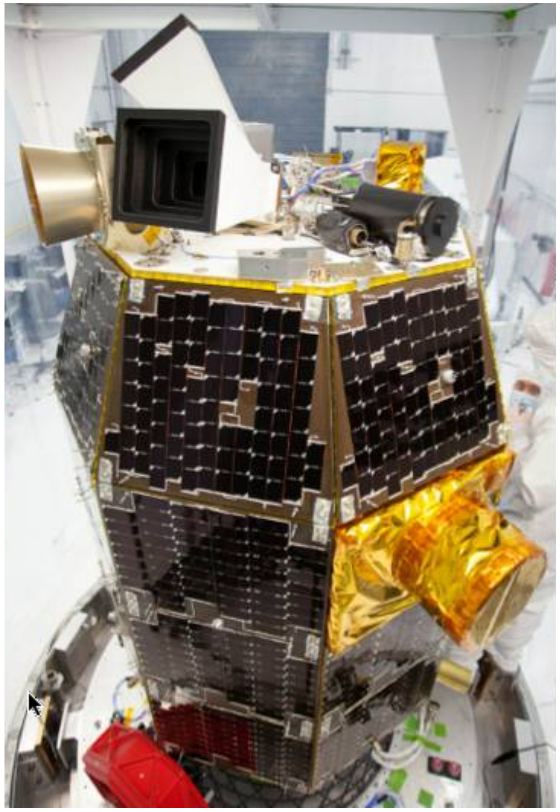


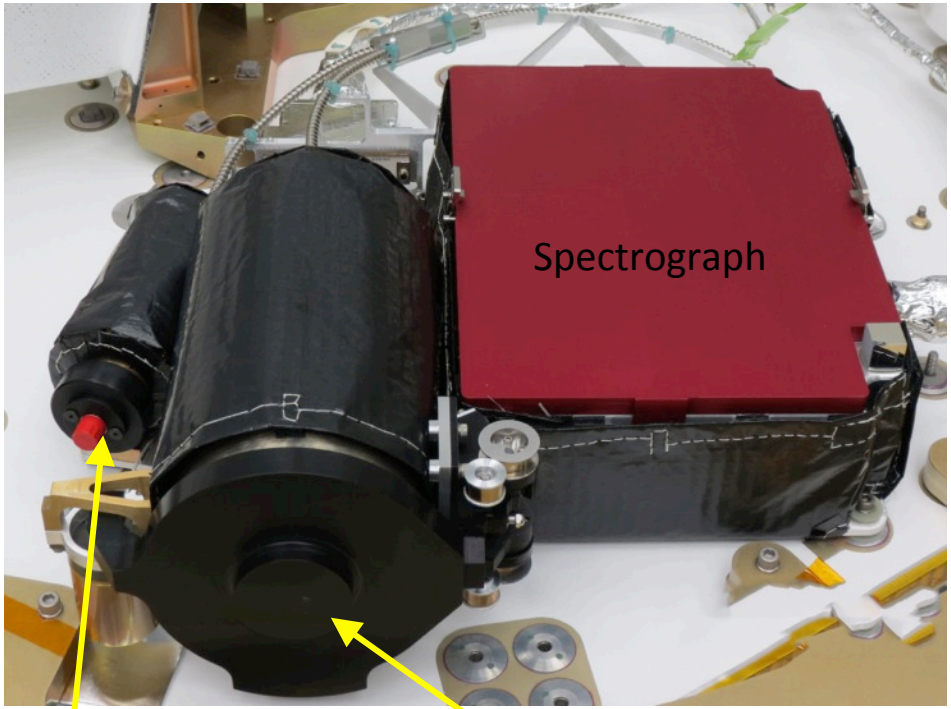
# LADEE Ultraviolet and Visible Spectrometer (UVS)

