

Scientific Report of the ISOCOMPOUND 2009 conference in Potsdam, Germany

Summary

The ISOCOMPOUND'09 conference took from place June 1-5, 2009 in the Seminaris SeeHotel, Potsdam Germany. 139 scientists from 22 countries discussed recent advances in the analyses and application of compound-specific stable isotope data across various disciplines in the area of ecology, and earth and ecosystem sciences.

Given the enormous potential of compound-specific isotope analysis (CSIA), but little interdisciplinary application, we assembled scientists with strong interests in CSIA in a 3-day conference with an emphasis on a discussion of recent developments and future applications across the traditional boundaries of ecology, and earth and ecosystem sciences.

The conference featured 31 talks by 25 invited speakers and 6 invited students, as well as two two-hour poster sessions and breakout sessions, during which 3 groups assembled to discuss specific topics.

Due to special financial support by MOLTER (ESF) and BASIN (NSF) we were able to invite 13 young researchers (PhD students and Postdocs), which were ranked highest by the scientific advisory committee out of 49 abstracts.

Through personal interaction numerous new collaborations have been established and three major review papers will be prepared to describe the state-of-the art in the field. These review papers will be co-authored by participants of the meeting. Therefore we can state, that the goal of the ISOCOMPOUND conference – to establish new research networks crossing the traditional boundaries of ecology, ecosystem sciences and the earth sciences – was accomplished.

Scientific content and discussion of event

Stable isotope analyses have become established as indispensable tools in the ecological and environmental sciences. Traditionally, CO₂ and H₂O as well as bulk samples of plants, soil or animal tissue have been analyzed for tracing the origin of materials or to integrate over biotic or abiotic processes. Analytical advances in the measurement of stable isotope ratios on individual organic compounds provide a new set of tools for ecology, ecosystem- and earth sciences where the molecular specificity and the isotopic signature of compounds can be explored concomitantly. The scope of applications of compound-specific stable isotope analyses (CSIA) is enormous. It does not only provide new levels of precision for the biochemical understanding of bulk sample stable isotope signals but will also allow for new mechanistic research directions in ecology, ecosystem- and the earth sciences.

During the last decades CSIA has become an established method in the field of organic geochemistry. In particular for the reconstruction of paleoclimates from terrestrial or marine sedimentary archives CSIA have been proven extremely valuable. Adoption of the approach to other related fields of environmental science is, however, surprisingly slow, possibly due to the unfamiliarity of scientists with the molecular techniques that underlie CSIA. Given the enormous potential of CSIA it was the right time to assemble scientists across the traditional scientific disciplines with strong interests in CSIA in a multi-day workshop that would allow the discussion of recent developments and future applications of CSIA in ecology, ecosystem- and earth sciences. It is critical at this point to exchange expertise on the advances in CSIA across scientific disciplines and to stimulate new and interdisciplinary research and therefore allow exploiting the full power of CSIA for ecology, ecosystem- and earth sciences.

The ISOCOMPOUND meeting was conducted at the Seminaris SeeHotel in Potsdam, Germany. As a conference hotel the hotel provided all the infrastructure necessary for such a meeting. We invited 25 of the leading scientists in the fields the

conference was to cover. Through additional financial support by MOLTER, we were also able to invite 13 young scientists (PhD students and Postdocs) from Europe (8) and overseas (5). The commitment of the 25 high-profile invited speakers lead to great interest in participation in the different communities. In total 139 scientists from 22 countries attended the conference. 60 abstracts were submitted for poster presentations. In total 91 scientific contributions (posters and talks) were presented at the meeting.

The secured funding from MOLTER (ESF) and BASIN (NSF) allowed a relatively low conference fee for the non-invited participants of 250€, which ensured participation by a large number of students. 33 Postdocs and 34 graduate students attended the conference, 13 of which were covered by the MOLTER young scientist award, accounting for nearly half of the participants. Additionally, four major companies, which deliver the analytical tools needed for CSIA (ThermoFisher, Isoprime, Picarro Inc. and Sercon) were present with exhibition booths.

