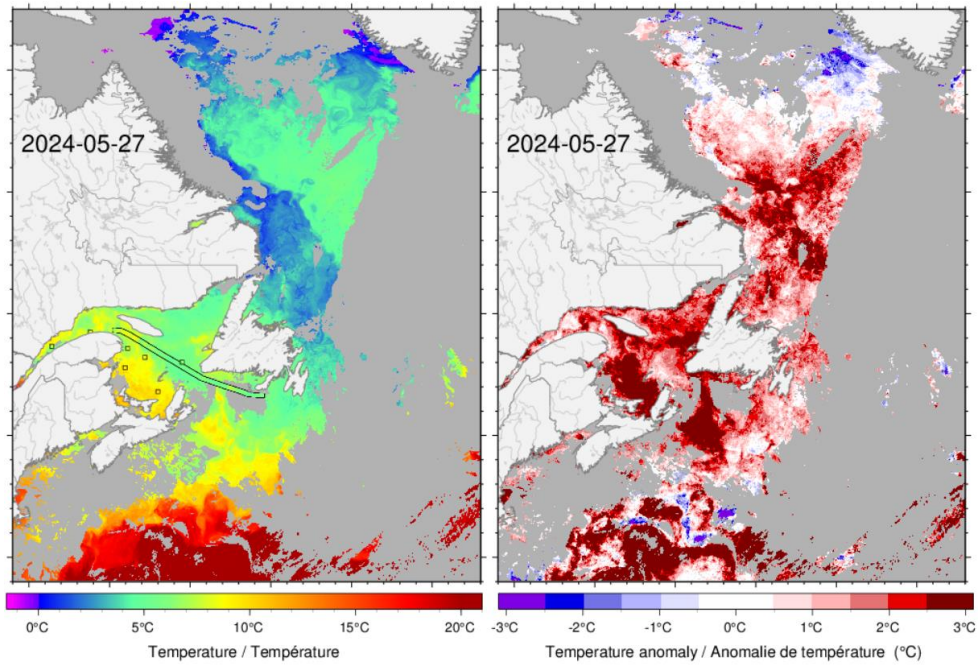
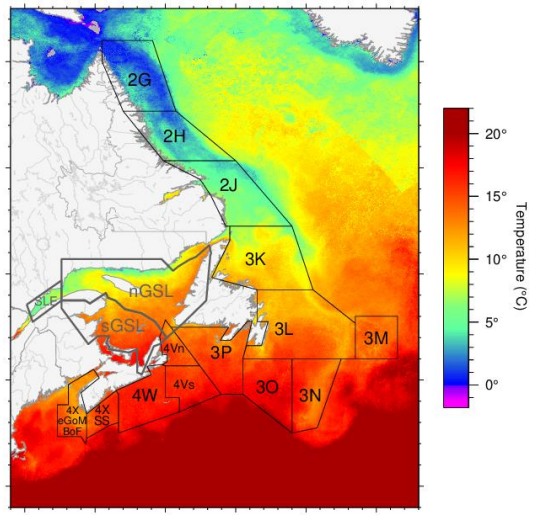
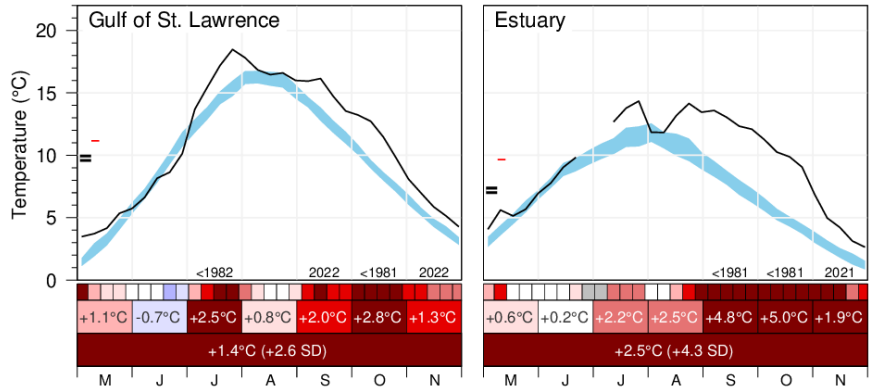
Selection, in-situ calibration, and minimum coverage of a GHRSST product for the monitoring of the Canadian Atlantic Zone.

Peter S. Galbraith
Research scientist @ Fisheries and Oceans Canada

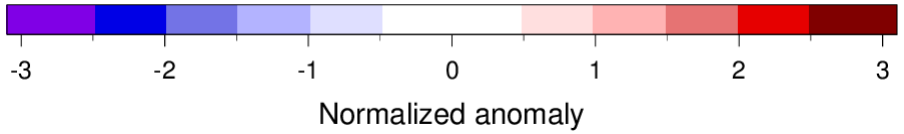






Criteria for State of the Ocean monitoring of SST

- Long-term coverage suitable for 30-year climatology.
  - Can combine different products if inter-calibrated.
- No filtering-out of regional upwelling or mixing that lead to cold spots.
- Real-time availability.
- Need to resolve better than ½ standard deviation (SD) of variability, after seasonal cycle is removed; we report based in standardized anomalies with increments of ½ SD, where anomalies within ½ SD of the mean are considered near normal.

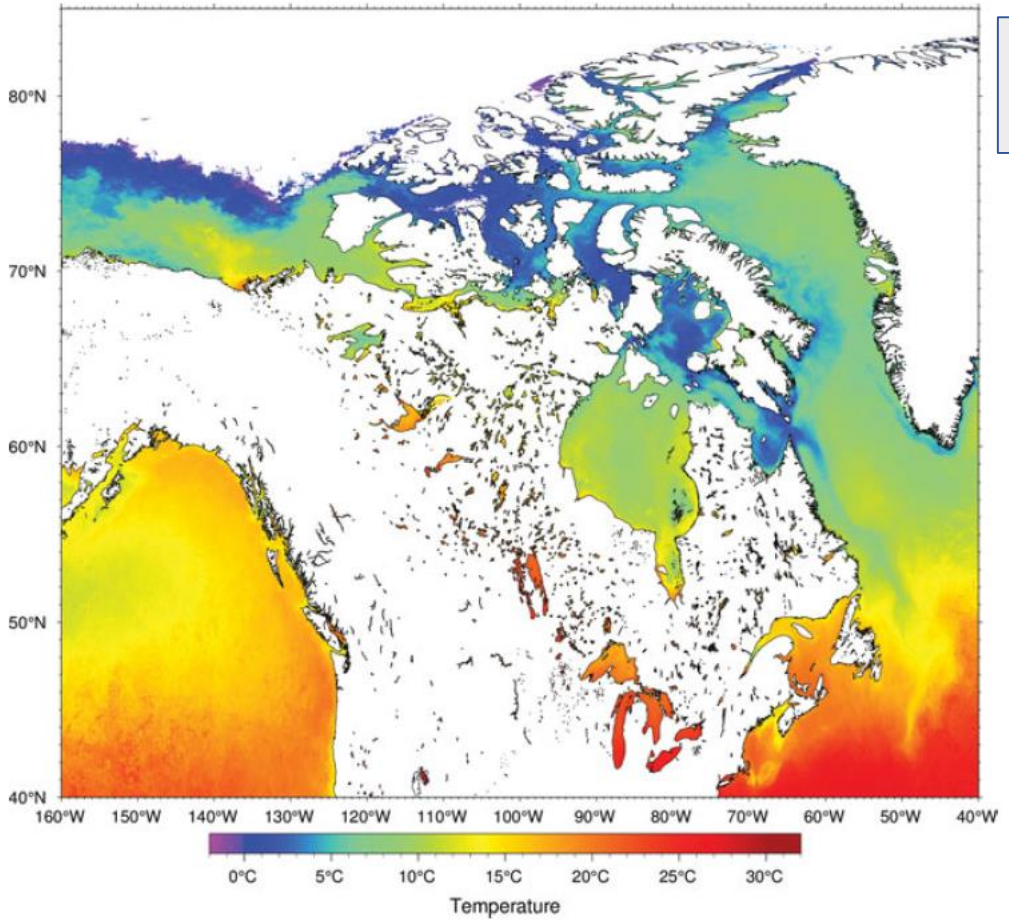


This is not an issue of pixel level accuracy, but in errors in estimating area averages based on sparse surface coverages (e.g. clouds).

Long-term coverage suitable for 30-year climatology

We have an internal Fisheries & Oceans (but discontinued) national product (MLI)

- Daily composites of 0.015° longitude × 0.01° latitude (e.g. 1 km)
- 1983-04 to 2013-09, which covers cooler period



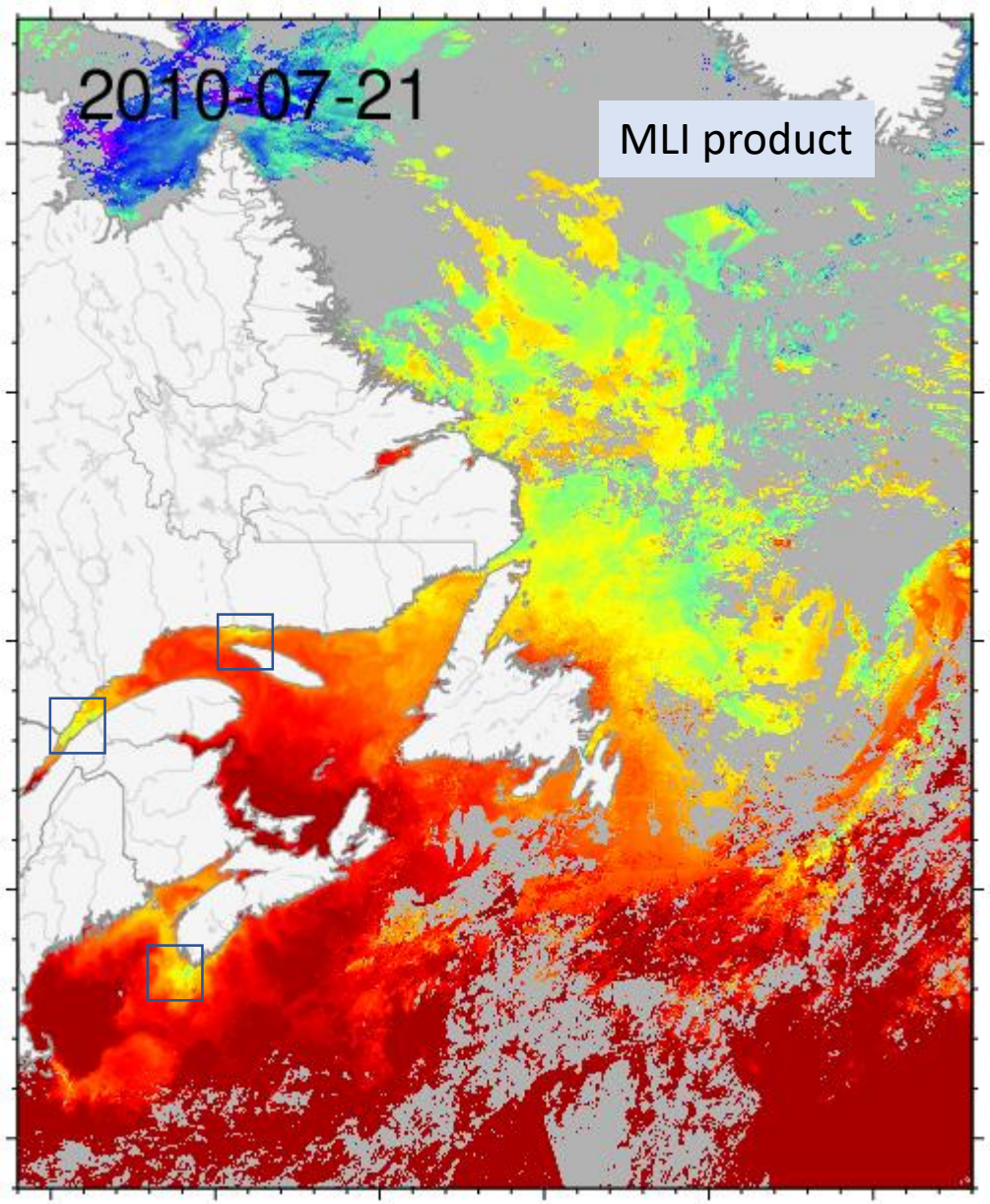
Larouche, P. and **P. S. Galbraith**. 2016. Canadian coastal seas and Great Lakes sea surface temperature climatology and recent trends. Canadian Journal of Remote Sensing, 42:3, 243-258, DOI: 10.1080/07038992.2016.1166041

