

GHR SST
GROUP FOR HIGH RESOLUTION
SEA SURFACE TEMPERATURE

GHR SST Training Plan

Group for High Resolution Sea Surface Temperature



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The GHR SST Project Office is funded by the European Union Copernicus Programme and is hosted by the Danish Meteorological Institute, Sankt Kjelds Plads 11, 2100 Copenhagen (DK).



The GHR SST website is performed in the frame of the Sci4MaST project managed by EUMETSAT and led by NOVELTIS with funding by the European Union Copernicus Programme.

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<https://www.youtube.com/@GHR SST>

Document change record

Version	Date	Author	Description
GHR SST Training Plan v1.0	25 November 2025	See list "Contributors"	Core GHR SST Training Plan document and modules and implementation plans 2025
GHR SST Training Plan v1.2	07 January 2026	See list "Contributors"	Core GHR SST Training Plan document and modules and implementation plans 2025. Corrections and feedback from EUMETSAT.

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Reference materials

Document name	Publication date	Reference link
GHR SST Outline of Training Plan	2023	https://zenodo.org/records/17672475
GHR SST Education and Training webpage	Updated periodically	https://www.ghrsst.org/outreach/education-and-training/

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Introduction

About GHR SST

The Group for High Resolution Sea Surface Temperature (GHR SST) is an open international science group that:

- coordinates research and operational developments in satellite-derived sea surface temperature (SST).
- promotes the application of satellites for monitoring SST by enabling SST data producers, users and scientists to collaborate within an agreed framework of best practices.
- provides a framework for SST data sharing, best practices for data processing, and a forum for scientific dialogue, bringing satellite-derived SST to users.

GHR SST has been successful in revolutionising how satellite SST data sets are developed, shared, and applied in modern oceanography, meteorology, and climate centres. Success is achieved by solving scientific, operational, and technical problems and by cooperation at an international level to agree on data product definitions and standards that are acceptable to users, producers, and data managers.

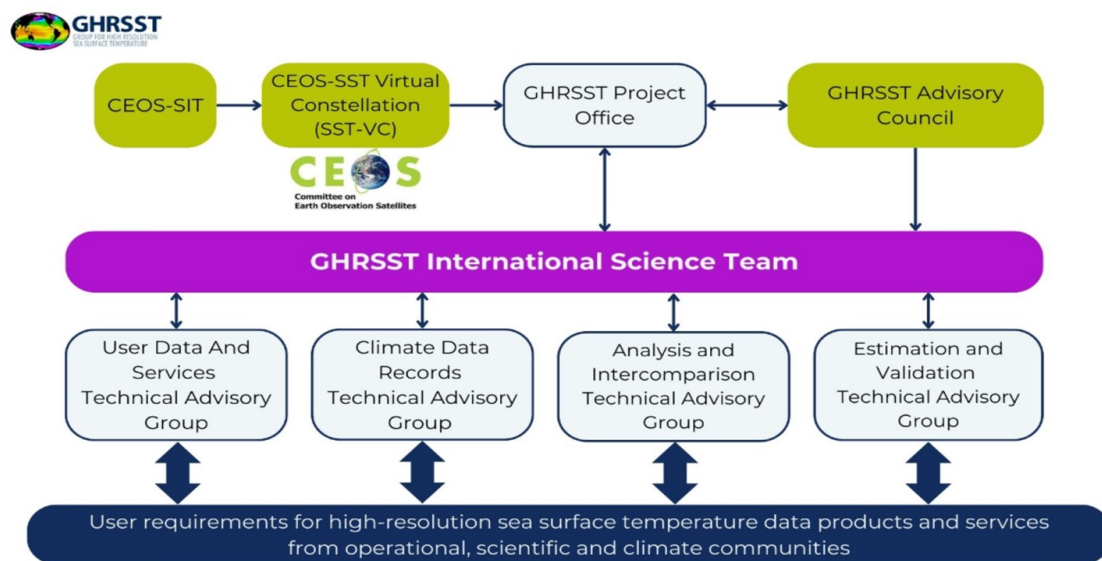
GHR SST coordinates and conducts research, establishes procedures and protocols, provides near real-time data access portals and user services, and implements near real-time quality control monitoring services. Large volumes of data and data services are harnessed together to deliver the new generation of global coverage high-resolution SST data thereby meeting GHR SST User Requirements.

GHR SST Governance

GHR SST is comprised of an elected International [Science Team](https://www.ghrsst.org/about-ghrsst/organisation) of researchers and operational practitioners. The Science Team is involved with data production activities, scientific research and users. The Science Team is organised into Technical Advisory Groups (TAGs) focused on challenges and activities (<https://www.ghrsst.org/about-ghrsst/organisation>).

Several Task Teams are initiated to address and work on identified issues and tasks within a set timeframe and to report to the GHR SST community on an annual basis on their level of progress.

