Observing Cloud-Driven Surface Irradiance Patterns

EMS22 - Radiation, Clouds, and Aerosols (UP2.3)

Wouter Mol [1] Bert Heusinkveld [1] Oscar Hartogensis [1] Chiel van Heerwaarden [1]

[1]Wageningen University, The Netherlands

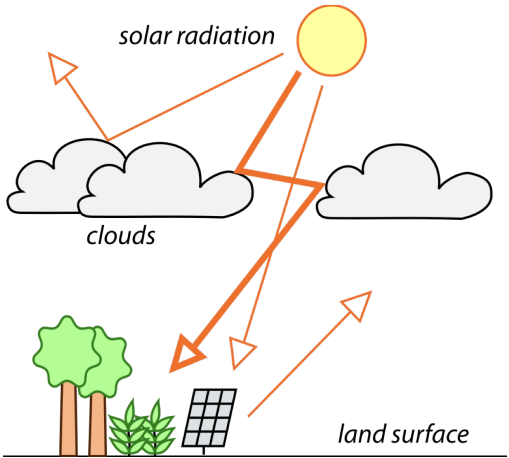
Friday, 9 September 2022

"Shedding Light On Cloud Shadows" (NWO VIDI)

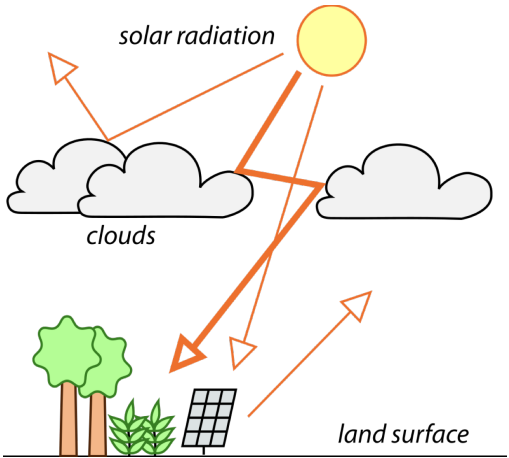
Contact: **wbmol@wur.nl**



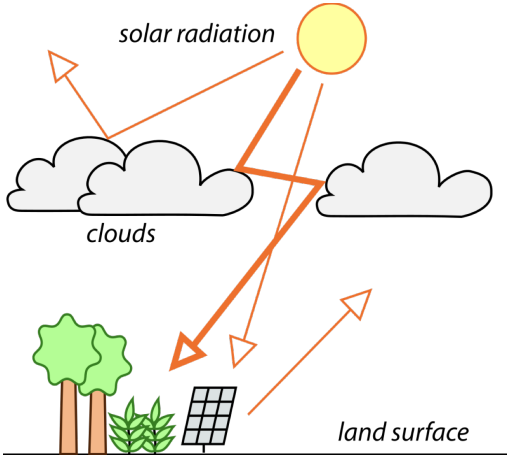




- How does a cloud (field) make surface patterns?
- Detailed spatial surface & in-canopy observations lacking



