Global Weather States and their Properties from Passive and Active Satellite Retrievals

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Regime definitions:

1. Using dynamic/thermodynamic parameters

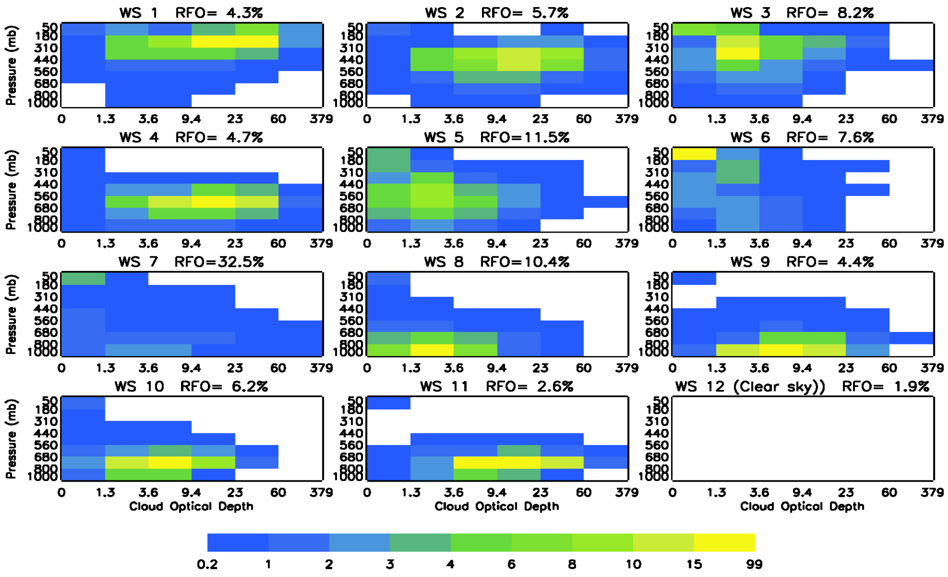
SLP – e.g. Tselioudis et al. 2000
Vertical Velocity – e.g. Tselioudis and Jakob 2002, Bony et al. 2004. Wyant et al. 2006
W-SST-Static Stability combinations – e.g. Norris and Iacobellis 2005, Williams et al. 2006
Large scale circulation proxies – Clement et al. 2009

2. Using cloud parameters

TAU-PC Clustering – e.g. Jakob and Tselioudis 2003, Rossow et al. 2005

Clustering in the past was done for specific climate regimes

Here we present TAU-PC clusters derived for the global domain and analyze their properties and variability



Global Weather States (WS) derived through cluster analysis of ISCCP TAU-PC histograms:

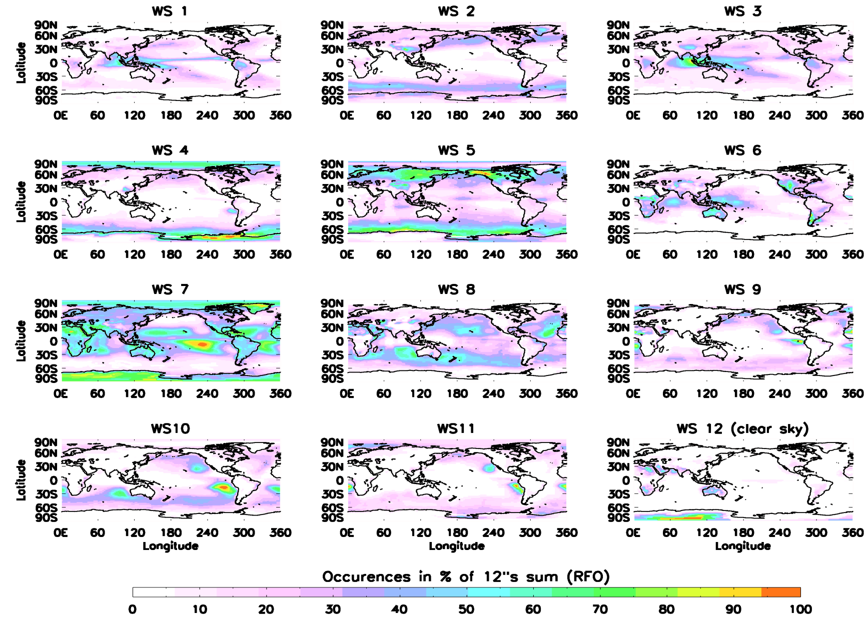
11 WS going from deep convective to stratocumulus clouds

