

# Analyses of CAPT simulations with CAM5.5 candidate schemes based on observations in the Azores

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 **Lawrence Livermore  
National Laboratory**



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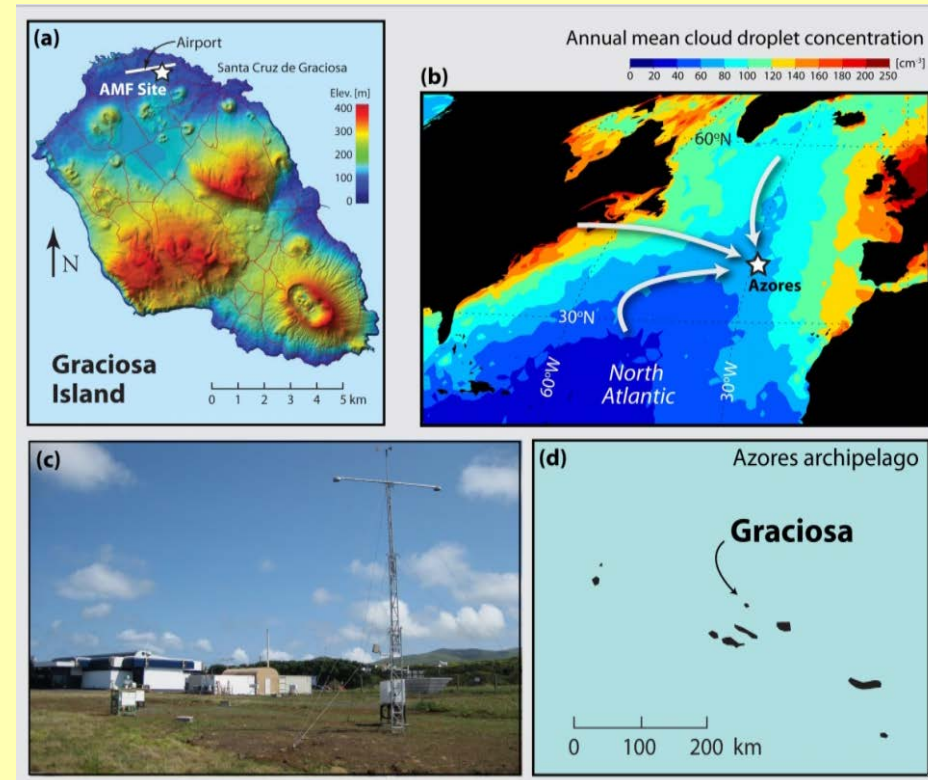
This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under contract DE-AC52-07NA27344. Lawrence Livermore National Security, LLC



# Motivation:

To assess CAPT simulations of **marine boundary layer (BL) clouds** with the CAM5.5 candidate schemes:

- CAM5.3 with CLUBB/MG2
- CAM5.3 with UNICON

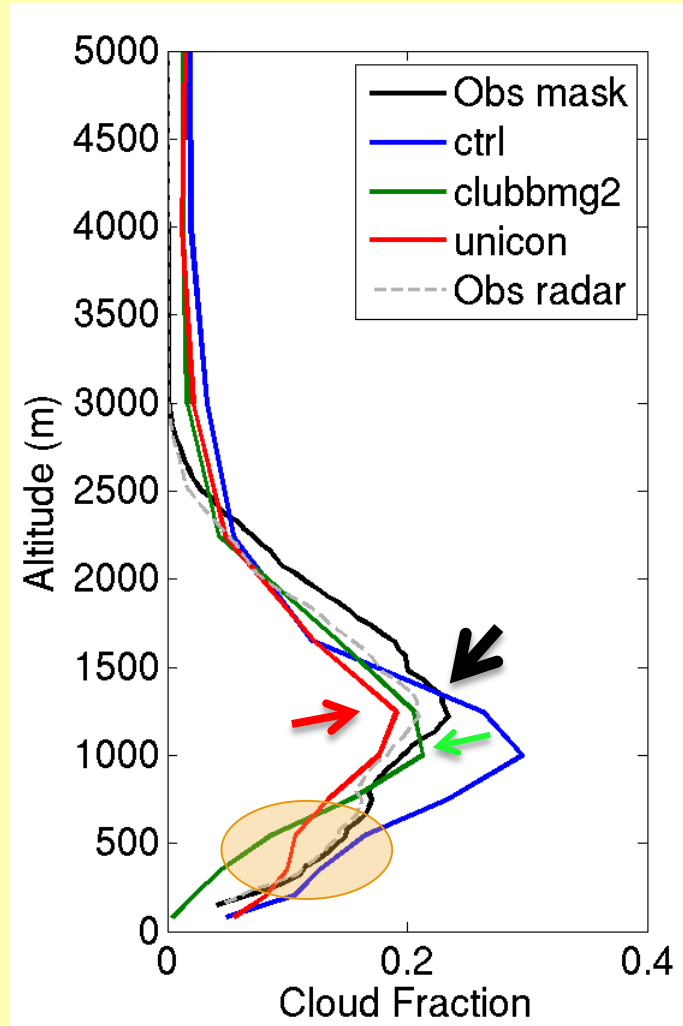


CAP-MBL field campaign from Jun. 2009 to Dec. 2010. (Wood et al. 2014)

