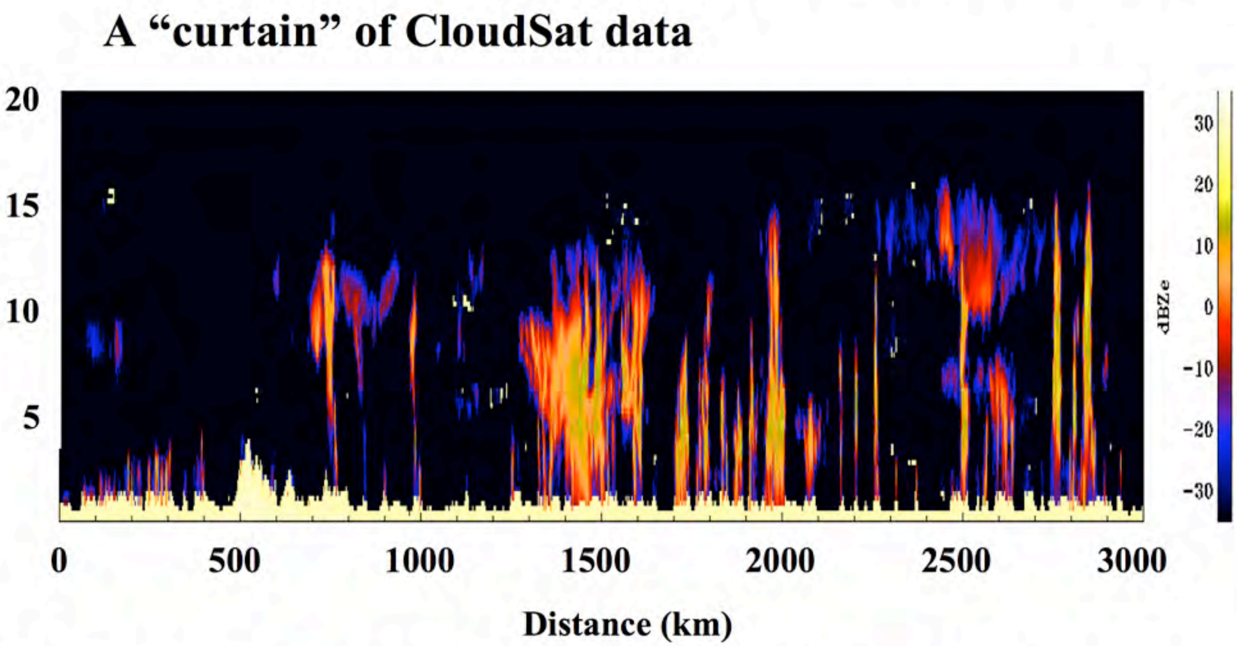
Evaluation of tropical cloud simulations in forecasts with CAM3 using the A-Train data

Yuying Zhang[1], Steve Klein[1], Jim Boyle[1], Jay Mace[3], and Jerry Potter[2],

[1] Lawrence Livermore National Laboratory
[2] University of California, Davis
[3] University of Utah

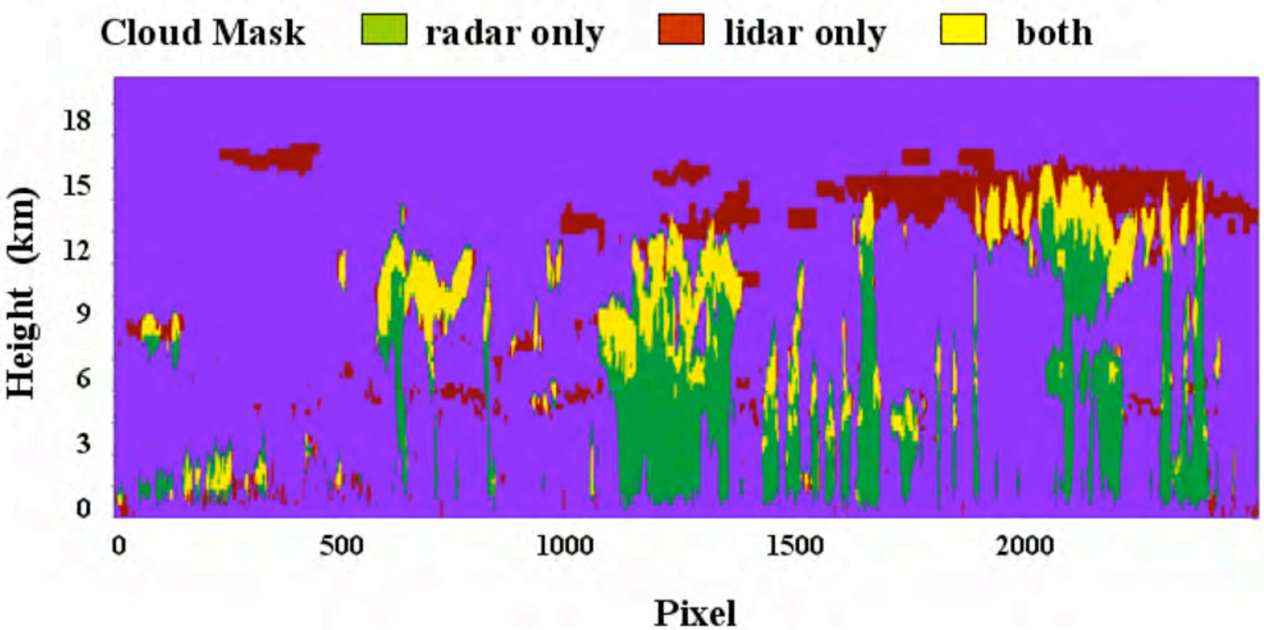
Observations

Tropics (23.5ºS - 23.5ºN) Averaged June - September 2006



Radar reflectivity included in 2B-GEOPROF (Mace et al. 2007)

