Atmospheric Radiation Measurement

Update on the ARM Cloud Modeling Working Group Activities

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ARM CPWG Fall Meeting, Annapolis, MD, 8-10 November, 2006

Major Issues Discussed in the CMWG Fall Meeting

- ***ARM Future Observing and Modeling Plans***
  - ***2nd AMF, AVA, AAVP, ALT, CLASIC, MC^{3}E***
- ***M-PACE Model Intercomparison Study***
  - ***Preliminary results***
  - ***Issues***
- ***TWP-ICE***
  - ***Data analysis***
  - ***Potential research activities***

Discussion of Proposed New Instrumentation – AVA (provided by Steve Klein)

- **Pavlos Kollias provided an educational talk explaining capabilities of new systems**
- **There is some interest in the abilities of the proposed system to retrieve the 3-dimensional distribution of clouds, winds, and humidity**
- **A goal of the Observing System Simulation Experiments (OSSEs) should be to determine if AVA could discriminate between good and bad cloud models**

Discussion of Proposed New Instrumentation – AVA (provided by Steve Klein)

- **The radar simulators in these OSSE should be made available to cloud modelers**
- **A sample of 3-dimensional wind data from CASA might be useful to understand the capabilities of the proposed system**
- **A list of detailed products (quantities, resolution, quality & uncertainty indicators) that would be produced from both 1 & 3 scanning radar systems is desired**

M-PACE Model Intercomparison Study

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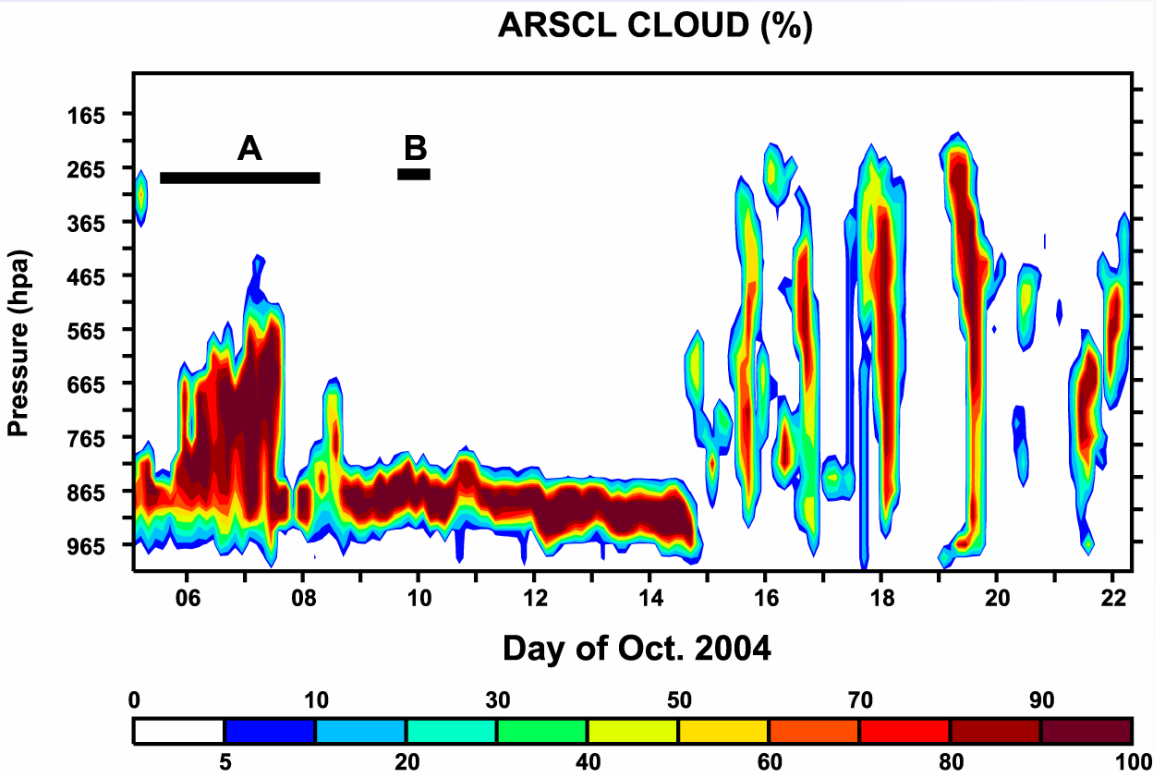
Goals

- **Document the current state of mixed-phase cloud microphysics in models**
- **Understand differences between models and observations in their simulations of mixed phase cloud microphysics**
- **Spur improvements in the representation of mixed phase cloud microphysics in climate and cloud resolving models**.

