



Introducing SAM (Sun and Aureole Measurement), a New, Ground-based Capability for Measuring Cloud Optical Properties

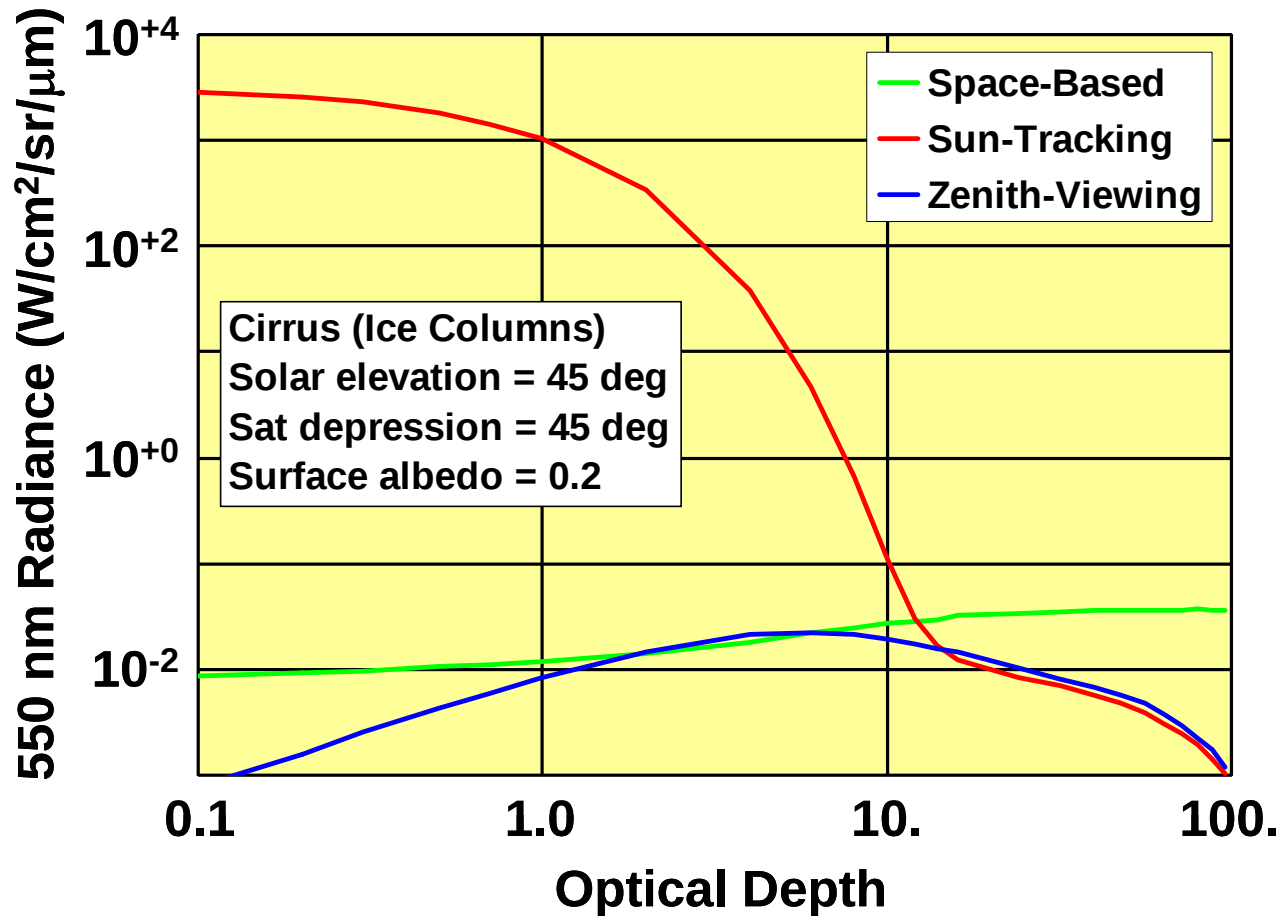
Presented to
Cloud Properties Working Group
IRF Working Group
ARM Science Team Meeting

