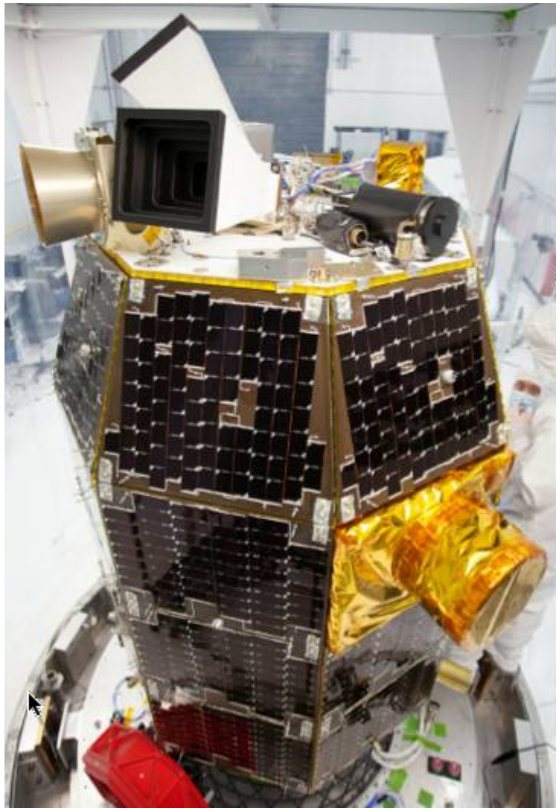


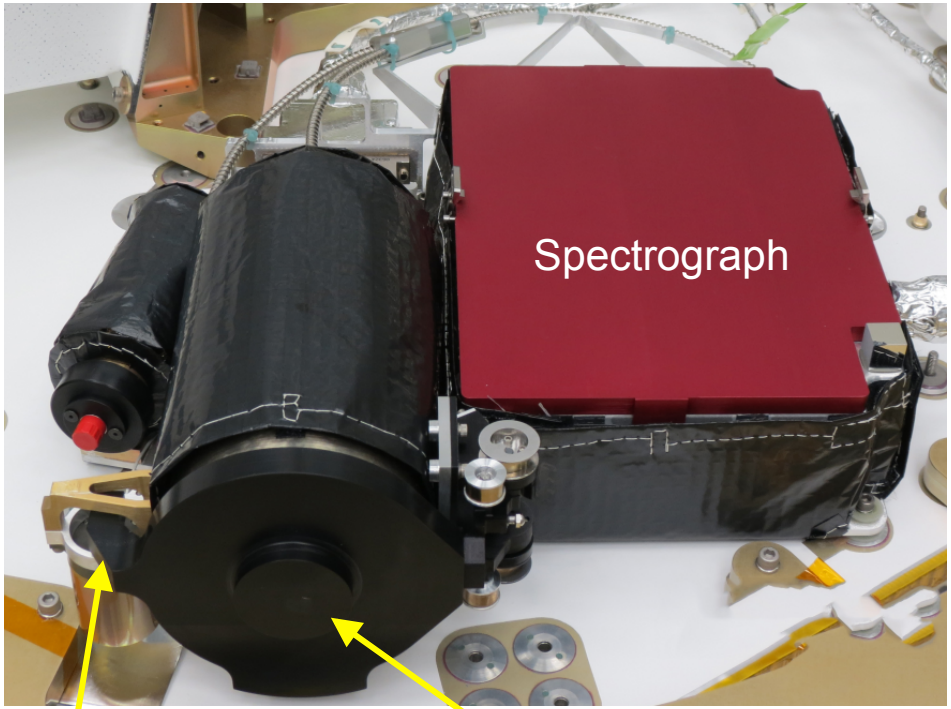
LADEE Ultraviolet and Visible Spectrometer (UVS)

Summary of Operations and Initial Results

July 22, 2014

Colaprete, A., Shirley, M., Vargo, K., Cook, A., Wooden, D., Hermalyn, B., Landis D., B., Karcz, Sarantos, M., et al.

Instrument Summary



Solar Viewer

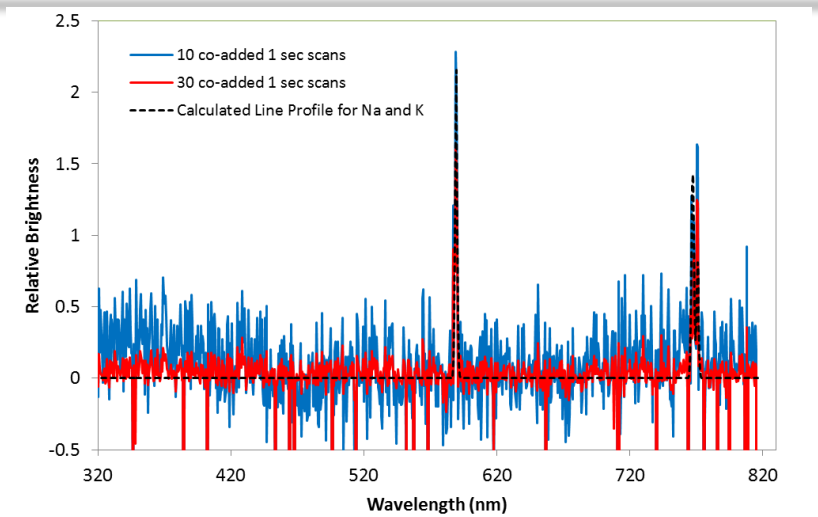
Limb Telescope

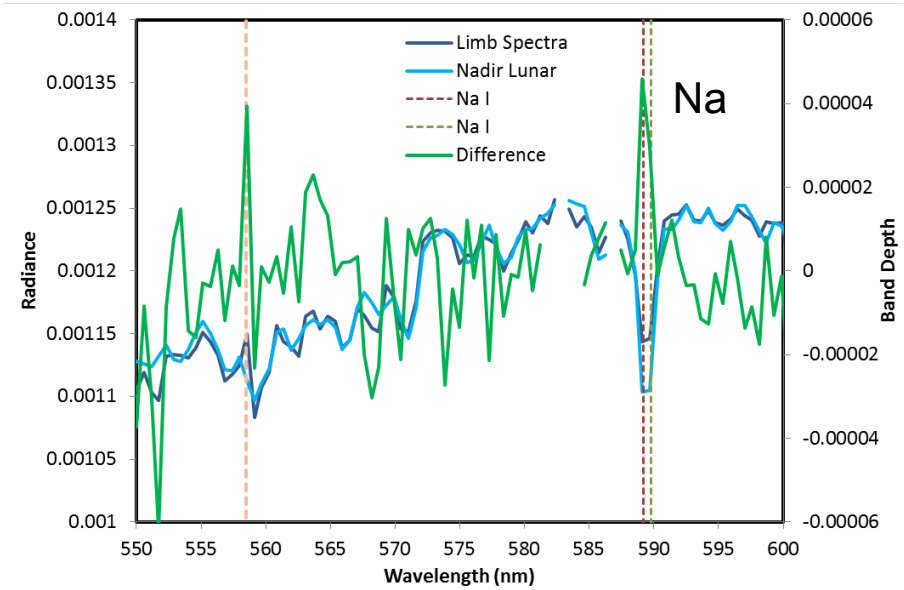
- Fiber-fed, CCD "Point" Spectrograph (all vertical pixels are binned)
- λ = 230-810 nm, dλ ~0.5 nm
- Utilizes two 1°FOV foreoptics: Telescope and Solar Viewer
- Active cooling (radiator limits detector temps to >-35C)
- Observed a variety of geometries trying to maximize utility
- >1,000,000 spectra collected

Emission Line Observations

UVS uses different techniques to extract line information

- Terminator observations, looking back at illuminated exosphere while SC/ Telescope in shadow
- During periods when surface scatter is higher strong bands (e.g. Na) is derived by subtracting scatter reference
- Using these techniques can monitor Na and K at morning, noon and afternoon periods

