



Objective mapping of persistent SST fronts based on global satellite observations

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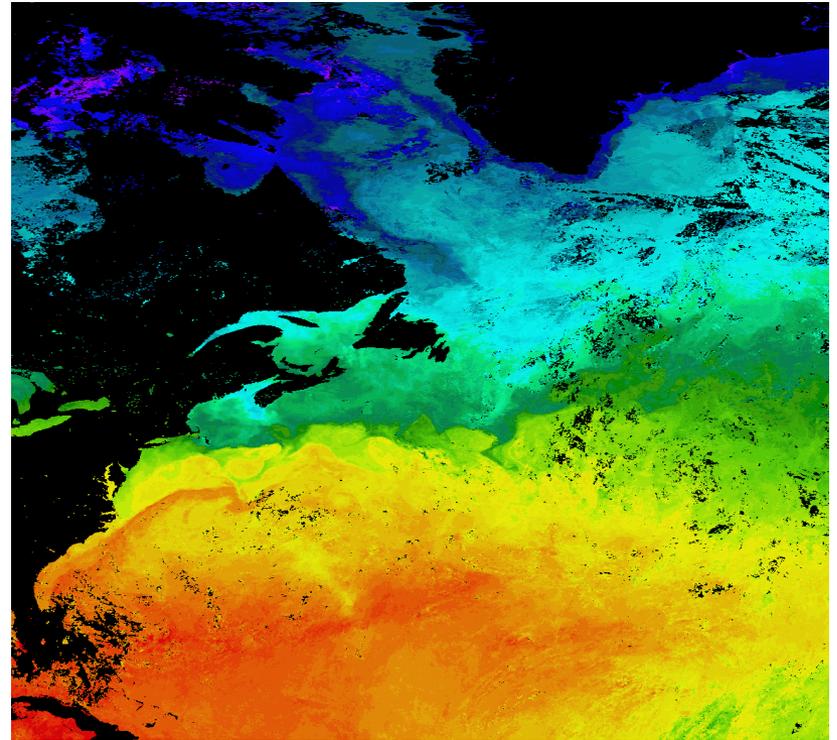
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Colloquium on Ocean Dynamics

Outline

- Context
- Objectives
- Datasets and Methods
- Results

What are SST fronts?

- Fronts are narrow boundaries between water masses of different properties.
- Sea surface temperature (SST) fronts separate water masses with distinct SST.
- Persistent SST fronts occur at the same location over extensive periods of time (months, seasons, years...)



NASA, Terra MODIS composite SST image.

Previous studies

SST measurements from space started in the late 1970s, and allowed to develop a global perspective on fronts.

