Atmospheric correction for the full spectrum of optical water types

Efforts towards best Ocean Colour products for the Baltic Sea

Martin Hieronymi[1], Roland Doerffer[1,2] , Hajo Krasemann[1] & Eike Schütt[1]

[1] Institute of Coastal Research, Helmholtz-Zentrum Geesthacht, Geesthacht, Germany
[2] Brockmann Consult, Hamburg, Germany

21 September 2020

Helmholtz-Zentrum Geesthacht
Centre for Materials and Coastal Research

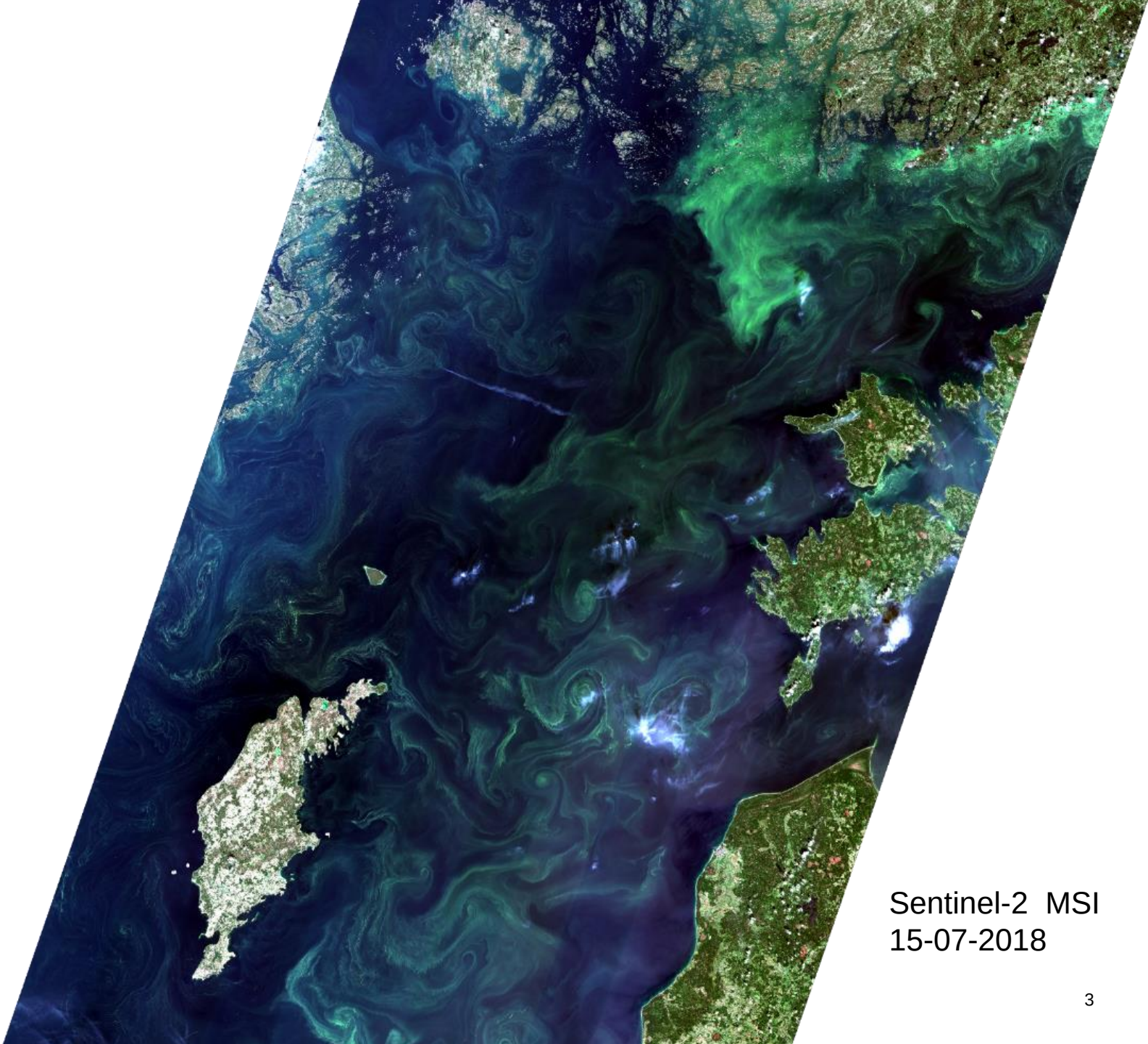
Objectives for Baltic Sea OC and Challenges

Helmholtz-Zentrum Geesthacht
Centre for Materials and Coastal Research

- 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

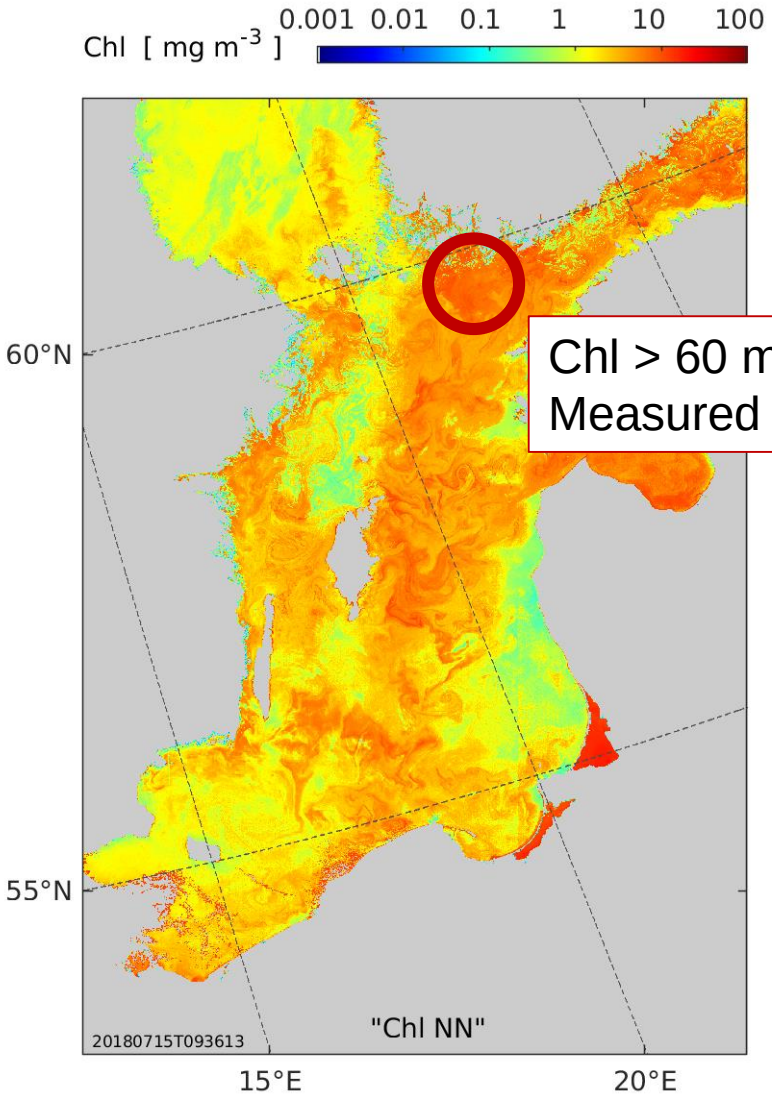
- Particular objectives for the Baltic
  - Identification of high biomass and floating algae



