EuroSDR
Scaling up the Sentinels in Europe
26.-27.10.2020

Developments of coastal and lake water quality applications and services in Norway

Therese Harvey, Anna Birgitta Ledang, Sabine Marty, Pierre Franqois Jaccard, Kai Sørensen and Andrew King

NIVA, Norwegian Institute of Water, Norway
NIVA Denmark, Denmark

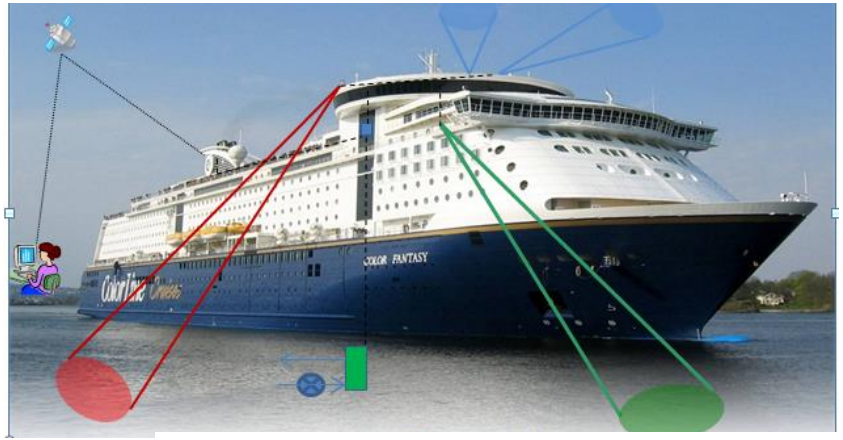
Outline

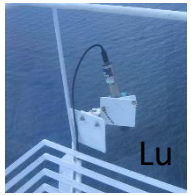
- Infrastructure at NIVA
  - Ferrybox data for validation
- Examples of remote sensing activities from recent and ongoing R&D projects
  - Marine coastal areas
  - Freshwater (lakes)

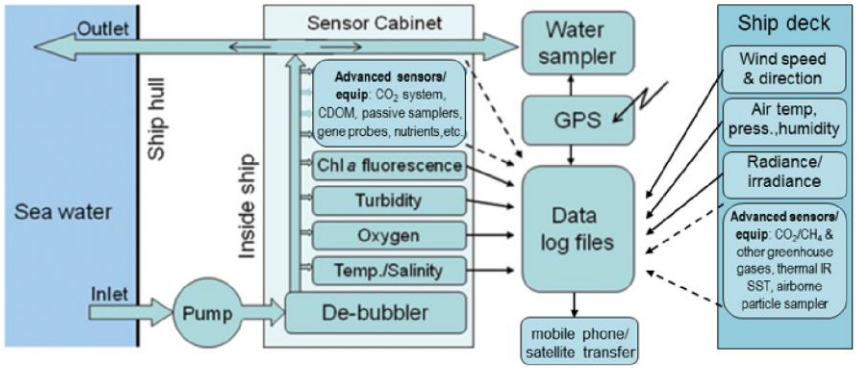
Infrastructure at NIVA

- Boats, network of collaborators
- Discrete in situ monitoring (Chl-a, TSM, cDOM_abs, Turbidity, Secchi depth, Pig_Abs, Nutrients, pH, pCO2, Alcalinity,
- Optical equipment (Reflectance (Sky Irradiance and Radiance, Marine Reflectance, PAR, Hyper Spectral, SST (DMI), Lidar, AC9, bb6, bb9)
- Ferryboxes on Ships of opportunity
- Accredited labs (e.g. Chl-a and phytoplankton composition)

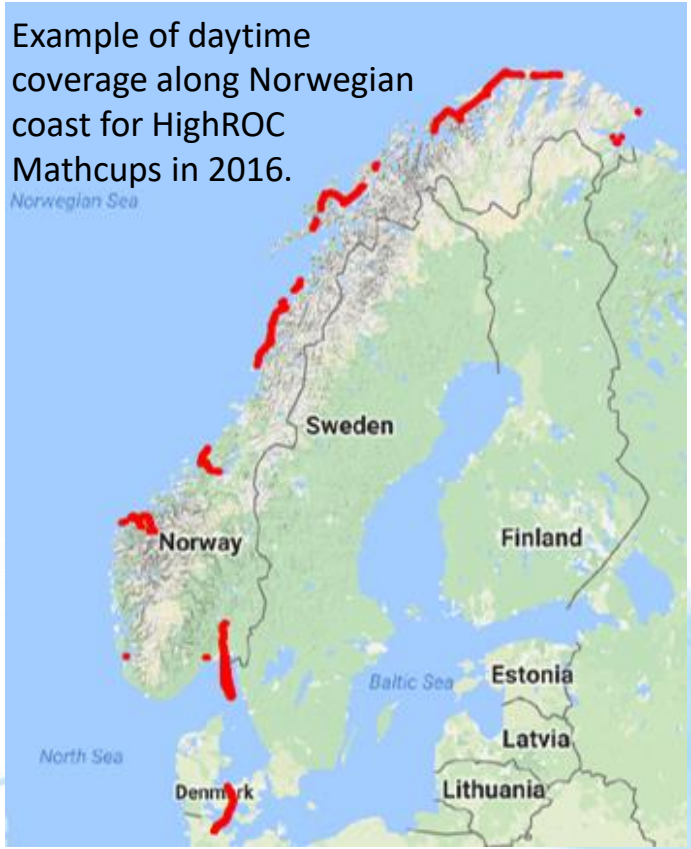
Configuration for in situ, Rrs and SST







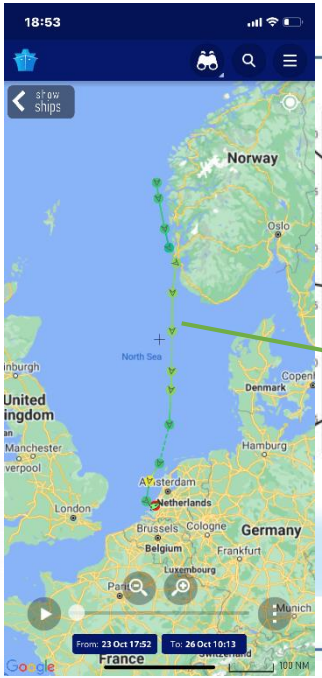
Example of daytime coverage along Norwegian coast for HighROC Mathcups in 2016.

