Comparison of NASA GCE-CRM and SCM-CAM5 (SCAM) with ARM data

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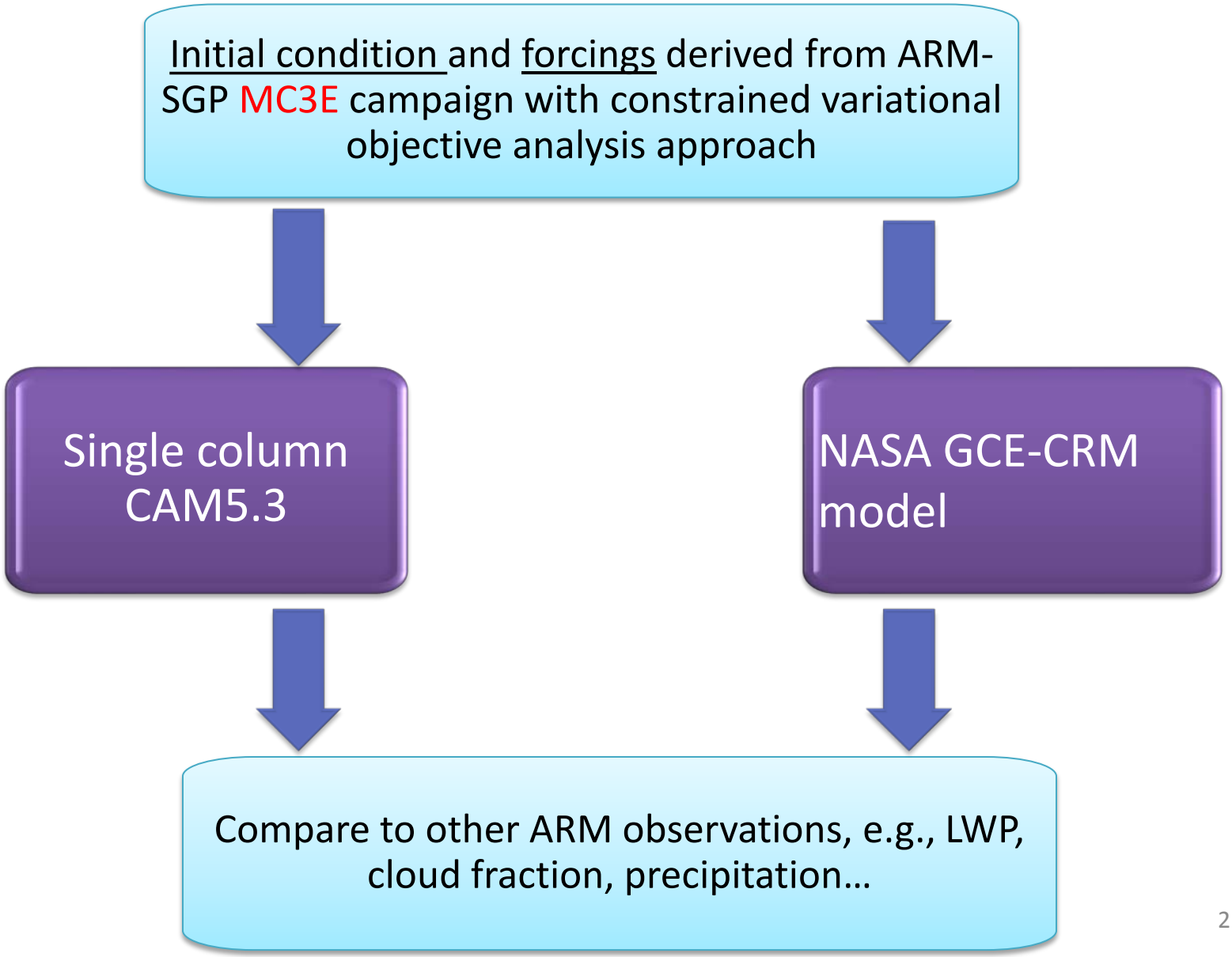
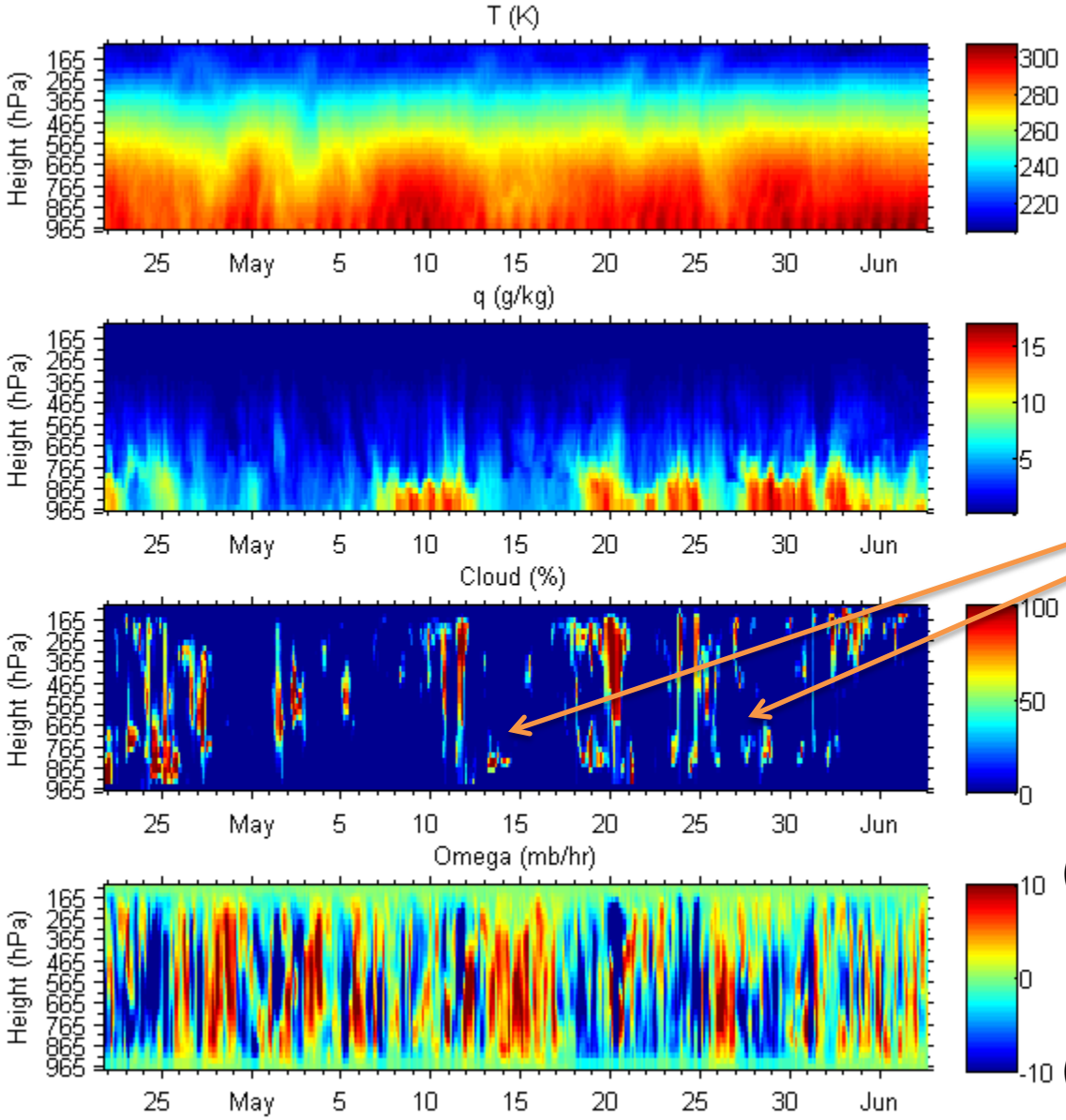
Methodology



Comparison of some basic features of the two models

	Single Colum CAM5.3 (SCAM)	CSRM (GCE)
Horizontal resolution	1 point	50m, 6.4kmX6.4km
Vertical resolution	30 layers, ~100 to 500m below 4km	144 layers, 50m near surface, stretched to ~400m at 12km
Temporal resolution	Half hour	0.5 second
Sub-grid cloud process parameterization	• Shallow Convection Scheme (Park and Bretherton [2009]) • Deep Convection Scheme (Zhang and McFarlane [1995])	Resolved
Microphysics	• Two-momentum scheme for ice and water (Morrison and Gettelman [2008]) in stratus only • Version 1.5 (version 1.0 shows problem with cloud droplet activation)	RAMS physics, 3 species of liquid (small and large cloud droplets and rain) and 5 species of ice
Aerosol scheme	Prescribed MAM3 aerosols	Prescribed aerosol numbers, look-up table.

