

SAGE III/ISS update to the particle size distribution data product

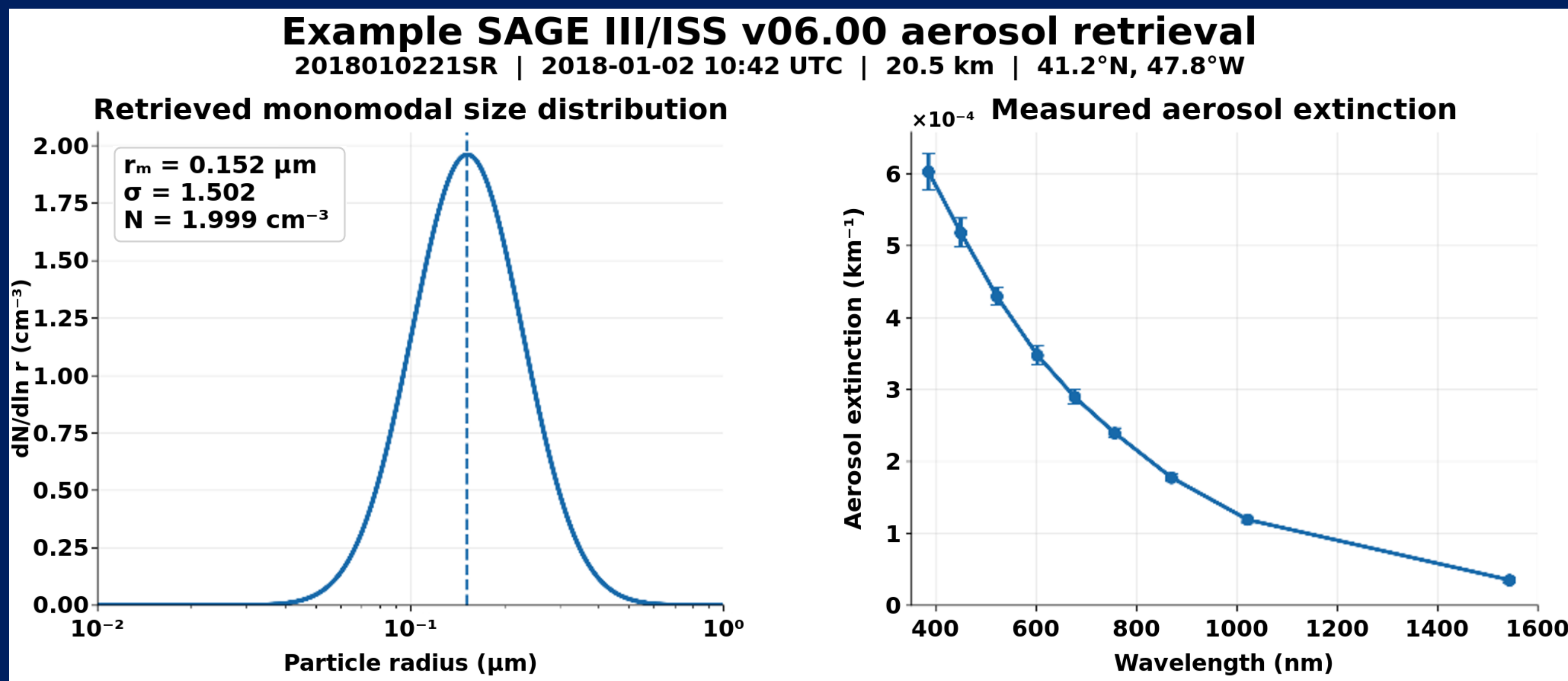


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Introduction

For the purposes of studying the impacts of aerosols on the chemistry and climate of the atmosphere, size distribution information has been inferred from extinction measurements for decades. Particle size distribution (PSD) data has been provided for the SAGE III/ISS data product since version 5.3. Here we describe an update to the algorithm which calculates the PSD parameter values and PSD derived values. This update will replace an assumption of 75 wt % H₂SO₄ and a constant set of refractive index values with a measurement-by-measurement calculation of refractive index depending on atmospheric state variables (pressure, temperature, water vapor concentration). As well, we have updated the calculation of number density by using all relevant SAGE channels instead of only the 1020 nm channel.

