Application of ARM Ground-Based Simulator to GCMs

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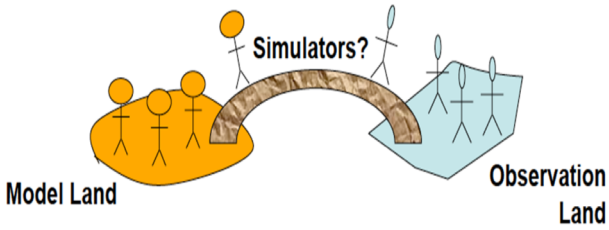
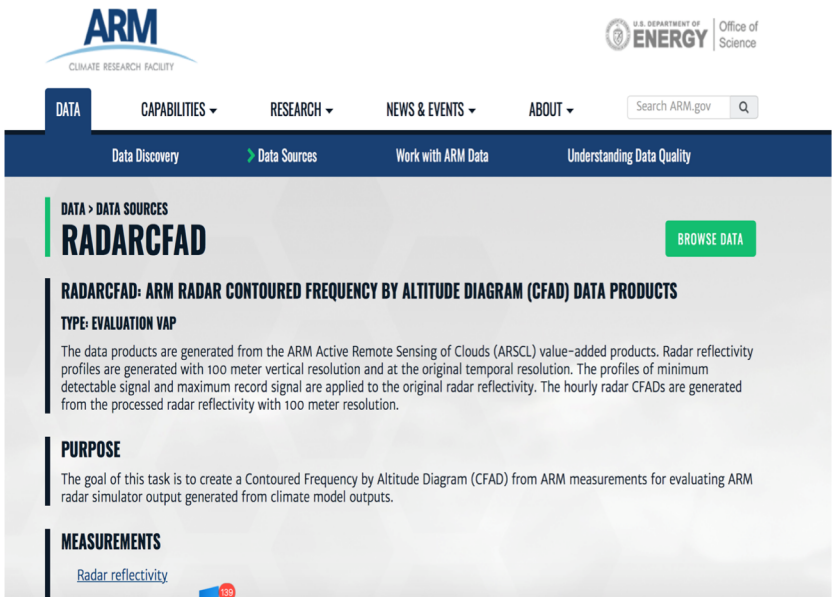
ARM Cloud Radar Simulator for GCMs

Zhang, Y., S. Xie, et al., 2017: BAMS.

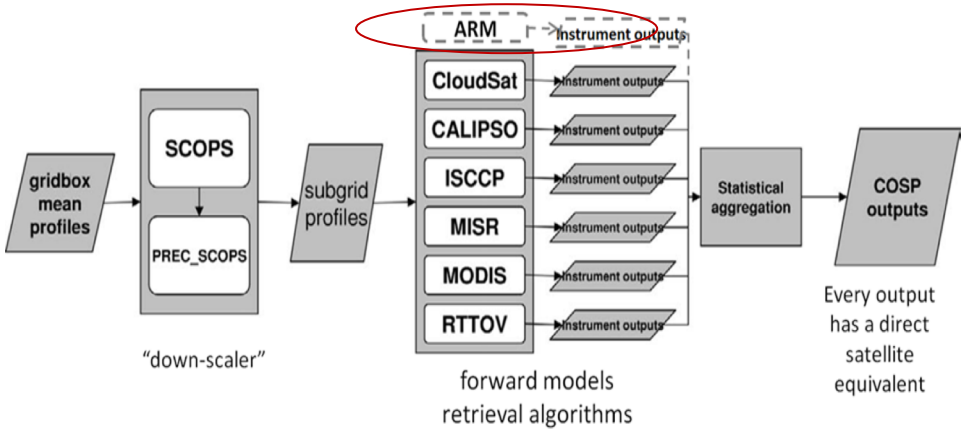
- *Bridge the gap between detailed ARM cloud OBS and GCM clouds*

