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Airborne Microwave Radiometer Measurements During CanEx-SM10

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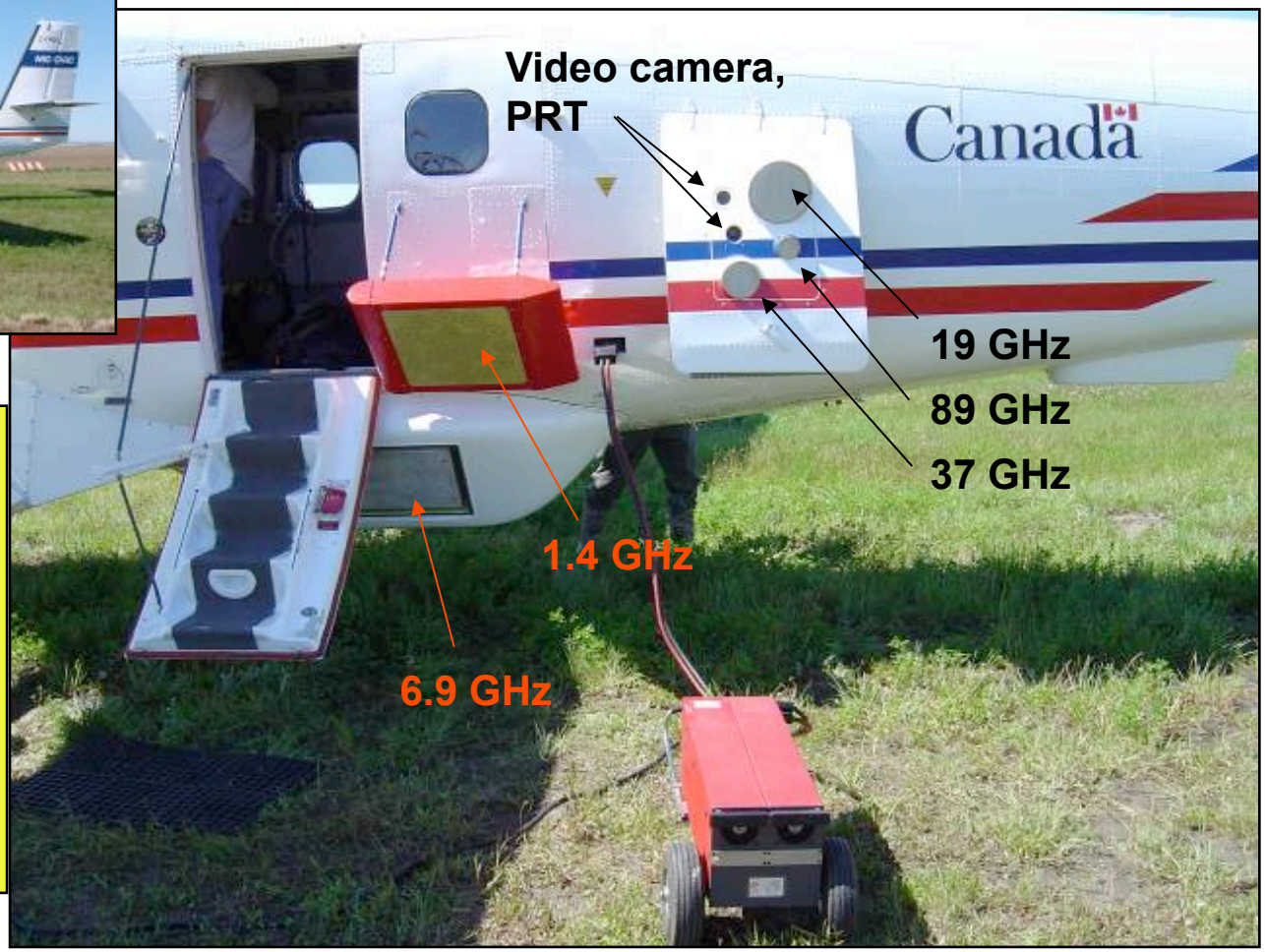
Environment Canada's Microwave Radiometer Installation on the NRC Twin Otter – CanEx-SM10

- 6.9, 19, 37 and 89 GHz → 53° incidence angle
- 1.4 GHz → 40° incidence angle
- Dual polarization except for 6.9 GHz (H pol. only)



