S-NPP OMPS Reprocessing and Soft calibration

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OUTLINE

- Introduction to S-NPP OMPS and Ozone retrievals
- General Description of Soft Calibration
- Soft Calibration Statistics (V8TOZ)
- Soft Calibration Statistics (V8PRO)
- OMPS V8TOZ/V8PRO retrieval products
- Conclusion

Introduction to S-NPP OMPS and Ozone retrievals

- The Ozone Mapping and Profiler Suite (OMPS) onboard the S-NPP satellite (JPSS) is the next generation of US operational space-borne UV and ozone monitoring instruments, which was launched on October 28, 2011

- There are three spectrometers onboard; OMPS NM (total column ozone sensor) , OMPS NP (nadir ozone profile sensor) and OMPS limb profile

- The Version8 total O3 (V8TOZ) algorithm and Version8 O3 profile (V8PRO) algorithm, developed by NASA Ozone Science Team, are the most recent version of a series of BUV (backscattered ultraviolet) ozone retrieval algorithm (Applied to SBUV/2, GOME-2, OMI, OMPS and TOMS)

Introduction to S-NPP OMPS and Ozone retrievals

Current Status of NOAA S-NPP OMPS

- V8TOZ/V8PRO have been routinely used for processing at STAR with IDPS-produce SDR data

- We have made a third delivery of V8TOZ/V8PRO to NDE (new adjustments, codes working for both NPP and J01 SDR input data)

- We completed OMPS EDR reprocessing for both V8PRO and V8TOZ, the retrievals were saved at:
  / data/data074/NPP/OMPS/DATA/NM/yyyy/mm/dd/V8TOZ_REP
  /data/data074/NPP/OMPS/DATA/NP/yyyy/mm/dd/V8PRO_REP
  Retrievals for 2012-01-26 to 2015-09-09 were based on re-processed SDR data
  Retrievals for 2015-09-10 to 2017-05-31 were based on IDPS SDR data

General Description of Soft calibration

The main purposes of soft-calibration:

- Adjust ozone retrievals between different instruments (SBUV/2, OMPS) to make consistent long-term climate data records.
- Remove bias between the retrieved ozone and a “truth” data set.
- Remove the systematic cross-track bias in ozone, reflectivity and aerosol index, mainly for NM total column ozone retrievals .

General Description of Soft calibration

The procedure of soft-calibration:

1) Determine ΔΩ (ozone differences) and ΔR (reflectivity differences):

* For V8TOZ, those are the biases of retrieved total ozone and reflectivity related to cross-track positions;

* For V8PRO, those are the difference of ozone and reflectivity between two instruments (SBUV/2, OMPS)

2) Calculate N-Value adjustments for ozone (318nm) and reflectivity (331nm), using N-Value sensitivity to ozone and reflectivity

$$\Delta N_{(318)} = \Delta R * dN_{(318)}/dR + \Delta\Omega * dN_{(318)}/d\Omega$$

$$\Delta N_{(331)} = \Delta R * dN_{(331)}/dR + \Delta\Omega * dN_{(331)}/d\Omega$$

3) * For the rest of 10 channels of V8TOZ algorithm, calculate the N-Value adjustments by averaging the adjusted step2 residuals from ΔΩ and ΔR

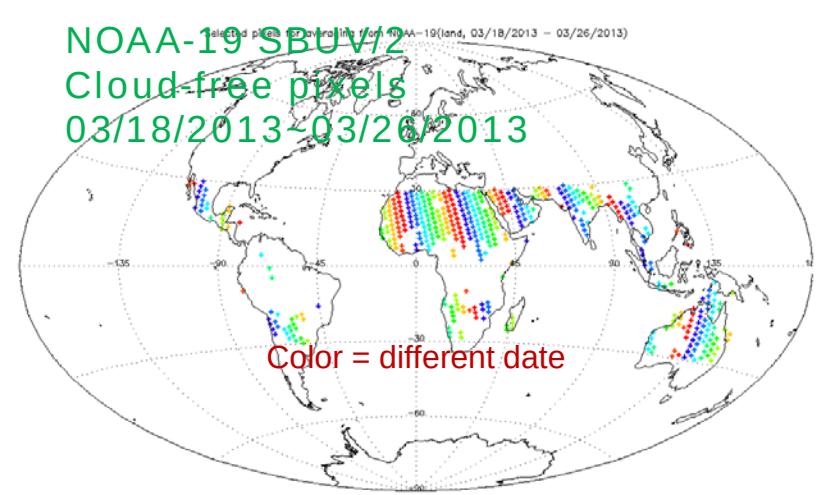
$$\Delta N_{(wl)} = \text{mean}(\text{Step2Res}_{(wl)} - \Delta R * dN_{(wl)}/dR - \Delta\Omega * dN_{(wl)}/d\Omega)$$

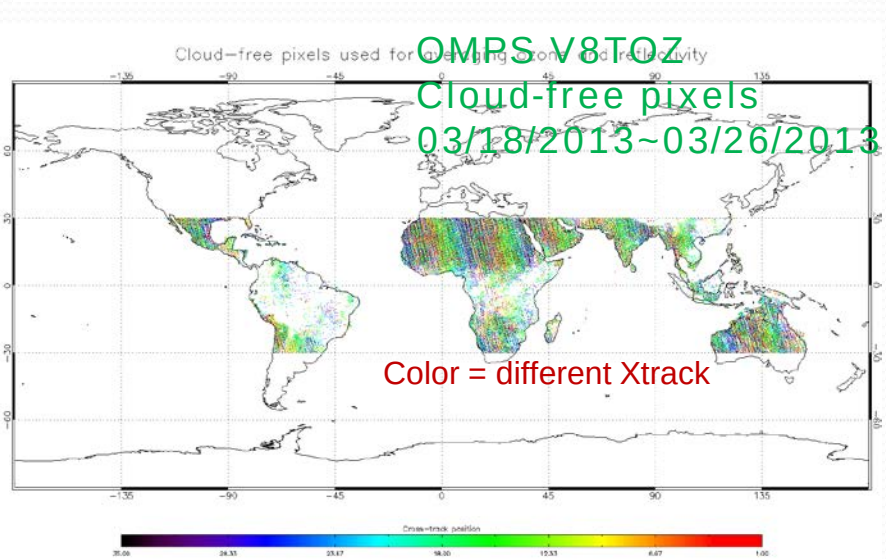
* For the rest channels of V8PRO algorithm, we make the measurement residual agree between two instruments.

General Description of Soft calibration

OMPS V8TOZ soft-calibration:

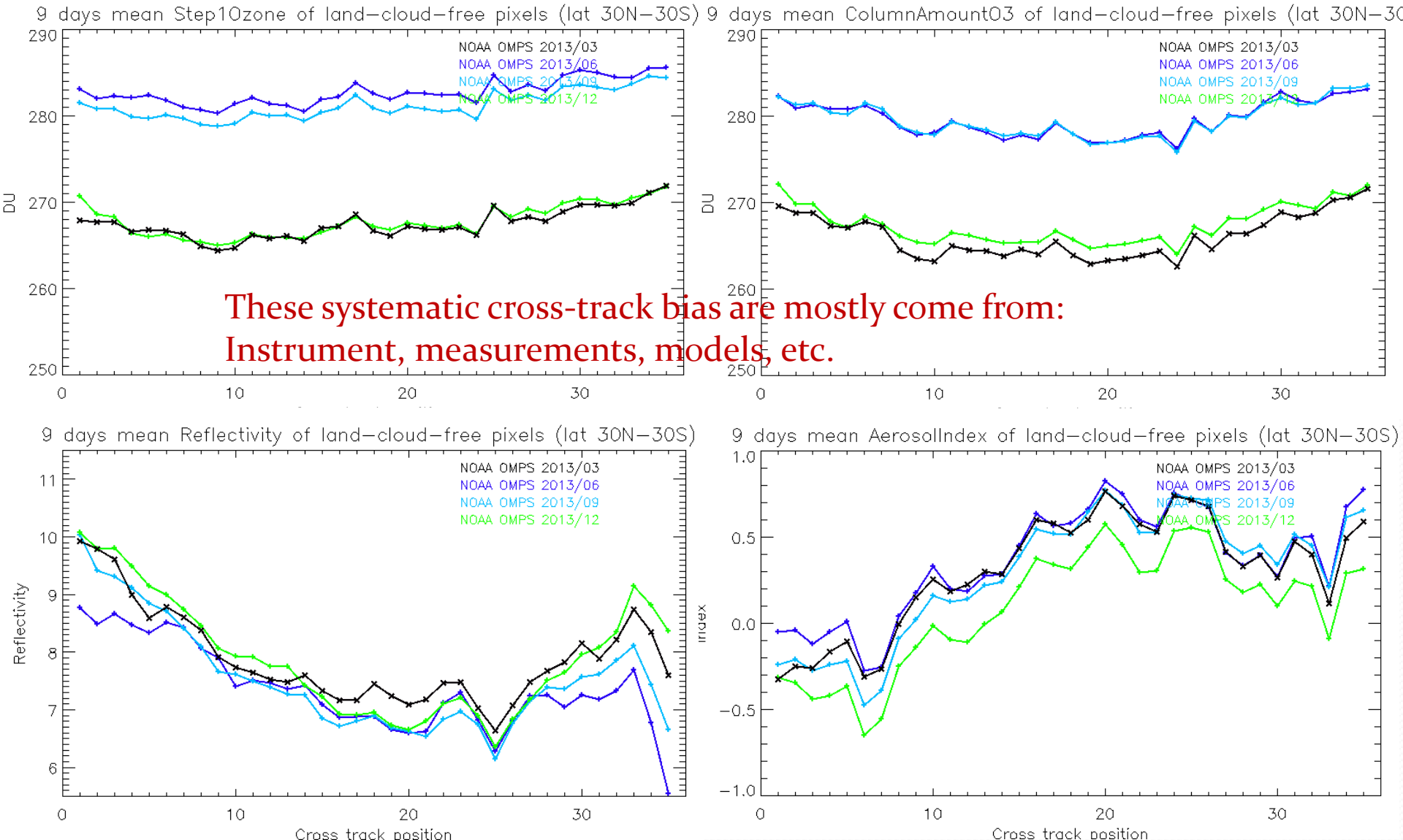
- Remove cross-track structure in OMPS total ozone and reflectivity, and make the averaged retrieval values close to those from NOAA-19 SBUV/2
- Choosing 9 day's of data because OMPS orbits will go back close to the same position after 9 day's run
- Choosing land pixels to avoid potential contamination from sun glint
- Choosing cloud-free pixels to avoid potential contamination from cloud





Soft Calibration Statistics (V8TOZ)

