NOAA STAR SOCD OceanView: The Level-4 thermal fronts module

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S3. Calibration, validation and product assessment
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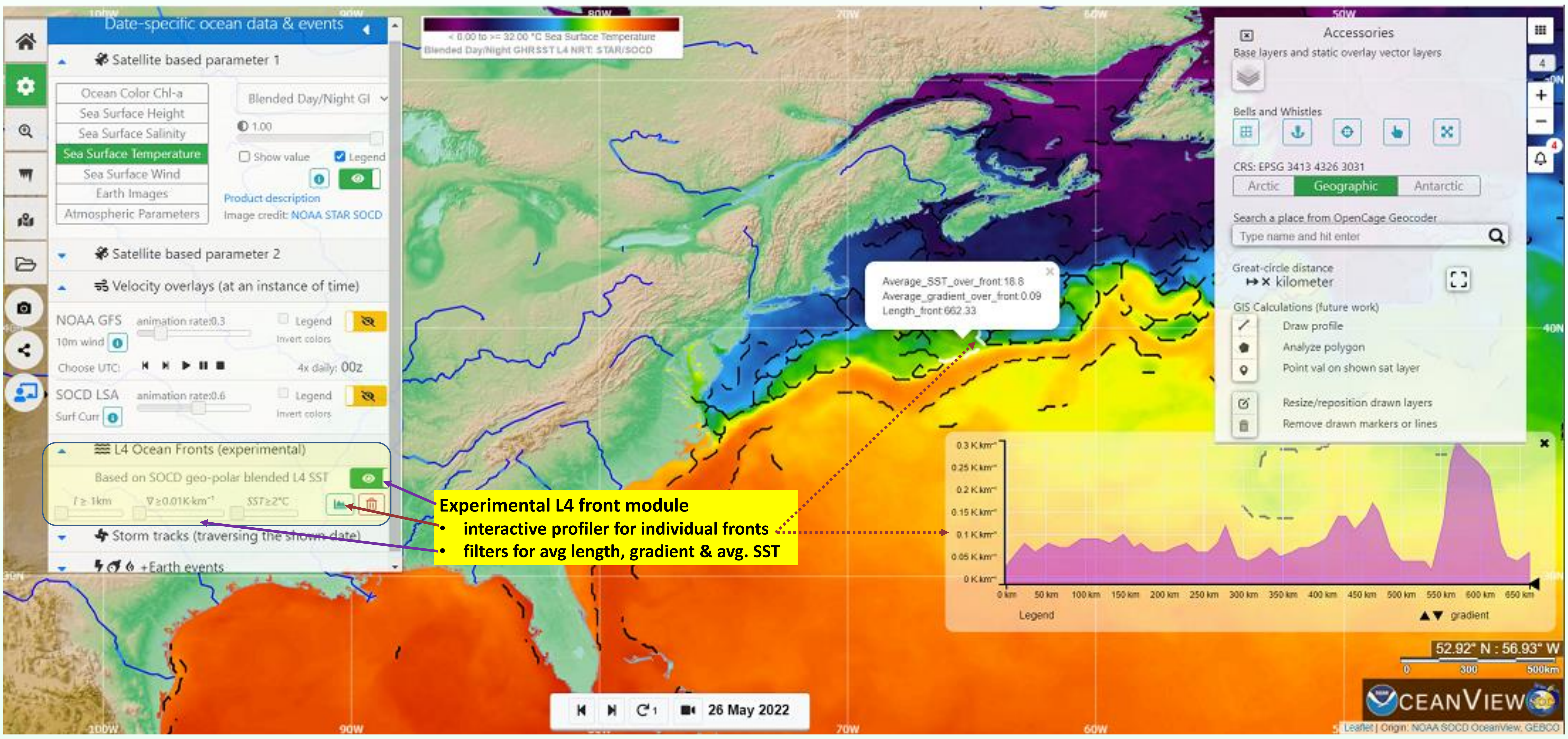
Preamble: The NOAA STAR SOCD OceanView (OV) v1.0 was publicly released in May-2021 at **https://www.star.nesdis.noaa.gov/socd/ov/**. The OceanView is a web-based application delivering an integrated display of remote sensing, *in situ*, and model data over oceans, polar areas, and coastal and inland waterways **[1]**. It incorporates products primarily from **NOAA** and some from **NASA** and other sources. The application comprises several modules, including an experimental thermal fronts component capable of **deriving** and **interactively visualizing level-4 SST fronts**. This L4 fronts module will potentially contribute to the GHRSST Climatology and L4 Inter-comparison Task Team (**IC-TT**) in discussion with its participants and other enthusiasts. Here, we demonstrate the existing capability with only one L4 SST and aim to gauge features of interest and potential extension to meet GHRSST TT objectives.



Simplified overview of: *Science* | *Technology* | *Example*

Numerical operations

Science

1. Calculate **gradient values** per pixel using finite difference, with central differences in the interior and first differences at the boundaries.
2. Use **Sobel operator** to detect edges. Canny was also tested (Marouan B.) but did not seem to provide significant improvement.

