

Testing Superparameterization Results with ARM Data

Initial Results and Plans for Future Research

Tom Ackerman
Mikhail Ovtchinnikov
Roger Marchand
Ruby Leung

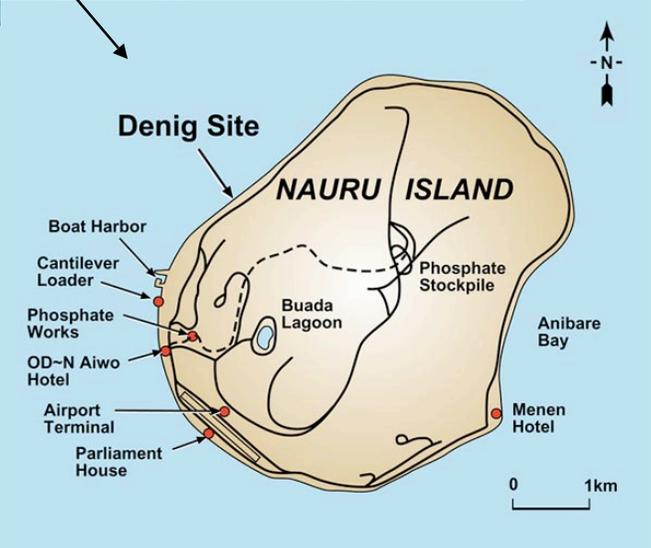
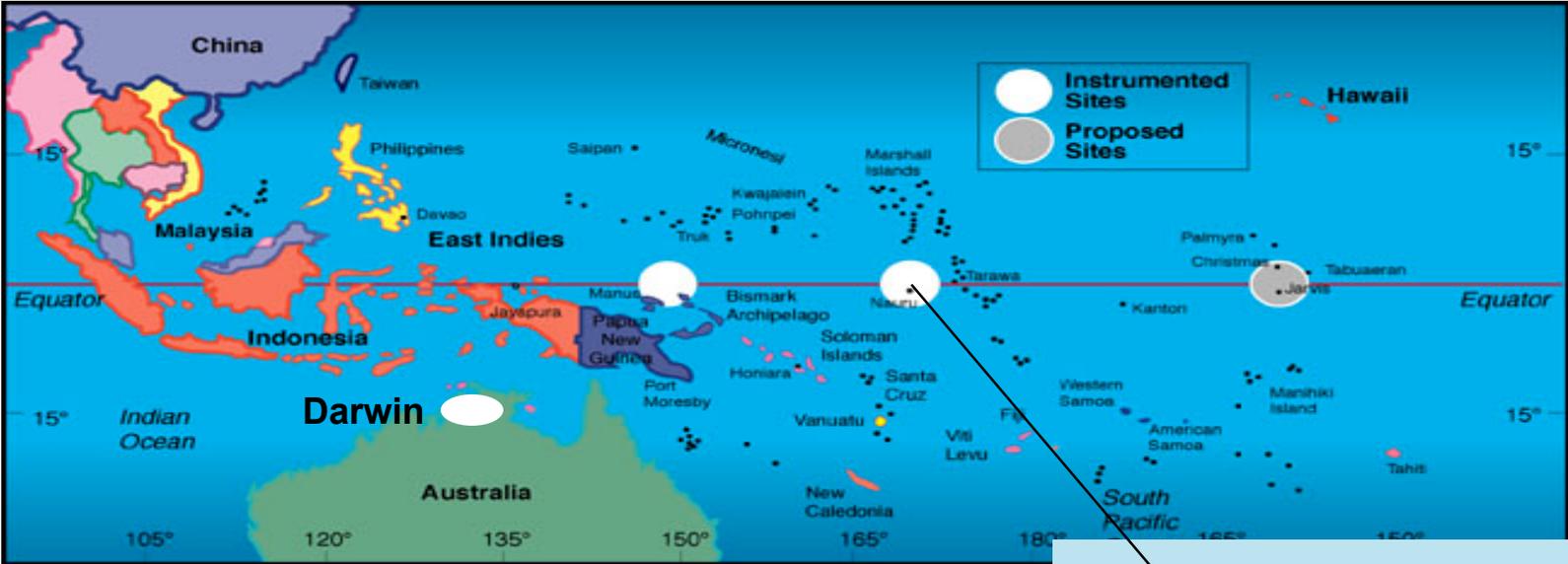
Why Are We Interested in SP approach?

- ▶ Science – linking observations and climate models
 - Scale of model output matches scale of observations (for both surface and newer satellite instruments)
 - More direct tie between improvements in physical understanding and incorporation into models
- ▶ Programmatic
 - Observational programs like ARM and NASA EOS have had a demonstrable impact on the understanding of cloud physics and radiation and on numerical weather forecasting
 - BUT, they have had a much weaker influence on climate modeling, which has been used to justify them

Comparison sets

- ▶ **NCAR CAM**
 - T42, 26 levels, climatological SST
 - 365 days
 - 3-hour averages
- ▶ **Super-CAM (SP-RAD)**
 - 2D cloud model, climatological SST
 - 365 days
 - 3-hour average over domain
- ▶ **ARM Nauru data set**
 - 1999 – 2001 time period
 - Typically 1-minute data

