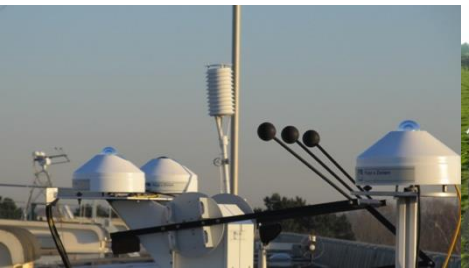
15th BSRN Scientific Review and Workshop July 16-20, 2018, Boulder

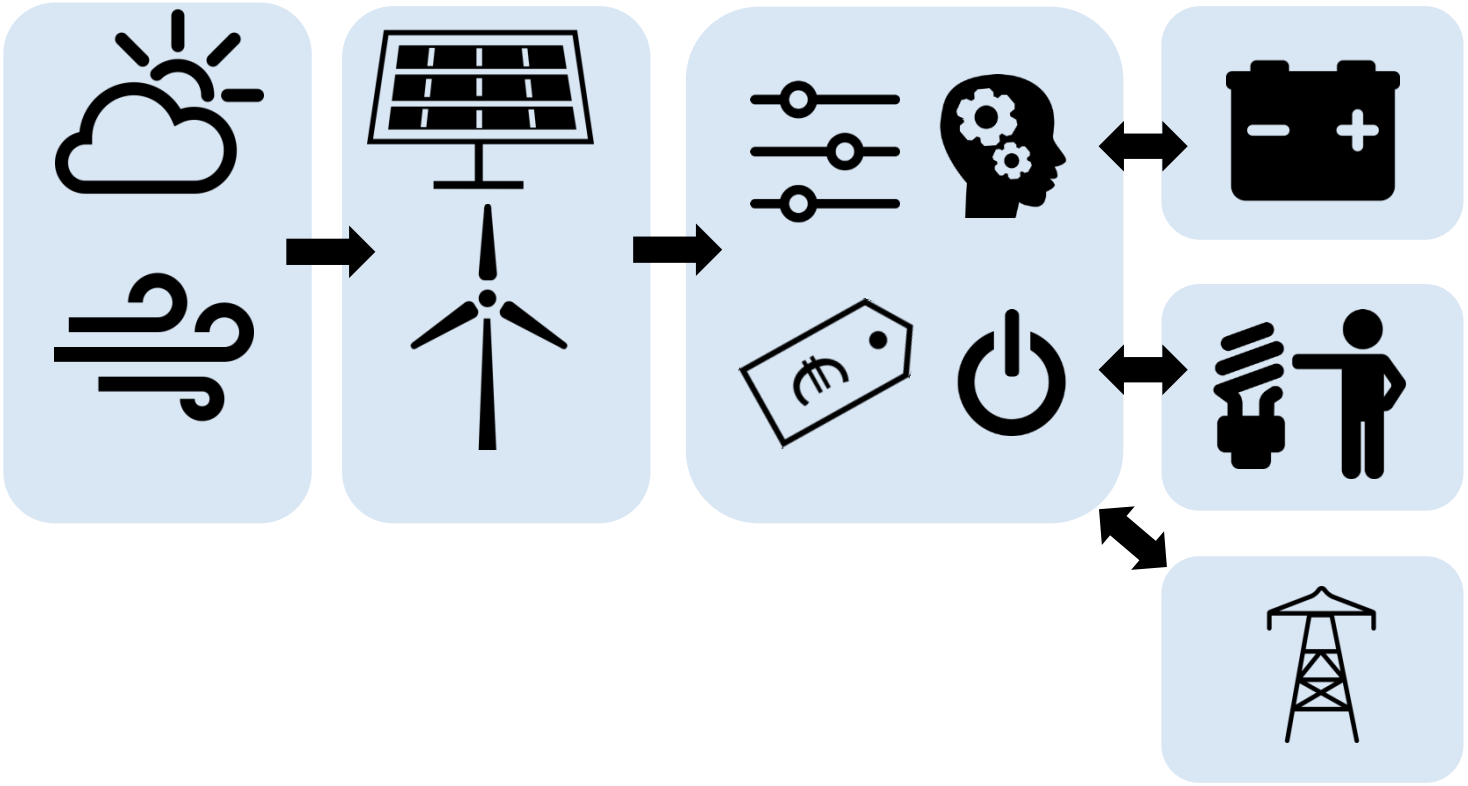
The uses of the PAL BSRN station: research, innovation and training

Jordi Badosa,
LMD/IPSL, Ecole Polytechnique

SIRTA
Site Instrumental de Recherche par Télédétection Atmosphérique



Research topics



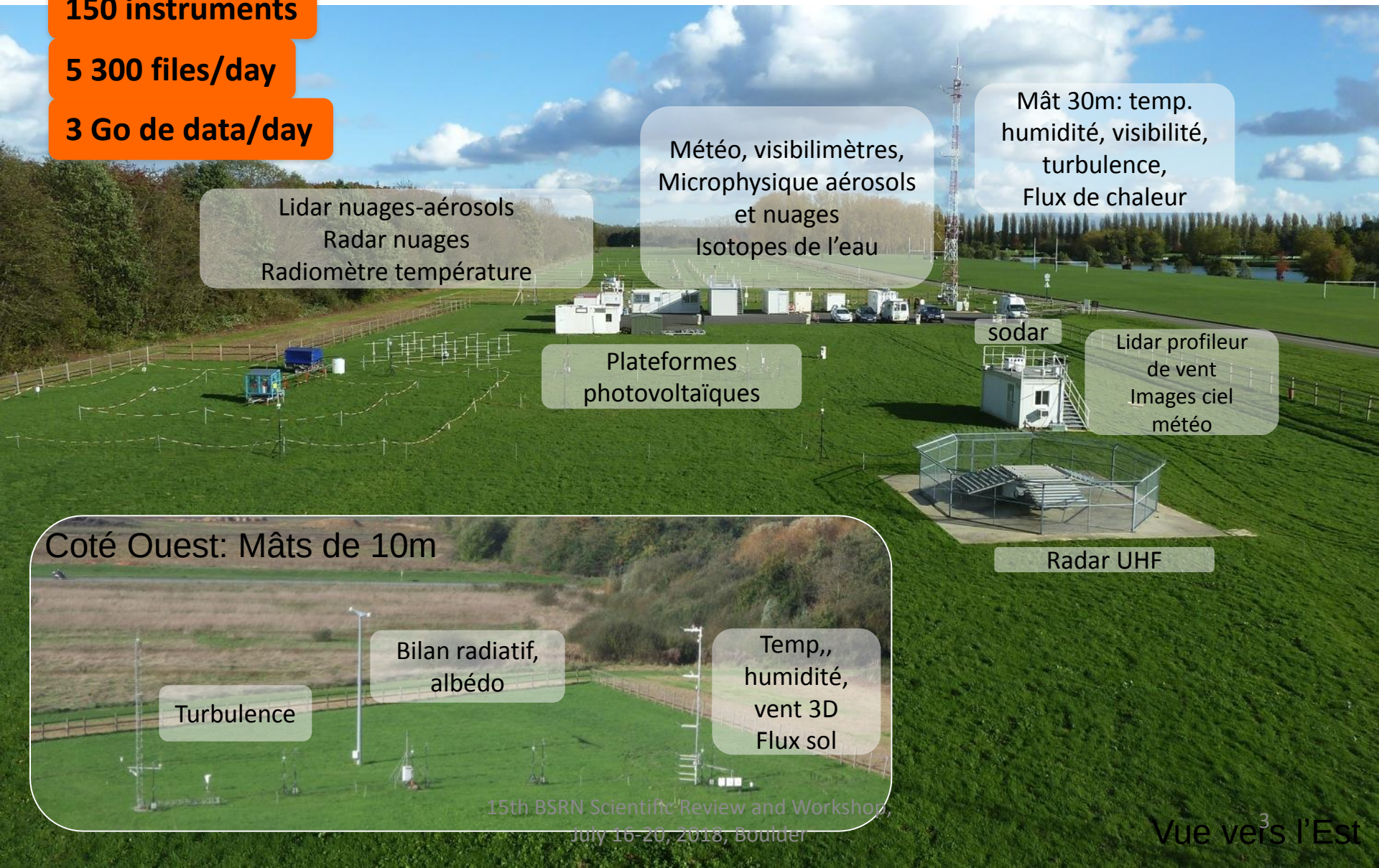
How to manage the uncertainty and variability from renewables and consumption?
How to model, optimise and simulate a realistic system?
What are the methods to promote green behaviour to support grid flexibility?

A multi-parameter site (www.sirta.fr)

150 instruments

5 300 files/day

3 Go de data/day



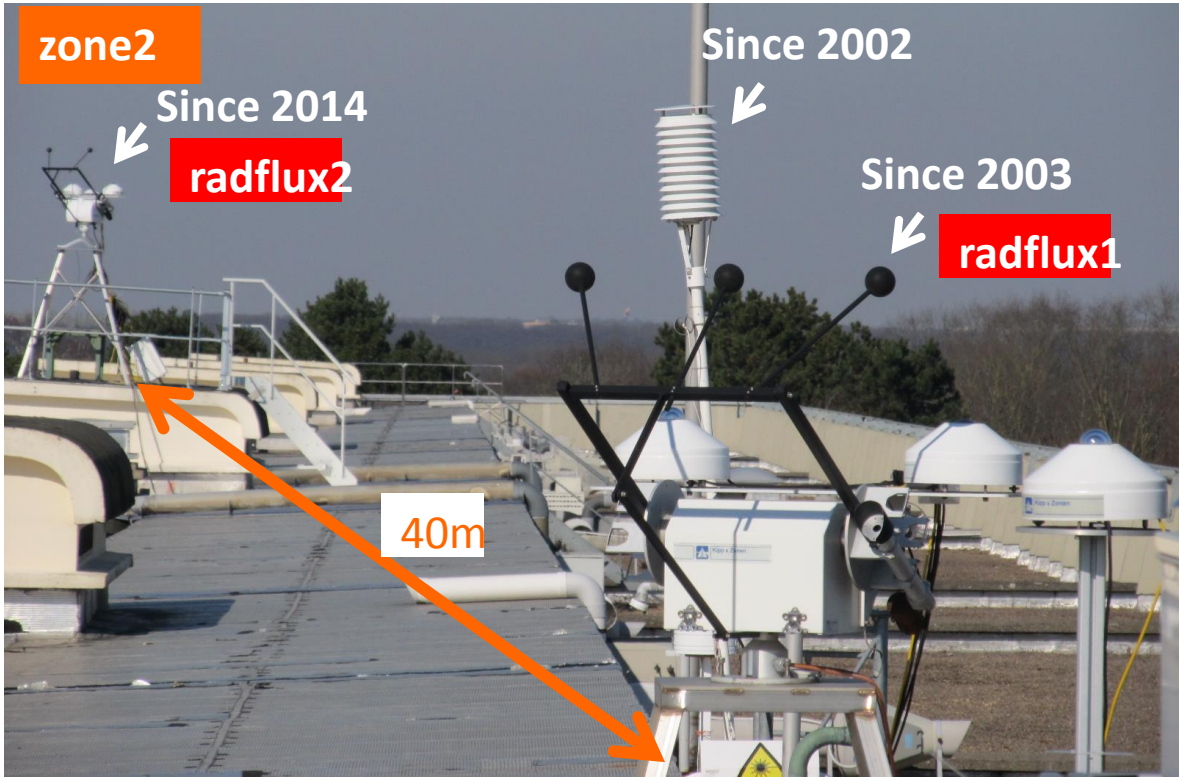
Station PAL, Paris region, France

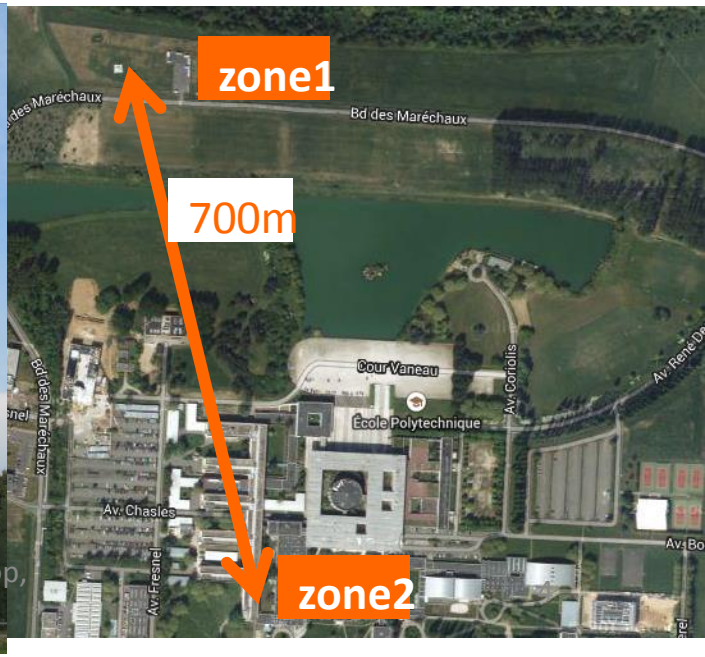
Contribution to BSRN since 2003.

Current available parameters in BSRN archive :

- SWDn (DIF, DIR, GLO), LWDn
- Air temperature, RH, pressure

The new installation in 2014 will become reference for the site.





Questions addressed using the PAL BSRN data

How accurate are SWdn and LWdn measurements ?

What are the aerosols effects on solar radiation on pollution peak events ?

What is the accuracy of solar resource assessment depending on the data available ?

How to improve numerical weather predictions?

How radiometers of different quality compare on tilted surfaces?

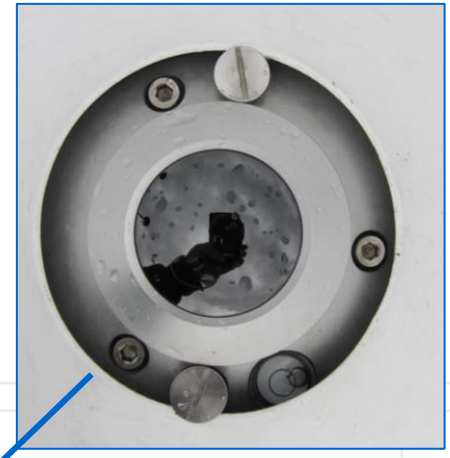
Which is the gain of combining photovoltaic panels with reflectors ?

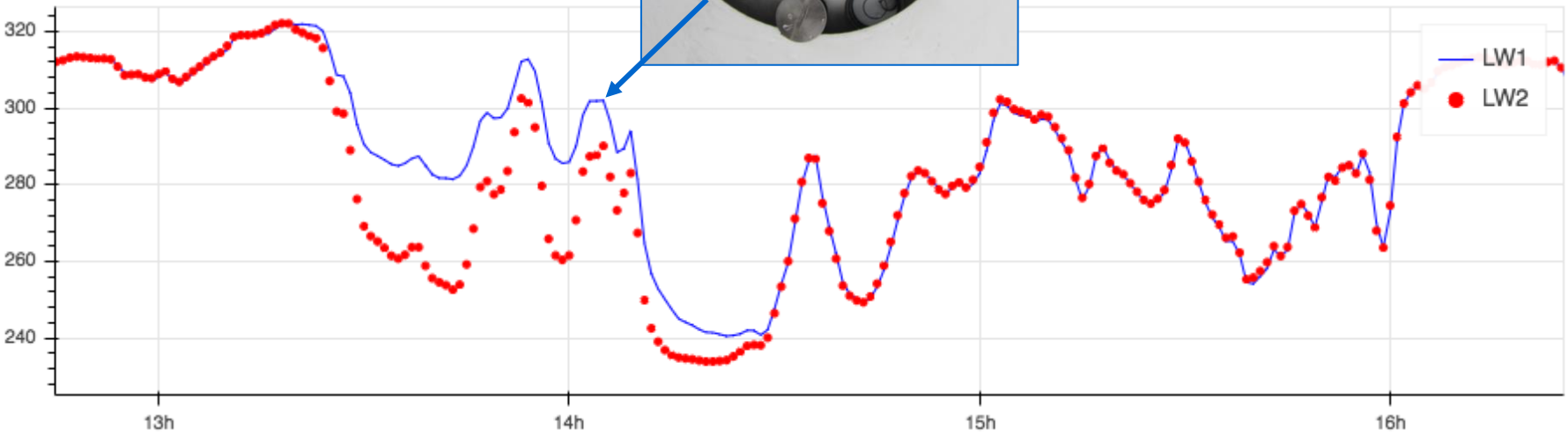
How to train on SW and LW radiation ?

What are the cloud effects on SWdn and LWdn ?

How accurate are SWdn and LWdn measurements ?

