Aerosol and Cloud Spatial Distributions and Microphysical Properties

Bruce Anderson, Lee Thornhill, Gao Chen, Ali Omar,
Eddie Winstead, and Ed Browell
NASA Langley Research Center, Hampton, VA

Tony Clarke and Cam McNaughton
University of Hawai'i, Honolulu, Hawai'i

LaRC INTEX-NA Objectives

- Obtain high quality in situ measurements of aerosol and cloud particle number densities, volatility, size distribution and optical properties
- Use collected data to identify and characterize North American aerosol sources and sinks and to examine evolution of aerosol properties during transport
- Investigate links between background aerosols and cloud microphysical properties
- Evaluate active remote sensor algorithms that derive aerosol extinction from backscattering measurements

INTEX-NA Mission Preparation

• Questions regarding DC-8 aerosol inlet transmission efficiency were raised based on TRACE-P platform intercomparisons

• Large particles were anticipated to comprise a sizeable fraction of INTEX-NA aerosol loading in some circumstances

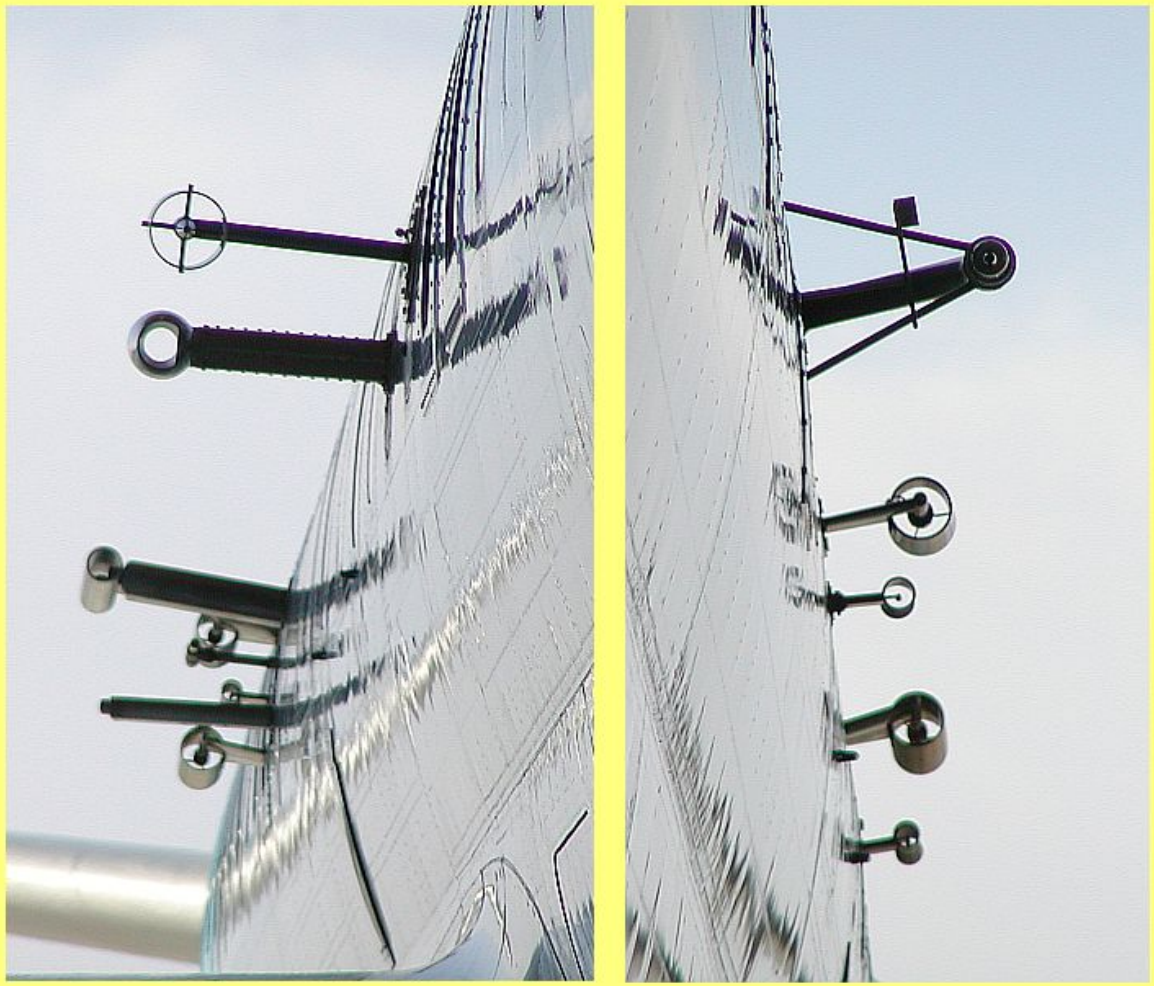
• NASA HQ sponsored mission in 2003 to evaluate performance of potential DC-8 aerosol inlets

• DC-8 Inlet Characterization Experiment (DICE) led by LaRC and included participants from UH, UNH, GIT, LaRC and CIT

DICE: Experiment Plan

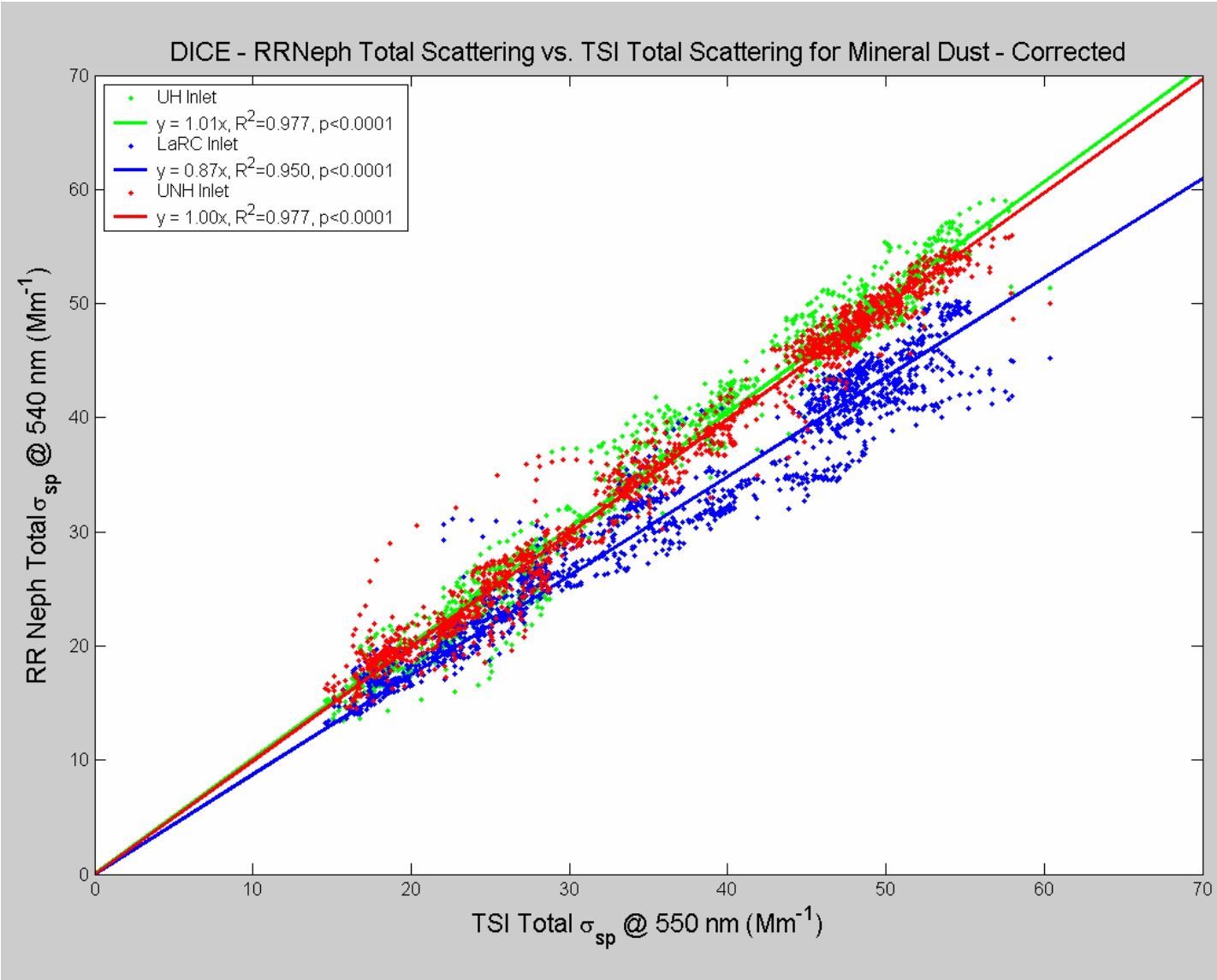
- Installed LaRC, UNH and UH inlets on DC-8 during May 2003 at NASA DFRC
- Connected each inlet to an identical set of instruments to measure particle size, number density and scattering coefficients; placed an additional set of instruments on Edwards Tower
- Performed 8 flights, wherein we flew by Eddie Tower (dust) and Trinidad Head (sea salt) NOAA station
- Also compared relative inlet transmission efficiencies while sampling marine, industrial, and agricultural air masses

