HIRS Inter-satellite Bias from the Simultaneous Nadir Overpass Observations

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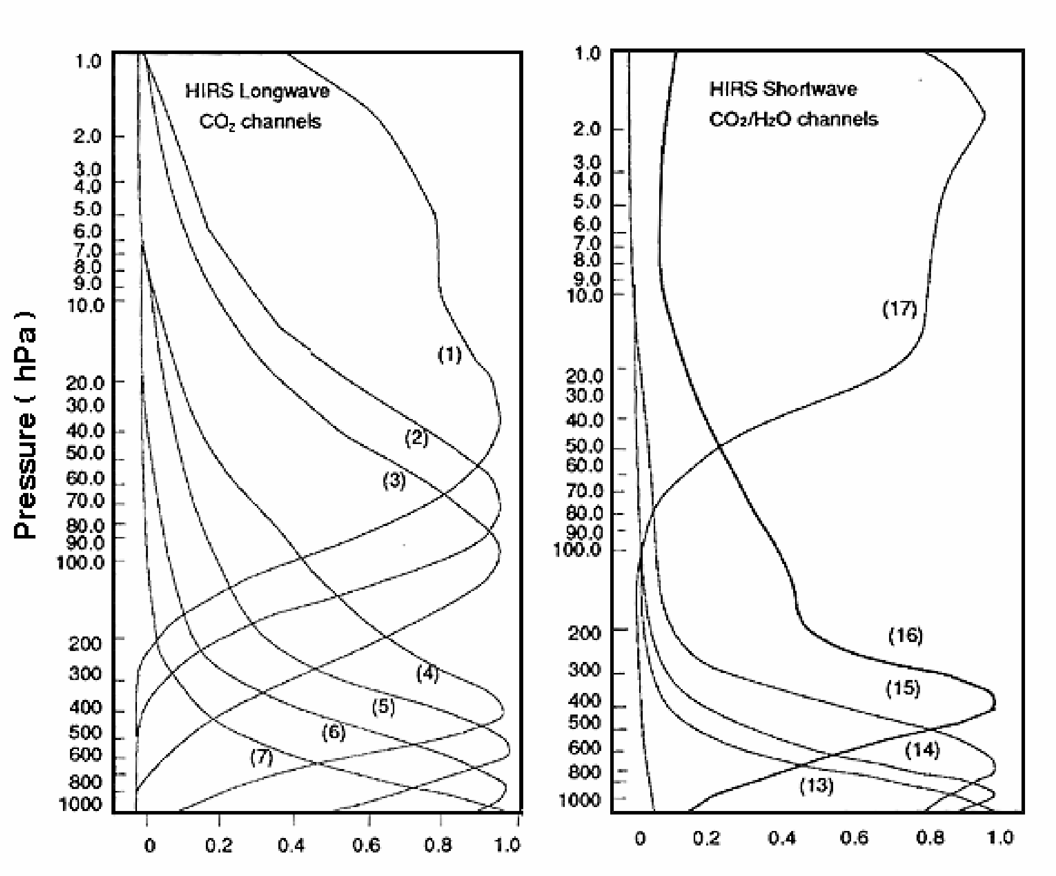
HIRS Instrument



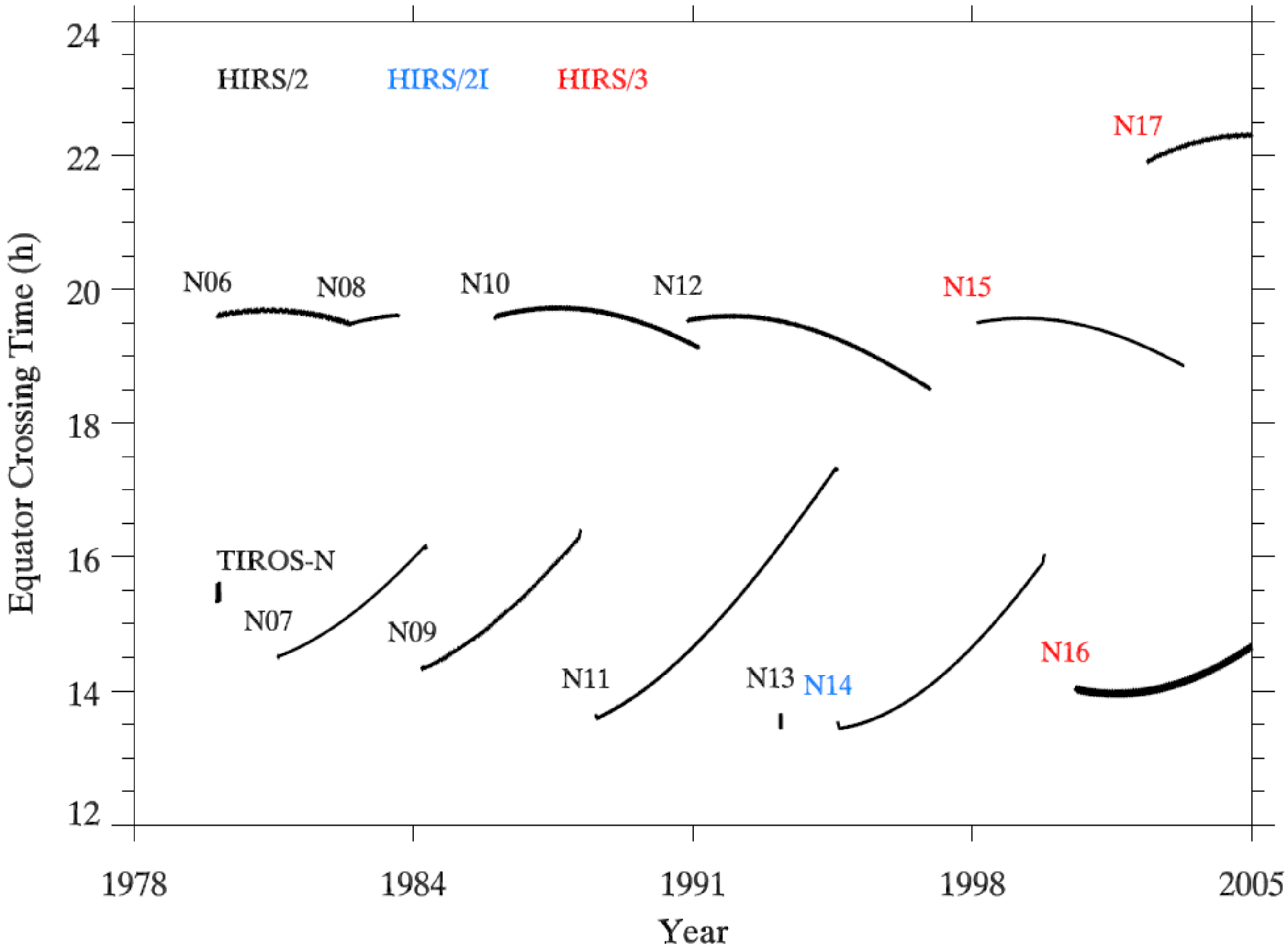
- 12 longwave (6.5-15 µm)

  7 shortwave (3.7-4.6 µm)

  1 visible (0.69 µm)

- Onboard calibration for IR channels
  - Space View
  - Blackbody View

HIRS Historic Dataset



Inter-satellite Bias

- **Type 1 – Related to instrument itself** (HIRS instruments are not exactly identical)
  - SRF difference
  - Instrument degradation
  - Change of calibration algorithm

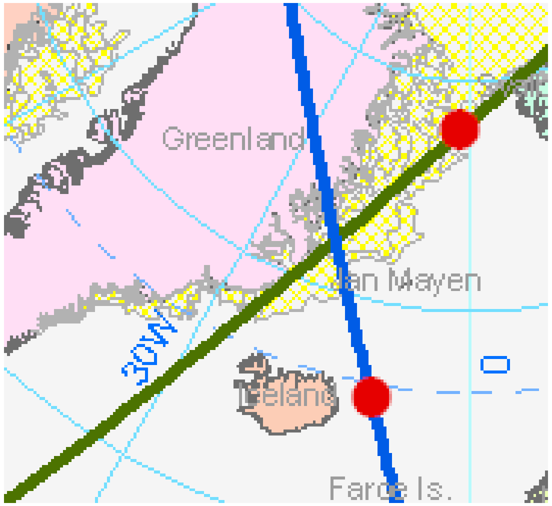
- **Type 2 – Different observation time**
  - Diurnal variation of HIRS observations
  - Orbit drift of satellite

