Observing conditions at Skinakas Observatory

P. Reig & M. Palaiologou
Institute of Astrophysics – FORTH
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This report presents an analysis of the observing logs for five observing periods, 2014 to 2019, at Skinakas Observatory. We present the main indicators characterizing the quality of the site that is: weather, seeing, extinction, and sky brightness.

Summary

A summary of our findings is presented bellow:

- **Weather:** on average more than half of the nights are clear. However this fraction increases to ~70% during the mid-summer months.
- **Seeing:** median seeing is 0.69 arcsec (July 2001)
- **Extinction** : typically 0.17 mag in V
- **Sky brightness:** <B>=22.36, <V>=21.60, <R>=21.07 mag/arcsec^2 in the darkest conditions

Weather

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.

A typical observing season covers the period May to October. 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, every 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). Each observing 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 threefourth 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

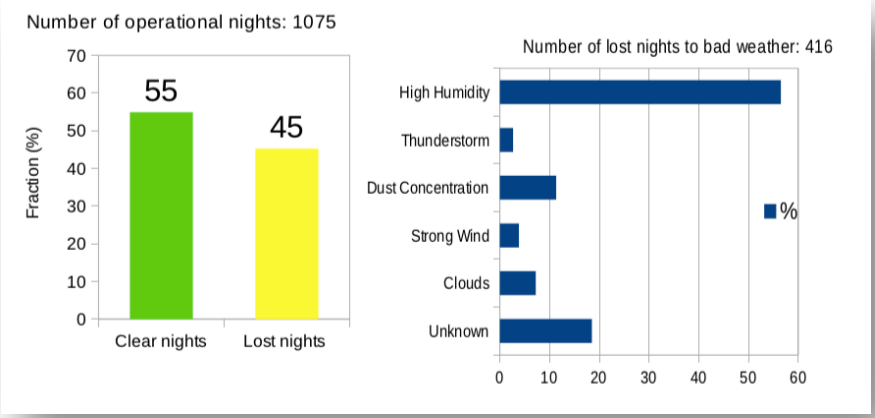
There are two main caveats in this analysis:

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 problems**. 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 count these nights as lost nights and allocate them under "unknown weather reason".

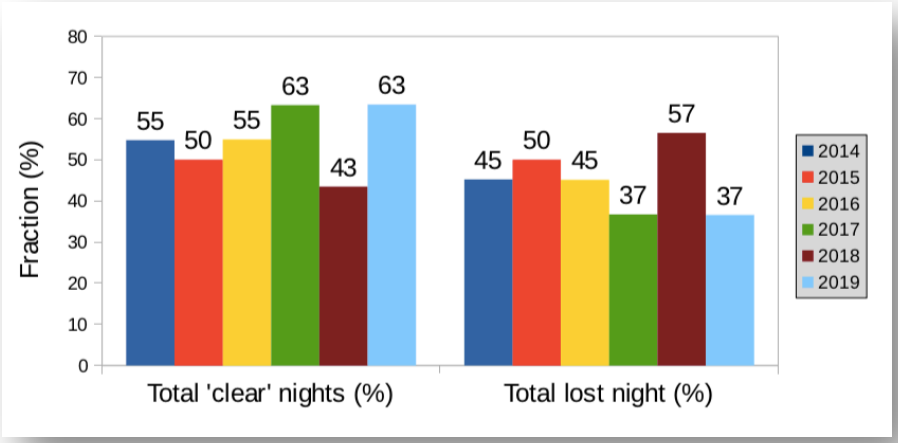
The nights could be lost due to bad weather for the following reasons:

- **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 allowedrange.
- **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 of70 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.