# Methodology

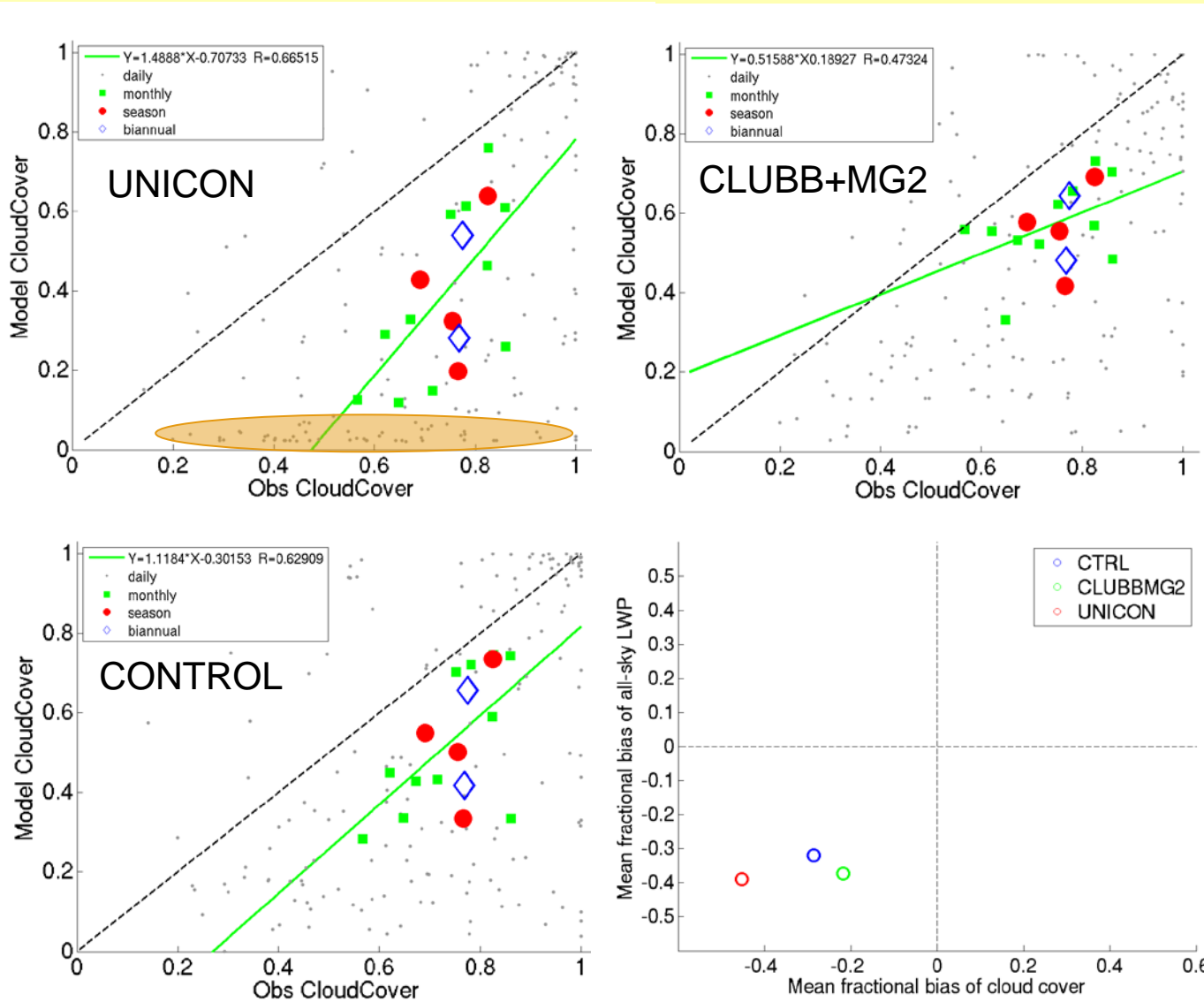
- Three sets of 5-day hindcasts from June 2009 to April 2010: Day 2 at one grid column (39.1N, 27.5W)
  - CAM5.3 control; CAM5.3 CLUBB/MG2; CAM5.3 UNICON
- Observations: ~7600 hours of observations; ~2200 hours of low-cloud only condition (30%)
- Low cloud statistics: low-cloud-only hours in both model and observation
- Case study: a two-day time period experiencing open cell clouds and closed cell clouds

