Retrieval of Aerosol Vertical Profiles Using the Oxygen A-band

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Importance of Aerosols I

- **Directly impact Earth's radiation budget by scattering and absorbing solar radiation and by interacting with clouds**

- **Offset some of the radiative forcing from greenhouse gases**

- **Contribute largest uncertainty to total radiative forcing estimate**

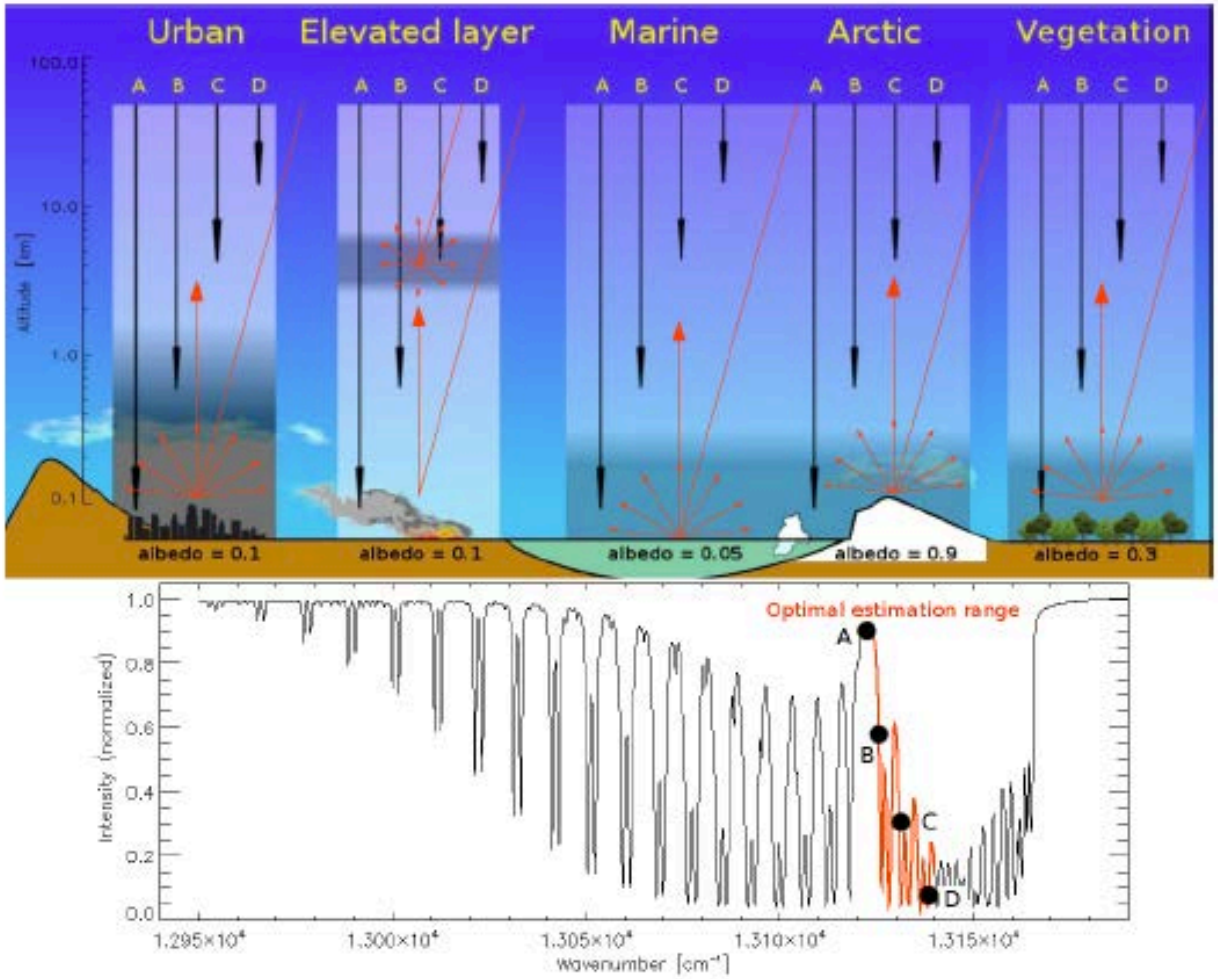
- **Impact of aerosols on radiative forcing depends on their vertical distribution**

