

Atmospheric correction for the full spectrum of optical water types

Efforts towards best Ocean Colour products for the Baltic Sea

Martin Hieronymi¹, Roland Doerffer^{1,2}, Hajo Krasemann¹ & Eike Schütt¹

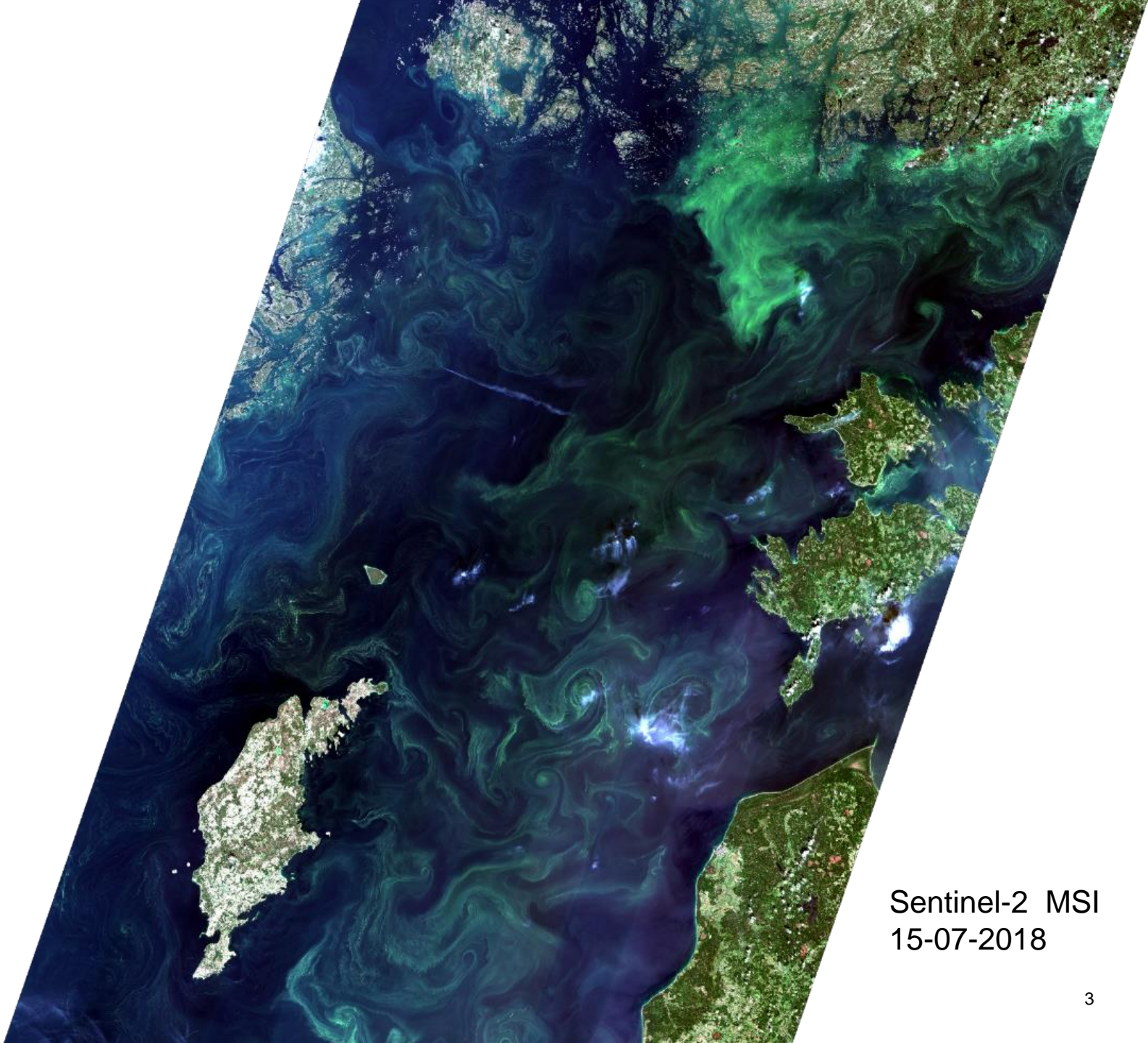
¹ Institute of Coastal Research, Helmholtz-Zentrum Geesthacht, Geesthacht, Germany

