Mitigating Phytoplankton Phenology Mismatches in the Arctic Ocean Biogeochemical Reanalysis

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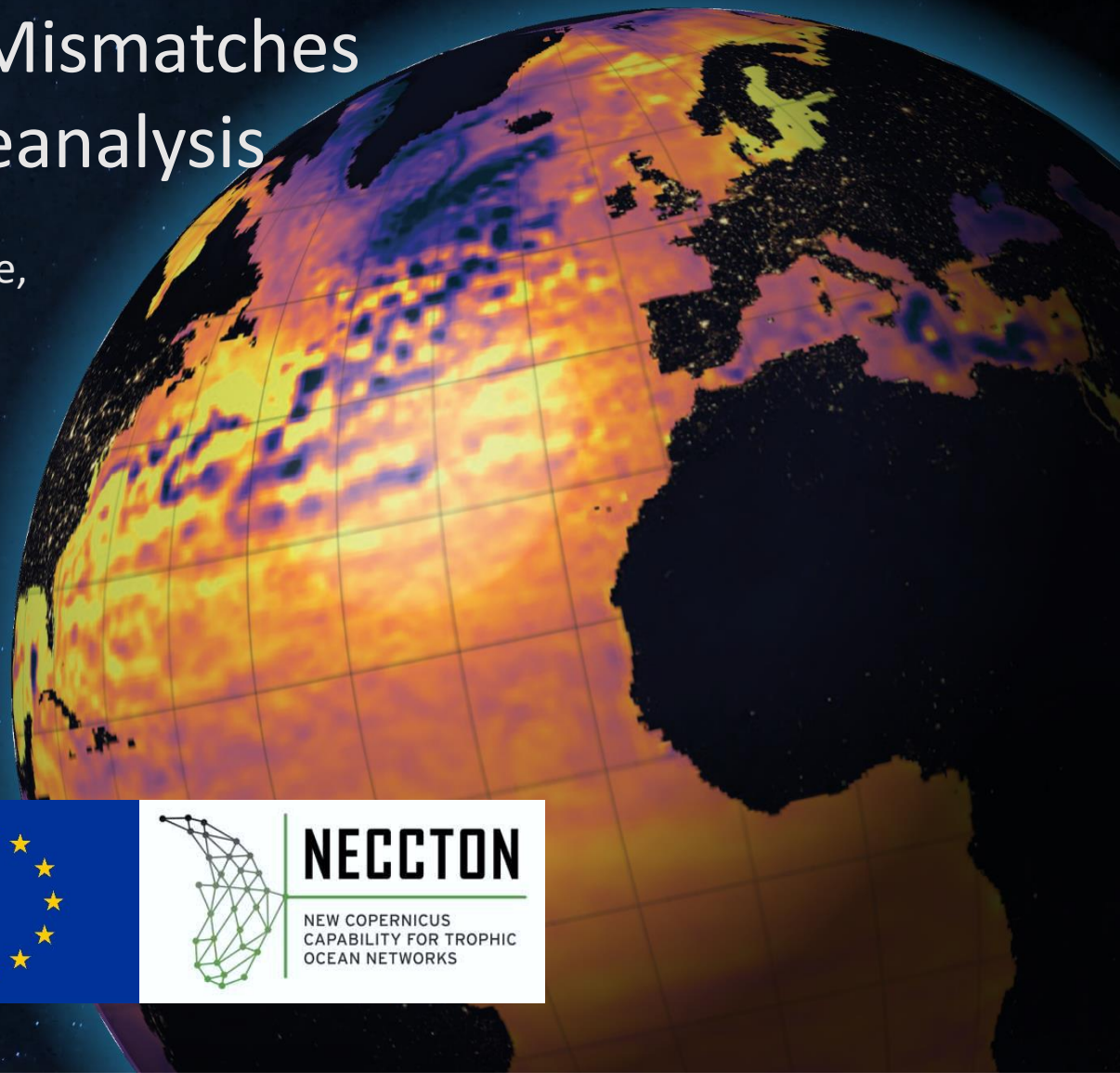
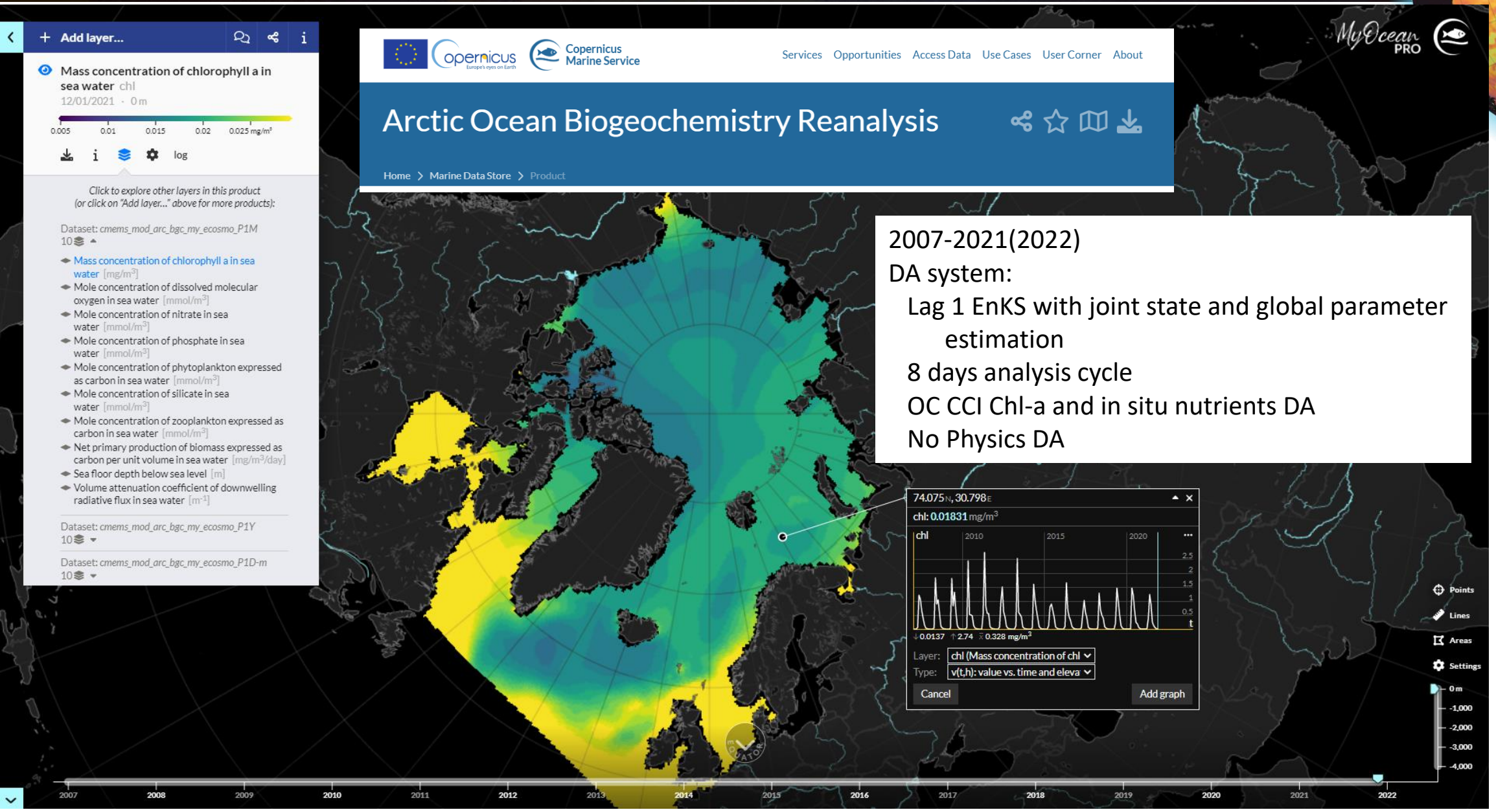


Ocean Predict

SYMPOSIUM OP'24

In partnership with unesco Intergovernmental Oceanographic Commission

2021 2030 United Nations Decade of Ocean Science for Sustainable Development



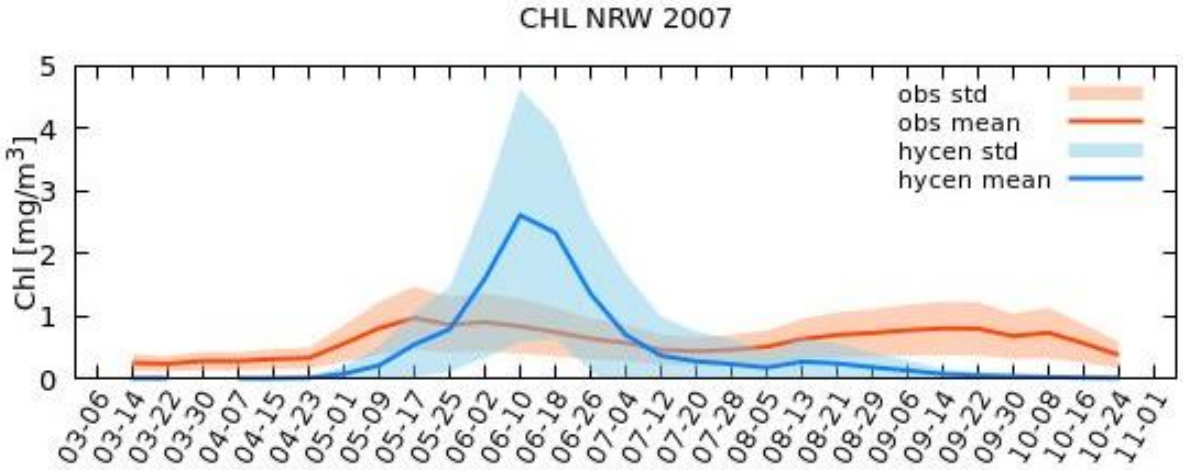
2007-2021(2022)

