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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

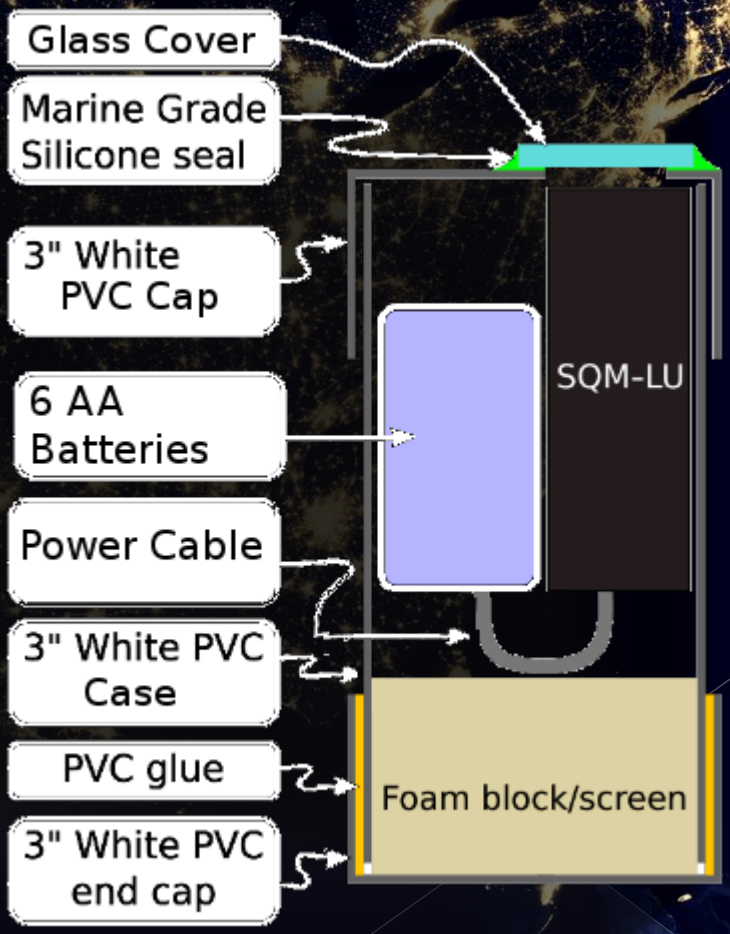
To characterize the light pollution in and around Tucson and to search for spatial and temporal trends.

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?

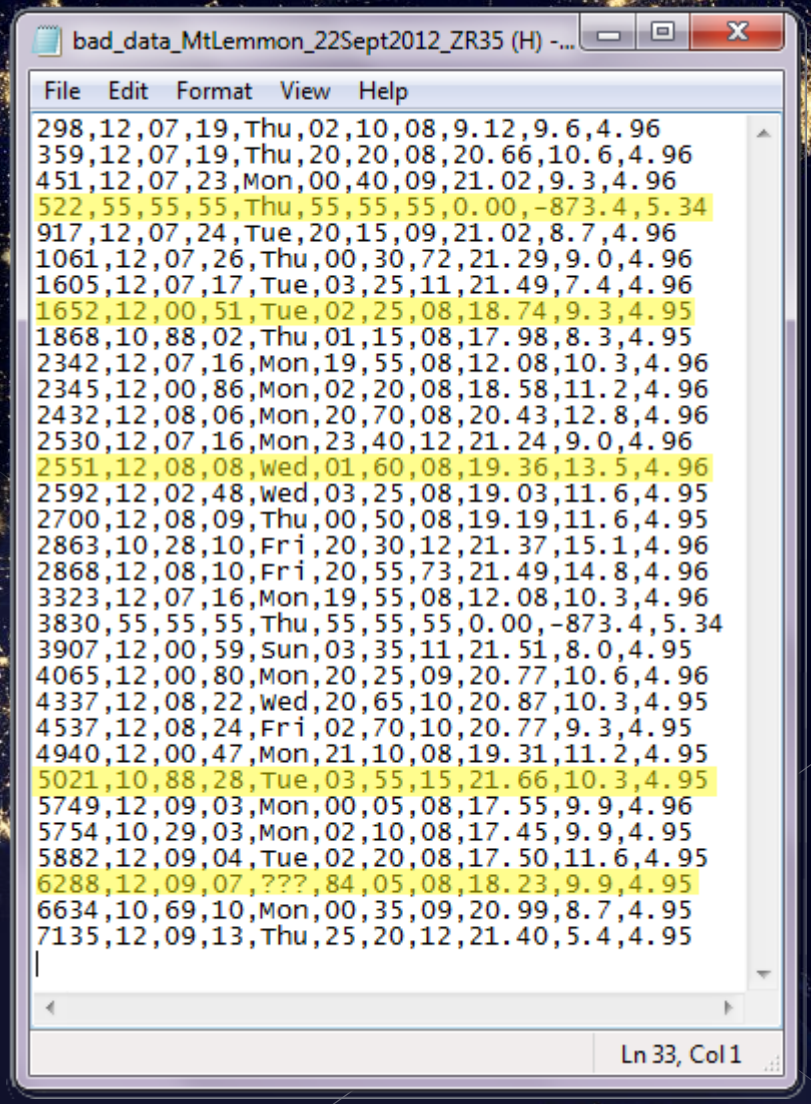
- FOV FWHM of 20°
- TSL237 300-110 0 nm
- CM500 IR filter
- Data-logging
- Weatherproof Housing
- 8 used for testing
- Data taken every 5 minutes



