Total Solar Irradiance as Measured with CLARA onboard NorSat-1 In Orbit Performance and Data Release (almost)

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Sun Climate Symposium
Flagstaff, 18-21,October, 2023

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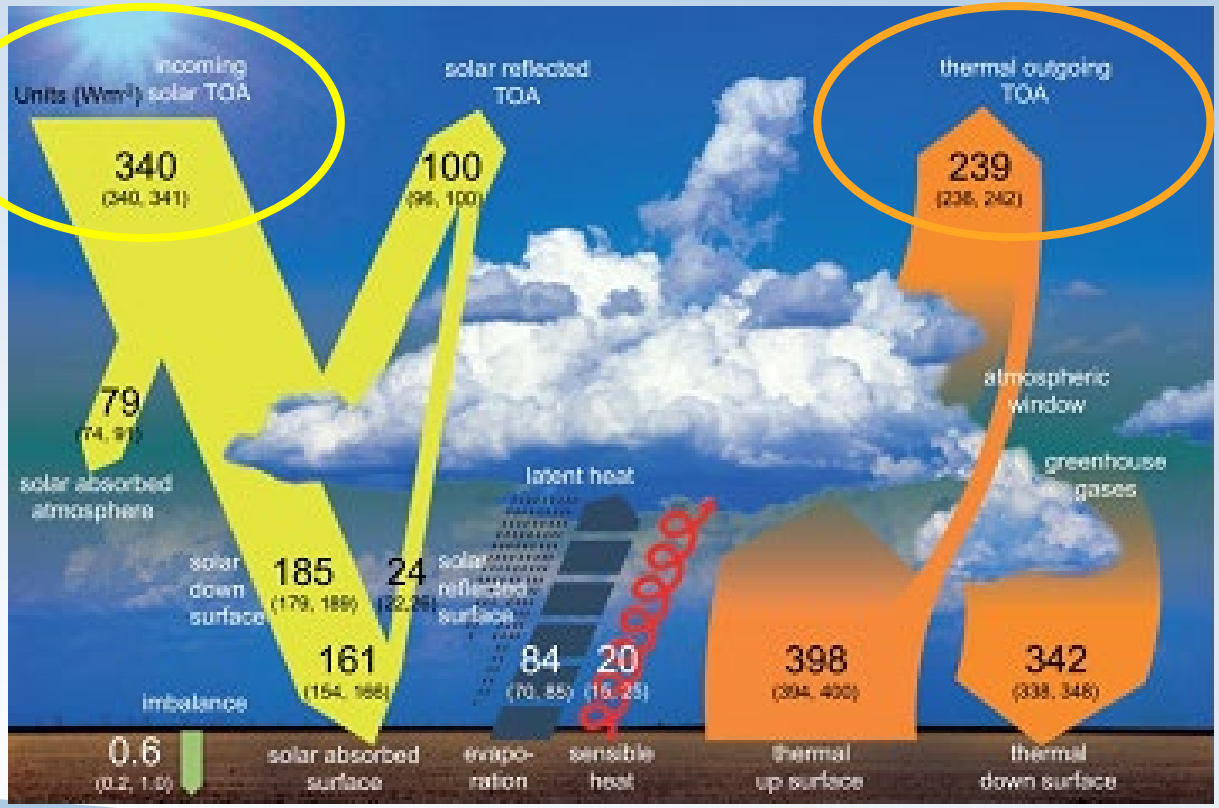
Earth Radiation Budget

Total Solar Irradiance (TSI)



Outgoing Longwave Radiation (OLR)

(from IPCC 2013; adapted from Wild et al., 2013).

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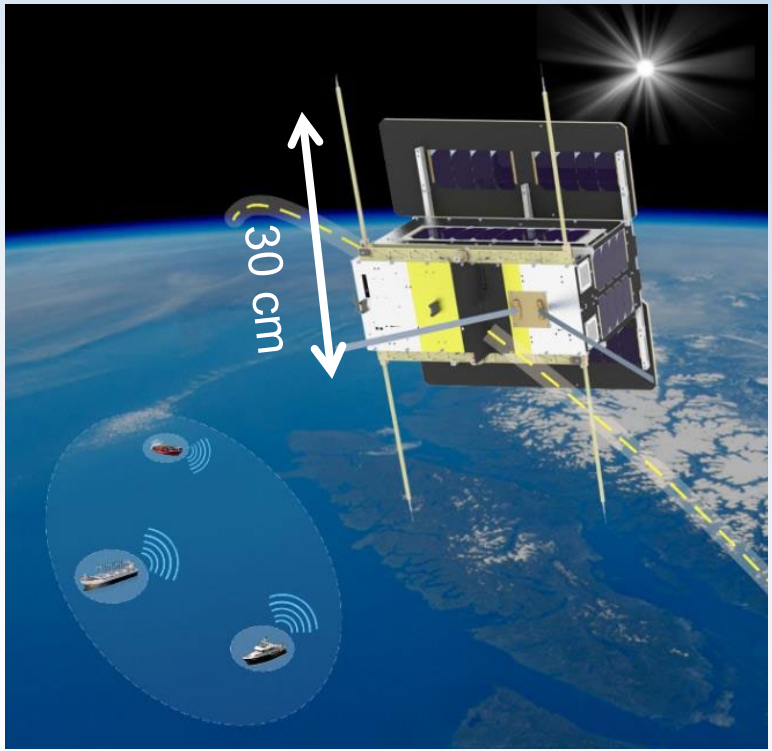
NorSat-1 key facts



Norwegian low-cost satellite

Payloads

- Automatic Identification System (AIS) ship tracker
- Langmuir probes
- CLARA TSI radiometer

Launch

- 14 July, 2017

Orbit

- Polar Low Earth Orbit midnight-noon, drifting height 600 km

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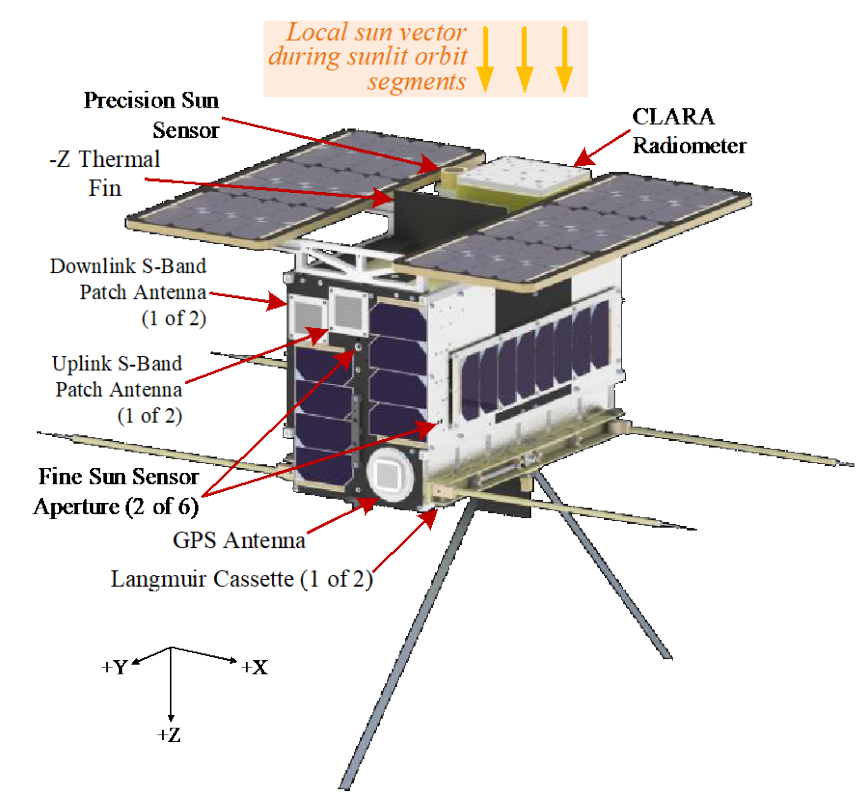
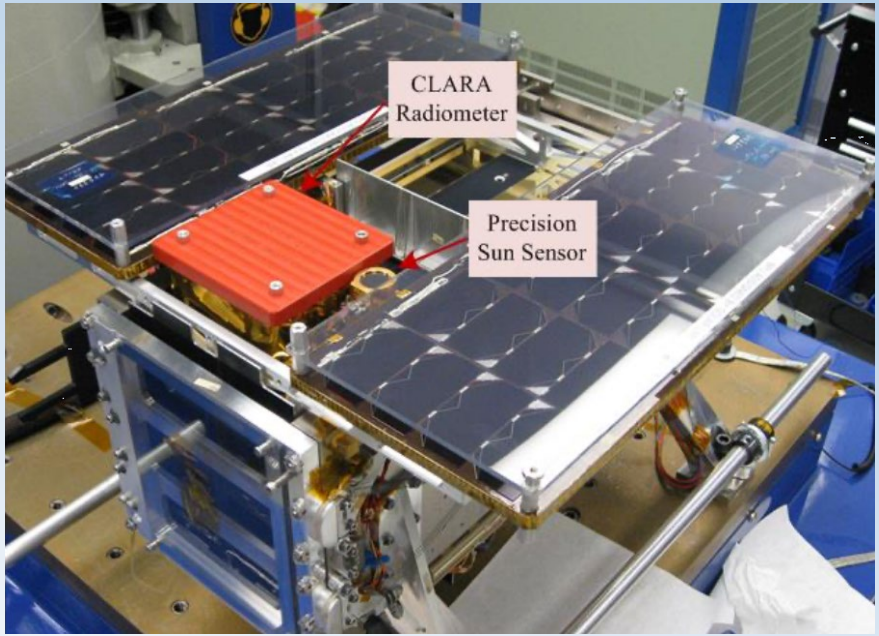
NorSat-1 Platform



