

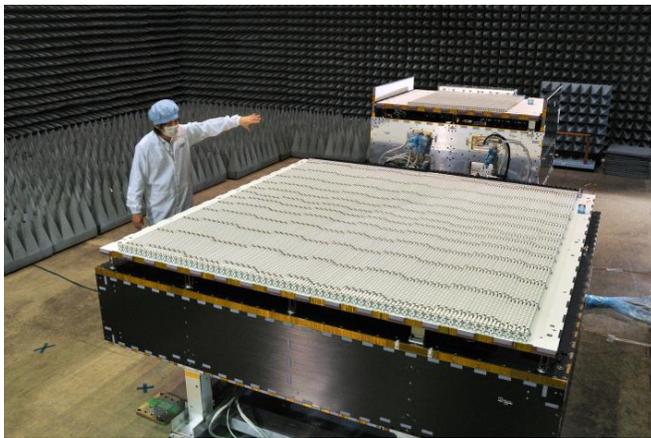
# A conversation in convection between the GPM DPR and CAM5

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Once upon a time, there was a radar called DPR and a global climate model called CAM5 and they met in a place called Indianapolis...



DPR, JAXA/NASA

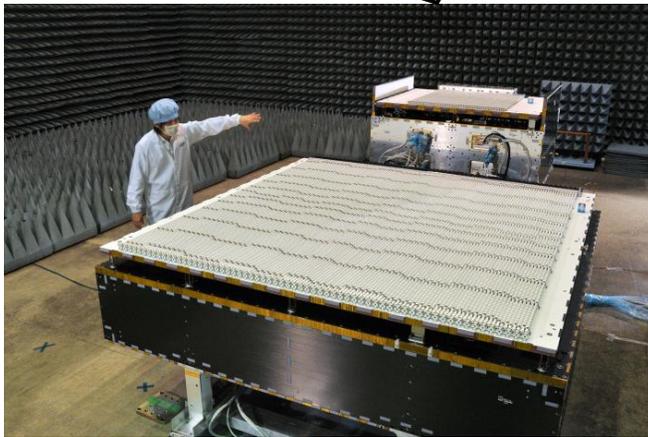


IBM Blue Gene/P, Wikipedia

But they had a hard time communicating.

$$P_r(r) = \frac{C|K|^2}{r^2} Z_{m0}(r)$$

$$\rho \left( \frac{\partial \mathbf{v}}{\partial t} + \mathbf{v} \cdot \nabla \mathbf{v} \right) = -p + \nabla \cdot \mathbf{T} + \mathbf{f}$$



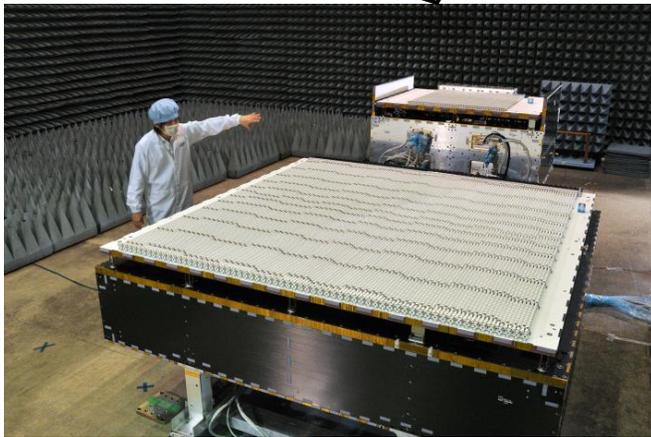
DPR, JAXA/NASA



IBM Blue Gene/P, Wikipedia

So they looked for commonalities.

Do you speak rain?



DPR, JAXA/NASA

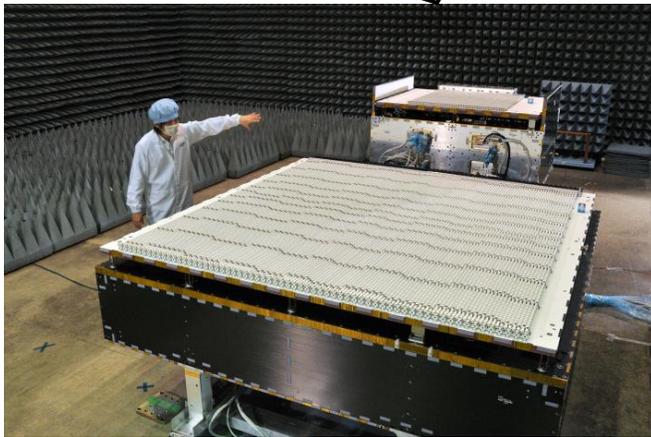
Yes!



