland and these small pools of water”, says Professor Sommer. That is set to change in the next two to three years, when the new device is operational and researchers can uncover at least one aspect of the great unknown.

SEARCH ENGINE FOR TRACE GASES

Researchers combine infraspectroscopy and tomography

Dr. Mike Schwank from the German Research Center for Geosciences in Potsdam has an ambitious to-do list. Together with colleagues from the TERENO network he plans to develop a piece of equipment that can measure the concentration of greenhouse gases directly above the soil with high spatial resolution. “A method has yet to be developed which is up to the job”, explains Dr. Schwank, a physicist and electrical engineer. “Our idea is to combine infrared absorption spectroscopy and tomography.” The absorption of laser light reveals the concentration of gases along the given measurement path. Tomography is applied to many of these types of measurements to determine the spatial resolution of gas concentration. The principle is similar to that used in computer tomography. The new instrument is intended to detect CO_2, methane and other gases within a circular area 100 metres in diameter and with a spatial resolution of one metre.

Daylight and temperature confounding factors

“The challenge is in working outdoors”, says Dr. Michael Böhm, a physical chemist at the University of Potsdam and a metrology expert. Allowances must be made for changes in temperature and the influence of daylight. Laser safety precautions are an issue. Extending the laser beam over longer distances is also a problem area. Dr Böhm’s solution is to send the beam through an inverted telescope. Following successful tests in the laboratory, initial field experiments have been scheduled.

The project would not be possible without the interdisciplinary collaboration fostered by TERENO. If everything goes according to plan then prototypes could roll off the production line in two to three years. Dr. Schwank hopes that his colleagues at the Leibniz Centre for Agricultural Landscape Research (ZALF) will be able to use these first measurement devices to monitor CO_2 and methane emissions from different land types and the transitional zones between land and water. The patent for this technique is currently pending. It could even be used to evaluate the relationship between different carbon isotopes in CO_2, which in turn, would provide valuable information about processes taking place in the soil. “But that really is blue sky thinking”, says the GFZ researcher.

FINDING OUT THE REAL IMPACT

Scientists at the UFZ develop an indicator for poisonous substances that provides more realistic assessments of the environmental risks to bodies of water

Photos: privat

Dr. Mikhail Beketov (left) conducts research within the catchment area of the river Bode. The river branches into small agricultural streams (right) that are frequently contaminated by pesticides from the surrounding fields. The measurement devices which Dr. Beketov has installed in the river Bode collect samples at high tide. Pesticides are particularly liable to seep into the river from the fields after it has rained

Without pesticides, crops would yield a less bountiful harvest. The chemical substance provides effective protection from unwelcome pests. At the same time, the environment can suffer if insufficient attention is given to the active agents it contains and if guidelines on maximum quantities are not adhered to. Existing risk forecasts for pesticide use are based on laboratory test results. “The problem is that nobody really knew whether the theory corresponded to reality, or if there were potential dangers which were not included in the forecasts at all. We have been able to change this with the SPEAR (Species at Risk) pesticide indicator”, explains Dr. Mikhail Beketov, an ecologist and ecotoxicologist at the Helmholtz Centre for Environmental Research (UFZ). Dr. Beketov analyzes environmental changes in bodies of water located at the TERENO observatory in the Harz/Mid-German Lowlands, in particular the catchment area of the river Bode. In addition, he is looking for ways to apply the innovative analysis technique to other poisonous substances. It must be noted that scientists at environmental conferences have been insisting on the need to take the natural environment in to account when making risk forecasts for decades – though up to now their plea has fallen on deaf ears.

Taking the natural environment into consideration

The environmental impact assessment of new pesticides continues to take place under ideal conditions and in relation to just one or very few species, such as the water flea. “That explains why 5 milligrams of pesticide in water can have no affect at all in the lab, despite the fact that the environment often responds in a much more sensitive way to poisonous substances”, argues Dr. Beketov. In the same way that stress makes people more susceptible to falling ill, organisms too can respond in a more sensitive way if they are lacking certain essentials such as sunlight, food or oxygen. In addition, the effects of intoxication are necessarily very different depending on whether the organism in question is an insect with a short life-span or a relatively long-lived frog. The SPEAR pesticide indicator takes these factors into consideration and uses them to provide concrete assessments of environmental risks for a given location.