Fair-weather WS7 most frequent one

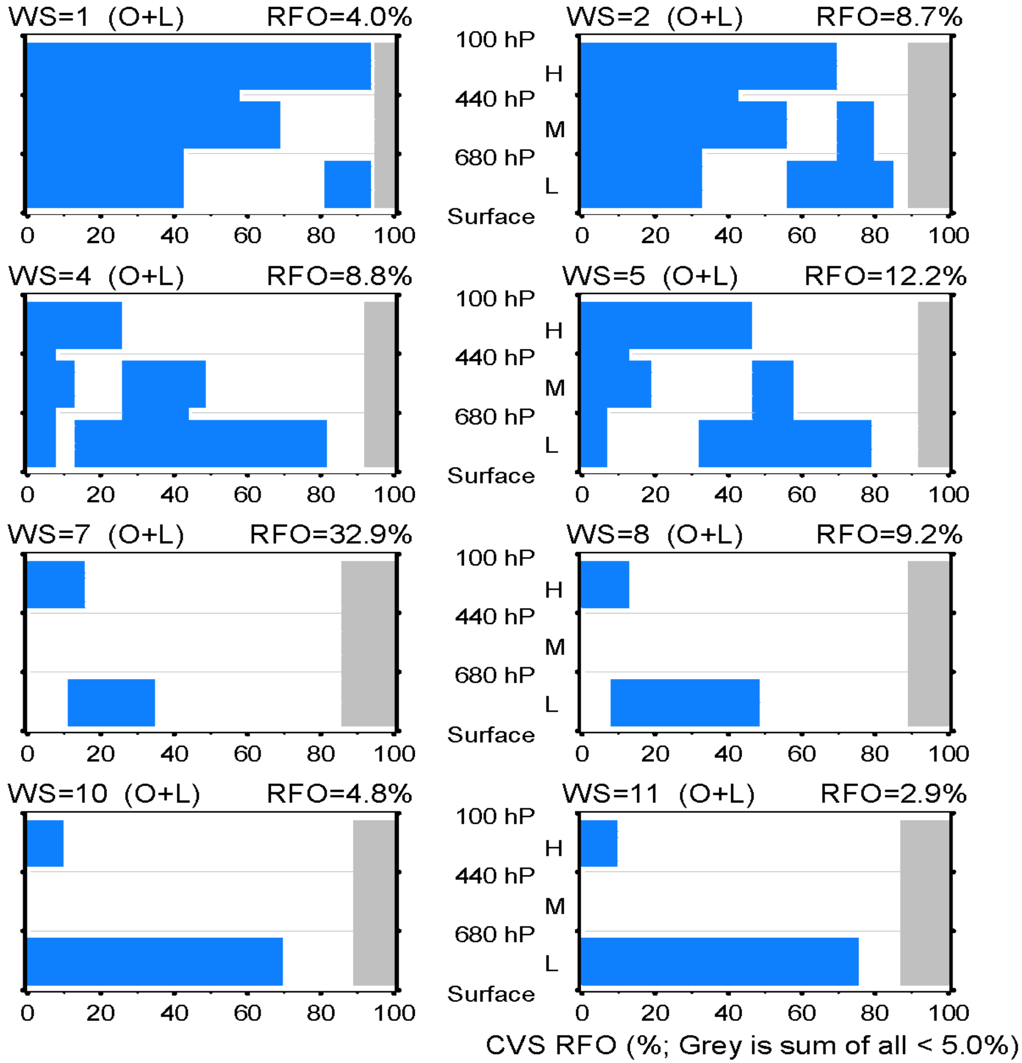
Separation of tropical and midlatitude convective clouds

Tropical-subtropical region shows a stratocumulus-shallow cumulus-fair weather balance

Tselioudis et al. 2013



Cloud Vertical Structure (CVS) of the ISCCP WS derived from CloudSat-CALIPSO retrievals



