Radiometer intercomparison exercise, June 2022

FRM4SST: ISFRN Workshop
09/09/2022 University of Southampton

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5th CEOS TIR radiometer comparison (June 2022)

National Physical Laboratory

- Objective
  - To establish degree of equivalence of radiometric scales between field deployed ship-borne TIR radiometers
  - Ensure robust traceability to SI
- Past Comparisons: 2001 (Miami), 2009 (NPL & Miami), 2016 (NPL)
- Overview of the comparison:

  Laboratory-based and field-based exercise to compare
  - against the SI via NPL references (lab-comparison)
    - ✓ Blackbodies viewed by reference radiometer
    - ✓ TIR radiometers viewing reference blackbodies
  - against each other (field-comparison).
    - ✓ TIR radiometers as used viewing the ocean

Schedule

Event	Date
Invitation to participate	December 2021
Preparation and formal agreement of protocol	January - May 2022
Preparation of the reference standards, transfer standard and facilities at the NPL	February - April 2022
Participants send preliminary report of measurement system and uncertainty to pilot	May 2022
Calibration of the reference and transfer standards at NPL/ Calibration of the participants' radiometers before dispatch	~ June 2022
Lab Comparison / Field Comparison	*June 2022*
Stability check measurement of the reference and transfer standards at NPL/ Stability check measurement of the participants' radiometers after return	June - July 2022
Participants send all data and reports to pilot	August 2022
Pre-Draft A result sent to individual participants	September 2022
Draft A report circulated to participants for comments	October 2022
Draft A report (final version) circulated to participants for approval	November 2022
Draft B submitted to CEOS WGCV	January 2023
Final Report published	March 2023

Participants

Attendee	Institute	Short version	Lab comp.		Field comp.
			Blackbody	Radiometer	
Yoshiro Yamada **Subrena Harris**	National Physical Laboratory United Kingdom	NPL	Pilot	Pilot	(Pilot)
Werenfrid Wimmer	National Oceanography Centre United Kingdom	UoS	✓	✓	✓
Tim Nightingale **Arrow Lee**	STFC Rutherford Appleton Laboratory United Kingdom	RAL	✓	✓	✓
Nis Jepsen	Danish Meteorological Institute Denmark	DMI		✓	✓
Nicole Morgan	CSIRO / Australian Bureau of Meteorology Australia	CSIRO	✓	✓	✓
Frank-M. Göttsche	IMK-ASF / Karlsruhe Institute of Technology Germany	KIT	✓	✓	✓
Raquel Niclòs **Martin Perello** **Vicente Garcia-Santos**	University of Valencia Spain	UoV	✓	✓	✓

Issues encountered in previous comparison

- The high-emissivity NPL reference standard blackbody aperture was too small
  → alignment covering the FOV was difficult for some of the radiometers
- The time allocated to each participant for measuring the blackbody was too short

This comparison

- Blackbody comparison: a transfer radiometer is introduced to measure the participant's blackbodies – to increase flexibility
- Radiometer comparison: a second variable temperature blackbody with a larger aperture is introduced – to improve efficiency and accuracy

