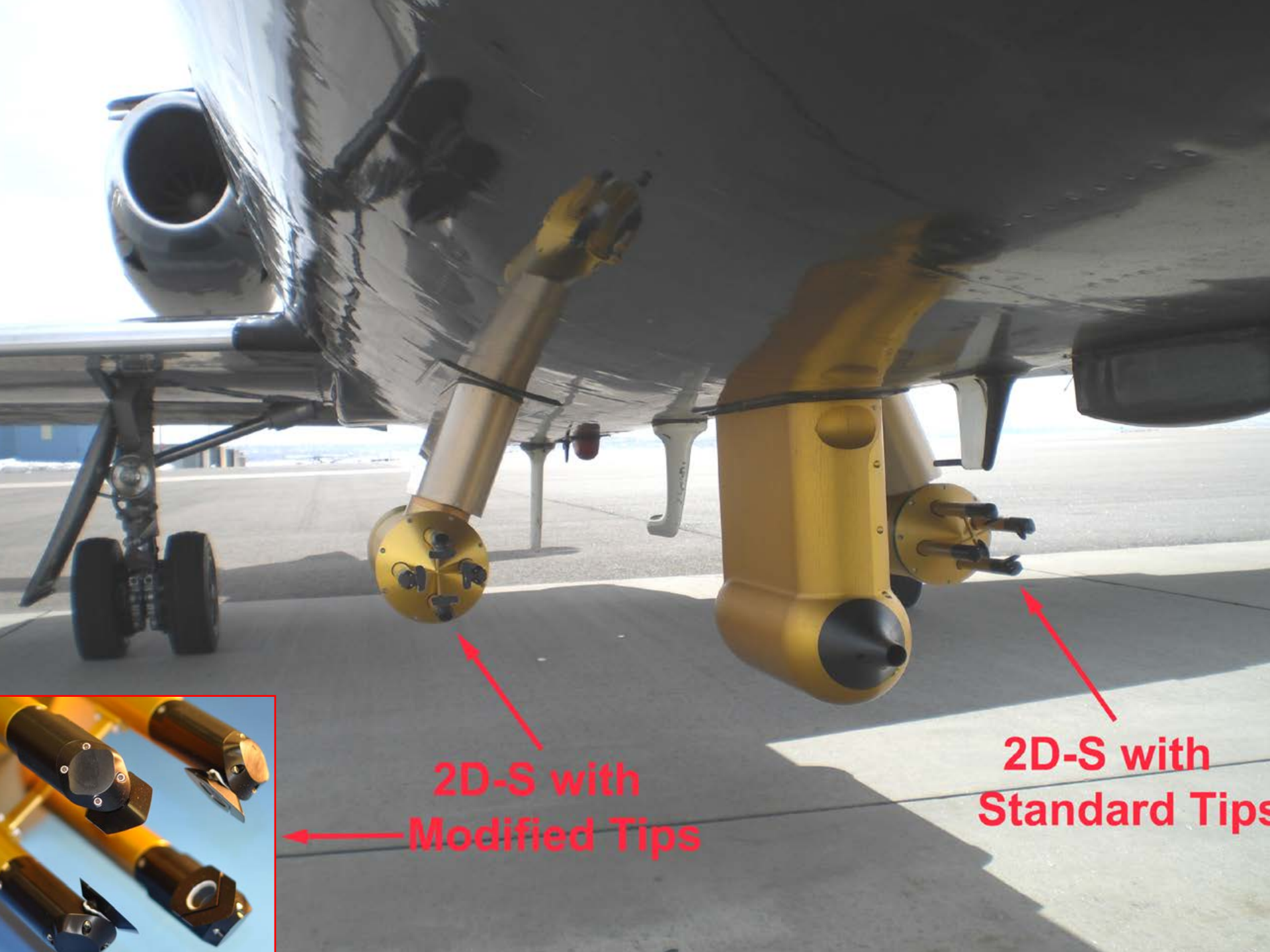
SPEC inc

Shattering on Cloud Particle Probe Tips: Lessons Learned from SPARTICUS

Paul Lawson and Brad Baker


2D-S with
Modified Tips
2D-S with
Standard Tips

Effects of Shattering on the 2D-S

Effects of Shattering on the 2D-S

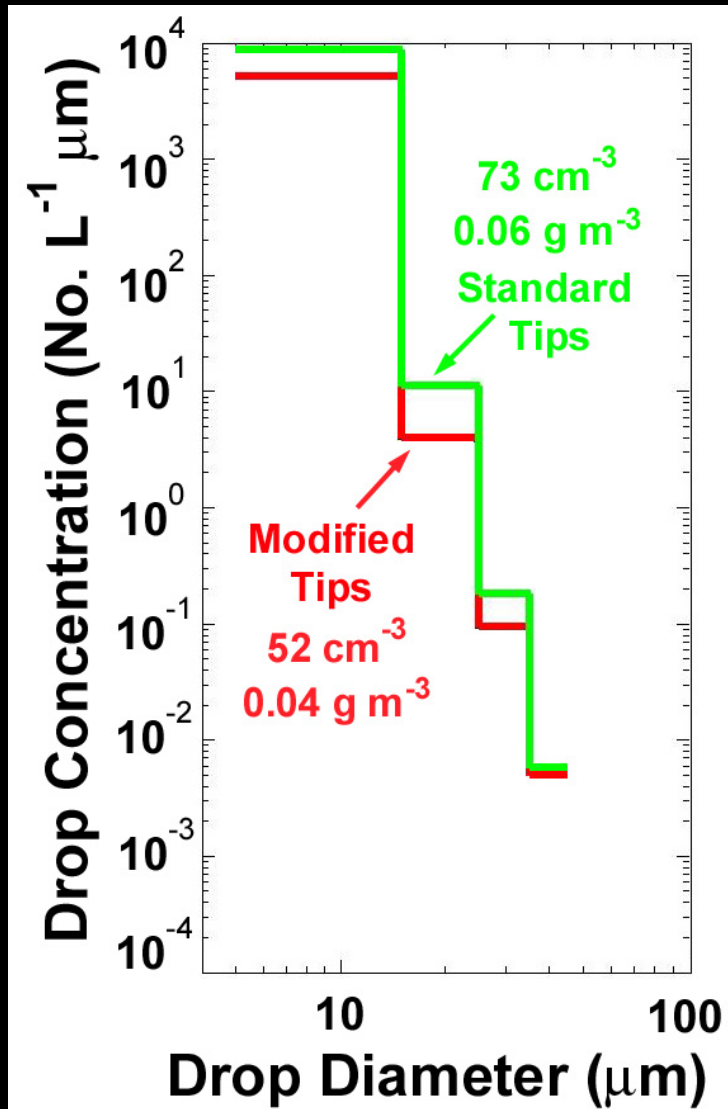
Methodology

- Two 2D-S Probes flown on the SPEC Learjet in SPARTICUS, one with Standard Tips and one with Modified Tips.
- Measurements compared in Cumulus cloud containing only Cloud Drops (no shattering), and in Large Aggregates Precipitating from an Anvil .

