A satellite view of Earth at night, showing city lights and star trails. The text is overlaid on the image.

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Understanding Light Pollution in and around Tucson, Arizona

REU 2013

Overview

- Goals of this project
- What is light pollution?
- What is an SQM?
- Data Reduction
- Trends
- Sky Brightness Model
- Laboratory testing
 - > Glass
 - > UV Yellowing
 - > CM500 Filter
- Future Work

Goals of this Project

A satellite view of Earth at night, showing the continents of North and South America. The landmasses are covered in a dense network of yellow and white lights, representing city lights and light pollution. The oceans are dark, with some faint lights visible along the coastlines. The overall scene is a dark blue background with a complex pattern of bright, glowing points and lines.

To characterize the light pollution in and around Tucson and to search for spatial and temporal trends.

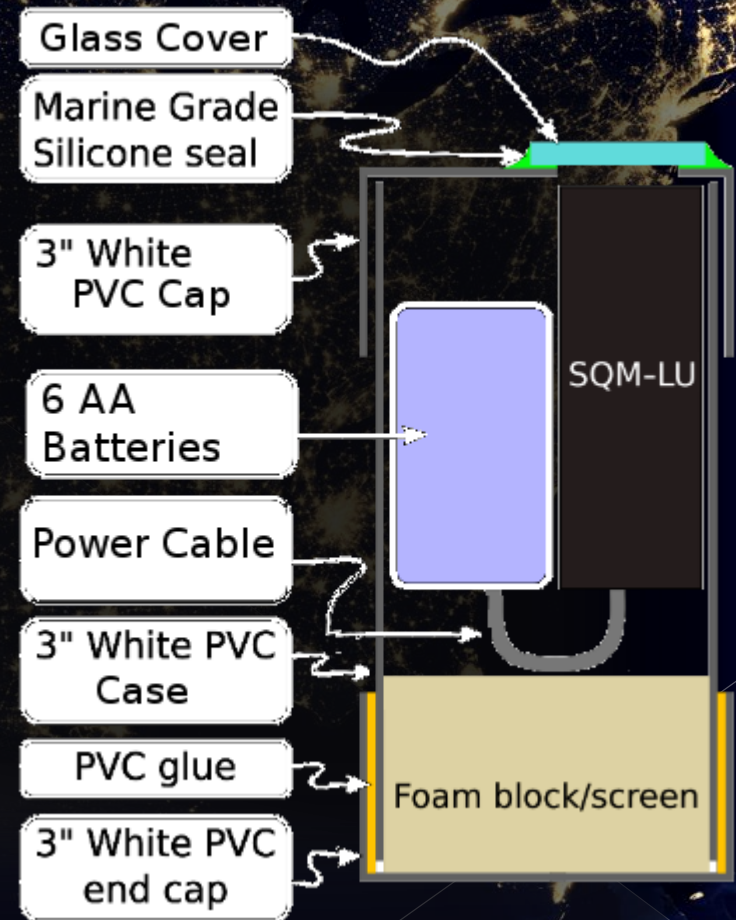
What is Light Pollution?

- ◉ Light where it is unwanted and unneeded
- ◉ Concerned with sky glow
 - > Anthropogenic contribution mostly due to inefficient light shielding



What is an SQM-LU-DL+H?

- FOV FWHM of 20°
- TSL237 300-1100 nm
- CM500 IR filter
- Data-logging
- Weatherproof Housing
- 8 used for testing
- Data taken every 5 minutes



Locations of Collection Sites

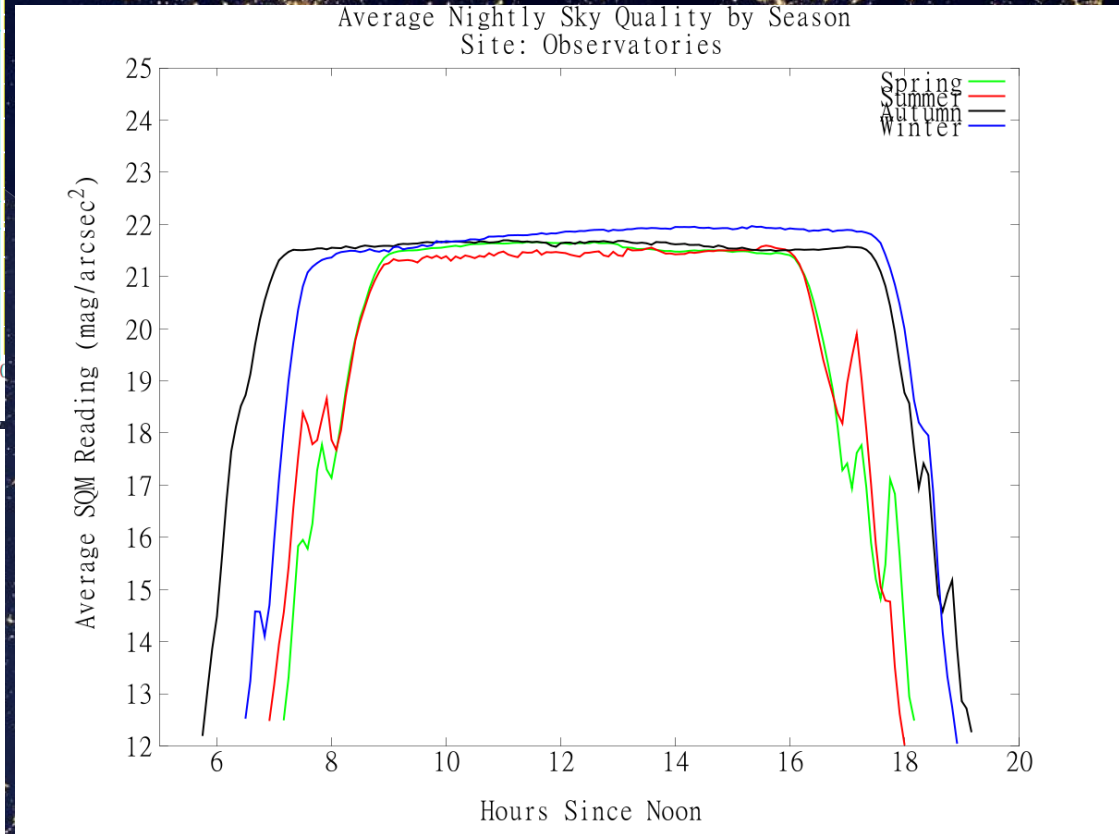
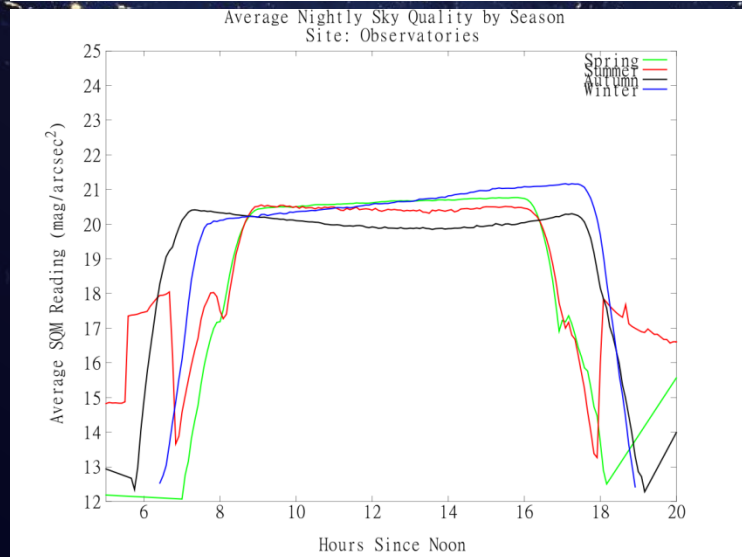
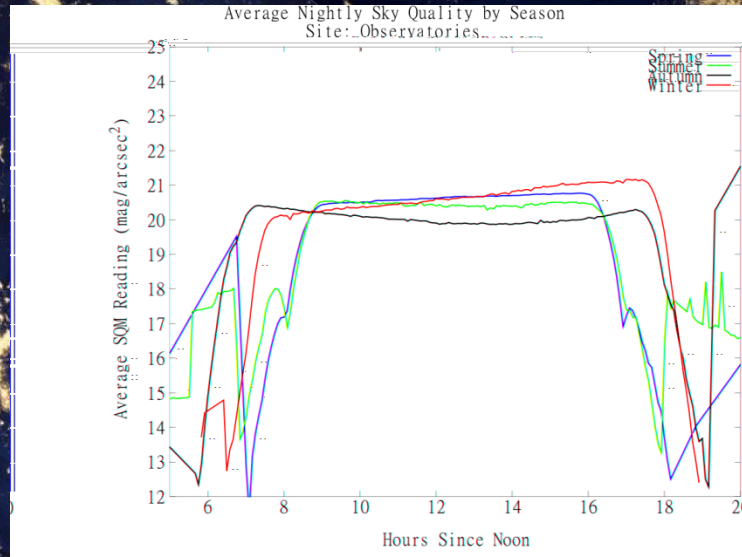