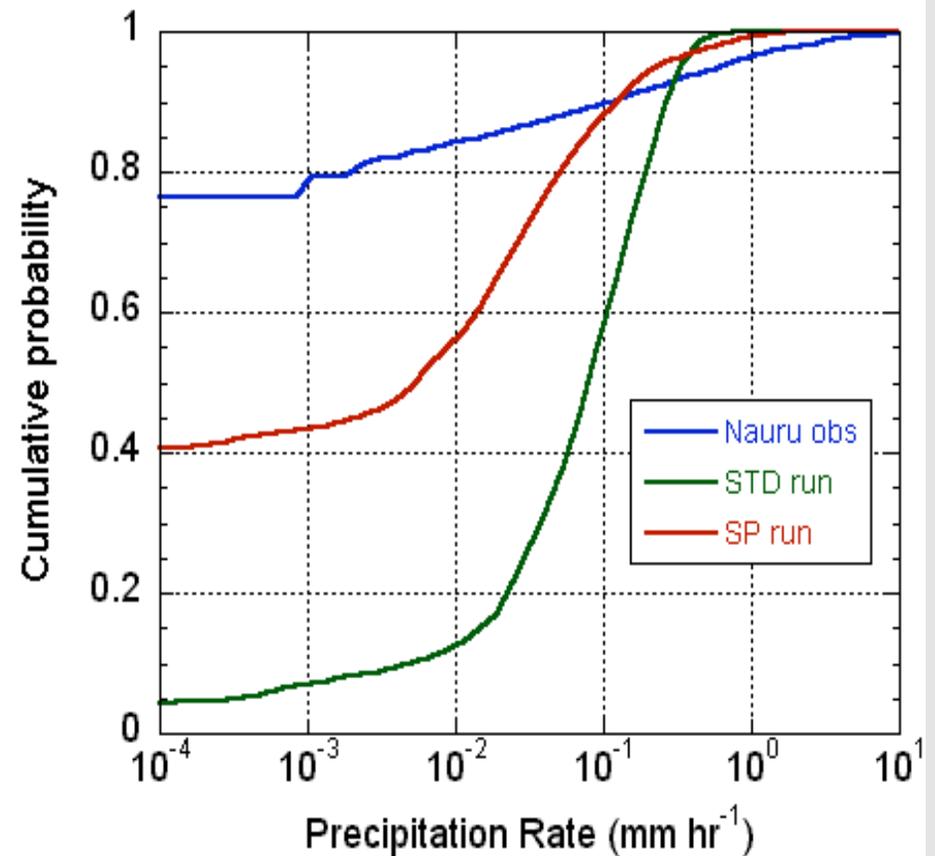
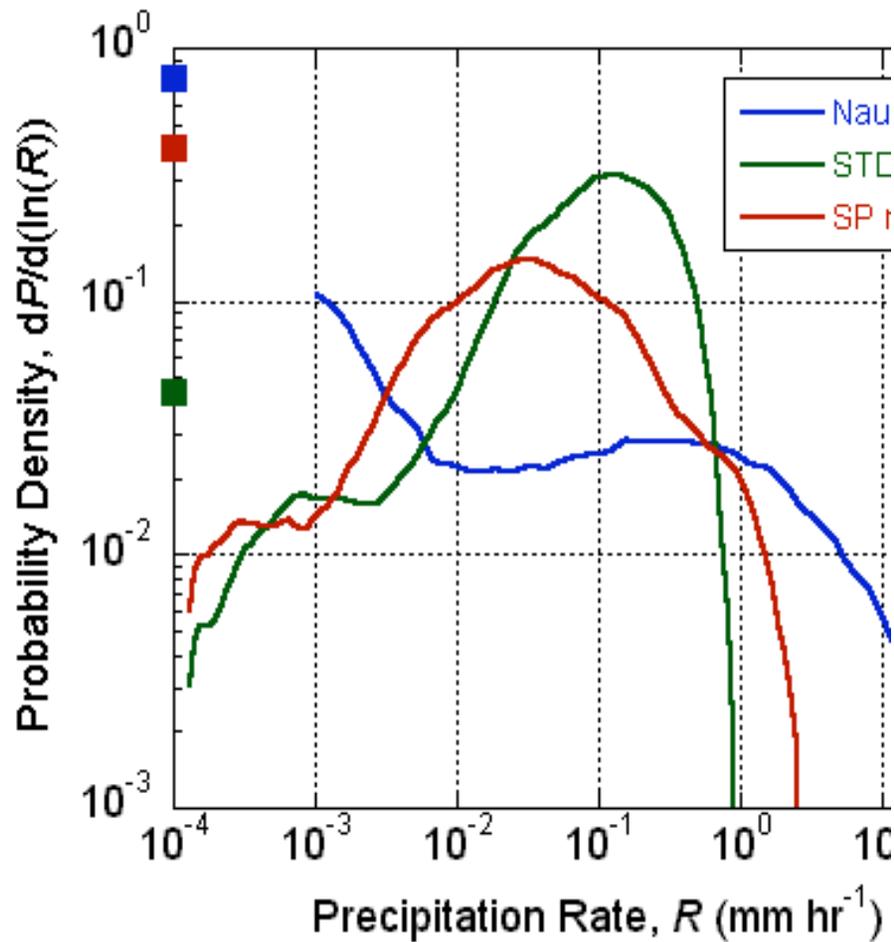
Location of Nauru

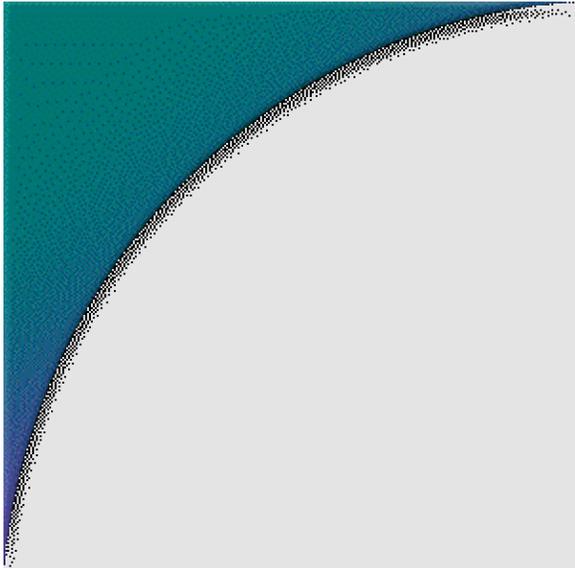


Nauru Site



Total precipitation rate (Nauru)





