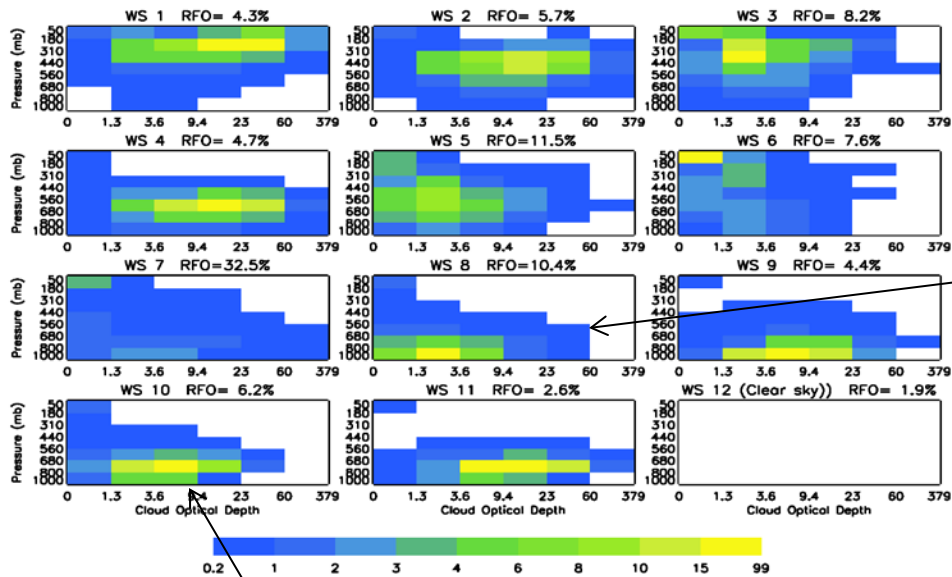


LES and SCM simulations of a closed and an open cell case over the Azores.

*George Tselioudis, Jasmine Remillard, Andy Ackerman, Ann Fridlind
NASA/GISS – Columbia University*

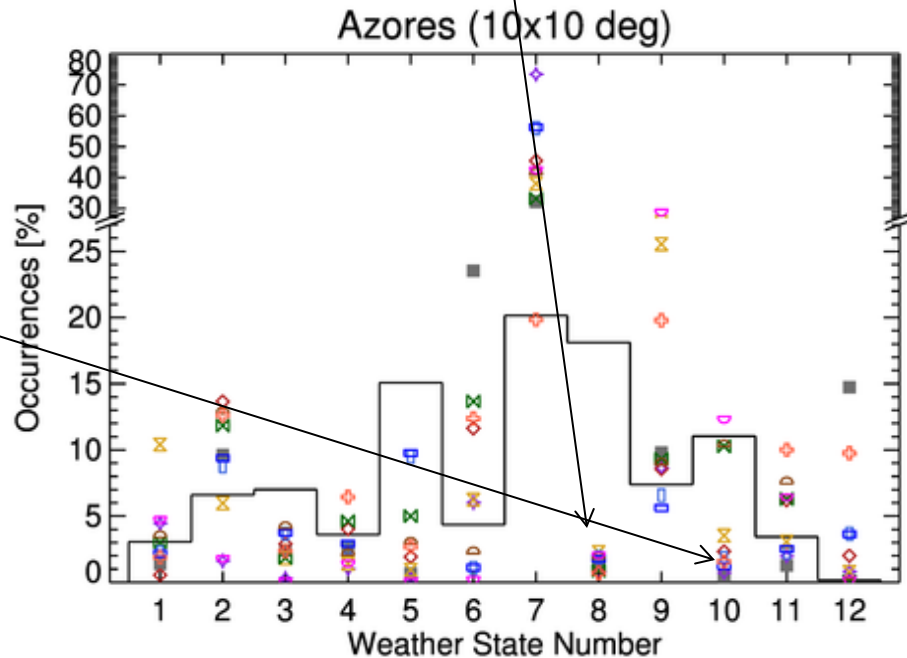
ISCCP global Weather States



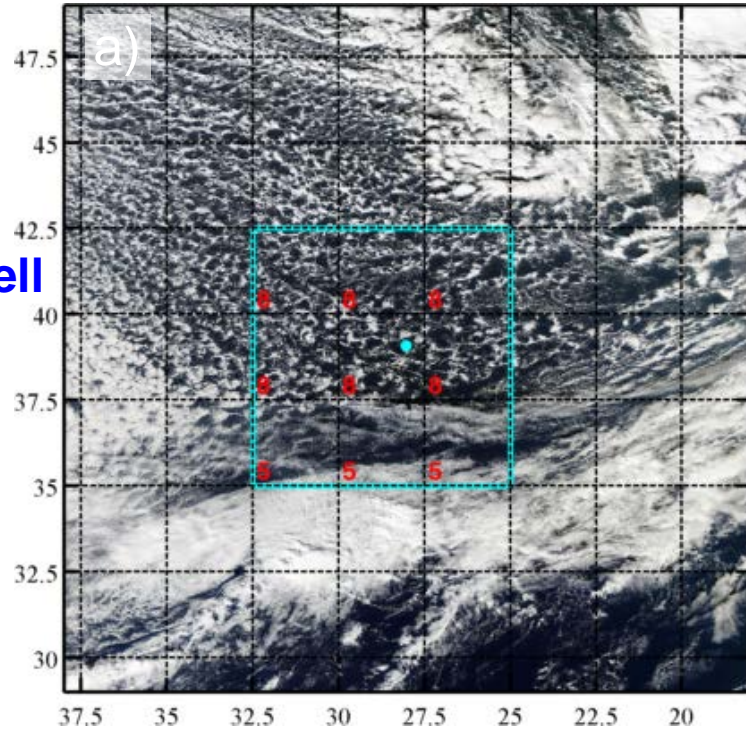
Shallow Cumulus
WS8

CMIP5 GCM WS in the Azores

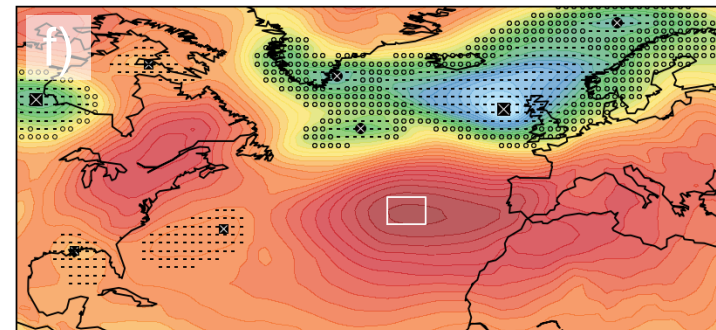
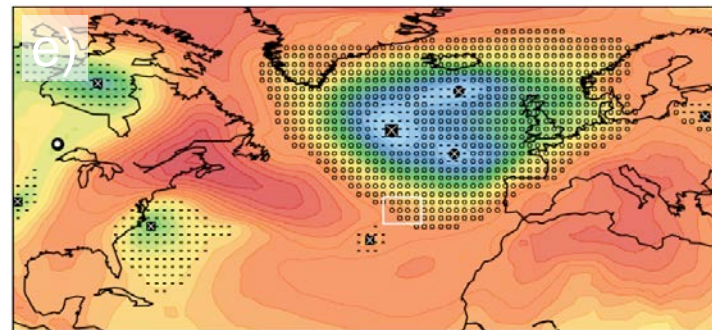
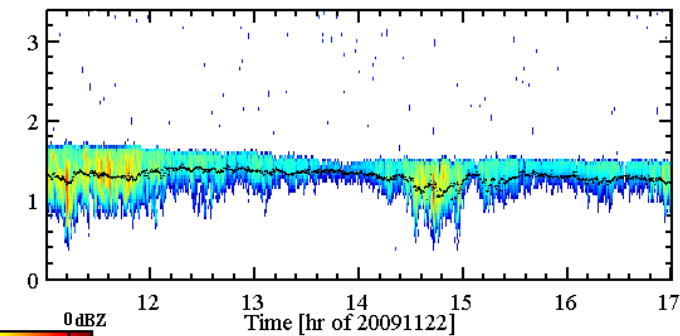
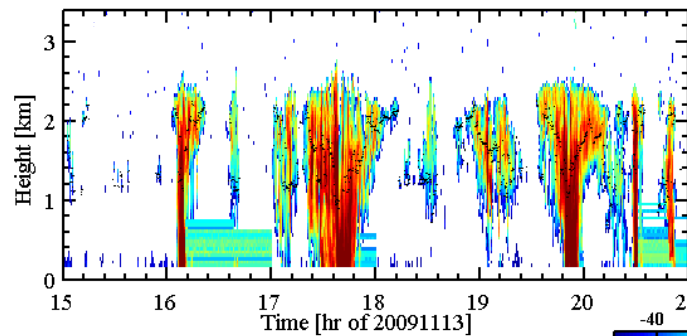
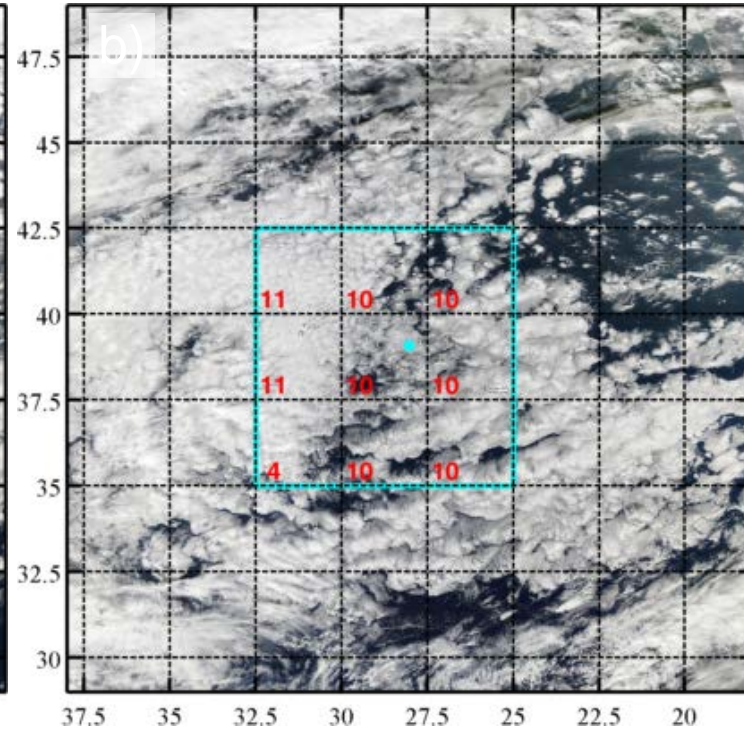
Stratocumulus
WS10



