Observing brownification from space

- the benefits of using satellite observations

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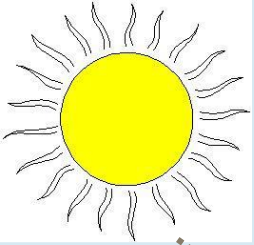
Satellite observations, or Earth Observations (EO) are visually impressive overviews of the color of the water and its changes.

The spatial resolution of these observations (10-60m) suits well for observing water quality in coastal estuaries, lakes and even some Finnish rivers.

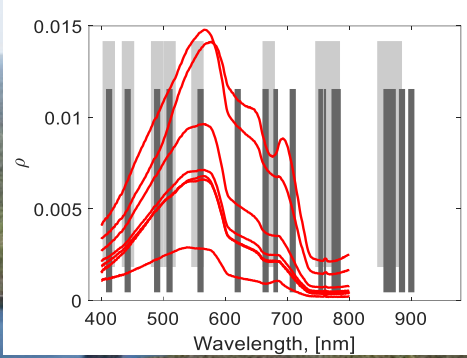


Satellite observations & following brownification

When we use satellite observations to detect water color, we use passive instruments that measure reflected light using a combination of wavelengths.

Water constituents define, which part of the light is reflected, and which is part absorbed.

In Finnish lakes and coastal areas, the absorption at the wavelenghs of blue light is mainly caused by the Coloured Dissolved Organic Matter (CDOM).



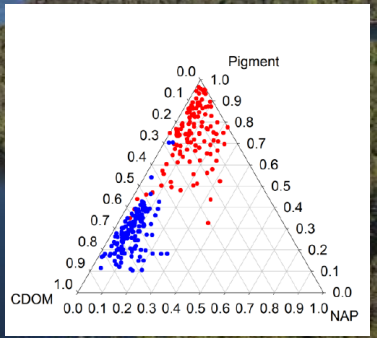


Photo: Kymenlaakson liitto

Finnish lakes are small and have irregular shapes

- Satellite instruments with high spatial resolution are practical
- Daily observing instruments like Sentinel -3 OLCI by the Copernicus programme can monitor less than 1000 Finnish lakes with 300m resolution.

Copernicus Sentinel-2 satellite series (A&B) and NASA Landsat (8&9)