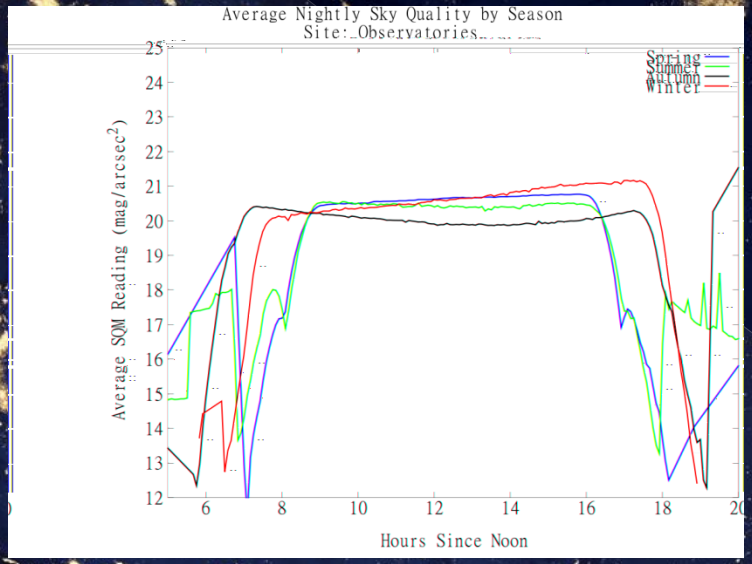
Locations of Collection Sites

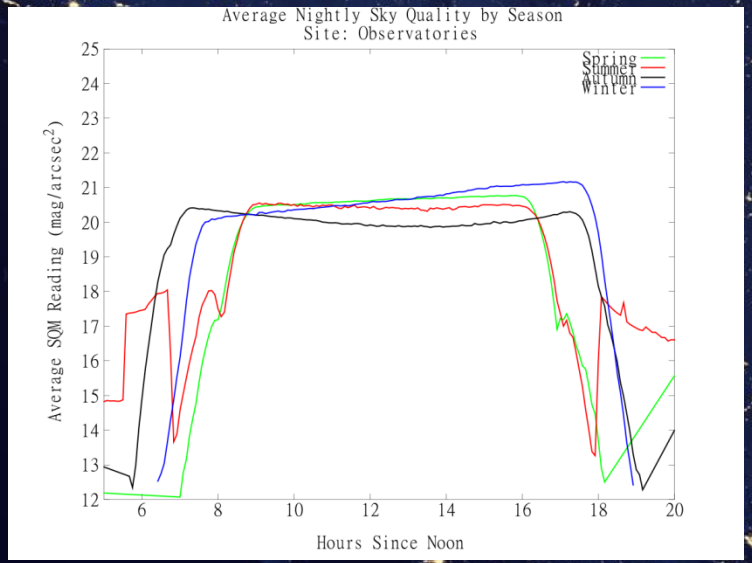
Reducing the SQM data

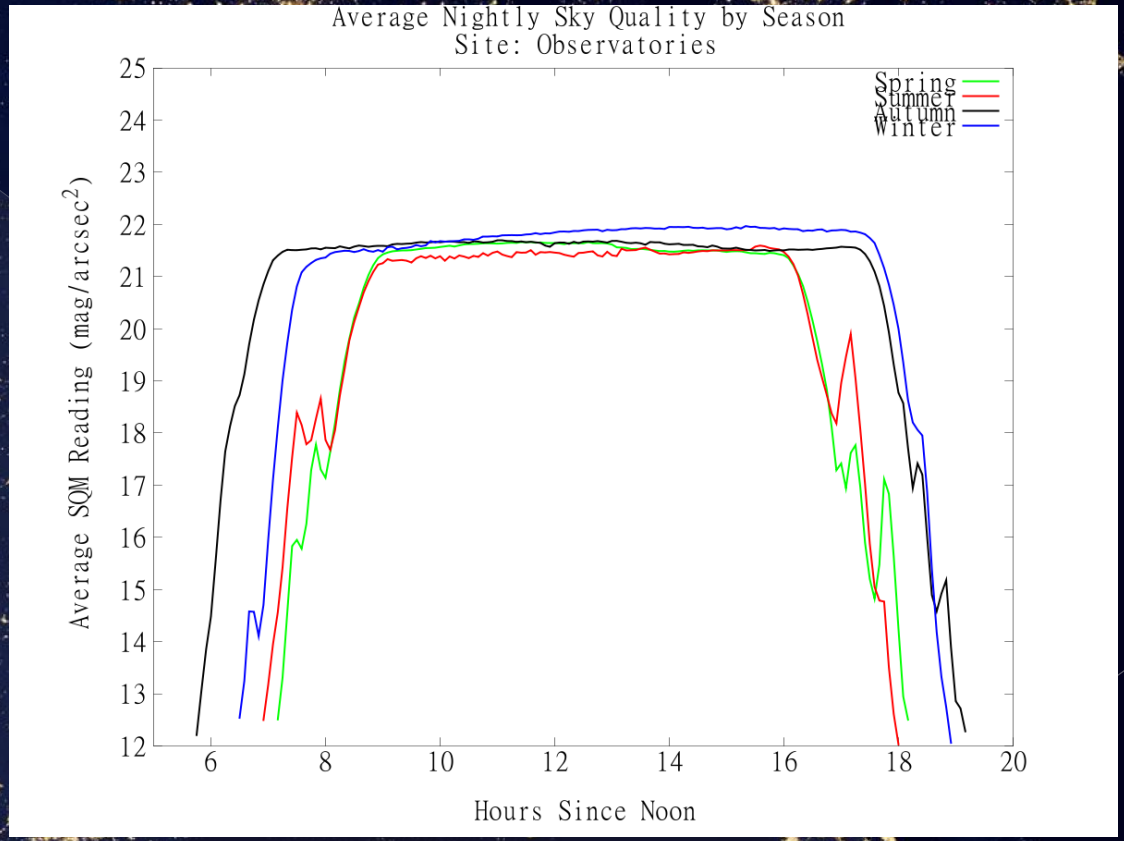
- Series of python scripts
- Faulty data
- Remove sun, Milky Way, moon, moon twilight, and twilight



