Ten Year Ozone Profile Record from Suomi NPP OMPS Limb Profiler

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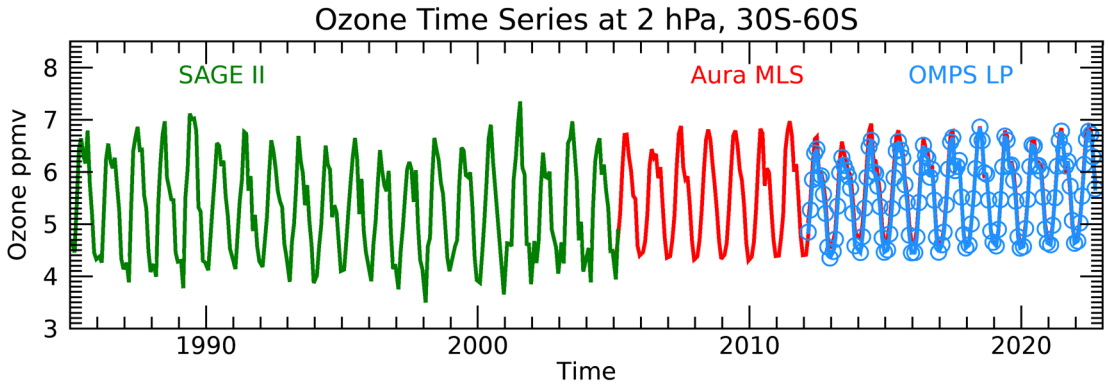
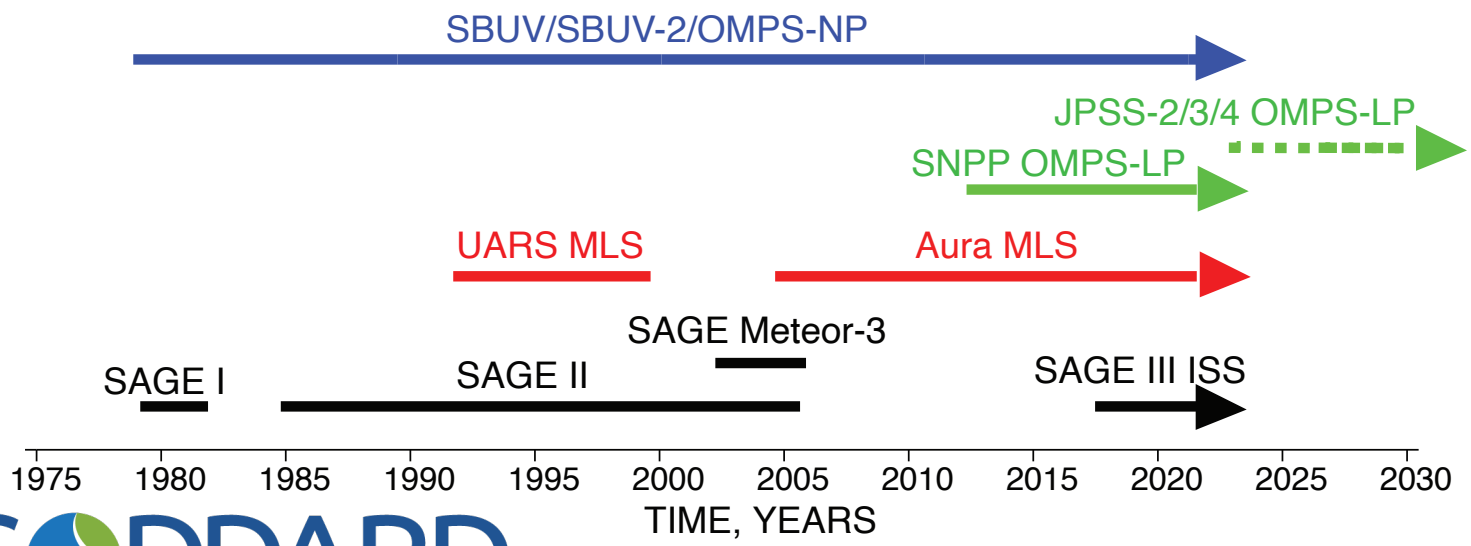
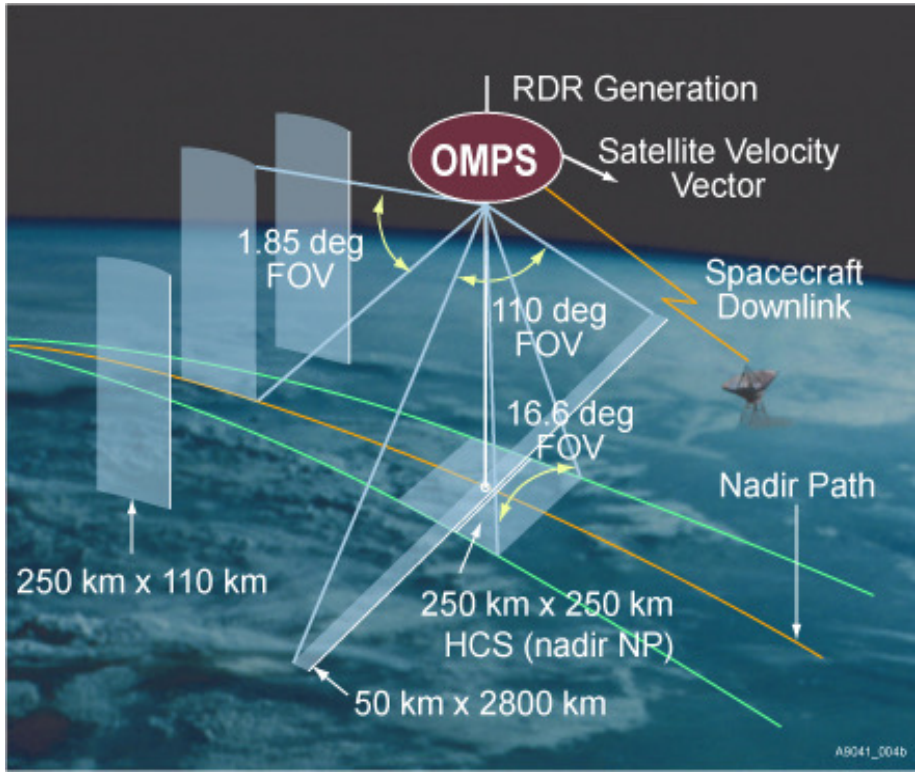
SATELLITE OZONE PROFILE MEASUREMENTS







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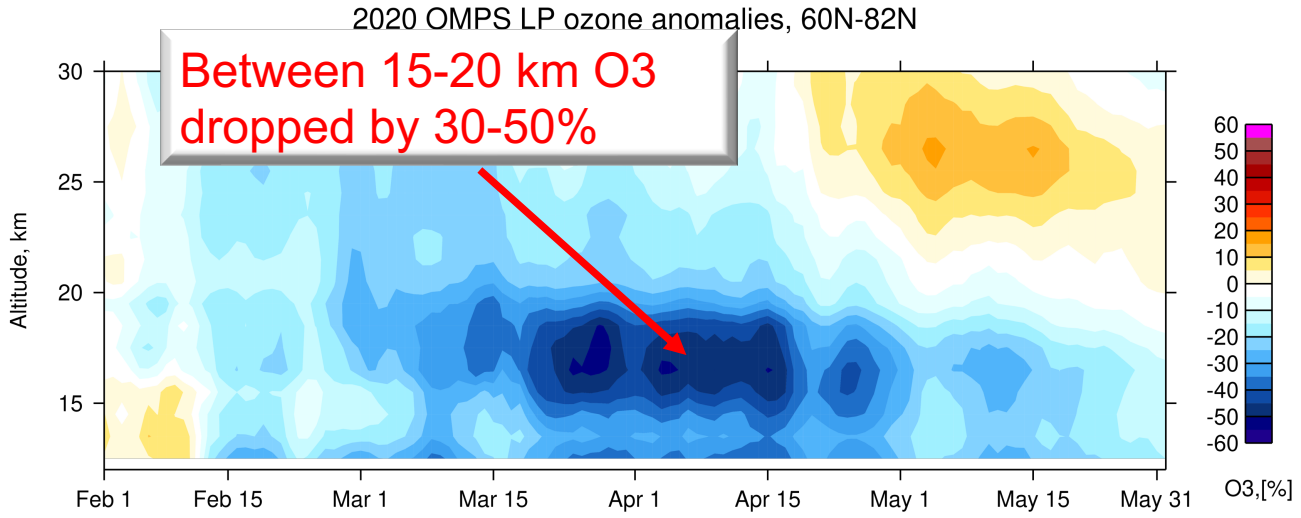
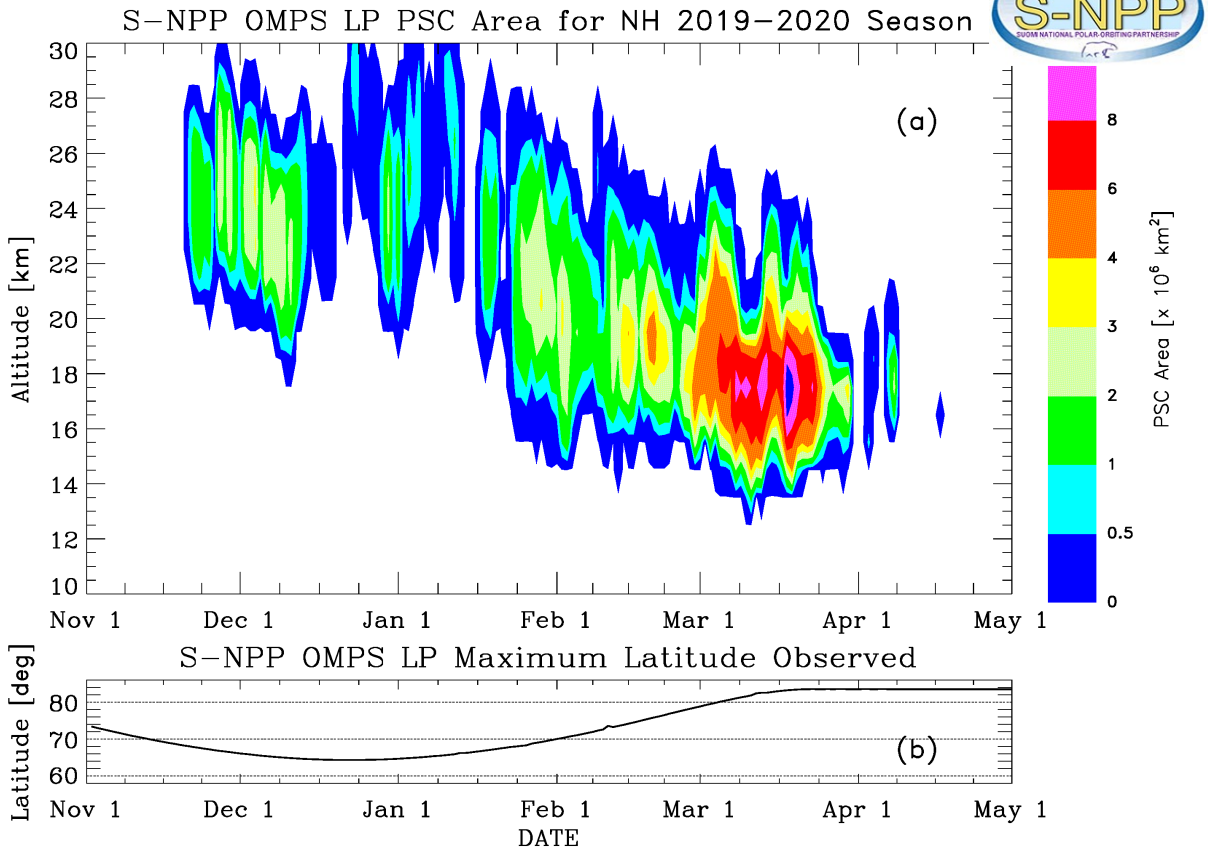
MONITORING POLAR OZONE DEPLETION WITH THE SNPP OMPS