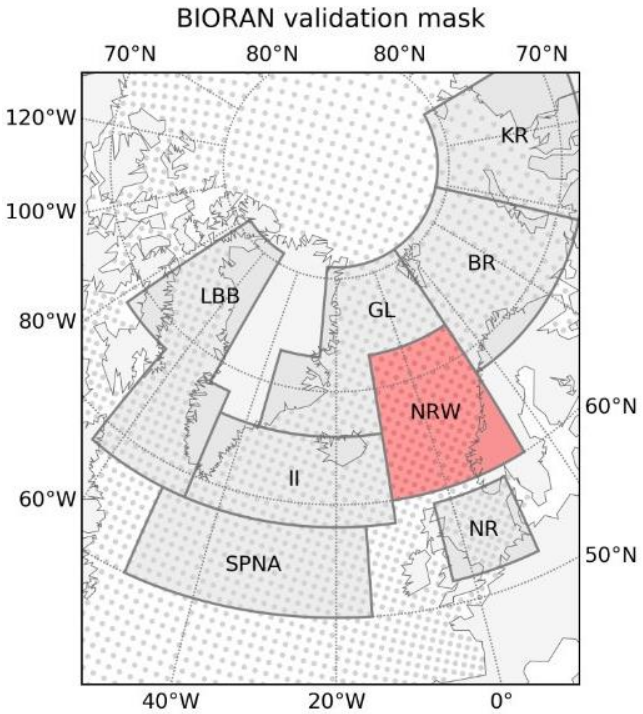
DA system:

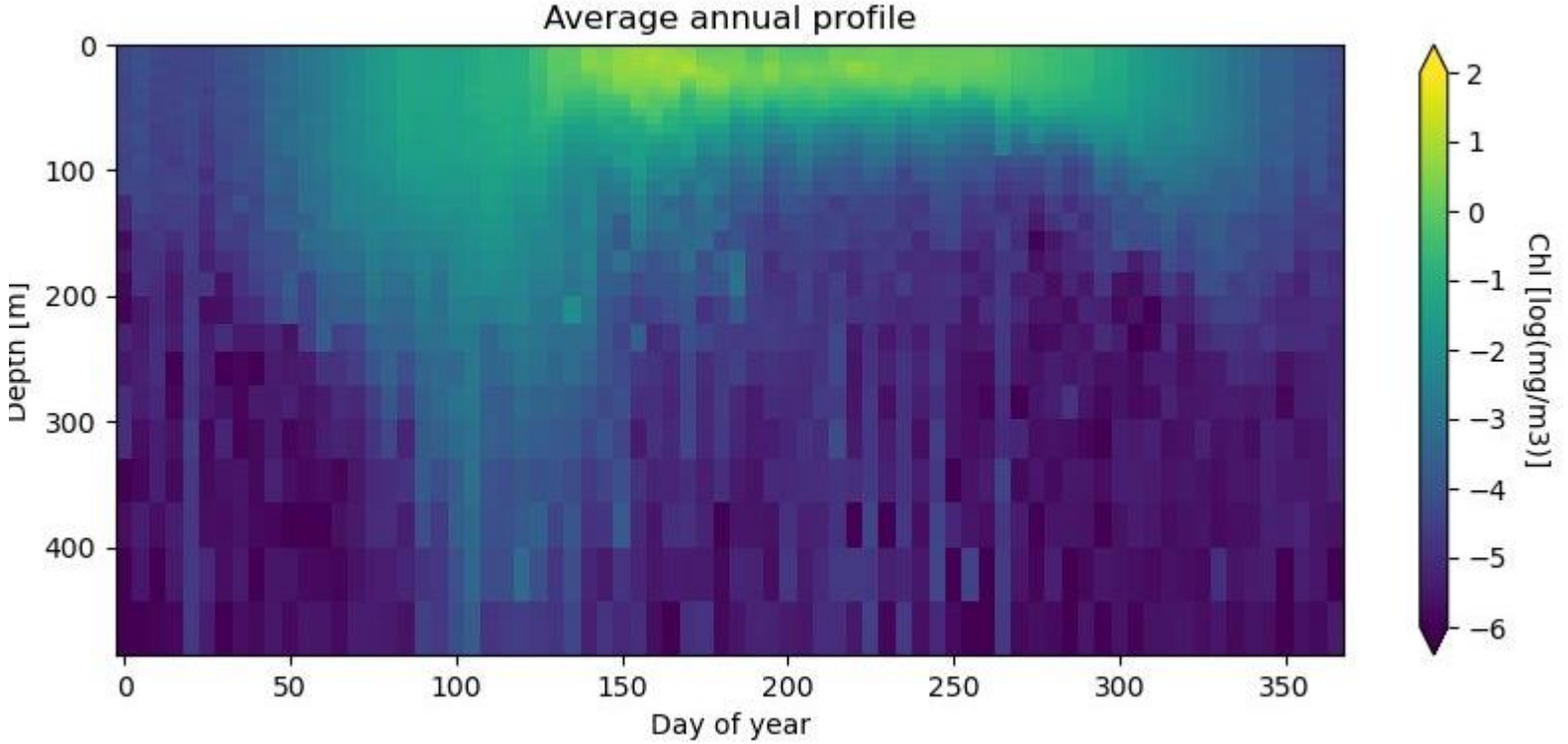
- Lag 1 EnKS with joint state and global parameter estimation
- 8 days analysis cycle
- OC CCI Chl-a and in situ nutrients DA
- No Physics DA

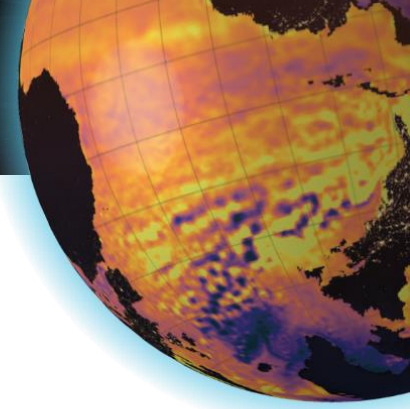
Phytoplankton Phenology mismatch between model and data in Norwegian Sea

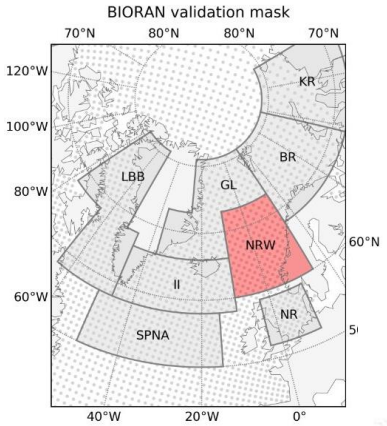
Late bloom onset
Too string peak spring bloom
Luck of fall bloom