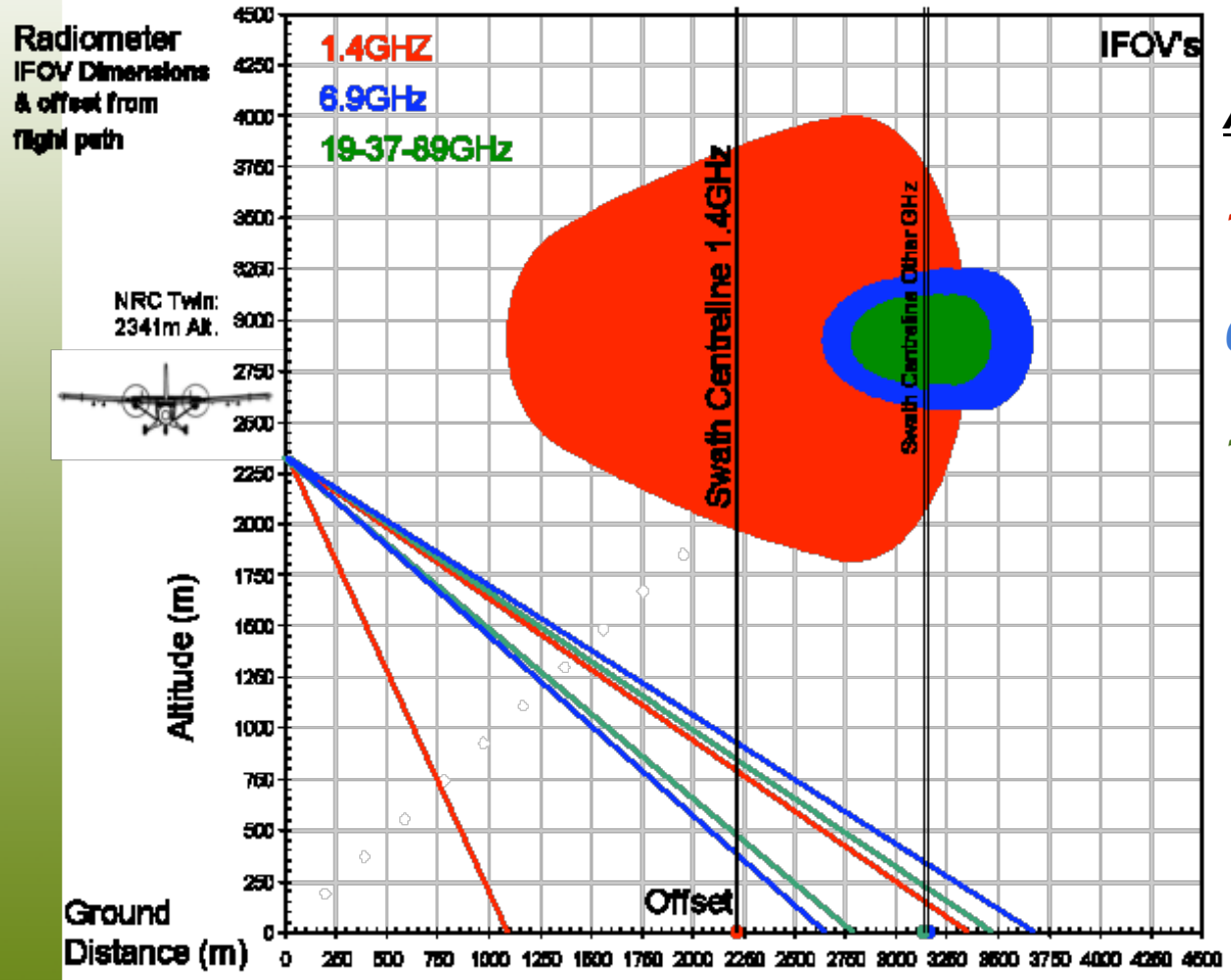
EC's L-band (1.4 GHz) Microwave Radiometer

Specifications:

- Manufactured by Radiometrics Corp.
- 1400-1500 MHz bandwidth range with selectable centre frequency to minimize RFI
- 30 degree beamwidth
- Dual-polarization (V and H)
- 1 second integration time

- CanEx-SM10 was the first aircraft campaign with this microwave radiometer
- Real-Time Digital Signal Processor performs a fast fourier transform of the receiver data to separate the broad band data into over 300 channels of brightness temperatures to facilitate detection and removal of RFI
  - Not installed in time for this campaign

Airborne Microwave Radiometer Viewing Configuration



Approx. FOV's in metres:

1.4 GHz: 1700 x 2250

6.9 GHz: 610 x 1029

19/37/89 GHz: 410 x 681

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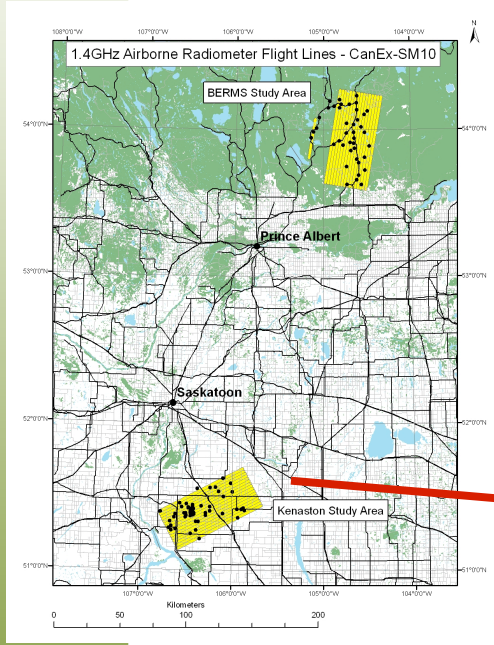
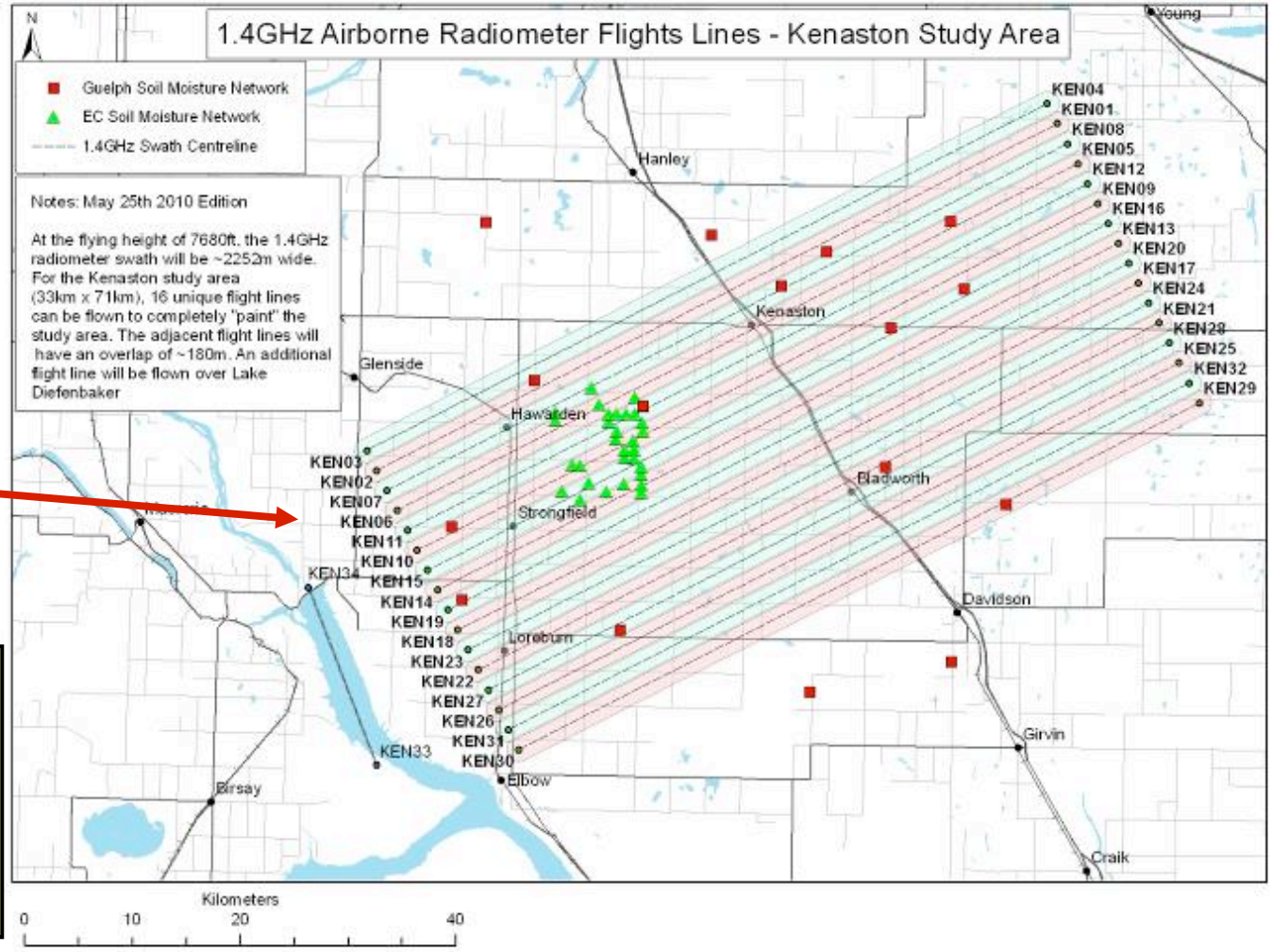
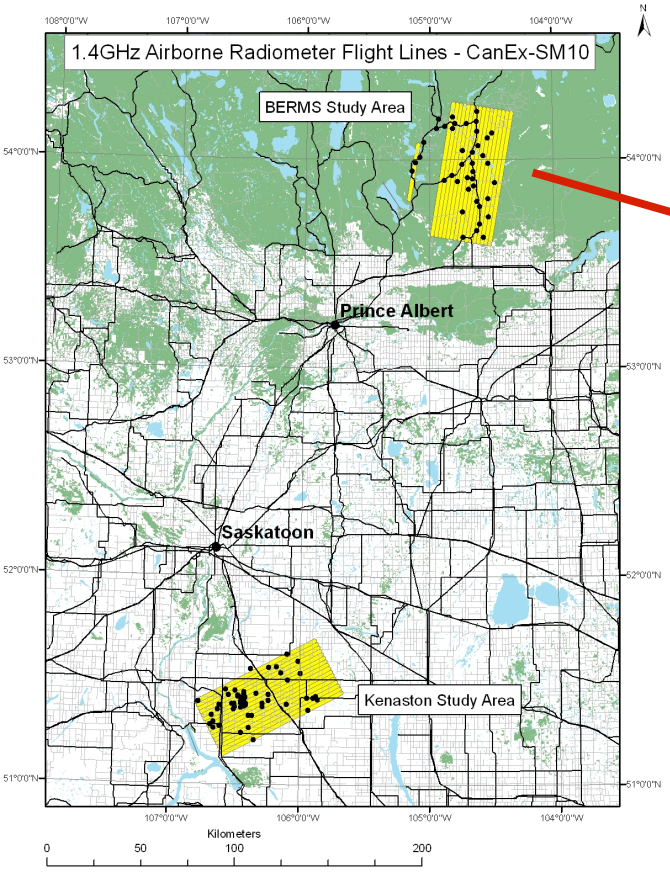
Microwave Radiometer Flight Lines – Kenaston Study Area