Water on the pyrgeometer dome creates a positive measurement offset





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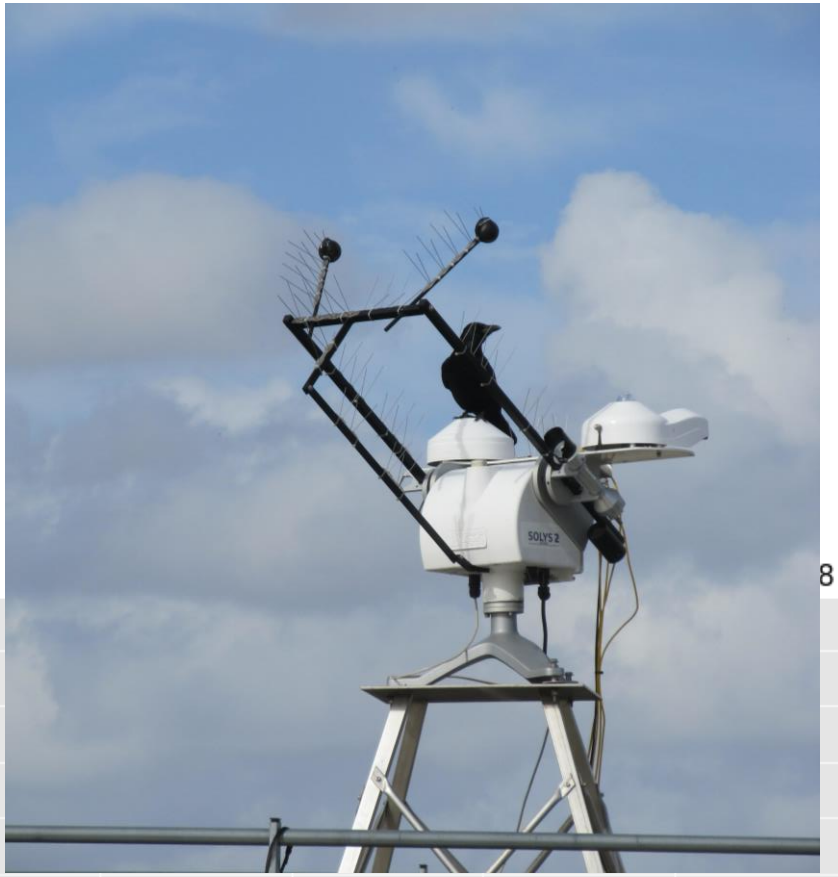
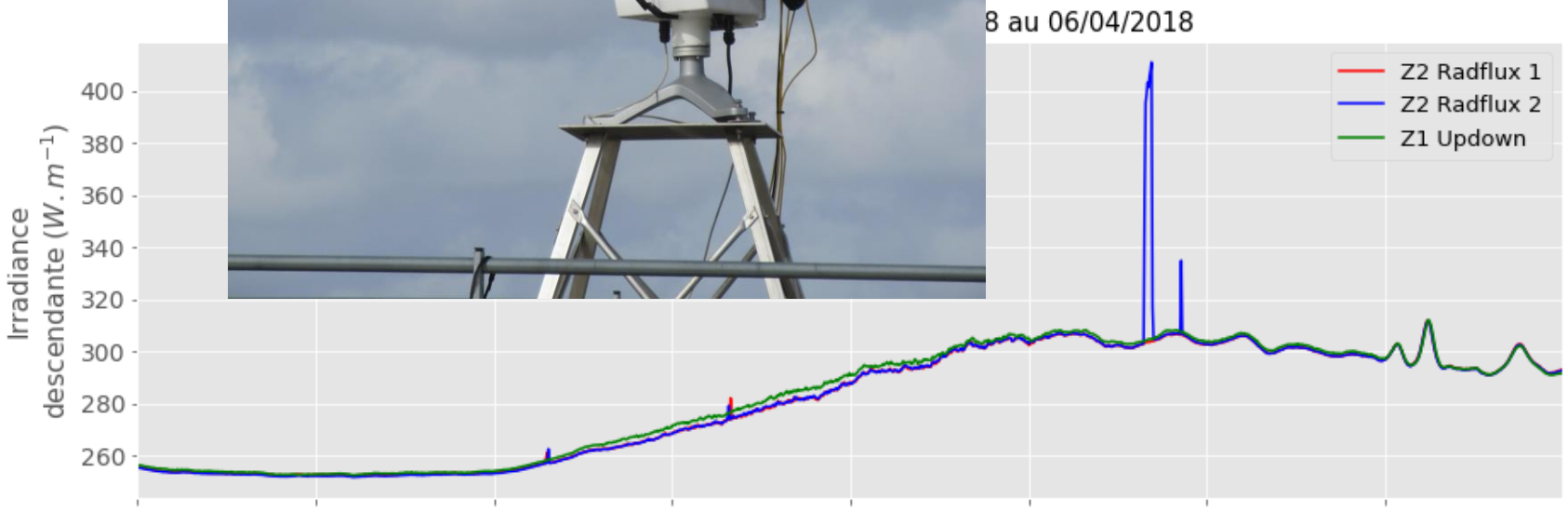


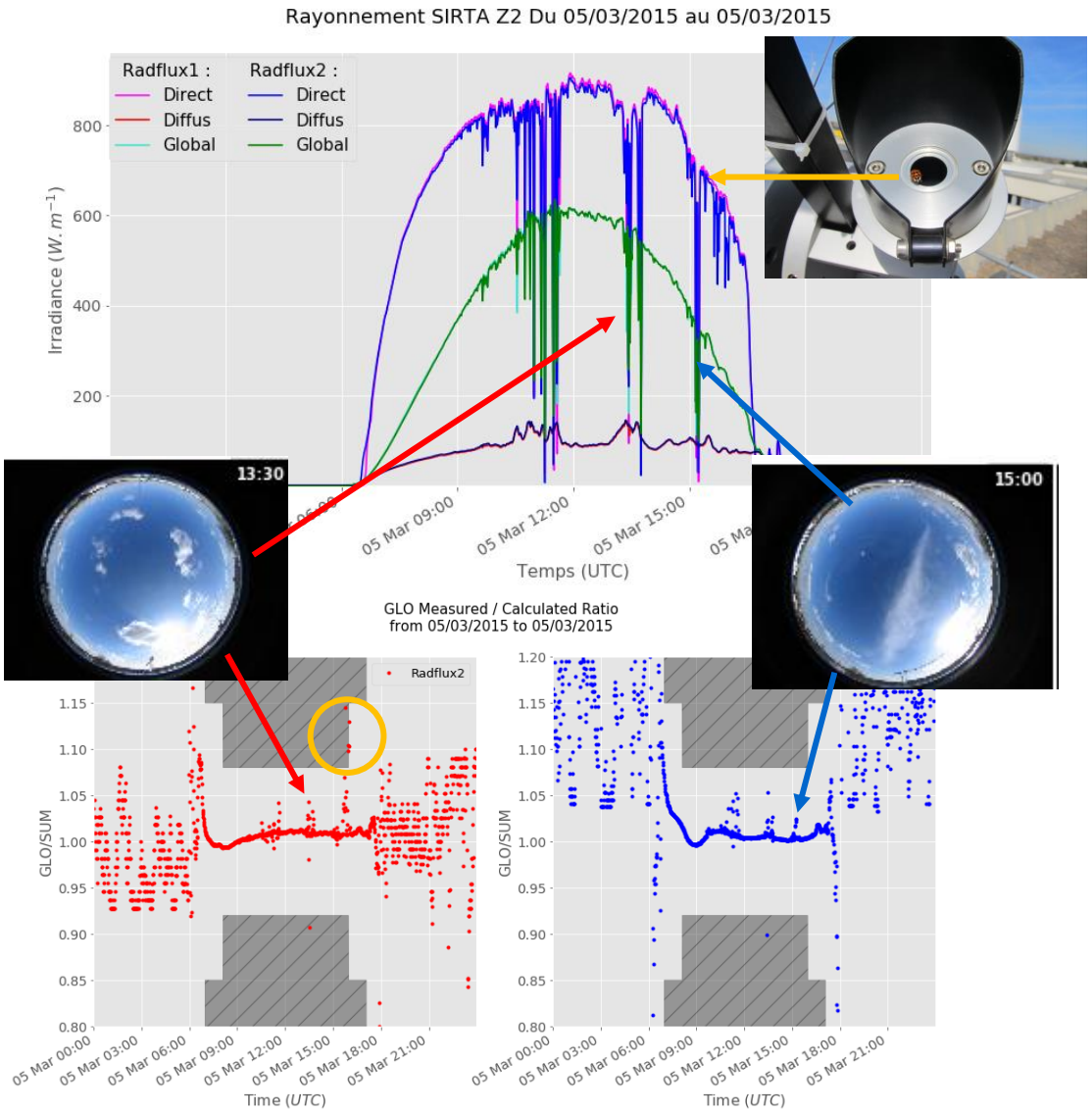
Bird sitting on the instrument domes creates large spikes in LWDn or large GLO/SUM inconsistencies



How accurate are SWdn and LWdn measurements ?

Situations with broken clouds, with brightness changes on the circumsolar region, might lead to GLO/SUM inconsistencies.

On this day, around 15 UTC, there was a small animal (probably a ladybug) on the window of the pyrheliometer of radflux2.



What are the aerosols effects on solar radiation on pollution peak events ?

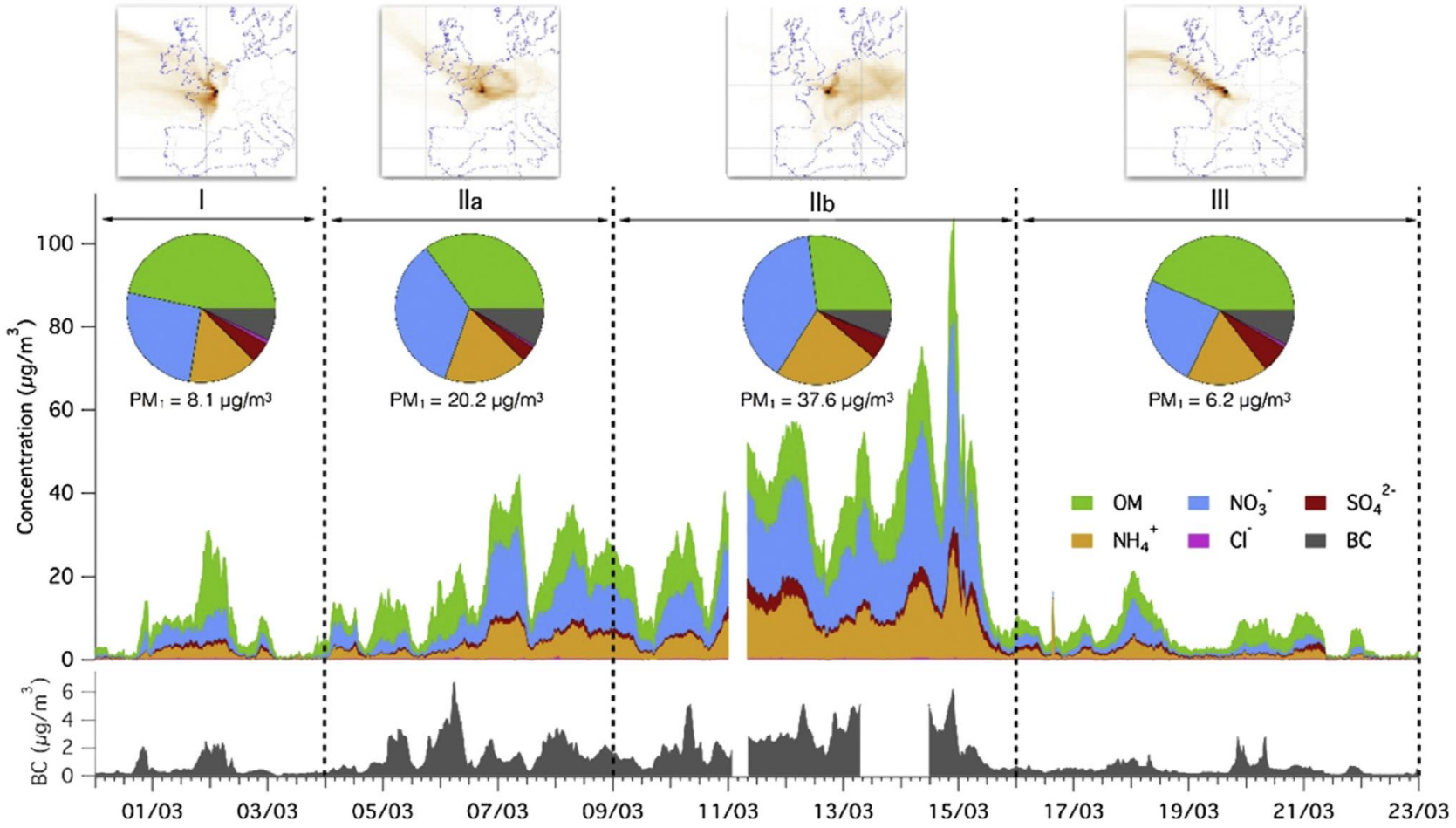


Fig. 2. Temporal variations of the chemical composition of submicron aerosols from ACSM and Aethalometer measurements before, during and after the high level pollution event. The top panel shows the average Flexpart backtrajectories for each delimited period, represented as the number of particles crossing each 0.5° × 0.5° grid cell during the 8 days of transport, relatively to the maximum of this number over the grid.

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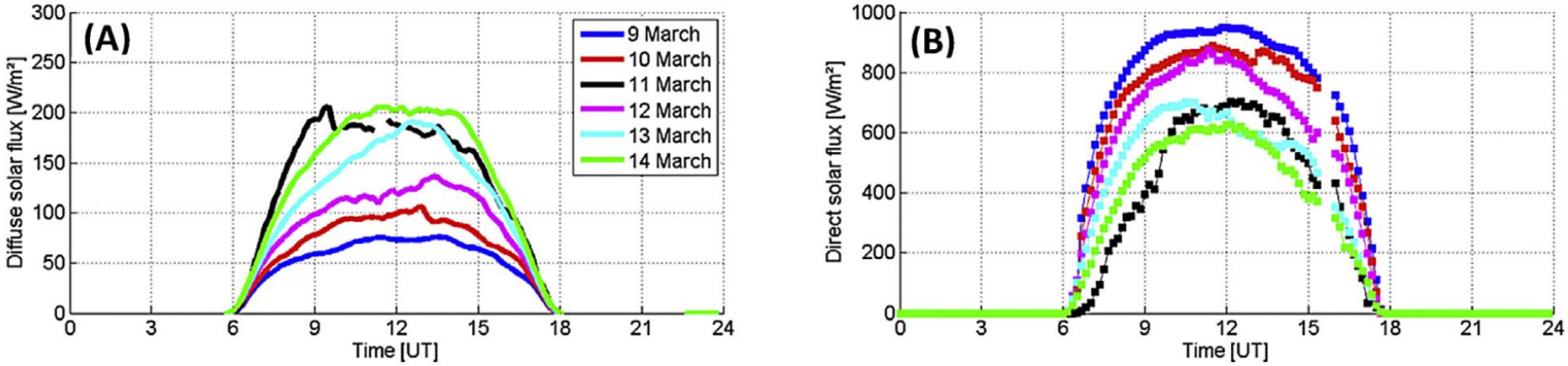


Fig. 4. Diurnal cycle of diffuse solar downwelling flux (A) and direct solar downwelling flux (B) between March 9 and March 14, 2014. Relationship between aerosol optical depth and visible extinction depending on relative humidity (C) and boundary layer depth (D) and between aerosol direct radiative effect and aerosol optical depth for direct, diffuse, and global irradiance (E).

What is the accuracy of solar resource assessment on a tilted surface depending on the data available ?

BSRN measurements

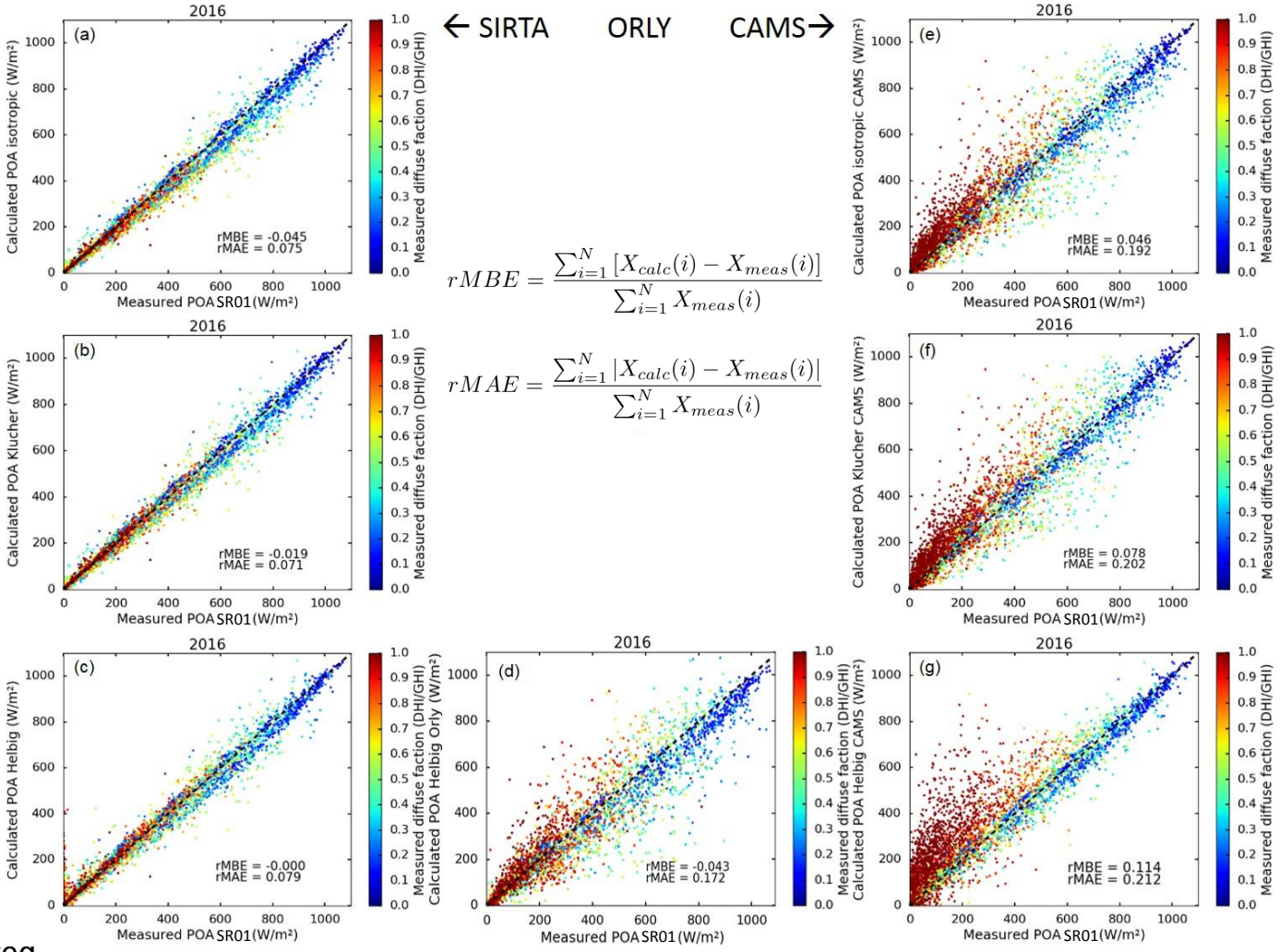
Nearby station (ORLY, 10 km away)

