



SAGE III
/ISS

Stratospheric Aerosol and Gas Experiment

An Earth Science Mission on the International Space Station

SAGE-III/ISS Science Team Meeting

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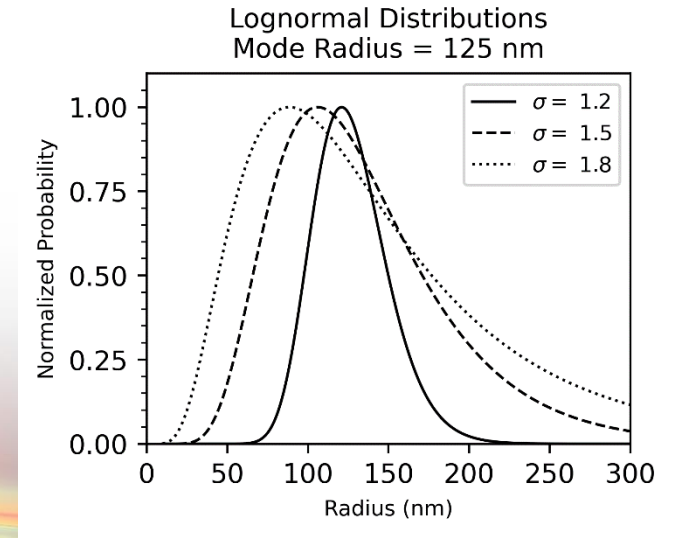
Quantifying Particle Size Distribution

Errors Derived from SAGE III/ISS Observations



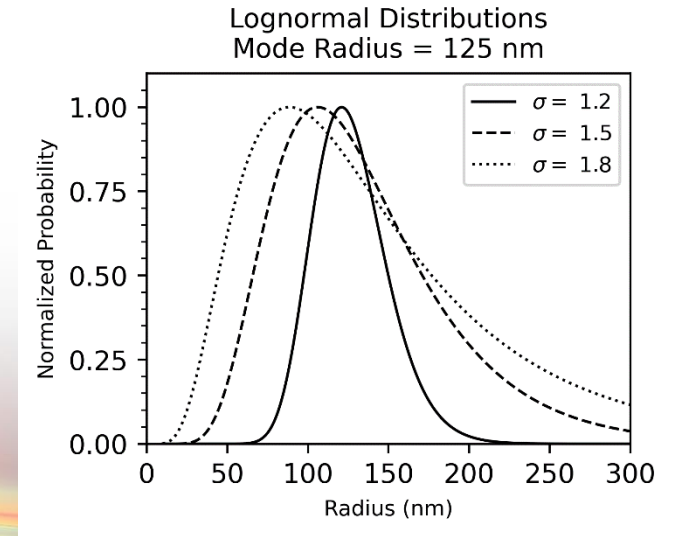
Background

- SAGE data have been used to estimate particle size distribution (PSD) parameters
 - Mode radius
 - Distribution width (σ)



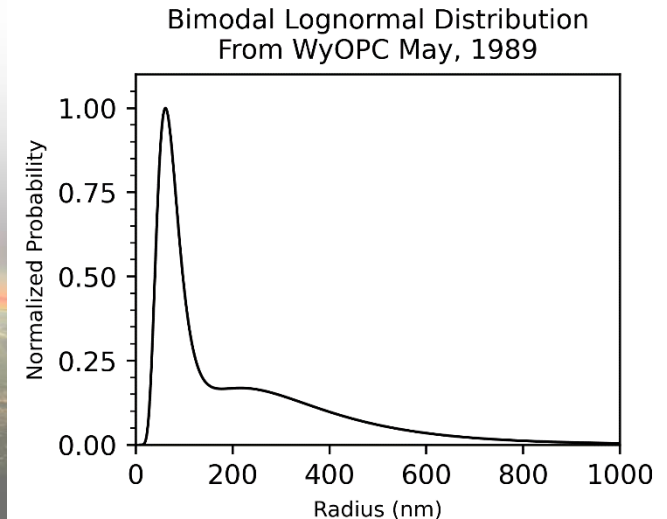
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- Measurement error is often neglected
 - Wrana et al. 2021 included error
- Bimodal distributions have not been evaluated





Our Proposed Work



- Use Mie theory to identify PSD parameters from SAGE III/ISS data
 - Account for measurement error in PSD estimates
 - Provide confidence level for PSD estimates
 - Expand to include other microphysical properties (e.g., SAD and VD)
 - Extend analysis to include bimodal distributions



