Weather State Variability at the Azores Site and the Relevance to Climate Model Evaluation

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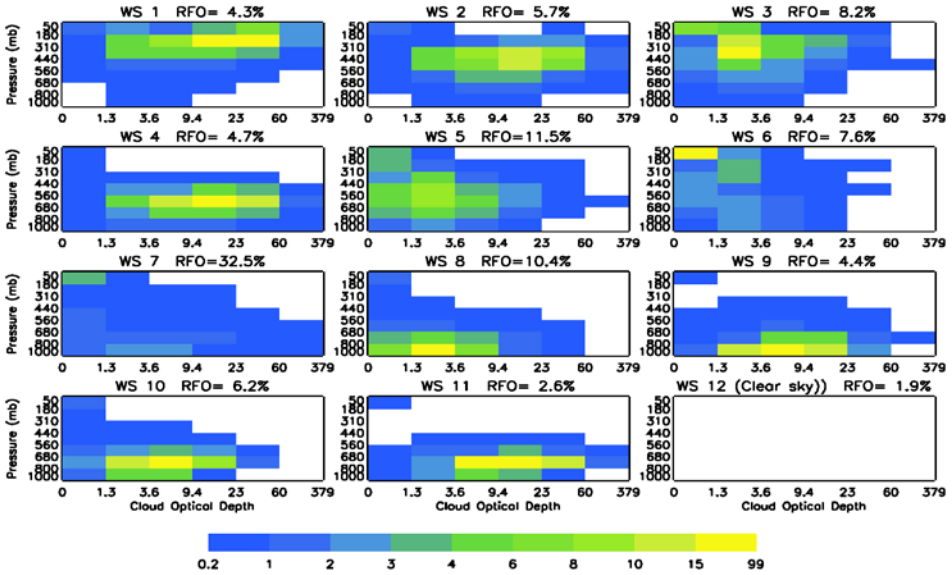


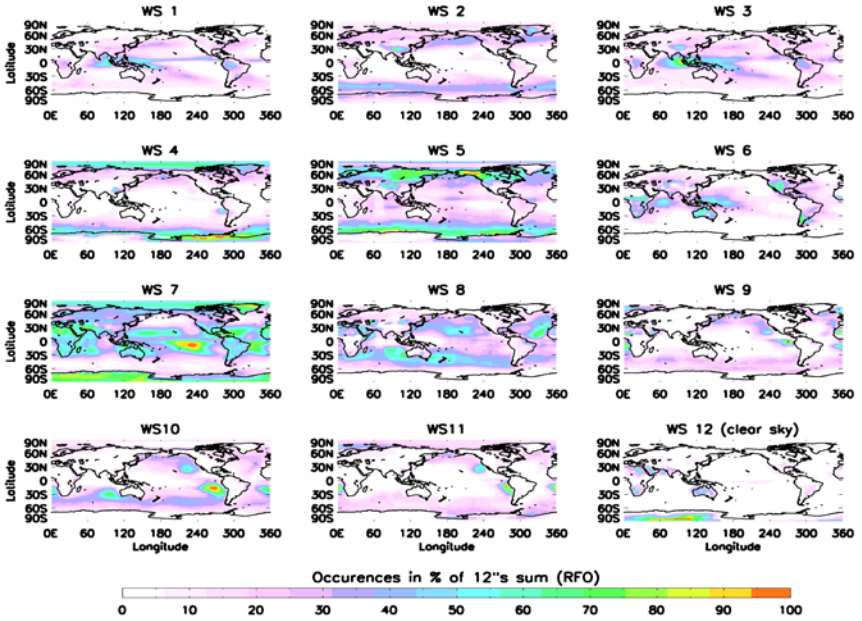
Global Weather States (WS) derived through cluster analysis of ISCCP TAU-PC histograms:

11 WS going from deep convective to stratocumulus clouds

Fair-weather WS7 most frequent one

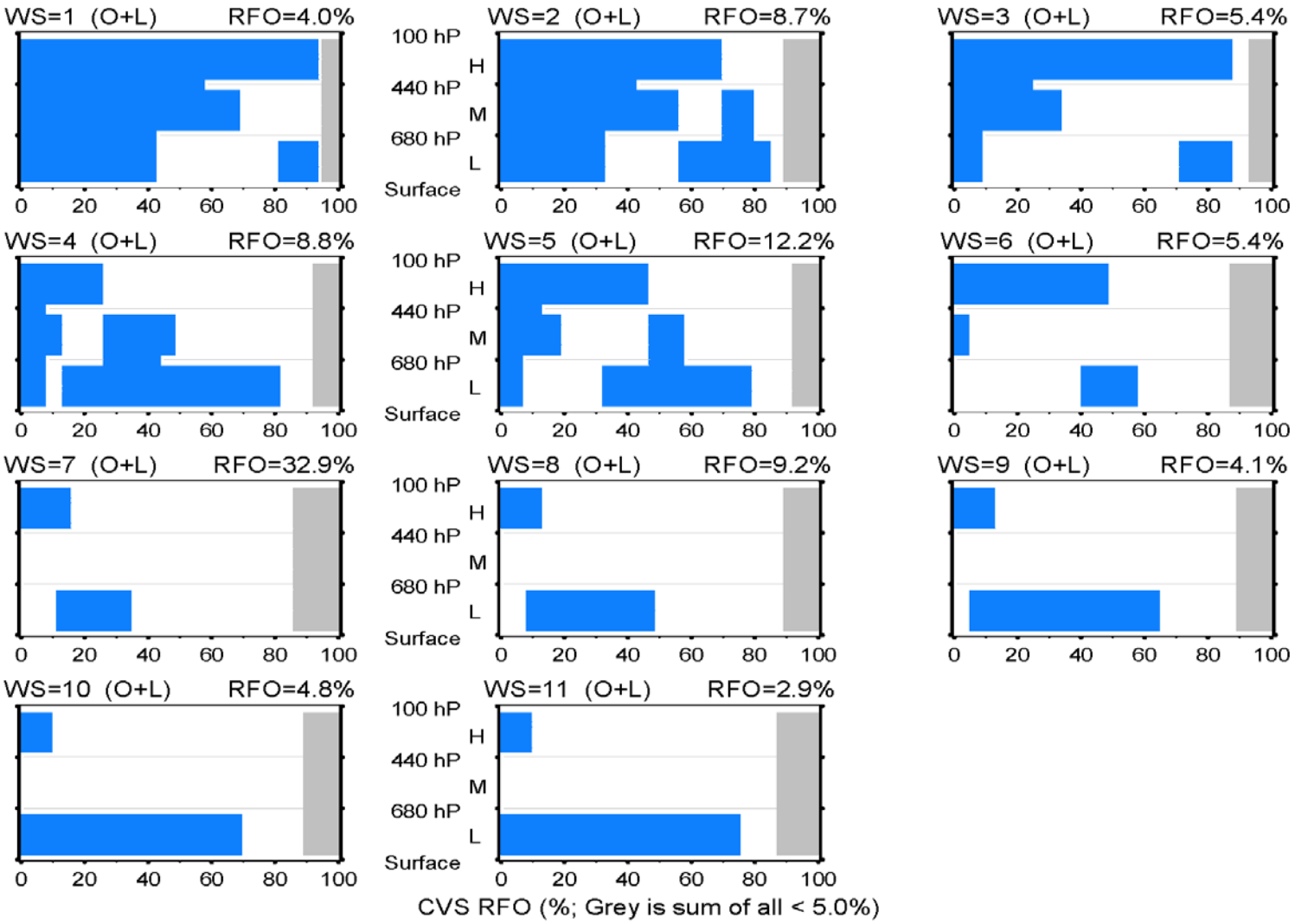
Separation of tropical and midlatitude convective clouds

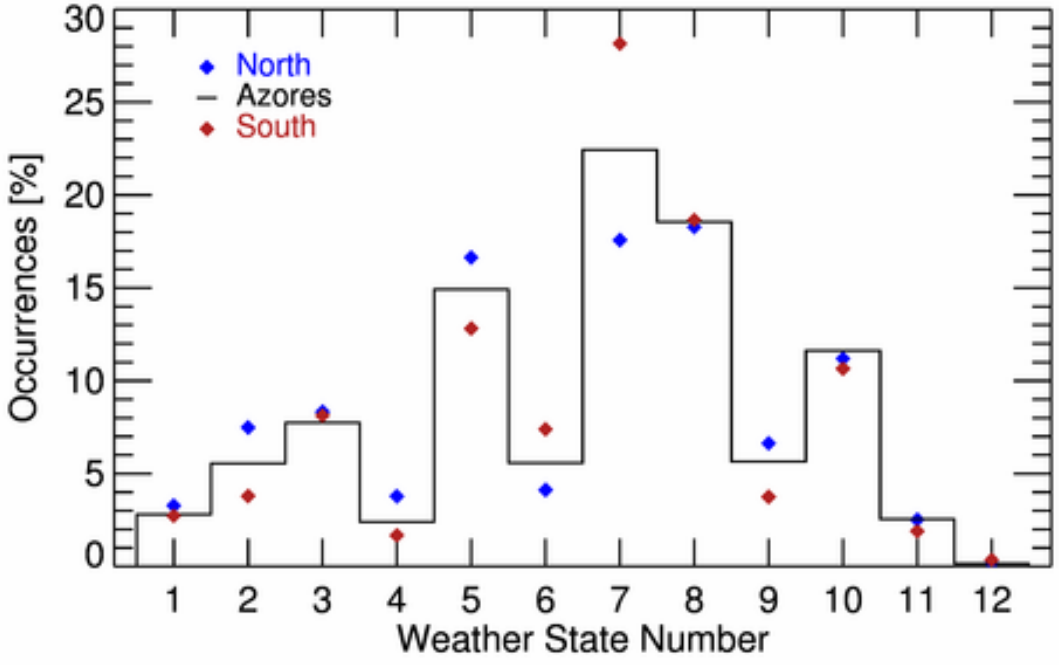
Tropical-subtropical region shows a stratocumulus-shallow cumulus-fair weather balance



