LP L1B Status and Results

- Preparing for V2.5 ozone reprocessing in early 2015 (shift retrieval altitude ranges, improve altitude registration, add aerosol correction).
- Revise tangent height adjustment parameters to reduce biases between slits.
  - Analyze variations in slit edge position to derive quantitative pointing changes for L1B processing.
  - Separate analysis of L2 radiance results (305 nm remainder) also gives slit-to-slit and intra-orbit TH variations that can be evaluated.
- Use LP radiances and radiative transfer model to evaluate reported pressures from GMAO, MLS.
- Examine cloud effects in LP measurements away from tangent point (PSCs, PMCs).

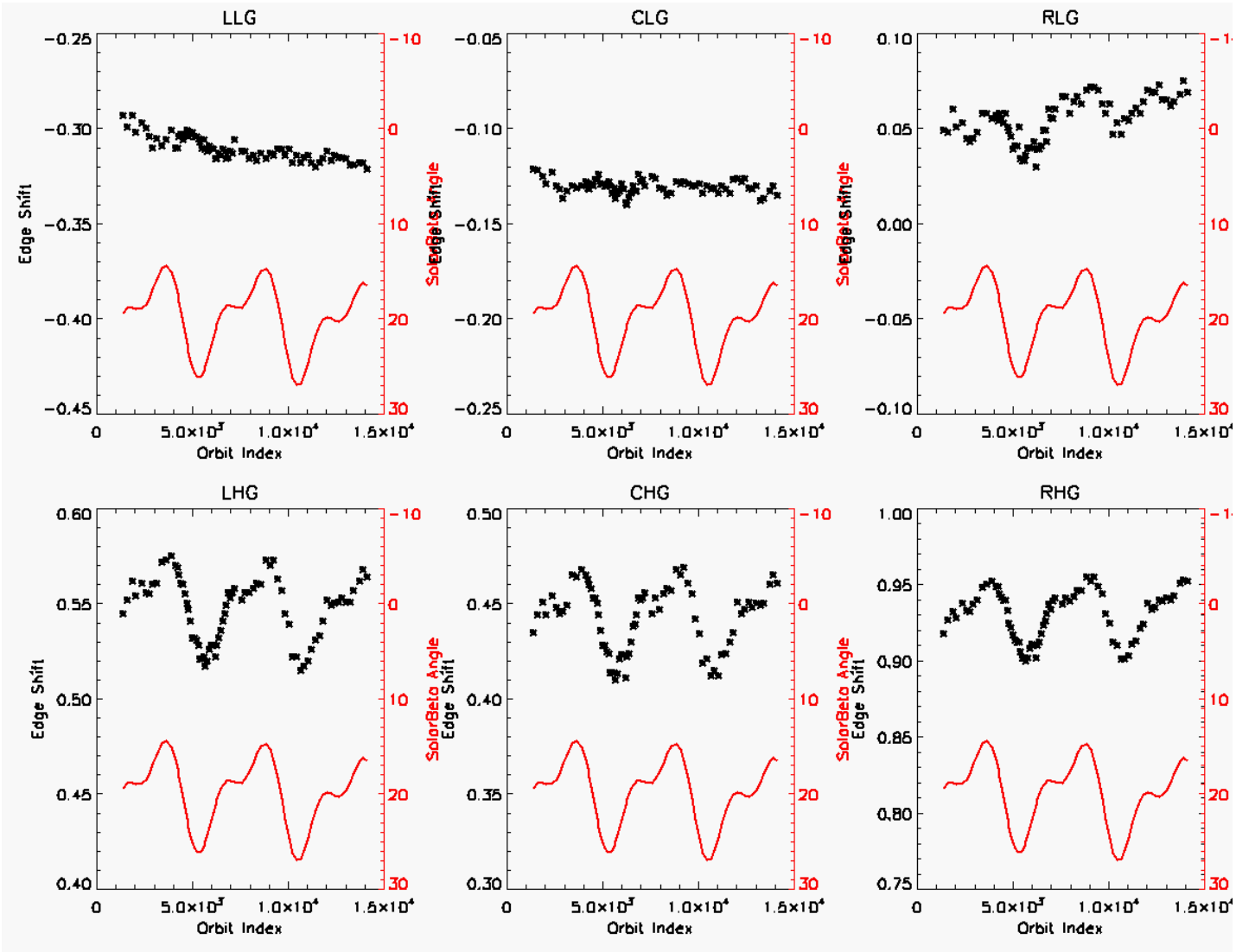
Tangent Height – Level 1 Data

- Determine location of slit edge on CCD for each aperture (left/center/right, low gain and high gain) using full-frame data.
- Absolute offsets are observed in addition to known ground-to-orbit pointing shifts.
- Hypothesis of star tracker pointing offset in pitch (1-2 arcmin) is supported by VIIRS data.
- Seasonal pointing variations correlated with solar beta angle are small [< 100 m in TH].
- Intra-orbit pointing changes [200-400 m in TH] are observed at end of orbit (t > 40 minutes).