Satellite-based CAMS product

Isotropic
GHI, DNI, DHI

Klucher model
GHI, DNI, DHI

Helbig model
GHI



$$rMBE = \frac{\sum_{i=1}^{N} [X_{calc}(i) - X_{meas}(i)]}{\sum_{i=1}^{N} X_{meas}(i)}$$

$$rMAE = \frac{\sum_{i=1}^{N} |X_{calc}(i) - X_{meas}(i)|}{\sum_{i=1}^{N} X_{meas}(i)}$$

Migan et al, 2018, to be submitted

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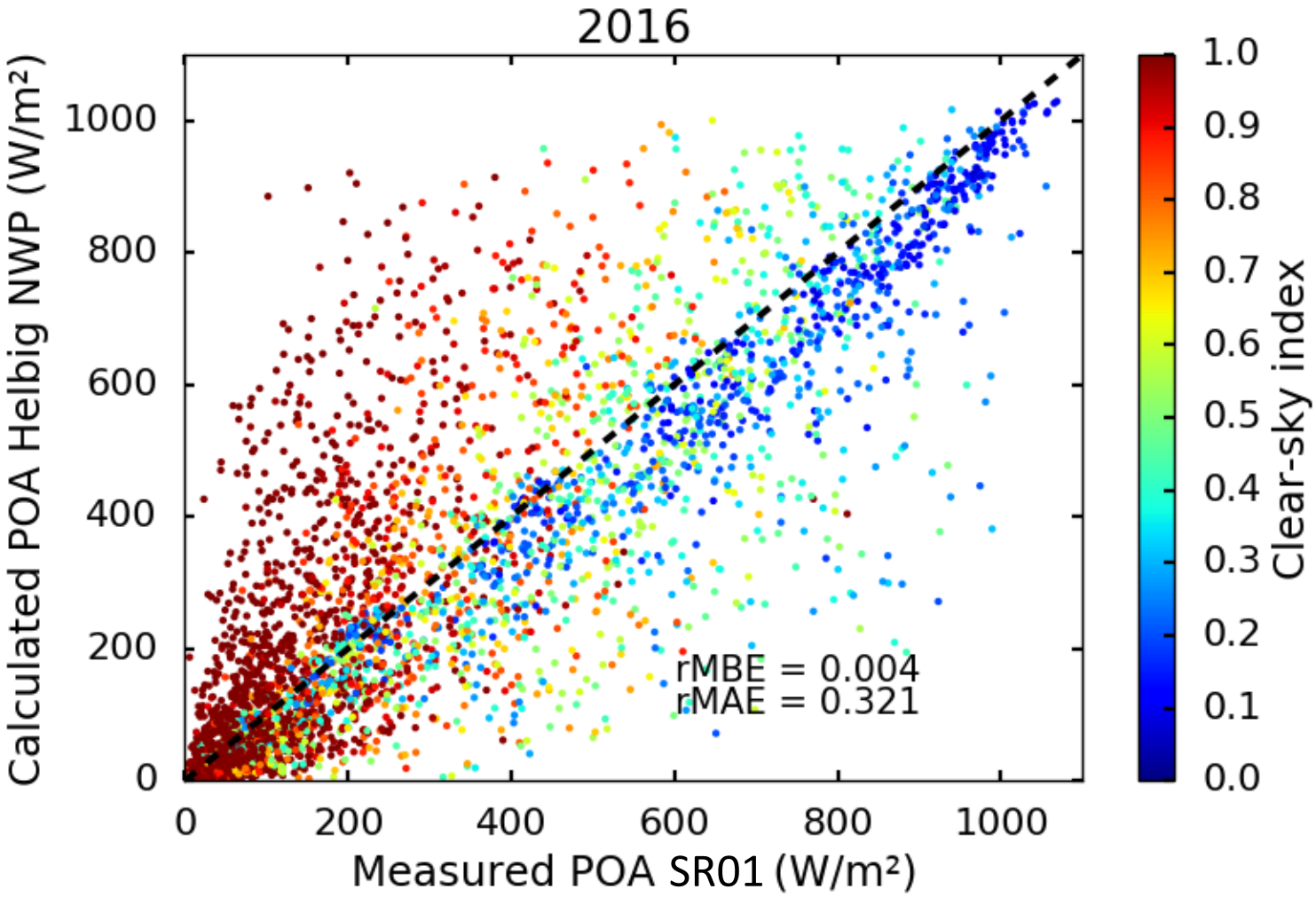
TABLE 2: Uncertainty estimation in the calculation of G_{POA} (smallest values in red)

Step	Model	Input data					
		SIRTA		ORLY		CAMS	
		rMBE	rMAE	rMBE	rMAE	rMBE	rMAE
2	Isotropic	-0.045	0.075	–	–	0.046	0.192
	Klucher	-0.019	0.071	–	–	0.078	0.202
1+2	Helbig	0.000	0.079	-0.043	0.172	0.114	0.212

Migan et al, 2018, to be submitted

How to improve numerical weather predictions?



How to improve numerical weather predictions?

observations.ipsl.fr/espri/cosydata/

COSY | shortwave downwelling | Date < Jul 16 2018 | 00h00 | UTC > | Video | Multi-Field On | Domain « SIRTA »

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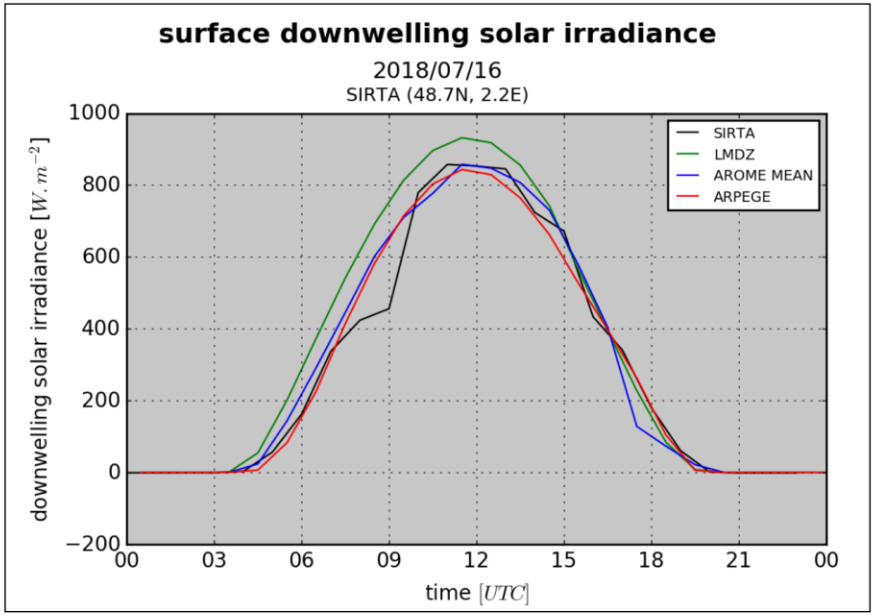

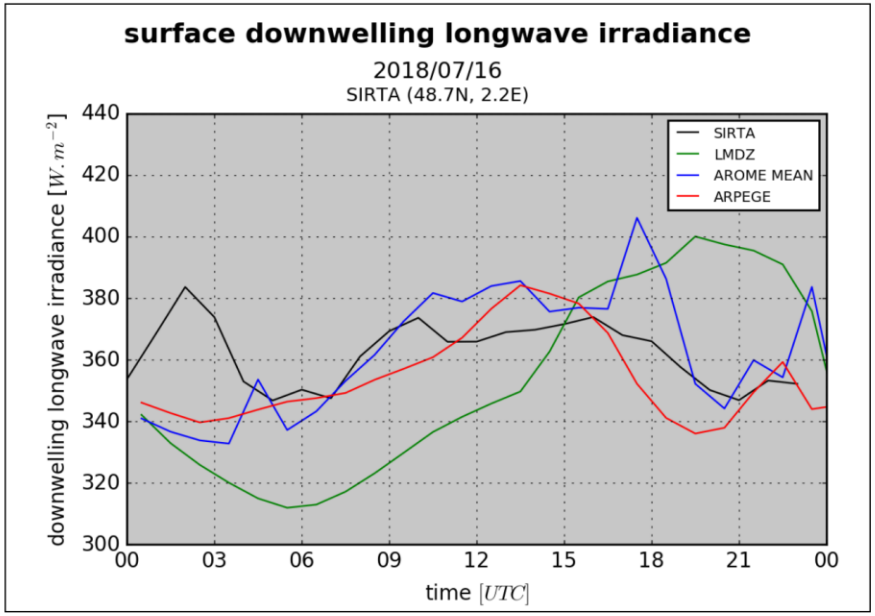

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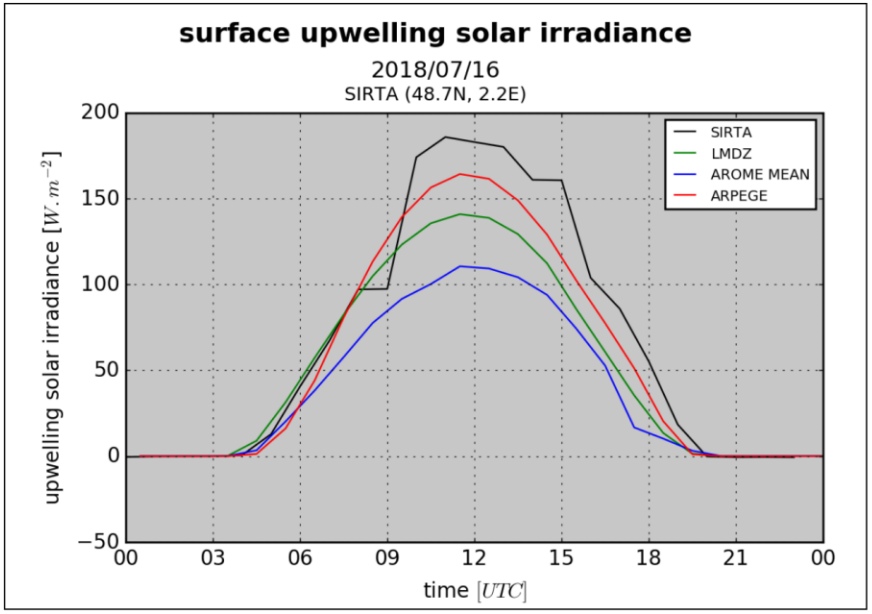
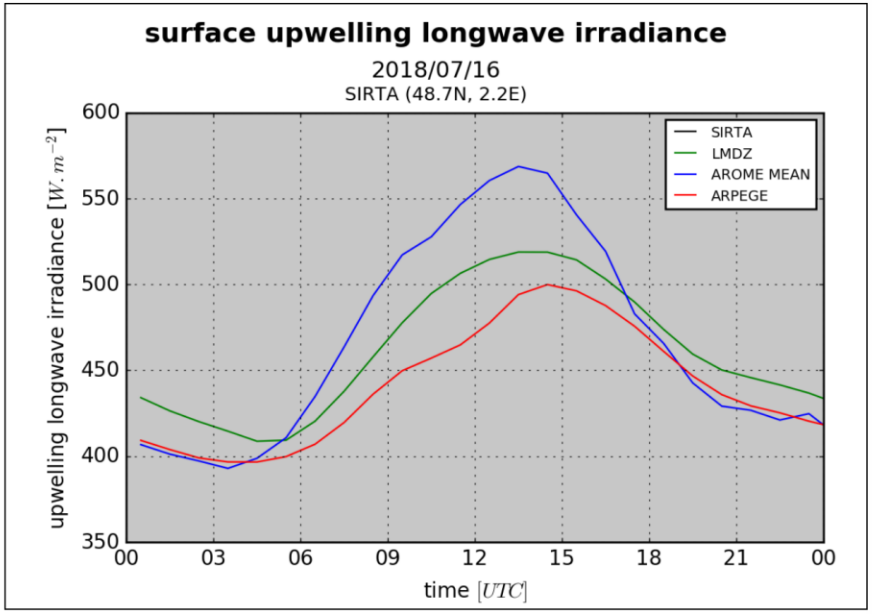
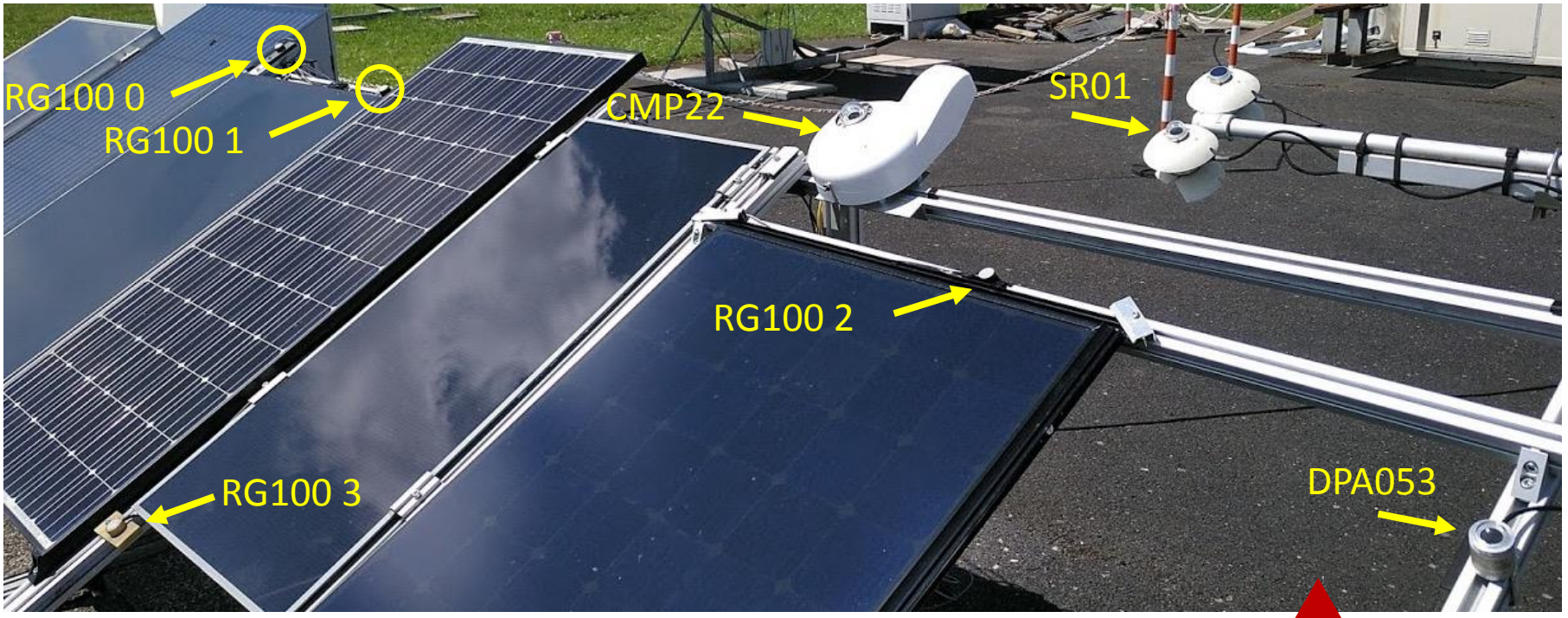
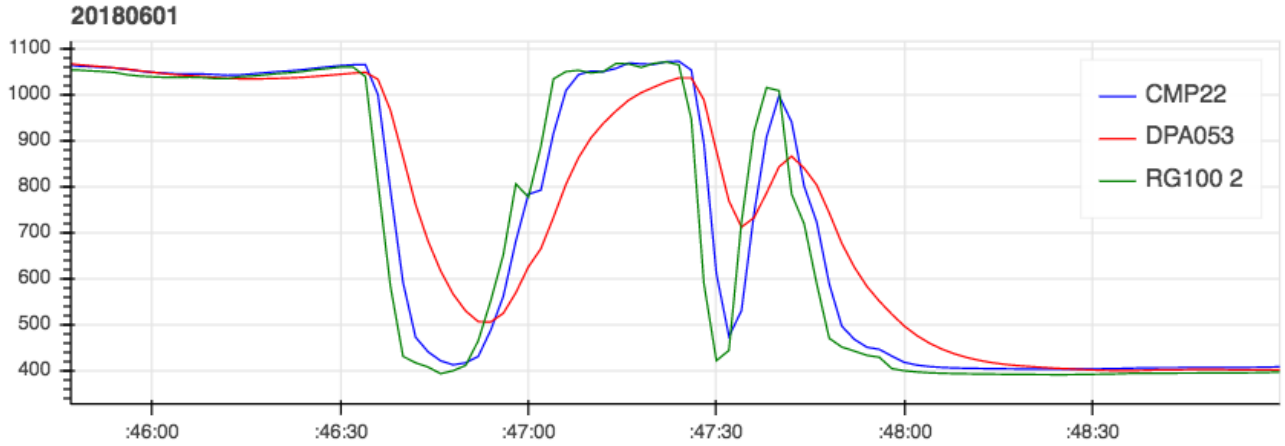




How radiometers of different quality compare on tilted surfaces?





