:

FRM4SST Project

ISFRN Workshop Book of Abstracts

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21 April 2024

Customer	**:**	**ESA**	**Document Ref**	**:**	**FRM4SST-WSA-SCL-001**
Contract No	**:**	**3-15990/19/NL/IA**	**Issue Date**	**:**	**21 April 2024**
WP No	**:**	**50**	**Issue**	**:**	**1**

Reference : **FRM4SST-WSA-SCL-001**

Title : **FRM4SST Project : ISFRN Workshop Book of Abstracts**

Abstract : This document contains abstracts from the talks at the ISFRN Workshop, held at NOC Southampton, on 22-23 April 2024.

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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	1	15/03/2024	Document created (Draft A)
B	2	19/04/2024	Updated after internal review
1	2	21/04/2024	Issued for publication to project website

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1. INTRODUCTION

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 annual ISFRN Workshop, which aims to bring together scientific and operational users and producers of *in situ* radiometer SST data to review progress, achievements and developments within the radiometer community. The meeting this year is held in-person and online, and is open to anyone actively involved and interested in SST science, satellite validation and the uses of *in situ* radiometer measurements.

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).

This report contains abstracts from the talks at the 2024 ISFRN Workshop.

2. SESSION 2: EXPERIENCES OF RADIOMETER OPERATORS

2.1 ISAR UK

Speaker: Werenfrid Wimmer

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Abstract

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The Infrared Sea surface temperature Autonomous Radiometer (ISAR) was developed in the late 1990s at the University of Southampton by a team lead by C. Donlon. To celebrate the 25 years of infrared radiometers we will show how the project started and how it evolved, with some pitfalls, to become a very successful instrument, completing over 90 deployments resulting in over 1.1 million sea surface temperature skin (SSTskin) measurements. Examples of the deployments and experience will be shown together with lessons learned and the improvements made to ISAR over the years.

The infrared SST autonomous radiometer (ISAR) is a self-calibrating instrument capable of measuring in situ sea surface skin temperature (SSTskin) to an accuracy of better than 0.1 K. The ISAR instrument has been developed for satellite SST validation and other scientific programs. The ISAR can be deployed continuously on ships of opportunity without any service requirement or operator intervention for periods of up to 3 months. The ISAR instrument is a single channel radiometer with a spectral band pass of 9.6 µm – 11.5µm to be adapted for autonomous use. The entire instrument infrared optical path is calibrated by viewing two blackbody reference cavities at different temperatures in order to maintain high accuracy while tolerating moderate contamination of optical components by salt deposition. During bad weather, an innovative storm shutter, triggered by a sensitive optical rain gauge, automatically seals the instrument from the external environment. Data are presented that verify the instrument calibration and functionality in such situations. A watchdog timer and auto-reboot function support automatic data logging recovery in case of power outage typically encountered on ships.

2.2 Update on the deployments of the Marine-Atmospheric Emitted Radiance Interferometers (M-AERIs), and radiometers on Saildrones.

Speaker: Peter J Minnett

Institute name: Rosenstiel School of Marine, Atmospheric and Earth Science, University of Miami

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Abstract

Peter J Minnett, Miguel Angel Izaguirre, Chong Jia, and Goshka Szczodrak

The sudden emergence and rapid spread of the COVID-19 virus in early 2020 introduced a significant change in the way we could take radiometer measurements at sea for comparison with satellite data. At the time of the introduction of travel restrictions, we had four Marine- Atmospheric Emitted Radiance Interferometers (M-AERIs) deployed at sea; three on cruise ships of the Royal Caribbean Group and one on the NOAA R/V Ronald H Brown. The Royal Caribbean ships were idled, and no data were taken. The Ronald H Brown was in Cape Town when travel restrictions were imposed and she eventually returned slowly to the USA, where she remained at the quay side for many months. Since travel restrictions have been lifted, we have refurbished the instruments and recalibrated them again SI-traceable laboratory blackbody targets, and begun to re-equip the Royal Caribbean ships with M-AERIs and ancillary equipment At present, we have one system on Celebrity Equinox, and are working on reinstalling on Allure of the Seas and Adventure of the Seas. We recently completed the installation on the R/V Neil Armstrong of the Woods Hole Oceanographic Institution. The presentation will give an update on progress.