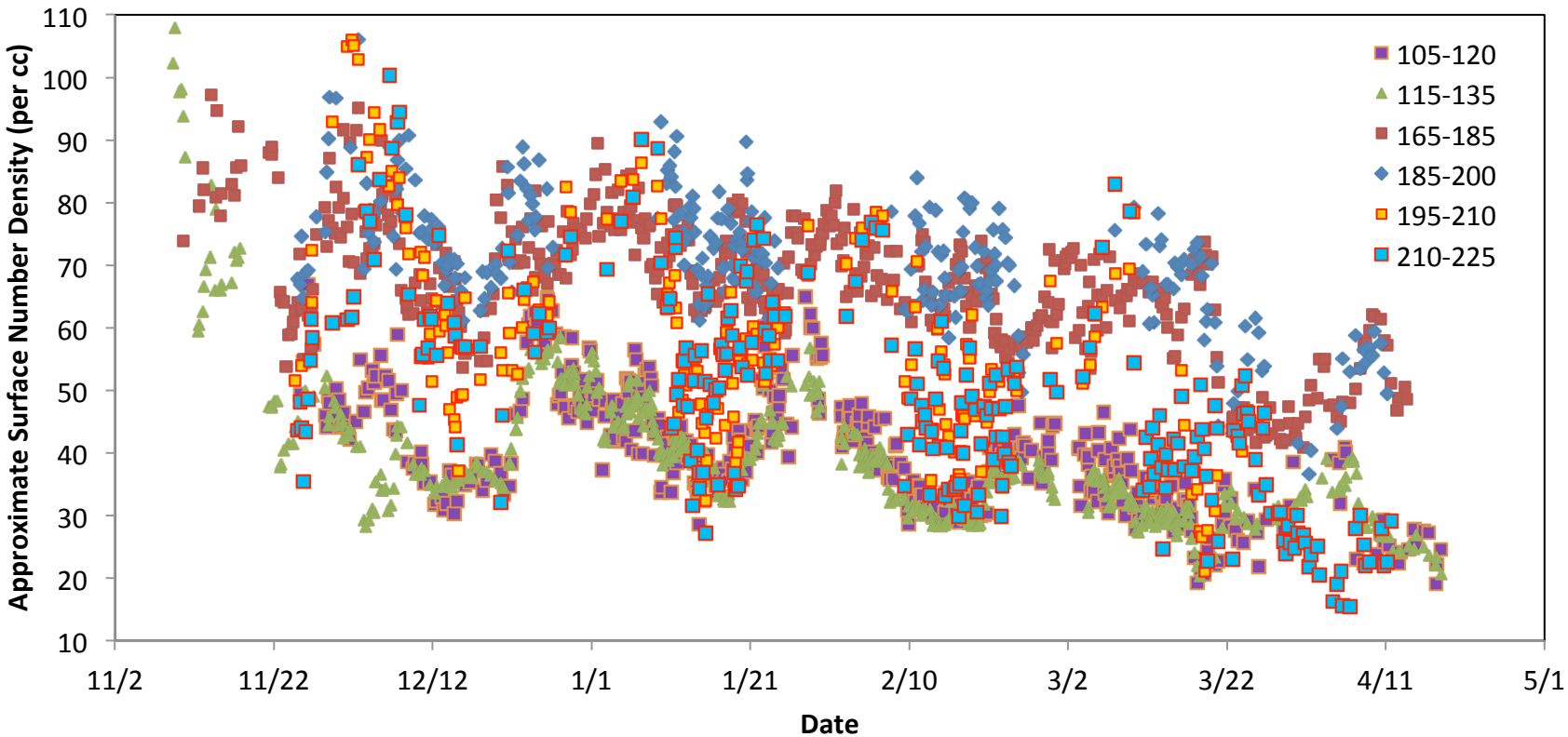




Sodium Observations

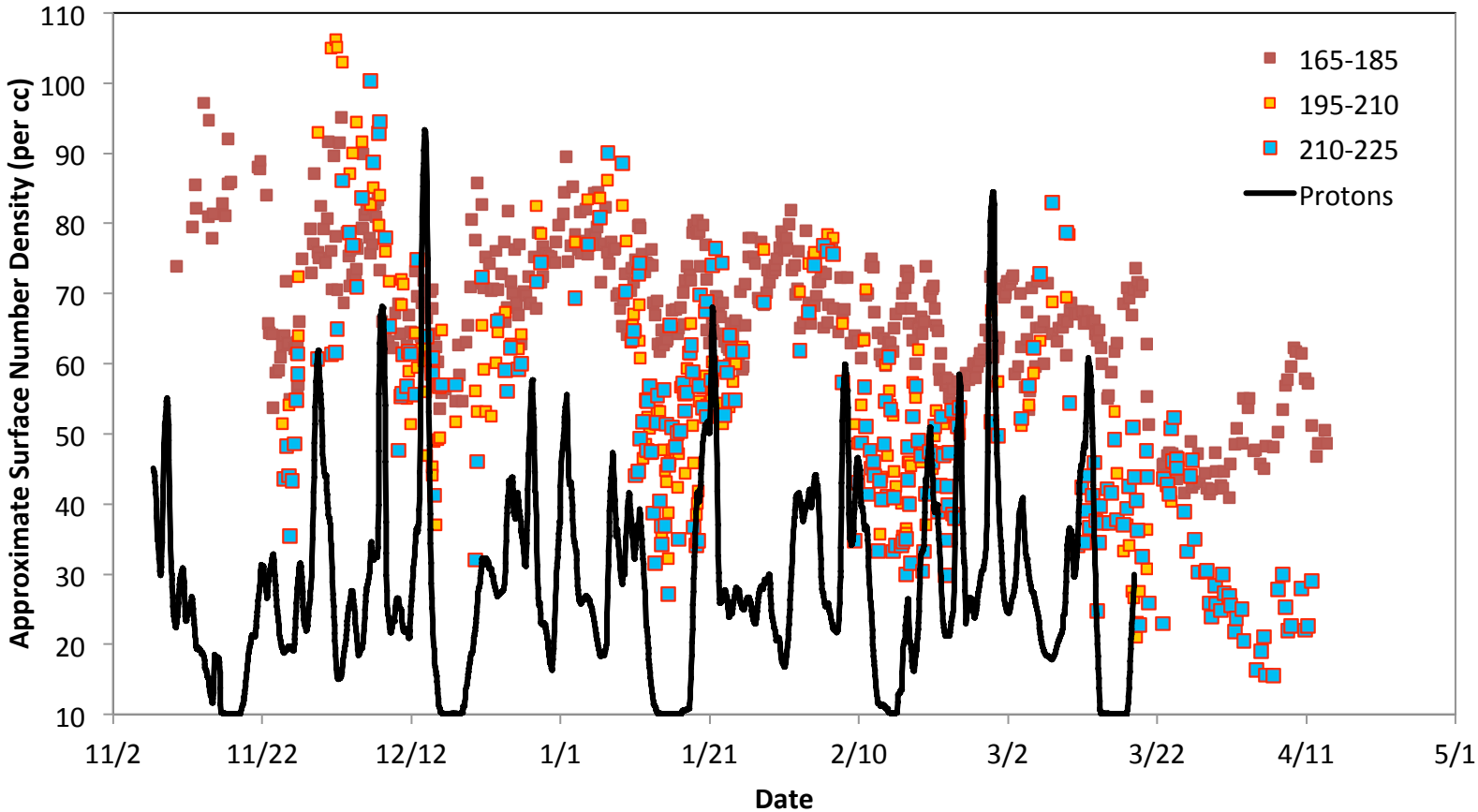
Derived sodium concentrations at several different local times

- Constrained to altitudes between 30-50 km near noon and 10-30 km near terminators

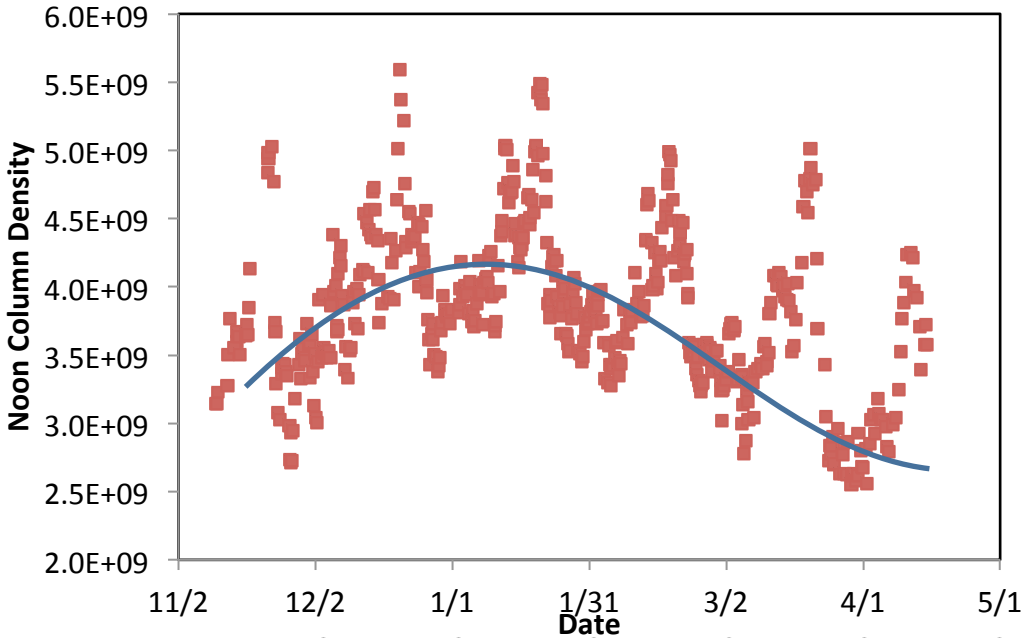


Sodium Observations

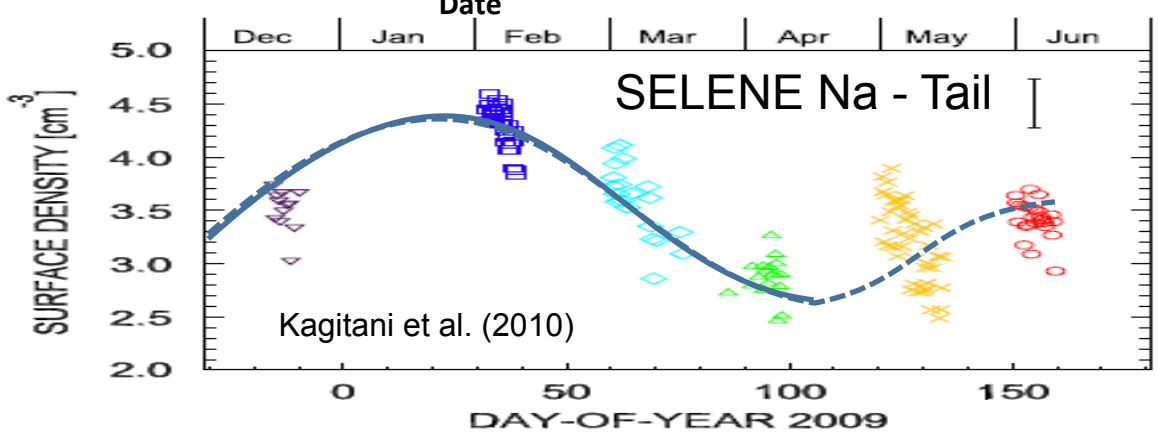
Clear response to magnetopause and meteoroid streams



Sodium Annual Variation



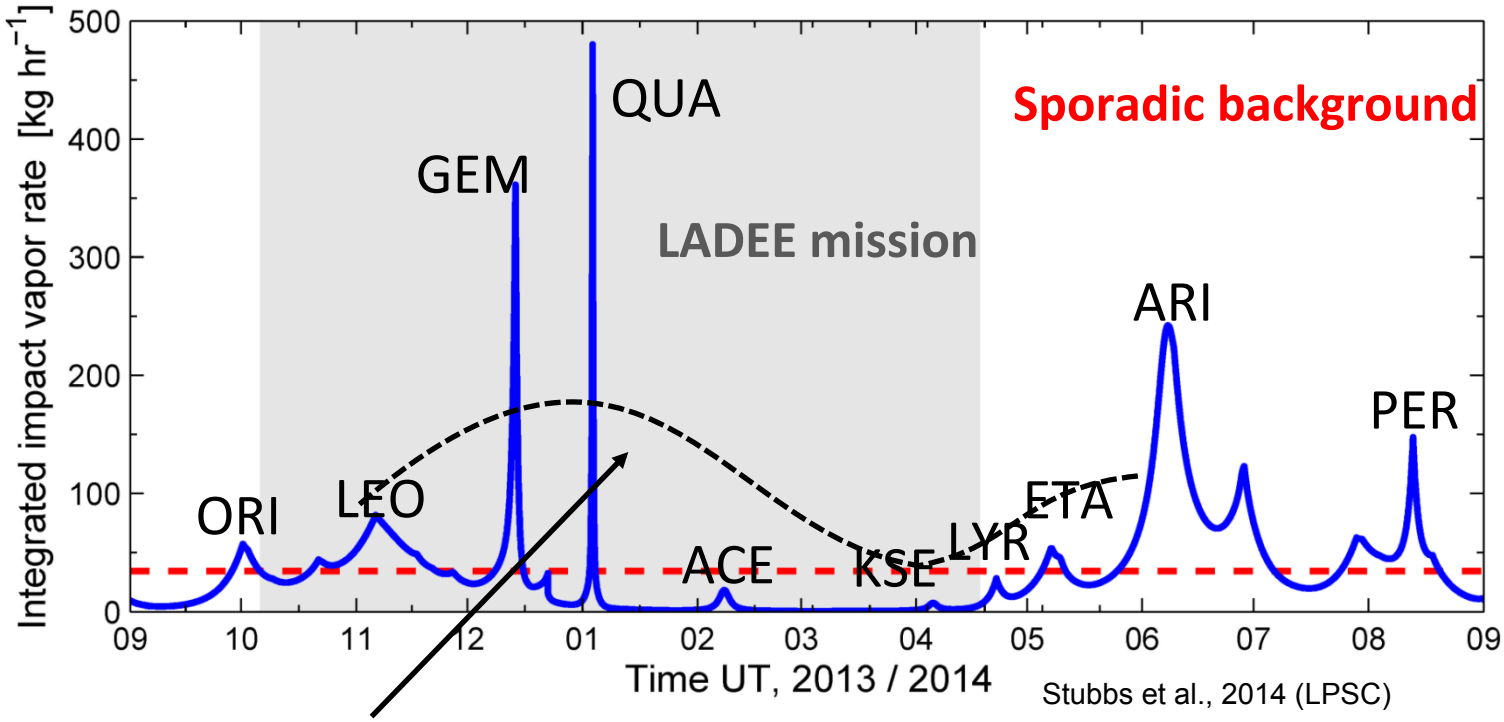
- General agreement between Kaguya observations and UVS
- Suggest a possible long-term variation (annual?) variability