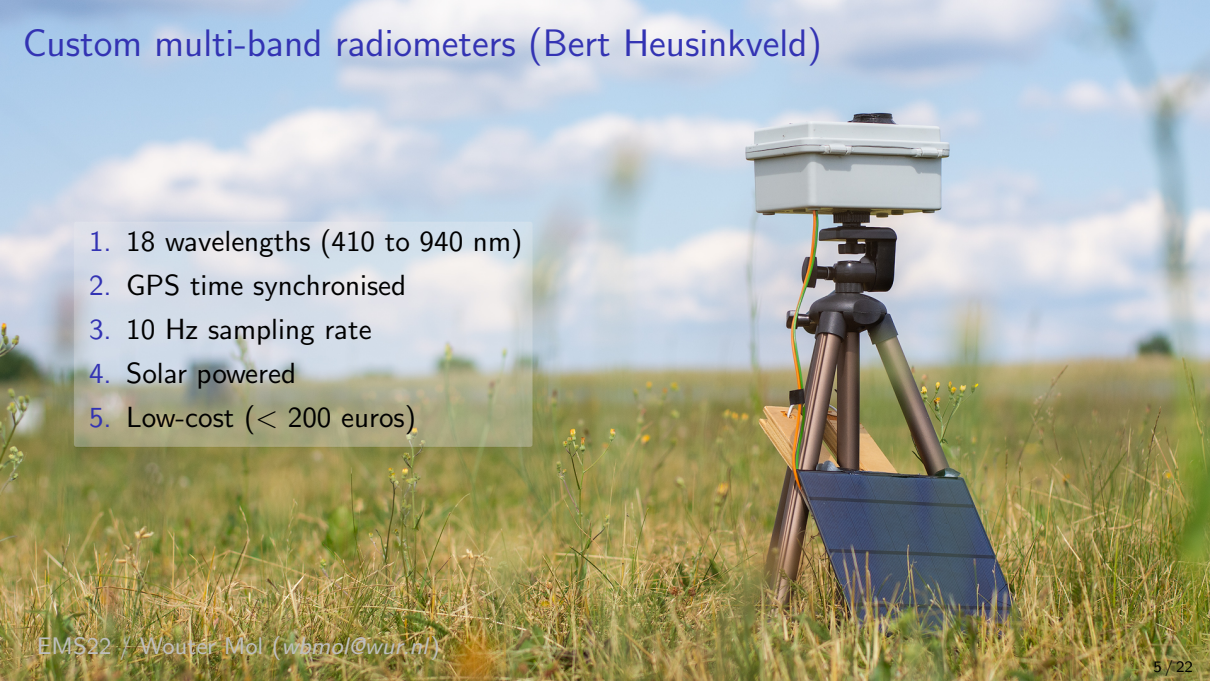
- How does a cloud (field) make surface patterns?
- Detailed spatial surface & in-canopy observations lacking
- Apply knowledge to simplify models, allowing forecasting (e.g. solar energy, heat fluxes, photosynthesis)



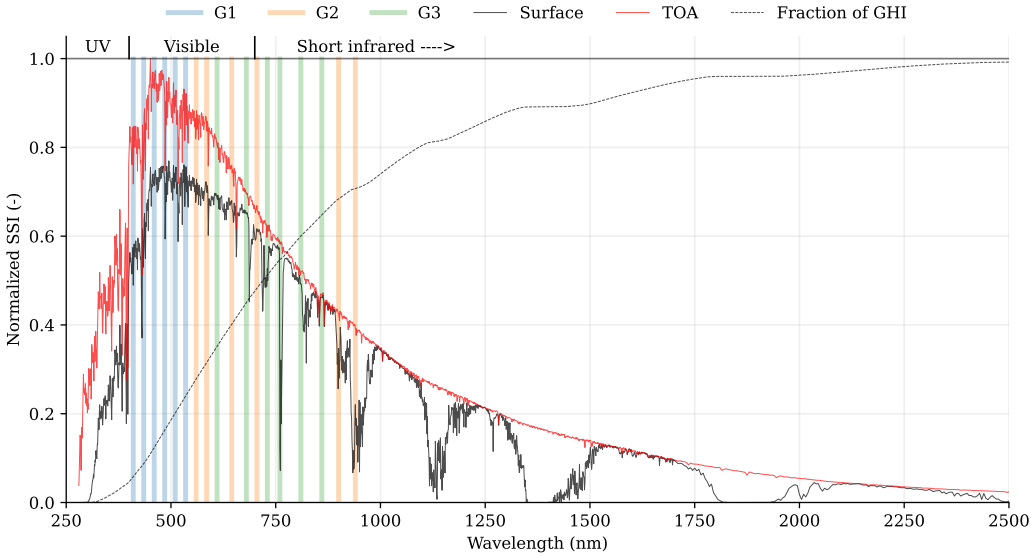
Gathering new observations (this talk):

1. 2d grid measurements of total irradiance
2. Integrated water vapour from spectra
3. In-canopy vertical profiles (bonus)

Custom multi-band radiometers (Bert Heusinkveld)



1. 18 wavelengths (410 to 940 nm)
2. GPS time synchronised
3. 10 Hz sampling rate
4. Solar powered
5. Low-cost ($<$ 200 euros)


G1
G2
G3
Surface
TOA
Fraction of GHI
UV
Visible
Short infrared ---->
Normalized SSI (-)
Wavelength (nm)
0.0
0.2
0.4
0.6
0.8
1.0
250
500
750
1000
1250
1500
1750
2000
2250
2500

https://doi.org/10.5194/egusphere-2022-726
© Author(s) 2022. This work is distributed under
the Creative Commons Attribution 4.0 License.