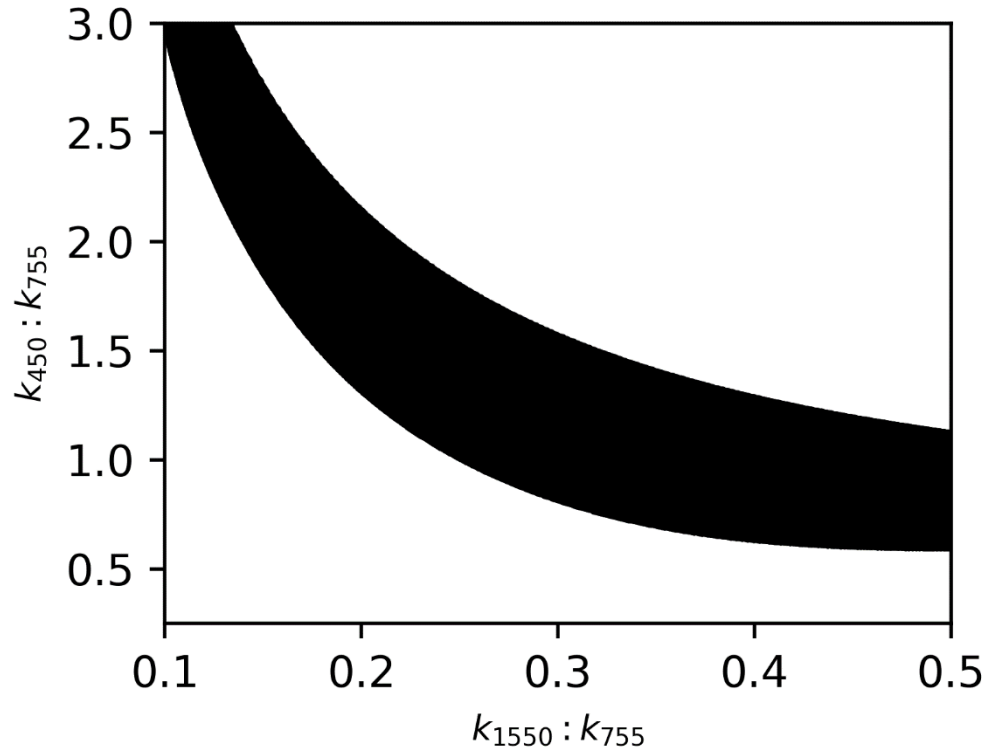
Methodology



- Invoke standard Mie theory assumptions
 - all particles spherical
 - all distributions are lognormally distributed
 - mode radius range: 10 – 500 nm (1 nm resolution)
 - sigma range: 1.2 – 2.0 (0.001 resolution)
- particles composed of 75% (wt) sulfuric acid, 25% water
 - Palmer and Williams (1975) refractive indices
- above assumptions used in lookup table (LUT) creation
- Match observed values to LUT values
 - use extinction ratios to alleviate number density issues
 - use same wavelengths as Wrana et al. 2021 (450:755 and 1550:755)