300 km x 300 km

3 hour average



256 km x 4 km

3 hour average

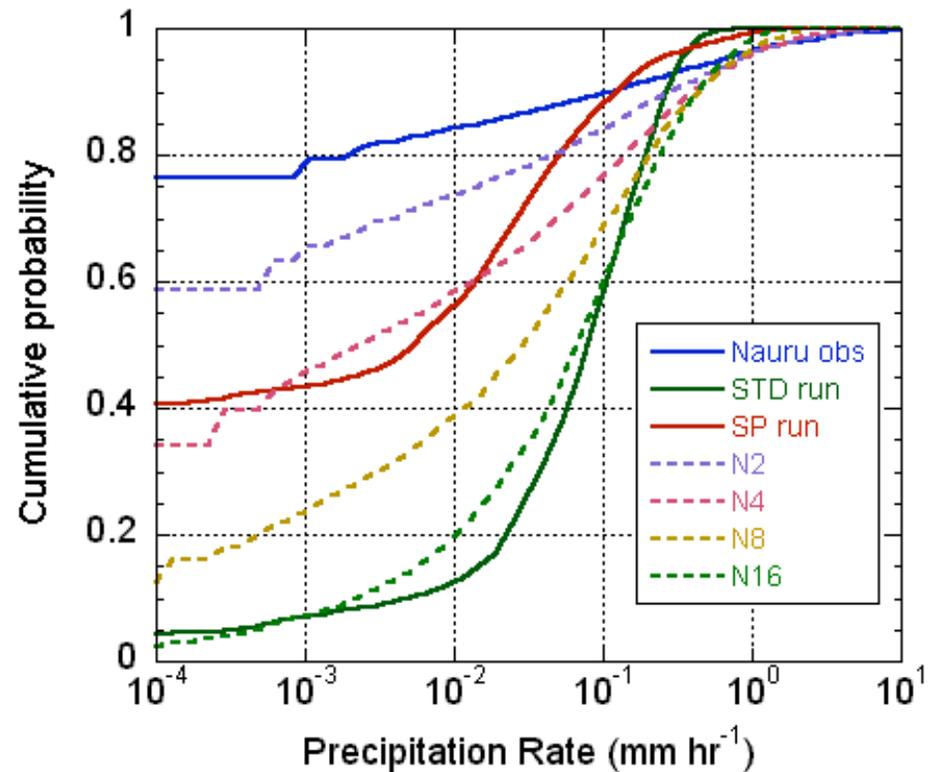
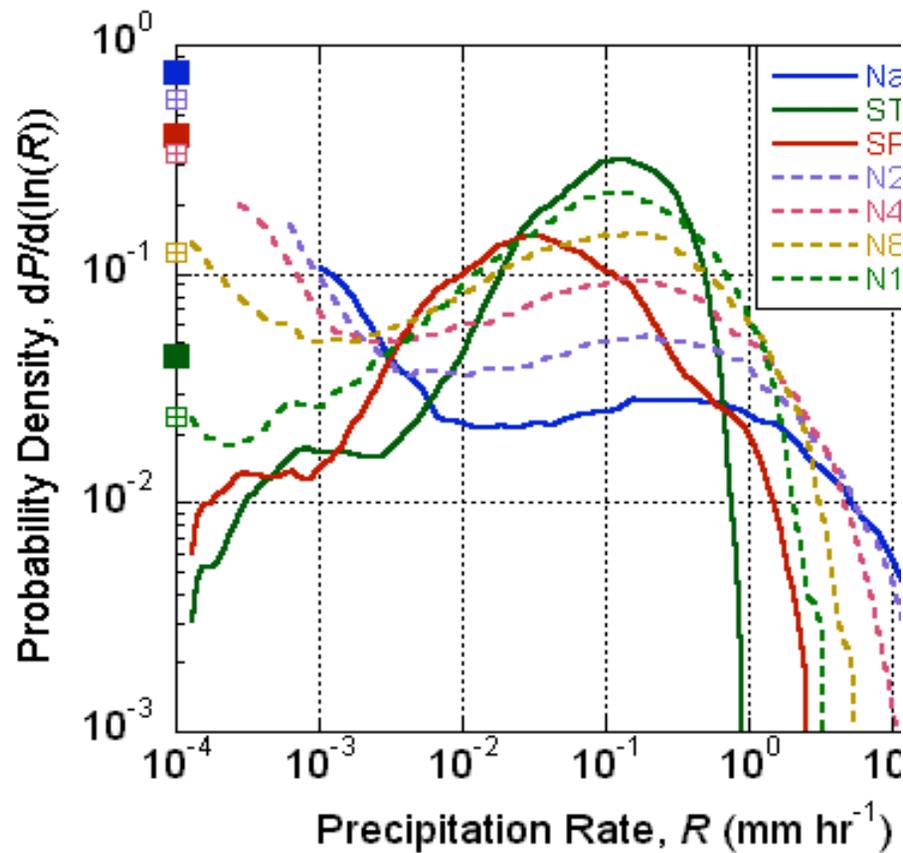


Single location

3 hour average

Minimum rain rate 10^{-3} mm/hour

Total precipitation rate (Nauru)



By the way,

- ▶ In simulations of climate change over the next century, it's the **water** that counts!
- ▶ Impact assessment revolves around changes in water availability
- ▶ If the SP effort can improve the accuracy of precipitation simulations, that would be of huge value

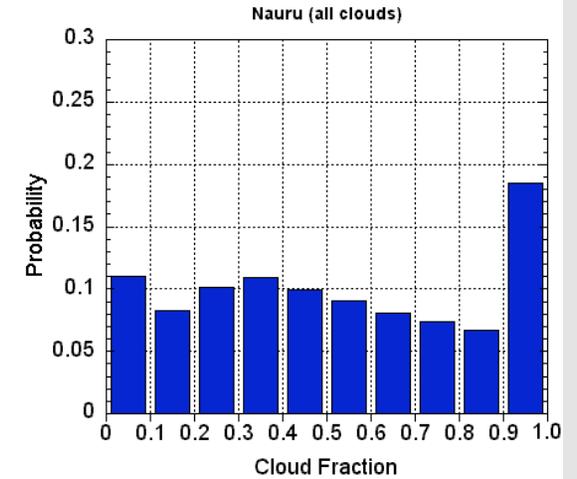
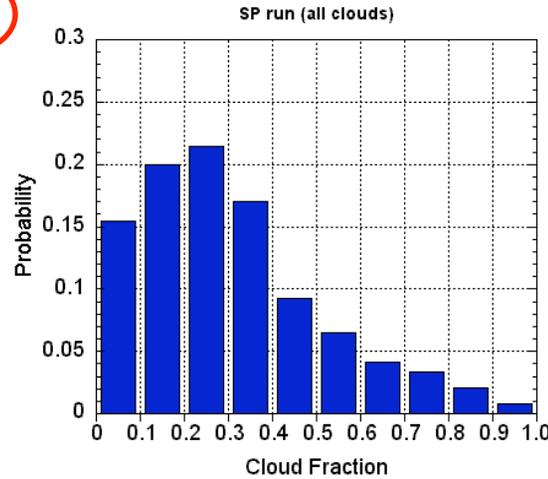
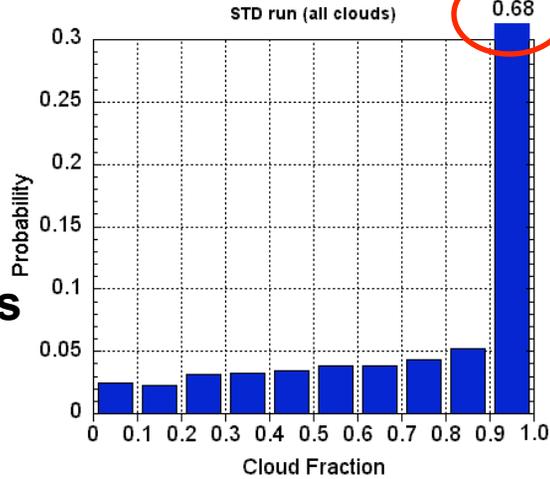
Total cloud fraction (Nauru)

