

# Variability and trends of the major phytoplankton functional types in the Fram Strait (Arctic Ocean) from two-decade satellite observations

Hongyan Xi<sup>1</sup>, Ehsan Mehdipour<sup>1,2</sup>, Ilka Peeken<sup>1</sup>, Eva-Maria Nöthig<sup>1</sup>, Alexandra Kraberg<sup>1</sup>, Katja Metfies<sup>1</sup>, Marine Bretagnon<sup>3</sup>, Vanessa Lampe<sup>4</sup>, Leonardo M. A. Alvarado<sup>1</sup>, Antoine Mangin<sup>3</sup>, Astrid Bracher<sup>1,5</sup>

<sup>1</sup> Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research, Bremerhaven, Germany; <sup>2</sup> School of Business, Social and Decision Sciences, Constructor University, Bremen, Germany; <sup>3</sup> ACRI-ST, 06904 Sophia Antipolis Cedex, France; <sup>4</sup> GEOMAR Helmholtz-Centre for Ocean Research, Kiel, Germany; <sup>5</sup> Institute of Environmental Physics, University of Bremen, Bremen, Germany

## Background

- Phytoplankton composition structure varies in ocean biomes and phytoplankton functional types (PFTs) drive differently the marine ecosystem and biogeochemical cycles;
- Phytoplankton in the Arctic Ocean are highly influenced by sea ice conditions and brine release, and their dynamics are influenced by the extent of stratification as this determines the timing of nutrient and light dependent biological production;
- Fram Strait – Gateway to the Arctic:** where warmer nutrient-rich Atlantic water meets the cold fresher Arctic water, with complex ecosystem subject to severe climate-induced environmental changes;
- A systematic approach for consistent long-term monitoring of PFTs has been established within the framework of Copernicus Marine Service Evolution Program, enabling the study for inter-annual variation and trend analysis of the PFTs on various scales.

## Objectives

- Evaluation of satellite PFT products in the Fram Strait;
- Analysis on the time series of PFTs in the Fram Strait from 2002 to 2022 (separating Atlantic and Arctic water masses);
- Reveal PFT status in the Fram Strait w.r.t. inter-annual variations, phenology, and potential changes.

