Introduction:
The precipitation science community is in great need of high-quality data sets for developing falling snow detection and estimation algorithms. In the past, the retrieval community has used a number of approximate models for the frozen atmospheric particles and the surface emission, all giving different results based on choices of parameters and assumptions. The field campaign data set described in this poster can help the snowfall retrieval algorithm community develop a better understanding of the relationships between non-spherical snowflakes and their radiative properties, surface emission (especially over snow covered surfaces), and the impact environmental conditions (e.g., profiles of T and RH) can have on falling snow estimates.

A database linking radar and radiometer signals with the falling snow physical state would be a useful tool that can be developed using field campaign data. Since high frequency channels (89 to 183 GHz) are particularly sensitive to precipitating snow, these channels must be included in the database. Thus we are generating a High Frequency Active Passive (HFAP) database for use in Bayesian retrievals of falling snow. This HFAP phase is one part of the proposed work for falling snow retrievals.

Field Campaign:
The Canadian CloudSat/CALIPSO Validation Program (C3VP) was a field campaign held from Oct. 31, 2006 through March 1, 2007. The C3VP field campaign provided an opportunity for the CloudSat/CALIPSO and Global Precipitation Measurement (GPM) mission teams to participate in cold-season northern latitude data collection activities. Our interest in this experiment was to collect data for developing falling snow detection and estimation algorithms. The C3VP field campaign was held at the Centre for Atmospheric Research Experiments (CARE) research facility operated by the Air Quality Research Branch of the Meteorological Service of Canada. It is located 80 km north of Toronto, in a rural agricultural and forested region (Fig. 1) and has regular CloudSat and AMSU-B overpasses and was heavily instrumented (See Figs. 2 and http://www.c3vp.org).}

TB Ambiguity due to Surface Features (near CARE site)
Surface emissivity from each TB seen from space. The surface emission of 3K (not accounted for) can contaminate the TB signal from the atmospheric falling snow and cause errors in the retrievals. The 89 GHz image shows offsets in TB in the upper right and lower right likely due to the differences in soil temperature and vegetation type (as shown in the images below). Surface snow depth also affects surface emissivity. The result is a range of TB for various snowfall rates (see Figs. 2).

Retrieved Emissivity from AMSU-B/MHS Observations
Oct 06 to March 07 at CARE site

January 22, 2007 Synoptic Light Snow Event
(~3-cm accum at CARE)

CloudSat (07:33 UTC)

AMSU-E TB (07:33 UTC)

AMSU-B TB (07:33 UTC) UTC times above columns

AMSU-B TB

AMSU-E TB

CARE Location (#)

Figure 2: Location of the CARE site and ten CloudSat overpasses.

Falling Snow Retrieval Database Development Work

Gail Skofronick-Jackson1, Benjamin Johnson2, James R. Wang3, Anne Kramer2
1Mesoscale Processes Branch, Code 613.1, NASA Goddard Space Flight Center, Greenbelt, MD Gail.S.Jackson@nasa.gov
2University of Maryland Baltimore County (JCET/GEST), 3SSAI

Falling Snow Detection Procedure
Goal: Remove effects of Surface and Relative Humidity from AMSU-B data
1) Use WRF modeled data or GOES derived data for surfT and profiles of T & RH
2) Estimate surface emissivity using AMSU-B/MHS data (see lower left of poster)
3) Verify surface emissivity during clear air overpasses (see block below)
4) Compute TB w/ surfT, emissivity and T/RH profiles & assuming clear air
5) Take the difference: TBAMSU-B –TBcomputed
6) If 3 of 6 channels have a negative difference (scattering), then snow detected (see below).

Verify Surface Emissivity for Clear Air (21 Jan 2007 11:31 UTC)

NOAA-18 MHS Overpass at 22 Jan 07 at 06:42 UTC

Diff

89 GHz 150 GHz 183 GHz

T B Differences at 150 GHz ±7 GHz 183 GHz

These images show the difference Observed minus Computed for 89, 150 and 183±7 GHz. We note that at 89 GHz the differences are between 0 and -2K showing that the AMSU-B estimated emissivity is accurate and vertical T & RH conditions do not affect that result. On the other hand for 150, the atmosphere T and RH are changing the overall TB by ~2K. For 183 GHz the surface emission used in the calcs was from 150 GHz and the atmospheric T and RH are causing differences up to -10K. The 183 GHz emissivity retrievals need to be updated to a multi-level atmosphere.

Conclusions
Retrievals over land are challenging due to contamination from surface emission, but falling snow detection is achievable using basic surface and atmospheric profiles. Radar on CloudSat will continue process to further distinguish rain, clear-air, snow, and sub-freezing cases. Future Work: Generate HFAP Bayesian databases using CloudSat/CALIPSO snow retrievals and AMSU-B/MHS data. Relevant References

3) Future Work: Generate HFAP Bayesian databases using CloudSat/CALIPSO snow retrievals and AMSU-B/MHS data. Relevant References