2.9 INTER-EL NIÑO VARIABILITY OF THE SOUTHERN HEMISPHERE CIRCULATION. PART II: GENERATION MECHANISMS

Carolina S. Vera [*+], Michael A. Alexander [&], James D. Scott [&], Gabriel Silvestri [#] and Vicente Barros [+#]
[*]Centro de Investigaciones del Mar y la Atmósfera (CIMA/CONICET), Argentina
[+]Department of Atmospheric and Ocean Sciences, University of Buenos Aires, Argentina
[&] NOAA-CIRES Climate Diagnostics Center, Boulder, Colorado, U.S. A.
#Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), Argentina.

1. INTRODUCTION

Although the South Pacific Ocean exhibits considerable low-frequency variability, it has not been studied as well as its northern counterpart. On both interannual (ENSO) and interdecadal time-scales the sea surface temperature (SST) anomalies over that particular region are out-of-phase with the ones occurring in the tropical Pacific (Garreaud and Battisti, 1999, among others). Recently, Vera et al. (2002) has shown that differences in the atmospheric response to different El Niño or ENSO warm events are linked to distinctive SST conditions over the subtropical south central Pacific (SSCP) region. However, the processes responsible for the generation of SST anomalies in the extratropical South Pacific Ocean and their feedback on the atmosphere circulation are not clear yet. In addition, the extent to which SST anomalies in the SSCP are induced by atmospheric teleconnections associated with ENSO or result from ocean processes independent of ENSO deserves further exploration. Here we use observations and model simulations to examine air-sea interaction over the South Pacific during El Niño years and its influence on both SSTs and the atmospheric circulation.

2. MODEL SIMULATIONS

The two model experiments used here were conducted by Alexander et al. (2002), who focused on the "atmospheric bridge" between the eastern equatorial Pacific and the North Pacific Ocean during ENSO events. Both experiments were performed with the GFDL R30 AGCM in which observed SSTs were specified in the eastern tropical Pacific (15°S-15°N, 172.5°E-South America) over the period 1950-1999. The two experiments only differ in their treatment of the ocean outside of this region. In the "TOGA" modeling experiment, climatological SSTs, which repeat the same seasonal cycle each year, were specified at all remaining ocean grid points. In the mixed layer model ("MLM") experiment, a column ocean model was coupled to the atmosphere at each ocean grid point outside of the eastern equatorial Pacific.

Corresponding author address: Carolina Vera, CIMA, 2do. piso, Pab. II, Ciudad Universitaria, 1428 Buenos Aires, Argentina. e-mail: carolina@at.fcen.uba.ar

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The atmospheric response to prescribed boundary conditions can drive SST anomalies outside the tropical Pacific in the MLM but not in the TOGA experiment. Differences between the two experiments indicate whether air-sea interaction in the South Pacific extratropics affects the atmospheric response to EN. To enhance the signal-to-noise ratio, experiments were performed using an ensemble of simulations where each simulation was initiated with a different atmospheric state. There are 8 TOGA and 16 MLM simulations.

3. DISCUSSION

The evolution of observed SST anomalies in the Niño 3.4 (5°S-5°N, 170°W-120°W) region and the simulated and observed anomalies in the SSCP (40°S-20°S, 170°W-120°W) region are presented in Fig. 1.

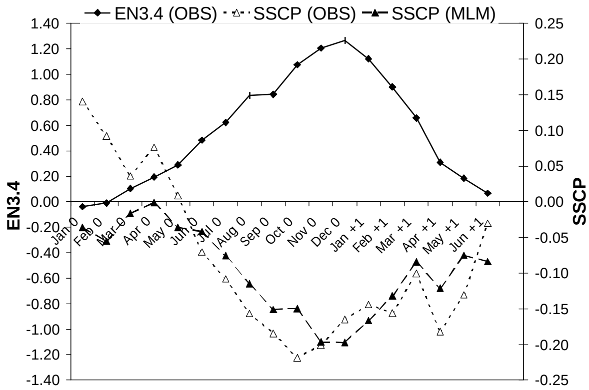

Fig. 1: *El Niño minus neutral year composite time-series of SST anomalies at El Niño3.4 (observed) and SSCP (observed and simulated) regions.*

The model reproduces the ENSO-induced South Pacific SST anomalies with cooling through the latter half of EN yr(0) and warming in the first half of yr(1). The SST anomaly evolution in the SSCP is nearly out-of -phase with the anomalies in Nino 3.4, especially in the model. The observed SSCP anomalies reach a minimum in October, one-two months prior to the model.

Maps of composite El Niño-minus-neutral year anomalies of SST and sea level pressure (SLP) are presented in Fig. 2 for January-February-March (JFM) of the year following the El Niño event. The observed fields are computed from NCEP/NCAR reanalysis dataset and the corresponding simulated fields are from the ensemble mean of the 16 MLM simulations.