DICE: Experiment Plan

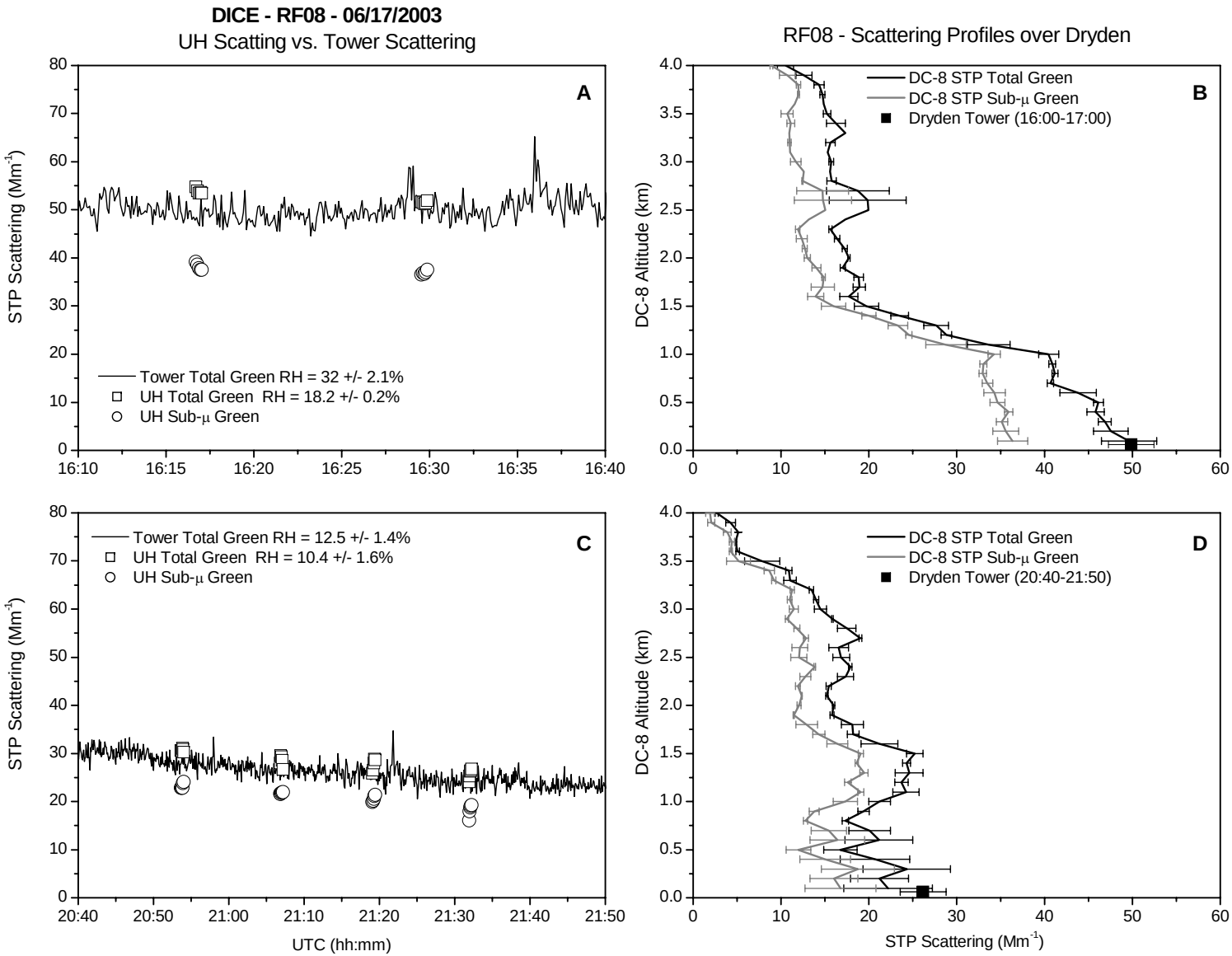


DC-8 DICE/LRR Window-mounted Air Sampling Probes

DICE Inlet Inter-comparisons



DICE DC-8 versus Ground Station



DICE Description and Detailed Results

1) **See http://www-gte.larc.nasa.gov/dice/**

- Flight reports
- White paper
- Experiment plan
- Cool video clips

2) **See Cameron McNaughton's Poster**

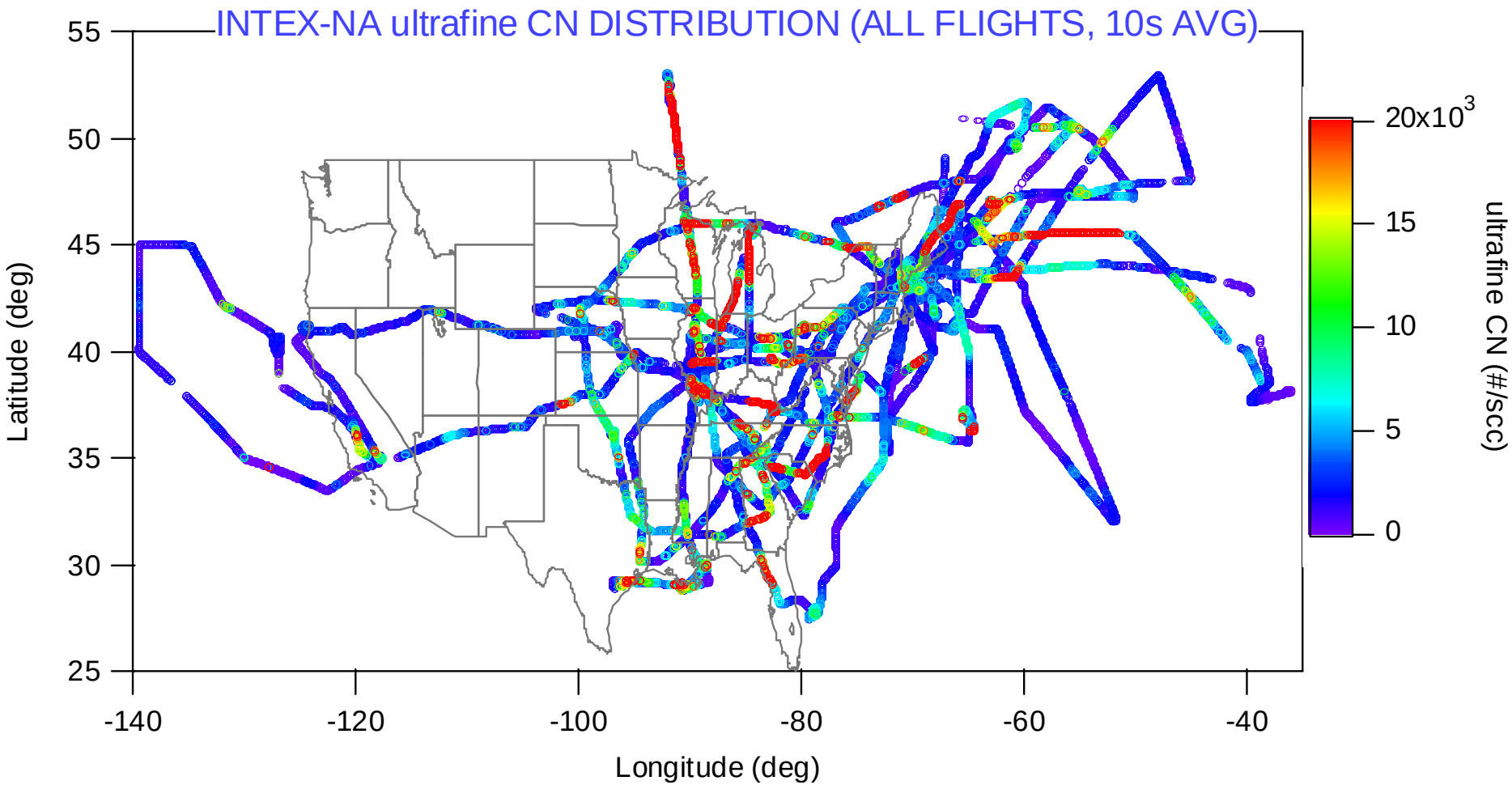
- Comparison of Inlets
- Comparison of DC-8 with Eddie Tower and Trinidad Head

LaRC Instruments (shared with UH)

