ships4sst

shipborne radiometers for sea surface temperature

FRM4SST Project: Annual Data Report

RAL Space

UNIVERSITY OF Southampton

DMI Vejr, klima og hav

Space ConneXions

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Title : **FRM4SST Project: Annual Data Report**

Abstract : This document contains an overview of the data processed by the FRM4SST project team during the year 2024 - 2025.

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CONTRACT REPORT

The work described in this document was done under ESA contract.
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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-4 on the FRM4SST contract and documents FRM4SST data processing, quality control and archiving: it is updated each year, starting from April 2024. This report provides a comprehensive overview of data processed, quality control and significant issues addressed, and finally, a plan of activities for the following year.

2.1 Ships4sst Data Archive

Data from FRM4SST project partners is stored on the ships4sst data archive, which is hosted at Ifremer. 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 2-1 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

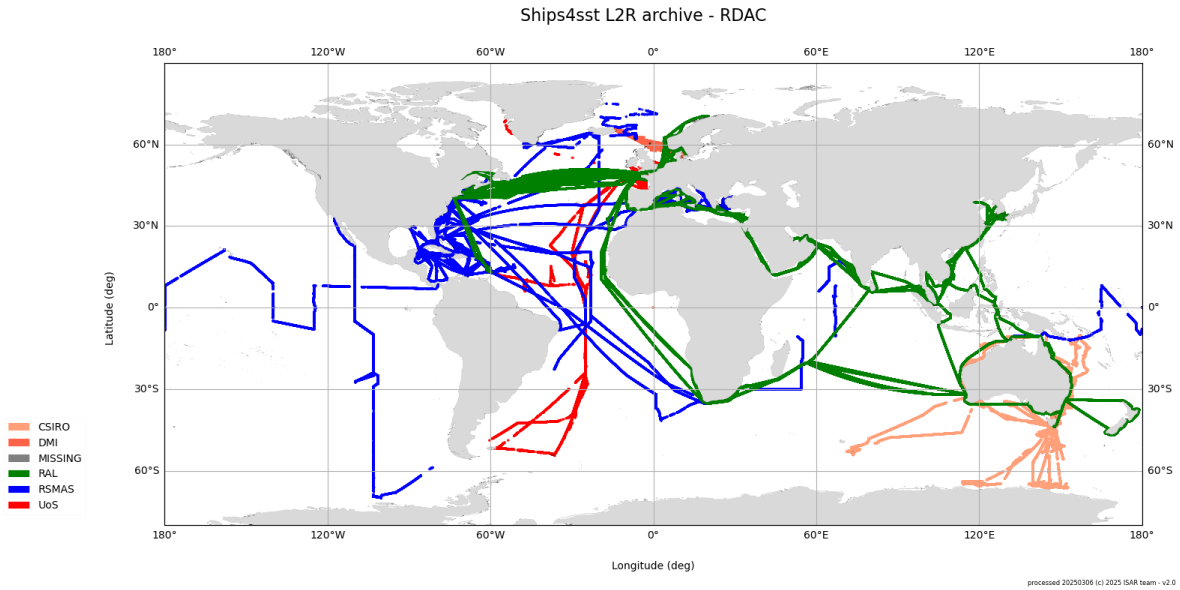

Figure 2-1: The ships4sst data archive L2R files plotted by data provider, March 2025

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. Figure 2-2 shows the combined archive SST_{skin} data from the ISARs, M-AERI and SISTeR, as shown on a world map.

