SST Climatology and Analysis Inter-Comparison Task Team Report

Helen Beggs[1], Chunxue Yang[2], Jorge Vazquez[3], Prasanjit Dash[4], Marouan Bouali[5], Xu Li[6] and the IC Task Team

[1]Bureau of Meteorology, Melbourne, Australia

[2]ISMAR, Roma, Italy

[3]NASA/JPL, Pasadena, USA

[4]NOAA/NESDIS/STAR, College Park, MD, USA

[5]IOUSP, Brazil

[6]NOAA/NCEP, USA

22nd GHRSST Science Team Meeting, On-line, 7th – 11th June 2021

Tasks

Task 1: Inter-comparison of SST analyses for climate studies (led by Chunxue Yang, CNR/ISMAR) *(Completed)*

1.1: Peer-reviewed paper published comparing various long-term SST analyses for climate applications. *(Completed. Published April 2021 in J. Climate)*

Task 2: Understand differences among the SST analysis products and find ways to improve these products (led by Xu Li, NOAA/NCEP) *(Ongoing)*

Task 3: Feature inter-comparison of SST analyses (led by Jorge Vazquez, NASA/JPL) *(Ongoing)*

Task 1

Aims: To perform various diagnostics on a range of publicly available, global sea surface temperature (SST) analyses, in order to provide guidance for users on the application of long-term SST analyses for climate studies and climate applications.

- A contribution to the **Independent Assessment of Essential Climate Variables (C3S_511) Project** for the Copernicus Climate Change Service (C3S) – *Project closing 30 June 2021. Plans for intercomparison activities under next phase of C3S TBD.*

Progress since GHRSST-XXII:

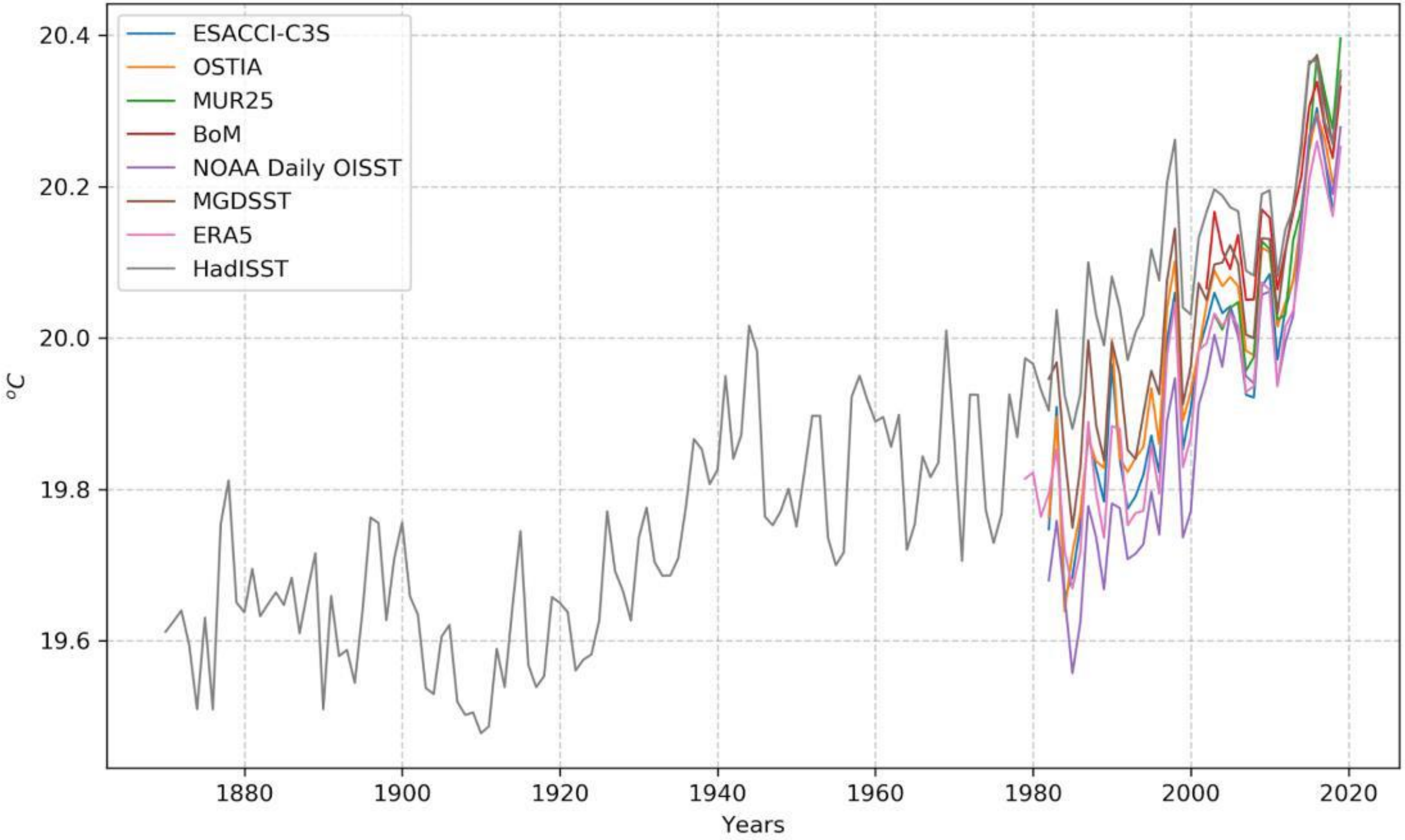
- Switched to using Multi-Product ***Median*** (was previously ***Mean***) SST
- NOAA/NCEI DOISSTv2.0 (1981-2015) and DOISSTv2.1 (2016-present) replaced NOAA/NCEP OISSTv2 in study (https://www.ncdc.noaa.gov/oisst)
- CMEMS OSTIA-based Reprocessed SST Analysis (1981-2018) added to study (https://resources.marine.copernicus.eu)
- Yang et al. (2021) Sea Surface Temperature intercomparison in the framework of the Copernicus Climate Change Service (C3S), *J. Climate* (https://doi.org/10.1175/JCLI-D-20-0793.1)