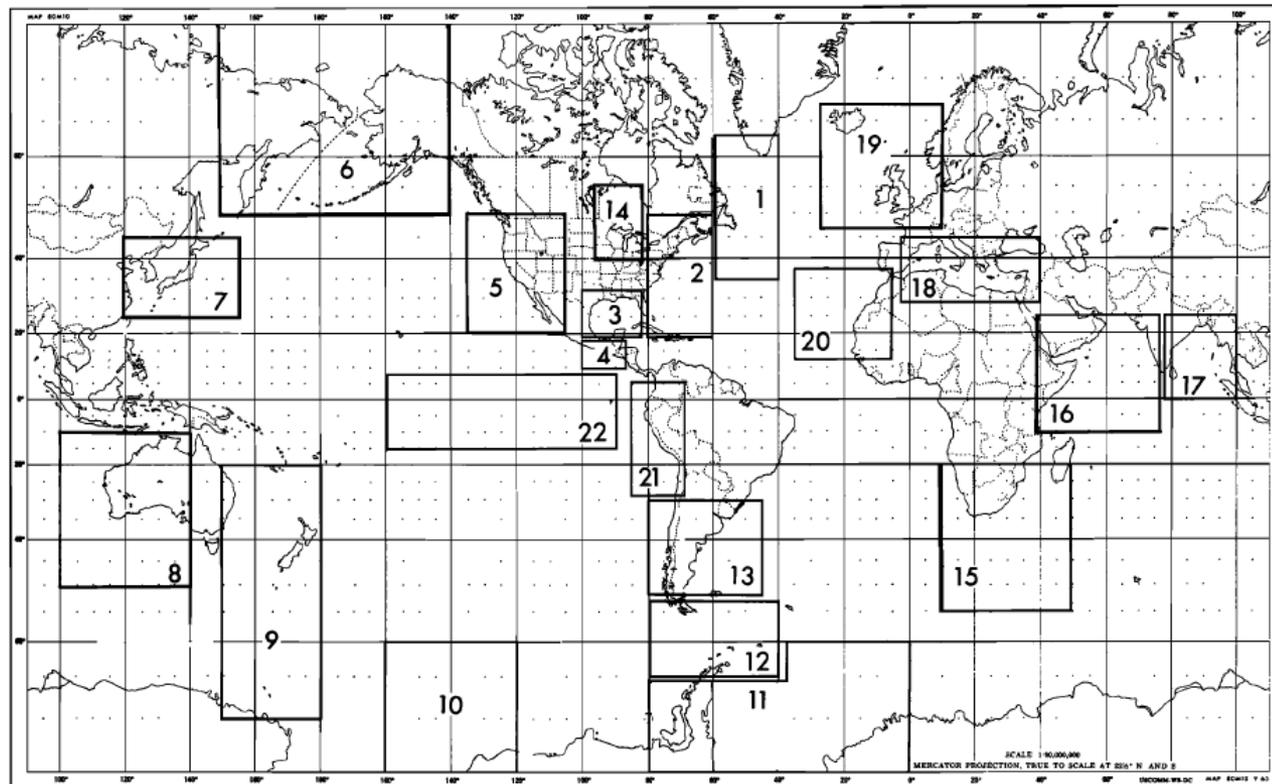
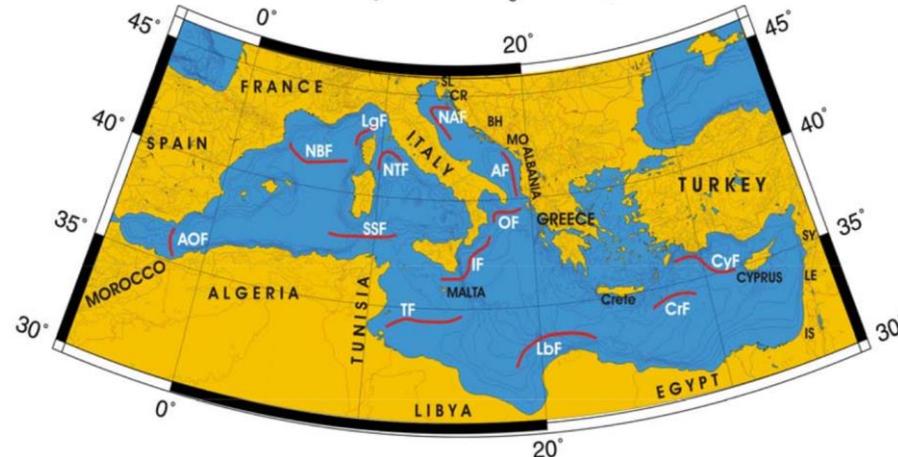
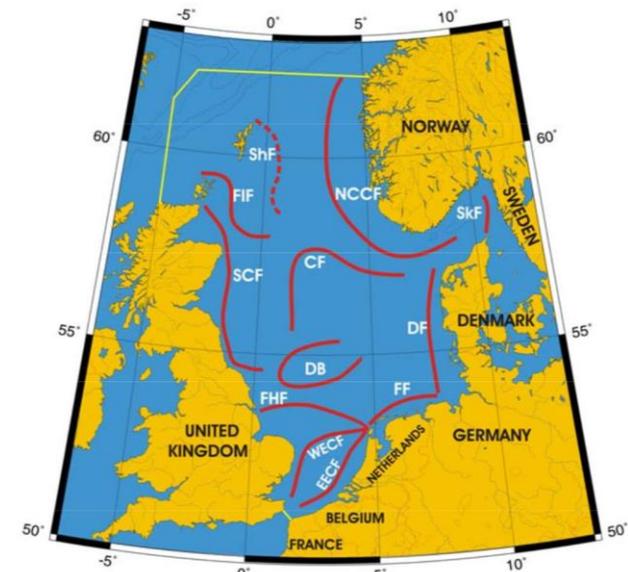
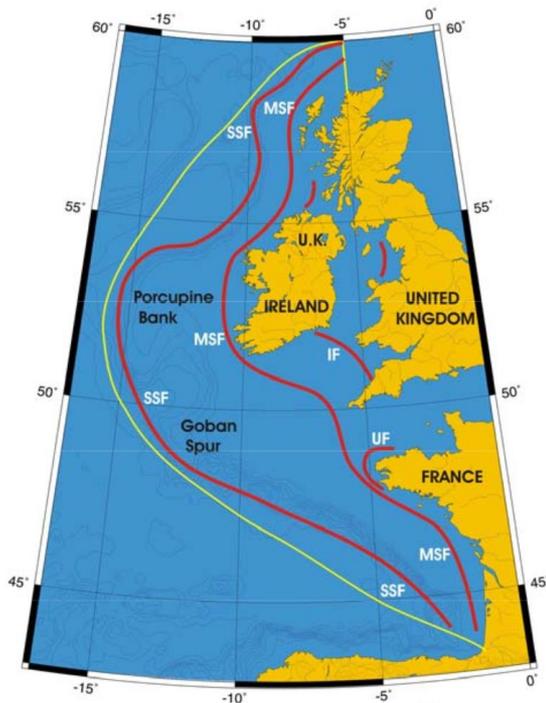


Fig. 1. The areas of the world in which sea surface temperature fronts have been observed in satellite thermal infrared images are outlined from 1 to 22 on the map of the world.

Previous studies

A collection of regional maps of SST fronts was published more recently. Fronts were hand-drawn from satellite maps, and named according to their geography.



From Belkin et al., 2009.

Objectives

- To design an **automated** method, to reduce human bias in locating persistent SST fronts.
- To develop **global** maps of fronts, since most observational studies on fronts are typically regional.
- To establish a **consistent climatology** of SST fronts based on satellite data.