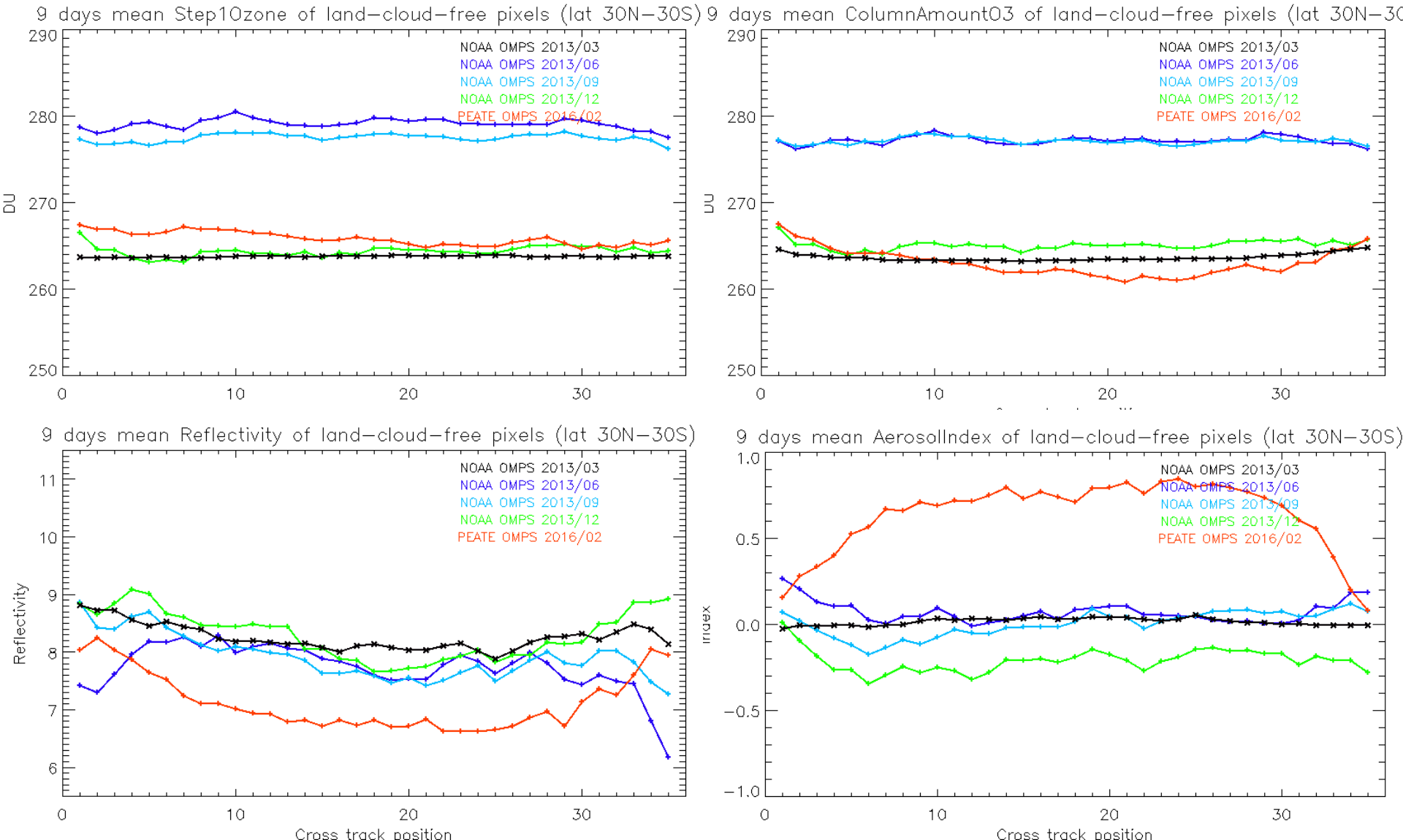
Cross-track related retrieval statistics for different seasons
Land-cloud-free pixels (lat 30N – 30S), before adjust



These systematic cross-track bias are mostly come from:
Instrument, measurements, models, etc.

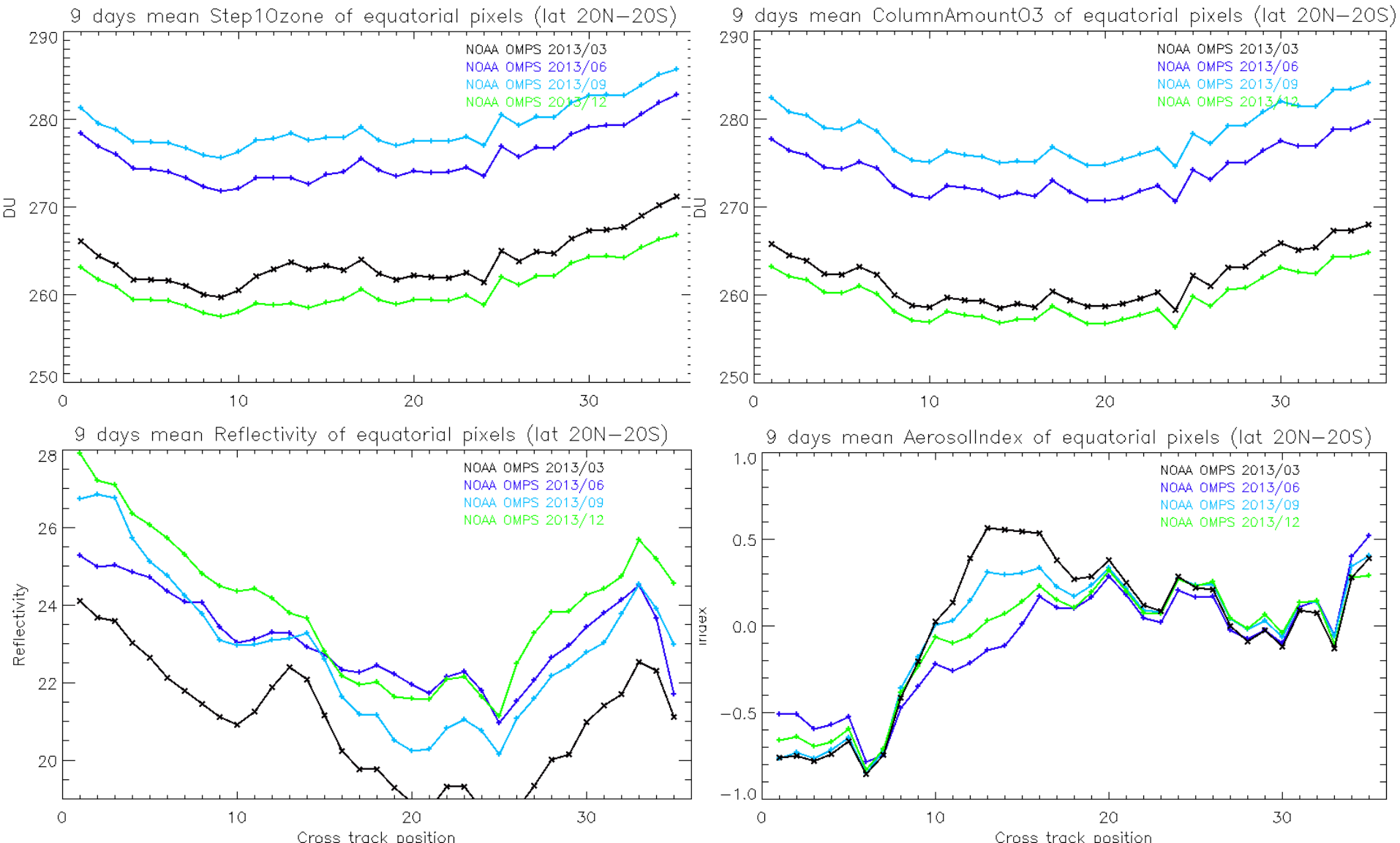
Soft Calibration Statistics (V8TOZ)

Cross-track related retrieval statistics for different seasons
Land-cloud-free pixels (lat 30N – 30S), after adjust



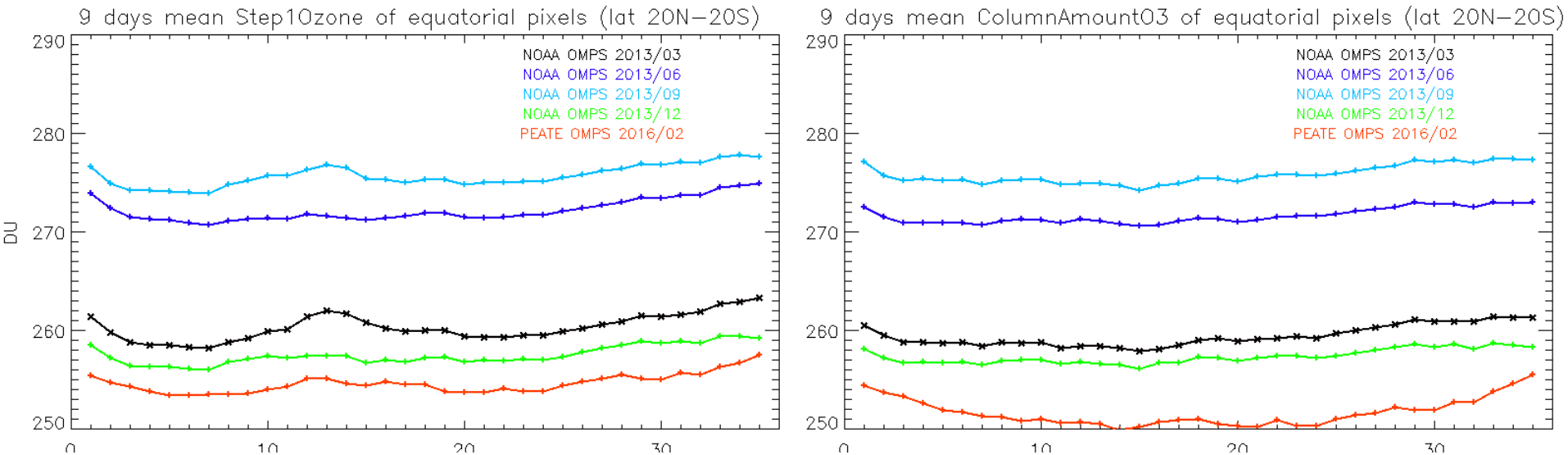
Soft Calibration Statistics (V8TOZ)

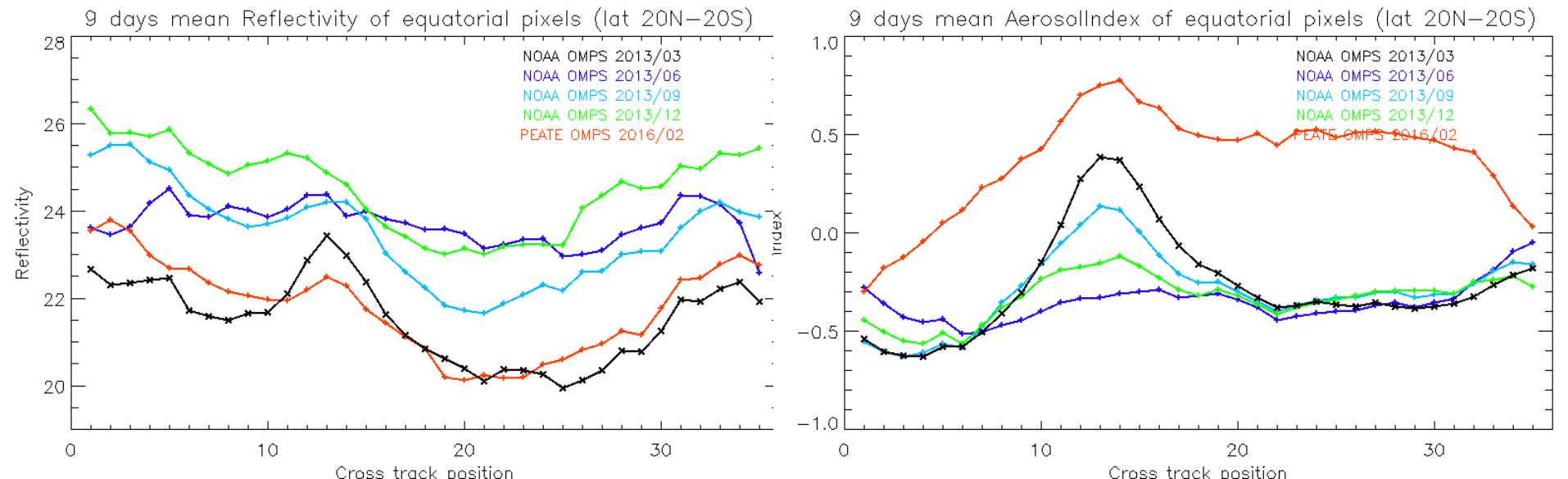
Cross-track related retrieval statistics for different seasons
All equatorial pixels (lat 20N – 20S), before adjust



