

Supplementary Information

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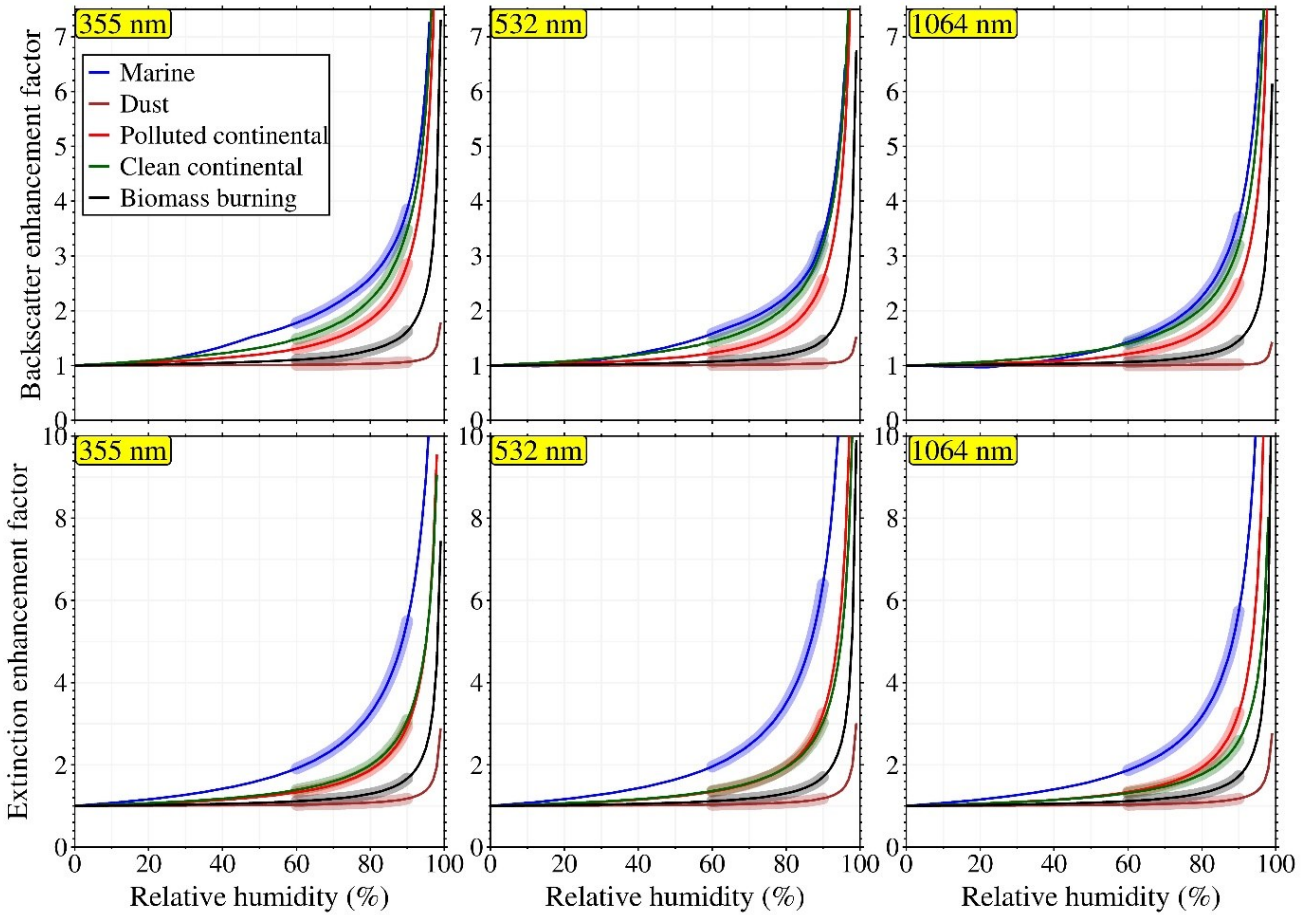
4 **Table S1:** Typical parameter ranges for the aerosol bimodal distribution. V_f^t / V_c^t is the ratio of
5 the volume concentration of the fine mode to the coarse mode. m_R and m_I represent the mean
6 values of real and imaginary parts of the complex refractive index.