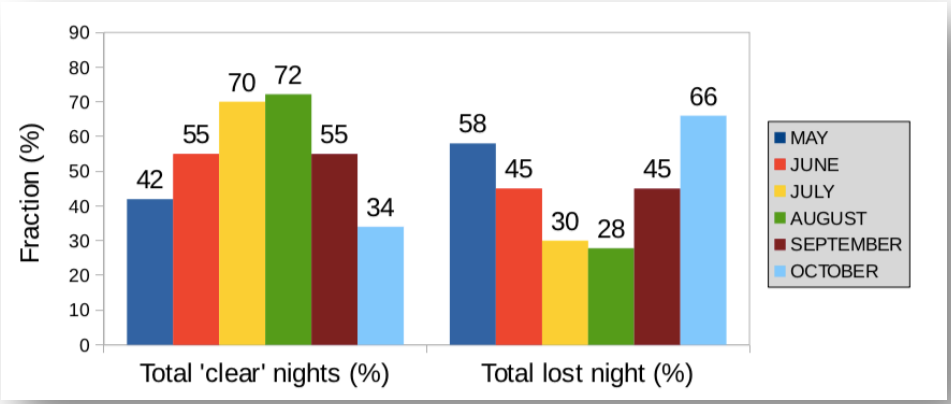
The overall picture (2014-2019)



Yearly comparison (2014-2019)

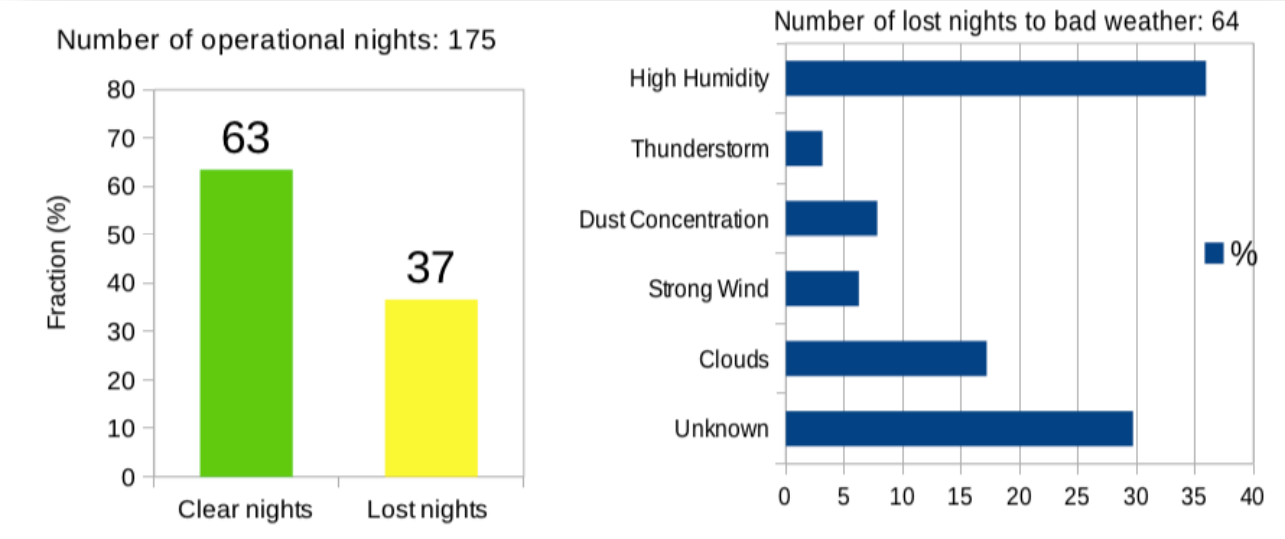


Monthly comparison (2014-2019)