# An Examination of LADEE UVS Spectral Variability Associated with the Geminid Meteoroid Shower

July 23, 2015

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

# Instrument Summary



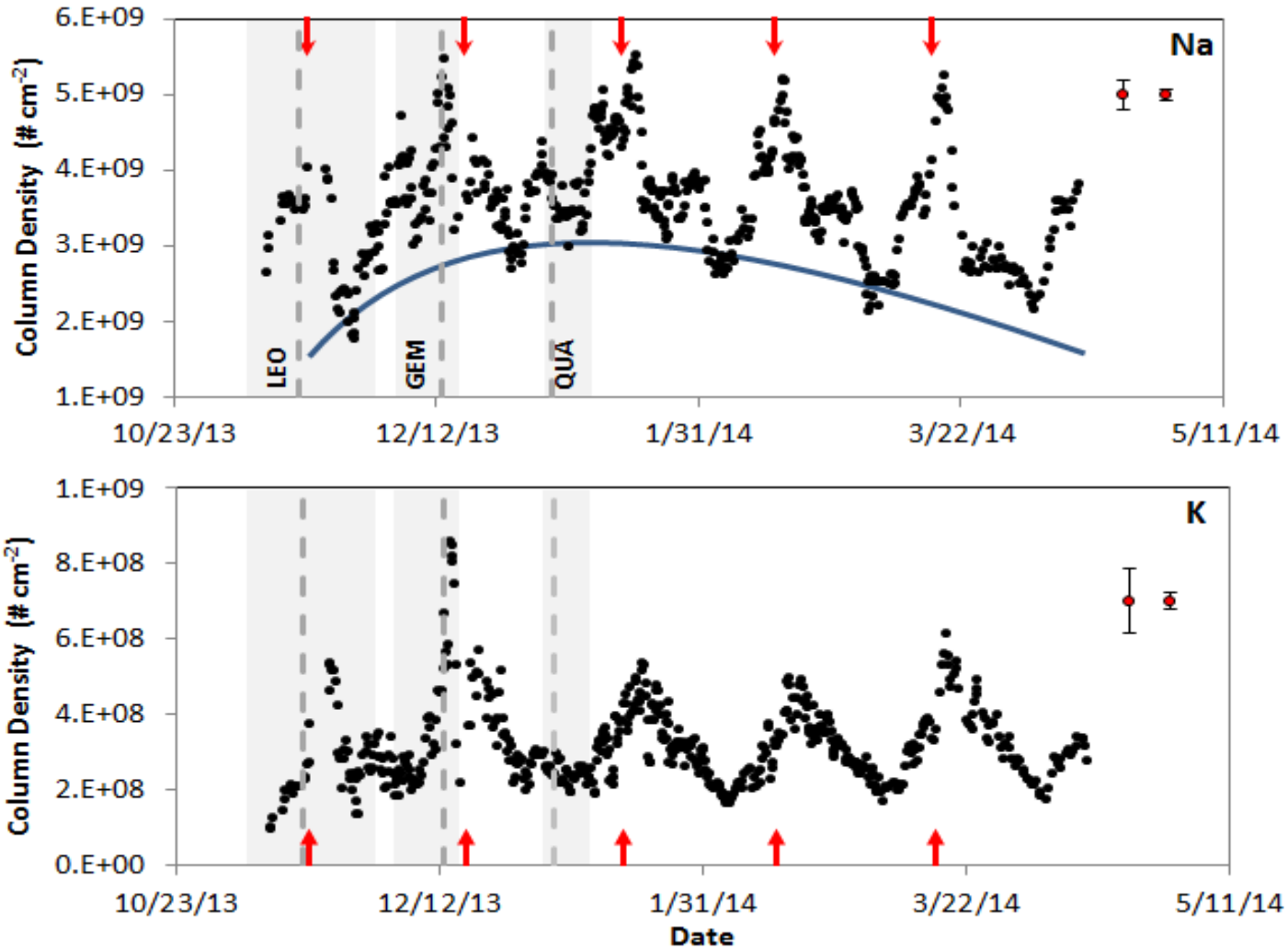

Solar Viewer

Limb Telescope

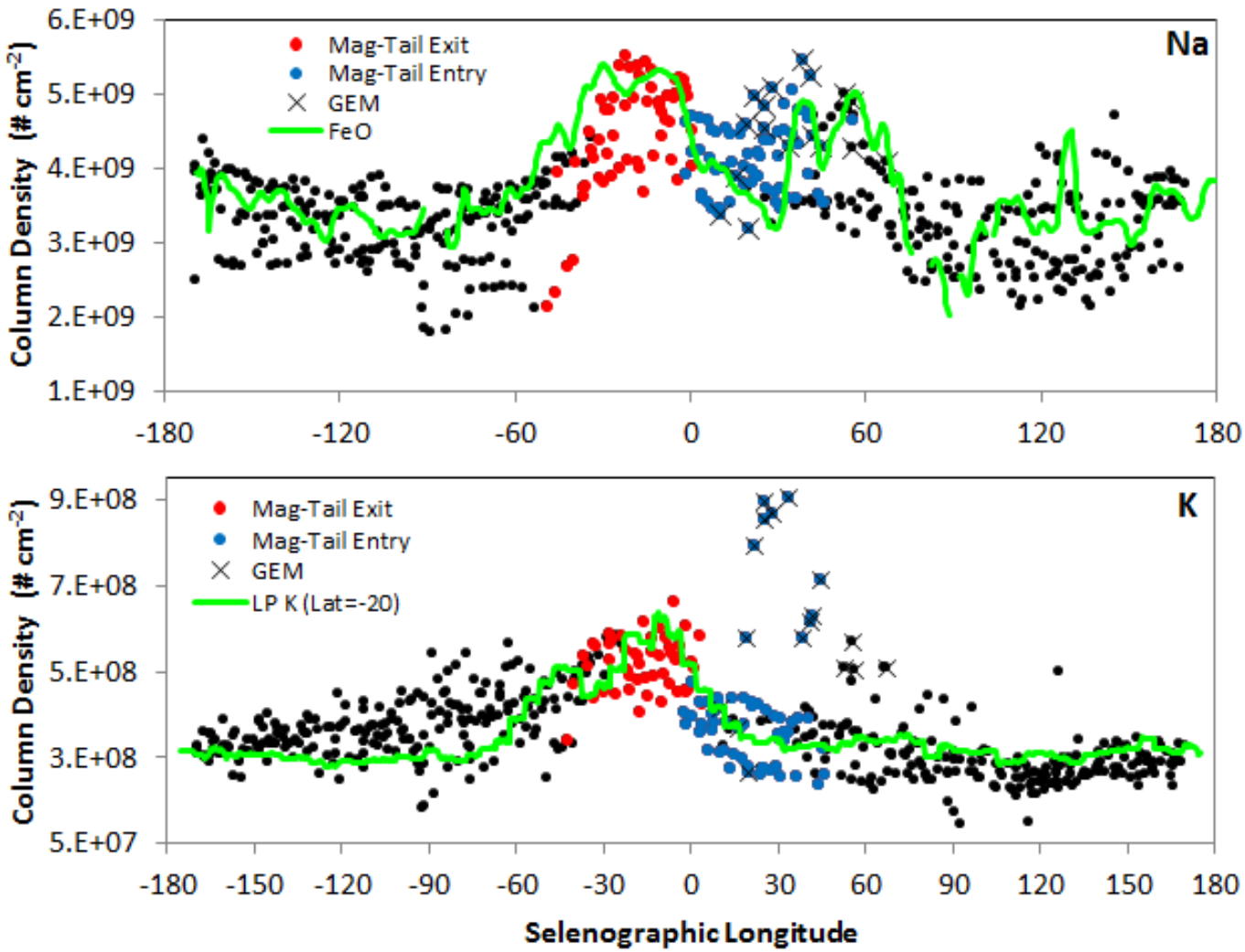
- Fiber-fed, CCD "Point" Spectrograph (all vertical pixels are binned)
- $\lambda$ = 230-810 nm, d$\lambda$ ~0.5 nm
- Utilizes two 1°FOV foreoptics: Telescope and Solar Viewer
- Active/passive cooling (radiator limits detector temps to >-35C)
- Observed a variety of geometries trying to maximize utility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

# Sodium and Potassium Variation

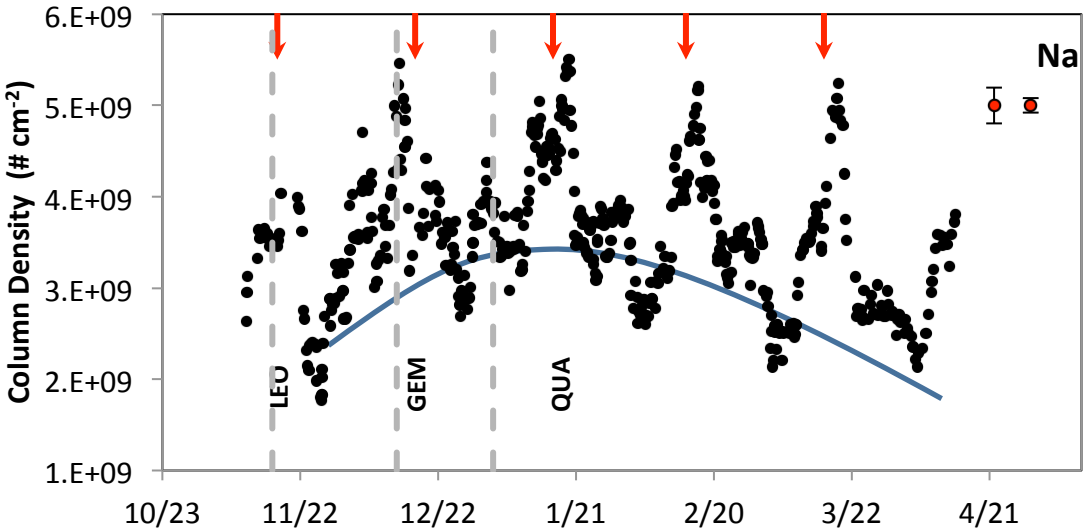
"Noon" observations with a stare altitude of 40 km



