Karlsruhe Institute of Technology

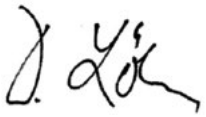
Issue 1|2015

CLIMATE AND ENVIRONMENT news

Newsletter of the KIT Climate and Environment Center

Editorial

After the election of Professor Dr. Frank Schilling as spokesperson, a petrophysicist now represents the KIT Climate and Environment Center to the inside and outside. Together with him, we wonder which topics will become important in the next years. The answer is given by this newsletter: The spectrum of articles is as wide as is the scope of topics covered by our research. Still, three paramount objectives are in the focus: We have to help make the energy transition feasible and to pay attention to the protection of the climate. Environmental hazards will play a bigger role in the lives of billions of people. That is why I consider risk minimization a second major field of work. And third, we have to succeed in reducing environmental pollution in spite of the growing global population. This newsletter presents examples of excellent science conducted by our KIT Center in all of these areas. This is encouraging and makes me face the future with great optimism.



Yours, Professor Dr. Detlef Löhe
Vice President Research and Information

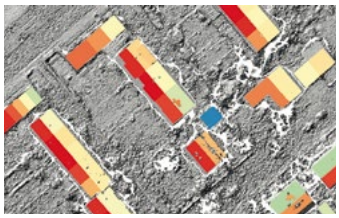
Solar Cadaster

Which Roof Is Suited for Photovoltaics?

Having transformed the energy system, solar energy is to have a larger share in covering our electricity consumption. Installation of photovoltaics systems on every suited roof would be an important step in this direction. But which roof is suited? This question will now be answered by the eaglesolar.eu web platform. It was designed under the EAGLE EU project, in which KIT's Institute of Photogrammetry and Remote Sensing (IPF) is involved. The platform addresses house owners, installation companies, and municipalities wishing to promote the energy turnaround.

"As geodesists, we provided the scientific basis for assessing the suitability of roofs for the installation of solar systems," Dr. Thomas Vögtle, project coordinator of IPF, says. The complex work package of Vögtle and his team covered the identification of roof areas from laser data of measurement flights or aerial photographs, calculation of their positions, inclinations, and orientations, and determination of the extent to which the areas are shaded by neighboring buildings or vegetation.

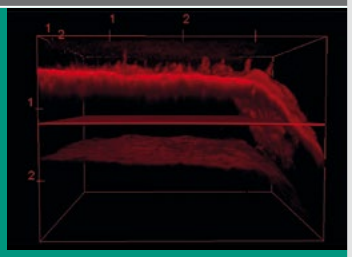
"It was also important to prognosticate the economic efficiency of any installation," Vögtle adds. For this reason, the calculations also consider weather statistics. The project



Excerpt of an aerial photograph of the Karlsruhe test area and automatically generated surface model with extracted roof surfaces. (Photo: Stadt Karlsruhe, Liegenschaftsamt)

partner, Steinbeis Transfer Center Solar and Thermal Technology, Stuttgart, additionally supplied data on the efficiency of various types of solar cells.

13 partners of research, industry, and solar associations were involved in the project that expired in late 2014. Still, work on the platform is continued: "We now plan to use data of even higher resolution, which will be measured in future flight campaigns," Vögtle says. "In this way, we will be able to exclude chimneys or dormers." This will be of relevance to automatic derivation of roof utilization plans. "The load-carrying capacity of the houses, however, still will have to be estimated by the installation company," Vögtle emphasizes.



Detective Work in the Stratosphere

Atmosphere researchers understand the impacts of gases, such as chlorinated fluorocarbons (CFCs), on the ozone layer quite well. But there are a number of other substances of natural or anthropogenic nature that also damage the protective covering of the earth. Examples are bromine compounds. "Neither do we know their concentration in the upper atmospheric layers," Hermann Oelhaf of the Atmospheric Trace Gases and Remote Sensing Division of the Institute of Meteorology and Climate Research (IMK-ASF) says, "nor do we know in detail the chemical reactions in which they are involved." To study such problems, a consortium of scientists of KIT, the German Aerospace Center (DLR), and the University of Heidelberg launched a helium balloon in the Canadian province of Ontario last autumn.

