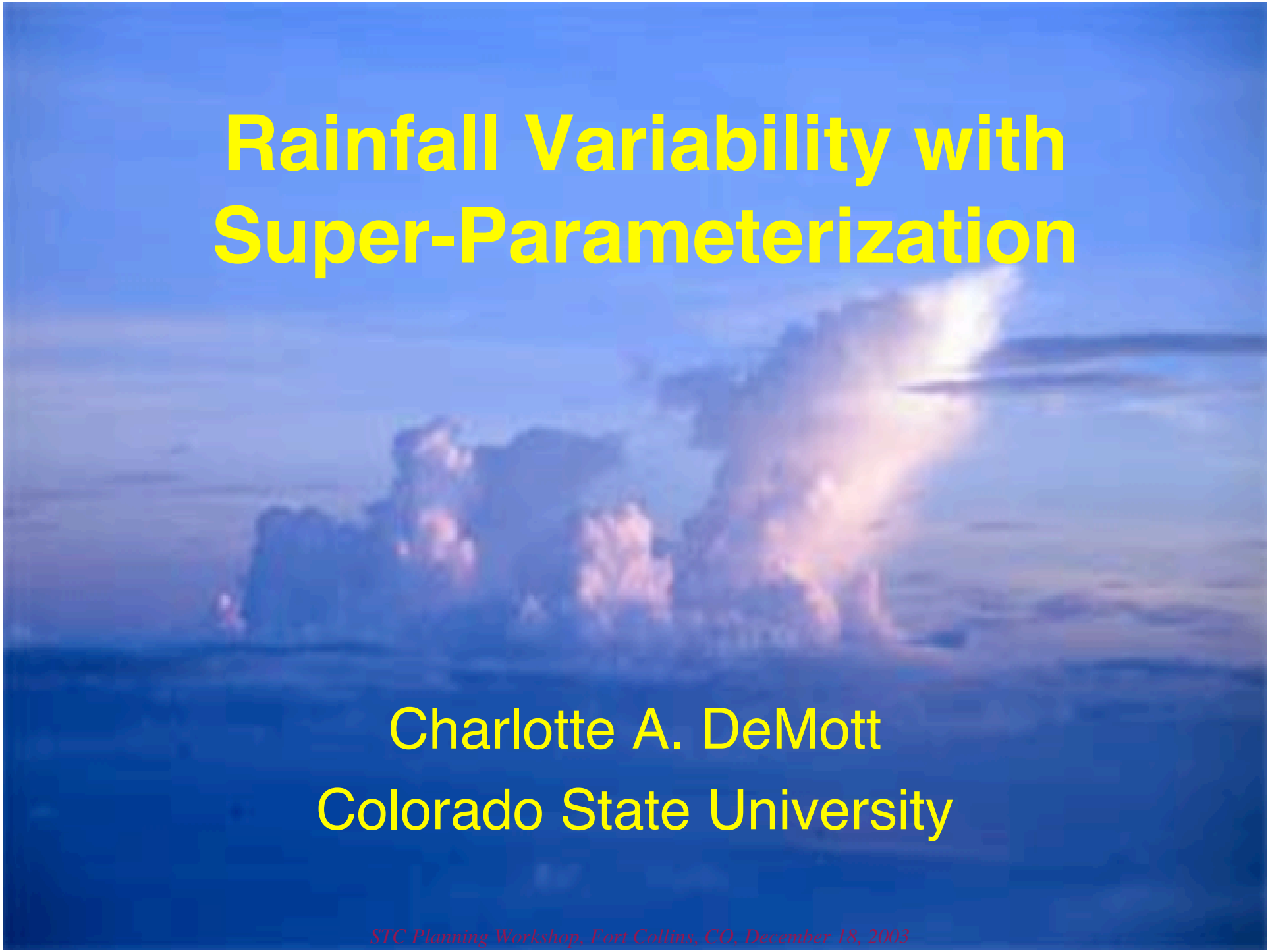

Rainfall Variability with Super-Parameterization

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STC Planning Workshop, Fort Collins, CO, December 18, 2003

Introduction

- How does rainfall variability using SP compare to observations?
  - As a function of rainfall rate
  - As a function of precipitable water (PW)
- When the SP improves upon the CAM, does it do so for the right reasons?