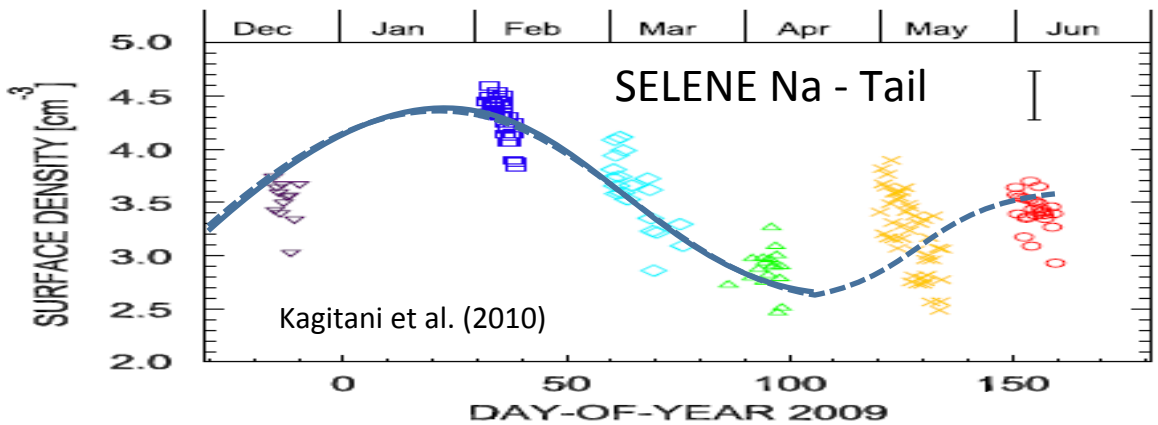
# Na and K Surface Dependence



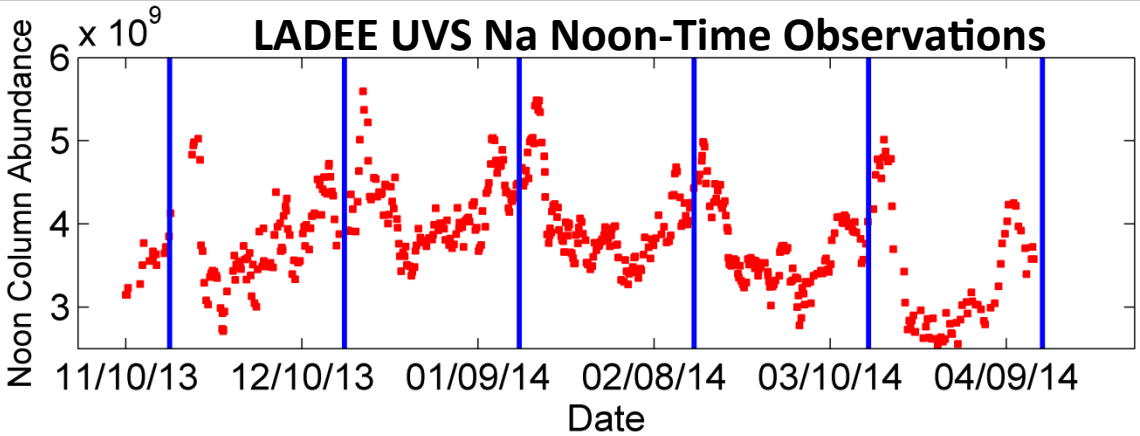
# Sodium Annual Variation

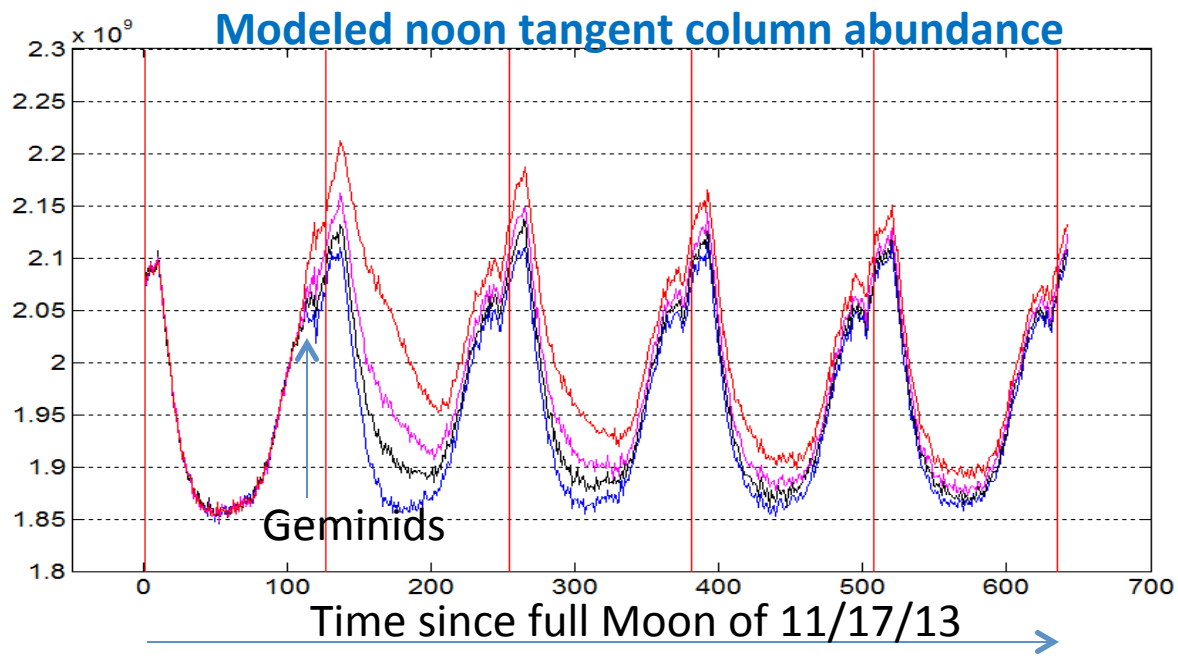



- General agreement between Kaguya observations and UVS
- Suggest a possible long-term variation variability associated with annual meteoroid streams



# Modeled Geminid Effect




Source for reservoir is micrometeoroids, but different cases were modeled:

1. Blue=constant background meteoroids;
2. Magenta=x2during Geminids
3. Red=x3 during Geminids

Radiant 60 deg before dawn

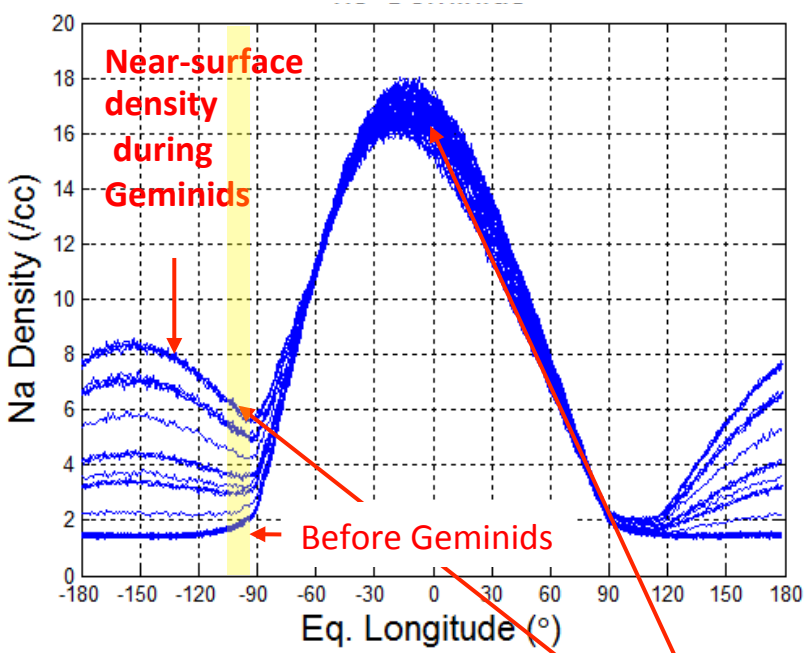
Sarantos, 2015

Promising result: Geminids raise the "valleys" near New Moon; their effect in the model Dies down in a couple of months using known sinks