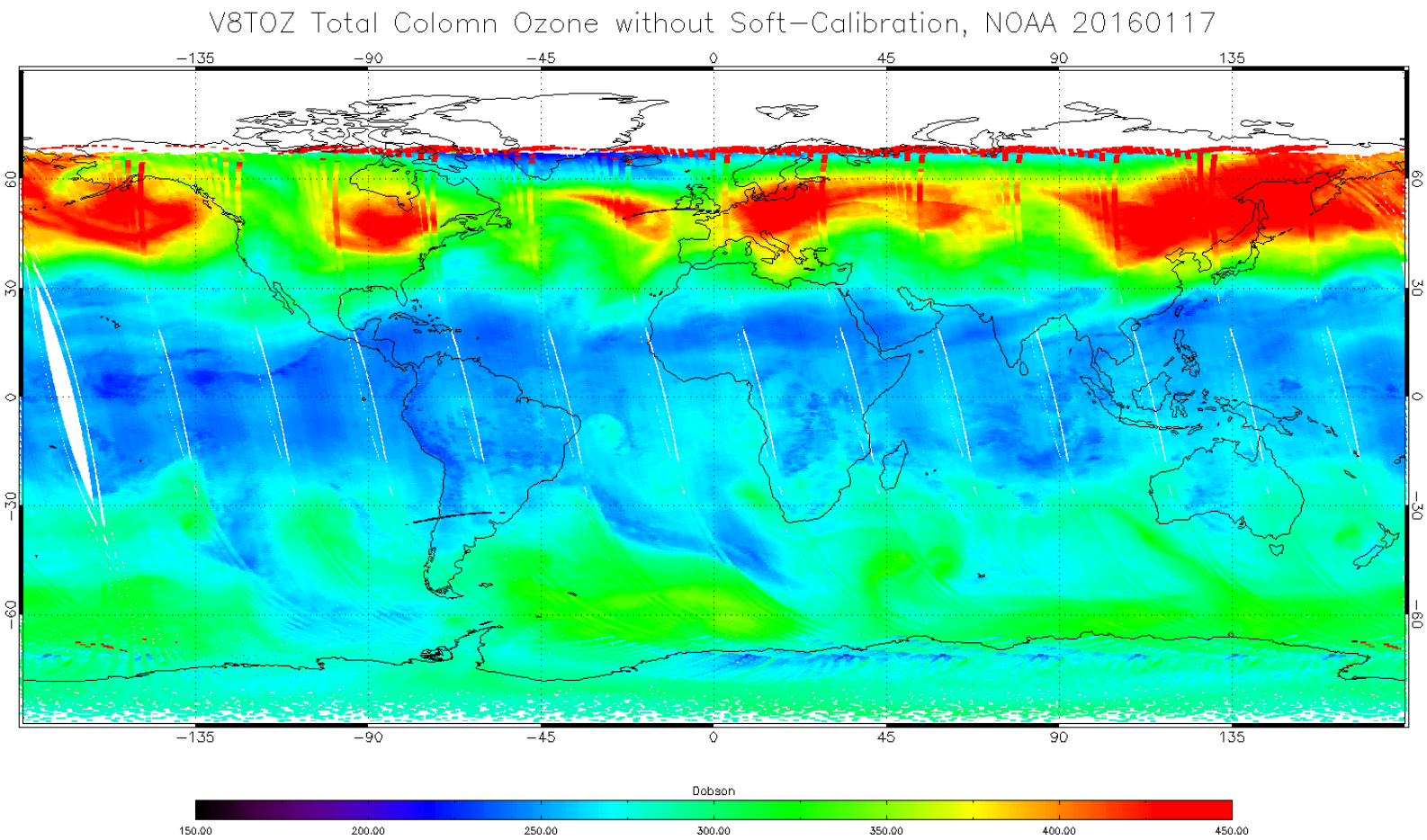
Soft Calibration Statistics (V8TOZ)

Cross-track related retrieval statistics for different seasons
All equatorial pixels (lat 20N – 20S), after adjust



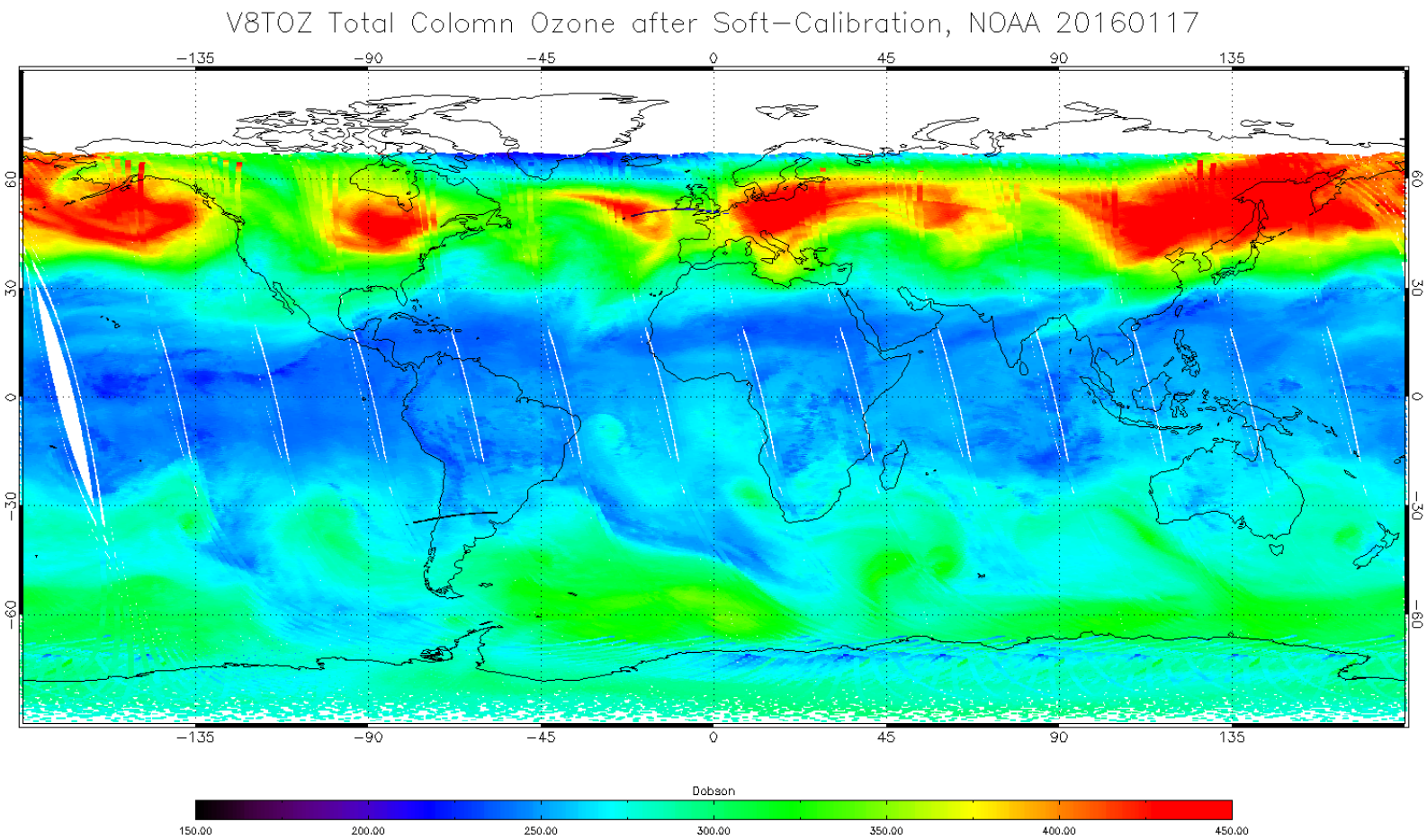


OMPS V8TOZ Retrieval Products



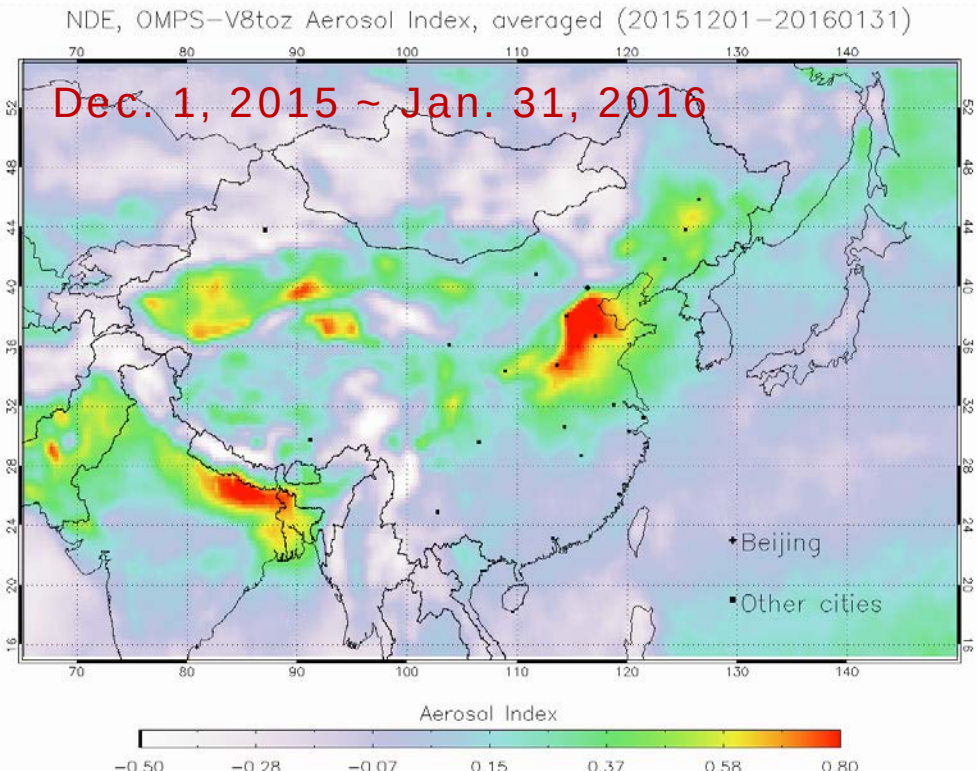
Retrieved Total Column Ozone without Soft-Calibration