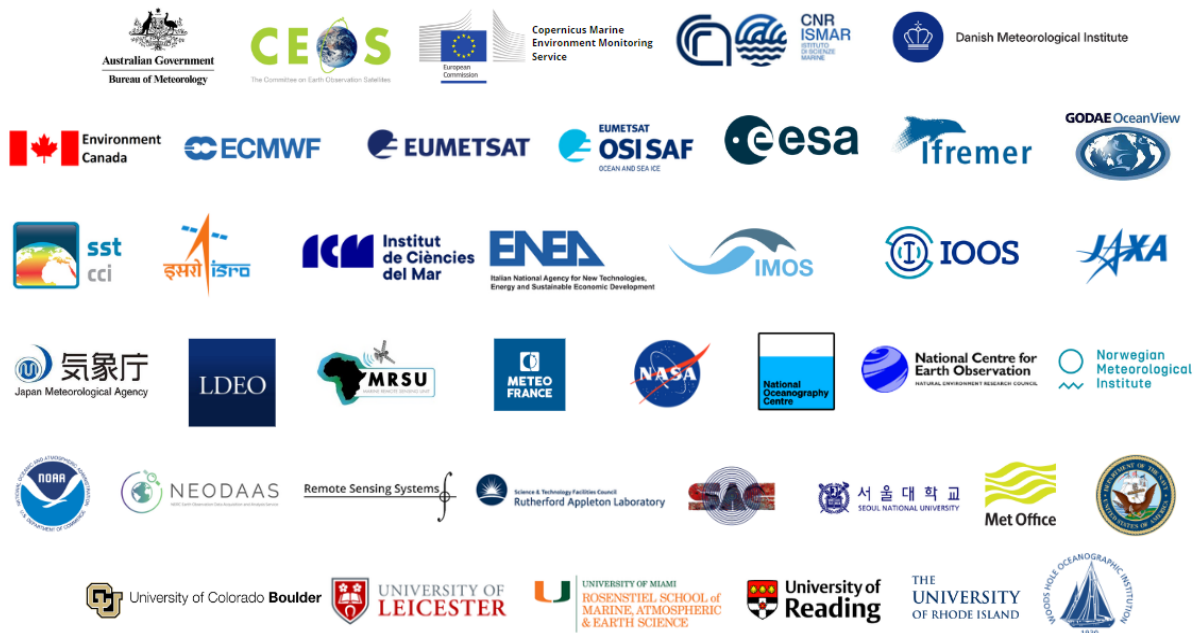
Major stakeholders are represented in the GHR SST Advisory Council, which advises the GHR SST Science Team on its strategy. The GHR SST Project Office, located at the Danish Meteorological Institute and funded by the European Union Copernicus Programme, supports the day-to-day coordination and working of the GHR SST science team and community.



GHR SST Governance Structure

International Collaboration

GHR SST comprises researchers and operational practitioners of SST from several worldwide institutes and agencies. These bodies are represented by the set of logos shown below. Participation in GHR SST is increasing as new groups join the GHR SST community.



GHR SST patrons and sponsors are worldwide institutes and agencies.

Scope

This document presents the GHR SST Training Plan. As a core GHR SST deliverable document, maintained by the GHR SST Project Office, the GHR SST Training Plan gathers both past and future efforts of the GHR SST community towards creating and delivering education and training materials. The Training Plan starts by presenting the history of GHR SST training, with links to previous modules, workshops or courses, and the related materials (presentations and recordings, where available). After this, specific modules and their respective implementation plans are defined. Once completed, the module materials will be made available through the GHR SST website. The GHR SST Training Plan will be revised periodically, and a new version will be published every two years. Once a two-year training period is completed, the report will include information on the completed module description, including links to relevant materials. New or extended module descriptions, with corresponding people responsible and new implementation plans will be added in subsequent sections.

Background

The History of GHR SST Training

GHR SST is committed to capacity building, education and training. Over the years, and before the implementation of a 'GHR SST Training Plan', GHR SST organised several activities and courses to make satellite-derived SST data and products more accessible, both to Early Career Researchers and to the wider scientific community. The following training courses are highlighted, for which we also link to the training materials:

- Joint workshop of the DV-WG, HL-TAG, ST-VAL, and EARWiG on Tropical Warm Pool and High Latitude SST Issues. [Access the summary of the workshop here.](#)
- Short course on GHR SST on satellite-derived SST, University of Cape Town, 29-30 May 2014. [Access the training materials here.](#)
- Short course on satellite-derived SST, Ocean University of China, in Qingdao, China, 31 May-2 June 2017. [Access the training materials here.](#)
- Training in-person for SST Users, Ahmedabad, 20 October 2023: (Outline GHR SST Training Plan): GHR SST specified/formatted products: Which SST products in GHR SST specification are the most suitable for me? [Access the training materials here.](#)

Outline GHR SST Training Plan

The "[GHR SST Outline of Training Plan](#)" was published in 2023, following a plenary panel discussion on GHR SST Training Formats on SST at the 23rd GHR SST science team meeting held in Barcelona (and online). The panel, together with the GHR SST science team, focused on the experiences and future needs of GHR SST training, including for the wider user community of satellite-derived Sea-

Surface Temperature (SST). The video of this panel discussion is available in the [GHR SST video channel](#).

