Observing conditions at the Skinakas Observatory

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This report describes the quality of the Skinakas observatory as a site to perform astronomical observations. The site quality is characterized by the following indicators: weather, seeing, extinction, and sky brightness.

Summary

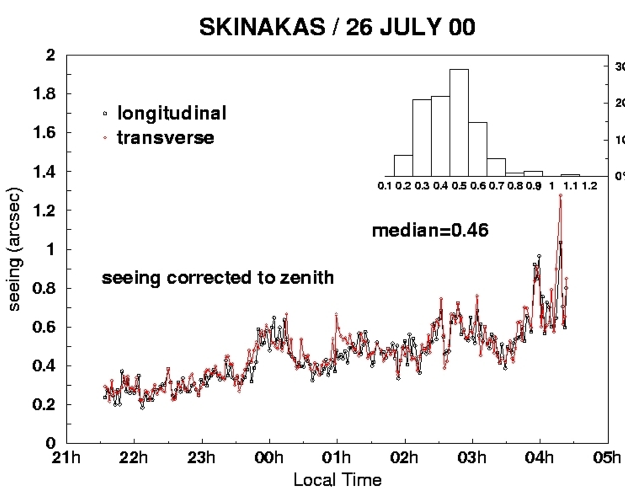
- **Weather –** on average ~60% of the nights are clear. However this percentage increases to more than ~70% during the summer months.
- **Seeing** - mode seeing is 0.69 arcsec (July 2001), 0.65 arcsec (2015).
- **Extinction** - typically 0.17 mag in V
- **Sky brightness** (zenith in mag/arcsec^2)- <B>=22.80±0.10 ; <V>=21.92±0.09; <R>=21.39±0.07

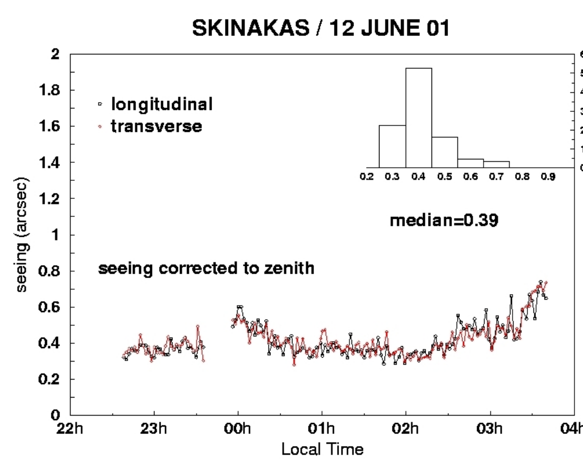
Seeing

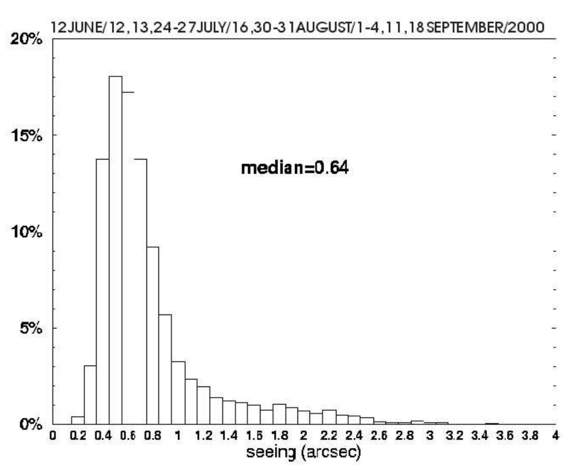
[Observations and data analysis performed by Dr. M. Palaiologou (University of Crete)]

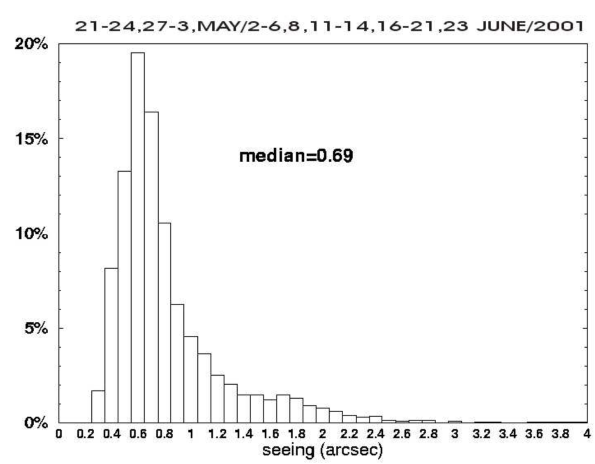
Using a two-aperture Differential Image Motion Monitor (DIMM), which is a device measuring the seeing, it was shown that the Skinakas Summit is indeed an excellent site – in fact one of the best known in the Mediterranean area and comparable to major sites wordwide. The seeing observations were made in two different campaigns, each one spanning over two years. The first one took place from the beginning to the end of randomly chosen astronomical nights from June to September 2000 and from May to June 2001 (43 nights in total). The second campaign were made in 2014 (August: 18-23) and 2015 (June: 20-21; July; 10-12, 14,18-20; August: 12,15-18; September: 12,15; November: 11-12). Examples of two such nights of the Skinakas DIMM measurements are shown in the figures below.

