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ONE-WAY COUPLED PHYSICAL-BIOGEOCHEMICAL 1D DATA ASSIMILATION AT BASIN WIDE DISTRIBUTED FLOAT LOCATIONS IN THE MEDITERRANEAN SEA

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Why a one-way coupled physical-biogeochemical 1D data assimilation in Mediterranean Sea?

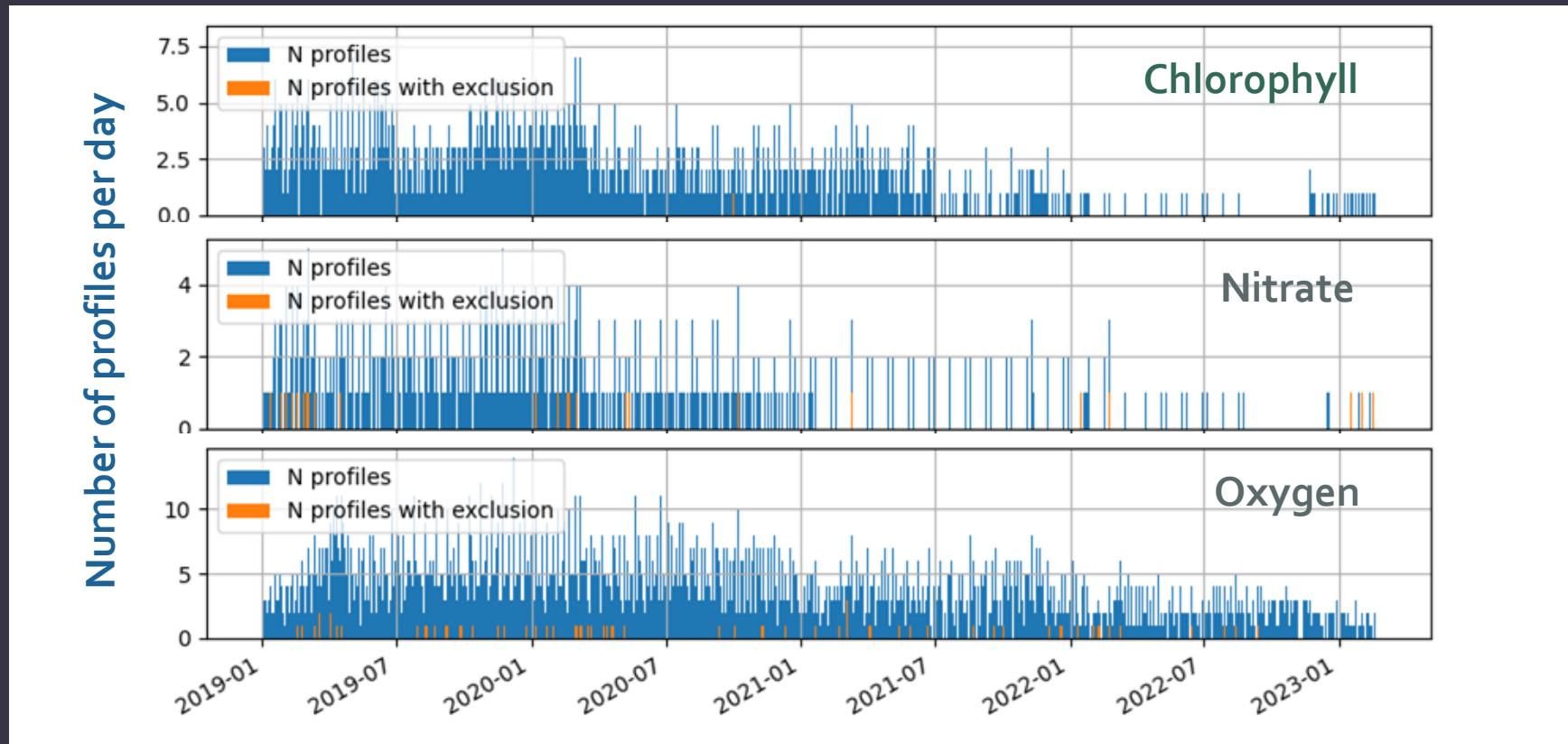
- Profile data assimilation is valuable* but number of BGC-Argo floats is decreasing
- Physical DA affects biogeochemistry – also positively** – but not necessarily consistently
- Application in the operational 3D system in Copernicus Marine Service

*Verdy and Mazlof (2017), Cossarini et al. (2019), Teruzzi et al. (2021), Skákala et al. (2021)

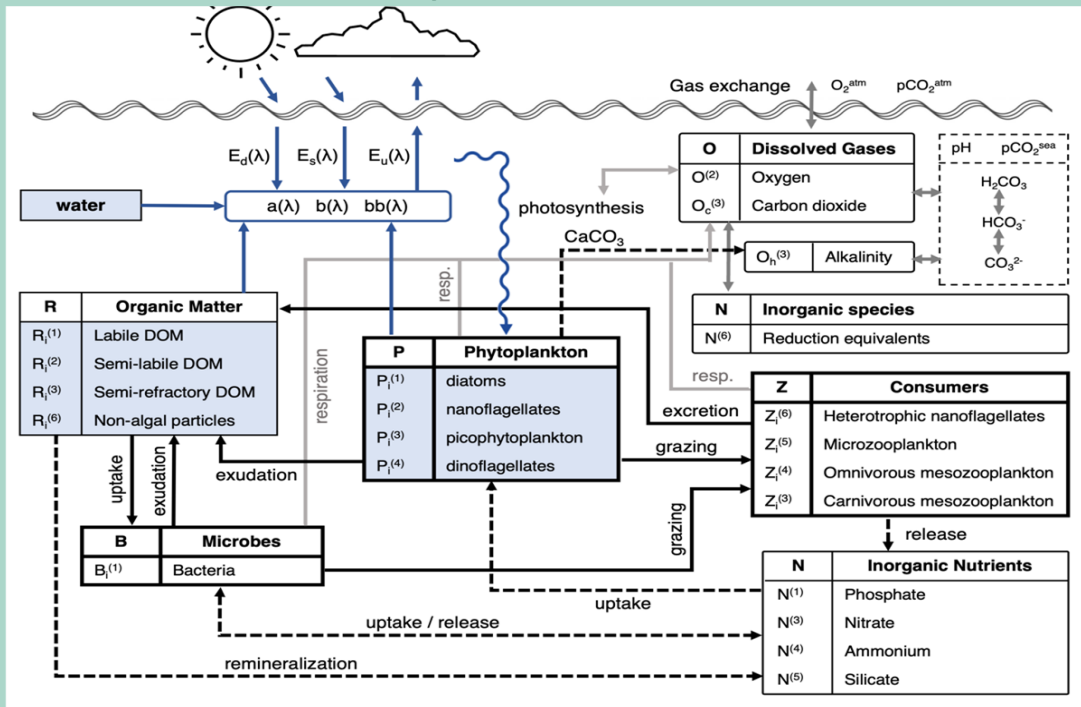
**Glider assimilation in EuroSea project

Why a one-way coupled physical-biogeochemical 1D data assimilation in Mediterranean Sea?