Observed T, Q, Cloud fractions, Omega



T (K) from soundings

Q (g/kg) from soundings

May 13th, 27th

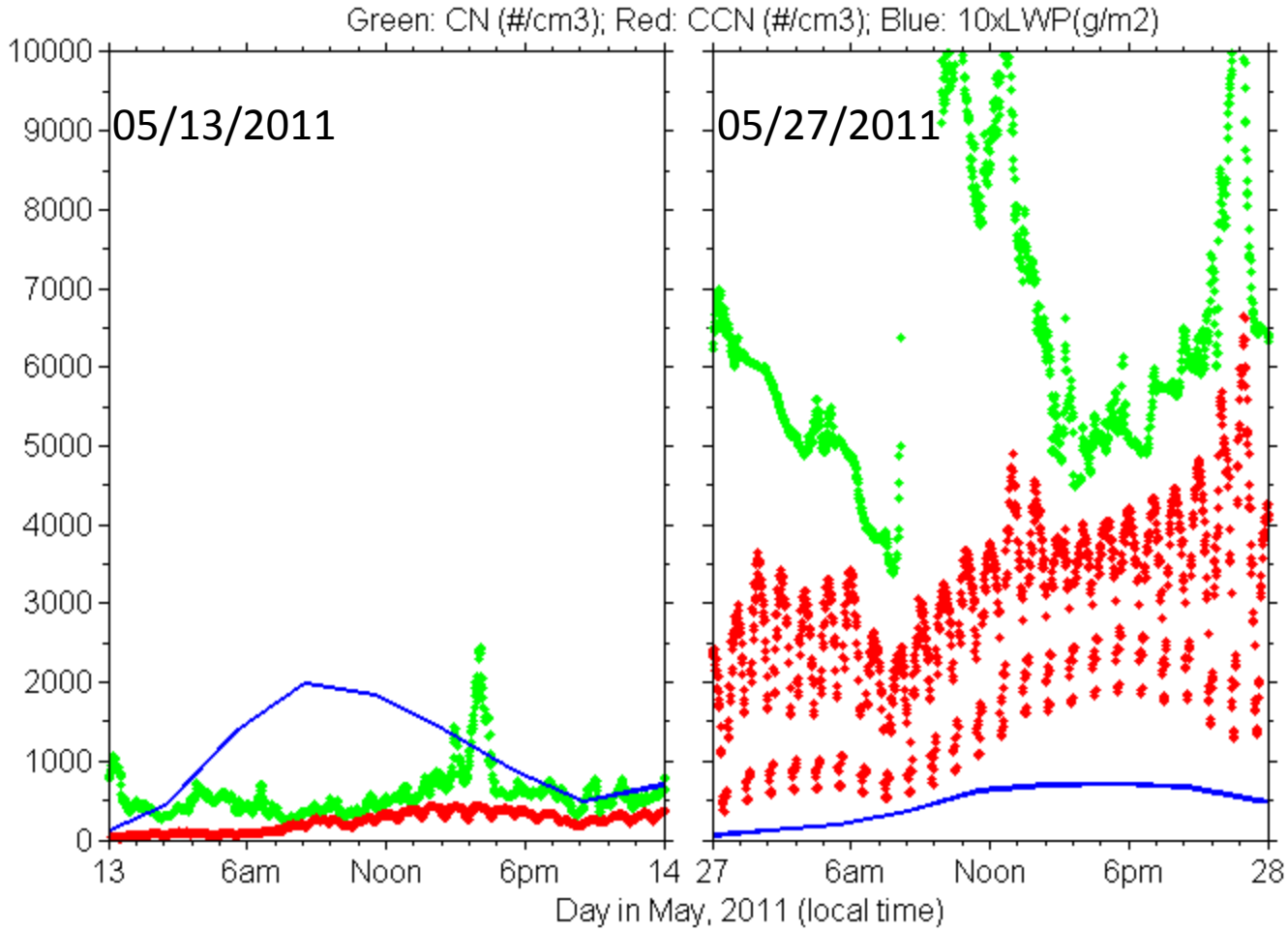
Cloud (%) from ARSCL

(descending)

Omega (mb/hr) from Soundings +RUC analysis

(ascending)

Observed CN/CCN/LWP on May 13th, 27th



Source of OBS

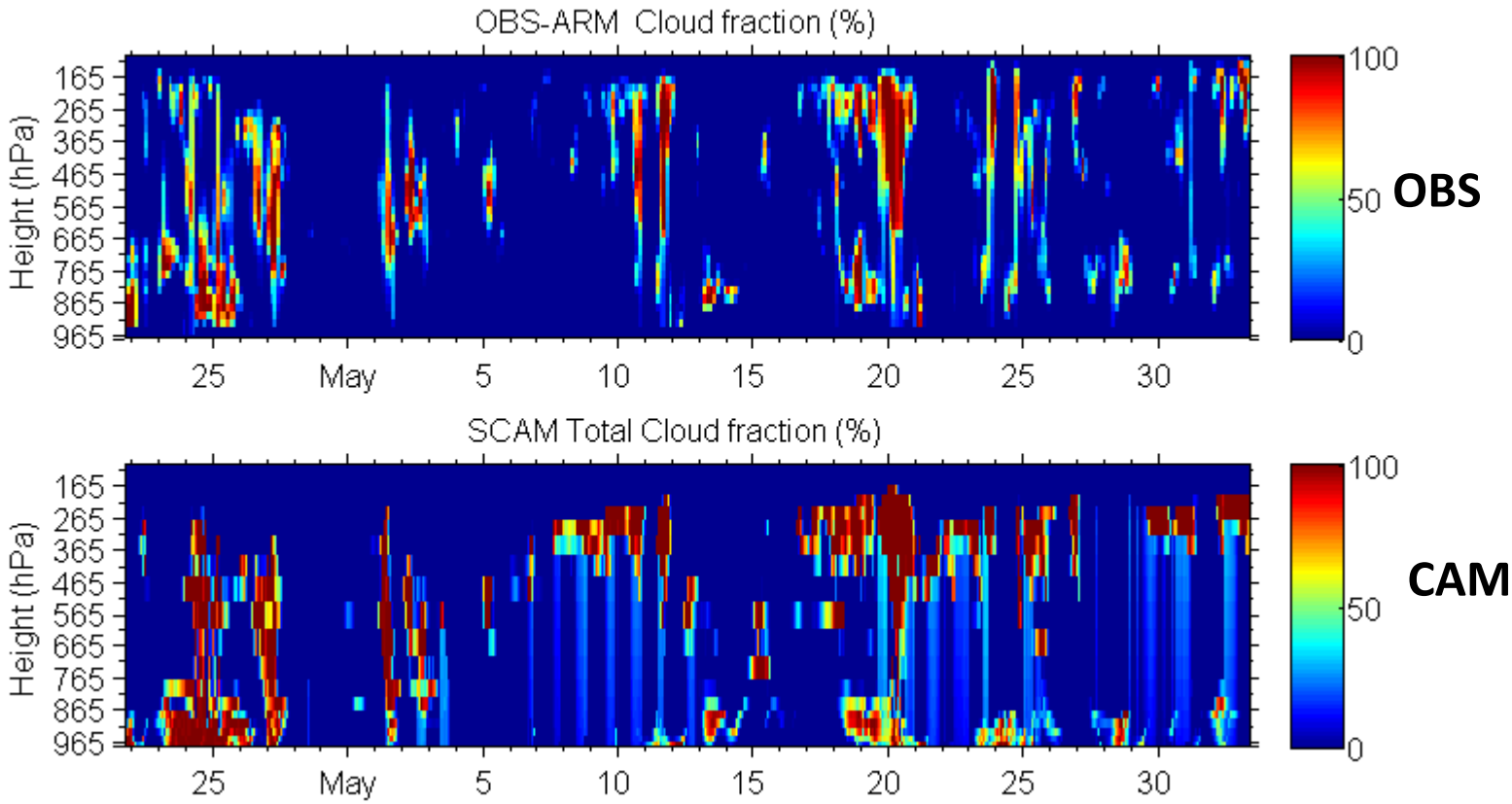
LWP: MWR

CN : AOS TSI model 3010 Condensation Particle Counter

CCN: AOS DMT CCN: Condensation Nuclei Counter

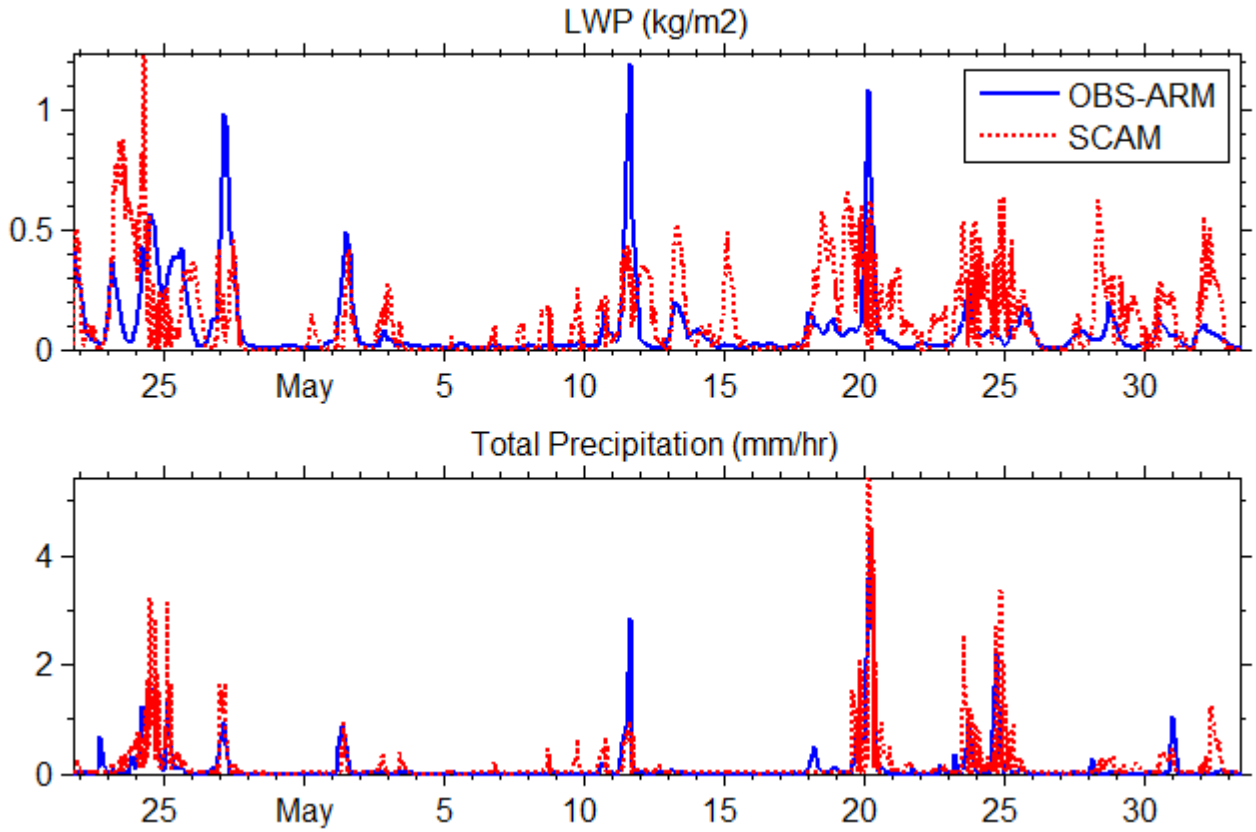
- **Note that LWP (g/m2) is timed by a factor of 10 to use the same y-axis.**
- **Relevant CN (green) number is from 400 to 800 #/cc on May 13th, from 4000 to 8000 on May 27th.**
- **Relevant CCN (red) number is 100-400 at 1%ss on May 13th , 2000-4000 at 1%ss on May 27th**
- **On both days, CCN:CN ~ 1:2 at ~1% super saturation.**

