

Vertically Resolved Radiative Properties of Aerosol and Clouds

B. Schmid (PNNL) & Hong Guan (BAER Inst.)

Task 1: Sensitivity of Aerosol Radiative Forcing to vertical profile

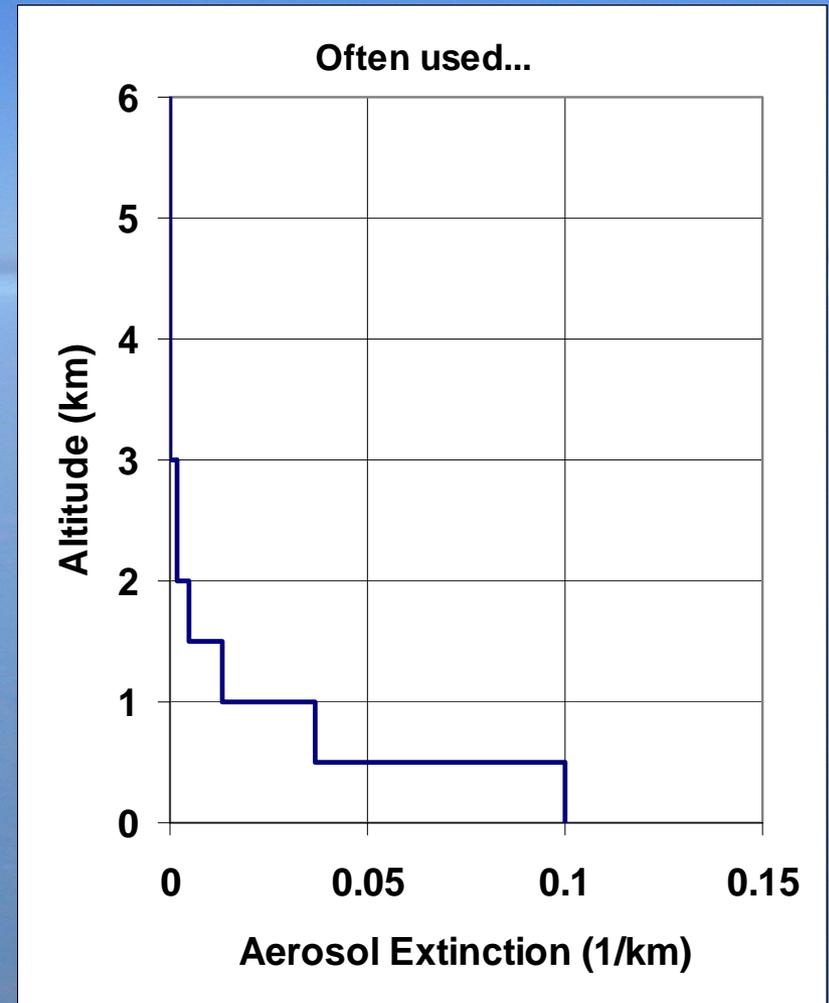
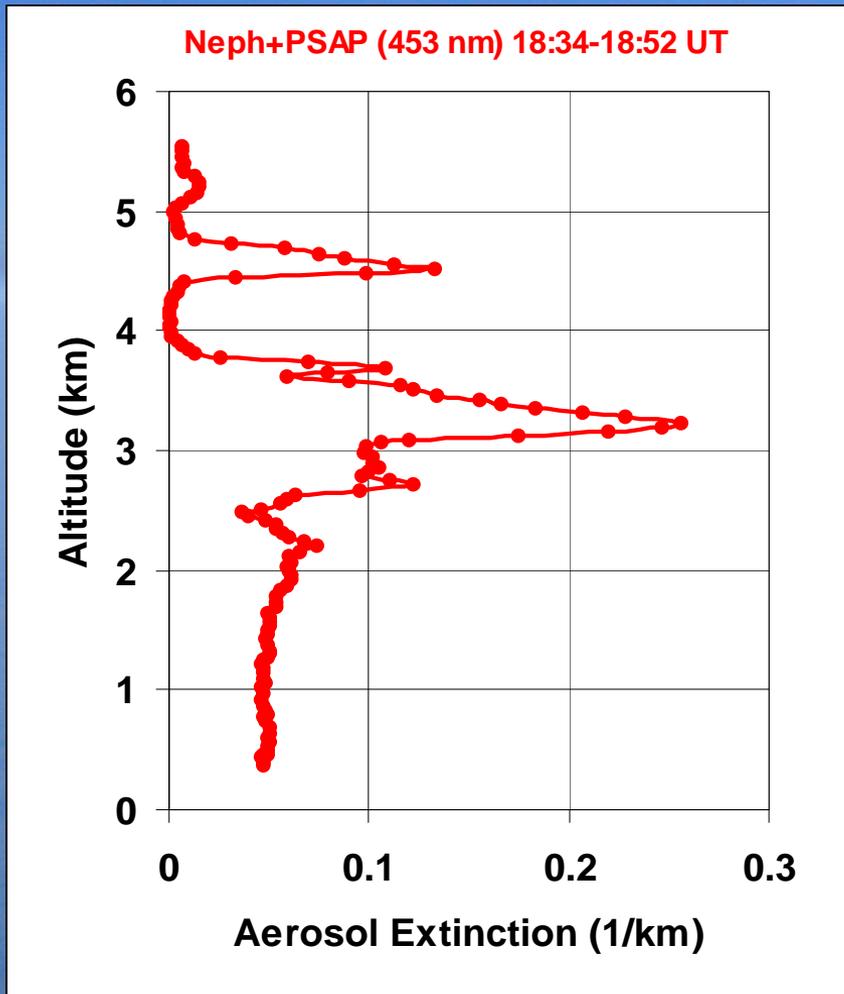
**Task 2: Measurement of Aerosol Vertical Profile
→ ALIVE**

