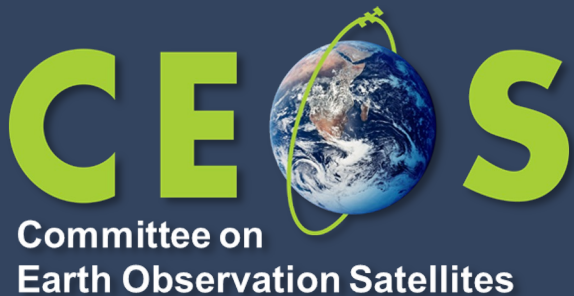


CEOS

WGCV-56 / LSI-VC-19

Joint Meeting

*HotSat Uncertainty
Budget*



SatVu

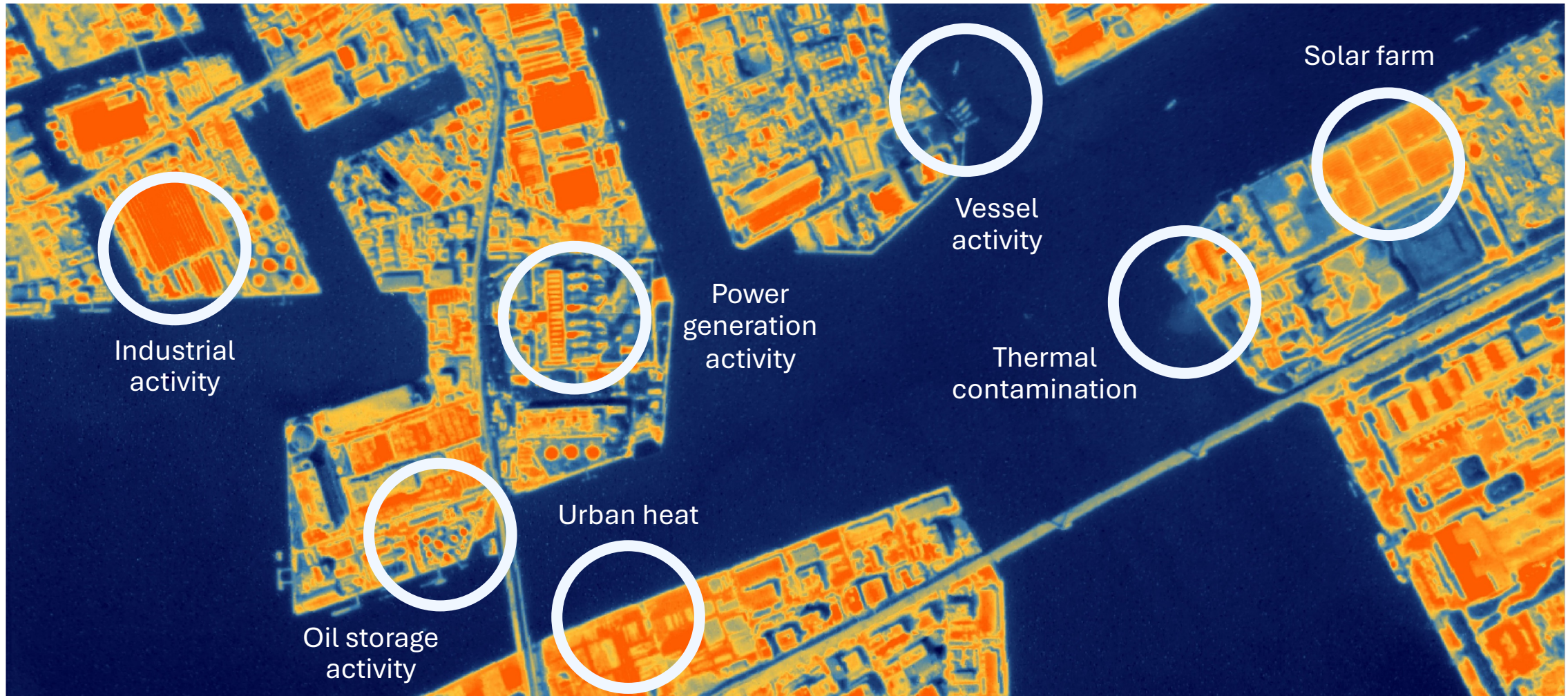
Jamie McMillan, SatVu

Agenda Item W8.2

WGCV-56 / LSI-VC-19 Joint Meeting

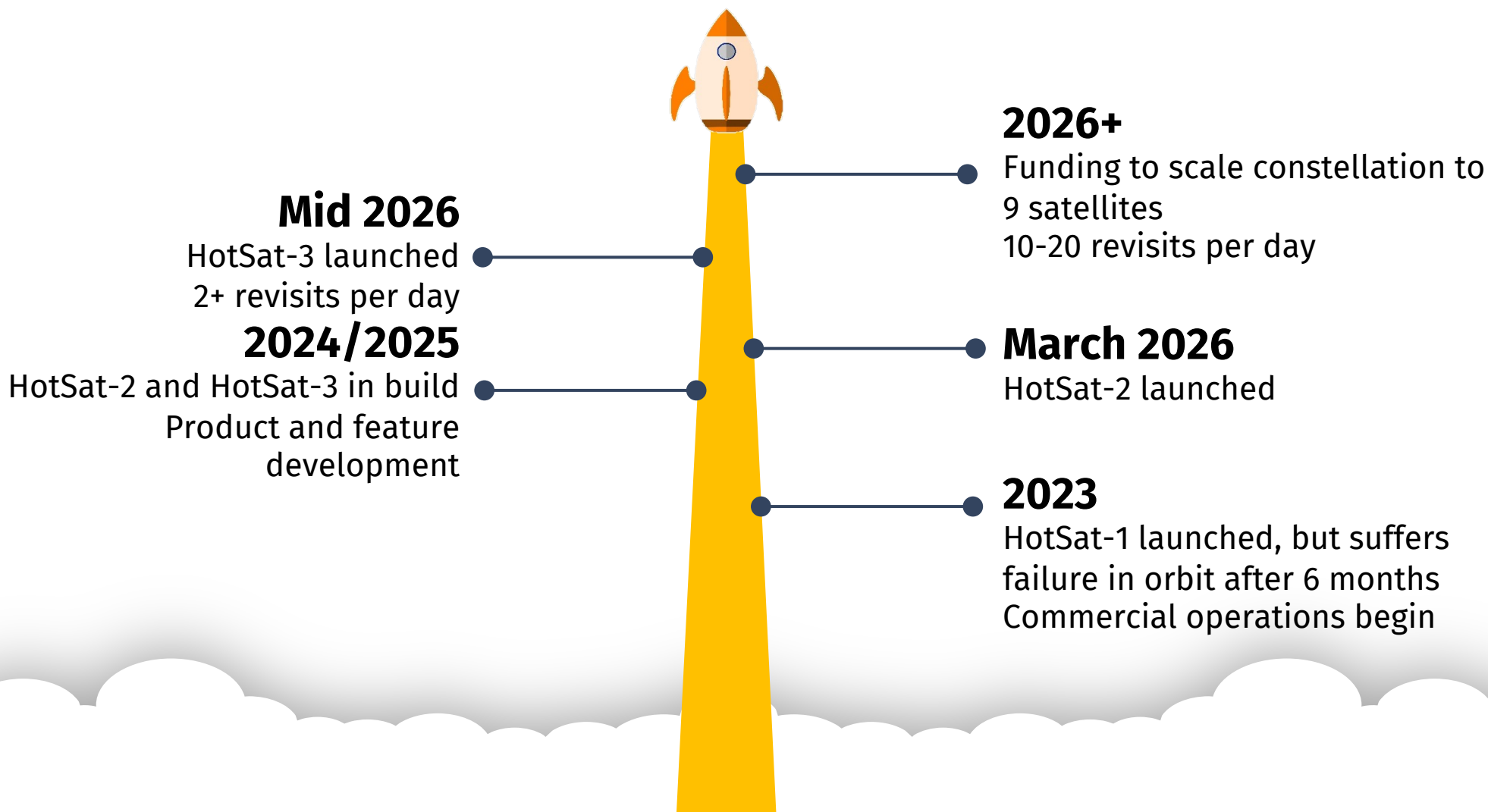
