Validation of AIRS V6 surface temperature over Greenland with GCN and NOAA stations

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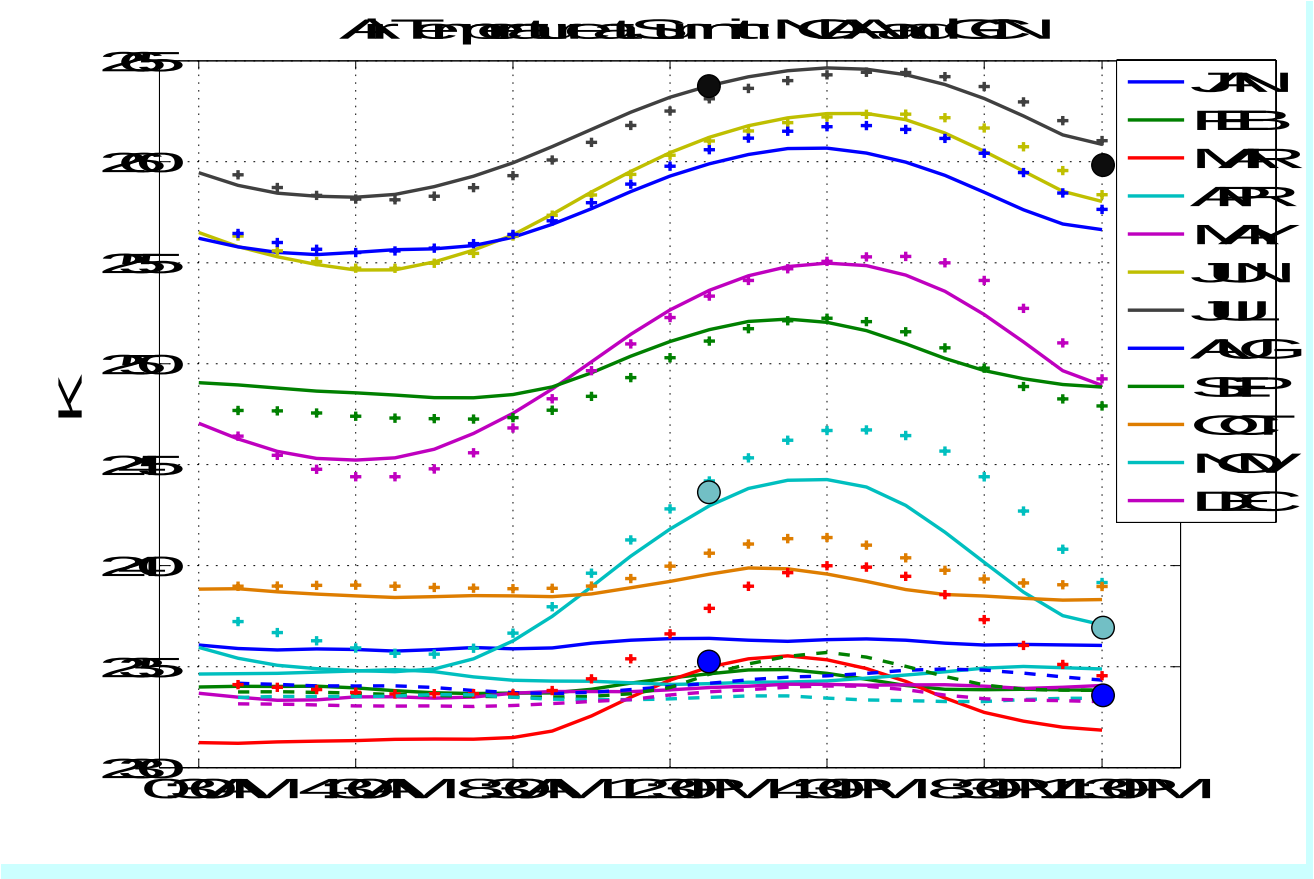
Why global skin temperature? Why Greenland? Why Summit?

- Satellite can measure skin temperature (i.e., AIRS and MODIS) all over the Greenland and globe, but only at 1:30AM/PM or daily.
- Summit stations provide quality hourly data but have limited coverage.
- Station data are Invaluable for validation of satellite observations.
- Comparison allows the detection of instrument drifts and the examination of calibration consistency.