Schematic view of the payload



NorSat-1 at SFL vibration test facility

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CLARA brief operation history

July 14, 2017	NorSat-1 Launch
Aug 21, 2017	First Light
April 2018	Issues with reaction wheel started
May 13, 2018	Solar measurements were stopped
Nov 8, 2019	"2nd First Light" (TSI and OLR)
Aug 19, 2021	Firmware issue with 2nd reaction wheel
June 14, 2022	Restart of CLARA TSI and OLR measurements
Nov 2018	Issues with reaction wheel started

- NorSat-1 now operates only with two reaction wheels
- Limited fine pointing stability

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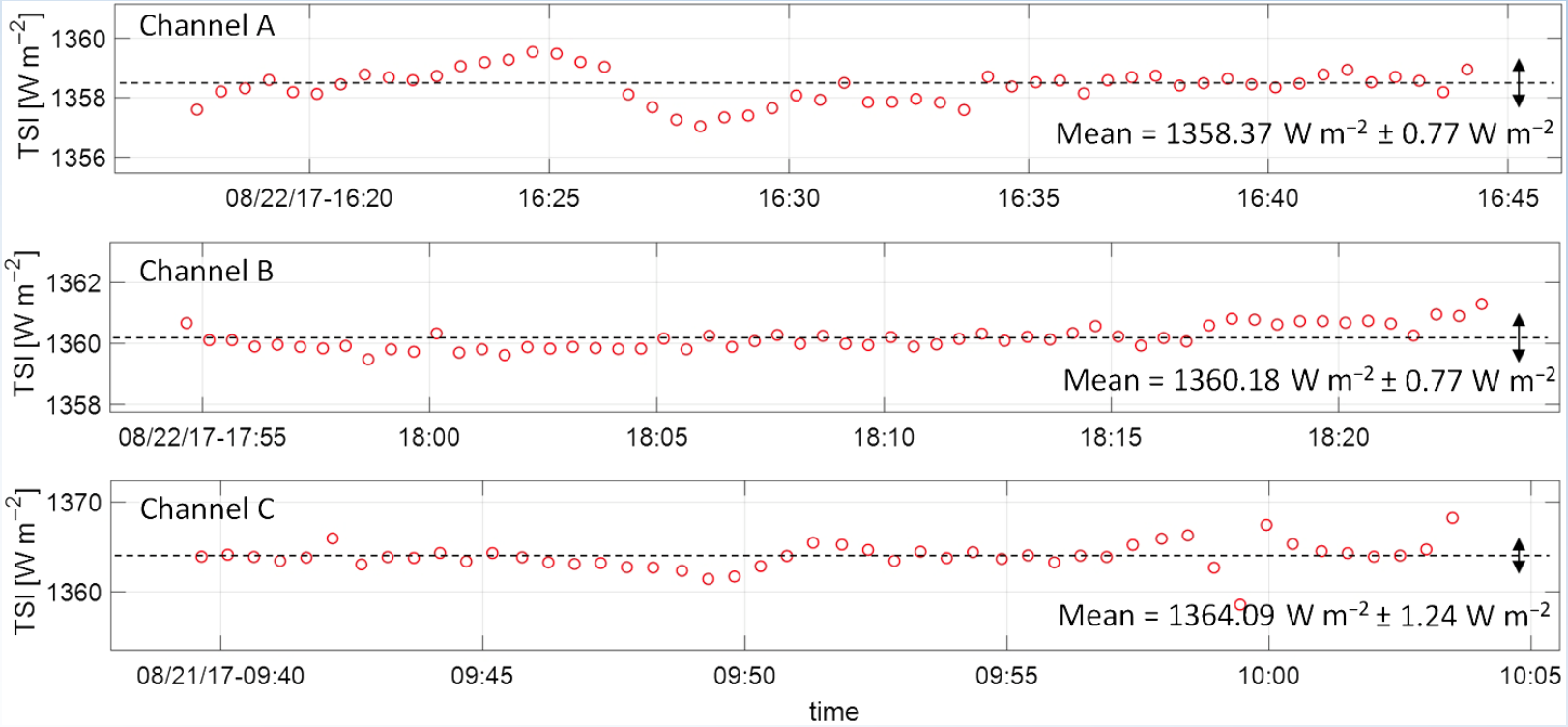
First Light measurements



Average for same time period for SOHO/VIRGO: 1360.15 Wm^{-2}

Walter et al., 2020, IAU Proceedings

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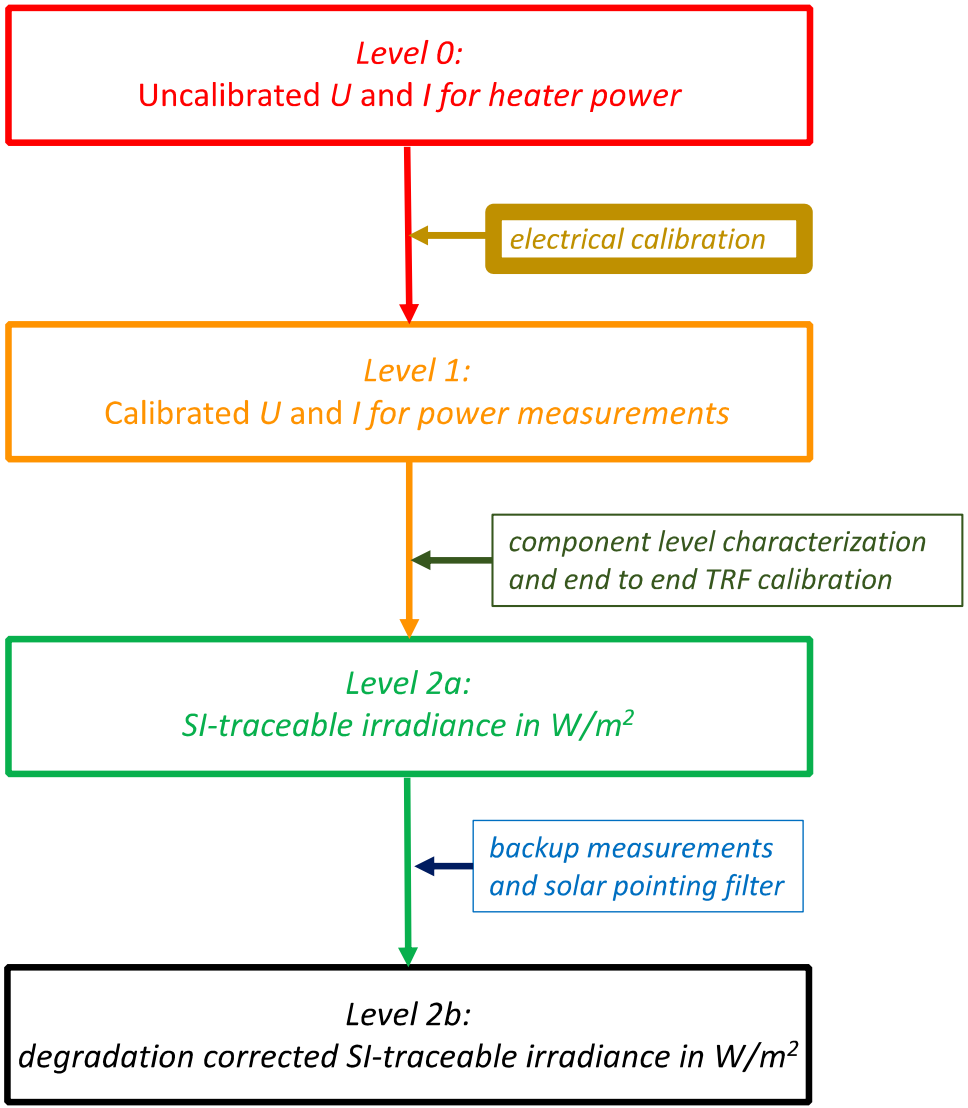
CLARA Data pipeline