The balloon filled with 400,000 cubic meters of helium brought three remote

The fragile atmospheric layer. (Photo: Tilman Wimmer, DLR)

sensing instruments up to an altitude of nearly 40 kilometers. "These instruments complement each other ideally and we can measure a broad spectrum of electromagnetic radiation," Oelhaf says. "This is the basis for determining concentrations of trace gases, such as bromine oxide or bromine nitrate, simultaneously and as a function of time." Now, the scientists have derived first findings from the huge amounts of data. "Evaluation is hard detective work," Oelhaf says. "We first had to calibrate spectra from raw data. Then, concentrations of chemical substances were derived as a function of time and altitude. In addition, measurement values were compared with already existing atmosphere models. With the help of the recorded spectra, the scientists are now able to quantify chemical reactions, by which reactive bromine oxide is formed from the bromine nitrate reservoir or vice versa depending on the sun's position. Oelhaf: "Only when we will have understood these processes exactly and compared them with modelings, will we be able to say how hazardous bromine compounds are to the ozone layer."

MORE INFORMATION:
www.imk-asf.kit.edu/english/ffb.php

The Forest that Should not Exist

Actually, Yatir forest in Israel should not exist. It is located at the Northern edge of Negev desert, where temperatures may frequently exceed 40°C. Water is very scarce, such that trees can hardly cool themselves down by evaporation. In theory, they should overheat and die. Instead, the forest is growing. Since the trees have been planted in the 1960s, they have grown to a height of almost 15 m.

"We assume that the forest releases energy in the form of hot air," Matthias Mauder of the Atmospheric Environmental Research Division of the Institute of Meteorology and Climate Research (IMK-IFU) explains. "First studies revealed that the hot air ascends vertically above the forest at a speed of up to three meters per second and descends over the desert again."

The Doppler lidar (left) is used to measure how air flows ascend above the forest and how they affect the boundary layer of the atmosphere. (Photo: Matthias Mauder)

But does the hot air fan of the plants influence the local and regional climate? This question is studied by the KIT scientists around Matthias Mauder together with researchers of the Israeli Weizmann Institute of Science under the DFG-funded Cliff (Climate feedbacks and benefits from semi-arid forests) project.

Since the beginning of this year, the scientists have been using ground-based remote sensing methods to measure the heights to which the air flows ascend and whether they displace the boundary layer of the atmosphere upwards. Manipulation experiments are carried out on site and in the greenhouse at Garmisch-Partenkirchen

Preparations for measurements: The scientists unload the Doppler wind lidar. (Photo: Matthias Mauder)

to analyze how heat and drought stress affect the pine trees.

In the second project phase, it is planned to use the data measured in computer simulations. Work is aimed at finding out how the forest will react to the changed climate conditions in the next decades and whether effects of climate change may be mitigated by reforestation in other semi-arid regions.

MORE INFORMATION:
www.imk-ifu.kit.edu/projects_2244.php

Suited for the Sewage Treatment Plant

Technical Study of Anaerobic Ammonium Oxidation by EBI

Modern sewage treatment plants are gigantic bioreactors, in which pollutants and nutrients are specifically removed from water by means of microbial processes. "This technology is now experiencing a fundamental change," Professor Dr. Susanne Lackner of the Water Chemistry and Water Technology Division of the Engler-Bunte Institute (EBI) says. One of the reasons are so-called anammox bacteria. These microorganisms were discovered in the 1990s and efficiently remove nitrogen compounds from wastewater. For this, they need neither oxygen nor an organic carbon source. On the contrary, climate-damaging carbon dioxide is consumed by the bacteria conducting anaerobic ammonium oxidation.

These properties of anammox bacteria are of high value for the operators of sewage treatment plants both ecologically and financially. So far, however, the process has been stable and studied well for partial flows of sewage only. These sewage flows had a high nitrogen content and high temperature. "At EBI, we want to find out which technical improvements are required to apply the anammox process to the main flow as well," Susanne Lackner says.