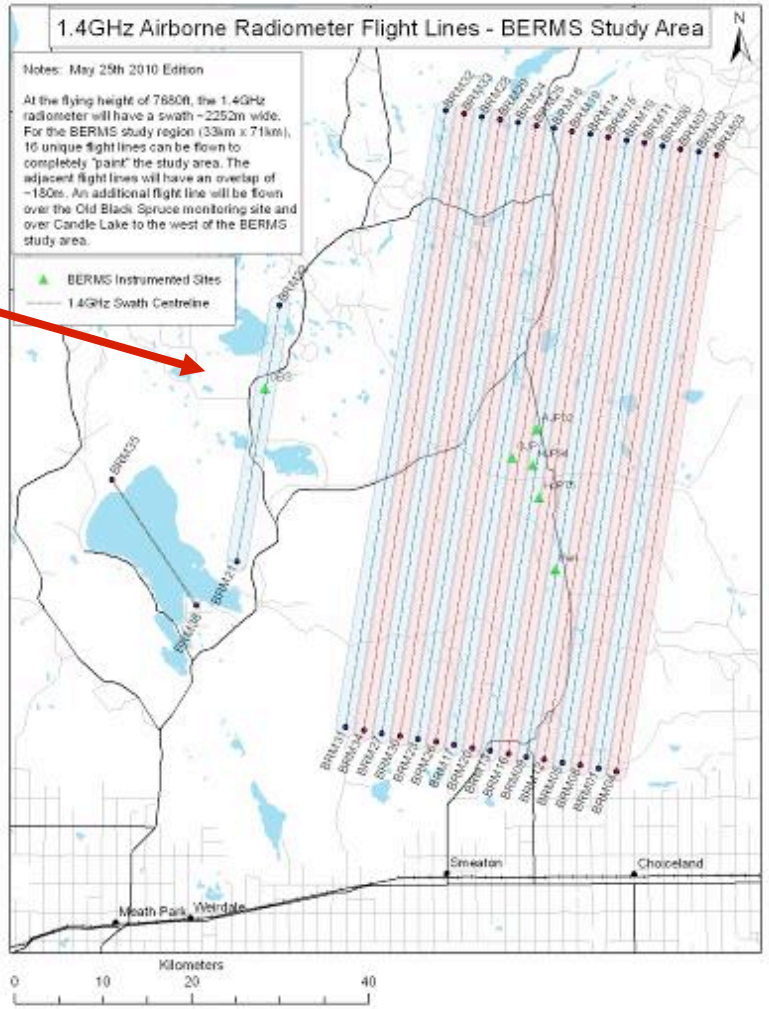




Objective:
Complete coverage of the study area with 1.4 GHz → 16 flight lines

Microwave Radiometer Flight Lines – BERMS Study Area





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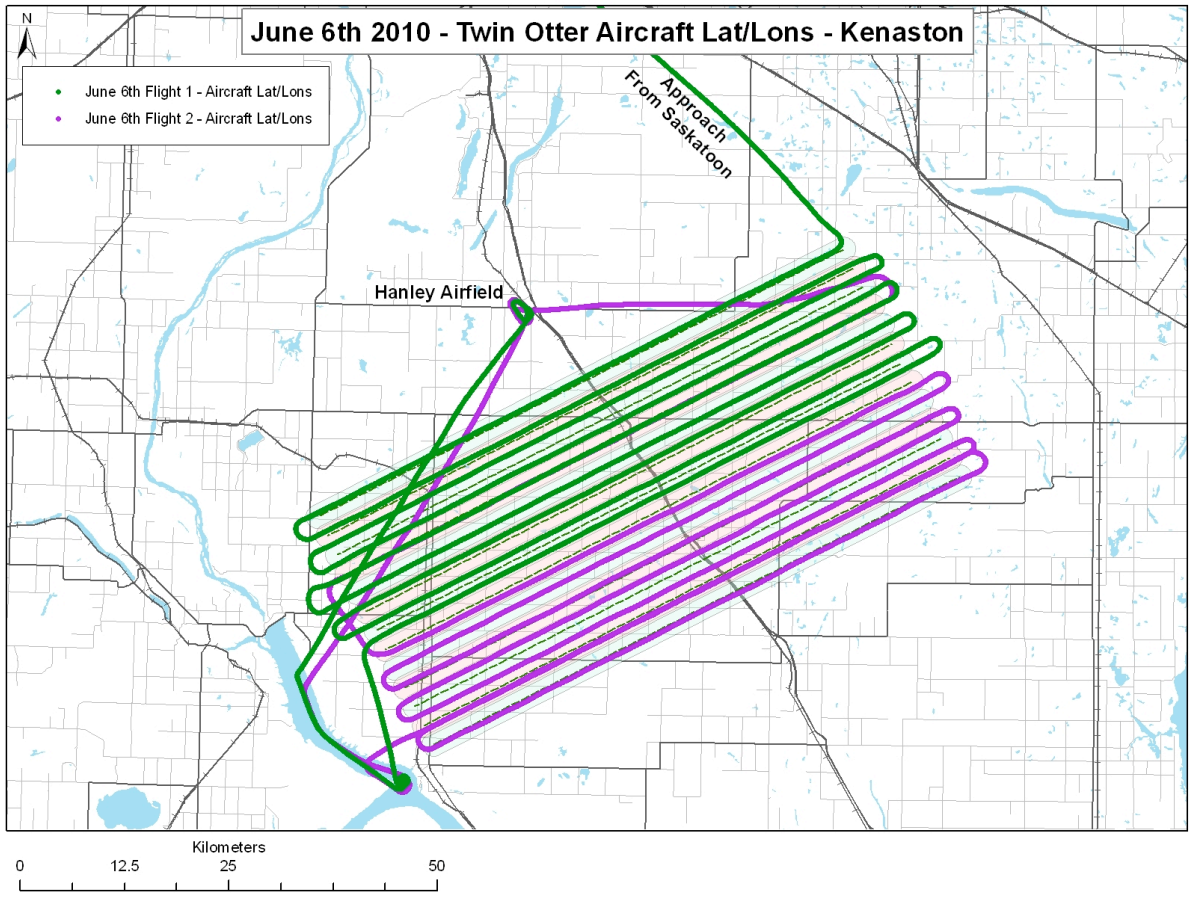
Microwave Radiometer Flight Plan – Kenaston Study Area



Twin Otter flight duration is ~4 hrs. (VFR conditions) → 2 flights required for complete coverage of study area. Six (2-flight) missions carried out.