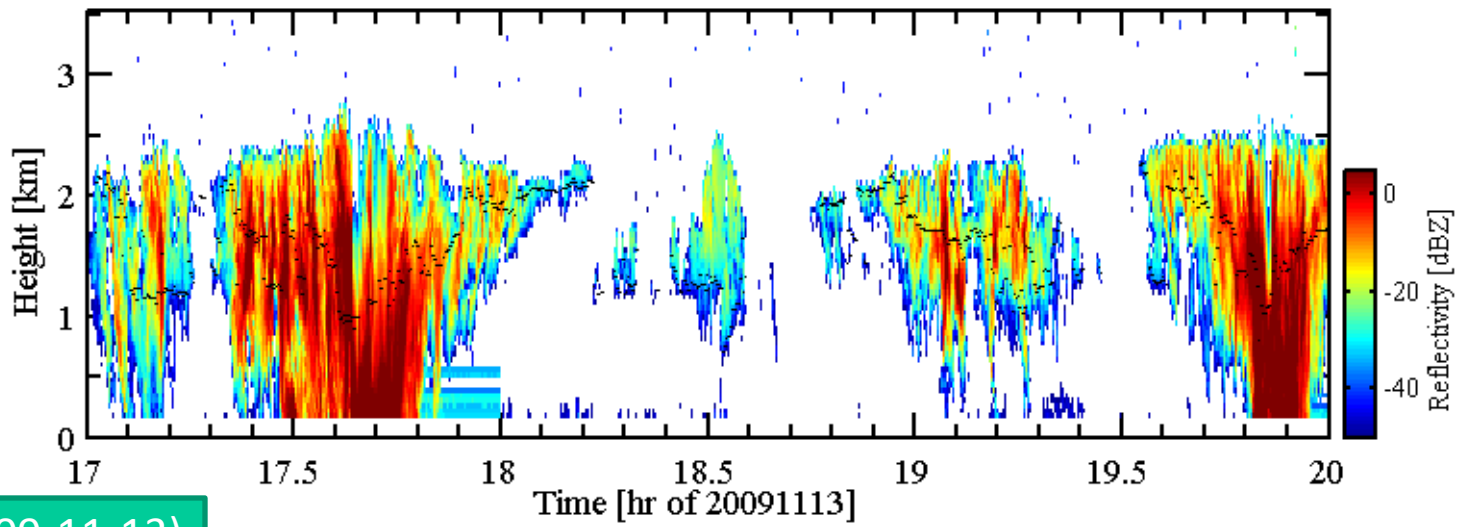
Open cell case



Closed cell case

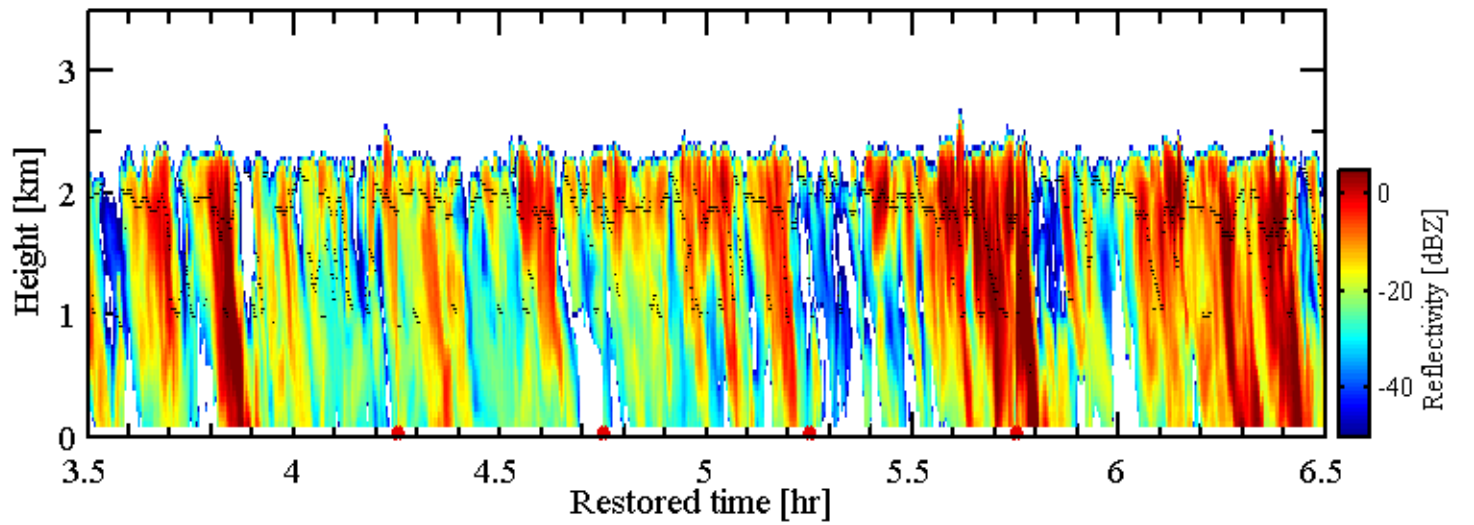


Obs

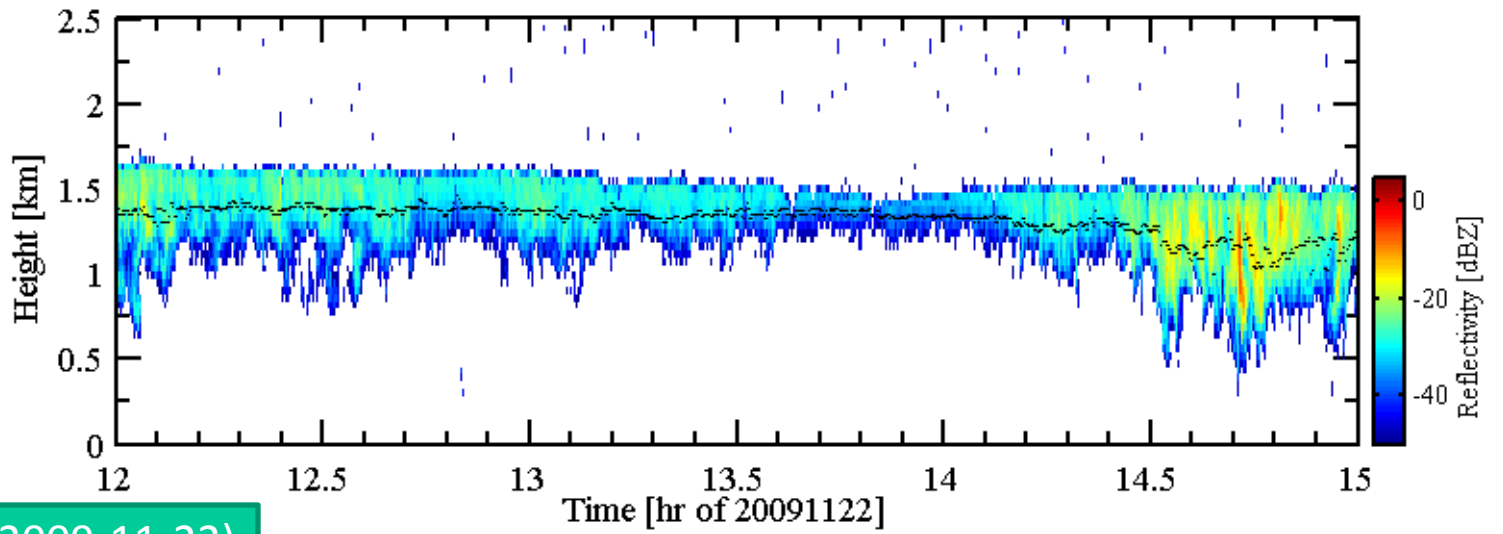


Open cell case (2009-11-13)
3-hour comparison

LES

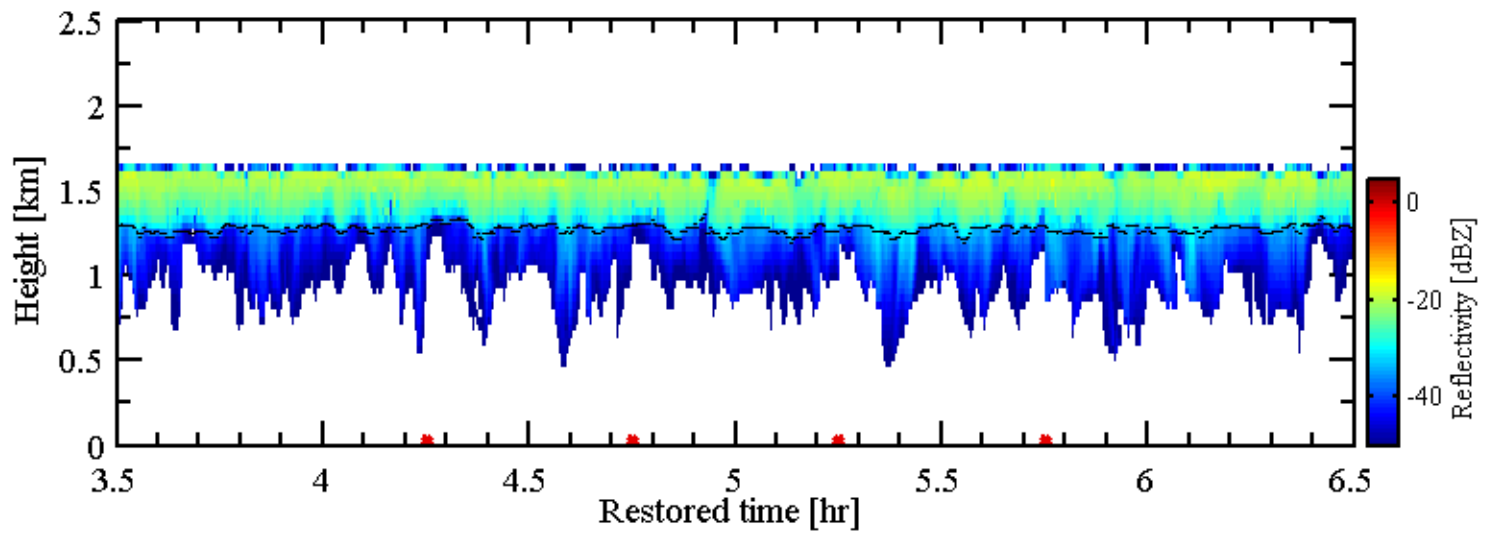


Obs



Closed cell case (2009-11-22)