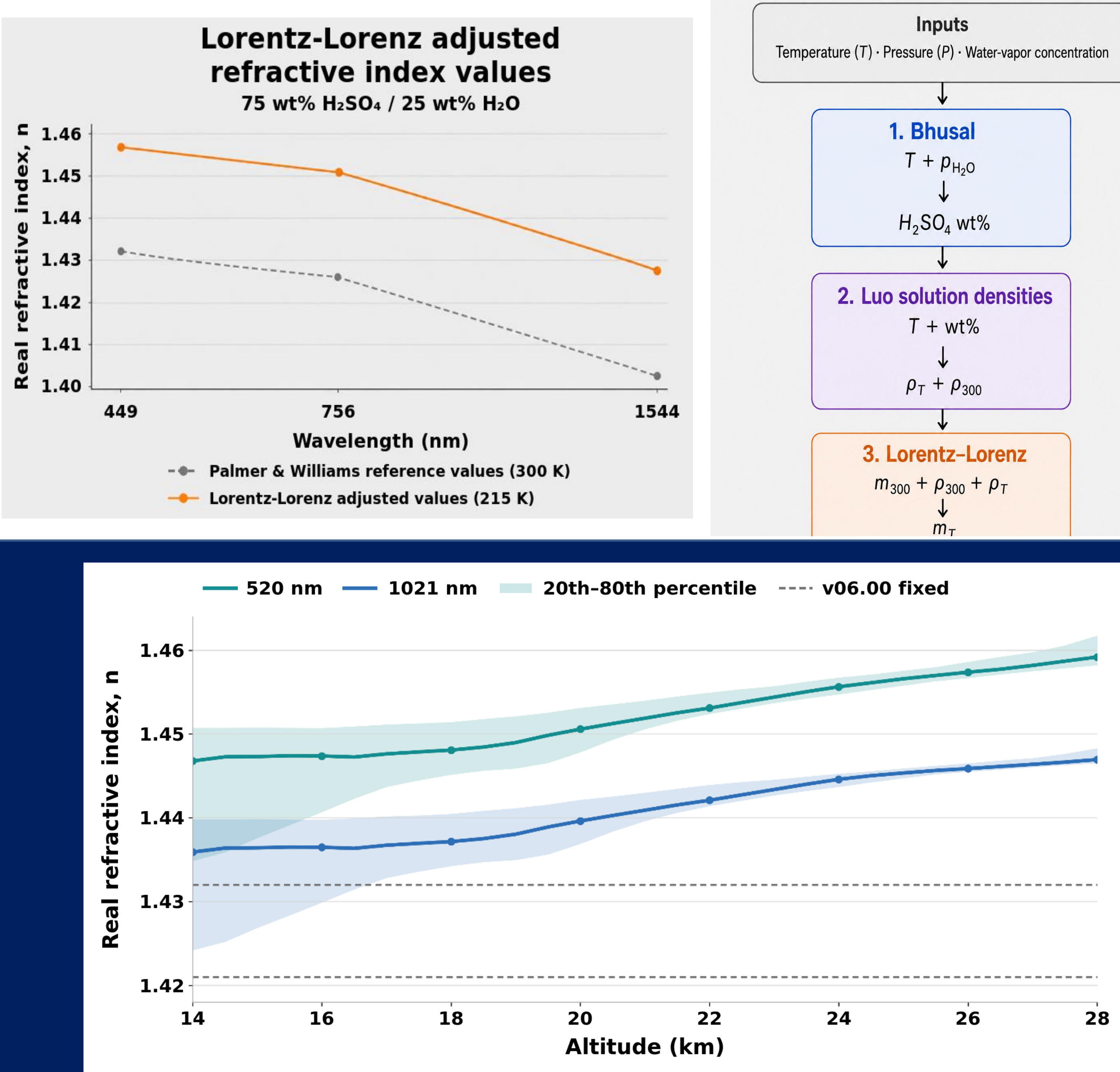
Number Density Calculation Update



The method described in Knepp (2023) uses look-up-tables which maps extinction ratios to PSD parameters mode radius and mode wid. Using extinction ratios allows the early process to focus only on the two shape parameters, holding number density at 1/ cm³. Shown in these plots is example SAGE extinction measurements (right) and the derived PSD (left)