Sioux Falls, SD, USA

20-24 April, 2026



Yokohama, Japan – 24 October 2023

20231024_041338_HS1



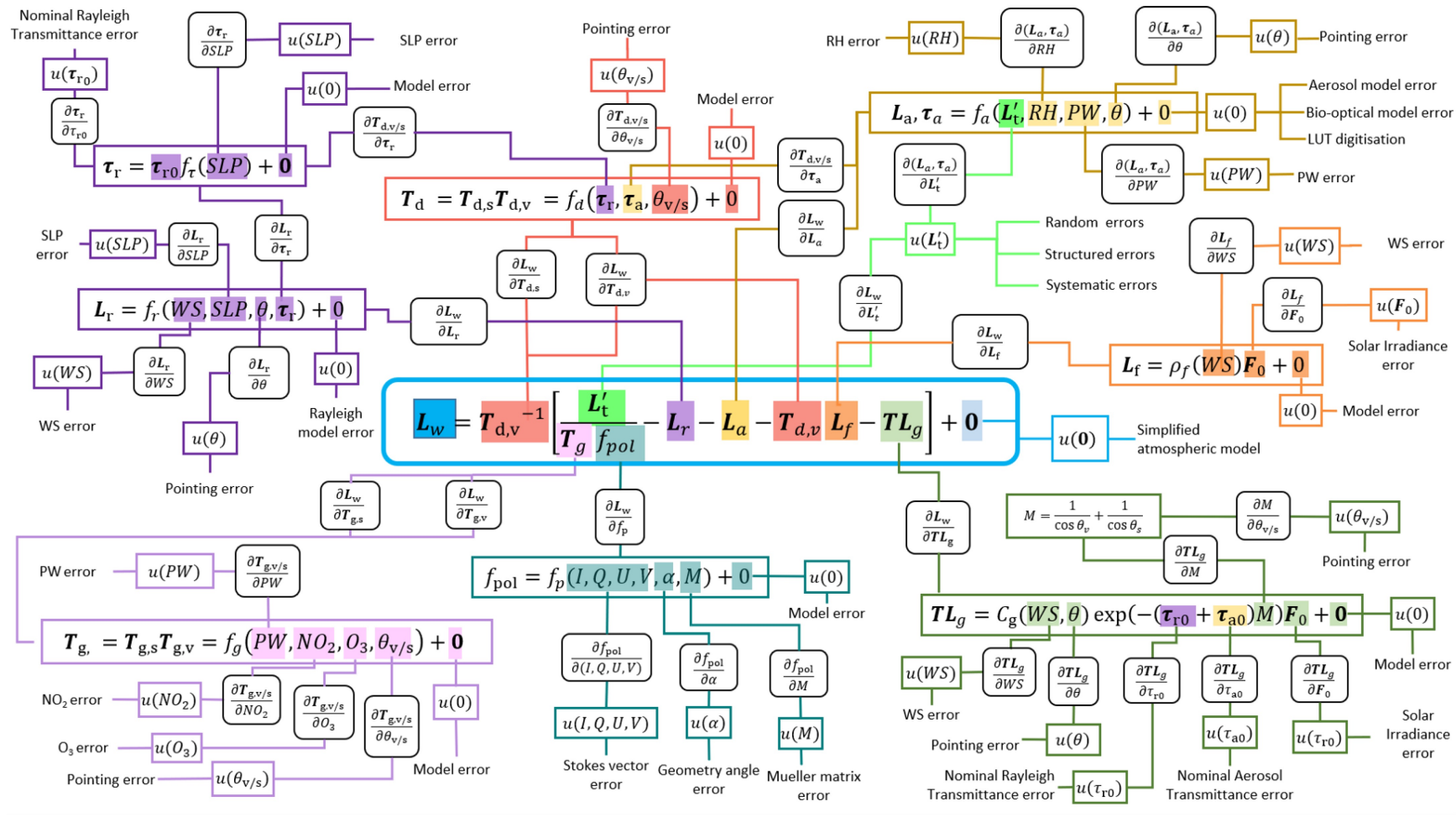
- ❖ **Uncertainty intro**
- ❖ **Uncertainty sources**
- ❖ **Propagation**
- ❖ **Components**
- ❖ **Discussion**