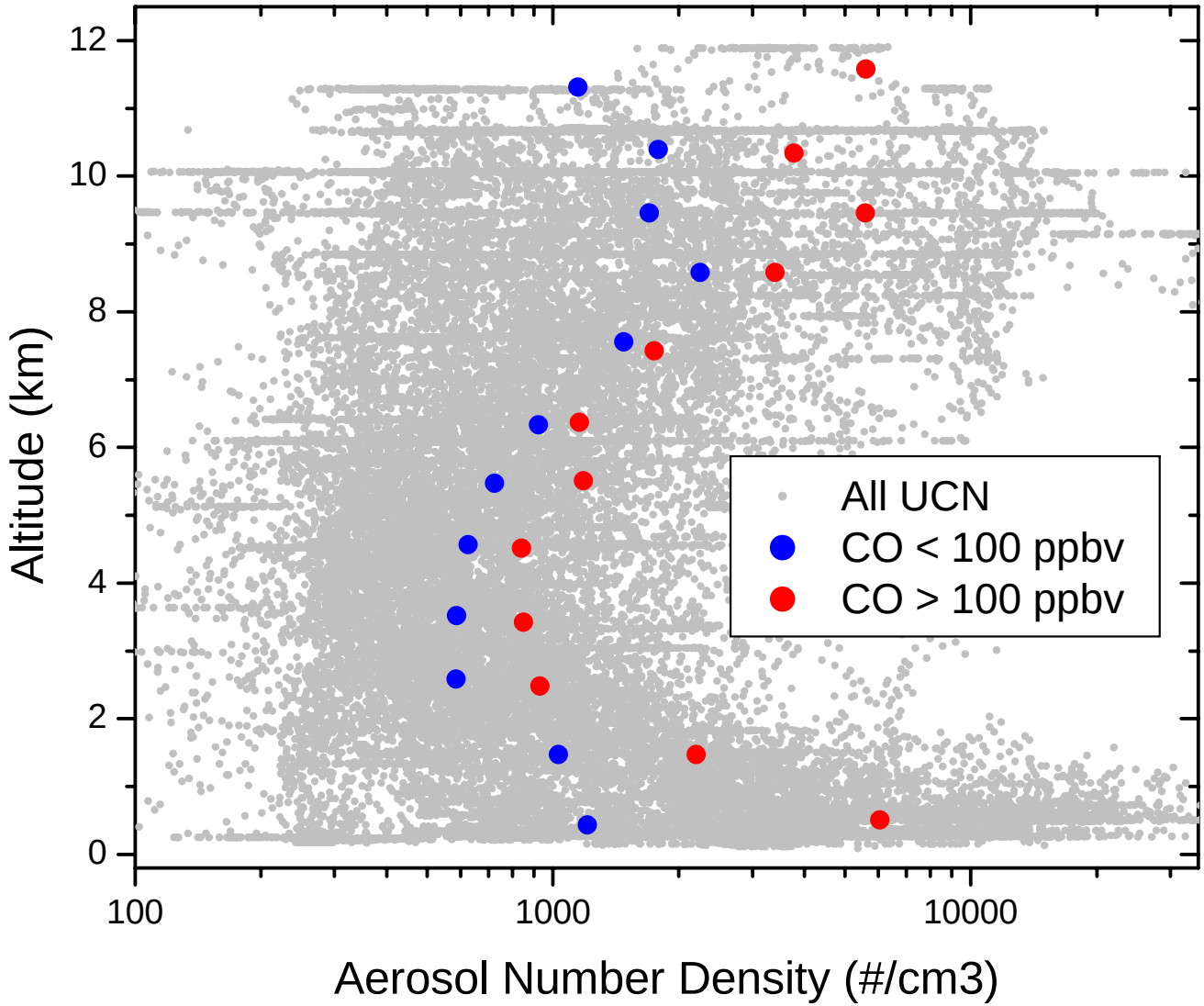
Measured Parameter	Instrument	Size Range (microns)	Response (seconds)	Precision
Total and Ultrafine Aerosols	TSI 3025, TSI 3010	0.003 - 0.01	1	10%
Aerodynamic Particle Size	TSI 3321	0.5 - 10	1	20%
Light Scattering Coefficients at 450, 550, and 700 nm	TSI 3563	< 10	1	1 e-6/m
Black Carbon	PSAP	< 10	10	100 ng/m3
Ambient Aerosol Size	PMS FSSP-300	0.4 - 20.0	1	30%
Cloud Particle Size	DMT CAPS	0.6 - 1550	1	30%
Cloud Liquid Water Content	DMT CAPS	-	1	.01 g/m3

17 total Instruments!

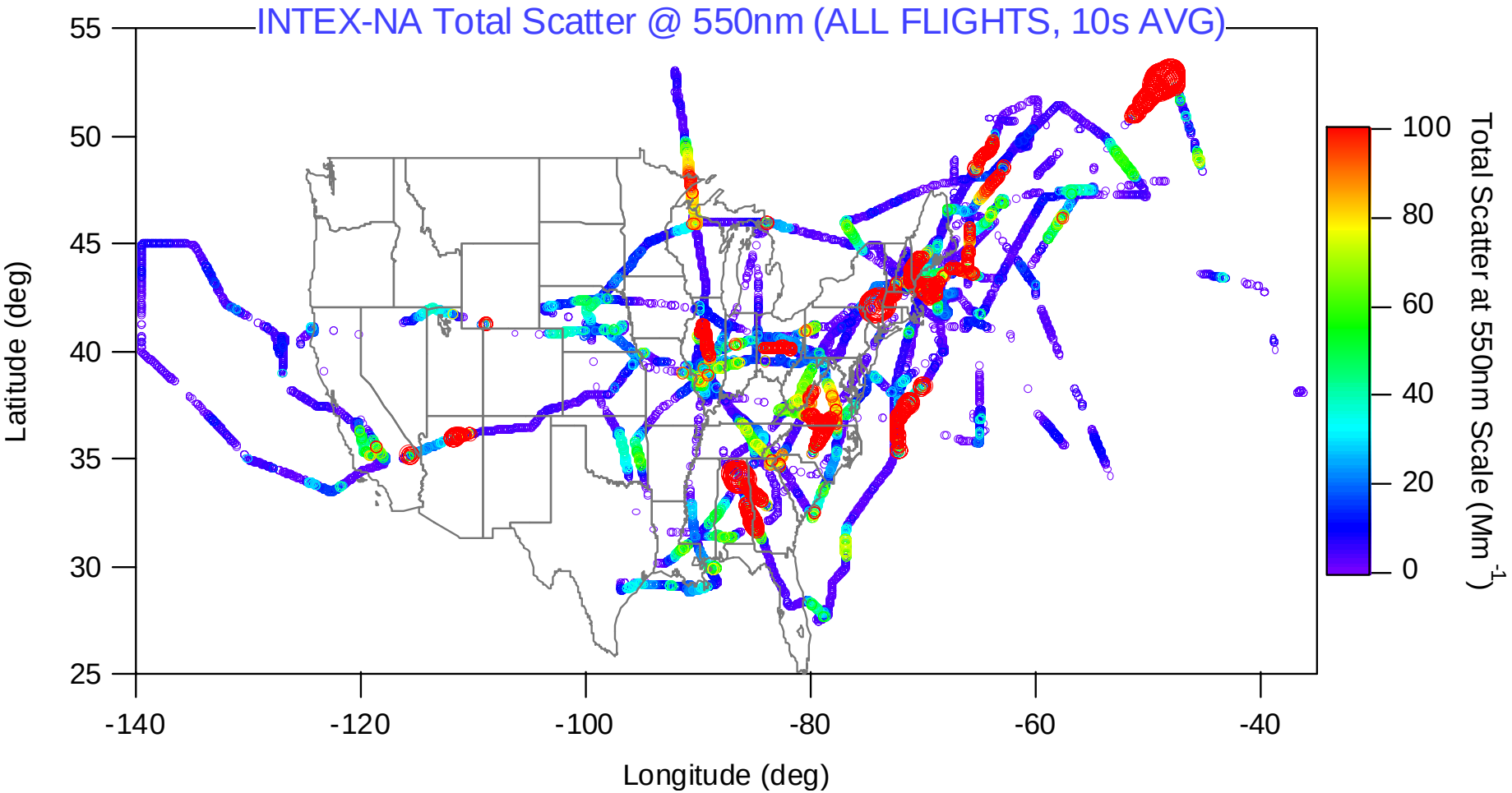
Spatial Variations in Aerosol Density



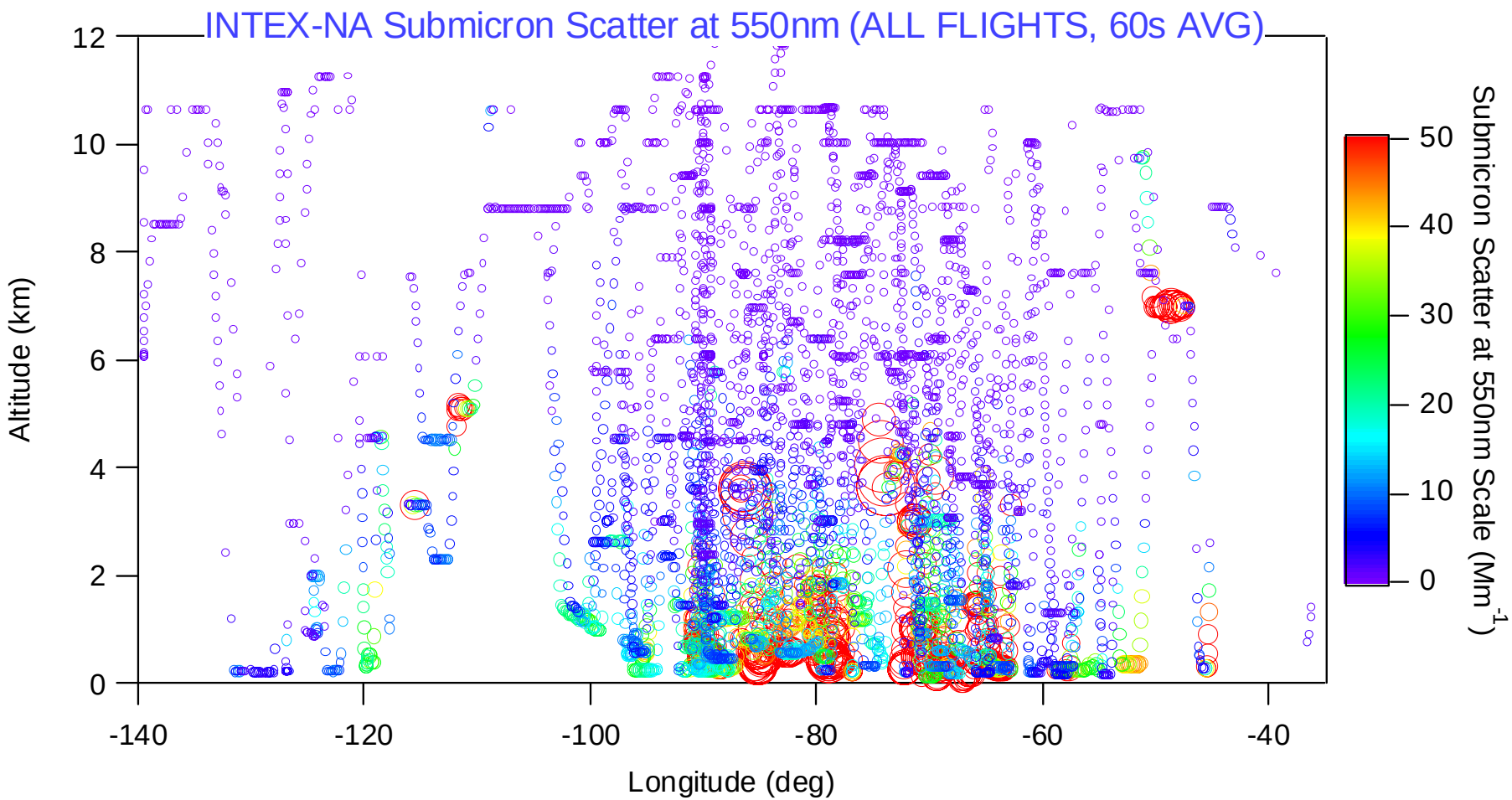
Anthropogenic Effects upon Aerosol Density