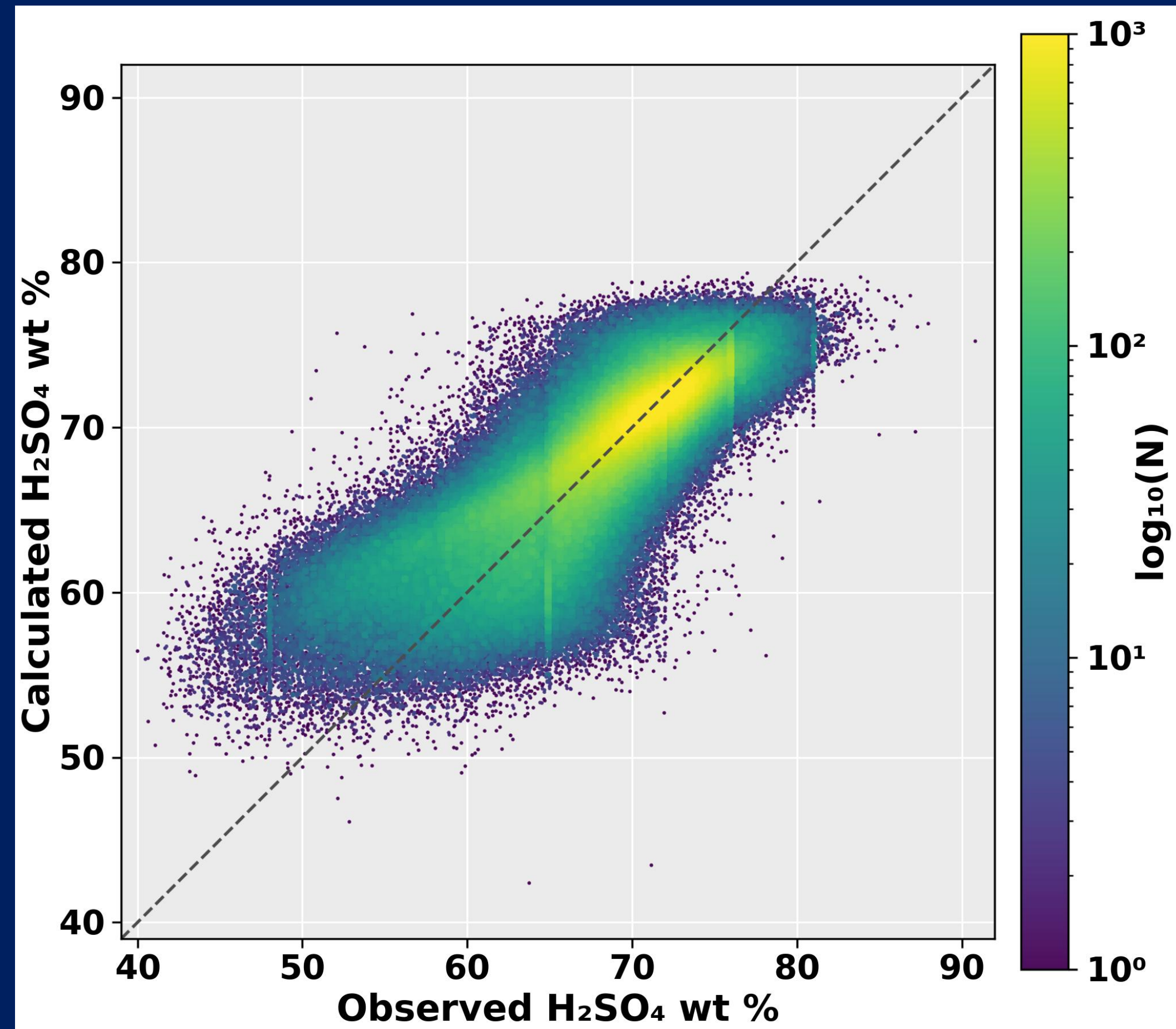
$$w_{\text{H}_2\text{SO}_4} = -406.55017 - 92.40446 \cdot \log(p_{\text{H}_2\text{O}}) + 3.82546 \cdot T + 0.66745 \cdot \log(p_{\text{H}_2\text{O}}) \cdot T - 0.00779 \cdot T^2 - 3.33299 \cdot (\log(p_{\text{H}_2\text{O}}))^2 - 0.00143 \cdot \log(p_{\text{H}_2\text{O}}) \cdot T^2$$