Tselioudis et al. 2013

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





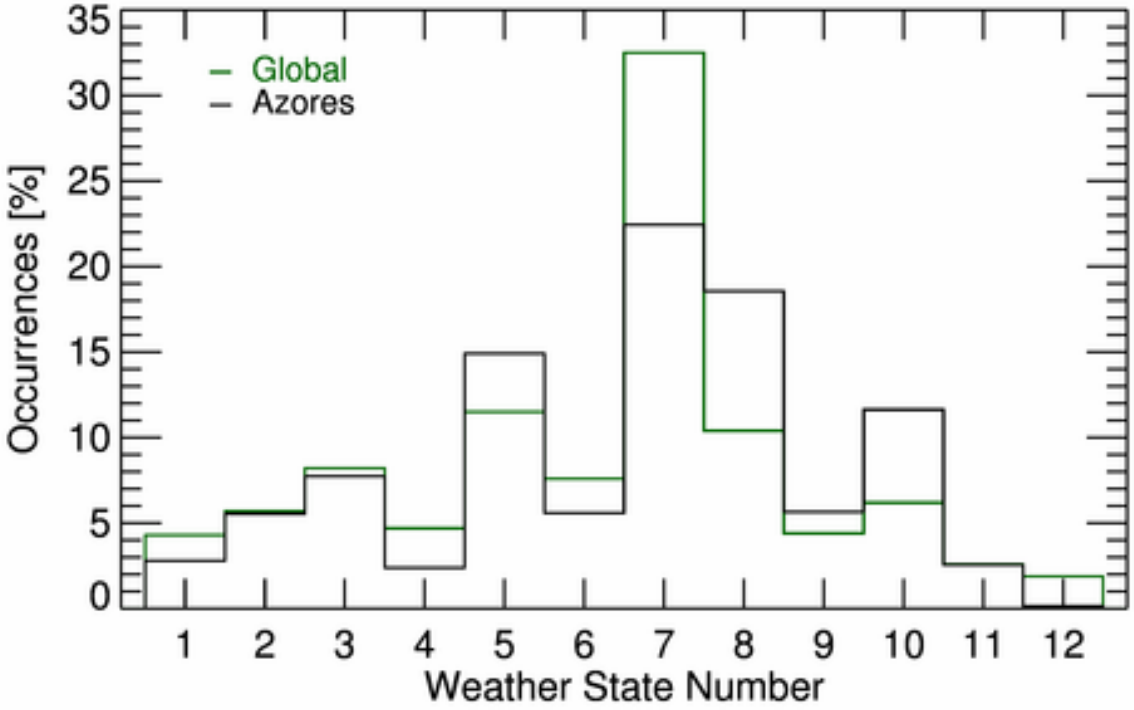
Weather States in the Azores

Fair-weather most frequent but significant amounts of shallow cumulus, stratocumulus, and storm clouds