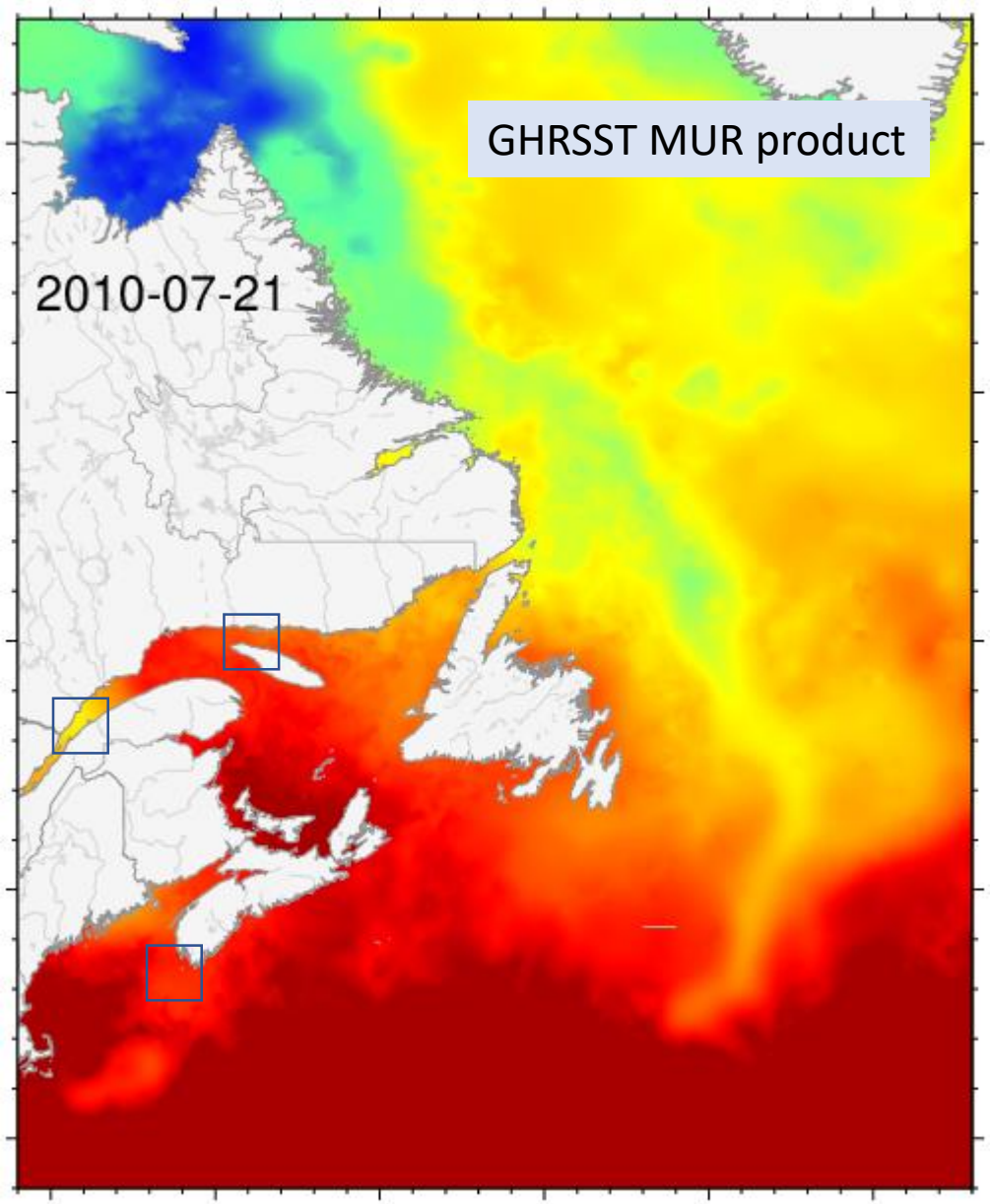
This was combined with another product from another Fisheries & Oceans lab (BIO) covering from 1997

Galbraith, P.S., P. Larouche, C. Caverhill. 2021. A sea-surface temperature homogenization blend for the Northwest Atlantic. Canadian Journal of Remote Sensing, 47(4), 554-568, DOI: 10.1080/07038992.2021.1924645

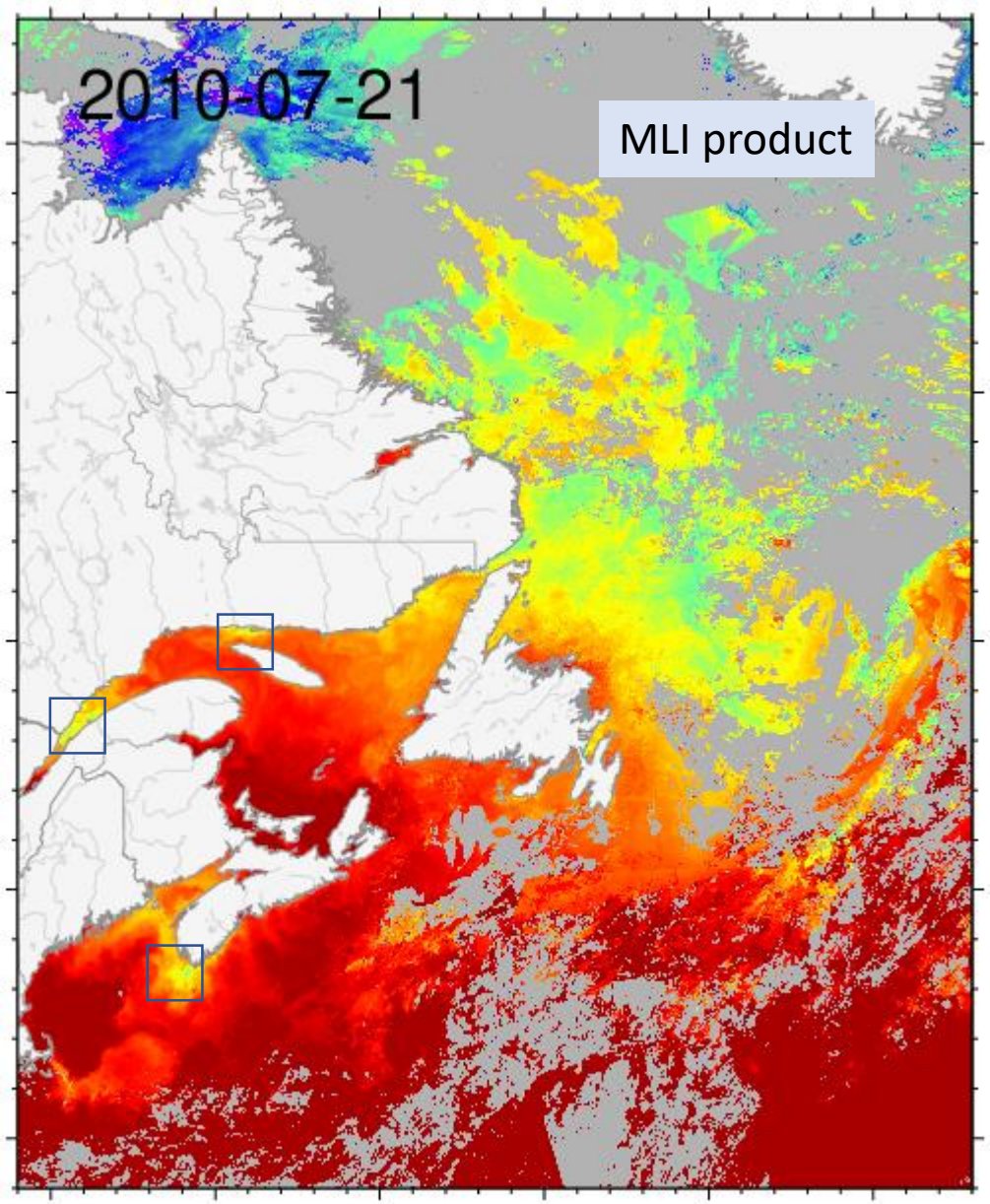
...which was also discontinued in 2022. We needed a replacement.

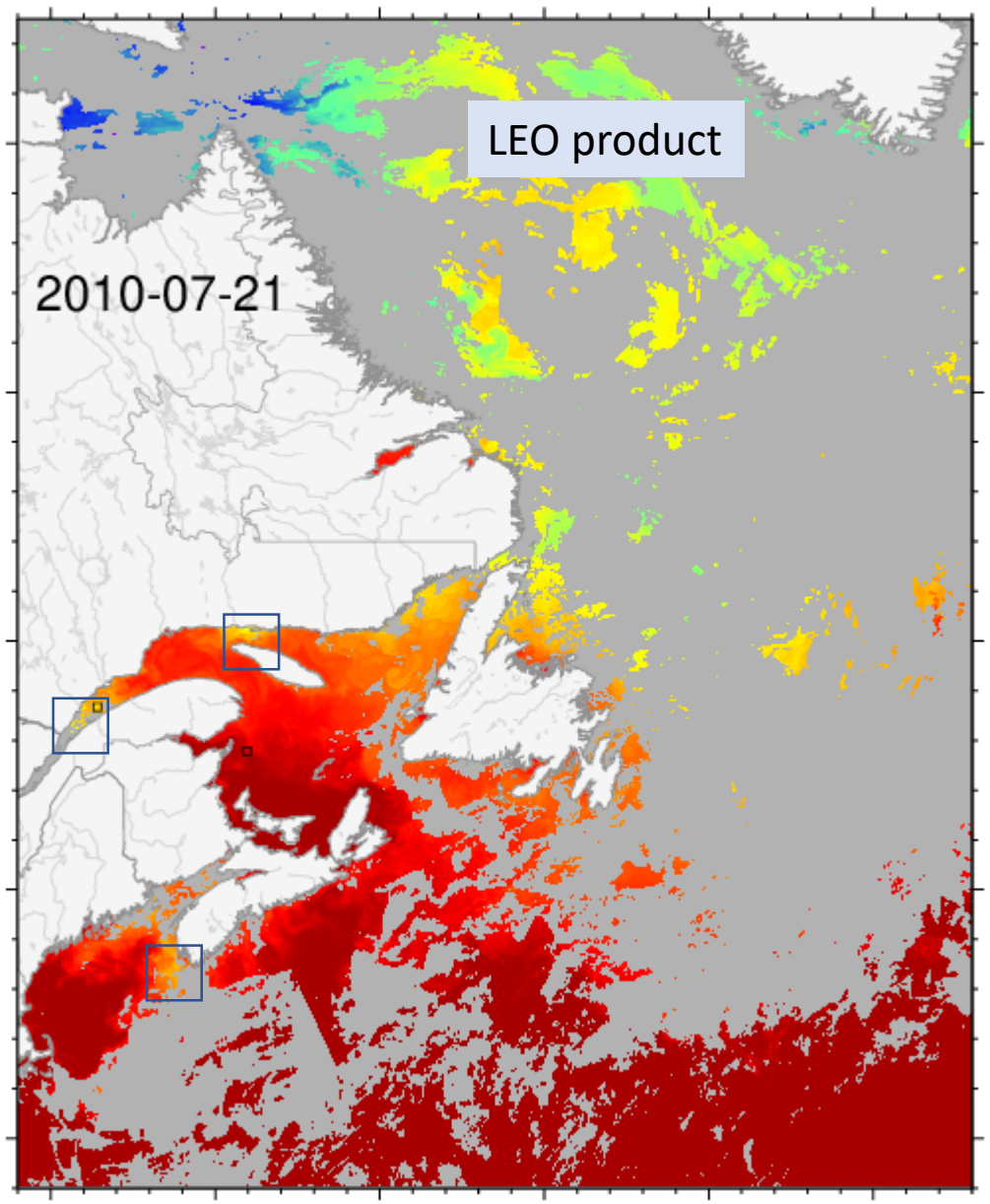
No filtering-out of regional upwelling or mixing