Results from SCM-CAM5.3



- **CAM overestimates cloud fractions,**
  - **from low clouds to high clouds**
  - **deep convective clouds**

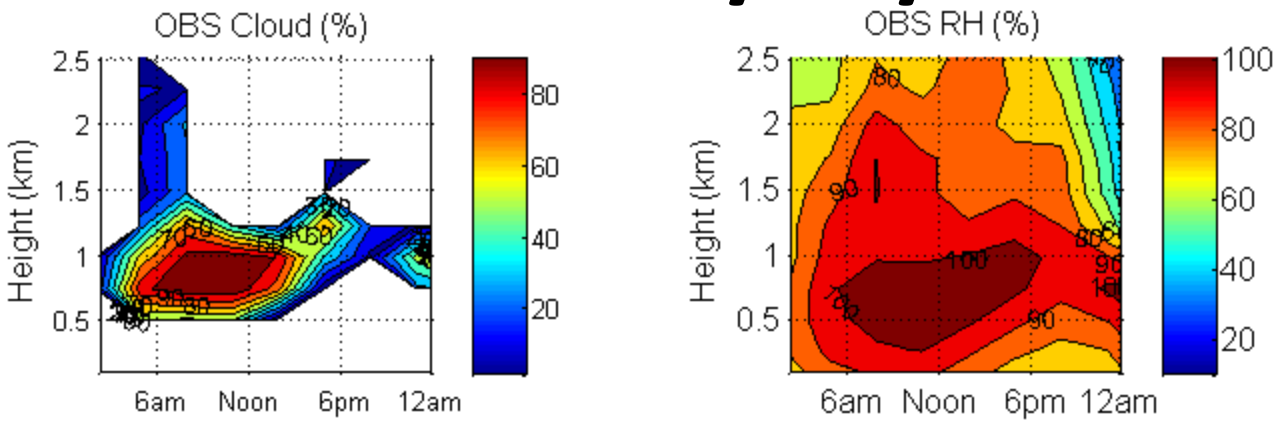
Results from SCM-CAM5.3: LWP and precipitation



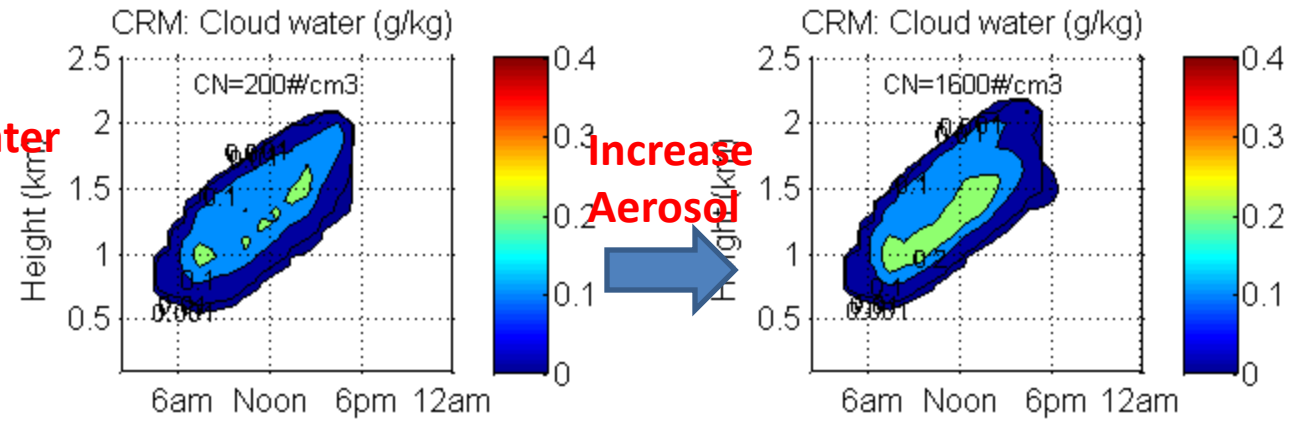
- **CAM overestimates LWP**
- **Strong precipitation days generally match well. Overestimate on many days with weak precip rate.**