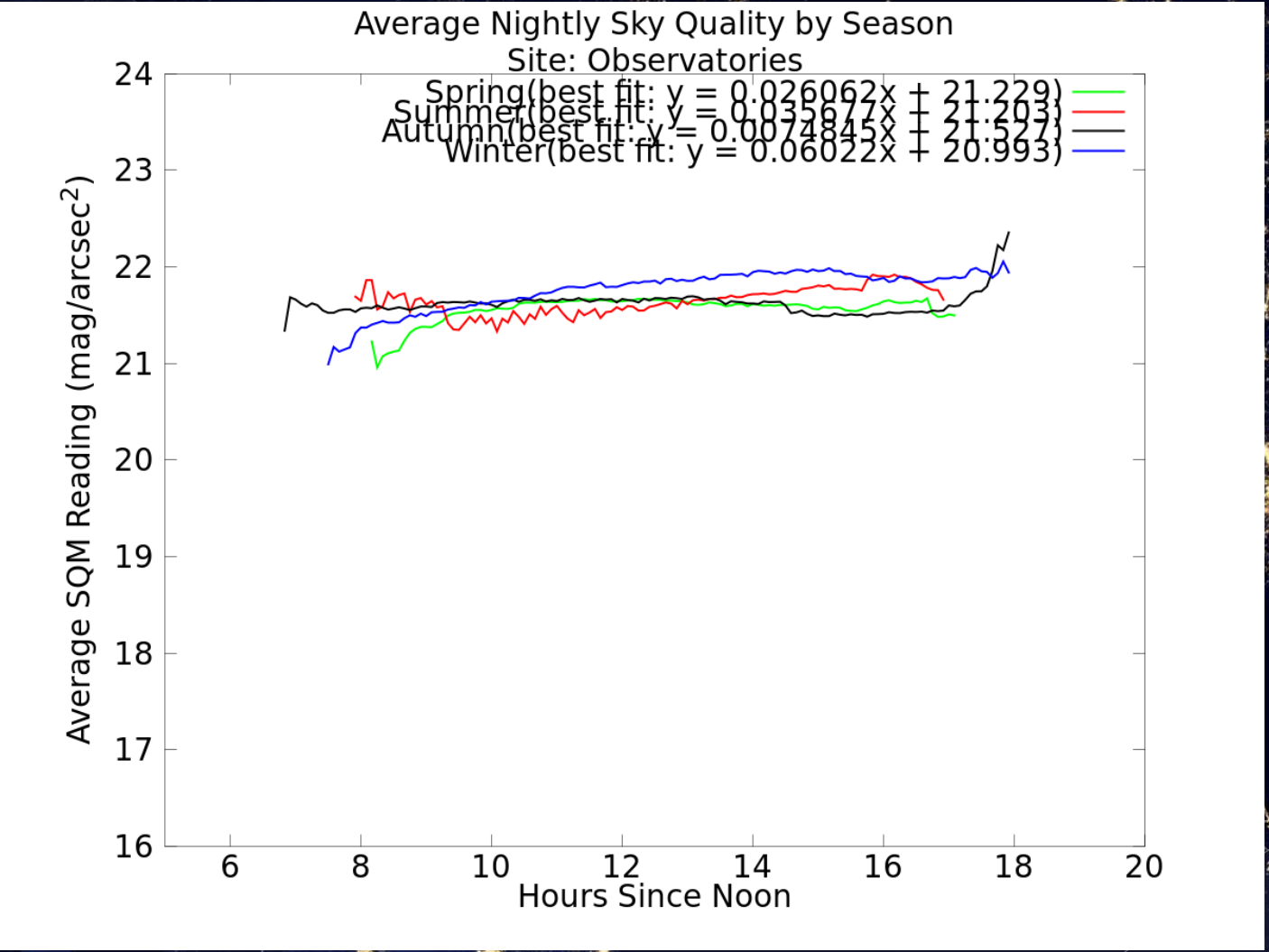
Removing the Faulty Data







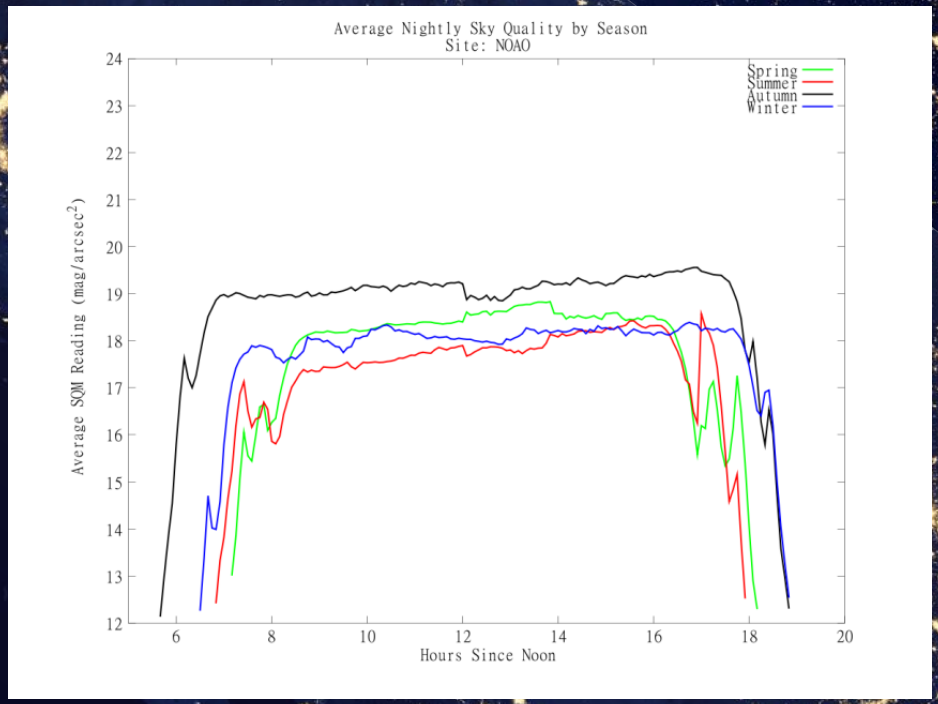
Reduced SQM Data

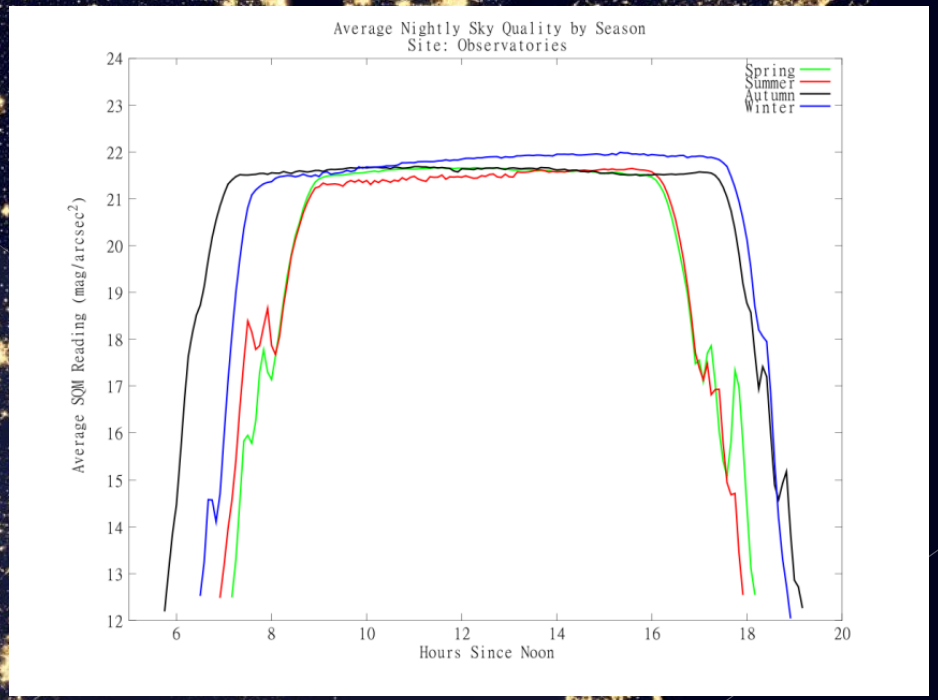


Trends

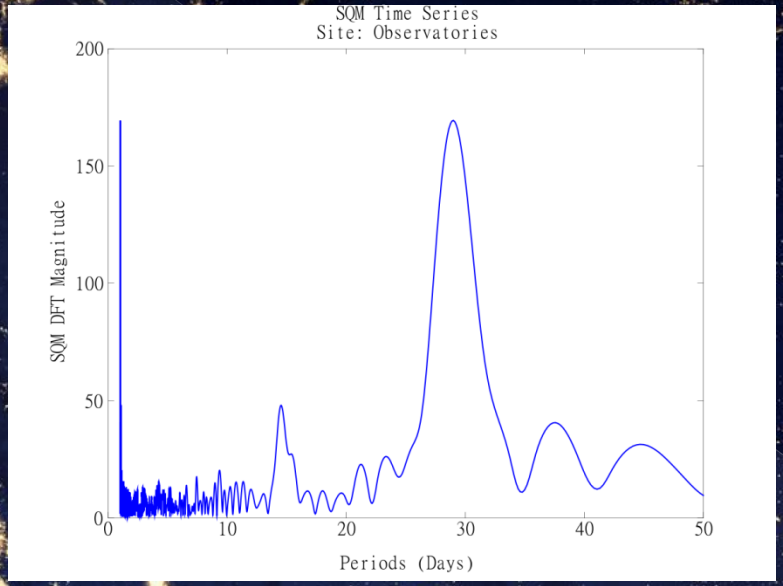
- Periodograms for temporal trends
  - Weekly
  - 10 Day
  - 15 Day
  - Seasonally
  - Annually
- Sites were divided into 3 groups for spatial trends
  - NOAO
  - Cardinal Point Sites
  - Observatory Sites