The implementation of the GHR SST Outline of Training Plan was carried out in 2023 at the 24th International SST Users' Symposium and GHR SST Science Team Meeting held in Ahmedabad, India. The in-person training focused on GHR SST specified/formatted products: Which SST products in GHR SST specification are the most suitable for me? The course aimed to connect users to the GHR SST Catalogue, outlining the ramifications for selecting Level 4 gridded products of a given type (e.g. IR, microwave, blended) and therefore allowing them to make better informed decisions for their applications. The training set out to provide practical examples of a broad range of applications from the meso- to global-scale, from event-based to climate variability. The course provided a basic introduction to L2, L3, and L4 fields for existing and potential users to gain knowledge in these. It also provided guidance to the participants in their decisions on what is needed for their studies and applications as many were unaware of the consequences of their choices.

The training contents can be accessed through the [dedicated GHR SST website page](#). All presentations are available in Moodle. All the videos of the training sessions are available through the GHR SST YouTube [playlist](#).

The GHR SST Training Plan

An update to the GHR SST Training Plan progressed in 2025, and was discussed at the 26th International SST Users' Symposium and GHR SST Science Team Meeting (GHR SST26) held in Copenhagen. The topic on opportunities for GHR SST Training was brought forward during discussions and final reporting on GHR SST priorities connected to the scientific sessions on: (1) Advances and Challenges of Surface Temperature in Polar Regions, (2) Global Sea (and Sea-Ice) Surface Temperature: Climate Data Records, Trends, Indicators, and Definitions, (3) Atmospheric and Ocean Modelling and Reanalysis of SST, (4) From Observations to Products – Advances in SST Calibration, Validation, and Product Assessments, (5) Climate Change, Variability, and Applications of Sea and Sea-Ice Surface Temperature, and (6) Advances in Computing, Retrievals, and Products.

Based on the discussions and inputs from the Science Team members, GHR SST26 participants, and the session chairs and rapporteurs, key points addressing opportunities for training that could be included in the update of the GHR SST Training Plan were brought forward. These included the following:

- New GHR SST data producers are expected to design their own scheme for SSER within broad common principles. Is there a need to review the sufficiency of public guidance?
- General agreement on the importance of simplifying both access to and interpretation of SST data (for example, via user-friendly visual tools), in order to better engage the non-scientific community
- Exchanges of young researchers and students between laboratories should be planned

- Example tutorials on how SSTs are calculated, including L2, L3 and L4 production.
- Training on accessing data already available in the different cloud providers

From the inputs highlighted during GHR SST26, the GHR SST Project Office organised these into training modules, focusing on four key areas:

- 1) Enhancing Accessibility and Communication of SST Data
- 2) Fostering Capacity Building Opportunities for the Next Generation of SST Researchers and Scientists
- 3) Implementing and Utilising Cloud Optimised GHR SST Data
- 4) Strengthening Understanding of Uncertainties

The GHR SST Training Plan will continue to be updated every two years. The links to materials including presentations, recordings or reports for completed modules will be added to the sections above. Moreover, new or extended modules, as well as new contents or formats may be introduced to expand on all previous training materials.

Training Module Descriptions and Implementation plans 2025-2027

Module 1: Enhancing Accessibility and Communication of SST Data

There is general agreement on the importance of simplifying both access to and interpretation of SST data, particularly for non-scientific and non-expert users. Many users, especially non-expert or non-scientific users, may struggle to find, access, and apply existing SST training resources.

Overall Objective

This training module aims to enhance the accessibility and usability of GHRSSST-formatted products, with a primary focus on non-scientific and non-expert SST users. It seeks to support these audiences in understanding the range of available SST products, interpreting their content, and selecting the most appropriate product for their specific needs. This module will also address how to improve accessibility across data centres and agency-operated cloud infrastructures, aiming to promote transparent cross-access for users.

Beneficiaries

Primary Beneficiary Audience: Non-scientific and non-expert SST users

This group usually lacks formal training in fields such as remote sensing or oceanography, but relies on SST information for operational and decision-making needs. They benefit from simplified guidelines, visualisations, and user-friendly access to data. This group typically needs support in interpreting the SST data and choosing the appropriate products for their needs.

Secondary Beneficiary Audience: Experienced SST users seeking product-specific training materials

This group is most likely familiar with SST concepts and products but may need further support in specific SST products to fit their needs. They benefit from this training module through enhancing their skills in product selection and comparison in using SST products for specific applications.