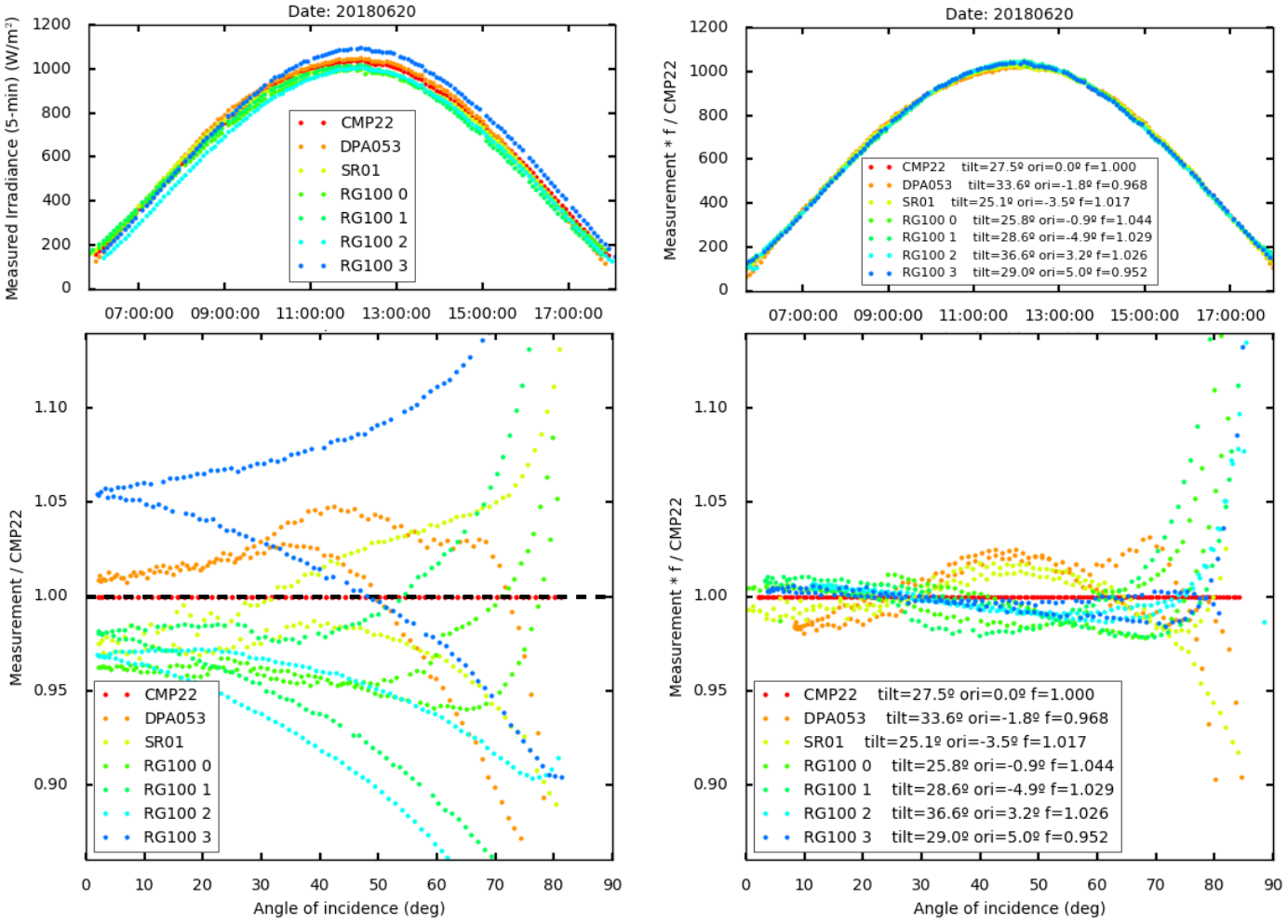
POSTER

Intercomparison of 7 solar radiometers on a tilted plane for photovoltaic applications: preliminary results

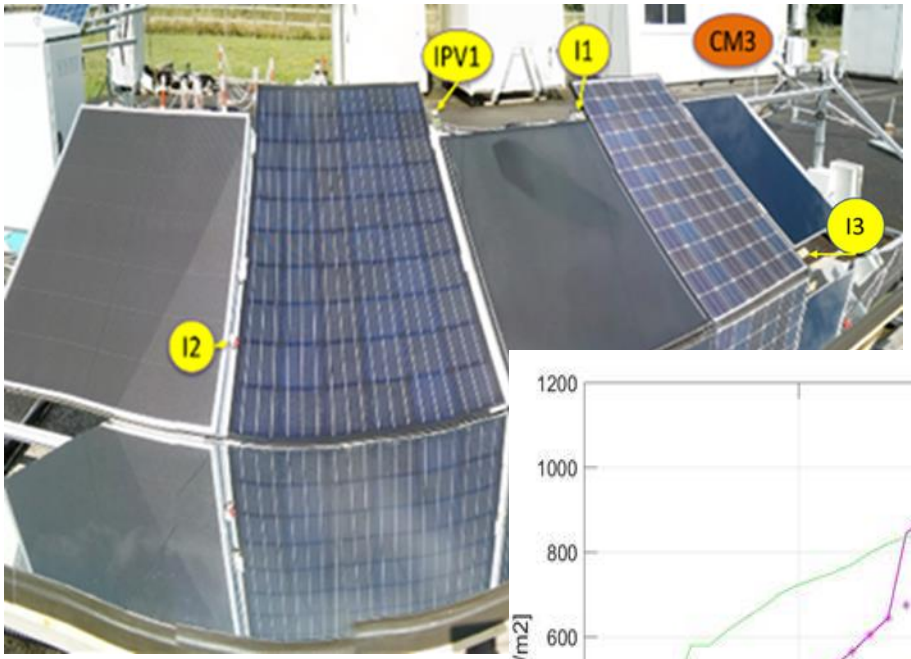
How radiometers of different quality compare on tilted surfaces?

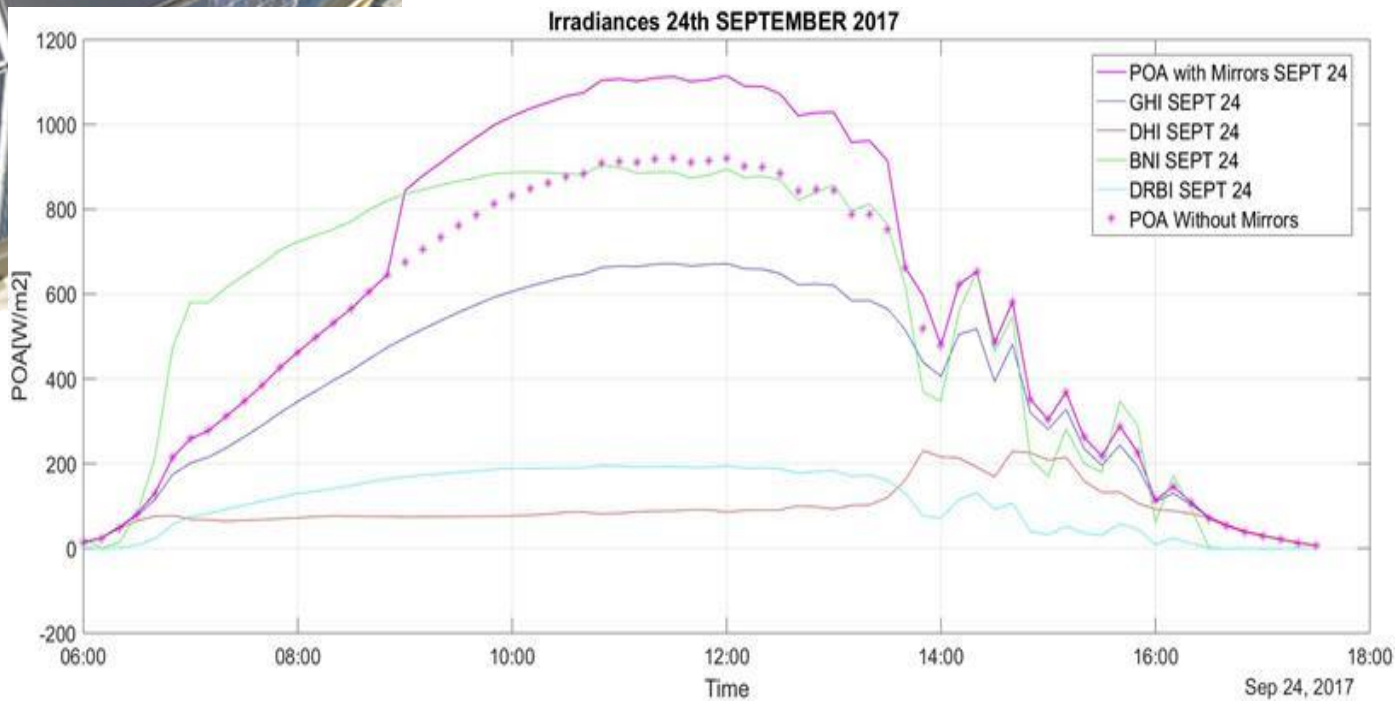
Original measurements

Corrected for 1) plane reprojection and 2) factor scaling



Which is the gain of combining photovoltaic panels with reflectors ?





How to train on SW and LW radiation ?

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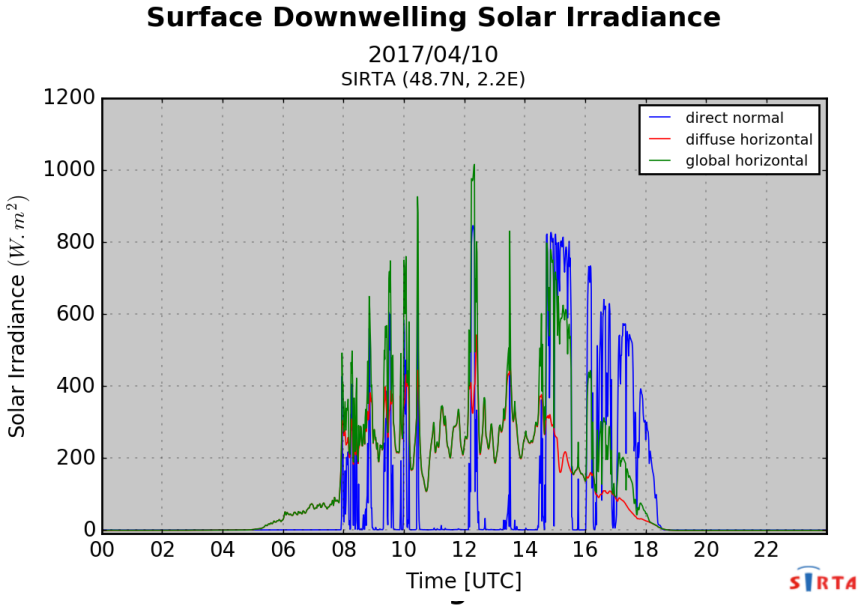

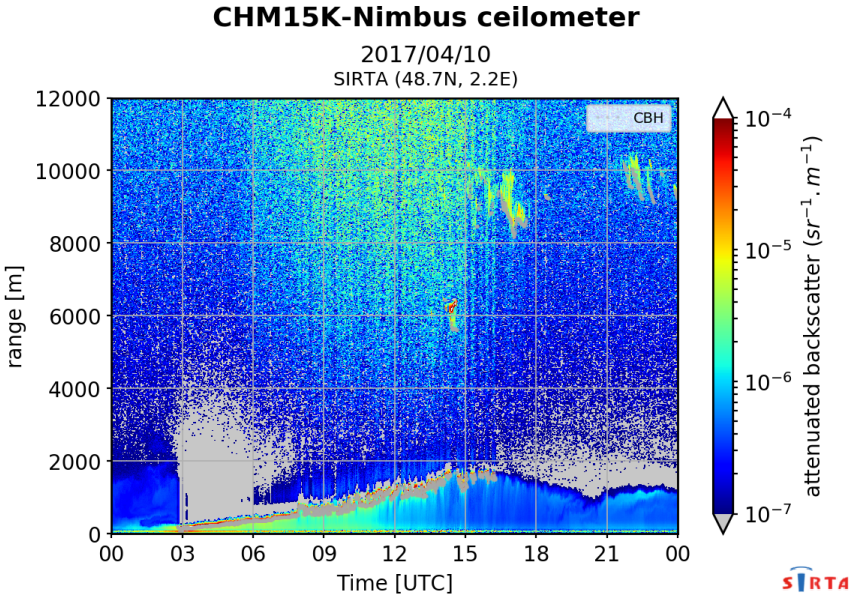

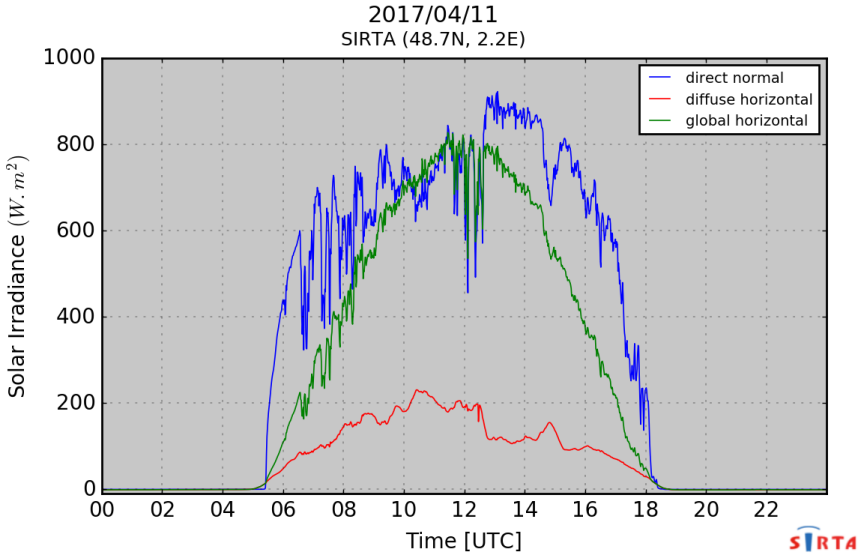

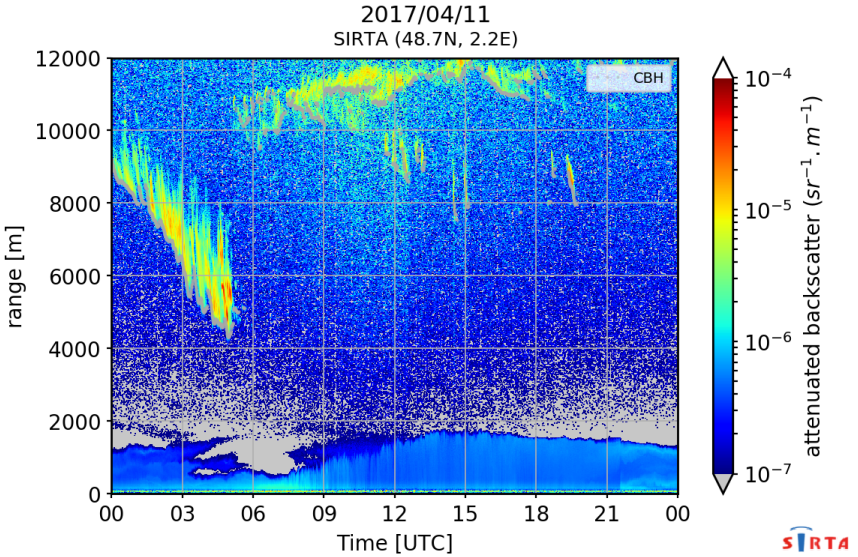

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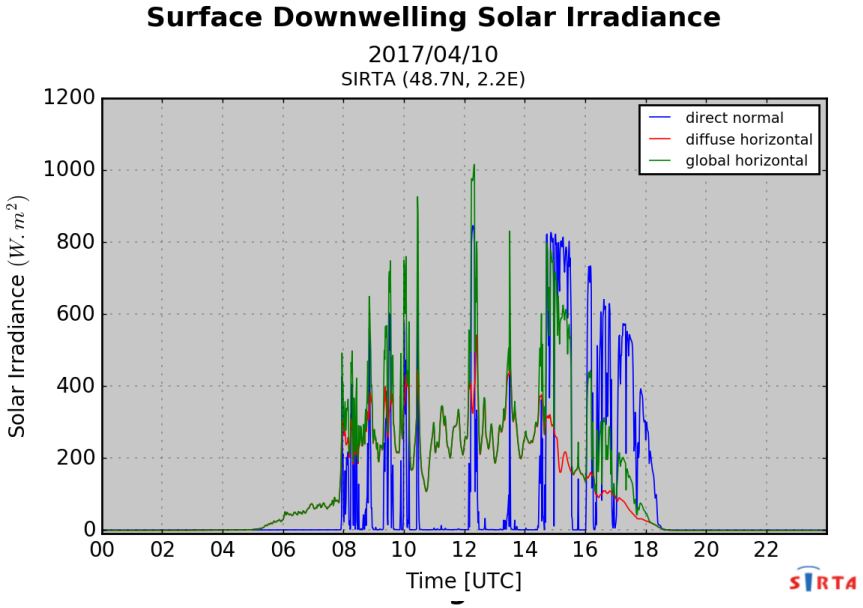