Climate
Change

Global monthly mean SST

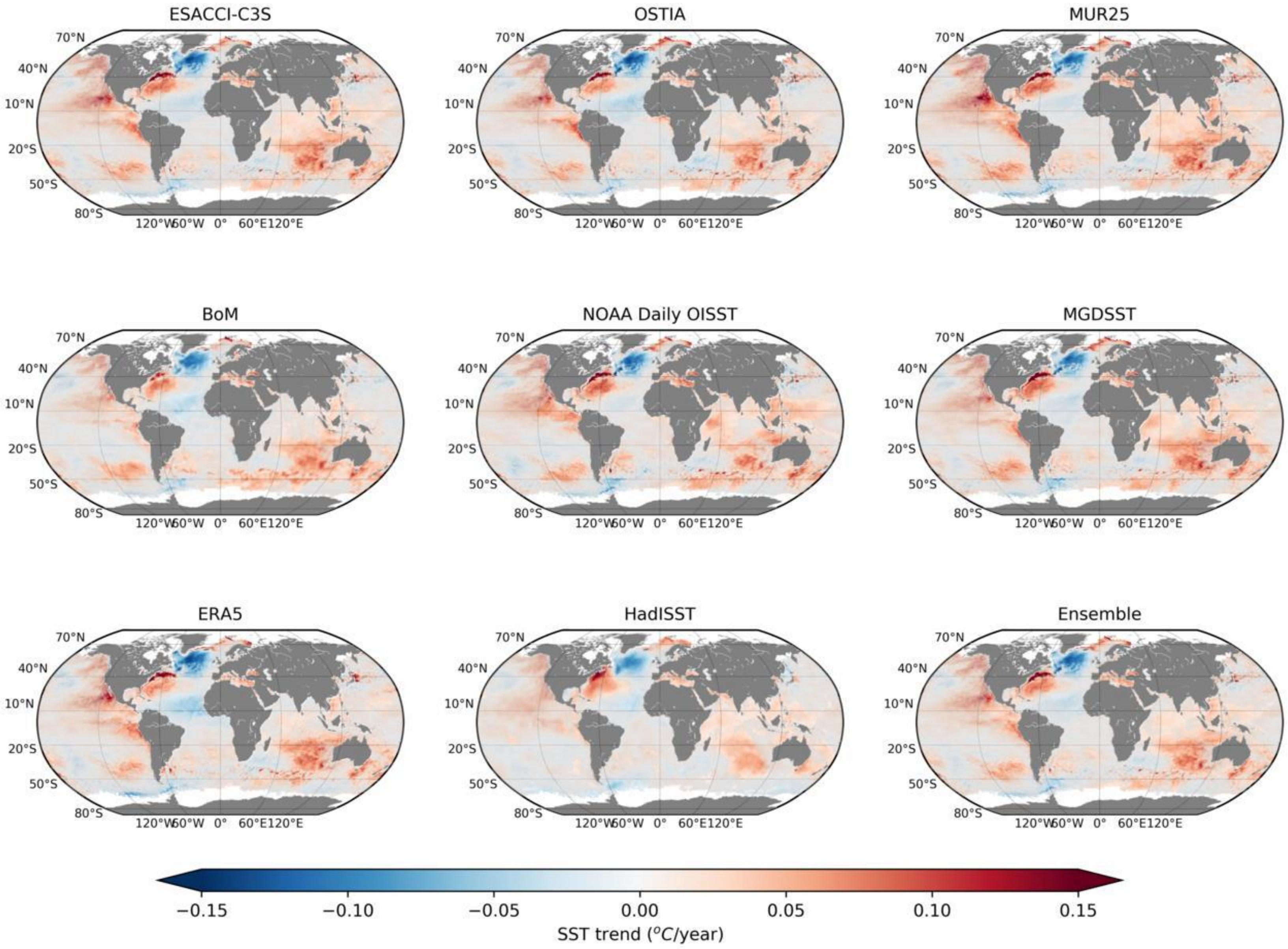
CNR ISMAR
ISTITUTO DI SCIENZE

Yang et al. (2021) *J. Climate* (https://doi.org/10.1175/JCLI-D-20-0793.1)



Climate
Change

Linear trends of global SST for the period 2003-2018



Task 2

Aims: Understand differences among the L4 products and then find out the possible ways to improve L4 products.

Contact: Xu.Li@noaa.gov if you would like to join this task.

2.1: For 1 – 10 May 2020, for various operational SST analyses (NCEP NSST, GAMSSA, OSTIA, CMC) compare the total number of available drifting buoy SST observations with the number that pass the pre-processing tests before the analysis and the number that pass the tests after the analysis. *(Completed. Reported at G-XXI)*

2.2: Understand the contribution of all types of in-situ SST data (drifting and moored buoys, ships, Argo floats, etc) used in operational SST analyses. Investigate the way in-situ data are used (directly assimilated, quality control or bias correction of satellite data, etc). *(No progress since G-XXI)*