- Climate analysis: Both are important
  Data assimilations: Type 1

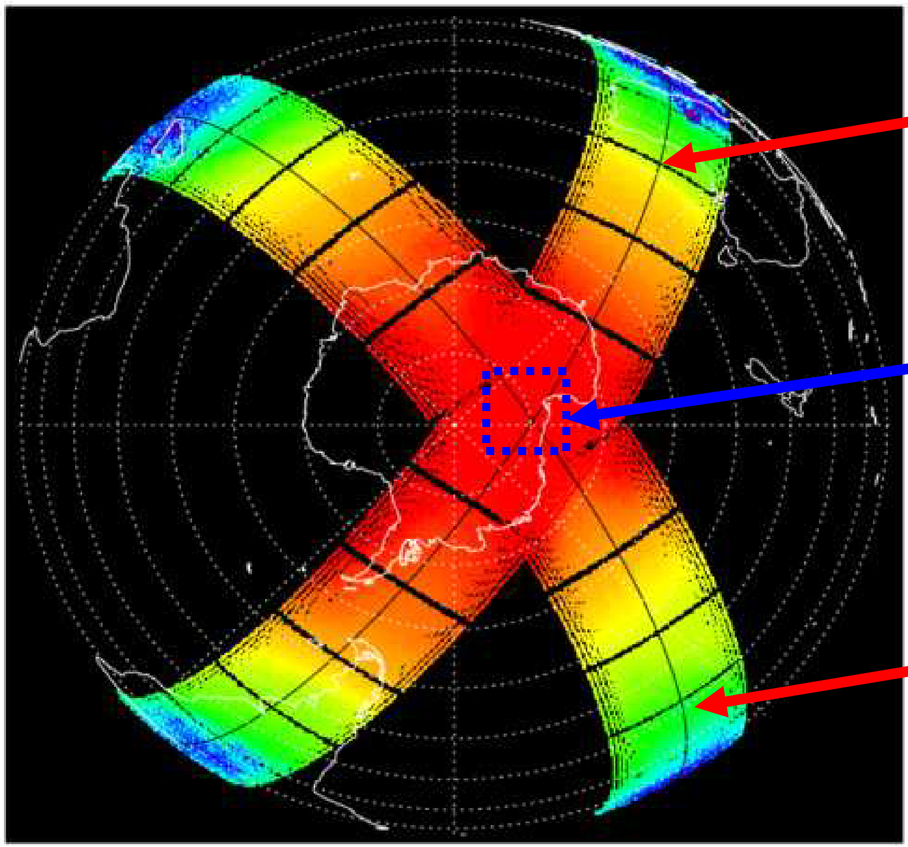
- The inter-satellite bias from the SNO observations can only resolve Type 1 inter-satellite bias

Simultaneous Nadir Overpass (SNO)

- Polar orbiting satellites intersect each other at high latitudes.
- When the SNO occurs, the radiometers from both satellites view the Earth and the atmosphere at the same place and same time but from different altitudes.
- It greatly reduces the comparison uncertainties related to satellite observational time and viewing geometries



Example of SNO events
- HIRS ch2 between NOAA12 and NOAA14



Orbit for satellite 1

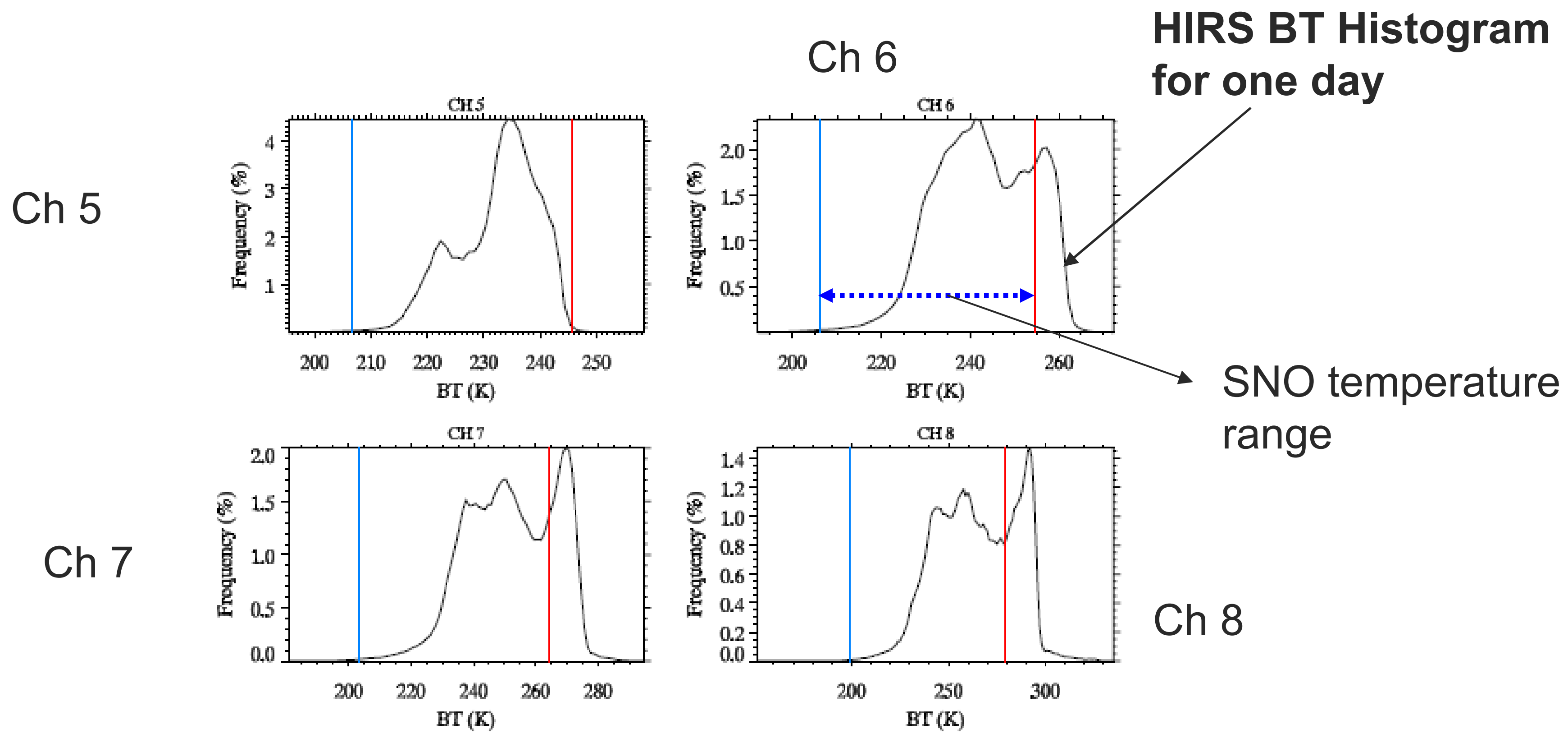
SNO pixels: 4X5

Pixel size: 17.2 km (HIRS/2)
20.4 km (HIRS/2I HIRS/3)

Orbit for satellite 2

Observational time difference: < 40 seconds

SNO detected BT range



Cover the lower to upper-mid range of the HIRS measured brightness temperature but miss the upper range for some channels.

All the SNO data on website

http://www.orbit.nesdis.noaa.gov/smcd/spb/calibration/icvs/hirs_historic/

NOAA/NESDIS/ORA Satellite...