Sodium Annual Variation

Possible explanation for variability variation in stream flux?

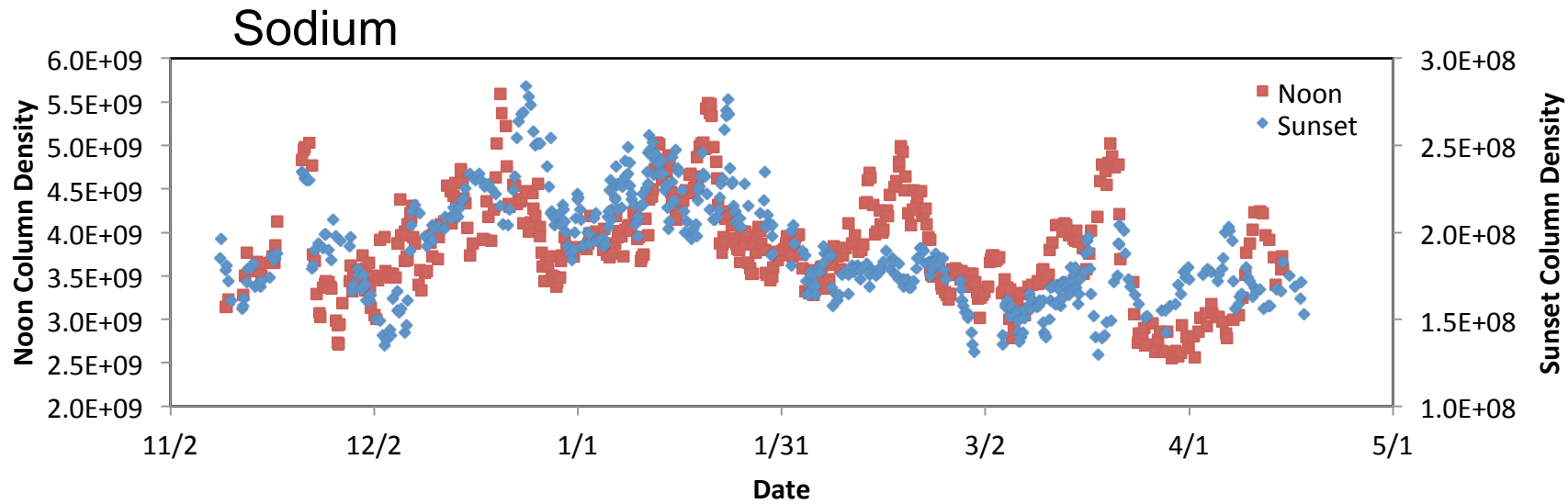
- If only LADEE had gone another six months…<sigh>

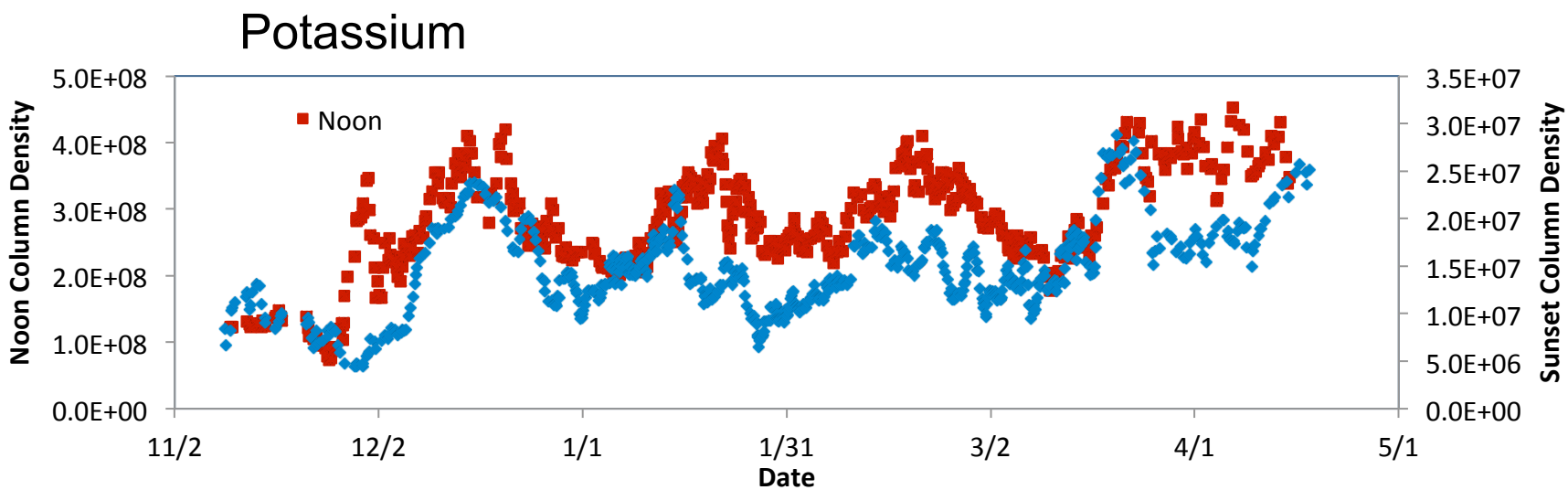


Stubbs et al., 2014 (LPSC)