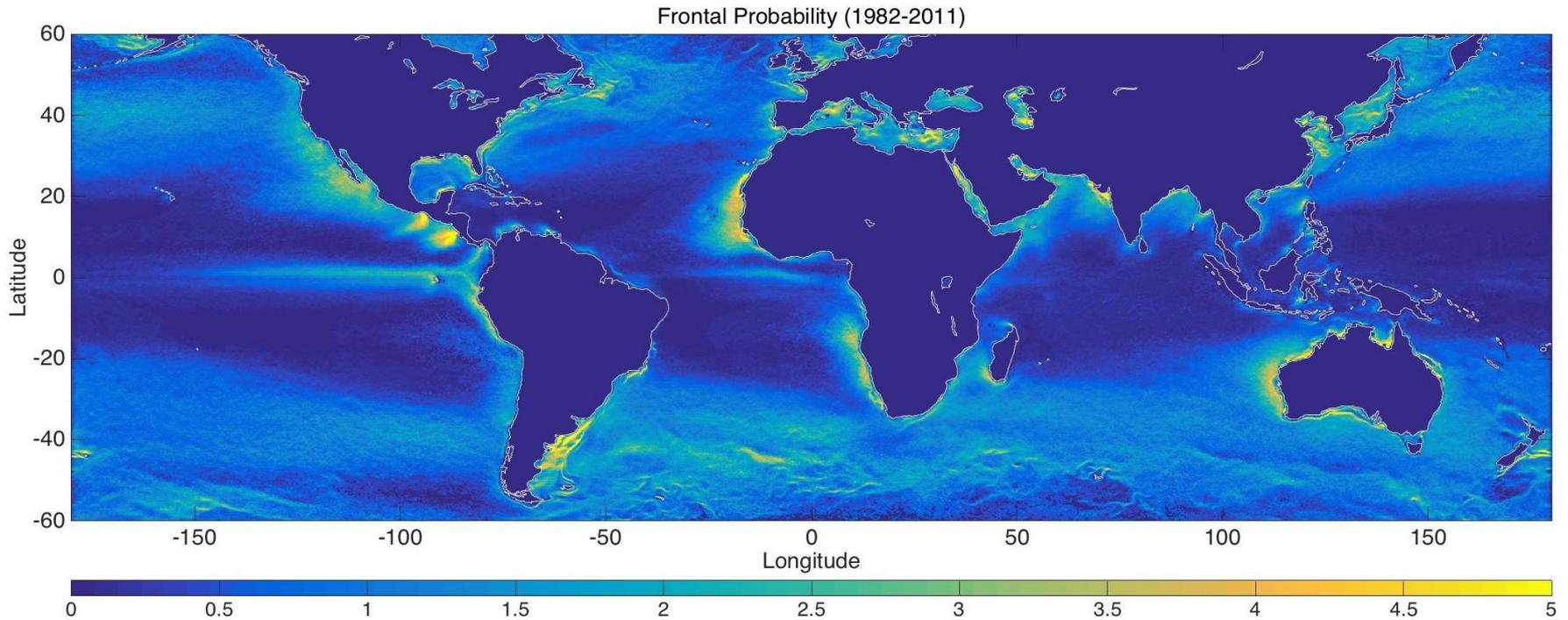
Datasets



- Pathfinder AVHRR (Advanced Very High Resolution Radiometer)
1982-2011
- MODIS (MODerate resolution Imaging Spectroradiometer)
Aqua and Terra 2003-2011
- 17,100+ L3 global gridded daily SST fields at a spatial resolution of 4 km.
- Only nighttime fields were used to avoid diurnal warming effect.

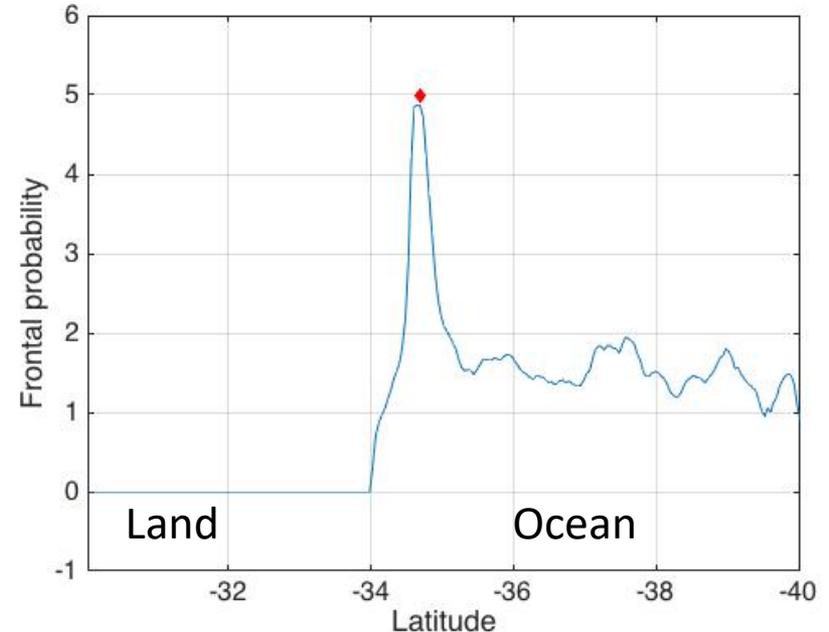
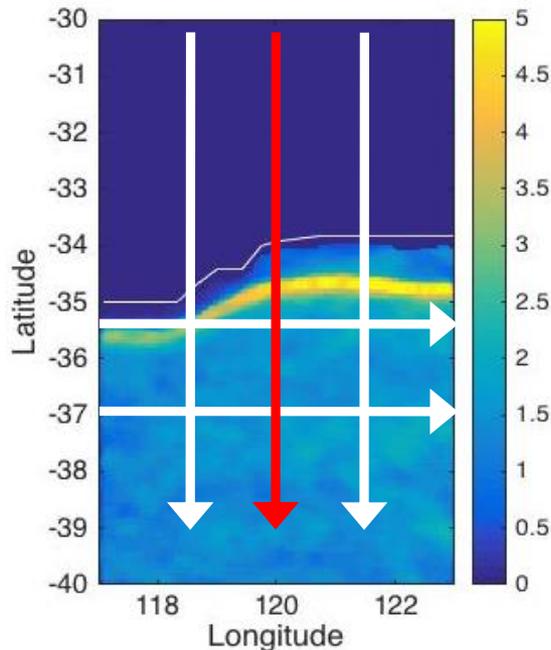
Frontal probability

Frontal probability is a measure of the likelihood to observe fronts relative to the cloud cover over a period of time.