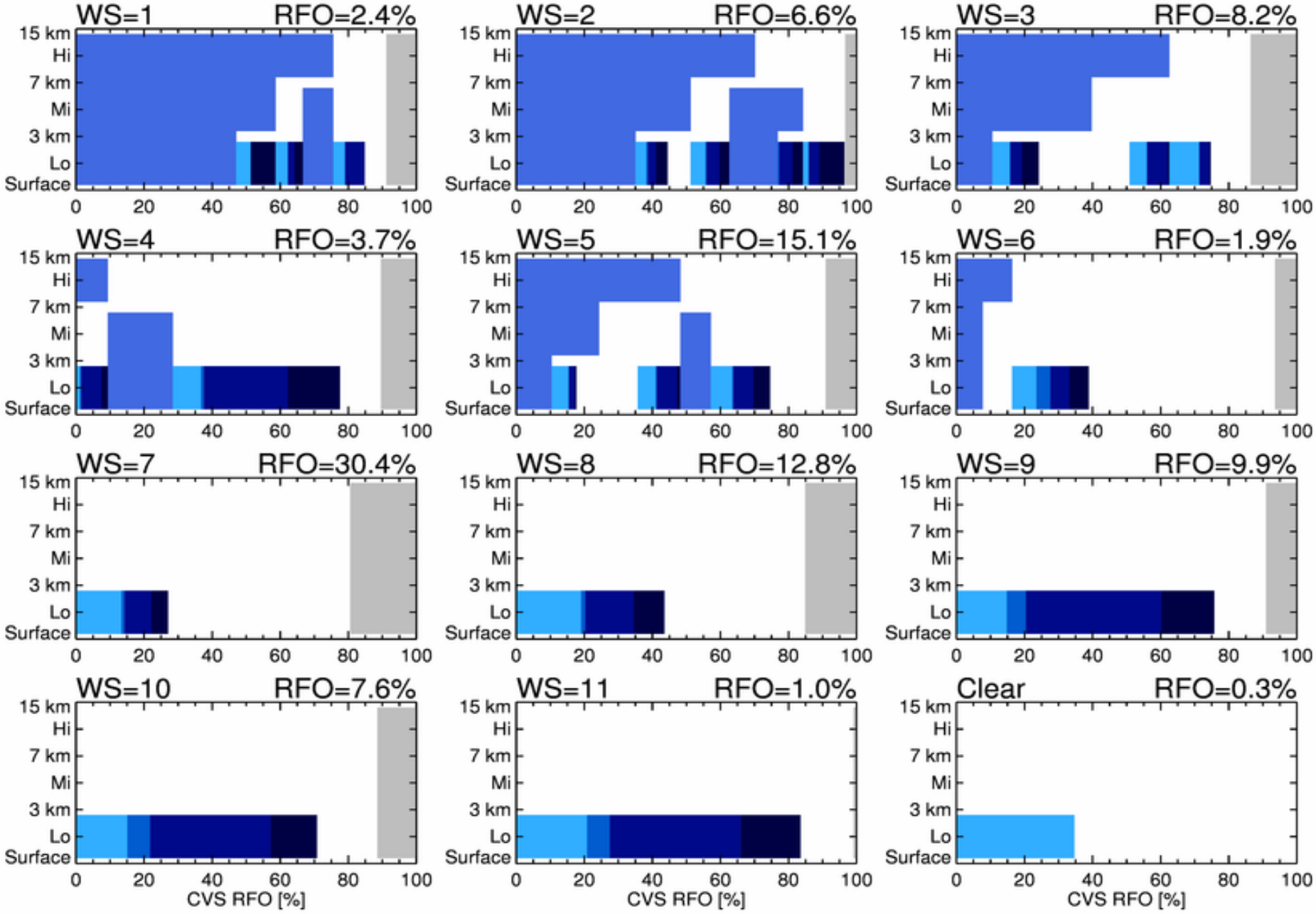
Fair-weather increases southward and storm clouds northward of the Azores grid box.

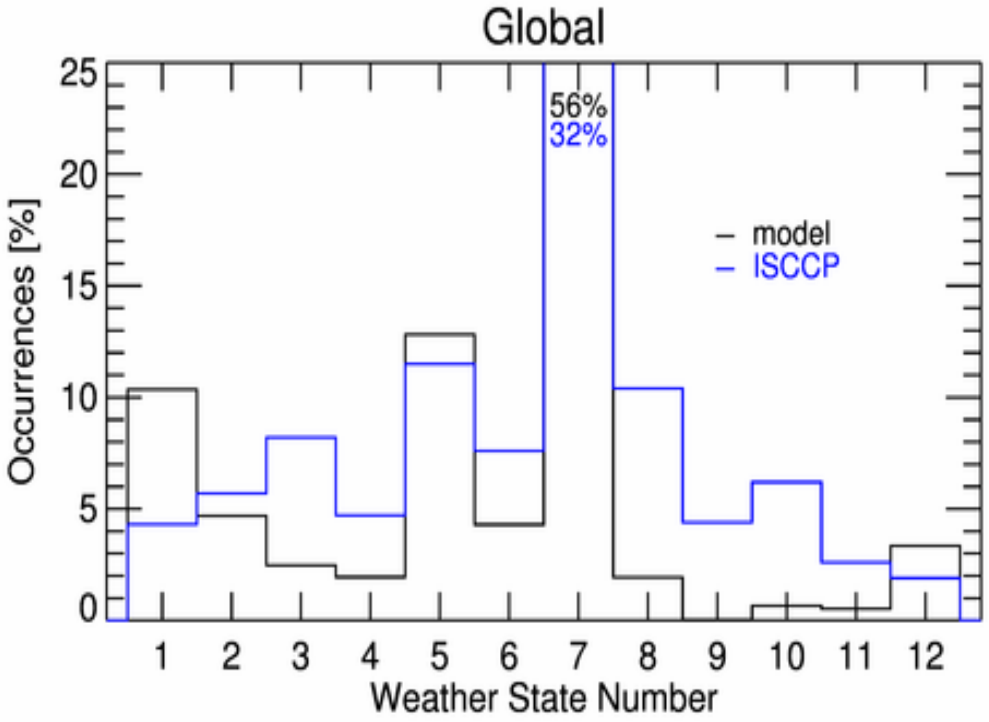
Azores vs Global WS

Lower fair-weather and deep convection frequency and higher frequency of shallow cumulus and stratocumulus clouds