² Brockmann Consult, Hamburg, Germany

21 September 2020

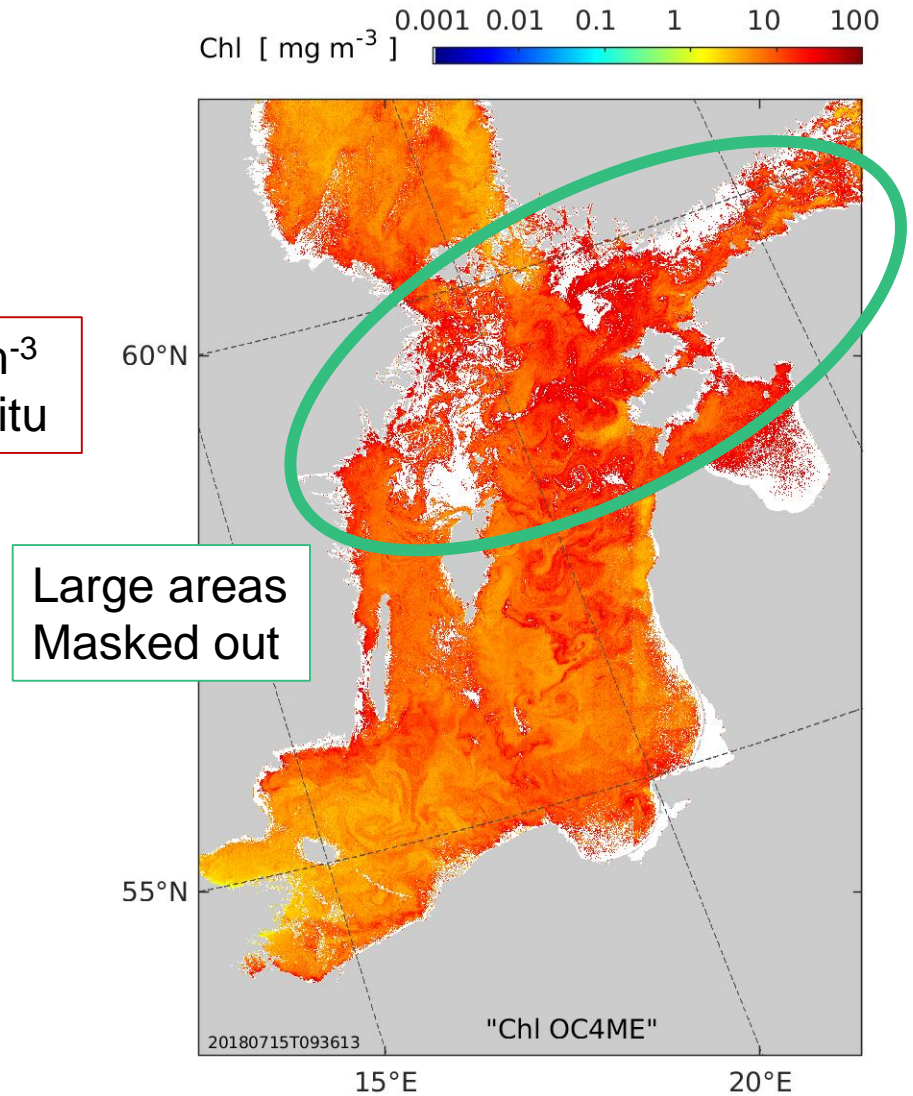
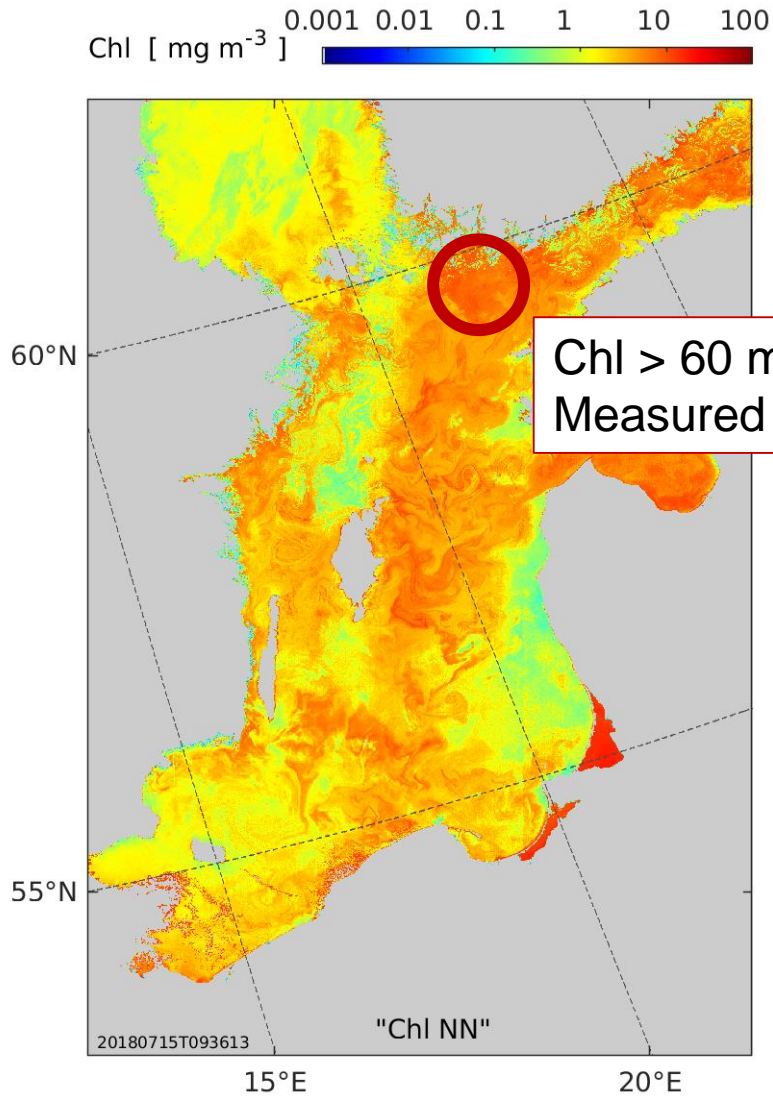


-
- Accuracy requirements of Ocean Colour Essential Climate Variables for open sea
 - Remote Sensing Reflectance → 5 % (blue-green bands)
 - Chlorophyll concentration → 30 %
 - Particular challenges of the Baltic Sea
 - Relatively high concentrations of CDOM → dark waters
 - Massive algae blooms (possibly cyanobacteria) often with floating scum
 - Particular objectives for the Baltic
 - Identification of high biomass and floating algae

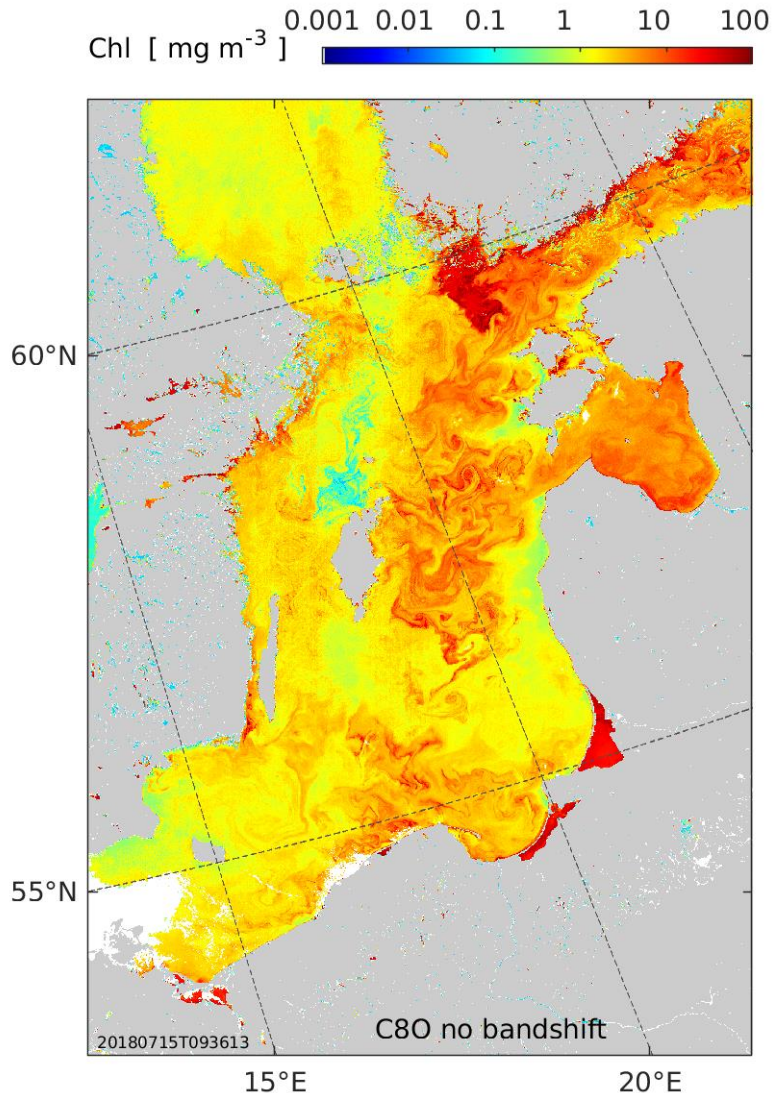


Sentinel-2 MSI
15-07-2018

Sentinel-3 OLCI Level-2 chlorophyll products



Chlorophyll from ONNS (like in CMEMS)



