Development of a Video Disdrometer – Particle Video Imager (PVI)

History of PVI

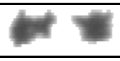
- Larry Bliven NASA/Wallops Flight Facility originally developed the PVI (or called SVI for snow) as inexpensive, robust instrument for imaging precipitation particles
  - 2001: Initial prototype was deployed in Key West, FL to measure raindrops
  - 2002-2006: Deployed in North Dakota for winter time applications
  - 2007-current: A system was deployed at the Marshall Field site in Boulder
  - Other Deployments:
    - Proposed to deploy a small network in Antarctica

Instrumentation Overview

- The SVI is comprised of a video system mounted inside a heated housing unit and a halogen lamp (150 Watts)
- The camera is a Supercircuits PC28C monochrome C-mount camera with a charge-coupled device (CCD) image sensor and a 100-300 mm telephoto lens
- The sensor has 640 x 480 pixels, however, it is operated in a 640 x 240 non-interlaced mode so that the frame rate is 60 frames/sec
- The exposure time is 1/100,000 s to minimize blurring due to particle motion
- The focal plane is 2 m from the end of the lens and the field of view (FOV) is 32 x 24 mm
- Nominal pixel size of an image is 0.05 x 0.1 mm

Snowflake Classification

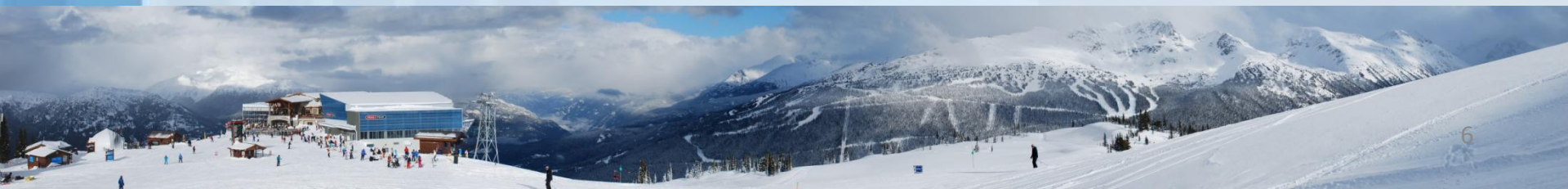
- The SVI has been very useful in identifying snowflake habits
- Currently, we perform the classification manually, but would like to develop an automated algorithm

F1	Plate	
F2	Stellar Crystal	
F3	Column	
F4	Needle	
F5	Spatial Dendrite	
F6	Capped Column	
F7	Irregular Crystal	
F8	Graupel	
F9	Ice Pellet	

Deployment of the SVI during the Winter Olympics (SNOWV10 Experiment)

