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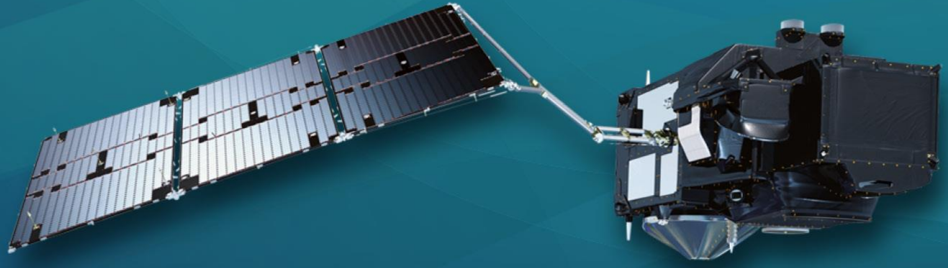


9th Sentinel-3 Validation Team meeting 2026

30 March–01 April 2026 | ESA–ESRIN | Frascati (Rome), Italy

Land Surface Temperature validation with the University of Leicester In-situ validation network

Jasdeep Singh Anand, Darren Ghent, Agnieszka Soszynska, Abi Waring, Ritika Shukla, Rocio Barrio Guillo, and local partners

National Centre for Earth Observation, University of Leicester, UK

Category A validation is crucial for LST

GCOS Implementation Plan (2022)		
Property	**Threshold**	**Goal**
Accuracy/Precision	< 1 K	< 1 K
Stability	0.3 K $decade^{-1}$	0.1 K $decade^{-1}$

Satellite LST retrieval uncertainty sources	
Instrumental	• Detector noise • ISRF • Geolocation
Atmospheric	• H_2O • Other trace gases • Atmospheric temperature
Scene	• Surface emissivity • Shadows • Cloud cover

