Planning and site selection of the new 6.5m Egyptian Large Optical Telescope (ELOT)

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Astronomy in Egypt

- Astronomy department follows NRIAG and has about ~70 Astronomers & Engineers.

- In addition, Egypt has 3 universities teaching astronomy.

Abbasia Observatory since 1872

Helwan Observatory 1907

Kottamia 1964

Kottamai 1.88m Telescope

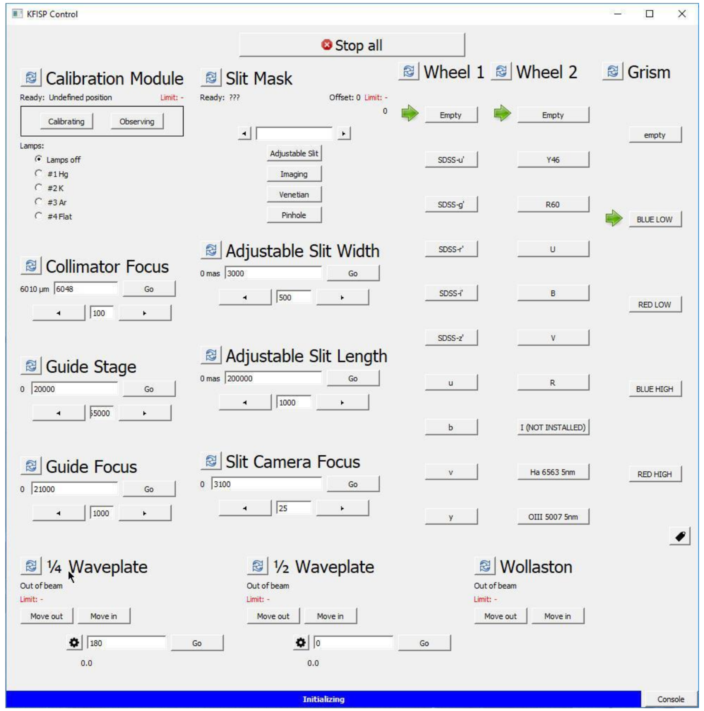
It is the only one (with this size) in the middle east and the second in Africa

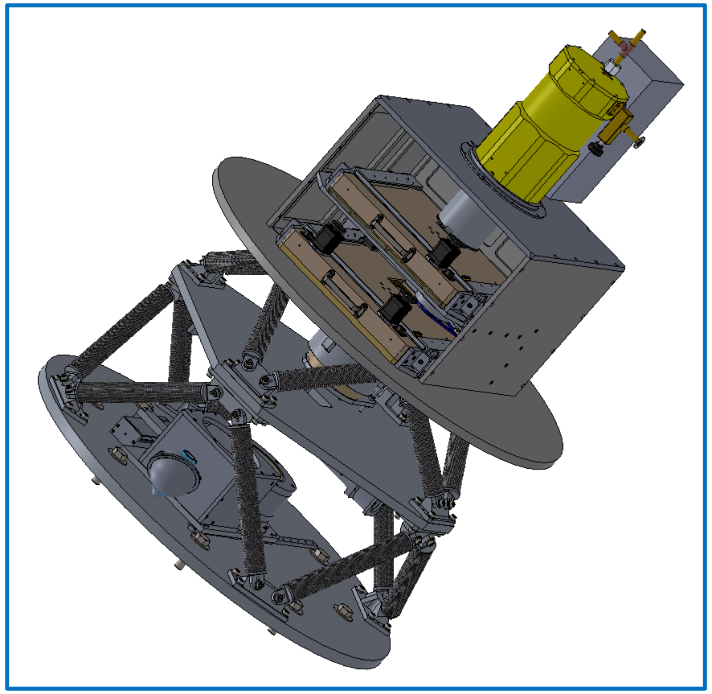
Parameters of the KAO's Foci

Focus	Focal length (m)	F-number	Plate scale (arcsec/mm)
Newtonian	9.15	4.9	22.53
Cassegrain	33.98	18	6.09
Coude	54.29	28.9	3.8

Kottamia Faint Object Imaging Spectro-Polarimeter (KFISP)

- Is attached to the Cassegrain focus.
- Is used for direct imaging, spectroscopy and polarimetry.

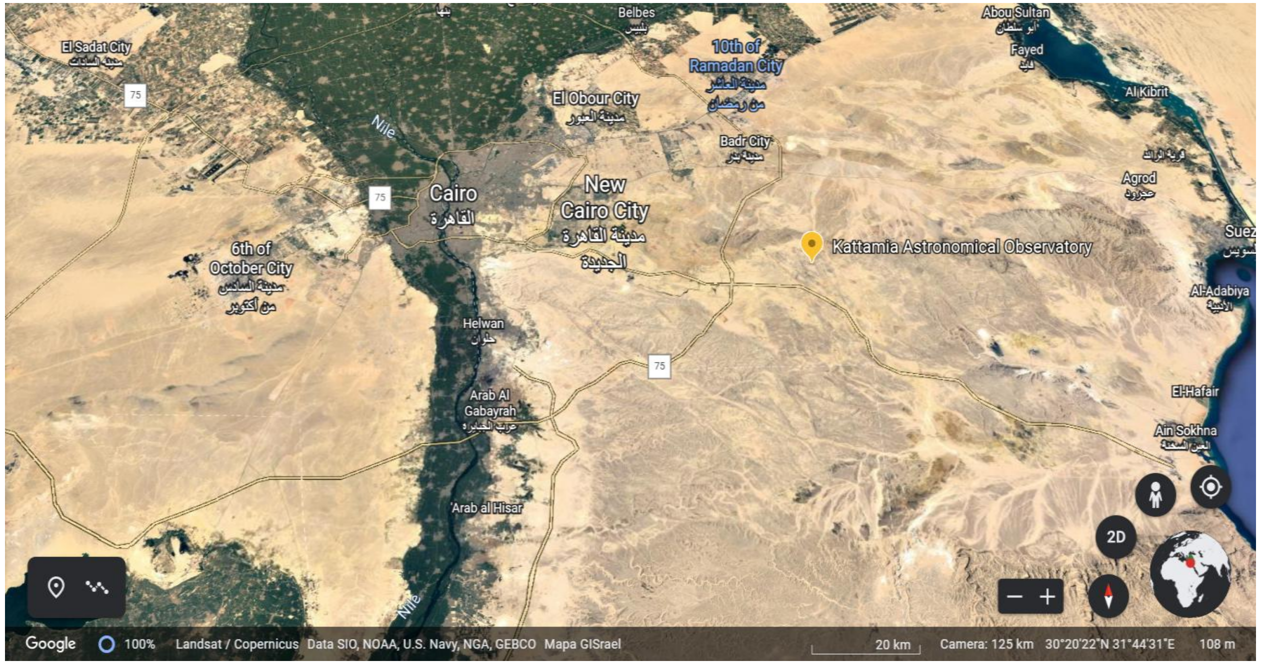


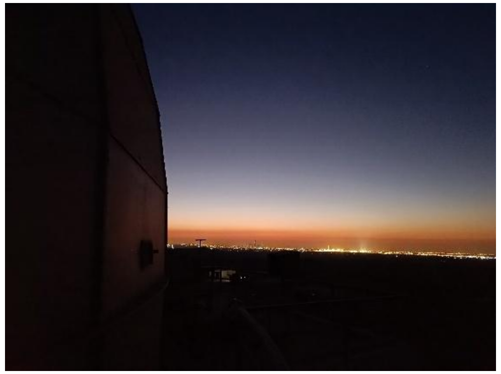


The optical system has a focal reducer, that turns the f/18 beam into an f/6 beam

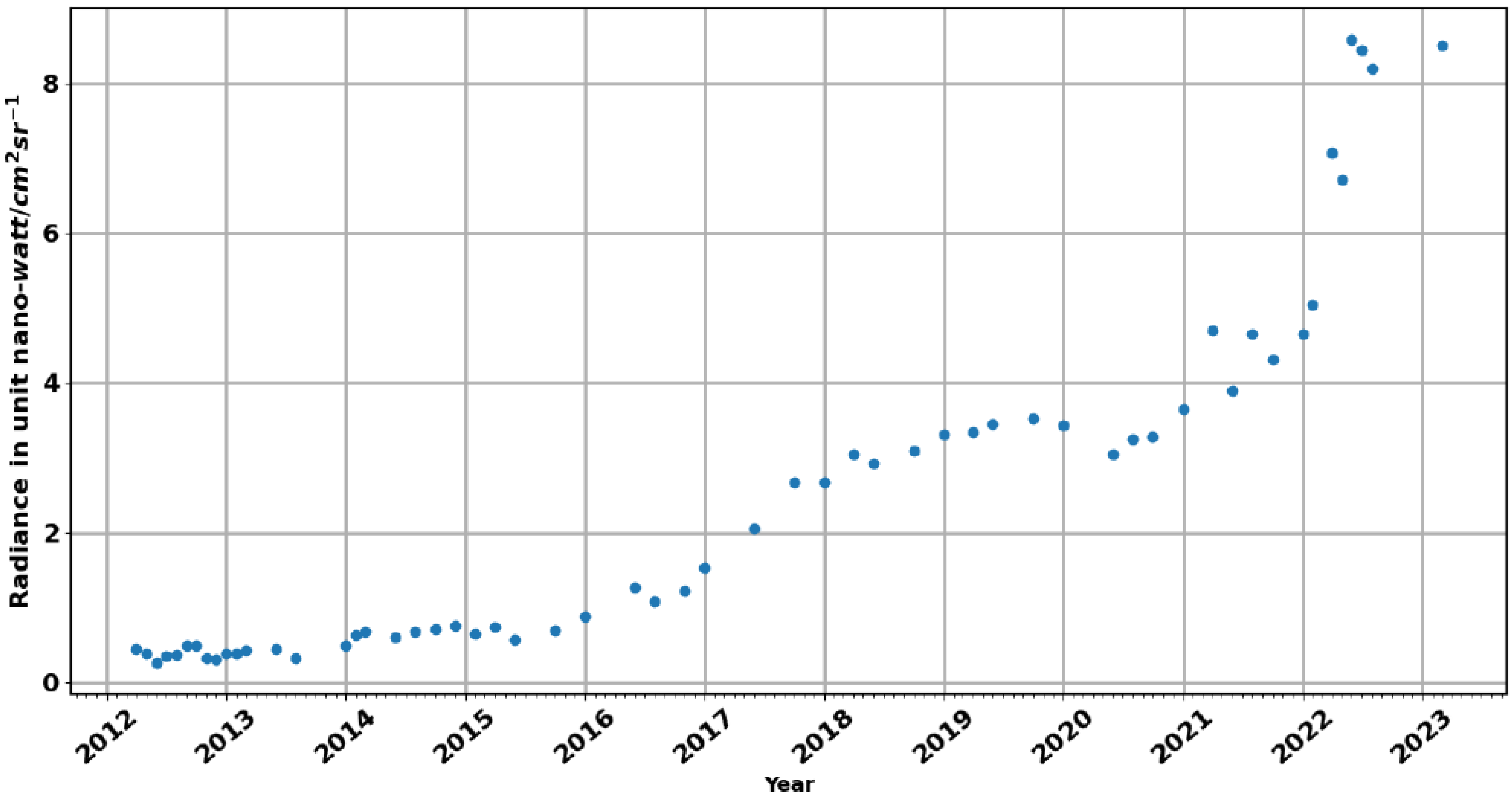
Why (ELOT) ?

The Egyptian government starts constructing a new adminstrative capital west of KAO.

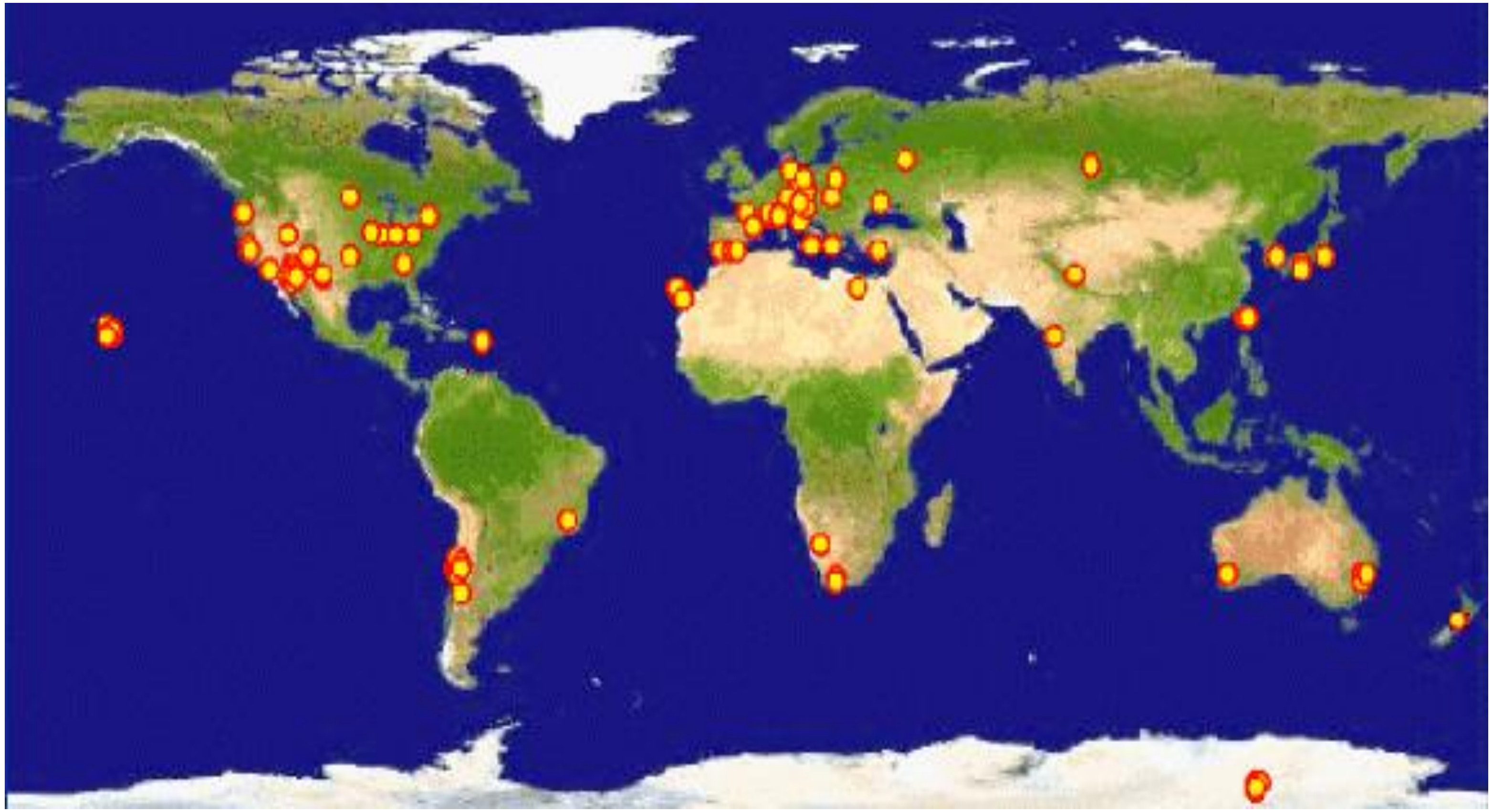




Evolution of Sky brightens above KAO



- To fill in the gap between Asia and America and between Europe and South Africa.
- To be as a regional telescope for the MENA region.



Previous studies about MENA and Egypt

- FriOwl Report on searching for ELT candidate site.
- Gassoum, Alsaeed and Abdelhafiz ,2014, The Observatory.
- Abdelaziz et. al., 2017, Journal of Physics Conference Series.
- Aksaker N., et.al., 2020, Global Site Selection for Astronomy, MNRAS, 493, 1204.

Previous studies about MENA and Egypt

FriOwl Report on searching for E-ELT candidate site

Proc. of SPIE Vol. 7012, 70121Y, (2008)

Site selection for Extremely Large Telescopes using the FriOWL software and global re-analysis climate data

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5. CONCLUSIONS

The FriOWL software has demonstrated its use in site selection studies in terms of (i) being a single portal for a large database of long-term global climatic and geophysical data information, and in (ii) providing the means to investigate, study, analyse and manipulate the data.

