

**12:15 p.m.**

**Radiocarbon distribution and <sup>14</sup>C-based circulation age of the Atlantic Ocean during the Last Glacial Maximum**

Enqing Huang, *Tongji Shanghai* and *MARUM Bremen*

**12:45 p.m.**

**What is shaping the C<sup>14</sup>-DIC relationship in the deep ocean?**

Birgit Schneider, *Univ. Kiel*

**01:15 p.m. | Lunch + Coffee**

**02:00 p.m. | Open Discussion**

**Results and limits to reconstruct carbon cycle changes**

Thomas Bauska, Samuel Jaccard and Margret Steinhorsdottir

**04:00 p.m.**

**Modelling the role of CO<sub>2</sub> in shaping the glacial-interglacial climate**

Ayako Abé-Ouchi, *Univ. Tokyo*

### Terrestrial Carbon Inventories

**04:30 p.m.**

**High latitude impacts on deglacial CO<sub>2</sub>: Southern Ocean westerly winds and northern hemisphere permafrost thawing**

Peter Köhler, *AWI Bremerhaven*

**05:00 p.m.**

**Last glacial maximum terrestrial carbon stocks, multiple constraints from global isotopic budget to incorporating mammoths in land surface models**

Philippe Ciais, *LSCE Saclay*

**05:30 p.m.**

**The role of the terrestrial biosphere in CLIMBER-2 simulations of the last 4 glacial CO<sub>2</sub> cycles**

Victor Brovkin, *MPI Hamburg*

**06:00 p.m.**

**Constraints on global climate-carbon cycle feedbacks on interannual to glacial cycle time scales**

Martin Heimann, *MPI Jena*

**07:00 p.m. | Joint Dinner**

## Saturday, 21 March 2015

### Hypotheses and Data for Mechanisms of Change

**09:00 a.m. | Keynote**

**Deglacial CO<sub>2</sub> / Climate feedback models, myths and misconceptions**

Axel Timmermann, *Univ. Hawaii*

**09:45 a.m.**

**The role of air-sea disequilibrium in ocean carbon storage and its isotopic composition**

Eric Galbraith, *McGill Univ. Montreal*

### Ocean Alkalinity / Syntheses

**10:15 a.m.**

**Is late Quaternary climate change governed by self-sustained oscillations in atmospheric CO<sub>2</sub>?**

Klaus Wallmann, *Geomar Kiel*

**10:45 a.m. | Coffee Break**

**11:15 a.m.**

**The combined effects of changes in ocean chemistry, biology and hydrodynamics on alkalinity**

Tatiana Ilyina, *MPI Hamburg*

**11:45 a.m.**

**Iron Fertilization of the Subantarctic Ocean During the Last Ice Age**

Alfredo Martinez-Garcia, *ETH Zurich*

**12:15 p.m.**

**Glacial CO<sub>2</sub> as a key to the glacial-interglacial problem**

Didier Paillard, *LSCE Gif-sur-Yvette*

**12:45 p.m.**

**Are the oldest proxies the best? Patterns of bulk CaCO<sub>3</sub> and glacial carbon storage**

Andy Ridgwell, *Univ. Bristol*

**01:15 p.m. | Lunch + Coffee**

**02:00 p.m. | Poster**

**04:00 p.m.**

**Southern Ocean overturning role in modulating high southern latitude climate and atmospheric CO<sub>2</sub> on millennial timescales**

Laurie Menviel, *UNSW Melbourne*

**04:30 p.m.**

**Quantifying deep Atlantic carbon sequestration during the last glaciation**

Jimin Yu, *ANU Canberra*

**05:00 p.m.**

**Effects of glacial-interglacial sea-ice and ocean circulation changes on deep-ocean radiocarbon**

Tobias Friedrich, *Univ. Hawaii*

**05:30 p.m.**

**Model-based reconstruction of the marine carbon cycle during the Last Glacial Maximum**

André Paul and Michael Schulz, *Univ. Bremen*

**06:00 p.m. | Keynote**

**Taking stock of the hypotheses for polar ocean stratification and CO<sub>2</sub> sequestration during the last ice age**

Daniel Sigman, *Univ. Princeton*

**Adjourn / Farewell**

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# Deglacial changes in ocean dynamics and atmospheric CO<sub>2</sub>