2000-2001 campaign: The diagrams show that the seeing does not change rapidly at Skinakas during the observing night, staying within 0.3”. Extremely good seeing values have been measured often (0.4”), with the best measured ~0.23”. Also, two histograms with the seeing measurements for the year 2000 and 2001 are given. The median seeing for the two periods was 0.64” and 0.69” respectively.









2014-2015 campaign: Note the secondary peak at ~0.2-0.3'' , indicating the presence of extraordinarily good nights and in agreement with data from the 2000-2001 campaign.

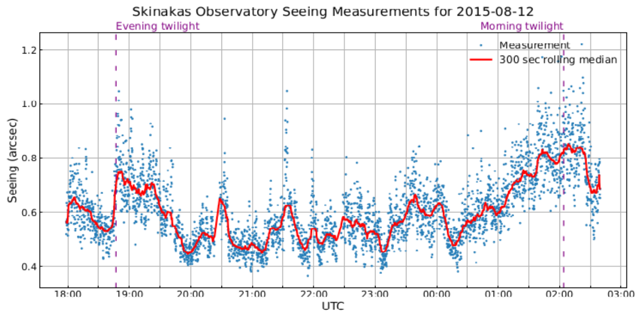


Figure 2. A **Typical** night

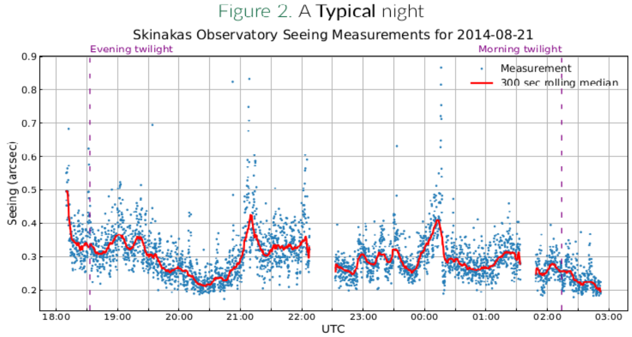


Figure 3. A **Good** night

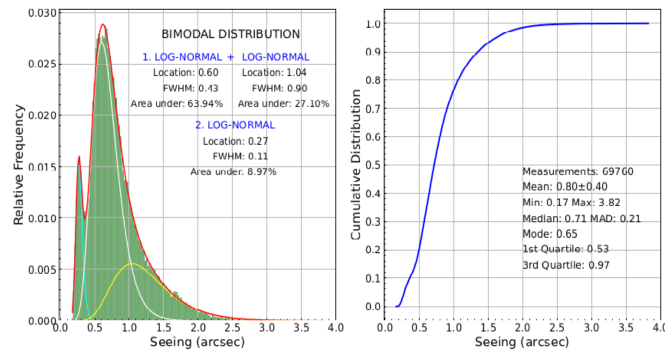
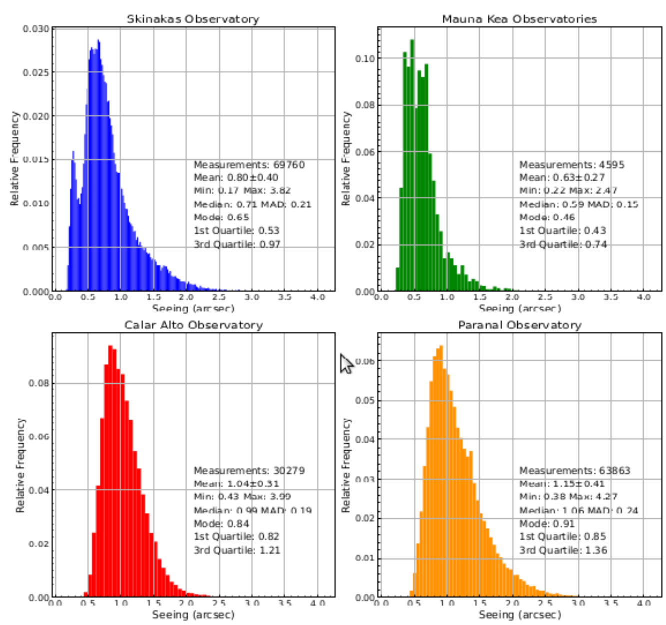


Figure 7. Seeing statistics of the entire campaign



Seeing measurements were obtained from other observatories' archives, corresponding exactly to the same observing nights as in this campaign.