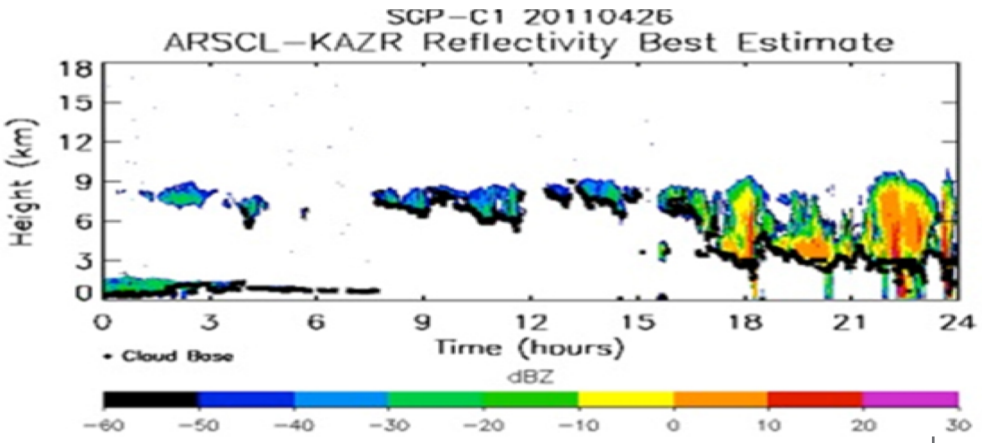


ARM Radar Simulator Homepage



- It has been merged into COSP v2 for climate model applications





Support Cloud Evaluations

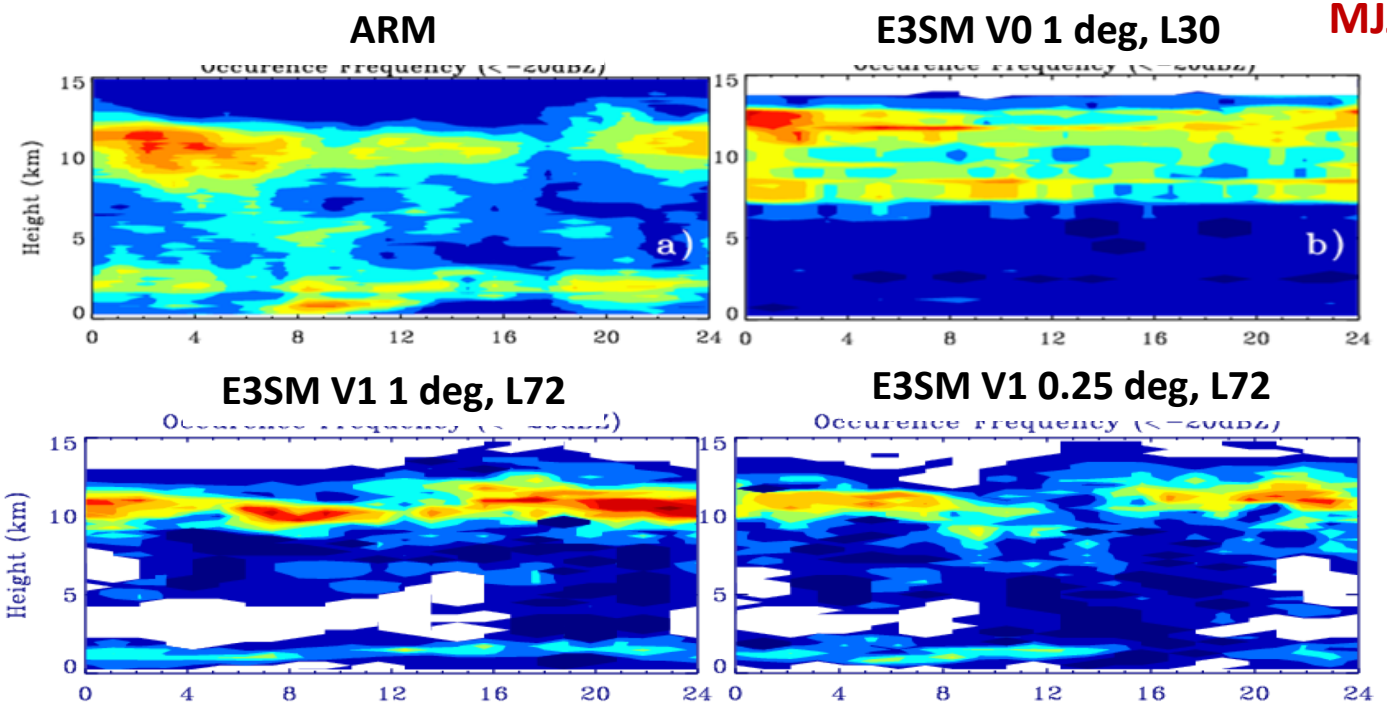
- Create CFAD with calibrated MMCR/KAZR data for both ARM permanent sites and selected AMF sites
- Assist major modeling centers to implement ARM radar simulator to their models in support of cloud parameterization development and evaluation
  - E3SM, CAM5, ECMWF, MIROC, Metoffice
  - GFDL, Tsinghua, GEM (Canada NWP)
- Assist ASR scientists to apply the ARM radar simulator in cloud research using detailed ARM cloud observations
  - Larry Berg - ECMWF clouds with TCAP
  - Xue Zheng – E3SM SCM for MAGIC