3-hour comparison

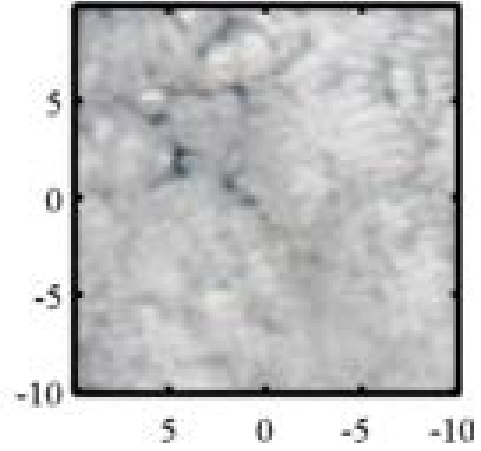
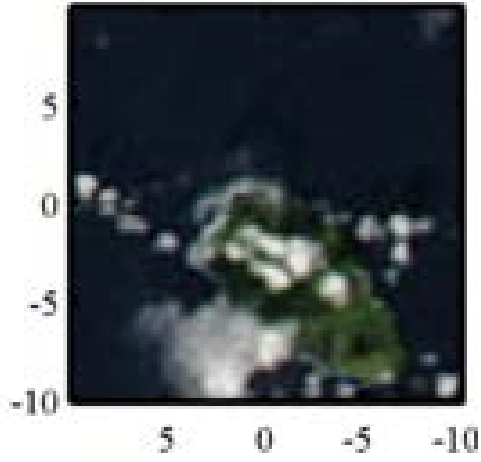
LES



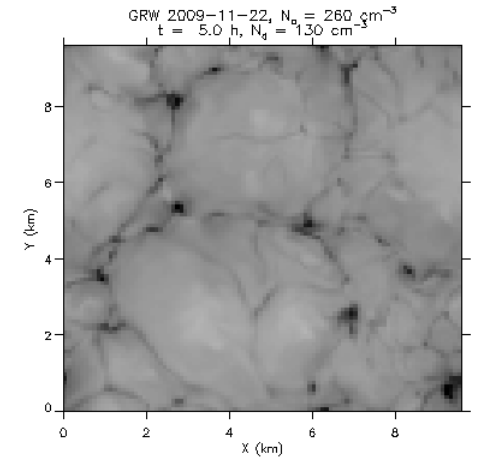
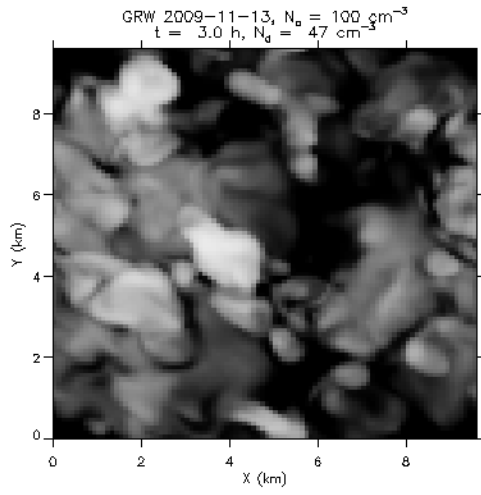
Open cell case

Closed cell case

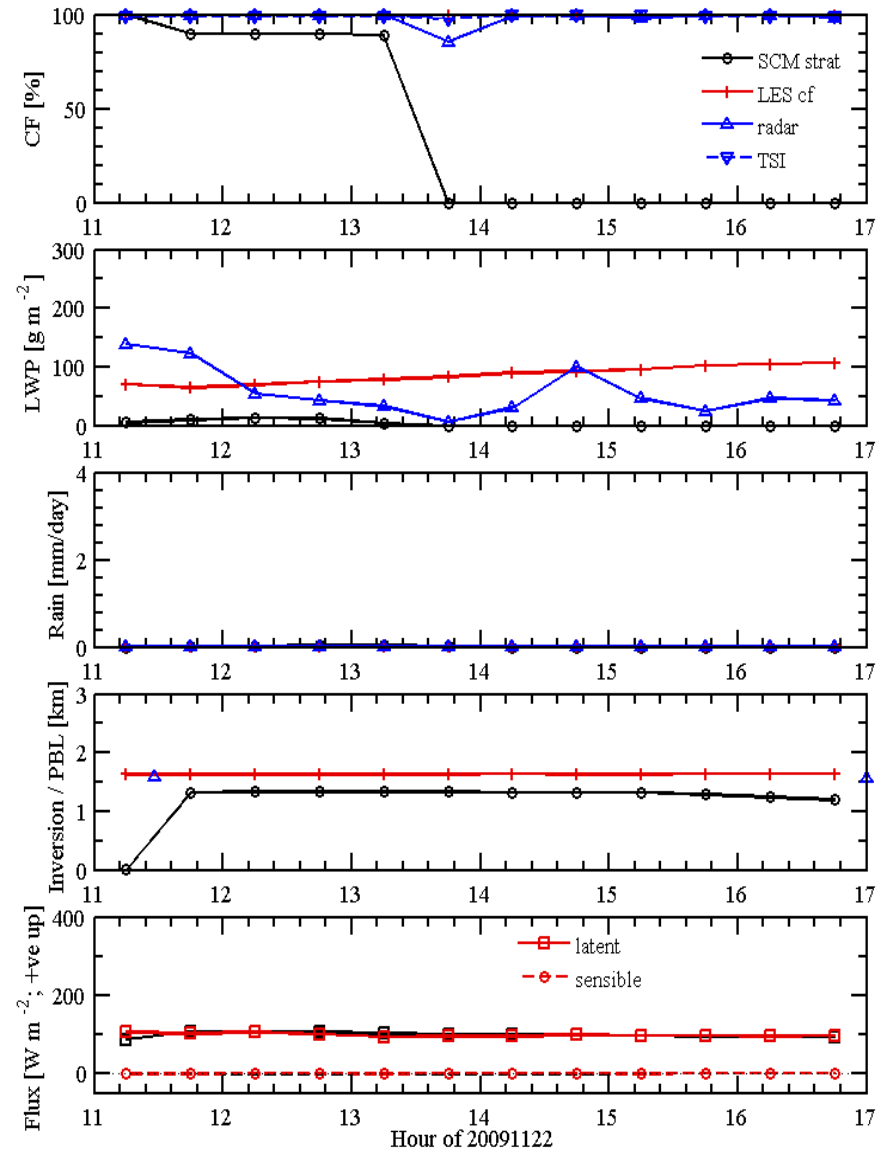
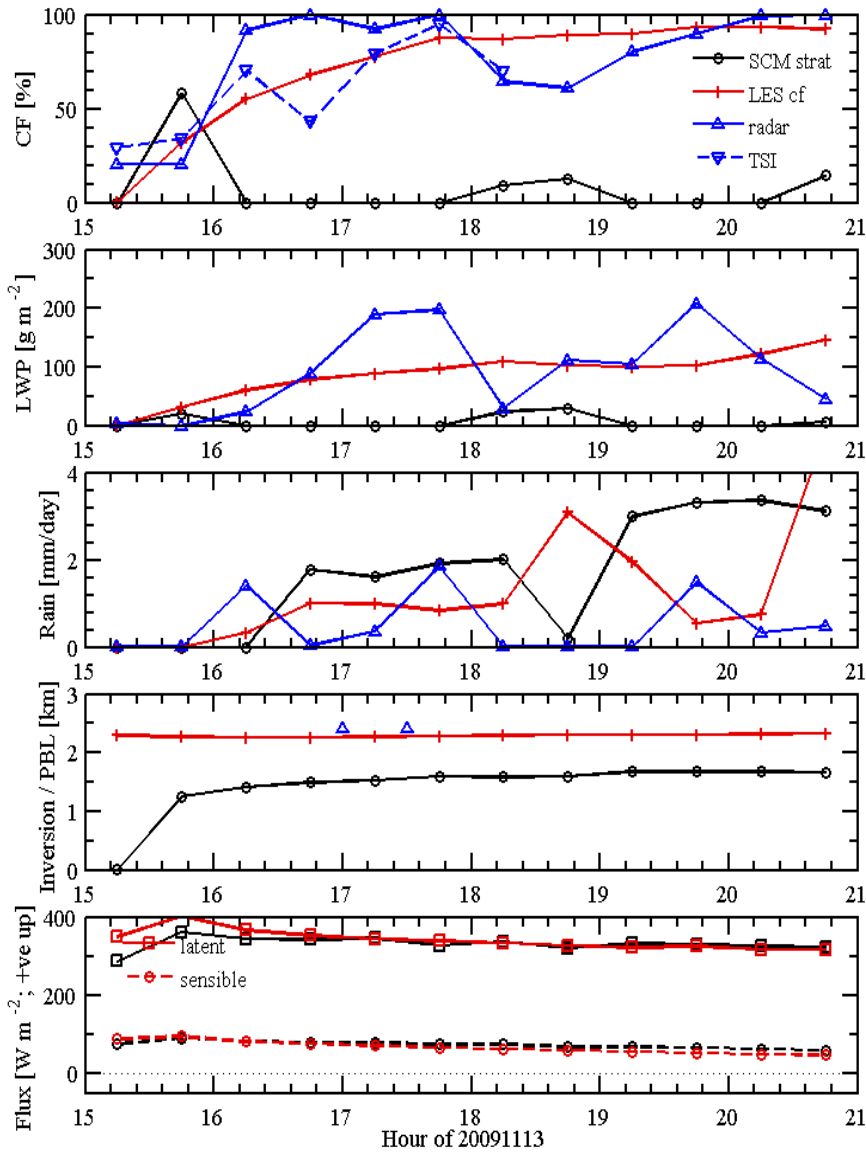
Obs



