



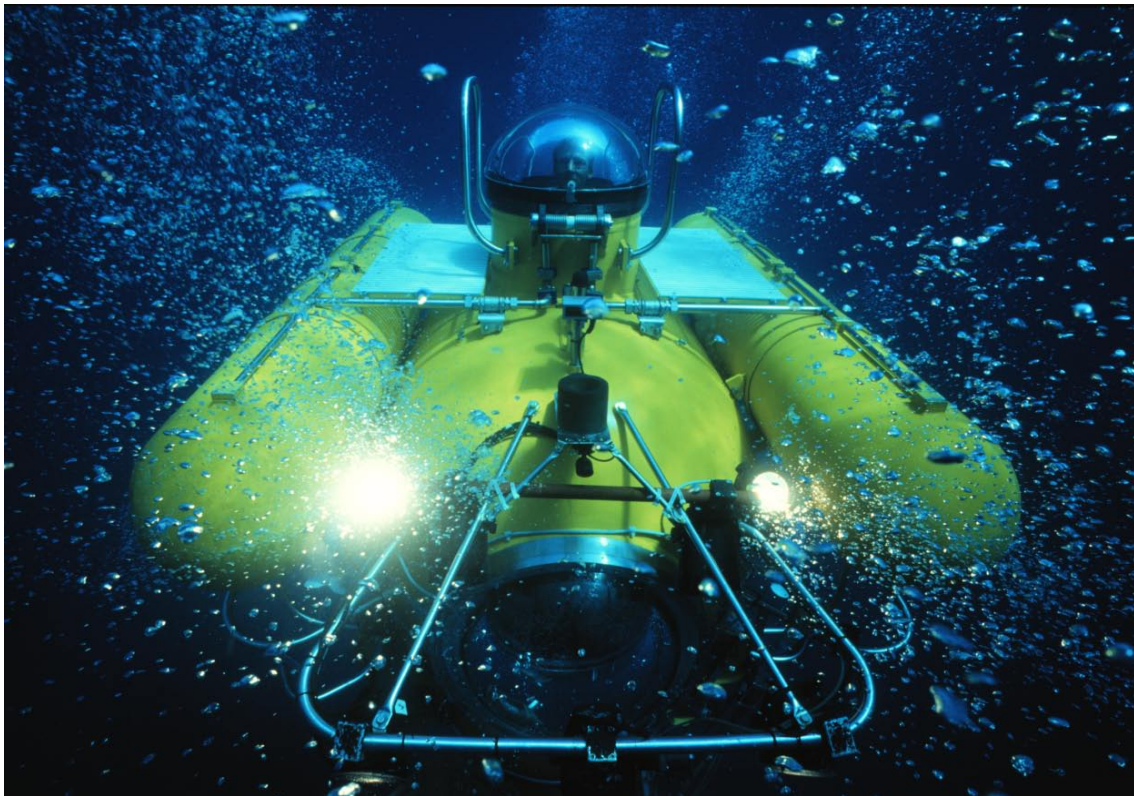
IFM-GEOMAR

Leibniz-Institut für Meereswissenschaften
an der Universität Kiel

IFM-GEOMAR Report 2006

From the Seafloor to the Atmosphere

- Marine Sciences at IFM-GEOMAR Kiel -



IFM-GEOMAR Report 2006

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Cover photo: Submersible JAGO diving in the Indian Ocean (Jürgen Schauer, IFM-GEOMAR).
Inner cover: s.a.

Preface

Three years after the merger of IFM and GEOMAR, the decision to merge the two institutes has proven to be a strategic and scientific success. The reputation and profile of IFM-GEOMAR has increased tremendously and has established Kiel as a major centre of marine sciences in Germany and Europe. One indicator of the success of the new institute is the so-called "DFG-ranking", published by the German Research Foundation (DFG). For the period 2002-2004, IFM-GEOMAR was by far the most successful non-university research institute in terms of DFG-project funding. An important milestone for the strategic development of the institute is represented by the positive funding decision for the excellence cluster "The Future Ocean". In this project, IFM-GEOMAR cooperates with six different faculties of the University of Kiel, the Kiel Institute for the World Economy and the Muthesius College of Fine Arts. The cluster, which has a budget of 36 Mio. Euros for a 5-year period, will cover a wide range of topics including chances and risks of the future ocean such as ocean acidification, marine resources and the consequences of climate change. Four of the 14 new junior research groups will be located at IFM-GEOMAR. The generous funding of "Future Ocean" will enable the creation of about 100 new high-profile jobs in Kiel.