ARM Cloud Simulator in E3SM

Zhang, Y, S. Xie, W. Lin et al.. (2018), to be submitted to JAMES

Diurnal cycle of no-precipitating clouds (<-20 dBZ)

MJJA SGP



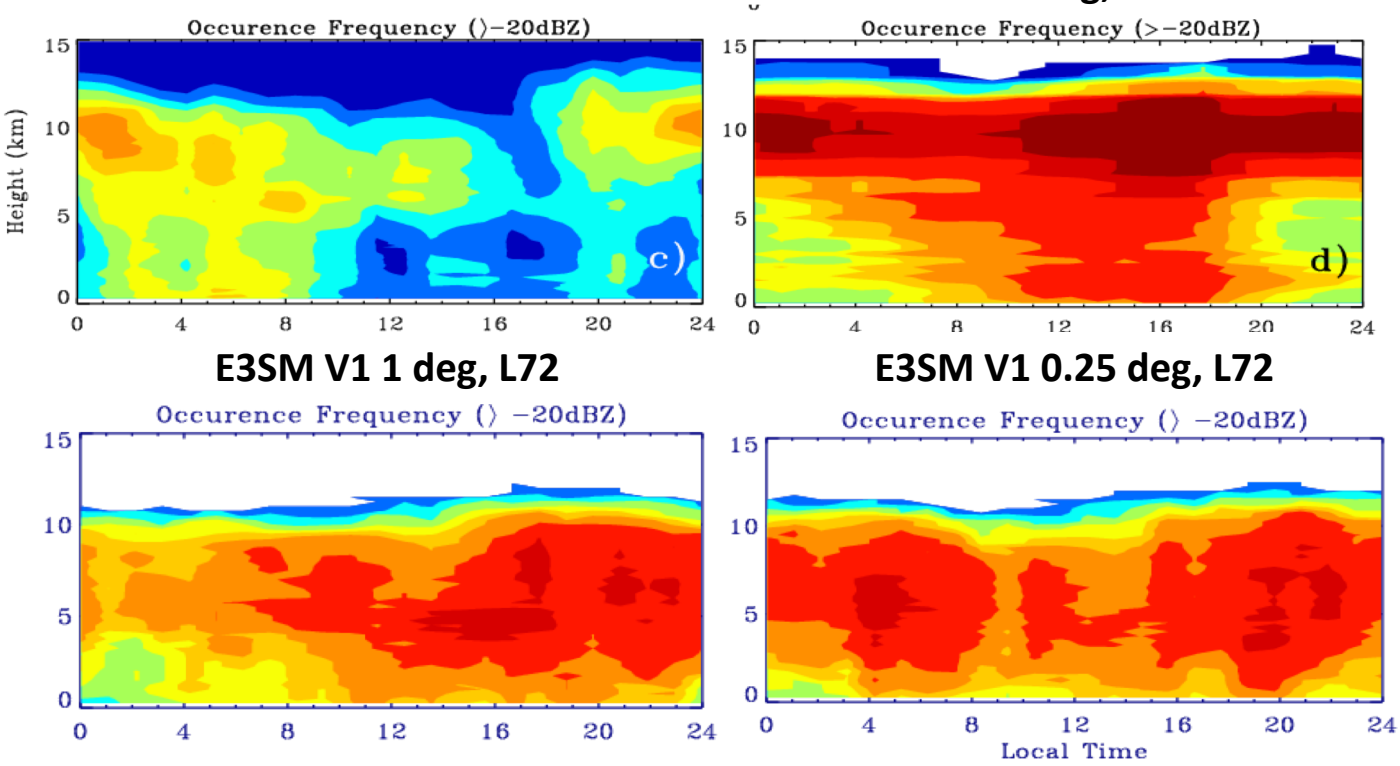
- Lack of shallow non-precipitation clouds in E3SM v0
- Notable improvements seen in E3SM v1 for both low and high clouds. Likely due to the use of CLUBB and increase of vertical levels
- The high-res E3SM captures the diurnal variability very well