Reducing the SQM data

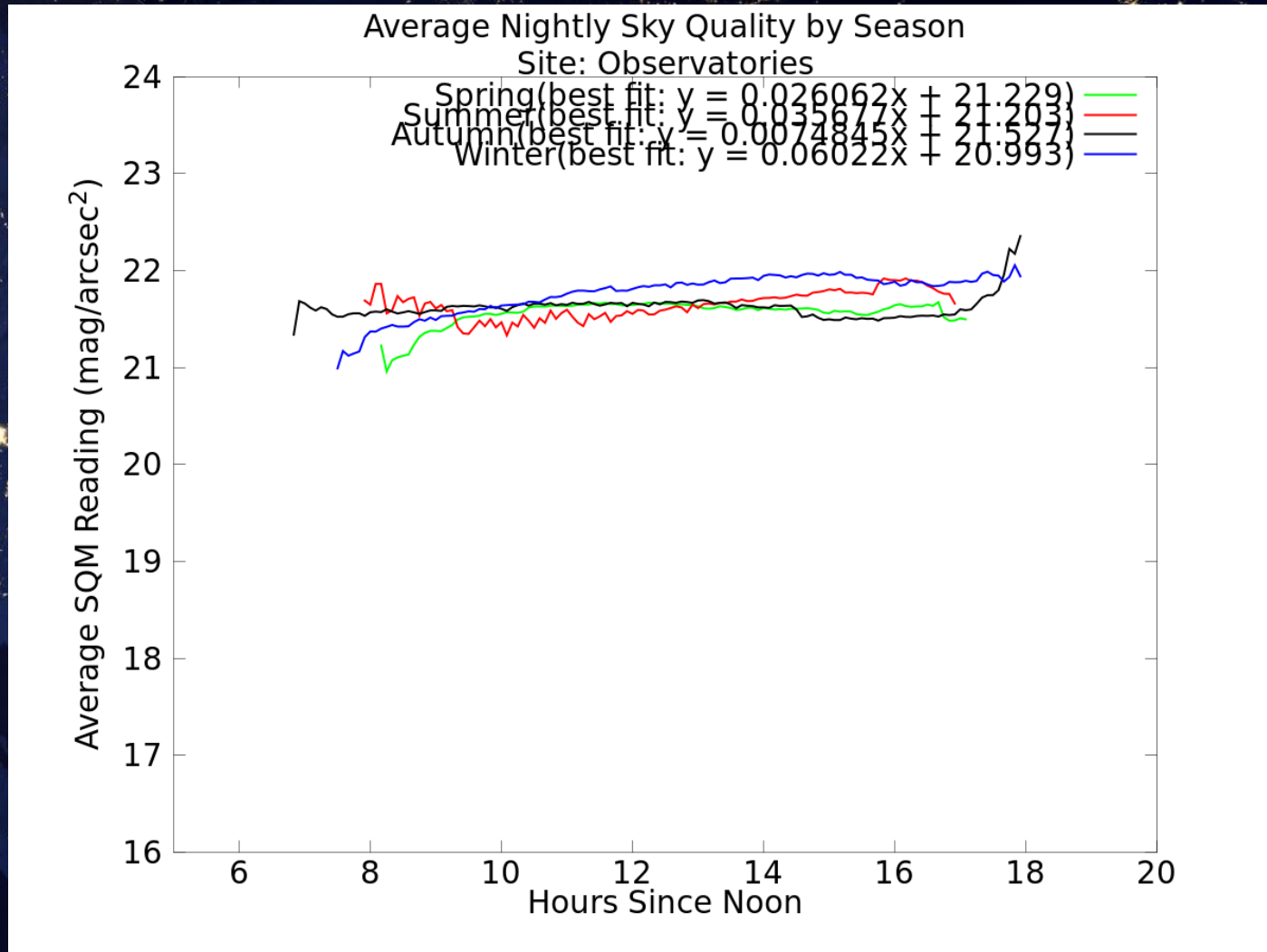
- Series of python scripts
- Faulty data
- Remove sun, Milky Way, moon, moon twilight, and twilight

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Removing the Faulty Data



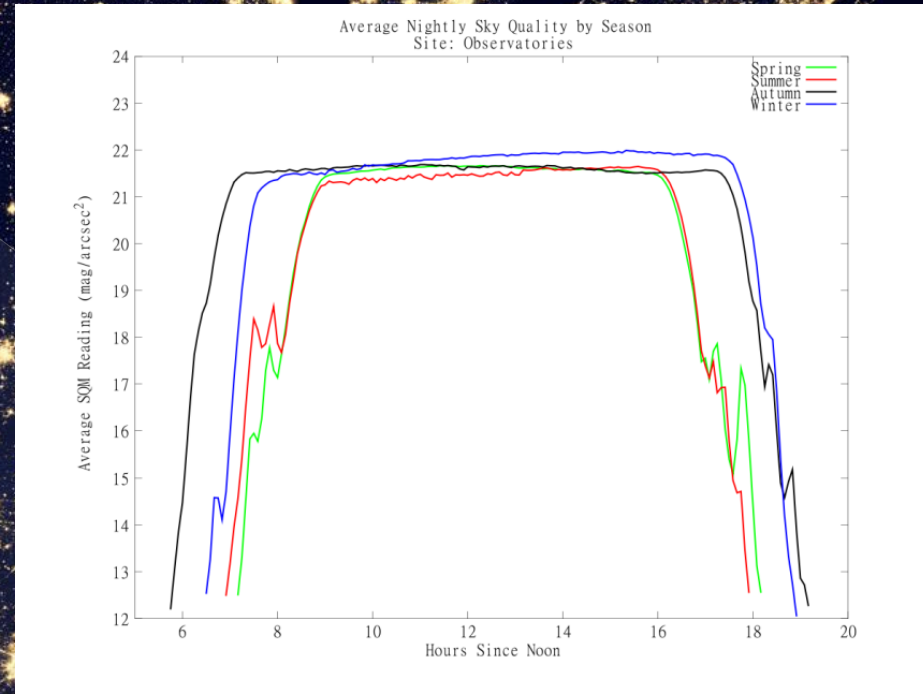
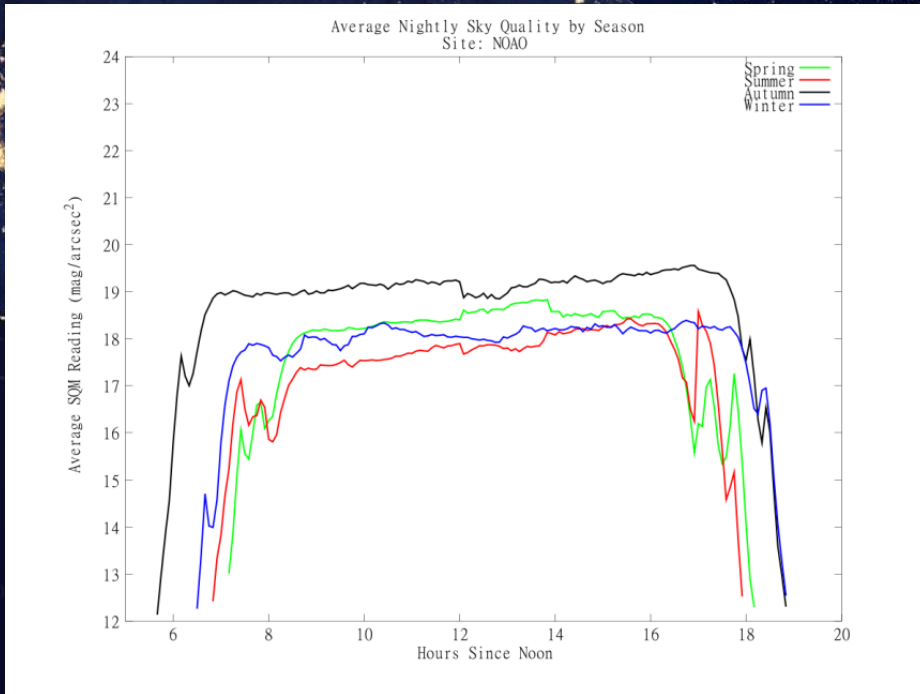
Reduced SQM Data



