

A Practical Application of Atmospheric Tomography with 3D Radiative Transfer (AT3D) to the Multi-angle Imaging SpectroRadiometer (MISR)



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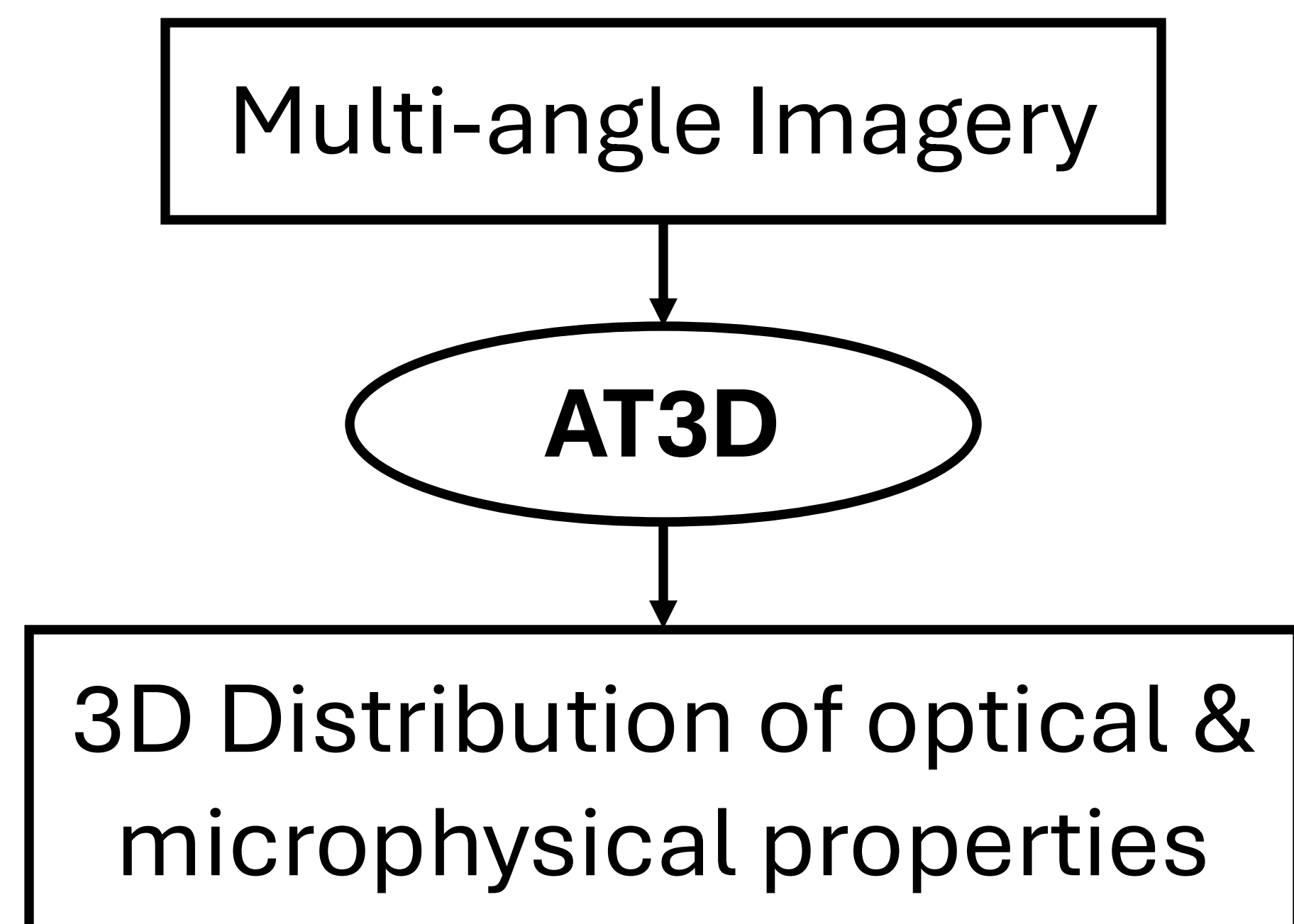
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What is AT3D?

