



# ships4sst

shipborne radiometers for sea surface temperature

## FRM4SST Project: Annual Data Report

### FRM4SST Annual Data Report



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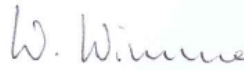
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**Title** : FRM4SST Project: Annual Data Report

**Abstract** : This document contains an overview of the data processed by the FRM4SST project team during the year 2023 - 2024.

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# TABLE OF CONTENTS

<b>1. EXECUTIVE SUMMARY .....</b>	<b>6</b>
<b>2. INTRODUCTION .....</b>	<b>7</b>
2.1 ships4sst Data Archive	7
<b>3. OVERVIEW OF DATA PROCESSED .....</b>	<b>9</b>
3.1 ISAR (University of Southampton)	9
3.2 ISAR (DMI)	13
3.3 SISTeR (RAL)	13
<b>4. QUALITY CONTROL .....</b>	<b>15</b>
4.1 ISAR (University of Southampton)	15
4.2 ISAR (DMI)	15
4.3 SISTeR (RAL)	15
<b>5. PROBLEMS ENCOUNTERED DURING REPORTING PERIOD.....</b>	<b>16</b>
5.1 ISAR (University of Southampton)	16
5.2 ISAR (DMI)	16
5.3 SISTeR (RAL)	16
<b>6. PLAN OF ACTIVITIES FOR NEXT PERIOD.....</b>	<b>17</b>
6.1 ISAR (University of Southampton)	17
6.2 ISAR (DMI)	17
6.3 SISTeR (RAL)	17
<b>7. ACRONYMS AND ABBREVIATIONS.....</b>	<b>18</b>

# LIST OF FIGURES AND TABLES

Figure 2-1: The ships4sst data archive L2R files plotted as by data provider, March 2023 ..... 7

Figure 2-2: The ships4sst data archive L2R files plotted as SST on a world map, May 2023..... 8

Figure 3-3: shows the per-deployment calibration for deployment D75 in the left panel and the post-deployment calibration in the right-panel..... 9

Figure 3-4: shows the per-deployment calibration for deployment D76 in the left panel and the post-deployment calibration in the right-panel..... 10

Figure 3-5: data plot of the processed ISAR data for deployment D75. .... 11

Figure 3-6: data plot of the processed ISAR data for deployment D76. .... 12

Figure 3-7: data plot of the processed ISAR data from DMI deployments since the start of the contract, including D23 to D25. .... 13

Figure 3-8: data plot of the Queen Mary 2 cruise on the world map, deployment # 27 ..... 14

## 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 June 2023. 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.