Results on 05/13/2011

OBS

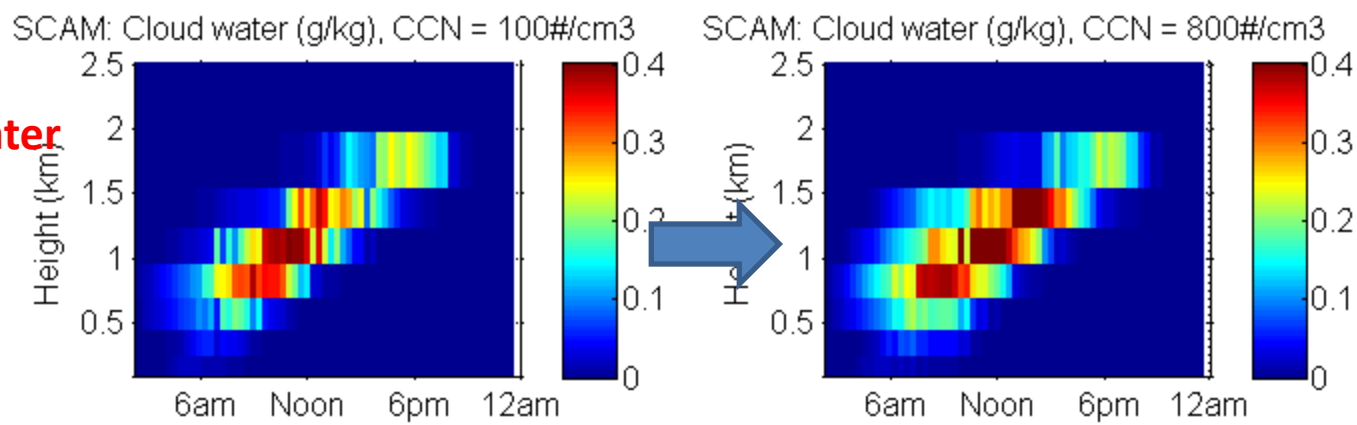


CRM: cloud water



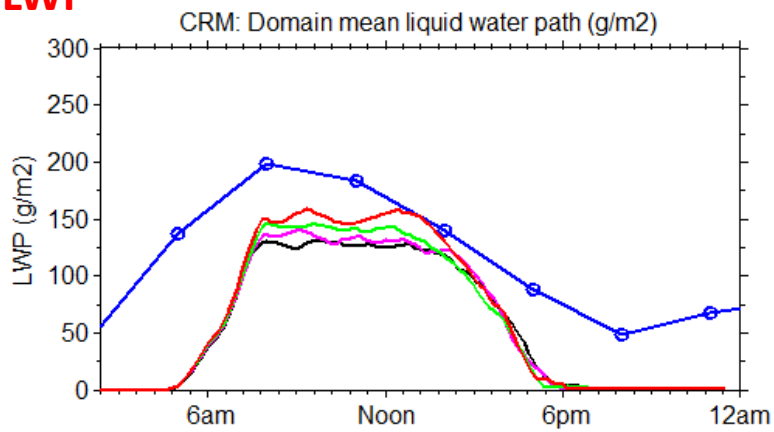
Increase Aerosol

SCM: cloud water

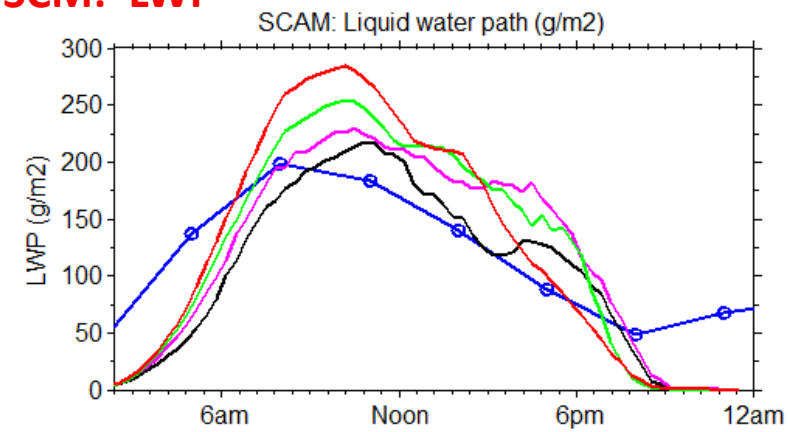


Results on 05/13/2011

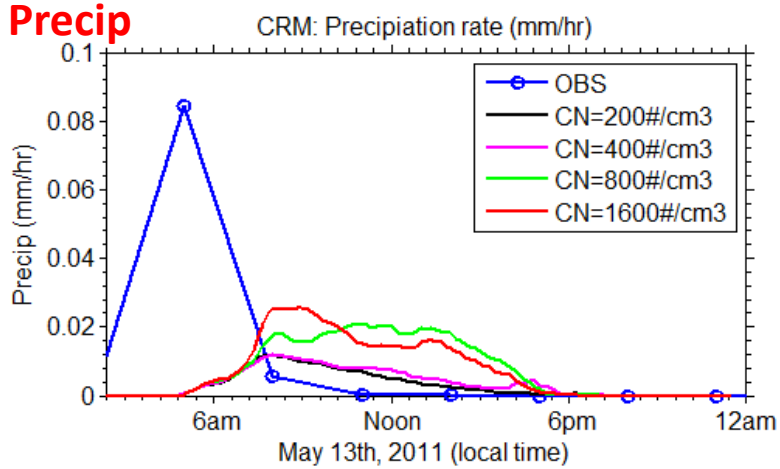
CRM: LWP



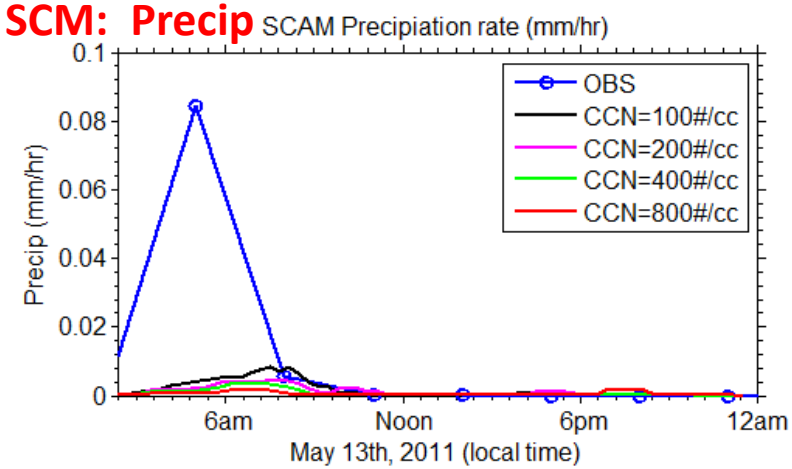
SCM: LWP



CRM: Precip



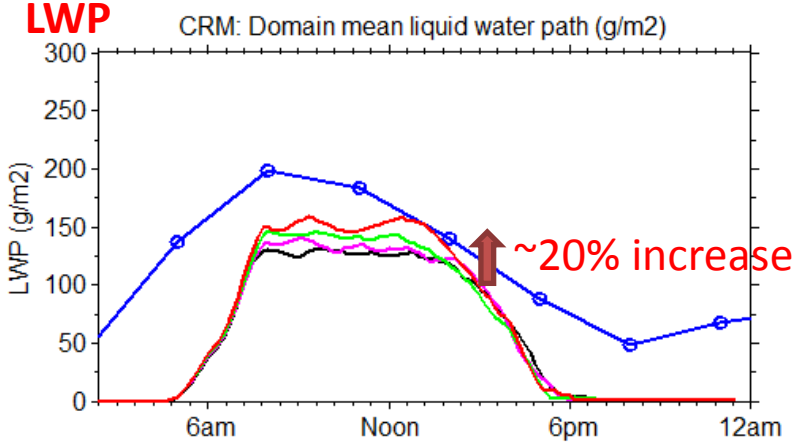
SCM: Precip



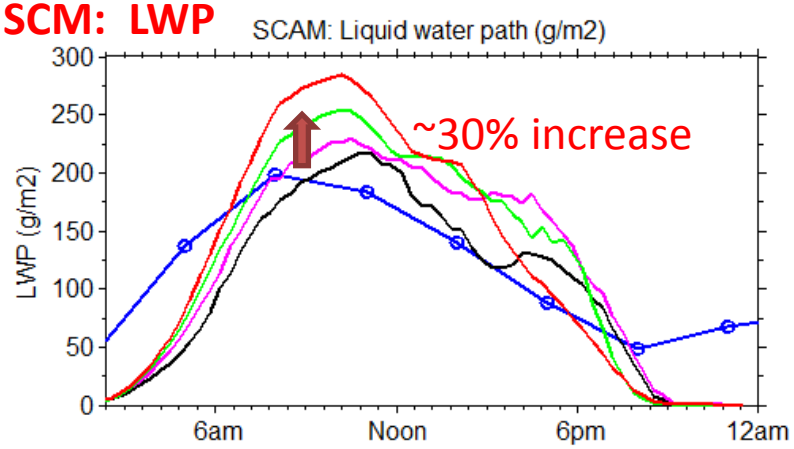
- **SCAM simulated larger LWP and smaller precipitation rate**
- **Both models fail to show strong precipitation around 6am, (one site precipitation data vs. regional mean forcing?)**

Results on 05/13/2011
Aerosol effect on LWP and precipitation

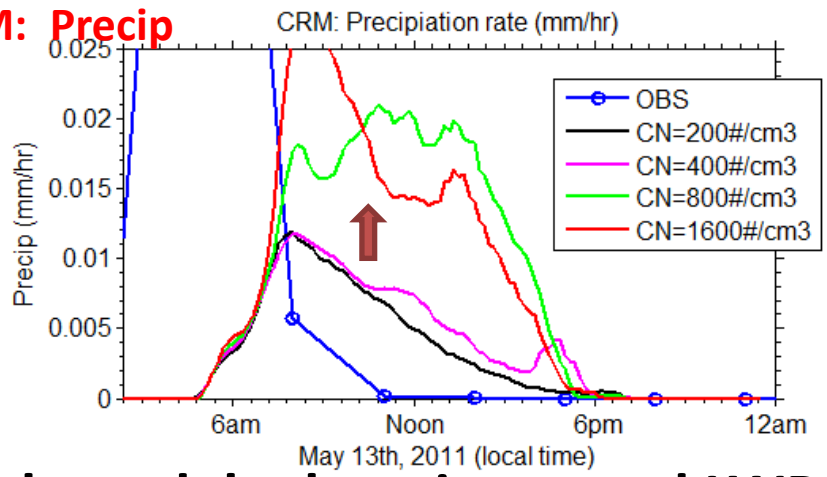
CRM: LWP



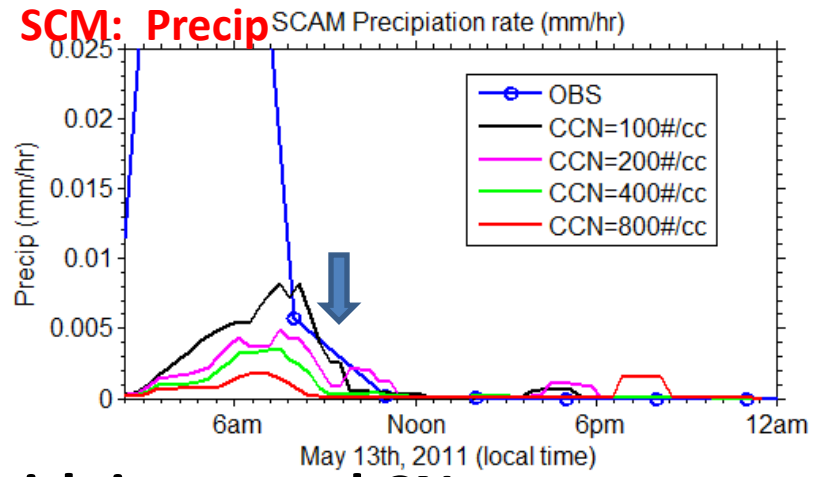
SCM: LWP



CRM: Precip



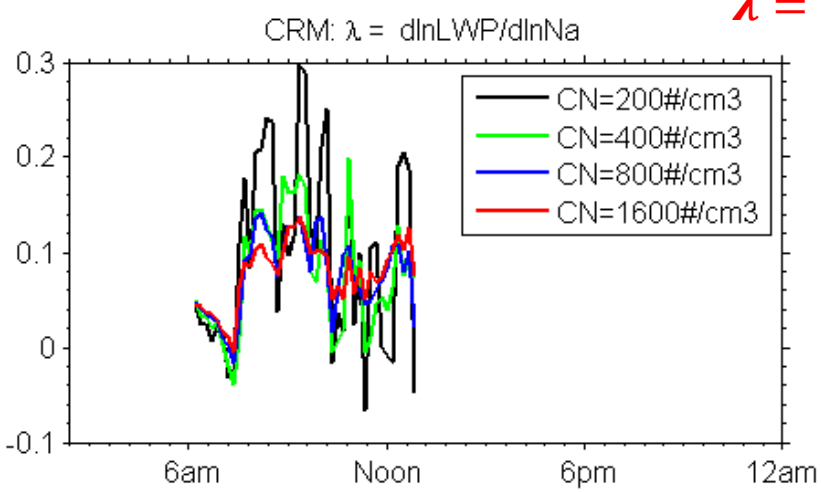
SCM: Precip

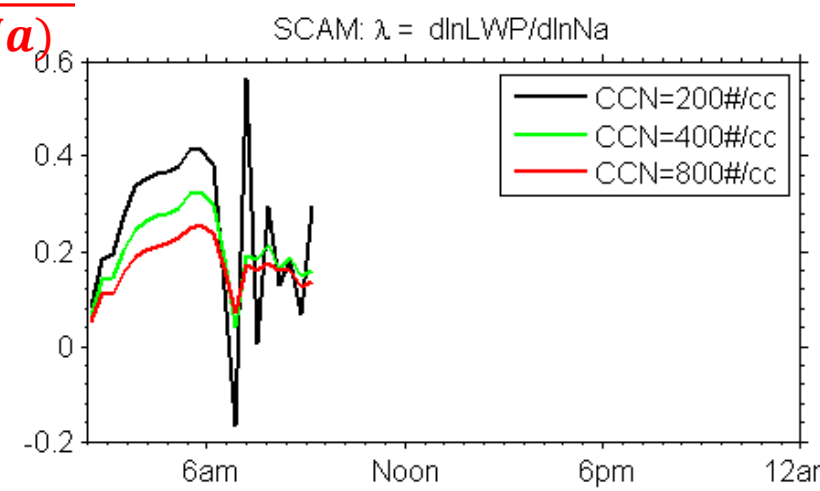


- **Both models show increased LWP with increased CN.**
- **CRM shows increased precipitation rate while SCAM shows decreased precipitation rate.**

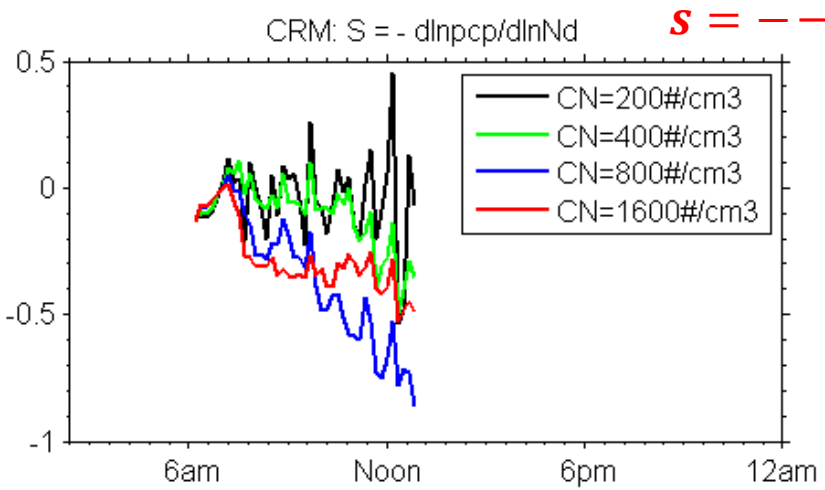
Relative changes of LWP and Precipitation rate to the relative changes of aerosol/cloud drop numbers