Task 3: Radiative closure in vertical profile

Does the vertical profile of aerosol properties matter for the radiation budget?

Siberian smoke over Oklahoma as seen from Twin Otter on May 27, 2003

Photo courtesy of Roy Woods



How well can we measure the vertical profile of tropospheric aerosol extinction?

unaltered aerosol @ ambient concentration
@ thermodynamic state

Answer: 15-20%

Based on the results of >7 field campaigns using

- Lidars (aircraft, ground, ship)
- Airborne Sunphotometers
- Various in situ

*Schmid et al. "How well do state-of-the-art techniques measuring the vertical profile of tropospheric aerosol extinction compare?" *J. Geophys. Res.* 111, D05S07, 2006.

& Results from ALIVE and MILAGRO

How well do we need to know the vertical profile of tropospheric aerosol extinction?

→ Need Aerosol Radiative Forcing Study

→ We joined forces with an ongoing project by McComiskey, Schwartz, Ricchiazzi, Lewis, Ogren, and Michalsky

→ But don't have answer quite yet...

Aerosol Radiative Forcing

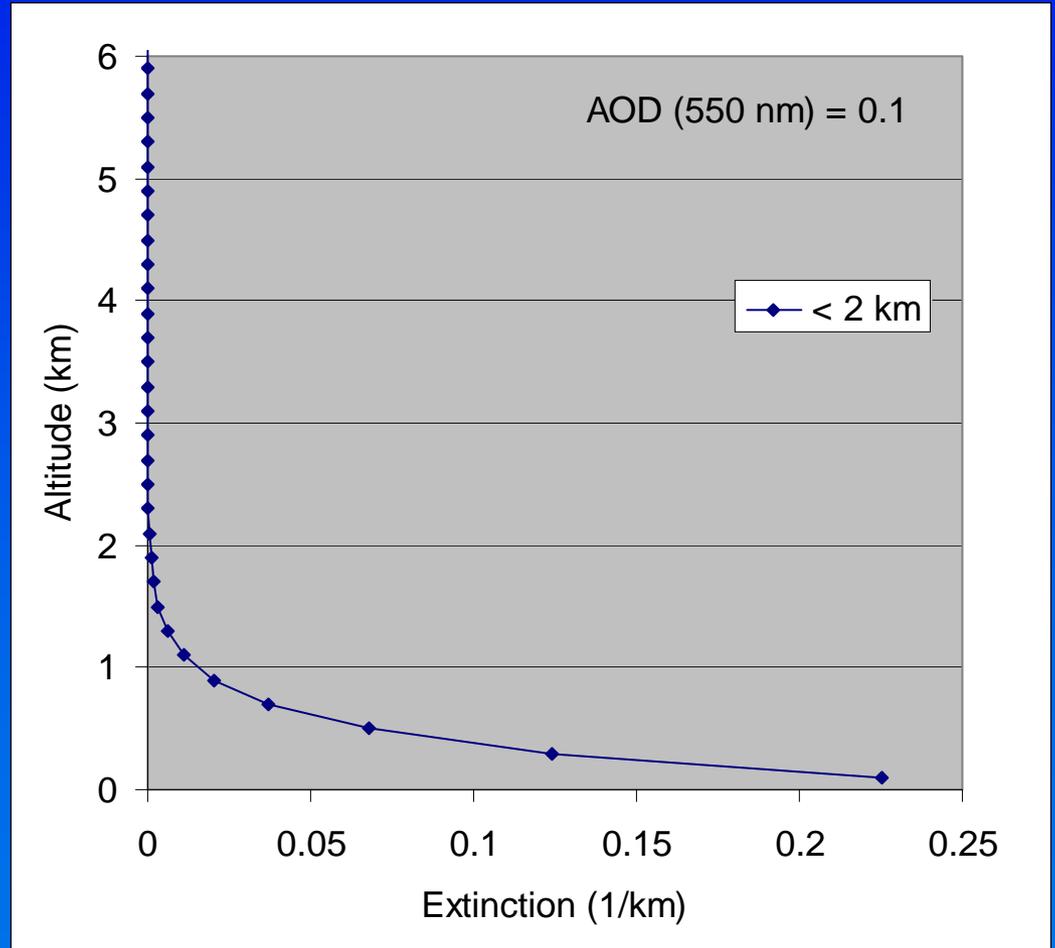
$$F_{net} = F_{\downarrow} - F_{\uparrow}$$

