Microphysical Observations in the Melting Layer of Precipitating Clouds

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MOTIVATION

The goal is to **characterize microphysical properties in the melting layer**, where snow transitions to rain.

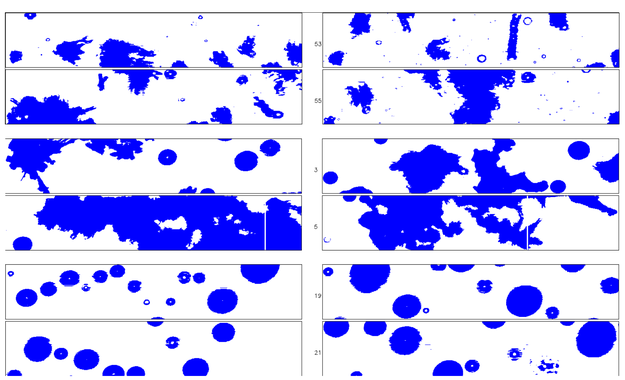
- This layer affects storm evolution
- Improved understanding of microphysical processes can lead to more accurate model forecasts

DATA

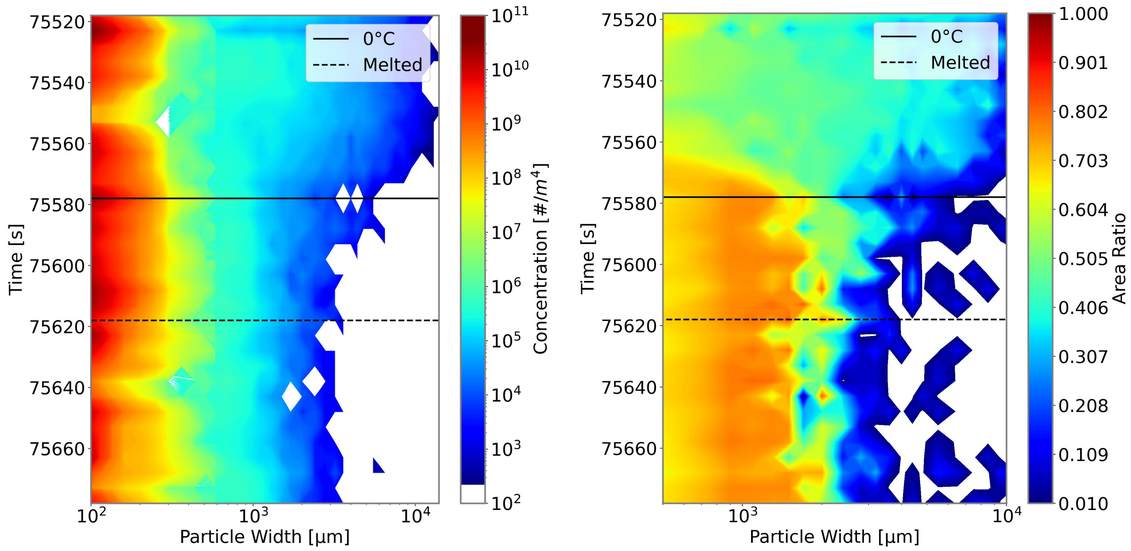
Melting layer observations are available from aircraft profiles during ten NASA campaigns.

Program	Dates	MLs
CAMEX-4	08/01 - 09/01	3
CRYSTAL-FACE	07/02 - 08/02	4
NAMMA	08/06 - 09/06	3
TC4	07/07 - 08/07	2
GRIP	08/10 - 09/10	0
LPVEx	09/10 - 10/10	2
MC3E	04/11 - 06/11	7
GCPEx	01/12 - 02/12	11
IPHEx	05/14 - 06/14	4
OLYMPEX	*11/15 - 12/15*	*9*
IMPACTS	*01/20 - 02/20*	*6*
TOTAL		**51**

- Airborne instruments provide data on hydrometeor size, liquid water content, and temperature
- Particle size measurements from the 2D-S are integrated to determine mass through the ML and compared to Nevzorov probe mass measurements