HIRS Inter-Satellite Bias from SNO observations (1978-2003)

HIRS

NOAA06_07
Select a Channel: CH 1 Show

NOAA07_08
Select a Channel: CH 2 Show

NOAA08_09
Select a Channel: CH 1 Show

NOAA09_10
Select a Channel: CH 1 Show

NOAA10_11
Select a Channel: CH 1 Show

NOAA11_12
Select a Channel: CH 1 Show

NOAA12_14
Select a Channel: CH 1 Show

NOAA14_15
Select a Channel: CH 1 Show

NOAA15_16
Select a Channel: CH 18 Show

NOAA16_17
Select a Channel: CH 1 Show

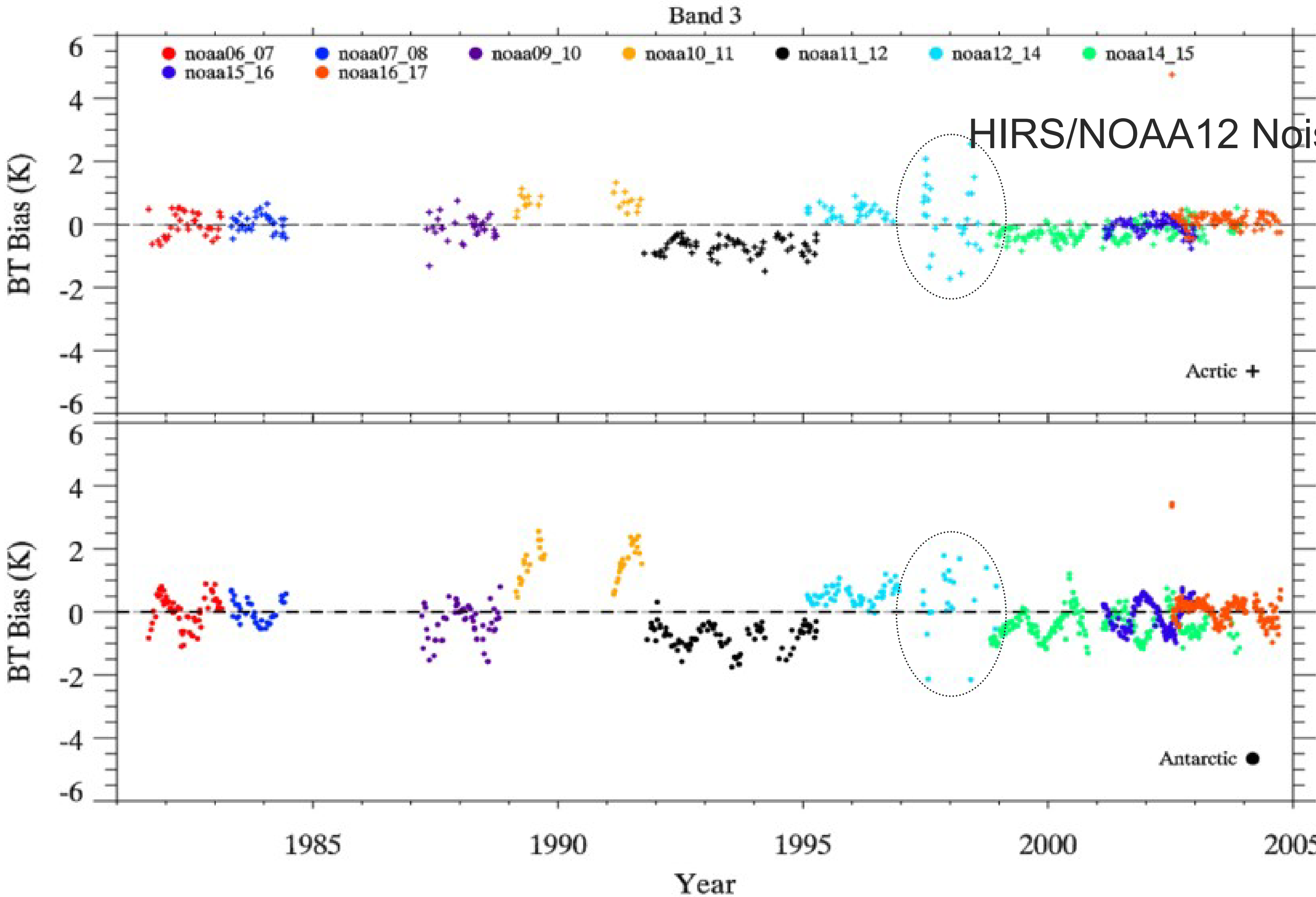
Updated on 06/14/07

N07/N08 Band 02 Temperature bias for both Pole Intersections

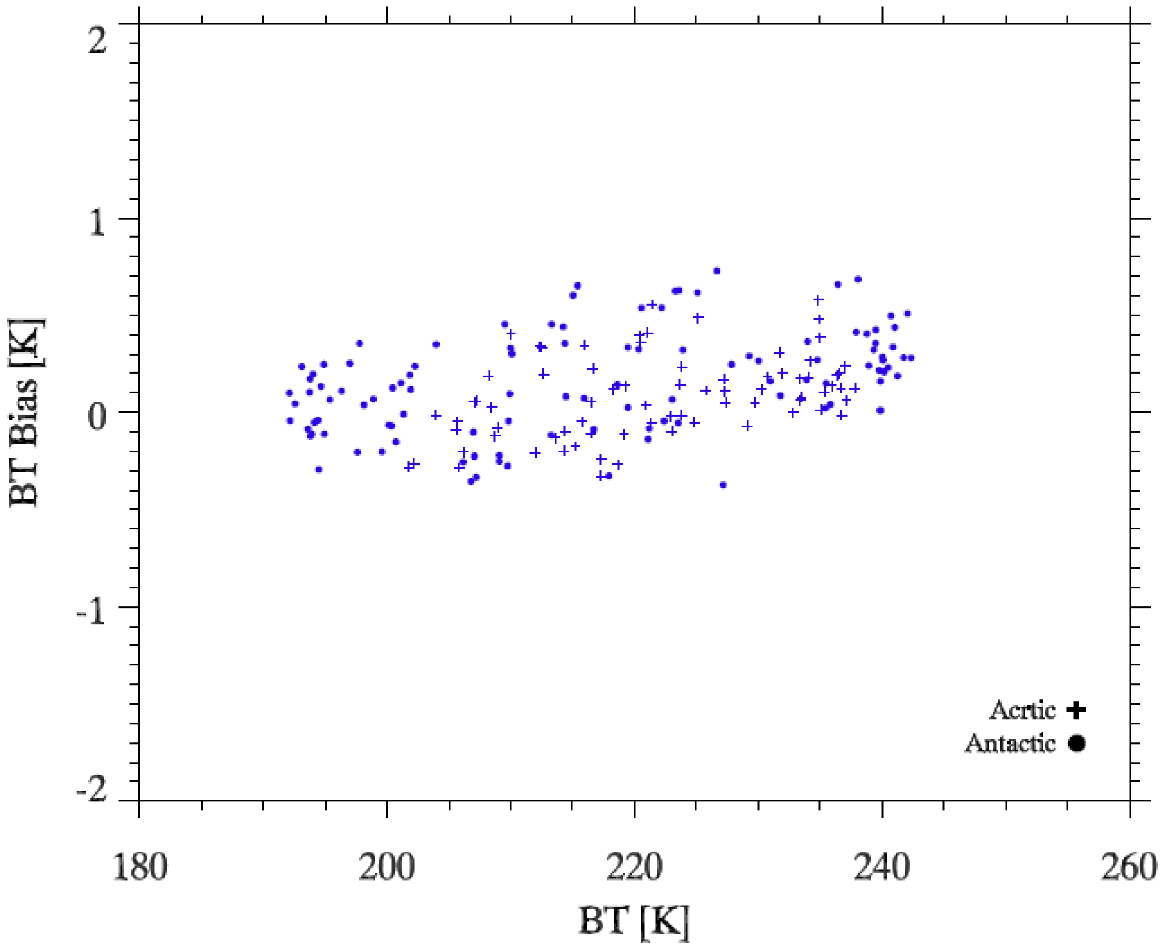
YEAR	JDAY	lat	lon	T_Diff	STDEV	Samples	T_N07(K)	STDEV	T_N08(K)	STDEV
83	123.181	79.602	102.781	0.328	0.352	18	230.918	0.146	230.590	0.317
83	123.216	-79.375	-89.336	0.019	0.402	6	206.504	0.154	206.484	0.469
83	123.287	-79.320	-115.133	0.384	0.371	12	206.923	0.317	206.539	0.428
83	133.803	79.547	-121.711	0.486	0.215	17	231.793	0.146	231.306	0.177
83	133.839	-79.398	46.727	0.248	0.347	19	202.370	0.264	202.122	0.240
83	133.874	79.703	-145.742	-0.020	0.206	16	230.825	0.171	230.845	0.185
83	133.909	-79.312	20.734	0.440	0.255	7	201.654	0.178	201.215	0.155
83	144.532	-79.242	156.047	0.606	0.375	18	199.363	0.424	198.757	0.441
83	155.119	79.672	125.820	0.390	0.293	16	236.369	0.208	235.979	0.219
83	155.154	-79.312	-67.484	-0.436	0.301	14	198.252	0.226	198.688	0.188
83	165.777	-79.453	69.625	0.008	0.347	19	196.909	0.373	196.901	0.435
83	165.812	79.664	-123.602	0.528	0.141	17	238.176	0.232	237.648	0.209
83	165.848	-79.367	43.625	0.574	0.331	19	195.579	0.325	195.005	0.369
83	176.399	-79.289	-155.758	-0.348	0.335	18	194.857	0.362	195.205	0.231
83	176.435	79.664	12.367	0.471	0.232	19	237.069	0.179	236.598	0.162
83	176.470	-79.227	178.414	-0.647	0.399	15	193.846	0.272	194.492	0.446
83	187.022	-79.406	-18.867	0.132	0.362	20	190.675	0.243	190.543	0.381
83	187.057	79.586	147.641	0.418	0.228	16	237.755	0.175	237.337	0.197
83	187.093	-79.352	-44.672	0.055	0.263	18	192.079	0.184	192.024	0.170