Uncertainty evaluation using these references:

- Guide to Uncertainty Measurement (GUM, BIPM 2008)
- Quality Assurance Framework For Earth Observation (QA4EO)
- FIDUCEO convention (Jonathan Mittaz *et al* 2019)
- Community Metrology toolkit (CoMet)
- CEOS ARD Surface Temperature v5.0 (item 3.3 measurement uncertainty)



Uncertainty Sources

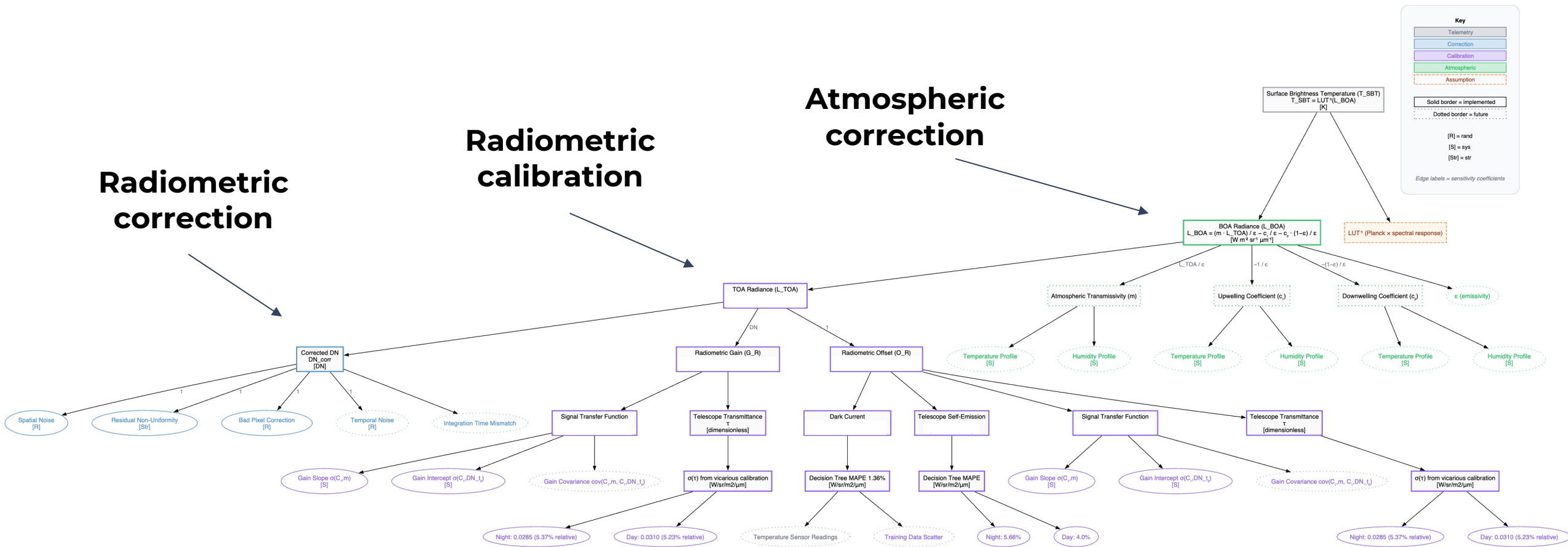


De Vis et al, Remote Sensing, 2022

Uncertainty Sources



Surface Brightness Temperature (T_{SBT})