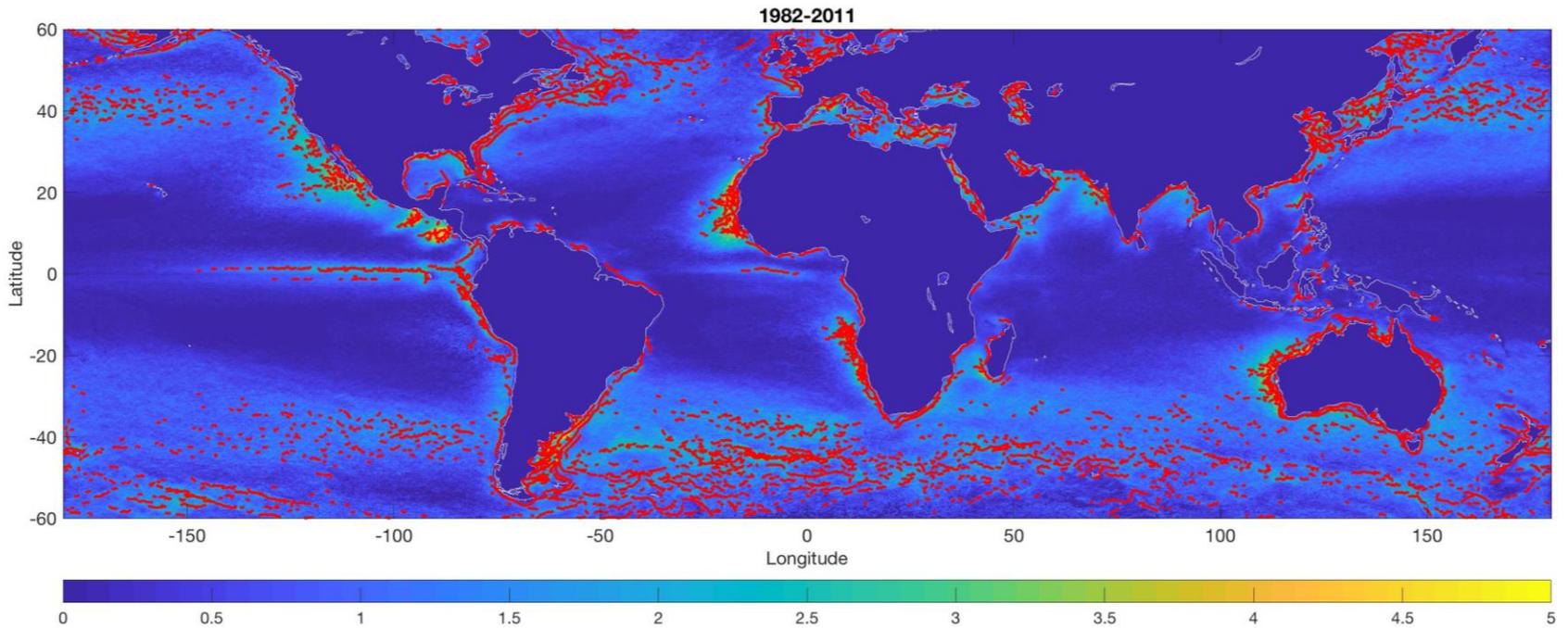


Methods

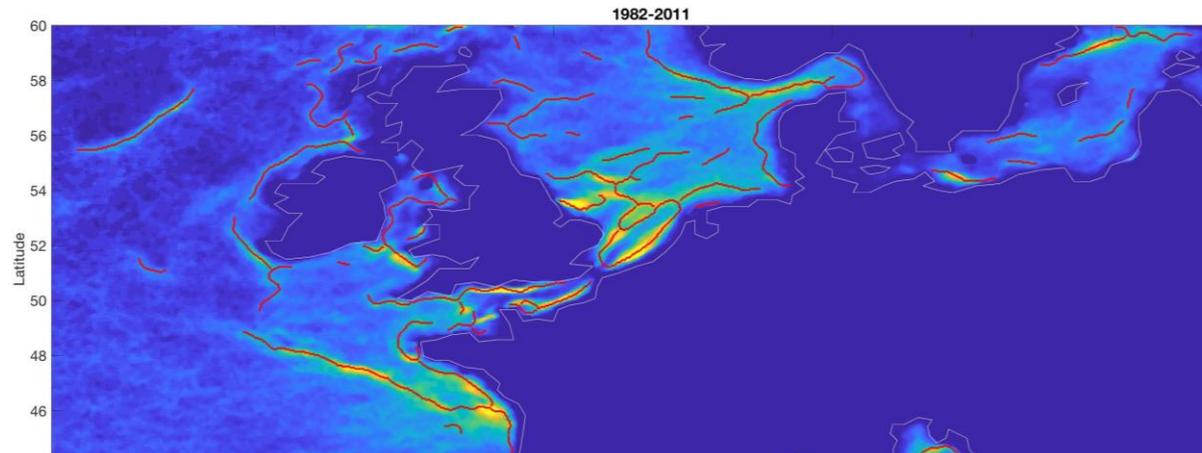
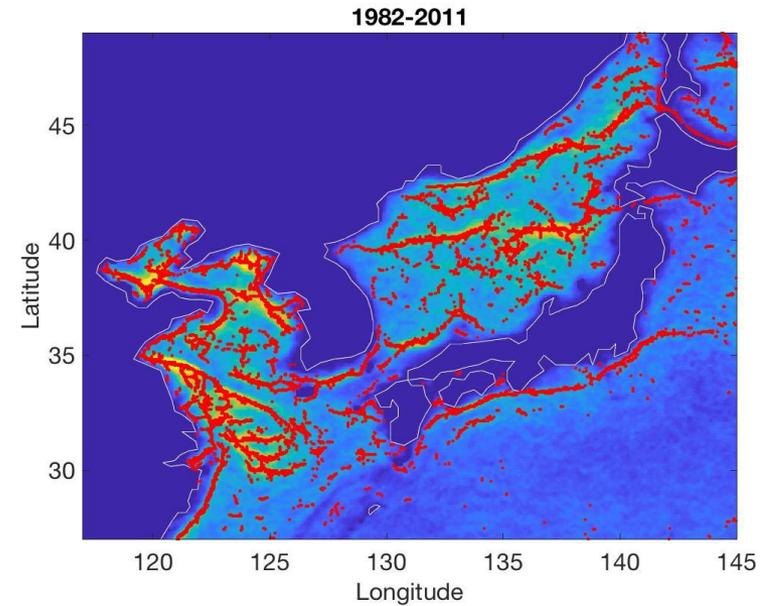
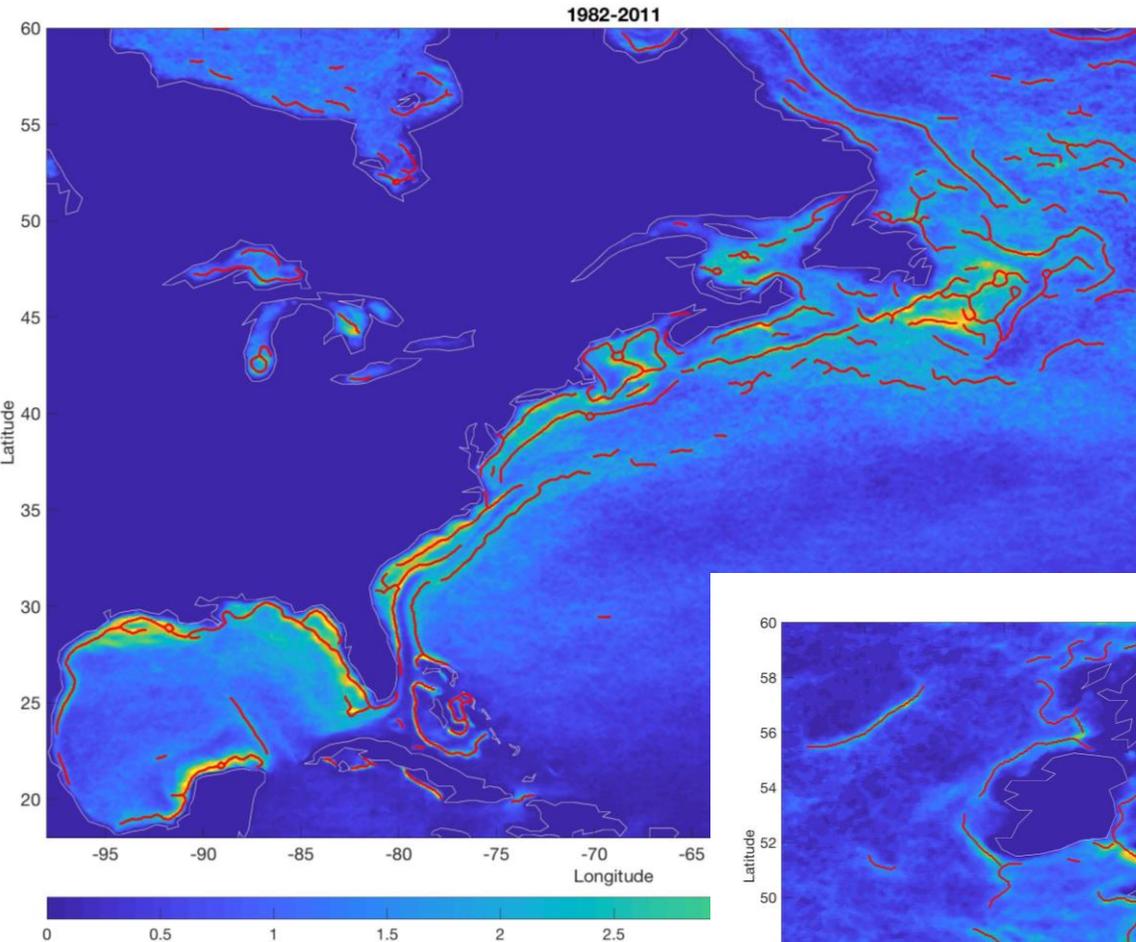
- The frontal probability field is scanned vertically and horizontally to find local maxima.
- Depending on the height and the width of the peaks, noise can be removed from the original signal.