IBM Blue Gene/P, Wikipedia

So they looked for commonalities.

Shall we have lunch?



DPR, JAXA/NASA

Sure, how about Italian?

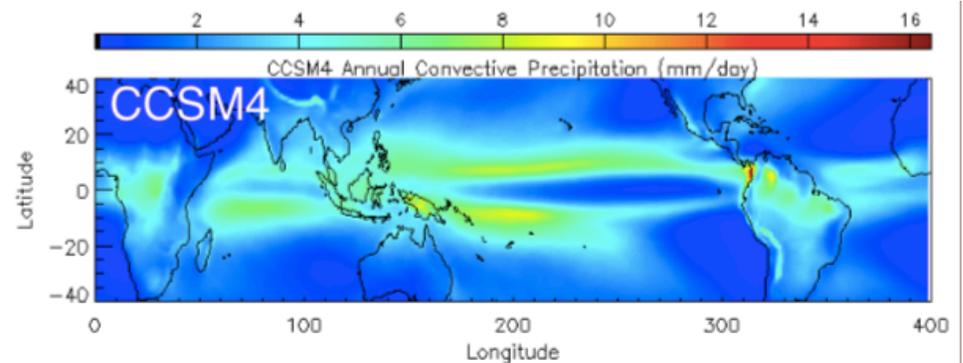
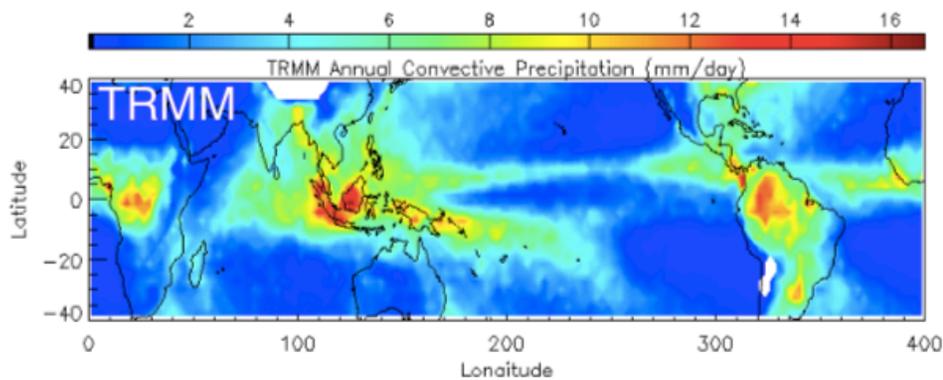


IBM Blue Gene/P, Wikipedia

DPR and CAM5 went across the street to a place called Giordanos and talked about their parents.

My mom, PR, was the first of her kind.

My dad, CAM4, was pretty cool too.



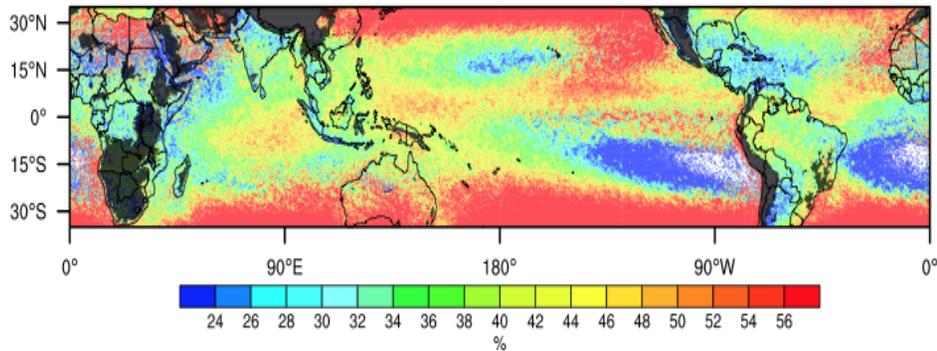
Narrator's aside: These maps represent the annual convective rain from TRMM's 2A23 raintype algorithm and CAM4's convective parameterization. While the patterns are generally similar, CAM4 suffers from the common GCM double ITCZ bias and has weaker land maxima relative to the ITCZ than TRMM.

