UP 16: Meßtechnik

Time: Friday 10:45–13:00 Location: G/gHS

UP 16.1 Fri 10:45 G/gHS

High-precision surface-based Ground-Penetrating Radar monitoring of near-surface hydrological processes — •Patrick Klenk, Stefan Jaumann, and Kurt Roth — Inst. f. Umweltphysik, Universität Heidelberg, Im Neuenheimer Feld 229, 69120 Heidelberg

Throughout the last decade, Ground-Penetrating Radar (GPR) has been developed as a versatile tool for imaging the sub-surface. Especially its application for observing soil water content, a crucial state variable in soil hydrology, has been investigated, since traditional methods have often proven to be insufficient at the field-scale. For developing high-precision GPR methods for monitoring soil water dynamics, the ASSESS experimental site was constructed close to Heidelberg. This test-site has been designed with a complicated but known subsurface structure to advance the quantification of GPR methods under a wide range of different conditions. Highly dynamic conditions can be induced by either varying the water table position through pumping water into and out of an observation well or by infiltration with a sprinkler system.
We here present a series of *time-lapse GPR observations* of deliberately induced *infiltration*, *imbibition* and *drainage processes*, which we compare with numerical simulations of both subsurface water flow and the expected GPR response. In particular, we discuss the attainable precision in this well-controlled setup with respect to high-resolution observation of infiltration processes, which is currently about one order of magnitude better than so far demonstrated in the field.

UP 16.2 Fri 11:00 G/gHS

Soil moisture sensing by cosmic ray induced neutron showers — •Markus Köhli[1], Martin Schrön[2], and Ulrich Schmidt[1] — [1]Physikalisches Institut, Universität Heidelberg, Heidelberg, Germany — [2]Helmholtz Zentrum Für Umweltforschung, UFZ, Leipzig

Techniques for probing soil moisture at intermediate scales inbetween those of satellite based systems and local on site measurements have become a highly demanded field of research. Passive sensing of neutrons originating from cosmic particle air showers offers the possibility of detecting water by averaging over a large area. It is a characteristic feature of hydrogen to slow down neutrons very efficiently whereas heavier elements more likely reflect them. This leads to the spectrum of reflected neutrons being dependent on the water content in the environment. We present Monte Carlo based simulations to study the footprint of this method for various conditions. Intensity and range dependencies can furthermore now be described by analytical functions.

Kaffeepause

Invited Talk UP 16.3 Fri 11:45 G/gHS

Air-Sea Gas Exchange: from Empiric Wind Speed Relations to Regimes and Ranges — •Bernd Jähne — Institut für Umweltphysik, Universität Heidelberg — HCI, Universität Heidelberg

Even after more than thirty years of intensive research on air-water gas transfer (the 1st symposium on Gas Transfer at Water Surfaces took place in 1983), no satisfactory physically-based model of gas transfer is available. Consequently, semi-empirical relationships between the gas transfer velocity k and wind speed at 10 m height, U_{10}, are still state-of-the-art — and (too) many of them are available.

However, measured transfer velocities show significant deviations from a such a simple relationship. This variability is obviously caused by different conditions at the water surface at the same wind speed such as atmospheric stability, water temperature, different degrees of contamination by surface active material, and the sea state — but a comprehensive model will need further years of research.

Given this unsatisfactory situation, a better alternative to empirical wind speed relations is proposed: the definition of upper and lower limits in different wind speed regimes both for the gas transfer velocity and its dependency on the Schmidt number. This approach is possible by a combined analysis including theoretical considerations and available laboratory and field data. In this way, modelers get clear evidence about the range of possible gas transfer velocities in different wind speed ranges.

UP 16.4 Fri 12:15 G/gHS

Sensing Environmental Water Content with Cosmic-Ray Neutrons — •Martin Schrön[1], Markus Köhli[2], Steffen Zacharias[1], Peter Dietrich[1], and Sascha Oswald[3] — [1]Helmholtz-Zentrum für Umweltforschung - UFZ Leipzig — [2]Physikalisches Institut, Universität Heidelberg — [3]Institut für Erd- und Umweltwissenschaften, Universität Potsdam

Cosmic-ray neutron sensing has become an increasingly accepted and unique method to monitor the effective soil water content at the field scale. The technology is famous for its low maintenance, non-invasiveness, continuous measurement, and most importantly, for its large footprint.

The method takes advantage of neutrons induced by cosmic radiation which are extraordinarily sensitive to hydrogen and behave like a hot gas in air. Information about nearby water sources quickly mixes in a domain of tens of hectares.

We investigate different contributions to the neutron signal and the influence of spatial structures and environmental conditions. Stationary detectors as well as mobile surveys with the Cosmic-Ray Rover reveal pros and cons of this state-of-the-art technology.

UP 16.5 Fri 12:30 G/gHS

Active Thermography as a Tool to Investigate Heat and Gas Transfer — •Jakob Kunz[1] and Bernd Jähne[1,2] — [1]Institute of Environmental Physics, University of Heidelberg, INF 229, D-69120 Heidelberg, Germany — [2]Heidelberg Collaboratory for Image Processing, University of Heidelberg, Speyerer Straße 6, D-69115 Heidelberg, Germany

Gas exchange between the ocean and the atmosphere plays a key role for climate modelling. While direct measurements of the gas exchange are mainly suitable for laboratory measurements with well-defined air and water volumes, local measurements of heat transfer are also possible in field experiments.

The active thermography measuring technique provides a tool to estimate heat transfer velocities both in lab and field experiments on spatial scales of less than a m^2 and time scales in the order of minutes. It is based on heating a well-defined area of the water surface with a laser and measuring the temperature response of the water surface with an infrared camera in the 3-5 μm range.

To compare gas and heat exchange under the most natural conditions possible in a laboratory, measurements with sea water from the north Atlantic have been performed in November 2014 in the annular Heidelberg wind-wave facility (Aeolotron) within the framework of the BMBF SOPRAN project.

The talk will explain the measuring technique and will present first results.

UP 16.6 Fri 12:45 G/gHS

High-resolution 2-D fluorescence imaging of gas transfer at a free water surface — •Christine Kräuter[1,2], Darya Trofimova[1,2], Daniel Kiefhaber[1,2], and Bernd Jähne[1,2] — [1]Institut für Umweltphysik, Heidelberg University, Germany — [2]Interdisciplinary Center for Scientific Computing, Heidelberg University, Germany

Results from a first study with a novel 2-D fluorescence imaging technique to visualize gas exchange between air and water are presented. The invasion of ammonia into water leads to an increase in pH (starting from a value of 4), which is visualized by a fluorescent dye. Fluorescence is stimulated with high power LED arrays and observed with a low noise scientific CMOS camera. Thus, it is possible to visualize ammonia concentration differences in a thin layer (< 1 mm) at the water surface. By controlling the flux of ammonia, a fraction of the mass boundary layer at the water surface is controlled. In this way, processes from different depths are observed. In addition to the fluorescence measurements, collocated infrared imagery as well as wave slope measurements are available from an experiment at the large annular Aeolotron wind-wave facility at the Institute of Environmental Physics in Heidelberg. The measurements give a direct insight into the mechanisms of air-sea gas transfer. Langmuir circulations enhance gas transfer but do not change the Schmidt number exponent. With increasing frequency of microscale wave breaking, the Schmidt number exponent gradually changes from 2/3 to 1/2. Surface films significantly suppress the frequency of mircoscale wave breaking.