Periods of Interest

Barrow Cloud Observation



Period A

Multi-layer mixed-phase stratus formed in low-level uplift

Suitable for SCM/CRM models

Period B

Cold-air outbreak, well-mixed, mixed-phase, single layer stratocumulus

Suitable for SCM/CRM/LES models

Models

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10 Single Column Models

- ARCSCM (Morrison), CCCma (Cole), ECHAM5 (Hoose/Lohmann), ECMWF (Neggers), GFDL (Klein), GISS (Wolf/DelGenio), GISS LBL (Sednev/Menon), NCEP GFS (Yang), Scripps (Veron/Foster), UWisc (Larson/Falk)
- Some operational; Some research

7 Cloud Resolving Models or Large Eddy Simulations

- COAMPS (Golaz), DHARMA (Fridlind/Ackerman), GCE (Zeng/Tao), RAMS CSU (Avramov/Harrington), SAM (Chen/Khairoutdinov), UCLA/LARC (Luo/Xu), UWM NMS (deBoer/Tripoli)
- Some 3-dimensional; some 2-dimensional
- Horizontal grid resolution varies from 50 m to 2 km

Liquid Water Path – Period B

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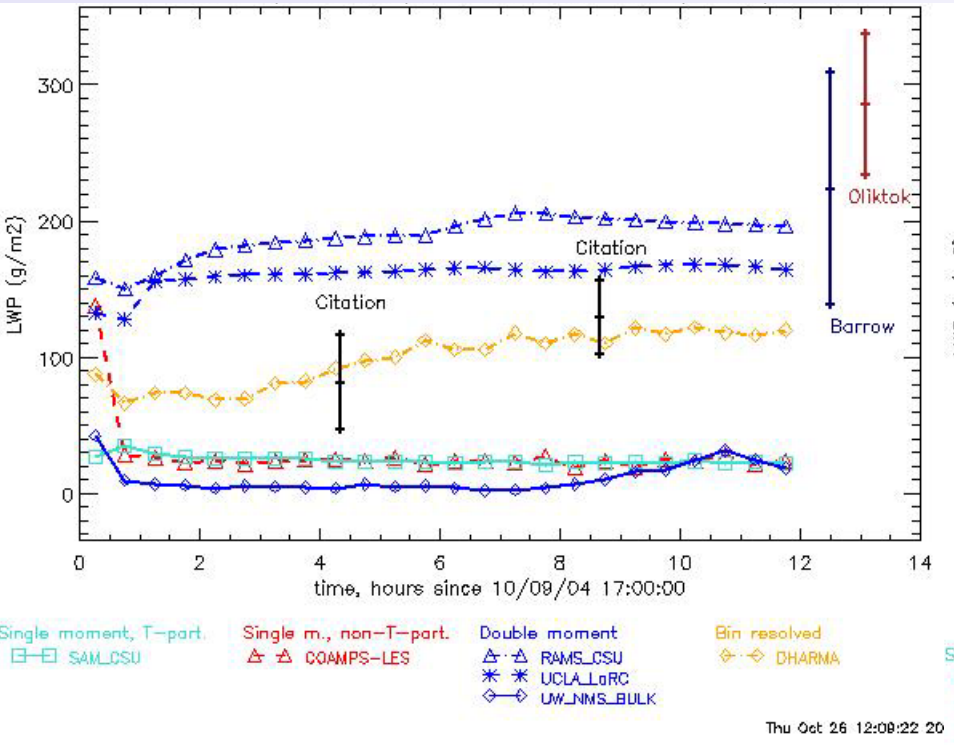
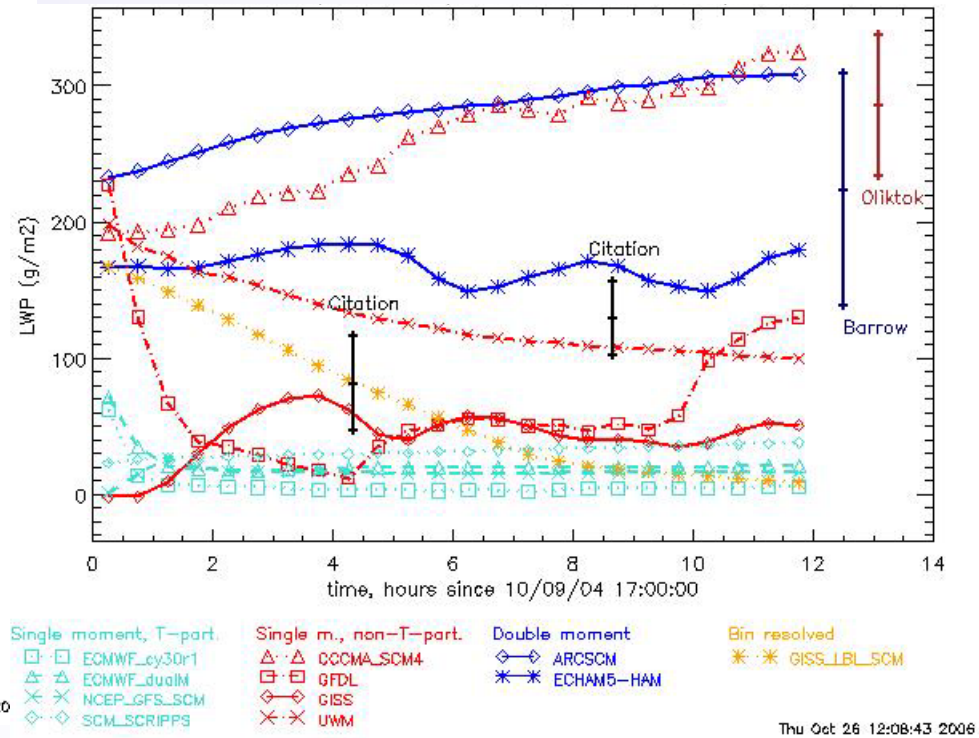
CRM/LES



