Phytoplankton functional types observation from space in the Fram Strait (2002-2020)

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- **Fram Strait - Gateway to the Arctic: w**armer nutrient-rich Atlantic water meets the cold fresher Arctic water
- Complex ecosystem subject to severe climate-induced environmental changes
- Phytoplankton as the base of food web regulate the key biogeochemical processes are highly variable there

Objectives

- Evaluation of satellite PFT products in the Fram Strait
- Time series of PFTs in the Fram Strait from 2002 to 2020 (separating Atlantic and Arctic water masses)
- PFT phenology, inter-annual variations, changes in composition

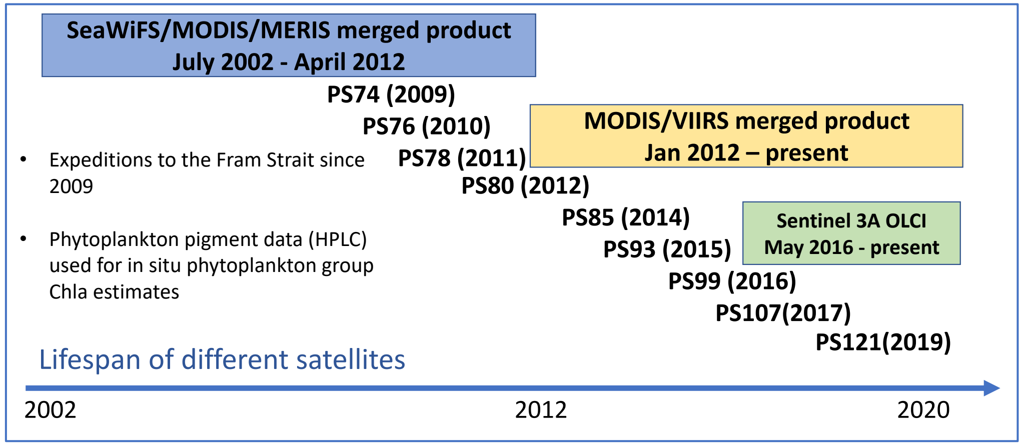
Evaluation of PFT products from satellites

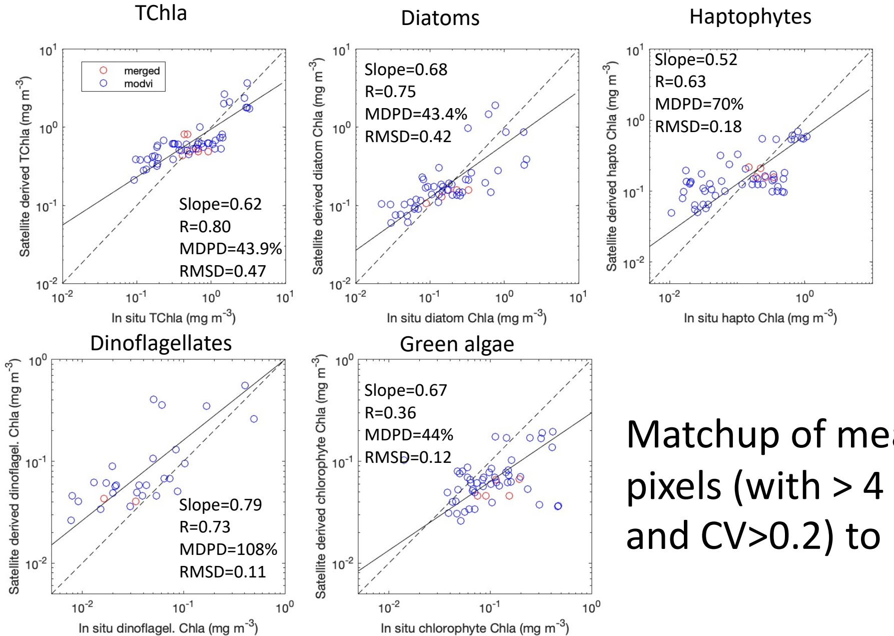
- **A global approach for PFT chlorophyll retrieval using ocean color reflectance data and SST**
  - A set of empirical orthogonal function based algorithms
  - Capability of retrieving Chla of 6 groups- diatoms, haptophytes and others

(Xi et al. 2020, 2021)