Slit Edge Shift *vs*. Time

Low Gain

High Gain

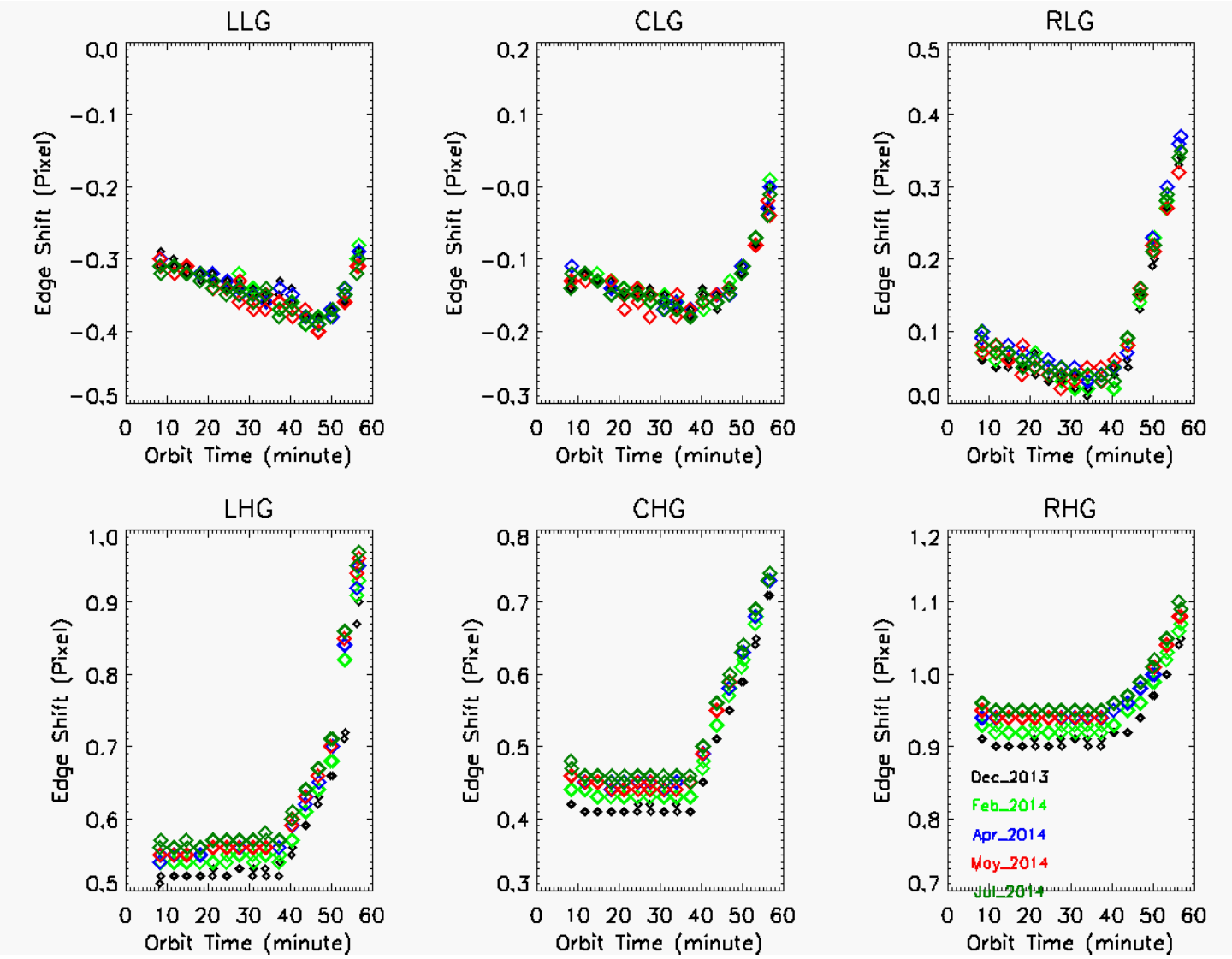


Weekly full frame measurements throughout NPP mission

Intra-Orbit Slit Edge Shift

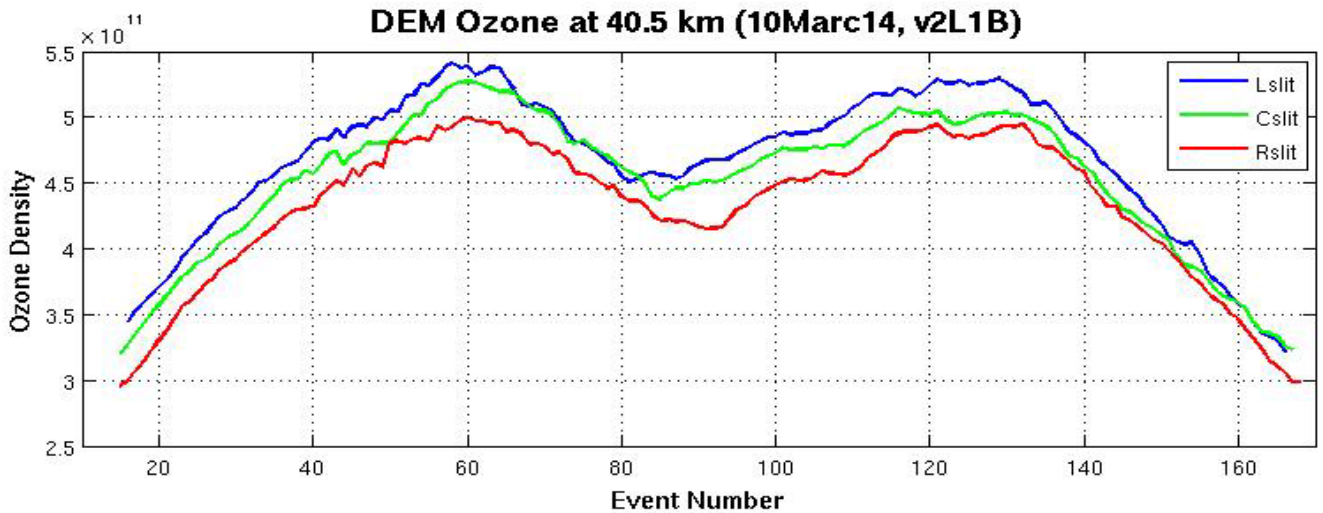
Low Gain

High Gain

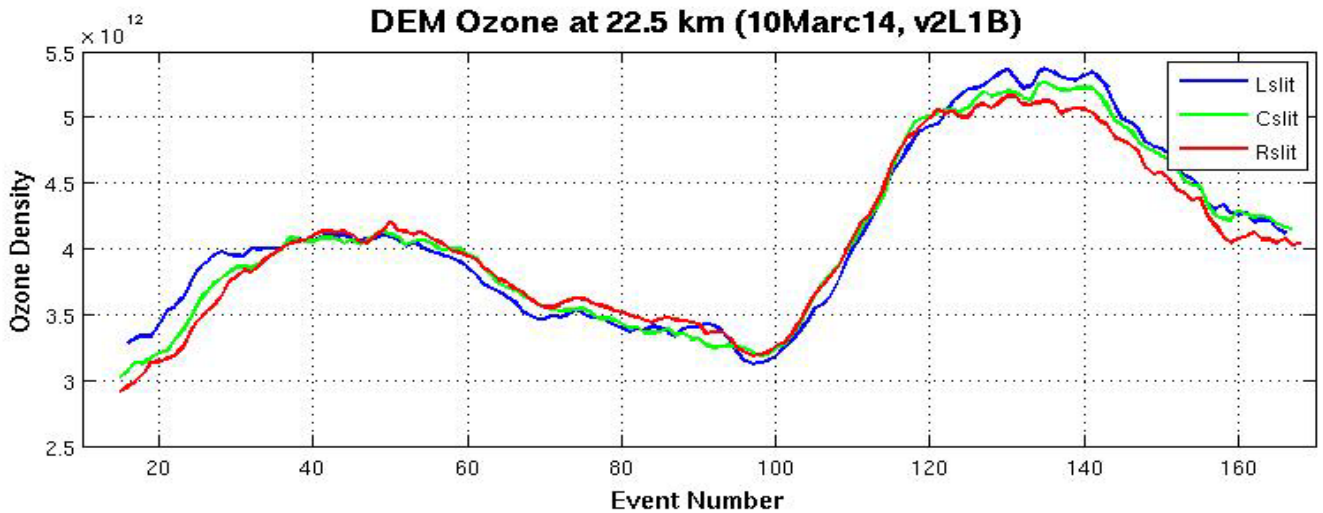


Intra-orbit Ozone – V2 L1B Data

40.5 km = more sensitive to TH error

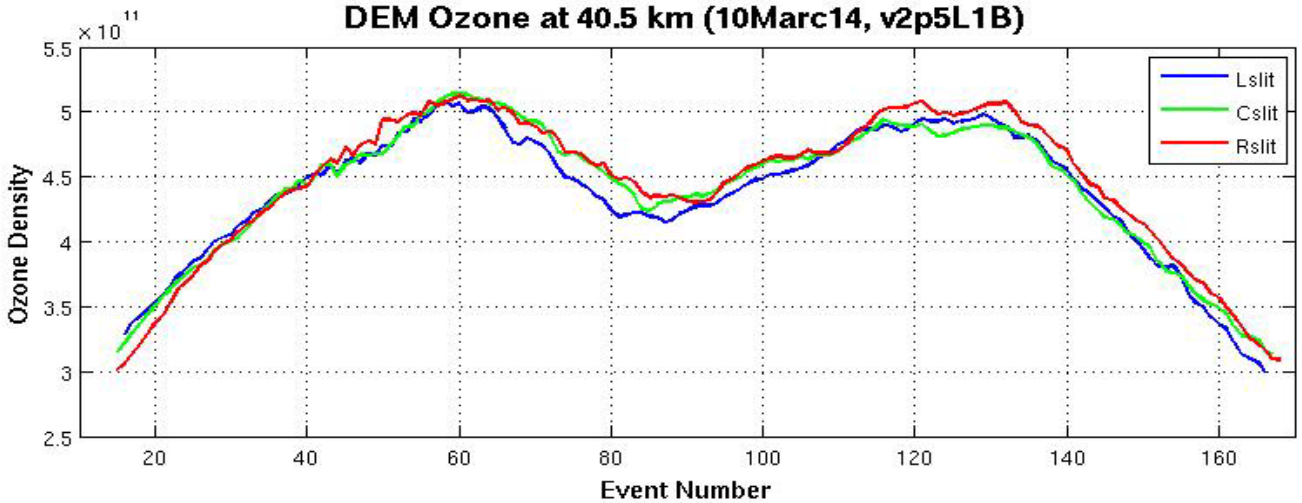


22.5 km = less sensitive to TH error

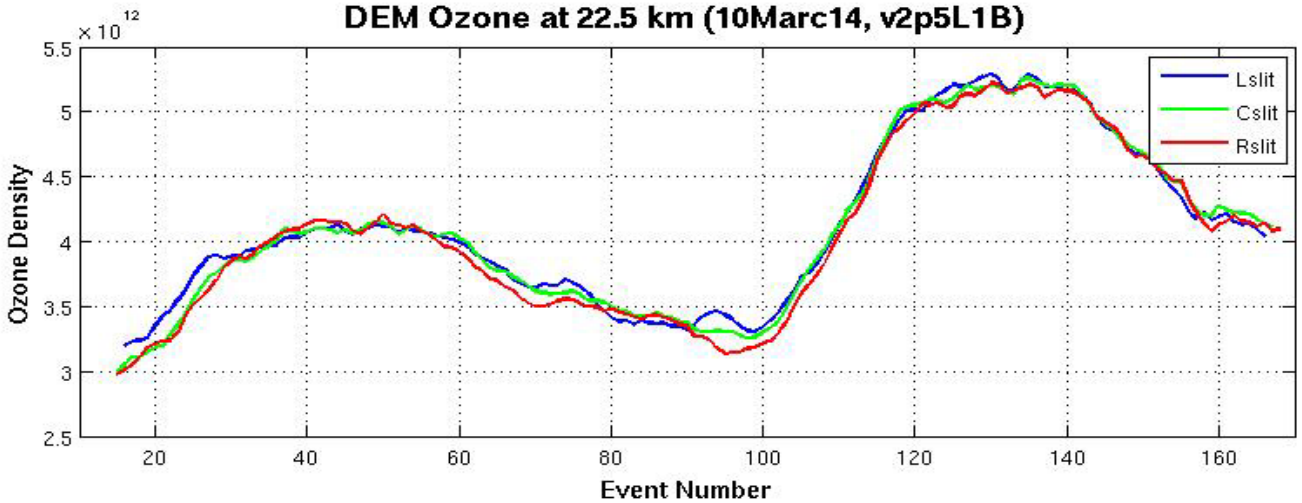


Intra-orbit Ozone – L1B with ΔTH

40.5 km = more sensitive to TH error



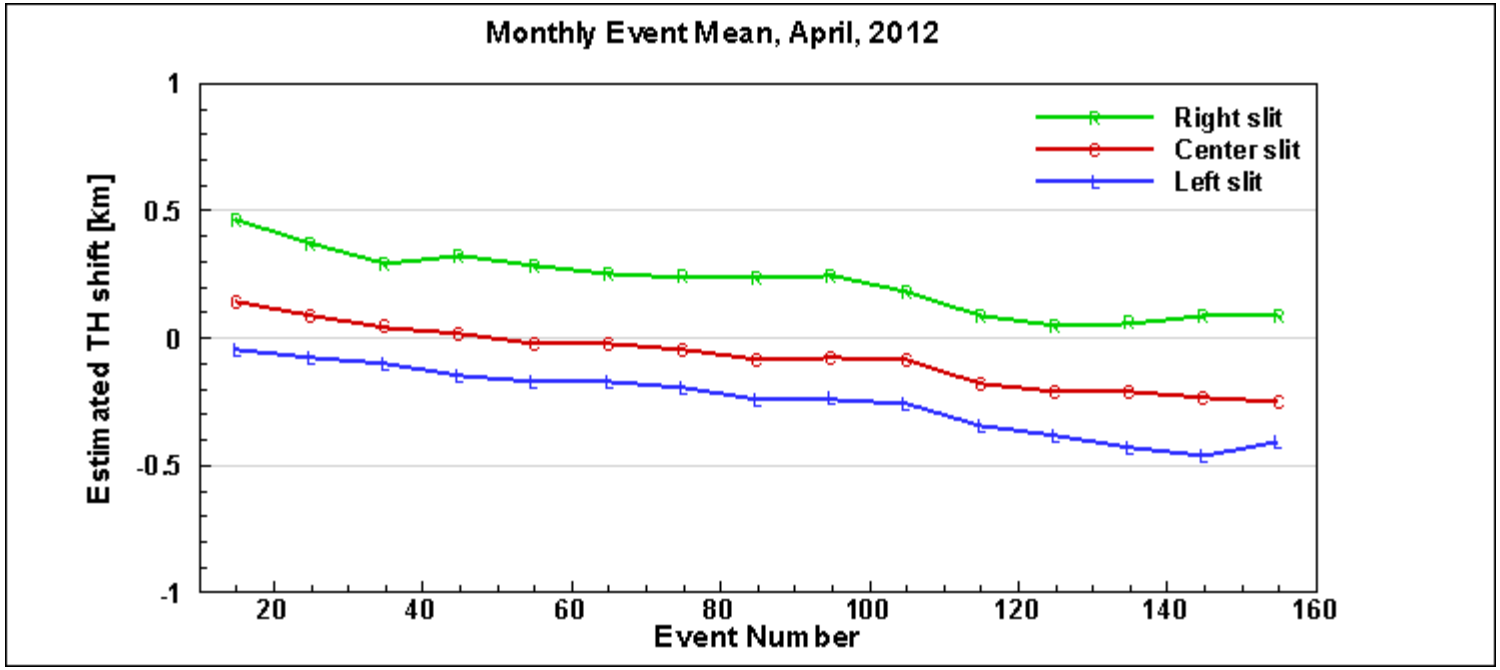
22.5 km = less sensitive to TH error



Tangent Height – Level 2 Data

- Evaluate errors for each slit using remainder method at 305 nm.
- L2 test processing for selected dates, using single set of monthly average TH adjustment results to correct for slit-to-slit, intra-orbit variations.
- Results show smaller remainders with less intra-orbit variation, improved agreement in ozone values between slits.
