

One Year of Ground-Based Solar Irradiance Measurements: Data Quality Assessment and Insights from Limassol Cyprus Site

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Outline:

1. Main Solar Station in Limassol and the 4 regional stations
2. Introduction of solar radiation measurements
3. Measurements and Data quality

CONSORTIUM



AFFILIATED ENTITIES



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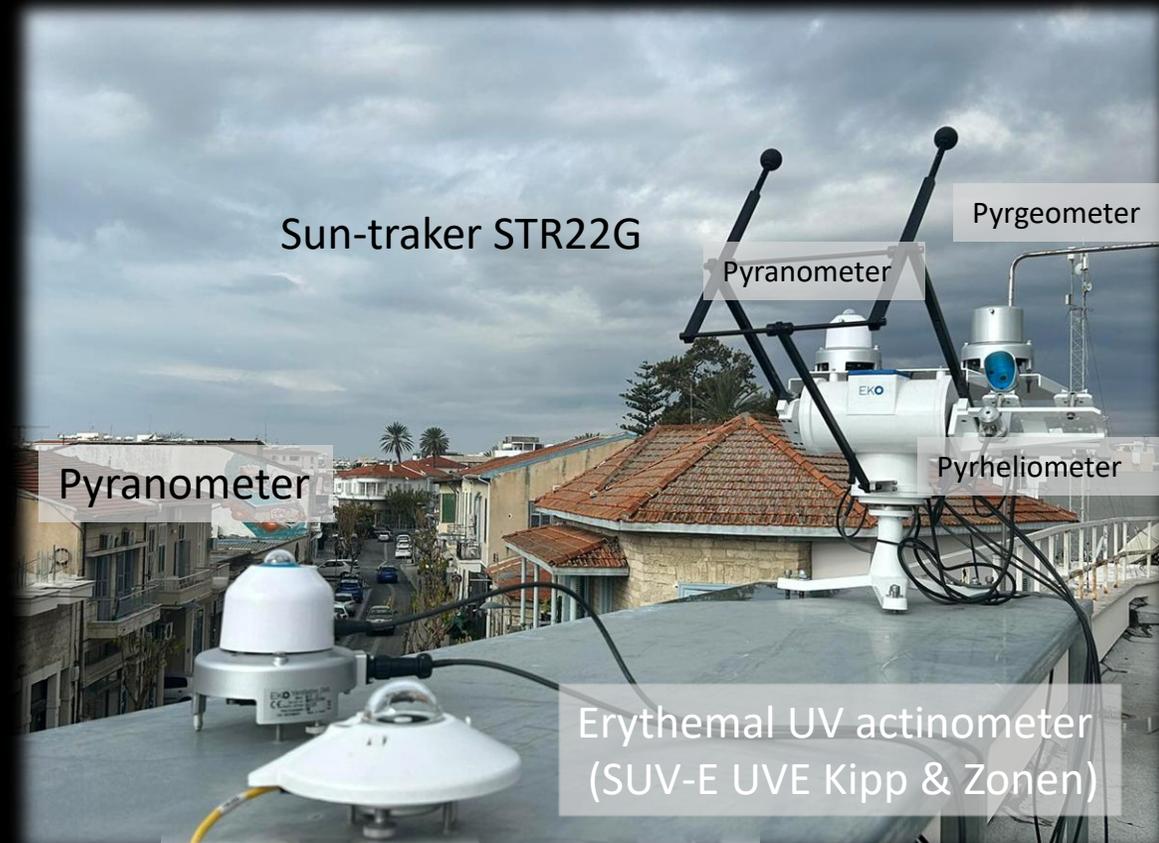


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Central station in Limassol for the Solar radiation monitoring



✓ Solar radiation monitoring → (sun – tracker STR 22G, MS-80 pyranometers x2 → global broad-band solar radiation, MS-21 pyrgeometer → longwave downwelling radiation and longwave net radiation in a wide spectral band, MS-57 pyrheliometer → direct normal incidence (DNI) solar irradiance sensor, EKO instruments)