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Revisit of TRF calibration of Walter et al. (2017) with updated electrical calibration

1. Channel A (first measurement)

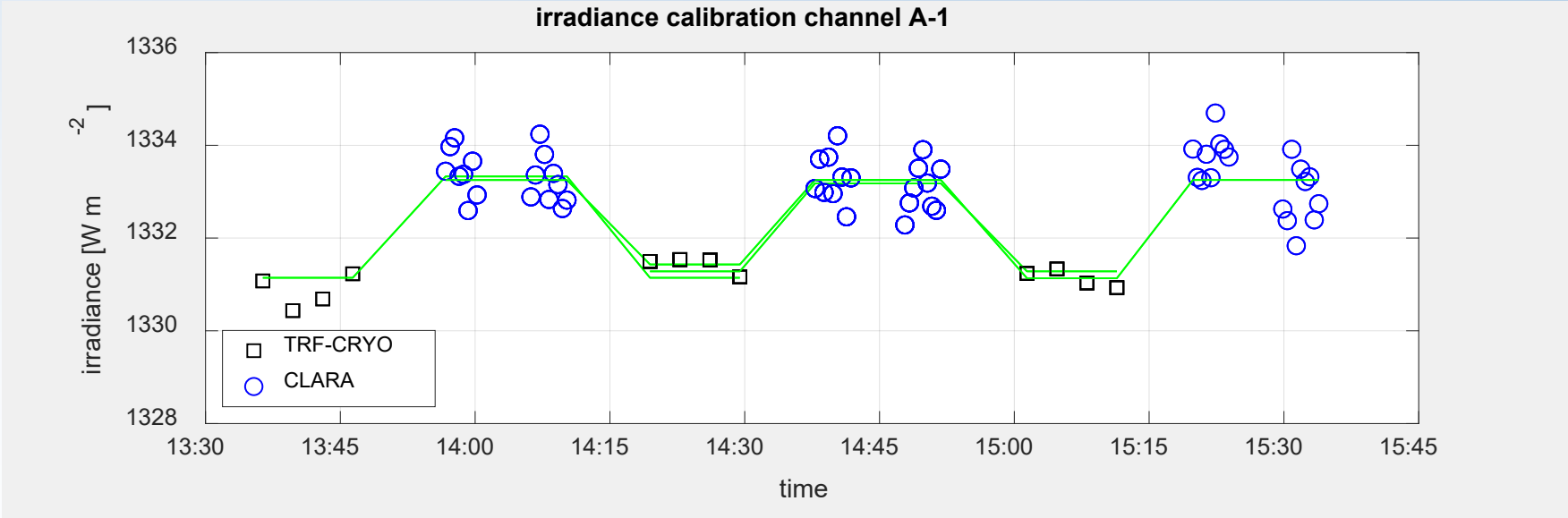
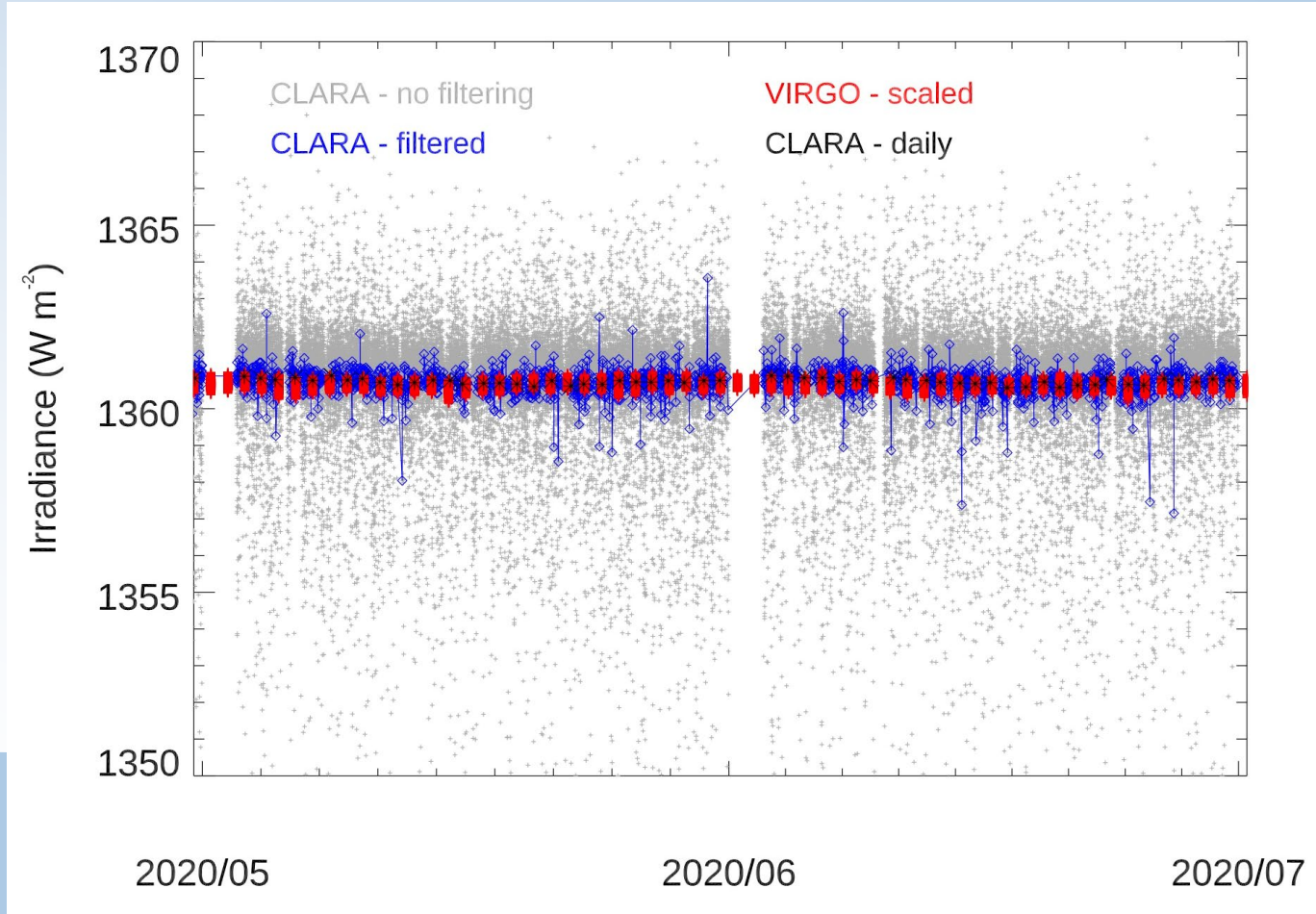
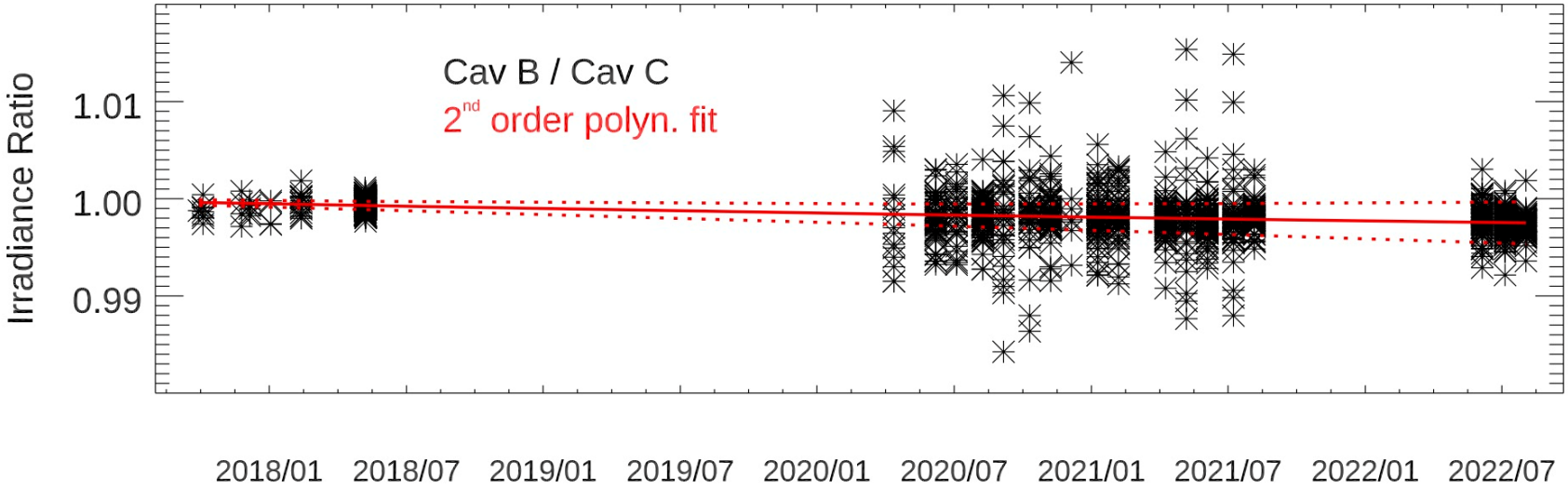