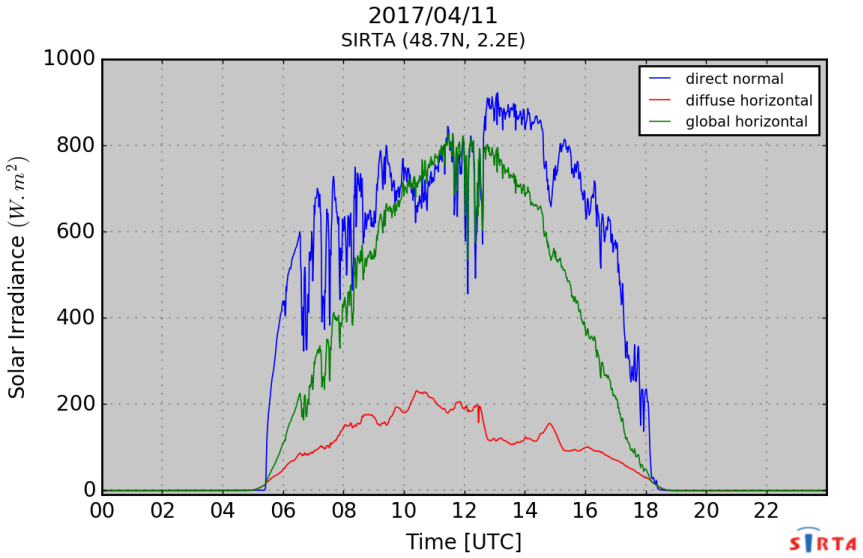

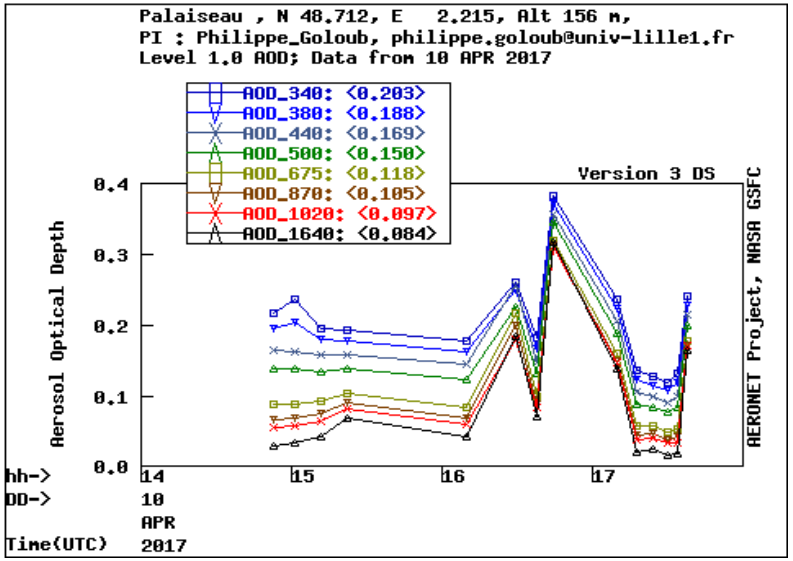

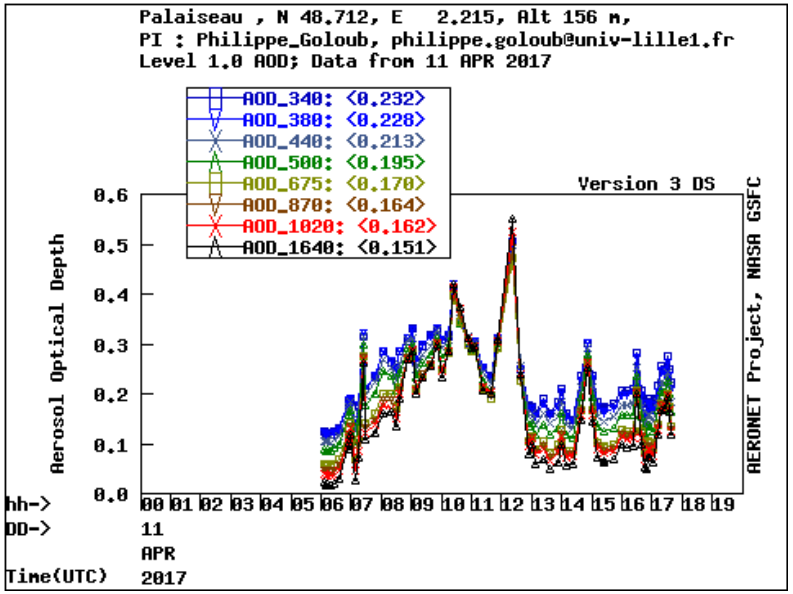

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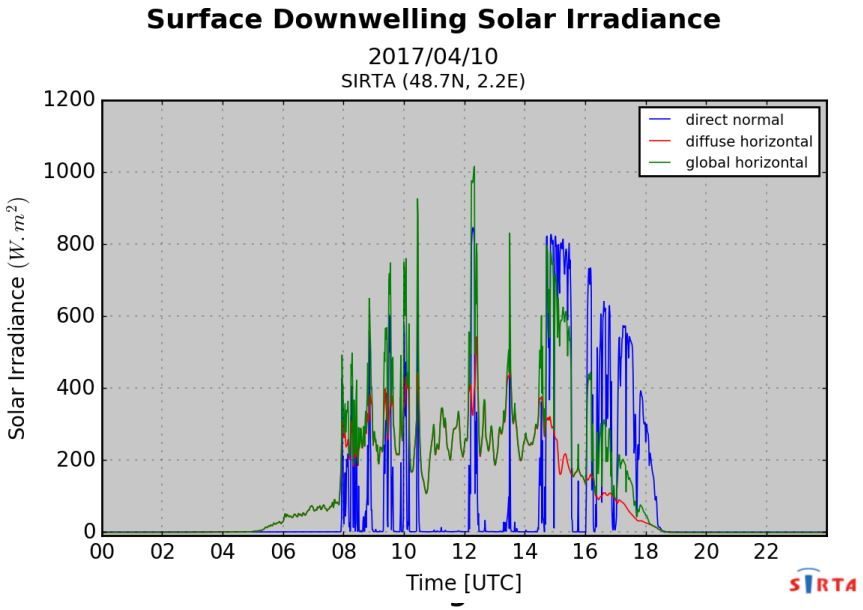

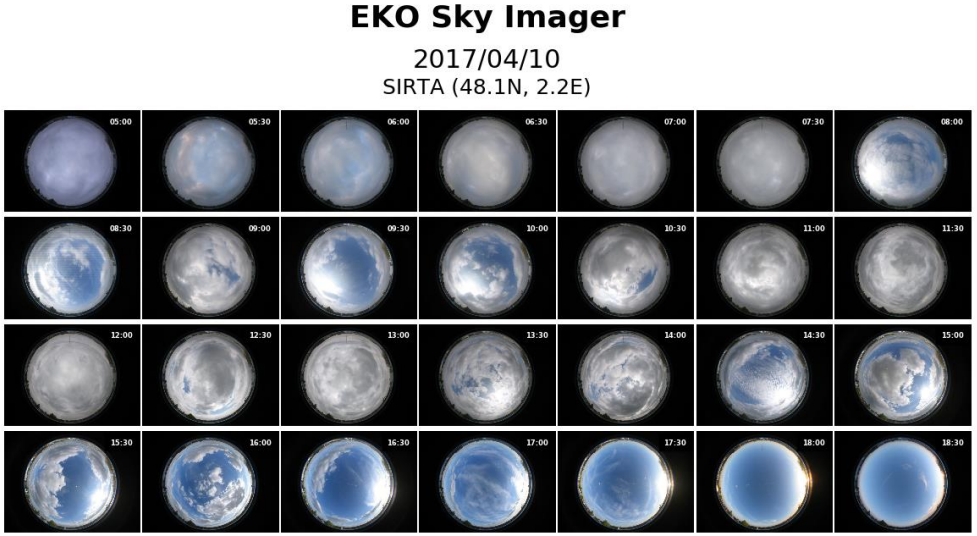

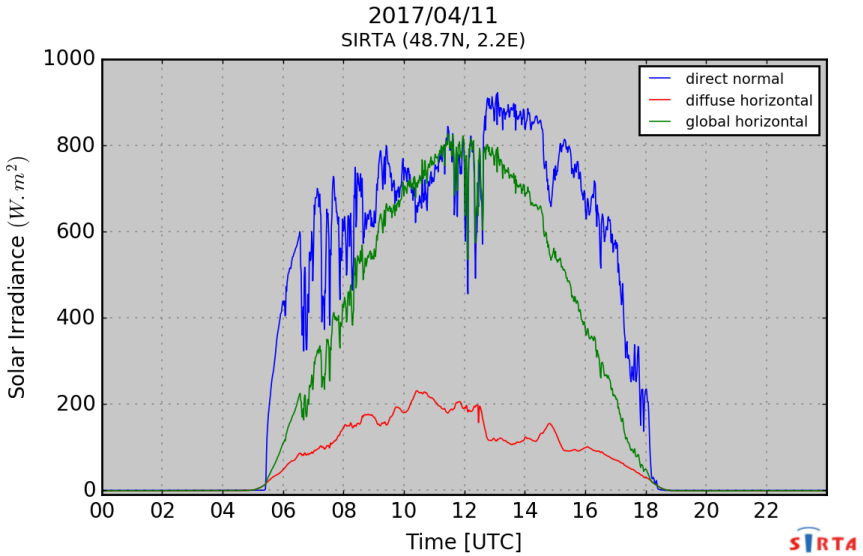

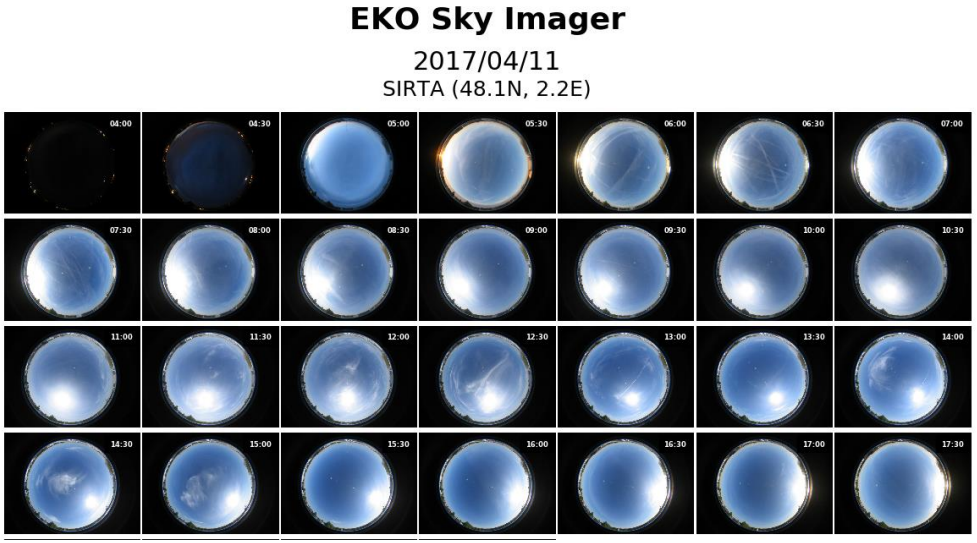

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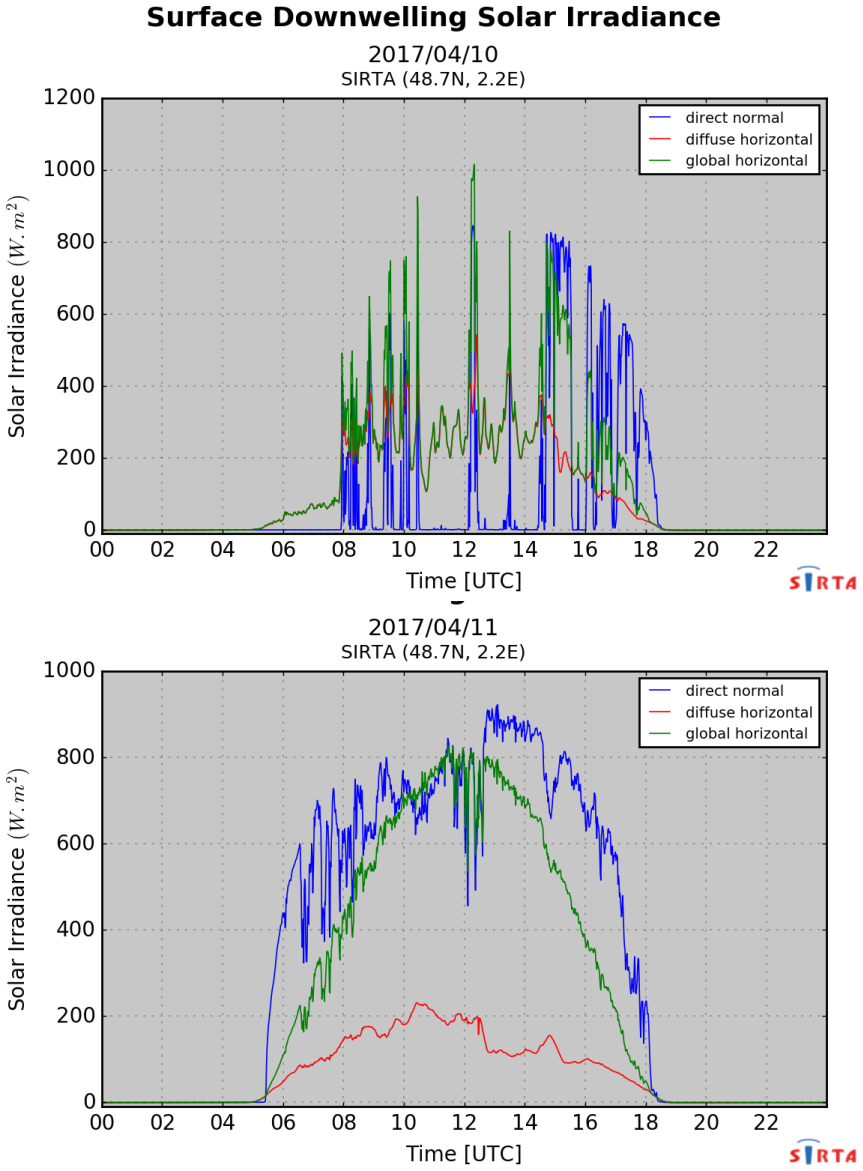