AT3D [1] retrieves the 3D distribution of optical & microphysical properties by minimizing the misfit between observed multi-angle images and 3D radiative transfer simulations.



CAMP2Ex RF 17 Overview

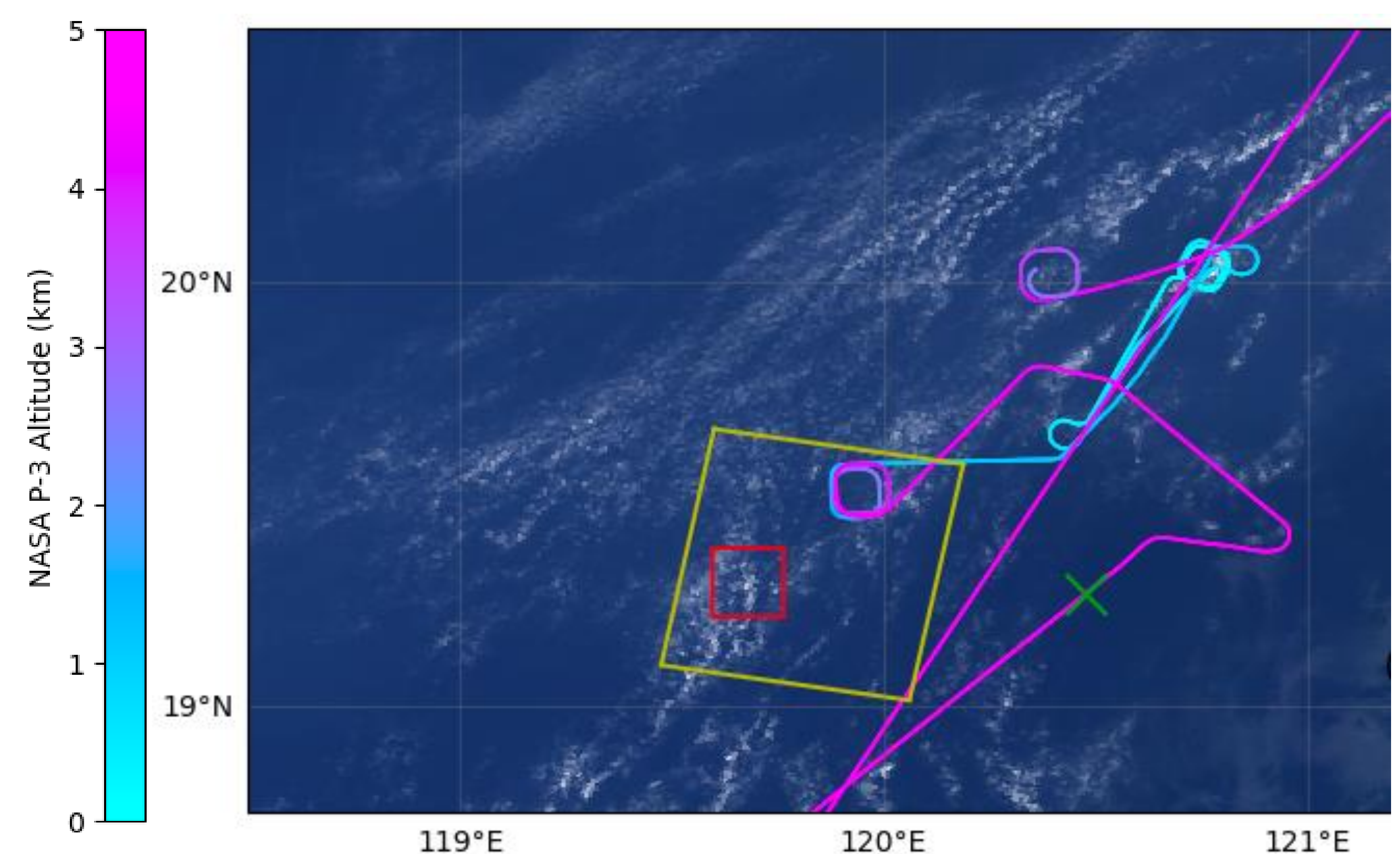
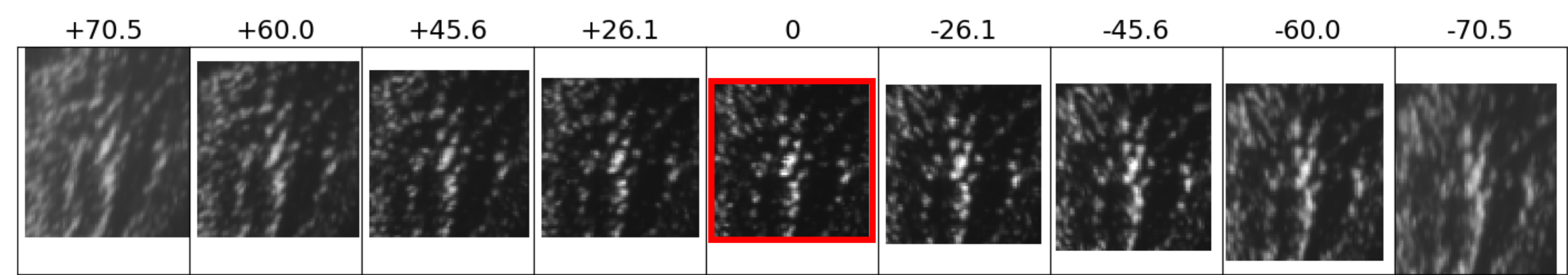