  "*In modeling, there are a lot of wrong ways to get the right answer.*"--Bill Gray
- When the SP produces large errors, can variability analysis suggest why?

Outline

- Methodology
- Observational data
- Rainfall rate distributions
- Rainfall as a function of PW

Approach

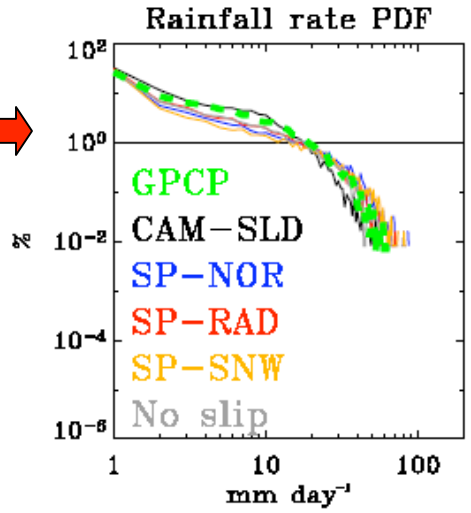
- Compare modeled and observed daily mean rainfall and PW over several locations and seasons.
- Regions and seasons:
  - ♥ The Good News: Amazon Basin, DJF
  - ♦ The Bad News: "Great Red Spot", JJA

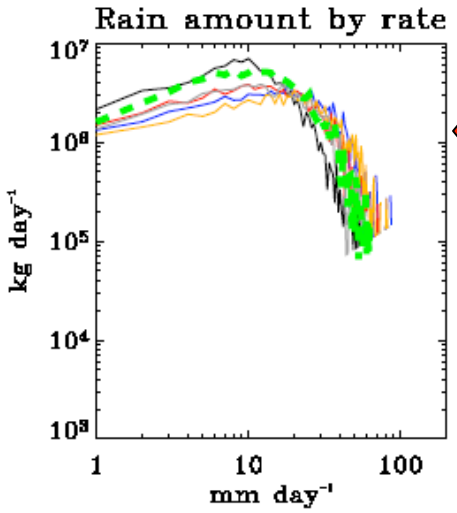
Observational Data

- Precipitation
  - GPCP daily mean rainfall, 1°×1° resolution, 9/1998 - 12/1999.
  - Data regridded to 2.5°× 2.5° or 2.8°× 2.8° resolution for comparison with PW data or model output, respectively.
- Precipitable water
  - ECMWF ERA 40 Reanalysis dataset, 9/1998-12/1999, 2.5°× 2.5° resolution.

