



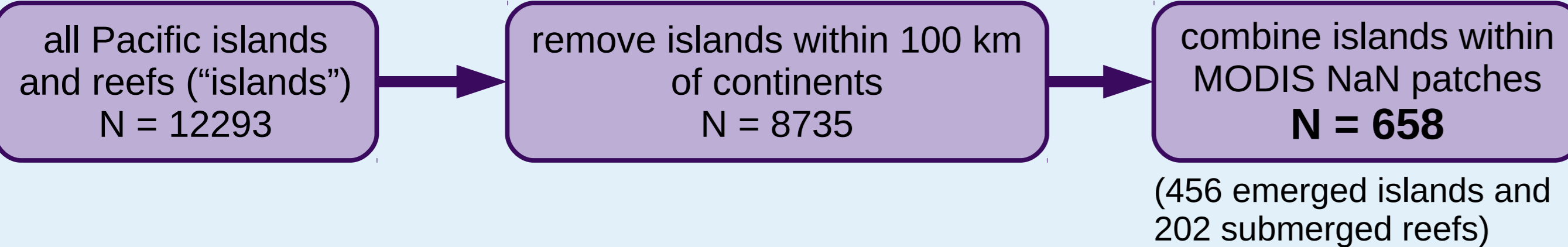
## Overview

- The **island mass effect (IME)** is defined as a chlorophyll concentration (Chl) increase in the vicinity of islands (e.g., Doty and Oguri, 1956). This may be a near-ubiquitous process according to a 35-island study (Gove et al., 2016), but basin-scale impacts on Chl and phytoplankton community composition are unknown.
- Here we systematically investigate all islands and atolls in the tropical Pacific by using an **algorithm automatically detecting the IME zone from satellite Chl**. We contrast physical and biological variables within climatological IME and background (BG) zones for each island.
- **Goals:** (1) **quantify** the IME impact on phytoplankton biomass and diversity; (2) **classify** the islands as a function of enrichment processes and phytoplankton response.

## Methods

### ISLAND AND REEF DATASET

Islands = closed contours in the GSHHS full resolution coastline  
 Reefs = ETOPO1 pixels shallower than 30m (submerged or matched with islands)



