A STUDY OF THE NOAA NEAR-NADIR MICROWAVE HUMIDITY SOUNDER BRIGHTNESS TEMPERATURES OVER ANTARCTICA

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ABSTRACT

Brightness temperatures from NOAA-18 and NOAA-19 MHS measurements are investigated over Antarctica to establish it as a natural vicarious calibration target for determination of the Inter-satellite/inter-sensor Calibration Biases (ICB) of the two MHS radiometers. Establishment of a natural test site for calibration references is important for calibration and validation of space-borne microwave instruments

Index Terms— Microwave Humidity Sounder, Satellite Data, Brightness temperatures, Calibration and Validation.

1. INTRODUCTION

The Microwave Humidity Sounder (MHS) instruments are a generation of total-power microwave radiometers which have been flown on the NOAA-18 and NOAA-19 satellites since May 2005 and February 2009, respectively. Each MHS is a five-channel, self-calibrating, cross-track scanning, total-power radiometer with two channels centered at 89 and 157 GHz and three centered on the 183.31 GHz water vapor resonance line at 183.31±1, ±3, and 183.31+7 GHz [1]. The MHS antenna system has a nominal field of view (FOV) of 1.111^{o} at the half-power points and scans cross-track with a maximum scan angle of $\pm 48.95^{o}$ (beam centers) from nadir with each scan position separated by 1.111^{o}. The antenna reflector executes one complete revolution every 2.667 seconds during which MHS measures 90 earth views, four space views, and four internal blackbody target views. The MHS data have been used extensively in weather prediction models and climate studies at NOAA and worldwide to generate products for weather and climate forecasting, humidity sounding, and hydrological analyses [2]-[3]. FOVs 1 and 90 are the outermost scan positions of the Earth views, while FOVs 45 and 46 at ±33' straddle the nadir. Channels 1 and 2, which have weighting functions peaked near the surface, aid the retrieval of humidity sounding by providing information to correct the effect due to surface emissivity. Before launch, MHS was tested and calibrated by the instrument contractor *Astrium.* These pre-launch calibration data are analyzed at NOAA and EUMETSAT to derive the calibration parameters [1] which are used in the operational calibration algorithm to generate the MHS Level 1B data sets, of which more detailed description can be found in the NOAA KLM User Guide (available online at http://www2.ncdc.noaa.gov/docs/klm/c7/sec7-3). A systematic post-launch calibration and validation of the instrumental performances was conducted with on-orbit data. The long-term trends of the housekeeping sensors and radiometric counts from the cold space and warm targets are continuously monitored.

This study is under taken to investigate the MHS measurements from NOAA-18 and NOAA-19 over Antarctica to establish it as a natural vicarious calibration target [4] and to determine the Inter-satellite/inter-sensor Calibration Biases (ICBs) of the two MHS radiometers.

2. MHS MEASUREMENTS OVER ANTARCTICA

Figure 1 shows the comparison of MHS noise equivalent differential temperatures (NEΔT) of pre-launch and on-orbit results. In Figure 2, the thirty-day mean brightness temperatures (T_B) over Antarctica derived from measurements by the MHS radiometers onboard NOAA-18 and NOAA-19 satellites are shown to demonstrate the characteristics of the data over this test site. Note that the NOAA-19 data are available only after day 40 as it was launched on 6 February 2009. These time series provide a useful pattern of annual variation of the MHS measurements for determination of ICBs of two microwave radiometers. To investigate the diurnal effect on the measurements, the time series of 30-day mean brightness temperatures are constructed separately for the ascending and descending passes even though little diurnal variation is expected in the Antarctic region, where, over much of the year, it either always daytime or always nighttime. Results show that there are little diurnal differences in measurements during the Antarctic winter months from each satellite. Therefore these measurements provide a practical approach to obtain relative channel biases of inter-satellite data. The results in Figure 2 show that the measurements from the two satellites are nearly identical. These MHS data can be used to demonstrate the ICB determination as shown in Figure 3 which compare the differences (ΔT) between near-nadir MHS brightness temperatures measured over Antarctica: (a) ΔT=*ascending–descending* for NOAA-18 and NOAA-19; and (b) ΔT=*NOAA18–NOAA19*. Each data point is a 30-day mean value located at the 30-day center. The results in Figure 3a show that diurnal variability is small during the winter months (when it is nearly 24-hour nighttime) in Antarctica but significant near the beginning and end of the years. The ICBs (Fig. 3b) are defined as the mean of the ΔT values between 90 and 240 of Julian days. These measurements in the winter months

