UP 9 Poster: Hydrosphäre

Zeit: Dienstag 14:00–16:00 Raum: C

UP 9.1 Di 14:00 C

Imaging concentration profiles of water boundary layer by Double-Dye LIF and inverse modelling — •Achim Falkenroth[1] and Bernd Jähne[1,2] — [1]Institut für Umwelphysik, IUP, Heidelberg — [2]Interdisziplinäres Zentrum f. Wissenschaftl. Rechnen, IWR, Heidelberg

Laser-Induced Fluorescence (LIF) is applied to observe directly the mechanism of gas exchange in the aqueous viscous boundary layer.
In order to make dissolved oxygen visible, a new class of fluorescent dyes is used with a life time in the order of microseconds, so that the quenching constant for dissolved oxygen is sufficiently high for sensitive measurements. Absorption spectra, fluorescent spectra, and the quenching constant are measured.
Depth profiles of the O_2 concentration are obtained by two competing techniques. The first technique uses a standard vertical laser sheet and is suitable for a measurement sector up to several centimetres down from the water surface with a resoluion in the order of 50–100 μm.
The second technique uses a second dye that attenuates the emitted fluorescent light differently for different wavelengths so that the shape of the observed fluorescence spectrum depends on the path length of the light in the water. For a given wavelength, the fluorescence received is the integrated intensity over a characteristic depth $\hat{z} = \alpha^{-1}(\lambda)$, where $\alpha(\lambda)$ is the absorption coefficient of the dye solution. Because $\alpha(\lambda)$ is known, the depth-dependent concentration can be computed from the spectra as a linear inverse problem.
This technique is specially useful for water surfaces undulated by waves, because it results in a coordinate system fixed to the water surface.

UP 9.2 Di 14:00 C

Gas Exchange Measurements: The Chemically Enhanced Gas Transfer of Carbon Dioxide at the Water Surface. — •Kai Armin Degreif[1], Joachim Kuss[2], and Bernd Jähne[1] — [1]Interdisziplinäres Zentrum für Wissenschaftliches Rechnen, Im Neuenheimer Feld 368, D-69120 Heidelberg — [2]Institut für Ostseeforschung, Seestrasse 15, D-18119 Warnemünde

The exchange of carbon dioxide between the atmosphere and the ocean is a fundamental problem in earth sciences. Despite the fact that hydrodynamics at the free water surface is poorly understood, CO_2 exchange is complicated by chemical reaction of the dissolved CO_2 with bicarbonate and carbonate ions present in the ocean. At low turbulence intensity at the water surface the concentration gradients can significantly be influenced by chemical reactions leading to enhanced gas transfer.

Laboratory experiments were performed using the "controlled-leakage"-technique permitting measurements of the gas transfer rates at the water surface with a temporal resolution of a few minutes. For a sensitive measurement of the chemical enhancement simultaneous gas exchange measurements were performed with CO_2 and N_2O.

The effect of the chemically enhanced gas transport was demonstrated under a variety of chemical and physical conditions. The experimental results are in agreement with a simple theoretical model. For clean water surfaces chemically enhanced transport occurs only at low wind speeds. If wind-waves are damped by the presence of a surfactant, chemical enhancement can be observed at wind speeds up to 6 m/s in the annular experimental facility.

UP 9.3 Di 14:00 C

Noble gases in fluid inclusions of speleothems: a new palaeoenvironmental proxy? — •Y. Scheidegger[1], M.S. Brennwald[1], V.S. Heber[2], R. Wieler[2], and R. Kipfer[1,2] — [1]Water Resources & Drinking Water, Eawag, Switzerland — [2]Isotope Geochemistry & Mineral Resources, ETH Zürich, Switzerland

The concentrations of dissolved atmospheric noble gases in water reflect temperature and salinity of the water that prevailed during gas exchange between the water and the atmosphere. This principle has been successfully applied to reconstruct palaeoenvironmental conditions from groundwater or from pore water of lake sediments. While both these archives provide long-term palaeoclimatic records, their temporal resolution remains limited due to mixing and diffusion in the water. We therefore propose to apply noble gases as palaeoenvironmental proxies in water inclusions of speleothems, which provide a well-defined and high-resolution timeframe. While experimental difficulties prevented the assessment of the potential of this archive until now, we recently developed a new approach to determine the noble gas abundance in fluid inclusions of speleothems. We found that a large fraction of the noble gases we extracted from bulk speleothem samples originate from air inclusions. In addition to this air component, we observed a small component with the same noble-gas signature as air-equilibrated water, which indicates that this latter fraction originates from water inclusions in the speleothems. This shows that the noble gas signature of the water inclusions is experimentally accessible, which supports the potential of noble gases in water inclusions in speleothems as palaeoenvironmental proxies.

UP 9.4 Di 14:00 C

Environmental tracers indicate exceptional mixing event in Lake Lugano, Switzerland — •Christian P. Holzner[1], Werner Aeschbach-Hertig[2], Marco Simona[3], and Rolf Kipfer[1,4] — [1]Water Resources and Drinking Water, Eawag, Switzerland — [2]Institute of Environmental Physics, University of Heidelberg — [3]Ufficio Protezione e Depurazione Acque, Bellinzona, Switzerland — [4]Institute of Isotope Geochemistry and Mineral Resources, ETHZ, Switzerland

The deep northern basin of Lake Lugano (z_{max} = 288 m, mean residence time ∼14 yrs) showed a permanent stratification over the last few decades due to strong eutrophication. Seasonal mixing only reached down to 60 - 100 m water depth and the deep water below was stagnant and anoxic. In winter 1999/2000 first signs of a decrease of the stratification stability were observed. The very long, cold and windy winter of 2004/2005 finally lead to a "complete overturn" of the northern basin of Lake Lugano, i.e. to a massive deep water exchange and drastic changes in the distribution of oxygen and nutrients in the water column.

Lake Lugano was monitored using noble gases and other environmental tracers (like SF_6) since 1990. Here we compare measurements from 2005 (shortly after the mixing event) with earlier data. Helium concentrations decreased in the deep water because terrigenic ^{4}He and tritiogenic ^{3}He that had accumulated in the deep water were transfered to the shallower water and partly released to the atmosphere. SF_6 increased close to atmospheric equilibrium concentrations in the whole lake. Therefore, environmental tracers clearly indicate a considerable deep water renewal and gas exchange in winter 2004/2005.

UP 9.5 Di 14:00 C

Imaging System for Simultaneous Slope and Height Measurements of Short Wind-Waves — •Roland Rocholz and Bernd Jähne — Institut für Umweltphysik, Heidelberg

A novel imaging system for the measurement of short wind waves named imaging slope/height gauge (ISHG) is described. It is designed for the simultaneous measurement of wave slopes and wave heights with high spatio temporal resolution and a reconstruction of the moving water surface. Gas-exchange experiments and studies of the fluid dynamics at wind wave tanks are the framework of this effort. The technique is based on slope measurement by means of refraction, height measurement using infrared absorption, telecentric illumination, and telecentric imaging. The setup utilizes a programmable, area extended light source and a high speed camera with more than 1000 frames/s. In order to measure both components of the wave slope and the water height, the position-dependent intensity of the light source is varying between four distinct states. The telecentric illumination suppresses the influence of height variations on slope measurement. The telecentric imaging keeps the image magnification constant, even in the presence of higher wave amplitudes.