Comparison of Measured and Modeled Aerosol Backscatter at the 2-μm Wavelength

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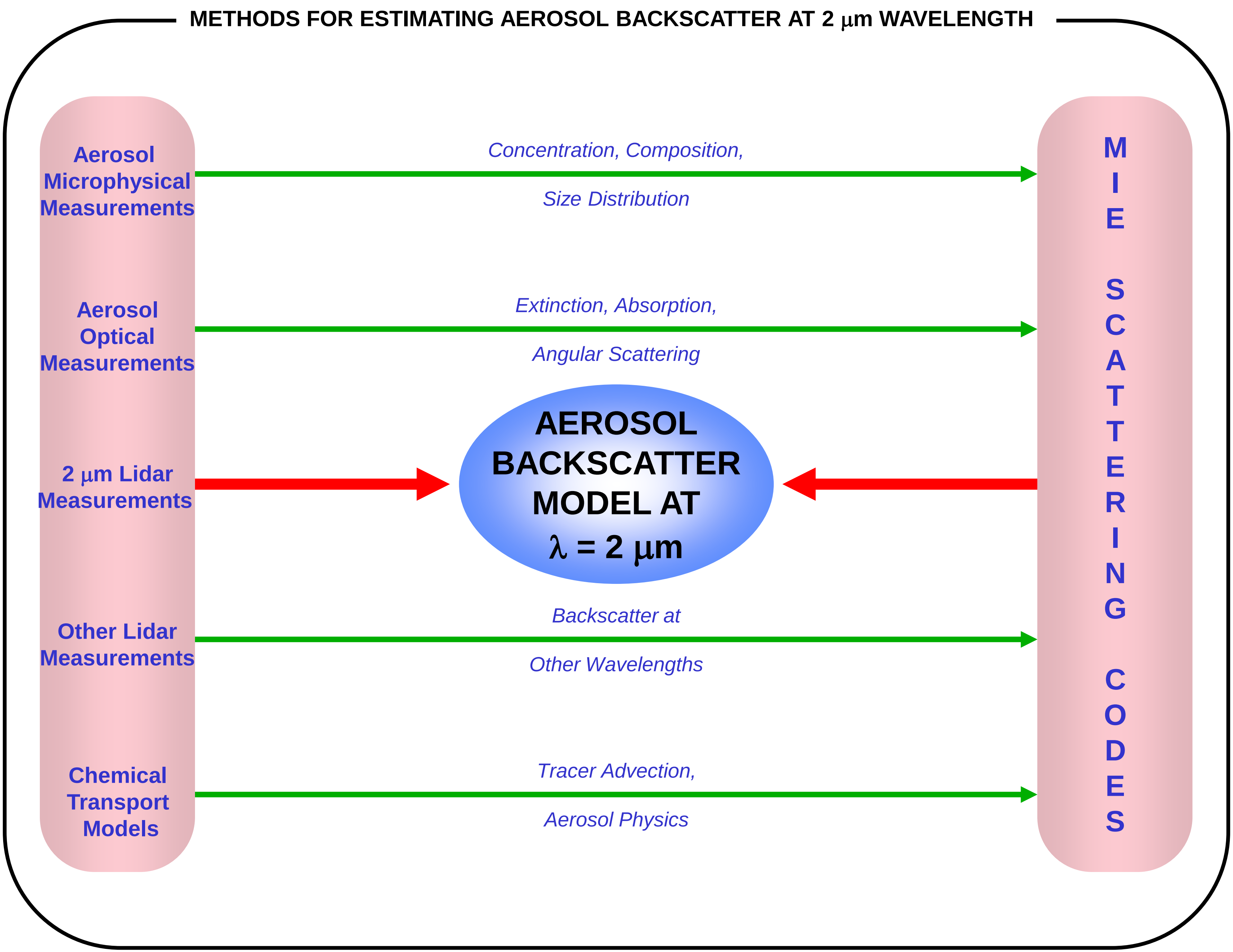
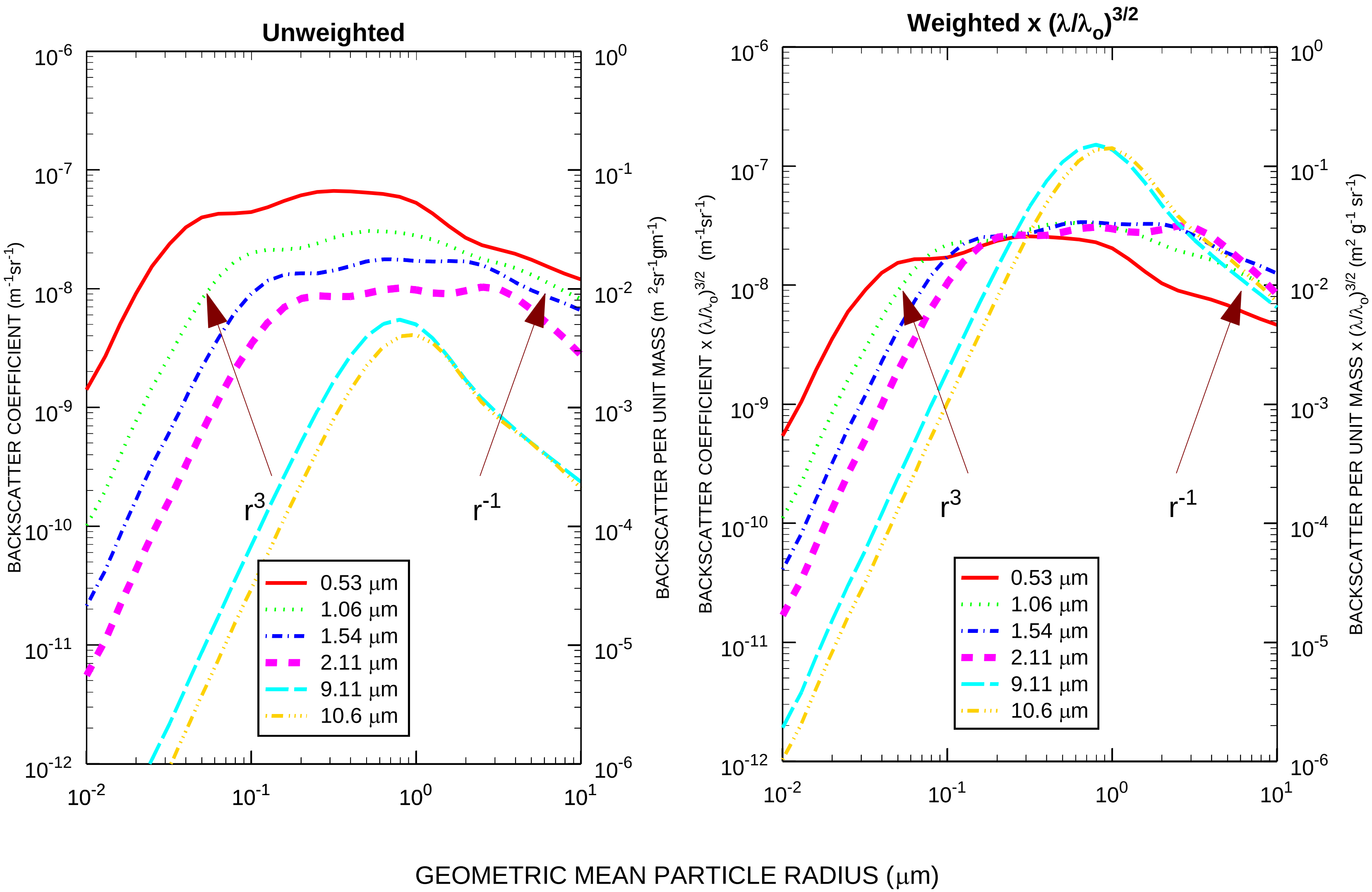