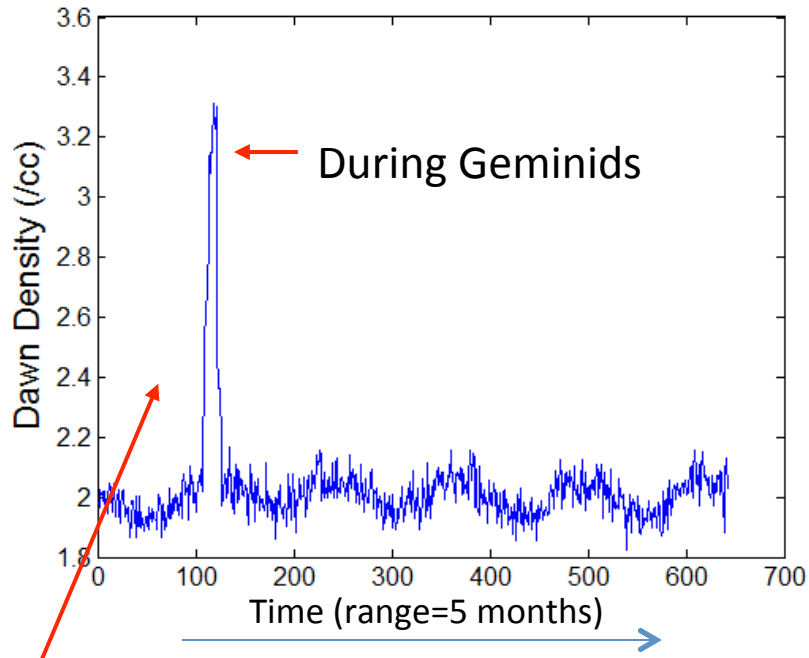
# Modeled Geminid Effect

Shown are snapshots of the modeled Equatorial density before and during Geminids

3.5x cumulative production over the 100 hrs of Geminid shower duration




2x Geminids



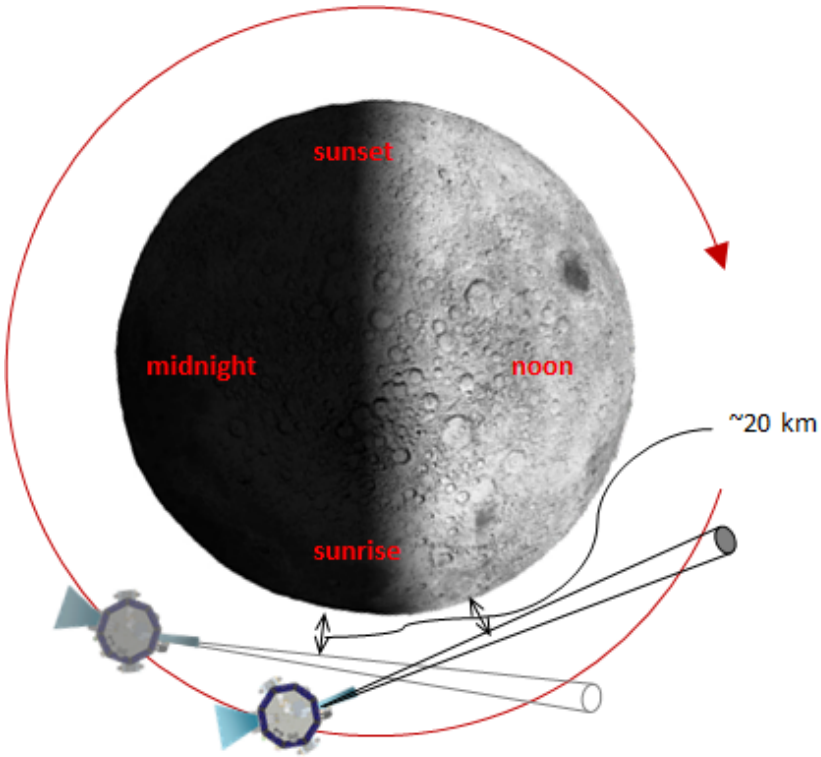

Sarantos, 2015

**Instantaneous effect ~x2 at dawn,**
**Whereas only ~25% effect near subsolar point**

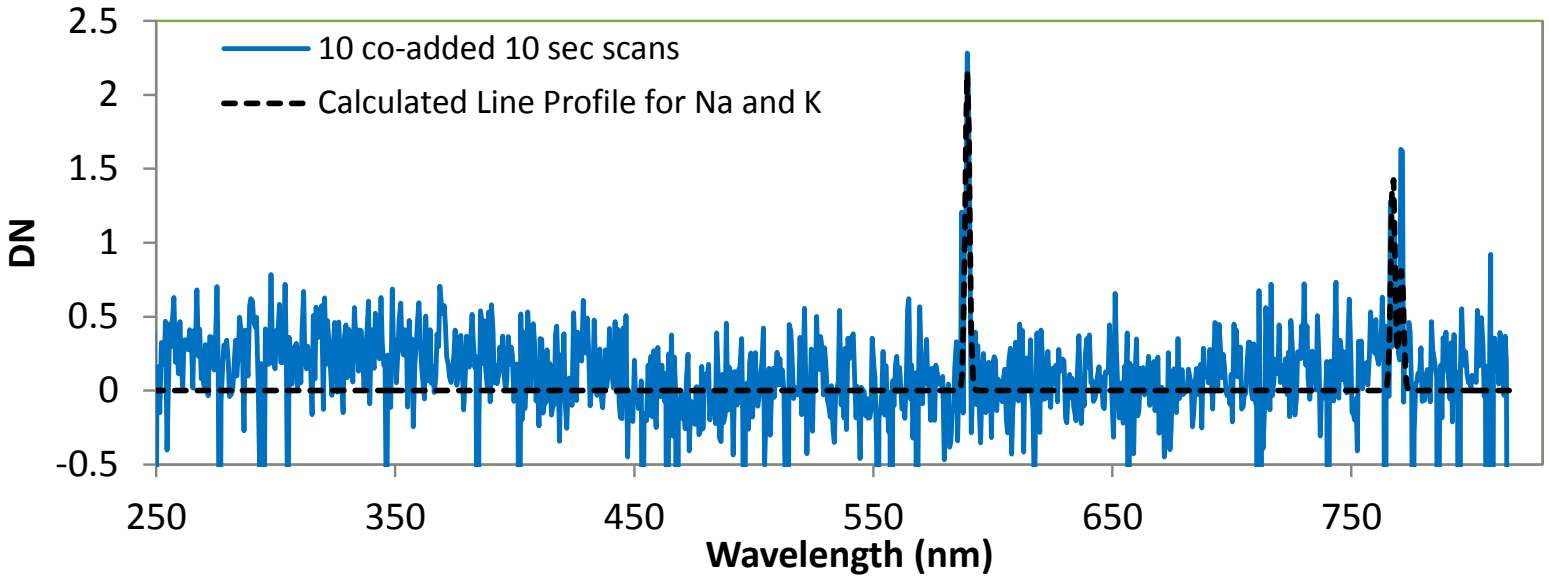
# Sunrise Data Analysis

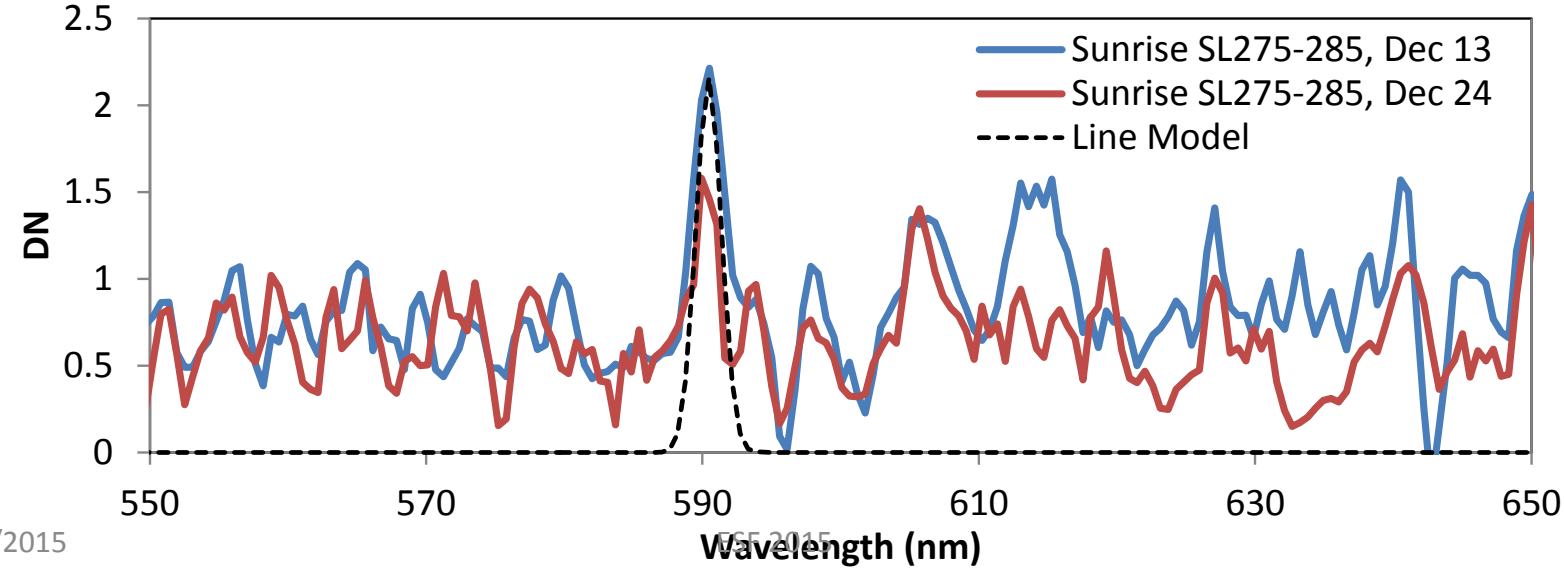
**Looked at "Sunrise Activity" Data**

- Surface in shadow results in very low solar scatter
- For period surrounding Geminids Sunrise activities included a nod at the terminator of the telescope FOV between ~15-45 km.
- Usually the last of three activities, so often only the first 100-200 scans have stable detector temperatures
- Used activities with increasing detector temps to further isolate "hot pixels" and correct for other thermal effects
- Scrubbed for cosmic ray hits
- Averaged spectra between the first 20-160 seconds (80 scans) after the start of the activity