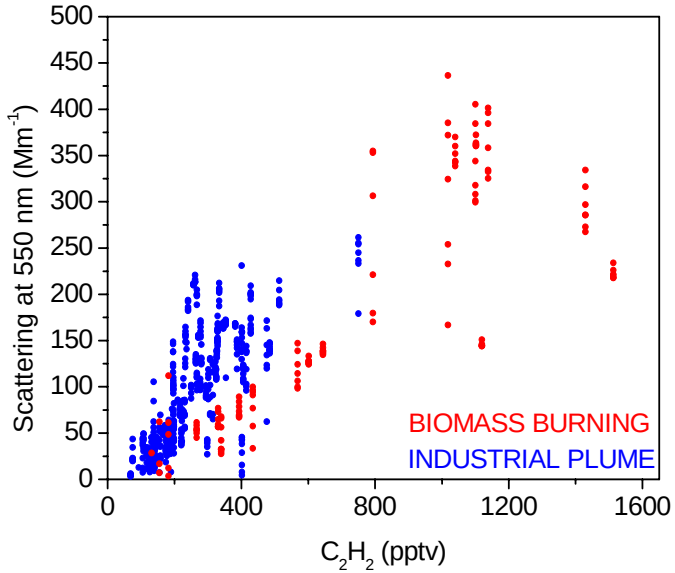
Spatial Variations in Aerosol Scattering

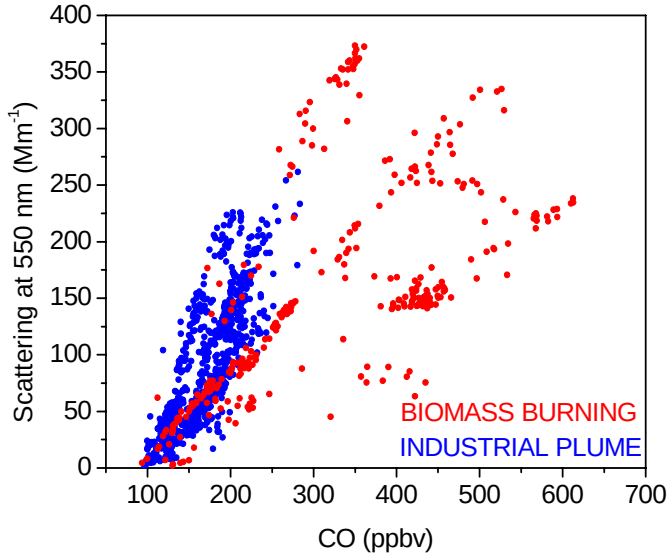


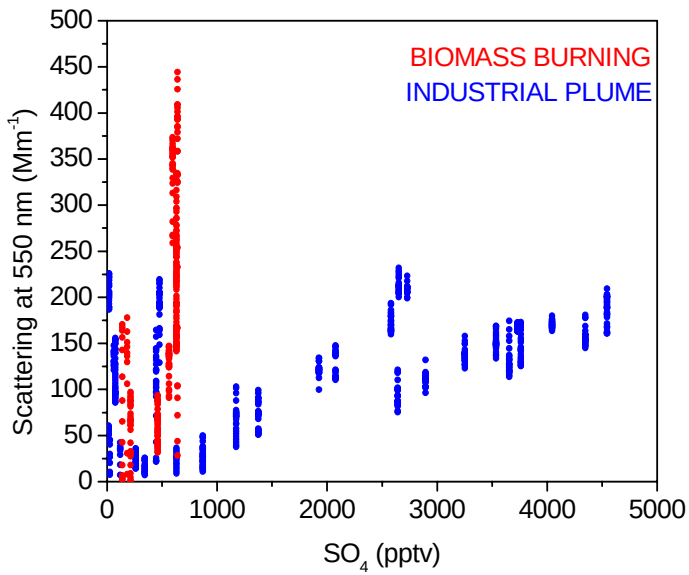
Spatial Variations in Aerosol Scattering

