SnowEx2017 ground-based passive microwave data

1. Introduction

Four surface-based radiometers (SBR : 89 37 19 11 GHz) were deployed into the field during the SnowEx2017 campaign from February 14th to February 18th. The radiometers were mounted on a sleigh attached to a snowmobile. TB measurements were acquired at 89, 37, 19 and 10.67 GHz in both vertical (V-pol) and horizontal (H-pol) polarizations at a height of approximately 1.5 m above the ground and at an angle of 55 with the PR-series Surface-Based Radiometers from Radiometrics Corporation (Langlois, 2015) (hereinafter, the 10.67GHz SBR is noted 11GHz for simplicity). The integrating time of the four radiometers are 6 seconds (one measurement every 6 second is taken). With a beamwidth of 6 for 89, 37 and 19 GHz SBR, the footprint of the measurements at the snow surface was approximately 0.6m x 0.6m. The 11 GHz beamwidth is 8 with a footprint of about 0.8m x 0.8 m. At each site, brightness temperatures (TB) were measured during 2-4 minutes close (as close as possible) to snowpits done by ground-based teams (pictures were taken at each sites).

On Feb. 14th, SBR measurements were done at LSOS at 2 different locations : close to the radar (RS) and close to Michigan radiometers site (JC).

From Feb. 15th to Feb. 17th, measurements were done across the Grand Mesa region (GM : 29 sites). During surface melt, continuous measurements (~ 20 minutes) were taken to look at the TB increase caused by the liquid water in the snow (32S, 97S and 84N : see in "ContinuousData" folder).

On Feb. 18th, measurements were done behind the two mega trenches (LSOS_MegaTrenchAspen and LEP_MegaTrench[spruce]). Measurement of the snow surface (_snow : 55), and measurement of the forest emission (see Roy et al., 2016) (_veg : 55 looking at the sky/vegetation) was done. Measurements were also done at the County Line parking on a scissor-lift (2 highs [970 cm; 1240 cm] and 3 footprints [s1:open; s2:spruce; s3:spruce]). At the end of the day, a calibration with LN2 and ambient black body was conducted.

2. Surface-Based Radiometer Calibration

At the end of the campaign (Feb 18th), a calibration with LN2 and ambient black body was conducted. The calibration coefficients TND0C and Offset0C were optimized from the LN2 and ambient measurements and then used to calculate calibrated TB over the whole campaign.

During the campaign, several ambient black body (BB)

measurements were taken to quantify the radiometers stability. Figure 2 shows that the Mean absolute errors (absolute difference between the radiometers measurements and measured black body physical temperature) of all BB measurements are around 1 K. The values are slightly higher at 37 GHz (~ 1.4 K). It is caused by the BB measurements done at LSOS-JCTruck site (just behind the Michigan radiometer truck), where there is a difference of more than 5 K between TB at 37 GHz and BB temperature. This instability at 37 GHz is not understood, so precaution should be taken when using SnowEx_LSOS_JCTruck at 37 GHz. Otherwise, all other TB are reliable with 1 K. Note that the biases are under 1 K for all radiometers.

3. Surface-Based Radiometer Campaign dataset overview

The calibrated data are stored in .csv file. There are 3 .csv (",") files :

SBRsnowpits_TBcalibrated : LSOS and GM sites
SBRCountyLine_TB : County Line parking site (scisor-lift)
SBRTrench_TBcalibrated : MegaTrench sites (Aspen and spruce)

All 3 files contains the following information :
File : Name of the TBraw file (SnowEx_SITE_SnowPit_YYMMDD_HHMM, MST)
Pit : Name of the adjacent snowpit (NaN = no adjacent pit)
Snow Depth : Snow Depth measurements were done with an avalanche probe in the footprint of the radiometer (cm) (NaN = no snow depth measured)
UTM (12 S and 13S) : UTM coordinates of the SBR footprint (NaN = no GPS point taken during the measurements)
TBFRP : Averaged calibrated brightness temperature (TB) (over the 2-4 minutes) at a given frequency (FR) and a given polarization (P : horizontal [H] or vertical [V]) in Kelvin (K)
stdFRP : Standard deviation of the measurements during the 2-4 minute period. Note that std are generally lower than 0.5 K. Higher std are seen only where surface melt occurs and continuous measurements were taken (site 32S, 97S and 84N).
IDPhoto : Photo ID that were taken at the SBR site (see "Picture_SBRsnowpit" and "Picture_SBRTrench" directory).
SnowFork : Identifies if snowfork measurements were taken.
Comments : General comments on when and where the measurements were conducted.

For County Line parking site (scissor-lift), the TBraw file include the high on the scisor-lift and the footprint (s1,s2,s3)

For MegaTrench sites (Aspen and spruce), the TBraw file include the position on the trench and the view (snow surface [_snow : 55] or forest emission [_veg : 55 looking at the sky/vegetation]

The corrected TB files of the 3 sites (32S, 84N, 97S) where continuous measurements were taken are store in the "ContinuousData" directory where :
Frequency (GHz)
Year
Month
Day
Minute
Second
Vload : internal load observations
VloadND : internal load - Noise diode
Tload : Radiometer temperature
Tcase : Case temperature
V(V-pol)(V) : Voltage at V-pol
V(H-pol)(V) : Voltage at H-pol
Incidence Angle() : Incidence Angle of the measurement (from horizontal)
Tb (V-pol) (K) : calibrated brightness temperature (TB) at V-pol
Tb (H-pol (K) : calibrated brightness temperature (TB) at H-pol
Note that the values between Seconde and Tb (V-pol) (K) are radiometer raw data (not useful).

4. SnowFork measurements

SnowFork measurements were also performed at some snowpit locations. For each Snowfork measurements, a file was created :

headerline1 : "date",YYYY-MM-JJ,HHhMM,"site",SITE
After, the 3 columns give the following information
depth (top = 0) : Depth of the measurement from the top (note: v is a vertical measurement on the top of the snowpack)
Wetness (% vol.) : SnowFork Snow wetness measurements in % vol..
Snow density (kg cm-3) : SnowFork snow density measurement in kg cm-3

5. REFERENCES
Langlois, A., 2015. Applications of the PR Series Radiometers for Cryospheric and Soil Moisture. Research, Technical Report. Vol. 2015. Radiometrics Corporation, p. 40.

Roy, A., Royer, A., St-Jean-Rondeau, O., Montpetit, B., Picard, G., Mavrovic, A., Marchand, N., Langlois, A., 2016. Microwave snow emission modeling uncertainties in boreal and subarctic

environments. Cryosphere 10:623638. http://dx.doi.org/10.5194/tc-10-623-2016.