# Averaged cloud fraction from observed low-cloud hours



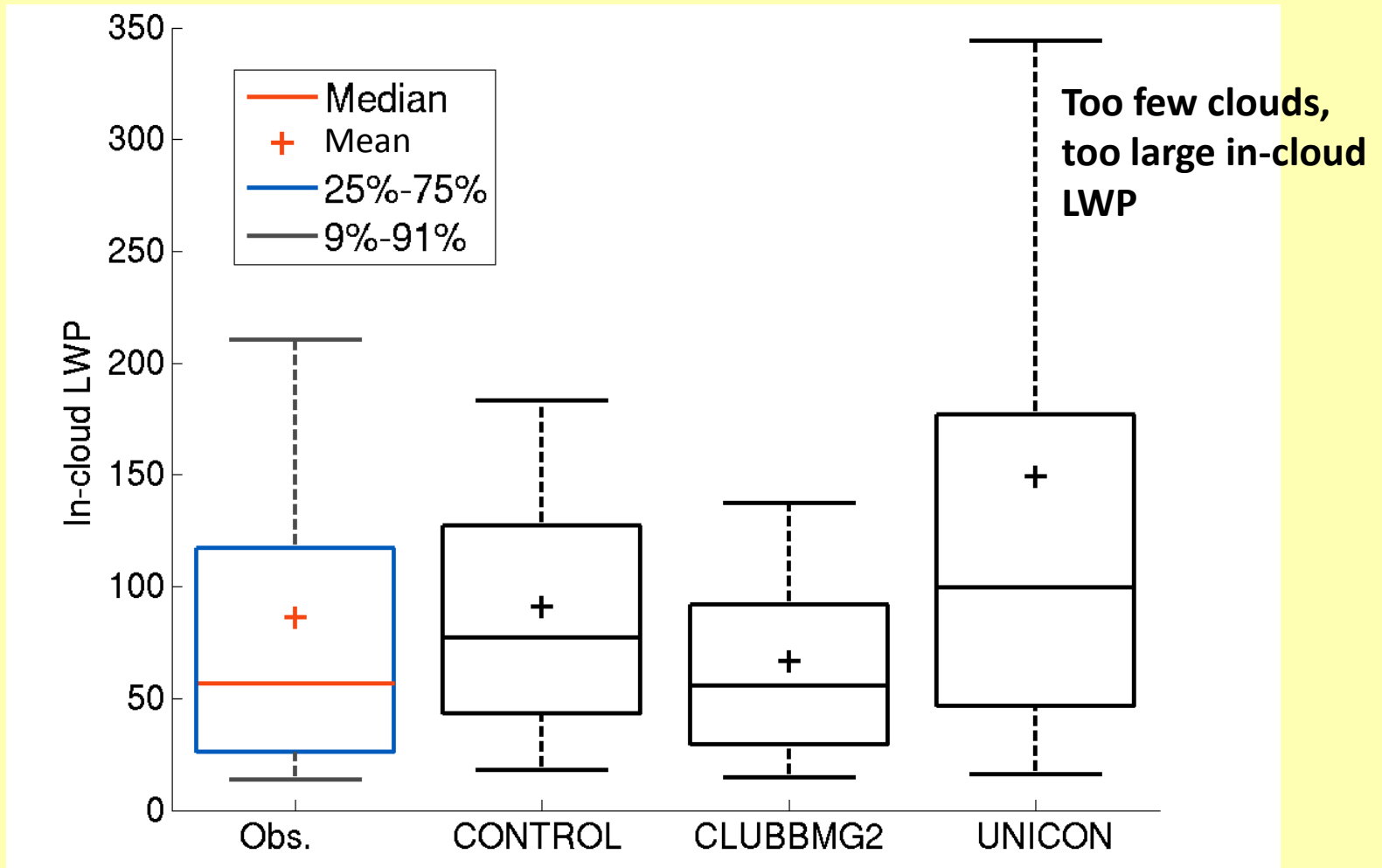
- Control simulation has the highest cloud fraction
- CLUBBMG2 and UNICON are pretty close to each other except the lower BL

# Low cloud statistics: low cloud cover



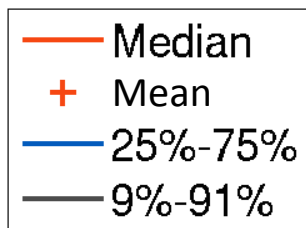
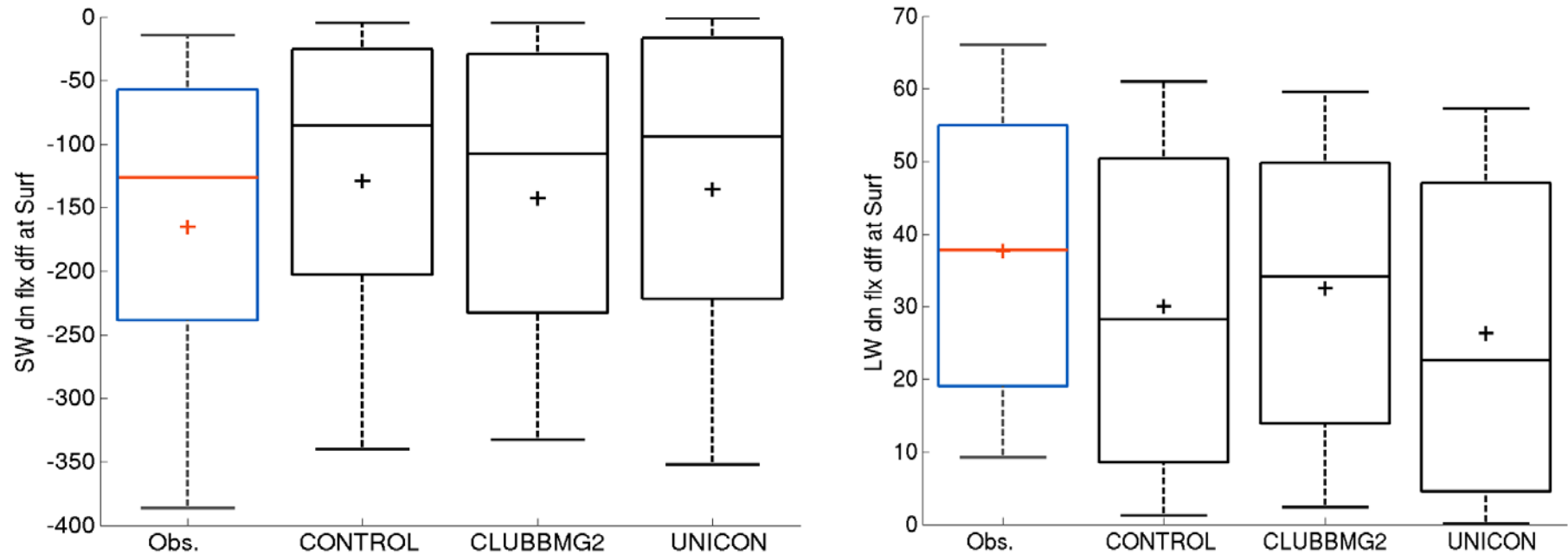
- Very low values in UNICON low cloud cover
- UNICON gets the best correlation
- CLUBB+MG2 gets the best mean cloud cover
- Negative bias in cloud cover and all-sky LWP

