# Probabilistic evaluations of a cloud system model using ARM observations

**Pete Henderson & Robert Pincus. CIRES/NOAA, University of Colorado, Boulder**

PeterH@Colorado.Edu, Robert.Pincus@Colorado.Edu

## Introduction

- 3-year runs of a CSRM[1] in quasi-MMF[2] configurations are made over the SGP[3] site (1999-2001) using ARM's observationally-constrained forcing data [1].
- To constrain our evaluation of cloud, winds & temperature are nudged back to observed values every 2 & 24 hours.
- Evaluations of model cloud-occurrence are then made against ARM's ARSCL[4] data [2].

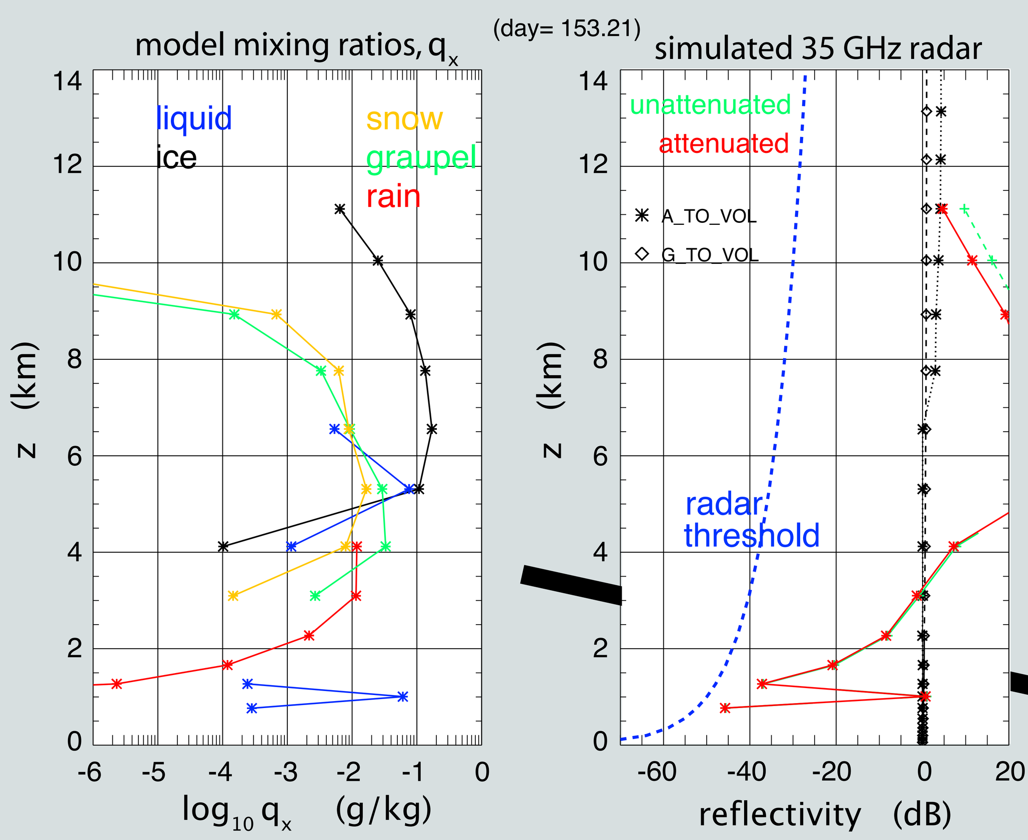
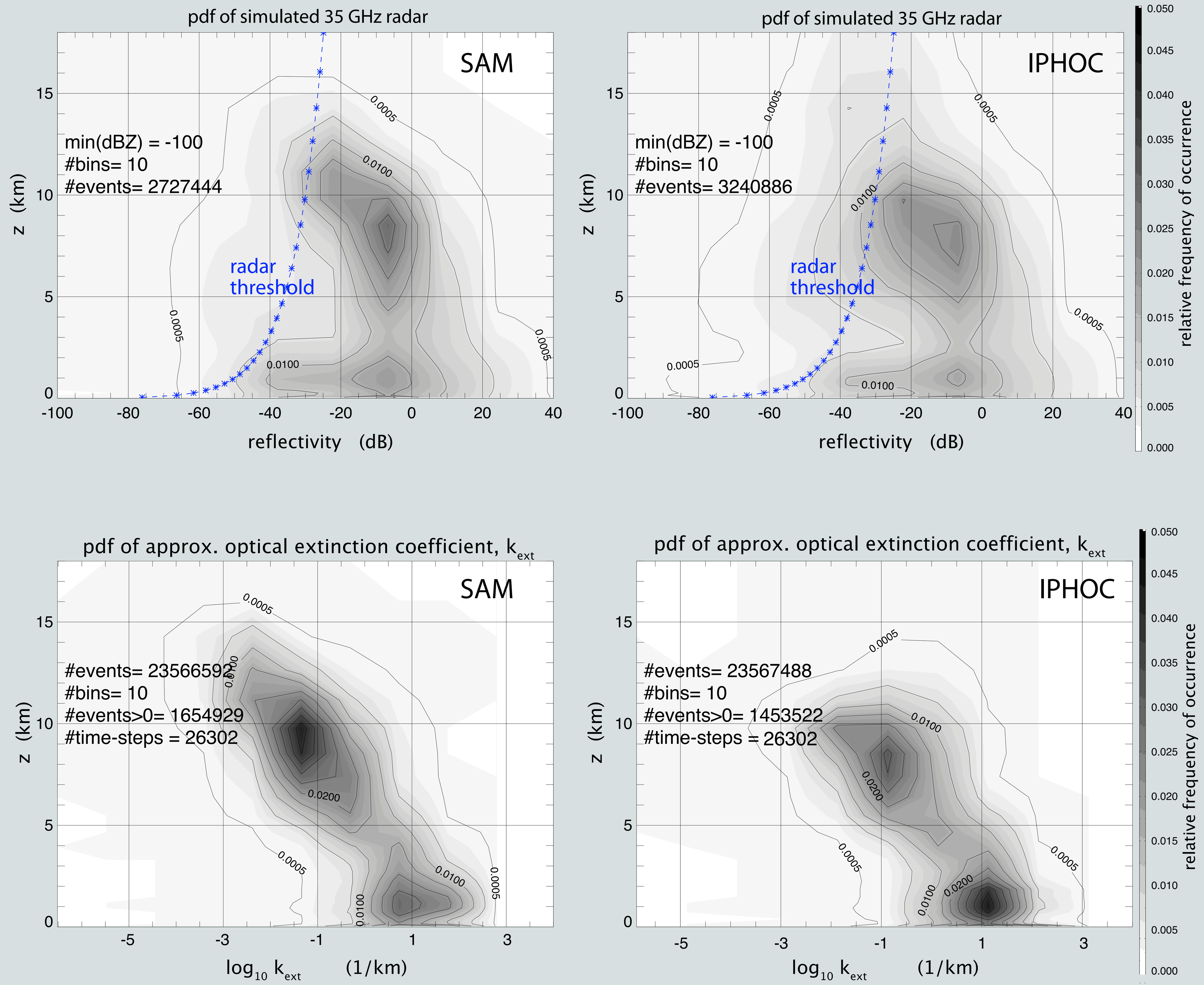