Standard facilities for *blackbody* comparison

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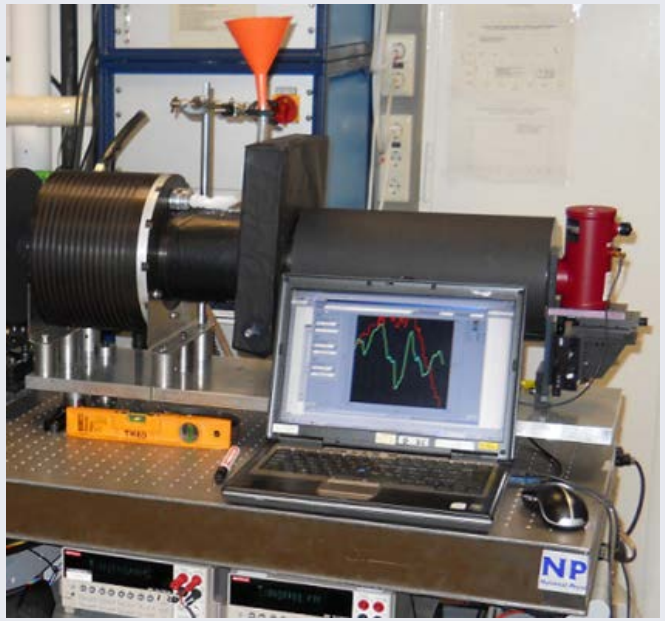
Radiometer specifications		
	AMBER (Absolute Measurements of Blackbody Emitted Radiance) (reference standard)	Heitronics TRT-IV.82 *New* (transfer standard)
		
Wavelength	10.1 µm (9 µm – 11 µm)	8 µm - 14 µm
Target size	ϕ 5 mm	ϕ 8.7 mm
Measurement distance	70 mm	503 mm
Effective lens diameter	ϕ 13 mm	ϕ 57 mm
Scale realization	Through relative spectral response measurement and a fixed-point blackbody measurement at the Ga melting point.	By comparison with AMBER