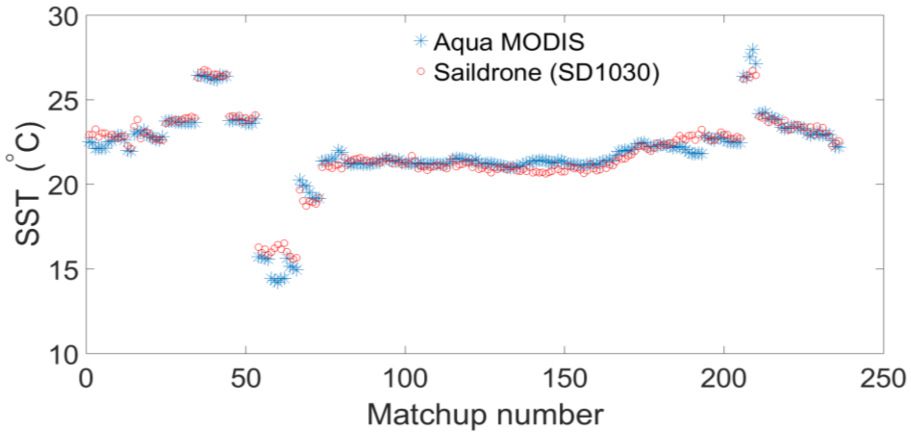
Task 3.1

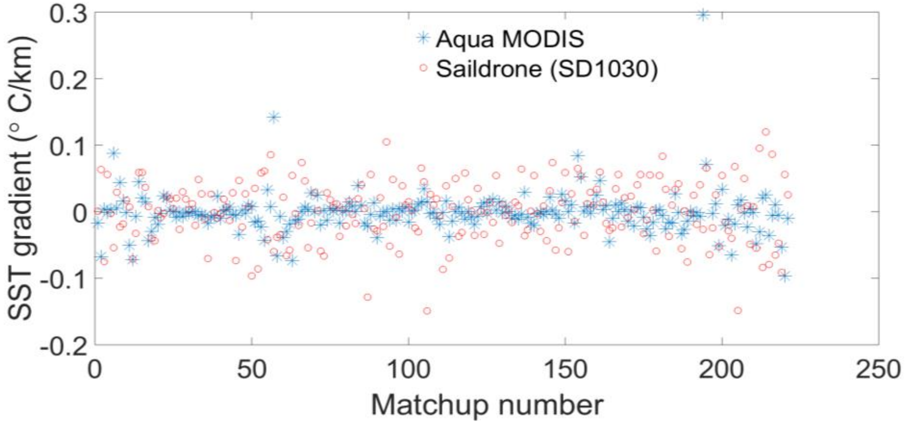
Aim: Validate L2, L3 and L4 SST gradients in highly variable regions using SailDrone SST data

Ongoing:

- Following a similar methodology to that used for Level 4 datasets (*see Jorge Vazquez' poster S1-ID-006*), a new approach was developed for Level 2 SST products
- Preliminary results compare SST gradients from Terra/Aqua MODIS and SNPP VIIRS with those derived from Saildrone campaigns (SD1030 and SD1053) from the Atlantic to Mediterranean (October 18, 2019 to July 17, 2020). (*See Marouan Bouali's poster S3-ID-032*)
- Future work will use similar approach with additional Saildrone campaigns over regions with low cloud coverage

Saildrone SD1030 Atlantic-Mediterrenean mission (Oct 18, 2019- Jul 17, 2020)





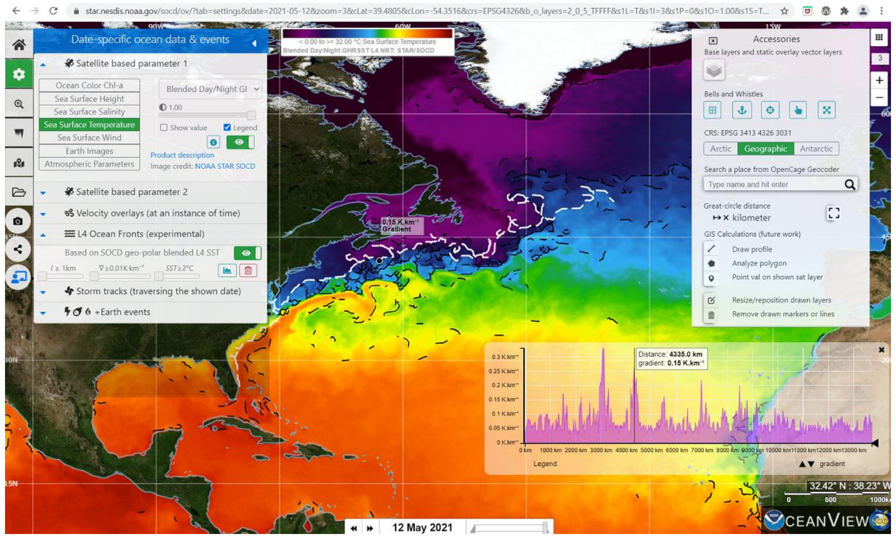
	Bias	Correlation	RMSE
SST	-0.019	0.976	0.48
∇SST	--	0.079	0.05