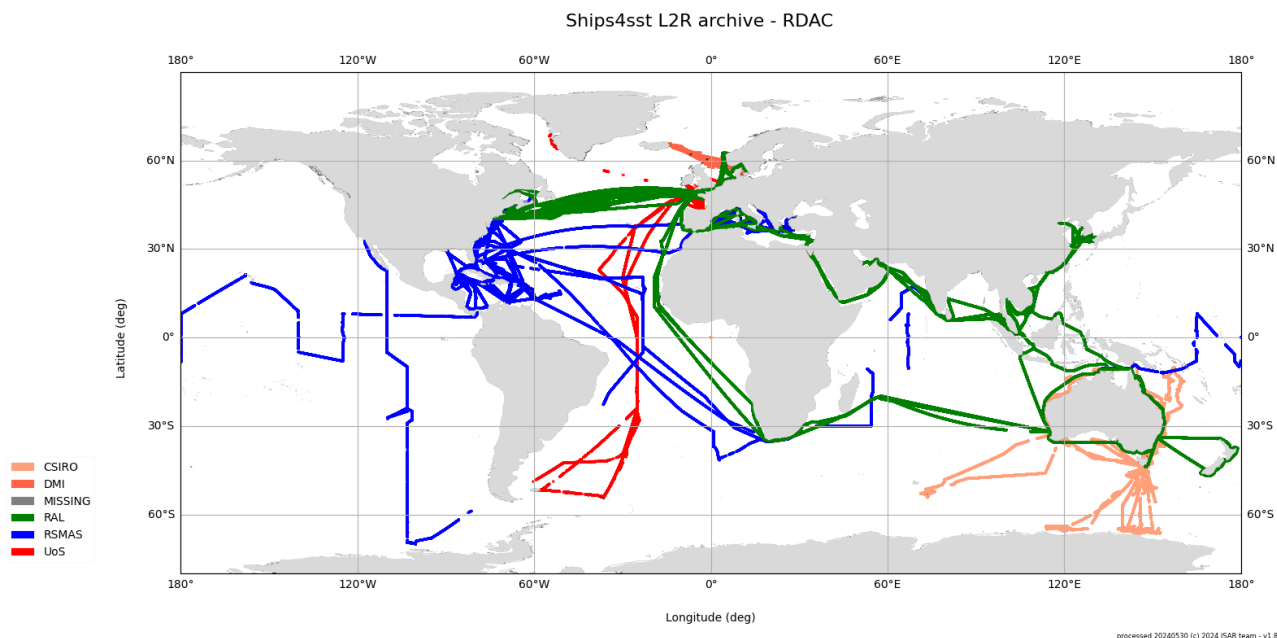


Figure 2-1: The ships4sst data archive L2R files plotted by data provider, March 2024

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. Figure 2-2 shows the combined archive SST<sub>skin</sub> data from the ISARs, M-AERI and SISTeR, as shown on a world map.

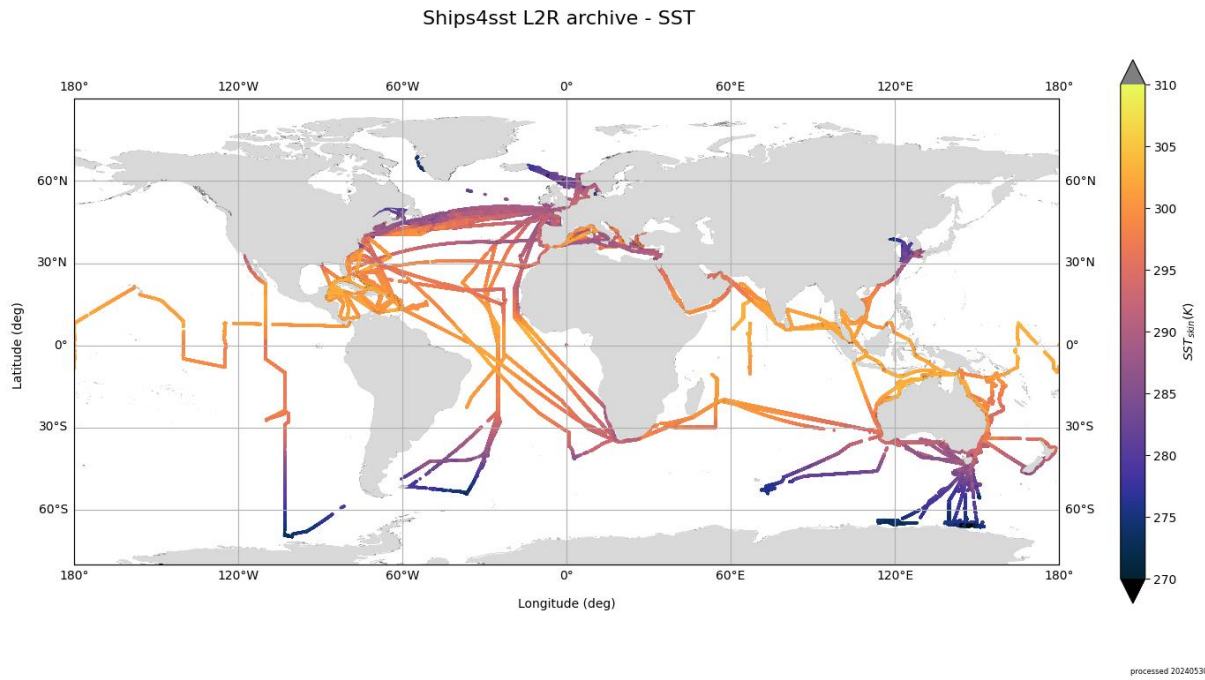


Figure 2-2: The ships4sst data archive L2R files plotted as SST on a world map, May 2024



### 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 June 2023 and June 2024.

#### 3.1 ISAR (University of Southampton)

ISAR data for deployments D75 (29/03/23 to 23/08/23) and D76 (23/08/23 to 11/11/23) have been processed and uploaded to the archive. The processing includes the calibration data processing before and after each deployment (see Figure 3-3) as well as the post-processing of the data which produces the netCDF files needed for the archive data upload.