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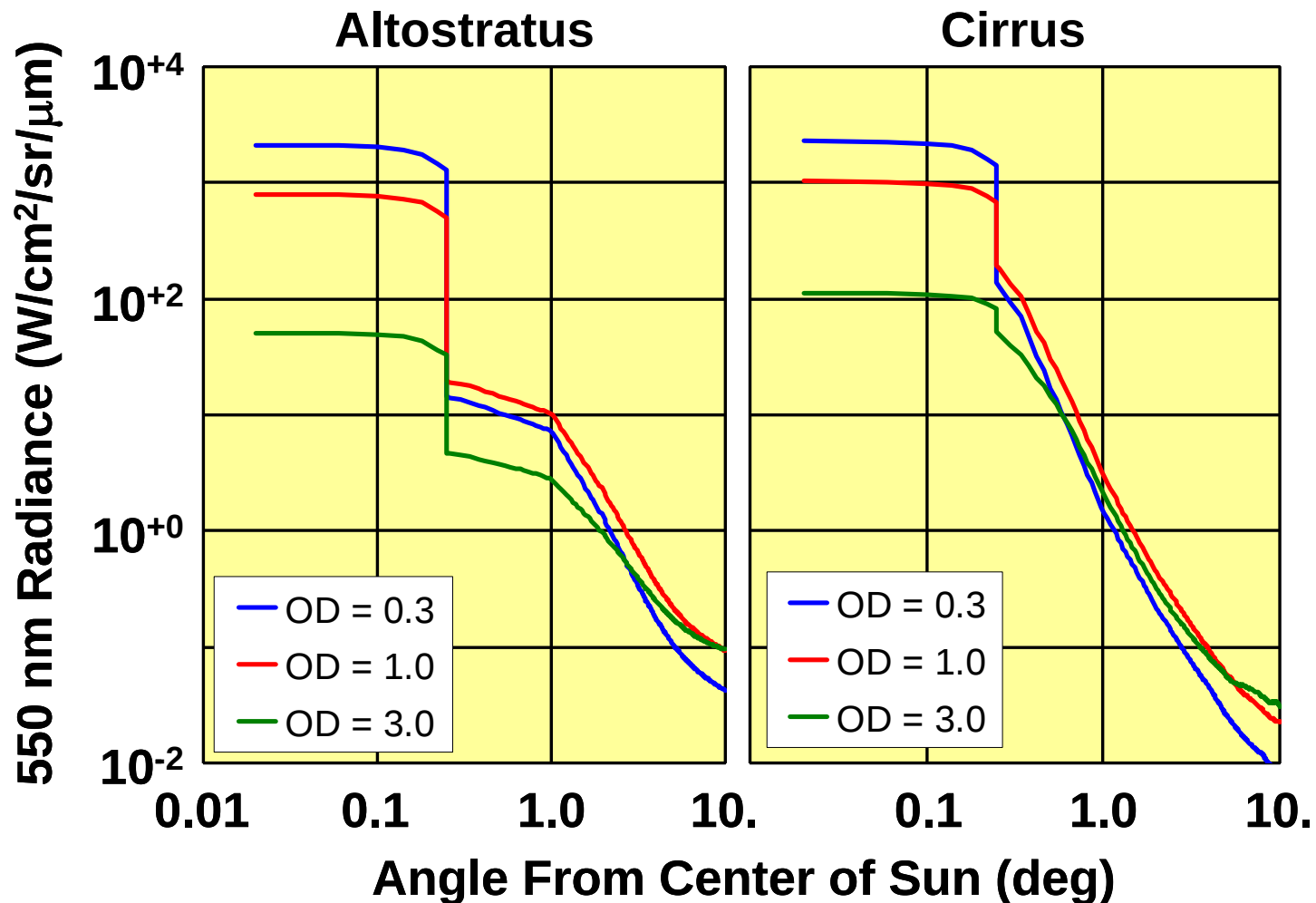
Sun Tracker Advantages for Cloud ODs



- More dynamic range for measuring OD
- No assumptions about the scatterers
- Not affected by the ground albedo