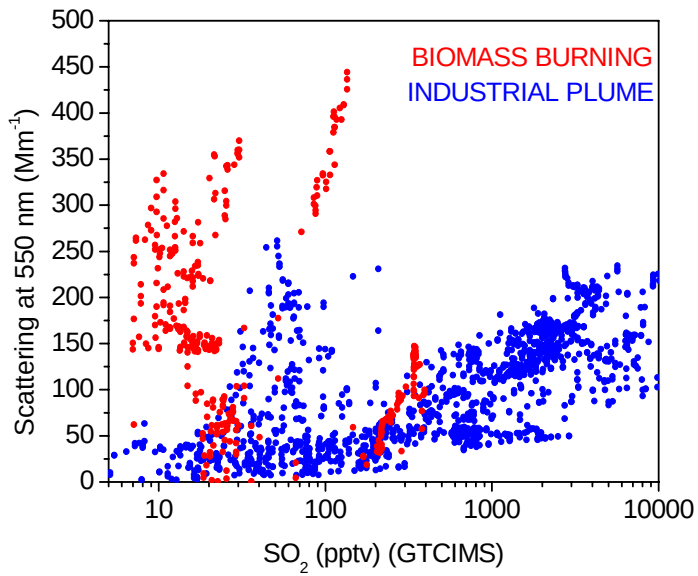


Aerosol Source Characteristics

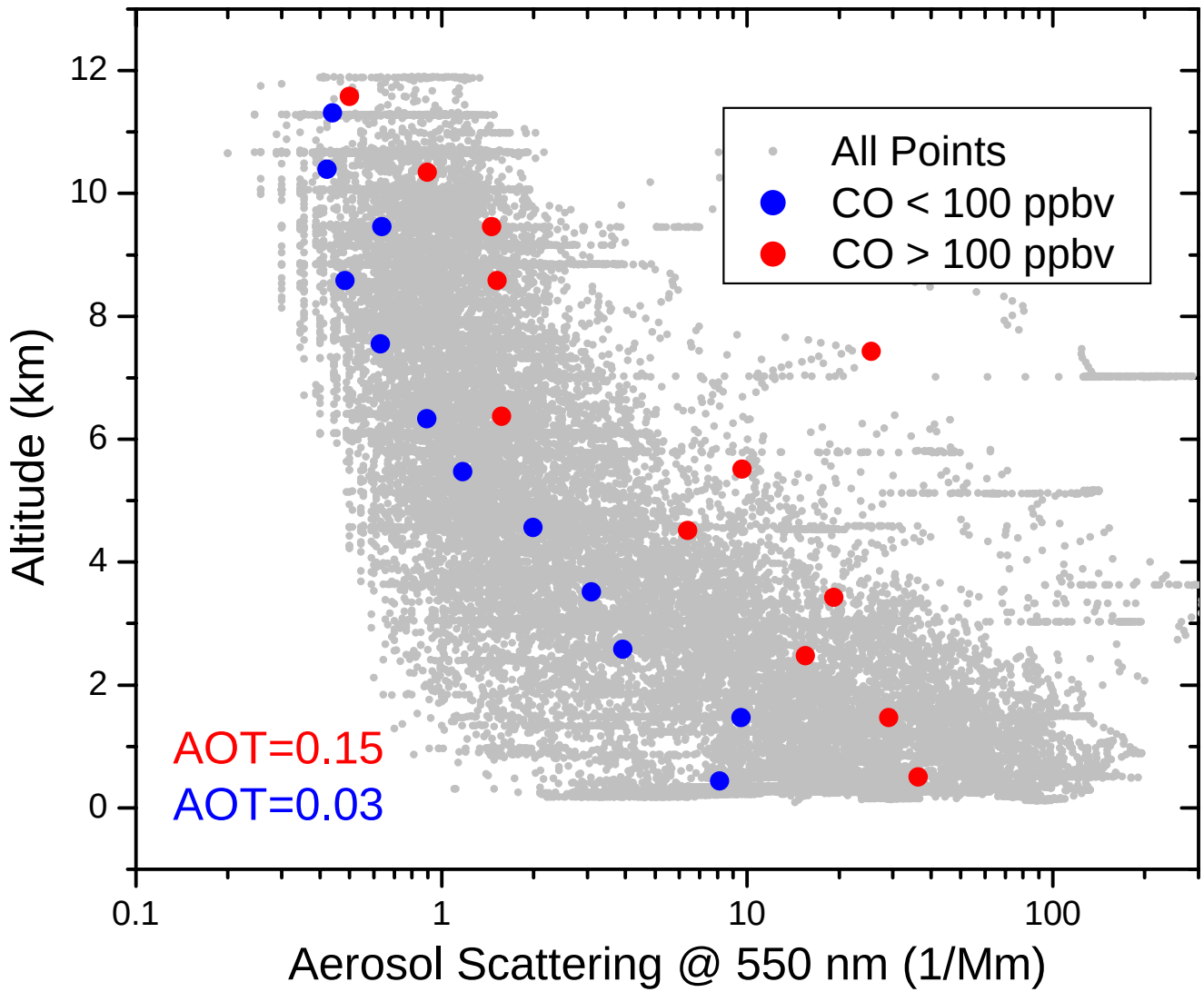




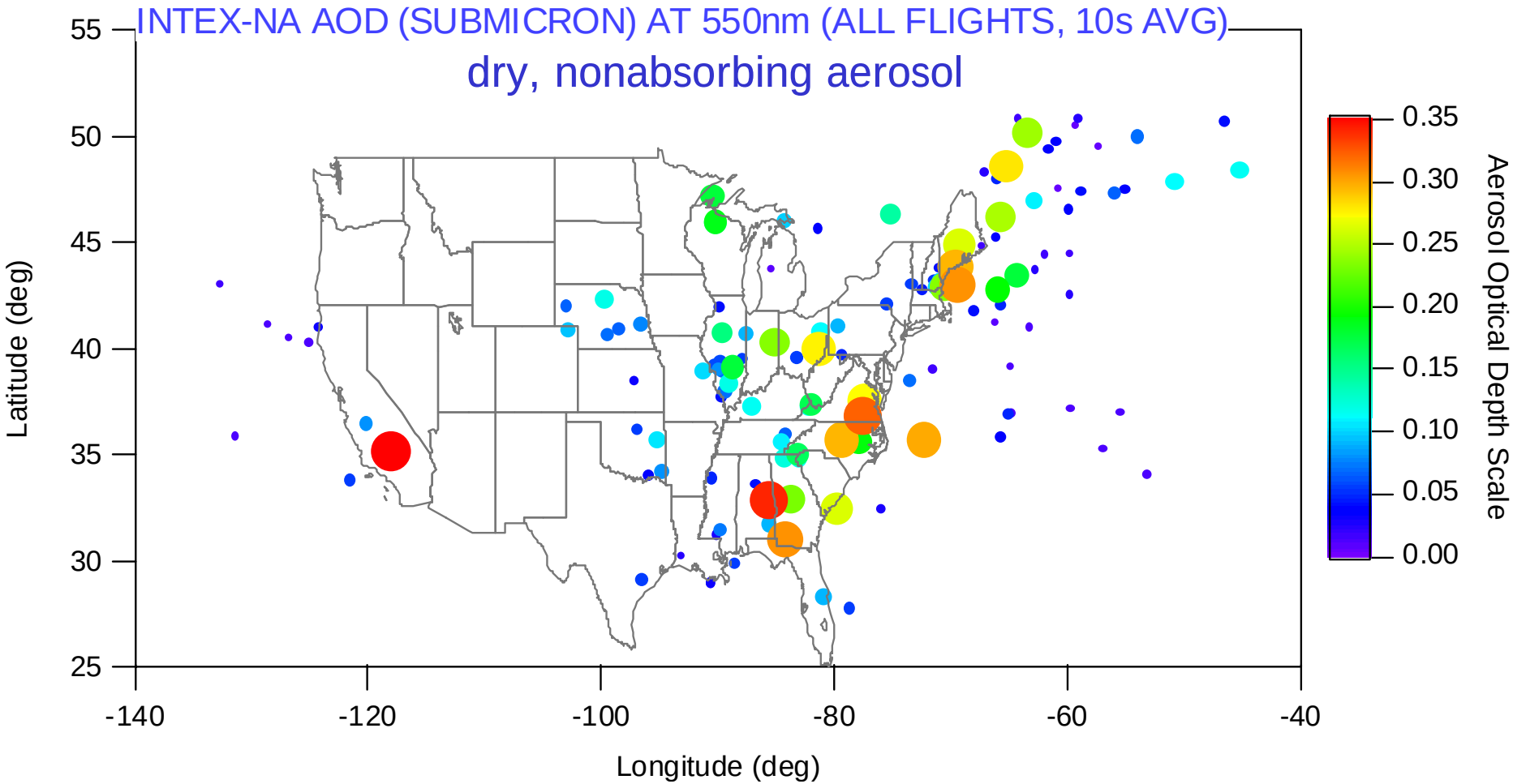




Anthropogenic Effects upon Aerosol Scattering

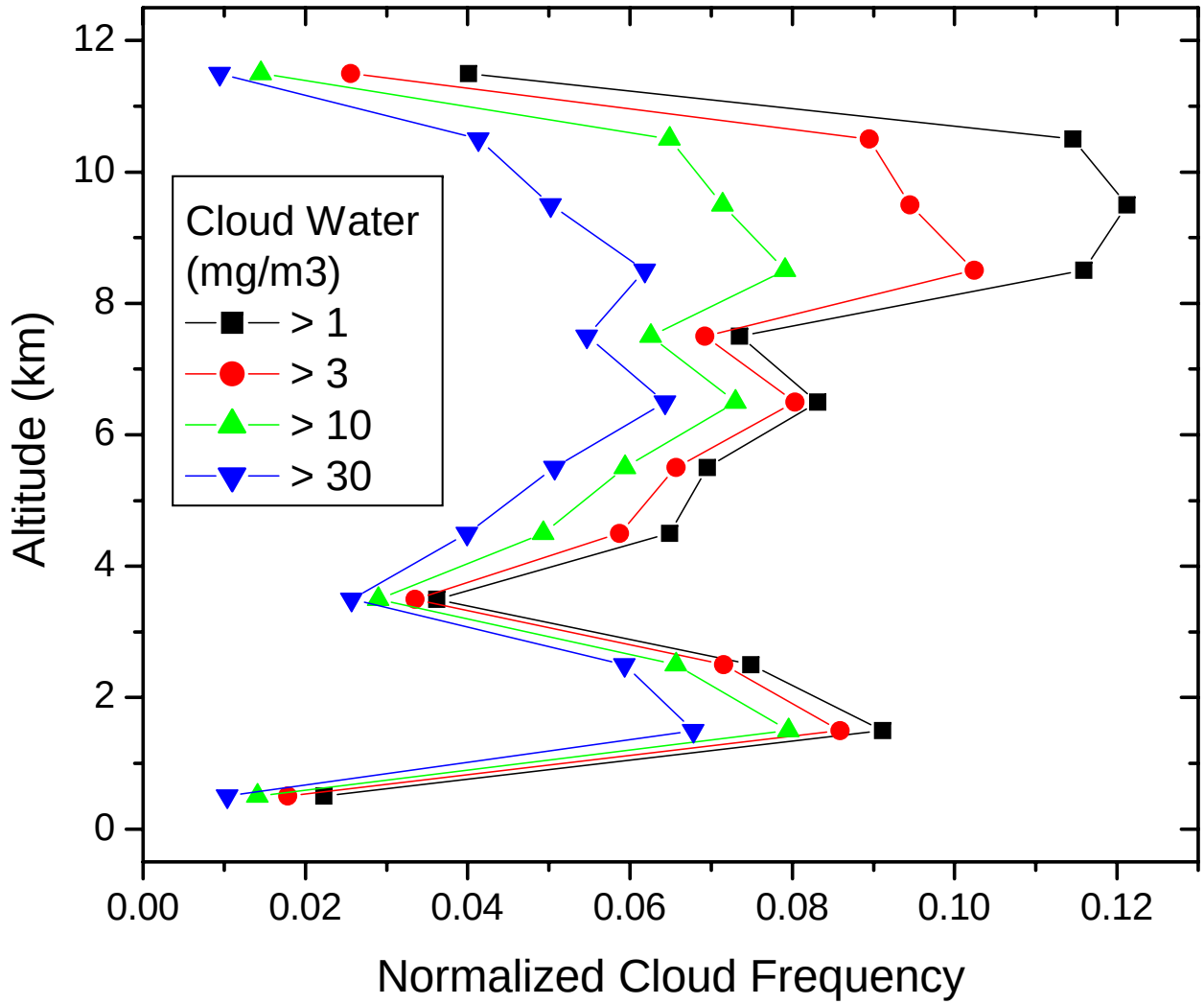


Continental Aerosol Impact on Radiative Forcing

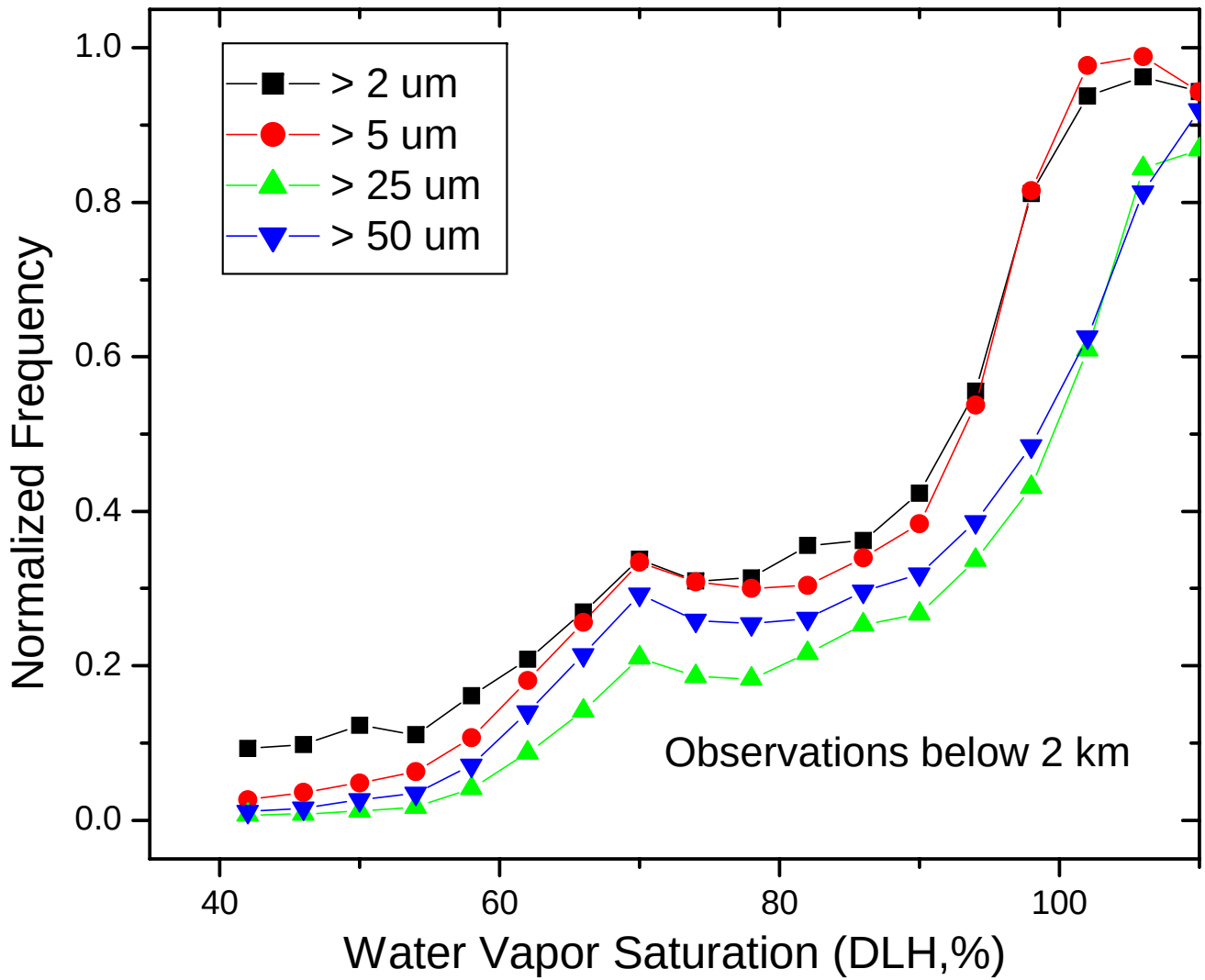


INTEX-NA DC-8 Cloud Observations

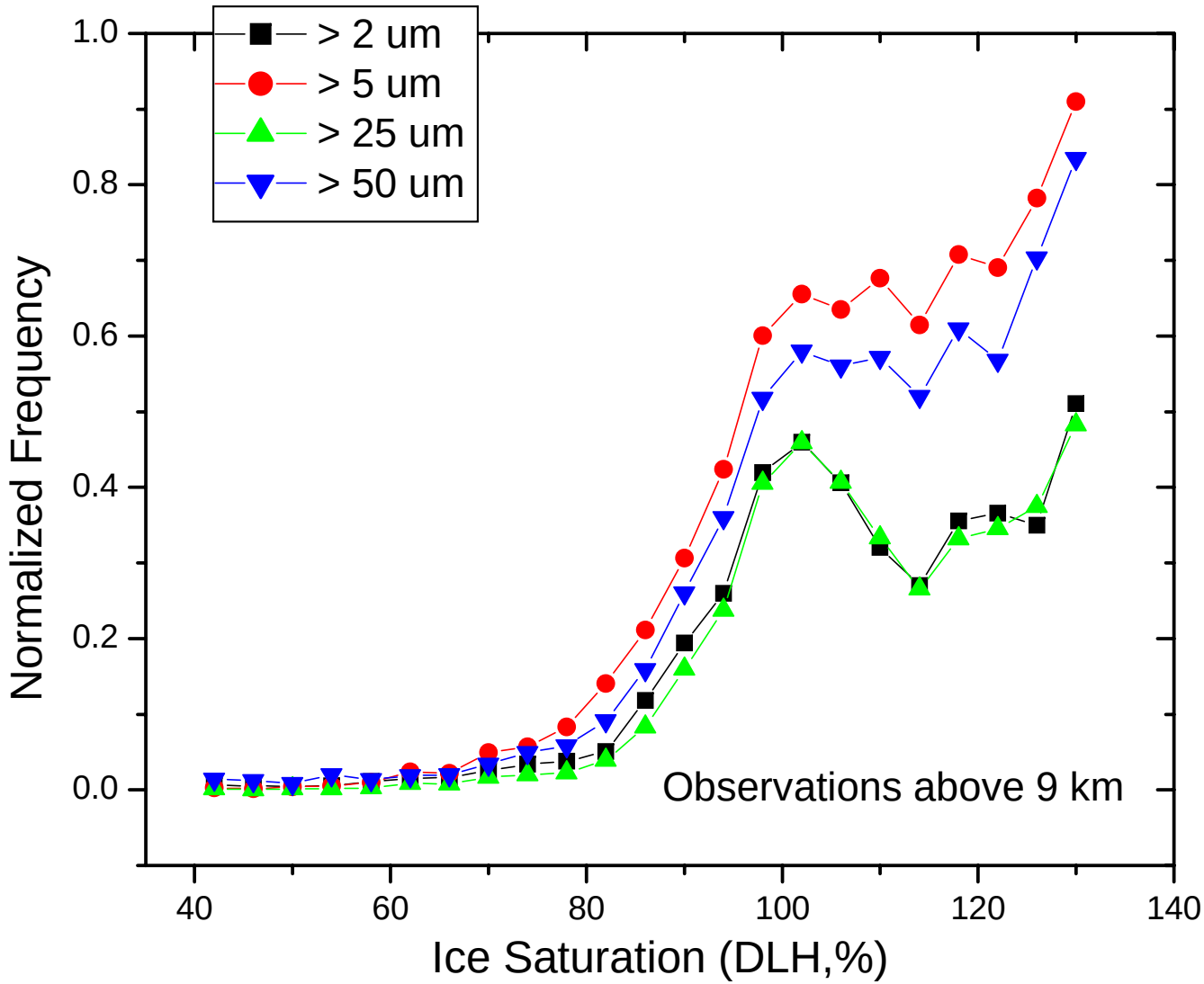