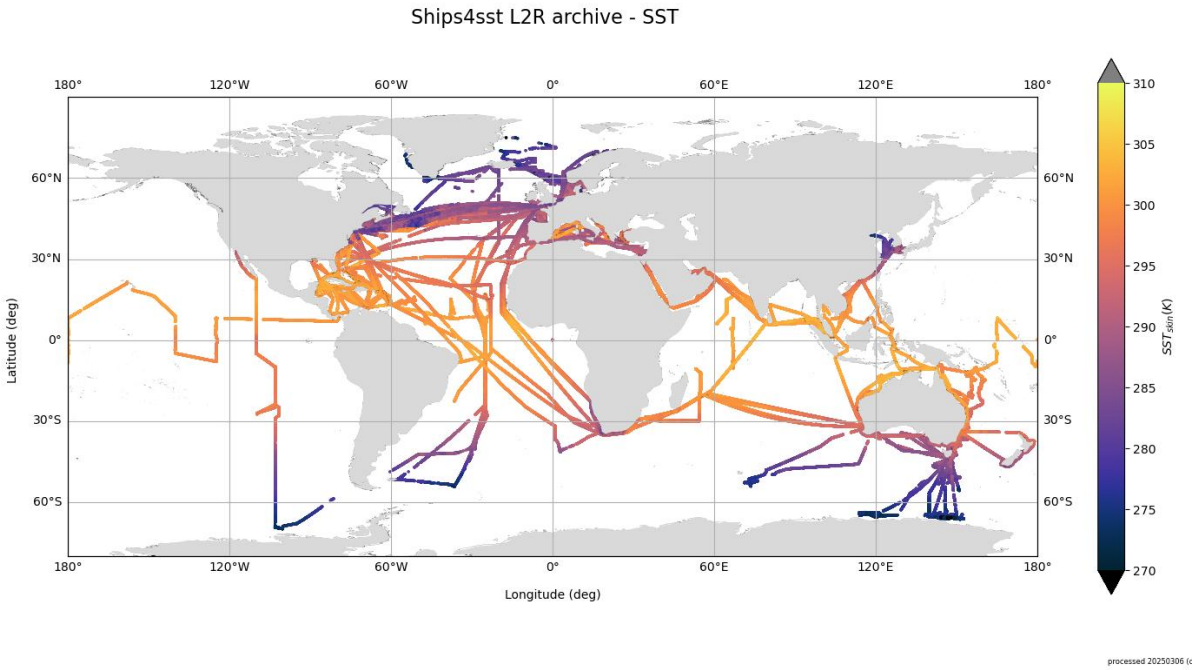

Figure 2-2: The ships4sst data archive L2R files plotted as SST on a world map, April 2025

3. OVERVIEW OF DATA PROCESSED

In this section, the three data providers from the FRM4SST contracts; UoS, DMI and RAL, provide an overview of the data processed between April 2024 and April 2025.

3.1 ISAR (University of Southampton)

ISAR data has been processed for the following deployments:

Deployment #77 spanned from 22.02- 03/07/2024 resulting in 16238 SST values, measuring a combined total 63 days out of the 132 days deployed. The time no data was recorded is mainly due to weather and the power cut.

Deployment #77 then spanned from 03/07 – 23/10.2024 resulting in 9347 SST values, measuring a combined total 33 days out of the 112 days deployed. The time no data was recorded is mainly due to weather and the scan drum issues.

EarthCare / Meteor spanned from 09/08 – 23/-92024 resulting in 6987 SST values, measuring a combined total 28 days out of the 45 days deployed. The time no data was recorded is mainly due to weather.

Deployment #79 spanned from 23/10 – 5/11/2024 resulting in 3284 SST values, measuring a combined total 10 days out of the 13 days deployed. The time no data was recorded is mainly due to weather. The deployment ended because the Pont Aven entered its annual refit lasting until the End of March 2025.

M-AERI data from 2023 and 2024 was reformatted to ships4sst L2R netcdf daily files, because the University of Miami currently lacks the funding to routinely produce L2R files.

The Felyx MD files for 2023 and 2024 have been processed and the results are shown in the validation report.

3.2 ISAR (DMI)

Deployment #27 spanned from 6th July to 5th October 2024. Unfortunately, data processing is still pending due to a failure of the GPS signal and date recording on ISAR19. Data processing has been postponed because of the extra time demanded.

Deployment #28 started on 30th November 2024 and the instrument was retrieved on 23rd February 2025. An inspection of the data shows that it recorded during 17 days before the instrument (ISAR19) failed.