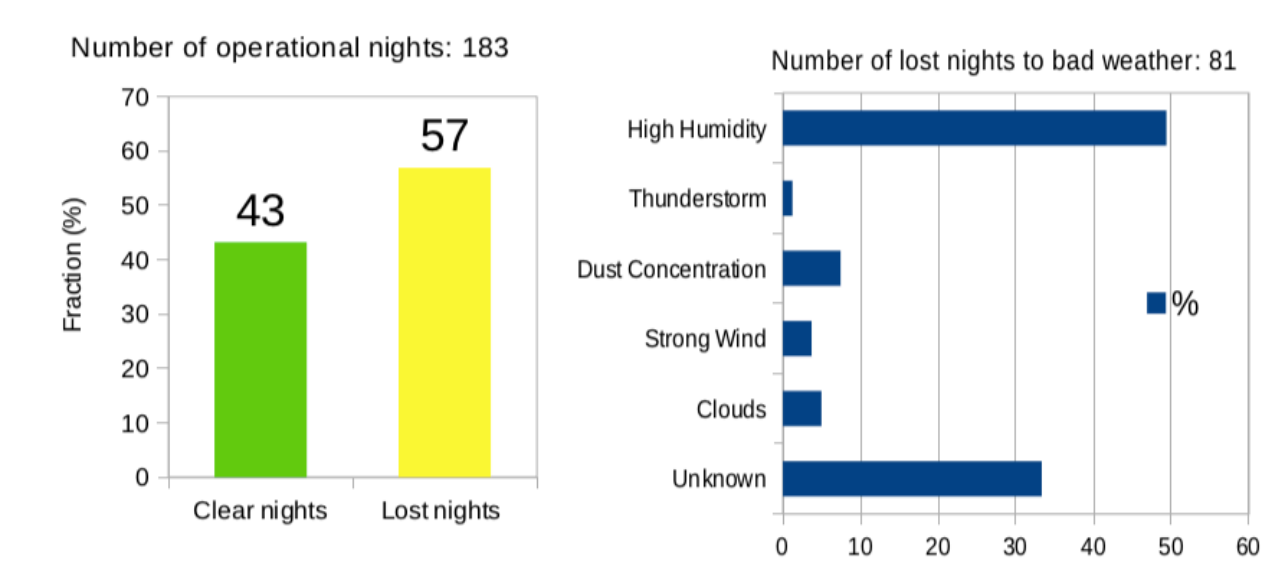


Analysis per year

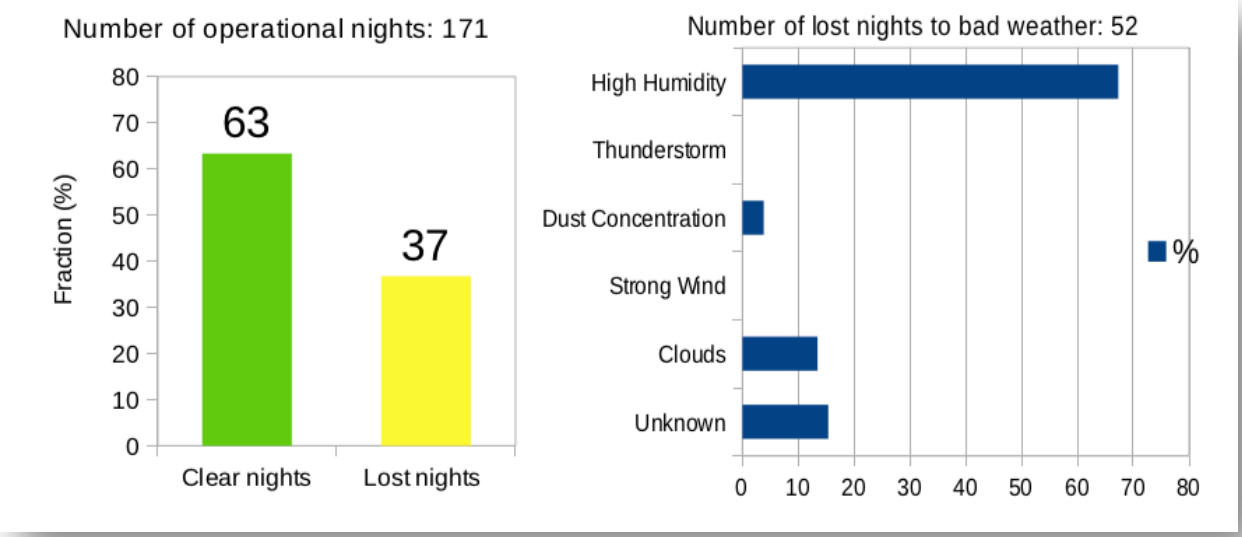
2019



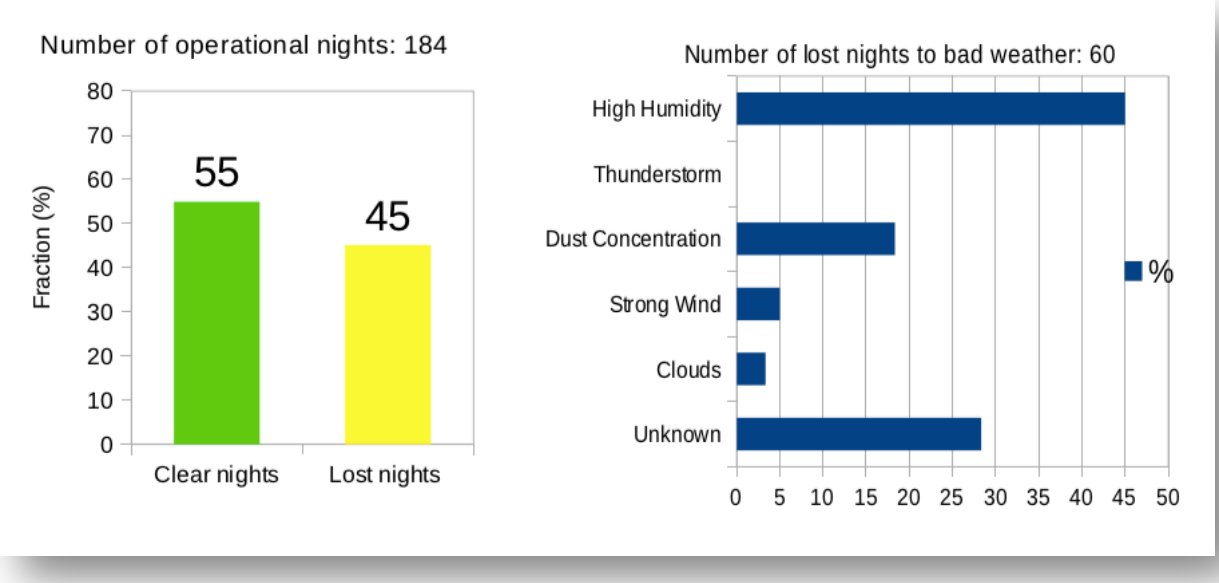
2018



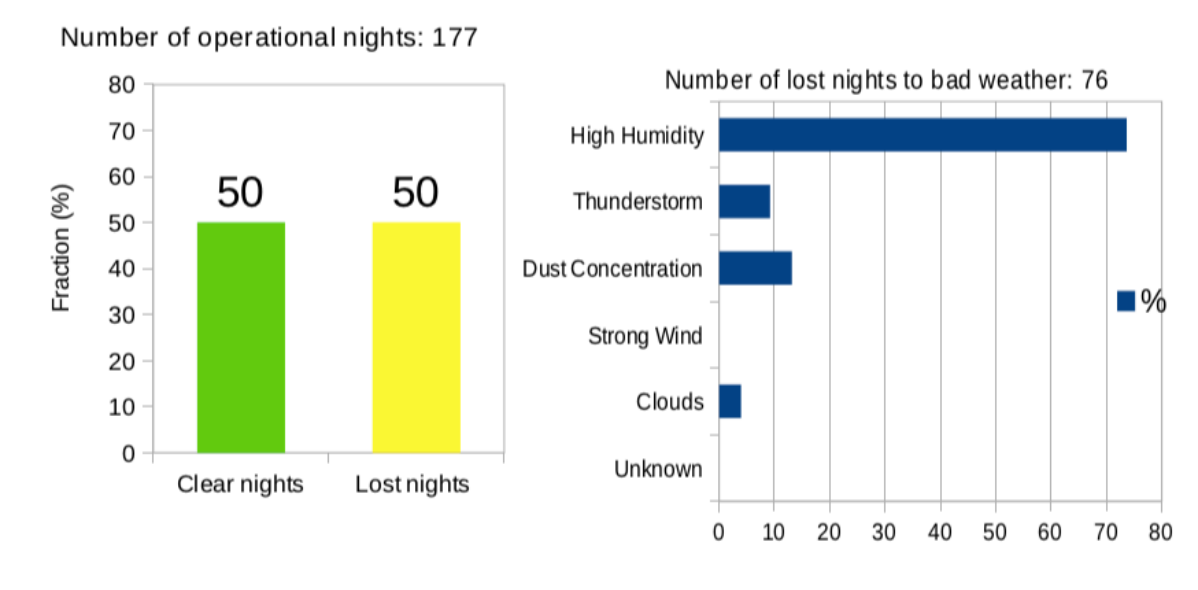
2017


Number of operational nights: 171
Fraction (%)
80
70
60
50
40
30
20
10
0
63
37
Clear nights
Lost nights
Number of lost nights to bad weather: 52
High Humidity
Thunderstorm
Dust Concentration
Strong Wind
Clouds
Unknown
%
0
10
20
30
40
50
60
70
80