Plot based on
Monte Carlo
calculations

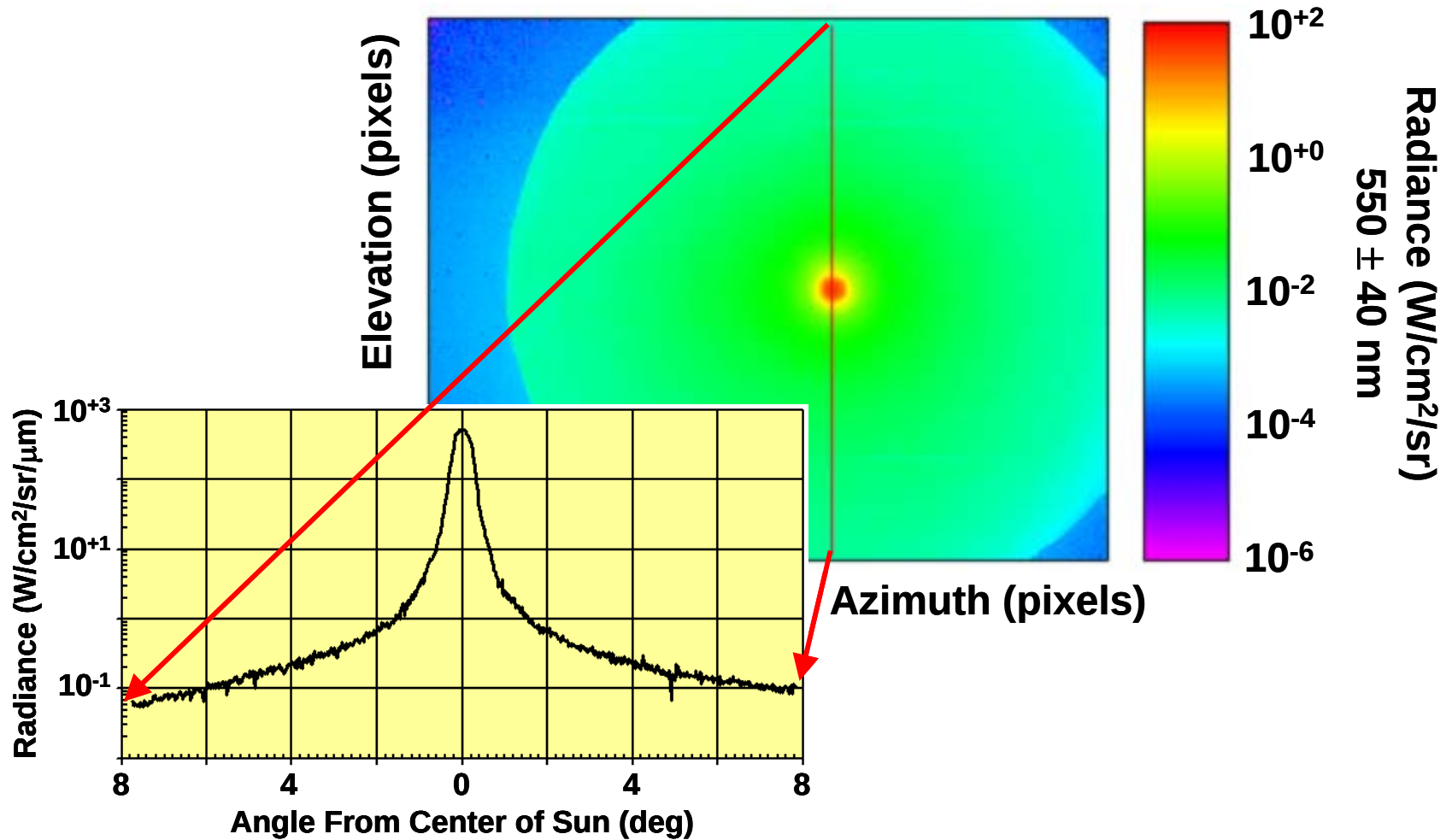
Example Calculations of Aureole Profiles



- Altostratus distribution of water droplets
- Cirrus distribution of hexagonal ice columns
- Profile shape determined by size distribution

