SVI at C3VP

The NASA Snowflake Video Imager obtained nearly continuous data from 1 Dec 06 thru 7 Mar 07.

This presentation contains a summary for the entire data set, which is sorted into (a) priority days selected by GSFC investigators, and (b) non-priority days.

The results are displayed in images of DSD(t), which reveal (a) the large variability of snowflakes sizes during events and (b) the intermittency of snowfall – even during intense storms.

Additionally, results from a preliminary study of snowflake orientation reveals that there is a higher occurrence of snowflakes that are ‘horizontally’ orientated than ‘vertically’ orientated.

=================================================================
Larry Bliven \614.6
12 March 2007
>>> Internet Explorer & FireFox allow random page access. Safari does not! <<<
Video Snowflake Imager (SVI)

Larry Bliven at NASA\GSFC. Phone: 757-824-1057. Francis.L.Bliven@nasa.gov

Field Tested in North Dakota. Deployed in Canada for C3PV during winter of 06/07.

- Measures Snowflake Size Distributions.
- Measures Snowflake Orientation Distributions.

Open measurement volume = low wind distortion. CCD camera, not line scan camera = direct image. Very simple setup. Field tested to -40 degrees. 24/7 operation for months.

Camera Specs
- standard rs170 analog video
- 60 frames per second – non-interlaced
- 1/80,000 s shutter speed
- Focal plane size 24 x 32 mm
- Calibrated to 0.05 x 0.1 mm resolution

Snowflakes: 9 mm 11 mm
SVI Data

Step 1: Precipitation particles are imaged using video camera hardware and PC Labview Software. The images are archived on the PC.

Level 1 files: compressed video images from SVI during the 24/7 operation at the field site.

Step 2. We characterize individual particles in the video images.

Level 2 files: Spreadsheet formatted files that
(a) Contain identification and characterization of individual particles,
(b) Provide 1 second data summary and
(c) Provide 1 minute data summary.

Step 3. We calculate DSDs for each minute using Level_2 files.

Level_3 files: DSDs summarized for each minute in spreadsheet file format.

Get the C3VP DSD Level_3 files:

Zipped_Excel_Files
<table>
<thead>
<tr>
<th>MID</th>
<th>UTC</th>
<th>EVENT</th>
<th>AC OPS</th>
<th>AMSU-B OP</th>
<th>SONDE UTC</th>
<th>AMFR</th>
<th>KING RADAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>01/15</td>
<td>12:30-17:00</td>
<td>Synoptic</td>
<td>No</td>
<td>N15-1214; N17-1514, 1654</td>
<td>1130,1430,1700</td>
<td>PPI/RHI/RPT</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Rime aggregates on site; freezing rain near King Radar</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>01/19</td>
<td>16:40-18:30</td>
<td>Strong Band</td>
<td>No</td>
<td>N17-1522,1639</td>
<td>1200,1815</td>
<td>PPI/RHI/BRL</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Large Aggregates; Stellar, branched crystals; dendrites; graupel-like snow</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>01/19-20</td>
<td>23:00-01:30</td>
<td>Lake-Effect Bands</td>
<td>Yes</td>
<td>No</td>
<td>22:17,0134</td>
<td>No</td>
<td>Yes (RHI @35° to cover AC)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Good AC microphysics in strong snow band that should be very similar to sampling at 1640-1830</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>01/22</td>
<td>02:00-08:00</td>
<td>Synoptic</td>
<td>Yes</td>
<td>N17-0938; N18-0242,0823</td>
<td>04:03,0830</td>
<td>PPI/RHI/TX/YPT</td>
<td>Yes (CARERHI, Chandra TS)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Convair over CARE (spiral descent/ascent; radial stacked leg along King C-band RHI 33°). Stellar dendrites and aggregates of dendrites</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>01/23</td>
<td>18:30-23:00</td>
<td>Pre-Frontal</td>
<td>No</td>
<td>N16-1952; N18-1900</td>
<td>21:16</td>
<td>PPI/RHI</td>
<td>Yes (CARERHI)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Light snowfall, dendrites and aggregates</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>01/24</td>
<td>18:30-19:30</td>
<td>Clouds</td>
<td>Yes</td>
<td>N16-1941; N18-1932</td>
<td>17:45</td>
<td>PPI/RHI</td>
<td>Yes (CARERHI)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Few clouds, Convair flew but not over CARE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>01/26</td>
<td>03:45-04:30</td>
<td>Lake-Effect Bands</td>
<td>No</td>
<td>N17-0207,0347</td>
<td>None</td>
<td>PPI/RHI</td>
<td>Yes (CARERHI)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ku wouldn’t work due to cold. Scanned with Ka only. Very small ice crystals in snow. AMFR saw very little.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>01/26</td>
<td>21:05-00:00</td>
<td>Synoptic bands</td>
<td>Yes</td>
<td>N15-2234; N17-0144</td>
<td>21:20,23:50</td>
<td>PPI/RHI</td>
<td>Yes (CARERHI)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Convair did spiral descent over CARE and stacked 25° radials; Ku worked but then dropped out just prior to AC arrival.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>01/27</td>
<td>21:30-23:45</td>
<td>Synoptic Low</td>
<td>No</td>
<td>N15-2210; N16-2047, N17-0301</td>
<td>22:40,0120</td>
<td>PPI/RHI</td>
<td>Yes (CARERHI)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>AMFR computers died 23:45, nice long snow band off Lake Huron hit site afterward</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Analysis Priority:**  Red- High²²²; Green-Moderate²²²; Black- Lower²²²
C3VP. GSFC SVI.

