

Fram Strait linkages of phytoplankton community composition to ocean physics and sea ice properties

Astrid Bracher^{1,2}, Hongyan Xi¹, Wilken von Appen¹, Ehsan Mehdipour^{1,3}, Katja Metfies¹, Rebecca McPherson, Moritz Zeising¹, Eva-Maria Nöthig¹

¹ Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research, Bremerhaven, Germany; ² Institute of Environmental Physics, University of Bremen, Bremen, Germany;

³ School of Business, Social and Decision Sciences, Constructor University, Bremen, Germany;

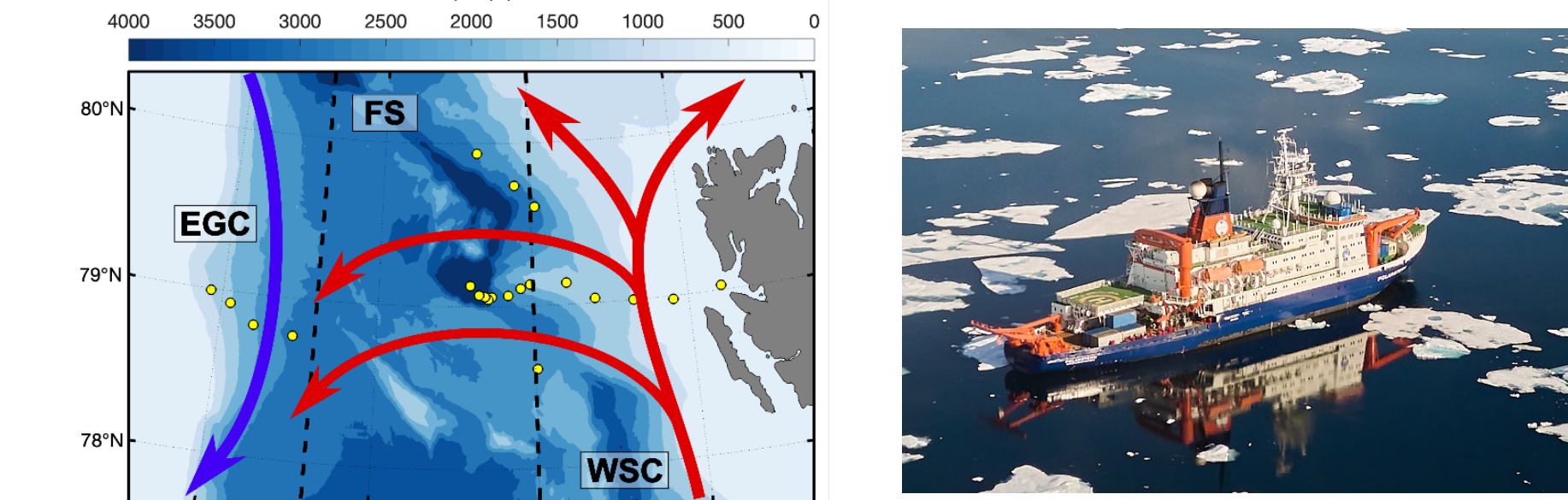
Motivation & Objectives

- Multiple environmental drivers shape Arctic biogeography which leads to regional differences in trends in marine primary production (PP, Ardyna & Arrigo 2020)

Fram Strait contrary to Arctic wide trends :

- Highly dynamic: West Spits-bergen Current (WSC) transports warm & salty Atlantic Water (AW) to °N vs. East Greenland Current (EGC) with cold & fresh polar water (PW) accounts for sea-ice export to Atlantic.
- PP has negative (1998-2012: Arrigo and van Dijken 2015) or no (1998-2022: Cherkasheva et al. 2025) trend based on satellite data.
- Satellite (1998-2012) and in-situ (1991-2015) Chl-a conc. confirm regional opposing trends → localized variability in PP dynamics (Nöthig et al. 2015, 2020).