Egypt and the Sinai Peninsula, including the whole area surrounding the Gulf of Aqaba (Eilat) has been identified as possible candidate region for large telescope projects, an area which remains largely unexploited to date. Several mountain peaks reach above 2,000 metres elevation in this region. Summertime cloudiness in this area is the lowest of anywhere in the world and integrated water vapour values at 700 hPa may approach those of the southern Atacama in Chile at the same elevation.

Previous studies about MENA and Egypt

- Gassoum, Alsaeed and Abdelhafiz ,2014, The Observatory.

PRELIMINARY SEARCH FOR ASTRONOMICAL OBSERVATORY SITES IN THE MENA REGION

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American University of Sharjah, Sharjah, United Arab Emirates

Following a recent *Nature* article[1], where the extreme dearth of astronomical observatories in the Arab world was decried and the construction of new ones was recommended as a prime solution for the renaissance of Arab astronomy, we conduct a 'theoretical' search for the most promising astronomical observatory sites in the Middle East & North Africa (MENA) region. We first establish the criteria that characterize observatory sites in the world, which we divide into: (*i*) atmospheric and environmental factors (air transparency, sky darkness/brightness, number of clear nights per year, humidity, temperature profile, and winds), and (*ii*) physical factors (obstructions, risk factors, access to infrastructure). Starting with MENA locations with altitudes higher than 1500 m, we subject each to the above criteria using data found on-line or reconstructed with some reasonable assumptions. We thus rule out those locations with unsatisfactory characteristics, *i.e.*, too much light pollution (from proximity to cities), too low a percentage of clear nights, too high a humidity level, or excessive diurnal temperature ranges. We are left with seven sites (from among 14, originally) that we deem suitable for professional astronomical observatories and which we rank in decreasing overall quality:

TABLE II

Weather conditions of best nine locations

Location	*Percentage of Usable Nights per Year**	*Relative Humidity (%)*† *High*	*Relative Humidity (%)*† *Low*	*Wind Speed (m/s)*	*Diurnal temperature variation (°C)*‡
South Sinai	82%	45 – 74	16 – 33	0 – 7	12·08
Hejaz Mountains	80%	42 – 77	10 – 32	0 – 7	13·67
Wadi Rum	72%	84 – 93	41 – 58	0 – 7	9·33
Marrah Mountains	60%	45 – 97	11 – 63	0 – 6	16·95
Ahaggar Mountains	57%	24 – 50	10 – 20	0 – 6	15·08
Cheekha Dar	56%	73 – 94	26 – 67	0 – 7	13·04
Aures Mountains	55%	67 – 91	18 – 51	0 – 9	12·34
Atlas Mountains	51%	81 – 94	21 – 42	0 – 7	12·67
Moyen Atlas	36%	68 – 92	24 – 52	1 – 6	3·67

*Obtained from weatherspark.com
†Obtained from worldweatheronline.com
‡Obtained from the plots in Fig. 1.

Previous studies about MENA and Egypt

- Abdelaziz et. al., 2017, Journal of Physics Conference Series.

Search for Best Astronomical Observatory Sites in the MENA Region using Satellite Measurements

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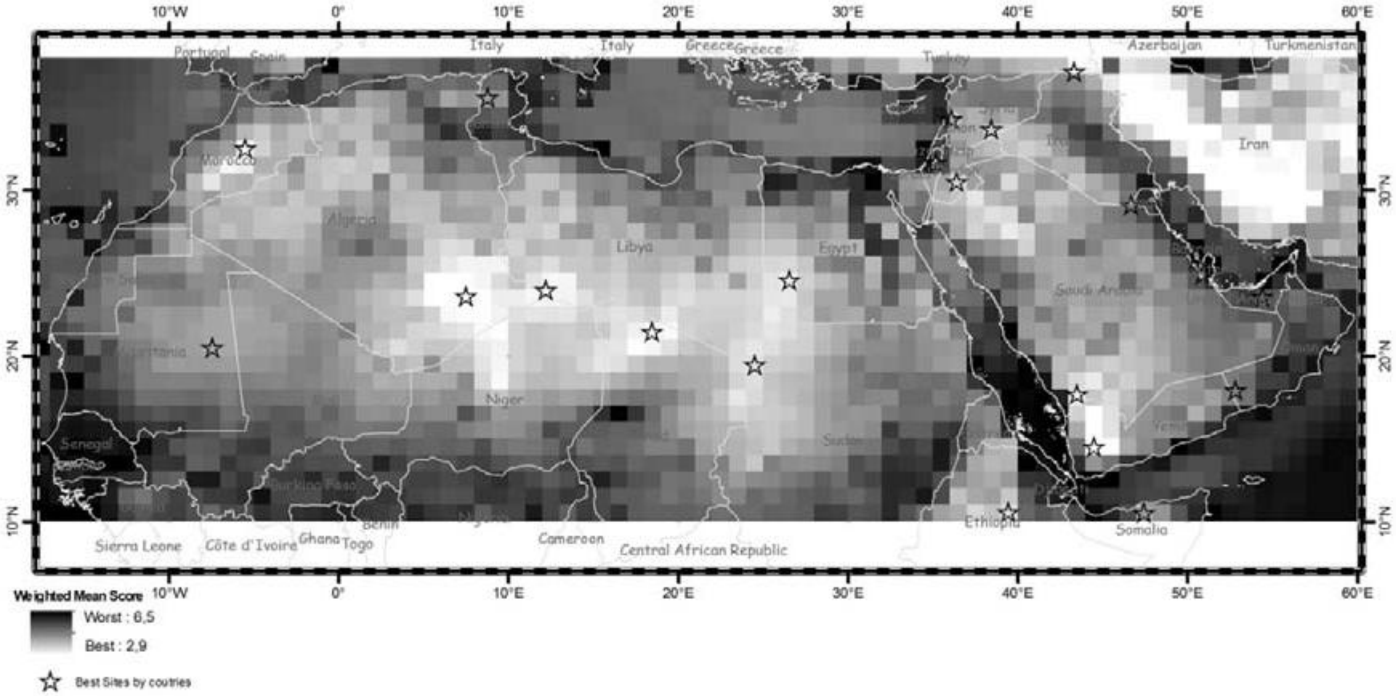
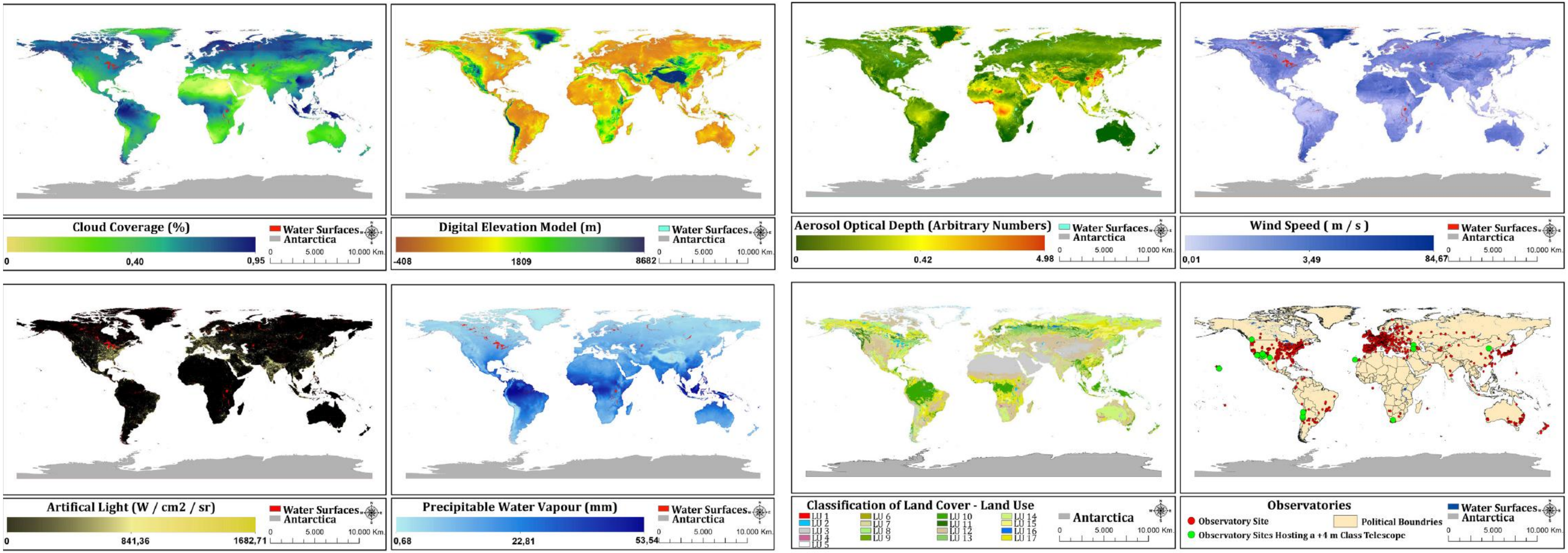
Abstract. We perform a systematic search for astronomical observatory sites in the MENA (Middle-East and North Africa) region using space-based data for all the relevant factors, i.e. altitude (DEM), cloud fraction (CF), light pollution (NTL), precipitable water vapor (PWV), aerosol optical depth (AOD), relative humidity (RH), wind speed (WS), Richardson Number (RN), and diurnal temperature range (DTR). We look for the best locations overall even where altitudes are low (the threshold that we normally consider being 1,500 m) or where the combination of the afore-mentioned determining factors had previously excluded all locations in a given country.
In this aim, we use the rich data that Earth-observing satellites provide, e.g. the Terra and Aqua multi-national NASA research satellites, with their MODIS (Moderate Resolution Imaging Spectroradiometer) and AIRS (Atmospheric Infrared Sounder) instruments, the Defense Meteorological Satellite Program's Operational Linescan System (DMSP-OLS), and other products from climate diagnostics archives (e.g. MERRA).
We present preliminary results on the best locations for the region.



Previous studies about MENA and Egypt

- Aksaker N., et.al., 2020, Global Site Selection for Astronomy, MNRAS, 493, 1204.



Global Site Selection for Astronomy

- Aksaker N., et.al., 2020, Global Site Selection for Astronomy, MNRAS, 493, 1204.

ABSTRACT

A global site selection for astronomy was performed with 1 km spatial resolution (~1 gigapixel in size) using long-term and up-to-date datasets to classify the entire terrestrial surface of the Earth. Satellite instruments are used to get the following datasets of geographical information system (GIS) layers: cloud coverage, digital elevation model, artificial light, precipitable water vapour, aerosol optical depth, wind speed, and land use and land cover. A multi-criteria decision analysis (MCDA) technique is applied to these datasets, creating four different series where each layer will have a specific weight. We introduce for the first time a suitability index for astronomical sites (SIAS). This index can be used to find suitable locations and to compare different sites or observatories. The midwestern Andes in South America and the Tibetan Plateau in western China were found to be the best in all SIAS series. Considering all the series, less than 3 per cent of all terrestrial surfaces are found to be the best regions to establish an astronomical observatory. In addition to this, only approximately 10 per cent of all current observatories are located in good locations in all SIAS series. Amateurs, institutions or countries aiming to construct an observatory could create a shortlist of potential site locations using a layout of SIAS values for each country without spending time and budget. The outcomes and datasets of this study have been made available through a website, the Astro GIS Database, at www.astrogis.org.

Global Site Selection for Astronomy

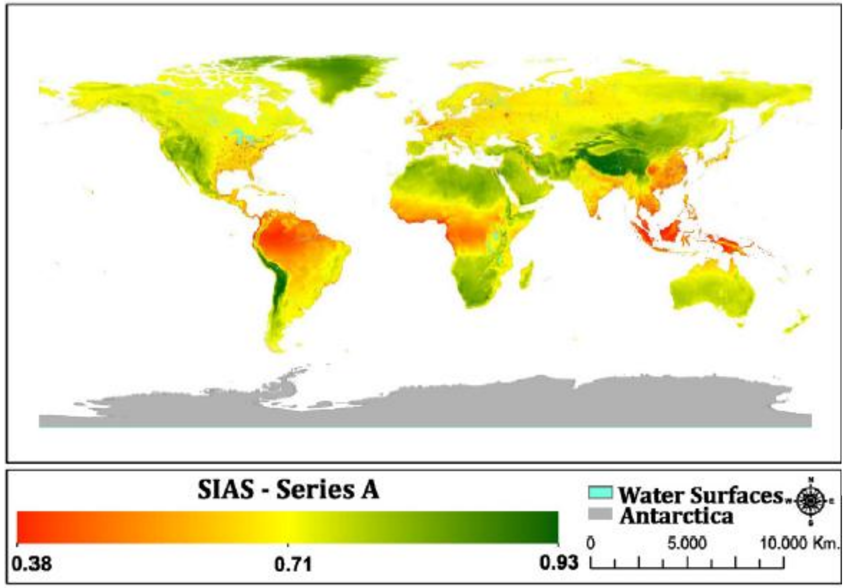
- Aksaker N., et.al., 2020, Global Site Selection for Astronomy, MNRAS, 493, 1204.

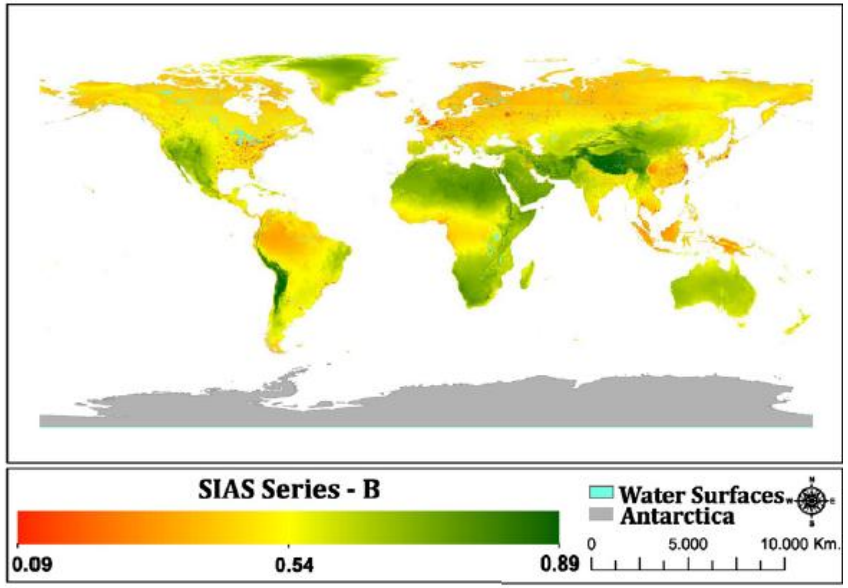
Table 4. Series created by MCDA analysis for the layers discussed above. In each series a weight is given to each targeted layer. In all four series created, the layer lists of earlier works were modified in this work.