Copernicus Marine Service

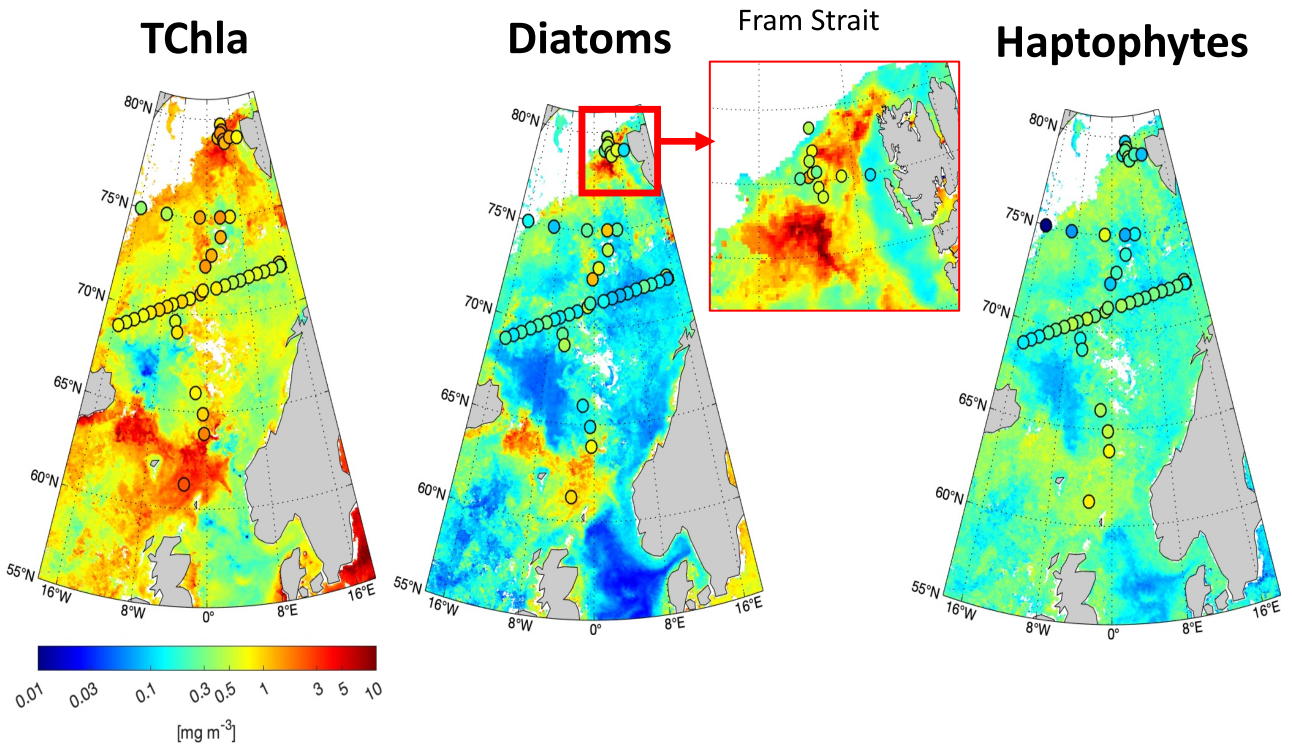
- **Data products available** in **CMEMS** at https://marine.copernicus.eu/





Matchup of mean of 3x3 pixels (with > 4 valid pixels and CV>0.2) to in-situ

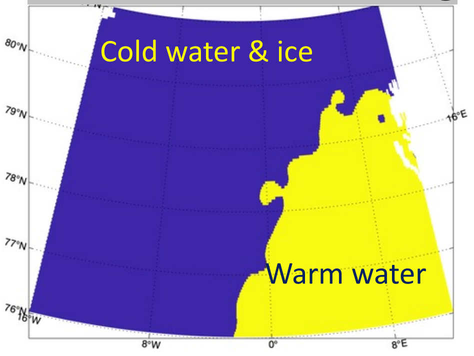
Satellite PFT composites versus in situ PFT during expedition PS74: 20090622-0731 (an example)



