Roles of oceanic intraseasonal variability in the El Nino Southern Oscillation and its prediction

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Introduction

While the ability of coupled general circulation models (CGCMs) to forecast ENSO warm and cold events has improved in recent years (e.g., Barnston et al. 1994), none of the CGCMs could successfully predict the development and demise of 1997-98 El Nino (e.g., Landsea and Knaff 2000). The unusually rapid development of this El Nino could be attributed to at least two MJO events, which passed eastward across the tropical Indian and western Pacific Oceans prior to the onset (e.g., Bergman et al. 2001). MJO events also may have played an important role in termination of 1997-98 El Nino (Takayabu et al. 1999). Accordingly, understanding of the upper ocean response to the MJO could be crucial for the further improvement of models' skill in predicting ENSO and determining its predictability.

While oceanic response to MJO forcings have been recently studied through various modeling and data analyses (e.g., Shinoda and Hendon 1998, 2001, 2002), many outstanding issues remain unresolved. The proposed study will investigate upper ocean processes in response to the MJO that could be important for the onset, development and termination of ENSO. In particular, we will focus on the oceanic response to multiple MJO events and its dependence on the seasonality of spatial structure of the MJO, which have not been emphasized in previous studies. We will further explore the predictability of oceanic intraseasonal variability using an OGCM and a statistical atmospheric model.

Project Goals

The overall goal of this proposed study is to understand the role of oceanic intraseasonal variations in the onset, development and predictability of ENSO. The specific objectives are:

- To determine how multiple MJO events affect the upper ocean response and the extent to which the interannual variation of initial upper ocean structure influences the oceanic response.

- To understand the impact of seasonality of the spatial structure of the MJO on the upper ocean response.

- To investigate predictability of oceanic intraseasonal variability.

Methodology

The objectives stated above will be achieved through experiments of ocean general circulation model (OGCM) and a statistical atmospheric model.

Computation of surface fluxes

Surface forcing fields will be calculated from gridded data in order to integrate the OGCM. Previously, Shinoda et al. (1998) demonstrated that surface flux datasets can be created from gridded data, which agree reasonably well with flux estimates based on TOGA COARE observations. Because the data from a variety of satellite measurements are now available, flux estimates from gridded data can be further improved by using these satellite data. The data used in this study include QSCAT and NSCAT winds, TRMM precipitation, and ISCPP cloud.

OGCM experiments

The OGCM will be first integrated for the 19 year period from 1983 to 2002, when the cloud data from satellites are available. The mean and variability in the upper ocean from the model experiment will be compared with observations, which include TOGA TAO array, TOGA COARE data, TOPEX/Poseidon altimeter data, and satellite-derived SSTs (e.g., TMI SST). In particular, intraseasonal variability of 20°C isotherm depth during large MJO events will be carefully compared with observations. Then the model will be integrated using composite MJO forcings for each season to elucidate how the seasonality of the spatial structure of the MJO impacts the oceanic response. Model experiments are also designed to isolate the impact of multiple events on the upper ocean response using low-pass filtered surface forcing fields.

Prediction of oceanic intraseasonal variations

Predictability of the oceanic intraseasonal variability will be investigated by the OGCM integration with surface forcing fields predicted by a statistical atmospheric model (Wheeler and Weickmann 2001). OGCM integrations with predicted MJO forcings will be first conducted during the period when large MJO events were observed. Upper ocean fields in the OGCM will be compared with observations in order to quantify the skill of the prediction. A special emphasis of this prediction is given to SST changes associated with generation and propagation of Kelvin waves. After prediction skill is thoroughly examined, the method will be used in an experimental real time mode.

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