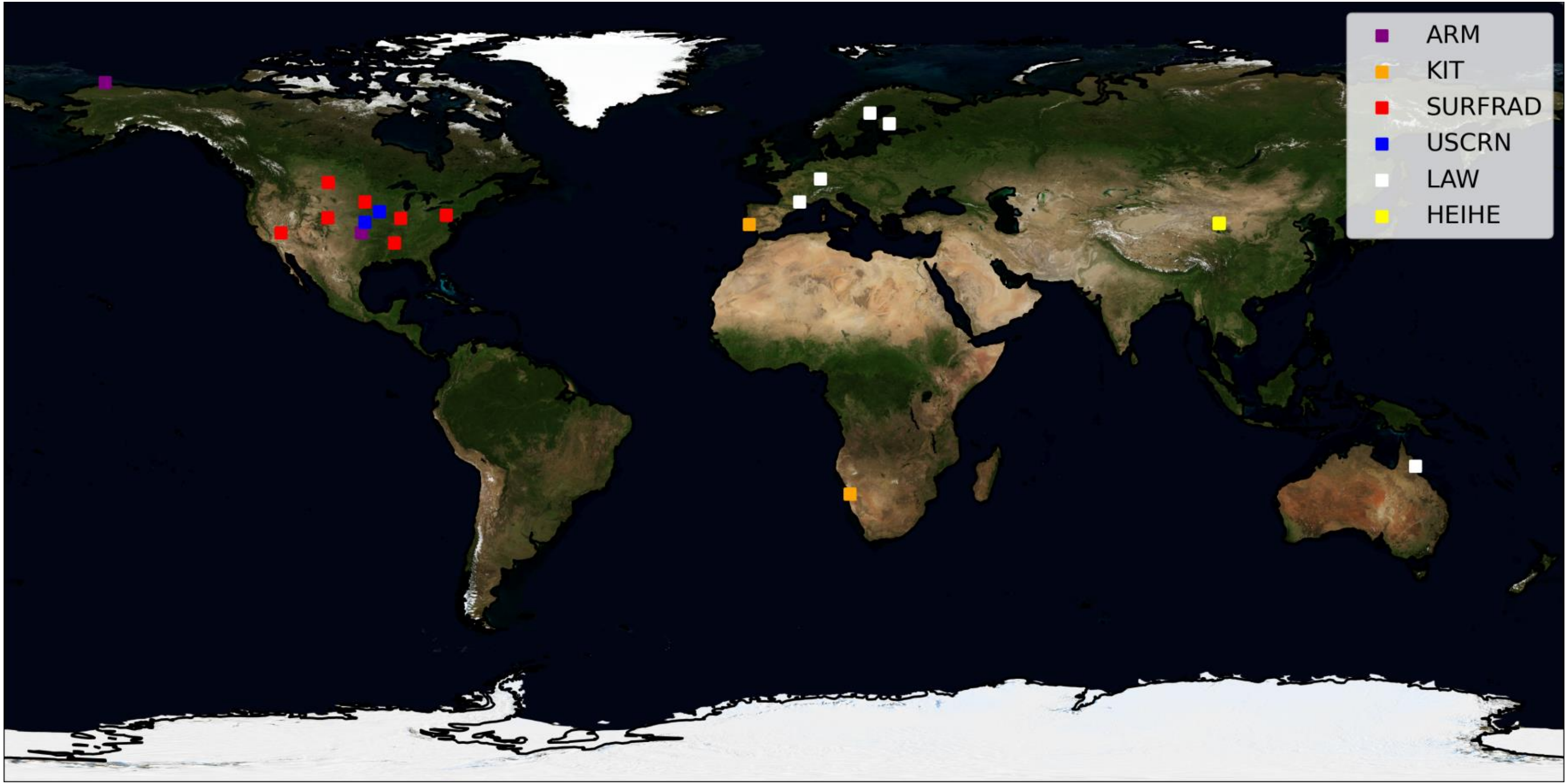
Definitions

- **Accuracy:** closeness of the agreement between the measured LST and the truth
- **Precision:** closeness of the agreement