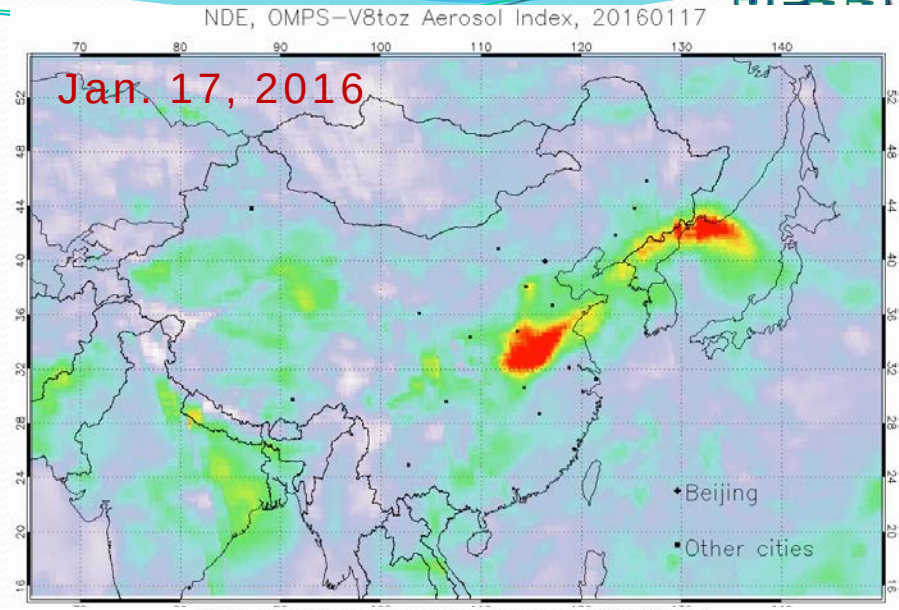
OMPS V8TOZ Retrieval Products

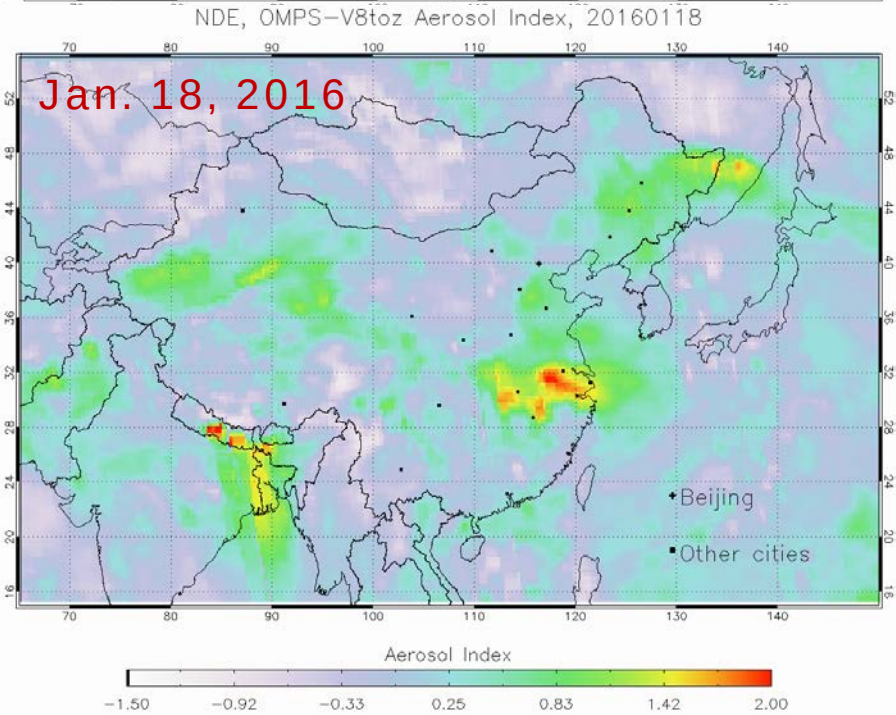


Retrieved Total Column Ozone after Soft-Calibration

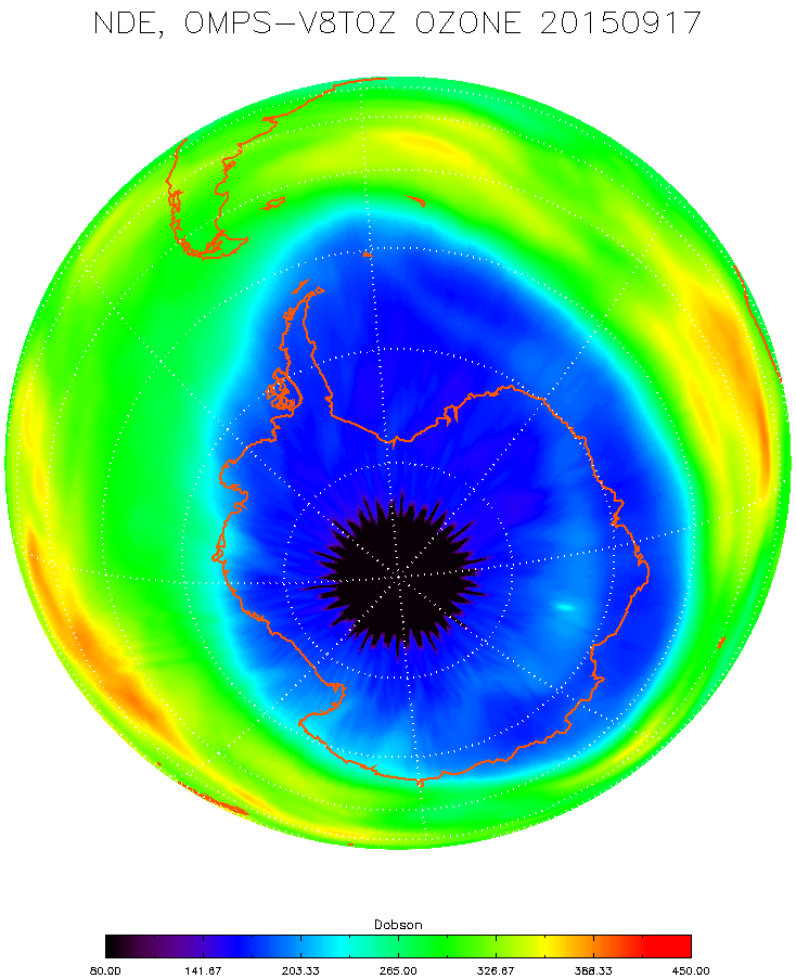
OMPS V8TOZ Retrieval Products

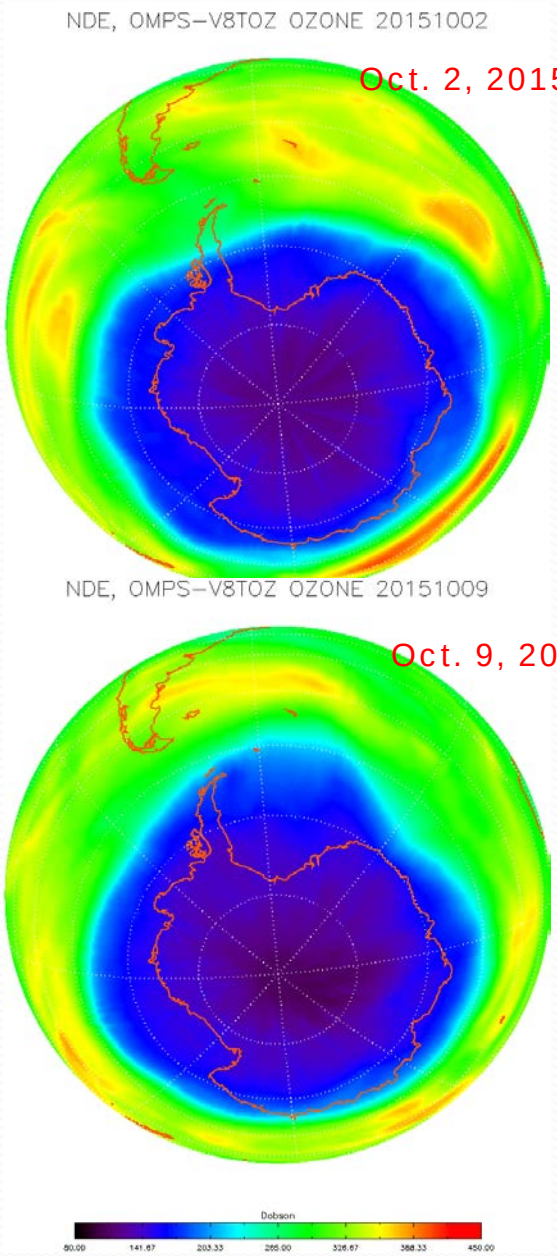






OMPS V8TOZ Retrieval Products

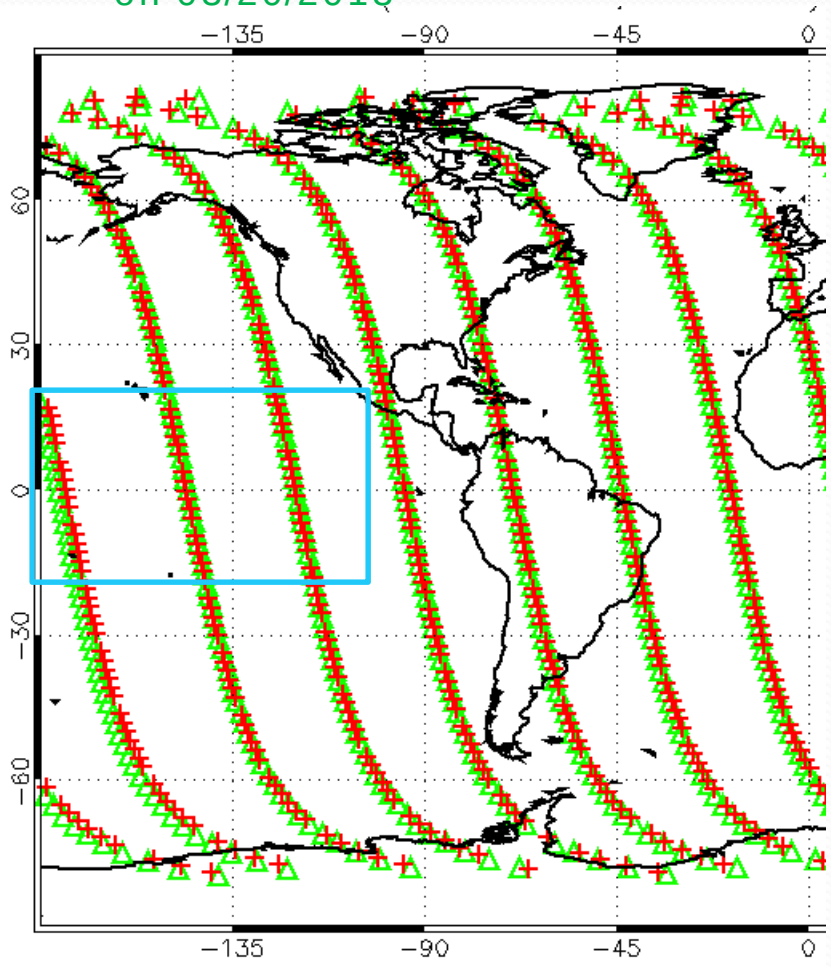




Daily Ozone Hole Change in 2015

General Description of Soft calibration

OMPS (green) and NOAA-19 (red) have chasing orbits (Time<600sec., Dis<110Km) on 03/20/2013



OMPS V8PRO soft-calibration:

- Make the STAR reprocessing of OMPS ozone profile retrievals close to those from NOAA-19 SBUV/2.
- We choose 03/20/2013 to make soft-calibration for STAR reprocessed V8PRO, because OMPS and N19 have very close chasing orbits and have stable measurements at that time.

Soft Calibration Statistics (V8PRO)

1) Adjusting STAR re-processed V8PRO to N19 SBUV/2, 03/20/2013

------ The OMPS NP solar measurements were analyzed with a model using components for solar activity, wavelength shifts and separate degradation rates for the diffusers and instrument throughput.