Illustration of Pointing filter and Quality check



Monitoring CLARA Degradation



- Variation of irradiance ratio of Cav B/Cav C
- Polynomial fit shows smooth degradation of nominal cavity (Cav B)
- Increased scatter starting Mar 2020 due to lower NorSat-1 pointing performance

Haberreiter et al. in preparation

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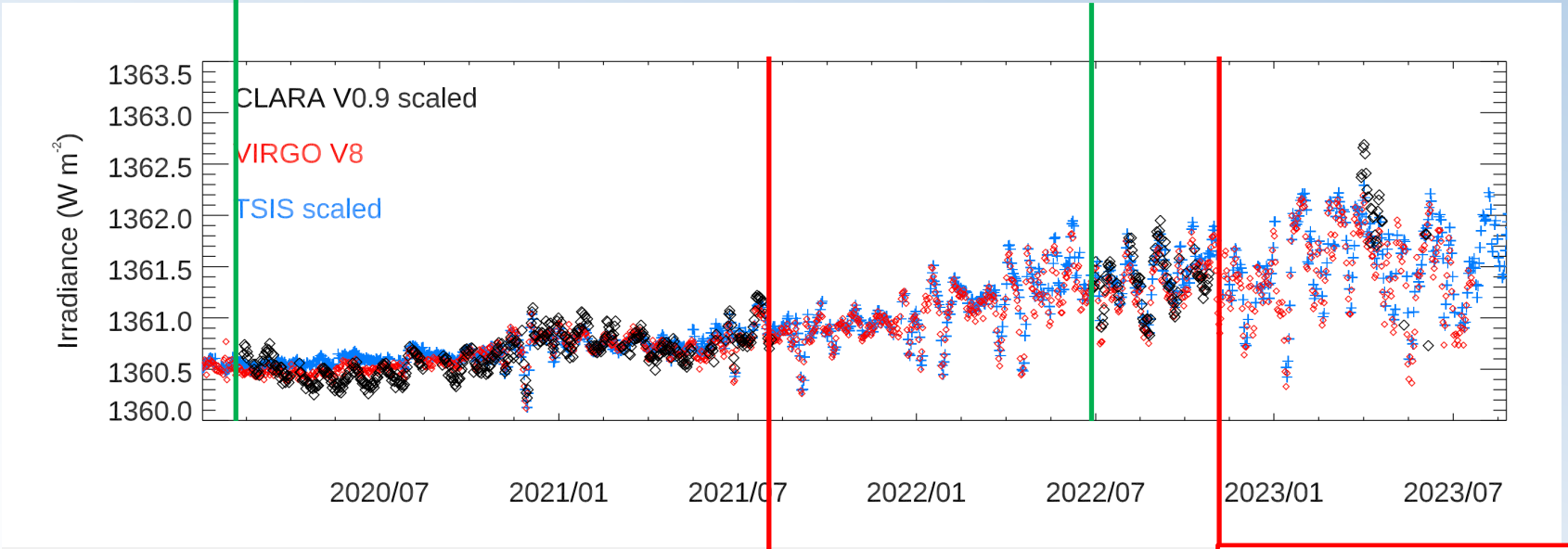
CLARA observes solar variability

Restart of solar measurements Jan 2020

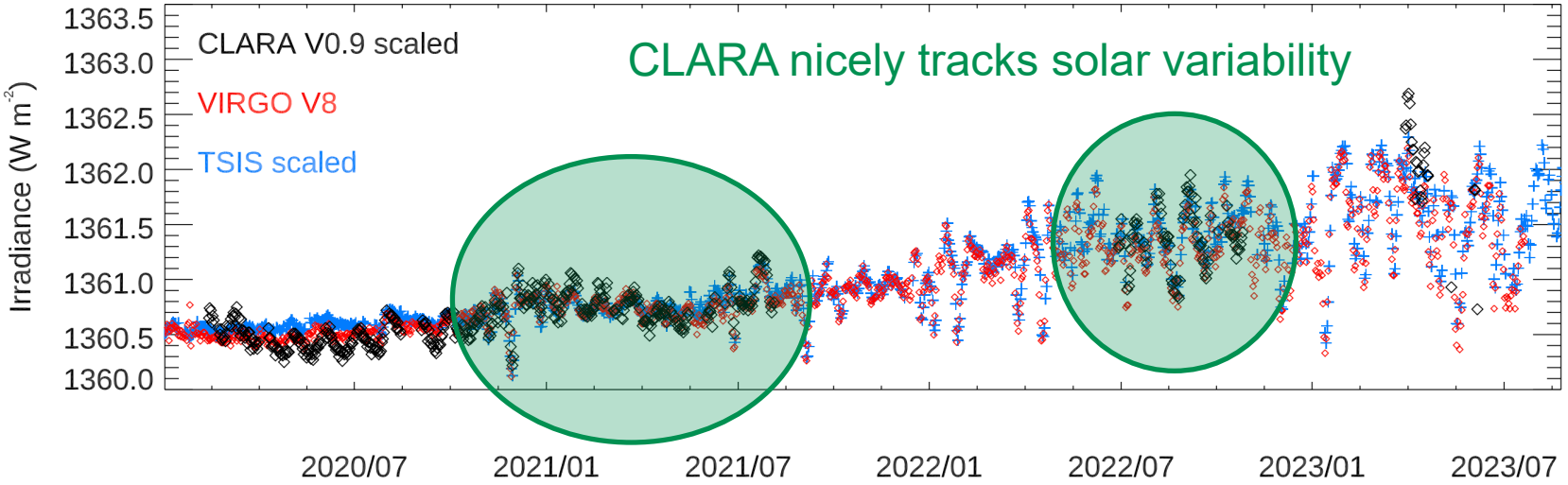
Jun 14, 2022: Restart of solar measurements