Progress has also been made in the area of research infrastructure. The new Technology and Logistics Centre (TLC) of IFM-GEOMAR opened as the new central basis for the development and maintenance of instrumentation, as well as for the technical preparation of seagoing expeditions. The first large device that found its new home in the TLC is the submersible "Jago" the only manned research submersible in Germany. "Jago" was acquired by IFM-GEOMAR in January and provides an attractive platform for multi-disciplinary marine research. In addition, the construction of a Remotely Operated Vehicle (ROV) with a diving capability of 6000m started recently. The ROV will be available for the marine research community in late 2007. Other large-scale facilities such as offshore mesocosms and an Autonomous



Underwater Vehicle (AUV) are also being developed.

On the scientific side, plans for a new collaborative research centre (SFB) on "Climate-Biogeochemistry Interactions in the Tropical Oceans" are well developed. The review of the pre-proposal was very encouraging and the on-site review and the funding decision are expected for 2007.

Overall, the developments in marine sciences in Kiel and particularly at IFM-GEOMAR have been extremely positive during the past year. Due to successful proposals and generous additional support by the State of Schleswig-Holstein, the institute now enjoys a solid foundation with which it can strive for continued excellence in marine research. We are confident that we can further strengthen our leadership position over the next few years in order to establish IFM-GEOMAR as a "National Centre for Marine Sciences" with high international visibility.

This report provides a short overview of the major developments and scientific highlights during the past year. Detailed statistical information can be found in the appendices. I hope that you will enjoy reading the "IFM-GEOMAR Highlights 2006".

Kiel, October 2007

A handwritten signature in black ink, which appears to be "P. Herzig". The signature is stylized and written in a cursive-like font.

Prof. Peter M. Herzig
Director

Bromine from the ocean and stratospheric ozone

The oceans supply large amounts of halogens (chlorine, bromine and iodine) to the atmosphere not only in the form of salt but also via naturally-produced organic compounds. When these compounds degrade in the atmosphere, the released halogen atoms drive stratospheric and tropospheric O₃ depletion. Recently, more and more attention has focused on the role of bromine (Br) which is up to 50 times more effective as an ozone-destroyer than chlorine (Cl). Synergistic reactions with Cl released by mankind have caused an increase in the ozone-destroying power of natural Br in the present-day, polluted atmosphere (Figure 1).

Many of the naturally-produced halogenated gases have short lifetimes in the atmosphere. Because of this, and because exchange of trace gases between the troposphere and stratosphere occurs predominantly in the tropics, localised sources in subtropical and tropical oceans are of potentially major importance for ozone chemistry that occurs in the lower stratosphere and upper troposphere.

Bromoform (CHBr₃) is the dominant carrier compound for Br transfer from the ocean to the atmosphere. In coastal regions seaweeds are an important source of this compound.

Open ocean sources are poorly understood, but the distribution of CHBr₃ has been linked previously to phytoplankton abundance, especially production by diatoms. The overall magnitude of oceanic emissions is uncertain and its spatial and temporal variability unknown. In order to reduce uncertainty in the source strength, distribution and variability of Br emissions to the atmosphere we have been making simultaneous measurements of CHBr₃ and other Br-containing gases in air and seawater: These allow us to estimate fluxes and gain insight into control mechanisms.

We have found that the sea-to-air flux of CHBr₃ is strongly localized. Previously, we identified a connection between biological production in the subsurface ocean, equatorial upwelling, and the supply of Br to the tropical marine atmosphere. These findings contradicted several modeling studies which assumed a spatially uniform oceanic source of CHBr₃ (Figure 2). Further, we measured very high concentrations of atmospheric CHBr₃ in air masses that originated near the Northwest African coast. We hypothesized that these were due to enhanced biogenic production and sea-to-air fluxes in the diatom-rich water of the Northwest African (Mauritanian) upwelling.

