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Spatial behavior of snow observations, radiometric data and microwave emission modeling

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The spatial resolution of passive microwave satellite sensors is a major concern for many applications and there is a strong desire to resolve sub-pixel heterogeneity effects on the accuracy of retrievals. However, limited spacecraft and mission resources impose severe constraints and tradeoffs. In order to maximize science return while mitigating risk for a sensor concept, it is essential to understand the scaling behavior of snow in terms of what the sensor sees (brightness temperature) as well as in terms of retrieved quantities (snow water equivalent, SWE) and geophysical parameters.

The NASA's Cold Land Processes Experiment-1 (CLPX-1: Colorado, 2002 & 2003) was designed to help understanding at what scales does spatial variability of key state variables in the terrestrial cryosphere, including snow characteristics, soil moisture, the extent of frozen soils, and the transition between frozen and thawed conditions, control fluxes and transformations of water, energy, and carbon, and if can remote sensing resolve this variability at these scales.

In this talk we will report the results of observations from CLPX-1 ground, airborne, and satellite passive microwave sensors. We will use this data to examine and evaluate the scaling behavior of brightness temperatures and retrieved SWE across scales from meters to 10's of kilometers. Histograms of brightness temperatures collected at different frequencies over the Fraser and North Park Meso-Scale Areas by the NOAA Polarimetric Scanning Radiometer (PSR/A) airborne sensor are modelled by a log-normal distribution (Fraser, forested area) and by a bi-modal distribution (North Park, patchy-snow, non-forested area). Then, the airborne brightness temperatures are

re-sampled over a range of resolutions to study the effects of sensor resolution on the shape of the distribution. The values of brightness temperatures obtained by re-sampling the PSR-A data at 25 km resolution are consistent with those recorded by the Advanced Microwave Scanning Radiometer (AMSR-E) and Special Sensor Microwave/Imager (SSM/I) satellite radiometers at similar resolutions. We also report the results of evaluation of the scaling behavior of observed and modeled brightness temperatures and observed and retrieved snow parameters across scales from meters (ISA's) to 10's of kilometers (MSA's). The conclusions provide direct examples of the appropriate spatial sampling scales of new sensors for snow remote sensing. The analyses will also be helpful for illustrating the effects and spatial scales of the underlying phenomena (e.g., land cover) that control sub-pixel heterogeneity.