Before COVID, we had started a program to take measurements in the Pacific sector of the Arctic Ocean using autonomous Saildrones with the intention of validating satellite data and studying air-sea interactions in an under-sampled part of the world. Two Saildrones, heading north from Dutch Harbor in Alaska in summer 2019, had a pair of radiometers mounted on their deck, resulting in the derivation of SST_{skin} values that are sufficiently accurate for satellite validation, as well as studying upper ocean thermal processes. A short summary of these deployments will also be given.

2.3 Ocean Surface Skin Temperature Measurements using a Simplified Calibration Technique and an Optimal Spectral Band

Speaker: Andy Jessop

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Abstract

The importance of accurate measurements of ocean skin temperature, Tskin, is increasingly recognized for estimating heat and gas fluxes for climate modelling. However, Tskin measurements currently are made using infrared radiometer systems that have relatively limited deployment due to the challenging nature of the measurements. Two major factors that affect the complexity and accuracy of Tskin measurements are in situ calibration and correcting for the reflected downwelling sky radiance and emissivity.

Progress is presented on using a simplified calibration scheme and an optimal spectral band technique. The calibration approach combines a one-point in situ blackbody with laboratory characterization, including the parameterizing the combined effects of self-emission and size of source. The optimal band has a large optical depth between the ocean surface and the top of the atmosphere. The relevant reflected sky radiation is from the atmosphere within a few kilometres of the ship and thus is relatively invariant because it is minimally affected by clouds. This approach minimizes the difference between the radiative, or brightness, temperature and the skin, or thermodynamic, temperature of the ocean surface. The effect of uncertainty in the emissivity is reduced because the apparent sky temperature is comparable to Tskin. The downwelling radiance depends primarily on the atmospheric temperature and humidity profiles within 1-2 km of the ship. If these profiles can be approximated by standard atmospheric profiles initialized with ship measurements of air temperature and humidity, then the modeled sky radiance could be used for the sky correction, potentially eliminating the need for a separate sky measurement.

The optimal band technique is tested by comparing open ocean measurements from two ROSR (Remote Ocean Surface Radiometer) instruments, which measure Tskin with an accuracy of +/- 0.1 C. The measured downwelling sky radiance is compared to MODTRAN-based estimates using both measured and modelled atmospheric profiles of temperature and humidity. These estimates of downwelling sky radiance are then substituted for the measured sky radiance and combined with the upwelling ocean radiance in the radiative transfer equation to compute alternate estimates of Tskin.

3. SESSION 3: ENSURING HIGH-ACCURACY MEASUREMENTS

3.1 2022 CEOS International TIR radiometer comparison

Speaker: Yoshiro Yamada

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Abstract

An international comparison of field-deployed radiometers for sea surface skin temperature (SST_{skin}) retrieval was conducted during two weeks in June 2022. The comparison comprised a laboratory comparison and a field comparison. In the laboratory part, the radiometers were compared with reference standard blackbodies, while the same was done with the blackbodies used for the calibration of the radiometers against a transfer standard radiometer. This was followed by the field comparison at a seaside pier on the south coast of England, where the radiometers were compared against each other while viewing the closely adjacent surface of the sea. The combined results from the laboratory comparison and the field comparison contribute to improve confidence in the retrieved SST_{skin}.

3.2 The TRUSTED Project

Speaker: Dr Marc Lucas

Institute name: CLS

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Abstract

The Copernicus TRUSTED project aims to provide high quality sea surface temperature data in order to help improve the calibration and validation of the sentinel 3 radiometers. It is articulated around 4 pillars, namely hardware, Procedures, Data Management and Documentation to ensure that each data point collected can be classified as a Fiducial Reference Measurement.

In this presentation, we will look at the maturity level of each of these pillars and how this breakdown translates into the project activities such as calibration, deployment and data collection. We will also look at current and forthcoming activities for Ice Surface Temperature retrieval that have recently been included within the project objectives.

3.3 ASTERN: A Next Generation In-Situ Radiometer

Speaker: Dr Dave Smith

Institute name: STFC, UK

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Abstract

SST validation is supported by a number of autonomous self-calibrating ship-borne radiometers deployed by a number of institutes. The current UK in situ radiometer designs (ISAR, SISTeR) are now 20+ years old. Hence, a new generation of radiometers are required to enhance and maintain capability for next decade.