- Feb-Mar 2020: Lack of planetary wave forcing → stratospheric T below average;
- Cold temperatures → increased volume of PSCs over the Arctic;
- The Arctic ozone depletion in March 2020 was the worst since 1979.





[DeLand et al., JRL, 2020]

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OMPS LP VERSION 2.6

Level 1	Level 2
Altitude registration: • Static correction update (1.58 km or +200 m); • Remove the second 100m step in Sep. 2014; • Simplified intra-orbital correction (~ 650 m);	Update O_3 and NO_2 absorption cross sections and climatologies: • Brion-Dumont-Mallicet (BDM) in UV (290-355 nm); • Serdyuchenko-Gorshelev (SG) in VIS (500-700 nm); • Update O_3 and NO_2 climatological profiles;
Update Stray Light correction: • Slit image increased by a factor of 1.5 for VIS; • 12% increase in the tails for PSF for OOR;	Combine UV and VIS radiances to retrieve a single O_3 profile;
Static radiometric calibrations updates: • Smoothed albedo pre-launch; • Goniometric Day-1 + seasonal component; • Wavelength scale Day 1 assignment	Increase number of wavelengths (6 UV pairs and 1 VIS triplet);
	Dynamical vertical range for each pair/triplet contribution (based on max sensitivity to O_3);
	Implement Tikhanov regularization to vertically smooth retrieved profiles;
Wavelength-shift correction (time-dependent);	Update convergence criteria and quality filters;
Radiometric calibration drift;	Switch to gamma-function aerosol size distribution;

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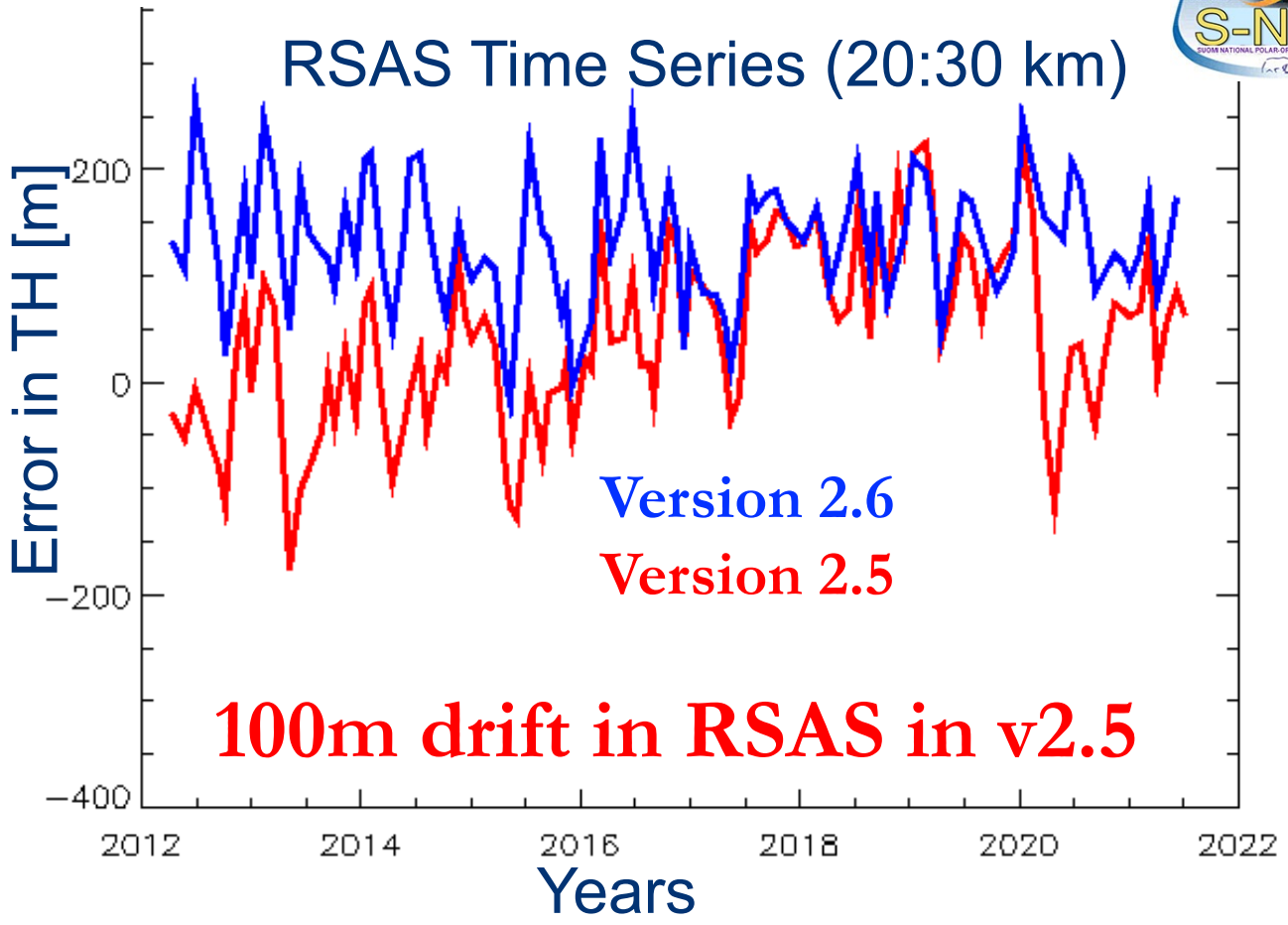
OMPS LP ALTITUDE REGISTRATION

- Uncertainties in the altitude registration are the main source of errors in the limb scattering technique (200 m → 5% error in O_3);
- Preliminary analysis of v2.6 data shows no significant drift in the center slit;
- Radiometric calibrations, improvements in forward model calculations and updated aerosol PSD led to improvements in RSAS time series in v2.6.