Abstract | Discussion | Metrics

07 Sep 2022

Download
- Preprint (1439 KB)
- Metadata XML
- Supplement (52 KB)
- BibTeX
- EndNote

Status: this preprint is open for discussion and under review for Atmospheric Measurement Techniques (AMT).

Short summary
A new instrument for fast measurements of solar irradiance in 18 wavebands (400–950 nm). A GPS...
Read more

A new accurate low-cost instrument for fast synchronized spatial measurements of light spectra

Bert G. Heusinkveld, Wouter B. Mol, and Chiel C. van Heerwaarden
Meteorology and Air Quality Group, Wageningen University & Research, P.O. Box 47, 6700 AA Wageningen, the Netherlands

Received: 31 Jul 2022 – Discussion started: 07 Sep 2022

Share



Figure: Full details in reference paper (`https://doi.org/10.5194/egusphere-2022-726`)

Summer 2021 Field Campaigns

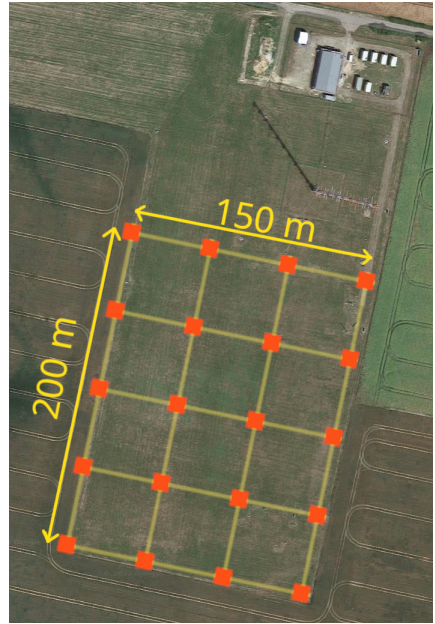
- FESSTVaL (June): sub-mesoscale spatial heterogeneity
- LIAISE (July): land-atmosphere interaction

More info, see:

- `https://fesstval.de`
- `https://www.hymex.fr/liaise/index.html`



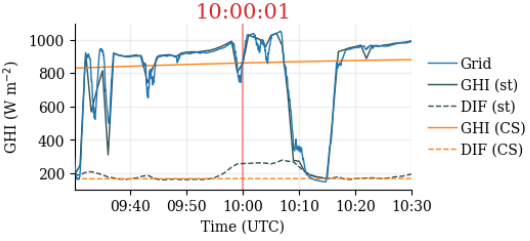
- 20 sensors deployed at FESSTVaL (Falkenberg site), 4 x 5 @ dx $\approx$ 50 m
- Two action cameras to capture how the clouds look
- Measured from 14 to 29 June 2021, calibrated against suntracker
- Multiple case studies, will focus on 27 June

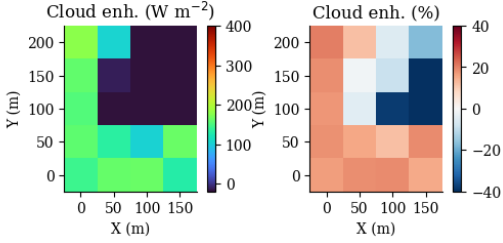


FESSTVaL 27 June 2021 case - grid observations [video]