- Profile data assimilation is valuable* but number of BGC-Argo floats is decreasing



Biogeochemical model of the 3D system
www.bfm-community.eu



FABM
<https://github.com/fabm-model/fabm/wiki>

GOTM 1D water column model
<https://gotm.net/portfolio/>

Biogeochemical model of the 3D system
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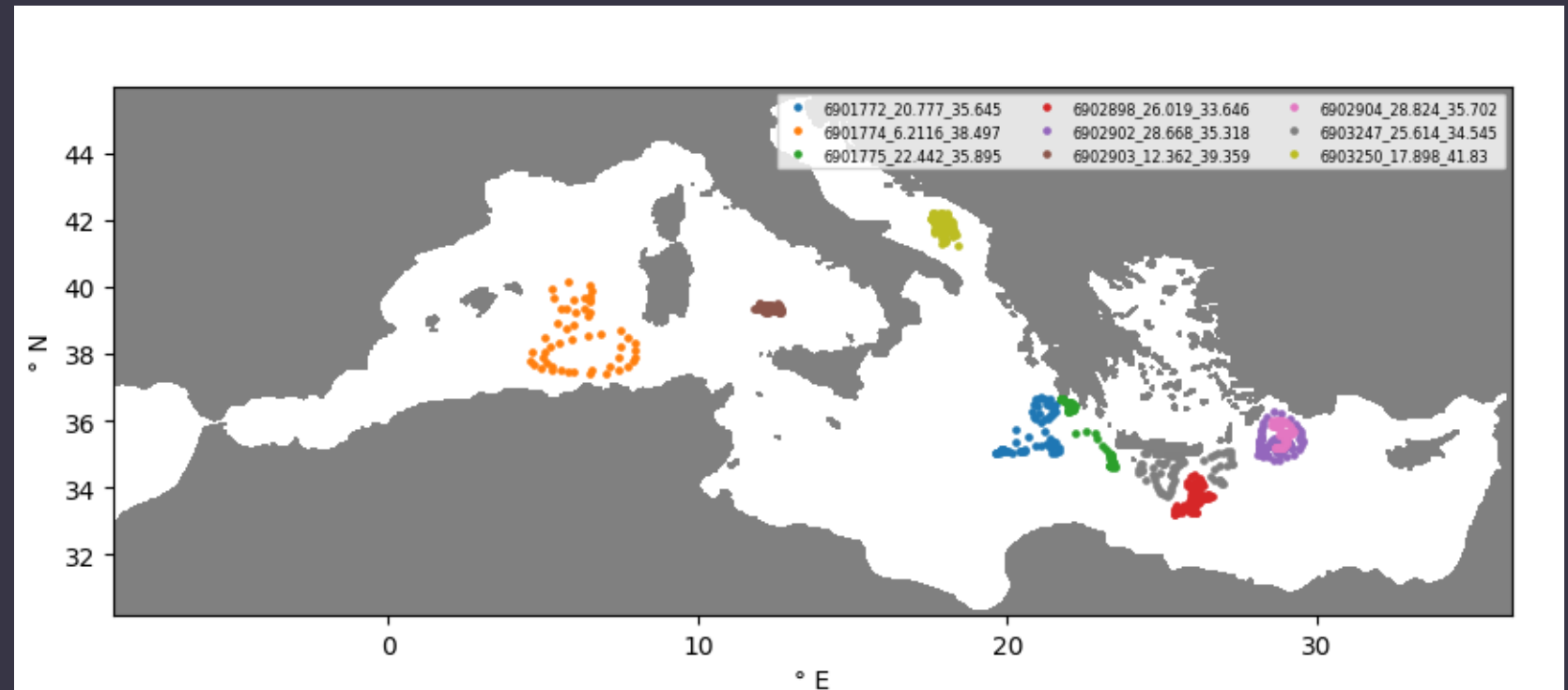
FABM
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GOTM 1D water column model
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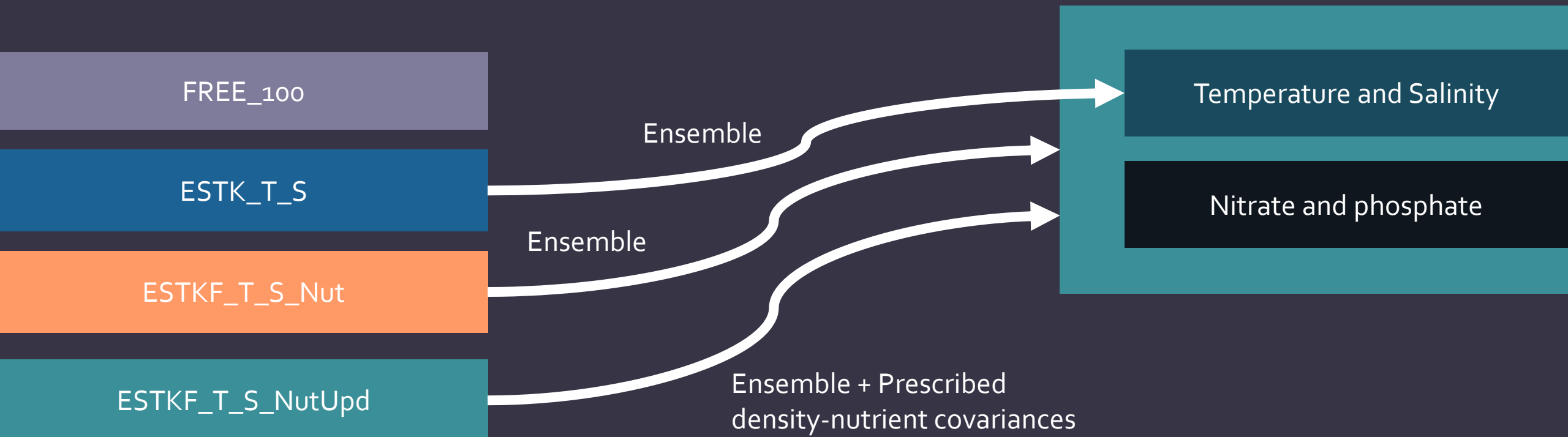
PDAF ensemble data assimilation
<https://pdaf.awi.de>