Figure 1: MODIS RGB imagery with NASA P-3 flight tracks overlaid on 2 October 2019 (2:40 UTC). Terra Orbit 105254. The green cross marks the location of the aircraft as Terra flew over. The yellow box indicates the ASTER image footprint, and the red box indicates the area of the AT3D retrieval domain.

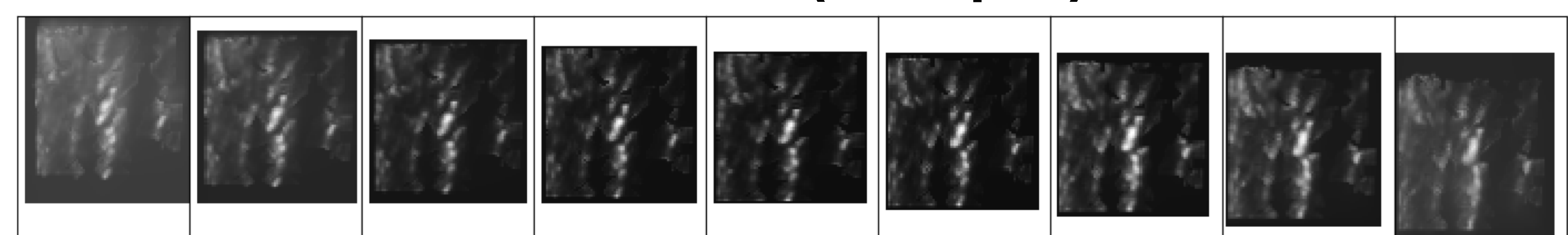
AT3D Volume Extinction Coefficient Retrieval

AT3D Parameters	
Volumetric Constraints	Space Carving + Cloud Top Heights + LCL
Surface	Cox and Munk ocean surface ($v = 0.67$ m/s)
Aerosols	Sea salt at RH=80%; AOD = 0.2; homogeneous from 0-400m
Retrieval resolution (x, y, z)	(275 m x 275 m x 50 m)