Statistics over equatorial Pacific after adjustment

```
-------------------------------------------------------------
the average NOAA19 reflectivity is:                0.208
the average STAR OMPS reflectivity is:             0.208

NOAA19 stp1oz is:                                  256.8
STAR OMPS stp1oz is:                               256.8

NOAA19 stp2oz is:                                  254.9
STAR OMPS stp2oz is:                               255.3

the average NOAA19 aerosol index is:               0.42
the average  STAR OMPS aerosol index is:           0.42

NOAA19 stp3oz(bsttoz) is:                          253.7
STAR OMPS stp3oz(bsttoz) is:                       254.1
-------------------------------------------------------------
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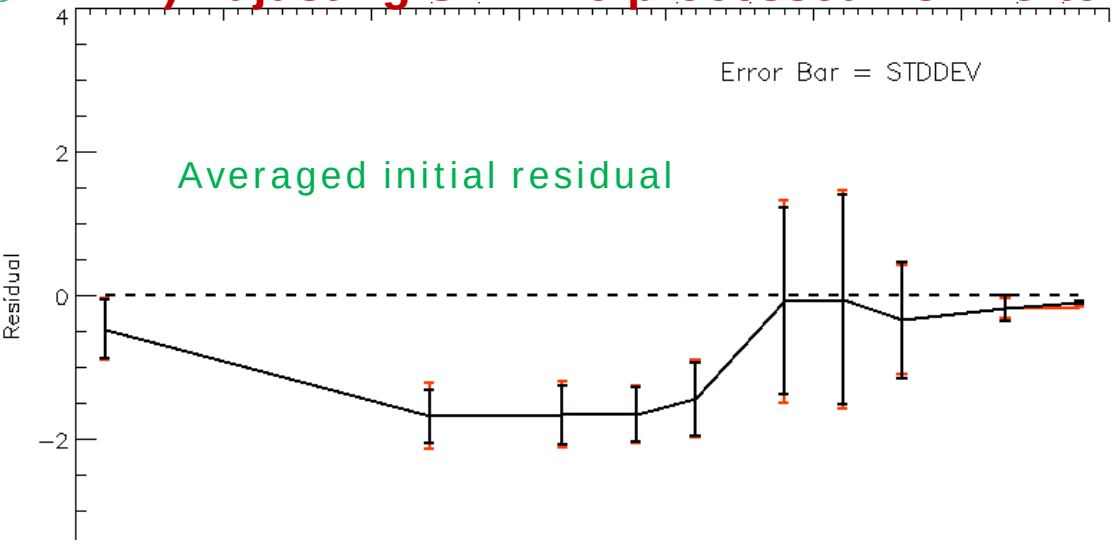
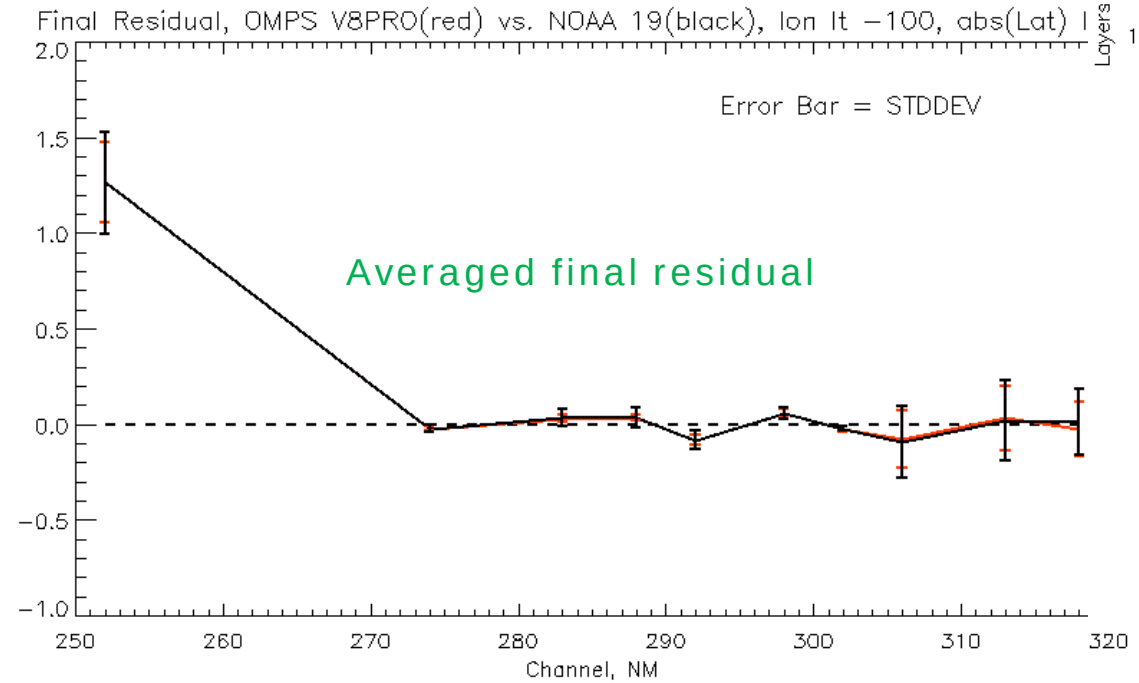
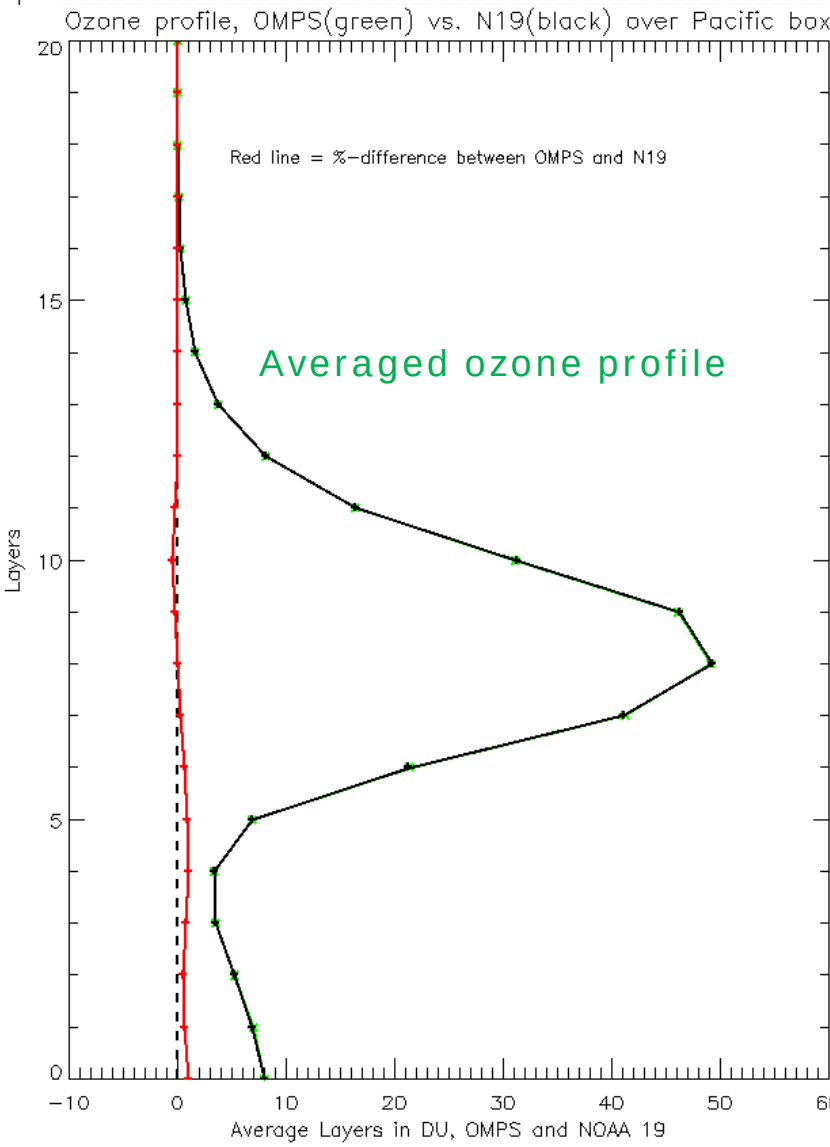
Soft Calibration Statistics (V8PRO)

1) Adjusting STAR re-processed V8PRO to N19 SBUV/2, 03/20/2013

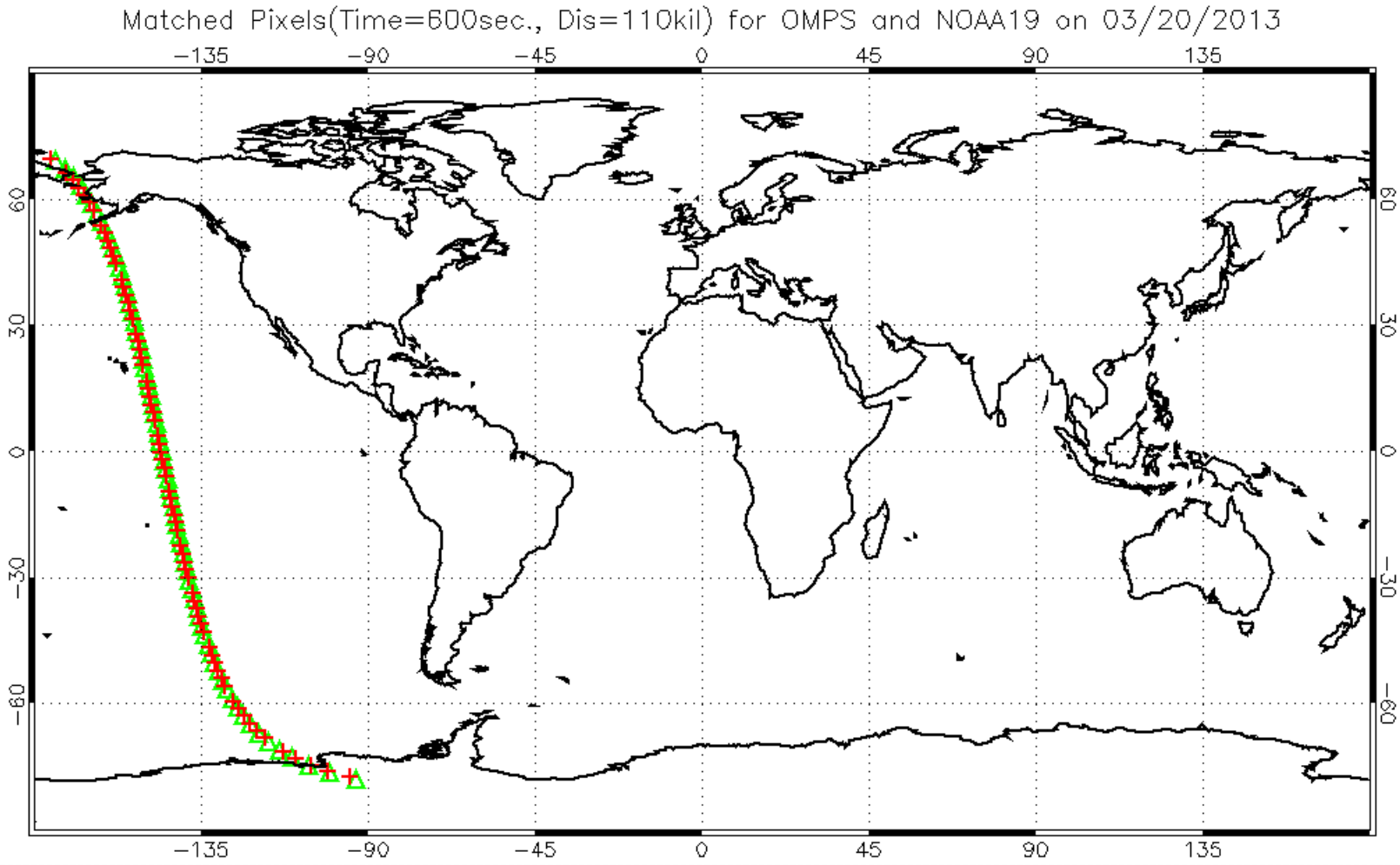






Soft Calibration Statistics (V8PRO)

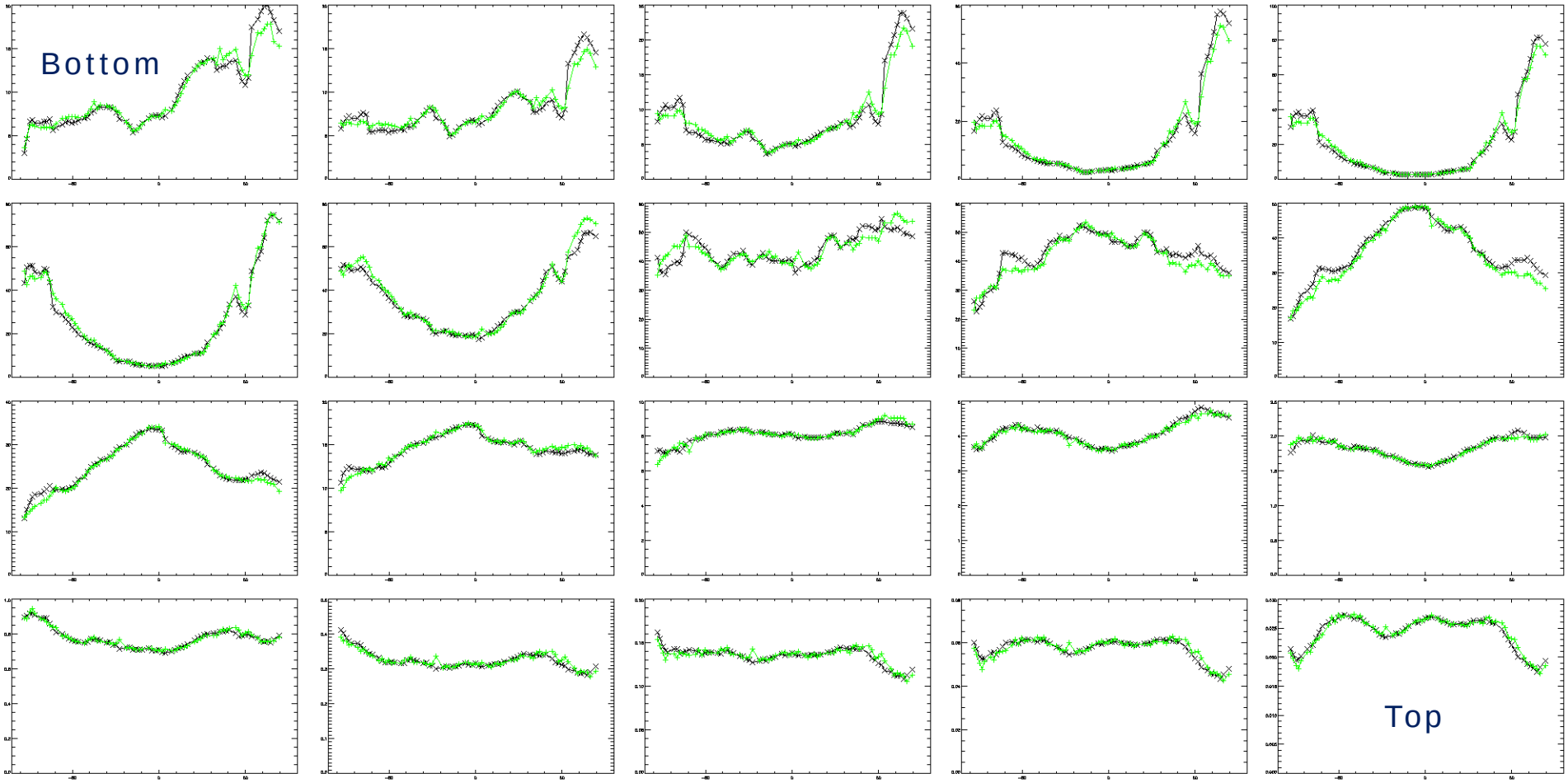
1) Adjusting STAR re-processed V8PRO to N19 SBUV/2, 03/20/2013



Soft Calibration Statistics (V8PRO)

1) Adjusting STAR re-processed V8PRO to N19 SBUV/2, 03/20/2013

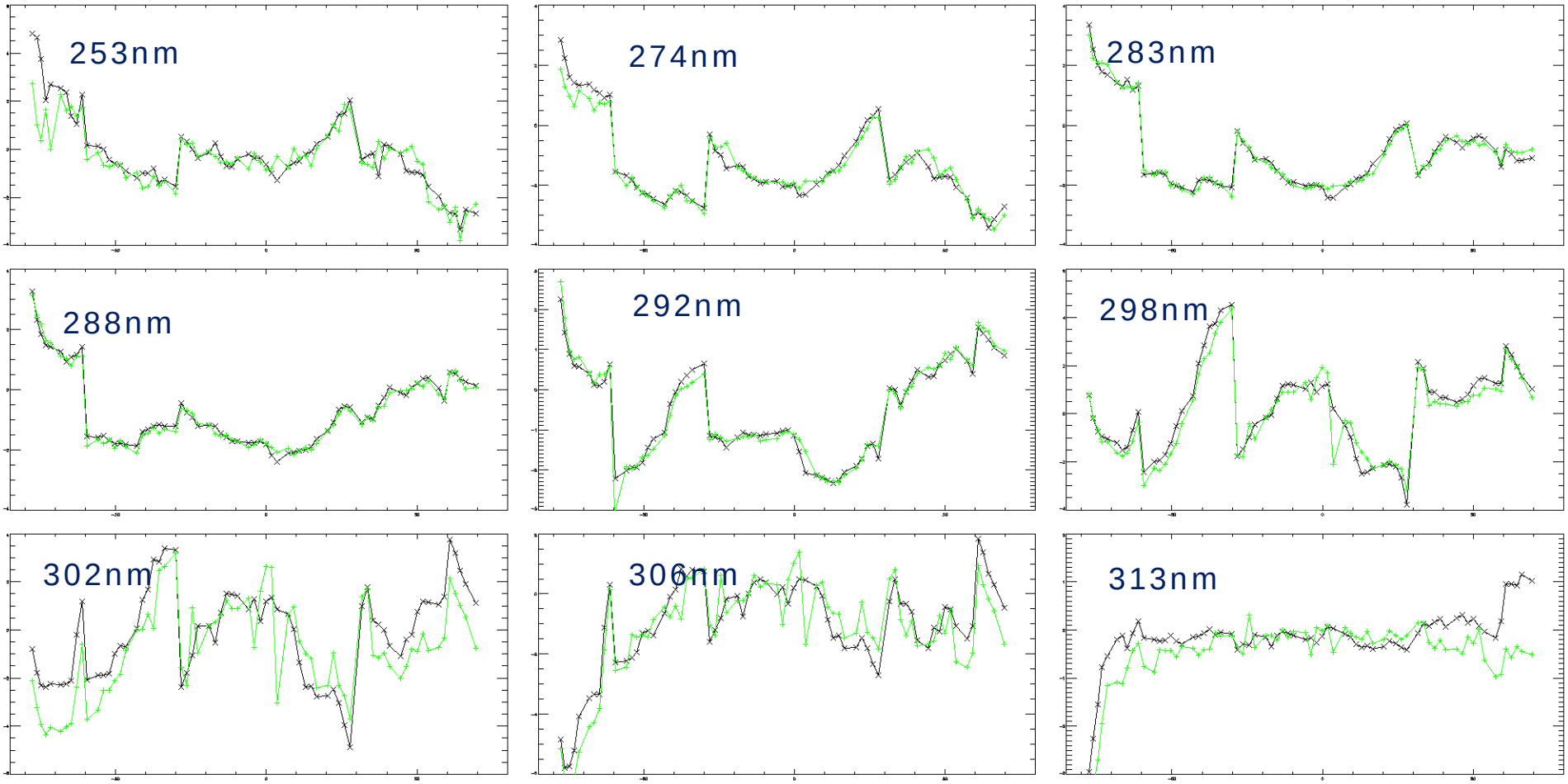
Layer ozone along orbit, OMPS (black), N19 (green)