CloudSat only)



The combined hydrometeor mask is generated using 2B-GEOPROF and 2B-GEOPROF-LIDAR data products (Mace et al. 2008)

CloudSat+CALIPSO

Model simulation

Model evaluated: NCAR's CAM3

CAPT : CCPP-ARM Parameterization Testbed

- Perform weather forecasts with climate models
- Identify model deficiencies before longer-time scale feedbacks develop
- Be able to link deficiencies with atmospheric processes through case study

NCAR's CAM3 was initialized with NCEP GDAS analysis data for Jun-Sep 2006 (J. Boyle, LLNL)

Examine 24-48 hour forecasts

The Simulator

The Cloud Feedback Model Inter-comparison Project

COSP: CFMIP Observation Simulator Package

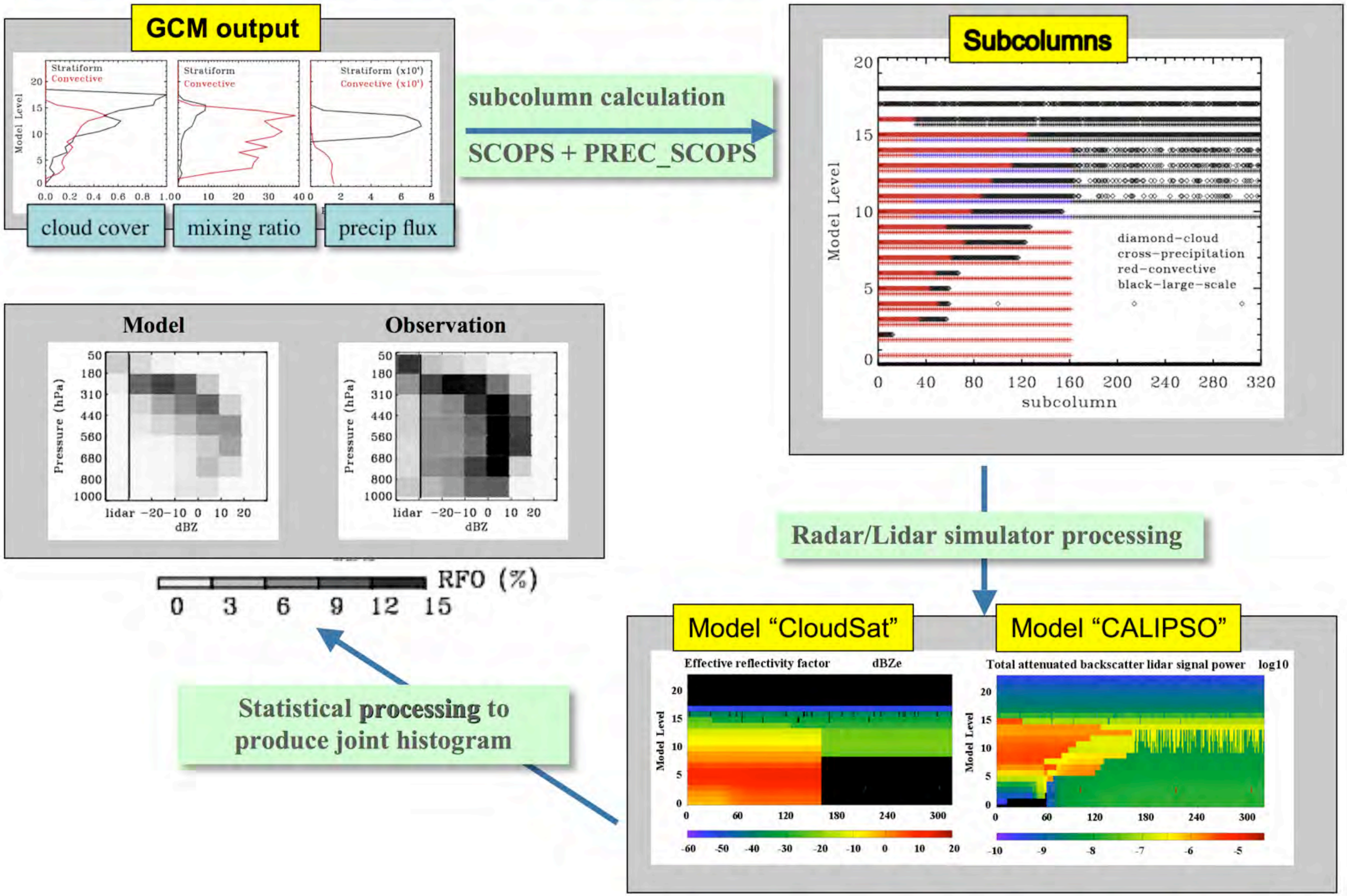
Contributor:
- Alejandro Bodas-Salcedo and Mark Webb *(UKMO)*
- Helene Chepfer and Sandrine Bony *(LMD/IPSL)*
- Yuying Zhang and Steve Klein *(LLNL)*
- Roger Marchand *(U. Washington)*
- John Haynes and Graeme Stephens *(CSU)*