METHODS FOR ESTIMATING AEROSOL BACKSCATTER AT 2 μm WAVELENGTH
Aerosol Microphysical Measurements
Aerosol Optical Measurements
2 μm Lidar Measurements
Other Lidar Measurements
Chemical Transport Models
Concentration, Composition,
Size Distribution
Extinction, Absorption,
Angular Scattering
AEROSOL BACKSCATTER MODEL AT λ = 2 μm
Backscatter at
Other Wavelengths
Tracer Advection,
Aerosol Physics
MIE SCATTERING CODES

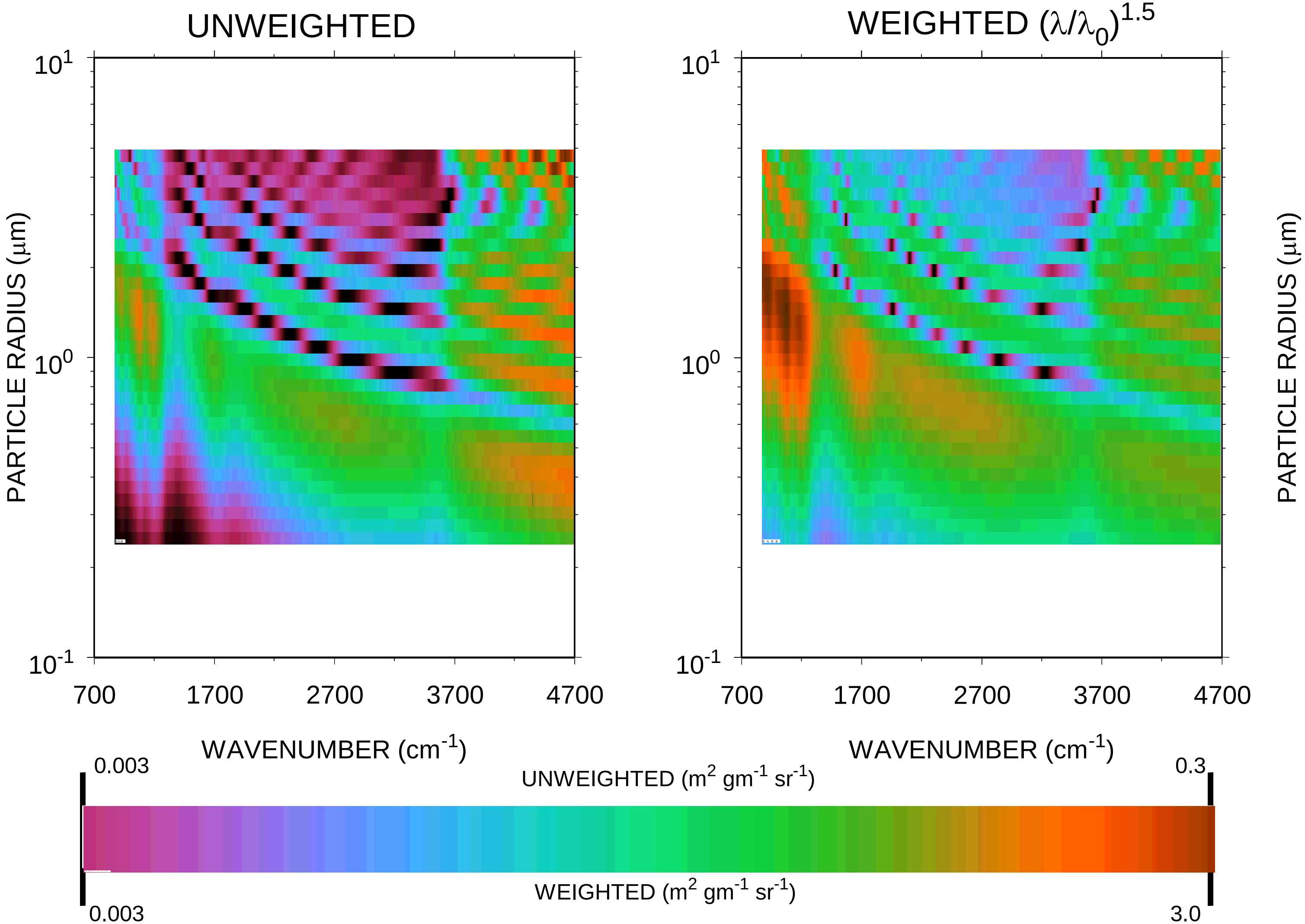
MODELED AEROSOL BACKSCATTER VERSUS WAVELENGTH AND PARTICLE SIZE

