ships4sst

shipborne radiometers for sea surface temperature

FRM4SST Project: Annual Operations Report

FRM4SST Annual Operations Report

RAL Space

UNIVERSITY OF Southampton

DMI Vejr, klima og hav

Space ConneXions

Customer	**:**	**ESA**	**Document Ref**	**:**	**FRM4SST-AOR-SCL-002**
Contract No	**:**	**3-15990/19/NL/IA**	**Issue Date**	**:**	**April 25**
WP No	**:**	**50**	**Issue**	**:**	**Issue 1**

Reference : **FRM4SST-AOR-SCL-002**

Title : **FRM4SST Project: Annual Operations Report**

Abstract : This document contains a description of the operations performed by the FRM4SST project team during the year 2024 - 2025.

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ESA

EUROPEAN SPACE AGENCY
CONTRACT REPORT

The work described in this document was done under ESA contract.
Responsibility for the contents resides in the author or organisation that prepared it.

Document Version Control

Issue	Revision	Date of issue / revision	Description of changes
A	A	24/02/2025	Document created
B	B	12/05/2025	Updated
1		14/05/2025	Issued

TABLE OF CONTENTS

LIST OF FIGURES AND TABLES

1. EXECUTIVE SUMMARY

The FRM4SST project is funded by the European Space Agency (ESA) and, through various activities, aims to sustain and evolve the International Sea Surface Temperature (SST) Fiducial Reference Measurement (FRM) Network (ISFRN). One way that this aim is fulfilled is through the collection, processing, analysis, publication and reporting of *in situ* FRM field measurements made using ISAR and SISTeR Instruments, that are near-contemporaneous with satellite data from the Sentinel-3A and Sentinel-3B SLSTR instruments.

The objectives for the FRM4SST project are:

- OBJ-1: Deploy and maintain shipborne thermal infrared (TIR) FRM radiometers and necessary supporting instrumentation to validate satellite SST products.
- OBJ-2: Maintain FRM protocols for satellite SST measurements and uncertainty budgets.
- OBJ-3: Process, quality control, archive and deliver approved FRM4SST data sets following documented FRM procedures and approve their use for FRM satellite validation.
- OBJ-4: Validate satellite SST products to FRM standards and publish monthly results.
- OBJ-5: Promote the FRM4SST outputs and maintain the International SST FRM Radiometer Network (ISFRN).

In order to ensure that the SLSTR geophysical data products are reliable, they must be validated by comparing them with measurements from the long-term *in situ* deployment of the ISARs, and also from the SISTeR instrument; these measurements confirm the consistency of the SST data products. As such, regular deployments must be maintained to ensure consistent and long-term data collection.

2. INTRODUCTION

This report is deliverable D-1 on the FRM4SST contract and describes the annual operations performed by the FRM4SST Team starting from April 2024; contributed to by the UoS- and DMI-operated Infrared Sea surface temperature Autonomous Radiometers (ISARs), and the Scanning Infrared Sea surface Temperature Radiometer (SISTeR) operated by RAL.

2.1 Overview of operations and performance

Deployments for ISAR (UoS and DMI) and SISTeR have continued during 2024 – 2025, with the number of deployments shown in tables within Section 3. Useable data from these deployments have been regularly uploaded to the project data archive that is hosted at Ifremer. In general, the data collected by RAL has been assessed to have been of good quality but a number of problems were encountered by UoS and DMI radiometer operator last year. For UoS these were investigated and fixed however DMI has only one ISAR partially operational, and it continues to exhibit unresolved and unidentified issues. More details can be found in Section 5. Over the next year, each operator intends to continue with its deployments and data gathering, with the UoS planning to look for other opportunities to deploy ISARs. DMI plan to enhance the performance of their ISARs and continue the investigation into their technical issues, and RAL plan to maintain and deploy SISTeR as usual, and complete and commission a new generation of black body to be used to replace what SISTeR currently has, see section 6 for further details. The deployment data on the ships4sst archive, up until March 2025 is shown in Figure 2-1 below as SST_{skin} (K) plotted on a world map.