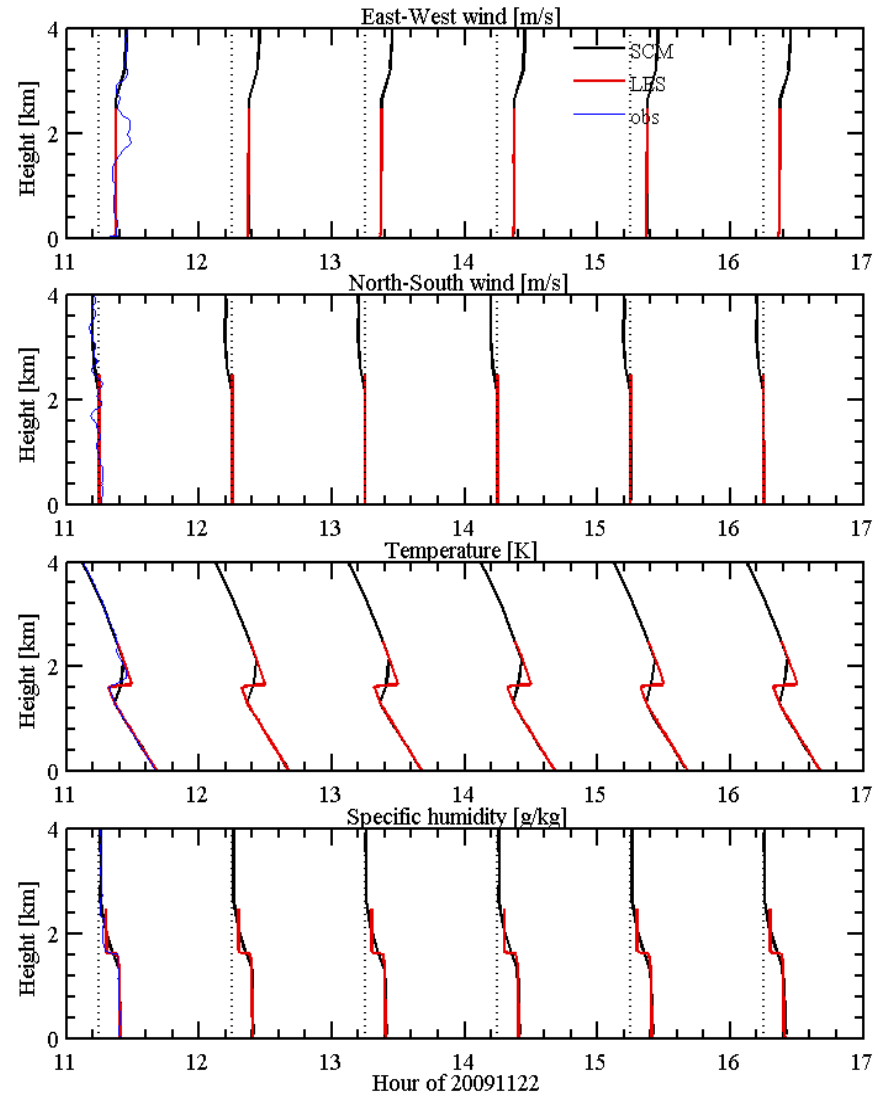
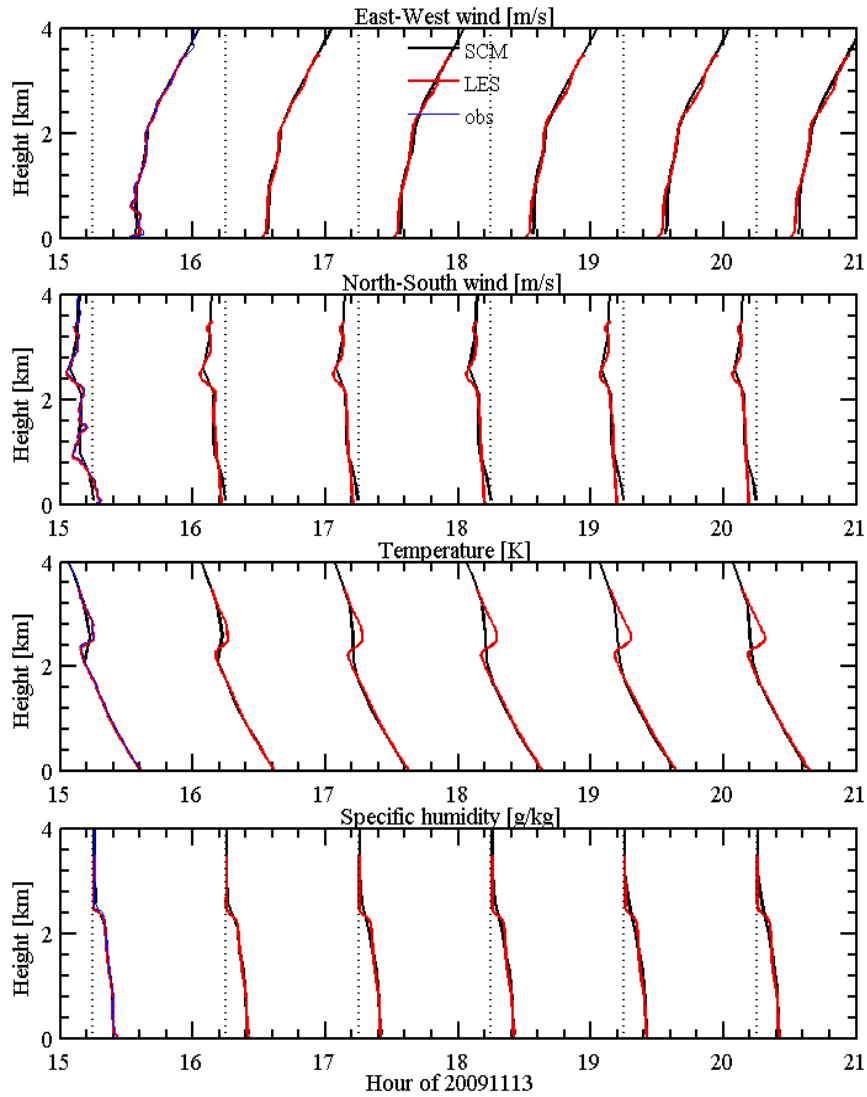
LES



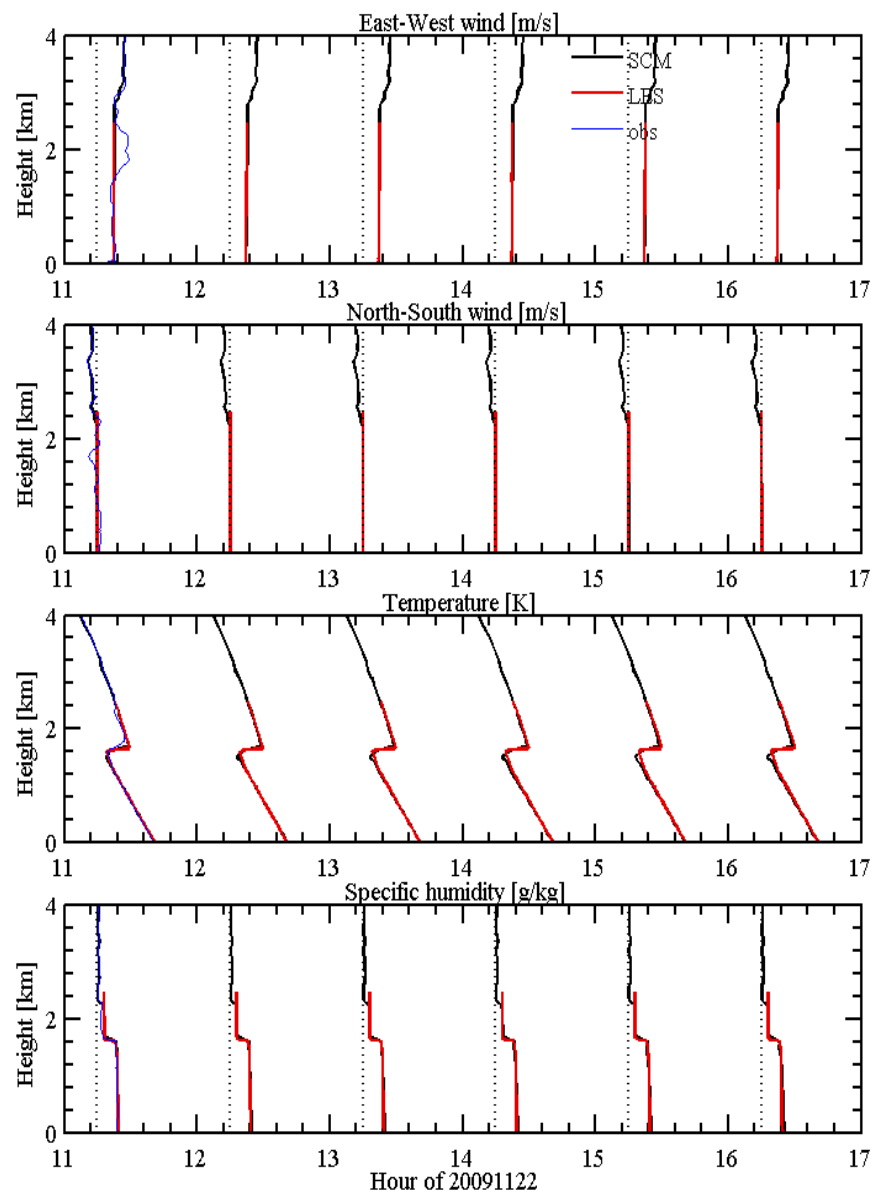
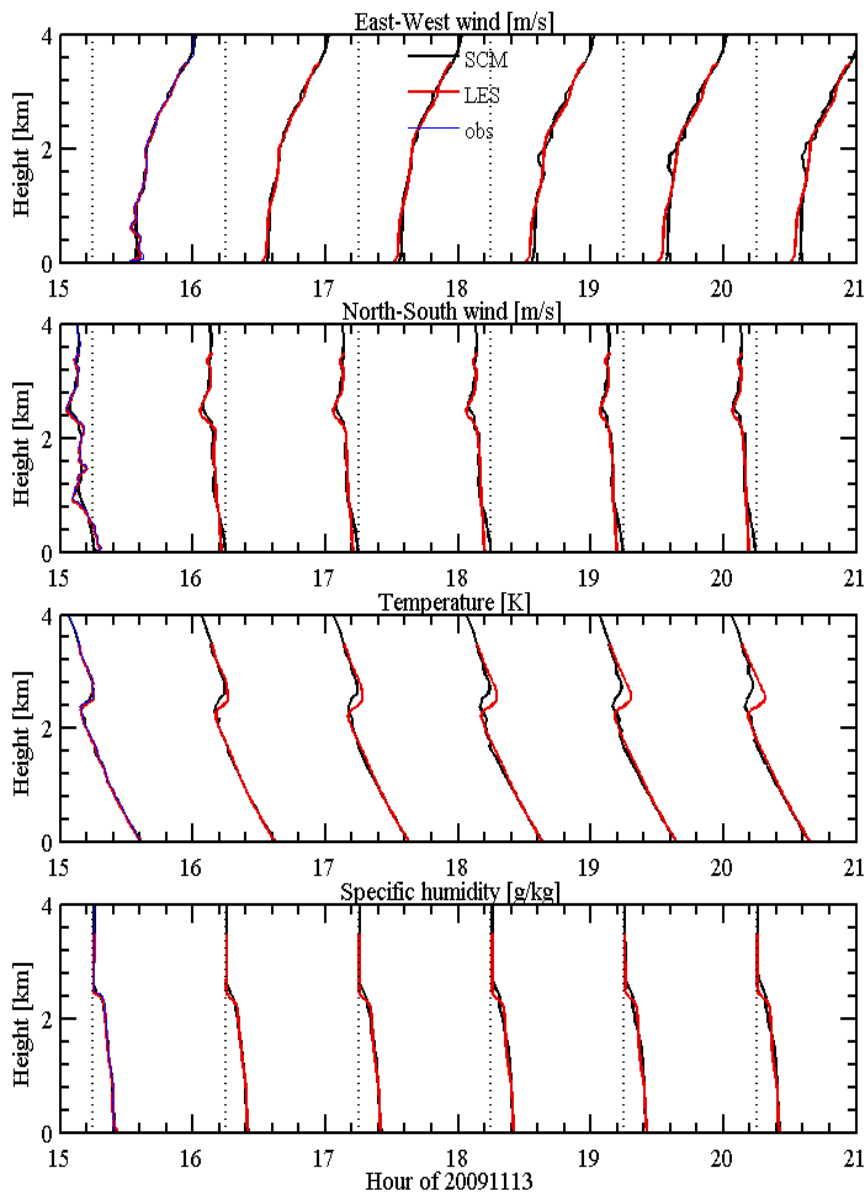
LES/SCM runs