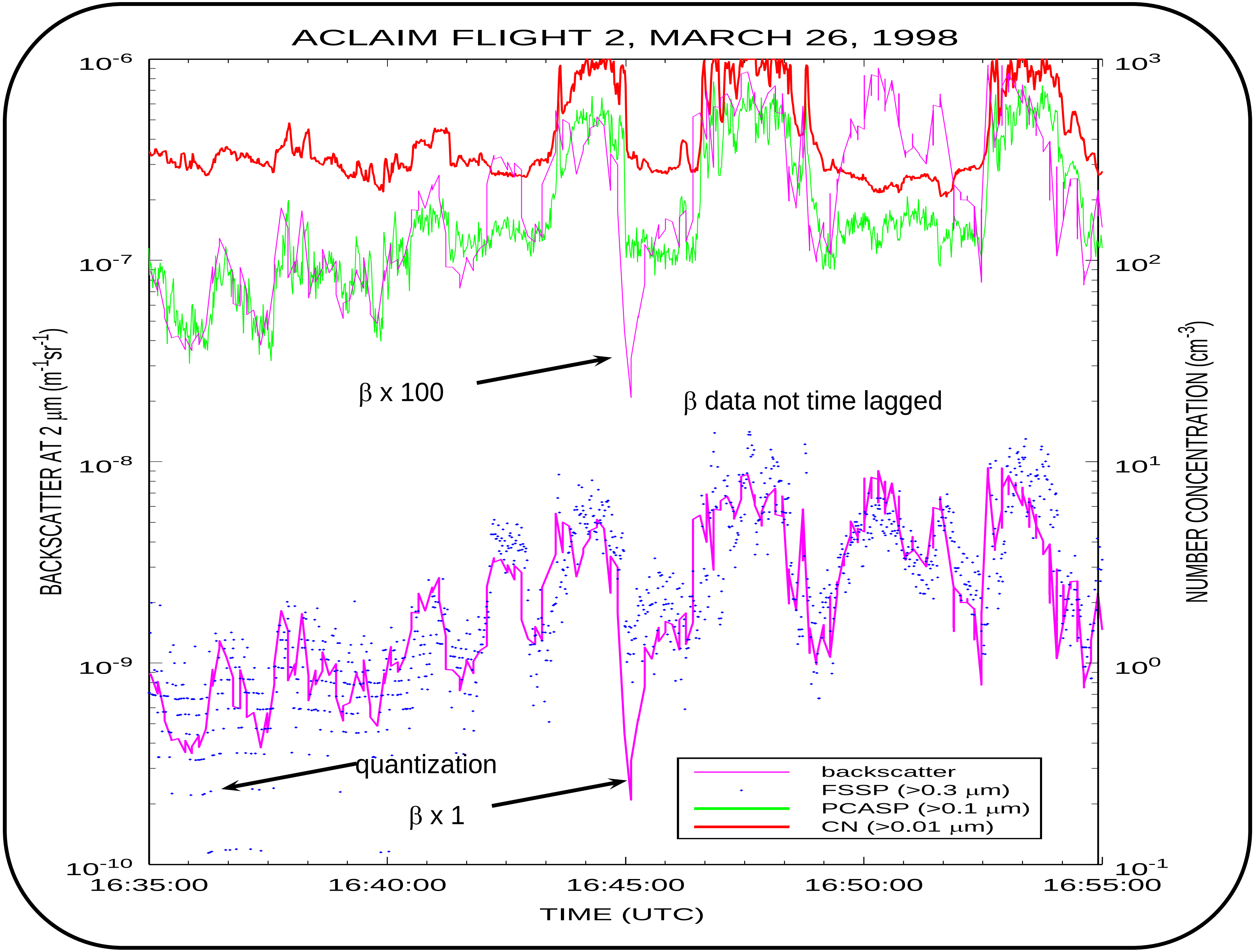
75% SULFURIC ACID AEROSOL, CONSTANT CONCENTRATION (1.0 μg m-3)



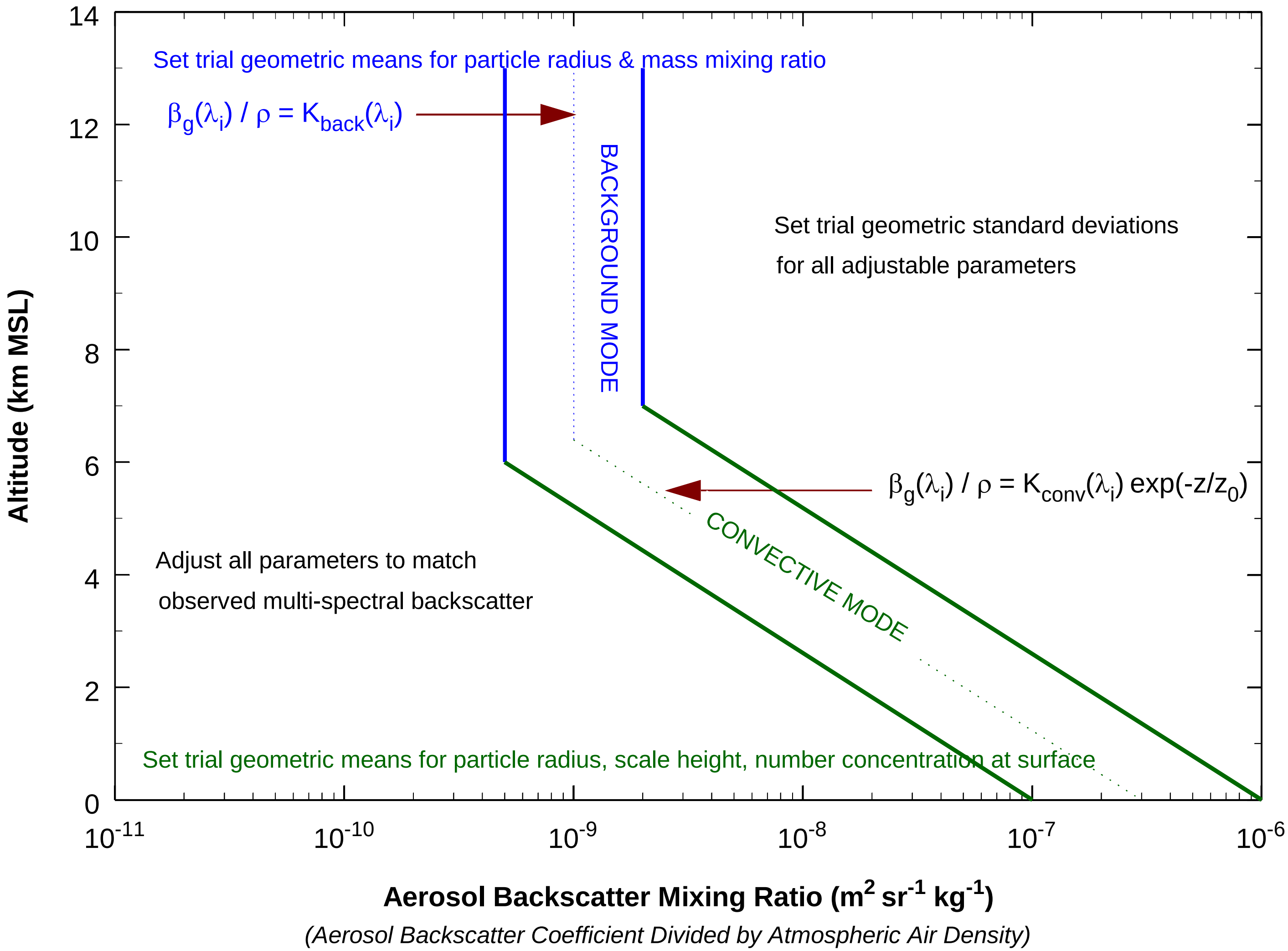
MODELED PARTICULATE BACKSCATTER PER UNIT MASS