$$forcing = F_{net} (with\ aerosol) - F_{net} (without\ aerosol)$$

- **Altitude:**
 - Top of Atmosphere
 - Surface
 - **Profile**
- **Averaging (or not)**
 - Spectral and **Broadband**
 - **Instantaneous** and 24 hour

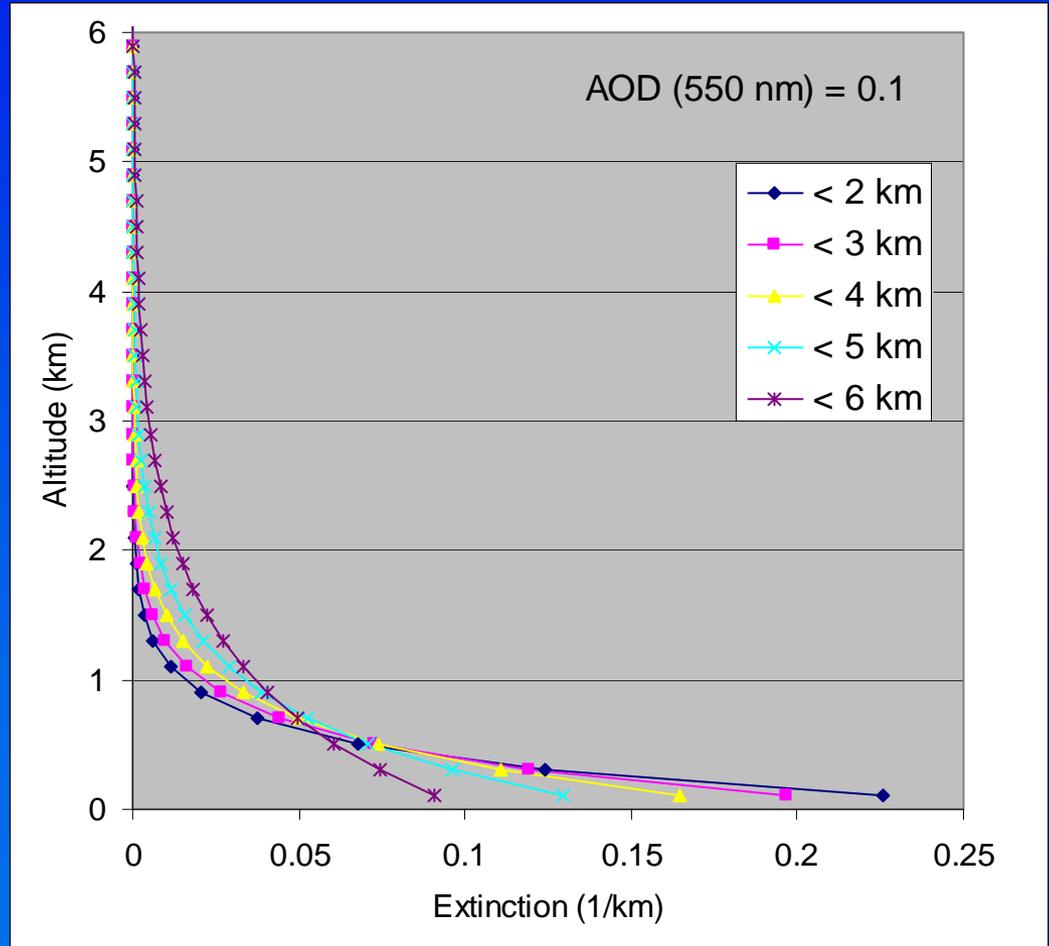
INPUT

| | |
|----------------------------------|--------------|
| | SGP |
| τ (0.55 μm) | 0.1 |
| ω_0 (0.55 μm) | 0.95 |
| g (0.55 μm) | 0.6 |
| A_s 0.25-0.75 μm | 0.1 |
| A_s 0.75-4.0 μm | 0.4 |
| \dot{a}_{sp} | 1.0 |
| \dot{a}_{ap} | 1.0 |
| SZA | 45° |
| Standard Atmosphere | US 62 |