# Example of Sunrise Spectra

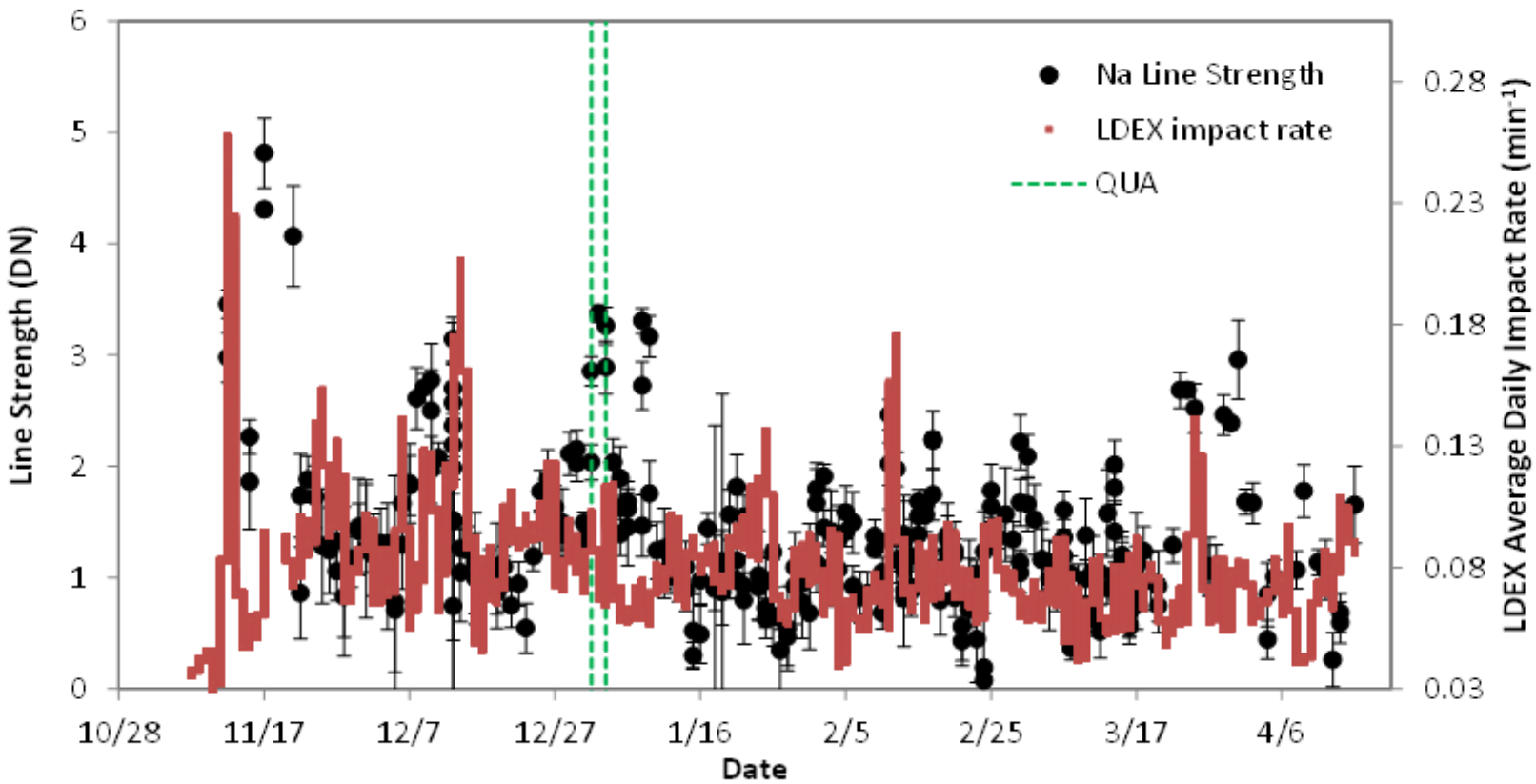


# Sodium Sunrise Line Strength

**Sodium line strength plotted vs date**

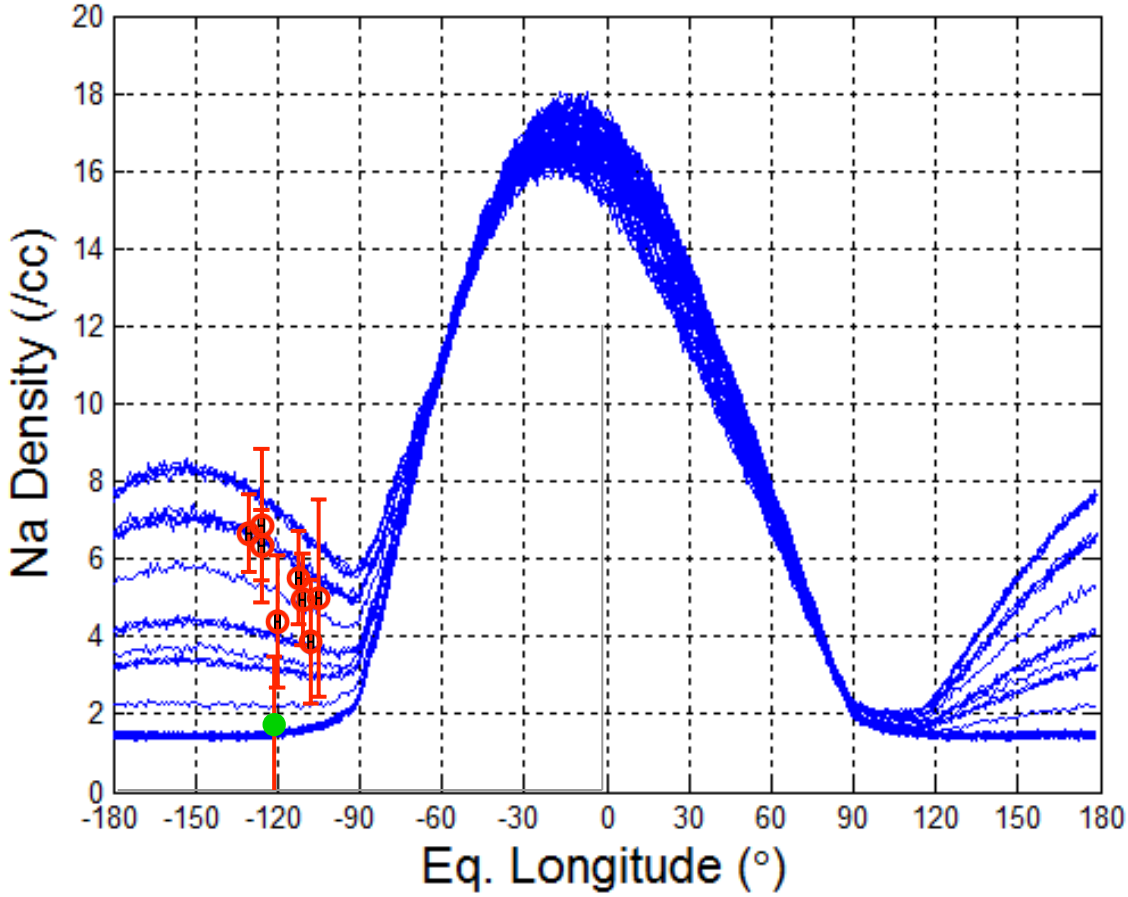
- LDEX Impact rater over-plotted for comparison
- Quadrantid shower indicated



# Modeled Geminids Effect

**Initial comparison of pre-dawn Na line strength to modeled densities**

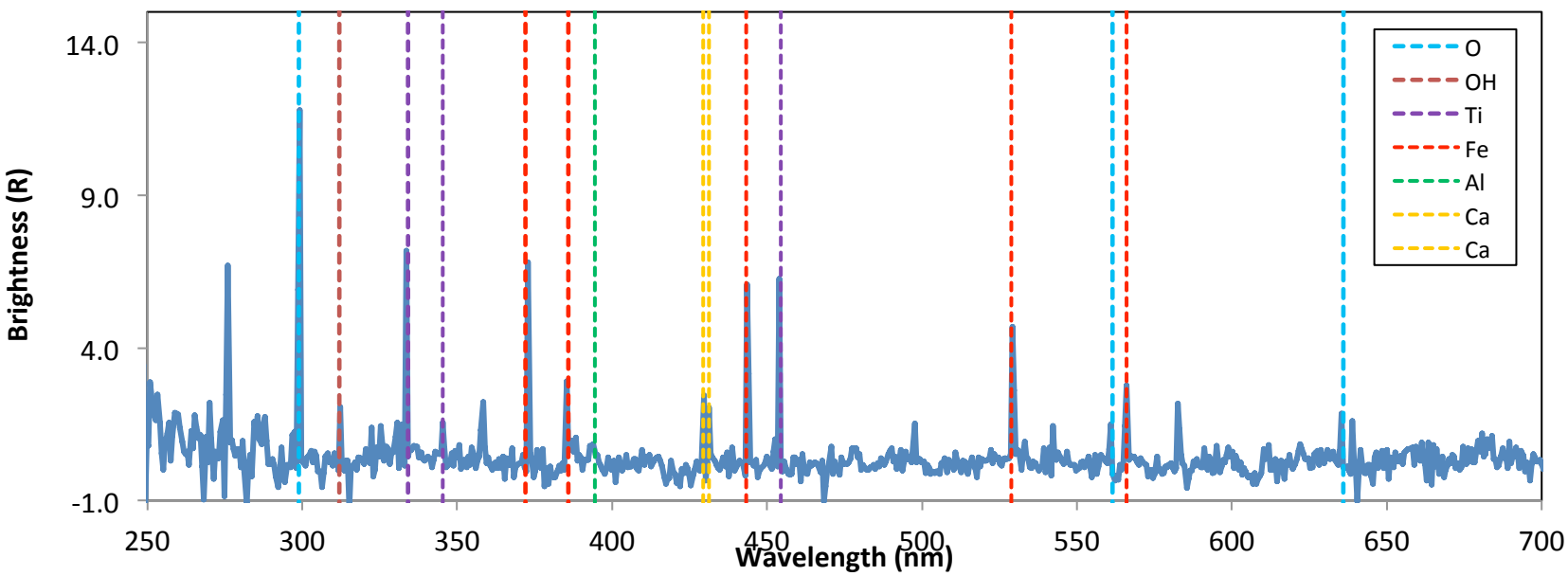
3.5x cumulative production over the
100 hrs of Geminid shower duration