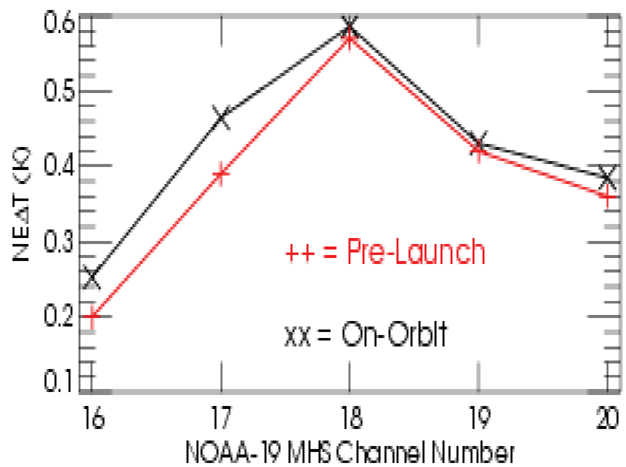

Figure 1. Comparison NEΔT values of pre-launch and on-orbit results. MHS NEΔT values of specification are 1K at all channels.

provide a practical approach to determine the ICBs. These ICBs in Figure 3b are much smaller than the corresponding NEΔT values of ~0.5 K (Fig. 1).

3. REFERENCES

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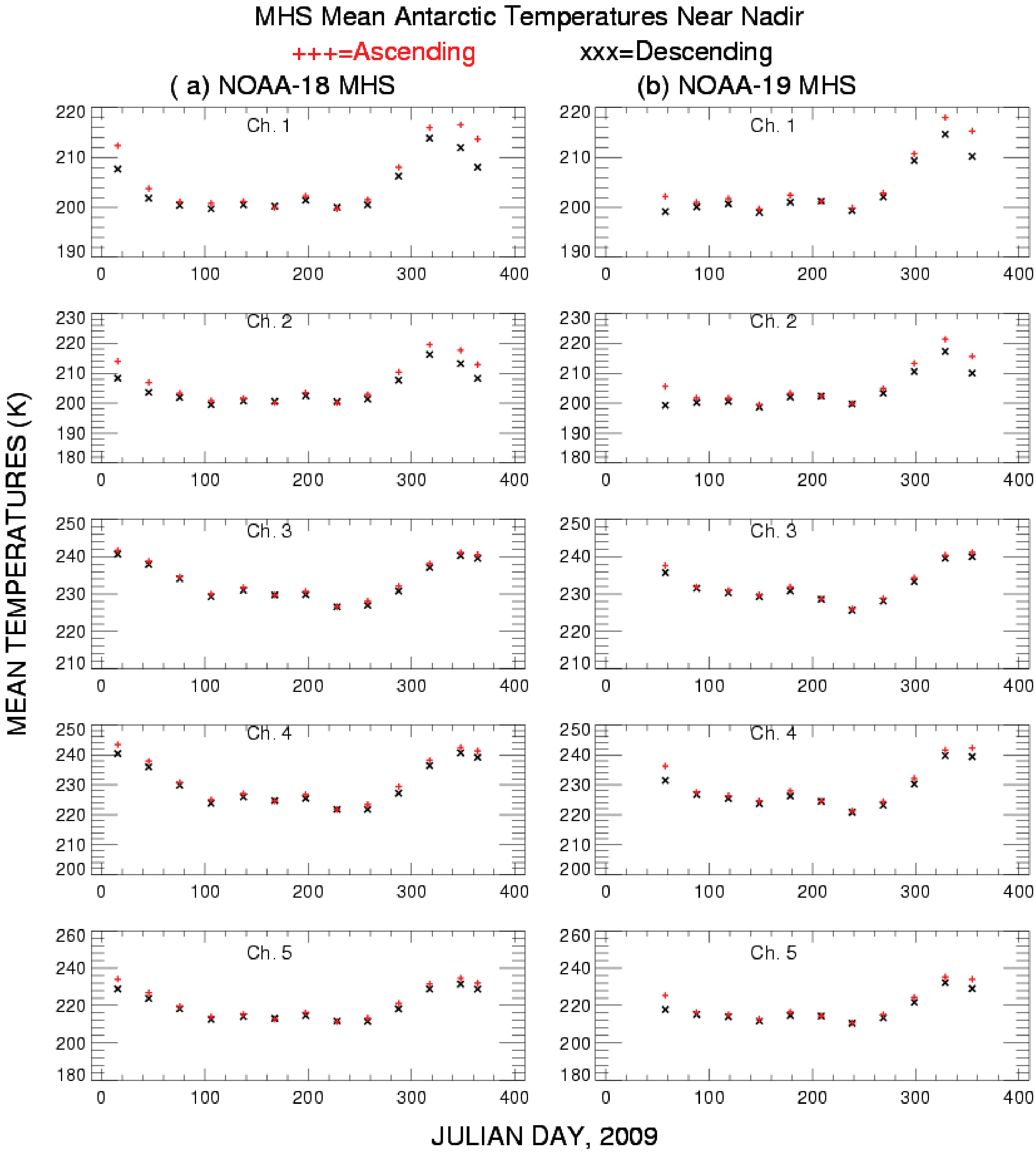

Figure 2. Ascending and descending 30-day mean brightness temperatures at nadir from the NOAA-18 and NOAA-19 MHS measurements in 2009 over Antarctica. Each data point is located at the 30-day center. The NOAA-19 data are available only after day 40 as it was launched on 6 February 2009.