All clouds

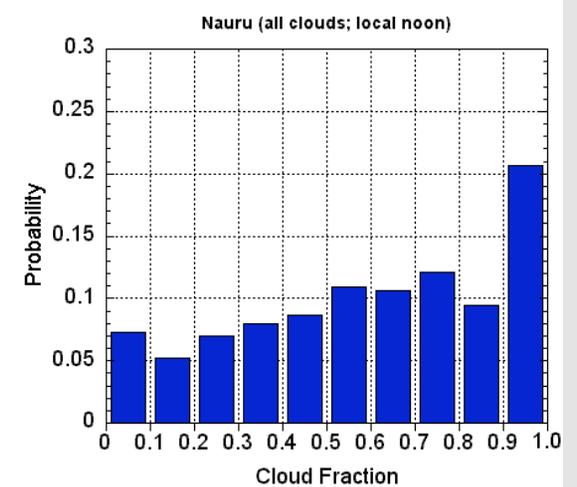
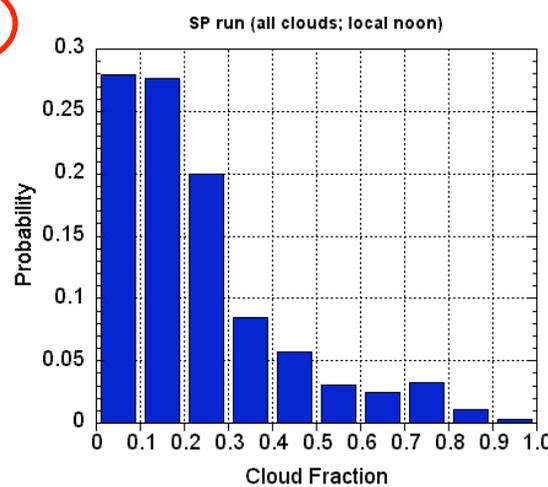
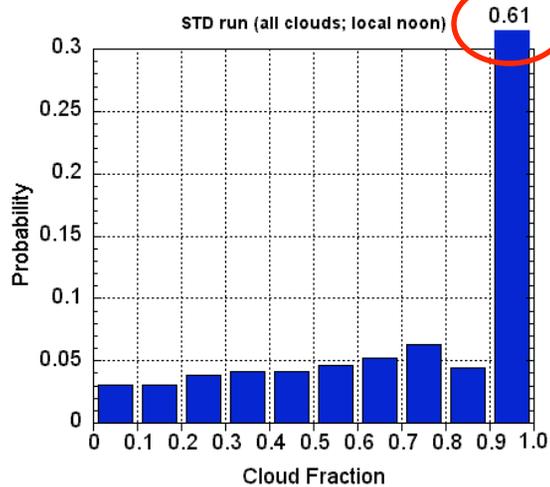
CAM

SP - RAD

Radar obs

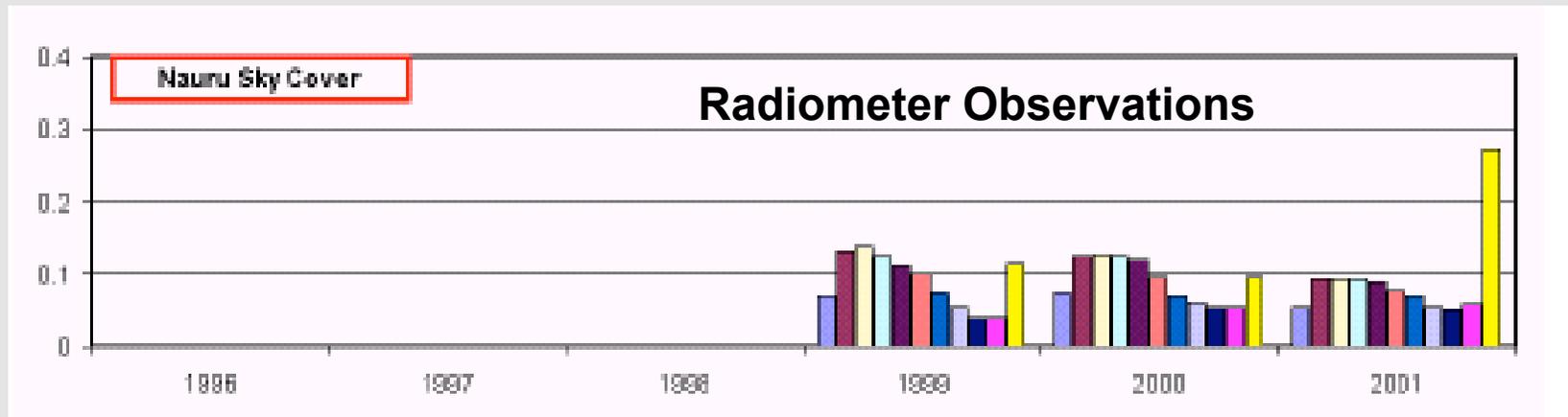
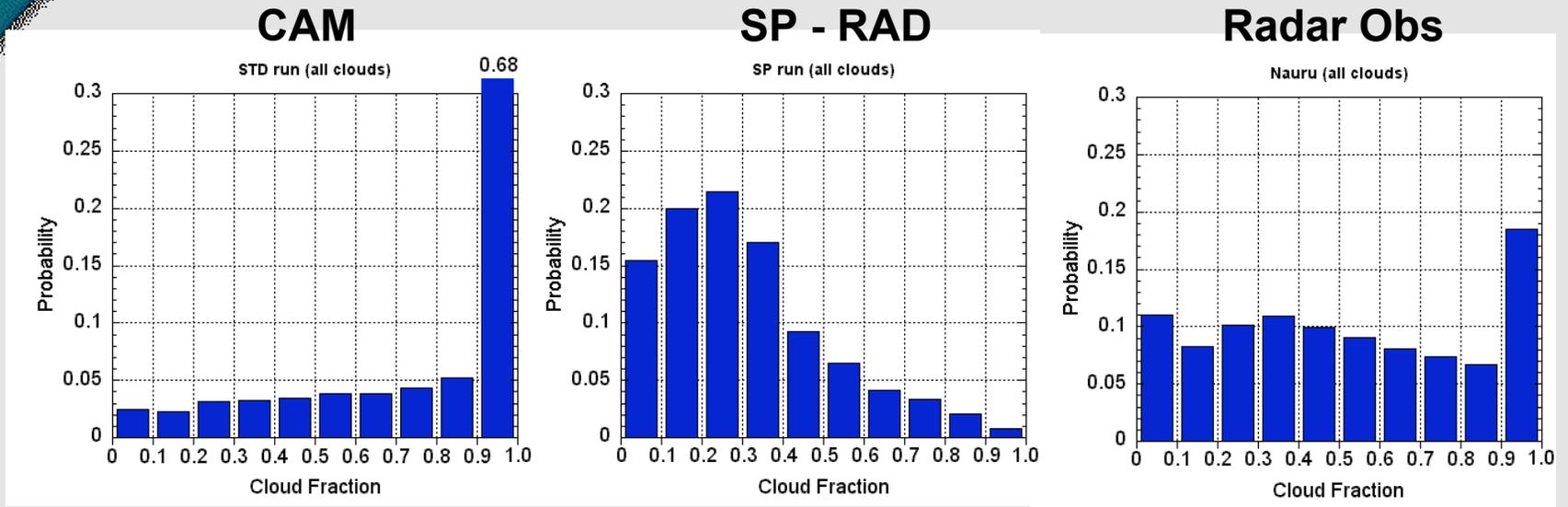