- Need to repeat analysis with revised L1B data.

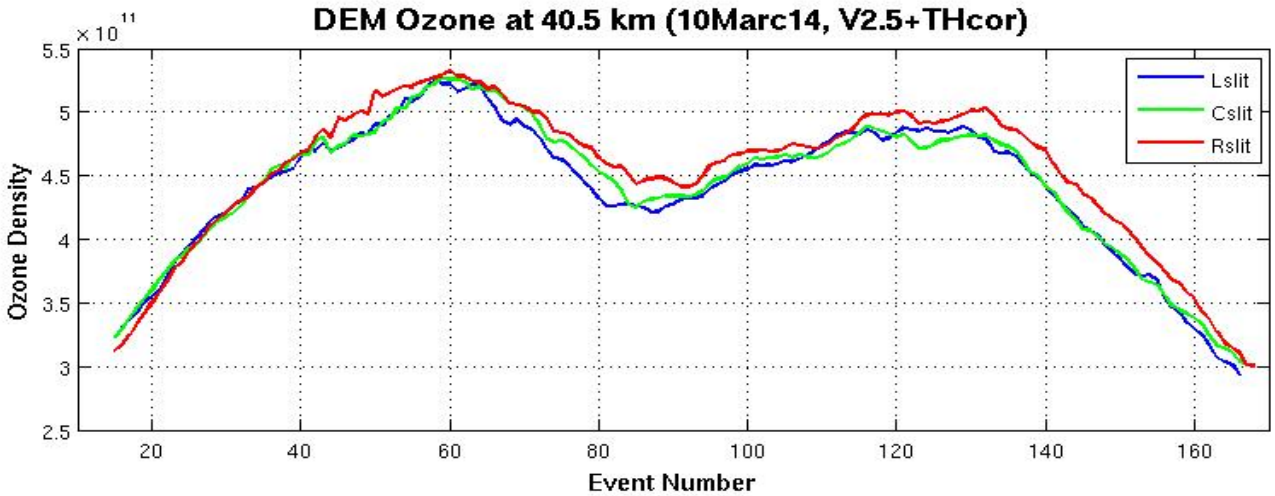
Derived Monthly Mean TH Error



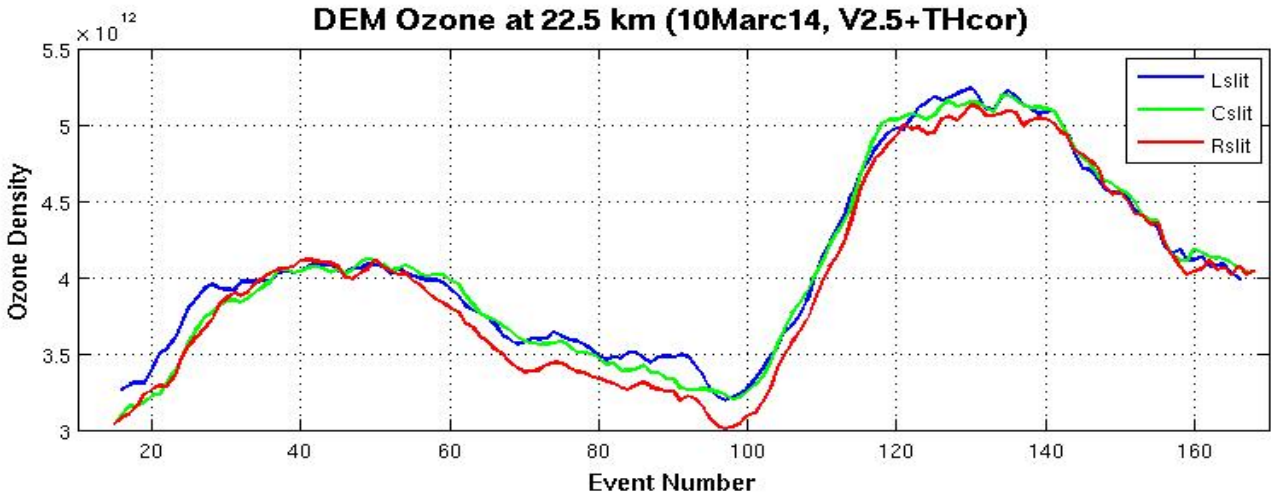
- Results derived from 305 nm remainder (radiance residual at 55 km, adjusted for altitude normalization and aerosol scattering).
- Monthly average, 10-event bin values shown for each slit.
- Convert to TH error using slope of radiance profile.

Intra-orbit Ozone – V2.5 + L2 ΔTH

40.5 km = more sensitive to TH error



22.5 km = less sensitive to TH error

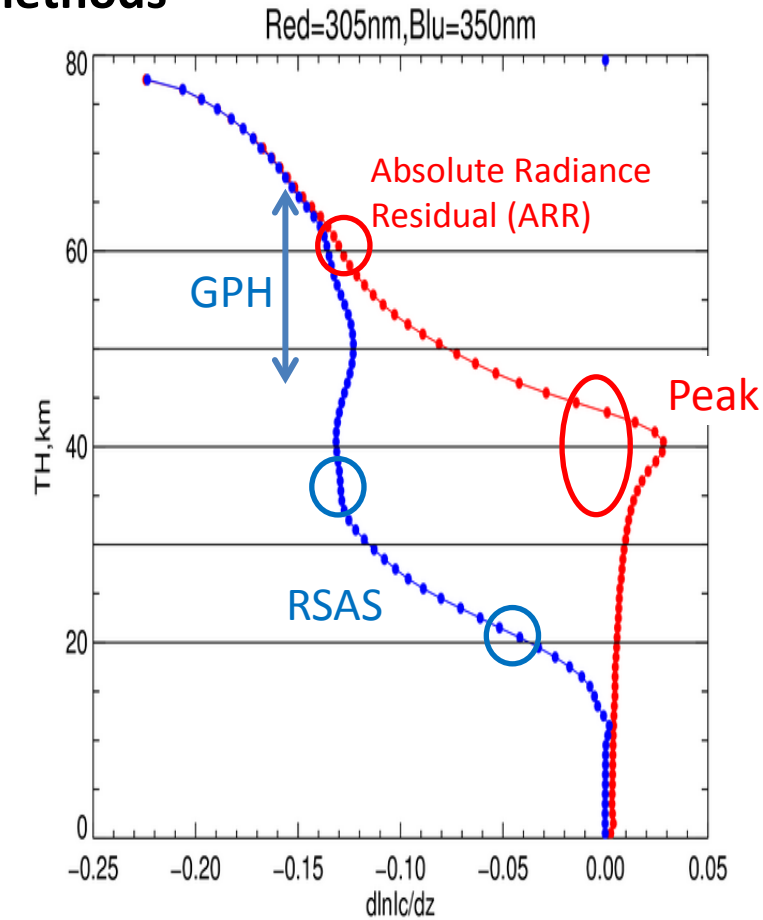


Evaluation of Pressure Profiles

- External pressure profiles (as created from geopotential height [GPH] data) are used in LP ozone retrieval, and to convert LP ozone density profiles into mixing ratio format. GMAO ancillary data used for V2 processing.
- LP radiance residuals can provide information about accuracy of input GPH profile.
- Run radiative transfer model with GPH data (MLS or GMAO) as input.
- Examine altitude dependence of radiance residuals.