Convert model data into variables similar to observations

Consider instrument limitations including minimum detected signal and attenuation of signals

Avoid effects of inconsistent assumptions

Flowchart of CloudSat/CALIPSO Simulator for GCMs

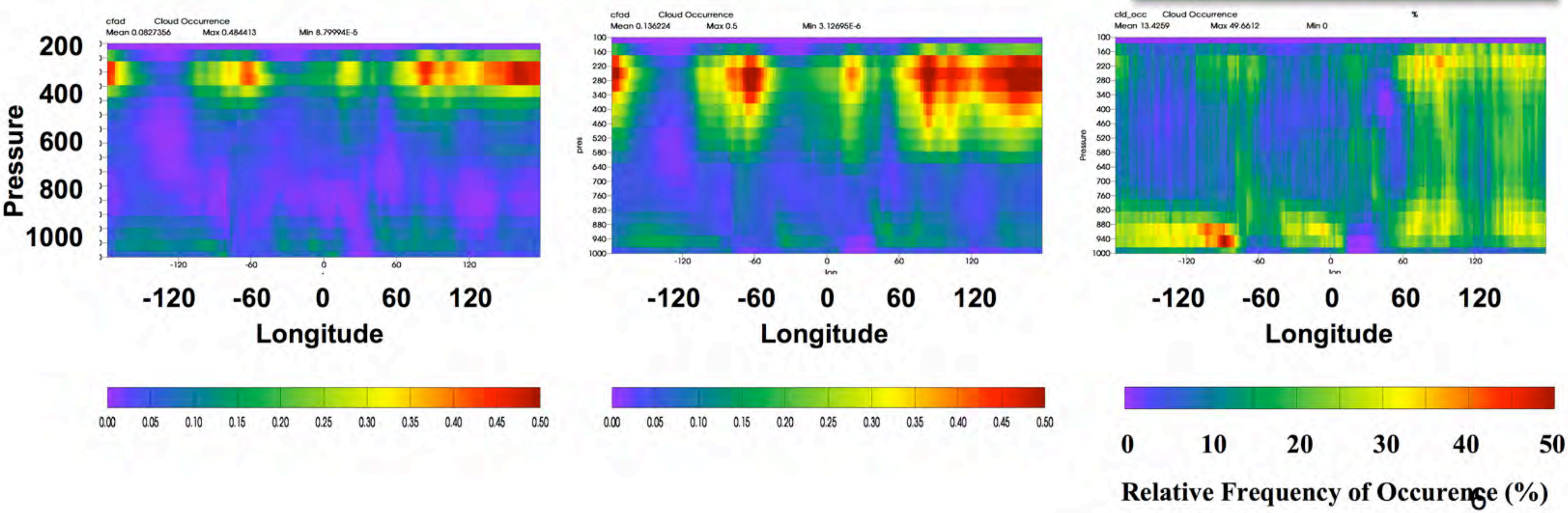


Sample result from the Simulator with CAM3.1 forecast

Meridional mean in tropics for June-Sept. 2006

Hydrometeor Fraction

Cloud Fraction from model | **Combined radar/lidar simulation** | **Observed CloudSat/CALIPSO data**



Methodology for model evaluation

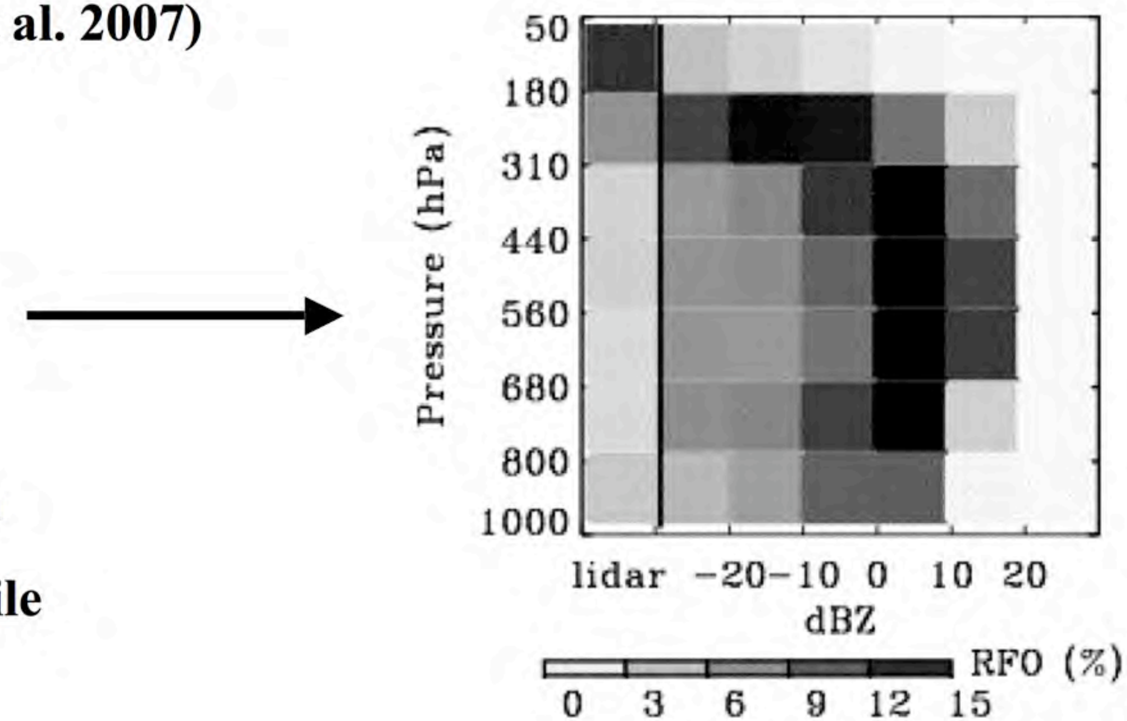
- Traditional method: Climatological maps
- More objective: Clustering analysis