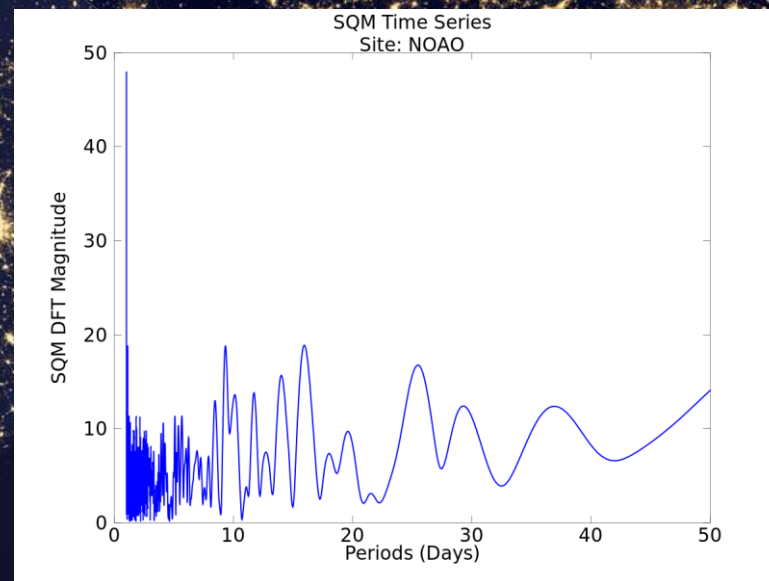
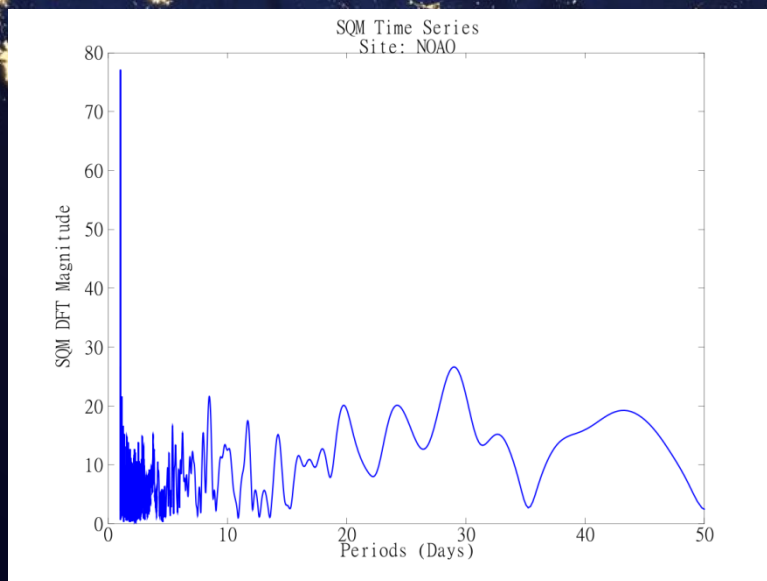
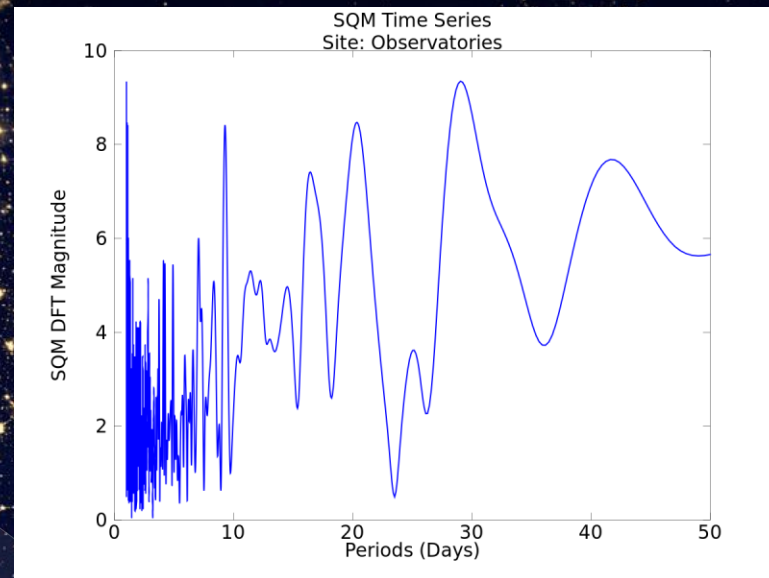
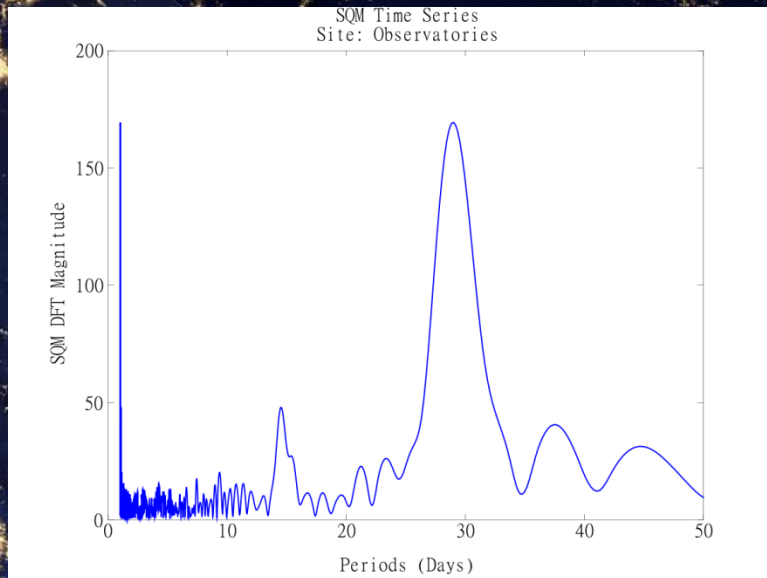
Trends

- ⦿ Periodograms for temporal trends
 - > Weekly
 - > 10 Day
 - > 15 Day
 - > Seasonally
 - > Annually
- ⦿ Sites were divided into 3 groups for spatial trends
 - > NOAA
 - > Cardinal Point Sites
 - > Observatory Sites

