SPEC inc

Preliminary Results from SPartICus (Small Particles in Cirrus) Project

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ARM
CLIMATE RESEARCH FACILITY

SPartICus

Small Particles in Cirrus

U.S. DEPARTMENT OF ENERGY | Office of Science

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SPartICus Science Questions

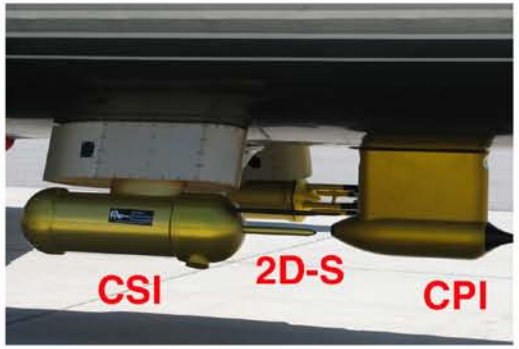
1. To what degree do small particles (i.e., < 50 μm diameter) contribute to the mass and radiative properties of mid-latitude cirrus?

2. How do cloud-scale dynamical processes control the evolution of cirrus properties through nucleation, particle growth, and sublimation?

3. What degree of complexity is required in cloud property retrieval algorithms, and what minimal set of algorithms can be used to rigorously describe cirrus microphysical properties using ground-based ACRF data?

SPEC Learjet Research Aircraft

Fast FSSP	AIMMS-20 Air Motion	Differential GPS
CDP	CSI IWC	Ver. 3 HVPS
2D-S	Nevzorov LWC/TWC (2)	RVSM Pitot/Static
CPI	NASA Diode Laser Hygrometer	Rosemount Temp



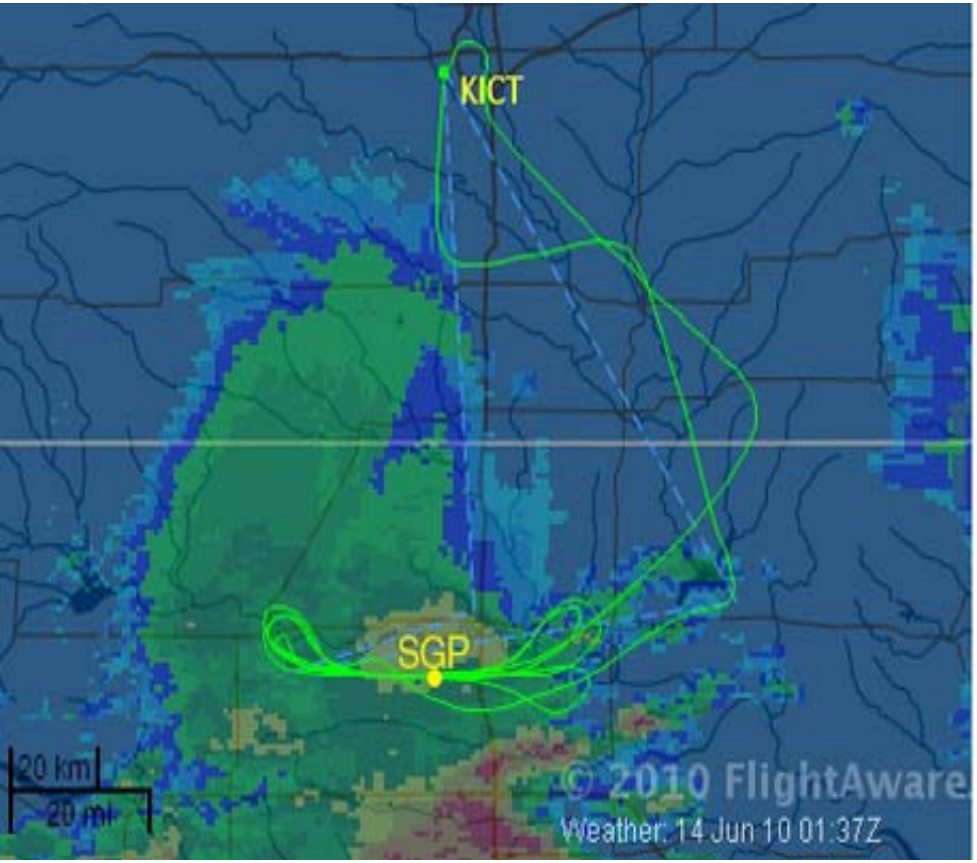
Mission Profiles

1. **190 Flight Hours from January – July 2010. Lear based out of Rocky Mountain Metro Airport near Boulder, CO. Approximately 60 flights and 100 hours of data collected in clouds.**

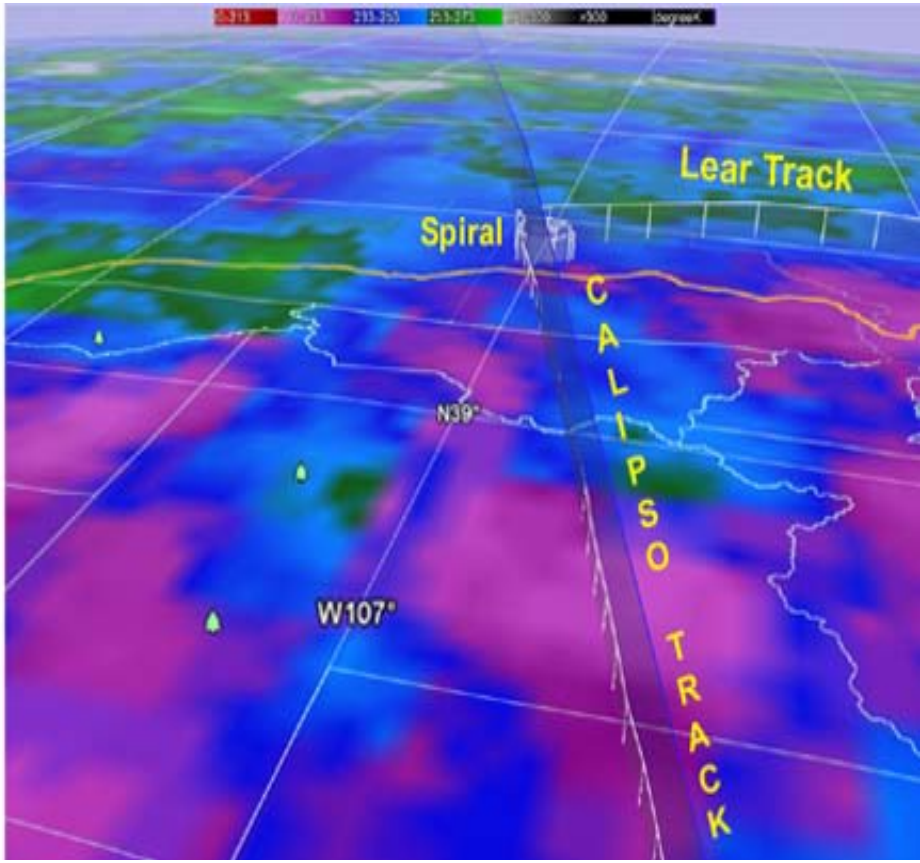
2. **Flights with spirals and horizontal step-down/up legs in synoptically-generated and anvil-generated cirrus over the ARM Southern Great Plains (SGP) site in North Central Oklahoma.**

3. **Flights with spirals and horizontal step-down/up legs in synoptically-generated and anvil-generated cirrus under A-Train (Calipso/CloudSat) satellite tracks within 400 nm of Boulder, CO and the SGP.**