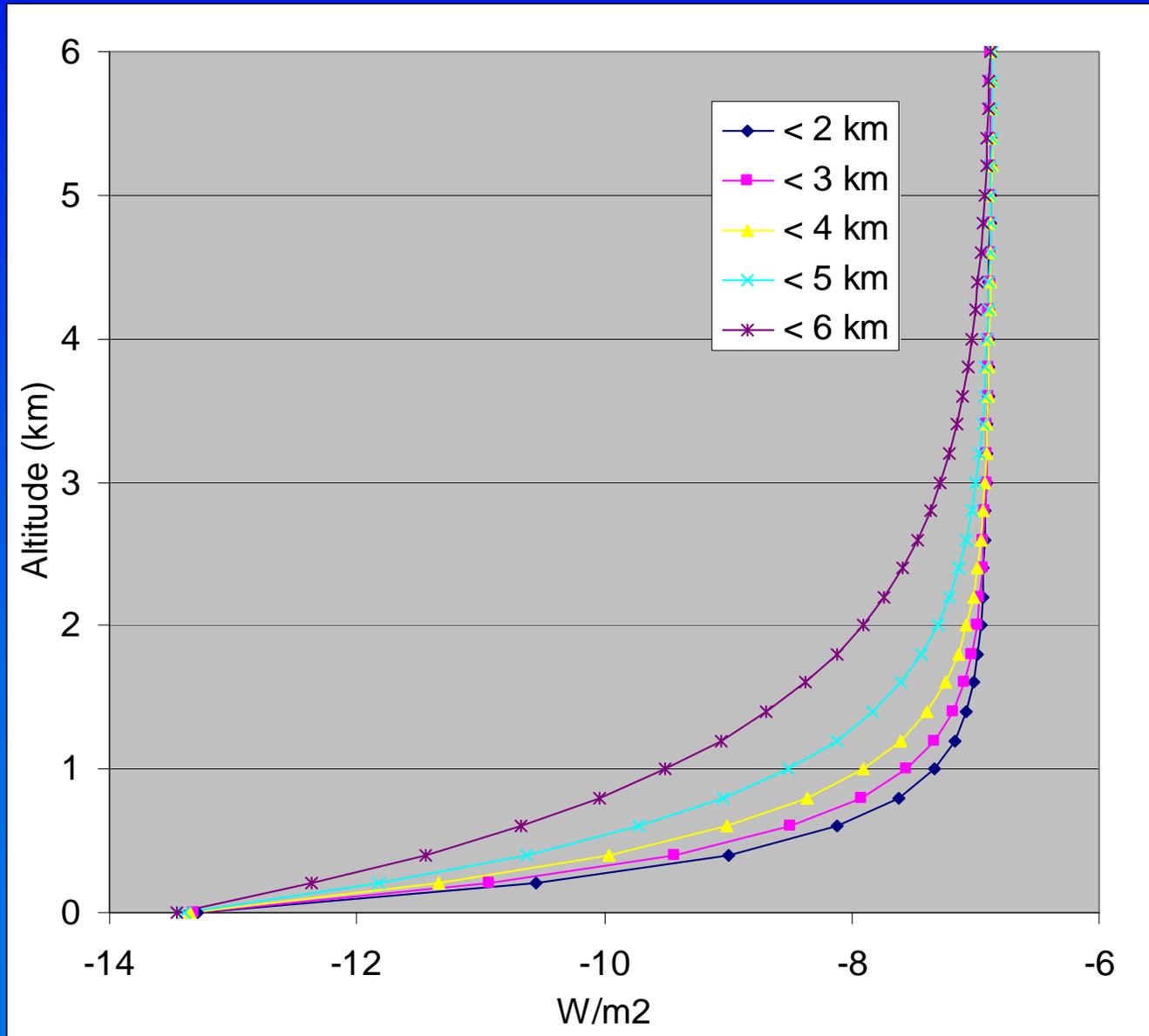


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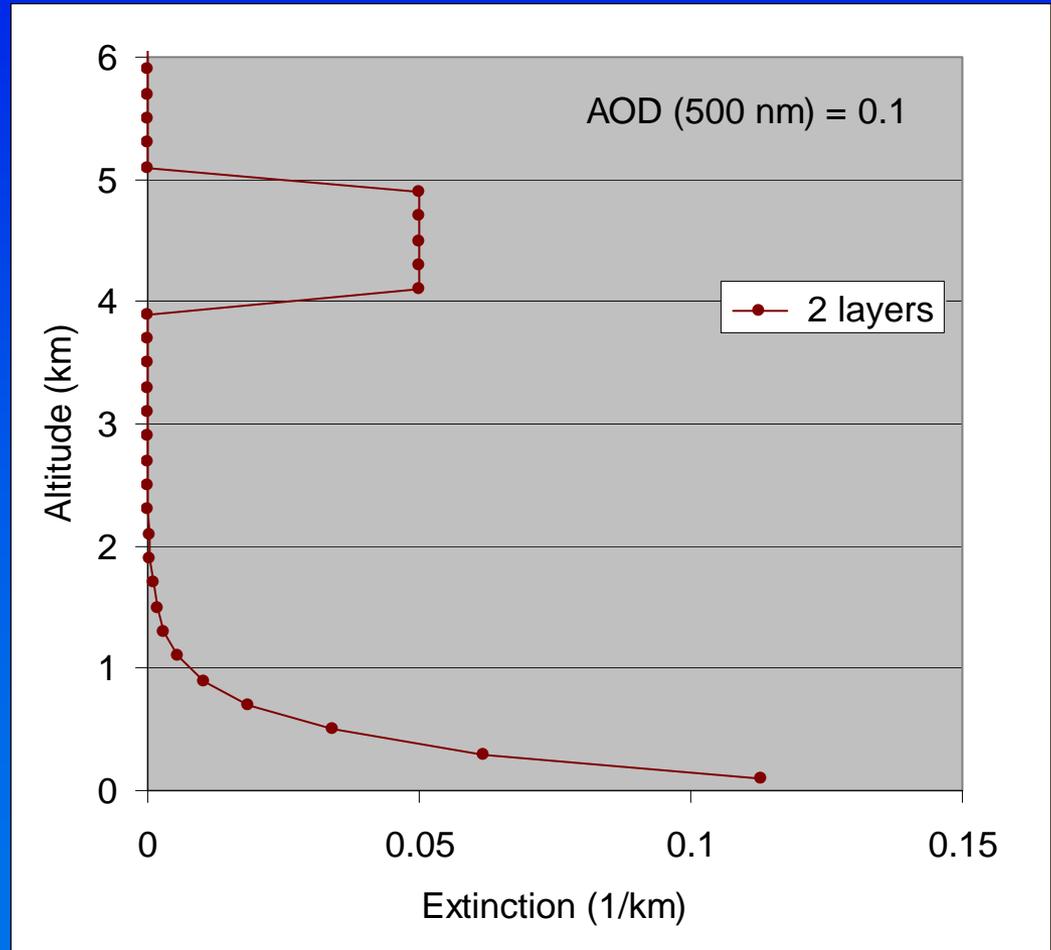