EAT: Ensemble and Assimilation Tool - MPI
developed in SEAMLESS

- 9 BGC-Argo floats in 2019
- 200 z-levels
- Atmospheric forcing from iGOTM (ERA u , v , precipitation)

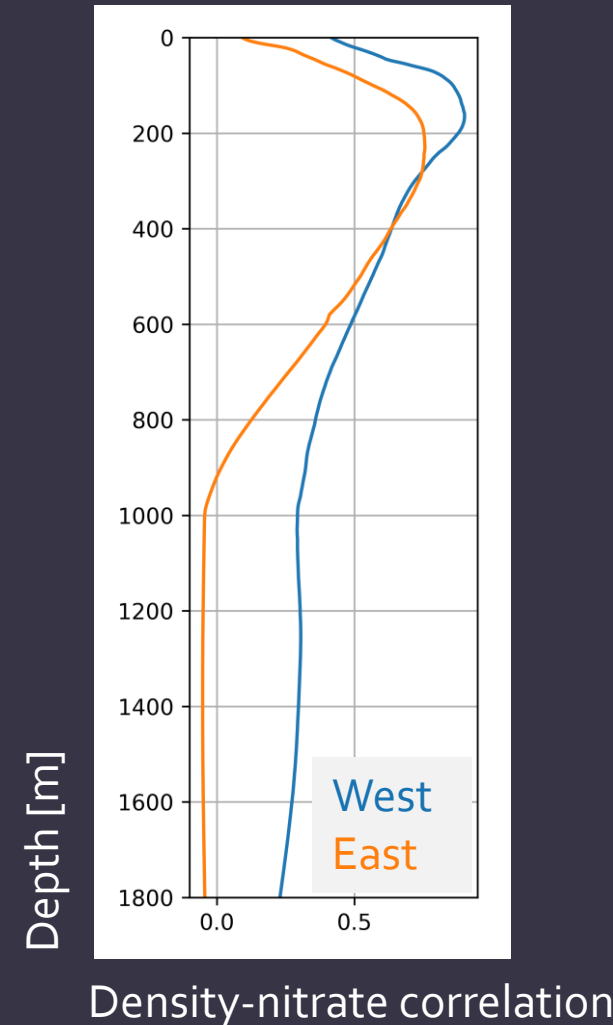


- Ensemble KF (ESTKF)
- Assimilation of **temperature and salinity Argo profiles**
- Perturbations on ICs and meteorological forcings (20%)
- 100 ensemble members
- 4 simulations that differs on updated variables and methods



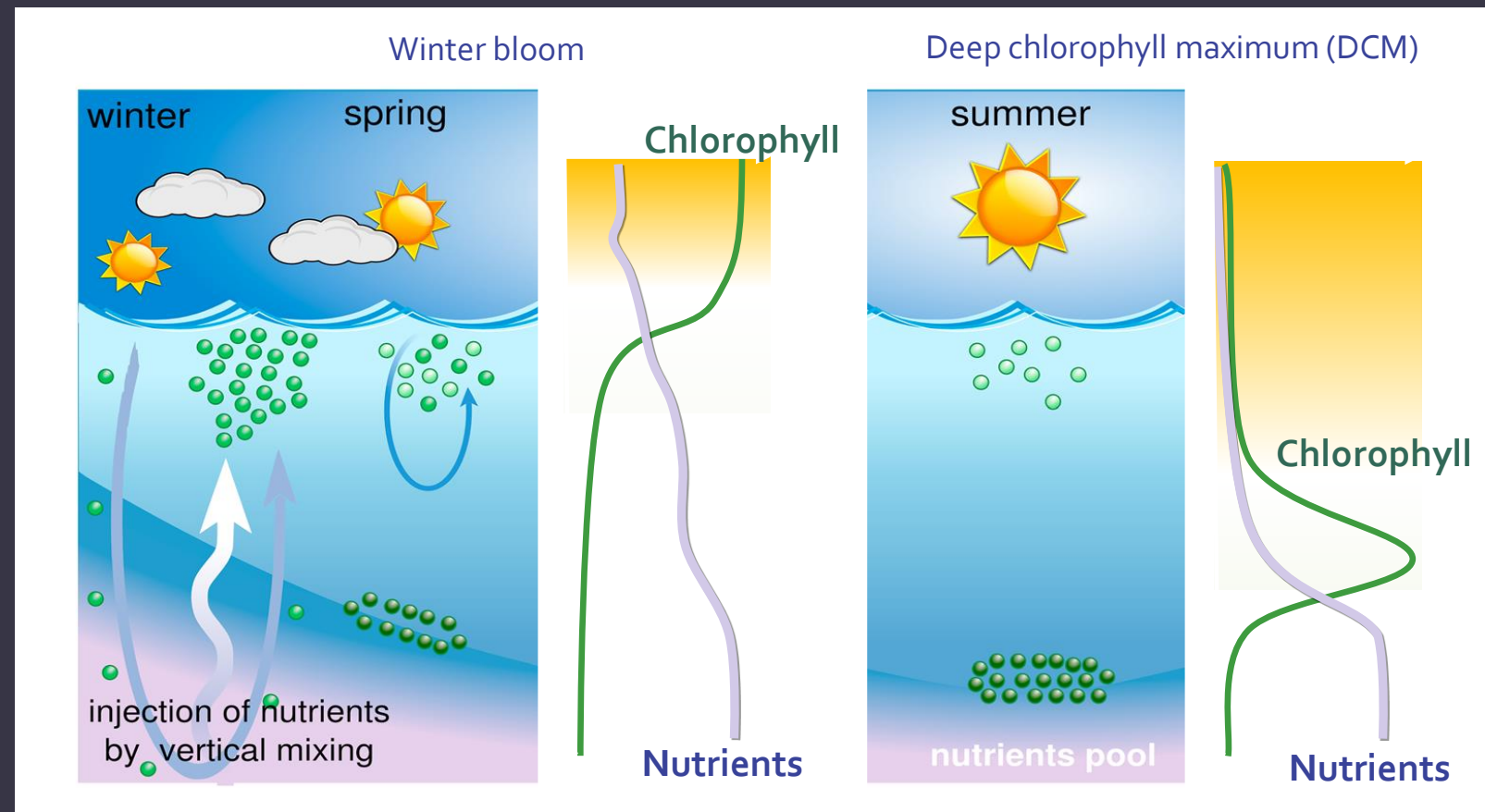
Prescribed density-nutrient covariances

- Based on BGC-Argo floats since 2013
- Eastern and western Mediterranean to account for different patterns in the two basins



