Symposium Trace species in environmental research (SYER)

gemeinsam veranstaltet vom
Fachverband Massenspektrometrie (MS) und dem
Fachverband Umweltphysik (UP)

Hans-Arno Synal (MS)
PSI/ETH Institut für Ionenstrahlphysik
ETH Hönggerberg
Schafmattstr. 20
CH-8093 Zürich
synal@phys.ethz.ch

Ulrich Platt (UP)
Universität Heidelberg
Institut für Umweltphysik
Im Neuneheimer Feld 229
D-69120 Heidelberg
ulrich.platt@iup.uni-heidelberg.de

Übersicht der Hauptvorträge und Fachsitzungen

(Hörsaal 3C)

Hauptvorträge

SYER 1.1	Mi	12:00–12:30	3C	**^{14}C - ein vielseitiger Tracer für die Umweltforschung** — •Bernd Kromer
SYER 1.2	Mi	12:30–13:00	3C	**Changes in ocean meridional overturning circulation over glacial termination I – The global record of marine C-14 paleoreservoir ages 23 - 13 cal. ka** — •Michael Sarnthein, Pieter M. Grootes, Ann Holbourn, James P. Kennett, Marie-J. Nadeau
SYER 2.1	Mi	14:00–14:30	3C	**Hochempfindliche Messungen atmosphärischer Spurengase: Massenspektrometrie mit selektiver Ionisation durch Ion-Molekül-Reaktionen** — •Frank Arnold
SYER 2.2	Mi	14:30–15:00	3C	**AMS at low energies - Recent developments and applications in environmental sciences** — •Marcus Christl, Arnold Müller, Lukas Wacker, Vasily Alfimov, Martin Stocker, Hans-Arno Synal, Martin Suter
SYER 2.3	Mi	15:00–15:30	3C	**Geochemistry of rare cosmogenic nuclides** — •Friedhelm von Blanckenburg
SYER 2.4	Mi	15:30–16:00	3C	**Iodine-129 in the Environment** — •Rolf Michel
SYER 3.1	Mi	16:30–17:00	3C	**Tracers in polar ice cores** — •Raimund Muscheler
SYER 3.2	Mi	17:00–17:30	3C	**Real-time, in-situ chemical composition measurements of aerosols and clouds: Application of particle mass spectrometry** — •Stephan Borrmann
SYER 3.3	Mi	17:30–18:00	3C	**Quantitative estimates of fossil fuel CO_2 over Europe using high-precision Radiocarbon observations** — •Felix Vogel, Bernd Kromer, Ingeborg Levin

Fachsitzungen

SYER 1.1–1.2	Mi	12:00–13:00	3C	**Session I**
SYER 2.1–2.4	Mi	14:00–16:00	3C	**Session II**
SYER 3.1–3.3	Mi	16:30–18:00	3C	**Session III**

SYER 1: Session I

Zeit: Mittwoch 12:00–13:00 Raum: 3C

Hauptvortrag SYER 1.1 Mi 12:00 3C

^{14}C - ein vielseitiger Tracer für die Umweltforschung — •Bernd Kromer — Heidelberger Akademie d. Wissenschaften, Inst. f. Umweltphysik, Univ. Heidelberg, INF 229, 69120 Heidelberg

Obwohl ^{14}C ein 'gestandenes' Arbeitspferd im Zoo der Isotopen-Tracer ist, bleibt es für etablierte und neue Anwendungen in der Umweltforschung hoch aktuell. In diesem Beitrag wird der derzeitige Stand in drei ^{14}C-Anwendungsfeldern präsentiert : (1) Schwankungen des ^{14}C-Pegels in der Vergangenheit als Proxy der Sonnenaktivität, verknüpft mit der Frage nach einem solaren Antrieb in natürlichen Klimaschwankungen , (2) ^{14}C als Tracer für fossile Anteile im heutigen CO_2 und in Brennstoffen, z.B. im Kontext der Einhaltung des Kyoto-Protokolls und im Emissionshandel, und (3) Bomben-^{14}C als transienter Tracer in biologischen und biomedizinischen Studien. Auf der messtechnischen Seite sind die aktuellen Fortschritte in der Beschleuniger-Massenspektroskopie (AMS) höchst bemerkenswert, und sie erweitern das Spektrum von hochselektiven Analysemethoden in der Umweltforschung.