Anvil Investigation over the ARM SGP on 14 June 2010



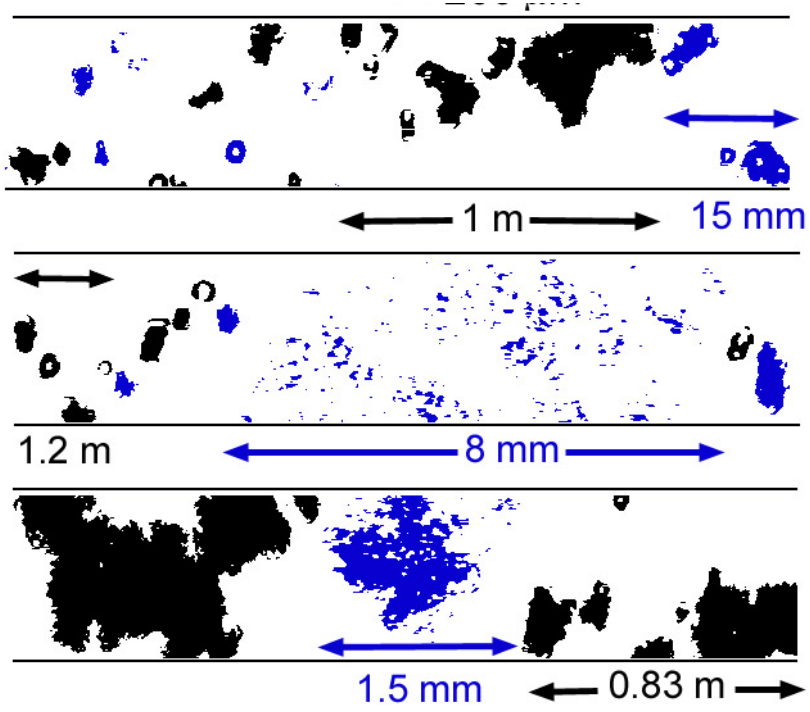
CALIPSO/CloudSat Satellite Overpass Near Amarillo Texas on 27 March 2010

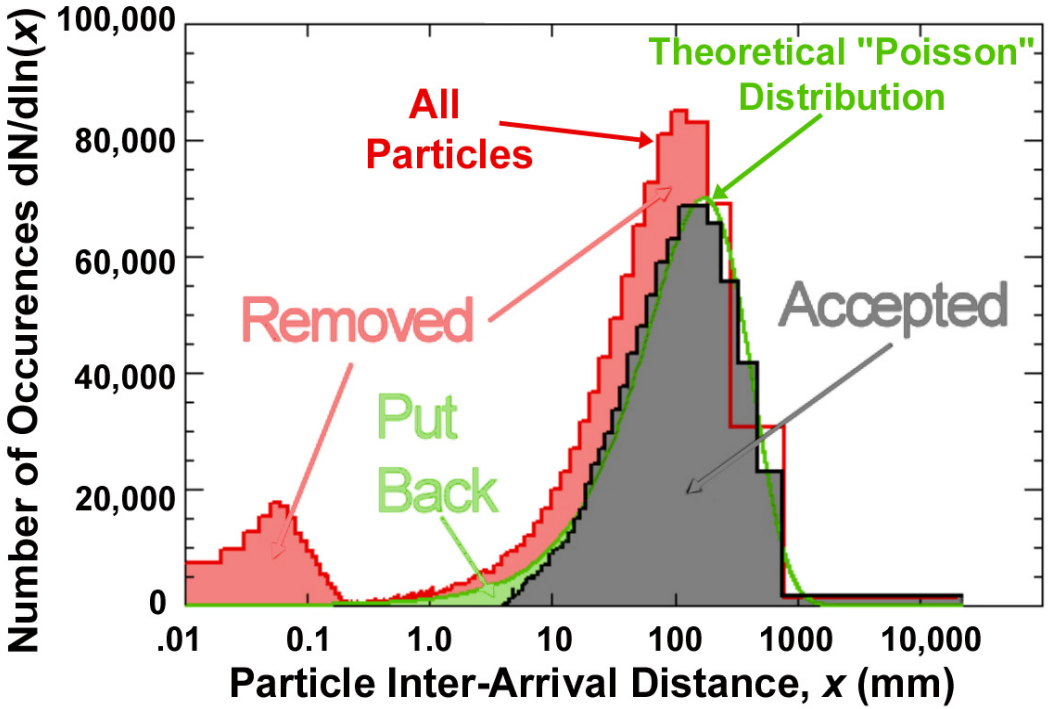


1. Shattering on 2D-S Probe Appears to Behave Differently than 2D-C and CIP (as Reported by Korolev in AIIE).

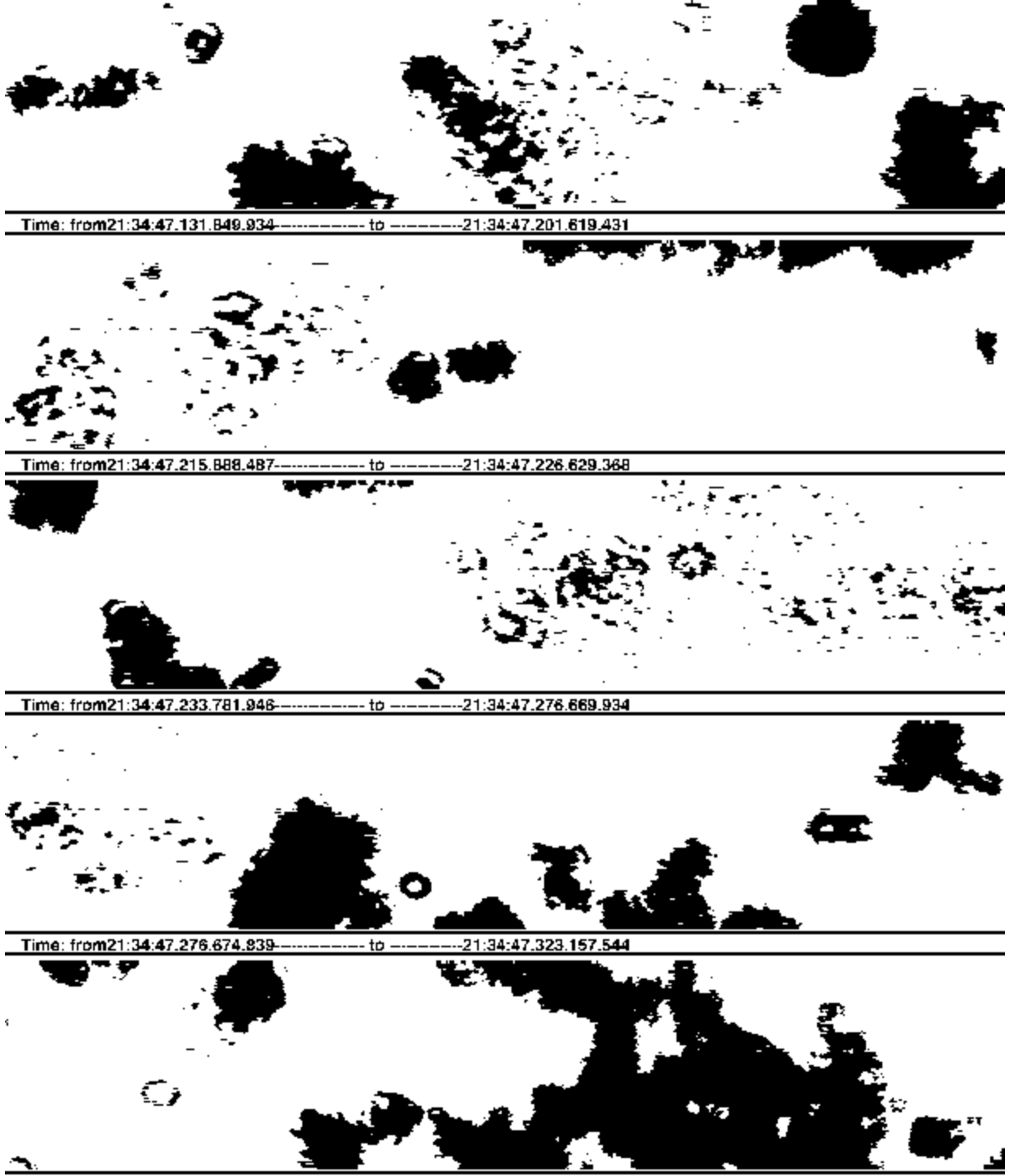
2. Modified 2D-S Probe Tips Prevent more Small Particles from Reaching the Sample Volume than Standard Tips, but Inter-arrival Time Algorithm is more Effective in Removing Shattered Artifacts