## Method and Data

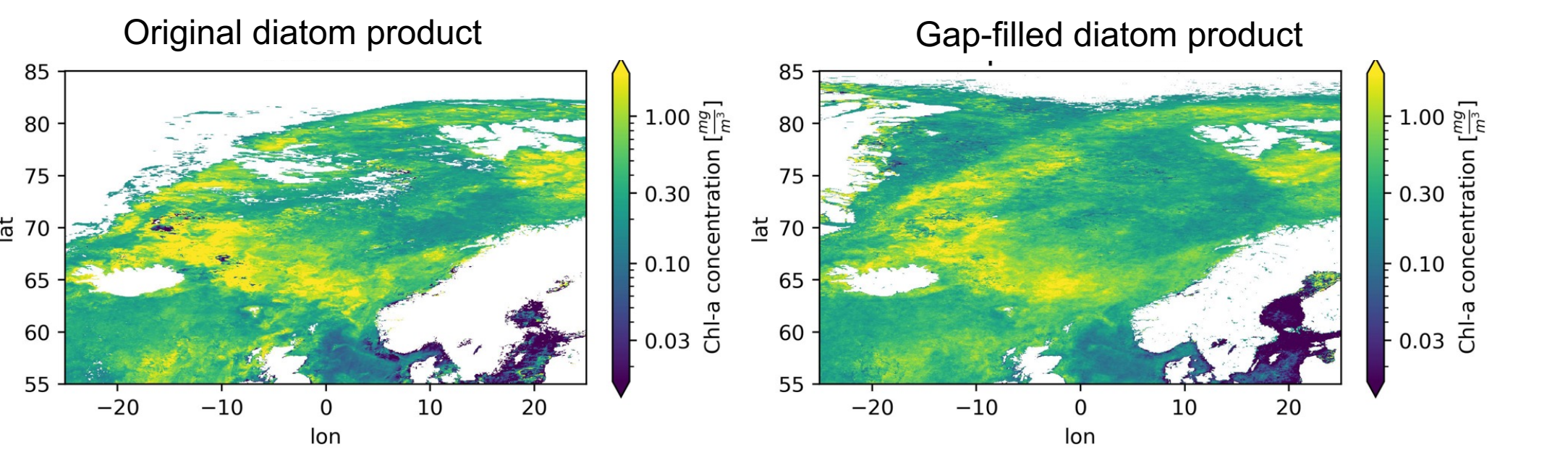
### Satellite PFT products

- A global approach (EOF-PFT) for PFT chlorophyll a (chl-a) retrieval using ocean color reflectance data and SST (Xi et al. 2020; 2021; 2023)
  - A set of empirical orthogonal function based algorithms
  - Capability of retrieving chl-a of 6 groups – diatoms, haptophytes, prokaryotes and others
- Daily PFT products with 4-km resolution (L3 and L4) available on **Copernicus Marine Service**: <https://marine.copernicus.eu/>

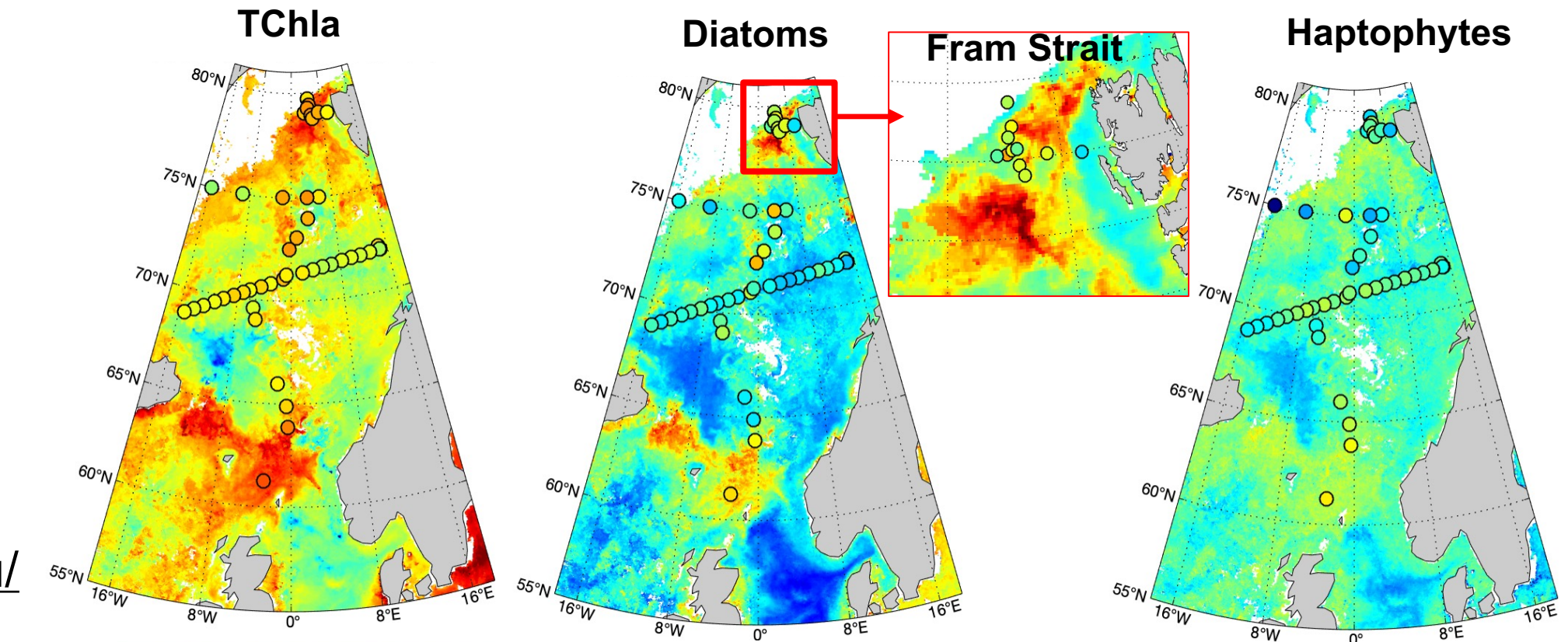
### Update of the PFT products within the framework of Copernicus Marine Service Evolution project ‘GLOPHYTS’