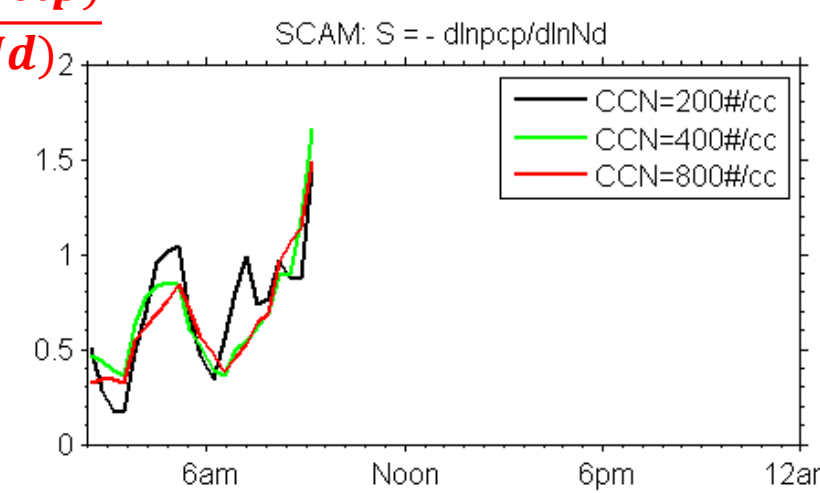
$$\lambda = \frac{dln(LWP)}{dln(Na)}$$





$$s = -\frac{dln(Precip)}{dln(Nd)}$$





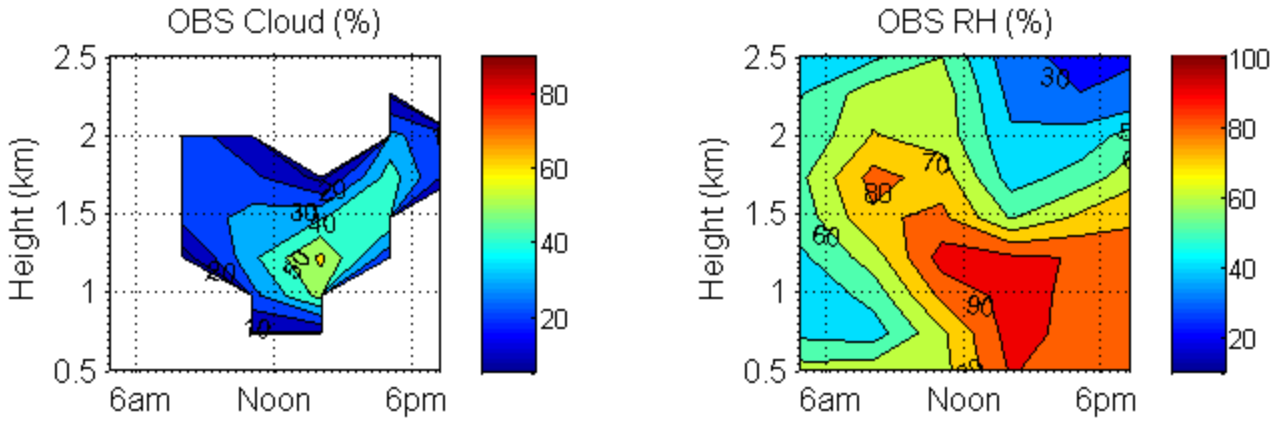
Relative changes of LWP and Precipitation rate to the relative changes of aerosol/cloud drop numbers

05/23/2011	CRM	SCAM
$\lambda = \frac{dln(LWP)}{dln(Na)}$	+0.10	+0.20
$s = -\frac{dln(Precip)}{dln(Nd)}$	-0.24	+1.0

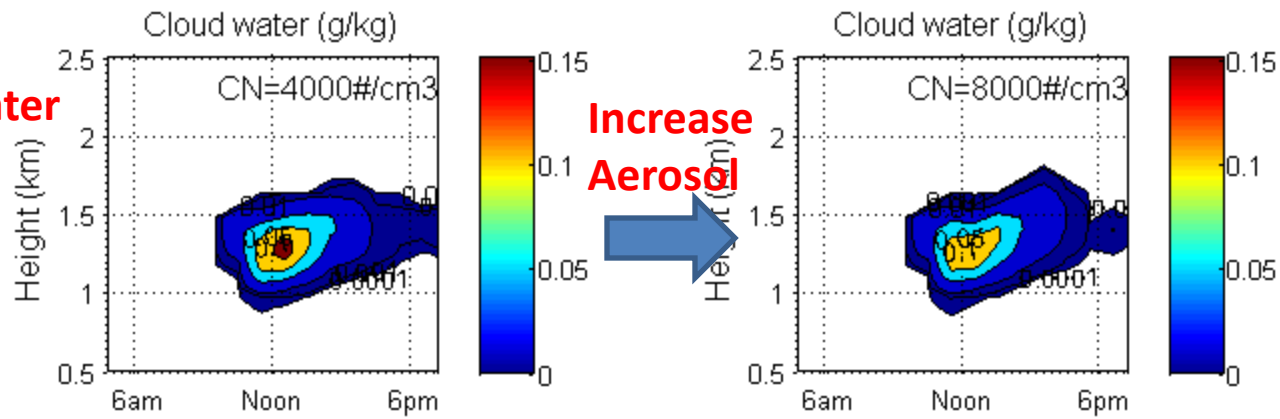
- **Numbers vary depending on the averaging period. Here from <u>9am to Noon</u> for CRM and <u>6am to 10am</u> for SCM.**
- **Numbers also vary depending on aerosol loading. Here we averaged over all runs.**
- **Same trend for LWP but opposite trend for precipitation.**

