Evaluation of IASI and AIRS Spectral Radiances using Simultaneous Nadir Overpasses

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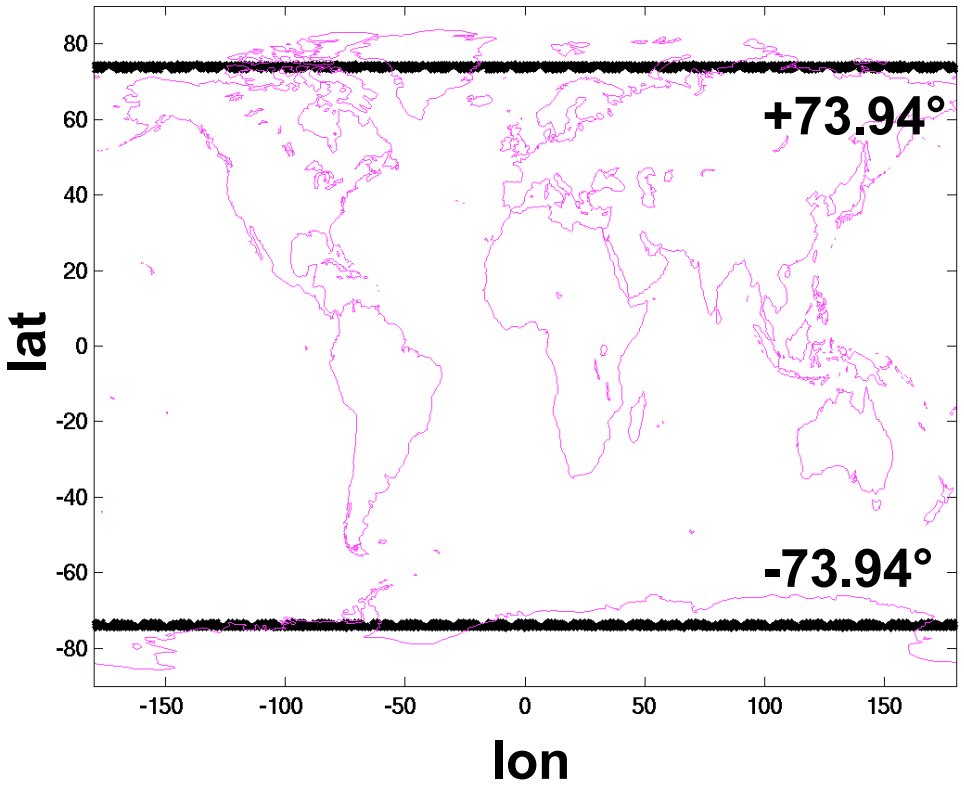
SNOs

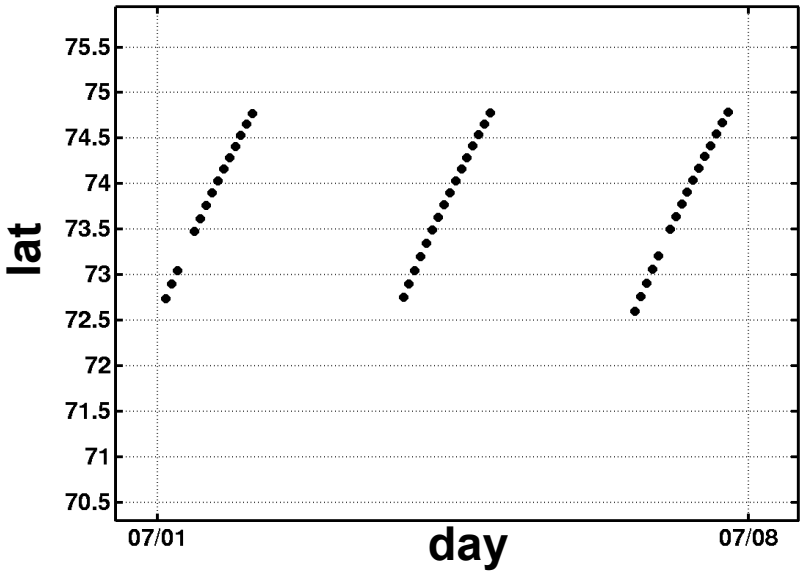
- “Simultaneous” “Nadir” Overpasses of AIRS and IASI
- SNOs based on the intersections of nadir ground tracks of METOP-A and Aqua (i.e. exact SNO locations)
- IASI and AIRS FOV selections for each SNO:
  - Time window: +/- 20 min from SNO time
  - Spatial window: 60 km from Nadir track intersection point to center of IASI/AIRS FOVs
- Resulting in:
  - ~45 AIRS FOVs, ~16 IASI FOVs per SNO
  - ~32 SNOs every ~3 days (16 North, 16 South)
  - 8102 SNOs in this study, covering May 2007 to Nov 2009