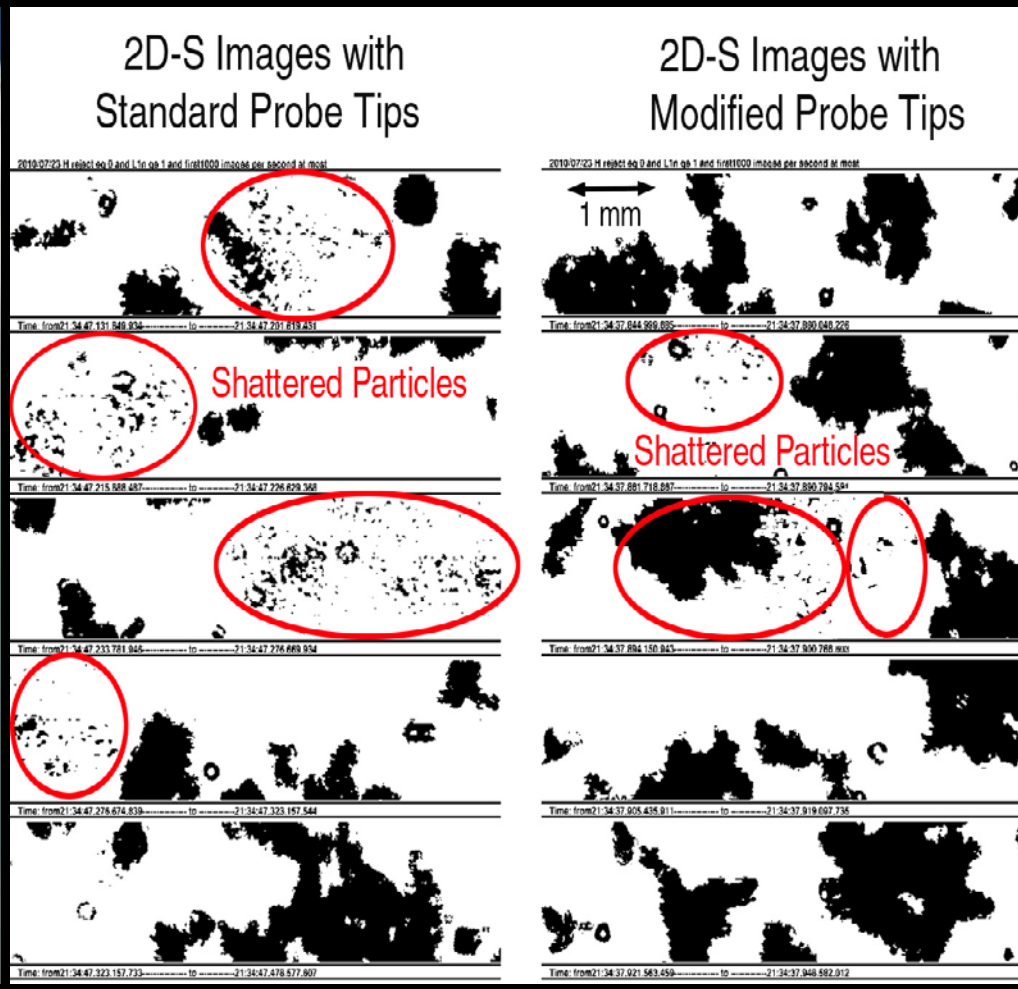
Results

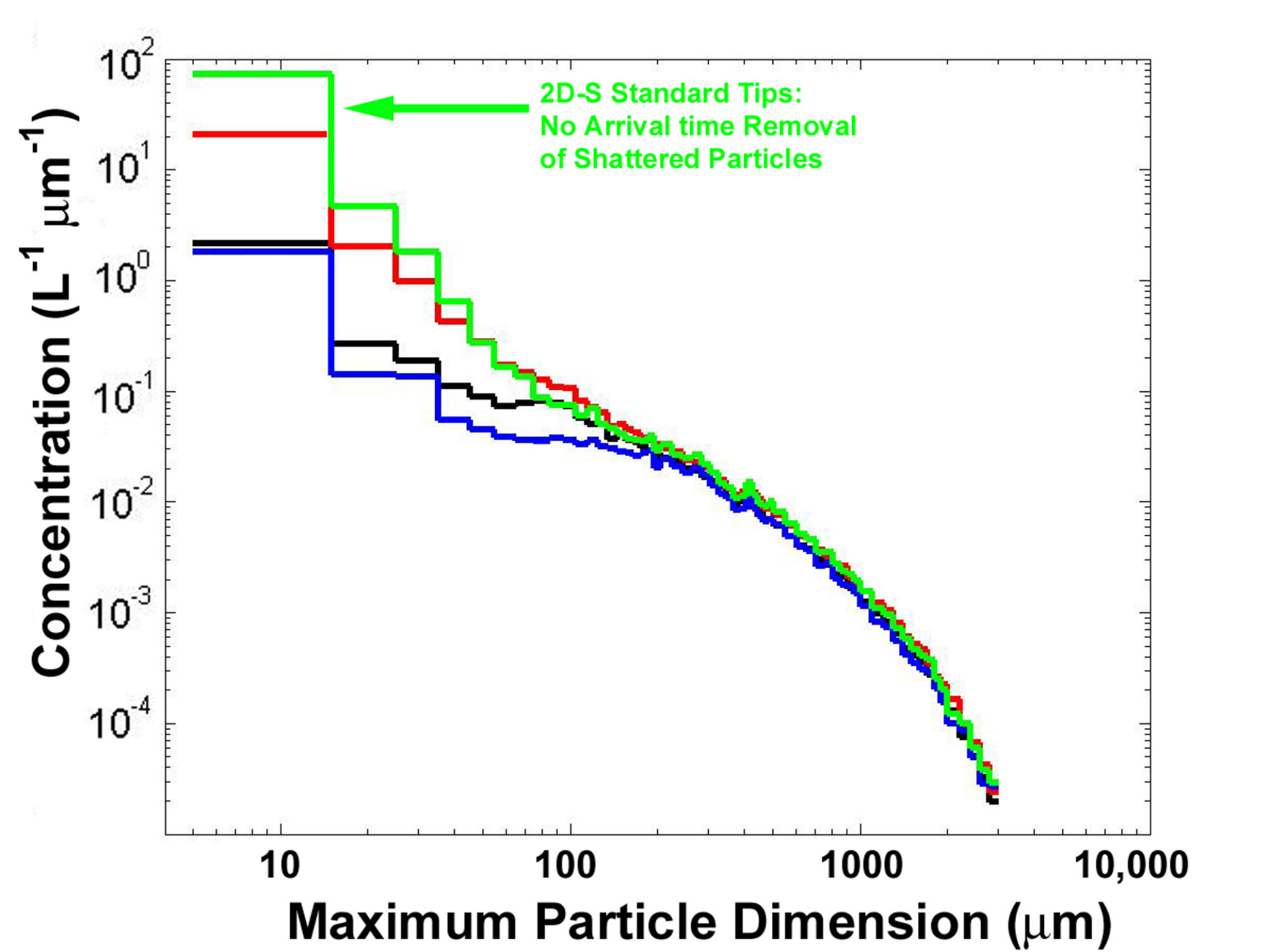
- Modified Tips Reduce Effects of Shattering, but are not as Effective as Post Processing using Arrival Times and other Techniques to Remove Artifacts.