between the results of successive LST measurements
- **Stability:** Long-term drift due to degradation in instrument accuracy

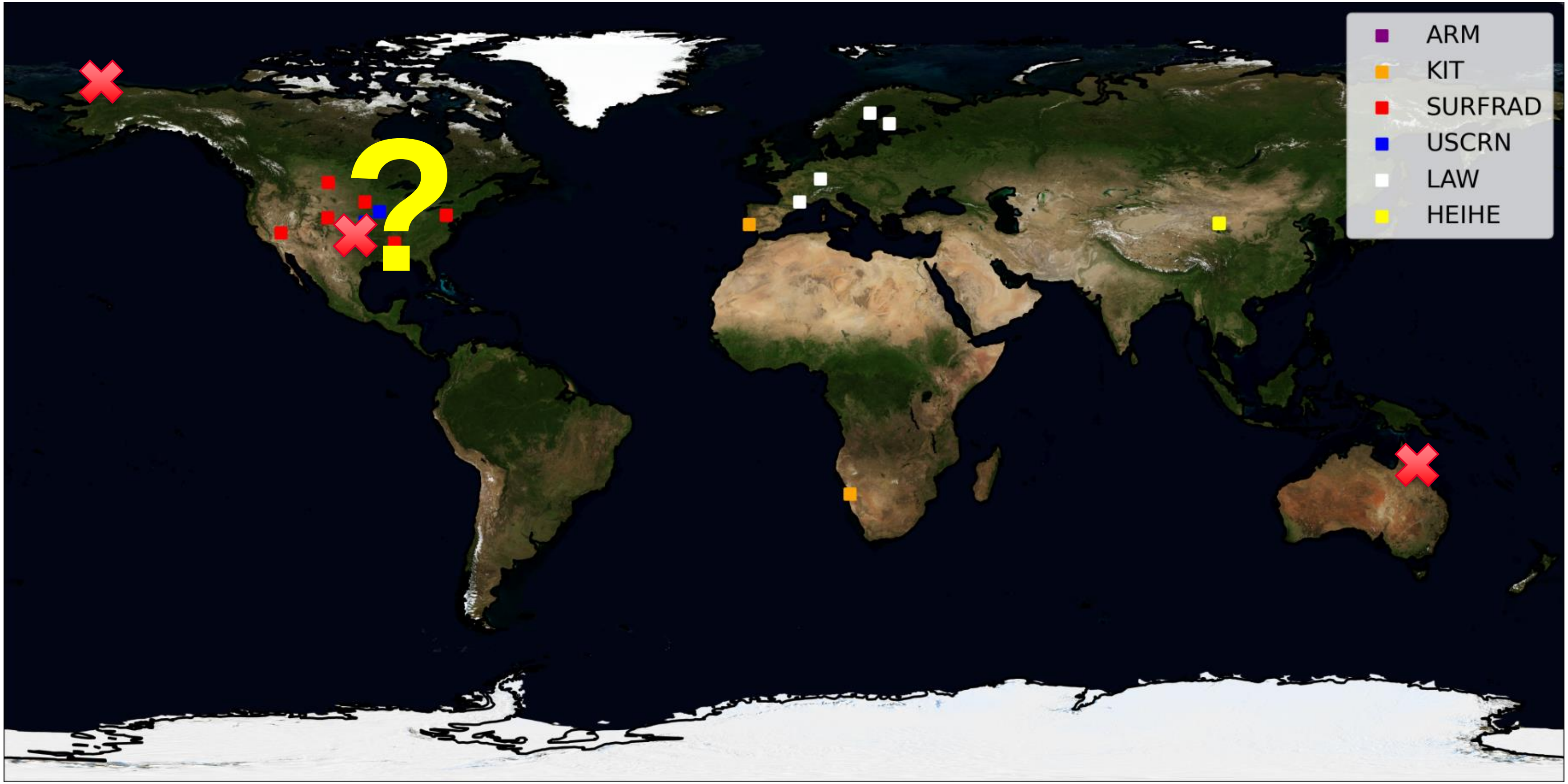
Why in situ LST?