Task 3.2

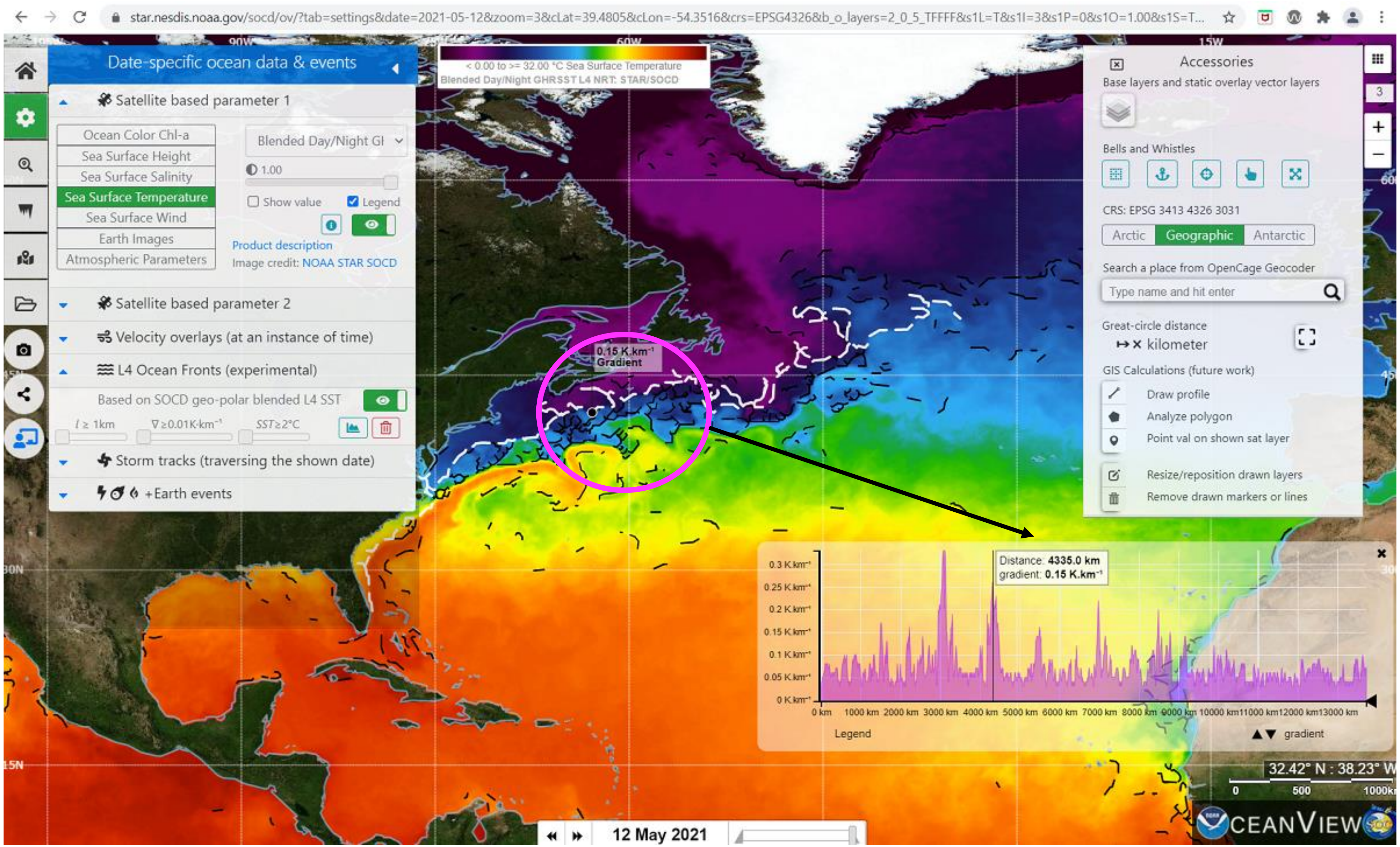
Aim: Produce an online visualisation tool for L4 SST gradients

Ongoing:

- First version of NOAA STAR SOCD's OceanView (OV) completed and public: **https://www.star.nesdis.noaa.gov/socd/ov/** (*See Prasanjit Dash's poster S2-ID-041*)
- OV displays the location of SST fronts derived from SOCD Geo-Polar blended Level 4 SST, according to user specifications
- Characteristics of detected fronts such as average SST gradient magnitude and length are available and can be used to filter the displayed fronts.
- OV also includes a profiler to see the value of SST gradients along a given front



Task 3.2


star.nesdis.noaa.gov/socd/ov/?tab=settings&date=2021-05-12&zoom=3&cLat=39.4805&cLon=-54.3516&crs=EPSG4326&b_o_layers=2_0_5_TFFFF&s1L=T&s1I=3&s1P=0&s1O=1.00&s1S=T...
Date-specific ocean data & events
Satellite based parameter 1
Ocean Color Chl-a
Sea Surface Height
Sea Surface Salinity
Sea Surface Temperature
Sea Surface Wind
Earth Images
Atmospheric Parameters
Blended Day/Night Gl
1.00
Show value
Legend
Product description
Image credit: NOAA STAR SOCD
Satellite based parameter 2
Velocity overlays (at an instance of time)
L4 Ocean Fronts (experimental)
Based on SOCD geo-polar blended L4 SST
Storm tracks (traversing the shown date)
+Earth events
< 0.00 to >= 32.00 °C Sea Surface Temperature
Blended Day/Night GHRSST L4 NRT: STAR/SOCD
0.15 K.km⁻¹
Gradient
Accessories
Base layers and static overlay vector layers
Bells and Whistles
CRS: EPSG 3413 4326 3031
Arctic
Geographic
Antarctic
Search a place from OpenCage Geocoder
Type name and hit enter
Great-circle distance
kilometer
GIS Calculations (future work)
Draw profile
Analyze polygon
Point val on shown sat layer
Resize/reposition drawn layers
Remove drawn markers or lines
Distance: 4335.0 km
gradient: 0.15 K.km⁻¹
Legend
gradient
32.42° N : 38.23° W
12 May 2021
OCEANVIEW

Task 3.3

Aim: Develop the science to calculate SST fronts and intercompare

Ongoing:

- Currently, OceanView includes NOAA's SOCD Geo-Polar Blended L4 SST with a module that displays corresponding SST fronts and their characteristics
- In the current version of OV, the detection of fronts is based on a Sobel filter
- Include other L4 datasets in OV (CMC, OSTIA and others) to allow visual comparison of SST fronts
- Improve the detection of SST fronts by exploring other techniques
- Continue the comparison of SST gradients from several GHRSST L4 products with each other and with those derived from Saildrone campaigns (see Vazquez et al. 2020*****)