ISCCP D1 dataset (Rossow et al. 2005)

CloudSat (Zhang et al. 2007)

CloudSat+CALIPSO

(Zhang et al. 2008)



Domain size: ~200 km

Revised method: profile

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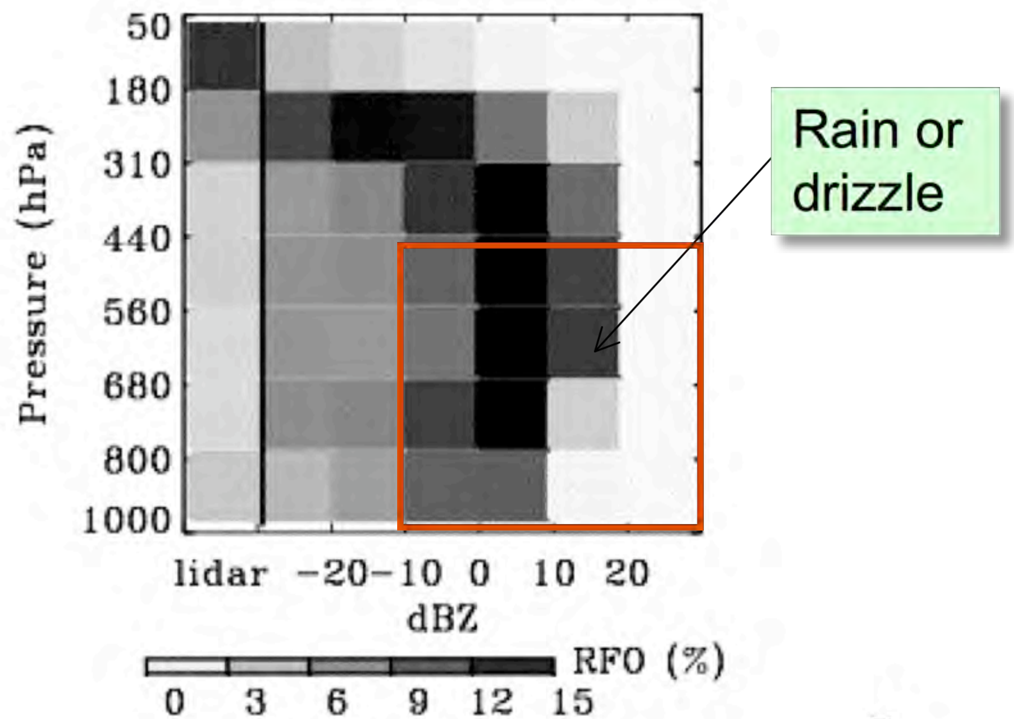
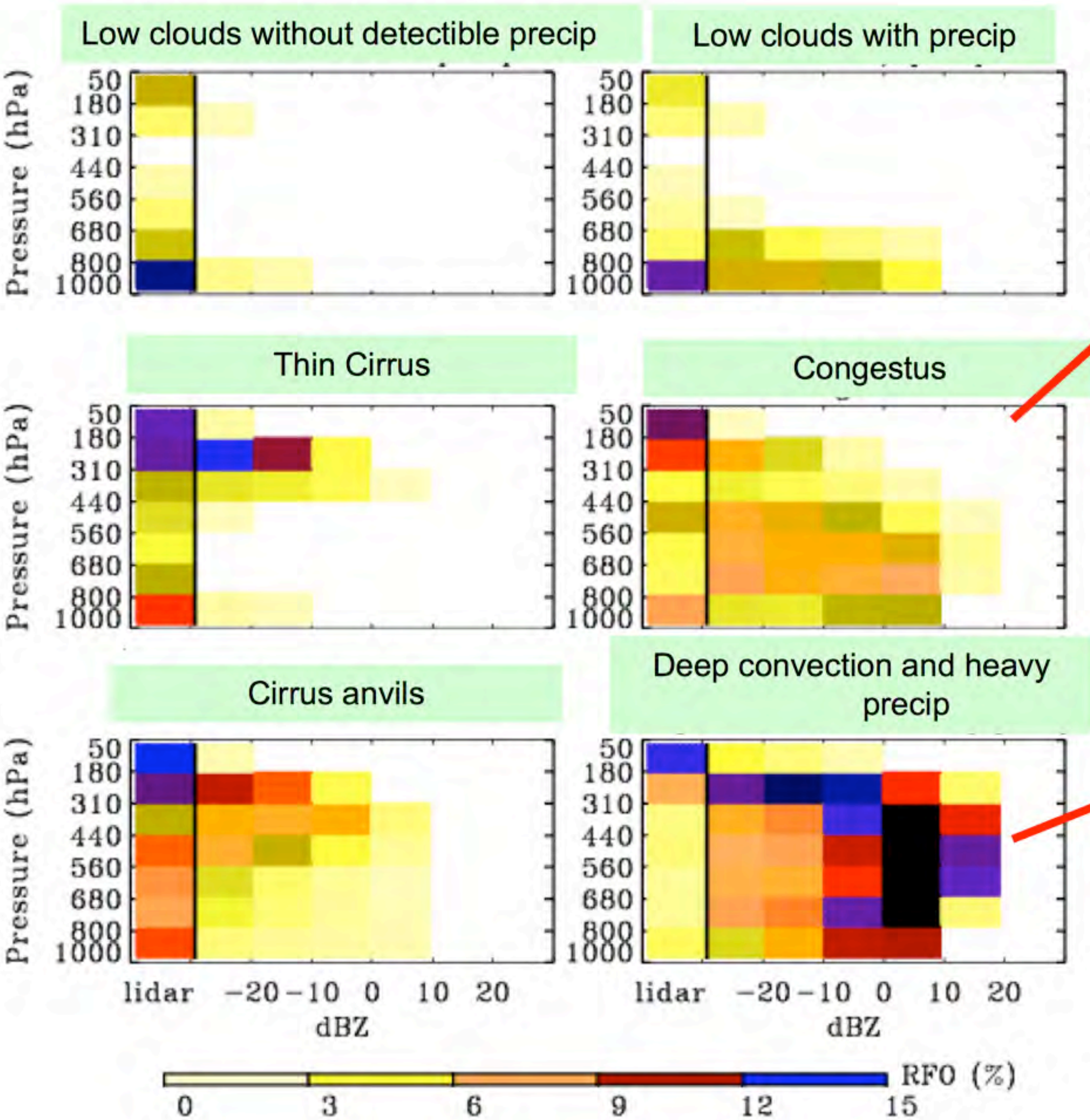