Importance of Aerosols II

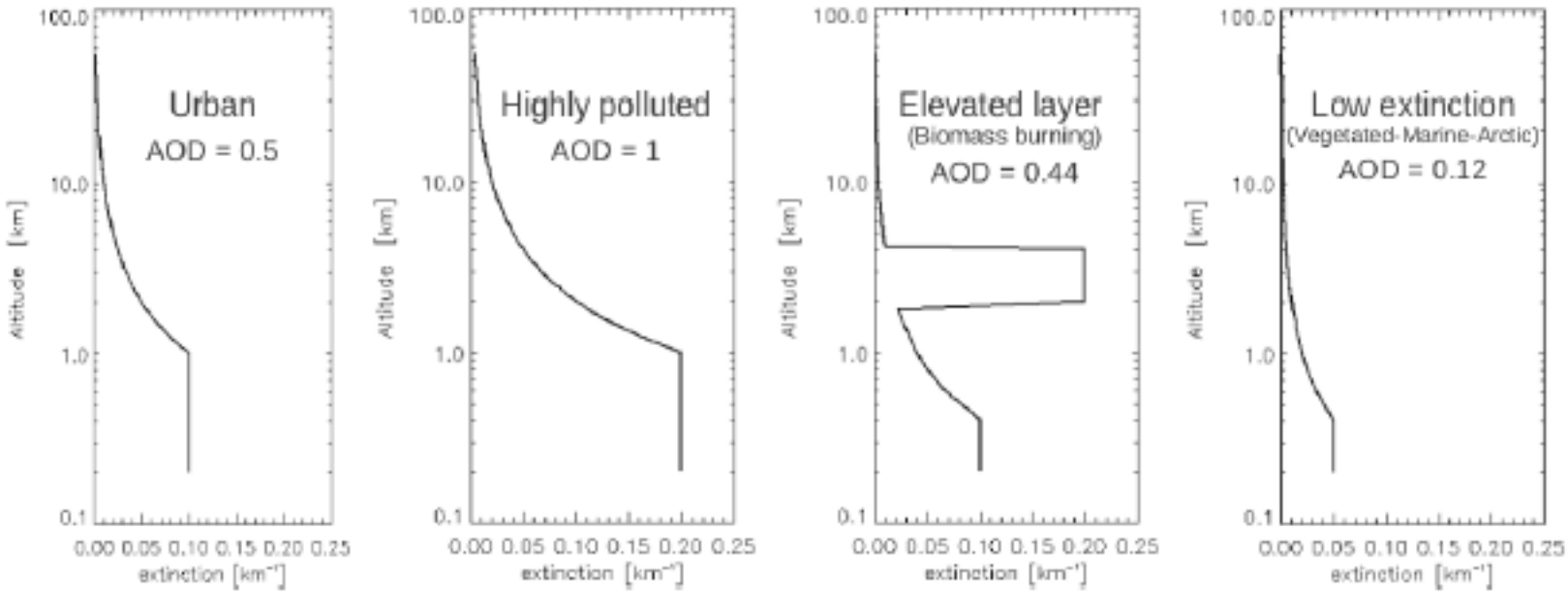
- **Aerosol vertical distribution crucial in determining area impacted by them**
  - **aerosols transported to the free troposphere or stratosphere will be horizontally transported over a large distance, impacting large regions**
  - **aerosols confined to the boundary layer are removed quickly by rain.**

- **Aerosols and their vertical distribution also impact remote sensing observations by varying photon path length**
  - **observations of atmospheric trace gases or surface parameters such as ocean color need to be corrected for aerosol effects**

Oxygen A-band and Aerosol Vertical Profiles



Scenarios I



Urban: moderately polluted urban or rural atmosphere, with aerosols constrained to a well-defined boundary layer

Highly polluted: aerosol extinction in BL higher than urban (e.g. megacities)