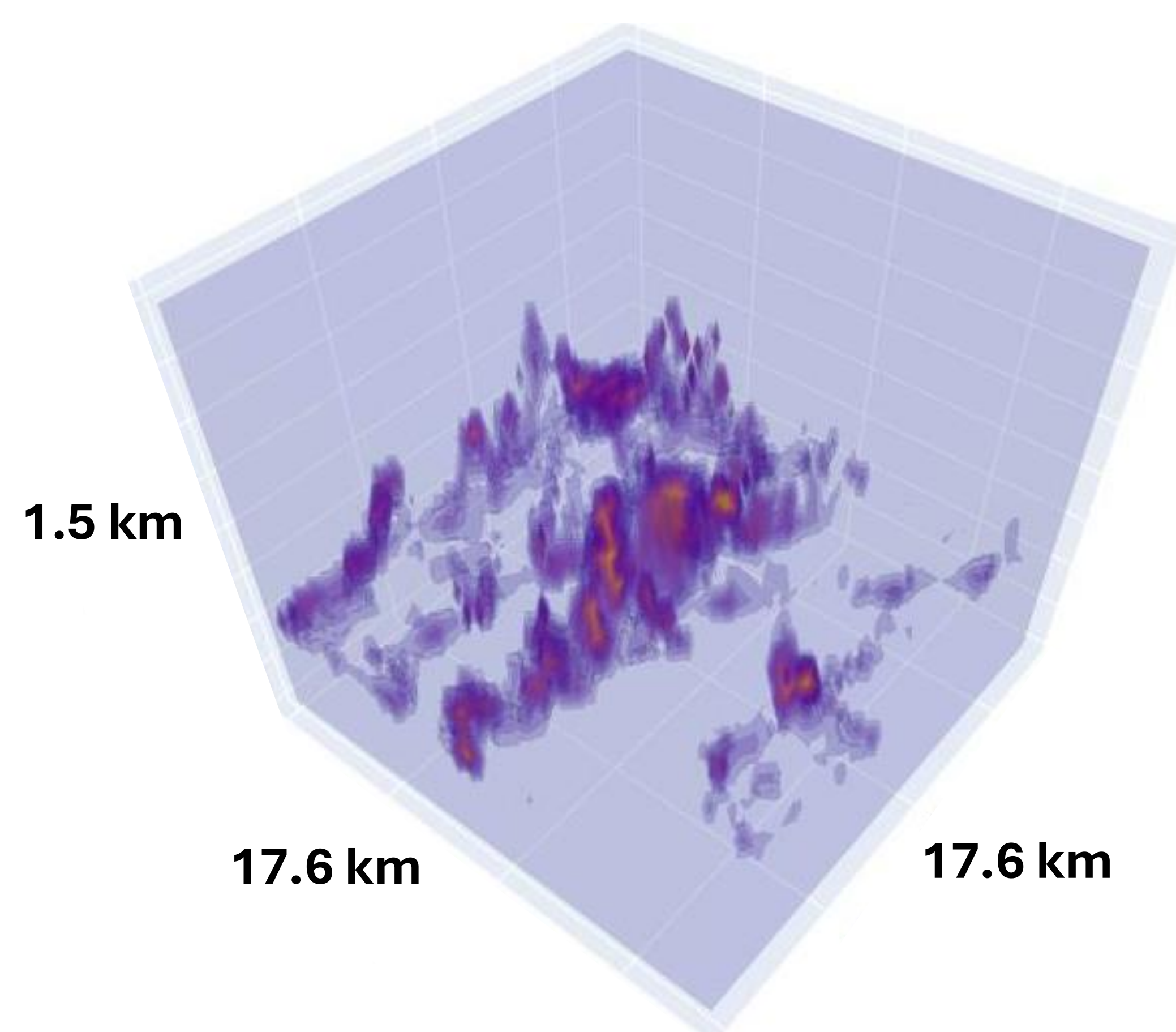
MISR BRF (0.67 μ m)