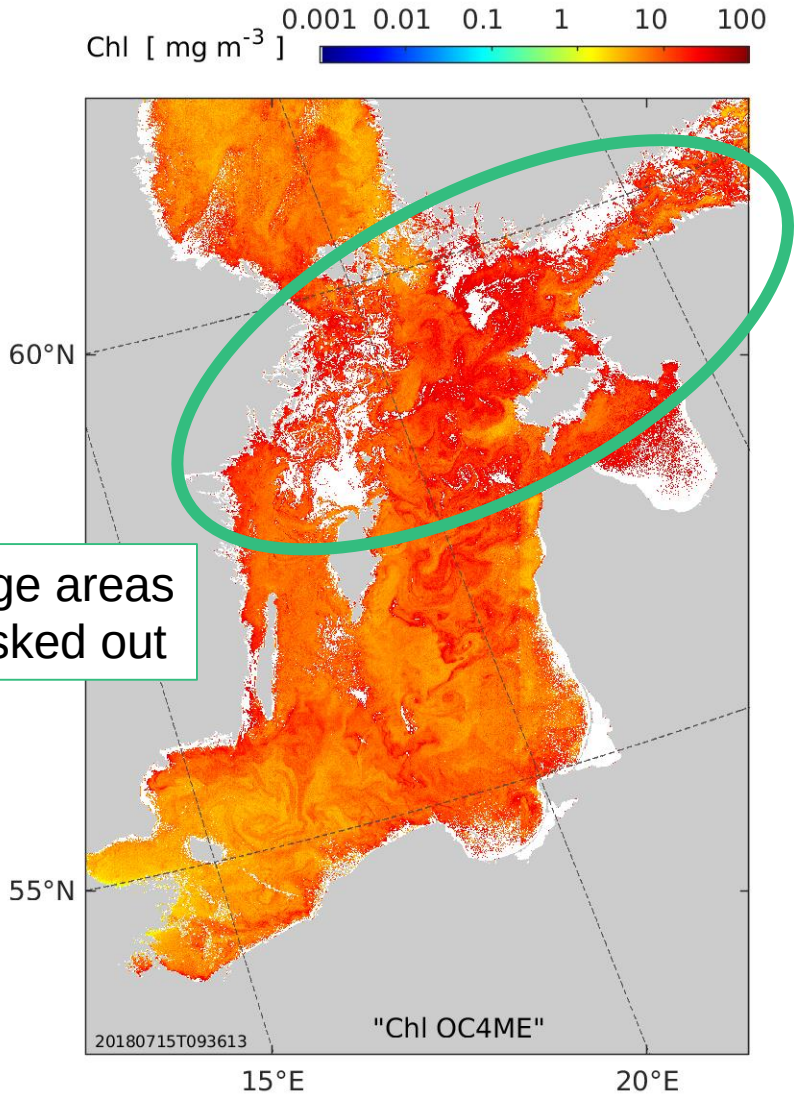
Sentinel-2 MSI
15-07-2018

Sentinel-3 OLCI Level-2 chlorophyll products

Helmholtz-Zentrum Geesthacht
Centre for Materials and Coastal Research



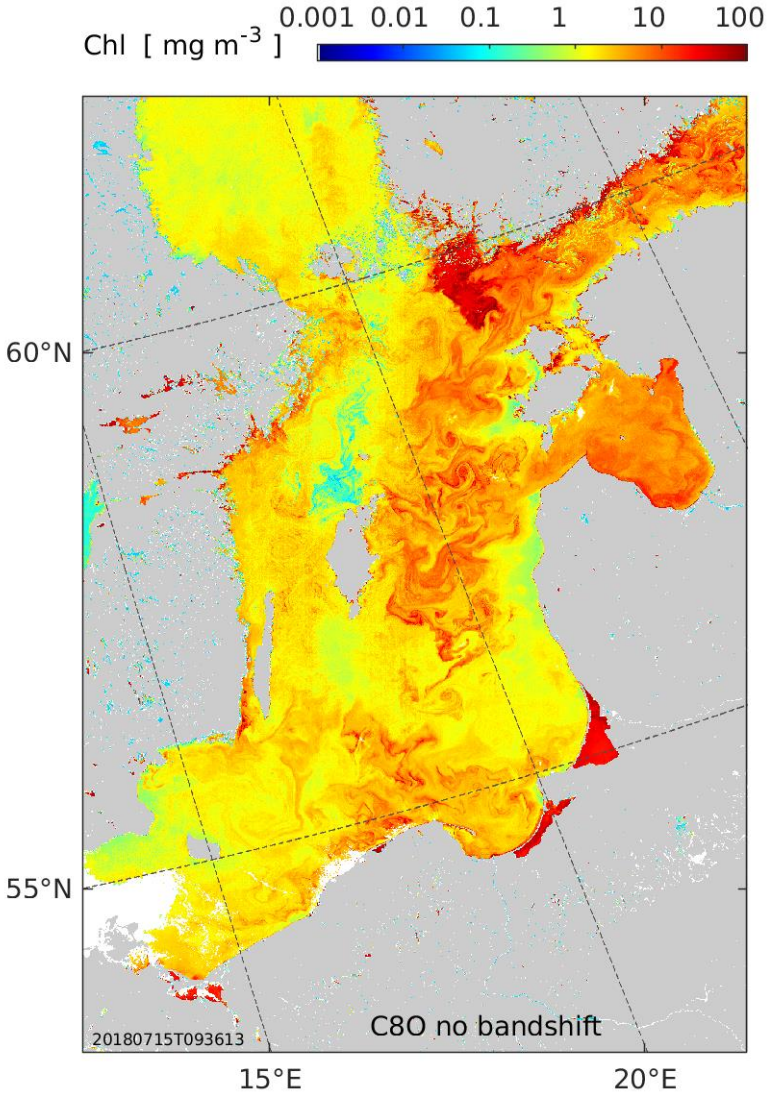
Chl > 60 mg m^{-3}
Measured in situ



Large areas
Masked out

Chlorophyll from ONNS (like in CMEMS)

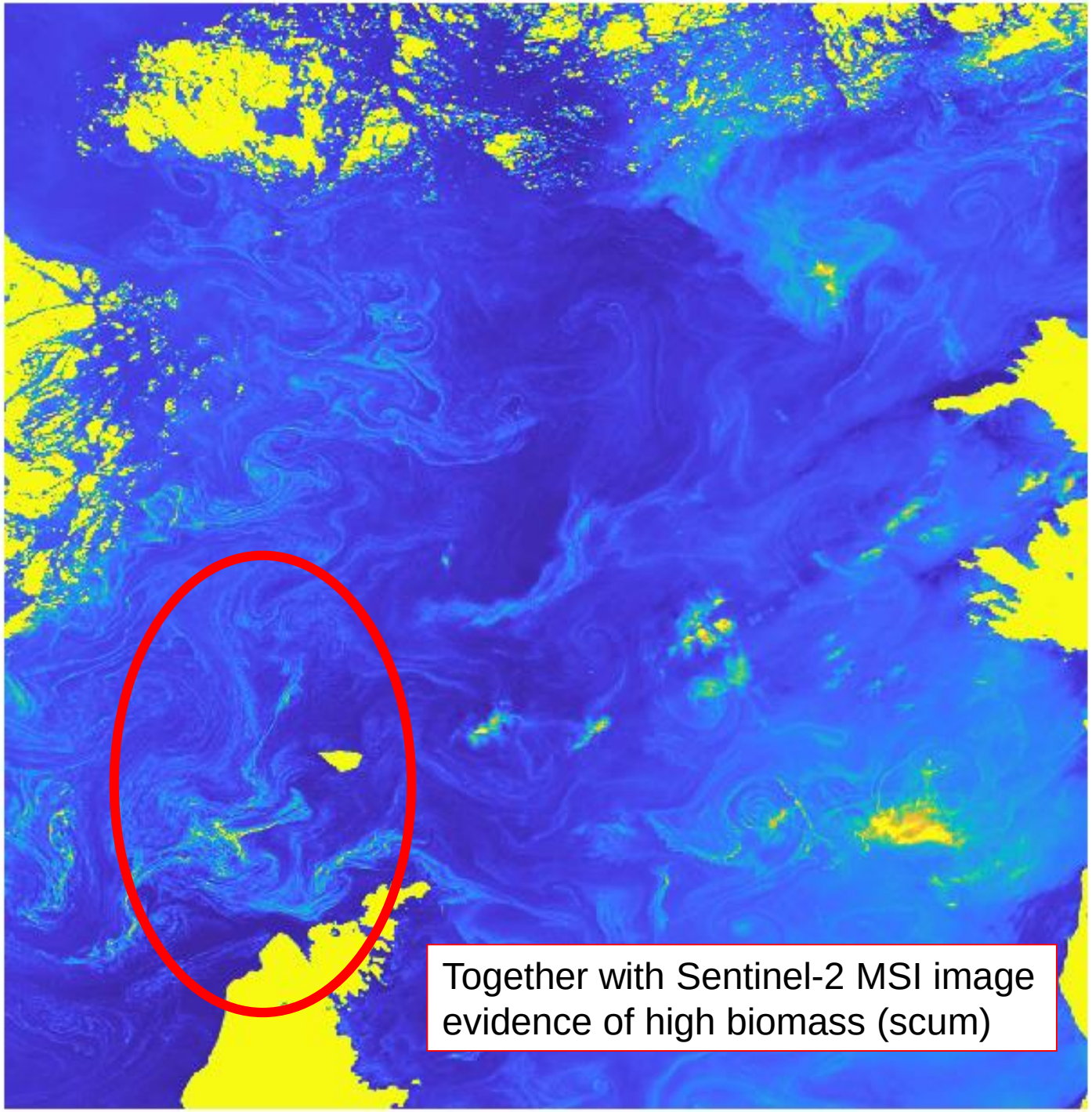
Helmholtz-Zentrum Geesthacht
Centre for Materials and Coastal Research