The sophisticated indication system is based on observations, biological and chemical analyses, carried out by UFZ researchers at different water sites throughout the observatory. The results were modeled with the help of computerized models in order to create a bioindicator that includes the pesticide sensibility of organisms as well as their capacity to recover if affected. The web-based SPEAR indicator is designed to be very easy to use for the target audience – water decision makers throughout Europe (www.systemecology.eu/SPEAR). All they have to do is go online and enter data on the type and number of organisms which are found in the water site they are working on, and in just a few minutes they will receive information about risk potential, broken down into various groups of organisms.

Basis for a European index

“The system is so effective that it has the potential to become a European index for biomonitoring”, says Dr. Beketov, with an eye to the EU water directive which stipulates that all bodies of water have a “good ecological status” by the year 2015. In a bid to help water decision makers make even more sustainable management directives researchers at the UFZ are working on further indicators. For example, the “SPEAR organic” index for petrochemicals is already up and running. Further indicators for poisonous substances, such as screens for residues of pharmaceuticals are in the pipeline. This brings researchers another step closer towards the end goal of providing a toolbox for sustainable water management which makes it possible to regulate based on an ecologically and geographically specific factual situation, rather than hypothetical laboratory simulations.

Making research easier

Water ecologist Dr. Mikhail Beketov has been developing the SPEAR indicator at the system ecotoxicology department of the UFZ in Leipzig for the past six years. The native Russian already worked together with his research director, Dr. Matthias Liess, the author of the SPEAR system, as a researcher at the Russian Center for Biomonitoring in Novosibirsk, where he investigated innovative bioindicator systems.

PUBLICATIONS

FLOOD WATCH

An in-depth sediment study at Lake Ammersee, located within the TERENO observatory "Bavarian Alps/pre-Alps" has provided detailed insights into the lake's flood history. Using a novel methodological approach, scientists based at the GFZ German Research Centre for Geosciences have been able to establish a precise flood chronology spanning some 450 years.

The lake's sediment was analysed by a technique called microfacies analyses. Identifying and precisely locating layers of sediment formed by flood-triggered fluxes of catchment material enabled researchers to accurately identify and date flood events.

Flood layers at Lake Ammersee were found to be well preserved in the sediment archive. Analysis revealed that they were seasonal in nature, being formed mainly in spring and summer. It was even possible to estimate the degree of flooding responsible for flood layer formation by comparing the seasonal flood layer record with daily run-off data from the inflowing River Ammer.

The frequency of flood events over the 450 year time series varies according to climatic conditions. During colder periods of the Little Ice Age, for example, more spring-summer flood layers were formed. From 1881 onwards flood layer trends reflect frequencies of particular flood-prone weather regimes, which suggest a causal link between solar variability and changes in midlatitude atmospheric circulation patterns.

Czymzik, M., P. Dulski, B. Plessen, U. von Grafenstein, R. Naumann, and A. Brauer (2010), *A 450 year record of spring summer flood layers in annually laminated sediments from Lake Ammersee (southern Germany),* Water Resour. Res., 46, W11528, doi:10.1029/2009WR008360.

CARBON-RICH DATA

A new data analysis model has been developed by scientists at the Forschungszentrum Jülich (FZJ) and the universities of Cologne and Bonn to provide more accurate evaluations of how much carbon dioxide gas is emitted from the soil.

Existing methods for calculating soil carbon dioxide efflux usually average many measurements across a given test site. While such an approach controls for distorting factors such as variable conditions across the field and microclimatic disturbances, it necessarily sacrifices information contained in the raw data.

The proposed methodology attempts to bridge this gap by breaking down data into components that are stable or changing over time. The time-stable part characterizes the spatial patterns of emission strengths, while the dynamic part characterizes rapid changes in soil CO_2 efflux.

It is hoped that richer data will provide new insights into the effects of radiation, temperature and rainfall on root transpiration. Initial tests applied to data collected from measurement campaigns located within the TERENO observatory "Eifel/Lower-Rhine Valley" have established its potential.