✓ Spectrophotometer (DMc150 double monochromator, Bentham, 280 – 500 nm)

✓ Cloud cover monitoring system (ASI-16 All Sky Imager)

✓ Erythemal UV actinometer (SUV-E UVE Kipp & Zonen)

✓ Portable calibrator (KS-J1011 CMS ING. DR. SCHREDER GMBH, 3 calibrated lamps traceable to Physikalisch-Technische Bundesanstalt)

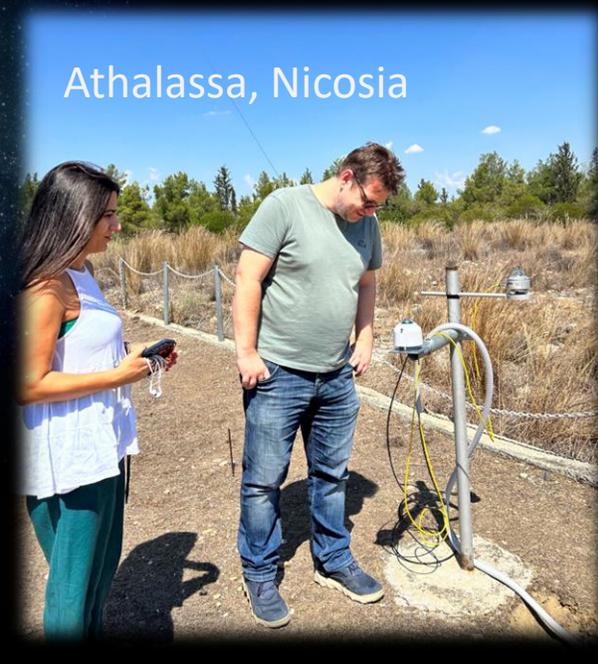


4 Regional Stations

- ✓ Pyranometer (MS-80 EKO instruments → global broad-band solar radiation)
- ✓ Erythemal UV actinometer (SUV-E UVE Kipp&Zonen)