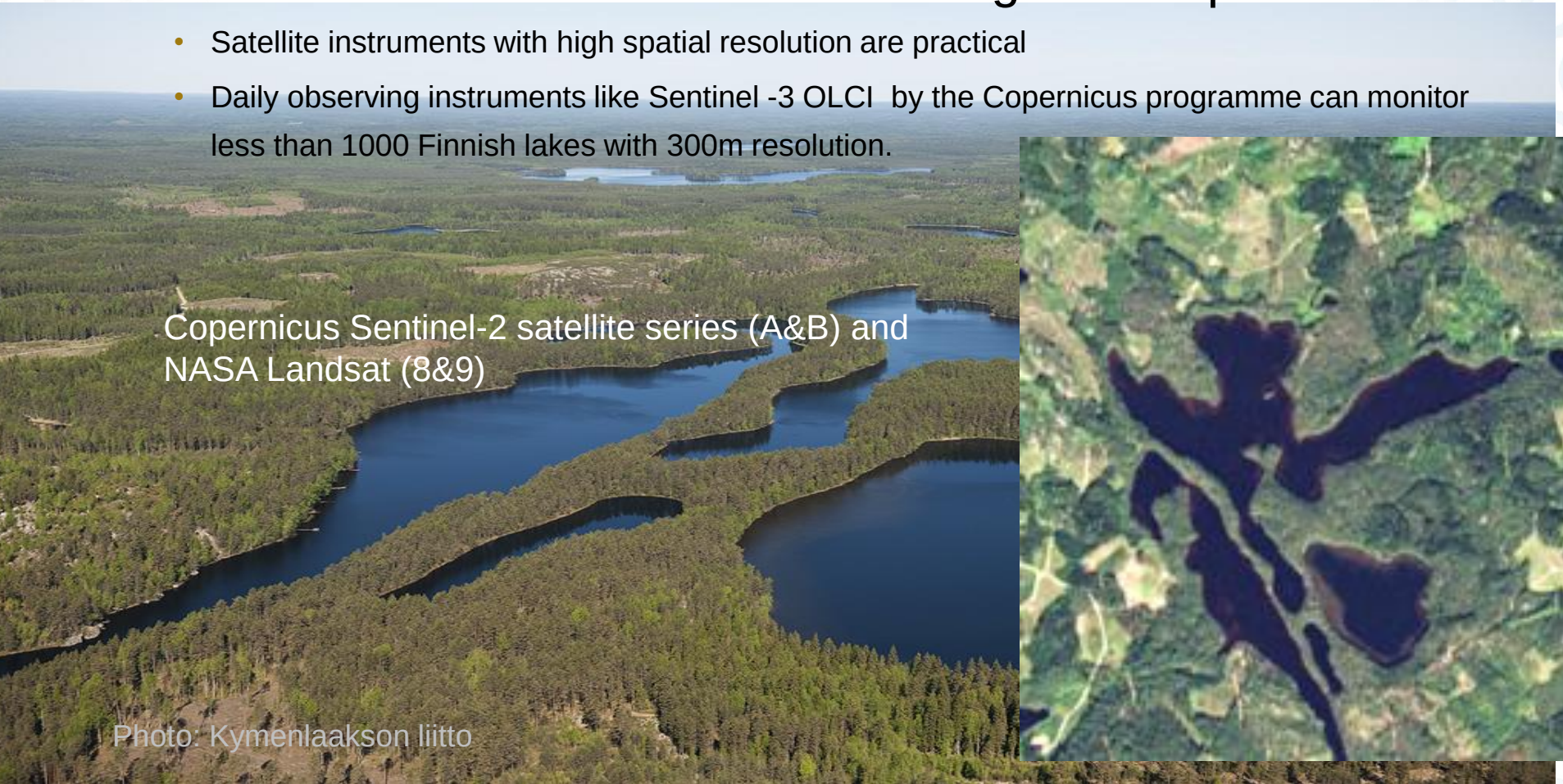


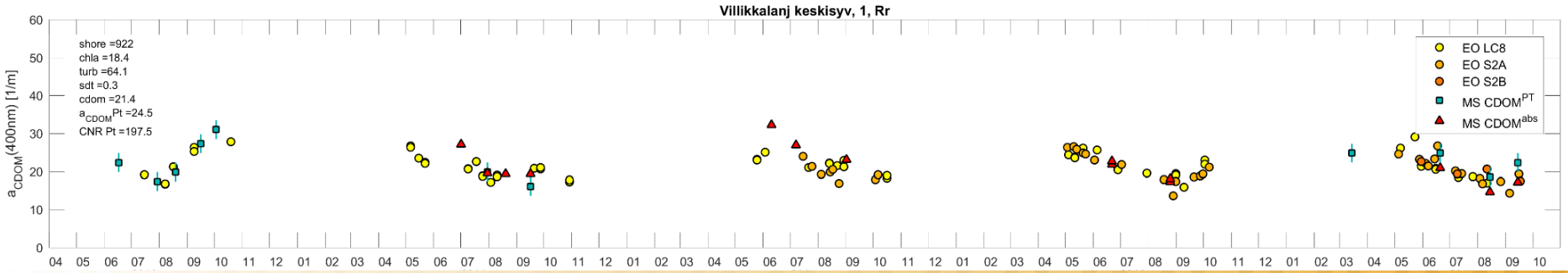
Photo: Kymenlaakson liitto

Using a combination of altogether four high resolution satellites, we can get a fairly good time series of CDOM observations. Either from the surroundings of monitoring station, or the whole lake (water body).

EO LC8
EO S2A
EO S2B

We can compare it to CDOM absorption determined from water samples.

MS $CDOM^{abs}$



Station sampling of CDOM are sparse: a rough estimate based on Water colour Pt measurements is used. Pt water color measurements cover well Finnish lakes and coastal waters.

MS $CDOM^{PT}$

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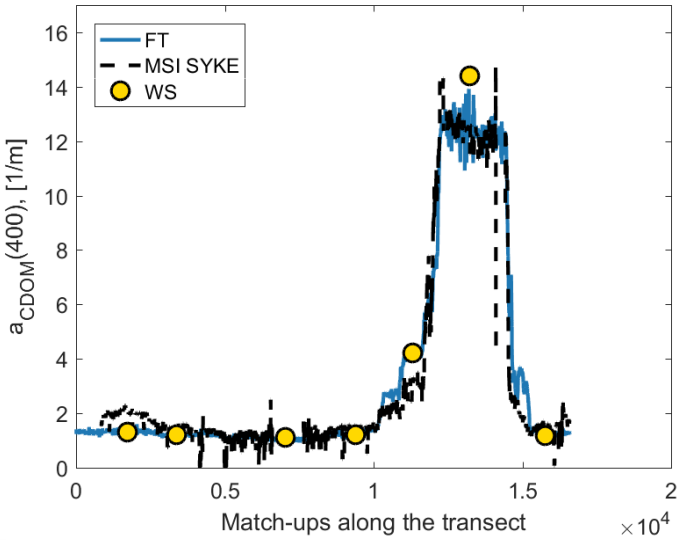
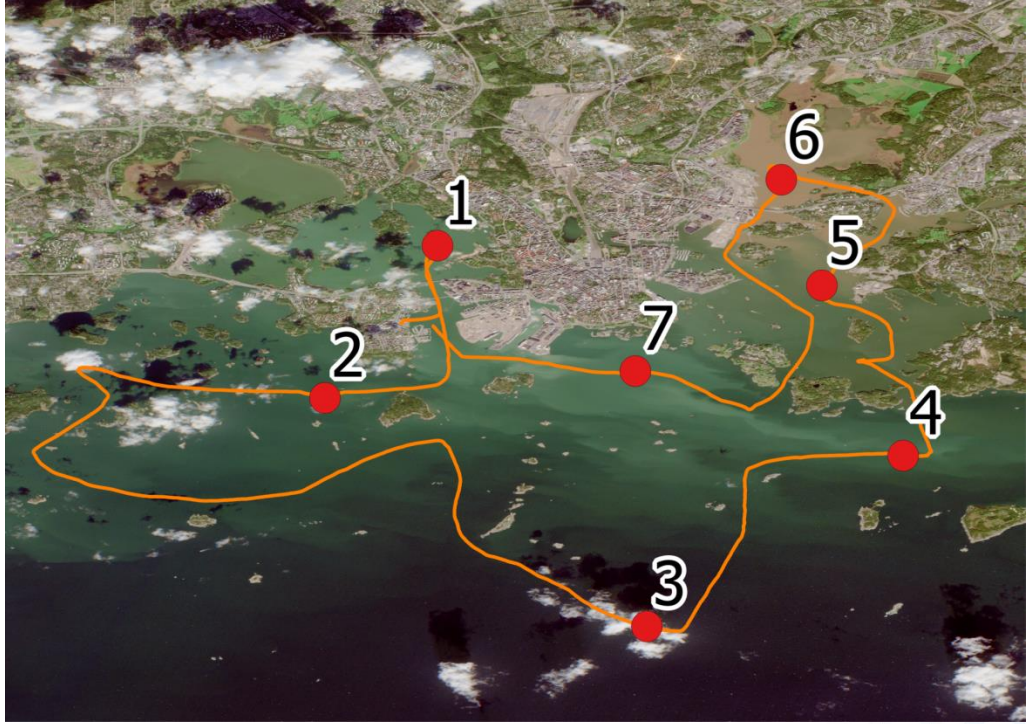
Bio-optical model to determine CDOM via satellite observations