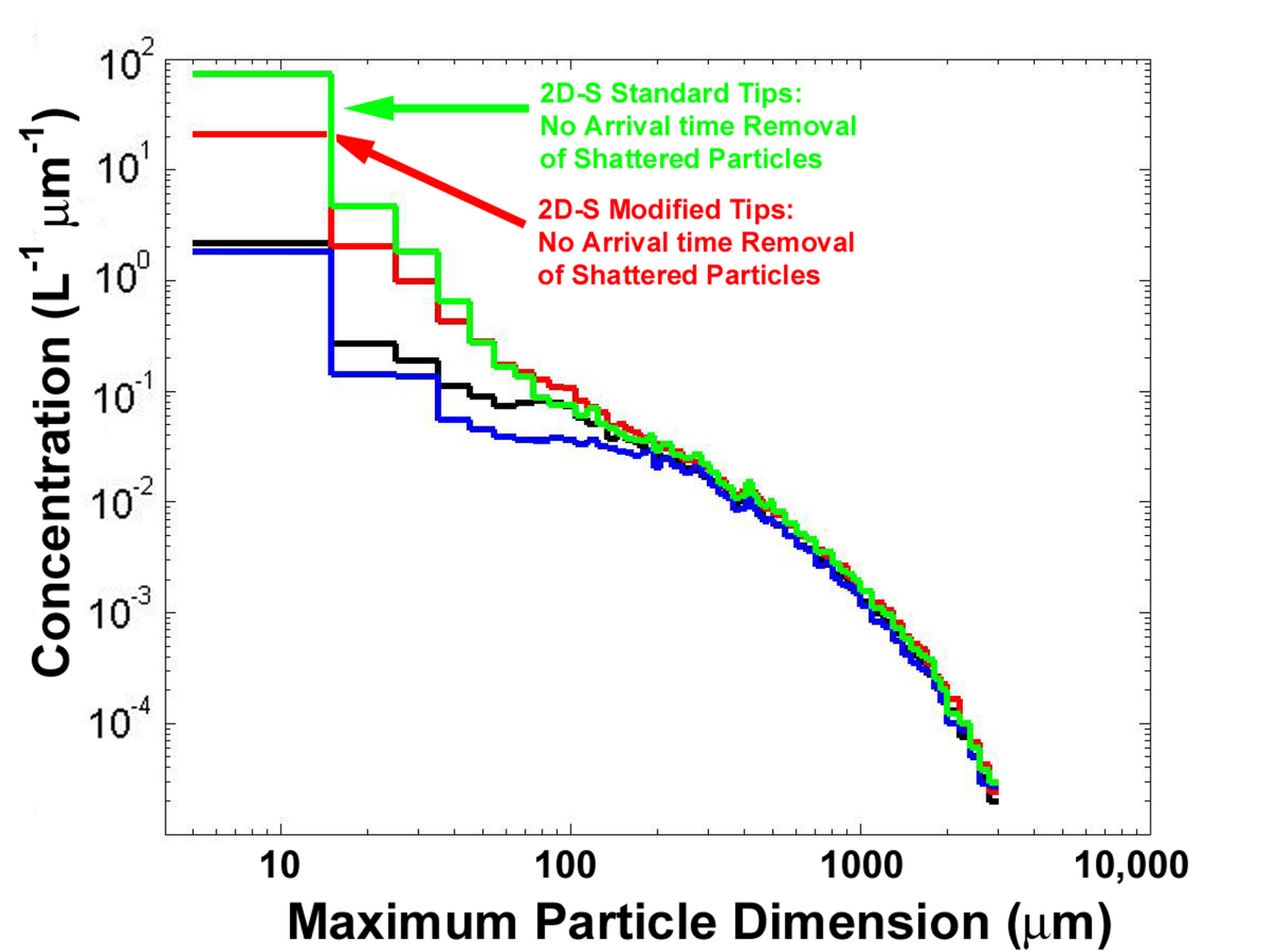
Comparison of Standard and Modified Probe Tips in Cumulus Containing only Cloud Drops