Kyperounta, Limassol



Athalassa, Nicosia



Polis Chrysochou, Pafos



Frenaros,
Larnaca

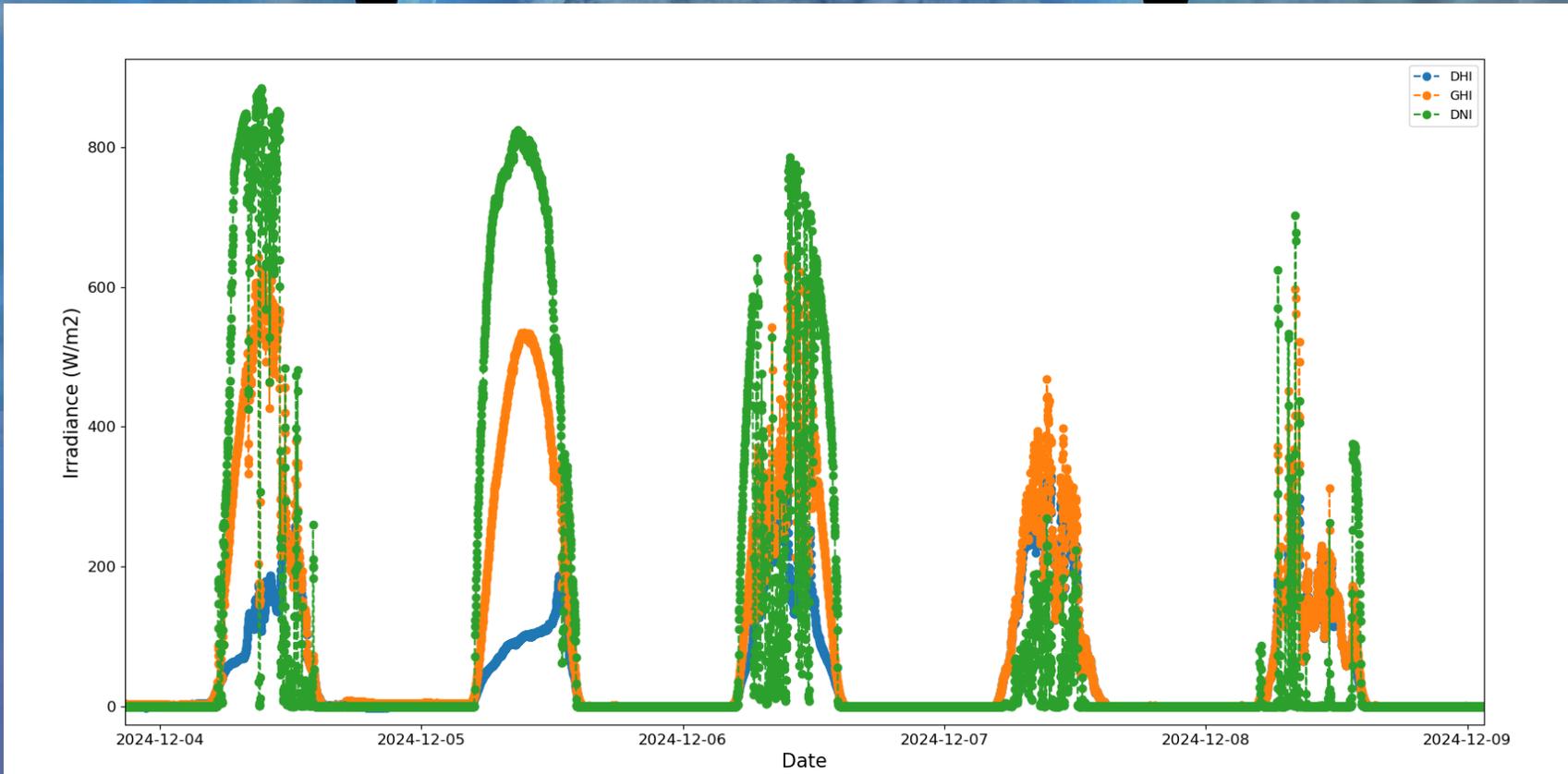
Limassol Station

1. Global Horizontal Irradiance (W/m^2 , temporal resolution 1 min)
2. Diffuse Horizontal Irradiance (W/m^2 , temporal resolution 1 min)
3. Direct Normal Irradiance (W/m^2 , temporal resolution 1 min)
4. Erythema UV Irradiance (W/m^2 , temporal resolution 1 min, multiply by 40 to get UV-Index dimensionless)
5. Spectral Solar irradiance (spectral range from ~ 290 to 600nm . This can be used as the reference instrument for the UV measurements, quantities that could be derived, UV-Index, UV-DNA damage, Vitamin D production, UV quantities related to agriculture e.g., UV plant growth or blue light etc.)
6. All Sky Camera (captures every 1 min), Cloud coverage

2.)

Other stations

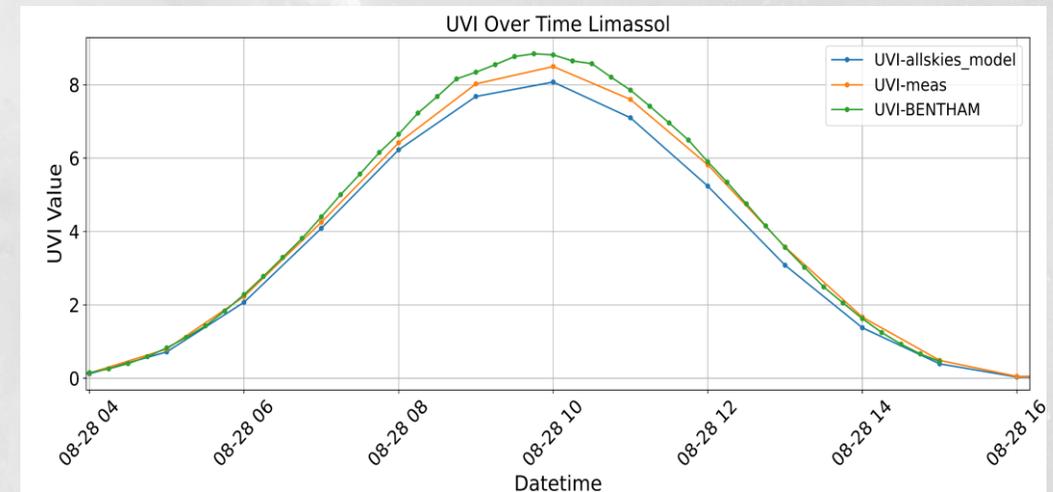
- Global Horizontal Irradiance (W/m^2 , temporal resolution 1 min)
- Erythema UV Irradiance (W/m^2 , temporal resolution 1 min, multiply by 40 to get UV-Index dimensionless)