Suggested variability from UVS and Kaguya

Potassium Observations

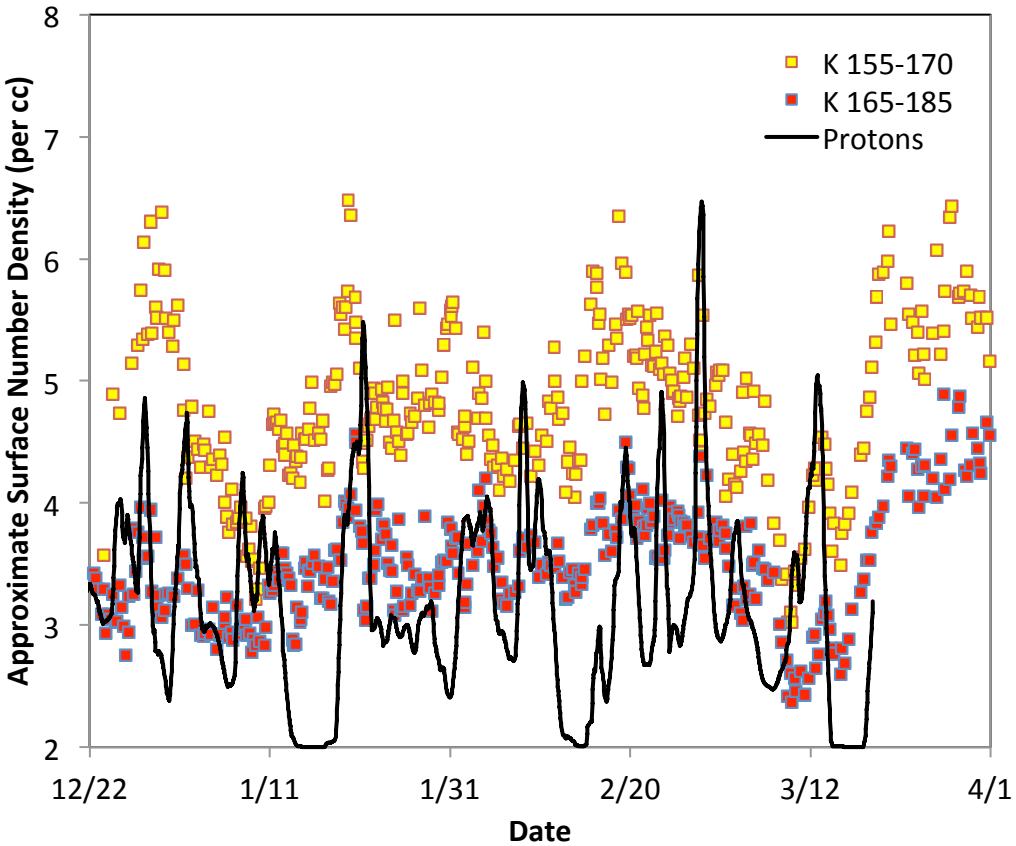


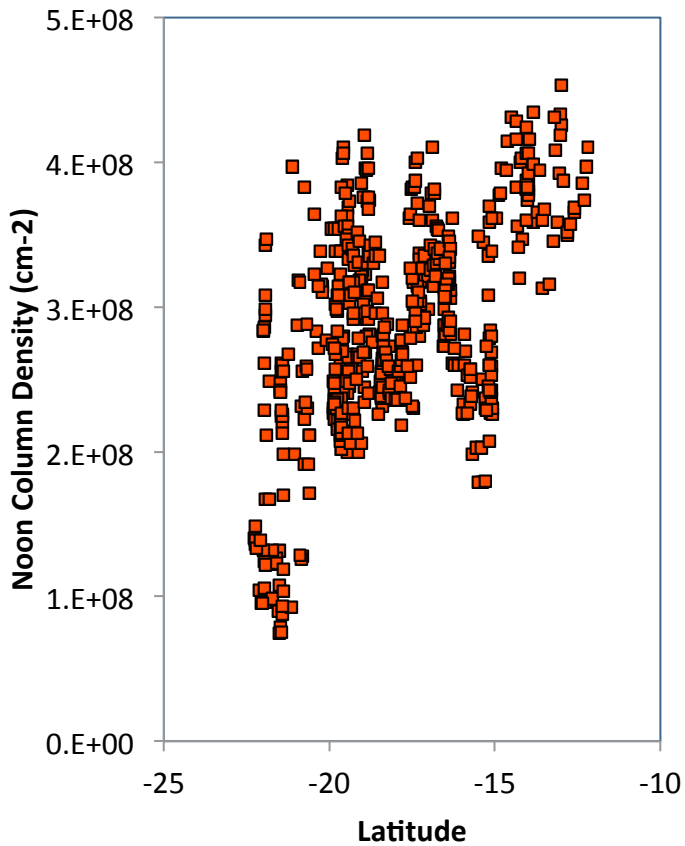


Potassium Observations

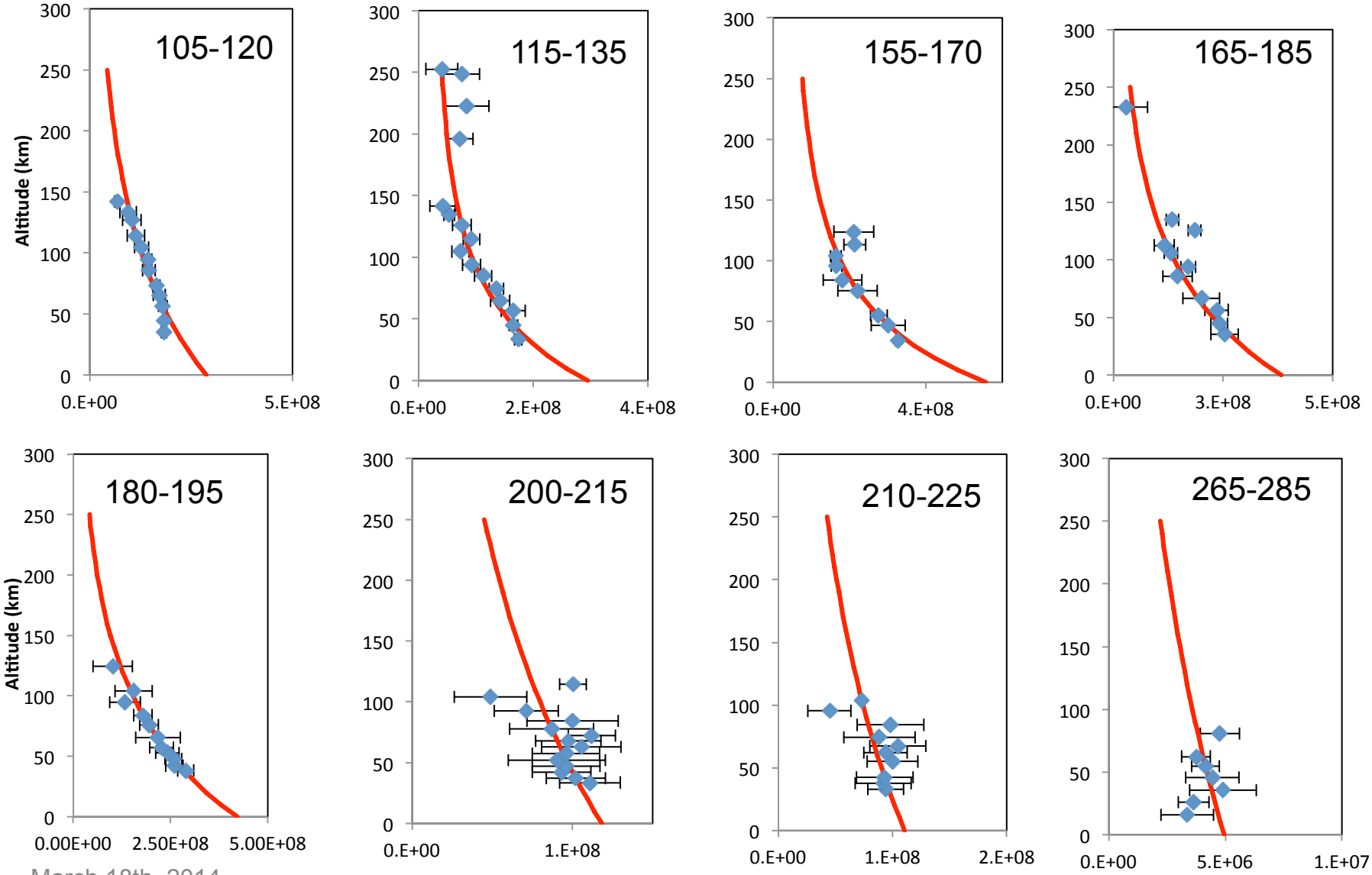
Potassium exosphere shows some correlation to proton flux, but not the obvious Na drop during magnetopause

- Surface concentration of potassium more important





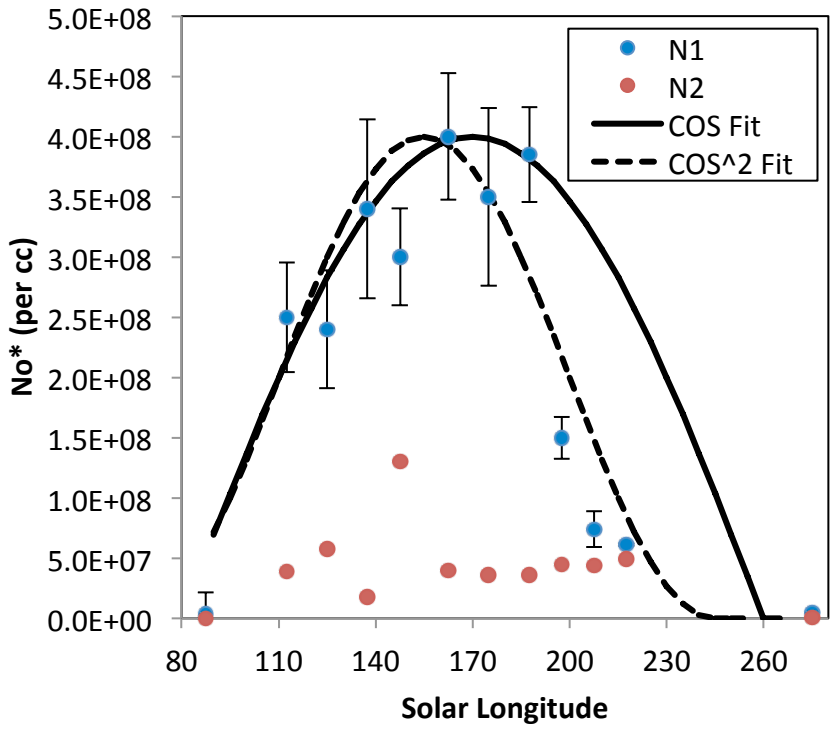
Potassium Profiles

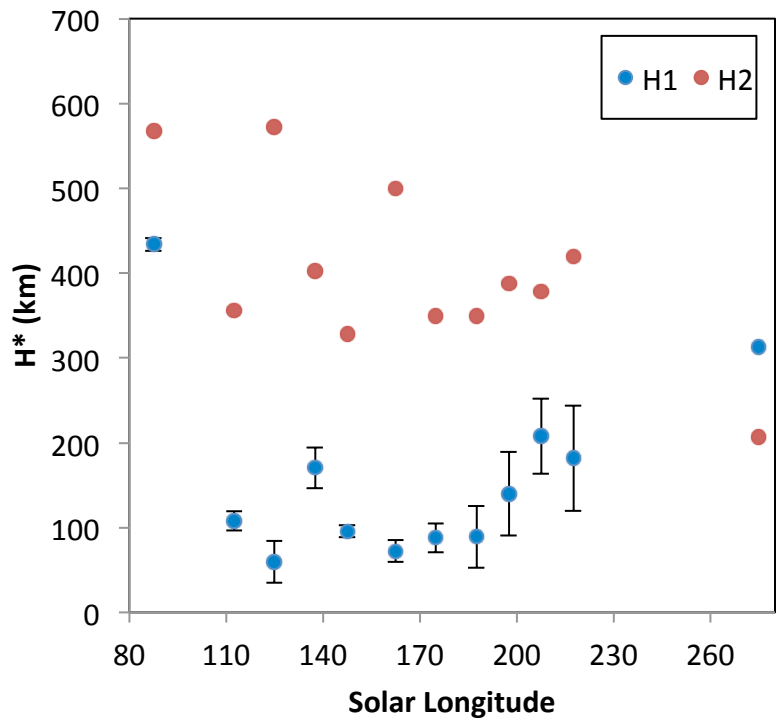


Potassium Profiles

Two component ("hot" and "cold") fit concentrations and scale heights

- Appears to be a ~10-20 deg shift in peak K concentrations past noon
- Thermal component minimum near noon, slightly rising at later times
- Non-thermal component lowest near dawn and rises through day





Summary of Observations

- UVS has made measurements of Na and K, and has either set new upper limits or made tentative detections of several other gases
- Is currently mapping several gases spatially and in time
- Will be able to constrain scale heights using differing local time of day observations and limb “nods”
- Have first results suggesting we can constrain sources (sputtering, impacts & PSD)
- Currently using limb and solar occultations to look for dust, either associated with impacts or other lofting mechanisms