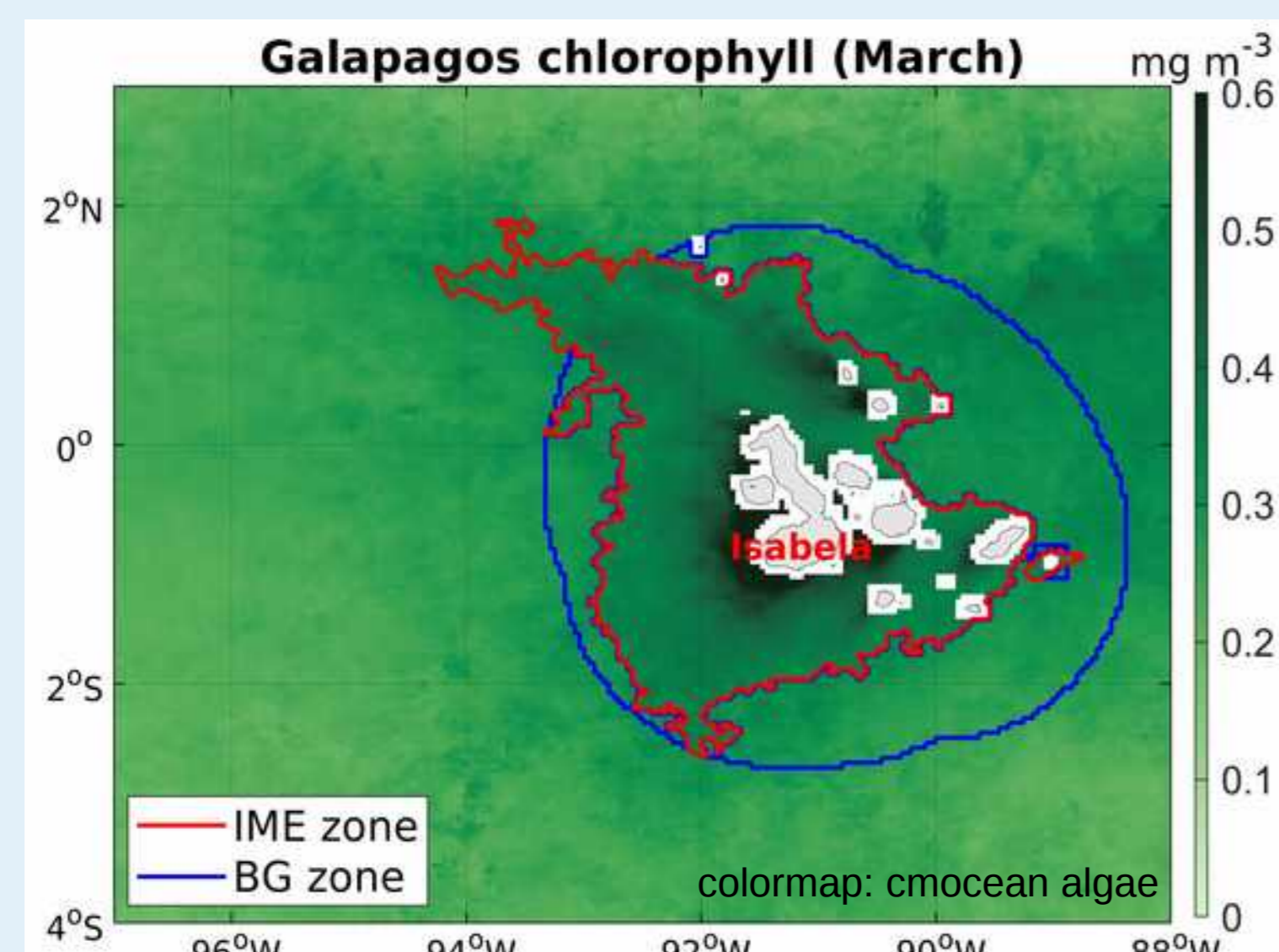
### IME AND BACKGROUND ZONE DETECTION

- Sort islands by Chl\_max = highest nearby Chl(\*)
- For each islands, iteratively lower the IME contour cChl starting at Chl\_max, until one of the 4 criteria below is met. **IME zone** = inside the cChl contour.
- Define the background area **BG** as the first nIME pixels closest to the island outside of the IME zone (nIME = # of IME pixels). Chl\_bg = mean Chl in BG area.

$$\text{IME strength} = \text{Chl}_{\text{max}} - \text{Chl}_{\text{bg}}$$

#### 4 criteria to stop iterations:

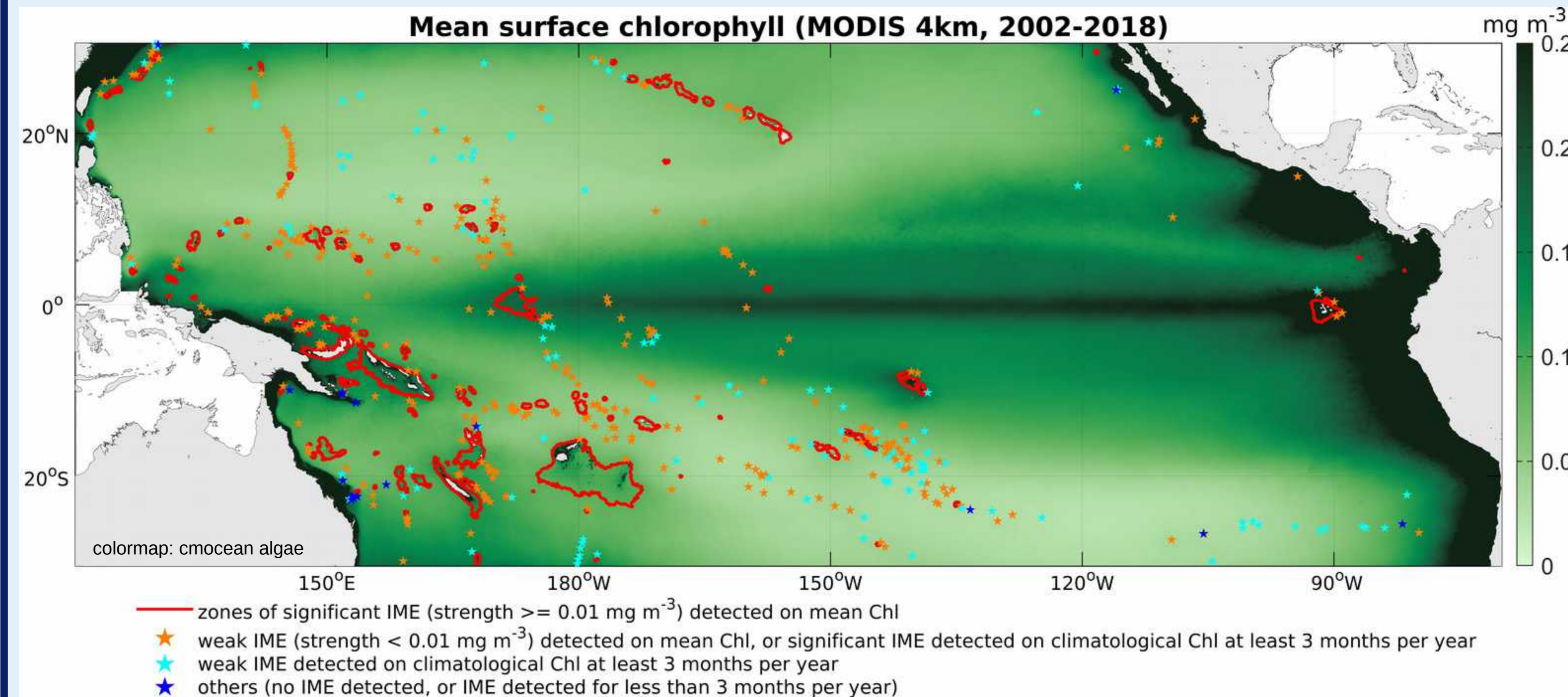
- cChl lower than the min nearby Chl
- the IME zone is too large (exiting an arbitrary circle or touching continents)
- the IME zone intersects a previously detected IME
- zones of high Chl are found within the IME zone, not connected to the island.