Contents and Format for Training

GHRSSST Training Hub Published on the GHRSSST Website

Develop a dedicated "GHRSSST Training Hub" serving as an online repository of existing training materials, hosted on the GHRSSST website.

The webpage should be user-friendly and intuitive for the users to easily find training content by theme, purpose, type of product or other relevant content. The webpage can include downloadable guides, videos, presentations, and external links to relevant training resources (e.g., Copernicus EUMETSAT marine training, CoastWatch tutorials, Copernicus Climate Data Store training).

To encourage continuous improvement and user engagement, the webpage will also feature a function for users to provide their input and feedback to indicate their training needs and suggest areas where further training materials are needed. Moreover, this feedback mechanism can also be used to gain insights on user backgrounds and what products are being used.

Towards the goal of improved accessibility across data centres and agency-operated cloud infrastructures, the module will present and use the “GHR SST opensearch federation service” (which can be accessed through <https://opensearch-ghrsst.ifremer.fr/>) to search and access data across data centres. This opensearch API was developed for GHR SST by IFREMER, supported by Copernicus through EUMETSAT.

In the long-term, the GHR SST Training Hub will function as a central access point for capacity building, supporting more inclusive use of SST products, particularly for non-scientific and non-expert users.

Intended Outcomes

- Simplified access to training materials through a one-stop, user-friendly webpage
- Increased relevance of future training offerings, informed by actual user needs and identified gaps
- Greater engagement of the non-scientific community, who can now more easily interpret and apply SST data
- Stronger feedback loop between GHR SST and its user base, improving trust, uptake, and long-term utility of SST products

Potential Implementation Plan for 2025 – 2027

Activities	Outputs
Collection of existing training materials from service providers	Compiled repository of existing training resources (e.g., tutorials, webinars, documentation, user guides) from GHR SST-related service providers (e.g., Copernicus Marine, EUMETSAT, NASA, NOAA, JAXA) leading to an inventory of resources organised into categories such as training type, format, provider, relevance
Examine the collection of resources to identify gaps in knowledge for potential training activities	Training gap analysis document with an overview of key SST topics or user needs not covered by existing resources, user groups that lack training materials leading to suggested new training content to be developed
Generate a form for collecting input from SST users on	Online feedback form/survey with questions that capture training needs and preferred

training needs	formats and potentially additional information on user background and product usage leading to a database of responses
Build webpage on GHR SST website to host the repository of training materials and collecting input	Published training hub webpage on the GHR SST website

Lead and Contributors

GHR SST Project Office Coordinator to administer the collection of materials from GHR SST Science Team and broader community. Furthermore, the GPO will coordinate with EUMETSAT in order to gather inputs from the EUMETSAT Copernicus marine training team.

Target Launch Date

June 2027

Module 2: Fostering Capacity Building Opportunities for the Next Generation of SST Researchers, Scientists and Data Producers

Building long-term capacity within the SST community requires meaningful opportunities for early career researchers and students to gain practical experience and form professional networks. Barriers to entry points into the GHR SST community can hinder those at the early stages of their careers to get involved if opportunities for engagement and collaboration are not easily accessible and visible. Creating these opportunities is essential to support the next generation of SST researchers, scientists and data producers.

Overall Objective

This training module aims to promote career development, knowledge exchange, and long-term engagement of early-career researchers and students in the GHR SST community. It supports capacity building by facilitating connections between early-careers and ongoing GHR SST activities, such as those being implemented via the Task Teams, enabling them to gain hands-on experience, develop research skills, and contribute to the broader SST community. In addition, this module promotes the engagement and support for new SST satellite missions and data producers, particularly promoting the understanding and use of the GHR SST Data Specification (GDS).

Beneficiaries

Primary Beneficiary Audience: Early-career researchers and university students

This group includes individuals currently pursuing graduate or postgraduate education, as well as those in the early phases of their research careers. They are often building their research profiles, exploring SST-related topics, and looking for opportunities to apply their knowledge in real-world contexts. They benefit from access to project-based learning, mentorship, and collaborative experiences with more established scientists and institutions.

Contents and Format for Training

GHR SST Activity Inventory

The GHR SST Activity Inventory will be a list of short-term collaboration opportunities, thesis topics, and project-based activities submitted by members of the GHR SST Science Team and Task Teams. The purpose of the GHR SST Activity Inventory is to connect early-career researchers and students with real-world engagement opportunities that contribute to GHR SST's activities while supporting their academic and professional development.

Each project entry in the catalogue will include:

- Project title
- Short description of the task or project (max 200 words)
- Optional image or graphic

- Contact person & email

These activities will allow GHR SST Science Team and Task Team members to gain valuable assistance with activities while also offering opportunities for students and early-career researchers a chance to work on real-world projects and engage directly with more established experts in the SST field.