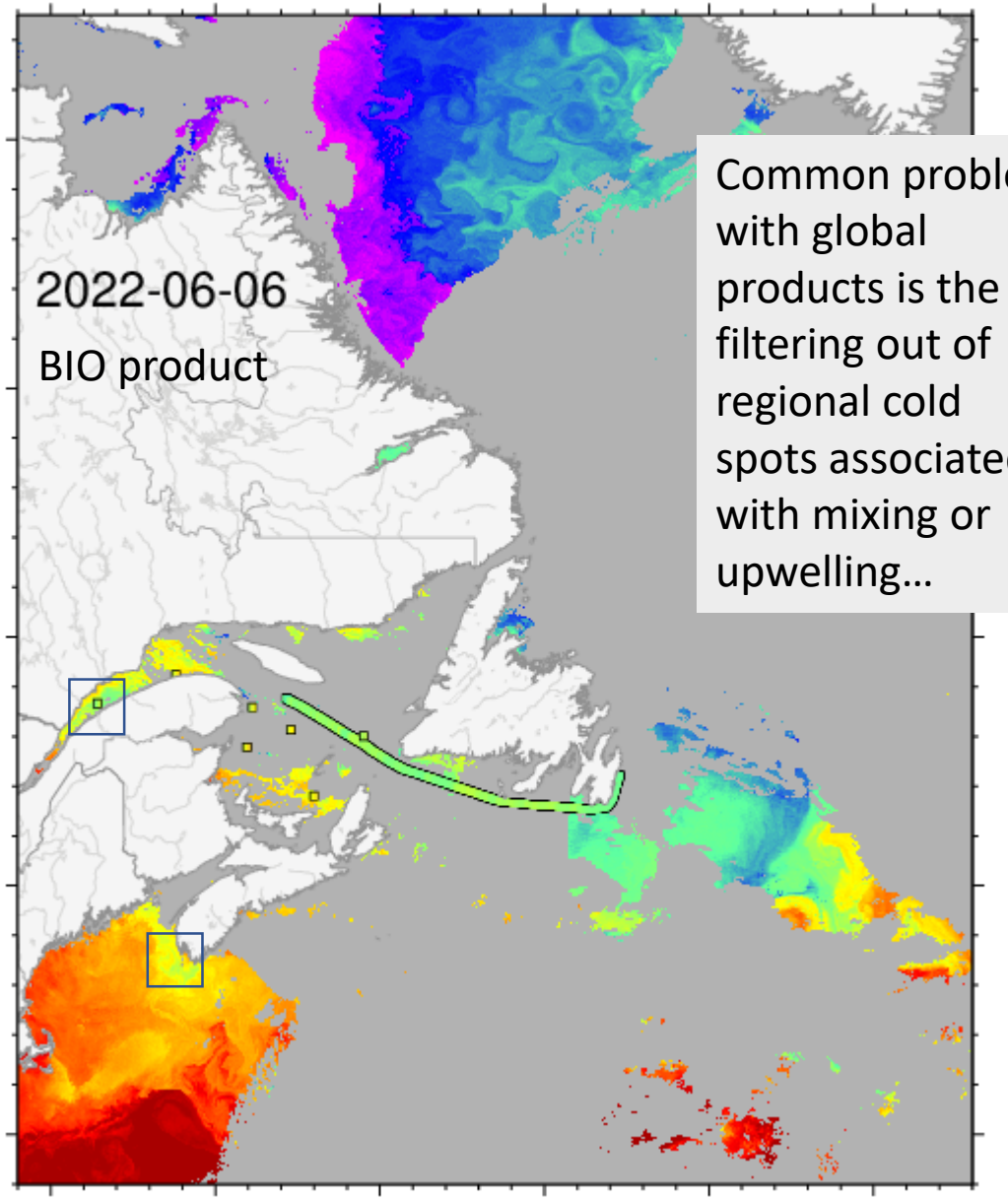


No filtering-out of regional upwelling or mixing

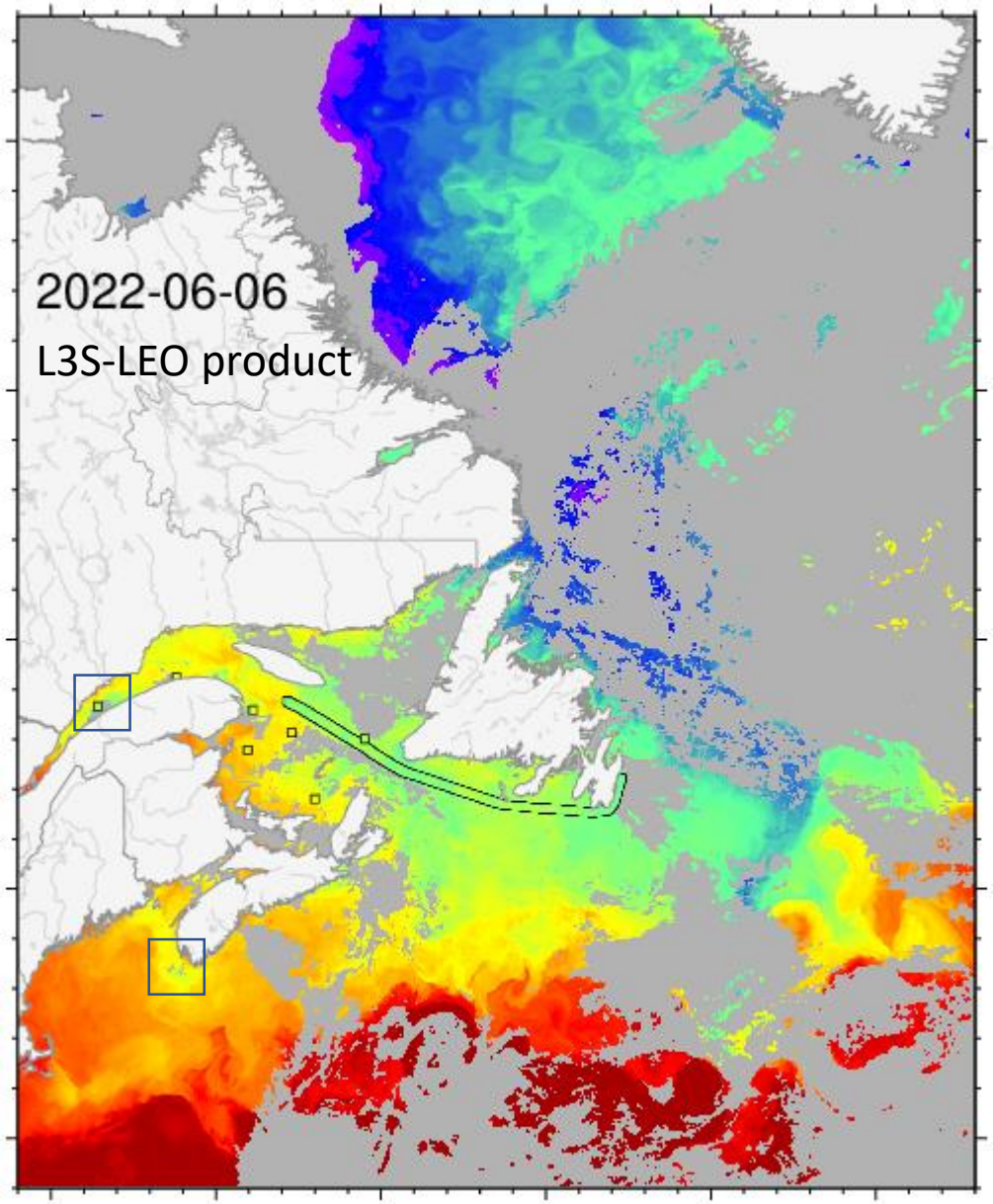




No filtering-out of regional upwelling or mixing



Common problem with global products is the filtering out of regional cold spots associated with mixing or upwelling…



Selection of real-time available product

GHRSST L3S-LEO-AM "super-collated" product from NOAA

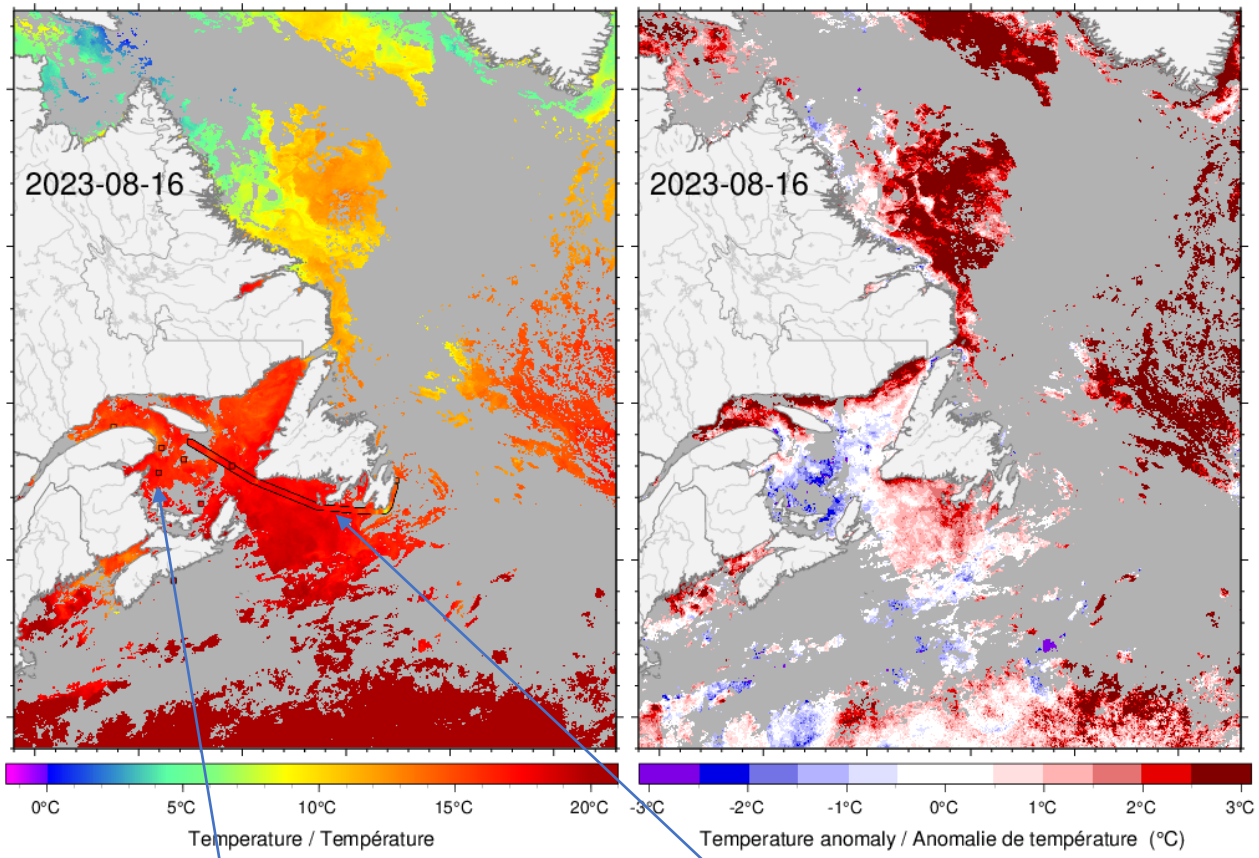
2007 to present; 0.02 degree grid resolution; real-time availability.

"we remove the retired and degraded quality satellites/sensors, and replace them with newly launched, high quality products" – Alex Ignatov, NOAA.

Daytime and one night time files are downloaded and combined into a daily composite by averaging both when they are both available or adding/substracting half the average offset (diurnal cycle) to the one available.

…But a new product introduced last December called L3S-LEO-Daily goes to 2000 and already accounts for the diurnal cycle. We will evaluate migrating to it.

NOAA-LEO satellite SST calibrated to *in-situ* DFO Viking buoys and off-shore thermographs

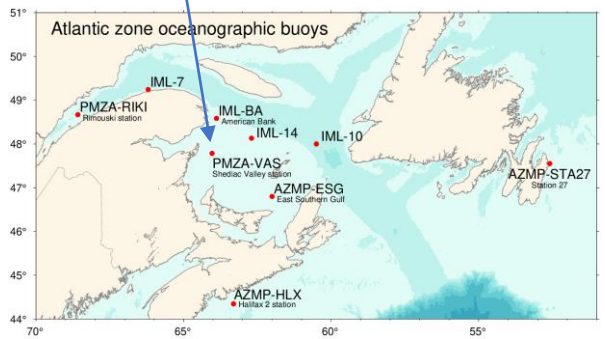


SST products are self-consistent, but may have an offset with other data that must be adjusted in order to combine them and obtain 30-year monitoring climatologies and time series.

10165 overlapping daily observations with buoys or thermographs, equivalent to 28 years of daily observations at one station!

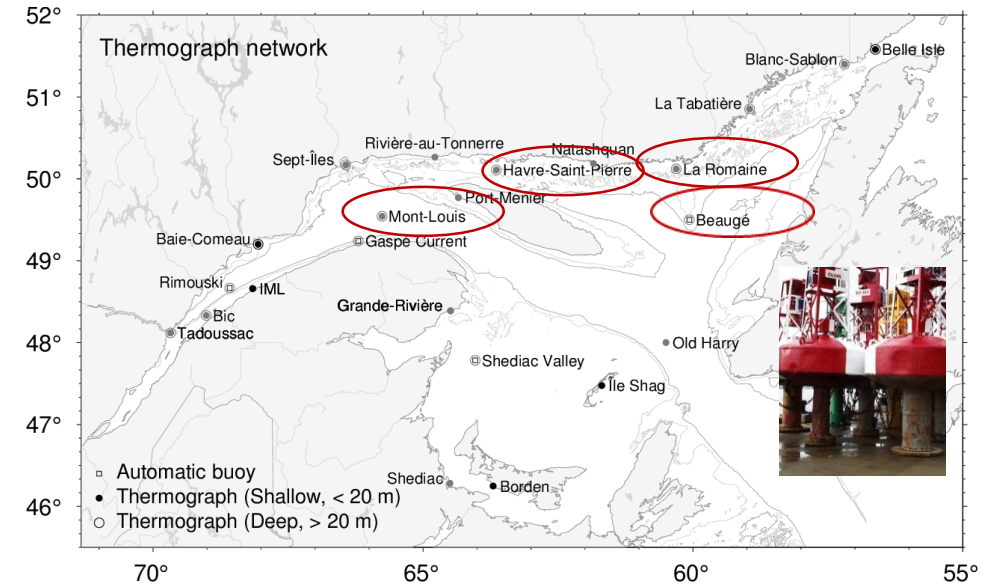
The mean SST diurnal range is 1.6°C
We removed 34% of the observations with the highest diurnal range, leaving a new mean diurnal range of 0.91°C

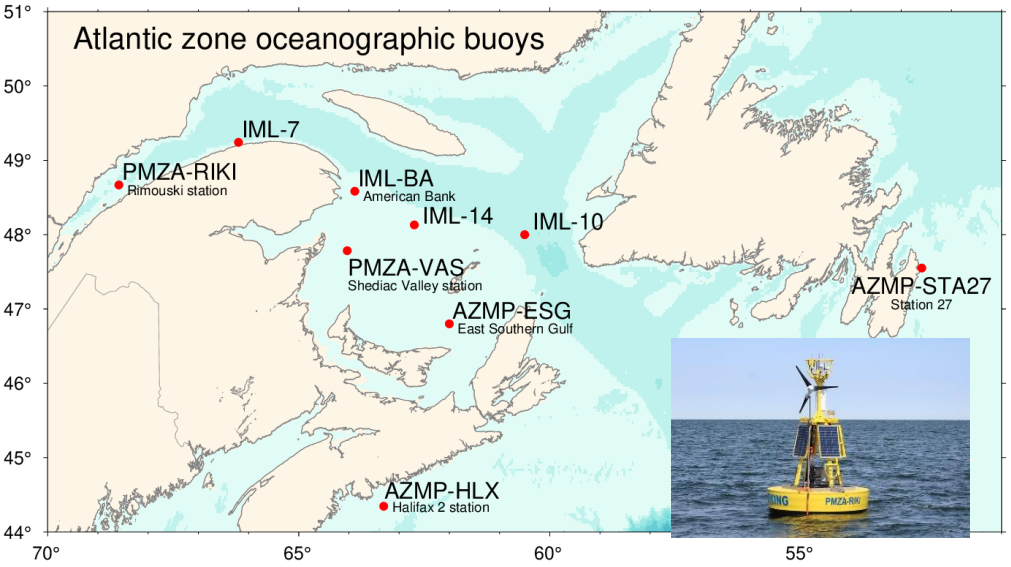
These were used for calibration.

