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# **Intersatellite/intersensor Calibration of Microwave Radiometers over Antarctica**

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AMSU/MHS/SSMT2 CDR WORKSHOP

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# OUTLINE



- Antarctica: Long winter months with ~24-hour nighttime
- Minimal diurnal variability in data
- Data used in this report:
  - NOAA-18 and -19 AMSU-A over Antarctica (82°-70°S)
  - NOAA-18, -19, & METOP-A MHS over Antarctica
- **Ascending** and Descending time series
- 30-day mean near-nadir bright temperatures (BT)
- $\Delta T = (\text{Ascending} - \text{Descending})$  to demonstrate diurnal effect
- $\Delta T = (\text{NOAA18} - \text{NOAA19})$  to determine  
**Intersatellite/intersensor Calibration Bias (ICB)**

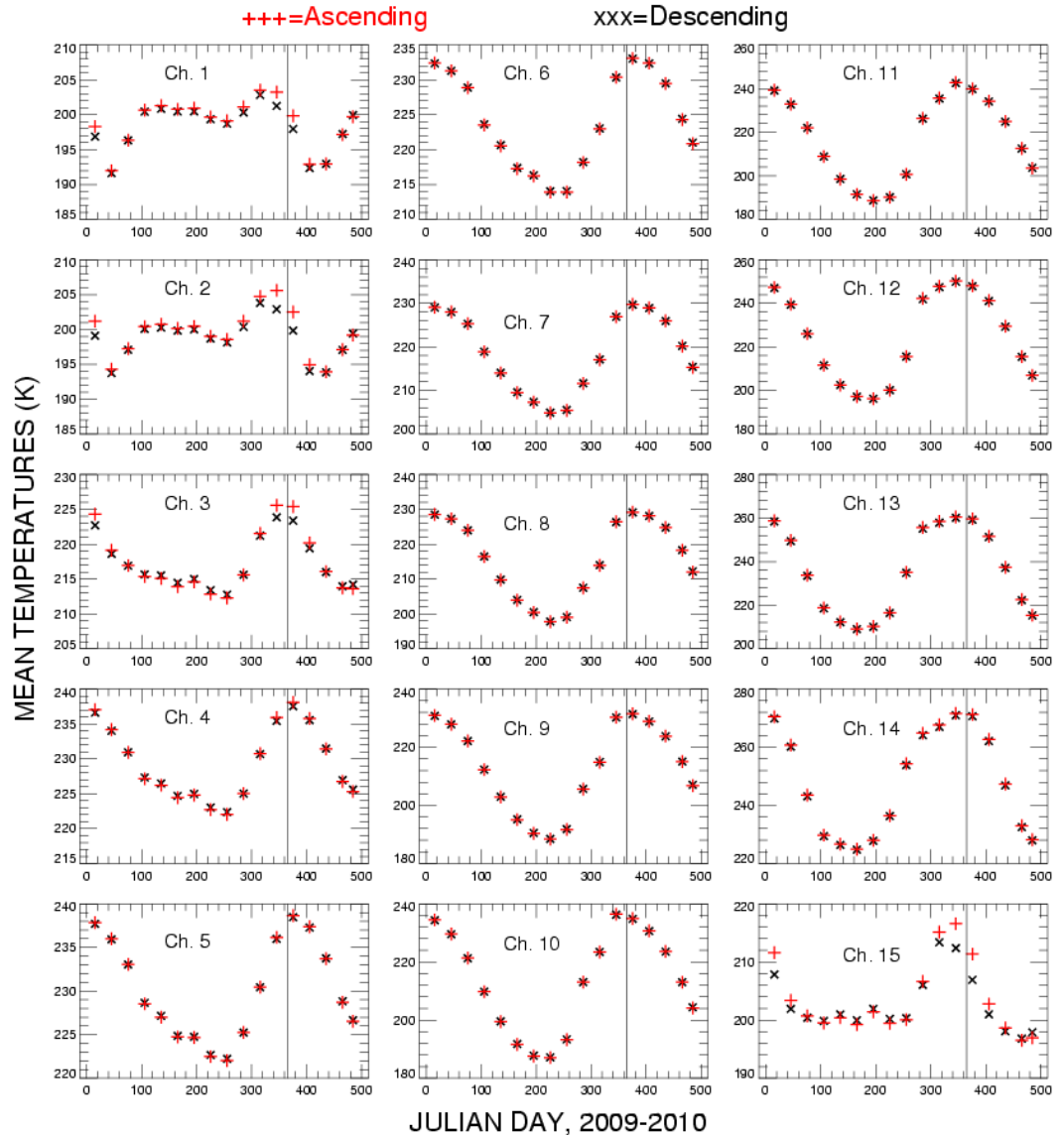


# Local Equatorial Crossing Times(LECT) & Operational Statuses of the NOAA and METOP Satellites

Satellite ID	LECT (Early 2010)		Launch Date	Sensors Operational Statuses
	Ascending	Descending		
NOAA-15	1648	0448	13 May 1998	Ch. 6, 11, and 14 failed
NOAA-16	1748	0548	21 Sept. 2000	Ch. 4 failed
NOAA17	2127	0927	24 June 2002	Ch. 3-15 failed
NOAA-18	1345	0145	20 May 2005	Nominal
NOAA-19	1354	0154	6 Feb. 2009	Ch. 8 NEΔT >Spec
METOP-A	2130	0930	19 Oct. 2006	Ch.7 failed
METOP-B	2130	0930	April 2012	
METOP-C	2130	0930	TBD	