Attila J., Koponen S., Kallio K., Lindfors A., Kaitala, S., Ylöstalo, P. (2013). MERIS Case II water processor comparison on coastal sites of the northern Baltic Sea, Remote Sensing of Environment, 128, 138–149.
doi:10.1016/j.rse.2012.07.009



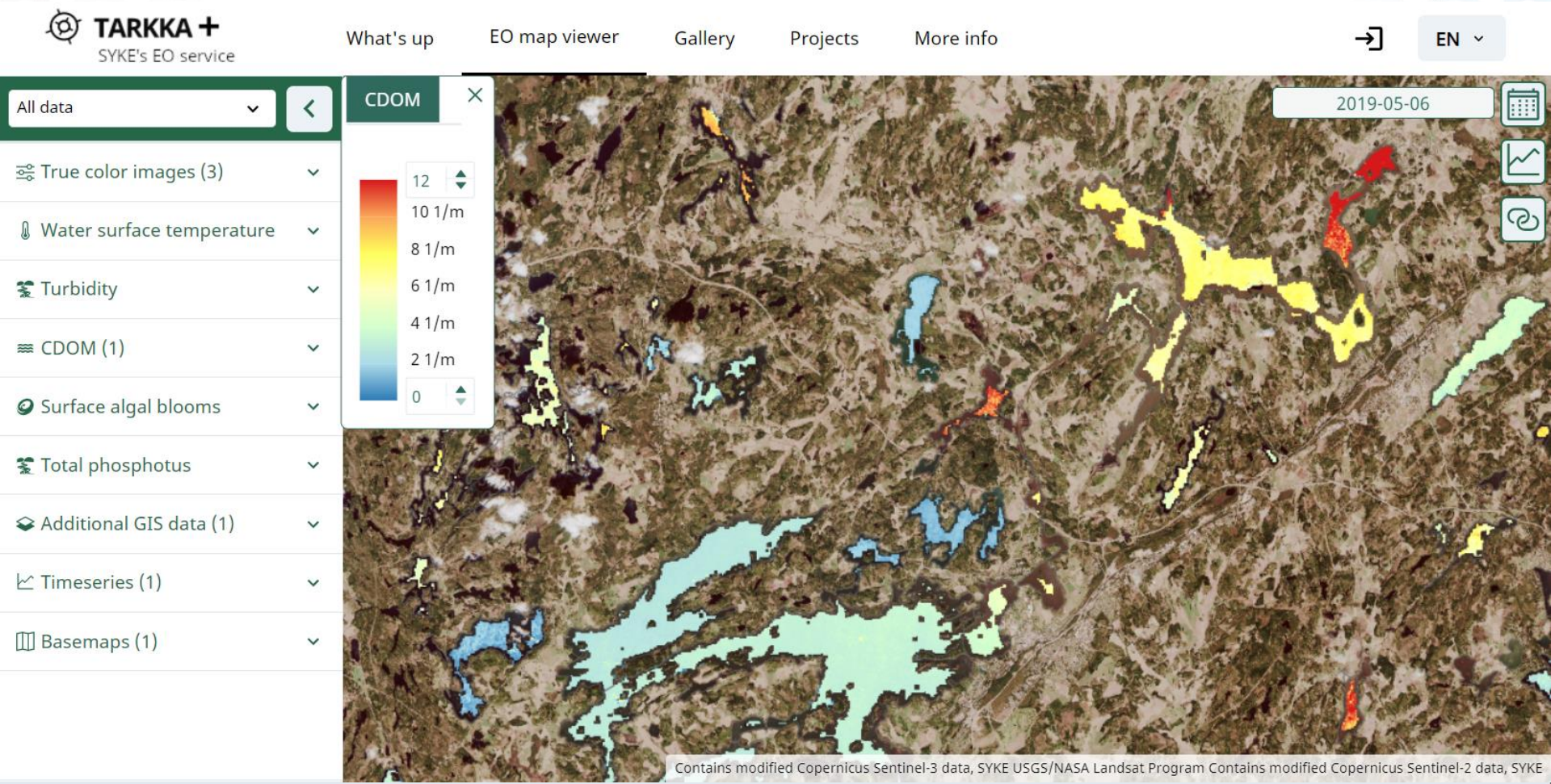
[Current version of C2RCC & open code https://c2rcc.org/](https://c2rcc.org/)