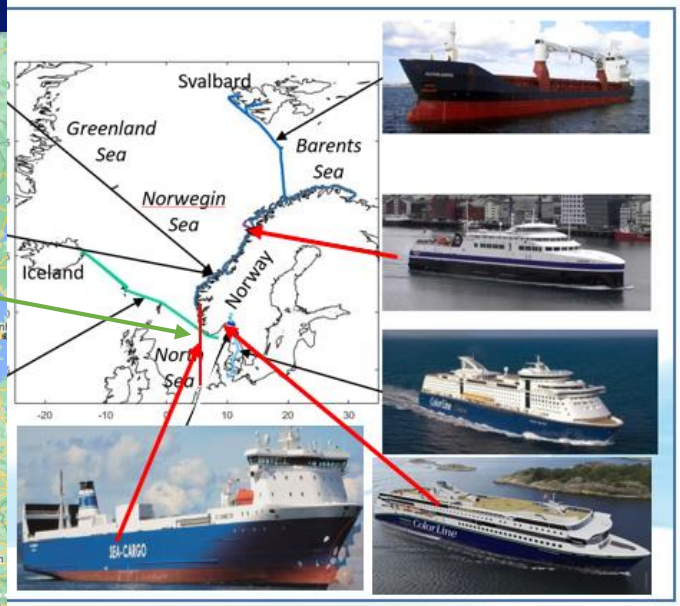


NorSOOP: **Nor**wegian **S**hips **O**f **O**pportunity **P**rogram for marine and atmospheric research (www.niva.no/norsoop)

Norwegian Institute for Water Research - NIVA (lead)

Partners: Institute for Marine Research, Akvaplan-niva, met.no





- Red arrows represents new FerryBox lines to be used for validation.
- Highlighted in red are sensor or sampling used for product validation.

Standard Ferrybox

- *Temperatur, Salinity, Chl-a_Fluoresence, cDOM_Fluoresence, PC_Fluoresence, Turbidity/Scattering*
- *Water Samplers (Chl-a, TSM, cDOM_abs, Pig_Abs, Nutrients)*
- *Nutrient analyzers (PO4, NO3, SiO2, NH4)*
- *Carbonsystem (pH, pCO2, Alcalinity)*

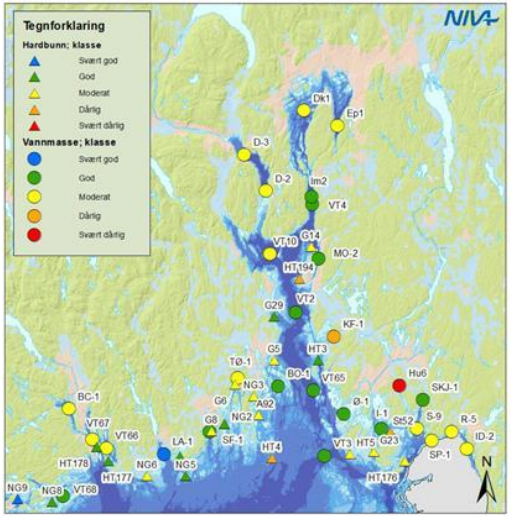
Deck installations:

- *Marine reflectance and PAR*
- *Weather stations (e.g.True Wind)*
- *Sea Surface Temperature (DMI)*
- *Hyper Spectral Lidar*

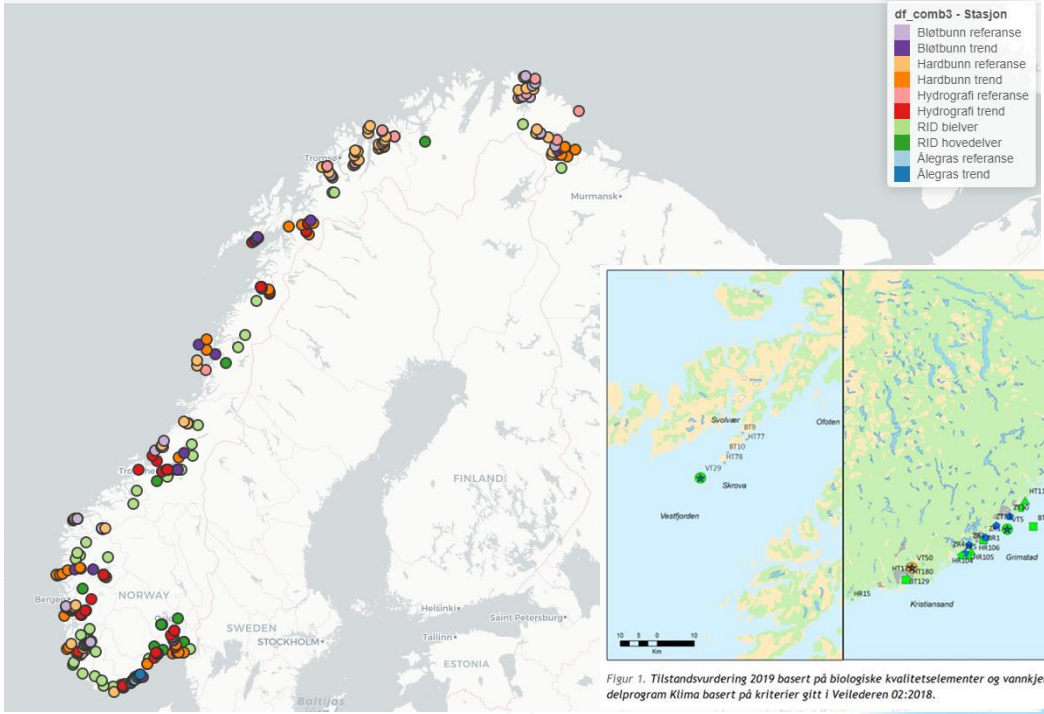
Advanced installasjons

- *Contaminants and microplastic sampler*
- *CPR (SAHFOS), ADCP and XBT (Univ. Rode Island)*
- *Flow Cytometry, Imaging, PSICAM, FRRF/PAM,*
- *Atmospheric properties over marine water*

Marine Coastal areas



Figur 1. Marine overvåkningsstasjoner i Oslofjorden som er undersøkt i 2019 og klassifisert etter Veileder 02:2018. Klassifisering av vannmassene er merket med sirkler og hardbunn med trekanter. Stasjoner fra Økokyst Skagerrak (VT10, VT2, VT65, VT3, VT67, VT66 og VT68, samt HT3, HT4, HT5, HT177, HT178, HT179 og HT194) og Indre Oslofjord programmet (Ep1, Dk1 og Im2), samt en stasjon i Hunnebunn (Hu6), er inkludert for å få et mer helhetlig bilde.



Figur 1. Tilstandsvurdering 2019 basert på biologiske kvalitetselementer og vannkjemiske støtteparametere per stasjon i delprogram Klima basert på kriterier gitt i Veilederen 02:2018.