# Low cloud statistics: in-cloud LWP





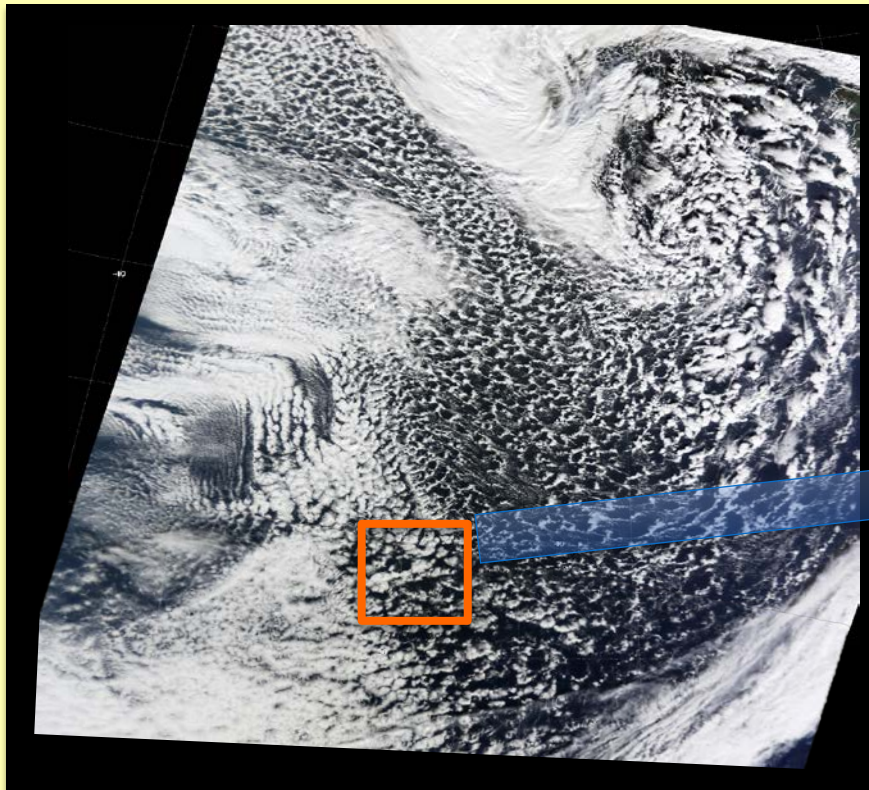
# Low cloud statistic: surface radiative forcing



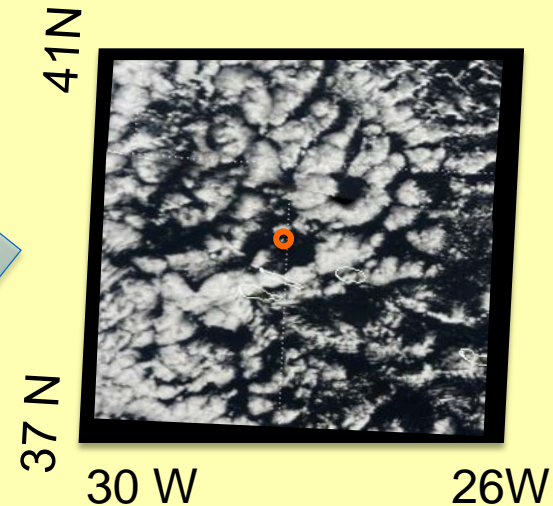
Weaker than Obs., consistent with cloud cover and LWP biases

**Thin clouds:** among the low clouds observed in the Azores, 40% have LWP < 60 g/m<sup>2</sup> and 1/3 are with a thickness < 250 m. >50% clouds are thinner than the model layer depth.