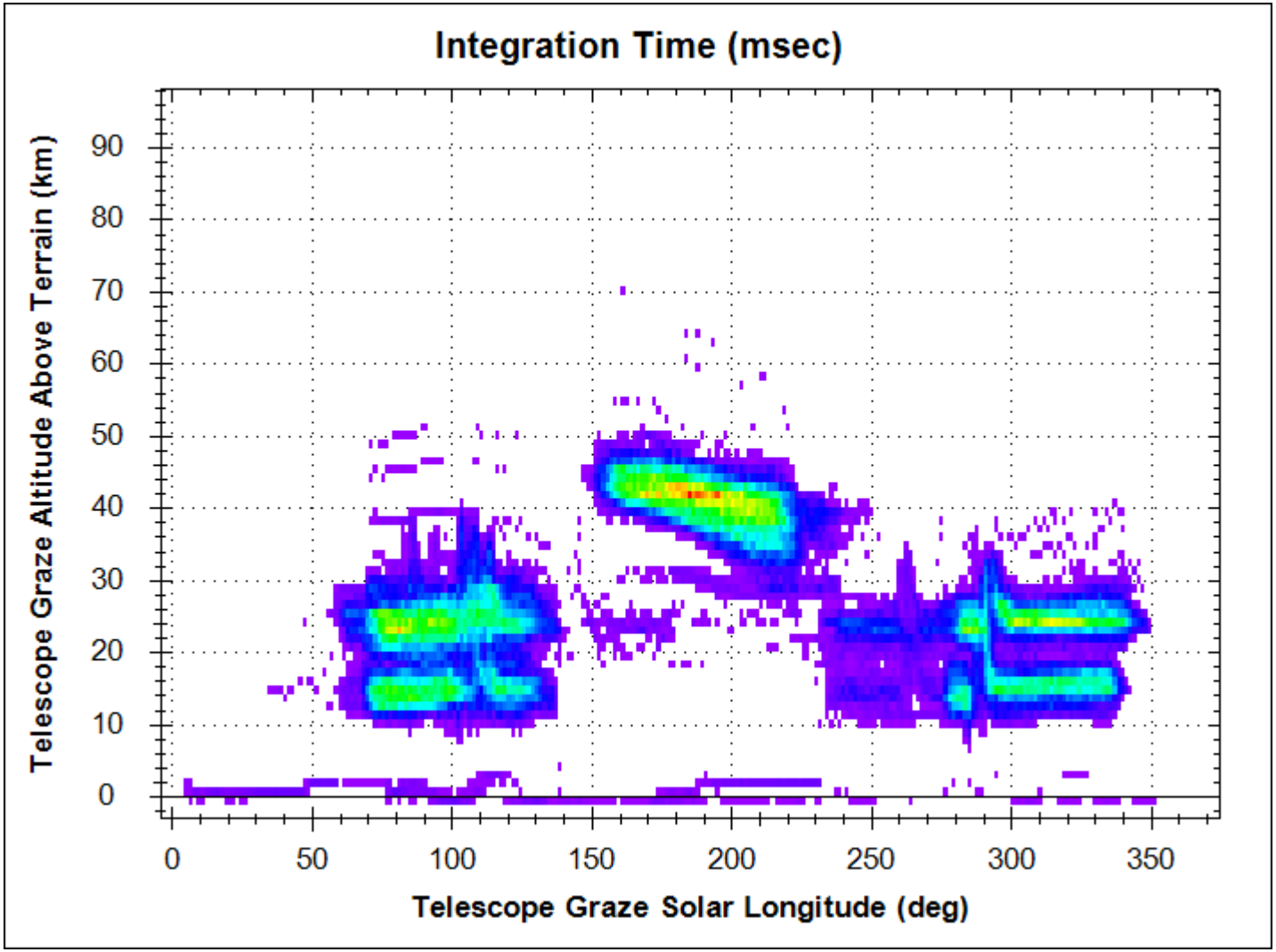
Species	Previous Upper Limit (#/cc)	UVS Limit (#/cc)
OH	1.E+06	27.8
Al	55	454.0
Ca	1	93.5
Ca+	-	29.7
Fe	380	0.7
K	17	0.2
Li	0.01	0.1
Na	70	1.0
Si	-	122.4
Ti	1	3.2
Ba	0.2	0.1
Mg	6.E+03	6.5
H2O+	-	263.4
O	-	16.7
He+		
Na+		

Tentative Detection

Measuring

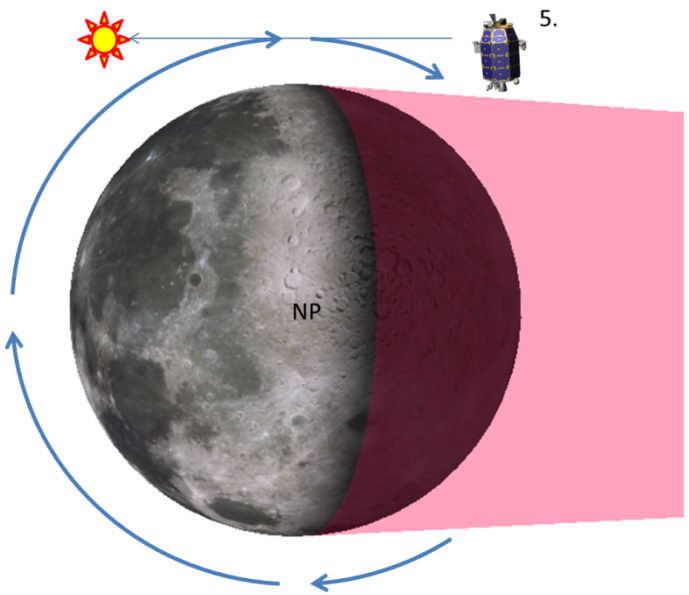
Thank you!

Example of Coverage



Categories of Observations

1. **Limb Stares**, with nods at Sunset and Sunrise Terminators
   - In "Backward" and "Forward" SC orientations
2. **Noon Stares**
   - In "Backward" or "forward" geometry telescope is pointed at limb, typically centered about noon
3. **North-South Looks**
   - Telescope is pointed due-North or South, centered +/-6 minutes about the terminators
4. **Na Tail Looks**
   - Telescope is pointed ~anti-sun, starting on dark-side at midnight and running to umbra exit.

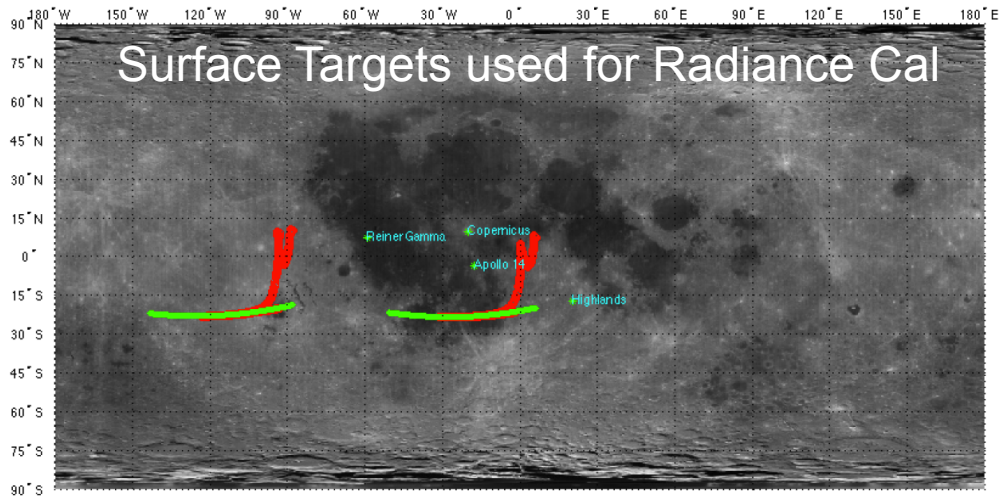


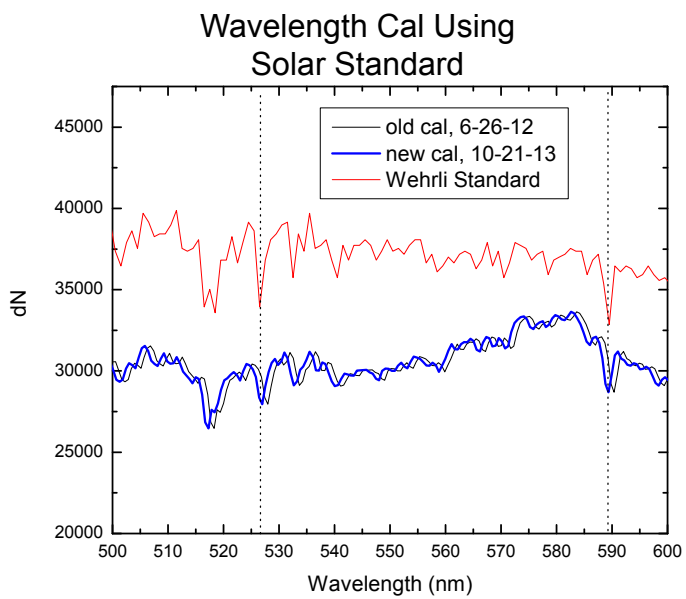
5. **Solar Occultation**
   - Solar Viewer is pointed at sun while SC passes over sunrise terminator, observing apparent "sunset" over sunrise terminator
6. **Darks / Calibrations**
   - A variety of solar, lunar surface (lit and dark), and Earth disk calibrations

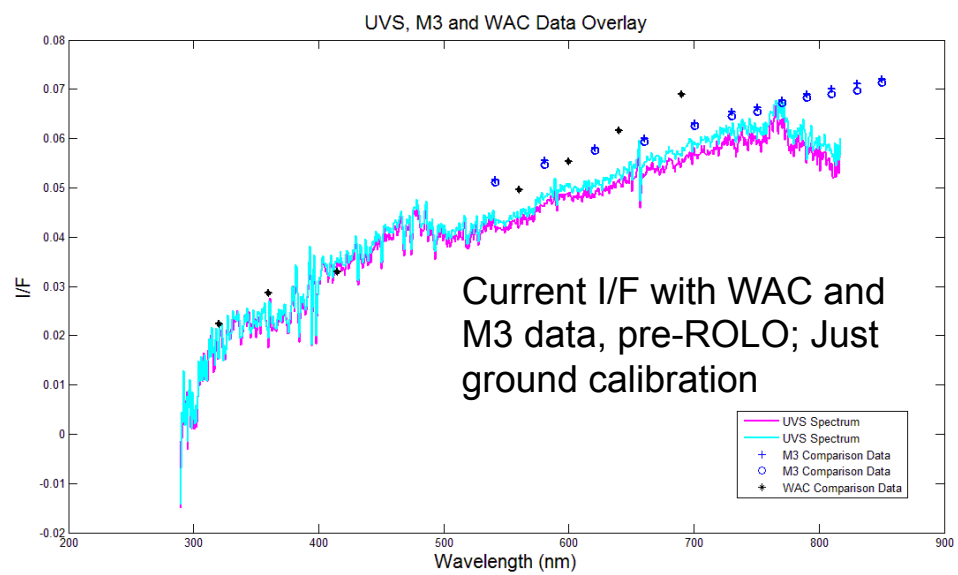
Calibrations

Calibrations Include:

- Radiance (Specific Surface Targets and ROLO)
- Spectral (Solar lines)
- Darks (Dark side during Full Moon; Temp and Δt)