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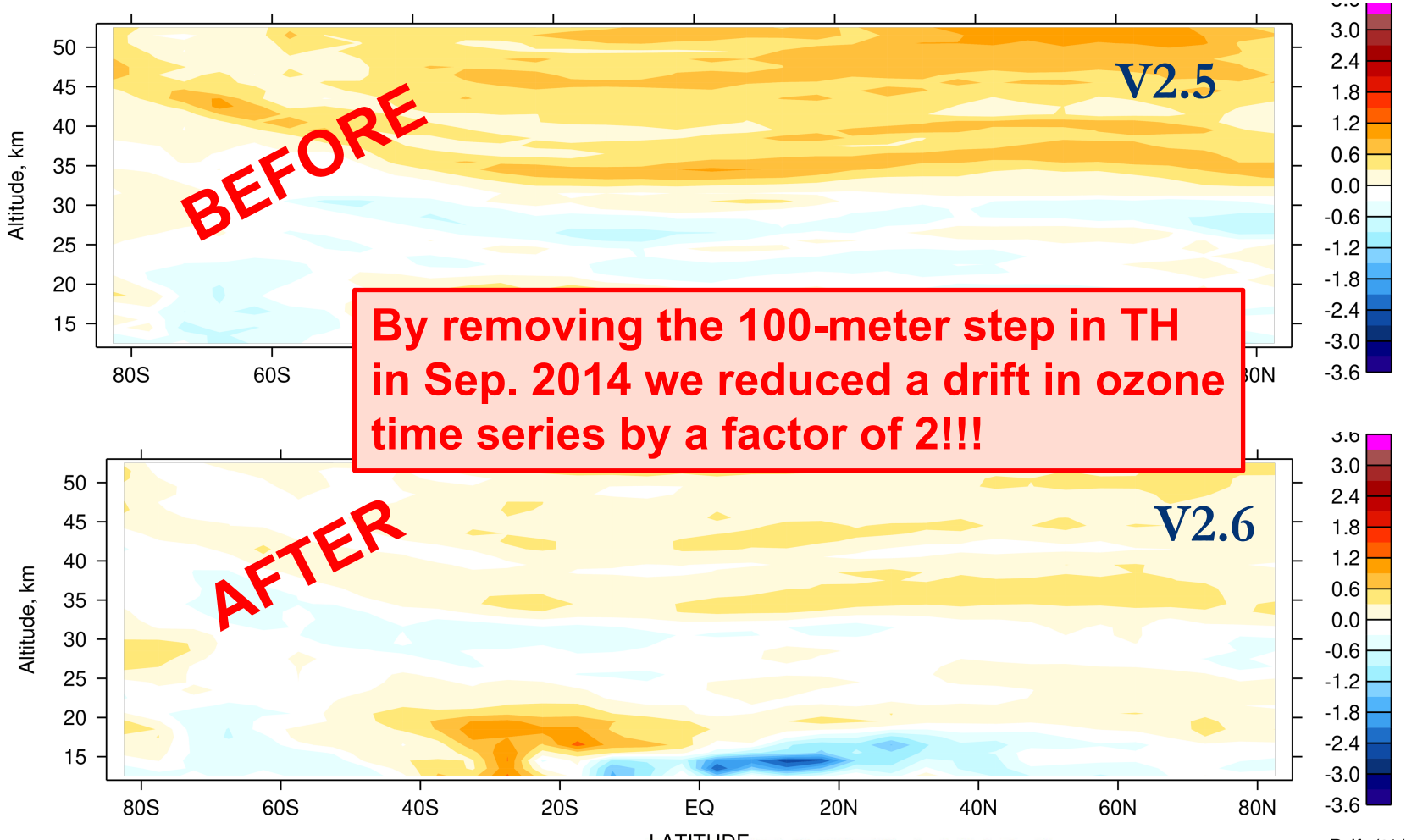
RELATIVE DRIFT AGAINST AURA MLS

- Several studies found a drift in v2.5 LP O_3 time series with the patterns consistent with a possible drift in altitude registration;
- Preliminary results demonstrate a factor of 2 reduction in relative drifts.



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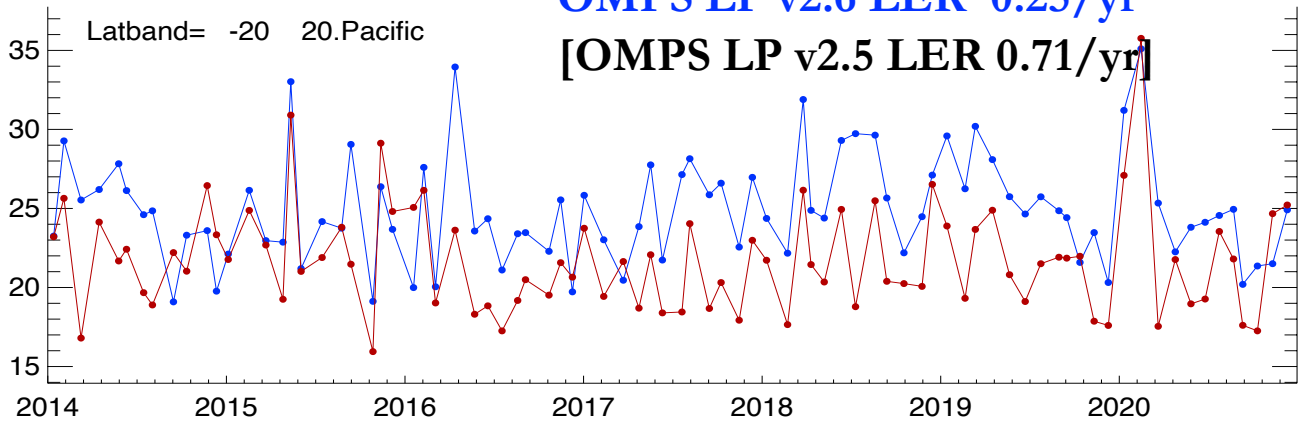
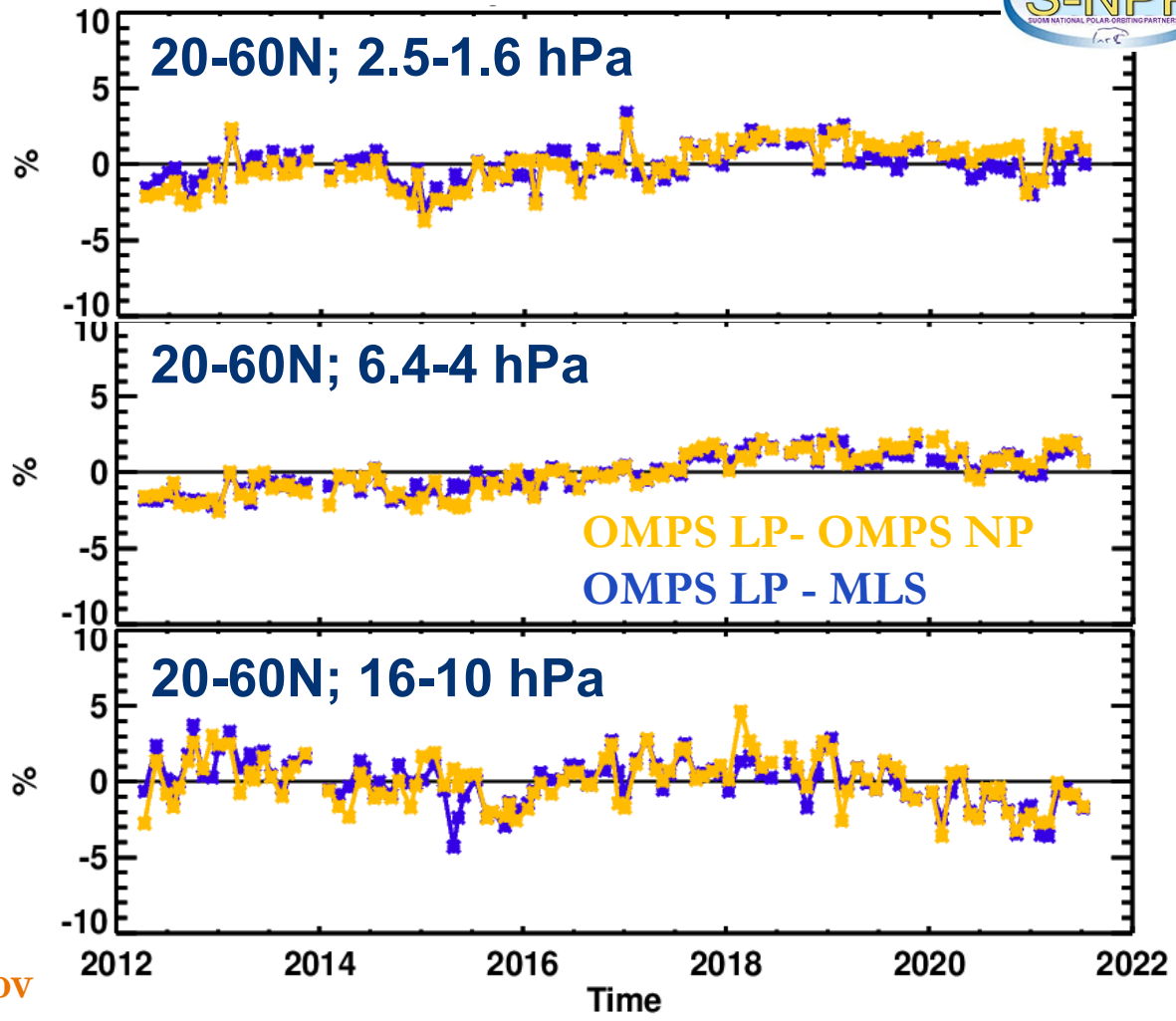
EVALUATION OF OMPS LP ALTITUDE REGISTRATION USING OMPS NADIR

We use reflectivity and ozone profiles derived from OMPS nadir to evaluate the accuracy of the LP altitude registration.