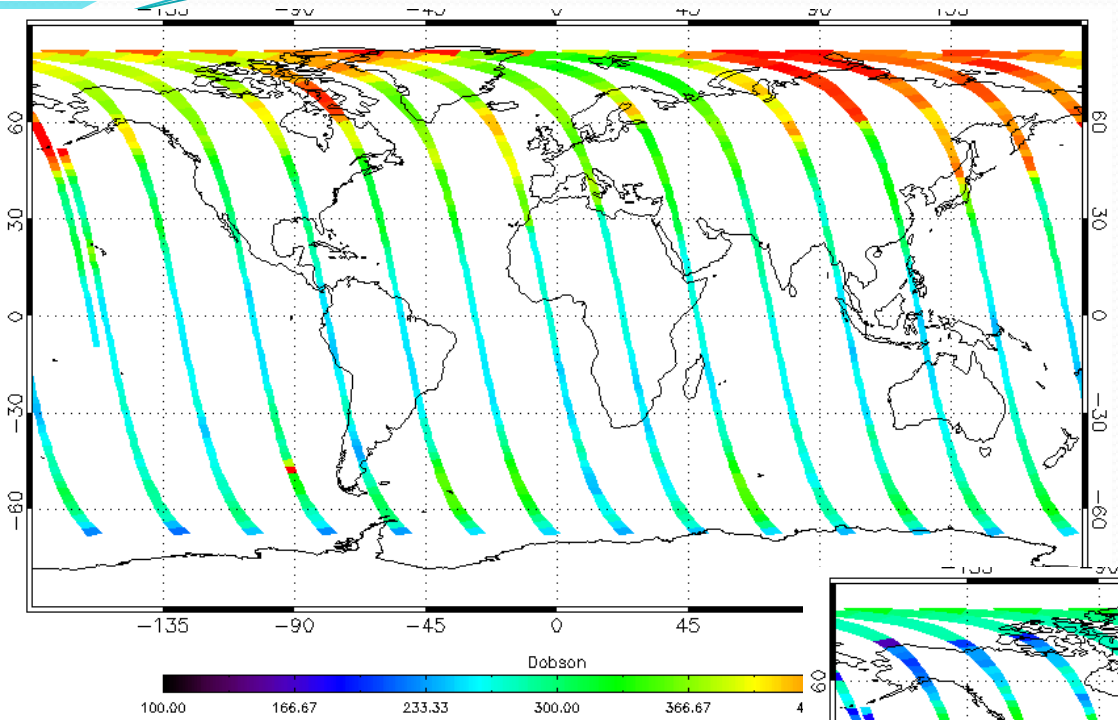
Soft Calibration Statistics (V8PRO)

1) Adjusting STAR re-processed V8PRO to N19 SBUV/2, 03/20/2013

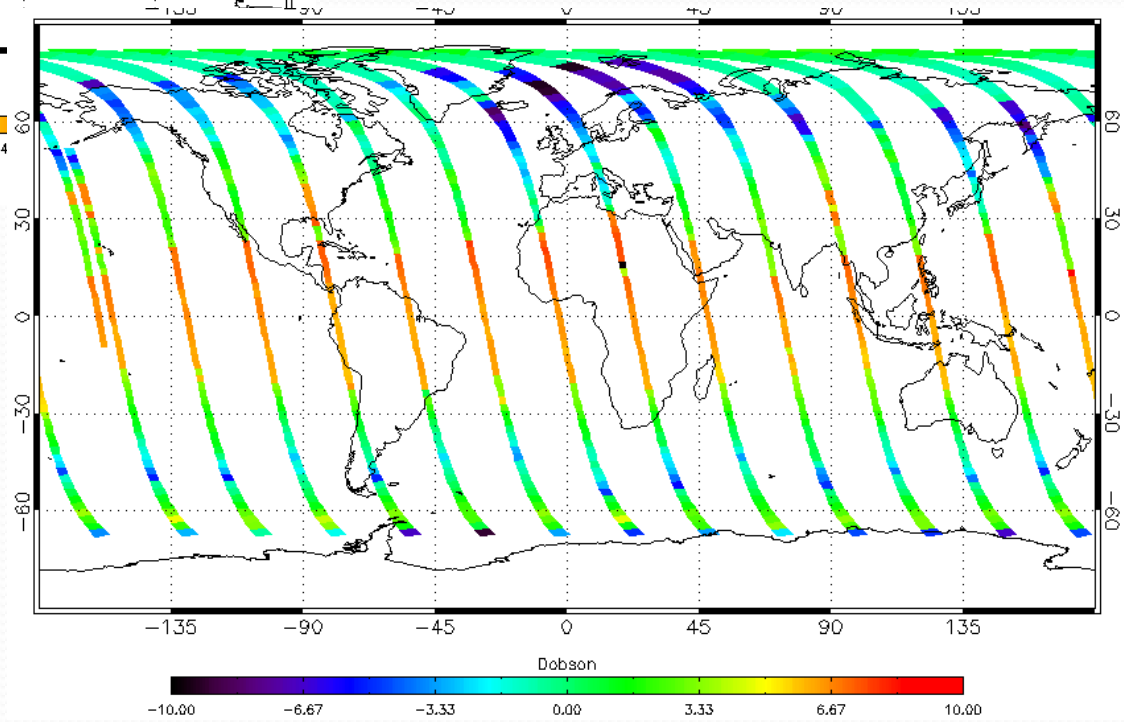
Initial residual along orbit, OMPS (black), N19 (green)



OMPS V8PRO Retrieval Products

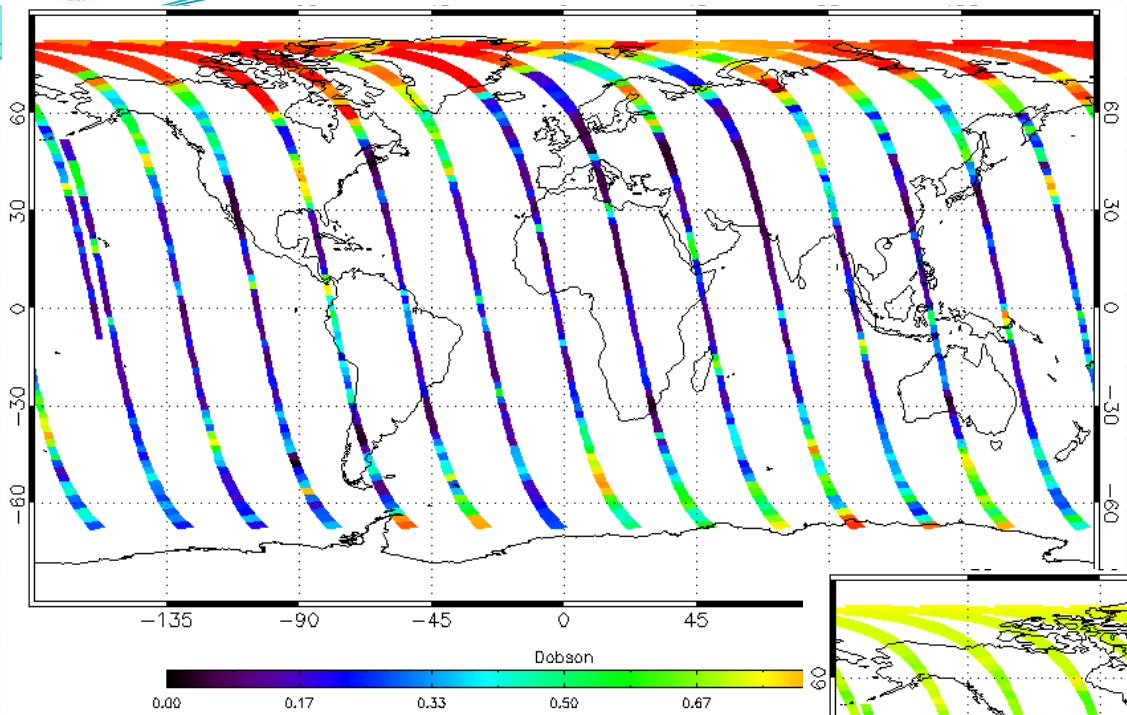


OMPS V8PRO retrieved total ozone profile, 04/30/2017

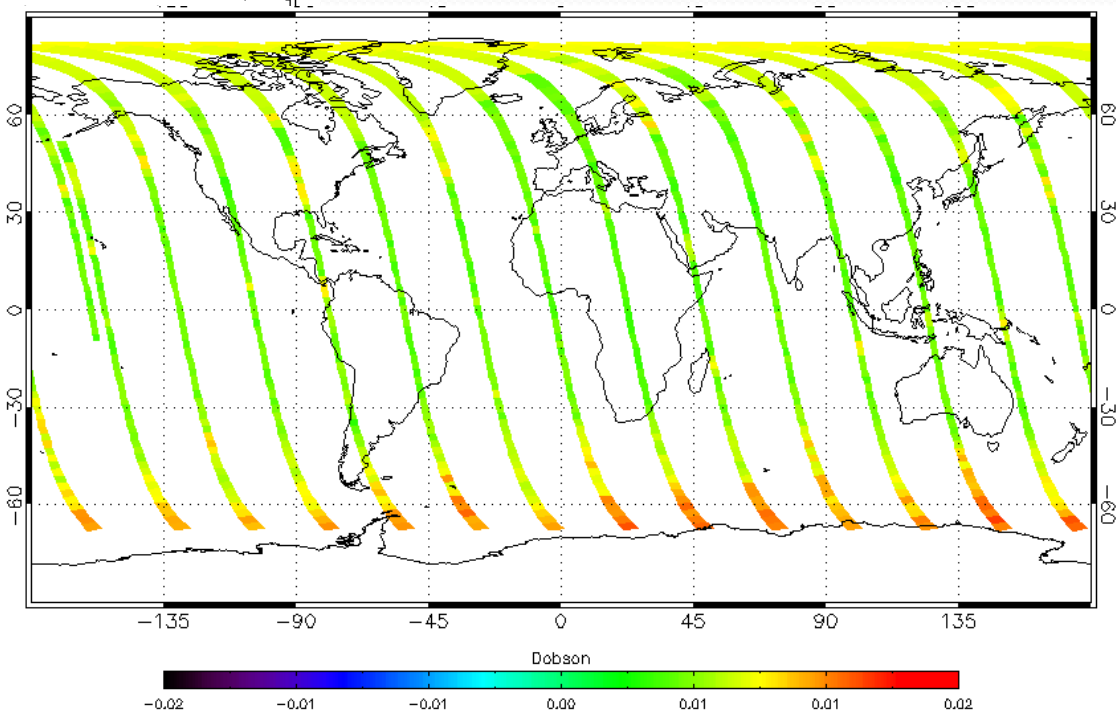


The adjustment of total ozone profile by soft calibration, 04/30/2017

OMPS V8PRO Retrieval Products



OMPS V8PRO retrieved reflectivity, 04/30/2017



The adjustment of reflectivity by soft calibration, 04/30/2017

Conclusion

- The systematic bias in OMPS V8TOz retrievals can be removed to produce consistent products for all FOVs.
- Using land and cloud-free pixels in soft calibration for OMPS V8TOz can avoid potential contamination from sun glint and clouds.
- Using chasing orbit matchups between OMPS and N19 for generating OMPS V8PRO soft calibration, can largely avoid noise from atmospheric variation in time and space.
- Soft calibration can make ozone retrievals from different satellite in agree with each other, and provides a continuation of the long-term climatology record.

Thanks!

Soft Calibration Statistics (V8PRO)

2) Adjusting V8PRO at NDE to STAR re-processed V8PRO, 04/30/2017

Statistics over equatorial Pacific after adjustment