NIVA

MILJØ-DIREKTORATET

highroc.eu

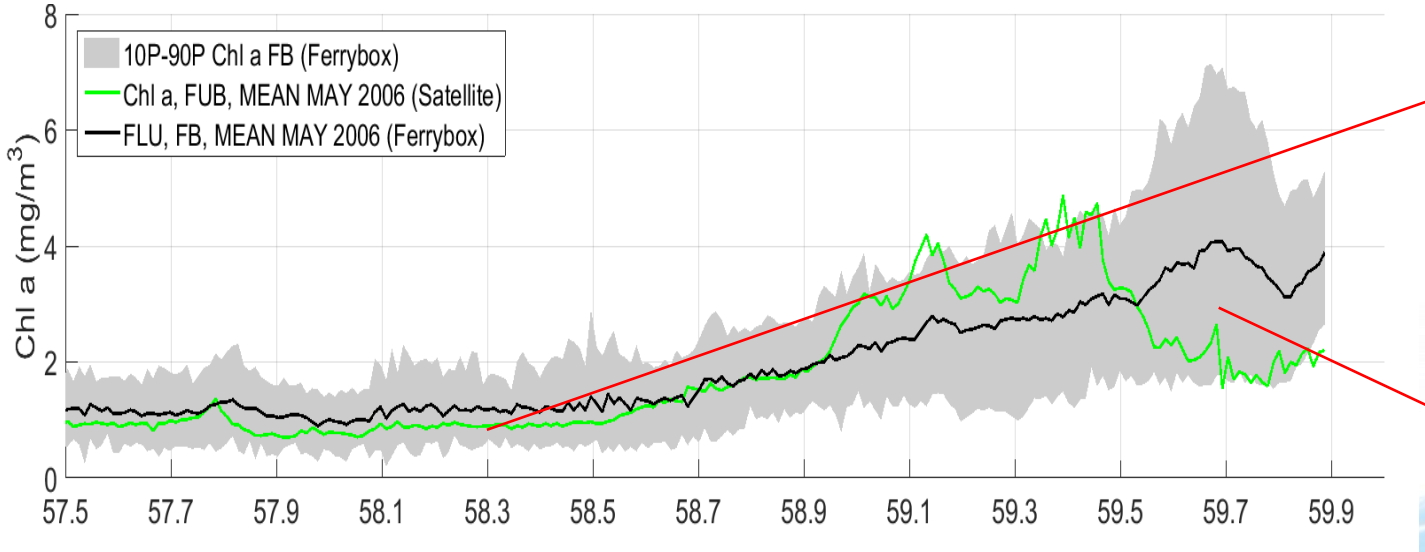
DCS4COP

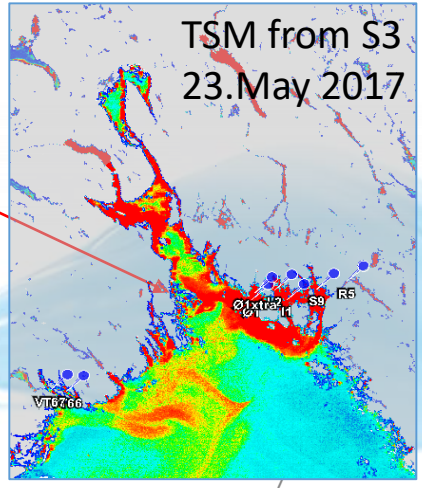
HORIZON 2020

FAGRÅDET for vann & avløpsteknisk samarbeid i indre Oslofjord

HighROC (HIGH spatial and temporal Resolution Ocean Colour)

FerryBox_Chl-a_Fl data work well for validation the Chl-a products in the c
area (MERIS)