SCM



Aircraft observations differ from Microwave Radiometer LWP by a factor of 2!

Note that cloud thickness from ARSCL at Barrow is 750 m, but the cloud thicknesses from the Citation are 550 m and 730 m

Adiabatic liquid water path is ~200 g m^{-2} for Barrow cloud thickness, thus an adiabatic cloud with thicknesses measured by the citation would be 105 g m^{-2} and 190 g m^{-2}

Clear tendency in both CRM/LES and SCM group for more detailed microphysics to simulate greater LWP

Sensitivity Study

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No Ice Microphysics

- ***What is the role of ice-microphysics in mixed-phase clouds?***
- ***Does the model produce a well-mixed boundary layer and nearly adiabatic liquid water content in the absence of ice microphysical processes? (as it should?)***

Vertical Resolution

- ***Is high vertical resolution (~100 m) necessary to simulate the thin liquid water layers?***
- ***Are the microphysical simulations strong functions of vertical (and/or temporal) resolution in models?***

Liquid Water Path: CRM/LES

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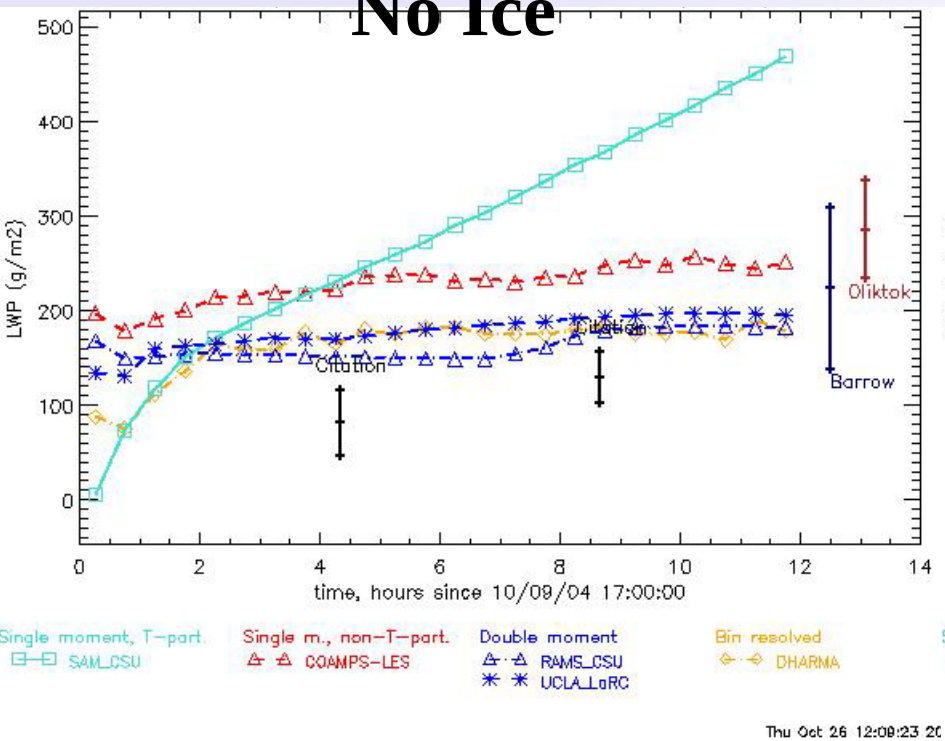
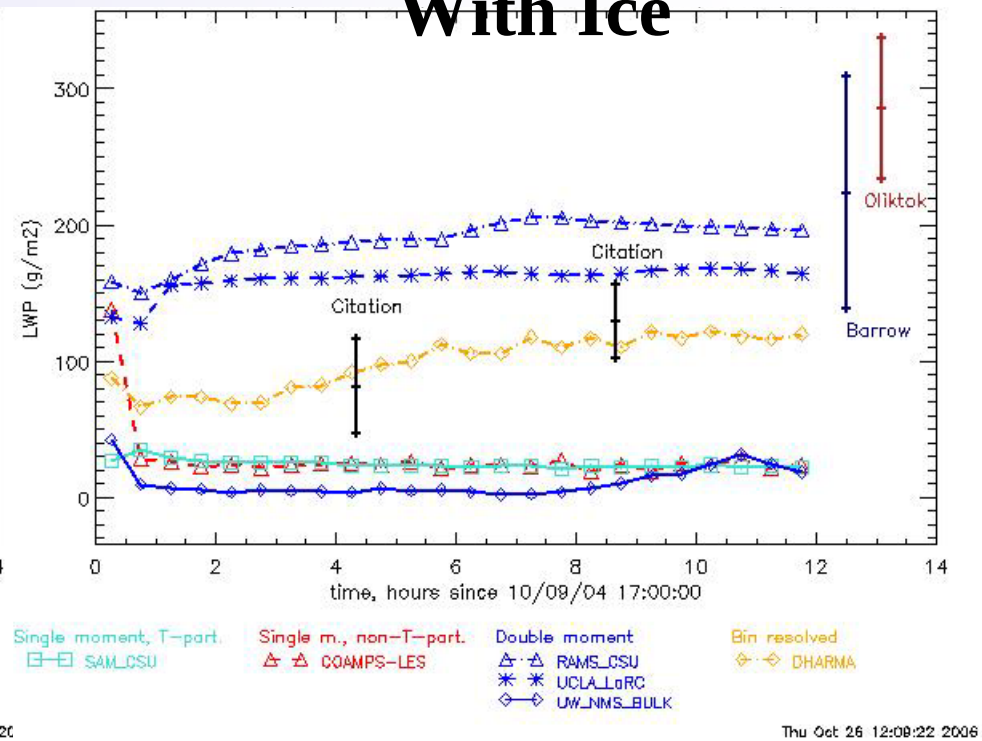
No Ice



With Ice



Liquid water path increases when ice microphysics is suppressed – most dramatically in models with very little LWP in the control run