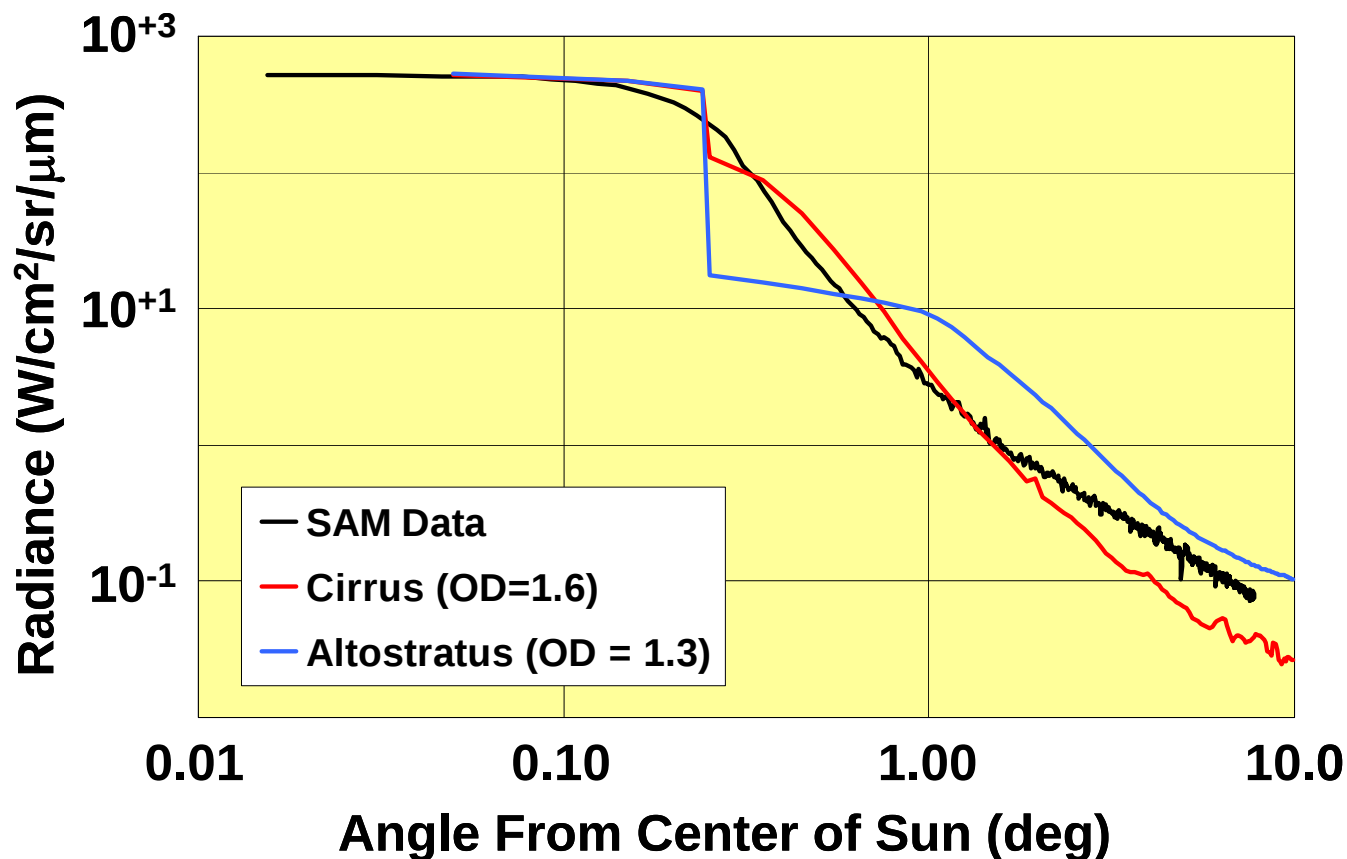
Solar
elevatio
n = 45°

Example SAM Dataset



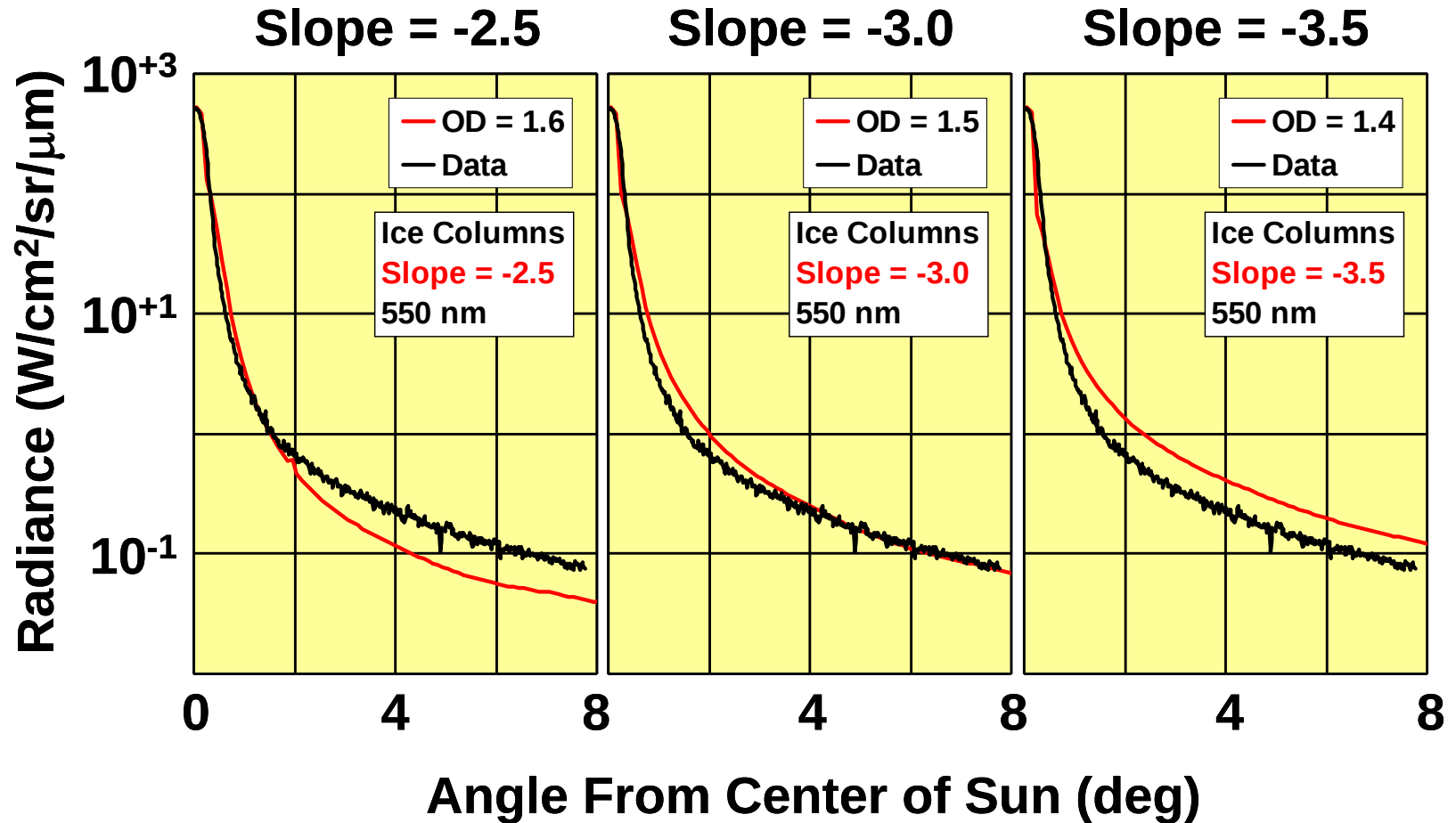
- Note large dynamic range (~ 4 decades)
- OD ~ 1.3 (uncorrected)
- Corresponds to photo on title chart

