INTERNATIONAL DARK-SKY ASSOCIATION
OREGON CHAPTER

TO PRESERVE THE MAGNIFICENT DARK SKIES OF OREGON AND DIMINISH LIGHT POLLUTION FOR THE HEALTH, SAFETY AND WELL-BEING OF ALL LIFE

Central Oregon Skyglow Measurement Network
First Data – June to Mid-August 2019
Technical Report
September 5, 2019

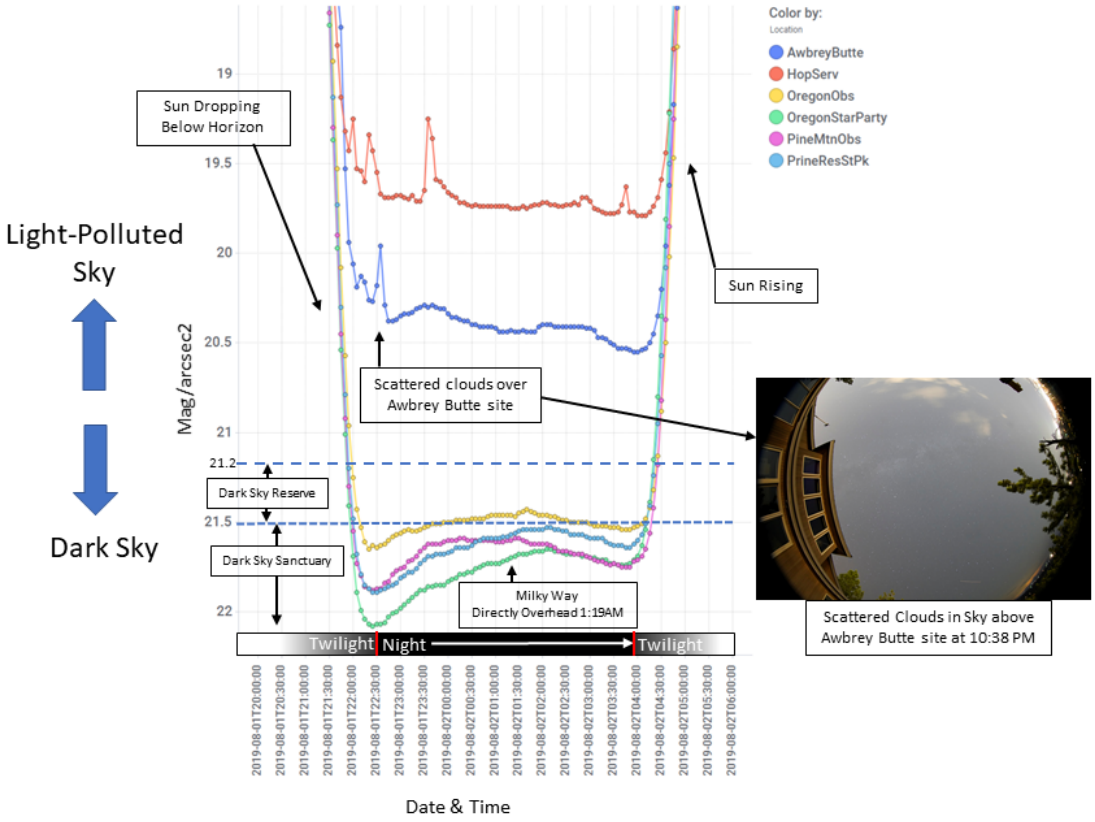
The Oregon Chapter of IDA has established a network of continuously-recording Sky Quality Meters (SQMs) in Central Oregon identified as the Central Oregon Skyglow Measurement Network, or COSMN. Skyglow is literally the glowing sky at night, due to both man-made artificial light and natural light. SQMs measure the brightness of the night sky and provide a measure of both light pollution and natural light at night.