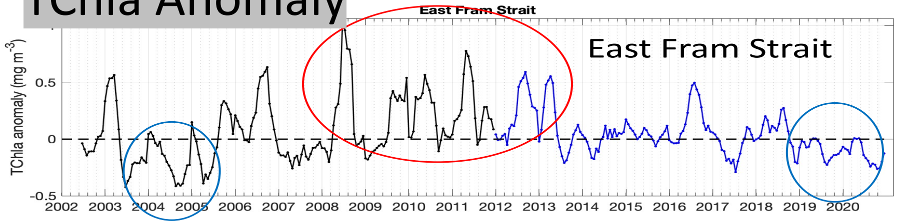
PFT observation in the west and east Fram Strait

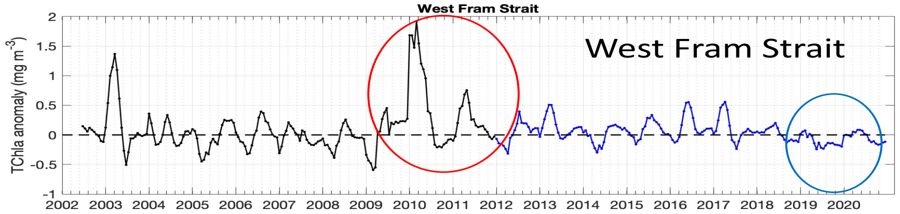
- Whole region: 16W – 12E, 75N – 81N
- Period: April to August (2002-2020)
- A dynamic clustering of the water masses based on CMEMS daily SST

Water mass clustering



TChla Anomaly

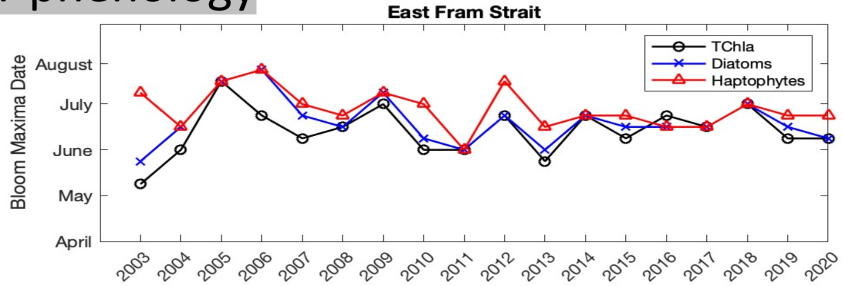


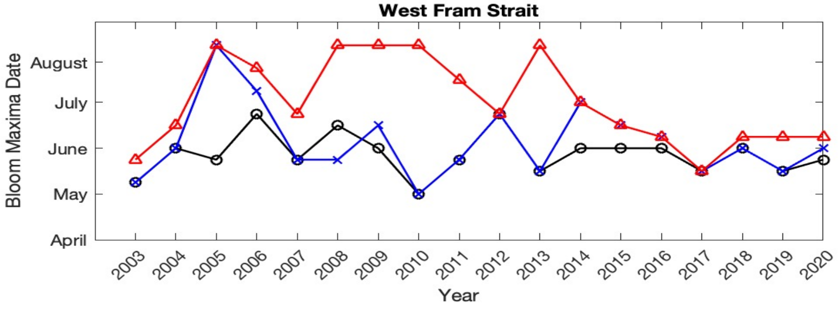


TChla observations coincide with the previous reported patterns in the FS (e.g., Cherkasheva et al., 2014; Nöthig et al. 2015; Engel et al. 2019)