Model Comparisons with SAM Data



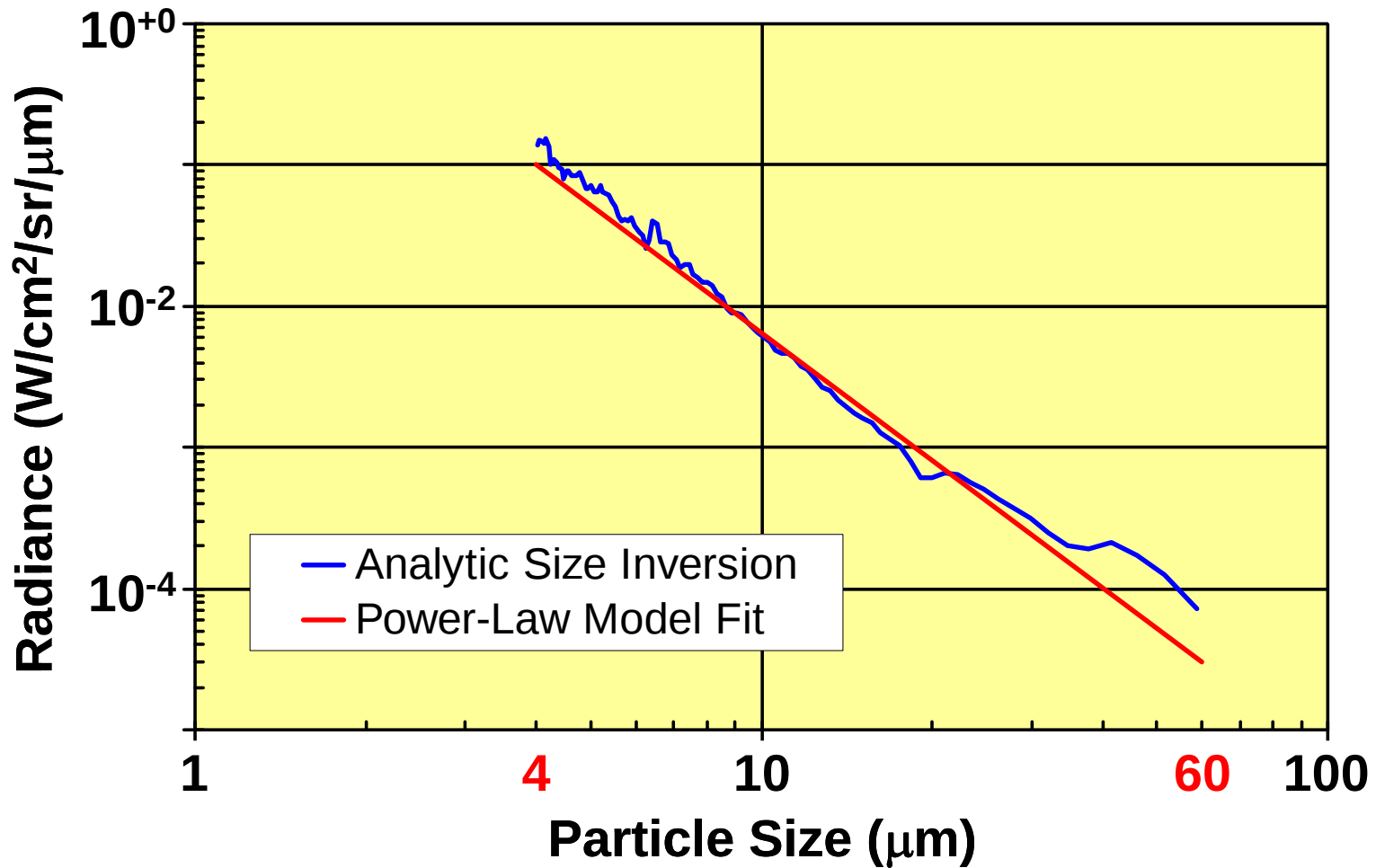
- Same models as in chart #3
- Best fit is for cirrus distribution of ice crystals
- OD difference is due to forward scattering