Reflectivity

OMPS NM LER -0.09/yr
OMPS LP v2.6 LER 0.25/yr
[OMPS LP v2.5 LER 0.71/yr]





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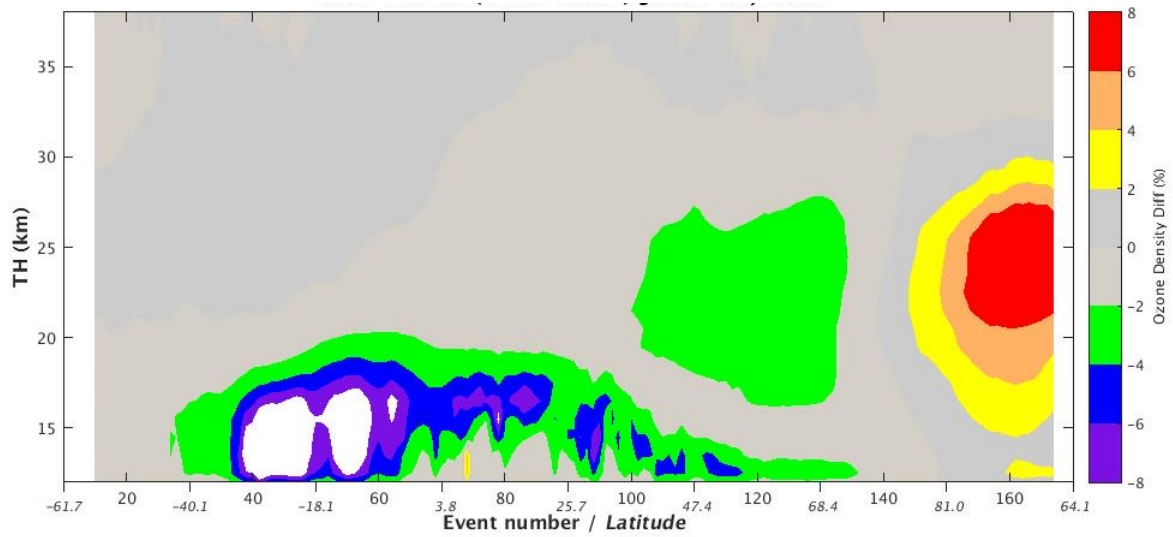
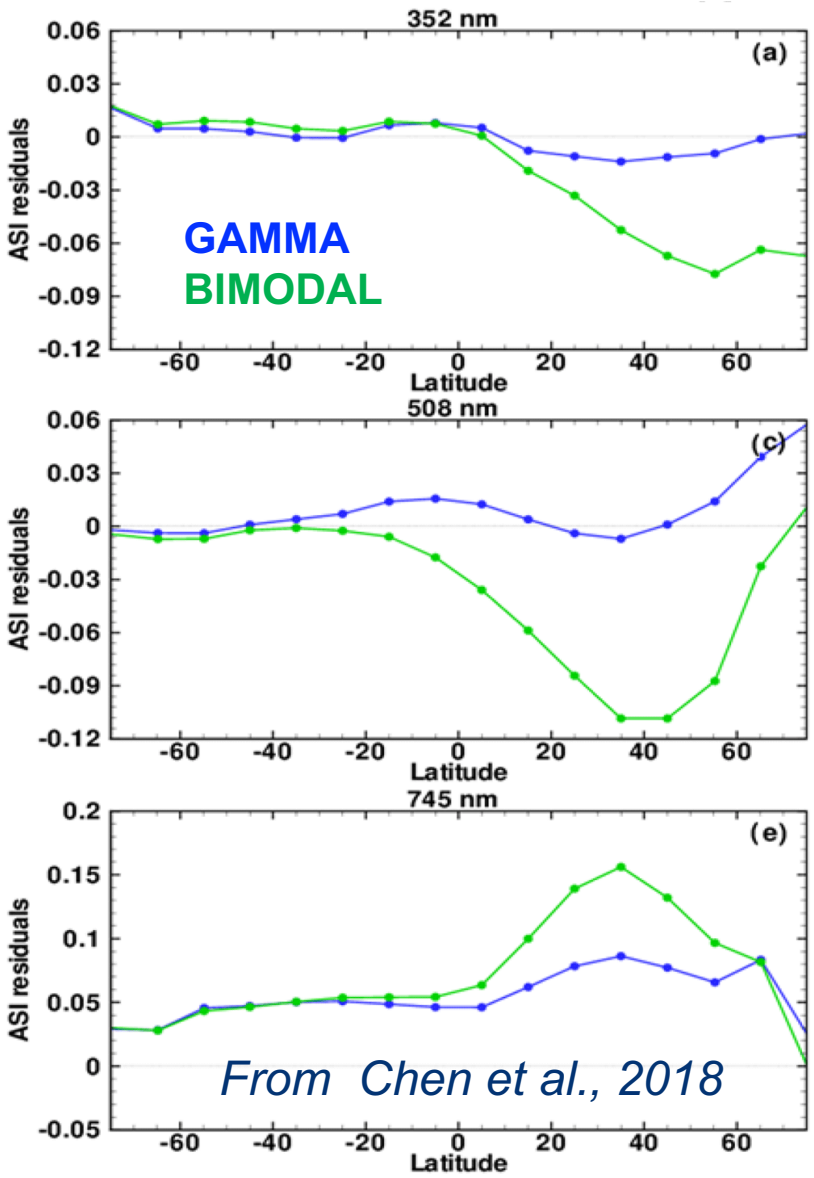
AEROSOL CORRECTION

In v2.5 we assumed the bimodal lognormal particle size distribution (PSD) which we replaced with the gamma function PSD in v2.6.

O3 differences, (Gamma-Bimodal)





From Chen et al., 2018

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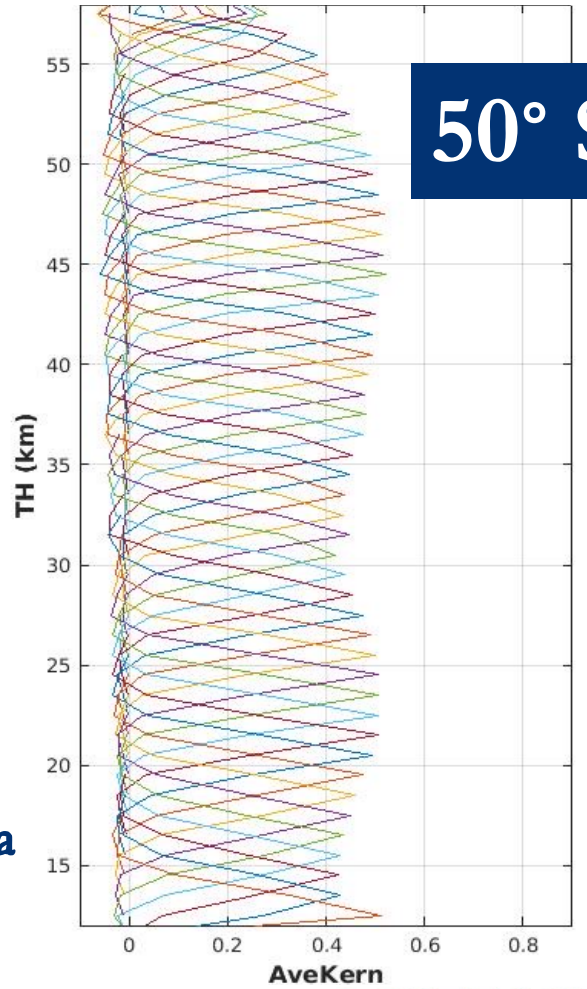
ALGORITHMIC CHANGES

Key changes include:

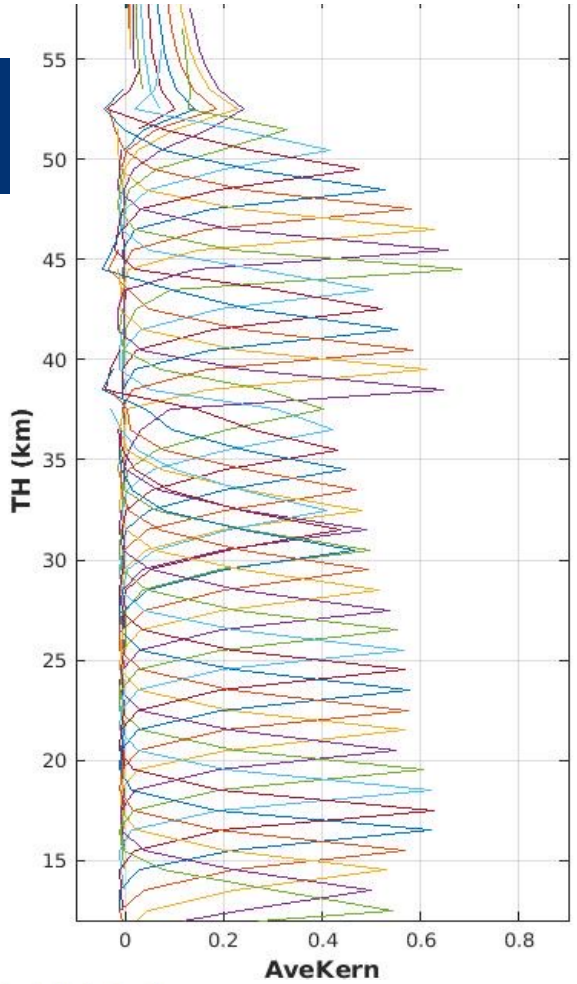
- Merged UV and VIS →combined O_3 profile;
- Increased number of UV pairs with dynamically controlled contributions;
- Replaced Optimal Estimation with Tikhanov regularization algorithm.

- The averaging kernels have consistent widths in the stratosphere leading to a vertical resolution of ~ 2 km
- The estimated precision reduced to 3-4% between 20 and 52 km (compared to 6-8% in V2.5).
- Updated convergence criteria and quality flags for data screening.

