



ships4sst

shipborne radiometers for sea surface temperature

FRM4SST Project: Annual Operations Report

FRM4SST Annual Operations Report



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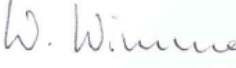
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Title : FRM4SST Project: Annual Operations Report

Abstract : This document contains a description of the operations performed by the FRM4SST project team during the year 2023 - 2024.

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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).

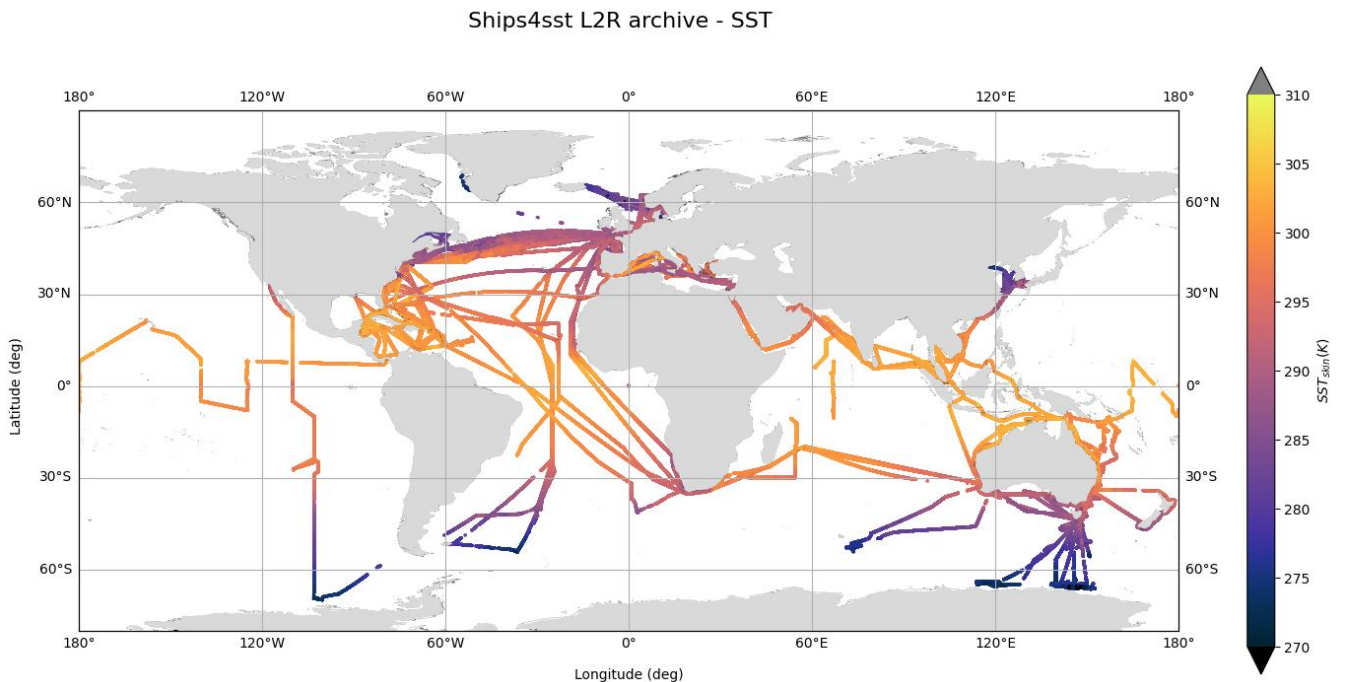
In order to ensure that the SLSTR geophysical data products are reliable, they must be validated by comparing them with measurements from the long-term *in situ* deployment of the ISARs, and also from the SISTeR instrument; these measurements confirm the consistency of the SST data products. As such, 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 June 2023; 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 2023 – 2024, 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. A number of problems were encountered by each radiometer operator last year that were investigated and fixed, with the exception of DMI, whose ISAR problems are ongoing and still under investigation. More details can be found in Section 5. Over the next year, each operator intends to continue with its deployments and data gathering, whilst the UoS also plans to provide an ISAR for the EarthCARE validation campaign on M/V Meteor during the Summer of 2024. 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, see section 6 for further details. The deployment data on the ships4sst archive, up until May 2024 is shown in Figure 2-1 below as SST_{skin} (K) plotted on a world map.