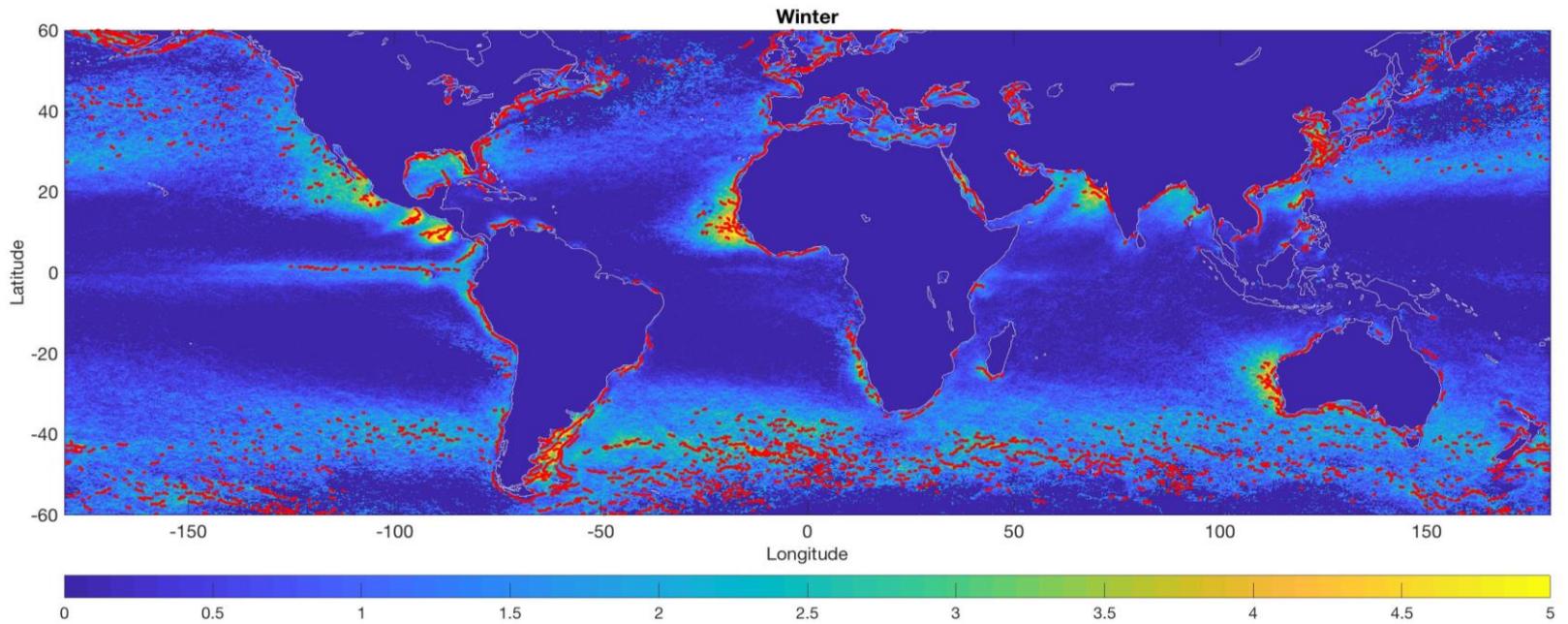
Results: Long-term map



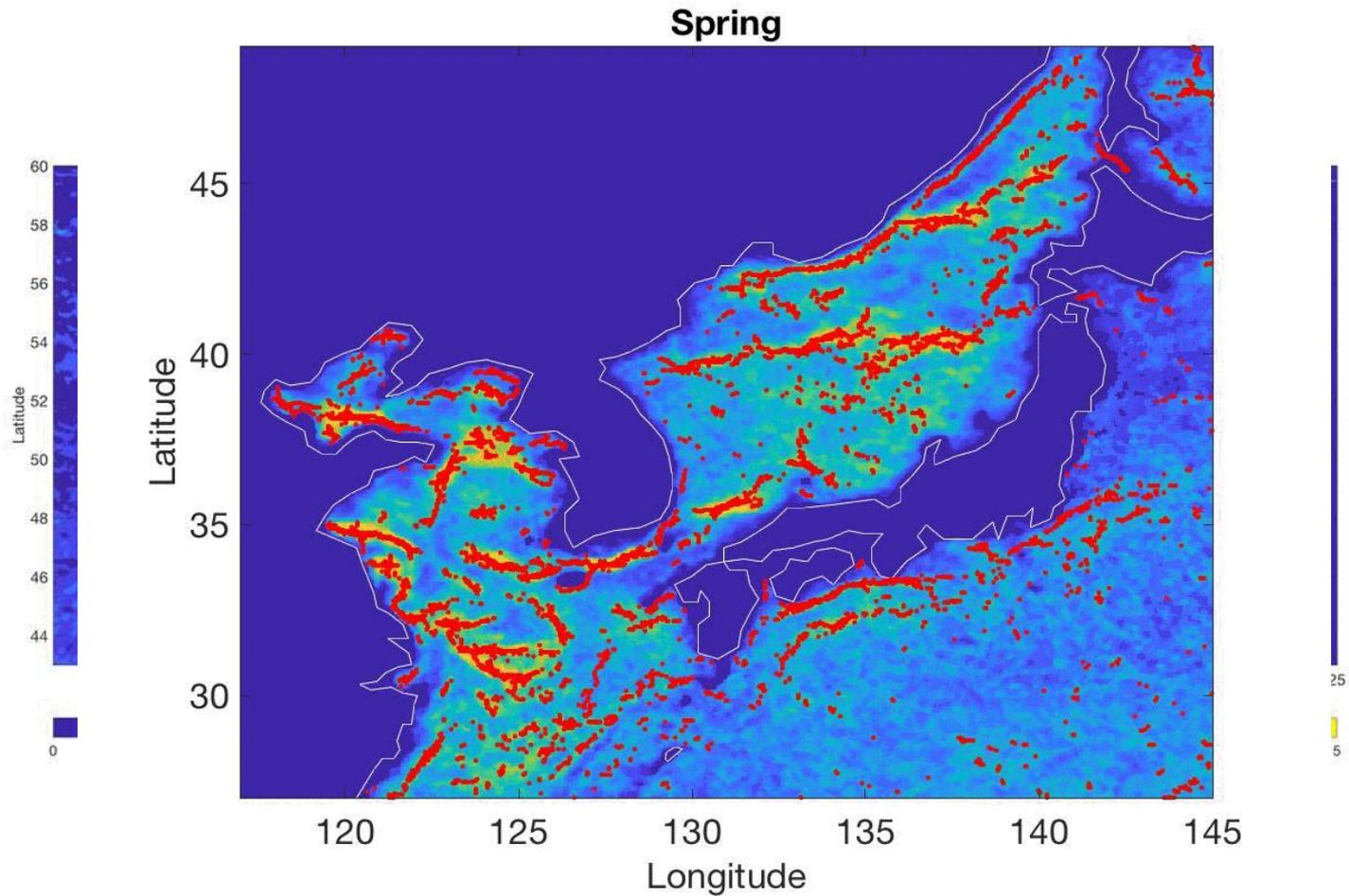