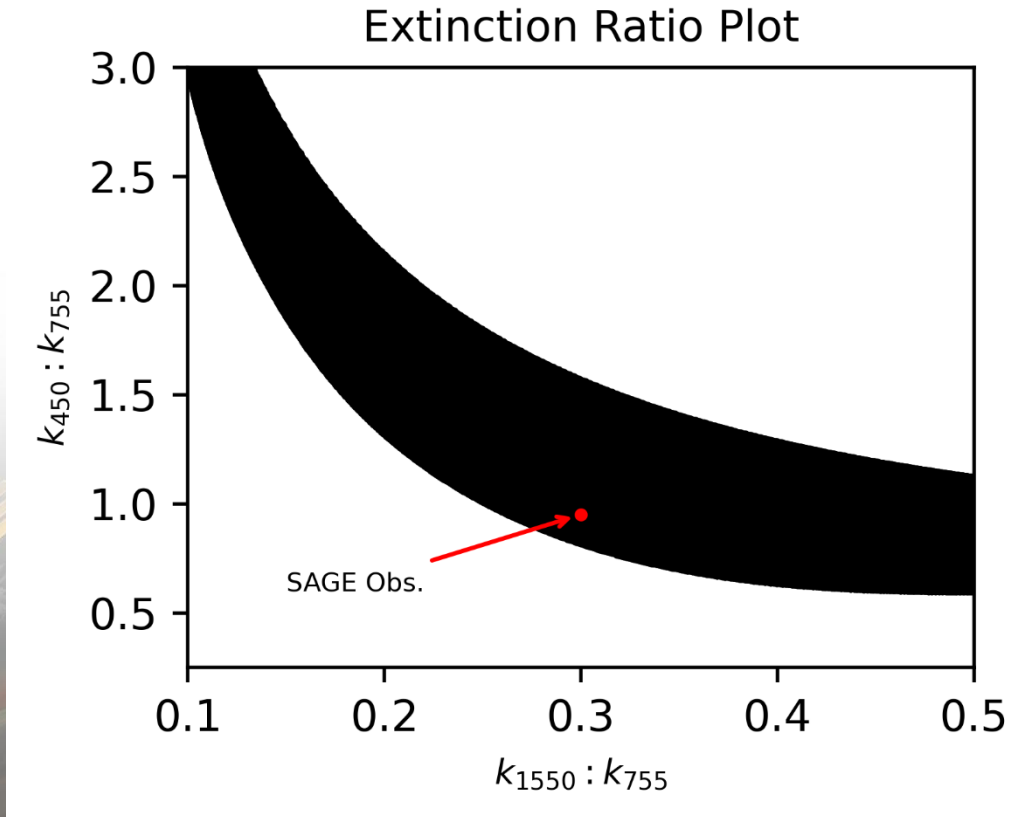
Visualizing the Solution Space

Extinction Ratio Plot



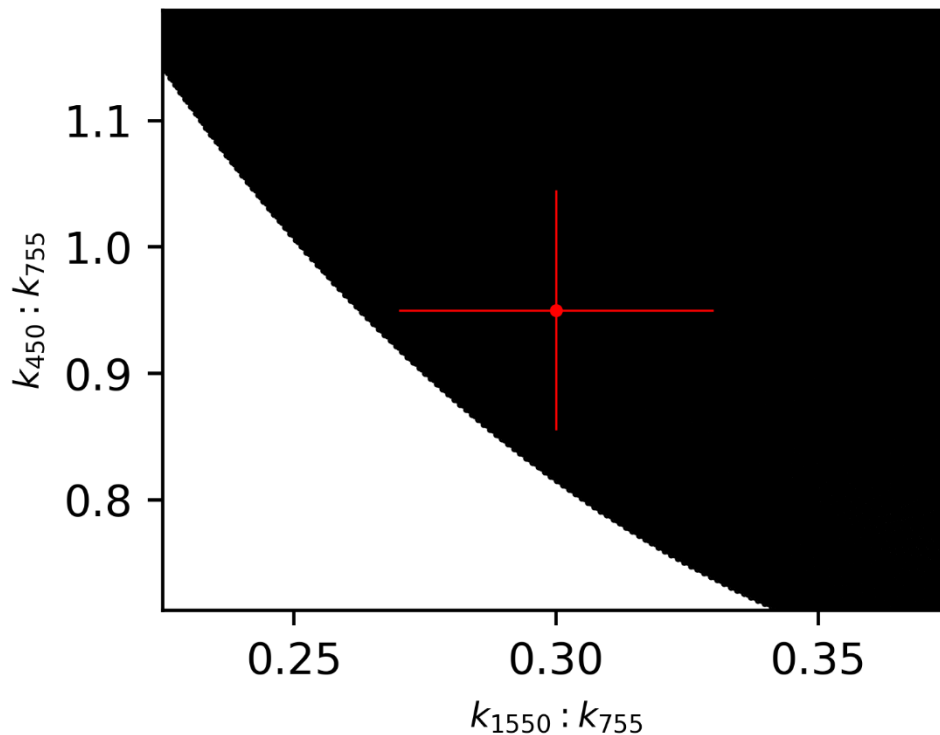
Composed of
millions of dots

Visualizing the Solution Space