- OLCI Neural Network Swarm algorithm
- Application of **Optical Water Type classification** with specialized NNs
- Delivers diverse ocean colour products like IOPs and concentrations
- Depending on atmospheric correction
- Up to now AC for ONNS is based on C2R (similar as for “Chl_NN”)

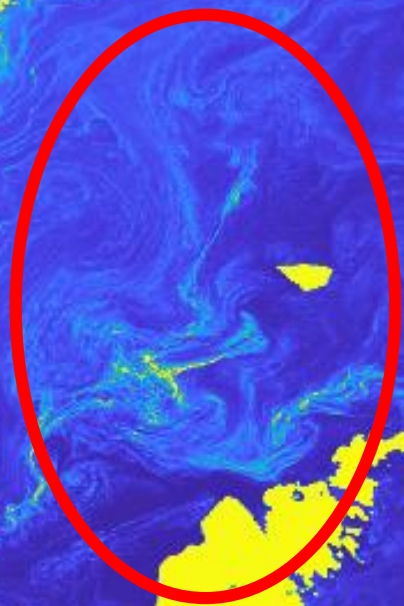
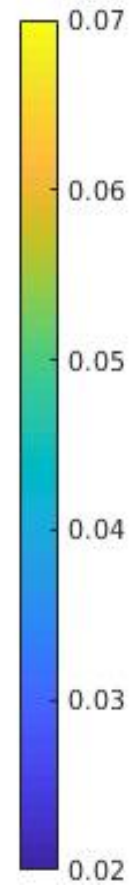
Hieronymi, M., Müller, D., & Doerffer, R. (2017). The OLCI Neural Network Swarm (ONNS): A bio-geo-optical algorithm for open ocean and coastal waters. *Frontiers in Marine Science*, 4, 140.

Sentinel-3A OLCI

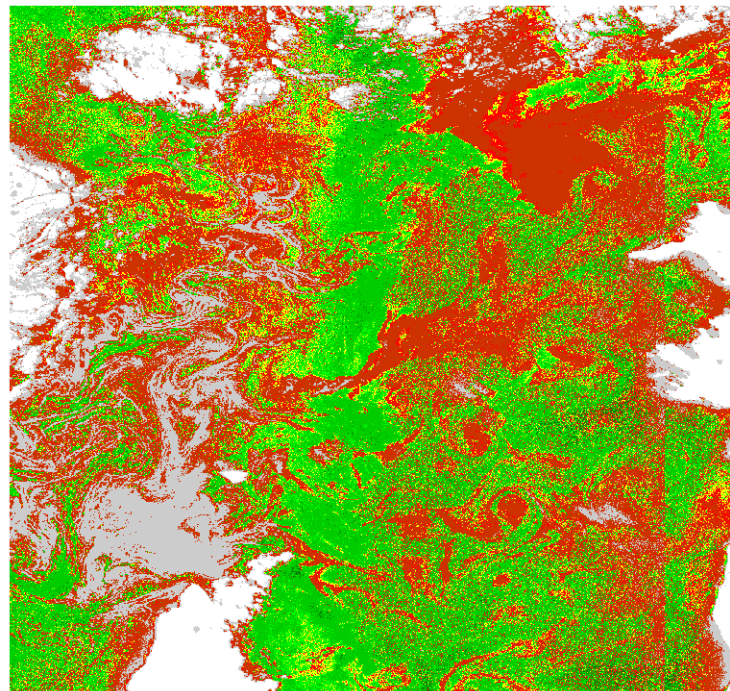
15-07-2018

Baltic Sea

R_{TOA} (708) (Level-1)
[-]

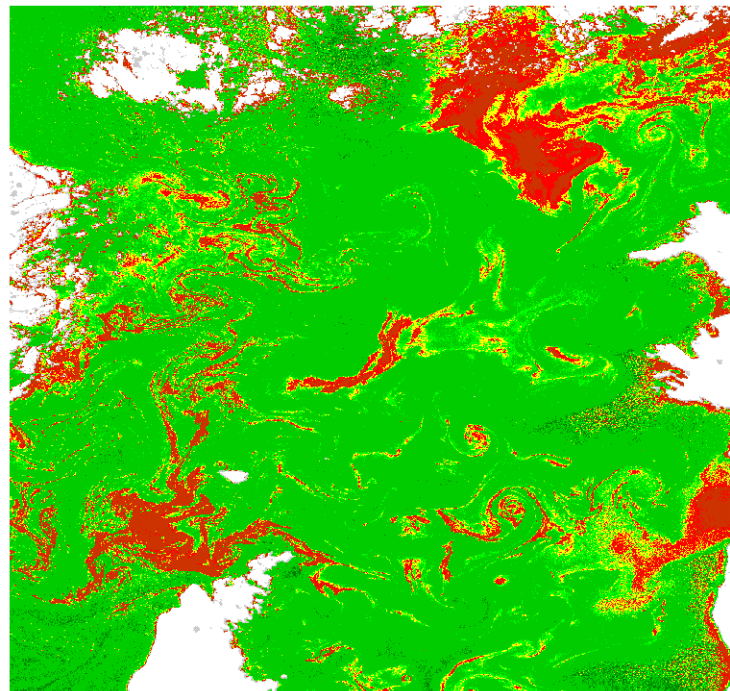
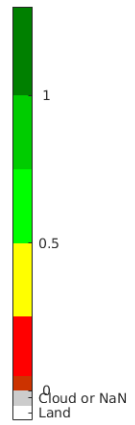


Together with Sentinel-2 MSI image
evidence of high biomass (scum)