OUTPUT: Aerosol Radiative Forcing

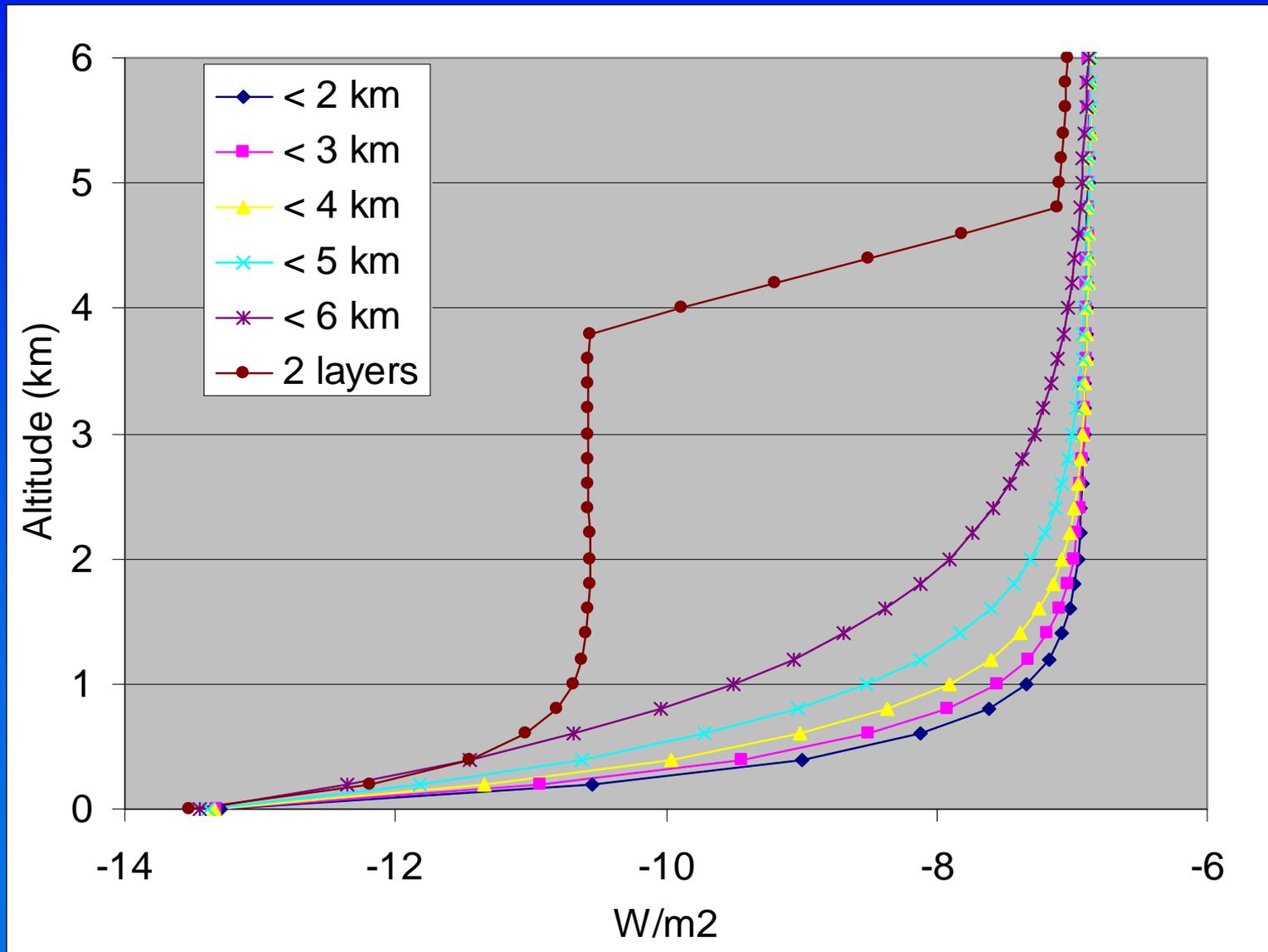