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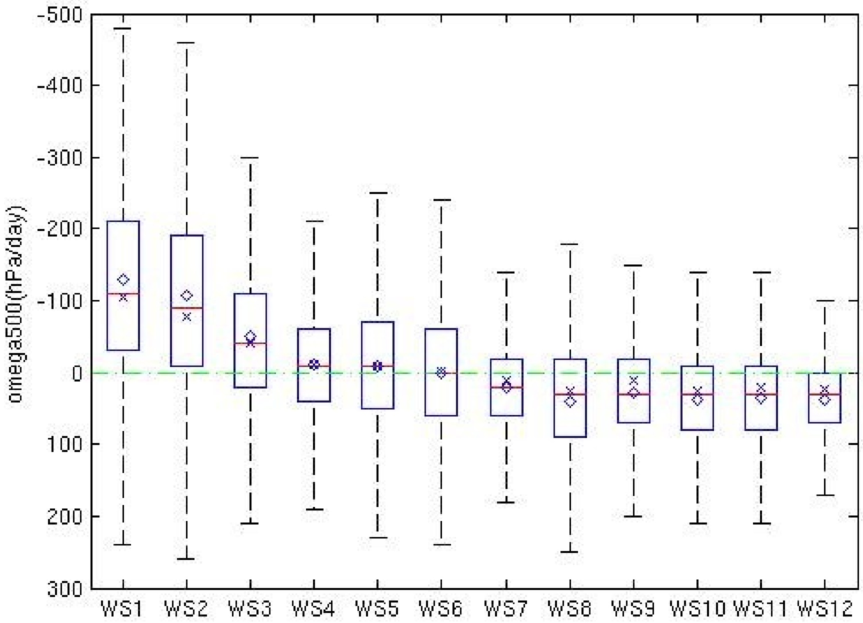