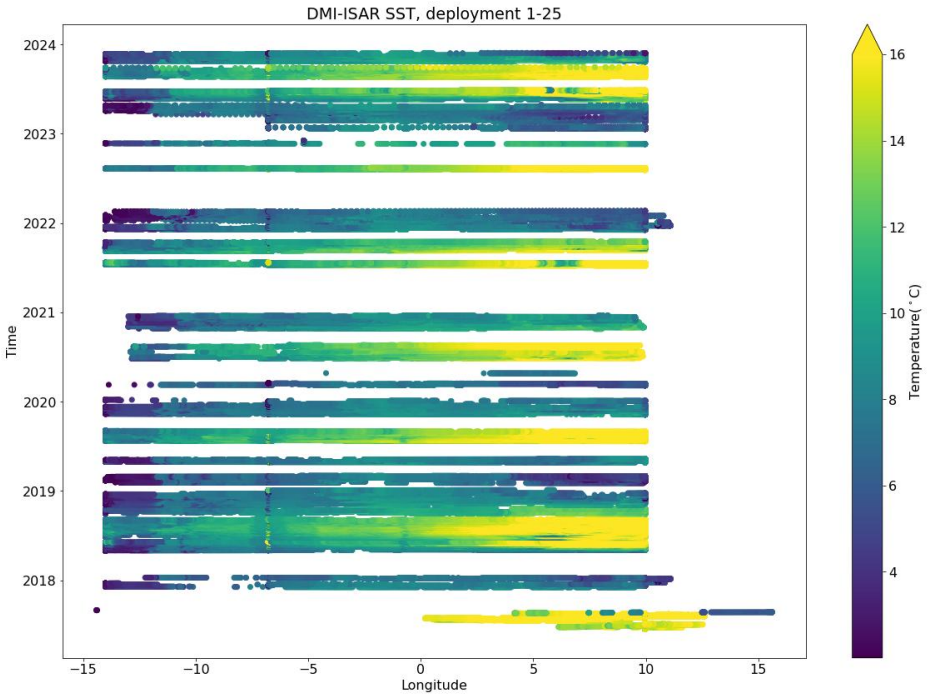

Figure X: Hovmöller plot of the ISAR data processed from DMI deployments since the start of the contract, from D1 to D25

3.3 SISTeR (RAL)

Several cruises of data have been processed and released using the latest version 2.5 of the processor: all available data since 2022 when the QM2 restarted cruises after the COVID pandemic have been checked and disseminated on the Ships4SST archive, and are soon to be available on the CEDA archive as well. In addition, complete cruise documentation in PDF format has been completed for the following cruises: 24, 25, 27, 28, 29. KML files of each cruise have also been made available on the Ships4SST website - data access page, which enable a quick and easy view of geographical coverage and a visual idea of SST for each cruise before downloading the complete data. The same data will be provided for cruise 30 shortly after SISTeR has been retrieved and calibrated.

4. QUALITY CONTROL

In this section, the quality control used by UoS, DMI and RAL during the period April 2024 to April 2025 is discussed. For further information on the satellite SST validation procedures, see project document FRM4SST-PROCVAL-SCL-001, and for the annual satellite SST validation report between June 2024 and June 2025, see document FRM4SST-ASVR-SCL-002.

4.1 ISAR (University of Southampton)

ISAR data was quality controlled following the ISFRN protocols, this includes verification of the calibration data before and after each deployment, and plotting the engineering data for each deployment to verify correct operation of the ISAR.

4.2 ISAR (DMI)

Data quality control is performed by verifying the correct generation of netCDF files. Most issues we encounter are mechanical, which often hinder data collection throughout the entire deployment period, hence lack of continuity.

4.3 SISTeR (RAL)

Data processing and documentation is progressing well for the remaining historical QM2 data, and will begin to be uploaded to the Ships4SST archive as soon as the CEDA data upload chain is completed and confirmed, to ensure consistency between the datasets.

5. PROBLEMS ENCOUNTERED DURING REPORTING PERIOD

In this section, the data providers explore the data-related problems that occurred between April 2024 and April 2025. Solutions, where applicable, are also discussed.

5.1 ISAR (University of Southampton)

ISAR data processing was event free, however due to funding and man power issues the University of Miami is unable to produce Ships4sst L2R files. In the short term UoS has produced the M-AERI daily L2R files, reformatting the M-AERI data produced by the University of Miami, for 2023 and 2024 and upload the L2R data to the archive.

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)

RAL data processing has stalled with the CEDA data upload problems but CEDA are issuing an update ASAP and this should be resolved soon.

6. PLAN OF ACTIVITIES FOR NEXT PERIOD

In this section, the data providers list plans for data processing during the period April 2025 to April 2026.

6.1 ISAR (University of Southampton)

UoS will process ISAR data as needed and process the felyx MDB files when they are available.

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)

RAL 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.

7. ACRONYMS AND ABBREVIATIONS

CDR	Climate Data Record
DMI	Danish Meteorological Institute
ECV	Essential Climate Variable
ESA	European Space Agency
FRM	Fiducial Reference Measurements
FRM4STS	Fiducial Reference Measurements for validation of Surface Temperature from Satellites
IR	Infra-Red
ISAR	Infrared SST Autonomous Radiometer
ISFRN	International SST FRM Radiometer Network
NOCS	National Oceanography Centre, Southampton
OP	Operational Processor
RAL	Rutherford Appleton Laboratory
RP	Reference Processor
RSD	Robust Standard Deviation
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