Noon period



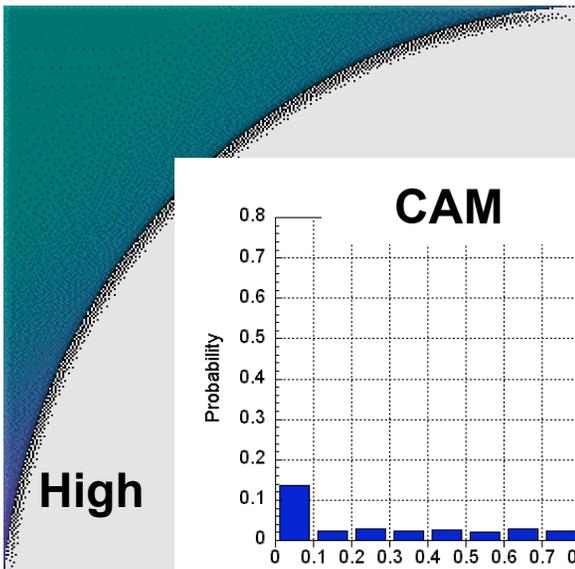
Cloud Fraction 0 □ 1

Total cloud fraction (Nauru)

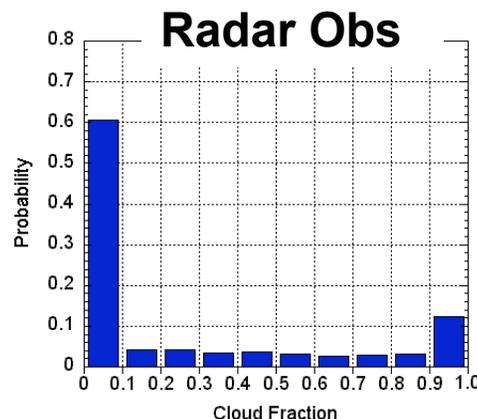
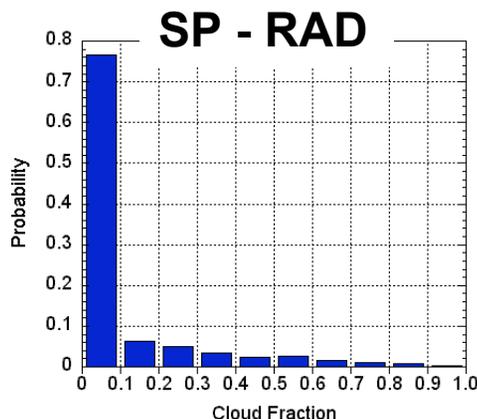
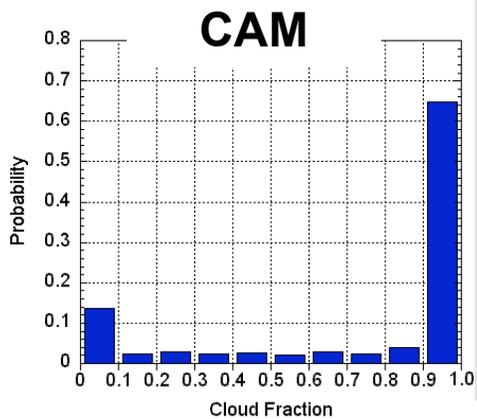


From Gaustad and Long (2002), 12th ARM Science Meeting Proceedings

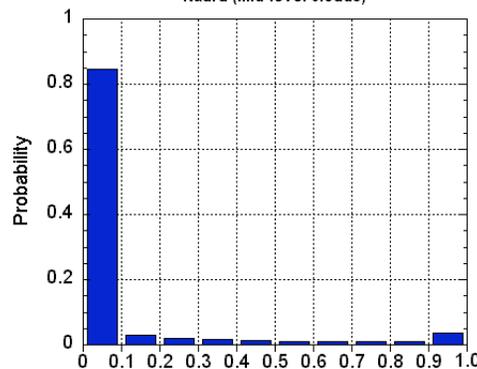
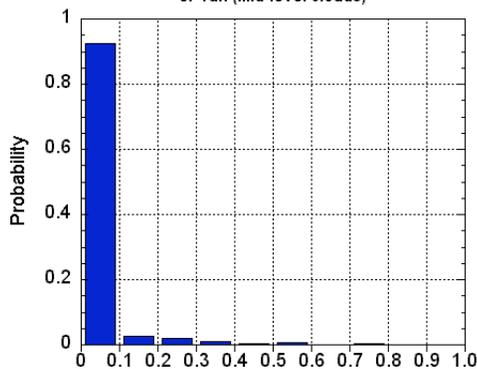
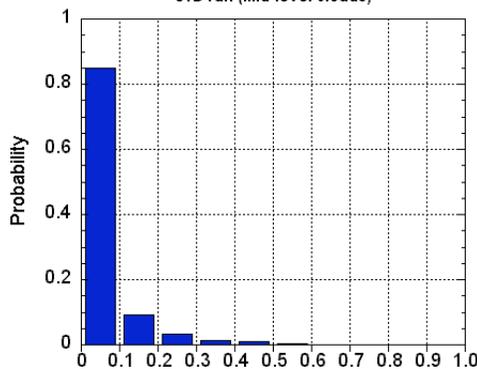
Cloud fraction (Nauru)



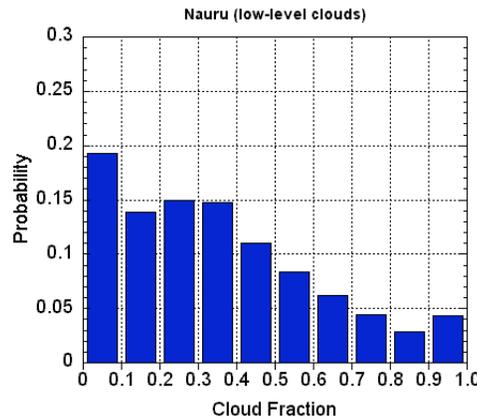
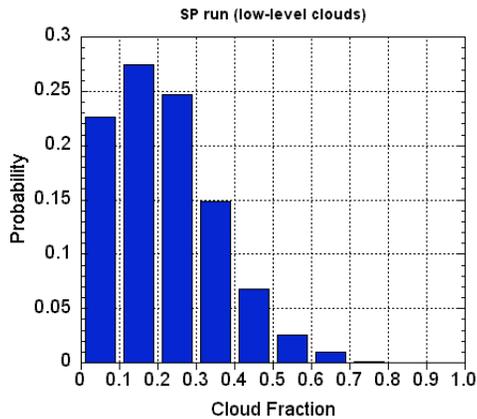
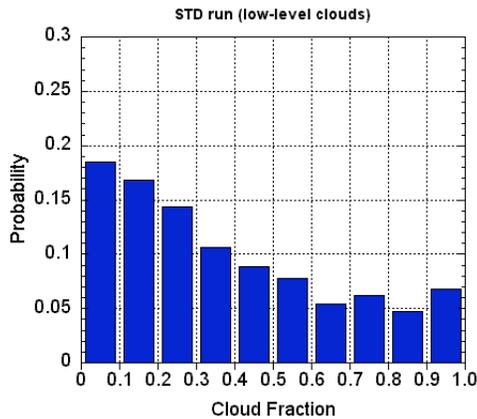
High