C2RCC Community Project

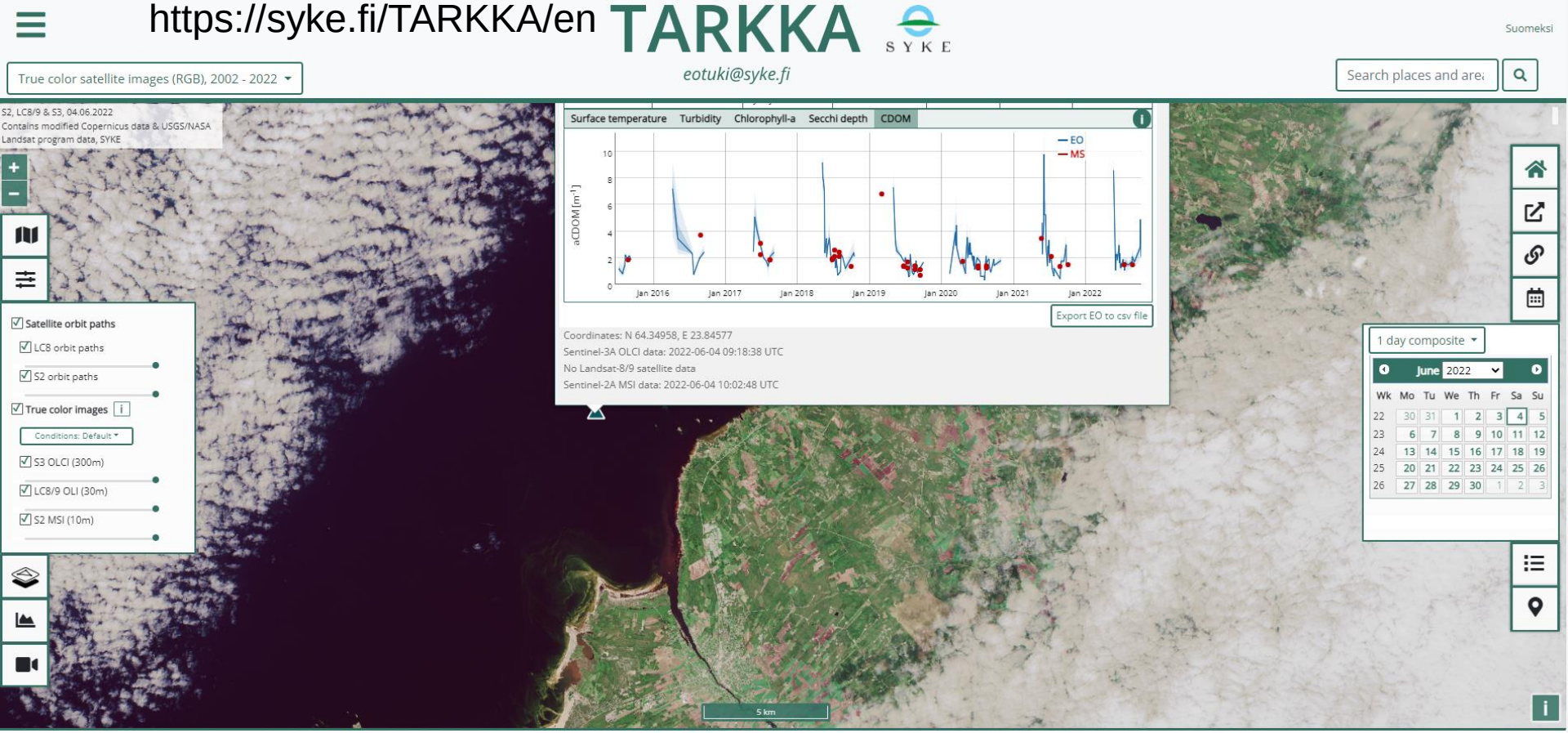
Atmospheric correction and in-water processing of optical earth observation data