SNO characteristics

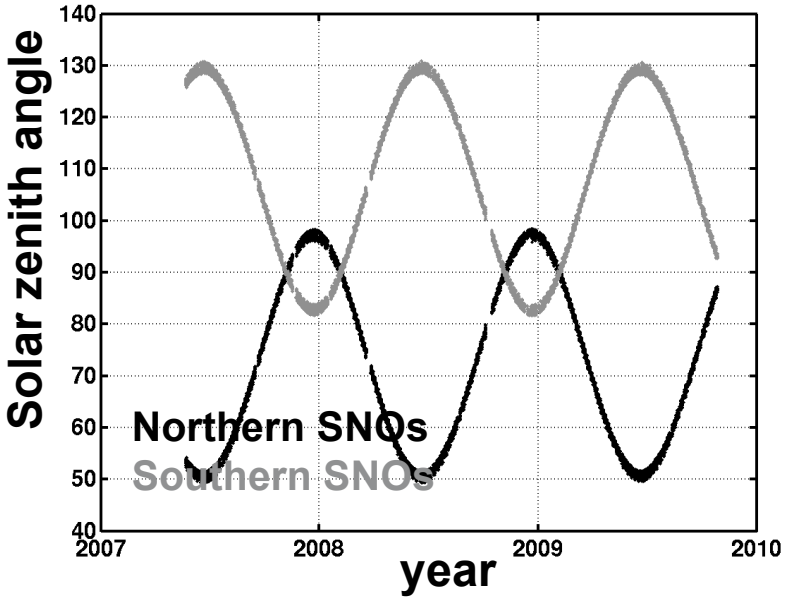
locations



timing

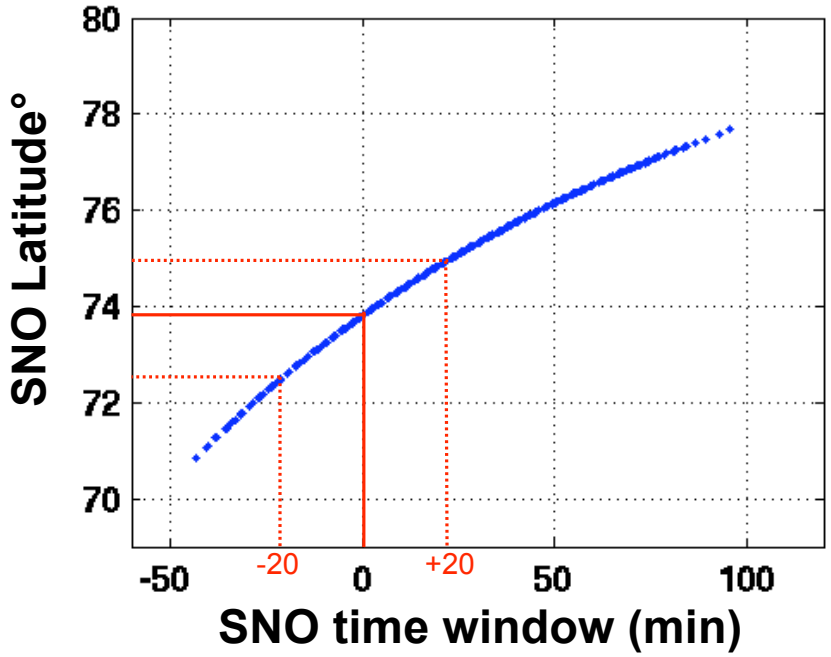


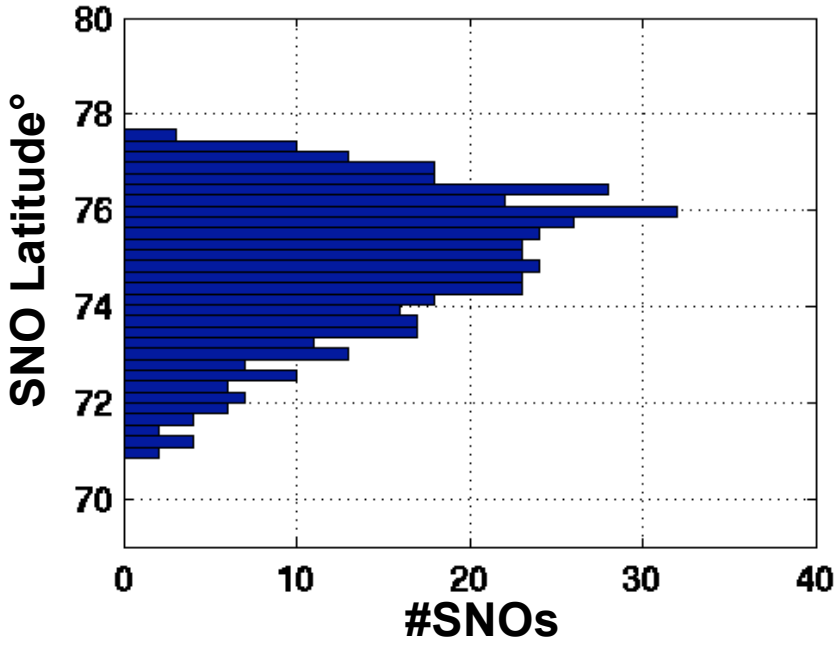
seasons



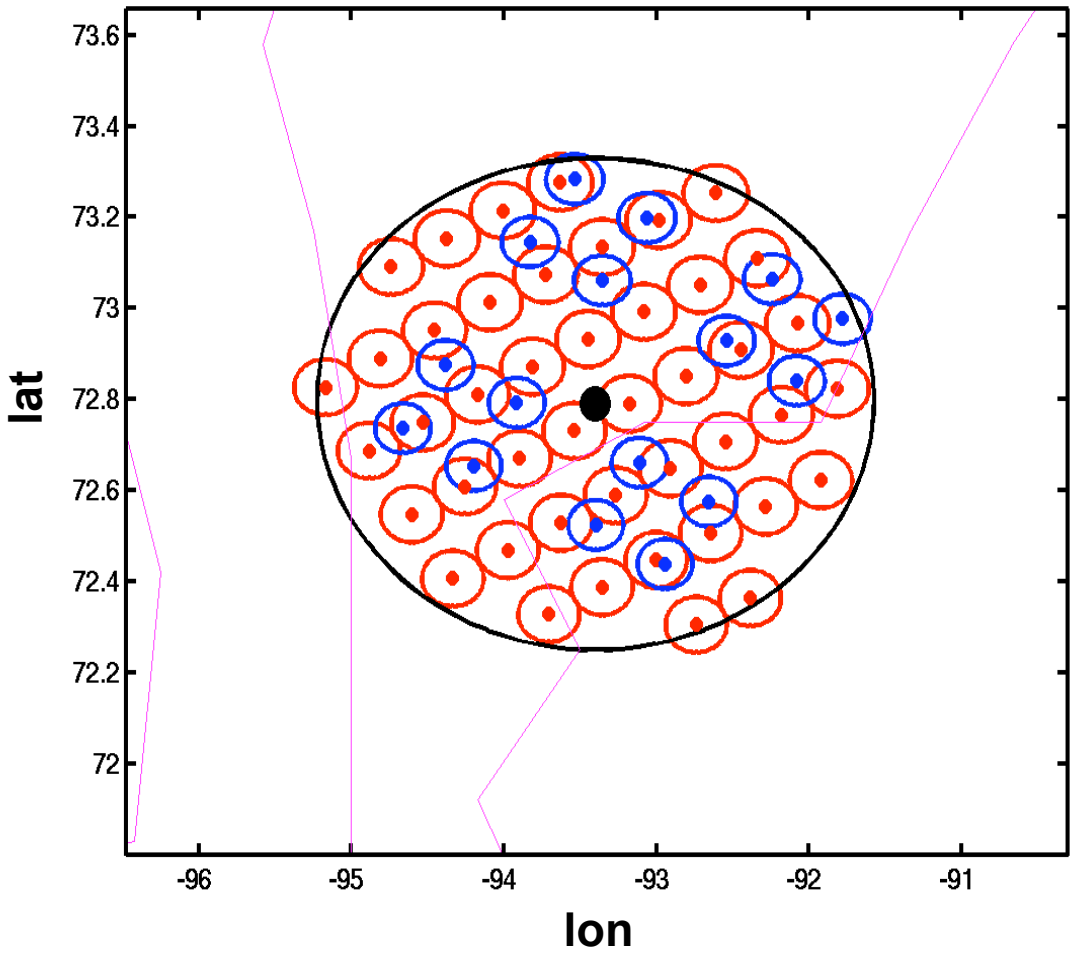
SNO Time Window

May 2007





Sample SNO

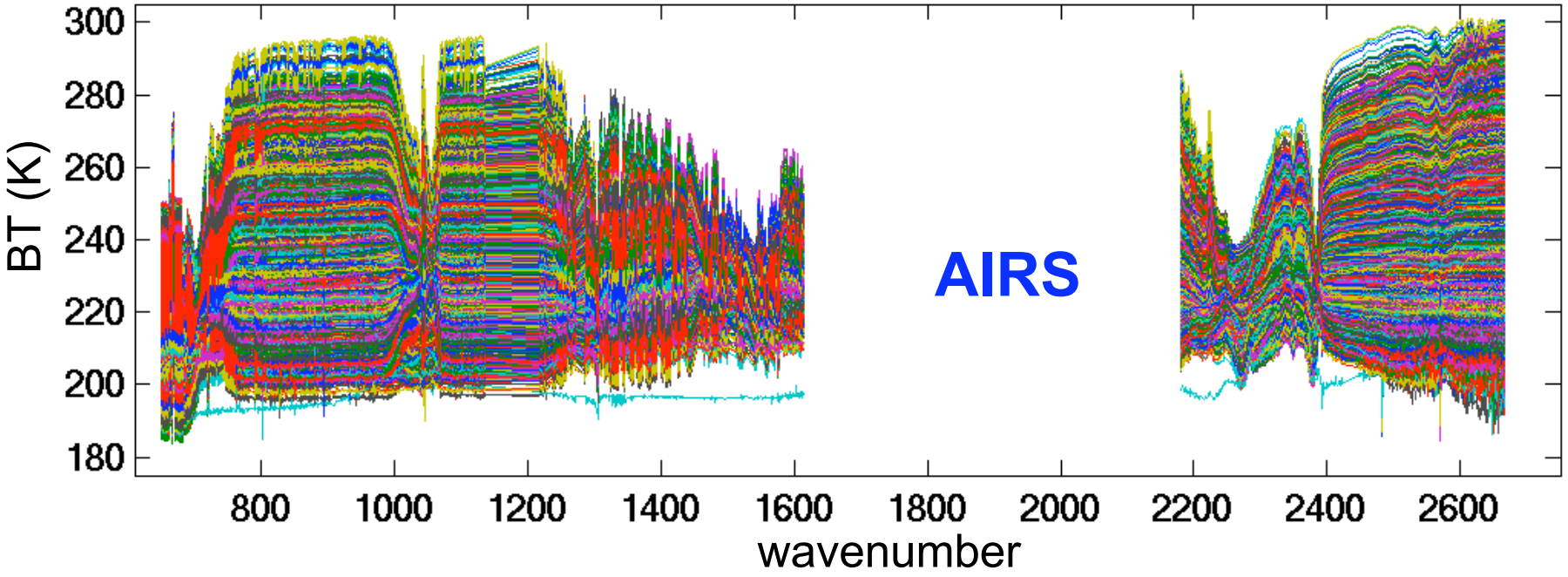


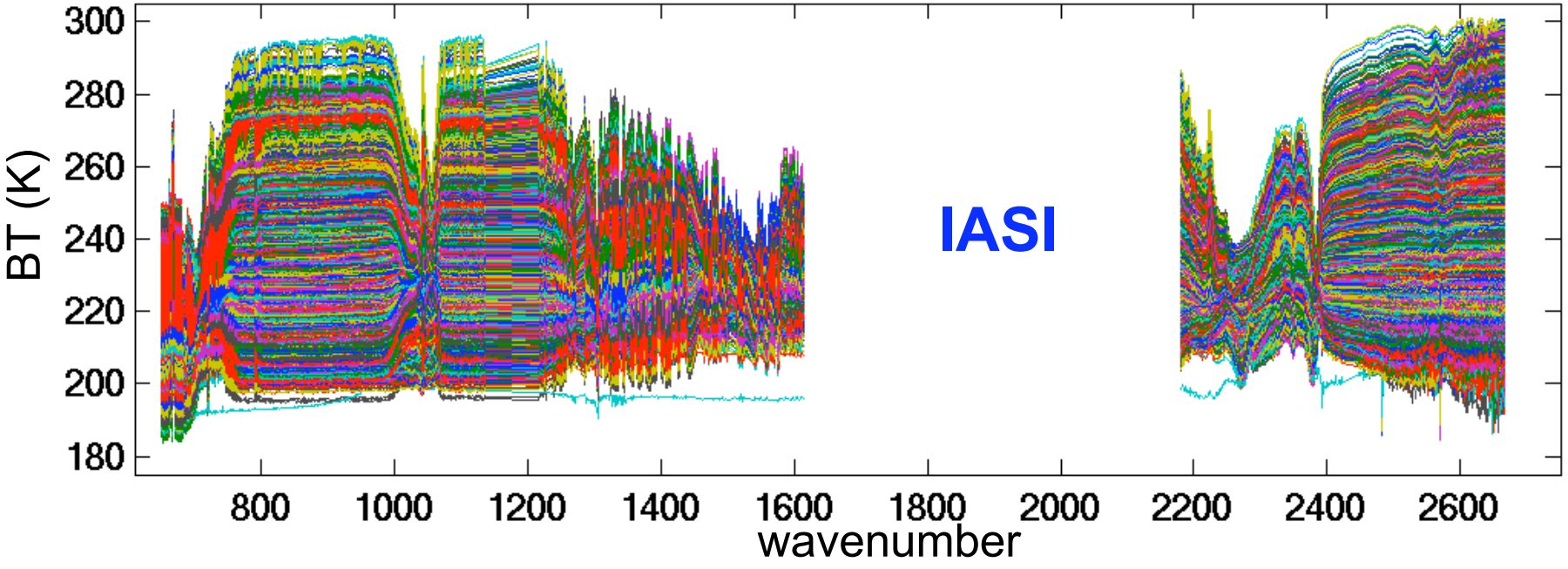
Nadir track intersection location and 60 km radius

AIRS FOVs (L1B v5.0.0.0)