# Case study: 11/21/2009 open cell clouds

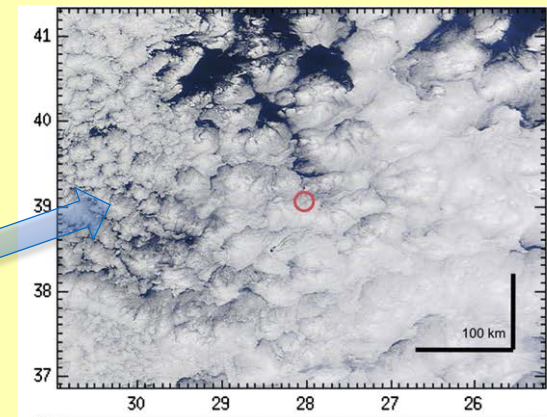
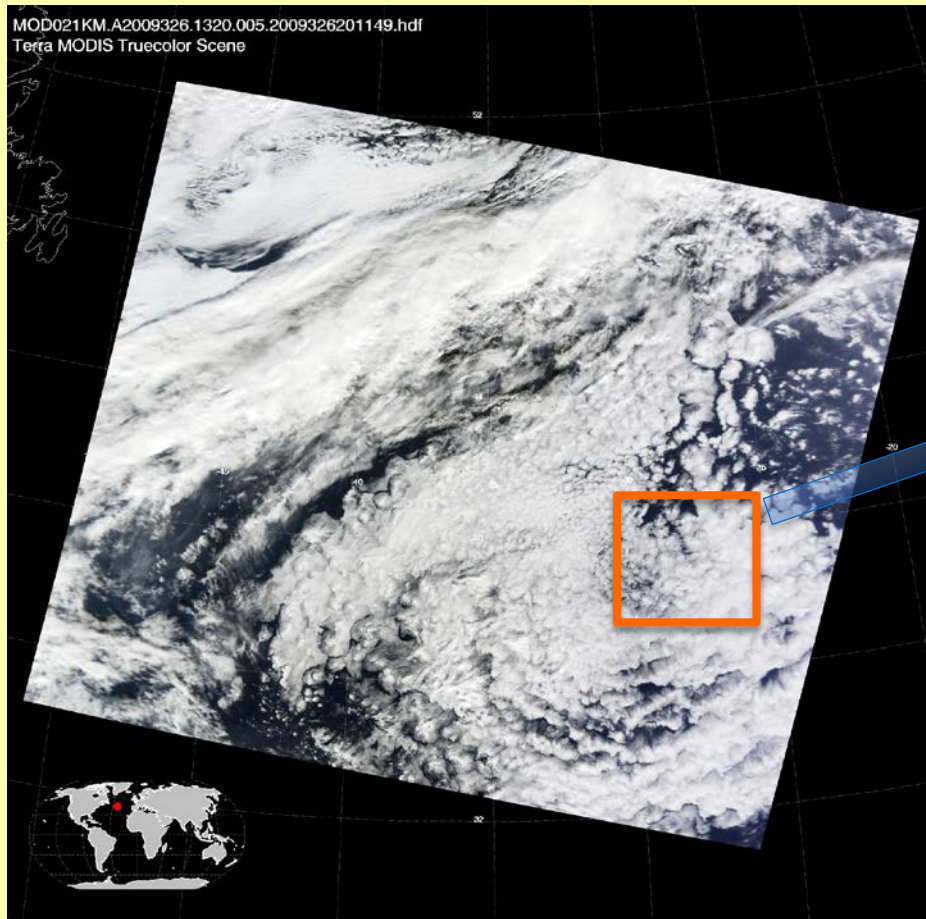