Intended Outcomes

- Greater inclusion of students and early-career researchers in GHR SST activities
- Increased visibility of SST activities and GHR SST
- Strengthened long-term capacity and sustainability of the GHR SST community

Potential Implementation Plan for 2025 – 2027

Activities	Outputs
Collect projects from the Task Teams and GHR SST Science Team for the Inventory	Project submissions for building the GHR SST Activity Inventory
Organise and publish the GHR SST Activity Inventory on the GHR SST website	Online or downloadable PDF catalogue hosted on the GHR SST website
Promote via social media channels and at conferences or other relevant events	Social media posts, news posts, and printed materials of the inventory available

Lead and Contributors

GHR SST Project Office Coordinator to manage the development and launch of the Inventory, supported by voluntary contributions from Task Teams, Science Team members, and partner institutions.

Target Launch Date

June 2027

Module 3: Implementing and Utilising Cloud Optimised GHR SST Data

Overall Objective

Beneficiaries

Primary Beneficiary Audience:

This group includes scientists and application users of GHR SST data products that often encounter barriers with long time series analysis of GHR SST data that are accessible from the cloud. Some GHR SST products have over a 40-year time series length, often at very high spatial and temporal resolution, making the netCDF file-by-file, subset and download workflow model an unwieldy process.

Cloud data optimization and virtualization offers a more seamless pathway for data access using data prepared with virtualizarr and/or icechunk and accessed via python xarray or zarr either locally or in the cloud. Users benefit from data in a more analysis ready format, with seamless access allowing them to analyse only the regions and temporal periods of interest using popular community supported programming packages, and tools and services. Data distributors also benefit from no additional storage requirements to support this netCDF data virtualization model and workflow.

In addition, and towards the wider user uptake and training of GHR SST data and products, this module will cover other datasets such as European Weather Cloud, WEkEO or the Copernicus Data Store, among others. Although not all datasets are yet supporting virtualizarr and/or icechunk, the module will explore which technologies are available and possible to apply to all (or the majority of) GHR SST products. This consideration stems from the goal to improve the interoperability across data centers as a whole.

Contents and Format for Training

Introduction to the Cloud Data Optimisation Principles

- Description

Format: Online seminar

Introduction to Different Technology Implementations

- Kerchunk/ Virtualizarr
- Icechunk
- netCDF chunking strategies
- Technologies available for other GHR SST datasets (European Weather Cloud, WEkEO, Copernicus Data Store, etc.)

Format: Online seminar with Tutorials

Case Study Example: PO.DAAC Dataset Implementations

- Description
- Gulf of Tehuantepec upwelling and ocean response
- Indian Ocean Dipole
- Equatorial Kelvin waves
- SST trend analysis

Format: Online seminar / TBC

Practical Example

- Creating a virtualized GHR SST dataset

Format: TBC

Intended Outcomes

- Increased understanding of Cloud Data Optimisation Principles applied to GHR SST data
- Discussion and increased understanding of other GHR SST datasets and data types, including European Weather Cloud, WEkEO, Copernicus Data Store.
- Increased uptake and more seamless use of GHR SST data products due to improved data access

Potential Implementation Plan for 2025 – 2027

Activities	Outputs
Promote online seminars via social media and GHR SST website	Social media posts and news articles on GHR SST website to engage participants ahead of webinar series
Delivery of online seminars	Online seminar series (2-4 separate sessions) to introduce the concepts of Cloud Data Optimisation and how to apply to GHR SST data

Lead and Contributors

Edward Armstrong, Jean-François Piolle

Target Launch Date

June 2026

Module 4: Strengthening Understanding of Uncertainties in SST

Overall Objective

Providing SST users and producers with information on uncertainty characteristics and how to interpret and use them.

Beneficiaries

Primary Beneficiary Audience: Scientific SST Users and SST Producers

Scientific users of GHR SST products are presented with sensor specific error statistics (SSES) and in some products' additional uncertainty values and information. Generally, there is awareness that uncertainty should be considered in scientific applications, but there is often a lack of clarity about how to use GHR SST information. This group may benefit from both the availability of general training and from specific training related to GHR SST product uncertainty information.

SST producers are required by GHR SST standards to provide SSES as uncertainty information. Previous GHR SST discussions have also raised but not concluded on whether it is desirable to move towards providing uncertainty information more in line with international norms, including metrological conventions. This group may benefit from this training in enhanced collective understanding of the issues at stake and confidence in progressing the provision and exploitation of uncertainty information within GHR SST.

Contents and Format for Training

TOPIC 1: Example > Introduction to Uncertainties (All audiences)

A foundational overview of uncertainty including definitions, how they are derived, and why they matter. Review of how GHR SST uncertainty information (SSES) relates to metrological uncertainty.

Format: (1) GHR SST-specific live webinar. (2) Access to introductory EO-uncertainty course at NPL.

TOPIC 2: Example > SST uncertainty review workshop (SST producer audience)

A structured workshop for producers of data (L2 to L4) to share and critically examine current practices in GHR SST provision of uncertainty information.