SIAS series	CC	DEM	AL	PWV	AOD	WS
A	1	1	1	1	1	1
B	1	1	1	–	–	–
C	2	1	1	–	–	–
D	1	2	1	–	–	–

	Stat. of the series				Sigma level Observatories (N) – ratio (per cent) Surface area ($\times 10^6$ sq km) – ratio to total land (per cent)					
Series	Min	μ	σ	Max	$\mu + 1\sigma$		$\mu + 2\sigma$		$\mu + 3\sigma$	
A	0.38	0.71	0.05	0.93	0.77		0.82		0.87	
					205	9.66	37	1.74	3	0.14
					63.80	37.38	19.59	11.47	3.79	2.22
B	0.09	0.54	0.08	0.89	0.62		0.70		0.77	
					219	10.32	39	1.84	10	0.47
					43.26	25.35	27.87	16.33	3.67	2.15
C	0.09	0.54	0.10	0.87	0.63		0.73		0.83	
					235	11.07	43	2.03	1	0.05
					41.67	24.42	29.36	17.20	4.08	2.39
D	0.07	0.44	0.07	0.92	0.51		0.58		0.66	
					239	11.26	89	4.19	10	0.47
					45.18	26.47	22.53	13.20	5.13	3.01

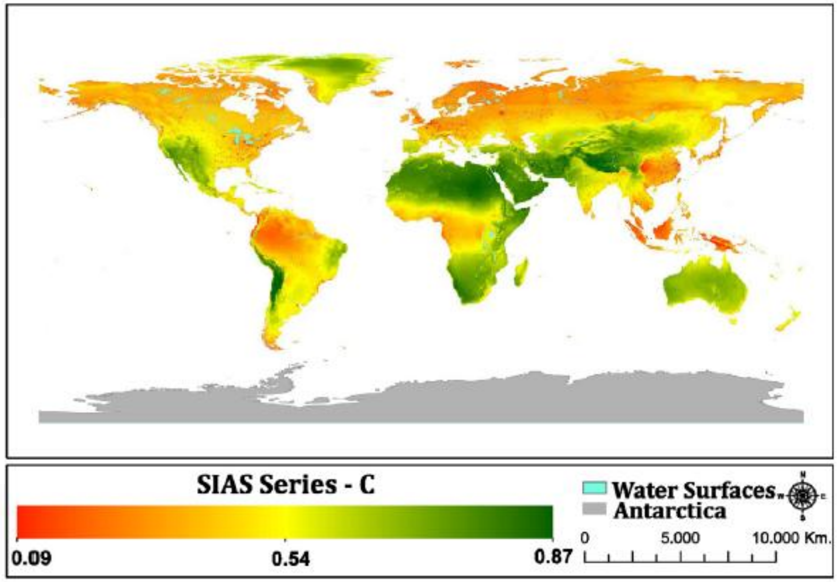
Global Site Selection for Astronomy

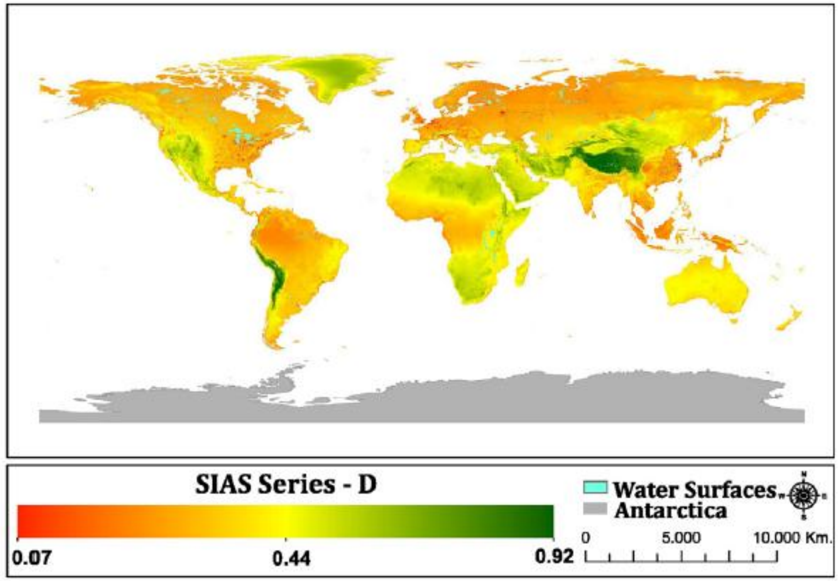




(iv) A quick visual search of the results shown in Fig. 3 can be summarized as follows. The *best* locations with maximum SIAS values in all series, corresponding to regions with dark-green shading and $\geq 3\sigma$ level, are (a) the midwestern Andes in South America, (b) the Tibetan Plateau in western China.

(v) Similarly, *good* locations will have SIAS values corresponding to regions with light-green shading and 2σ level are (a) Greenland, (b) western North America, (c) Iran and the Arabian Peninsula, (d) western South America, (e) the northern, Middle Eastern and southern regions of Africa.





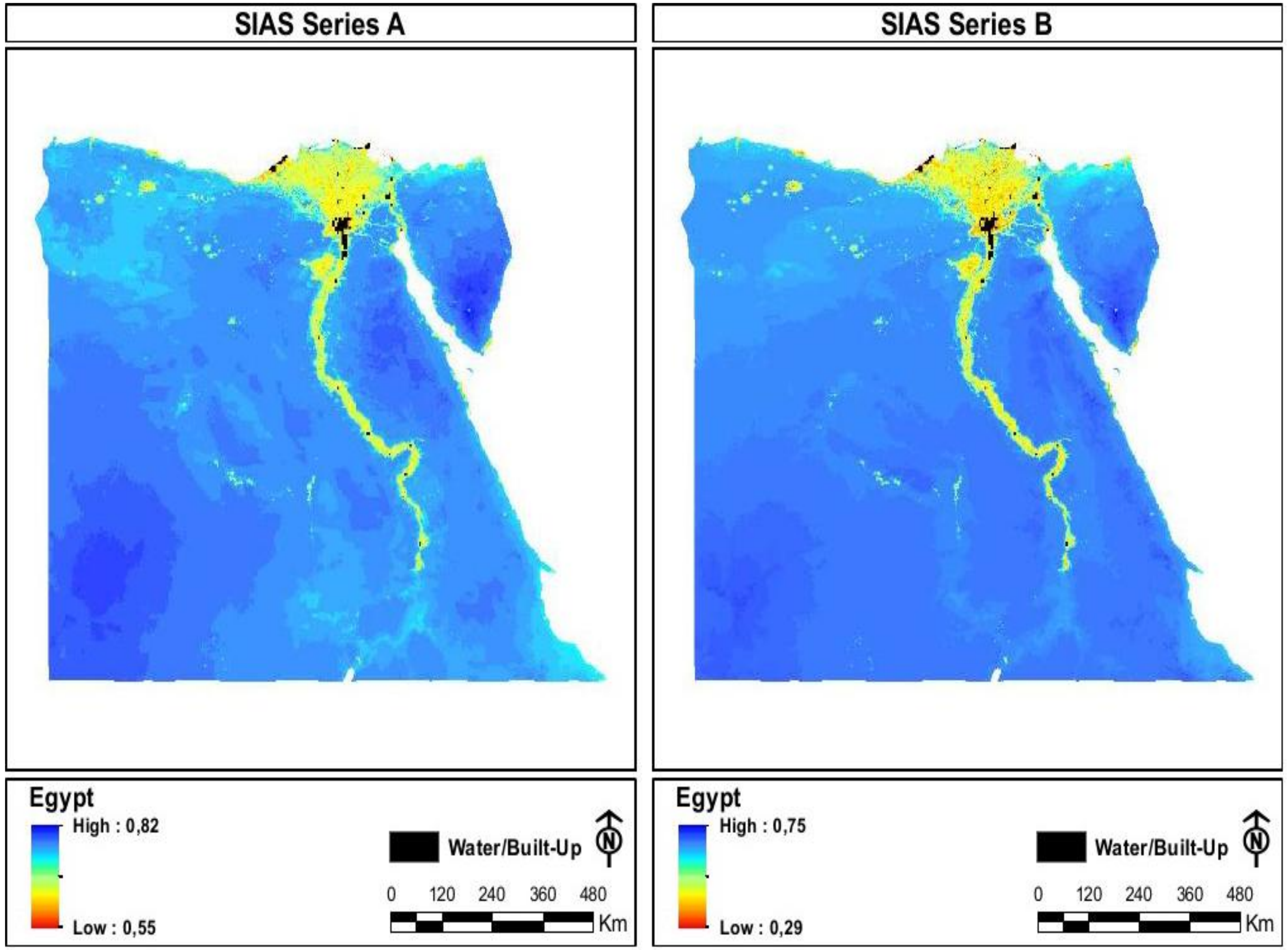
Actions adopted for Egyptian sites

SIAS B > μ + 2σ

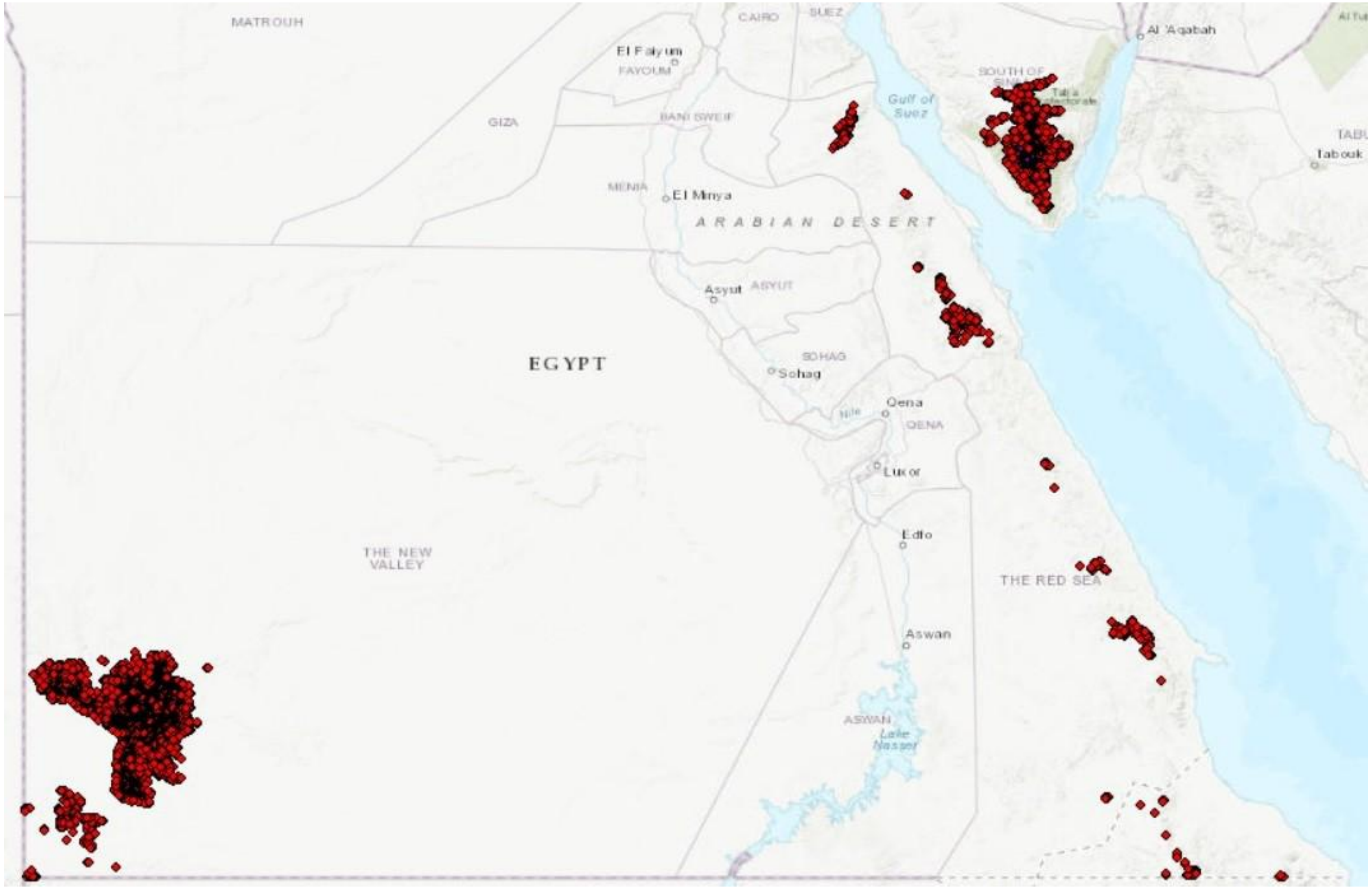
SIAS B [0.70-0.75]

DEM > [824-2500] m

~ 10 Sites



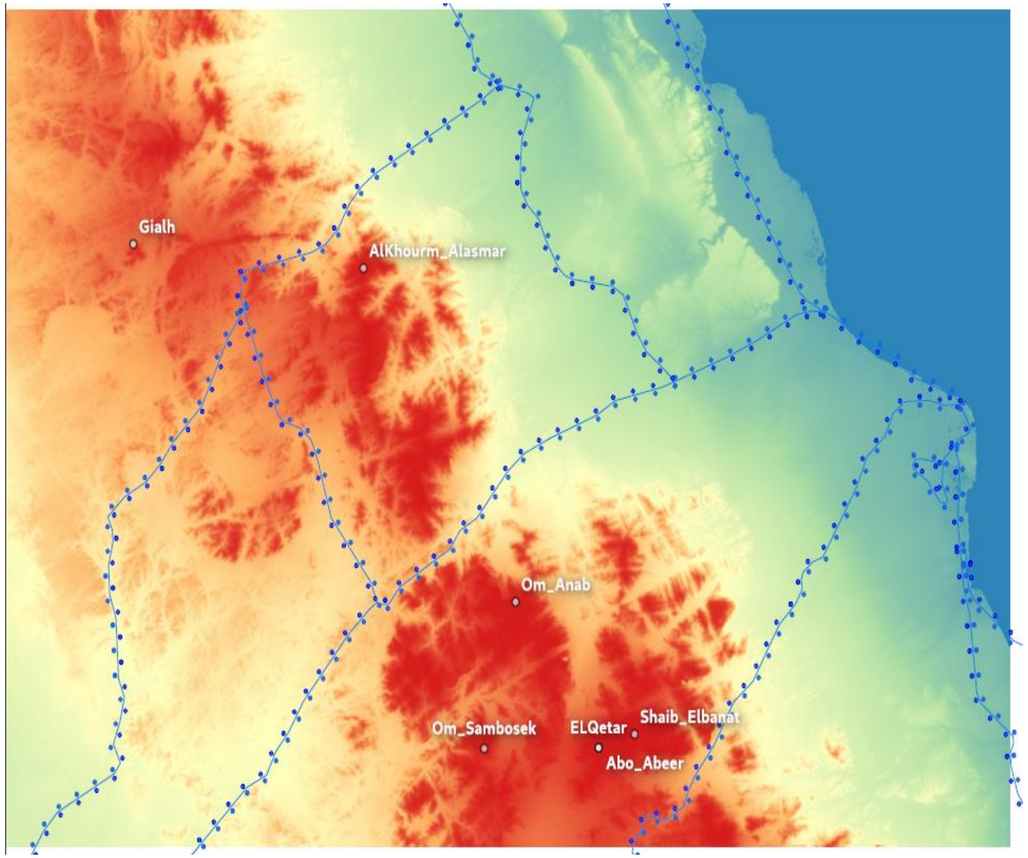
Good candidate sites in Egypt



Good candidate sites in Egypt

Eastern Desert Mountains

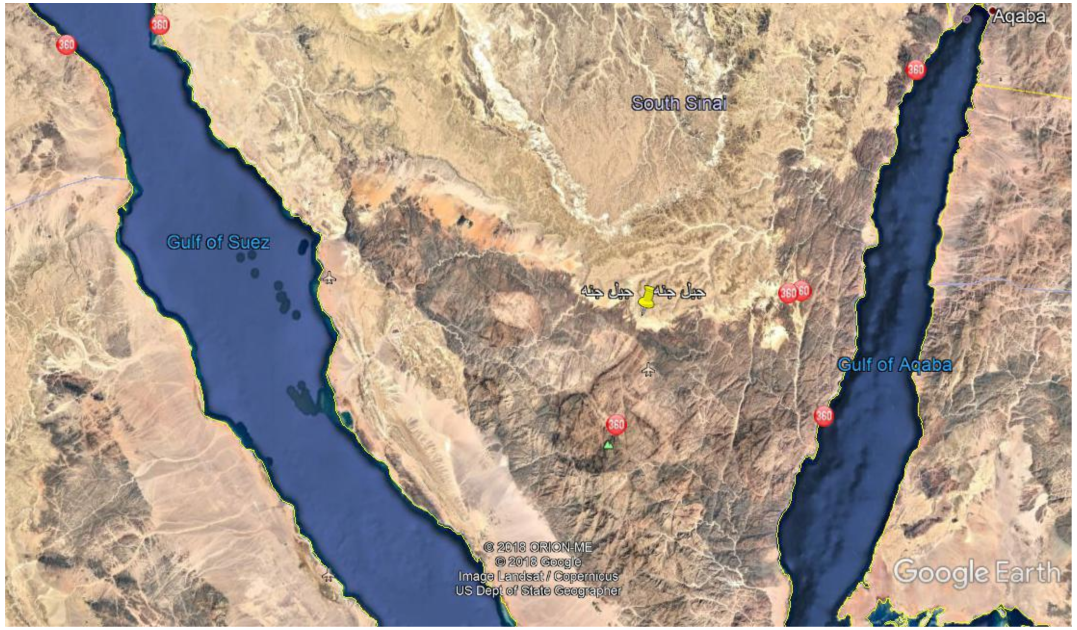
Height in meter	Coordinates		Mountain Name	م
	Latitude	Longitude		
2100	26.978605	33.487795	جبل شايب البنات	1
1283	22.7185	34.696	جبل مشبح	2
1381	**27.470417**	**33.011806**	**Zubair Mountain**	3
1631	27.027083	33.286250	جبل أم ديسة	4
1937	27.090417	33.363472	جبل القطار	5
1432	27.061250	33.253194	جبل الثلمة	6
1531	26.966806	33.333522	جبل أم سميوك	7