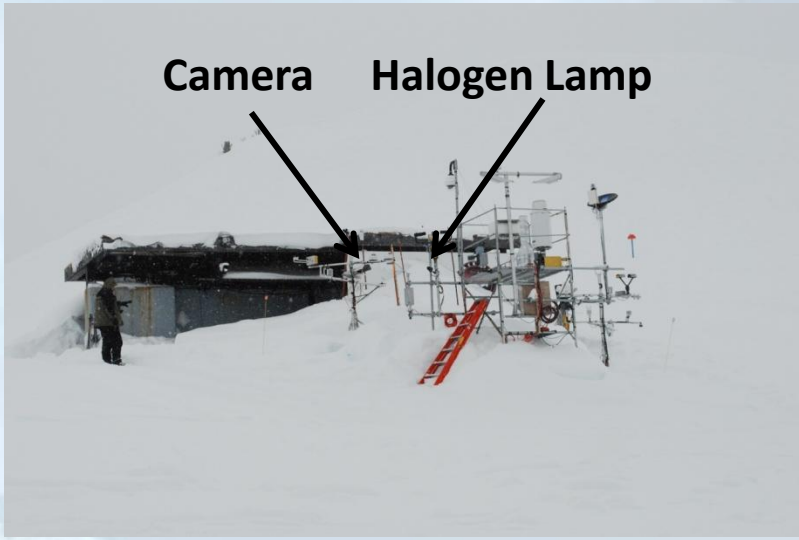
Deployment during SNOWV10

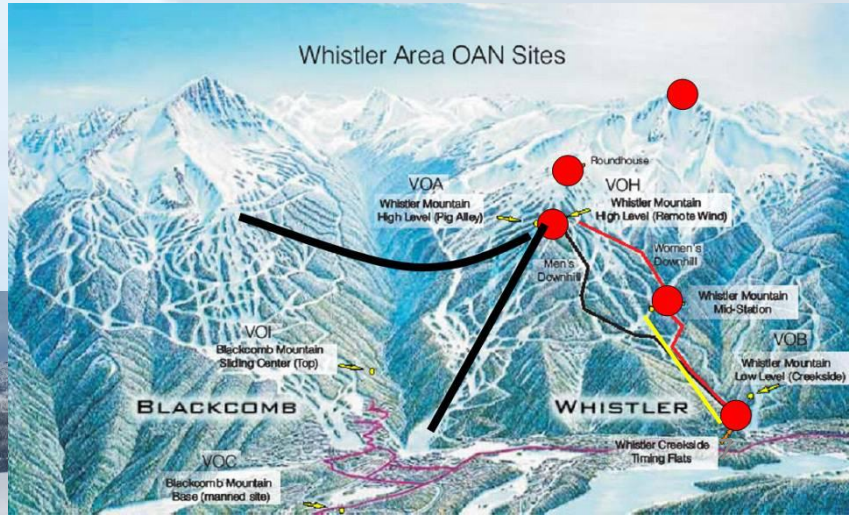
- The SVI was deployed at Whistler Mountain (at Roundhouse) to image and characterize the snowflake distributions observed during SNOWV10
  - The SVI operated from 25 January 2010 – 20 April 2010
  - ~11 million snowflake images were observed



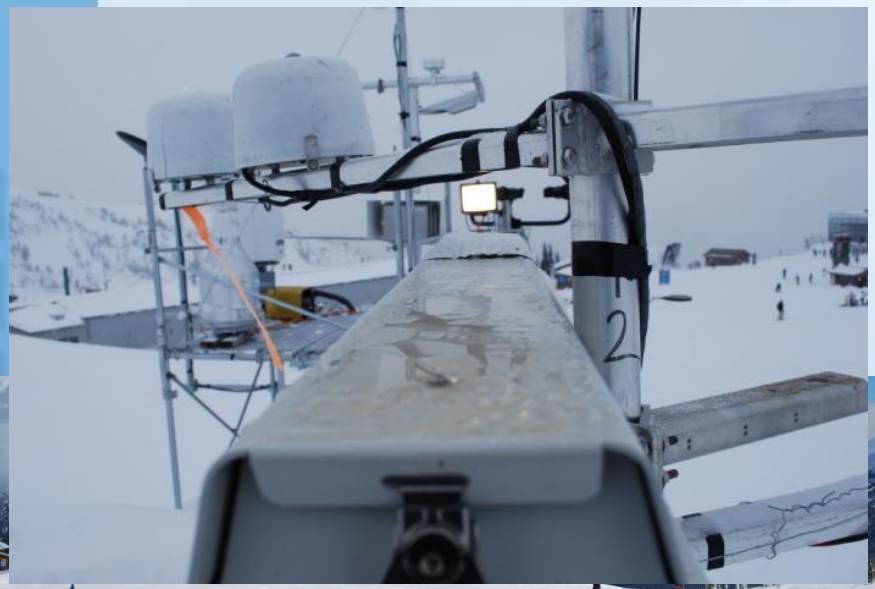
SVI Deployment at Whistler

- Location: Lat: 50.068° N
  Lon: 122.945° W
  Alt: 1855 m
- The camera was mounted on a Met tower
- The light was mounted on scaffolding with a 3 m separation
- The camera housing was heated to minimize ice accumulation