Brockmann Consult

https://testbed.ymparisto.fi/eo-tarkka/



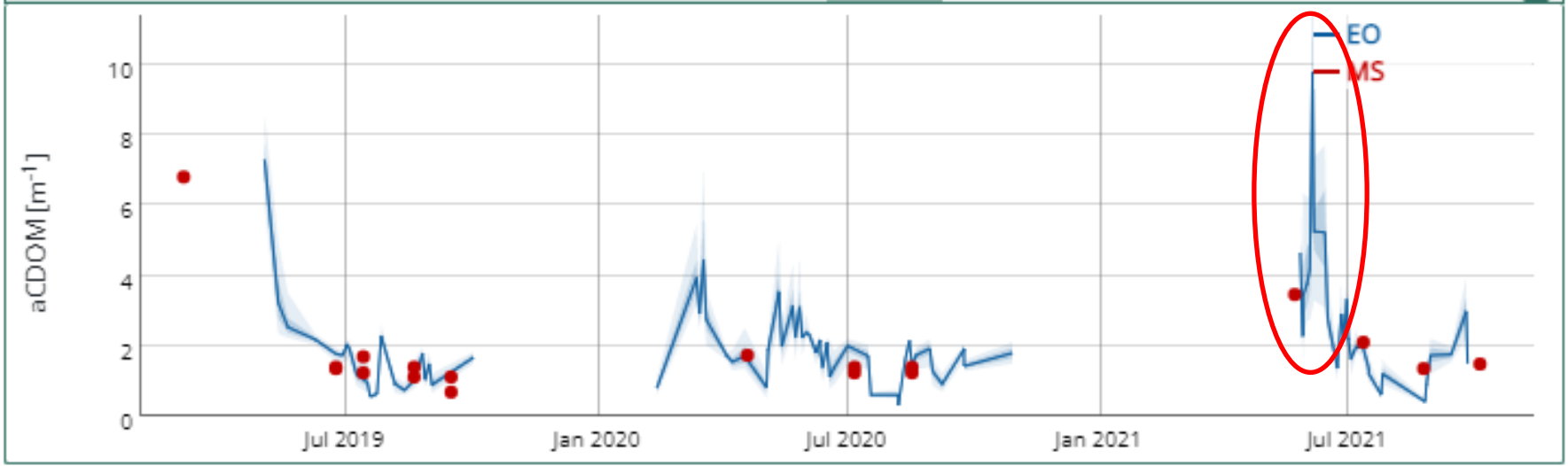
Over Finnish coastal waters, time series of satellite based CDOM estimates are available in open EO service TARKKA.
https://syke.fi/TARKKA/en



Reference stations of coastal areas and lakes

Place number	Station name	Water body name	WFD id	WFD type	ELY	Depth [m]
27622	Ka-2 Kalajoen edusta	Kalajoki - Pyhäjoki	4_Pu_010	Pu	POP	16