Summary of TH registration methods

Absolute Radiance Residual Method	RSAS Method	Peak Method
+200m to -200m along an orbit	+200 m at Start of orbit	+200m to -200m along an orbit



Absolute Radiance Method

$$TH_ARR(km) = Res(305nm, 60km) * \frac{dz(km)}{dI(305nm, 60km)}$$

Peak Method

$$\text{Res}(305\text{nm}, \sim 35\ to\ \sim 45km) = \frac{dRad(calc)}{dTH} dTH_peak$$

Linearly interpolate Res to Radiance gradient, slope is dTH

RSAS Method

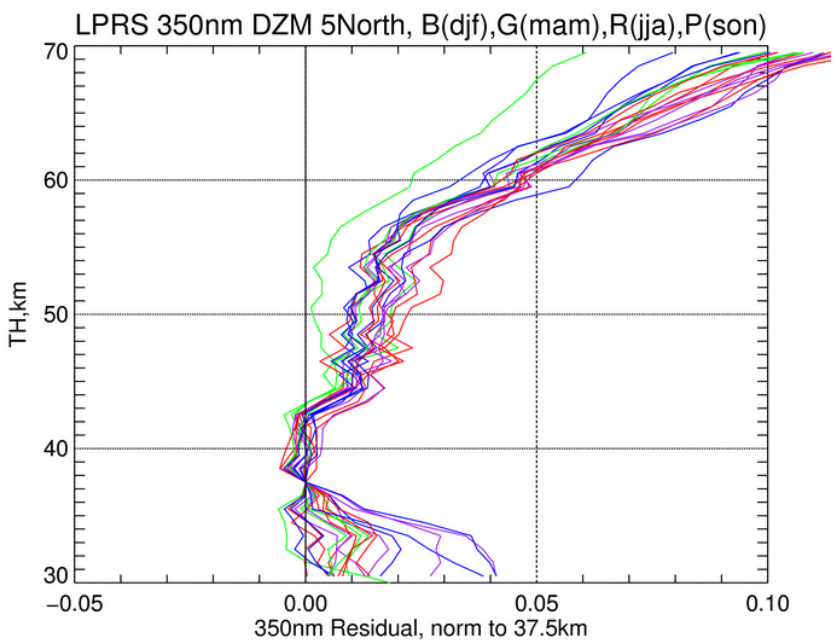
$$TH_RSAS(km) = \{Res(350nm, 32km) - Res(350nm, 20km)\} * \frac{dz(km)}{dRes(350nm, 30km)}$$

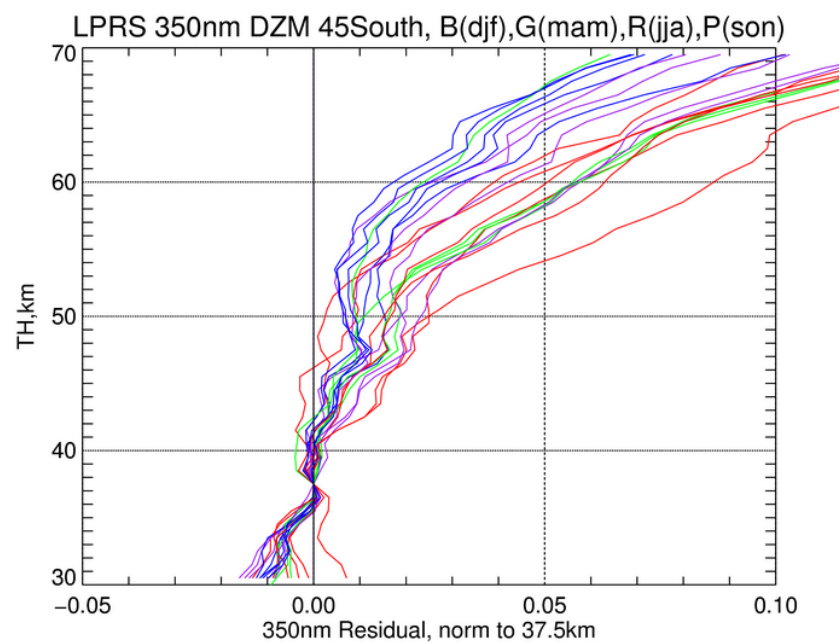
Evaluation of GPH profile

$$\text{GPH error}(km) = \{Res(350nm, 35{:}\,65km) - Res(350nm, 37km)\} * \frac{dz(km)}{dRes(350nm, 37km)}$$

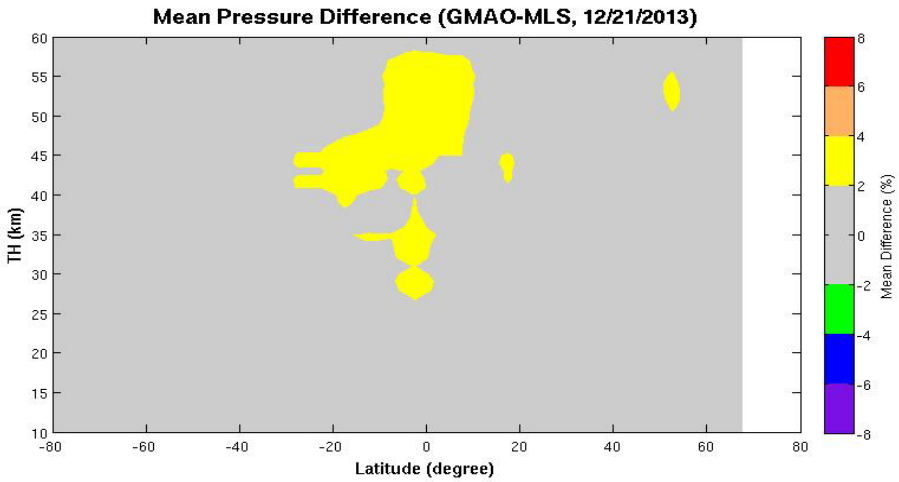
Daily Zonal Mean Residuals

- 350 nm residual profiles from LPRS runs throughout a year are shown, normalized at 37.5 km.
- Results shown for 5°N (*left*) and 45°S (*right*).
- Residual values are ~2% or less between 40 km and 55 km.
- At 65 km the residuals grow to +5%.
- More spread of DZM residuals observed at higher latitudes.





GMAO and MLS Agreement



Daily mean differences between GMAO and MLS pressures are generally less than 2%, and are altitude-independent. The figure shown for 12/21/2013 is typical; there are no seasonal differences.

	Region	Resolution Vert. x Horiz. / km	Precision[a] / meters	Modeled bias uncertainty / m	Observed bias uncertainty / m
	<0.001 hPa	—	—	—	—
	0.001 hPa	10–13 x 220	±110	700±150	−450
	0.01 hPa	8–12 x 185	±85	600±100	−100
64 km	0.1 hPa	6 x 165	±60	500±150	0
48 km	1 hPa	7 x 165	±45	300±100	100
32 km	10 hPa	4.3 x 165	±35	200±100	100
16 km	100 hPa	5.2 x 165	±30	150±100	150
	261 hPa	5.3 x 170	±35	100±150	150
	1000 – 316 hPa	—	—	—	—

However, MLS published GPH bias uncertainties show larger values with higher altitudes.

➔ This implies that the GMAO profiles should also have larger uncertainties with altitude.