Refractive Index Derivation Update



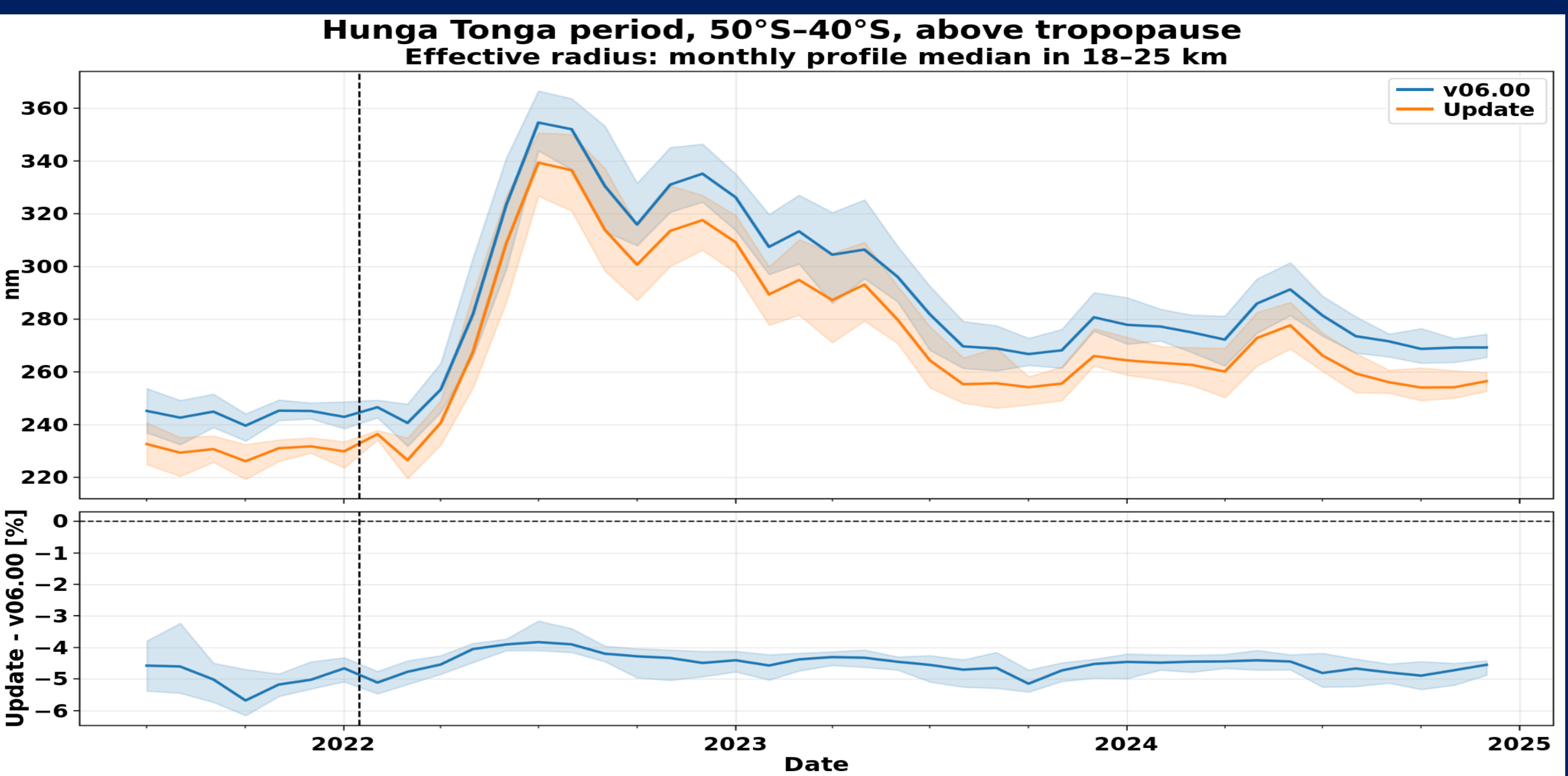
Utilizing SAGE and MERRA-2 atmospheric state measurements refractive indices are calculated. Resulting in a change in RI within a range of a few percent. A clear and consistent slope in RI is observed with altitude.

