April 3, 2025

A Community Request on behalf of the CEOS Sea Surface Temperature (SST) and Coastal Observations, Applications, Services and Tools (COAST) Virtual Constellations supported by the GHRSST Science Team on the Proposed Coverage of Future Missions including the NASA Surface Biology Geology Mission for Coastal Ocean Observations

Members of the Committee of Earth Observation Satellites (CEOS) Sea Surface Temperature (SST) and Coastal Observations, Applications, Services and Tools (COAST) Virtual Constellations have noted the requirement of consistent ultra high resolution SST observations in the coastal zone where SST is a vital tracer of sub-mesoscale physical phenomena. Coastal hydrodynamic model validation and assimilation also require ultra high satellite-derived SST from several sources to be presented in a consistent manner with respect to spatial extent. Several science team members within the Group for High Resolution Sea Surface Temperature (GHRSST) Science Team also participate in related CEOS entities including the CEOS SST and the CEOS COAST Virtual Constellations (VCs). The GHRSST Project was established 25 years ago to promote state-of-the-art SST datasets built on community interoperability principles, product standardization (GHRSST Data Specification - GDS), and best practices for SST retrievals and data uncertainty.

An emerging focus and interest area of the CEOS VCs and GHRSST are the advent of ultra high resolution (<100 meter) SST retrievals from existing and future planned thermal infrared (IR) radiometer missions including NASA’s ECOsystem Spaceborne Thermal Radiometer Experiment on Space Station (ECOSTRESS) deployed in 2018, the joint CNES/ISRO Thermal infraRed Imaging Satellite for High-resolution Natural resource Assessment (TRISHNA) to be launched in 2026, and ESA’s Land Surface Temperature Monitoring (LSTM) to be launched in 2028. Also of high interest are the ocean observing capabilities of the emerging NASA Surface Biology Geology (SBG) mission with the Thermal Infrared (TIR) instrument having a 60 meter spatial resolution and a 935 km swath. Recent documentation has the launch date of this part of the SBG mission in 2028.

These novel ultra high resolution IR measurements will certainly open a new era of SST observations and remotely sensed coastal oceanography as they are nearly an order of magnitude improvement over the typical “750-1100 meter” observations from traditional thermal IR sensors such as VIIRS, MODIS, SLSTR, AVHRR, METimage etc. JAXA's

Global Change Observation Mission - Climate (GCOM-C) launched in 2017 has IR observation with 250 meter resolution for coastal areas in a wide range (max 700 km from the coast) and bridges traditional thermal IR sensors and novel ultra high resolution IR measurements. From ECOSTRESS, results have shown large improvements in resolving coastal sub-mesoscale eddies and filaments, tidal signatures, and other phenomena not previously possible via thermal IR remote sensing. The ultra high resolution observations will also be critical for resolving the air-sea coupling in coastal regions where these eddies, filaments and fronts dominate.

The spatial resolution of observation is a key factor but also the size of the area is extremely important so that synoptic ocean observations can be made. All the ultra high resolution sensors have limitations on the quantity of ocean observations obtained as their designed focus has primarily been on land phenomena and telemetry bandwidth requirements preclude total global ocean coverage.

However, SBG-TIR stands in noteworthy contrast to the other three sensors in the reduced quantity of high resolution observations in very significant coastal areas (see Figure 1). In this typical example, SBG would miss the predominant coastal variability signatures of eddies and filaments off the west coast of North America, and its existing proposed global coverage map has similar “gaps” for many of the world's dynamic upwelling and western boundary current regions.