```
-------------------------------------------------------------
the average OMPS STAR reflectivity is:          0.181
the average OMPS NDE reflecitivity is:          0.181

OMPS SATR stp1oz is:                            271.6
OMPS NDE stp1oz is:                             271.5

OMPS STAR stp2oz is:                            269.8
OMPS NDE stp2oz is:                             269.8

the average OMPS STAR aerosol index is:         -0.08
the average OMPS NDE aerosol index is:          -0.08

OMPS STAR stp3oz(bsttoz) is:                    270.0
OMPS NDE stp3oz(bsttoz) is:                     269.9
-------------------------------------------------------------
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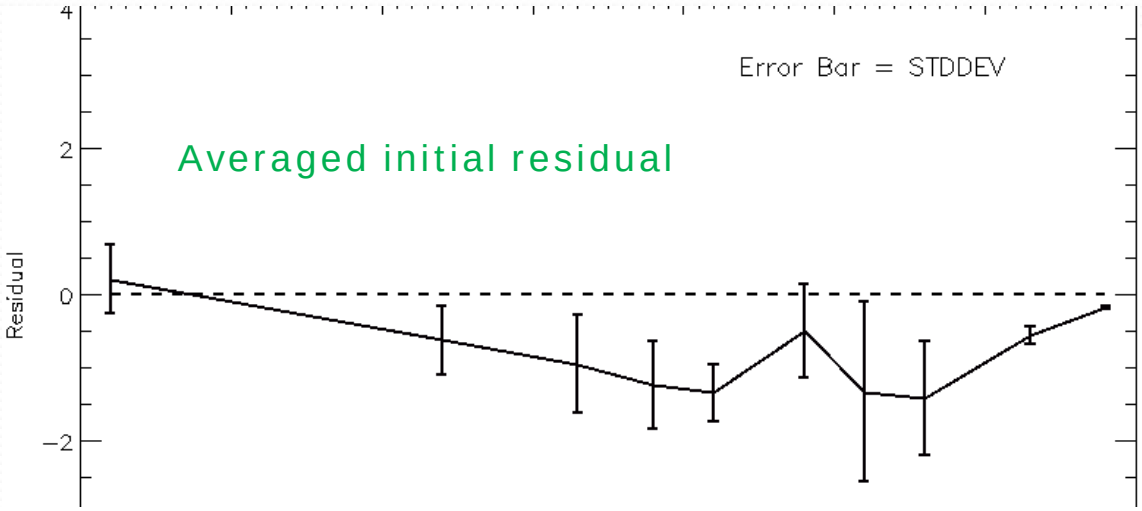
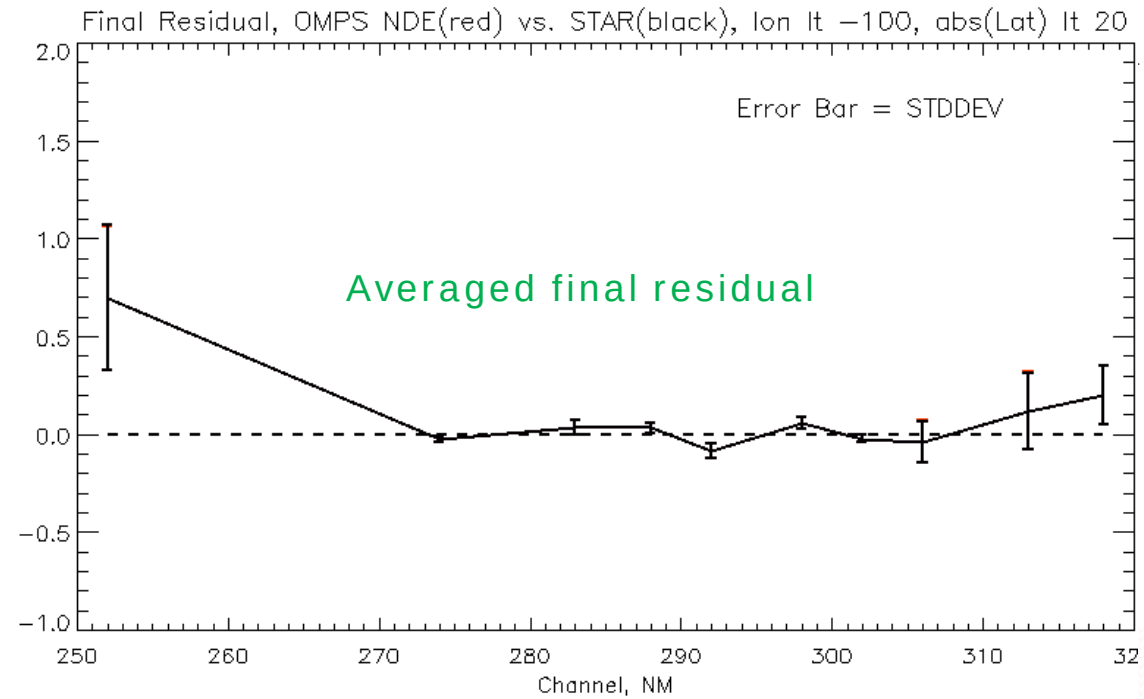
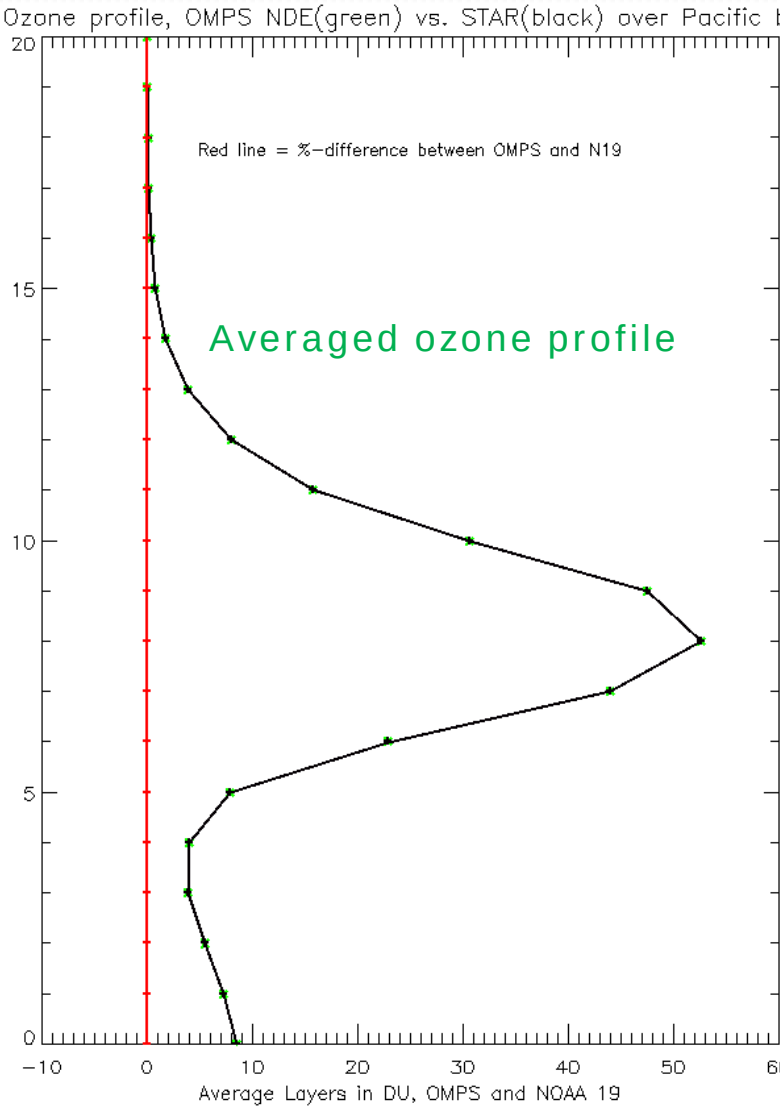
Soft Calibration Statistics (V8PRO)