ARM Cloud Simulator in E3SM

Zhang, Y, S. Xie, W. Lin et al.. (2018), to be submitted to JAMES

Diurnal cycle of precipitating clouds (>20dBZ)

ARM **E3SM V0 1 deg, L30** **MJJA SGP**

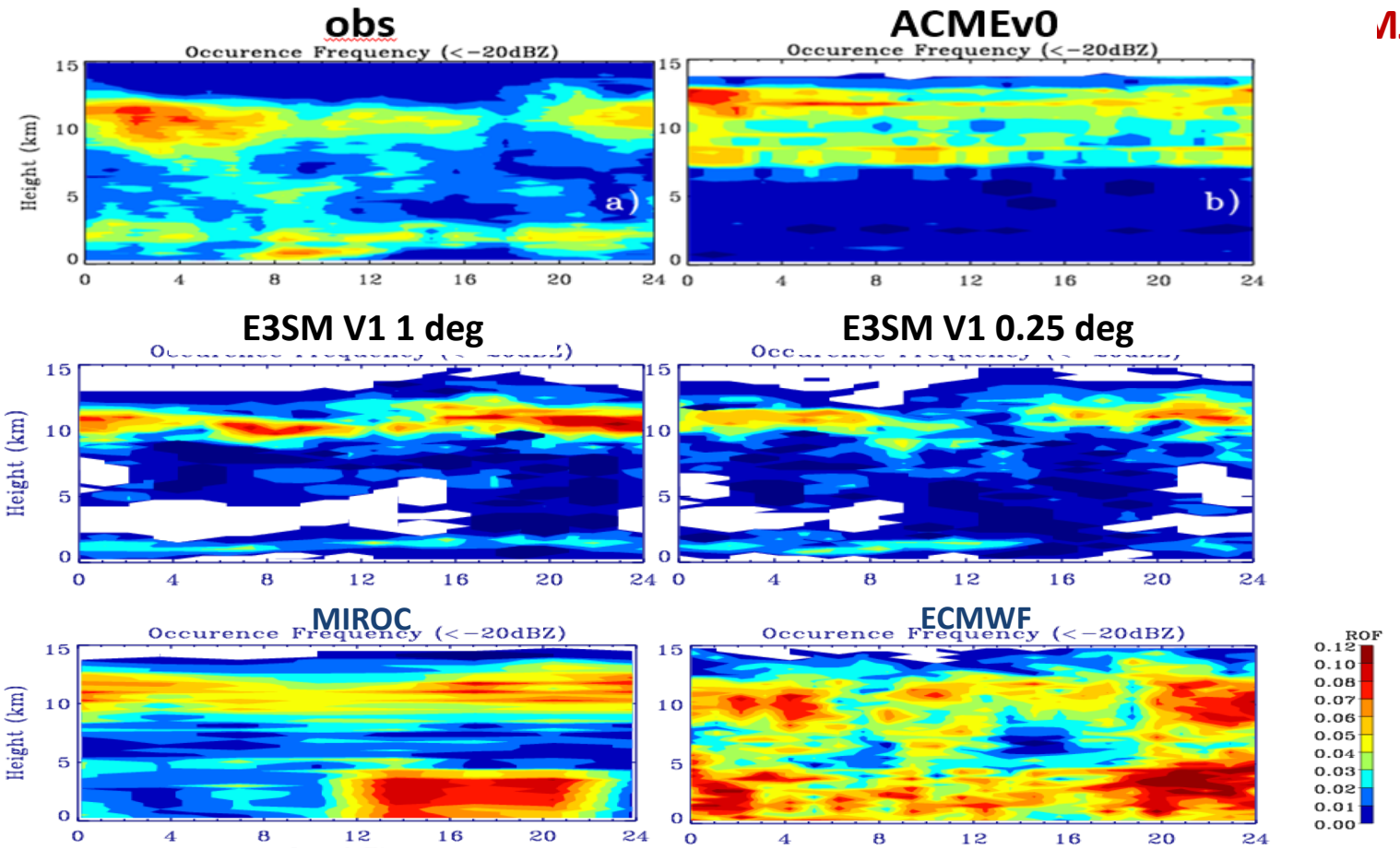


- Models overestimate the precipitating clouds and have difficulty in capturing the diurnal cycle.
- Less high cloud over 8km in E3SM v1 and better diurnal cycle in the high-res model.

