Using Sentinel 3 OLCI to monitor dissolved organic carbon in the Lena River

Results from a matchup analysis of 4 years of high-frequency insitu sampling observations with S3 OLCI satellite measurements, 17.02.2022

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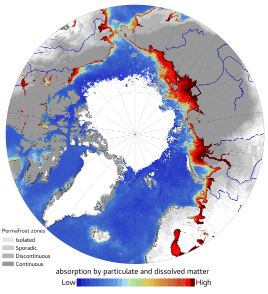
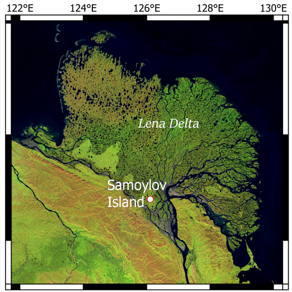
In situ Observations

Lena River

- 7.3 Tg C yr^{-1} dissolved organic carbon (DOC) fluxes (Stedmon et al. 2011[1]) → highest of all arctic rivers
- discharge of arctic rivers is expected to increase and permafrost is degrading
- transport of organic carbon from land to arctic ocean is expected to increase





Sampling Program at Samoylov Island [2]

- 3-4 daily sampling from April 2018 to present
- measured parameters include absorption of chromorphic dissolved organic matter ($a_{CDOM}(254)$, dissolved organic carbon (DOC)
- serves well as validation dataset

[1] Stedmon, C. A., et al. 2011, *Mar. Chem.* 124

[2] Juhls, B., et al. 2020, *Front. Environ. Sci.*

a_{CDOM} and DOC from Polymer corrected S3 OLCI Observations

Spatial and Temporal Collocation of S3-OLCI Spectra

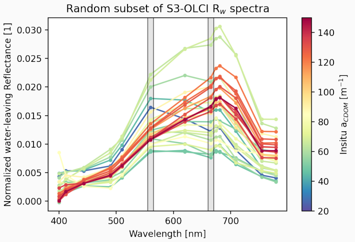
- water-leaving reflectances were calculated using Polymer v4.13[3]
- ≈47% of all ice-free days
- 729 scenes, 1841400 valid pixels within 10 km diameter around Samoylov

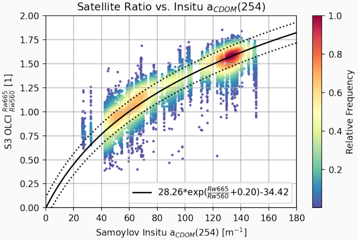
Reflectance → $a_{CDOM\,SAT}$

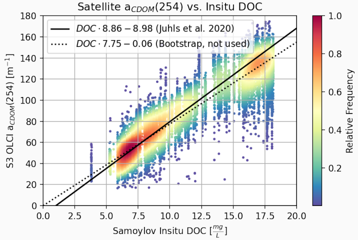
- bootstrap with 8000 samples (≈5%) with repetition
- best correlation with a_{CDOM}: $\frac{Rw(665)}{Rw(560)}$ (r^2=0.89)
- $a_{CDOM\,SAT} = a * e^{(\frac{Rw665}{Rw560}+b)} + c$

$a_{CDOM\,SAT}$ → DOC_{SAT}

- Linear relationship between $a_{CDOM\,SAT}$ and Insitu DOC
- a_{CDOM}-DOC conversion taken from Juhls et al. 2020[4]



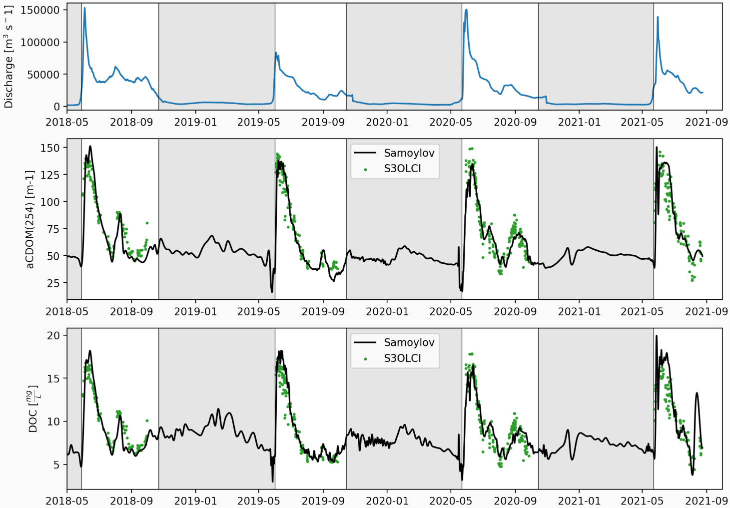


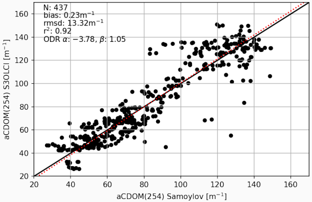


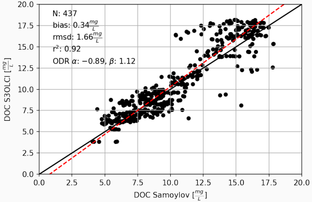
[1] Steinmetz, F., et al. 2011, *Opt. Expr.*