Standard facilities for *radiometer* comparison

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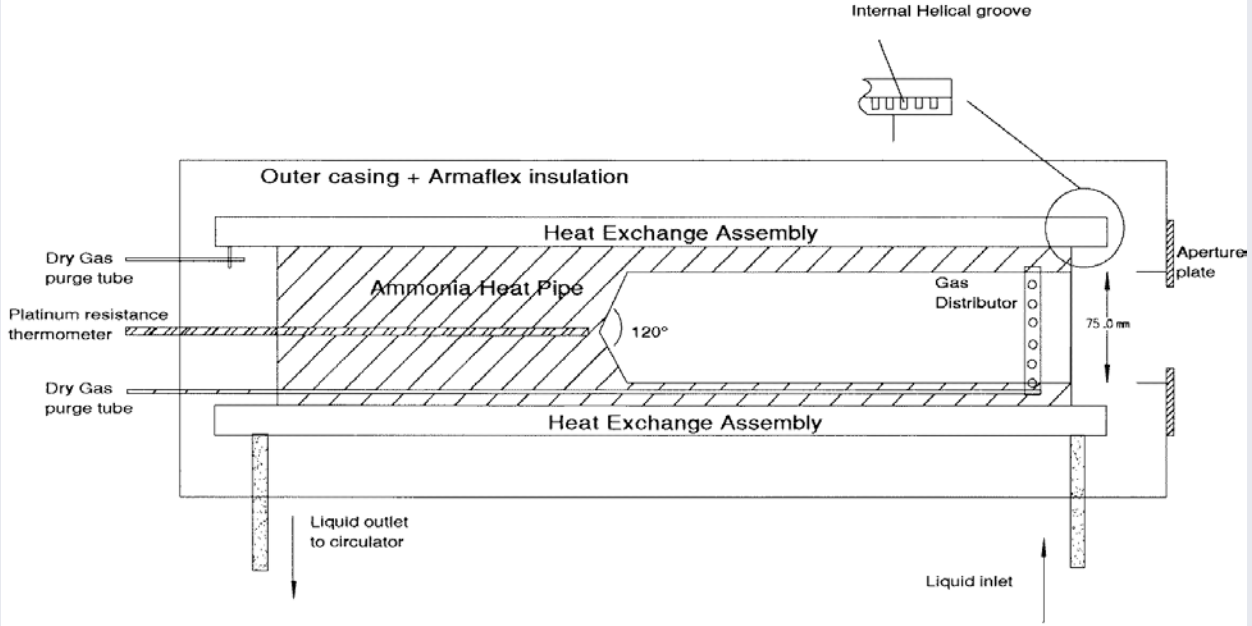