Talks were grouped into 4 topical sessions (see attached program) and one special session featuring the six highest ranked recipients of the young investigators travel award. The 30-minute invited talks were held in the mornings and early afternoon, while poster sessions were conducted in the afternoon. While only invited talks were given, we made sure enough time was available for discussion. Through the abundant poster sessions, breakout groups as well as the common lunches and dinners, the conference provided such platforms for scientists to engage in discussion about specific topics, arising from the results and ideas of the talks and posters as well as to discuss ideas for future cooperation. Some of the immediate outcomes are outlined below.

Numerous participants expressed the wish of a regular meeting on developments of CSIA across the different fields, in a similar format as ISOCOMPOUND, probably on a bi-annual basis. We, as the organizing committee of ISOCOMPOUND are very supportive of this idea and will provide our help and experience for a possible follow-up conference in 2011.

Results and impact of event on the future direction of the field

In the light of the feedback we have received from conference participants and judging by the outcomes of the meeting (see below) our aim to “bring together the scientific communities from different fields and to stimulate new and interdisciplinary research and therefore exploit the full power of CSIA for ecology, and earth and ecosystem sciences”, succeeded. We will also prepare a meeting report to be published in EOS to inform the scientific community on the outcomes of the ISOCOMPOUND conference.

Specifically it was agreed that three major review papers will be prepared, scheduled to appear in high-visibility journals (Biogeochemistry, Organic Geochemistry etc.) early next year, which will assess the state-of-the art in the three focal topics and lay out future areas of research:

1. Frontiers in Paleoclimatic Applications of Compound-Specific Isotope measurements (responsible lead author: Ann Pearson, Harvard University, USA)
2. The isotopic fingerprint of the terrestrial carbon cycle: CSIA to understand processes and spatio-temporal variations (lead authors: Ansgar Kahmen, University of California, Berkeley; Gerd Gleixner (MPI-BGC Jena))
3. Sources of variability in the hydrogen isotopic composition of organic compounds from photosynthetic organisms (lead author: Dirk Sachse, Universität Potsdam, Germany)

A follow-up workshop where the environmental and physiological controls of the hydrogen isotopic composition of organic material (topic of the third review paper) will be discussed is planned for December 2009 in Berkeley, USA, just prior to the upcoming AGU fall meeting.

Additionally we will maintain the website we established for ISOCOMPOUND (www.isocompound2009.org), so it may serve as a platform for scientists interested in the field. Talks as well as poster presentation from authors who have agreed on publishing will be made available from the website.

Final meeting programme

See attached pdf-file

List of Speakers

Introductory Lecture: On the History and Future of Stable Isotope Signals in Biomarkers

- John Hayes, Woods Hole Oceanographic Institution, Emeritus and now at Berkeley, USA – The development of compound specific isotope analyses in ecology, ecosystem and earth sciences

SESSION 1- Recent Methodological Improvements in the Analysis of C, H, N, O Stable Isotopes on Individual Organic Compounds

- Arndt Schimmelmann, Indiana University, USA - Standardization for compound-specific H, C, N, O isotope analysis
- Eric Crosson, Picarro Inc., USA – High-precision optical measurements of $^{13}\text{C}/^{12}\text{C}$ in inorganic bulk organic material and individual organic compounds
- Andreas Hilker, Thermo Fisher Scientific (Bremen), Germany – Improvements in irm-GC/MS Technology

SESSION 2 - Tracing Biosynthetic Processes and the Stable Isotope Composition of Biomarkers

- Yoshito Chikaraishi, Tokyo Metropolitan University, Japan - Tracing lipid biosynthesis in higher plants with carbon and hydrogen isotope analysis
- Frank Keppler, Max Planck Institute for Chemistry, Germany - Tracing methane production by plants using compound-specific stable isotope ratios
- Hans Ludwig Schmidt, TU Munich, Germany – Systematics of in-vivo hydrogen isotope fractionations – The basis of the deuterium patterns of natural plant compounds
- Andrew Merchant, University of Sydney, Australia - Isotopic composition of organic compounds in phloem sap
- Lucas Cernusak, Charles Darwin University, Australia – Isotopic composition of non-photosynthetic tissues in plants