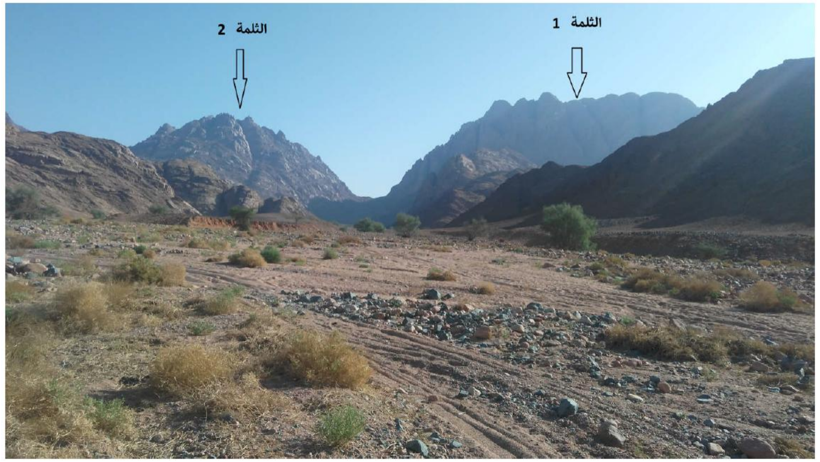
Good candidate sites in Egypt

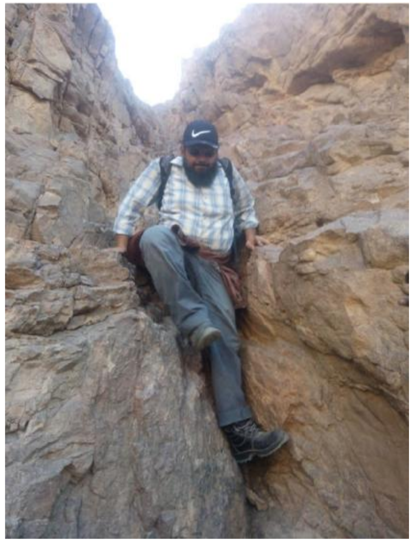
South of Sinai Mountains

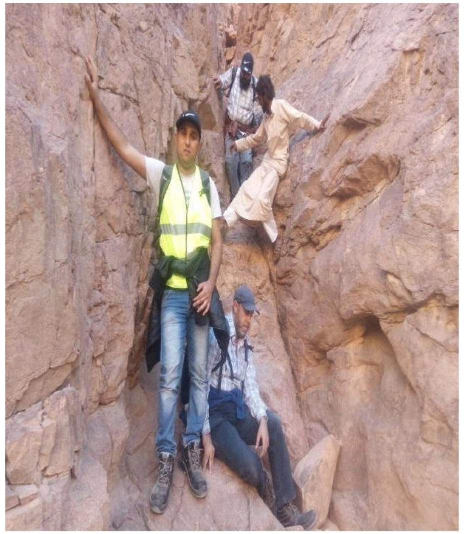
Height in meter	Coordinates		Mountain Name	م
	Latitude	Longitude		
1583	28.48357	34.06	جبل جنة	1
1612	28.53284	33.54516	جبل الضلل	2
1626	29.045706	33.910842	Rojoom Mountain	3



Field Trips to candidate sites







Field Trips to candidate sites






Candidate sites' multi-parameter study

Criteria affecting site location

- Digital Elevation Model (DEM)
- Cloud Coverage.
- Air Temperature.
- Wind Speed and Direction.
- Relative Humidity.
- Precipitable Water Vapor (PWV)
- Aerosols (AOD).
- Sky Brightness.

Other factors

- Sky brightness and light pollution.
- Site accessibility and seismic hazards

Meteorological satellite observations Atmospheric Reanalysis Projects.

ERA-5 Reanalysis (ECMWF) covers more than 40 years of grided data, with spatial resolution about 30 km and hourly temporal intervals.

Monthly Notices of the ROYAL ASTRONOMICAL SOCIETY

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Multiparameter study for a new ground-based telescope in Egypt

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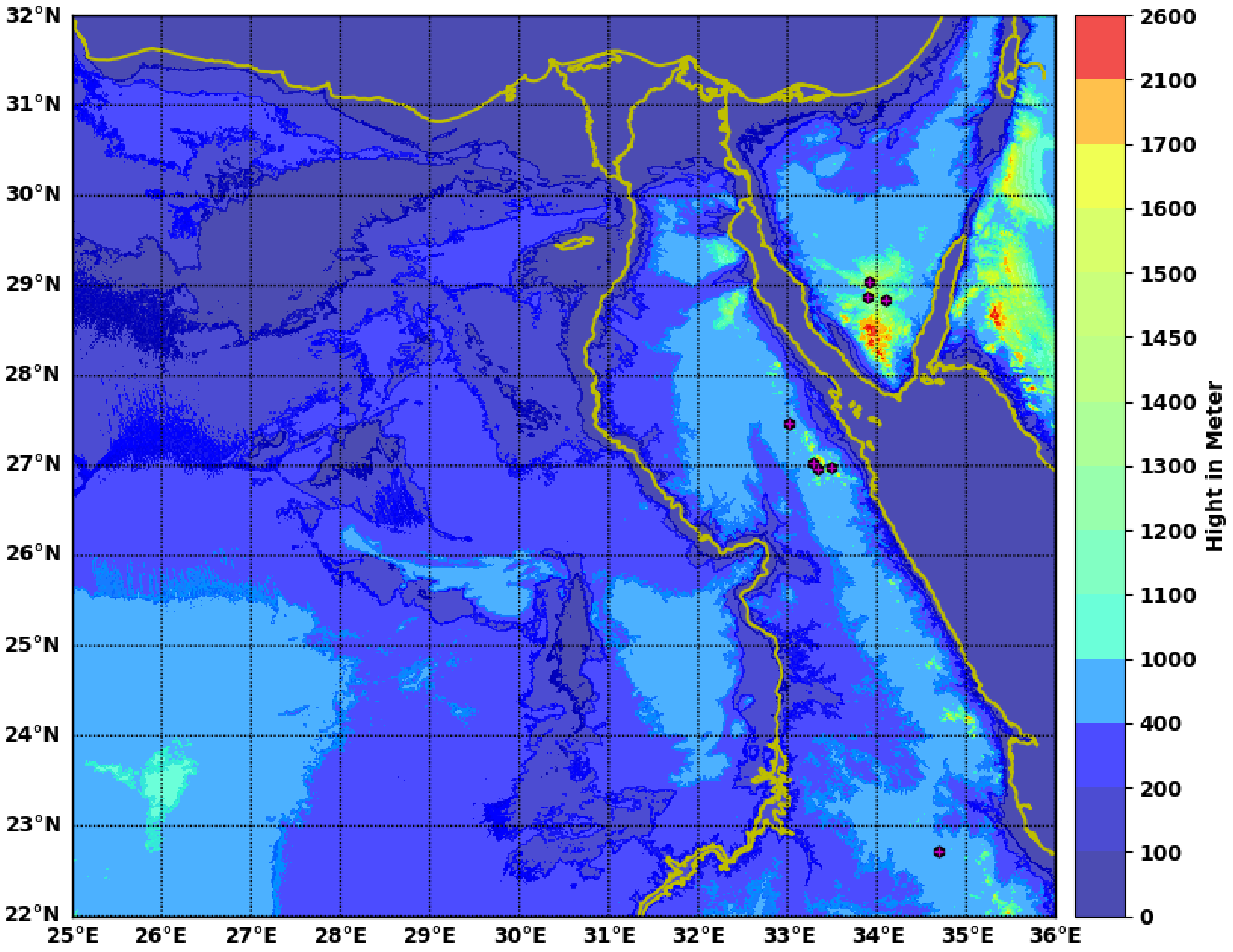
Digital Elevation Model (DEM)

- Elevation (> 1000 m)
- Site accessibility distance from the nearest city (≥ 50 km)
- Night Sky Brightness (NSB) fainter than 21.85 mag./arcsec2

Site No.	N Latitude (deg)	E Longitude (deg)	Elevation(m)
1	28.847995	34.096922	1583
2	28.880113	33.891536	1612
3	29.045706	33.910842	1626
4	27.470417	33.011806	1381
5	26.978606	33.487795	2100
6	27.027083	33.28625	1631
7	26.966806	33.332917	1531
8	22.7185	34.696	1315



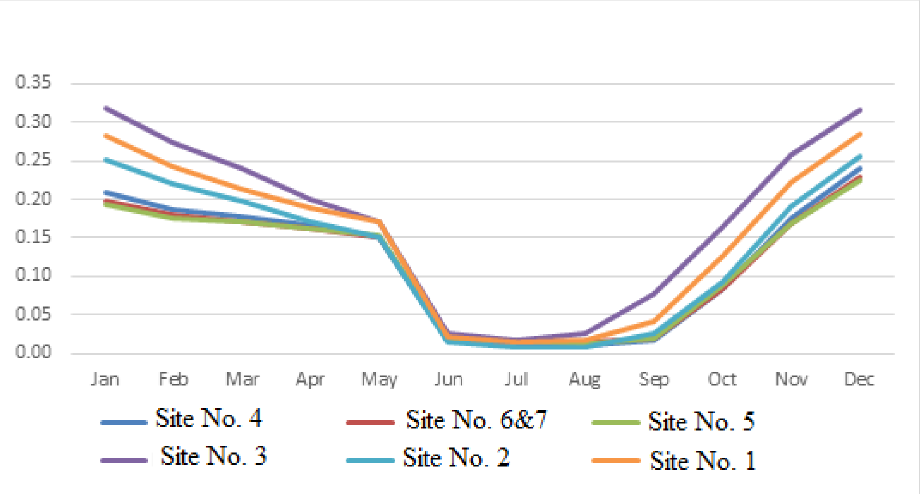
Digital Elevation Model (STRM V3 with spatial resolution 30m)

Total Cloud coverage (TCC)

	Month	Site No. 1	Site No. 2	Site No. 3	Site No. 4	Site No. 5	Site No. 6&7
TCC (fractions)	Jan	0.28	0.25	0.32	0.21	0.19	0.2
	Feb	0.24	0.22	0.27	0.19	0.18	0.18
	Mar	0.21	0.2	0.24	0.18	0.17	0.17
	Apr	0.19	0.17	0.2	0.17	0.16	0.16
	May	0.17	0.15	0.17	0.15	0.15	0.15
	Jun	0.02	0.02	0.02	0.02	0.02	0.02
	Jul	0.01	0.01	0.02	0.01	0.02	0.02
	Aug	0.02	0.01	0.03	0.01	0.01	0.01
	Sep	0.04	0.02	0.08	0.02	0.02	0.02
	Oct	0.13	0.09	0.16	0.08	0.09	0.08
	Nov	0.22	0.19	0.26	0.18	0.17	0.17
	Dec	0.28	0.26	0.32	0.24	0.22	0.23
	Annual	0.15	0.13	0.17	0.12	0.12	0.12

Number of photometric nights for each site during 2019.

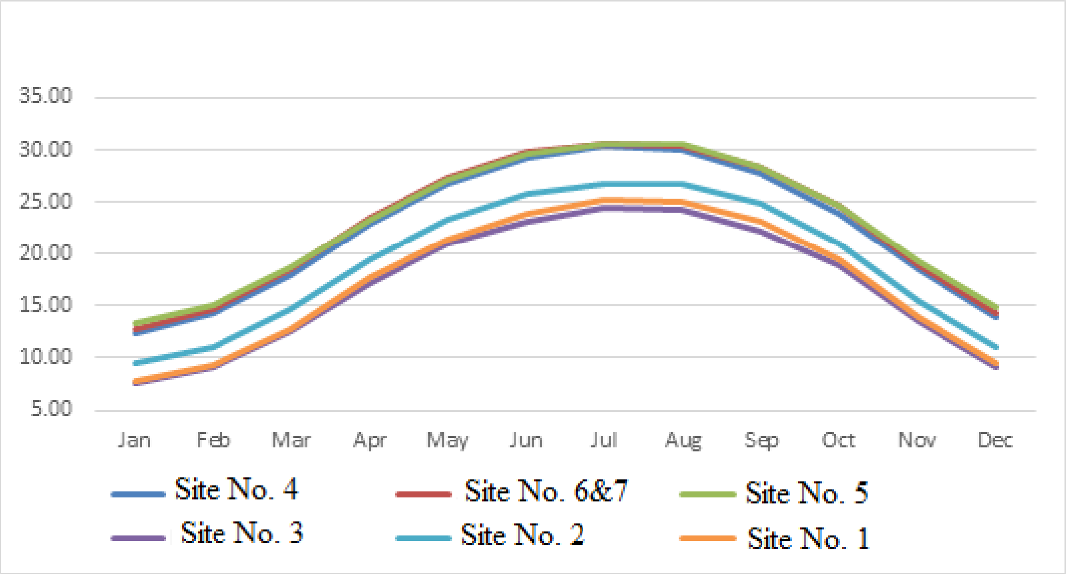
ID	No. of Clear Nights	Ratio
1	289	79.18%
2	302	82.74%
3	276	75.62%
4	294	80.55%
5	290	79.45%
6&7	290	79.45%



Monthly average of the TCC

Air Temperature (AT)

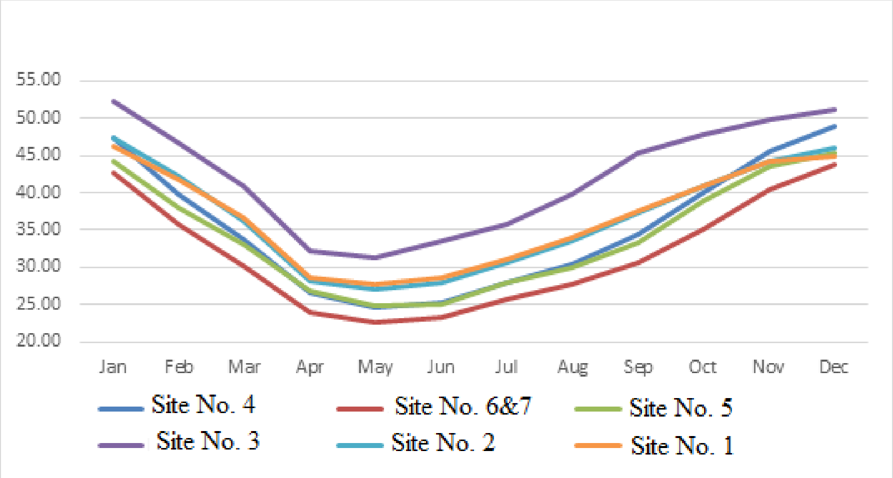
	Month	Site No. 1	Site No. 2	Site No. 3	Site No. 4	Site No. 5	Site No. 6&7
T (°C)	Jan	7.77	9.47	7.63	12.44	13.35	12.83
	Feb	9.28	11.02	9.12	14.27	15.05	14.67
	Mar	12.82	14.61	12.55	18.02	18.62	18.53
	Apr	17.69	19.39	17.25	22.84	23.27	23.47
	May	21.47	23.23	20.96	26.83	27.19	27.4
	Jun	23.87	25.73	23.16	29.29	29.69	29.76
	Jul	25.14	26.78	24.47	30.32	30.64	30.61
	Aug	25.08	26.67	24.26	30.08	30.5	30.4
	Sep	23.19	24.77	22.21	27.76	28.32	28.36
	Oct	19.43	20.96	18.88	23.97	24.56	24.65
	Nov	13.87	15.51	13.6	18.5	19.21	18.99
	Dec	9.48	11.09	9.23	13.9	14.84	14.35
	Annual	17.42	19.1	16.94	22.35	22.94	22.84



Monthly average of the Air Temperature (AT)