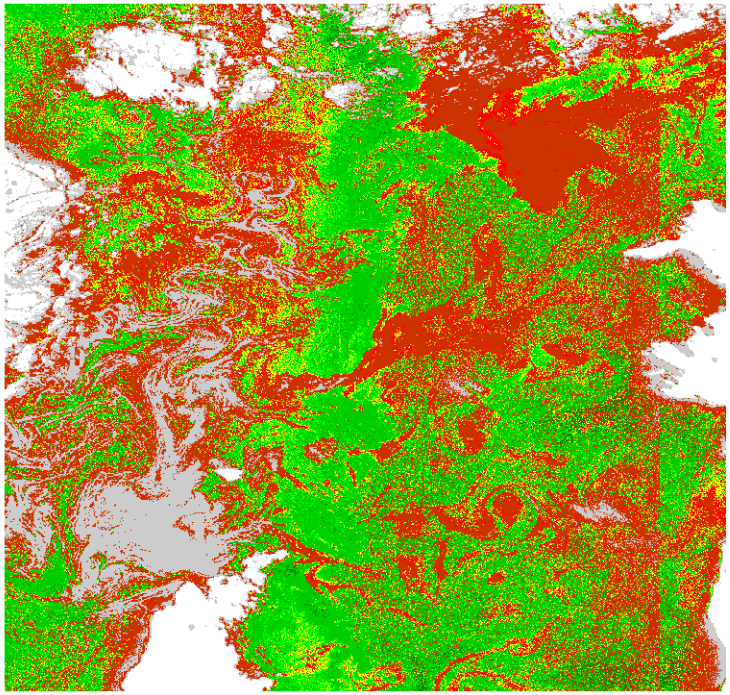


- OLCI Neural Network Swarm algorithm
- Application of **Optical Water Type classification** with specialized NNs
- Delivers diverse ocean colour products like IOPs and concentrations

- 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.

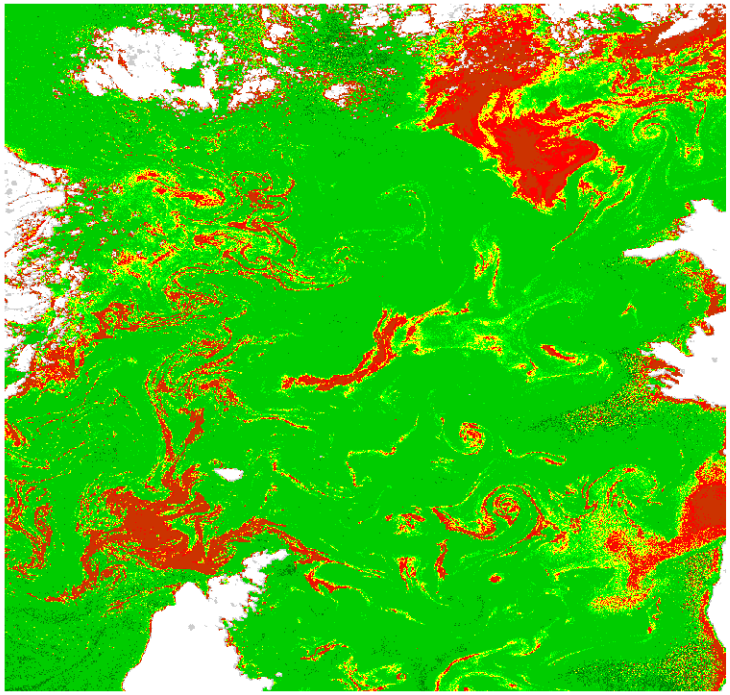

Sentinel-3A OLCI
15-07-2018
Baltic Sea
R_{TOA} (708) (Level-1)
[-]
0.07
0.06
0.05
0.04
0.03
0.02
Together with Sentinel-2 MSI image evidence of high biomass (scum)



IPF

Total Membership
[-]

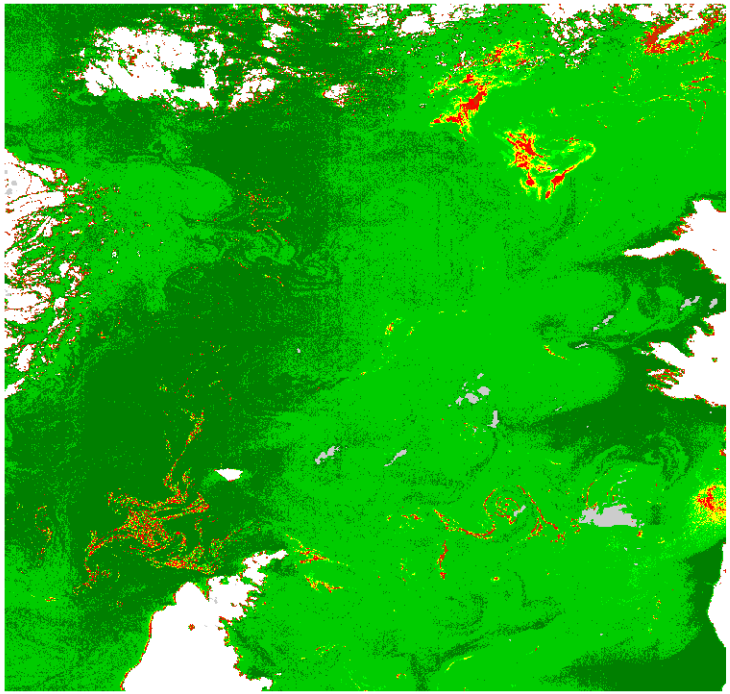
1
0.5
Cloud or NaN
Land



POLYMER

Total Membership
[-]

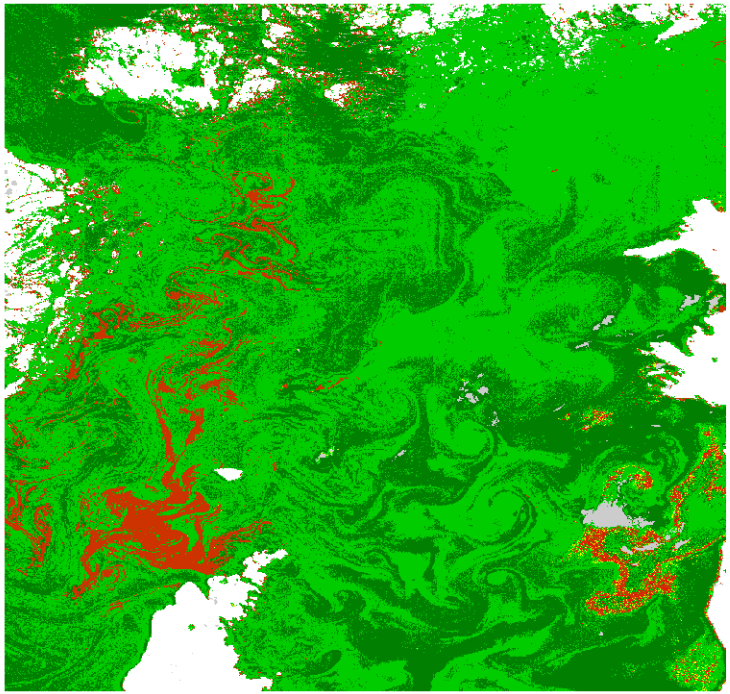
1
0.5
Cloud or NaN
Land



C2R

Total Membership
[-]