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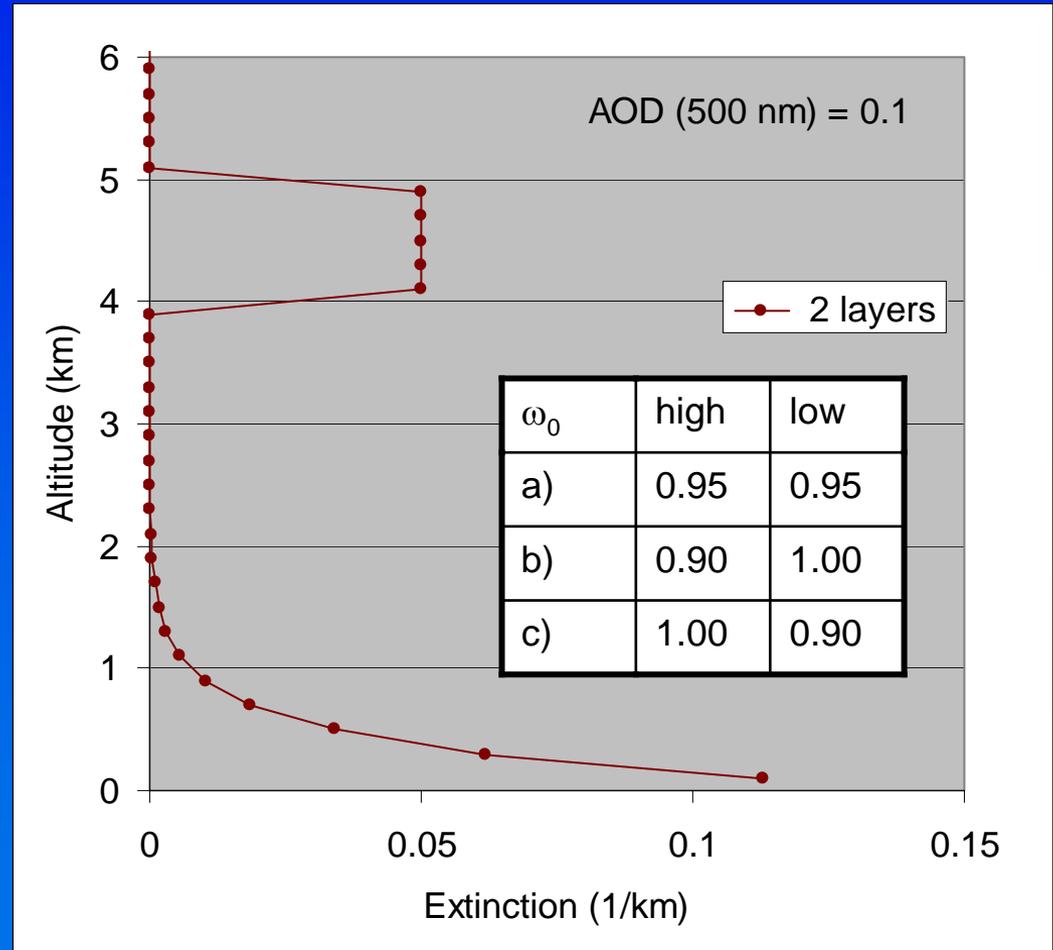