- SLSTR LST retrieval is biome specific, so multiple validation datasets are required over different biomes/climates
- Only method for absolute validation of L2 data
- Satellite inter-comparisons limited by choice of retrieval algorithm, matching overpass times, etc.

But “gold-standard” stations are sparse…



…and becoming sparser



The University of Leicester validation network

- UoL has obtained capital funding from UKRI and UK Govt to support the re-integration into Copernicus
- This fund has enabled the deployment of **9 LST validation sites**, based at existing flux or weather station networks to share infrastructure and minimise costs, with **4 more sites to be deployed over next few months**
- Sites were selected based on a gap analysis of these stations, weighted by the following criteria:
  - Previously unmonitored land cover/biome (e.g. mixed forest) or geographic region
  - Homogeneity in land cover in the SLSTR footprint (~1 km^2)
  - Likelihood of regular cloud-free scenes at the SLSTR overpass time
  - Logistical ease (nearby site staff, carnet agreements, etc.)

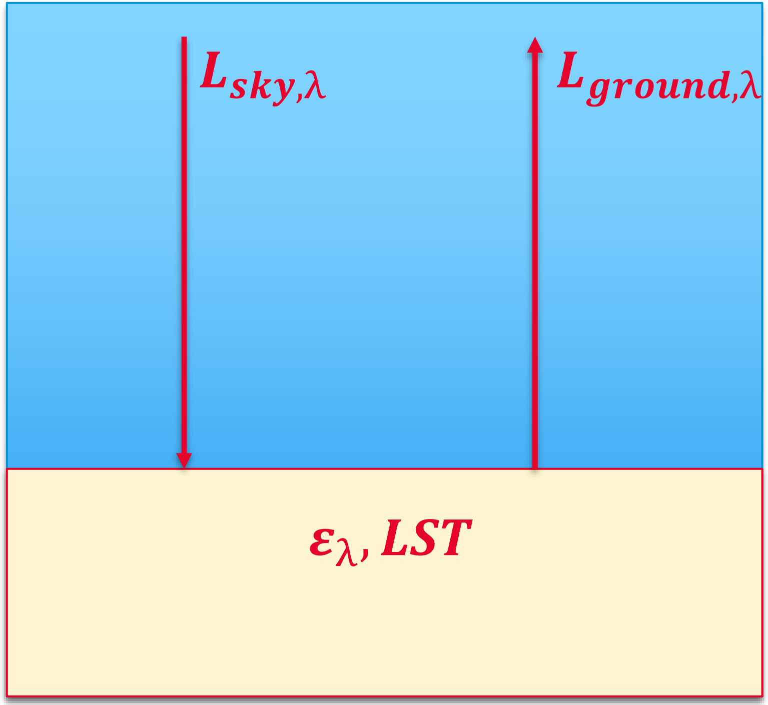
Gap analysis per biome

Biome	Current sites				Expected sites			
	Station	Country	Network	Status	Station	Country	Network	Status
10					**Kanpur**	**India**	**UOL**	Semi-operational
11	Bondville Penn St. Un. Sioux Falls SGP	US US US US	SURFRAD SURFRAD SURFRAD ARM	At risk At risk At risk At risk	Lonzee	Belgium	NUBICOS	Operational
12								
20								
30	Des Moines	US	USCRN	At risk	**Tandil**	**Argentina**	**UOL**	Operational
40	Goodwin Creek	US	SURFRAD	At risk	**Wroclaw**	**Poland**	**UOL**	Deployment Q3 2026
50	Robson Creek	Australia		Decommissioning	Congo Flux **Whroo**	DRC **Australia**	NUBICOS **UOL**	Operational Operational
60					**Santa Rosa**	**Costa Rica**	**UOL**	Deployment Q2 2026
61					**Hainich**	**Germany**	**UOL**	Operational
62					**Wytham Woods**	**UK**	**UOL**	Operational
70	Hyytiala Svartberget Puechabon	Finland Sweden France	LAW LAW LAW	Operational Operational Operational	Hyytiala Svartberget Puechabon	Finland Sweden France	LAW LAW LAW	Operational Operational Operational
71					**Sodankyla**	**Finland**	**UOL**	Operational
72								
80								
81								
82								
90	KIT Forest	Germany	LAW	Operational	KIT Forest Brasschaat	Germany Belgium	LAW NUBICOS	Operational Operational
100					**Majadas**	**Spain**	**UOL**	Deployment Q2 2026
110					**Wicken Fen**	**UK**	**UOL**	Semi-operational
120	Desert Rock Williams	US US	SURFRAD USCRN	At risk At risk				
121								
122								

Gap analysis per biome

Biome	Current sites				Expected sites			
	Station	Country	Network	Status	Station	Country	Network	Status
130	Fort Peck Manhattan	US US	SURFRAD USCRN	At risk At risk	Laqueuille Auchencorth Moss	France UK	NUBICOS LAW	Operational Deployment Q2 2026
140	NSA (summer)	US	ARM	At risk	**Svalbard (summer)**	**Norway**	**UOL**	Operational
150					**Nuuk (summer)**	**Greenland**	**UOL**	Operational
151								
152								
153								
160								
170								
180					Abisko	Sweden	NUBICOS	Operational
190					**SPL**	**UK**	**UOL**	Deployment Q2 2026
200								
201								
202								
203								
204								
205								
206								
207								
210								
220	NSA (winter)	US	ARM	At risk	**Svalbard (winter)** **Nuuk (summer)**	**Norway** **Greenland**	**UOL** **UOL**	Operational Operational

In situ LST retrievals



- Land surface radiance (***B***):

$$B = \frac{L_{ground,\lambda} - (1 - \varepsilon_\lambda) \cdot L_{sky,\lambda}}{\varepsilon_\lambda}$$

- For **narrow-band** instruments:

$$LST = \frac{2 \cdot h \cdot c^2}{\lambda \cdot \ln\left(\frac{h \cdot c}{B \cdot k \cdot \lambda^5} + 1\right)}$$

- Emissivity provided by climatology based on the NASA Combined ASTER and MODIS Emissivity database over Land (CAMEL) dataset

Radiometers I: Heitronics KT15.85 IIP

- **Chopped pyrometer** (measures both target and internal radiance for greater accuracy)
- **FOV**: 16°/66° (depending on scene homogeneity)
- **Spectral band**: 9.6 – 11.5 µm
- **Accuracy**: 0.5 K (+ 0.7% of target-to-sensor temperature difference)
- **Stability**: < 0.1% $year^{-1}$