However, the more they talked, the more they realized they weren't understanding each other as well as they thought they were.

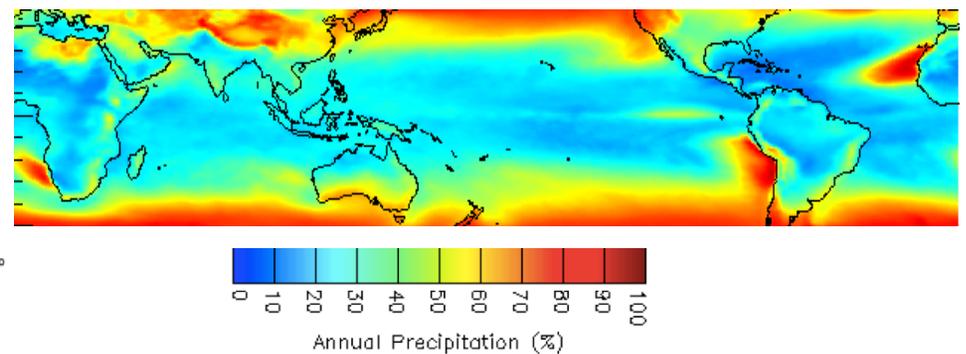
My mom's rain maps are the best.

That looks kind of different than what my dad told me.

TRMM stratiform rain fraction



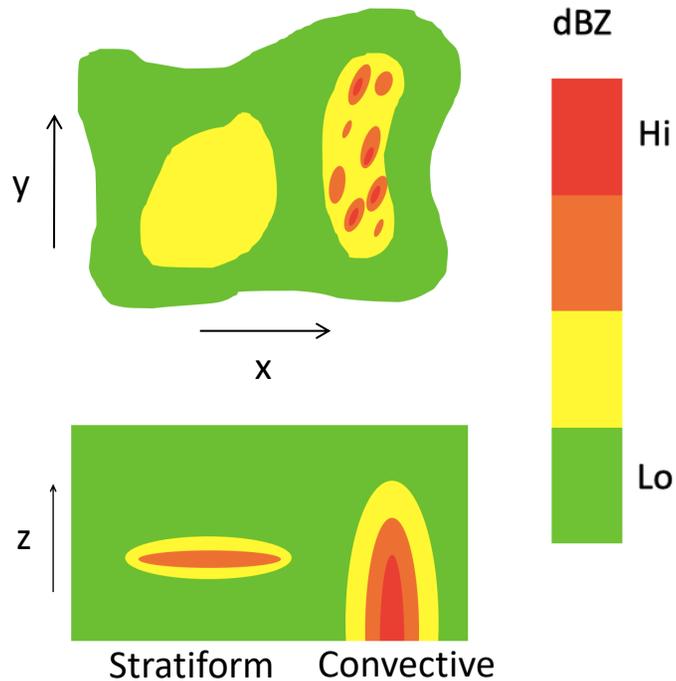
CAM4 large-scale rain fraction



Narrator's aside: CMIP5 models vary widely in LS rain (i.e., the rain that doesn't come from the convective parameterization), with little convergence since Dai (2006). Recent work by Stephens et al. (2019) suggests that the LS rain fraction may dictate a GCM's climate sensitivity to a doubling of CO<sub>2</sub>.

They tried to explain how they each came up with their respective rain maps.

This is how I do it.



This is how I do it.