The Advanced Surface Temperature Radiometer Network (ASTeRN) is a project to design and manufacture radiometers with the capability for measuring sea, land and ice surface temperatures with high accuracy and precision. The radiometers will be an evolution of existing designs with the same basic measurement approach as existing instruments but drawing on lessons learned and incorporating modern components. The design includes: additional spectral channels for atmospheric characterisation, extended capability for measuring Land Surface Temperatures, address obsolescence issues, and to improve manufacturability and maintainability.

4. SESSION 4: SST DATA IN PRACTICE

4.1 Update M-AERI and Saildrone validation of SLSTR, MODIS, VIIRS, ABI, and Reanalysis SST_{skin}

Speaker: Prof Peter J Minnett

Institute name: Rosenstiel School of Marine, Atmospheric and Earth Science, University of Miami

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Abstract

Peter J Minnett, Miguel Angel Izaguirre, Bingkun Luo*, Chong Jia, and Goshka Szczodrak

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The first Marine-Atmospheric Emitted Radiance Interferometer (M-AERI) was developed in the mid-1990s. In the year 2000, soon after the launch of the first MODIS on the NASA Earth Observing System satellite Terra, an M-AERI was mounted on the Royal Caribbean cruise ship *Explorer of the Seas*. Multiple M-AERIs have since been installed on many ships providing a near-continuous time series of SST_{skin}. With several instruments taking measurements simultaneously from up to four ships in different areas, a very rich data set of SST_{skin} values has been derived. Once deployed, the M-AERIs operate nearly continuously going into a safe hold mode in rain or conditions of heavy spray. They have taken measurements in a wide range of conditions from close to the North Pole to the edge of Antarctic sea ice, and in all the world's oceans. The SST_{skin} data have been compared to SST_{skin} retrievals from several satellites leading to assessments of the accuracy of the satellite retrievals and providing information to help refine the atmospheric correction and cloud screening algorithms. To assess the accuracy of the satellite data, the SST_{skin} derived from the shipboard instruments must have significantly better accuracy than is expected of the satellite retrievals. The presentation will give an overview of the M-AERI assessment of the accuracies of SST_{skin} derived from several satellite instruments. In addition, we will present recent results using Saildrone-derived SST_{skin} in the Arctic Ocean to explore the limitations of the atmospheric correction algorithms in these extreme conditions, leading to ideas of how these can be improved. The M-AERI and Saildrone measurements have also been used to study surface thermal properties and air-sea interactions.

4.2 The increasing importance of sea surface temperature data records for global carbon assessments used to guide policy

Speaker: Prof Jamie Shutler

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Abstract

The ocean is one of two observational constraints on the global carbon assessments used to guide policy on the emission reductions that are urgently needed to stabilise our climate. Within these observation-based ocean sink estimates, sea surface temperature is a strong controller mainly through its impact on gas solubility, so precise, accurate and temporally stable, but also depth specific, sea surface temperature data are critical. This talk will discuss how seemingly small differences in sea surface temperature measurements, with respect to their vertical assignment to depth within the water column, differences in uncertainties due to different sensors, and how small temporal drifts within records, can lead to large differences in the resulting ocean and global carbon budgets. It will end with some suggestions for a carbon specific sea surface temperature climate data record.

5. SESSION 5: THE ISFRN NETWORK

5.1 Status of the ISFRN and the ships4sst data archive

Speaker: Werenfrid Wimmer

Institute name: University of Southampton

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Abstract

W. Wimmer[1], T. Nightingale[2], J. Høyer[3], H. Kelliher[4], R. Wilson[4], J-F. Piolle[5], C. Donlon[6]

[1]University of Southampton , [2]RAL Space, [3]DMI, [4]Space ConneXions, [5]Ifremer, [6]ESA

The International Shipborne Fiducial reference Radiometer Network (ISFRN) represents the shipborne infrared radiometer operators and data users around the world. Its aim is to maintain and deploy Infrared Radiometers of fiducial reference measurement (FRM) quality which are necessary to validate Sentinel-3 SLSTR SST products. Furthermore, all data are processed, archived, formatted and quality controlled following documented FRM procedures and protocols.

We will give an update of the current status of the ISFRN, the data providers and the users. Furthermore, we explore some the central archive (hosted by IFREMER), which due to the common data format, allows common tools to be used for the data exploitation. Examples of the data usage will be demonstrated, however the main use of the ships4sst data is for the SLSTR validation, which is shown in separate talk.

