Karlsruhe Institute of Technology

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CLIMATE AND ENVIRONMENT news

Newsletter of the KIT Climate and Environment Center

Editorial

It may be called a sensation: In December at the World Climate Conference in Paris, 195 countries agreed on the 2° C limit of global warming. They even envisage the 1.5° C target. Almut Arneth of the Atmospheric Environmental Research Division of the KIT Institute of Meteorology and Climate Research attended the conference in Paris. In her article in this newsletter, she points out that now much research will be required to reach this objective.

KIT is prepared well to make a significant contribution. The new umbrella strategy "KIT 2025" clearly shows that KIT's excellent research in the society's fields of demand of energy, mobility, and information can contribute to reaching the climate objectives. These activities have to be closely coordinated with the environmental research activities pursued by our KIT Climate and Environment Center. It is a central component of research at KIT for the benefit of the society and environment.

Prof. Dr. Oliver Kraft
Vice President for Research

The CAOS DFG-funded Research Group – CAtchments as Organized Systems

Opening the Hydrological Black Box

Erwin Zehe compares water catchments with the human body: "Water catchments drink, sweat, and discharge water. They have a cycle with underground 'veins and 'arteries' and a 'liver' for detoxification. However, interaction of physiology and the functions of terrestrial systems still is hardly understood".

"We mostly treat hydrological problems like a physician, who knows neither the physiology of the patient nor the function of the organs," the holder of the Chair for Hydrology of KIT and spokesman of the research group "CAOS" (CAtchments as Organized Systems) says. "Like urologists, we analyze water and mass flows entering and leaving the catchment area. Internal processes remain a black box." One of the big unknowns is biotic impact: Vegetation controls 60% of the terrestrial water balance in humid areas. Earthworm channels play a key role in water and mass transport. The second big unknown is the feedback between water and energy flows and the structure and morphology of environmental systems." Prognosis of impacts of change, hence, equals the solution of an equation with two unknowns. There is no single solution."

The "Attert" catchment is the CAOS model region.
(Photo: Malte Neuper)

Under the CAOS German-Luxembourg DFG-funded research group, hydrologists, meteorologists, geophysicists, geoecologists, and soil scientists have been cooperating for four years now to eliminate the above unknowns. As a key to solving the problem, the researchers test the idea of an environmental system representing a (thermodynamically) optimum adaption to its history. Methodologically, they search for an optimum combination of observation methods to quantify the interaction between "physiology" and "function" of catchments areas with a minimum expenditure. CAOS also focuses on the development of a "perfect" prognosis model that links the necessary complexity with maximum simplicity, to paraphrase de Saint Exupéry.

Long-term Goal: Clean Drinking Water for the Taihu Region

A surface water sample reveals the concentration of algae. (Photo: Stefan Norra)

Lake Taihu is the third biggest freshwater lake in China. It is the drinking water source for about ten million people in the region and one of the most highly polluted water bodies in China. Wastewater flows from several cities with over one million inhabitants each enter the lake uncleaned or insufficiently cleaned together with fertilizers and pollutants from agriculture and industry.

This repeatedly causes strong growth of blue and green algae. "Dense carpets of algae color the lake green and unpleasant odors may develop," Stefan Norra, Head of the Environmental Mineralogy and Environmental Systems Analysis Group of the KIT Institute of Applied Geosciences, describes the situation. "As blue algae in particular may form toxic substances, secure drinking water supply of the population cannot be guaranteed under these circumstances."

Together with geoecologist Andreas Holbach, Stefan Norra develops multiple sensor-supported in-situ and online methods for monitoring water dynamics under a BMBF-funded project. It is their goal to make available technologies that might be used as a basis for improving water quality and for developing early warning systems. DYNAQUA is part of the SIGN (SIno-German Water Supply Network) project. In cooperation with the companies of ADM and bbe Moldaenke, the researchers plan to upgrade an existing towed underwater multi-sensor system with a blue algae sensor to characterize algae blooms in more detail. In addition, they develop a buoy for measuring a number of water parameters in the different strata of the lake.

On a sensor platform coupled to an elevator system, temperature, age, radiation intensity, and turbidity of water are measured among others. A newly developed algae sensor detects five different alga classes. In addition, the buoy is equipped with a weather station. "We want to develop and establish an early warning system that informs the water supply companies about algae pollution in due time," Norra says. In spring 2016, the buoy will be installed in the northern part of the lake. Later on, the results will be used to develop a monitoring concept for the complete lake.