Graf, A., N. Prolingheuer, M. Herbst, J.A. Huisman, L. Weihermüller, B. Scharnagl, C. Steenpass, R. Harms, and H. Vereecken, *Temporal Downscaling of Soil Carbon Dioxide Efflux Measurements Based on Time-Stable Spatial Patterns.* Vadose Zone J. 10: 239–251. doi:10.2136/vzj2009.0152

Photo: iStock

Lake Ammersee in Bavaria is a popular leisure destination. For scientists, the lake, which is located within the TERENO observatory "Bavarian Alps/Pre-Alps", is an important archive of environmental and climatic conditions. Researchers at the GFZ German Research Centre for Geosciences have examined sediment samples and gleaned insights into flood events over the past 450 years

Soil is an important source of atmospheric carbon dioxide (CO_2), which is released when plant residues are broken down. This process is dependent on various factors, including soil temperature and water content. Amongst other things, TERENO conducts long-term observations of element fluxes in the soil, for example at the Scheyern research station

TURNING SOIL ORGANIC CARBON MODELS AROUND

Statistical models are often used to estimate the initial amount of soil organic carbon present in a given soil sample. However, a problem with conventional models is that they are based on a theoretical pool of various carbon compounds which do not necessarily correspond to real amounts of measurable carbon.

This study tested the validity of inverse modeling, in particular the Rothamsted carbon model, using soil incubation experiments that measured the rates at which soil organic carbon was broken down. Two to three years of incubation were sufficient to estimate mineralization rates that allowed the model to reliably estimate the carbon present in the initial soil samples.

However, the model performed poorly when both the decomposition rate and the initial amount of carbon had to be estimated. The authors of the study conclude that inverse modeling is particularly ill-adapted for determining carbon pools of humified and inert organic matter.

Scharnagl, B., J. A. Vrugt, H. Vereecken, and M. Herbst. 2010. *Information content of incubation experiments for inverse estimation of pools in the Rothamsted carbon model: a Bayesian perspective.* Biogeosciences, 7, 763–776

UNEARTHING BETTER INSIGHTS INTO SOIL RESPIRATION

Heterotrophic soil respiration is an important flux within the global carbon cycle. This process, which releases carbon from organic matter in the soil in the form of carbon dioxide, is highly dependent on soil temperature and water content. The conventional statistical approach for determining the involvement of temperature has been criticized for neglecting confounding factors, such as spatial and temporal changes in soil water content and soil organic matter.

A new alternative uses inverse modeling to work out the role of soil temperature and water content. For temperatures below 25 degrees C, inverse modeling yielded precise estimates of temperature response function over a wide range of soil water content. Estimates were less reliable at greater than 25 degrees C because soil so infrequently reaches these temperatures. This temperature sensitivity of inverse modeling is comparable to statistical approaches.

Inverse approaches are therefore a promising avenue for improving our understanding of soil respiration. The authors call for future modeling studies to investigate the limits of inverse modeling in disentangling factors that often confound statistical estimation of the sensitivity of soil respiration to temperature and soil water content.

Bauer, J., L. Weihermüller, J. A. Huisman, M. Herbst, A. Graf, J. M. Sequaris and H. Vereecken. 2011. *Inverse determination of heterotrophic soil respiration response to temperature and water content under field conditions.* Biogeochemistry. DOI 10.1007/s10533-011-9583-1

EVENTS

September 18-23, 2011 | Garmisch-Partenkirchen

3rd iLEAPS Science Conference

Climate researchers from all over the world are meeting in Garmisch-Partenkirchen from September 18-23 for the third iLEAPS Science Conference. The conference is being hosted by the Institute for Meteorology and Climate Research, Atmospheric Environmental Research (IMK-IFU) at the Karlsruhe Institute of Technology (KIT). Various workshops are also being offered as part of the event. iLEAPS is an international interdisciplinary research programme which focuses on the processes between land surface and atmosphere. The conference will, amongst other things, address observation and modeling issues as well as innovative methods, ideas and challenges.

