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Preface

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PREFACE

The oceans and the atmosphere are intimately linked in determining global climate. The greenhouse gas carbon dioxide is a key player in this, its concentration in the atmosphere being dynamically controlled via generation from the biosphere, geosphere and hydrosphere, and through 'draw down' into carbon reservoirs of short-term historical and long-term geological timescales. Physical and biological processes in the oceans play a central role in atmospheric carbon dioxide regulation. Hence, public concern over climate change immediately confronts our knowledge of the oceanic carbon cycle, both now and in the past. The North Atlantic is of special interest, being an extremely dynamic ocean with an enormous effect on the heat and humidity balance of the Northern Hemisphere and, in consequence, on the agriculture and lifestyles of the populations of North America, Europe and Asia. There is considerable controversy over the role of the North Atlantic in drawing down man-made CO_2 from the atmosphere and hence in determining climate. Predicting the impact of the increased levels of atmospheric CO_2 which are being generated anthropogenically depends upon quantification of sources, sinks and the processes inter-relating them.

In recent years, the scientific community has mounted major national and international efforts in marine and atmospheric sciences to study the North Atlantic under the auspices of the IGBP Joint Global Ocean Flux Study (JGOFS). One U.K. component of this effort has been the Biogeochemical Ocean Flux Study (BOFS) which was established as NERC's first Community Research Project. BOFS was completed in 1994 after 13 cruises had been undertaken over a five-year period, resulting in data sets of exceptional quality which have provided new insights into the carbon cycle in the North Atlantic. Other national and international programmes are being developed but this Discussion Meeting has brought together results from BOFS and JGOFS to provide an overview of a number of important areas.

The fourteen papers presented were grouped under four inter-related themes.

1. Air-sea gas exchange: the contemporary role of the North Atlantic as a sink for atmospheric CO_2. (Papers: by Watson *et al.*, Keeling & Peng and Takahashi *et al.*)

2. The biologically driven carbon cycle: what controls the internal dynamics of the ocean carbon cycle, and to what effect? (Papers by: Marra, Ducklow *et al.*, Conte *et al.* and Turley *et al.*).

3. Processes and modelling: how can we integrate observations of the processes which drive the carbon cycle? Can we derive basin-wide assessments of the role of the Atlantic Ocean in the global carbon cycle? (Papers by: Platt *et al.*, Fasham & Evans and Sarmiento *et al.*)

4. Geological perspective and palaeoceanography: how variable has the system been in the past and what role can be attributed to the biological cycles? (Papers by: Shimmield *et al.*, McCave, Boyle and Labeyrie *et al.*)

What emerges is that our understanding of the carbon cycle in the North Atlantic is now beginning to come into a semi-quantitative focus, in which fluxes have been measured, largely for the first time, for various processes and brief snap shots obtained of sea–atmosphere interactions, water column processes and water–sediment interactions. Parts of the problem have become much clearer, if only for a short time interval or a limited location, while remote sensing and other survey methods have given some indication of mesoscale physics, chemistry and biology. Overall, there is clear variability both in space and time, but nonetheless it has proved possible to begin modelling the oceanic carbon cycle. Experimentalists and modellers are jointly trying to determine the role of the North Atlantic in relation to withdrawal and emission of carbon dioxide.

Turning more to the question of short- and long-term climate change, it has become clear that bringing together measurements which can afford local, regional and sometimes global information overlapping different timescales is clearly very important. A start has been made, as is reflected in the papers in this volume. To take one parameter as an example, sea surface temperatures (SST) can be estimated for large sea areas by satellite observation. SST can now be estimated for geological times using several proxies, but only limited data are available from historical times. We need to link these disparate datasets to find out whether SST changes, now and in the historical past, can be related to those estimated for geological times. Only then will we be able to judge if our present modelling skills allow successful temperature predictions on the basis of past changes, trends and cyclicities. Of course, SST may turn out to be, in part at least, stochastic and hence unpredictable with our present approaches. This is just one aspect of the general question: can modelling based on past records be expected to provide good estimates of the effects of the massive contemporary inputs of CO_2 from fossil fuel combustion, rain forest destruction and agriculture practices?

The outcome of such calculations will be vital to the circum-North Atlantic nations for the prediction of climate change and of sea level stands, both of which have direct bearing on the viability of coastal cities and borderlands for human habitation and exploitation.

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