Relative Humidity (RH)

	Month	Site No. 1	Site No. 2	Site No. 3	Site No. 4	Site No. 5	Site No. 6&7
RH-2m (%)	Jan	46.33	47.37	52.29	47.33	44.35	42.62
	Feb	41.81	42.24	46.69	39.81	38.09	35.8
	Mar	36.64	36.18	40.82	33.79	33.09	30.26
	Apr	28.59	28.22	32.22	26.71	26.8	23.99
	May	27.73	27.06	31.37	24.7	24.83	22.5
	Jun	28.71	28.02	33.47	25.36	25.07	23.15
	Jul	30.97	30.63	35.83	27.98	27.89	25.77
	Aug	33.9	33.54	39.87	30.35	29.92	27.74
	Sep	37.5	37.33	45.43	34.37	33.35	30.57
	Oct	40.88	40.93	47.77	40.1	39	35.16
	Nov	44.3	44.34	49.82	45.56	43.65	40.45
	Dec	44.95	46.01	51.29	49.02	45.41	43.73
	Annual	36.86	36.82	42.24	35.42	34.29	31.81

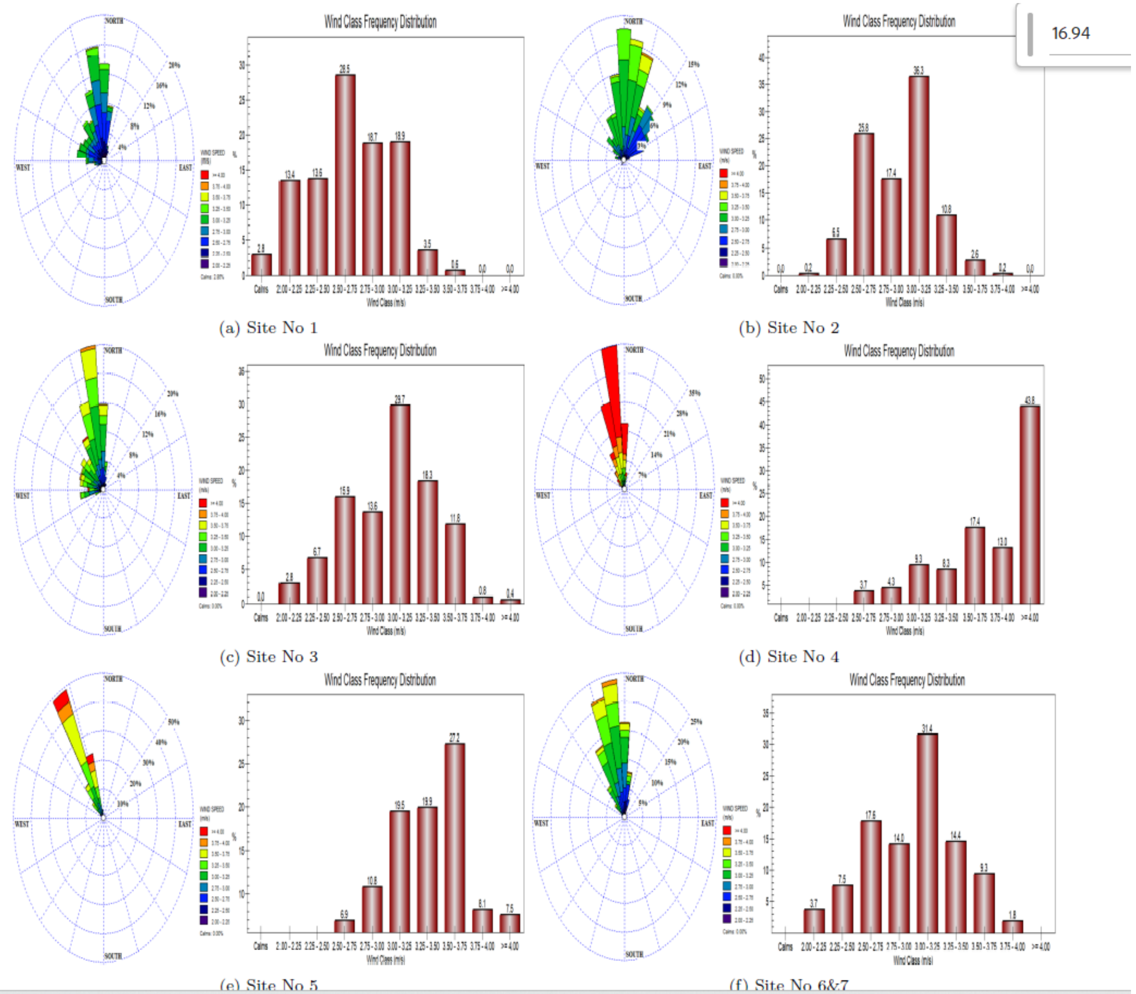


Monthly average of the Relative Humidity (RH)

Wind Speed & Direction

	Month	Site No. 1	Site No. 2	Site No. 3	Site No. 4	Site No. 5	Site No. 6&7
WS-10m (m/s)	Jan	2.42	2.53	2.82	3.35	3.07	2.66
	Feb	2.7	2.67	3.11	3.62	3.26	2.93
	Mar	2.87	2.93	3.23	3.83	3.39	3.12
	Apr	2.92	3.05	3.22	3.89	3.41	3.18
	May	2.99	3.17	3.29	4.14	3.51	3.25
	Jun	3.16	3.4	3.54	4.83	3.96	3.55
	Jul	2.8	3.15	3.27	4.27	3.68	3.22
	Aug	2.68	3.09	3.16	4.3	3.73	3.23
	Sep	2.6	3.08	2.98	4.27	3.57	3.07
	Oct	2.24	2.79	2.53	3.38	3	2.58
	Nov	2.19	2.64	2.51	3.17	2.87	2.47
	Dec	2.24	2.52	2.59	3.21	2.95	2.52
	Annual	2.65	2.92	3.02	3.86	3.37	2.98

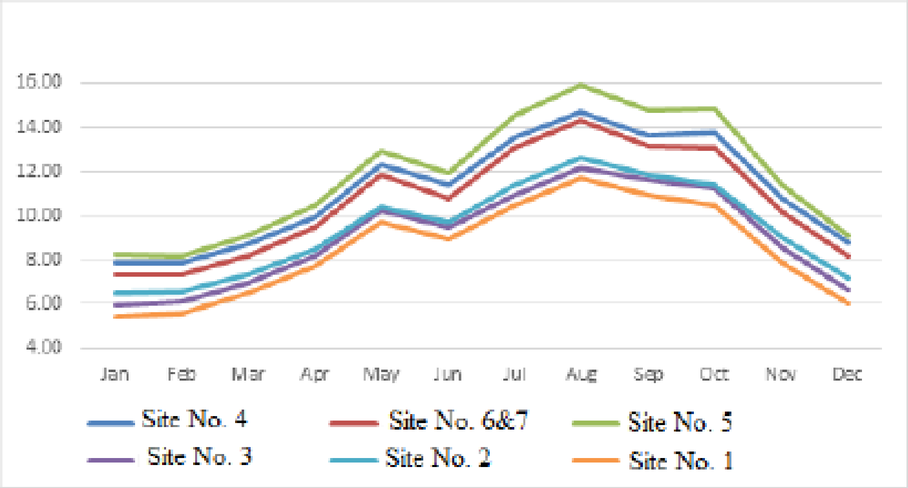
	Month	Site No. 1	Site No. 2	Site No. 3	Site No. 4	Site No. 5	Site No. 6&7
WD-10m (degree)	Jan	283.84	90.16	279.66	322.62	314.13	309.71
	Feb	285.22	196.79	283.7	322.34	316.15	294.94
	Mar	293.69	223.09	294.49	327.41	325.53	293.78
	Apr	304.77	263.96	308.09	271.54	327.28	270.34
	May	320.61	247.03	321.56	272.53	336.81	277.83
	Jun	263.39	118.94	321.25	342.26	335.66	338.99
	Jul	330.43	239.13	343.54	343.2	330.84	333.95
	Aug	299.83	132.62	348.05	342.36	329.27	334.11
	Sep	141.83	36.03	199.03	334.11	332.95	315.34
	Oct	214.16	43.7	229.72	191.15	336.41	169.64
	Nov	173.84	56.23	191.05	287.6	330.63	166.95
	Dec	229	63.81	256.65	324.68	319.47	226.89
	Annual	261.72	142.62	281.4	306.82	327.93	277.71



(a) Site No 1
(b) Site No 2
(c) Site No 3
(d) Site No 4
(e) Site No 5
(f) Site No 6&7

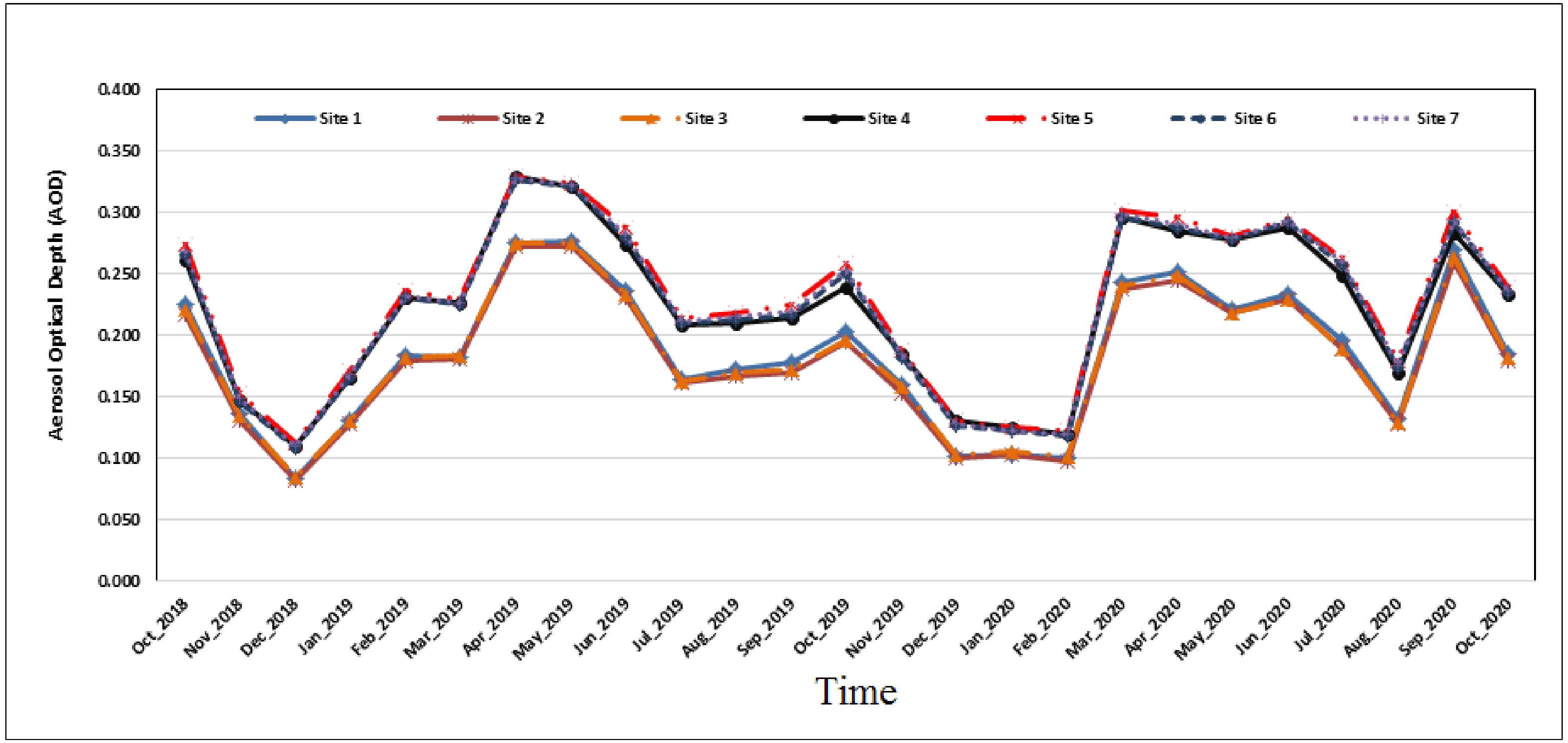
Precipitable Water Vapor (PWV)

	Month	Site No. 1	Site No. 2	Site No. 3	Site No. 4	Site No. 5	Site No. 6&7
PWV (mm)	Jan	5.4	6.48	5.96	7.87	8.23	7.37
	Feb	5.59	6.58	6.12	7.85	8.18	7.36
	Mar	6.48	7.31	6.98	8.69	9.1	8.21
	Apr	7.72	8.47	8.21	9.96	10.48	9.48
	May	9.69	10.42	10.22	12.36	12.95	11.83
	Jun	8.96	9.68	9.46	11.41	11.9	10.8
	Jul	10.5	11.39	10.95	13.54	14.54	13.1
	Aug	11.69	12.61	12.2	14.72	15.92	14.31
	Sep	10.92	11.83	11.6	13.65	14.74	13.17
	Oct	10.45	11.39	11.22	13.76	14.84	13.1
	Nov	7.85	8.99	8.54	10.76	11.42	10.14
	Dec	6.06	7.18	6.68	8.77	9.13	8.18
	Annual	8.44	9.36	9.01	11.11	11.79	10.59

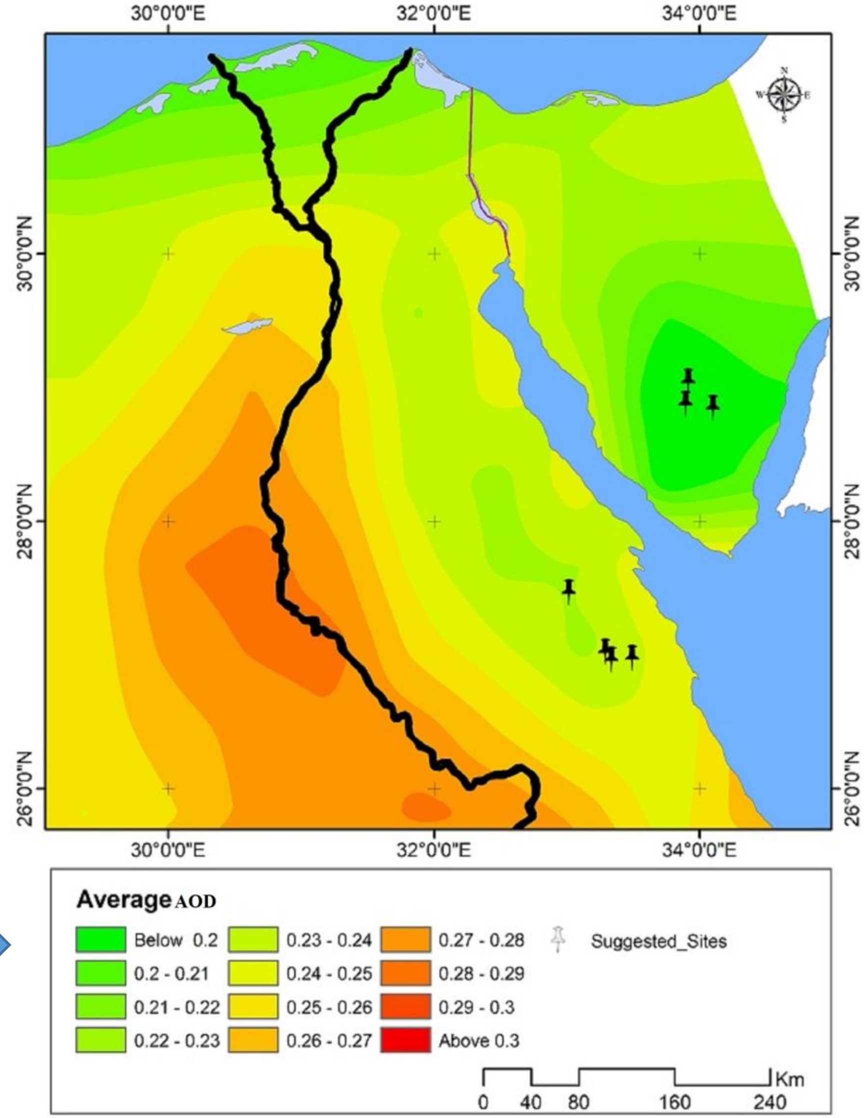


Monthly average of the PWV

Aerosol Optical Depth (AOD)



