

# DETECTING FINE SCALE CIRCULATION IN THE HAURAKI GULF - BAY OF PLENTY

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## Motivation

Fronts and eddies are common features in the ocean, whether in the open-sea environment, or along the coasts. While the knowledge of large scale features is growing [2, 3], very little is known about finer structures, i.e. around 1km scale.

This project aims to understand the submesoscale circulation in the Hauraki Gulf-Bay of Plenty area and its impact on the ecosystem.

Fronts and other structures in the 1km scale are highly variable in time, and stay stable for a week at most. In order to detect them with precision, it is necessary to scan multiple images in a short time. We use an algorithm processing ocean color images showing chlorophyll at very fine resolution (0.3km).

## Detection: pyBOA

### Key challenges

- Detect gradients
- Avoid deleting local extrema

### Solution: MF3in5 [1]

Isolating the center of a 5\*5 windows, then applying a median filter (MF) on the center of a 3\*3 window (if both are extrema).

0.99	1.16	1.26	1.38	1.46
0.84	0.92	1.01	1.14	1.22
0.62	0.7	0.79	0.95	1.03
0.48	0.52	0.58	0.69	0.85
0.46	0.46	0.47	0.55	0.65

### Project challenges

- Clouds presence
- Avoid slicing the image
- Allow detection near and off-shore on the same threshold
- Artefacts on images
- Go from gradient to single line fronts

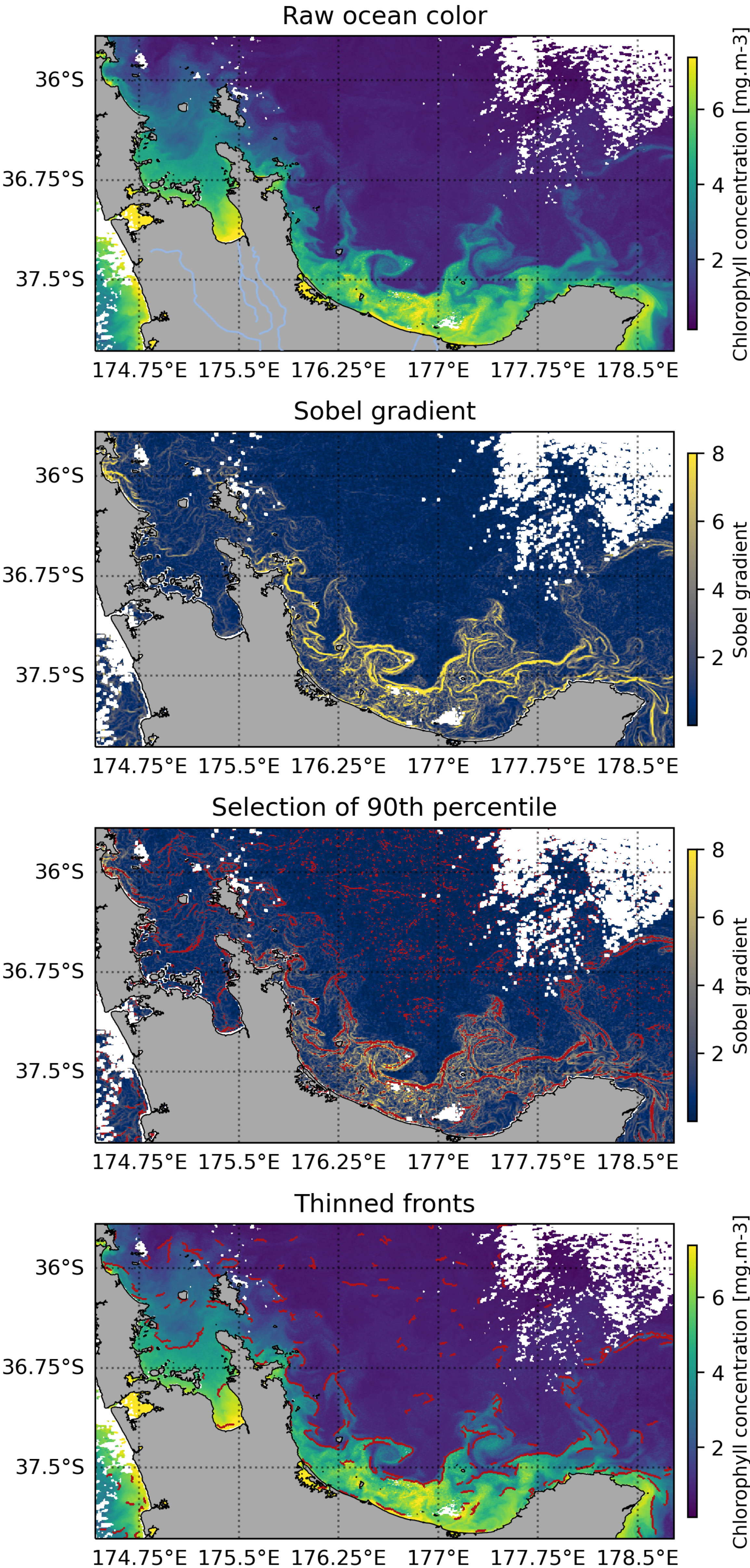
### Project solutions

- Flags all local extrema in the 5\*5 windows and 3\*3 window, and compare them with the centers' value.
- Isolating clouds vicinity
- Selecting gradient > 90<sup>th</sup> percentile in rolling window
- Thinning with a morphological approach, including holes and isolated features removal