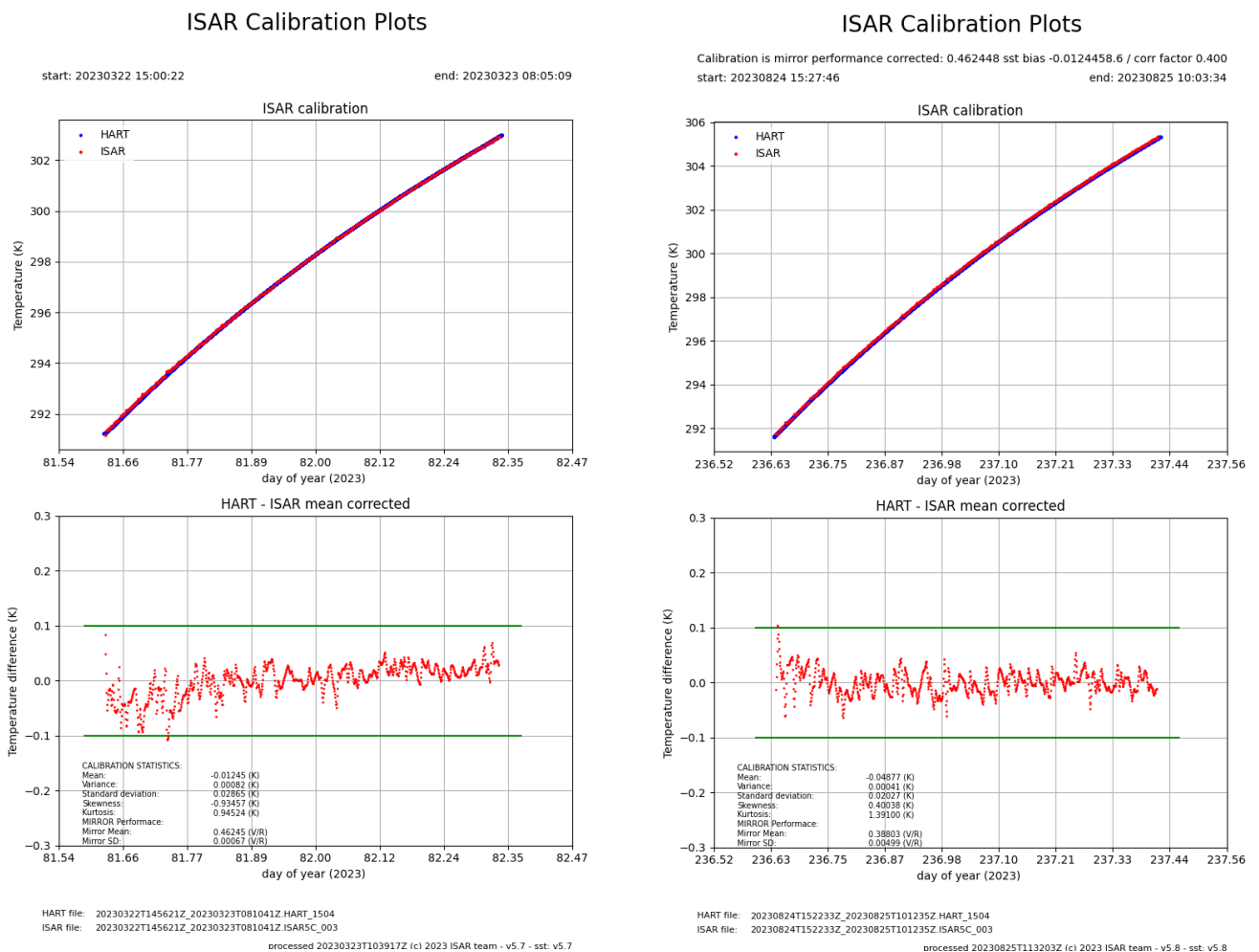


Figure 3-3: shows the per-deployment calibration for deployment D75 in the left panel and the post-deployment calibration in the right-panel.