**FIGURE 1.** (left) Snapshot of the hourly mixing ratios of a single column of the model's domain. (right) Corresponding total reflectivity simulated by Quick-Beam [2].

**FIGURE 2.** Probability distributions for two model runs (left & right), of simulated radar reflectivities (top-row) relative to the radar's sensitivity threshold (blue) and approximated lidar extinction coefficient (bottom-row),




## Method

- To make observed and modeled cloud more comparable, ARSCL's sensitivity thresholds are used to define cloud occurrence in the model (Figs.1–2).
- Using the model's mixing ratios of cloud liquid and ice, rain, snow and graupel; we simulate observations made by ARSCL's radar using Quick-Beam [3], and ARSCL's lidar with an approximate calculation of the extinction coefficients, $k_{ext,\,liq}$ and $k_{ext,\,ice}$. Effective radii, $r_e$ from the CAM[5] are used to find the droplet number concentration, $N$ from which $k_{ext}$ follows, assuming a scattering efficiency of 2.
- The "lidar-proxy" defines cloud when $k_{ext} > 0$, unless optical depth > 2, in which case the beam is assumed to be fully extinguished and the clear-cloud decision is made by the simulated radar component alone, which defines an event as cloudy if it exceedes the the sensitivity threshold, shown in Figs.1–2.
- At each time-step, the model's probability of cloud (PoC) is determined from the binary decision.
- Although simple, the lidar-proxy does improve estmations of ARSCL's cloud-based during precipitation.