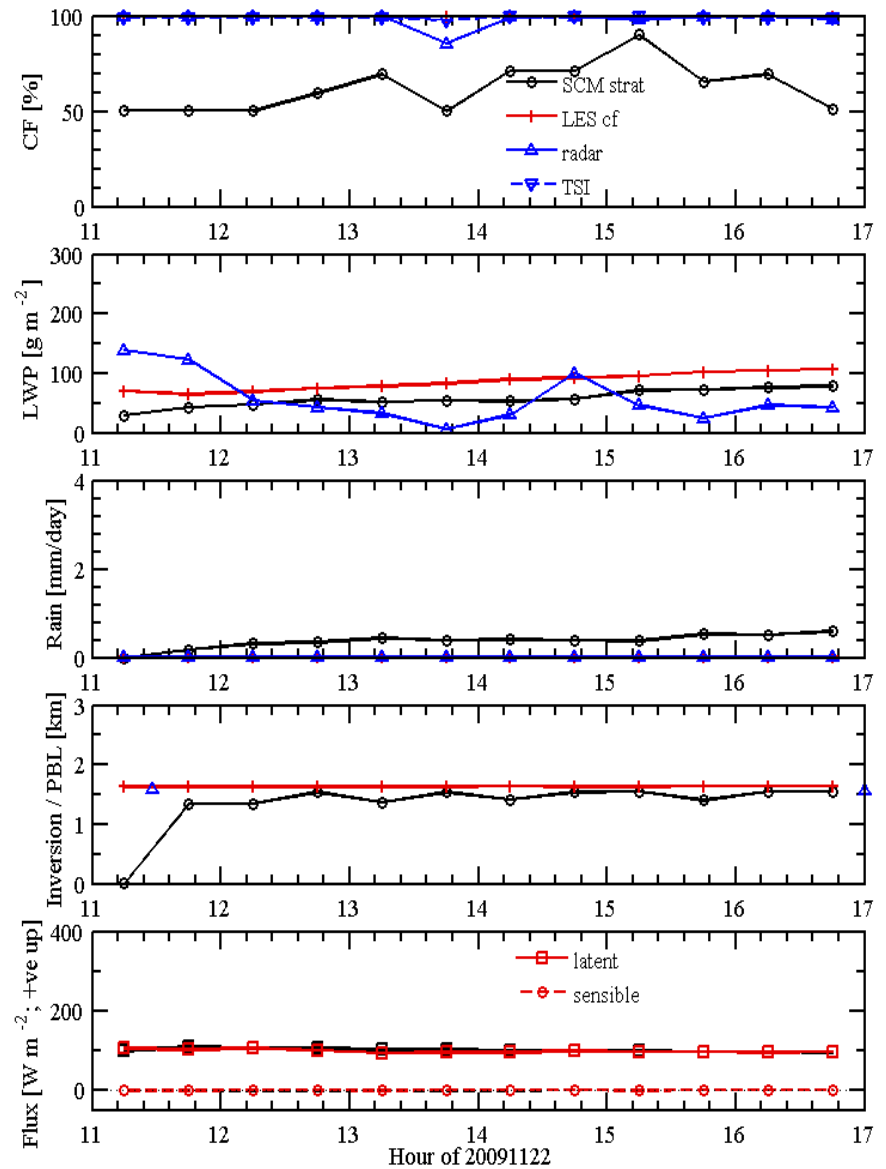
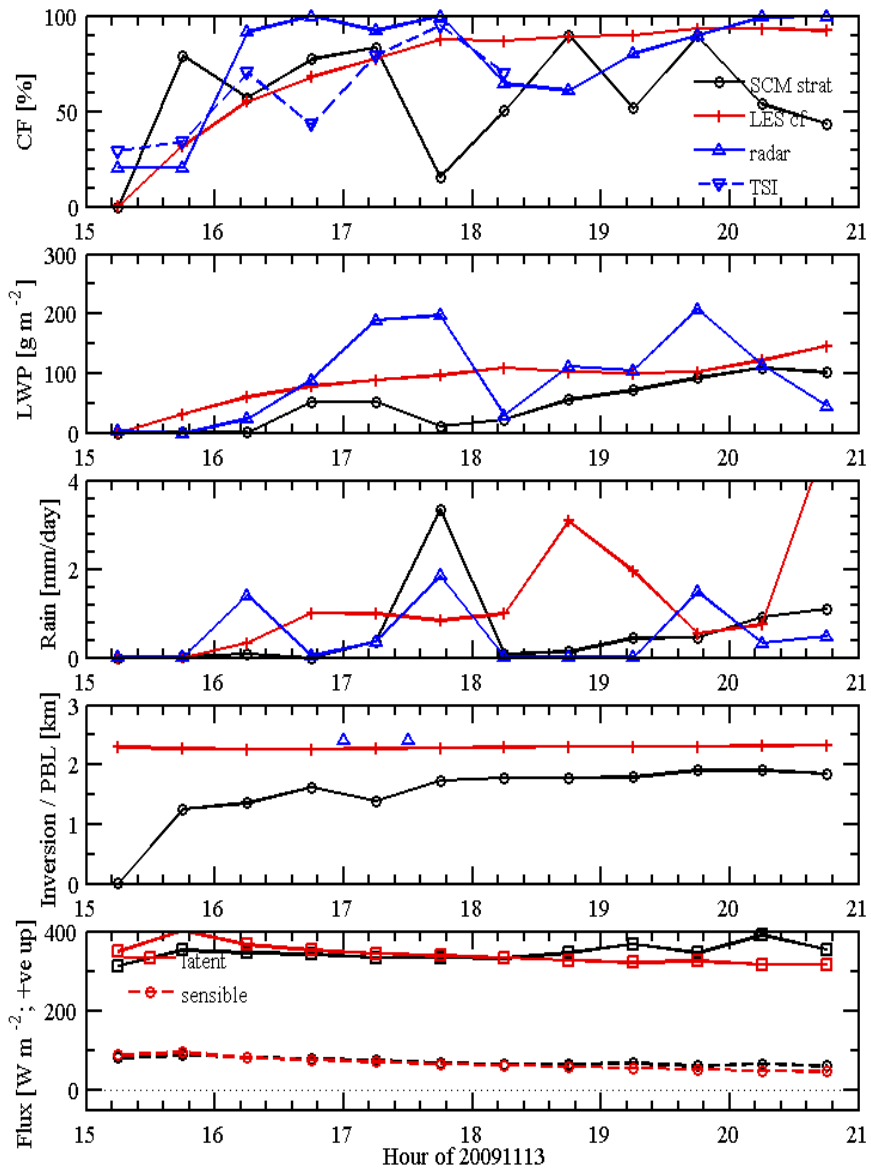
LES/SCM runs soundings



LES/SCM-high res. runs



LES/SCM-high res. runs



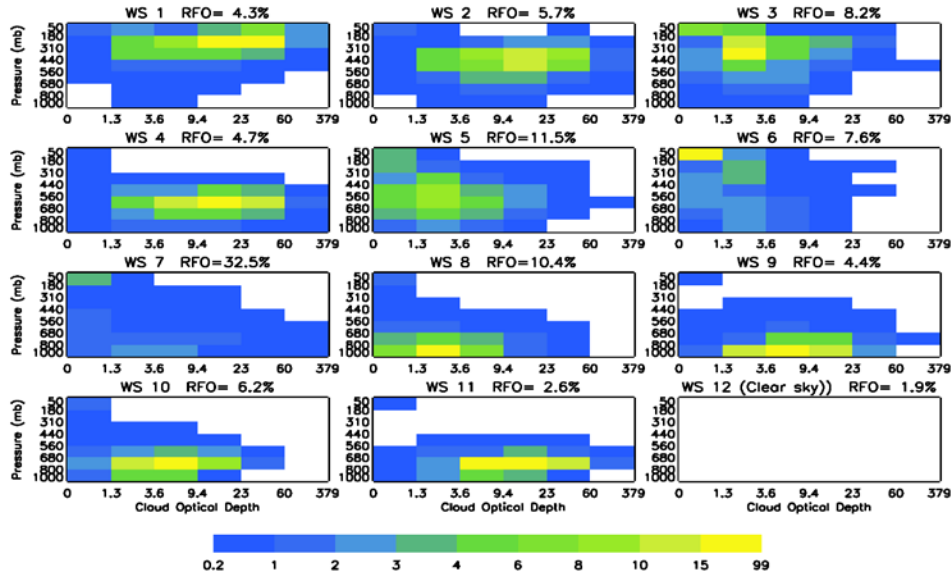
Summary

Weather State analysis shows the Azores to be a great lab to study major deficiencies in GCM cloud property simulations. One strategy is to use case study SCM and LES simulations constrained by AMF observations to explore model deficiencies in simulating cloud processes and properties, and use satellite and GCM analyses to understand the relevance of those deficiencies to global model climate simulations.