Apply the ARM Cloud Simulator to GCMs in Major Modeling Centers

Diurnal cycle of no-precipitating clouds

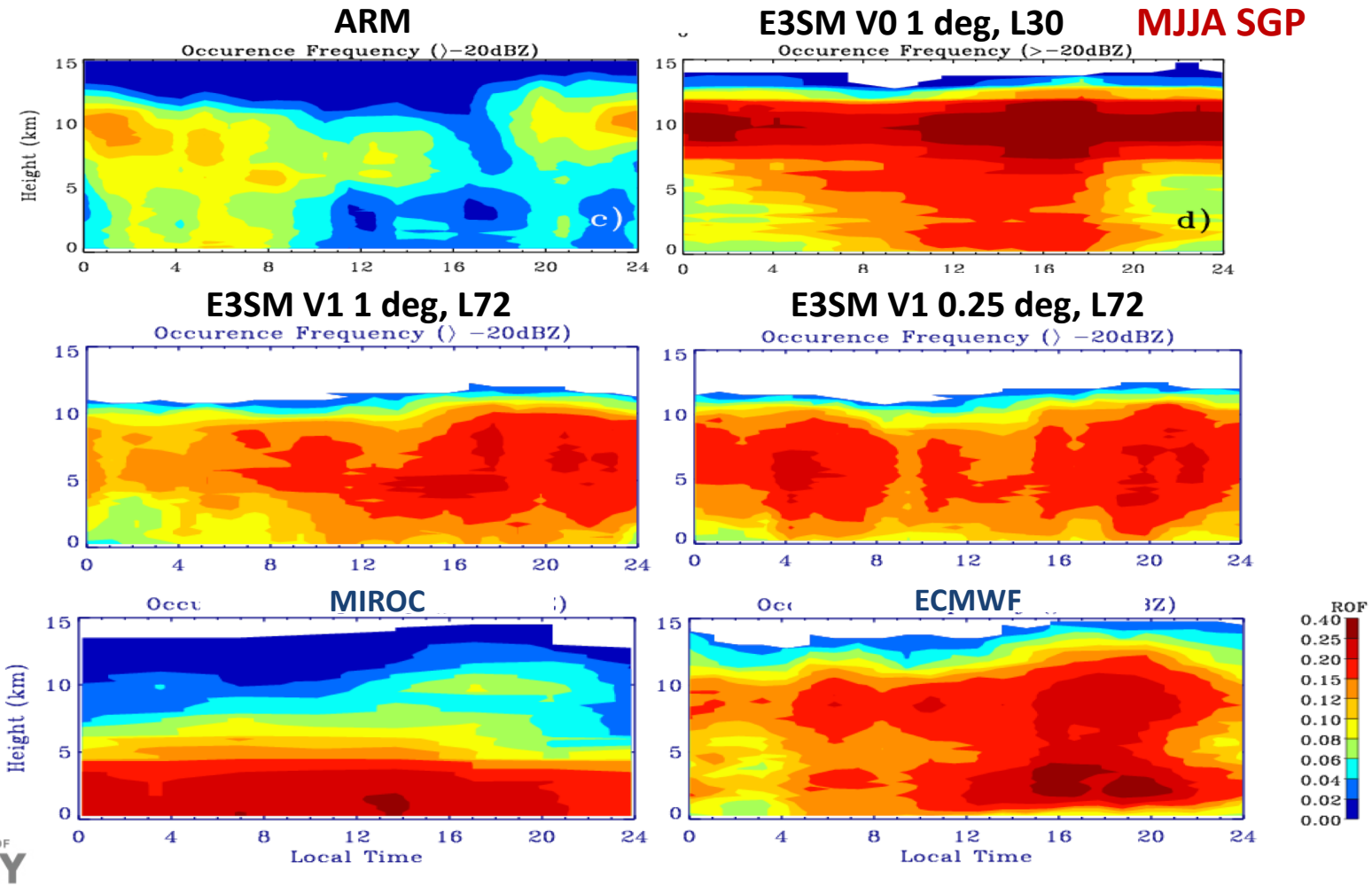
MJJA SGP