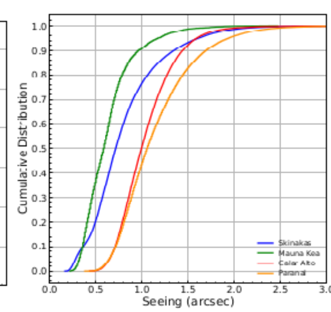


Figure 8. Seeing histograms between observatories

Figure 9. Cumulative seeing distributions

Extinction

[Observations and data analysis performed by Dr. P. Reig (Institute of Astrophysics/FORTH)]

Atmosphere extinction is the astronomical parameter that evaluates sky transparency. Sources of sky transparency degradation are clouds (water vapor) and aerosols (dust particles included). Extinction values and their stability throughout the night are essential for determining the accuracy of astronomical measurements. The nights with low and constant extinction are classified as photometric.

The extinction at the Skinakas Observatory *during photometric nights* are (in mag/airmass):

B mag	V mag	R mag	I mag
0.26 ± 0.06	0.17 ± 0.03	0.13 ± 0.04	0.09 ± 0.06

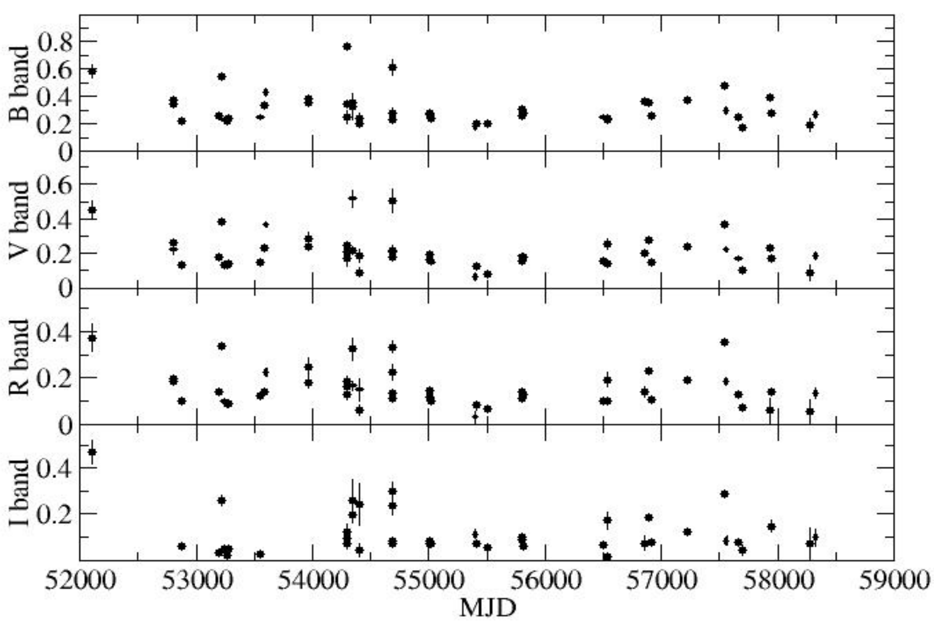


Figure: Evolution of the extinction coefficient with time.

Night Sky Brightness and Spectrum

[Observations and data analysis performed by Dr. M. Palaiologou (University of Crete)]

We have performed two different campaigns to study the brightness of the sky over the Skinakas observatory during moonless nights. The first one took place in August 2008 and the second one over a five month period from June to October 2016. These campaigns revealed that Skinakas Observatory is a dark site, with the exception of the direction towards the city of Heraklion (North East).

	B Mag		V mag		R mag	
Year	Zenith	All-sky	Zenith	All-sky	Zenith	All-sky
2008	22.51±0.05	22.36±0.16	21.74±0.06	21.60±0.14	21.18±0.07	21.07±0.14
2016	22.80±0.10	22.35±0.03	21.92±0.09	21.50±0.02	21.39±0.07	20.98±0.04