Hauptvortrag SYER 1.2 Mi 12:30 3C

Changes in ocean meridional overturning circulation over glacial termination I – The global record of marine C-14 paleoreservoir ages 23 - 13 cal. ka — •Michael Sarnthein[1], Pieter M. Grootes[1], Ann Holbourn[1], James P. Kennett[2], and Marie-J. Nadeau[1] — [1]Universität Kiel, D-24098 Kiel, Germany — [2]University of California Santa Barbara, Santa Barbara, California 93106, USA

Dramatic climate changes occurred during early last deglacial times, 19.0-14.5 cal. ka. They were linked to most fundamental recent changes in ocean circulation, which likely contributed to major shifts in CO_2 transfer from ocean to atmosphere. Marine radiocarbon (C-14) paleoreservoir ages provide unique new insights into the fate of paleo-water masses associated with changes in meridional overturning circulation (MOC). These ages are monitored at an ever growing number of key locations in all three oceans by means of a new C-14 plateau tuning technique. Opposite trends in paleoreservoir ages indicate a short-lasting phase of deep and intermediate-water formation in the North Pacific 17.5 to less than 14.6 cal. ka. This event was coeval with a brief northward reversal of Denmark Strait Overflow waters in the North Atlantic, the source region of modern global MOC, and a dramatic cooling of North Atlantic and Eurasian climate (Heinrich-1 event).

SYER 2: Session II

Zeit: Mittwoch 14:00–16:00 Raum: 3C

Hauptvortrag SYER 2.1 Mi 14:00 3C

Hochempfindliche Messungen atmosphärischer Spurengase: Massenspektrometrie mit selektiver Ionisation durch Ion-Molekül-Reaktionen — •Frank Arnold — Prof.Frank Arnold, Max-Planck-Institut für Kernphysik, ostfach 103980, D-69000 Heidelberg, Deutschland

Spurengase spielen eine wichtige Rolle in der Atmosphäre und nehmen Einfluss auf die atmosphärische Umwelt. Selbst Ultra-Spurengase mit atmosphärischen Molfraktionen unterhalb von einem ppt (parts per trillion) wie z.B. OH oder H_2SO_4 können sehr bedeutsam sein. In den vergangenen Jahren wurden verschiedene Messmethoden zur atmosphärischen Spurengasanalyse entwickelt. Eine besonders leistungsfähige und vielseitige Methode ist die Massenspektrometrie mit selektiver Ionisation durch Ion-Molekül-Reaktionen, die häufig auch CIMS (Chemical ionistion Mass Spectrometry) genannt wird. Sie zeichnet sich durch hohe Nachweisempfindlichkeit und hohe Zeitauflösung aus und ist daher auch für die Untersuchung von Kurzzeitprozessen (z.B. Blitze) und für den Einsatz auf schnell fliegenden Flugzeugen und Raketen geeignet. Dieser Vortrag gibt einen kurzen Überblick über die Entwicklung und den Einsatz dieser Methode. Der Fokus liegt hierbei auf Arbeiten unserer Heidelberger Max-Planck Forschungsgruppe. Wir haben zahlreiche unterschiedliche CIMS-Instrumente entwickelt und diese im Labor, an Motor-Teststänsden und in der Atmosphäre (am Boden, auf Bergmessstationen und an Bord von Flugzeugen, Ballonen, und Raketen) eingesetzt.