MORE INFORMATION:
www.water-sign.de
www.img.kit.edu/3952_4129.php

CARIBIC – Atmosphere Research in a Passenger Aircraft

The idea is appealingly simple: Thousands of passenger airplanes fly around the globe every day. Why not use them for scientific measurements of the atmosphere? For nearly twenty years now, scientists of various research institutions in Germany and abroad have turned this idea into reality under the CARIBIC (Civil Aircraft for the Regular Investigation of the Atmosphere Based on an Instrumented Container) project. The project is coordinated by Andreas Zahn of the Atmospheric Trace Gases and Remote Sensing Division of the Institute of Meteorology and Climate Research.

Via an inlet system, air and aerosol samples are taken during the flight.
(Photo: Stefan Weber)

Once per month, a team of KIT researchers stows a measurement laboratory of several tons in weight in the cargo compartment of a Lufthansa Airbus with more than 300 passengers. This laboratory accommodates a total of 16 instruments that take air and aerosol samples via an inlet system and analyze some of these samples directly on board of the plane. Another six instruments are planned to be installed in the near future. In total, about 100 different parameters can be determined at flight altitude.

The researchers want to study the variety of physical and chemical processes in the atmosphere, which influence our weather and climate. For this purpose, they measure all climate-relevant greenhouse gases, a number of reactive trace gases, or aerosol particles. "From the flight schedules of Lufthansa, we select routes that appear to be of interest to cover special scientific problems," Andreas Zahn explains. "Flights to Japan, for instance, enable us to study the influence of large-area steppe fires in Siberia on atmosphere chemistry. When flying to South America and China, we can analyze the exhaust gas plumes of big conurbations."

The advantage of aircraft measurements is that they are more precise and more detailed than satellite measurements. Moreover, most of the processes responsible for the greenhouse effect take place at the flight altitude between ten and twelve kilometers. Last year, CARIBIC researchers reported in the Nature Communications journal that many aerosol particles emitted by volcano eruptions "remain stuck" at this altitude. "The radiation effect of these stratospheric particles is twice as high as assumed in the past," Zahn says.

MORE INFORMATION:
www.imk-asf.kit.edu/english/1443.php
www.caribic-atmospheric.com

ScaleX: Measurement Campaign Goes into Second Round

Mountain regions, such as the Alps, are characterized by a pronounced relief, diverse soil types, variable vegetation, and variable land use. In such complex landscapes, environmental and climate researchers face many challenges: "In mountain regions, measurement and modeling of precipitation, water discharge, mass and energy transfer are more difficult," Benjamin Wolf of KIT's IMK-IFU explains. "But also in complex landscapes, we need models to make e.g. flood forecasts or to better estimate the impacts of climate change."

Wolf coordinates the ScaleX campaign at the TERENO Bavarian Alps/Pre-Alpine Observatory. It is to contribute to reducing model uncertainties and improving measurements of energy and mass flows in complex terrain. "For this purpose, we combine point measurements on the terrain surface with measurements in the air and data collected by remote sensing methods," Wolf says. "ScaleX is carried out by scientists of IMK-TRO, the institutes IGUA and ISSE of Augsburg University, the German Aerospace Center, the German Weather Service, the Helmholtz Center for Environmental Research in Leipzig, and the European Academy of Bozen/Bolzano. They work on five packages covering various aspects of research."

During the first project phase in 2015, the scientists of the German Weather Service determined precipitation by remote radar measurements. In addition, the scientists used classical methods, such as measurement pots, to measure precipitation on the ground. "By combining these data, spatial distribution of precipitation can be acquired much better, which then allows for more precise forecasts of flood events," Wolf says.

A team of Augsburg University even used a swarm of drones to measure vertical profiles of temperature and humidity in the air. Other researchers studied the impact of typical circulation patterns in the lower atmosphere on measurements of energy and mass flows. In 2016, the second phase the ScaleX campaign started. Interested institutions and scientists are cordially invited to take part. Contact: benjamin.wolf@kit.edu

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

Where to Go after the Earthquake?

CEDIM Researchers Study Shelter and Protection Options for the People after the Nepal Earthquake

About 900,000 houses were destroyed by the disastrous earthquakes of April and May 2015. As a result, about 2.3 million people lost their homes and had to seek for emergency sheltering. Some went to designated camps, others built makeshift, self-administrated shelters on squares and other free areas. Which factors did them make seek for the one or the other type of shelter? Which groups are particularly threatened by long-term homelessness? And which information needs do these people have in the camps after such a disaster?