### ISAR Calibration Plots

### ISAR Calibration Plots

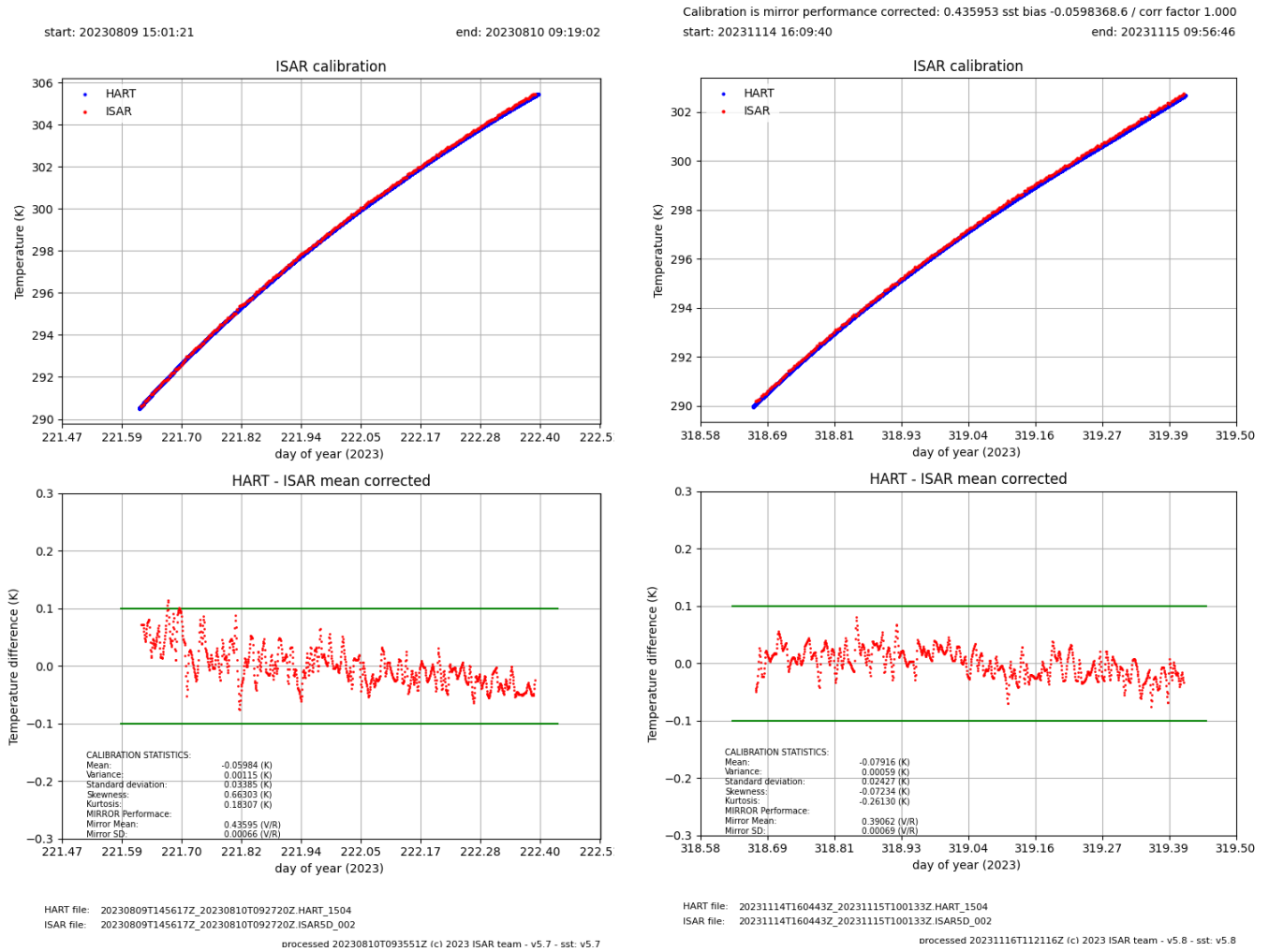


Figure 3-4: shows the per-deployment calibration for deployment D76 in the left panel and the post-deployment calibration in the right-panel.