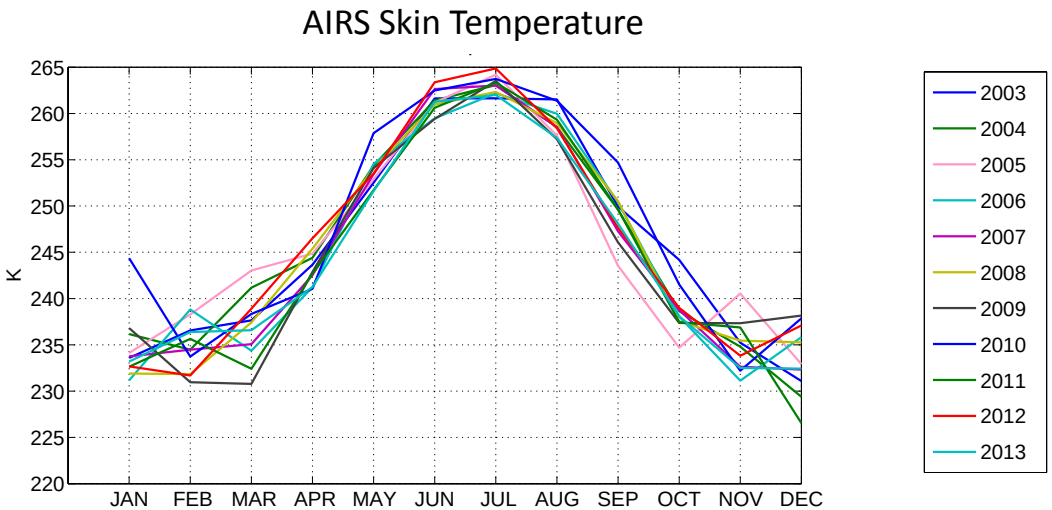
Diurnal Differences at Summit

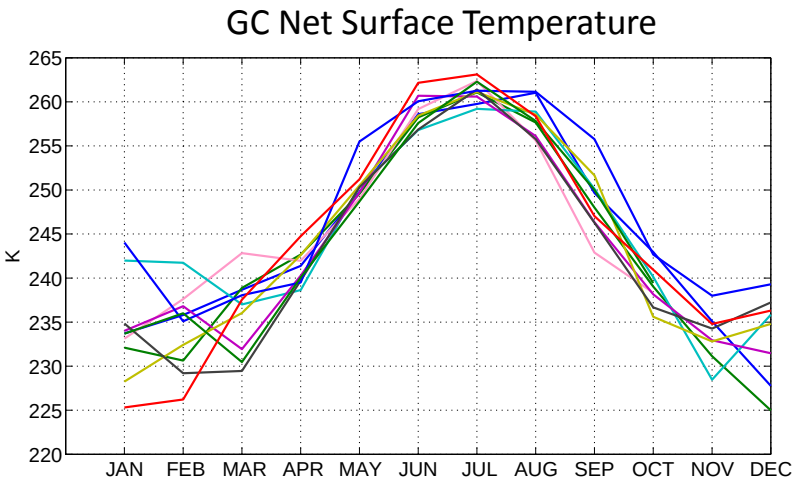
Largest diurnal variation occurs during spring (Apr-May), while largest interannual variation occurs in January.

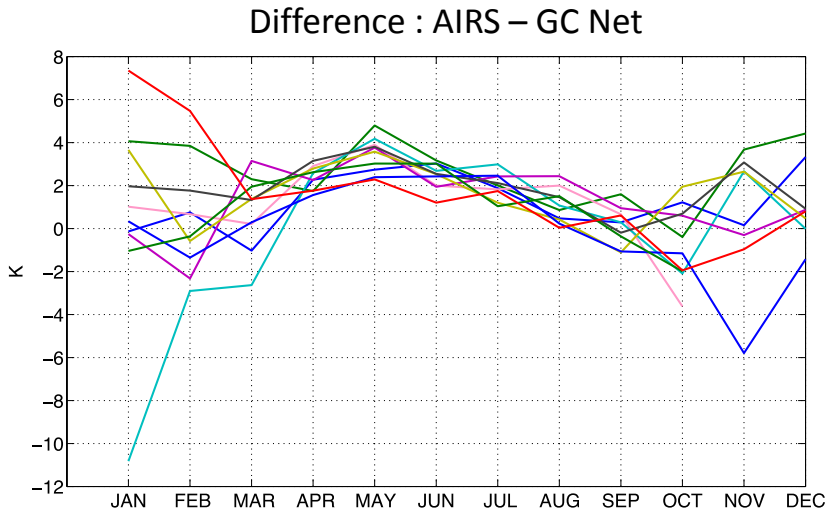
AIRS (2002-2013) GCN (2002-2013) NOAA (2009-2013)



Seasonal variation of T at Summit



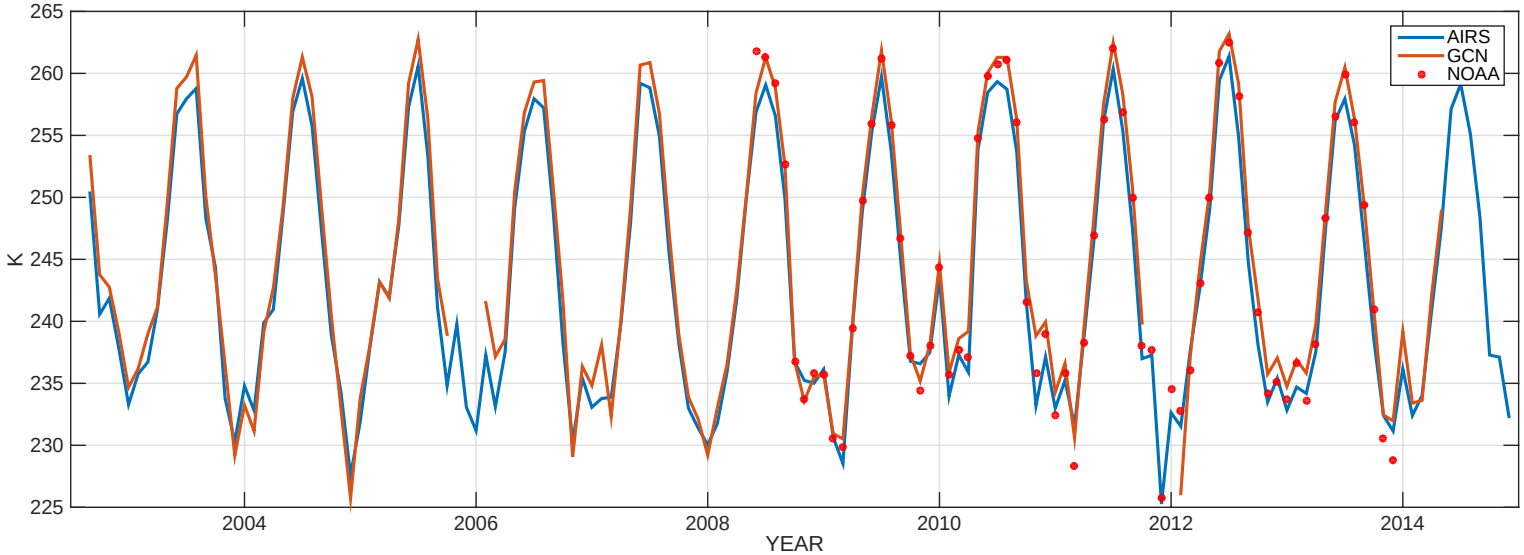




- Surface skin temperature is highest in July, but interannual variability is largest in January

