

# How Weather Conditions Affect Light Pollution

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## Project Information

I took a trip and traveled up and down the state of California collecting astrophotography pictures to compare the differences in star visibility in different regions of the state.

Simultaneously, I started collecting data from light pollution maps comparing Zenith Sky Brightness readings from two regions in Northern California and two regions in Southern California. Lastly, I was able to collect information on local weather conditions in those four counties and use that data to explain the differences in light pollution readings in relation to the astrophotography photographic evidence.

## My Role

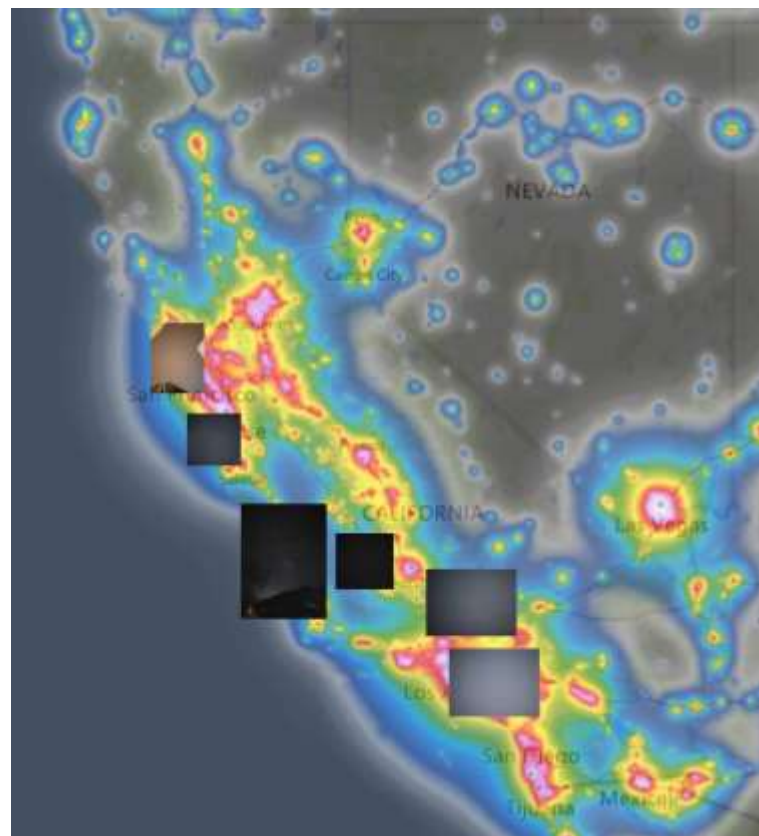
I took it upon myself to learn how to adapt my iPhone 11 into using "Night Mode" and with my extremely steady hands, take clear astrophotography pictures. To get the correct brightness and allow your phone to fully calibrate to the level of brightness of the stars, you must direct your iPhone at a 90-degree angle from your body, being directly parallel to the sky. Then setting your camera to Night Mode, click the button when you believe you are under your desired scope of stars and as you see the yellow plus sign slowly fading into view in the middle of the screen, keep steady; and the less the yellow plus sign moves away from the emerging white plus sign, the better the photograph will be.

Aside from astrophotography, I took on a role as an analyzer of different information. I used maps and zenith readings collected from *lightpollutionmap.info* to keep track of the data from the regions where I took pictures. And I used *weatherspark.com* to keep track of the cloud cover readings and humidity levels of the regions where I took pictures as well.

### Experience Description

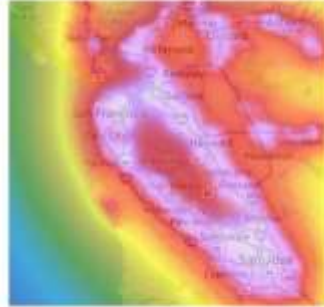
The documented, real-life astrophotography photos compared side-by-side to the air pollution readings and cloud cover data I retrieved.