Modeled and Forecasted Quantities

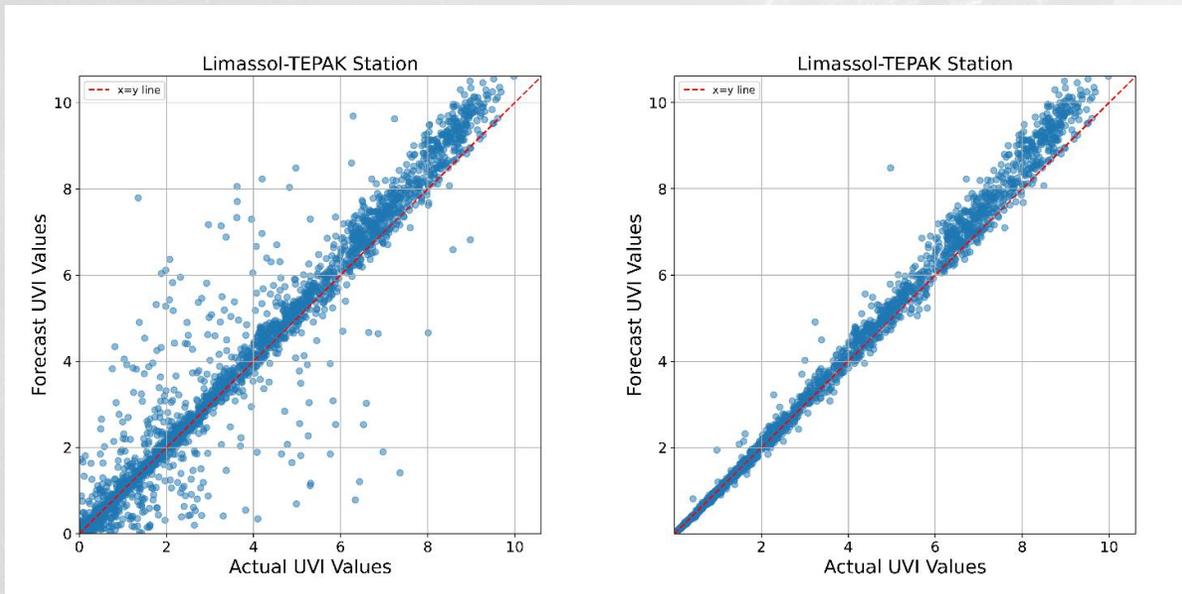
- Global + Direct Horizontal Irradiances (W/m^2 , temporal resolution 15 min, spatial resolution ~ 5 Km). Climatological products that can be produced and have possible commercial value: Solar atlas of Cyprus with a resolution of 5×5 Km^2 , time series of GHI or DNI over a specific area of interest and creation of Typical Meteorological Year. Forecasted products: Nowcasting and short-term forecasting (15 to ~ 3 hours ahead). For the moment, this product can be used only for research purposes according to the EUMETSAT license agreement. It would also be possible to have the 2-3 days ahead forecasting of those quantities if we could have cloud coverage forecasts from NWP for the days ahead.