Tropical cloud regimes derived from the CloudSat/CALIPSO data

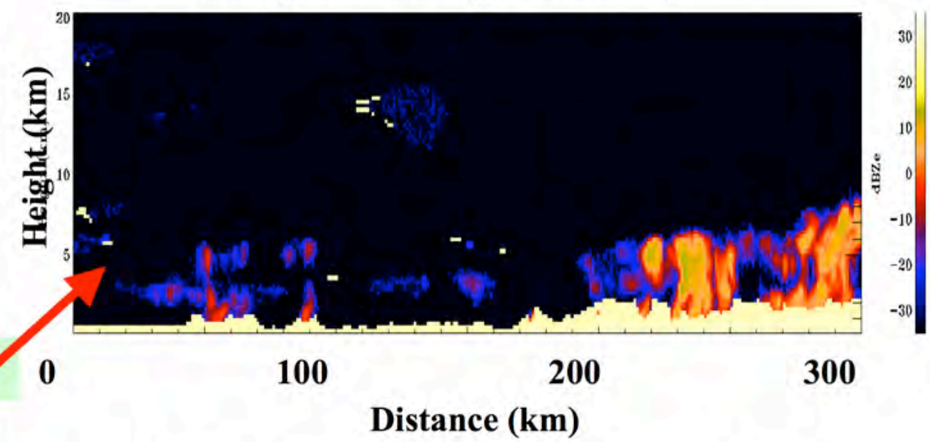
1. Low clouds without detectible precipitation
2. Low clouds with precipitation
3. Thin cirrus
4. Congestus
5. Cirrus anvils
6. Deep convection and heavy precipitation

Clustering method: describe the principal cloud regimes in tropics

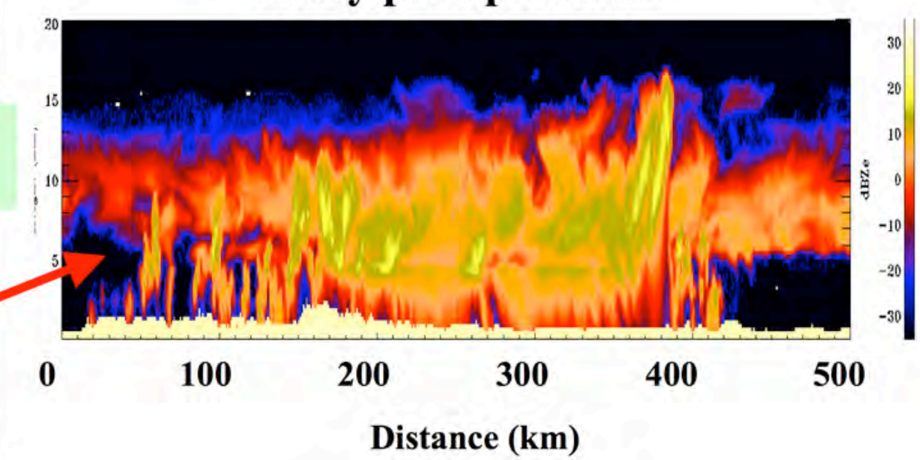
The vertical structures of cloud fields are defined using the joint histogram of altitude and reflectivity