Example of IME and background zones detected for the Galapagos islands. Here the Isabela IME is merged with IMEs from smaller islands.

(\*) Ocean color data removed in pixels < 30 m depth to avoid bottom contamination (Gove et al., 2016).

## Results



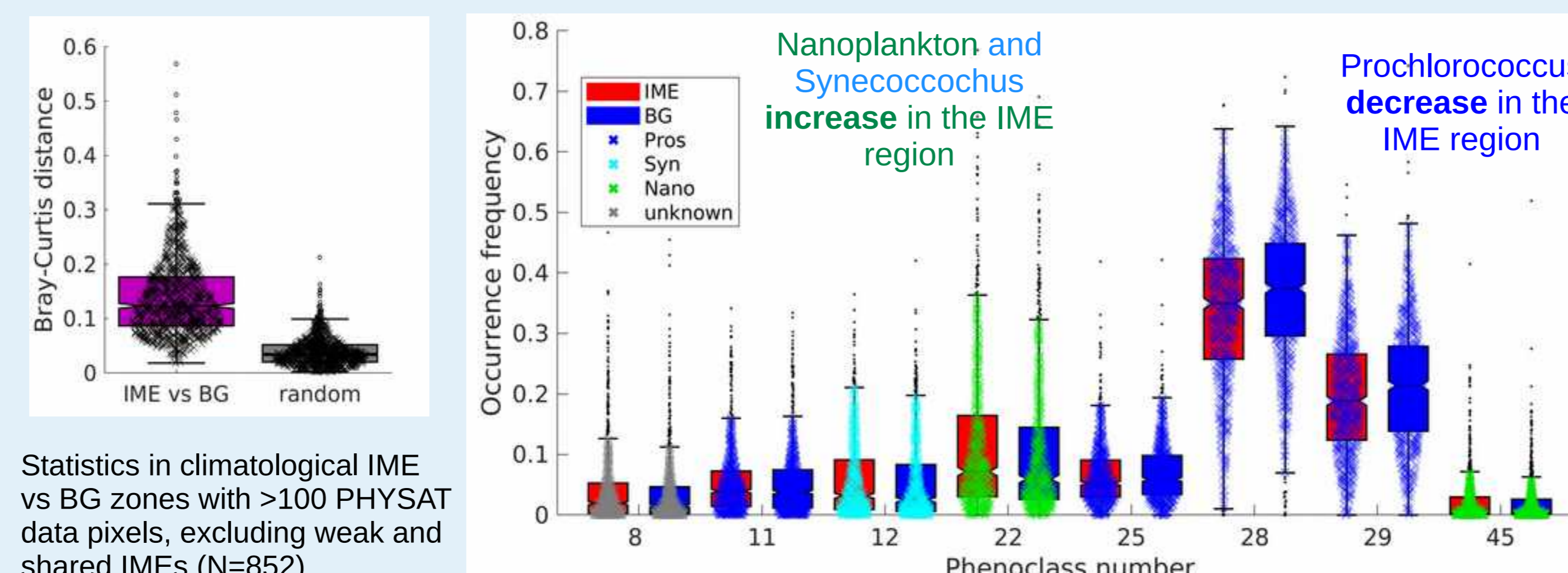
— zones of significant IME (strength  $\geq 0.01 \text{ mg m}^{-3}$ ) detected on mean Chl  
 ★ weak IME (strength  $< 0.01 \text{ mg m}^{-3}$ ) detected on mean Chl, or significant IME detected on climatological Chl at least 3 months per year  
 ★ weak IME detected on climatological Chl at least 3 months per year  
 ★ others (no IME detected, or IME detected for less than 3 months per year)