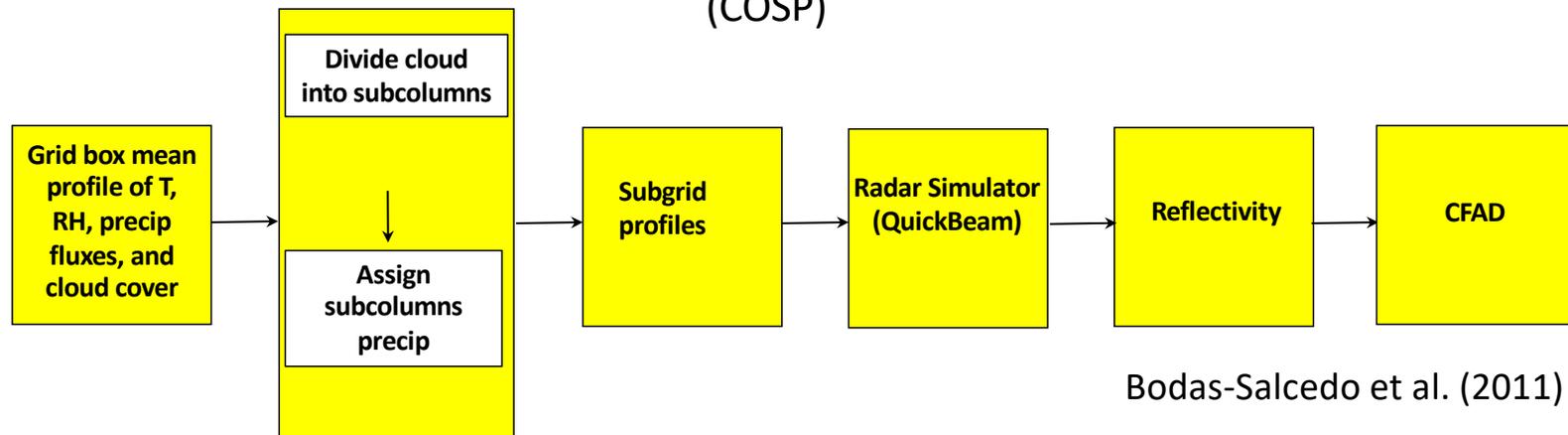
- CAM5 uses the Zhang and McFarlane (1995) convective parameterization for deep convection with a modified dilute plume calculation following Raymond and Blyth (1986, 1992) and the addition of convective momentum transport by Richter and Rasch (2008). There is a separate shallow convection scheme based on Park and Bretherton (2009).
- Large-scale rain and snow is diagnosed in CAM5 using a two-moment bulk microphysics scheme (Morrison and Gettelman 2008).

The waiter came at that moment, temporarily diffusing the tension, and the DPR and CAM5 both ordered spaghetti with meatballs. While they were waiting for the food to arrive, CAM5 thought part of their differences might be a communication issue.

Sounds great!

Why don't I try to speak in reflectivity?

### Cloud Feedback Model Intercomparison Project (CFMIP) Observation Simulator Package (COSP)

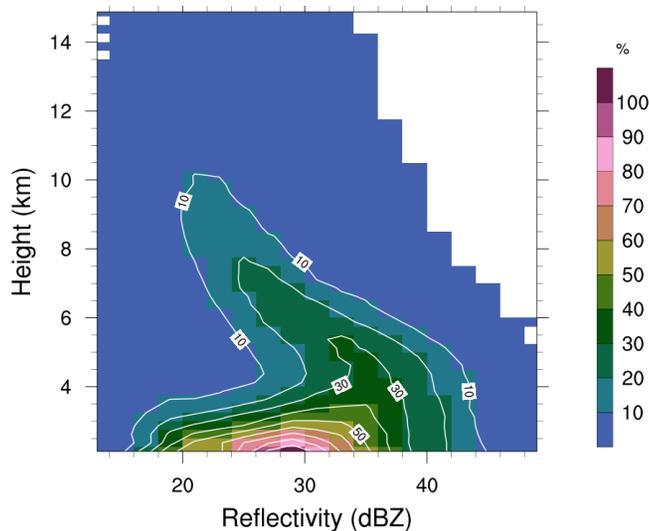


Bodas-Salcedo et al. (2011)

They tried convection from boreal summer tropics first (i.e., June 35°S-35°N).