All sky maps

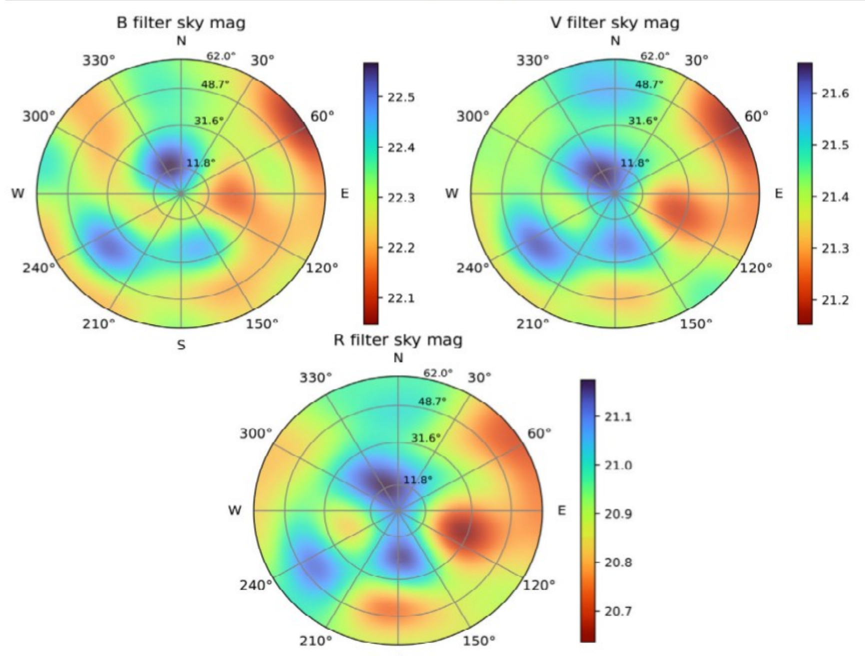


Figure 5. Zenith-corrected night sky surface brightness maps in the passband of B, V and R filters, expressed in magnitudes arcsecond^{-2}. The polar grid indicates the local horizontal coordinate system, with constant zenith-distance circles corresponding to the lower boundary of the 4 Zones considered.

Weather

[Data analysis performed by Dr. P. Reig (Institute of Astrophysics/FORTH)]

This section presents an statistical analysis on the efficiency of the observing time at the 1.3 m telescope at the Skinakas Observatory. It gives the average fraction of observing time lost to bad weather and the parameters involved as the main cause of the bad weather. The fraction of lost night due to technical issues represent a very small part of the overall number of lost nights.

A typical observing season covers the period May to November. Although observations during November are not rare, the available data are scarce. Thus we do not include November in the analysis.

Source of data

The source of data for this analysis is based on the feedback of the observers. The observer fills in a questionnaire or log each night, reporting on the observing condition during the night (both technical and weather related) as well as information about the purpose of the observations (name of the Principal Investigator, observers and night assistant, title of the project, technique employed, etc). The night is recorded as:

- **Closed all night (CAN):** The dome was closed during the entire night regardless of the reason. This also includes the case when the entire site was closed.
- **Open all night (OAL):** The dome was open during the entire night, hence observation took place normally.
- **Open 1/2 of the night (OHN):** The dome was opened during at least half of the night.
- **Open 1/4 of the night (OOQ):** The dome was opened for about one fourth of the night.
- **Open 3/4 of the night OTQ):** The dome was opened for about three fourth of the night.

From this information we built up the following variables:

- **'Clear' nights (CN):** It is calculated as
 CN=OAN+1/4*OOQ+1/2*OHN+3/4*OTQ

- **'Lost' nights (LN):** The lost nights refer to the total time that the telescope was not operational during a Skinakas season. It is calculated as
 LN=CAN+1/4*OTQ+1/2*OHN+3/4*OOQ

There are two main caveats in this analysis regarding data before 2019:

1. **Missing dates**. This may occur for two reasons. One is that the observer forgot to fill in the questionnaire. The second reason is that if the site was closed, nobody provided the information. The reasons that the site was closed are unknown although it is expected to be mainly due to bad weather conditions. In the absence of clear information, we do not use those nights in the weather analysis but they are counted as lost nights.
2. **Unknown weather problem**. In some cases, the reason for closing down the dome was bad weather. However, the specific reason causing the problem (humidity, wind, dust, etc) was not

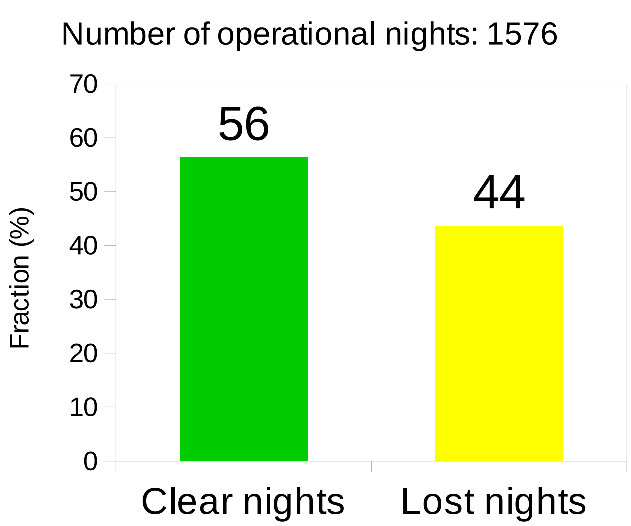
reported. We compute these nights as lost nights and allocate them under “unknown weather reason”.