83	197.715	-79.398	91.688	-0.329	0.398	19	194.498	0.404	194.827	0.519
83	197.750	79.648	-101.211	0.206	0.350	9	235.670	0.186	235.465	0.294
83	208.372	79.727	35.445	0.264	0.155	17	235.619	0.081	235.355	0.139
83	229.652	-79.500	115.203	0.310	0.342	19	194.584	0.315	194.274	0.428
83	229.688	79.633	-78.703	0.062	0.162	18	233.923	0.112	233.861	0.179
83	240.275	-79.523	-108.531	-0.068	0.515	17	196.006	0.239	196.074	0.358
83	240.310	79.695	57.828	0.236	0.327	20	229.672	0.157	229.436	0.247
83	250.968	-79.438	1.367	0.672	0.419	15	206.200	0.516	205.528	0.663
83	251.003	79.820	169.562	0.181	0.245	15	228.986	0.109	228.805	0.248
83	272.177	79.805	106.828	-0.046	0.272	20	219.082	0.240	219.128	0.315
83	272.212	-79.352	-87.281	0.205	0.278	17	204.048	0.171	203.842	0.295
83	282.870	79.711	-143.273	0.311	0.263	14	218.366	0.284	218.055	0.208
83	282.905	-79.359	23.461	0.505	0.263	8	212.273	0.180	211.768	0.185
83	293.527	-79.547	161.031	0.533	0.191	8	225.651	0.230	225.118	0.291
83	293.598	-79.492	135.219	0.543	0.427	16	226.341	0.405	225.798	0.686
83	304.114	79.875	130.211	0.348	0.148	5	210.091	0.228	209.743	0.204
83	304.149	-79.438	-63.852	0.504	0.207	12	221.848	0.134	221.343	0.154
83	304.185	79.812	104.281	-0.024	0.308	20	209.646	0.234	209.670	0.242
83	304.220	-79.586	-87.930	0.169	0.247	15	222.403	0.239	222.234	0.257
83	325.464	-79.453	-177.031	0.257	0.263	17	240.615	0.166	240.358	0.270
83	336.121	79.648	125.656	0.390	0.272	15	201.866	0.267	201.476	0.273
83	336.157	-79.414	-66.594	0.036	0.229	19	241.581	0.169	241.545	0.191
83	346.779	-79.383	69.188	0.290	0.234	12	241.087	0.145	240.797	0.166
83	346.814	79.875	-121.633	0.645	0.379	17	210.657	0.480	210.012	0.503
83	346.850	-79.516	45.008	0.351	0.218	20	241.081	0.147	240.730	0.183
84	13.751	79.789	-99.477	0.130	0.226	6	207.731	0.350	207.601	0.418
84	13.786	-79.578	68.492	0.076	0.256	18	240.131	0.194	240.055	0.116

http://www.orbit.nesdis.noaa.gov/smcd/spb/calibration/icvs/hirs_historic/

HIRS Inter-satellite Bias for Ch2 (70hPa Temperature)