Apply the ARM Cloud Simulator to GCMs in Major Modeling Centers

ARM CLIMATE RESEARCH FACILITY

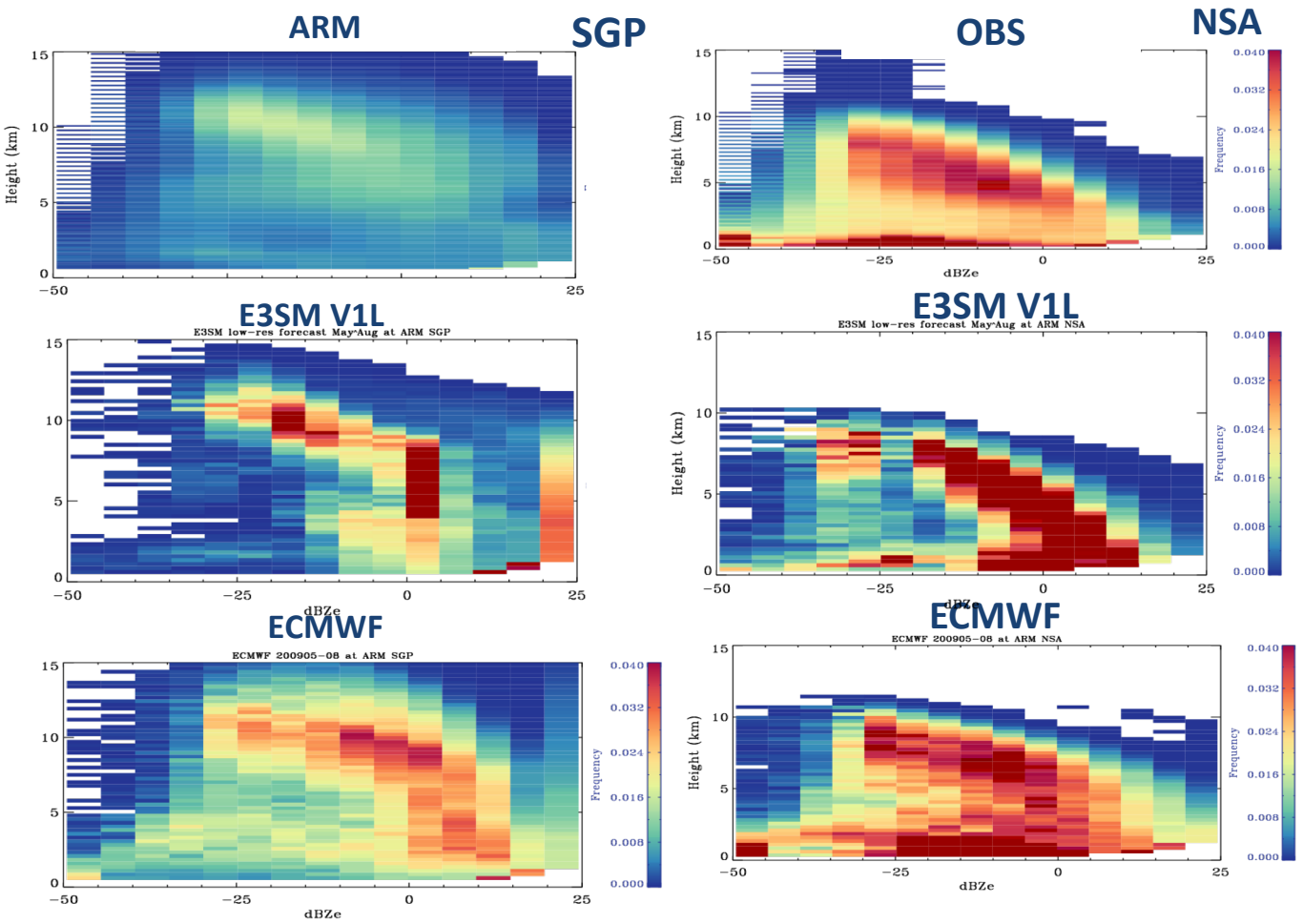
Diurnal cycle of precipitating clouds (>20dBZ)



