On the Correlation of Area-Extensive Measurement of Fractional Area Whitecap Coverage With Microwave Brightness Temperatures

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Experiment objectives

- Collect a combined data set of:
  - Sea foam coverage, F_c, with video camera;
  - Brightness temperature, T_B, with microwave radiometer (6.8–37 GHz);
  - Oceanographic and meteorological variables (U_{10}, SST, wave chars):
    - *in situ* (buoys);
    - Satellite-based (WindSat, SSM/I, altimeter);
- Provide basis to investigate on a regional scale:
  - Direct relation $T_B(F_c)$;
  - F_c as a function of various oceanographic and meteorological data;
  - Validate satellite-based retrievals of F_c;
  - Assess the performance of the F_c-retrieval algorithm.

Motivation

The involvement of the sea foam in a suite of processes important for climate:

- Whitecaps:
  - Ocean albedo;
  - Retrievals: wind, ocean color, salinity;
  - Gas exchange;
  - Ocean ambient noise;
- Sea spray:
  - Heat exchange;
  - Tropical storm intensification;
- Sea-salt aerosols:
  - Direct climate effect – cooling;
  - Indirect climate effect:
    - Dominate the activation of CCN;
    - Compete with SO42- aerosols;
  - Halogen chemistry:
    - Reactive Cl and Br;
    - Tropospheric O3;
    - Sink of S.

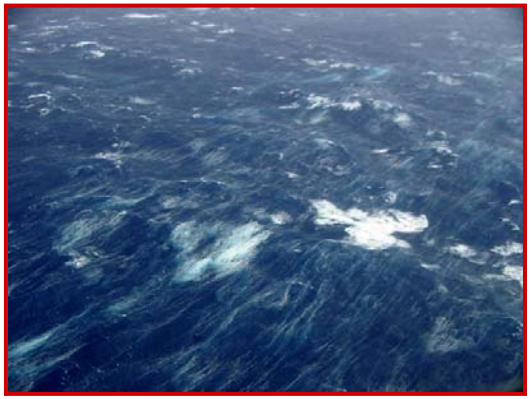
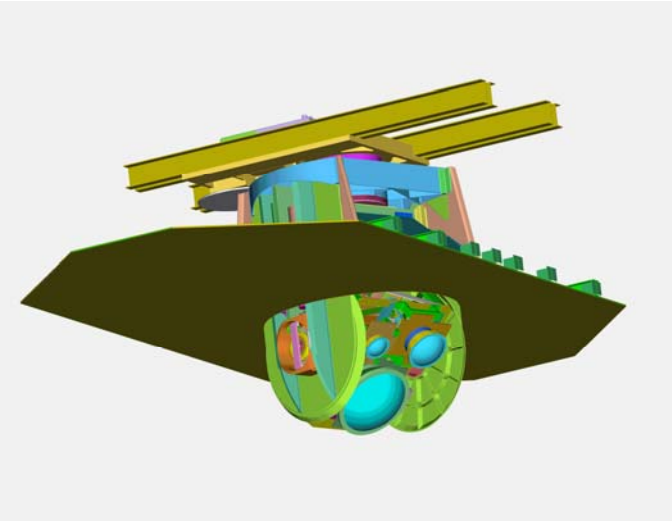
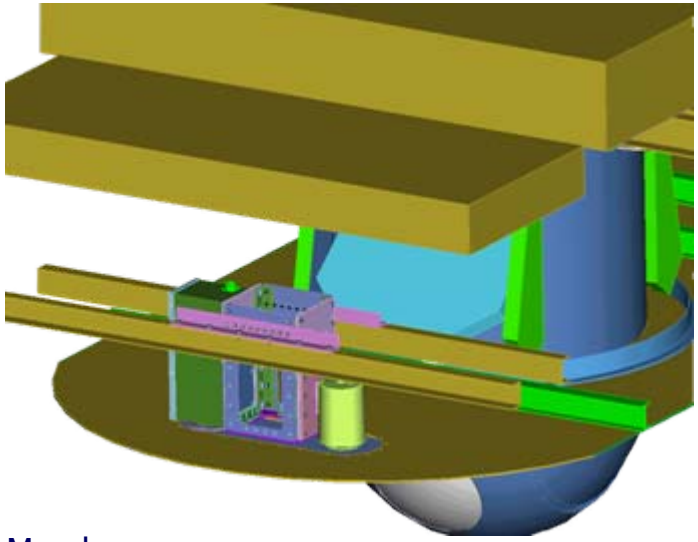


Photo courtesy of Chris Fairall

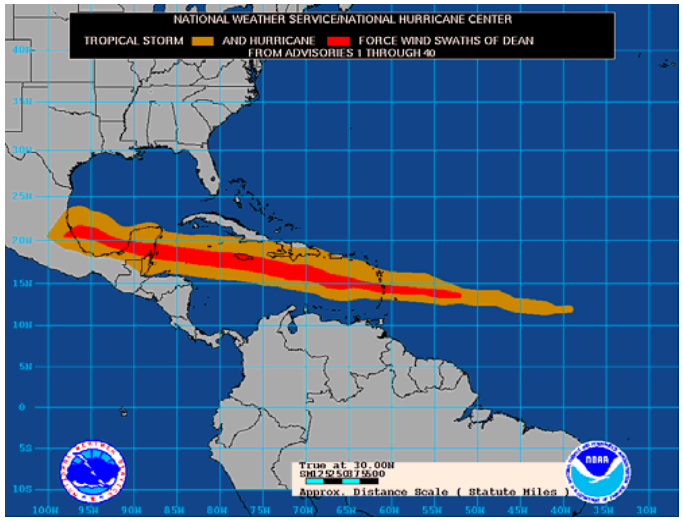
Platform

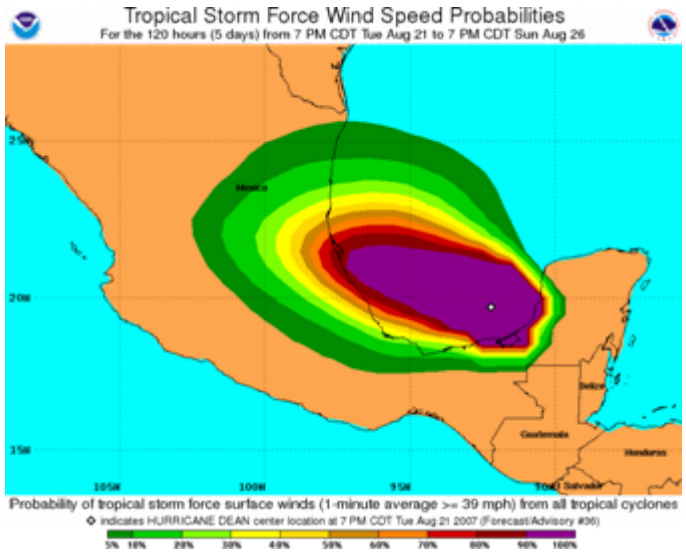
- Channels available: 37vh34, 19vh34, 6.6vh, 6.8vh, 7.2vh (some data at channels at 10.7 and 22.235)
- Footprint size: roughly 1x2 km from 6.7 km (22000ft) on 19 and 37 GHz
- High resolution video