- Stefan Schouten - Royal Netherlands Institute for Sea Research, The Netherlands - The effect of biosynthetic pathways on the stable isotopic composition of lipids in algae, bacteria and archaea

SESSION 3 - Compound Specific Analysis in Ecology, Ecosystem and Soil Sciences

- Brian Popp, University of Hawaii, USA - Compound specific nitrogen isotope analyses of amino acids in marine organisms and their use in marine food webs
- Ann Pearson, Harvard University, USA - Insights into modern and past marine nutrient cycles – Compound specific nitrogen analysis of geoporphyrins
- Gerd Gleixner, Max Planck Institute for Biogeochemistry, Germany - Microbial fingerprints in terrestrial carbon cycling
- Tim Filley, Purdue University, USA - Using plant biopolymer isotopic composition to track litter and soil organic matter dynamics
- Richard Evershed, University of Bristol, UK - The fate of methanotrophically fixed carbon in soils
- Egbert Schwartz, Northern Arizona University, USA - $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ of DNA extracted from soils; a new approach to investigate microbial control of C and N cycling

SESSION 4 - Paleo-Environmental Applications of Compound Specific Stable Isotope Analysis

- Kate Freeman, Penn State University, USA - Reconstructing paleoenvironments using compound specific C and N isotopes analyses
- Julian Sachs, University of Washington, USA - Tropical Pacific Hydrologic Changes during the Holocene from Lipid D/H Ratios on Remote Islands
- Yongsong Huang, Brown University, USA - Driven by the ice and Sun: understanding the abrupt and high frequency climate changes in New England during the late Pleistocene and early Holocene
- Enno Schefuss, University of Bremen, Germany - African paleo-climatology from a marine molecular-isotopic perspective
- Mark Pagani, Yale University, USA - Arctic hydrology during the Paleocene-Eocene thermal maximum
- Tim Eglinton, Woods Hole Oceanographic Institution, USA - Exploring the links between climate and the stable isotopic compositions and radiocarbon ages of terrestrial biomarkers in marine sediments
- Jürgen Rullkötter, University of Oldenburg, Germany - Reconstruction of continental climate using the molecular and isotopic composition of land-plant biomarkers in deep-sea sediments of the Atlantic Ocean

Evening Lectures

- Jim Ehleringer, University of Utah, USA - Forensic interests in stable isotope ratios of different compounds
- Sue Trumbore, Max-Planck Institute for Biogeochemistry, Germany – Turnover of organic matter in soils – ¹⁴C analysis of individual compounds

Special Session of the Recipients of the MOLTER Young Investigator Award:

- Samuel Bodé (Ghent University): Determination of residence time of amino sugars precursors in soils by HPLC-IRMS
- Lori A. Ziolkowski (University of California, Irvine): Compound specific radiocarbon analysis of black carbon in marine dissolved organic matter
- Stephanie Kusch (Alfred Wegener Institute for Polar and Marine Research): Synthesis, degradation and depositional dynamics of chloro- and pheopigments from the Western Black Sea: insights from combined $\delta^{13}\text{C}$, $\delta^{15}\text{N}$ and $\Delta^{14}\text{C}$ analysis
- Clayton R. Magill (Pennsylvania State University): Environmental variability in the 'Cradle of Mankind' at the Plio-Pleistocene boundary
- Kyungcheol Choy (Max Planck Institute for Evolutionary Anthropology): Investigation of single amino acid $\delta^{13}\text{C}$ signatures from human and faunal bone collagen using LC-IRMS: Implications for reconstructing human paleodiets in Korean prehistory
- Maria L.L. Calleja (University of California, Santa Cruz): Compound-specific $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ amino acid signatures in dissolved organic matter exudates from different autotrophic oceanic organisms: initial results