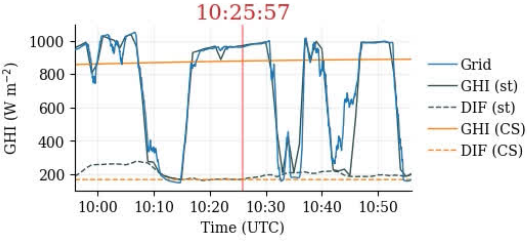


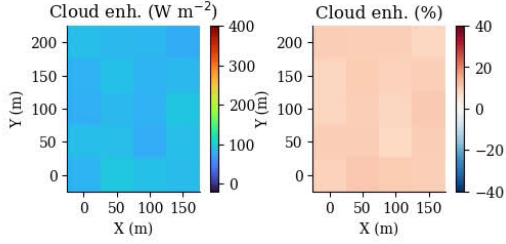




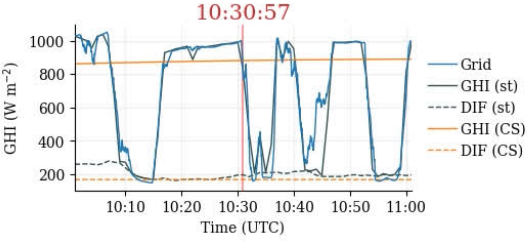


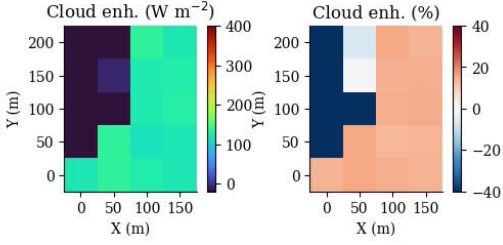
Wouter Mol (wbmol@wur.nl)






Wouter Mol (wbmol@wur.nl)

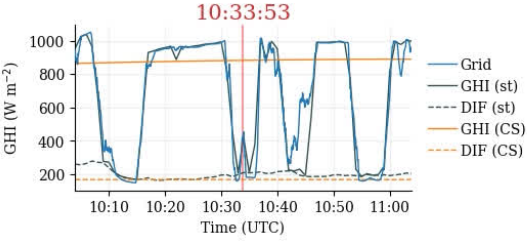

10:30:57
GHI (W m^{-2})
1000
800
600
400
200
10:10
10:20
10:30
10:40
10:50
11:00
Time (UTC)
Grid
GHI (st)
DIF (st)
GHI (CS)
DIF (CS)

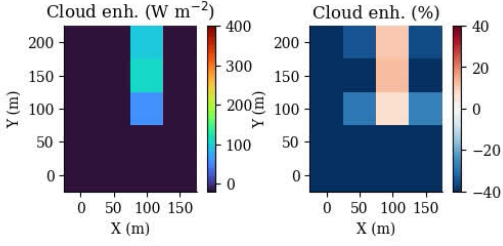

Cloud enh. (W m^{-2})
Y (m)
200
150
100
50
0
0
50
100
150
X (m)
400
300
200
100
0
Cloud enh. (%)
Y (m)
X (m)
40
20
0
−20
−40





Wouter Mol (wbmol@wurnl)

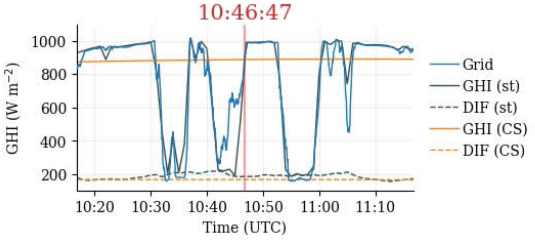








Wouter Mol (wbmol@wur.nl)


10:46:47
GHI (W m^{-2})
1000
800
600
400
200
10:20
10:30
10:40
10:50
11:00
11:10
Time (UTC)
Grid
GHI (st)
DIF (st)
GHI (CS)
DIF (CS)