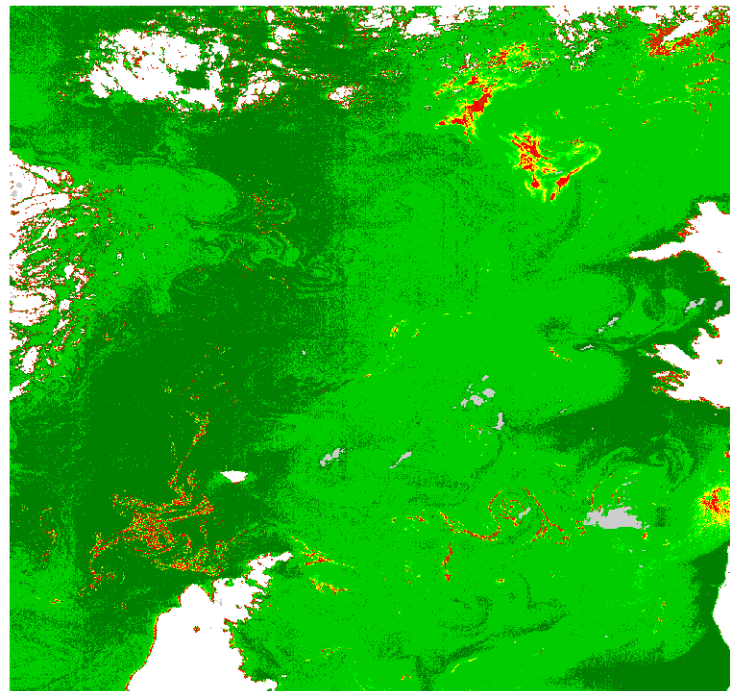
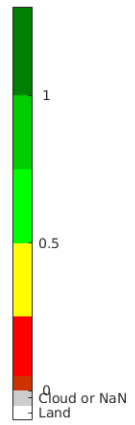
IPF

Total Membership
[-]



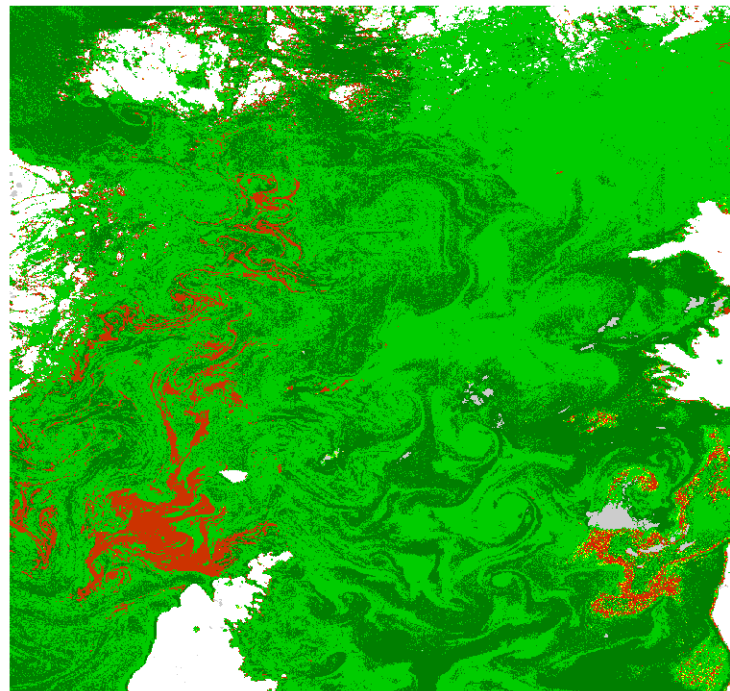
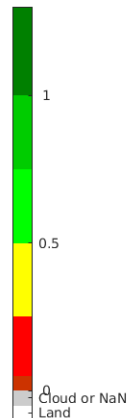
POLYMER

Total Membership
[-]



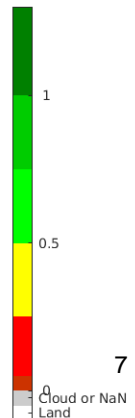
C2R

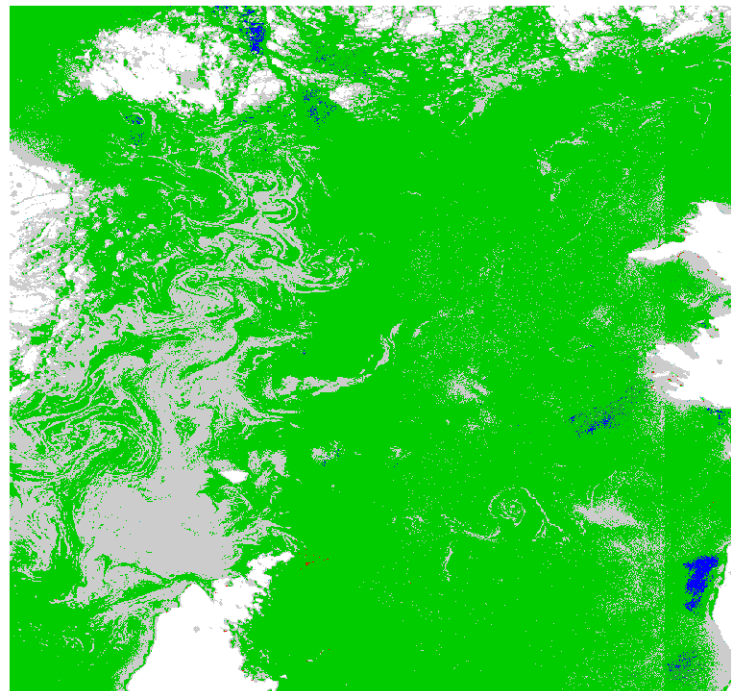
Total Membership
[-]