Test Model Clouds over Different Climate Regimes

ARM CLIMATE RESEARCH FACILITY

Radar CFAD – Joint histogram of the radar reflectivity and altitude

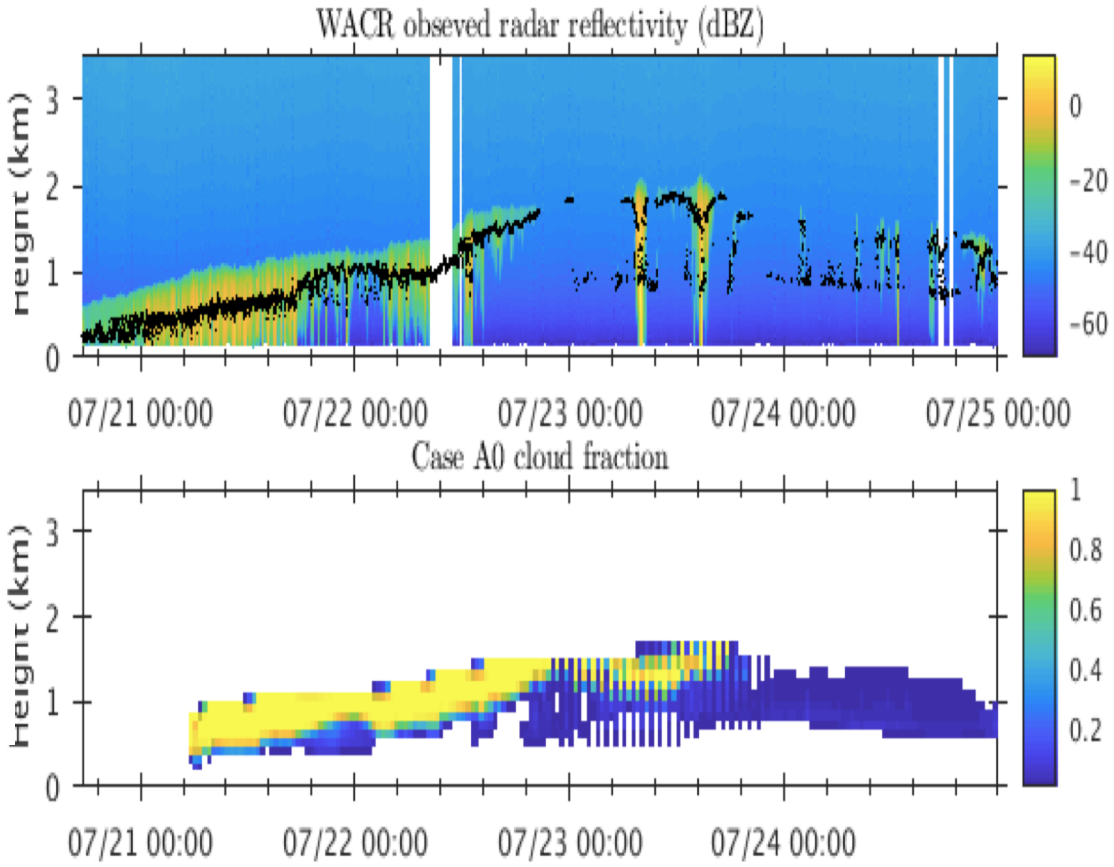


Assist ASR scientists to improve cloud evaluation with the ARM radar simulator

Evaluate E3SM simulation of marine BL clouds

ARM Radar

E3SM SCM



Use the ARM cloud radar simulator to better constrain model precipitation

Xue Zheng & Steve Klein of LLNL.

