SATELLITE ALTIMETER DATA ASSIMILATION IN THE OCCAM GLOBAL OCEAN MODEL

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ABSTRACT

Assimilation of satellite altimeter data into ocean models offers the best prospect for testing the ability of ocean models to correctly represent near surface circulation and to extrapolate observations of that circulation in space and time. This will ultimately lead to real time prediction of ocean circulation and of sea surface temperature which will contribute to improving weather and climate forecasts.

The relative scarcity of observations of the ocean, even when satellite data are considered, places special importance on the choice of numerical model in any oceanographic data assimilation system. The 1/4 degree OCCAM global ocean model used here represents the state of the art. This model has been combined with a new approach to assimilating altimeter data developed at Edinburgh, in which emphasis is placed on preserving sub-surface water mass properties.

The basic altimeter assimilation scheme has been tested successfully in an idealised, 'twin' experiment. Further experiments are now underway assimilating TOPEX/POSEIDON altimeter data into the OCCAM model. Early results of a model run assimilating altimeter sea surface height data from 1993 are presented.

INTRODUCTION

The oceans play a vital role in the global climate, as emphasised by the current El Niño event which is affecting climate as far afield as North America and southern Africa. The ability to predict such climate variations requires a combination of ocean observations and numerical models of the global ocean circulation. Data assimilation is the term applied to this
process of combining observations and models to obtain a more accurate estimation of ocean
circulation than possible with either model or data alone.

The work presented here forms part of the AGORA (Assessment of the Global Ocean 
circulation with data Assimilation systems for climate studies) project. This is funded by the 
EU Environment Program and its aim is the inter-comparison of global ocean data 
assimilation systems.

The method described is for the assimilation of satellite altimeter data into a high 
resolution global ocean model. The model used is the Natural Environmental Research 
Council's OCCAM Global Ocean Model (Gwilliam et al., 1997), developed at the 
Southampton Oceanography Centre and run on the Cray T3D at Edinburgh. A simple 
assimilation scheme for projecting altimeter surface height data in the vertical by lifting or 
lowering of water columns is used. This has the advantages of conserving water properties 
on isopycnals, while being simple to implement and consuming little computer time. Some 
results of experiments assimilating mapped TOPEX/POSEIDON altimeter data are presented.

THE OCCAM GLOBAL OCEAN MODEL

The Ocean Circulation and Climate Advanced Modelling (OCCAM) Project was started 
in 1992 to develop and run a high resolution global ocean model on the UK Research 
Councils' first MMP super-computer. It is a three-dimensional global general circulation 
model based on the GFDL MOM code with the addition of a free surface. The resolution is 
1/4° east-west and north-south with 36 levels in the vertical, varying in thickness from 20m at 
the surface to 255m at depth.

OCCAM was integrated for 14 model years, starting from a climatological state and 
applying monthly mean conditions at the surface. For the purposes of this project, it has been 
run with 6 hourly wind forcing for the years 1992-1993 and a repeat 1993 run assimilating 
TOPEX/POSEIDON altimeter maps has been performed.

TOPEX/POSEIDON ALTIMETRY

Observations of the ocean from space are limited to the sea surface. Observations of sea 
surface height are of particular importance since near-surface currents are primarily 
geostrophic - flows are parallel to contours of sea surface height. Altimeter data are most 
useful when combined with knowledge of the sub-surface water structure. Measured changes 
in surface currents can then be related to changes at greater depth. Sea surface height 
measurements are also essential in monitoring possible sea level changes associated with 
climate change.

The TOPEX/POSEIDON mission is a co-operative project between NASA and the 
French Space Agency, CNES. The satellite uses advanced radar altimetry to make very 
precise and accurate observations of sea level. Since its launch on 10th August 1992, it has 
been providing high quality sea surface measurements to the scientific community. Because 
of a lack of knowledge of the ocean geoid (the signal due to local variations in the 
gravitational field), the use of altimeter data by the oceanographic community is limited to 
anomalies from the mean.

ASSIMILATION METHODS

Altimeter data provides a view of the sea surface height and several methods have been 
developed to project this information on to the deeper ocean layers. These methods fall into 
three groups: statistical methods using correlations between sea surface height and ocean