SAM:Cloud Fraction

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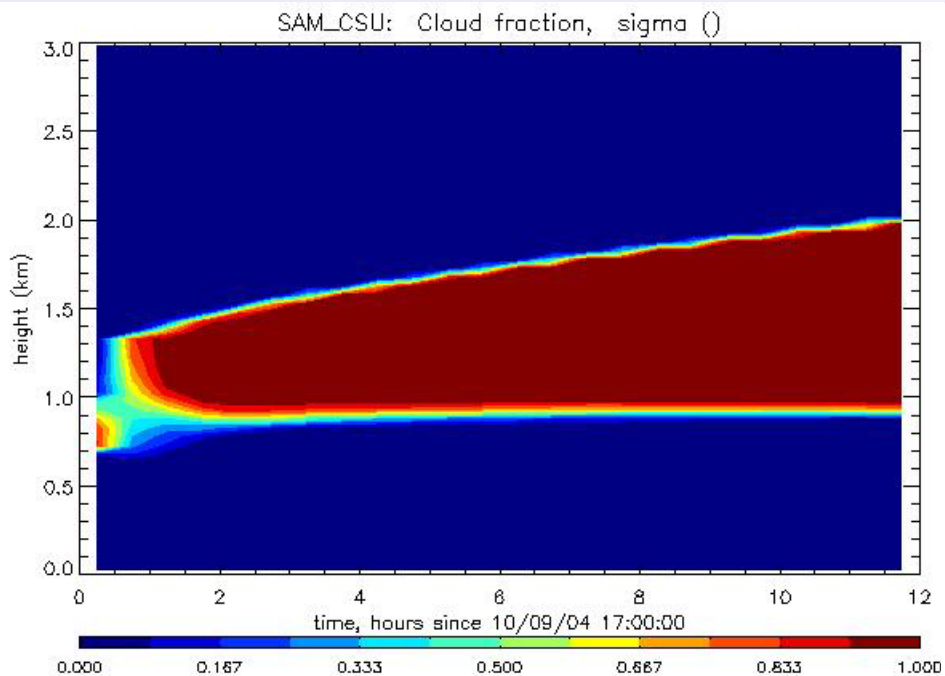
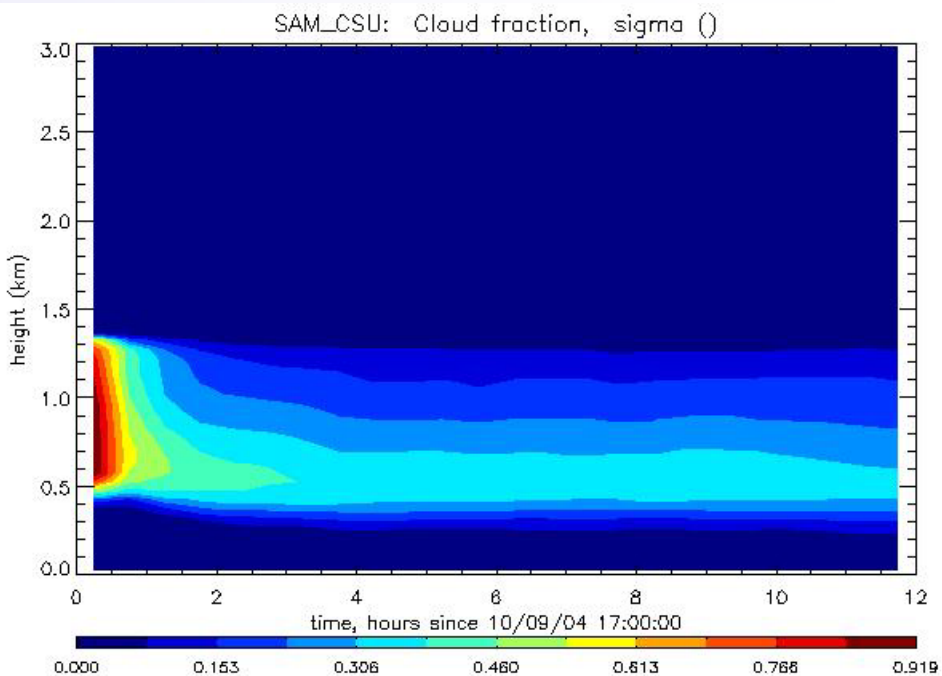
No Ice



With Ice

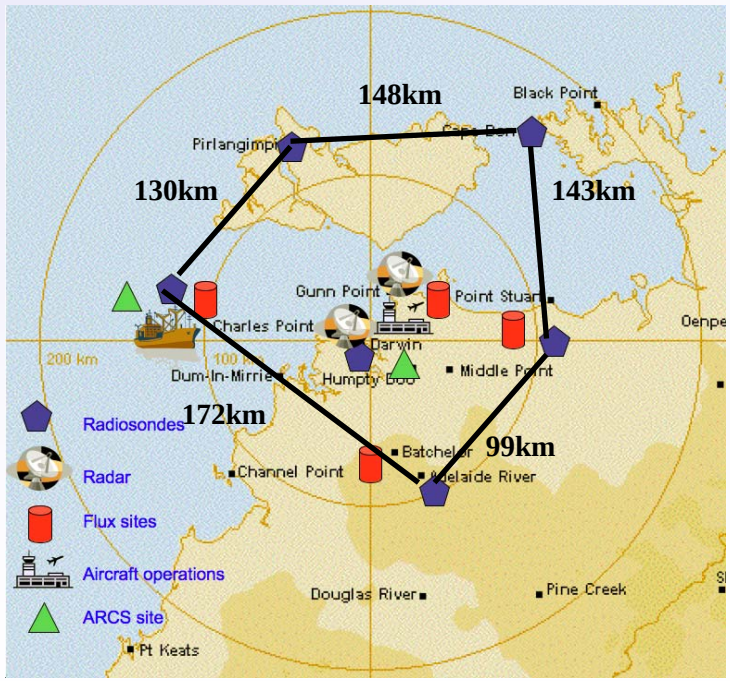


Cloud structure is dramatically different

TWP_ICE

Update on the Variational Analysis of Tropical Warm Pool International Cloud Experiment (TWP_ICE) Data (01/22/2006 – 2/13/2006)