- Updated global in situ PFT chl-a data set based on HPLC pigments (Xi et al. 2023b)
- Retuned EOF-PFT algorithm for merged (2002-2016) and OLCI sensors (2016-2022)
- DINEOF gap-filled 8-day PFT products (Alvera-Azcárate et al. 2009; Mehdipour et al. 2023)

### 8-day diatom chl-a product 20180517-20180524 in the North Atlantic – Arctic Ocean

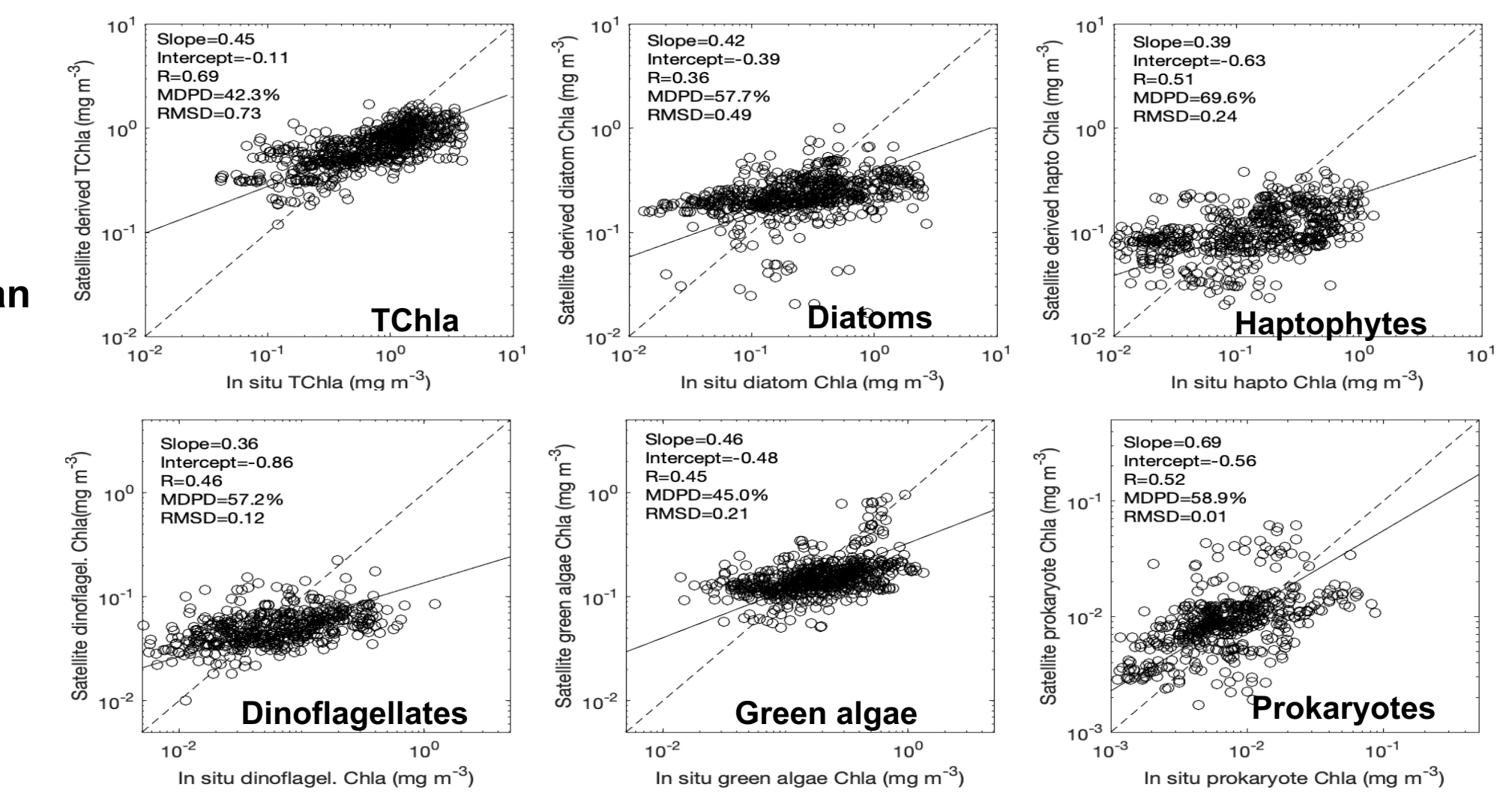


## Satellite PFT Evaluation



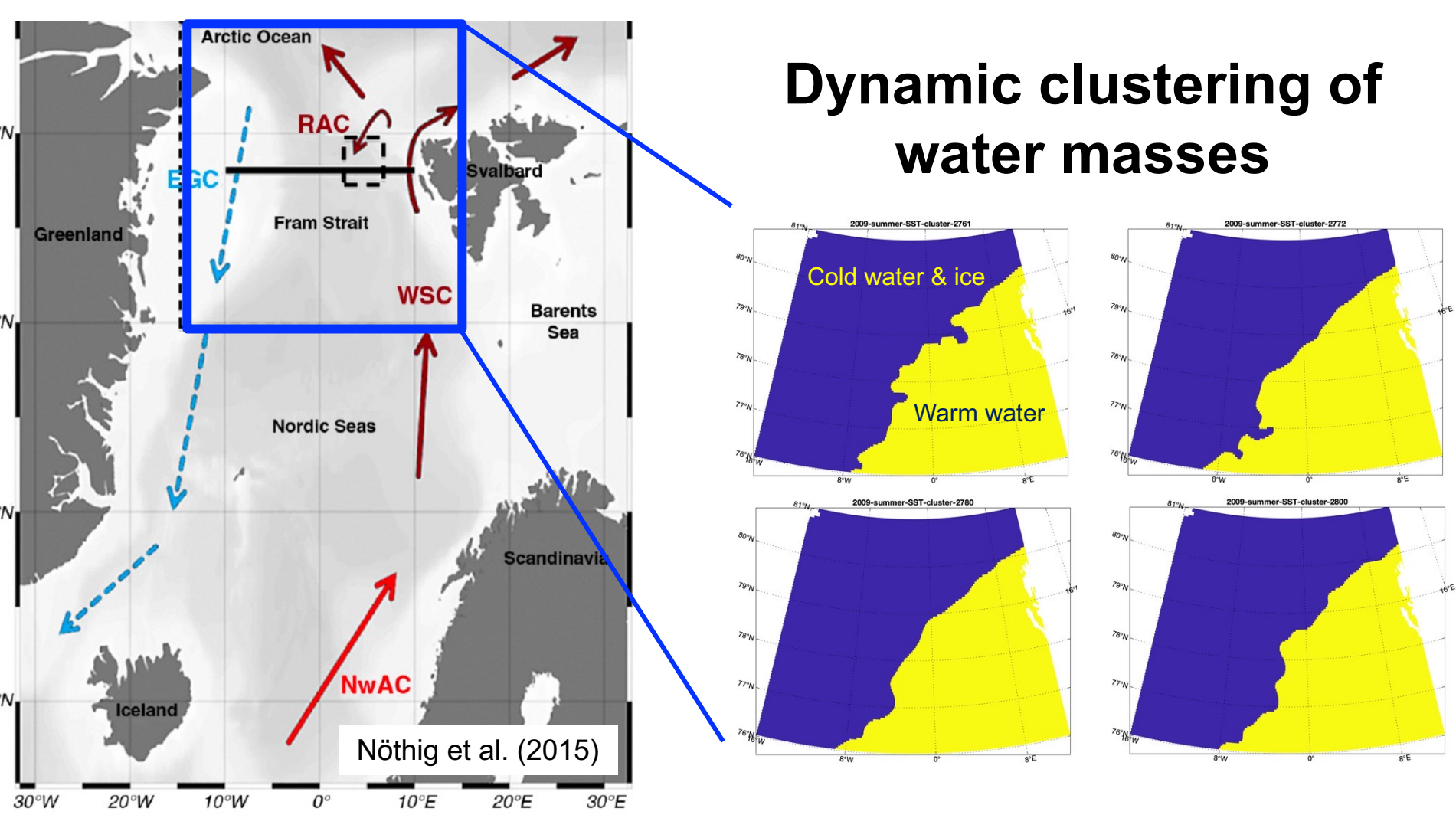
Satellite PFT composites versus in situ PFT during expedition PS74: 20090622-0731 (an example)