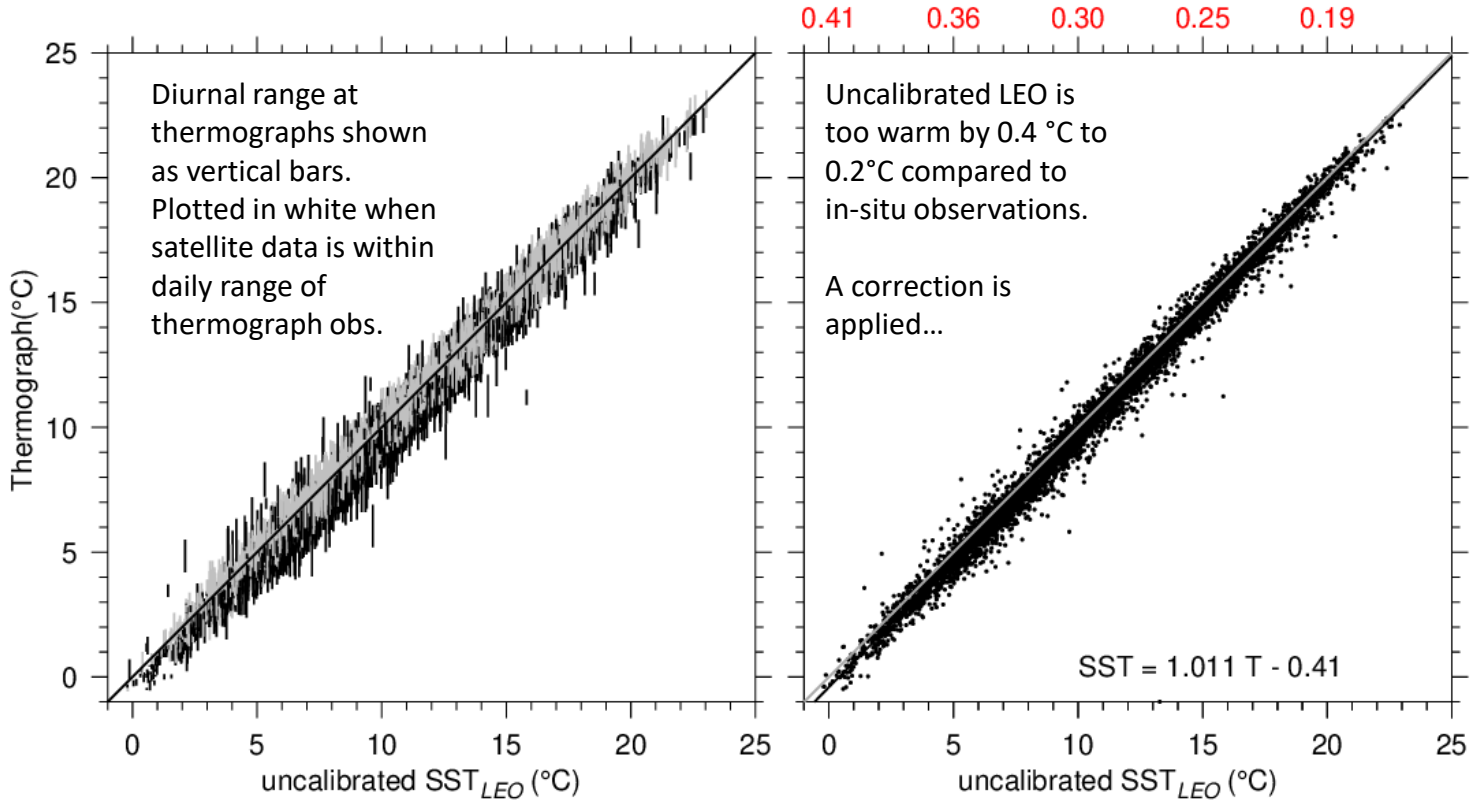


Shipboard thermosalinograph track data

Comparison of **uncalibrated** NOAA-LEO to Viking buoys and off-shore thermographs

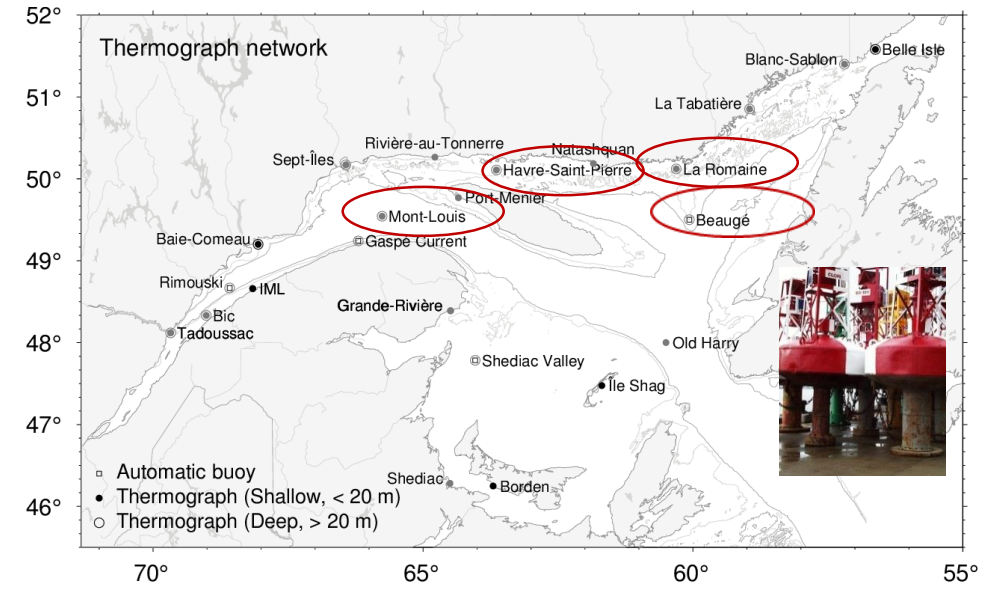


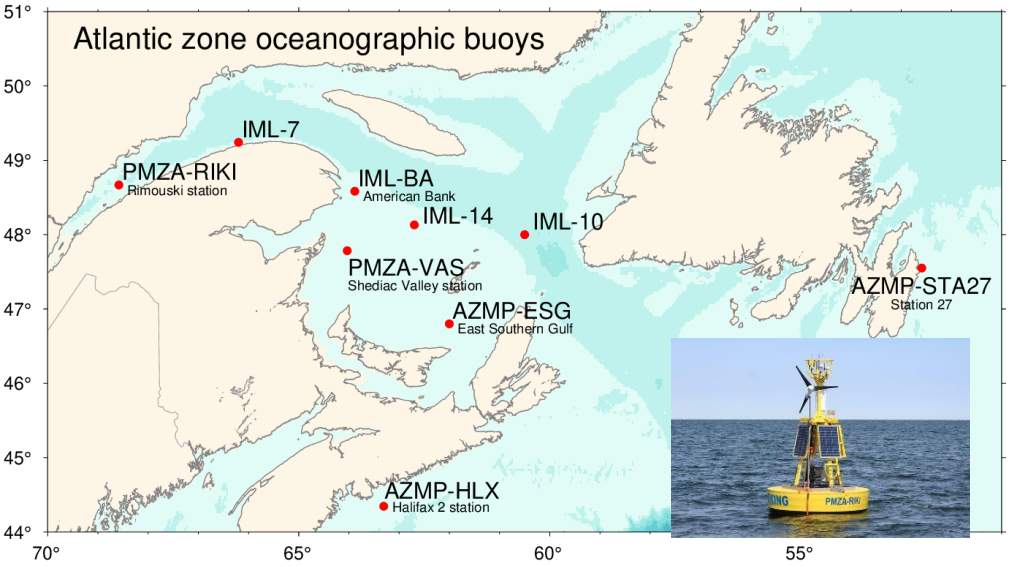


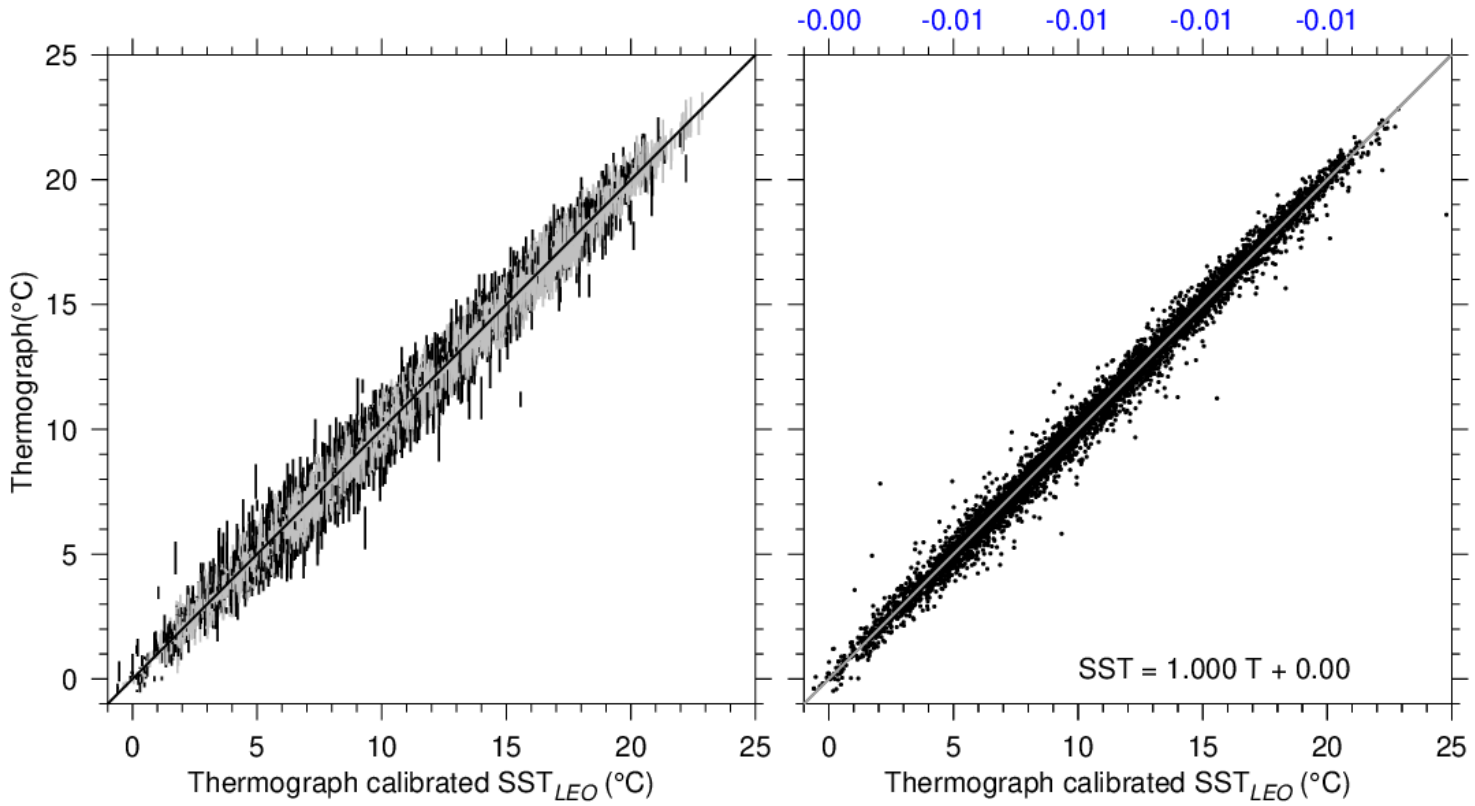


69% of un-adjusted LEO SST fall within thermograph diurnal range.