- UV (e.g. UV-Index) and agricultural products (e.g. PAR): Climatology of those quantities. Forecasted products: Nowcasting and short-term forecasting (15 to ~ 3 hours ahead). Forecast (1-2 days ahead) of clear sky values.



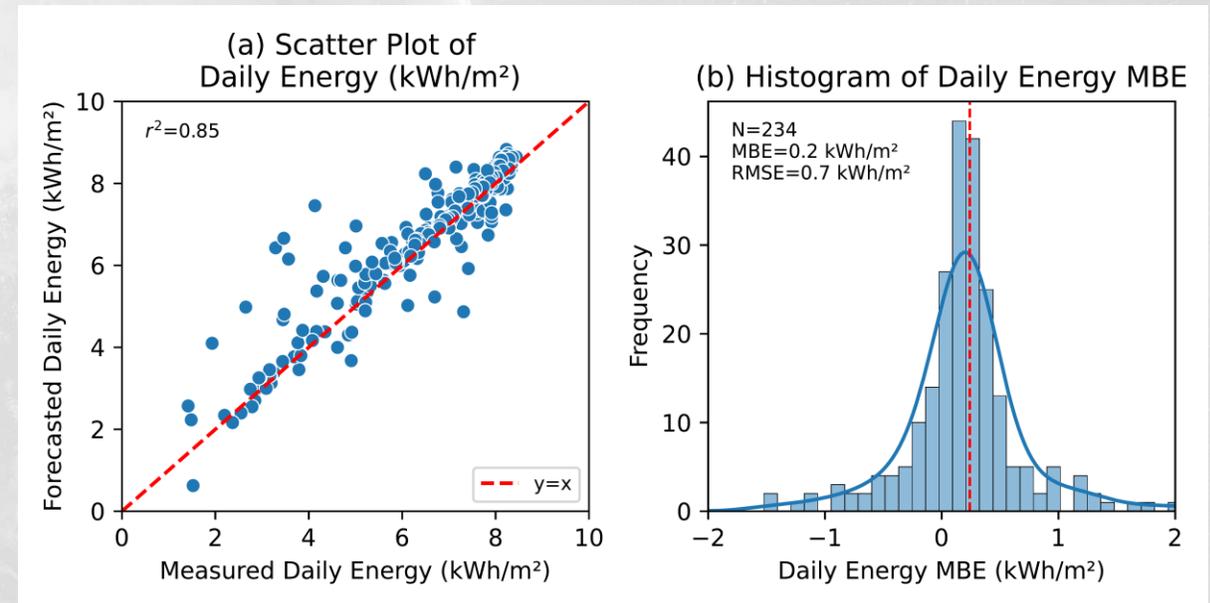
(Charalampous et al, 2025)