Light Pollution Map of California with included Astrophotography Photos

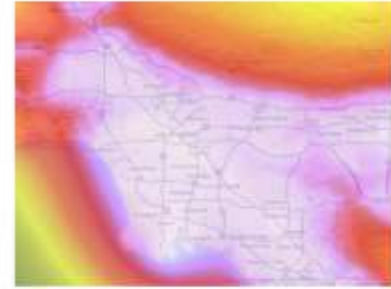


Comparison of Light Pollution in Northern California versus Southern California

NORCAL



SOCAL



Comparison of Cloud Cover in Northern California versus Southern California



**Daly City**  
San Mateo County, California, United States

**Day View** Today

Spring Summer Fall Winter  
Jan Feb Mar Apr May Jun  
Jul Aug Sep Oct Nov Dec

Summary  
Temperature  
Clouds  
Precipitation  
Sun  
Moon  
Humidity  
Wind



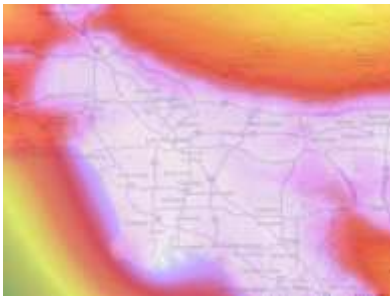

**Los Angeles**  
Los Angeles County, California, United States

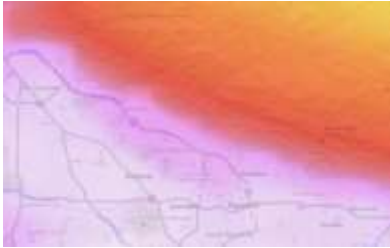

**Day View** Today

Spring Summer Fall Winter  
Jan Feb Mar Apr May Jun  
Jul Aug Sep Oct Nov Dec



Summary  
Temperature  
Clouds  
Precipitation  
Sun

<p>Documented Photos of the Cloud Dome over the San Francisco Area</p>	 <p>Taken: August 3, 2021 at 6:27pm</p>
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<p>(Southern California) Los Angeles County- San Gabriel Valley Area Population ~ 2 mil</p>	 <p>18.30 mag./arc sec<sup>2</sup></p>	 <p>Taken: July 28, 2021 at 10:12pm</p>
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<p>(Southern California) Los Angeles County- Angeles National Forest ~19.0 mi away from LA</p>	 <p>20.42 mag./arc sec<sup>2</sup></p>	
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		 <p>Taken: July 28, 2021 at 11:03pm</p>
<p>(Northern California) San Francisco County- Daly City Area Population ~ 874, 961</p>	 <p>18.76 mag./arc sec<sup>2</sup></p>	 <p>Taken: August 4, 2021 at 10:31pm</p>
<p>(Northern California) Palo Alto County- Los Altos Hills ~ 31.0 mi away from SF</p>	 <p>19.44 mag./arc sec<sup>2</sup></p>	 <p>Taken: August 2, 2021 at</p>

		10:12pm
(Mid-California, Mountain Range Area) San Luis Obispo County- Lake Lopez	 21.68 mag./arc sec <sup>2</sup>	 Taken: July 30, 2021 at 11:16pm

### Knowledge Gained

Both Northern California (NorCal) and Southern California (SoCal) have concentrated areas with terrible degrees of light pollution. However, there is a reddish spot in the middle of the Bay Area, almost like a slight break in the intense areas of light pollution that is due to a small body of water separating the San Francisco Bay region from the right side of NorCal which

is attached to the rest of the state on the eastern side of NorCal. This is a peculiar detail shown on the map because this body of water between terrestrial ranges is still subject to great degrees of light pollution. Whereas in SoCal, as you reach the beach, the light pollution diminishes to green almost abruptly.

The Zenith Sky Brightness scale is from 22 to 17.5 mag./arcsec<sup>2</sup> (the scope of difference of the whole scale is 4.5 units).

In Los Angeles County, the population is around 2 million so there is a logical reason as to why light pollution is so high in this region and why so obviously, the hue of the sky on camera is more blue/grayish than black. And just 19 miles away, the sky is clearly darker, and you can start to see some stars. However, with just a 4.5-unit difference of extremities on the entire present Zenith Sky Brightness scale, they vary by 2.12, which is close to half the scale -- so the readings difference from the San Gabriel Valley and the Angeles National Forest (dis. ~19 miles) is pretty far from each other.

While in San Francisco County, where the population is even less than half of Los Angeles, the light pollution readings are roughly the same. Not only that, a little less than double the distance away than what the Angeles National Forest is from LA, the distance from Daly City to Los Altos Hills (dis. 31.0 miles), the readings show that their zenith levels are not even 1 unit apart. That day was not too cloudy in Los Altos Hills so the sky was a little darker, but the average readings show that there isn't much of a difference in light pollution intensities between the two NorCal cities even though the distance between them is greater than the distance between two SoCal cities.

