Karlsruhe Institute of Technology

Issue 2|2013

CLIMATE AND ENVIRONMENT news

Newsletter of the KIT Climate and Environment Center

Editorial

Research with persistence. This is our maxim at the Climate and Environment Center. And it is the subject of this newsletter: The Helmholtz programme "Atmosphere and Climate", in which we are a major partner and the scientific spokesperson of which is our Center's head Professor Orphal, reached excellent results in the recent PoF evaluation. Another five years of research for the future of our planet are guaranteed.

However, long-term research also means to think about more than five years. The climate and ecosystems respond to anthropogenic impacts very slowly, and sometimes differently from what was expected. We therefore need measurements over several decades, as is shown by the example of water use efficiency of forests. Hans Peter Schmid passionately pleads for a research perspective extending beyond one human generation. Excellence of our long-term research is reflected by this year's Erwin Schrödinger Prize on which we congratulate Klaus Butterbach-Bahl and his team.

Yours Dr. Karl-Friedrich Ziegahn
Chief Science Officer, Division 5

The Opposite Is True

KIT Researchers Received the Erwin Schrödinger Prize

Interdisciplinarity and scientific excellence characterize the work of the Climate and Environment Center and they are also major criteria for awarding the Erwin Schrödinger Prize. This year, the team of Professor Klaus Butterbach-Bahl and Dr. Michael Dannenmann from the Atmospheric Environmental Research Division of the KIT Institute of Meteorology and Climate Research (IMK-IFU) were granted this renowned award. The prize was handed over at the Helmholtz Annual Meeting in mid-September.

The study made by Butterbach-Bahl's research team refuted the so far prevalent opinion of large-area grazing of steppe grass contributing to the constantly increasing nitrous oxide concentration in the atmosphere and, hence, to global warming. "The opposite is true," biologist Butterbach-Bahl says: "Grazing of steppes reduces the emission of nitrous oxide." The reason: When the grass is not fed by the animals, the soil emits nitrous oxide. "In this case, microorganisms decompose the biomass," Butterbach-Bahl explains. According to him, this effect is larger than that of grazing: "In winter, higher grass holds the snow much better," Butterbach-Bahl says. "When the humidity of the soil and microbial activity increase in spring, so does natural gas emission."

Idyll as a subject of research: How does grazing of steppe grass influence the climate? (Photo: Butterbach-Bahl)

Apart from the KIT researchers, also scientists from the Chinese Academy of Sciences, Forschungszentrum Jülich, and the Swiss Federal Laboratories for Materials Science and Technology, Zurich, were involved in the studies. "We were successful only, because we brought together biology, geography, atmosphere research, chemistry, and geoecology," Butterbach-Bahl points out. He plans to use the prize money granted by the Stifterverband to extend the study area to Africa: "So far, our research has focused on Asia. We still know far too little about trace gas flows and environmental changes in Africa."

KITcube – Cloud Research for Weather Forecast

The KIT Cube has passed its second test: From April to May this year, one of the most modern large-scale facilities for atmosphere research in Europe collected data on a measurement field near Forschungszentrum Jülich. The HOPE measurement campaign was part of the project HD(CP)² – "High Definition Clouds & Precipitation for Advancing Climate Prediction." This project is aimed at analyzing cloud and precipitation formation and improving the accuracy of weather and climate models.

The KITcube arrives at Jülich. (Photo: Wieser)

The KITcube is an observation system consisting of various instruments to experimentally study the atmosphere. Among these instruments are ground-based radars and lidars, dropsondes, and instruments to measure turbulence and various meteorological parameters. The instruments are synchronized by a central data processing system and allow for the exact measurement of the atmosphere in a cube of ten kilometers edge length.

During the measurement campaign of two months, KITcube collected a total of six terabytes of data. Researchers around Dr. Norbert Kalthoff, Dr. Andreas Wieser, and Dr. Katja Träumner from the Troposphere Research Division of the Institute of Meteorology and Climate Research (IMK-TRO) are particularly interested in the processes taking place in the atmospheric boundary layer one to two kilometers above the earth's surface. There, turbulences, i.e. random wind movements that are difficult to predict, occur very frequently.

"However, these wind fields contain ordered patterns, so-called coherent structures," Katja Träumner explains. "These structures are assumed to cause convection and to co-determine our weather." The data collected are compared with the forecasts based on established weather and climate models. In this way, model accuracy is improved. Apart from KIT, several German universities and institutes and international partners are involved in the project.