5.2 TIRCALNet – Top of Atmosphere Thermal Infrared Vicarious Calibration Network

Speaker: Steffen Dransfeld, Aimé Meygret

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Abstract:

The coming years will see an increase in the development and preparation for higher spatial resolution thermal imaging missions. While the sector for high resolution optical visible imagery has been a large focus of space agencies and many commercial players around the world, thermal imagery at high resolution is still lagging behind largely due to the increased complexity of instrumentation required. CNES, NASA and ESA with the TRISHNA, SBG and LSTM missions aim to launch in the current decade

thermal imaging missions of 50 - 60m spatial resolution to address this current gap and various commercial enterprises are emerging with their own plans of operation HR thermal imaging missions. This increase of thermal missions provides an unprecedented opportunity to monitor frequently and at high detail at global level the thermal status of our planet. It is thus becoming essential to ensure data intercomparability to allow understanding of measurement biases that may affect one mission with respect to the others. Independent anchoring points on ground are a means to provide a reference measurement that can be propagated to the top of atmosphere allowing satellite operators to compare it to what their satellite instrument measures and thus to reveal any biases of the satellite measurement. For high resolution visible optical sensors such on-ground measurements are provided by the RadCalNet initiative consisting of a network of ground-instrumented sites that provide ground-based reflectance measurements propagated to Top of Atmosphere spectrally resolved reflectances. This network has had an enormous impact in terms of providing satellite operators with an independent reference framework that allows to calibrate at ToA their various satellite instruments and also intercompare them to each other, an essential pre-cursor to any application making use of combined and fused data from more than one mission.

Such a network providing ToA reference measurements does not yet exist for TIR (Thermal InfraRed) missions and based on the RadcalNet experience it would provide key data to allow intercalibration and harmonization of thermal data across missions and hence their combined synergistic exploitation.

Providing accurate ToA TIR signals is even more challenging than for reflectances in the visible domain since thermal behavior of the ground is impacted by significantly varying emissivity and actual surface temperature. Moreover, the composition of the atmospheric column over the site affects the ToA signal. BoA and atmospheric parameters need to be precisely known inclusive of their related measurement uncertainties to provide a ToA derived signal that can be of effective use. Ideally the uncertainty of the derived ToA Brightness Temperature provided by such a network should not surpass 0.5 K. This is a hugely challenging task and currently only provided by sites of stable and homogeneous emissivity and temperature as well as with known atmospheric profiles typically present in aquatic environments. While these sites are providing key measurements for the radiometric assessment and also calibration of ToA TIR sensors there is a need to be providing these measurements for other surfaces corresponding more to the extremes of the calibration range to cover the dynamic range of the satellite instruments. This presentation will introduce the current studies that are being done to build such a network and provide a plan towards a roadmap to an operational network status.

6. SESSION 6: EXPERIENCES OF RADIOMETER OPERATORS

6.1 ISAR(s) in Australia

Speaker: Nicole Morgan

Institute name: CSIRO

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Abstract

The CSIRO Research Vessel RV Investigator has a full meteorological suit of instruments including a hull mounted temperature probe and an Infrared Sea Surface Temperature Autonomous Radiometer. CSIRO has previously been a contributor of SST observations to the FRM4SST project however due to ongoing issues of reliability with the ISAR and key staff changes there has been almost no data submitted post COVID despite being collected.

With the introduction of the new ISAR design an on-board comparison between the new ISAR and old ISAR was completed. The arrival of the Research Science Vessel RSV Nuyina has also added another ISAR into the region, with Nuyina being responsible for the resupply of the Australia Antarctic bases.

6.2 ISAR in Ocean University of China (OUC): Measurements and Applications

Speaker: Dr Minglun Yang

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Abstract

The Infrared Sea Surface Temperature Autonomous Radiometer (ISAR) with serial number ISAR5C_005 has been operating continuously on the research vessel Dong Fang Hong (DFH) II of the Ocean University of China (OUC) from 2009 to 2019, and has been moved to the new DFH III since 2019. The ISAR has measured the sea surface skin temperature (SST_{skin}) for over 90 voyages. The ISAR was calibrated before and after each voyage using an external BB-ASSIST II blackbody, manufactured by LR TECH, Canada. Both the ISAR and blackbody participated in the Fiducial Reference Measurements for Surface Temperatures derived by Satellite (FRM4STS) international comparison project conducted by the National Physical Laboratory (NPL), UK, in June 2016.