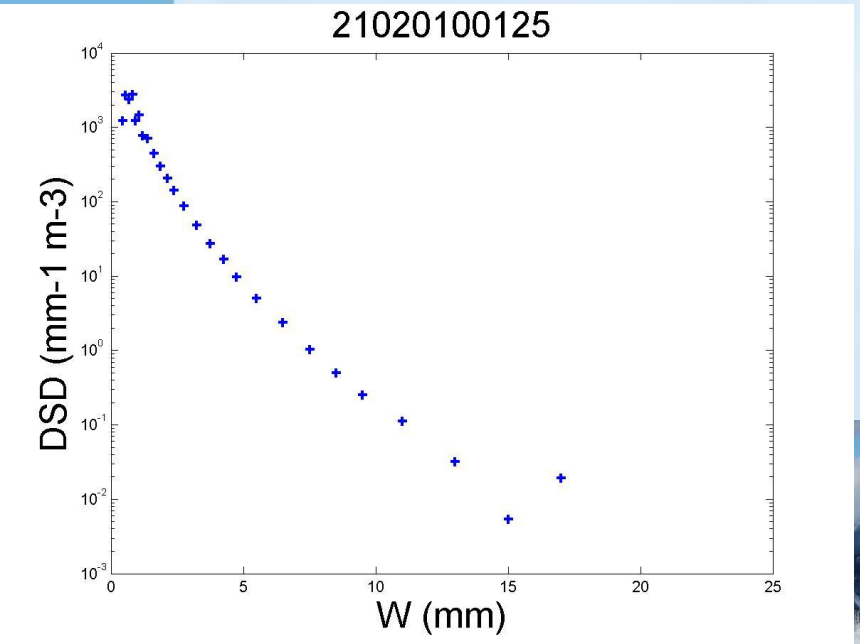


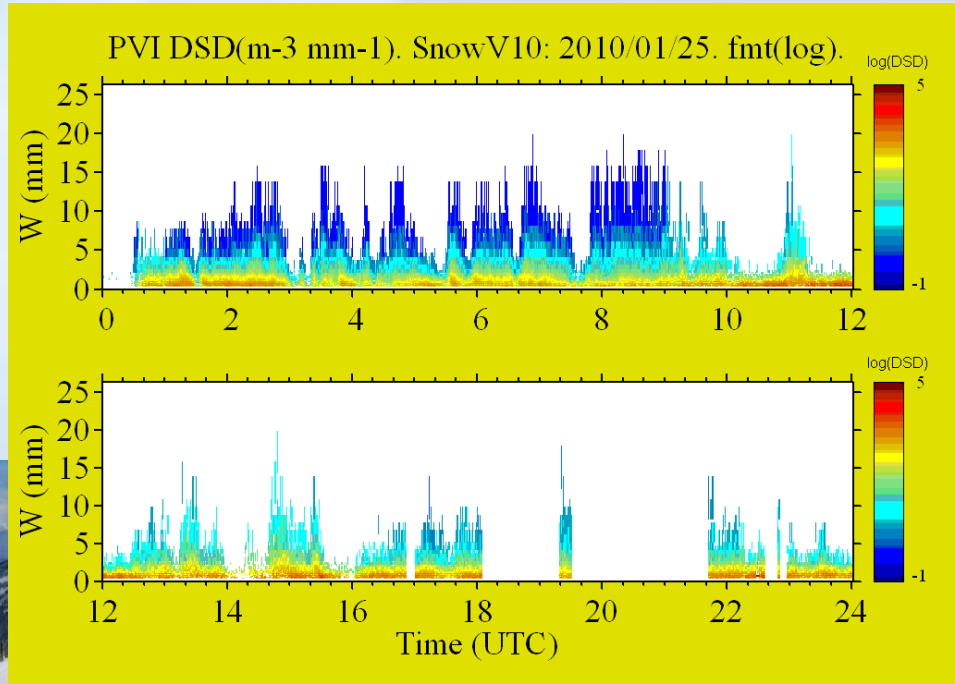
SVI Deployment at Whistler



Example Observations

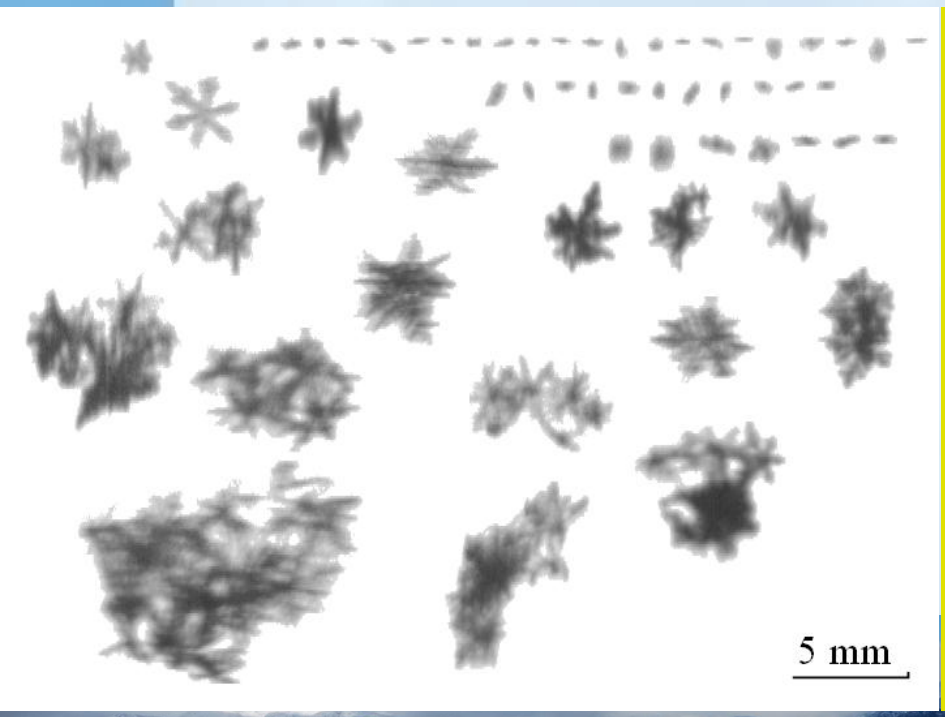
- One minute time series of particle size distributions (PSDs) are created (example left panel)
- A time series of the PSDs is created (right panel)
  - Blue indicates a concentration 10^{-1} # mm^{-1} m^{-3}
  - Red indicates a concentration 10^{5} # mm^{-1} m^{-3}