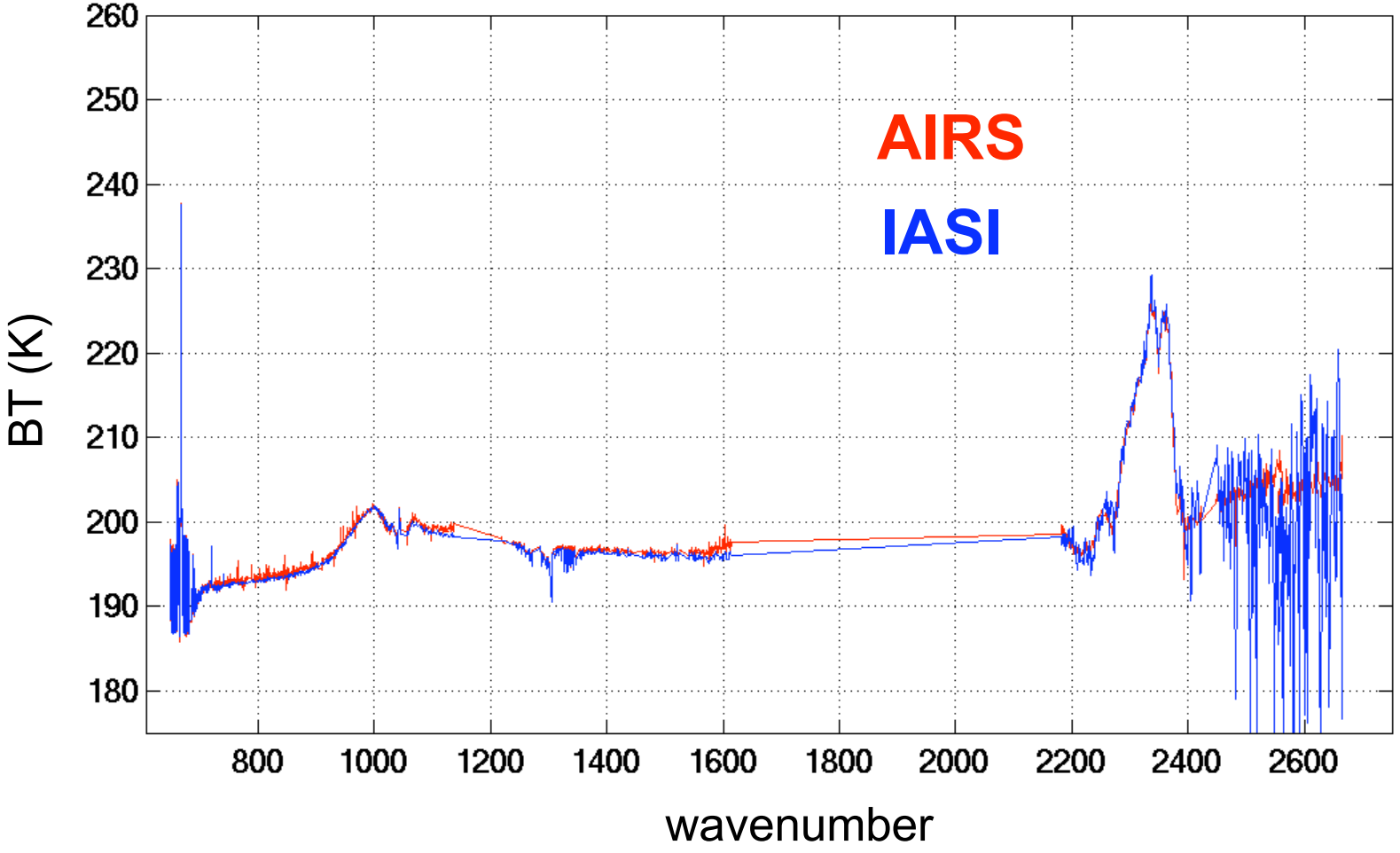
IASI FOVs

Mean Spectra



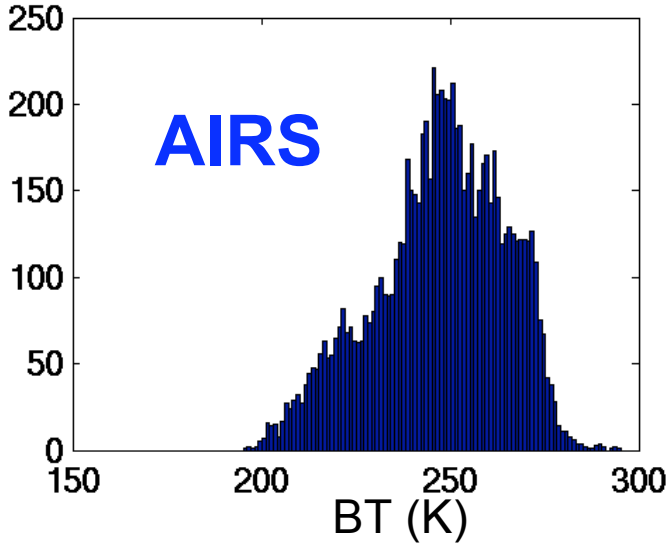


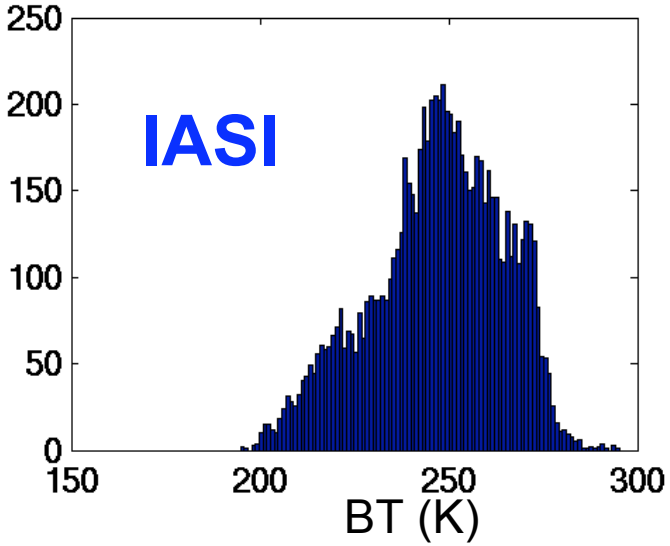
Coldest Spectrum of the set

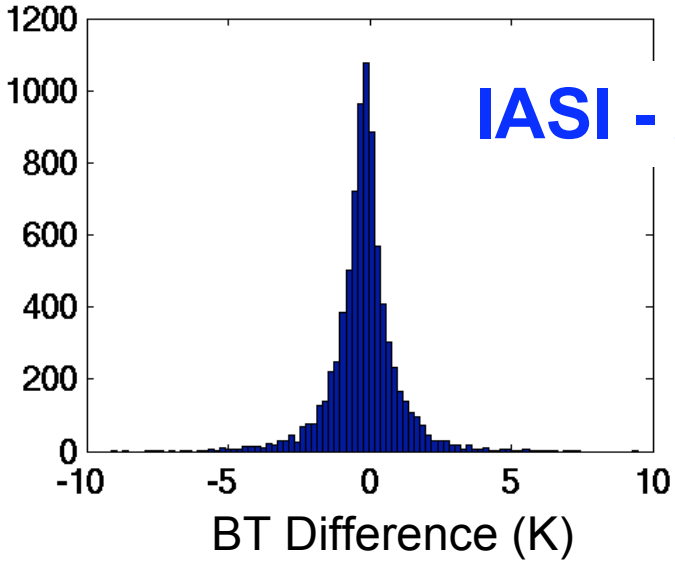


17 Jul 2008 21:30:03 @ 32.58°/-73.47°

Sample spectral channel, 900.3 cm^{-1}

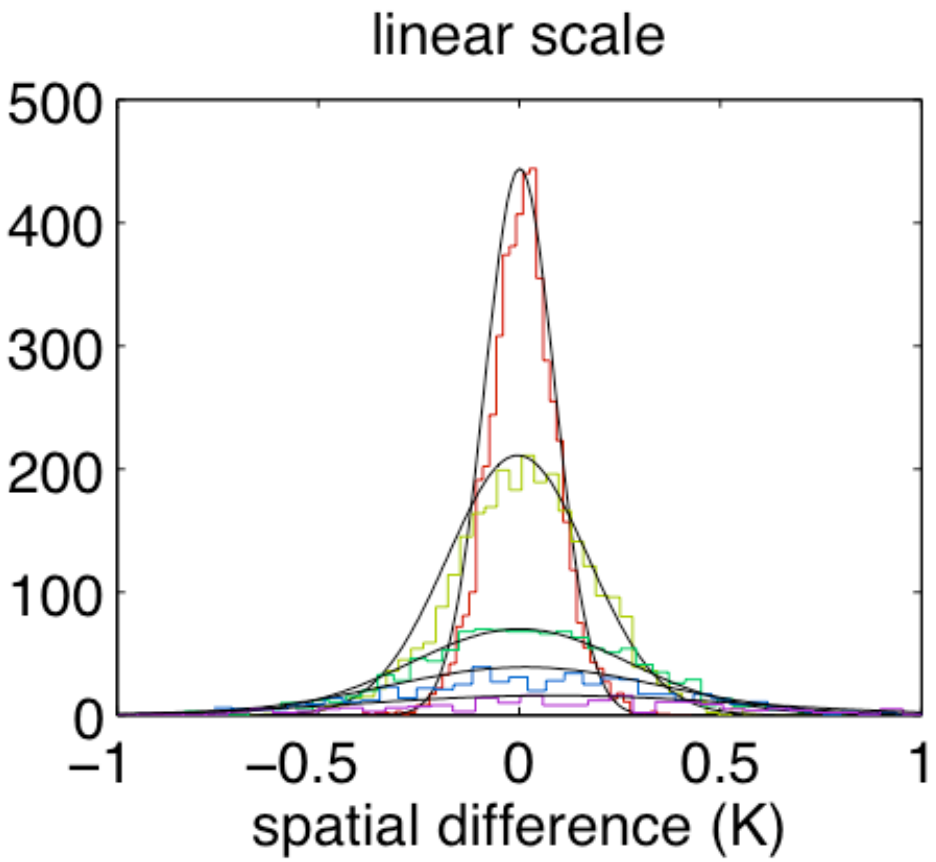


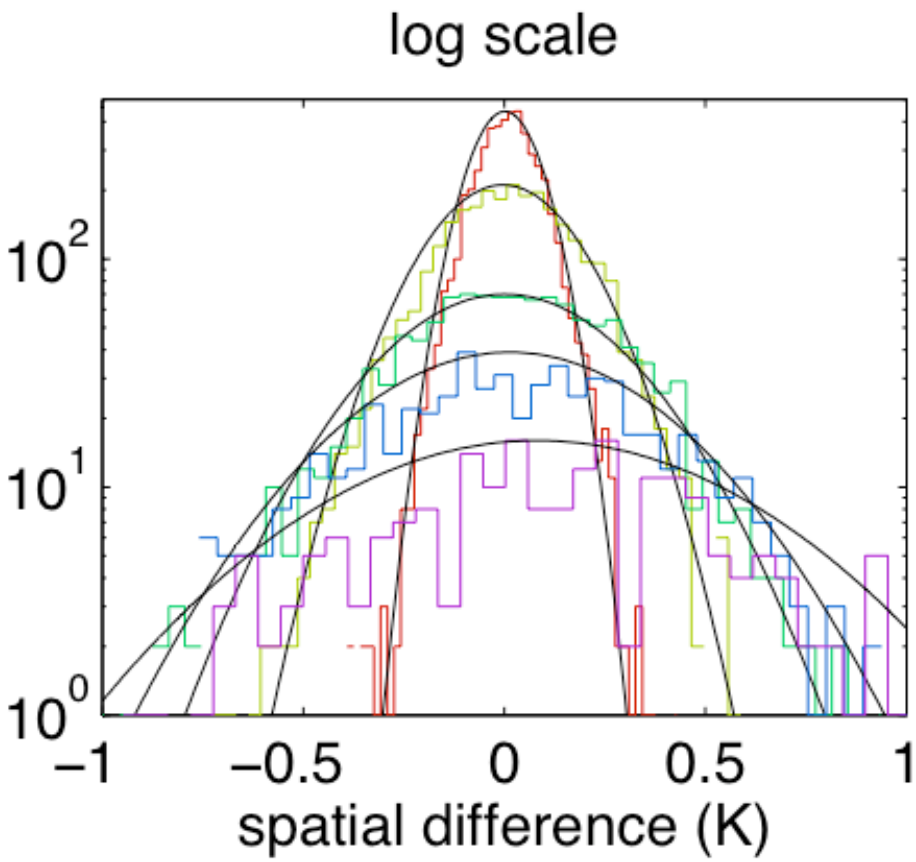




Spatial Sampling Differences

MODIS Band 31@11μm; 100km CLARREO FOVs every 14s; CrIS/AIRS





1 ≤ STDEV ≤ 2 (5074 pts, stdev=0.08)
3 ≤ STDEV ≤ 4 (2783 pts, stdev=0.18)
5 ≤ STDEV ≤ 6 (1179 pts, stdev=0.27)
7 ≤ STDEV ≤ 8 (563 pts, stdev=0.34)
9 ≤ STDEV ≤ 10 (211 pts, stdev=0.47)

Yes, Gaussian.

Analysis Approach

- For each SNO, the AIRS FOVs within 60 km of the SNO location are identified and the mean (MN) and standard deviation (SD) radiance spectra are computed. The same is done for IASI.
- For each SNO, the spectra are processed to have common spectral resolution and sampling and the difference between AIRS and IASI is computed

  $\delta_i = MN'_{AIRS,i} - MN'_{IASI,i}$
- The resulting primary source of comparison error for each SNO case is due to the difference in the sparse sampling of the scene radiance provided by AIRS (nearly contiguous 3x3 FOVs) and IASI (non-contiguous 2x2 FOVs). The 1-sigma uncertainty for each SNO case is therefore computed as

  $\sigma_i = [SD'^{2}_{IASI,i} + SD'^{2}_{AIRS,i}]^{1/2}$
