Transregional Collaborative Research Centre 32
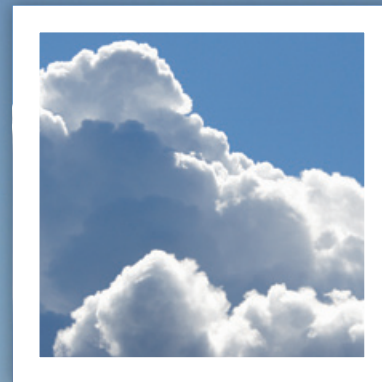„Patterns in Soil-Vegetation-Atmosphere Systems:
Monitoring, Modelling & Data Assimilation"

From groundwater to rain and back

How the interplay of soil, vegetation and atmosphere affects weather and climate.

universität**bonn**   Universität zu Köln   **RWTH**AACHEN UNIVERSITY   JÜLICH FORSCHUNGSZENTRUM

- *Energy, CO_2 and water fluxes between soil, vegetation and atmosphere govern weather evolution and climate.*

- *The study of these exchange processes, and their representation in coupled model systems will provide more reliable weather, flooding and climate predictions.*
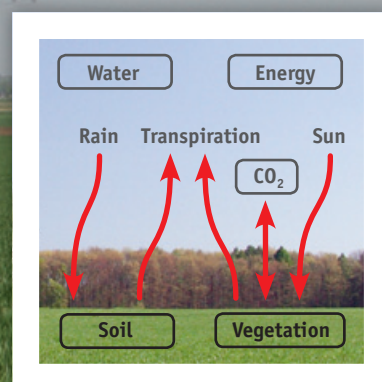
Background

The cycling of energy, water and carbon through soil, vegetation and atmosphere influences the distribution and quality of life on Earth. With the rapid growth of the world population and its needs, the sustainable and efficient management of our natural resources becomes more important than ever. The Transregional Collaborative Research Centre 32 focuses on a better understanding of the processes and interdependencies within and between soil, vegetation and the atmosphere which will lead to more reliable weather and climate models and more accurate predictions for water and CO_2 transport to support an improved management of natural resources.

Spatial and temporal patterns in the soil-vegetation-atmosphere continuum are postulated to play a key role. For example, agricultural land-use – wheat next to beet, or potatoes and corn – influences the exchange of water, CO_2 and heat between soil and atmosphere. All processes are inseparably intertwined, resulting in complex feedbacks and system responses on different spatial and temporal scales.


Our goal

The overall goal of TR32 is to clarify the origins of and the interrelations between spatial and temporal patterns of each single component within the soil-vegetation-atmosphere system using innovative monitoring and modelling approaches. Spatial and temporal structures of physical parameters (e.g., soil hydraulic conductivity), state variables (such as soil moisture or air temperature) and processes (for example fluxes of CO_2, water and heat) can be observed on all scales. The detection of these patterns and the understanding of the interactions involved are required to represent the different spatial and temporal scales in numerical models.
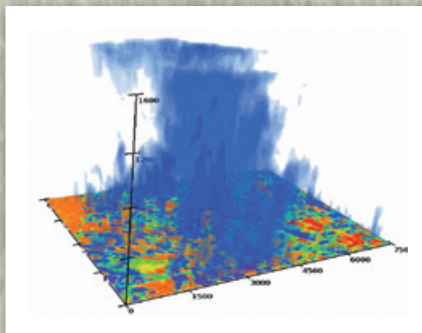
- *In TR32 researchers investigate the structures of energy, gas and water interactions between soil, vegetation and atmosphere with very high resolution integrated models.*

Gestaltung: Bosse und Meinhard Wissenschaftskommunikation, Bonn
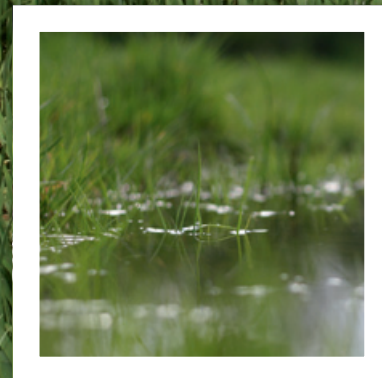
Thinking "out of the box" – Interdisciplinary research and training

The study of patterns and exchange processes within and between the different "spheres" (bio-, hydro-, pedo-, and atmosphere) inherently requires thinking and working across disciplinary boundaries. Within TR32, cooperation between disciplines ranging from agrology, geography and hydrology to meteorology and mathematics ensures a fruitful synergy within the network of geoscientists, Geoverbund ABC/J.

Different scientific worlds meet and cross-fertilize each other on a methodological level: field and laboratory observations directly feed into computer models, leading to enhanced regional climate predictions and the improvement of our understanding of the flow of water in soils while modellers identify optimal positions for observations.

The main TR32 research is carried out by doctoral students from varied backgrounds ranging from geography to meteorology and physics, and from mathematics to water management and civil engineering. Since 2011, all new doctoral students are enrolled in the TR32 Integrated Research Training Group which offers training and guidance for solving interdisciplinary scientific and applied problems, and for working independently in academia or industry.

The young scientists are introduced to the wide range of scientific fields represented in TR32 which helps them to build their own professional network besides an in-depth technical and scientific training in their specific field of research.

- By spectral reflection-emission measurements of photosynthesis TR32 investigates the physiological development of plants and the related CO_2 and water fluxes.

Four-dimensional precipitation acquisition

State-of-the-art remote sensing equipment visualizes the pulsating interior of the atmosphere, and allows researchers to investigate the origins of quickly changing humidity, cloud, and precipitation patterns. In addition to the weather radars of TR32 and TERENO, the Jülich Observatory for Cloud Evolution (JOYCE) contributes cloud, wind, and water vapour observations. TR32 closely collaborates with the Deutsche Wetterdienst (DWD) within the framework of the Hans-Ertel-Zentrum für Wetterforschung (HErZ) on the synthesis of data and model development to improve rainfall predictions.
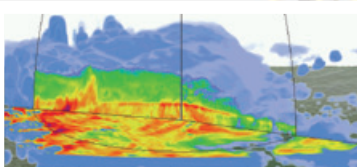
Coupled modelling

TR32 combines computer models for atmosphere, vegetation and soil including ground water dynamics, and develops a terrestrial system model, which explicitly takes into account the interactions between complex patterns in the atmosphere, vegetation and soil.
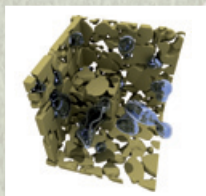
- Modelling the flow of water in porous soil.

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- University of Cologne
- RWTH Aachen University
- Forschungszentrum Jülich

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Patterns and Structures

- In TR32 patterns are identified using non-invasive methods, such as geoelectrical techniques to monitor soil moisture. Optical remote sensing techniques determine vegetation parameters such as sun-induced fluorescence which are used to estimate the uptake of CO_2 by vegetation. While CO_2 uptake is intimately related to plant transpiration, interactions between fluorescence patterns and the distribution of moisture in soil and atmosphere reveal the functional status of the vegetation.