H_2SO_4, 240 K, 69 wt %, complex index of refraction from University of North Carolina

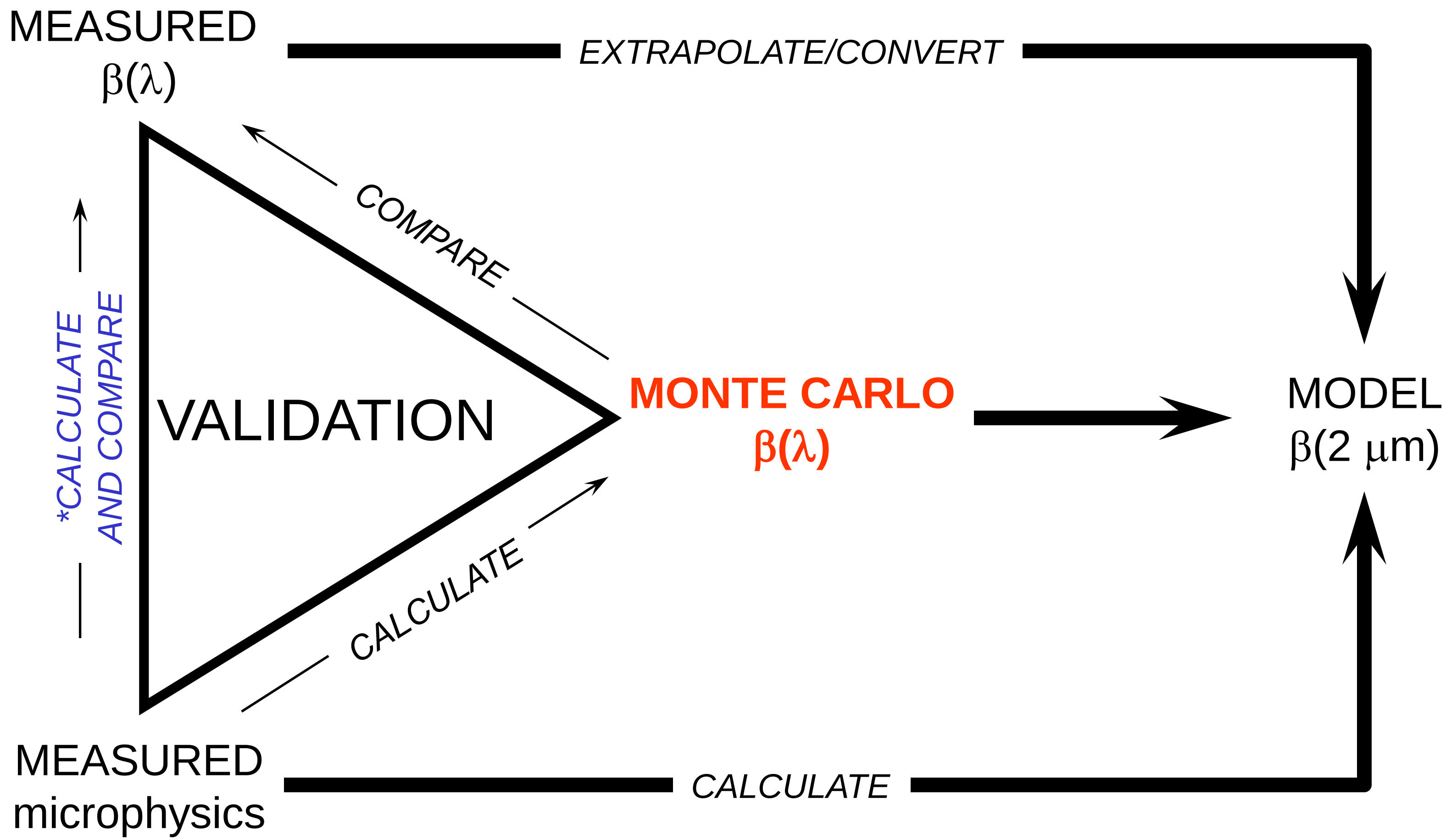



ACLAIM FLIGHT 2, MARCH 26, 1998
BACKSCATTER AT 2 μm (m⁻¹sr⁻¹)
NUMBER CONCENTRATION (cm⁻³)
10⁻⁶
10⁻⁷
10⁻⁸
10⁻⁹
10⁻¹⁰
10³
10²
10¹
10⁰
10⁻¹
β x 100
β data not time lagged
quantization
β x 1
backscatter
FSSP (>0.3 μm)
PCASP (>0.1 μm)
CN (>0.01 μm)
16:35:00
16:40:00
16:45:00
16:50:00
16:55:00
TIME (UTC)