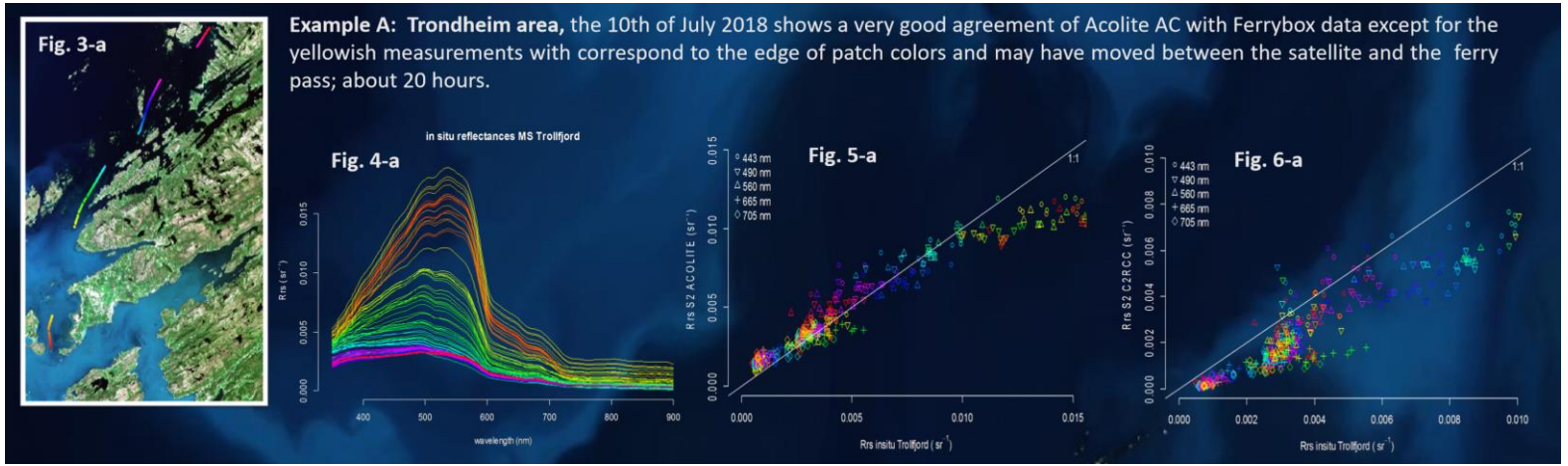




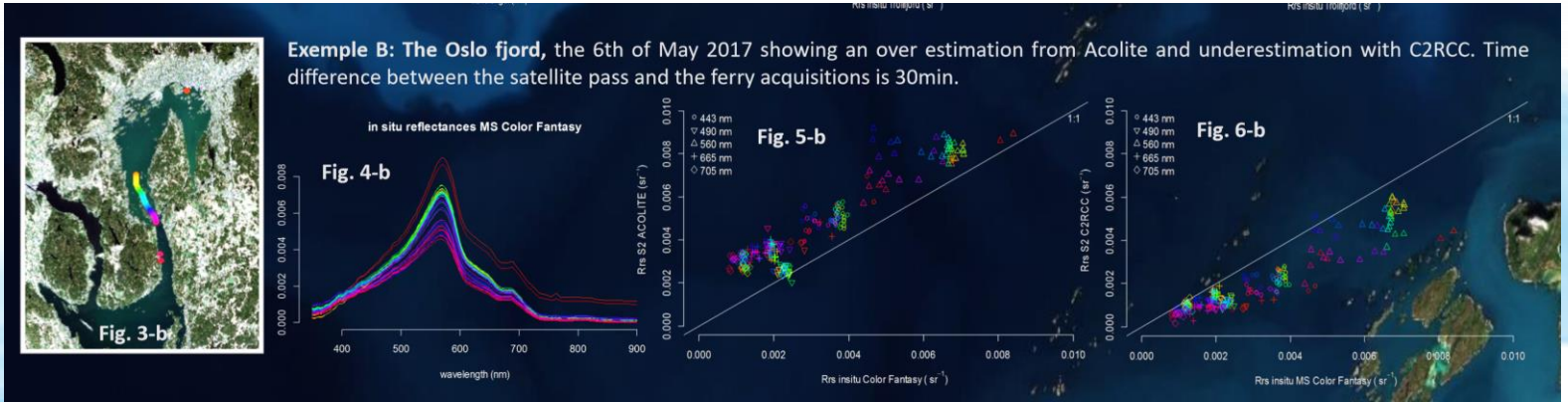
Sentinel-3 data from HighROC Acolite processing >>

NIVA highroc.eu

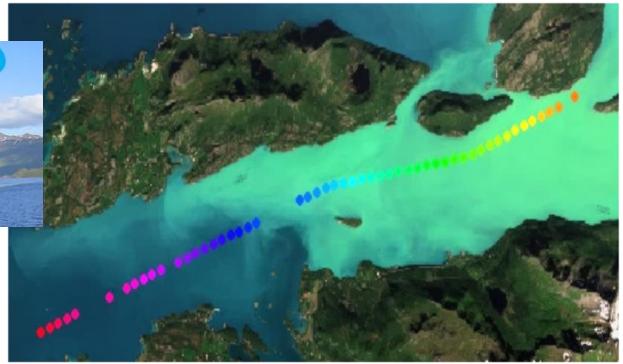
S-2 validation: Ferrybox mounted radiometers

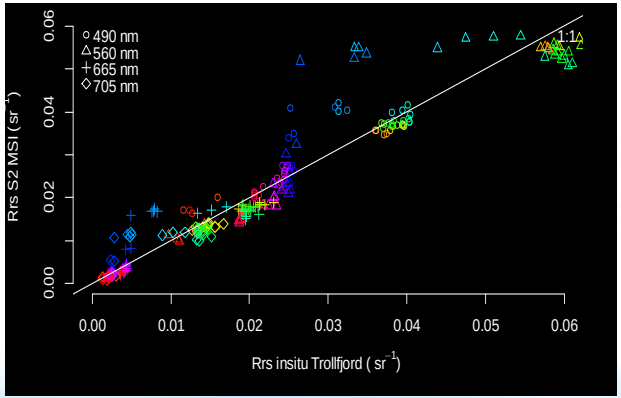


Ref: Sabine Marty et al. (2017)



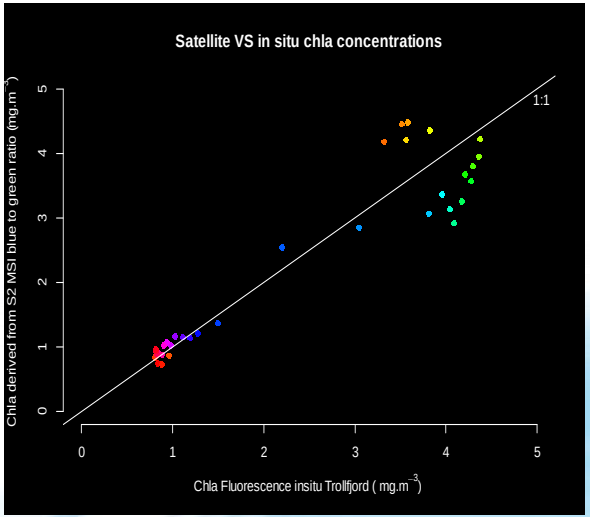
S-2 validation: Glomfjord (67 lat) study





Dataset

- Sentinel-2A MSI image 20/07/2016
- *in situ* measurements from the MS Trollfjord (4 hours diff)
- Processing using Acolite



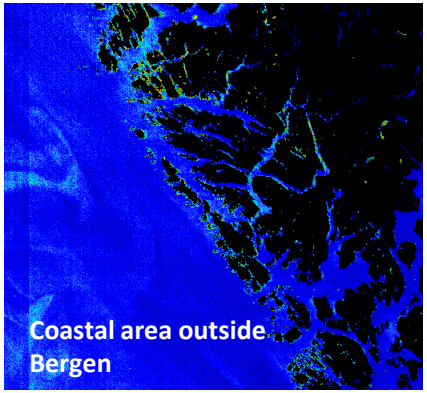
Ref: Sabine Marty et al. (2017)