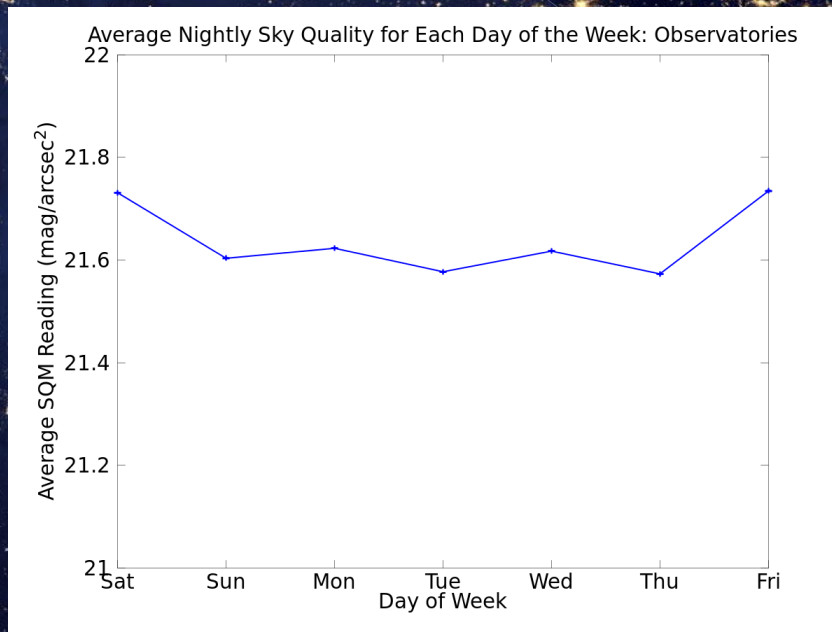
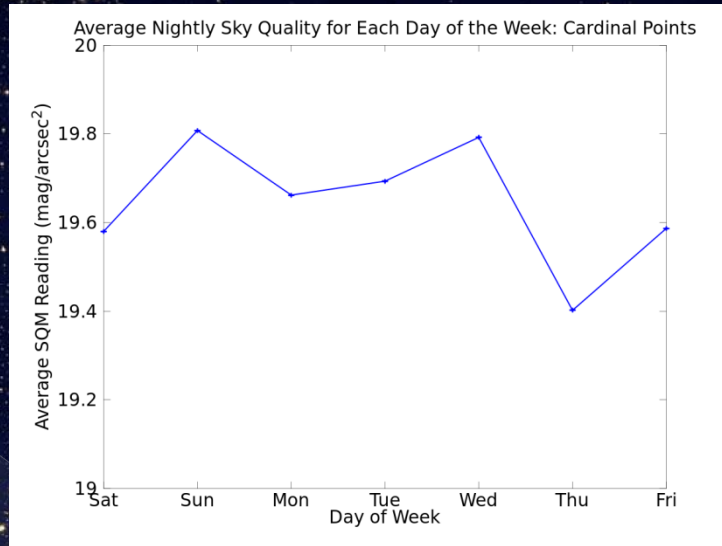
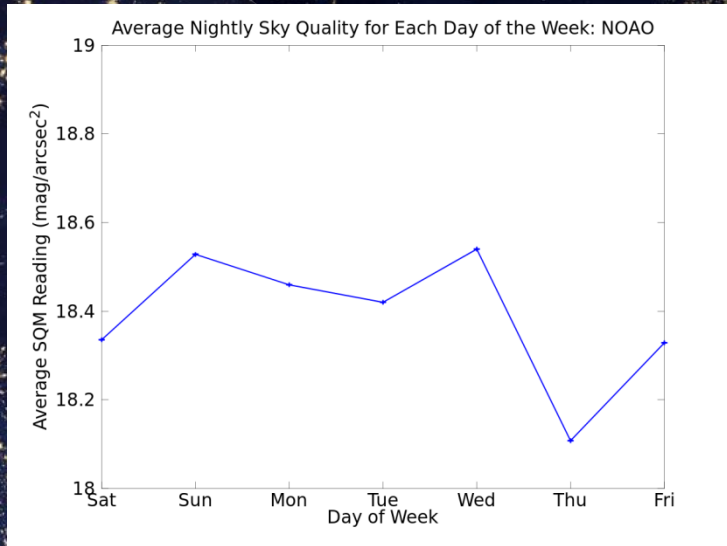
Location Dependent Trends



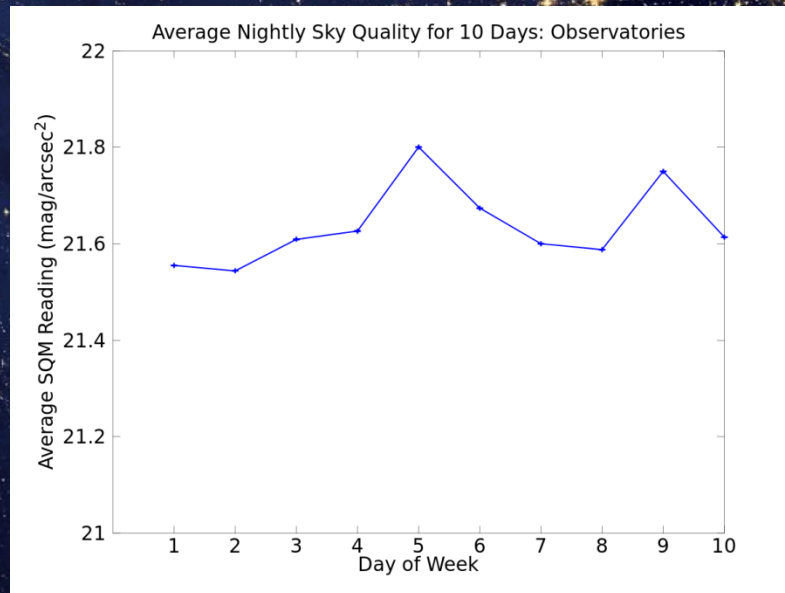
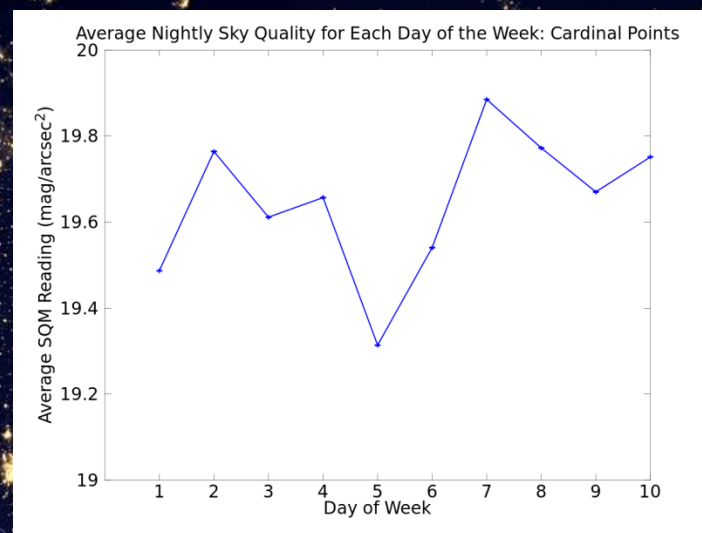
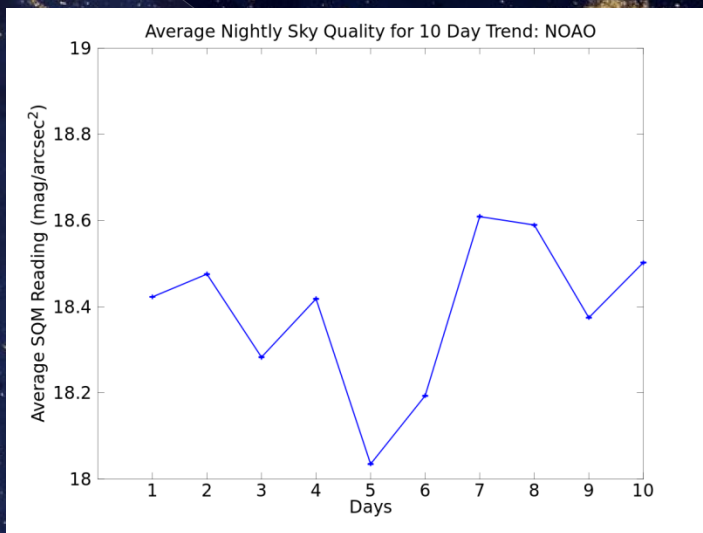
Periodograms: Raw vs Reduced