For this purpose, her team tested various bioreactors for suitability for treatment of the main sewage flow. It was found that certain reactions compete with the anammox reaction desired at low temperatures and low ammonium concentrations. Other bacteria withdraw nitrite from water, which is needed for deammonification. "Our comparative studies revealed that apart from other factors, the structure, in which the bacteria settle, plays a decisive role for the efficiency of the anammox process" Lackner points out. "The thicker these biofilm structures are, the more favorable this is for the settlement of bacteria catalyzing nitrogen decomposition."

This finding is an important step to make anammox suited for sewage treatment plants. "However," Lackner adds, "we still have to learn a lot more about the complex living conditions in this microbial ecosystem, before we really manage the anammox process in sewage treatment."

The four laboratory reactors used for studying deammonification. (Photo: Susanne Lackner, KIT)

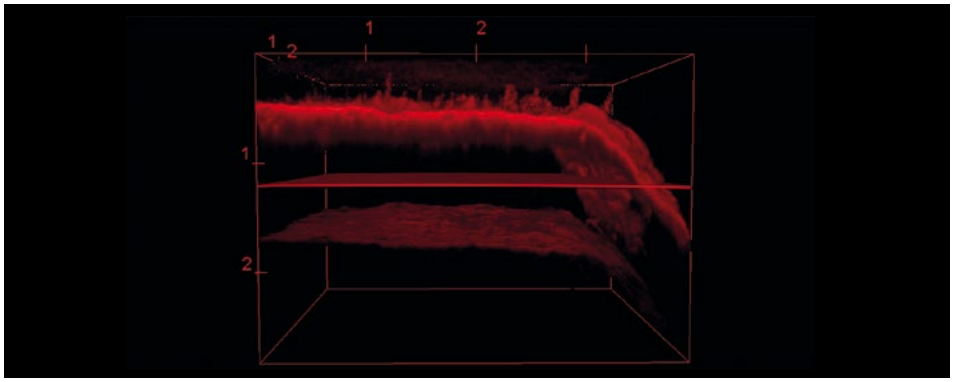
MORE INFORMATION:
wasserchemie.ebi.kit.edu/918_2746.php

Researchers Make Biofilms on Ceramic Filters Visible

About one eighth of the world's population has no access to clean drinking water. For protection against infectious diseases, many people in poorer countries use water filters that are sometimes made of ceramics. But how long do these filters effectively remove disease-causing microorganisms? When do bacterial films form on the filters, so-called biofilms, which plug the filters and pollute the water?

These questions are studied by researchers in the team of Gerald Brenner-Weiß of the Institute of Functional Interfaces of KIT. "We are looking for a process, by means of which biofilms can be detected rapidly and reliably, also when they hide in the pores of filters." In a first project, the scientists made biofilms grow on broken ceramic pieces. Then, they analyzed bacterial growth using various imaging methods.

"Optical coherence tomography provided 3D images, on which the biofilm can be distinguished well from the ceramic material," Brenner-Weiß explains. First experiments using microcomputer tomography revealed that this method can also be applied to detect bacterial films in pores. "These are only preliminary results, we still have to conduct further studies for confirmation."



Visualization of a biofilm by optical coherence tomography (OCT). (Photo: EBI Wasserchemie/IFG)

The studies also revealed that silver coating of the ceramic material may be superfluous. Due to its antibacterial effect, silver is frequently used in the filters. "But it is washed out quickly and efficiency is lost," Brenner-Weiß says. For this reason, the scientists are working on the development of silver-free alternatives for ceramic water filters.

MORE INFORMATION:
www.ifg.kit.edu/english/26.php

Development of Hailstorm Risk Models for the Insurance Sector

Hailstorms are comparatively rare meteorological events that often affect small areas only. And still, a single hailstorm can cause insurance costs in the amount of several billion euros, an example being the hailstorm in late July 2013 north of the Swabian Alps in the center of Germany. Scientists of the Troposphere Research Division of the Institute of Meteorology and Climate Research (IMK-TRO), in cooperation with experts of the insurance sector, study the frequency and intensity of hailstorms and the damage caused by them.