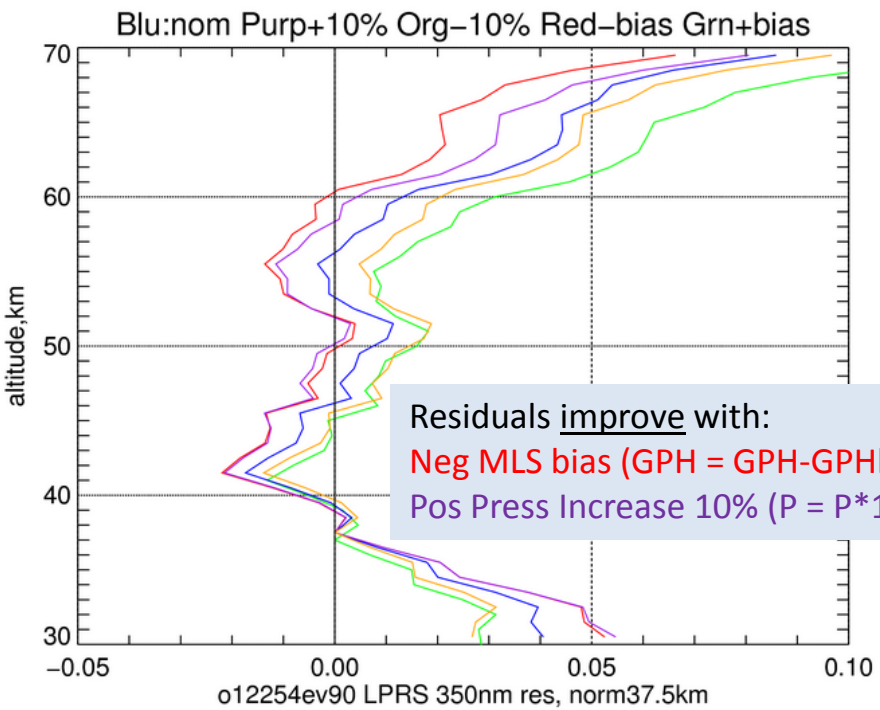
Sensitivity to MLS Pressure Errors

LPRS run for one event (o12254ev90)

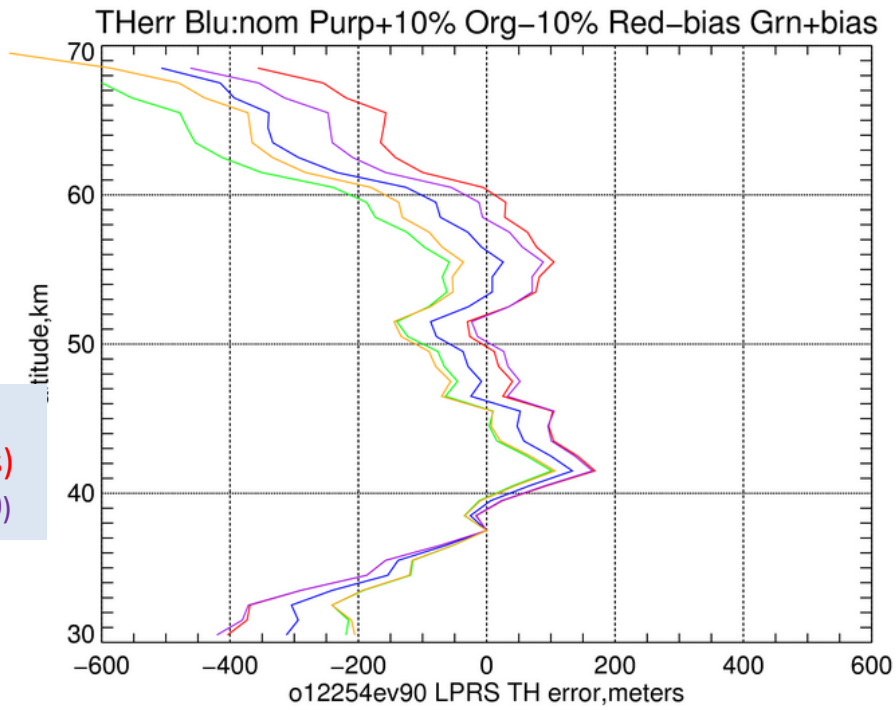
Blue = nominal MLS pressure profile

Red = MLS negative GPH bias (+dp bias)
Green = MLS positive GPH bias (-dp bias)
Purple = +10% bias to pressure profile
Orange = -10% bias to pressure profile

- At 64 km, nominal MLS profile yields GPH error of -300 m (but these values are normalized to 37.5 km)
- With the profile adjustment, the best GPH error is approximately -175 m wrt 37.5 km



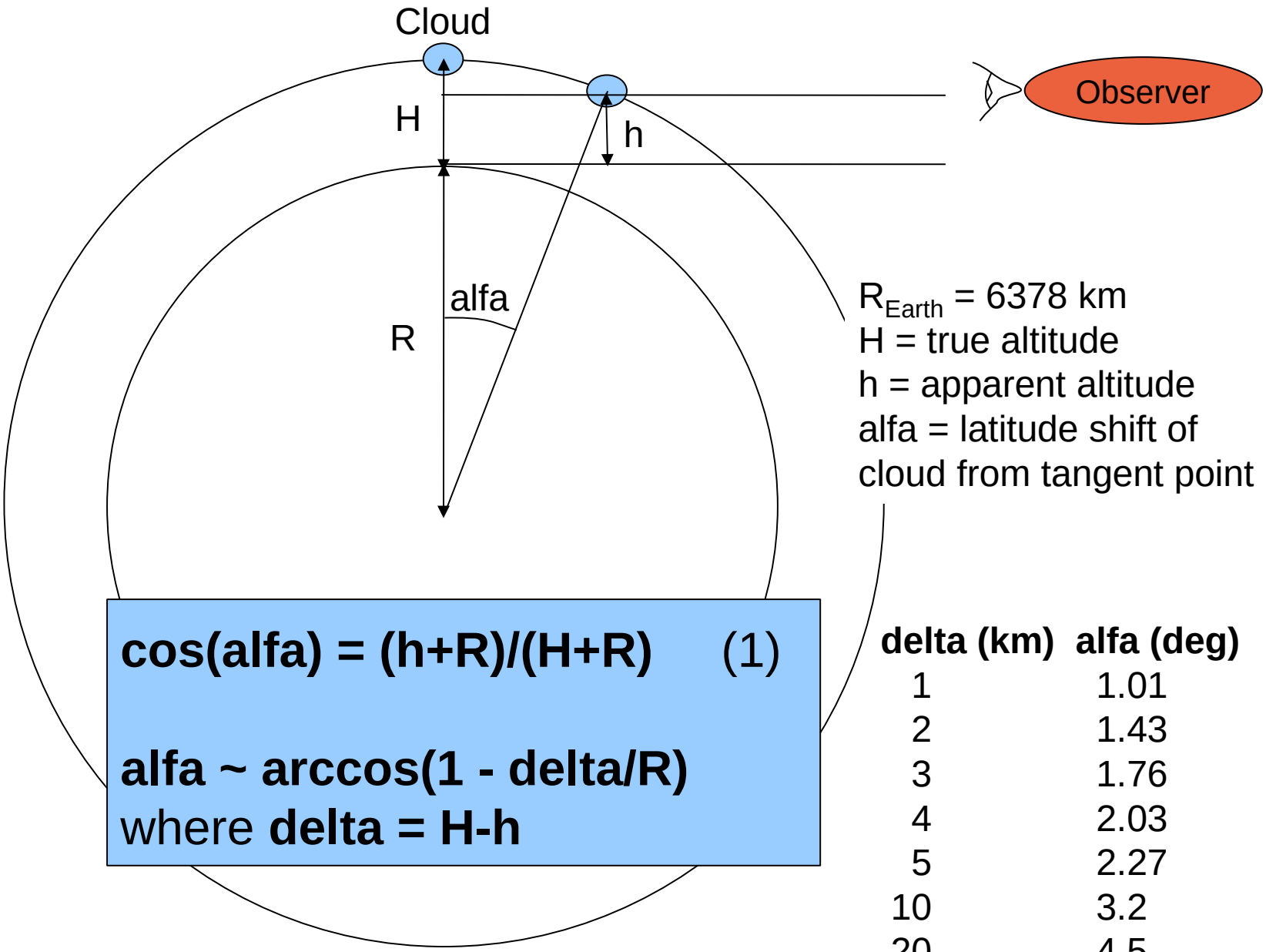
Residuals improve with:
Neg MLS bias (GPH = GPH-GPHbias)
Pos Press Increase 10% (P = P*1.10)



Cloud Effects in LP Measurements

- Upper level clouds typically occur in narrow vertical layers (PSCs exist at 15-30 km in winter stratosphere, PMCs exist at 80-85 km in summer mesosphere).
- LP viewing geometry can project this radiance signal to lower altitudes far away from tangent point location.
- PMC signal at radiance normalization altitude can affect UV ozone retrieval (65 km), ASI674 profiles (45 km).