Elevated layer: aerosol profile confined to 2-4 km (e.g. biomass burning plume)

Low extinction: lower aerosol extinction at the surface and lower BLH (e.g. marine, arctic, vegetation)

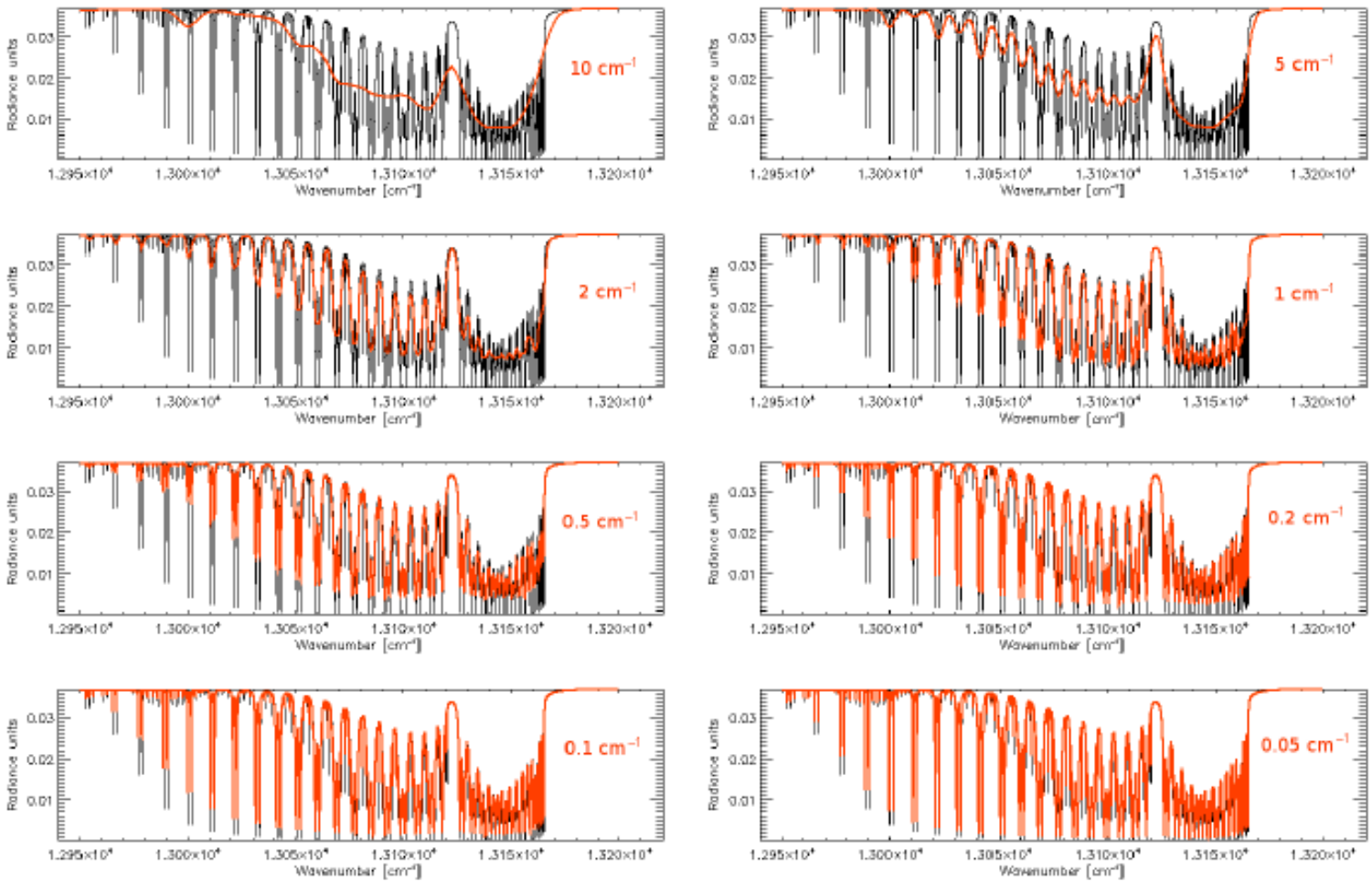
Scenarios II

- **Atmosphere divided into 60 layers**
- **Pressure range between 1001.6 hPa (surface) and 0.3 hPa (TOA)**
- **Altitude range between 0 and 55 km**
- **P/T profiles based on US Standard Atmosphere**
- **Vertical grid spacing set to 0.2 km from 0–5 km, 0.5 km from 5–10 km, and 1 km above 10 km altitude**