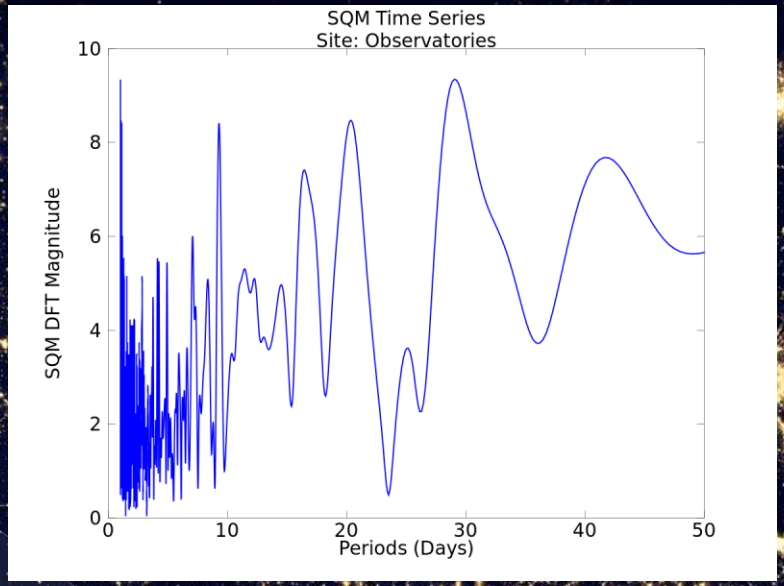
Location Dependent Trends

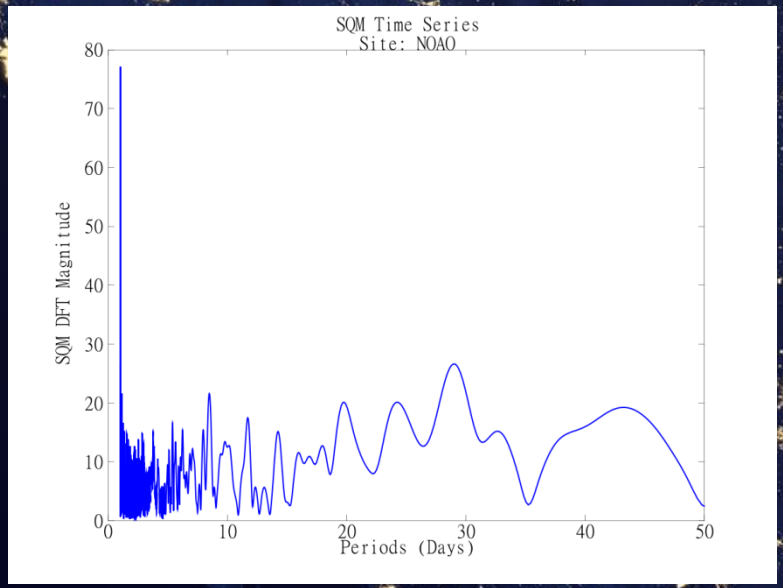


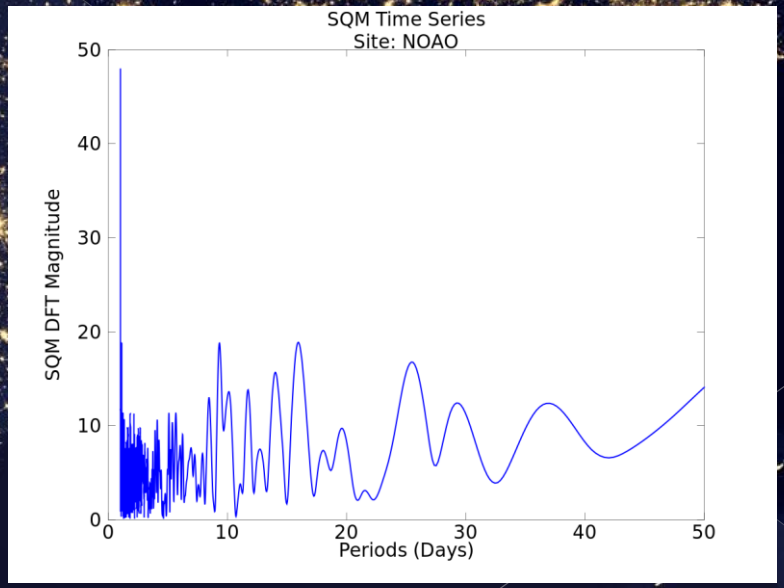


Periodograms: Raw vs Reduced

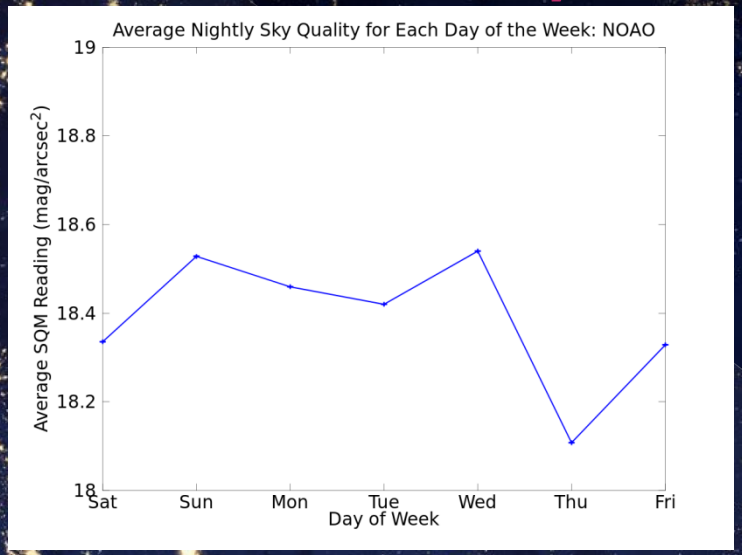


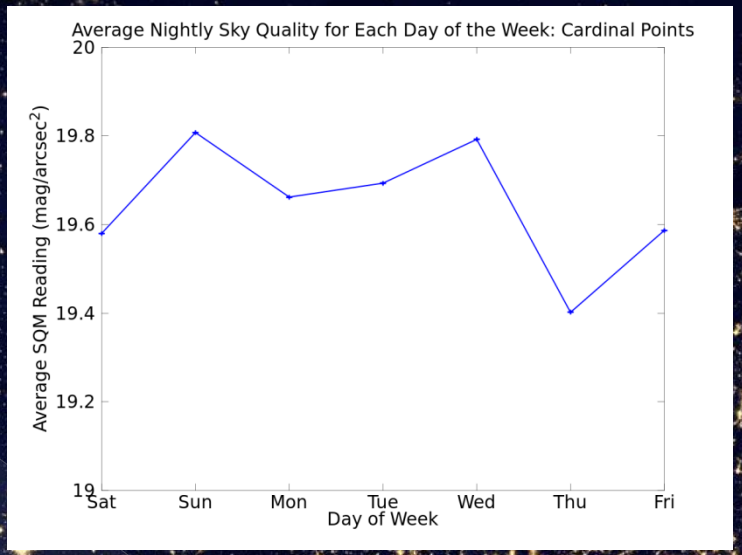


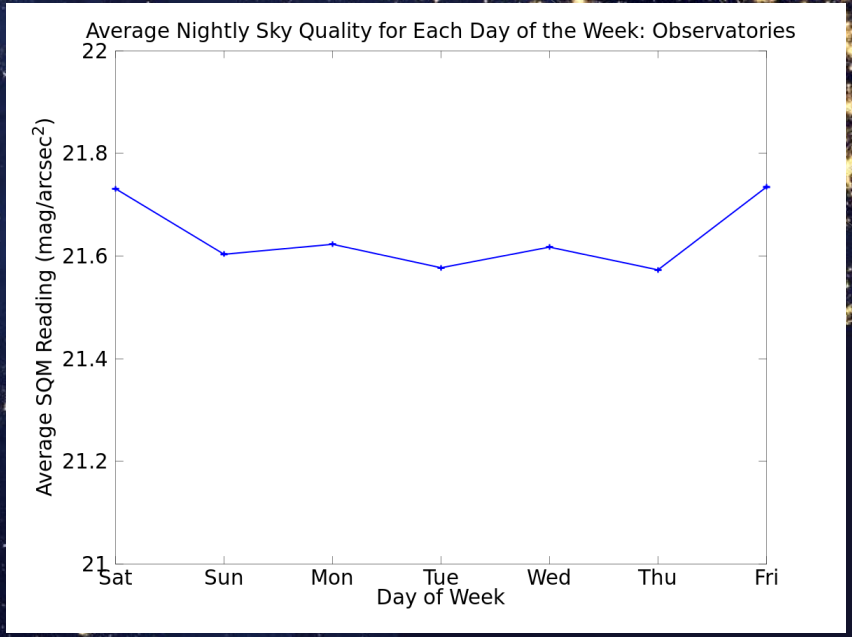