2D-S and Fast FSSP Probes Remove Shattered Particles Using Particle Arrival Times

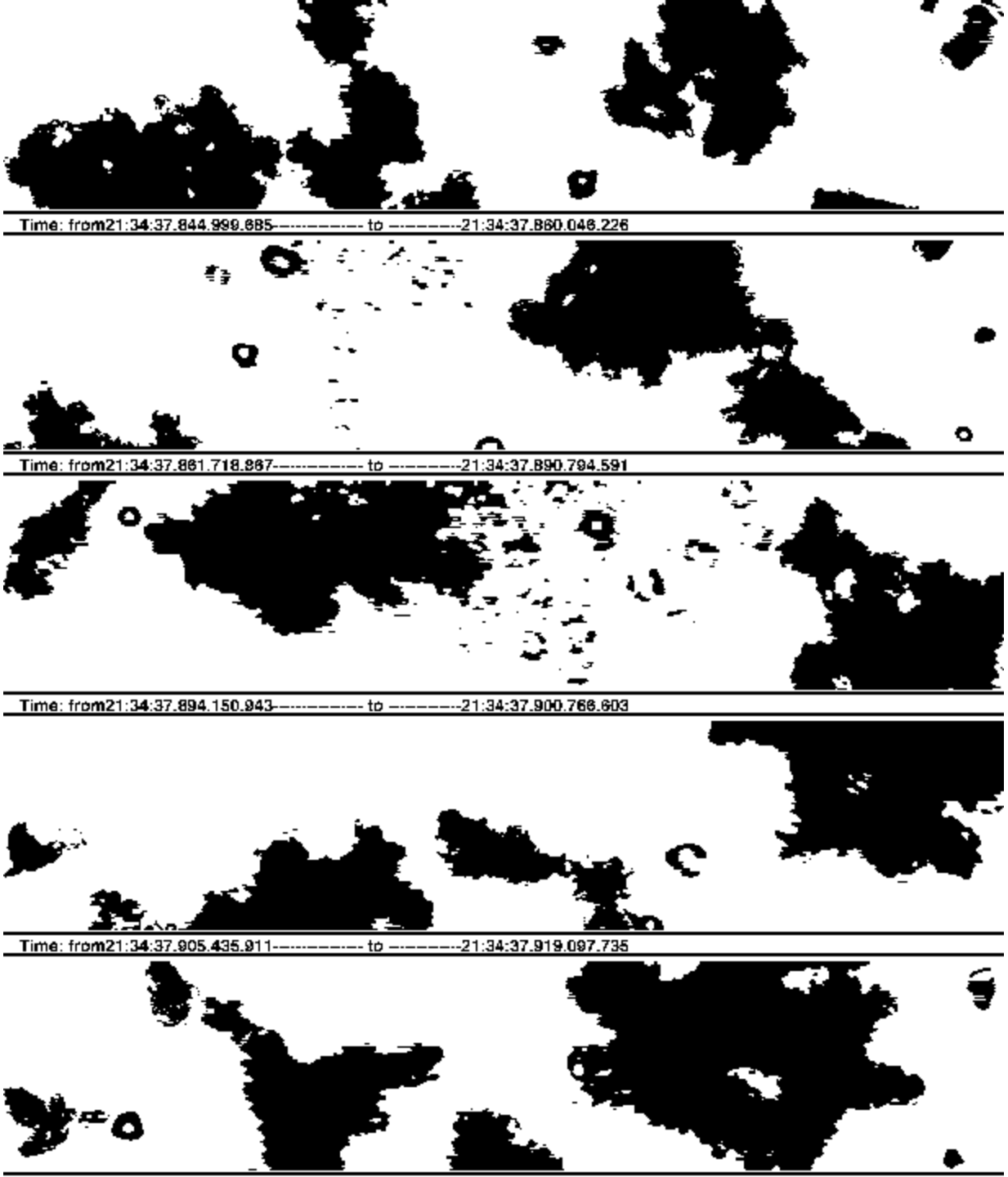




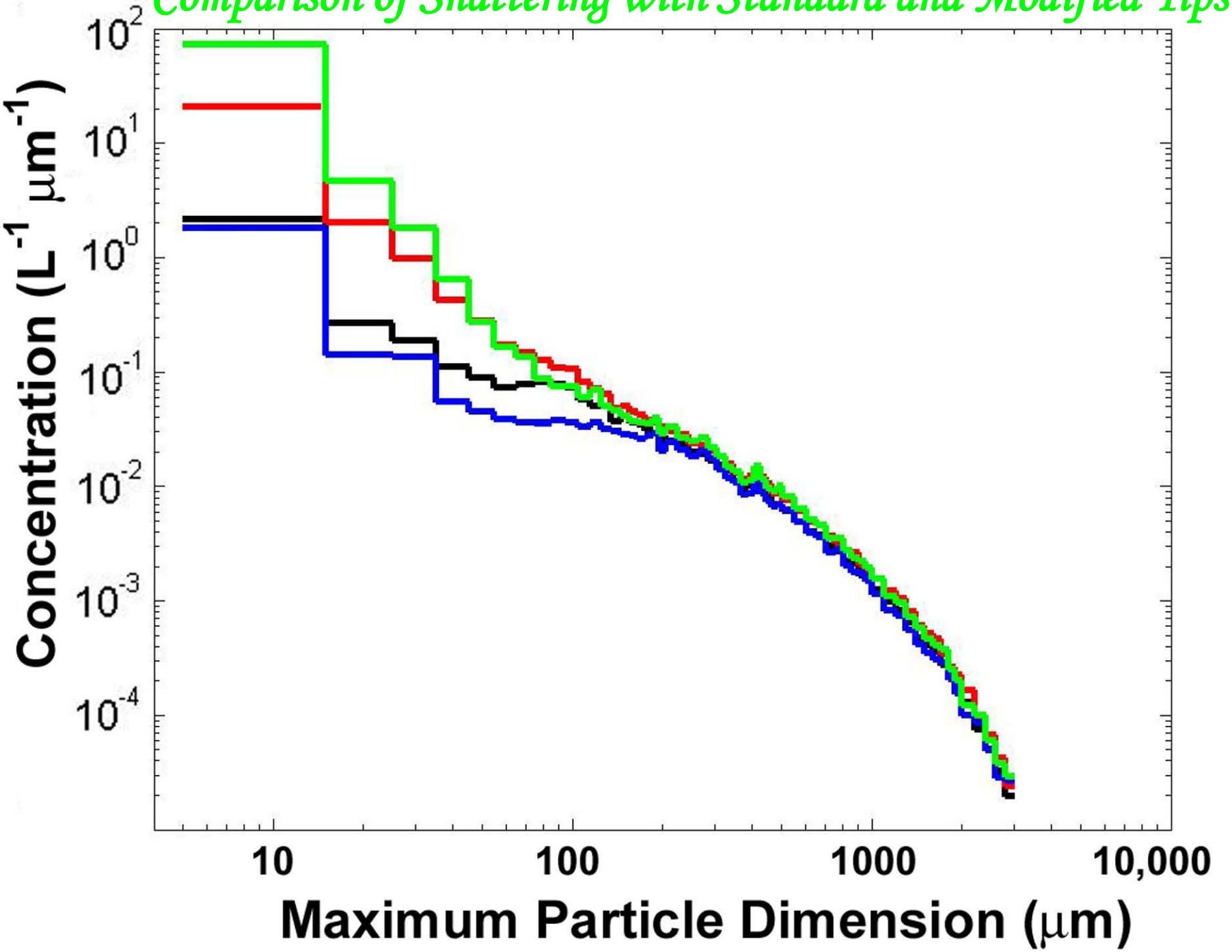
2D-S Shattering with Standard Probe Tips



