CLIMATE VARIABILITY AND CHANGE IN THE AUSTRALIAN REGION

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This project is a coordinated plan to use TOPEX/POSEIDON satellite altimeter data to improve our understanding and prediction of both climate change and variability in the Australian region. It also contributes to the development of a system of management of the Australian Exclusive Economic Zone. In support of this program there are continuing efforts to improve methods for combining data from different satellite altimeter missions [van Gysen and Coleman, 1995; 1997a and b]. To accomplish these goals, the project is divided into a number of streams of activity.

Satellite Altimeter Verification

The rate of drift of the TOPEX/POSEIDON altimeter bias and the absolute bias was estimated using a calibration site at Burnie in Bass Strait [White et al., 1994]. Data from Burnie and a number of other tide gauges are now being used to measure the bias drift. We are continuing efforts to extend and improve our verification studies by maintenance of the existing instrumentation together with geodetic resurveys of the datum and efforts to improve the geoid model around Burnie.

Understanding and Predicting ENSO and Indian Ocean Impacts on Australian Climate Variability

Australia has marked climate variability which is closely associated with phenomena in the Pacific Ocean region (the El Niño Southern Oscillation) and sea surface temperature patterns in the Indian Ocean [Meyers et al., 1996]. We are collaborating with atmospheric scientists to develop a dynamical climate forecast system using a coupled ocean-atmosphere numerical model. In situ upper ocean thermal data together with satellite altimeter data are being assimilated into the ocean model to provide accurate initial conditions. A vital element of this project is to assimilate subsurface temperature information, inferred from a combination of altimeter and sea surface temperature data.

To date we have developed a model with an equatorially-enhanced grid, appropriate resolution of the island-topography that affects the Indonesian Throughflow, representation of tidal mixing in the Indonesian seas and an appropriate parameterisation of air-sea fluxes and mixed layer dynamics [Godfrey and Schiller, 1997]. The ability of our numerical ocean general circulation model (OGCM) to simulate interannual circulation and SST anomalies from combined satellite and in situ observation is being assessed.

Understanding basin-to-global scale ocean circulation and variability

Understanding natural climate variability is a key to understanding and detecting climate change. No ship borne observation system can adequately resolve the time and space scales of ocean variability and thus the T/P altimeter with its capacity to sample the ocean on global scales is critical. Our current work using the Hamburg Large Scale Geostrophic model has already shown that the gravest modes of the seasonal cycle can be well explained by the fluxes of heat into the mixed layer and by a dynamical response (whole water column) of the model to the winds [Bindoff et al., 1995; 1997].

Dynamics of the Antarctic Circumpolar Current

In situ and satellite altimeter observations are being combined with numerical models to determine the importance of eddy fluxes in the dynamical and thermodynamical balance of the Antarctic Circumpolar Current and to monitor changes in the location, structure and transport of the Current.

The USñAustralian Subantarctic Front Dynamics Experiment (SAFDE) array of moored instruments was recovered after a two year deployment in April 1997 from the Southern Ocean south of Tasmania. The array will provide measurements of eddy heat, momentum and vorticity fluxes in the ACC as well as direct observations of the eastward transport across the 400 km long section of the array. The current meter measurements of eddy fluxes will be related to altimeter estimates of surface Reynoldsí stresses. The in situ and satellite studies will be complemented by data assimilation model studies.

Data from repeat CTD and XBT [Rintoul et al. 1997] sections between Tasmania and Antarctica have been used to infer relationships between upper ocean temperatures and total transport function and surface dynamic height. This relationship has been combined with the altimeter data to infer the baroclinic transport variability through the section [Church et al., 1997]. After averaging over 50 days, the rms transport variability is about 4 Sv. If instead the surface height variability is assumed to represent barotropic variability, then the rms variability is about 10 Sv.

Understanding and modelling the Australian Exclusive Economic Zone

The altimeter data is being used to produce mesoscale hindcasts and nowcasts of physical ocean conditions in support of applications in the offshore industry, maritime safety, meteorology, environment, fisheries, and defence sectors [Ridgway et al., 1997]. Observations are being merged with a three-dimensional circulation model in an analysis-prediction-analysis cycle.

In preliminary investigations, we have shown that altimeter data are one of the most useful products available for this project because of their accuracy, the dominance of mesoscale variability, our ability to infer over 80% of the subsurface density anomaly from the sea surface height residual, and the availability of fast-delivery data for operational uses.

In the Tasman/Coral Sea, a high resolution ocean climatology has been developed which enables a mean surface steric height field to be determined. This serves as a replacement for the mean oceanographic height which is not available from T/P data due to inadequacies in existing geoid models.

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