Aerosol Parameters	Marine	Dust	Polluted Continental	Clean Continental	Biomass burning
r_f^v	0.065-0.085	0.062-0.082	0.075-0.095	0.08-0.11	0.072-0.082
r_c^v	0.5-0.6	0.59-0.64	0.6-0.71	0.42-0.52	0.75-0.80
σ_f^v	0.46-0.54	0.4-0.53	0.38-0.46	0.37-0.45	0.4-0.47
σ_c^v	0.68-0.78	0.6-0.7	0.65-0.75	0.70-0.80	0.65-0.75
V_f^t / V_c^t	0.1-0.25	0.1-0.5	1.0-2.0	0.01-0.15	1.5-2.5
m_R / m_I	1.36/0.0015	1.56/0.001	1.47/0.014	1.401/0.003	1.51/0.021
κ	0.7	0.03	0.27	0.31	0.1

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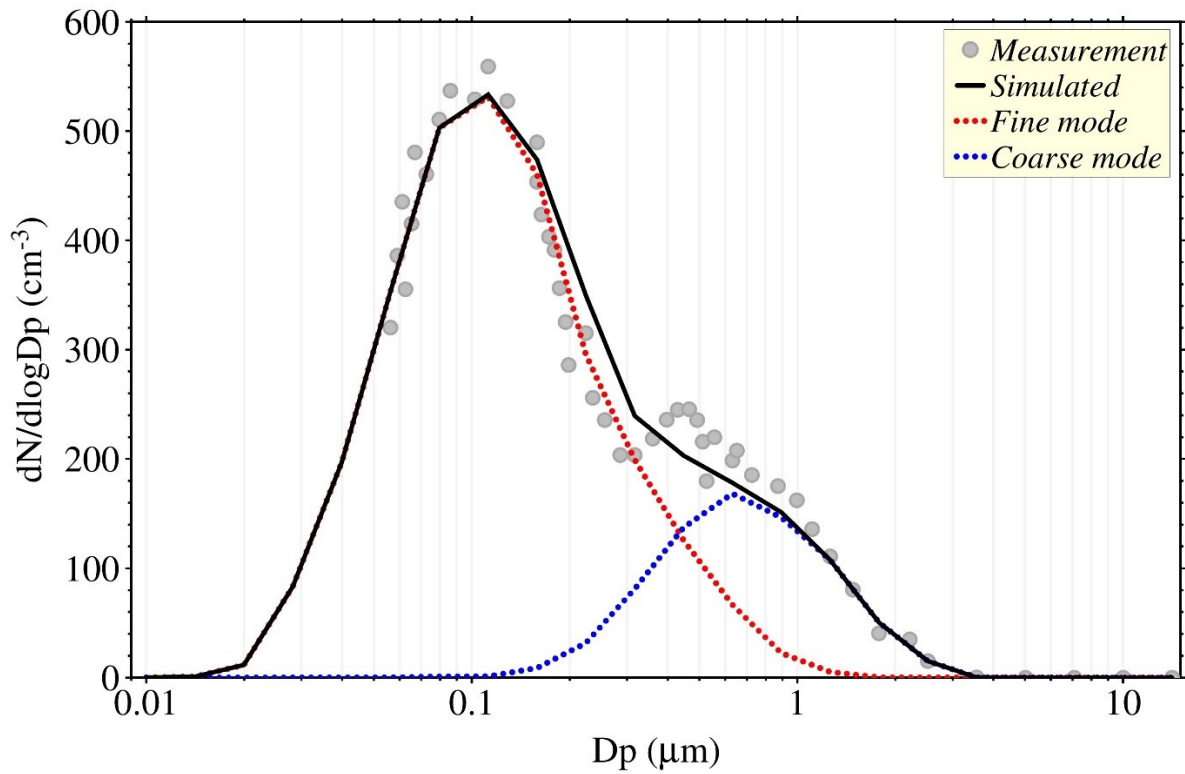


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12 **Figure S1:** Mean enhancement factor for backscatter and extinction coefficients at 355, 532 and
13 1064 nm are fitted using Eq (6) for five aerosol subtypes. This mean fitting curve is calculated with
14 the set of PNSD and κ considered for the construction of LUTs. The thin line represents Mie model
15 simulations, and the highlighted thick line (within RH range of 60-90%) are used to fit
16 parameterization lines.