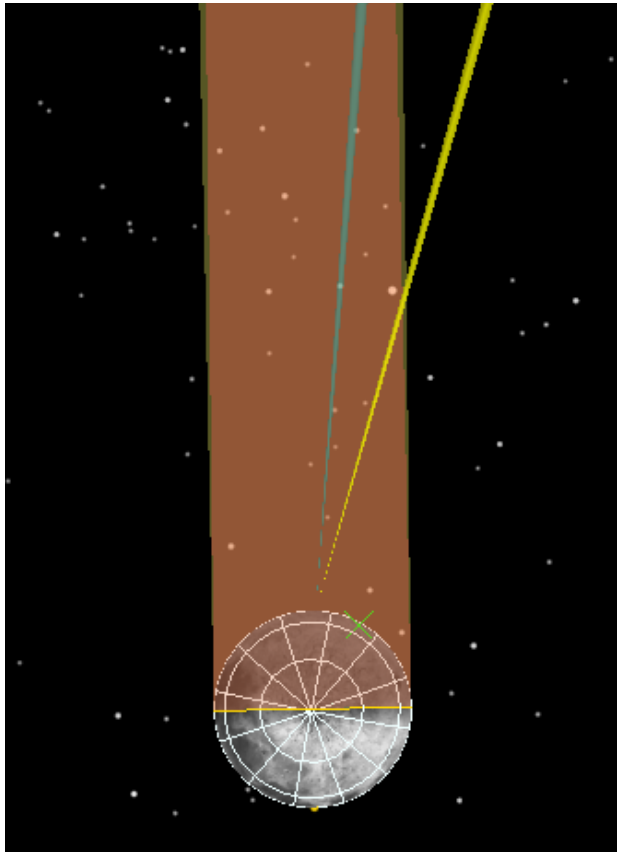




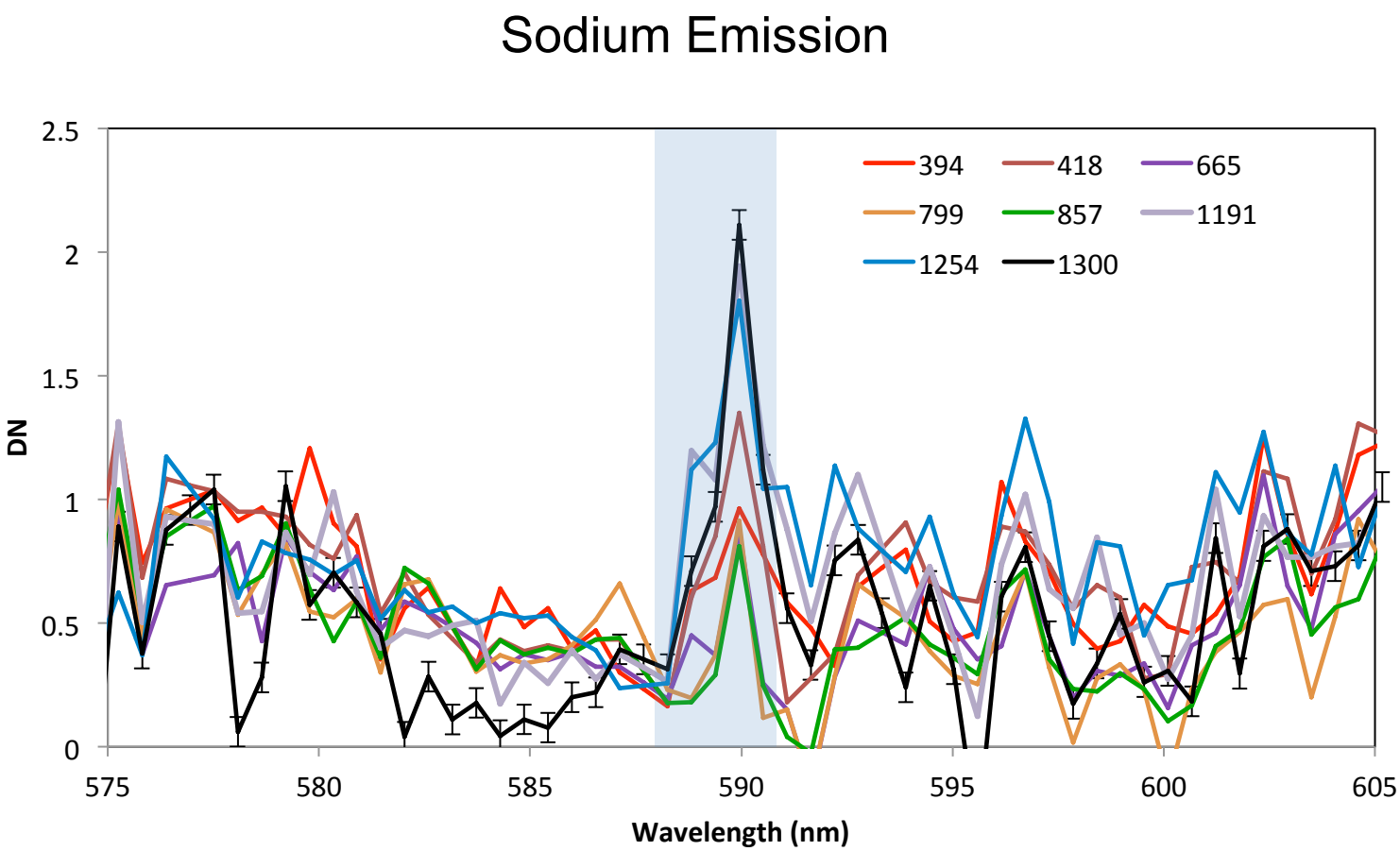


“Sodium Tail” Observations

- Sodium Tail observations looked “anti-sun” (but in LADEE orbit plane)
- Observed from midnight to dawn (dark side of moon)
- Activity conducted every ~2 weeks (sometimes within a few days around known showers)

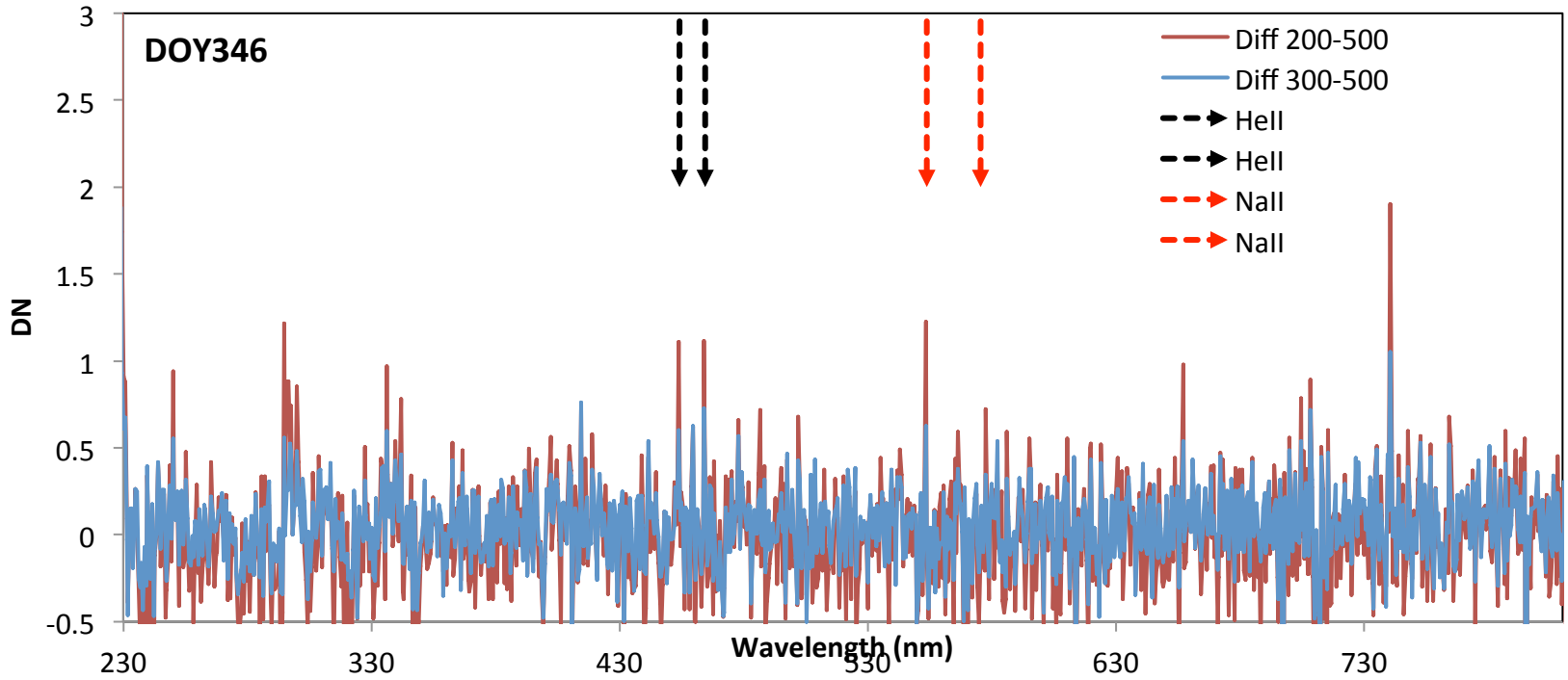


“Sodium Tail” Observations



“Sodium Tail” Observations

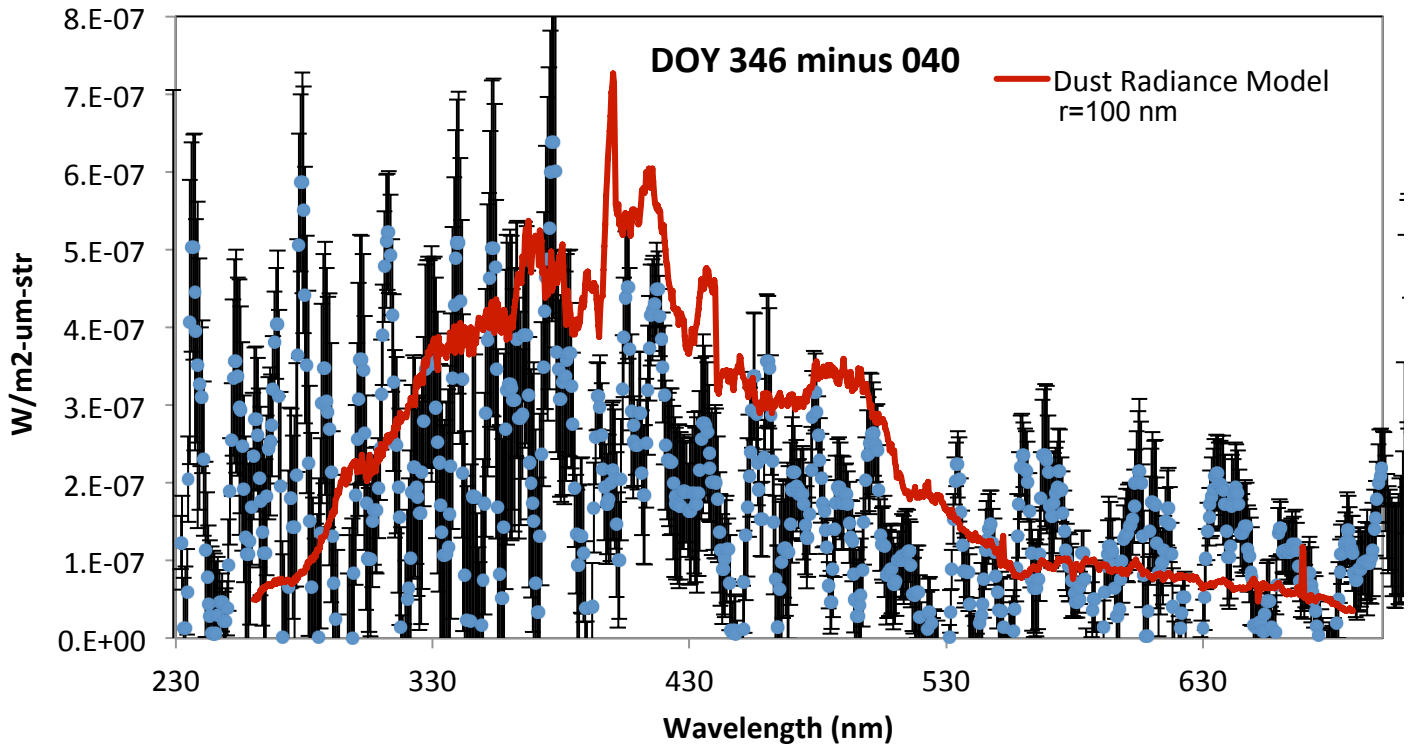
Difference between different times in activity (first and second half) shows several possible emission lines