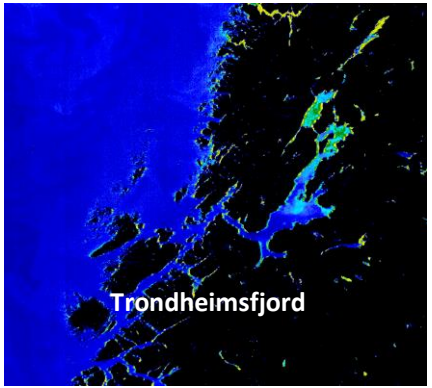
EU H2020 DCS4COP

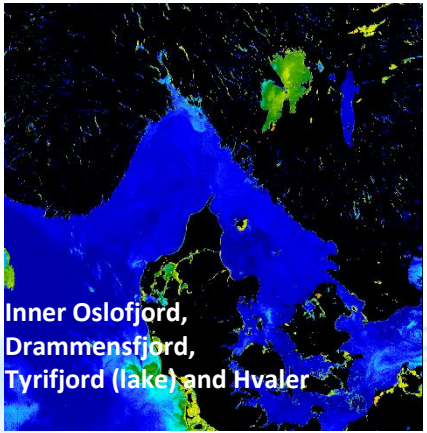
Sentinel-3 OLCI data

xcube

EDataBee

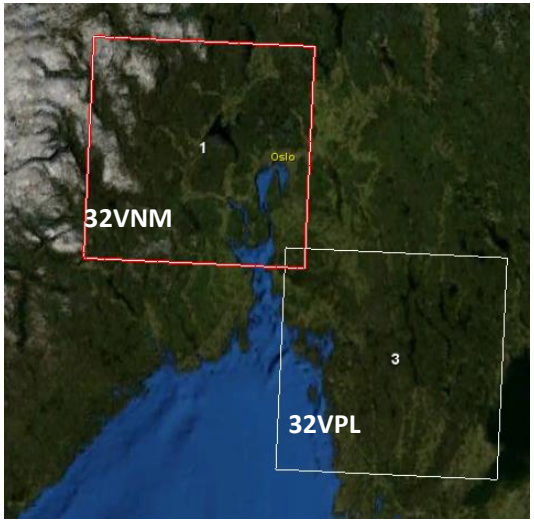


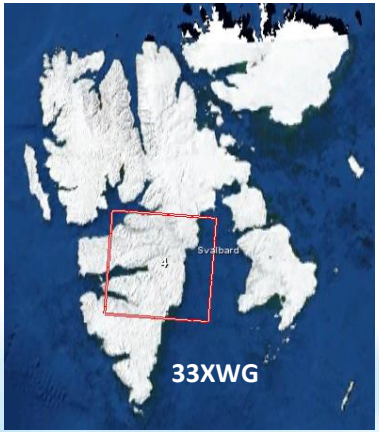




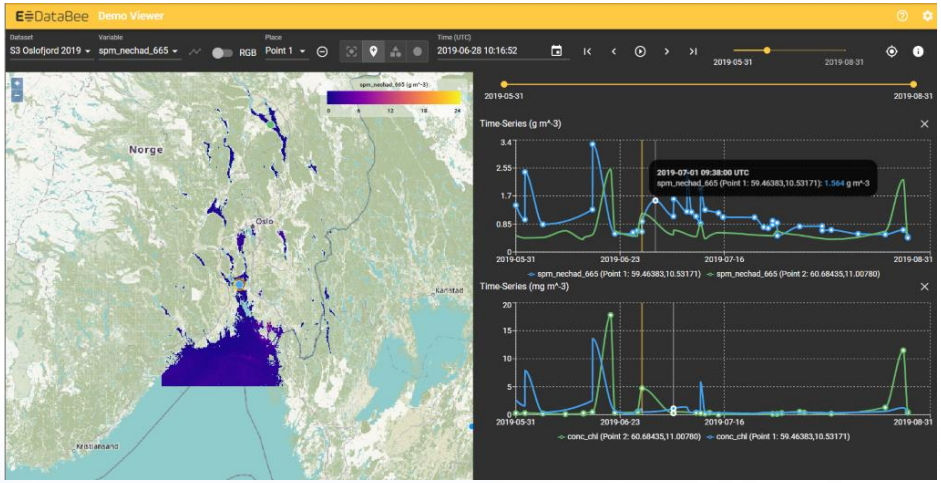
Partners: Brockmann Consult, RBINS, VITO, NIVA, Univ. Hull, Cefas, LOV, Starlab

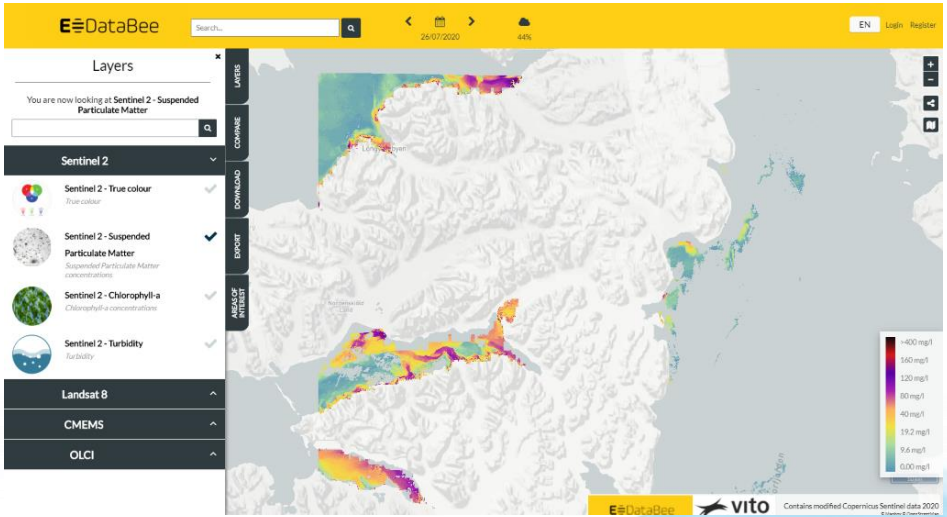
Sentinel-2 MSI data





Evaluating different viewers for Norwegian applications developed by Brockmann consult and Vito





Freshwater- Lakes

- Dedicated in situ sampling in 2019 (4 lakes), 2020 (Mjøsa)
- Synergy/collaboration with the ØKOSTOR and Mjøsa monitoring programs for lakes with extra sampling and reflectance measurements

MILJØ-DIREKTORATET

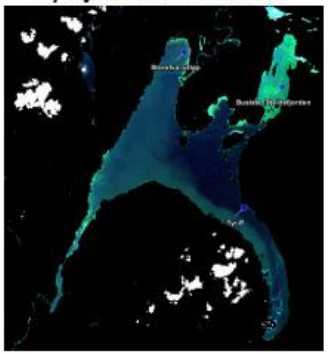
DCS4COP

NIVA

Case studies-2019

- Tyrifjorden including Steinsfjorden (different basins)
- Mjøsa (clear lake)
- Vansjø (particles and humic substances)
- Hemnessjøen (humic substances)

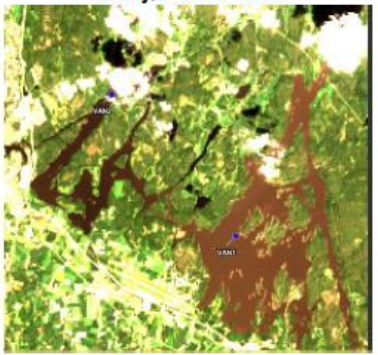
Tyrifjorden 26. Mai 2017



Hemnessjøen. 23. Mai 2017

Mjøsa 23. Mai 2017

Vansjø 7. Juli 2016



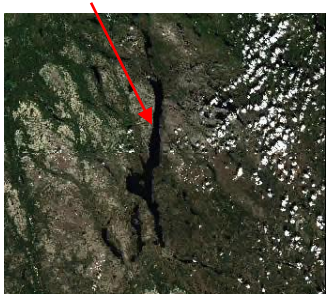
Case studies-2020

- **Femunden** (clear, northen lake, very shallow)
- **Selbusjøen** (clear, but relatively high colour, northern lake)
- **Gjende** (clear, shallow)
- **Snåsavatnet** (clear, but relatively high colour, northern lake)
- **Røssvatnet** (clear, northern lake)
- **Mjøsa** (deep, clear lake)