Hauptvortrag SYER 2.2 Mi 14:30 3C

AMS at low energies - Recent developments and applications in environmental sciences — •Marcus Christl, Arnold Müller, Lukas Wacker, Vasily Alfimov, Martin Stocker, Hans-Arno Synal, and Martin Suter — PSI/ETH Laboratory of Ion Beam Physics, Institute for Particle Physics, ETH-Zürich, Switzerland

Considerable progress has been made over the past decade in establishing long-lived radionuclide measurements on small, low energy AMS systems. Small AMS machines are cost saving alternatives for laboratories in the earth and environmental sciences and in many cases these systems now may compete with much larger machines with respect to over all efficiency, precision, and accuracy. This talk gives an overview about the most recent technical developments and demonstrates the potential of compact AMS machines for their application in the earth's and environmental sciences. Various examples will be presented covering a wide range of applications (e. g. earth's sciences, environmental monitoring, dating) as well as a wide mass range (Be-10, C-14, Al-26, I-129, Pu-, Pa-, and U-isotopes).

Hauptvortrag SYER 2.3 Mi 15:00 3C

Geochemistry of rare cosmogenic nuclides — •Friedhelm von Blanckenburg — Institut für Mineralogie, Universität Hannover, Callinstrasse 3, 30167 Hannover

Cosmogenic nuclides (mostly ^{3}He,^{10}Be, ^{14}C, ^{21}Ne, ^{26}Al, ^{36}Cl) currently fuel a fascinating scientific development boosted by Accelerator Mass Spectrometry (AMS). Cosmogenic nuclides are produced by interaction of galactic cosmic rays (mainly protons of GeV energy) with the surface of meteorites (Cosmochemistry); with molecules in the atmosphere (Environmental and Climate sciences); and with interaction of secondary cosmic rays (mainly MeV neutrons) with the uppermost meter of the Earths surface (Geosciences). The so-called "in-situ produced"cosmogenic nuclides can be used to determine, for example, exposure ages of prominent features of the Earths landscapes, such as glacial moraines or lithospheric faults. However most surfaces of the Earth are always slowly eroding, in which case erosion rates can be calculated. For nuclides produced in the atmosphere from where they are introduced into terrestrial or oceanic material their radioactive decay from an initial isotope ratio (e.g. ^{14}C/^{12}C, ^{10}Be/^{9}Be) can be used to determine ages (such as that of organic matter or of ground water). In ocean water and sediment, they mark paleo-ocean circulation and sedimentation. When measured in well-dated environmental archives, such as tree-rings (^{14}C) or ice cores (^{14}Be), the changes of production rates of atmospheric cosmogenic nuclides provide information about the past solar modulation, and its impact on climate change. These developments will be reviewed in this talk.

Hauptvortrag SYER 2.4 Mi 15:30 3C

Iodine-129 in the Environment — •Rolf Michel — Zentrum für Strahlenschutz und Radioökologie, Leibniz Universität Hannover, Germany

The natural environmental abundances of Iodine-129 were globally changed by orders of magnitude due to atmospheric nuclear explosions and by accidental and routine releases from nuclear installations. Today, the environmental I-129/I-127 ratios range from more than 10^{-6} to less than 10^{-12}. The situation in Western Europe is reviewed based on investigations of seawater from the English Channel, the Irish Sea, the North Sea, the Baltic Sea and the North-East-Atlantic. In Northern Germany, air-borne species, precipitation, surface and groundwater as well as the complete terrestrial food-chain were investigated. The iodine isotopes are in severe disequilibrium in all the environmental compartments. A differentiation by about a factor of ten between the iodine isotopes was observed for different air-borne iodine species. Time series for iodine in precipitation show a decade-long increase of I-129 fallout until the 1990ties and an ongoing constant input of I-

129. In surface waters, a dilution of the fall-out iodine takes place by stable iodine which is just weakly adsorbed in the soils. The isotope ratios in soils and ground waters demonstrate a high mobility and an accumulation of I-129 in the water unsaturated soil zones and an efficient migration into water saturated soil layers and ground water. The transfer into the food chain is ruled by the complex situation in the water-soil system. In spite of the extreme anthropogenic changes, I-129 is presently not of radiological concern.