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Figure 2-1: The ships4sst data archive L2R files plotted as SST on a world map, May 2024

3. OPERATIONS FOR 2023 - 2024

In this section, the operations performed between June 2023 and June 2024 is summarised by each data provider.

3.1 ISAR (University of Southampton)

From June 2023 to June 2024, ISARs were deployed on the Brittany Ferries M/V Pont Aven. These deployments are summarised in Table 1 below. After Deployment D76, the M/V Pont Aven went to a refit, which ended in February 2024. ISAR 03 was then refitted for deployment D77 on 22.02.2024 and this deployment is ongoing.

Table 1: ISAR (UoS) deployments during 2023 – 2024.

ISAR Number	Deployment Number	Date Started	Date Ended
ISAR 03	D75	29.03.2023	23.08.2023
ISAR 02	D76	23.08.2023	11.11.2023
ISAR 03	D77	22.02.2024	ongoing

3.2 ISAR (DMI)

DMI has continuously deployed ISAR instruments on Norröna Ferry for the period June 2023 – June 2024. The deployment number 26 has finished, with the instrument retrieved on the 1st June, 2024.

Table 2: ISAR (DMI) deployments during 2023 – 2024.

ISAR Number	Deployment Number	Date Started	Date Ended
ISAR 19	D23	19.05.2023	29.07.2023
ISAR 19	D24	20.08.2023	30.09.2023
ISAR 19	D25	22.10.2023	27.01.2024
ISAR 19	D26	09.03.2024	01.06.2024

3.3 SISTeR (RAL)

SISTeR was deployed on the QM2 between 16 November 2023 and 15 December 2023, between 11 January 2024 and 28 April 2024 for the World Cruise and was redeployed on the 16th May 2024 for upcoming North Atlantic crossings. The brief trip in 2023 returned no useable data, but the World Cruise operated mostly as expected. The World cruise was planned to be an anti-clockwise route to and around Australia, and back through the Suez Canal, but unrest in the Middle East necessitated a change of plan in the return route, and the ship returned on the same route it followed outwards around the West coast of Africa.

Table 3: SISTeR (RAL) deployments during 2023 – 2024.

Instrument	Deployment Number	Date Started	Date Ended
SISTeR	26	16.11.2023	15.12.2023
SISTeR	27	11.01.2024	28.04.2023
SISTeR	28	16.05.2024	ongoing

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.