INTEX-NA DC-8 Cloud Sampling Frequency



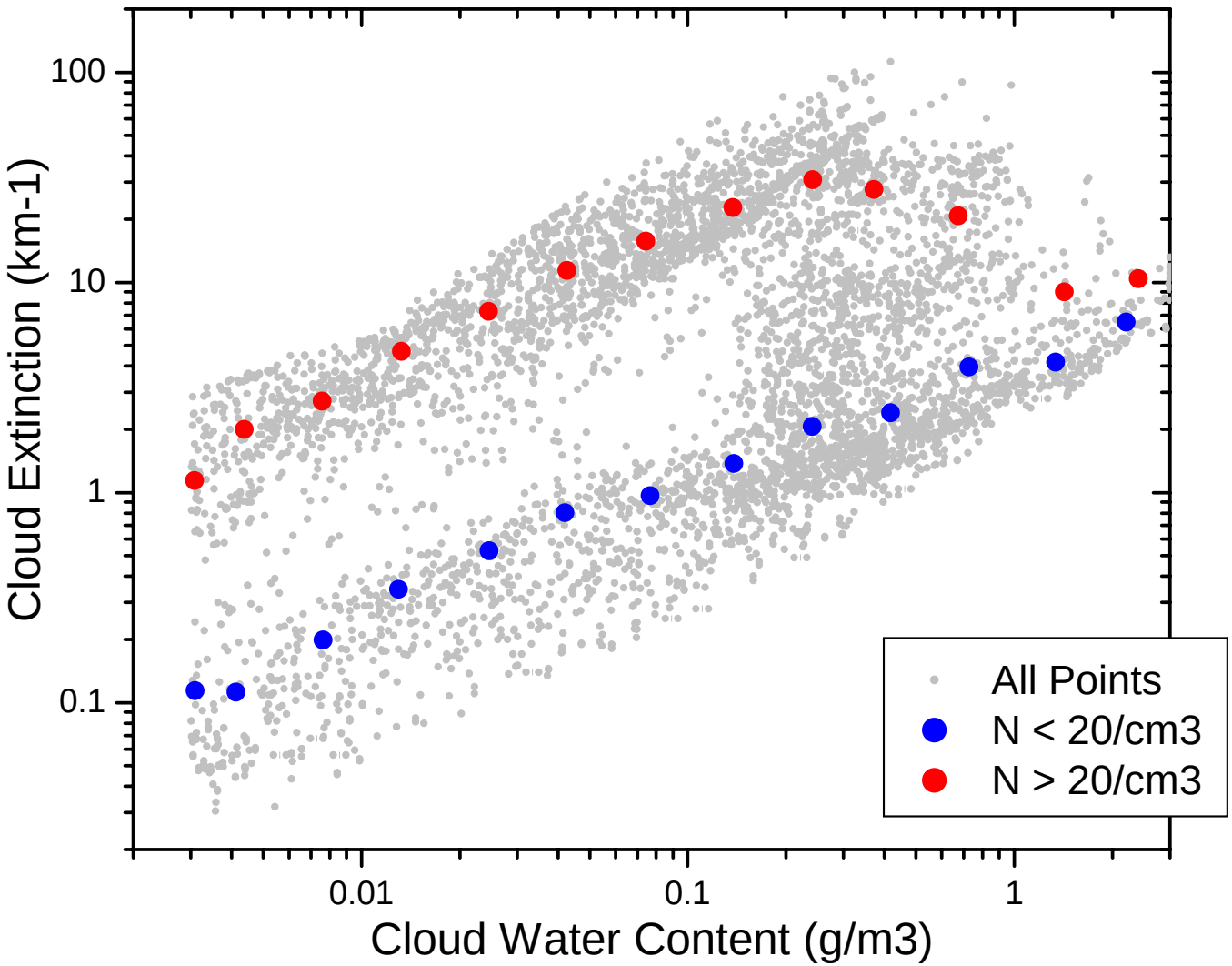
Warm Cloud Relationship with Humidity



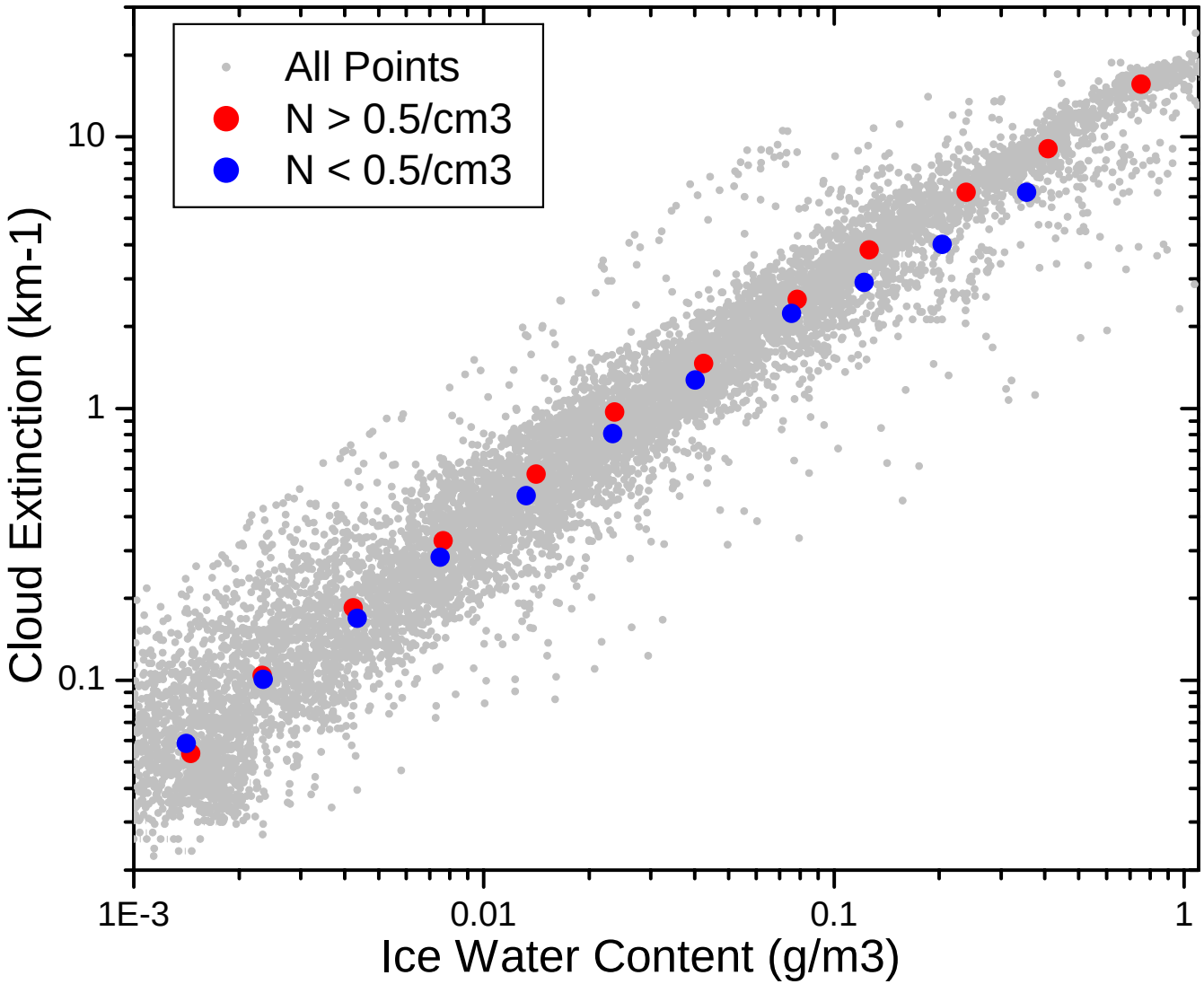
Ice Cloud Relationship with Humidity



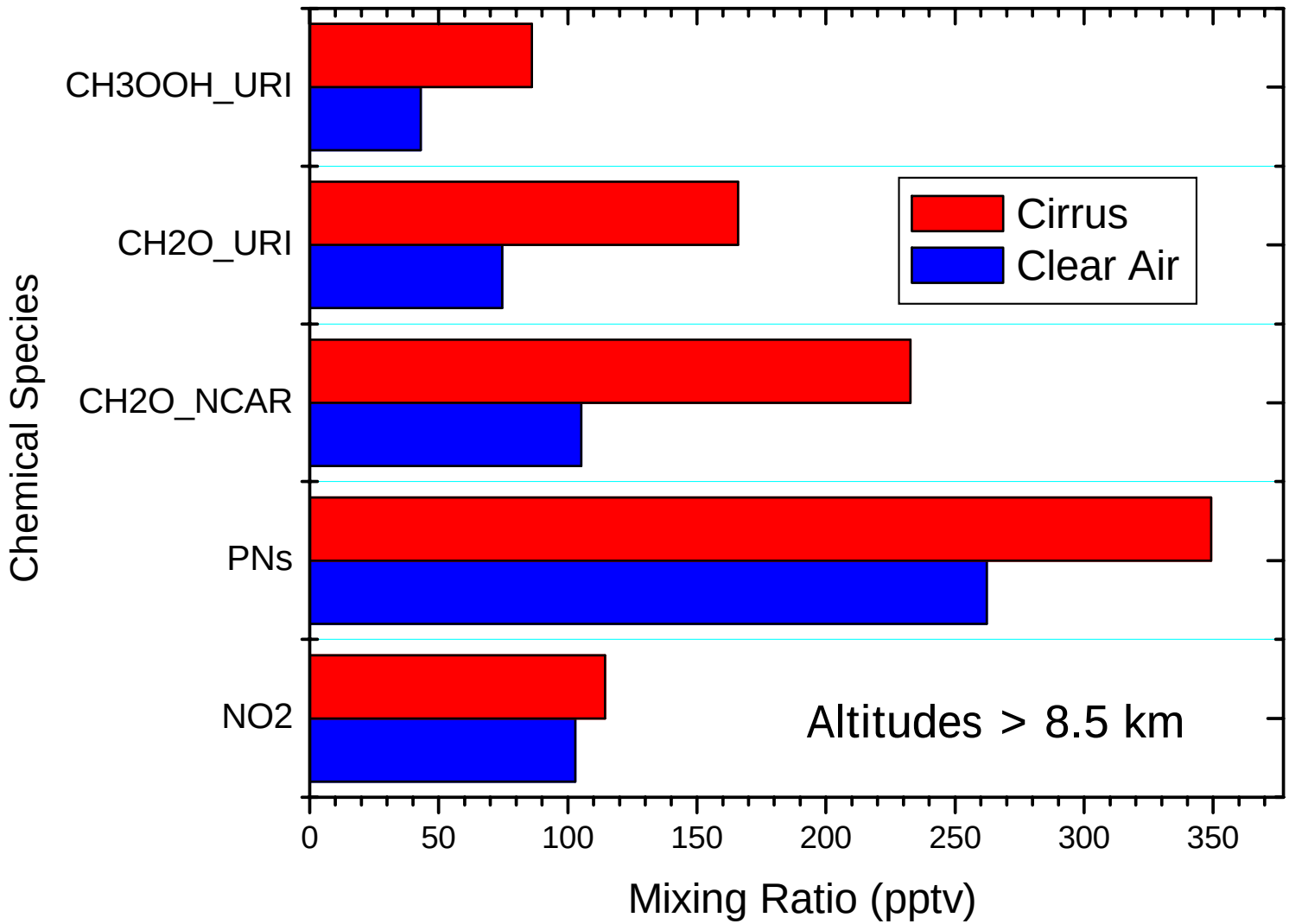
Warm Cloud-Aerosol Interactions



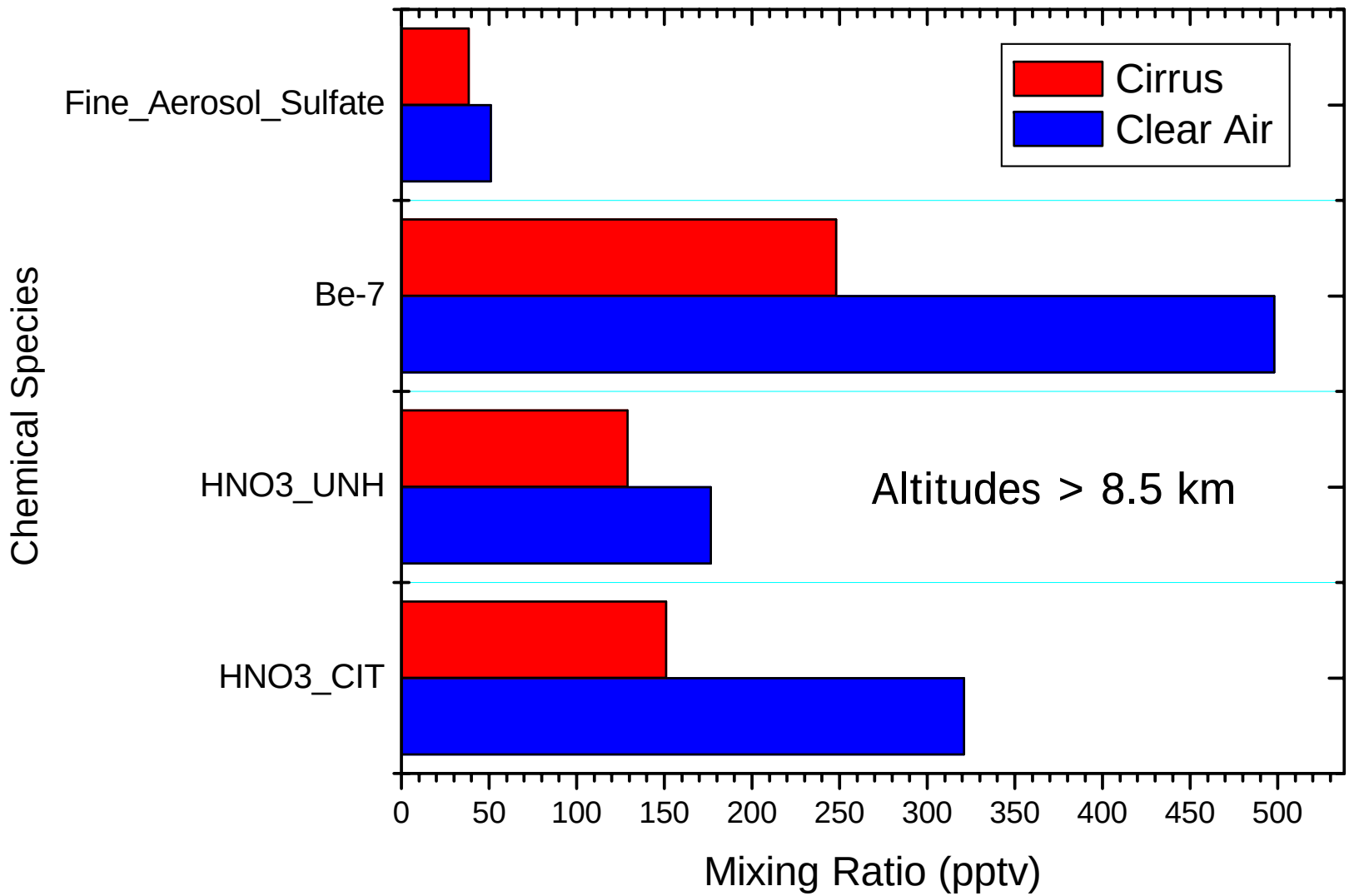
Cirrus Cloud-Aerosol Interactions



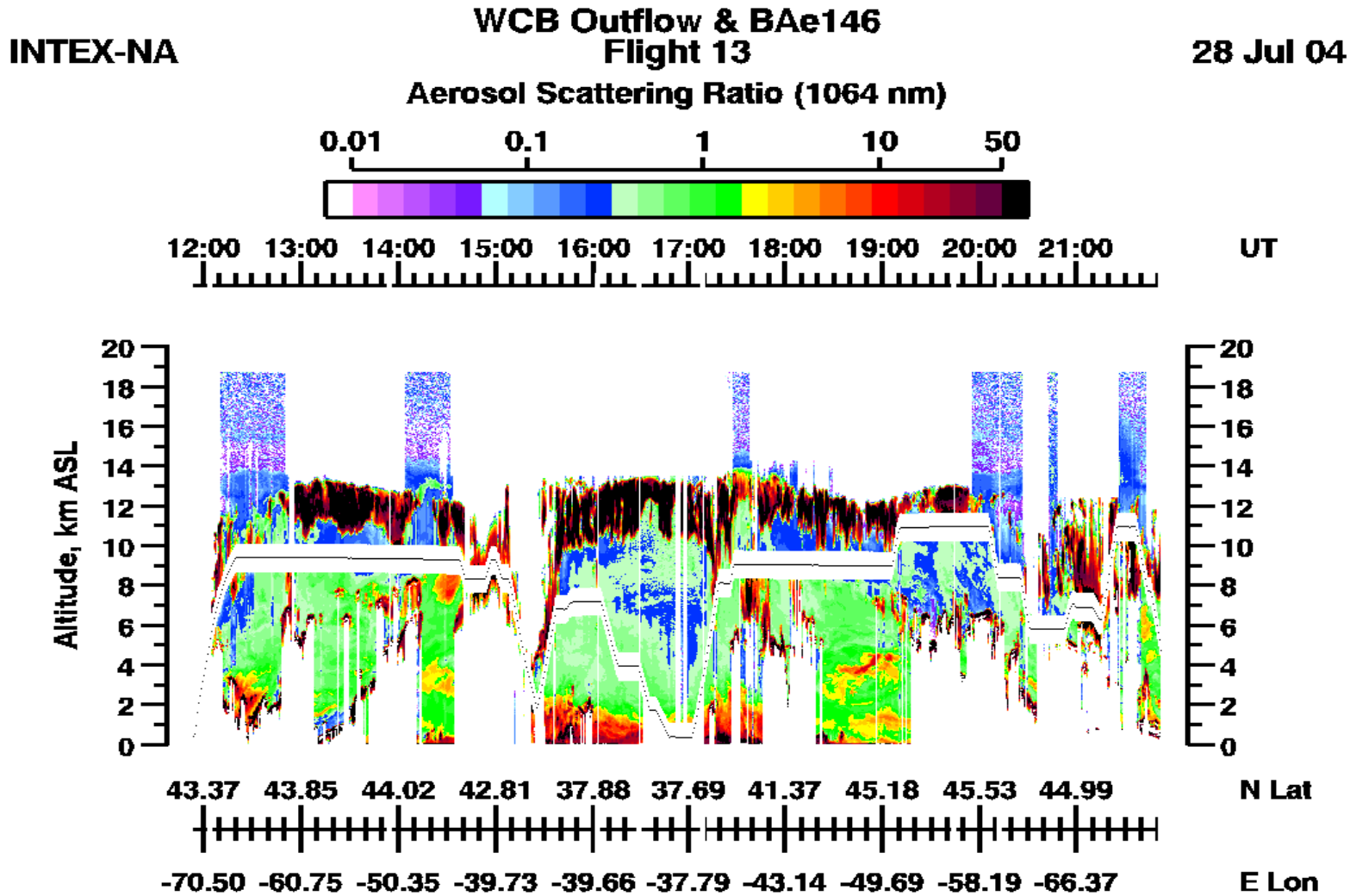