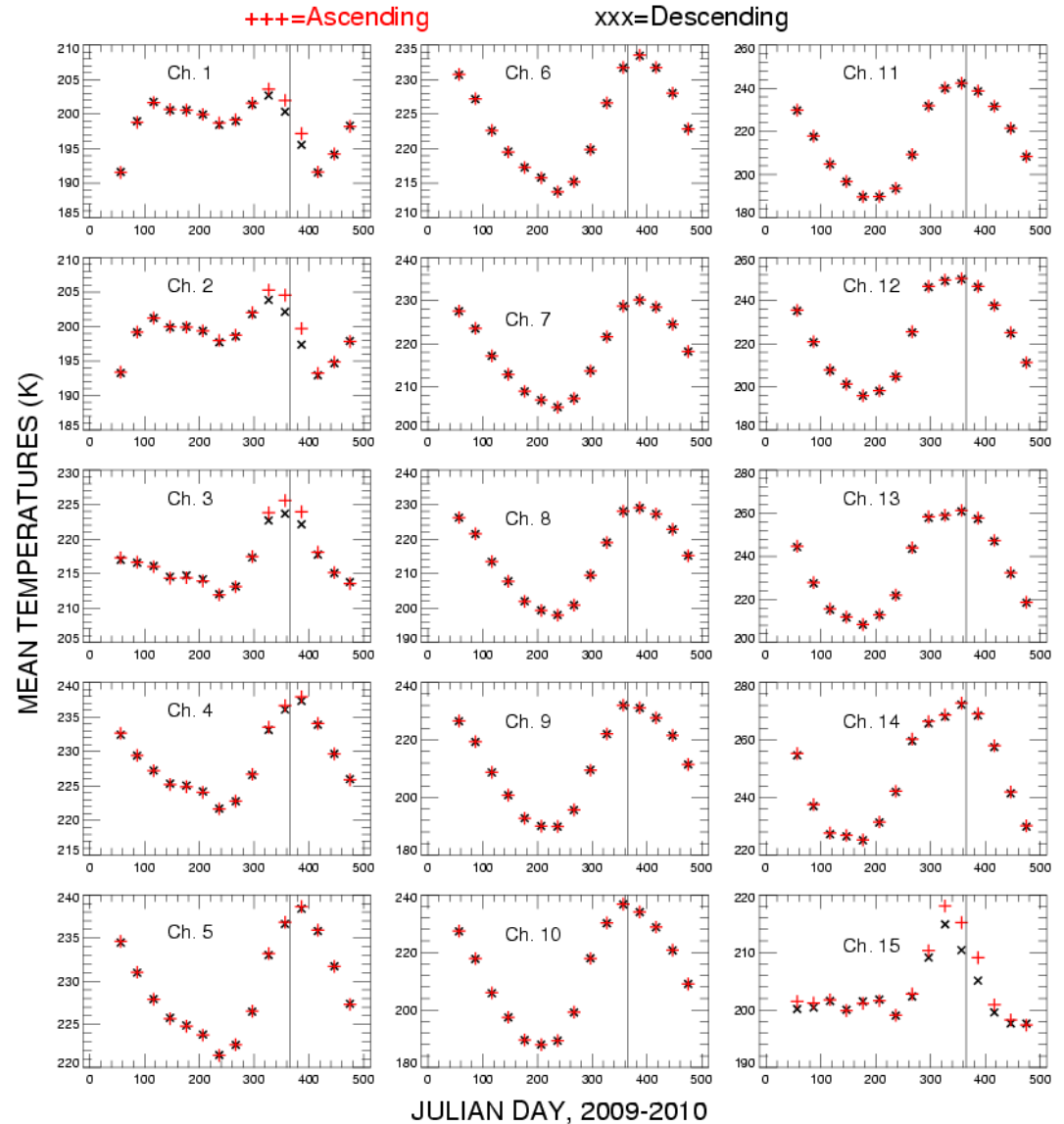
## NOAA-18 AMSU-A BT Over ANTARCTICA

- **Ascending** and descending 30-day mean brightness temperatures near nadir from the NOAA-18 AMSU-A
- Jan. 1, 2009 to April 30, 2010 over Antarctica.
- **Vertical lines** indicate the inter-year location.



## NOAA-19 AMSU-A BT Over ANTARCTICA

- **Ascending** and descending 30-day mean brightness temperatures near nadir from the NOAA-19 AMSU-A
- Feb. 10, 2009 to April 30, 2010 over Antarctica.
- Vertical lines indicate the inter-year location.
- NOAA-19 was launched on Feb. 6 2009.



$\Delta T = \text{Ascending} - \text{Descending}$

● Differences between ascending and descending 30-day mean brightness temperatures near nadir from the NOAA-18 and NOAA-19 AMSU-A over Antarctica.