Technology

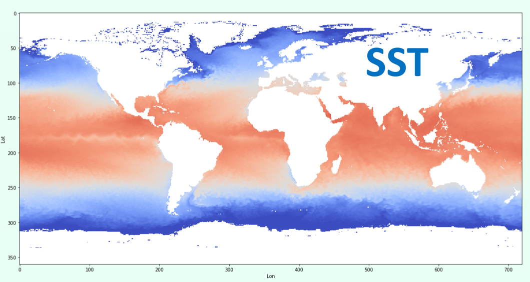
2D finite difference method

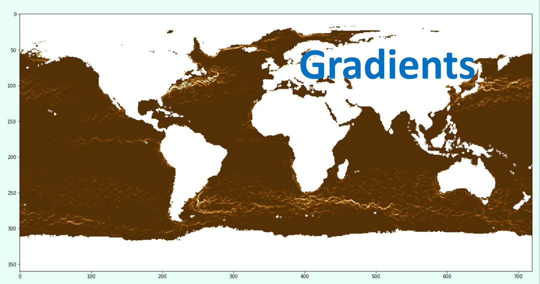
Calculate magnitude and adjust to the grid res.; Python NumPy

$$G_x = \begin{bmatrix} -1 & 0 & +1 \\ -2 & 0 & +2 \\ -1 & 0 & +1 \end{bmatrix} \quad G_y = \begin{bmatrix} +1 & +2 & +1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{bmatrix}$$

$$|G| = \sqrt{Gx^2 + Gy^2}$$

Example





Morphological operations

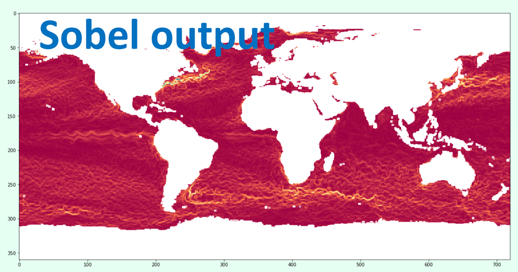
Science

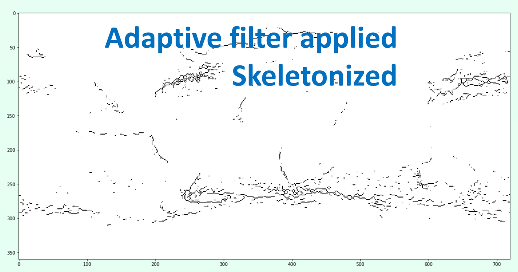
3. **Adaptive threshold** for Sobel filter using cumulative distribution function
4. **Binarize** to 1 or 0 using the above threshold
5. **Skeletonize** to make it thinner (1-pixel)
6. **Contourize** the detected edges (computer vision)

Technology

Python NumPy
SciKit
OpenCV

Example





Web-suitability operations*

Science

7. Store gradient values & location info for each point on the contours (for web interactivity)
8. Store average SST and length for each contour as attributes (for web interactivity)
9. Save all features in a GeoJSON file for web-display

*These steps enable web-visualization & provide interactivity

Technology

SSTs are tiled using a modified version of MRF technology (NASA JPL/GSFC)

LeafletJS for web-display of raster tiles and GeoJSON

A profiler (using D3.js) for deep-dive

Example

https://www.star.nesdis.noaa.gov/socd/ov/
[use chalkboard blue icon for onboarding/how to]

STATUS	Experimental
L4 SST data included	NOAA SOCD 5km blended geopolar [2]
Scalability to other L4	Moderate effort

IC-TT potential use

In a simple sense, a front is a boundary between two distinct fluid masses, e.g., ocean water, caused by currents, winds, and/or Coriolis force. These water masses may have different temperatures, salinity, or ocean biological parameters like chlorophyll-a. The fronts may dissipate quickly or can persist longer, and the water masses may converge or diverge. Aside from the physical reality, various L4 SST products can inherently resolve different features for various reasons [3, 4]. The overall long-term activities of IC-TT 3, as of now and that may change, are to:

1. Validate L2, L3, and L4 SST gradients in highly variable regions using SailDrones
2. Produce an online visualization tool for L4-SST gradients
3. Develop the science to calculate fronts and intercompare
4. Validate SST gradients/fronts with other independent but related data, e.g., salinity or altimeter currents
5. Compare feature resolution and its spatial consistency across marine regions
6. Compare SST gradients over seasonal and interannual time scales

The OceanView L4-front module contributes explicitly to **#2** above and will potentially contribute to **#3** and **#4** in coordination with members of the IC-TT. At this point, we seek feedback on the illustrated approach and suggestions for candidate L4 SSTs in this early attempt. Future efforts will consider including sea-truth validation by the IC-TT 3 led by Jorge Vazquez.

Summary

The Satellite Oceanography and Climate Division (SOCD) of NOAA STAR released the OceanView v1.0 in 2021. The L4 fronts module of OceanView currently has only one L4 SST front (NOAA GOES-POES blended). However, the system is scalable and will be expanded depending on identified needs and the path forward. This preliminary illustration aims to gauge features of interest and potential extension to meet GHRSST IC-TT objectives. The work is experimental and will likely undergo improvements in both algorithm and validation approaches.

References

[1] Dash, P. and DiGiacomo, P, 2021: The NOAA STAR SOCD OceanView (OV): an application for integrated visualization of satellite, in situ, and model data & ocean events – the debut release.; GHRSST XXII Proc. Virtual meeting, 7-11 June 2021. https://doi.org/10.5281/zenodo.5750123

[2] Maturi, E., and Coauthors, 2017: A New High-Resolution Sea Surface Temperature Blended Analysis. BAMS, 77–80, 21–30, https://doi.org/10.1175/BAMS-D-15-00002.1

[3] Martin, M., and Coauthors, 2012: Group for High Resolution Sea Surface temperature (GHRSST) analysis fields inter-comparisons. Part 1: A GHRSST multi-product ensemble (GMPE). DSR. II, 77–80, 21–30, https://doi.org/10.1016/j.dsr2.2012.04.013

[4] Dash, P., and Coauthors, 2012: Group for High Resolution Sea Surface Temperature (GHRSST) analysis fields inter-comparisons. Part 2: Near real time web-based level 4 SST Quality Monitor. DSR. II, 77–80, 31–43, https://doi.org/10.1016/j.dsr2.2012.04.002

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