Results on 05/27/2011

OBS

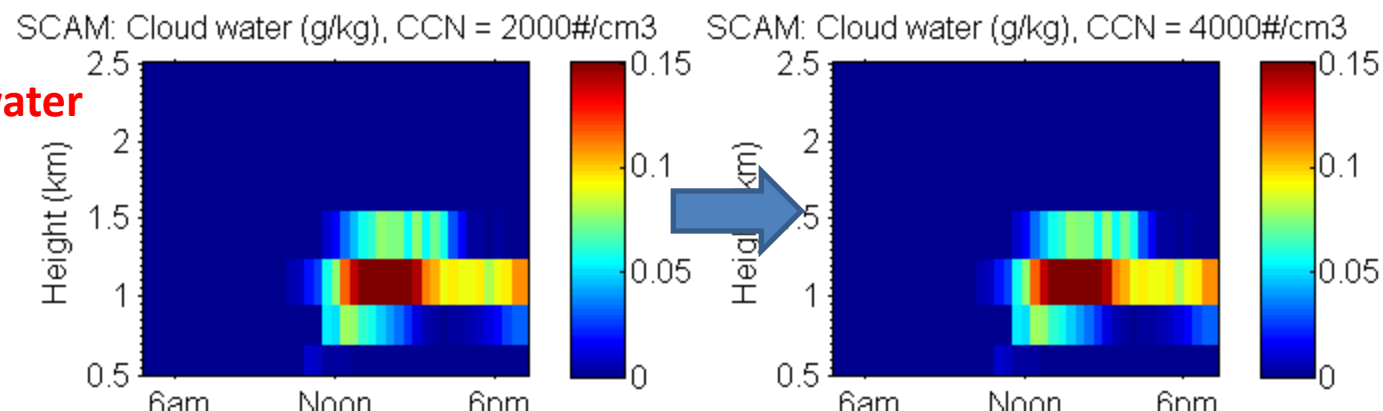


CRM: cloud water

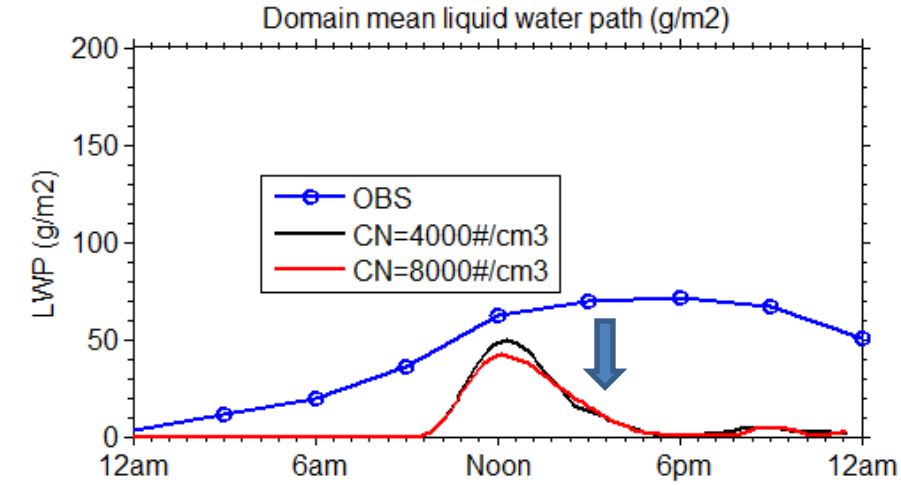


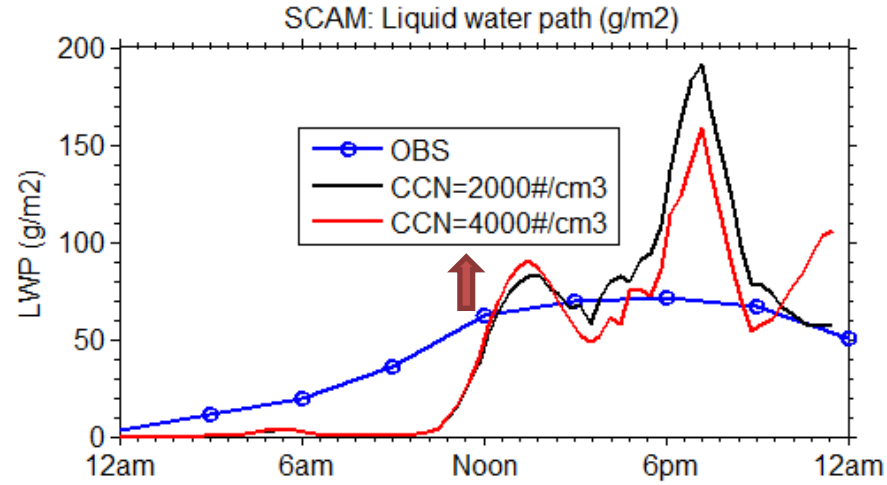
Increase Aerosol

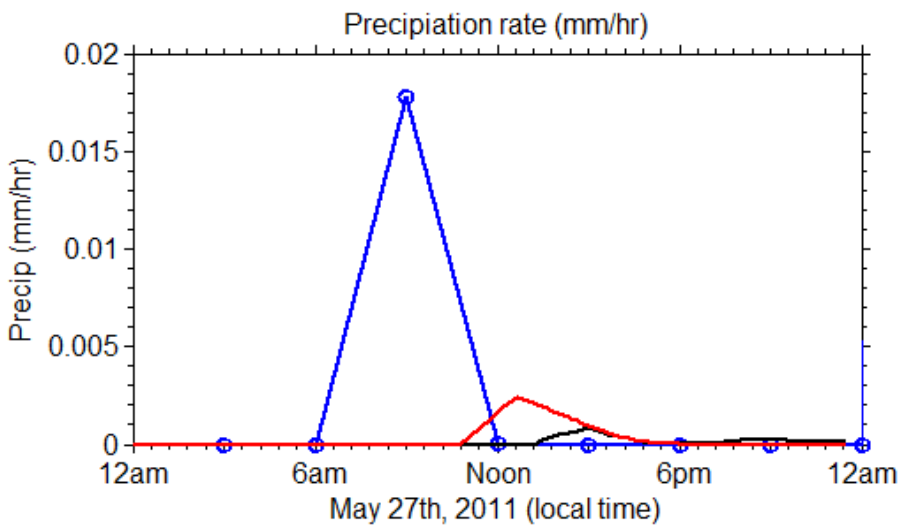
SCM: cloud water

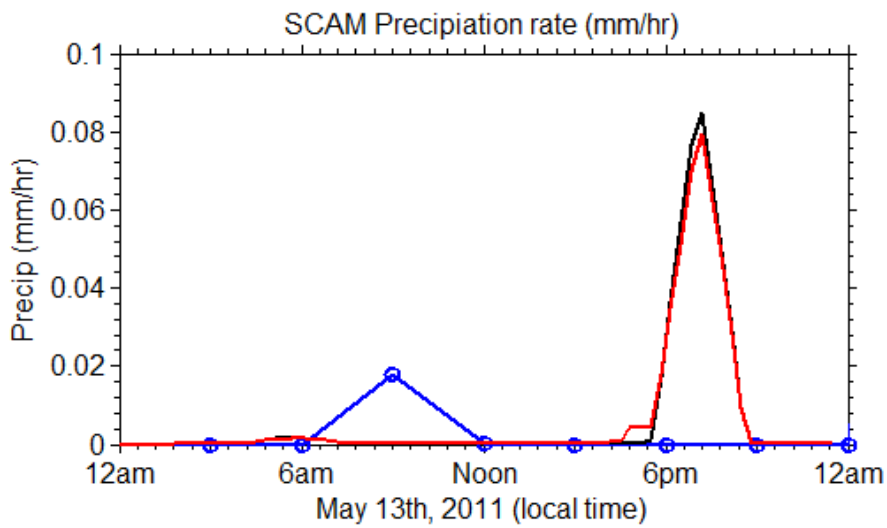


Results on 05/27/2011
Aerosol effect on LWP and precipitation









Relative changes of LWP and Precipitation rate to the relative changes of aerosol/cloud drop numbers

05/27/2011	CRM	SCAM
$\lambda = \frac{dln(LWP)}{dln(Na)}$	-0.20	+0.02
$s = -\frac{dln(Precip)}{dln(Nd)}$	<0	Precip is suppressed

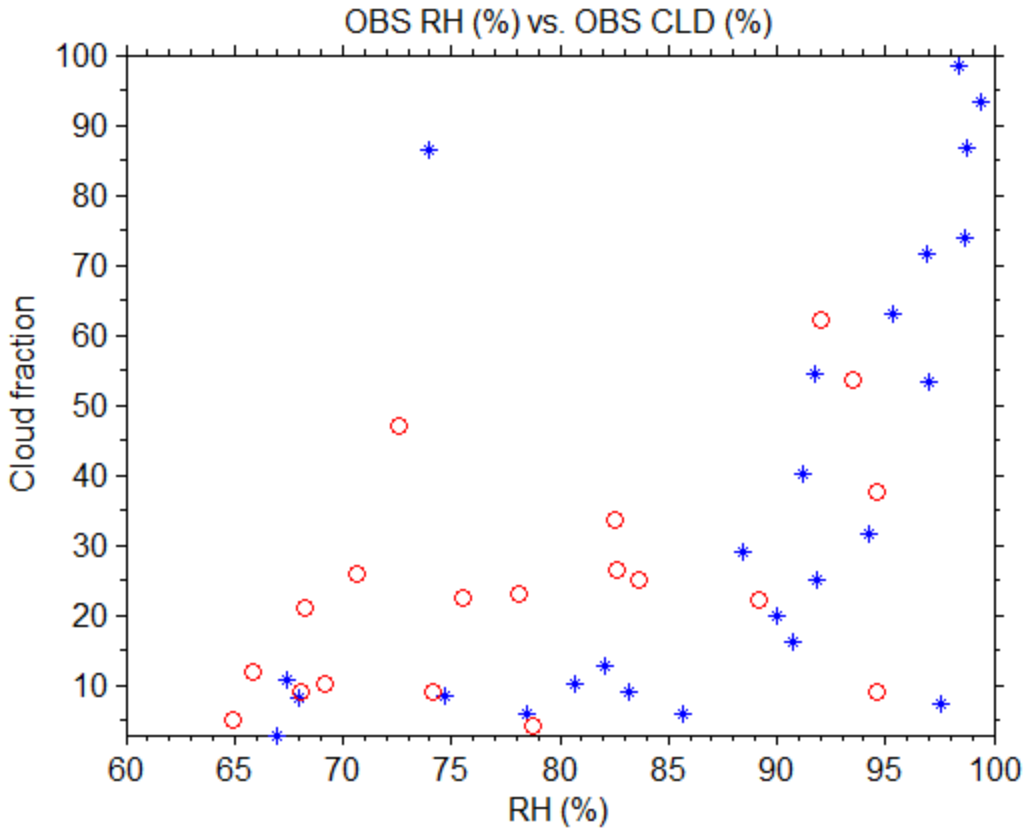
- **Numbers vary depending on the averaging period. Here from 11am-1pm for both CRM and SCM.**
- **Opposite trend for LWP.**

Summary / Conclusion

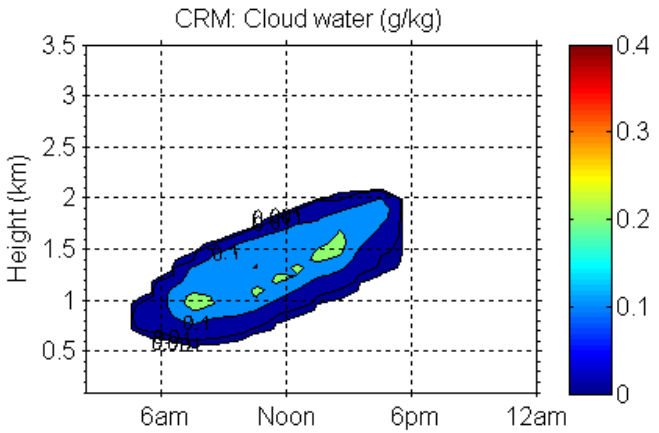
05/13/2011	CRM	SCAM	
$\lambda = \frac{dln(LWP)}{dln(Na)}$	+0.10	+0.20	LWP increases with Na, but SCAM is more sensitive
$s = -\frac{dln(Precip)}{dln(Nd)}$	-0.24	+1.0	Opposite responses of precipitation rate to aerosol increases
05/27/2011			
$\lambda = \frac{dln(LWP)}{dln(Na)}$	-0.20	+0.02	Opposite responses
$s = -\frac{dln(Precip)}{dln(Nd)}$	<0	N/A	CRM show increased precipitation rate.

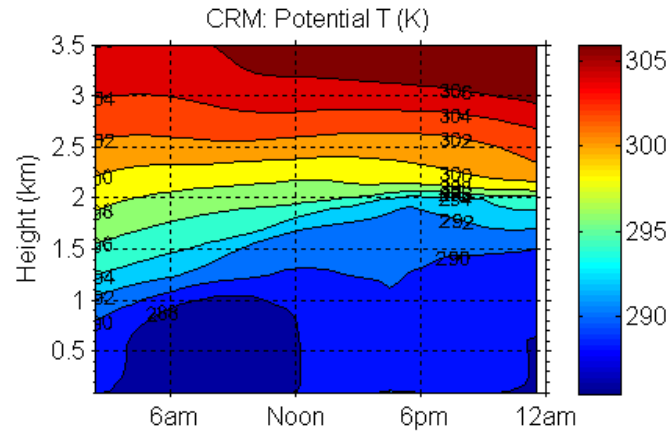
THANK YOU!