List of Participants

First Name	Last Name	Affiliation
Bernhard	Aichner	Alfred Wegener Institute for Polar and Marine Research Potsdam
Sam	Barker	Sercon Limited
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Carsten	Schubert	Eawag, Switzerland
Egbert	Schwartz	Northern Arizona University

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Iris	Kristen	Helmholtz Centre Potsdam GFZ German Research Centre for Geosciences



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ecology ecosystem earth sciences

June 1 - 5 2009, Seminaris SeeHotel, Potsdam, Germany

Monday, June 1:

arrival at Seminaris SeeHotel

from 4:00 p.m. Registration opens (conference office at SeeHotel)

from 5:00 p.m. Boards available for posters in lecture room 1

7:00 p.m. Icebreaker Reception at Hotel Bar

Tuesday, June 2:

8:45 a.m. Welcome Notes by Todd Dawson (BASIN) and Pascal Boeckx (MOLTER)

9:15 a.m. Introductory Lecture: *John M. Hayes (WHOI)*: On the history and future of natural isotopic signals in biomarkers

10:00 a.m. coffee break

SESSION 1: Recent Methodological Improvements in the Analysis of C, H, N, O Stable Isotopes on Individual Organic Compounds

10:30 a.m. *Eric Crosson (Picarro Inc.)*: High-precision optical measurements of ¹³C/¹²C in inorganic, bulk organic and individual organic compounds

11:00 a.m. *Andreas Hillkert (ThermoFisher Scientific)*: Improvements in irm-GC/MS Technology

11:30 a.m. *Arndt Schimmelmann (Indiana University)*: Development of H, C, N, O stable isotope reference materials at Indiana University

12:00 p.m. lunch break

SESSION 2: Tracing Biosynthetic Processes and the Stable Isotope Composition of Biomarkers

- 2:00 p.m. *Lucas A. Cernusak (Charles Darwin University):* Why are non-photosynthetic tissues generally ^{13}C enriched compared to leaves in C3 plants? Review of current hypotheses and opportunities for compound-specific isotopic analyses
- 2:30 p.m. *Frank Keppler (Max-Planck Institute for Chemistry):* Tracing Methane production by plants using compound-specific stable isotope ratios
- 3:00 p.m. *Andrew Merchant (University of Sydney):* Isotopic composition of organic compounds in phloem sap
- 3:30 p.m. *coffee break*
- 4:00 p.m. *Hanns-Ludwig Schmidt (Technische Universität München, isolab GmbH):* Systematics of *in-vivo* Hydrogen Isotope Fractionations, Basis of the Deuterium Patterns of Natural Plant Compounds
- 4:30 p.m. *Yoshito Chikaraishi (Japan Agency for Marine-Earth Science and Technology):* Tracing lipid biosynthesis in higher plants with carbon and hydrogen isotope analysis
- 5:00 p.m. *Stefan Schouten (NOIZ):* The effect of biosynthetic pathways on the stable isotopic composition of lipids in algae, bacteria and archaea
- 5:30 p.m. POSTER SESSION I
- 6:45 p.m. Evening Lecture: *James Ehleringer (University of Utah):* Forensics interest in stable isotope ratios of different compounds
- 7:30 p.m. *dinner*



Wednesday, June 3:

SESSION 3: Compound Specific Isotope Analysis in Ecology, Ecosystem and Soil Sciences

- 9:00 a.m. *Brian Popp (University of Hawaii)*: Compound specific nitrogen isotope analyses of amino acids in marine organisms and their use in marine food webs
- 9:30 a.m. *Ann Pearson (Harvard University)*: Insights into modern and past marine nutrient cycles - Nitrogen stable isotope analyses of chlorins and porphyrins
- 10:00 a.m. *Egbert Schwartz (Northern Arizona University)*: $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ of DNA extracted from soils; a new approach to investigate microbial control of C and N cycling
- 10:30 a.m. *coffee break*
- 11:00 a.m. *Gerd Gleixner (Max-Planck Institute for Biogeochemistry)*: Microbial fingerprints in terrestrial carbon cycling
- 11:30 a.m. *Timothy Filley (University of Illinois)*: Using plant biopolymer isotopic composition to track litter and soil organic matter dynamics
- 12:00 p.m. *Richard P. Evershed (University of Bristol)*: Stable isotope probing of the physical and biological controls on the fate and isotopic composition of carbon derived from the terrestrial methane sink
- 12:30 p.m. *lunch break*
- 2:00 p.m. POSTER SESSION II (incl. coffee break at 3:00 p.m.)