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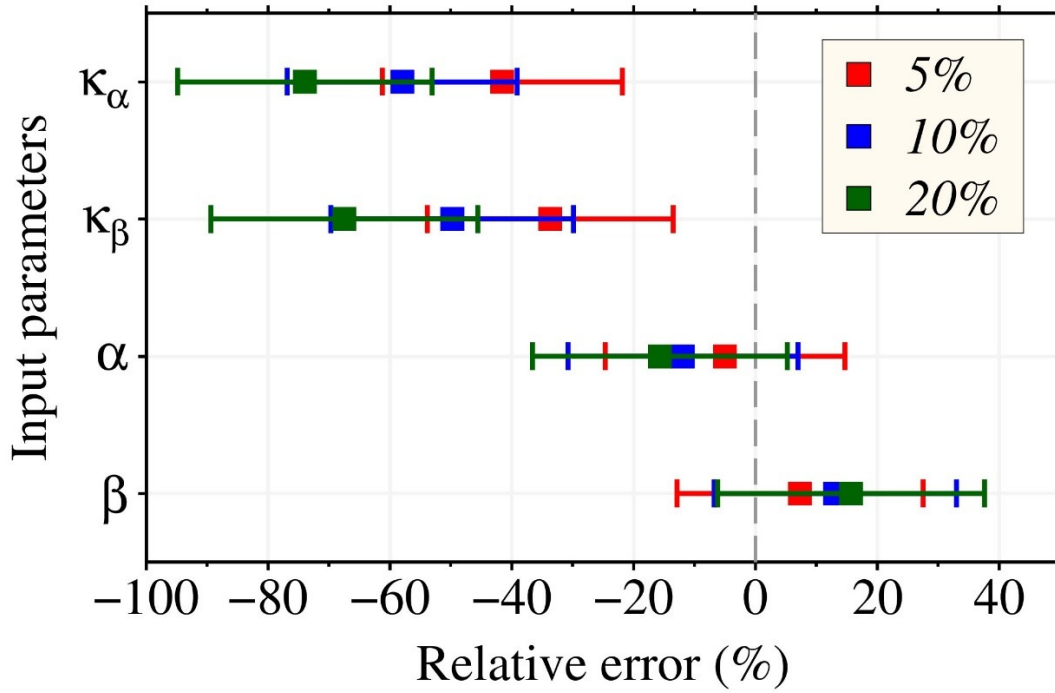
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Figure S2: Observed aerosol particle size distribution during the NASA Oracles mission. Particle size is represented by the geometric diameter. Solid dots denote integrated Ultra-High Sensitivity Aerosol Spectrometer (UHSAS) and Aerodynamic Particle Sizer (APS) measurements. Curves are bimodal lognormal fits for the size distributions of the fine mode (red dotted line), the coarse mode (blue dotted line), and the full mode (black solid line).

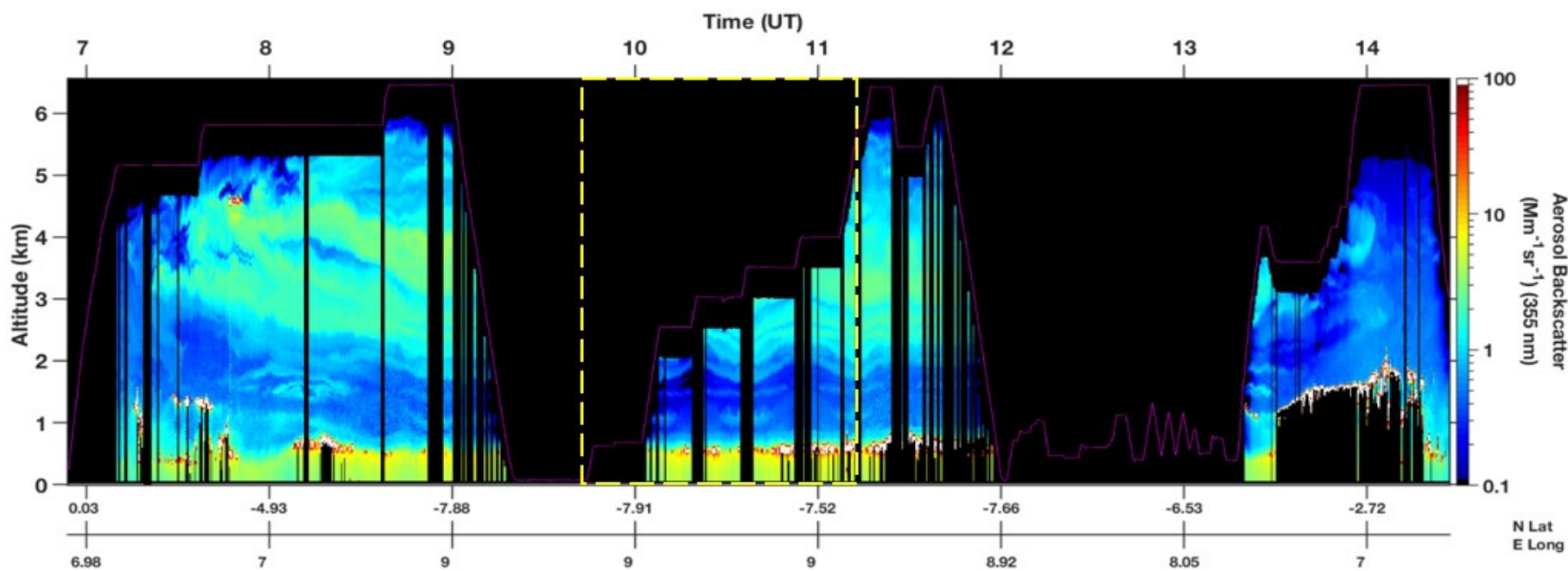
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31 **Figure S3:** Relative errors in input parameters (backscattering coefficient, extinction coefficient,
32 enhancement factor of backscatter coefficients and enhancement factor of extinction coefficients)
33 with 5%, 10% and 20% of random error in relative humidity. The dots are the median values and
34 the error bars denote the 5th and 95th percentile.