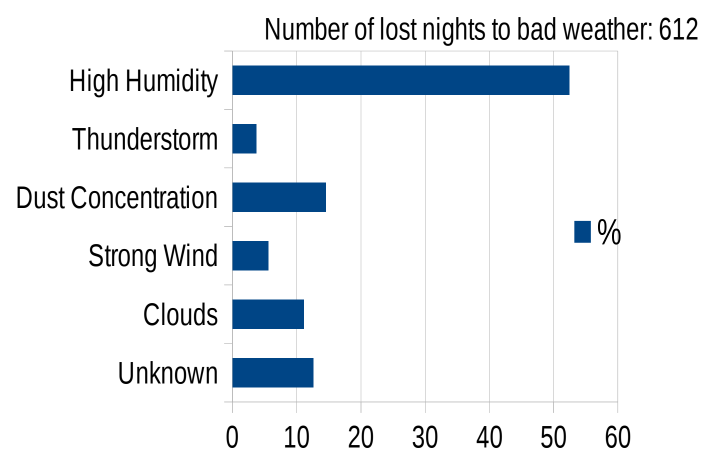
The nights could be lost due to bad weather for the following reasons:

- **High humidity:** It refers to the number of nights during which the dome was closed because the humidity level was higher than the allowed limit of 80%.
- **Clouds:** These are nights when the clouds prevented normal operation but the humidity was in the allowed range.
- **Thunderstorms:** implies electrical phenomena. The protocol demands to shut down all electric devices at the observatory and the transfer of the observers down to Heraklion.
- **Strong wind:** It refers to the number of nights during which the dome was closed because the wind velocity was higher than the operational limit of 70 km/h (or > 50 km/h if pointed directly into the wind).
- **High dust content:** When the dust level was higher than 800 particles per cubic feet.
- **Unknown:** when the weather problem was not specified.