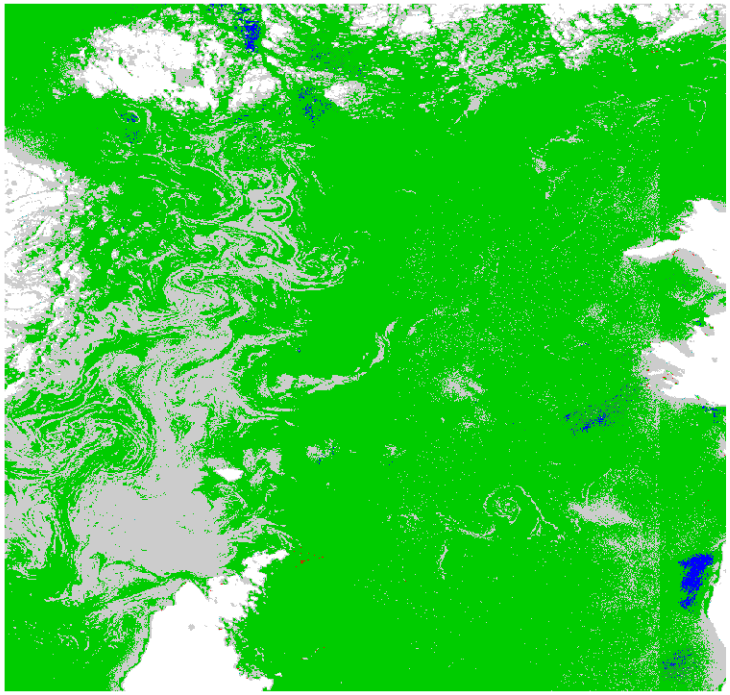
1
0.5
Cloud or NaN
Land



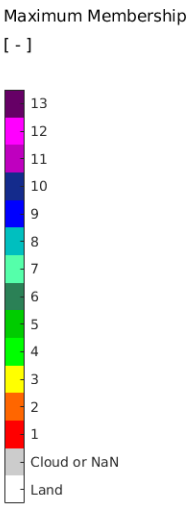
Novel AC A4O

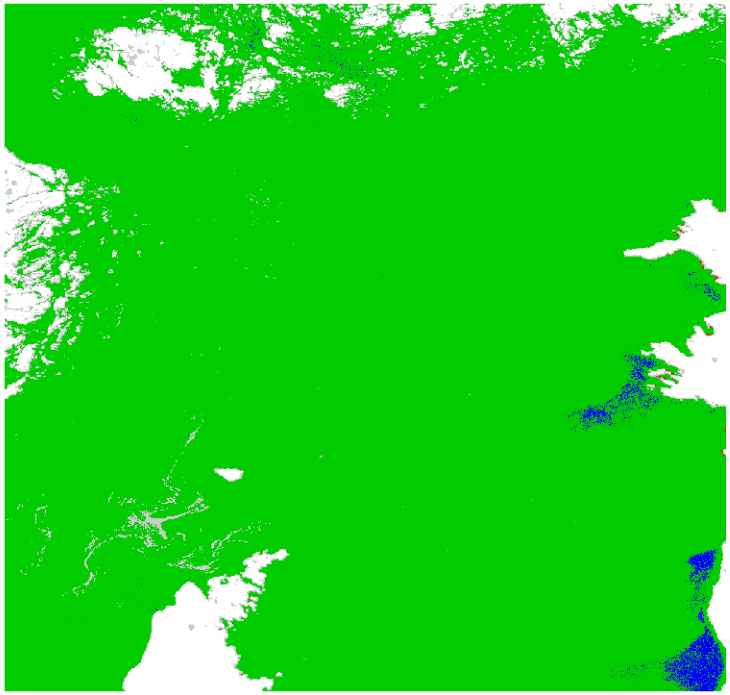
Total Membership
[-]