ACE-FTS Empirical Relationship between pH₂O, Temp, and H₂SO₄ wt % (Bhusal et al. 2026)

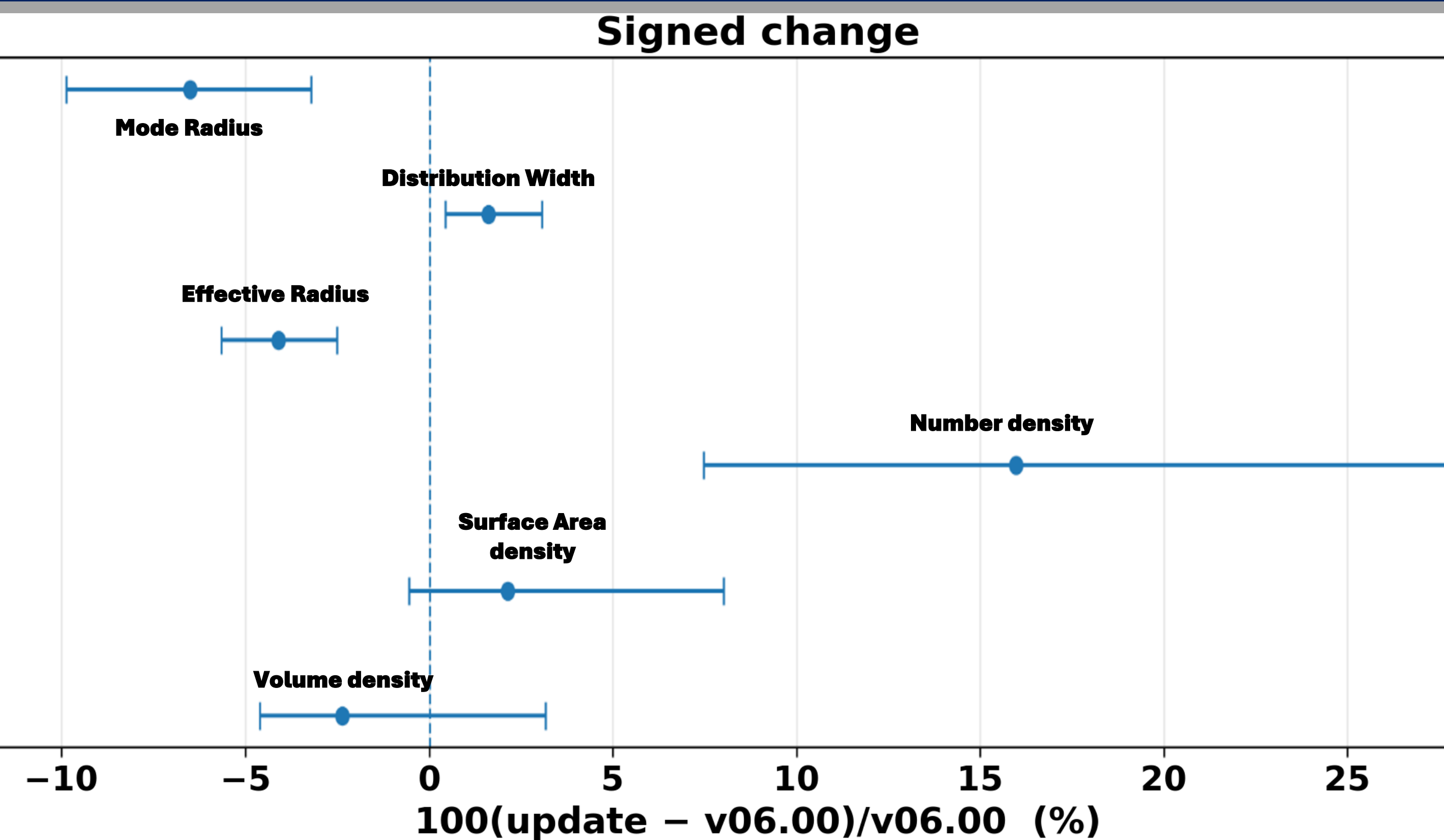


Result

Effect of the updates are relatively uniform across background and high aerosol loading event.



Percent Change with respect to version 06.00



Number Density Calculation Update

$$N = \text{median} \left(\frac{k_{\lambda}^{\text{SAGE}}}{k_{\lambda}^{\text{LUT}}} \right)$$