The project's primary aim is to quantitatively measure, interpret, and share skyglow measurements in Central Oregon to better understand the current level of light pollution in comparison to other regions and to document changes over the next five years. The skyglow data will help to inform action toward healthier and safer communities with less light pollution. The data will also support local efforts to nominate sites under IDA's International Dark Sky Place (IDSP) Program.

We have begun the skyglow measurement project in the Deschutes Basin of Central Oregon as a pilot project due to (1) the rapid growth of population in the region, (2) probable increase of skyglow as a result, and (3) availability of observatories and interested people in Central Oregon. We expect to expand the project to other regions throughout Oregon in the future. We solicit any help to establish and to expand the Skyglow Measurement Network.

Currently, we have five SQM devices recording in the Upper Deschutes Basin. The five operating locations, shown at the green circles on the map below are: Awbrey Butte in Bend, Pine Mountain Observatory, Oregon Observatory in Sunriver, Prineville Reservoir State Park, and the Hopservatory in Bend. The first six weeks of data from the five SQMs provide a quantitative measure of skyglow variation across Central Oregon, help to support efforts to obtain recognition of dark skies at local areas and allow useful observations on factors that affect the darkness of the night sky.

Each SQM records a skyglow measurement every five minutes. The next picture shows typical data from the five SQMs during the night of August 1-2, 2019, which was a mostly cloud-free night during a New Moon period. Data units are in magnitude per arc second squared (mag/arcsec2). This unit of measure, for example, 21.5 mag/arcsec2, is like saying that the sky glows as though the light of one 21.5-magnitude star, a very dim star, were smeared out across each square arcsecond (a very small 2-dimensional area) of sky.



The vertical axis displays the SQM measurements – larger numbers are toward the bottom and represent measurements of darker sky. The horizontal axis is Date and Time, over the night of August 1-2, 2019, with labels one hour apart. The colored lines show the recorded data from the five SQM locations and additional data recorded at a temporary site during the Oregon Star Party at Indian Trail Spring – the green line.

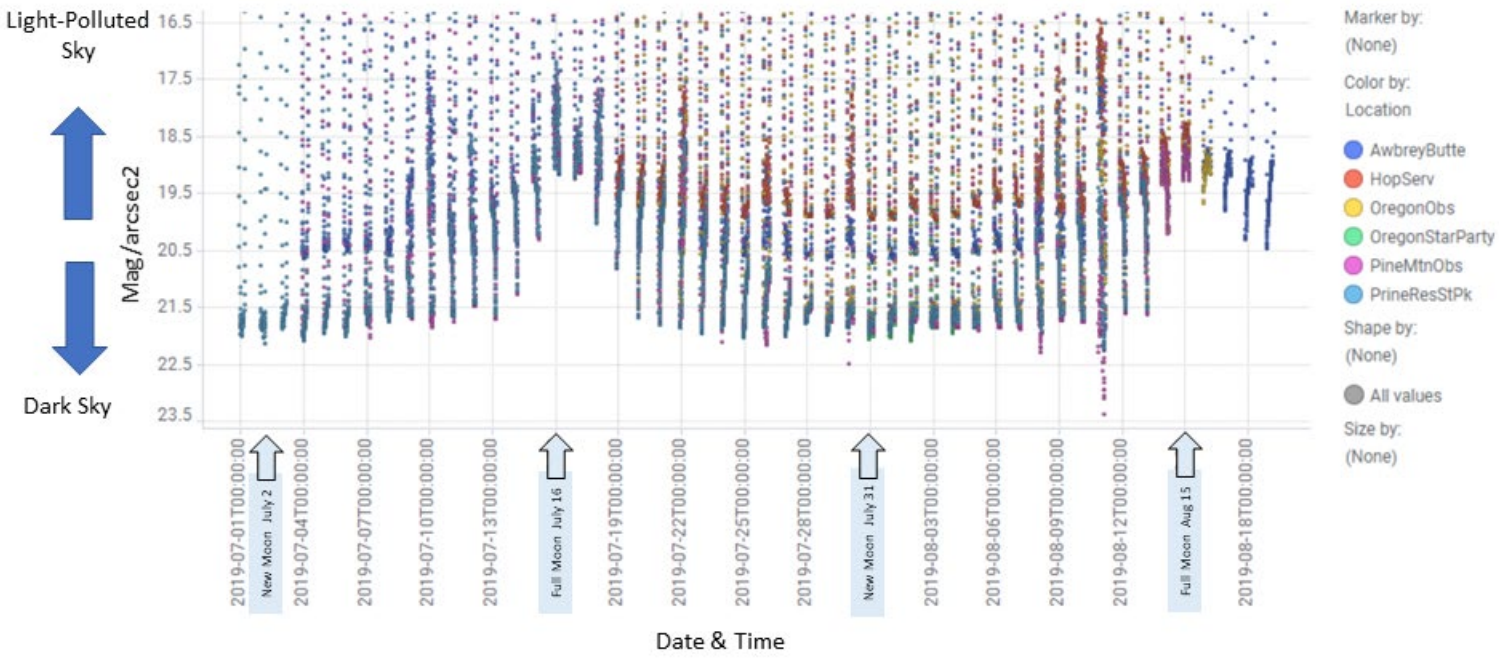
The data show that the night sky, directly overhead at the Hopservatory and Awbrey Butte sites, which are located within the light-dome over the city of Bend, is light-polluted. The other four sites have darker skies – they are away from light-polluted cities. The Oregon Star Party had the darkest night sky on August 1 – 2 and is located to the east, furthest of all the sites from the Central Oregon cities.