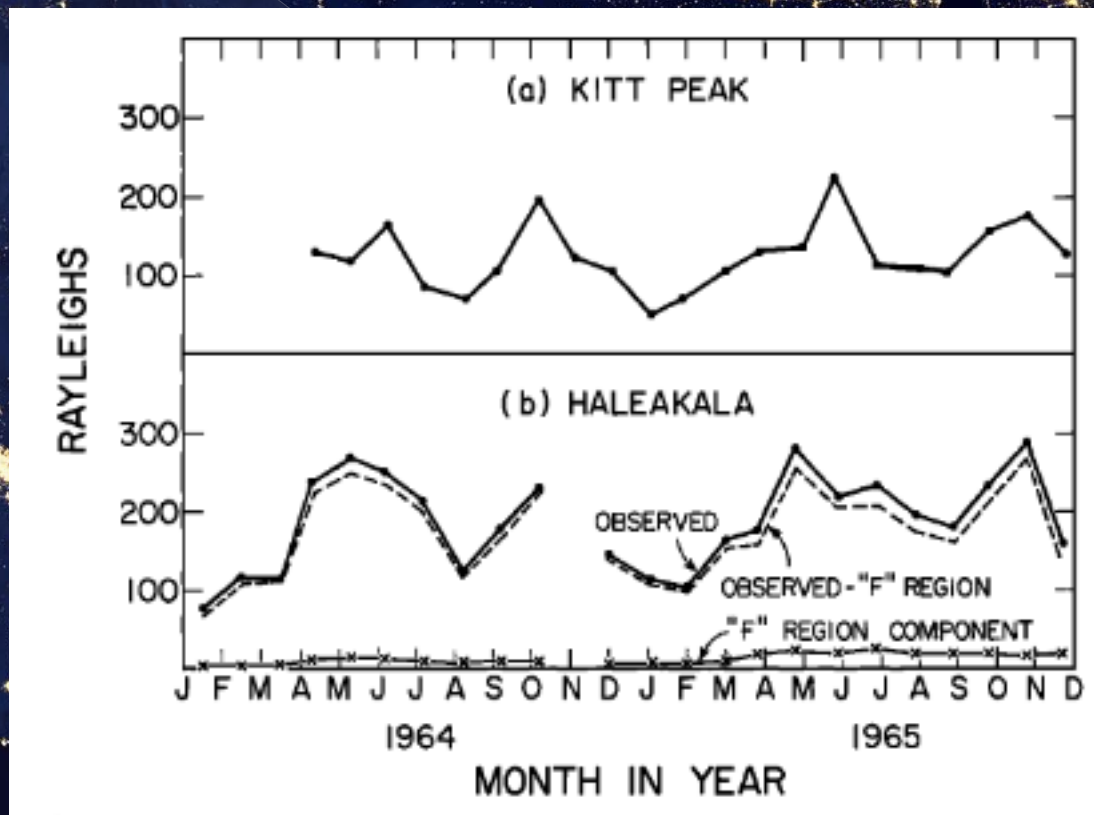
Weekly Trend



10 Day Trend

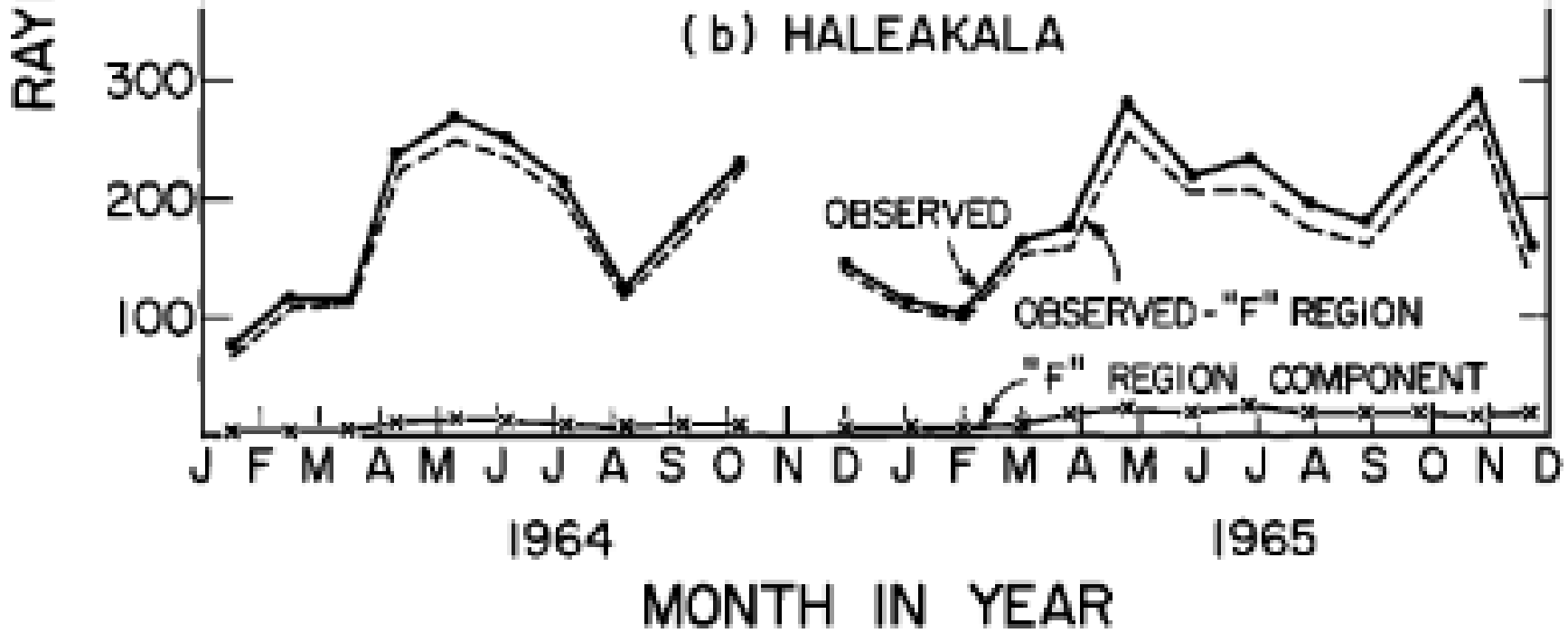
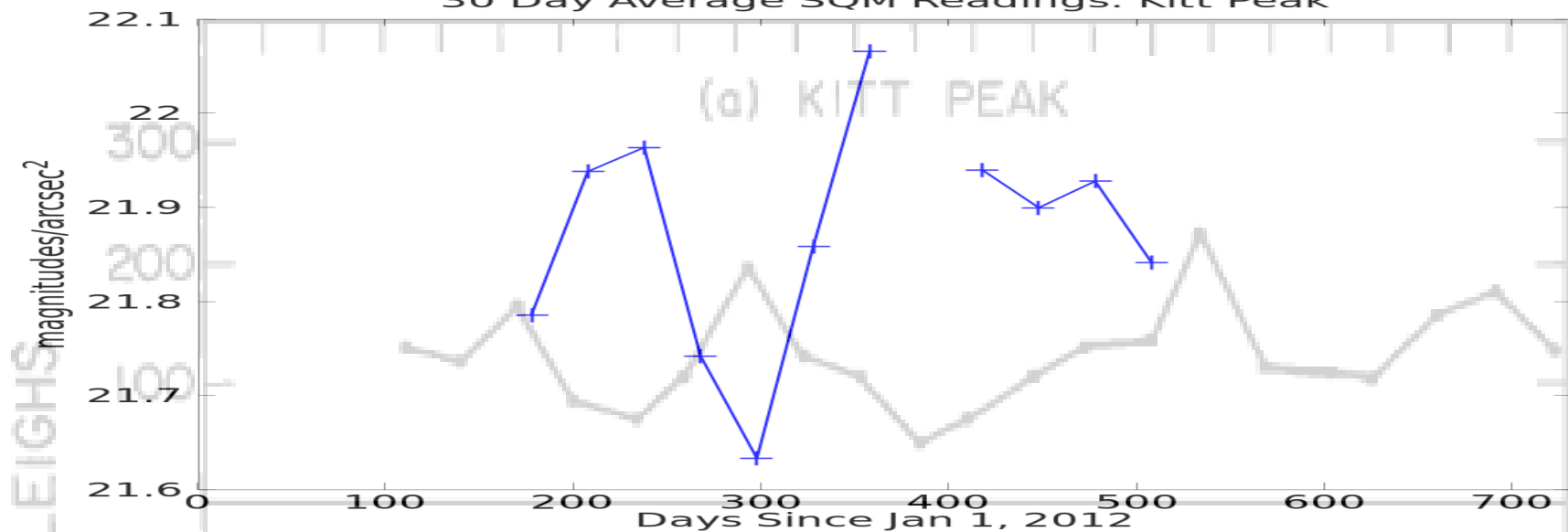