## Provisional results

- Fig.3 shows that both runs reproduce the overall shape of ARSCL's mean profile.
- Differences in the local maxima of mean PoC, near 1 km and 8–10 km, correspond to those in the pdfs of Fig.2.
- IPHOC is in better(worse) agreement with ARSCL for z <(>) 7 km.

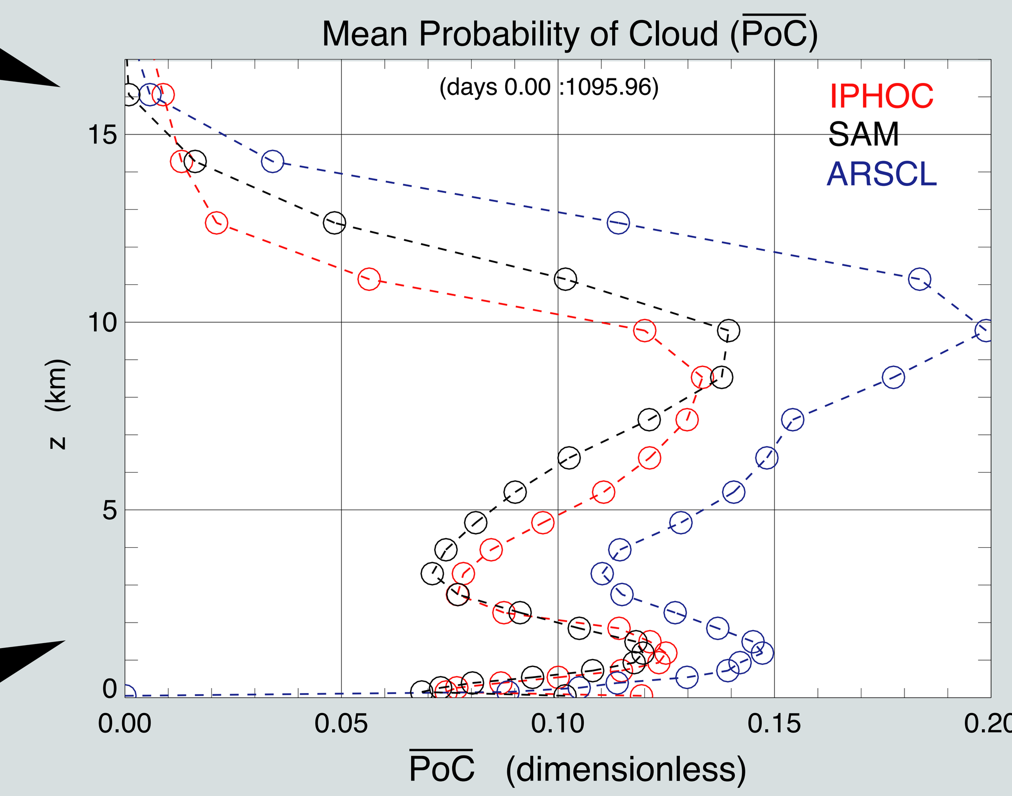



**FIGURE 3.** Comparisons of control run (SAM), the same CSRM with a higher-order turbulence closure (IPHOC) and mean cloud ocurrence in ARSCL.

**References:**

**[1]** Xie, S., R. T. Cederwall and M. Zhang, 2004: Developing long-term SCM/CSRM forcing data using NWP products constrained by surface and TOA observations. *J. of Geophys. Res.*, 109, D01104.

**[2]** Clothiaux, E. E., T. P. Ackerman, G. G. Mace, K. P. Moran, R. T. Marchand, M. A. Miller, and B. E. Martner, Objective Determination of Cloud Heights and Radar Reflectivities Using a Combination of Active Remote Sensors at the ARM CART Sites, 2000: *J. Appl. Meteorology*, 39, 645–665.

**[3]** Haynes, J. M., R. T. Marchand, Z. Luo, A. Bodas-Salcedo, and G. L. Stephens, 2007: A multi-purpose radar simulation package: Quick-Beam. *Bull. Amer. Meteor. Soc.*, 88, 1723–1727.

**FOOTNOTES**: 1. Cloud System Resolving Model. 2. Multiscale Modeling Framework. 3. Southern Great Plains. 4. Active Remotely-Sensed Cloud Locations. 5. Community Atmospheric Model