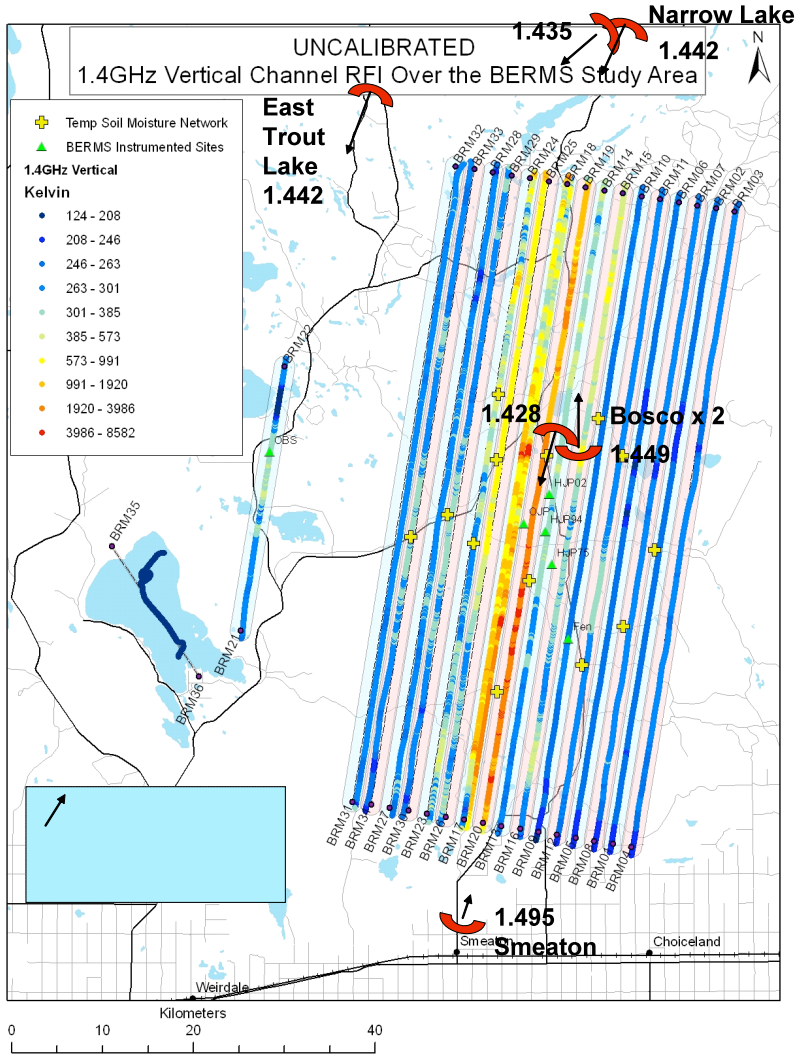
Microwave Radiometer Calibrations

- Calibrations performed before and after each flight
  - Warm target #1 – eccosorb at ambient temperature using custom-built target boxes (6.9, 19, 37 and 89 GHz) or flat on ground (1.4 and 6.9 GHz)
  - Warm target #2 – heated (~70°C) blackbody target box (1.4 GHz only)
  - Cold target #1 – Liquid nitrogen (6.9, 19, 37 and 89 GHz only)
  - Cold target #2 – Sky (all microwave radiometers)
- Additional calibration cold reference points from flight data over open water (e.g. Lake Diefenbaker) – aircraft roll to allow nadir viewing of microwave radiometers
- Liquid nitrogen calibration testing carried out on 1.4 GHz at Saskatoon hangar at end of campaign

Post-campaign Processing of Airborne Microwave Radiometer Data Sets

- Calibration data sets for each frequency analysed to determine uncertainties
- Non-linear equations used to adjust T_B's for calibration targets (warm, cold, lake) to achieve best match with expected T_B's