To answer these and other questions, a team of scientists headed by Bijan Khazai for the Center of Disaster Management and Risk Reduction Technology (CEDIM) traveled to the Kathmandu valley six weeks after the earthquake. The researchers asked people from 284 households at 177 places. "Many people did not go to the big camps, but built makeshift camps near their friends, relatives, and own houses," Khazai reports one result of the survey. "Many people considered insufficient protection against storms and rain the biggest problem. Supply of these scattered camps was a big challenge for the municipalities." The survey also revealed that many respondents felt insufficiently informed and would like to have information on how to build their houses earthquake-resistant, for instance.

People seeking for emergency sheltering in tents near Dhading Besi. (Photo: Johannes Anhorn)

The researchers plan to use the results of their survey to adapt the existing disaster management plan, such that the needs of the people are taken into account much better.

In April 2016, the researchers will present their results at the International Conference on Earthquake Engineering and Post Disaster Reconstruction Planning in Nepal. Another study is planned to be carried out in the region to analyze the long-term impacts of the earthquake on the people.

MORE INFORMATION:
www.cedim.de/2624.php

DIARS Research Project: Aircraft-based Ecology

Plants hardly make it to cover pages of newspapers. Giant hogweed, Himalayan balsam, or Japanese knotweed, however, occasionally manage to do so. They are so-called invasive plant species: Coming from remote parts of the world, they have settled in Europe. In some regions, they can spread strongly. If habitats are changed significantly or if the plant causes risks to human health, such as ragweed or giant hogweed, the immigrant plants are sure to catch attention.

"But often, we do not know exactly what happens and which reasons and ecological impacts the spreading of these neophytes has," Michael Ewald, geoecologist and doctoral student of the group headed by Professor Sebastian Schmidtlein of KIT's Institute of Geography and Geoecology (IfGG), says. "Using new remote sensing approaches, I help improve knowledge."

The project is part of the DIARS (Detection of Invasive plant species and Assessment of their impact on ecosystem properties through Remote Sensing) collaboration. Apart from the working group of KIT, the University of Erlangen and partners from Italy, France, Belgium, and the USA (Stanford) participate. The project is funded by the European BiodivERsA network. Cooperation is to put the knowledge on invasive plant species on a broader basis.

For this, Michael Ewald combines field work with the evaluation of spatially and spectrally highly resolved remote sensing data measured by aircraft in summer 2014. He uses hyperspectral images and laser scanning data. "With the laser scanning data, we can exactly determine the height of vegetation, the density of foliage, and the plant biomass," Ewald says. "Hyperspectral remote sensing data allow conclusions to be drawn with respect to the nutrient content of leaves, composition of species communities, and their photosynthetic activity."

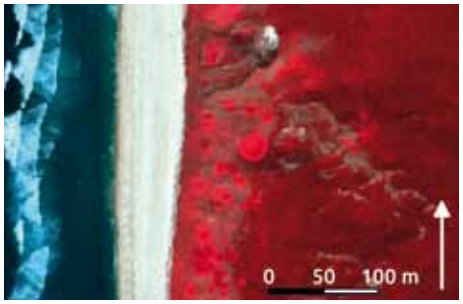
Moss species Campylopsus introflexus on Sylt. (Photo: M. Ewald)

Forest of Compiègne with Prunus serotina in the undergrowth. (Photo: M. Ewald)

However, the geoecologist needs measurement data from nature which he relates to the remote sensing data. "I study different habitats, in which neophytes spread, such as sand dunes on the island of Sylt or the forest of Compiègne in France." On the island in the North Sea, it is the inconspicuous moss species Campylopsus introflexus that has made it from the southern hemisphere to Europe and North America. It forms carpet-like cushions on open sand areas and is suspected to displace other species and to fundamentally change the habitat.

"In our investigation area in France, forest vegetation is strongly influenced by the black cherry Prunus serotina," Michael Ewald adds. "The species was originally planted in hedges and used as a soil conditioner in forestry. Today, it spreads in mixed forests and has a strong influence on the plants of the shrub and herb layer and, above all, on natural rejuvenation of forestry-relevant species."