Chl-a, CDOM, TSM, Turbidity, AC9, Secchi depth measured in all lakes

Extra match-up cruises in 2020 for bio-optics (e.g. pig_abs) and reflectance data *in Mjøsa*

Femunden



Selbusjøen

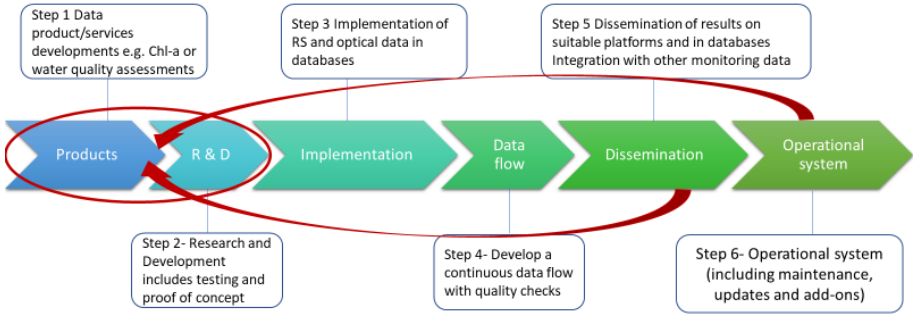
Gjende

Snåsavatnet

Røssvatnet

Mjøsa

1) Applications of satellite remote sensing data for water quality in Norwegian lakes (pilot 2017-2019)
2) Classification of chl-a status for lakes based on remote sensing data- method development 2020



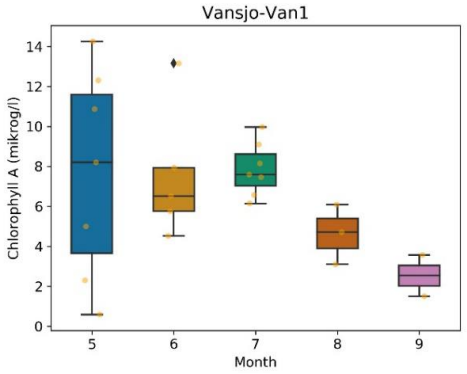
Goals:

1) Evaluate the performance of the sensors and algorithms for the use of remote sensing data for water quality assessment in Norwegian lakes

2) Develop methods and services for an operational use of remote sensing data that can e.g. be used for within the lake monitoring program of the Norwegian environmental agency (Miljjødirektoratet)