- RMSDs for the 4 simulations
- Nitrate and Chlorophyll from BGC-Argo
- 4 seasons
- Different layers

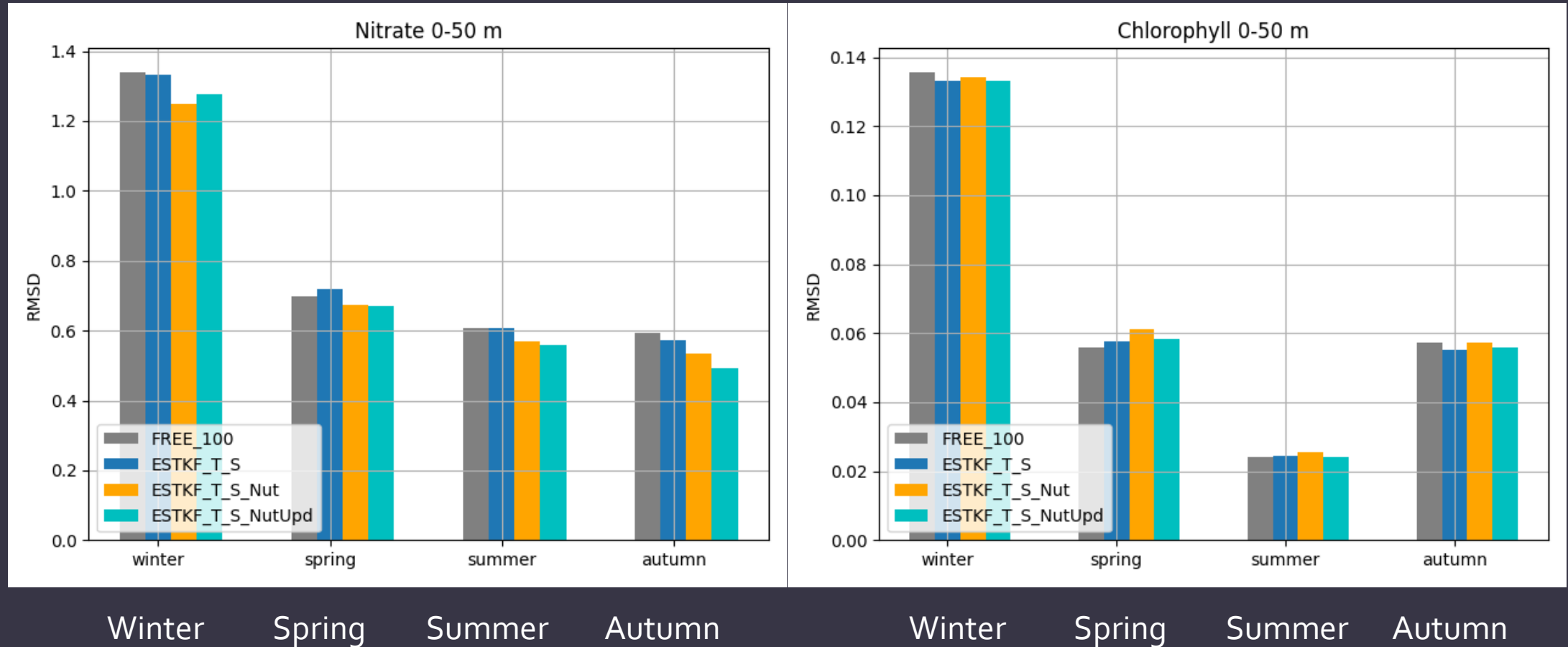
Adapted from Mignot et al., 2014



RMSD - Layer 0-50 m

Nitrate [mmol/m³]

Chlorophyll [mg/m³]