Comparison of Standard and Modified Probe Tips in Anvil Precipitation




2D-S Standard Tips:
No Arrival time Removal
of Shattered Particles
Concentration (L-1 µm-1)
Maximum Particle Dimension (µm)
10
100
1000
10,000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No Arrival time Removal
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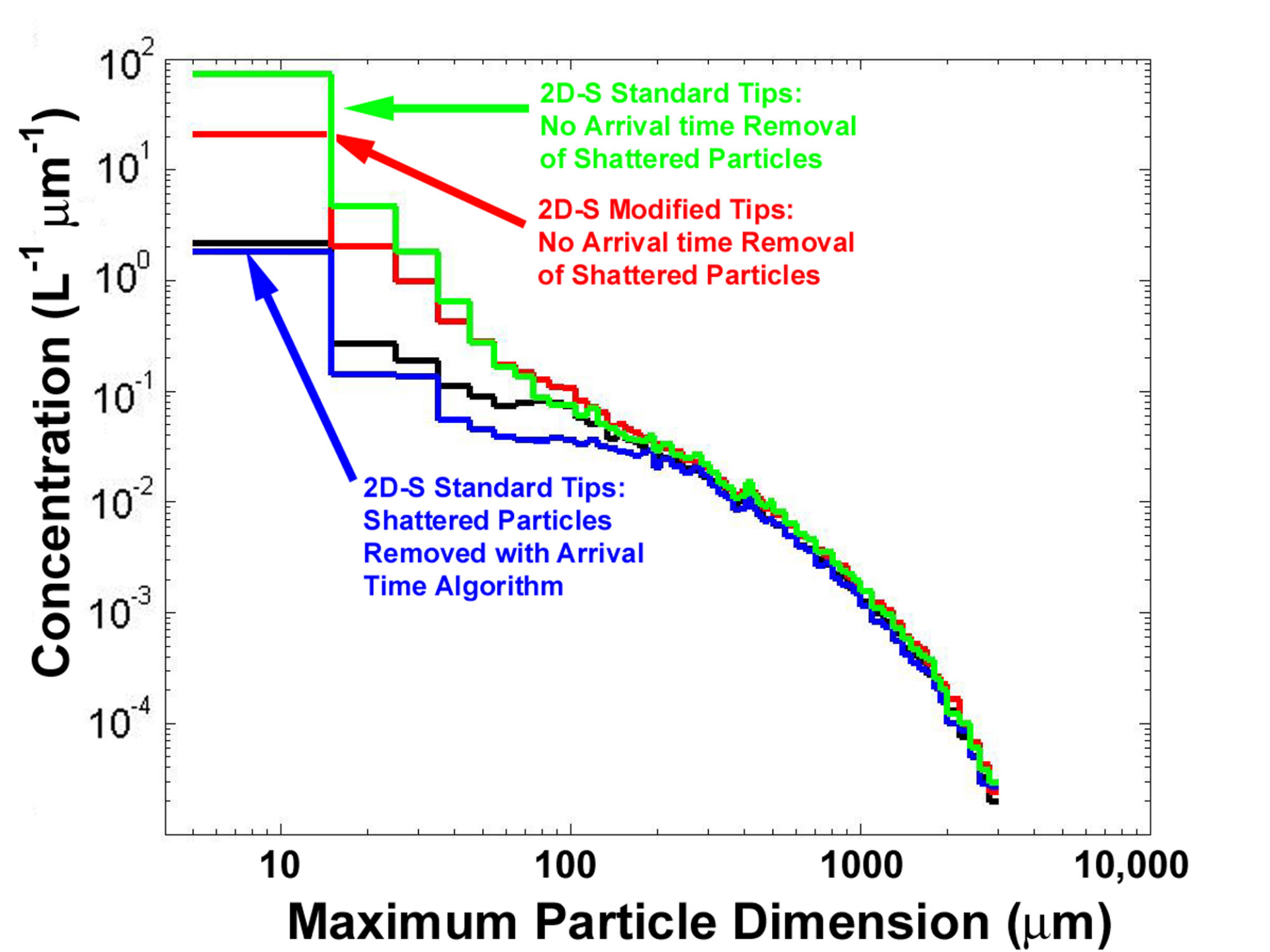
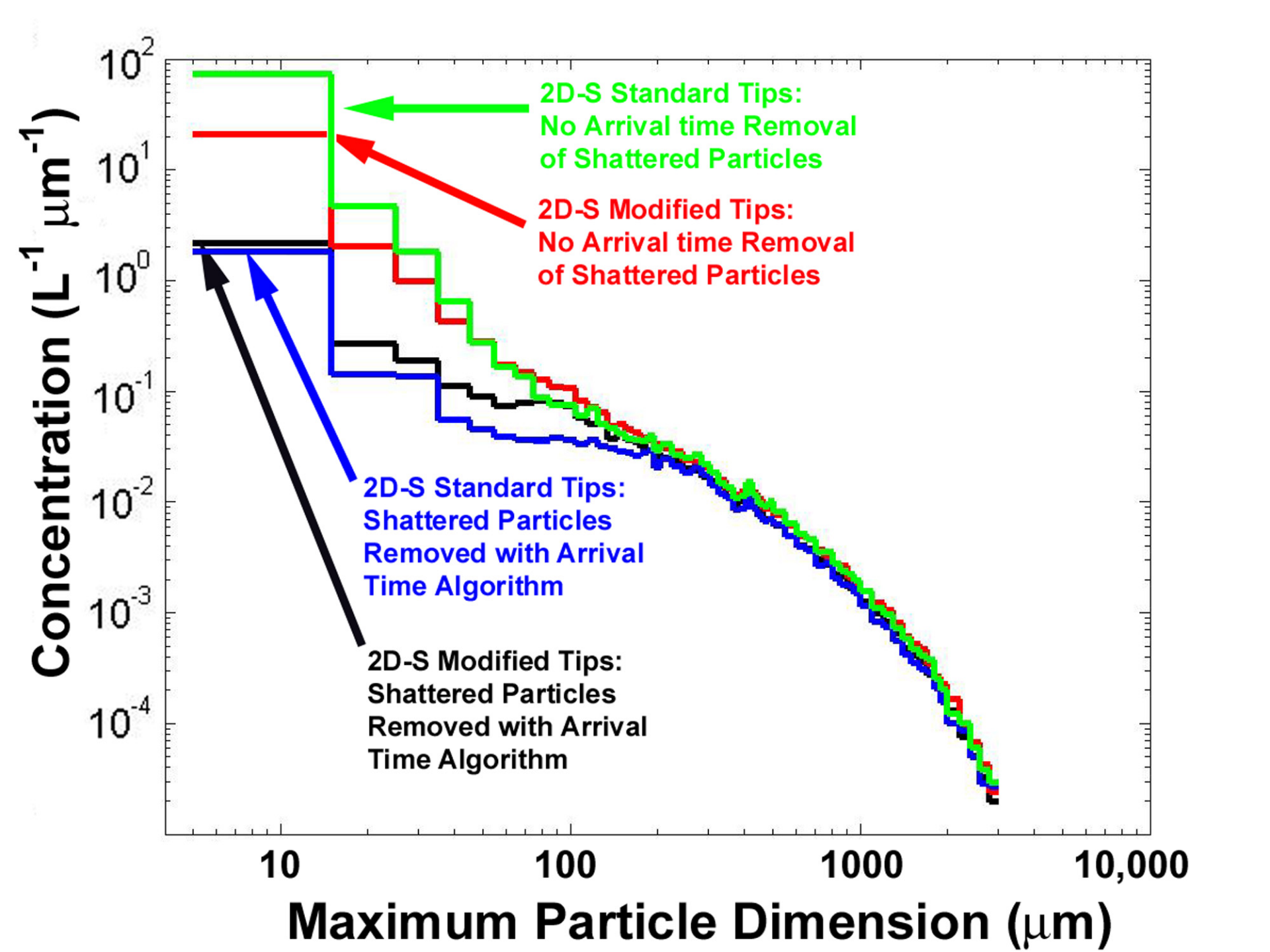
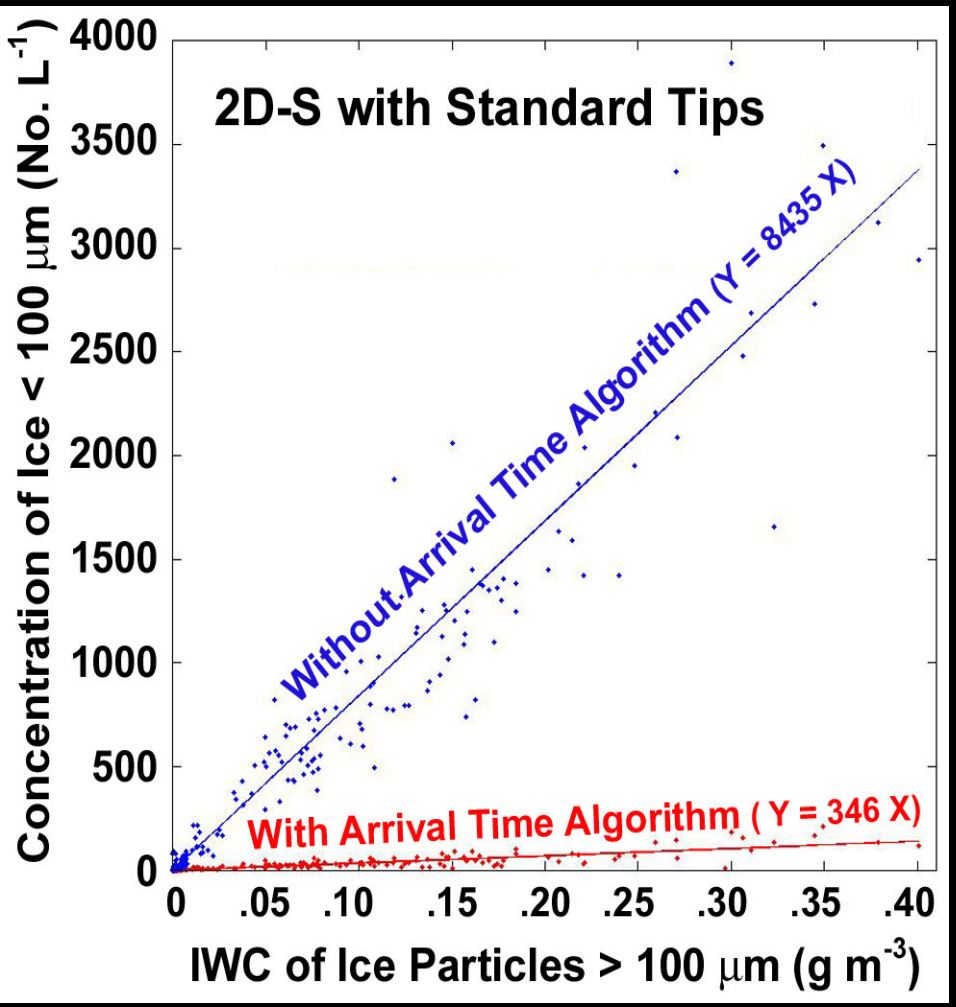
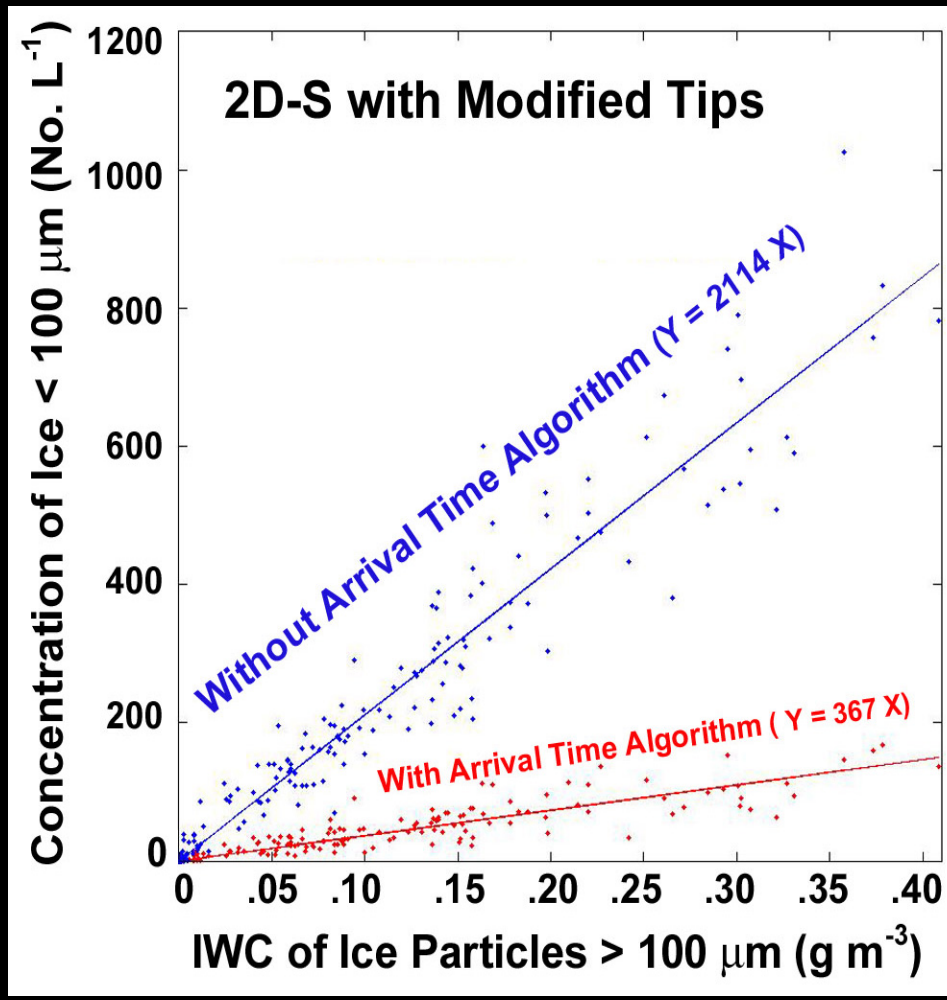
2D-S Modified Tips:
No Arrival time Removal
of Shattered Particles
Concentration (L-1 μm-1)
Maximum Particle Dimension (μm)
10
100
1000
10,000