Results: Long-term map - regions



Results: Seasonal maps

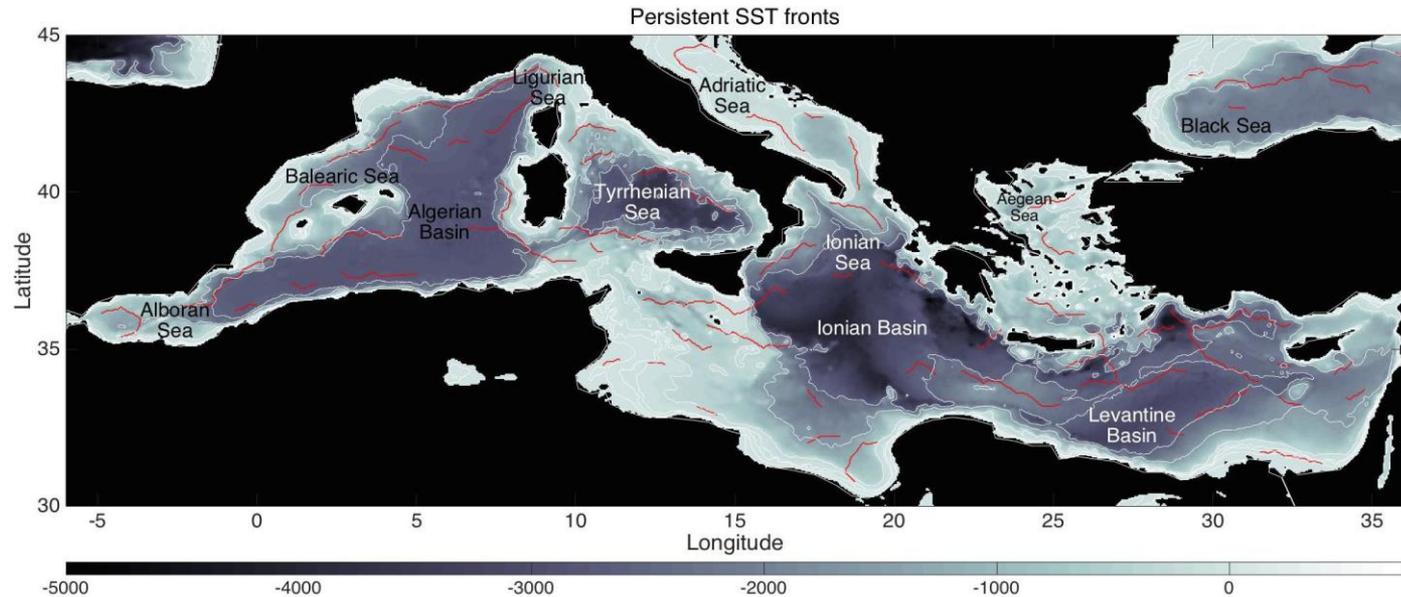
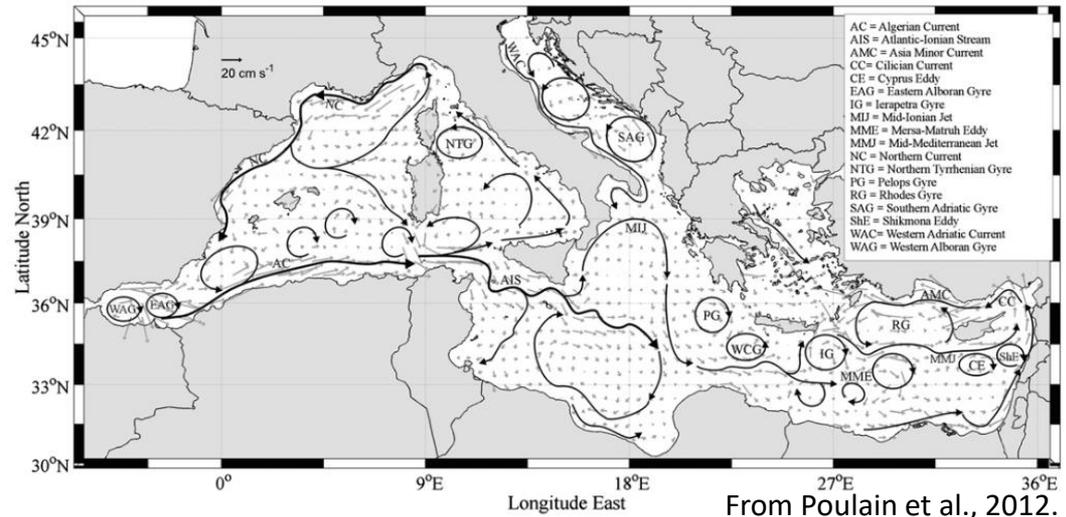