Averaging Kernels v2.6



Averaging Kernels v2.5



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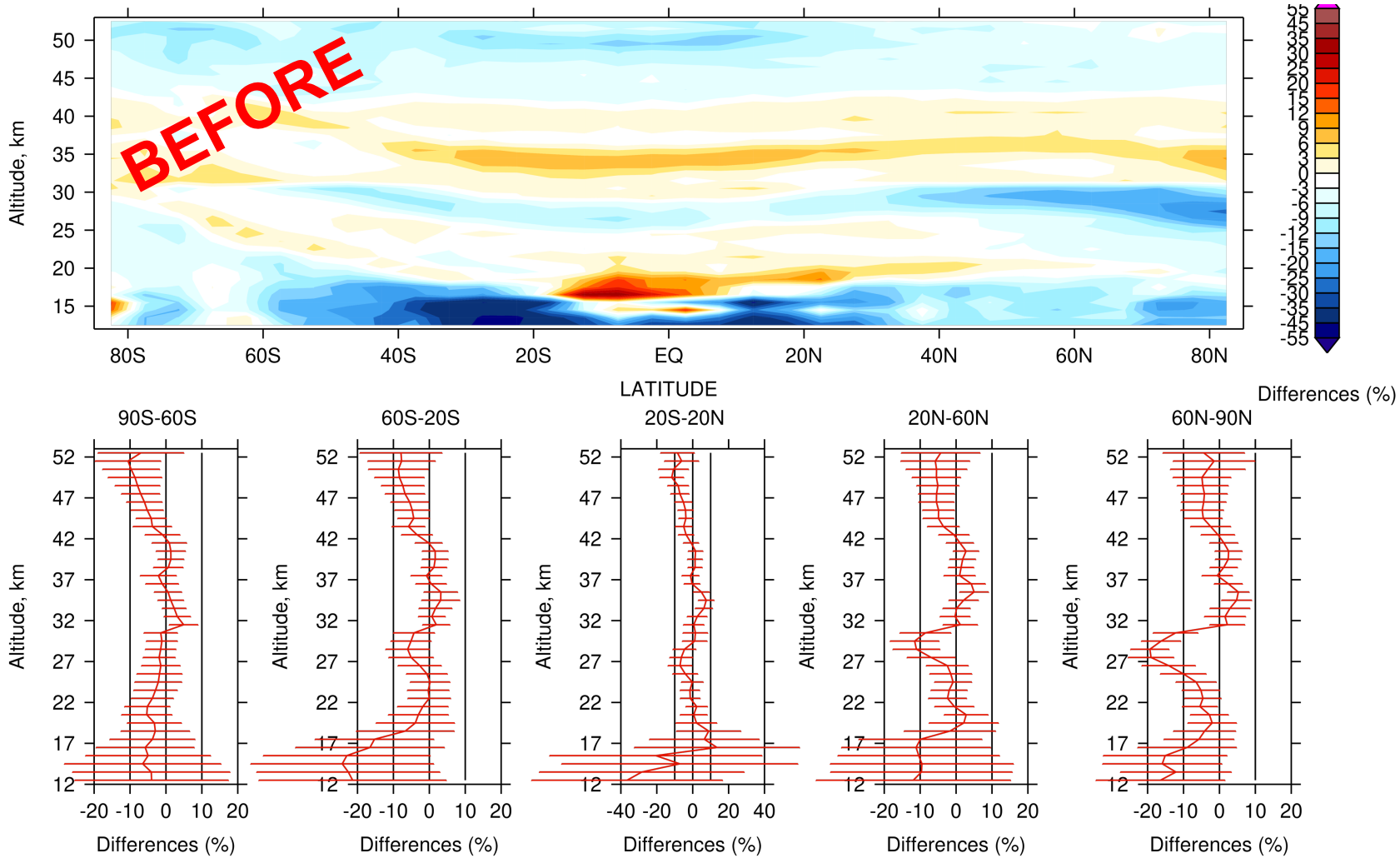
Mean differences OMPS LP v2.5 and MLS v5



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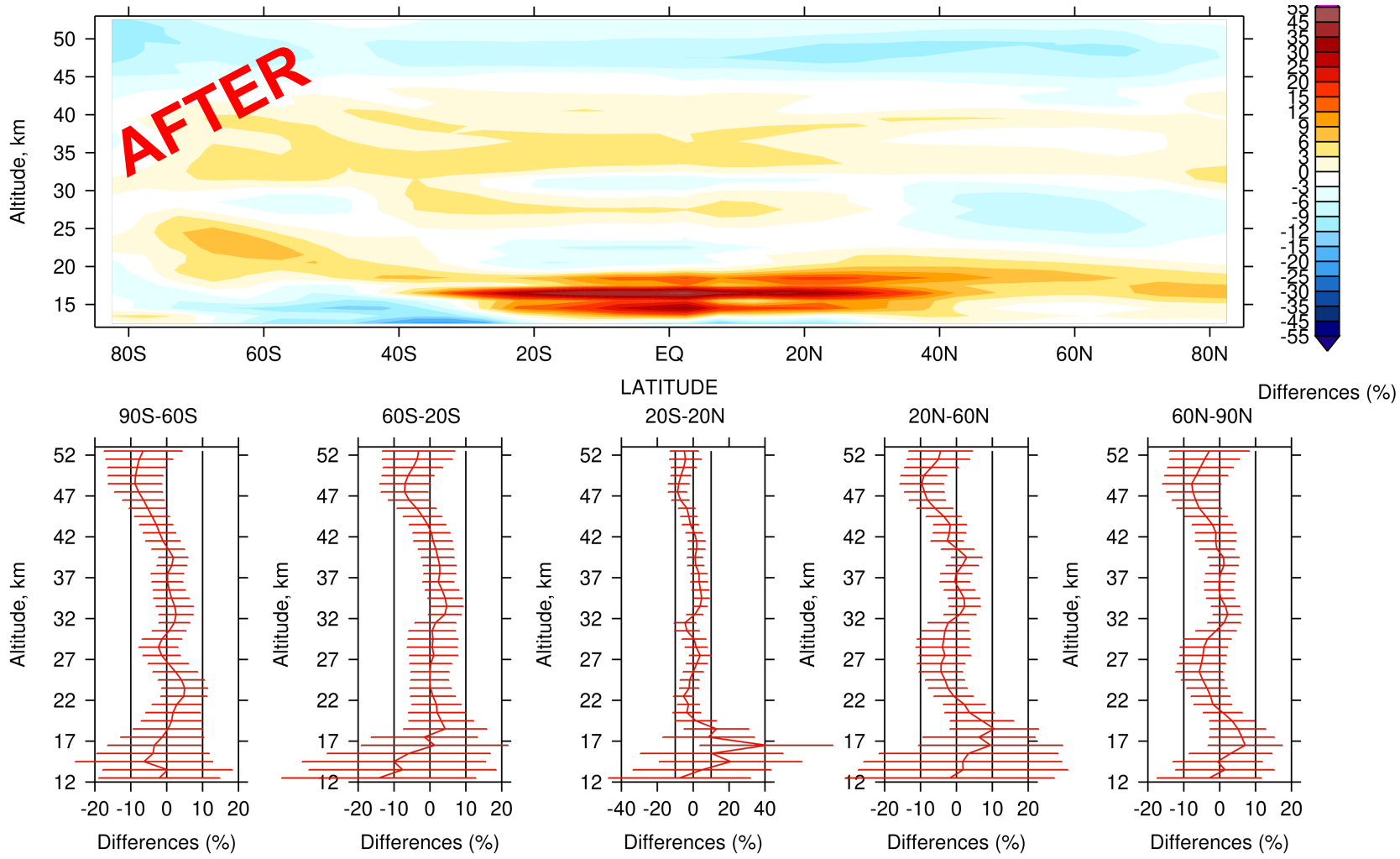
Mean differences OMPS LP v2.6 and MLS v5