LP Measurement Geometry



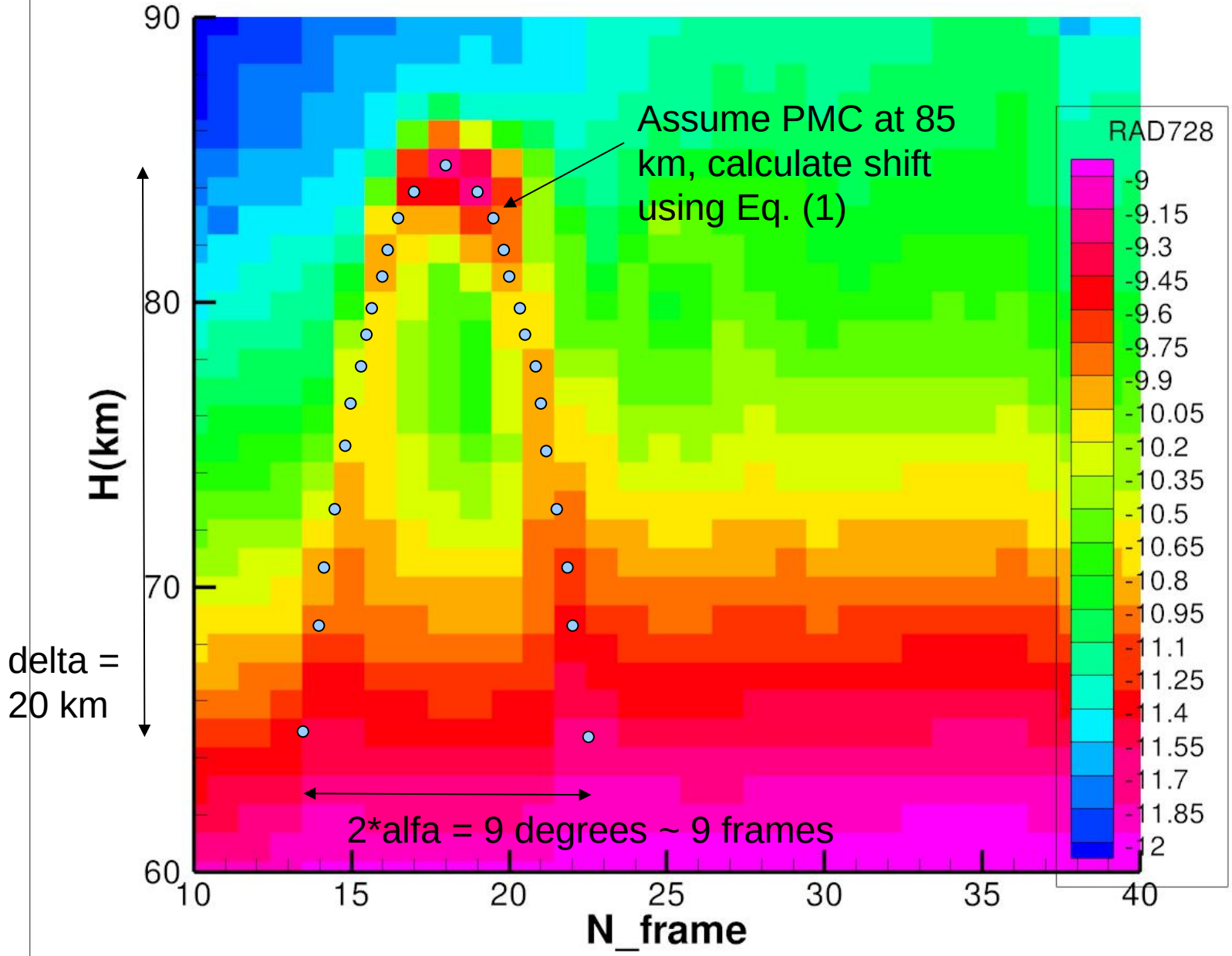
R_{Earth} = 6378 km
H = true altitude
h = apparent altitude
alfa = latitude shift of cloud from tangent point

cos(alfa) = (h+R)/(H+R) (1)

alfa ~ arccos(1 - delta/R)
where **delta = H-h**

delta (km)	**alfa (deg)**
1	1.01
2	1.43
3	1.76
4	2.03
5	2.27
10	3.2
20	4.5
30	5.6