INTERNET:
www.kitcube.kit.edu
info@kitcube.kit.edu

CEDIM Researchers Prognosticate Earthquake Damage

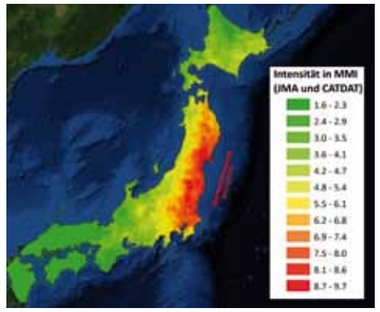
"Please call me again later. We have an earthquake!" The interview has to wait. James Daniell is very busy now, because the earth is quaking in Pakistan. For the scientist, this is a good opportunity to test his research in practice. Daniell and his colleagues at the Center for Disaster Management and Risk Reduction Technology (CEDIM) develop methods to directly prognosticate and analyze earthquake damage.

Even before it is reported by official authorities, the researchers become aware of the earthquake when the number of users on the website earthquake-report.com, a website for information on earthquakes and volcanoes, is increasing rapidly. Whenever an earthquake has happened, people in the region look for information on the internet, e.g. about its magnitude or the damage caused by it.

The scientists then start immediately to make their prognoses. How many dead and injured persons have to be expected? How strongly are buildings damaged and how long will the infrastructure be affected? "For this purpose, we combine a number of data in mathematical equations," James Daniell explains. "Among these data are the population density of the region, historical data about previous earthquakes, or the ranking of the country in the Human Development Index, a kind of prosperity indicator."

First eye witness accounts are evaluated and incorporated in the damage analysis. Statements of witnesses, such as "the earth shook" or "windows broke" help the researchers determine the intensity of the earthquake.

It is their long-term objective to quickly inform governments and relief organizations about the damage to be expected in case of an earthquake. The earthquake of Pakistan has confirmed that this approach works: Prognoses were in good agreement with the later damage reports.



In 2011, a severe seaquake occurred in the Pacific Ocean off the Japanese coast. The map shows its intensity in various areas of the region affected. (Map: Daniell)

INTERNET:
www.cedim.de/2232.php
www.gpi.kit.edu/NaturgefahrenUndRisiken.php
www.earthquake-report.com

Research for a Better Flood Management

CEDIM Estimates Potential Damage

For weeks, the one-hundred-year flood this summer has kept the people in suspense. While rescue forces still piled up sandbags in the disaster zone, scientists of the Center for Disaster Management and Risk Reduction Technology (CEDIM) already started an in-depth analysis of the disaster. "A few days before the first rivers burst the banks, we already knew what was to come," Bernhard Mühr says. The meteorologist constantly monitors the weather with respect to potential extreme events.

"Of course, it was impossible at that time to predict the extent." It is one of the major tasks of CEDIM scientists to estimate potential damage as rapidly as possible. First calculations then revealed that the consequences in certain regions would be worse than in others, although flood intensity was the same. "This is due to the variable resilience of the districts," Bijan Khazai explains. Resilience is the capability of a society to cope with the impacts of a natural disaster. It is influenced by a number of social and economic factors, such as the age structure and education of the population, the type of development or the medical capacity in a region.

Based on some factors that are rapidly available at the time of the flood, Khazai and his team determined a preliminary resilience index for individual districts. Then, they combined this index with current information on evacuation measures or traffic obstruction. „According to this preliminary evaluation, a high resilience apparently is accompanied by small flood impacts and vice versa." Presently, the researchers are identifying other resilience factors, among others, information on various precautionary measures in the districts or on the type of flood protection systems. In the end, these analyses are to contribute to identifying problem areas and improving flood protection.

The river Neckar near Reutlingen-Mittelstadt in early June: Cars have to stop. (Photo: Kaschuba)

INTERNET:
www.cedim.de/english/2408.php
www.wettergefahren-fruehwarnung.de/Ereignis/20130531_e.html

Top Grades for Atmosphere and Climate Research

"Superb" and "world class" – this is how the international reviewers assessed the scientific quality of the Atmosphere and Climate Programme (ATMO) at the end of the second funding phase. After the commission's funding recommendation, ATMO researchers will now start off into the third funding phase from 2014 to 2018 with a nearly doubled budget of more than EUR 40 million.

