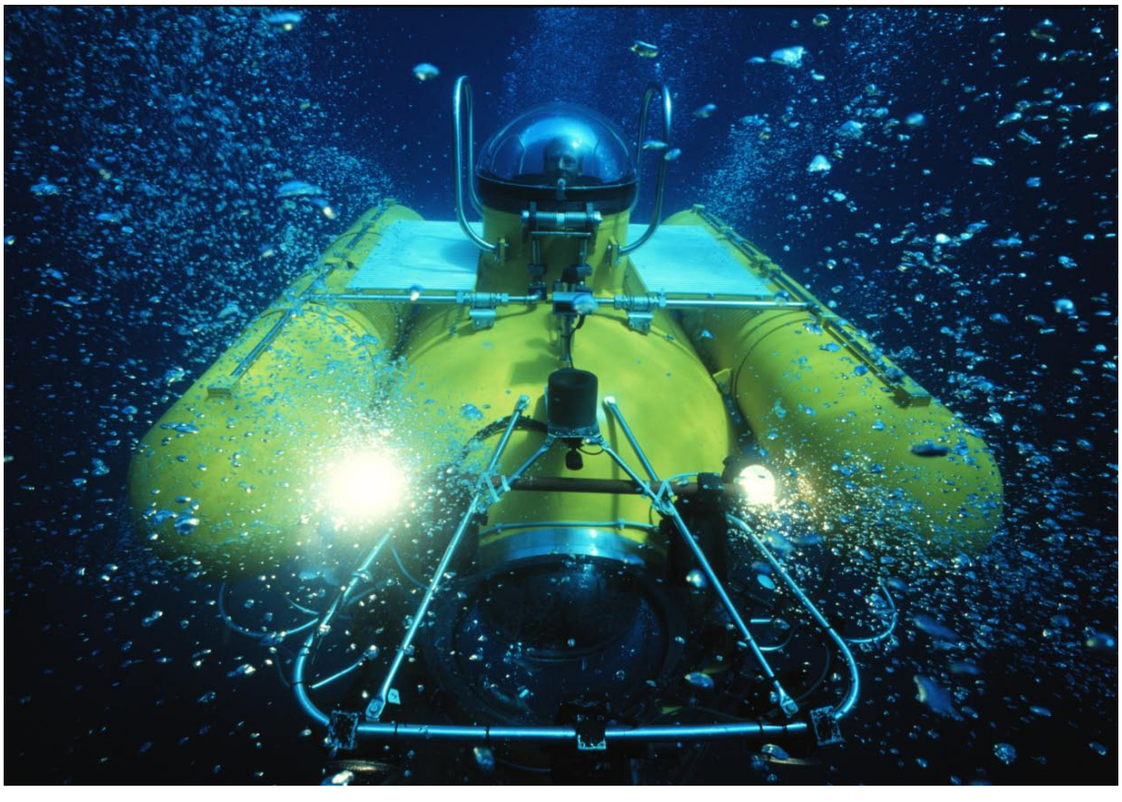
IFM-GEOMAR

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 multidisciplinary 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 mesokosms and an Autonomous

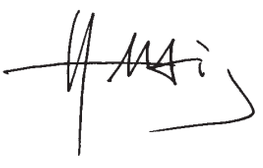
Underwater Vehicle (AUV) are also being developed.

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".

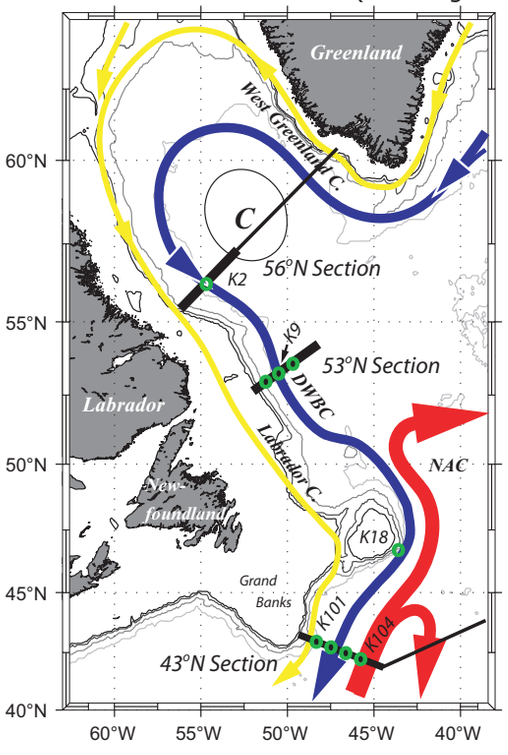
Kiel, October 2007



Prof. Peter M. Herzig
Director

Heating up the Labrador Sea

The Physical Oceanography Group at IFM-GEOMAR has been actively involved in climate-related research in the sub-polar North Atlantic since 1996. The Labrador Sea (see Figure