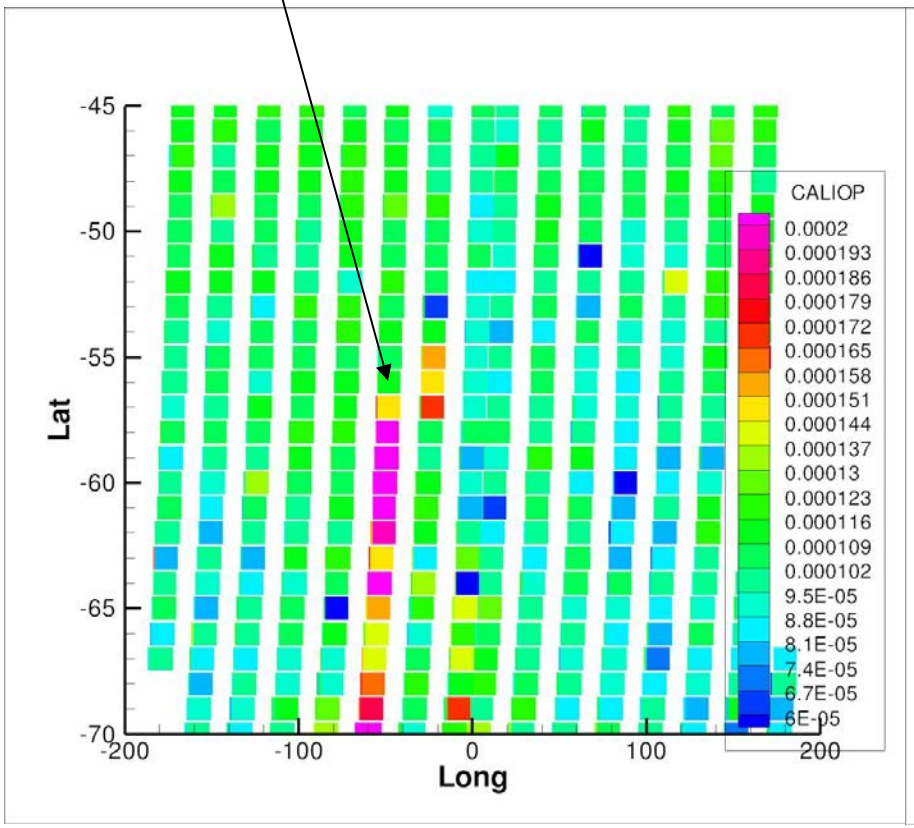
LP Radiance at 728 nm – Orbit 11916

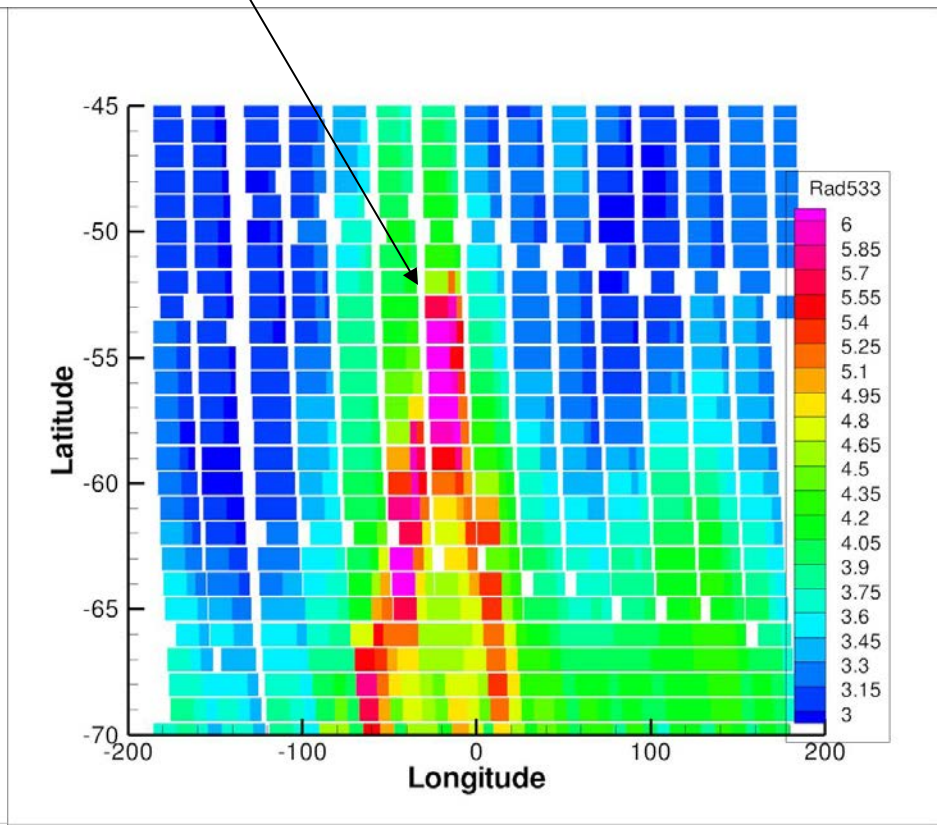


PSC Location in Southern Hemisphere

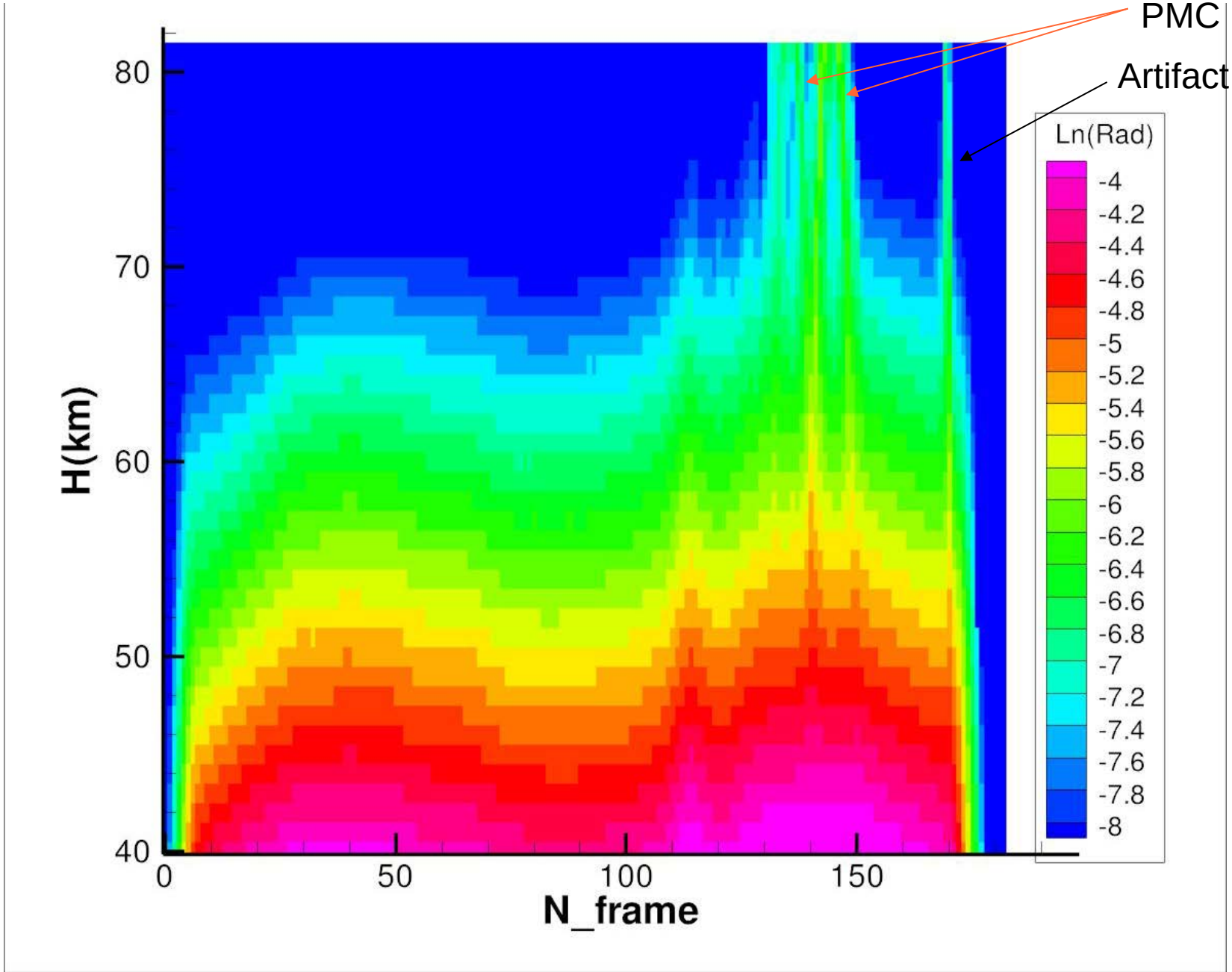
- CALIOP backscatter (night) at 532 nm, 20.5 km, 27 Aug 2014
- PSC extends up to 55-57°S

- OMPS LP radiance at 533 nm, 20.5 km, 27 Aug 2014 (day)
- PSC enhancement extends farther north (up to 53°S)