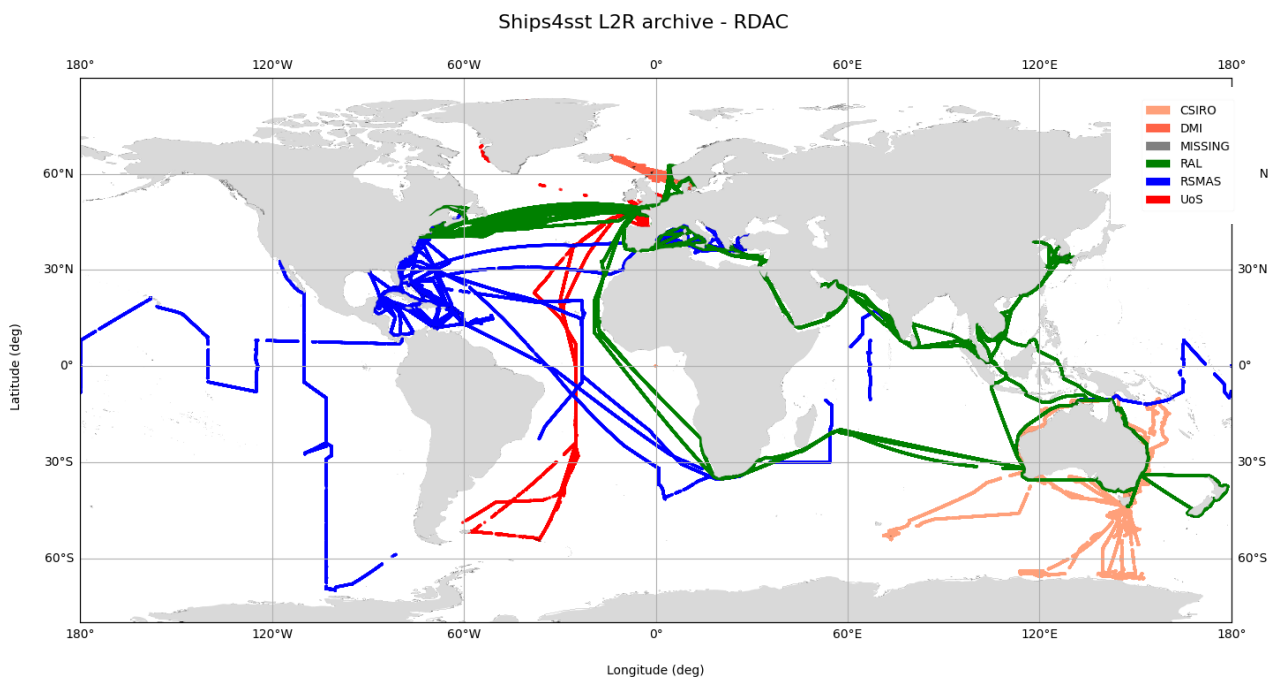


Figure 4-2: The ships4sst data archive L2R files plotted as by data provider, May 2024

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 June 2023 – June 2024, and how these problems were fixed (or are being investigated) is summarised by each data provider.

5.1 ISAR (University of Southampton)

ISAR 03 had occasional GPS dropouts during deployment D75, these were fixed with the backup GPS system, which is attached directly to the data logger on the M/V Pont Aven. ISAR 03 also developed a window thermistor issue during the deployment, which was corrected in the post-processing and the thermistor was replaced in the post-deployment maintenance.

There have been some power issues to the data logging cabinet on the M/V Pont Aven in April 2024, due to the data logging cabinet sharing its supply with the ships searchlight. The searchlight was removed for repairs and the power supply switched off, because the new ships crew was not being fully updated by the previous crew that the searchlight power is shared with the ISAR equipment. This has been resolved with a discussion with the radio and deck officer to implement steps to avoid this issue in the future, including better direct communication between the ISAR team and the ship and labelling of the relevant power circuits.

5.2 ISAR (DMI)

We have encountered ongoing issues with the opening and closing mechanisms of our instruments. Over the past eighteen months, DMI have only been able to use one out of three DMI-ISARs, requiring frequent maintenance to keep it operational.

DMI will continue to investigate the ISAR issues and work in close collaboration with Werenfrid Wimmer from UoS, who will visit DMI in June 2024, along with Craig Donlon, to have a closer look at the instruments.

5.3 SISTeR (RAL)

Data quality was very poor on Cruise 26 between November and December 2023. There was a very high number of GPS dropouts and CRC errors. Before the following cruise, a number of replacement parts were fitted and the problems were significantly reduced.

In addition, at the end of the World Cruise, the data stream was lost for approximately two weeks, which is believed to be caused by a loss of power on the ship beyond what the UPS could handle. On retrieval, the instrument appeared to be working well and showed no problems on calibration. To mitigate against this repeating, the laptop battery was replaced before the current cruise. Wear is apparent on the rain door mechanism, so a replacement drive shaft will be manufactured before the next deployment.

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)

The M/V Pont Aven deployments will continue, subject to the ship's availability, during the next year. We also plan to provide an ISAR for the EarthCARE validation campaign on M/V Meteor during the Summer of 2024.

6.2 ISAR (DMI)

DMI are implementing a series of measures to enhance the performance of the ISAR instruments and expect to have them fully operational as soon as possible, aiming to maintain the continuity of the data collection. This includes changing the mechanism and coordinating a visit from Werenfrid Wimmer and Craig Donlon to provide better advice on addressing current technical issues.

6.3 SISTeR (RAL)

The current deployment will continue as usual unless the received data raise concerns about the door failing, and will largely repeat the north Atlantic crossing route. Future deployments are expected to repeat at the usual rate, since the QM2 will not complete a World Cruise this year and therefore alignment of the schedule with the World Cruise is not a concern. At the next opportunity the rain door shaft and connector saver will be replaced and the cables will be replaced as necessary.

Work will continue to assemble and test SISTeR B.

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