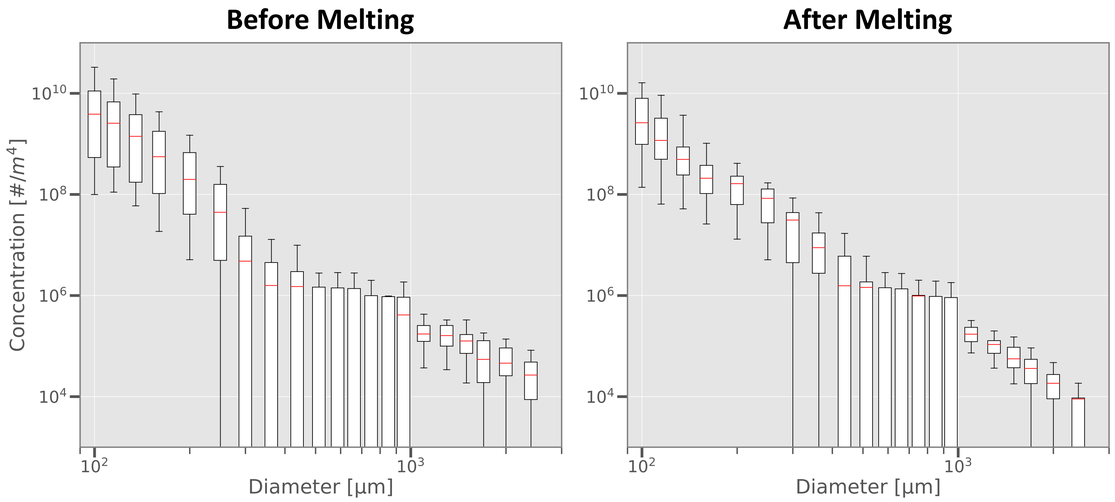


2D-S particle images showing the transition of hydrometeors for 12 NOV 2015 during OLYMPEX: snow (top), mixed (middle), rain (bottom).



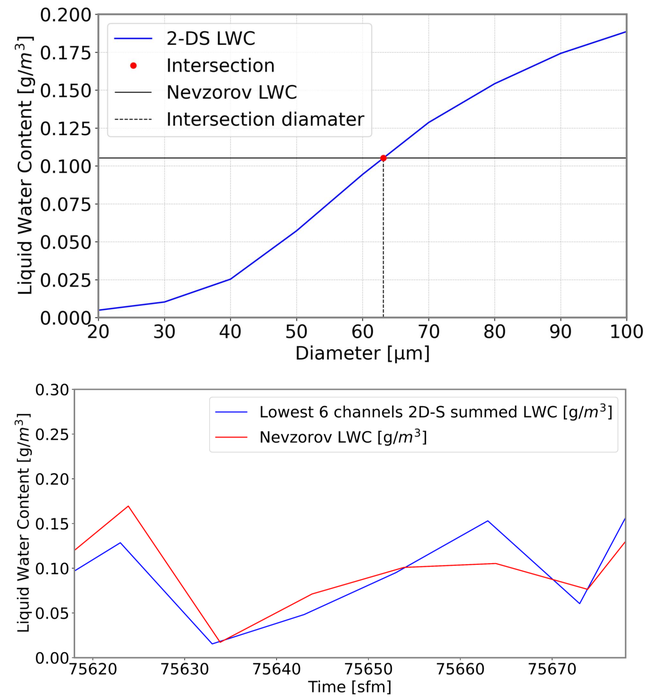
Colored contour plots showing combined 2D-S and HVPS3 particle size distribution (left) and HVPS3 area ratio (right) through the melting layer for 12 NOV 2015 during OLYMPEX.

- As snow melts, there is a decrease in maximum diameter
- Concentration of small particles remain relatively unchanged during the melting process
- The melting process causes irregular-shaped particles to become rounder, leading to an increase in area ratio as liquid water overtakes the crystals



Box-and-whisker plots showing 2D-S (< 10^3 μm) and HVPS3 (> 10^3 μm) combined spectrum concentration on 12 NOV 2015 over the durations: 75519 to 75579 sfm, before melting (left); and 75618 to 75678 sfm, after melting (right).

- Variability is larger above the melting layer
- The 95% confidence interval is wider for larger 2D-S channels (under 10^3 μm)



Liquid water content (LWC) for Nevzorov probe compared to 2D-S mass (top) and a time series of the lowest six channels of 2D-S LWC compared to Nevzorov LWC (bottom).

- The lowest six channels of the 2D-S measurements (up to 60 μm) are in closest agreement with Nevzorov probe
  - However, the diameter of the least difference between the two is between the sixth and seventh channel
- There are variations in how the lowest six channels of the 2D-S and Nevzorov compare over time

CONCLUSION

- Melting affects size distribution and hydrometeor shape
- Concentration measurements have larger variability before melting than after
- Nevzorov LWC measurements most closely match the 2D-S for only the first six channels
- Further work is necessary to quantify total mass and uncertainty through the melting layer