Results: Seasonal maps - regions



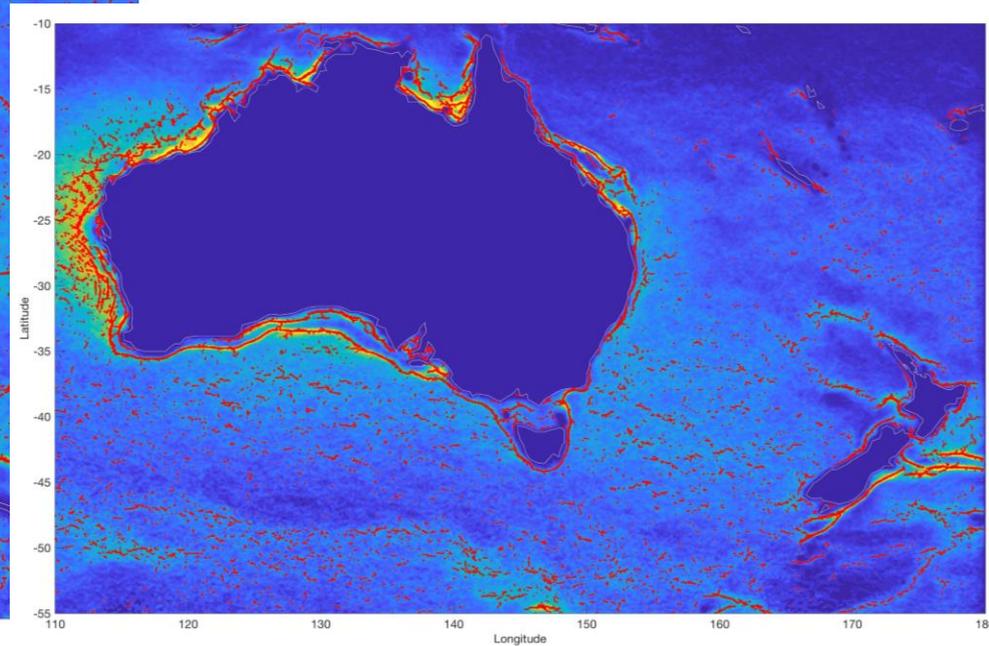
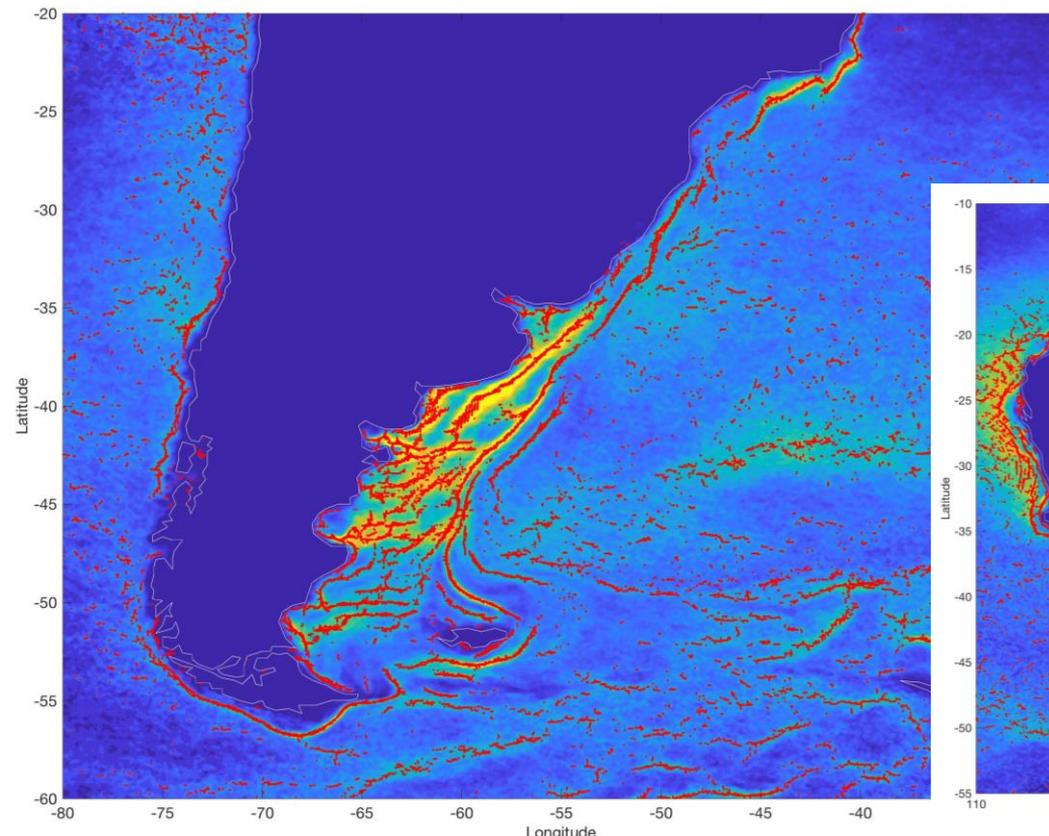
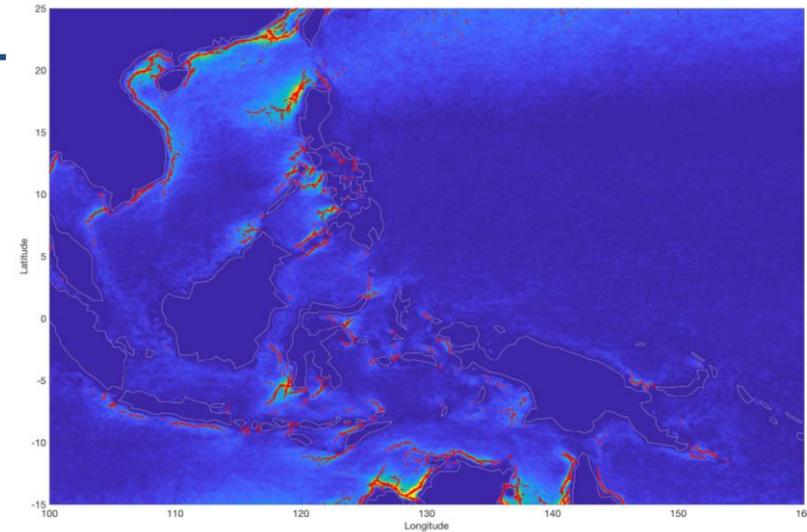
Interesting findings

In some well-documented areas, like the Mediterranean Sea, more persistent SST fronts are detected. Here, the fronts' location tends to match the surface geostrophic currents of the region.



Interesting findings

In some under-documented areas, such as Patagonia, Southeast Asia and Oceania, new persistent SST fronts are detected through the algorithm.



Results

- Persistent fronts of submesoscale and larger spatial scale were successfully detected through this method.
- The frontal maps can be used during research cruises to assist in finding SST fronts at sea.
- The location of the fronts is a stand-alone dataset, which can be used in combination with either in-situ or other remote sensing data.

Implications

- By refining the definition of large frontal zones, associated marine ecosystems can be observed in greater details.
- Biological activity is linked to the presence of fronts and SST fronts can be used as predictor in fisheries studies.
- An estimation of air-sea gas exchanges occurring at persistent SST fronts, as well as the contribution of these fronts to the heat and energy balances may be investigated and add to our understanding of ocean dynamics.

Summary

- An automated method to detect SST fronts was derived based on satellite data, for the long-term mean and climatological seasons.
- 3,000+ fronts per map were found, some in under-documented regions, in the Southern Hemisphere, some in well-studied areas, like Western Europe.
- A global database is being developed, including the fronts location and properties, and should be made available to the scientific community soon.

Thank you for your attention

Any questions?

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