

The ARM Cloud Radar Simulator Value-added Product

The ARM cloud radar simulator is a ground-based cloud radar simulator developed to facilitate the comparison of climate model-simulated clouds with ARM observations from its vertically pointing 35-GHz radars. It is based on the QuickBeam radar simulator, implemented in the Cloud Feedback Model Intercomparison Project (CFMIP) Observation Simulator Package (COSP) to convert model-calculated cloud properties to what can be directly observed by a cloud radar (i.e., radar reflectivity). The inputs required to run the ARM cloud radar simulator include the Global Climate Model (GCM) gridbox means of the temperature and relative humidity and the hydrometeor profiles of stratiform/convective cloud fraction, cloud liquid/ice mixing ratio, precipitation fluxes with associated effective radii, and number concentrations (optional). The ARM simulator output summaries are joint histograms of radar reflectivity and altitude [i.e., the Contoured Frequency by Altitude Diagrams (CFADs)]. To date, ARM CFADs, constructed from the operational ARM Active Remote Sensing of Clouds (ARSCL), are available for multiple years at the ARM's Southern Great Plain (SGP), Tropical Western Pacific (TWP) and North Slope Alaska (NSA) Research Facility.

With the ARM cloud radar simulator incorporated within COSP, the climate modeling community can easily and routinely compare the model-simulated clouds with ARM cloud observations and evaluate their model performance. One unique feature of ARM cloud radar simulator is that it uses a finer vertical resolution (100 m compared to 500 m for *CloudSat*), which can resolve more detailed vertical structures within clouds on the diurnal cycle. The ARM cloud radar simulator also enhances the capability of COSP in the simulation of cloud radar reflectivities from ground-based radars. While the low-level clouds are difficult to be observed by the *CloudSat* radar, it can be easily detected by the ground-based radars.

It should be noted that the ARM cloud radar simulator cannot be applied to identify model issues in simulating high thin cirrus clouds. Small cirrus cloud particles are not detectable due to the limitations of cloud radars. As a result, the cloud-top height of high thin cirrus clouds is usually underestimated by the ARM cloud radar simulator. Another big data issue is that the historical ARM cloud radar were not well calibrated when the data was created. The data will be reprocessed once the calibrated radar reflectivity is available. We recommend that users refer to the technical report (Zhang and Xie, 2017) or contact the relevant ARM Translators for more information on the data limitation and uncertainties for this data product.

References:

- Zhang, Y., and S. Xie, 2017: ARM Cloud Radar Simulator Package for Global Climate Models Value-Added Product. Available at https://www.arm.gov/publications/tech_reports/doe-sc-arm-tr-190.pdf.
- Zhang, Y., S. Xie, S. A. Klein, et al., 2018: The ARM cloud radar simulator for global climate models: Bridging field data and climate models, *Bull. Amer. Meteor. Soc.*, **99**, 21-26, doi:10.1175/BAMS-D-16-0258.1.