Comparison of **calibrated** NOAA-LEO to Viking buoys and off-shore thermographs







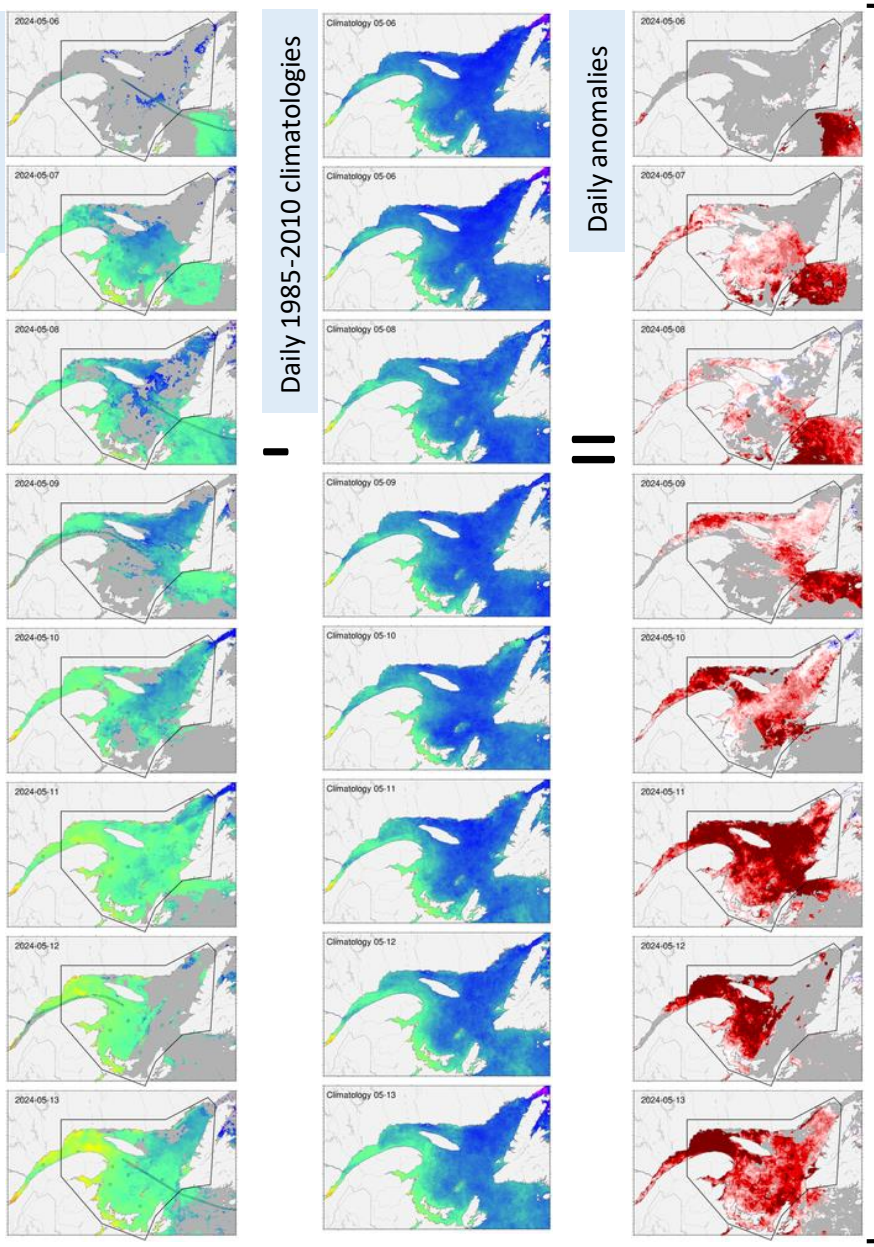
After calibration to our buoy data, 95.4% of adjusted LEO SST daily averages (at pixels corresponding to buoy locations) fall within the diurnal range observed on that day at the buoys. Less than 5% of remote sensing data fall a bit outside of our observations.

Building weekly and monthly composites

Daily composites

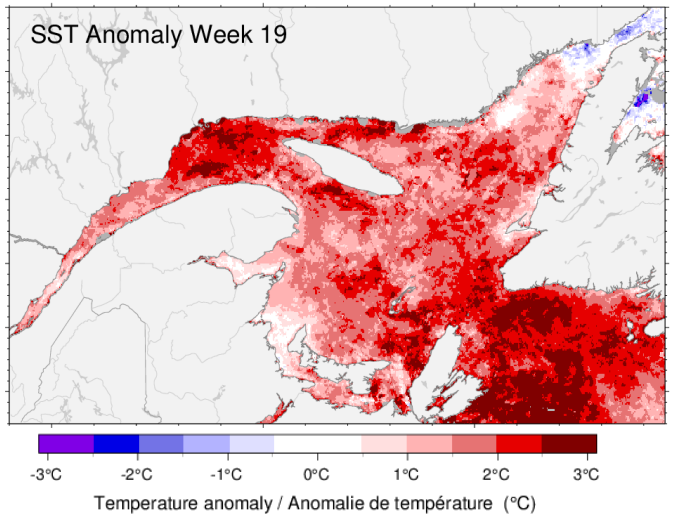
Daily 1985-2010 climatologies

Daily anomalies

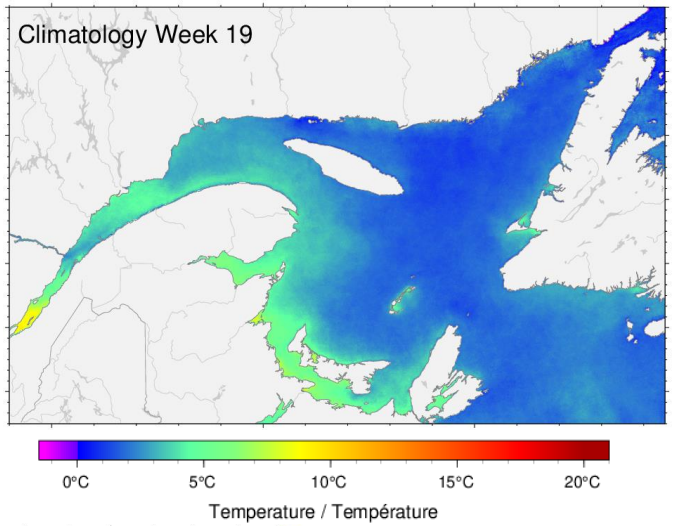


Weekly/monthly composites built on average of daily anomalies, added to the climatology for the period. This reduces biases introduced by incomplete data covering a period when SST is changing rapidly (e.g. spring or fall).

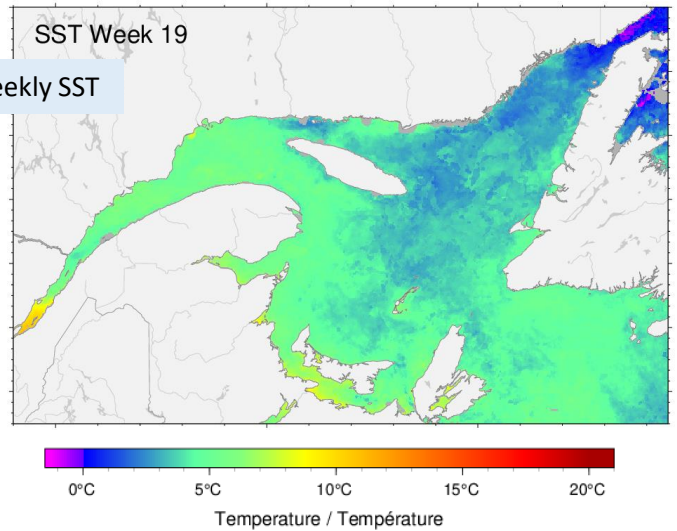
Average daily anomalies



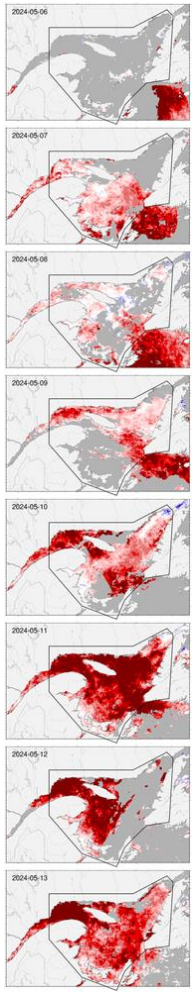
Climatology for that week



Composite for best estimate of weekly SST



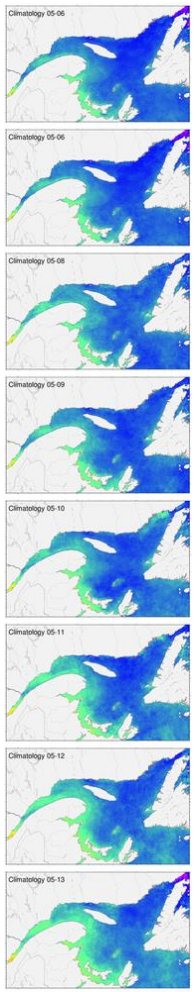
Calculating polygon averages for SST



Average of all pixel-level anomalies within the polygon

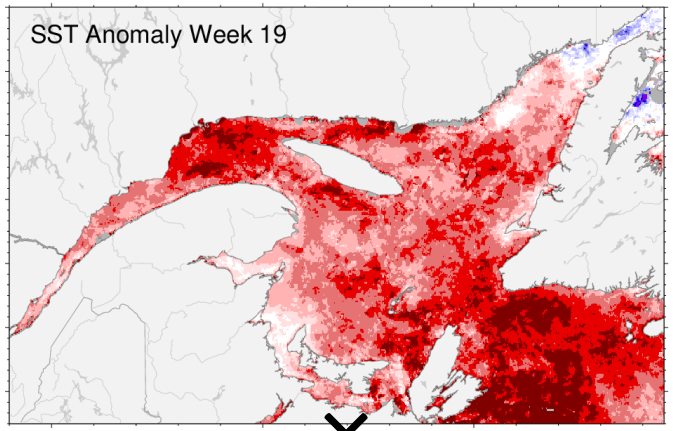
$$\frac{\sum T'(i,j,day)}{N}$$

+



Average of all climatology pixels

Average of all pixel-level anomalies within the polygon simply obtained by weighting each weekly pixel anomaly by its pixel count



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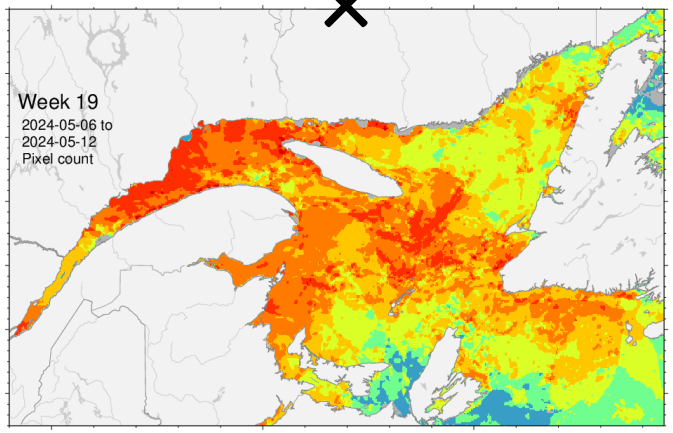

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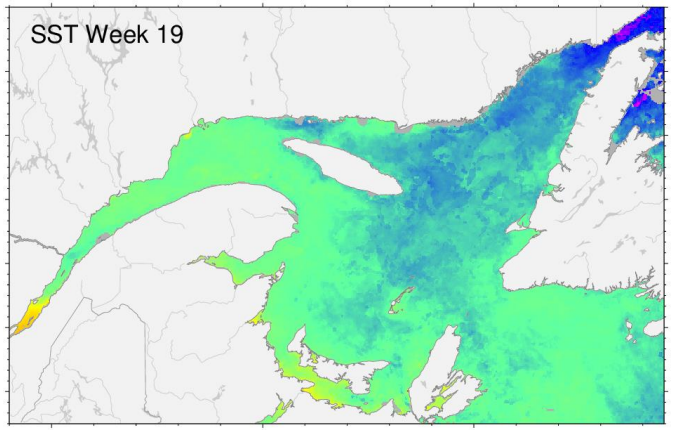
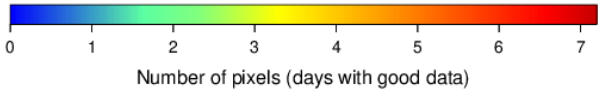
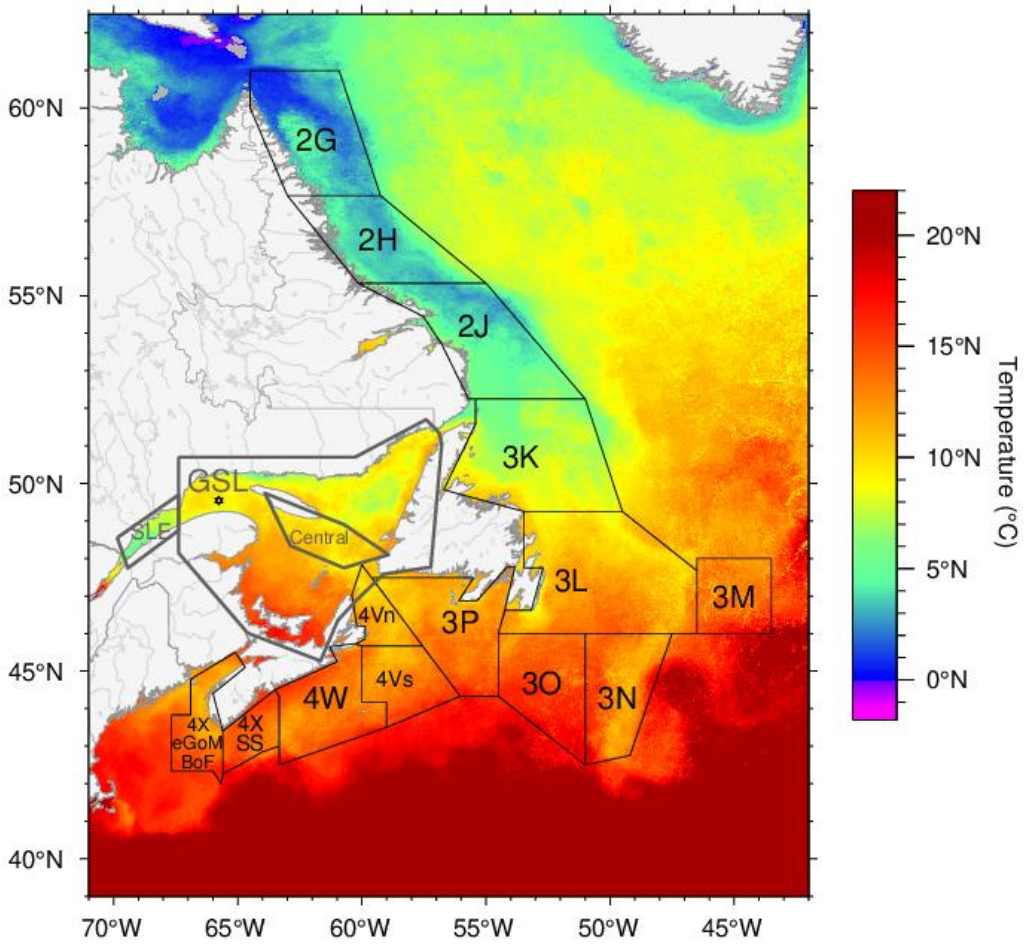




Averaging anomalies (rather than SST) within a polygon reduces biases introduced by incomplete data covering an area with spatial SST gradients.