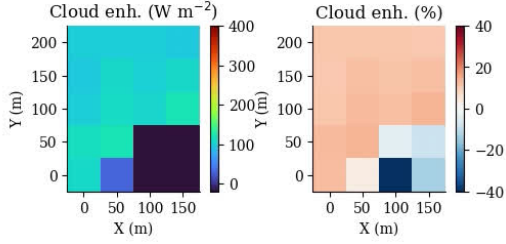
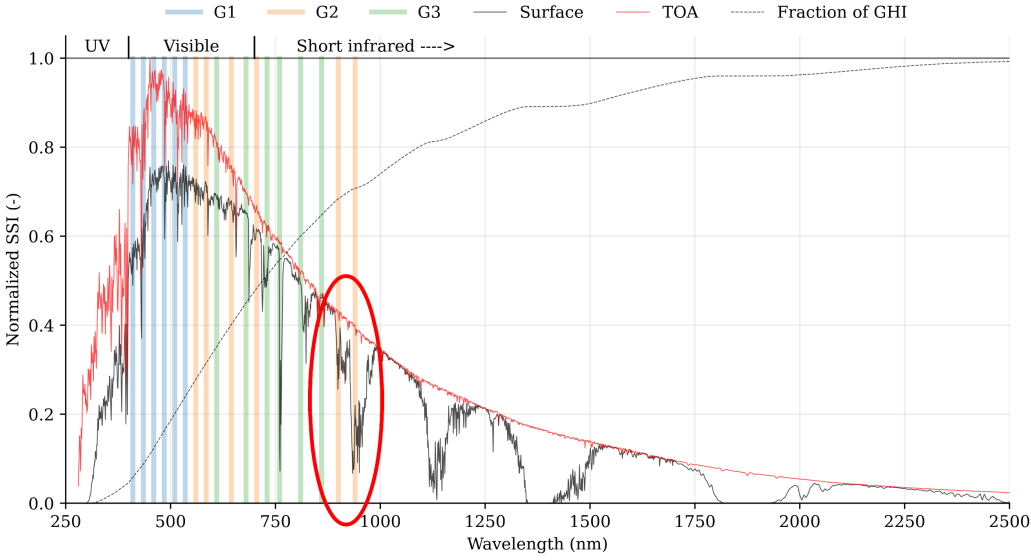

Cloud enh. (W m^{-2})
Y (m)
200
150
100
50
0
0
50
100
150
X (m)
400
300
200
100
0
Cloud enh. (%)
Y (m)
X (m)
40
20
0
−20
−40



Figure: https://doi.org/10.25592/uhhfdm.10273


G1
G2
G3
Surface
TOA
Fraction of GHI
UV
Visible
Short infrared ---->
Normalized SSI (-)
Wavelength (nm)
0.0
0.2
0.4
0.6
0.8
1.0
250
500
750
1000
1250
1500
1750
2000
2250
2500

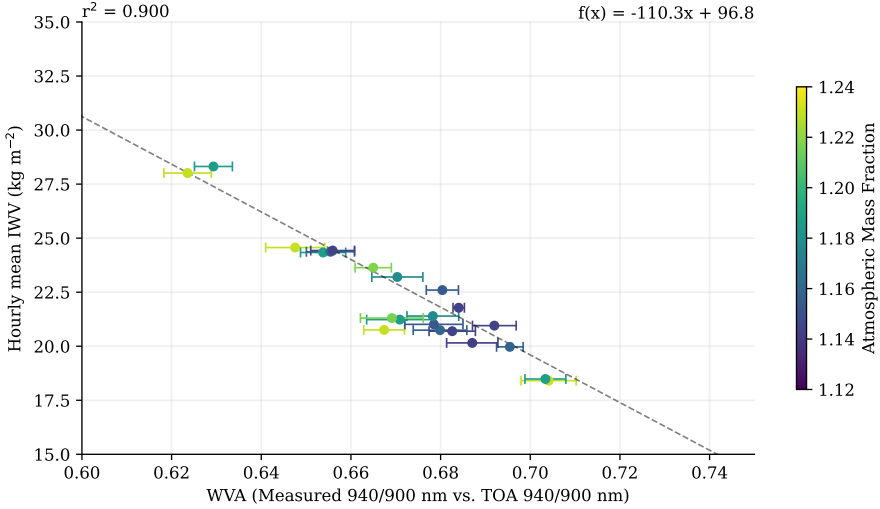


Figure: Integrated water vapour (IWV) correlated to measured 940/900 nm ratio (IWV from MWR, Löhnert et al. 2022)

- Multiple grid setups, different configurations
- Less cloud cases to analyse compared to FESSTVaL



Figure: La Cendrosa (irrigated alfalfa field)