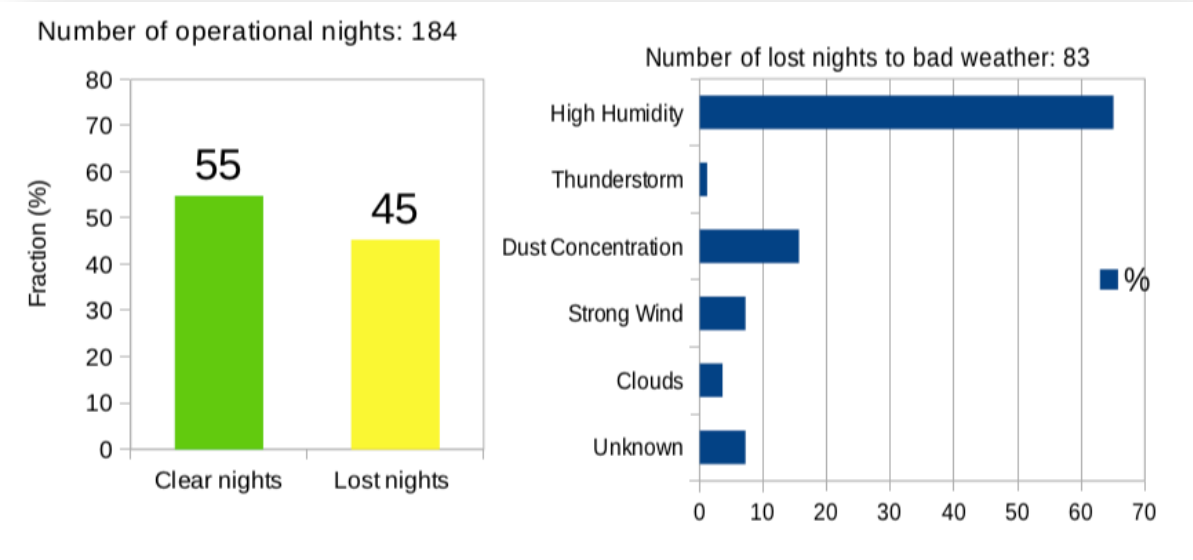
2016


Number of operational nights: 184
Fraction (%)
80
70
60
50
40
30
20
10
0
55
45
Clear nights
Lost nights
Number of lost nights to bad weather: 60
High Humidity
Thunderstorm
Dust Concentration
Strong Wind
Clouds
Unknown
%
0
5
10
15
20
25
30
35
40
45
50

2015


Number of operational nights: 177
Fraction (%)
80
70
60
50
40
30
20
10
0
50
50
Clear nights
Lost nights
Number of lost nights to bad weather: 76
High Humidity
Thunderstorm
Dust Concentration
Strong Wind
Clouds
Unknown
%
0
10
20
30
40
50
60
70
80

2014


Number of operational nights: 184
Fraction (%)
80
70
60
50
40
30
20
10
0
55
45
Clear nights
Lost nights
Number of lost nights to bad weather: 83
High Humidity
Thunderstorm
Dust Concentration
Strong Wind
Clouds
Unknown
%
0
10
20
30
40
50
60
70

Meteorological data. Weather graphs

The data comes from the weather station at the observatory. It records a number of parameters at intervals of 1 minute. The data presented below correspond to values measured from the evening twilight to morning twilight.