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## pyBOA in action

pyBOA outputs using chlorophyll concentration taken on the 10<sup>th</sup> of August 2021.



## Frontal distribution (work in progress)

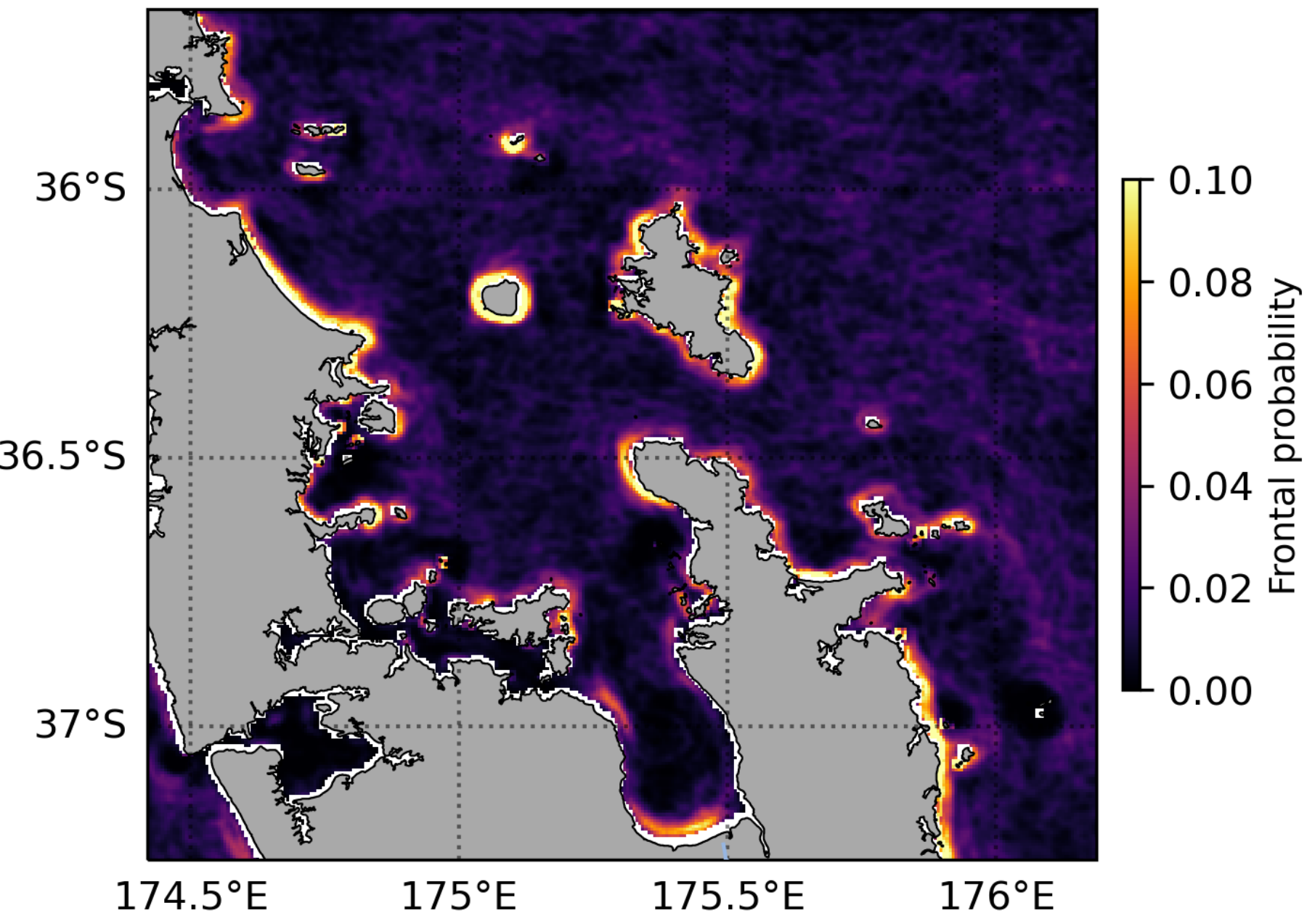


Fig. 5: Fine scale frontal probability in the Hauraki Gulf.