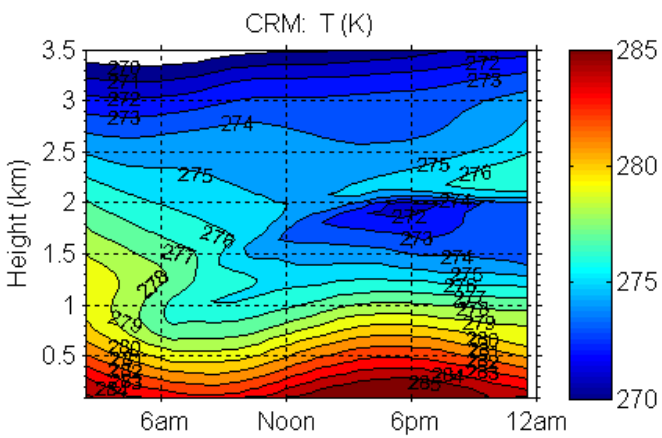
Observed cloud fraction vs. RH
Blue:05/13/2011, red: 05/27/2011

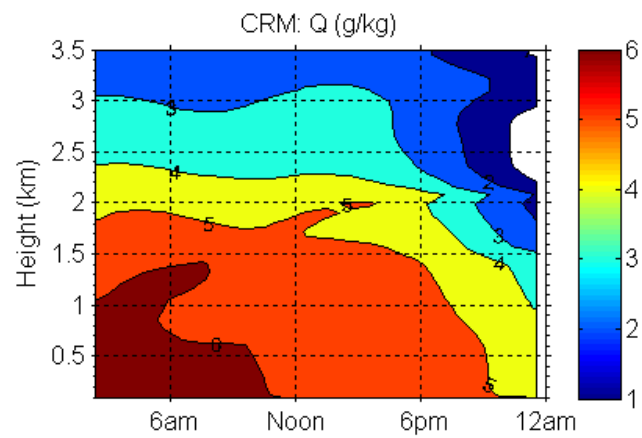


Q,T on 05/13/2011

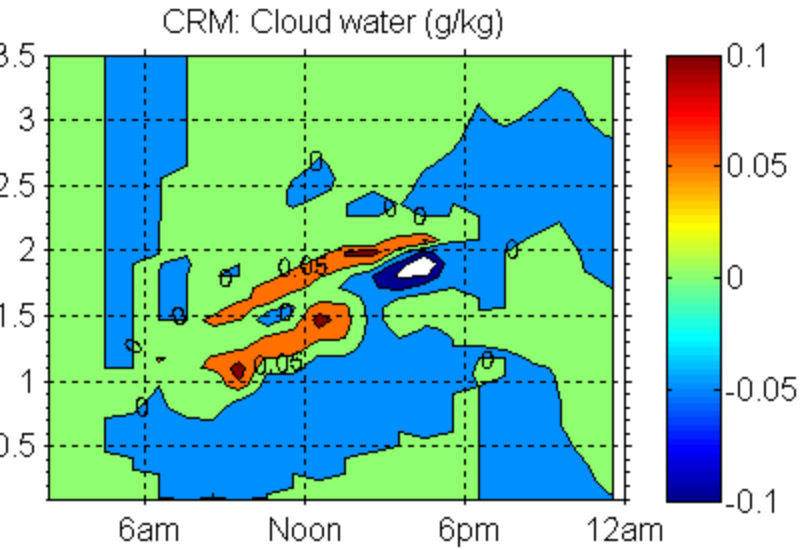


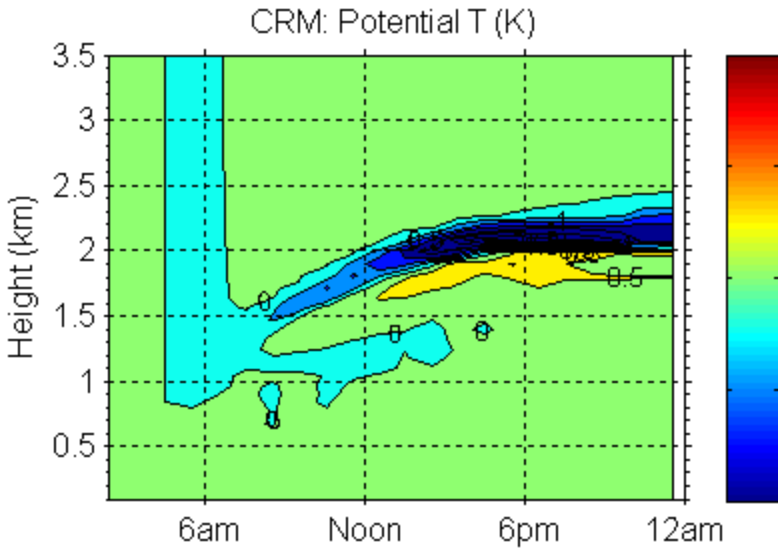


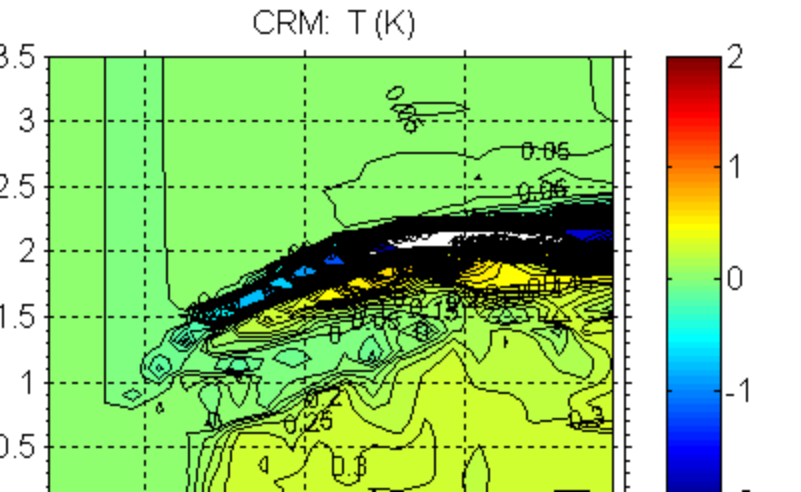


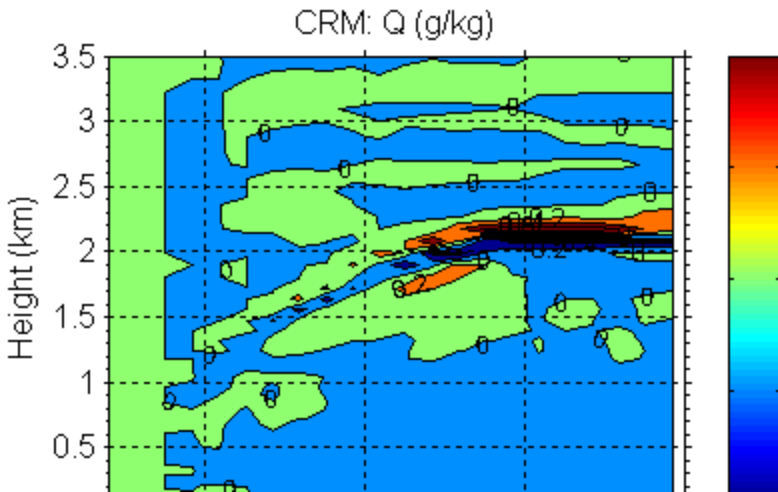


CRM: CN1600 –CN100

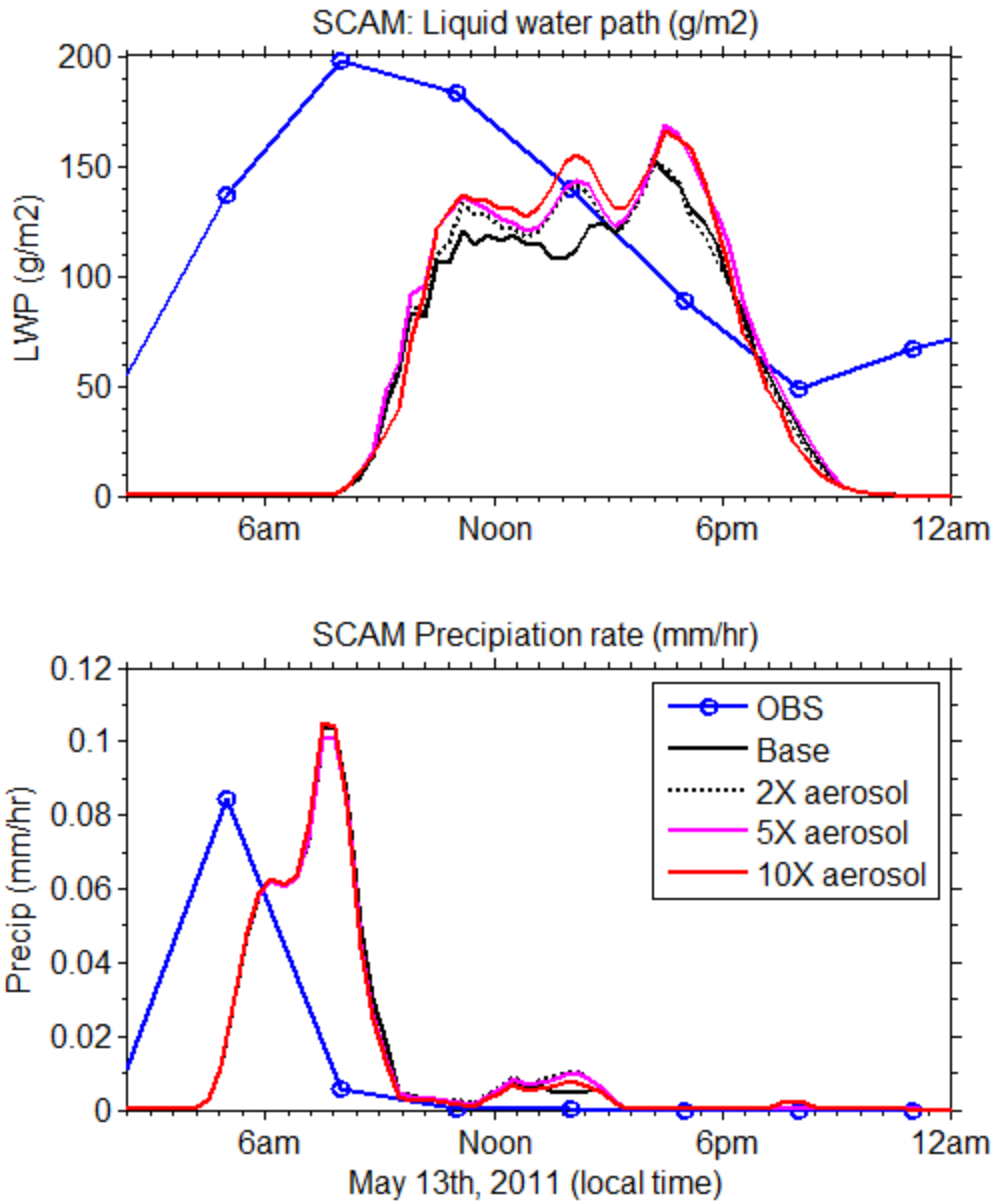








SCAM/MG1.0 has problem!