“Sodium Tail” Observations

Difference between “Tail” activities show changes in background radiance

- Shown below is post Geminids and later during quiet shower period shows blue enhancement, but not yet conclusive (see talk and poster on UVS dust observations)
- Model below shows model for back-scatter from 5×10^{-6} per cc, 100 nm radius grains

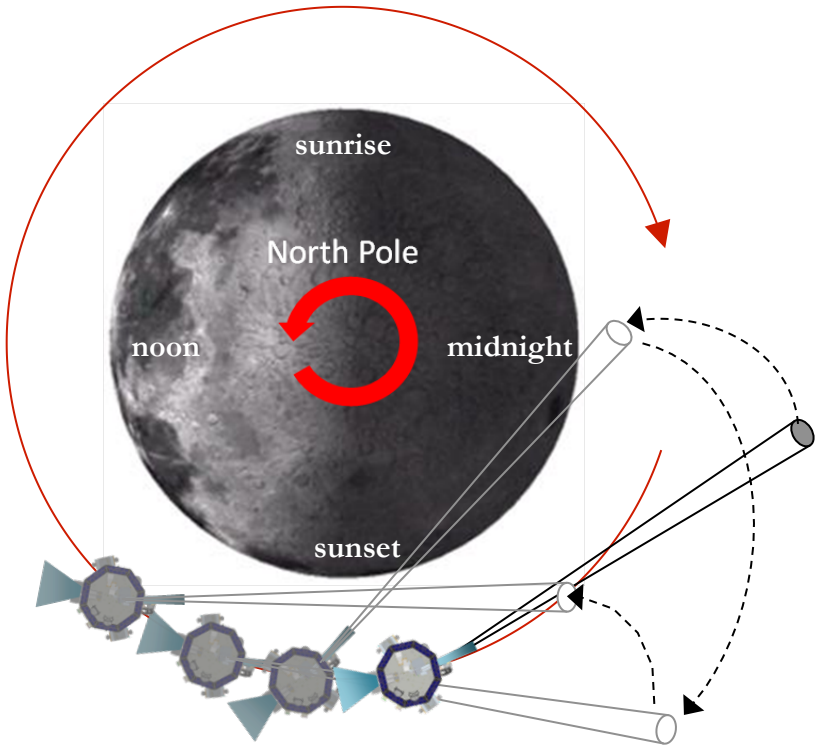


“Massive” co-adds:

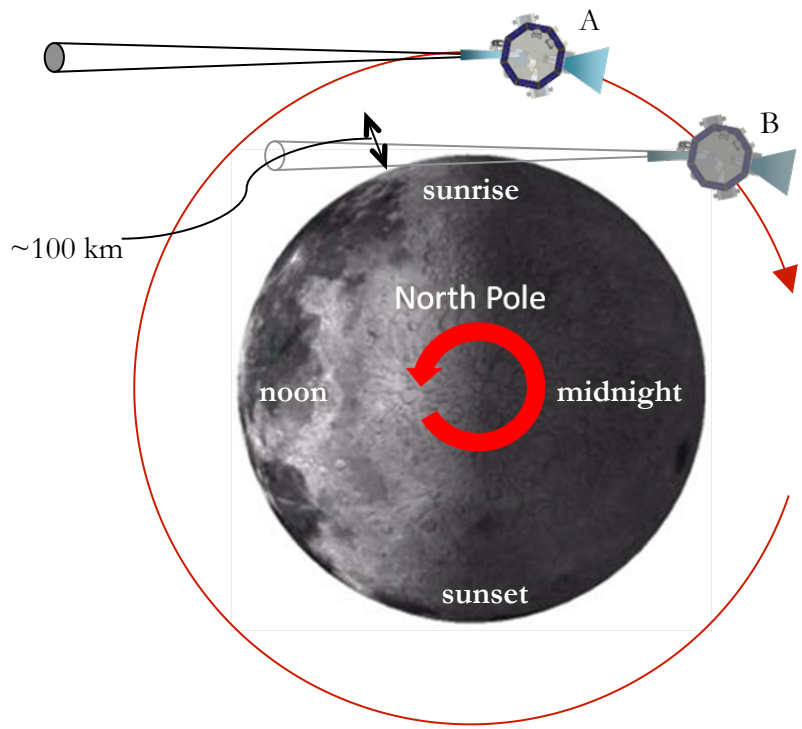
- Constrained by max counts (scatter), Solar longitude, detector temp (<-30C)
- >12,000 Sunrise scans (~24,000 sec)
- >8,100 Sunset scans (~16,000 sec)
- All hot pixels removed