2D-S Shattering with Modified Probe Tips



Comparison of Shattering with Standard and Modified Tips



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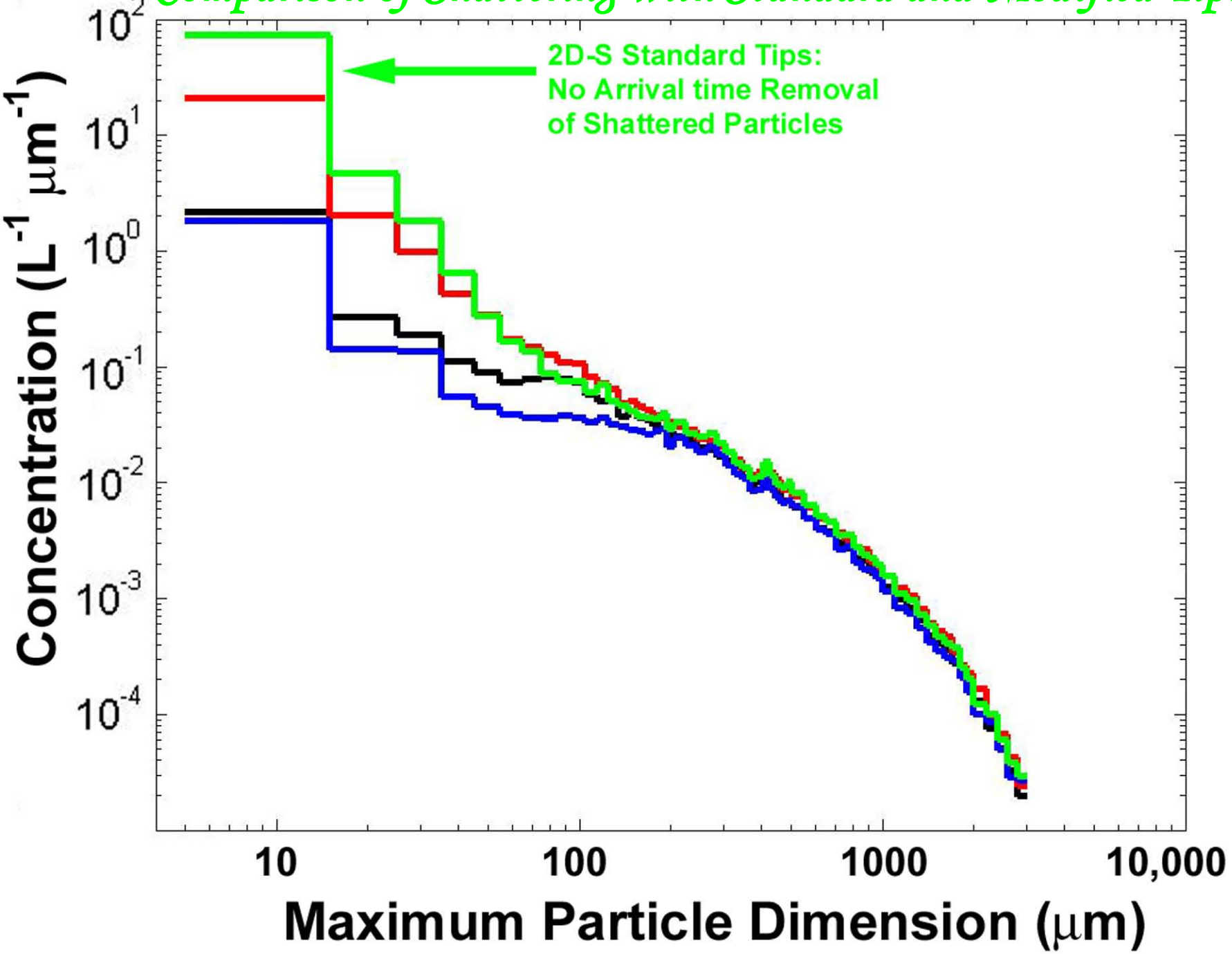

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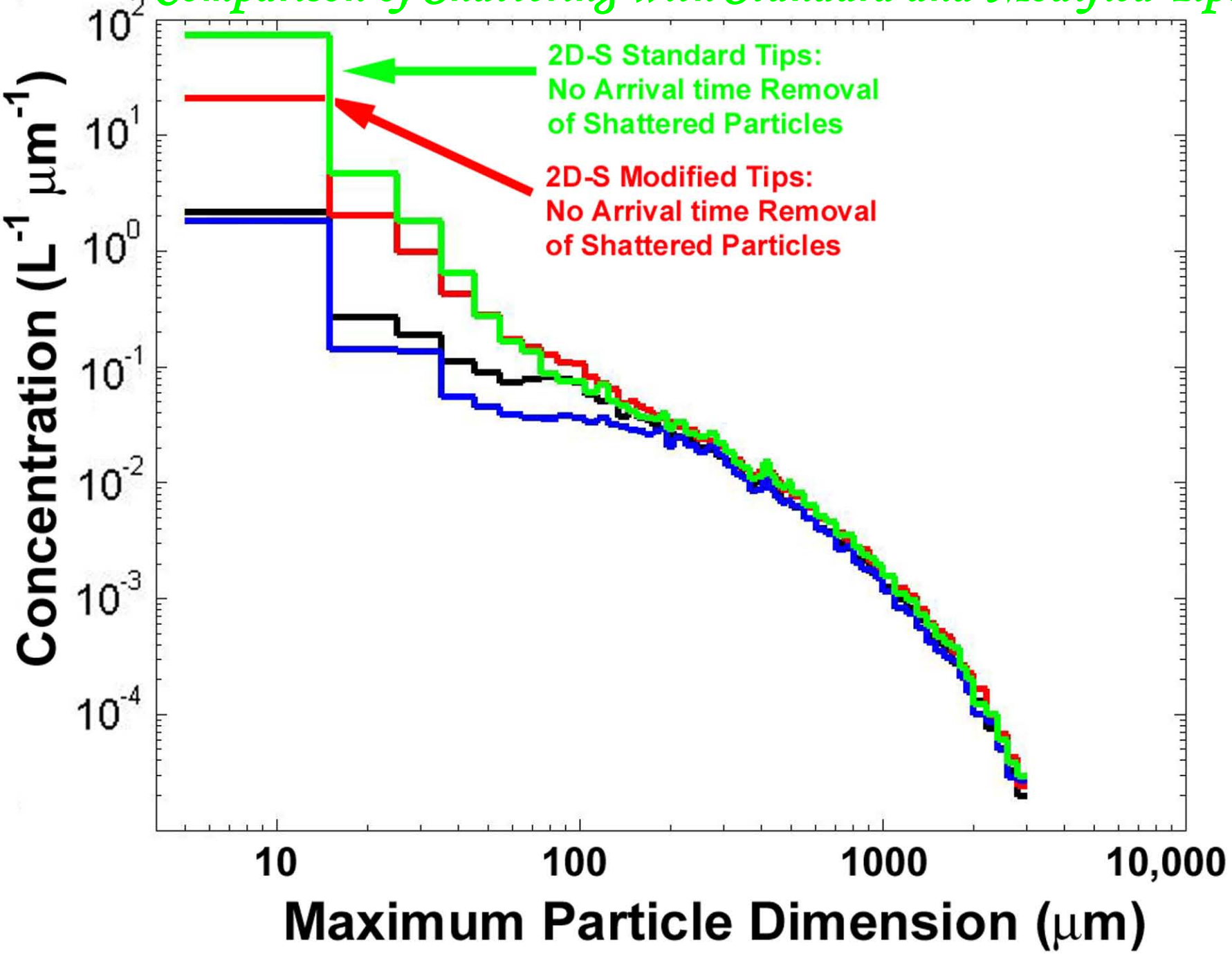