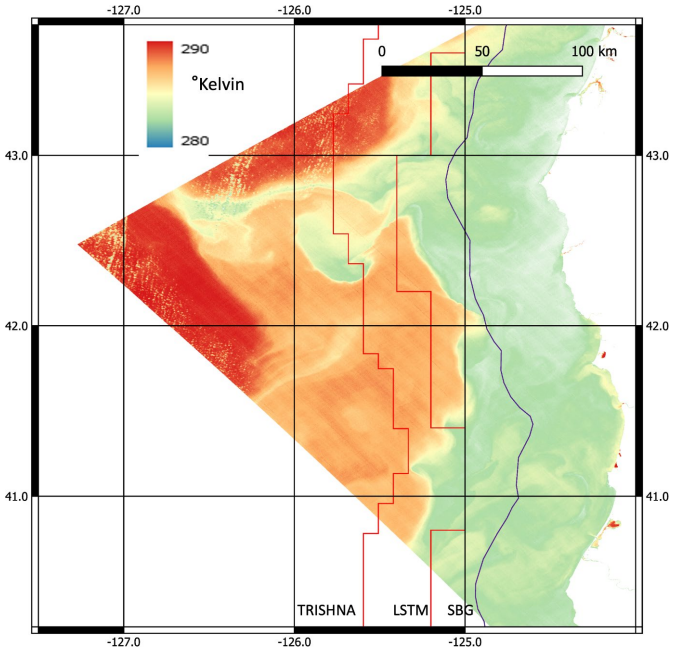

Figure 1. SST image from ECOSTRESS on 2021-09-01 with the proposed ocean observation boundaries from TRISHNA (orange line), LSTM (red line), and NASA’s SBG-TIR (purple line) overlaid. SBG would miss the thermal fronts, eddies and filaments observable from the other sensors.

Discussion at the 2024 SIT Technical Workshop (September 2024 at Sydney, Australia) suggested the original 100 km from coast recommendation, a 'one-size-fits-all approach', may fail to fully consider various coastal user needs and lack scientific justification. After the workshop, at the urging of the CEOS membership and to ensure the coastal coverage distance recommendation is science-based, CEOS SST and COAST VC's convened a series of discussions and six teleconferences during the period from November 21, 2024 to March 5, 2025, and invited subject matter experts (Appendix A) to advise on this topic. Consensus agreement captured six coastal features for which ongoing scientific research demands ultra high resolution SST data (details are available in Appendix B and C). Figure 2 depicts the recommended spatial coverage distances on a global map and Table 1 presents these six features, the recommended coverage distances from the nearest shore, and seasonal sampling optimization for a few features (as applicable). The revised coastal coverage recommendations in Table 1 now capture coastal areas where temperature dynamics might especially influence ecology, biogeochemical, and physical processes; or where coastal high resolution models require ultra-high resolution SST inputs.