1/20/07 (0000-0130)**

100k Flakes. 

log10(dsd(mm-1 mm3))

D(mm) 

Time (UDT)

105k Flakes. 

log10(dsd(mm-1 mm3))

D(mm)
1/22/07 (0200-0800)***

**C3VP. GSFC SVI.**

- **47.8k Flakes.**
  - $\log_{10}(\text{dsd (mm-1 mm}^3))$

- **0.066k Flakes.**
  - $\log_{10}(\text{dsd (mm-1 mm}^3))$

**D(mm)** vs **Time (UDT)**
1/23/07 (1830-2300)*

C3VP. GSFC SVI.

12.9k Flakes. \[ \log_{10}(\text{dsd}(\text{mm-1 mm3})) \]

7.17k Flakes. \[ \log_{10}(\text{dsd}(\text{mm-1 mm3})) \]
C3VP. GSFC SVI.

0k Flakes. \[ \log_{10}(\text{dsd}(\text{mm}^{-1} \text{ mm}^3)) \]

40k Flakes. \[ \log_{10}(\text{dsd}(\text{mm}^{-1} \text{ mm}^3)) \]
1/27/07 (2130-2345)*

C3VP, GSFC SVI.

6.52k Flakes. log10(dsd(mm-1 mm3))

1.98k Flakes. log10(dsd(mm-1 mm3))

D(mm)

Time (UDT)
Non-Priority Days.

In addition to the Priority Days, the SVI obtained precipitation data on about 40 Non-Priority Days. Those data are summarized in the following figures.

The days are classified by the number of snowflakes.

- 0k to 50k particles: *
- 50k to 100k particles: **
- 100k to 200k particles: ***
- >200k particles: ****
C3VP. GSFC SVI.

8.31k Flakes. \( \log_{10}(dsd(mm^{-1} \text{ mm}^3)) \)

77.5k Flakes. \( \log_{10}(dsd(mm^{-1} \text{ mm}^3)) \)

Time (UDT)

D(mm)
C3VP. GSFC SVI.

0k Flakes. \[ \log_{10}(\text{dsd}(\text{mm}^{-1} \text{ mm}^3)) \]

11.9k Flakes. \[ \log_{10}(\text{dsd}(\text{mm}^{-1} \text{ mm}^3)) \]
C3VP. GSFC SVI.

3.7k Flakes.  \[ \log_{10}(\text{dsd}(\text{mm}-1 \text{ mm}^3)) \]

22.2k Flakes.  \[ \log_{10}(\text{dsd}(\text{mm}-1 \text{ mm}^3)) \]
C3VP. GSFC SVL.

0k Flakes.

log10(dsd(mm-1 mm3))

30.5k Flakes.

log10(dsd(mm-1 mm3))
C3VP. GSFC SVI.

1.17k Flakes.  log10(dsd(mm-1 mm3))

17.8k Flakes.  log10(dsd(mm-1 mm3))

D(mm)

0 2 4 6

0 2 4 6

12 14 16 18 20 22 24

Time (UDT)
C3VP. GSFC SVI.

0.045k Flakes.  log10((dsd(mm-1 mm3))

9.46k Flakes.  log10((dsd(mm-1 mm3))

D(mm)
0 2 4 6
0 12 14 16 18 20 22 24
Time (UDT)

1/9/07*
C3VP. GSFC SVI.

13.7k Flakes. \[ \log_{10}(d_{sd}(\text{mm}^{-1} \text{ mm}^3)) \]

3.72k Flakes. \[ \log_{10}(d_{sd}(\text{mm}^{-1} \text{ mm}^3)) \]
35.7k Flakes. \[ \log_{10}(\text{dsd(mm-1 mm}^3)) \]

0.747k Flakes. \[ \log_{10}(\text{dsd(mm-1 mm}^3)) \]

C3VP. GSFC SVI.
C3VP. GSFC SVI.

7,09k Flakes.

0k Flakes.

Time (UDT)

D(mm)

log10(dsd(mm-1 mm3))

D(mm)

log10(dsd(mm-1 mm3))
C3VP. GSFC SVI.

4.21k Flakes.  \[ \log_{10}(\text{dsd} (\text{mm}^{-1} \text{mm}^3)) \]

0.0k Flakes.  \[ \log_{10}(\text{dsd} (\text{mm}^{-1} \text{mm}^3)) \]

D(mm)

Time (UDT)
2/14/07

C3VP, GSFC SVI.

398k Flakes

log10(dsd(mm-1 mm3))

69.1k Flakes

log10(dsd(mm-1 mm3))

Time (UDT)
C3VP. GSFC SVI.

0k Flakes. \[ \log_{10}(\text{dsd(mm-1 mm3)}) \]

44.9k Flakes. \[ \log_{10}(\text{dsd(mm-1 mm3)}) \]

D(mm)

Time (UDT)
C3VP. GSFC SVI.

0k Flakes.

log10(dsd(mm-1 mm3))

83.5k Flakes.

log10(dsd(mm-1 mm3))
Other Data Products.

The SVI data can be used to obtain other data products.

For example:
(a) Snowflake Orientation
(b) Size Distributions for various time intervals.

The following figures show a couple of cases.
Snowflakes are twice as likely to be horizontally orientated rather than vertically orientated.

Snowflake orientation is relatively size independent.

- $0.5 < D < 1.0$ mm. $N = 6k.$
- $1.0 < D < 3.0$ mm. $N = 11k.$
- $3.0 < D$ mm. $N = 3k.$

Canada: 3CVP
6 Dec 2006
1400-1500
SVI: Snowflake Size Distribution.

As size increases, the number of snowflakes decreases.

Count

1.0E+04

1.0E+03

1.0E+02

1.0E+01

Snowflake Eq Diameter (mm)

0 1 2 3 4 5 6

Canada: 3CVP
6 Dec 2006
1400-1500

20k Snowflakes