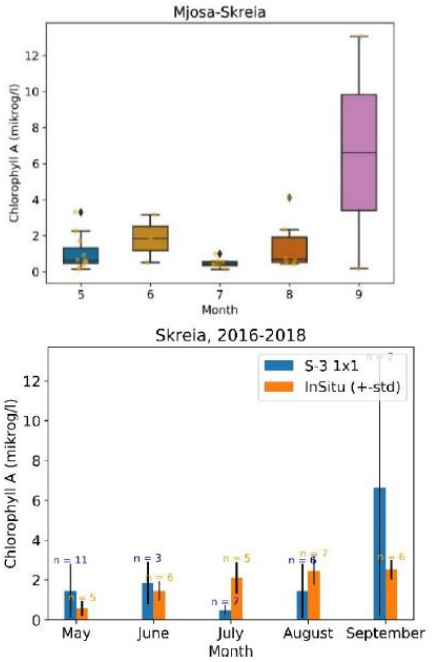
Sentinel-2 Chl-a in Vansjø

Station Van-1

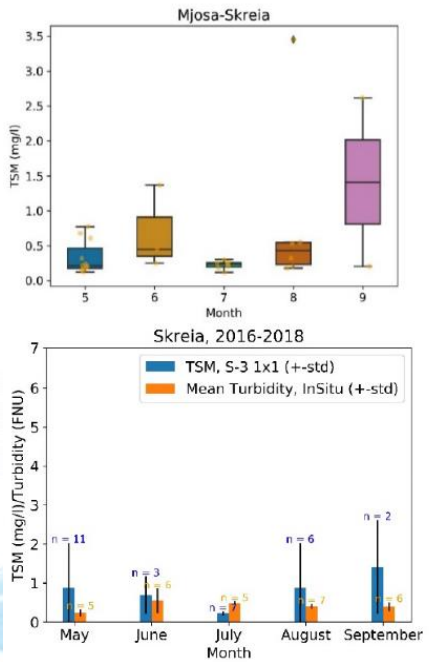


Sentinel-3 Chl-a and turbidity at station Skreia in lake Mjøsa

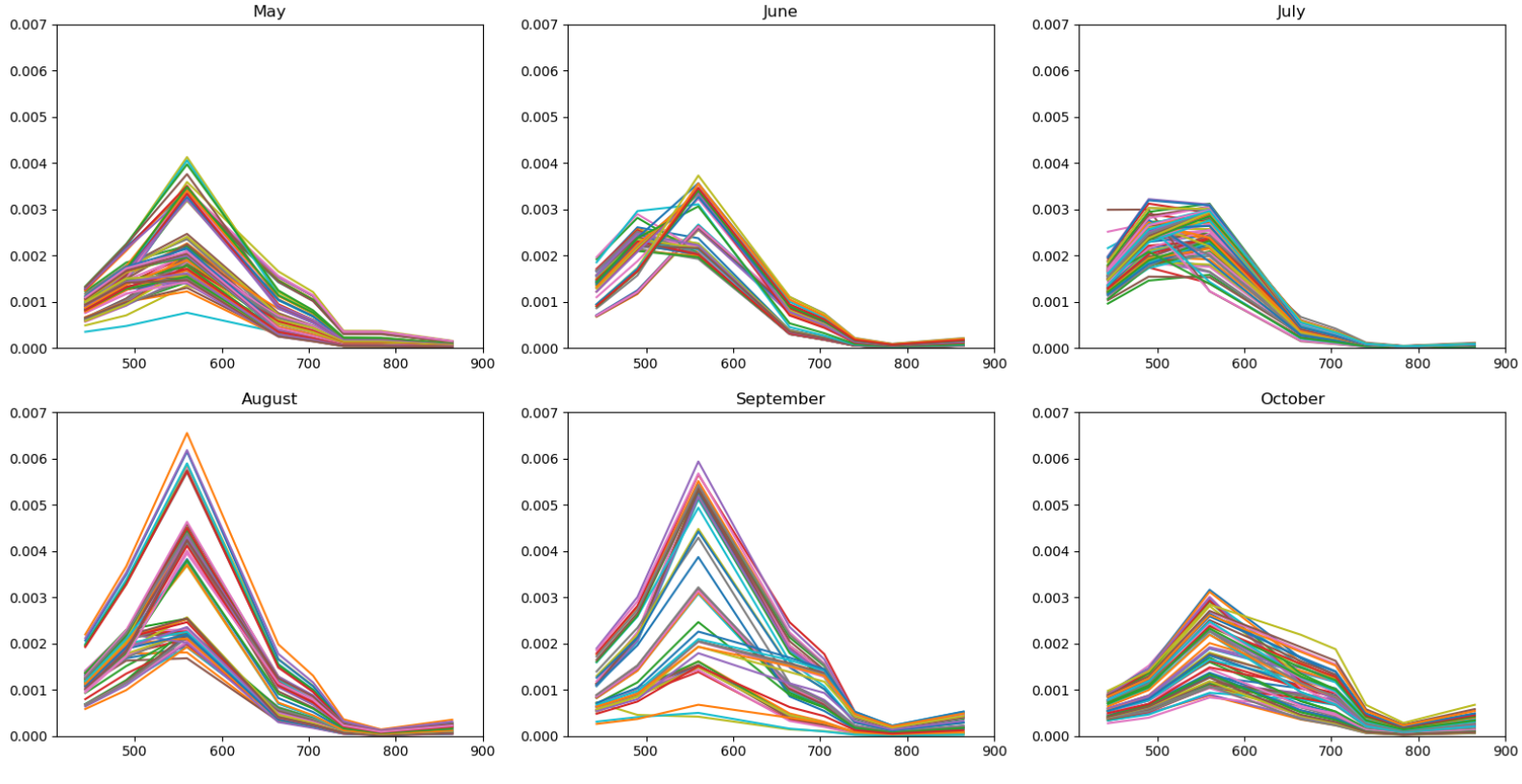
Klorofyll-a



TSM / Turbiditet

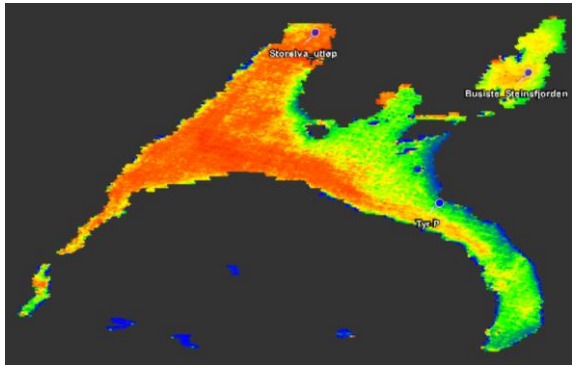


Steinsfjorden, 2016-2018

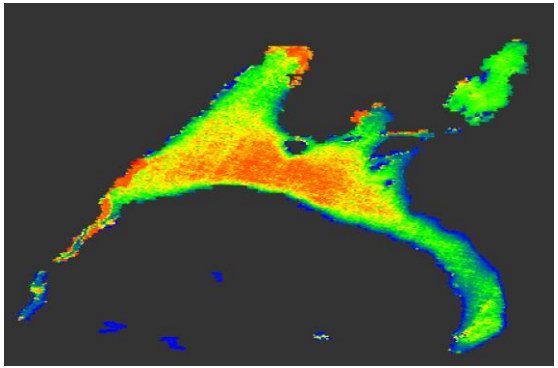


L3 composite, Chl-a, 100 m, 2016-2018

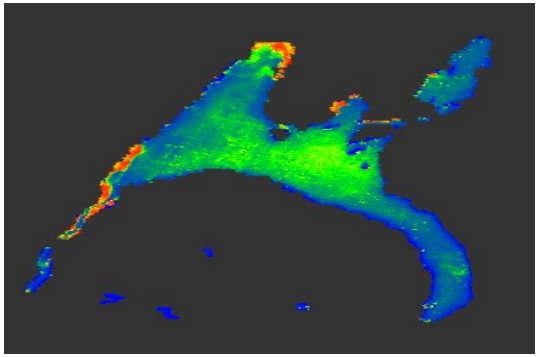
May



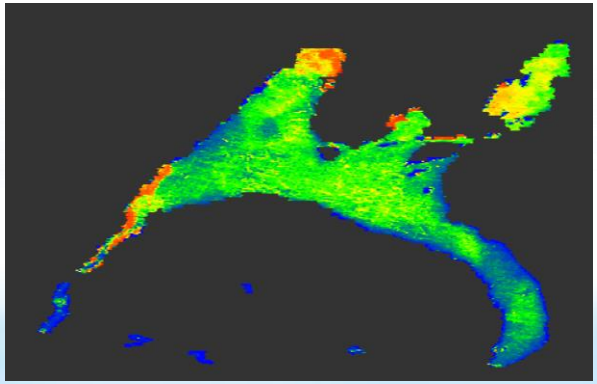
June



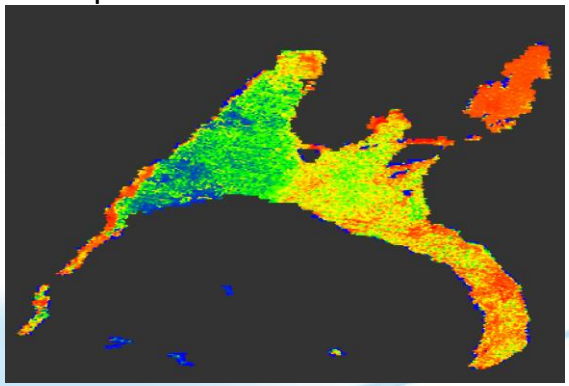
July



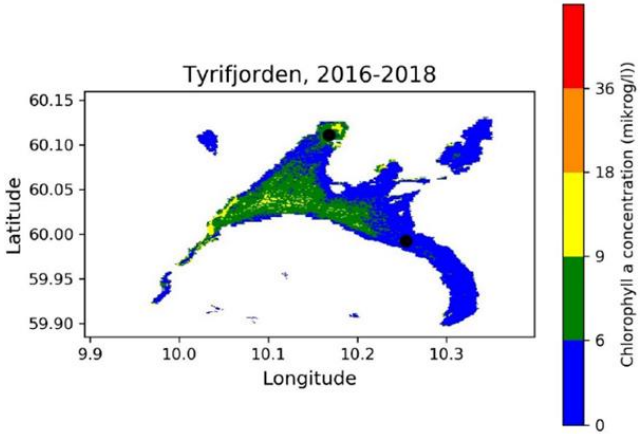
August

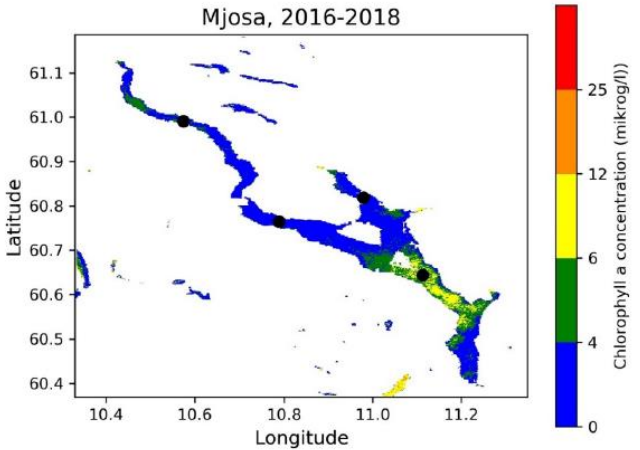


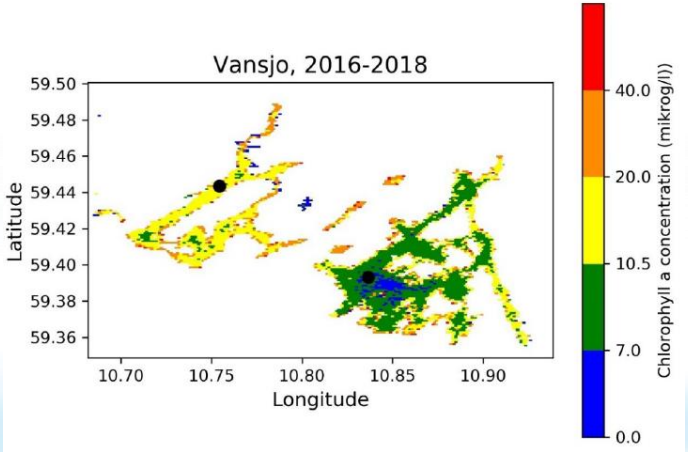
September

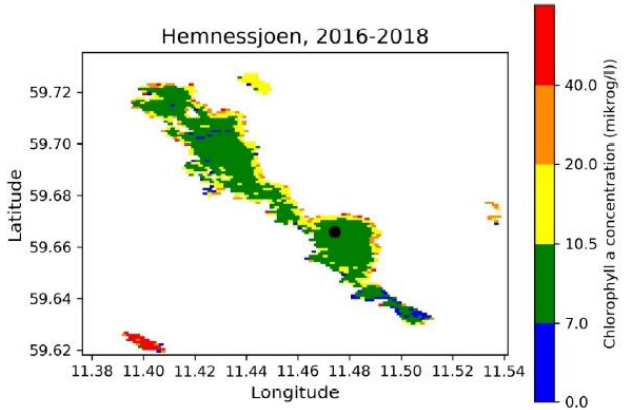


Klassifisering basert på S-2 data fra 2016 til 2018





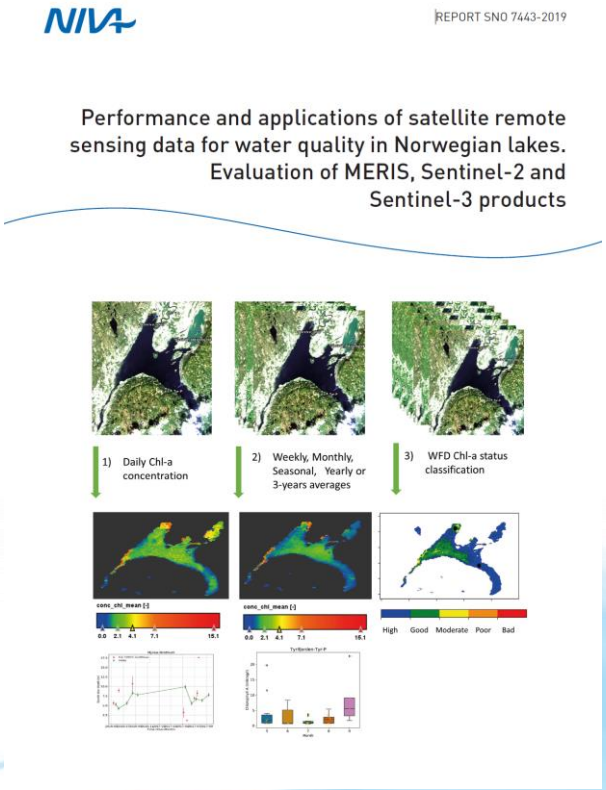




Conclusions and further priorities

- S-2 data can be used for water quality measurements in Norwegian lakes