The International Dark-Sky Association (IDA) has a program to recognize areas that are still mostly unaffected by light pollution. Two categories of such dark sky places are known as Dark Sky Reserves and Dark Sky Sanctuaries. As shown by the horizontal dashed lines in the figure above, a Dark Sky Reserve must have SQM readings of at least 21.2 mag/arcsec2. Dark Sky Sanctuaries must meet a stricter night sky darkness of at least 21.5 mag/arcsec2. The data suggest that all four of the Central Oregon SQM locations may meet the stricter criterion. Note that other significant criteria must also be met to obtain status as a Dark Sky Reserve or Dark Sky Sanctuary.

The sky overhead at the four dark sites brightens as the Milky Way rises directly overhead, and then darkens as the Milky Way begins descending through the early morning hours. We don't see the effect

of the Milky Way brightening in the data for the two sites under the City of Bend light dome, because the Milky Way is washed out by the light-polluted skies at those two sites. Instead, we see a gradual darkening through the night hours, which we presume is due to some external lights in the City being dimmed or turned off, and fewer car headlights as most people are sleeping.

The figure below shows all of the data recorded from June 30 to August 18, 2019. The horizontal axis is compressed, so the individual nights are vertical streaks of data. The downward extent of each streak shows how dark the night sky was that night. The sky overhead was not very dark during the Full Moon periods centered on July 16 and Aug 15.