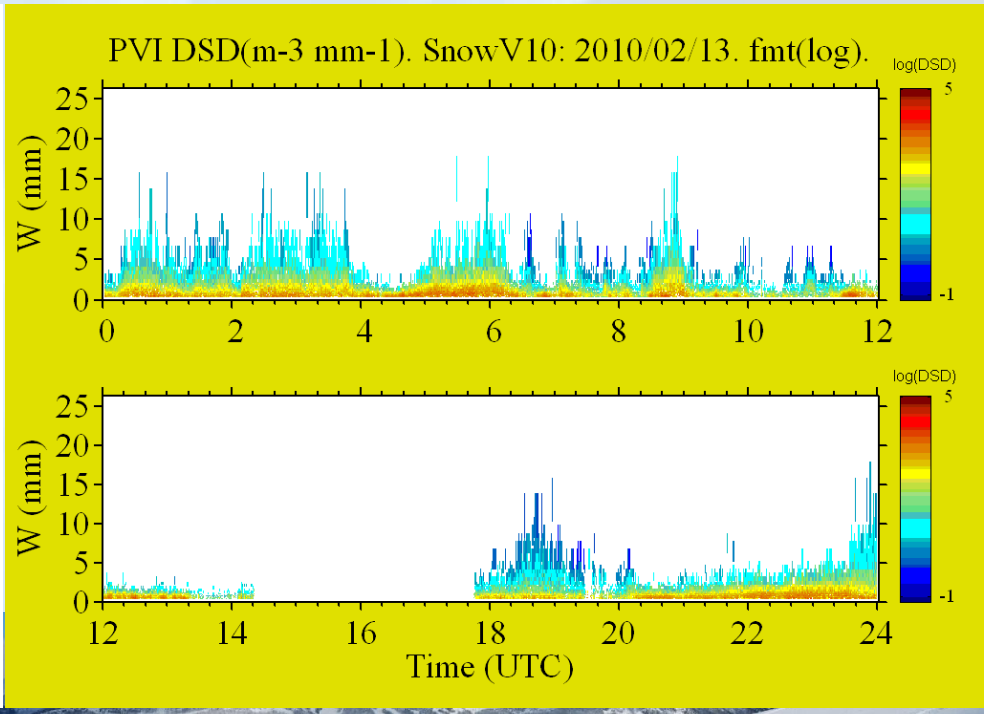




Example Observations – 13 February 2010

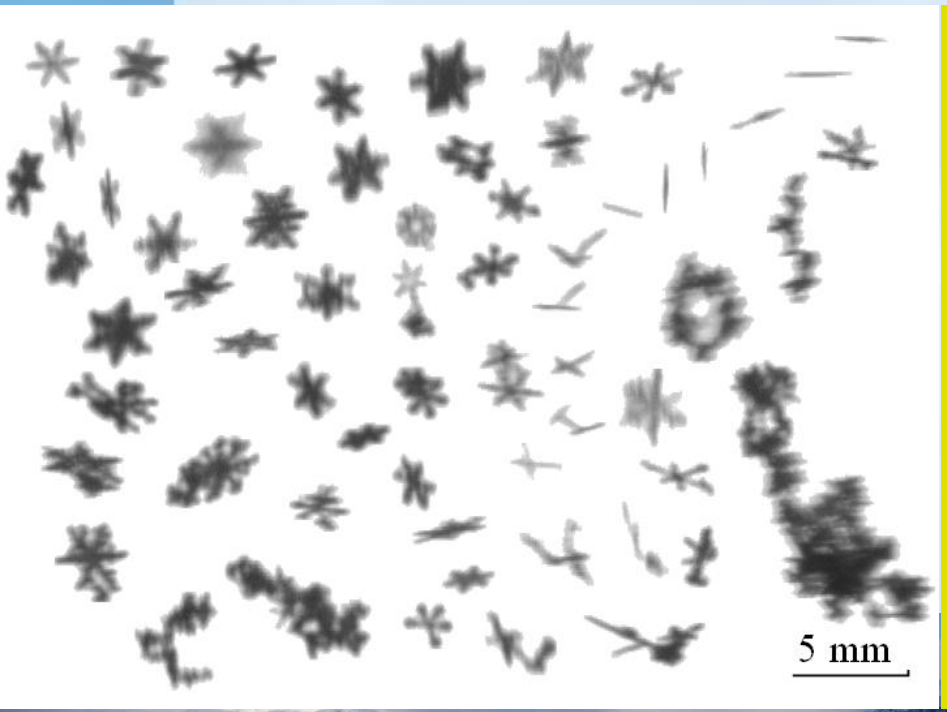
- Opening day of the Olympics: combination of aggregates and individual crystals were observed