2D-S Standard Tips:
No Arrival time Removal
of Shattered Particles
2D-S Modified Tips:
No Arrival time Removal
of Shattered Particles
2D-S Standard Tips:
Shattered Particles
Removed with Arrival
Time Algorithm
Concentration (L-1 μm-1)
Maximum Particle Dimension (μm)
10
100
1000
10,000

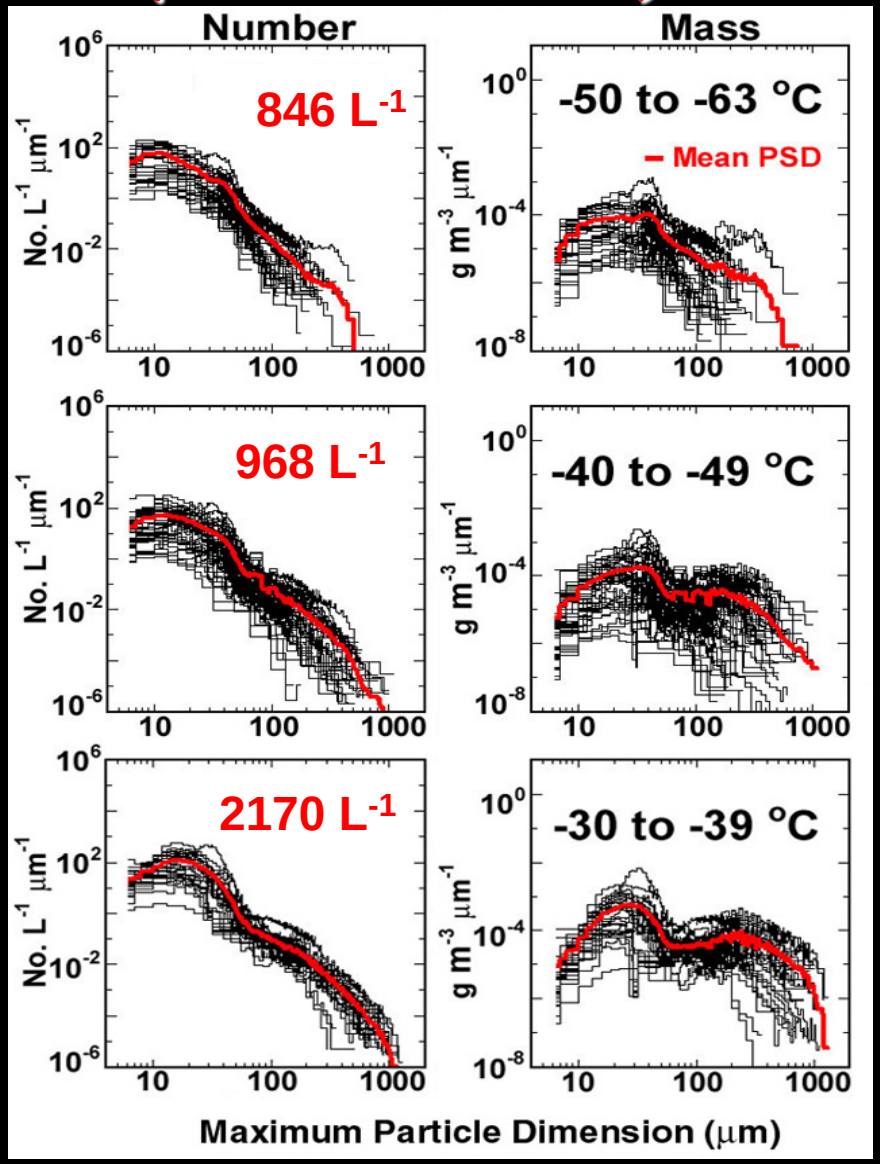

Concentration (L^{-1} μm^{-1})
10^2
10^1
10^0
10^{-1}
10^{-2}
10^{-3}
10^{-4}
2D-S Standard Tips:
No Arrival time Removal
of Shattered Particles
2D-S Modified Tips:
No Arrival time Removal
of Shattered Particles
2D-S Standard Tips:
Shattered Particles
Removed with Arrival
Time Algorithm
2D-S Modified Tips:
Shattered Particles
Removed with Arrival
Time Algorithm
10
100
1000
10,000
Maximum Particle Dimension (μm)

Scatterplots Showing Effectiveness of Standard and Modified Tips in Anvil Precipitation