The overall picture

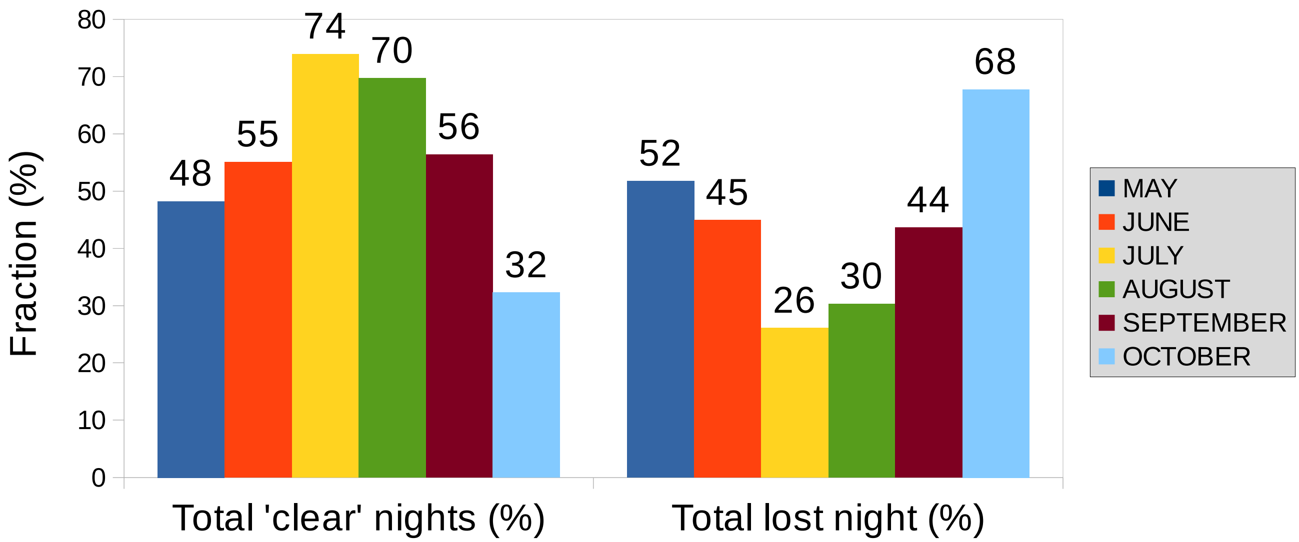
Period: 2014-2022



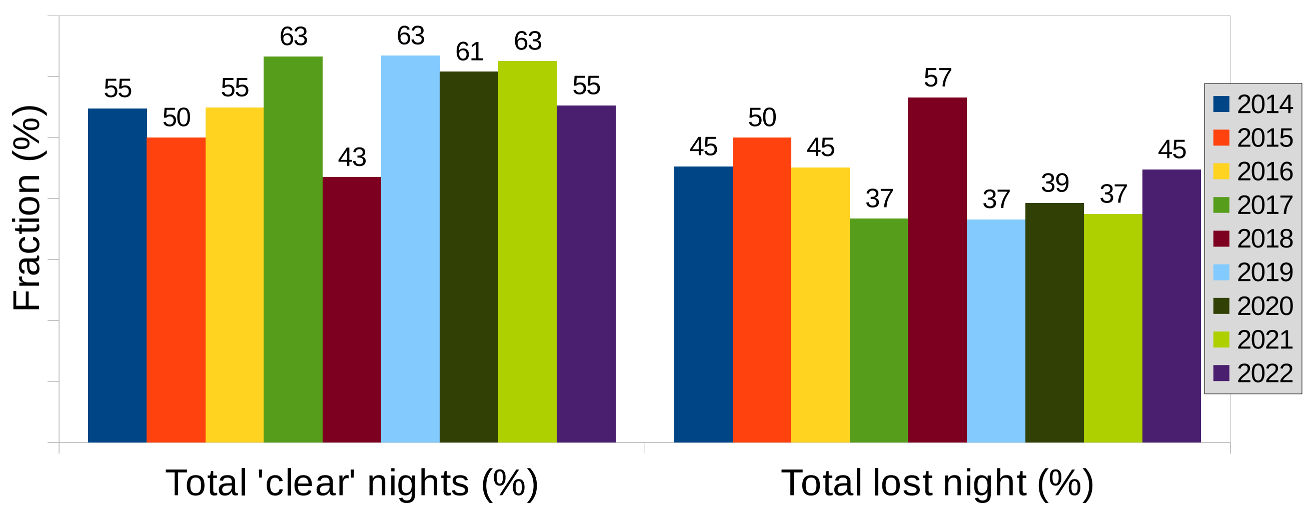


Analysis per month

Period: 2014-2022



Analysis per year



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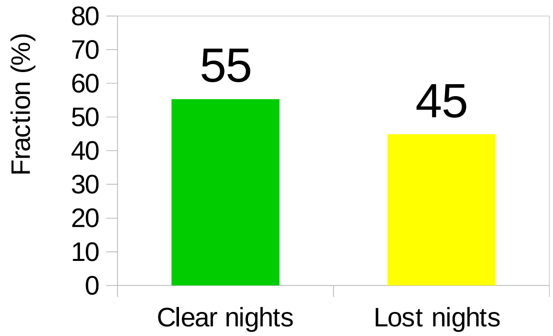
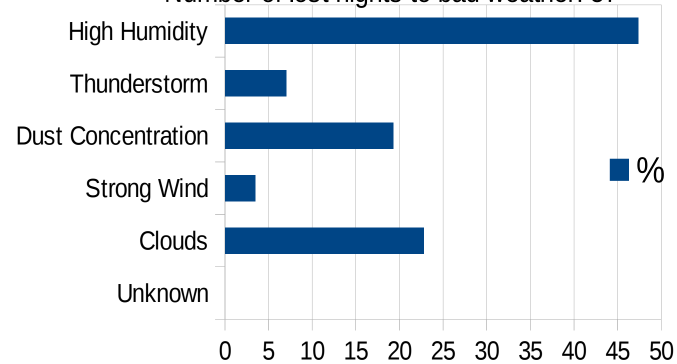
Individual years