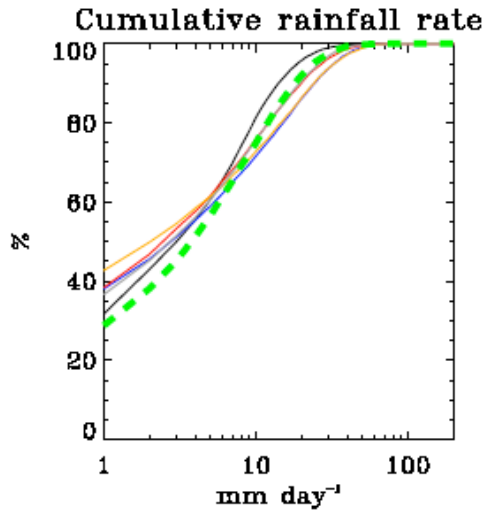
Rainfall Distributions, Amazon

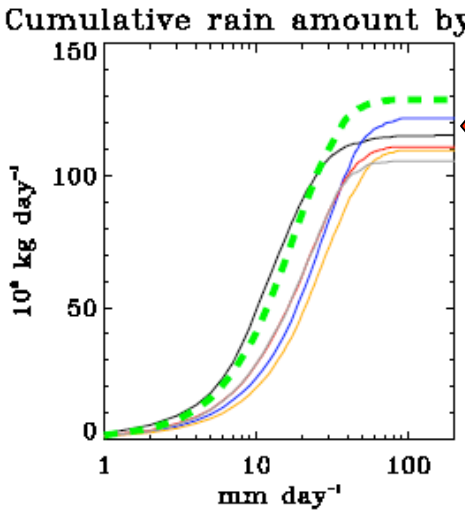
Simple histogram of daily rainrates, expressed as a percentage.





PDF at left multiplied by bin-mean rainfall rate.



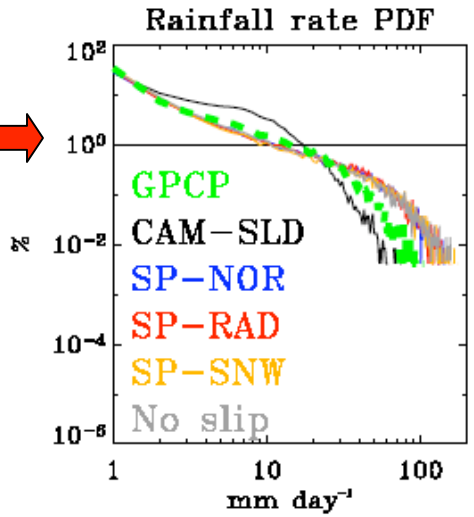


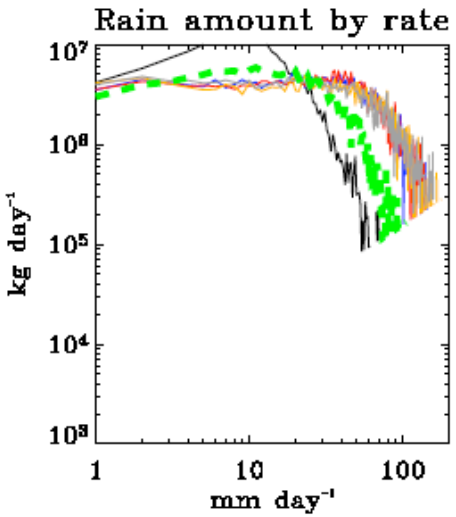
Summation of rain amount plot, above.

Rainfall Distributions, GRS

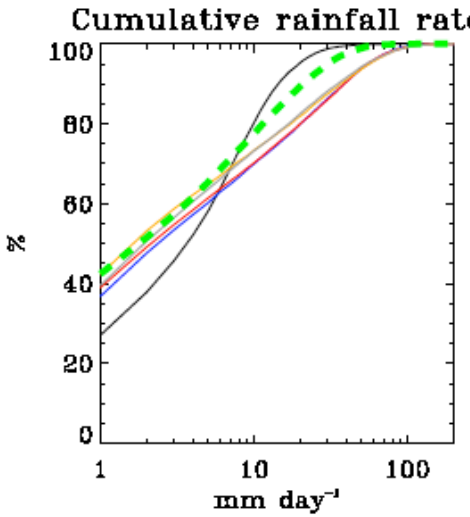
JJA Great Red Spot

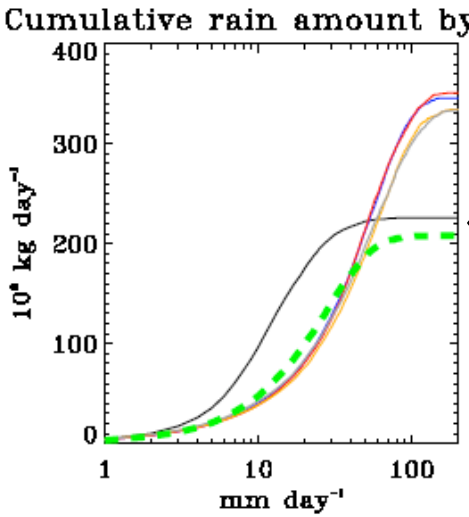
SP runs show best agreement with obs out to 20~30 mm/day.





