Cloud Structure Anomalies Over Tropical Pacific During 97/98 El Nino

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Motivation

• To show cloud structure changes from several highly correlated cloud variables over the equatorial Pacific during the 97/98 El Nino by using CERES data.

• To investigate the apparent negative correlation between OLR and SST under both all and clear sky over the eastern equatorial Pacific during the strong El Nino.
Study Area

Western: 5S-10N, 120E-170E
Eastern: 7.5S-7.5N, 80W-160W
El Nino Index 3: 5S-5N, 90W-150W
Data

- CERES SRB AVG2 data:
  cloud fraction, cloud altitude, cloud optical depth and OLR
  Time: January -- August, 1998
- NOAA CDC: NINO3
- NOAA NCDC: SST
- ECMWF Reanalysis: P, T, SH (specific humidity)
1997/98 El Nino Index 3

Index 3: 5S-5N, 90W-150W
Cloud Altitude

Eastern region

Western region

Cloud altitude (km)

Month

Cloud altitude (km)

Month
Cloud Property Formula

\[
\bar{A} = \frac{\sum_{j=1}^{n} \sum_{i=1}^{4} A_{ij} f_{ij}}{\sum_{j=1}^{n} \sum_{i=1}^{4} f_{ij}}
\]

\(\bar{A}\) : is the regional monthly average
\(A_{ij}\) : specific variable for each grid
\(f_{ij}\) : cloud fraction
\(n\) : is the total number of 1×1 grids within the region
\(4\) : four non-overlapping layers.
Clear Sky Sensitivity

Graphical representation showing the relationship between OLR (°C) and SST (°C). A red line indicates a correlation with a correlation coefficient of $R = -0.83$. This line is labeled as 'Clear sky'.

Bar graph showing changes in OLR (W/m²) for different perturbed quantities: SST, SH, LR, and TOTAL.
Summary

- The changes of major cloud parameters are highly correlated over both western and eastern equatorial Pacific during 97/98 El Nino. Eastern region clouds become thicker and more widespread due to stronger convection while western region shows just the opposite.
- The all sky OLR change over Eastern region is not directly driven by SST but mainly by cloud altitude and cloud fraction.
- The clear sky OLR change is mainly due to moisture change. The SST and lapse rate play minor and compensating roles for OLR change. All these factors play roles in all sky OLR change with relative smaller effects than that of cloud properties.