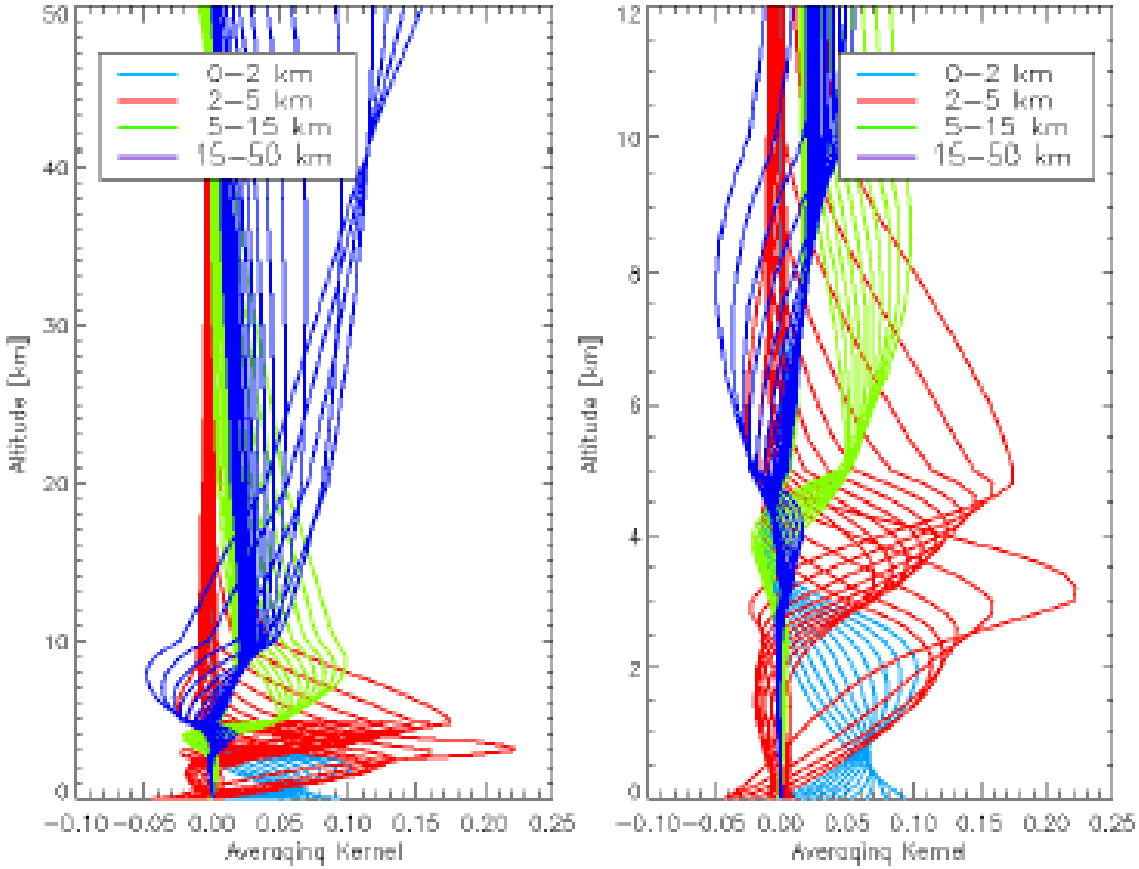
Scenarios III

- **Molecular oxygen is the only absorber considered**
- **O_2 spectral line parameters taken from HITRAN 2008 database**
- **Clouds not considered**
- **Lambertian reflecting surface assumed, with a surface albedo *a* = [0.05; 0.1; 0.3; 0.9]**
- **Four solar zenith angles SZA = [30, 45, 60, 75] degrees; instrument looking down at nadir and 30 degrees off-nadir, with a fixed relative azimuth angle of 45 degrees**