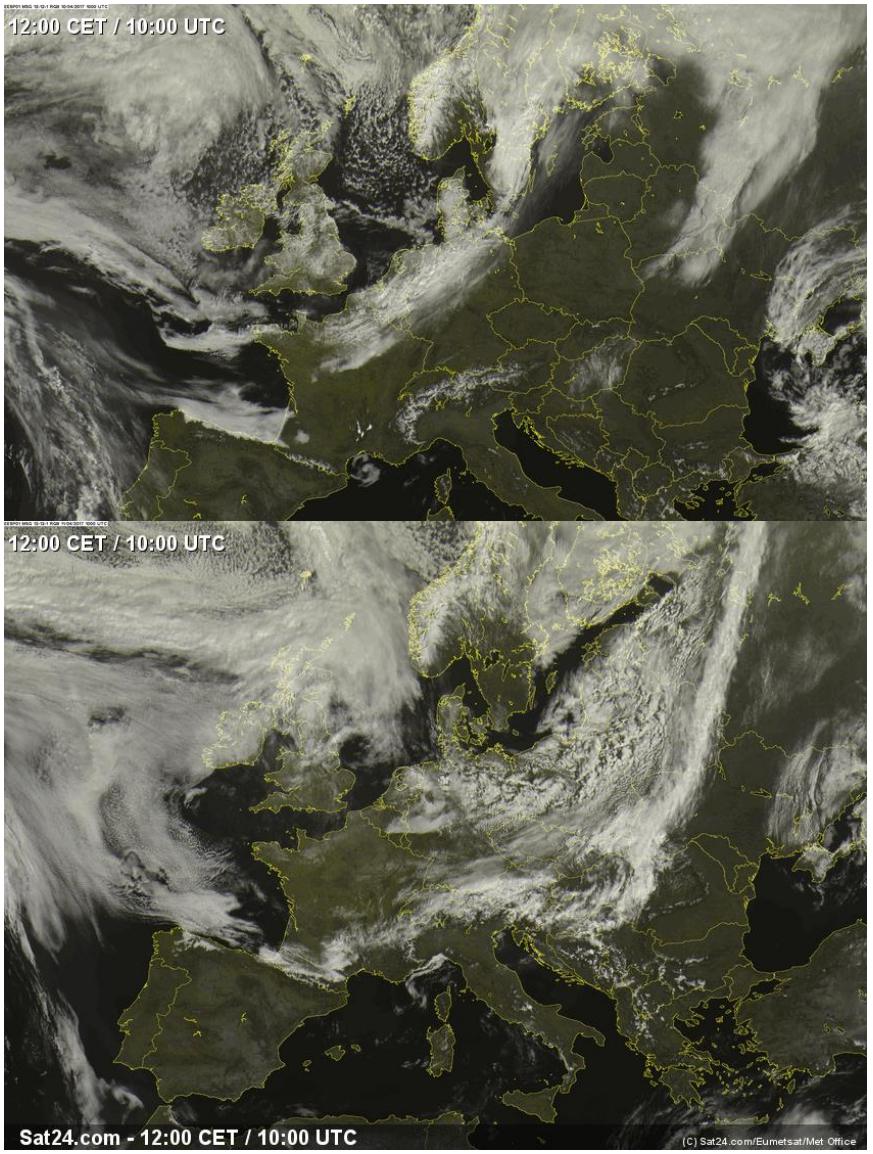

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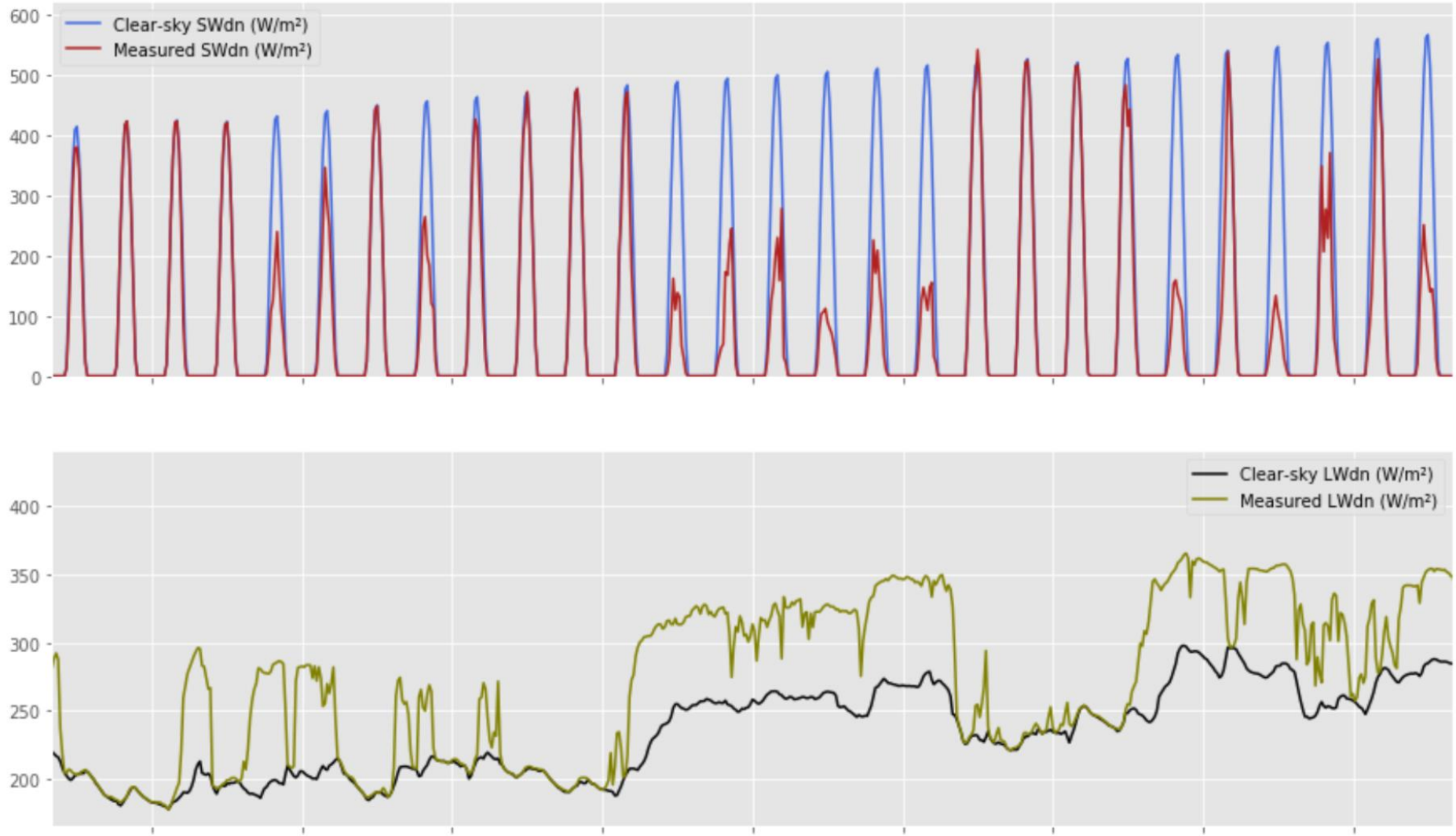
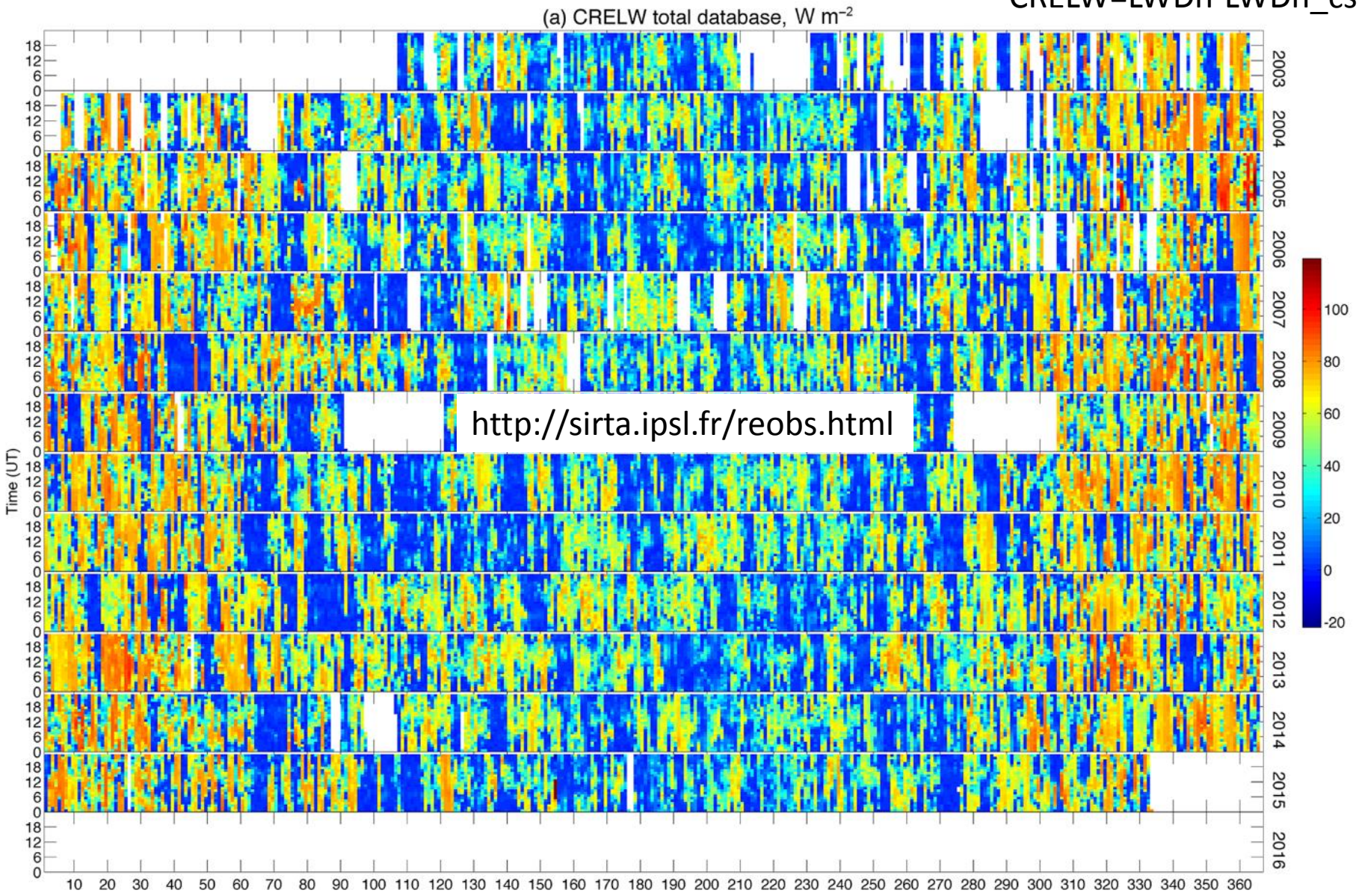


Clear-sky fluxes from Long et al, 2000, 2006, 2008

What are the cloud effects on SWdn and LWdn ?

CRELW=LWDn-LWDn_cs



Chiriaco, M., Dupont, J. C., Bastin, S., Badosa, J., Lopez, J., Haeffelin, M., ... & Guzman, R. (2018). ReOBS: a new approach to synthesize long-term multi-variable dataset and application to the SIRTA supersite. *Earth System Science Data*, *10*(2), 919.

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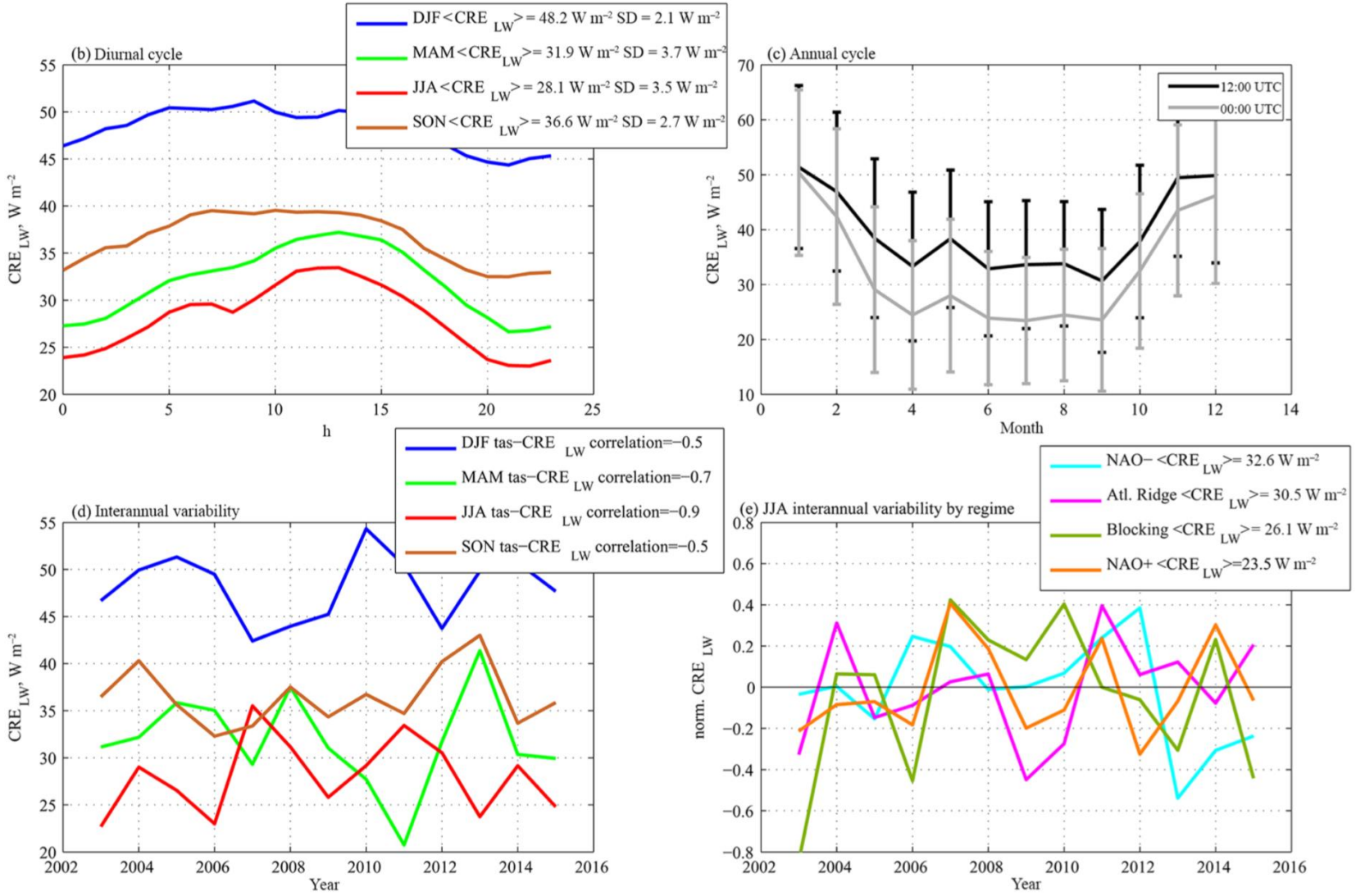

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Thanks for your attention!

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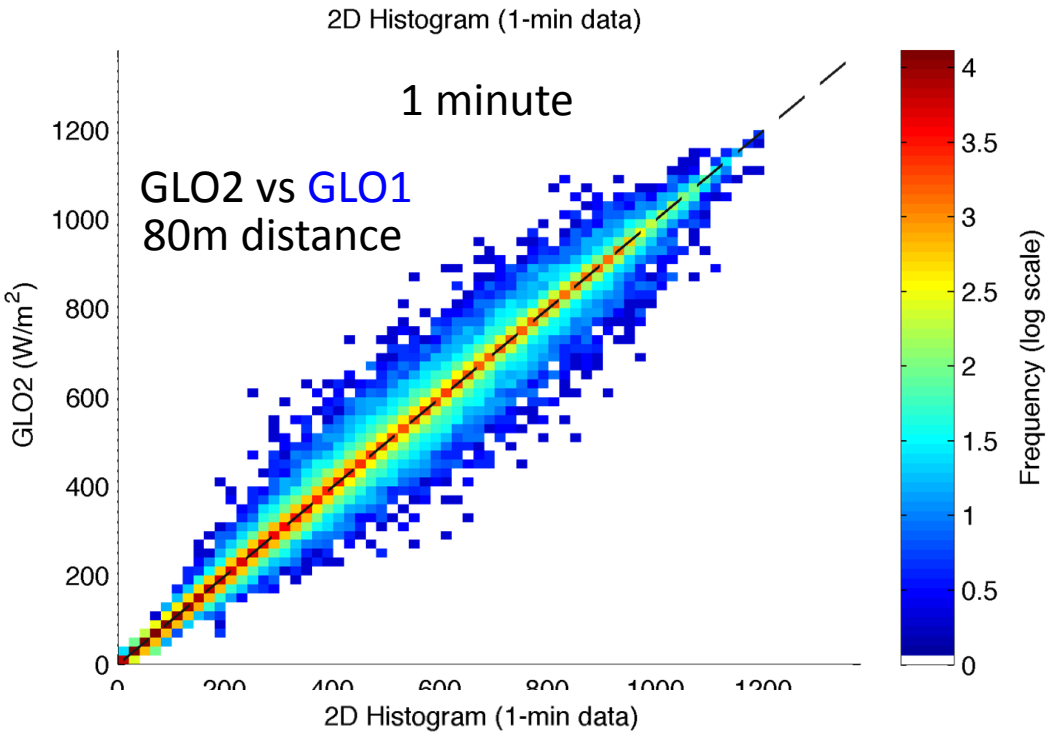
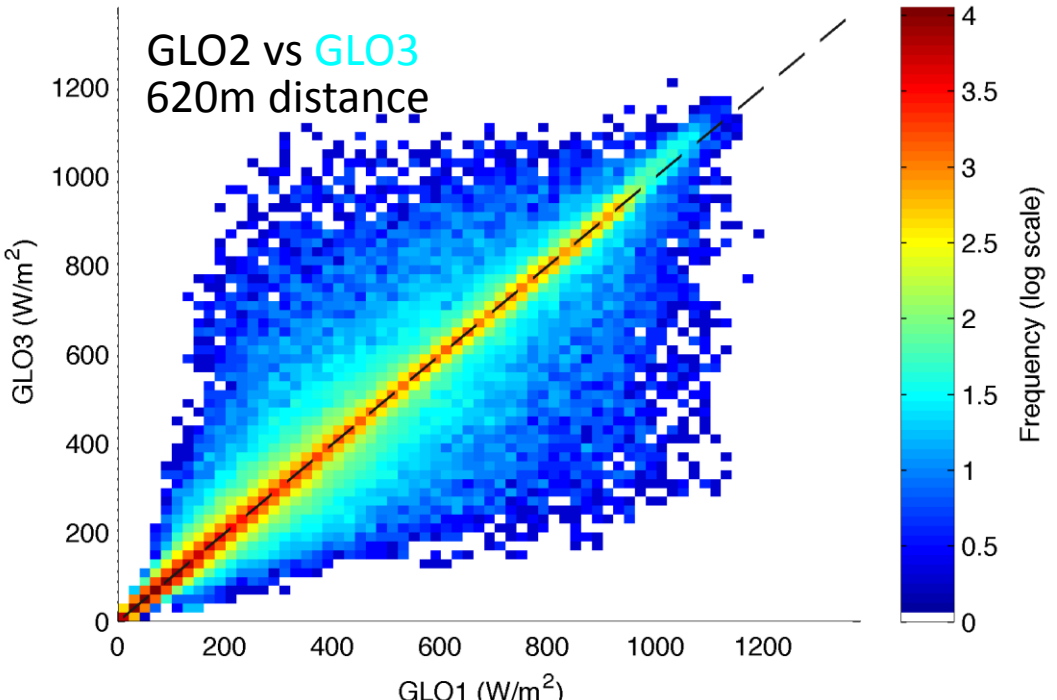
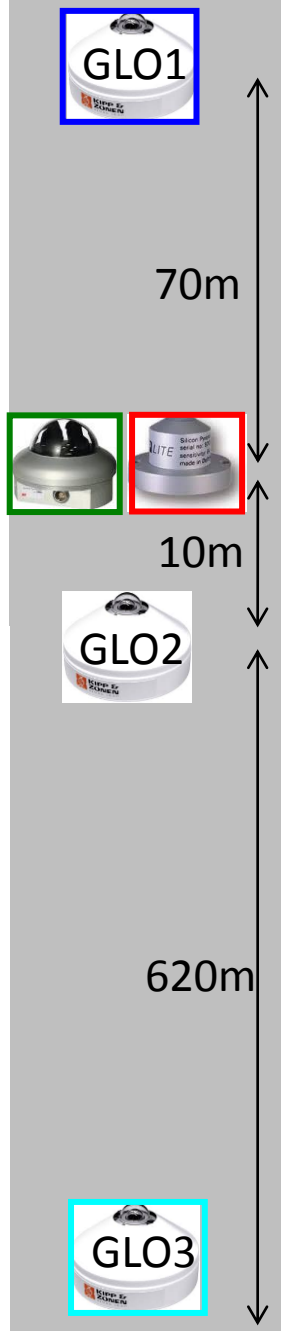
Extra slides

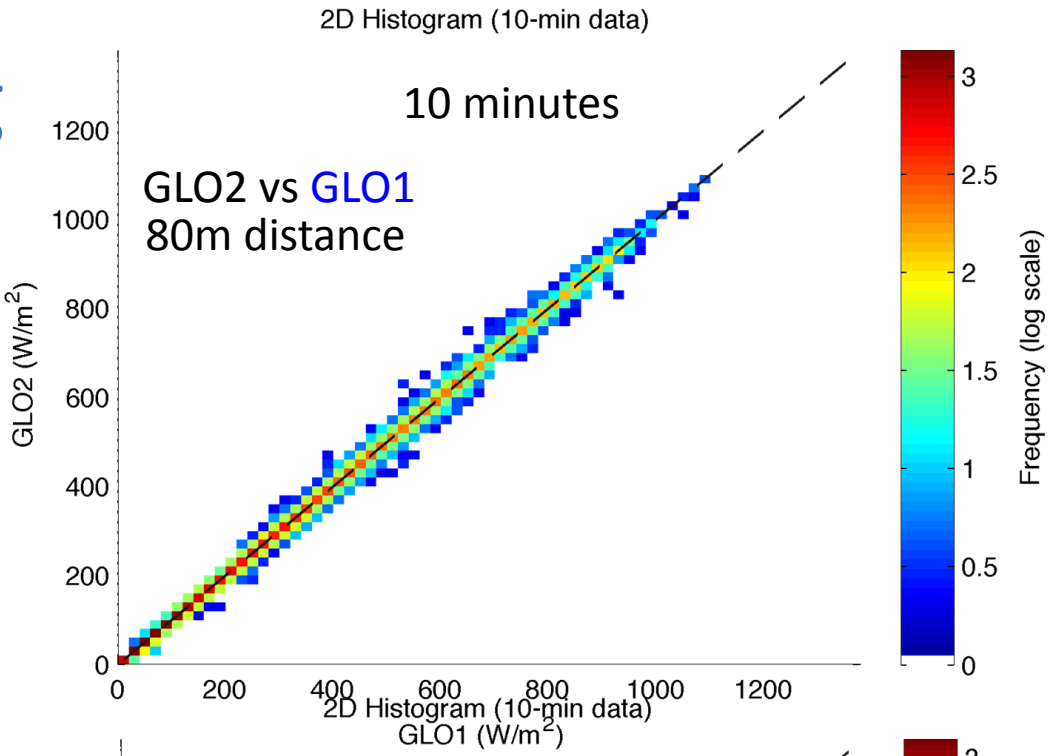
Downwelling SW irradiance comparison (2015)