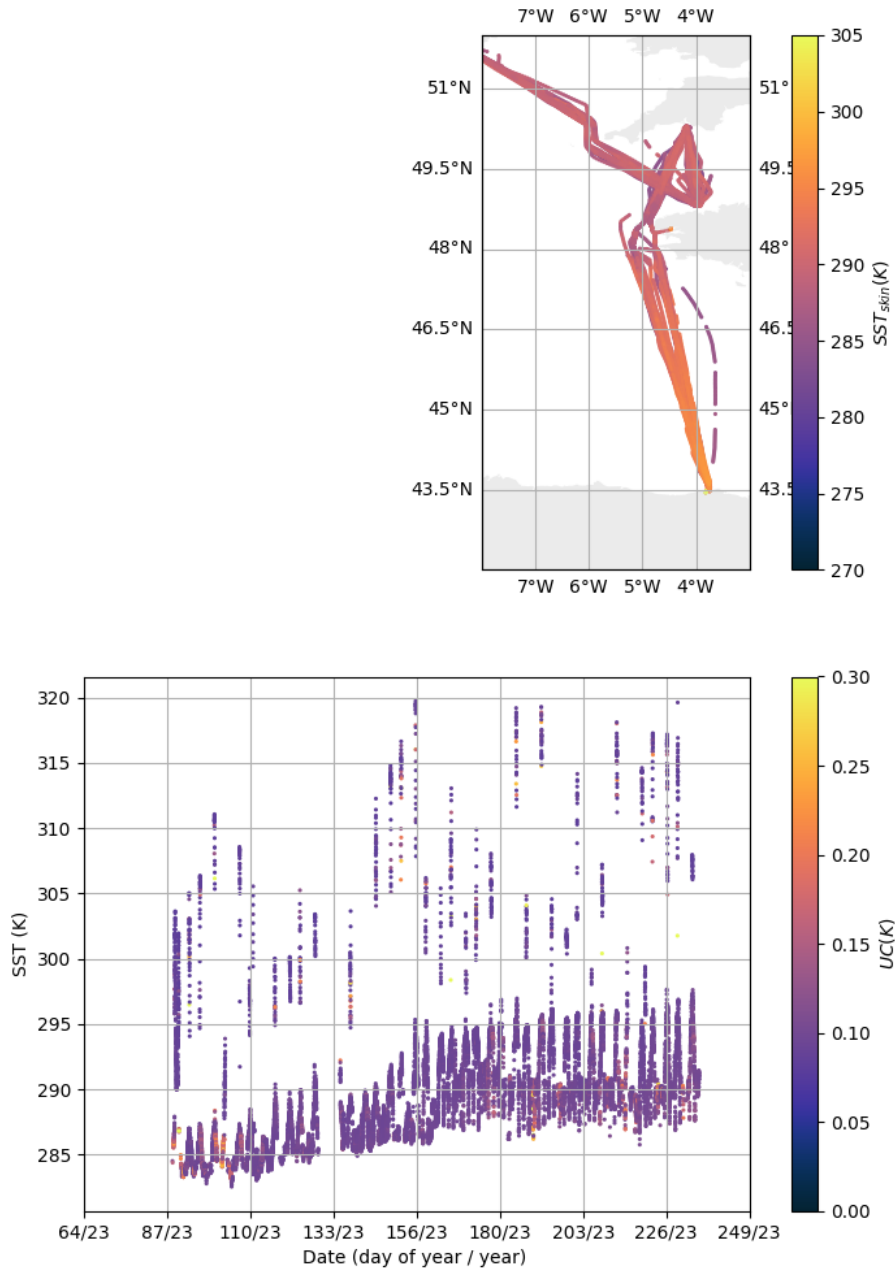
# ISRN netcdf data plots

ISAR 003

start: 20230329 21:06:00

Fig: 1 ISAR ship track

end: 20230823 11:31:06

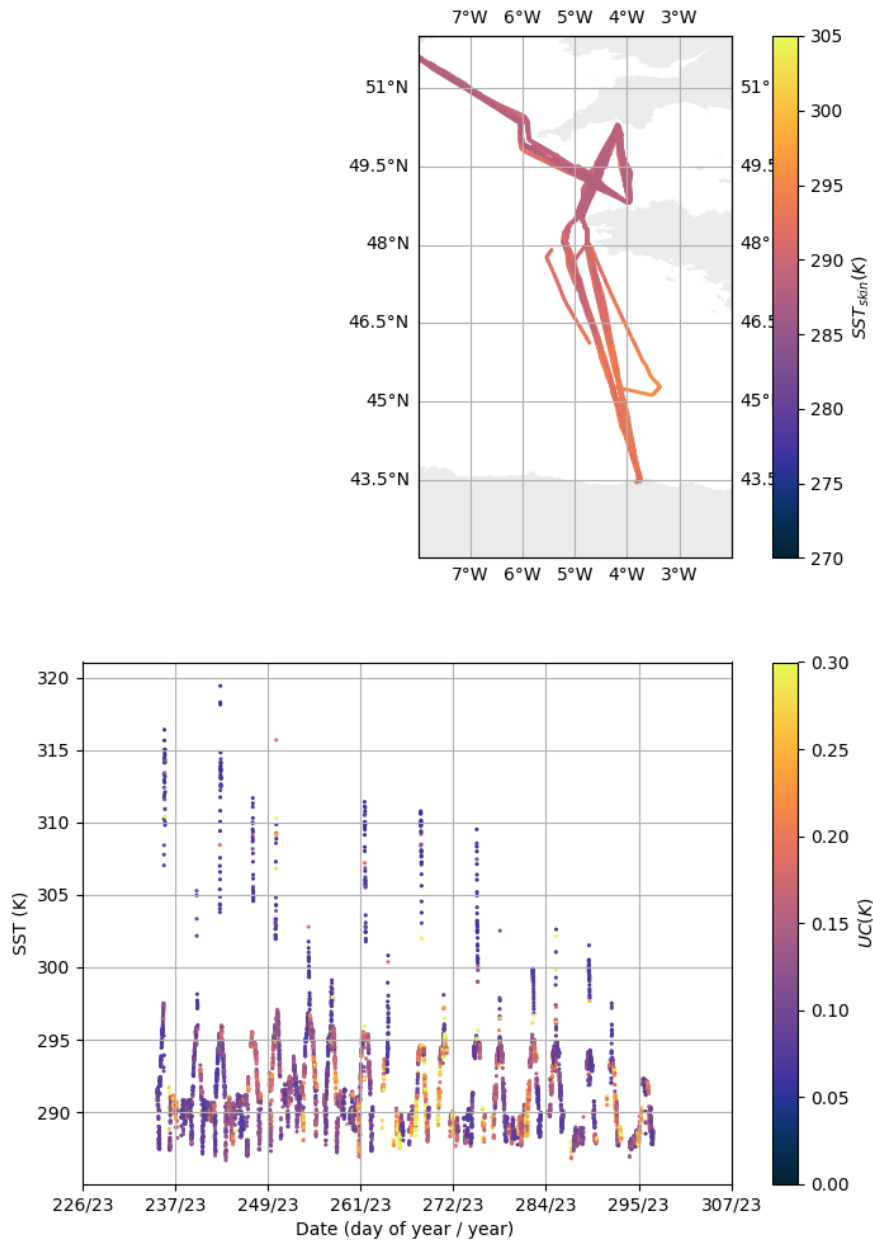


processed 20230831 09:18:41 (c) 2023 ISAR team - v3.1 - sst: v5.8

Figure 3-5: data plot of the processed ISAR data for deployment D75.

### ISRN netcdf data plots

ISAR 002  
Fig: 1 ISAR ship track  
start: 20230823 15:32:24 end: 20231024 13:50:19



processed 20231123 20:25:58 (c) 2023 ISAR team - v3.1 - sst: v5.8

Figure 3-6: data plot of the processed ISAR data for deployment D76.

## 3.2 ISAR (DMI)

DMI has continuously deployed ISAR instruments on the Norröna Ferry for the period June 2023 – June 2024 (covered by deployments #23 to #25). Data processed for this period reaches up to 100 days with the last deployment completed on the 27<sup>th</sup> January, 2024.