Format: (1) Side session workshop at GHR SST science team meeting

Intended Outcomes

- More accessible information on how to use GHR SST uncertainty information
- Increased clarity on GHR SST uncertainty information, and potential future plans or best practices
- Increased visibility of GHR SST products and how to use them

Potential Implementation Plan for 2025 – 2027

Activities	Outputs
Promote webinars and workshop through social media and GHR SST website	Social media posts and news articles on GHR SST website to engage participants ahead of webinar series, promote the access to introductory course and engage science team ahead of GHR SST science team meeting
Delivery of GHR SST-specific webinar	Online webinar on GHR SST uncertainty information
Side session workshop at GHR SST science team meeting	Feedback from data producers regarding GHR SST provision of uncertainty information
Sharing of feedback from science team meeting	Short report back to the science team regarding the discussions and any potential further actions arising from workshop

Lead and Contributors

Christopher Merchant, Jonathan Mittaz, Gary Corlett

Target Launch Date

June 2027

ANNEX 1: Outline of Training Plan (2023)¹

¹ <https://zenodo.org/records/17672475>



GHR SST Outline of Training Plan



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The GHR SST Project Office is funded by the European Union Copernicus Programme and is hosted by the Danish Meteorological Institute, Lyngbyvej 100, 2100 Copenhagen (DK).

The animation of the GHR SST website is performed in the frame of the Sci4MaST project led by NOVELTIS and funded by the European Union Copernicus Programme.

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Cover: Training diagram. Chiara Bearzotti (DMI)

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Introduction

At the GHR SST23 meeting in June 2022, the GHR SST International Science Team kicked off a discussion on the experiences and future needs for training for both GHR SST itself, and the wider user community of satellite-derived sea surface temperature (SST). A panel discussion at the meeting included a panel of experts with experience in delivering training on SST and related topics, as described below. Short presentations from the panel were followed by an interactive discussion with the audience and focussed on the planning of future training resources and the development of training modules and capacity building events.

The session had three primary aims, each of which was addressed via a different approach, as detailed below:

- Aim 1: exchange thoughts and experiences on training on satellite-derived sea surface temperature beyond. This was addressed through panel discussion.
- Aim 2: gather experiences and needs from the community present at the meeting. This was done using the [Sli.do](#) online polling and Q&A tool.
- Aim 3: begin planning activities, both courses and resources. This was achieved using [Miro](#) online whiteboard tool.

Key inputs for the design of the Training Plan and for its implementation

As a result of the discussion with experiences trainers and users, the following suggestions have been integrated in the current outline for GHR SST Trainings.

- **Interactive, active online learning formats:** New users are virtual by nature, they are digital natives¹. The training should accommodate an online audience, as online formats can reach many students and can be studied asynchronously. In these online formats, interactivity is key. PowerPoints can be quite boring, and physical examples of hardware, or the use of video helps to enliven learning. GHR SST should offer recorded lessons and synchronous Q&A sessions with the support of the GHR SST science team, offer more debates, problem-based learning and mini-projects.
- **Offer interactive short courses in-person and target some specific geographical areas:** Putting technology, such as instrumentation, in people's hands, provides a good focus point for teaching, to integrate online formats. The hands-on in-person sessions should be organized alongside the GHR SST science team meeting. These annual GHR SST meetings are more gradually turning in symposia for satellite-derived SST users.. They offer the chance to link to a local community in the country where the annual meeting is taking place, and can offer opportunities for capacity building and for the growth of a local network in a specific country.
- **Keep the formats short for achieving higher motivation:** The most important this is to get trainees trying something as quickly as possible, keeping motivation is key to any training activity.
- **Consider the sustainability of GHR SST training modules,** and what long term plan is for resources developed as part of them. Things move fast. It is likely that two months after authoring any training code, it is old, broken or defunct. Come up with the possibility to create communities of practice to help maintain the learning modules in the simplest ways possible.
- **Focus more on inexperienced users who are using Level-4 products:** These are the users to focus upon and who need to be supported. Experienced data scientists are more skilled and more likely to find an answer to their questions, independently. The less

¹ Term coined by Marc Prensky in his 2011 article [Digital Natives, Digital Immigrants](#).

experienced, day-to-day user, who is unlikely to be a data scientist, needs more direct support.

- **Use the modules as a tool for network development:** Offer the possibility to trainees to discuss papers of interest with the actual authors and have a dialogue with the GHR SST International Science Team.

Target audience

Based on the outcomes of the discussion and inputs from an initial team of contributors, the following modules could be planned for the specific target audiences.