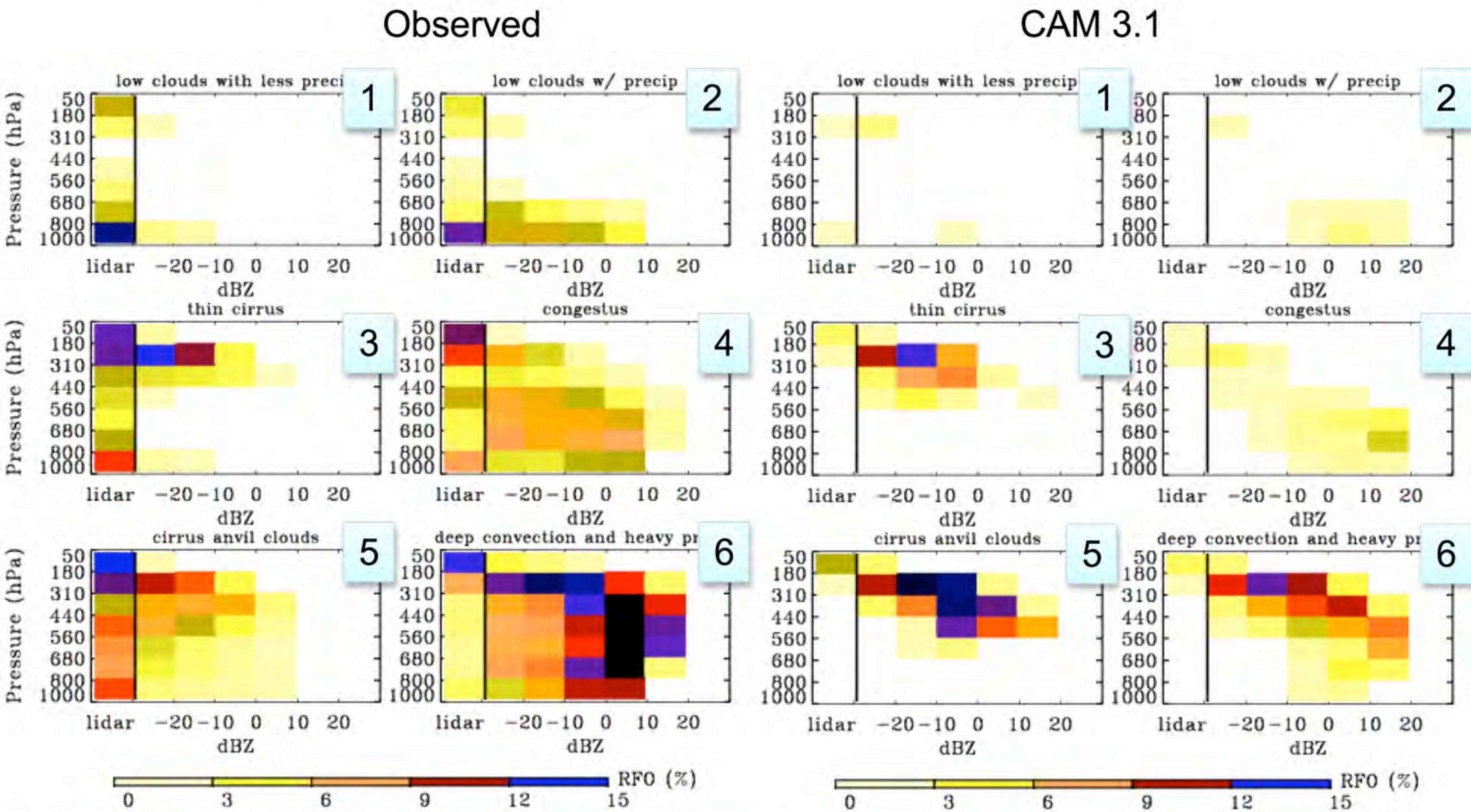
Sample of congestus



Sample of deep convection and heavy precipitation



Model simulations are then assigned to the cloud clusters determined from observations



1= low clouds w/no det. precip.

2= Low clouds with precip.