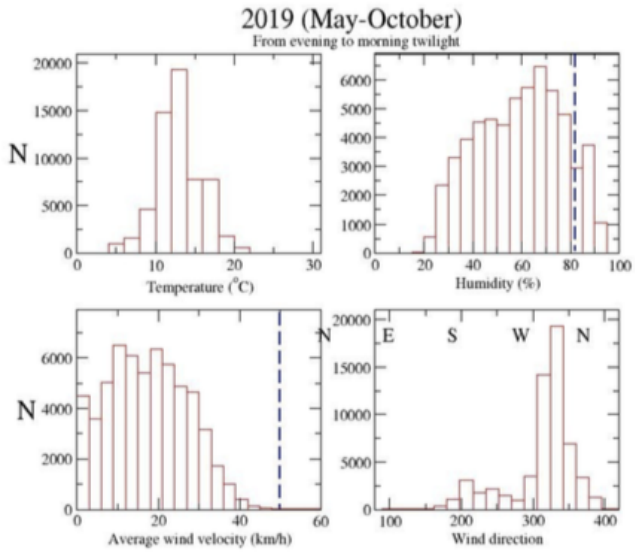


Figure 1: Histograms of the temperature, humidity, wind velocity, and wind direction. The data shown correspond to values measured from the evening to the morning astronomical twilight in 2019. The vertical line indicates the limit allowed for observations.

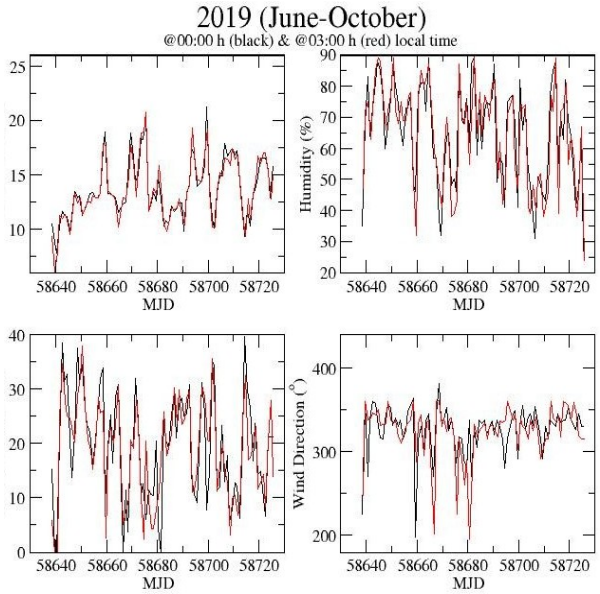


Figure 2: Evolution of the weather parameters during the 2019 season at 00:00 h (black line) and 03:00 h (red line) local time.

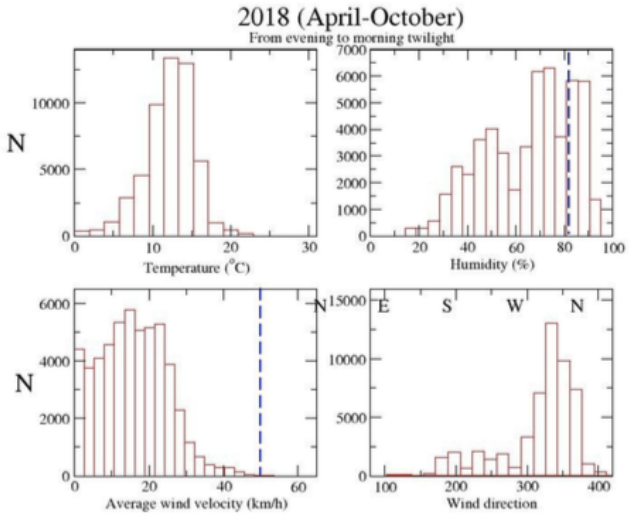


Figure 3: Histograms of the temperature, humidity, wind velocity, and wind direction. The data shown correspond to values measured from the evening to the morning astronomical twilight in 2018. The vertical line indicates the limit allowed for observations