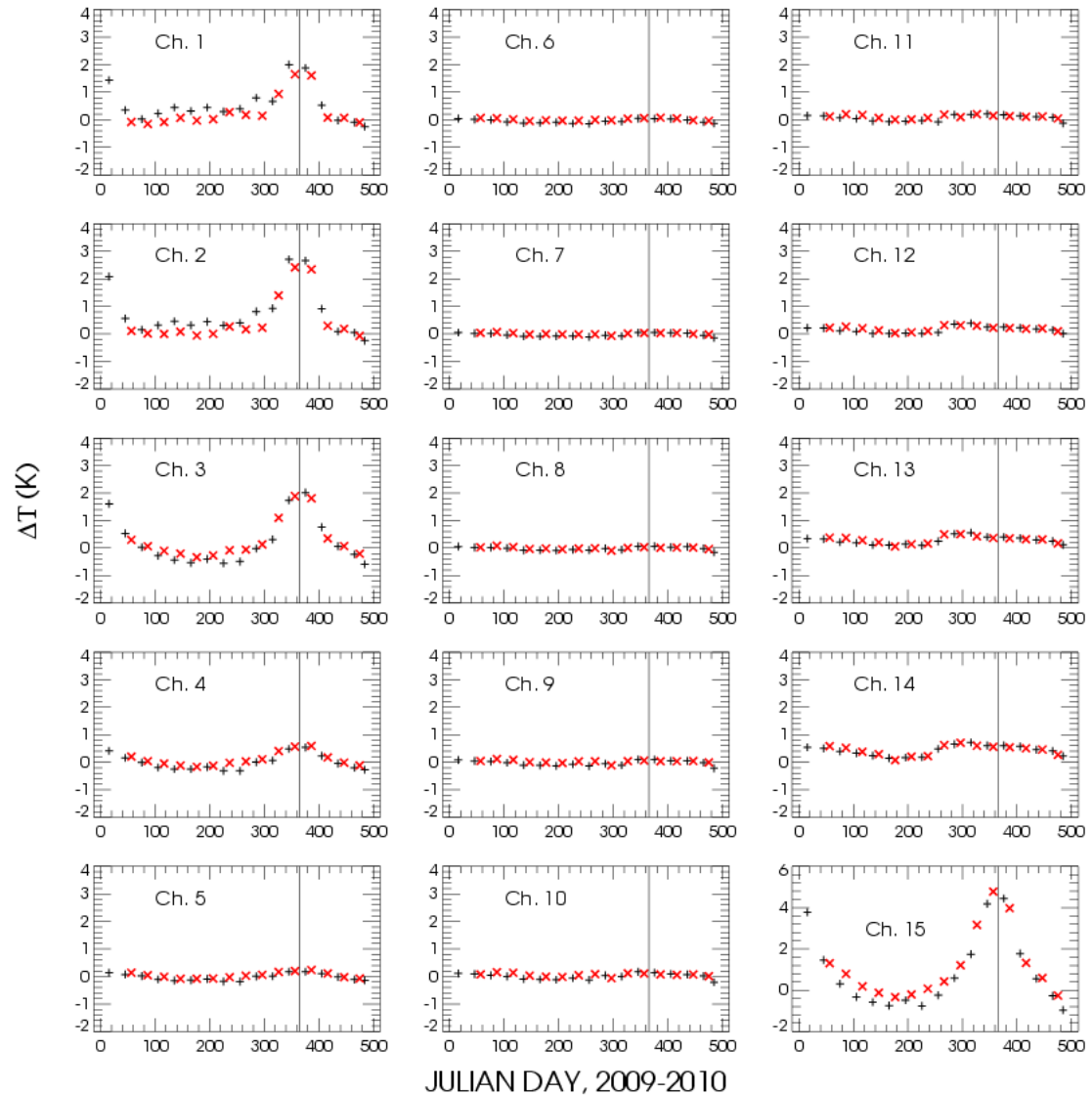
● NOAA-19 data are available only after day 40 as it was launched on 6 February 2009