Surface temperature | Turbidity | Chlorophyll-a | Secchi depth | CDOM

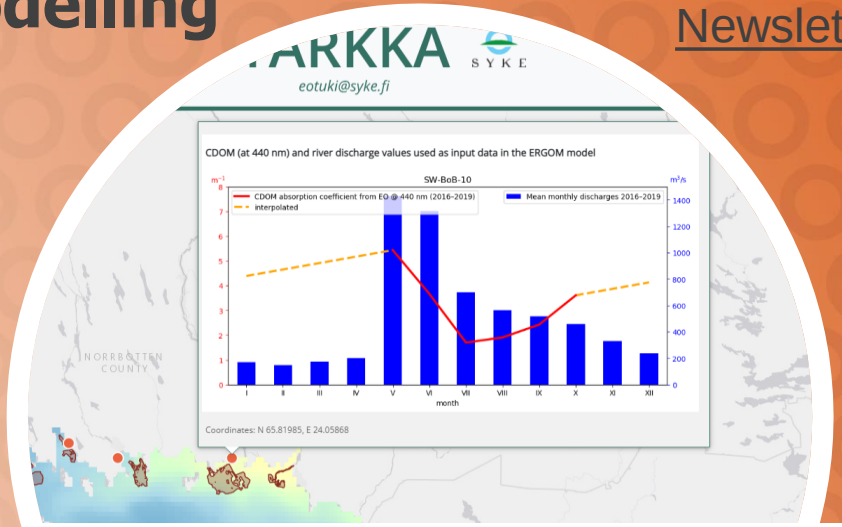


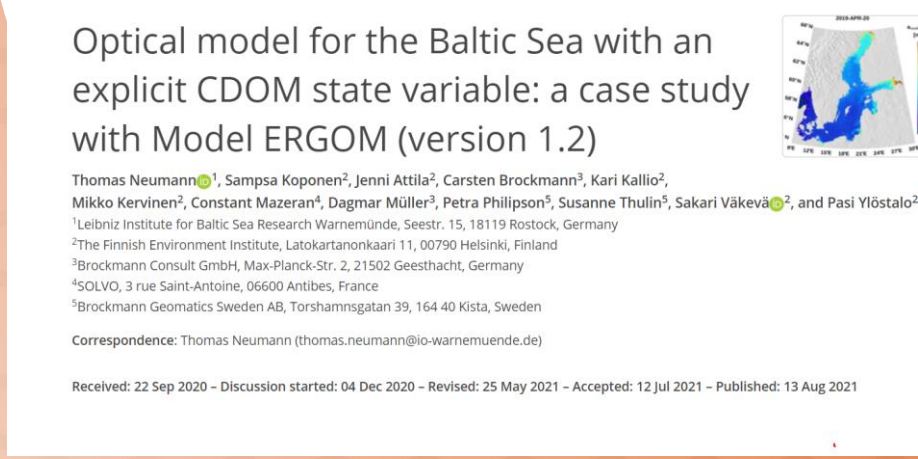
Export EO to csv file

Baltic Sea CDOM & TOC modelling

Newsletter

- SeaLaBio-project: In situ, EO and models combined together were proven powerful combination to advance estimation of TOC in the Baltic Sea level.
- Biogeochemical ERGOM model was improved with enhanced estimation of light conditions.
    - satellite based CDOM absorption values and discharge as input.
- Clear linkages between CDOM and Total Organic Carbon (TOC): to gain better knowledge on carbon loads from rivers.





Optical model for the Baltic Sea with an explicit CDOM state variable: a case study with Model ERGOM (version 1.2)

Thomas Neumann[1], Sampsa Koponen[2], Jenni Attila[2], Carsten Brockmann[3], Kari Kallio[2], Mikko Kervinen[2], Constant Mazeran[4], Dagmar Müller[3], Petra Philipson[5], Susanne Thulin[5], Sakari Väkevä[2], and Pasi Ylöstalo[2]
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[5]Brockmann Geomatics Sweden AB, Torshamnsgatan 39, 164 40 Kista, Sweden

Correspondence: Thomas Neumann (thomas.neumann@io-warnemuende.de)

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Geosci. Model Dev., 14, 5049–5062, 2021
https://doi.org/10.5194/gmd-14-5049-2021

SYKE · Brockmann Consult · Brockmann Geomatics Sweden AB · solvo · Leibniz-Institut für Ostseeforschung Warnemünde IOW

TARKKA

SYKE

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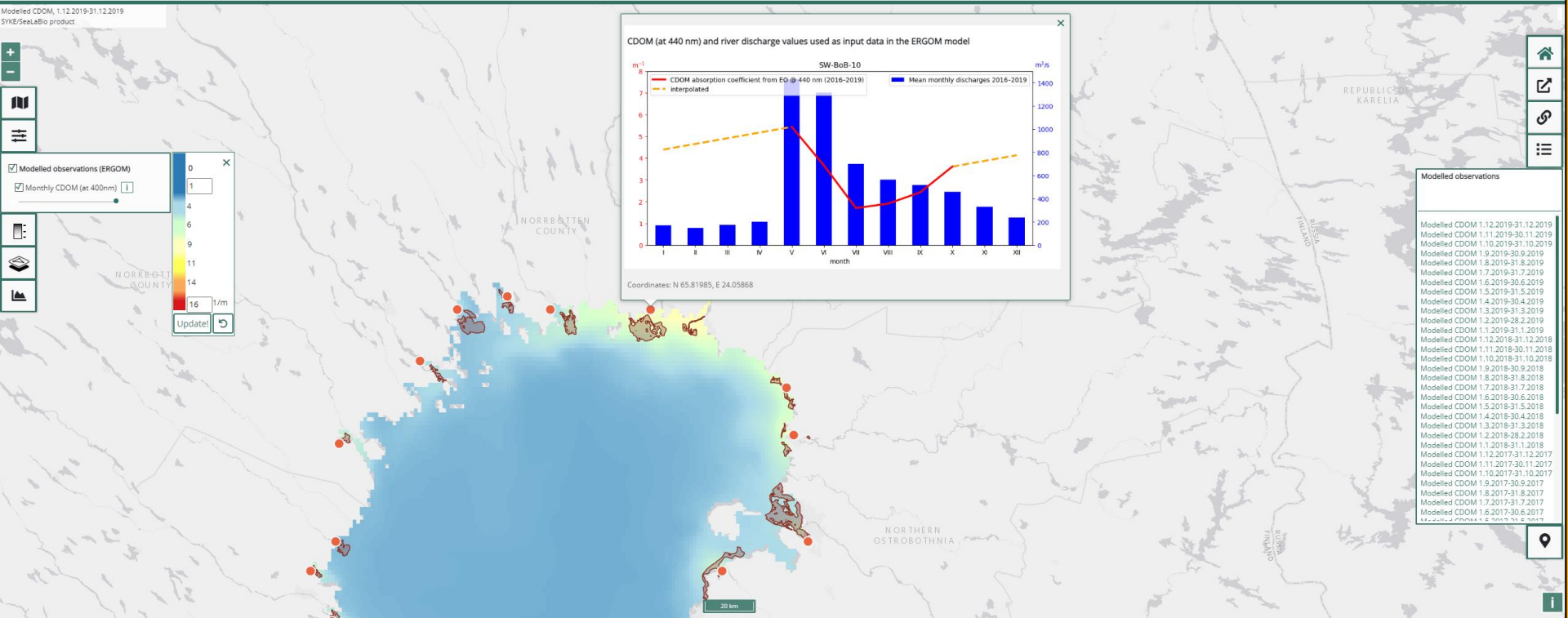
Suomeksi