"The risk of hailstorms currently is significantly underestimated by both the public and the insurance sector," Michael Kunz, Head of the Atmospheric Risks Working Group, says. Unfortunately, there are only very few and very simplified hail damage models for the European market. "To change this situation and to better assess financial risks, insurance companies need information about the frequency and intensity of hailstorms. We scientists are mainly interested in where hailstorms occur under which meteorological conditions," Michael Kunz explains the basis of cooperation.

In most European countries, also in Germany, no direct hail measurements are made. The researchers use radar and satellite data as indirect data, so-called proxies, to estimate hail events. In a cooperation project with SV Sparkassenversicherung, for instance, the scientists combined radar data of the German Weather Service with lightning data, damage data provided by insurance companies, and other meteorological information in order to produce a statistics of high spatial resolution on the probability of hailstorms in Germany.

For Baden-Württemberg, the KIT scientists developed a total damage model, by means of which the amount of damage can be estimated for an extreme hailstorm event that statistically occurs once every 200 years. These data are needed by insurance companies for the new regulations of the market from 2016. "For us scientists, one of the most interesting results of the project was that spatial distribution of hailstorms is bound to certain topographic conditions," Manuel Schmidberger, one of the team members, explains. Hailstorms were found to occur mainly on the lee side of low mountain ranges, which is presumably due to flow conditions above the mountains.

Hailstones are beautiful, but damaging. (Photo: Marco Kaschuba, www.marcokaschuba.com)

Within the Willis Research Network (WRN), the team of Kunz also develops a stochastic model for the frequency and extent of hailstorm events in Europe based on satellite data. Satellite data reveal certain structures that indicate storms with a high probability of hail.

Hailstones of this size may cause enormous damage. (Photo: Marco Kaschuba, www.marcokaschuba.com)

"In the end, we use the model to calculate how probable a hailstorm event of a certain intensity is and how frequently an event causing a certain amount of damage has to be expected. In cooperation with Willis, a damage model was developed that is now being used by many insurance companies to assess their risk," Willis Fellow Heinz Jürgen Punge of the Kunz working group explains.

This project confirmed the relationship between hailstorm probability and topography: A high hailstorm risk mainly exists in the Alps, Pyrenees, and near the Massif Central. For Kunz, cooperation between research and industry pays off: "Today, we understand the risk of hailstorms much better than ten years ago."

MORE INFORMATION:
www.imk-tro.kit.edu/english/5195_5213.php
www.imk-tro.kit.edu/english/5195_5447.php

(Photo: private)

PD Dr. Katja Emmerich

The Deutsche Ton- und Tonmineralgruppe e.V. (DTTG, German-Austrian-Swiss Clay Group) has a new president: Since September 2014, crystallographer PD Dr. Katja Emmerich has been heading the association of scientists and users studying clays and clay minerals in Germany, Austria, and Switzerland.

Emmerich wishes to contribute to strengthening clay mineralogy in the scientific community. "Industry has a big need for clay mineralogists, but the number of experts is very small." An exception is the KIT, where clay mineralogy has a high priority. "As president of this association, it is an enormous advantage for me to work at such an institution." At KIT, Katja Emmerich works at the Competence Center for Material Moisture (CMM) and at the Institute of Functional Interfaces (IFG).

(Photo: private)

Professor Dr. Olivier Eiff

Professor Dr. Olivier Eiff has joined the team of the KIT Climate and Environment Center. Since April 2015, the fluid dynamics scientist has been member of the board of directors of KIT's Institute for Hydromechanics and of the Environmental Fluid Mechanics Working Group. His interest is devoted to fluid mechanics in the context of environmental problems: "Many models do not adequately represent the complexity in nature, in particular in special or extreme cases. To increase accuracy and make better prognoses, we also need laboratory experiments representing natural conditions and allowing for high-resolution measurements." The researcher, who has worked at the French Institut de Mécanique des Fluides, Toulouse, finds the prerequisites required for this work at KIT. "Here, colleagues study flows in air and water. This gives me the opportunity to bring both worlds together."