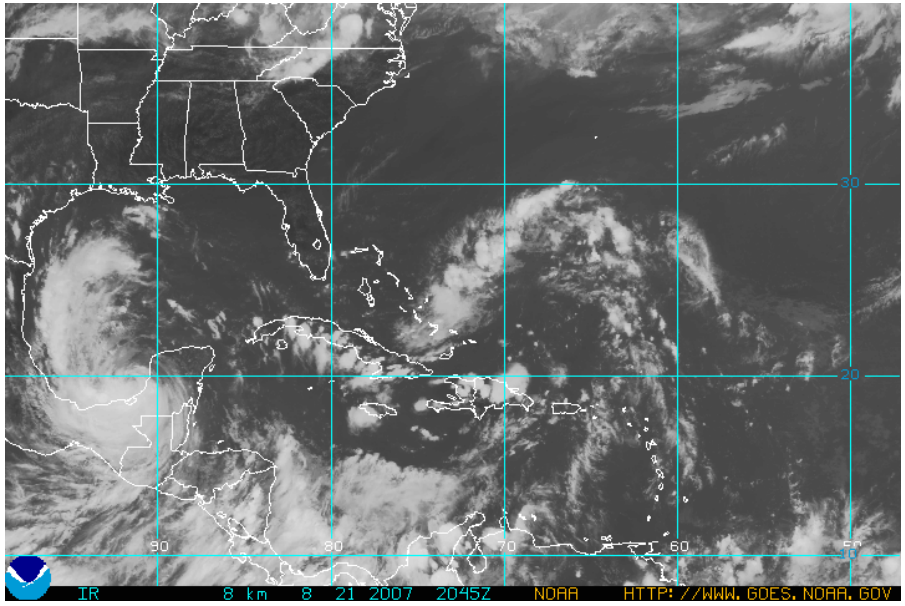


Hurricane Dean (8/21/2007)

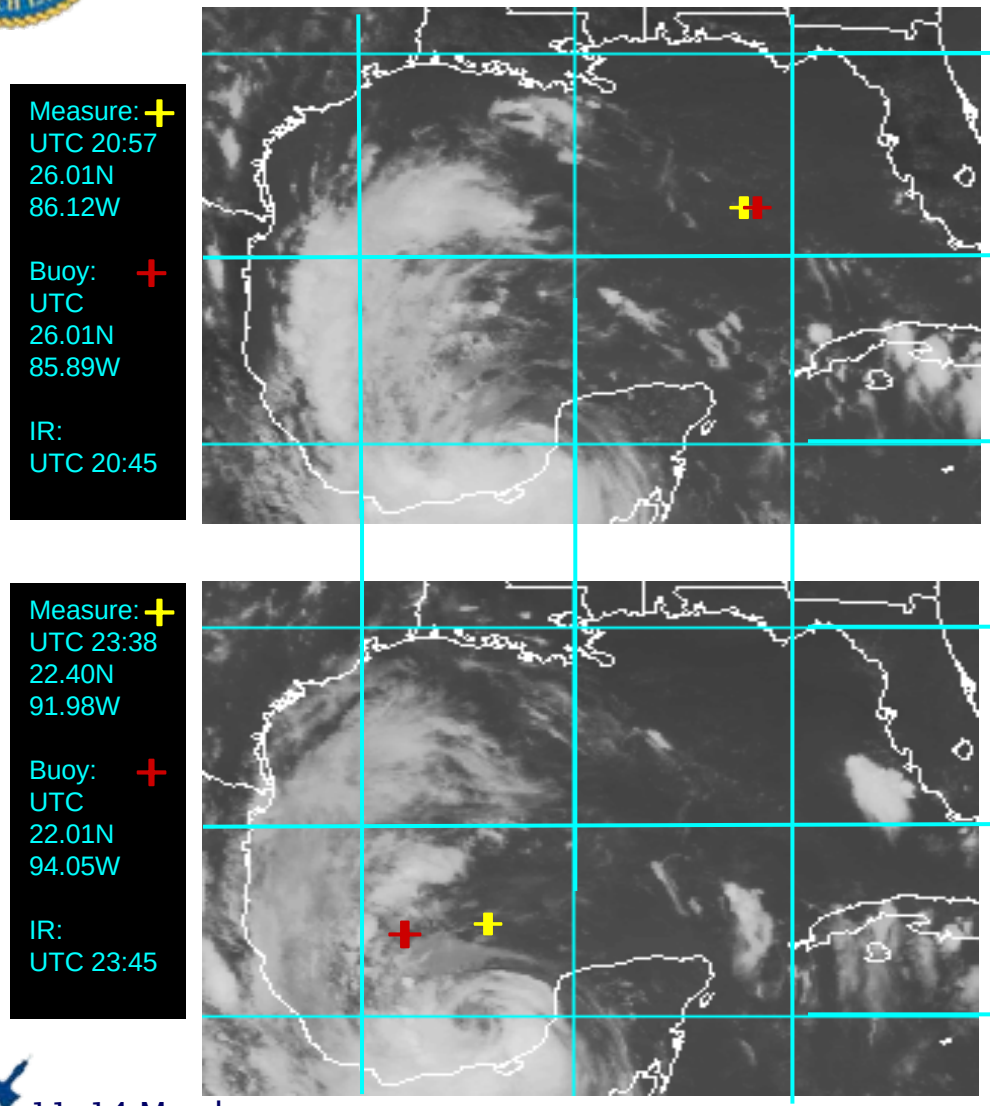




- Storm of opportunity
- Special thanks to flight crew and CDR Heidi Fleming of VXS-1 for allowing us to fly a 10-hr mission to the outer bands of a hurricane