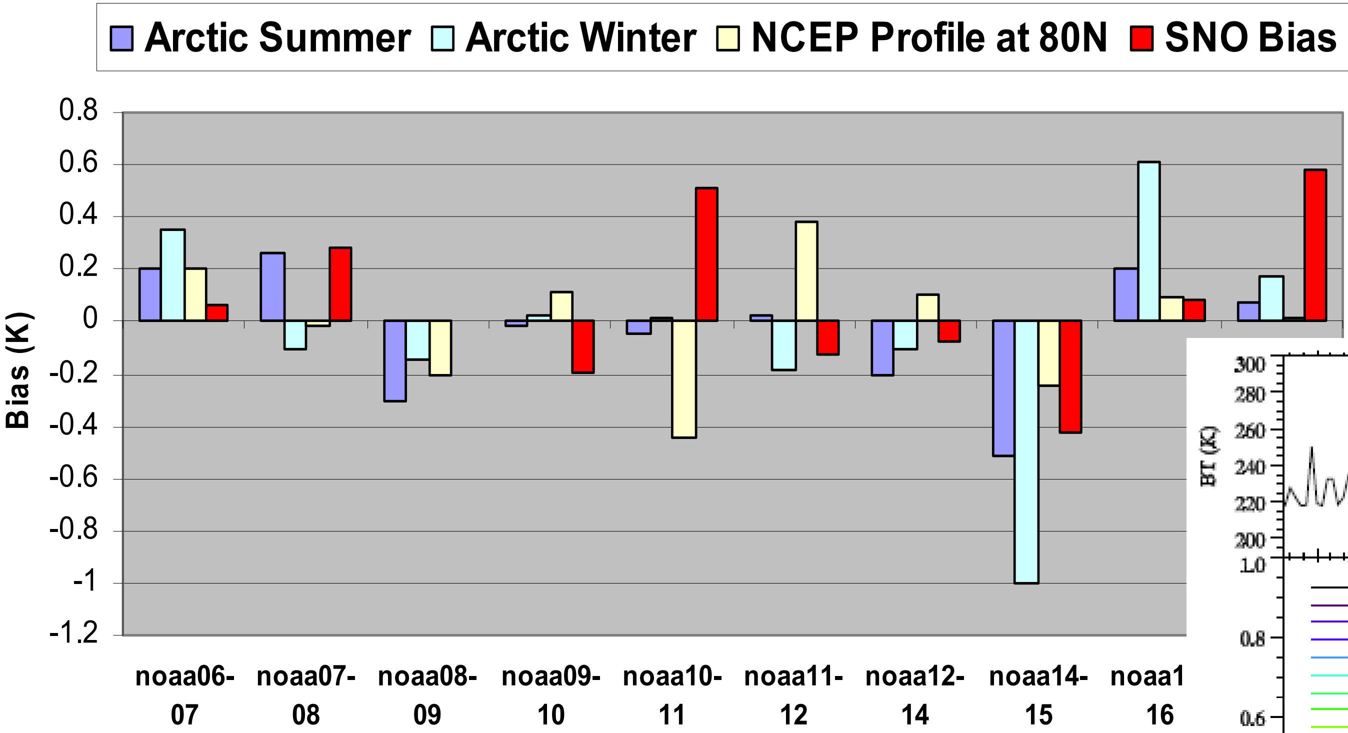


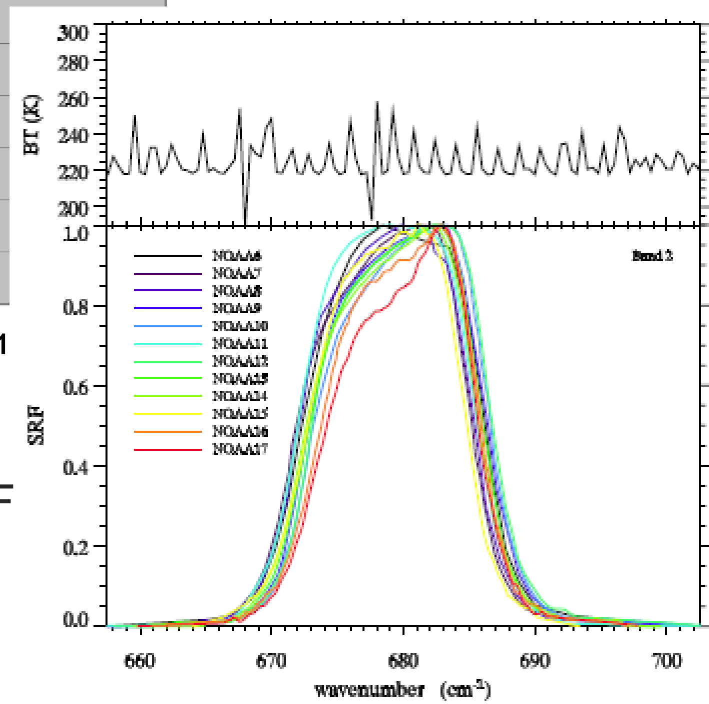
Scene-Temperature Dependent Bias



Channel 2 for NOAA14 – NOAA15

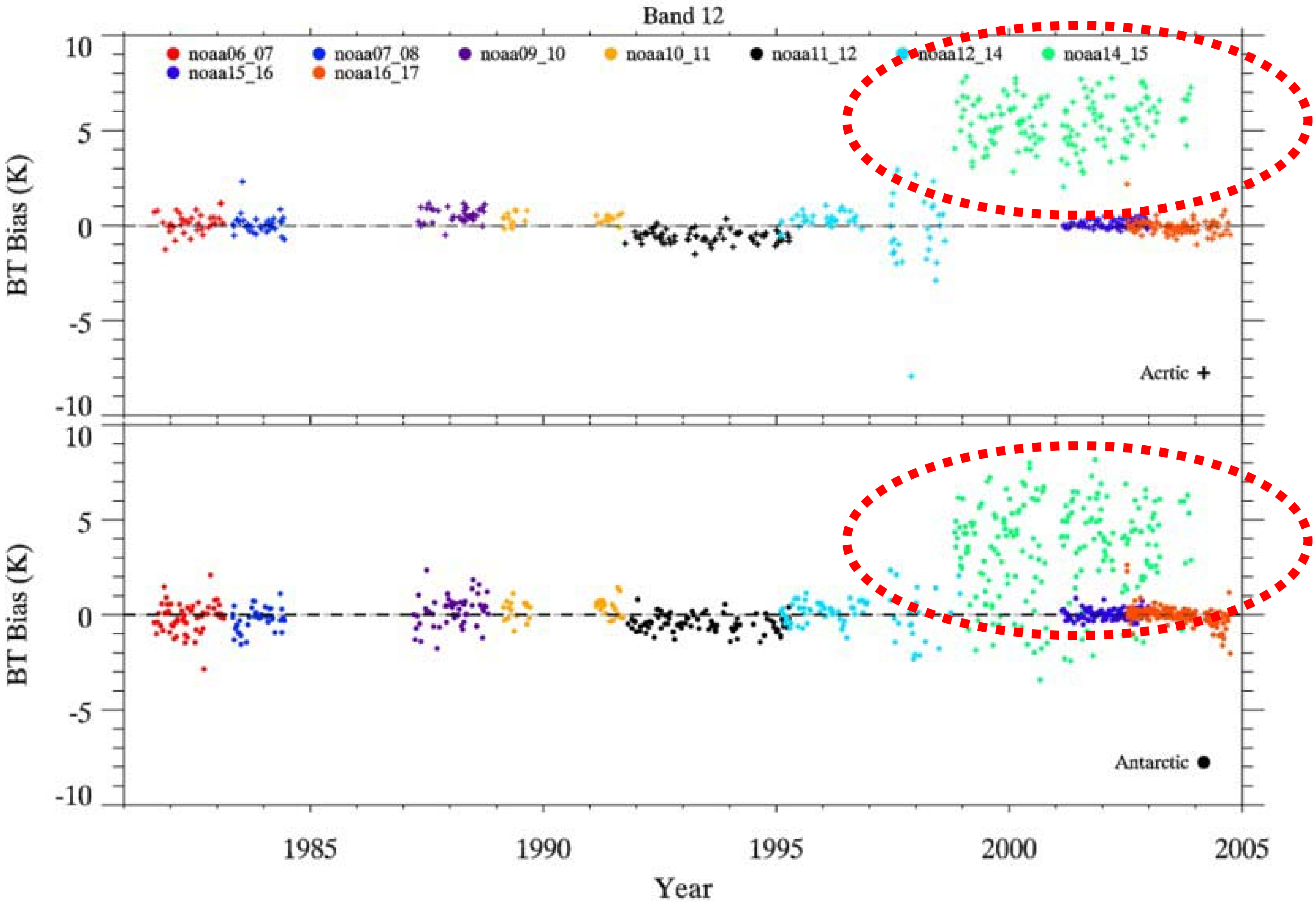
SRF difference



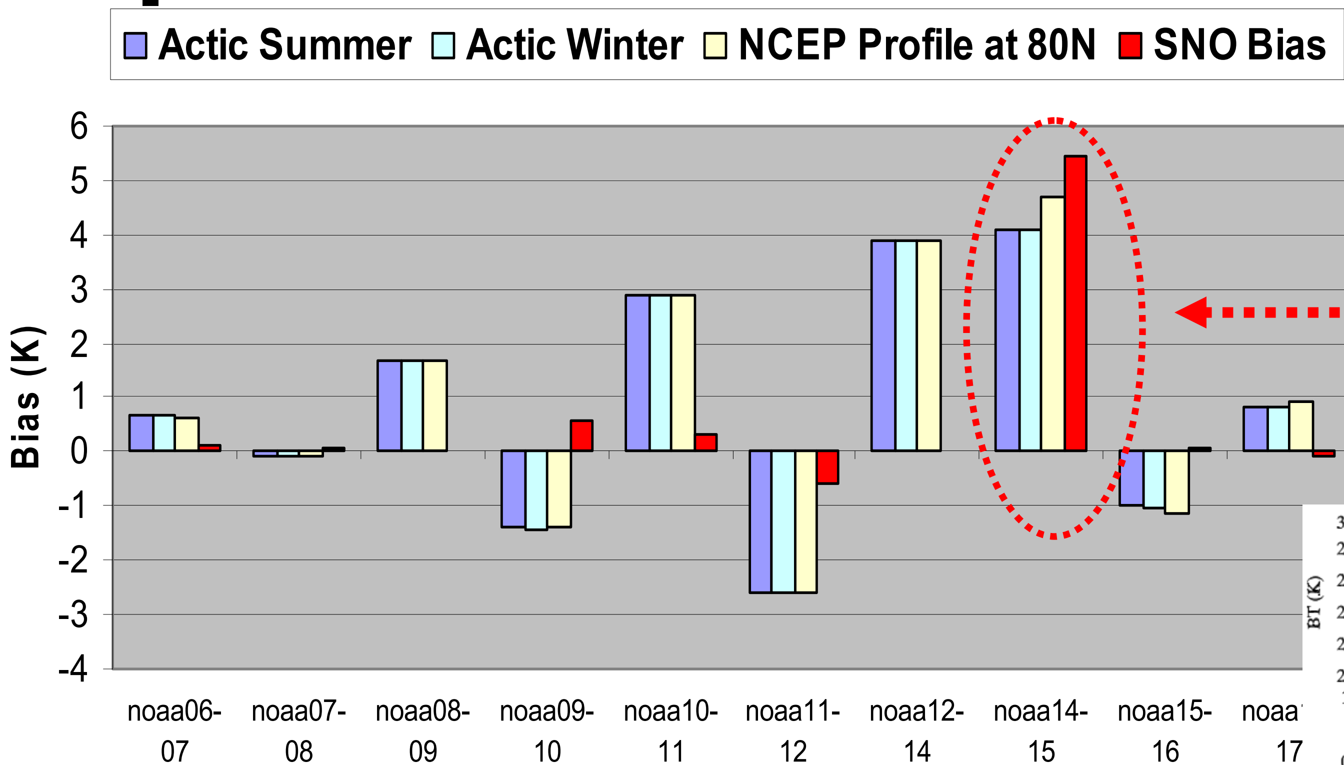


The biases can not be totally explained by the SRF difference.