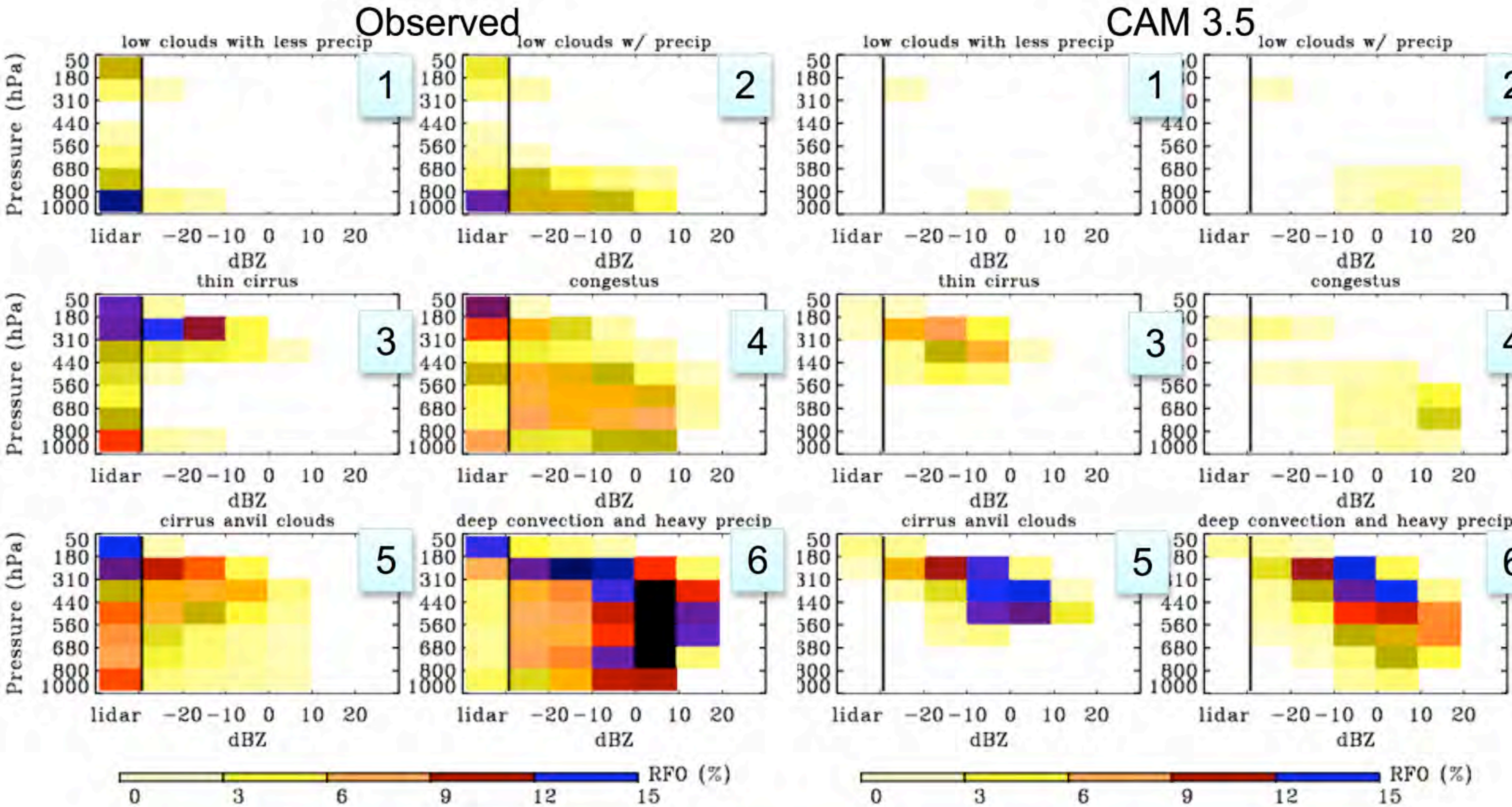
3= Thin cirrus

4= Congestus

5=Cirrus anvils

6= Deep convection and heavy precip

Model simulations from CAM 3.5 compared to observations



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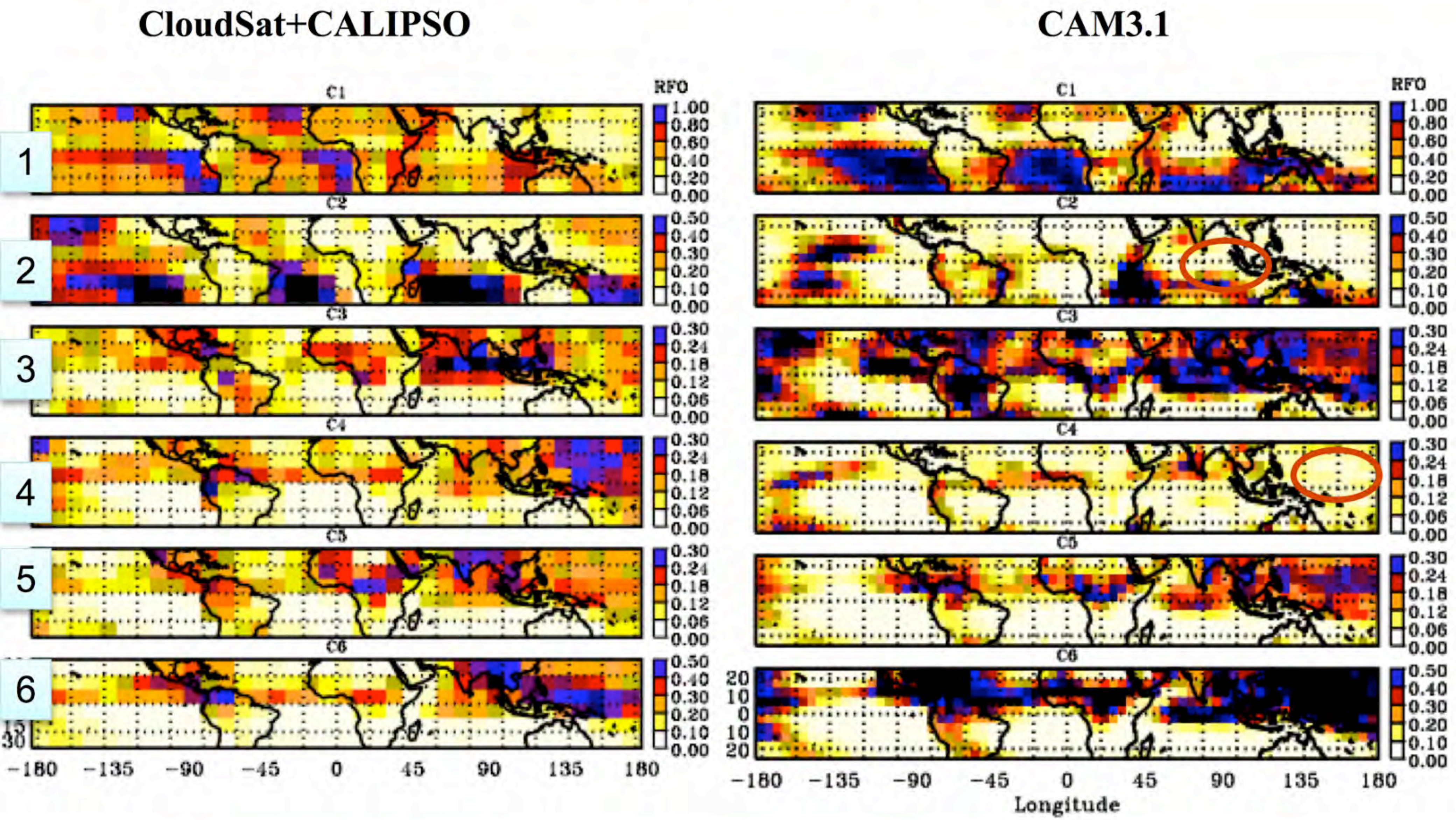
Geographical distributions of the principal cloud regimes