LTER Observatory Hausgarten (HG) since 1999



Polarstern East Greenland Sea expeditions 2015-2024

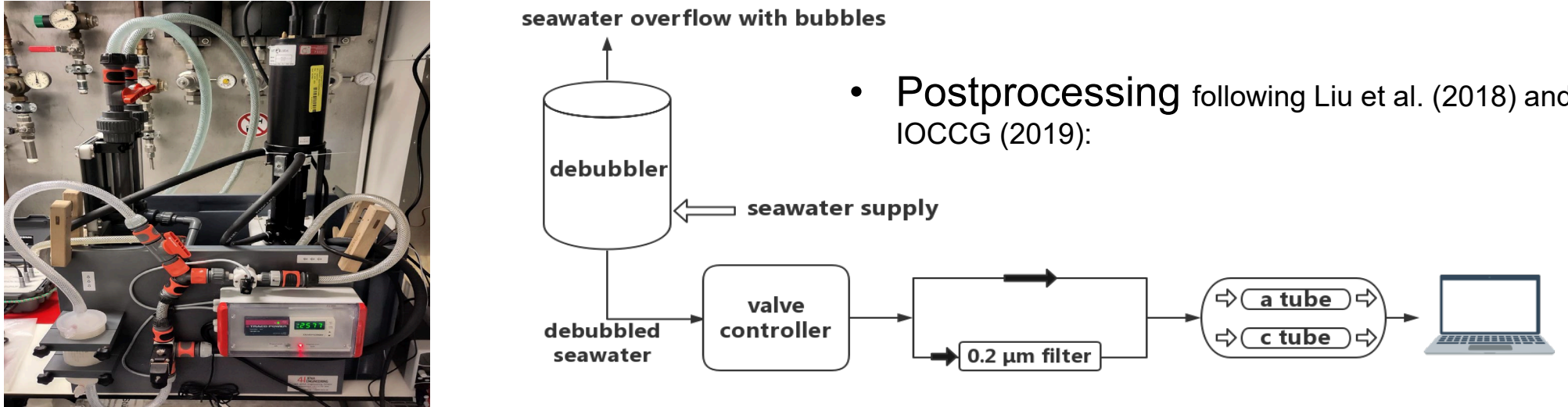
With high-resolution surface data on ap(λ) ns phytoplankton pigments

PS93-2 Jul-Aug 2015 PS126 May-Jun 2021 Spring
 PS99-2 Jun-Jul 2016 PS131 Jul-Aug 2022 Early Summer
 PS107 Jul-Aug 2017 PS136 May-Jun 2023 Mid Summer
 PS121 Aug-Sep 2019 PS143-2 Jul-Aug 2024 Late Summer

Research Questions

- Does underway spectrophotometry data deliver high-spatial (<1 km) information on surface TChl-a and PG-Chl-a along the ship track?
- Are there regional differences in mean patterns and interannual changes of phytoplankton phenology and composition in Fram Strait?
- What is the linkage of these observations to sea-ice conditions and surface ocean physical properties?