FREE_100

ESTKF_T_S

ESTKF_T_S
_Nut

ESTKF_T_S
_NutUpd

FREE_100

ESTKF_T_S

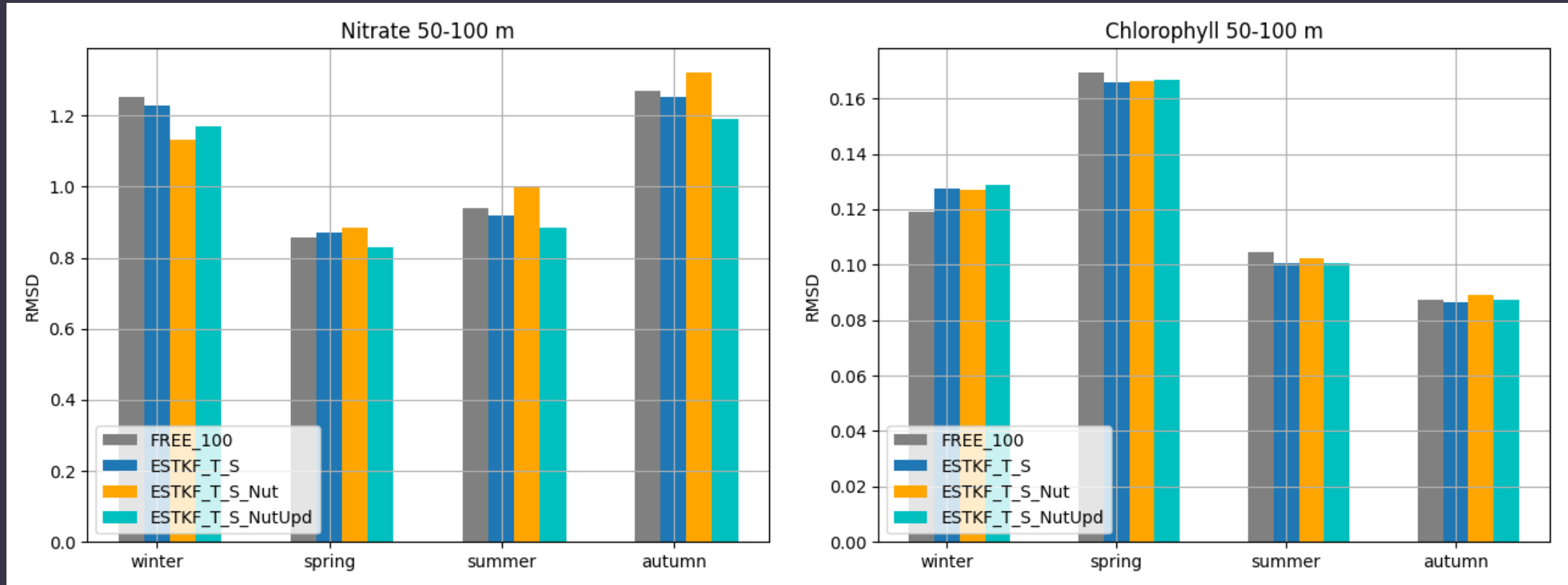
ESTKF_T_S
_Nut

ESTKF_T_S
_NutUpd

RMSD - Layer 50-100 m

Nitrate [mmol/m³]

Chlorophyll [mg/m³]