OI Airglow

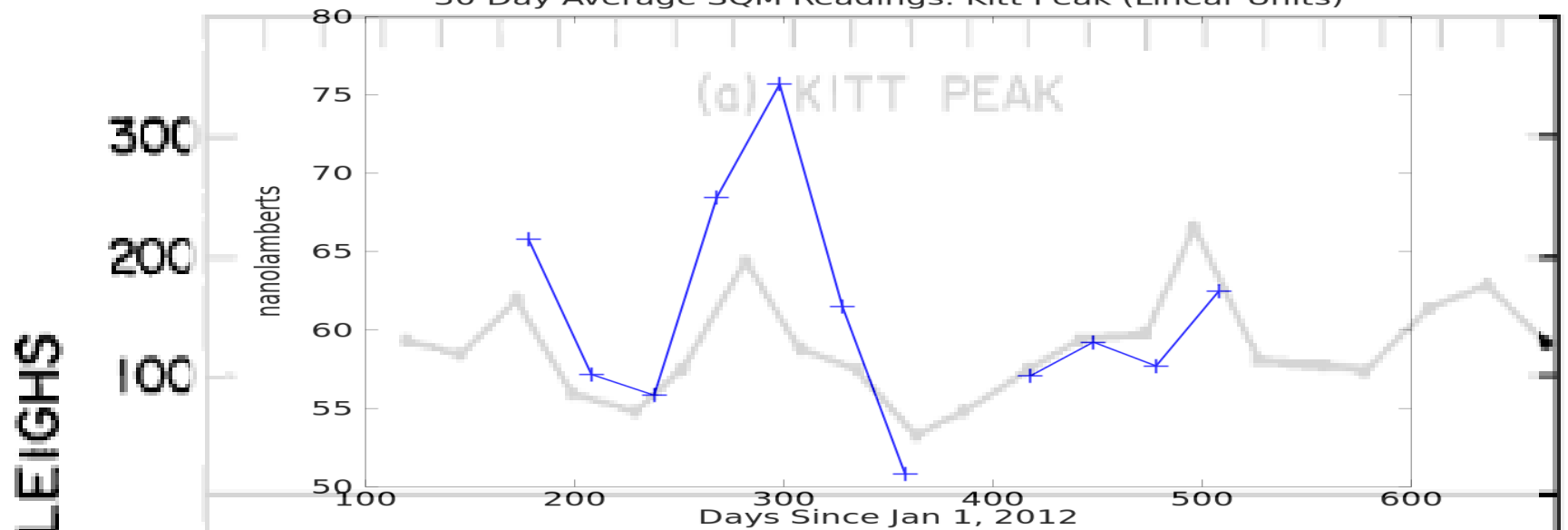


Smith, L. L. and Steiger, W. R.