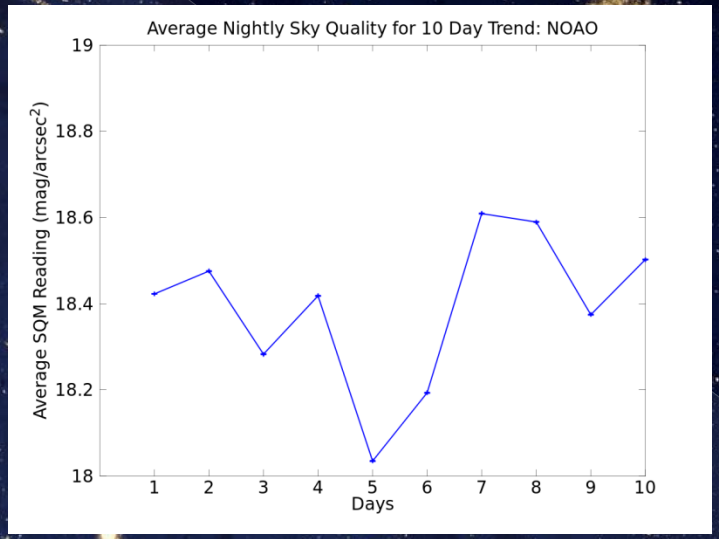
Weekly Trend

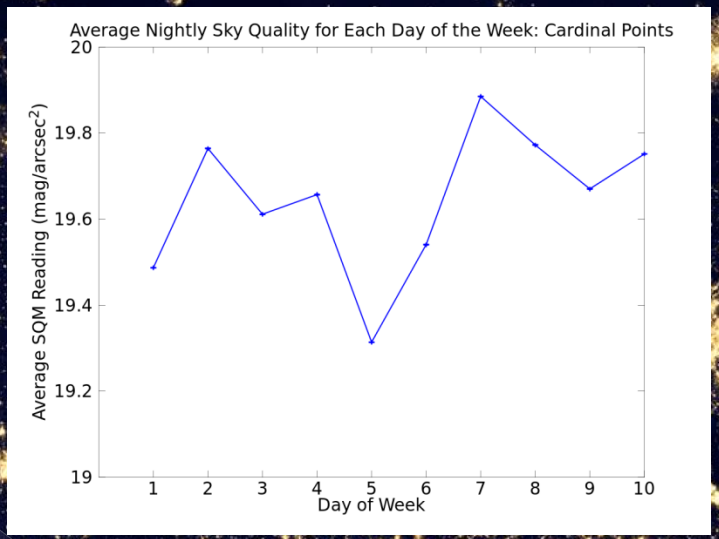


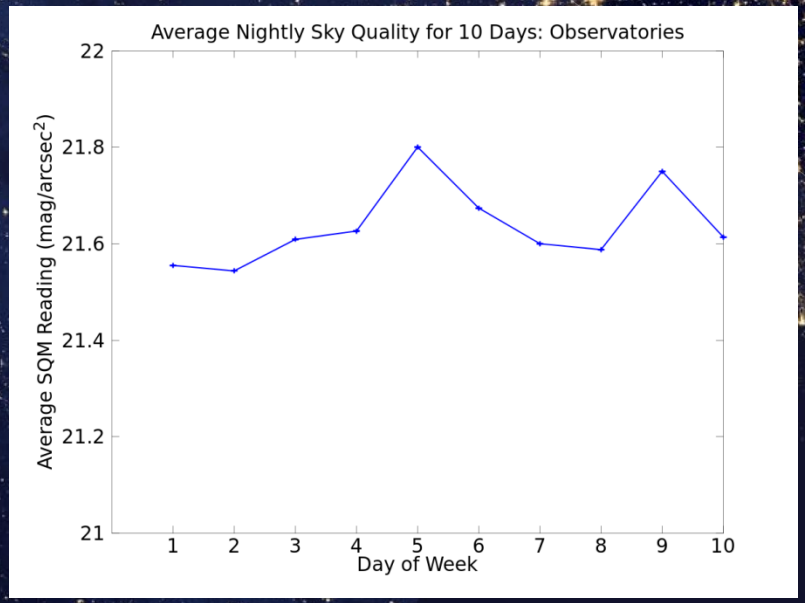




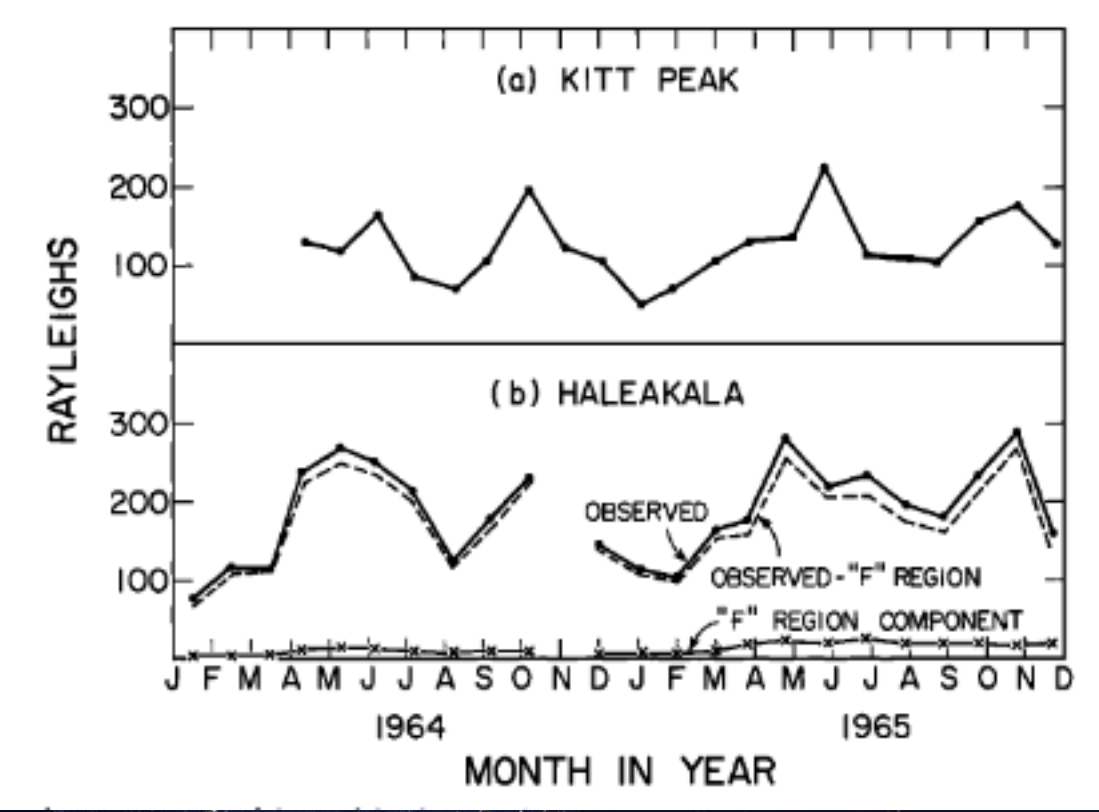
10 Day Trend


Average Nightly Sky Quality for 10 Day Trend: NOAO
Average SQM Reading (mag/arcsec^2)
Days
19
18.8
18.6
18.4
18.2
18
1
2
3
4
5
6
7
8
9
10