From the statistics, the amount of people is not the issue contributing to the light pollution levels, so I have inferred that it is related to weather conditions because regular weather

conditions in NorCal are much cloudier than in SoCal. From the San Francisco cloud pictures, not only can you tell there is heavy cloud cover, but on the right photo, there is actually a dome of clouds, blanketing the city. That doesn't happen at all in sunny SoCal and the differences start to make more sense in relation to the light pollution maps. It also explains why even when there is no terrain, light pollution is still a problem over middle waters because the evidence now shows that: clouds expand the range of light pollution.

I was able to solidify these findings through two articles I read:

"In particular, the amplification of skyglow by clouds needs to be studied, as clouds can extend the reach of skyglow into remote areas not affected by light pollution on clear nights." Jechow, et. al., (2017) Nature.com

"Weather conditions indeed have a great impact on the urban night light environment." Liu, et al., (2019) Sciencedirect.com

"Clouds are a kind of atmospheric factor that most effectively scatters the artificial light coming from the ground. Therefore, they have the most significant impact on the brightness of the night sky... A linear correlation between the cloudiness and the brightness of the night sky was found." Sciezor, (2020) Sciencedirect.com

## Recommendations

I thought this was all really interesting to learn! I didn't intend on doing this research project, I actually sought out to do a project on the correlation of air pollution to light pollution, but the difference in weather patterns were just so much more prevalent to me and the answer in clouds were clear to me through my photos as well. However, if anyone would like to start a



research project using my data and findings along with their research involving air pollution, I'd love to be involved and contribute with astrophotography. In this time, I also was able to learn and research a little into air pollution and found out that air pollution intensifies light pollution. However, in reference to climate in general, I think that is more related to the grander scheme of climate change and that it would be the umbrella term that of course, affects weather patterns, air pollution, and in turn: light pollution.

Though, I am super glad I got to experience this journey because in searching for the stars and doing intentional analysis, I saw really cool stars! It wasn't until this class that I realized I should be looking for the Milky Way, in dark regions away from light polluted areas especially. So halfway on my trip to Norcal, when I went camping in the San Luis Obispo mountains by Lake Lopez, I was under a beautiful dark sky where I saw a lot of stars, and even constellations and I was thrilled to realize I was able to capture the Milky Way on my camera too. So, to anyone new to astrophotography as well, I heavily suggest taking a little bit of a further drive to experience the hues of the beautiful stars at night.

#### Timeline

7/13/21	Interviewed Brian Espey where I learned the most about Milky Way viewings
7/28/21	Sought out to take Astrophotography photos of the Southern California region
7/29/21	Finished and submitted my Educational Community Project with the use of my photos

7/30/21 - 8/1/21	Trip to Lake Lopez near San Luis Obispo County where I was able to capture astrophotography photos of the dark sky, constellations, and the Milky Way
8/2/21 - 8/3/21	Stayed in Los Altos Hills and captured a few astrophotography photos
8/3/21 - 8/5/21	Stayed in Daly City and captured a few astrophotography photos
8/6/21	Sent in Research Update and Research Team Meetings for Review through email
8/9/21	Research and collected data from light pollution maps
8/11/21	Research and collected quotes from light pollution/cloud patterns correlation articles
8/12/21	Put together presentation for Skyglow Research class titled "Photo Evidence of how Weather Conditions Affect Light Pollution"
8/17/21	Finish final report titled "How Weather Conditions Affect Light Pollution"

References

Light Pollution Map:

<https://www.lightpollutionmap.info>

Cloud Cover Readings:

<https://weatherspark.com/y/1705/Average-Weather-in-Los-Angeles-California-United-States-Year-Round>

<https://weatherspark.com/y/505/Average-Weather-in-Daly-City-California-United-States-Year-Round>

Articles:

Jechow, A., Kolláth, Z., Ribas, S.J. *et al.* Imaging and mapping the impact of clouds on skyglow with all-sky photometry. *Sci Rep* 7, 6741 (2017).

<https://doi.org/10.1038/s41598-017-06998-z>

Liu, Ming, et al. “Research on the Influence of Weather Conditions on Urban Night Light Environment.” *Sustainable Cities and Society*, Elsevier, 22 Nov. 2019,

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Ścieżor, Tomasz. “The Impact of Clouds on the Brightness of the Night Sky.” *Journal of Quantitative Spectroscopy and Radiative Transfer*, Pergamon, 14 Mar. 2020,

[www.sciencedirect.com/science/article/pii/S0022407319308726?via%3Dihub](http://www.sciencedirect.com/science/article/pii/S0022407319308726?via%3Dihub).