MOD021KM.A2009325.1240.005.2009325214620.hdf  
Terra MODIS Truecolor Scene



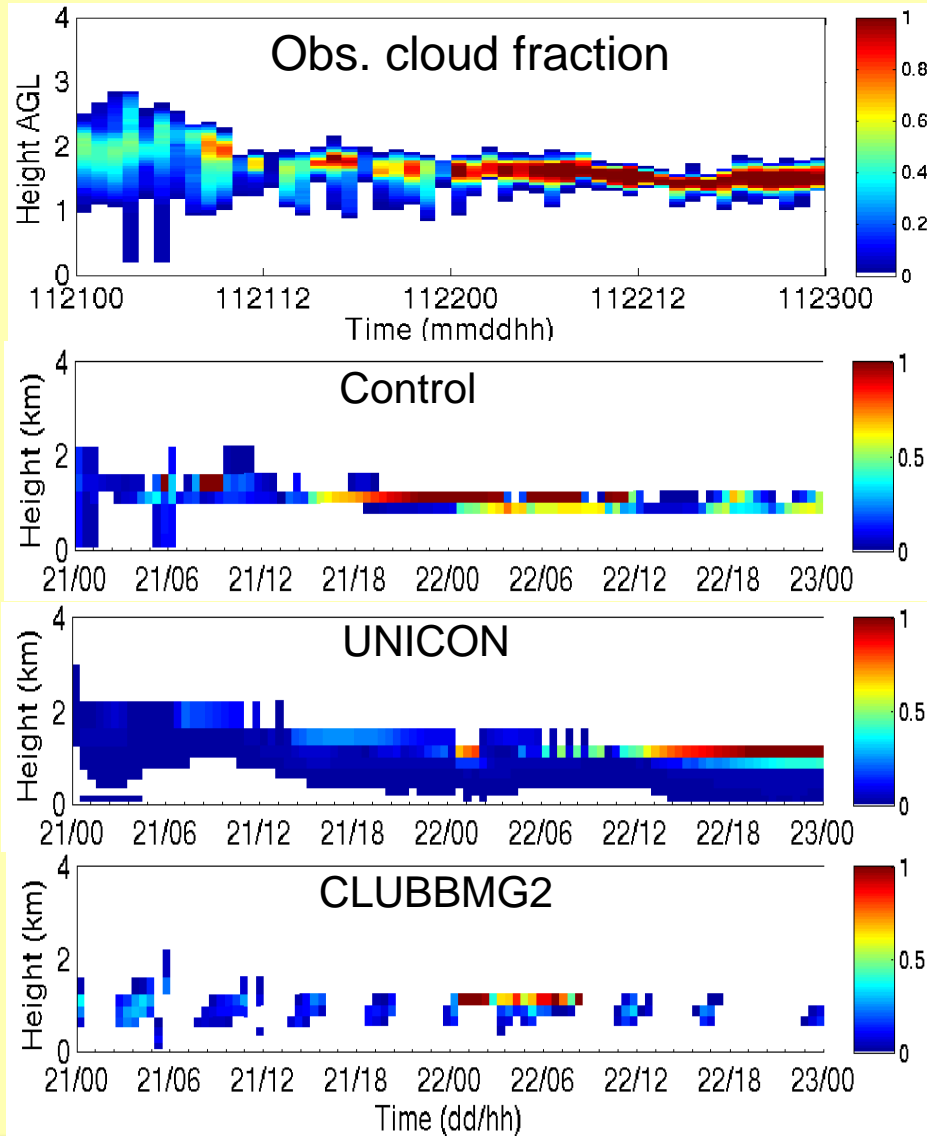


# Case study: 11/22/2009 closed cell clouds



(Remillard et al. 2012)