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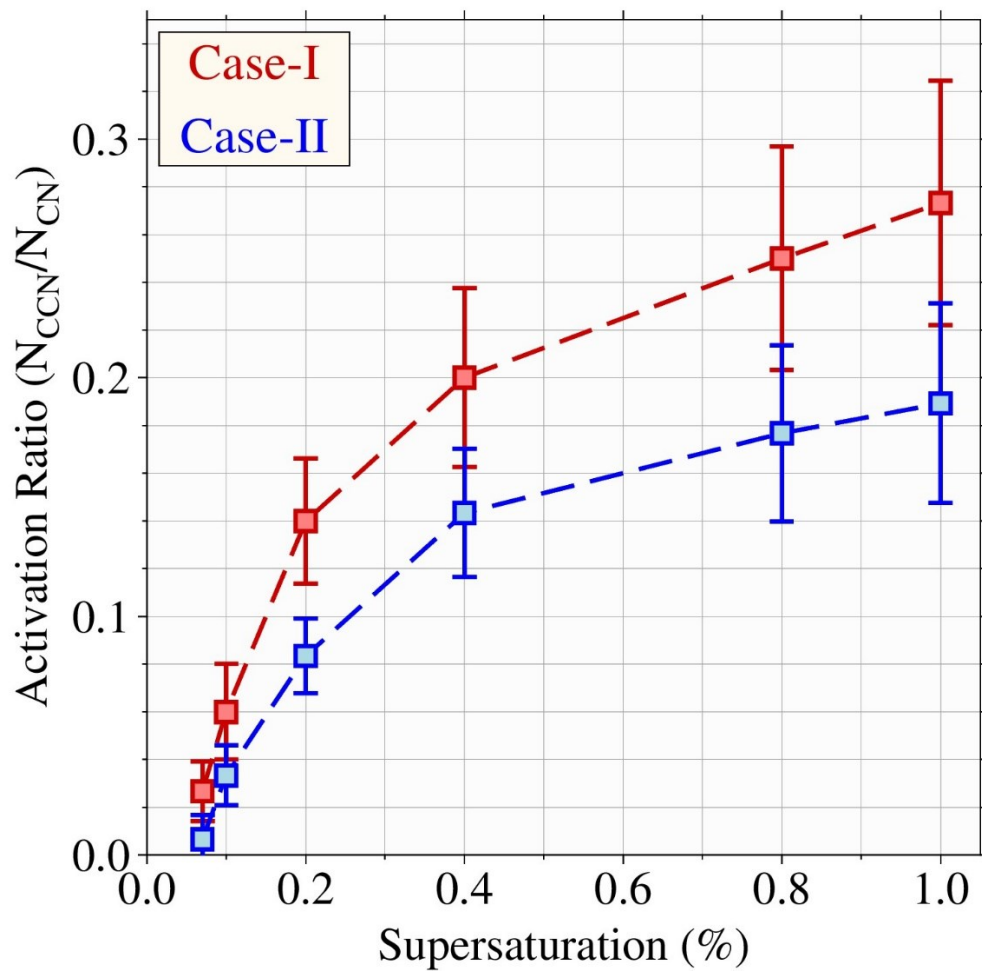


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39 **Figure S4:** The HSRL-2 derived aerosol backscatter at 355 nm from the flight of NASA ORACLES campaign on 19 October 2018. The
40 pink line displays the flight trajectory, whereas the yellow dotted line box illustrates the region of interest with the ascending of flight
41 were used for the profile-based validation of ECLiAP retrieved NCCN from HSRL-2 measurements against the measured NCCN from
42 CCN counter.

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48 **Figure S5:** The mean activation ratio spectra as a function of supersaturation for the case-I and
49 case-II identified from the CALIOP observations on 01 January 2019.

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