Monthly modelled CDOM values 2016 – 2019

Search places and are

Modelled CDOM, 1.12.2019-31.12.2019
SYKE/SeaLaBio product



Summary

- The added value in utilizing satellite observations is that the observations can be made at times and in areas that are not covered by station sampling.
- Modern high resolution (60m) satellite observations have been collected for the seventh year already, thus their compatibility with station sampling measurements is clear & can be analysed further over lakes.
- Over a longer period than the past seven years, medium resolution satellite observations (300m) can be used to define the CDOM and it's seasonal variations in open sea areas, large coastal estuaries and largest Finnish lakes starting from 2003.

SYKE

Thank you!

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TARKKA:
https://syke.fi/TARKKA/en

TARKKA+ testbed:

https://testbed.ymparisto.fi/eo-tarkka/

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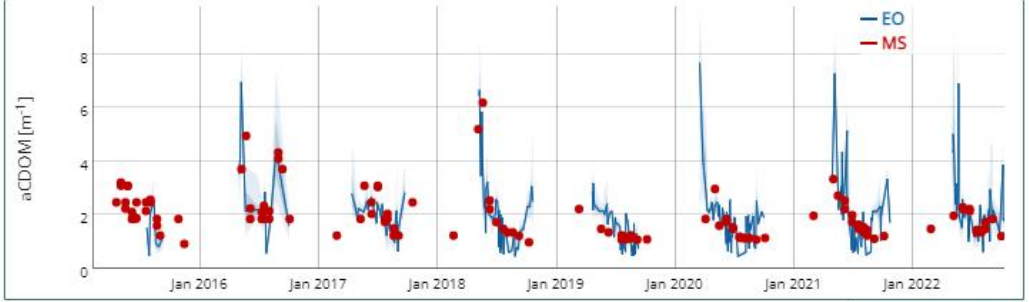
Reference stations of coastal areas and lakes

Place number	Station name	Water body name	WFD id	WFD type	ELY	Depth [m]
42159	Vavy-19 Storbådan	Östra gloppet	3_Mu_050	Mu	EPO	26.5

Surface temperature | Turbidity | Chlorophyll-a | Secchi depth | CDOM



Export EO to csv file

Coordinates: N 63.40388, E 21.98900

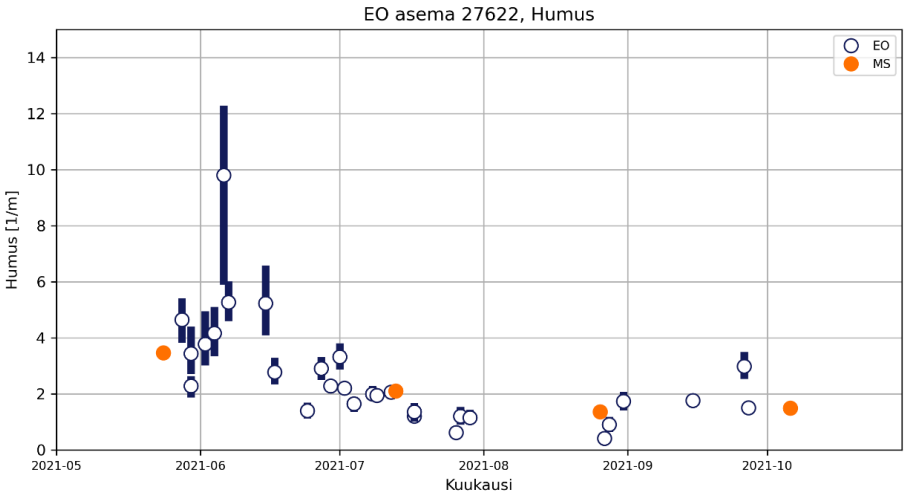
Sentinel-3A OLCI data: 2022-06-04 09:18:38 UTC