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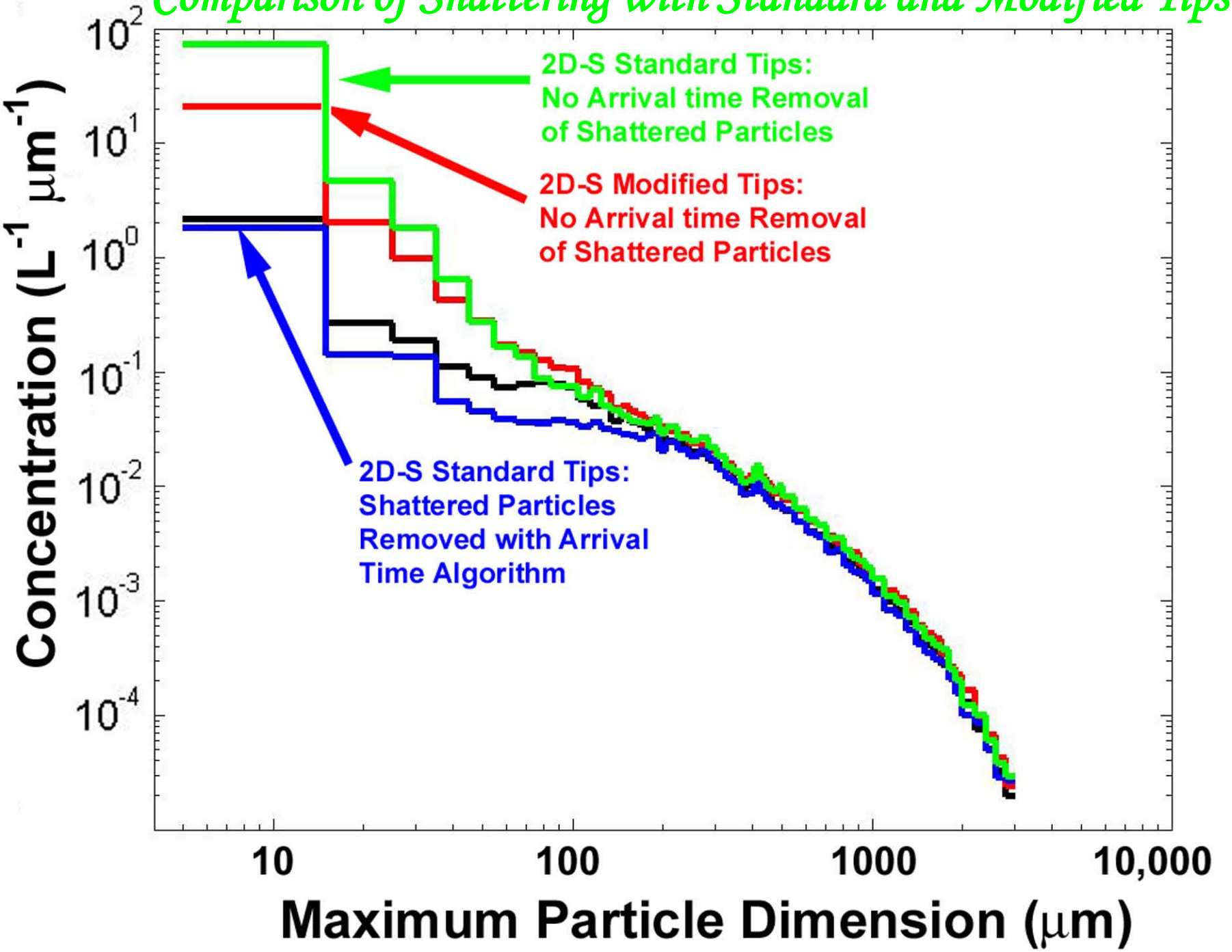

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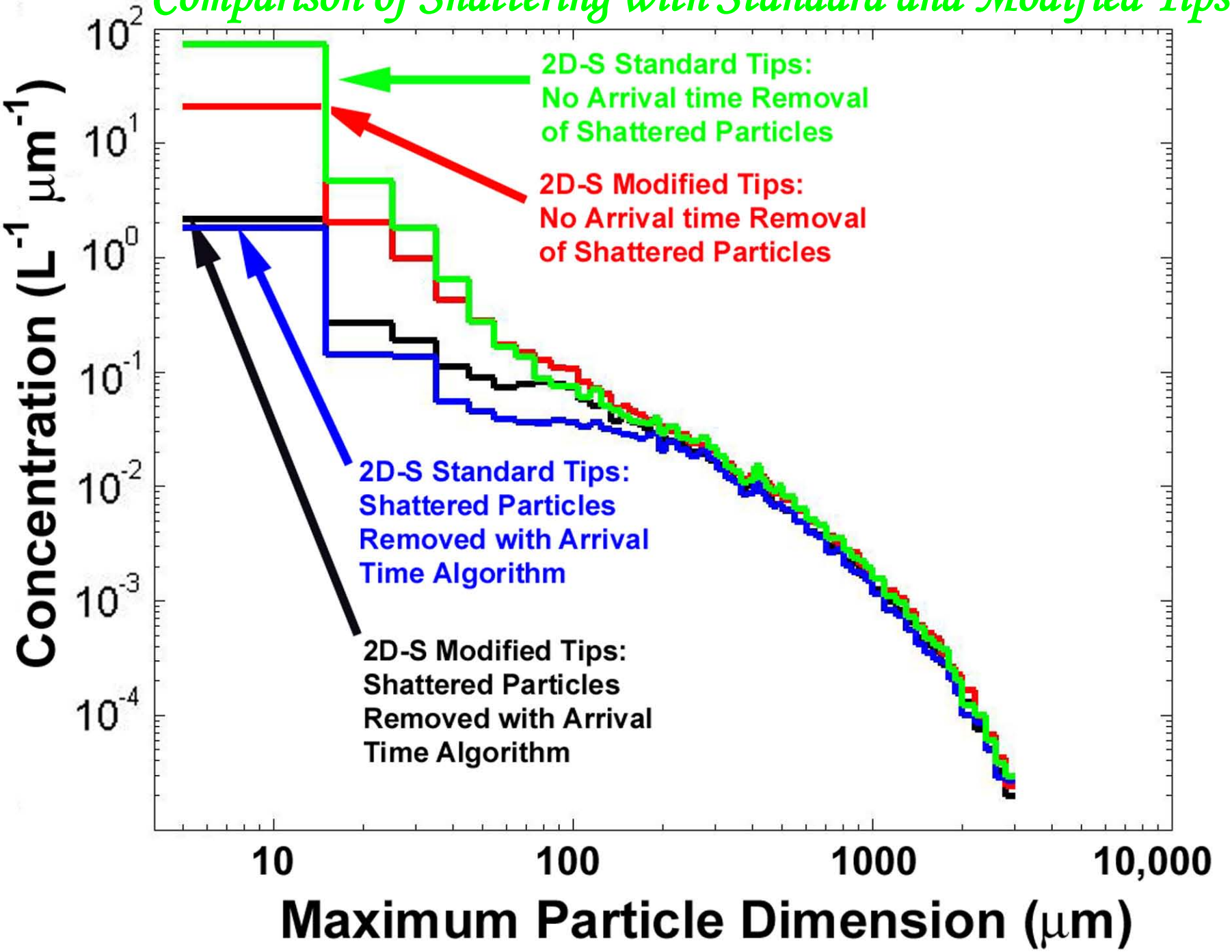
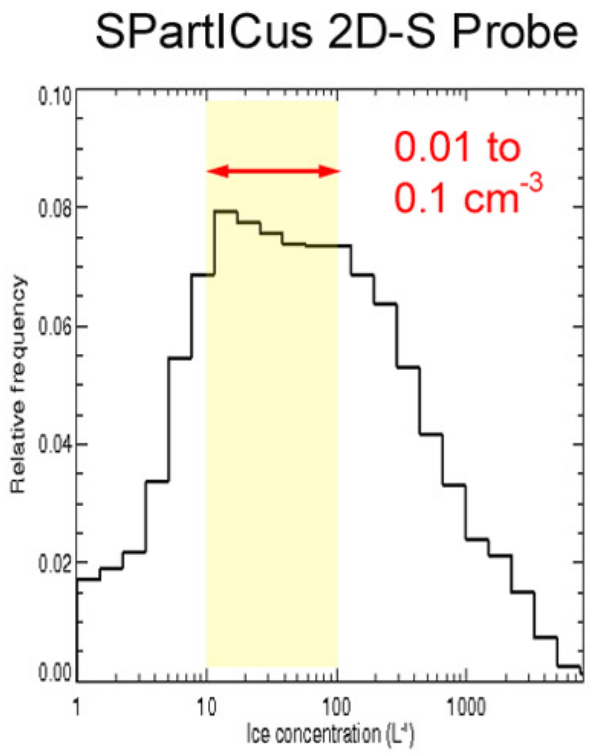
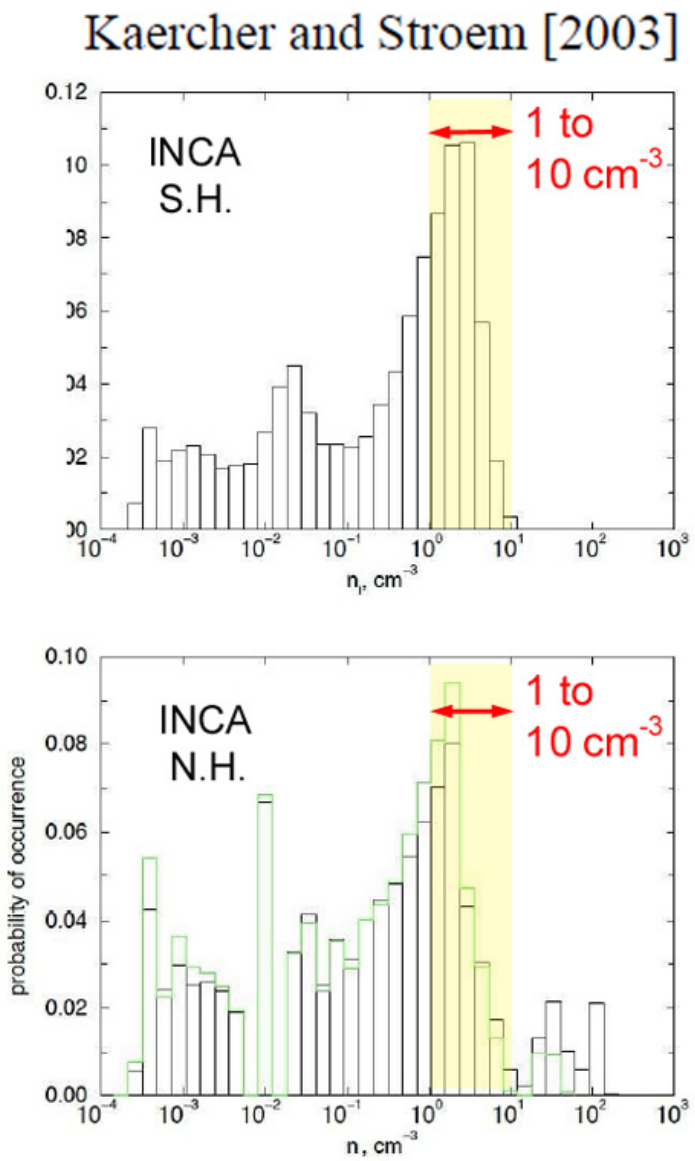