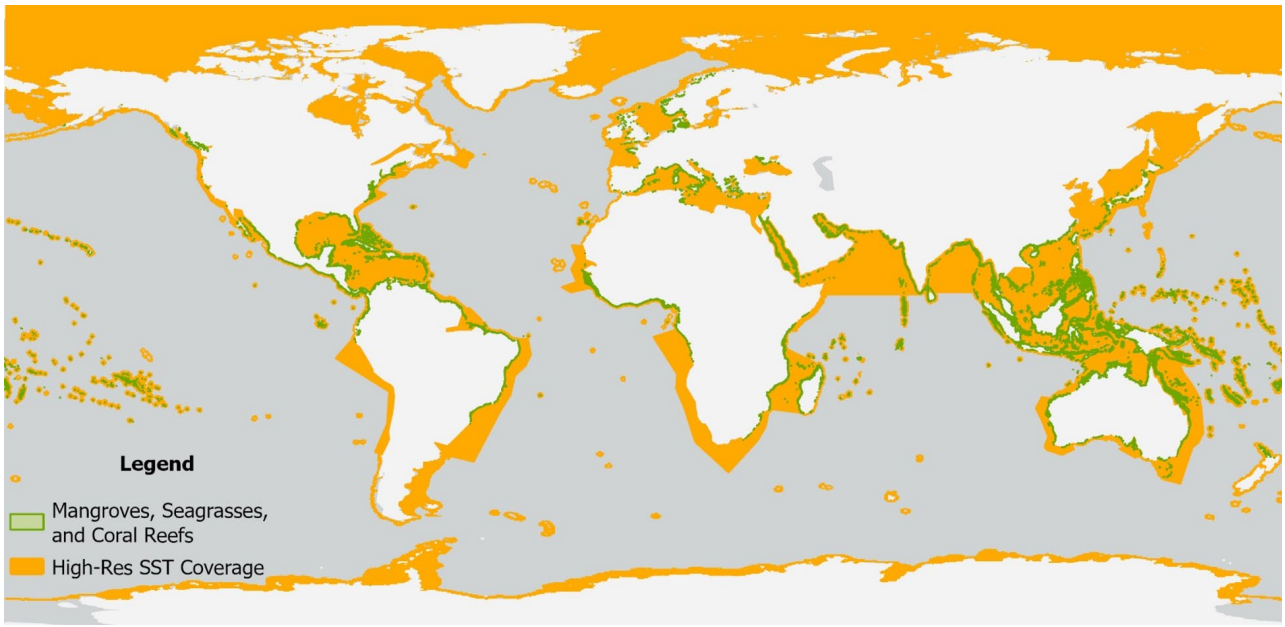

Figure 2. Composite CEOS Global coverage mask areas recommendation for Ultra Hi Resolution SST.

Table 1 Summary recommendations from the CEOS Subject matter expert panel listing six coastal features (underlined), offshore minimum coverage distances, and optimized seasonality of Ultra High Resolution SST data collection for the global ocean.

Feature	Distance from Shore (km)	Example Areas (respectively)	Data Collection Seasonality
Boundary Currents			
Eastern	350, 200, 225, 300, 250	Benguela, Canary, Humboldt, California, Leeuwin	Yes: widest in hemispheric summer/fall and narrowest in winter/early spring.
Western	100, 400, 300, 100, 300	Gulf Stream, Kuroshio, East Australia, Brazil, Agulhas	Yes: widest in hemispheric summer/fall and narrowest in winter/early spring.
Estuaries/River Mouth (major)	to reach of major boundary current	(many)	Yes: during the hemispheric wet season;
Meltwaters			
Hi Latitude	250		Yes: during hemispheric spring/summer
Himalayan	200		Yes: during N hemisphere spring/summer
Chronic Harmful Algal Bloom (HAB) Areas	350	West Florida Shelf, Arabian Sea, Baltic, Cape & Horn of Africa, Mediterranean, Mozambique Channel	Yes: during the start and end of known HAB seasons
Operational Hi Res Coastal Model Areas	100		No
Highly Productive Habitats			
Reefs	as needed to encompass	Great Barrier Reef (GBR), Caribbean islands, Maldives,	No, despite assumptions about high heat in summers it may be cooler season stressors that set up bleaching, thus yearlong data collection is justified
Seagrasses	as needed to encompass	GBR, Dutch Wadden Sea, Northern Australia, Madagascar, Bahamas and Florida Bay, Indonesia, English Channel	No
Mangroves	as needed to encompass	Sundarban, Indonesia, Northern Australia, Equatorial Africa, Gulf of Mexico/Caribbean,	No

We strongly encourage the CEOS members who plan future ultra high resolution TIR missions to provide the opportunity to obtain coastal SST in GHRSST format with enough coverage up to minimum 100 km from the coast, like TRISHNA. In addition, we strongly recommend future mission planners enable the coastal coverage distances for features listed in Table 1 and Figure 2, and based on the justifications detailed in the appendices herein. Following these recommendations will make data from emerging missions significantly more valuable and usable to the scientific coastal ocean community, and increase the likelihood of breakthrough science and improved information for decision making and societal benefits.

We look forward to your response.

For your urgent consideration,

[Signatures]

