UNDERSTANDING SEASONAL/DECADAL CLIMATE CHANGES USING MODELS AND SATELLITE DATA

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Our research applies improved ocean models and satellite data to understand low-frequency oceanic variability that occurs as part of seasonal to decadal climate fluctuations. The model is the Parallel Ocean Climate Model (POCM), whose performance is documented in Stammer et al. [1996]. The model was improved by adding the Arctic Ocean and sea ice and using daily surface forcing from atmospheric reanalyses, which include heat and moisture fluxes as well as wind stress. Satellite data are primarily the TOPEX/POSEIDON height anomalies. Additional SSM/I data are used for evaluating sea ice; and altimetric data were used to refine the global bathymetry. Results are described from the first nine months of TPEM funding.

Forcing fields and integrations to date

Reanalyzed data for 1979-93 were obtained from the European Centre for Medium-range Weather Forecasts (ECMWF) through the National Center for Atmospheric Research (NCAR). Extensive processing of the data removed biases during the early years, resulting in a consistent set of daily forcing data. To test the forcing data, an Arctic/subpolar-Atlantic integration was made at NCAR and the sea-ice fields compared with SMMR and SSM/I observations. The simulation captured the important shifts in circulation found in satellite observations. Then the global 1979-97 integration began, to be completed in January 1998. By October 1997, six years of integration were finished; and evaluations are underway using data for 1979-84. A tide-gauge comparison shows excellent tracking of height variations during this period (with correlations above 0.8 in the tropics). The multi-year RMS height variability increased as a result of using high-resolution winds and daily heat and moisture fluxes; and the 1/4-degree model now reproduces 60% of the observed T/P mesoscale height variability. We expect even better comparisons with T/P results than reported earlier [McClean et al., 1997]; and fully spun-up model results will place the T/P observations into a physically consistent space-time context from 1992 onward.

Ongoing analyses

Analyses are underway using the earlier 1987-96 simulation with operational forcing and the newer reanalysis run. As reported at the 1997 Operational Oceanography Symposium, the seasonal cycle of near-surface heat storage is improved by the new forcing of the model; and production of Antarctic Intermediate Water is better simulated. The magnitude and timing of 1982-83 El Niño are very well modeled; and this suggests that the model will provide a superb representation of 1997's El Niño at the end of the present run.

Connections have been found of both ocean transports and subsurface fields with height variations observable from space. For example, height variations between Indonesia and Australia capture many variations in simulated flow through Indonesia, confirming a capability to monitor that important transport. Significant links between height variations and convective heat loss and subduction have been found in the North Atlantic.

Of importance to seasonal to decadal climate change, analyses have examined the Empirical Orthogonal Functions (EOFs) in the model's earlier decadal simulation, as shown in Figure 1 and 2. The seasonal to interannual EOFs compare well with the observed T/P EOFs provided to us by D. Stammer. Pentadal and decadal EOFs of surface height give reliable information on subsurface temperatures that can be related to climate changes on similar time scales.