Monthly variation of Ts

Summit Station

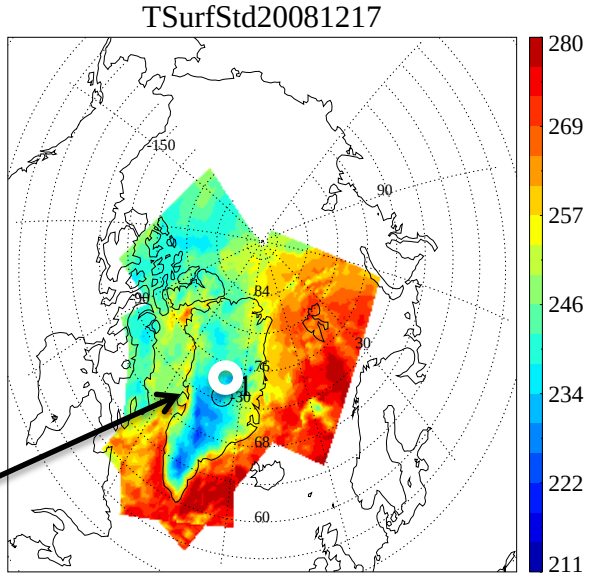


Station	Mean (K)	Std	Bias (AIRS-GCN)	RMS
Tunu-N	244.28 (251.29)	11.28 (10.28)	-1.75 (1.54)	2.01 (3.15)
NASA-E	245.51 (246.84)	10.03 (10.96)	0.26 (1.56)	1.02 (1.79)
Summit	243.09 (248.85)	9.84 (9.86)	-1.40 (3.01)	2.00 (3.26)
South Dome	253.39 (257.00)	8.01 (8.16)	-0.79 (2.68)	2.00 (3.01)

Motivation

- AIRS surface temperature observations are valuable for cross validation of current and up-coming campaigns.
- AIRS observations can be used to investigate regions that do not have in-situ measurements.
- We use AIRS Level2 observations to reduce the sampling biases
- MERRA (and MERRA2) can provide additional validation and observations

Typically there are 4 matchups per day within 30km and within 30min.



GC-Net and NOAA station at Summit

Match-up Experiment
2009 (one year)

1. AIRS surface skin and air temperatures

- All AIRS observations within 30km of a point between both summit stations
- Variables : Surface skin temperature (TSurfStd), surface air temperature (TSurfAir), surface pressure (PSurfStd). In the future we will ad other variables such as relative humidity, cloud fraction, OLR, as well as profile data.

2. GCN and NOAA station temperatures

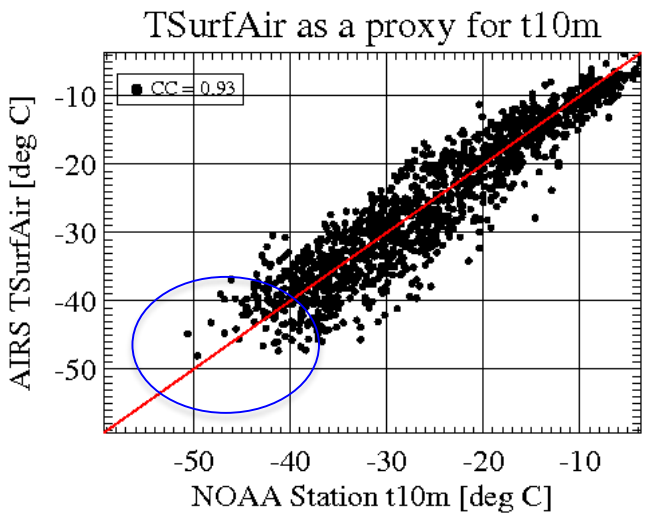
- There are two stations at Summit :
  Greenland Climate – Network (GCN), and NOAA stations ~2 miles apart.
- Each station provides T at 1m, 2m, 10m, Ps, etc, at each hour.

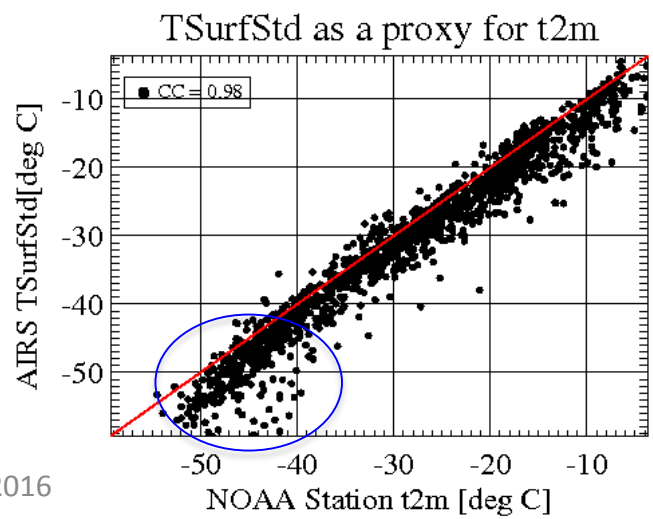
3. MERRA AIRS like sampled 2m temperature

- MERRA is sampled like AIRS (sun-synchronous), using AIRS V6 quality criteria (MSAQC).

AIRS comparison with NOAA Station temperatures

- In general, the AIRS correlates well with NOAA station data, but bias is most prominent during the cold season.