Validation statistics of SST and derived gradients for several GHRSST Level 4 products using the Saildrone campaigns of Baja California (left) and the North Atlantic Gulf Stream (right)

–	–	Bias	RMSE	Correlation
CMC	SST	-0.074	0.417	0.975
	|∇SST|	-0.009	0.022	0.315
K10	SST	0.137	0.475	0.969
	|∇SST|	-0.007	0.022	0.293
REMSS	SST	0.075	0.401	0.977
	|∇SST|	-0.007	0.023	0.243
OSTIA	SST	0.022	0.365	0.980
	|∇SST|	-0.008	0.022	0.306
DMI	SST	0.040	0.489	0.966
	|∇SST|	-0.008	0.023	0.255
MUR	SST	0.285	0.500	0.975
	|∇SST|	-0.003	0.021	0.395

–	–	Bias	RMSE	Correlation
CMC	SST	-0.350	1.310	0.962
	|∇SST|	-0.012	0.054	0.374
K10	SST	-0.688	1.928	0.917
	|∇SST|	-0.009	0.062	0.072
REMSS	SST	-0.085	0.962	0.977
	|∇SST|	-0.016	0.055	0.342
OSTIA	SST	-0.209	1.185	0.968
	|∇SST|	-0.012	0.053	0.371
DMI	SST	0.002	1.401	0.951
	|∇SST|	-0.017	0.058	0.210
MUR	SST	-0.051	1.057	0.975
	|∇SST|	-0.010	0.054	0.321

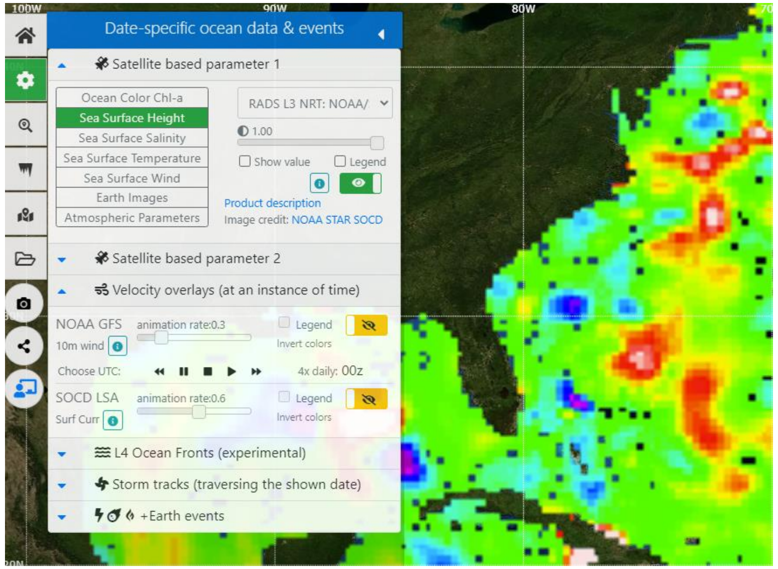
**** Vazquez-Cuervo, J.; Gomez-Valdes, J.; Bouali, M. Comparison of Satellite-Derived Sea Surface Temperature and Sea Surface Salinity Gradients Using the Saildrone California/Baja and North Atlantic Gulf Stream Deployments. Remote Sens. 2020, 12, 1839. https://doi.org/10.3390/rs12111839***

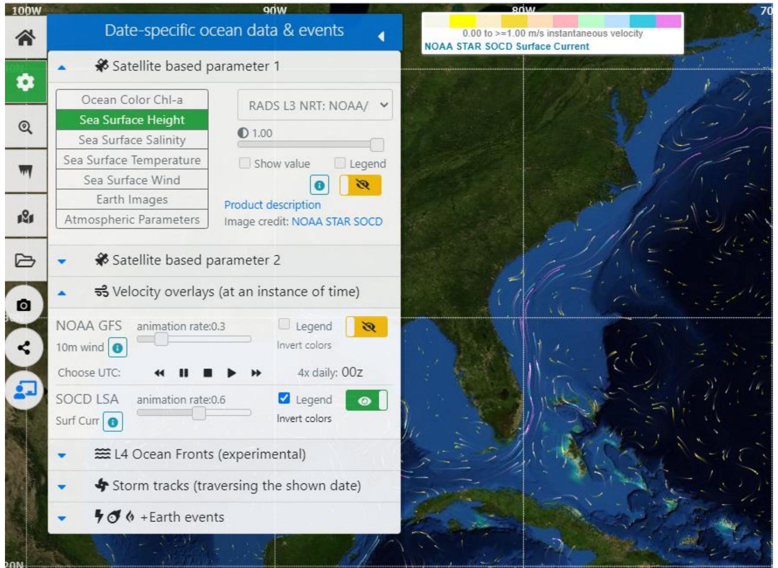
Task 3.4

Aim: Validate SST gradients/fronts with other independent but related data, e.g., sea surface salinity gradients or altimeter derived currents

Ongoing:

- OceanView currently includes visualision of other ocean parameters such as
  - Sea Surface Salinity: L3 SMAP/SMOS
  - Ocean Color Chl-a: DINEOF NRT, N20/SNPP blended, CMEMS L4
  - Sea Surface Height: NOAA SOCD RADS LSA
  - Ocean Surface currents: NOAA SOCD RADS LSA
- The methodology to compare the properties of SST fronts with other ocean variables will evolve depending on available literature and new ideas from the ocean community





Task 3.5

Aim: Compare feature resolution of various SST analyses

Ongoing:

- Explore methodologies other than spectral analysis to define a “resolution” metric in the spatial domain

Future work:

- Test the metric on several GHRSST L4 products over a limited dataset manually/visually selected to contain small scale ocean features (meanders, eddies, vortex...)
- Assess the ability of such a metric to determine automatically which L4 product is better at preserving the resolution of ocean features observed at Level 2

Questions for discussion

Task 1: Under Phase 2 of C3S, how could we contribute to the further inter-comparison of SST analyses for climate studies?