Conceptual Design of Monte Carlo Backscatter Model



BACKGROUND AEROSOL BACKSCATTER ESTIMATION METHOD AT 2-μm WAVELENGTH



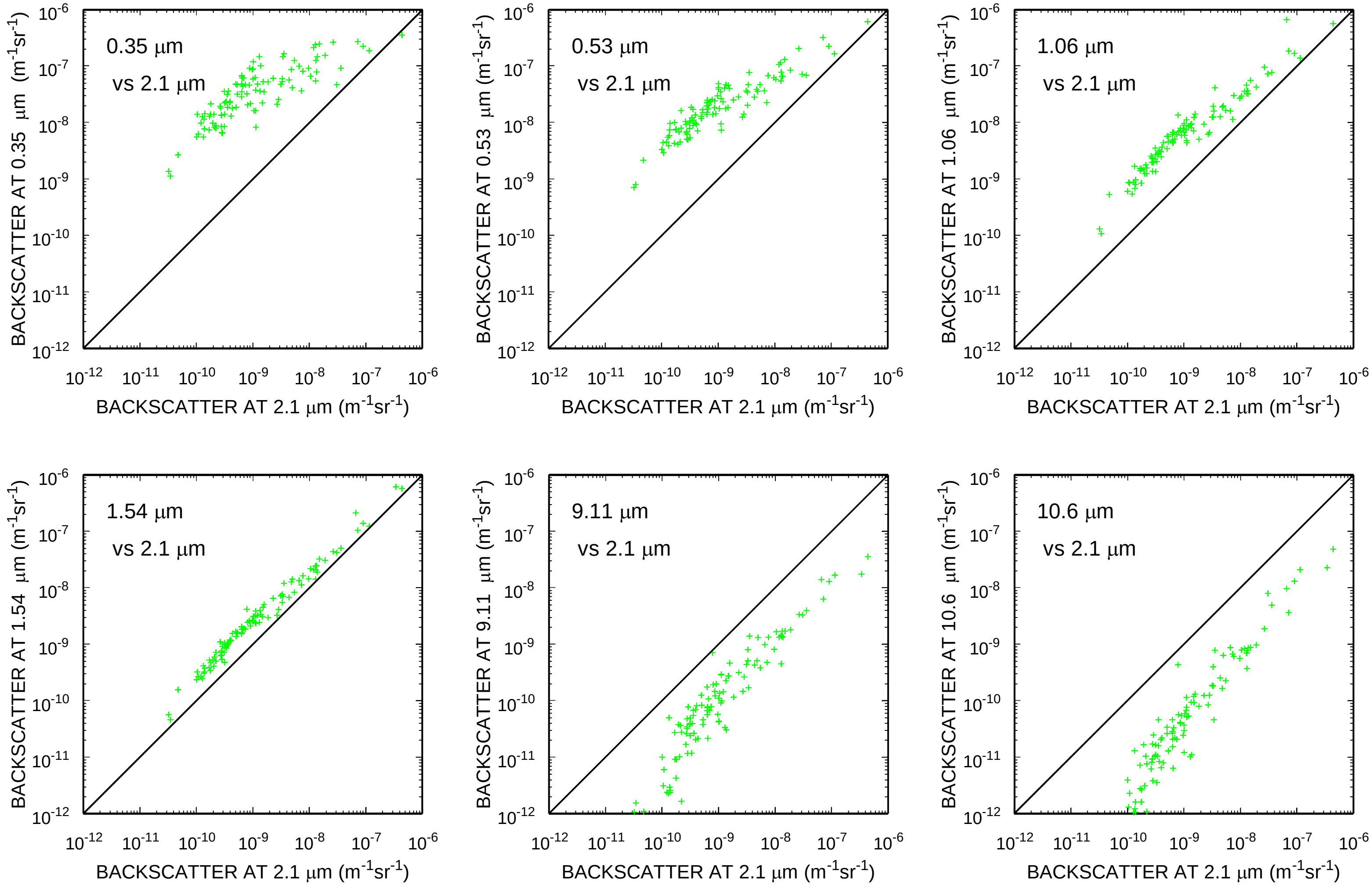
e.g., Srivastava *et al.*, Appl. Opt., Vol. 40, No. 27, pp 4759-4769, 2001

MODELED TROPOSPHERIC AEROSOL BACKSCATTER WAVELENGTH DEPENDENCE

MIE SCATTERING THEORY, SPHERICAL PARTICLES

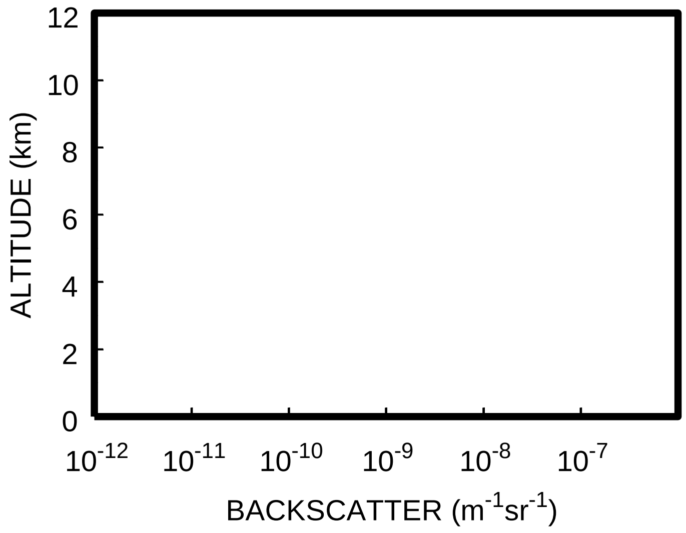
MONTE CARLO, 75% H_2SO_4 (l)

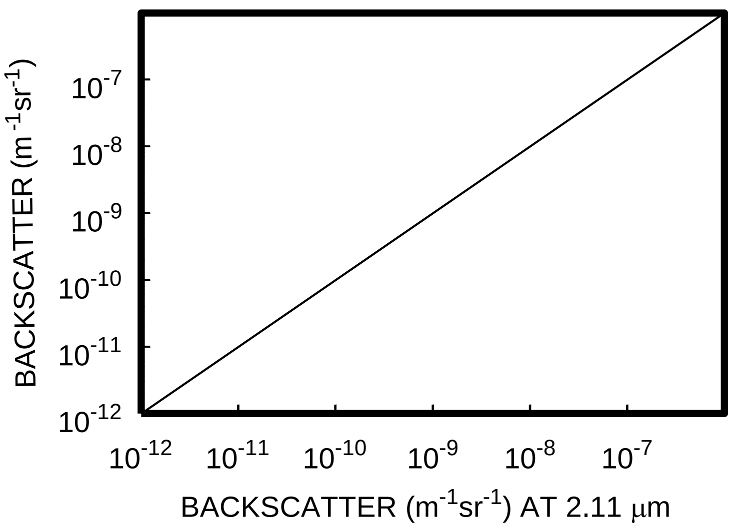
GLOBE II, PACIFIC, 7-11 km, OPC (+)