On the test areas at Sylt and Compiègne, Ewald collected detailed data on the status of vegetation and habitat. "I systematically relate these data to the remote sensing data," Ewald says. "With the help of remote sensing, I generate maps of as many ecosystem properties as possible. These properties can then be related to the spatial spreading of neophytes and I can find out how they influence their environment. It is also possible to quantify the impacts. The results will be used to better assess the spreading of invasive plant species."



Infrared representation of the coast area of Sylt. (Photo: M. Ewald)

(Photo: Private)

Armin Zeh

Professor Armin Zeh has been heading the Petrology Group of the Institute of Applied Geosciences since September last year. His work focuses on the development of the Earth's crust and deposit formation. The 50 year old geologist in particular studies fluid-rock interactions. This research area that has many interfaces to geothermal energy use gives Zeh the opportunity to push applied petrology at the institute. After his doctorate at the University of Greifswald and work at the University of Würzburg and the Freie Universität Berlin, Armin Zeh was member of the staff of the Mineralogical Institute of the University of Frankfurt before he came to KIT.

(Photo: Private)

Andreas Braun

In May 2015, geoecologist Professor Andreas Ch. Braun was appointed Junior Professor for Risk-oriented Regional Development at the Institute of Regional Science of KIT. Taking into account aspects of economics, social and natural sciences, the 33 year old scientist studies perspectives of developments of society in particular in countries of Latin America. His research interest is guided by the question of how social vulnerability, i.e. vulnerability of man to natural disasters or unfavorable economic and social processes can be reduced. In higher education, Andreas Braun, who studied in Karlsruhe and was conferred his doctorate by KIT, among others develops and supervises a German-Chilean cross-border master's program.

(Photo: Private)

Aman Kidanemariam

Dr. Aman Kidanemariam of the Computation Fluid Mechanics Group of the Institute for Hydromechanics is winner of the Ercoftac da Vinci Award 2015 of the European Research Community on Flow, Turbulence, and Combustion (Ercoftac). The 35 year old scientist was awarded this renowned prize by the Community for his doctoral thesis.

Under the heading "Pattern formation in subaqueous sediment", Kidanemariam studied hydromechanical mechanisms underlying aquatic dune formation and, hence, contributed to the technical understanding of this phenomenon.

"With the help of massively parallel computer systems, we made high-resolution numerical simulations of the movement of individual sediment grains and of water flow under various conditions," Kidanemariam explains. "This has never been done before with this level of detailing."

Analysis of the formation and dynamics of dunes and prognosis of their properties are of high significance to a number of environmental technology problems. Dunes, for instance, change flow properties of water bodies, such as bed-load discharge and water bed roughness. Dunes also affect navigability of rivers and function of hydro engineering facilities in the river.

The Ercoftac da Vinci Award is granted annually to outstanding young scientists in the areas of fluid mechanics, turbulence research, and combustion. The five finalists selected presented their work in October last year at Vinci in Italy. Kidanemariam convinced the Ercoftac jury and won the prize in the amount of EUR 1,000.

In 2008, 35 year old Kidanemariam came to KIT from Eritrea with a scholarship of the German Academic Exchange Service DAAD. While attending the international master's program of resource engineering, he established contacts to the Institute for Hydromechanics, where he started to work on his doctoral thesis in 2011. Presently, he is continuing his studies of fluid mechanics as a member of the scientific staff of the institute. Kidanemariam is married and father of a little daughter.

KIT Climate and Environment Center

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Deputy Scientific Spokesperson:	Professor Dr. Thomas Leisner
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Spokesperson of Topic 4:	**Ecosystems:** Professor Dr. Hans Peter Schmid
Spokesperson of Topic 5:	**Urban Systems and Material Flow Management:** Professor Dr. Stefan Emeis
Spokesperson of Topic 6:	**Natural Hazards and Risk Management:** PD Dr. Michael Kunz

Climate Research: A Social Obligation of Us as Scientists

by Prof. Dr. Almut Arneth

The most important big event of the past year for the atmosphere of the earth was the UN Climate Conference at Paris, COP21. In December, heads and delegates of 195 states met to discuss the future of the earth's climate. In addition, a number of stakeholders and scientists attended. I also had the opportunity to travel to the COP21. At two information events, I presented findings obtained by environmental science in the past years with respect to the interaction of atmosphere and biosphere.

The result of the conference is known: On December 12, the states agreed on limiting global warming to less than 2°C, if possible, even to 1.5°C. This is a big success: At last, all states have acknowledged that we have to do something. At last, the will to cooperate appears to be stronger than the necessity of denying facts or blaming others. This breakthrough was celebrated rightly, and I am personally very happy that the earth's climate as we know it today and, hence, our future is given another chance.