Cloud Vertical Structure (CVS) of the Azores WS derived from AMF retrievals





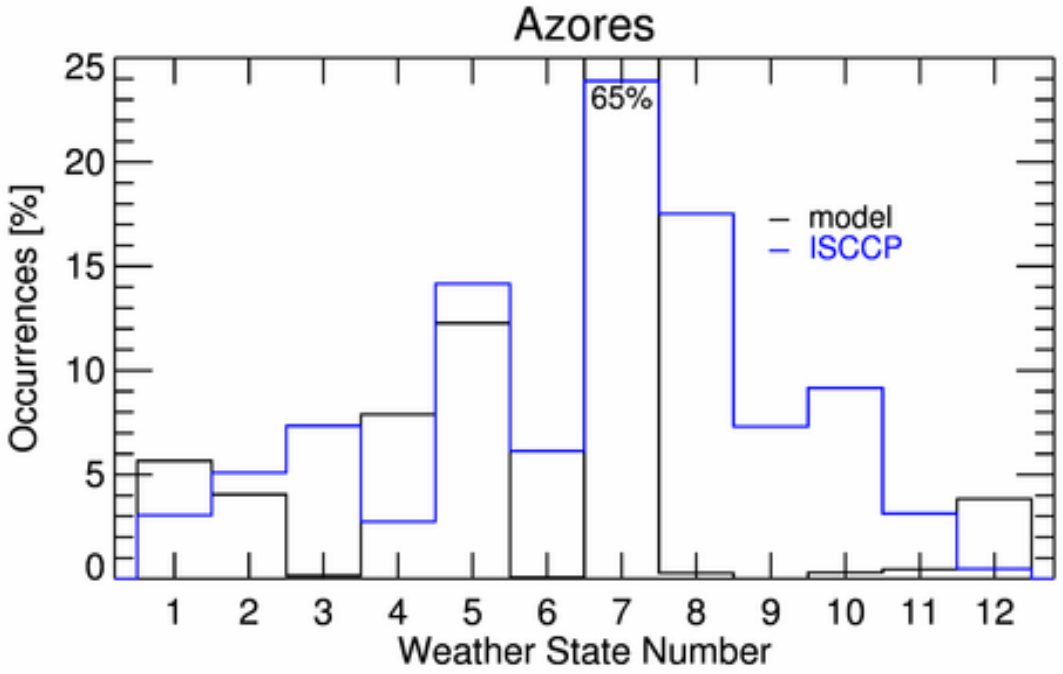
Weather States in the GISS GCM

Model severely overpredicts the fair-weather WS and underpredicts the low cloud WS

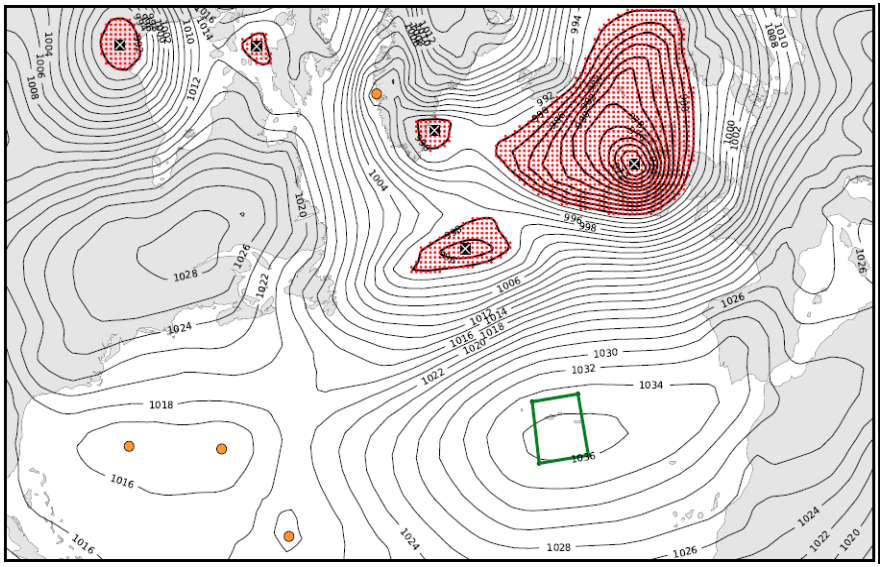
Tropical convection is overpredicted in the model