www.ileaps.org/multisites/Science_Conference_2011

July 22-27, 2012 | Leipzig

2nd International Conference on Hydropedology

Hydropedology combines soil sciences and hydrology. The international conference being held in Leipzig brings together the various disciplines involved. Links between soil properties and hydrological processes will provide a focus for debate. Modern techniques such as remote sensing have an important role to play in this area. The conference agenda also includes a visit to the TERENO observatory "Harz/Mid-German Lowlands". The meeting is being organized by Professor Hans-Jörg Vogel from the Department of Soil Physics at the Helmholtz Centre for Environmental Research (UFZ).

www.ufz.de/hydropedology2012

WELCOME INTERFERENCE

PROCEMA uses microwave link networks to collect better data on rainfall

Precipitation plays a central role in the Earth's water cycle. However, rain, hail and snow are not uniform phenomena; they are subject to a high degree of spatial and temporal variability. Determining the exact amount of precipitation in time and space is no easy matter. Partners from science and industry have joined forces to develop and test a new measurement technique as part of the research project PROCEMA. This method makes use of microwave links run by mobile phone network operators and is being tested at the TERENO observatory "Bavarian Alps/Pre-Alps".

If the rainfall in a particular region fluctuates widely in different years, perhaps due to alternations between long dry spells and torrential rain, or because rainfall changes markedly over short distances, as is the case in the Alps, then scientists refer to high rainfall variability. "Accurately measuring spatial rainfall variability is one of the main challenges in hydrology research", says Professor Harald Kunstmann from the Institute for Meteorology and Climate Research (IMK-IFU) at the Karlsruhe Institute of Technology (KIT).

Even light drizzle affects reception

Conventional measurement and calculation methods suffer, to a large extent, from high uncertainty. Regions such as the Alps and the Alpine foothills are a case in point. Data collected from so-called 'rain gauges are heavily influenced by topography and prevailing winds. Furthermore, as their measurements only represent a value at a single point they are often unable to determine large spatial variations in amounts of rainfall. In contrast rain radars offer higher spatial coverage and resolution but are potentially subject to a large degree of interference and error. The measured reflectivity can therefore not be easily attributed to an absolute amount of rainfall.
Professor Kunstmann hopes that the new method will provide better results. It was developed and analyzed within the framework of PROCEMA ("Regional Precipitation Observation by Cellular Network Microwave Attenuation and Application to Water Resources Management"), a virtual institute funded by the Helmholtz Association of German Research Centers. The method is based on microwave links operated in the frequency range 10 – 40 gigahertz which are usually used by the mobile phone network providers for communication between the base station towers. It makes uses of a side-effect which network operators consider something of a nuisance. Even light drizzle attenuates the received power of a microwave link considerably. Scientists working in the field of high-frequency engineering have long been aware of this effect. However, it wasn't until 2006 that the project's Israeli partners had the idea to make use of it by exploting data from the existing network of microwave links to measure precipitation.

Supplementing conventional measurements

By analyzing the attenuation data, scientists at the IMK-IFU can quite accurately determine the amount of rainfall along the links within the TERENO observatory. "Comparisons with data collected by Germany's National Meteorological Service (DWD) show that they are largely consistent with regards to the detection of precipitation events and amounts of precipitation", reports Professor Kunstmann. In collaboration with project partners and the mobile network operator Ericsson, five microwave links have been selected in the area around Garmisch-Partenkirchen. As of 2010, the received power of these links is being recorded every minute.

In addition, tests began at the TERENO test site "Fendt" in Autumn 2010 to determine how microwave radiation is affected by various types of precipitation such as sleet, snow and ice as well as by other atmospheric conditions such as air moisture, temperature and solar radiation. Initial results indicate that not only does the in-house developed microwave transmission device make it possible to quantify the amount of precipitation, it can also determine the so-called integrated absolute humidity along the 650-metre long test track. As such it offers great opportunities, especially in improving weather and climate models, as humidity is an important variable in the accurate simulation of thunderstorms and rainfall.