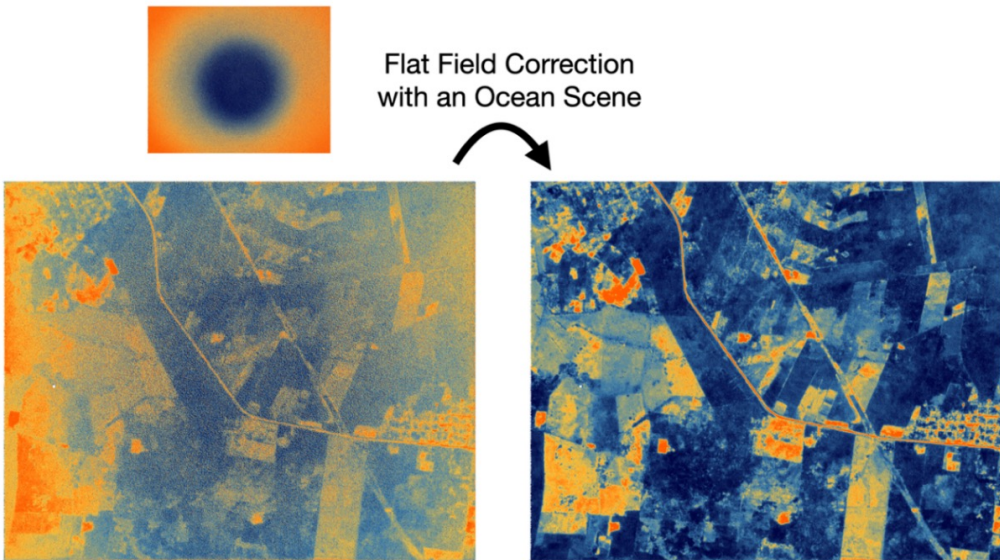
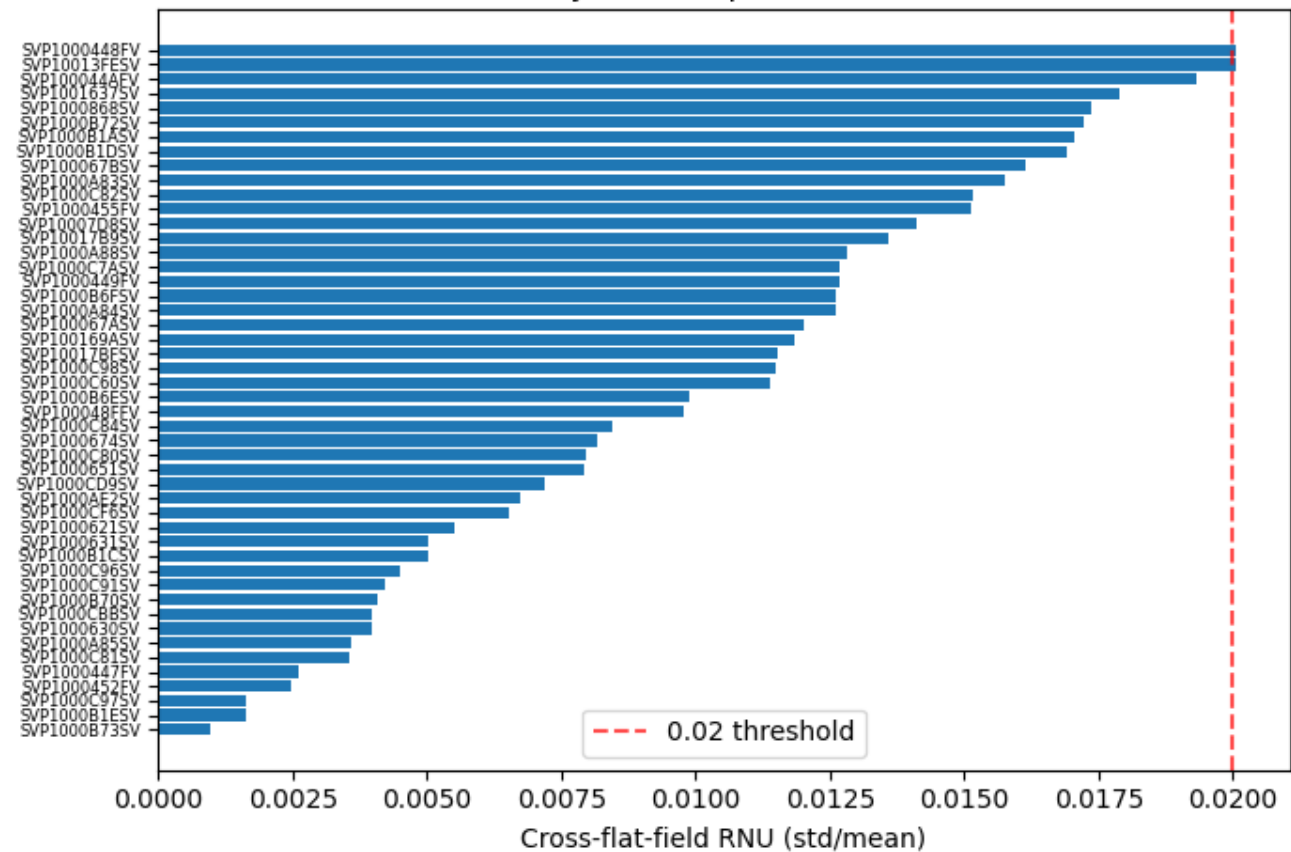


Components Considered

Residual non-uniformity



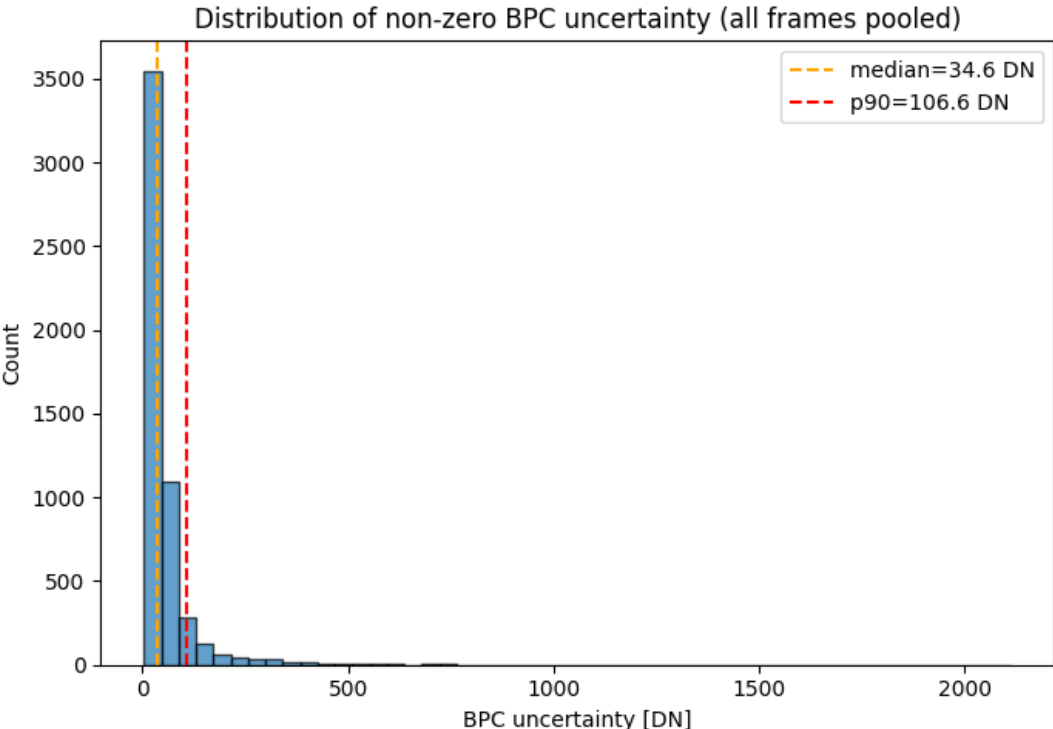
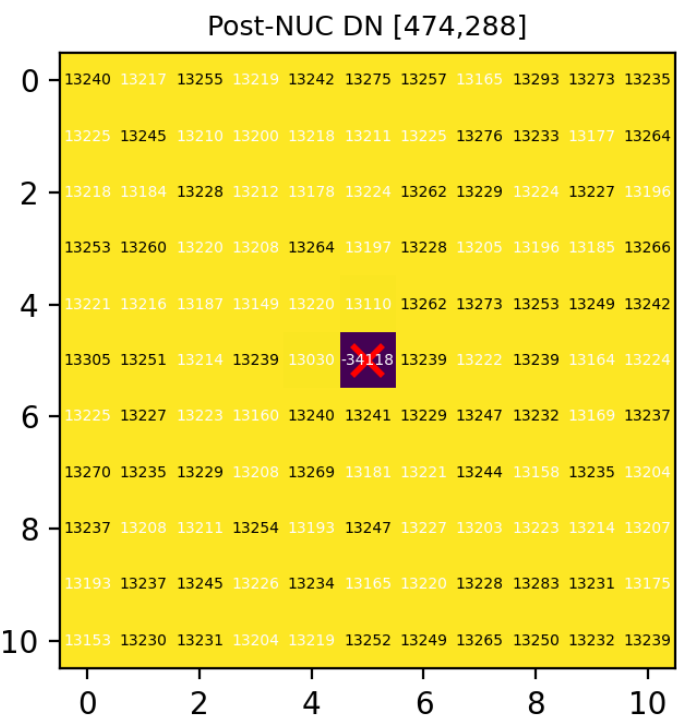
day band — per-flat RNU