(Photo: private)

Professor Dr. Frank Schilling

Professor Dr. Frank Schilling is new scientific spokesperson of the KIT Climate and Environment Center. Schilling was elected by the steering committee and now replaces Professor Dr. Johannes Orphal, the Head of the Atmospheric Trace Gases and Remote Sensing Division of the Institute of Meteorology and Climate Research, according to rotation.

Mineralogist Schilling is professor of petrophysics at KIT's Institute of Applied Geosciences. For him, research relating to the climate and environment is of central importance. "As a geoscientist, I study processes occurring over time spans of millions of years. This teaches a certain respect of nature," Schilling says. "Most fossil resources consumed today were produced over the last 400 million years. The environment in which we are living has developed in the past millions of years. Within a few generations, we put these goods at risk."

To preserve the bases of life of man and the entire biosphere, Schilling thinks that it is urgently required to better understand the complex relationships between man's acting and environmental resources, such as the climate, water or biosphere. In Schilling's opinion, science faces at least three big challenges in the decades to come: The combination of climate protection and energy turnaround, systematic minimization of environmental hazards, and development of efficient measures to reduce environmental pollution while the world's population is growing.

"The scientists of the KIT Climate and Environment Center make excellent and worldwide acknowledged contributions to a decent future on our dynamic planet," Schilling says. "The colleagues at the Center are playing in the top international league. Some – not few – define the world's state of the art." As scientific spokesperson, Frank Schilling wishes to contribute to identifying fascinating research topics, for the Center to remain visible by the international community in the future. For this, he considers intra- and interdisciplinary exchange to be important at the Center. "In addition, we have to be in dialog with the society and to understandably communicate our research findings. Only when our results are generally understood, can they contribute to change and help better protect our bases of life."

KIT Climate and Environment Center

Scientific Spokesperson:	Professor Dr. Frank Schilling
Deputy Scientific Spokesperson:	Professor Dr. Thomas Leisner
Spokesperson of Topic 1:	**Atmosphere and Climate:** Professor Dr. Thomas Leisner
Spokesperson of Topic 2:	**Water:** Professor Dr.-Ing. Franz Nestmann
Spokesperson of Topic 3:	**Georesources:** Professor Dr. Thomas Neumann
Spokesperson of Topic 4:	**Ecosystems:** Professor Dr. Hans Peter Schmid
Spokespersons of Topic 5:	**Urban Systems and Material Flow Management:** PD Dr. Stefan Norra and Dr.-Ing. Rainer Schuhmann
Spokesperson of Topic 6:	**Natural Hazards and Risk Management:** PD Dr. Michael Kunz

Risk Research and Education: The Opportunity Lying in Risk

By Professor Dr. Friedemann Wenzel

Natural risks threaten technical and societal systems. (Photo: Mauro Piccardi, Fotolia.com)

It is not in scientists to unduly stress concerns. But it can be stated that our modern world is increasingly exposed to higher risks. This is due to the fact that our infrastructure is increasingly interlinked, which applies to information technology as well as to the energy or transportation sectors. Other risks result from environmental changes, from climate change to ground sealing to plastic waste in oceans.

At Karlsruhe Institute of Technology (KIT), we are aware of this changed risk scenario: Two years ago, I organized a survey to identify the research potentials existing at KIT institutes with respect to natural risks. This balance, of course, is far from being complete, but still impressive and documented on the webpage www.klima-umwelt.kit.edu/english/285.php.

At an institution, such as the KIT that feels committed to research, innovation, and education, the question arises as to how the research potentials and education are interlinked. Or in other words: How can scientifically based findings and sharpened awareness of risks be conveyed to KIT students?

When the Center for Disaster Management and Risk Reduction Technology (CEDIM) was established in 2002 at the then University of Karlsruhe, it quickly gave rise to the idea of establishing a corresponding study program. However, we had to realize that a "Master of Disaster" is no job profile in Germany and that such an education hardly makes any sense.