[2] Juhls, B., et al. 2020, *Front. Environ. Sci.*

Results: Time Series of Satellite Retrieved

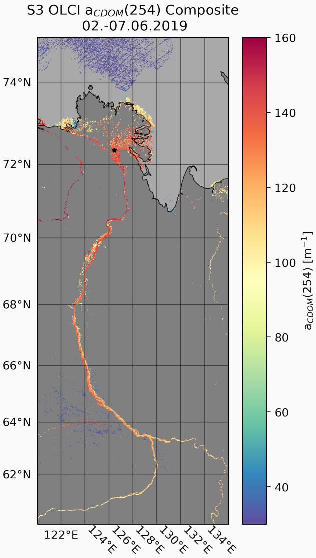


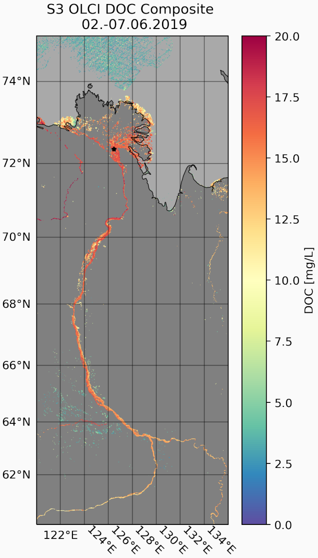




Overall good agreement!

Application: 3-Day Full River Composite





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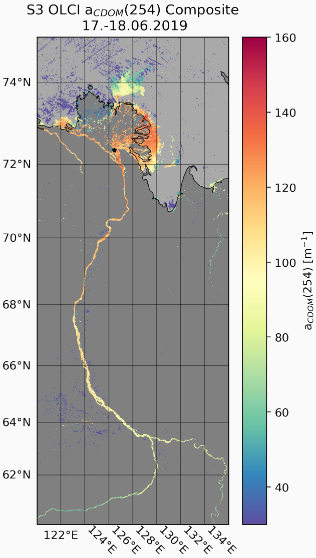

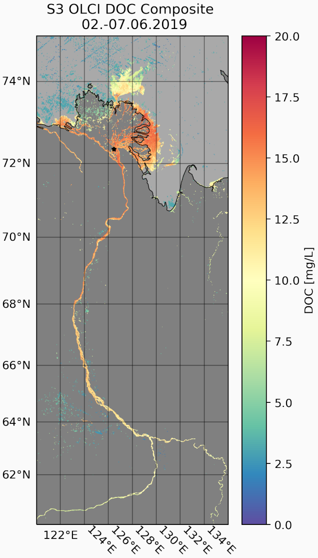

Conclusion/Outlook

Conclusions

- simple curve-fit algorithm: good results but some residual errors
- bootstrapping yields uncertainty estimates for curve-fits

Challenges

- in some cases Rw(665)/Rw(560) vs. $a_{CDOM}insitu$ deviates outside 1σ of bootstrap
- in presence of high sediment loading a_{CDOM}, DOC show larger deviations
- identify further sources of uncertainty

Outlook

- further work: extensive comparison against other algorithms
  - first results indicate curve-fit performs better (i.e. GSMA, ONNS)

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Knowledge Gaps and Priorities

1 year

- try other atmospheric corrections and/or retrievals
- validation/comparison against other retrievals, other reference data sets, other rivers
- identification of further impact factors on satellite spectra (apart from differential absorption of CDOM)

5 years

- similar high-frequency sampling on other rivers
- use available satellite observations to complement ground-based measurements, identify individual upstream sources of DOC
- extend retrieval, e.g. through utilisation of optimal estimation, bio-optical models, etc.
- use existing hyperspectral sensors

10 years

- new multispectral sensors:
  - spectral resolution of S3-OLCI
  - spatial resolution of S2-MSI
  - multispectral has superior SNR
- or even hyperspectral
- or use of LIDARs