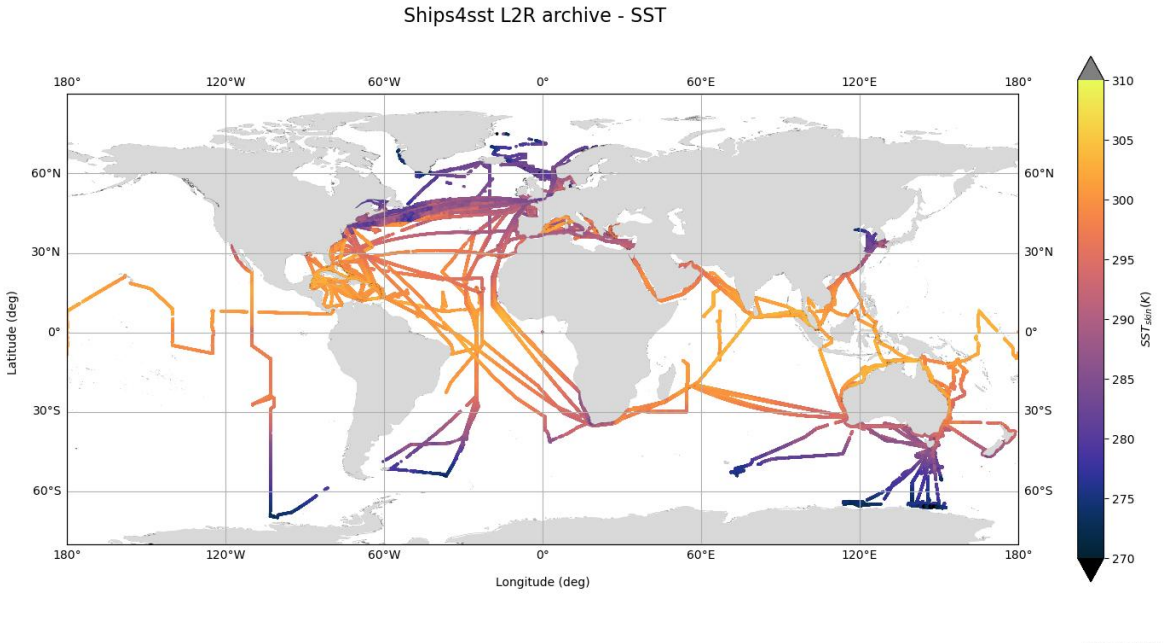

Figure 2-1: The ships4sst data archive L2R files plotted as SST on a world map, March 2025

3. OPERATIONS FOR 2024 - 2025

In this section, the operations performed between April 2024 and April 2025 is summarised by each data provider.

3.1 ISAR (University of Southampton)

From April 2024 to April 2025, ISARs were deployed on the Brittany Ferries M/V Pont Aven. These deployments are summarised in Table 1 below.

Table 1: ISAR (UoS) deployments during 2024 – 2025.

ISAR Number	Deployment Number	Date Started	Date Ended
ISAR 03	D77	22.02.2024	03/07/2024
ISAR 02	D78	03/07/2024	23/10/2024
ISAR03	D79	23/10/2024	05/11/2024
ISAR 02	D80	28/03/2025	Ongoing
ISAR 12	EarthCare / Meteor	09/08/2024	23/09/2024
ISAR 03	AMT31	26/11/2024	27/12/2024

3.2 ISAR (DMI)

DMI has deployed ISAR instruments on Norröna Ferry for the period April 2024 – April 2025. These deployments are summarised in Table 2 below.

Table 2: ISAR (DMI) deployments during 2024 – 2025.

ISAR Number	Deployment Number	Date Started	Date Ended
ISAR 19	D27	06.07.2024	05.10.2024
ISAR 20	D28	30.11.2024	23.02.2025

3.3 SISTeR (RAL)

SISTeR was deployed on the QM2 for three cruises between May 2024 and April 2025. These deployments are summarised in the table below. For the first time in 2025, following the launch of Cunard's Queen Anne, the QM2 has not run a World Cruise in the spring; it is expected that for the foreseeable future there will instead be more repeat coverage of the North Atlantic, Canada, the Caribbean and European routes.