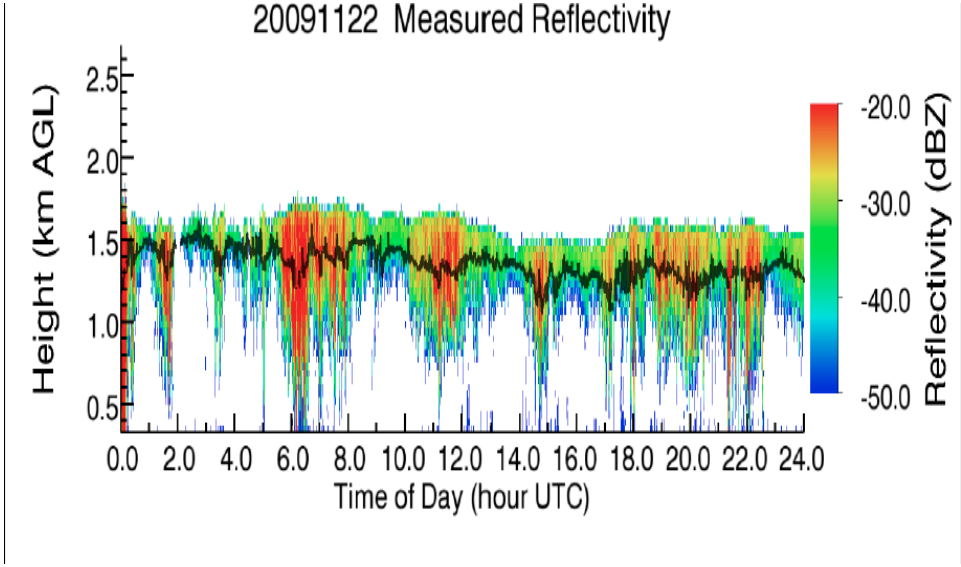
GISS GCM WS in the Azores

Most GCM WS deficiencies in the global domain are present in the Azores analysis

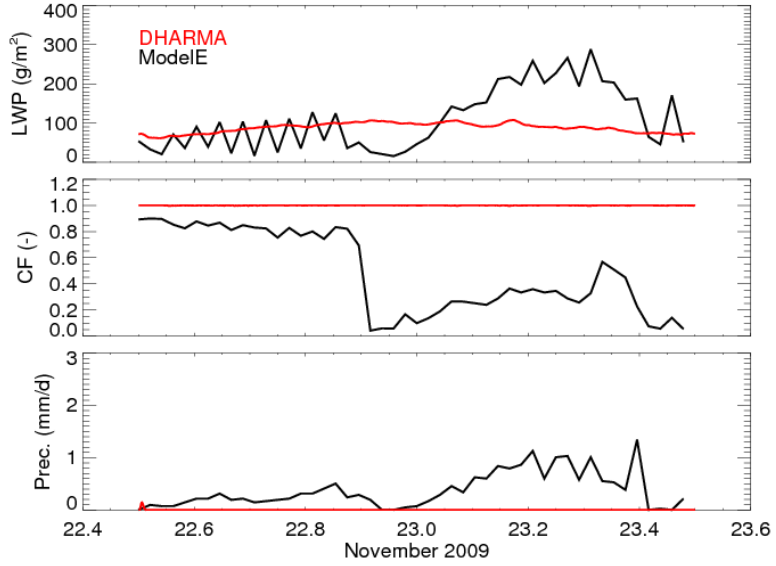


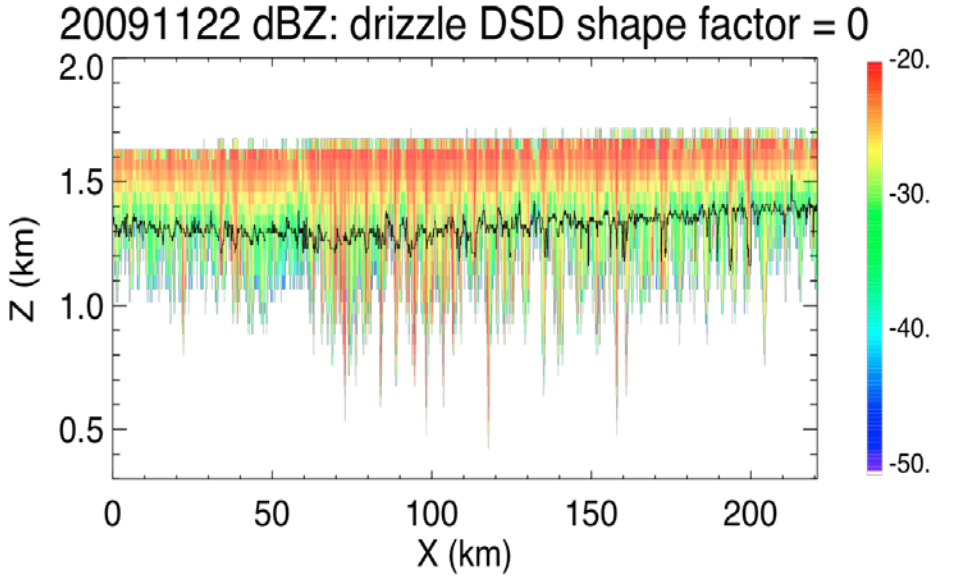
The case of Nov. 22, 2009: WS11 at 12z, WS10 at 15z