2) Adjusting V8PRO at NDE to STAR re-processed V8PRO, 04/30/2017



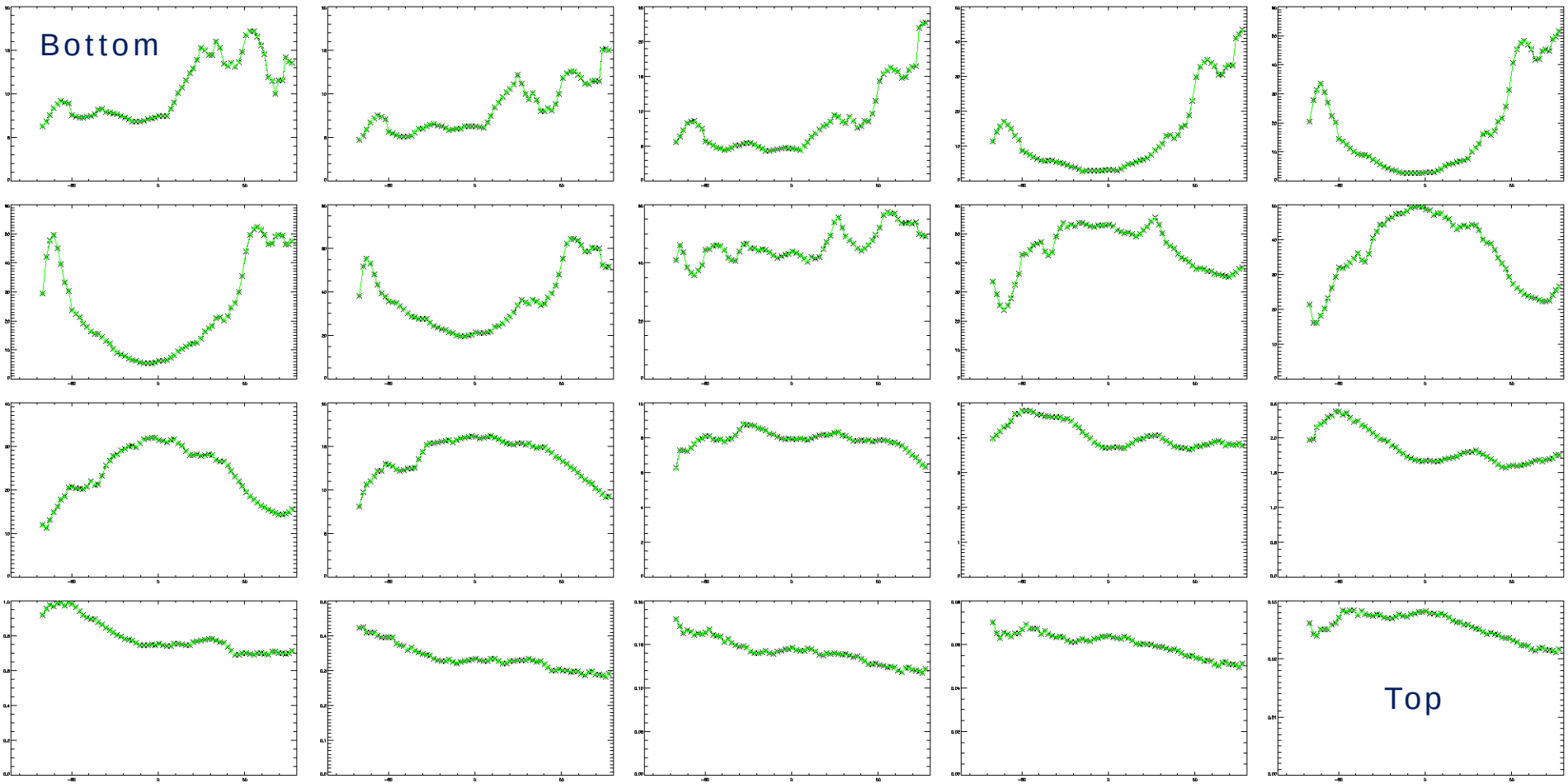




Soft Calibration Statistics (V8PRO)

2) Adjusting V8PRO at NDE to STAR re-processed V8PRO, 04/30/2017

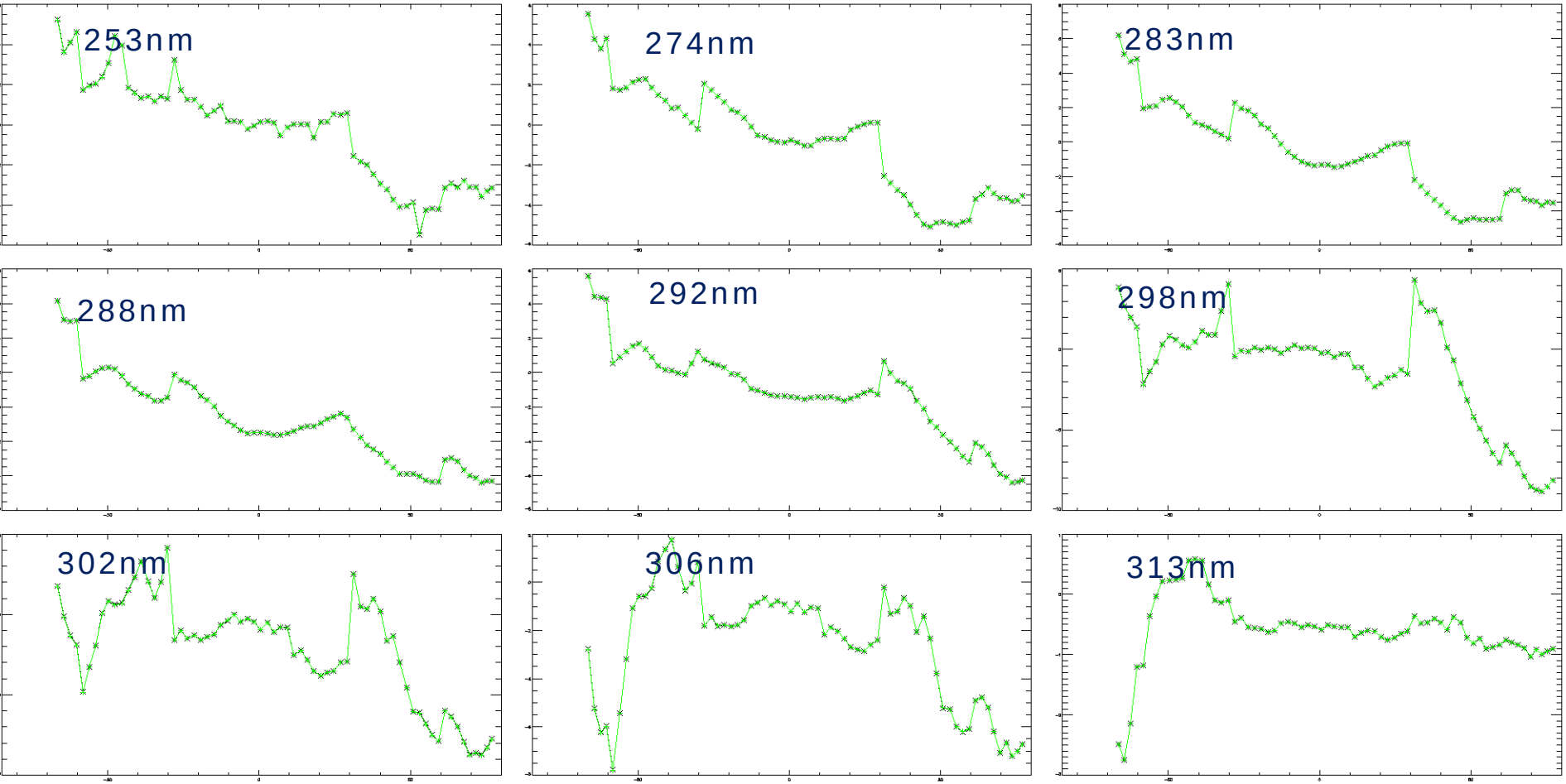
Layer ozone along orbit, NDE(black), STAR(green)

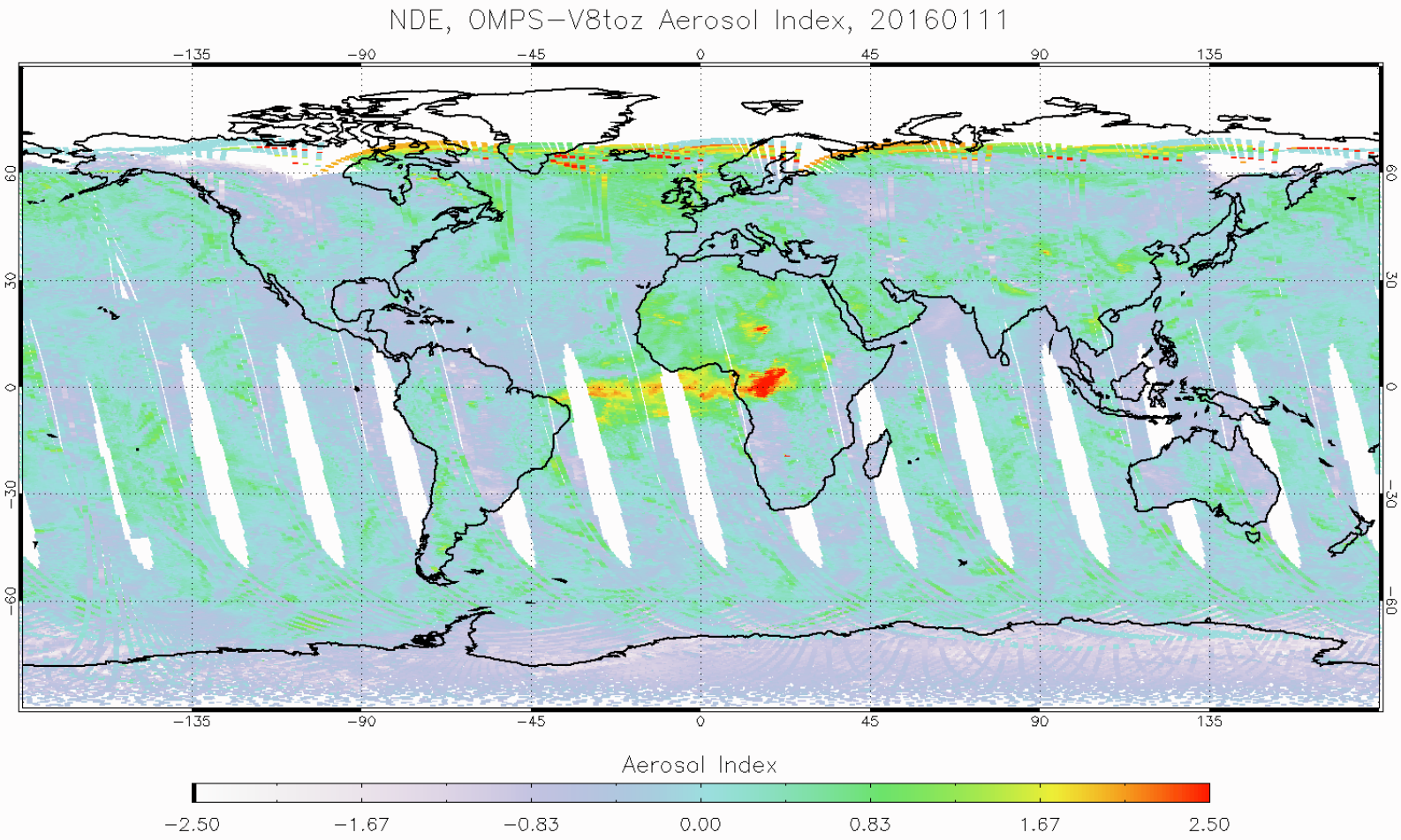


Soft Calibration Statistics (V8PRO)

2) Adjusting V8PRO at NDE to STAR re-processed V8PRO, 04/30/2017

Initial residual along orbit, NDE(black), STAR(green)




NDE, OMPS-V8toz Aerosol Index, 20160111
-135
-90
-45
0
45
90
135
60
30
0
-30
-60
Aerosol Index
-2.50
-1.67
-0.83
0.00
0.83
1.67
2.50