1998-2009 1998-2012 2009-2017

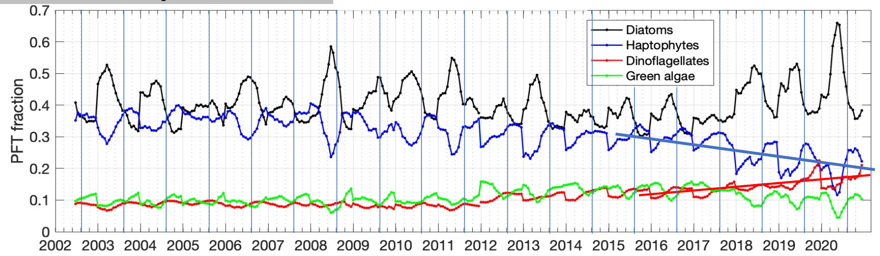
PFT phenology Bloom maxima date



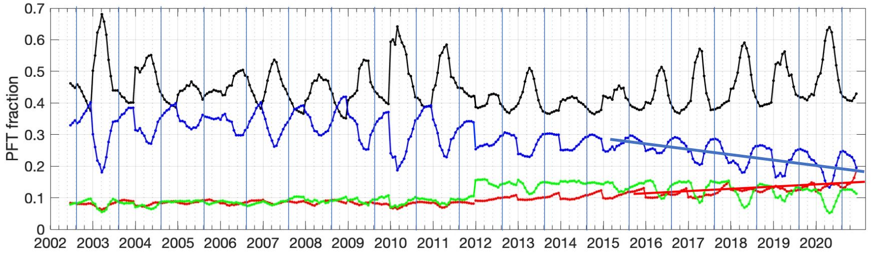


PFT composition

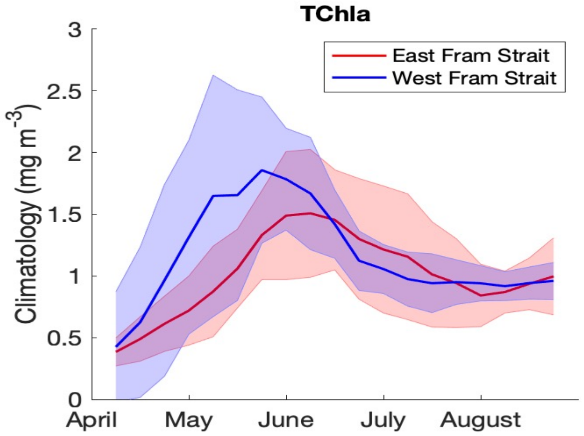
East Fram Strait

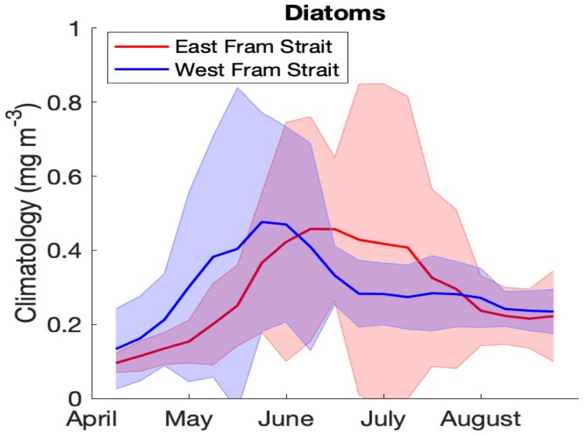


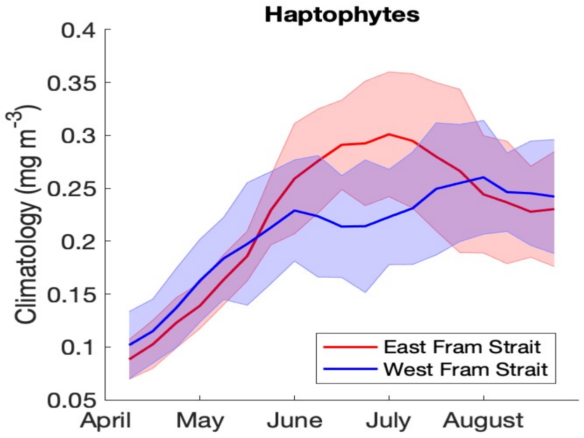
West Fram Strait



PFT Climatology







Summary and outlook

- Satellite PFT data match well with in situ pigment derived PFT
- Phytoplankton time series
  - Annual cycles of phyto growth are different in the west and east FS
  - High interannual variability
  - 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?
- Further investigate the changes found for satellite PFTs in linkage to other biogeochemical/physical parameters
- Phytoplankton carbon estimation by accounting for PFT community structure

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Perspective slide

Knowledge gaps (priorities from high to low in a time manner)

- Gaps in satellite PFT products (spatial and temporal) and inconsistency between different sensors (1-2 year)
- Difficulty in validating PFT products (different data type, estimation methods and units) (3-5 years)
- Uncertainty in the in situ pigment-derived PFT (diagnostic pigment analysis, CHEMTAX..) to allow comprehensive uncertainty study of the satellite PFTs (3-5 years)
- Accounting phytoplankton community structure for better phytoplankton carbon estimation and also primary production (3-5 years)
- Well synergy between in situ, satellite and modelling output with respect to phytoplankton community and be able to interpret trends over larger time scales (20 years)