- Correlation coefficients applied to microwave radiometer data sets
- More complicated process for 1.4 GHz due to calibration challenges and influence of RFI
- 2 versions of data sets produced before released to CanEx-SM10 team

Radiofrequency Interference (RFI)



- Spectrum analyzer flown on aircraft to detect RFI
- Pre-campaign ground survey of potential RFI sources around Kenaston (L-band and C-band)
- L-band RFI minimal and isolated at Kenaston – on ground and during flights
- Significant RFI detected along BERMS flight lines
- SaskTel cell phone transmission network (north-south) with antenna in 1.4-1.5 GHz range likely source
- Importance of pre-campaign surveys

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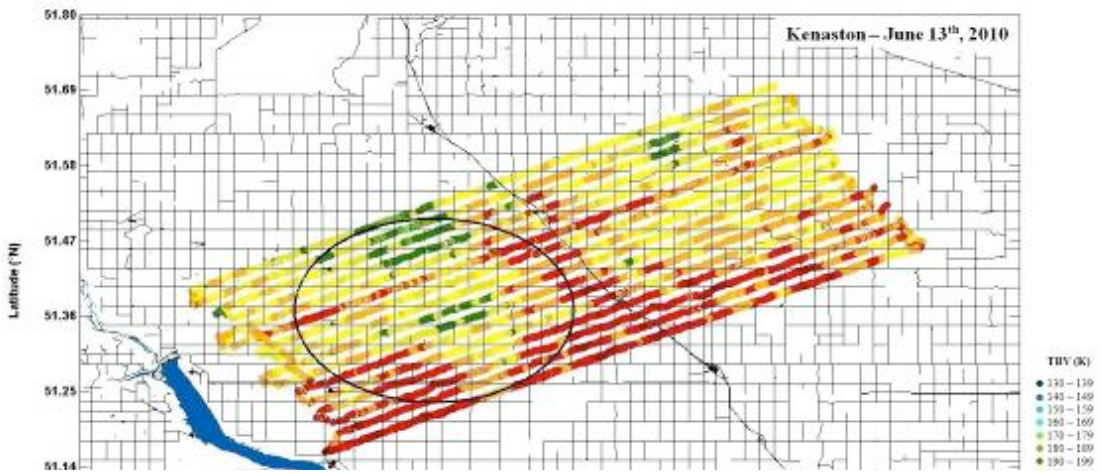
Example of L-band (1.4 GHz) Airborne Radiometer Data – Kenaston (June 13, 2010)

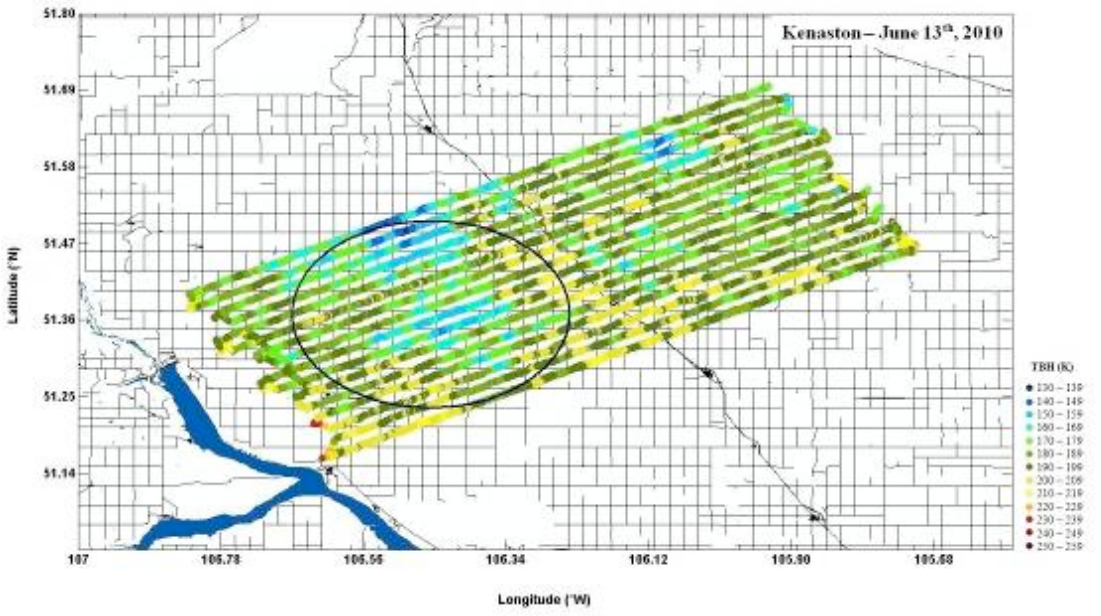
TB (K)