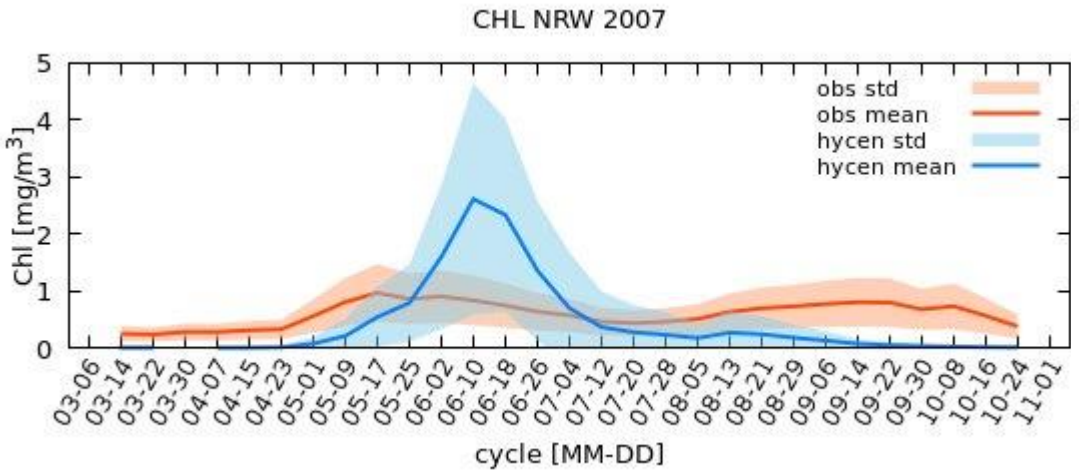


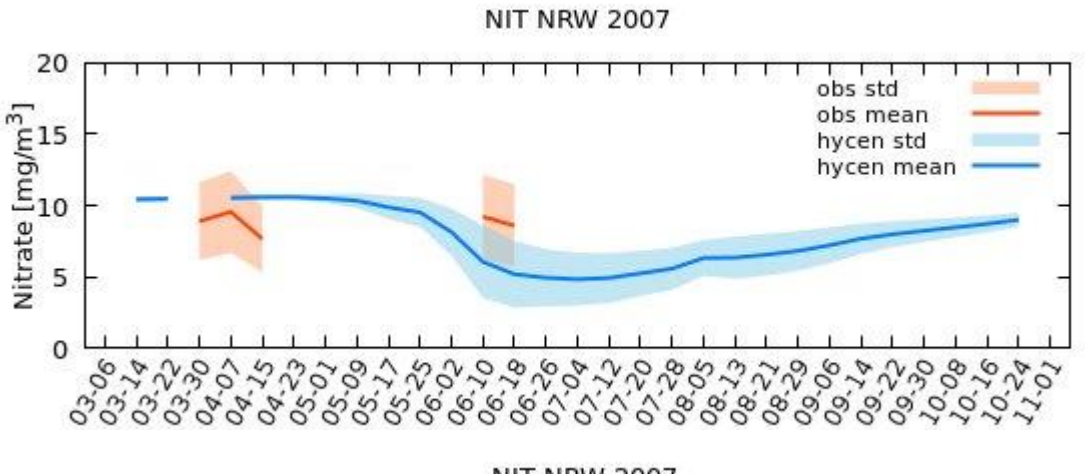


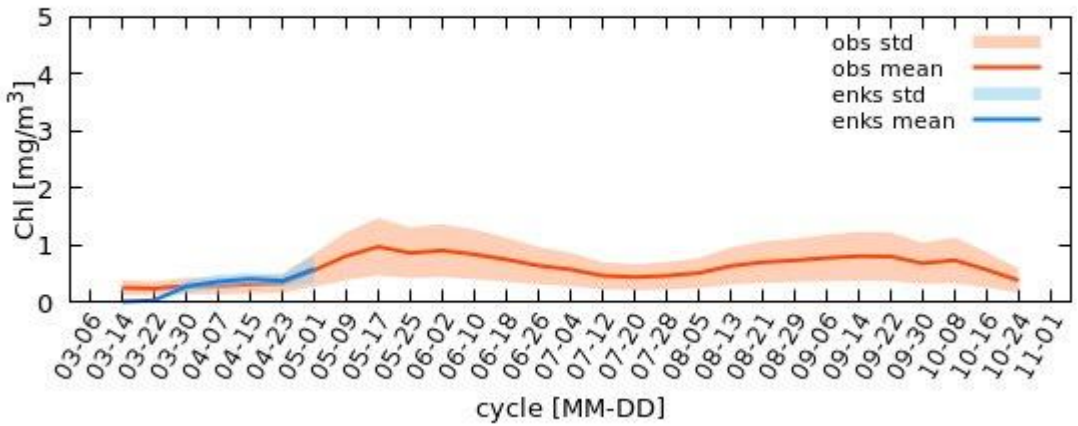


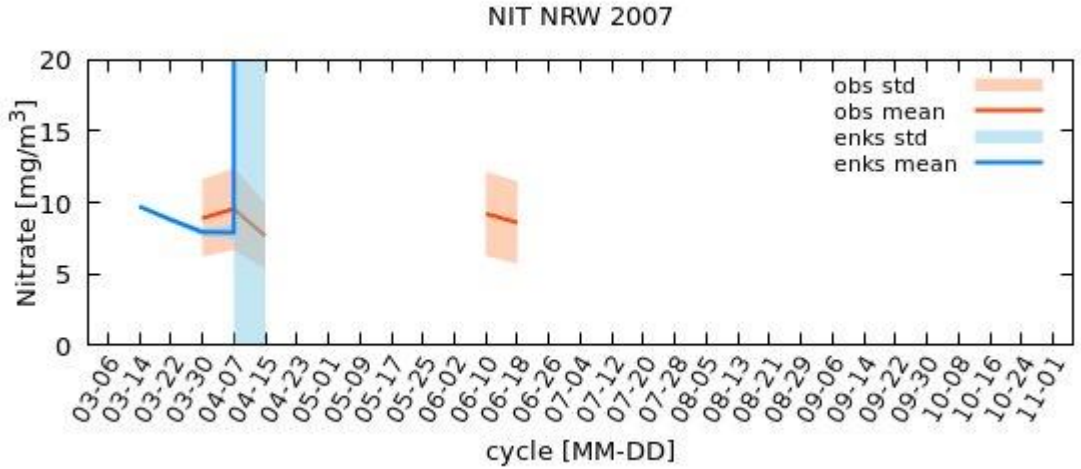


Case 1: DA incident in 2007-04-07: Nitrate blows up in Norwegian Sea.