Aug 19, 2021: Interruption of 2nd satellite reaction wheel

November, 2022: Recurring issues on NorSat-1 platform

CLARA vs VIRGO and TSIS



Haberreiter et al. in preparation

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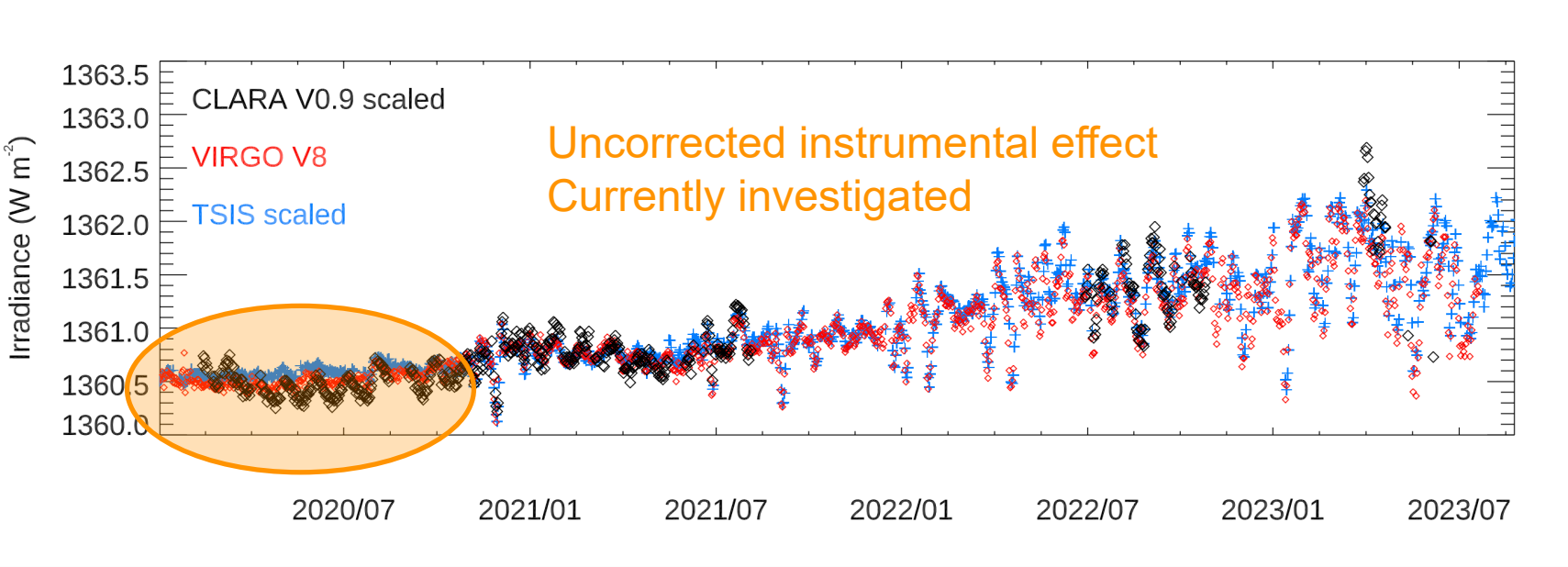
CLARA vs VIRGO and TSIS



Haberreiter et al., in preparation

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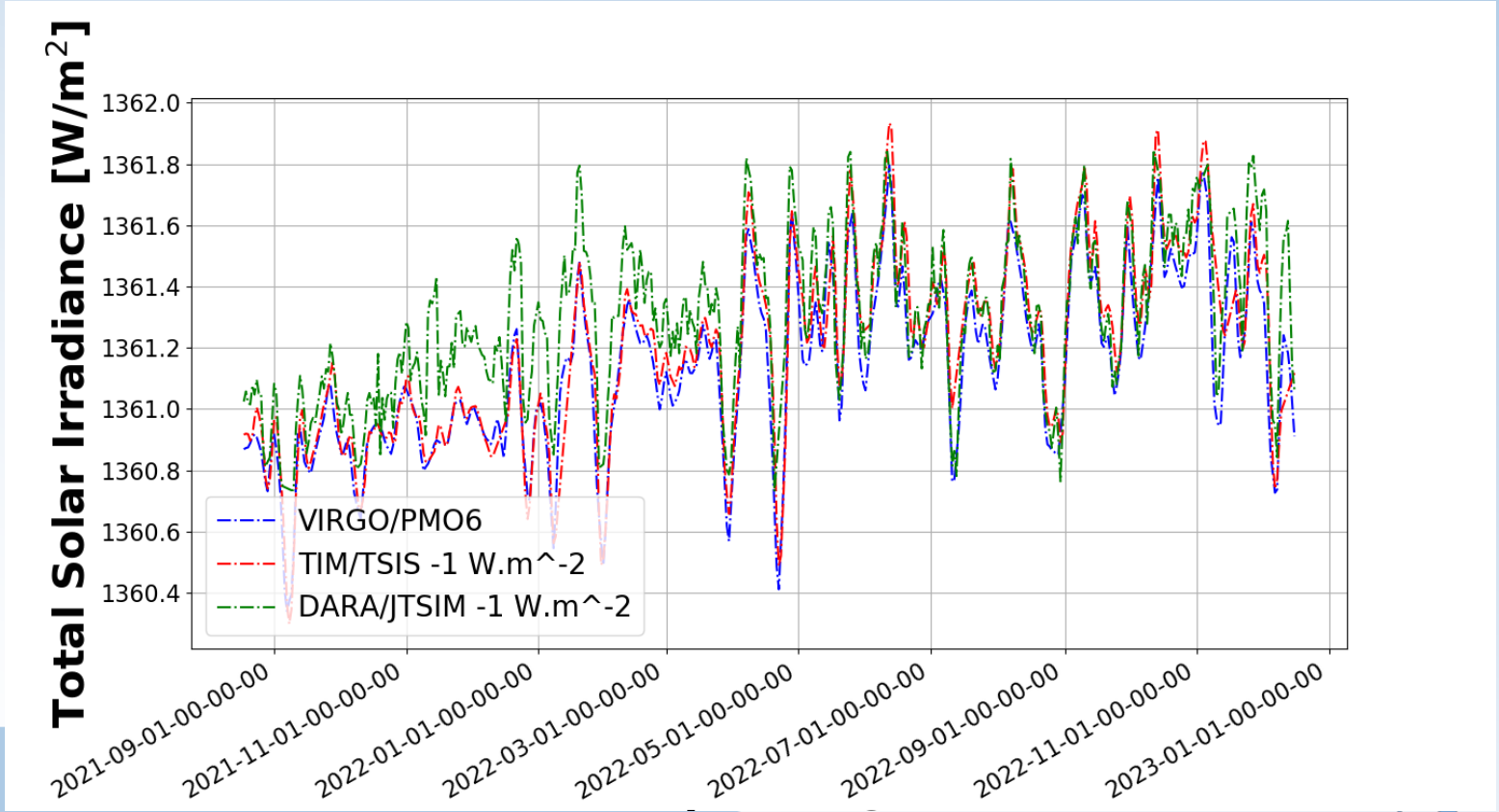
DARA/JTSIM