- 130 – 139
- 140 – 149
- 150 – 159
- 160 – 169
- 170 – 179
- 180 – 189
- 190 – 199
- 200 – 209
- 210 – 219
- 220 – 229
- 230 – 239
- 240 – 249
- 250 – 259

V



H



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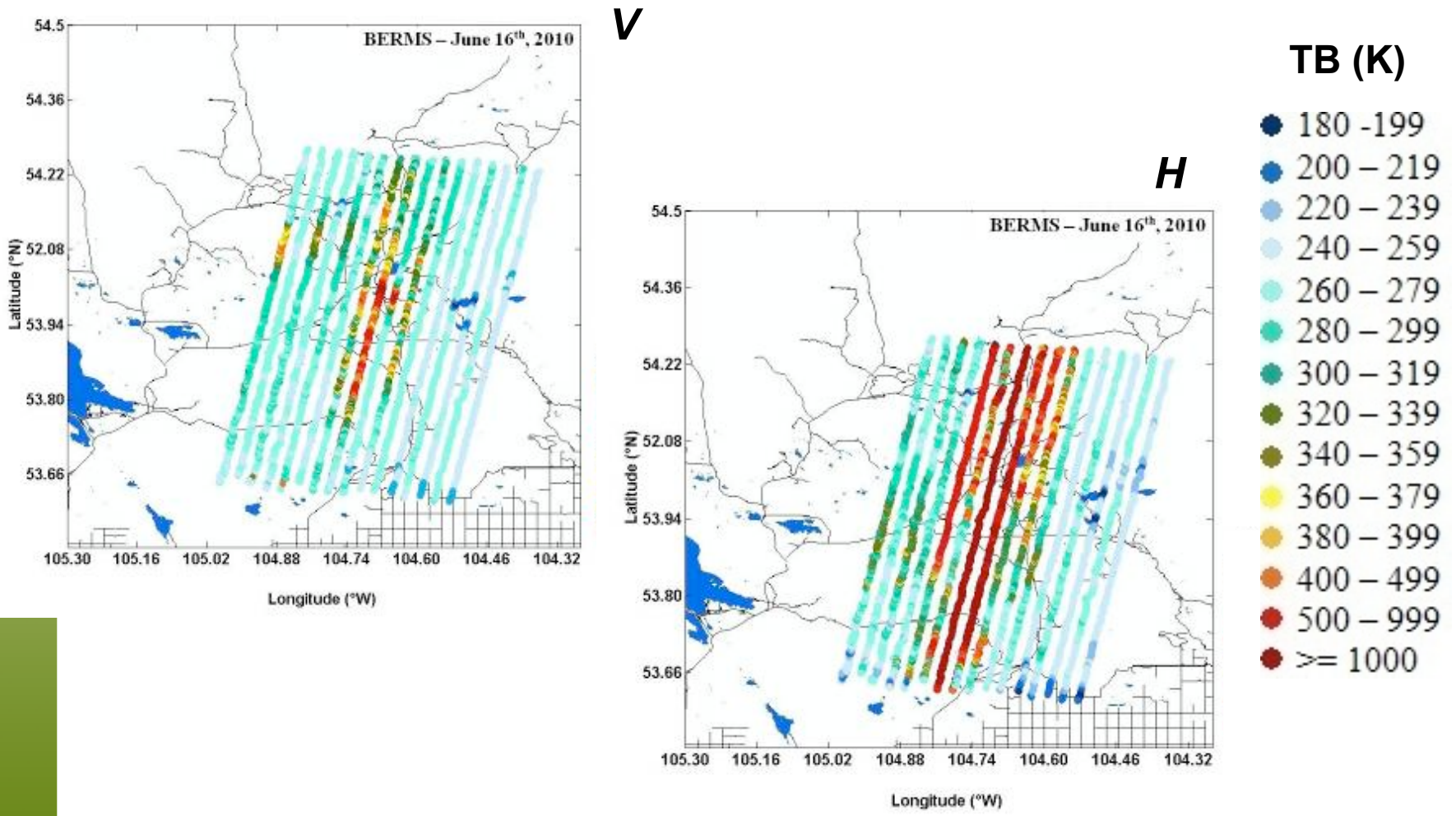
Example of L-band (1.4 GHz) Airborne Radiometer Data – BERMS (June 16, 2010)