### Gap-filled 8-day PFT data compared to the in situ matchups for the north Atlantic - Arctic Ocean (55°N-85°N, 25°W-25°E)

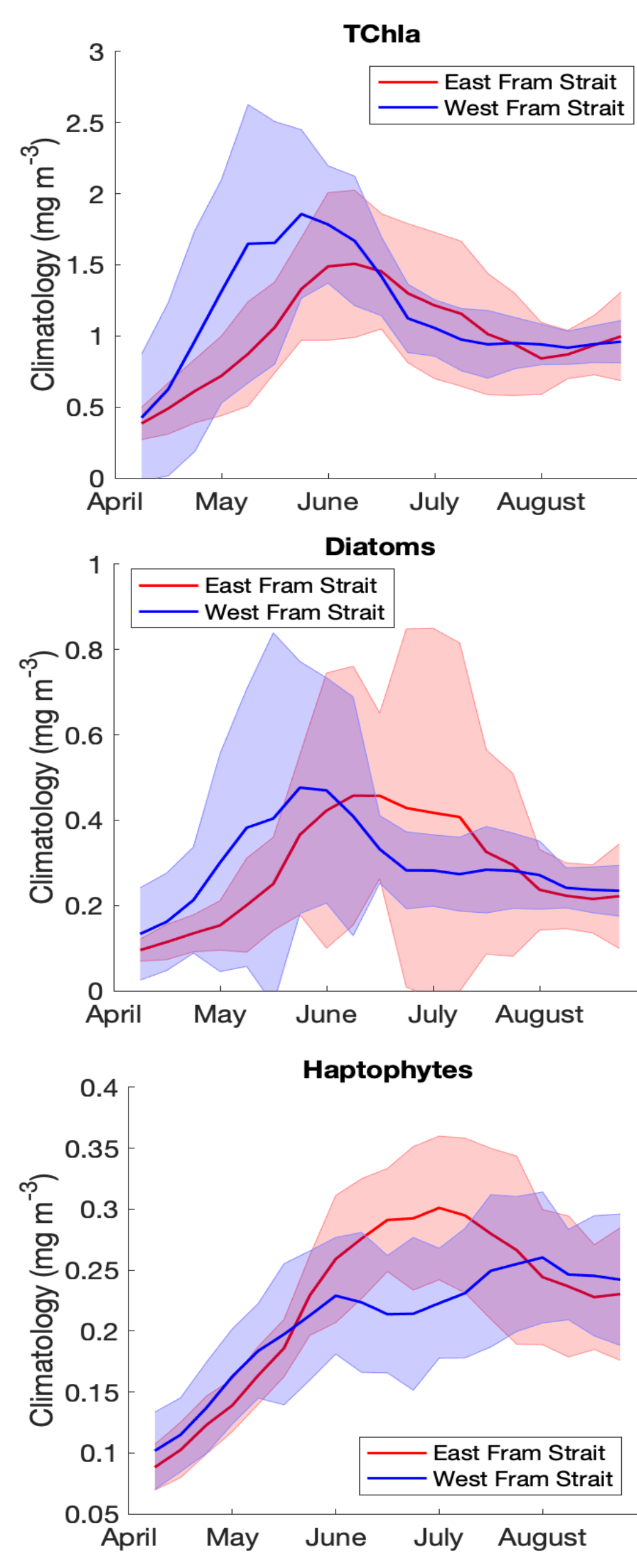


## PFT observations in the Fram Strait

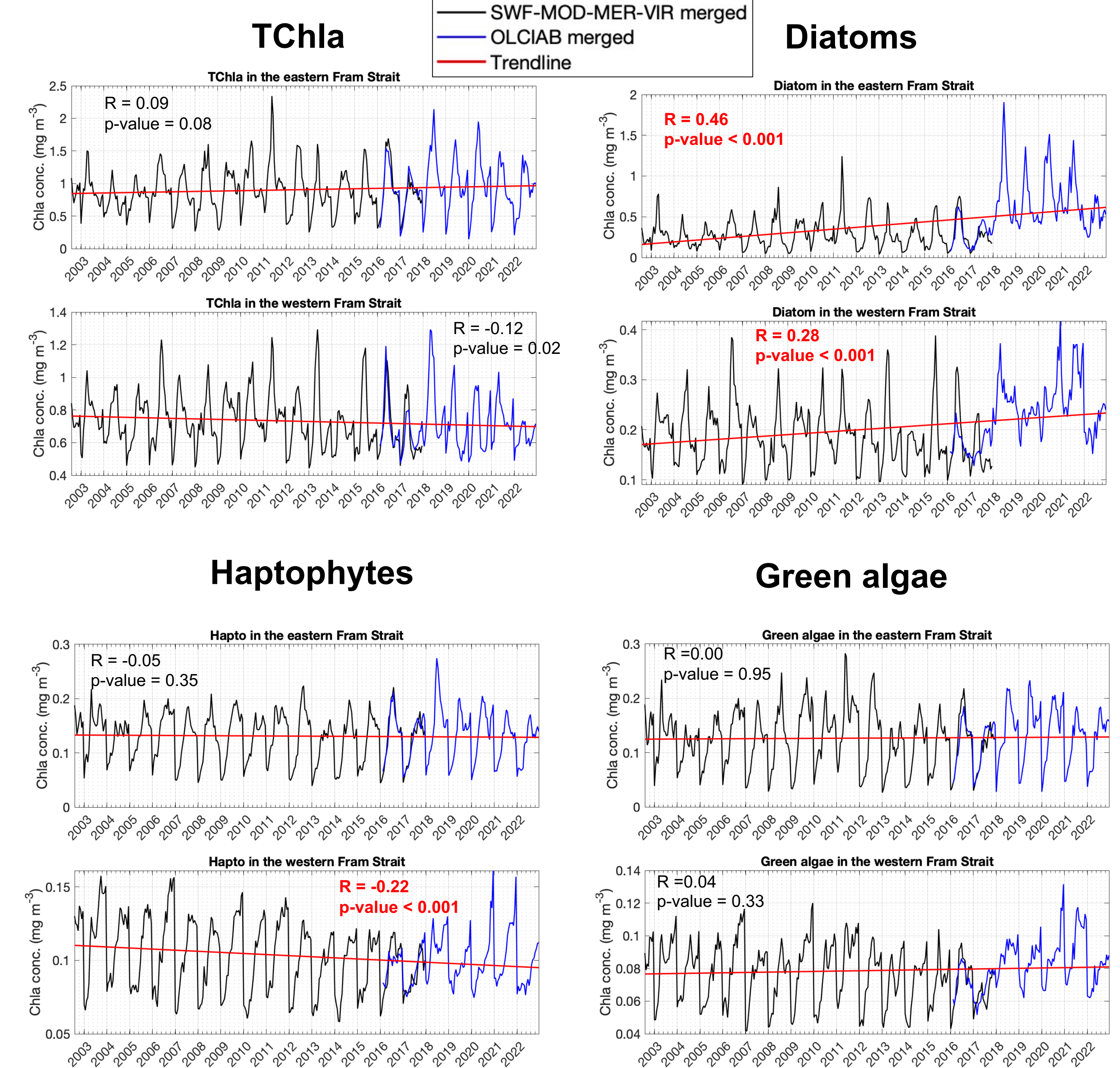
- Region of interest: 16°W – 12°E, 75°N – 81°N
- Period: April to August from 2002 to 2022
- Separation of the **western and eastern Fram Strait** using k-means clustering based on CMEMS daily SST



