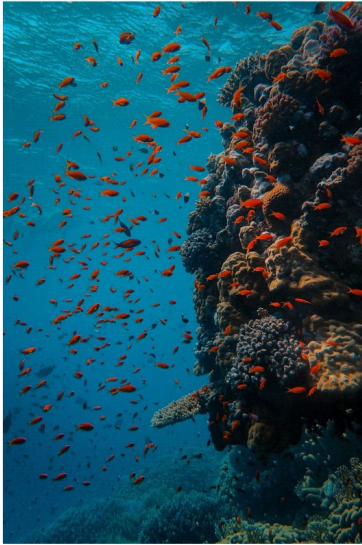# Sea surface temperature:
An introduction to users on the set of GHRSST formatted products
2023 update

Group for High Resolution Sea Surface Temperature (GHRSST)
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Introduction

To measure sea surface temperature (SST), scientists deploy temperature sensors on satellites, drifting and moored buoys, ships, Argo floats, gliders, marine mammals, for example seals, and ocean reference stations (Merchant et al., 2019). In situ measurements from drifting buoys, moorings, Argo floats, and ships are commonly used to calibrate and validate the satellite-derived SST data. SST measurements benefit a wide spectrum of operational applications, including **ocean, weather, climate and seasonal monitoring/forecasting, military defense operations, validation of atmospheric models, sea turtle tracking, evaluation of coral bleaching, tourism, and commercial fisheries management** (Beggs, 2010; O'Carroll et al., 2019; Merchant et al., 2019).

In this short document we have collected a list of valuable resources for you to use several **GHRSST formatted products** https://www.ghrsst.org/ghrsst-data-services/products/ *GHRSST* stands for the Group for High Resolution SST, an open international science group that promotes the application of satellites for monitoring sea surface temperature (SST) by enabling SST data producers, users and scientists to collaborate within an agreed framework of best practice.

We refer in this document to **GHRSST formatted product**s because there is no ONE GHRSST product, but a wide range of SST producers worldwide that use the common GHRSST format and specifications. These products suit different applications, and there are several web-tools available to assist a user to select an SST product, including validation sites.

The wide range of SST producers worldwide that use the GHRSST format and specifications to provide SST products in prescribed formats (*GHRSST Science Team, 2012*) – Level 2 pre-processed ("L2P") on the original swath projection, Level 3 composite (gridded with gaps) products formed using SST from either a single swath/scene ("L3U"), a single sensor but multiple swaths/scenes ("L3C") or multiple sensors ("L3S"), and Level 4 analysed (gridded, gap-free) SST from multiple sensors/platforms ("L4"). These global and regional spatially-mapped SST products are available for research and operational applications (Beggs, 2010; Donlon et al., 2009).

How to select a satellite SST product?

To select from an increasingly wide array of SST products, you need to consider which of the following parameters are most important for the application and analyses being undertaken (Beggs, 2021):

- SST measuring depth- skin, subskin or foundation?
- Temporal needs -are the dataset extent, local time of measurement, and latency suitable? Or is the local time of measurement (night, noon) an issue?
- Temporal resolution—what is the characteristic time period of the process you wish to measure? Daily or sub-daily?
- Spatial resolution - how fine a resolution is required for the feature/ process of interest?
- Spatial coverage completeness - gaps versus gap-free?

- Do you need microwave data to measure SST under cloud, for example during or after a tropical cyclone?
- Quality level (cloud/rain contamination) - what is the minimum acceptable level?
- Level of processing - native projection (L2P) or gridded (L3 or L4) or analysed (L4)?
- SST accuracy and stability- with respect to what reference? Is it for climate applications?
- Stability of sensor and orbit - what deviation is acceptable?

Further information: https://www.ghrsst.org/resources/publications/

Tools for quick-looks/visualization of SST products

- A particularly useful web tool for quick-looks at a range of GHRSST L2P, L3U, L3S and L4 SST products over defined ocean regions is the **NOAA/NESDIS/STAR ACSPO Regional Monitor for SST website v2.1 (ARMS)**: https://www.star.nesdis.noaa.gov/socd/sst/arms/

- **CEOS COVERAGE** website https://coverage.ceos.org/ displays GMPE and JPL MUR 25km SST data along with a wide range of other satellite and in-situ ocean data.

- **NOAA/NESDIS/STAR OceanView web tool** displays NOAA GeoPolar Blend L4 SST and fronts https://www.star.nesdis.noaa.gov/socd/ov/ along with other satellite and in-situ ocean data.