Professor Kunstmann is delighted with the results so far: "This new method has the potential to effectively complement existing station and radar measurements. It could even play a central role in regions where monitoring networks are either non-existent or very limited, as is often the case in developing and emerging countries". ■

PROCEMA PARTNERS

- Karlsruhe Institute of Technology (KIT), Institute for Meteorology and Climate Research (IMK-IFU)
- Technical University of Munich (TUM)
- University of Applied Sciences Regensburg
- Tel Aviv University
- Kinneret Limnological Laboratory
- Cyprus Institute
- Germany's National Meteorological Service (DWD)
- Ericsson

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Photos: KIT/IMK-IFU


Photo: Wikipedia

Precipitation data is often collected with the help of so-called 'rain gauges'. The new method being tested by the PROCEMA project makes use of microwave links run by mobile network operators (image right: a radio tower). The in-house developed measurement device can also calculate integrated absolute humidity

FROM CAUSES TO CONSEQUENCES

Helmholtz Climate Initiative REKLIM focuses on regional climate change

Glaciers are melting, oceans are getting warmer, the air temperature is rising – all signs of global warming which scientists have alerted us to in recent decades. However, the effects of climate change vary greatly according to region. In addition to TERENO, the Helmholtz Association has a second research project that focuses on the regional and local consequences of climate change: the Helmholtz Climate Initiative REKLIM (Regional Climate Change).

REKLIM is a consortium of eight research centres within the Helmholtz Association. All of the six centres involved in TERENO are partners and are joined by the Alfred Wegener Institute for Polar and Marine Research (AWI) and the Helmholtz-Zentrum Geestacht Centre for Materials and Coastal Research. REKLIM's Scientific Coordinator is climate and polar expert Professor Peter Lemke, Head of the Climate Sciences Research Division at the AWI.

Key research topics include, amongst other things, changes in atmospheric components and trace elements, changes in ice coverage in polar regions and in sea levels. Scientists are investigating processes in polar regions that impact the climate, the effects of changes in land surface, and changes in extreme weather events. At the same time, they are also trying to establish whether these phenomena, be they global, regional or local, are due to natural or anthropogenic causes. In the long-run, the aim is to develop models which make allowances for interactions between the atmosphere, oceans, ice-covered regions, the biosphere, land surface and the pedosphere. These models will make it possible to estimate current and future regional climate changes. These forecasting tools can then be used to optimise mitigation and adaptation strategies.

Close cooperation with TERENO

REKLIM's research activities are currently divided into seven topics, with three additional topics in the pipeline. There is a particularly strong tie-in with TERENO in Topic 4: Land surfaces in the climate system. This topic focuses on the complex chain of cause and effect at the intersection of atmosphere and land surface, where numerous physical, chemical and biological processes occur. The aim is to understand how these processes are interlinked. That is the key to better predictions on the regional effects of climate change and their potential consequences. To this end, scientists require environmental data which have been collected over a longer period of time. That is precisely what the monitoring programme TERENO delivers with its four observatories. The data supplied by TERENO make it possible to simultaneously test and improve climate models. Accordingly, the two initiatives work closely together. ■


Photo: AWI/Hans Oerter

Sea levels are rising as glaciers and ice sheets in polar regions melt at an increasing rate (photo depicts a glacier in Greenland). REKLIM examines regional consequences, for example, investigating possible effects on Germany's coastal region consequences at a regional level, for example Germany's coastal region

www.reklim.de/en

FROM LOCAL HYDROLOGY TO A REGIONAL CLIMATE MODEL

An interview with REKLIM Coordinator Peter Lemke


Photo: AWI

Peter Lemke

Professor Peter Lemke from the Alfred Wegener Institute for Polar and Marine Research, located in Bremerhaven, is the Scientific Coordinator of the Helmholtz Climate Initiative REKLIM. He hopes that realistic regional climate models will become a reality within the next ten years.

We still know far too little about the concrete effects of climate change on individual regions. What is the current state of regional climate research in Germany?
We are making good progress. REKLIM is an important step forward as it has allowed us to pool our resources – from climate observation to the development of new models. There isn't a comparable initiative in Europe or anywhere else in the world.

What is TERENO's role?
TERENO is important because it tackles a great unknown: the role of land surfaces in regional climate systems. There are many feedback processes between the atmosphere and land surfaces that we have yet to understand at all. For example, what are the consequences of changes in land use on the water cycle, and in turn what is their impact on the ecosystem? All of the Helmholtz Centres that participate in TERENO are also REKLIM partners, which means that we can coordinate our activities perfectly. The key is to make sure that all of the information and observations gathered within the framework of TERENO are used to help develop climate models.