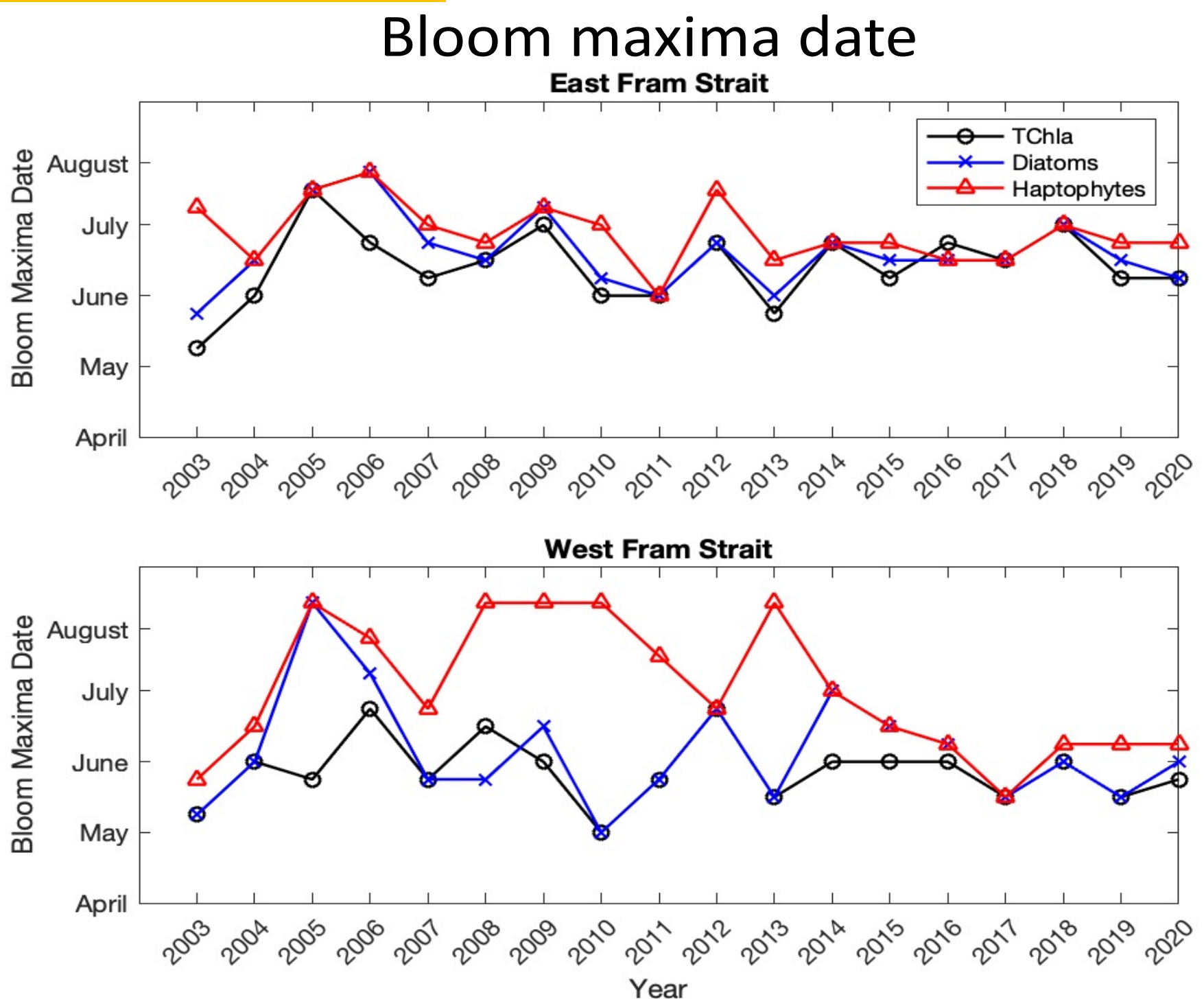
## Climatology



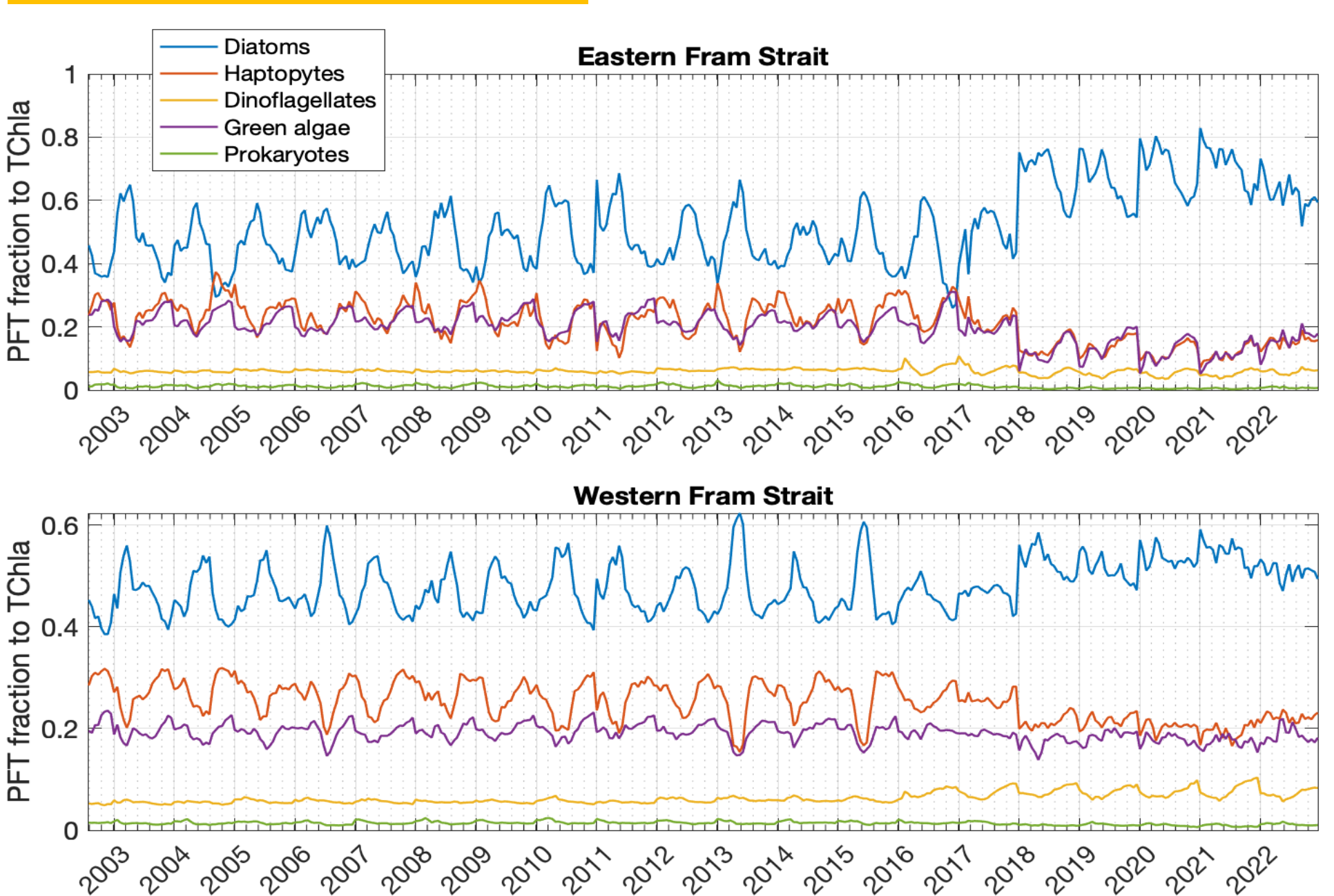
## Time series April-August from 2002 to 2022



## PFT phenology



## PFT composition



## Conclusions and Outlook

- Satellite PFT data match well with the in situ data based on pigment analysis;
- Gap filling technique has its potential for reconstructing satellite PFT products for high latitude waters with limited satellite coverage;
- Preliminary findings from the two-decade PFT observations in the Fram Strait (FS):
  - Annual cycles of phytoplankton growth are different in the western and eastern FS;
  - Inter-annual variability: significant increase for diatoms, a decrease for haptophytes in the western FS;
  - Blooms start slightly earlier in the west FS (more related to the marginal ice zone)
  - Haptophytes grow after diatoms and last until August
  - Obvious changes in the last few years in the composition, might due to high diatom abundance since 2018
- Further evaluation of the PFT products using more biological data on phytoplankton composition collected from LTER Observatory HAUSGARTEN area;
- Investigation of the changes found in satellite PFTs in linkage to climate/physical parameters.

### Acknowledgements

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