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



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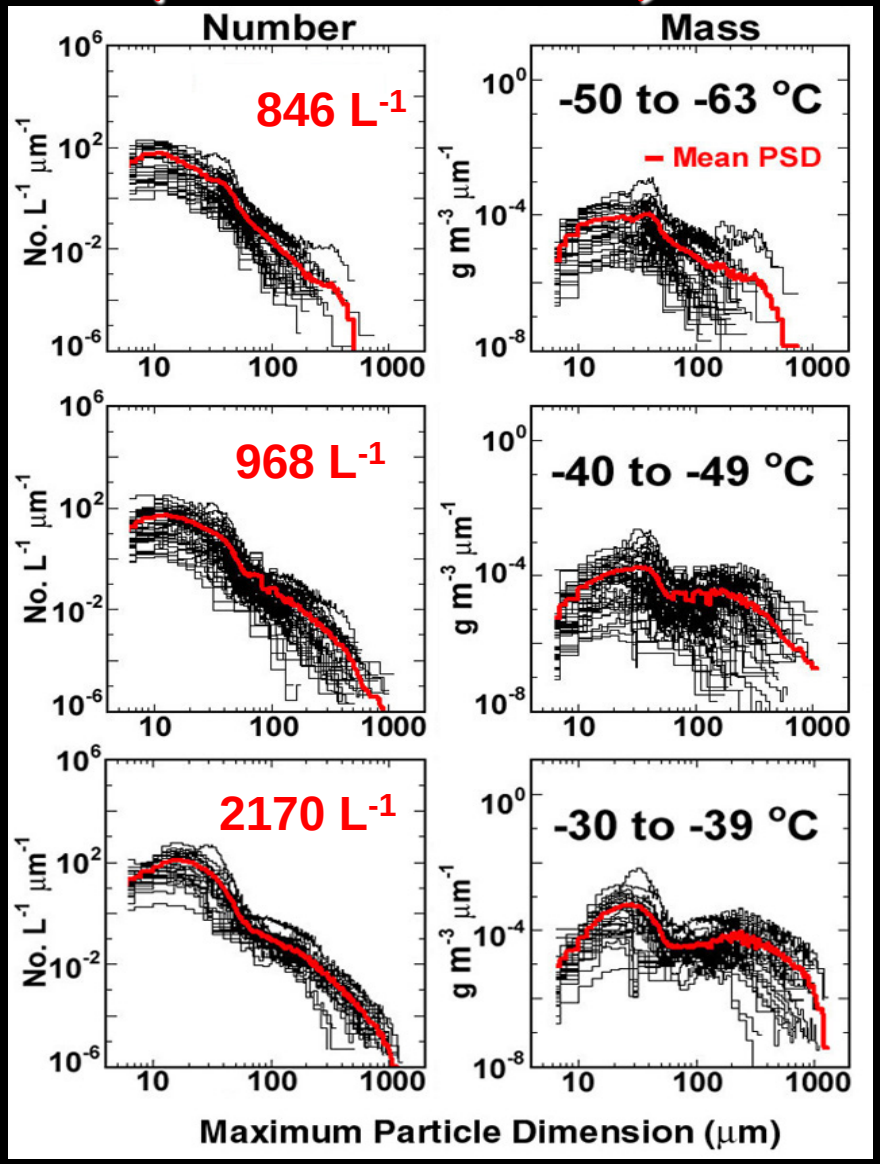
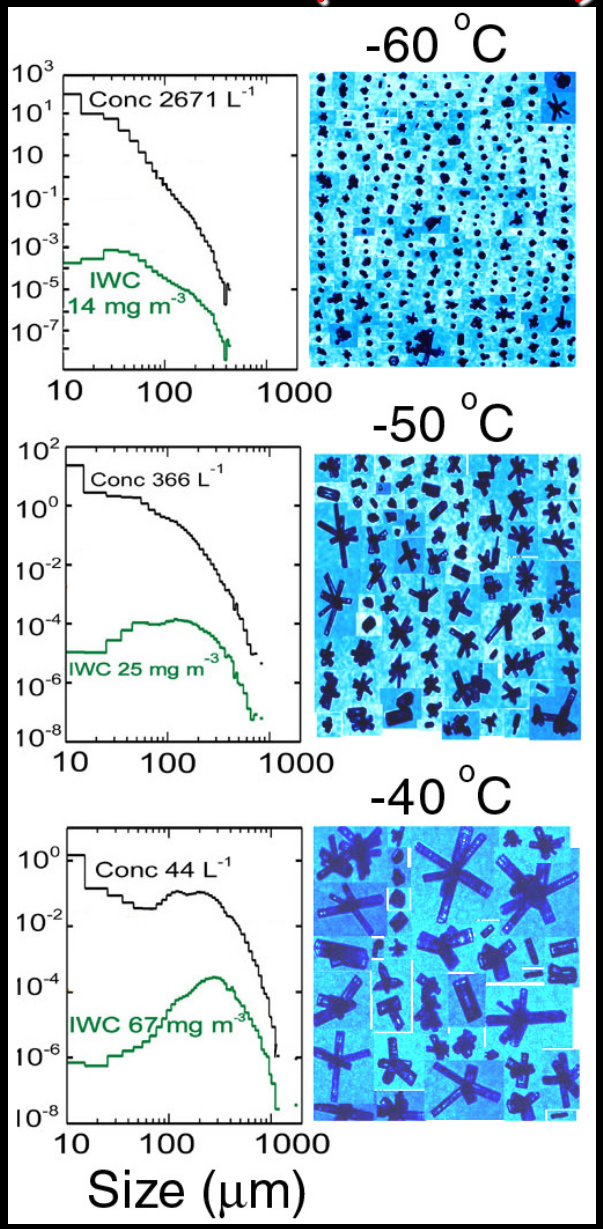


2D-S Size Distributions (with Shattered Particles Removed) in Mid-Latitude Cirrus (SPartICus)



SUMMARY of 2D-S Processing

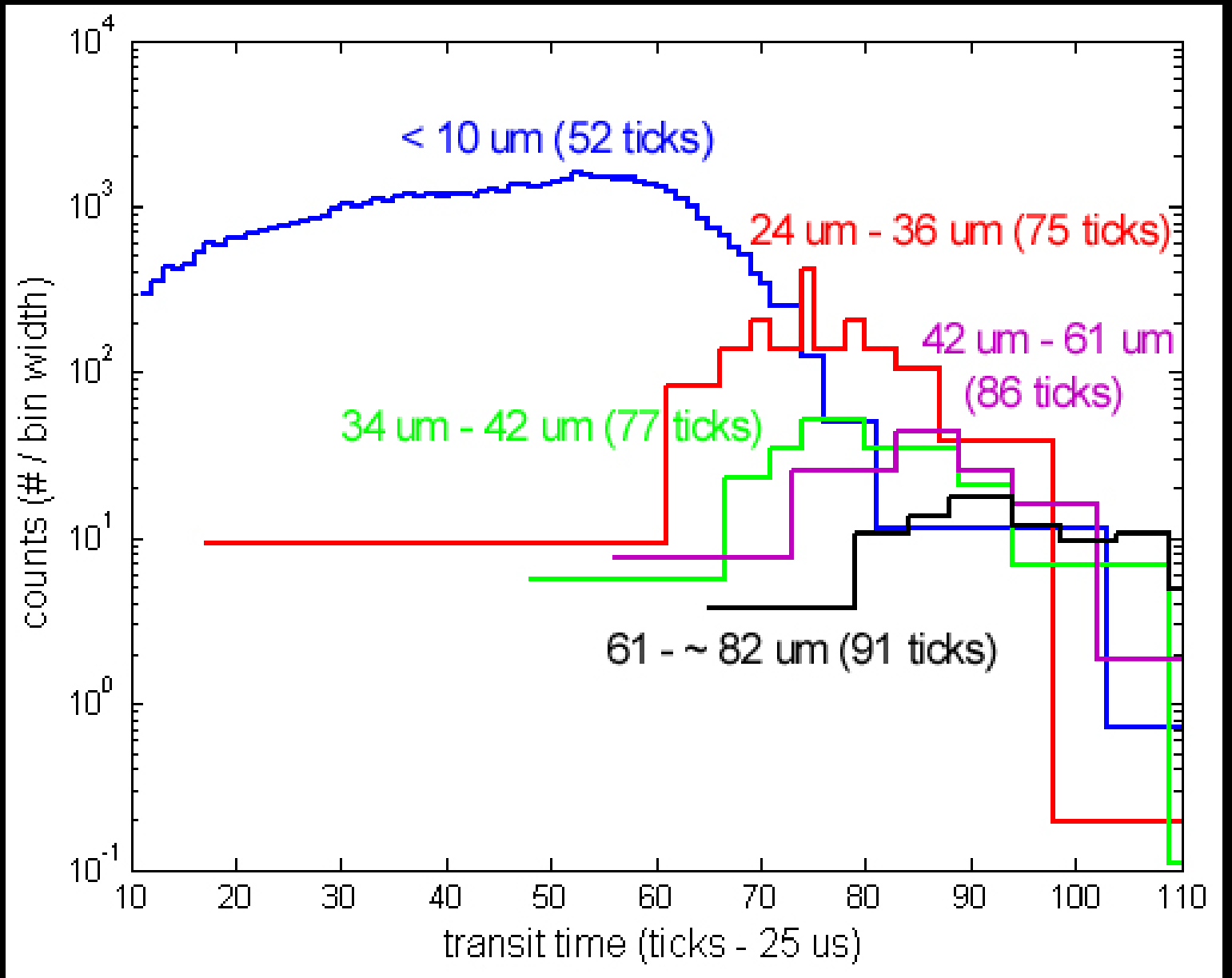
- Modified Tips Reduce Effects of Shattering on the 2D-S Probe, but are not as Effective as Post Processing using Arrival Times and other Techniques to Remove Artifacts.