1
0.5
Cloud or NaN
Land

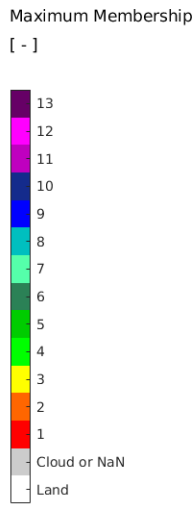


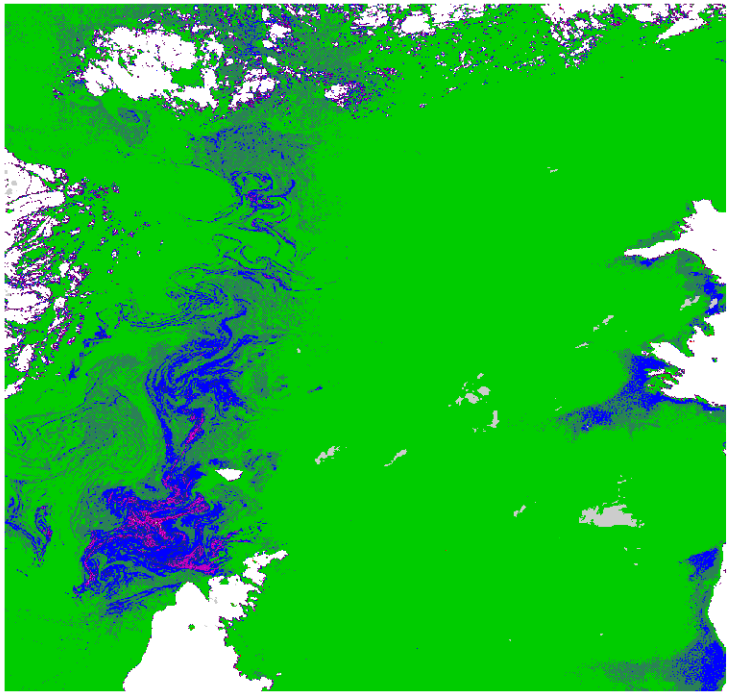
IPF



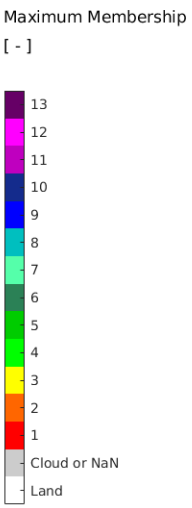


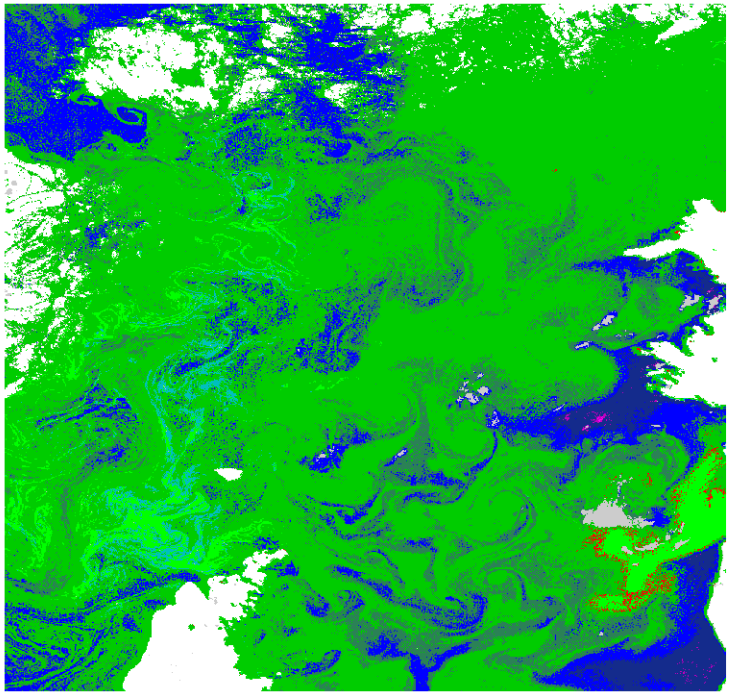
POLYMER



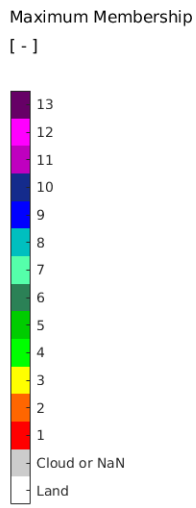


C2R





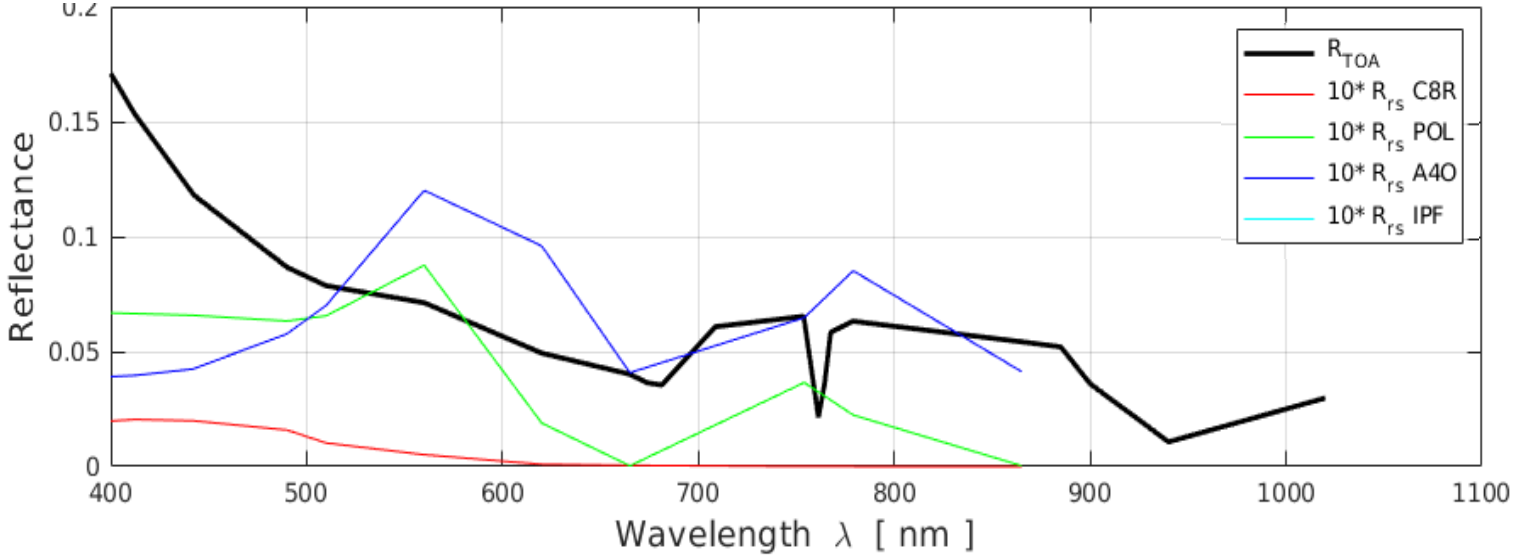
Novel AC A4O

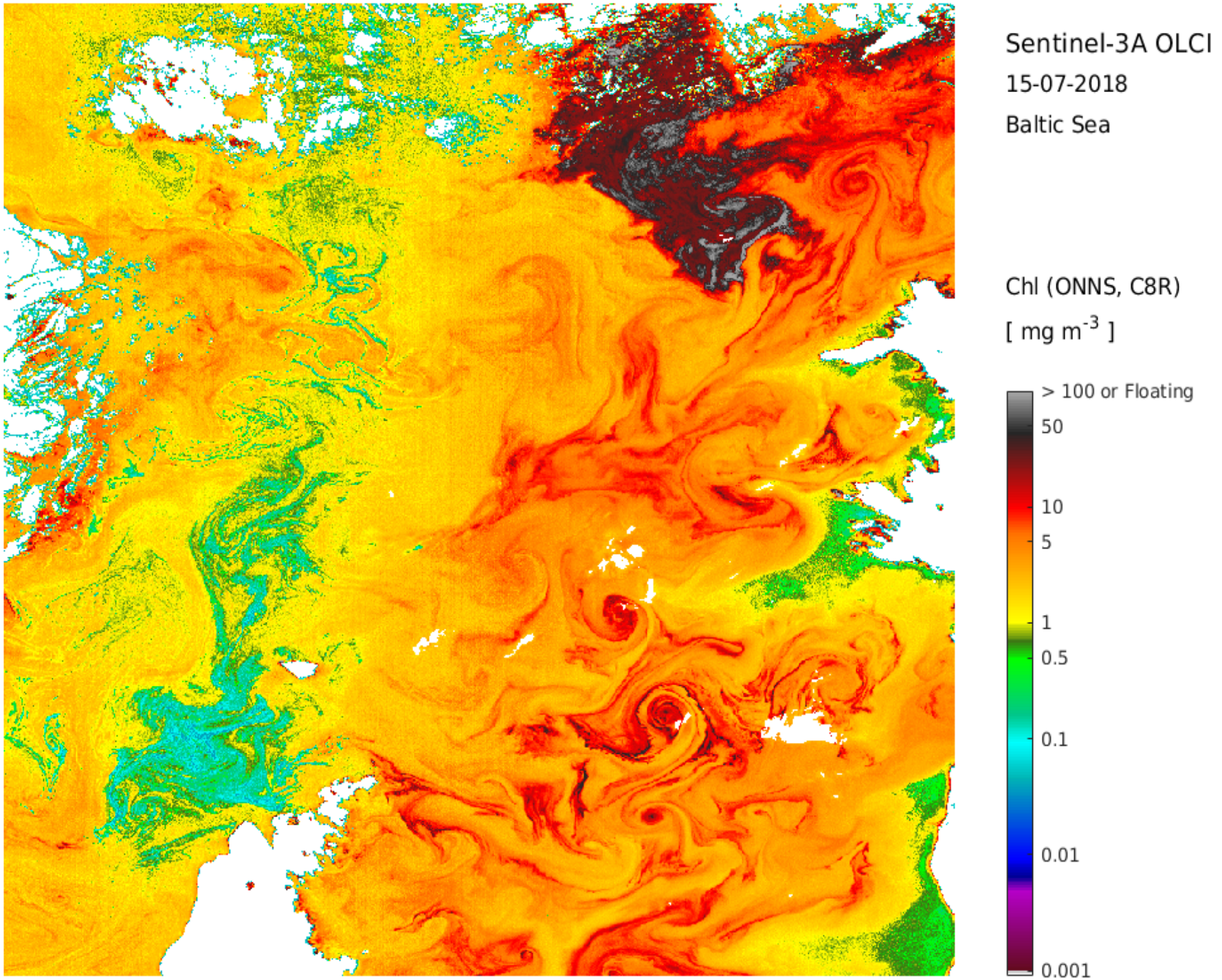


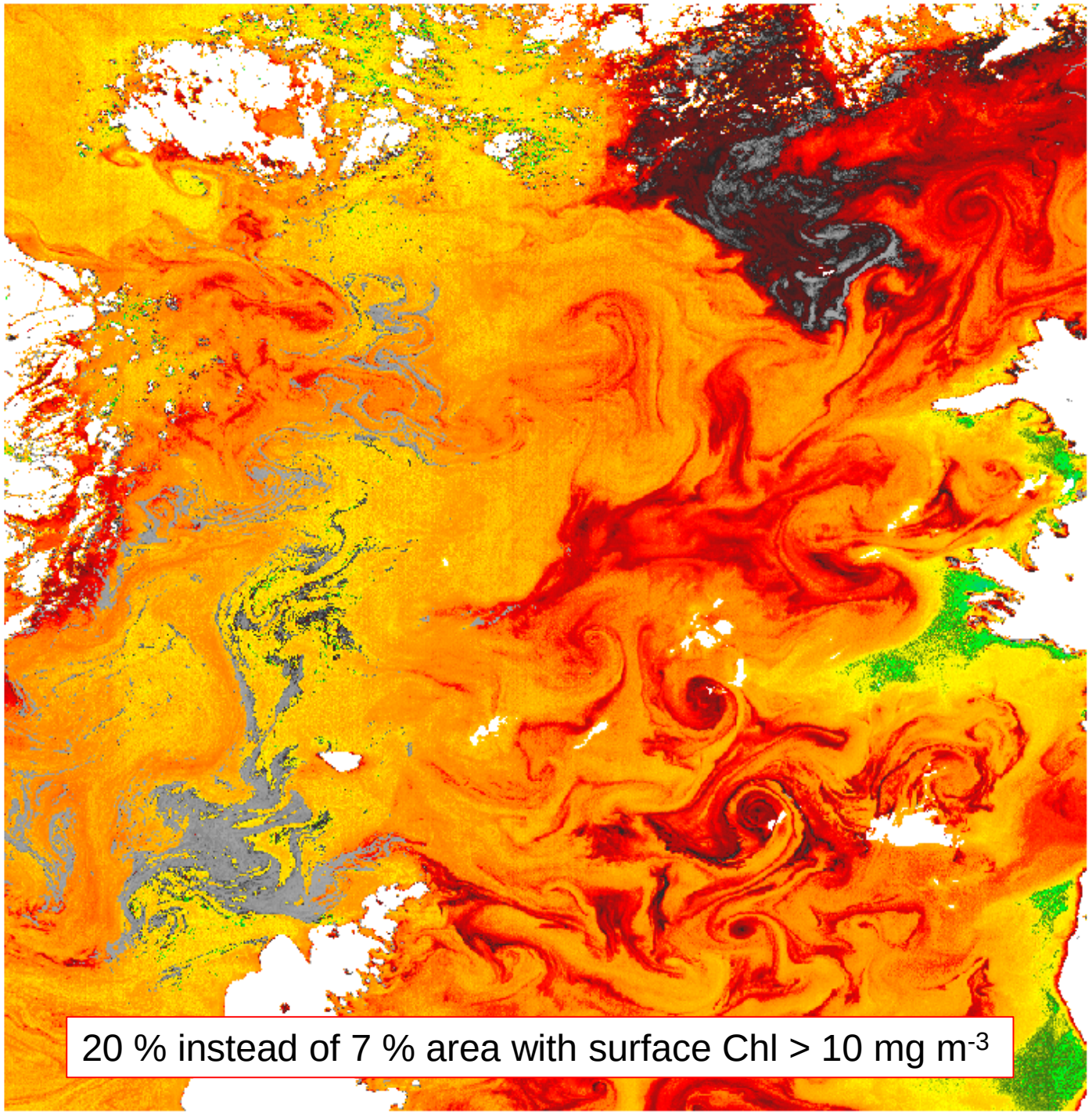
AC Issues with Floating Algae or High Biomass

Helmholtz-Zentrum Geesthacht