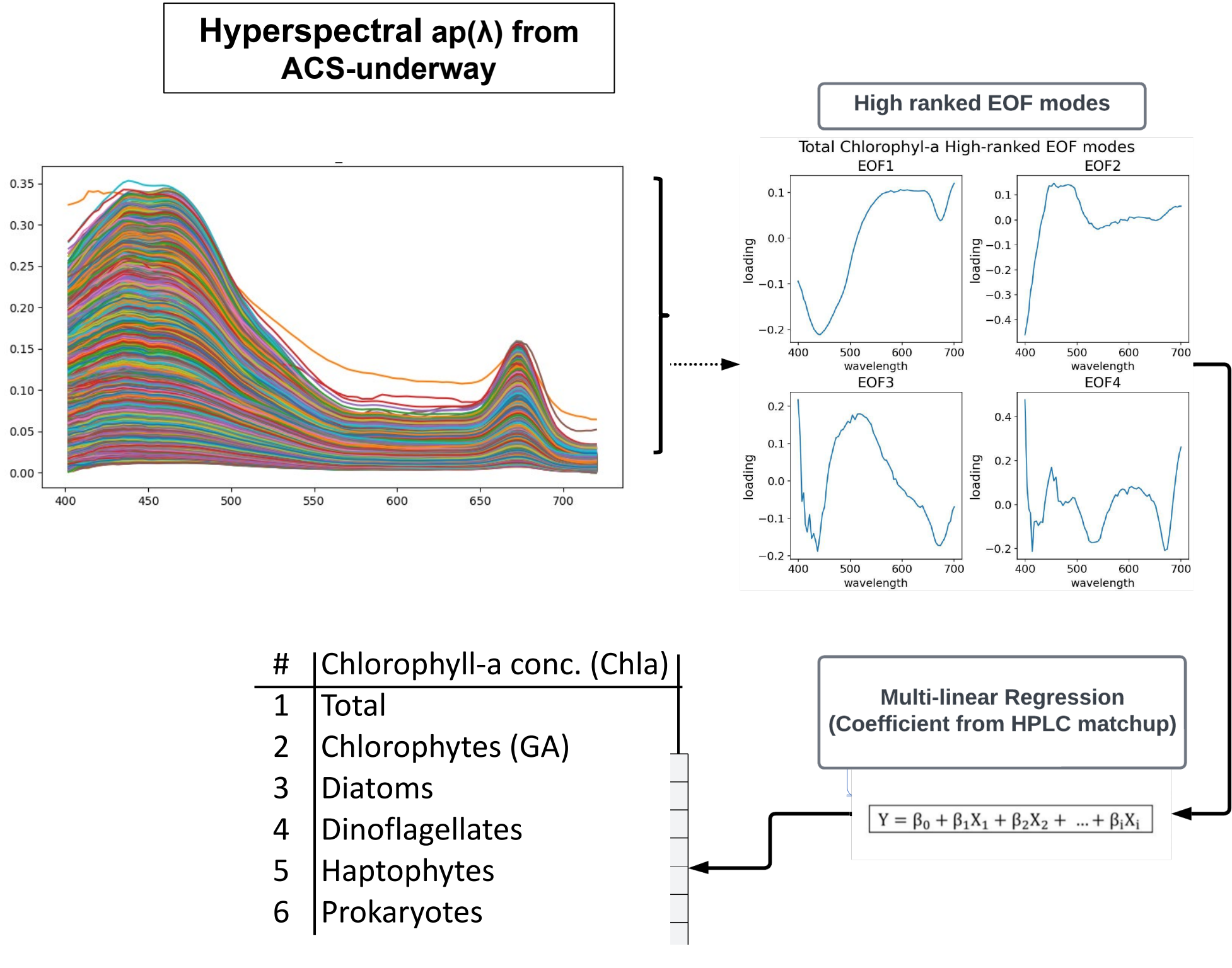
Hyperspectral ap(λ) by underway spectrophotometry (AC-S)



Phytoplankton pigments to derive TChla and PG Chla from HPLC

- Surface seawater 3-hourly collected analysed with HPLC.
- Chla of PG via Diagnostic Pigment Analysis) using coefficient from large global pigment dataset (Xi et al. 2023).