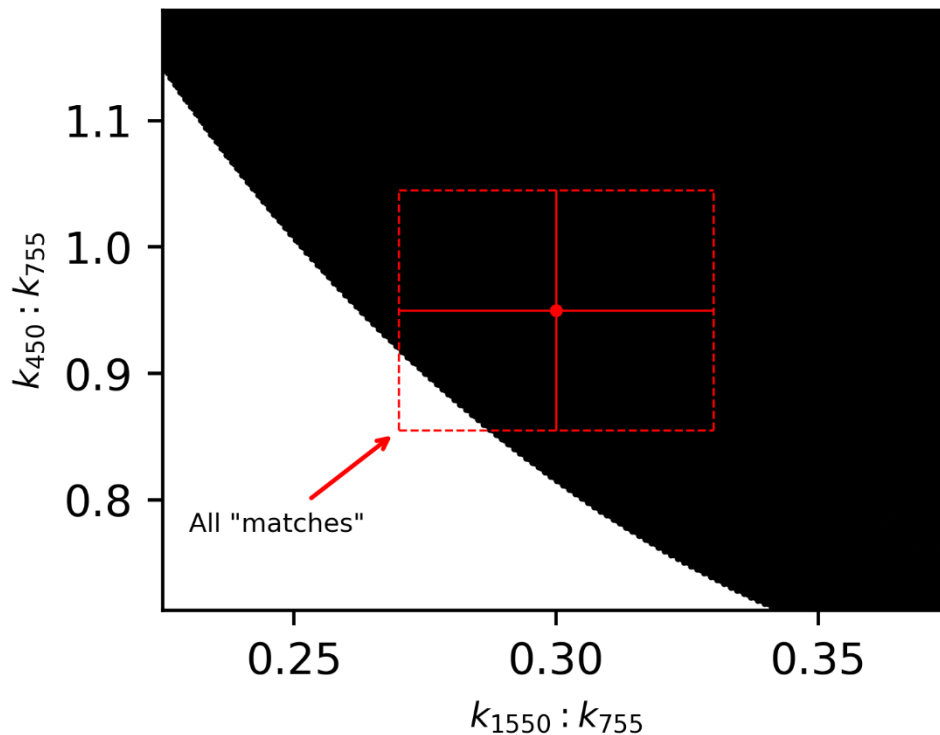
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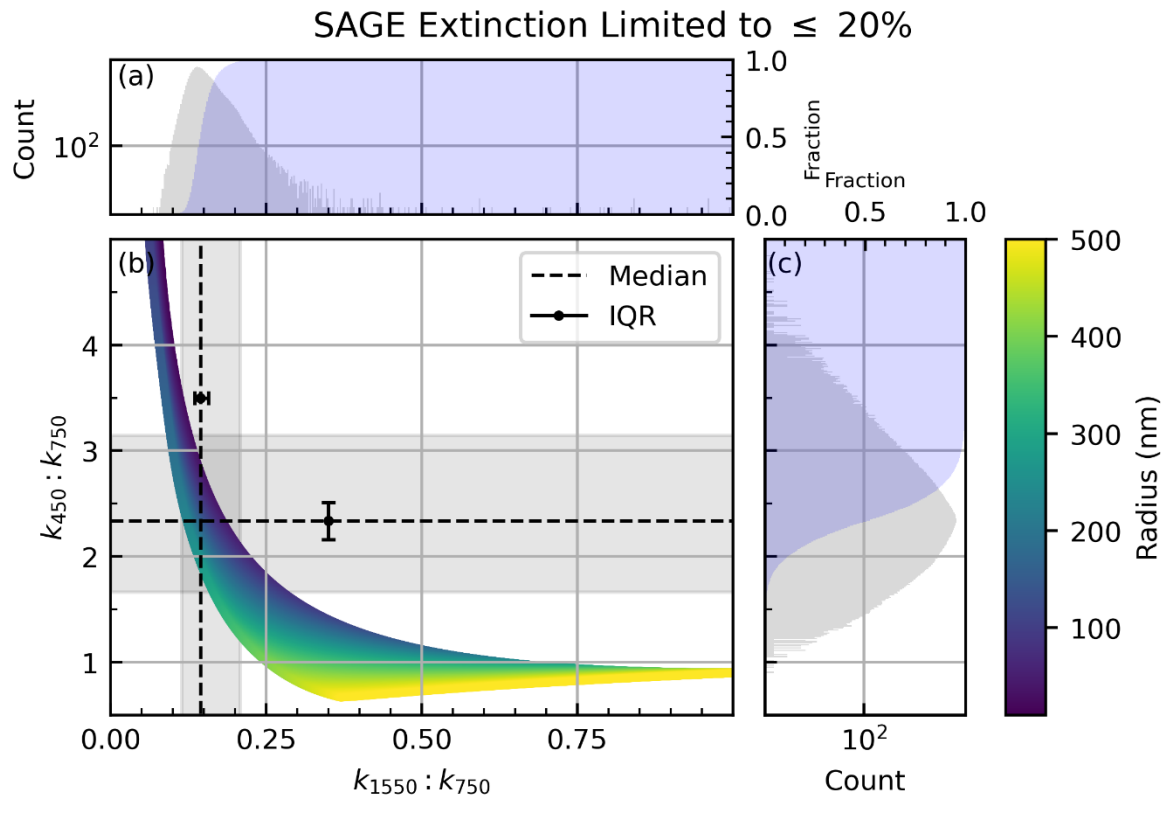


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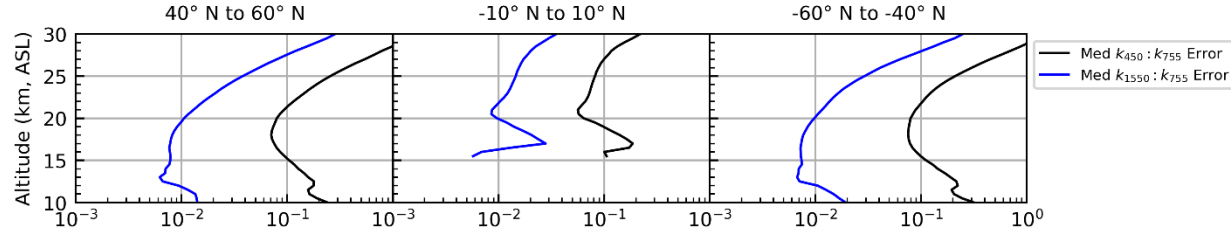