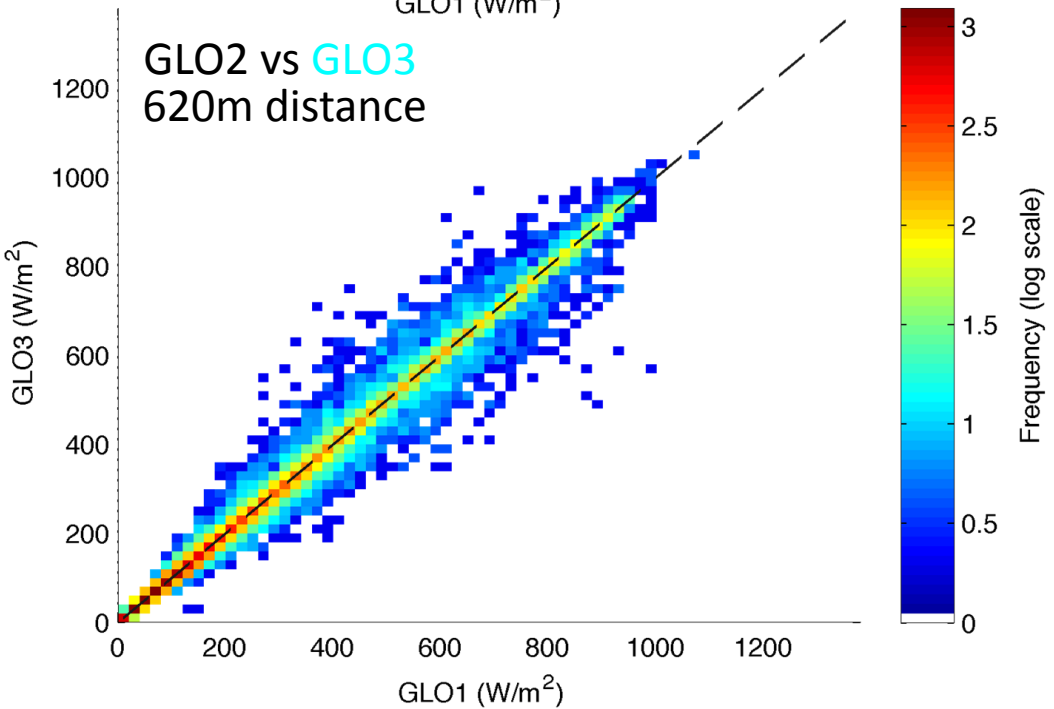


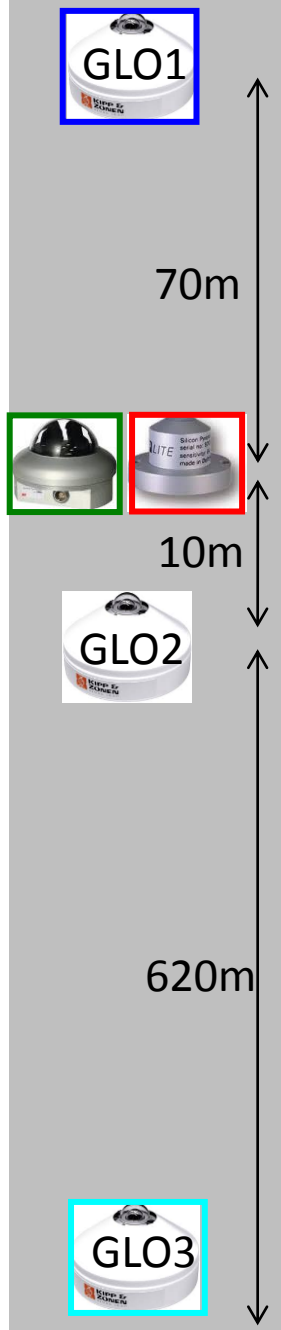




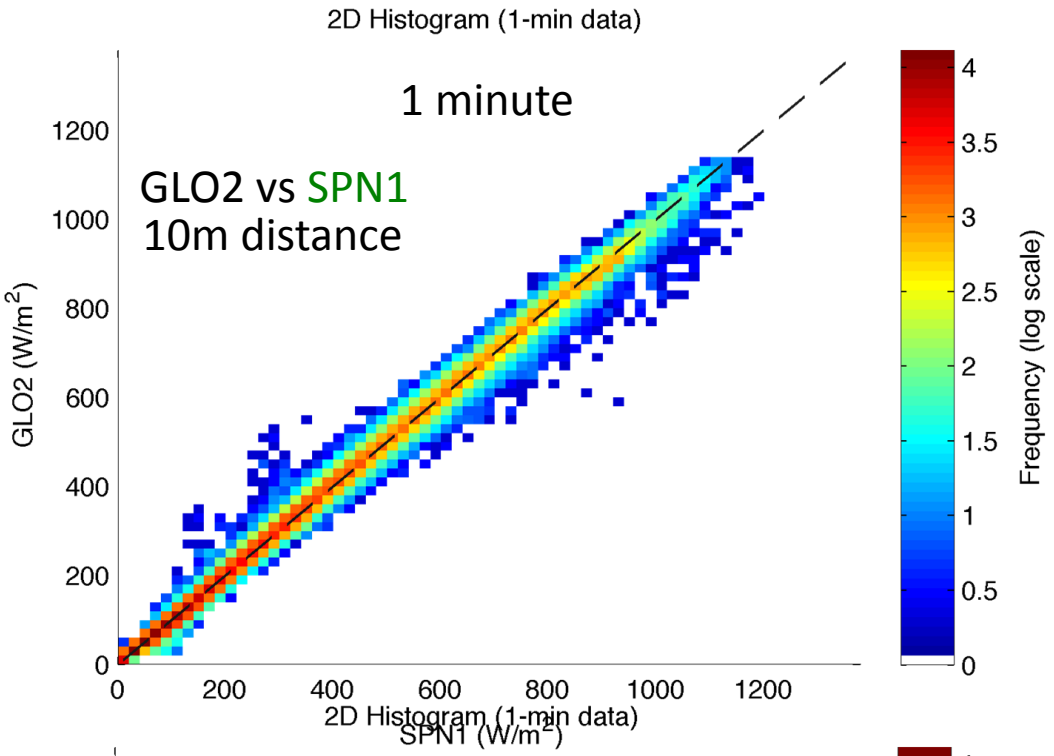
Downwelling SW irradiance comparison (2015)

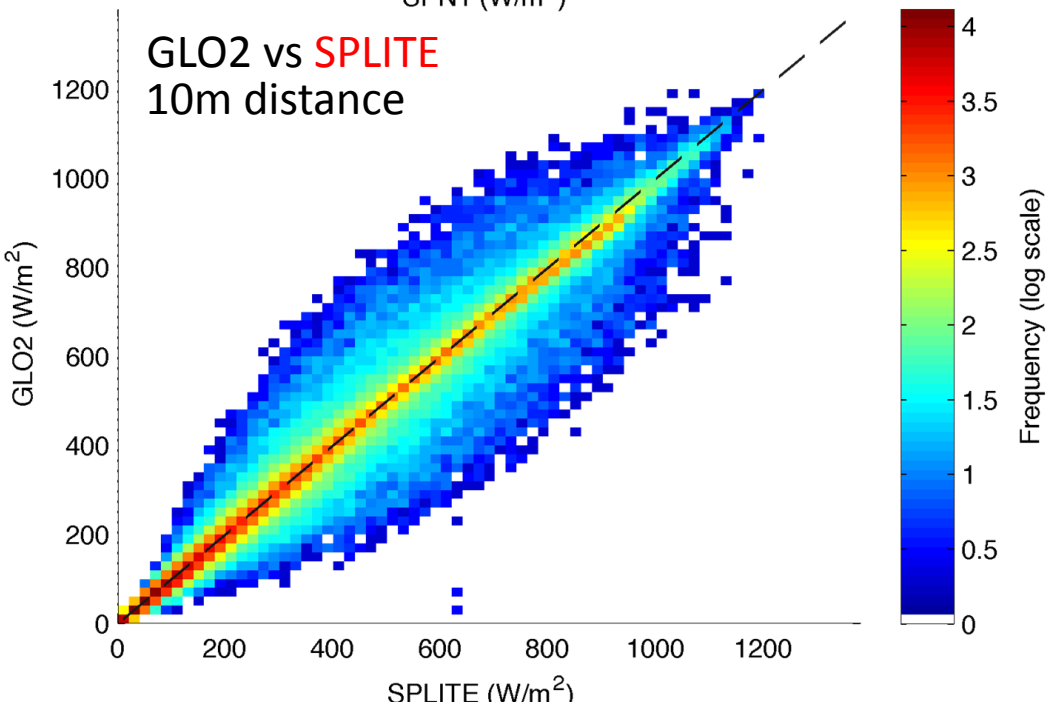


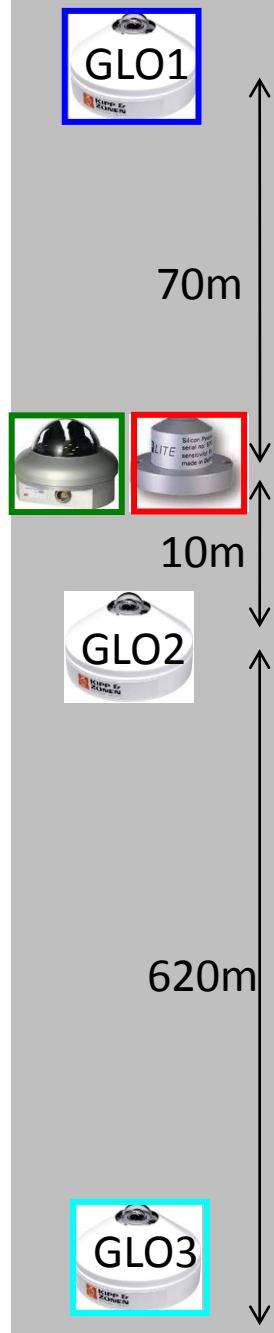




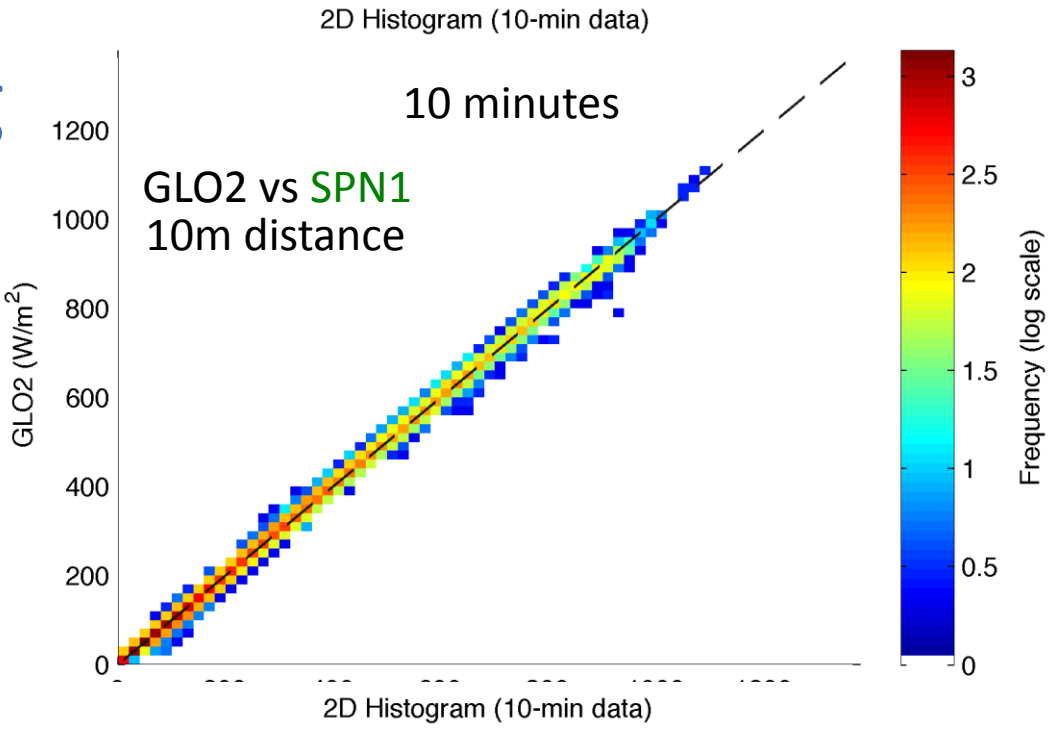
Downwelling SW irradiance comparison (2015)

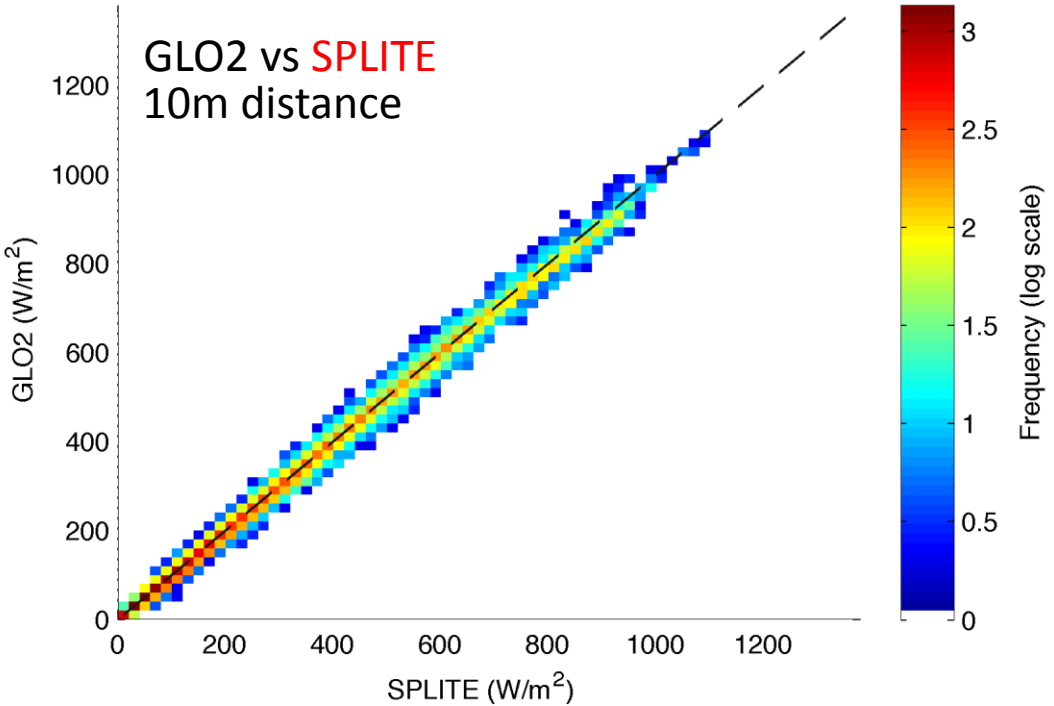


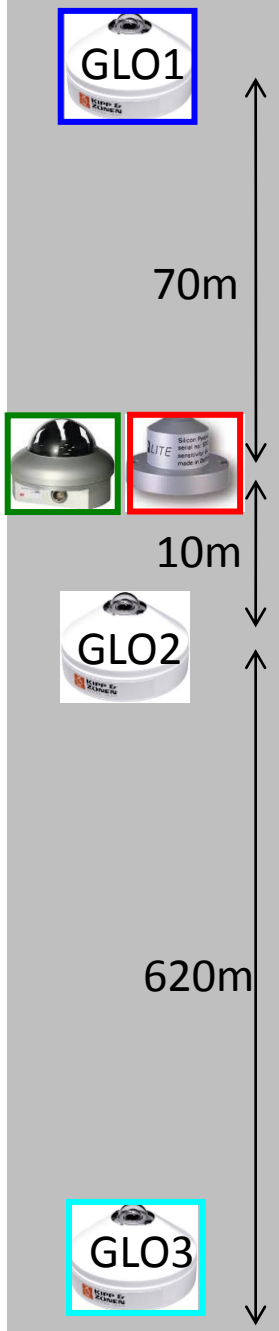




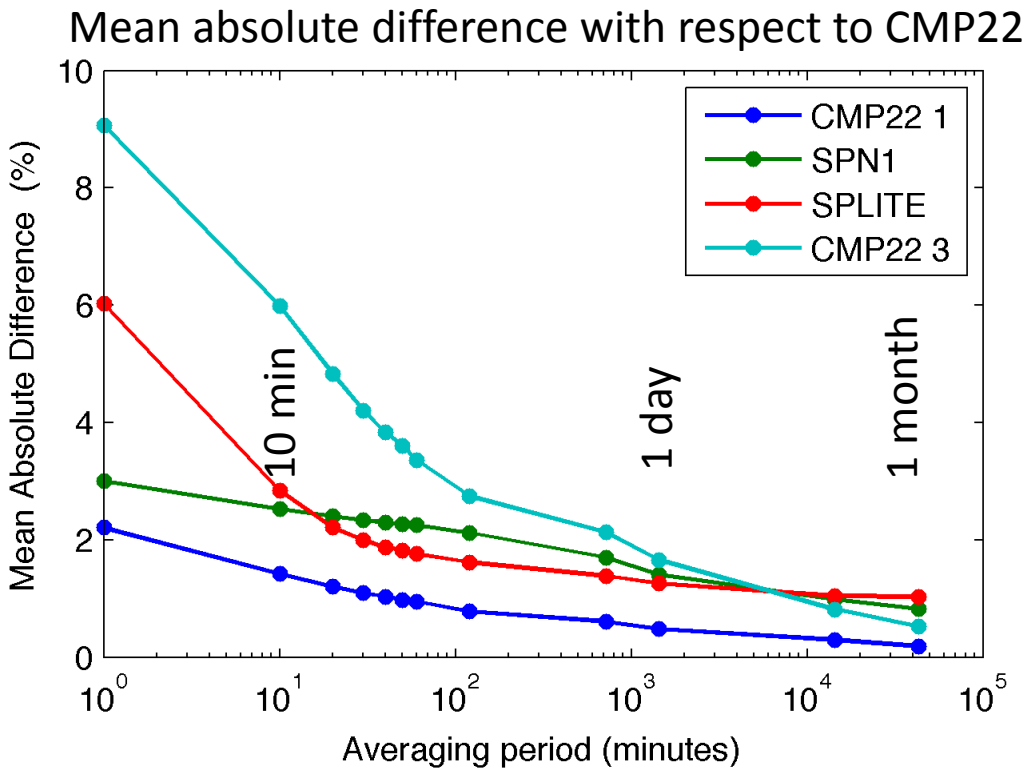
Downwelling SW irradiance comparison (2015)