CAM deviates substatially from obs.



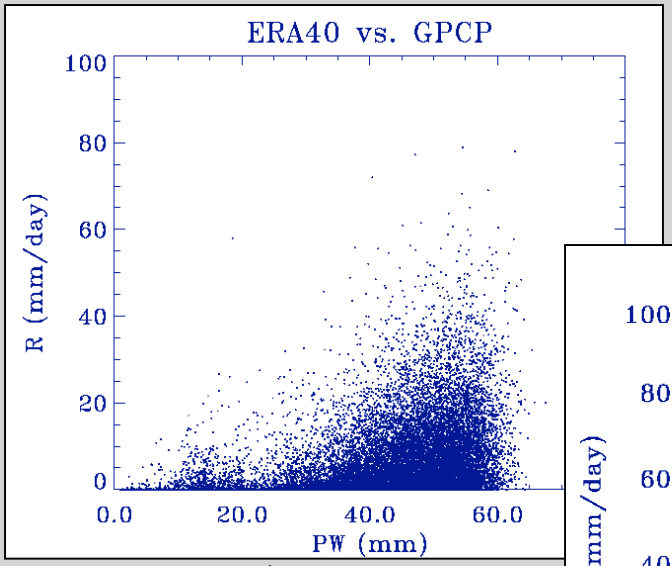


CAM produces right answer for wrong reasons.

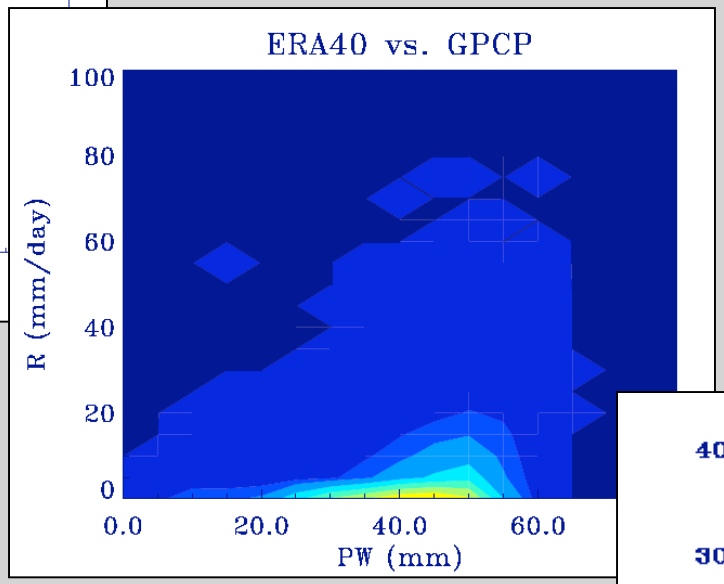
Rainfall vs. Precipitable Water

- Rainfall is influenced by PW and also influences PW by removing water vapor from the column.
- Comparing how rainfall relates to PW in models and observations may yield insight into how various parameterizations perform.