These deployments are summarised in table 3 below.

Table 3: SISTeR (RAL) deployments during 2024 – 2025.

Instrument	Deployment Number	Date Started	Date Ended
SISTeR	28	16.05.2024	30.08.2024
SISTeR	29	17.10.2024	11.01.2025
SISTeR	30	15.02.2025	16.05.2025 (provisional)

4. DATA PRODUCED AND ARCHIVED

The ships4sst data archive is hosted at Ifremer, and the Felyx tool at Ifremer processes and generates validation reports and satellite match-ups. This processing is now performed by EUMETSAT. All of the project partners store their ISFRN L2R data files at the archive once they become available, which is normally after the post-deployment calibration. The ISFRN L2R files are accompanied by calibration information, such as calibration factors from the pre- and post-deployment calibrations. Documentation of the traceability of all calibration equipment is also stored at the data archive, as well as on the ships4sst website.

Figure **4-2** shows the collective SST L2R files by data provider plotted on the world map where pink is CSIRO, light red is DMI, green is RAL, blue is RSMAS and deep red is UoS.

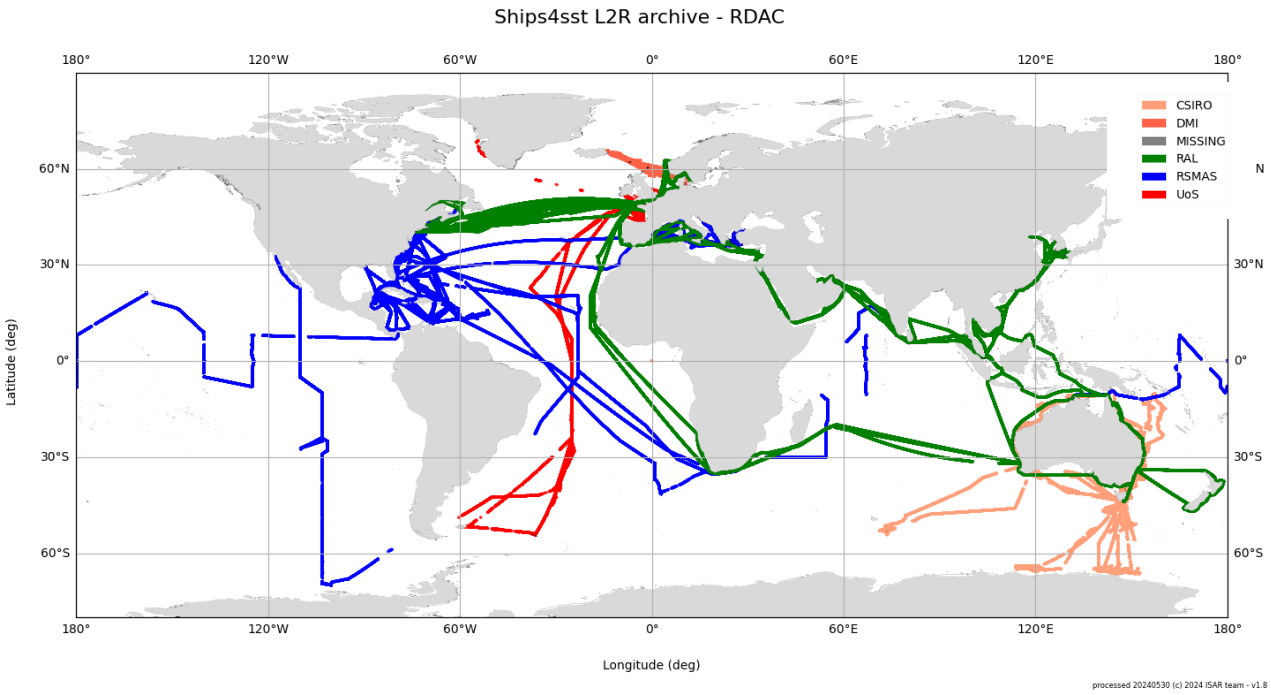

Figure 4-2: The ships4sst data archive L2R files plotted as by data provider, April 2025

The data archive is accessible through the ships4sst web portal and provides data to users on request. Uploading data from external partners who collect data to ISFRN standard and submit the data in ISFRN L2R format is also facilitated through the ships4sst web portal, as has been done with the CSIRO ISAR and RSMAS M-AERI data.