SPECIAL SESSION: Oral Presentations by the Recipients of the MOLTER sponsored Young Investigator Award

- 4:00 p.m. *Samuel Bodé (Ghent University)*: Determination of residence time of amino sugars precursors in soils by HPLC-IRMS
- 4:15 p.m. *Lori A. Ziolkowski (University of California, Irvine)*: Compound specific radiocarbon analysis of black carbon in marine dissolved organic matter

- 4:30 p.m. *Stephanie Kusch (Alfred Wegener Institute for Polar and Marine Research)*: Synthesis, degradation and depositional dynamics of chloro- and pheopigments from the Western Black Sea: insights from combined $\delta^{13}\text{C}$, $\delta^{15}\text{N}$ and $\Delta^{14}\text{C}$ analysis
- 4:45 p.m. *Clayton R. Magill (Pennsylvania State University)*: Environmental variability in the 'Cradle of Mankind' at the Plio-Pleistocene boundary
- 5:00 p.m. *Kyungcheol Choy (Max Planck Institute for Evolutionary Anthropology)*: Investigation of single amino acid $\delta^{13}\text{C}$ signatures from human and faunal bone collagen using LC-IRMS: Implications for reconstructing human paleodiets in Korean prehistory
- 5:15 p.m. *Maria L.L. Calleja (University of California, Santa Cruz)*: Compound specific $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ amino acid signatures in dissolved organic matter exudates from different autotrophic oceanic organisms: initial results
- 5:30 p.m. BREAKOUT SESSION
- 6:45 p.m. Evening Lecture:
Susan Trumbore (Max-Planck Institute for Biogeochemistry): Turnover of organic matter in soils – ^{14}C analysis of individual compounds
- 7:30 p.m. *conference dinner (BBQ at SeeHotel's lakeside beach)*

Thursday, June 4:

SESSION 4: Paleo-Environmental Applications of Compound Specific Stable Isotope Analysis

- 9:00 a.m. *Katherine H. Freeman (Pennsylvania State University)*: Ancient Climate Encoded in Molecular Records of C and N Isotope Abundances
- 9:30 a.m. *Timothy Eglinton (WHOI)*: Exploring the links between climate and the stable isotopic compositions and radiocarbon ages of terrestrial biomarkers in marine sediments
- 10:00 a.m. *Yongsong Huang (Brown University)*: Driven by the Ice and Sun: understanding the abrupt and high frequency climate changes in New England during the late Pleistocene and early Holocene
- 10:30 a.m. *coffee break*

- 11:00 a.m. *Julian P. Sachs (University of Washington, Seattle): Tropical Pacific Hydrologic Changes during the Holocene from Lipid D/H Ratios on Remote Islands*
- 11:30 a.m. *Mark Pagani (Yale University): Arctic hydrology during the Paleocene/Eocene thermal maximum: recent updates and revelations*
- 12:00 p.m. *Jürgen Rullkötter (ICBM, Carl von Ossietzky University of Oldenburg): Reconstruction of continental climate using the molecular and isotopic composition of land-plant biomarkers in deep-sea sediments of the Atlantic Ocean*
- 12:30 p.m. *Enno Schefuß (MARUM, Universität Bremen): Testing the validity of continental paleo-climatic reconstructions from marine sediments by isotopic analyses of plant waxes in African soils and lakes*
- 1:00 p.m. *lunch break*
- 2:00 p.m. SOCIAL EVENT - POTSDAM CASTLES CITY TOUR (requires reservation, starts at Hotel)
- 7:30 p.m. *dinner*

Friday, June 5:

departure

