

## PREFACE

This document is the final report of the Working Group on Air-Sea Fluxes (WGASF) which was jointly sponsored by the World Climate Research Programme (WCRP) and the Scientific Committee on Ocean Research (SCOR). For the WCRP, because the question of surface fluxes is considered central to a number of its scientific projects, the WGASF reported directly to the Joint Scientific Committee. For SCOR, the WGASF was SCOR Working Group 110: "Intercomparison and Validation of Ocean-Atmosphere Energy Flux Fields". This joint sponsorship has impacted the work of the WGASF in a number of ways. On a logistic level, it resulted in more funding being available for meetings than would otherwise have been the case, which was clearly advantageous. However there have been more fundamental effects. In particular, although uniform terms of reference were agreed by WCRP and SCOR, the expectation with regard to the Working Group outcome was somewhat different. Typically a SCOR working group consists of experts in a particular field, chosen to reasonably represent the international membership of SCOR. They are tasked with reviewing a subject in some depth and producing a monograph which may be formally published in book form; often this may take several years. The requirements of the WCRP were somewhat different since the results of the WGASF were expected to have a direct impact on future WCRP projects. Thus the WCRP requirement was for an expert group capable of rapidly concluding its deliberations and of producing one or more reports within a restricted time scale. Fulfilling this last requirement was particularly difficult since the inception of the WGASF coincided with the first dissemination of the results from the "reanalysis" projects at the European Centre for Medium Range Weather Forecasting (ECMWF) and the US National Centers for Environmental Prediction (NCEP); projects which were clearly of major importance with regard to the estimation of air-sea fluxes but which would take time to evaluate. Indeed a first detailed global intercomparison of the various analyses is presented in this report.

It was clear even from the first meeting of the WGASF that, both to justify any evaluation of flux products and also to provide a suitable review for SCOR, it would be necessary first to summarise the requirements for surface fluxes, the state of the art with regard to surface flux estimation, and the methods available for flux validation. The first half of the report deals with these issues. Two later chapters deal with the evaluation of the basic meteorological variables (temperature, wind etc.) and of a number of available flux products. All the chapters have been assembled from many separate sections written by different Working Group members. Inevitably the degree of detail varies considerably; in some cases a comprehensive review has been undertaken, in other cases a point has been made by quoting typical examples. Often Working Group members have relied heavily on their own work - justifiable because it was directly relevant, but also very necessary because there was not the time or resources for a more comprehensive review. Thus this report should not be considered an exhaustive review on air-sea flux research. However the WGASF does believe that the report represents a reasonably balanced assessment of the present state of air sea flux determination.

The conclusions with regard to the relative merits of different flux products are less precise than might have been hoped or originally anticipated. However it must be emphasised that this uncertainty does not stem from a lack of evaluation effort (although more work would clearly be desirable). The detailed discussions presented in the earlier chapters of the report emphasise that there are a number of issues where our knowledge remains inadequate. These include, for example, the question of the correct transfer coefficients for the turbulent fluxes, and the reconciliation of measurements and radiative transfer modelling for the radiation balance. Many of these issues have been the subject of research for years; however there has recently been significant progress both in measurement techniques and in our understanding. It is likely that, within a few more years, the absolute values of the surface fluxes over the earth's oceans will be much better known. It is hoped that this report represents a positive step toward that aim.