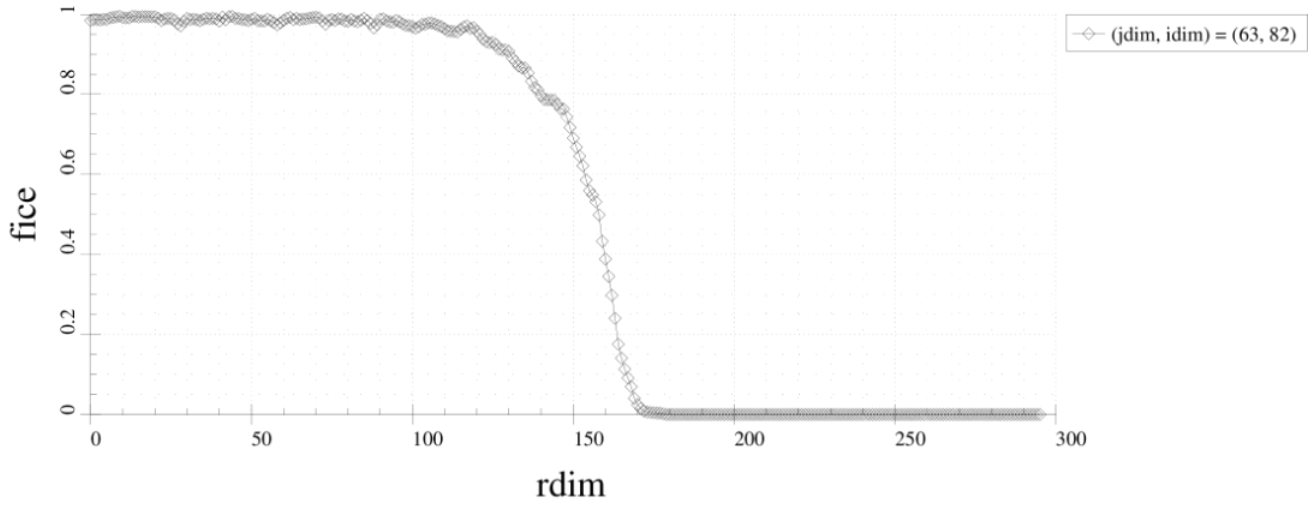


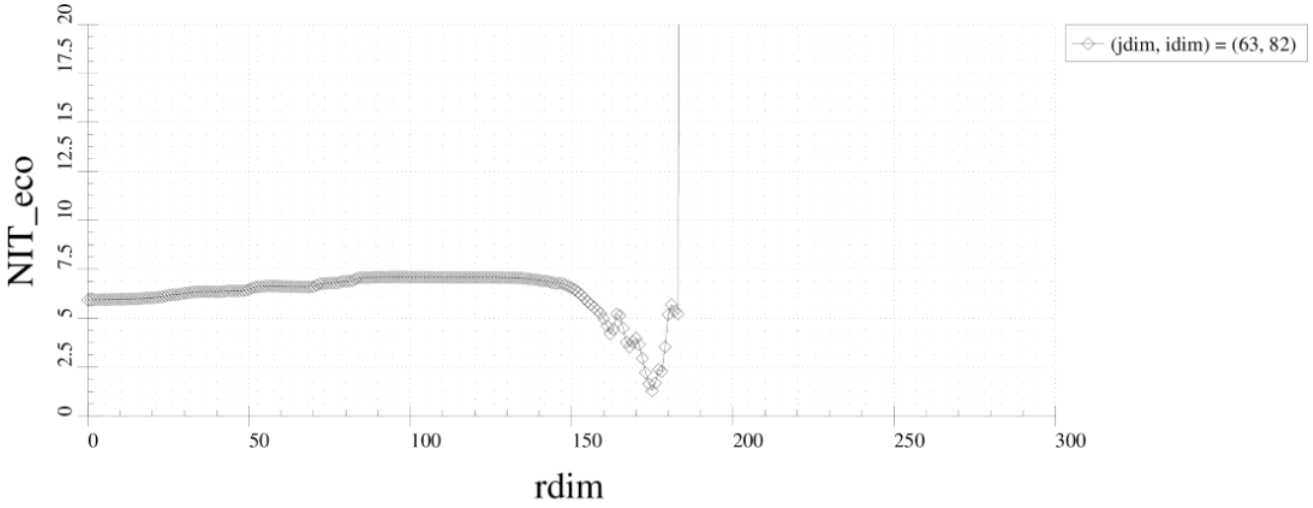


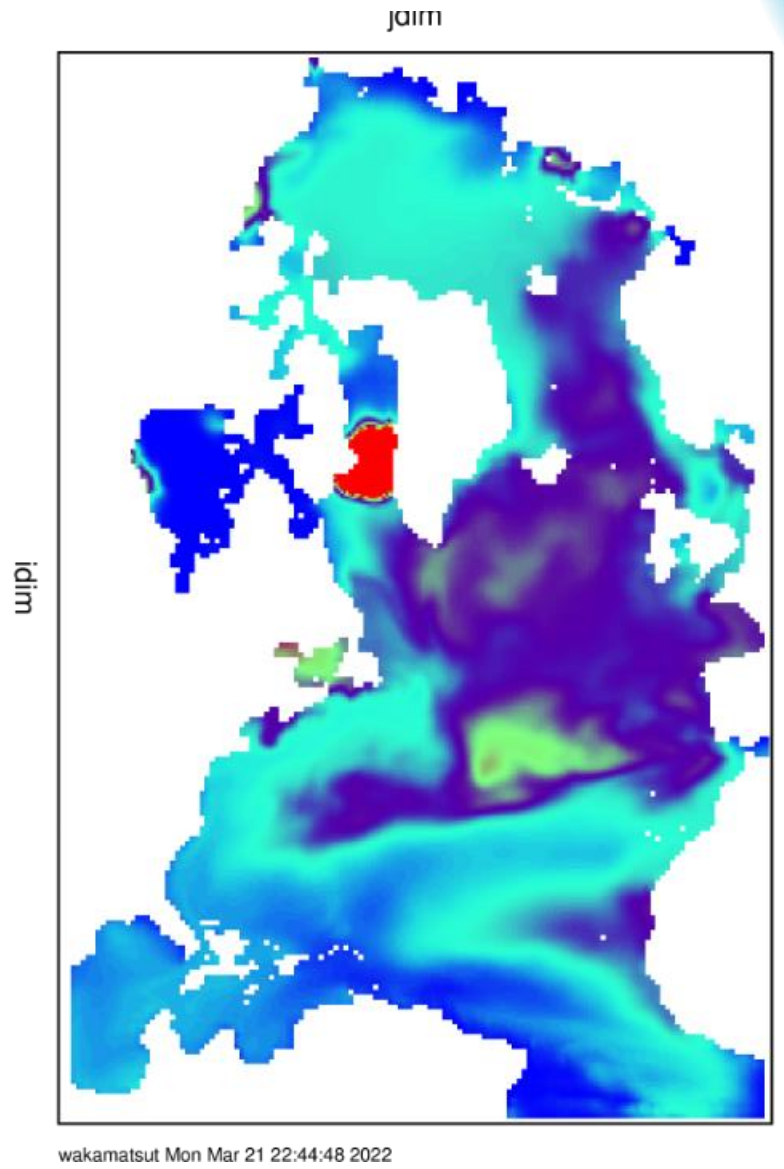




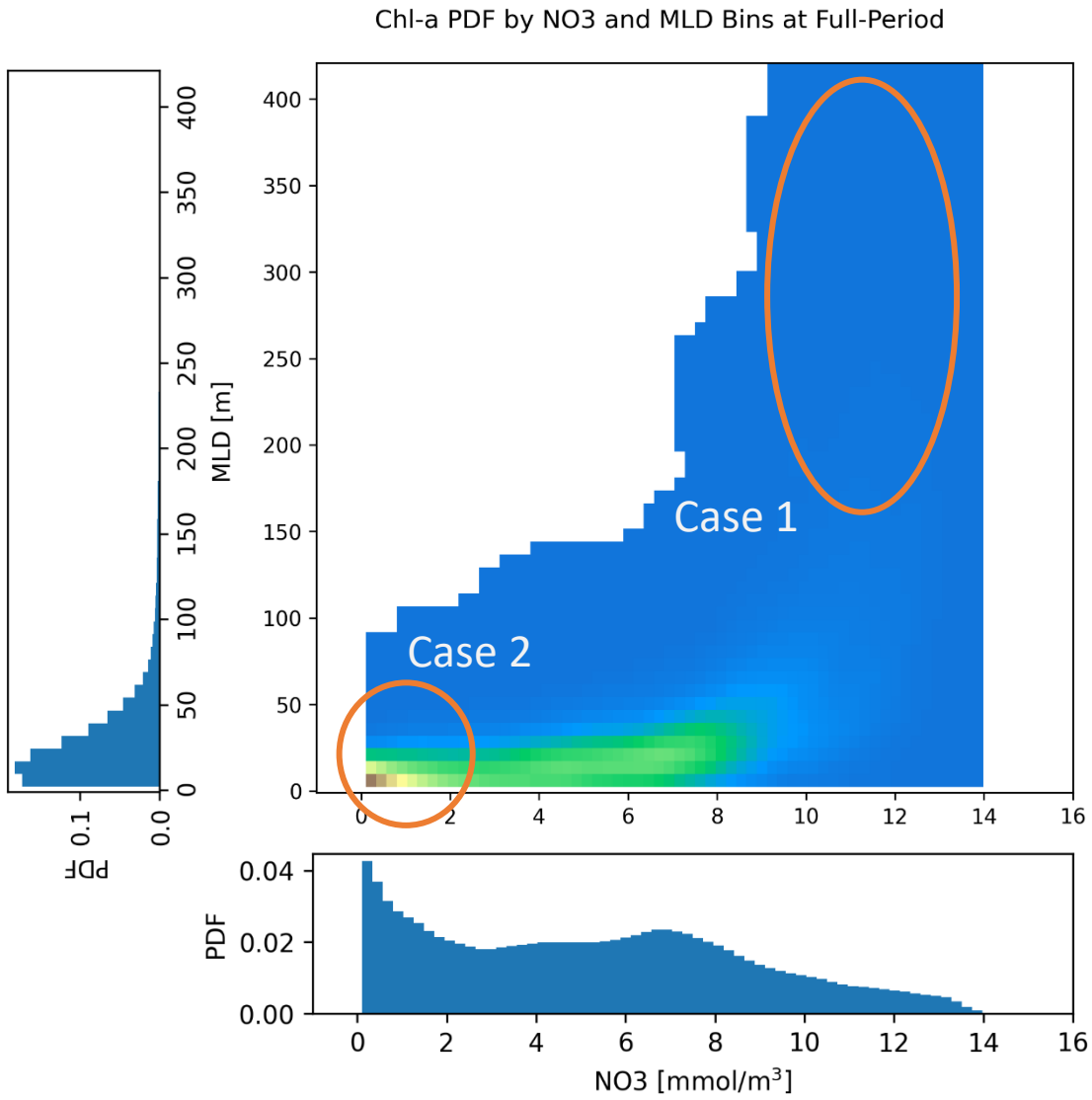
Case 2: DA incident in 2012 Day 175: Nitrate blows up in Davis Strait.







DA incidents on MLD - NO3 plane



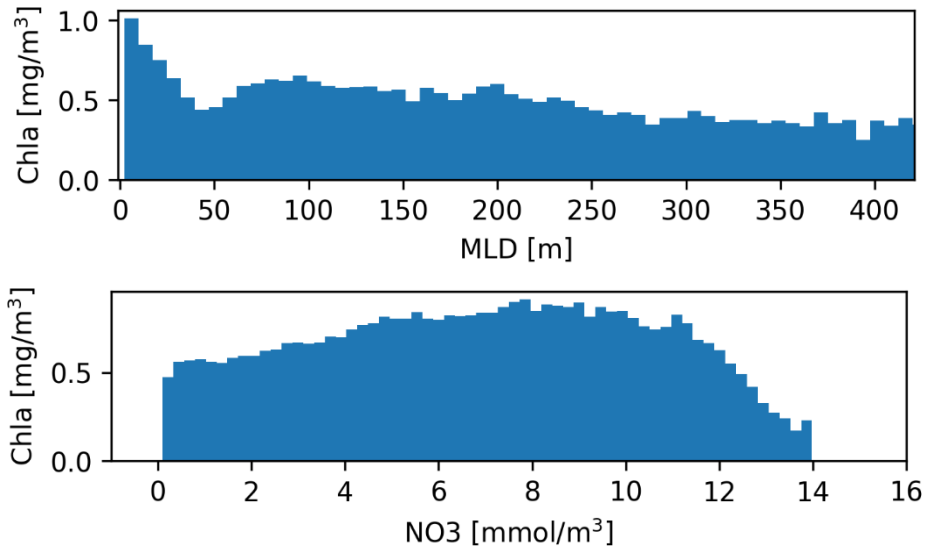
Left panel:

PDF of Phytoplankton bloom on the MLD - NO3 plane based on 2019-2021 model free run.