Where SAGE III/ISS Data Fall



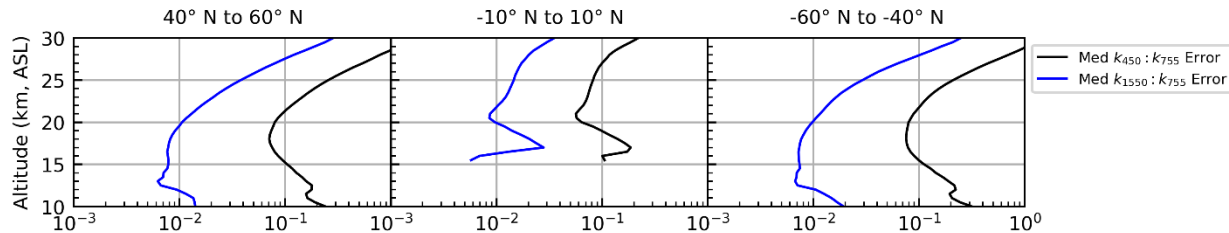
Reading the Tea Leaves of Uncertainty

Median Extinction Ratio Uncertainty Profiles
June 2017 - January 2021

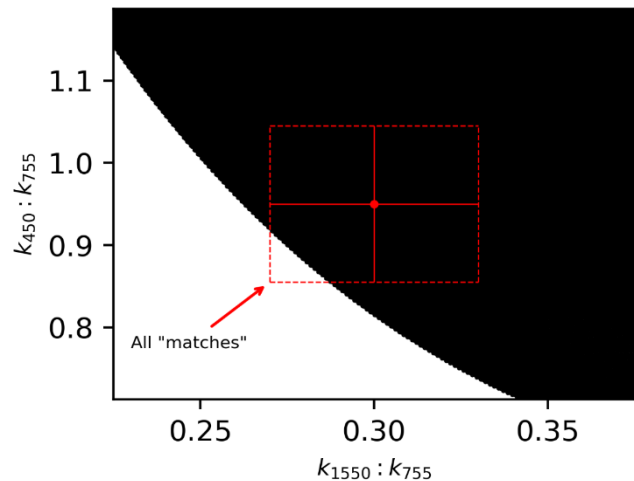


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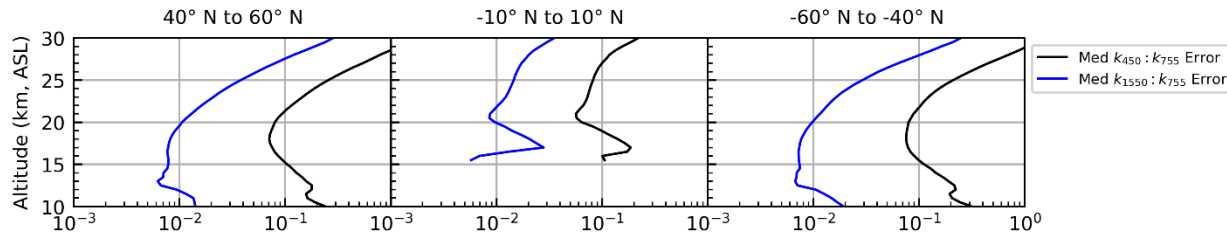


Extinction Ratio Plot

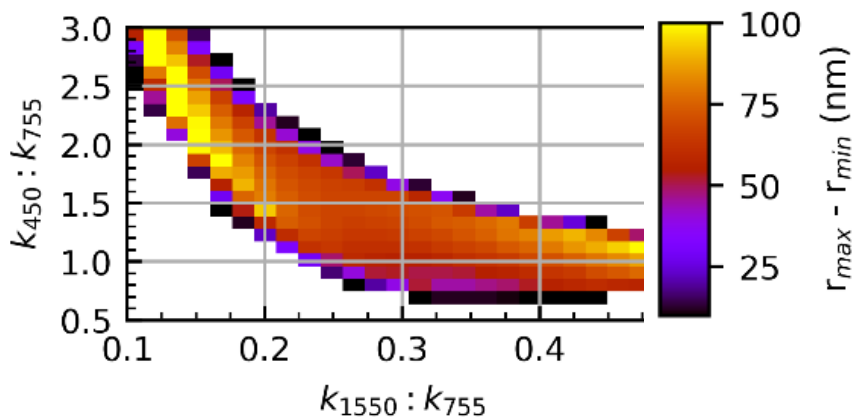
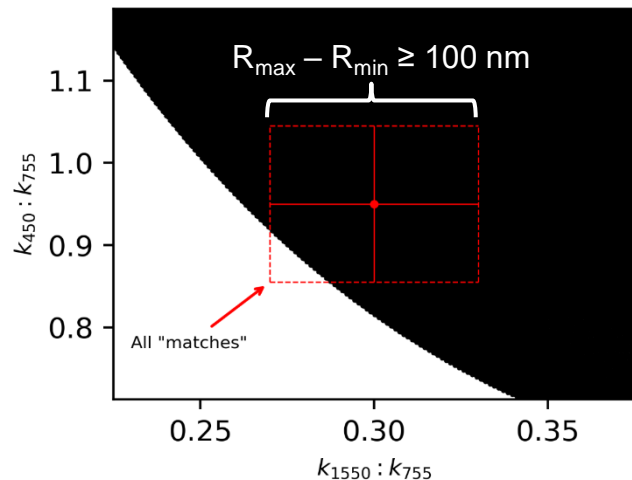