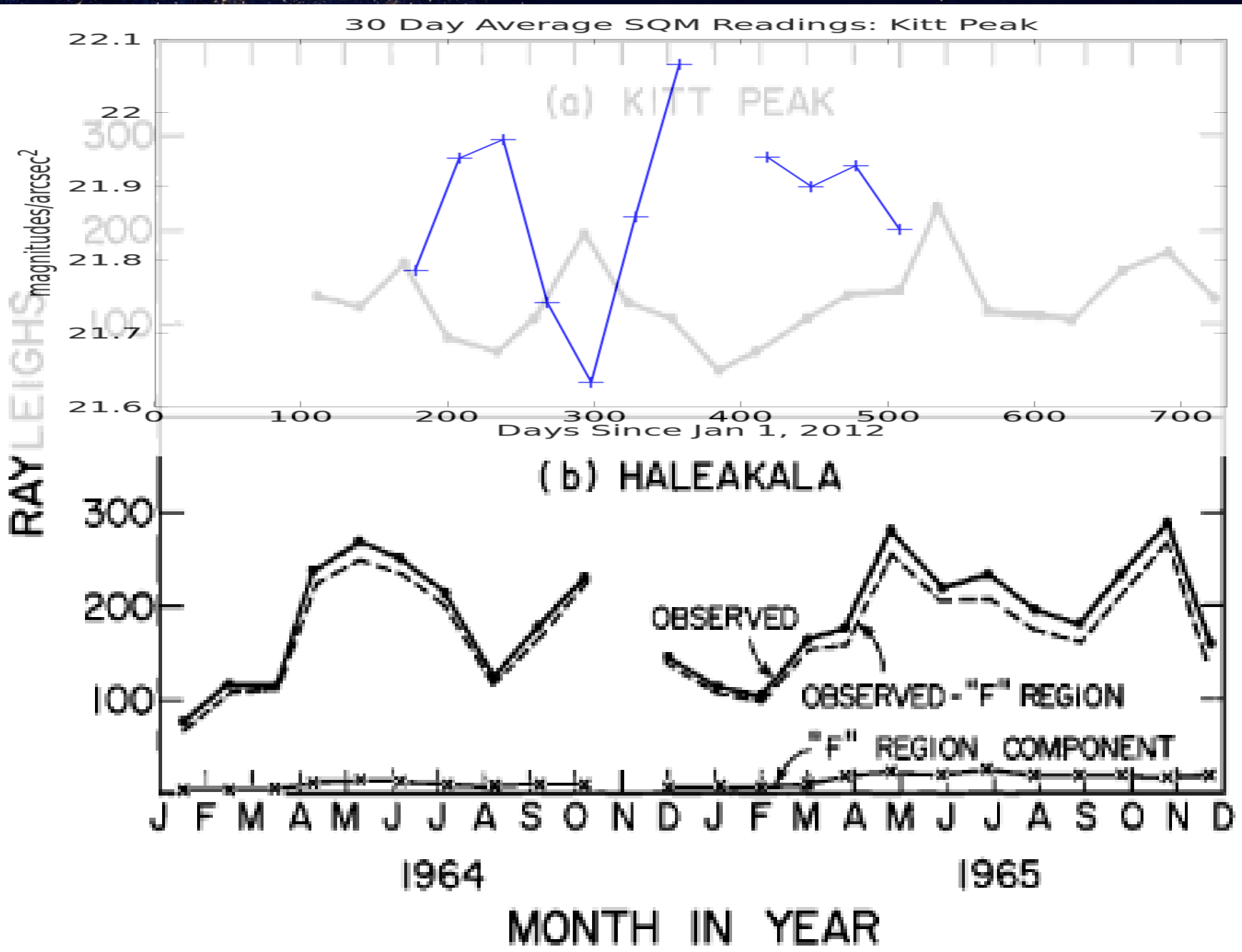

Average Nightly Sky Quality for Each Day of the Week: Cardinal Points
Average SQM Reading (mag/arcsec^2)
Day of Week
20
19.8
19.6
19.4
19.2
19
1
2
3
4
5
6
7
8
9
10

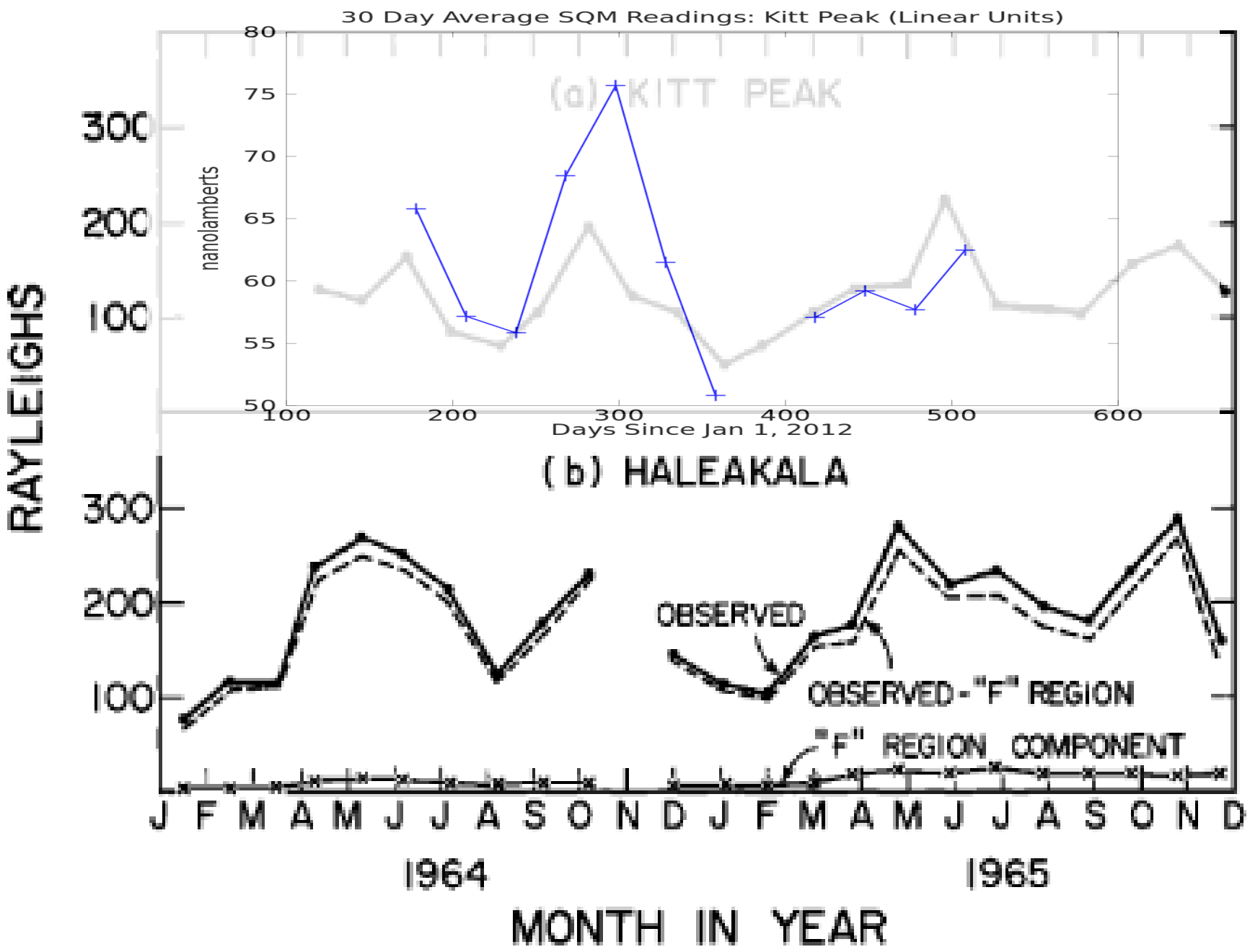

Average Nightly Sky Quality for 10 Days: Observatories
Average SQM Reading (mag/arcsec^2)
Day of Week
22
21.8
21.6
21.4
21.2
21
1
2
3
4
5
6
7
8
9
10