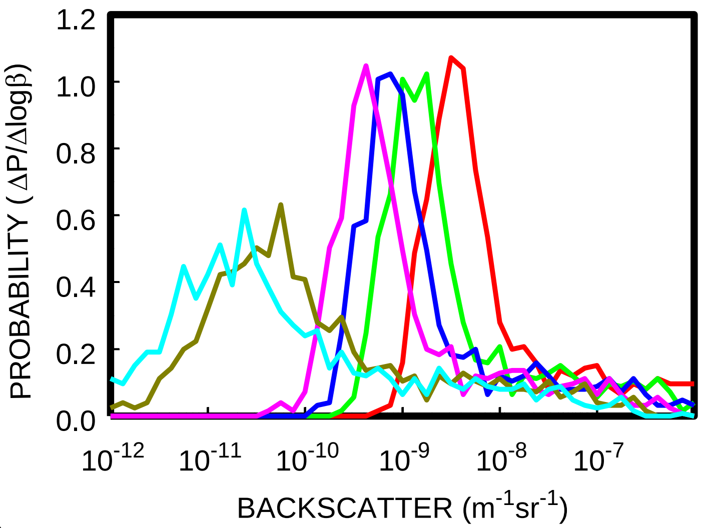


MODELED TROPOSPHERIC AEROSOL BACKSCATTER

VERTICAL STRUCTURE, WAVELENGTH DEPENDENCE, FREQUENCY OF OCCURRENCE







Monte Carlo backscatter climatology, 75% sulfuric acid

0.53 μm
1.06 μm
1.54 μm
2.11 μm
9.11 μm
10.6 μm

middle & lower troposphere (MLT)

$r_g = 0.5\ \mu m$, $\sigma_{rg} = 1.5$

$N_g = 10.0\ cm^{-3}$, $\sigma_g = 1.45$

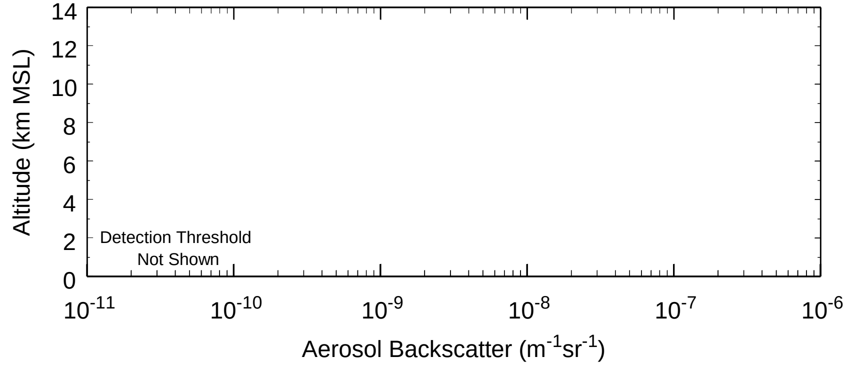
middle & upper troposphere (MUT)

$r_g = 0.2\ \mu m$, $\sigma_{rg} = 1.45$

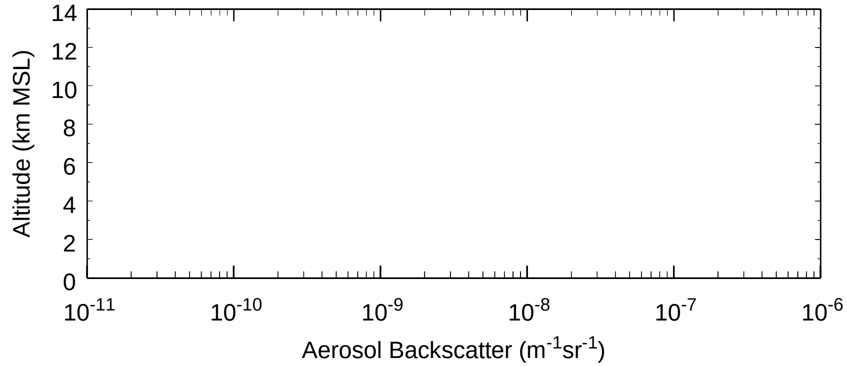
$m_g = 0.1\ \mu g\ kg^{-1}$, $\sigma_g = 1.5$