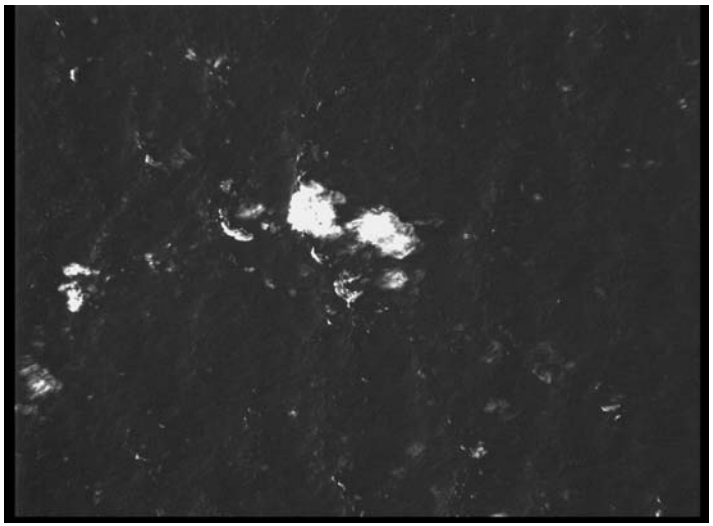


Flight path to Dean

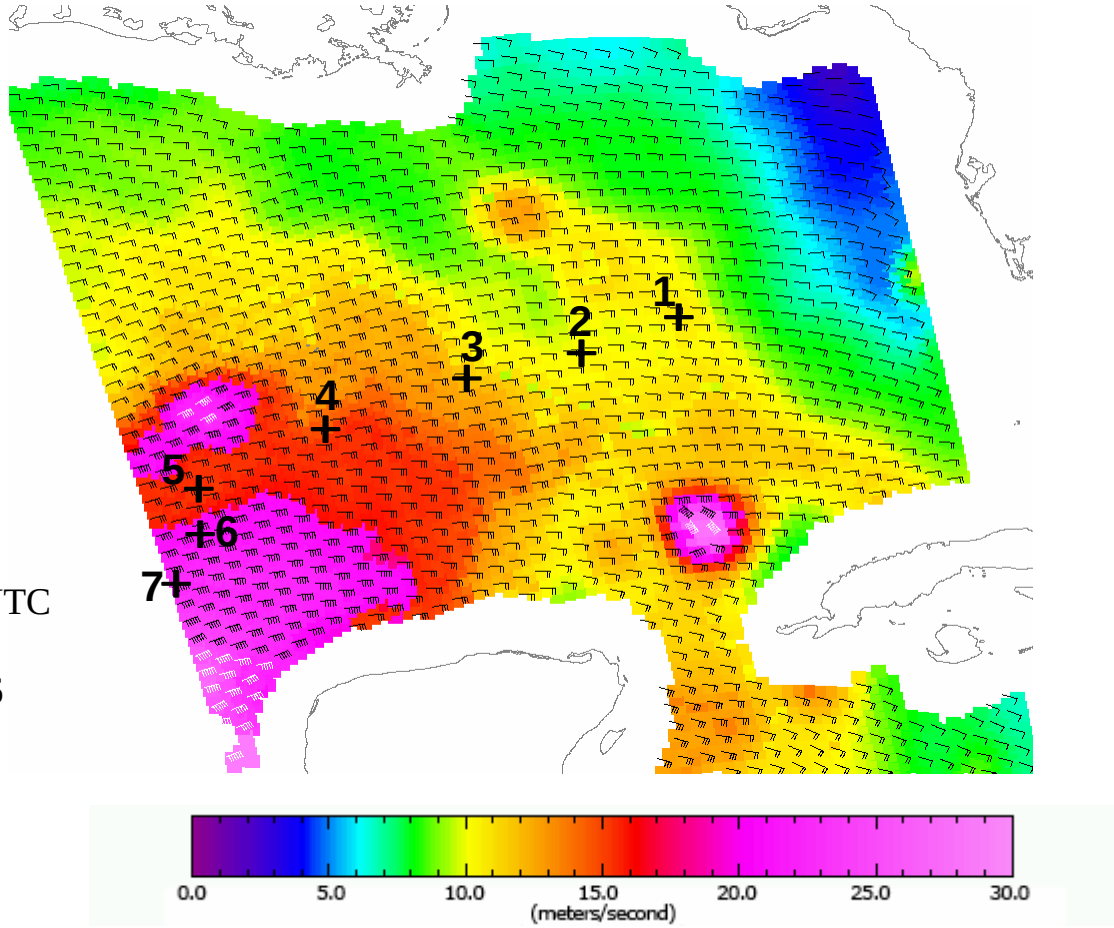


Conditions along flight line

- Relatively cloud-free areas were sought with varying success;
- Upper left shows low res video image at point 5, with much foam in evidence;
- Lower left shows low res video image at point 7 (closest to storm) with significant cloud cover;
- Below is high res video image from point 7, showing foam patch detail.