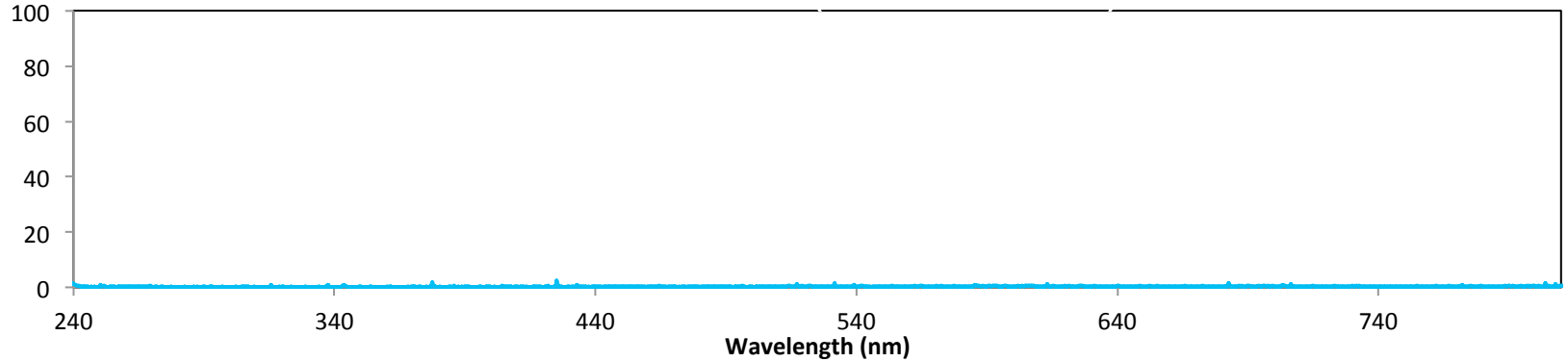
Reminder of Observation Geometries

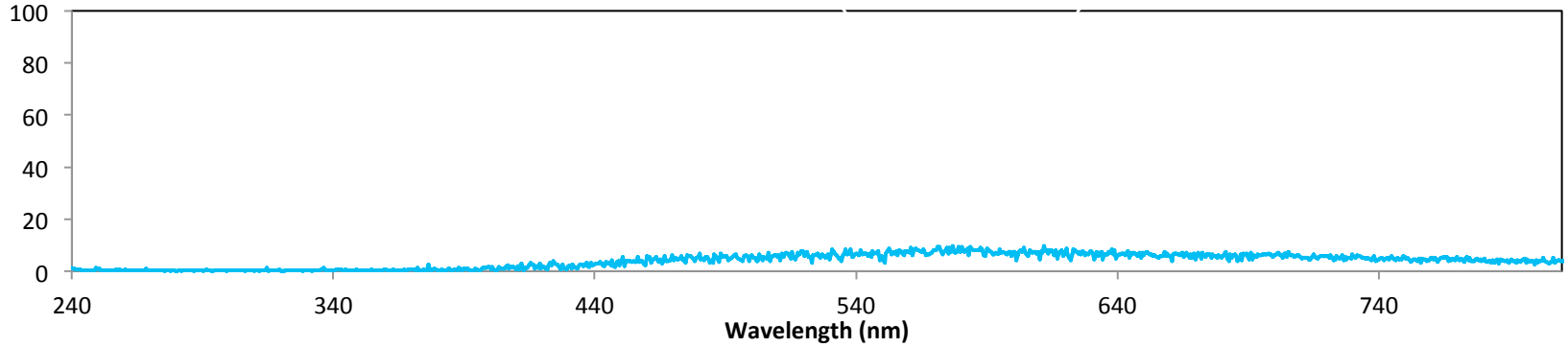
Sunset



Sunrise




100
80
60
40
20
0
240
340
440
540
640
740
Wavelength (nm)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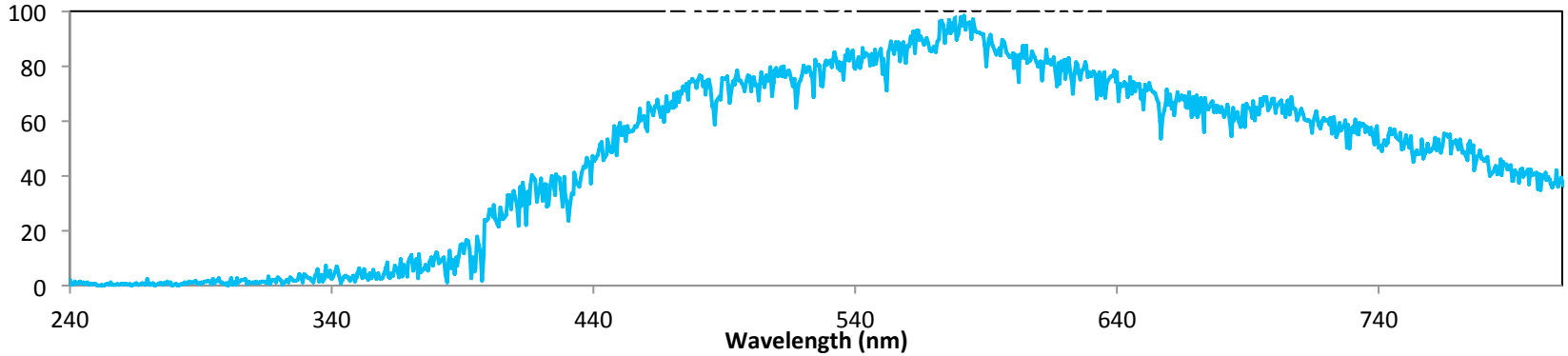
Wavelength (nm)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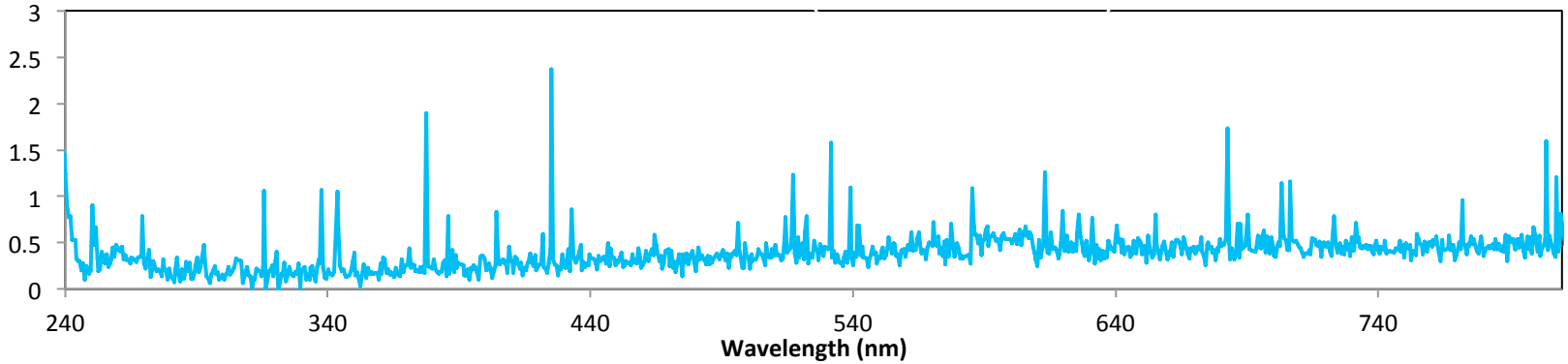
640
740
Wavelength (nm)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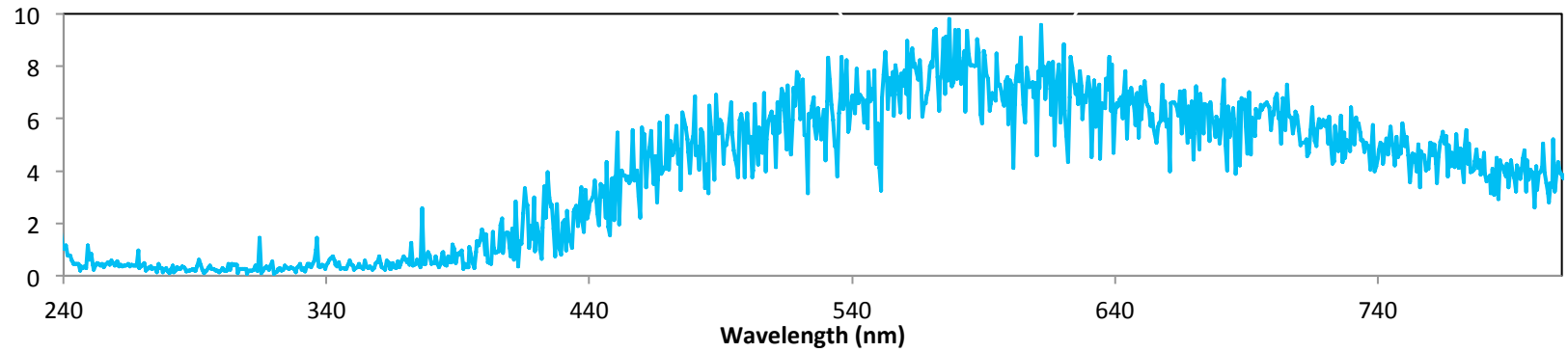
2.5
2
1.5
1
0.5
0
240
340
440
540
640
740
Wavelength (nm)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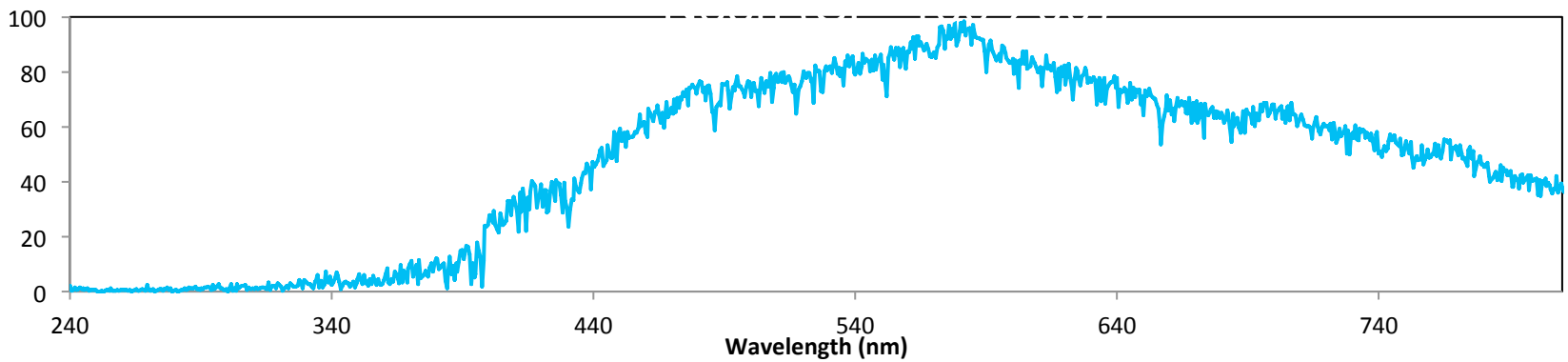
Wavelength (nm)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20
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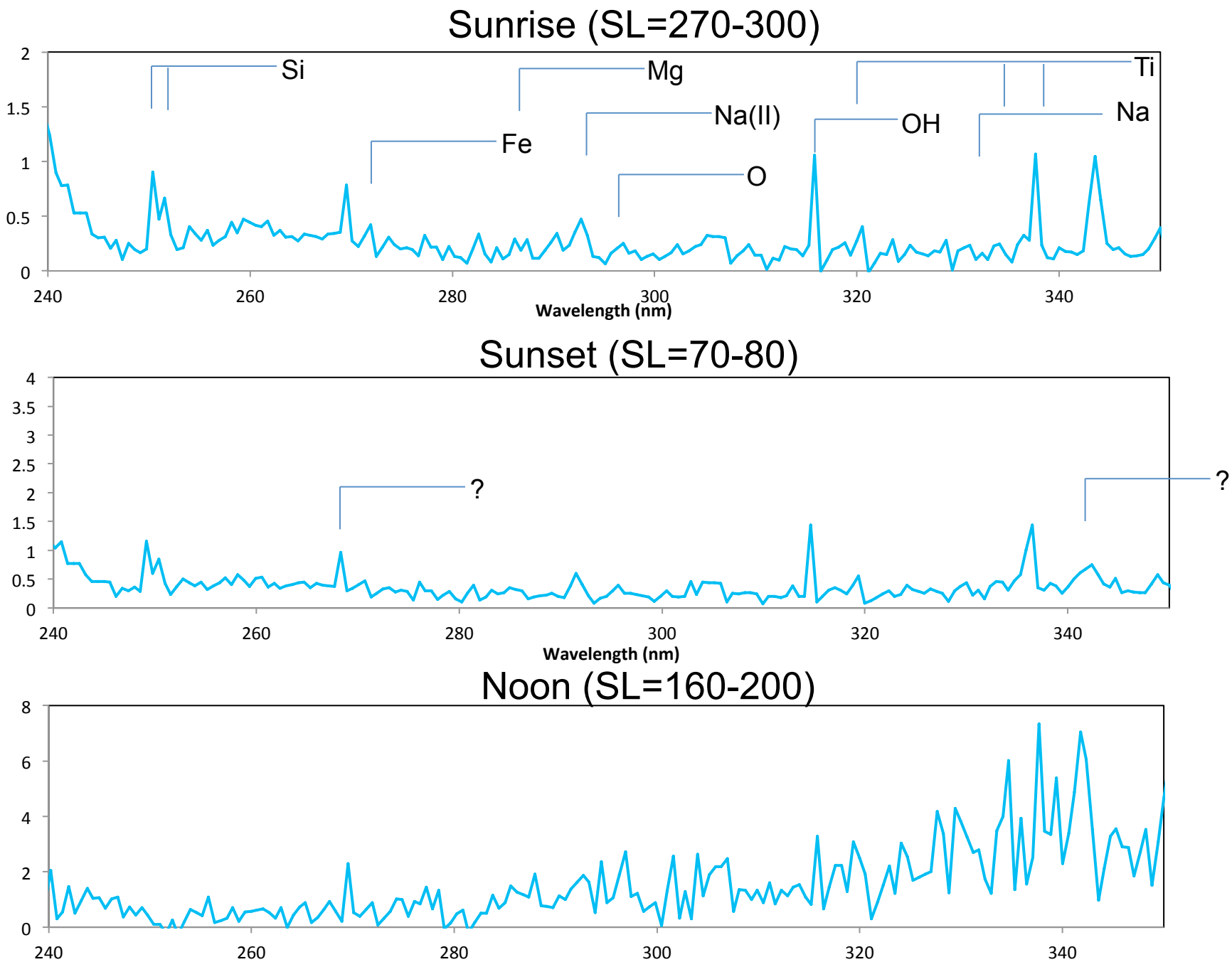
240
340
440
540
640
740
Wavelength (nm)


Sunrise (SL=270-300)
Si
Mg
Ti
Na(II)
OH
Na
Fe
O
Wavelength (nm)
Sunset (SL=70-80)
?
?
Wavelength (nm)
Noon (SL=160-200)