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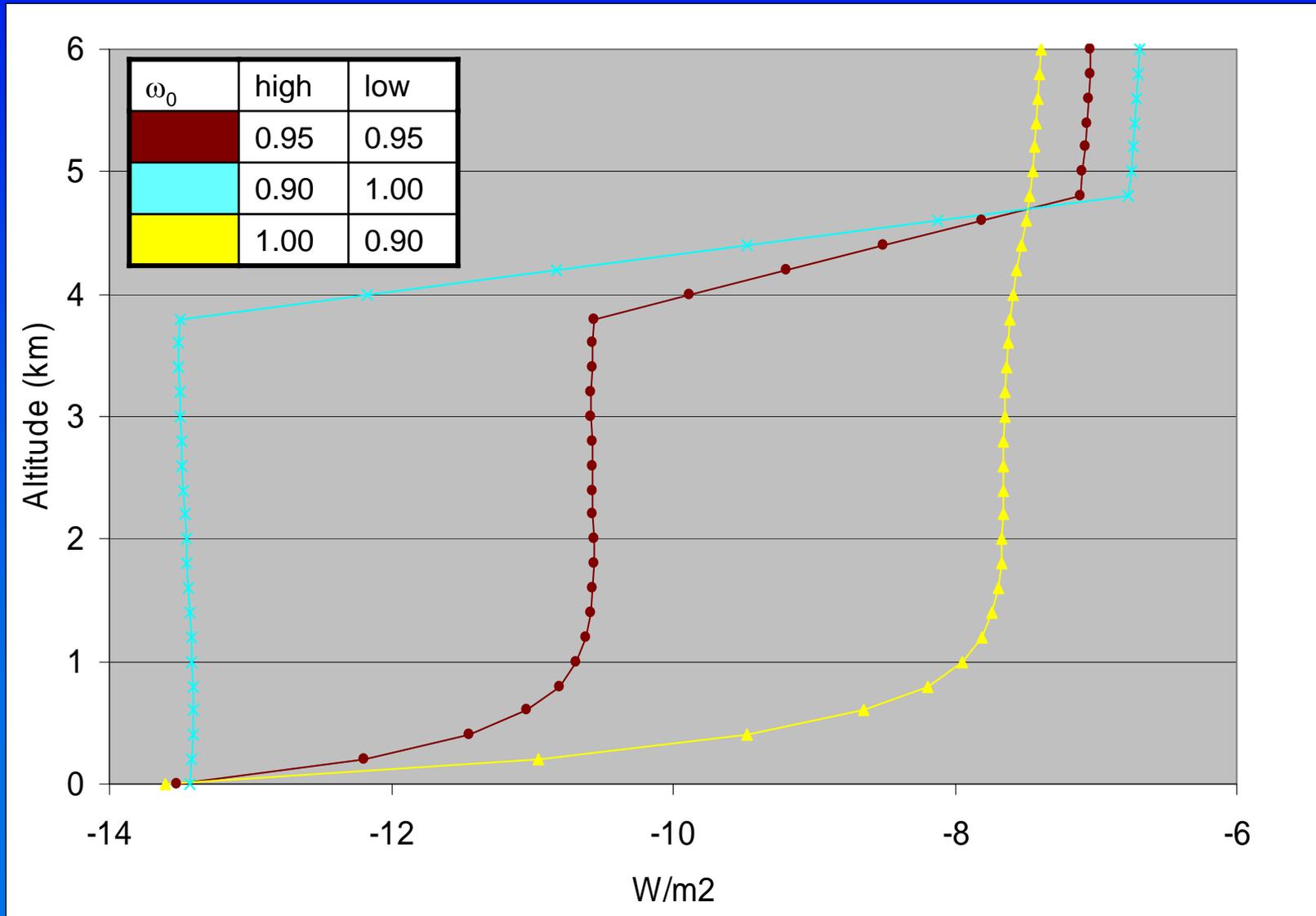