# Other Species?

**Initial comparison of Pre- and Post Geminids Dawn Limb Spectra**

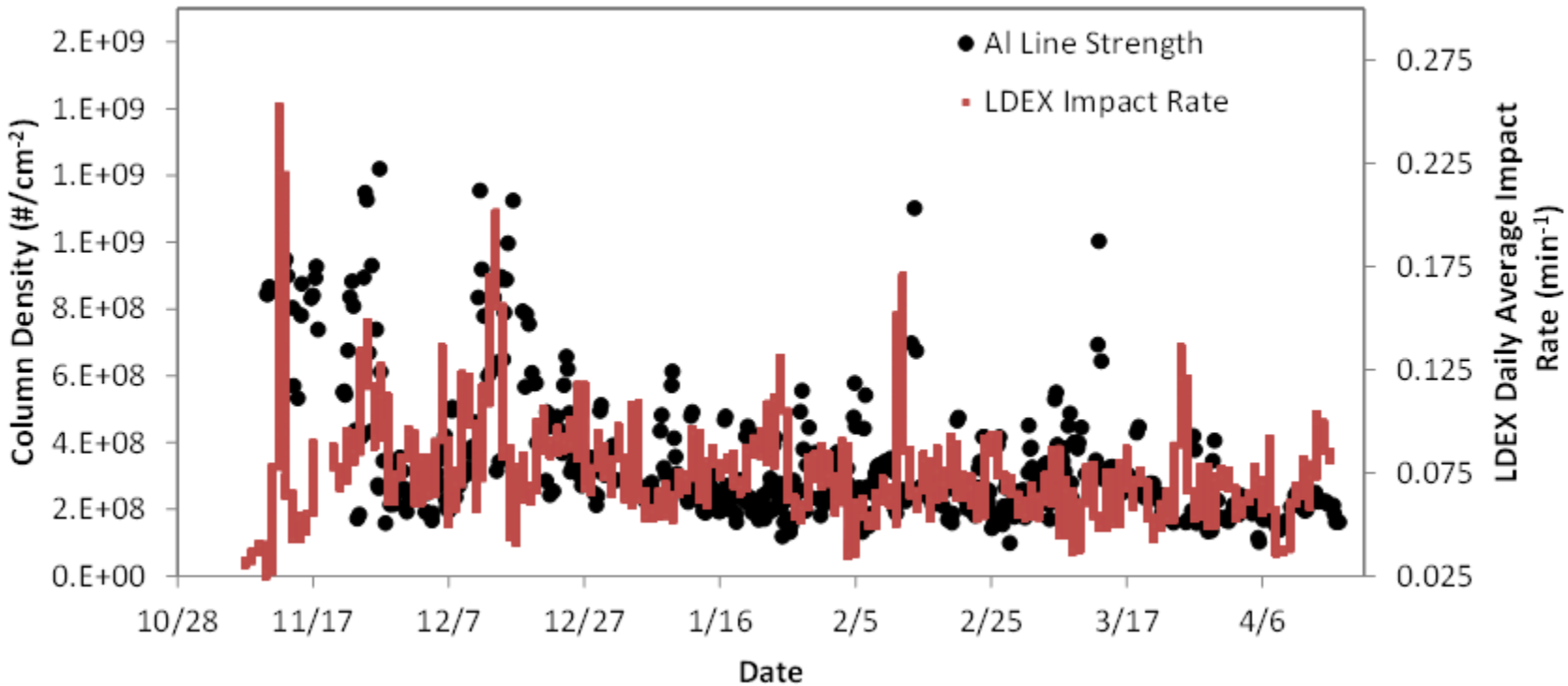
- Only spectra taken while the SC was in shadow (lunar umbra) and with a solar longitude (the position of the telescope filed-of-view grazing point) between 275-300 deg were used.
- For all measurements the dark current and instrument bias was corrected for, and "hot pixels", identified through a series of on orbit dark calibrations, were removed.
- >100 spectra were co-added to improve the signal-to-noise ratio.