- For ensembles of SNOs, the spatial sampling differences are found to be random from case to case. The mean differences between AIRS and IASI and their uncertainties are computed using weighted mean differences using the spatial standard deviations to compute the weights for each case:

$$\text{Weights :} \quad \omega_i = 1/\sigma_i^2$$

$$\text{Mean Difference :} \quad \Delta = \sigma_\Delta^2 \, [\Sigma_{i=1:N} \, \omega_i \, \delta_i]$$

$$\text{Uncertainty :} \quad \sigma_\Delta = [\Sigma_{i=1:N} \, \omega_i]^{-1/2}$$

Datafiles

SNO files, HDF format, 1 file per SNO
Sample content:

fileName: 'SNO_20070522_1759.hdf'
SNO_Latitude: 72.79
SNO_Longitude: -93.4
IASI_Wavenumber: [1x8461 double]
IASI_Latitude: [4x4 double]
IASI_Longitude: [4x4 double]
IASI_Zenith: [4x4 double]
IASI_Azimuth: [4x4 double]
IASI_UTC: [4x1 double]
IASI_Radiance: [4x4x8461 double]
IIS_Latitude: [4x5x5 double]
IIS_Longitude: [4x5x5 double]
IIS_Image: [4x64x64 double]
AIRS_Wavenumber: [1x2378 double]
AIRS_Latitude: [1x62 double]
AIRS_Longitude: [1x62 double]
AIRS_scanang: [1x62 double]
AIRS_solzen: [1x62 double]
AIRS_Time: [1x62 double]
AIRS_Radiance: [62x2378 double]

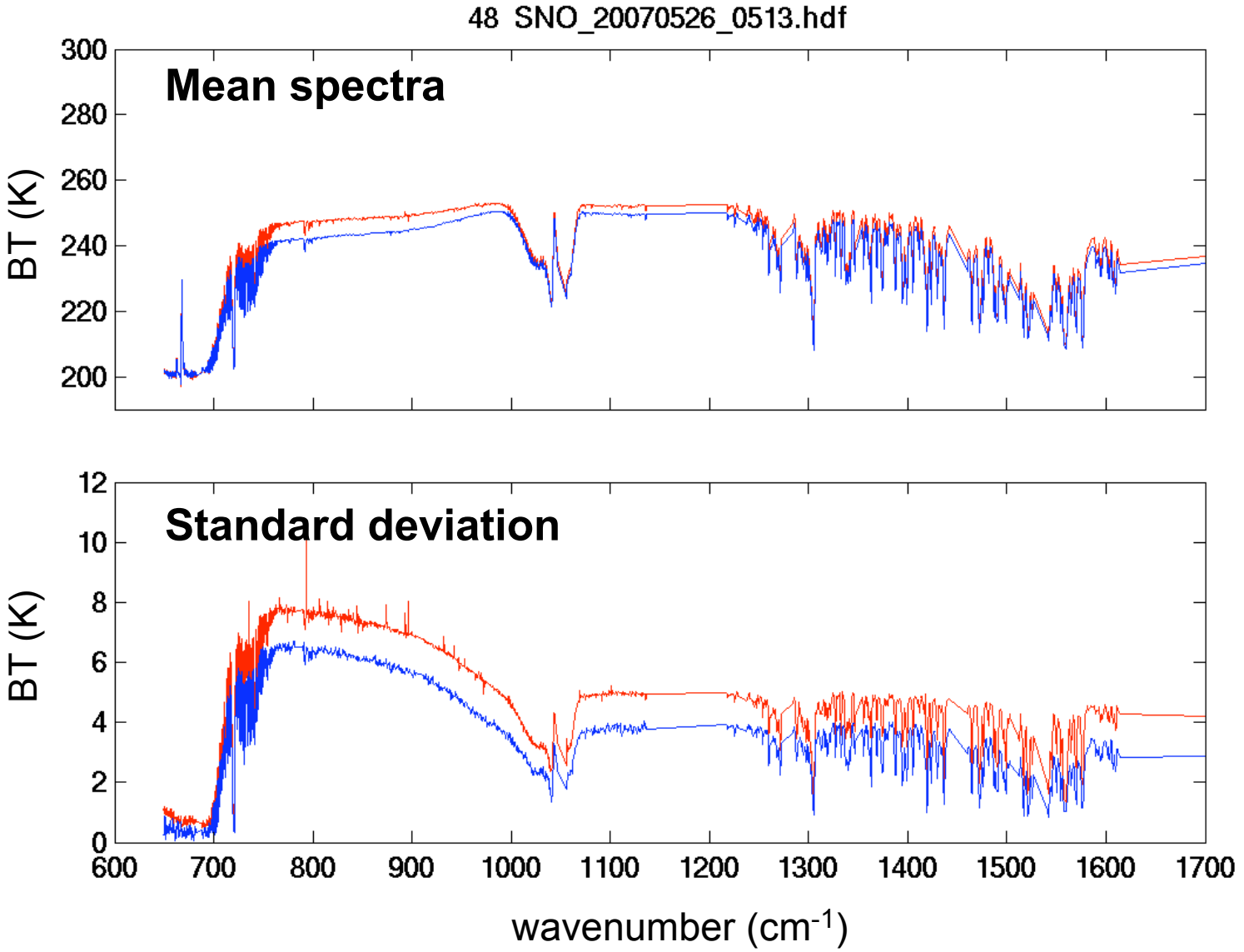
Accumulated results:

sno_lat: [8484x1 double]
sno_lon: [8484x1 double]
sno_dnum: [8481x1 double]

airs_mean_rad: [2378x8484 double]
airs_std_rad: [2378x8484 double]
airs_mean_bt: [2378x8484 double]
airs_btstd: [2378x8484 double]
airs_dnum: [8484x1 double]
airs_num: [8484x1 double]
airs_solzen: [8484x1 double]

iasi_mean_rad: [8461x8484 double]
iasi_std_rad: [8461x8484 double]
iasi_bt: [2378x8484 double]
iasi_btstd: [2378x8484 double]
iasi_dnum: [8484x1 double]
iasi_num: [8484x1 double]