- The AIRS variable TSurfAir is based on the temperature profile extrapolated to the surface pressure.

- TSurfAir matches better with the station 10-meter temperature than the 2-meter temperature.

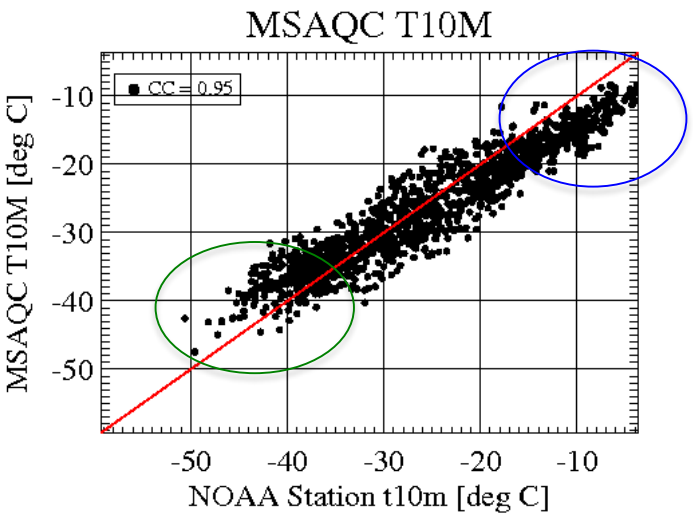
- Since AIRS does not measure the 2-meter temperature we compare the AIRS surface skin temperature to the station 2 meter temperature. The bias is probably due to a persistent temperature inversion at the station.

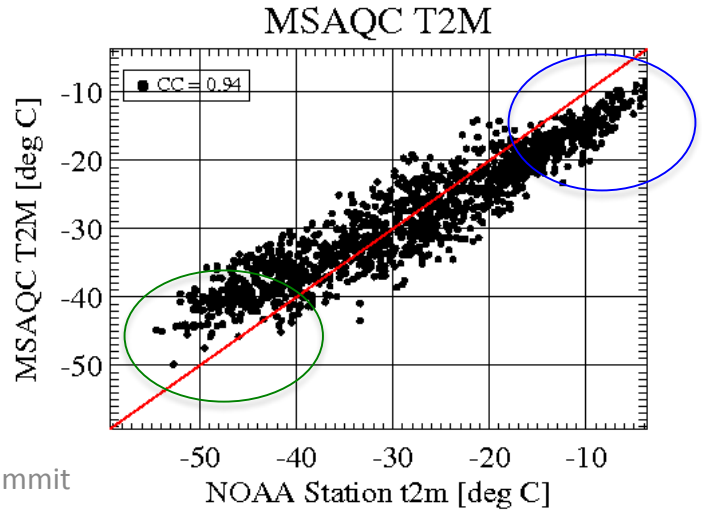
MERRA comparison with NOAA Station temperatures

In general, the correlation is good, but MERRA is warmer than the station in the cold season and colder than the station in the warm season.

- MERRA is sampled like AIRS quality controlled (MSAQC) observations within 1 deg and 30 min.

- A possible explanation is that the MERRA Ts is overly constrained by the 2-m deep sub-surface temperature of 230K (-43C).