# Other Metals?

**Initial comparisons of Aluminum column densities vs date**

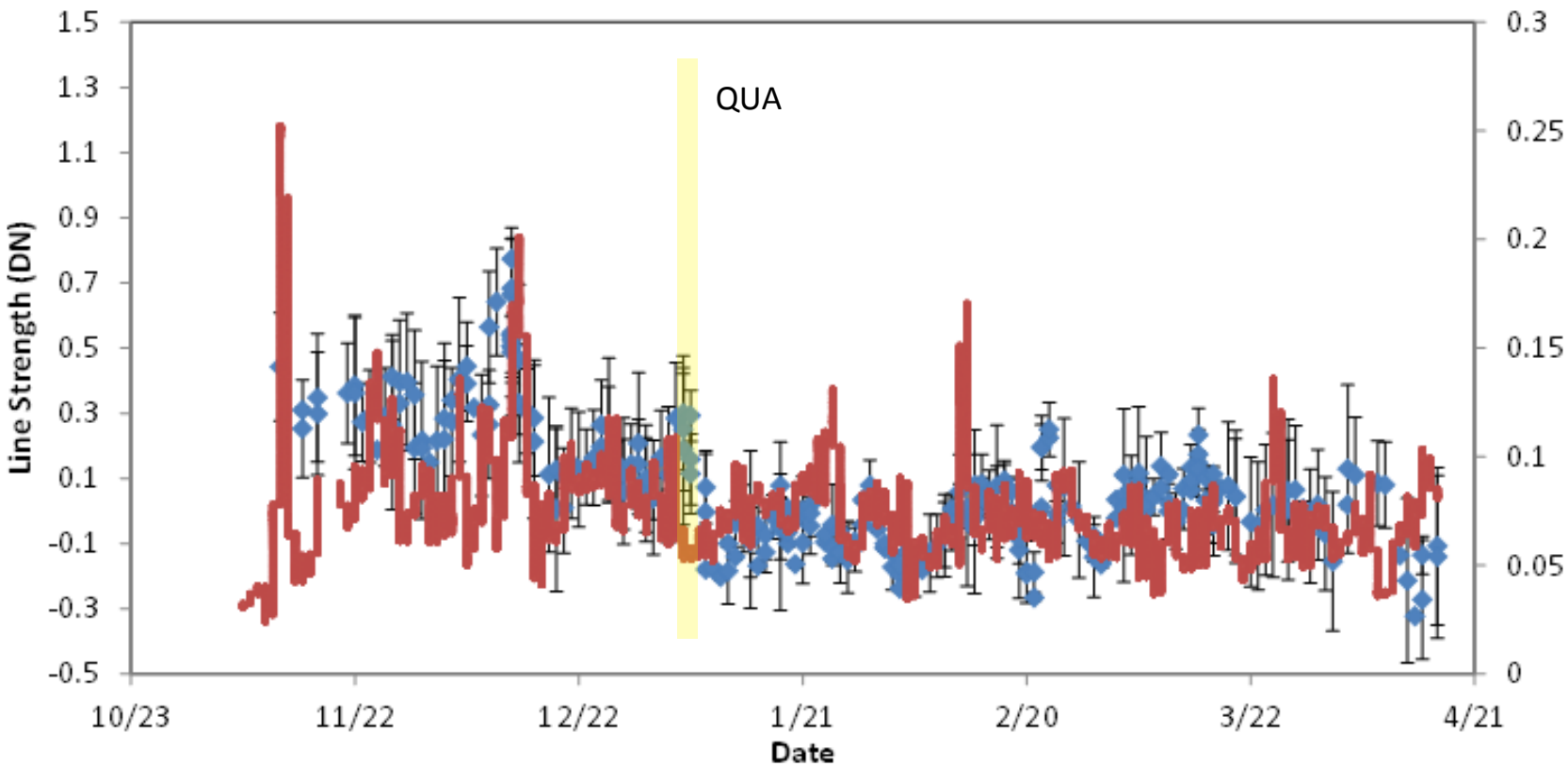
- LDEX impact rate over-plotted
- Aluminum column density calculated for Solar Longitude of 165-180
- Magnitude in good agreement with models



# OH?

**Initial OH Emission Line Strength at Sunrise vs Date**

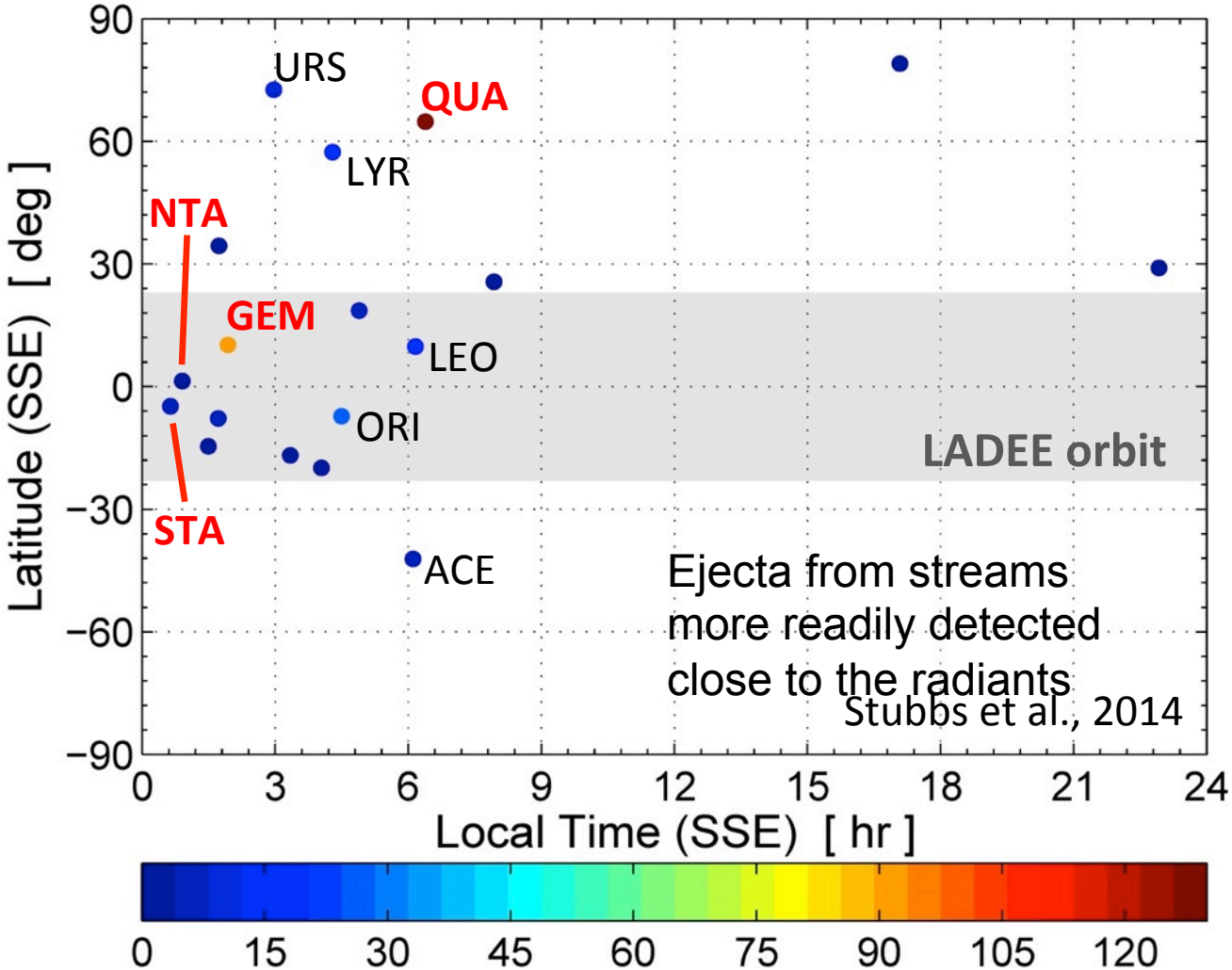
- LDEX Impact Rate over-plotted
- Reasonable correlation with LDEX impact rate



# Summary

- The evidence continues to mount that the sporadic meteoroid showers provide a significant and important contribution to the sodium atmosphere
- Modeling of the effect of the Geminid shower suggests that the rise and then fall of the annual mean sodium concentrations tied to showers
- Other metals (and other gases) also appear to have correlation with the showers (e.g., the Geminids)
- The combination of the UVS data and modeling will better quantify the vapor contributions of the showers, as well as loss rates of key exosphere constituents

**Thank you!**

# Meteoroid Streams During LADEE

## Radiants at the Moon during LADEE