● Little diurnal effect during the Antarctic winter months

Mean Antarctic Temperatures:  $\Delta T = \text{Ascending} - \text{Descending}$

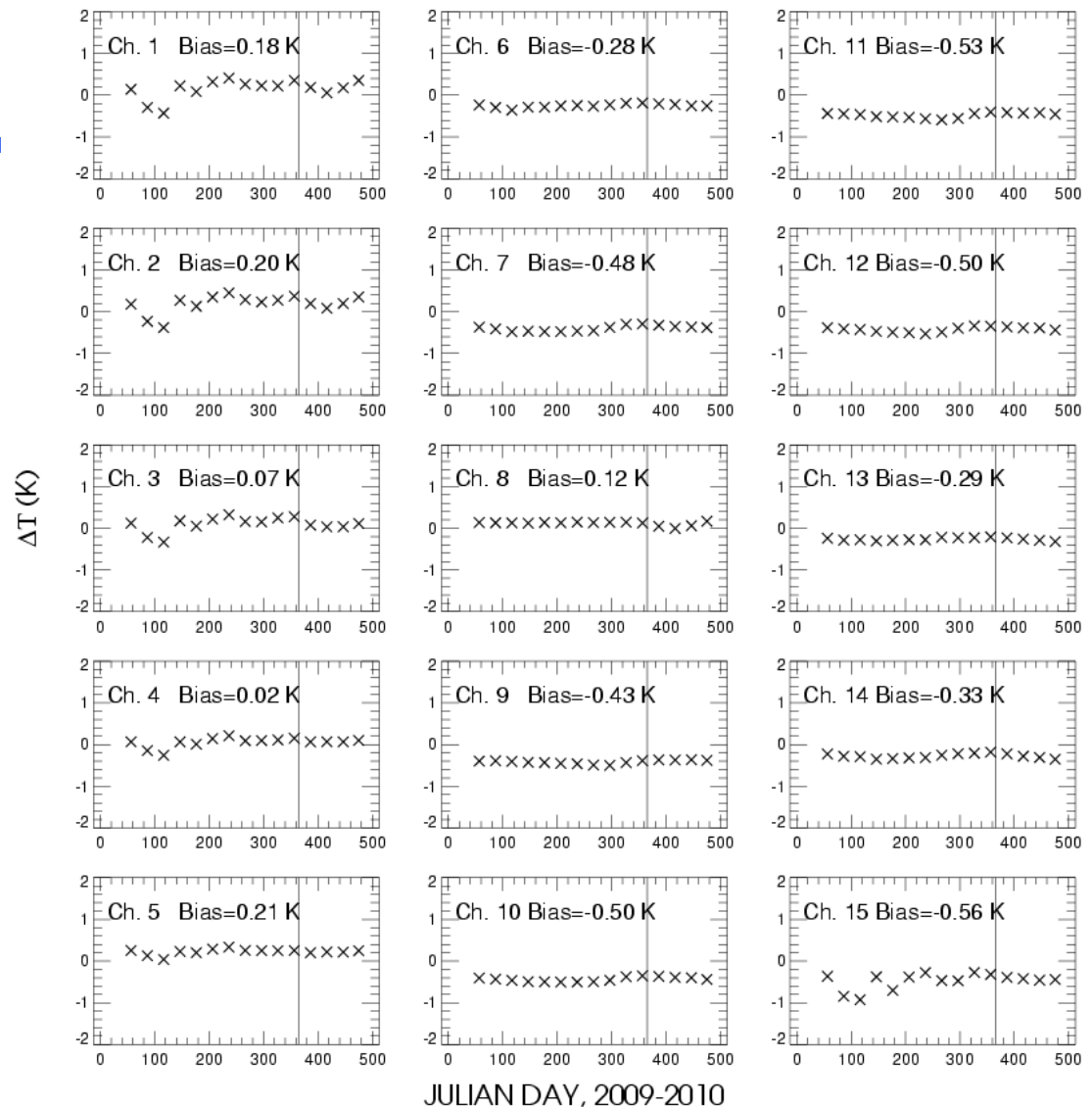
+++ = NOAA-18

xxx = NOAA-19

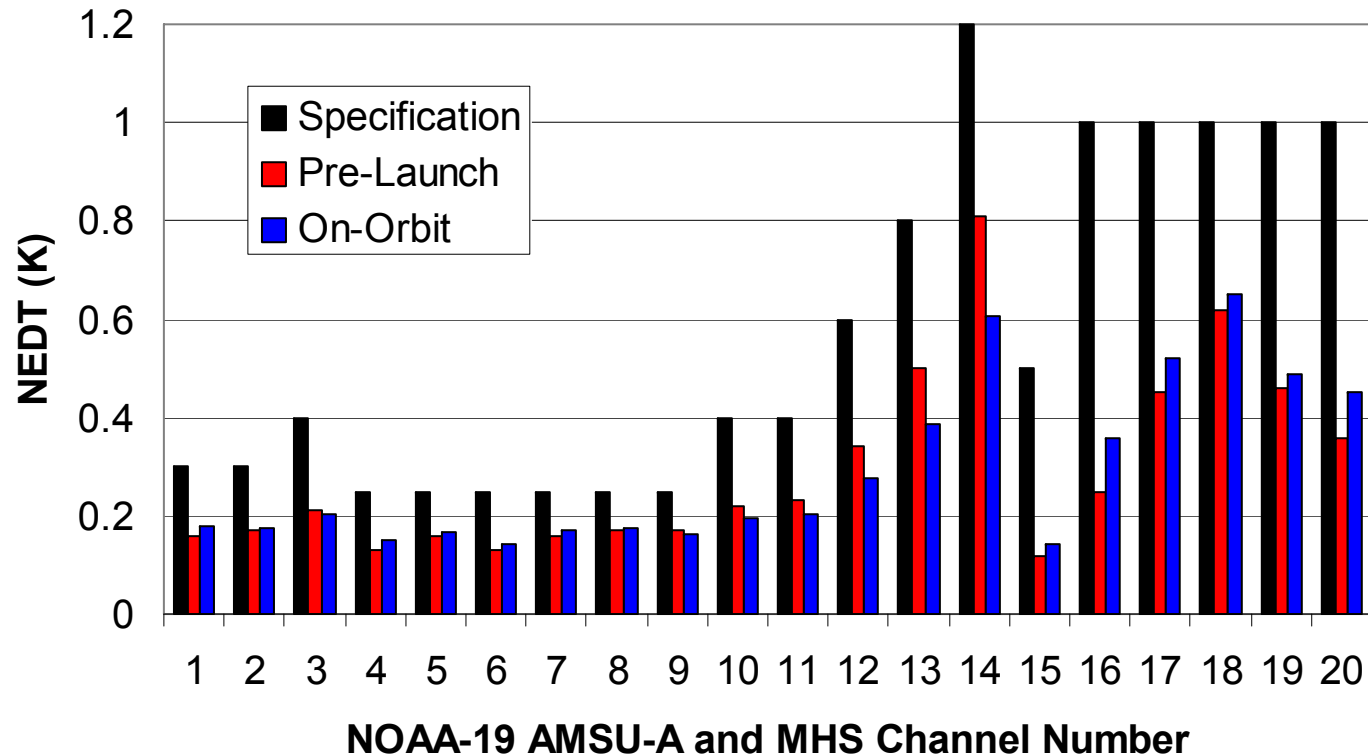


$$\Delta T = \text{NOAA18} - \text{NOAA19}$$

- Differences of 30-day mean brightness temperatures between NOAA-18 and NOAA-19 measurements at nadir over Antarctica. The NOAA-19 data are available only after day 40 as it was launched on 6 February 2009.
- Relative channel biases, which are defined as the mean  $\Delta T$  values over July when the Antarctica is nearly 24-hour nighttime
- The vertical lines indicate the inter-year location.



# On-orbit Verification (OV) of NOAA-19 AMSU-A and MHS performances







# Microwave Humidity Sounder (MHS)

- MHS (built by EUMETSAT) has flown onboard NOAA-18, NOAA-19, and MEOP-A since May 20, 2005
- MHS central channel frequencies

Channel	Central Frequency (GHz)
1	89.0
2	157.0
3	$183.311 \pm 1.0$
4	$183.311 \pm 3.0$
5	$183.311 + 7.0$