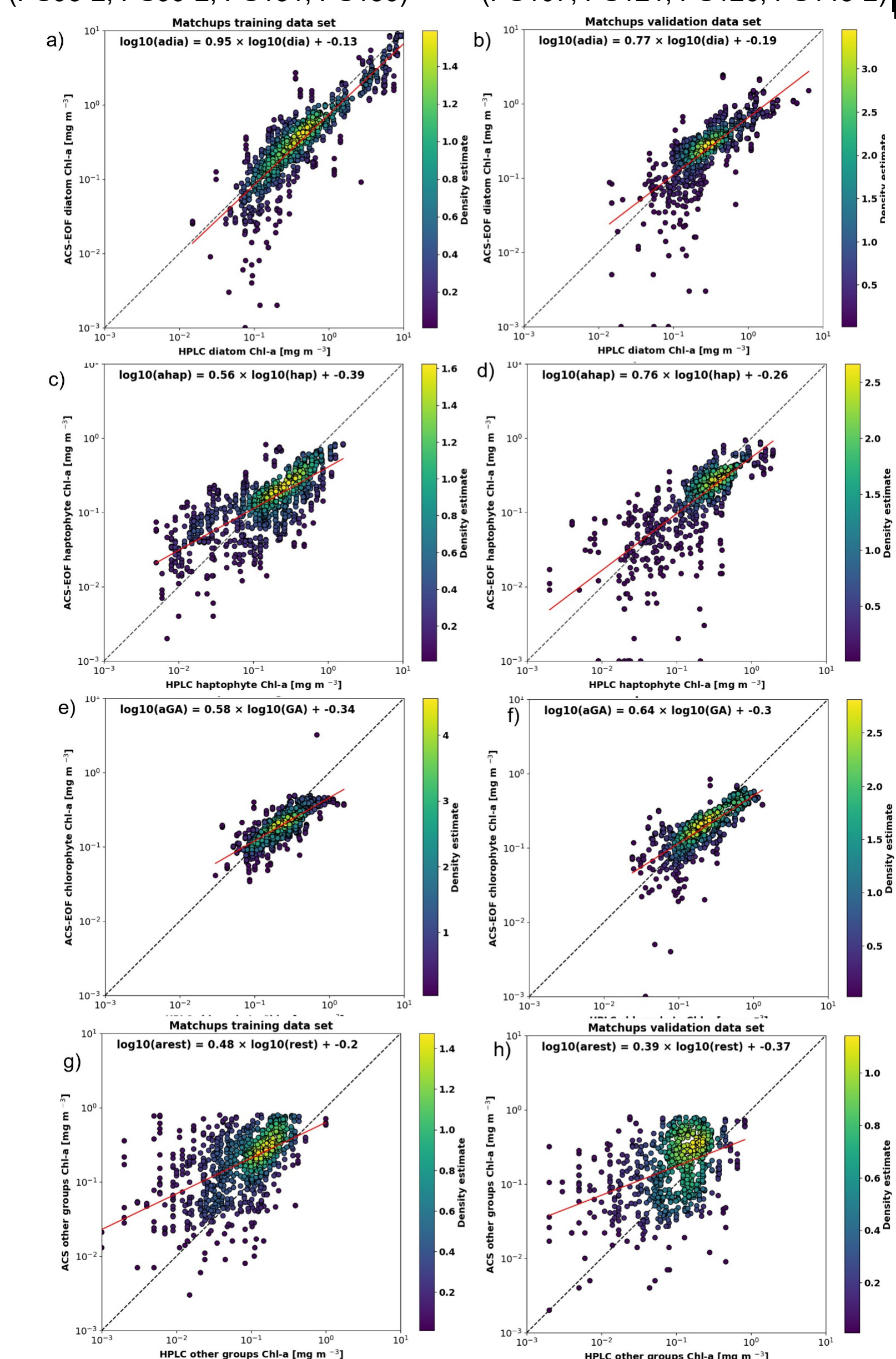
Method: Spectral feature extraction based on Empirical Orthogonal Functions (EOF) for total Chla (TChla) and PG Chla estimation (following Bracher et al. 2015 & 2020).