For me as a scientist and certainly for many other citizens, however, a number of questions arise from the result of this conference. Questions regarding the feasibility of the two-degree limit, the binding force of decisions, and the verifiability of measures. Questions regarding the role of science in the implementation process. And not least, the precise question as to how we at KIT can contribute to the resulting tasks.

First, the two-degree target: Also from the scientific perspective, it is desirable. But this should not make us too euphoric. The target is extremely ambitious and its feasibility appears to be questionable at first glance. Most models assuming a limitation of global warming to 2°C also postulate the use of technologies for CO_2 removal from exhaust gases and from the atmosphere and/or geoengineering processes. These are still far away from practice or are very critically evaluated by the public.

An important element in this connection is the combination of enhanced use of bioenergy and geological storage of carbon dioxide. The hope is to reach a negative CO_2 balance in the long term. Consumption of fossil fuels will be reduced considerably. As bioenergy plants take up CO_2 from the atmosphere during growth, atmospheric CO_2 is bound in the long term, provided that the CO_2 of the plants is separated from exhaust gases during combustion and stored. Still, it may be doubted whether this is technically and economically feasible and whether the population will accept CO_2 deposits in their vicinity. And where are the areas for the cultivation of energy plants? Conflicts with food supply of a growing global population and nature protection are inevitable.

Professor Dr. Almut Arneth at the COP21 World Climate Conference in Paris. (Photo: IISD) (www.iisd.ca/climate/cop21/enbots/9dec.html)

Nevertheless, we cannot afford to be pessimistic, pessimism is not adequate. I place my hope in the many grass root actors, who take climate protection very seriously. Here, I mainly think of companies and cities. Technology-oriented companies increasingly discover the opportunities associated with a transformation of industry towards the use of regenerative energy sources. In cooperation with science, new technological options will be developed, which are not yet considered by model calculations. Cities work hard to reduce their CO_2 emission. Often, they are mentally and conceptually further ahead than national politics. Here, a lot will be achieved.

Another opportunity lies in the cooperation of science and the public. Presently, national projects to reduce greenhouse gases are of voluntary character. Even if they are implemented fully, we will not reach climate warming by 2°C, but by even 3 or 4°C. Hence, objectives have to be tightened. It is the role of science to continuously accompany the process, to collect facts, and to make them available to the public. For this, we have to communicate understandably and to go where we are heard. For example, to information events in the course of climate conferences or to advising politics and to citizens conferences. Then, I see a chance of increasing public pressure. The declarations of intent of COP21 will then produce their own momentum and force politics to act.

And also we have to act, here on the spot. At KIT, we have considerable know-how in the area of earth systems research as well as in energy research. If we bring this together and link it with the relevant social and economic sciences, then KIT may position itself as a heavyweight in climate change and climate change assessment research. We have the potential to do so, and the social obligation.

Groundwater – Man – Ecosystems

The 25th Meeting of the Hydrogeology Section of DGGV will take place at KIT from April 13 – 17, 2016. This year's meeting will focus on one of the biggest challenges of mankind: Making the use of water for energy and food supply under the conditions of global change compatible with the preservation of ecosystems.

Various aspects of this interesting topic will be discussed in 14 sessions. In addition, keynote and evening lectures as well as excursions will be offered.

CEDIM to Be Continued at KIT

The Presidential Committee of KIT has decided to assume sole responsibility for the KIT Center for Disaster Management and Risk Reduction Technology (CEDIM) from January 2016. In the past, the Center was run jointly by the German Research Center for Geosciences (GFZ) and KIT.

This decision became necessary, as GFZ left the cooperation on December 31, 2015.

KIT Coordinates Water Research Network in Baden-Württemberg

The network was established on the initiative of the Baden-Württemberg Ministry of Science, Research, and the Arts (MWK) and is supported by a structural funding program. The Water Research Network is aimed at enhancing interdisciplinary networking of the many activities pursued in this area at different locations in Baden-Württemberg.

As a central program element, three interdisciplinary research collaborations of several universities in Baden-Württemberg are funded. In addition, funds will be provided for networking workshops in order to develop long-term perspectives in water research. The office of the network was established at KIT, spokesperson for the first three years is Professor Harald Horn (Engler-Bunte Institute, Water Chemistry and Water Technology).