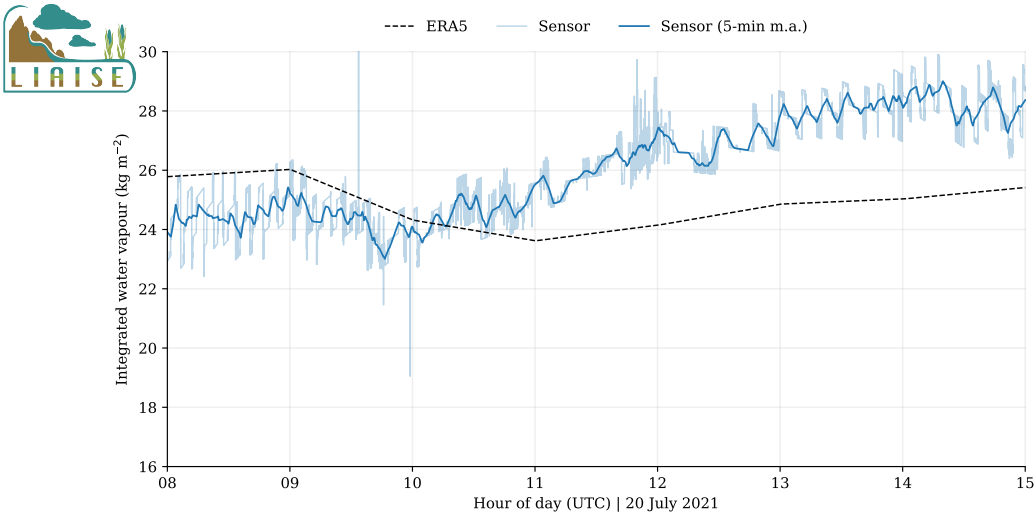


Figure: Sensor-derived IWV applied to LIAISE, which does not have a high quality reference

CloudRoots Amazonia 2022



Figure: Sensor on top of ATTO (321m)



Figure: Sensor in canopy

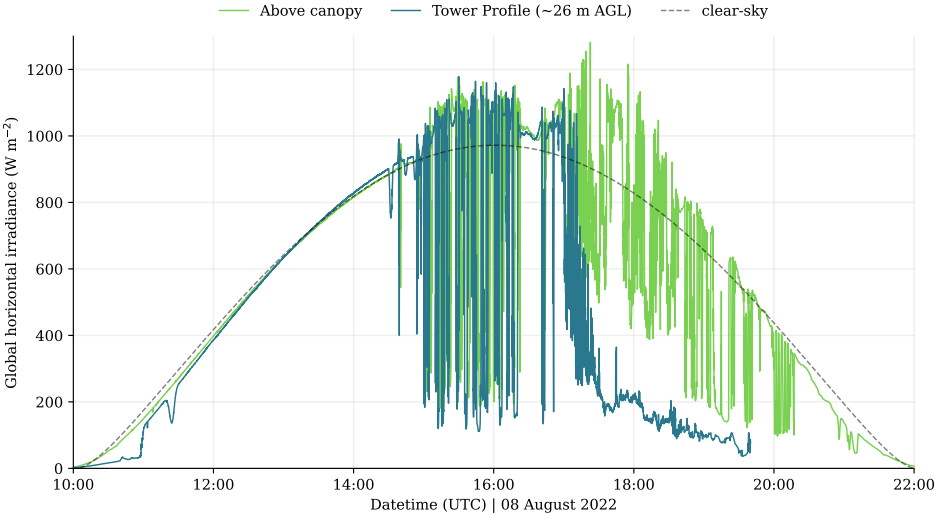


Figure: Preliminary data. Credits to Martin Janssens & Oscar Hartogensis. Read more at `https://weblog.wur.eu/nature-biodiversity/radiation-in-the-rainforest/`

Outlook

- Cheap, custom sensors are able to measure irradiance variability and spectra in multi-sensor setups
- Successfully deployed at three major campaigns, will provide essential information for process understanding and model validation
- Sensor design and campaign data is (or will soon be) publicly available



Our sensor @ FESSTVaL.de campaign