A joint effort between LLNL (Xie, McCoy, Klein), BMRC (Hume, Jakob), SUNYSB (Zhang), and other TWPICE participants



ARM CPMWG Fall Meeting, San Francisco, CA, 30-31 October, 2006

Issues

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1. ***Dry bias in RH***
2. ***Uncertainties in the surface and TOA constraints***
3. ***How do the derived forcing fields respond to those uncertainties in RH and constraints?***
4. ***How do SCMs/CRMs respond to the uncertainty in the forcing fields?***

Derived Large-scale Forcing Fields

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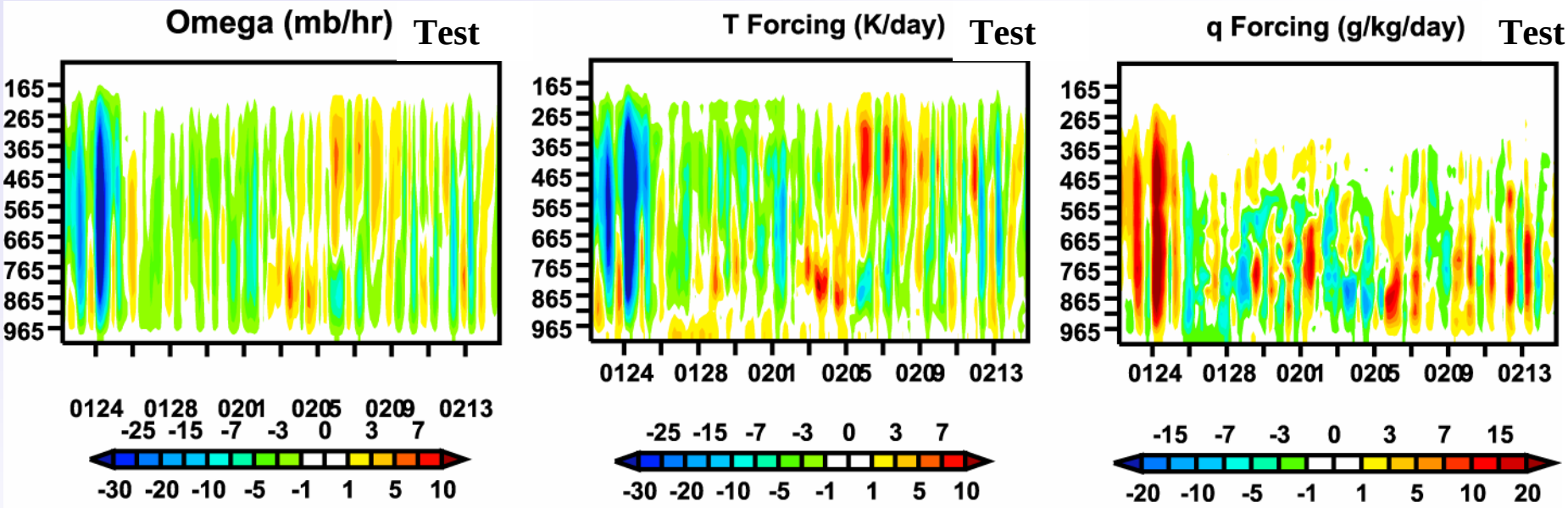