2022

Number of operational nights: 171

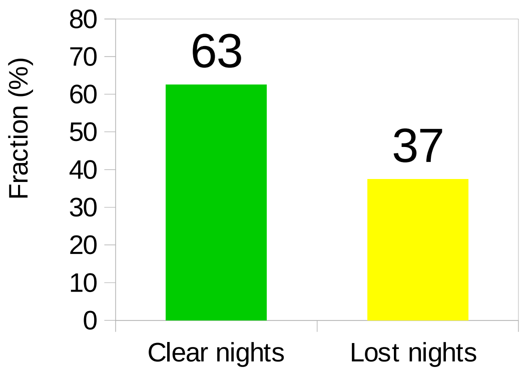


Number of lost nights to bad weather: 57

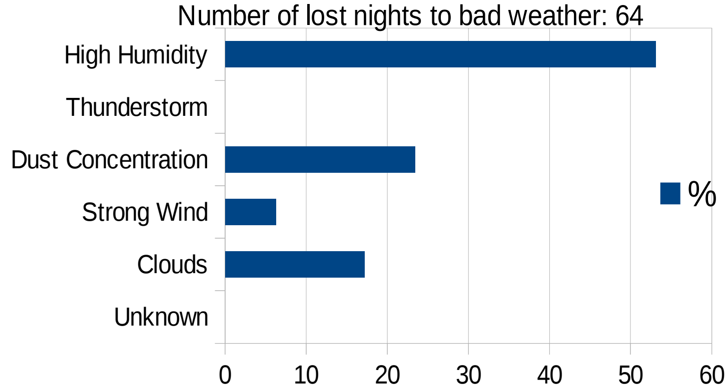


2021

Number of operational nights: 177

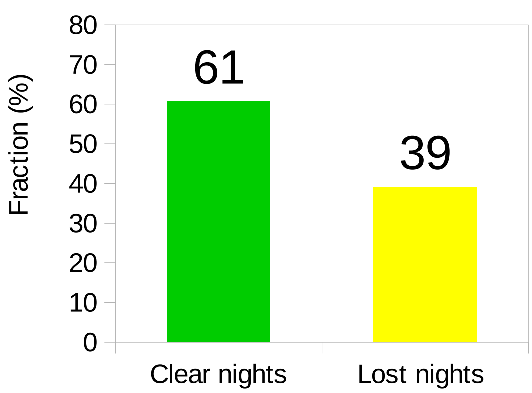


Number of lost nights to bad weather: 64

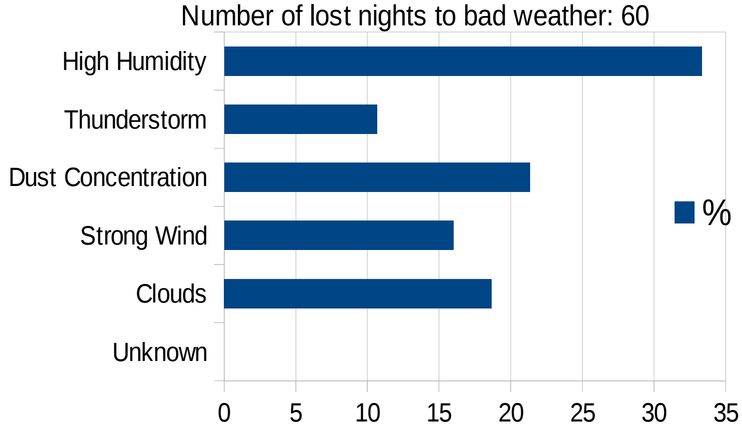


2020

Number of operational nights: 153



Number of lost nights to bad weather: 60



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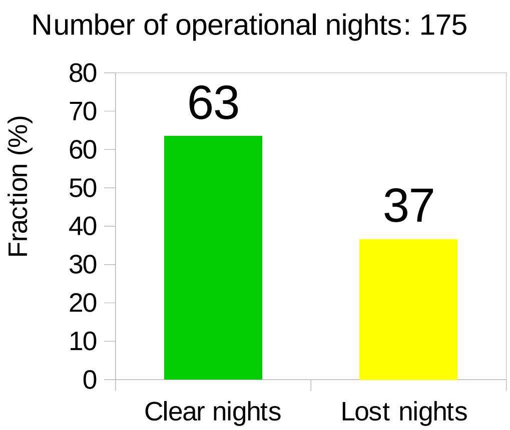
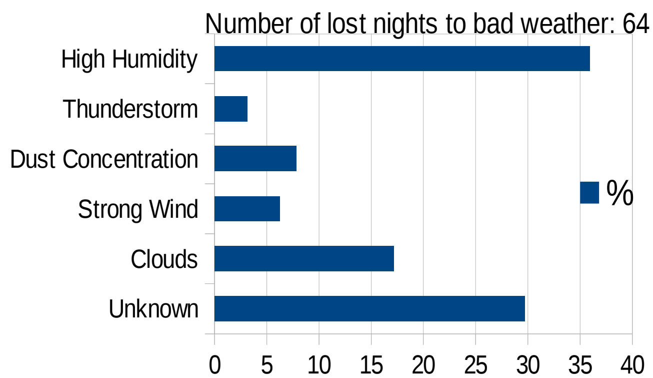
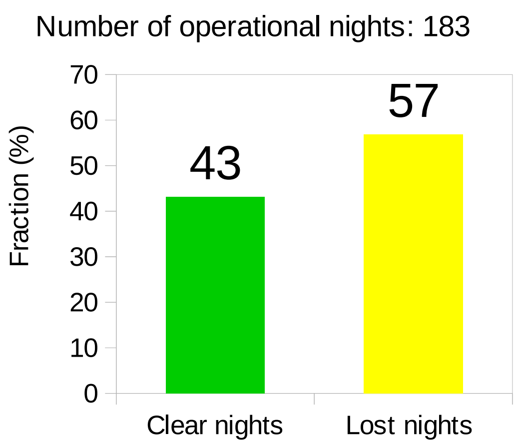
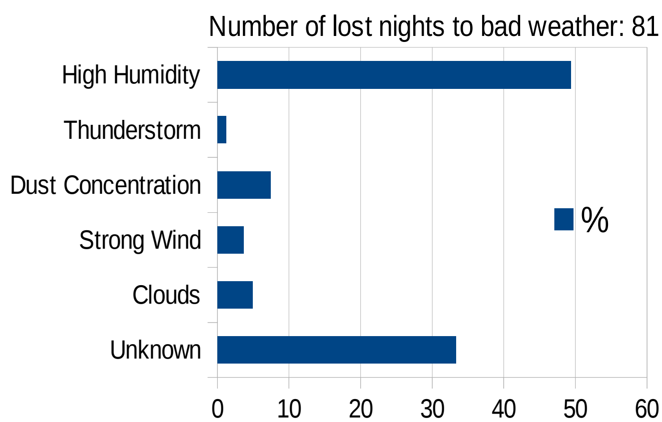
2019