MORE INFORMATION:
www.wassernetzwerk-bw.de/english/index.php

WASSERNETZWERK
BADEN-WÜRTTEMBERG

The Role of Oceans in Climate Change

Professor Mojib Latif of Geomar, Helmholtz Centre for Ocean Research, Kiel, inspired about 400 listeners by his descriptive and thrilling KIT 2015 Climate Lecture on the role of oceans in climate change. Understanding climate change without considering oceans is impossible, Latif said.

Professor Latif speaking about oceans and climate change.

During the past 40 years, oceans took up about 90% of the heat generated in the atmosphere as a result of the increased concentration of greenhouse gases. In addition to ice melting, this is an important reason why the sea level has risen. Apart from heat, oceans also take up CO_2, which results in their acidification. Changes of ocean flows lead to regional differences in climate development.

Professor Kottmeier, Professor Latif, and Professor Löhe at the KIT 2015 Climate Lecture.

Vaisala Award for Radiosonde Measurements above West Africa

Hand-over of the Vaisala Award on May 20, 2015 in London at the Royal Meteorological Society (RMetS); from left to right: Professor Doug Parker, University of Leeds; the Chairperson of the Royal Meteorological Society, Dr. Liz Bentley; Professor Andreas Fink, KIT, Karlsruhe.

We congratulate Professor Andreas Fink of the Institute of Meteorology and Climate Research (Troposphere Research Division) and the AMMA radiosonde team on the 2014 Vaisala Award granted by the World Meteorology Organization (WMO). Professor Fink and his colleagues Professor Doug Parker and Dr. Serge Janicot succeeded in compiling a unique dataset of meteorological parameters during a measurement campaign of several months. Based on this dataset, the upper atmosphere over Africa can be studied. While compiling the data, scientific, organizational, and logistic interaction of several weather services of West Africa and supranational organizations represented a big challenge.

GRACE Studies Urban Climate

During the interim evaluation in September, GRACE doctoral students presented their work. (Photo: Andreas Schenk)

GRACE wishes to enhance internationality of the graduate school and to establish a new cluster to attract doctoral students from abroad. The cluster starting in 2016 will focus on "Urban Climate and Urban Environmental Research." Interested institutes were invited to propose projects until March 01, 2016. One of the funding conditions: At least one of two doctoral students funded per project has to come from a university abroad.

The cluster is intended to scientifically fill with life an already existing KIT-coordinated Helmholtz research initiative. "This objective is combined with the wish of making GRACE more international in the future," Andreas Schenk, scientific coordinator of the graduate school, explains. "This was proposed by experts participating in the recent interim evaluation of the program for the remaining funding phase until mid-2017."

In the course of the interim evaluation in September, GRACE doctoral students presented their projects and answered the questions of the experts. Professors and doctoral students of the KIT Climate and Environment Center demonstrated their wide support of the graduate school. They pointed out that GRACE is needed and fills gaps in funding doctoral students.

The experts were impressed by the consolidation concept presented. "In the transition phase after the expiry of current funding by the Helmholtz Association, we will be able to draw on reserves first. Then, we will gradually open up other funding sources," Schenk explains. In this way, the graduate school will remain a reliable institution for doctoral students and the institutes of the KIT Climate and Environment Center even beyond its scheduled duration.

West Africa: Impacts of Air Pollution

In the next decades, the climate in West Africa will change, mainly due to global warming and a changed land use. Researchers in the team of Peter Knippertz of IMK-TRO now warn that increasing air pollution is not or not sufficiently considered in present climate models for the region.

"In the past years, emission of aerosols from households, transport, and industry increased rapidly," Peter Knippertz explains. "This mainly applies to the quickly growing cities along the coast of Guinea." The impacts on the climate are still unclear: Many of the underlying processes are far from being understood well. "We urgently need more research in this area. Continuous weather observation is lacking as are measurement campaigns with high-tech instruments, such as lasers and radars."

Such a measurement campaign is now planned by an international team of researchers headed by Peter Knippertz for June/July 2016. It will be part of the EU-funded project DACCIWA (Dynamics-Aerosol-Chemistry-Cloud Interactions over West Africa). "Improved process understanding is needed to develop strategies for mitigating the expected impact of climate change in cooperation with African partners."

Publication:
Peter Knippertz et al.: The possible role of local air pollution in climate change in West Africa. Nature Climate Change. DOI: 10.1038/NCLIMATE2727

More information:
http://www.dacciwa.eu/

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