Centre for Materials and Coastal Research

- 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 A4O)
  - provides correct OWT → high Chlorophyll
  - Provides generally high OWT diversity

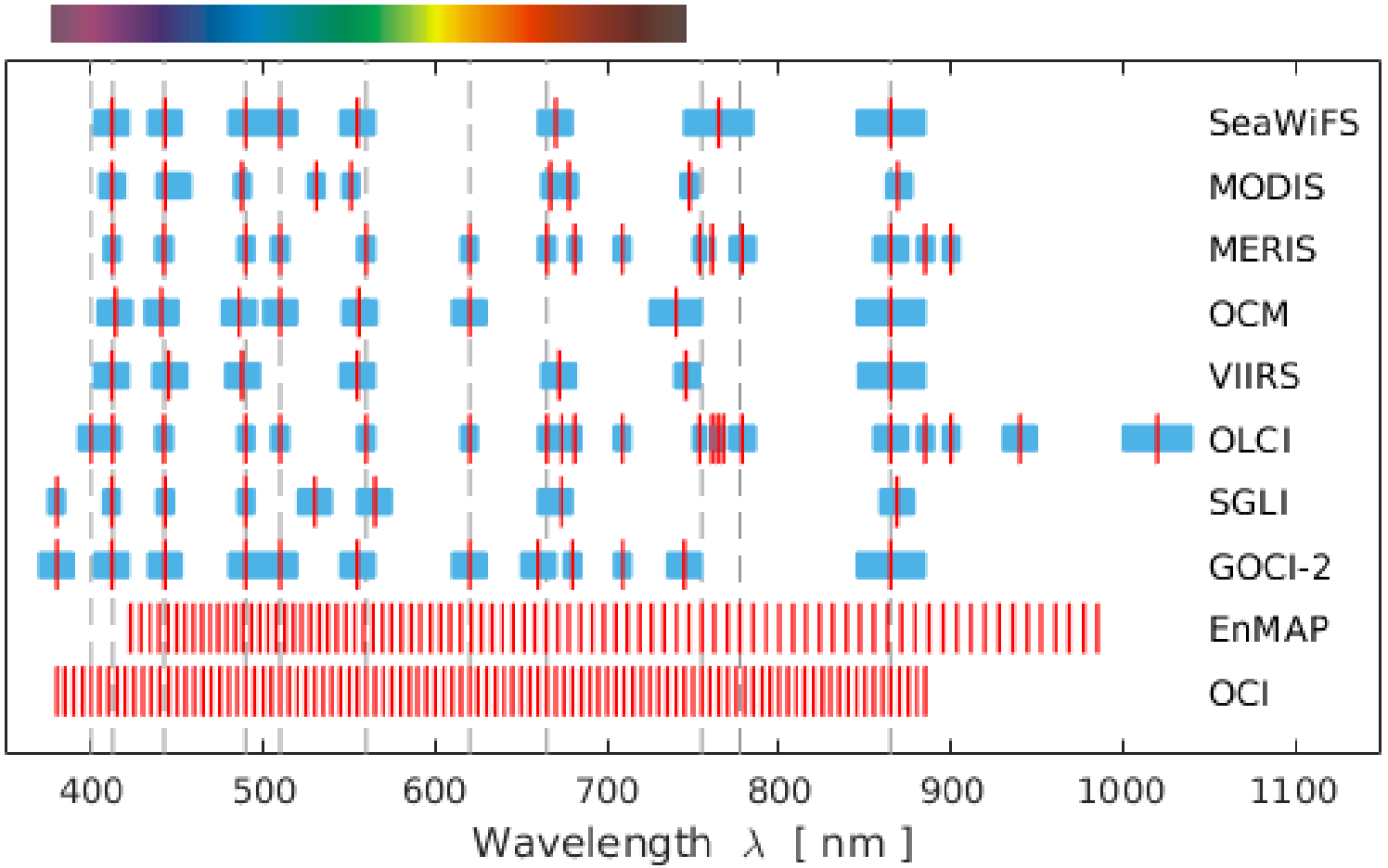



Sentinel-3A OLCI
15-07-2018
Baltic Sea
Chl (ONNS, C8R)
[mg m-3]
> 100 or Floating
50
10
5
1
0.5
0.1
0.01
0.001


Sentinel-3A OLCI
15-07-2018
Baltic Sea
Chl (ONNS, A4O)
[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