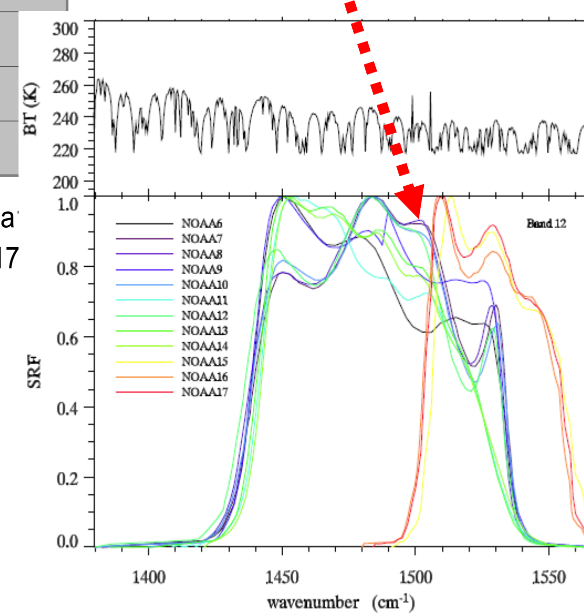
Inter-satellite Bias for Ch12 (Upper Troposphere Humidity)



Inter-satellite bias for ch12

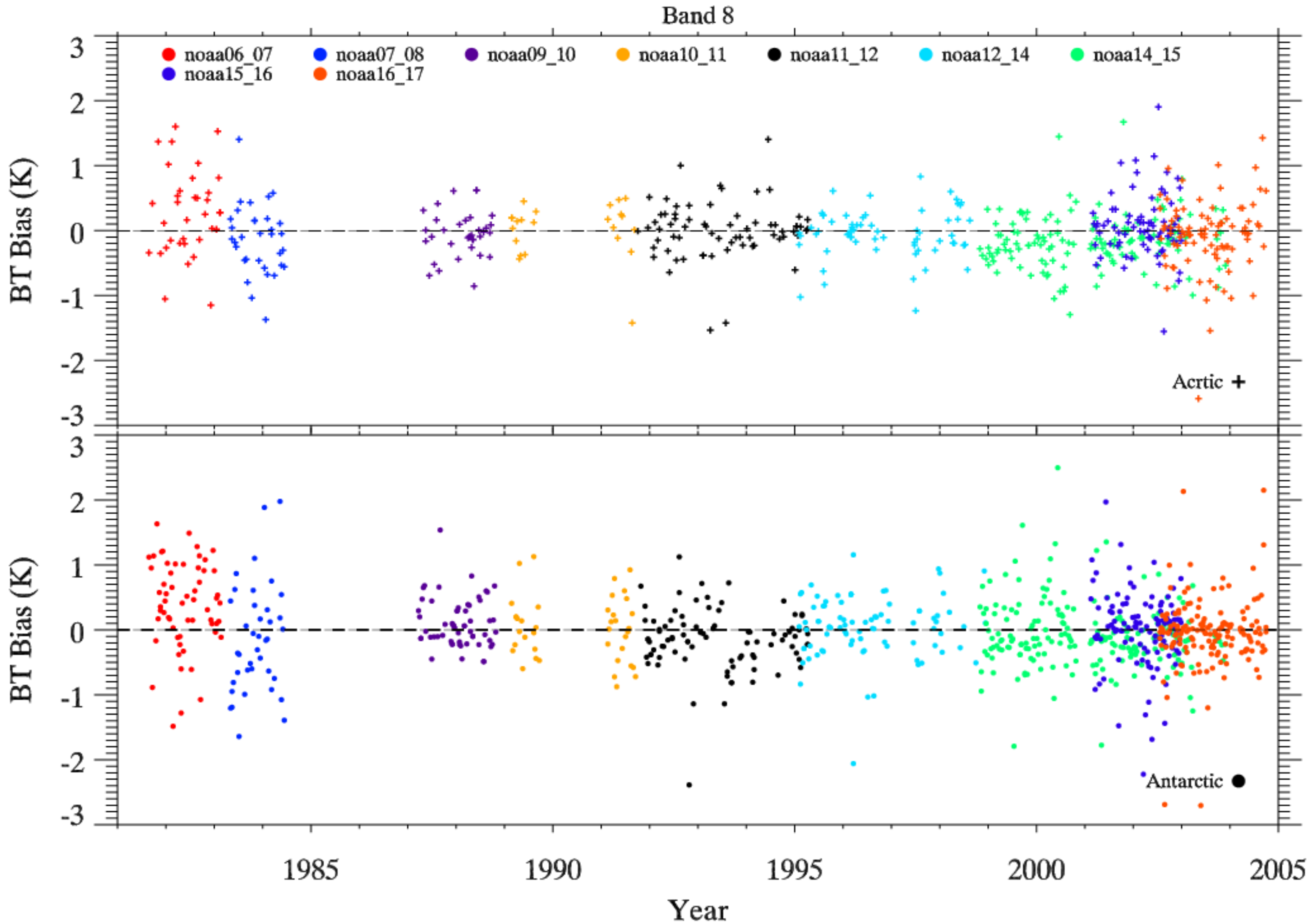


Spectral changes



The SRF change resulted in the larger inter-satellite bias between NOAA14 and NOAA15.

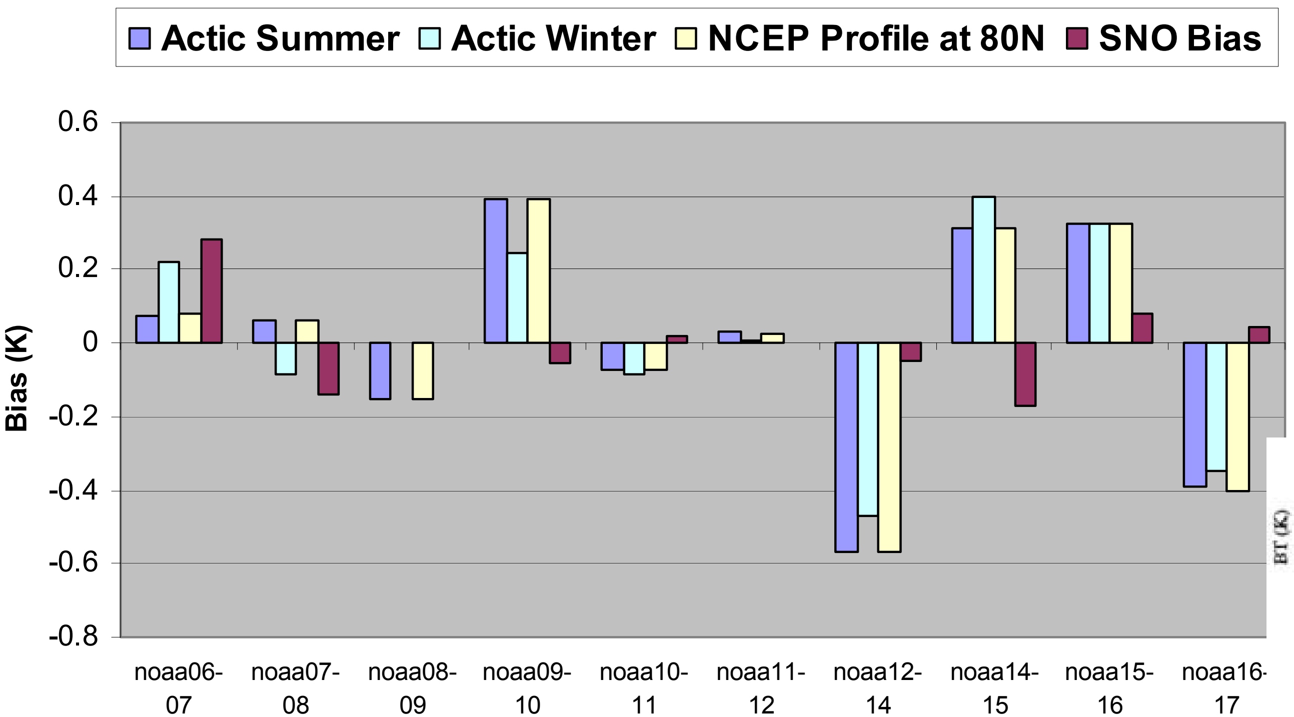
Inter-satellite Bias for Ch8 (Window channel; ISSCP reference)

