DECADAL CLIMATE VARIABILITY IN THE PACIFIC OCEAN

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1. INTRODUCTION

The tropical Pacific Ocean is the key region where El Niño and La Niña are initiated and then teleconnected to the rest of the world. Recent Empirical Orthogonal Function (EOF) studies of the Sea Surface temperature (SST) pattern in the Pacific Ocean have shown another spatial pattern similar to those of El Niño events but with longer (decadal to interdecadal) timescales. Even though this Pacific decadal SST variability spatial pattern is very similar to El Niño, there are some differences. The decadal pattern has a broader shape extending to the midlatitudes, with the strongest anomalies in the midlatitude North Pacific Ocean rather than in the tropics. Graham (1994) studied the effect of this tropical Pacific SST decadal variability on the frequency and intensity of El Niño behavior and described it as the background state of the ENSO.

Another interesting decadal variability that may related to this tropical Pacific SST variability is found in the North Pacific Ocean. Several studies claim that the source of the tropical Pacific decadal variability comes from the midlatitude Pacific Ocean (e.g., Barnet et al. 1999; Pierce et al. 2000) rather than originating from the tropics and then propagating to the midlatitudes, which is the mechanism that operates in the interannual ENSO variability.

This project aims to examine the behavior of the decade-long variability in the Pacific Ocean and to explore the mechanisms operating in this variability, initially using the CSIRO Mark2 Coupled General Circulation Model (CGCM).

2. DATA & METHODS

The numerical model data sets used here are outputs of the Mark2 Coupled Ocean Atmospheric Model by CSIRO (see Gordon and O' Farrell, 1997 for model descriptions). The period used extends from model year 201 to 500 (300 years).

Observed SST used in this study are annually averaged anomalies of the Extended Reconstruction of Global SST (ERSST) (Smith and Reynolds 2002). The data set is reconstructed from a new version of the Comprehensive Ocean Atmosphere Data Set; COADS (1854-1997) (Woodruff et al. 1998).

Observed Jan-Feb 500 mb geopotential height (1948-2001) anomalies used are derived from the NCEP Reanalysis monthly height data provided by the NOAA-CIRES Climate Diagnostics Center, from their Web site at http://www.cdc.noaa.gov/.

The Butterworth 8-year low pass filter is applied to the annually averaged SST data sets. The filter cutoff was chosen to eliminate the interannual ENSO variability.

EOF analyses of the covariance matrix of filtered annually averaged variables were used in order to identify the dominant spatial and temporal variability modes in the data sets.

3. RESULTS

3.1 *EOF Analysis of SSTs*

The EOF analysis of the 8-year low pass filter ERSST shows the ENSO-like decadal variability as the second mode (Figure a), explaining 12.83% of the total variance. The strongest variability of this ENSO-like decadal mode are centered in the central northern mid-latitudes, and the eastern equatorial Pacific Ocean.

The results of the Mark2 GCGM SST analysis are similar to those from the observed ERSST. The first mode is the ENSO-like decadal variability mode, explaining 20.71% of the total variance (Figure b). This suggests that the model simulates stronger ENSO-like decadal variability than in the observation.

Note that further comparison of the model second, third, fourth and fifth EOF modes with the rest of the observed ERSST EOF results shows that the model has a poorer ability to simulate less dominant modes compared to that for the ENSO-like decadal mode.

In order to examine the atmospheric variability associated with the ENSO-like decadal SST patterns, the Jan-Feb 500 mb height anomalies patterns associated with the observed ERSST and Mark2 ENSO-like decadal SST were examined.

3.2 *Jan-Feb 500 mb Geopotential Height*

Figure c and d are the correlation maps for the Jan-Feb 500 mb height anomalies and the observed and Mark2 ENSO-like decadal SST principal components, respectively.

For the observed 500 mb height pattern, the strongest correlations are centered in the south-east of the North Pacific Ocean, and on the north-western and eastern coasts of the North American continent. The model results are similar to those observes but with less significant at the north-western, and eastern coast of the American continent.

Both observed and Mark2 results of the 500 mb height patterns are similar to the Pacific North American Pattern (PNA), but the center near the Aleutian Islands is located further south-east in the North Pacific Ocean compare to the PNA.