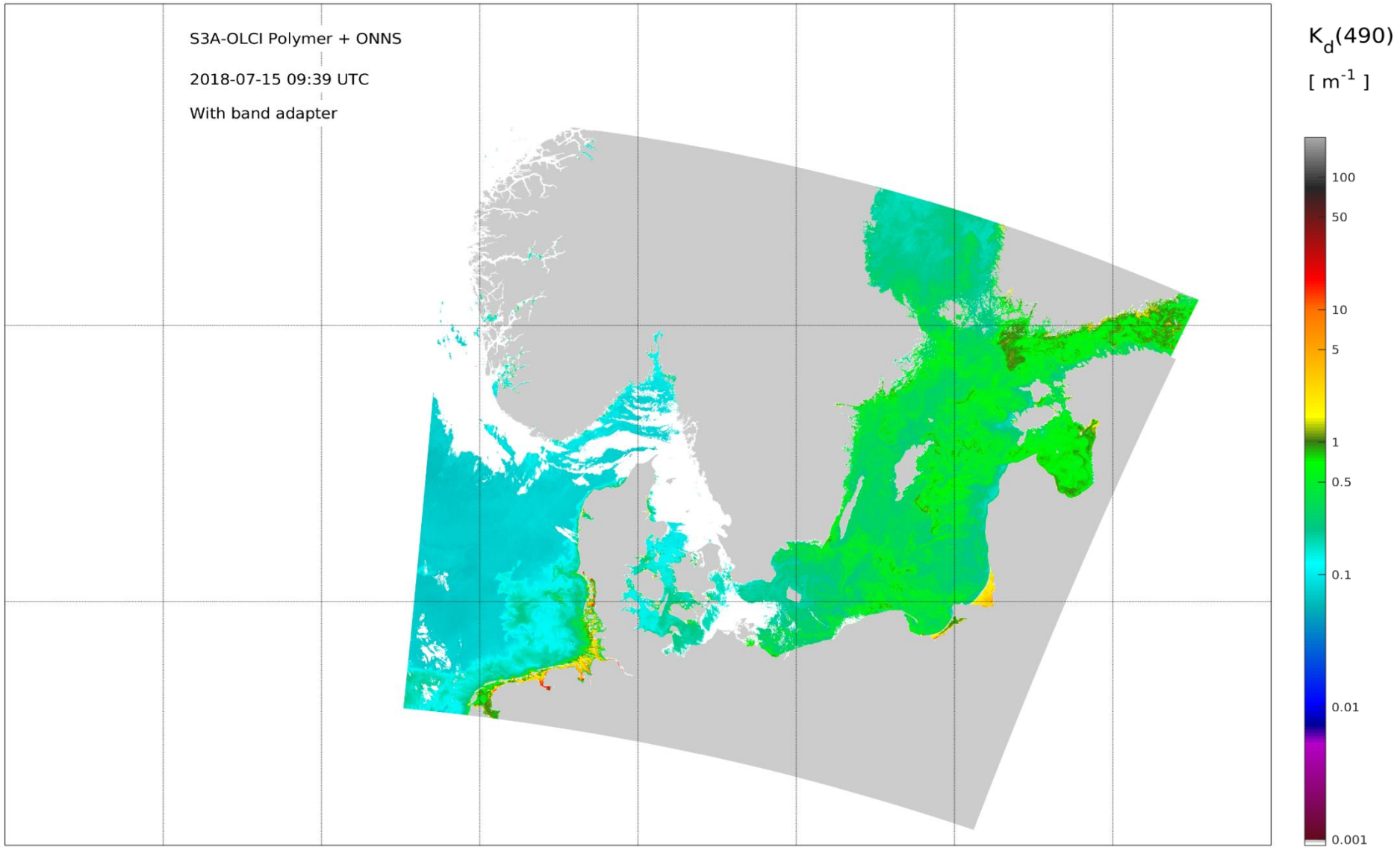
Helmholtz-Zentrum Geesthacht
Centre for Materials and Coastal Research



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.