Would it be possible to compare SST gradients over the interannual time scales for the different L4 products?

Task 2: Who can commit time to contributing to T2.2: "Understand the contribution of all types of in-situ SST data (drifting and moored buoys, ships, Argo floats, etc) used in operational SST analyses"?

Proposed new tasks:

T2.3: Impact of COVID on number of in-situ data ingested into operational L4 over past 12 months.

T2.4: Decrease in number of ship data due to TAC to BUFR format transition.

T2.5: Compare different methods for generating L4 background fields, important in data poor areas?

Task 3: Would it be possible to incorporate Saildrone into iQuam?

If interested in contributing to the IC-TT, please contact:

helen.beggs@bom.gov.au and chunxue.yang@artov.ismar.cnr.it

SST Climatology and L4 IC Task Team Members

Task Team Co-Chairs: Helen Beggs (BoM, Australia) and Chunxue Yang (ISMAR, CNR, Italy)

CNR/ISMAR (Italy): Andrea Pisano, Francesca Elisa Leonelli, Bruno Buongiorno Nardelli, Rosalia Santoleri

ENEA (Italy): Salvatore Marullo, Vincenzo De Toma, Vincenzo Artale

NASA/JPL (USA): Toshio (Mike) Chin, Jorge Vazquez

Uni. of Reading (UK): Owen Embury, Jon Mittaz, Christopher Merchant

Met Office (UK): John Kennedy, Simon Good, Chongyuan Mao

JMA (Japan): Toshiyuki Sakurai

NOAA/NESDIS/NCEI (USA): Boyin Huang, Huai-min Zhang, Chunying Liu

NOAA/NESDIS/STAR (USA): Alexander Ignatov, Eileen Maturi, Andy Harris, Prasanjit Dash

NOAA/NCEP (USA): Xu Li

IOUSP (Brazil): Marouan Bouali

CMC (Canada): Dorina Surcel Colan

WHOI (USA): Robert Schlegel

Additional Slides for Discussion

New OSTIA-based SST Reanalyses

(Simon Good, Mark Worsfold, UK Met Office)

- CMEMS reprocessed SST analysis based on Met Office OSTIA configuration: provides foundation SST and uses the latest OSTIA configuration, covering 1 Oct 1981 to June 2020, updated every 6 months https://resources.marine.copernicus.eu/?option=com_csw&task=results?option=com_csw&view=details&product_id=SST_GLO_SST_L4_REP_OBSERVATIONS_010_011

- ESA SST CCI and C3S reprocessed analysis: provides SST at 20 cm depth, covering 1 Sep 1981 to Feb 2021, updated daily to be 28 days behind present https://cds.climate.copernicus.eu/cdsapp#!/dataset/satellite-sea-surface-temperature?tab=form
- Both products used reprocessed satellite observations from the ESA SST CCI project.
- See Mark Worsfold's poster S5-ID-002