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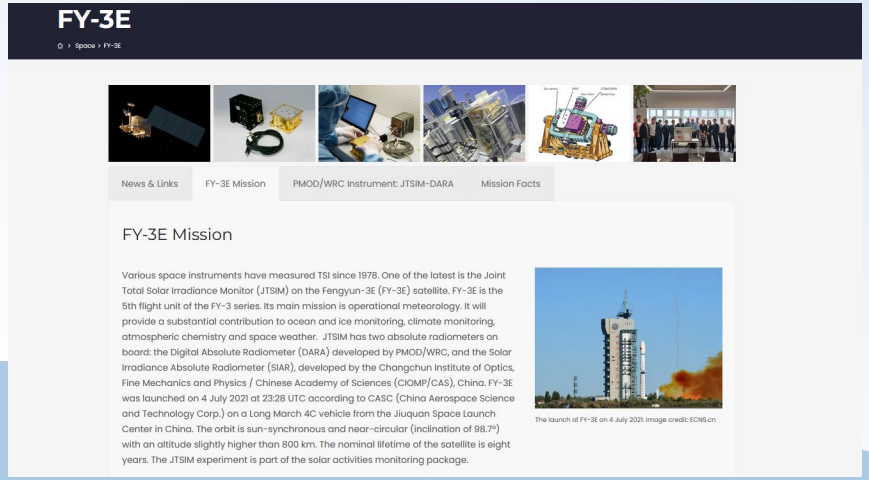
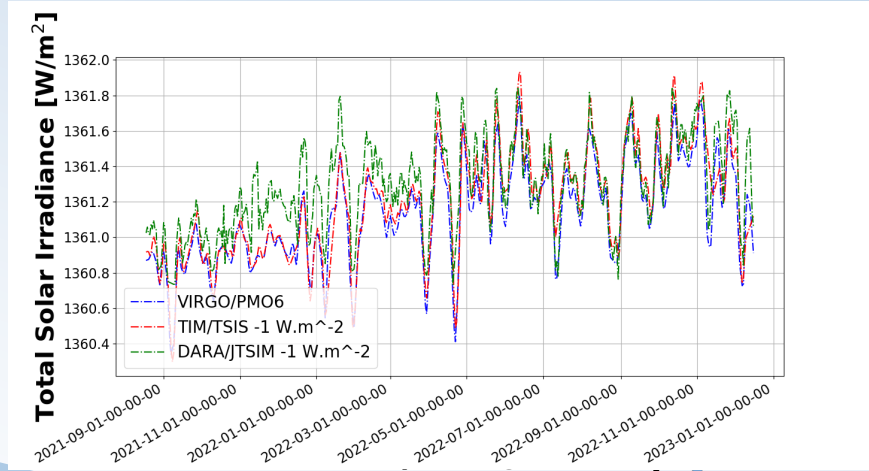
DARA-JTSIM v1.0 Soon available on the PMODWRC ftp server

- Daily and 6-hourly data
- Degradation correction based on ML algorithm by Finsterle et al. (2021) applied successfully to the SOHO/VIRGO data: https://doi.org/10.1038/s41598-021-87108-y
- First light study in Xe et al., 2023, EGU23, 10.5194/egusphere-egu23-1716; Zhu et al., 2023, ESS, under review
- Daily product to be included in TSI composite time series (Montillet et al., 2024 – in preparation)
- Please, look at the PMOD/WRC webpage to get the data soon:
  https://www.pmodwrc.ch/en/research-development/space/fy-3e/#1605855293631-69abe877-b9c1





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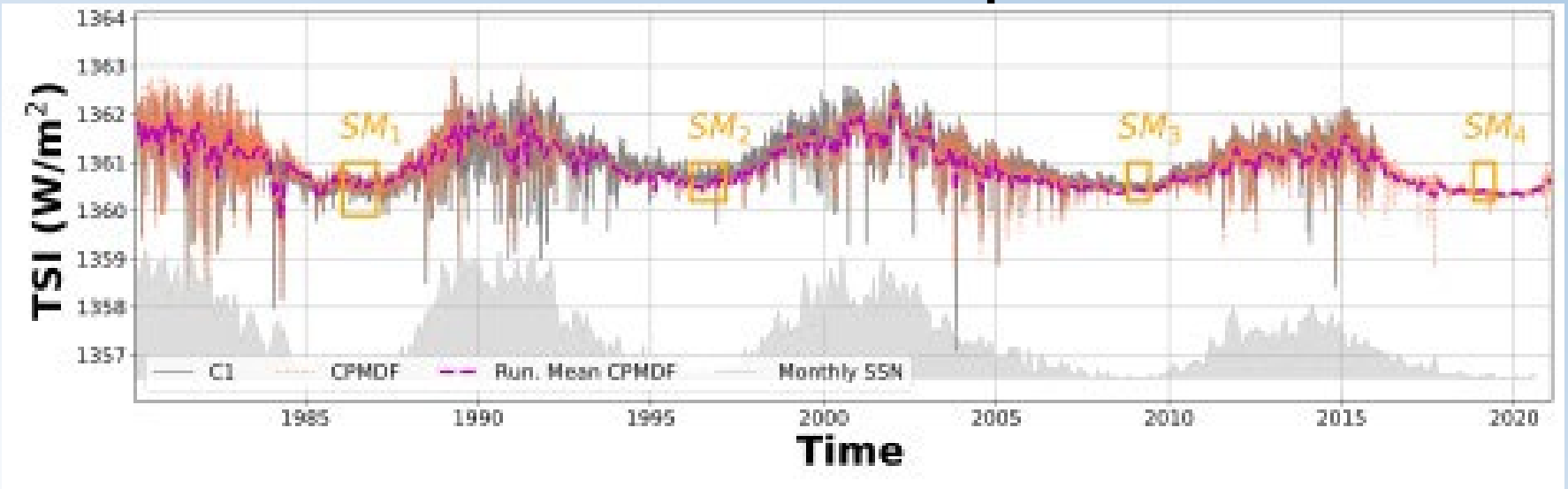
PMOD TSI Composite



New composite (CPMDF) based on merging 41 years of TSI measurements.

30-day running mean of Composite

Community Composite C1 (Dudok de Wit et al., 2017)

Boxes: Solar minima (SM) for each solar cycle, no significant difference between minima

Monthly sunspot number is also displayed.

Montillet et al., 2022, JGR

Continuation of the PMOD-composite based on updated ML techniques

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ISSI International Team
Towards Determining the Earth Energy Imbalance from Space

- Julien Amand, Stijn Nevens (RMI)
- Peter Pilewskie, Dave Harber (LASP)
- Bill Swartz (JPL)
- Ping Zhu (Shenzhen University, CN)
- Margit Haberreiter, Wolfgang Fintersle (PMOD/WRC, CH)
- Martin Wild (ETHZ, CH)
- Nigel Fox (NPL, UK)

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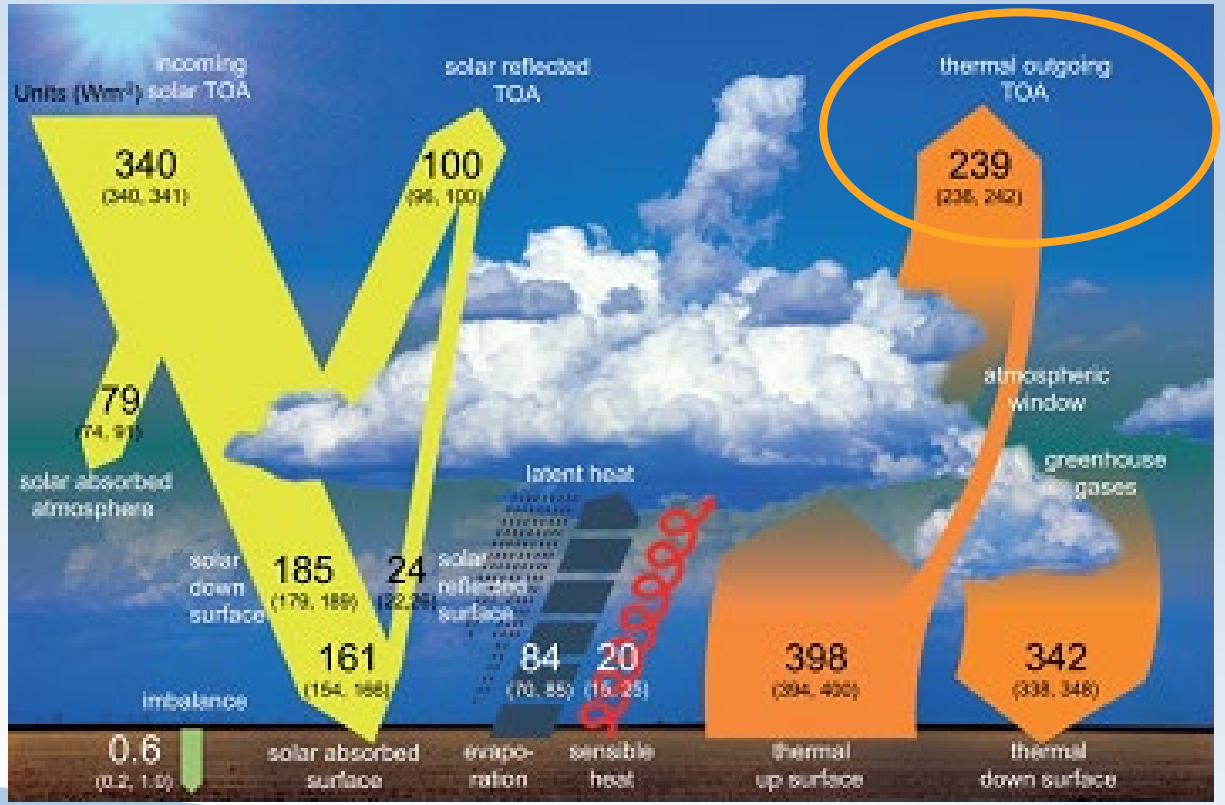
Earth Radiation Budget



Outgoing Longwave Radiation (OLR)

(from IPCC 2013; adapted from Wild et al., 2013).