UVI forecast and Measurements

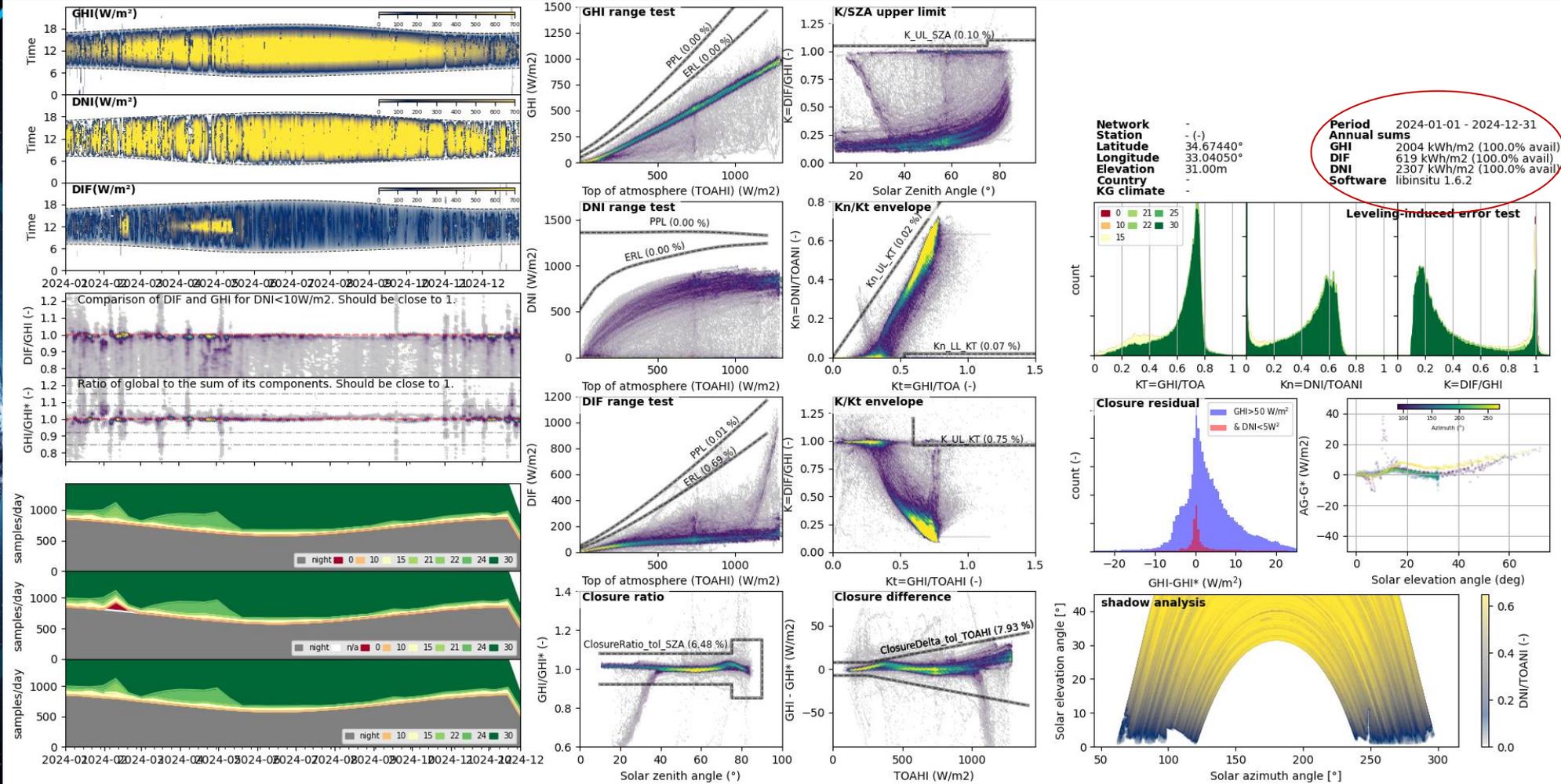


Charalampous et al, 2025

Global-Daily Energy Forecast and Measurements



Fragkos et al, 2024



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bit	name	condition	domain	components	source
1	GHI_PPL_UL_TOANI_SZA	$GHI \leq 1.5 * TOANI * \cos(\text{THETA_Z})^{1.2} + 100$	$SZA \leq 90$	GHI	Long and Dutton (2002)
2	GHI_ERL_UL_TOANI_SZA	$GHI \leq 1.2 * TOANI * \cos(\text{THETA_Z})^{1.2} + 50$	$SZA \leq 90$	GHI	Long and Dutton (2002)
3	DIF_PPL_UL_TOANI_SZA	$DIF \leq 0.95 * TOANI * \cos(\text{THETA_Z})^{1.2} + 50$	$SZA \leq 90$	DIF	Long and Dutton (2002)
4	DIF_ERL_UL_TOANI_SZA	$DIF \leq 0.75 * TOANI * \cos(\text{THETA_Z})^{1.2} + 30$	$SZA \leq 90$	DIF	Long and Dutton (2002)
5	DNI_PPL_UL_TOANI	$DNI \leq TOANI$	$SZA \leq 90$	DNI	Long and Dutton (2002)
6	DNI_ERL_UL_TOANI_SZA	$DNI \leq 0.95 * TOANI * \cos(\text{THETA_Z})^{0.2} + 10$	$SZA \leq 90$	DNI	Long and Dutton (2002)
7	K_UL_SZA	$(K < 1.05) \& (SZA < 75) \mid (K < 1.1)$	$(GHI > 50) \& (SZA \leq 90)$	GHI,DIF	Long and Dutton (2002)
8	K_UL_KT	$(K < 0.96) \mid (Kt < 0.6)$	$(GHI > 50) \& (SZA < 90)$	GHI,DIF	Geuder et al. (2015)
9	Kn_UL_KT	$Kn < Kt$	$(GHI > 50) \& (SZA < 90)$	GHI,DNI	Geuder et al. (2015)
10	Kn_LL_KT	$(Kn > 0.0171) \mid (Kt < 0.533)$	$(GHI > 50) \& (SZA < 90)$	GHI,DNI	Forstinger et al. (2023)
11	ClosureRatio_to_SZA	$(SZA \leq 75) \& (abs(GHI/GHI_est - 1) \leq 0.08) \mid (SZA > 75) \& (abs(GHI/GHI_est$	$(GHI > 50) \& (SZA < 90)$	GHI,DNI,DIF	Long and Dutton (2002)