Two cases of data assimilation incidents:

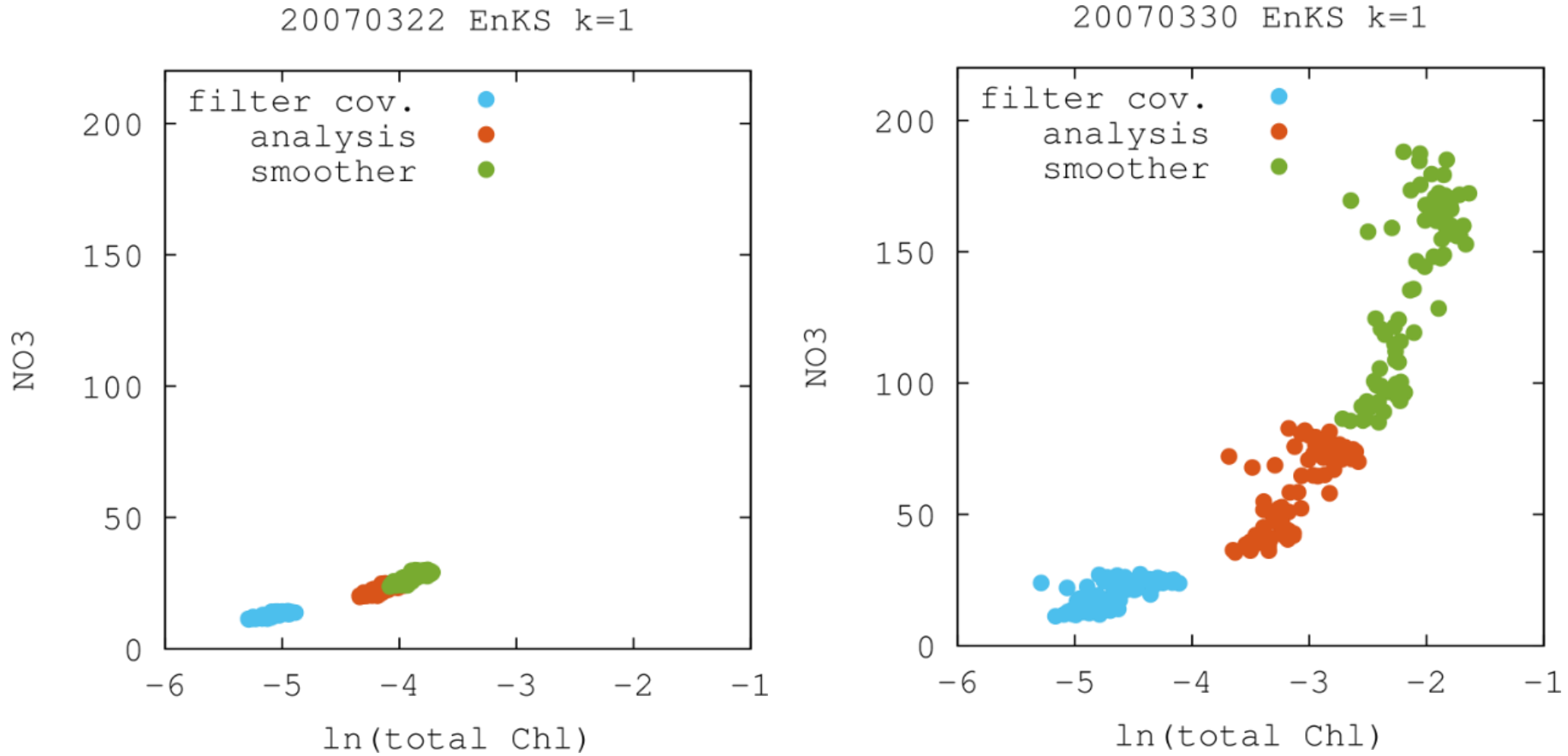
Case 1: Deep mixed layer depth (MLD) in early spring
Case 2: Low nitrate (NO3) concentration after the spring bloom

Note: low PDF does not mean low Chl-a (bottom panels)



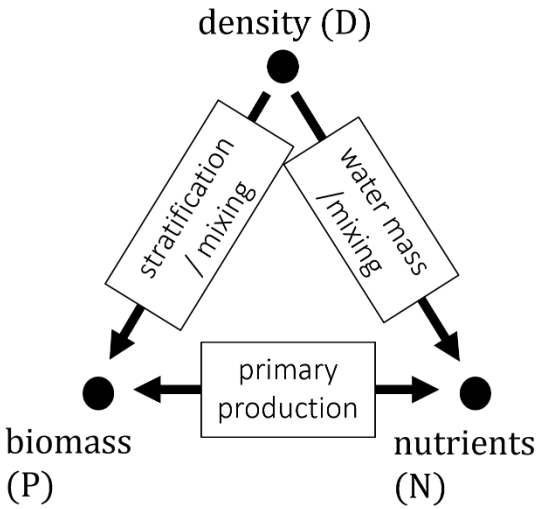
Positive correlation between surface Chl-a and NO3 is amplified through assimilation cycles with PERSISTENT negative Chl-a bias in model Chl-a.

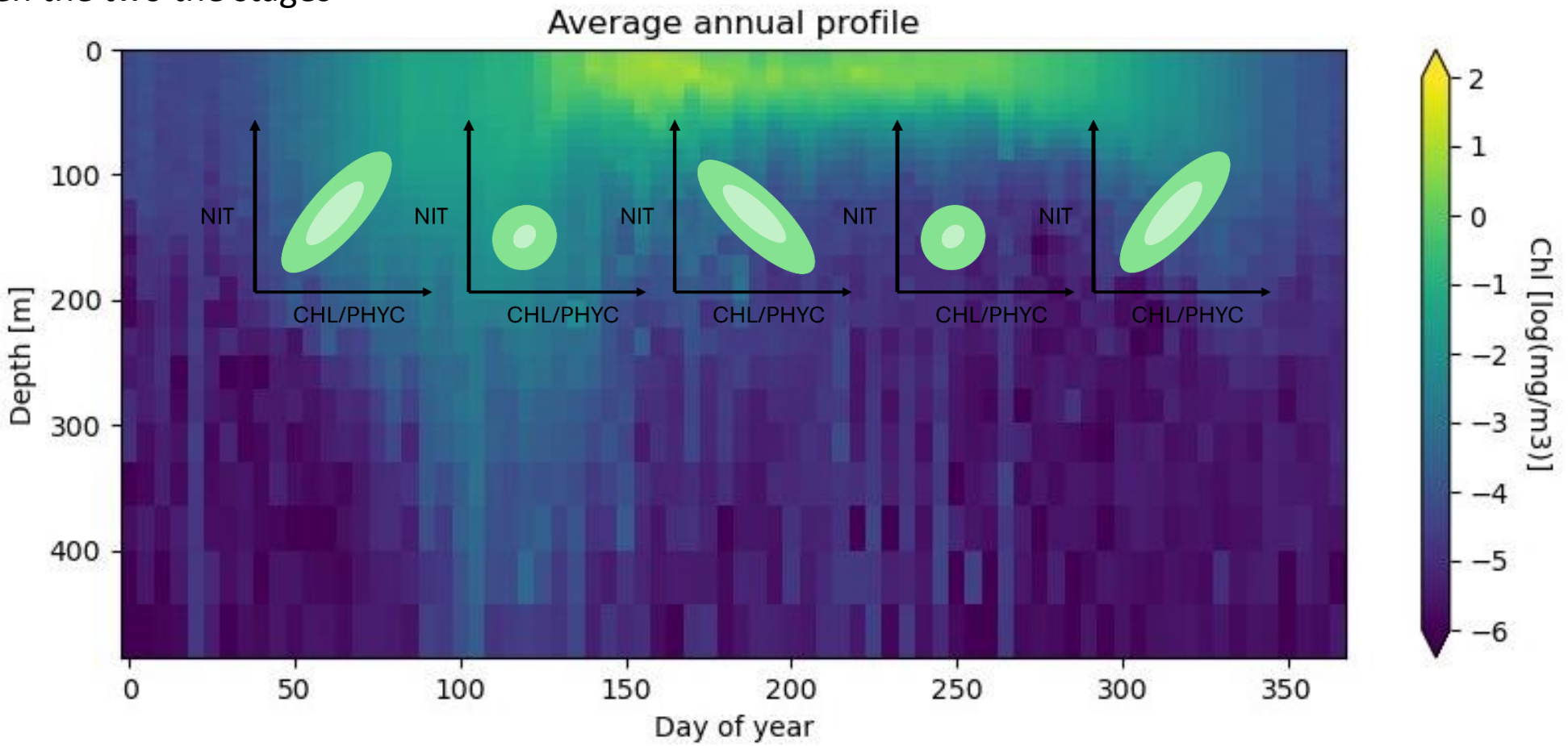
Example from Case 1 incident:



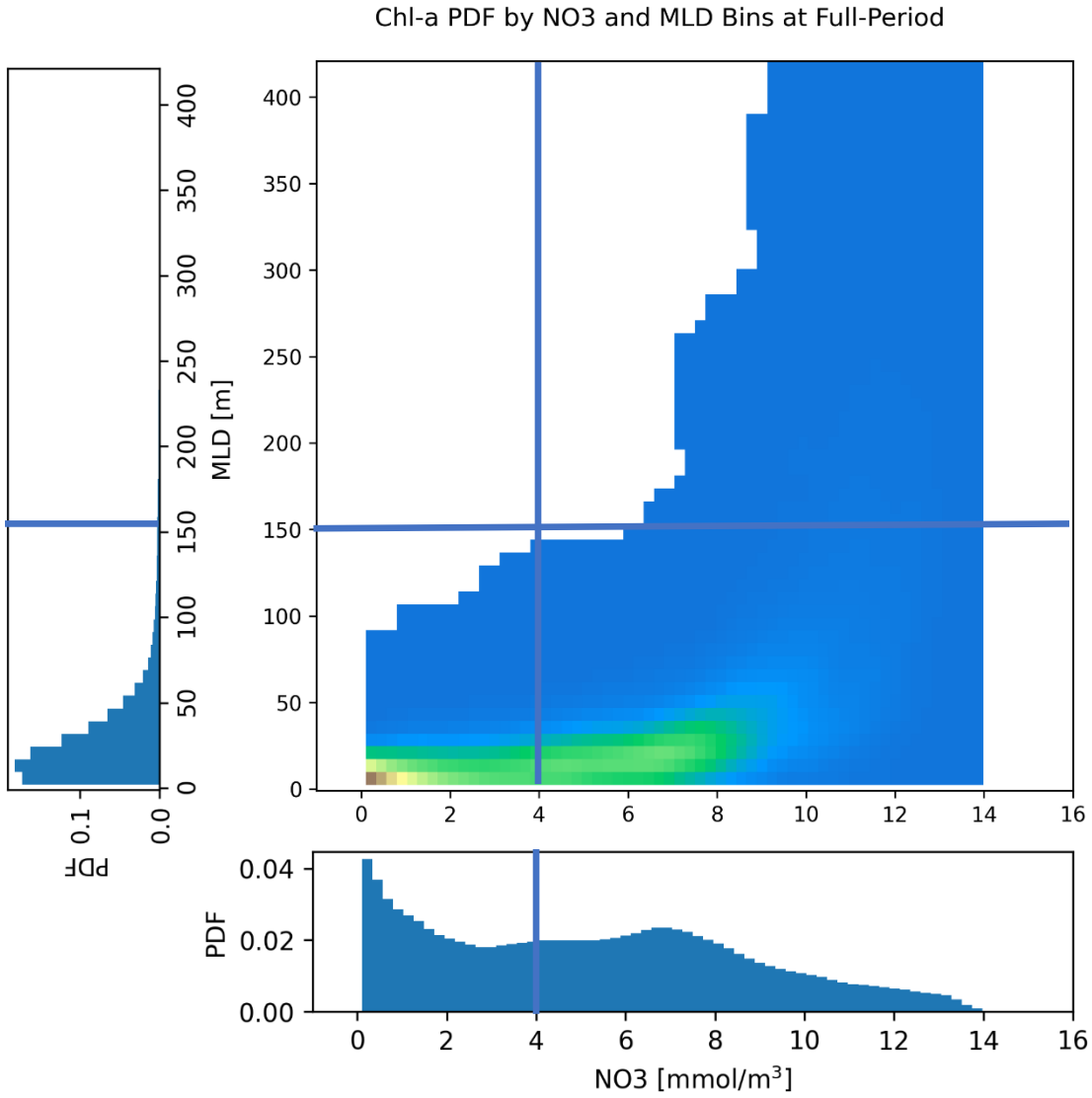
Stages of Chl – NO3 covariance formation in ensemble system

Stage A: Mixing (MLD depth) dominated covariance: Positive correlation
Stage B: Primary production dominated covariance: Negative correlation
Stage C: Transition between the two the stages





DA Thresholds on MLD - NO3 plane



Introduction of DA analysis masks:

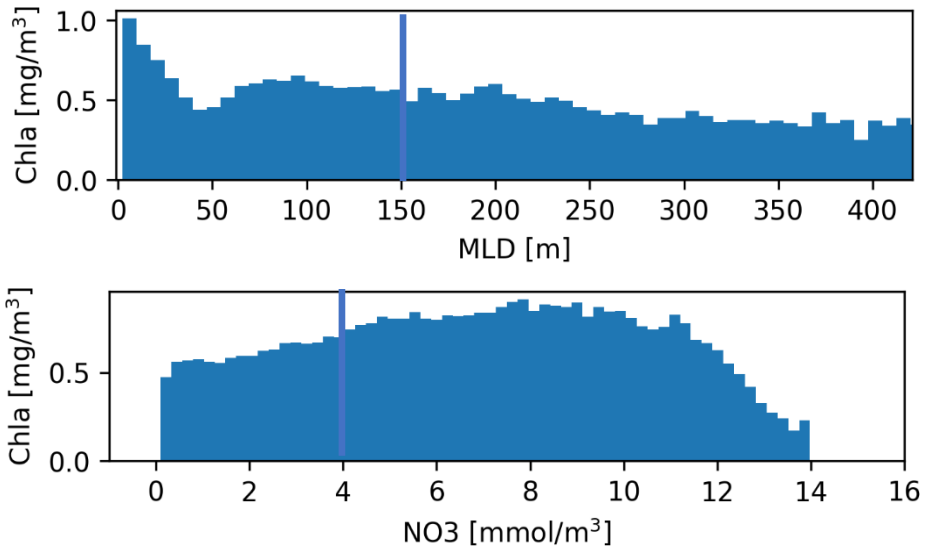
Area 1: Deep mixed layer depth (MLD) in early spring

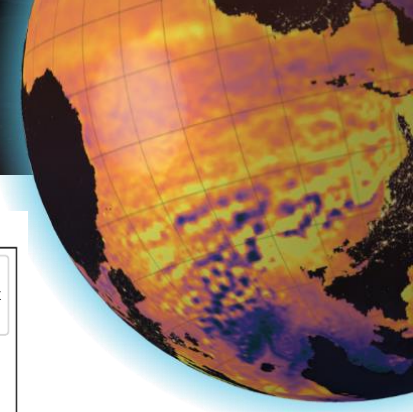
Threshold: MLD > 150m

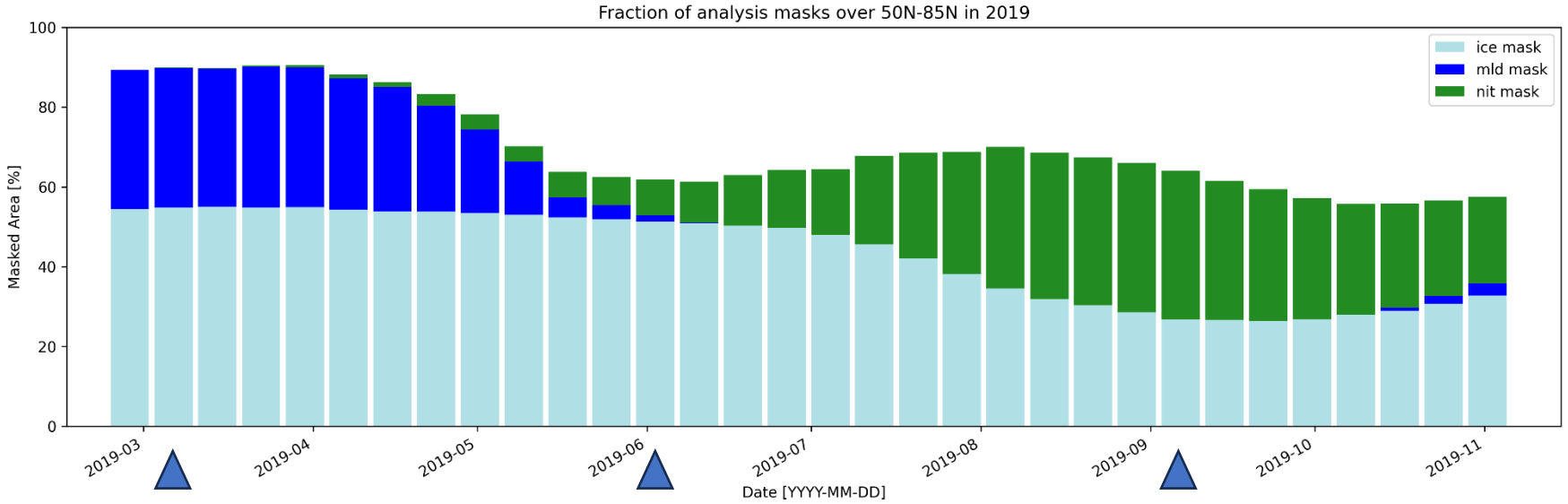
Area 2: Low nitrate (NO3) concentration after the spring bloom