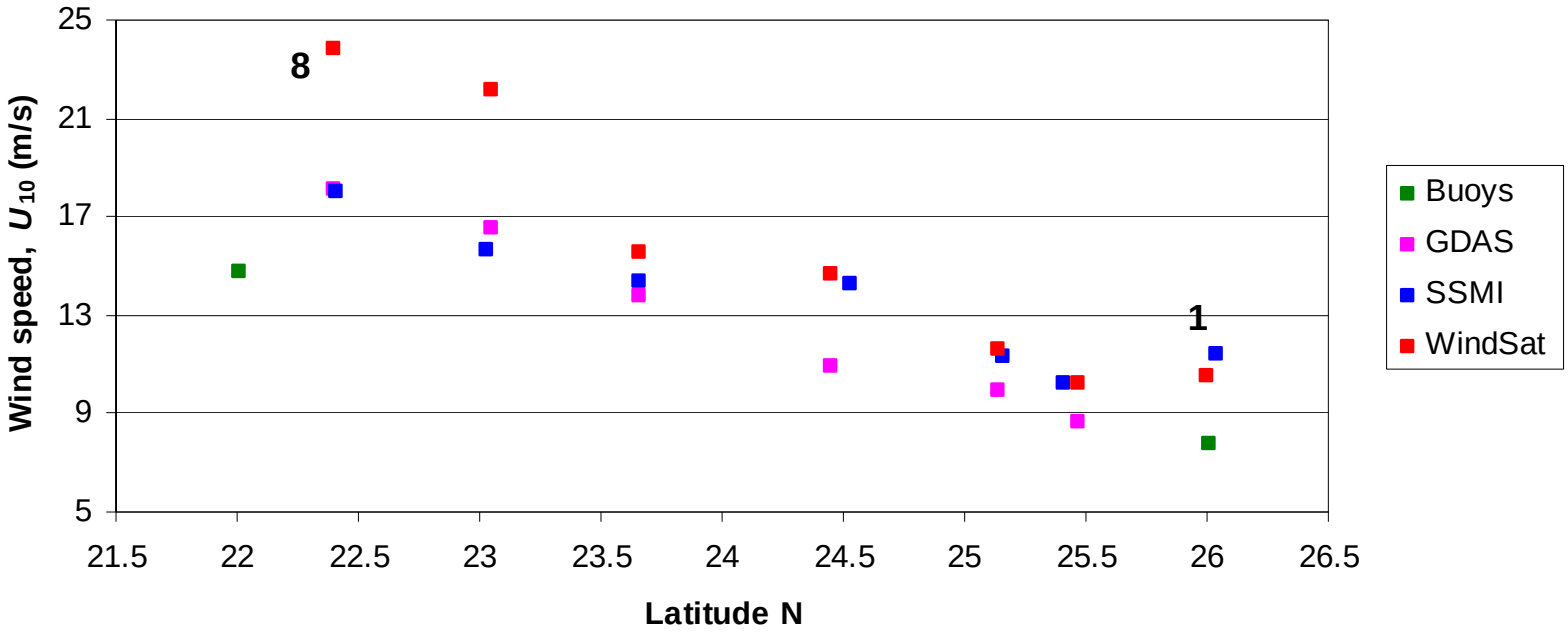


Wind speed and direction data from WindSat at flight time

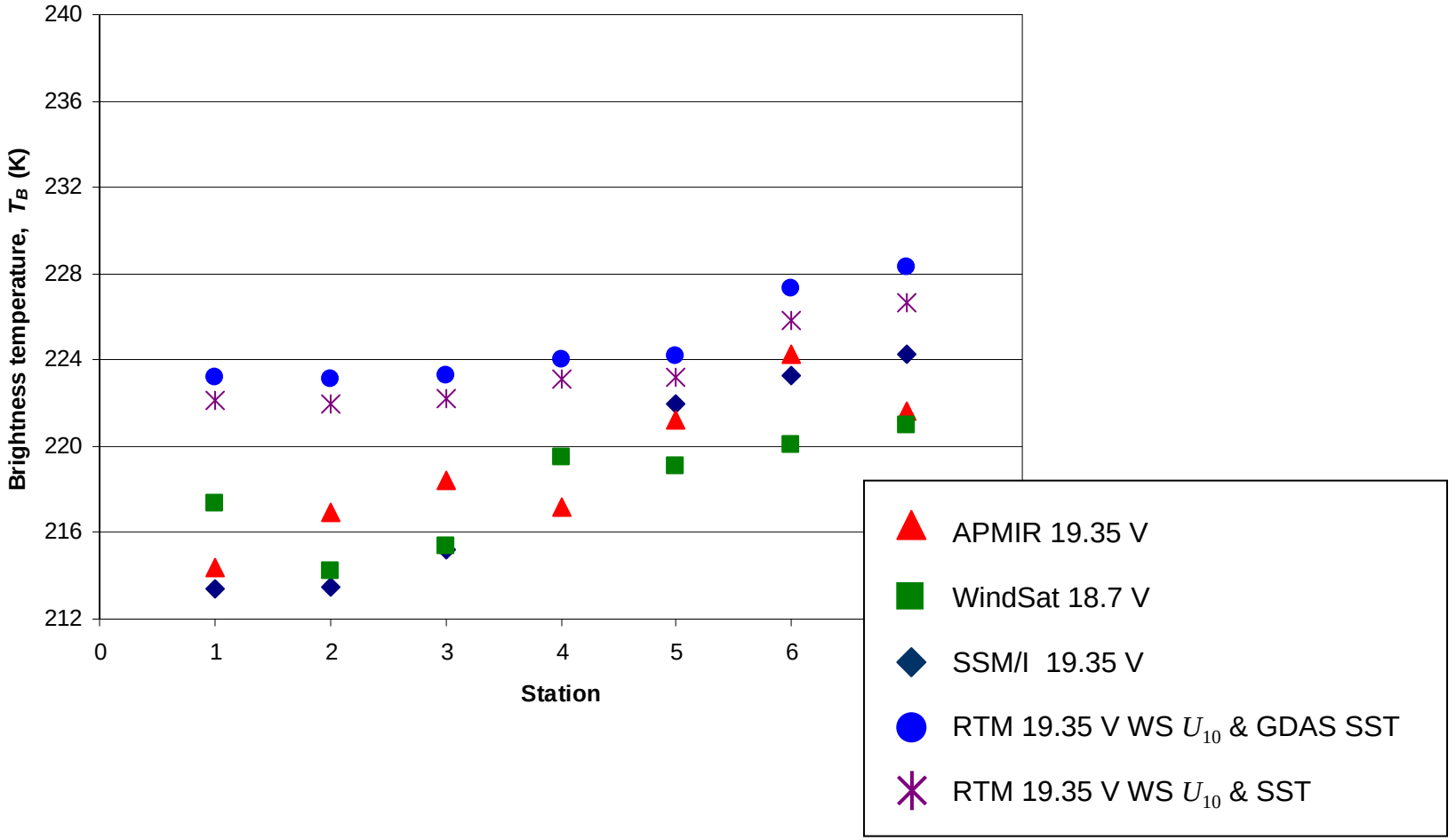


APMIR @ pt.1: 21:00 UTC
@ pt. 7: 23:38
WindSat crossing: 23:26

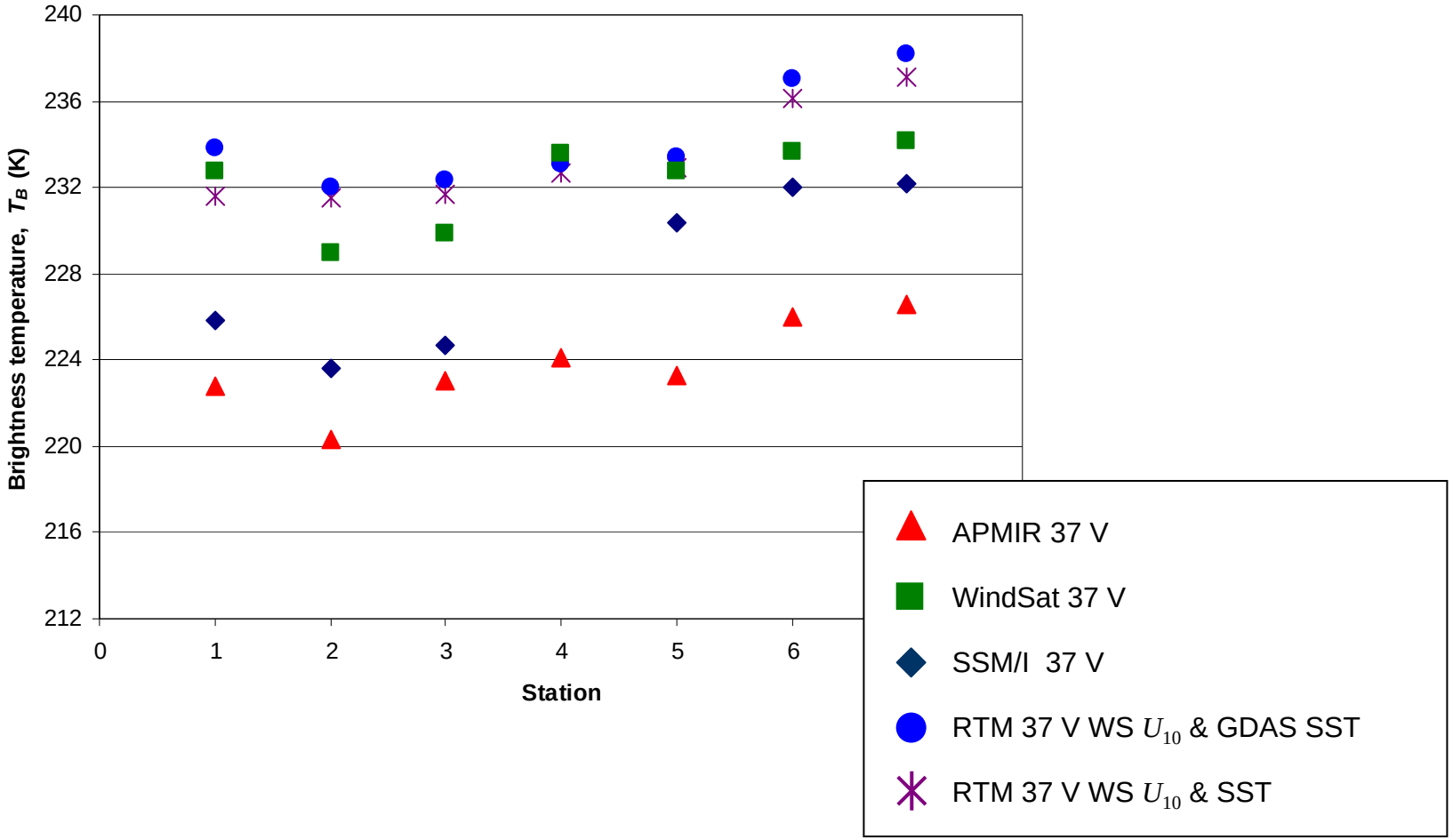
Wind speed data



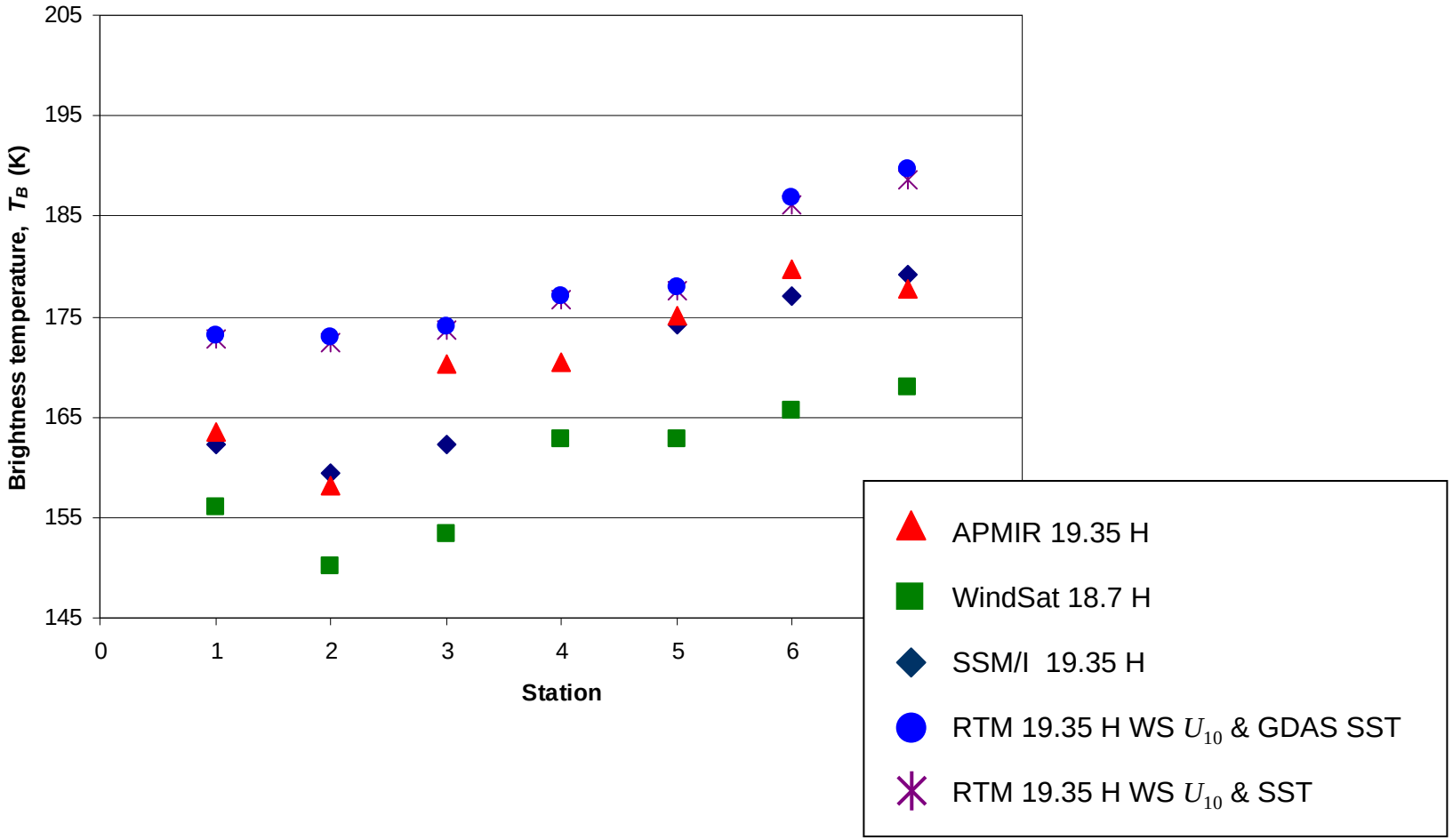