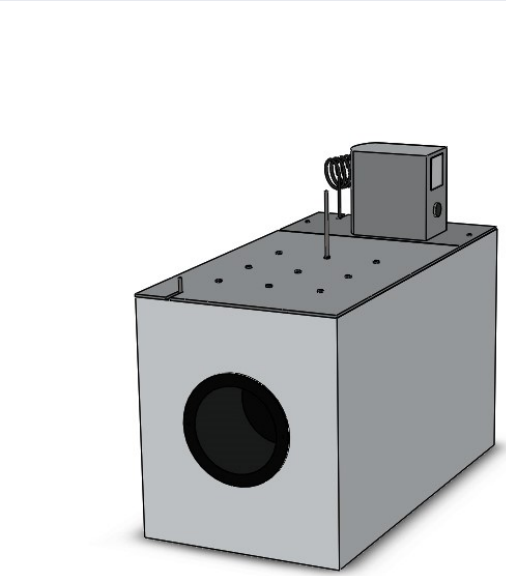
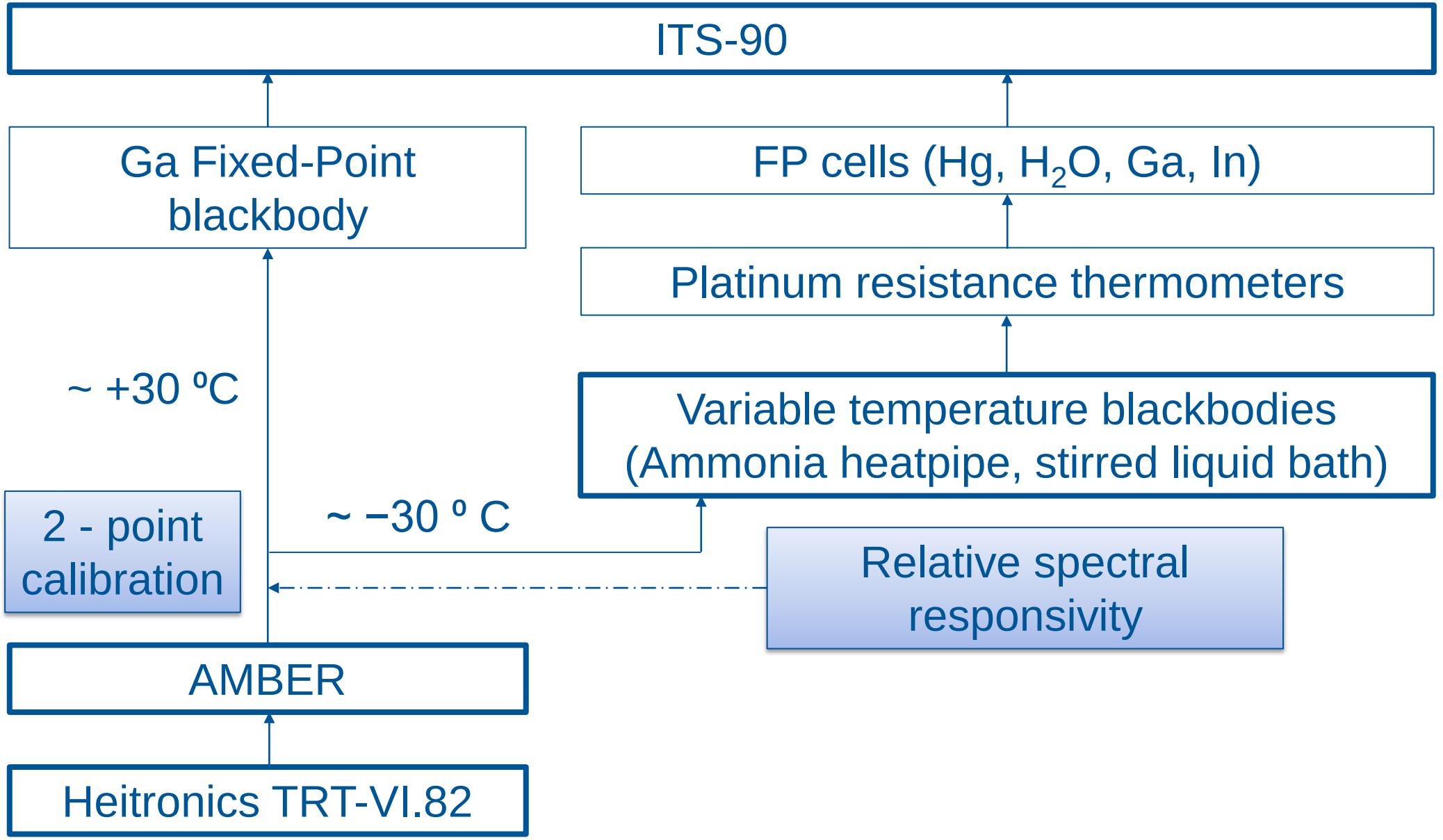
Variable-temperature blackbody specifications		
	Ammonia heatpipe BB	Stirred liquid bath BB *New*
		