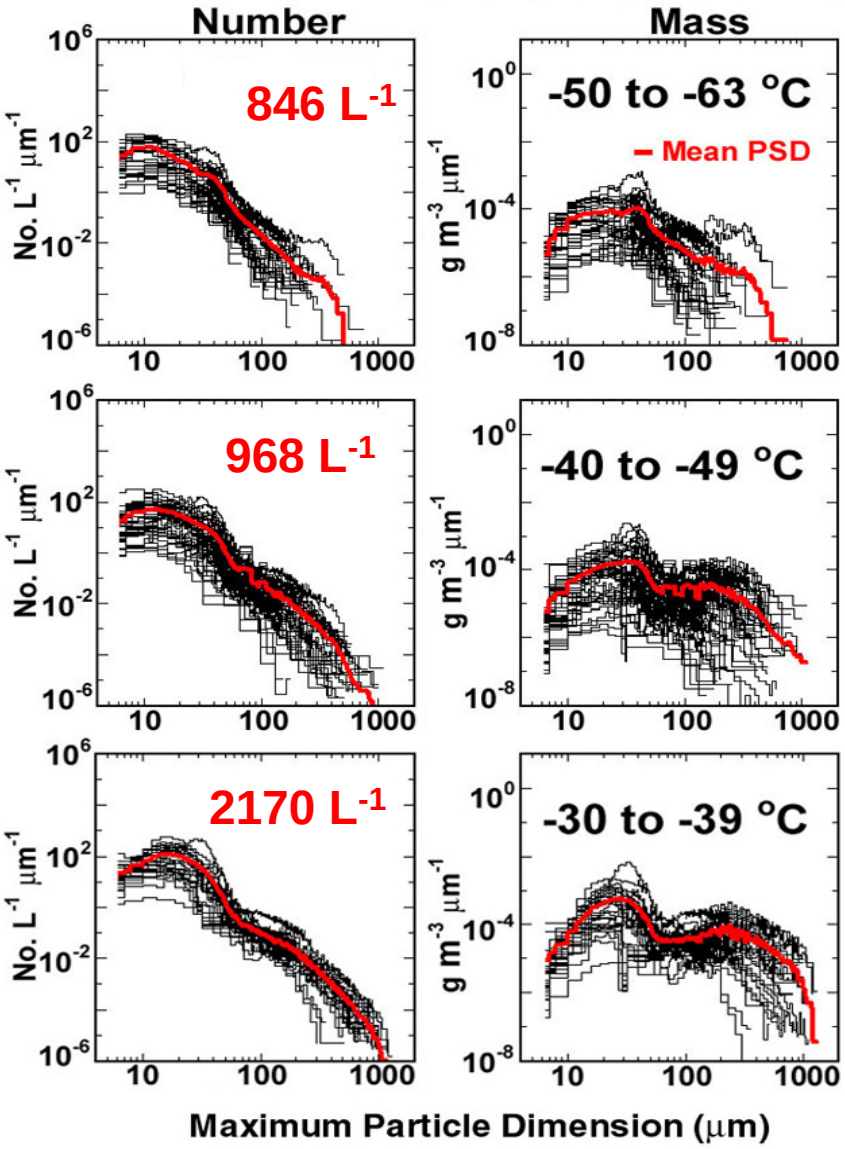
2D-S and Fast FSSP Measurements of Average Particle Concentration (with Shattered Particles Removed) in SPartICus Cirrus are less than some Previous Measurements

(From Jensen 2010)





Combined FSSP, CPI and 2D-C Size Distributions (without Shattered Particles Removed) in Mid-Latitude Cirrus (Lawson et al. 2006)