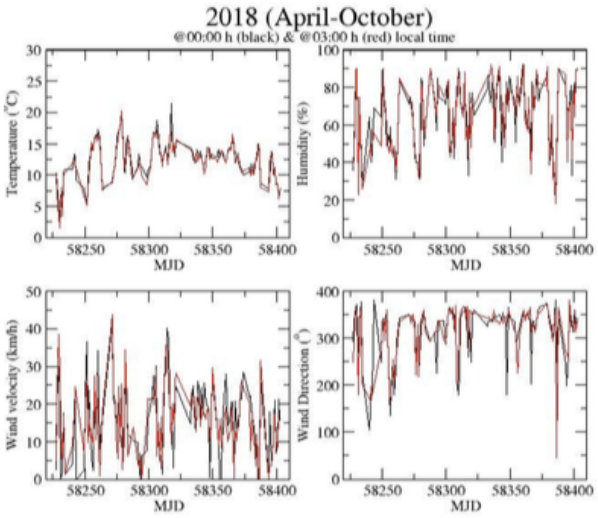
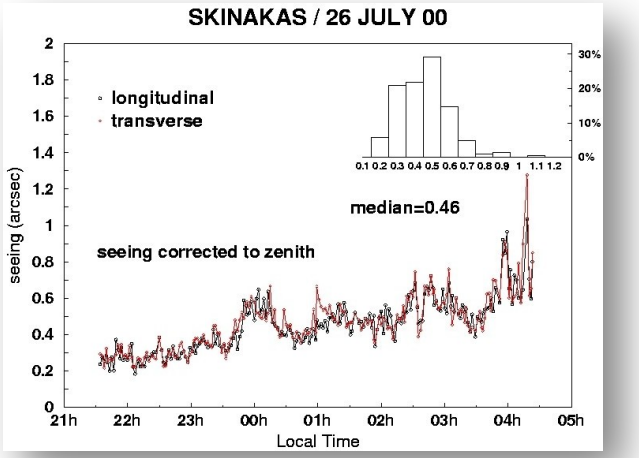
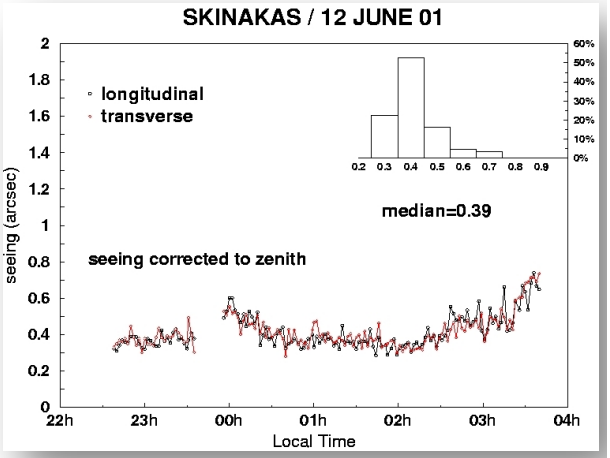


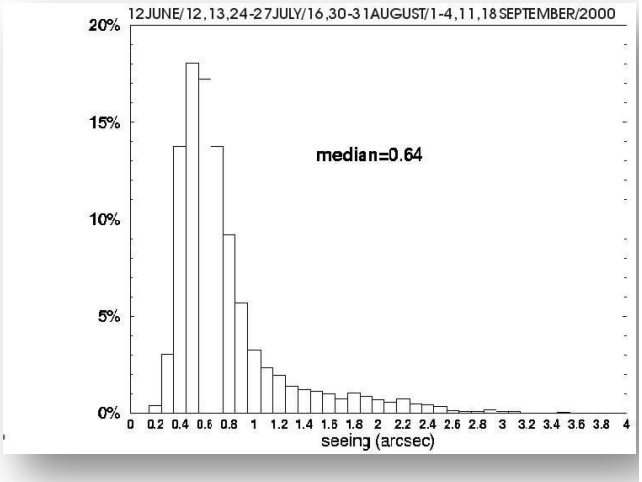
Figure 4: Evolution of the weather parameters during the 2018 season at 00:00 h (black line) and 03:00 h (red line) local time.

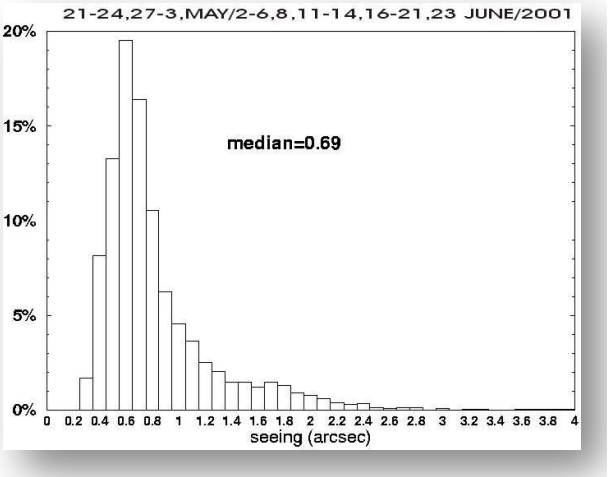
Seeing

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, probably one of the best known so far in the Mediterranean area. The seeing observations 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). Examples of two such nights of the Skinakas DIMM measurements are shown in the figures below. 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.