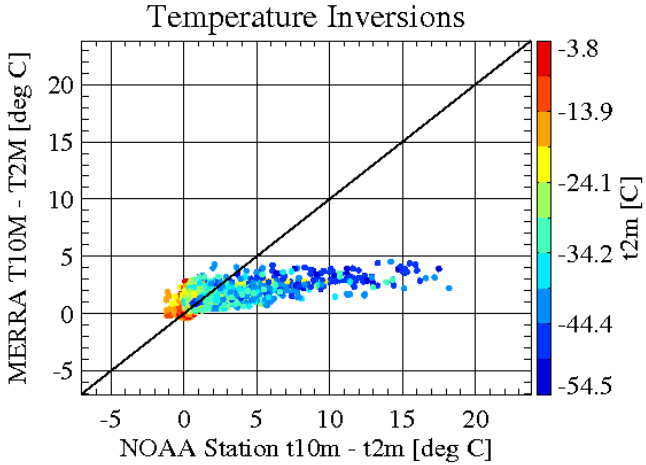


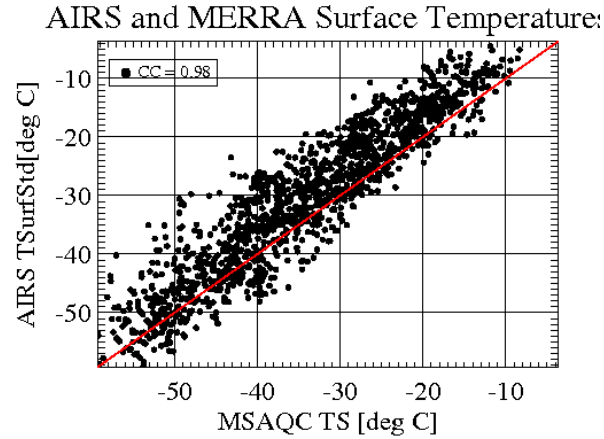


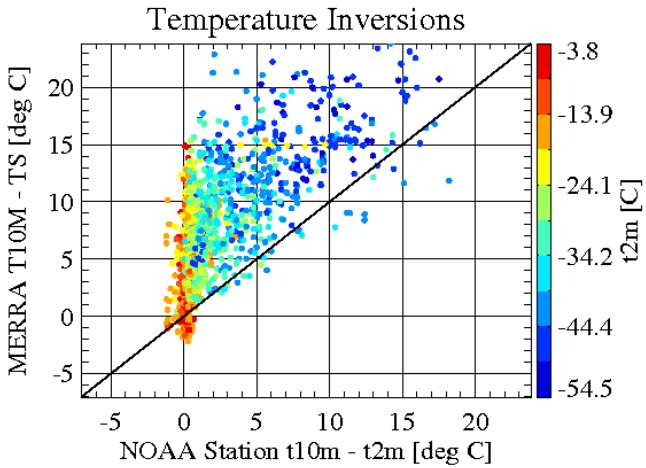
Temperature inversions

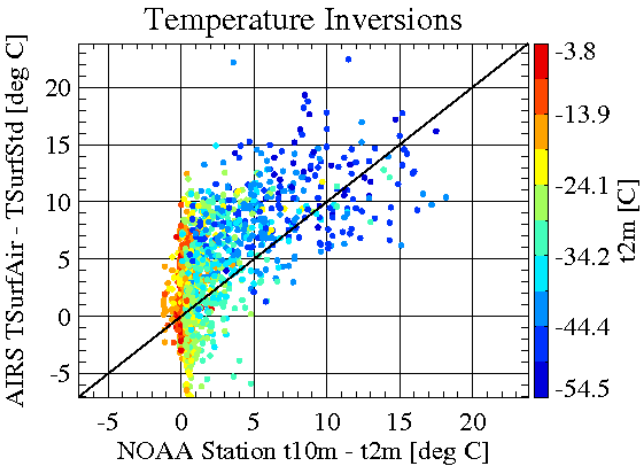
-MERRA tends to underestimate the stronger temperature inversions during the cold season.

- The MERRA Surface temperature (TS) matches the AIRS Skin Temperature fairly well for all season, so this may be used to calculate an inversion strength.









Summary

1. In-situ measurements of surface skin temperature

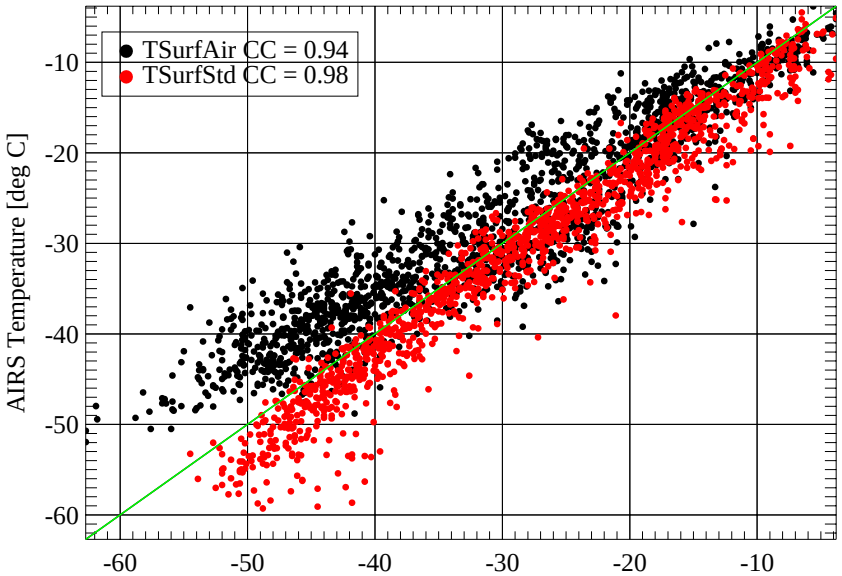
to validate cold temperature sensitivities in satellite measurements i.e., AIRS and MODIS

2. Future Work will include the development of systematic comparison tools which can match up In-situ measurements with satellite and modeled data to perform more experiments at Summit and in other regions.

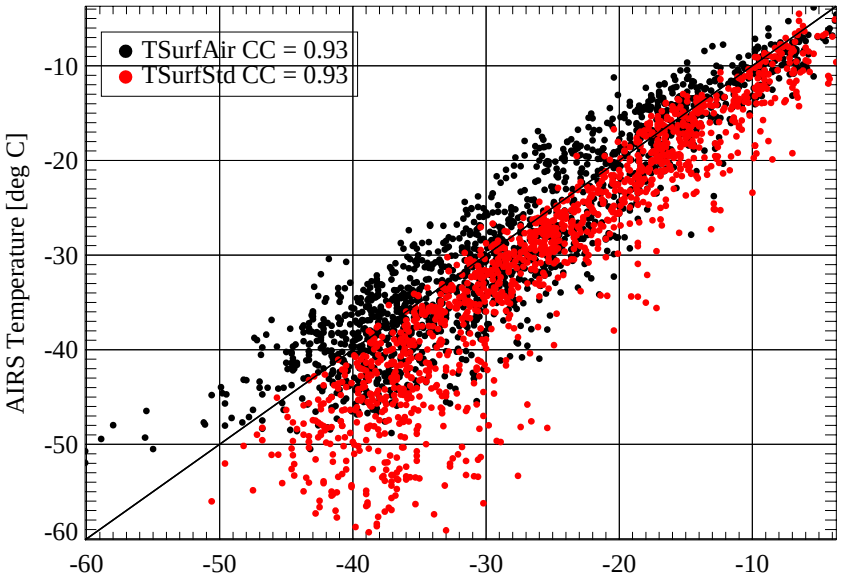
Back ups

- AIRS V6 surface temperatures and station temperatures comparison at Summit Station, GL is good in general, cold temperatures are more different. The correlation slope is nearly one.
- More errors can be expected in both data sets in cold temperatures.
- Temperature and pressure difference is dependent on distance from the station. Summit station is nearly at the top of GL, altitude decreasing with distance.
- There is no clear scan angle dependent bias in AIRS surface temperatures.