Winter

Spring

Summer

Autumn

Winter

Spring

Summer

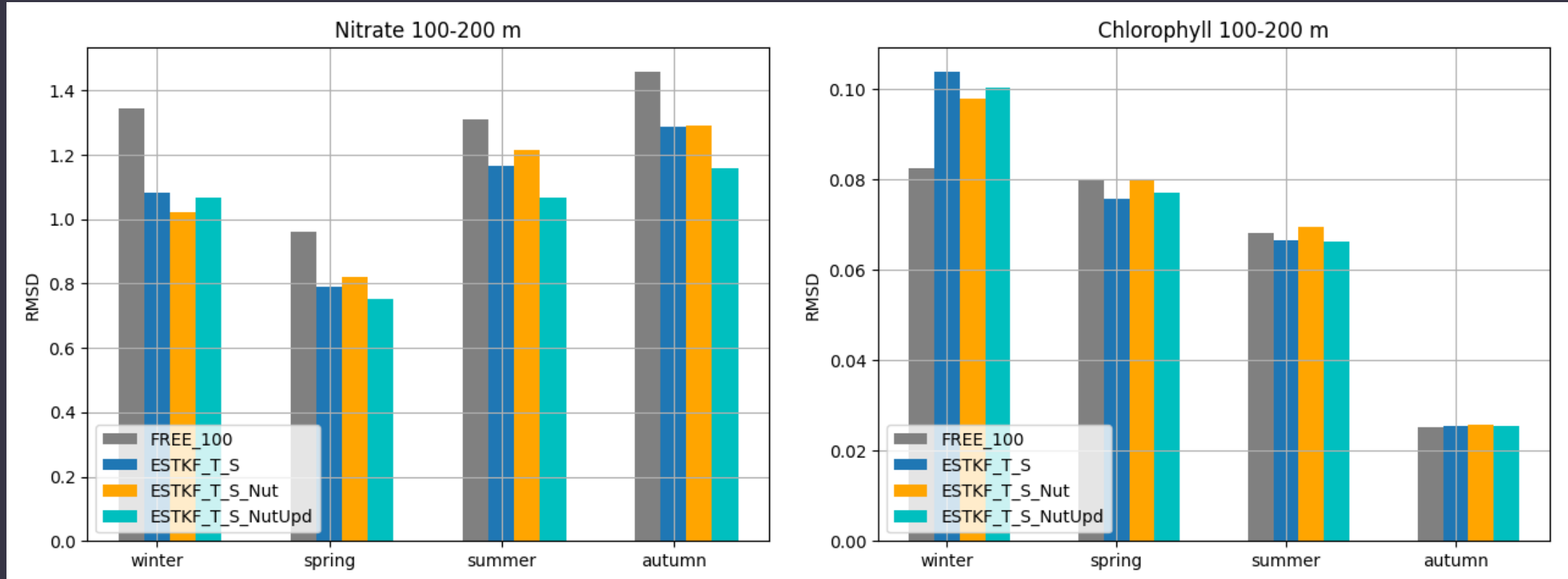
Autumn

- FREE_100
- ESTK_T_S
- ESTKF_T_S_Nut
- ESTKF_T_S_NutUpd

RMSD - Layer 100-200 m

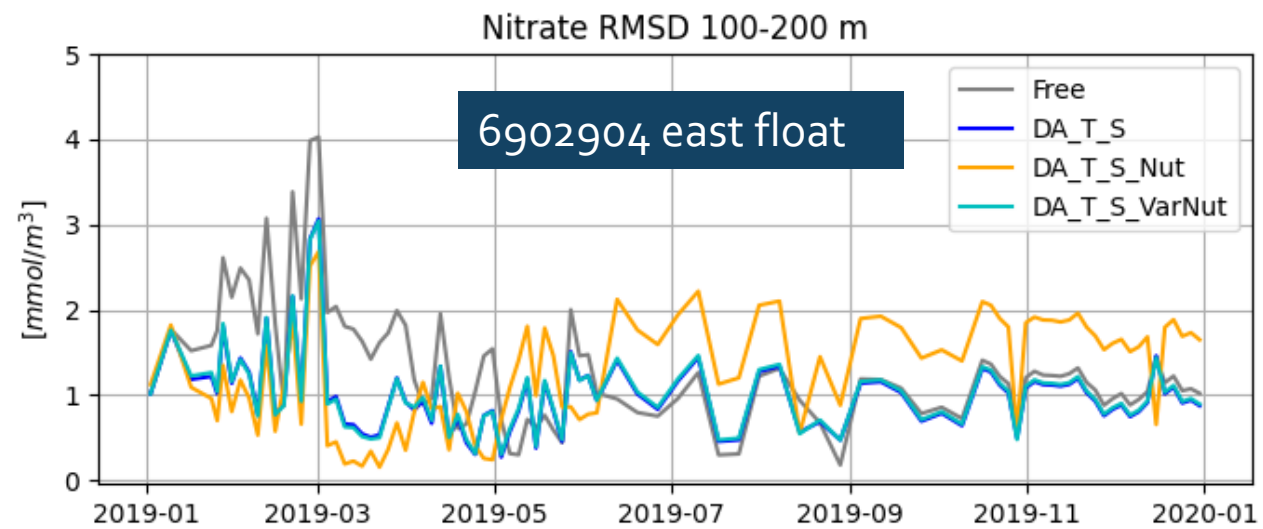
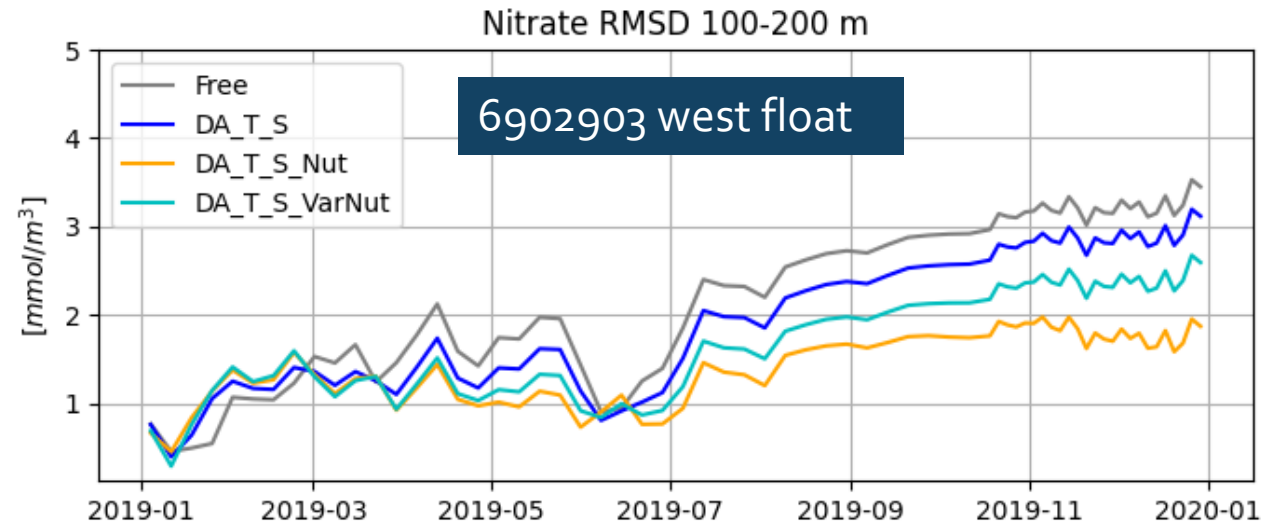
Nitrate [mmol/m³]

Chlorophyll [mg/m³]



Winter Spring Summer Autumn

Winter Spring Summer Autumn

Nitrate [mmol/m³] RMSD - Layer 100-200 m

FREE_100

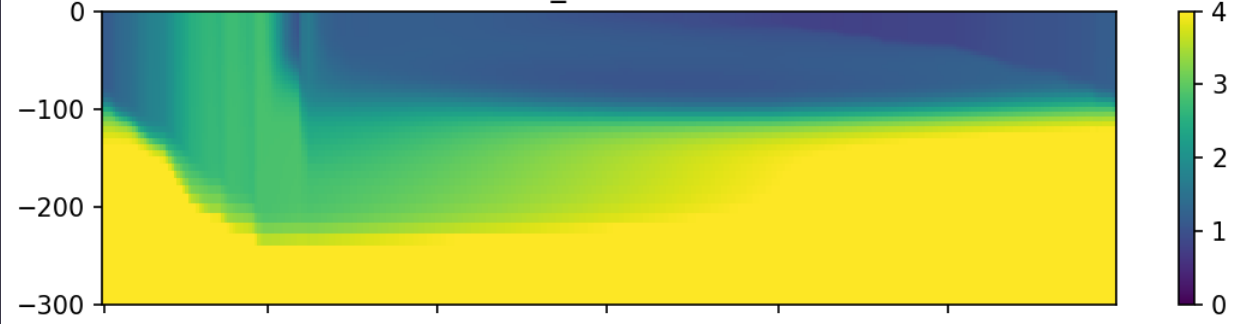
ESTK_T_S

ESTKF_T_S
_NutESTKF_T_S
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Nitrate [mmol/m³]