What do you hope these models will deliver?
The main goal is to bridge the gap between local hydrology and regional climate modelling. Observations from the ground are already being converted into local, small-scale models. The next step is to scale these up to regional climate models. Unlike previous approaches that only take a few factors into account, our aim is to include as many parameters as possible. I can well imagine that we will be working with these types of models within the next decade. That will also allow us to reach another goal: providing decision makers in politics, government and business with even better support in assessing the risks and opportunities of climate change and designing effective mitigation and adaptation strategies. ■

ICOS – CLIMATE PROTECTION DATA

ICOS pinpoints sources and sinks of carbon dioxide throughout Europe

How do carbon dioxide and other greenhouse gases impact on our climate? How do soil, forests and oceans fit into the global carbon cycle? In search of the answers to these questions, environmental researchers have come together as part of ICOS, a European research initiative to build an extensive network of carbon monitoring stations. The TERENO observatories are making an important contribution to this unique project.

ICOS stands for "Integrated Carbon Observation System". Over the coming decades, the project aims to pinpoint sources and sinks of carbon dioxide and other greenhouse gases throughout the whole of Europe and beyond. At the same time, researchers are eager to establish which factors affect this cycle, for example, changes in land use such as agriculture, forest clearing, reforestation, or already existing changes in the climate, such as drier summers. "ICOS is given a particular boost by the infrastructure which has already been set in place by TERENO. Each of these long-term monitoring platforms compliments the other beautifully" says Dr. Werner Kutsch, coordinator of the German contributions to ICOS and a specialist in trace gas fluxes between ecosystems and the atmosphere at the Johann Heinrich von Thünen Institute (vTI) located in Braunschweig.

ICOS unites measuring stations throughout Europe in a common network, including the research tower at the Wüstebach test site, part of the TERENO observatory "Eifel-Lower Rhine Basin"

Sea view

In addition to measuring stations on land, research equipment will also be loaded up on to ships in order to capture data at sea. Up to now, the sea has been considered a massive carbon dioxide sink, and as such, a great hope for climate protection. However, new data suggest that the oceans' capacity for absorbing climate-damaging carbon dioxide is in rapid decline.

ICOS - A NEW INFRASTRUCTURE:

Until now, measuring stations in Europe were project-related enterprises run by individual institutes or research collaborations which were limited in time. ICOS aims to pool these resources by maintaining existing stations and extending them further over the next 10 to 20 years on a collaborative basis. It represents an important contribution to climate protection: Reliable data are key to assessing and analyzing the sensitive interactions between ecosystems and the atmosphere in response to increases in carbon dioxide and other climate damaging gases such as methane.

www.icos-infrastructure.eu

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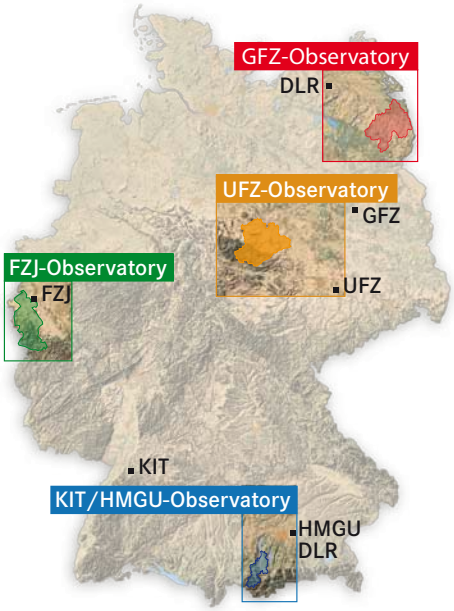

FZJ	Forschungszentrum Jülich (Coordination)
DLR	German Aerospace Center
KIT	Karlsruhe Institute of Technology
HMGU	Helmholtz Zentrum Muenchen, German Research Center for Environmental Health
UFZ	Helmholtz Centre for Environmental Research
GFZ	Helmholtz Centre Potsdam GFZ German Research Centre for Geosciences