Extinction

Atmospheric extinction is the astronomical parameter that evaluates sky transparency. Sources causing degradation if of the sky transparency are clouds (water vapor) and aerosols (dust particles included). The 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): 0.26 ± 0.06 for B, 0.17 ± 0.03 for V, 0.13 ± 0.04 for R, and 0.09 ± 0.06 for I.

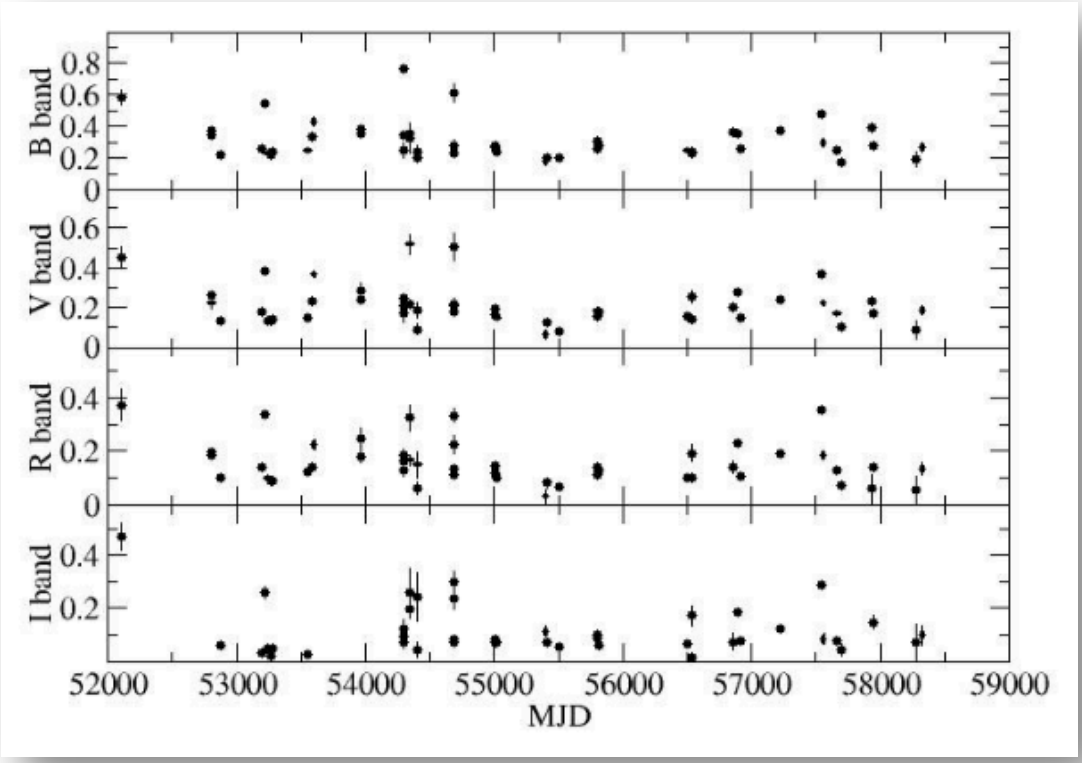


Figure 5: Evolution of the extinction coefficient with time.

Night Sky Brightness and Spectrum

Night sky BVR brightness observations were conducted in August 2008 and revealed that Skinakas Observatory is a dark site, with the exception of the direction towards the city of Heraklion (North East). The night sky surface brightness towards zenith was found to be $B_z = 22.55$, $V_z = 21.74$, $R_z = 21.18$ mag/arcsec^2.

When a zenith correction was applied to the sky magnitudes, the mean values of the night sky surface brightness (over all sky pointings used) were <B>=22.36 ± 0.16, <V> =21.60 ± 0.14, <R>=21.07 ± 0.14 mag/arcsec^2. For further details, see here.

The night sky spectrum at Skinakas, along with an estimate of the contribution of the light pollution lines to the sky brightness can be found here.