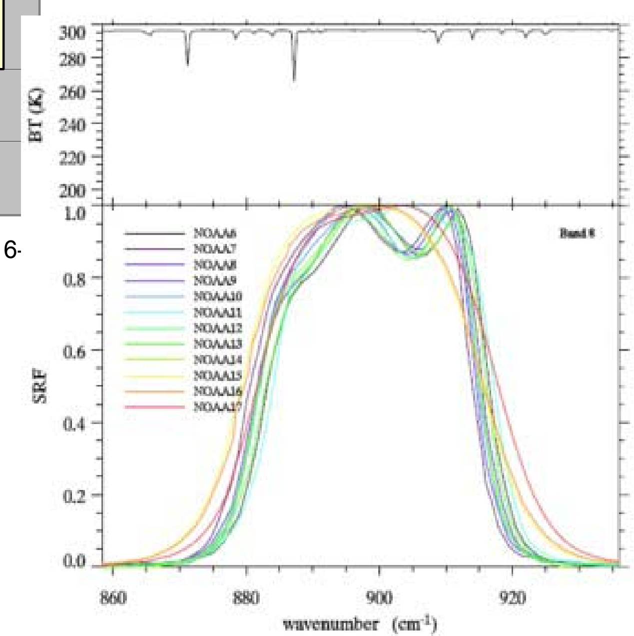


Conclusion

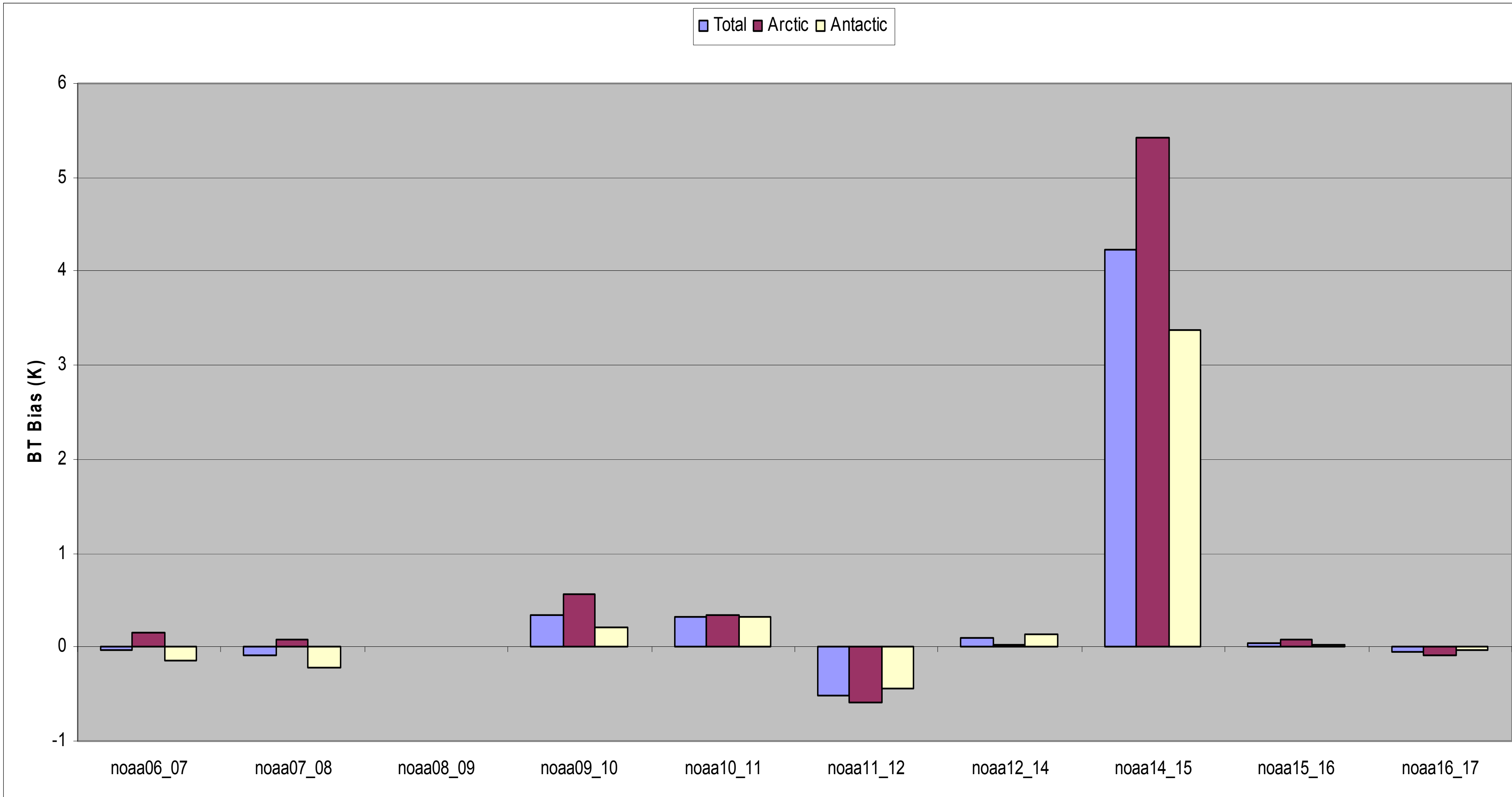
- HIRS inter-satellite bias have been analyzed using SNO observations for all HIRS instruments from 1980-2005. All the data are on-line now.
- We demonstrate the inter-satellite bias for channels 2, 8 and 12.
- We also found that the bias can not be totally explained by the difference of the HIRS SRFs. Other factors may also be involved.
- We are now investigating the root-causes for the HIRS inter-satellite bias channels by channels. We will focus on developing a algorithm to account for the inter-satellite biases in the future.