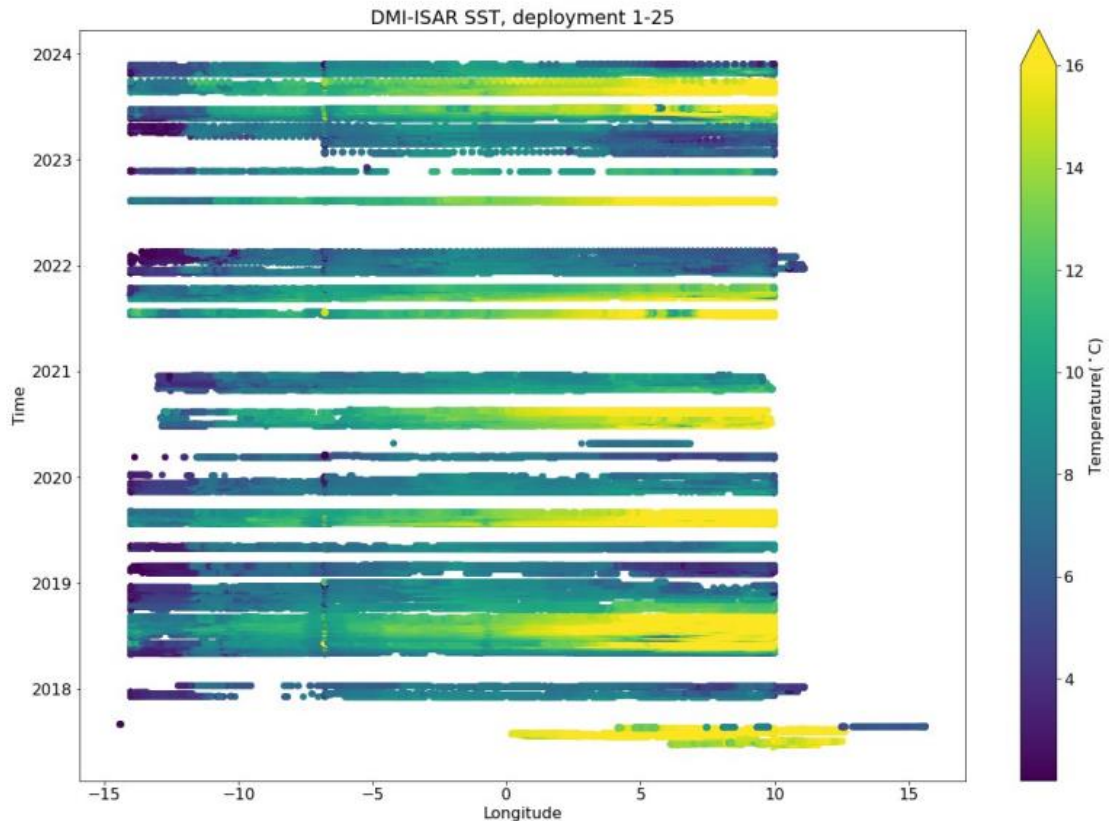


Figure 3-7: data plot of the processed ISAR data from DMI deployments since the start of the contract, including D23 to D25.

Data collected during the ongoing deployment (started on 9<sup>th</sup> March 2024) will be processed once the instrument is retrieved as planned on the 1<sup>st</sup> June, 2024.

## 3.3 SISTeR (RAL)

Several cruises have been processed using the version 2.5.1 processor and reports are being written based on a deep look at the data and also on information found in notes and emails. This will improve the reporting going forward so that important information about each cruise is recorded and made available to data users shortly after the end of the cruise. The dataset for cruise 24 is available on the ships4SST archive and more data will be made available shortly once it has been fully checked and documented, this will include deployments that took place between 2023 – 2024.