- This is Opposite to Korolev's findings indicating that Modified Probe Tips are More Effective than Arrival Time Algorithm on the 2D-C and CIP Probes.

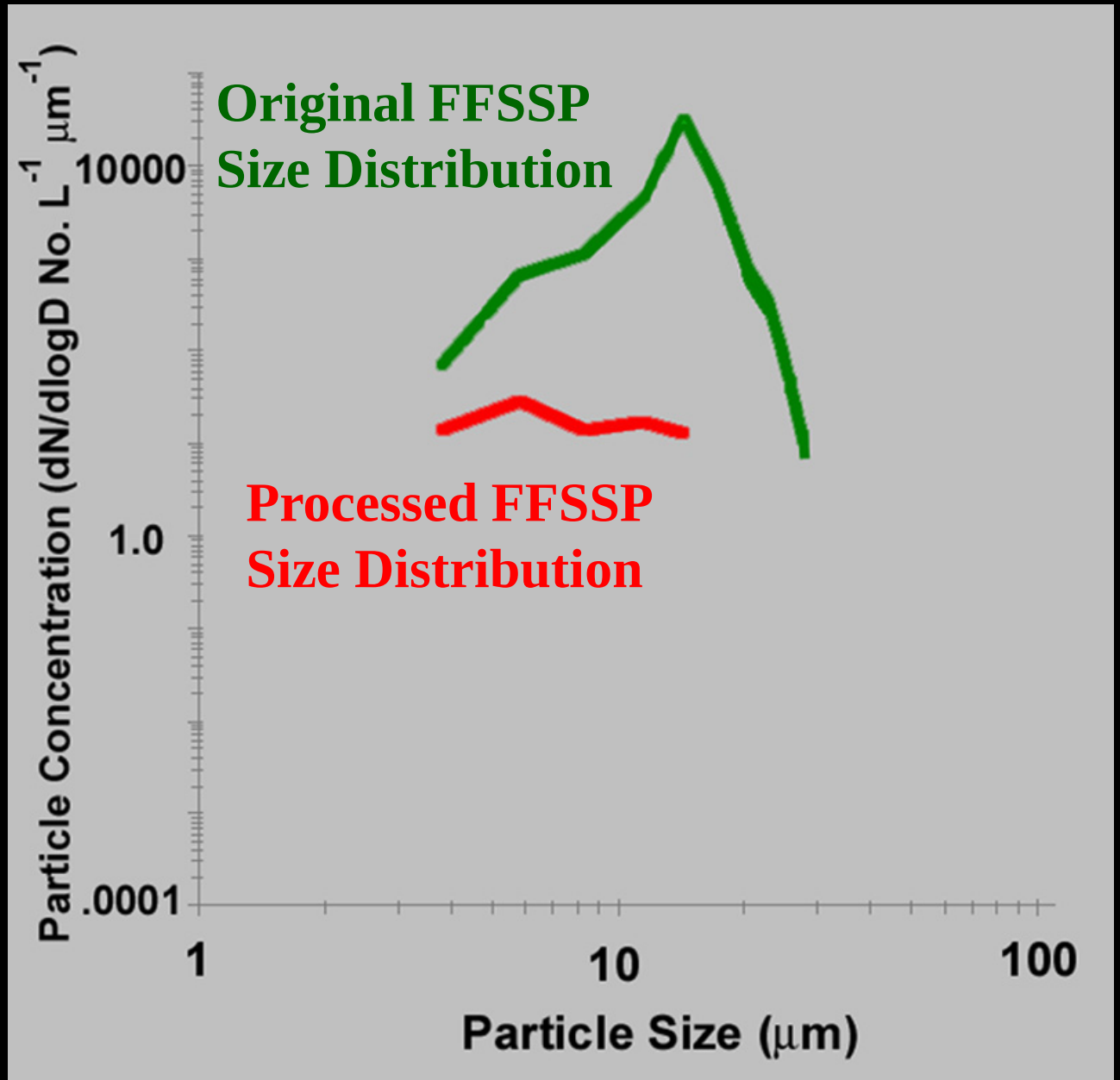
Fast FSSP Processing

- Brad Baker has been working on a Shattering Algorithm for the Fast FSSP. The Procedure Involves:
  1) Noise Reduction
  2) Shatter Reduction
  3) Depth of Field Qualification
  4) Transit Time Qualification
- Transit Times Correlate well with Particle Size (for the first time), Resulting in a New Algorithm that has Dramatic Effects in some conditions.

Plot Showing how Particle Transit Time Correlates well with Particle Size (for the first time).



One Example of Agressive Removal of Particles seen by the FFSSP as a Result of New Shattering and Transit Time Algorithm



One Example of Agressive Removal of Particles seen by the FFSSP as a Result of New Shattering and Transit Time Algorithm