Novel AC A40

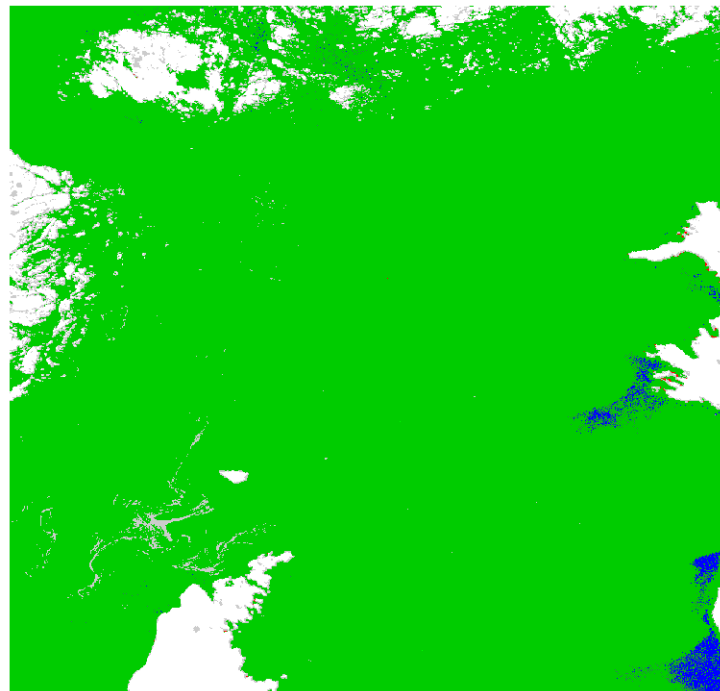
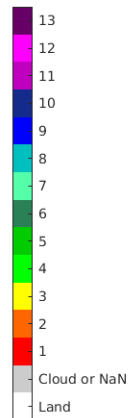
Total Membership
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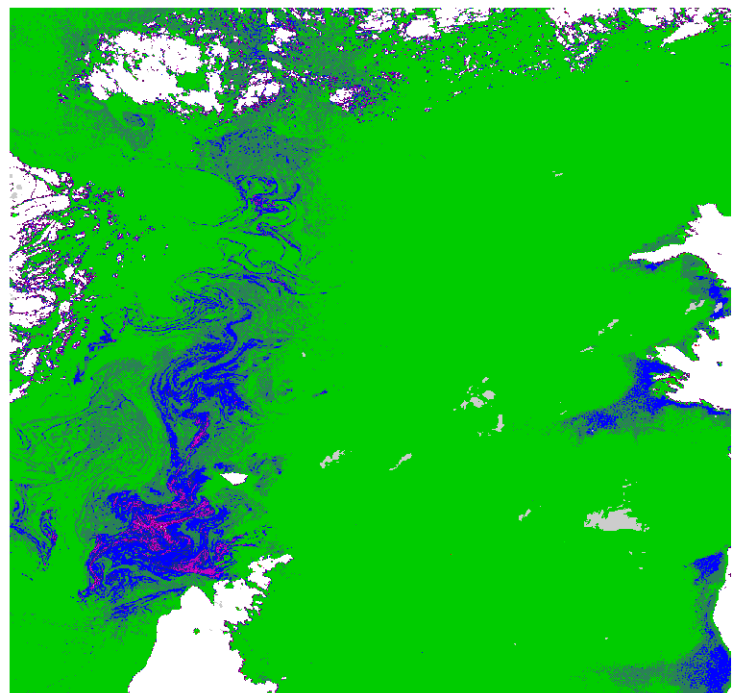
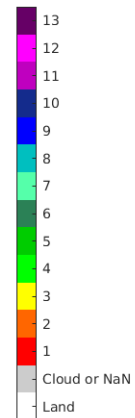
IPF

Maximum Membership
[-]



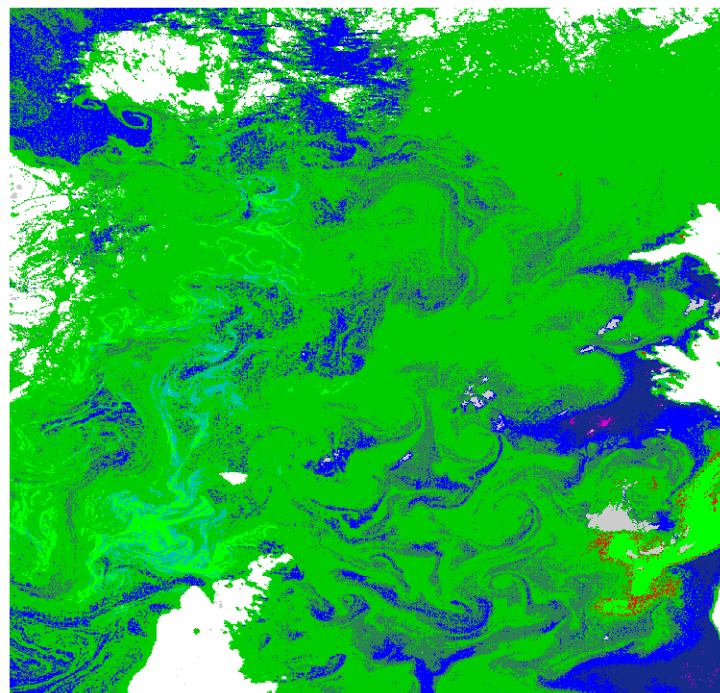
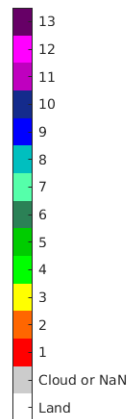
POLYMER

Maximum Membership
[-]



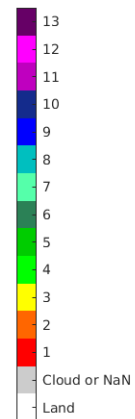
C2R

Maximum Membership
[-]



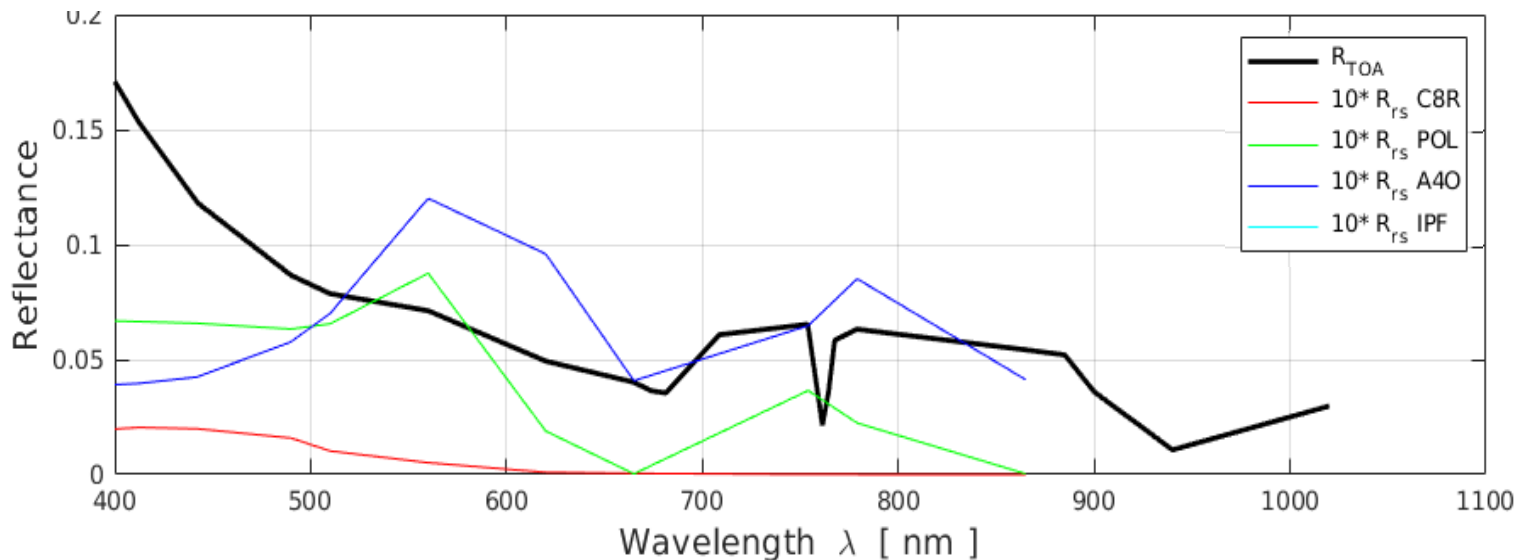
Novel AC A40

Maximum Membership
[-]