Cloud Impact on Atmospheric Composition



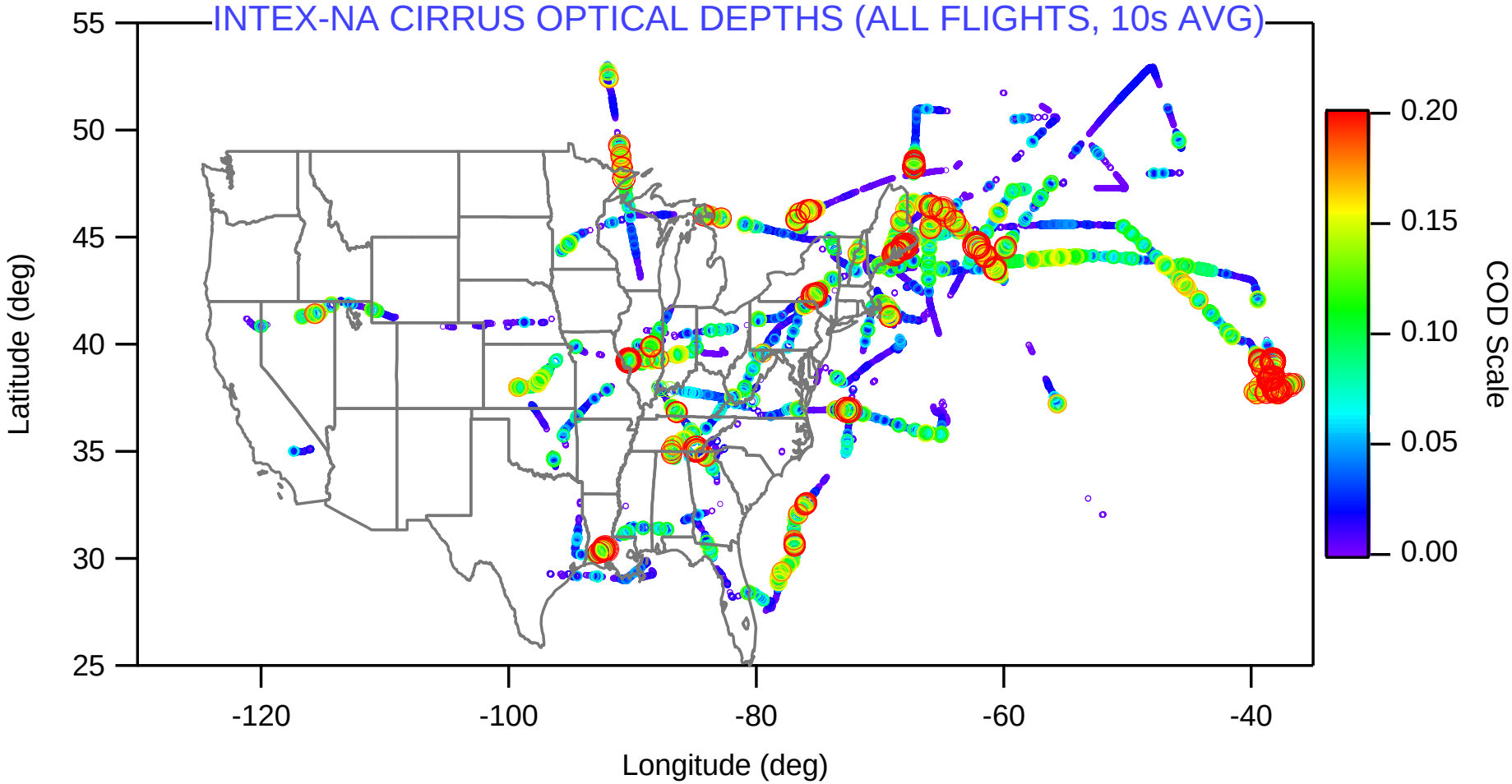
Cloud Impact on Atmospheric Composition



INTEX-NA UV-DIAL Cirrus Observations



UV-DIAL Cirrus Cloud Optical Depths



Remaining Tasks and Future Work

- Work with UH to complete DICE paper
- Apply more realistic density factors to ice particle data and recalculate ice water contents
- Work with UH (and others) to further develop characterization of aerosol sources and sinks, transformation processes and assess radiative impacts
- Continue cloud investigation, examining case studies, and performing lidar data interpretation more carefully
- Perform comparison of UV-DIAL extinctions with in situ observations to evaluate CALIPSO algorithms
- Work with Diskin/Sachse to develop better cloud microphysical sensors for INTEX-B