Aperture diameter	ϕ 75 mm max	ϕ 160 mm max
Aperture distance from front panel	75 mm	35 mm
Emissivity	0.9993	>0.99965 @10 µm
Temperature range	-40 °C – 50 °C	-10 °C – 40 °C
Reference thermometer	Standard platinum resistance thermometer	Platinum resistance thermometer

Traceability of reference instruments

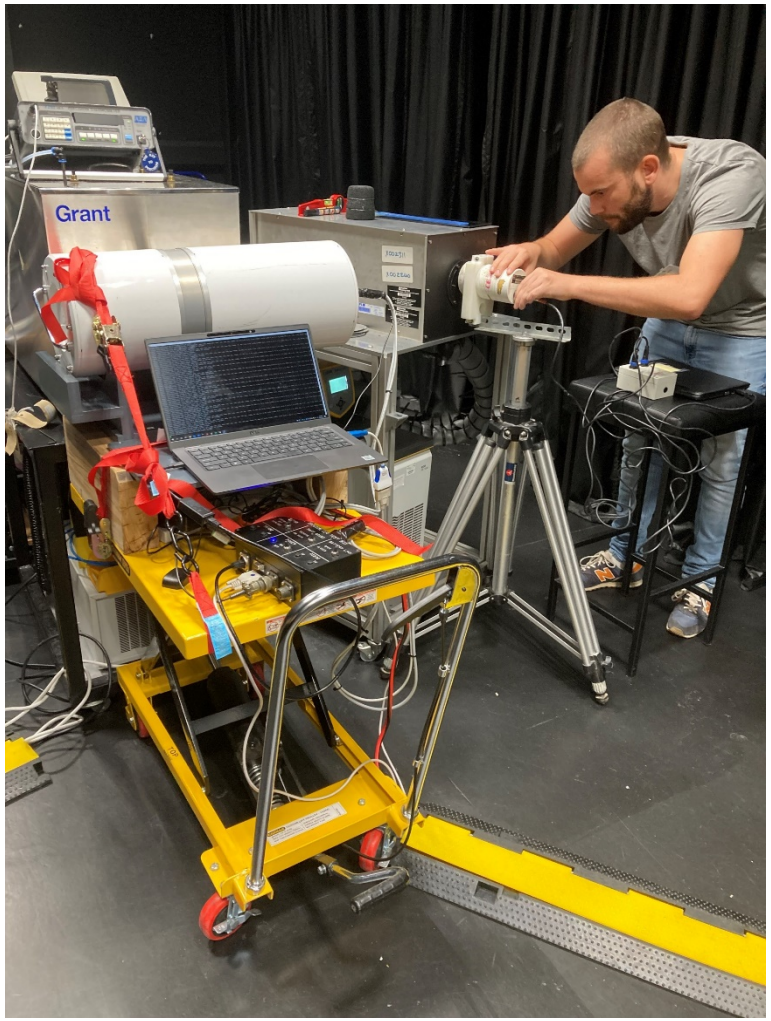


Measurement temperature points

Comparison type	Nominal temperature / °C
Blackbody comparison *1	10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60
Radiometer comparison	
Ammonia heatpipe BB *1	-30, -15, 0, 30, 35, 40, 50
Stirred liquid bath BB	0, 10, 20, 30