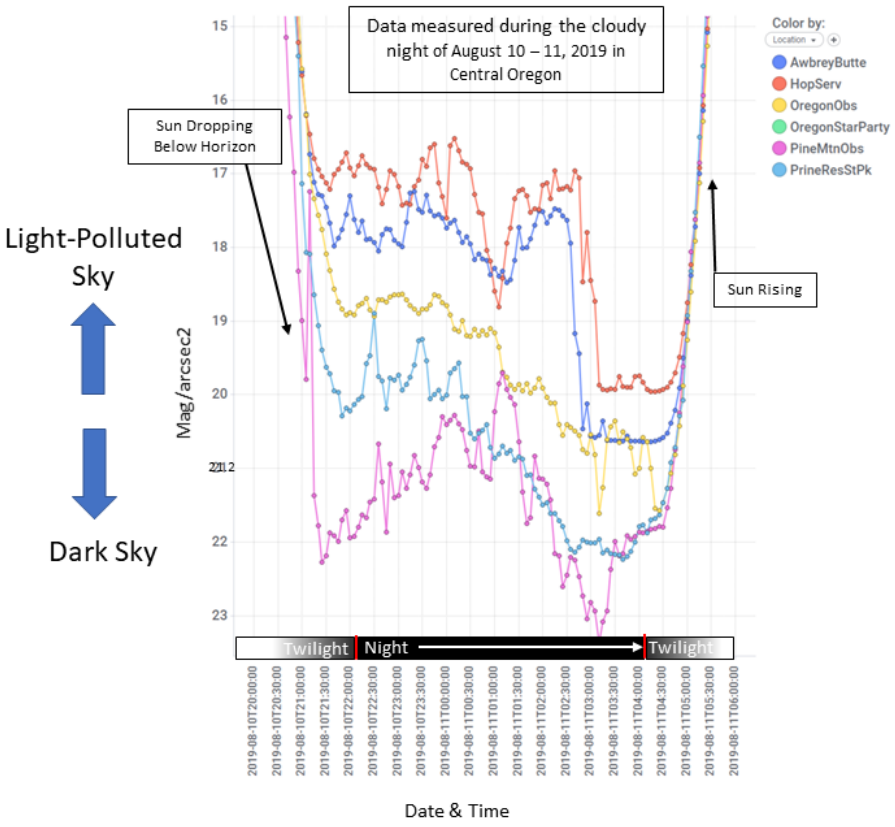


To eventually achieve the goal of measuring any increase or decrease in light pollution over a five-year time period, it's necessary to minimize extraneous variations in the data that are under our control. Primarily, to best measure artificial light at night, we need to eliminate the effects of sunlight and moonlight. To eliminate issues with sunlight, we only consider data recorded after astronomical twilight (dusk) and before the start of astronomical twilight (dawn) – defined as the period during which the Sun is 18 degrees or more below the horizon. To eliminate issues with moonlight, we exclude SQM data recorded when the Moon is above the horizon. Finally, we want to eliminate data acquired under cloudy or partly cloudy conditions.

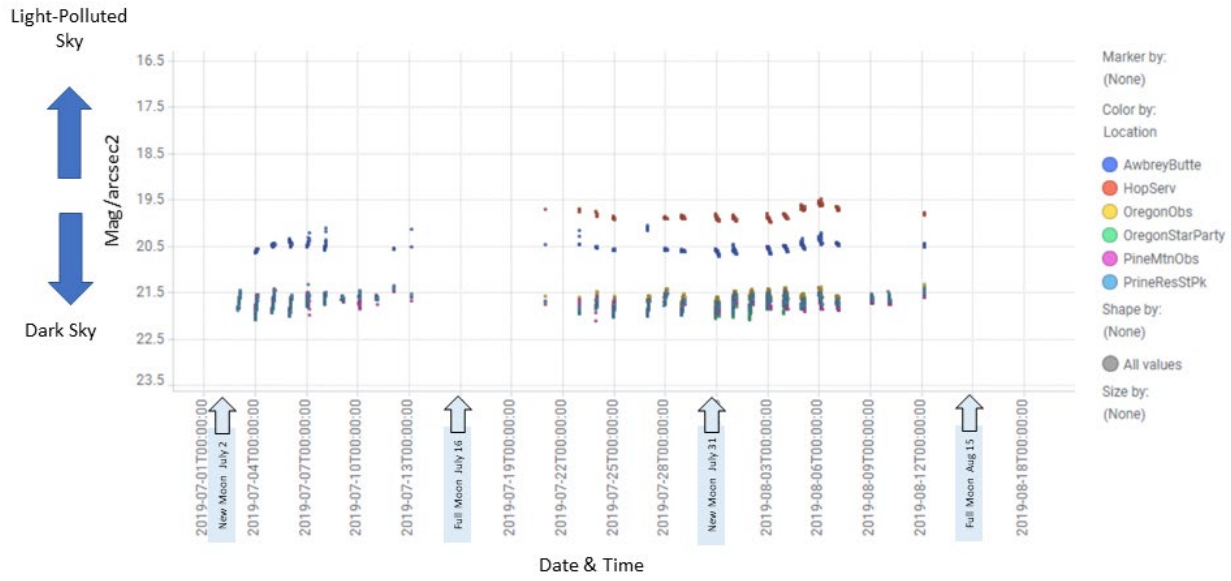
Notice that data from the night of August 10-11 in the above figure shows a very dark to very bright range, which is due to cloudy, overcast skies that night. The next figure shows details of the SQM data recorded during that particularly cloudy night across Central Oregon. The data show rapid variation at the 5-minute sampling interval due to changing cloud conditions overhead during the night of August 10-11, 2019.