Median SBT uncertainty: 2.0 K
Max SBT uncertainty: 6.4 K

Components Considered

Bad pixel correction



Median SBT uncertainty: 2.9 K
Max SBT uncertainty: 13 K

Components Considered

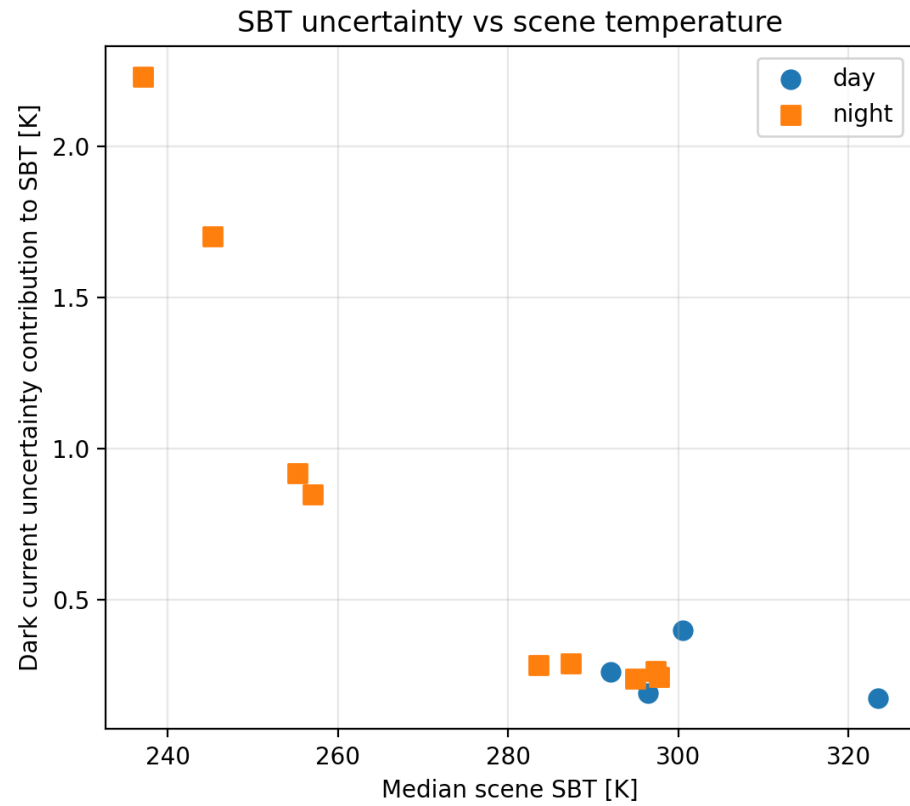
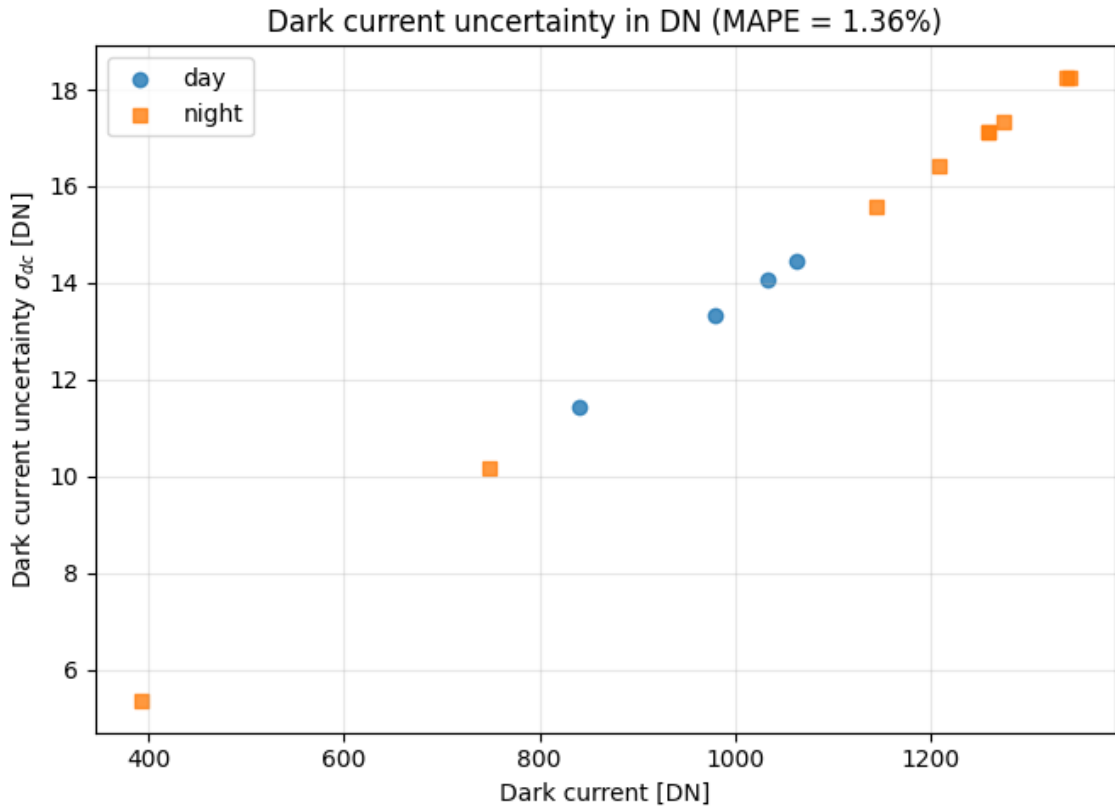
Signal transfer function