Leopoldina Symposium

18 – 21 March 2015

German National Academy of Sciences Leopoldina  
Jägerberg 1  
06108 Halle (Saale)

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**Symposium Guests** are cordially invited to register under their name and address until **27 February 2015** at [ms@gpi.uni-kiel.de](mailto:ms@gpi.uni-kiel.de)

### Registration fee for guests:

100 € / full symposium or 25 € / day  
(to be paid at the registration desk)

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## Leopoldina Symposium on

# Deglacial changes in ocean dynamics and atmospheric CO<sub>2</sub>

Modern, glacial, and deglacial carbon transfer between ocean, atmosphere, and land

A calculated transfer of ~530 Gt of <sup>14</sup>C depleted carbon is required to produce the deglacial coeval rise of carbon in the atmosphere and terrestrial biosphere and in soils. While a number of key processes underlying this transfer have been identified, earth-system models are still unable to fully reproduce it. Most likely, this transfer was linked to changes in the ventilation of the deep ocean, which contains the largest carbon pool on the Earth's surface.

Accordingly, the failure to correctly represent the carbon transfer in complex models raises several **important scientific questions**, in particular, **(I)** Whether deep-ocean ventilation was significantly reduced during the last glacial period, **(II)** How and where to trace empirical evidence for a deglacial carbon release from the ocean, **(III)** How to reconcile the carbon release with major shifts in atmospheric radiocarbon contents, and **(IV)** How to test the various alternative carbon sources and mechanisms that may have controlled the last-glacial-to-interglacial shifts in  $\Delta^{14}\text{C}$  and CO<sub>2</sub>, the most prominent short-term change in carbon pools over the last 100,000 years.

### Organized by

**Michael Sarnthein ML**, University of Kiel (chair), **Gerald Haug ML**, ETH Zurich (vice chair), in coop. with **Edouard Bard**, CEREGE Aix-en-Provence, **Hubertus Fischer**, Univ. of Bern, **Tatiana Ilyina**, MPI for Meteorology Hamburg, **Michael Schulz**, MARUM Bremen.

### Support

This workshop is funded by the German National Academy of Sciences *Leopoldina*, the Deutsche Forschungsgemeinschaft in Bonn (DFG), the Kiel Excellence Cluster 'The Future Ocean', and *IMAGES* The international Marine Past Global Change Study. Further travel funds are made available by MPI Hamburg, MARUM Bremen, ETH Zurich, and Oeschger Center in Bern, CH.

ML = Member of the Leopoldina

## Programme

### Wednesday, 18 March 2015

08:30 a.m. | Welcome

#### General + Modern-Ocean issues

09:00 a.m. | Keynote

**Southern Ocean overturning, controlled by wind or buoyancy flux? – Understanding the link between glacial-interglacial Antarctic temperature and atmospheric CO<sub>2</sub>**

Andrew Watson, *Univ. Exeter*

09:45 a.m.

**Ocean acidification: a biogeological perspective**

Jelle Bijma, *AWI Bremerhaven*

10:15 a.m.

**Robustness and uncertainties of current marine carbon cycle models**

Andreas Oschlies, *Geomar Kiel*

10:45 a.m. | Coffee Break

11:15 a.m.

**The global ocean carbon sink – recent trends and variability**

Niki Gruber, *ETH Zurich*

#### Ice Core Records

11:45 a.m.

**Ice core records: climate reconstruction**

Jean Jouzel, *LSCÉ Saclay*

12:15 p.m.

**Climate / CO<sub>2</sub> phase relationship and atmospheric signal smoothing: new insights**

Jérôme Chappellaz, *LGGE Grenoble*

12:45 p.m.

**The polar oceans during the Deglaciation**

Gerald Haug ML, *ETH Zurich*

01:15 p.m. | Lunch + Coffee

02:00 p.m. | Poster

04:00 p.m.

**Centennial Scale Changes in atmospheric CO<sub>2</sub> over the last 70,000 years**

Shaun Marcott, *OSU Corvallis*

04:30 p.m.

**Atmospheric  $\delta^{13}\text{C}$  of ice cores: an overloaded parameter**

Jochem Schmitt, *Univ. Bern*

05:00 p.m.