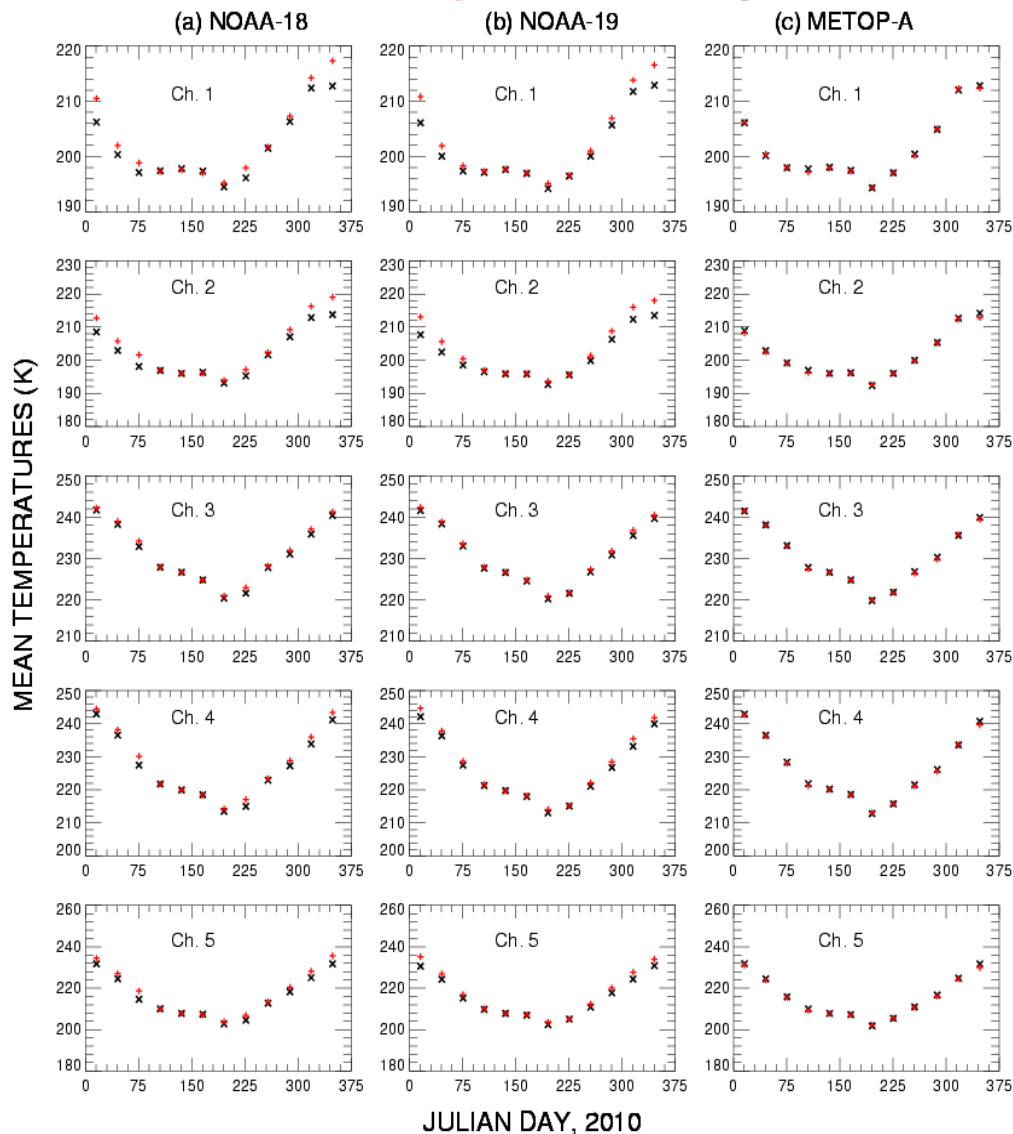
# MHS NEAR-NADIR MEASUREMENTS OVER ANTARCTICA

- **Ascending** and descending 30-day MHS mean brightness temperatures near nadir from:
  - NOAA-18,
  - NOAA-19, and
  - METOP-A measurements over Antarctica in 2010.