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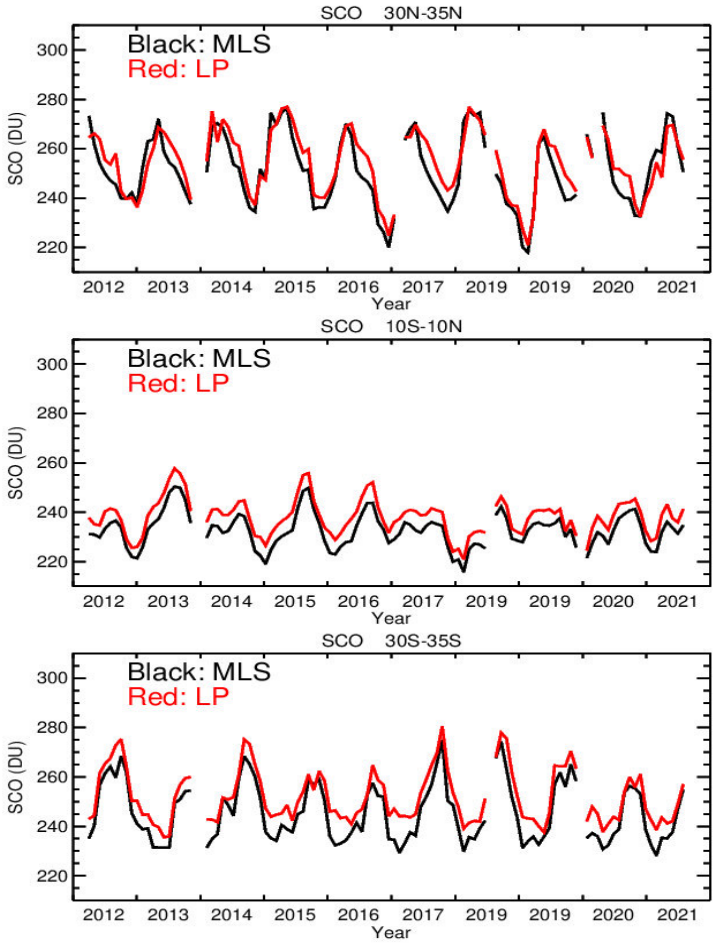
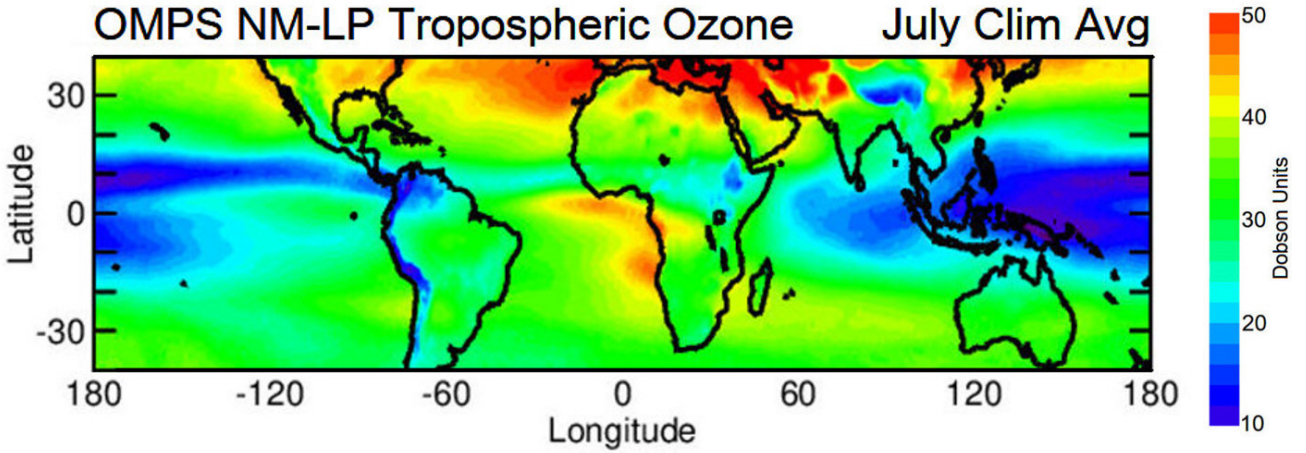
TROPOSPHERIC OZONE FROM OMPS LIMB AND NADIR



For daily tropospheric ozone maps, stratosp ozone columns (SCO) from LP are highly consistent with MLS

However, the current 12.5 km low altitude cutoff for LP ozone profiles limits global coverage to about ±40° latitudes



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SUMMARY:

Improvements in v2.6 include:

- ✓ Updated, traceable cross-sections and climatologies for O_3 and NO_2.
- ✓ Consistent sensitivity and vertical resolution from lower stratosphere to lower mesosphere, realistic precision.
- ✓ Combined UV/VIS profile enables smoother transition between UV and VIS.
- ✓ Substantial reduction in relative drift against MLS.

https://ozoneaq.gsfc.nasa.gov/data/ozone/

JPSS-2 (NOAA-21) successfully lifted off from Vandenberg Space Force Base on November 10, 2022 at 1:49 a.m.

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BACK-UP SLIDES

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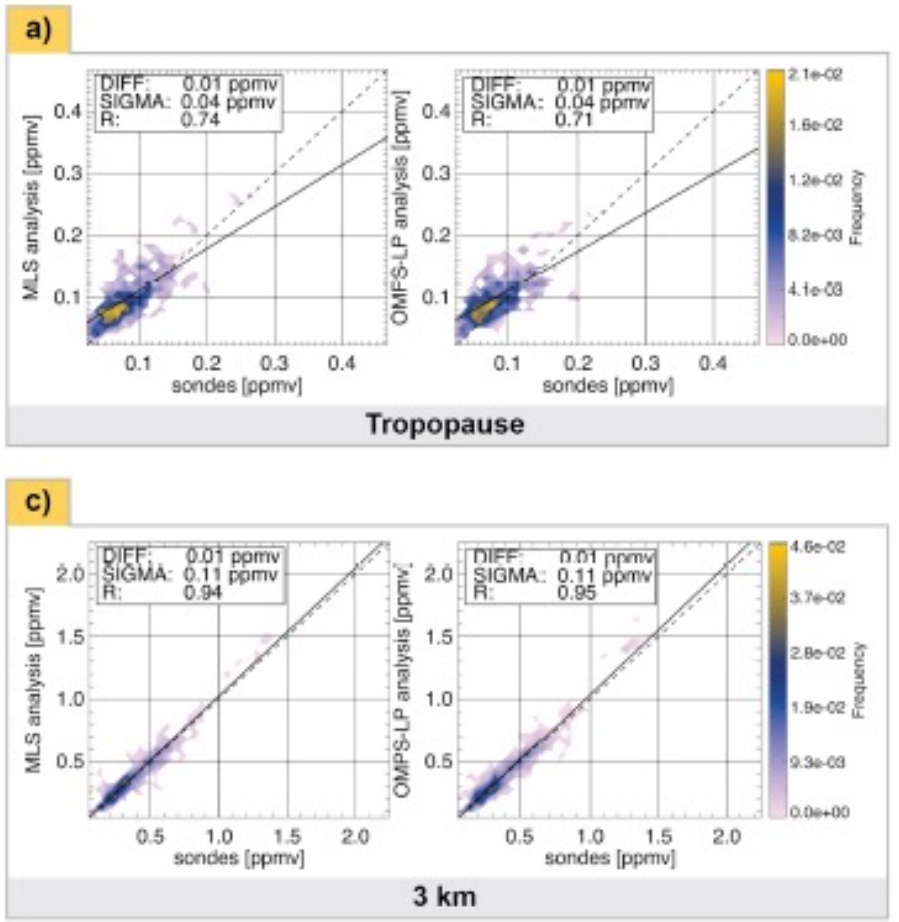
ASSIMILATION OF OMPS LP OZONE

- *MLS and OMPS-LP assimilation experiments are in good agreement with independent data and with each other*
- However, further work is needed to reduce a long-term spurious drift in OMPS-LP data



[Wargan et al., JGR, 2020]

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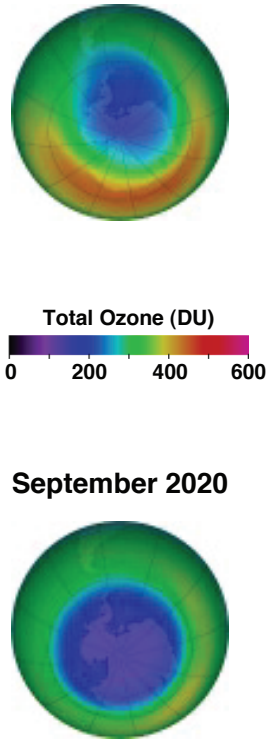
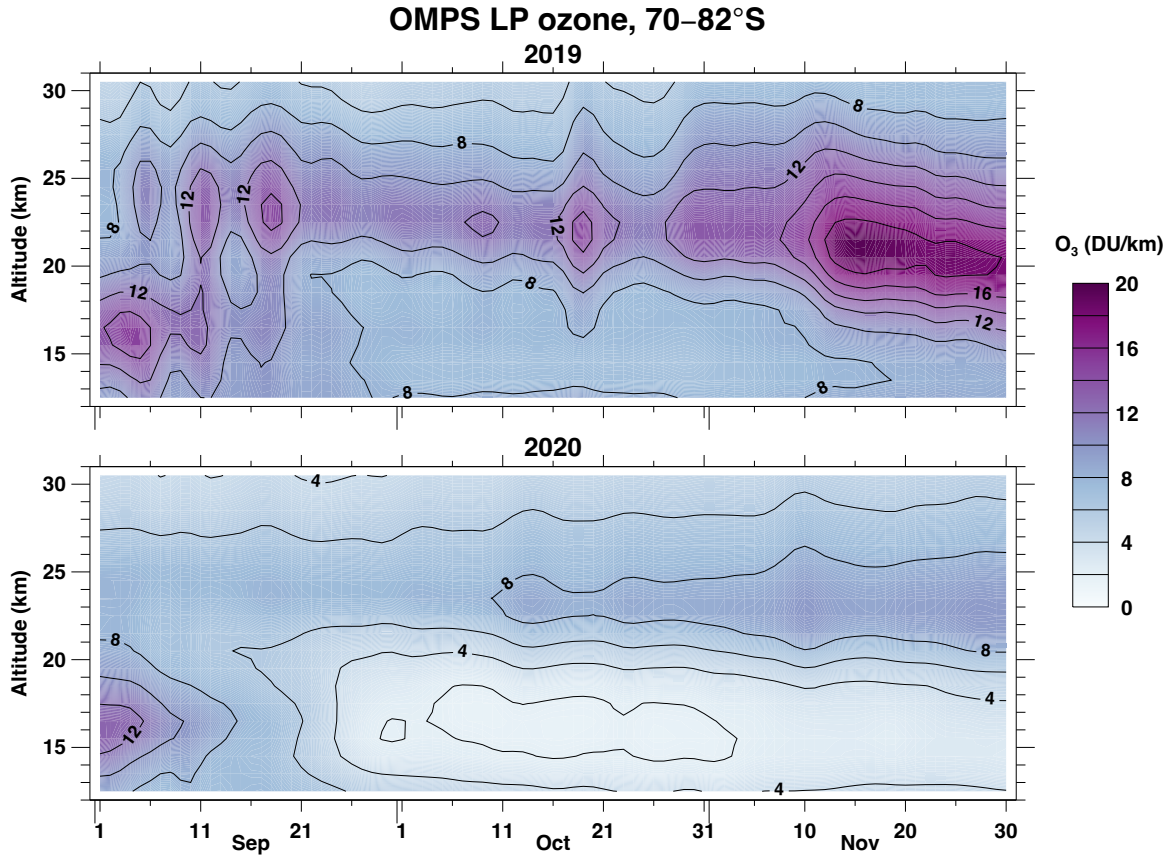
MONITORING POLAR OZONE DEPLETION WITH THE SUOMI NPP OMPS

- 2019: strong stratospheric warming weakened the polar vortex in earlier September resulting in the smallest ozone hole since early 1980s.
- 2020: persistently cold temperatures and strong circum-polar winds led to formation of a large, deep and long-lasting ozone hole.
- Continuation of ozone observations with OMPS instruments on board of Suomi NPP, NOAA-20 and upcoming JPSS-2, -3 and -4 is critical for the next decades to monitor the Antarctic ozone recovery.