1) between Greenland and Labrador (Canada) represents a major convection area for the production of North Atlantic Deep Water which in turn supplies vast regions of the Atlantic Ocean with freshly ventilated and dense waters rich in oxygen. This production typically occurs during the months March to April. There have been periods of intense convection activity in this area in the early 1990s, but less and less penetration of these newly formed water masses since 1994. This time evolution of temperature with depth for Mooring K1 near 56°N can be seen in Figure 2, indicating the nearly continuous warming throughout the water column. Our moored temperature measurements in the Deep Labrador Current clearly show this development as well (Figure 3a): At the depth of 1500 m where deep cooling was typically observed during winters with vigorous convection, our temperature sensors from various moorings in the area all display a nearly linear warming trend of 0.05°C/year. These measurements cover the entire region, from the northern convection area at 56°N all the way south to the exit of the Labrador Sea off Grand Banks at 43°N. This warming trend is not an isolated incident.

One of the related questions in the scientific as well as popular literature is whether or not these temperature changes - and subsequently water mass changes – have any effect on the global 'conveyor belt' of ocean circulation. Figure 3b shows the boundary current flow at 56°N and 53°N during the time period of the temperature measurements in Figure 3a, again from moorings located within the strong boundary current exiting the Labrador Sea. Even though there was a slight increase (more southward flow) in 2002, the statistical significance of this increase is lacking.

Even more evidence for this failure of the Labrador Current to convert temperature changes into appreciable flow changes is provided by Figure 3c: Mooring K104, located at the eastern end of the mooring line off Grand Banks at 43°N, measured the outflow of the NADW (North Atlantic Deep Water) at 3000 m and its deepest component, the DSOW (Denmark Strait Overflow Water), at 4200 m. Identical measurements had been taken by the Bedford Institute (BIO) in 1993-95, and the time series at these depths (left panel of Fig. 3c), plus the vertical profiles at mooring location K104 (right panel of Fig. 3c) show substantial changes in the deep water masses but no significant changes in the outflow of North Atlantic Deep water along this major route.

Rainer Zantopp, Jürgen Fischer, Martin Visbeck, Lothar Stramma, Andreas Funk, Marcus Dengler, Peter Brandt, and Friedrich Schott

Fig. 1: Schematic map of the circulation in the Labrador Sea. The red arrow represents the North Atlantic Current (NAC) which, as the extension of the Gulf Stream, carries warm water into northern latitudes. The cold upper ocean circulation is shown in yellow, the blue arrows represent the Deep Western Boundary Current (DWBC) carrying deep, cold water from the Nordic Seas overflow regions and adding newly convected water in the center of the Labrador Sea. Current measurements were taken at various times at the locations marked by the green circles along the CTD sections (marked as black lines).

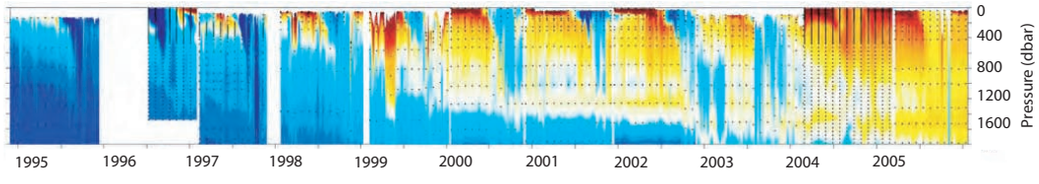


Fig. 2: Time-depth diagram of the temperature development at mooring K2 (56°N) in the upper 1800 m between 1994 and 2006. Blue colors indicate cold water, yellow to red indicates increasingly warmer water. Following deeply penetrating wintertime cooling in 1995 and 1996, the depth of this convection has been decreasing ever since, and the effect of warming at depth is also clearly evident.