Level of experience	Modules
Newcomers (e.g., early career scientists, stakeholders) interested in learning how to use SST data	<ul style="list-style-type: none"> • Module 1: Satellite-derived SST for beginners: An introduction to sea surface temperature from the satellite constellation. • Module 2: GHR SST specified products Which SST products in GHR SST specification are the most suitable for me?
Experienced SST users who are new to open-source and cloud computing	<ul style="list-style-type: none"> • Module 3: Open source software • Module 4: Cloud computing

Modules description

Module 1 - SST for beginners: An introduction to sea surface temperature from the satellite constellation

Specific objectives

- Increase knowledge on SST from the satellite constellation.
- Introduce GHR SST and GHR SST specified products.

Target audience and level of experience

Newcomers (e.g., undergraduates, stakeholders such as small scale fishers, environmental managers, early career scientists) interested in learning how to use satellite-derived SST data.

Duration

This module can vary in lengths, depending on the experience of the trainees. In average, 2 hours training are estimated to deliver each component listed below.

Contents

Component A- SST introduction: What is sea-surface temperature? Why is this important and for what? What are the expected signals? What are the fundamentals of its measurement? How to derive SST from satellites and radiometer measurements? Orbits and how these impose limitations. L1-L4 strengths and weaknesses. Examples: severe storms, upwelling, fronts, ENSO.

Component B - Introduction to GHR SST specified products: What are the SST products in GHR SST Data Specification (GDS <https://www.ghrsst.org/resources/ghrsst-project-documents>), how to use them, prompt questions that help to refine the most suitable product (e.g. based on resolution, coverage, applications). Offer an “online shopping” type approach where the product suite can be narrowed down by specific user needs, for example resolution, coverage, application etc.

Component C - Assignments for individuals or small teams: image processing exercises (e.g. via SNAP and SeaDAS) to get trainees to the data early on, and apply start on the trainees’ own analyses. Exploring online data access centres. Exercises on data in locally relevant, real-world cases (for example, how SST evolves alongside hurricane formation in some specific geographies).

Format

Online training with pre-recorded lessons and assignments, and some synchronous interaction with trainers.

When

Before the annual GHR SST international science team meeting /annual SST users’ symposium, in preparation for more in-depth modules (Module 2, 3...).

Training materials

- PowerPoints available on the GHR SST website.
- Short videos with explanations/tutorials available on the GHR SST Vimeo channel.
- Recorded sessions of the live training lessons on the GHR SST Vimeo channel.

- Dynamic Q&A on the GHR SST website.
- Dynamic Q&A sessions with GHR SST International Science Team members (synchronous).

Long-terms impacts

- Gradually build up a network of SST experts and users of GHR SST specified/formatted products.
- Strengthening the GHR SST user community.

Potential implementation plan for 2023

The Copernicus team at EUMETSAT is planning to deliver an online module with these contents by June 2023. GHR SST could take advantage of the Copernicus module (on the Moodle) to make it available to the GHR SST community of users

Module 2 - GHR SST specified / formatted products: Which SST products in GHR SST specification are the most suitable for me?

GHR SST coordinates an extensive catalogue of Sea Surface Temperature (SST) produced from many data producers, each with their own advantages and caveats. For a potential user, with a given application in mind, this landscape can be confusing and intimidating, often resulting in reaching for the most convenient product, irrespective of its suitability.

This course aims to more connect users to the catalogue more appropriately, outlining the ramifications for selecting level-4 gridded products of a given type (e.g. IR, microwave, blended) and therefore allowing them to make better informed choices for their applications. It will consider practical examples of a broad range of applications from the meso- to global-scale, from event-based to the climate variability. The course will provide a basic introduction to L2, L3 and L4 fields as many potential users have very little knowledge about these, and need guidance to decide what they really need for their studies and many are unaware of the consequences of their choices.

Specific objectives

Increase knowledge on GHR SST coordinated products for SST users.

Target audience and level of experience

Newcomers (e.g., undergraduates, stakeholders such as small scale fishers, environmental managers, early career scientists) interested in learning how to use satellite-derived SST data.

Duration

This module can vary in lengths, depending on the experience of the trainees.

In average, 2 hours training are estimated to deliver components A and B listed below.

For component C, a selection of tools could be offered, according to the interest of the trainees.

Contents

Component A - Refreshing SST knowledge: Basic introduction to L2, L3 and L4 fields; SST definitions, and difference between skin, sub-skin, depth, foundation SST. How to use the SSES and how it is constructed; Upwelling systems, WBC variability, ENSO; Eddies, fronts, plumes; Climate / CDRs; Diurnal heating or the differences between IR and microwave SSTs; Sampling differences (temporal and spatial); Marine Heat Waves; Ocean Phenology; satellite to in situ matchup; high latitudes SST (Arctic).

Component B - In-depth introduction to GHR SST specified / formatted products: What are the GHR SST specified products, criterion for selecting products, how to use them, prompt questions that help to refine the most suitable product (e.g. based on resolution, coverage, and applications). Tools and Services that can help in data set selection: visualization, data extraction for multiple data sets. How to provide feedback to GHR SST specified / formatted products to support their further development.

