Cloud Forcing in the Tropical Eastern Pacific

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Introduction

As part of the enhanced monitoring for the Eastern Pacific Investigation of Climate Processes (EPIC), an IMET mooring was deployed at 20S, 85W in the stratus region, and the easternmost (95W) TAO line of moorings was enhanced with additional sensors and moorings. In addition, the biannual TAO maintenance cruises were specially equipped to monitor air-sea fluxes and boundary layer properties.

In this poster we present a preliminary analysis of the observed cloud forcing, its relation to the underlying SST, latent and sensible heat fluxes, and rainfall. In addition, the observed cloud forcing is compared to ISCCP's and NCEP's seasonal climatological cloud forcing.

Methodology

Solar Cloud Forcing
= downwelling shortwave radiation - clearsky shortwave radiation

Longwave Cloud Forcing
= downwelling longwave radiation - clearsky longwave radiation

Clearsky shortwave radiation was computed from Iqbal (1988) algorithm with decimal yearday, latitude, longitude, and estimates of integrated water vapor, and aerosol optical depths.
Clearsky longwave radiation was computed from Fairall algorithm with SST, specific humidity, air temperature, and latitude.

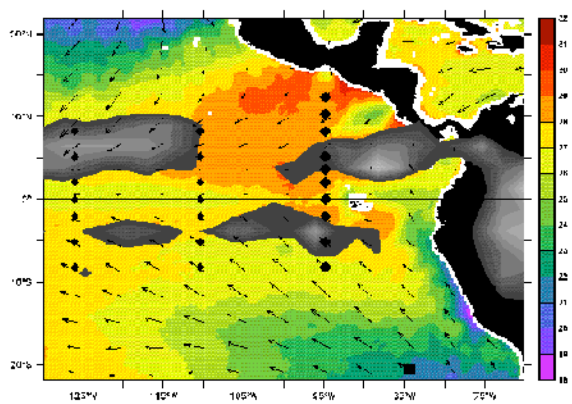

Figure 1. EPIC mooring array shown in relation to the April 2000 mean TMI SST, Xie and Arkin CMAP precipitation (grey), and QuikSCAT wind stress fields (vectors). EPIC mooring array includes: TAO buoys (diamonds), EPIC enhanced TAO buoys (large diamonds), and an IMET buoy (square).

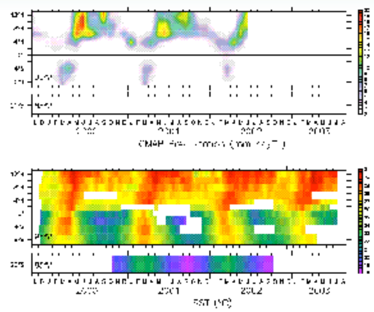

Figure 2. Xie and Arkin CMAP rainrates (top panel) and buoy SST along 95W and 85W (bottom panel). Although rainfall indicates the presence of clouds, not all clouds precipitate. At 20S, 85W there was no precipitation during the IMET's first deployment year.

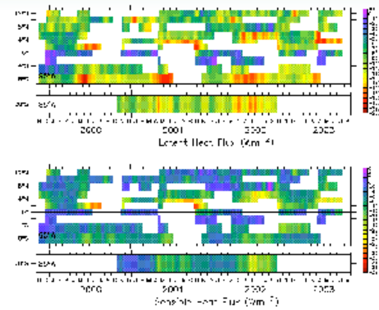

Figure 3. Latent (top panel) and sensible (bottom panel) heat fluxes computed from buoy data. Large heat and moisture transfers from the ocean to the atmosphere destabilize the boundary layer, promoting stratocumulus type clouds. The much lower heat fluxes in the equatorial cold tongue lead to more stratus type clouds.

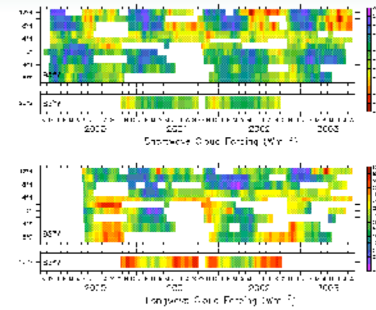

Figure 5. Solar (top panel) and longwave (bottom panel) cloud forcing along 95W and 85W. Clouds tend to reduce surface downwelling solar radiation (SWR) and increase downwelling longwave radiation (LWR). If solar and longwave cloud forcing were exactly equal and opposite, then clouds would have no effect on SST. This is not the case, as shown below.

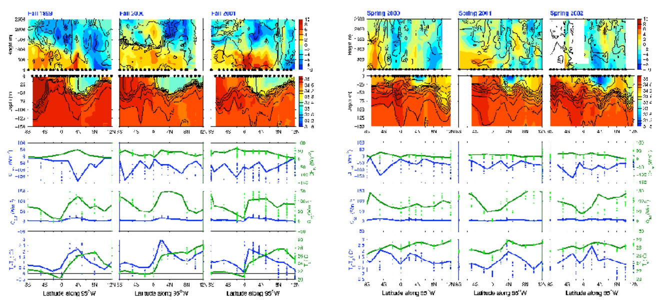

Figure 4. Boundary layer measurements along 95W from NOAA ships Ron Brown (fall sections) and Ka'imimoana (spring sections). Top row: meridional winds (shade) and relative humidity (contours); Second row: salinity (shade) and potential temperature (contours). Bottom 3 rows: solar (blue) and longwave (green) cloud forcing; sensible (blue) and latent (green) heat fluxes; sea-air temperature difference (blue) and SST (green). Daily-averaged data from ship (lines) and buoys (dots).

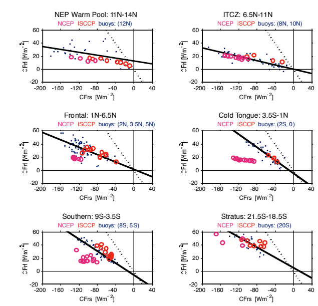

Figure 6. Scatter plots of solar and longwave cloud forcing in different latitude bands. Blue dots are from monthly-averaged buoy data. Red circles are ISCCP seasonal climatology. Magenta circles are NCEP seasonal climatology.

Conclusions

- **Solar cloud forcing is always larger than longwave cloud forcing.**
- **The relative reduction in solar radiation and increase in longwave radiation depends upon cloud type and varies across the stratus deck / cold tongue / ITCZ complex.**
- **ISCCP seasonal climatology compares well with the buoys.**
- **NCEP seasonal climatology compares well with the buoys in the ITCZ region, but does not compare well in the cold tongue and southern regions.**
- **These results suggest that NCEP analysis (and perhaps others) could be significantly improved through better assimilation of satellite-based products.**