Median SBT uncertainty: 0.4 K
Max SBT uncertainty: 0.9 K

Components Considered

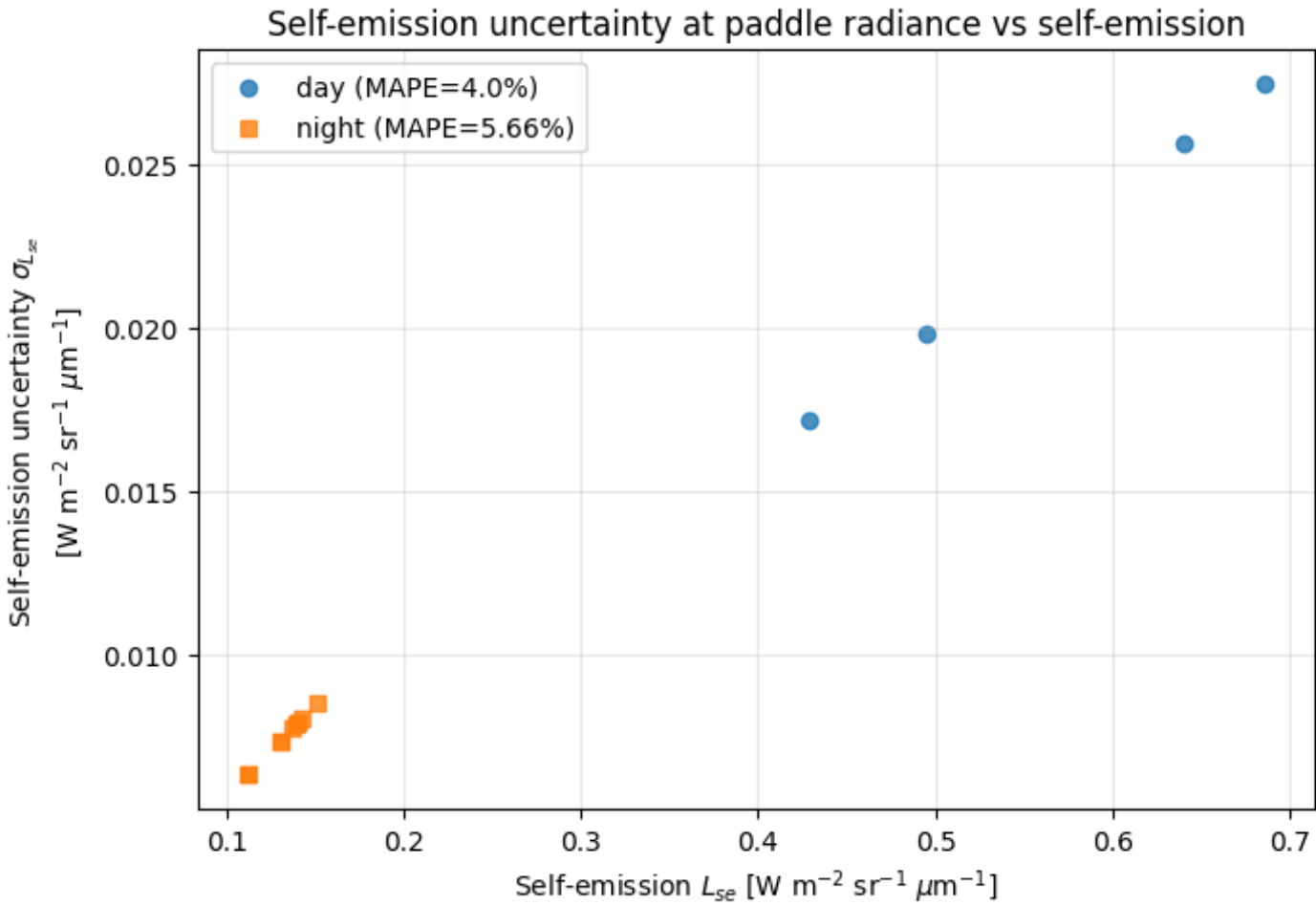
Dark current



Median SBT uncertainty: 0.3 K
Max SBT uncertainty: 2.2 K

Components Considered

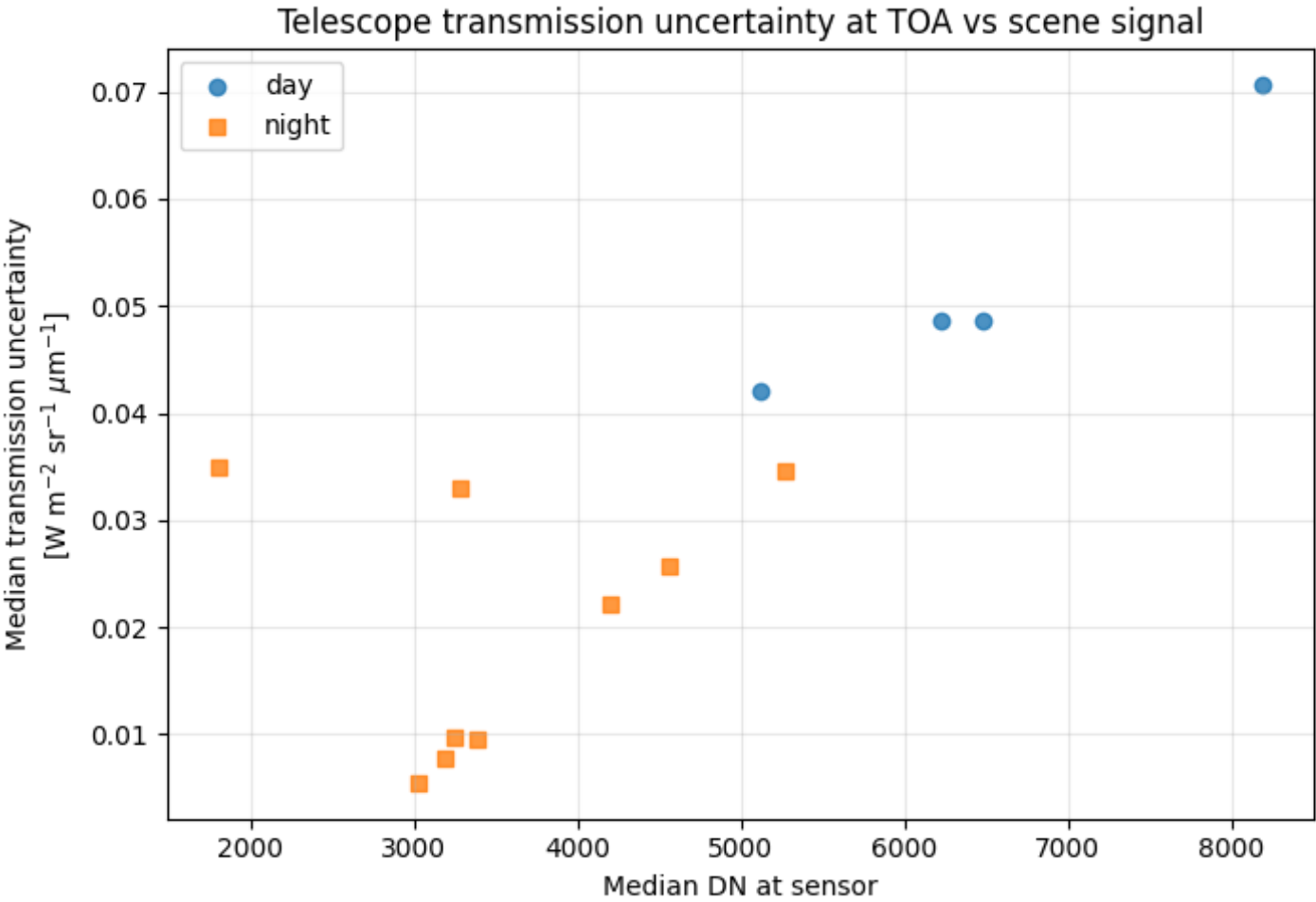
Thermal self-emission



Median SBT uncertainty: 1.7 K
Max SBT uncertainty: 8.6 K

Components Considered

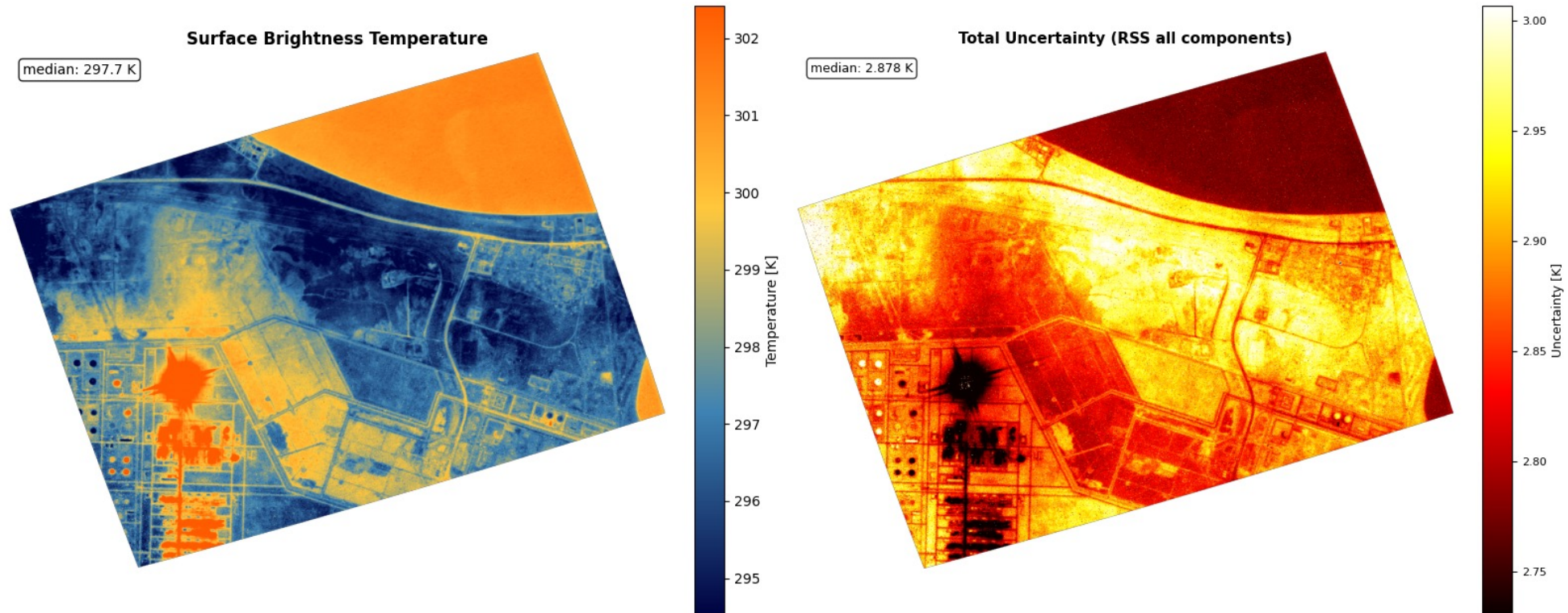
Telescope transmission



Median SBT uncertainty: 2.5 K
Max SBT uncertainty: 4.4 K

Component	Correlation	Median SBT / K	Range SBT / K	Affected pixels
RNU	Structured	2	—	All
Bad pixel correction	Random	2.9 (p90)	1.6–12.7	~292 (~0.02 %)
SiTF gain	Systematic	0.4	0.2–0.9	All
Dark current	Systematic	0.3	0.2–2	All
Telescope self-emission	Systematic	2	0.9–9	All
Telescope transmission	Systematic	2.5	1.7–4.4	All

HotSat-1 SBT and Uncertainty Budget
20231020_220042_HS1 • night band • 30.0 ms



Still on the roadmap:

- Correlation consideration and improved combination
- Atmospheric profile uncertainty

Internal usage:

- Iterative product improvement
- A high-level – evidence based – quality metric
- During intercomparison exercises

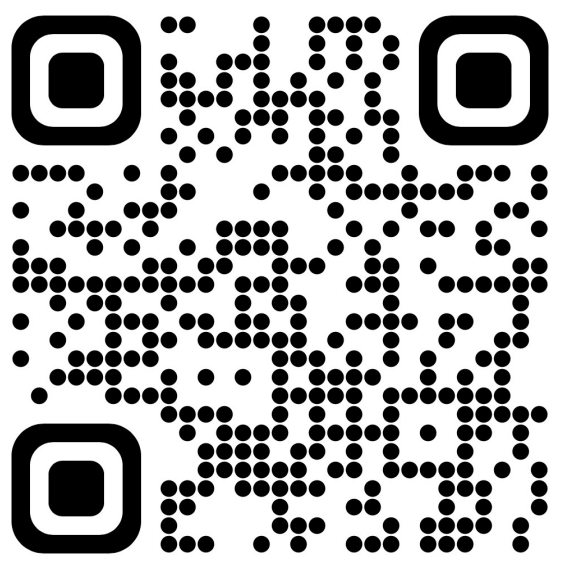
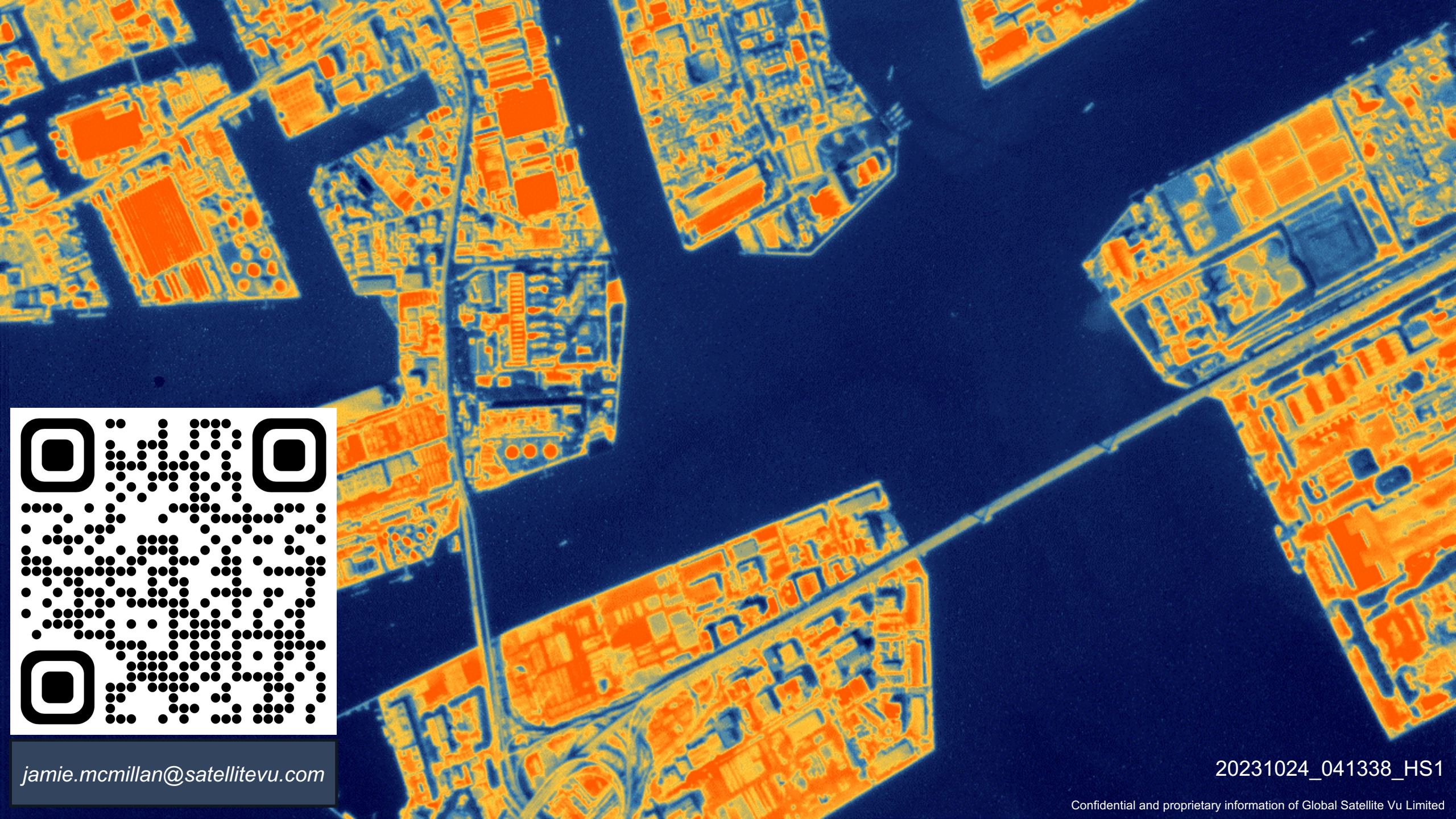
External usage:

- ?

Existing documentation and tooling is excellent!

- CoMet does a lot of heavy lifting but still required integrating into our pipeline architecture
- Defined a piece-by-piece architecture so components can be included independently
- Guidance on minimal set of uncertainty components to cover?
- Guidance from CEOS on data storage format for intermediary and output uncertainty files
 - Current each acquisition has a single zarr file with a data layer for each component
 - At the end, these are propagated to the output measurand
- Still unclear how external users would like this information
 - Per-pixel per components or each type or just the combined uncertainty?

- Uncertainty evaluation applied to HotSat-1 production pipeline
 - Meets CEOS ARD Surface Temperature per-pixel uncertainty
 - Not presently included in an external product
- Components considered from radiometric correction and calibration
 - Atmospheric correction still to be considered
- This will be evaluated for each HotSat-2 acquisition and explored during our first Product Quality Assurance Report (PQAD)



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