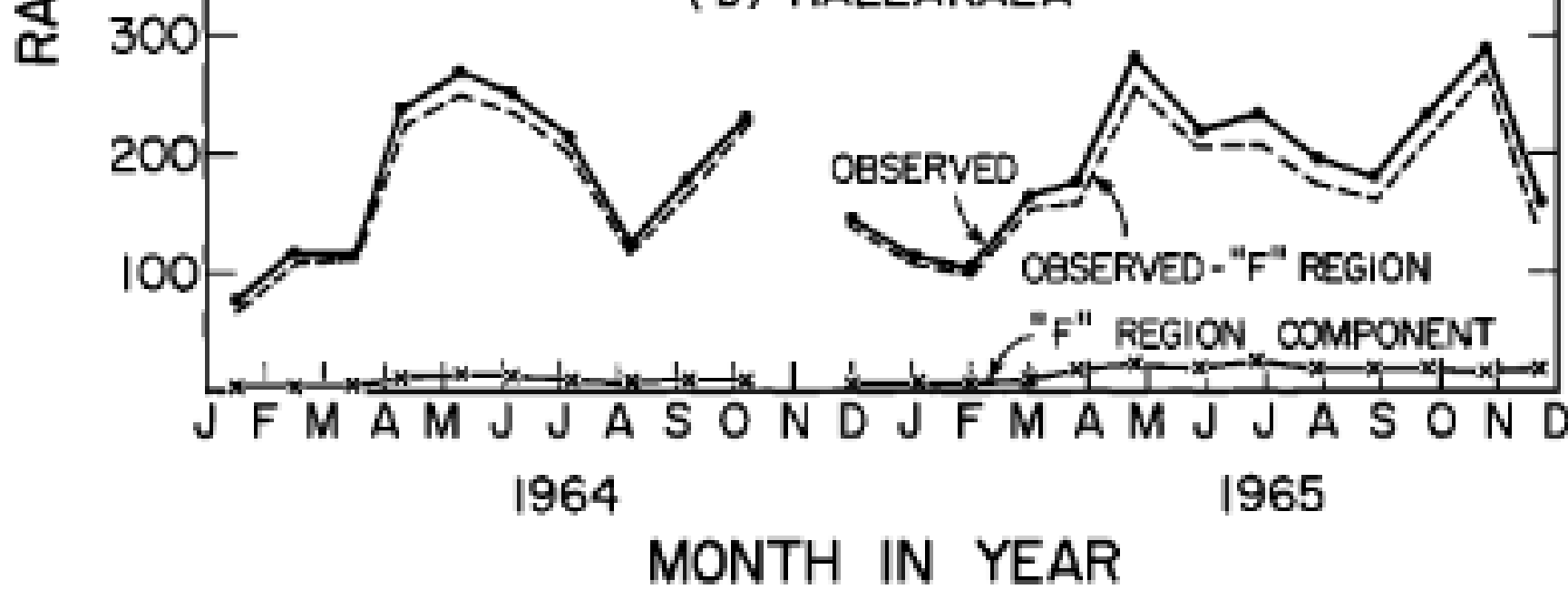
30 Day Average SQM Readings: Kitt Peak



30 Day Average SQM Readings: Kitt Peak (Linear Units)

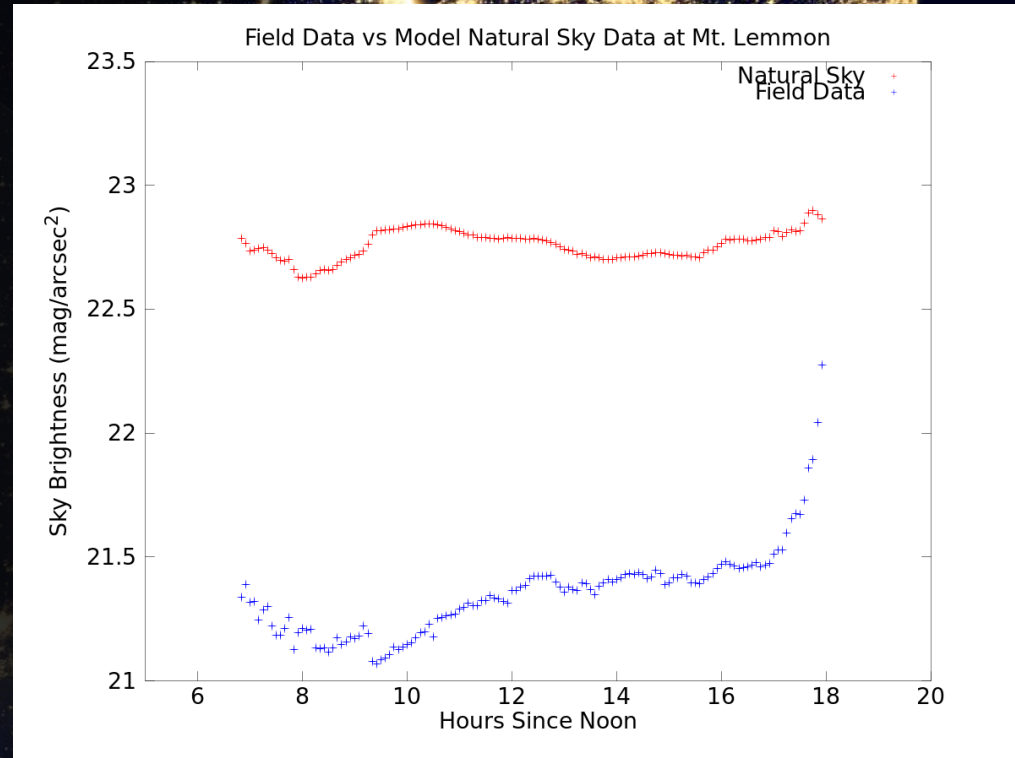


(b) HALEAKALA



Sky Brightness Model

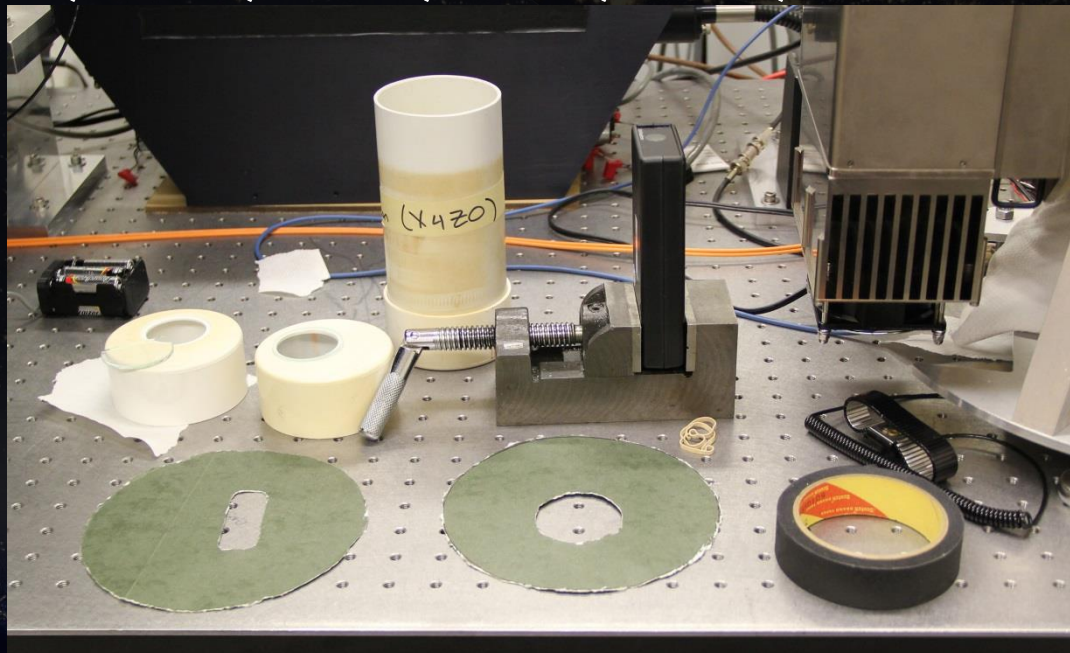
- Dan Duriscoe from NPS
- Natural sky brightness
- Anthropogenic sky glow
- Uses only V band wavelengths (midpoint 551 nm)



Wavelength Sensitivity

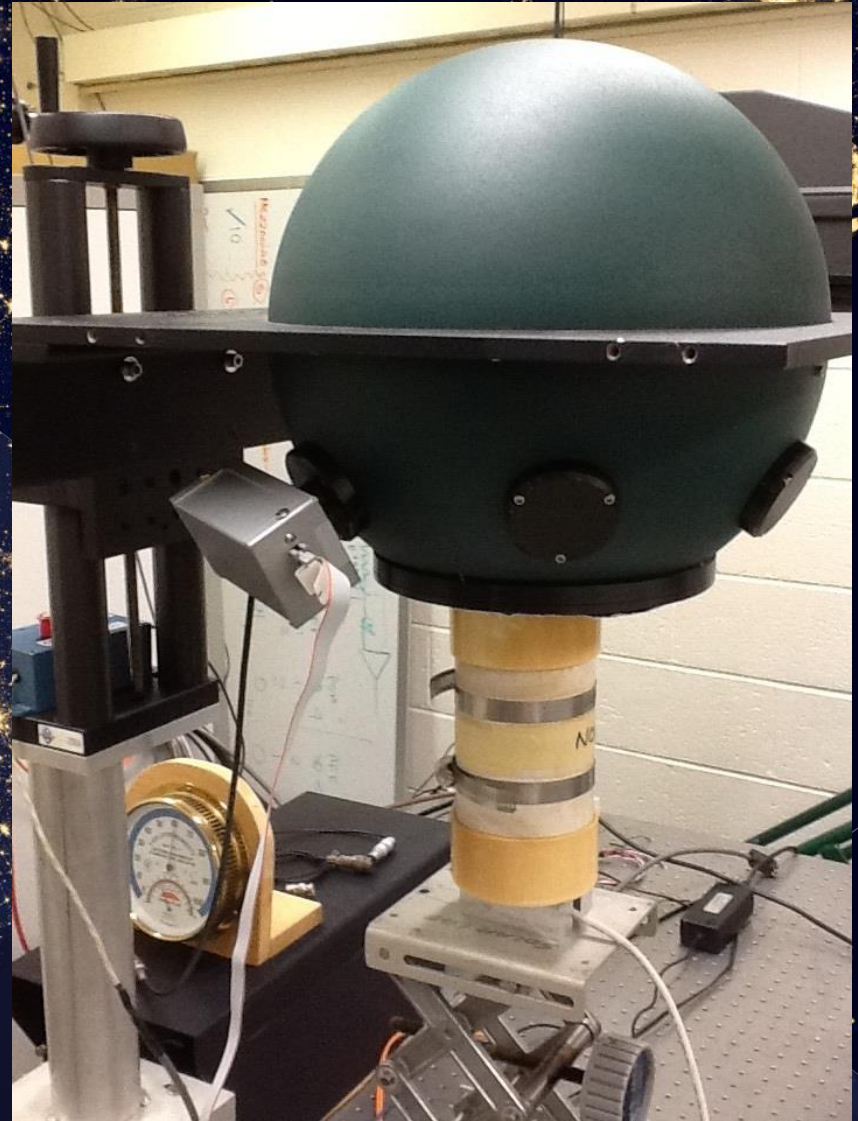
Laboratory Setup

- ◉ Integration sphere used for uniform light exposure
- ◉ 365, 470, 570, 655, 770, 850, and 950 nm