A two-dimensional rotating platform integrated with an independent infrared radiometer KT15.85 was designed to measure the angular downwelling sky radiance side by side the radiometer ISAR. Experiments with multiple angle combinations were used to study the impact of the sky radiance on the accuracy of SST_{skin} measurements under different weather conditions. The SST_{skin} and auxiliary measurements from eleven cruises in the Northwest Pacific between August 2015 and October 2018 were also used to estimate the cool skin and diurnal warming effect and compare model results.

6.3 Advancing Sea Surface Temperature Validation: Insights from In-Situ Observations in the Nordic Sea and Arctic

Speaker: Guisella Gacitua

Institute name: DMI

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Abstract

The Danish Meteorological Institute (DMI) is a key contributor to the extensive network of in-situ Sea Surface Temperature (SST) observations for satellite data validation through the FRM4SST project. This project focuses on in-situ Fiducial Reference Measurements (FRM) for SST, crucial for validating Copernicus Sentinel-3 Sea and Land Surface Temperature Radiometer (SLSTR) SST data, particularly in the Nordic Sea and Arctic regions associated with the Atlantic Meridional Overturning Circulation.

DMI has consistently provided SST data since 2017 using Infrared Sea Surface Autonomous Radiometers (ISARs) installed onboard the Smyril Line passenger ferry, Norröna, which traverses from Denmark to the Faroe Islands and Iceland weekly. Furthermore, in spring 2021, DMI, in collaboration with the Technical University of Denmark (DTU), conducted the first shipborne inter-comparison of thermal infrared (TIR) and passive microwave (PMW) SST observations over a week-long period. This initiative aimed to compare the skin and subskin temperatures derived from simultaneous observations, offering insights to enhance the methodology of such inter-comparisons, thus advancing the accuracy and consistency of combined TIR-PMW SST data.

6.4 SISTeR

Speaker: Dr Tim Nightingale

Institute name: STFC, UK

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Abstract

The SISTeR (Scanning Infrared SST Radiometer) is a chopped, autonomous, self-calibrating infrared filter radiometer that can measure IR brightness temperatures to high accuracy (~30mK). It is split into three compartments, the inner being the calibration enclosure which hosts two blackbodies and a rotating scan mirror. SISTeR measures the upwelling radiance from the sea surface and corrects for the reflected sky component with measurements of the downwelling sky radiance. The blackbody thermometer calibrations are traceable to ITS-90. SISTeR generates level 0 data and a dedicated processor unpacks this data.

SISTeR was first deployed in 1997 and since 2010 has been deployed on the Cunard *Queen Mary 2* (*QM2*) liner (usually sailing between Southampton and New York between May - January and annual world cruise between January - May) where it is mounted on a dedicated platform above the starboard bridge wing.

7. SESSION 7: SST DATA IN PRACTICE

7.1 ISAR Korea: Understanding of Skin-Bulk Temperature Differences from ISAR Measurements in the Seas around Korean Peninsula and Indian Ocean

Speaker: Kyung-Ae Park

Institute name: Department of Earth Science Education, Seoul National University, Korea

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Abstract

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[1]Department of Earth Science Education, Seoul National University, Korea [2]Department of Science Education, Seoul National University, Korea.

This study, conducted by Seoul National University in Korea, reports on the findings from recent years of sea surface skin temperature (skin SST) observations around the Korean Peninsula, the Indian Ocean, and the Northwest Pacific using the Infrared SST Autonomous Radiometer (ISAR). The ISAR was installed on Korea's research vessel, R/V ISABU, alongside thermosalinographic temperature measurements and simultaneous observations of atmospheric and oceanic variables such as air temperature, sea surface wind, and currents. To deepen our understanding of the vertical distribution of sea water temperatures, this study made collocation data between ISAR skin temperatures and data from satellite AMSR-2, surface drifters, and ARGO floats, facilitating a comprehensive comparison of temperatures across these datasets. The temperature difference between the ISAR skin SST and the shipborne thermosalinograph faithfully reproduced the well-documented diurnal variations found in previous research. The study revealed the impact of wind on the skin-bulk temperature difference, especially noting that during periods of low wind in the Indian Ocean, the temperature difference could reach as high as 5K during the day and lower than -2K at night. The diurnal effect of wind on temperature variations was pronounced, highlighting the time-dependent relationship between skin SST and subsurface temperatures. Utilizing ISAR skin temperature, satellite SST, drifter temperatures, shipborne SST, and ARGO temperatures, the study aimed to elucidate the vertical structure of sea temperatures. Moving forward, we plan to continue ISAR observations in alignment with the R/V ISABU's operational schedule, contributing further to our understanding of sea surface and subsurface temperature dynamics and their implications.