Average AOD values during the period Oct 2018 – October 2020 at λ= 500 nm



Average distribution of the AOD over Egypt (MERRA-2)

(https://disc.gsfc.nasa.gov/datasets/M2TMNXAER_5.12.4/summary)

Night Sky Brightness

	Rojom	Dhalal	Zubyer	Um symuk	Um disa	Thalama	Rowished
Max	22.1	22	21.88	21.75	21.88	21.66	21.64
Min	21.79	21.47	21.31	21.35	21.32	21.30	21.17
Mean	21.9	21.74	21.67	21.63	21.66	21.48	21.40

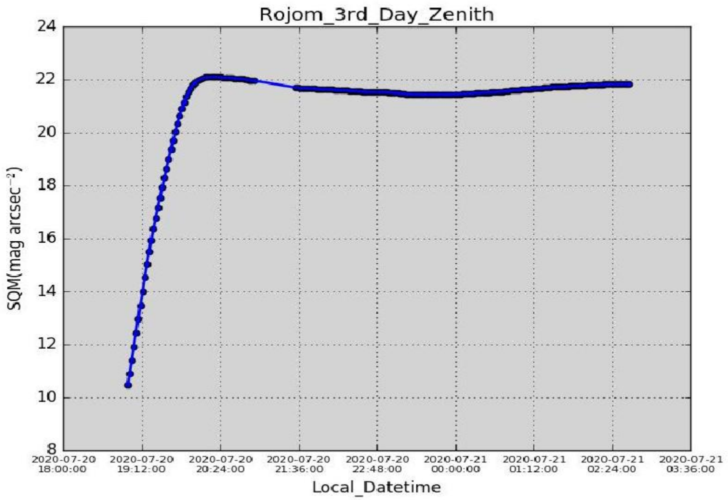
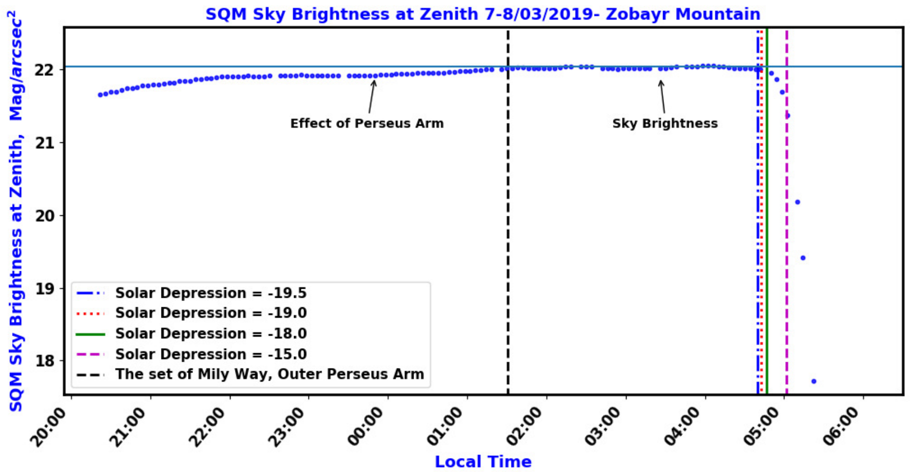


Fig.3 Night sky brightness observed in Rojom mountain.



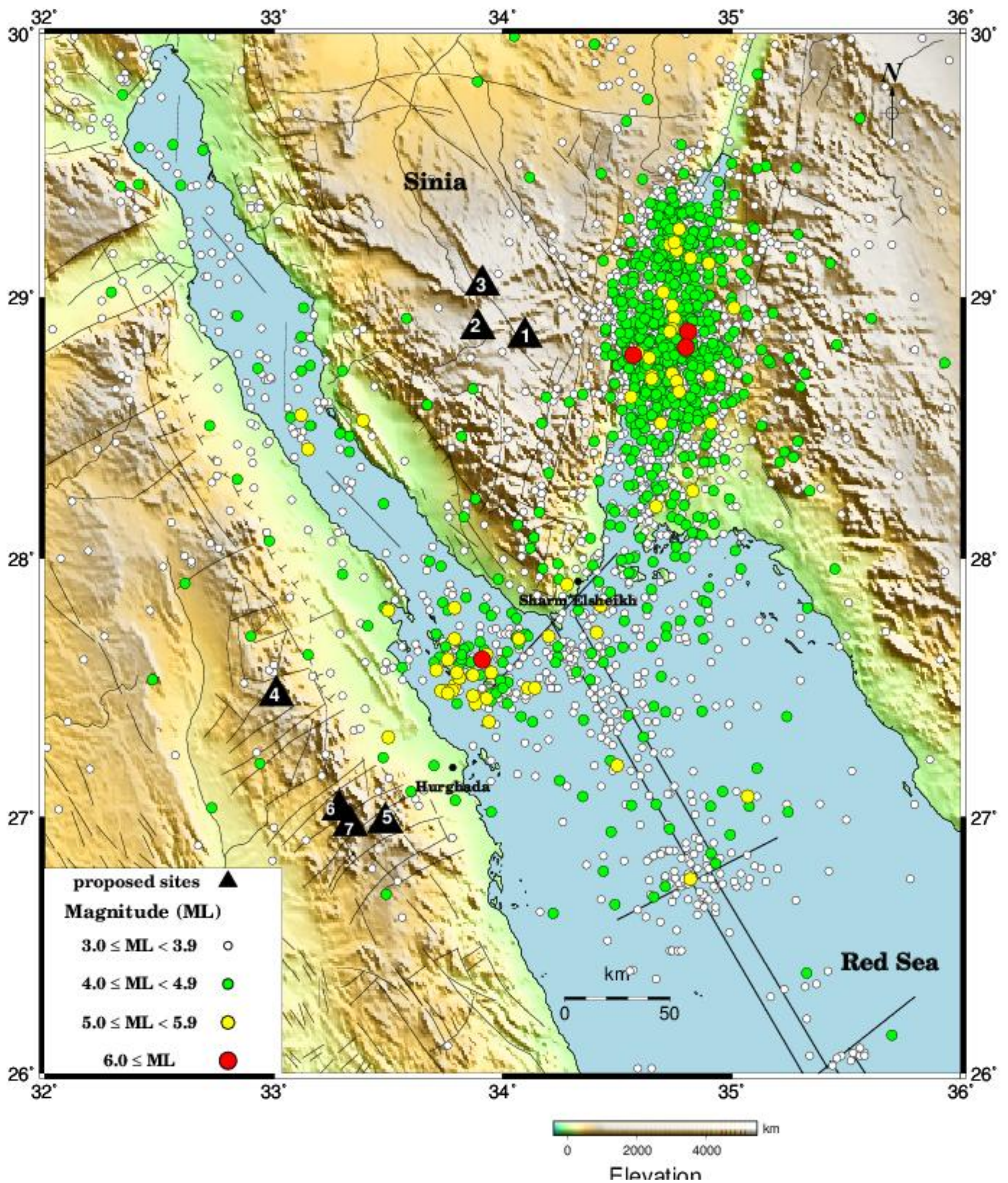
NSB measurements extracted from VIIRS 2015 world atlas

Site-No	NSB ($mag./arcsec^2$)
1	21.97
2	21.97
3	21.98
4	21.96
5	21.89
6	21.94
7	21.93

Seismic Hazards

Site No.	Seismic hazard
3 and 4	Low
6 and 7	Moderate
1, 2 and 5	High

Location of the proposed sites (black triangle) combined with seismicity (till 2020) and surface faults in the world atlas



Findings of candidate sites' research study (1)

Monthly Notices of the ROYAL ASTRONOMICAL SOCIETY
MNRAS 526, 6330–6346 (2023) https://doi.org/10.1093/mnras/stad3074
Advance Access publication 2023 October 28

Multiparameter study for a new ground-based telescope in Egypt

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Accepted 2023 October 4. Received 2023 October 3; in original form 2023 June 9

ABSTRACT

A multiparameter analysis was conducted to evaluate the impact of meteorological parameters, night sky brightness and seismic hazards on proposed sites for the new optical/infrared Egyptian astronomical telescope. The European Centre for Medium-Range Weather Forecasts (ECMWF) Reanalysis v5 (ERA5) data set is used to obtain the following meteorological parameters: total cloud coverage fraction, precipitable water vapour, relative humidity, wind speed and direction, and air temperature. To estimate the aerosol optical depth, we used the Modern-Era Retrospective analysis for Research and Applications version 2 (MERRA-2). Light pollution over the candidate sites was measured using the Visible Infrared Imaging Radiometer Suite (VIIRS) day/night band. In order to assess the seismic hazards for the candidate sites, the seismic input in terms of maximum acceleration and response spectra was computed using a physics-based ground motion approach to assess the seismic hazards and, consequently, the designation of a seismic-resistant structure for the proposed sites. Of the seven nominated sites, two sites are found to have the best measurements and might be considered as future sites for the new Egyptian astronomical telescope. The first site is located in the south of the Sinai peninsula, while the second site is located in the Red Sea mountains region.

Table 5. Number of clear nights for each site during 2019.

ID	Number of clear nights	Ratio
1	289	79.18%
2	302	82.74%
3	276	75.62%
4	294	80.55%
5	290	79.45%
6&7	290	79.45%

Table 6. NSB measurements over our candidate sites as extracted from the VIIRS 2015 World Atlas.

Site	NSB (mag arcsec^{-2})
1	21.97
2	21.97
3	21.98
4	21.96
5	21.89
6	21.94
7	21.93

Table 7. Seismic classification of the candidate sites.

Site	Seismic hazard
3 and 4	Low
6&7	Moderate
1, 2, and 5	High

Table 8. Overall score summary for the four proposed sites.

Site	AOD	NSB (mag arcsec^{-2})	WS (arcsec)	Var(WD-10m) (m s^{-1})	RH (%)	PWV (mm)	TCC (fraction)	AT (°C)	A (gal)	Clear nights	Overall score
3	0.184	21.98	3.02	2784.3451	42.24	9.01	0.17	16.94	50.08	276	0.9128
4	0.223	21.96	3.86	1999.1101	35.42	11.11	0.12	22.35	61.52	294	0.8912
7	0.227	21.93	2.98	3607.1069	31.81	10.59	0.12	22.84	86.53	290	0.8571
2	0.181	21.97	2.92	7507.4972	36.82	9.36	0.13	19.1	93.44	302	0.8563

Final good candidate sites in Egypt

Excluding some sites (near the cities, plateau, accessibility, security issues, etc.)

Two good candidate sites were finally selected for site testing

Height in meter	Coordinates		Mountain Name	No
	Latitude	Longitude		
1626	29.045706	33.910842	Rojom	1
1381	27.470417	33.011806	Zubyer	2

Candidate sites' research study (2)

Another unpublished research been implemented by a Spanish group to compare between Rojoom and Zubair sites reached to similar findings

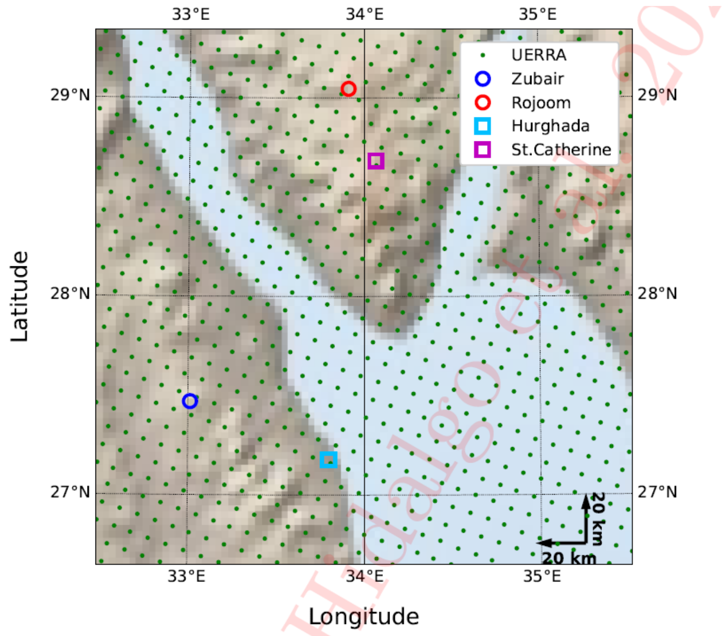
Cimate Site Comparison Report for Zubair and Rojoom in the period 2003–2019. Preliminary results July 2022

Hidalgo, S. L., Muñoz-Tuñón, C., Castro-Almazán, J., et al.

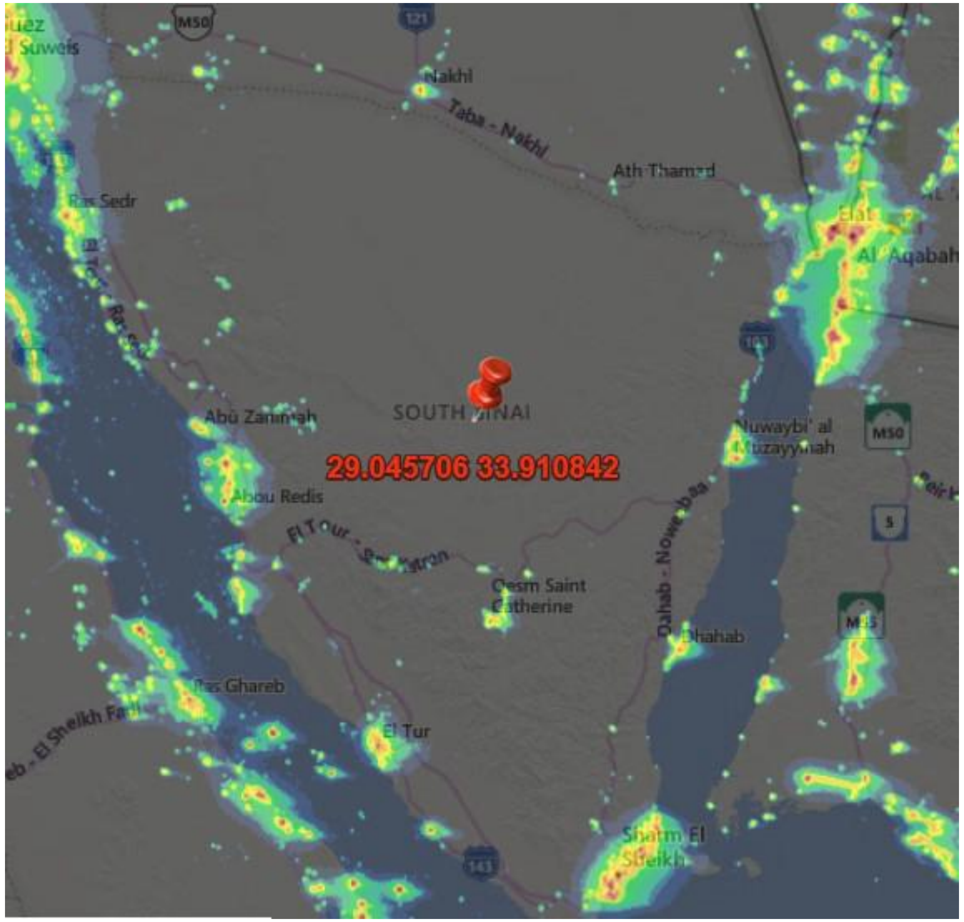
4 Summary Climate Study: Rojoom and Zubair Values.