MHS Mean Antarctic Temperatures Near Nadir

+++ = Ascending

xxx = Descending

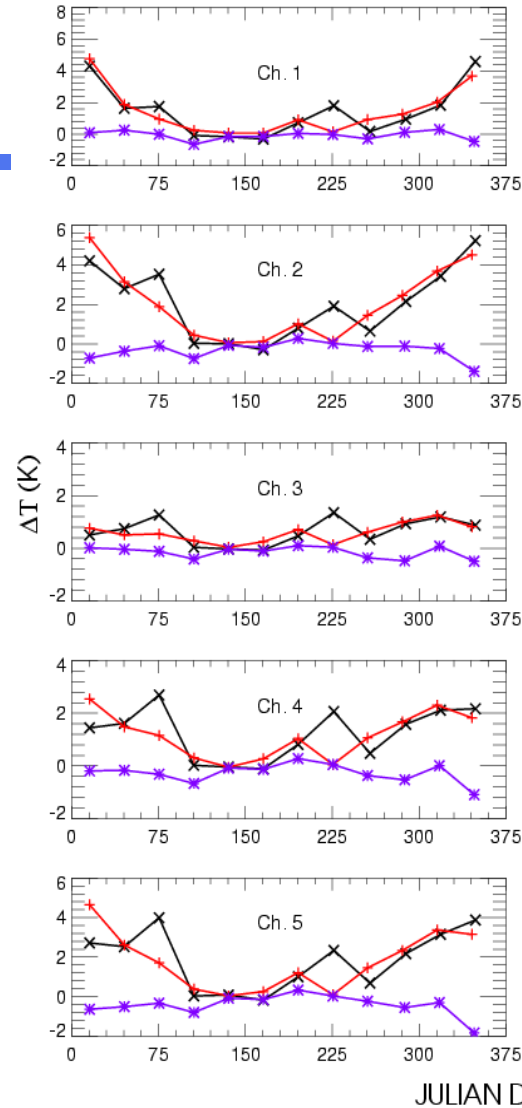


# Intersatellite/intersensor Calibration Bias (ICB)

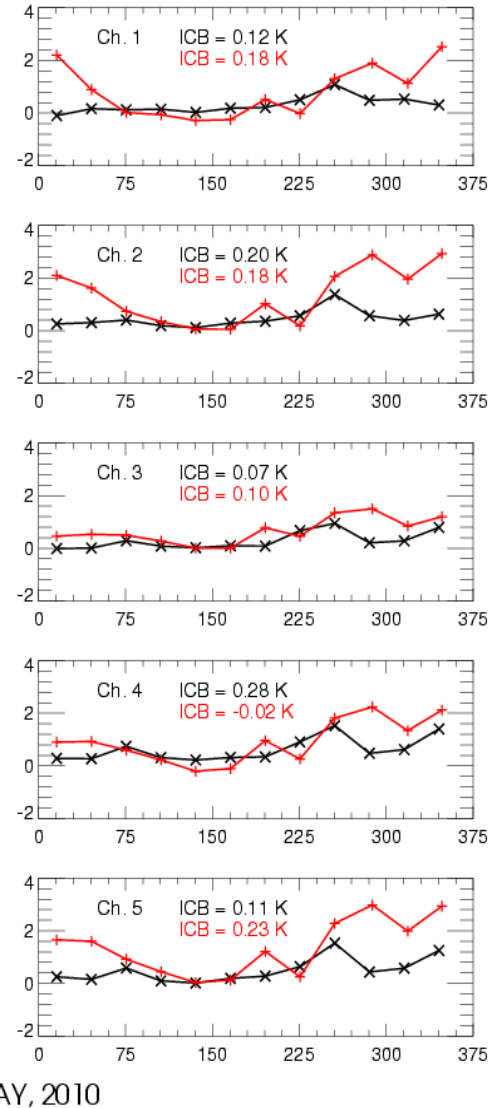
- (a) Differences between **ascending** and descending 30-day mean BT at nadir over Antarctica.
- (b) Differences of 30-day mean BT between the two satellites over Antarctica.
- **ICB = mean of days 91-180**

## MHS Mean Antarctic Temperatures Near Nadir

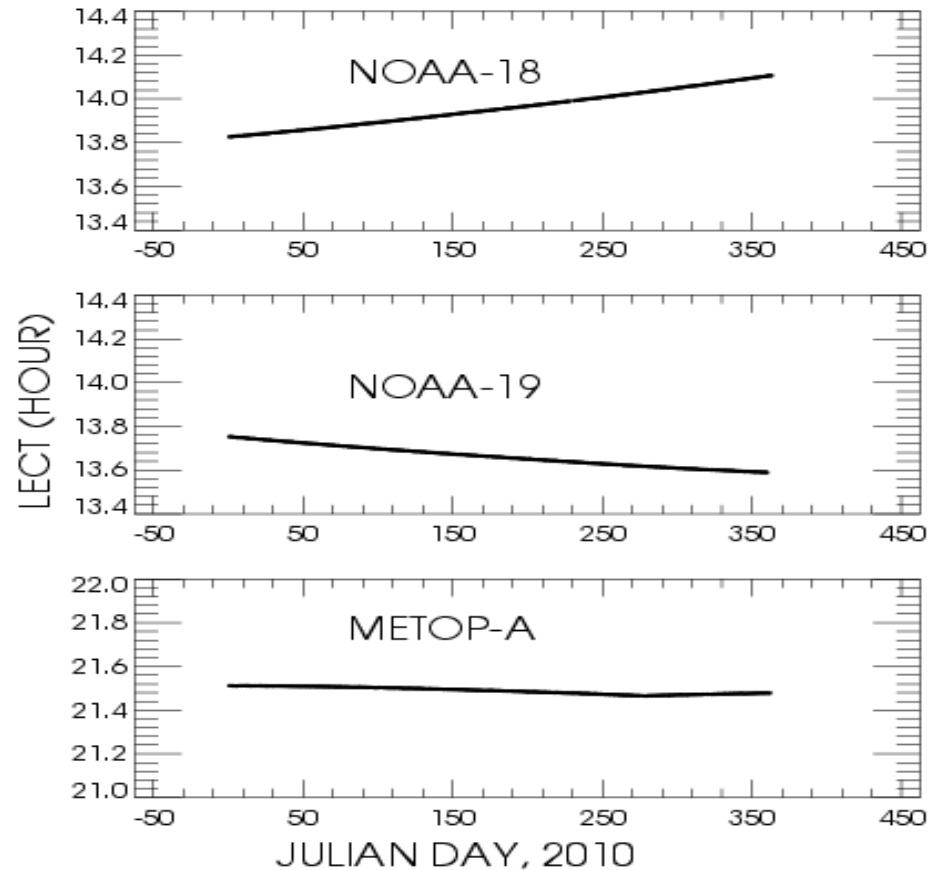
(a) Ascending - Descending  
xx=NOAA-18, +=NOAA-19, \*\*=MEOP-A