The clouds cause quite bright skyglow readings at the Awbrey Butte and Hopservatory light-polluted sites – the artificial light from the ground reflects from the clouds downward. The opposite tends to occur at the dark sky sites – the clouds block the starry night sky so we record darker sky than usual. Note that clouds at the Pine Mountain site caused readings greater than 23 mags/arcsec2 in the early morning hours, an unreasonably dark reading.

We excluded the August 10-11 data from the subsequent statistical summary. We also excluded data from other days adversely affected by overhead clouds.



The next figure shows the entire July to Mid-August, 2019 data set after eliminating the data adversely affected by the sun, moon and clouds.

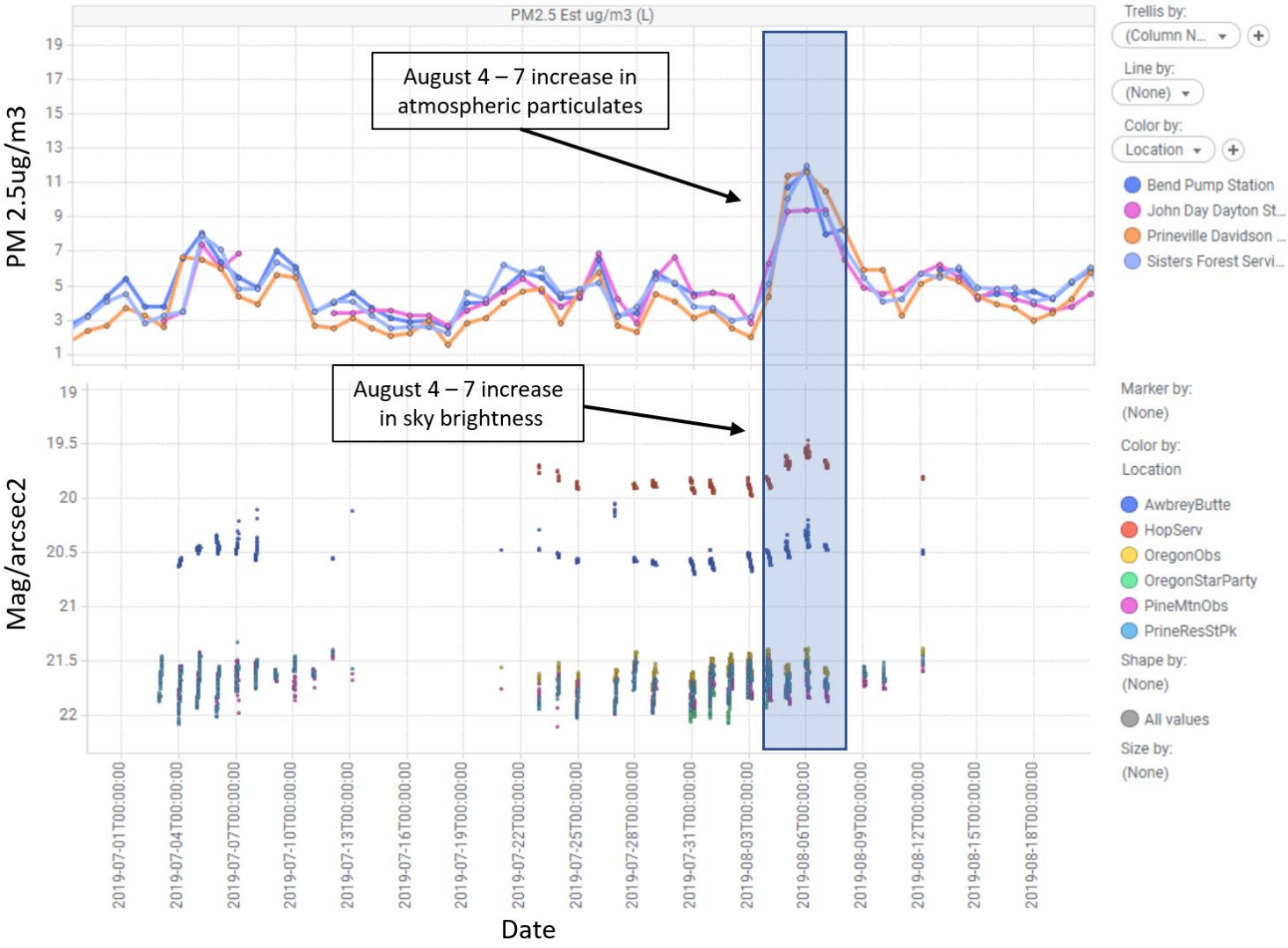


The table below summarizes the statistics of the trimmed SQM data from the first month and a half of measurements in Central Oregon. The Prineville Reservoir State Park, Pine Mountain Observatory and Oregon Observatory at Sunriver show mean and median SQM values which are darker than the Dark Sky Sanctuary minimum value of 21.5.

Aggregate Results
Descriptive Statistics (Jul_Aug_2019_Seven_Sites_datetime)
Exclude condition: SunElevDeg > -18 or MoonElevDeg > 0.0 or "Record Type" =3

Variable	Location	Valid N	Mean	Median	Minimum	Maximum	Std.Dev.
MSAS_Mean_Calib	PrineResStPk	1079	21.67338	21.66000	21.28000	22.08000	0.133635