FY18 Plan

- ARM radar simulator code will be released with COSP2.0 in 2018
- Create CFAD with calibrated MMCR/KAZR data for both ARM permanent sites and selected AMF sites
- Assist major modeling centers to implement ARM radar simulator to their models in support of cloud parameterization development and evaluation
  - E3SM, CAM5, ECMWF, MIROC, Metoffice
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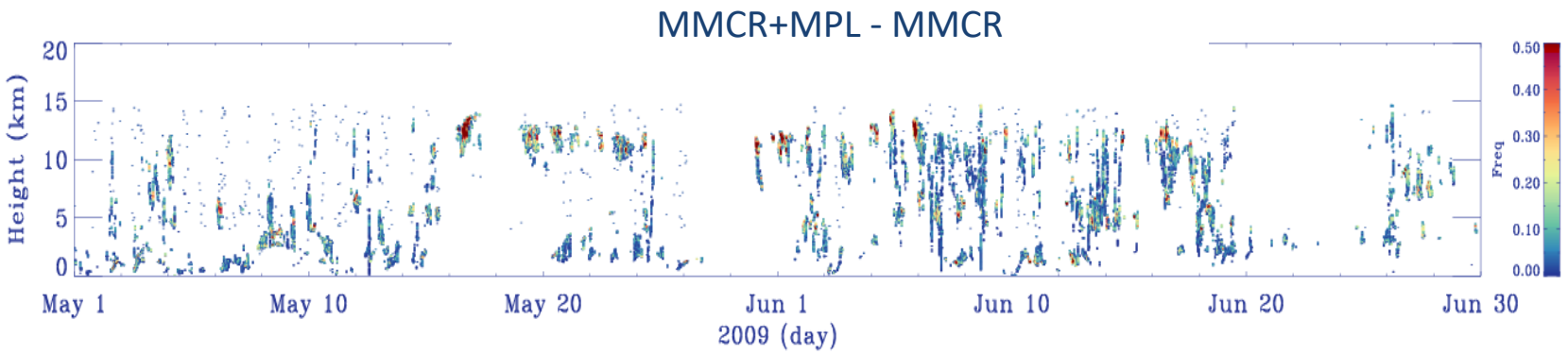
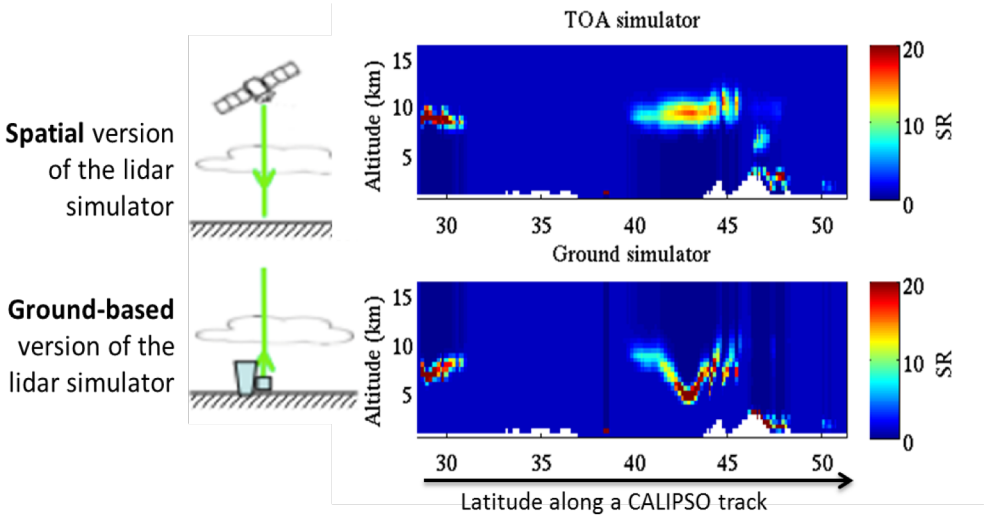
- Address both simulator and data uncertainties
  - Data uncertainties (Radar calibration, Clutter, Radar changes (MMCR vs. KAZR, …)
  - Vertical resolution, Subcolumn #, etc.
  - Particle size distribution of hydrometeors (Lognormal, exponential, gamma)
  - Precipitation area fraction (***) (most models do not have the information)

An ARM Cloud Lidar Simulator for GCMs?



- ARM Ground-based cloud radars have difficulty detecting the small cloud particles present at the top of many high altitude cirrus clouds.
- Need to address issues associated with lidar attenuation by low clouds and aerosols
- A ground based lidar simulator has been created at Institute of Pierre Simon Laplace (IPSL)
  - *Marjolaine Chiriaxo of LATMOS-IPSL*

An ARM Lidar Simulator?



Courtesy of Marjolaine Chiriaco of LATMOS-IPSL

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