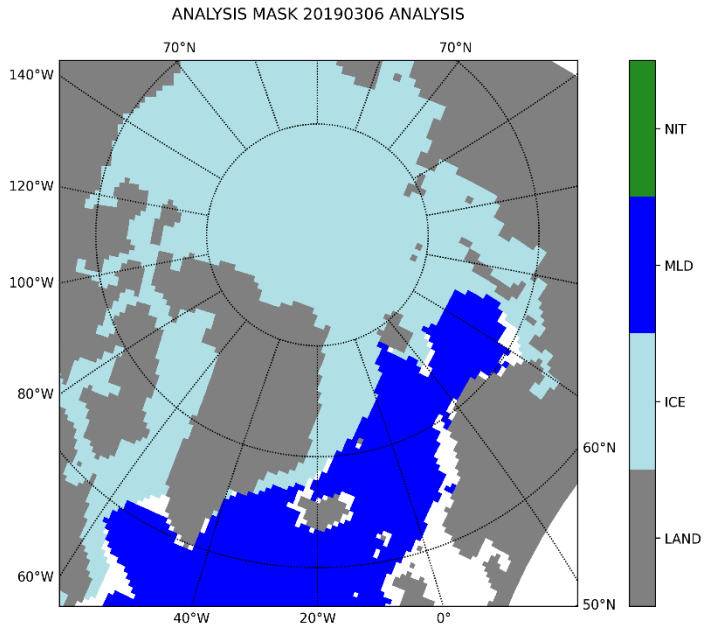
Threshold: NO3 < 4 mmol/m3

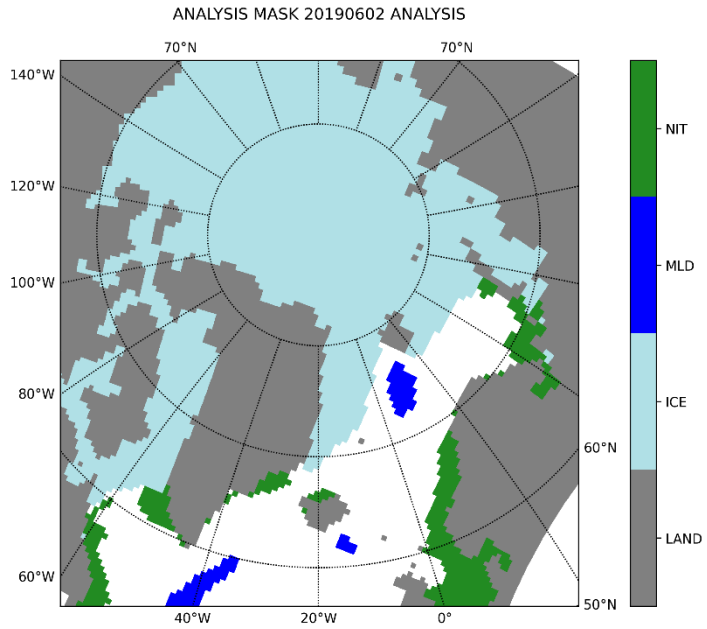
Note: DA analysis masks apply only to state estimation.
Area of DA analysis masks is defined

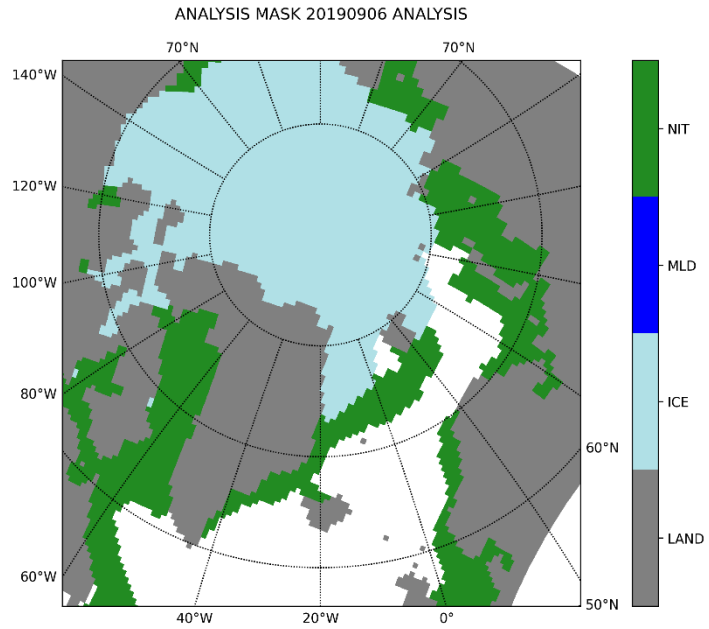




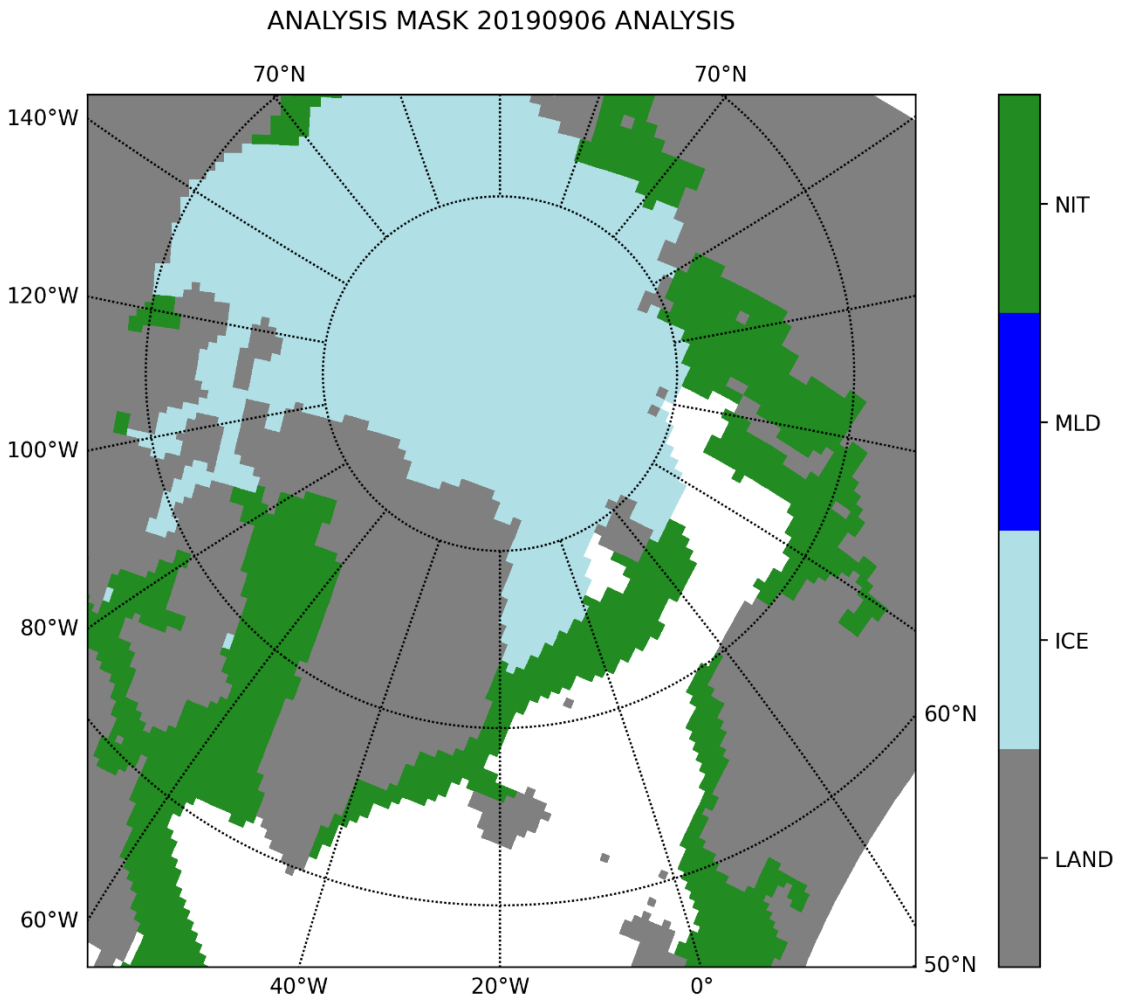

Fraction of analysis masks over 50N-85N in 2019
Masked Area [%]
Date [YYYY-MM-DD]
ice mask
mld mask
nit mask
2019-03
2019-04
2019-05
2019-06
2019-07
2019-08
2019-09
2019-10
2019-11