Mean SST timeseries are calculated for each area, then 1991-2020 anomalies are calculated.

How much data is enough data?

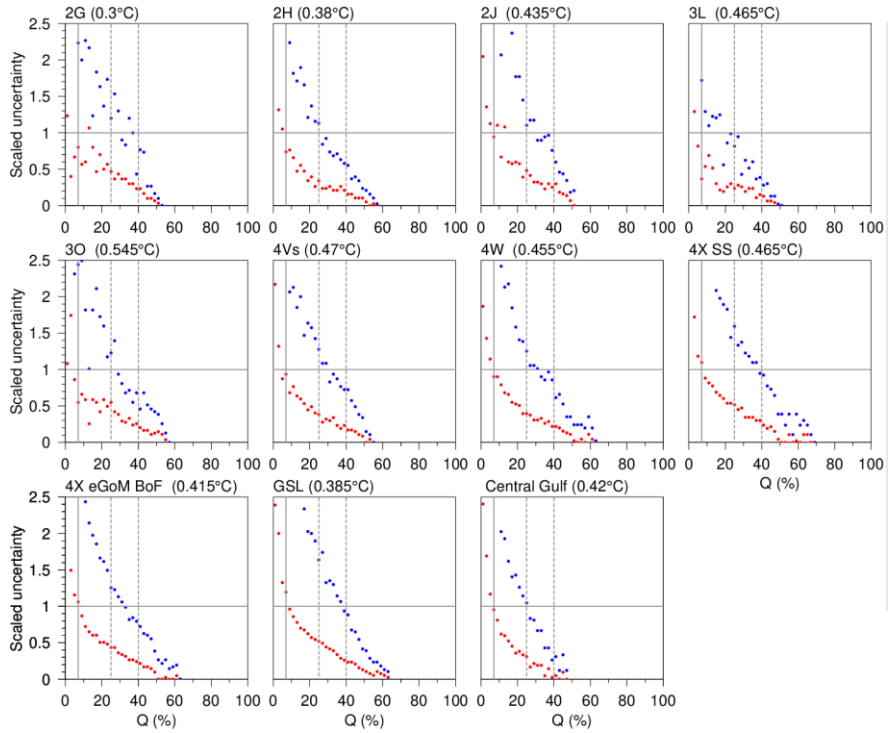


Galbraith, P.S., P. Larouche, C. Caverhill. 2021. A sea-surface temperature homogenization blend for the Northwest Atlantic. Canadian Journal of Remote Sensing, 47(4), 554-568, DOI: 10.1080/07038992.2021.1924645

For these areas that we report on, there were 109 months with ≥50% pixel coverage (over all days of the month).

To simulate the effect of missing data, the 109 months were resampled by omitting more and more days of data, repeating each number 30 times.

The error in estimating the monthly anomaly was then scaled by half of the standard deviation of the time series



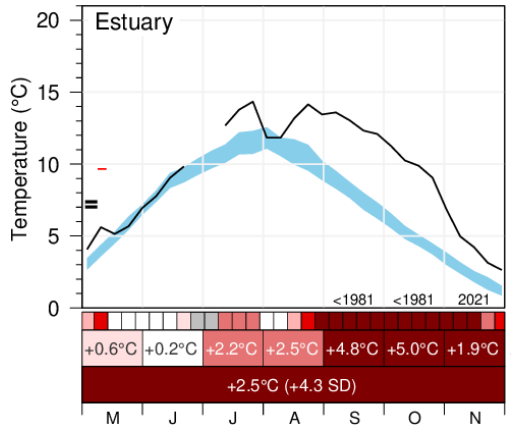
The median is shown (red) as well as the 95th percentile (blue)

At 25% to 40% data coverage, 95% of estimates are within 0.5 SD of the original (blue).

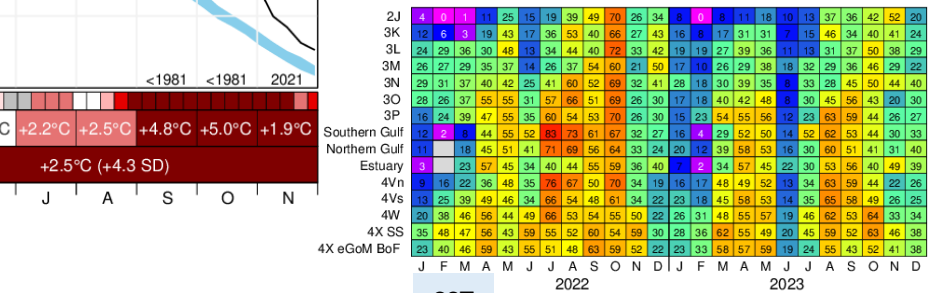
At 7%, half of estimates are still within 0.5 SD of the original (red).

What do we report

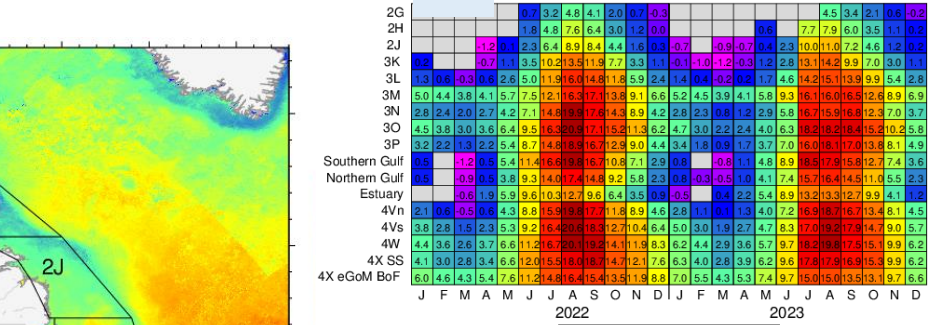
Weekly progression



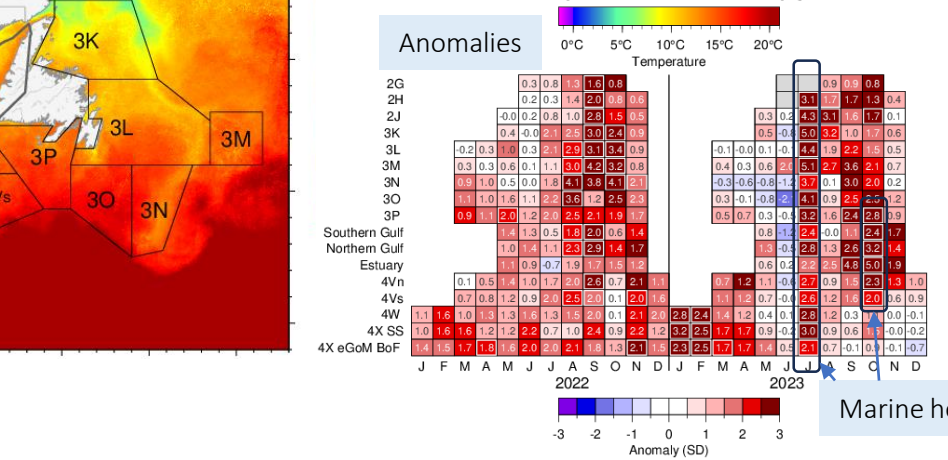
Coverage percentage

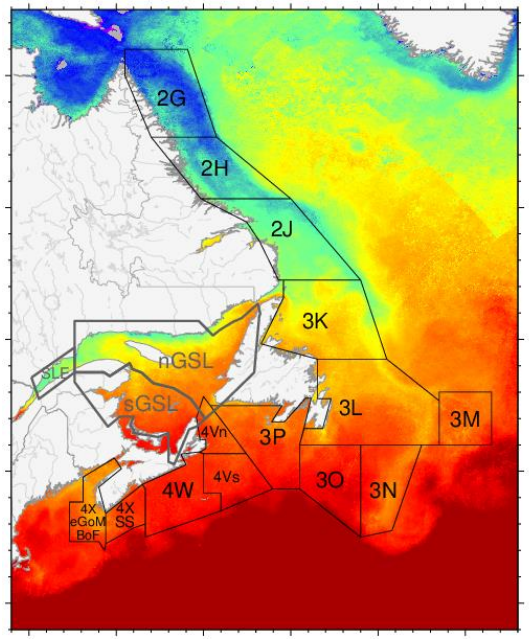


SST

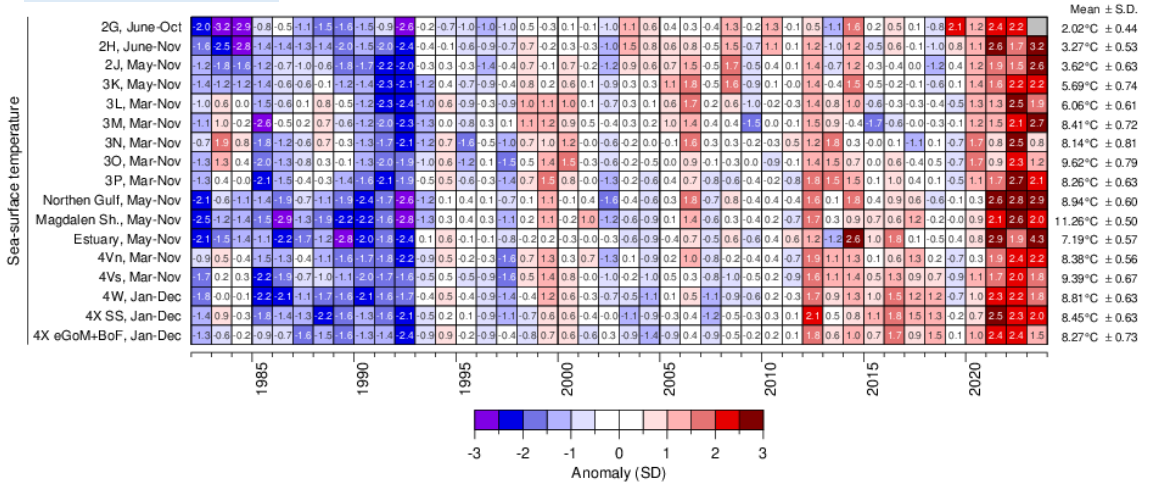


Anomalies

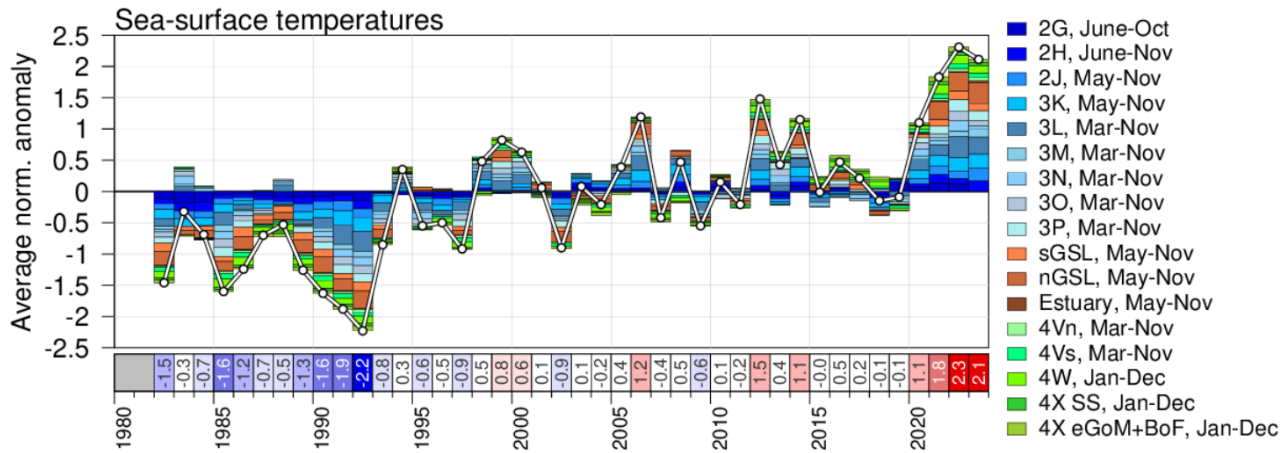




Seasonal averages

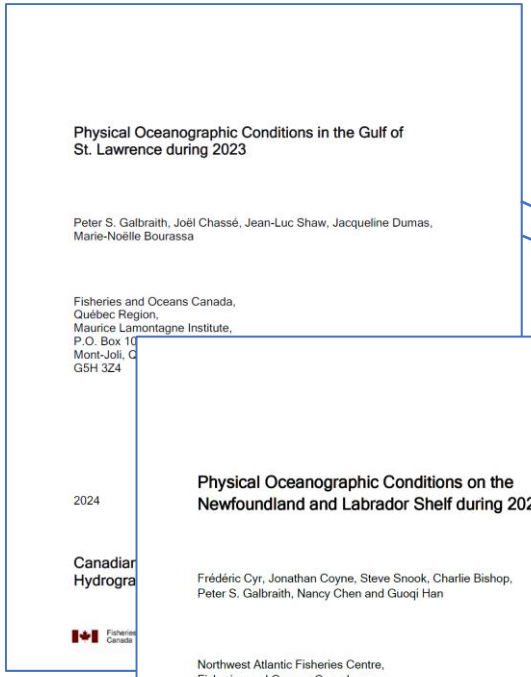


Stacked ‘area-weighted’ seasonal anomalies for the Atlantic Zone



Marine heatwaves!