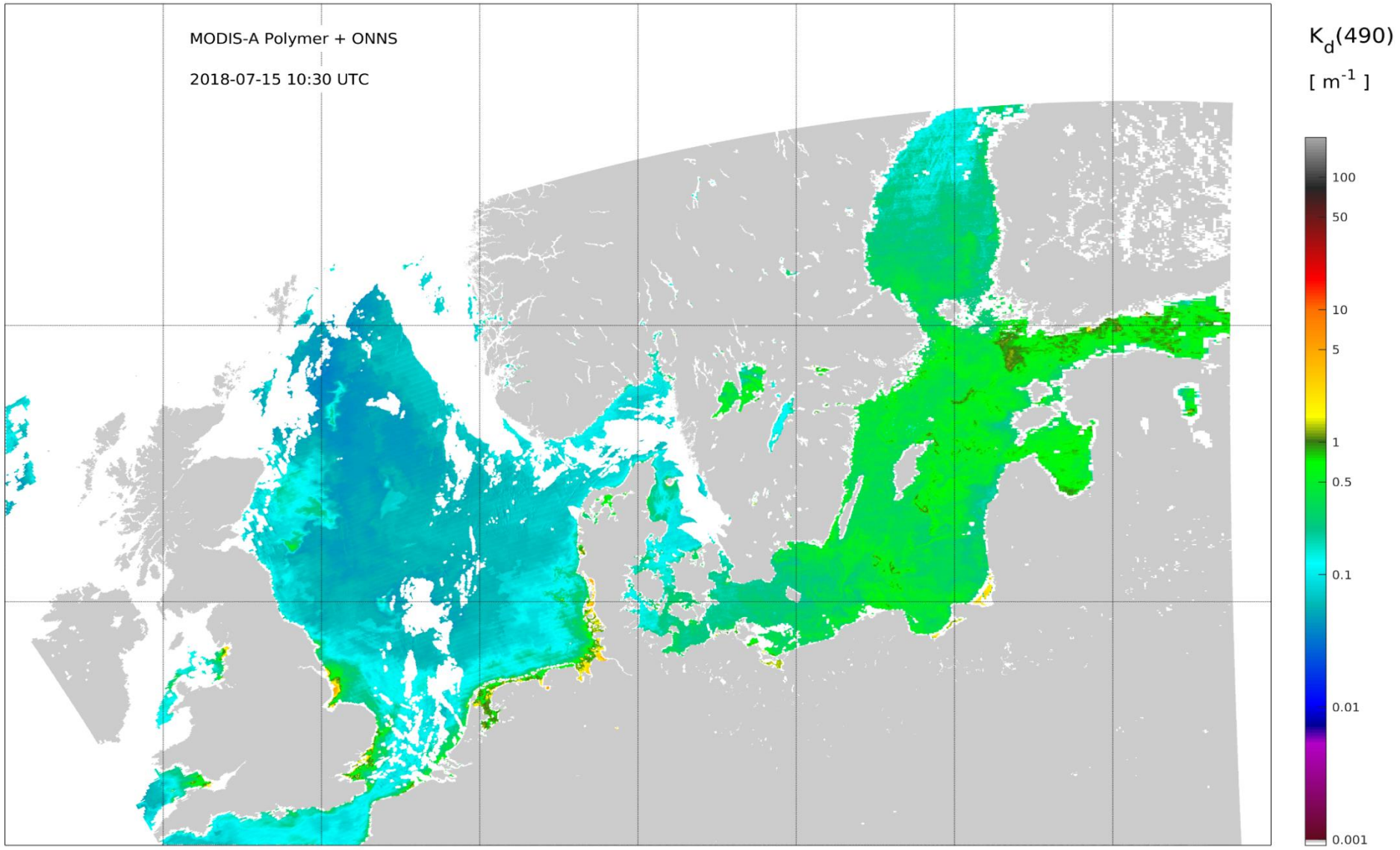
ONNS applicable to OLCI

Helmholtz-Zentrum Geesthacht
Centre for Materials and Coastal Research



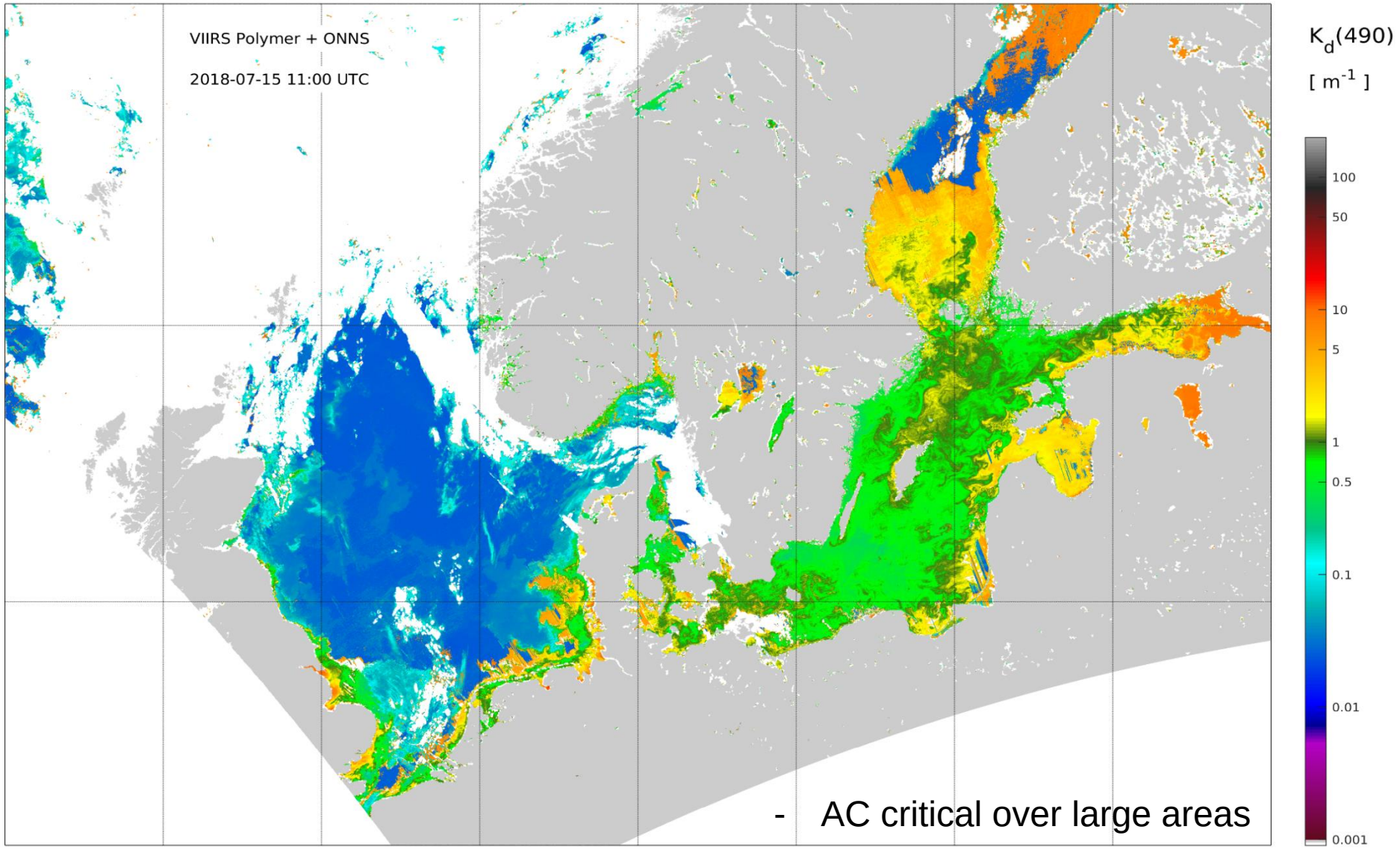
ONNS applicable to MODIS

Helmholtz-Zentrum Geesthacht
Centre for Materials and Coastal Research



ONNS applicable to VIIRS

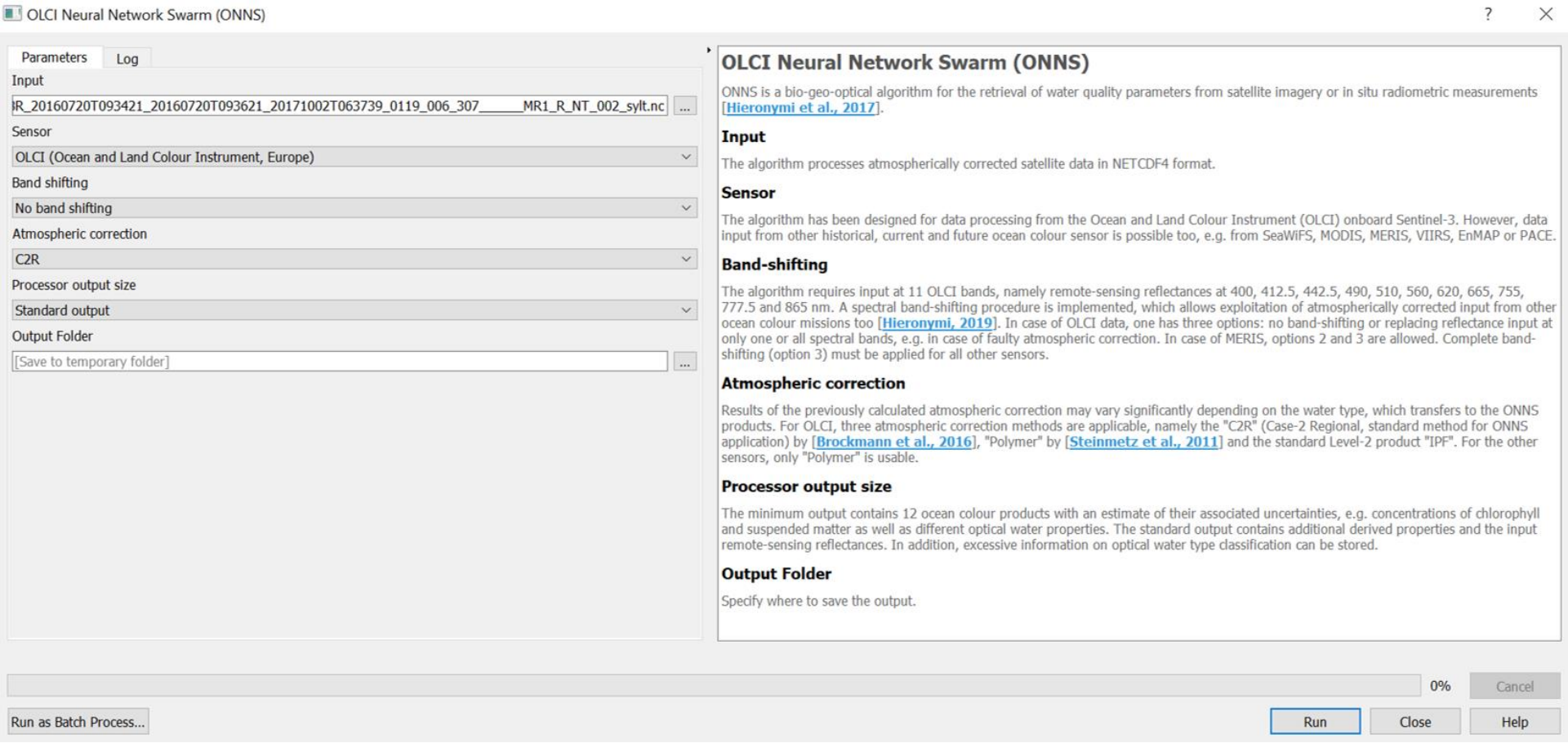
Helmholtz-Zentrum Geesthacht
Centre for Materials and Coastal Research



- AC critical over large areas

ONNS Available via EnMAP-Box

Helmholtz-Zentrum Geesthacht
Centre for Materials and Coastal Research



Summary & Outlook

Helmholtz-Zentrum Geesthacht
Centre for Materials and Coastal Research

- 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