Preliminary results from LES and SCM simulations of an open and a closed case study show LES skill in simulating the different cloud field structures and indicate the importance of properly resolving the vertical structure of the boundary layer in the SCM.

Ongoing work focuses on the effects of microphysics scheme choices, both in the LES and the SCM, on the simulation of the cloud field structure and properties.

ISCCP global Weather States



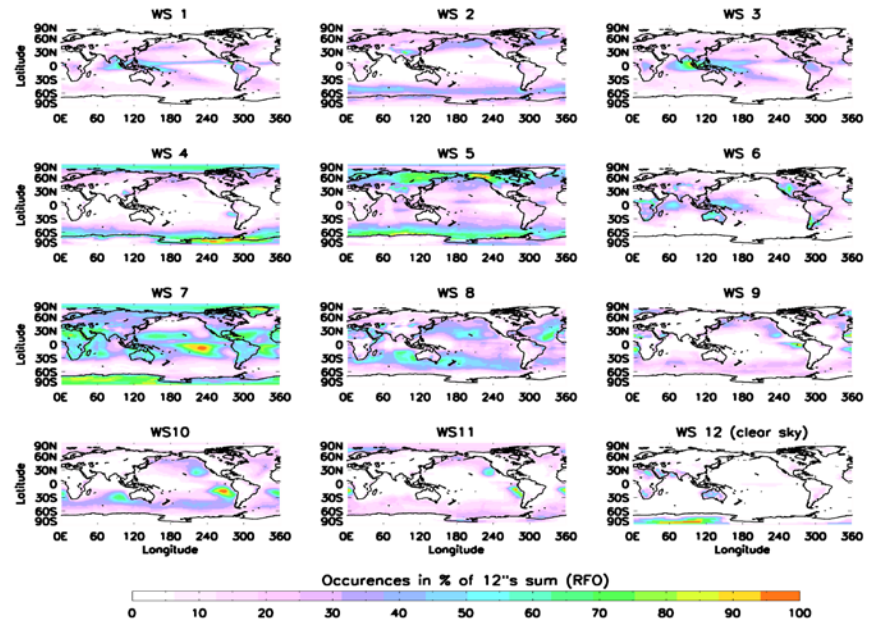
Global Weather States (WS) derived through cluster analysis of ISCCP TAU-PC histograms:

11 WS going from deep convective to stratocumulus clouds

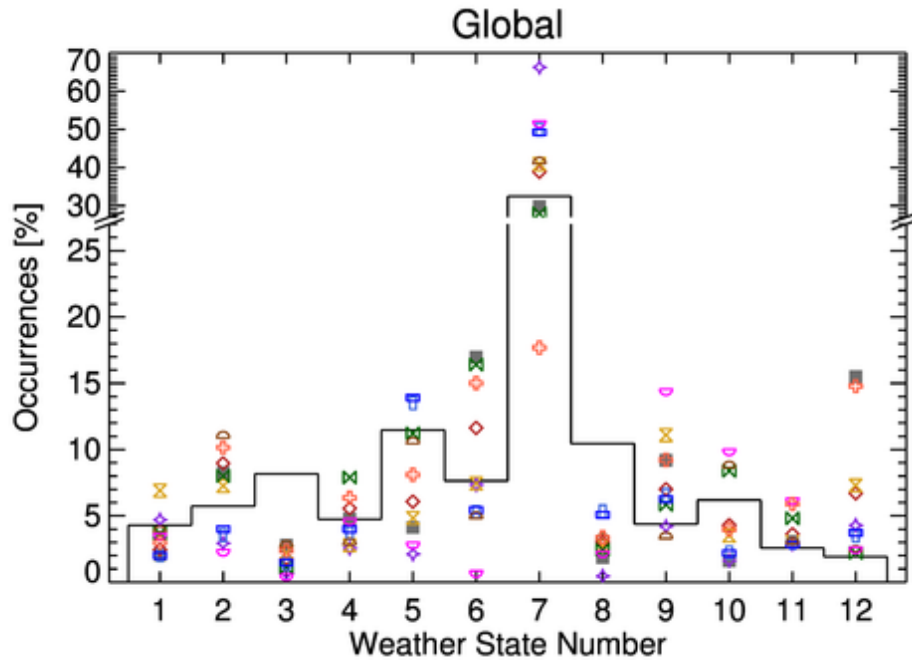
Fair-weather WS7 most frequent one

Separation of tropical and midlatitude convective clouds

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



[Tselioudis et al. 2013](#)

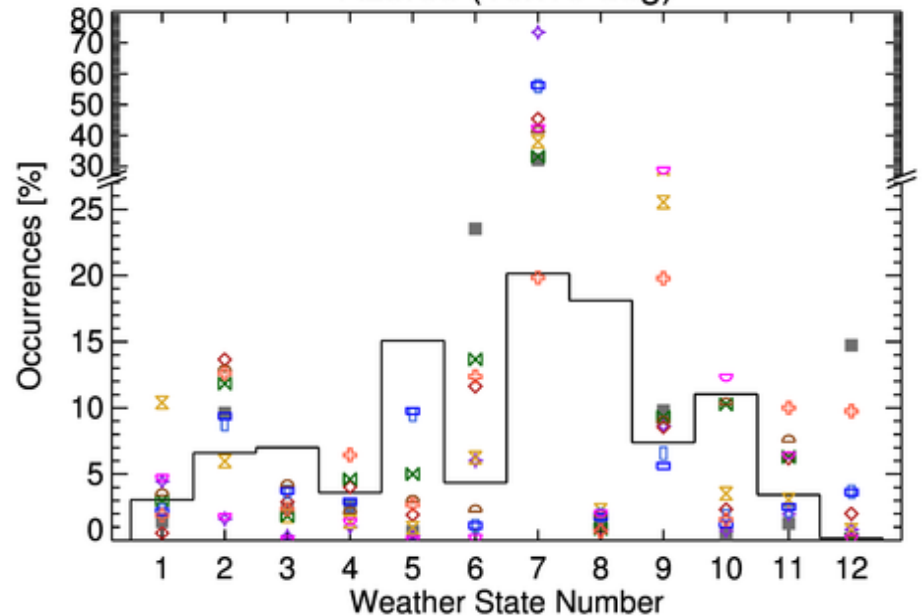


Weather States in CMIP5 GCMs

Models severely overpredict the fair-weather WS and underpredict the shallow cumulus and anvil cirrus WS

- ISCCP
- FGOALS-g2_r1i1p1_cf3hr
- ◆ CCSM4_r7i1p1_cfDay
- ◇ CNRM-CM5_r1i1p1_cfDay
- × CanAM4_r4i1p1_cfDay
- ⋈ GFDL-CM3_r1i1p1_cfDay
- GISS-E2-R_r6i1p1_cfDay
- GISS-E2-R_r6i1p3_cfDay
- △ HadGEM2-A_r1i1p1_cfDay
- ◇ MIROC5_r2i1p1_cfDay
- ◇ MPI-ESM-LR_r1i1p1_cfDay