"The strategic further development of the programme was highly appreciated by the reviewers," spokesperson Professor Johannes Orphal says. "In the past years, we constantly sharpened our profile and can now claim leadership in atmosphere research worldwide."

ATMO is embedded in the Helmholtz Association's research field "Earth and Environment". The programme studies how the atmosphere changes as a result of natural processes and anthropogenic impacts. It is aimed at better understanding the role of the atmosphere in the climate system through observations and modeling. ATMO covers four research topics, all of which were ranked excellently by the commission chaired by Professor Dr. A. R. Ravishankara from the National Oceanic and Atmospheric Administration (NOAA), Boulder, USA.

Change processes in the atmosphere are the subject of research under the ATMO programme. (Photo: Orphal)

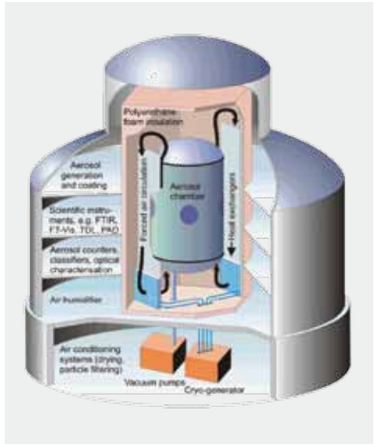
"It is the main objective of our research to make the society benefit from our findings, mainly by an improved forecast of regional climate changes. This approach met with a high acceptance." In the next funding phase, in-depth coverage of the research topics is planned rather than a refocus of the work. Studies will focus on the water cycle or on aerosols in the atmosphere. And according to the recommendation of the reviewers, coupling of atmosphere and oceans will be considered to a larger extent.

INTERNET:
www.helmholtz.de/en/research/earth_and_environment/atmosphere_and_climate

The Cloud Makers

Actually, making a cloud is no big deal. At least not, if an appropriate experiment chamber is available. Scientists working at the Atmospheric Aerosol Research Division of the Institute of Meteorology and Climate Research (IMK-AAF) can use such a chamber. In AIDA (Aerosol Interaction and Dynamics in the Atmosphere), the researchers can make clouds according to their wishes almost every day - a cloud in the morning, a cloud in the afternoon, that is what the usual program is like.

The key component of AIDA is a cloud chamber of nearly four meters height. It is accommodated in an overdimensioned refrigerator. In the chamber, the researchers can adjust temperature, air humidity, and air pressure and, thus, simulate various conditions of the earth's atmosphere. To make a cloud, they evacuate the chamber. Air pressure drops, water vapor condenses, fine mist develops, and then a cloud forms in the chamber.



Internal setup of the AIDA cloud chamber. (Photo: KIT)

Why? The scientists want to find out under which conditions clouds form, how they influence our weather, and which role they play in global climate change. Clouds are known to have a major influence on climate: They have a warming effect, because they prevent heat from being emitted from the Earth into space during the night. During the day, they have a cooling effect, as they reflect solar radiation. The predominating effect is determined by the height of the cloud.

From several levels, the researchers can control the conditions inside the cloud chamber. (Photo: KIT)

Many details have not yet been understood. For instance, how various aerosols – such as ashes, fine dust or pollen – influence cloud formation. Without these fine particles, water vapor can hardly condense and no clouds are formed. "We assume that climate change also changes the aerosols in the atmosphere," says Professor Thomas Leisner, the Head of the Institute. "For example, when more sand dust enters the atmosphere due to increased desertification."

To study potential effects on cloud formation and, hence, on the climate, the scientists prepare an aerosol mix in an antechamber and feed it into the cloud chamber. Then, they have half an hour to measure the cloud and to take samples.

The scientists are particularly interested in ice formation in the cloud. In our latitudes at least, raindrops result from very small ice crystals that are produced by freezing water vapor on the aerosol particles. However, an important aspect of ice formation is not yet understood: Not every aerosol initiates the freezing process: "We simply do not know why one particle is a good ice nucleus and another not," Leisner says. "Even when the particles are generated in the laboratory, only some of them will act as an ice nucleus, the order being ten particles out of a million."

For a longer look on the laboratory clouds in the future, the researchers plan to construct a new cloud chamber. It will be smaller, but have walls, the temperature of which can be varied. These walls will prevent the temperature in the chamber from rising and the cloud from clearing away too quickly.