FREE_100

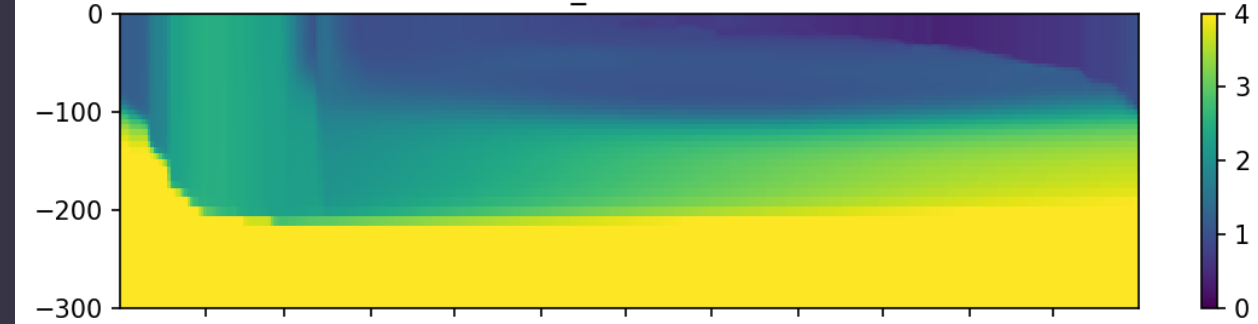
N3_n - mean



6902903 west float

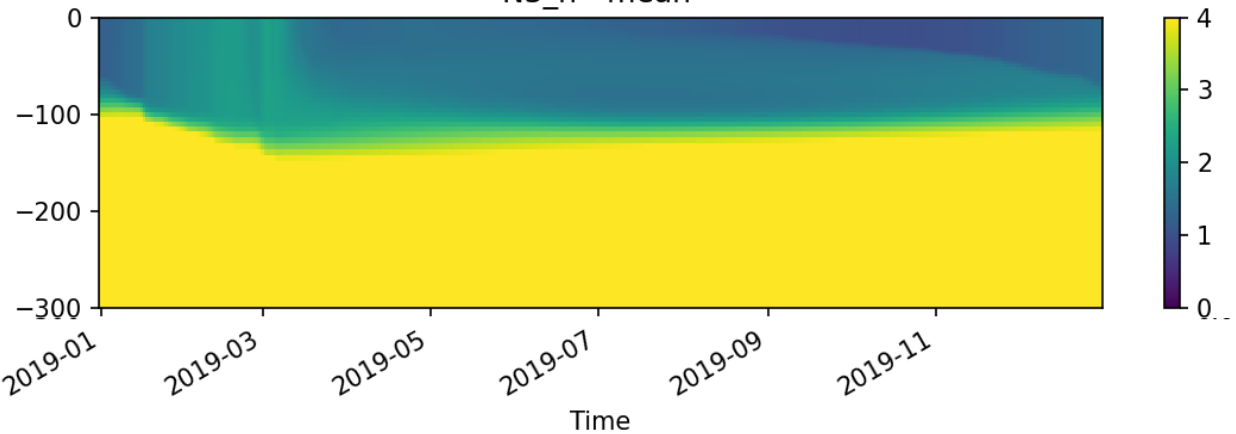
ESTKF_T_S
_NutUpd

N3_n - mean



FREE_100

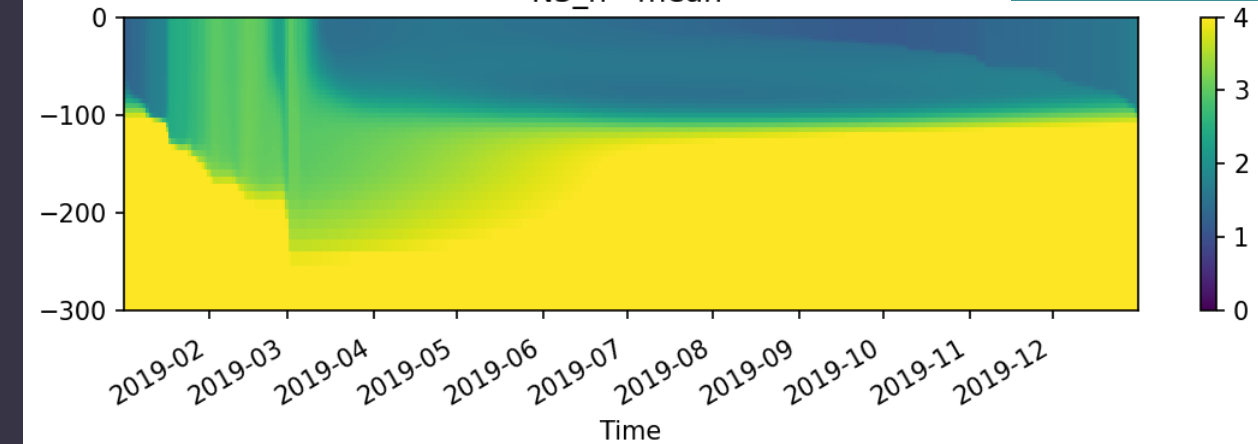
N3_n - mean



6902904 east float

ESTKF_T_S
_NutUpd

N3_n - mean



- Update of nutrients using prescribed covariances and temperature and salinity increments improves metrics with respect to independent BGC-Argo observations

Short-Mid term 1D

- Further investigation of processes
- Investigate effects on biogeochemical indicators
- Enlarge the number of floats

Long Term 3D

“How to improve integration of ocean DA developments in operational forecasts and demonstrate the impacts on ocean and coupled forecasts”

- 3D biogeochemistry operational in Copernicus Marine Service – Med-BGC
 - Forced offline with Med-PHY forcings
- Both implement DA

Med-MFC

Circulation Med-PHY

Biogeochemistry Med-BGC

Wave Med-WAV



Long Term

Implement updates on nutrients based on T and S in the 3D system compensating lack of BGC-Argo floats and increasing consistency between Med-PHY and Med-BGC

THANK YOU

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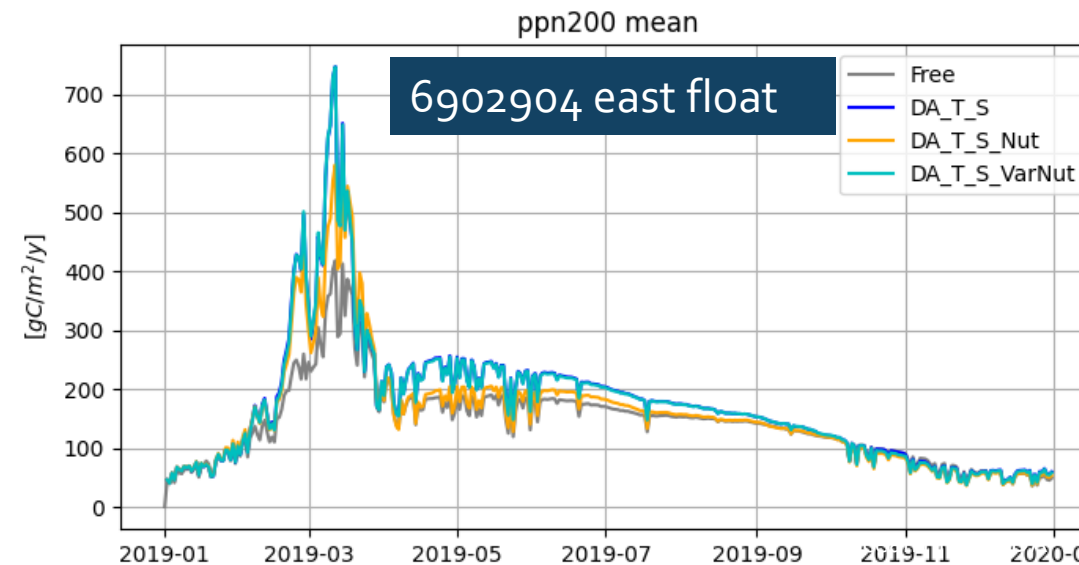
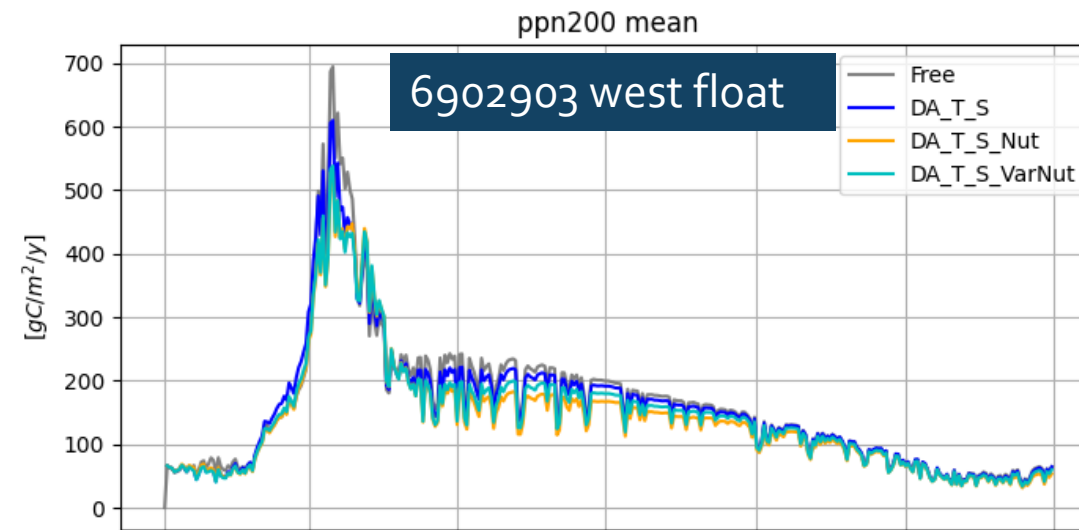
0-200 m Primary Production [$\text{gC}/\text{m}^2/\text{y}$]