Physically Possible Limits and Extremely Rare Limits

Name	standard_name	unit
GHI	surface_downwelling_shortwave_flux_in_air	W m-2
DHI	surface_diffuse_downwelling_shortwave_flux_in_air	W m-2
BNI	direct_downwelling_shortwave_flux_in_air	W m-2

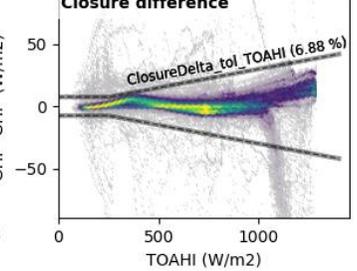
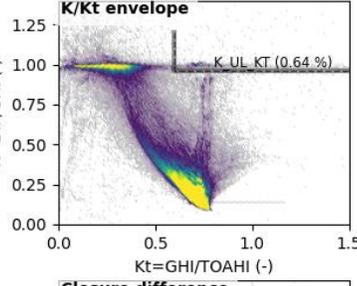
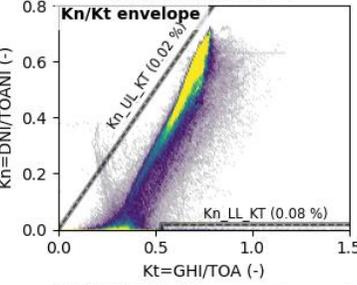
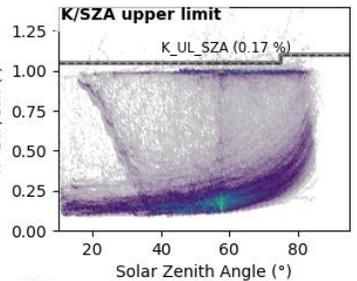
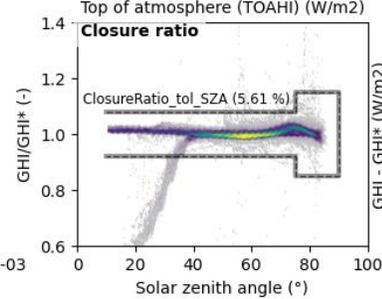
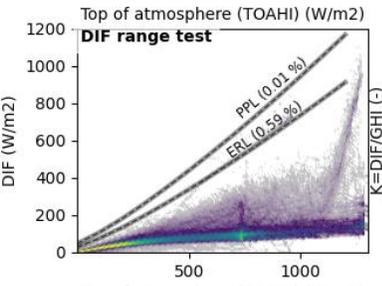
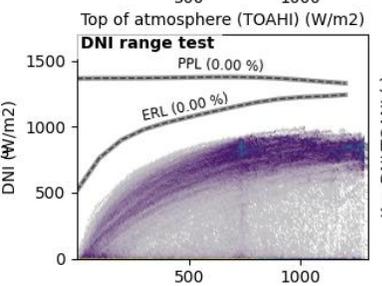
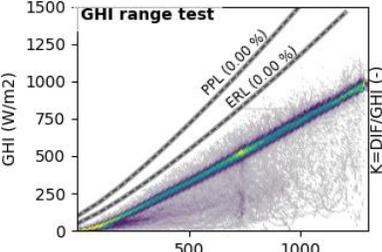
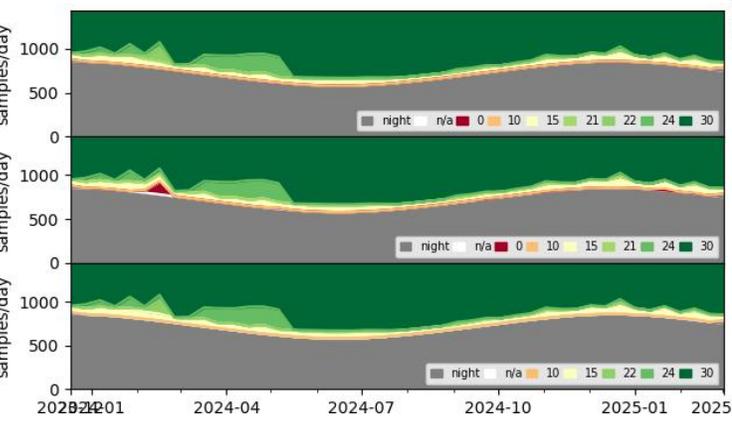
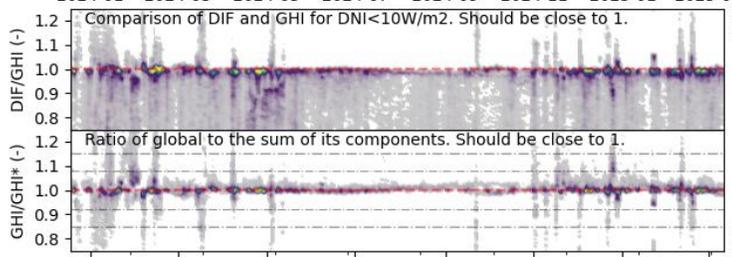
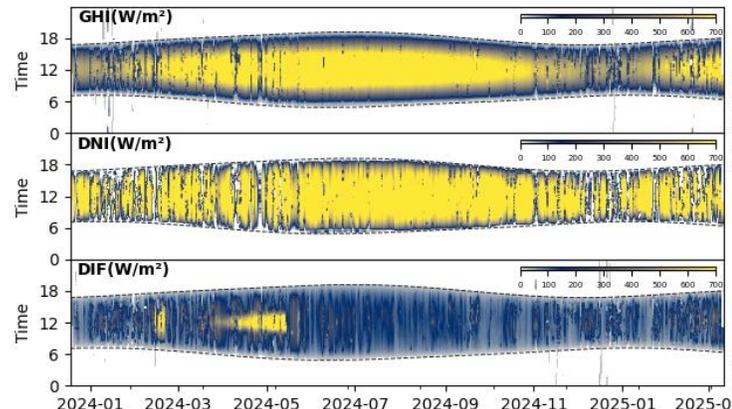
Conclusion

- Illustrates of GHI or DHI calibration problem
- For the first year of operation of the station the data are within the limits
- there have been some issues with the diffuse component after a wind event, as the shading balls where not on then right position.

Future Work

- Automation of the station is the next step
- Better evaluation of our models using the solar station measurement
- Planning to participate in campaigns both calibration and research background campaigns.

Thank you for your attention!!!!



Network	-	Period	2023-12-18 - 2025-03-11
Station	- (-)	Annual sums	
Latitude	34.67440°	GHI	1868 kWh/m ² (99.7% avail)
Longitude	33.04050°	DIF	583 kWh/m ² (99.8% avail)
Elevation	31.00m	DNI	2209 kWh/m ² (99.8% avail)
Country	-	Software	libinsitu 1.6.2
KG climate	-		