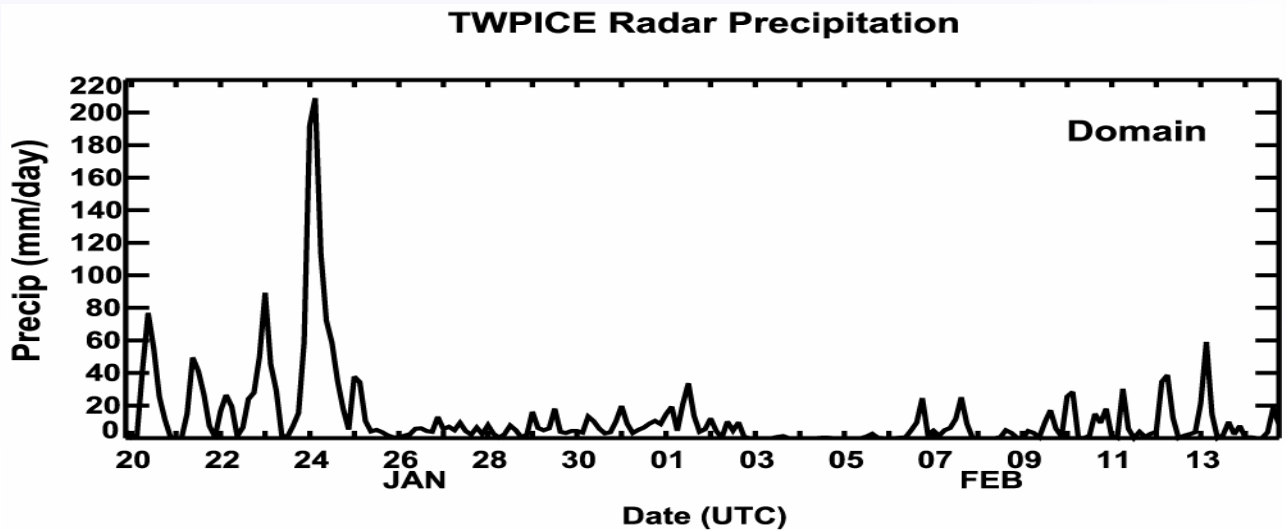

TWP-ICE discussion (Led by Del Genio)

- ***What is the analysis plan?***
- ***What science problems can be addressed?***
- ***How is ARM addressing data needs for convection science?***
- ***What scientific analyses are missing?***

Who is going to turn TWP-ICE data products into fundamental science understanding?

CPWG:

QC, dueling algorithms, VAP creation

Science analysis

→

CMWG:

Parameterization evaluation, development

Testbed for the focus group concept?

THE END

A Quick Update

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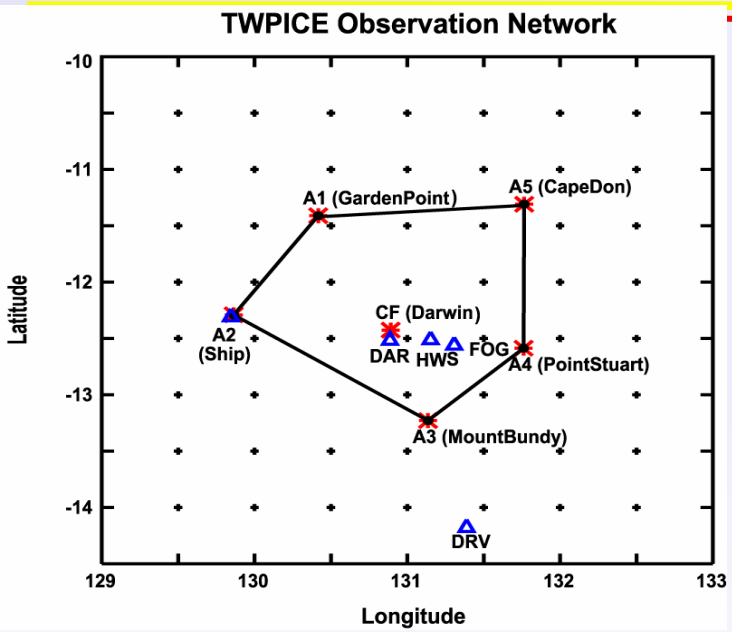


Done!

- ✓ 3-hourly radiosondes (6 stations)
- ✓ Background field from the ECMWF analysis
- ✓ Radar precipitation
- ✓ Surface turbulence fluxes (Darwin Harbour, Howard Spring, Fogg Dam, and Daly River)
- ✓ Surface radiative fluxes (Darwin, Cape Don, and Garden Point)
- ✓ Surface pressure, temperature, relative humidity, and winds (from sounding data)

Working on ……

TOA radiative fluxes (Japan's Multi-functional Transport Satellite- MTSAT)