- The **Copernicus Marine Service** displays and distributes a suite of L4 and L3S GHRSST products for the European Seas and also global ocean https://marine.copernicus.eu, along with other ocean parameters.

- A web-based visualization tool with many products and ocean variables is the **Ocean Data Laboratory** https://ovl.oceandatalab.com/.

- A list of available L4 GHRSST SST products for visualization over the last 7 days and monitoring is available through the **GMPE tool** https://ghrsst-pp.metoffice.gov.uk/ostia-website/gmpe-monitoring.html GMPE is the ensemble median of all the GHRSST products.

- NOAA SQUAM: L4 NRT, Global Quality Monitoring system https://www.star.nesdis.noaa.gov/socd/sst/squam/ and its counterpart for in situ data, iQUAM https://www.star.nesdis.noaa.gov/socd/sst/iquam/

- Only applicable over Australia and surrounding countries, the **IMOS OceanCurrent** website is really useful for a quick-look at SST, ocean current and ocean colour conditions http://oceancurrent.imos.org.au/
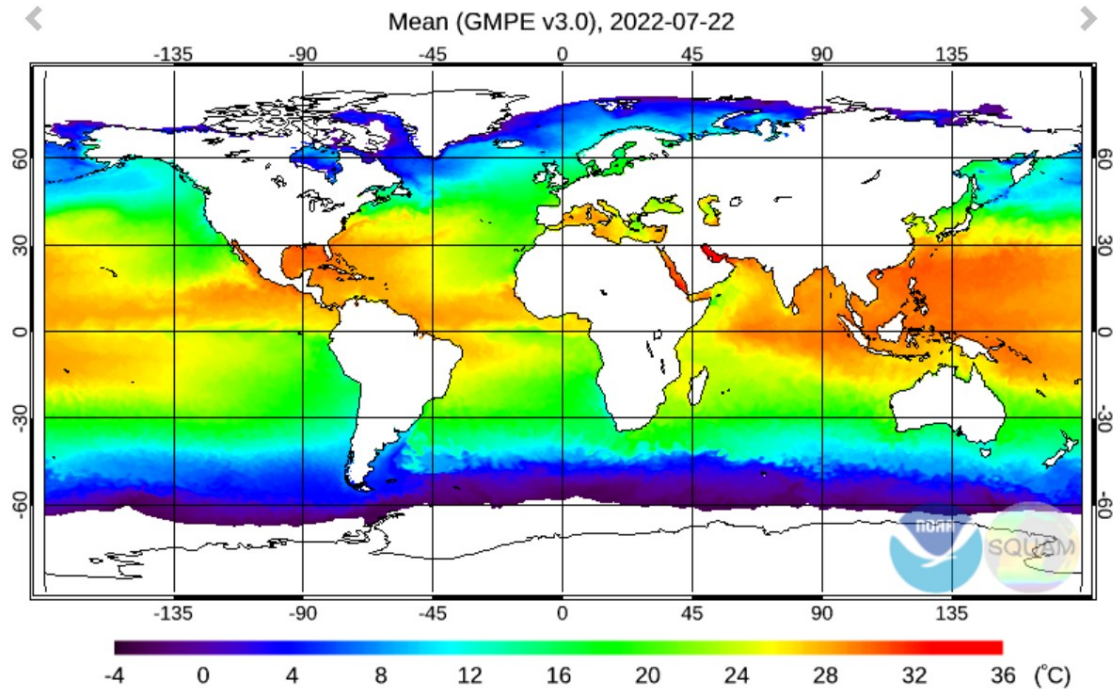
Figure 1: SST map over the global domain of the GHRSST daily 0.25 degree Multi-Product Ensemble (GMPE). YouSource: NOAA/NESDIS/STAR SQUAM L4 website at https://www.star.nesdis.noaa.gov/socd/sst/squam/analysis/l4

Tools for validation of SST products in near real time

- EUMETSAT L2P: http://metis.eumetsat.int/sst
- JAXA AMSR-2 L2P: https://suzaku.eorc.jaxa.jp/cgi-bin/gcomw/validation/gcomw_validation_ssti1.cgi
- GMPE validation tool: GMPE is the ensemble median of all the GHRSST products https://ghrsst-pp.metoffice.gov.uk/ostia-website/gmpe-monitoring.html
- NOAA/NESDIS SQUAM L2P/L3U/L4: SST Quality Monitor 2.1: http://www.star.nesdis.noaa.gov/sod/sst/squam
- NOAA/NESDIS iQUAM: in situ SST Quality Monitor v2.10: https://www.star.nesdis.noaa.gov/socd/sst/iquam/
- UK Met Office L4 validation: https://ghrsst-pp.metoffice.gov.uk/ostia-website/gmpe-argo-stats.html

How and where to get GHRSST formatted products

GHRSST formatted products are provided distributed through the Global Data Assembly Center (GDAC) and Long Term Stewardship and Reanalysis Facility (LTSRF), for current and historical data, respectively.