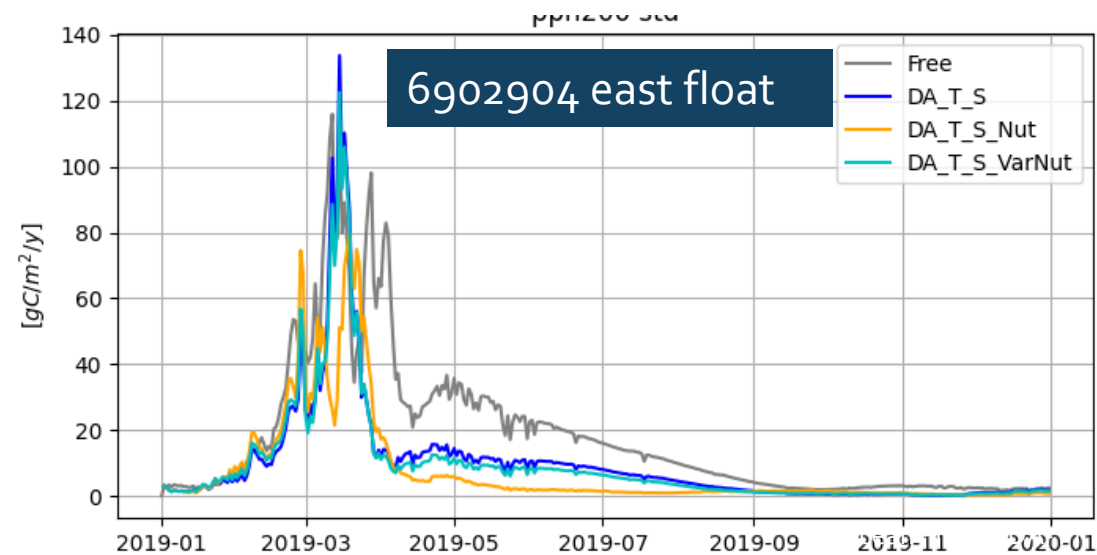
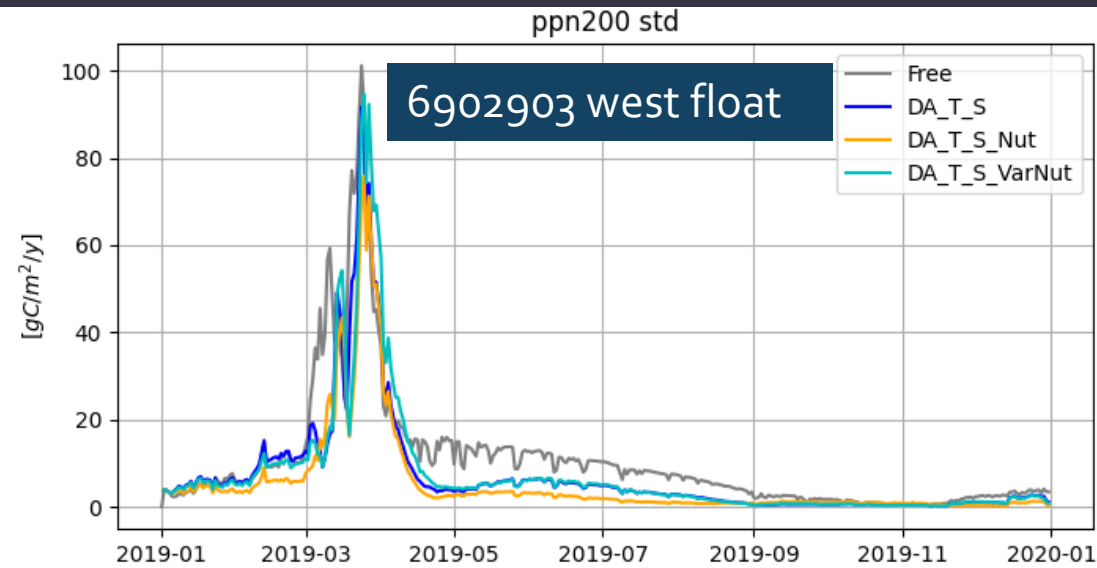
FREE_100

ESTK_T_S

ESTKF_T_S
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ESTKF_T_S
_NutUpd



0-200 m Primary Production [$\text{gC}/\text{m}^2/\text{y}$] ensemble STD

FREE_100

ESTK_T_S

ESTKF_T_S
_NutESTKF_T_S
_NutUpd