Climate Change

SST Analysis Datasets Description

CNR ISMAR
ISTITUTO DI SCIENZE MARINE

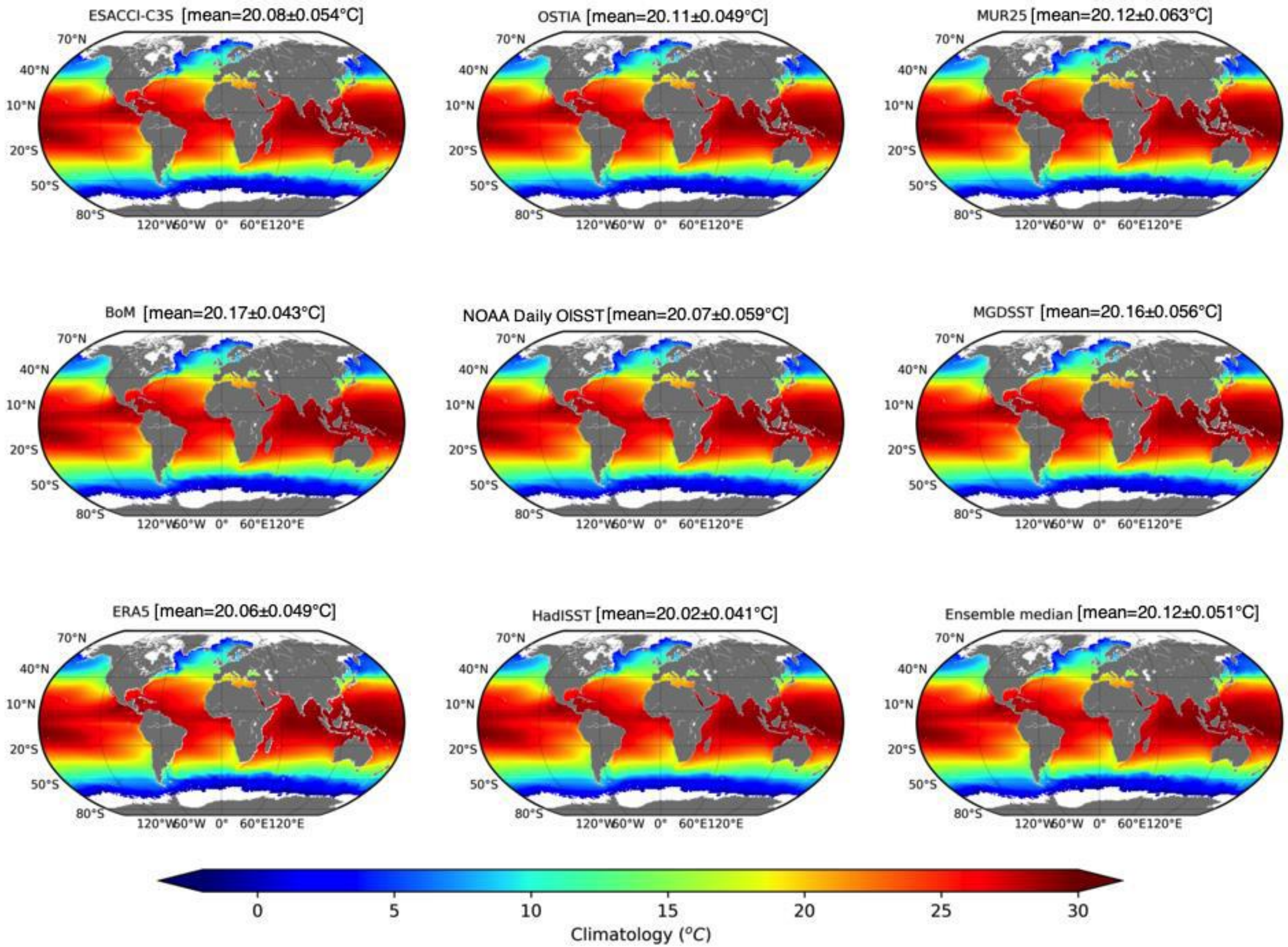
Dataset	Institution	Time Range	Observation input	Type of SST	Horizontal Grid spacing	Temporal resolution	Main Reference
ESA CCI SST (v2.0)	UK Met Office	1981-2018	IR	SST at 0.2 m	global 0.05°x0.05°	daily	Merchant et al. (2019)
ERA5	ECMWF	1979-2018	IR + MW + in situ	SSTdepth	global 0.25°x0.25°	hourly	Hirahara et al. (2016)
HadISST1	UK Met Office	1870-2018	IR + in situ	SSTdepth	global 1°x1°	monthly	Rayner et al. (2003)
NOAA Daily OISST (v2.1)	NOAA	1981-2018	IR + in situ	SST at 0.2 m	global 0.25°x0.25°	daily	Huang et al. (2020)
MUR25 (v4.2)	JPL PO.DAAC	2003-2018	IR + MW + in situ	Foundation SST	global 0.25°x0.25°	daily	Chin et al. (2017)
MGDSST	Japanese Met. Agency (JMA)	1982-2018	IR + MW + in situ	Foundation SST	global 0.25°x0.25°	daily	Sakurai et al. (2005)
BoM Monthly SST	Australian Bureau of Met. (BoM)	2001-2018	IR + in situ	SST at 0.2 m	global 1°x1° (weekly/monthly)	weekly and monthly	Smith et al. (1999)
CMEMS OSTIA	UK Met Office	1981-2018	IR + MW + in situ	Foundation SST	0.05°x0.05°	daily	Good et al. (2020)