19V TB comparison



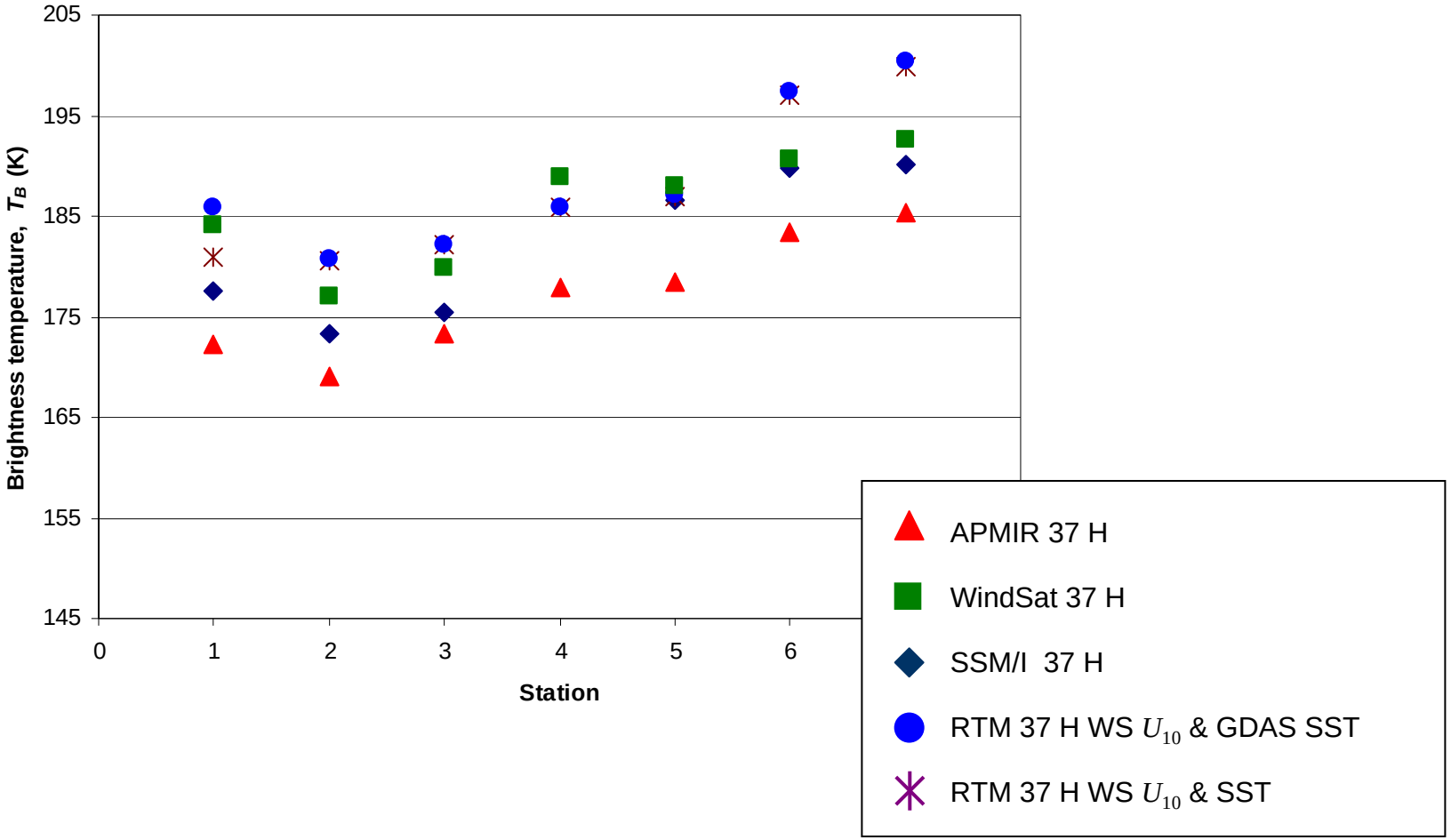
37V TB comparison



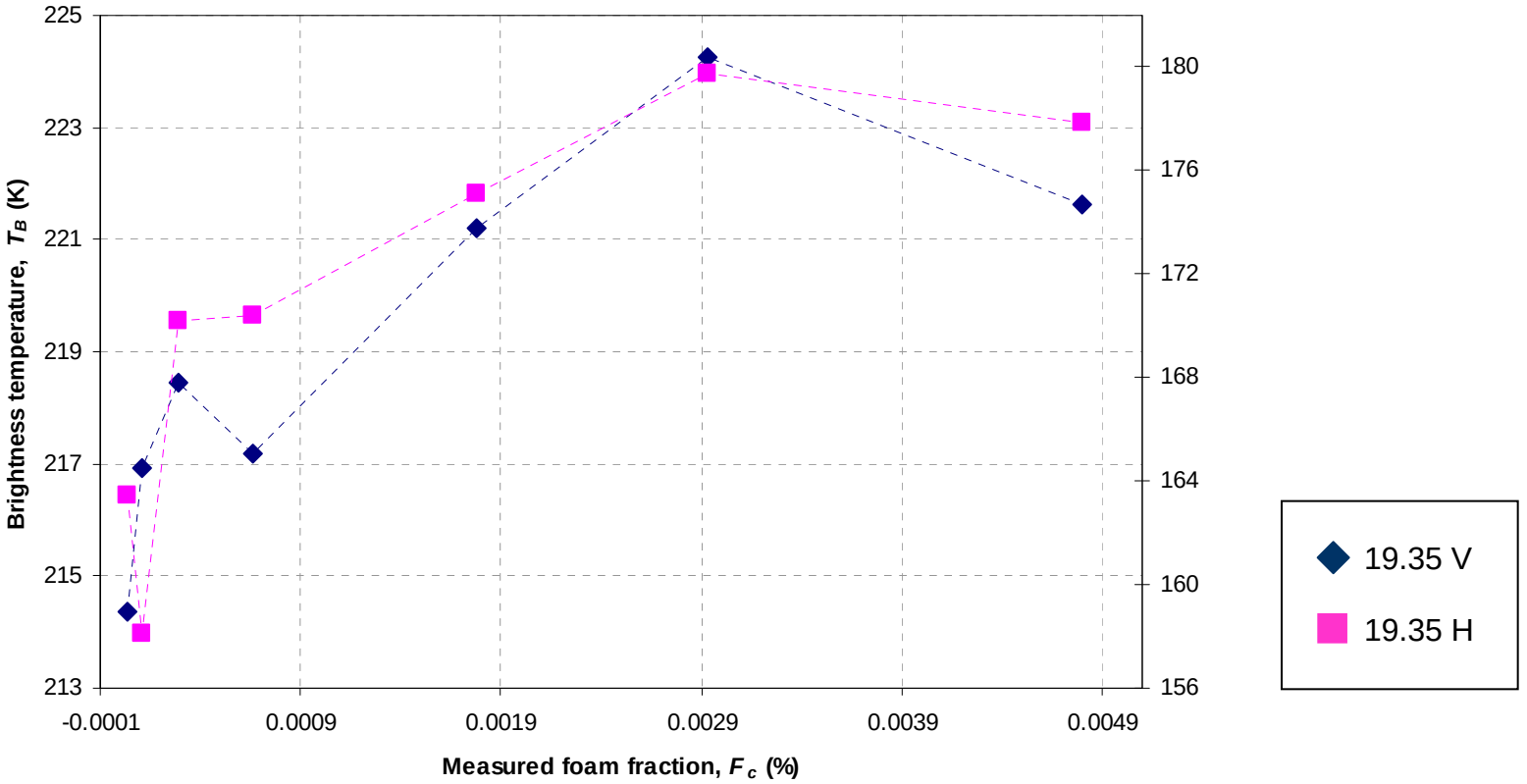
19H TB comparison



37H TB comparison



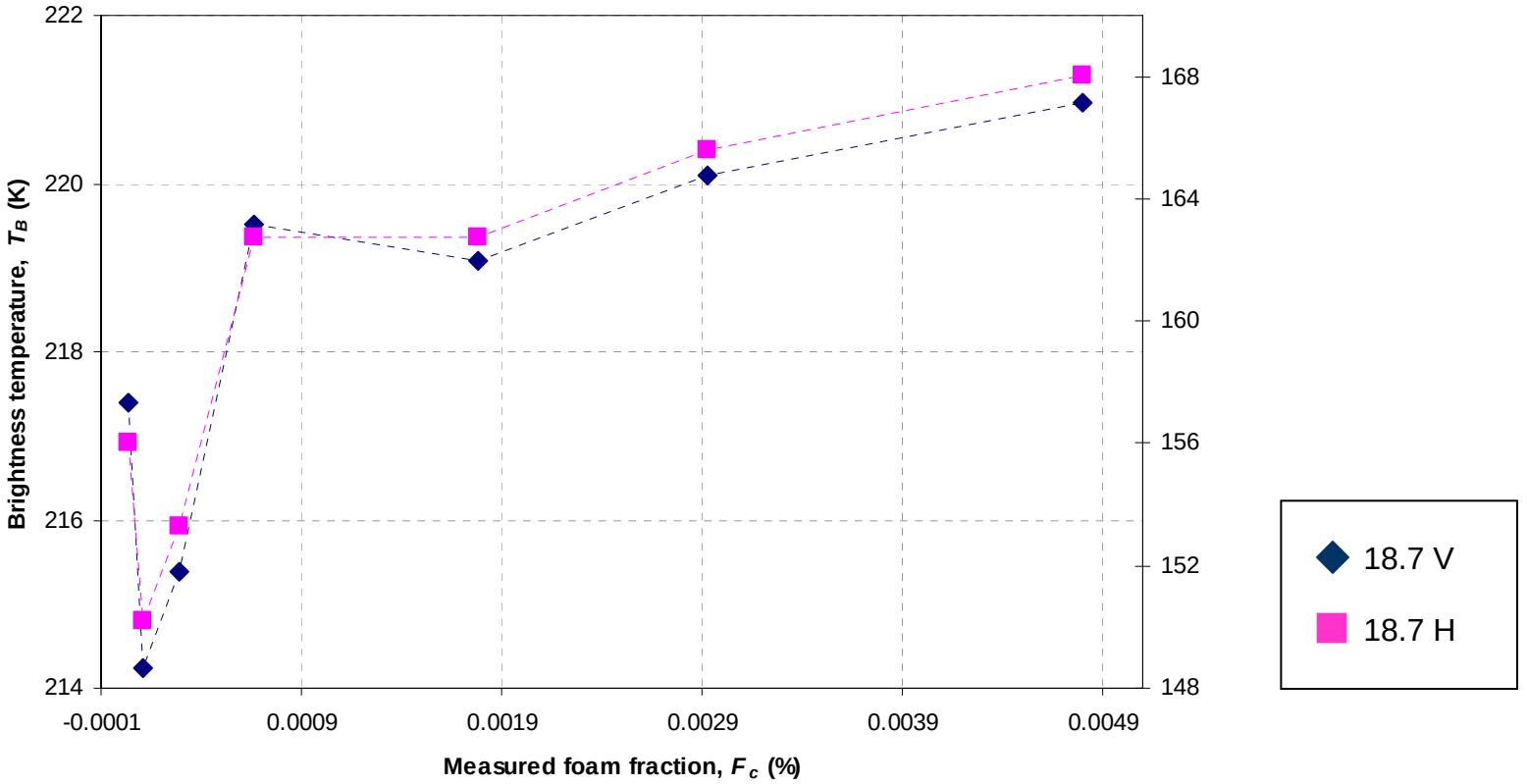
Foam coverage vs APMIR 19TBs



Foam coverage vs WindSat 18.7TBs

V pol

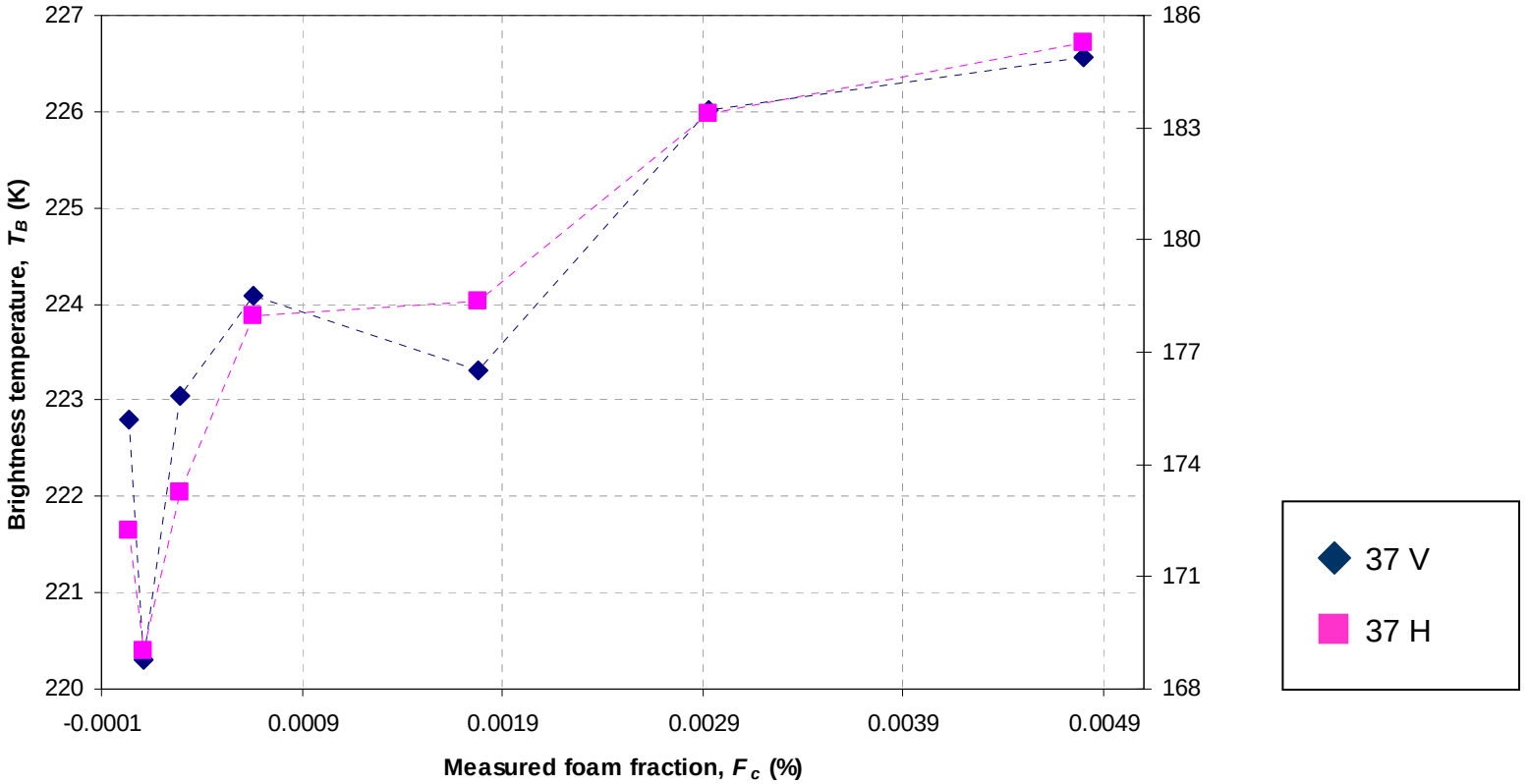