MLT top = 4.5 km, scale height = 1.4 km, $\sigma_{gsh} = 1.25$

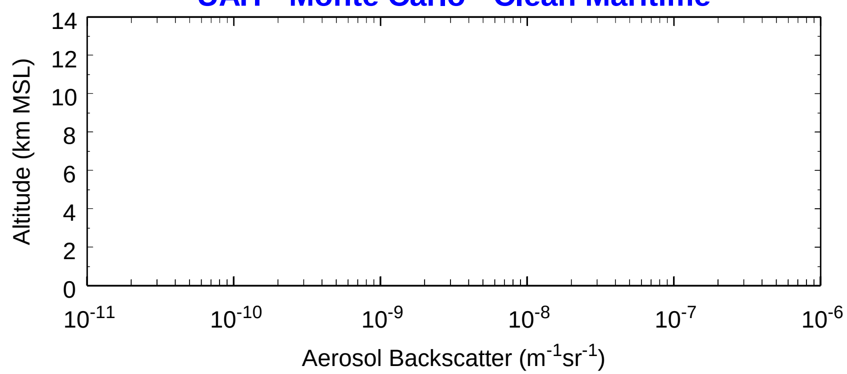
CTI - Ground-Based - Continental

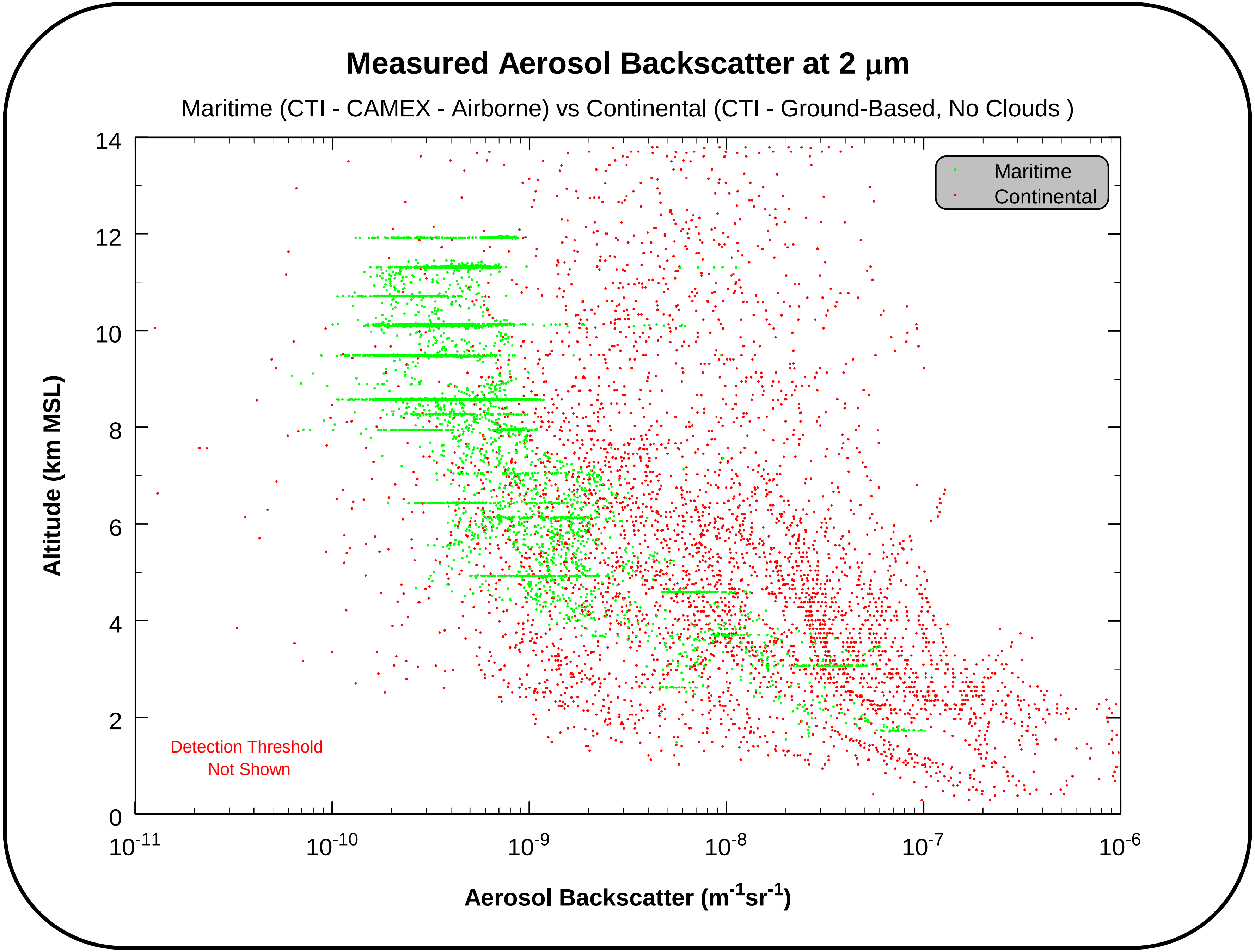


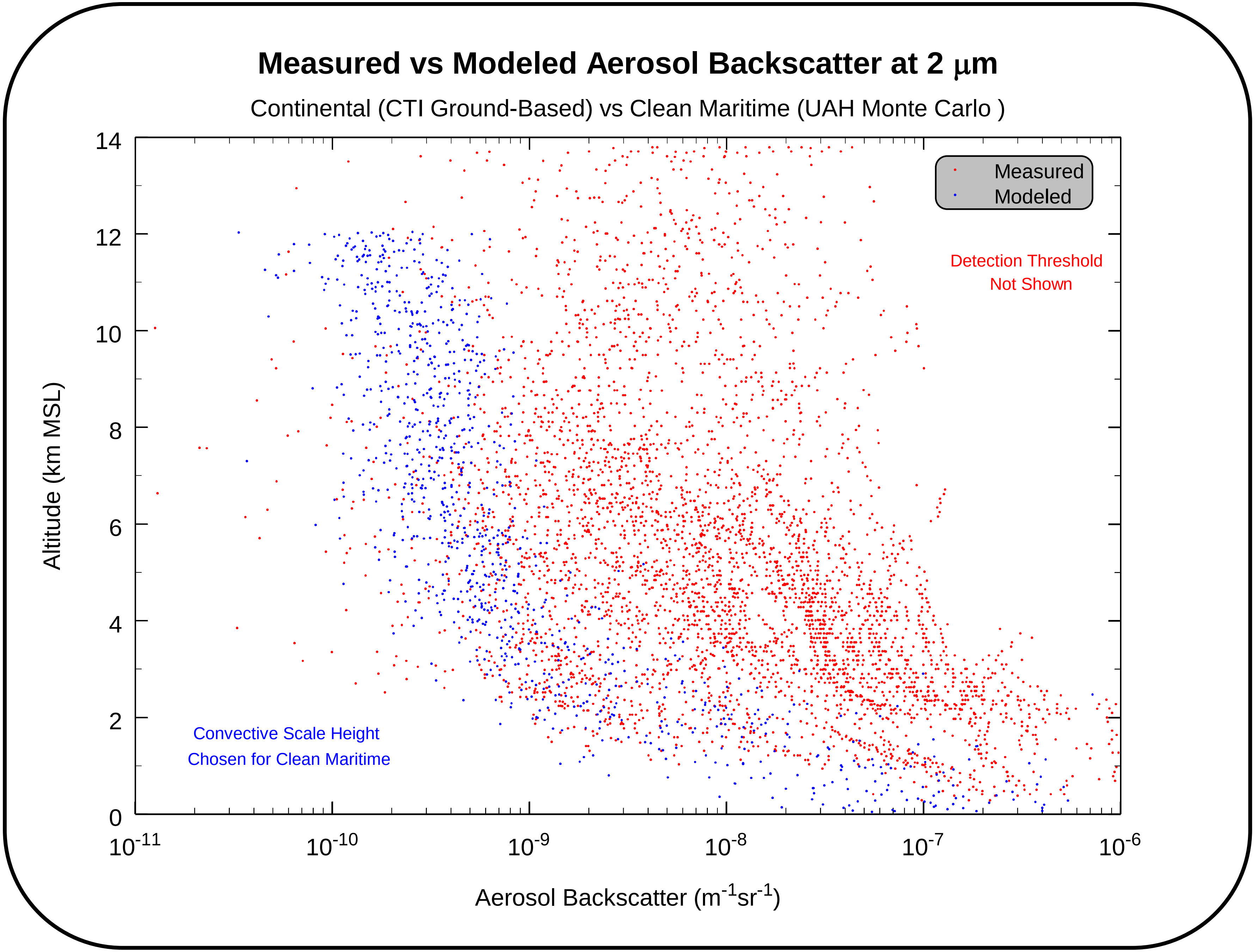
CTI - CAMEX - Modified Maritime



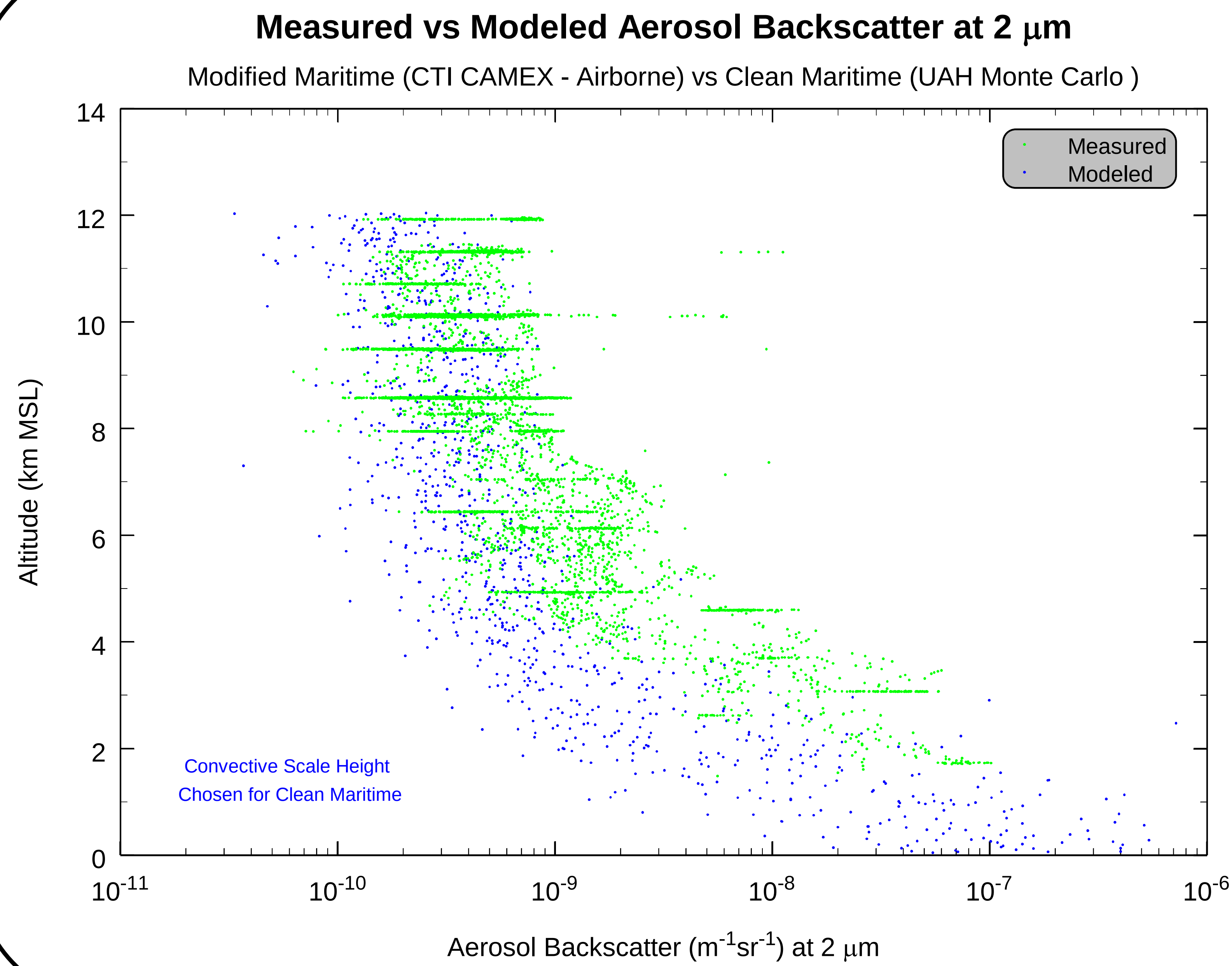
UAH - Monte Carlo - Clean Maritime




Measured Aerosol Backscatter at 2 µm
Maritime (CTI - CAMEX - Airborne) vs Continental (CTI - Ground-Based, No Clouds)
Maritime
Continental
Altitude (km MSL)
14
12
10
8
6
4
2
0
10^{-11}
10^{-10}
10^{-9}
10^{-8}
10^{-7}
10^{-6}
Aerosol Backscatter ($m^{-1}sr^{-1}$)
Detection Threshold
Not Shown



Measured vs Modeled Aerosol Backscatter at 2 μm
Continental (CTI Ground-Based) vs Clean Maritime (UAH Monte Carlo)
Measured
Modeled
Detection Threshold
Not Shown
Convective Scale Height
Chosen for Clean Maritime
Altitude (km MSL)
Aerosol Backscatter ($m^{-1}sr^{-1}$)
0
2
4
6
8
10
12
14
10^{-11}
10^{-10}
10^{-9}
10^{-8}
10^{-7}
10^{-6}



Measured vs Modeled Aerosol Backscatter at 2 µm
Modified Maritime (CTI CAMEX - Airborne) vs Clean Maritime (UAH Monte Carlo)
Measured
Modeled
Convective Scale Height
Chosen for Clean Maritime
Altitude (km MSL)
0
2
4
6
8
10
12
14
10^{-11}
10^{-10}
10^{-9}
10^{-8}
10^{-7}
10^{-6}
Aerosol Backscatter ($m^{-1}sr^{-1}$) at 2 µm

Model Performance – to First Order

- captures backscatter vertical structure
- captures backscatter climatology statistics
- matches backscatter spectral structure, NIR-MIR
- predicts backscatter for data-sparse bands

Potential Refinements

- aerosol response to relative humidity
- more aerosol types in convective mode
- improved background mode, UV-VIS
- stratospheric layer