Parametric Model Fit to Data



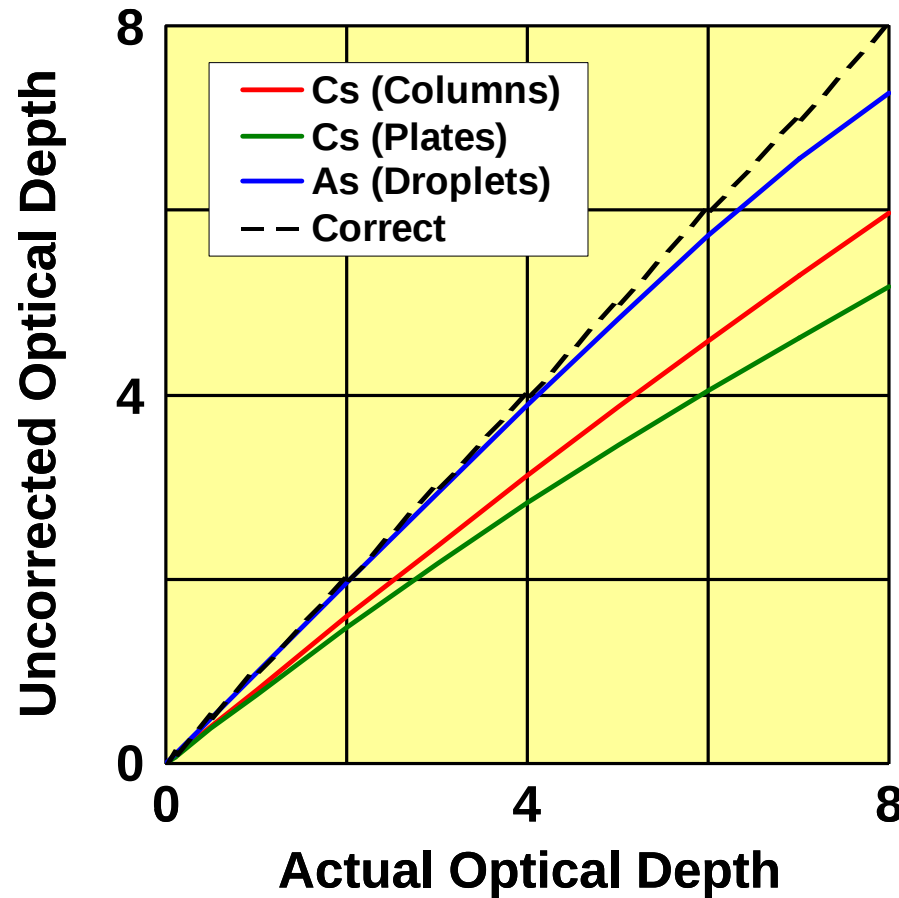
- Parametric in power-law slope
- Best fit slope ~ -3.0
- Best fit OD = 1.5

Particle Size Retrievals



- Power-law model with slope = -3.0
- Simple diffraction model approximation results in an analytic size inversion

Forward Scattering Correction for OD



- Forward scatter reduces apparent OD
- Correction increases with OD
- Correction depends upon shape and size

Based on
Monte Carlo
calculations

SAM Complements AERONET Instruments

Quantity	AERONET	SAM
Scatterer	aerosols	clouds (and aerosols)
Size range	$\sim 0.1 - 1 \mu\text{m}$	$\sim 1 - 100 \mu\text{m}$
OD range	0 to ~ 1	0 to ~ 5 (ice) ~ 10 (water)
Minimum aureole angle from disk edge	$\sim 2.25^\circ$	$\sim 0.25^\circ$ (breadboard)
Measurement frequency	~ 1 hr (typical)	$\sim$ every few secs (maximum)
Field of View or Field of Regard	$\sim 120^\circ$ (Scan FOR)	$\pm \sim 8^\circ$ (FOV) (breadboard)
Pixel FOV	1.2°	0.015° (1024 x 1280)
OD measurement accuracy (absolute)	0.01	≤ 0.05 (breadboard)
OD measurement precision (relative)	0.01	~ 0.02 (breadboard)

- SAM measures larger particles
- SAM corrects AERONET OD for cirrus

Postulated SAM Applications

- **Climate (cloud) monitoring**
- **Cloud physics research**
- **Complements AERONET**
- **Satellite cloud algorithm cal/val**
 - **EDRs (NPOESS, GOES-R)**
 - **CDRs (NPP)**
- **...**

- **Data shown taken with breadboard instrument**
- **Visidyne has built 3 prototype instruments**
- **Visidyne is seeking collaborative projects to demonstrate the utility of SAM**