GHRSST Global Data Assembly Center (GDAC): https://podaac.jpl.nasa.gov/ghrsst is located at NASA's Physical Oceanography Distributed Active Archive Center (PO.DAAC), and it serves as the near real time clearinghouse for all GHRSST data sets. Here all near real time data can be accessed. The GDAC provides services and tools for accessing all data products, including HTTP, and OPeNDAP. *Since 2021 PO.DAAC is in the process of migrating its data archive to the Earthdata Cloud, hosted in Amazon Web Services (AWS). During this transition, some data will continue to be available from the on premise archive, while some data will also be available from and within the Earthdata Cloud https://podaac.jpl.nasa.gov/cloud-datasets/migration*

After 30 days, the data are sent to the GHRSST Long Term Stewardship and Reanalysis Facility (LTSRF) at the NOAA National Oceanographic Data Center (NODC), for permanent archive. The LTSRF routinely ingests, formally archives, and provides access to, all GHRSST formatted products: https://www.ncei.noaa.gov/access/ghrsst-long-term-stewardship-and-reanalysis-facility

A large metadata transformation process to international standards is also completed at the LTSRF, where robust FGDC and ISO 19115-2 geospatial metadata records are maintained and provided to users. The LTSRF provides both the GHRSST long-term archive and forms the central hub of the distributed GHRSST re-analysis (RAN) system.
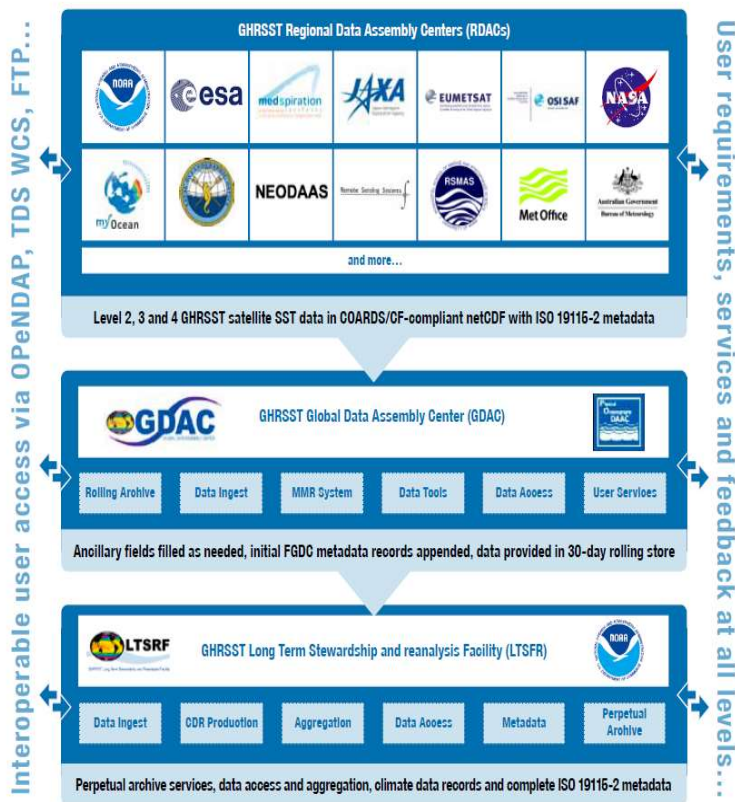

Figure 2: Overview of the Regional Data Assembly Centers producing GHRSST data.

Additional access mechanisms include:

- A THREDDS Data Server providing OGC Web Mapping Service (WMS) and Web Coverage Service (WCS), https://thredds.jpl.nasa.gov/thredds/catalog.html and
- An online analysis, visualization, and sub-setting service based on the Live Access Server (LAS), the PO.DAAC LAS service, found at https://podaac.jpl.nasa.gov/dataaccess (2nd row, 1st option). Direct link: https://podaac-tools.jpl.nasa.gov/las/UI.vm
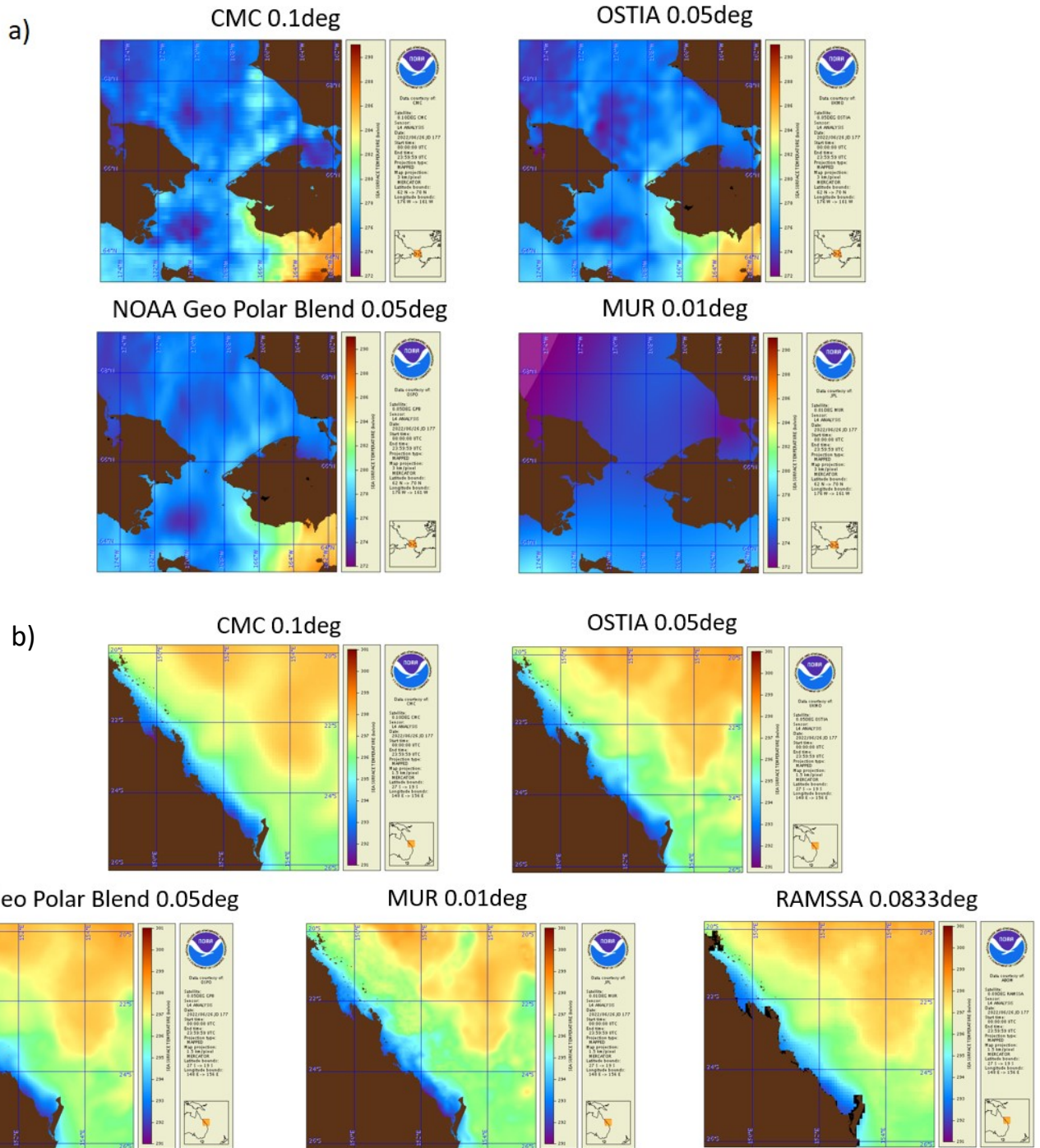
Figure 3: Comparison a) Four high-res L4 SSTs plotted over Bering Strait on 26 June 2022 show significant differences; b) Five high-res L4 SSTs plotted over southern Great Barrier Reef and EAC on 26 June 2022 show lesser differences. Source: https://www.star.nesdis.noaa.gov/socd/sst/arms (Courtesy of H. Beggs)

More resources for you

Beggs, H. (2021). Temperature. Ch. 14 in Earth Observation: Data, Processing and Applications. Volume 3B—Surface Waters. CRCSI, Melbourne. pp. 245–279. ISBN 978-0-6482278-5-4.