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4. WORK IN PROGRESS

The studies by Barnett et al. (1999), Latif and Barnett (1994,1996), and Pierce et al. (2000), identified other decadal variability modes operating in the North Pacific region and suggested that they are responsible for the 1970s climate shift event associated with the Aleutian low pressure system.

Similar analysis to the above studies was performed by performing EOF analysis of Pacific 8-year low pass filter SST northward of 20ºN. The preliminary results show several patterns similar to the above mentioned studies.

Other ocean and atmospheric parameters associated with ENSO-like and North Pacific decadal SST patterns (e.g., Aleutian low and surface wind stress) are being investigated.

5. REFERENCES

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Fig. a. Second EOF mode of the ERSST, explaining 12.83% of the variance.

Fig. b. First EOF mode of Mark2 SST, explaining 20.71% of the variance.

Fig. c. Correlation map of the Jan-Feb 500 mb height anomalies and the principal component of Fig. a., from 1948 to 1997.

Fig. d. Correlation map of the Jan-Feb 500 mb height anomalies and the principal component of Fig. b., from model year 201 to 500.

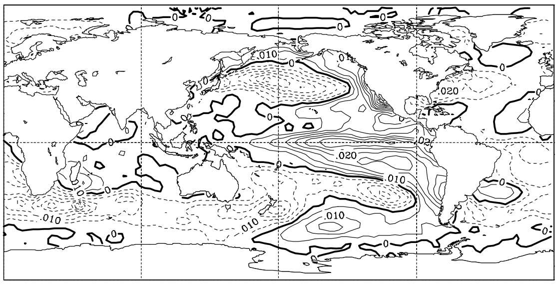

Fig. a. Contour interval 0.005

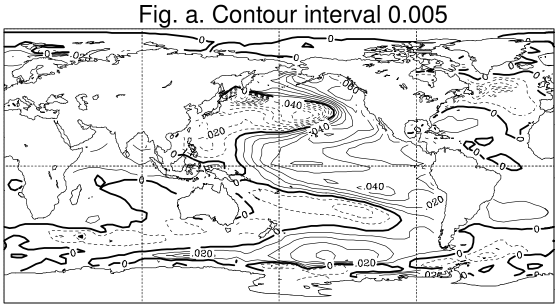

Fig. b. Contour interval 0.01

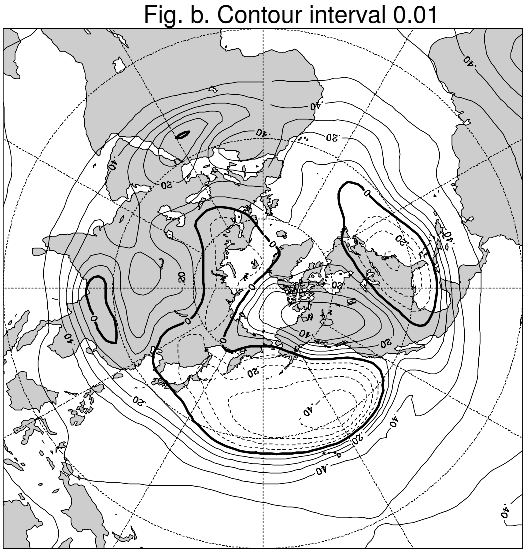

Fig. c. Contour interval 0.1

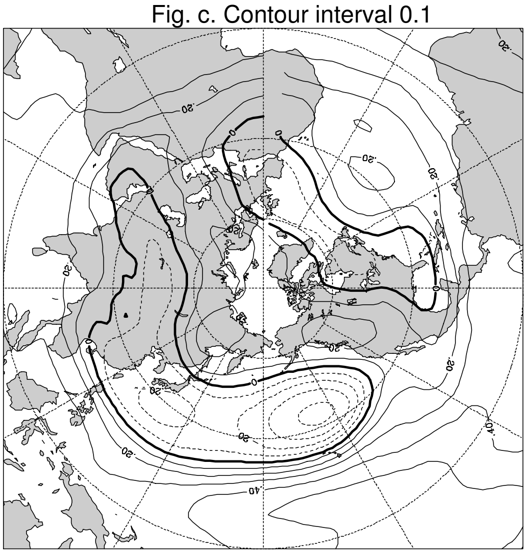

Fig. d. Contour interval 0.1