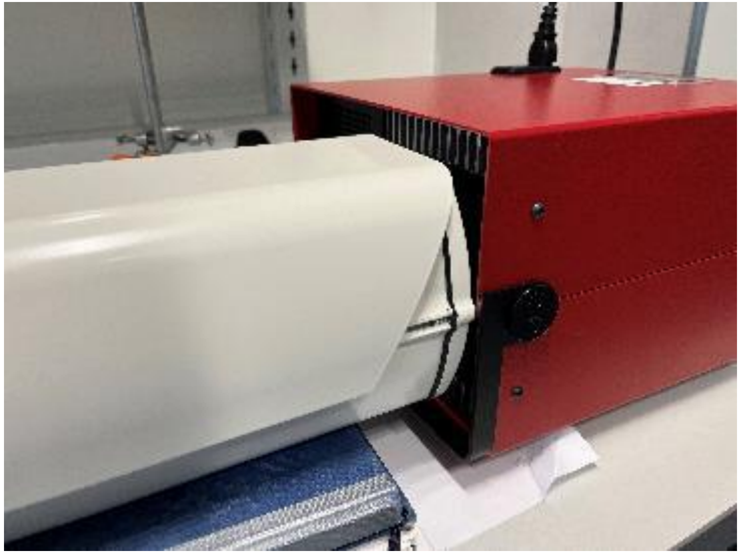
https://www.heitronics.com/en/product/radiation-thermometer/versatile-specialists/kt15-iip/

Radiometers II: Apogee Instruments SI-121-SS

- **Thermopile** radiation detector + reference thermistor for sensor temperature measurement
- **FOV**: 18°
- **Spectral band**: 8 – 14 µm
- **Accuracy**: 0.2 - 0.5 K (target – detector temperature bias dependent)
- **Precision**: 0.05 K
- **Stability**: < 2% yr^{-1}

https://www.apogeeinstruments.com/si-121-ss-research-grade-narrow-field-of-view-infrared-radiometer-sensor

Lab calibration with AMETEK Landcal P80P



- All radiometers calibrated with a NPL-certified blackbody calibration source before deployment
- Calibration range: **20 – 60°C**
- Procedure limited by ambient air temperature – unable to vary sensor temperatures (effect on both instruments thought to be minimal compared to other uncertainties like surface emissivity)

UoL radiometer deployment

Heitronics:

- VZA: 45° downward
- Direction: East/South (West/North at Tandil)
- FoV: 16° (Tandil, Ny-Ålesund, Sodankyla) or 66° (Whroo, Hainich, Nuuk)

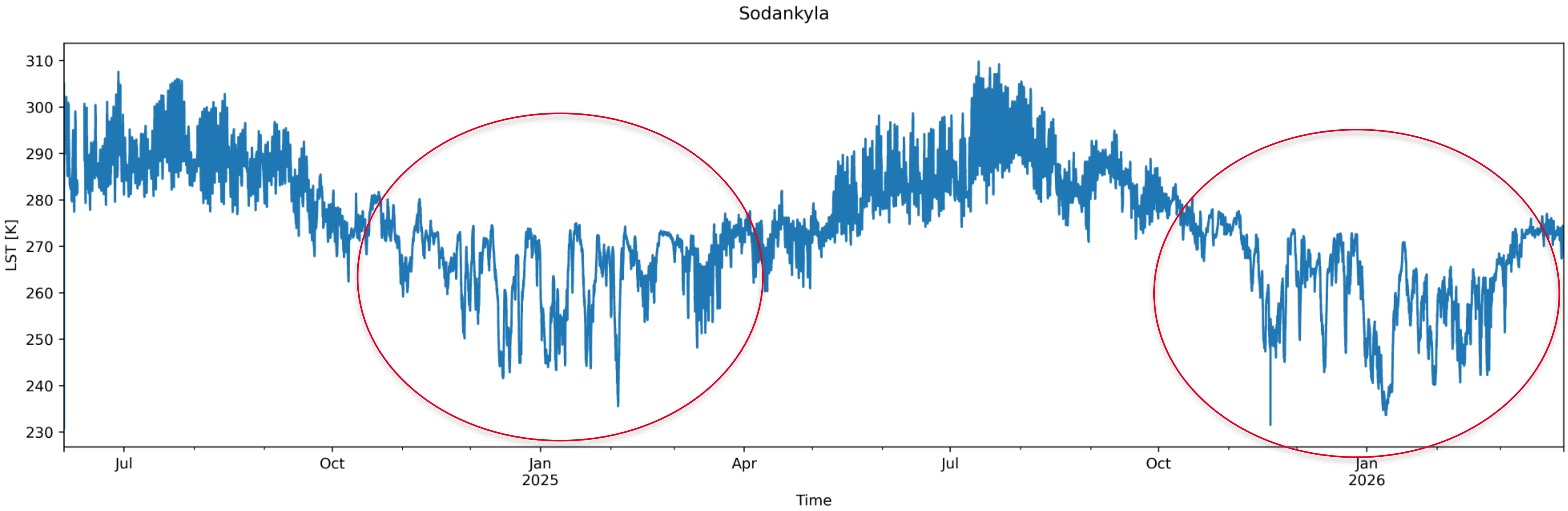
Apogee:

- VZA: 53° upward
- Direction: North (South at Tandil)

Also deployed cellular modem (R-Pi) for data telemetry at some sites

Sodankyla deployment – June 2024

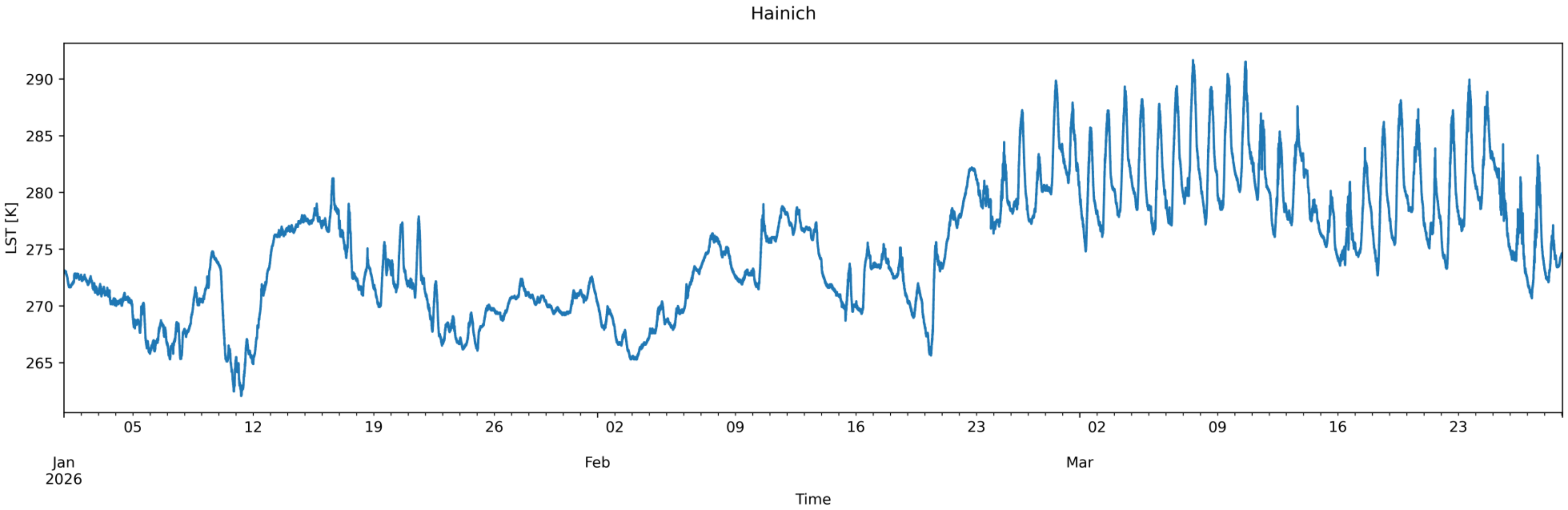
Sodankyla deployment – June 2024



Diurnal cycle changes due to biome changing from needleleaved forest to snow/ice

Hainich deployment – June 2024

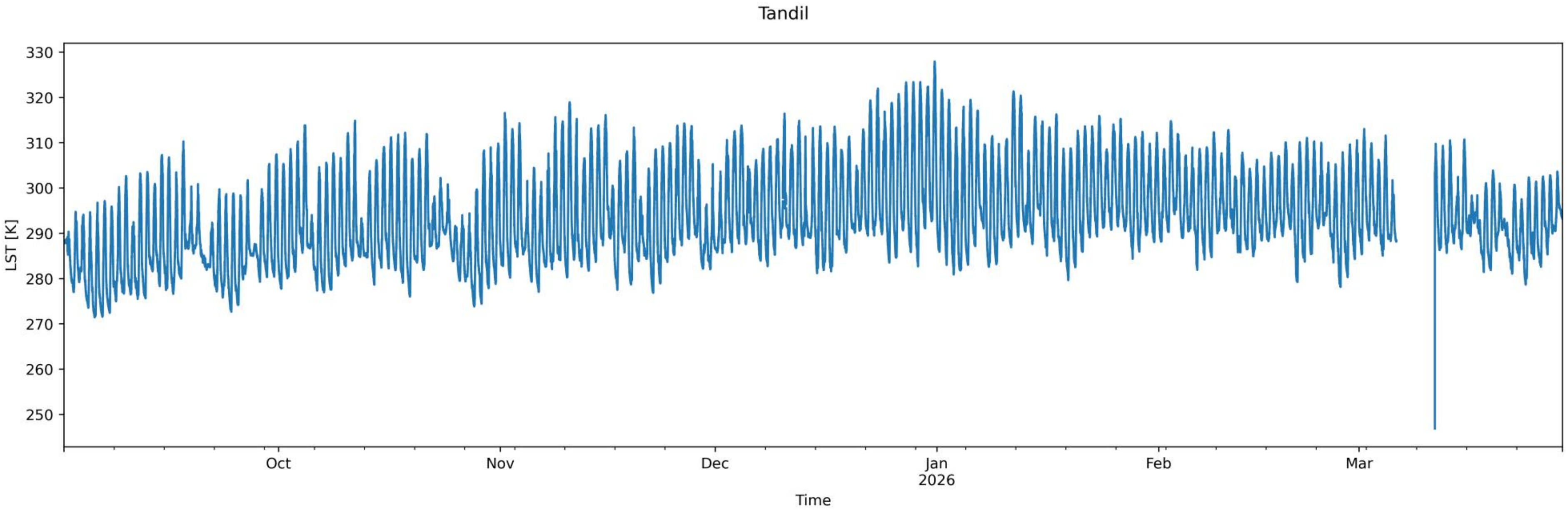
Hainich deployment – June 2024