AC Issues with Floating Algae or High Biomass

- IPF → delivers no data
- C2R out of scope → Case-1 spectrum → low Chlorophyll
- POLYMER provides partly implausible shape
- That's why we are developing a novel AC for ONNS (prototype A40)
 - provides correct OWT → high Chlorophyll
 - Provides generally high OWT diversity



Sentinel-3A OLCI

15-07-2018

Baltic Sea

Chl (ONNS, C8R)

[mg m^{-3}]

> 100 or Floating

50

10

5

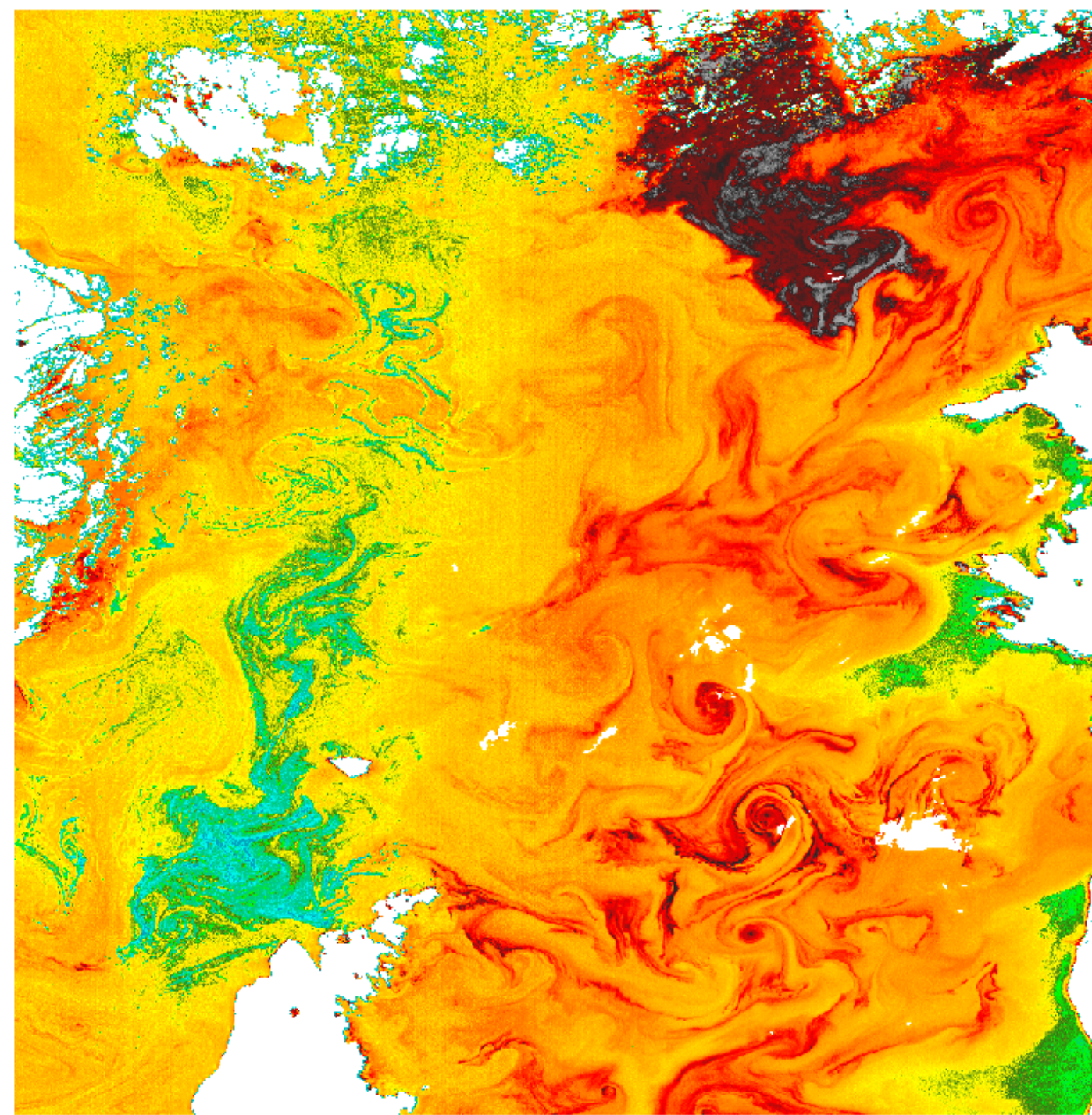
1

0.5

0.1

0.01

0.001



Sentinel-3A OLCI

15-07-2018

Baltic Sea

Chl (ONNS, A40)

[mg m^{-3}]