INTERNET:
www.imk-aaf.kit.edu/73.php

Cloud formation also outside: AIDA in winter. (Photo: KIT)

(Photo: Braesicke)

Peter Braesicke

On September 01, Professor Peter Braesicke moved from the National Centre for Atmospheric Science (NCAS) of the University of Cambridge (Great Britain) to IMK-ASF, Karlsruhe. At the newly established Chair for Atmospheric Physics, he will study the relationship between physical and chemical processes of the earth's atmosphere and climate change. Meteorologist Braesicke among others is interested in how the composition of the air influences the climate. His scientific work mainly deals with the question how well modeling of atmospheric processes reproduces reality. Peter Braesicke is member of a number of bodies and heads the High Impact Events (HIE) Collaborative Programme of the European Climate Research Alliance (ECRA).

(Photo: Mengistu Tsidu)

Gizaw Mengistu Tsidu

Professor Gizaw Mengistu Tsidu from the University of Addis Ababa will conduct research at KIT's IMK-ASF in the next months. Cooperation between both research institutions started in 2009. Since then, the research group of the Ethiopian scientist, together with IMK, has been operating a ground-based Fourier transform infrared spectrometer in the central African country. It measures the concentration of ozone and greenhouse gases in the atmosphere. Due to its elevated location, Addis Ababa is suited well for studying atmospheric processes in the tropics. Mengistu Tsidu will evaluate measured spectra in Karlsruhe and compare the results with model calculations. Within his Georg Forster research grant, he will stay in Karlsruhe for 18 months.

Awards

In early September, **Professor Herbert Fischer** was granted the 2013 Johannes Georgi Prize for his pioneer work in atmosphere research. The prize granted by the GeoUnion Alfred Wegener Foundation is the highest German geosciences award. Herbert Fischer, former Head of the KIT Institute of Meteorology and Climate Research (IMK), is considered one of the pioneers of remote sensing of atmospheric trace gases. They affect the earth's radiation budget and, hence, the climate and the ozone layer. "His enormous perseverance and high commitment for more than four decades have contributed decisively to the high level and worldwide visibility of our discipline," said Professor Johannes Orphal, scientific spokesperson of the KIT Climate and Environment Center, in his laudation.

Herbert Fischer received the Johannes-Georgi-Award 2013 (Photo: KIT)

The Head of the WWF Institute for Floodplains Ecology, Ratatt, **Professor Emil Dister**, received the 2013 Honorary German Nature Protection Award. It is to acknowledge his long and persistent work for the protection of rivers and floodplains in Germany. Since 1985, Dister has been heading the WWF Institute for Floodplains Ecology in Rastatt, which has been part of Karlsruhe University and, hence, of today's KIT since 2004. For years, Dister has not only been studying how sound floodplain ecosystems work. His work also focuses on the practical applicability of such findings to flood protection. By rerouting levees and the establishment of polders, rivers are to be given more space so as to reduce flood peaks and extend floodplain biotopes.

Giovanni Banfi from the KIT Institute for Water and River Basin Management (IWG), Chair of Water Resource Management, was granted the Hanns Voith Foundation Prize in the category of "Hydropower" for his diploma thesis. Banfi developed a hydropowered water pumping system for the city of Yogyakarta on Java, which is tailored to the local needs and equipped with wooden feed pipes. As a doctoral student, Banfi will also be involved in the next project of IWG in Vietnam.

KIT Climate and Environment Center

Scientific Spokesperson:	Prof. Dr. Johannes Orphal
Dep. Scientific Spokesperson:	Prof. Dr. Thomas Neumann
Spokesperson Topic 1:	**Atmospheric processes:** Prof. Thomas Leisner
Spokesperson Topic 2:	**Water resources and water management:** Prof. Franz Nestmann
Spokesperson Topic 3:	**Subsurface processes:** Prof. Thomas Neumann
Spokesperson Topic 4:	**Technology-induced material flows:** Dr. Rainer Schuhmann
Spokesperson Topic 5:	**Urban processes:** PD Dr. Stefan Norra
Spokesperson Topic 6:	**Risk and risk management:** Prof. Friedemann Wenzel
Spokesperson Topic 7:	**Climate change:** Prof. HaPe Schmid

Climate and Environment: Looking Properly – and for an Extended Period of Time!

In ecosystems and climate research in particular, perspectives extending over several years are important to verify scientific hypotheses. By Professor Hans Peter Schmid.