ECMWF Copernicus Europe's eyes on Earth European Commission

Climate Change

Global SST climatology from 2003-2018

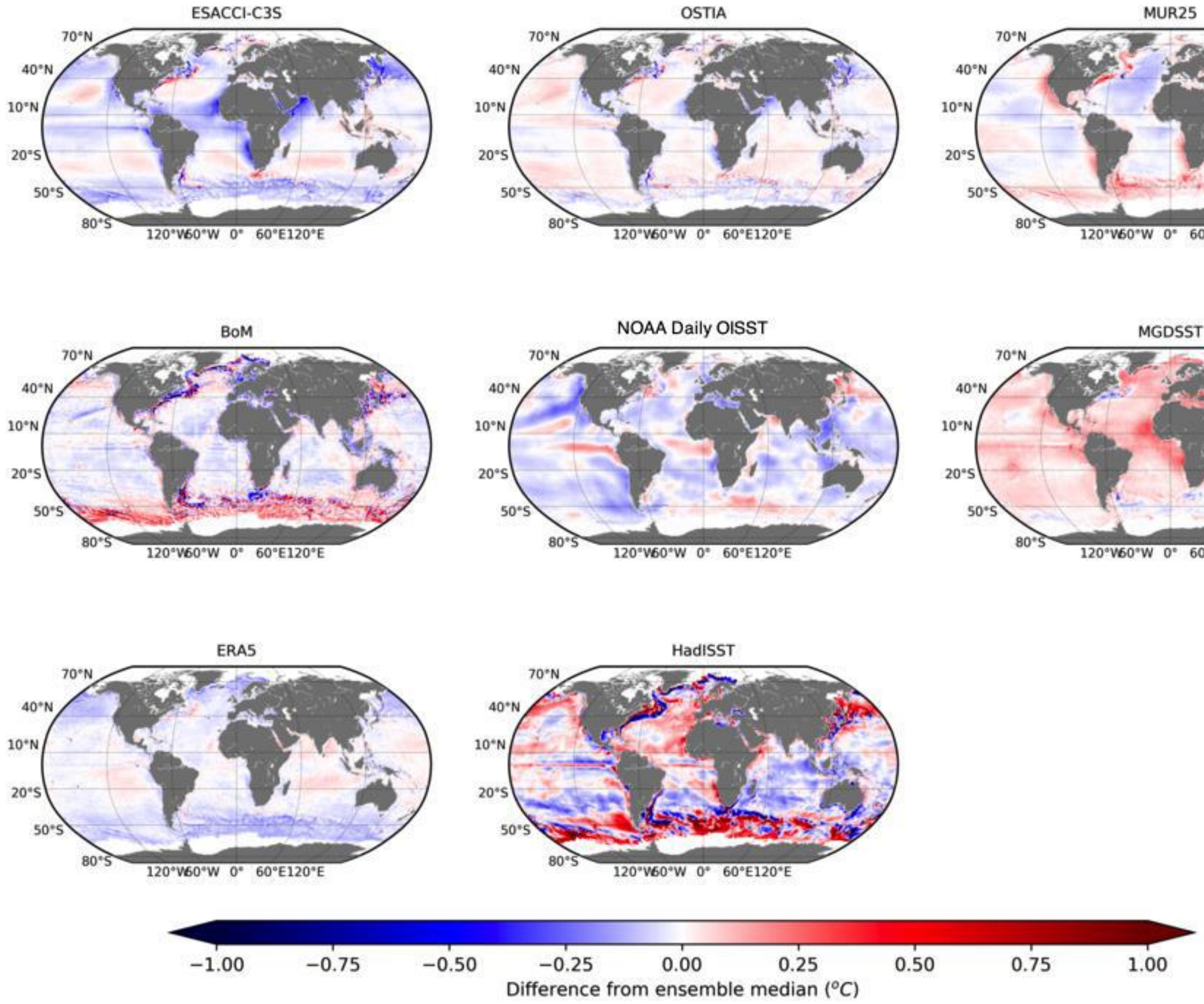
CNR ISMAR
ISTITUTO DI SCIENZE MARINE



European Commission

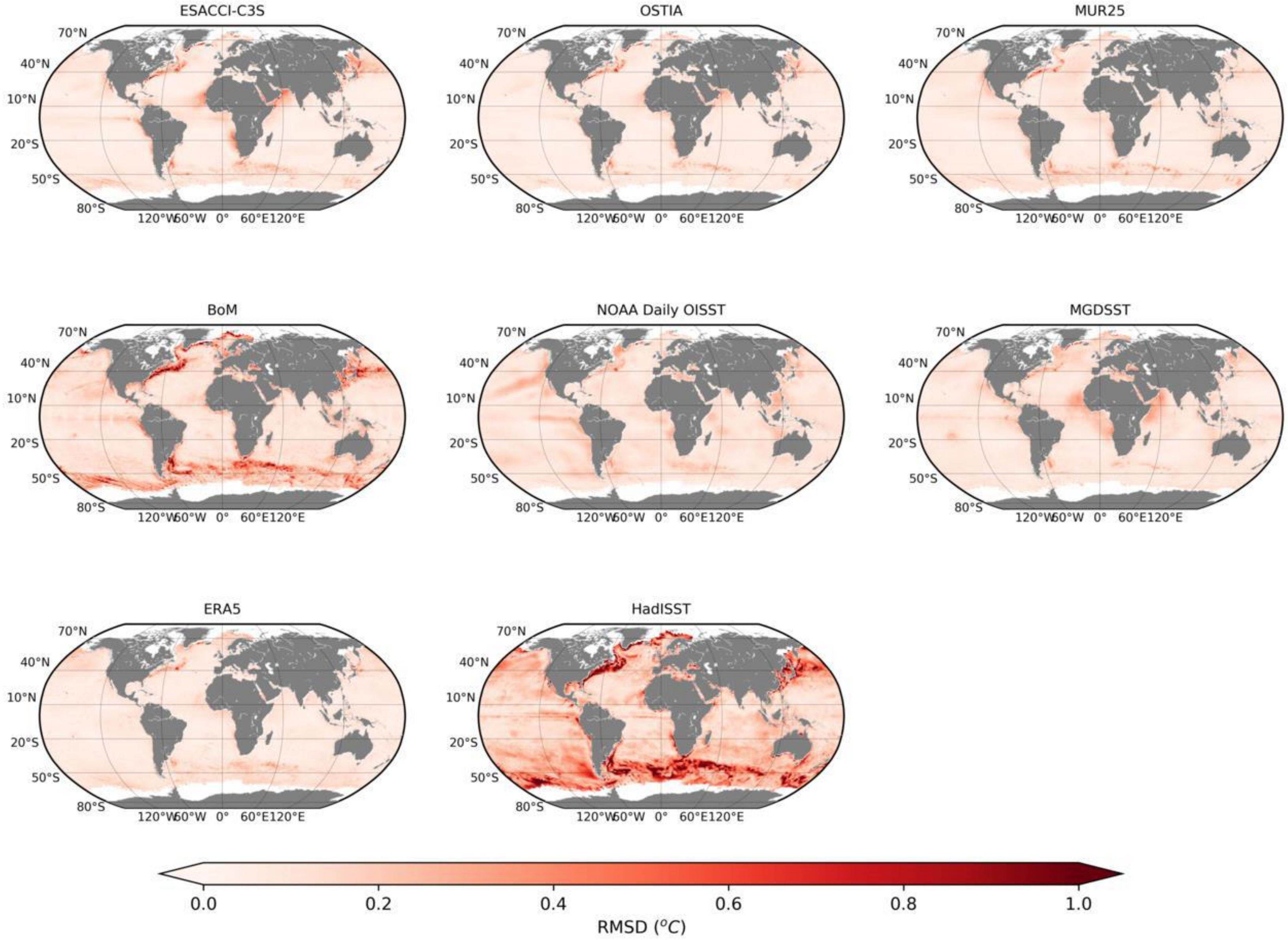
Climate Change

The difference between each SST data and the ensemble median for the period of 2003-2018



Climate Change

RMSD between each SST data and the ensemble median for the period of 2003-2018



CNR ISMAR
ISTITUTO DI SCIENZE MARINE

European Commission