> 100 or Floating

50

10

5

1

0.5

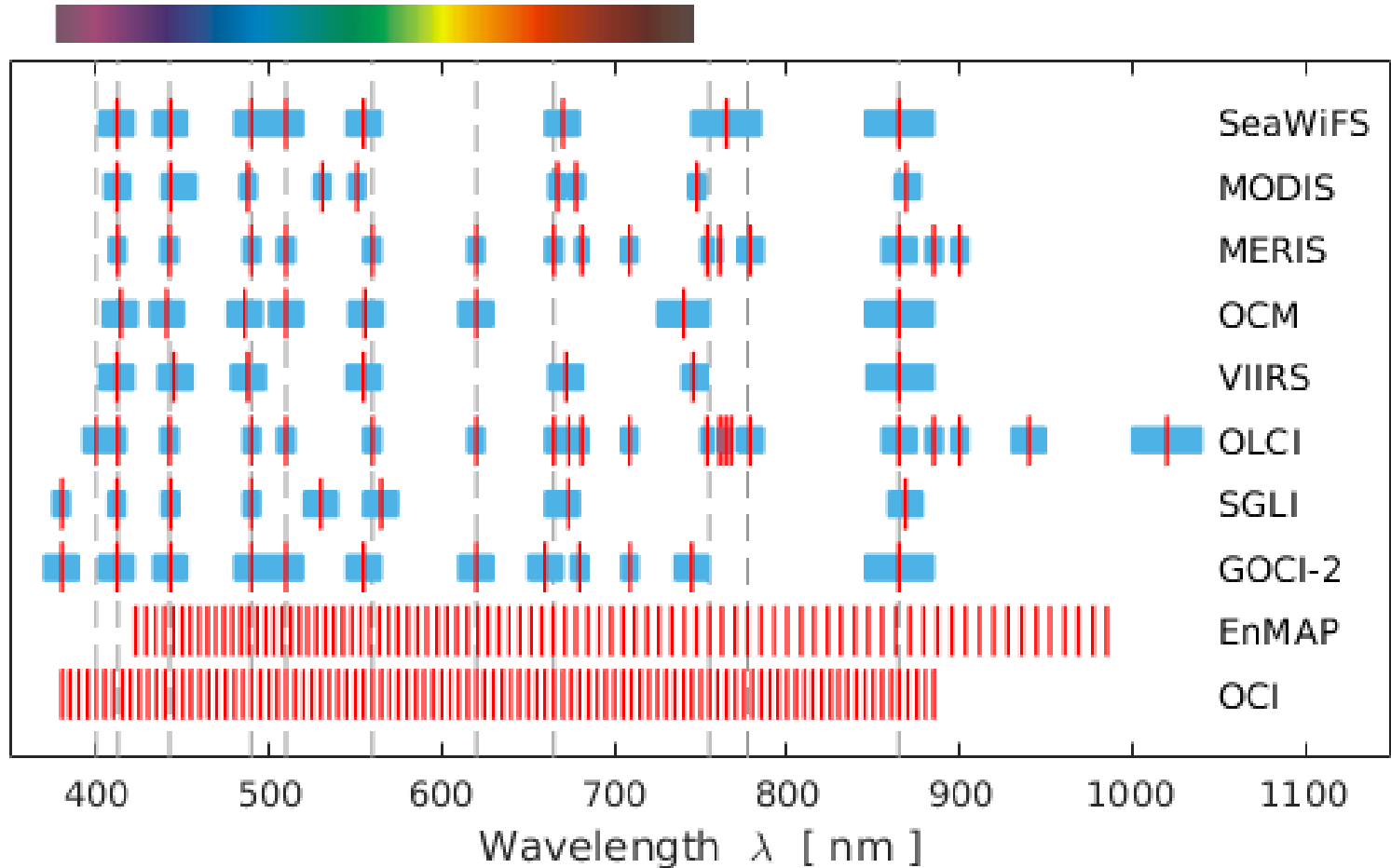
0.1

0.01

0.001

20 % instead of 7 % area with surface Chl > 10 mg m^{-3}

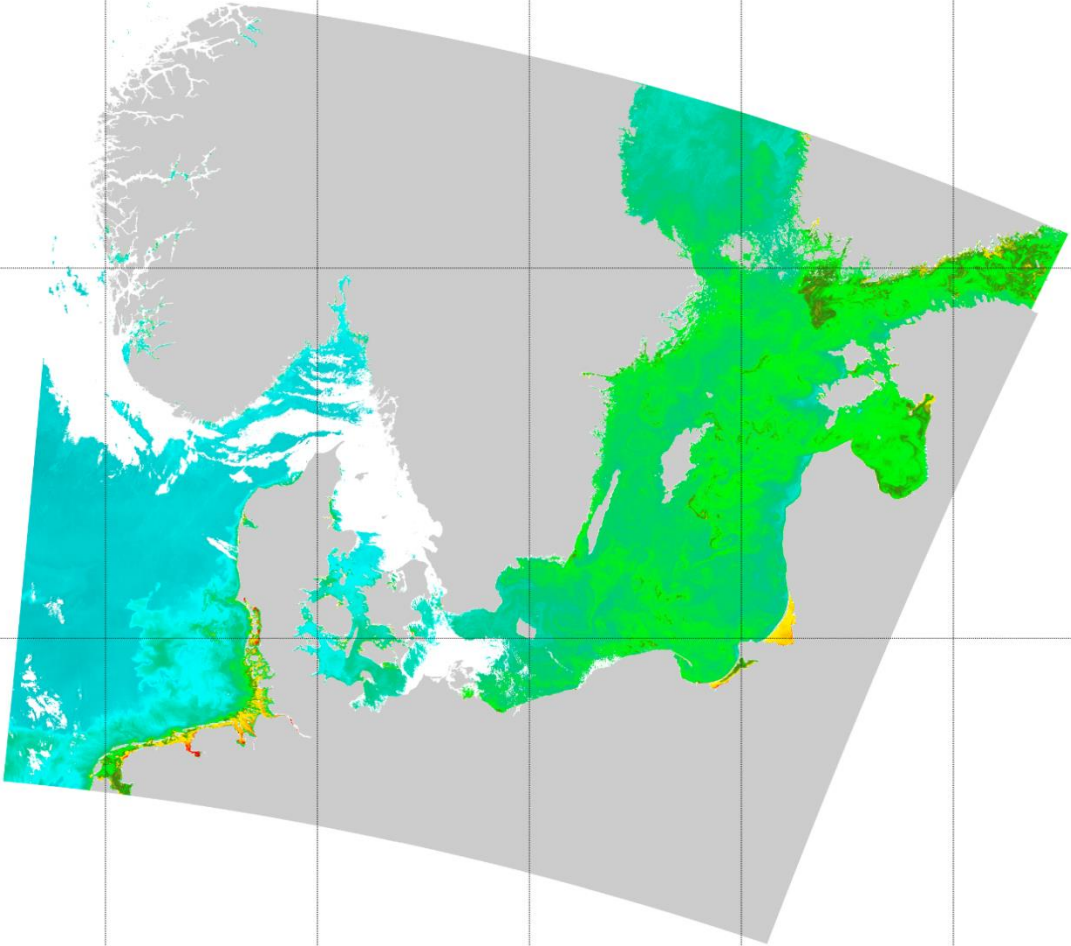
Spectral Synergy of OC Missions with ONNS



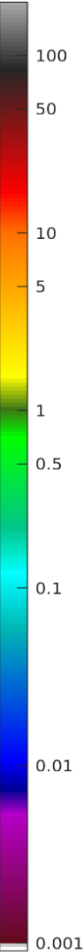
Hieronymi, M. (2019). Spectral band adaptation of ocean color sensors for applicability of the multi-water biogeo-optical algorithm ONNS. *Optics Express*, 27(12), A707-A724.