Middle



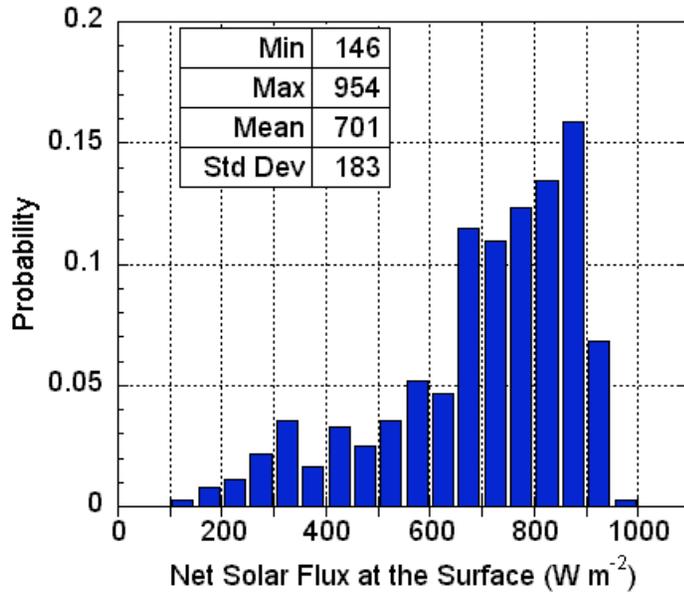
Low



Net solar flux at the surface (Nauru)

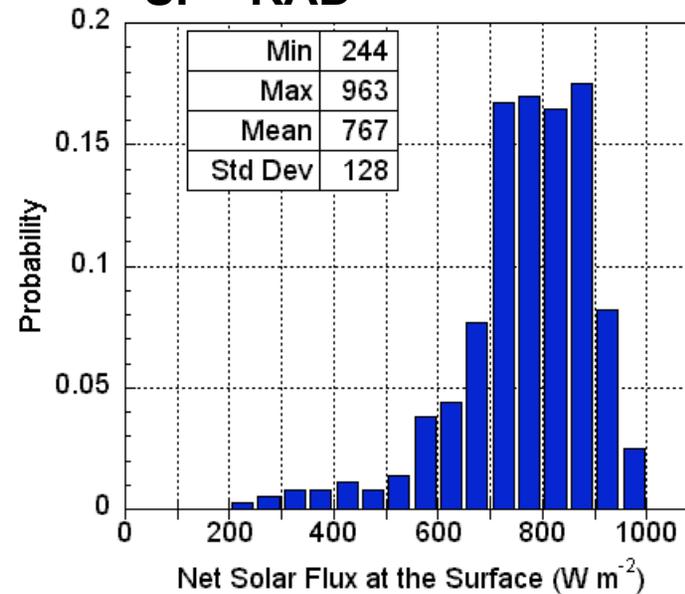
CAM

STD run



SP - RAD

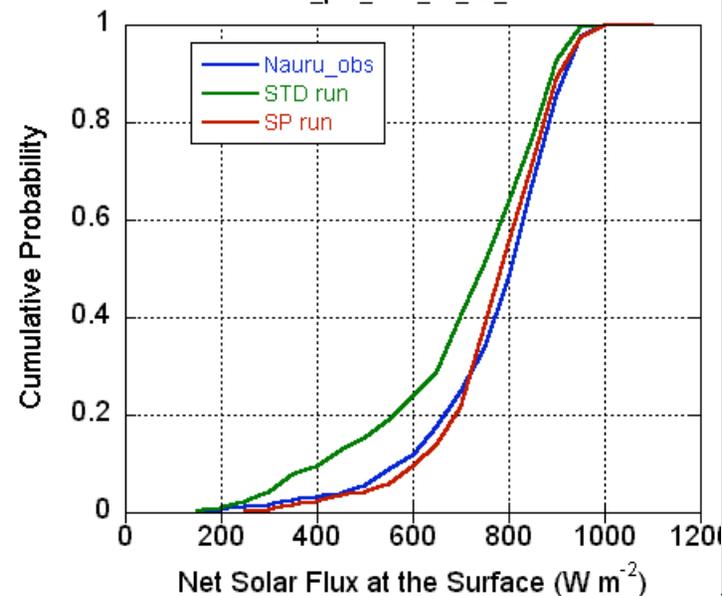
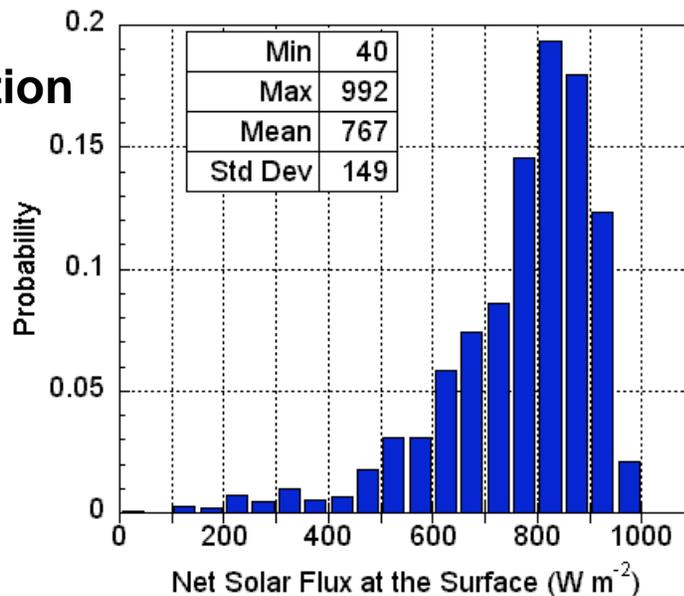
SP run