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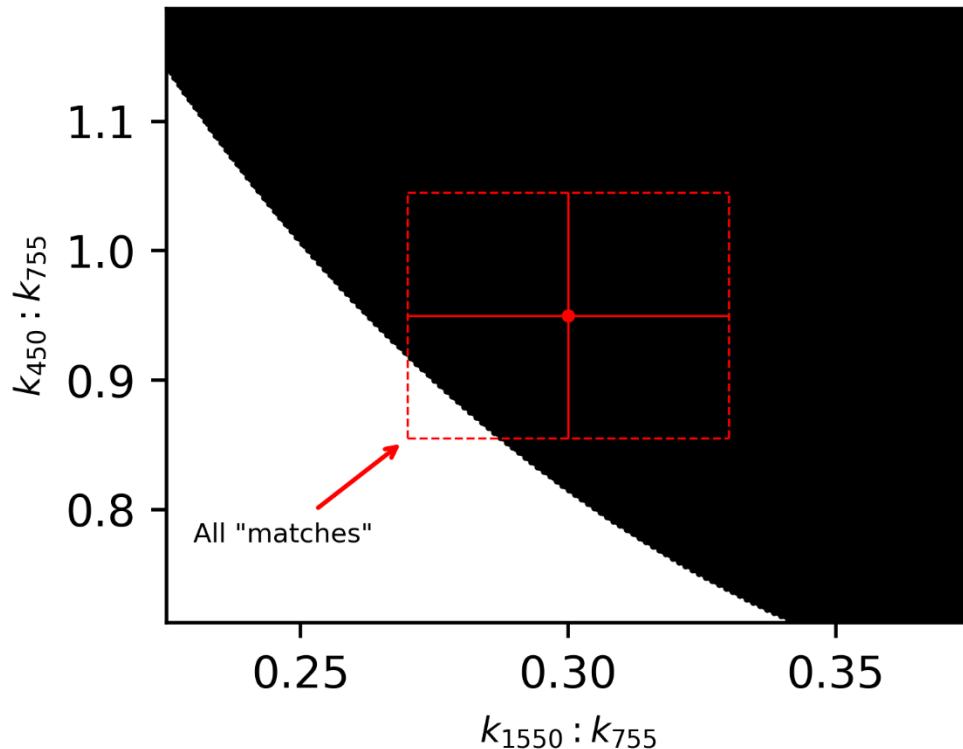