- RS gives a full coverage of the lakes
- More complementing data than from only in situ measurements (S3 every day and S2 every 2-3 day)
- RS data can be used for the status classification of chl-a to be used for the reporting of the EU Water Framework directive (WFD)

- Currently validations with in situ data for potential adjusting algorithms, including reflectance data
- Future studies/service of harmful algae blooms
- Operational service (pilot developed under DCS4COP)



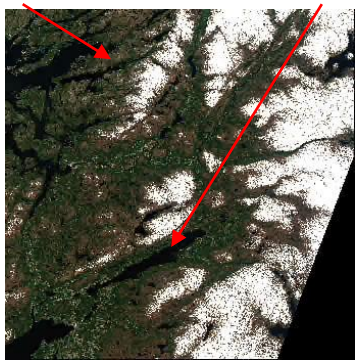

Thank you!

Case studies-2020

- Femunden (clear, northen lake, very shallow)
- Selbusjøen (clear, but relatively high colour, northern lake)
- Gjende (clear, shallow)
- Snåsavatnet (clear, but relatively high colour, northern lake)
- Røssvatnet (clear, northern lake)
- Mjøsa (deep, clear lake)
  - Extra match-up cruises for bio-optics and reflectance data

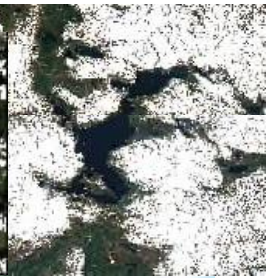
Femunden

Salsvatnet Snåsavatnet



Gjende

Røssvatnet



Mjøsa