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Major difference: parameterization of deep convection

CAM 3.1 : Undilute Plume

- air parcel ascends pseudoadiabatically, not mixing with the environment

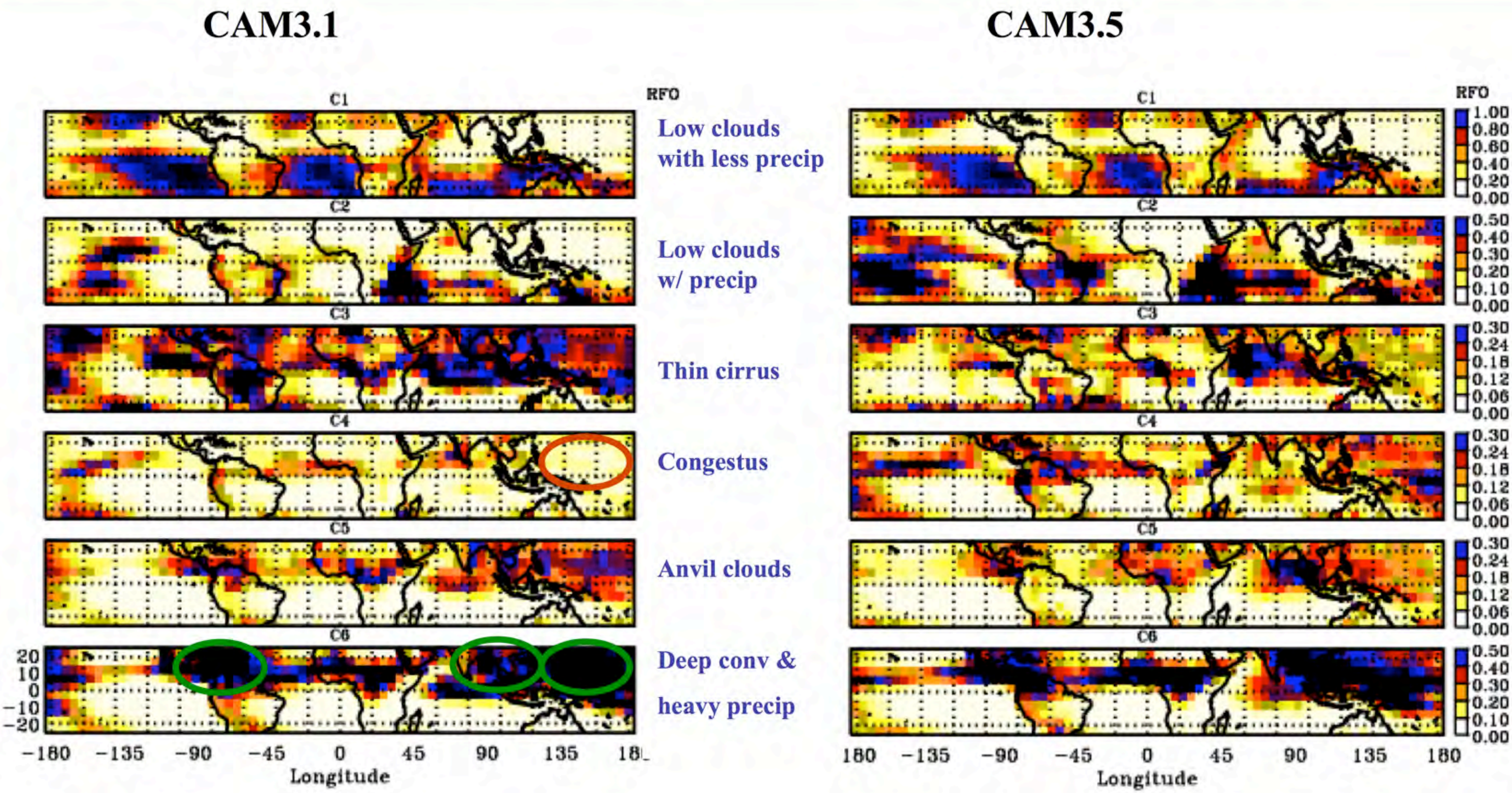
  insensitive to tropospheric moisture

CAM 3.5 : Dilute plume

- air parcel mixes with environmental air as it ascends through the atmosphere

  more sensitive to moisture

Geographical distributions for different versions of the model



Produce more mid-level clouds

Reduce high clouds

Summary and future work:

Summary:

• The comparison between modeled and observed clouds shows the model deficiencies:

overestimate high clouds
underestimate mid-level and some low-level clouds

• The new parameterization improves the cloud simulations:

reduce high clouds
produce more mid-level clouds and low-level precipitation

Future work:

• Use compositing technique and other data sources

• Extend to mid-latitude and longer time period

• Pilot study of model intercomparison with Met Office in U.K. and LMD in France

• Include GEOS-5

What the LLNL team needs from CERES

- We would like to describe the radiative characteristics of the individual regimes and examine the impact of the cloud regimes on the cloud radiative forcing (including shortwave and longwave) at the TOA. The collocated data along the CloudSat flight track would be perfect.

  \- Steve Klein

The End