# Radar observation vs. modeled cloud fraction

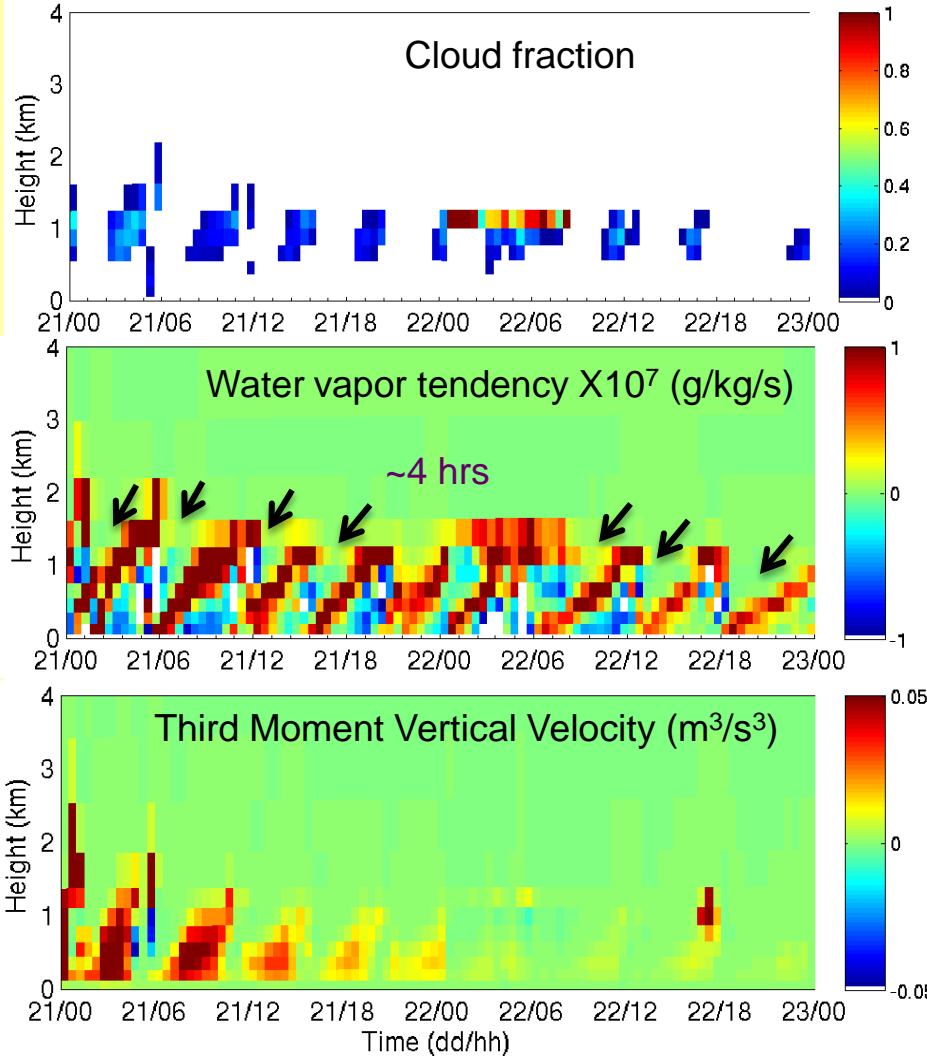


**convective cloud fraction (~3%)**

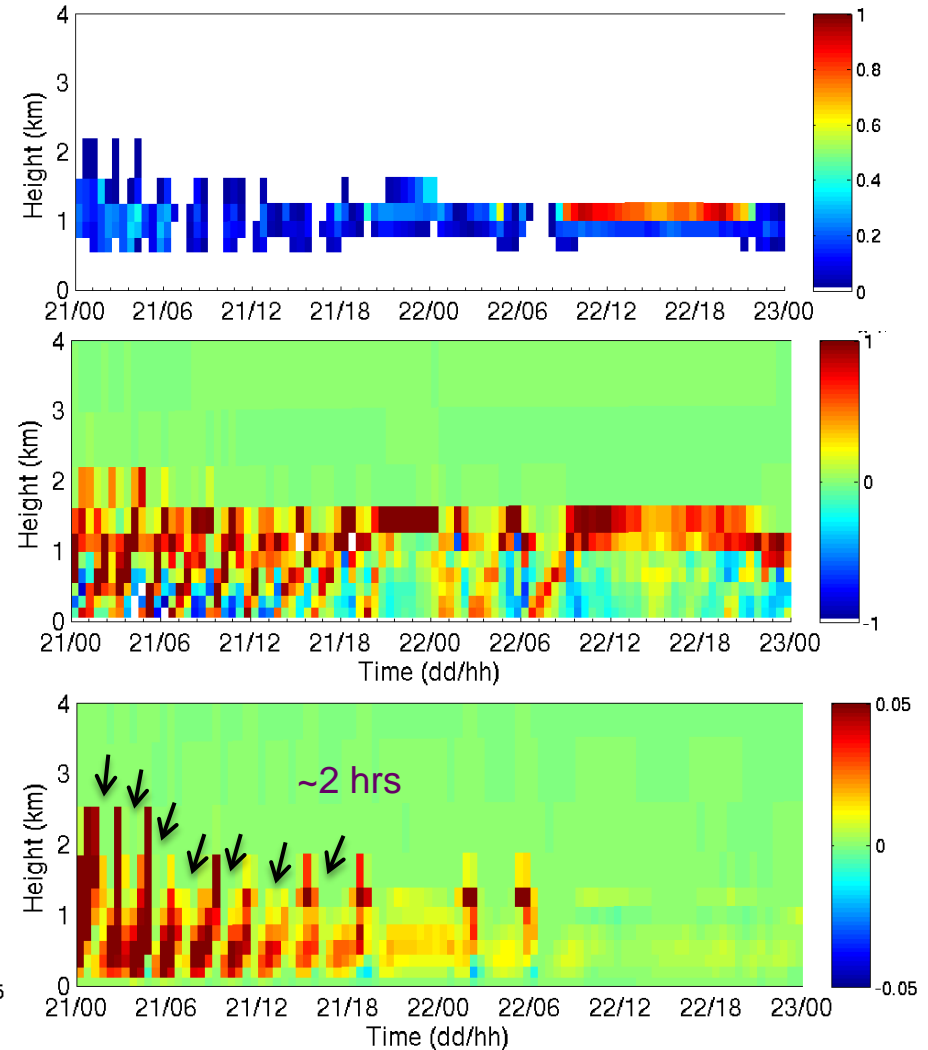
**Cloud oscillation in CLUBBMG2 scheme**

# Cloud/BL oscillation in CLUBMG2

subtime step = 5 min



subtime step = 30 sec



# Summary:

- All schemes produce too few low cloud cover and all-sky LWP.
- On Average, CLUBB/MG2 performs slightly better in-cloud LWP simulation. UNICON produces too few cloud cover and too much in-cloud LWP. Results are consistent with global satellite analyses and CAPT global analyses.
- Low clouds simulated with all three schemes have too weak surface radiative forcing. UNICON has the weakest surface longwave radiative forcing.
- In a case study, UNICON produces convective cloud fraction ( $\sim 3\%$ ) throughout the whole BL layer continuously.
- CLUBB/MG2 produces unrealistic cloud/BL oscillation, whose frequency relates to the sub-time step.