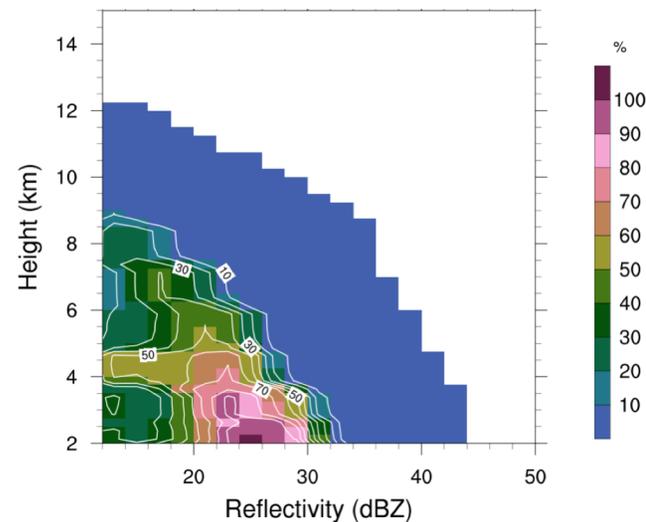
Looks like our low-level mode kind of matches.

DPR Convective



But my distribution is too narrow at low levels and too weak aloft ☹️

CAM5 Convective

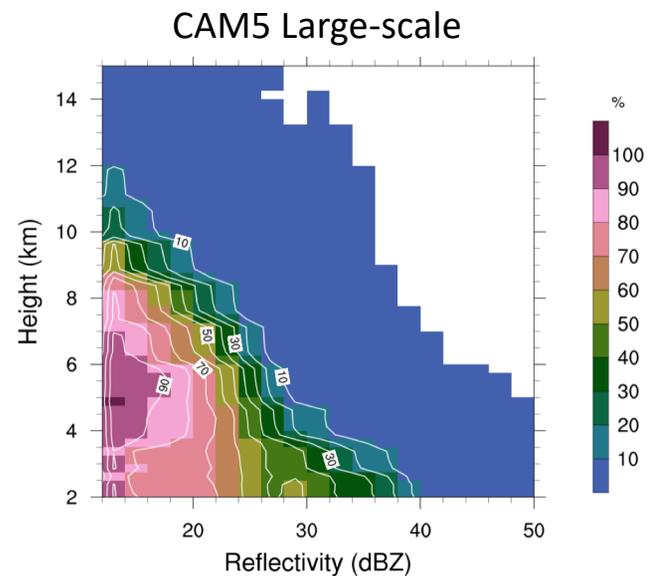
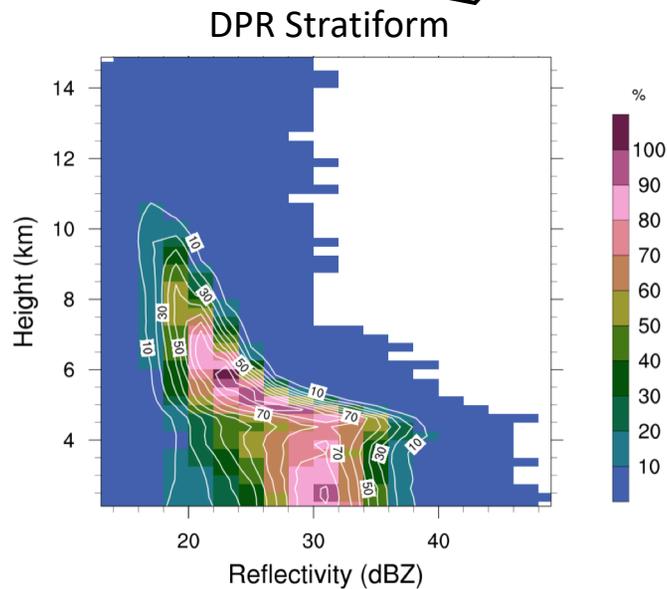


Narrator's aside: If you try this at home, be sure to match the resolution of your data to the resolution of the model. In this case, DPR data is gridded at 2 degrees to match CAM5 and then the CFAD is created.

Then they tried stratiform/large-scale rain (still June 35°S-35°N).

Now our upper levels look better, but what is happening lower down?

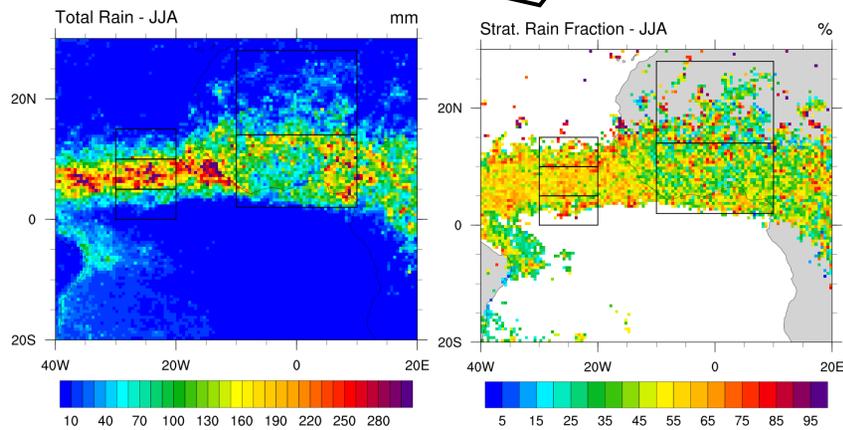
Um, I don't know.