### GLOBAL IMPACT

- ➔ **32% of islands have significant IMEs** on a seasonal basis at least 3 months / year (59% including shared IMEs, 98% also including weak IMEs).
- ➔ On average, IMEs represent **2% of the tropical Pacific area**
- ➔ **16% Chl increase** on average for significant IMEs (9.5% mean Chl increase near islands)
- ➔ Represents **~ 580 tons of Chl** over a 10 m surface layer.

### IMPACT ON PHYTOPLANKTON COMMUNITY

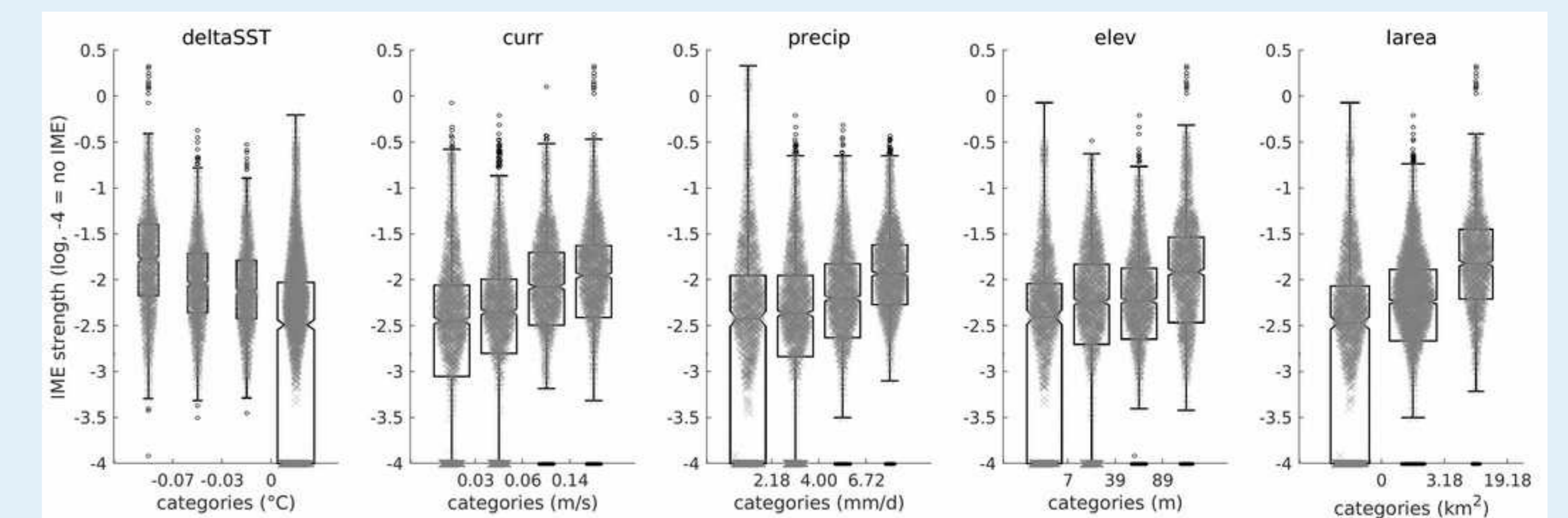
**PHYSAT** = ocean color radiance anomalies clustered into "**phenological classes**" and labelled using HPLC data (Alvain et al., 2008; Rêve-Lamarche et al., 2017). Climatological frequency of occurrence computed for each pixel and each class.



**Above:** Bray-Curtis dissimilarity between IME and BG communities, compared with random pixel drawings.  
**Right:** frequency distribution in IME and BG zones for dominant phenoclasses.  
**Bottom:** comparison of biodiversity indices in IME and BG zones.