CEOS SST-VC Co-Leads

CEOS COAST-VC Co-Leads

GHRSST Chair

APPENDIX A: List of Invited SST Subject Matter Experts and VC co-leads

SST Subject Matter Expert	Affiliation
Amala Mahadevan	Woods Hole Oceanographic Institution
Andy Harris	University of Maryland
Anne O'Carroll	EUMETSAT
Aurelien Carbonniere	CNES, COAST-VC
Balaji Baduru	INCOIS
Bror Jonsson	University of New Hampshire
Christo Whittle	SANSA/CSIR (South Africa), SST-VC
David Wethey	University of South Carolina
Edward M. Armstrong	NASA
Elyse Bonner	NOAA CoastWatch
Emmanuelle Autret	IFREMER
Gang Liu	NOAA Coral Reef Watch
Jorge Vazquez	NASA
Misako Kachi	JAXA, SST-VC
Olafur Jonasson	Global Science and Technology/NOAA
Pallavi Govekar	Australian Bureau of Meteorology
Paul DiGiacomo	NOAA, COAST-VC
Peter Strobl	LSI-VC/EC-JRC
Pradeep Thapliyal	ISRO
Prasanjit Dash	University of Colorado
Rashmi Sharma	ISRO, COAST-VC
Ratheesh Ramakrishnan	ISRO
SeungHyun Son	University of Maryland
Sheekela Baker-Yeboah	NOAA
Steffen Dransfeld	ESA
Veronica P. Lance	NOAA CoastWatch

APPENDIX B: Table of Features and Recommended SST Coverage Areas

Feature	Distance from Shore (km)	Example areas (respectively)	Supporting Publications/Reference Files	Seasonality
Boundary Currents				
E	350, 200, 225, 300, 250	Benguela, Canary, Humboldt, California, Leeuwin	Fofonoff, N. P. "The Gulf Stream." Evolution of Physical Oceanography: scientific surveys in honor of Henry Stommel(1981): 112-139. ;Wang, Yuntao, Renato M. Castelao, and Yeping Yuan. "Seasonal variability of alongshore winds and sea surface temperature fronts in Eastern Boundary Current Systems." Journal of Geophysical Research: Oceans 120, no. 3 (2015): 2385-2400. Nürnberg, D., Kayode, A., Meier, K. J. F., and Karas, C.: Leeuwin Current dynamics over the last 60 kyr – relation to Australian ecosystem and Southern Ocean change, Clim. Past, 18, 2483–2507, https://doi.org/10.5194/cp-18-2483-2022, 2022; https://marinewaters.fish.wa.gov.au/mwwp/wp-content/uploads/2019/06/leeuwi n-current-poster.pdf	Yes: widest in hemispheric summer/fall and narrowest in winter/early spring.
W	100km S of Hatteras/400km off Labrador, 400, 300, 100, 300	Gulf Stream, Kuroshio, EAC, Brazil, Agulhas		Yes: widest in hemispheric summer/fall and narrowest in winter/early spring.
Estuaries mouths of major rivers	to reach of major current system	Rio de La Plata, Orange River (S Africa), Gulf of Ob (Russia), Tampa Bay, Mississippi, Chesapeake Bay, Bay of Bengal, Amazon, Pearl, Mekong, Yellow, Yangtze, Murray/Darling, Ganges (3), Thames, Yenisey (Russia), Danube, Seine, Rhine, Nile, Fraser, Columbia, San Francisco, Mackenzie-Peace, Parana, St Lawrence, Long Island Sound, Indian River Lagoon, Albemarle-Pamlico, Laguna Madre/Galveston Bay		Yes: during the hemispheric wet season;
Meltwaters				
hi lat	250			Yes: during hemispheric spring/summer
himalayan	200			Yes: during N hemisphere spring/summer
Chronic Hab Areas	350+	GOM/WFS, Arabian Sea, Baltic, Cape and horn of Africa, Med, Mozambique channel		Yes: during the start and end of known HAB seasons
Hi Res Coastal Models operational	100			No

Hi productivity Habitats				
Reefs	as needed	Great Barrier Reef, Caribbean islands, Maldives,		No, despite assumptions about high heat in summers it may be cooler season stressors that set up bleaching, thus yearlong data collection is justified
Seagrasses	as needed	GBR, Dutch Wadden Sea, Northern Australia, Madagascar, Bahamas and Florida Bay, Indonesia, English channel	https://data.unep-wcmc.org/pdfs/7/WCMC_013_014_Global_Distribution_of_Seagrasses.pdf?1617122071	No
Mangroves	as needed	Sundarban, Indonesia, Northern Australia, Equatorial Africa, Gulf of mexico/Caribbean,		No

Appendix C: Cumulative Discussion Notes

Cumulative meeting summaries