8. SESSION 8: RADIOMETER PERFORMANCE AND UNCERTAINTIES

8.1 Radiometer uncertainty models

Speaker: Werenfrid Wimmer

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Abstract

When reporting the result of a measurement of a physical quantity, it is obligatory that some quantitative indication of the quality of the result be given so that those who use it can assess its reliability. Such an indication of quality is essential for any measurement but especially for Fiducial Reference Measurements (FRM) to comply with metrological and QA4EO standards.

To show how and uncertainty model can be derived for self-calibrating infrared radiometers the example of the Infrared Sea surface temperature Autonomous Radiometer (ISAR) uncertainty model will be shown. To develop the ISAR uncertainty model all the sources of uncertainty in the instrument are analysed and an uncertainty value is assigned to each component. Finally, the individual uncertainty components are propagated through the ISAR Sea Surface Temperature skin (SSTskin) retrieval algorithm to estimate a total uncertainty for each measurement. The resulting ISAR uncertainty model applied to a 20-year archive of SSTskin measurements from the Bay of Biscay shows that 77.6 % of the data are expected to to be within ± 0.1 K and a further 17.2 % are within 0.2 K.

9. SESSION 9: VALIDATION OF SATELLITE SST AND IN SITU SST MEASUREMENTS

9.1 Sentinel-3 SLSTR SST Validation using Fiducial Reference Measurements (FRM).

Speaker: Werenfrid Wimmer

Institute name: University of Southampton

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Abstract

W. Wimmer[1], T. Nightingale[2], J. Høyer[3], H. Kelliher[4], R. Wilson[4], J-F. Piolle[5], C. Donlon[6]
[1]University of Southampton , [2]RAL Space, [3]DMI, [4]Space ConneXions, [5]Ifremer, [6]ESA

ESA is building on almost 20 years of continuous Fiducial Reference Measurements (FRM) from UK-funded shipborne radiometers by establishing a service to provide historic and ongoing FRM measurements to the wider sea surface temperature (SST) community through an International SST FRM Radiometer Network (ships4sst). The ships4sst is open for partners around the world, currently compromising of partners from the UK (University of Southampton, Rutherford Appleton Laboratory, Space ConneXions), Denmark (Danish Meteorological Institute) and France (Ifremer) and not only collects shipborne radiometer data but also uses the data to validate satellite SST products.

Ships4sst not only provides FRM SST measurements, put also includes a long term data archive of the FRM datasets at Ifremer where the data are stored in the ships4sst netCDF L2R format. Furthermore, a validation service based on the ESA felyx match-up database (MDB) hosted at EUMETSAT is provided. The ships4sst data is freely available to anyone, as are the validation results. At ships4sst we organise and participate in regular inter-comparisons at the National Physics Laboratory (NPL) in the UK and the National Institute of Standards and Technology (NIST) in the USA, to ensure not only the SI (International System of Units) traceability of our remeasurements but also the validity of the per SST value uncertainties.

To demonstrate the value of the FRM SST, we will first show some examples of the ships4sst data around the world and second show the most recent validation results from SLSTR A and B from the ships4sst network regions. This will not only demonstrate that SLSTR A and B are preforming to specification and at least as well as their predecessor AATSR, but also show a potential route for SI-traceability for SLSTR SST measurements. And finally, we will show results from SLSTR A and B during the Sentinel-3 tandem phase using a number of comparison tools, including triple collocations between the ships4sst FRM data and the SLSTR units on Sentinel 3 A and B.

9.2 Comparison (of shipborne radiometers) with other in situ measurements

Speaker: Gary Corlett

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Abstract

Gary Corlett, Anne O'Carroll, Igor Tomazic

Accurate long-term measurements of ocean temperatures are required to understand key physical processes at the ocean-atmosphere interface and any changes that may occur to these processes over time. The first Copernicus Sentinel-3A Sea and Land Surface Temperature Radiometer (SLSTR-A) was launched on 16th February 2016. SLSTR-A is a multi-spectral dual-view radiometer with two on-board blackbodies and cooled detectors ensuring accurate radiometric measurements. SLSTR-A was joined in orbit by its twin, SLSTR-B, on 25th April 2018. SLSTR-A SST products were released operationally from the EUMETSAT marine centre on 5th July 2017 and SLSTR-B products were released operationally on 12th March 2019.