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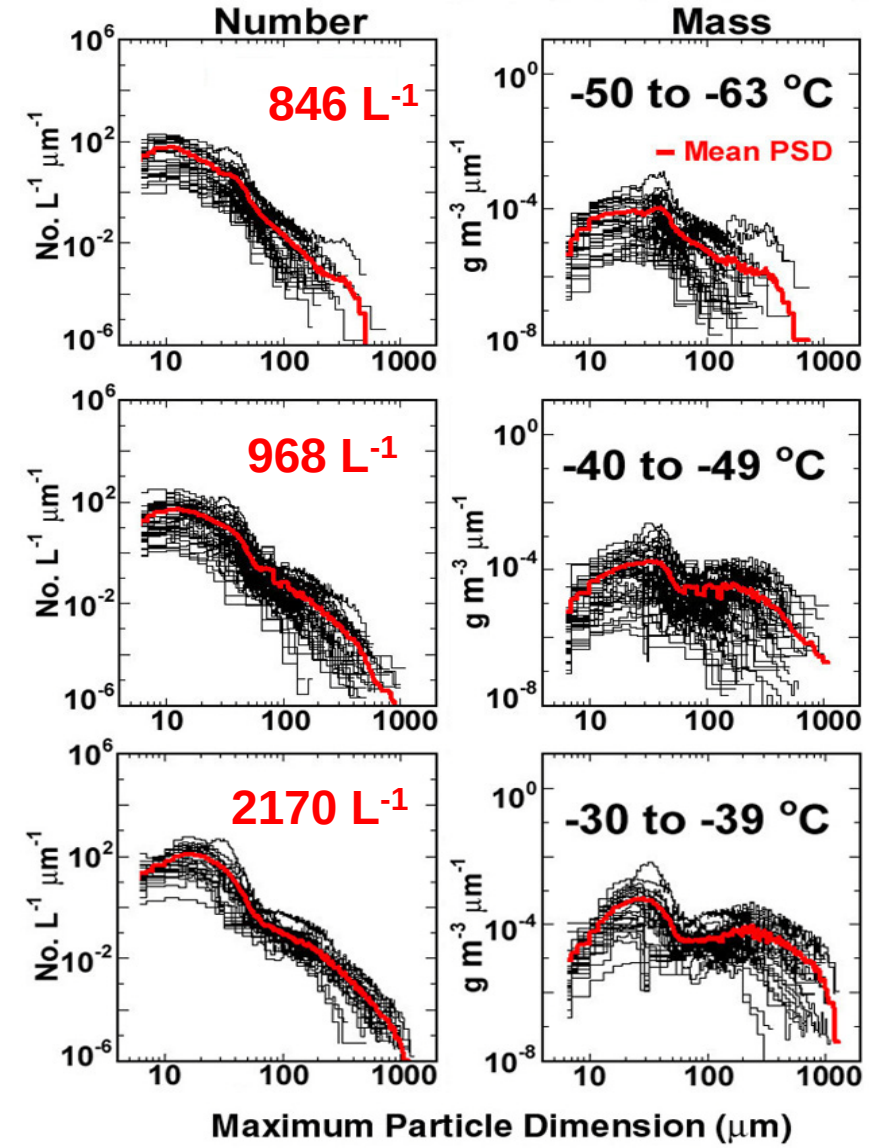
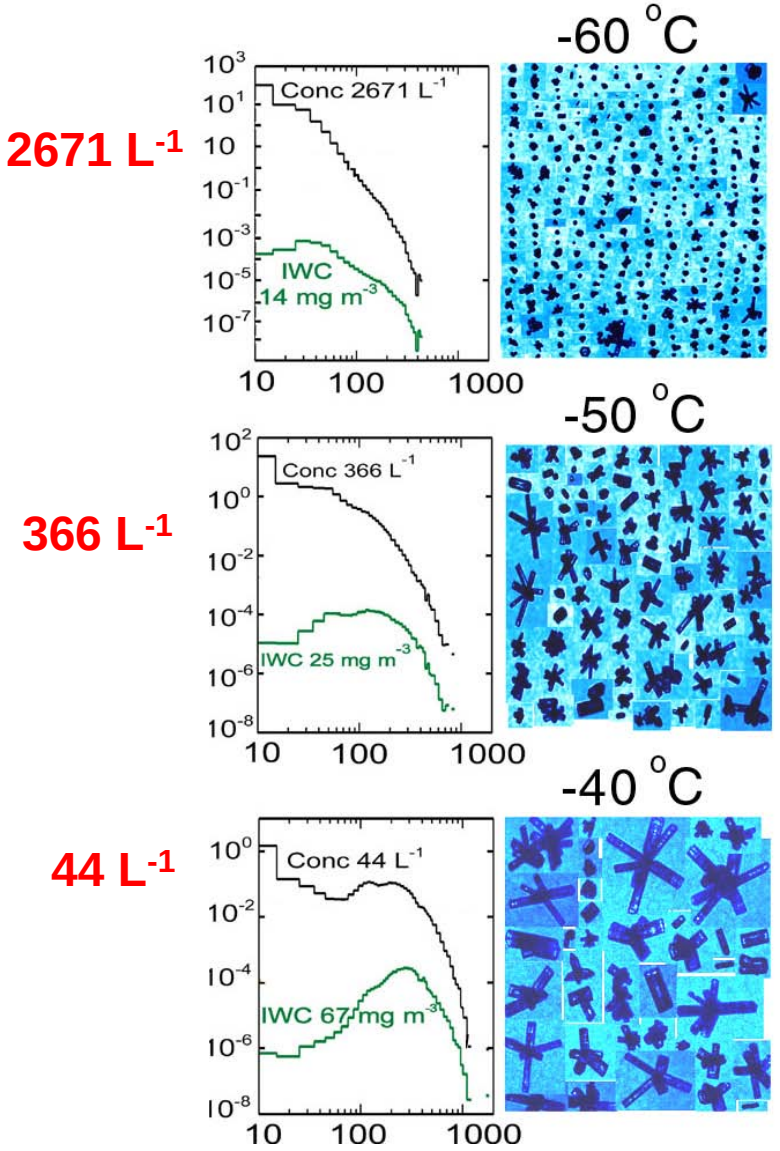
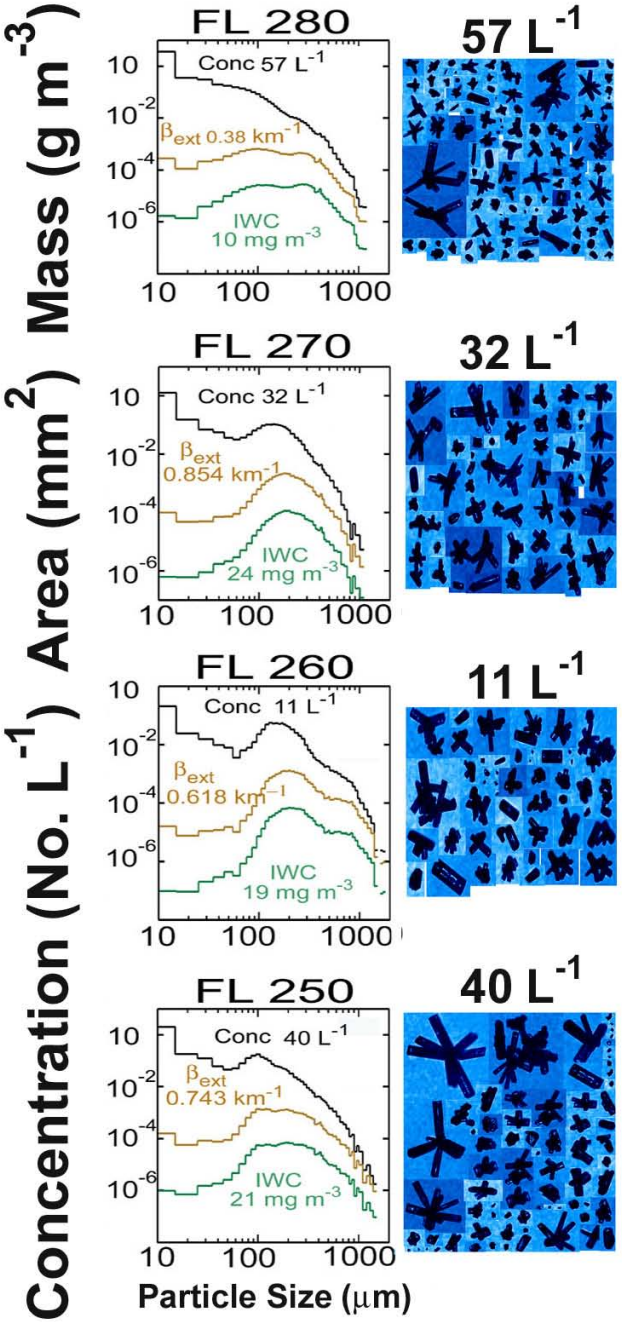
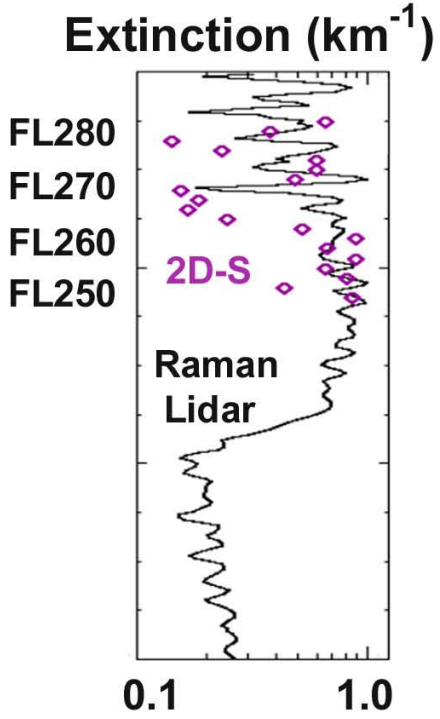