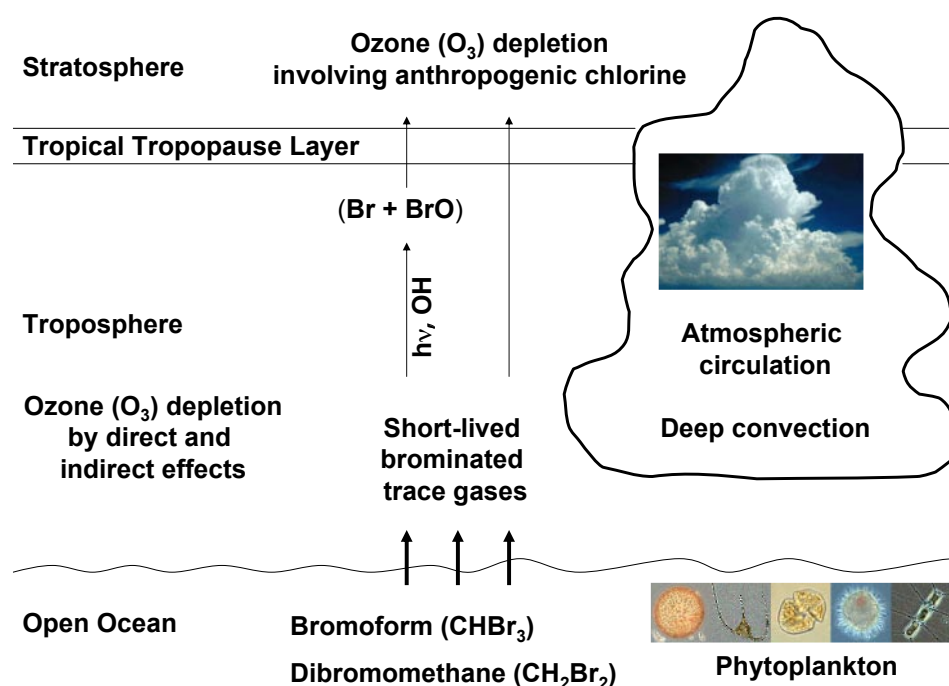
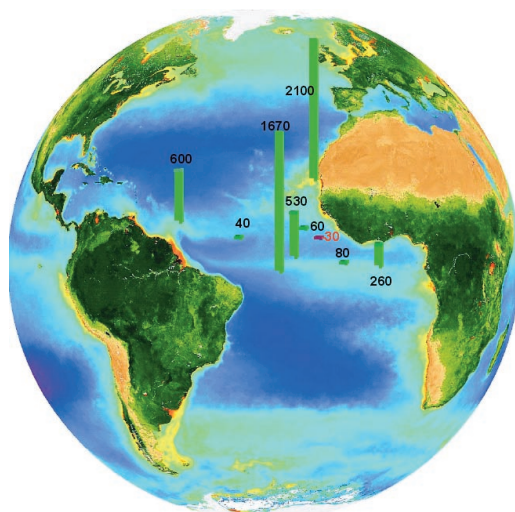


Figure 1: Bromocarbons with atmospheric lifetimes of weeks are produced in the tropical oceans and are an important source of reactive halogen atoms for the troposphere and the lower stratosphere. Rapid transport into the upper atmosphere is promoted by tropical deep convection. The shorter-lived bromocarbons, such as bromoform (CHBr₃), partly decompose in the troposphere by photooxidation (OH) or sunlight (h_v) to inorganic bromine (Br+BrO). This inorganic bromine contributes to stratospheric and tropospheric O₃ depletion, including interactions with anthropogenic chlorine, atmospheric sulfur and nitrate.

Figure 2: Regional emissions of bromoform ($\text{pmol CHBr}_3 \text{ m}^{-2} \text{ hr}^{-1}$) from the tropical Atlantic. High emissions have been found in the Amazon River plume, in the equatorial upwelling region, and the Guinean and the Mauritanian upwelling. The ocean can also act as a sink (red bar) for atmospheric bromoform in certain regions.



A recent cruise with RV Poseidon to this region confirmed that shelf waters are a strong source of bromoform (CHBr_3) as well as dibromomethane (CH_2Br_2) for the atmosphere. However the calculated sea-to-air flux from shelf and slope waters was insufficient to explain some very high concentrations that we measured in the atmosphere. Hence additional, and as yet unknown, sources contribute organic Br to the atmosphere of the eastern tropical Atlantic Ocean. Analysis of air mass trajectories for atmospheric samples with high concentrations suggests that these sources must be on land or, more likely, in the nearshore, coastal and highly productive regions of West Africa.

Further investigation into the marine source and atmospheric fate of organic Br-containing compounds is being conducted between the coast of Mauritania and Cape Verde as part of the SOPRAN (Surface Ocean Processes in the Anthropocene) coordinated project funded by the BMBF.

**Birgit Quack, Gert Petrick,
and Douglas Wallace**