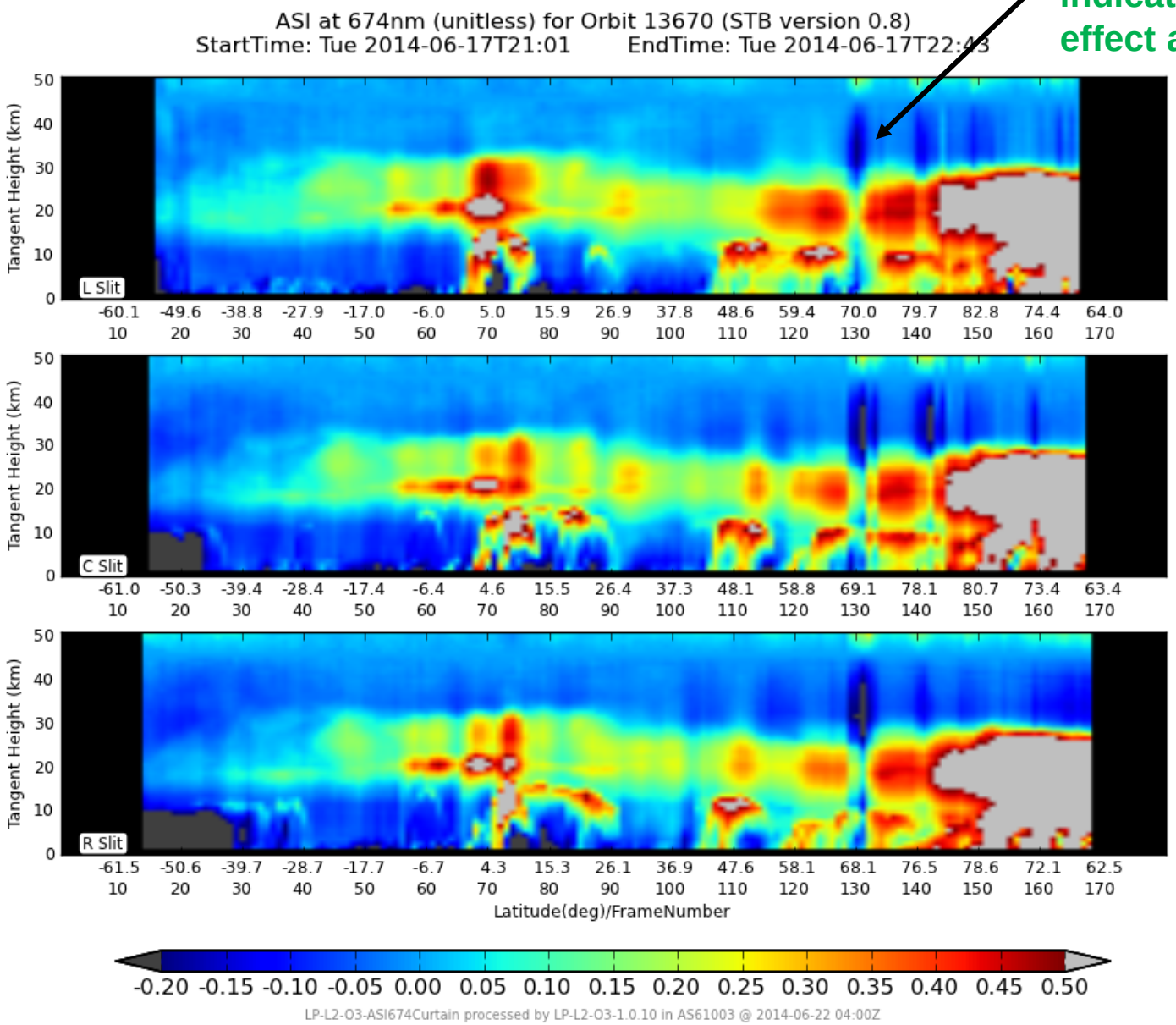


LP Radiance at 353 nm – Orbit 3250



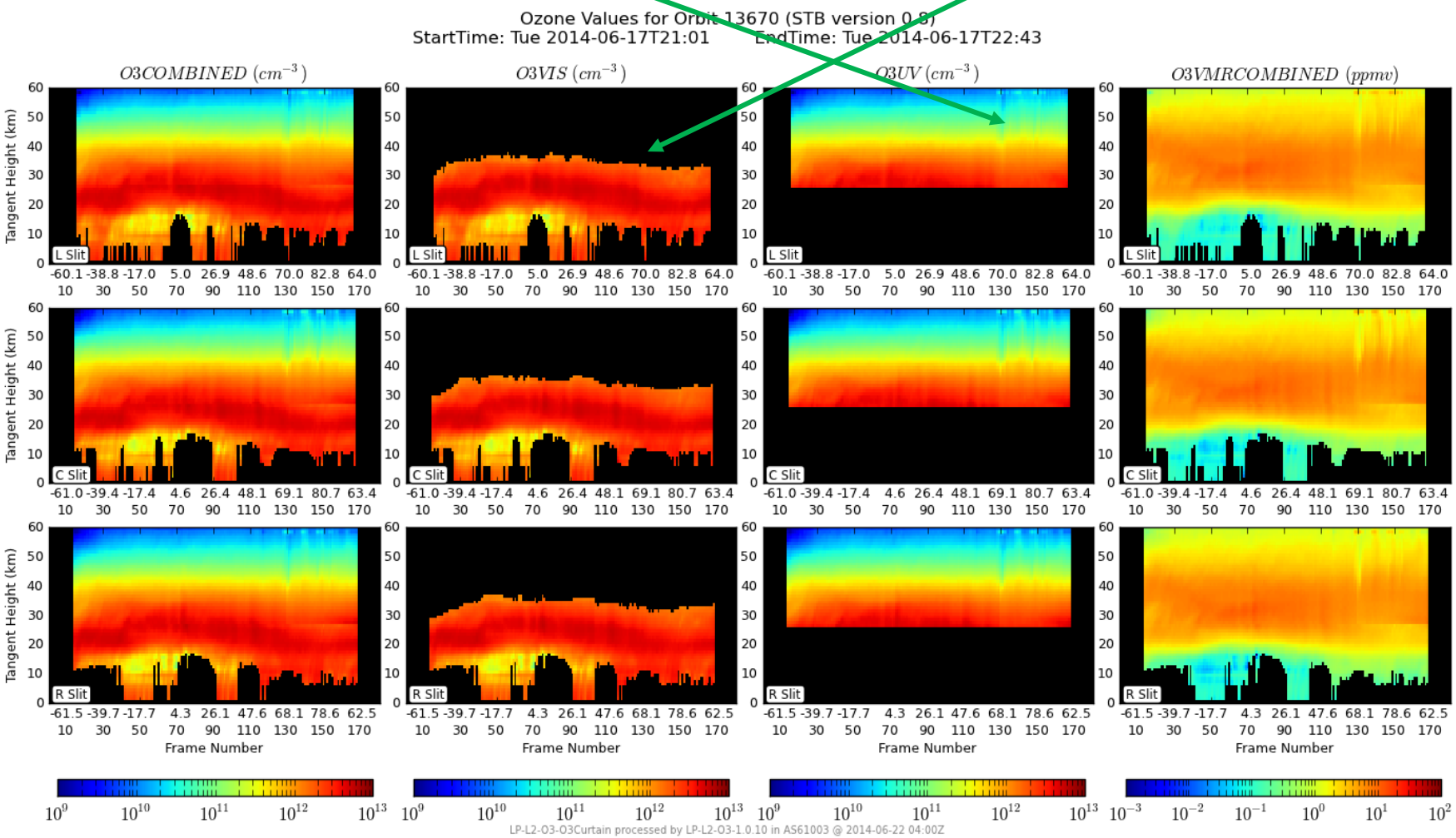
ASI674 for Orbit 13670

Negative stripes indicate PMC effect at 45 km



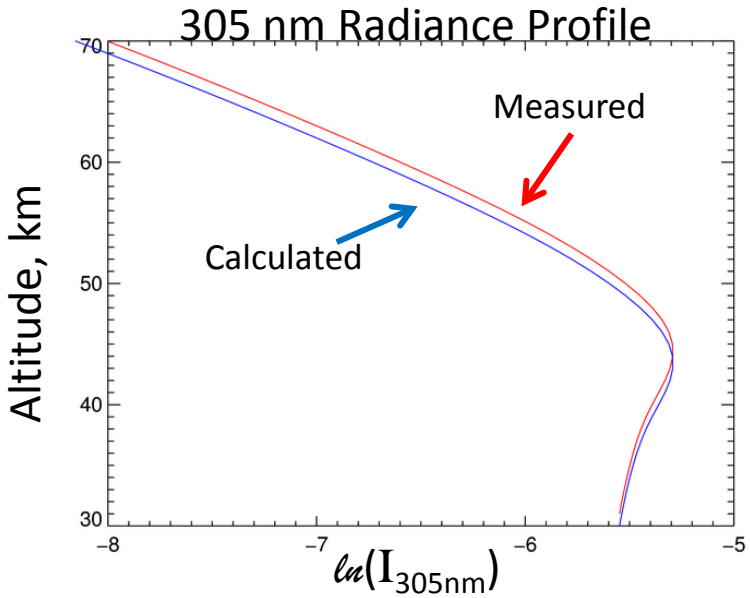
Ozone Curtain Plot for Orbit 13670

PMC effects visible in UV profiles (column 3), but not in VIS profiles (column 2)



Backup Slides

Accuracy of OMPS LP Radiance at 305 nm, 60 km

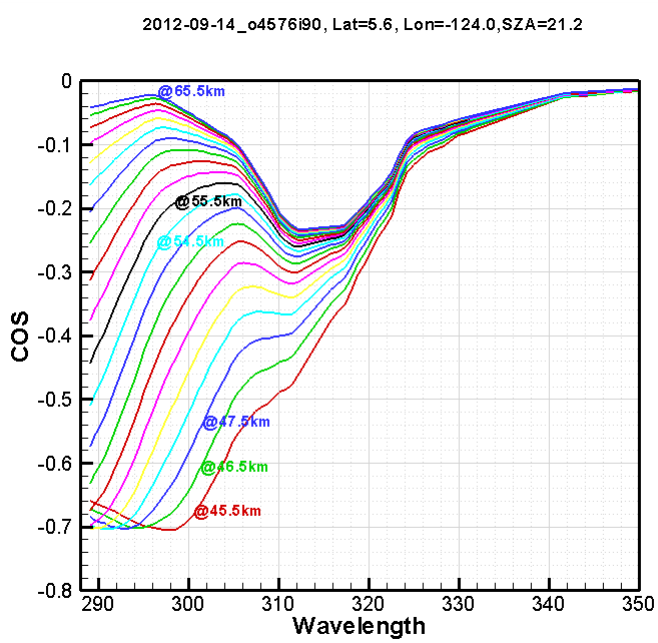


Ungridded measured radiances are compared to RTM calculations using GMAO GPH profiles.

At 60km, the radiance changes with altitude by 13%/km
➔ 1% error in measurements or calculations results in a 70 m TH error.

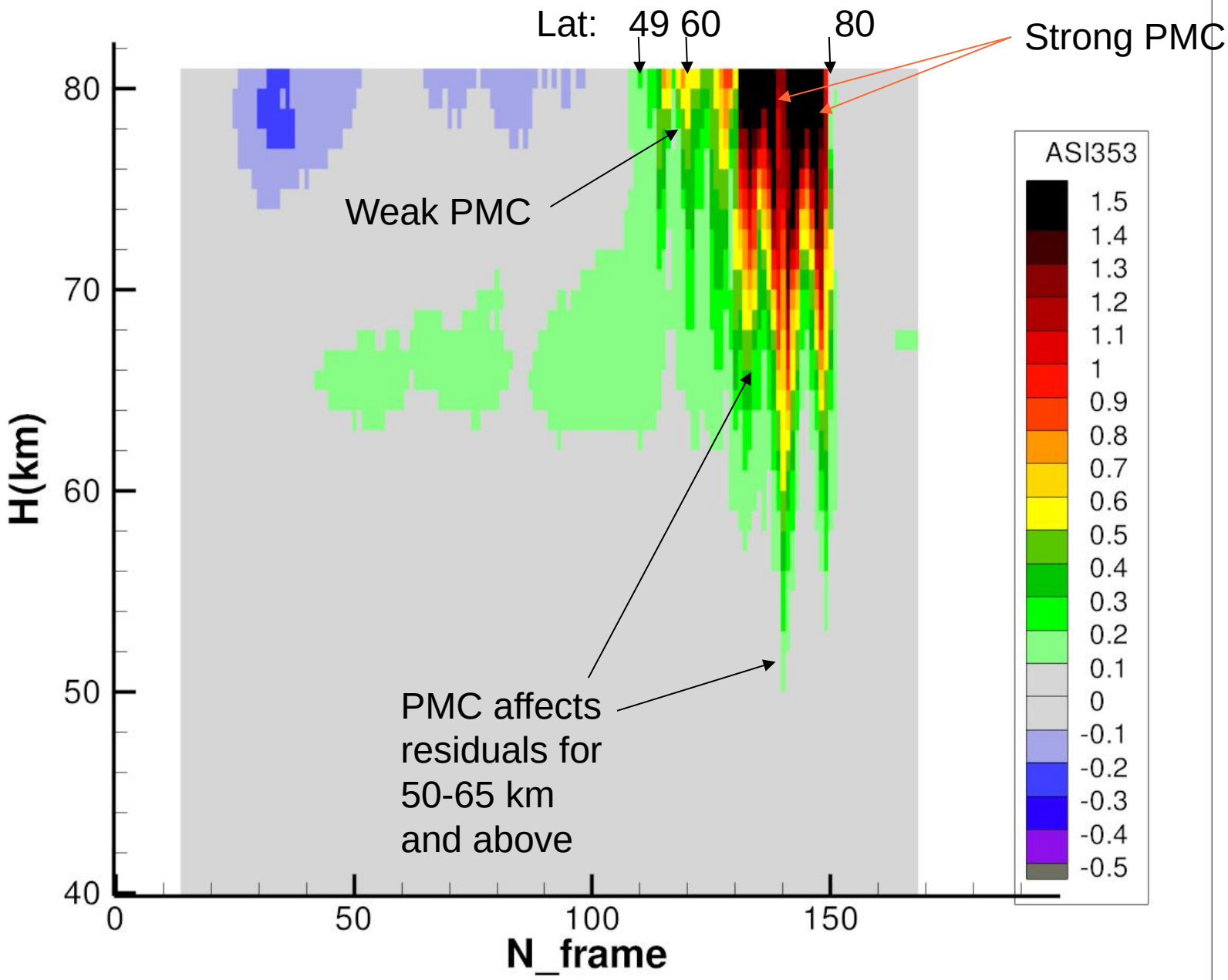
Sun normalized radiances (SNR) rather than absolute radiances are used to reduce calibration errors.

Our estimated error in SNR is ~1%.



<u>Why 305 nm? Why 60 km?</u>

Above 60 km the ozone sensitivity does not decrease much.

Shorter wavelengths are more sensitive to ozone.
Longer wavelengths are contaminated by reflected sunlight from tropospheric clouds, aerosols, and the surface.

353 nm Residual – Normalized at 45.5 km