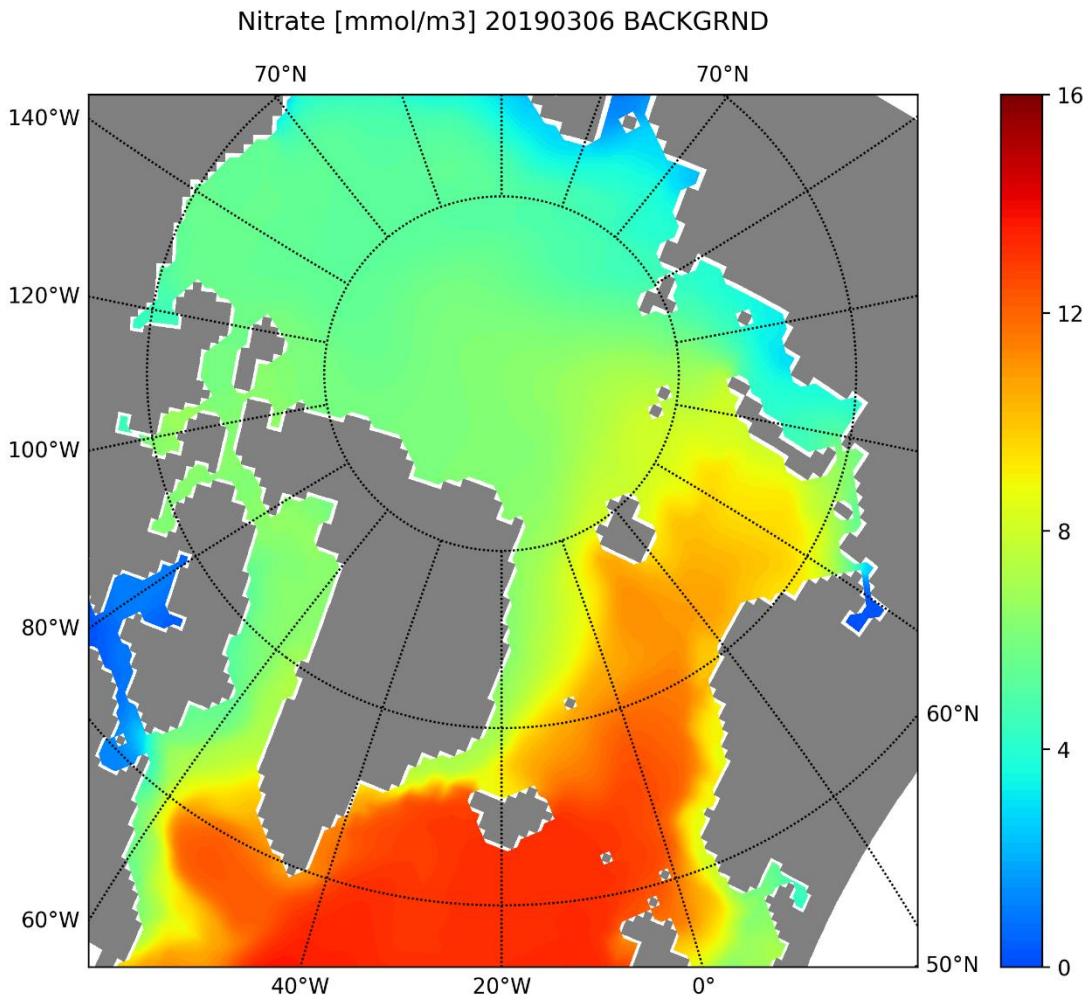

ANALYSIS MASK 20190306 ANALYSIS
NIT
MLD
ICE
LAND


ANALYSIS MASK 20190602 ANALYSIS
NIT
MLD
ICE
LAND


ANALYSIS MASK 20190906 ANALYSIS
NIT
MLD
ICE
LAND

Nitrate mask distribution is associated with low nitrate waters in pre-bloom period.



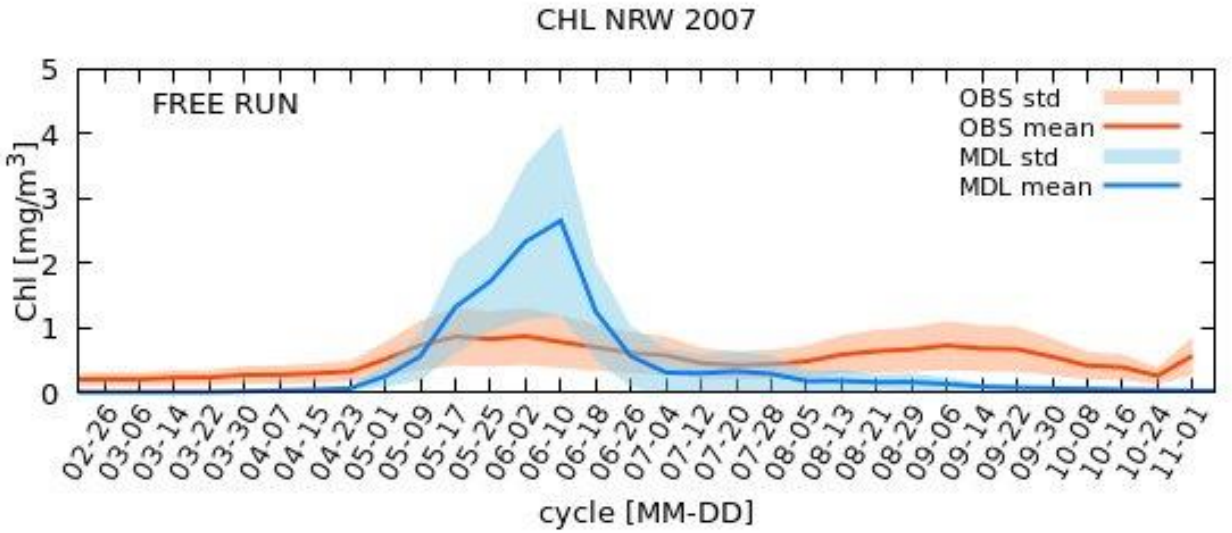


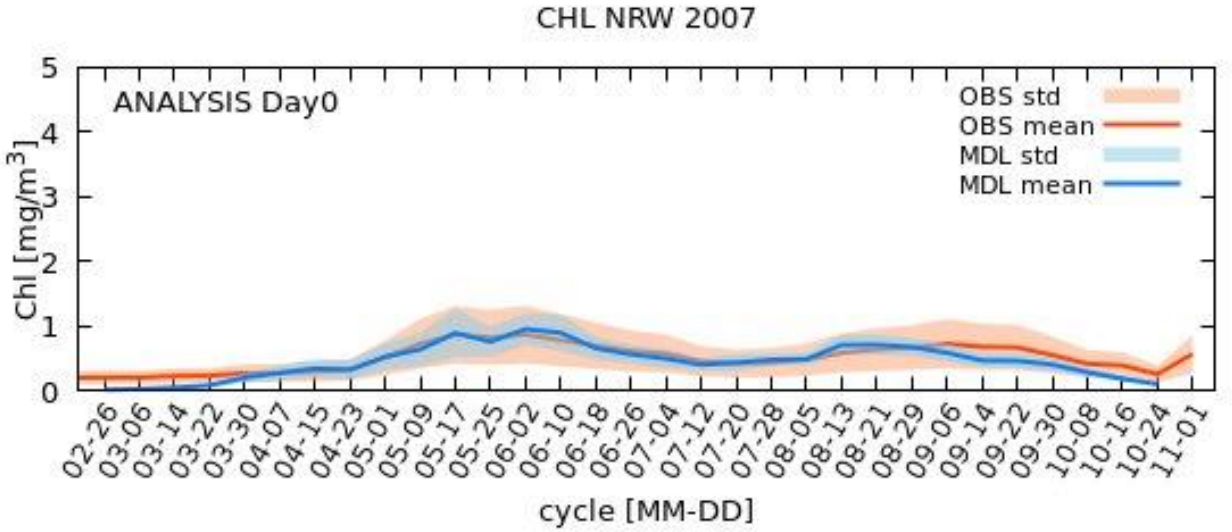
Introduction of DA analysis masks stabilize EnKS analysis throughout a year.

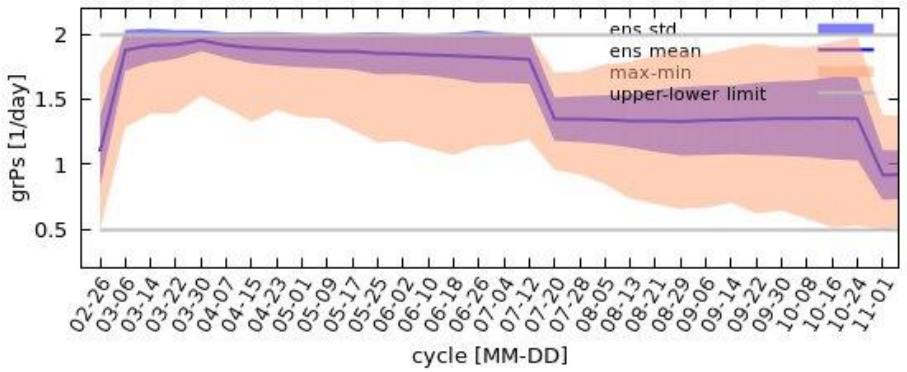
Improvement of early spring bloom is on online parameter estimation.

Next version of ARC MFC BGC MY:

- Use new set of BGC parameters optimized against BGC Argo (Yumruktepe et al.).
- Weakly coupled DA with physics DA
- Ecoregion dependent online GC parameter estimation







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esa

cnes
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Met Office

NERSC

Australian Government
Bureau of Meteorology

Canada

TP2 som classes: 2007-2016 (trial 82) smoothed