Diurnal cycle changes as growing canopy obscures bare soil in Spring

Tandil deployment – August 2024

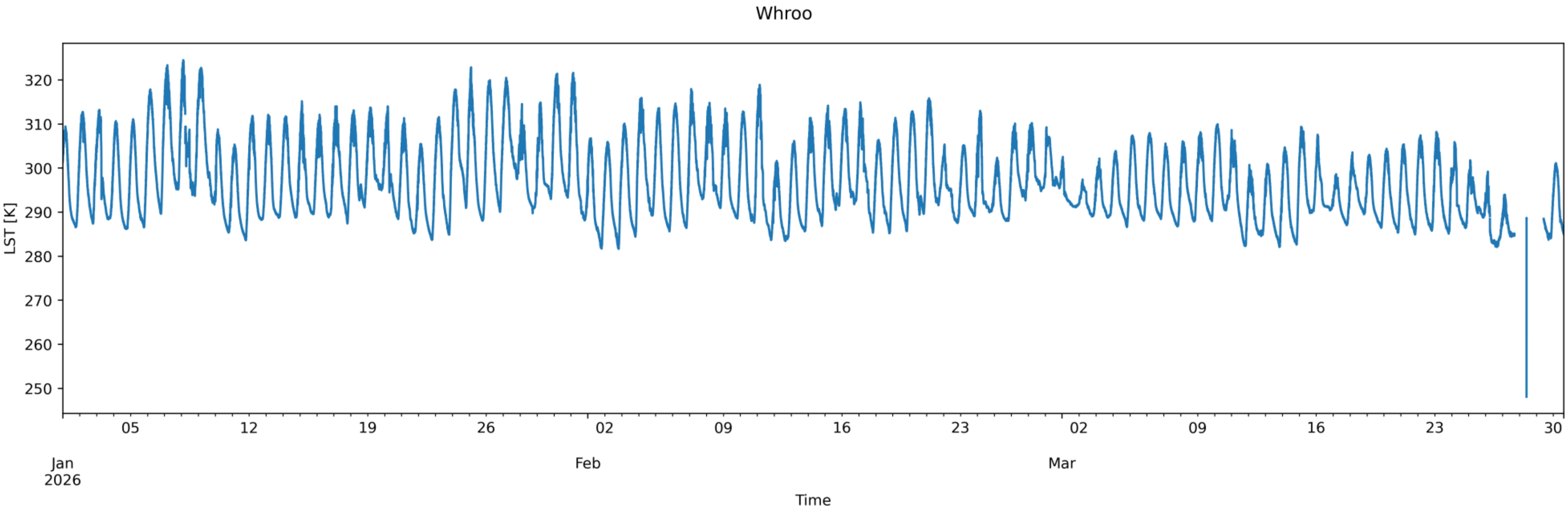
Tandil deployment – August 2024



Need more contextual info to understand diurnal cycle (crop type, LAI, etc.)

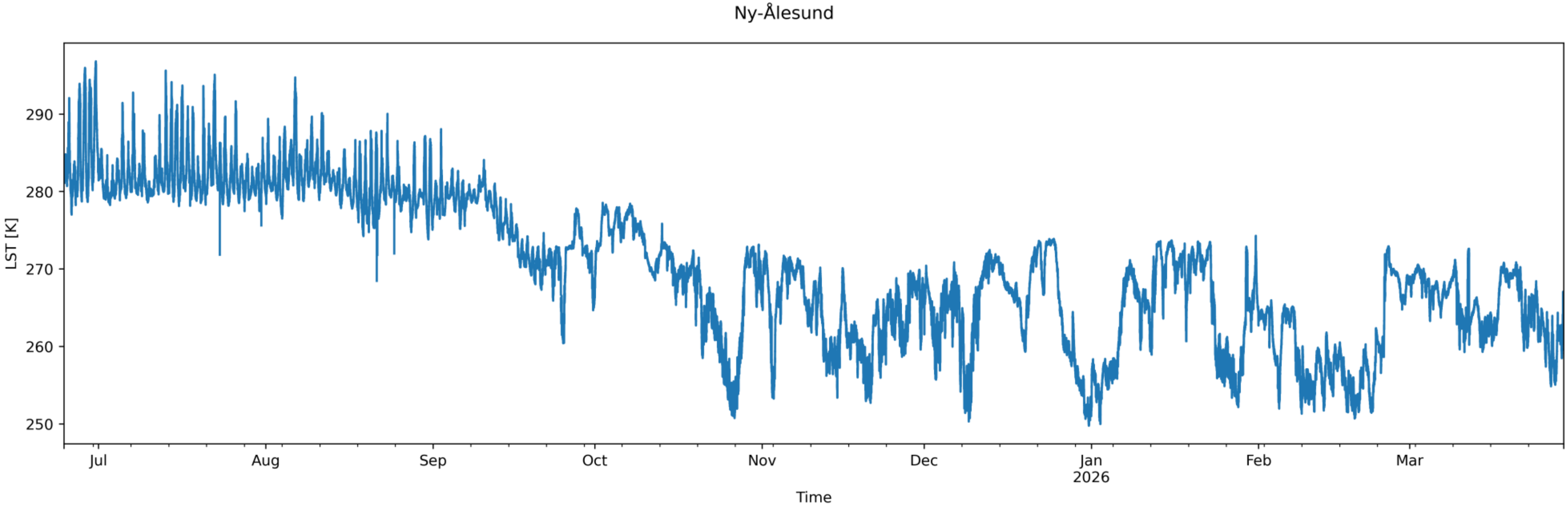
Whroo deployment – November 2024

Whroo deployment – November 2024



Ny-Ålesund deployment – June 2025

Ny-Ålesund deployment – June 2025



Diurnal cycle changes due to biome changing from tundra to snow/ice

Next steps

- Deployment lifetime ~ 2 years. Instruments will be swapped and recalibrated
- Integration of calibration results on processing chain, formalising drift correction on time series
- New deployments coming soon: Majadas (orchard, links with ET research), Poland (grassland/forest), Santa Rosa (dry rainforest), Urban site in Leicester
- Contact: jsa13@le.ac.uk for more details