Where do we report


Physical Oceanographic Conditions in the Gulf of St. Lawrence during 2023

Peter S. Galbraith, Joël Chassé, Jean-Luc Shaw, Jacqueline Dumas, Marie-Noëlle Bourassa

Fisheries and Oceans Canada,
Québec Region,
Maurice Lamontagne Institute,
P.O. Box 10
Mont-Joli, C
G5H 3Z4

2024

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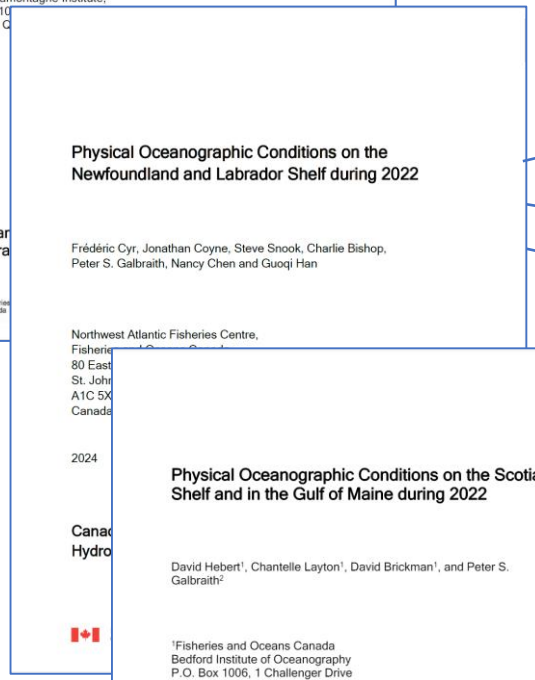
Hydrogra


Physical Oceanographic Conditions on the Newfoundland and Labrador Shelf during 2022

Frédéric Cyr, Jonathan Coyne, Steve Snook, Charlie Bishop, Peter S. Galbraith, Nancy Chen and Guoqi Han

Northwest Atlantic Fisheries Centre,
Fisherie
80 East
St. John
A1C 5X
Canada

2024

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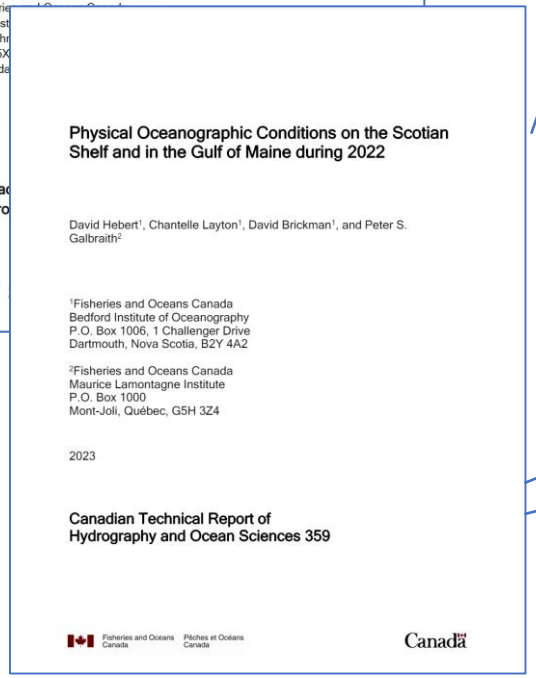
Hydro


Physical Oceanographic Conditions on the Scotian Shelf and in the Gulf of Maine during 2022

David Hebert[1], Chantelle Layton[1], David Brickman[1], and Peter S. Galbraith[2]

[1]Fisheries and Oceans Canada
Bedford Institute of Oceanography
P.O. Box 1006, 1 Challenger Drive
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Maurice Lamontagne Institute
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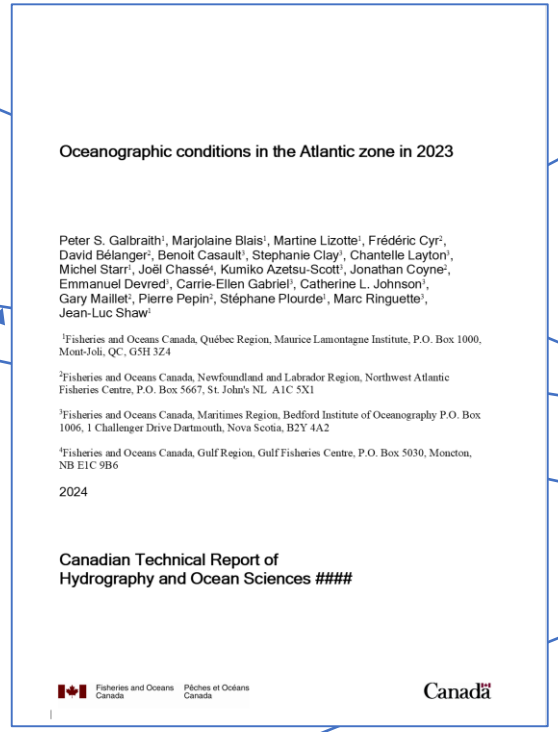
Mont-Joli, Québec, G5H 3Z4

2023

Canadian Technical Report of Hydrography and Ocean Sciences 359

Fisheries and Oceans Canada / Pêches et Océans Canada — Canada


Oceanographic conditions in the Atlantic zone in 2023

Peter S. Galbraith[1], Marjolaine Blais[1], Martine Lizotte[1], Frédéric Cyr[2], David Bélanger[2], Benoit Casault[1], Stephanie Clay[1], Chantelle Layton[1], Michel Starr[1], Joël Chassé[4], Kumiko Azetsu-Scott[3], Jonathan Coyne[2], Emmanuel Devred[3], Carrie-Ellen Gabriel[1], Catherine L. Johnson[3], Gary Maillet[2], Pierre Pepin[2], Stéphane Plourde[1], Marc Ringuette[3], Jean-Luc Shaw[1]

[1]Fisheries and Oceans Canada, Québec Region, Maurice Lamontagne Institute, P.O. Box 1000, Mont-Joli, QC, G5H 3Z4

[2]Fisheries and Oceans Canada, Newfoundland and Labrador Region, Northwest Atlantic Fisheries Centre, P.O. Box 5667, St. John's NL A1C 5X1

[3]Fisheries and Oceans Canada, Maritimes Region, Bedford Institute of Oceanography P.O. Box 1006, 1 Challenger Drive Dartmouth, Nova Scotia, B2Y 4A2

[4]Fisheries and Oceans Canada, Gulf Region, Gulf Fisheries Centre, P.O. Box 5030, Moncton, NB E1C 9B6

2024

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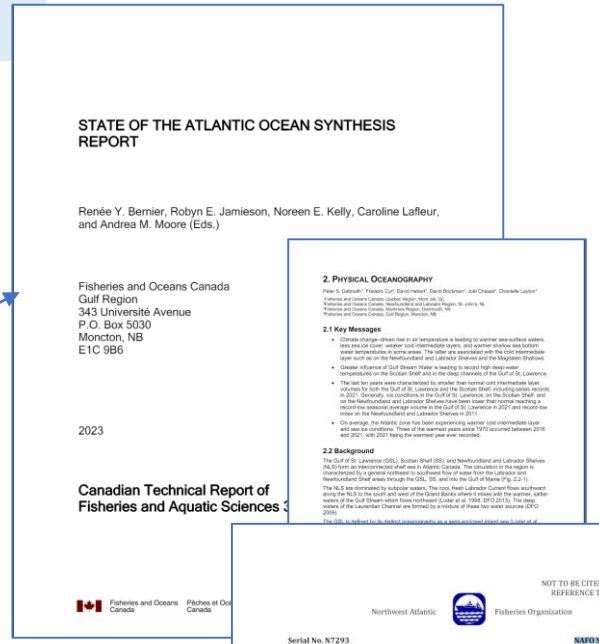
Fisheries and Oceans Canada / Pêches et Océans Canada — Canada


STATE OF THE ATLANTIC OCEAN SYNTHESIS REPORT

Renée Y. Bernier, Robyn E. Jamieson, Noreen E. Kelly, Caroline Lafleur, and Andrea M. Moore (Eds.)

Fisheries and Oceans Canada
Gulf Region
343 Université Avenue
P.O. Box 5030
Moncton, NB
E1C 9B6

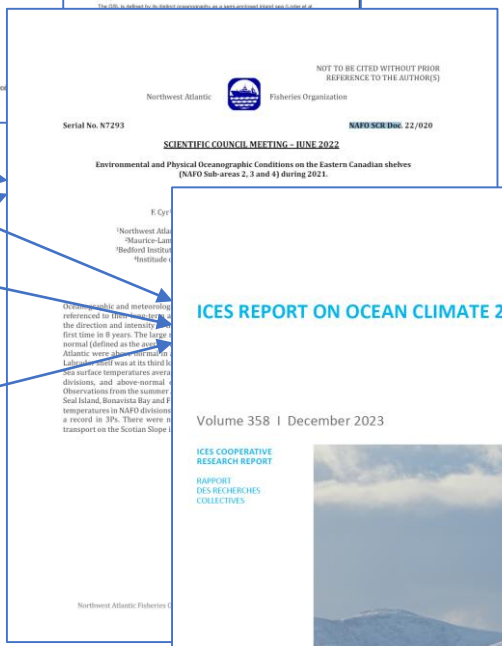
2023

Canadian Technical Report of Fisheries and Aquatic Sciences 3

2. PHYSICAL OCEANOGRAPHY

2.1 Key Messages

2.2 Background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Northwest Atlantic Fisheries Organization

Serial No. N7293 NAFO SCR Doc. 22/020

SCIENTIFIC COUNCIL MEETING – JUNE 2022

Environmental and Physical Oceanographic Conditions on the Eastern Canadian shelves (NAFO Sub-areas 2, 3 and 4) during 2021.

ICES CIEM

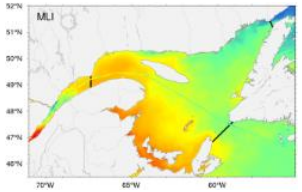
ICES REPORT ON OCEAN CLIMATE 2021

Volume 358 I December 2023

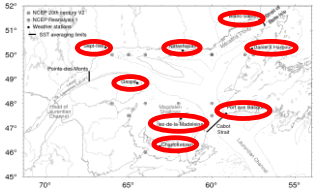
ICES COOPERATIVE RESEARCH REPORT

RAPPORT DES RECHERCHES COLLECTIVES

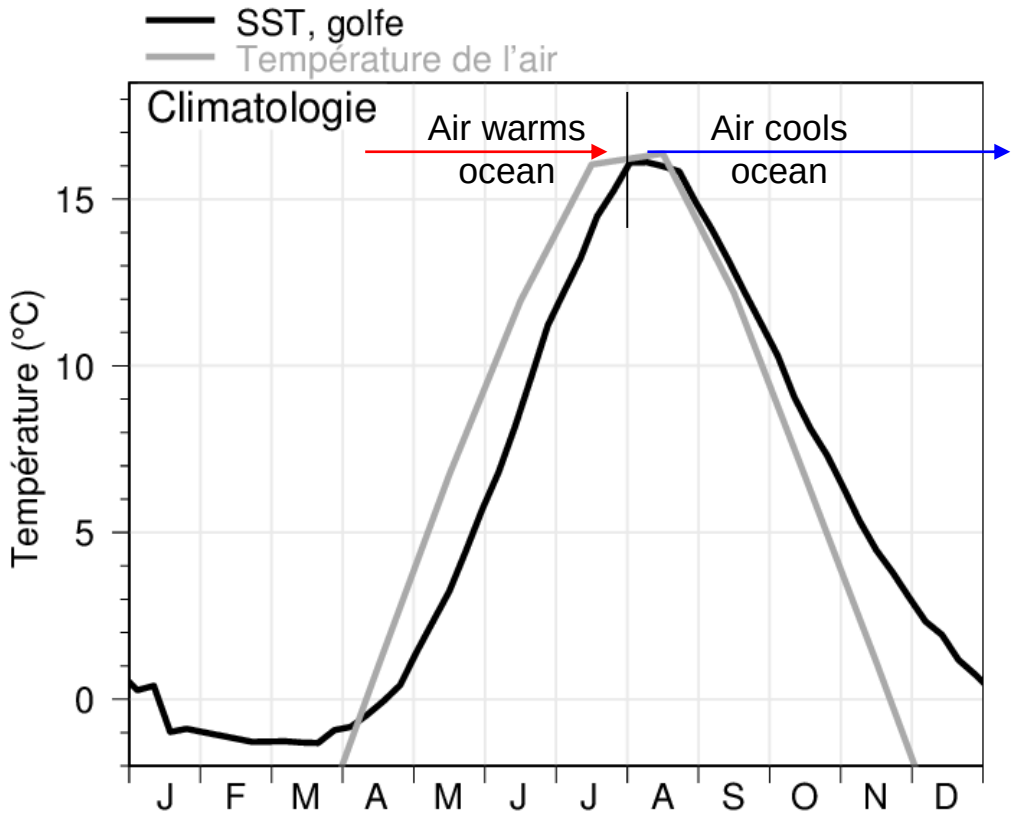
ICES INTERNATIONAL COUNCIL FOR THE EXPLORATION OF THE SEA
CIEM CONSEIL INTERNATIONAL POUR L'EXPLORATION DE LA MER



SST *vs* air temperature



Seasonal cycle of SST is identical to that of air temperature lagged by 2 weeks.