HPLC vs. ACS-EOF predicted Chla and PGs' Chla

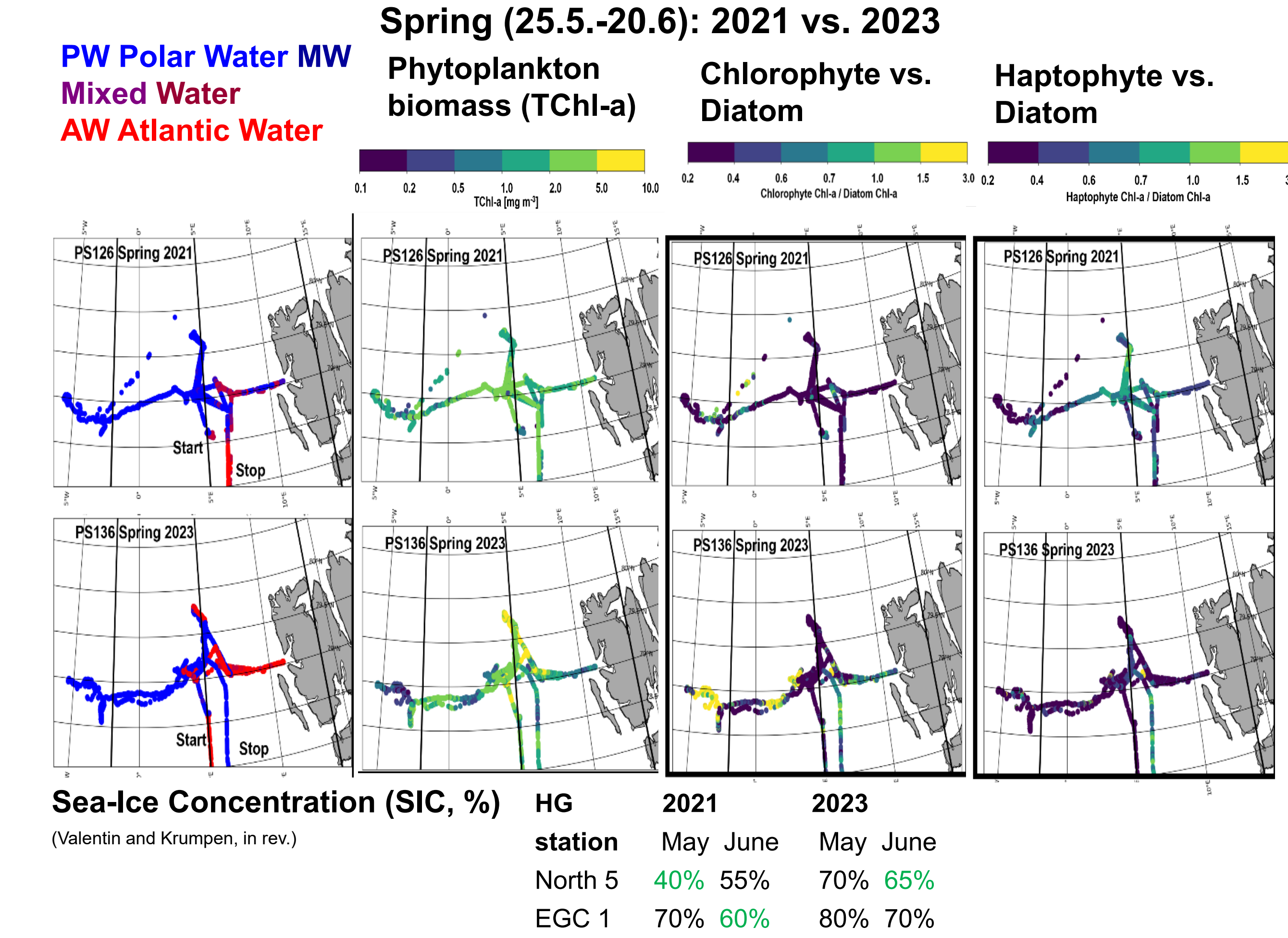
Data used in model development (PS93-2, PS99-2, PS131, PS136)

Data for independent Validation (PS107, PS121, PS126, PS143-2)