Comparison of AIRS Tskin and TsurfAir vs NOAA station temperature at Summit (2009)



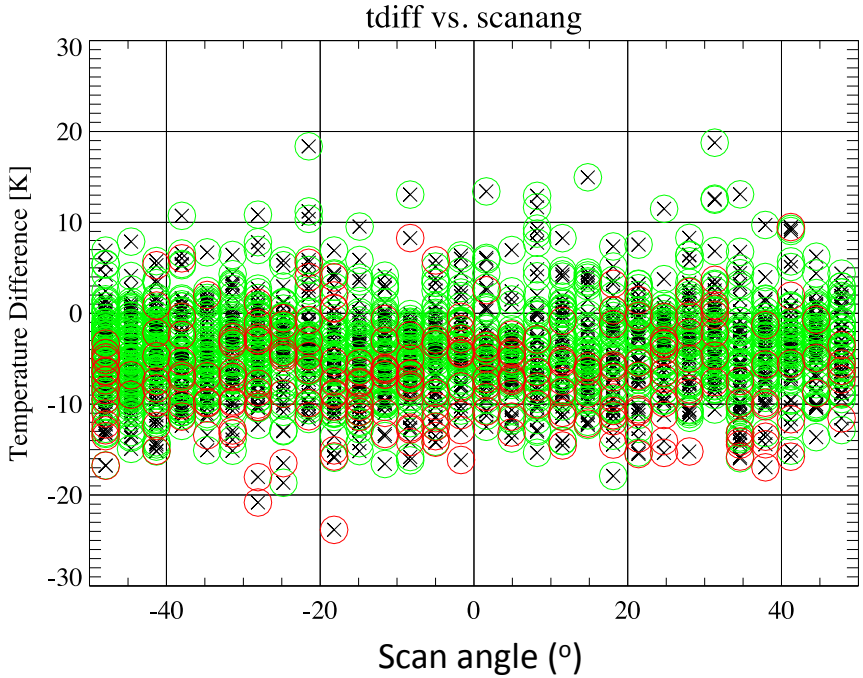
NOAA : 2m temperature (deg C)

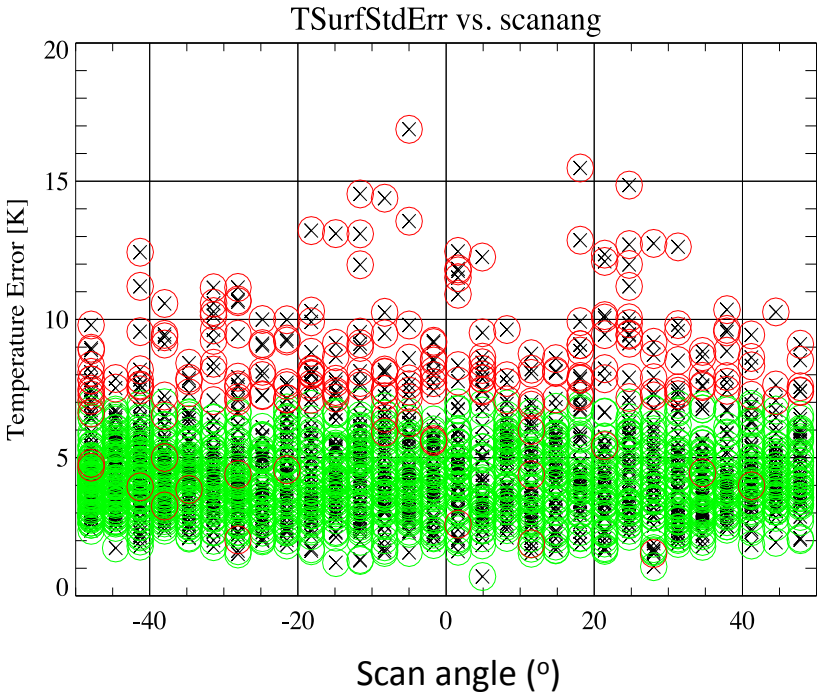


NOAA : 10m temperature (deg C)

- AIRS Tskin is highly correlated with T2m station data. Comparison is good (CC=0.98), cold temperatures below -40C are more different. The correlation slope is nearly one.
- More errors can be expected in both data sets for cold cases.

Is there scan angle dependence in Tskin difference?