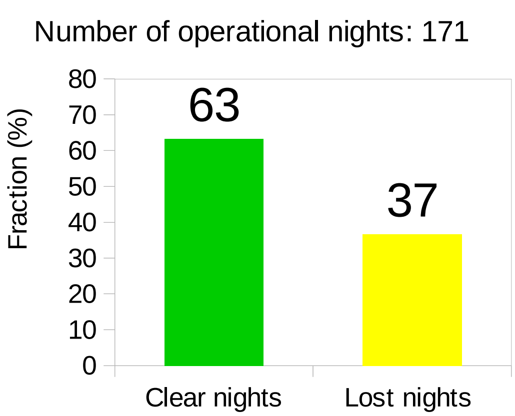


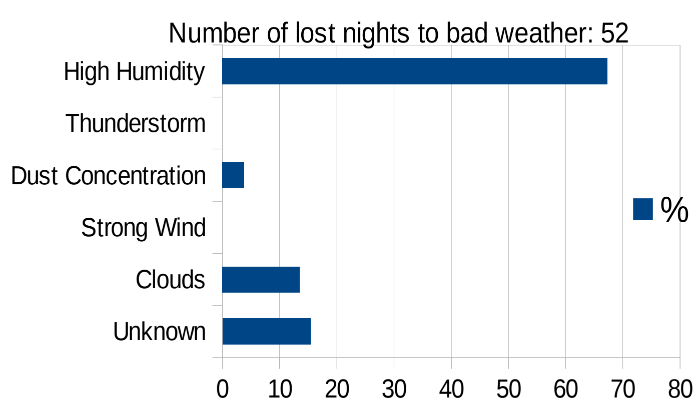
2018





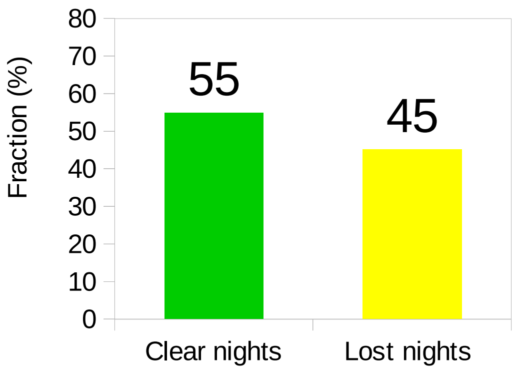
2017

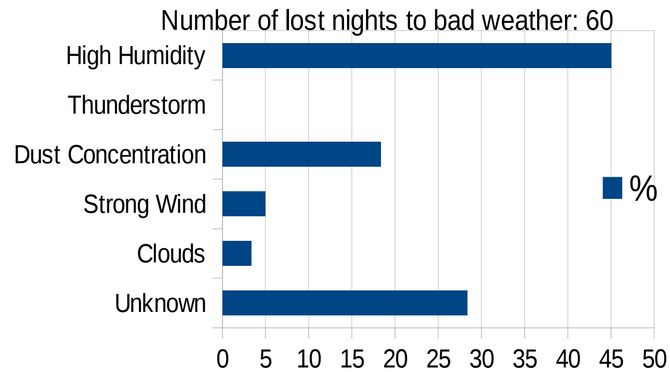




2016

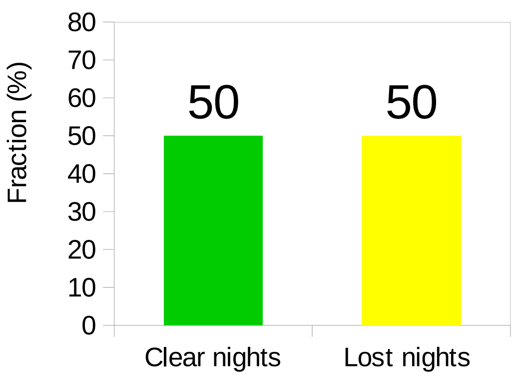
Number of operational nights: 184

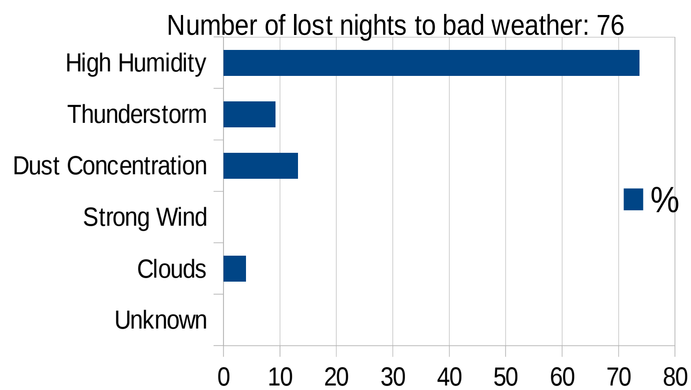




2015

Number of operational nights: 177





2014

Number of operational nights: 184