Beggs, H. (2010). Use of TIR from Space in Operational Systems, In: Oceanography from Space Revisited. (Eds: V. Barale, J.F.R. Gower and L. Alberotanza). Springer Science+Business Media B.V. pp. 249–271. doi:10.1007/978-90-481-8681-5. https://www.researchgate.net/publication/259823623_Use_of_TIR_from_Space_in_Operational_Systems

Beggs et al. (2018) Beggs, H., Griffin, C., Govekar, P., Majewski, L., Qi, L., and Zhong, A. (2018b). Which IMOS GHRSST product should I use? Presented at the IMOS Data Workshop, Adelaide, Australia, 6 July 2018. http://imos.org.au/fileadmin/user_upload/shared/SRS/SST/IMOS_Data_Workshop-SST-Beggs_08Jul2018.pdf

Dash, P., Ignatov, A., Martin, M., Donlon, C., Brasnett, B., Reynolds, R., Banzon, V., Beggs, H., May, D., McKenzie, B., Cayula, J-F., Chao, Y., Grumbine, R., Maturi, E., Harris, A., Mittaz, J., Sapper, J., Chin, T., Vazquez, J., Armstrong, E., Gentemann, C., Cummings, J., Piolle, J-F., Autret, E., Roberts-Jones, J., Ishizaki, S., Hoyer, J., and Poulter, D. (2012). Group for High Resolution SST (GHRSST) Analysis Fields Inter-Comparisons Part 2. Near real-time web-based Level 4 SST Quality Monitor (L4-SQUAM). Deep Sea Research II, 77–80, 31–43.

Donlon, C., Casey, K., Robinson, I., Gentemann, C., Reynolds, R., Barton, I., Arino, O., Stark, J., Rayner, N., Le Borgne, P., Poulter, D., Vazquez-Cuervo, J., Armstrong, E., Beggs, H., Llewellyn-Jones, D., Minnett, P., Merchant, C., and Evans, R. (2009). The GODAE High-Resolution Sea Surface Temperature Pilot Project. Oceanography, 22, 34–45.

Fiedler, E.K., McLaren, A., Banzon, V., Brasmett, B., Ishizaki, S., Kennedy, J., Rayner, N., Roberts-Jones, J., Corlett, G., Merchant, C.J., and Donlon, C. (2019). Intercomparison of long-term sea surface temperature analyses using the GHRSST Multi- Product Ensemble (GMPE) system. Remote Sensing of Environment, 222

Merchant, C.J., Minnett, P.J., Beggs, H., Corlett, G., Gentemann, C., Harris, A.R., Hoyer, J., and Maturi, E.. (2019a). Global Sea Surface Temperature, In: Taking the Temperature of the Earth. Steps towards integrated understanding of variability and change (Eds: Glynn Hulley and Darren Ghent). P. 5–55. Elsevier. https://doi.org/10.1016/B978-0-12-814458-9.00002-2

O'Carroll, A.G., Armstrong, E.M., Beggs, H., Bouali, M., Casey, K.S., Corlett, G.K., Dash, P., Donlon, C.J., Gentemann, C.L., Hoyer, J.L., Ignatov, A., Kabobah, K., Kachi, M., Kurihara, Y., Karagali, I., Maturi, E., Merchant, C.J., Minnett, P., Pennybacker, M. Ramakrishnan, B., Ramsankaran, R., Santoleri, R., Sunder, S., Saux Picart, S., Vazquez-Cuervo, J., and Wimmer, W. (2019). Observational needs of sea surface temperature. Frontiers in Marine Science, 6, 420. https://doi.org/10.3389/fmars.2019.00420

The Group for High Resolution Sea Surface Temperature Science Team, Piollé, Jean-François, Armstrong, Ed, Casey, Kenneth, & Donlon, Craig. (2022). The Recommended GHRSST Data Specification (GDS) (GDS 2.1 revision 0). Zenodo. https://doi.org/10.5281/zenodo.6984989 https://zenodo.org/record/6984989#.Y9je5XaZNnI

Rayner, N., Good, S., Block, T., P. Evadzi, P., and Embury, O. (2019). SST-CCI-Phase-II SST CCI Product User Guide Issue 2, European Space Agency, 115 p. https://climate.esa.int/media/documents/SST_cci_PUG_v2.pdf

Yang, C., Leonelli, F.E., Marullo, S., Artale, V., Beggs, H., Nardelli, B.B., Chin, T.M., De Toma, V., Good, S., Huang, B., Merchant, C.J., Sakurai, T., Santoleri, R., Vazquez-Cuervo, J., Zhang, H.-M., and Pisano, A. (2021). Sea Surface Temperature intercomparison in the framework of the Copernicus Climate Change Service (C3S). Journal of Climate, 33(13), 5257–5283. https://doi.org/10.1175/JCLI-D-20-0793.1