5. PROBLEMS ENCOUNTERED DURING REPORTING PERIOD

In this section, the problems encountered between April 2024 – April 2025, and how these problems were fixed (or are being investigated) is summarised by each data provider.

5.1 ISAR (University of Southampton)

A number of issues have been encountered during the reporting period. One issue was a loss of power on the Pont Aven, due to an electrical issue with the search light which shares the mains supply with ISAR. This was rectified with ships visit and discussion with the ships electrical engineer, but data between 08.04 and 24.04 was lost. Another issues was the scan drum on ISAR 2 got stuck around 09/09/2024, with intermitted performance after that. The instrument was changed 23/10/2024, but due to staff availability and ships schedule no earlier date was possible.

5.2 ISAR (DMI)

DMI has experienced persistent technical issues with its ISAR instruments, particularly related to mechanical components such as the opening and closing mechanisms, as well as electronic failures. Over the past 28 months, only one of the three ISAR units has been operational. In June 2024, Werenfrid Wimmer from UoS and Craig Donlon visited DMI in Copenhagen to inspect the instruments on site. During this visit, some issues were resolved and additional spare parts were identified and requested. As of now, DMI has one ISAR partially operational, though it continues to exhibit unresolved and unidentified issues.

5.3 SISTeR (RAL)

In general, the data collected have been assessed to have been of good quality. A number of poor-quality calibration attempts after cruise 28 were eventually assessed to have been caused by worn bearings on the chopper motor, which was replaced. This resulted in the cruise 28 dataset being assigned a global quality level downgrade from 3 to 2. In addition, the cruise has approximately 10 days of missing data due to a disturbance which appeared to cause a failed instrument restart. At the next visit to Southampton, it was manually restarted and no further problems were observed. The timing appeared to coincide with departure from the port of New York and discussions with the ship crew appeared to indicate that the new systems to handle the switches between shore and ship power may have caused a power disruption that the SISTeR UPS was not able to handle.

6. PLAN OF ACTIVITIES FOR NEXT PERIOD

In this section, operational plans by each data provider, including known deployments, intercomparisons and instrument fixes or update, are summarised.

6.1 ISAR (University of Southampton)

UoS will continue with the Pont Aven ISAR deployments and find other opportunities to deploy ISAR whilst ensuring the UoS ISAR are well maintained and calibrated.

6.2 ISAR (DMI)

DMI will continue efforts to solve current issues and improve the future performance of the operational deployments aiming to maintain the continuity of the data collection.

6.3 SISTeR (RAL)

A number of parts have been redesigned or manufactured over the year, including a refined process for replacement scan mirror coatings, some rain door parts, and a new set of black body parts alongside hardware to calibrate them in-house. This new generation of black bodies will be completed and commissioned in the coming year, after which two of them will be used to replace the SISTeR black bodies, and the current black bodies will be calibrated.

7. ACRONYMS AND ABBREVIATIONS

CDR	Climate Data Record
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DMI	Danish Meteorological Institute
ECV	Essential Climate Variable
ESA	European Space Agency
FRM	Fiducial Reference Measurements
FRM4SST	Fiducial Reference Measurements for Sea Surface Temperature
FTP	File Transfer Protocol
ISAR	Infrared SST Autonomous Radiometer
ISFRN	International SST FRM Radiometer Network
M-AERI	Marine-Atmospheric Emitted Radiance Interferometer
NOCS	National Oceanography Centre, Southampton
RAL	Rutherford Appleton Laboratory
RSMAS	Rosenstiel School of Marine, Atmospheric, and Earth Science
SCL	Space ConneXions Limited
SISTeR	Scanning Infrared Sea surface Temperature Radiometer
SLSTR	Sea and Land Surface Temperature Radiometer
SST	Sea Surface Temperature
STFC	Science and Technology Facilities Council
TIR	Thermal Infra-Red
QM2	Queen Mary 2