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Interannual variability of surface heat fluxes and upper ocean under stratus cloud decks in the southeast Pacific

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Persistent stratus cloud decks in the southeast Pacific play an important role in regional and global climate variability. Cloud decks shield incoming solar radiation because of their high albedo and cools the ocean while SST cooling helps maintain the stratus clouds by stabilizing the lower troposphere, and thus clouds and cool SST underneath may mutually reinforce each other. Accordingly, understanding the upper ocean processes that control SST in this region is crucial for simulating stratus clouds and thus predicting regional and global climate. This study investigates interannual variability of surface heat fluxes and upper ocean in the stratus cloud region and its relation with SST variability using gridded surface flux detasets and ocean general circulation model (OGCM) experiments.

The OGCM used in this study is the Hybrid Coordinate Ocean Model (HYCOM) for the tropical Indo-Pacific basin. The model was forced with daily surface fluxes from the NCEP/NCAR reanalysis for the period of 1979-2002. Figure 1 shows monthly SST anomalies from the OGCM and weekly SST analysis (Reynolds et al. 2002) at 85W, 20S where the Woods Hole Oceanographic Institution (WHOI) IMET buoy is located. The OGCM is able to well reproduce observed interannual SST variations in this region (correlation coefficient: 0.80).

These interannual SST variations are compared with surface heat fluxes and subsurface ocean variability. Gridded datasets of latent and sensible heat fluxes are recently created by researchers at WHOI using reanalysis products and satellite data along with TOGA COARE bulk flux algorithm. Surface shortwave and longwave radiation datasets based on ISSCP data are provided by NASA GISS. These estimates agree well with those based on WHOI IMET buoy measurements at 85W, 20S. For example, the correlation coefficient of daily average shortwave radiation between NASA GISS estimates and IMET buoy measurements is 0.8 for the period 2001-2002. These flux estimates are also compared with those from the NCEP reanalysis, showing that the NCEP estimates capture interannual variations of net surface heat flux reasonably well (not shown).

Figure 2 shows the interannual variations of net surface heat flux from the NCEP reanalysis, sea surface height (SSH) and SST from OGCM experiments at 85W, 20S. SST variations associated with ENSO events are evident. While the interannual variation of SSH is significantly correlated with SST, the surface heat flux is not well correlated with the SST and SST tendency. This suggests that three dimensional upper ocean processes play an important role in controlling interannual variations of SST in this region.

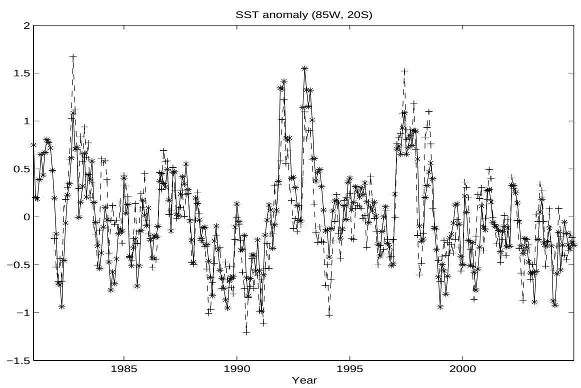

Figure 1. Time series of monthly average SST anomalies at 85W, 20S from OGCM experiments (solid line) and SST analysis (dashed line).

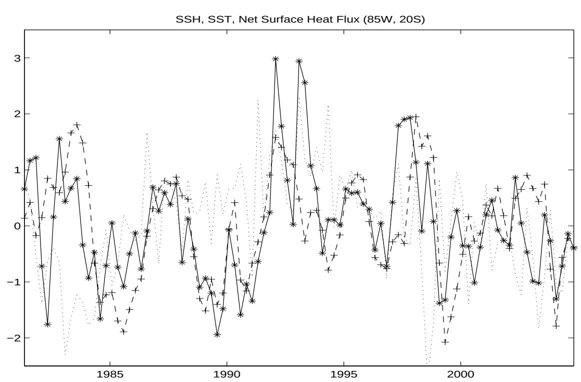

Figure 2. Time series of 3 month average SST (solid line) and SSH (dashed line) anomalies from OGCM experiments and net surface heat flux anomaly (dotted line) from the NCEP reanalysis at 85W, 20S. Time series are normalized by their standard deviations, and linear trends are removed.

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