Extinction Ratio Plot



Estimating Mode Radius and σ

Extinction Ratio Plot

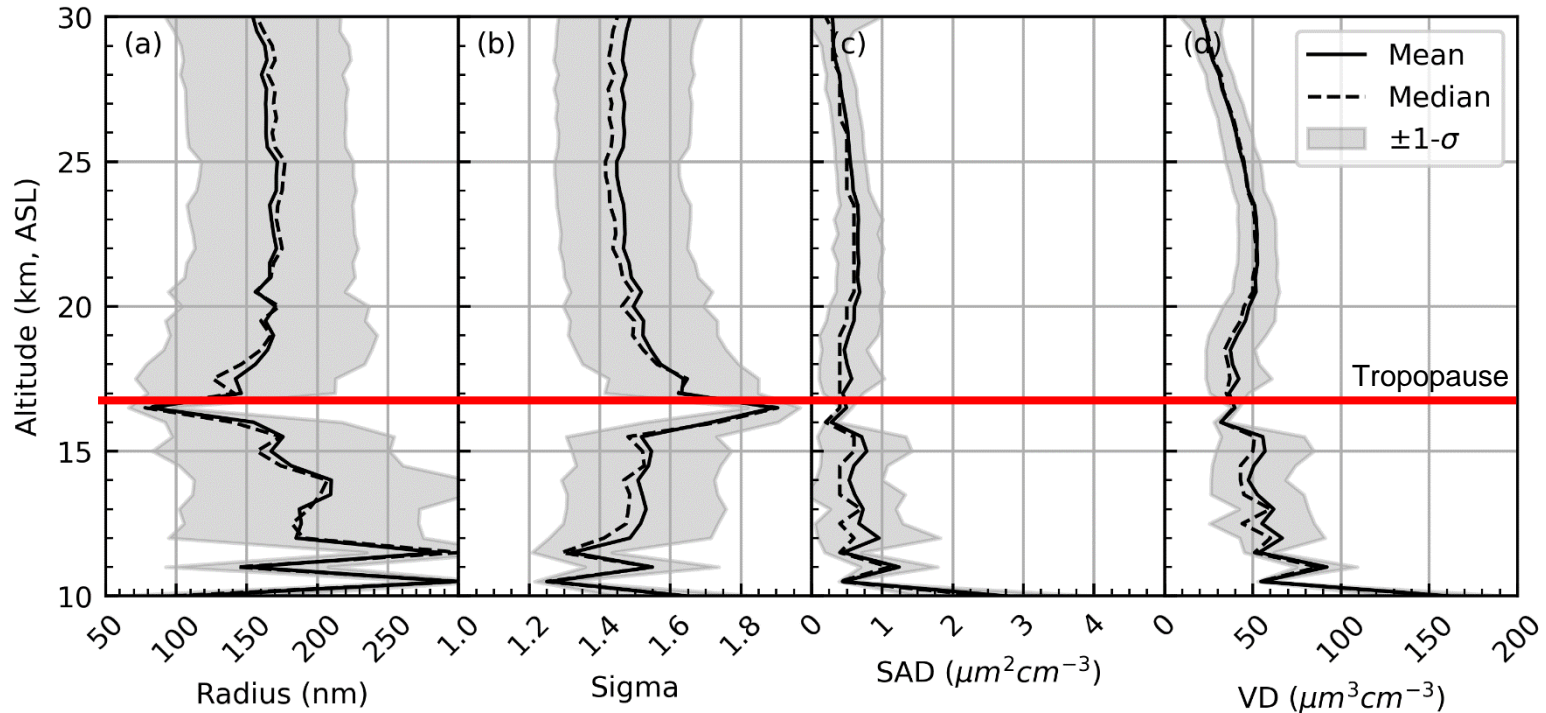


- How *do* we estimate PSD parameters?
 - Use all data within box
 - Extract arrays of radii and widths
 - Assume central dot is *most probable* values (not necessarily the *right* value)
 - Calculate weighted statistics
 - Weights are $1/\text{distance}$ to central point

Estimating Mode Radius, σ , SAD, and VD

June 2017

20°S - 20°N





Recap



- SAGE III/ISS extinction data will be used to estimate PSD parameters
 - we will expand scope of proposed work to include microphysical properties (SAD, VD)
- Single-mode code nearly complete
 - showed preliminary results
 - standard deviation for mode radius is ~40% of mean at 20 km
- Expansion to include bimodal distributions
 - preliminary results for 2022 STM?

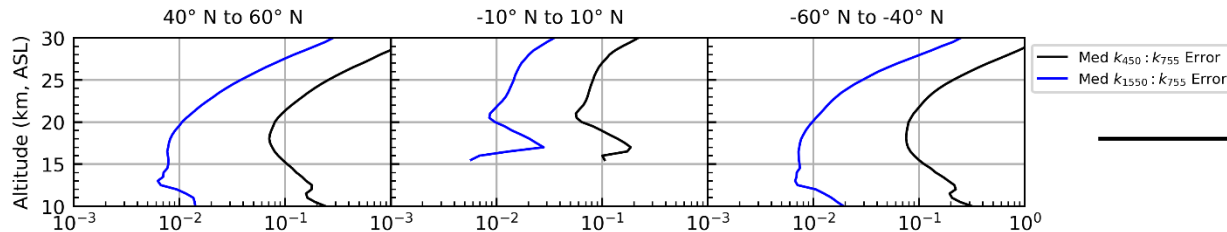


Questions



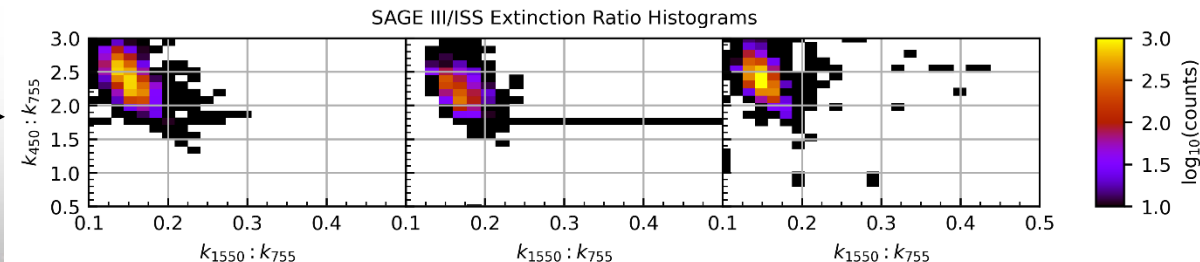
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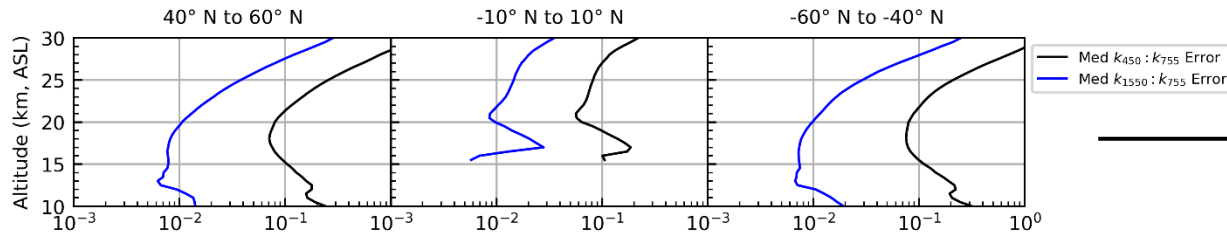
Ext. Ratio errors
used to define
bin widths