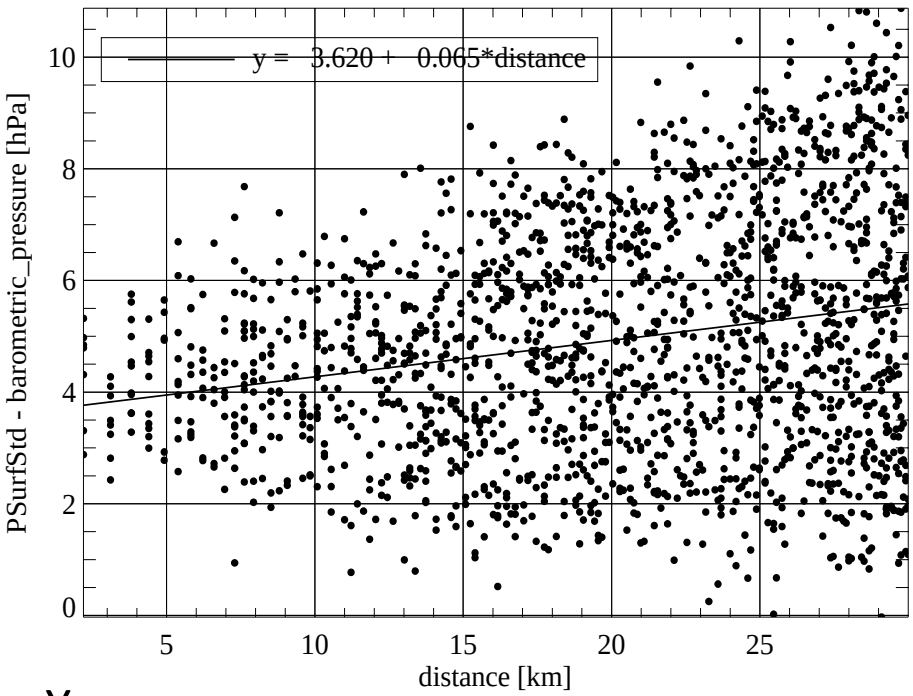




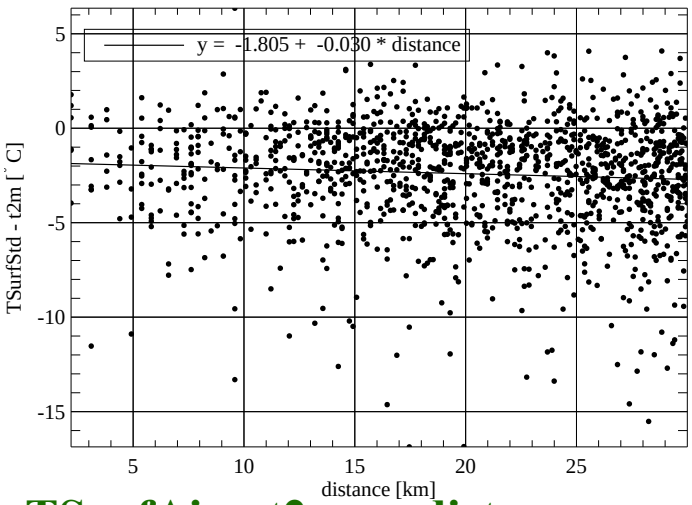
No,
there is no clear scan dependent bias in Ts.
There is no clear scan dependent bias in the Ts Error predictors.

Is there distance dependence in barometric surface pressure (Ps), TsurfAir, and TsurfStd difference?