# Thanks!



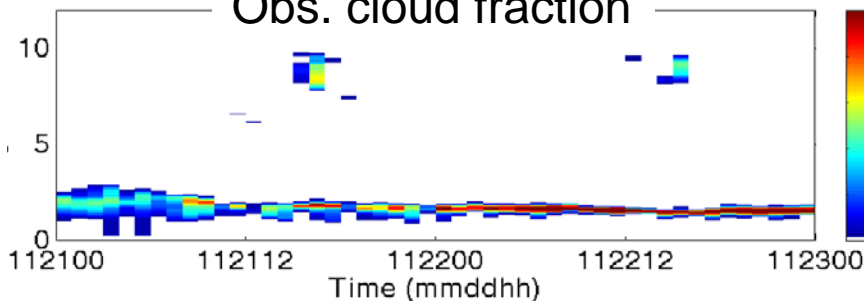


# Supplement slides

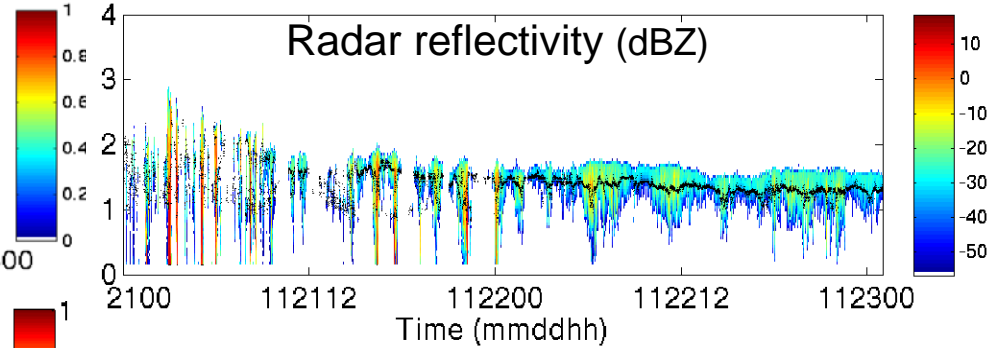


# Radar observation vs. modeled cloud fraction

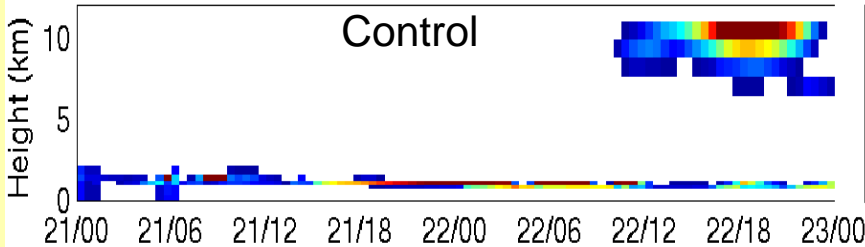
Obs. cloud fraction



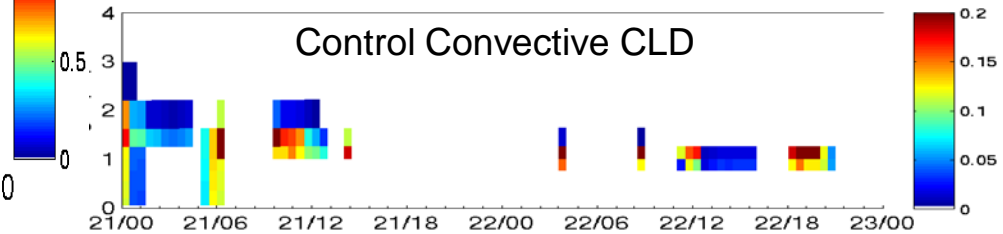
Radar reflectivity (dBZ)



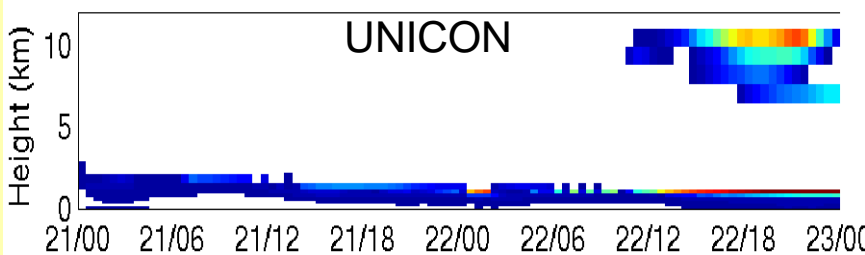
Control



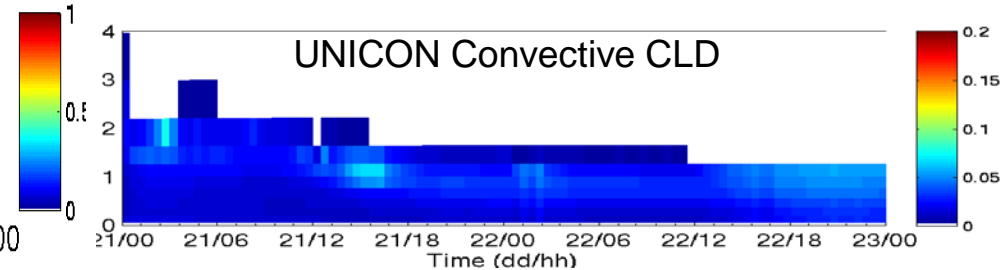
Control Convective CLD



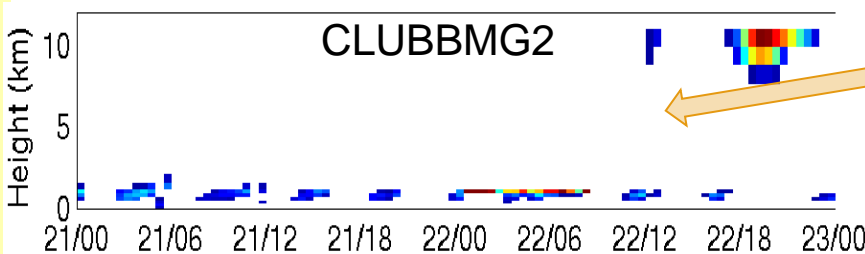
UNICON



UNICON Convective CLD



CLUBBMG2



Cloud oscillation in CLUBBMG2 scheme

# Cloud surface radiative forcing