Constructing Rainfall-PW Plots

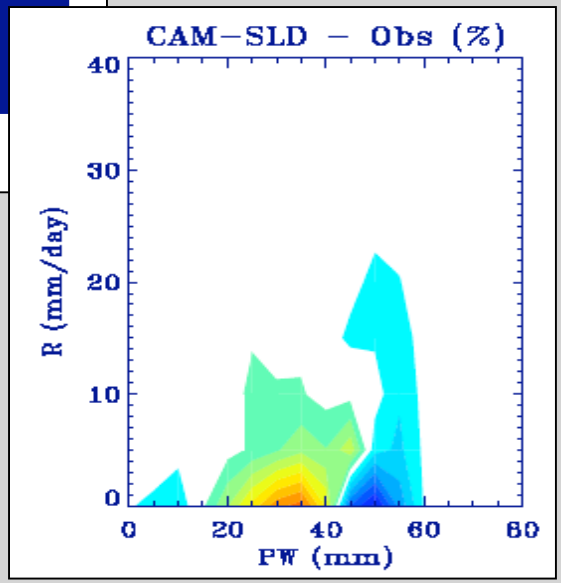


Scatter plot of daily mean rainrate-PW pairs for a given region and season.

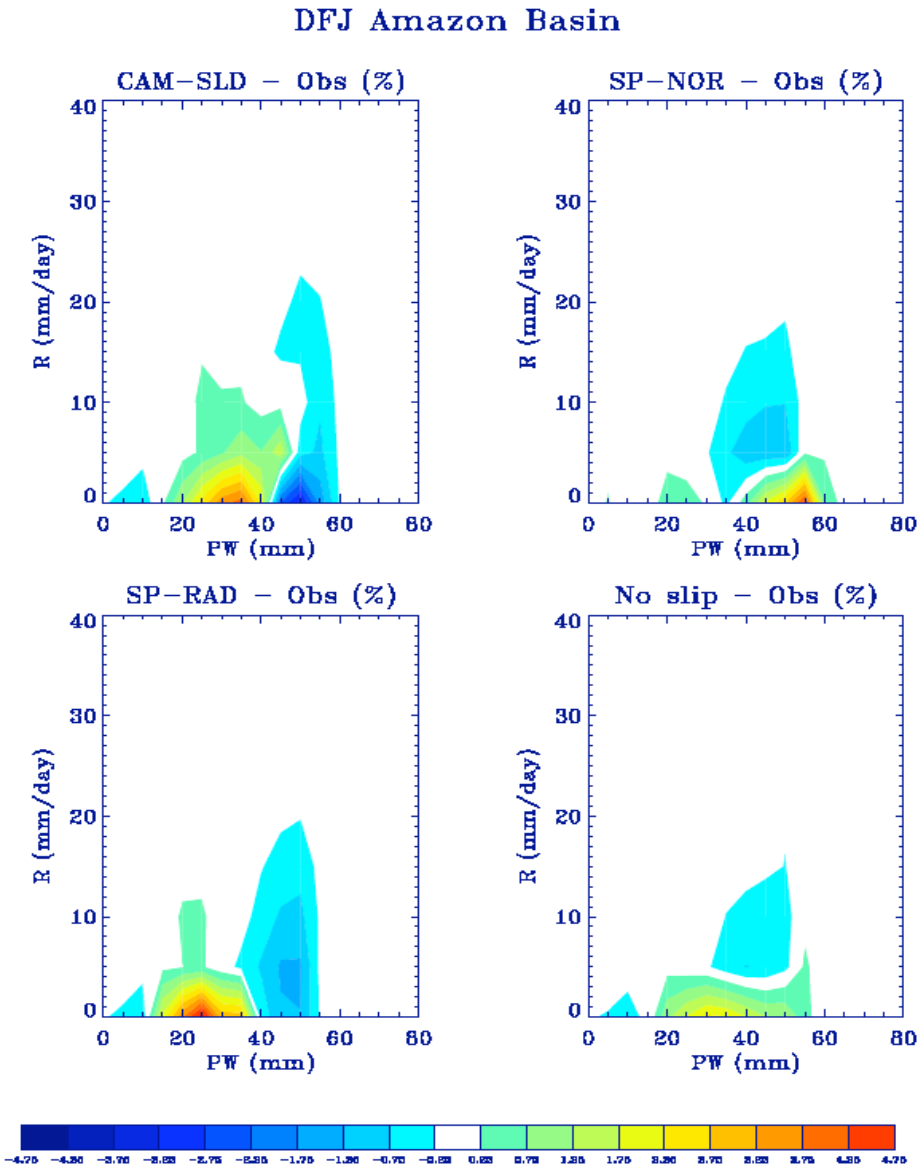


Contour density of RR-PW pairs from previous panel.