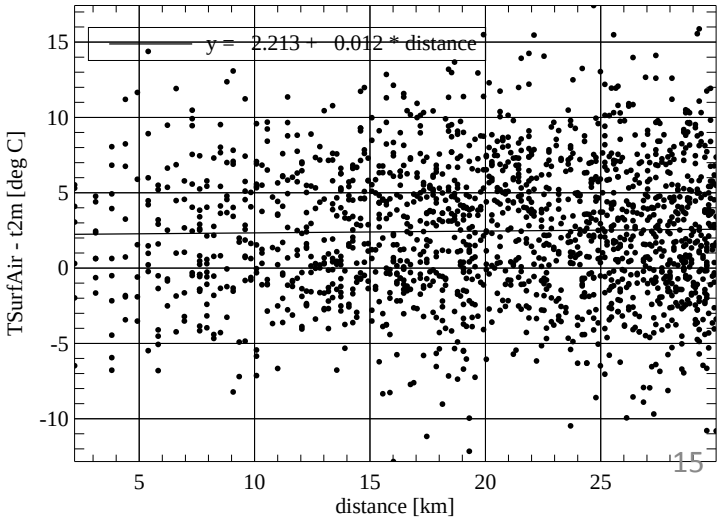
Surface Pressure diff vs distance



TSurfStd - t2m vs distance



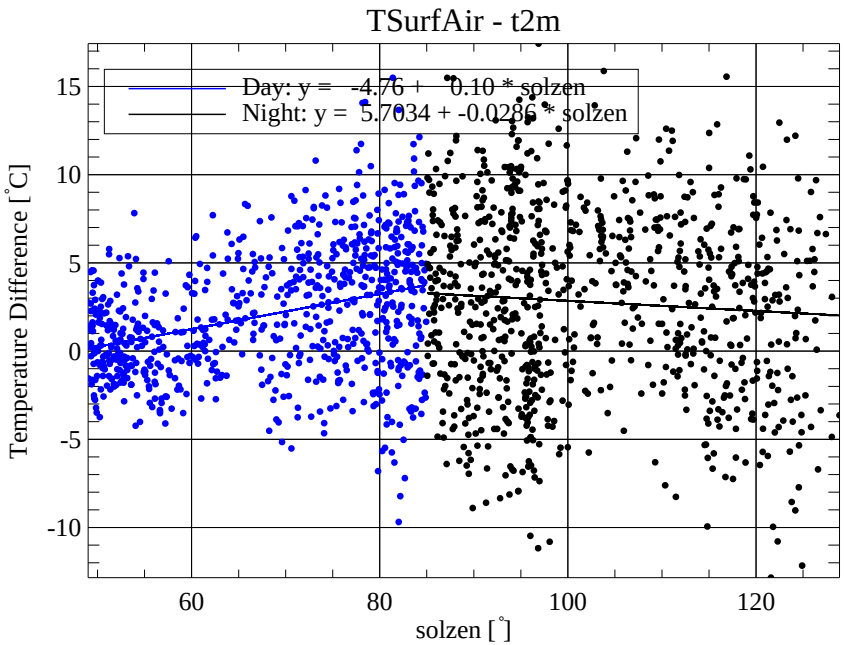
TSurfAir - t2m vs distance



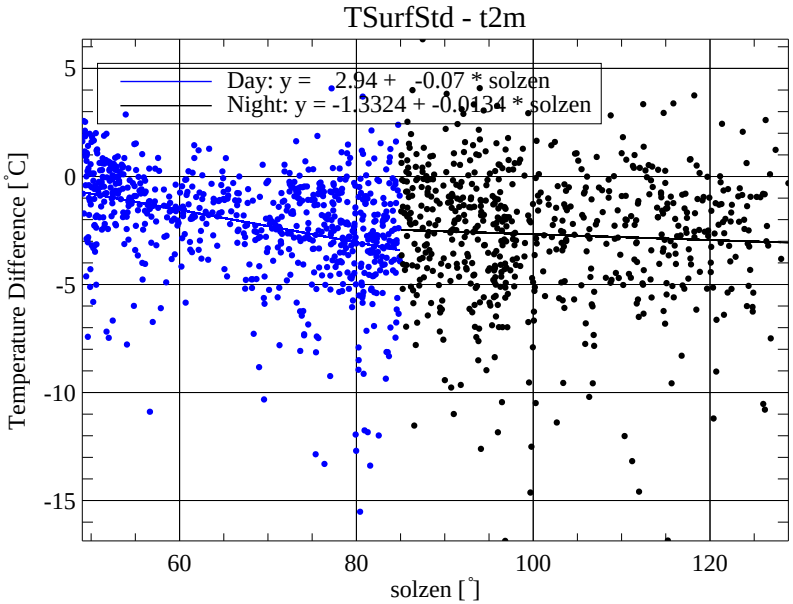
Yes,
there is distance dependent bias in Ps and surface temperatures.
But the dependence of TsurfAir difference to distance is small (slope = 0.030 (0.012) deg C/km).

Is there solar zenith angle dependence TsurfAir difference?

TSurfAir - t2m vs solzen

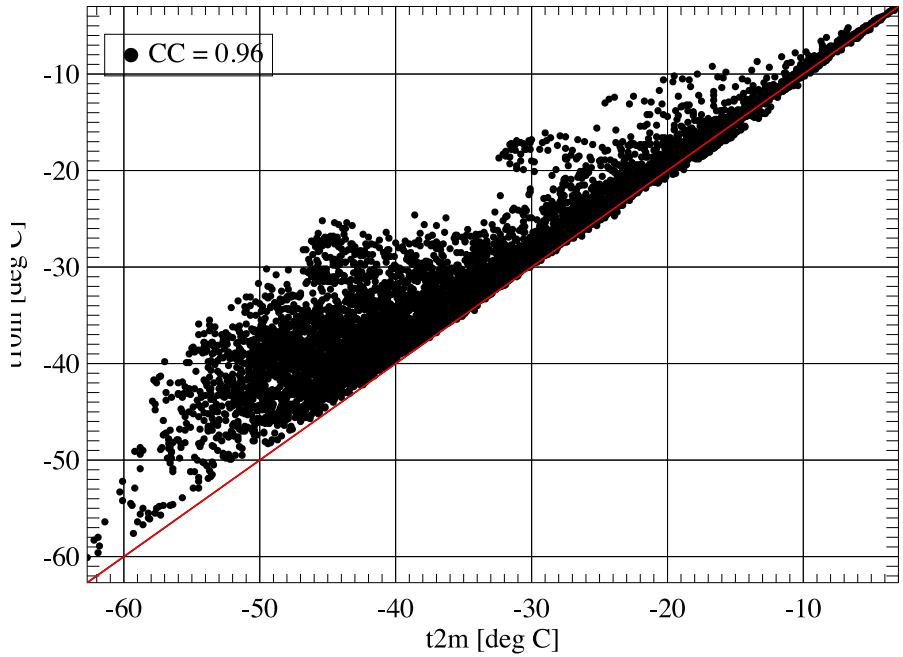


TSurfStd - t2m vs solzen

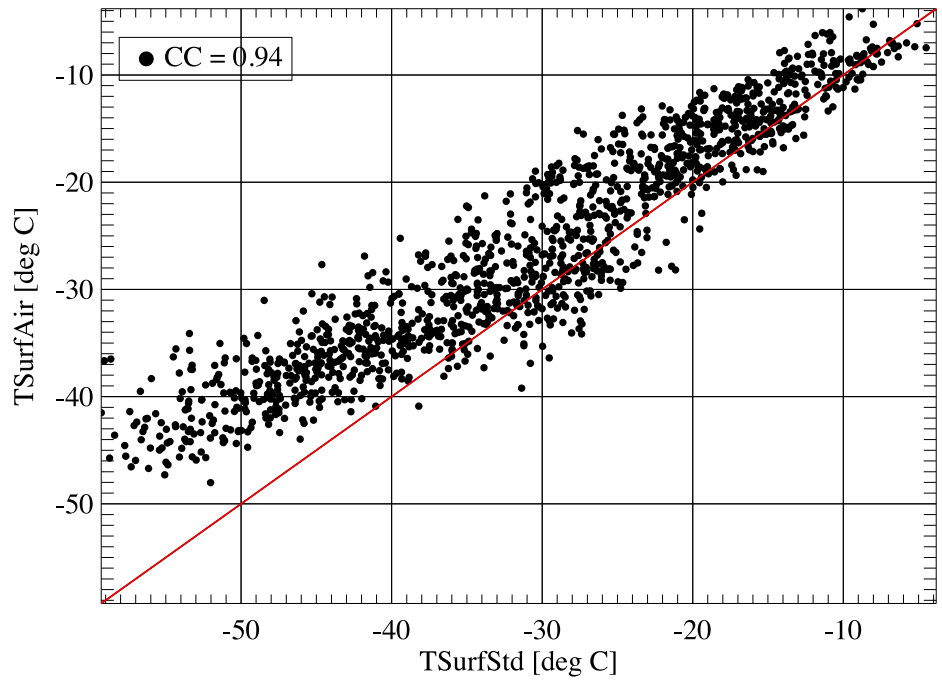


Can we see boundary layer inversion in AIRS surface temperatures?

t10m vs t2m



TSurfAir vs TSurfStd



Yes,

The station data has a stronger inversion, but AIRS surface temperatures can also detect the inversion.