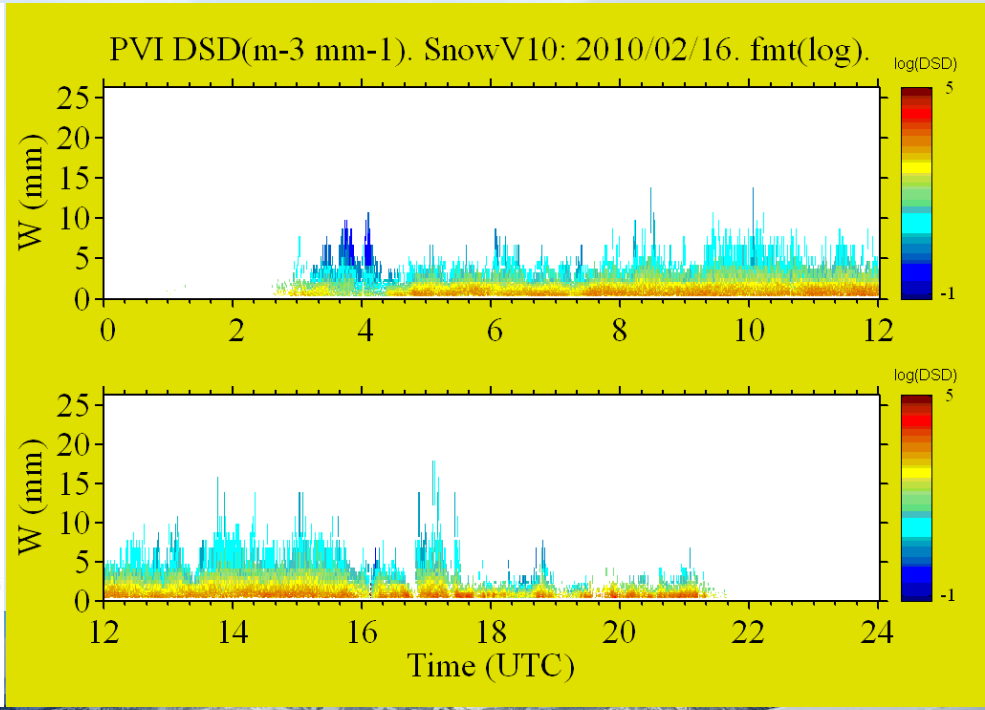




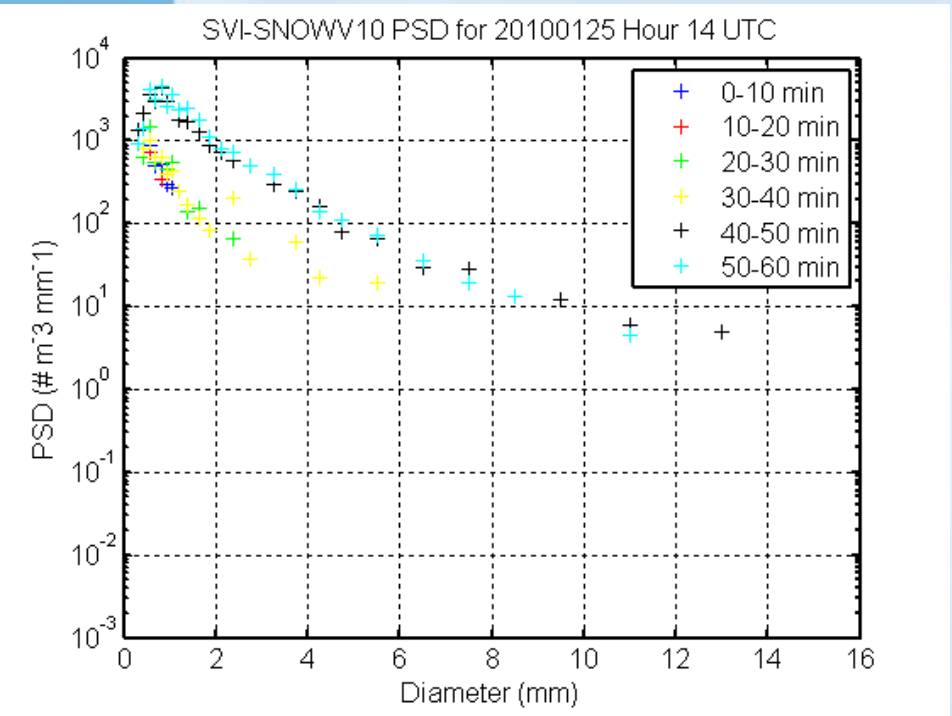
Example Observations – 16 February 2010

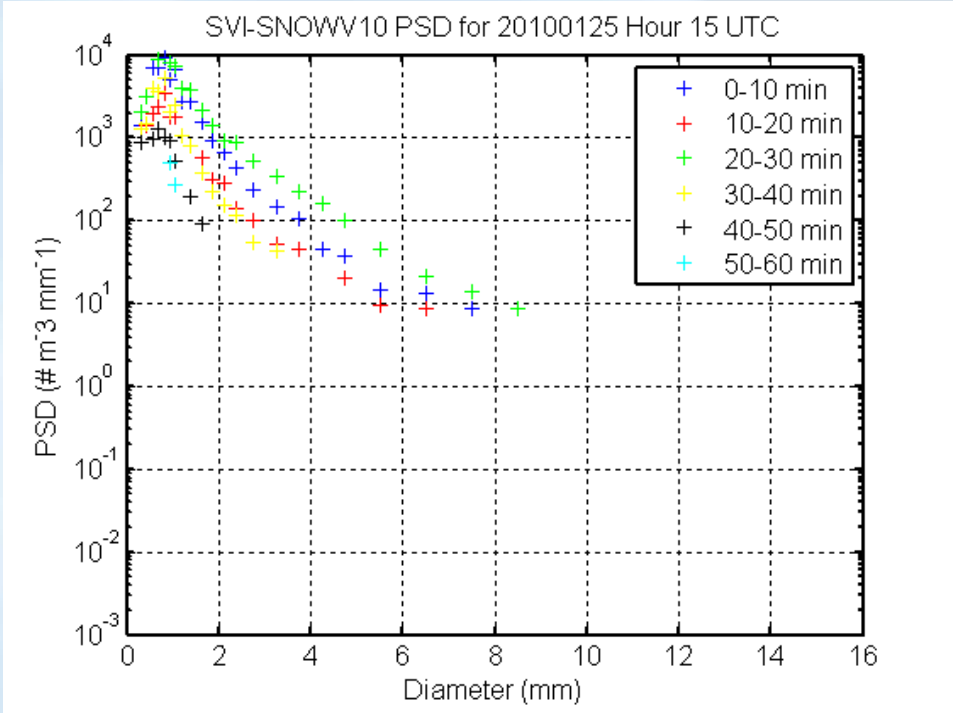
- Pristine crystals with a relatively few aggregates were observed on this day





Variability of PSD





Summary

- The SVI was very reliable for SNOWV10
- A tremendous amount of data have been collected (~11 million snowflakes)
- Large variability of snowflakes observed
  - Snowflakes ranged from small (~ 0.5 mm) pristine crystals (dendrites, needles, etc.) to large aggregates (maximum dimension ~20 mm)
- Snowfall events tended to be long in duration with some events last ~24 h
- Further investigation of case studies is underway to put the snowflake PSDs and type into the context of local and large scale meteorology