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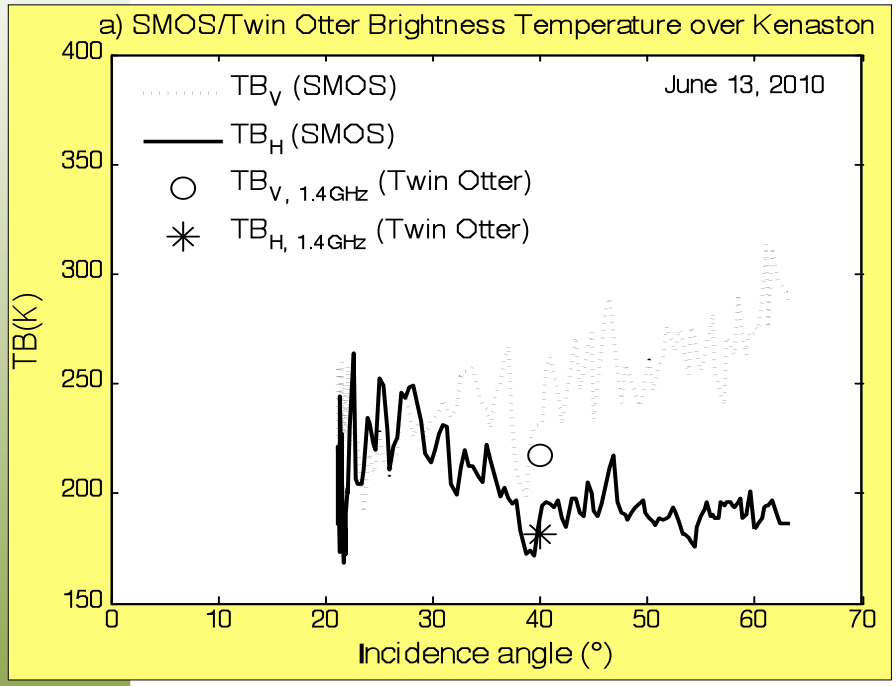
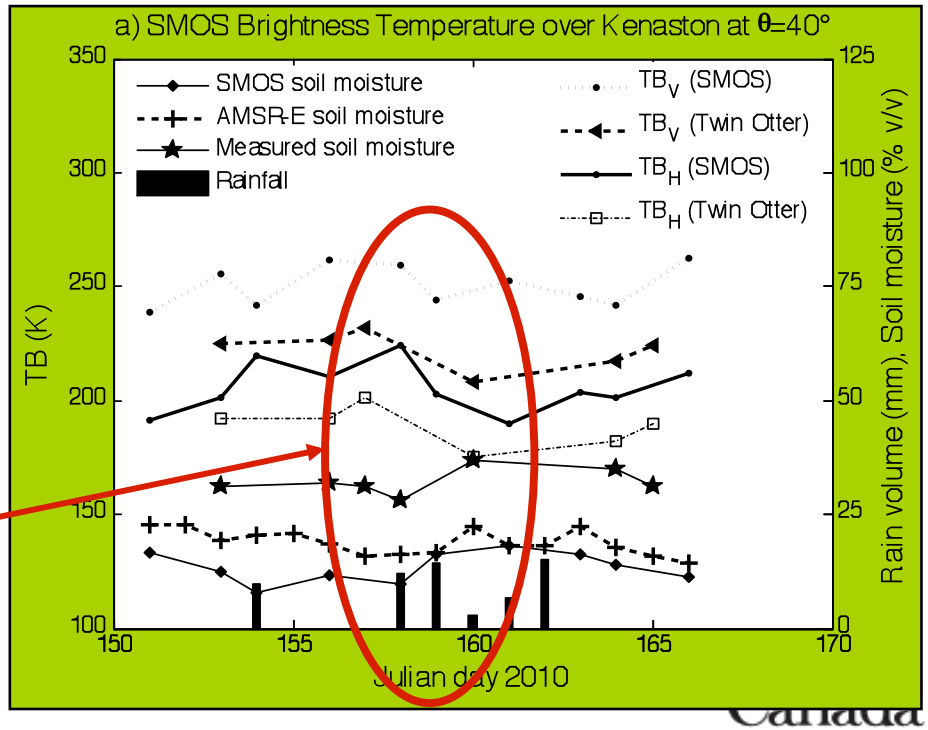
Comparison with SMOS T_B's (Kenaston)



From Magagi et al., "Canadian Experiment for Soil Moisture in 2010 (CanEX-SM10): Overview and Preliminary Results", submitted to *IEEE TGARS (SMOS Special Issue)*



Drop in 1.4 GHz T_B's associated with increased soil moisture after rainfall events

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Final Comments

- Acknowledgement to EC and NRC teams
- Data sets and documention available on CanEx-SM10 website
- Any questions regarding airborne microwave radiometer data sets can be sent to anne.walker@ec.gc.ca
- Further analysis by CanEx-SM10 team in progress