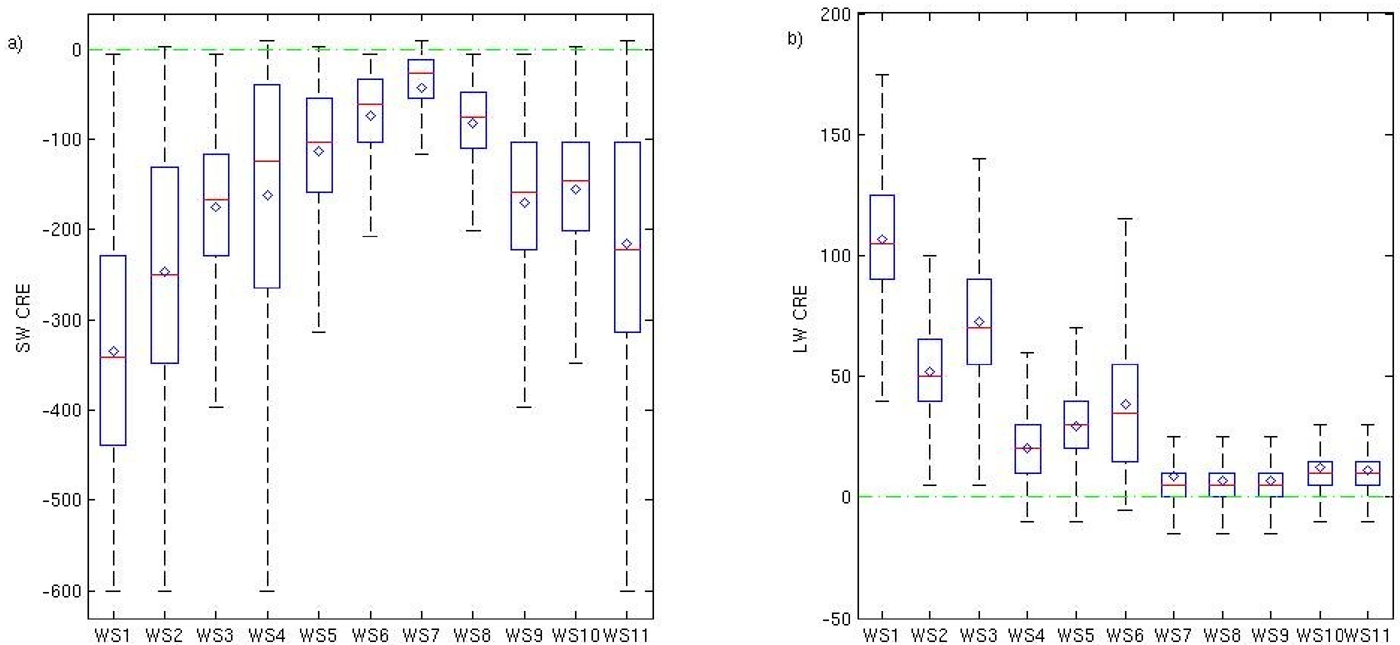
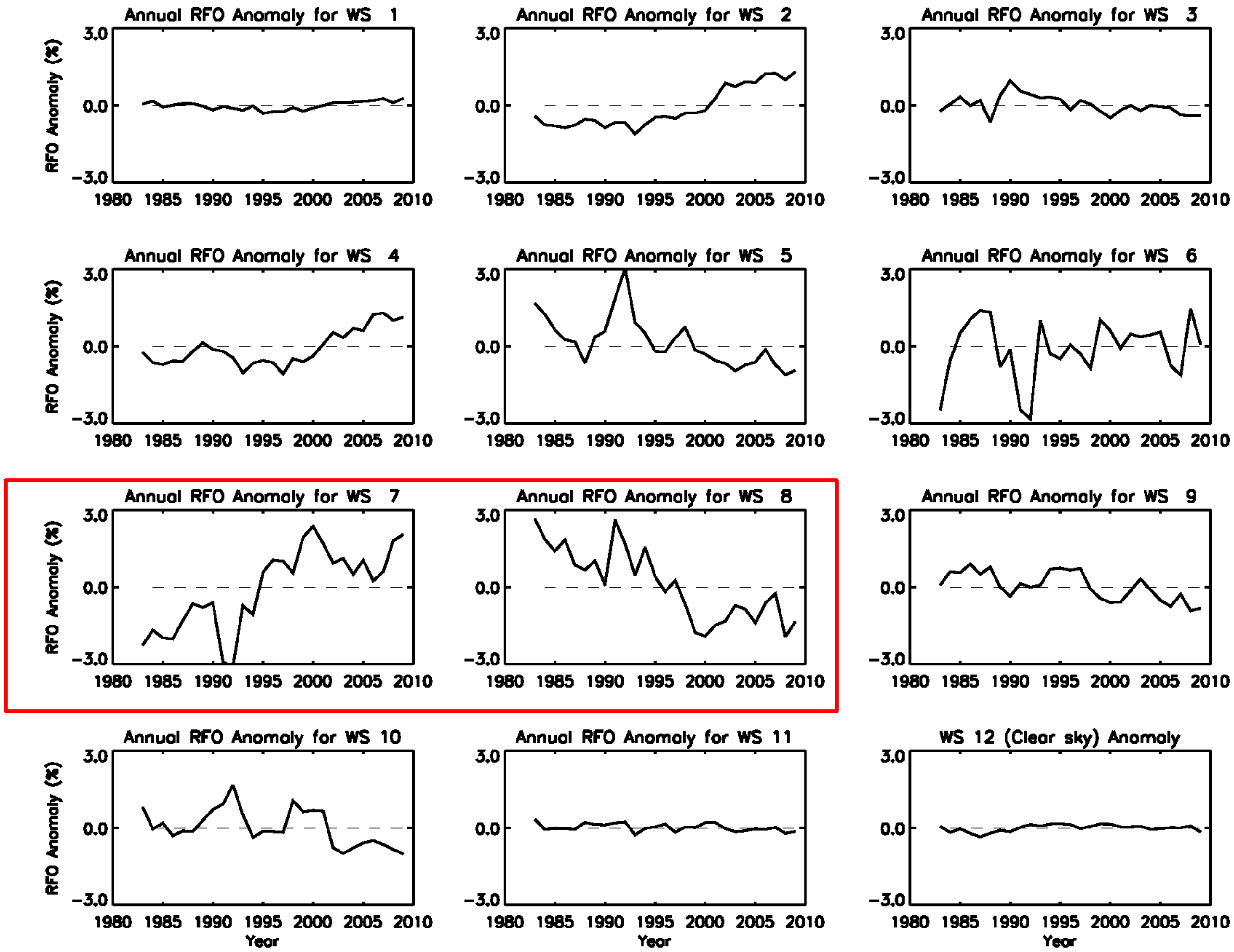