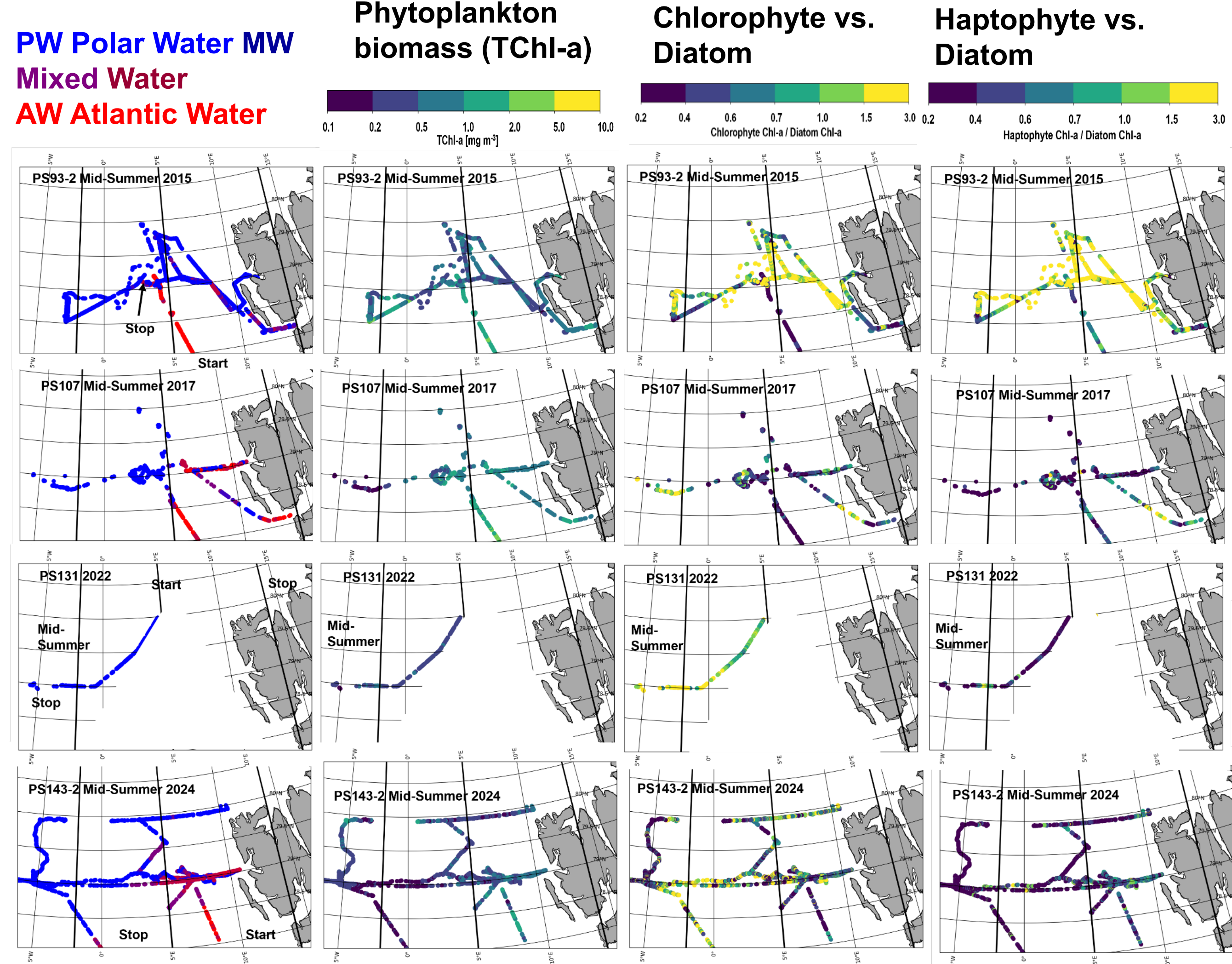
	T_TChla	V_TChla	T_diat	V_diat	T_hapto	V_hapto	T_chloro	V_chloro
N	1219	1061	1197	1061	1116	957	1141	1002
R2	0.91	0.85	0.79	0.57	0.54	0.57	0.59	0.58
RMSD	0.548	0.356	0.840	0.407	0.184	0.226	0.175	0.173
MPB	7	12	-7	1	42	10	-7	1
MdAPD	12	13	31	29	45	33	25	31