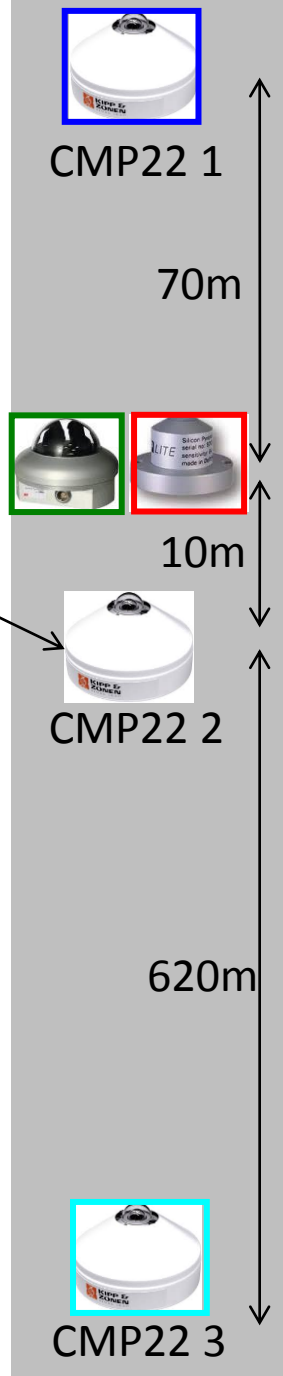




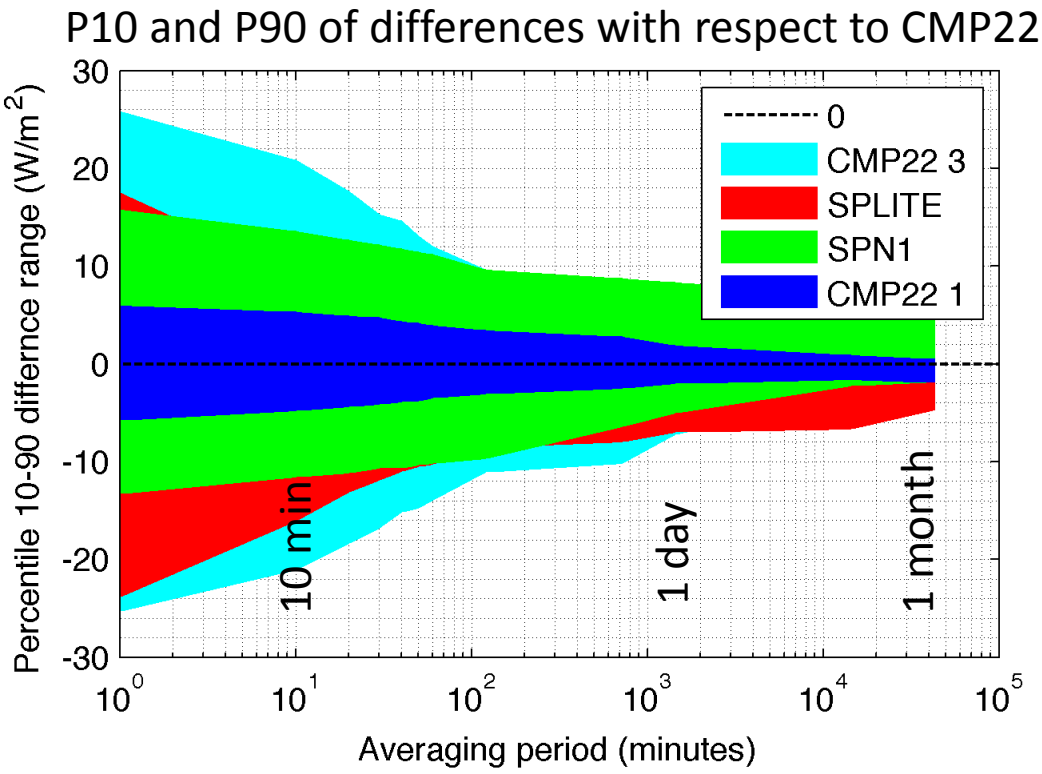


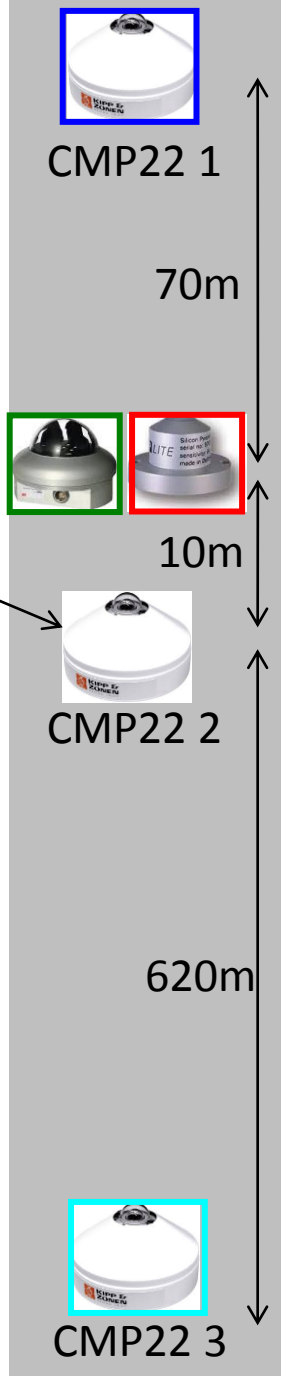
Downwelling SW irradiance comparison (2015, SZA<85º)

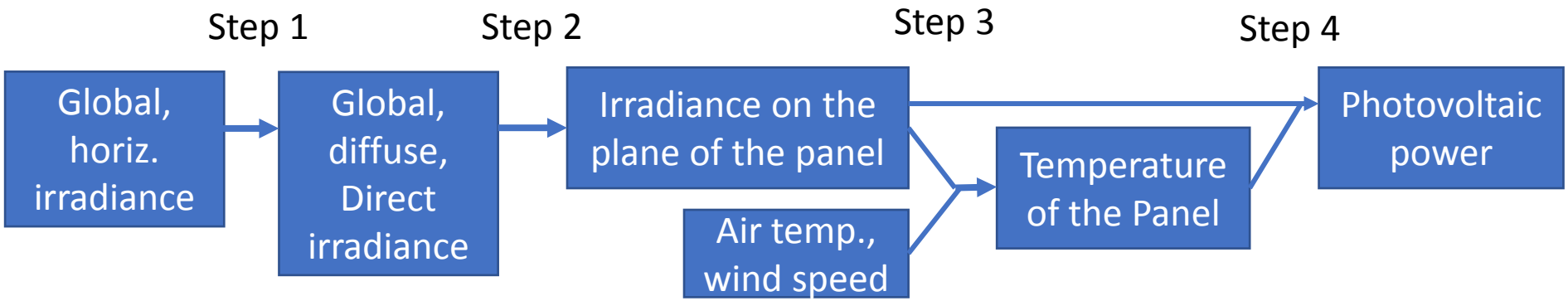


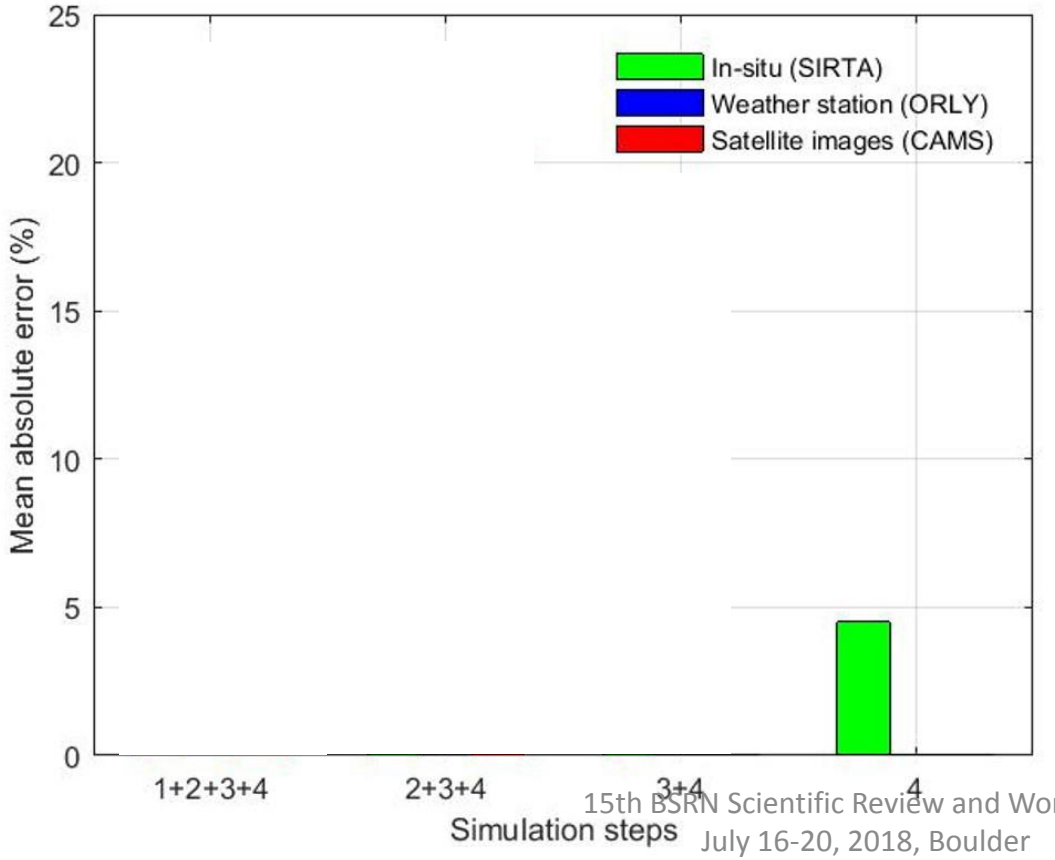


Downwelling SW irradiance comparison (2015, SZA<85º)






Step 1
Step 2
Step 3
Step 4
Global, horiz. irradiance
Global, diffuse, Direct irradiance
Irradiance on the plane of the panel
Air temp., wind speed
Temperature of the Panel
Photovoltaic power


In-situ (SIRTA)
Weather station (ORLY)
Satellite images (CAMS)
Mean absolute error (%)
25
20
15
10
5
0
1+2+3+4
2+3+4
3+4
4
Simulation steps

Quel panneau PV choisir ?

µc-Si/a-Si tandem
P_{mpp} = 128 W
η= 9,5%
Thin film technology

CIS
P_{mpp} = 150 W
η= 12,2%
Thin film technology

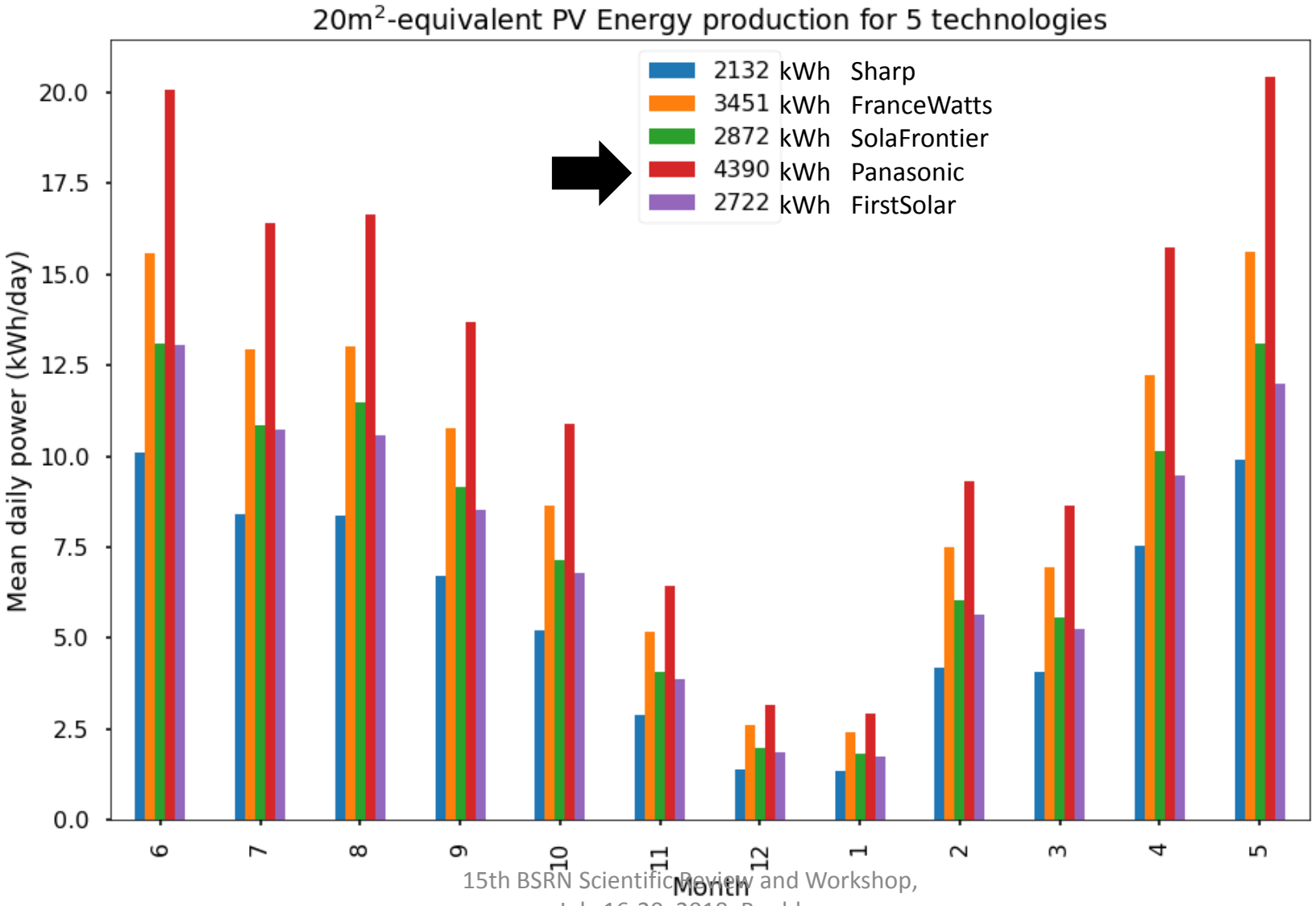
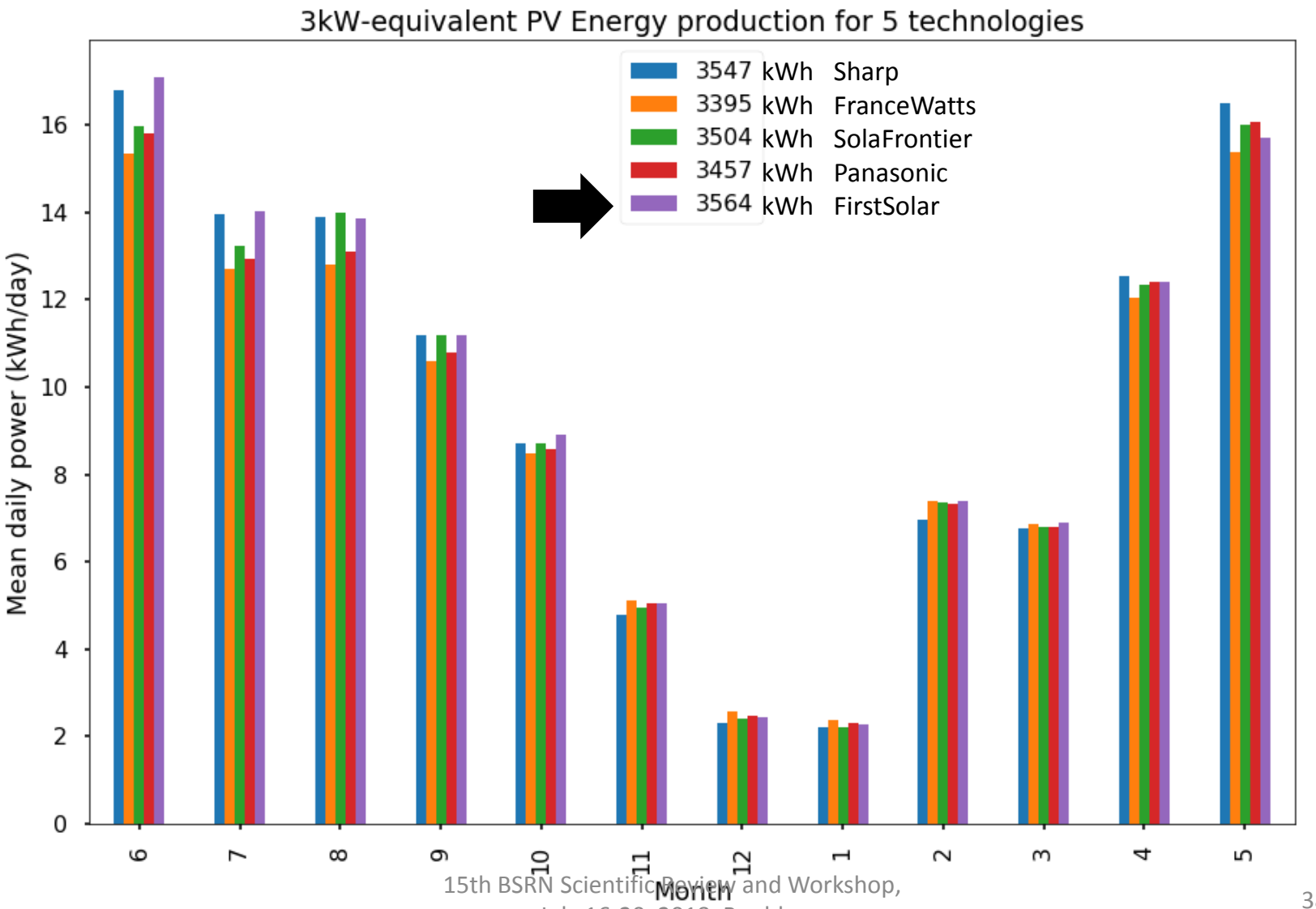
CdTe
P_{mpp} = 82,5 W
η= 11,4%
Thin film technology

C-Si
P_{mpp} = 250 W
η= 15%
1st generation

a-Si triple junction
P_{mpp} = 144 W
η= 6,7%
Thin film technology

HIT
P_{max} = 240 W
η= 19%
Best PV efficiency

Quel panneau PV choisir ?



Quel panneau PV choisir ?