The model is able to get the basic structure of the out-of-phase relationship between SLP in the eastern and western tropical South Pacific as well as the cold SST anomalies in the extratropics of both hemispheres. However, the simulated SLP response to ENSO in the middle and high latitudes has a somewhat different structure than in nature and the cold SST anomaly center is west of where it is observed in the central South Pacific Ocean. The latter may result from the simulated precipitation anomalies over the equatorial Pacific and South Pacific convergence zone (SPCZ) being located west of their observed positions. In addition, the upper level circulation is also shifted to the west and the penetration of the SPCZ into the extratropics is weaker than observed (not shown). Vera et al. (2002) showed that in El Niño events with cold SST anomalies in the SSCP region, the SPCZ is located east of its climatological position, providing an additional diabatic heat source over the central South Pacific.

The effect of extratropical air-sea feedback on the atmospheric circulation during El Niño is explored by comparing the MLM simulation (with interactive ocean) to the TOGA simulation (without interactive ocean). The anticyclonic anomaly located west of the Antarctic Peninsula is more intense in the MLM simulations, particularly during austral winter (not shown). The analysis of the year-to-year variability indicates that the observed and simulated SST anomalies over the subtropical South Pacific are well correlated with the El Niño 3.4 index time series, with values in austral spring of -0.63 and -0.74, respectively. However, when only the El Niño years are considered, that correlation drops to -0.10 for the observed SST anomalies while it remains significant (-0.69) for the ENSO-induced SST anomalies in the South Pacific extratropics. The question as to whether the model is unable to reproduce the interdecadal signal that also characterizes the observed SST variability or if the source of subtropical SST variability is not fully related to ENSO, still remains.

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REFERENCES

Alexander, M., I. Bladé, M. Newman, J. Lanzante, N.-C. Lau and J. Scott, 2002*, J. Climate* (in press).

Garreaud, R. D., and D. S. Battisti, 1999: Interannual (ENSO) and interdecadal (ENSO-like) variability in the Southern Hemisphere tropospheric circulation. *J. Climate*, **12**, 2113-2123.

Vera, C.S., G. Silvestri, V. Barros, and A. Carril, 2002: Inter-El Niño (and la Niña) variability of the Southern Hemisphere circulation during austral spring (*submitted to J. Climate).*

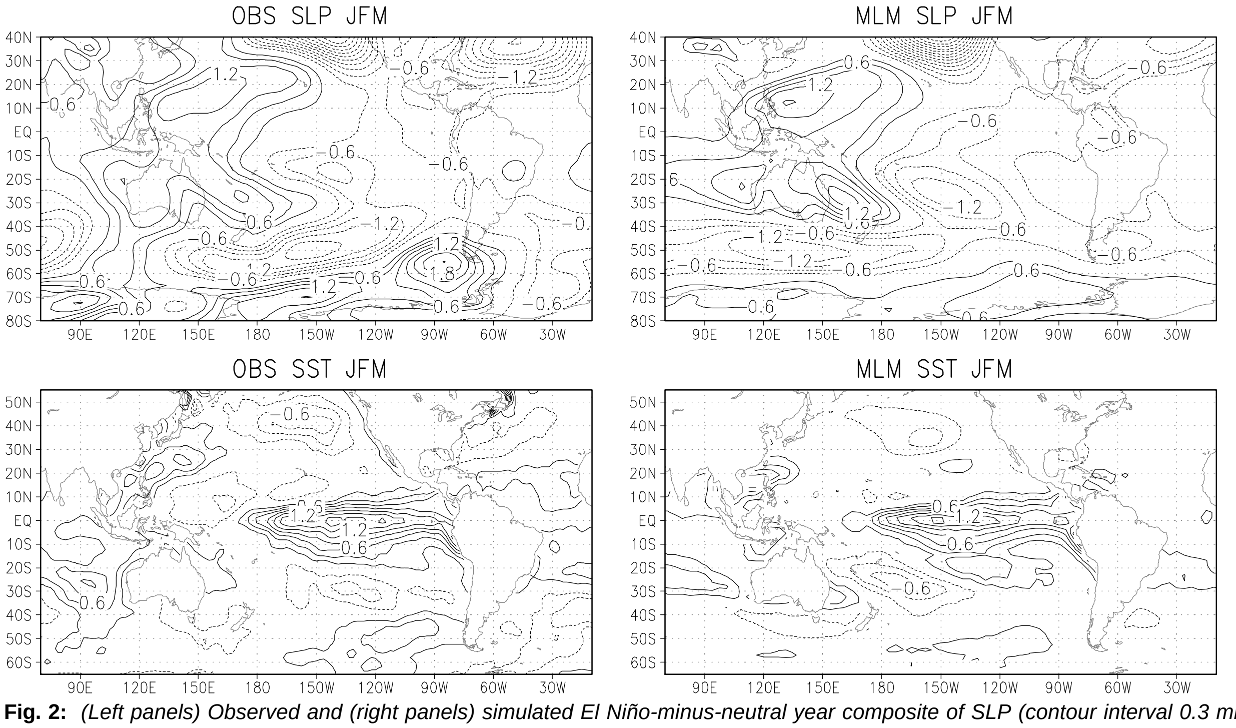

Fig. 2: *(Left panels) Observed and (right panels) simulated El Niño-minus-neutral year composite of SLP (contour interval 0.3 mb) and SST (contour interval 0.2°C) for JFM (+1).*