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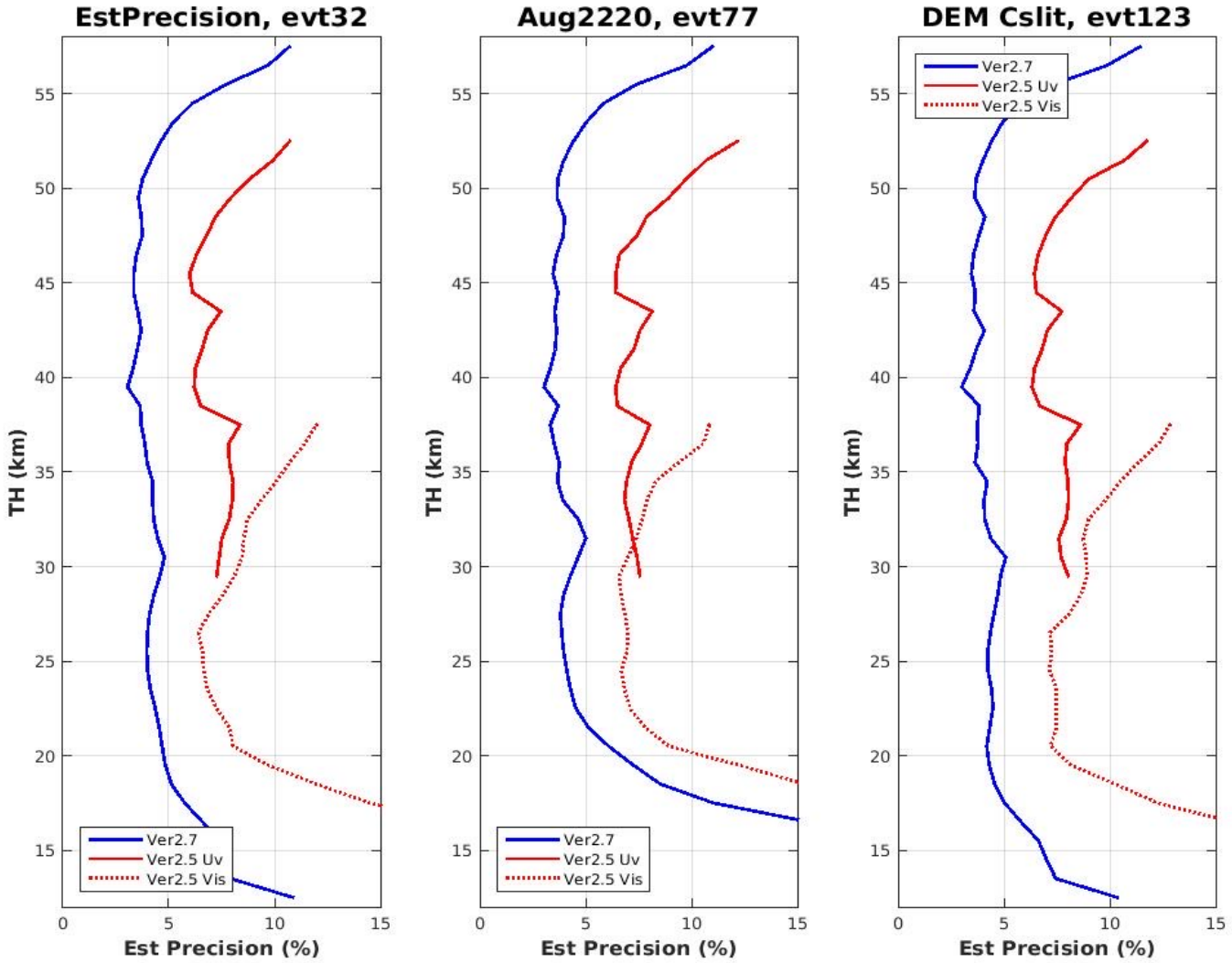
ALGORITHMIC CHANGES IN V2.6



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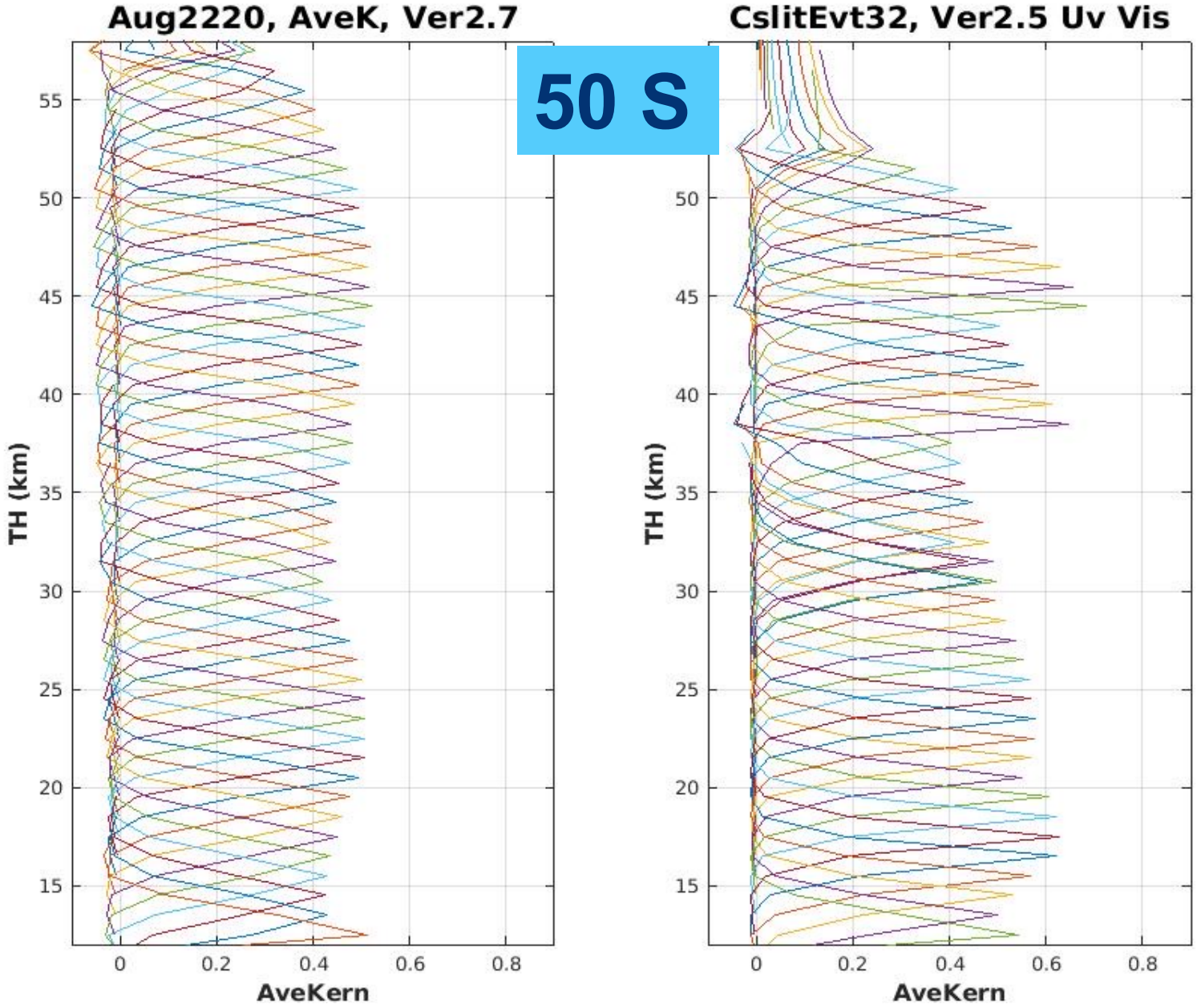
Algorithmic changes in v2.6