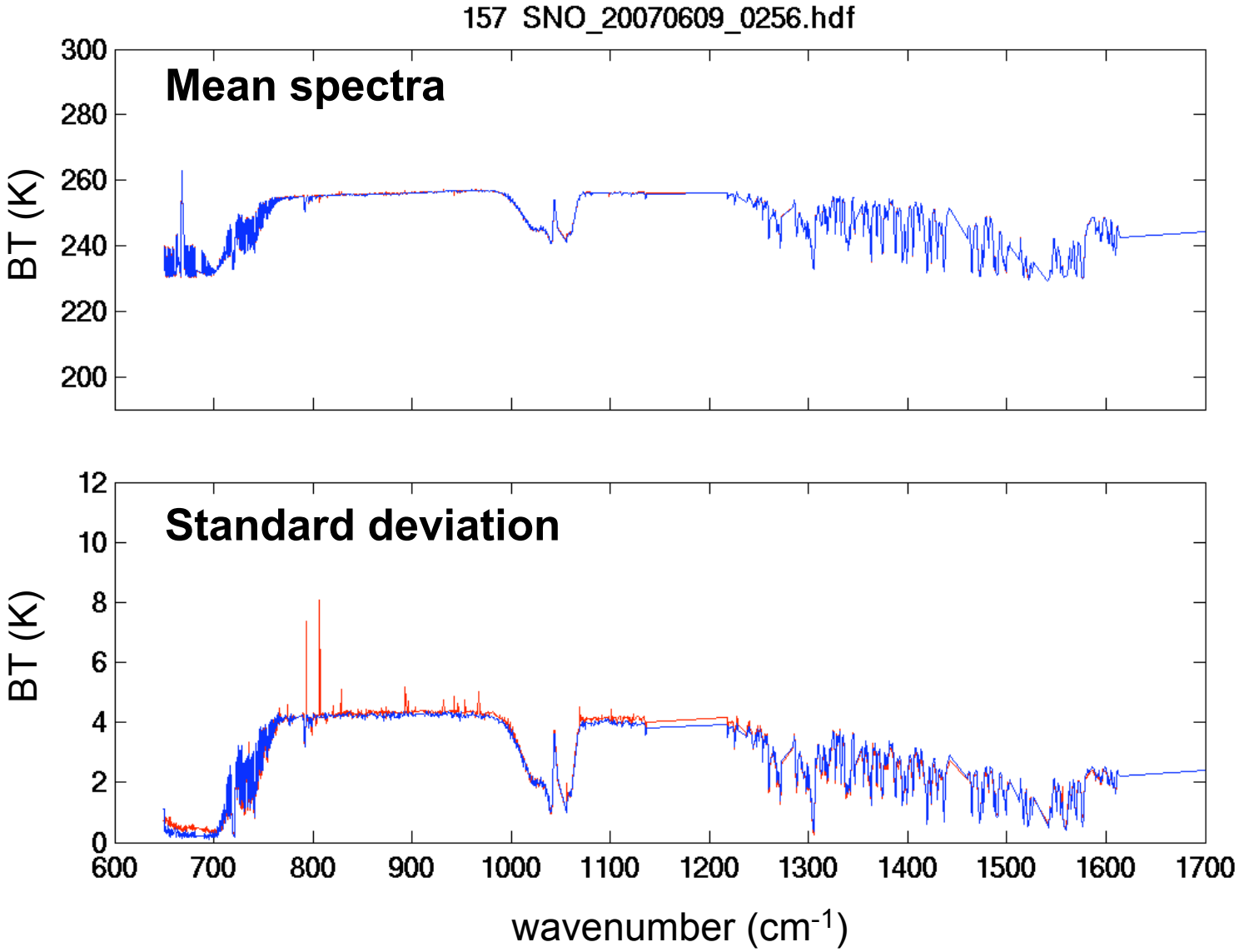
Sample SNO, #48



AIRS

IASI

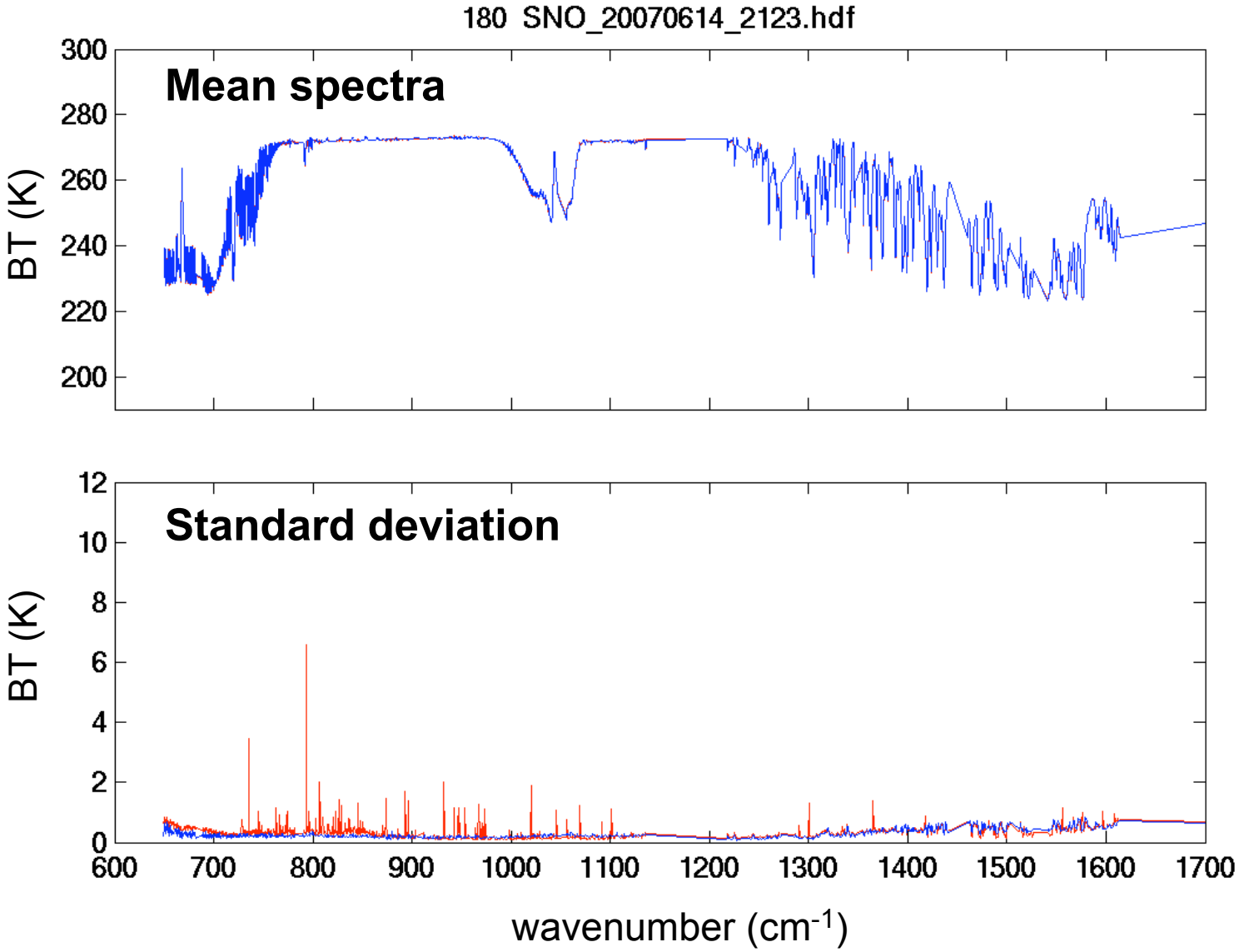
Sample SNO, #157



AIRS

IASI

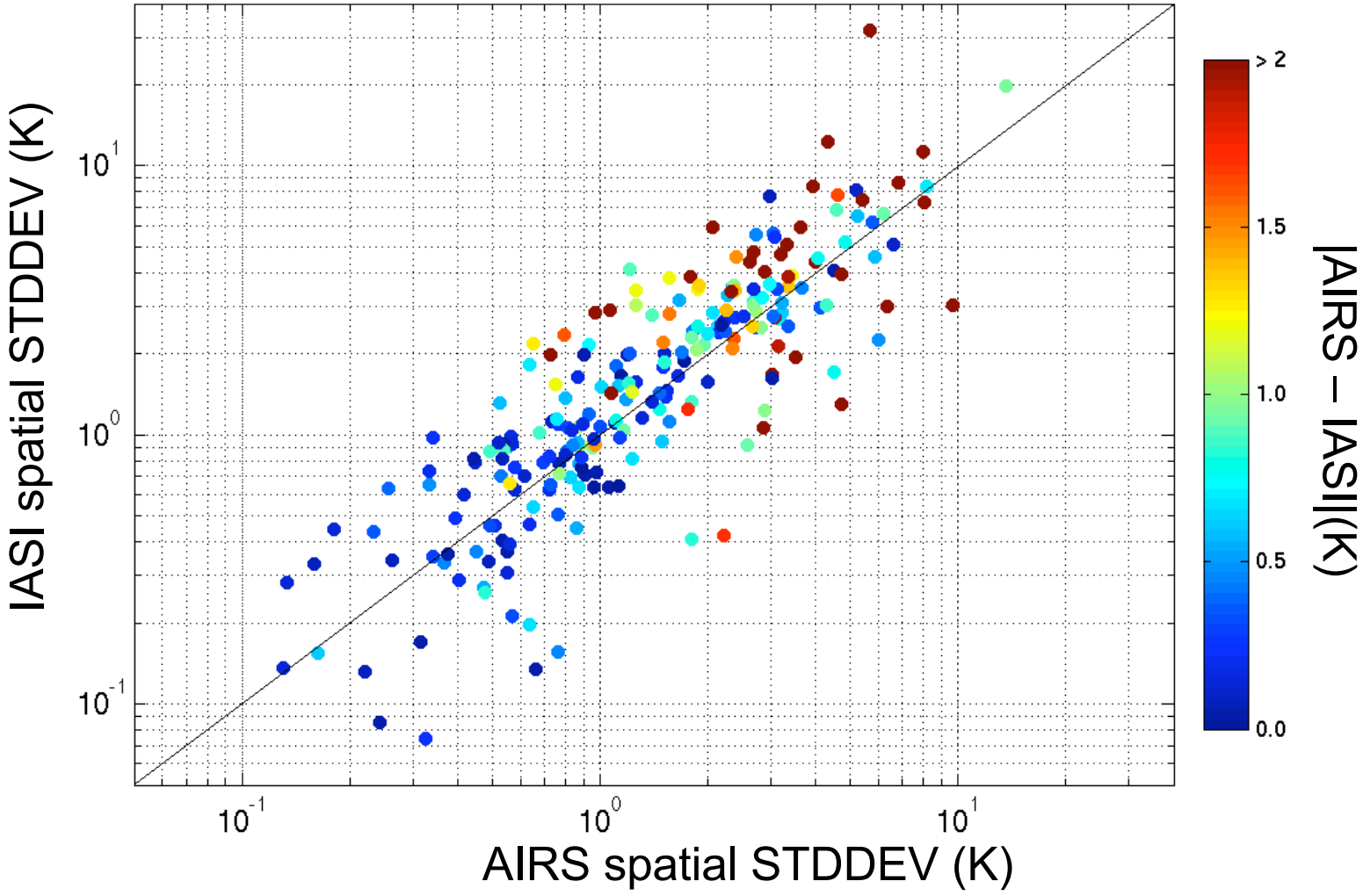
Sample SNO, #180



AIRS

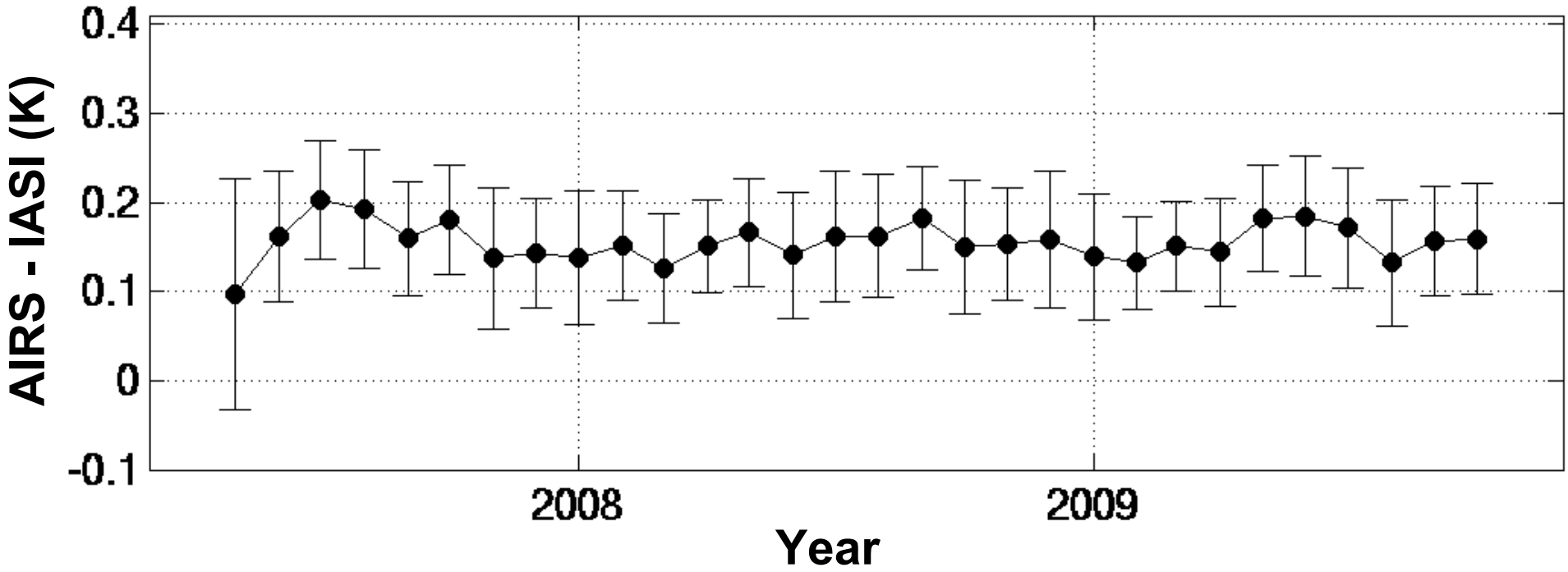
IASI

900.31 cm^{-1} channel differences as a function of IASI and AIRS spatial standard deviations