OI Airglow



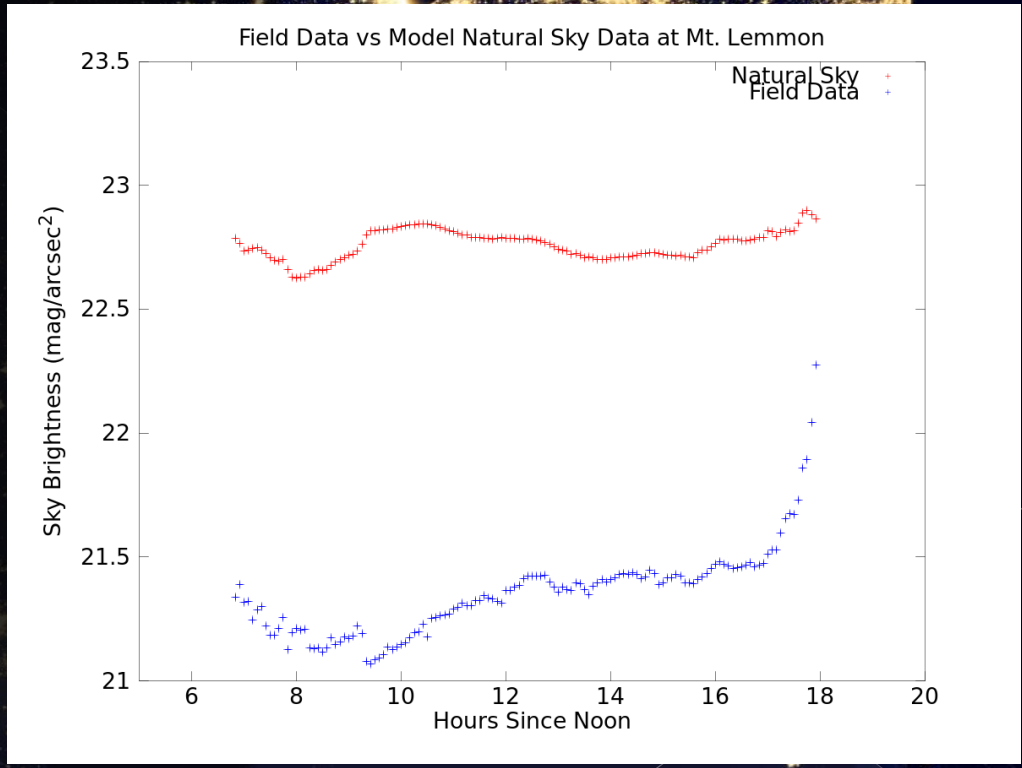
Smith, L. L. and Steiger, W. R.


30 Day Average SQM Readings: Kitt Peak
(a) KITT PEAK
magnitudes/arcsec²
22.1
22
21.9
21.8
21.7
21.6
0
100
200
300
400
500
600
700
Days Since Jan 1, 2012
RAYLEIGHS
(b) HALEAKALA
300
200
100
OBSERVED
OBSERVED - "F" REGION
"F" REGION COMPONENT
J F M A M J J A S O N D J F M A M J J A S O N D
1964
1965
MONTH IN YEAR


30 Day Average SQM Readings: Kitt Peak (Linear Units)
nanolamberts
80
75
70
65
60
55
50
100
200
300
400
500
600
Days Since Jan 1, 2012
(a) KITT PEAK
(b) HALEAKALA
RAYLEIGHS
300
200
100
OBSERVED
OBSERVED - "F" REGION
"F" REGION COMPONENT
J F M A M J J A S O N D J F M A M J J A S O N D
1964
1965
MONTH IN YEAR

Sky Brightness Model

- Dan Duriscoe from NPS
- Natural sky brightness
- Anthropogenic sky glow

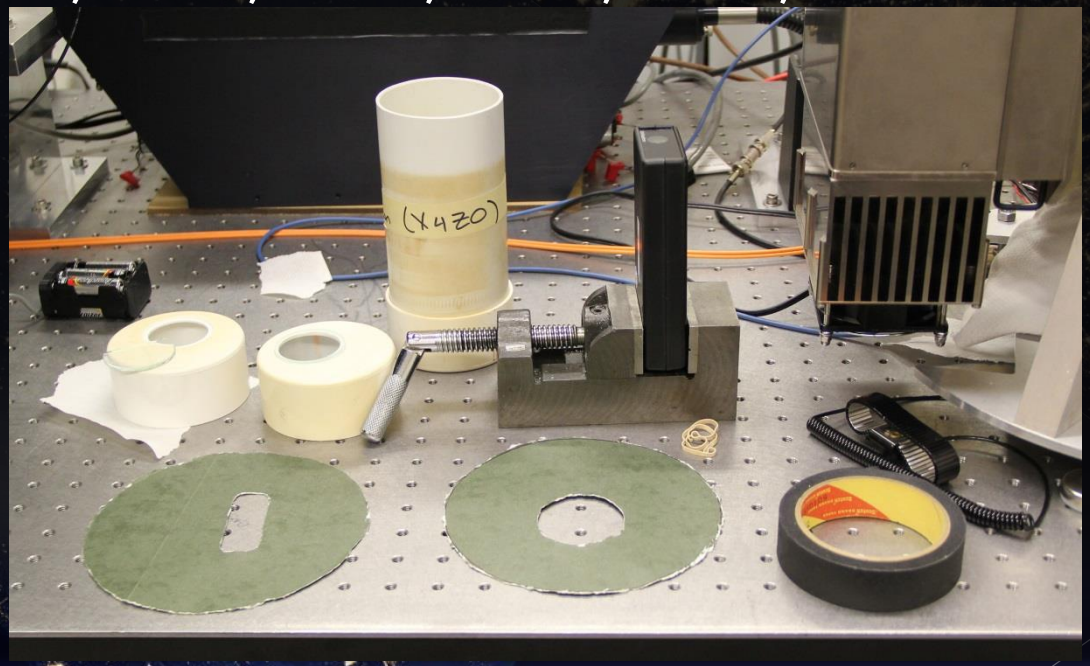


- Uses only V band wavelengths (midpoint 551 nm)