Phytoplankton phenology and composition in Fram Strait

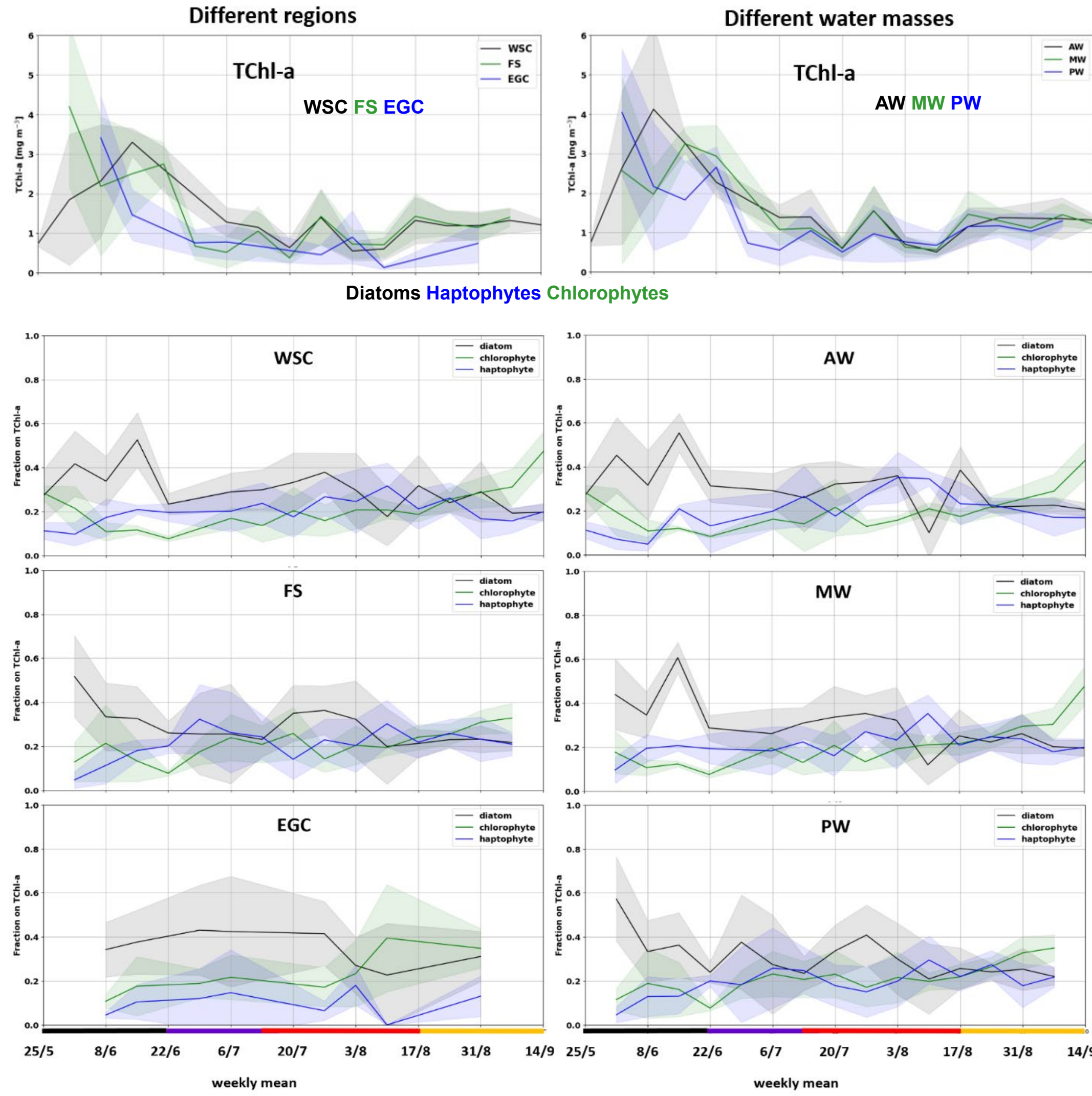


Fram Strait Mid-summer (10 July – 20 August):