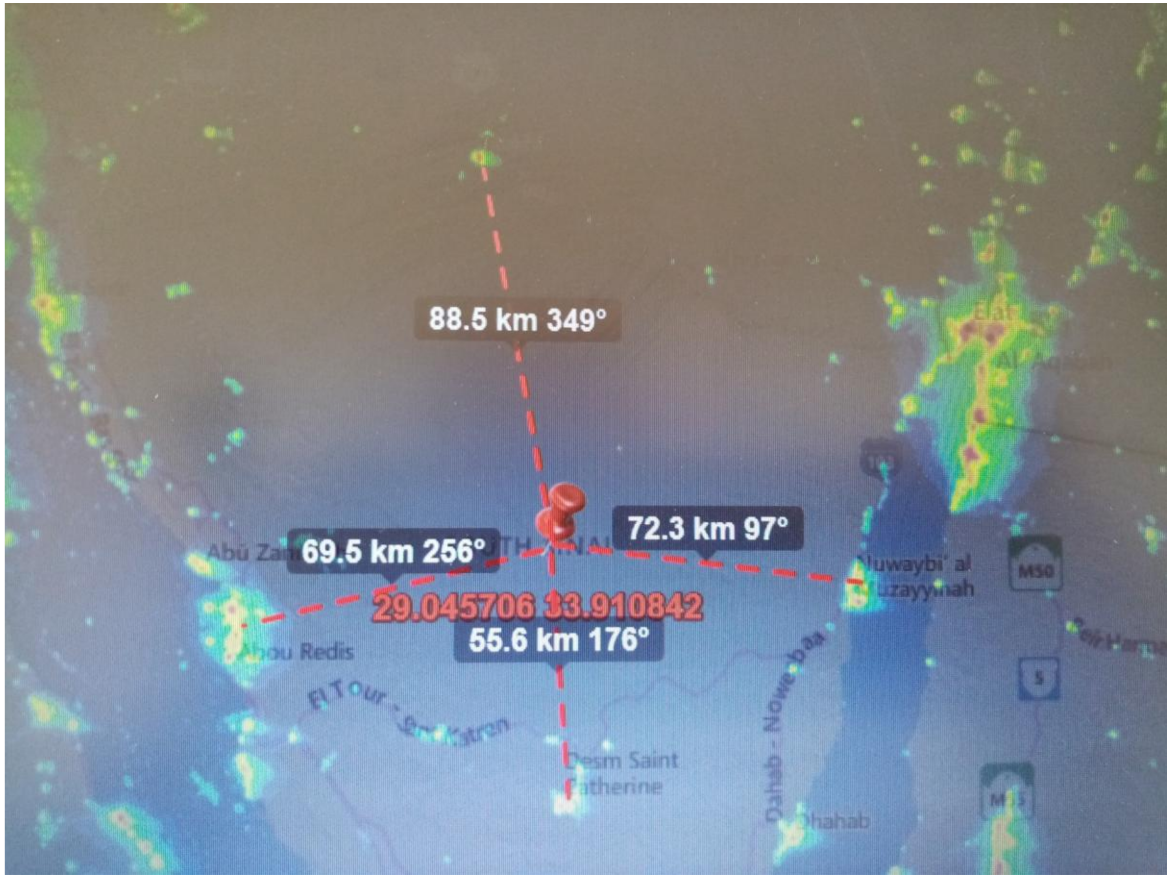
We have present an statistical and time series analysis for Rojoom and Zubair based in 4 climate parameters: Relative humidity, Temperature, WV, and WD. We sumarize here the comparison between the two sites:

- Rojoom and Zubair RH median values are $\lesssim$ **30%**, being slightly drier at 12:00 than 00:00 hours.
- Zubair site seems to be more drier the Rojoom by about 7%
- Mean temperature is $\lesssim 17\,^{\circ}\mathrm{C}$ in Rojoom and $\lesssim 20\,^{\circ}\mathrm{C}$ in Zubair.
- No difference in WV or WD has been found between both sites.

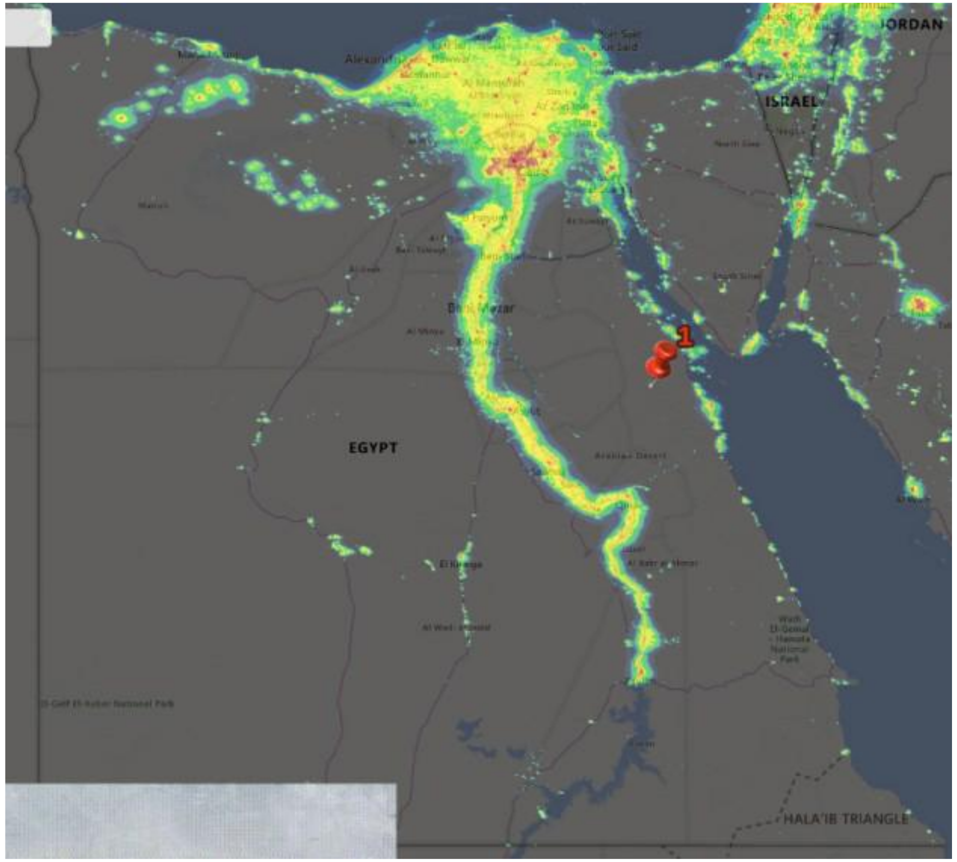


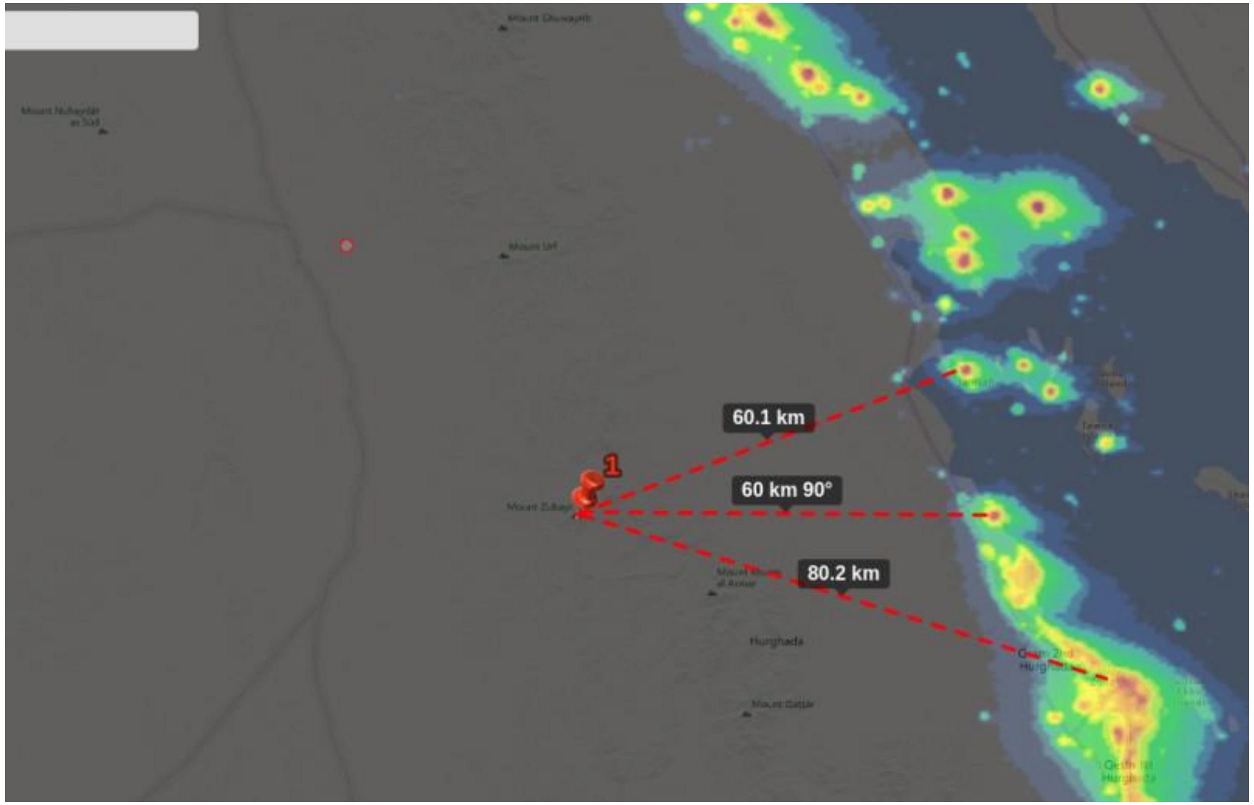
Light pollution maps (Rojom Site)





Light pollution maps (Zubayer Site)



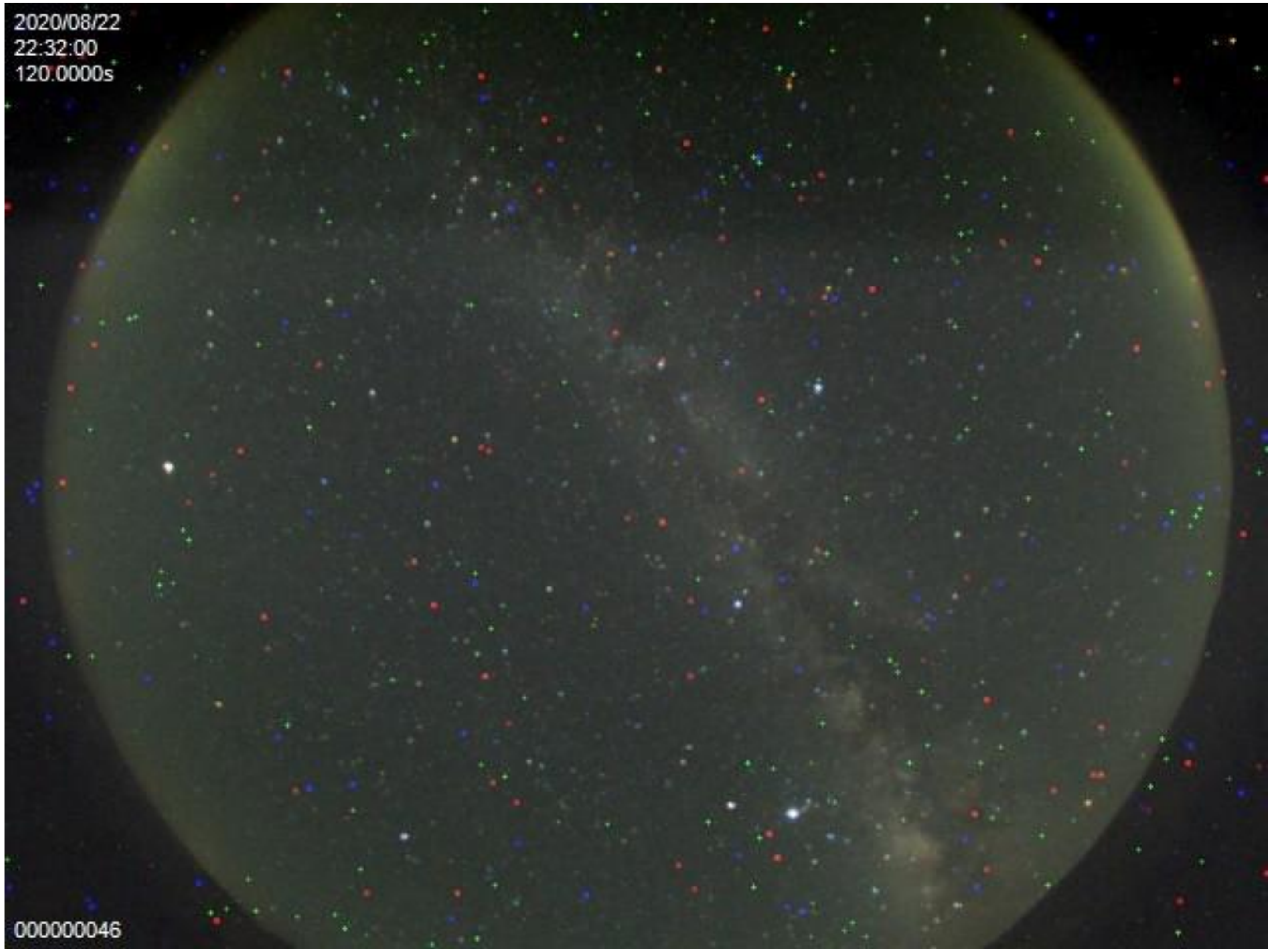


Final good candidate site in Egypt

Due to the fear of touristic extension projects and very difficult accessibility of the red see site, we have excluded that site and set only the Sinai location for site testing

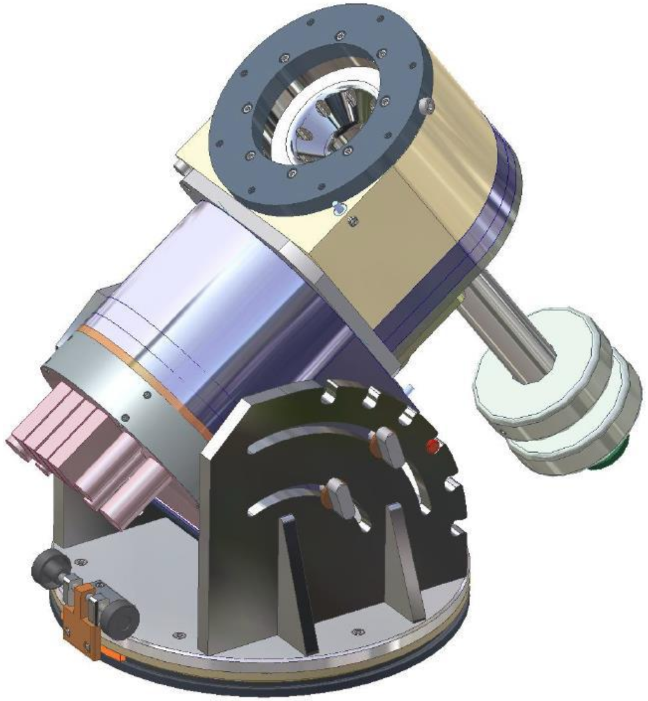
Height in meter	Coordinates		Mountain Name	
	Latitude	Longitude		
1626	29.045706	33.910842	Rojom	1

All Sky Camera measurement at Rojoom site



Current status of Site testing Process

- **Two copies of DIMM, Tower, Dome, ASC have been ordered from Astelco (Germany)**



DIMM system technical description

ASTELCO universal mount NTM-500 with its control unit and its ASTELCO-modified 12" RC DIMM telescope and camera.