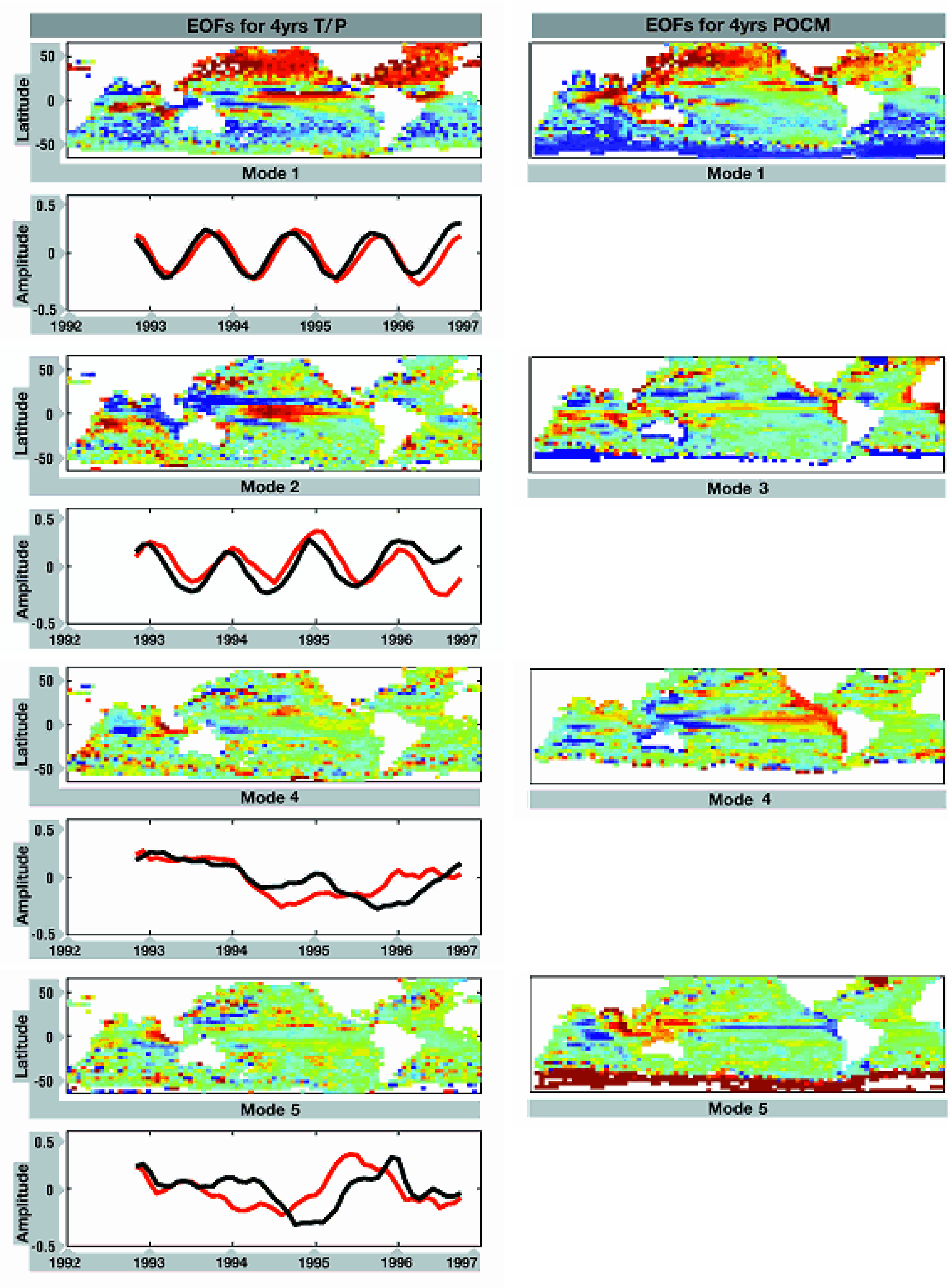

Figure 1

Comparison of seasonal/interannual EOFs from T/P satellite data and POCM model output.

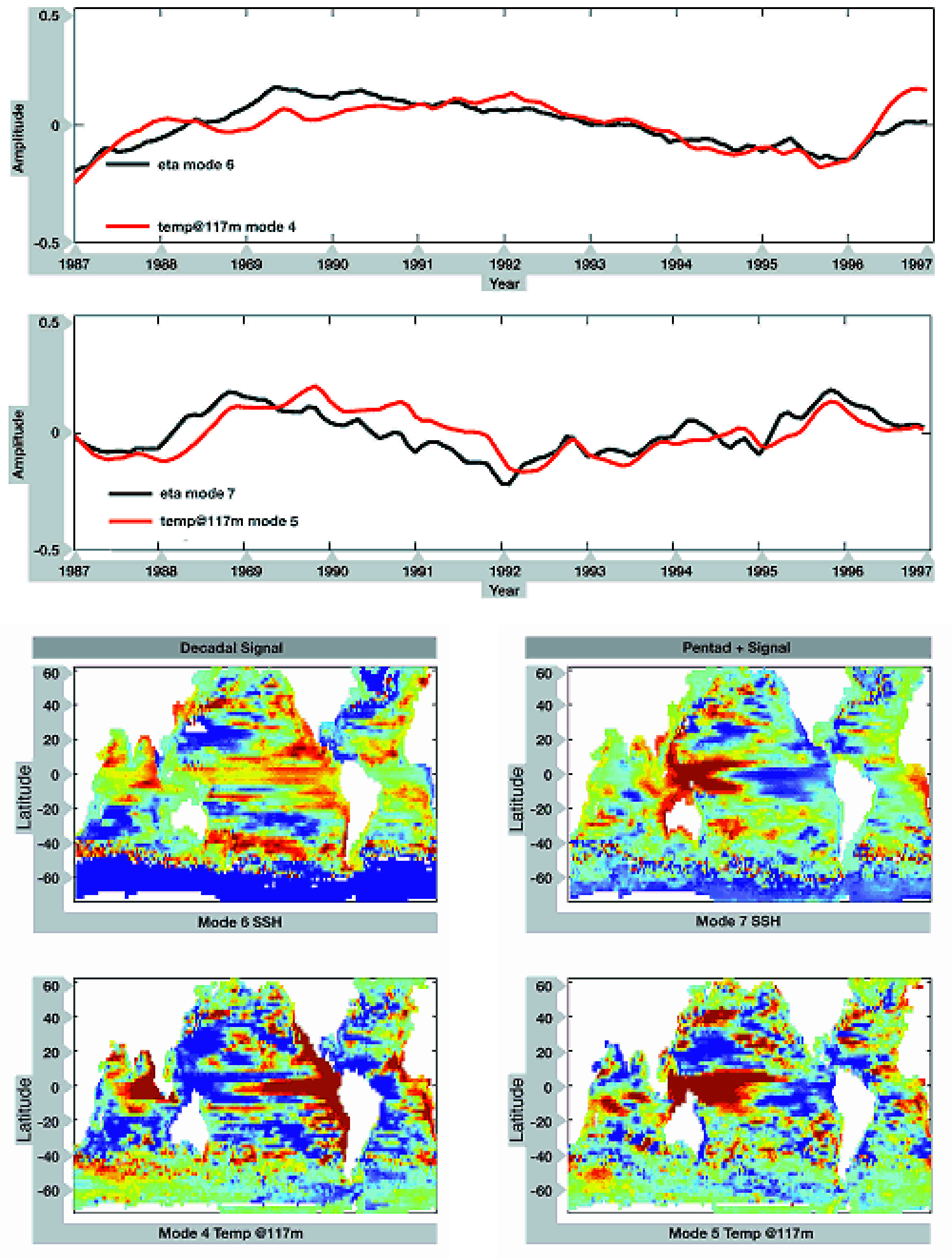

Figure 2

Comparison of pentadal/decadal EOFs of height and subsurface temperature from the POCM simulation.

When the global simulation is finished, we will investigate variations in the fields over nearly two decades. The EOFs will constitute predictors of seasonal to inter-decadal climate variations for comparison with a lengthening T/P and eventual Jason record of altimetric observations. Further analysis of subsurface phenomena should confirm the utility of satellite observations for understanding climate changes. The overall predictability of climate can be assessed by coupling the NCAR Community Climate Model to the global ocean-ice model, initializing the model by assimilating height data with the method of Tokmakian [1997].

References :

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