**Mechanisms and multi-tracer fingerprints of past carbon cycle changes in the Bern3D-LPX model**

Fortunat Joos, *Univ. Bern*

05:30 p.m.

**Isotopic constraints on greenhouse gas variability during the last deglaciation from blue ice archives**

Ed Brook and Thomas Bauska, *OSU Corvallis*

06:00 p.m. | Keynote

**Last insights into past carbon cycle changes from CO<sub>2</sub> and  $\delta^{13}\text{C}$  in ice cores**

Hubertus Fischer, *Univ. Bern*

### Thursday, 19 March 2015

#### North Pacific + South Ocean Records

09:00 a.m. | Keynote

**New constraints on the glacial extent of the Pacific carbon pool and its deglacial outgassing**

Ralf Tiedemann, *AWI Bremerhaven*

09:45 a.m.

**Radiocarbon constraints on Southern Ocean circulation**

Andrea Burke, *Univ. S. Andrews*

10:15 a.m.

**On the 'glacial' ocean circulation and its impact on atmospheric CO<sub>2</sub>**

Luke Skinner, *Univ. Cambridge UK*

10:45 a.m. | Coffee Break

#### Atlantic + Whole Ocean

11:15 a.m.

**Was the early deglacial CO<sub>2</sub> rise caused by a reduction of the Atlantic overturning circulation?**

Andreas Schmittner, *OSU Corvallis OR*

11:45 a.m.

**Radiocarbon (and other) constraints on the transition from glacial maximum to the Holocene**

Jess Adkins, *Caltech Pasadena*

12:15 p.m.

**Reconstructing deglacial circulation changes in the northern North Atlantic and Nordic Seas:  $\Delta^{14}\text{C}$ ,  $\delta^{13}\text{C}$ , temperature and  $\delta^{18}\text{O}_{\text{sw}}$  evidence**

David J. Thornalley, *WHOI Woods Hole*

12:45 p.m.

**Abrupt climate change experiments**

Gerrit Lohmann, *AWI Bremerhaven*

01:15 p.m. | Lunch + Coffee

02:00 p.m. | Poster

04:00 p.m.

**A carbon isotope perspective on the glacial circulation of the deep Southwest Pacific**

I. Nicholas McCave, *Univ. Cambridge UK*

04:30 p.m.

**Benthic <sup>14</sup>C ventilation ages record changing storage of Dissolved Inorganic Carbon in the abyssal ocean**

Michael Sarnthein ML, *Univ. Kiel*

05:00 p.m.

**Signals of CO<sub>2</sub> de-stratification from boron isotopes**

James Rae, *Univ. S. Andrews*

05:30 p.m.

**Using Global Paleodata Synthesis to Test Models of Glacial-Interglacial Carbon Cycle Changes**

Karen Kohfeld, *S. Fraser Univ. Burnaby*

06:00 p.m.

**The last 4 glacial CO<sub>2</sub> cycles simulated with the CLIMBER-2 model**

Andrey Ganopolski, *PIK Potsdam*

08:00 p.m. | Öffentlicher Vortrag / Public Lecture

**Klimawandel: Zu spät für 2°C?**

Thomas Stocker, *Univ. Bern*

### Friday, 20 March 2015

#### Biogeochemistry + Radiocarbon

09:00 a.m. | Keynote

**Ocean stratigraphy, carbon storage, and calcite compensation throughout the Late Pleistocene glacial cycles**

Robert Anderson, *LDEO N.Y.*

09:45 a.m.

**Variations of sea-surface <sup>14</sup>C reservoir ages and their paleoclimatic implications**

Edouard Bard, *CEREGE Aix-en-Provence*

10:15 a.m.

**Oceanic reservoir ages, <sup>14</sup>C concentrations and carbon dynamics (also in the 'Mystery Interval')**

Pieter M. Grootes, *Univ. Kiel*

10:45 a.m. | Coffee Break

11:15 a.m.

**Simulating atmospheric radiocarbon through deglaciation**

Mathis P. Hain, *NOC Southampton*

11:45 a.m.

**Response of the tropical Atlantic ocean-atmosphere system to deglacial changes in Atlantic Meridional Overturning**

Stefan Mulitza, *MARUM Bremen*