No Landsat-8/9 satellite data

Sentinel-2A MSI data: 2022-06-04 10:03:07 UTC

10 km

SYK


EO asema 27622, Humus
EO
MS
Humus [1/m]
0
2
4
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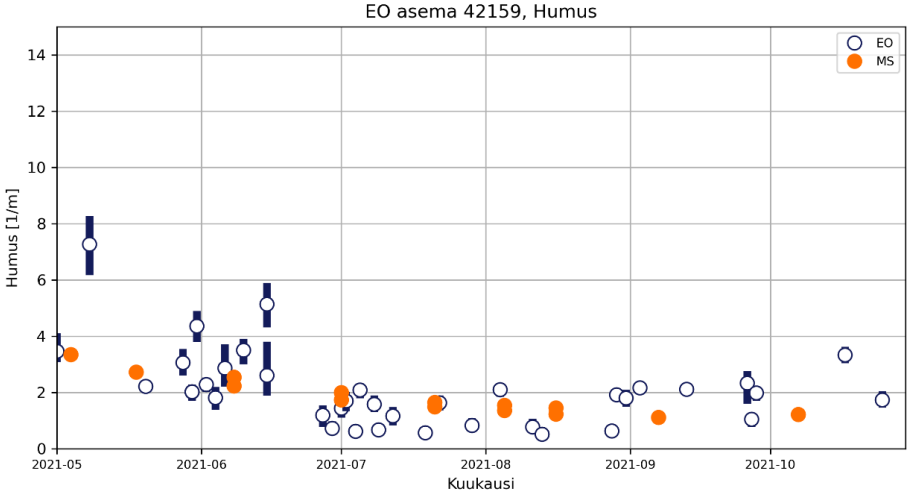
2021-06
2021-07
2021-08
2021-09
2021-10
Kuukausi


EO asema 42159, Humus
EO
MS
Humus [1/m]
0
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4
6
8
10
12
14
2021-05
2021-06
2021-07
2021-08
2021-09
2021-10
Kuukausi

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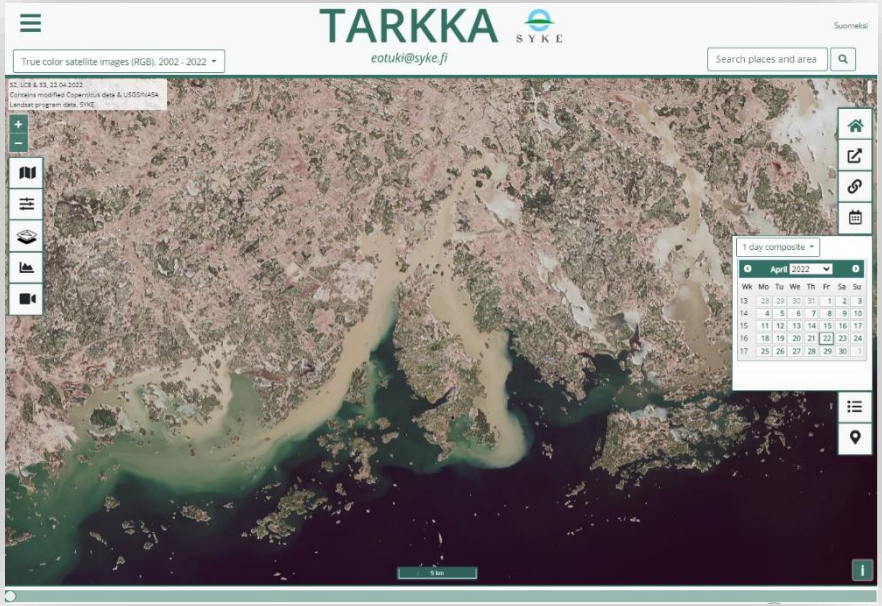
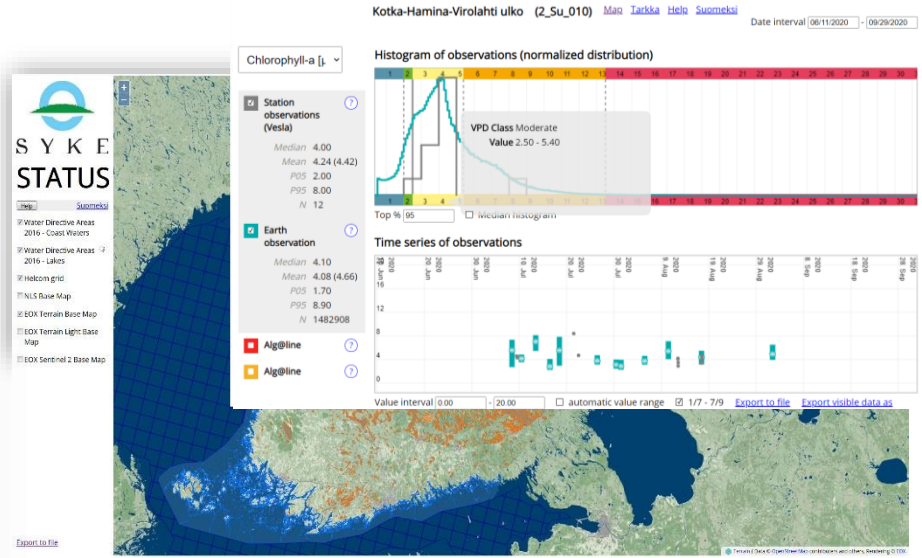
EO for water quality monitoring in Finland

TARKKA syke.fi/TARKKA/en

- Open service: Water quality products over Finnish lakes and the Baltic Sea
- Used by authorities, media and citizens





STATUS

- Numerical and aggregated water quality data for the water bodies
- For Finnish Environmental Authorities (regional and SYKE)