Optical Parameters

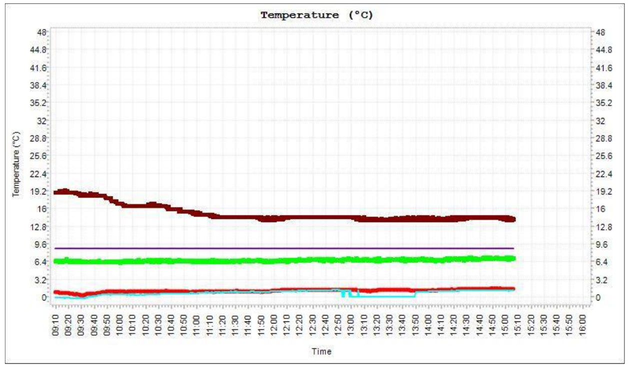
Clear aperture	304mm
Focal length	2432mm
System focal ratio	F/8
OTA mass	24kg
OTA diameter	485mm
Mirror material	low thermal expansion fused quartz glass
Coating M1, M2	dielectric Al protection coating; R_{max} ~ 98%

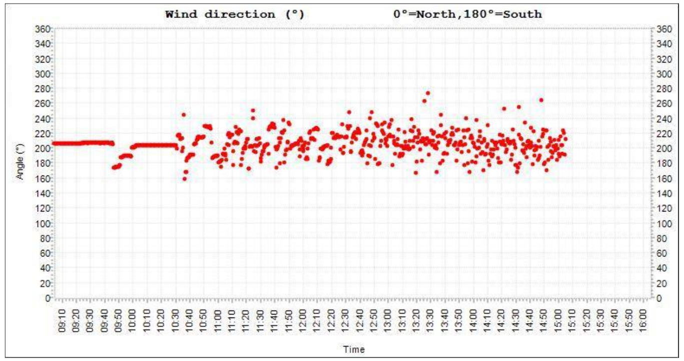
DIMM mask mounted to 12" truss OTA

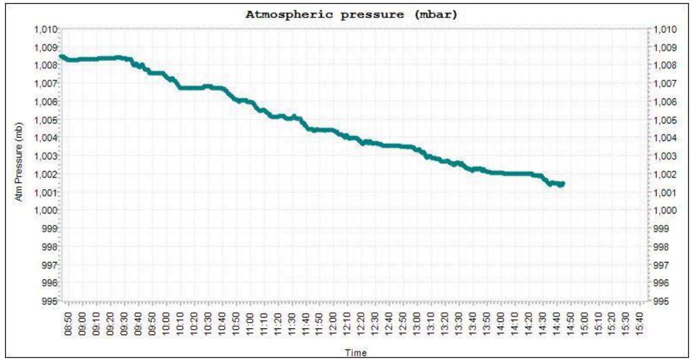
AllSky camera technical description

Name	Sensor	Fisheye circle "Illuminated" pixels	Detector resolution	Field of view	Pixel Scale	Daylight imaging
OMEA 9M	Mono-chrome	31.7 Million px	9575 x 6380 px	180° x 180°	1.6 arcmin/pix	Yes

By default, the camera records two weather parameters: relative humidity and external temperature.
A module, attached to the camera measures a wide range of weather parameters, such as wind speed, wind direction, and pressure.







Weather stations, Sky quality meters

- **Another 2 copies of weather station and 8 SQMs are also available**

Actions adopted for Egyptian sites

Actions adopted for Egyptian sites

these two chosen sites.
As of your vast experience, we need your help in the process of assigning the recent up-to-date instruments tha can be used in this process of site testing. These instruments include the telescope, DIMM, MASS, weather station, and any other instrument that is necessary for site testing.
So, if you can help in providing us with a proposal/quotation of these instruments, I'll be very thankful to you.

We can also make some sort of agreement and cooperation with your side (yourself/your university/Observatory) in order to benefit from your experience in this field. We can invite you to Egypt for a visit and/or send people for training at your observatory.

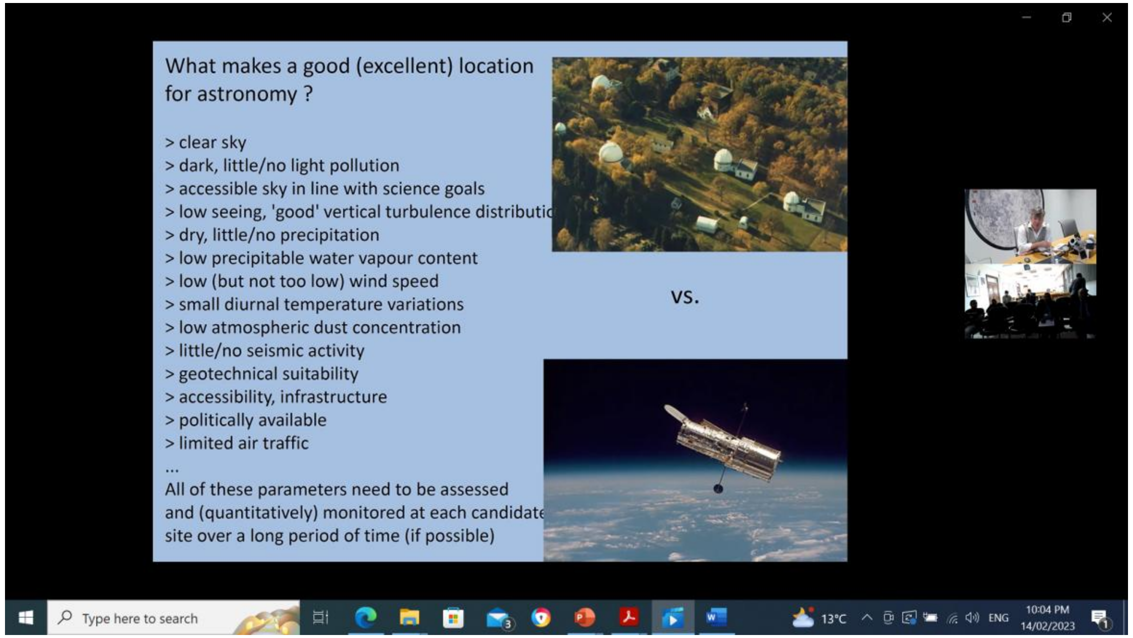
Waiting for your reply and all my best wishes to you.

Yours,

Yosry

Re: Site test of a 6.5 m telescope in Egypt
Yahoo/Inbox
Andrei Tokovinin <atokovinin@ctio.noao.edu>
To:Yosry Azzam
Cc:Edison E. Bustos
Mon, 10 Jun 2019 at 08:56
Dear Dr. Azzam,

I will be glad to provide an advice in your site-testing effort. However, I am detached from any field site-testing in the recent 10 years.



Site Prospect in the MENA REGION

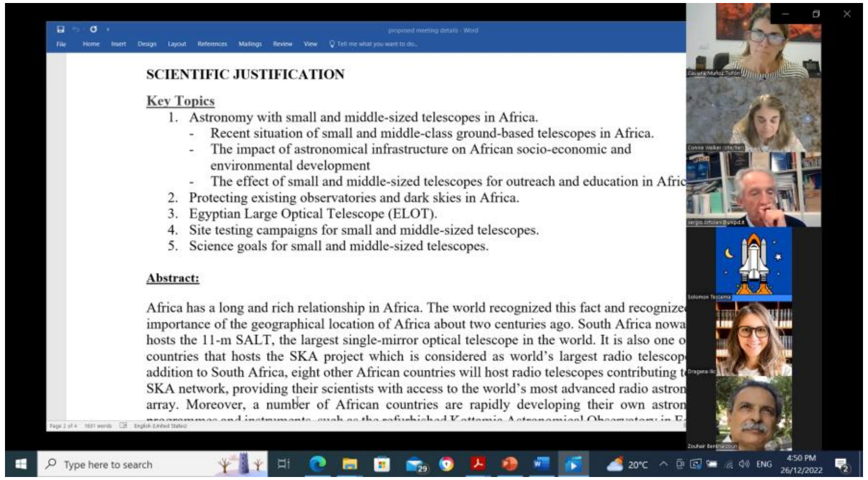
Zouhair Benkhaldoun
Director of Oukaimeden Observatory, Professor in Cadi Ayyad University's Department of Physics.
zouhair@uca.ac.ma

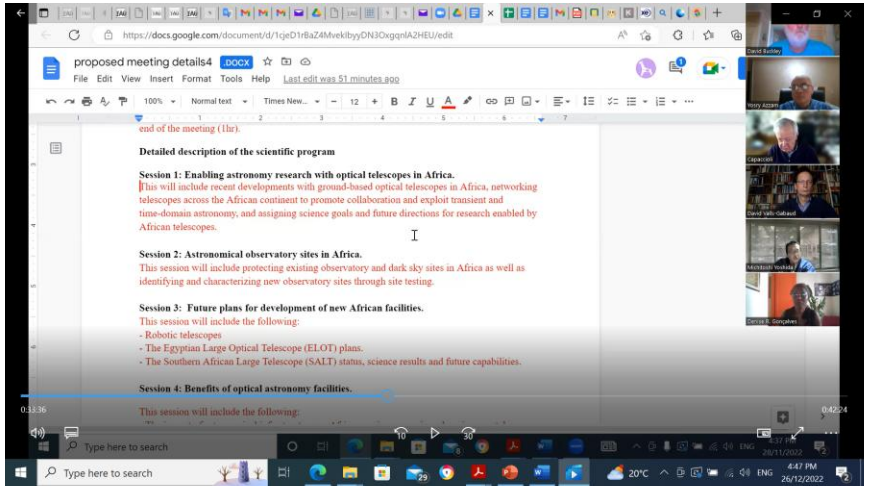
Focus Meeting at GA2024

Title: Harnessing ground-based optical telescopes: an opportunity for emerging astronomy in Africa.

SOC members:

1. Azzam, Yosry, NRIAG, Egypt (M)
2. Benkhaldoun, Zouhair, Cadi Ayyad University, Morocco (M)
3. Buckley, David, SAAO, South Africa (M)
4. Capaccioli, Massimo, INAF, Italy (M)
5. Gonçalves, Denise Rocha, Federal University of Rio de Janeiro, Brazil (F)
6. Ilic, Dragana, University of Belgrade, Serbia (F)
7. Morcos, Abdelfady, Head of the Egyptian National Committee of Astronomy and Space Science, Egypt (M)
8. Muñoz-Tuñón, Casiana, IAC, Spain (F)
9. Ortolani, Sergio, UNI-Padova, Italy (M)
10. Povic, Mirjana, SSGI, Ethiopia and IAA-CSIC, Spain (F)
11. Saad, Alshimaa, Cairo University, Egypt (F)
12. Street, Rachel, Las Cumbres Observatory, USA (F)
13. Tessema, Solomon Belay, Ministry of Technology and Innovation and SSGI, Ethiopia (M)
14. Valls-Gabaud, David, CNRS, France (M)
15. Walker, Constance E., NSF's NOIRLab and the IAU CPS (F)
16. Yoshida, Michitoshi, NAOJ, Japan (M)





Current status of Site testing Process

- A new road to Sinai Site has been prepared

Current status of Site testing Process

- Foundation Stone for Sinai Observatory

Current status of Site testing Process

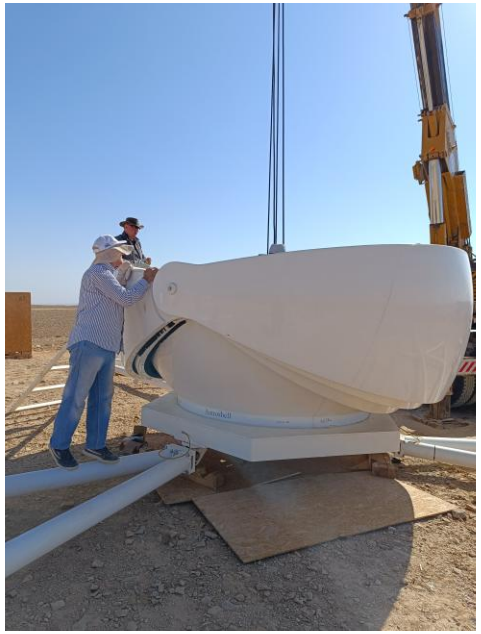
- **Transfer of instruments to the site**

Current Status of Site Testing Process

- **Installation of Internet Satellite communication at the site**

Current Status of Site Testing Process

- **Installation of Tower, Dome and other instruments at the site**


Current Status of Site Testing Process

- Installation of Tower, Dome and other instruments at the site

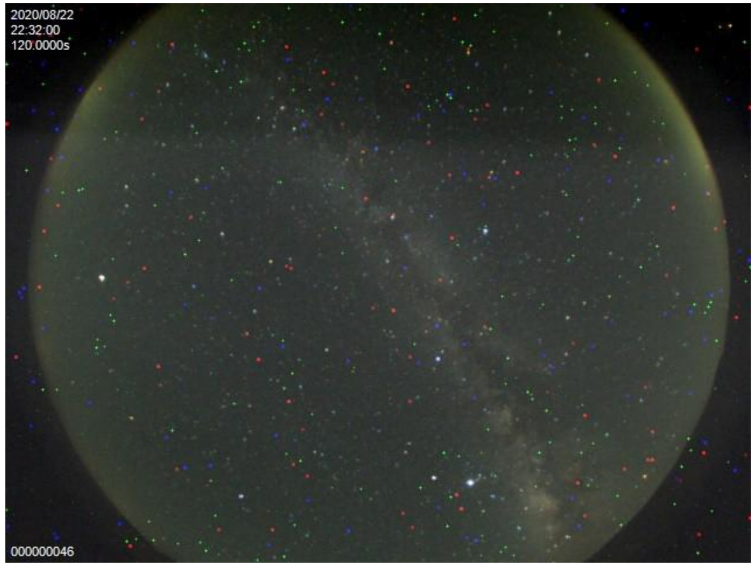


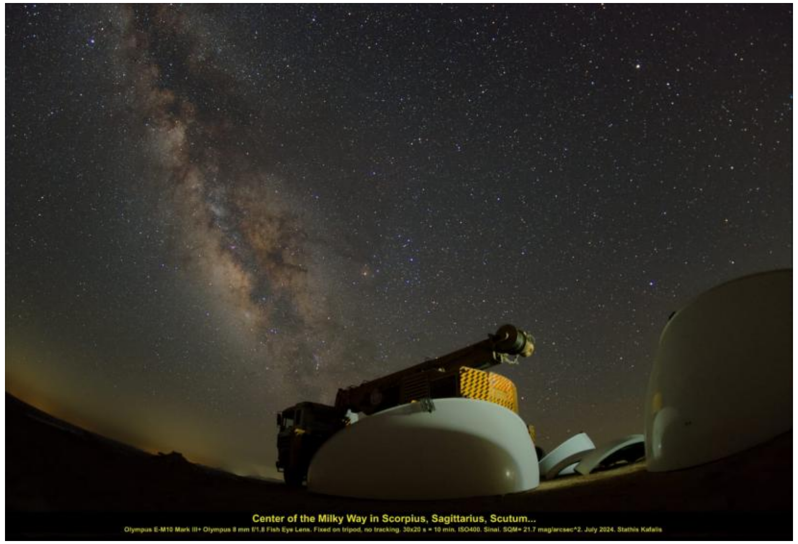





Sample images at Sinai site

- **Initial seeing value at the site is 0.7 (one night)**





Future Work

- Continue HW/SW installations and start site testing campaign.
- Install solar power cells for total remote and robotic operation.
- Prepare other necessary instruments for site testing like Dust sensor, Sonic Anemometer, SCIDAR (Scintillation Detection and Ranging), etc..

Challenges & Difficulties

- Urban extension and Touristic developments (Zubair site).
- Site accessibility / Security Issues (Sinai Site).
- Science & Engineering personnel are very few for such big project.

- Defining of scientific priorities and science cases for ELOT.
- Experience related to site testing has to be fostered.

We still need to:

1- Setting up an international scientific advisory committee to:

- Give advice about science goals
  Imaging: wide field? AO? Wavelength range? NIR?
  Spectroscopy: multi-object over a large FOV? Spectral resolution?

- Recommend on defining the instruments suitable to reach these goals.

2- Facilitate getting training and inspecting visits to similar telescopes around the world.

3- Asking for more jobs in Science and Engineering.

5- Develop regulations to protect dark skies in the selected site from urban/light pollution.

6- Fund-raising from multiple channels is necessary with a ROI plan.

Special Session SS48 at EAS 2025

Cork, Ireland, June 23-27, 2025

Programme

- Recent developments and research plans in relation to ground-based optical and radio telescopes in Africa.
- Identification and characterization of new observatory sites in Africa through collaboration with European areas of expertise.
- Enabling site testing campaigns in Africa through the sharing and loan of European equipment and human expertise.
- Enabling partnerships between European and African institutions for the construction of new telescopes in African countries.
- Collaborations between European and African institutions for defining science goals and directions for research enabled by future African telescopes.
- Networking existing telescopes across the European and African continents to promote collaboration and exploit transient and time-domain astronomy.
- Training early-career researchers' observational skills and experience across the African continent.
- The Egyptian Large Optical Telescope (ELOT) and Ethiopian Lalibela Optical Telescope future science plans and facilities.
- The Kenyan Optical Telescope Initiative (KOTI).

Conclusion

- A lot of work is needed to match between ELOT optical design, its attached astronomical instruments and site optical characteristics.

- Difficulties and challenges facing the process towards building and constructing of the new telescope have to be overcome.

Thank you for your attention.

- y.azzam@nriag.sci.eh