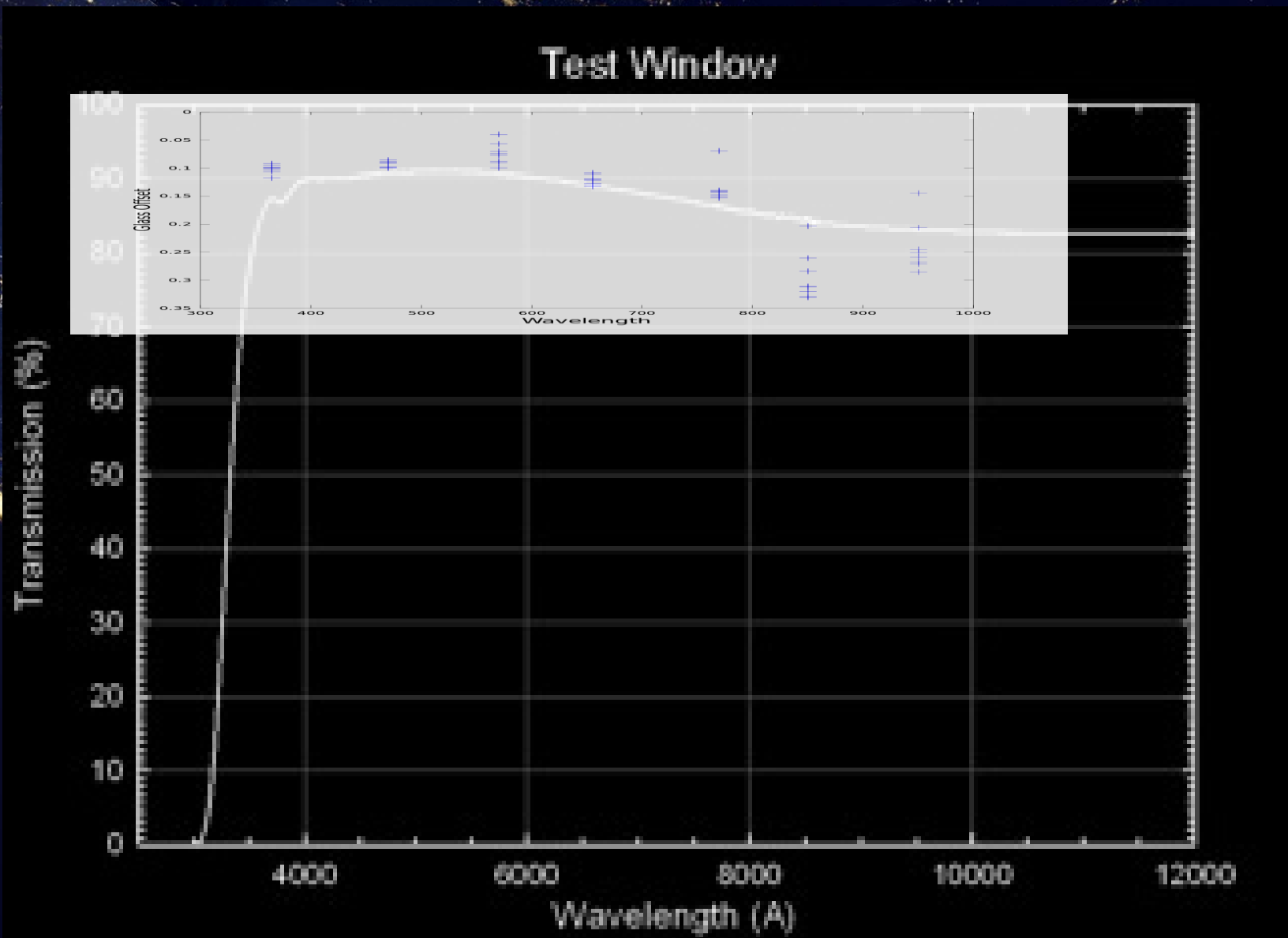


Laboratory Results

- ◉ Weatherproof housing glass causes an offset
- ◉ Housing itself affects readings due to UV yellowing
- ◉ CM500 filter is not cutting out wavelengths longer than 700 nm



Finding #1



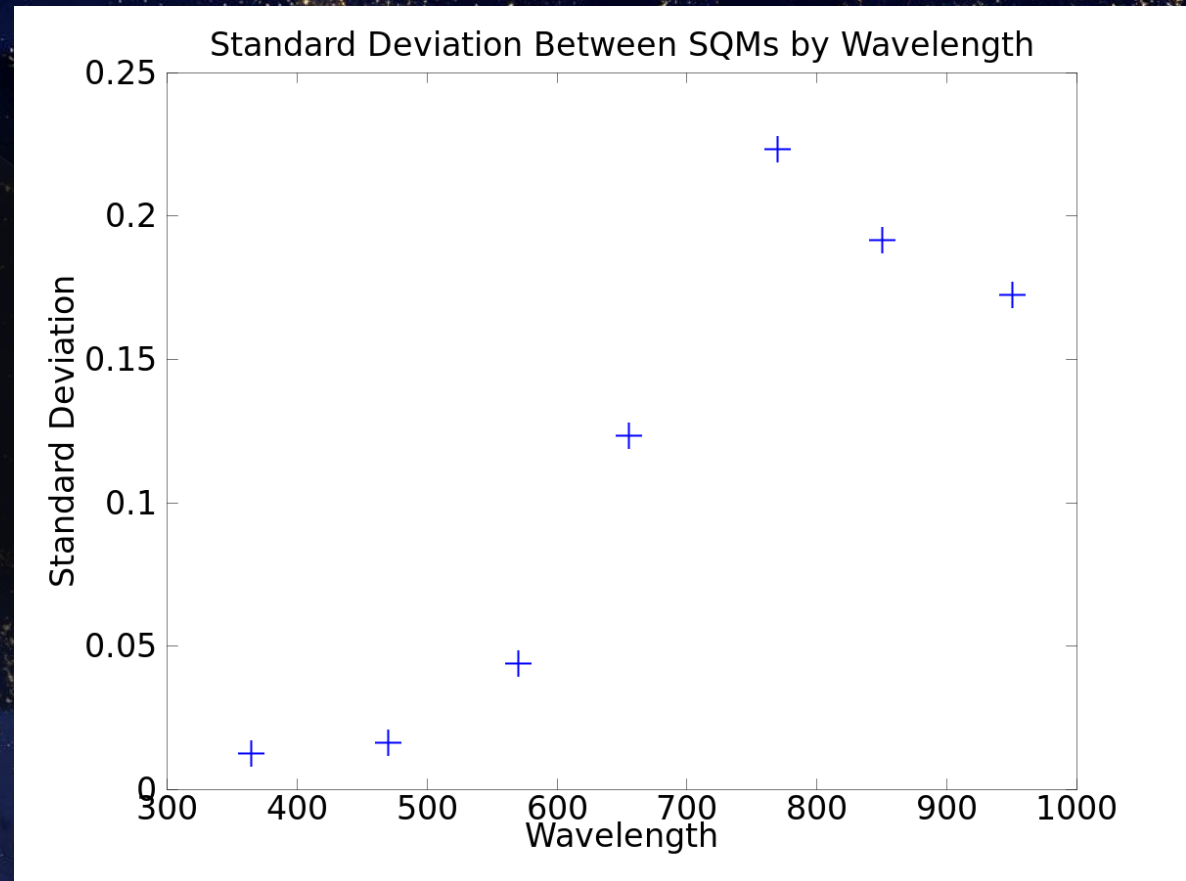
Finding #2

- ◉ UV yellowing problem
- ◉ Lab solution: light masks
- ◉ Solution: coat the housing in paint



Finding #3

- ⦿ IR filter should prevent detection of wavelengths >700 nm
- ⦿ Not true!



CM500 Filter

- ◉ The filter is not blocking a consistent amount of light for each SQM.



Future Work

- Continue looking for trends
- Compare to GaN and VIIRS data

Conclusion

- ◉ Lab testing
- ◉ Python pipeline
- ◉ Spatial and temporal trends

Acknowledgements

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- Dick Joyce
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- Anthony Tekatch
- William Roddy