Time Series of Monthly Means

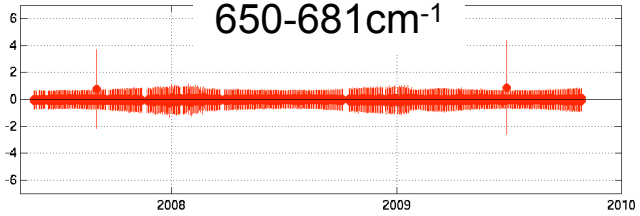
Module M-04b (1460-1527 cm^{-1})

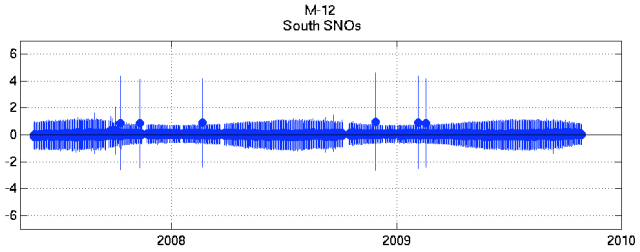


Mean difference is **150 mK (!)**

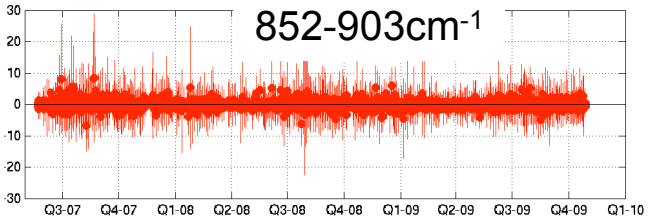
Slope is **0.9 +/- 5.6 (1 sigma) mK/year (!!)**