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WFOV and NFOV Radiometers

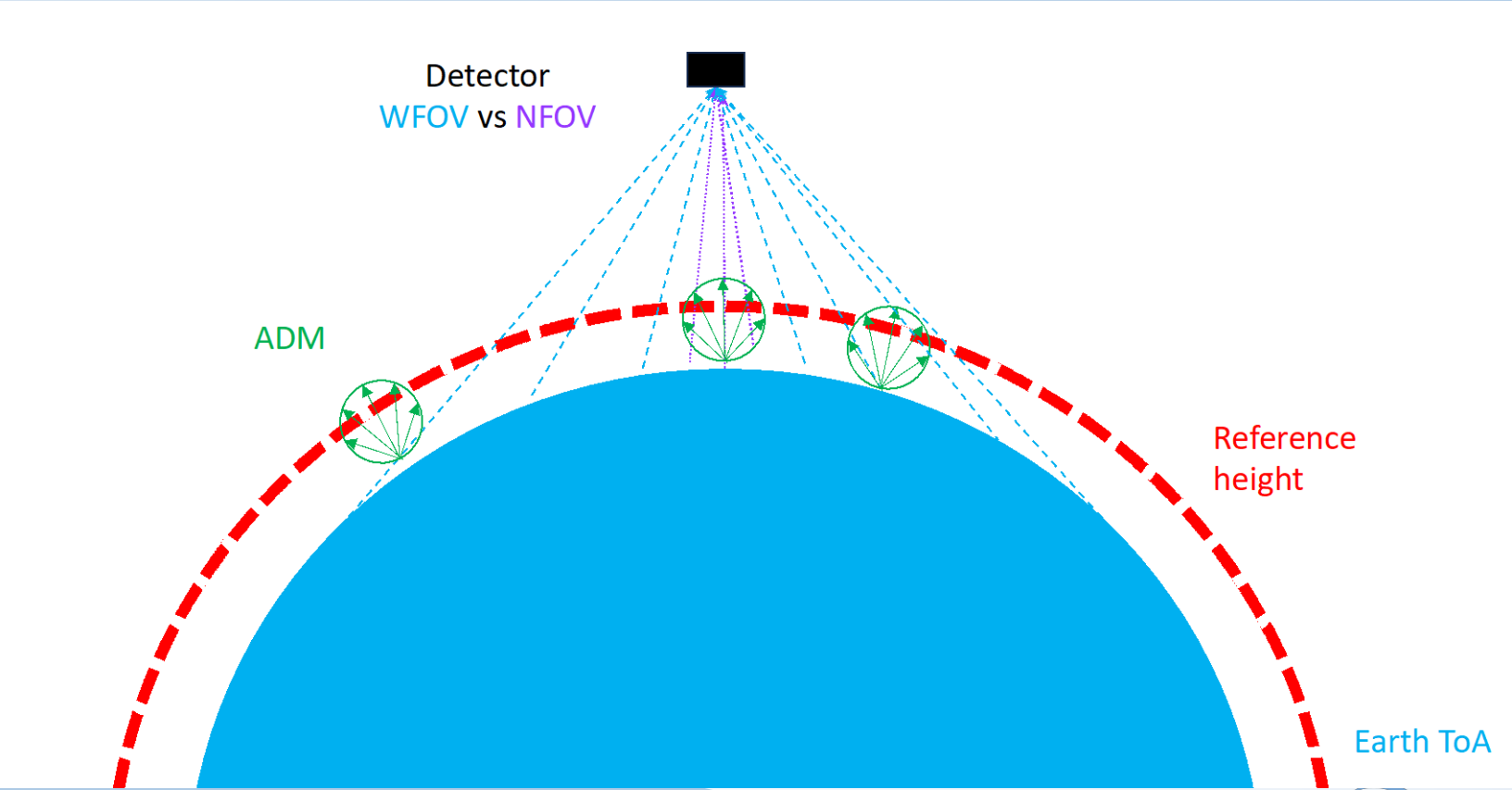

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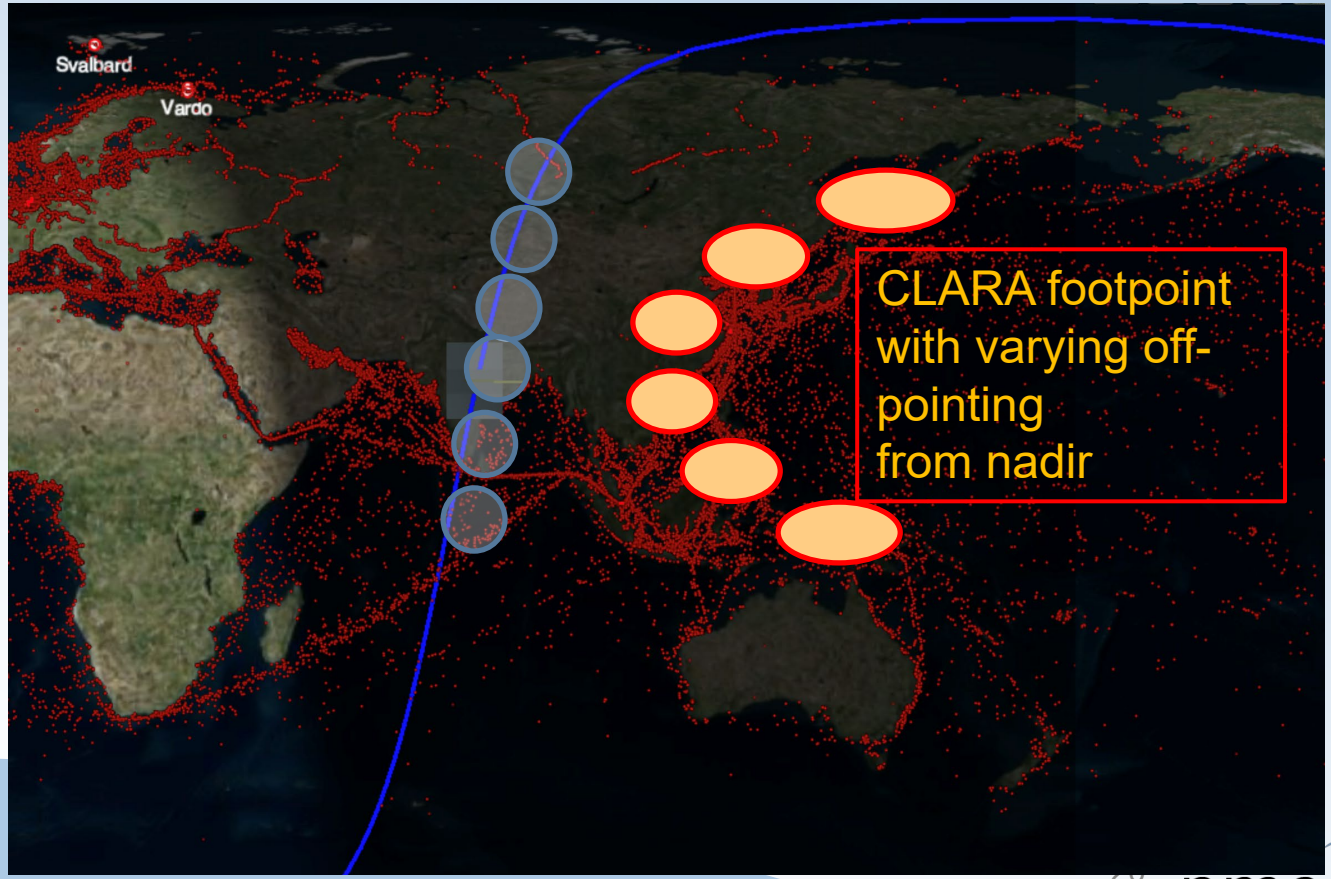
Illustration of CLARA Earth pointing