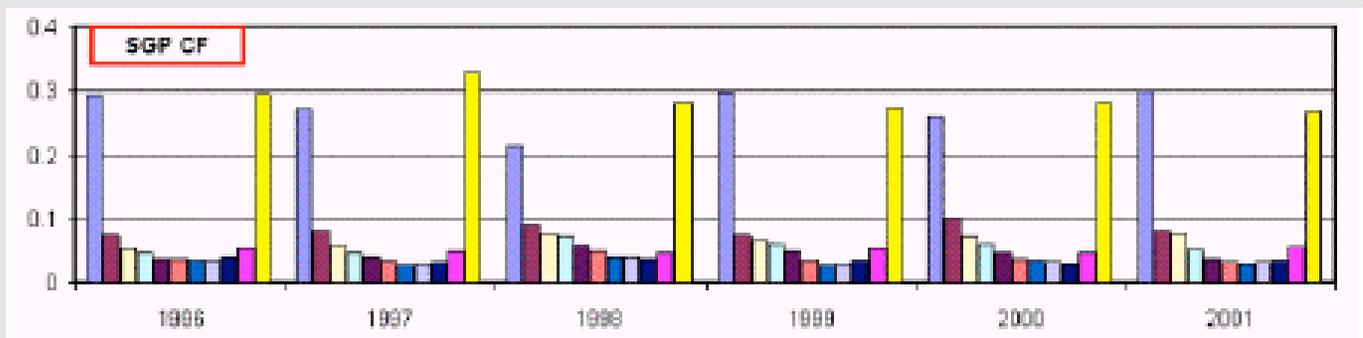
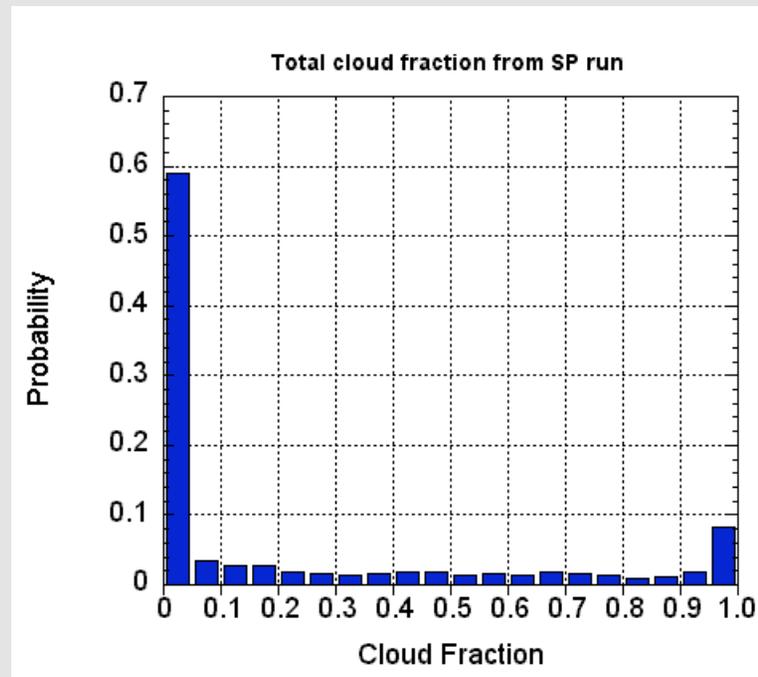
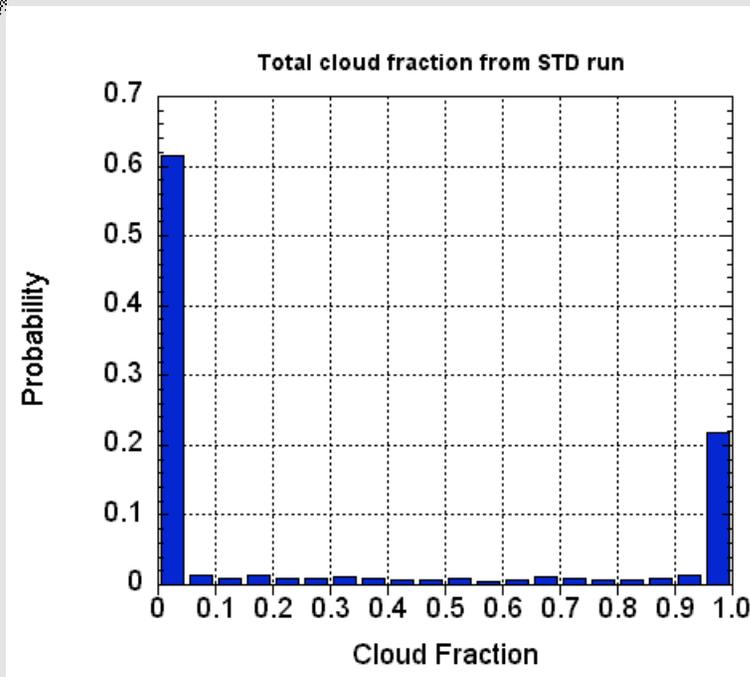
Net Solar Flux at the Surface ($W m^{-2}$)
Nauru observations

Net Solar Flux at the Surface ($W m^{-2}$)
rsns_par_cum_09_02_noon

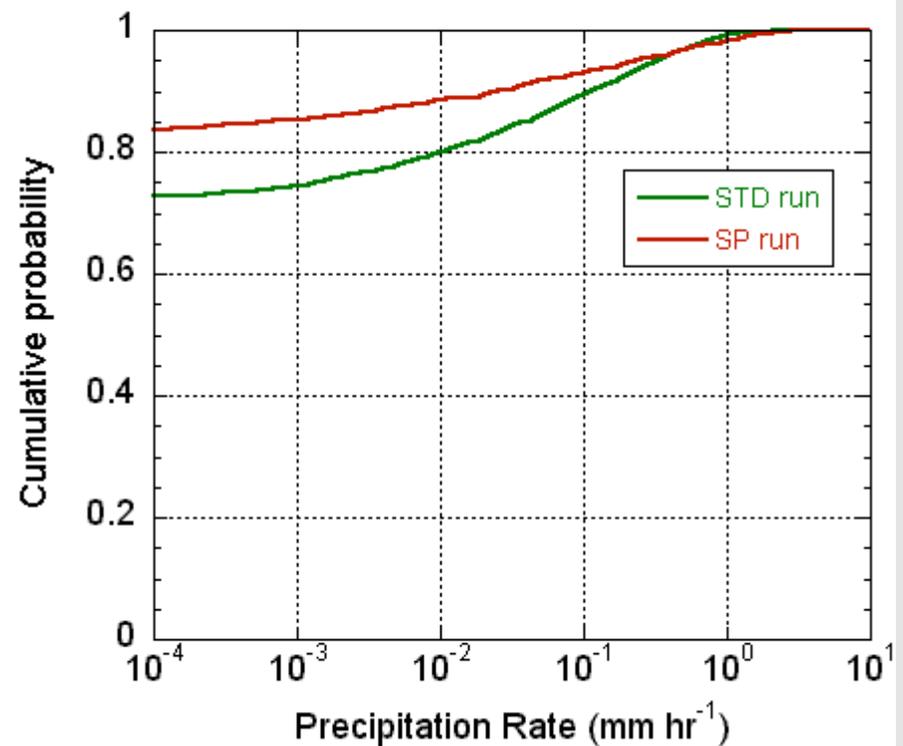
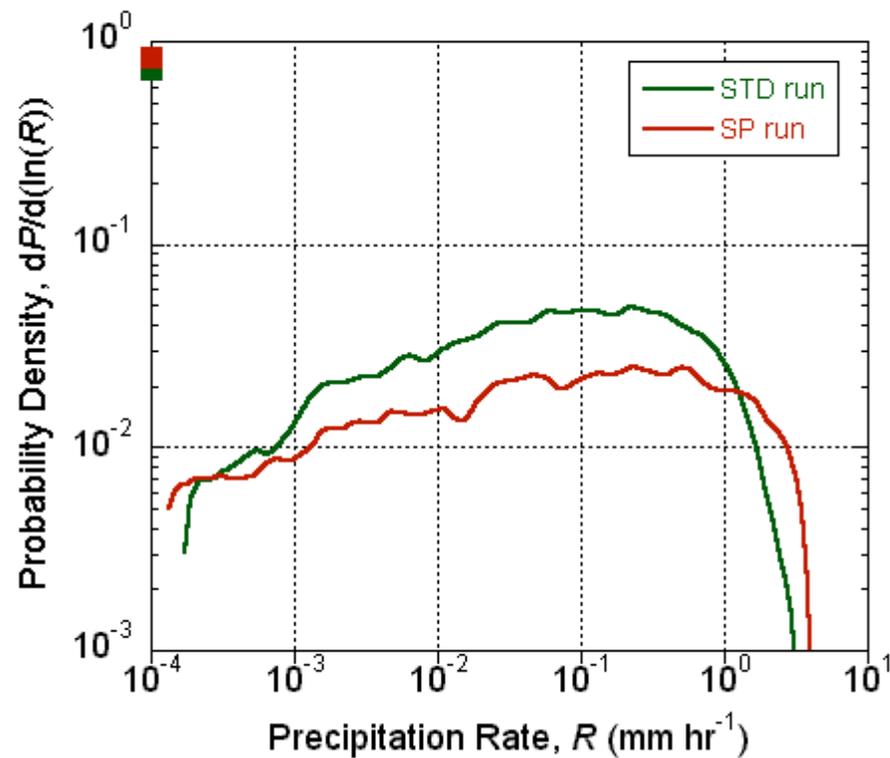
Observation