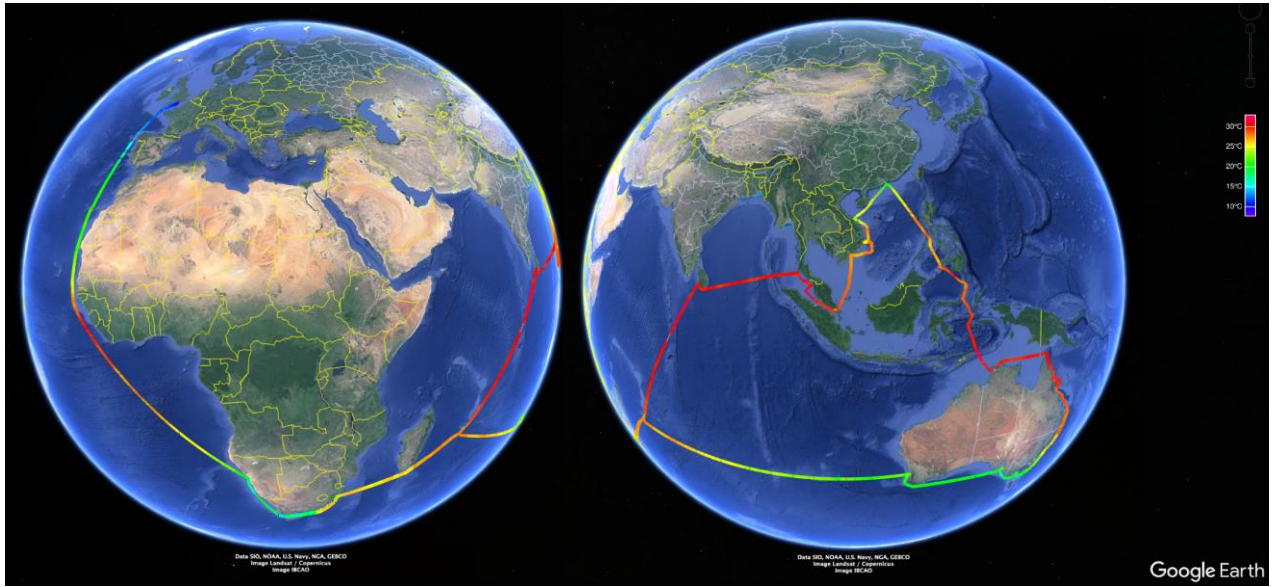


Figure 3-8: data plot of the Queen Mary 2 cruise on the world map, deployment # 27

## 4. QUALITY CONTROL

In this section, the quality control used by UoS, DMI and RAL during the period June 2023 to June 2024 is discussed. For further information on the satellite SST validation procedures, see project document FRM4SST-PROCVL-SCL-001, and for the annual satellite SST validation report between June 2023 and June 2024, see document FRM4SST-ASVR-SCL-001.

### 4.1 ISAR (University of Southampton)

ISAR data was quality controlled following the ISFRN protocols<sup>1</sup>, 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)

Where the number of GPS or CRC errors are very high, in particular from Cruise 26 between November and December 2023, the data will not be made available at this stage, unless it is judged in the future that any remaining data has some value. Cruise 27 is considered to be good quality, based on successful calibrations before and after deployment, and the calibration before the current Cruise 28 also showed SISTeR to be operating well.

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<sup>1</sup> <https://ships4sst.org/sites/shipborne-radiometer/files/documents/PO-PR-RAL-SI-001%20Radiometer%20protocols%20v1.0%2020170703.pdf>

## 5. PROBLEMS ENCOUNTERED DURING REPORTING PERIOD

In this section, the data providers explore the data-related problems that occurred between June 2023 and June 2024. Solutions, where applicable, are also discussed.

### 5.1 ISAR (University of Southampton)

ISAR 03 had some on-board GPS data issues during deployment D75. This was corrected in post-processing by using the secondary GPS data from the data logger on the M/V Pont Aven where the on-board GPS data was missing. The window thermistor on ISAR 03 failed during deployment D75, again this was corrected during post-processing by using the ambient blackbody temperature as a proxy. This was verified to yield equivalent results with the post-deployment calibration.

### 5.2 ISAR (DMI)

DMI 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 of three ISARs, requiring frequent maintenance to keep it operational. Online meetings have been held to discuss the issue in detail and to brainstorm possible solutions.

### 5.3 SISTeR (RAL)

From January 2024, work has been ongoing to set up a new Linux machine to install the IDL processor on. The move of the IDL-based processor from Mac OS to Ubuntu has encountered a number of small problems, but after investigation, it is now working well. The handover of processing and archiving work from Tim Nightingale to Arrow Lee is now close to completion.



## 6. PLAN OF ACTIVITIES FOR NEXT PERIOD

In this section, the data providers list plans for data processing during the period June 2024 to June 2025.

### 6.1 ISAR (University of Southampton)

Deployments after the post-deployment calibration has been carried out will be posted on the project data archive.

### 6.2 ISAR (DMI)

DMI are implementing a series of measures to enhance the performance of their 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)

By the end of the next reporting period, all data from QM2 cruises (since 2010) will be processed and reported on. All data considered to be useable will be made available through the data archives, along with pdf-format reports of the cruise and data quality.

## 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