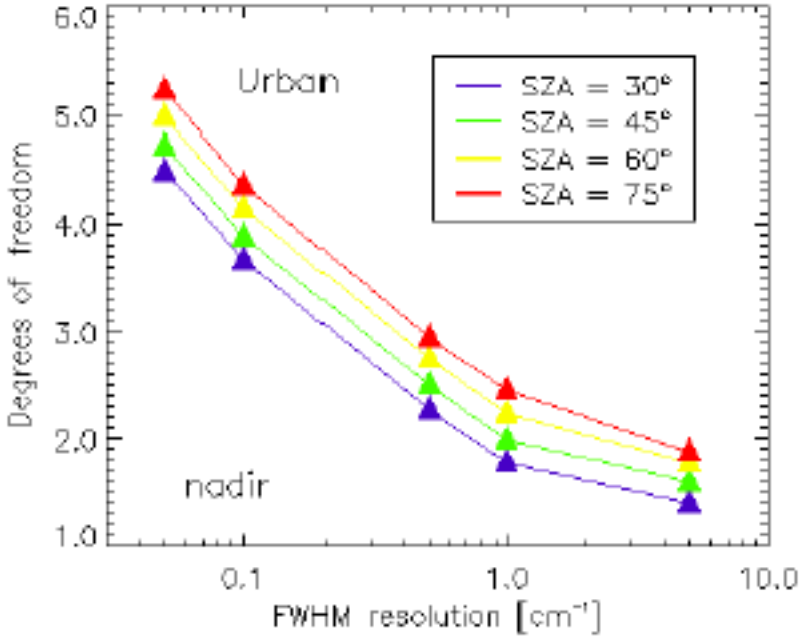
O_2 A-band at Different Spectral Resolutions