20 km only →



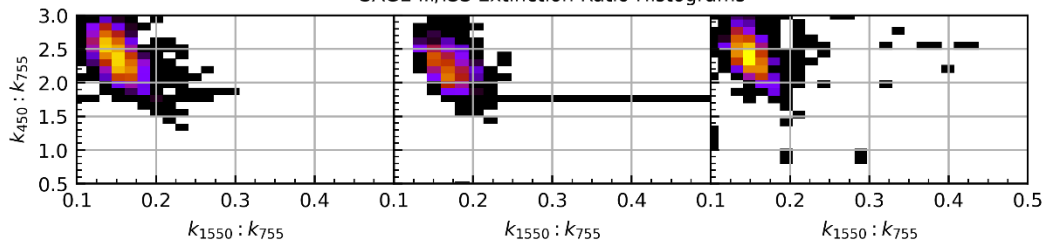
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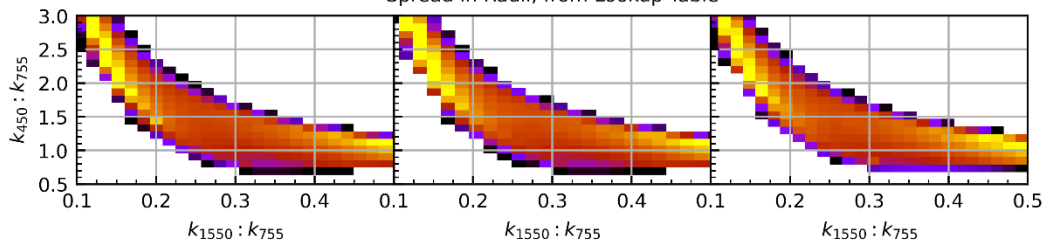


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SAGE III/ISS Extinction Ratio Histograms



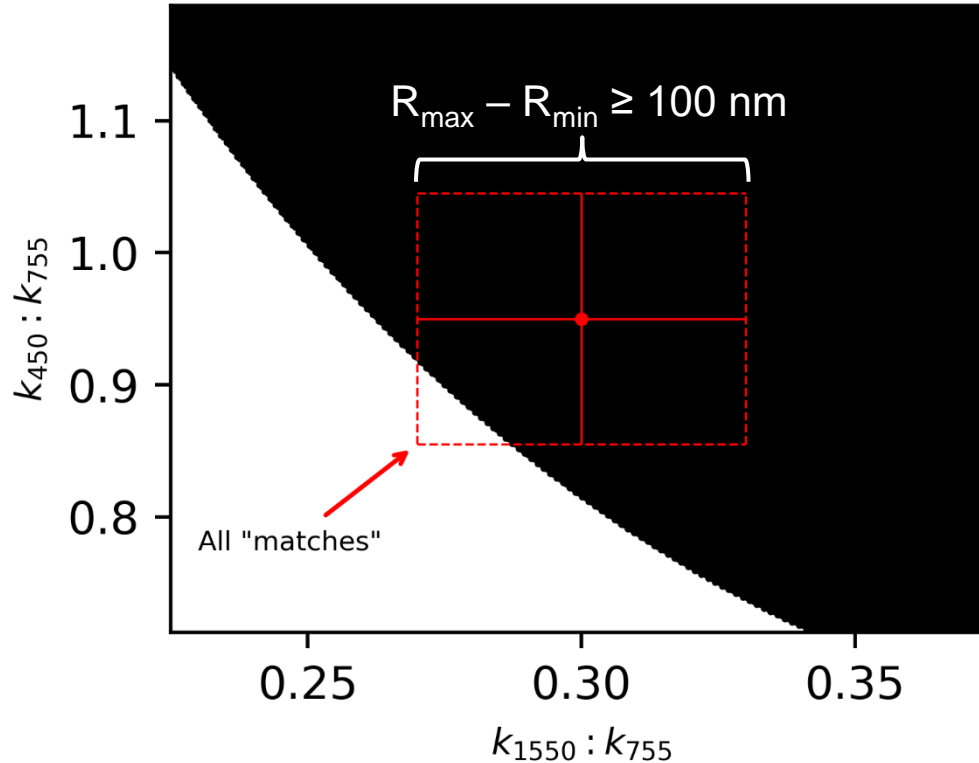
Spread in Radii, from Lookup Table



20 km only

Reading the Tea Leaves of Uncertainty

Extinction Ratio Plot



Worst-case scenario