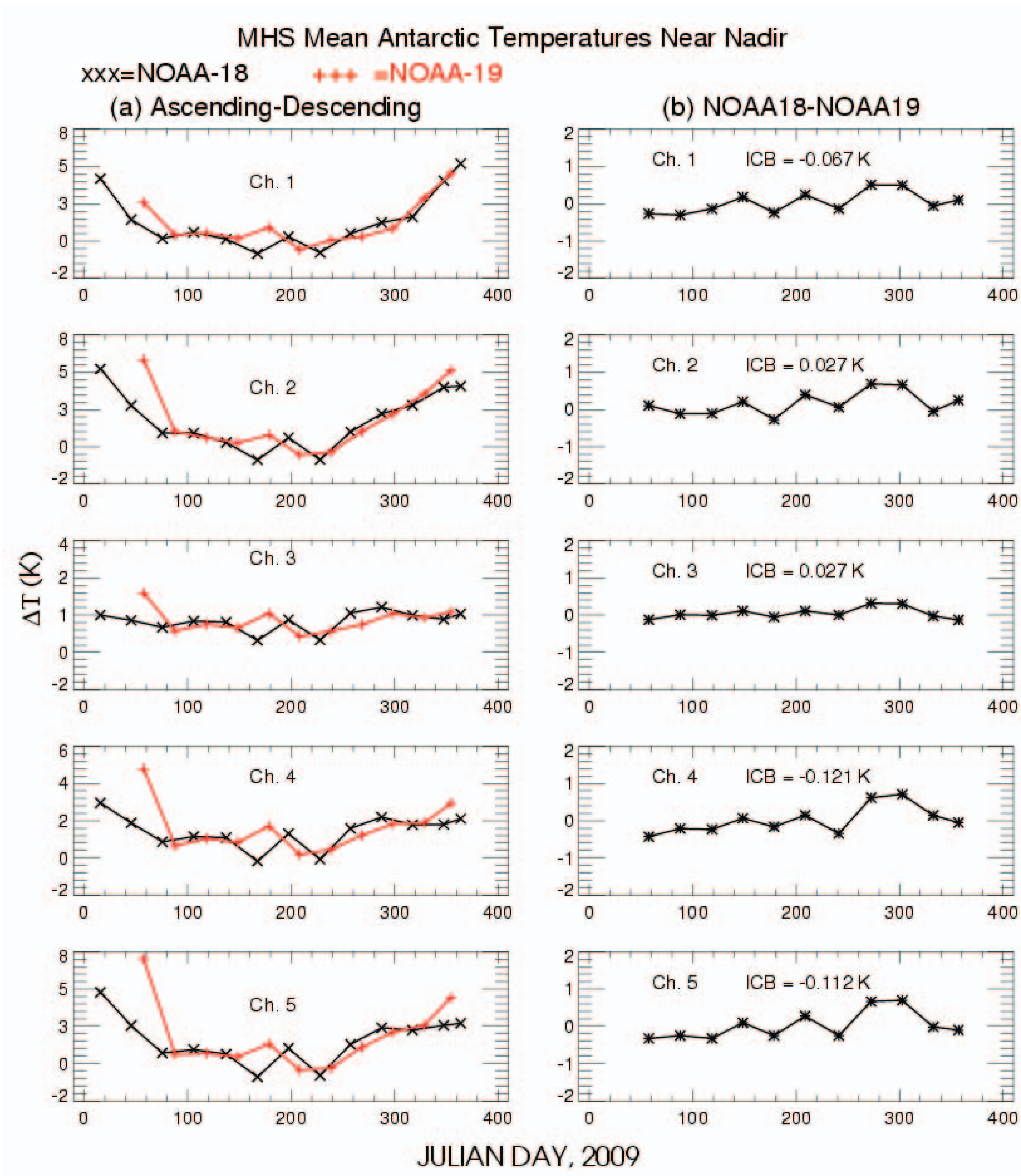

Figure 3. NOAA-18 and -19 MHS: Comparison of near-nadir brightness temperatures over Antarctica. Each data point is a 30-day mean value, (a) ΔT=ascending–descending and (b) ΔT=NOAA18–NOAA19. The ICB is defined as the mean between 90 and 240 of Julian days. Note that the NOAA-19 data are available only after day 40 as it was launched on 6 February 2009.