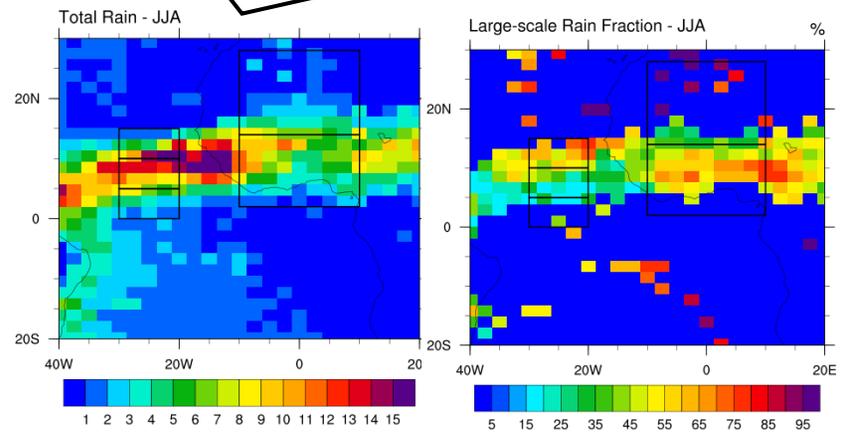
Narrator's aside: Hopefully you're realizing that while CAM5 produces rain analogous to convective and stratiform rain, the processes and definitions differ from those observed and used by radar. However, careful comparisons can help explain those differences and improve the model assumptions.

The spaghetti arrived and they both started talking about their recent travel in June.

The ITCZ was amazing.



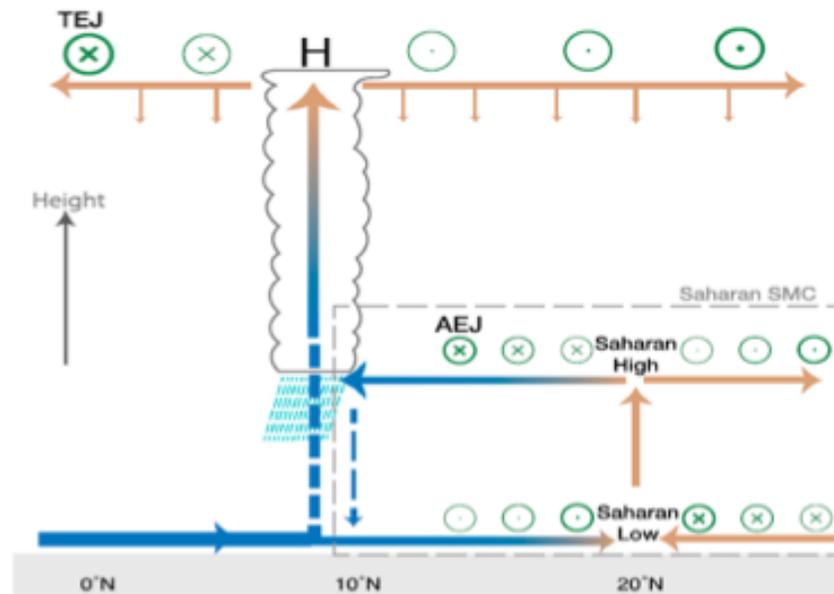
The African monsoon was intense.



The spaghetti arrived and they both started talking about their recent travel in June.

Why did you go to West Africa?

I was curious about the meridional overturning.