Measurement tower in the forest: In a number of forests in the Northern hemisphere, scientists studied how vegetation reacts to climate changes. (Photo: Schmid)

Science means gaining knowledge with uncertainty. We researchers generate hypotheses and correct them later on, either on our own or our colleagues do this work. The public rarely perceives this constant questioning and critical assessment of uncertainty of scientific statements. The climate system and in particular the atmosphere, ecosystems, and water are regulated by a multitude of "drivers" and "set screws". Their number appears immeasurable and, hence, cannot be understood by individual scientists at certain places or times. To understand the overall picture, we all together, at many places and over a long period of time, have to constantly monitor numerous variables, systematically analyze them, and integrate them into models. Thanks to modern measurement technology, data processing, and computers, we have meanwhile reached a degree of complexity we did not even dream of twenty years ago.

However, growing complexity inevitably results in the media, citizens, and politicians often receiving a distorted picture of our research results only, often reduced to headlines. The necessity of having to check the results over several years is no longer worth a word and also neglected when funding research. A fatal contradiction results: Research is gaining complexity, while its persistence is decreasing.

In cooperation with colleagues from Harvard University, Ohio State University, and Indiana University as well as from the USDA Forest Service, scientists from the Atmospheric Environmental Research Division of the Institute of Meteorology and Climate Research (IMK-IFU) have succeeded in correcting a long established doctrine in ecosystems research, thanks to long-term research. Increasing carbon dioxide (CO_2) concentration in the atmosphere was assumed to lead to an increase in the efficiency of photosynthesis of plants, binding carbon from the atmosphere, and biomass production. By means of this mechanism, land ecosystems reduce global CO_2 increase. However, we found that the principle "increasing CO_2 concentration leads to higher biomass productivity" is much too simple.

A key parameter in this complex is water use efficiency: During photosynthesis, plants bind CO_2 from the atmosphere. While they take up CO_2 via the open stomata of their leaves, water vapor is released. The ratio between transpired water and bound carbon is water use efficiency. It is the major indicator of the functioning of the ecosystem and plays a key role in the global cycles of matter.

We compared measurements of water use efficiency in a number of forests in the northern hemisphere. The result: In the past two decades, water use efficiency increased more strongly than expected. We succeeded in demonstrating that this is due to the fertilizing effect of CO_2: When the concentration of CO_2 in the atmosphere increases, the leaves partly close their stomata in order to keep the CO_2 concentration inside largely constant. As a result, less water vapor is released from the leaves at the same photosynthesis rate. Water use efficiency of the forest ecosystem increases. Hence, forests can adapt to changes of the environment and save water. On the other hand, forests are among the most important sources of humidity for the atmosphere. Saving water therefore promotes the aridity tendency that accompanies global warming. This may cause considerable problems to sensitive ecosystems. If the aridity tendency continues to persist, high adaptivity of the forests may turn into a global problem.

This finding was possible only, because we were able to use measurement series extending over decades. Verification of our hypotheses will now require data to be collected in the years to come. This is the only way to obtain a realistic picture of the complexity of interactions between the climate and ecosystems.

What do we need for this purpose? Funding programs that are of long-term character. Funding programs that are evaluated regularly, but extend over a period of 30 to 40 years. Persistent research – for us to persist on earth.

About Earthquake Damage and Watercourses

On July 27, 2013, the first annual meeting of the KIT Climate and Environment Center took place. During this meeting, the Sparkasse Environmental Award and the first GRACE certificates were handed over. The about 100 guests listened to excellent presentations by Dr. Schleicher about her Ph. D. thesis and by Mrs. Walz and Mr. Selbmann about their diploma thesis. Then, Professor Wenzel and Professor Nestmann presented selected aspects of the work of the KIT Climate and Environment Center. The official part of the meeting was completed by Professor Hinz handing over the certificates of the GRACE graduate school. The following reception was sponsored by Sparkasse Karlsruhe Ettlingen.

EMAC Symposium at KIT

About 60 German and international participants joined the annual EMAC symposium that took place from June 12 to 14 at KIT this year. It was organized jointly by the Institute of Meteorology and Climate Research (IMK) and the Steinbuch Centre for Computing (SCC).

By more than 30 scientific presentations, the participants were informed about model development and concrete scientific application of the EMAC (ECHAM5/MESSy Atmospheric Chemistry) global chemistry climate model operated in IMK's and SCC's Climate and Environment Simulation Lab. EMAC is used to simulate the global atmosphere from the ground to a height of 80 km in order to study climate-relevant processes in the troposphere, stratosphere, and mesosphere.