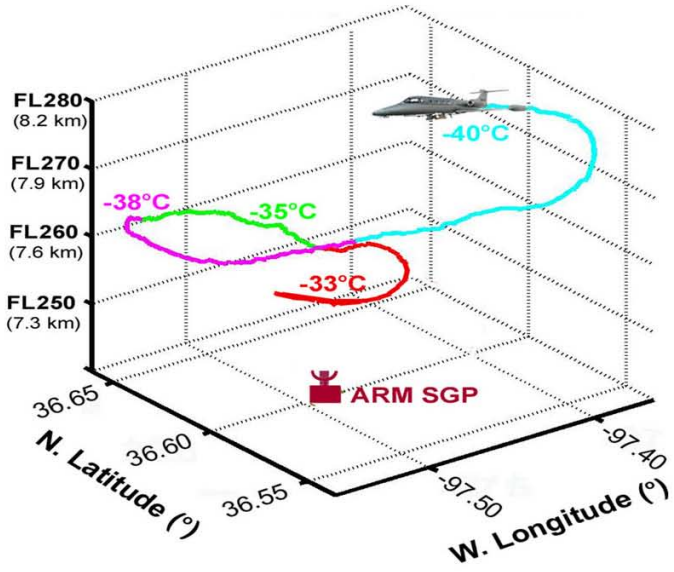
2D-S Size Distributions (with Shattered Particles Removed) in Mid-Latitude Cirrus (SPartICus)



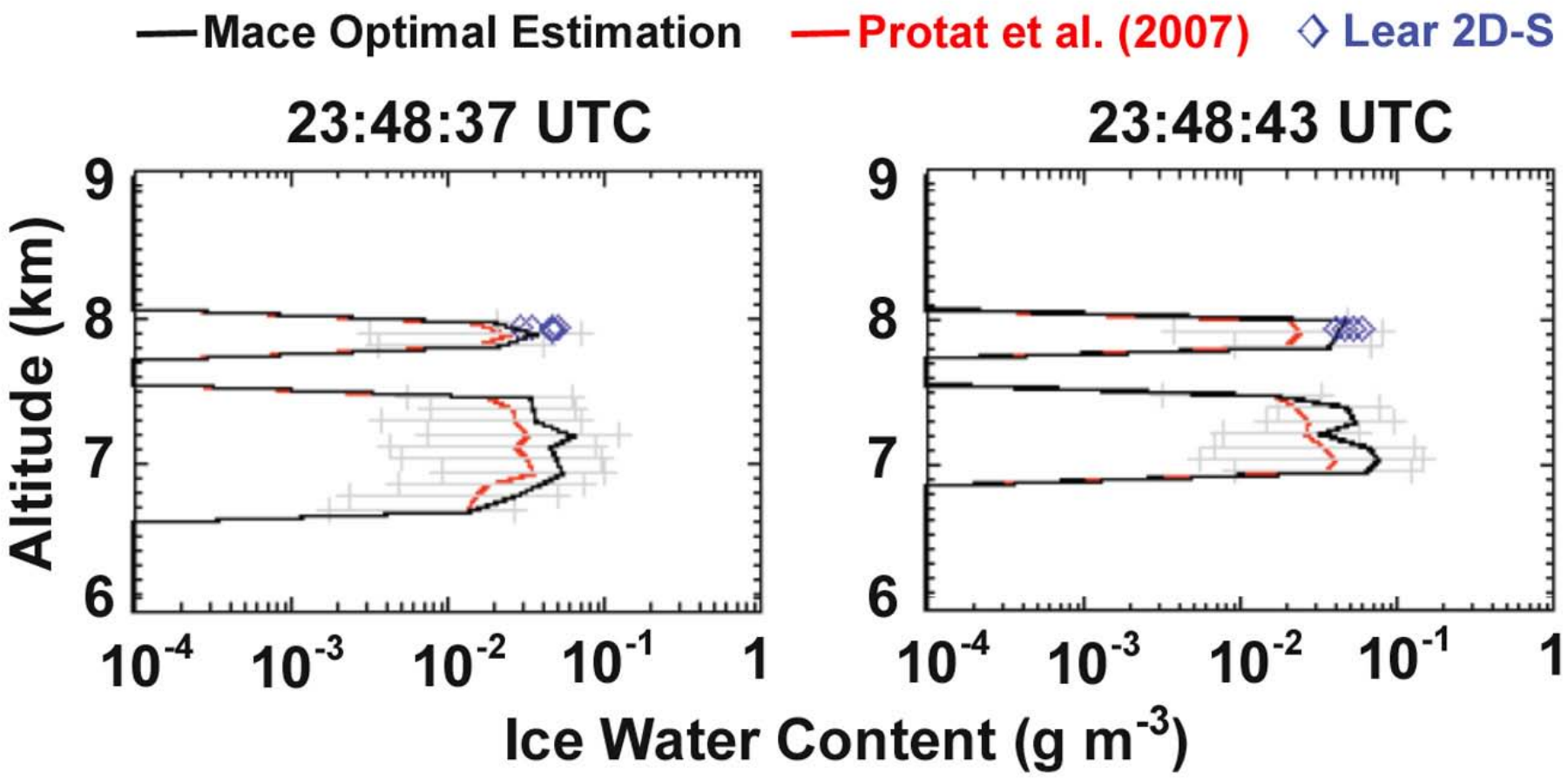
Comparison with Raman Lidar in Thin, Patchy Cirrus







Comparison with A-Train Satellite Retrieval



SPartICus Preliminary Summary

1. **190 SPEC Learjet flight hours focused on mid-latitude cirrus and anvil cirrus completed from Jan - June 2010. Most flights over remote sensors at the ARM SGP or A-Train satellites.**

2. **New in situ particle probes (2D-S, CDP, Fast FSSP, HVPS) and bulk IWC instrumentation (Nevzorov, CSI) designed to measure small ice and minimize the effects of ice particle shattering.**

3. **Preliminary results show a reversal of some previous results, i.e., relatively high concentrations of small ice are <u>not</u> observed throughout the depth of deep cirrus.**

4. **A statistical analysis of SPartICus data is proposed. The analysis will include (if funded) a rigorous instrument evaluation, back trajectories and stratification of cirrus formation, temperature curtain analysis, comparison of remote and in situ measurements, and improved parameterizations for numerical models.**