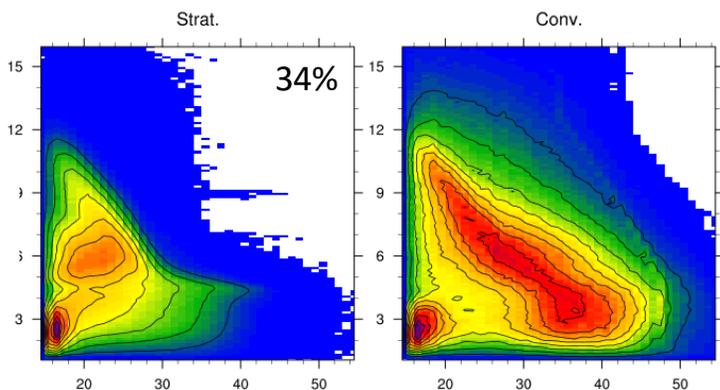
Shekhar and Boos (2017)

# West Africa

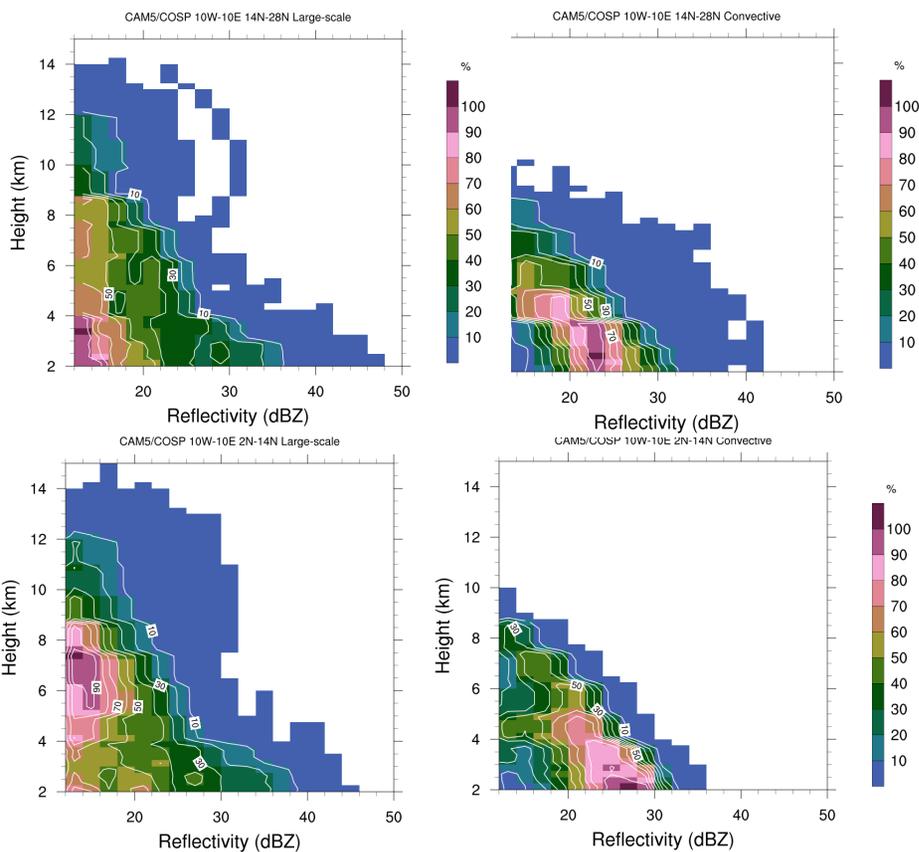
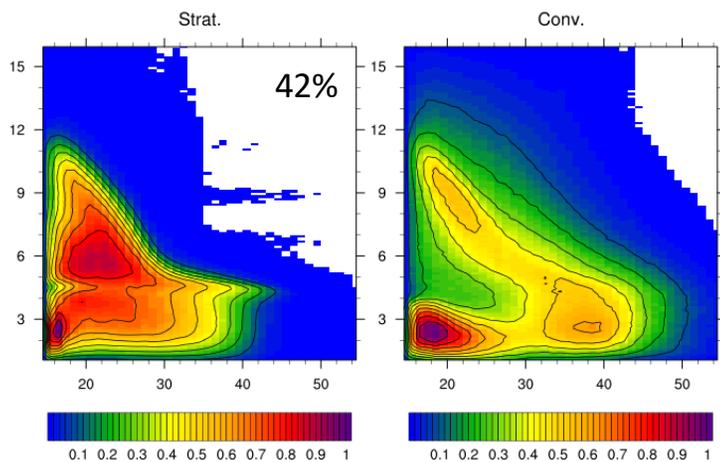
DPR