Subtract one contour plot from another to get relative differences.

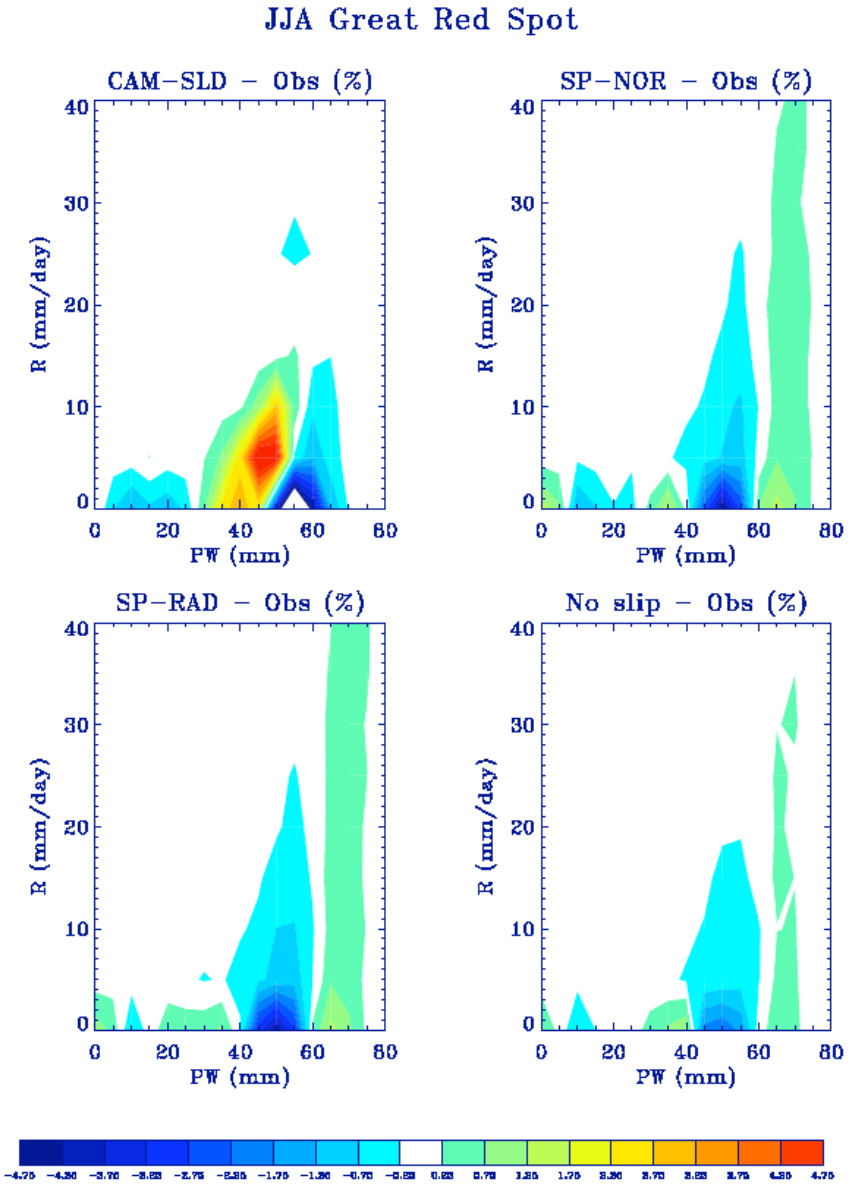


Rainfall-PW PDFs, Amazon



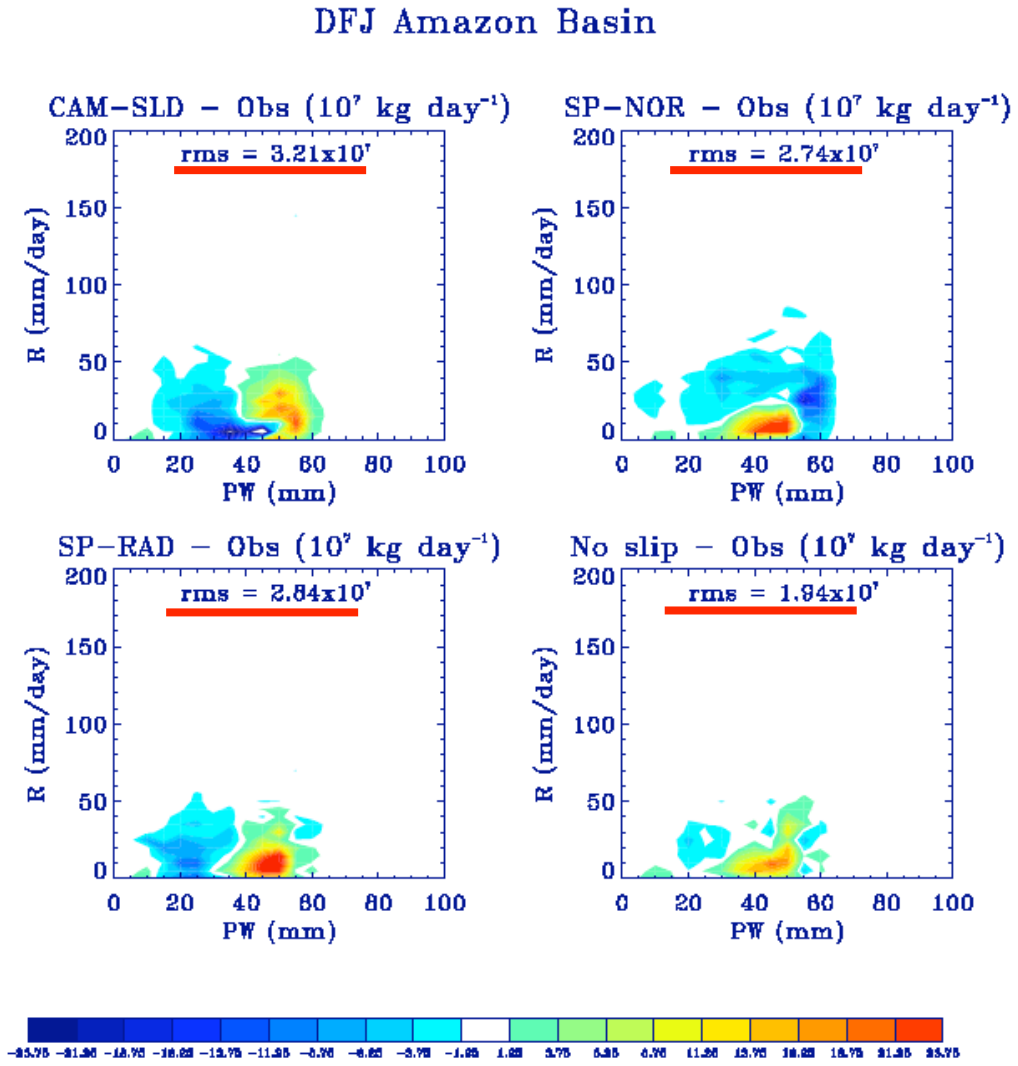
- CAM, SP-RAD produce too much rainfall at low PWs, not enough at high PWs.
- DRAG run produces too much rainfall at low RRs, but has smallest overall error.