(b) xxx=NOAA18 - NOAA19,  
+++ = NOAA18 - METOPA



# Ascending Local Equator Crossing Time (LECT)

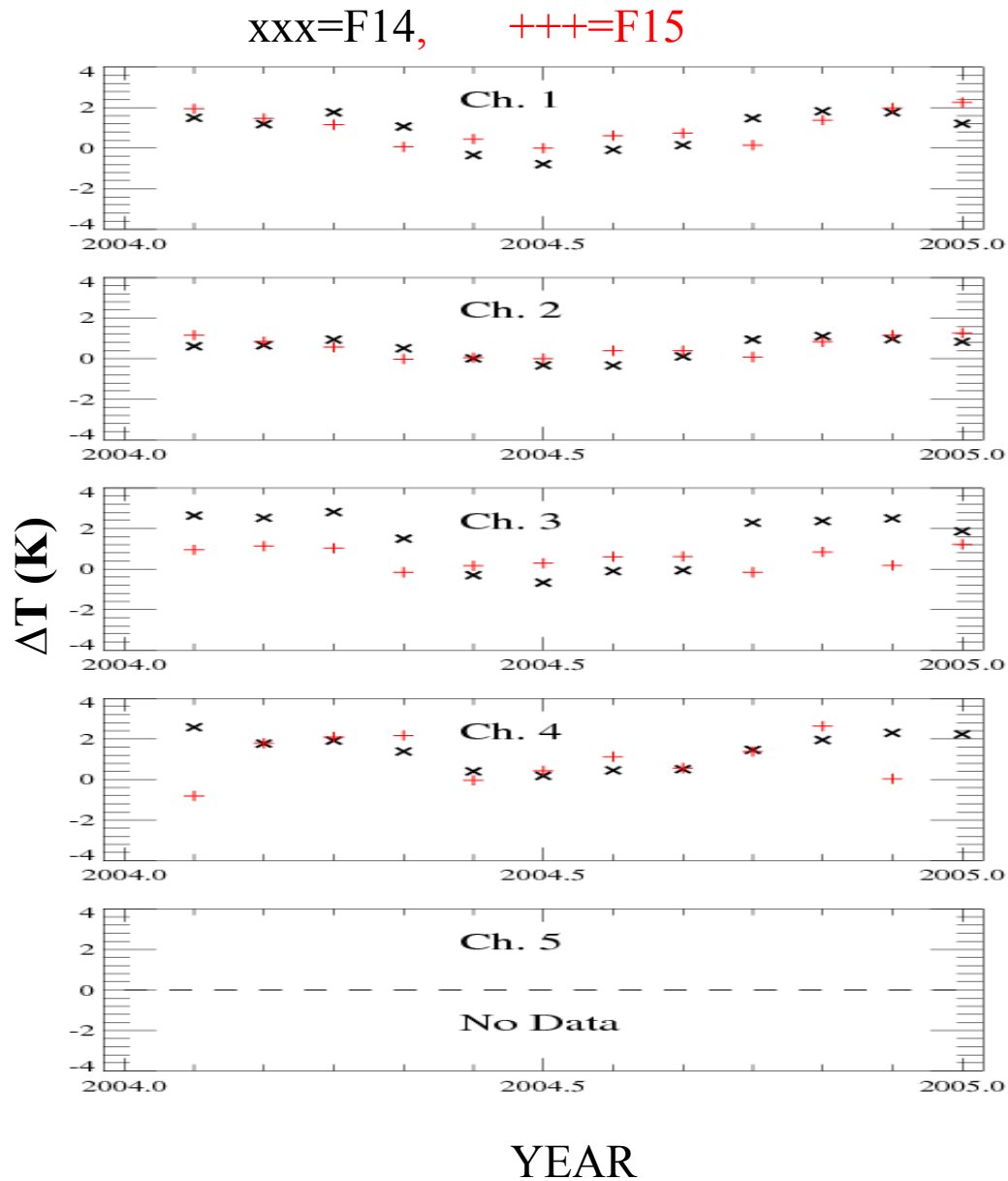


# SSM/T-2 Measurements over Antarctica

- $\Delta T = \text{Ascending} - \text{Descending}$   
F14 and F15 (2004)
- SSM/T2 Channel Frequency

Ch.	Freq. (GHz)
1	183.31±3.0
2	183.31±1.0
3	183.31±7.0
4	91.655±1.25
5	150.00±1.25

Courtesy of Yong Han



# Summary



- BOTH AMSU-A and MHS BT over Antarctica show that there is minimal diurnal variability in the winter months with 24-hour nighttime
- These measurements over Antarctica provide a practical approach to determine the Intersatellite/intersensor Calibration Biases (ICBs)
- It shows that Antarctica is good natural site for cal/val of space-borne microwave radiometers (MR)
- Establishment of a natural site for calibration reference is an important addition to the few tools available to date for cal/val of space-borne MR



# REFERENCES

- Tsan Mo, "Calibration of the NOAA AMSU-A Radiometers With Natural Test Sites," *IEEE Trans. Geosci. Remote Sens.*, 2011, in press
- Tsan Mo, "A Study of the NOAA Near-Nadir AMSU-A Brightness Temperatures over Antarctica," *J. Atmospheric and Oceanic Technology*, 27, 995-1004, DOI: 10.1175/2010JTECHA1417.1, June 2010.
- STAR Online Monitoring Website: (N. Sun, STAR Webmaster)  
[http://www.star.nesdis.noaa.gov/smcd/spb/icvs/satmonitoring\\_n19\\_amax.php](http://www.star.nesdis.noaa.gov/smcd/spb/icvs/satmonitoring_n19_amax.php)



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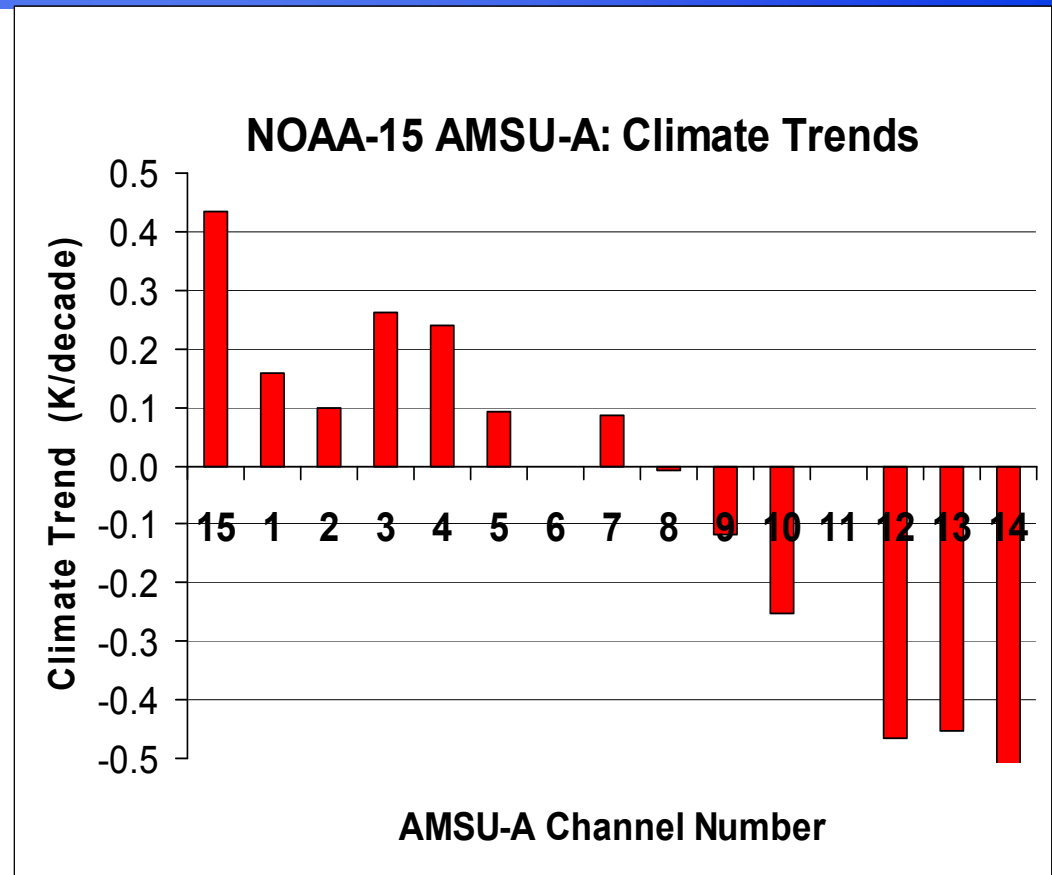
**Thank You**