Component C - Demonstration of tools:

- **Demonstration of the GMPE tool** (<https://www.ghrsst.org/latest-sst-map/> and <https://ghrsst-pp.metoffice.gov.uk/ostia-website/gmpe-monitoring.html>).
- **How to use the GHR SST Central catalogue:** Exploring the catalogue <https://www.ghrsst.org/ghrsst-data-services/ghrsst-catalogue/>
- **How to use the “ARMS” ACSPO tool?** This is a very useful place to show different products to new SST users.

- **Image processing exercises** (e.g. with SNAP & SeaDAS) to get trainees to the data and help them quickly apply this to their own analysis.
- **“Just plot” exercise:** Trainees will be asked to pick a region and zoom in and compare, to see weaknesses, resolutions etc.

Format

Two formats are possible:

- In-person, hands-on training.
- Online training with pre-recorded lessons and assignments, and some synchronous interaction with trainers.

When

- In-person: Alongside the annual GHRSSST international science team meeting /annual SST users’ symposium.
- Online: Before the annual GHRSSST international science team meeting /annual SST users’ symposium, in preparation for more in-depth modules.

Training materials

- PowerPoints available on the GHRSSST website.
- Short videos with explanations/tutorials available on the GHRSSST Vimeo channel.
- Recorded sessions of the live training lessons on the GHRSSST Vimeo channel.
- Dynamic Q&A on the GHRSSST website.
- Dynamic Q&A sessions with GHRSSST International Science Team members (synchronous).

Long-terms impacts

- Strengthening the user community of GHRSSST specified / formatted products.
- Build an early-career researchers’ network working with GHRSSST specified / formatted products.

Potential implementation plan for 2023

The materials to deliver this module could be set up in summer 2023, with staff working at the GHRSSST GPO and the SST experts at the Danish Meteorological Institute. The components A and B could be held online. The component C could be held at the GHRSSST24 meeting in October 2023.

Module 3: Open source software

Open science stimulates collaboration, inclusivity and reproducibility. However, it requires access to tools that are available to all within the community in order to support these goals. This course will expand on the benefits of open science, introducing relevant software and tools and including practical examples of their use within the SST community.

Specific objectives

Showcasing the benefits of open science.

Target audience and level of experience

Experienced SST users who are new to open-source.

Duration

2-3 hours.

Contents

- TOPS, contents from IODE conference, content from PO.DAAC and other NASA sources.
- DINEOF / DINCAE.
- EUMETSAT Jupyter-based training examples.
- EUMETSAT plugins / processors.
- Match-up extraction with Felyx (possibly on WekEO) (more producer oriented or for general intercomparison frameworks).
- AI/Machine Learning.

Format

Online. Synchronous.

When

Before the annual GHRSSST international science team meeting /annual SST users' symposium, in preparation for more in-depth modules.

Training materials

- PowerPoints available on the GHRSSST website.
- Short videos with explanations/tutorials available on the GHRSSST Vimeo channel.
- Recorded sessions of the live training lessons on the GHRSSST Vimeo channel.
- Dynamic Q&A on website.

Long-terms impacts

Strengthening the GHRSSST user community.

Potential implementation plan for 2024

The materials to deliver this module could be set up late 2023 based on the availability of the GHRSSST science team members, in order to deliver this module in 2024.

Module 4 Cloud computing

With the continuing expansion of cloud-based offerings, users must increasingly face decisions about whether to perform their tasks locally or remotely.

Specific objectives

Increase knowledge in cloud computing.

Target audience and level of experience

Experienced SST users with little knowledge on cloud computing.

Duration

2-3 hours.

Contents

- Barriers and advantages to cloud-processing.
- Architecture, upscaling, managing tenancies, product dissemination and process monitoring.
- CEOS COVERAGE; usage of WEkEO & AWS.
- Analysis in the Cloud using NASA Earth Science Data and Services.
- **Cloud SST access.** Trainees can expand on this notebook, include new cloud data, SST CCI v2.1 Analysis in the AWS Open Data <https://registry.opendata.aws/surftemp-sst/> and https://github.com/oceanhackweek/ohw-tutorials/blob/OHW20/10-satellite-data-access/Access_cloud_SST_data_examples.ipynb
- Intro to Satpy & L2: https://github.com/cgentemann/salinity/blob/master/Collocate_insitu_with_SSS.ipynb

Format

Online. Synchronous.

When

Before the annual GHR SST international science team meeting /annual SST users' symposium, in preparation for more in-depth modules.

Training materials

- PowerPoints available on the GHR SST website.
- Short videos with explanations/tutorials available on the GHR SST Vimeo channel.
- Recorded sessions of the live training lessons on the GHR SST Vimeo channel.
- Dynamic Q&A on website.

Long-terms impacts

Strengthening the GHR SST user community.

Potential implementation plan for 2024

The materials to deliver this module could be set up late 2023 based on the availability of the GHR SST science team members, in order to deliver this module in 2024.