Rainfall-PW PDFs, GRS

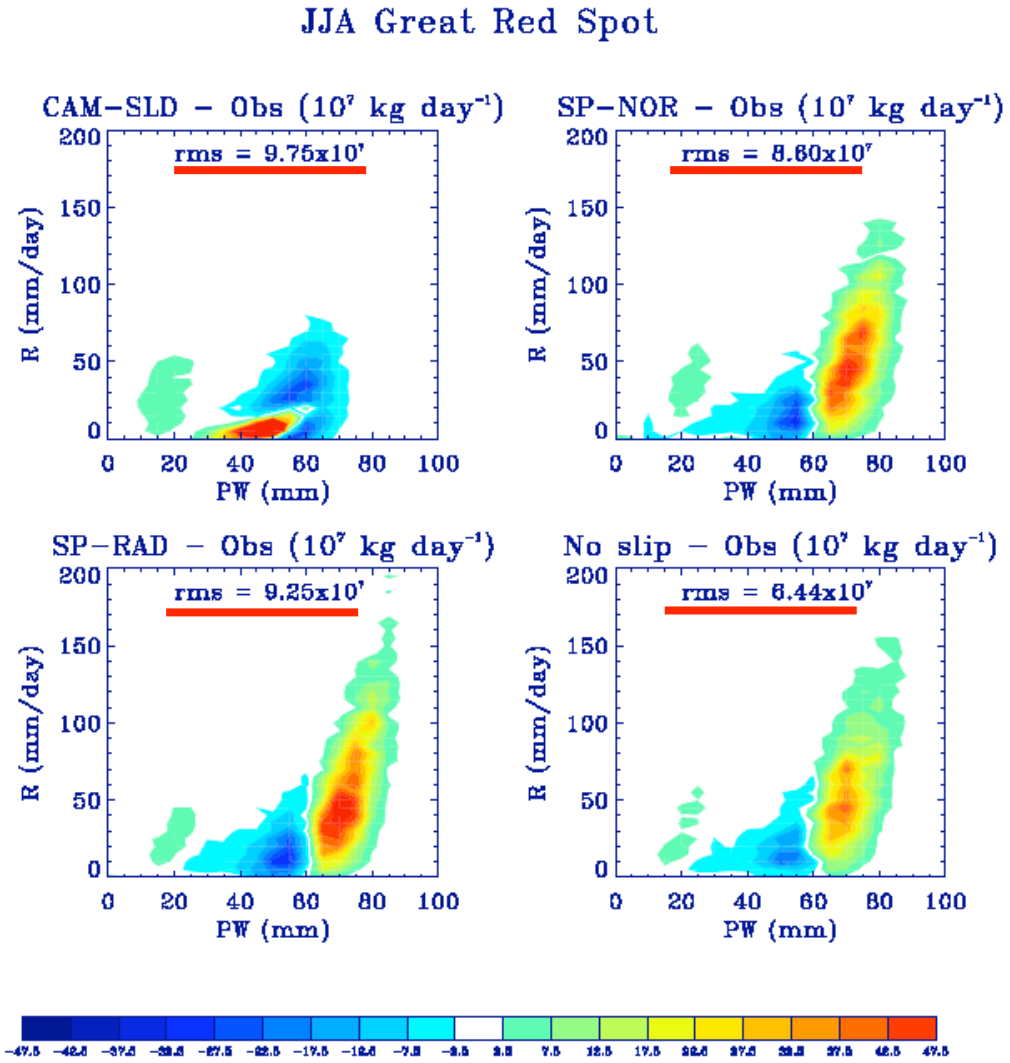


- CAM places bulk of rainfall in a small RR-PW parameter space.
- SP runs have erroneously large PW values, which are associated with the highest rainfalls.

Rain volume vs. PW, Amazon



Rain volume vs. PW, GRS



Summary

- SP runs tend to produce too much rainfall at the highest rainrates and too little at the lowest rainrates.
  - CAM has the opposite problem.
- Rainfall-PW distribution errors are smallest in SP runs, especially DRAG.
- Unrealistically high PW, RR values in GRS may result in part from cyclic boundary condition on CRM.