EFFEKTE 2013 Science Festival

Within the framework of EFFEKTE, the KIT Climate and Environment Center, together with the South German Climate Office, presented examples of its research in the areas of atmospheric sounding, novel remote sounding instruments, and AERO-TRAM to the curious and interested citizens of Karlsruhe.

2013 KIT Environment Lecture

Professor Kinzelbach (ETH Zurich) at the KIT Environment Lecture in June 2013. (Photo: Drollinger)

On June 13, 2013, Professor Wolfgang Kinzelbach from Zurich spoke about water as the critical resource of the 21st century to about 160 listeners at the Gartensaal of Karlsruhe castle. He pointed out that water is a critical resource, as it cannot be reproduced (supply), while the population is growing and our living standard increases (demand). The gap between supply and demand is still increasing under the framework conditions of climate change and technical development. Although climate plays the decisive role in some regions of the earth, Kinzelbach believes that the problem can be solved by need management, i.e. more effective and more sensitive use of the resource of water.

New Precipitation Radar

Polarimetry Yields Additional Measured Values to Describe Precipitation

After 20 years of permanent operation, IMK-TRO renewed its C-band radar on the roof of the institute building in June this year. In addition to the parameters measured so far, the new instrument can also detect how polarization properties of radiation are changed by reflection on precipitation particles. This allows e.g. water droplets to be distinguished from hailstones. The scientists hope to increase the accuracy of the estimated precipitation rate.

IAGOS European Infrastructure

The German Council of Science and Humanities evaluated eight European infrastructures for research in engineering, nature, medicine, biology, and the environment until April 29, 2013. IAGOS (In-service Aircraft for a Global Observing System) was given the second best rating. Now, its setup will be supported by the BMBF and the EU. Up to twenty airliners of various companies will be equipped with instruments to measure trace gases, clouds, and aerosol parameters. One of the two partial projects (IAGOS-CARIBIC) will be coordinated by KIT's Institute of Meteorology and Climate Research (IMK) from 2015.

IAGOS-CARIBIC A340-600 of Lufthansa with air inlet system (left) and laboratory of 1.6 t in weight (bottom right), which is installed into the cargo compartment for automatic measurements during four flights per month. (Photos: Kröner/Lufthansa AG (left), Lufthansa AG (top right), MPI for Chemistry (bottom right))

Successful Doctoral Students of GRACE

Invitation to Seminar

Professor Stefan Hinz hands over the certificate to this year's GRACE graduates. (Photo: Westermann)

Another six graduates successfully completed the GRACE Graduate School: Bishawjit Mallick from the Institute of Regional Science and the Institute of Urban and Spatial Planning, Yuefei Zeng from the Institute of Meteorology and Climate Research (IMK), and Wolfgang Woiwoide also from the IMK were handed over their final certificates by GRACE spokesperson Stefan Hinz in late July.

GRACE graduate Bishawjit Mallick. (Photo: Westermann)

Three graduates were not able to take part in the certificates ceremony for rather pleasant reasons: Dr. rer.nat. Annika Bork-Unkelbach is on maternity leave. Dr.-Ing. Hermann Bähr started work at Shell, Groningen (the Netherlands), and Dr.-Ing. Antje Thiele spent several months for research at the University of Alaska, Fairbanks. Congratulations to all graduates!

The still active doctoral students at GRACE are cordially invited to participate in a seminar on sustainable development in November. The seminar will be directed by Professor Mohan Munasinghe, who has been working as an advisor of international organizations and political institutions for more than 40 years now. Munasinghe was Vice President of the IPCC (International Panel on Climate Change) that shared the 2007 Nobel Prize for Peace with the former Vice President of the United States of America, Al Gore.

The seminar "Sustainable Development, Consumption, Production, and Climate Change" will start on November 5 with a public lecture by Prof. Munashinghe, which will focus on his vast experience in the area of sustainability and environmental protection. Thematic workshops will follow on November 7 and 14. The former will focus on energy, the latter on sustainability in education. From November 6 to 15, daily lectures will be organized for students only. The seminar will take place at TU Darmstadt.

Professor Munasinghe (Photo: Munasinghe)

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www.lehre-interdisziplinaer.tu-darmstadt.de

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