Model simulations using the GISS SCM and the Dharma LES



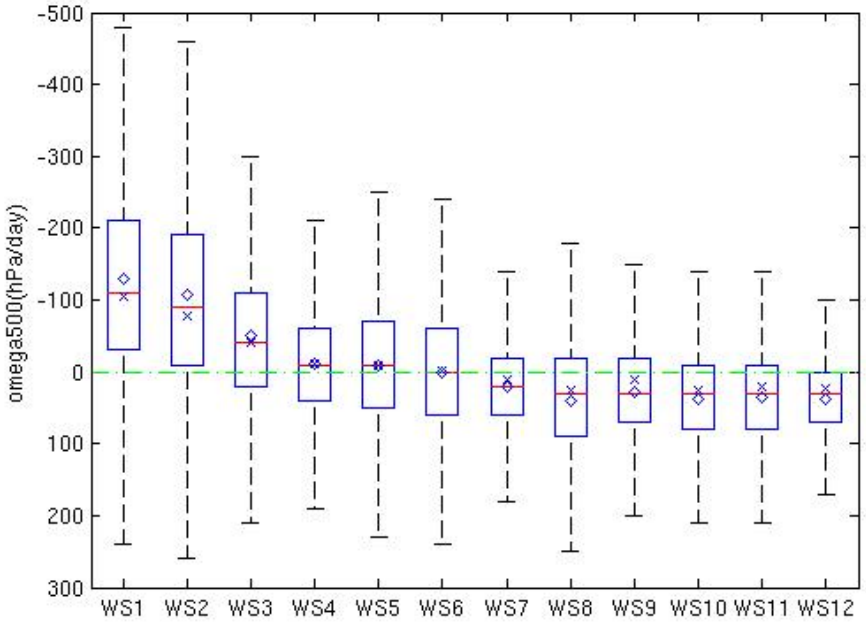


Summary

Weather State analysis shows Azores to be a good lab to study major deficiencies in GISS GCM cloud property simulations

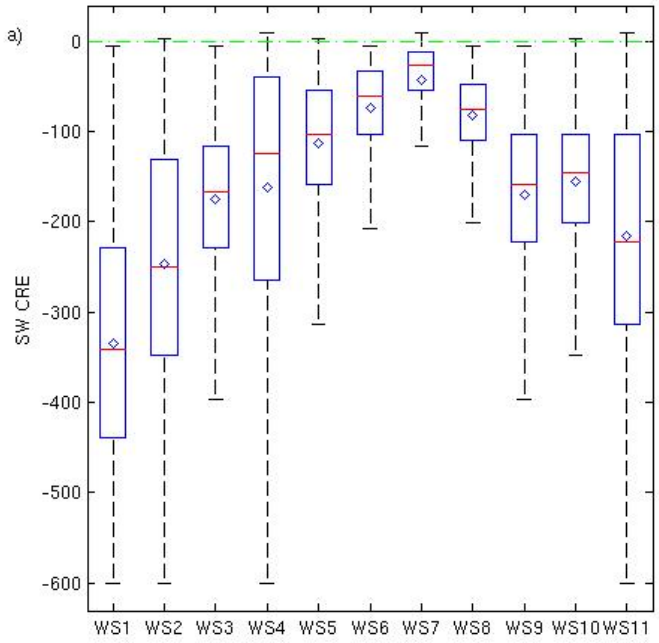
Tools are in place to allow us to slide back and forth between global and local scale observations and model simulations.

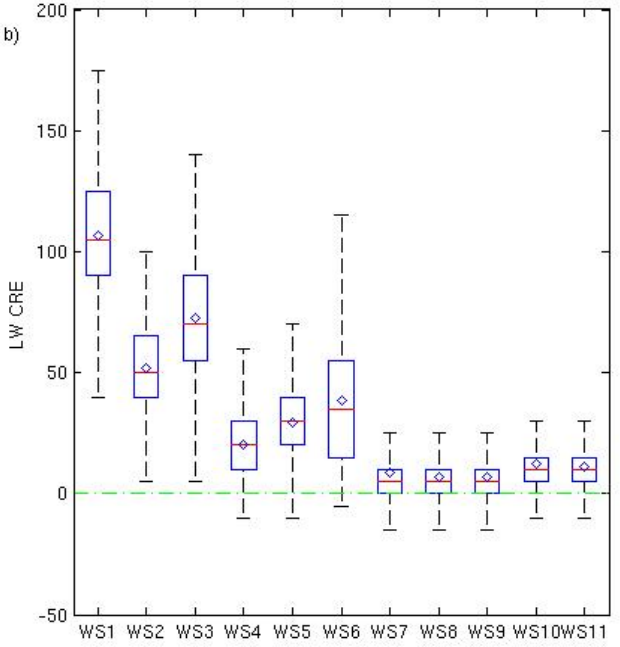
The strategy is to use case study SCM and LES simulations constrained by AMF observations to understand model deficiencies in simulating cloud processes and attribute them to forcing field inadequacies or parameterization problems, and then use the satellite and GCM analysis to understand the relevance of those deficiencies to the global model climate simulations.