SYER 3: Session III

Zeit: Mittwoch 16:30–18:00 Raum: 3C

Hauptvortrag SYER 3.1 Mi 16:30 3C

Tracers in polar ice cores — •Raimund Muscheler — Lund University

Ice cores provide unique records of past climate change. Some key findings about past climate come from ice core records since the precipitation is stored directly and remains relatively unaltered for thousands of years. In addition, the atmospheric composition in the past is stored in the bubbles enclosed in the ice. In many cases annual layers can be counted which provides accurate time scales that are indispensable for the understanding of past climate change.

This talk will give an overview about some of the tracers measured in ice cores and the results that could be obtained from them. Special emphasis will be given to cosmogenic radionculides which record past intensities of galactic cosmic rays reaching the Earth's atmosphere. Such records provide valuable information for different fields of Geosciences. Examples include solar activity reconstruction, solar influence on climate, geomagnetic dipole field reconstruction and carbon cycle changes.

Hauptvortrag SYER 3.2 Mi 17:00 3C

Real-time, in-situ chemical composition measurements of aerosols and clouds: Application of particle mass spectrometry — •Stephan Borrmann — Johannes Gutenberg Universität, Mainz, Germany — Max-Planck-Institut für Chemie, Mainz, Germany

Detailed knowledge of the chemical composition of aerosol particles is essential -among many other fields- for atmospheric physics and chemistry, cloud related research, assessement of pollution sources and atmospheric pollutant dispersal, as well as health related issues. This especially holds for the fine and ultrafine particle fractions with sizes down to 20 nanometers in diameter. For these reasons size resolved, real-time, in-situ aerosol chemical composition measurement techniques with non destructive sampling are key to many different types of experimental studies. In this presentation methods adopting particle mass spectrometry are reviewed including (1.) brief descriptions of the operational principles, (2.) a discussion of capabilities, limitations, and error sources of current modern instrumentation, (3.) and selected examples of applications. Particular emphasis is placed upon recently developed electron impact ionization thermal desorption time of flight mass spectrometers and laser ablation instruments. The measurement examples cover aerosols from emissions of individual cars, of large industrial factories, as well as smog situations. A more complex example involving pecialized particle sampling strategies is used to demonstrate the potential inherent in mass spectrometric particle measurement techniques for cloud research.

Hauptvortrag SYER 3.3 Mi 17:30 3C

Quantitative estimates of fossil fuel CO_2 over Europe using high-precision Radiocarbon observations — •Felix Vogel[1], Bernd Kromer[2], and Ingeborg Levin[1] — [1]Institut für Umweltphysik, Ruprecht-Karls-Universit"at Heidelberg, INF 229, 69120 Heidelberg — [2]Akademie der Wissenschaften & Institut für Umweltphysik, Ruprecht-Karls-Universit"at Heidelberg INF 229, 69120 Heidelberg

To assess the carbon balance on the European scale, quantitative knowledge of the anthropogenic CO_2 emissions from fossil fuel burning is indispensable. Radiocarbon is a key tracer for this purpose because fossil fuel CO_2 is free of ^{14}C. Conventional low-level counting as well as AMS measurements *now* have the precision to provide quantitative estimates of the fossil fuel CO_2 share of a polluted air sample. With this technique and a dedicated long-term monitoring program, validation of the Kyoto-process is possible and in fact provides the only independent method to validate the classical bottom-up emissions estimates and their anticipated changes. Besides this long-term application, we will also present new tools to assess processes on shorter timescales. Diurnal cycles of quasi-continuous CO measurements, previously calibrated using high-precision $^{14}CO_2$ measurements, are used to evaluate regional models as well as high-resolution inventories for fossil fuel CO2 emissions.