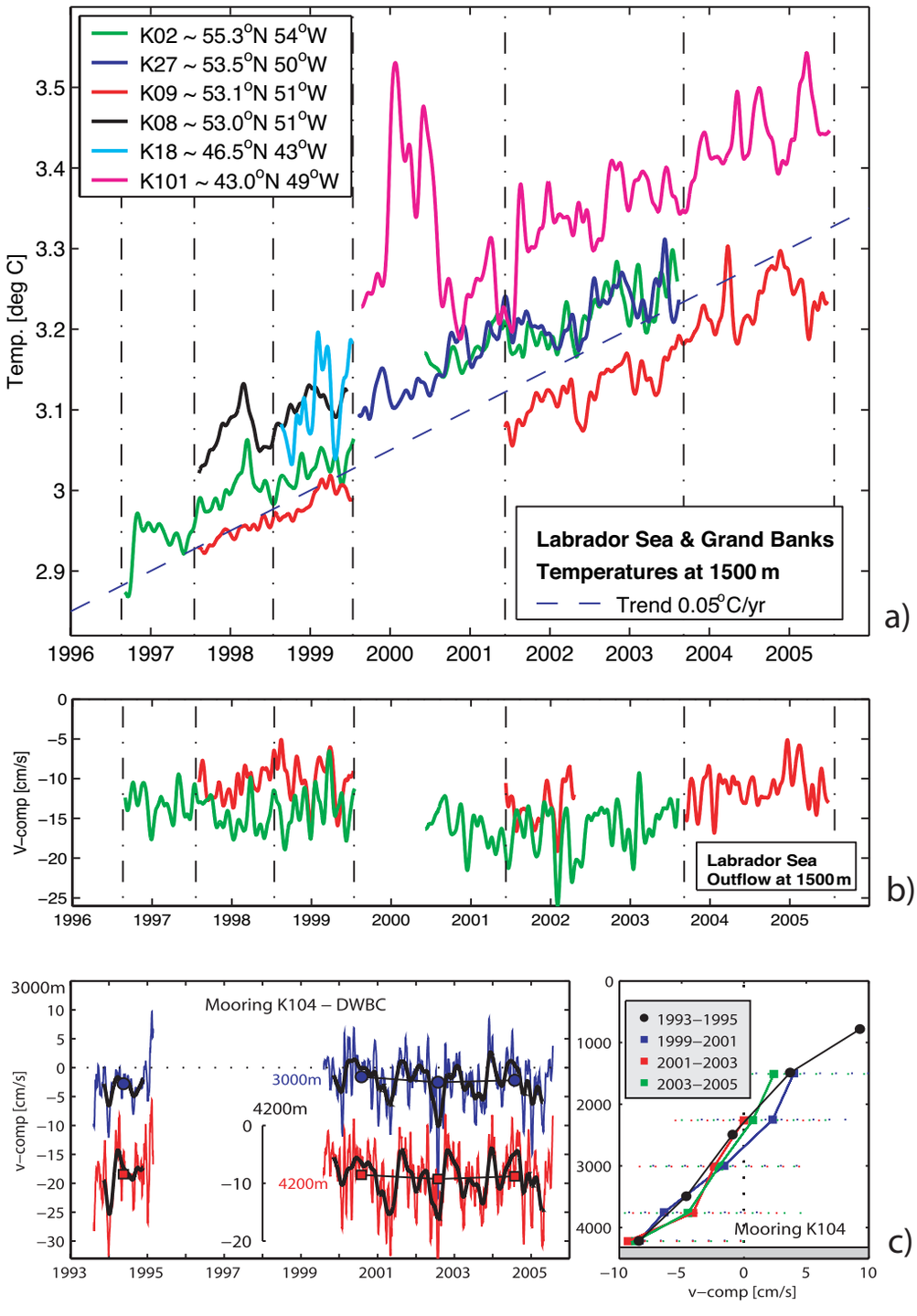


Fig. 3a: Time series of temperature at 1500m at various locations throughout the Labrador Sea, and at the Great Banks (K101). A 50-day lowpass filter has been applied to all time series. This figure shows that the increase of temperature at mid-depth is not confined to isolated regions but covers the entire western sub-polar North Atlantic. The dashed line indicates a linear temperature increase of 0.05°C per year.

Fig. 3b: Time series of outflow from the Labrador Sea at two locations in the Labrador Sea. A 50-day lowpass filter has been applied to all time series. These time series show that the temperature increase from the previous Fig. 3a does not coincide with an increased outflow from the region. Instead we find a minor increase of the outflow in mid-2000 to mid-2002, followed by a return to the previous levels.

Fig. 3c: Time series and profile characteristics of the deep outflow at Mooring K104, located at the eastern end of the mooring line off Grand Banks at 43°N, including NADW (North Atlantic Deep Water) at 3000 m and DSOW (Denmark Strait Overflow Water) at 4200 m. Identical measurements had been taken by the Bedford Institute (BIO) in 1993-95, and the time series at these depths (left panel of Fig. 3c), plus the vertical profiles at mooring location K104 (right panel of Fig. 3c) demonstrate that there has not been any appreciable change in the outflow since 1993.