500mb vertical velocity for the 12 WS

SW and LW Cloud Radiative Effect (CRE) for the 11 WS

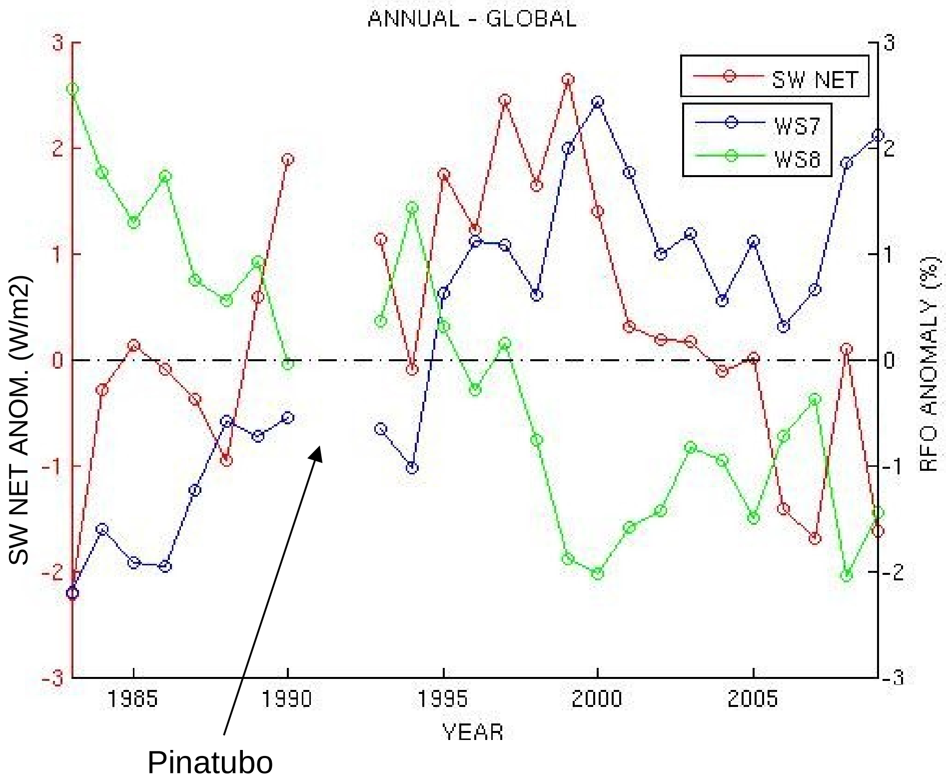


Time series of WS RFO



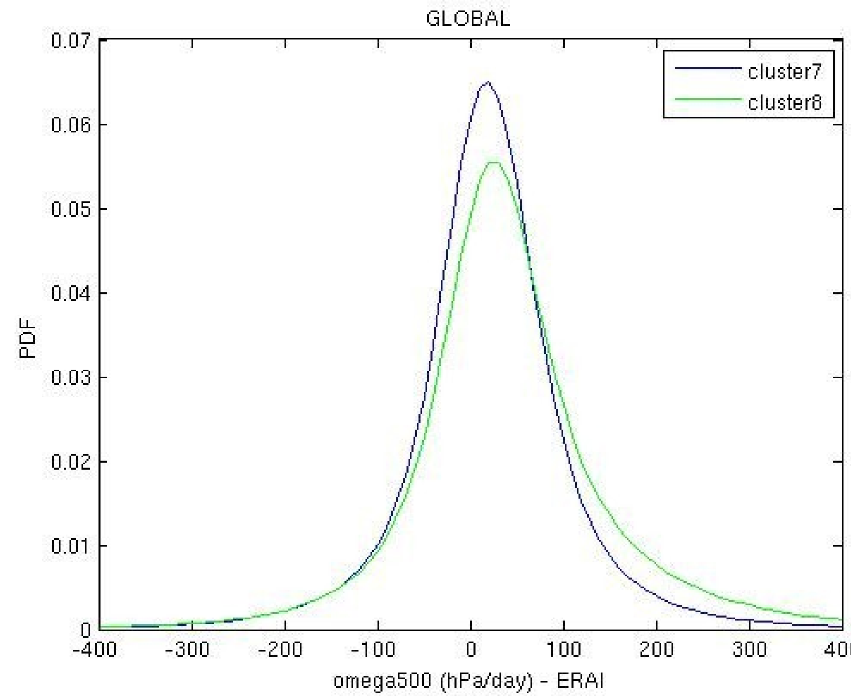
Increase in fair-weather WS7 and decrease in shallow cumulus WS8 the two more significant trends in the WS time series

A shallow cumulus – fair weather transition?



- Increase – decrease of ~4% in WS7 – WS8 in the 1980s-1990s followed by a decrease – increase of ~2% in the 2000s

- Increase of ~3W/m2 in the SW NET in the 1980s-1990s followed by a decrease of ~2W/m2 in the 2000s



Shallow cumulus – fair weather transition a change in the subsidence tail of the W-500mb PDF

Summary

- Weather State analysis shows consistent global patterns of WS distributions that relate directly to the regional patterns derived in previous studies.

- Compositing CloudSat/CALIPSO Cloud Vertical Structures for the Global WS shows unique features that correspond well with the expected patterns from the radiatively derived TAU-PC clusters.

- The Global WS show normal and significant transitions in 500mb vertical velocity and in SW/LW Cloud Radiative Effect.

- 30-year time series shows a shallow cumulus – fair weather transition with decreases - increases in the 80s and 90s and decreases – increases in the 00s. This coincides with increases – decreases in net absorbed SW radiation and could provide a radiative explanation for the slow down of climate warming in the last decade.