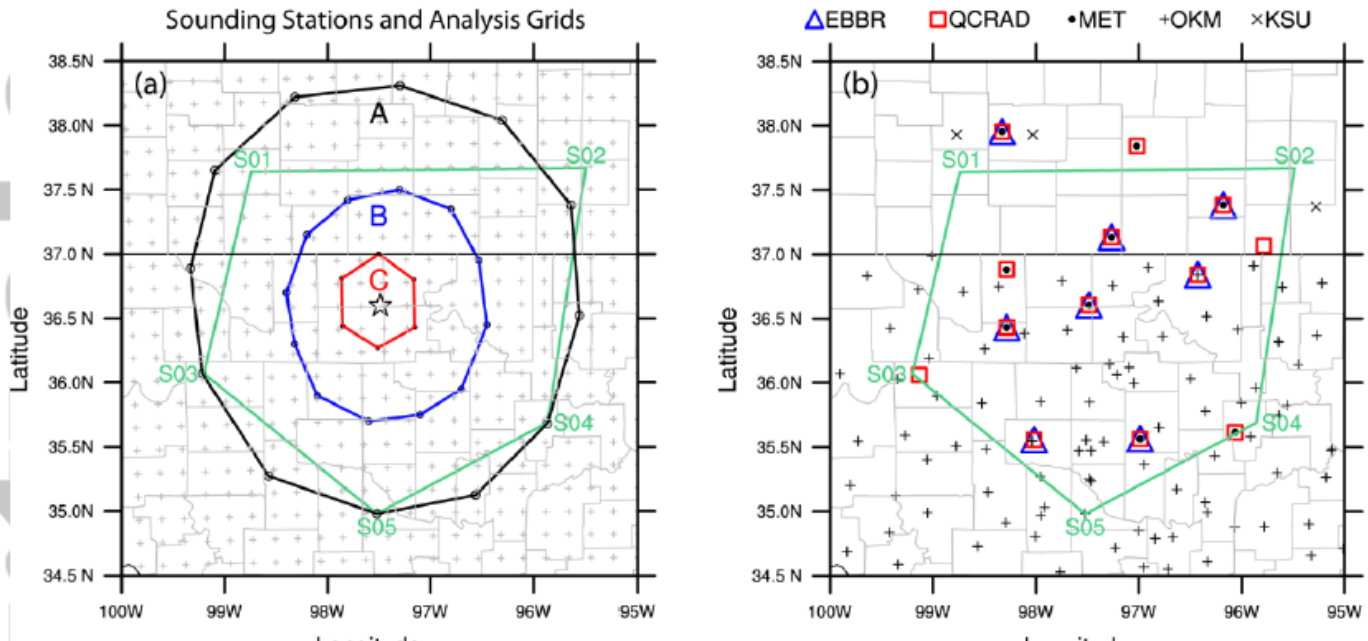


- MG1.0 has problem with cloud droplet activation.
- Cloud droplet number is too small which leads to really large autoconversion rate and quick removal of LWP.

MC3E: Midlatitude Continental Convective Clouds Experiment

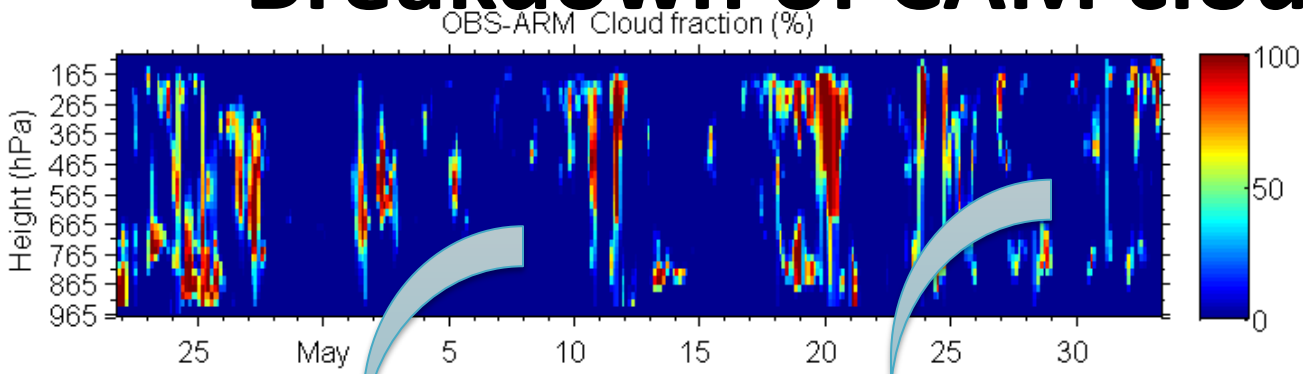
1. Conducted during April to June 2011 near the ARM Southern Great Plains (SGP) site
2. The analysis forcing data cover the period from 00Z 22 April - 21Z 6 June 2011.
3. The forcing data represent an average over the 3 different analysis domains centered at central facility with a diameter of 300 km (standard SGP forcing domain size), 150 km and 75 km

The MC3E Ground Observation Network



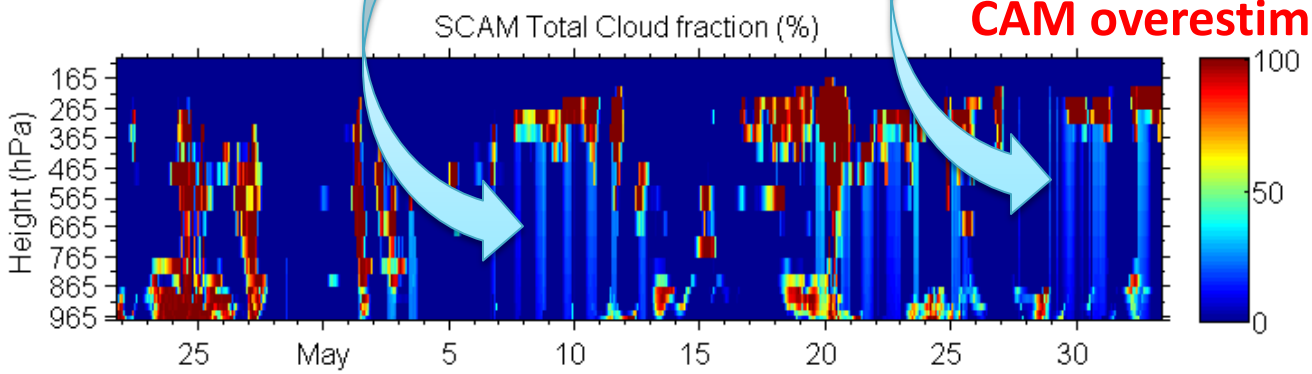
(From Xie et al. 2014)

Breakdown of CAM clouds

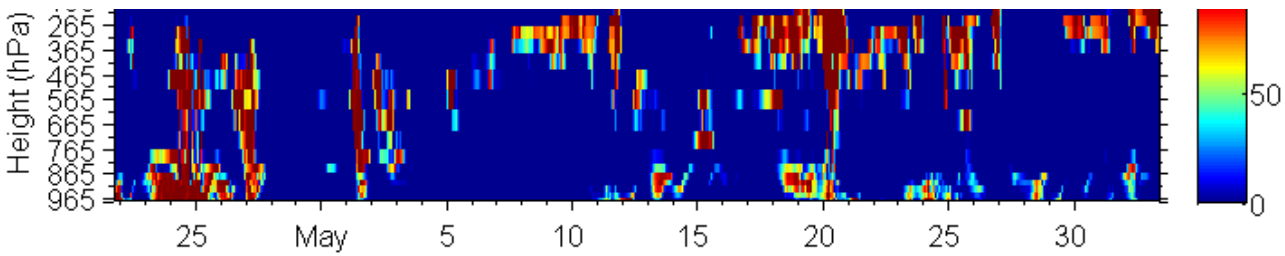


OBS

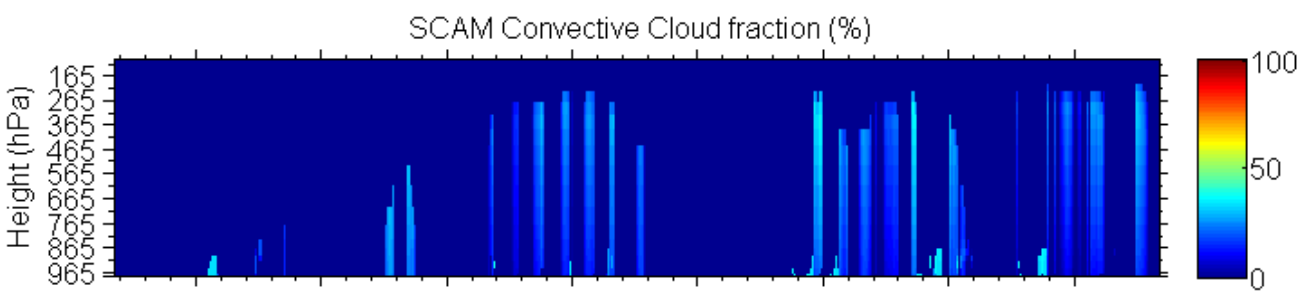
CAM overestimate!



CAM total



CAM Stratus



CAM convective