Not to scale

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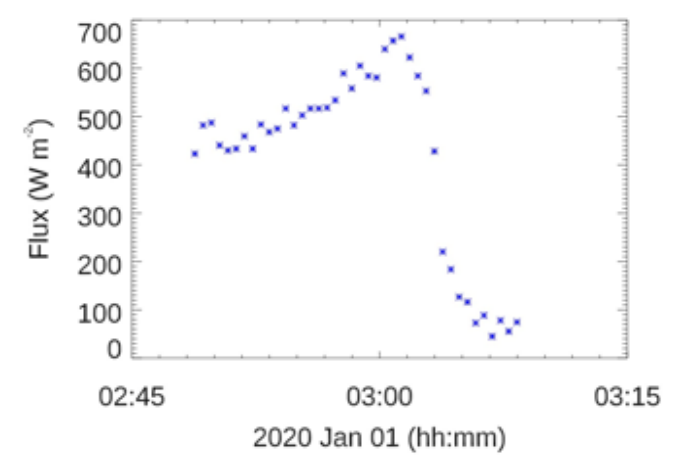
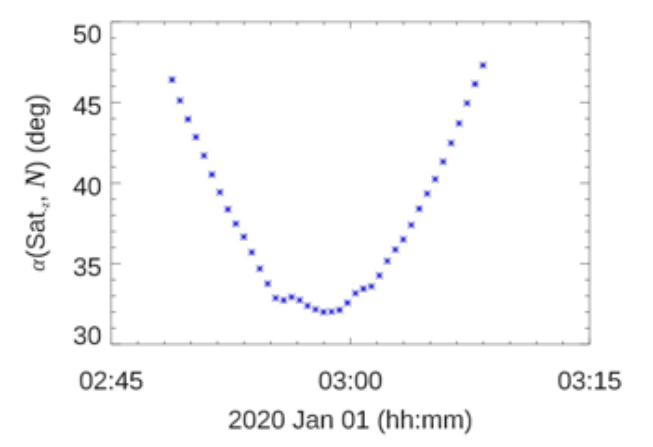
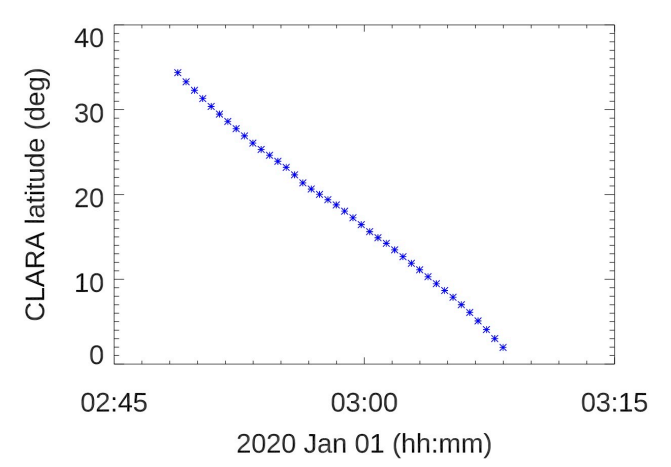
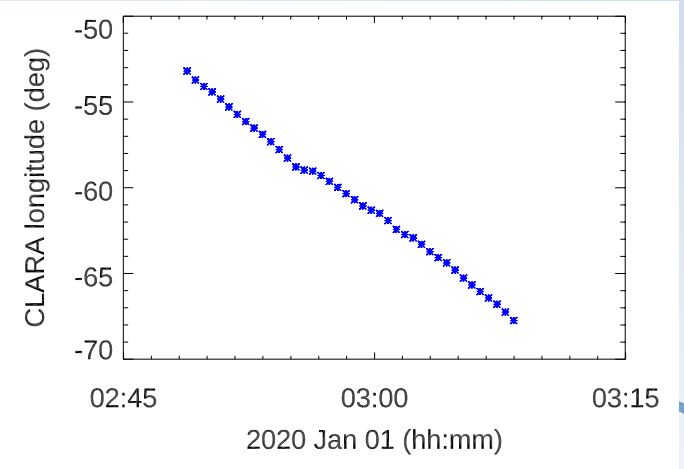
Example of OLR for Jan 1, 2020

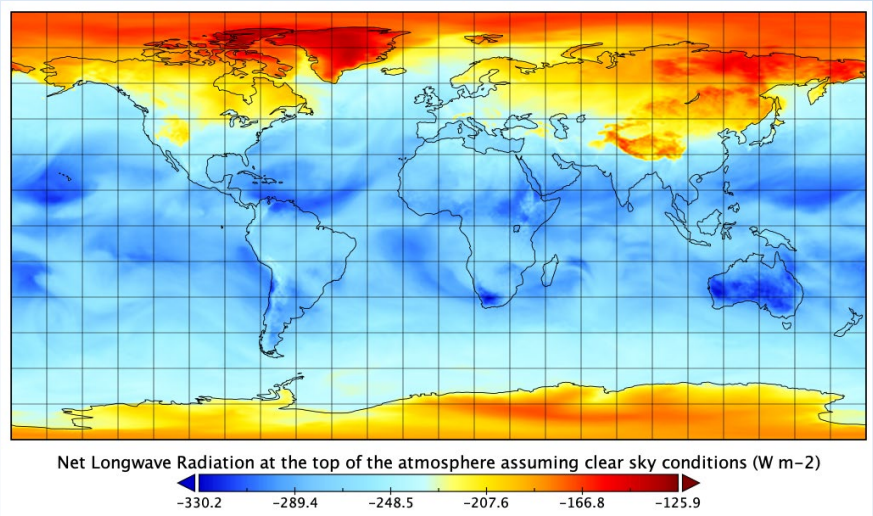


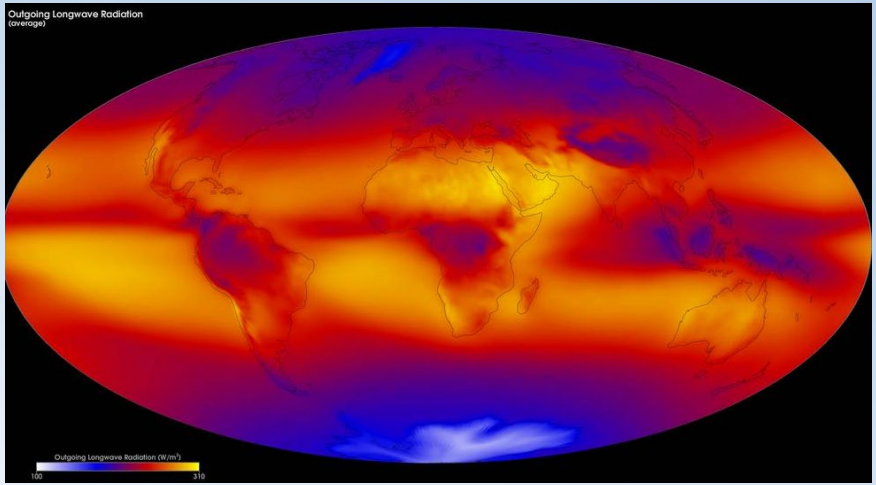






Comparison with ERA5 and CERES data





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Summary

- Despite issues with the NorSat-1 platform
  - CLARA is healthy and takes
  - TSI measurements track solar activity (if solar pointing is active)
  - OLR data analysis ongoing
- CLARA TSI data available towards the end of the year
- Statsat in Norway works on platform issue
- JTSIM/DARA data will be released towards the end of the year
- PMOD Composite (Montillet et al., 2022) will be routinely updated and replaces the composite by Claus Frölich