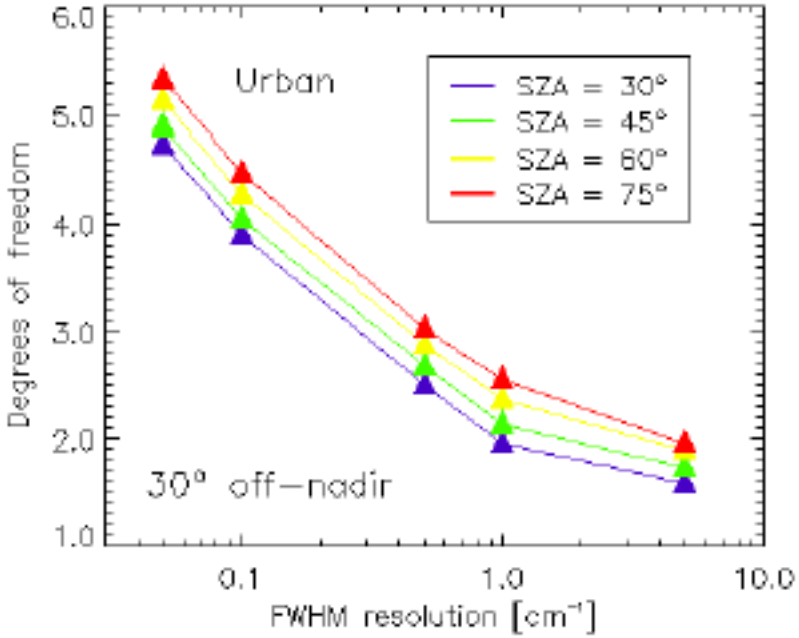


Sample Averaging Kernel

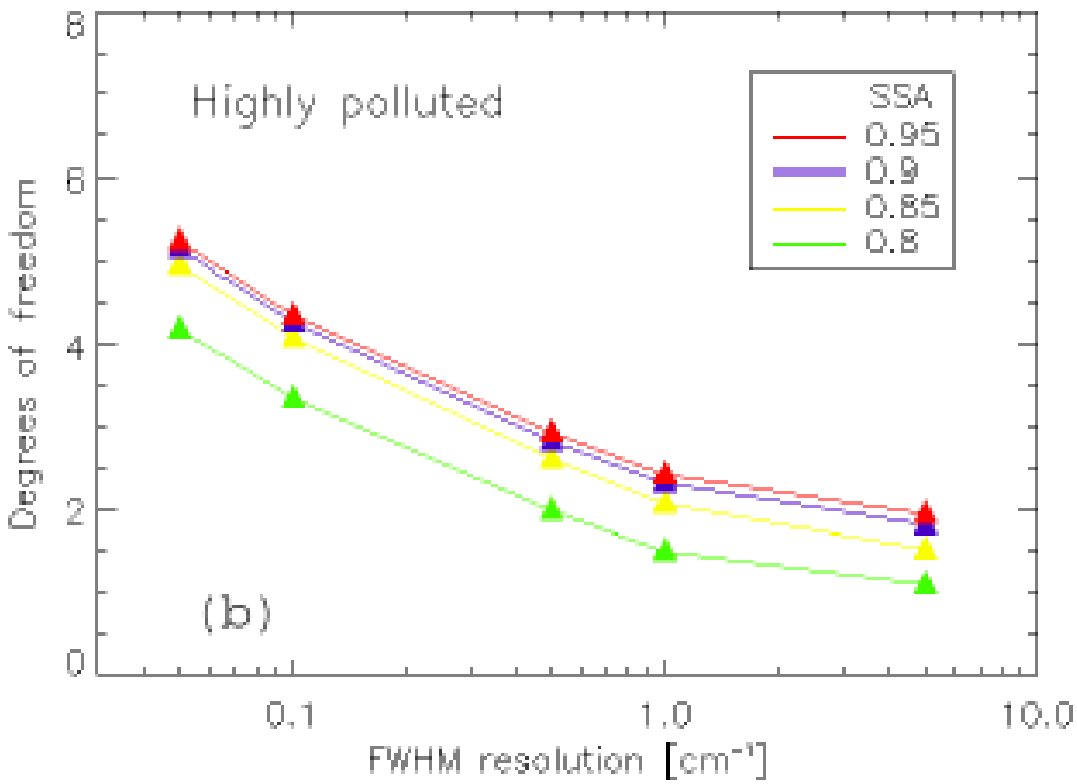


Sensitivity to Geometry

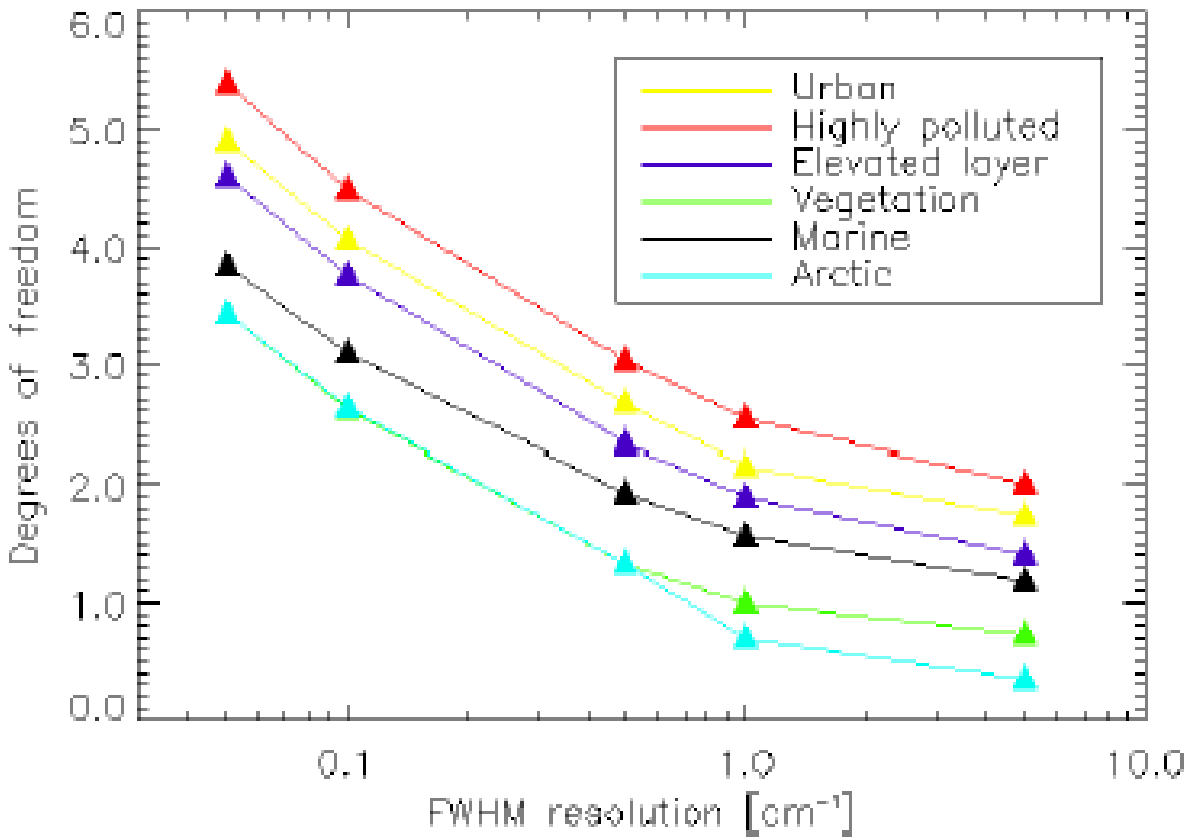




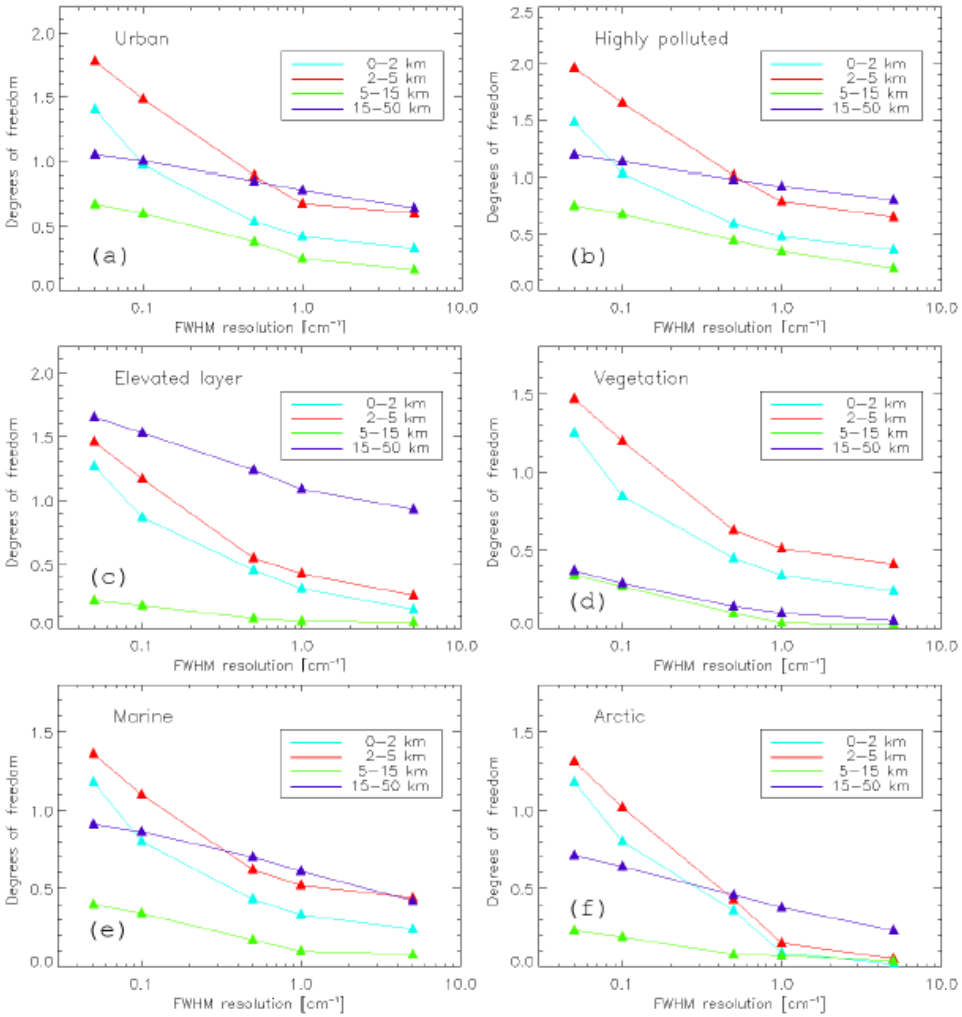
Sensitivity to Single Scattering Albedo



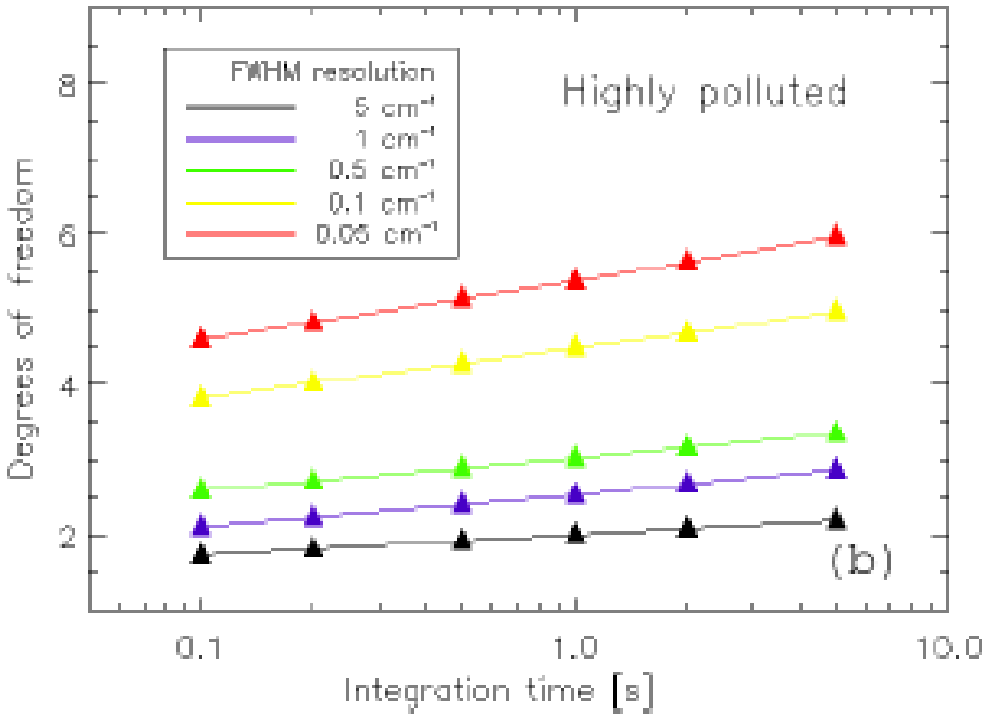
DoF Comparison for Aerosol Scenarios



Sensitivity to Vertical Profile



Sensitivity to Integration Time



Conclusions I

- **Retrieval of tropospheric aerosol extinction profiles in the lowest 5 km of the atmosphere considerably improved at higher spectral resolution**

- **High resolution retrievals have sufficient information content in the mid-troposphere to allow for identification and quantification of elevated aerosol layers, and to distinguish between boundary layer and elevated aerosols**

- **Retrieval sensitivity to aerosol single scattering albedo diminished at high spectral resolution**

Conclusions II

- **Influence of surface albedo considerably reduced at high spectral resolution**

- **Spectral resolution more important than SNR to optimize DoF.**

Next Steps

- **More complex aerosol profiles**
- **Coupling with multi-angle measurements**
- **Include polarization effects**
- **Use real data**