➔ **IMEs increase biodiversity and impact the phytoplankton community composition**

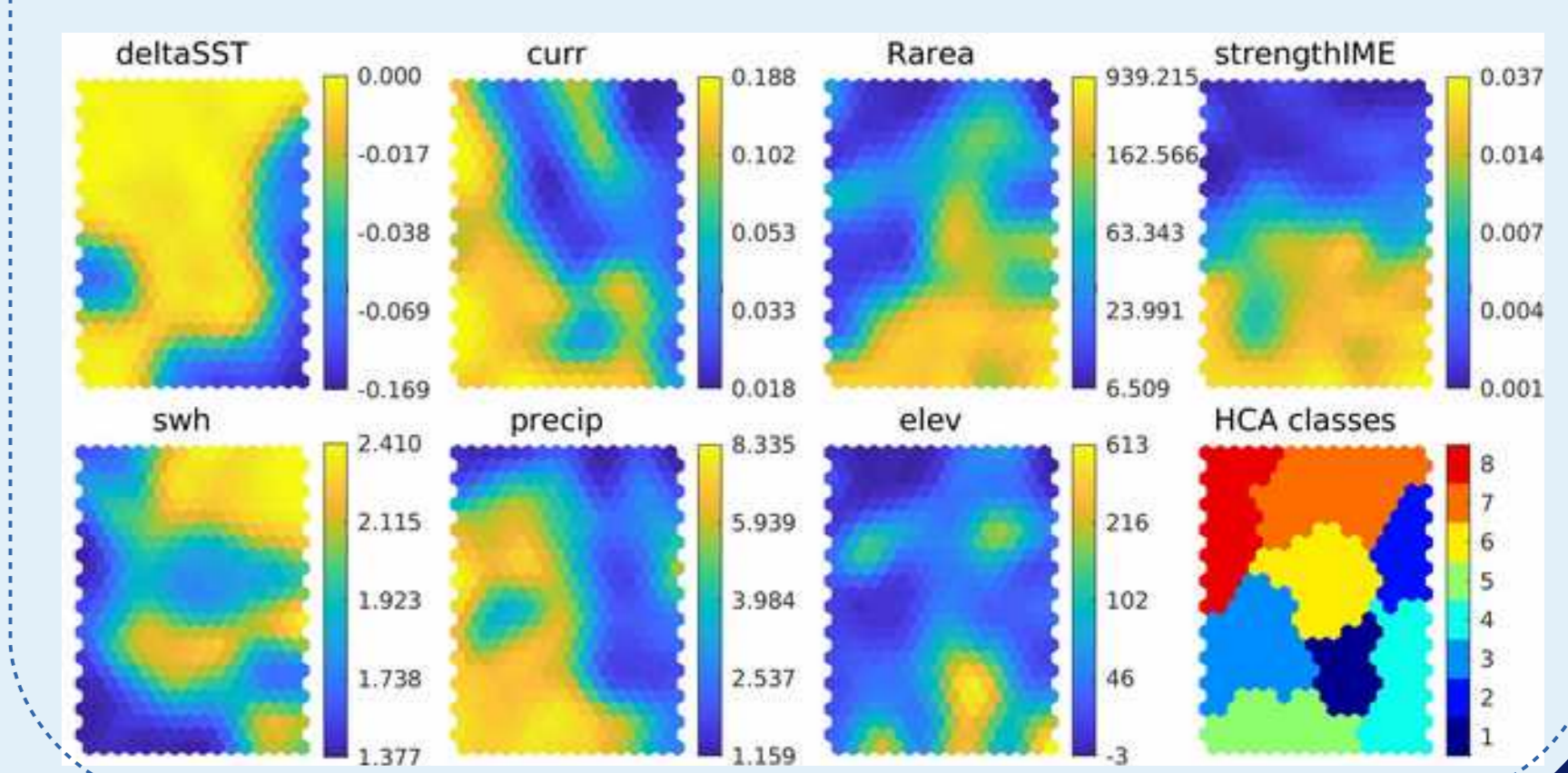
### PHYSICAL FORCING



**Above:** IME strength as a function of predictor categories (defined based on quantiles). **Predictors** = SST difference between IME and BG zones, currents, precipitation, maximum island elevation, island area / reef area, significant wave height. (Climatological analysis, shared IMEs excluded).

➔ **IME strength increases with SST cooling, current speed, precipitation, island elevation and island area.**

*In progress:* unsupervised machine learning using Self-Organizing Maps (SOM). Open for discussion!



### Acknowledgements

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No. 746530. Datasets include MODIS 4km chlorophyll and SST, PHYSAT phenological classes, OSCAR surface currents, GPCP precipitation, AVISO sea wave height, ETOPO1 bathymetry, and GSHHS full resolution coastline. Matlab toolboxes Alternative box plot (<https://mathworks.com/matlabcentral/fileexchange/46545-alternative-box-plot>), cmocean (<https://matplotlib.org/cmoccean/>) and SOM (<https://github.com/larinienmen/SOM-Toolbox>) were used.

### References

Alvain et al. (2008). Seasonal distribution and succession of dominant phytoplankton groups in the global ocean: A satellite view. *Global Biogeochem. Cycles*, 22(3), doi:10.1029/2007GB003154.  
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