What is the alternative? In my opinion, contents covering risks and risk management and of relevance to university graduates in their future profession should be integrated into existing programs and curricula: The architect wishes to study architecture and to plan buildings later on. But during studies, she/he should learn something about natural hazards buildings and infrastructure facilities are exposed to. The electrical engineer wishes to focus on the construction and building of electrical systems. But during the studies, she/he should learn something about the risks faced by such systems and how they can be minimized or managed.

I think that a stronger focus on these topics is urgently required in academic education. The relative safety in which we live in the context of technology today is the result of 200 years of risk research, even though the term is much younger: Investigation of risks started with the frequently exploding steam vessels of the late 18th and early 19th centuries. The results of these activities were technical and regulatory measures to reduce these risks. Today, engineers concentrate too much on the inner functionality of their plants. They are seldom aware of the fact that there are impacts from outside – floods, storms, earthquakes, or terror – that may affect systems with serious consequences for the environment, infrastructure, and society.

Hence, risks do not have to be analyzed separately or internally, such assessments have to become mainstream. As many students as possible of as many relevant programs as possible have to come in touch with it. We have to develop modules that can be integrated easily into specific academic education programs.

Such an integrated education in risk management will contribute to making technical and societal systems safer and more resilient and to minimizing direct damage of a system by external impacts, such that its function can be restored quickly. But resilience is more: For very complex systems in particular, it is decisive to develop the capability of adapting to the (emergency) situation. This applies to power grids that may be exposed to very different and difficult to foresee impacts: We cannot foresee everything and we cannot model and quantify everything. But we can try to make an adaptation to such impacts possible.

Education in the academic sector is a crucial step in this direction. The KIT with its high research potentials relating to risk may become a Europe-wide model. This is where the big opportunity for us lies in risk.

After the Earthquake in Nepal: Studies on Site

Within the framework of the current research program relating to close-to-time forensic disaster analyses, a team of CEDIM has analyzed the severe earthquake in Nepal on April 25 in more detail. For this purpose, several reports on damage analysis, vulnerabilities, and emergency shelters were drafted and published. Moreover, a team of CEDIM researchers, in cooperation with the South Asia Institute (SAI) of Heidelberg University, the National Society for Earthquake Technology (NSET), and the Earthquake Engineering Research Institute (EERI), analyzed the situation of the many emergency shelters and the reaction of the population in Nepal during a field excursion of two weeks (www.cedim.de).

Walls of houses damaged by earthquakes are provisionally stabilized by supporting pillars. (Photo: Bijan Khazai)

CEDIM Joined IRDR Network

Since June 2015, CEDIM has joined the new German International Centre of Excellence on Critical Infrastructures and Strategic Planning. Within the network installed by IRDR (Integrated Research on Disaster Risk), CEDIM cooperates with the United Nations University (Bonn), the University of Potsdam, and the German Committee for Disaster Reduction (DKKV). The coordinator is Stuttgart University.

KIT Environment Lecture: About Water and the Universe

(From left to right) Professor Schilling (KIT), Professor Bárdossy (Stuttgart University), and Professor Zehe (KIT) at the KIT Environment Lecture. (Photo: Irina Westermann)

In a captivating lecture on June 30, 2015, Professor Bárdossy (Stuttgart University) covered the complete spectrum from the course of the stars to the falling of raindrops. In an impressing way, he explained why we know what the position of stars will be in a few weeks' time and why we do not know whether or not it will rain that day. He argued that these knowledge gaps should be closed by investigating the resulting uncertainties in the modeling of hydrological processes.

KIT Coordinates Helmholtz Urban Research Initiative

KIT has succeeded in acquiring funds from the Helmholtz Association's Initiative and Networking Fund for the Helmholtz Urban Research Initiative.

During the current planning phase of one year, the seven Helmholtz Centers involved will develop an integrated urban research concept for Helmholtz based on natural sciences, engineering, health, and social sciences as well as architecture and urban planning. The strengths of the centers involved are to be optimally pooled. It is the objective to analyze the city as a holistic system by means of an integrated approach, to develop comprehensive solution options, and to supply decision know-how.

The project is headed by Dr.-Ing. Karl-Friedrich Ziegahn, Head of the "Natural and Built Environment" Division of KIT, and coordinated by Dr. Heike Boos, Office of the KIT Climate and Environment Center.