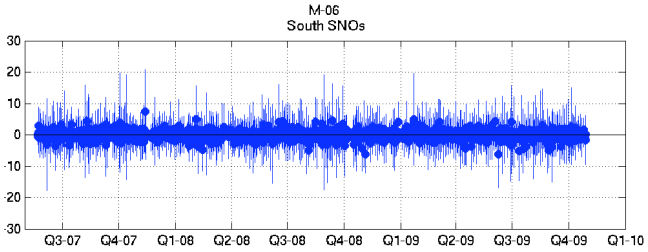
M-12
650-681cm^{-1}



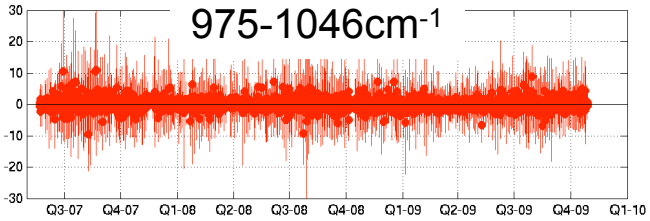


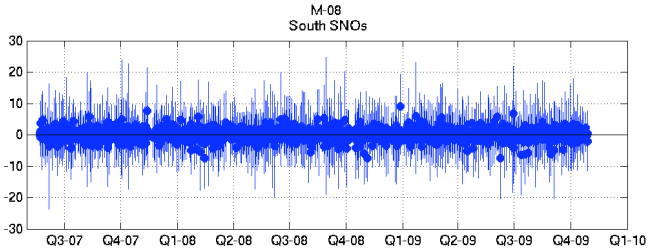
M-08
852-903cm^{-1}



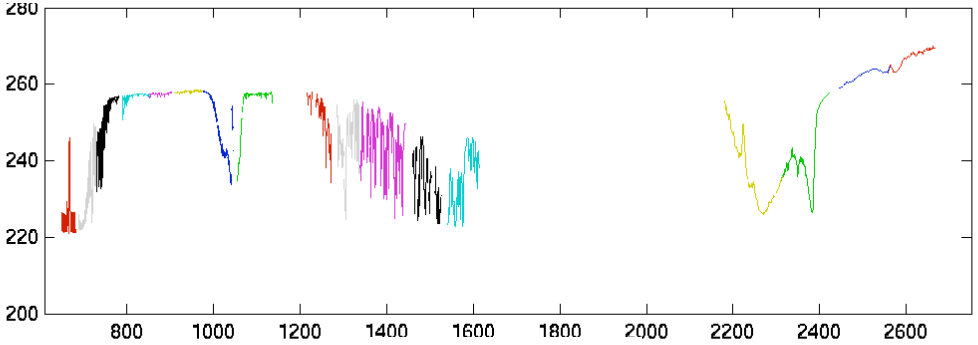


M-06
975-1046cm^{-1}



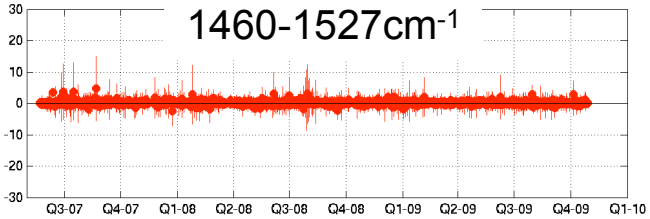


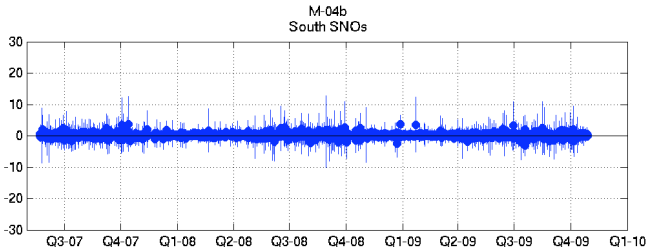
Time Series



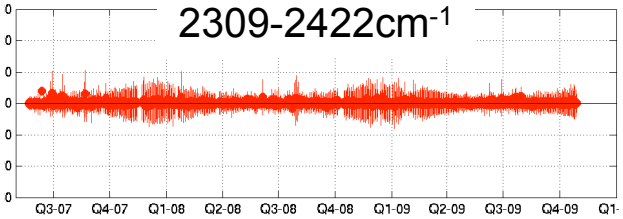
Preliminary:
Under investigation

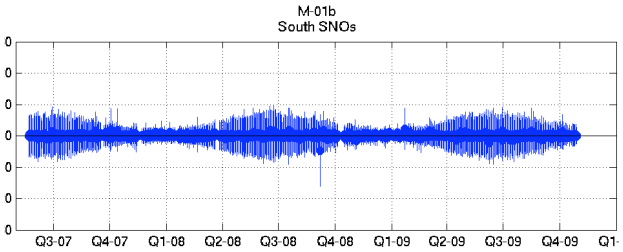
M-04b
1460-1527cm^{-1}



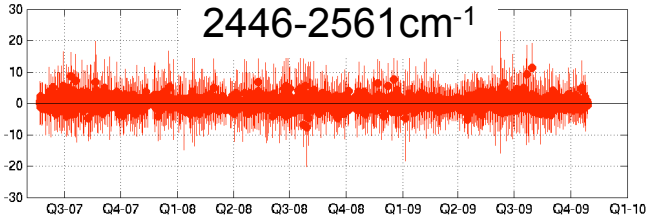


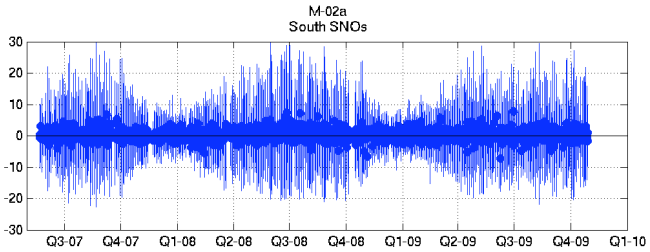
M-01b
2309-2422cm^{-1}

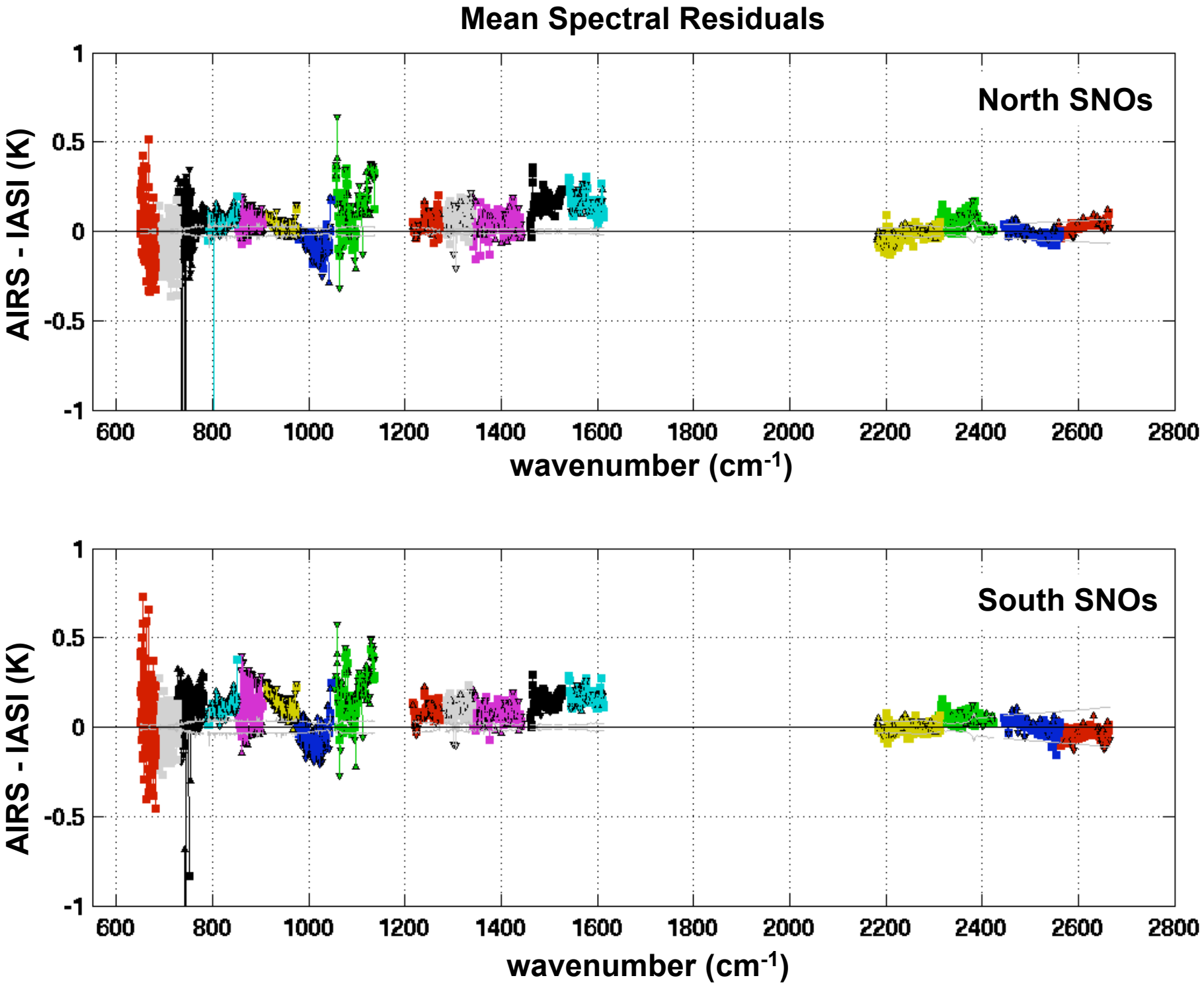


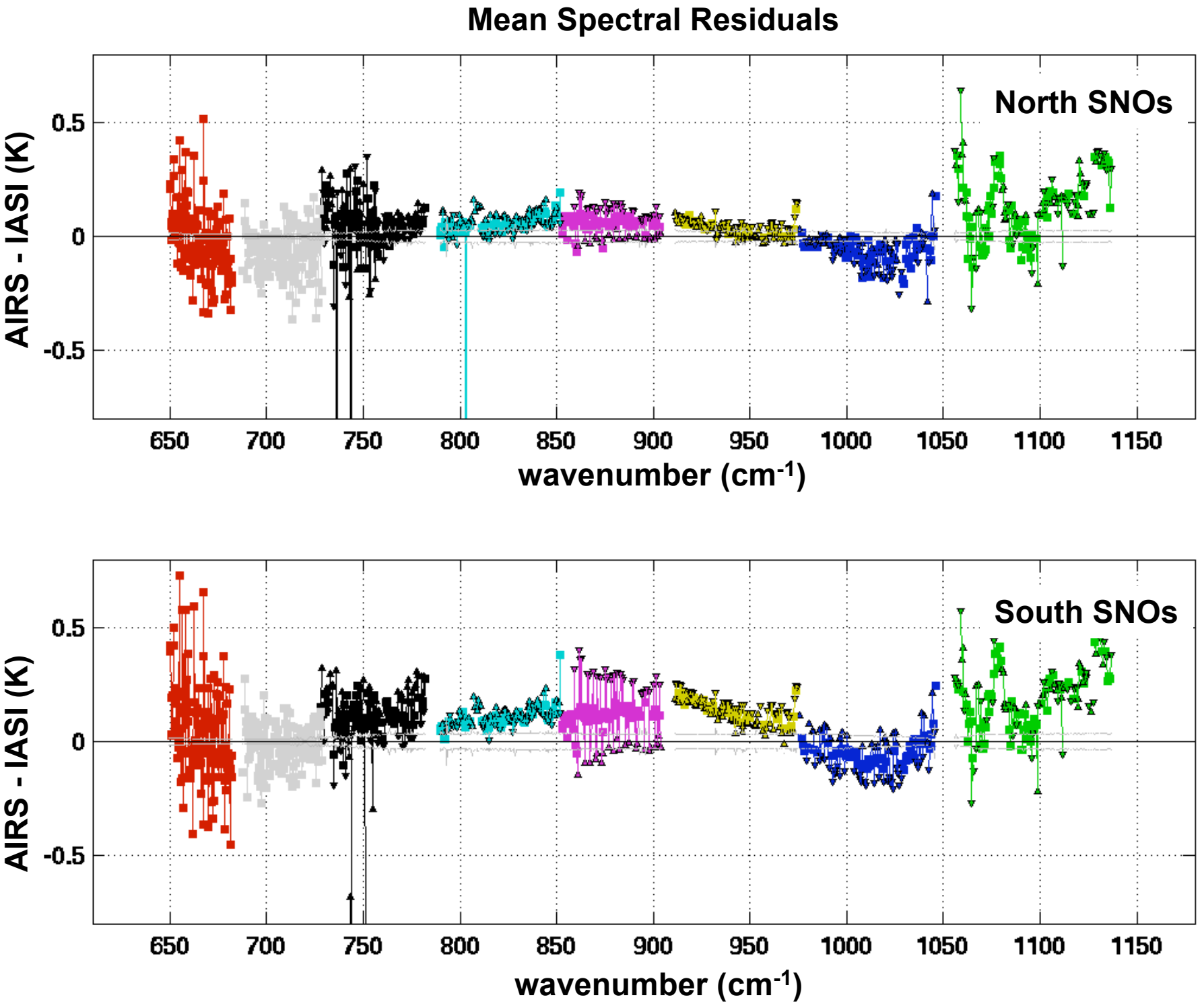


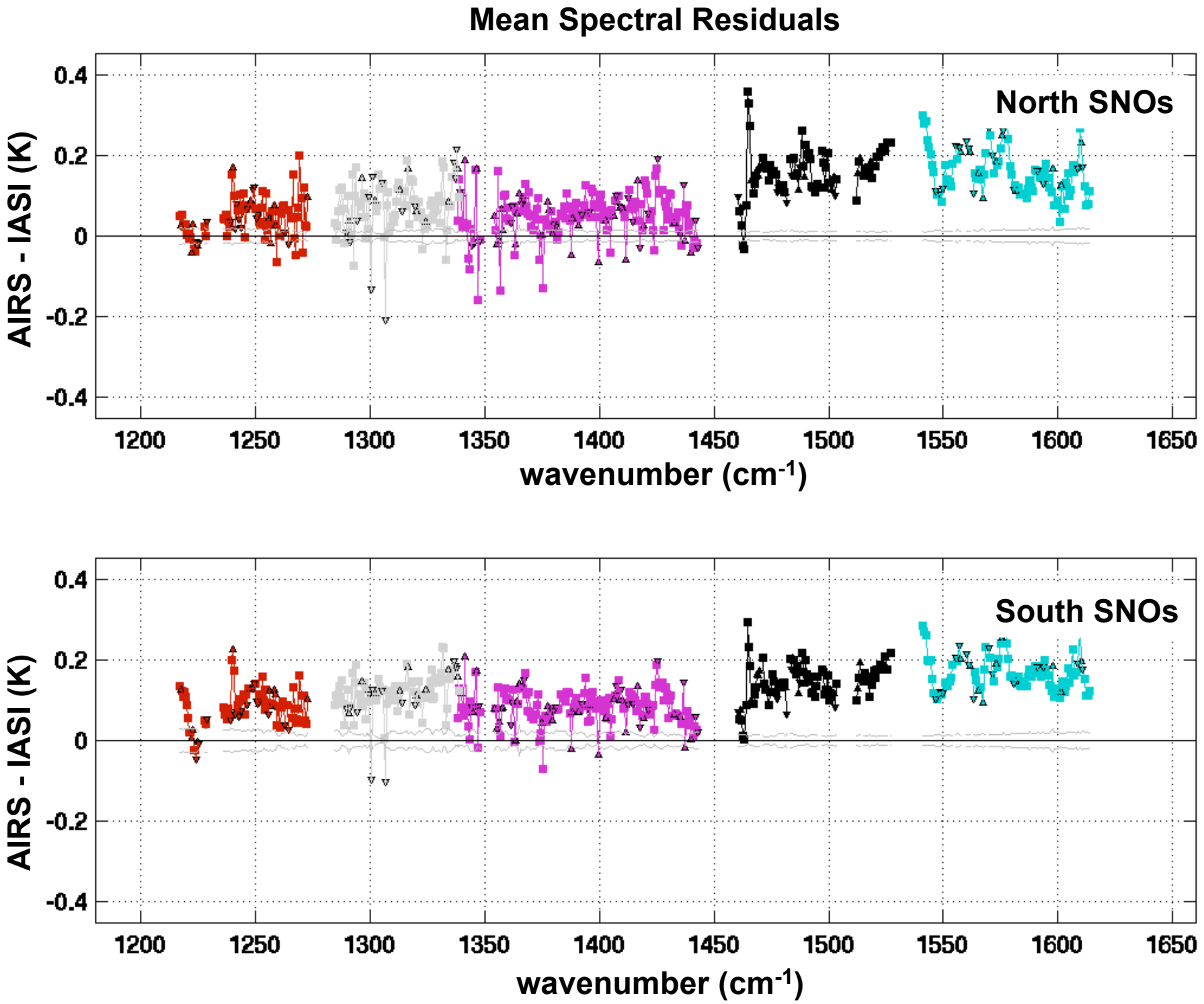
M-02a
2446-2561cm^{-1}

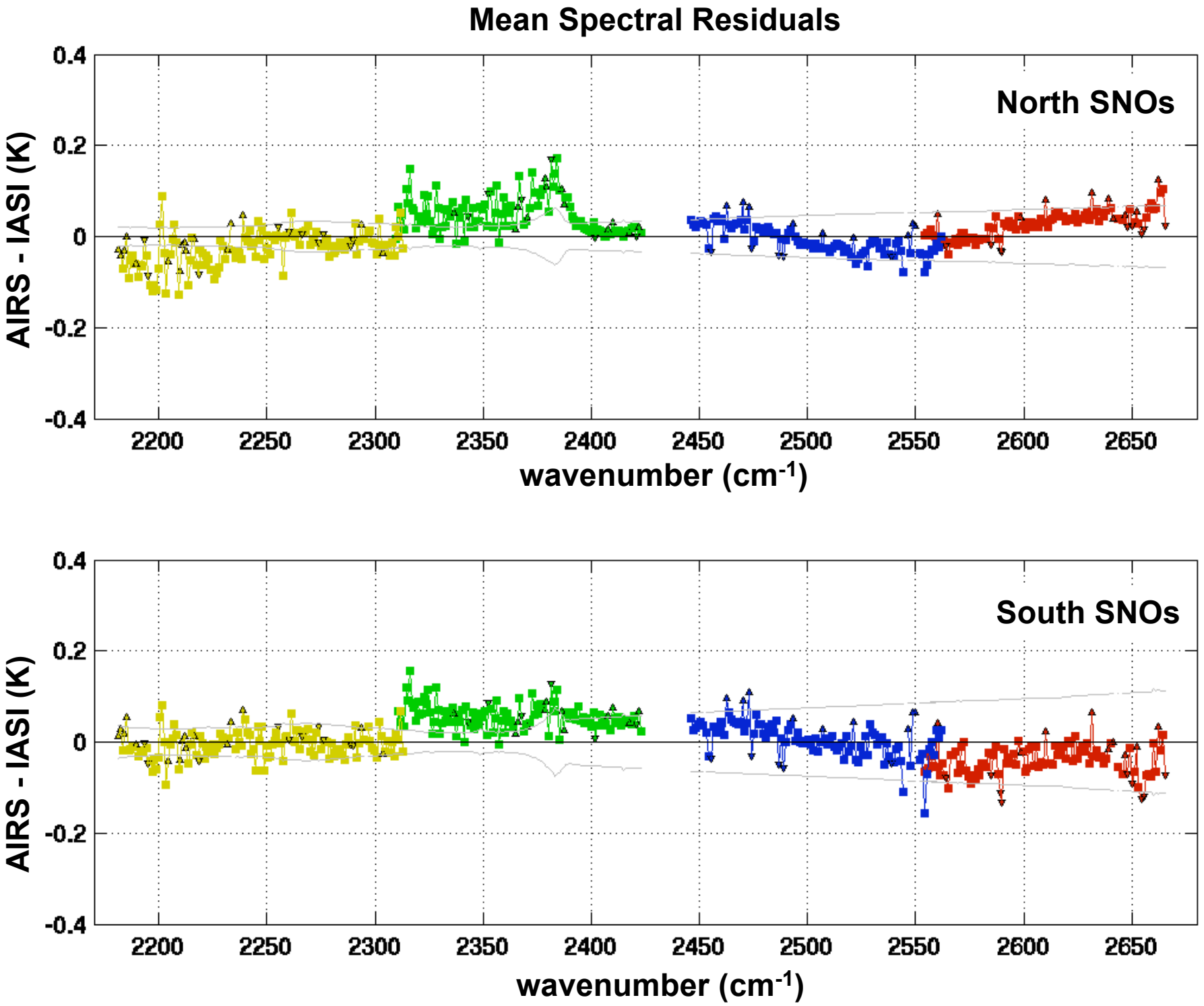





Mean Spectral Residuals
North SNOs
South SNOs
AIRS - IASI (K)
wavenumber (cm-1)
1
0.5
0
-0.5
-1
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800


Mean Spectral Residuals
North SNOs
AIRS - IASI (K)
0.5
0
-0.5
650
700
750
800
850
900
950
1000
1050
1100
1150
wavenumber (cm-1)
South SNOs
AIRS - IASI (K)
0.5
0
-0.5
650
700
750
800
850
900
950
1000
1050
1100
1150
wavenumber (cm-1)


Mean Spectral Residuals
North SNOs
South SNOs
AIRS - IASI (K)
0.4
0.2
0
-0.2
-0.4
1200
1250
1300
1350
1400
1450
1500
1550
1600
1650
wavenumber (cm-1)


Mean Spectral Residuals
North SNOs
South SNOs
AIRS - IASI (K)
wavenumber (cm-1)
0.4
0.2
0
-0.2
-0.4
2200
2250
2300
2350
2400
2450
2500
2550
2600
2650

Summary

- **SNOs provide a simple and accurate method to intercompare and evaluate IASI and AIRS, as well as other sensors.**

- **Mean differences between AIRS and IASI are generally on the order of a few tenth of degrees K or less. Various issues primarilly associated with the AIRS L1B processing could be investigated and refined to further improve the intercomparisons.**

- **Radiometrically, there are no significant long term changes in the SNO observed IASI-AIRS differences (slope vs time = 0.9 +/- 5.6 mK/year)**