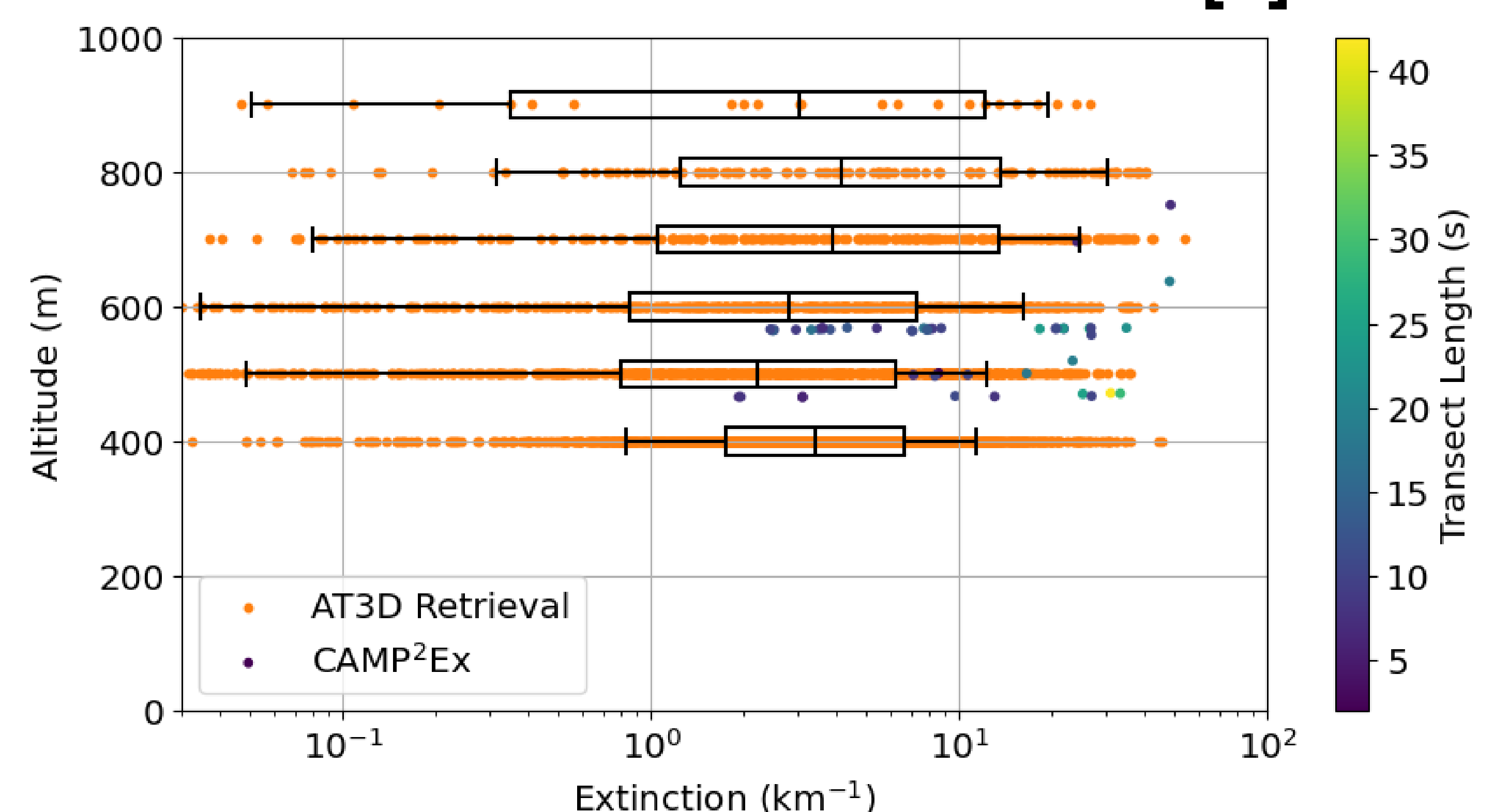
AT3D BRF (0.67 μ m)



Volume Extinction Coefficient [km^{-1}]



AT3D versus in-situ CAMP²Ex [2]



AT3D retrieved extinction coefficient agrees well with in-situ measurements from neighboring clouds.

To Enable AT3D, The Next Generation Satellite Must Have

1. **High-resolution** to resolve small scale variance in line with LES resolutions.
2. **A Constellation of simultaneous multi-angle views** to eliminate effects from cloud motion/evolution.

Acknowledgements

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References

- [1] Loveridge, J., A. Levis, L. Di Girolamo, V. Holodovsky, L. Forster, A. B. Davis, and Y. Y. Schechner, 2023: Retrieving 3D distributions of atmospheric particles using Atmospheric Tomography with 3D Radiative Transfer – Part 1: Model description and Jacobian calculation. *Atmospheric Measurement Techniques*, **16**, 1803–1847.
- [2] Reid, J. S., and Coauthors, 2023: The Coupling Between Tropical Meteorology, Aerosol Lifecycle, Convection, and Radiation during the Cloud, Aerosol and Monsoon Processes Philippines Experiment (CAMP2Ex). *Bulletin of the American Meteorological Society*, **104**, E1179–E1205.