2015 & 2017 vs. 2022 & 2024

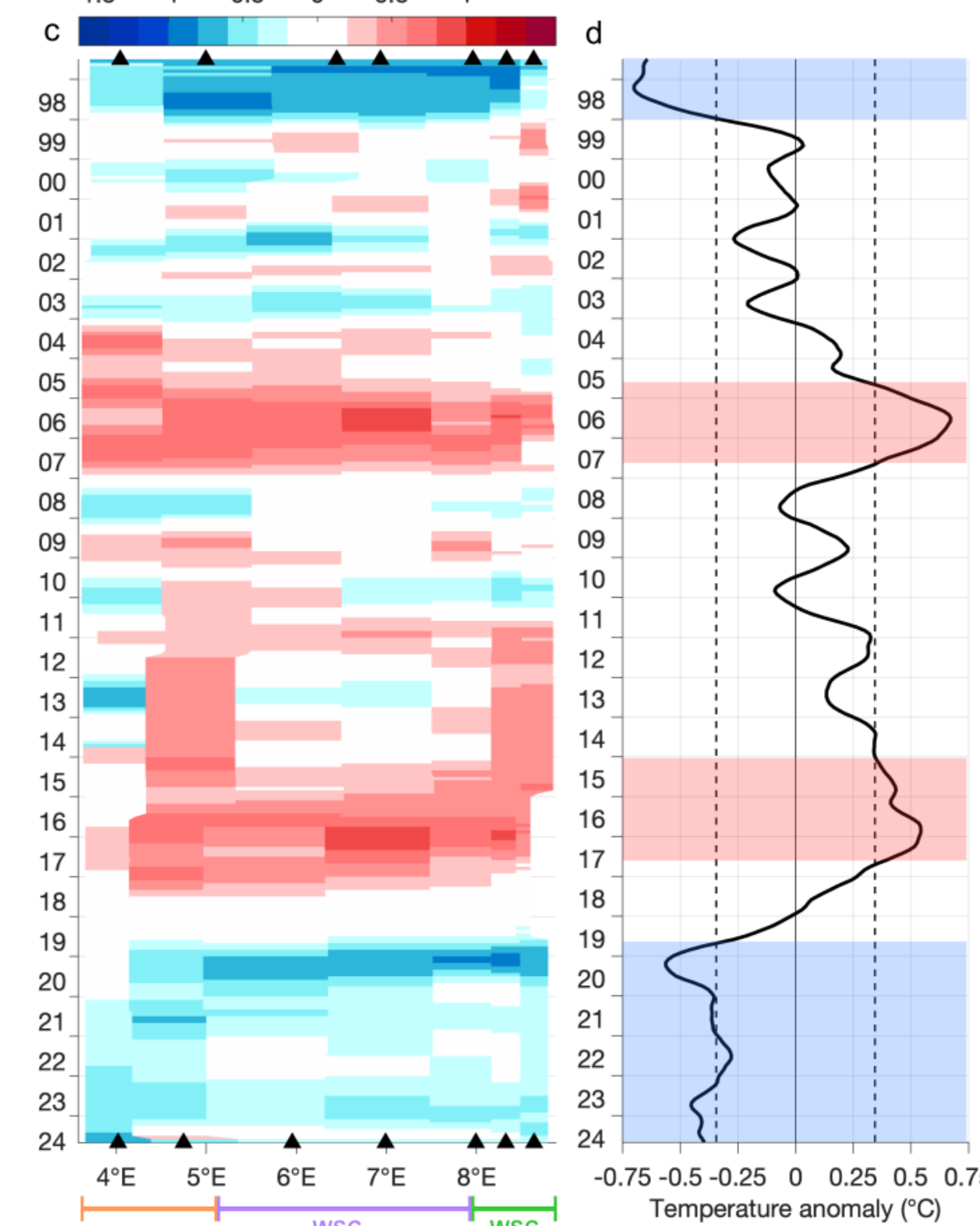


TChl-a and Phytoplankton Groups' (PG) Chl-a Phenology 2015-2024



Multi-year warm and cold AW temperature anomalies from moorings (1997-2024)

(McPhersson et al. in rev.)



Conclusions

First high resolution in-situ phytoplankton groups' Chl-a data set for the Arctic Ocean (Fram Strait) from a “quasi” automatized instrument sampling operation and postprocessing method.

2015-2024 Fram Strait data resolve

- spring to summer phenology and the interannual variability** along the different water masses and regions.
- diatoms, haptophytes, chlorophytes represent most** of phytoplankton community.
- confirm latest trends of higher diatom, less haptophyte contribution** to phytoplankton community, while chlorophytes Chl-a show no change.
- spring blooms' phytoplankton composition responds to distinct sea-ice thickness** in different years.
- multi-year warm/cold AW temperature anomalies** in WSC link to observed **variability of TChla and PG composition**, as the change in temperatures impact the vertical stratification of the upper water column.

Reference

Bracher A., Xi H., von Appen W.-J., Mehdipour E., Metfies K., McPherson R., Zeising M., Nöthig E.-M., (in press) Resolving the interannual variability of phytoplankton community composition in Fram Strait using ship-based high-frequency spectrophotometric measurements from 2015 to 2024. Deep-Sea Research Part II - the Topical Studies in Oceanography “25th years of Long-Term Ecological Research at the HAUSGARTEN Observatory”. <https://doi.org/10.1016/j.dsr2.2025.105568>

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