Surface radiative fluxes from the four surface flux stations

Cloud liquid path

Waiting for ……

Surface fluxes from the Ship

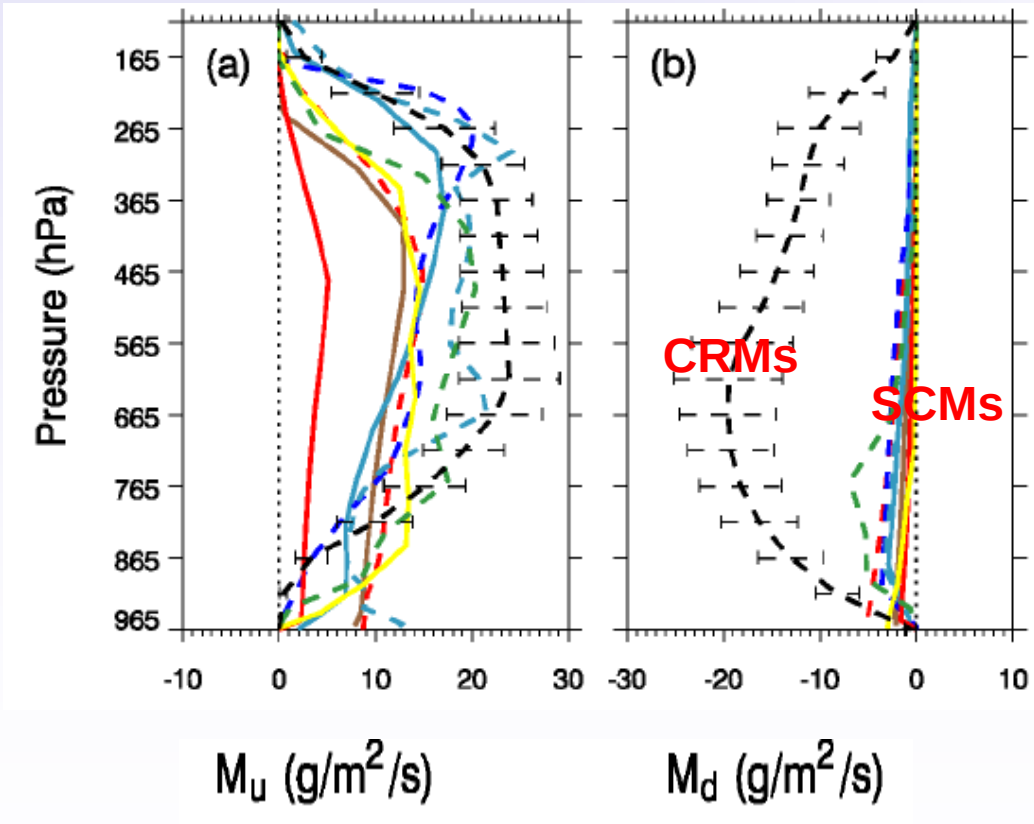
Surface meteorological data from local surface mesonet

Monsoon vs. break convection strength: "Shape of the CAPE"? Deeper PBL/bigger bubbles? More aerosol loading?

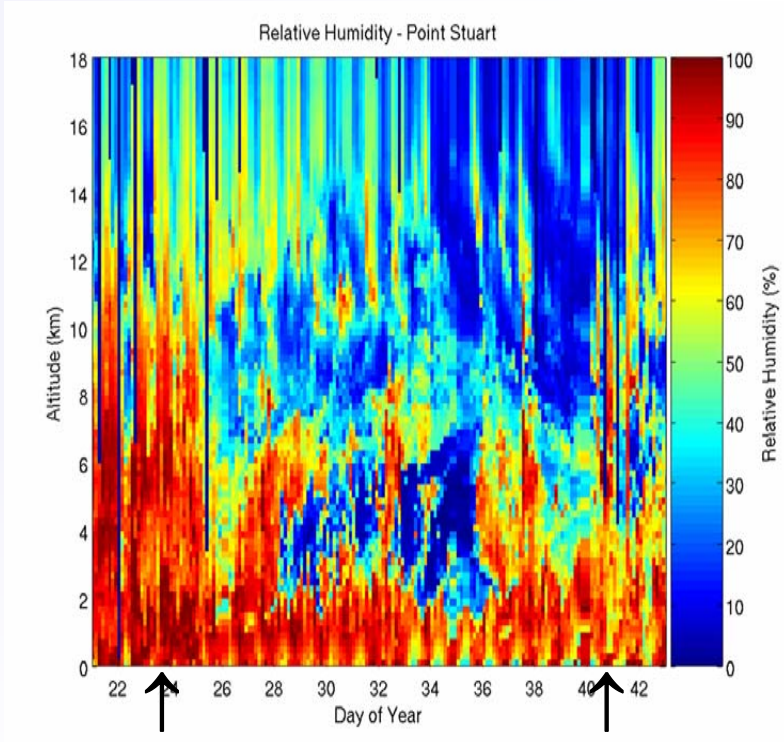
Rain radar convective/stratiform partitioning and reflectivity profiles evolve differently over land and ocean lifecycle – why?

How will our M-PACE-tuned models of cloud phase behave when we apply them to tropical anvils? What other cloud properties differ from one anvil region to the next, and why?

SCMs underpredict downdraft mass fluxes in a summer midlatitude case study (i.e., those that even have downdrafts) – What can CRMs tell us about how to do better? Precip- vs. evap-driven?



(Xie et al., 2002)



P-driven? E-driven?

(Mather 2006 ARM ST Mtg)