Wavelength Sensitivity

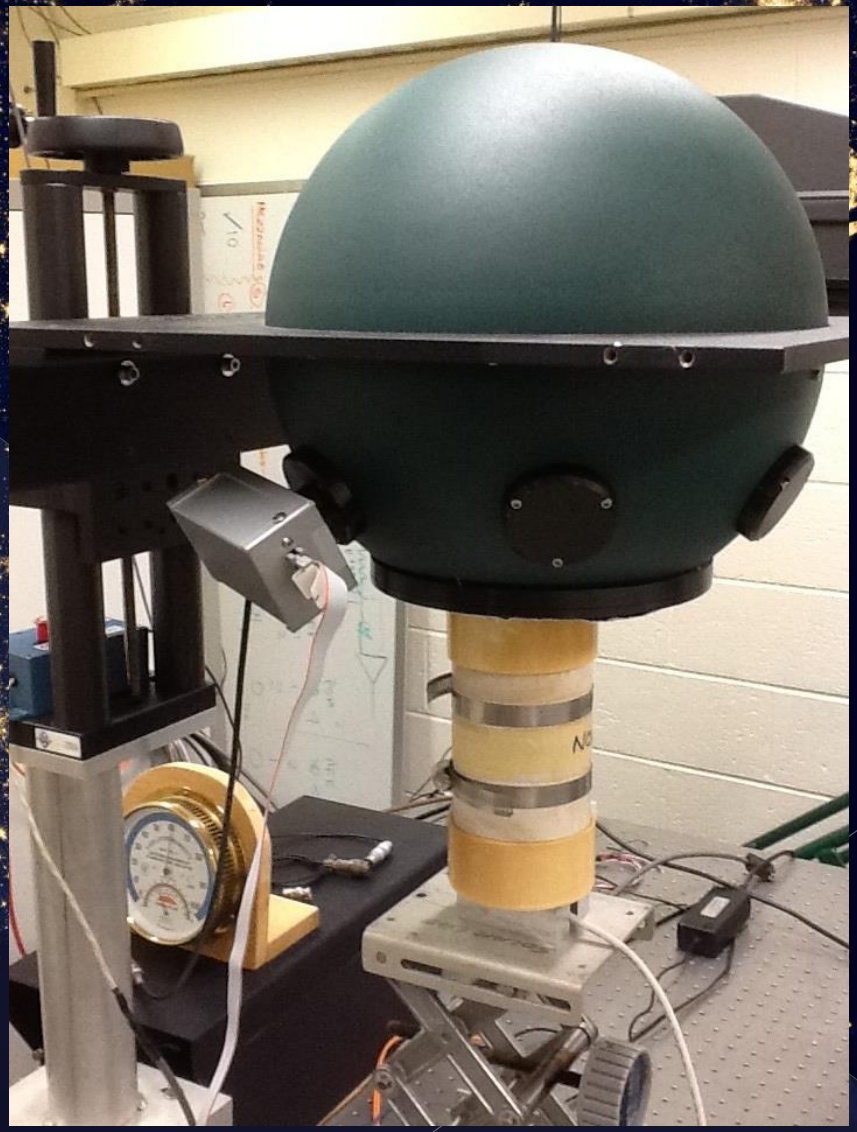
Laboratory Setup

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

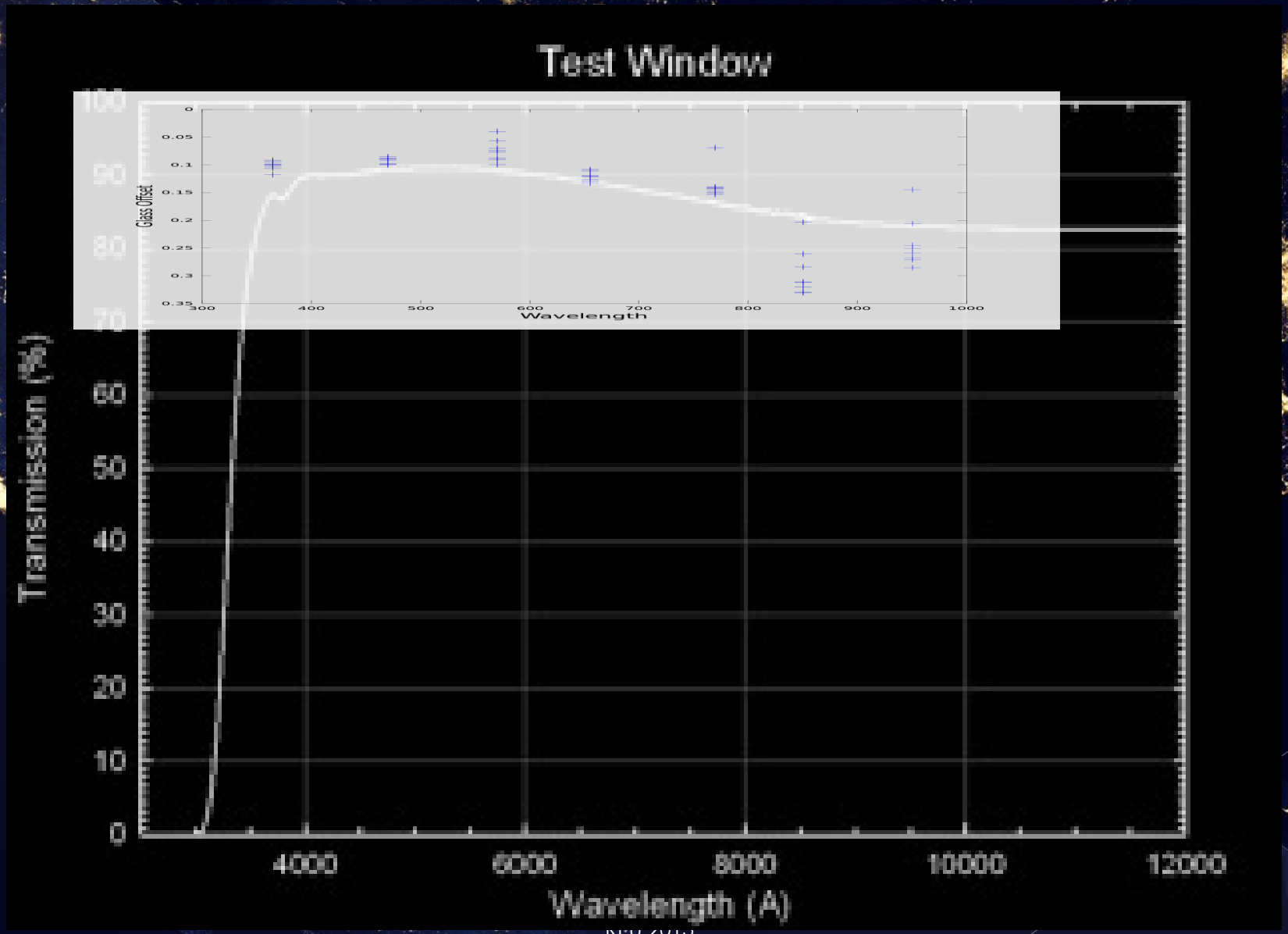


Laboratory Results

- 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

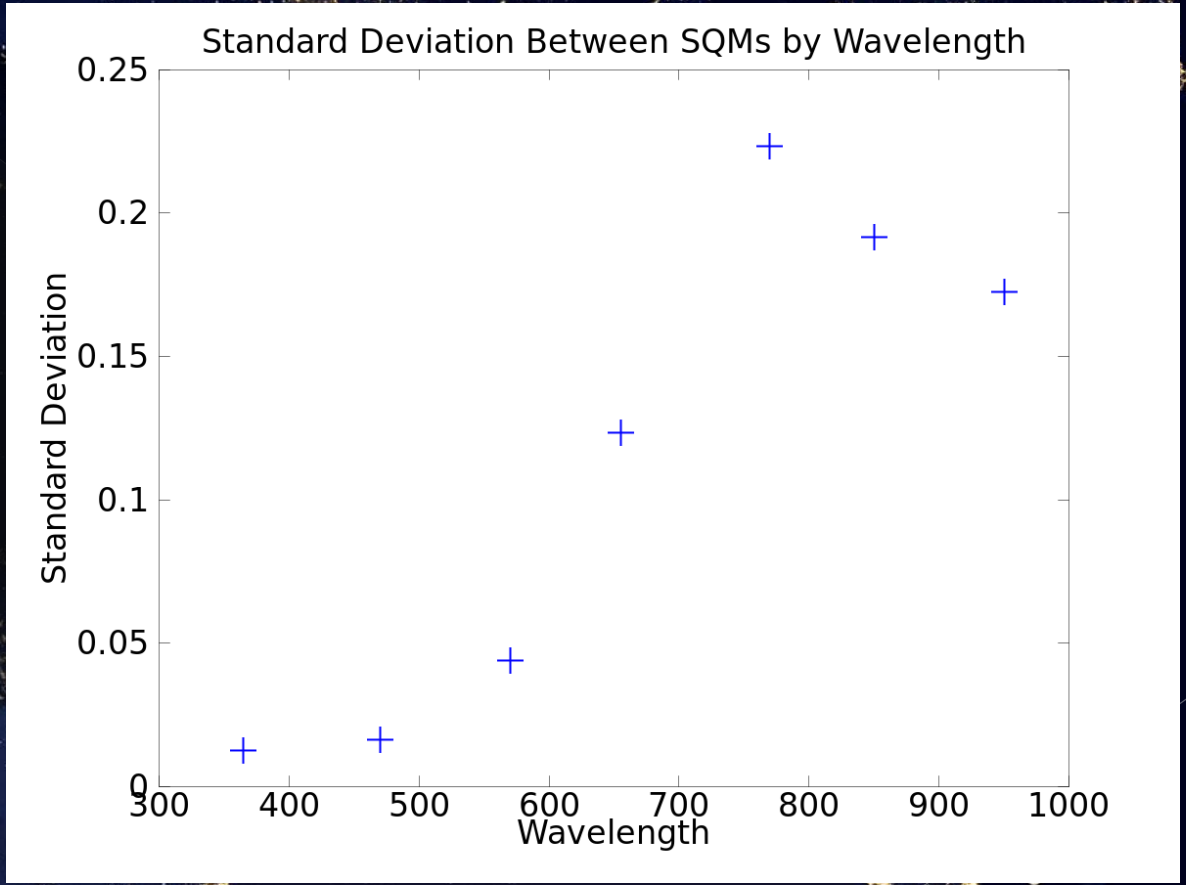

Test Window
Transmission (%)
Wavelength (A)
4000
6000
8000
10000
12000
Glass Offset
Wavelength

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

- NOAO
- NSF
- Connie Walker
- Ron George
- Dick Joyce
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- Dan Duriscoe
- Anthony Tekatch
- William Roddy