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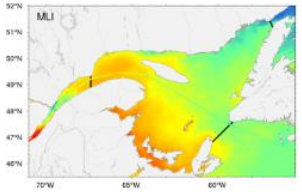

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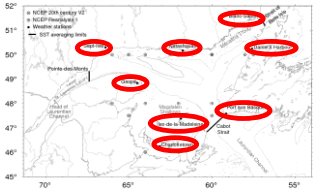

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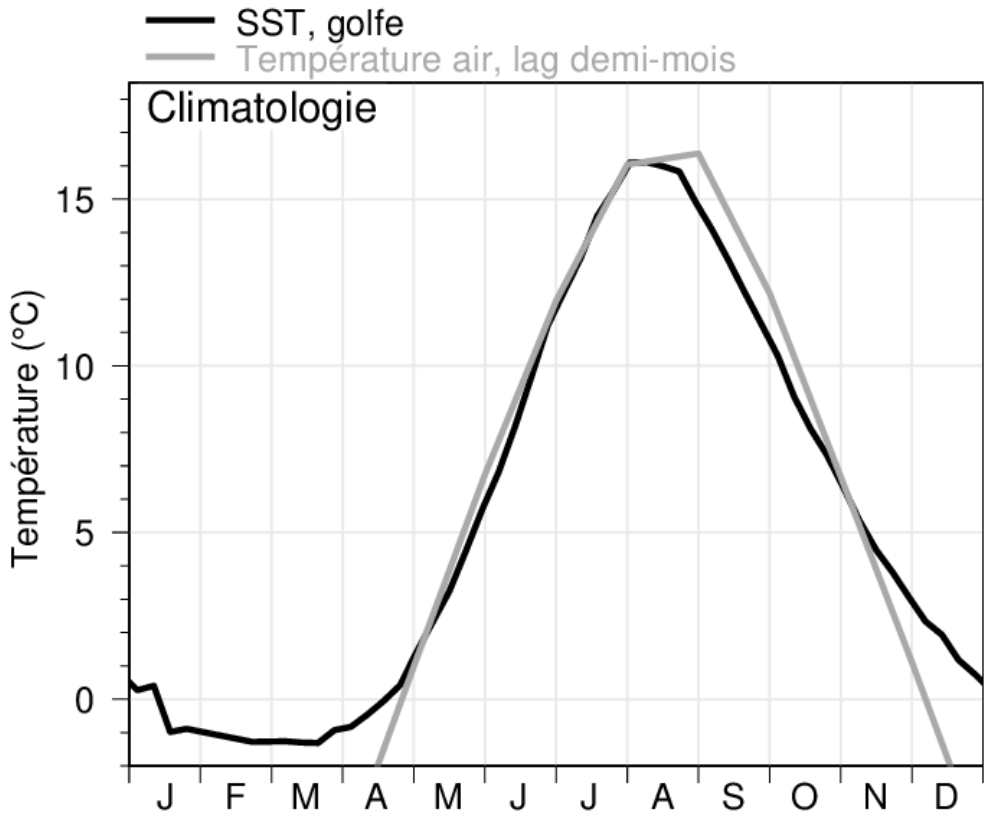
A climate change tool.



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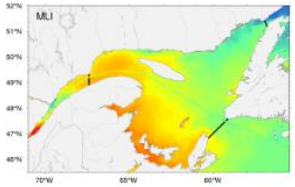
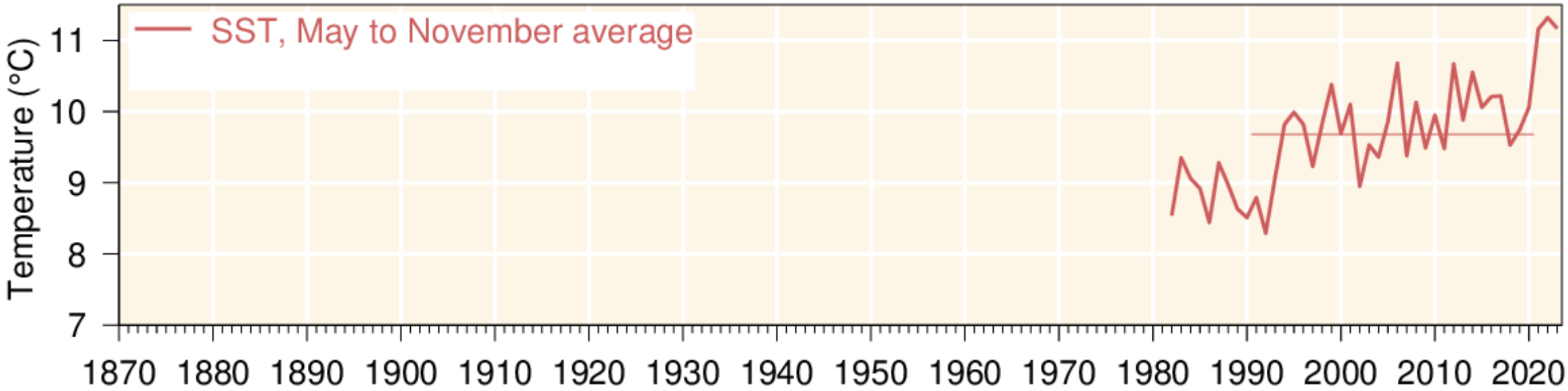


Sea surface temperature (SST) from satelittes



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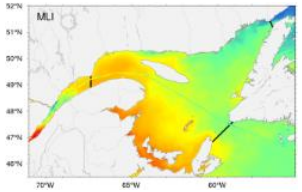

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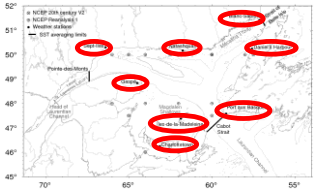
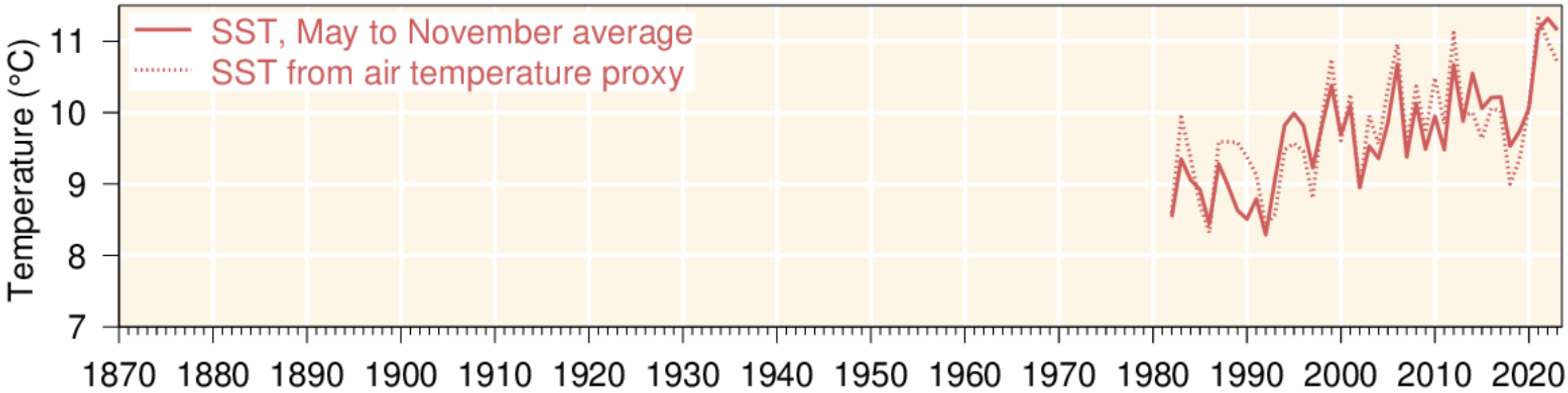


Interannual variability of May-November average SST is 72% explained by April-November air temperature.



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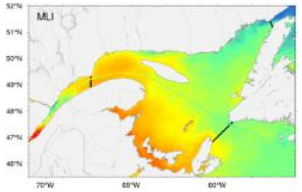

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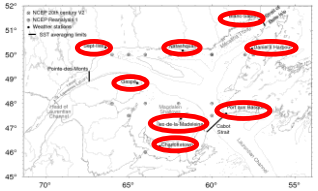

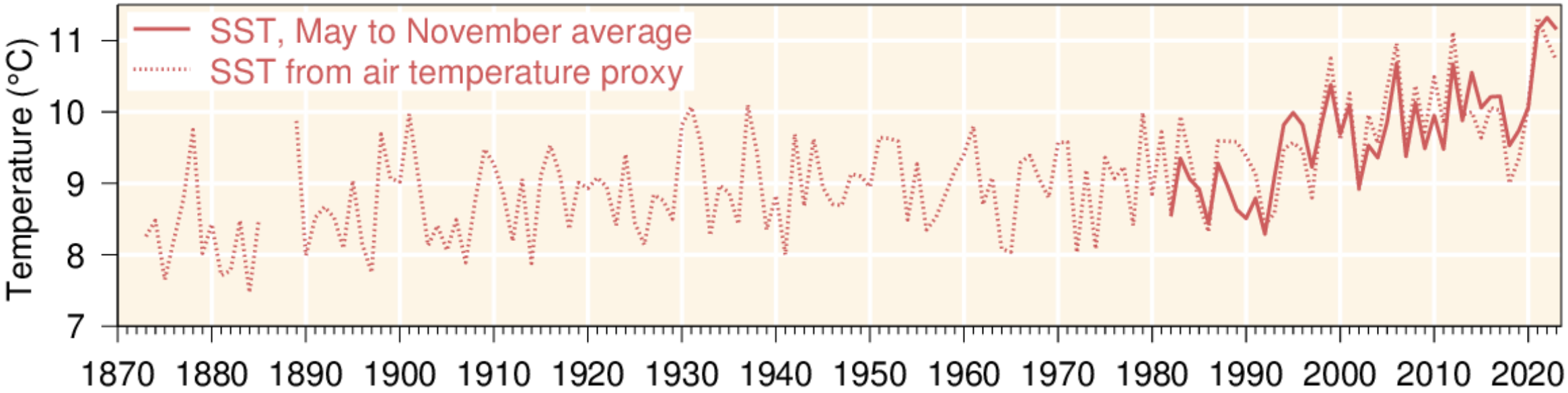

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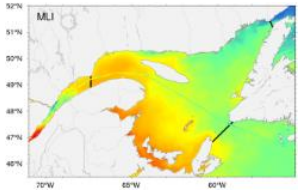

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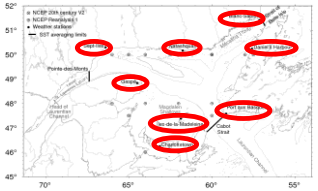

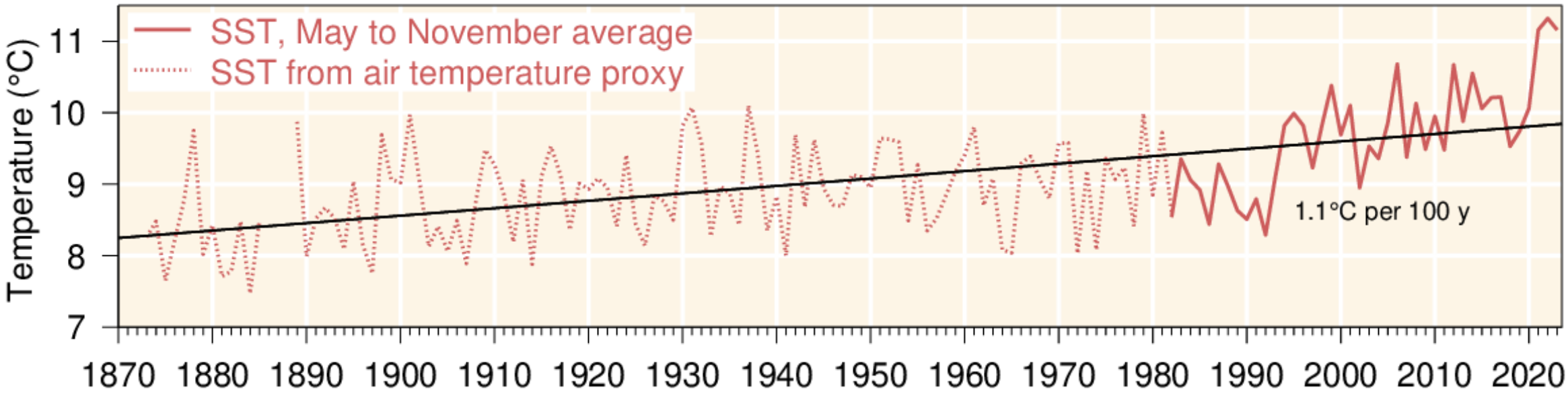

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Last 3 years have been the warmest on record.