MSAS_Mean_Calib	PineMtnObs	1055	21.68354	21.69000	21.26000	22.61000	0.128027
MSAS_Mean_Calib	AwbreyButte	828	20.50325	20.52000	17.57000	20.70000	0.166524
MSAS_Mean_Calib	HopServ	592	19.80444	19.86000	17.20000	19.98000	0.160321
MSAS_Mean_Calib	OregonObs	692	21.55723	21.57000	21.24000	21.79000	0.090207
MSAS_Mean_Calib	OregonStarParty	319	21.77423	21.76000	21.60000	22.07000	0.116673

Trends up and down in the SQM data still exist in the trimmed data of the above figure. Other variations not accounted for are at play. Variation in atmospheric clarity is a likely candidate. For example, the particulate data from Central Oregon Air Quality monitoring stations, shown in the next figure, show a 2x increase in particles during the Aug 4 -7 brightening of skyglow at the Awbrey Butte and Hopservatory sites.



The SQM data have been calibrated to each other by analyzing a two-week data set during which all the SQMs were mounted together at the Awbrey Butte site. Data from each SQM was adjusted up or down to reach the mean value recorded by all of the SQMs together. The adjustment was from 0.00 to 0.03 mag/arcsec2.

IDA Oregon acknowledges and thanks the representatives of Prineville Reservoir State Park, Pine Mountain Observatory, Oregon Observatory at Sunriver and the Hopservatory for their continued support on this project.

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