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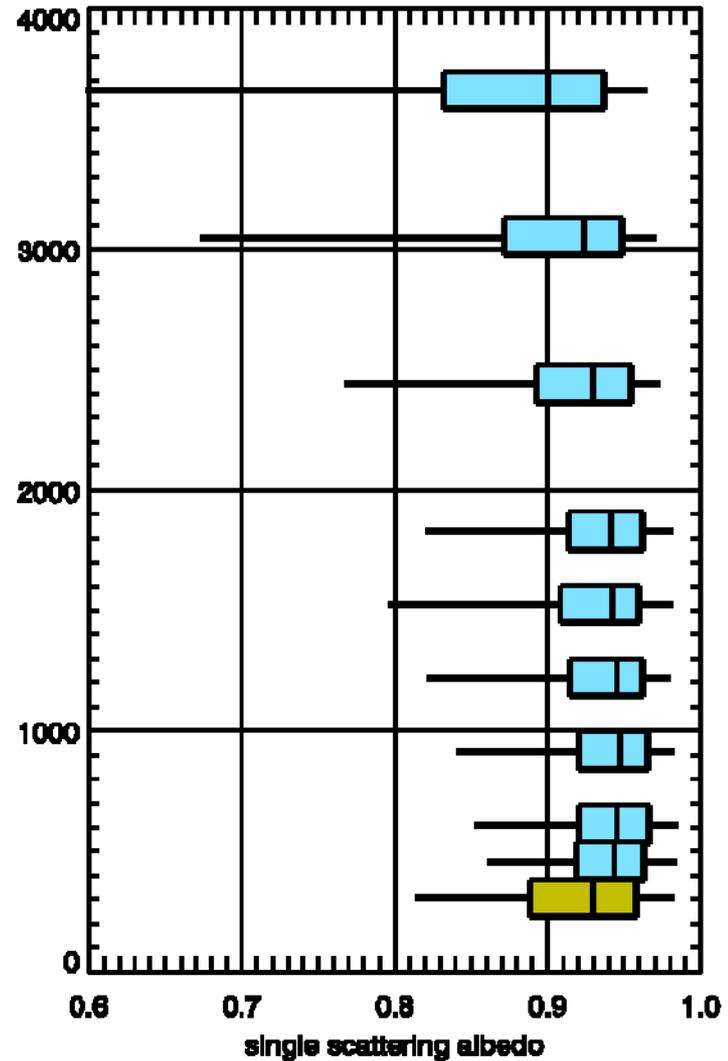
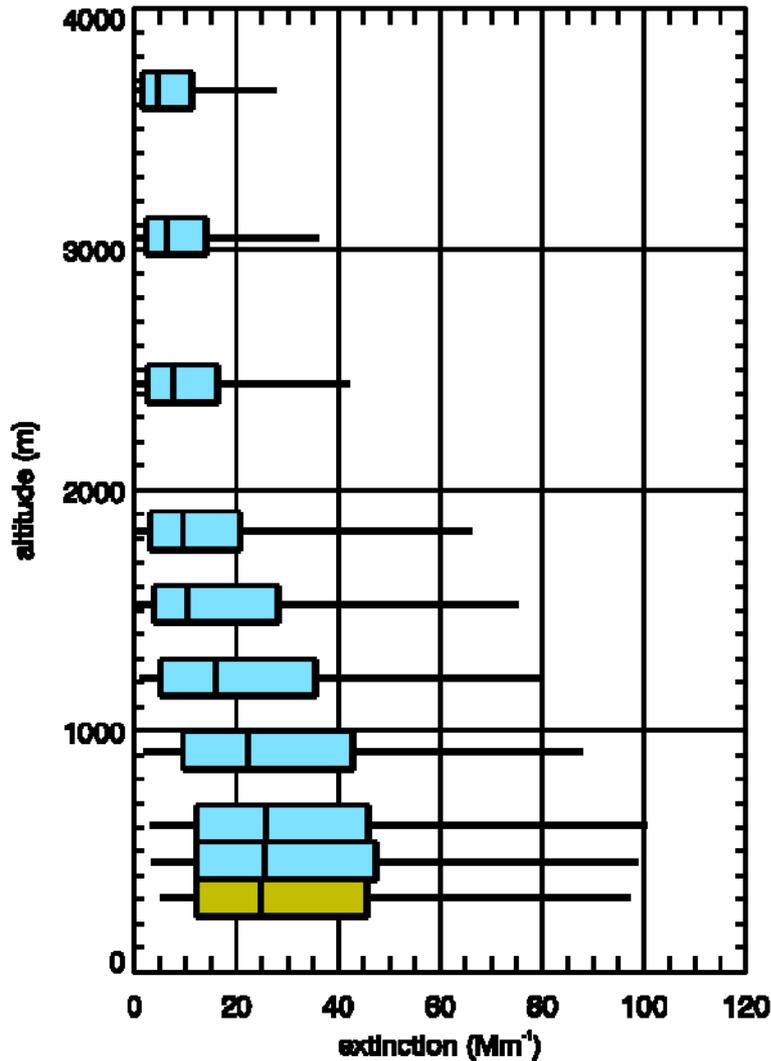
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How can we measure aerosol absorption?

- **Column:**
 - Rem Sens: Radiometry ground and space
- **Profile:**
 - in-situ: PSAP, Photoacoustic, Cavity Ringdown
 - Rem. Sens.: RSP, 4STAR

Regular *in situ* Aerosol Profiles (Ogren/Andrews)



Flights March 2000 - mid-April 2006, $\lambda=550$ nm, for $D_p < 1 \mu\text{m}$.

Spectrometer for Sky-Scanning, Sun-Tracking Atmospheric Research (4STAR)

**Partnership between NASA ARC and PNNL
PIs: B. Schmid, P. Russell, J. Redemann**