*1: Higher temperature points included for participants with LST measurement interest

Lab comparison
13th -17th June, 2022, @ NPL, Teddington, UK

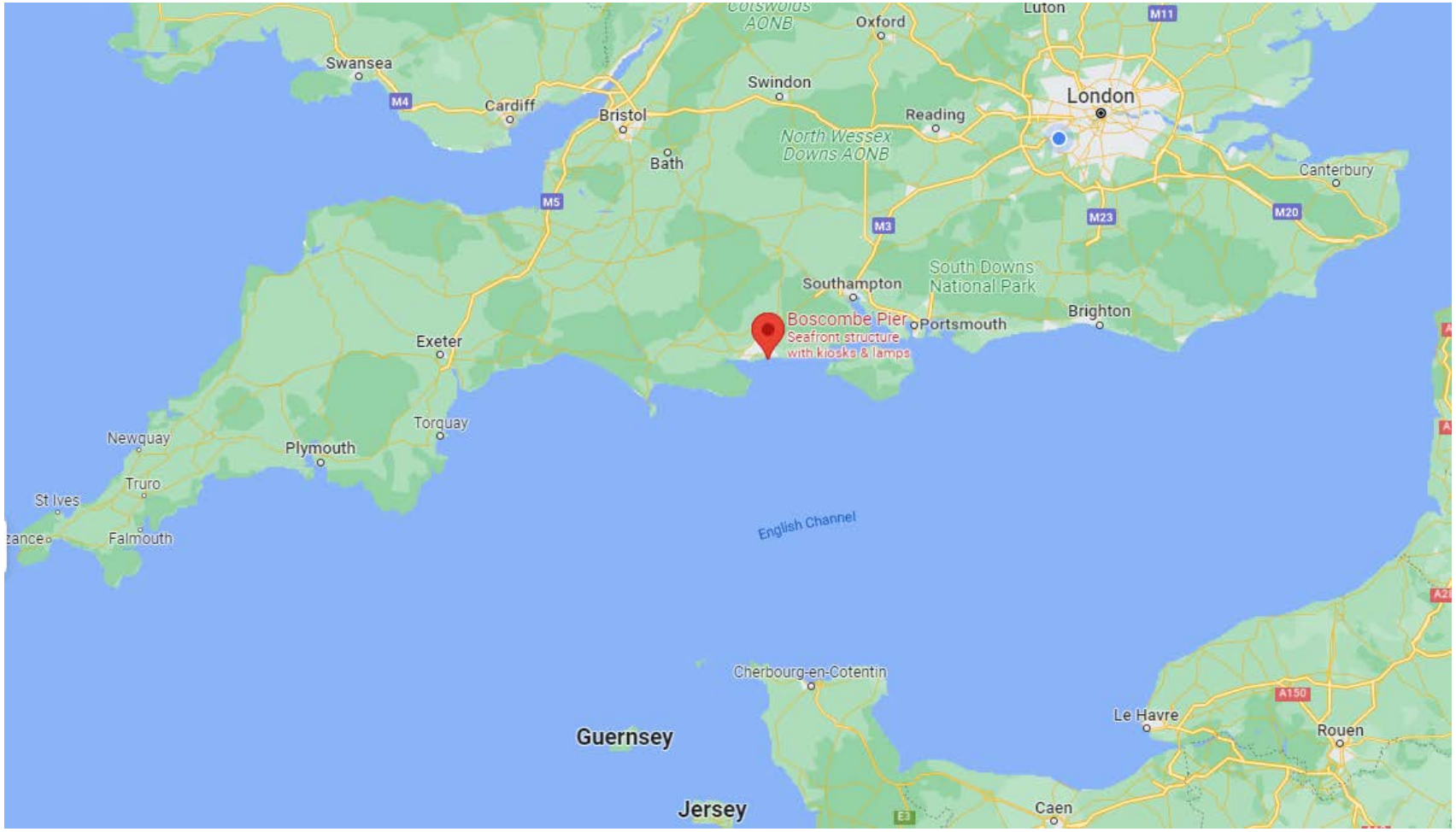


Radiometer comparison

Blackbody comparison

Field comparison

20th -24th June, 2022, @ Boscombe Pier, Bournemouth, UK

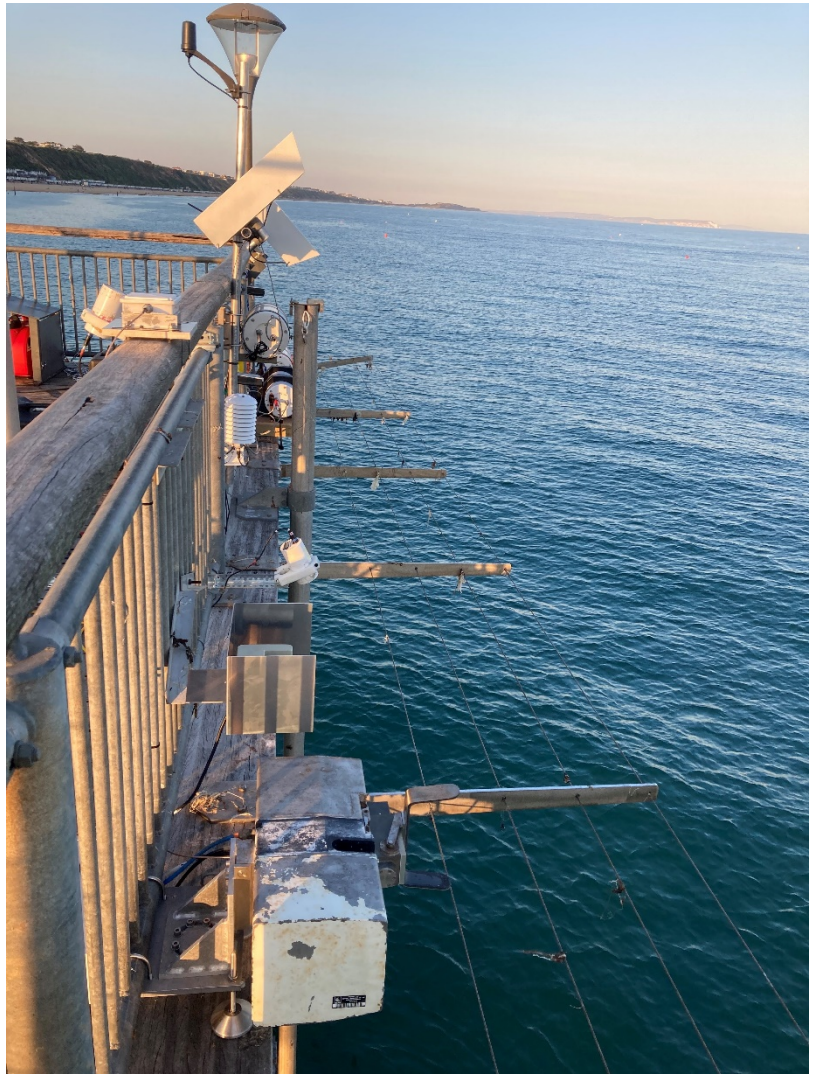


Location

The Pier

Field comparison

Preparation



After set-up

Future plans

- Data analysis in progress
- Reports to be submitted to CEOS WGCV and published
- Journal papers to be produced

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