CAM5

14°N-  
28°N



2°N-  
14°N



# Conclusions

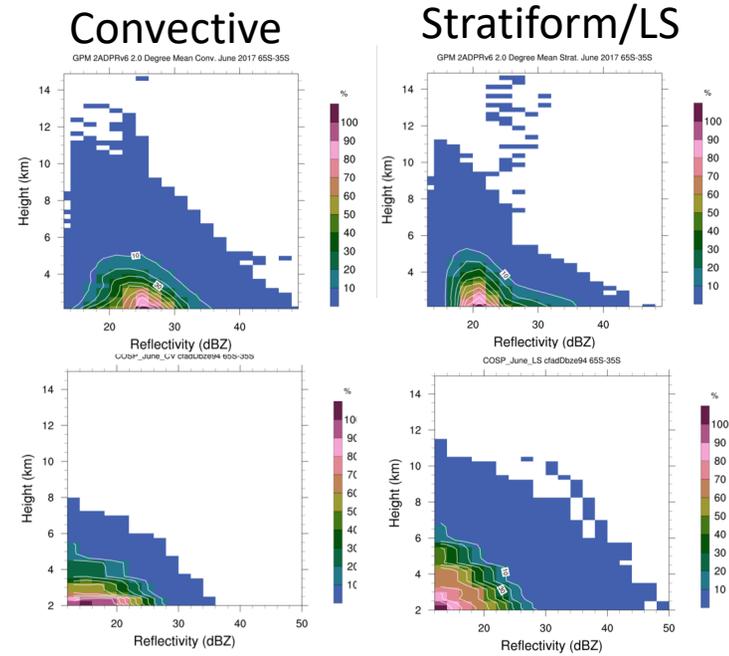
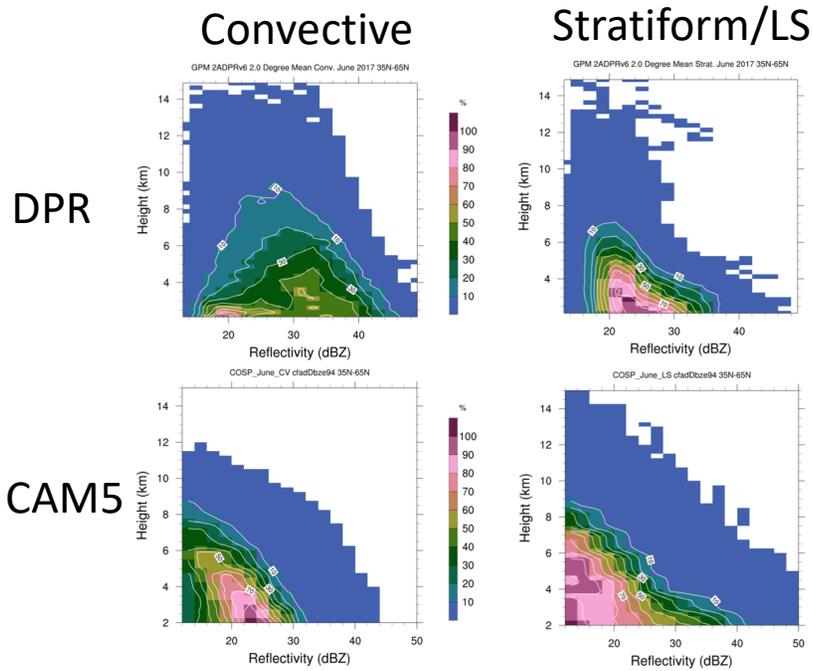


- We need to go beyond basic rain fall maps to understand differences in how rain is being produced by the atmosphere versus in GCMs.
- Separating rain into convective and stratiform (or large-scale) components is a good place to start, but the categories mean different things between radars and models and even within models themselves.
- Translating model data into radar reflectivity, esp. with height, helps isolate where the largest discrepancies originate.
- Looking forward, the DPR simulator can be used to analyze radar observations in relation to large-scale environmental fields to address a number of physical phenomena.

# Higher latitude comparisons

35°N-65°N

35°S-65°S



# Land-ocean comparisons

35°S-35°N