First ATMO PhD Days on June 23/24, 2015, in Annweiler

The "ATMO PhD Days" are aimed at enhancing internal networking and discussion of topics. 27 participants from eight institutes of Forschungszentrum Jülich (FZJ) and KIT presented their work briefly and answered questions of their colleagues. The program of the first day was completed by a scientific evening lecture of PD Dr. André Butz, Head of the Emmy Noether Young Investigator Group RemoteC on "Remote sensing of greenhouse gases and their sources and sinks," which was followed by an interesting discussion.

On the second day, various infrastructure facilities for climate and atmosphere research on KIT Campus North were visited, such as the precipitation radar, the CARIBIC (Civil Aircraft for the Regular Investigation of the Atmosphere Based on an Instrument Container) container, and the AIDA cloud simulation chamber. The PhD days were considered to be a big success by all participants.

ATMO is one of six Helmholtz programmes in the Helmholtz research field "Earth and Environment", with the KIT, FZJ, and the Helmholtz Centre Potsdam – German Research Centre for Geosciences (GFZ) being involved. It focuses on the role of the atmosphere in the dynamic climate system as well as on underlying processes. The scientific spokesperson of the programme is Professor Johannes Orphal (KIT).

Scientific spokesperson (front left) and participants of the ATMO PhD Days at the Kurhaus Trifels, Annweiler. (Photo: KIT)

Doctoral Students Deepen Their Knowledge at GRACE Science Schools

Participants of the DESERVE winter school. (Photo: Friederike Lott)

In December 2014, four doctoral students of the KIT Climate and Environment Center (ZKU) traveled to the Dead Sea in Israel. Funded by the GRACE Graduate School, they studied the special meteorological and hydrological conditions of the region. The DESERVE winter school of two weeks' duration was organized by KIT. In late 2016, another winter school is planned. It will focus on the investigation of sinkholes and on seismic hazards on the Dead Sea.

Science schools, such as DESERVE, are central elements of the GRACE Graduate School. "It provides orientation for our doctoral students and represents a good opportunity to look beyond horizons," Andreas Schenk, scientist of the Institute of Photogrammetry and Remote Sensing (IPF) and scientific coordinator of GRACE, explains. During the training events, doctoral students deepen specialized knowledge or scientific fundamentals.

In late July, the GRACE organizers coordinated a summer school: At Bad Herrenalb, the participants concentrated on the "Basics of Environmental Science". "Doctoral students of the KIT Climate and Environment Center were informed about the work of other scientists at the Center and about their research results or methods that may be of interest to their own work," Schenk says.

In October, GRACE will join the Advanced Statistical Methods Course organized by the Helmholtz Research School MICMoR. It will have a duration of four days and the participants will meet at Augsburg University to study statistical mathematics and its relationship to climate research.

MORE INFORMATION:
www.grace.kit.edu/english
www.micmor.kit.edu

Studies in Water-sensitive Regions Worldwide

Good news for CAOS researchers: The German-Luxemburg DFG Research Group (CAOS – Catchments as Organized Systems) was evaluated with excellent results and started the second funding phase in early 2015. Scientists study the interaction of landscape structures with spatially distributed hydrological processes.

The long-standing activities of KIT in the area of integrated water resources management (IWRM) in Southeast Asia will be further intensified. The research area was extended from Indonesia and Vietnam to Thailand. Several joint projects funded by the BMBF focus on the prevention of floods and droughts in water catchment areas.

KIT also is initiator and co-founder of the "Excellence Center for Science, Teaching and Research" named "Institute for Water, Structure, and renewable Energy" (IWSrE) at Sebelas Maret University (UNS) on Java, Indonesia.

Other target regions of international projects are Africa and South America as well as Israel, Jordan, and the Palestine Territories. In the Jordan region, the focus of several joint projects lies on the development of innovative technologies and management concepts for an efficient use of the scarce water resources in semi-arid regions. Use of data on microwave attenuation for precipitation measurement is being further developed under a new DFG joint project (IMAP) coordinated by KIT.

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