ONNS applicable to OLCI

S3A-OLCI Polymer + ONNS
2018-07-15 09:39 UTC
With band adapter



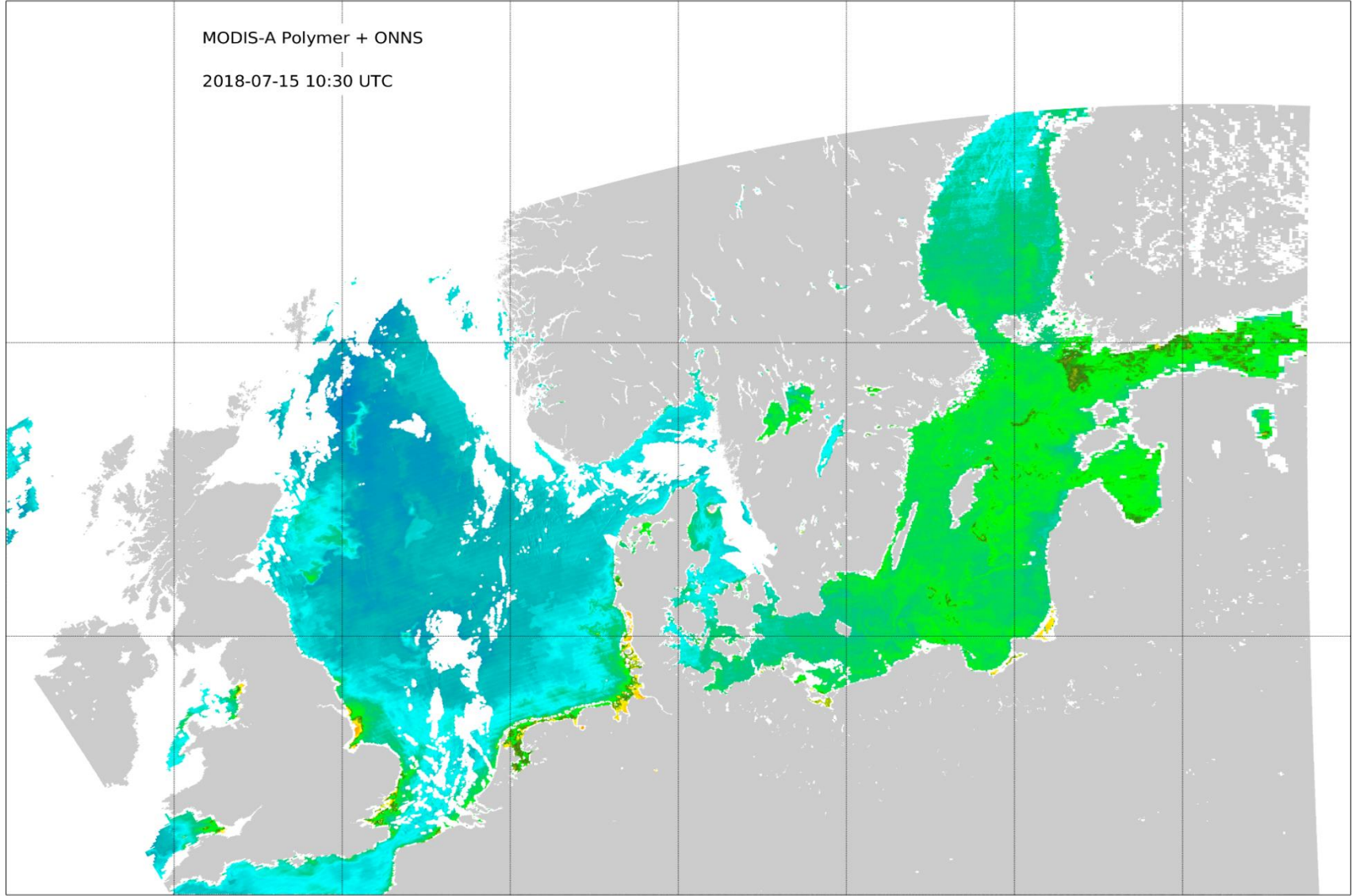
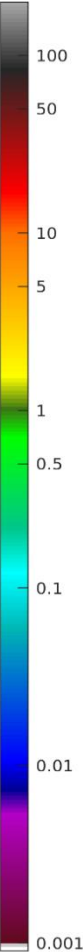
$K_d(490)$
[m^{-1}]



ONNS applicable to MODIS

MODIS-A Polymer + ONNS
2018-07-15 10:30 UTC

$K_d(490)$
[m^{-1}]



ONNS applicable to VIIRS

VIIRS Polymer + ONNS
2018-07-15 11:00 UTC

$K_d(490)$
[m^{-1}]



- AC critical over large areas

ONNS Available via EnMAP-Box

OLCI Neural Network Swarm (ONNS)

? X

Parameters Log

Input
R_20160720T093421_20160720T093621_20171002T063739_0119_006_307_____MR1_R_NT_002_sylt.nc

Sensor
OLCI (Ocean and Land Colour Instrument, Europe)

Band shifting
No band shifting

Atmospheric correction
C2R

Processor output size
Standard output

Output Folder
[Save to temporary folder]

OLCI Neural Network Swarm (ONNS)

ONNS is a bio-geo-optical algorithm for the retrieval of water quality parameters from satellite imagery or in situ radiometric measurements [\[Hieronymi et al., 2017\]](#).

Input
The algorithm processes atmospherically corrected satellite data in NETCDF4 format.

Sensor
The algorithm has been designed for data processing from the Ocean and Land Colour Instrument (OLCI) onboard Sentinel-3. However, data input from other historical, current and future ocean colour sensor is possible too, e.g. from SeaWiFS, MODIS, MERIS, VIIRS, EnMAP or PACE.

Band-shifting
The algorithm requires input at 11 OLCI bands, namely remote-sensing reflectances at 400, 412.5, 442.5, 490, 510, 560, 620, 665, 755, 777.5 and 865 nm. A spectral band-shifting procedure is implemented, which allows exploitation of atmospherically corrected input from other ocean colour missions too [\[Hieronymi, 2019\]](#). In case of OLCI data, one has three options: no band-shifting or replacing reflectance input at only one or all spectral bands, e.g. in case of faulty atmospheric correction. In case of MERIS, options 2 and 3 are allowed. Complete band-shifting (option 3) must be applied for all other sensors.

Atmospheric correction
Results of the previously calculated atmospheric correction may vary significantly depending on the water type, which transfers to the ONNS products. For OLCI, three atmospheric correction methods are applicable, namely the "C2R" (Case-2 Regional, standard method for ONNS application) by [\[Brockmann et al., 2016\]](#), "Polymer" by [\[Steinmetz et al., 2011\]](#) and the standard Level-2 product "IPF". For the other sensors, only "Polymer" is usable.

Processor output size
The minimum output contains 12 ocean colour products with an estimate of their associated uncertainties, e.g. concentrations of chlorophyll and suspended matter as well as different optical water properties. The standard output contains additional derived properties and the input remote-sensing reflectances. In addition, excessive information on optical water type classification can be stored.

Output Folder
Specify where to save the output.

0% Cancel

Run as Batch Process... Run Close Help

- Novel Atmospheric Correction for OWT-based algorithms under development
 - Neural Network based like C2R
 - Used temperature and wind speed as input and delivers normalized Rrs
 - Optimized to fulfil the requirements of ONNS for all water types
 - Results for bright pixel, very high biomass and floating algae promising
 - Future works
 - Known issues with particulate scattering properties need revision
 - Phytoplankton group detection
 - All-OWT-embracing validation needed
 - Uncertainties must include atmospheric corrections
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