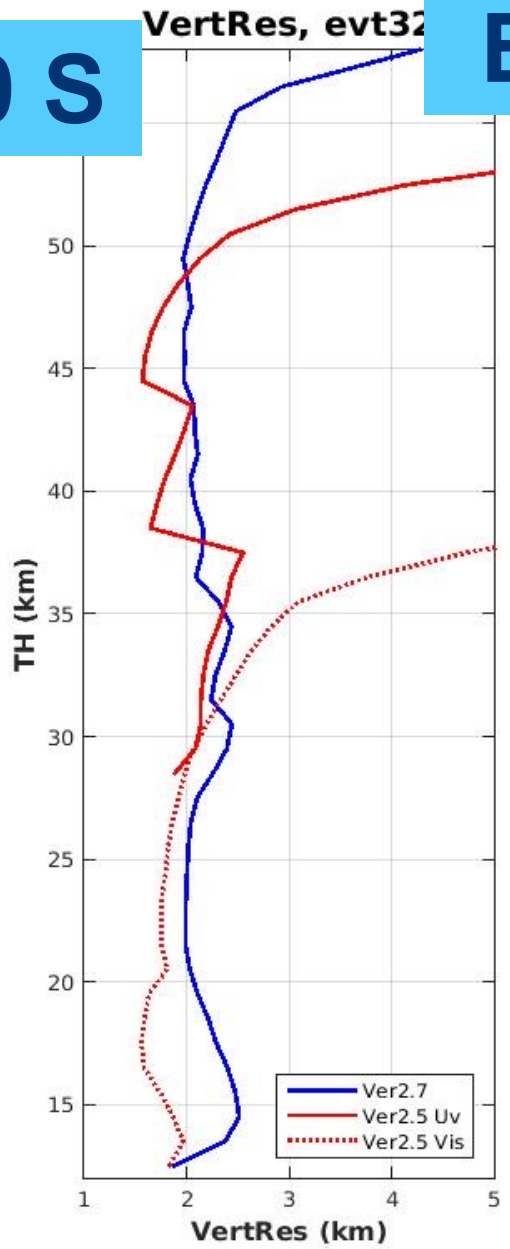


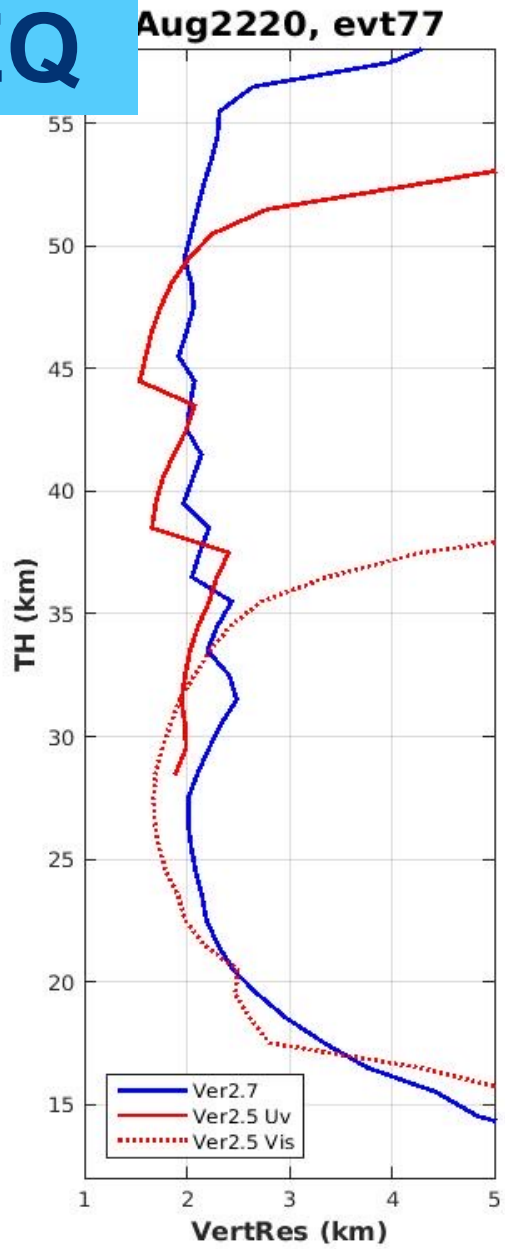
Algorithmic changes in v2.6

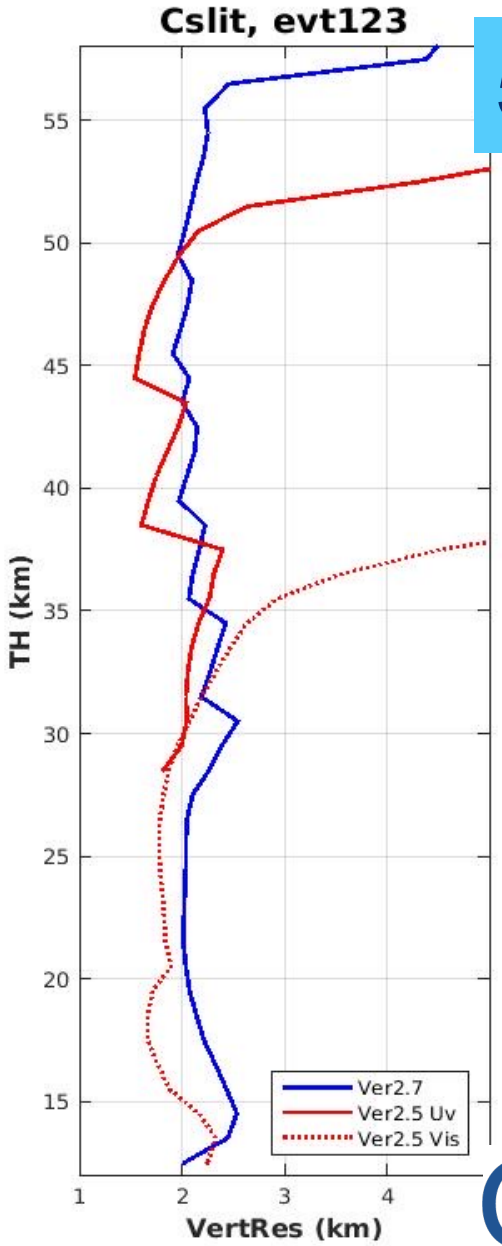
50 S

EQ

50 N







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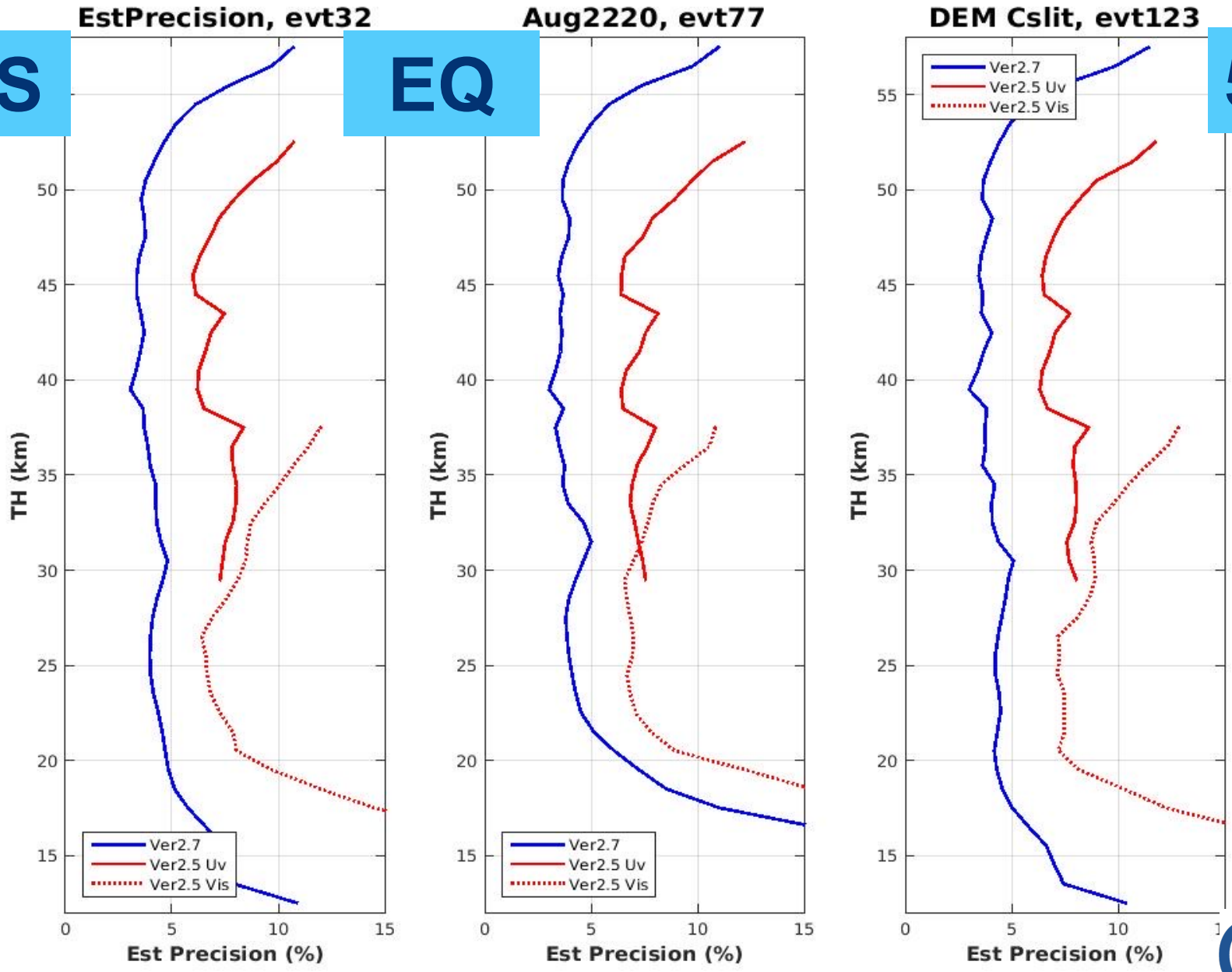

Ozone Profiles. OMPS LP v2.5, v2.6 and MLS v5

May 40 S