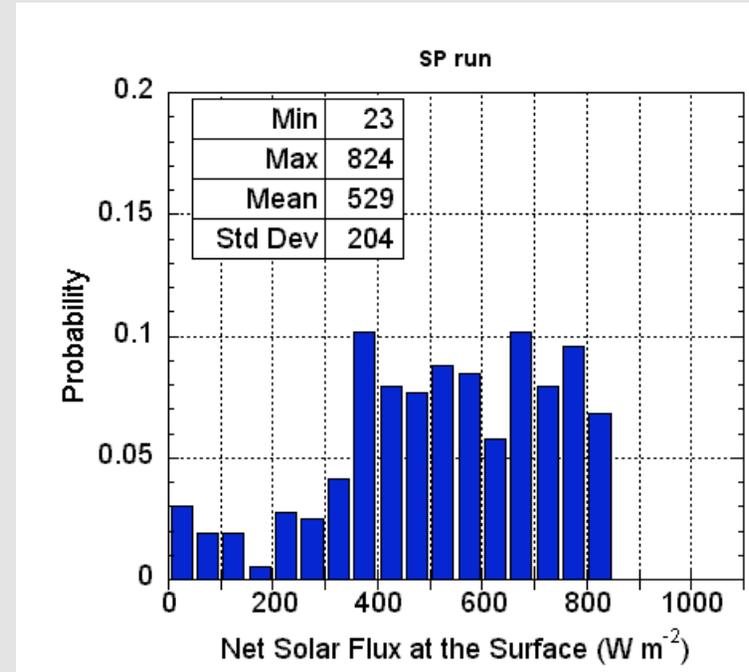
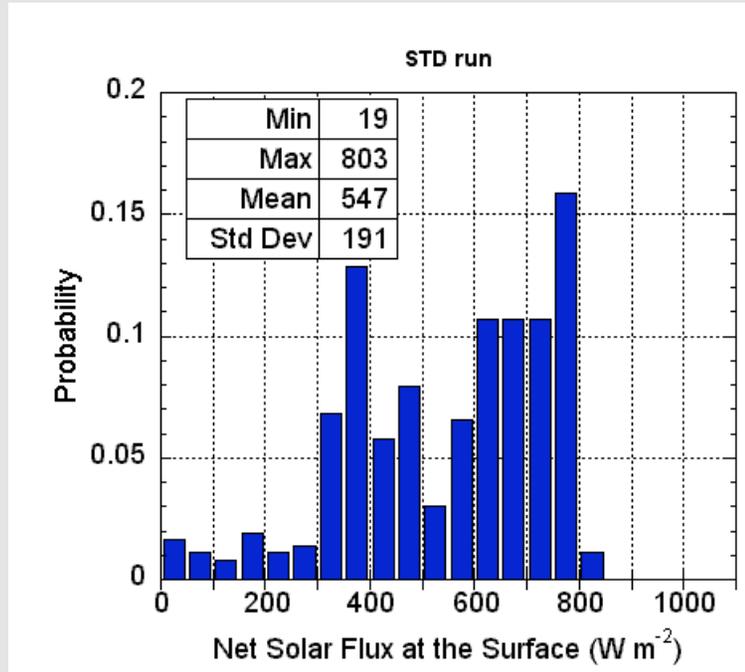
Total Cloud Fraction (SGP)



Total precipitation rate (SGP site)



Net solar flux at the surface (SGP site)



Immediate Plans

- ▶ Extend climatological SST analysis to SGP and possible NSA site
- ▶ Analyze new Super-CAM run with observed SST for 1999 (to be extended to 2001)
- ▶ Compare seasonal and diurnal cycles
- ▶ Use enhanced model output set
 - Single column from 2D model
 - Defined cloud threshold ice water contents
- ▶ Create ARM simulator for Super-CAM
 - Need higher resolution model output in space and time

Plans - Modeling

- ▶ Beginning process of porting CAM and Super-CAM to PNNL computer system
- ▶ Preparing Grand Challenge Proposal for computer time at PNNL
 - HP 1900 processor Linux machine
 - Asking for ~500,000 CPU hours per year
 - Model runs done in close consultation with CSU
 - Will require some consideration of dynamical core to maximize use of machine architecture
- ▶ Will implement a ~1-km version of WRF model running continuously over ARM sites

Climate Science Simulation Project

- ▶ Requesting a new initiative within DOE Office of Biological and Environmental Research (OBER)
- ▶ Focus on linking observations and climate modeling using superparameterization framework
- ▶ Multi-laboratory initiative with external partners
- ▶ Closely tied to NSF Science and Technology Center proposal at CSU

Possible roles

NSF

- ▶ Model development
 - Cloud model
 - New core framework
- ▶ Computational algorithm development
- ▶ Simulation of current climate

DOE

- ▶ Cloud model validation
 - ARM data
 - Satellite data
- ▶ Computational algorithm development and implementation
- ▶ Application runs for climate change (cloud feedback)

Concluding Thoughts

- ▶ Making the SP a “benchmark” model will require an extensive evaluation effort to
 - Quantify the accuracy of its clouds and radiation budget
 - Demonstrate that it is superior to existing GCM’s in terms of cloud properties and scale interactions
- ▶ We are actively pursuing comparison between model output and cloud-scale observations, but, we need to have more detailed model output to improve comparison studies
- ▶ We are working towards a new DOE initiative related to evaluating and ultimately using a SPM for climate change; any help in influencing DOE is gratefully accepted!