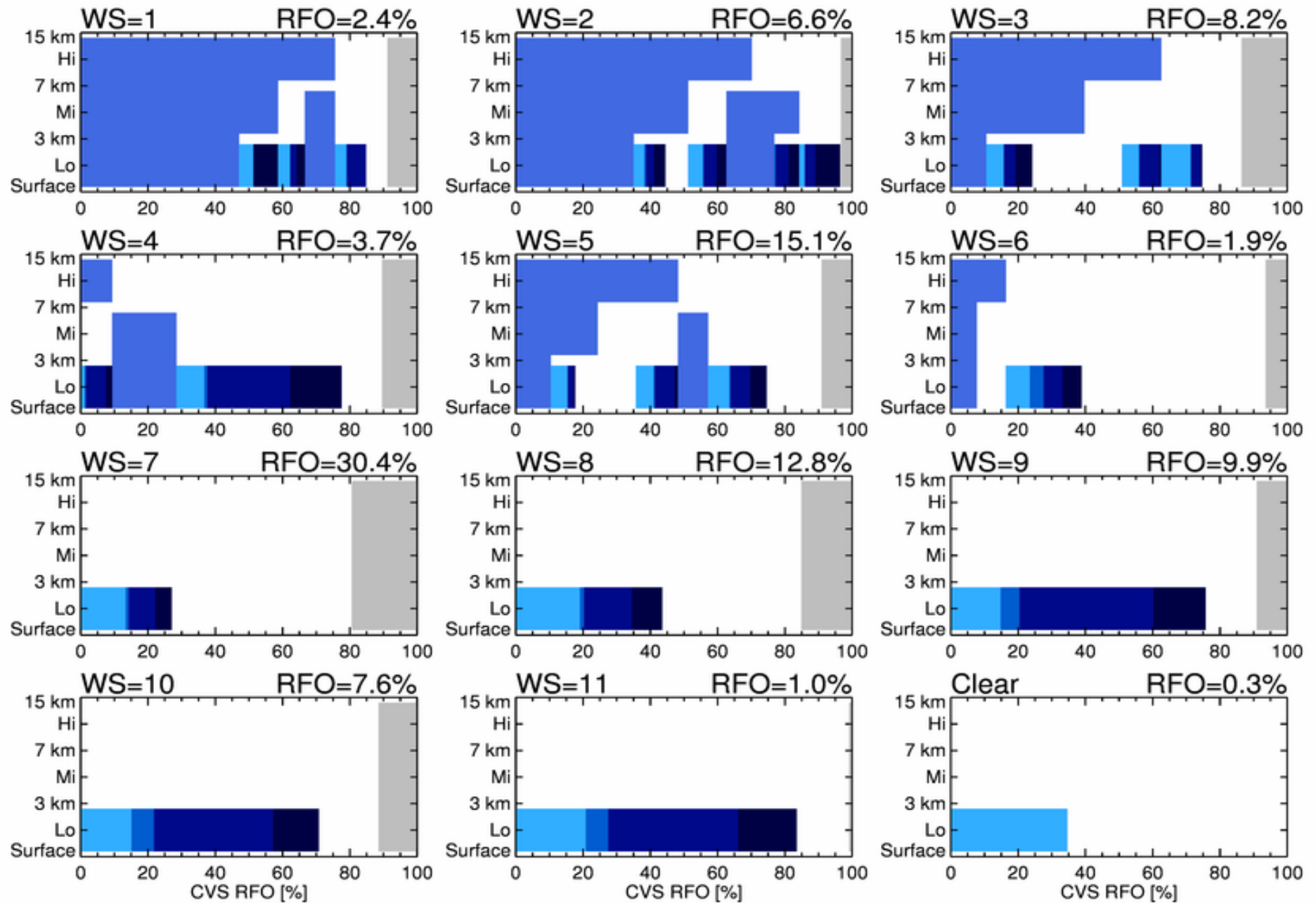
Azores (10x10 deg)

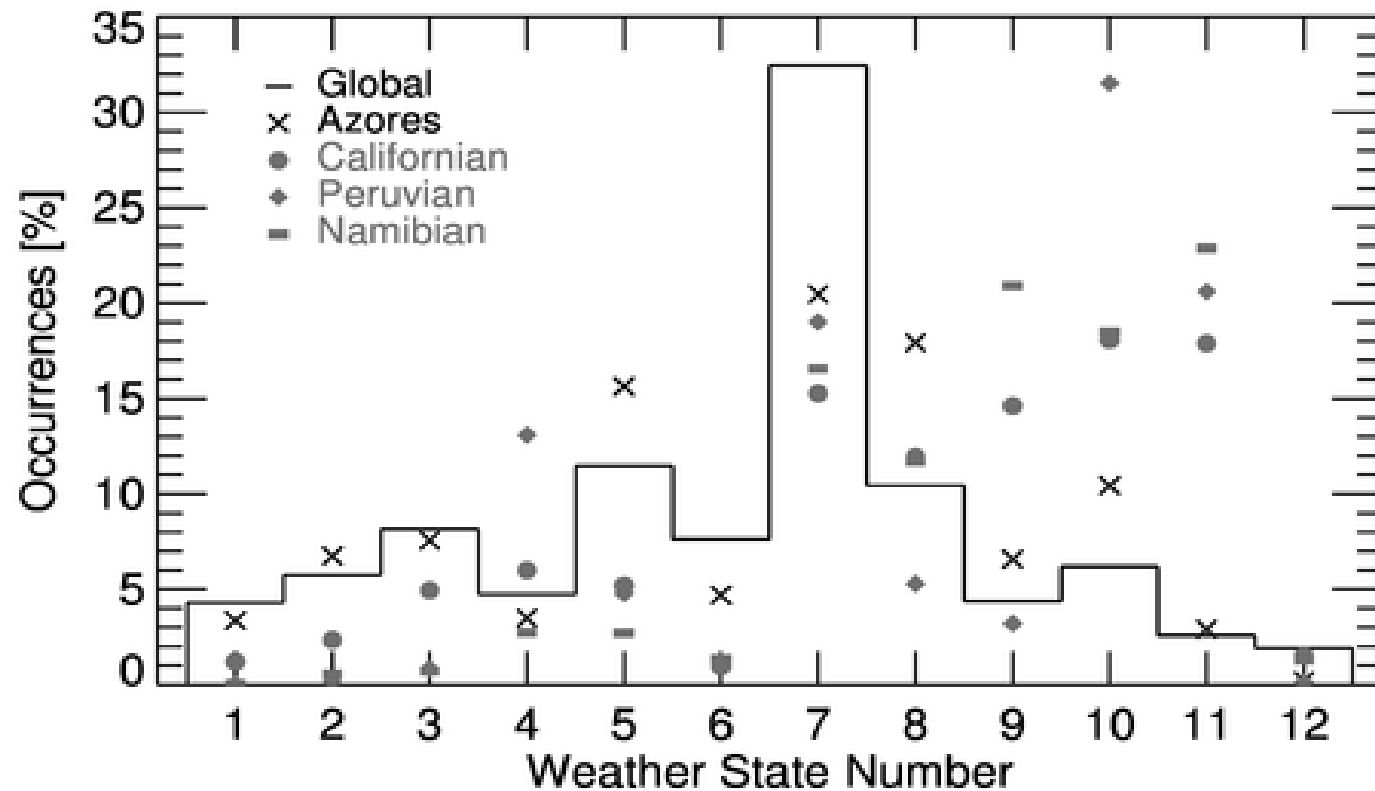


CMIP5 GCM WS in the Azores

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

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

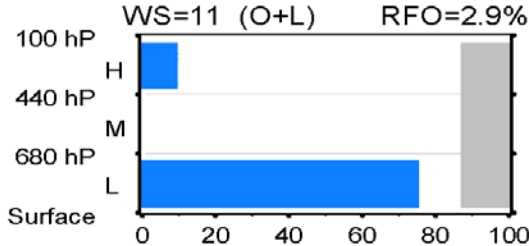
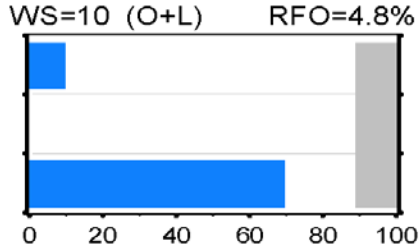
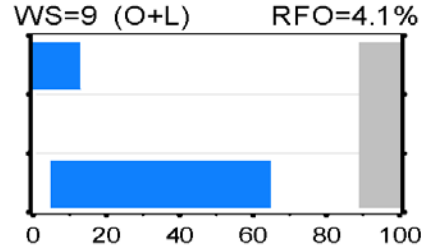
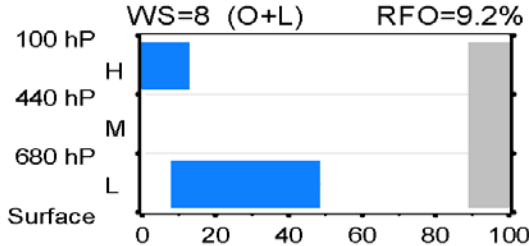
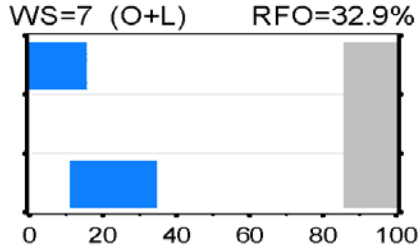
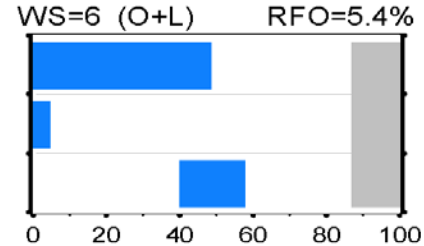
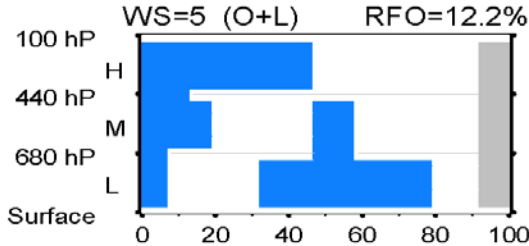
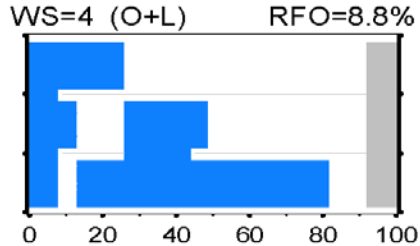
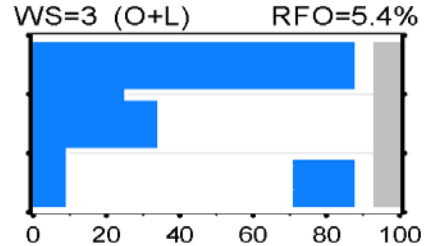
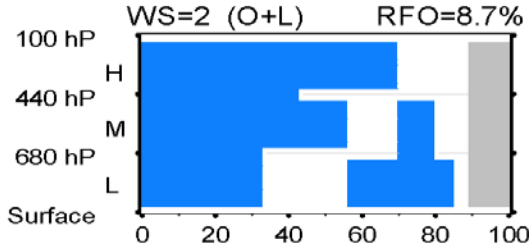
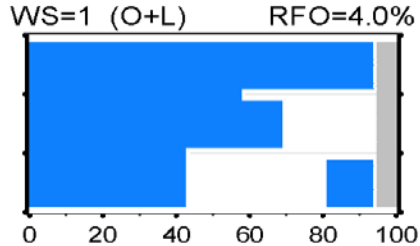