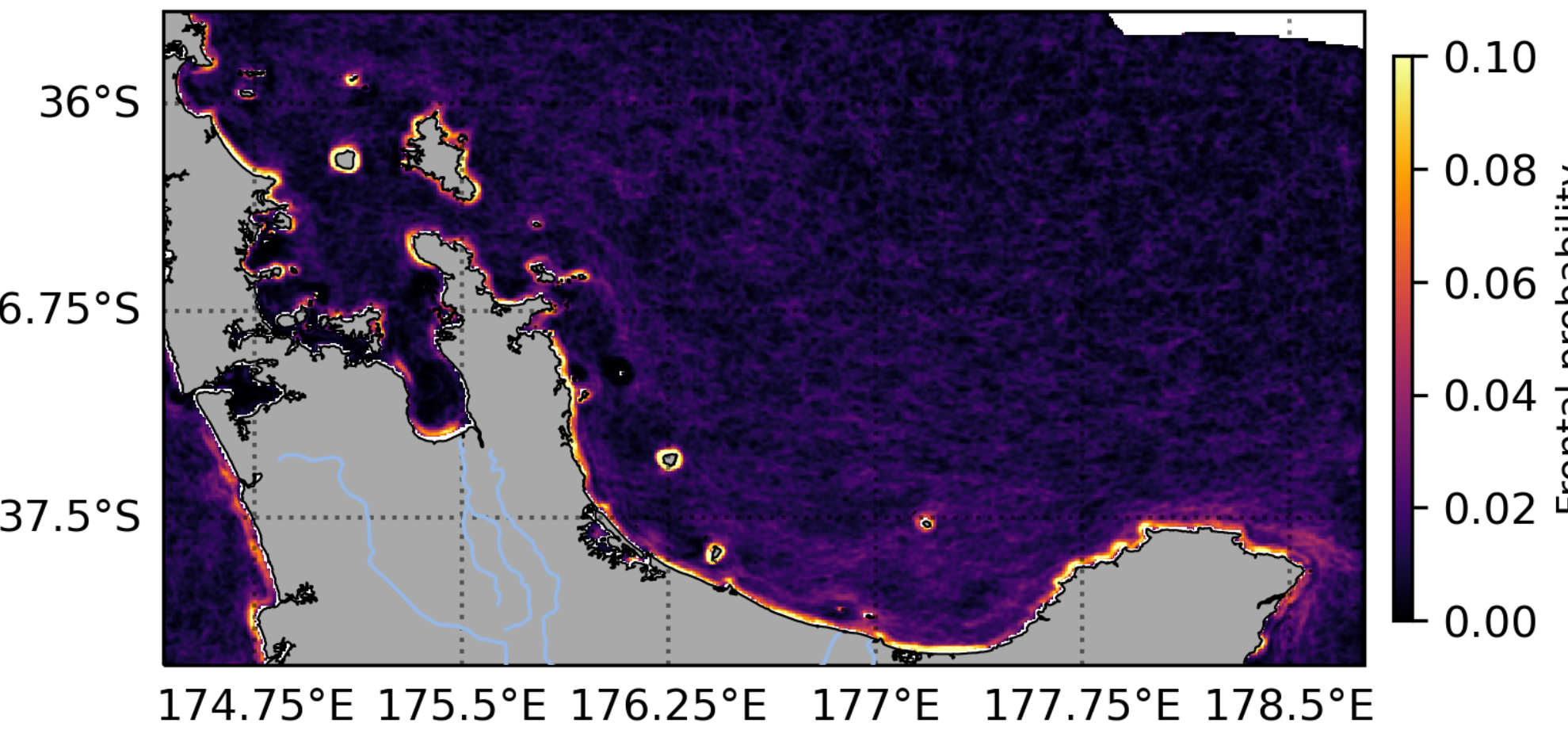


Fig. 6: Fine scale frontal probability including the Bay of Plenty.

### Hauraki Gulf (Fig.5)

- Higher probability seen in:
- Between Kawau and Waiheke
  - Between Waiheke and Colville Cap
  - In the Colville channel

### Bay of Plenty (Fig.6)

- Behind Mercury Islands.
- Plumes occurring after all islands in the bay.
- Major probability cloud East of Tauranga until the East Cape.
- Important Plume after East Cape.

## Data sourcing

The raw ocean color data used in the pyBOA are provided by the Copernicus Marine Service and available at <https://doi.org/10.48670/moi-00278>.

## References

- [1] Igor M. Belkin and John E. O'Reilly. An algorithm for oceanic front detection in chlorophyll and SST satellite imagery. *Journal of Marine Systems*, 78(3):319–326, October 2009.
- [2] L.F. de Pourtales. Contributions to the fauna of Gulf-stream at great depths. *Annals and Magazine of Natural History*, 3(13):87–92, January 1869.
- [3] K. Ridgway and K. Hill. The East Australian current. NCCARF Publication, 2009.

Access to pyBOA