# Climate Trends from NOAA-15 AMSU-A Measurements



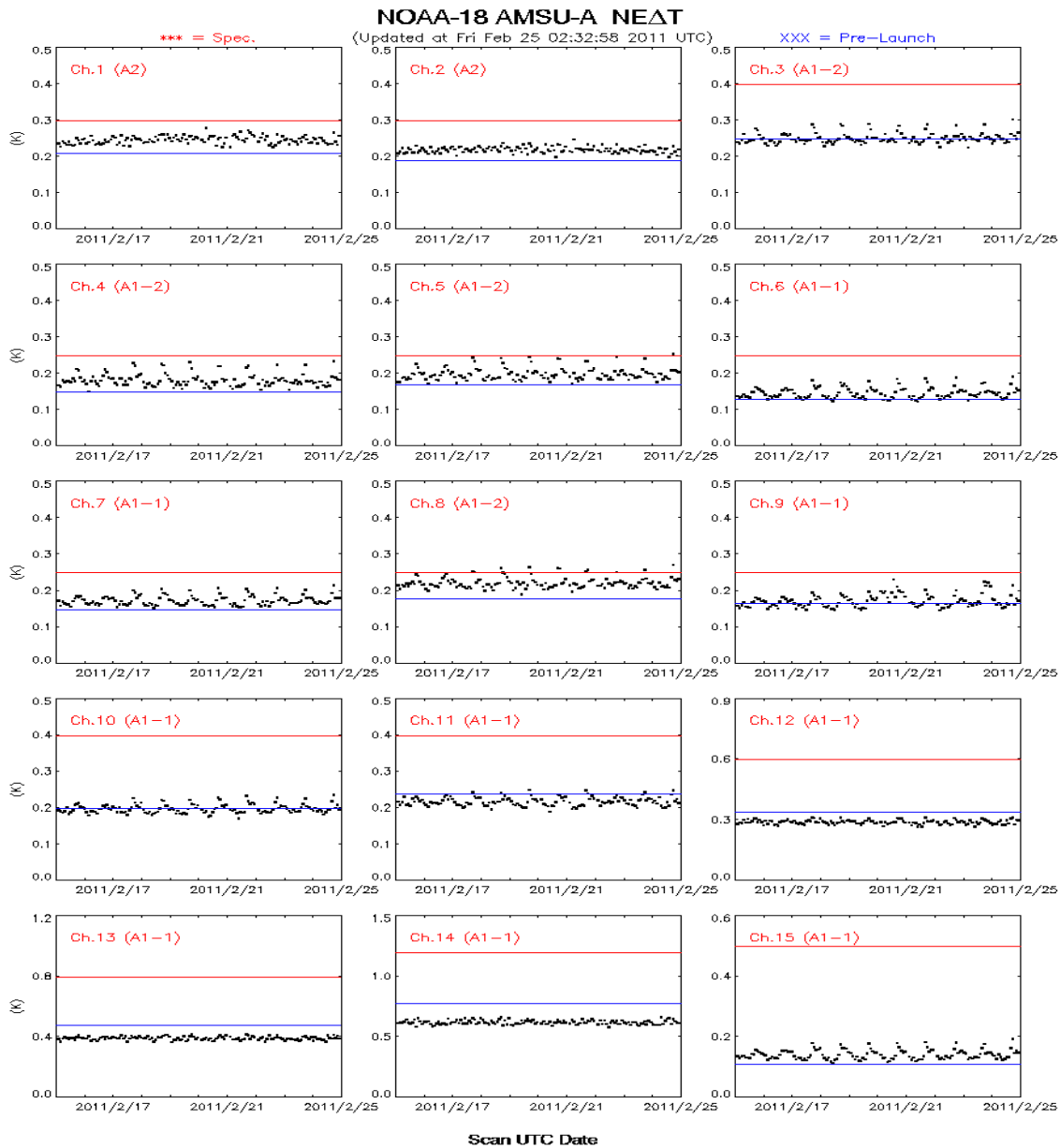
- Channel 15 measurements are closest to the Earth's surface
- Channel 9 measurements are near the tropopause.
- Channels 15 and 1-8 measurements are at multiple levels in troposphere
- Channels 10-14 measurements are at multiple levels in stratosphere
- The chart on the right shows the climate trends at multiple levels of atmosphere from 0 to 50 km.
- **Troposphere is warming and stratosphere is cooling**



T. Mo, (2009), JGR, 114, D11110

NOAA-15 AMSU-A Data from May 1998 through Dec. 2007 are used to derive these trends. Data at Channels 6 and 11 are not used due to channel failures

# NOAA-18 AMSU-A NE $\Delta$ T



# NOAA-18 MHS NE $\Delta$ T