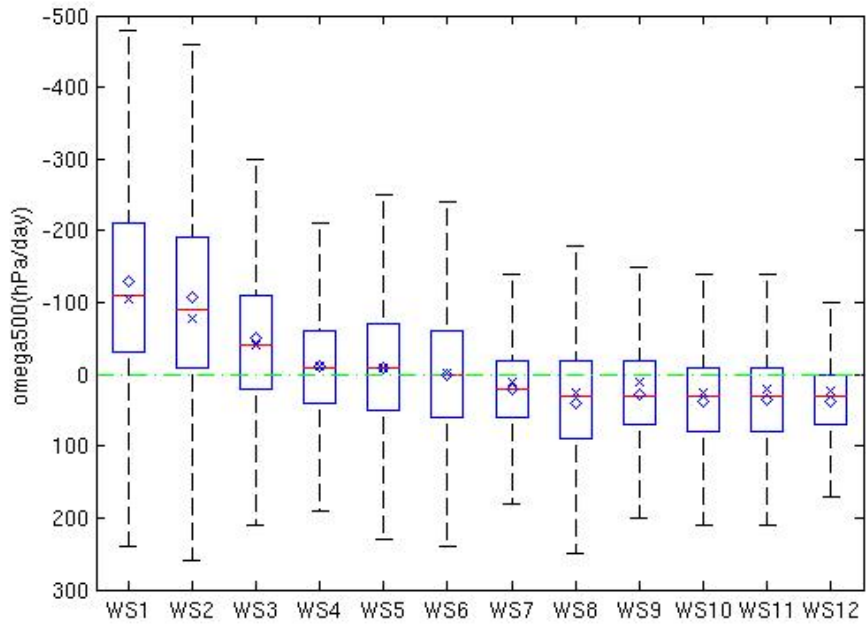
[Not your typical stratocumulus region: Azores vs Global WS](#)

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

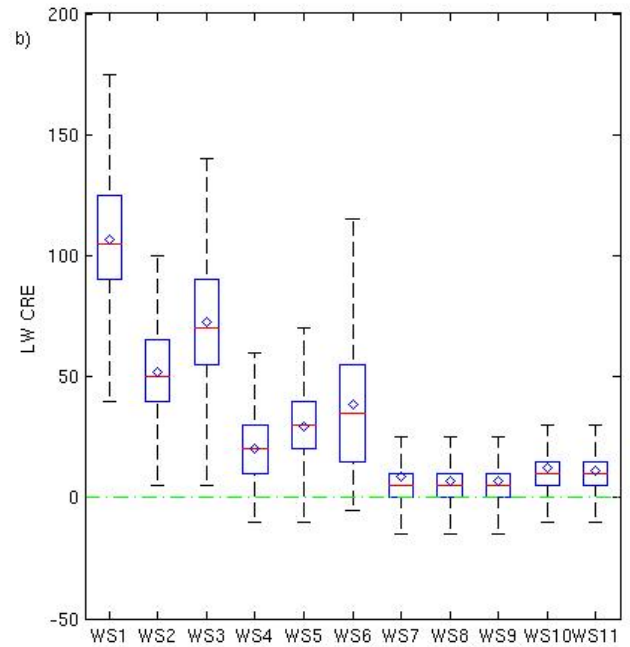
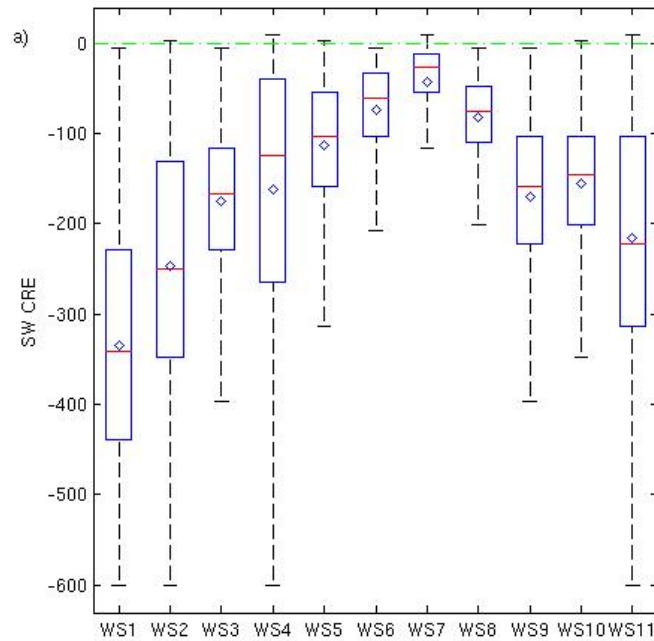
Cloud Vertical Structure (CVS) of the ISCCP WS derived from CloudSat-CALIPSO retrievals



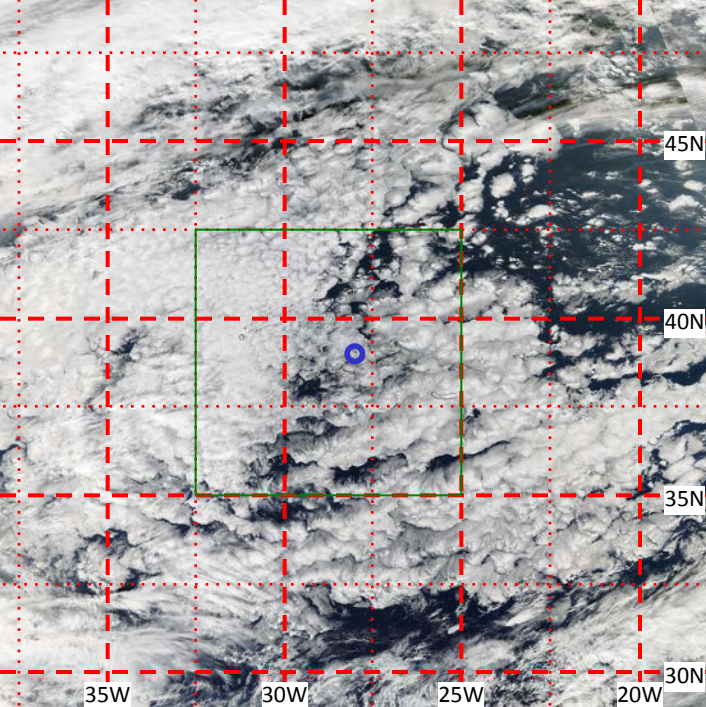
CVS RFO (%; Grey is sum of all < 5.0%)



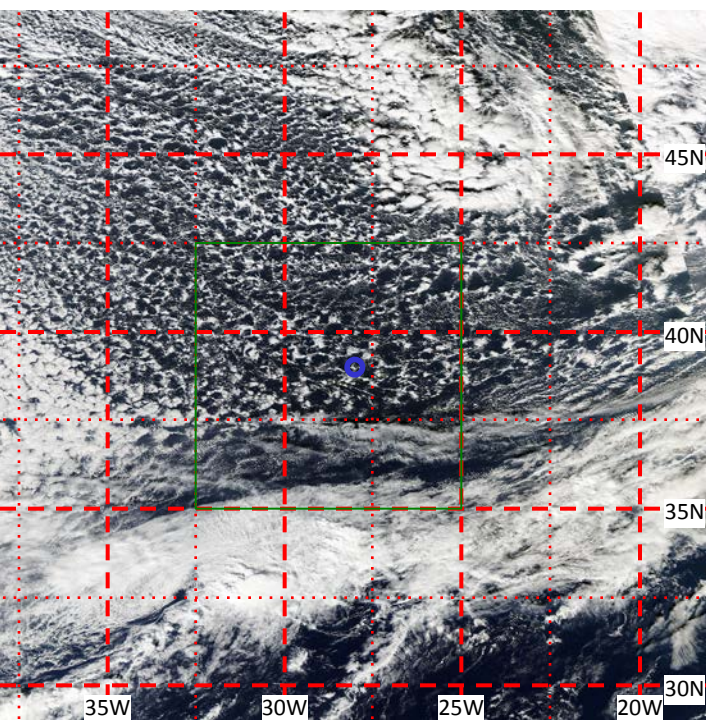
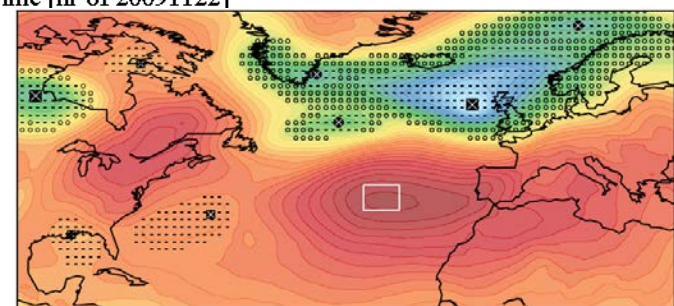
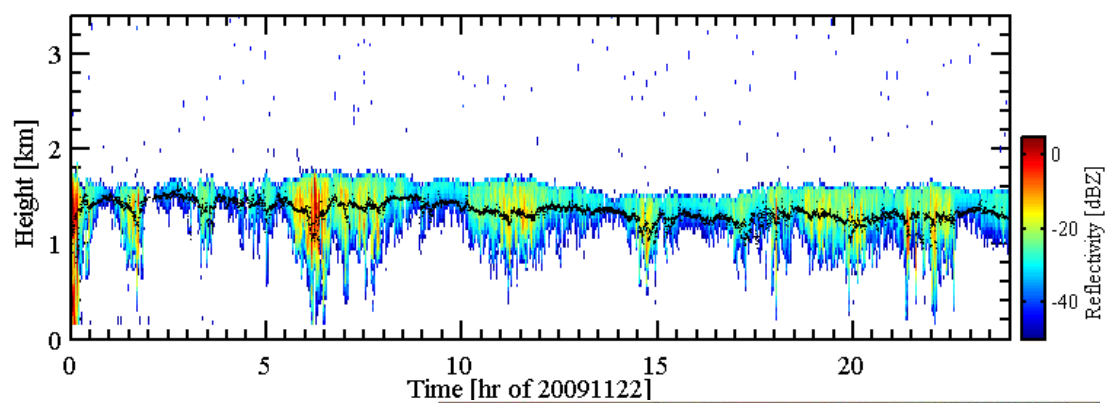
500mb vertical velocity for the 12 WS



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



1	2	5	5	5	5	5
1	3	5	4	10	7	8
5	11	11	10	10	7	7
4	11	11	10	10	10	10
5	4	4	10	10	11	11
5	10	4	11	10	10	10
3	3	10	10	8	8	2



10	8	8	1	5	2	5
5	8	8	8	8	5	5
5	8	8	8	8	7	8
4	10	8	8	8	8	2
5	5	5	5	5	5	2
3	4	4	2	4	3	5
10	10	5	10	7	7	7