SLSTR provides high-quality dual-view SSTs that are used as a reference sensor in several operational systems. In this presentation we summarise how SLSTR SSTskin measurements are validated using a range of in situ measurements at various depths including Fiducial Reference Measurements (FRM) from shipborne IR radiometers and recently deployed Copernicus drifting buoys. We describe the validation process as well as the concept of a validation space and show that the combination of in situ measurement and FRM provides high confidence in the quality of all datasets, as well as models of the skin-layer and diurnal variability required to adjust the temperature measurement from various depths.

9.3 Validation of the ESA SST CCI data using the Met Office SIRDS dataset

Speaker: Owen Embury

Institute name: University of Reading

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Abstract:

Abstract text ESA's Climate Change Initiative (CCI) has released the third major version of the SST CCI Climate Data Record (CDR) which now spans over 40 years, using data from Advanced Very High Resolution Radiometer (AVHRR), Along Track Scanning Radiometer (ATSR), Sea and Land Surface Temperature Radiometer (SLSTR) instruments, Advanced Microwave Scanning Radiometer (AMSR)-E and AMSR2. The dataset includes both single-sensor products plus a Level 4 SST analysis generated using the Met Office Operational Sea Surface Temperature and Ice Analysis (OSTIA) system.

Version 3 of the SST CCI CDR is the first to make use of data from AVHRR/1 instruments carried on board NOAA-6, -8, and -10 platforms. This increases data coverage in the 1980s and extends the dataset back to 1980. The quality of the AVHRR retrievals has been improved by using a new bias aware optimal estimation (BAOE) technique and updated radiative transfer modelling which significantly reduces the SST biases due to dust aerosols seen in previous CDRs. Additionally, the dataset also includes passive microwave AMSRE and AMSR2 data, MetOp AVHRR now at full resolution, and dual-view SLSTR data.

The CDR is validated using the SST CCI Independent Reference Data Set (SIRDS), which comprises in situ SST measurements extracted from the Met Office Hadley Centre Integrated Ocean Database. This presentation will summarise the SIRDS dataset and validation of the CDR.

10. ACRONYMS AND ABBREVIATIONS

AATSR	Advanced Along-Track Scanning Radiometer
AMSR	Advanced Microwave Scanning Radiometer
ASTeRN	Advanced Surface Temperature Radiometer Network
ATSR	Along-Track Scanning Radiometer
AVHRR	Advanced Very High-Resolution Radiometer
BB	Blackbody
BAOE	Bias Aware Optimal Estimation
CDR	Climate Data Record
CCI	Climate Change Initiative
CNES	Centre National D'Etudes Spatiales
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DMI	Danish Meteorological Institute
DTU	Danish Technical University
ECV	Essential Climate Variable
EO	Earth Observation
ESA	European Space Agency
EU	European Union
FRM	Fiducial Reference Measurements
FRM4STS	Fiducial Reference Measurements for validation of Surface Temperature from Satellites
FTP	File Transfer Protocol
GHRSST	Group for High Resolution SST
GTMBA	Global Tropical Moored Buoy Array
IPCC	Intergovernmental Panel on Climate Change
IR	Infra-Red
ISAR	Infrared SST Autonomous Radiometer
ISFRN	International SST FRM Radiometer Network
L2	Level 2
L2R	Level 2 in situ radiometric data product

LST	Land Surface Temperature
LSTM	Land Surface Temperature Monitoring
M-AERI	Marine-Atmospheric Emitted Radiance Interferometer
MODIS	Moderate Resolution Imaging Spectroradiometer
NASA	National Aeronautics and Space Administration
NOCS	National Oceanography Centre, Southampton
OP	Operational Processor
OSTIA	Operational Sea Surface Temperature and Ice Analysis
RAL	Rutherford Appleton Laboratory
RP	Reference Processor
RSD	Robust Standard Deviation
SBG	Surface Biology and Geology mission
SCL	Space ConneXions Limited
SISTeR	Scanning Infrared Sea surface Temperature Radiometer
SLSTR	Sea and Land Surface Temperature Radiometer
SST	Sea Surface Temperature
ST	Surface Temperature
STFC	Science and Technology Facilities Council
TIR	Thermal Infra-Red
TRISHNA	Thermal InfraRed Imaging Satellite for High-resolution Natural resource Assessment