Inter-satellite Bias for ch8

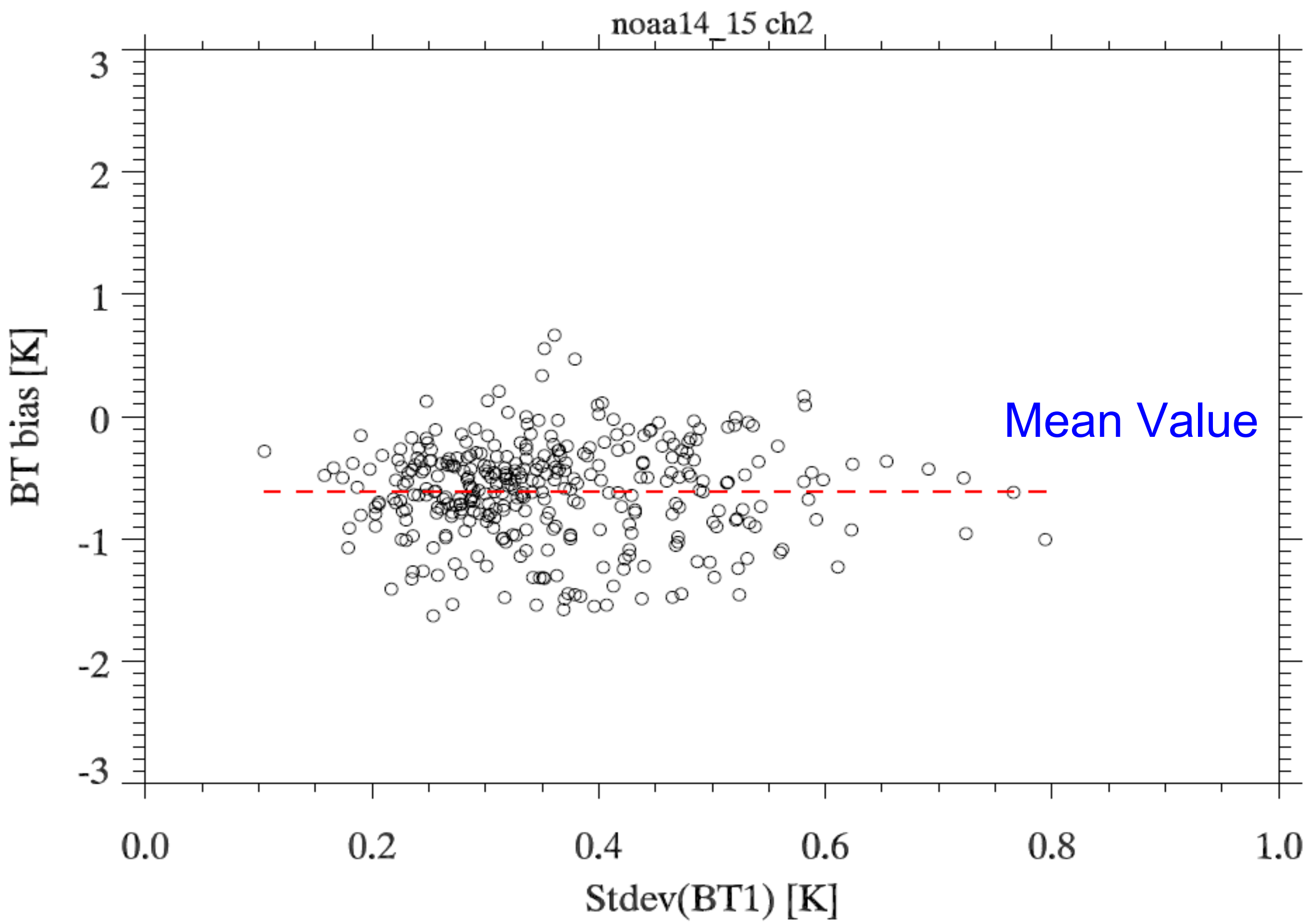




Inter-satellite bias for ch12



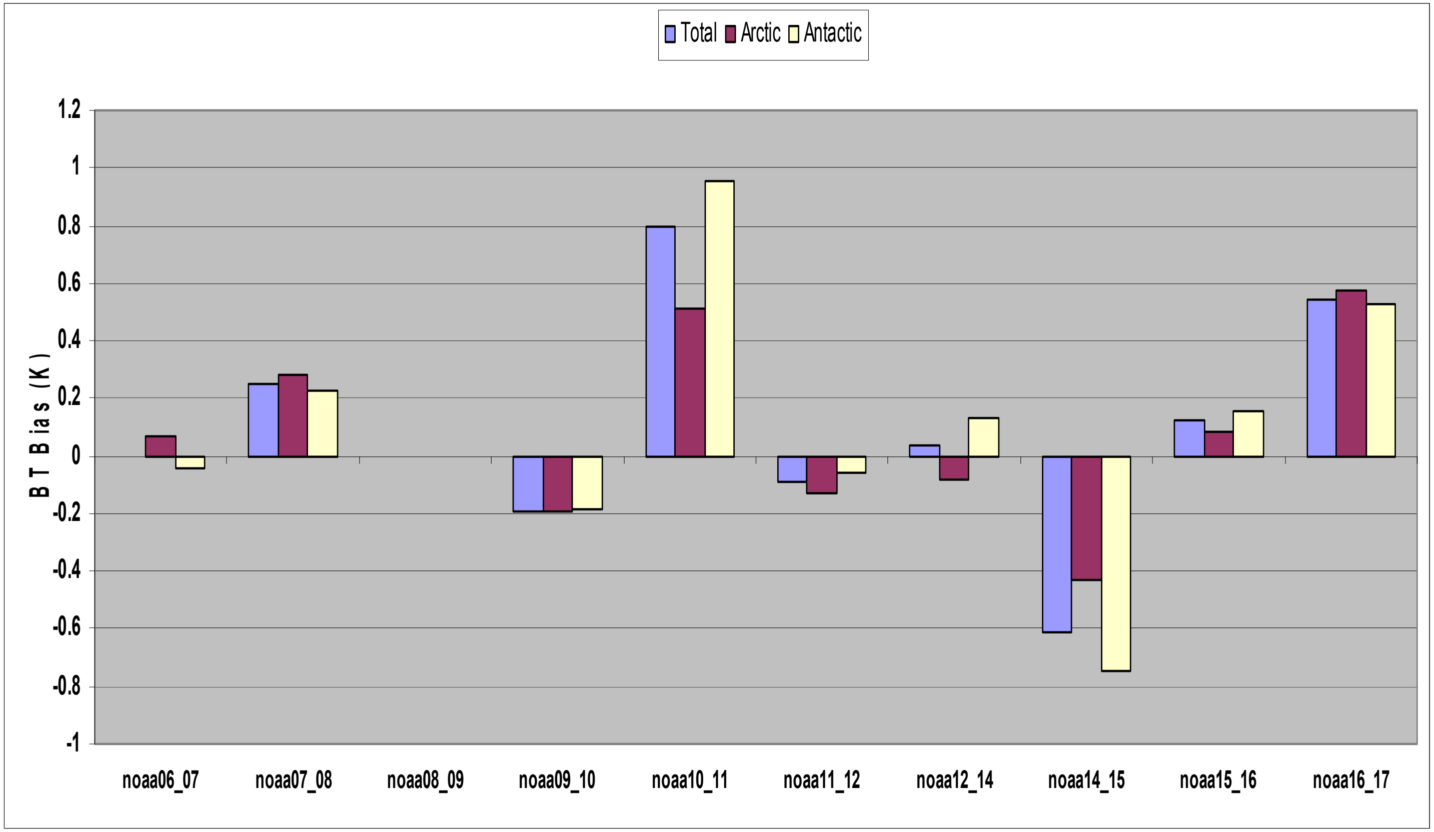
How does scene homogeneity effects on results?

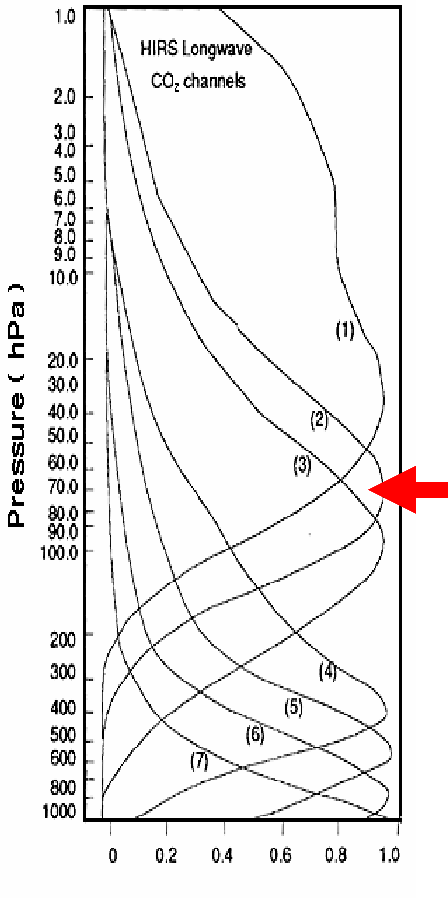


Two phases of this study

- Phase 1: Focus on the Inter-satellite biases between HIRS
  - Completed
- Phase 2: Develop a algorithm to account for the inter-satellite biases.
  - Working on

Example of results: channel 2





Inter-satellite Bias for ch8