H pol



Foam coverage vs APMIR 37TBs

V pol

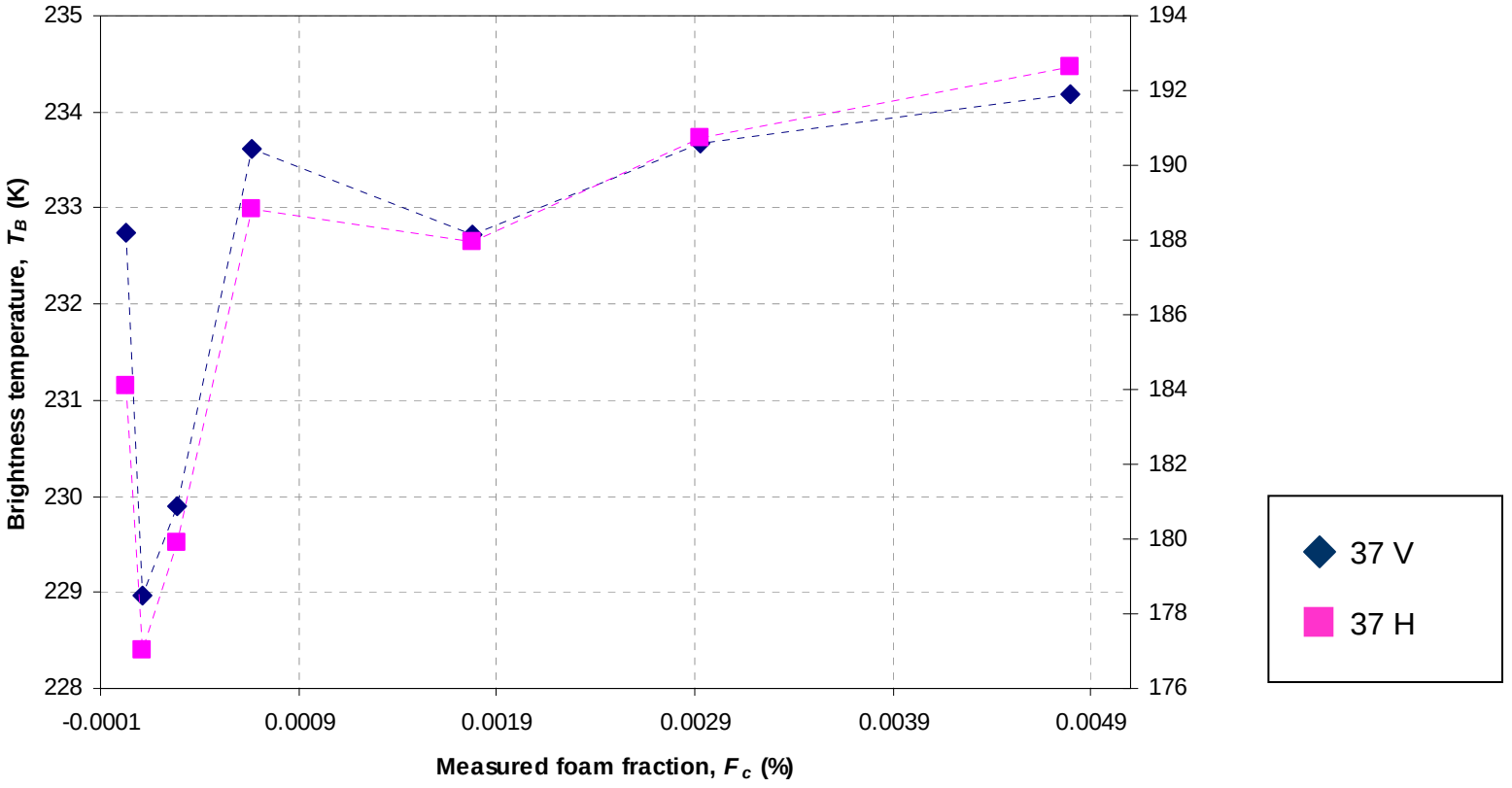
H pol



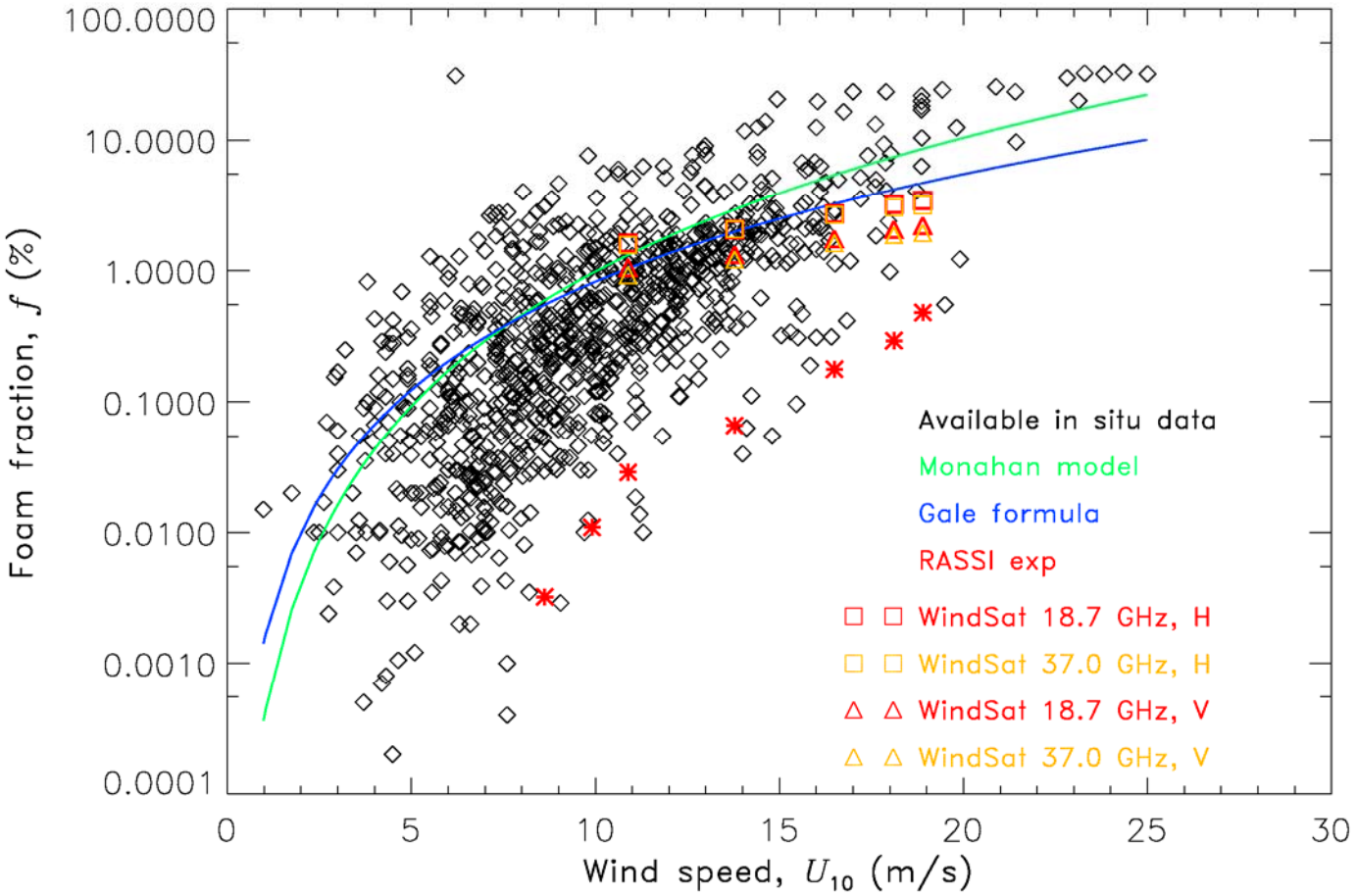
Foam coverage vs WindSat 37TBs

V pol

H pol



RASSI vs historical *in situ*



Wind speeds used for high resolution match-ups are from GDAS

Way forward

- More analysis of the radiometric data: look at
  - 10 GHz;
  - Polarimetric channels;
- More analysis of the foam fraction data:
  - Obtain and interpret $F_C(T_B)$ parameterizations;
  - Investigate the dependence of F_C on additional variables;
- Validate satellite-based retrievals of F_C and understand the differences due to:
  - Method of measurement (video vs radiometric);
  - Footprint size;
  - The effect of the atmosphere;
- Algorithm assessment:
  - Obtain retrievals of F_C from APMIR T_B
  - Compare with:
    - F_C from video data;
    - F_C from WindSat;
  - Use the information for tuning or modification of the F_C-retrieval algorithm.