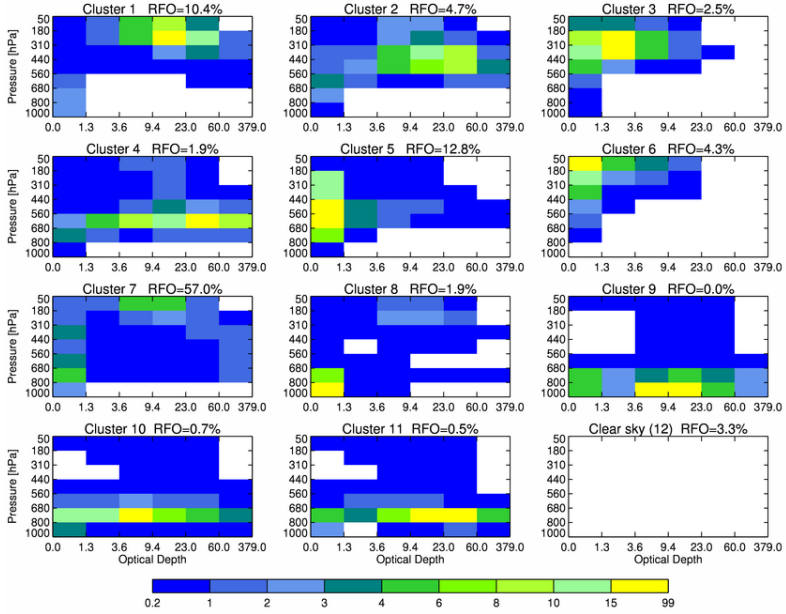


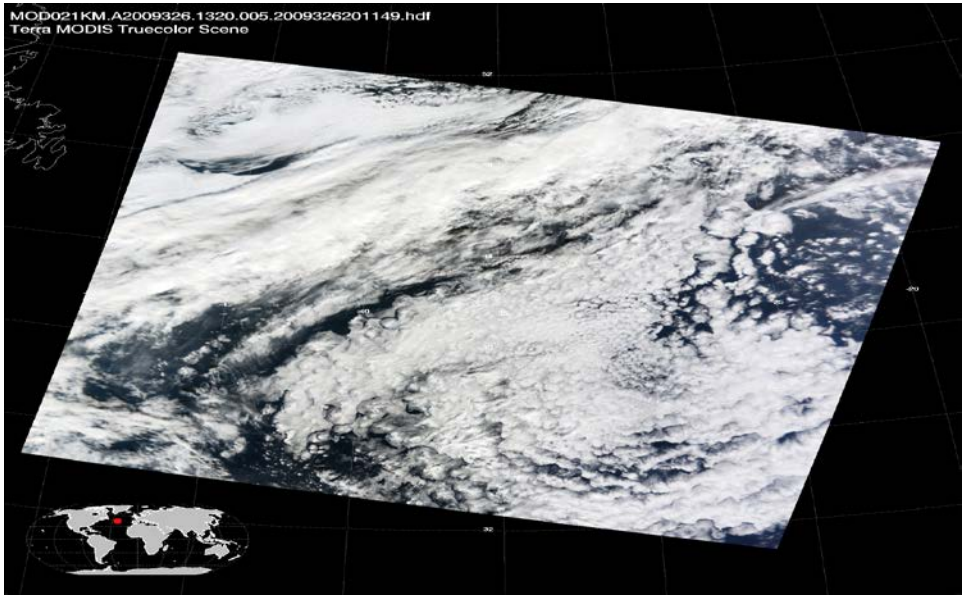
500mb vertical velocity for the 12 WS

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






Cluster 1 RFO=10.4%
Cluster 2 RFO=4.7%
Cluster 3 RFO=2.5%
Cluster 4 RFO=1.9%
Cluster 5 RFO=12.8%
Cluster 6 RFO=4.3%
Cluster 7 RFO=57.0%
Cluster 8 RFO=1.9%
Cluster 9 RFO=0.0%
Cluster 10 RFO=0.7%
Cluster 11 RFO=0.5%
Clear sky (12) RFO=3.3%
Pressure [hPa]
50 180 310 440 560 680 800 1000
0.0 1.3 3.6 9.4 23.0 60.0 379.0
Optical Depth
0.2 1 2 3 4 6 8 10 15 99


MOD021KM.A2009326.1320.005.2009326201149.hdf
Terra MODIS Truecolor Scene