PROGRAMME OF THE EUROPEAN UNION

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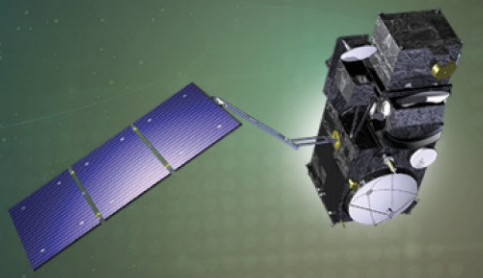


7th Sentinel-3 Validation Team Meeting 2022

18-20 October 2022 | ESA-ESRIN | Frascati (Rm), Italy

Validation of OLCI L2 Collection 3 water products and comparison with C2RCC over coastal and inland waters

Carole Lebreton[a], Kerstin Stelzer[a], Jorrit Scholze[a], Dagmar Müller[a], Petra Philipson[b]

[a]Brockmann Consult, [b]Brockmann Geomatics

Short overview: C2RCC provides IOPs and mass concentrations

rho_w → **neural net** trained on simulations → **IOPs** → concentrations derived from **in-situ relationships** → conc.

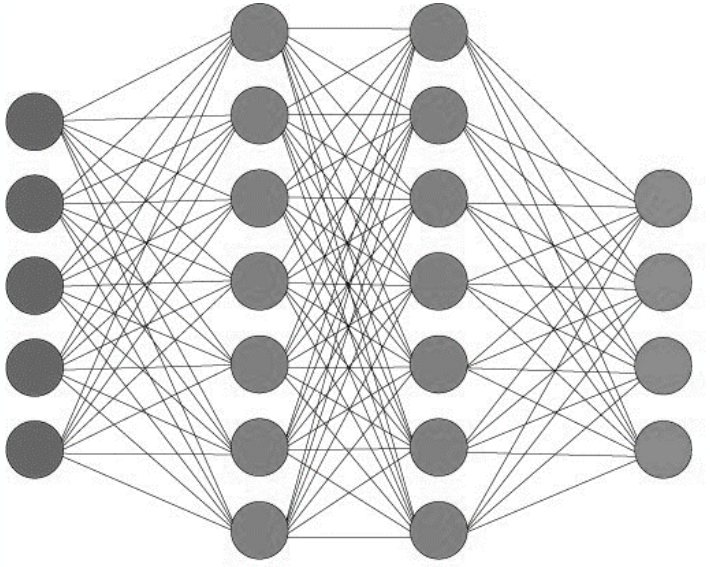
uncertainties: representativity of SIOPs, model error, neural net training error

uncertainties: natural variability, fit error

reflectances corrected for gaseous absorption

sun and observation angles

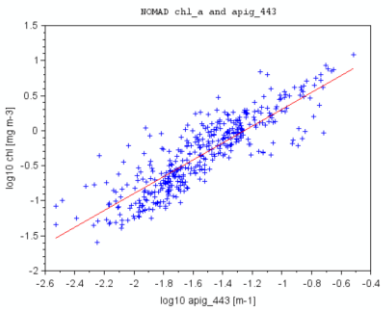
Surface pressure



a_{pig}

a_{gelb} , $a_{detritus}$

b_p , b_{white}



CHL_NN

ADG443_NN

TSM_NN

- Available internally in IPF
- Output in SNAP

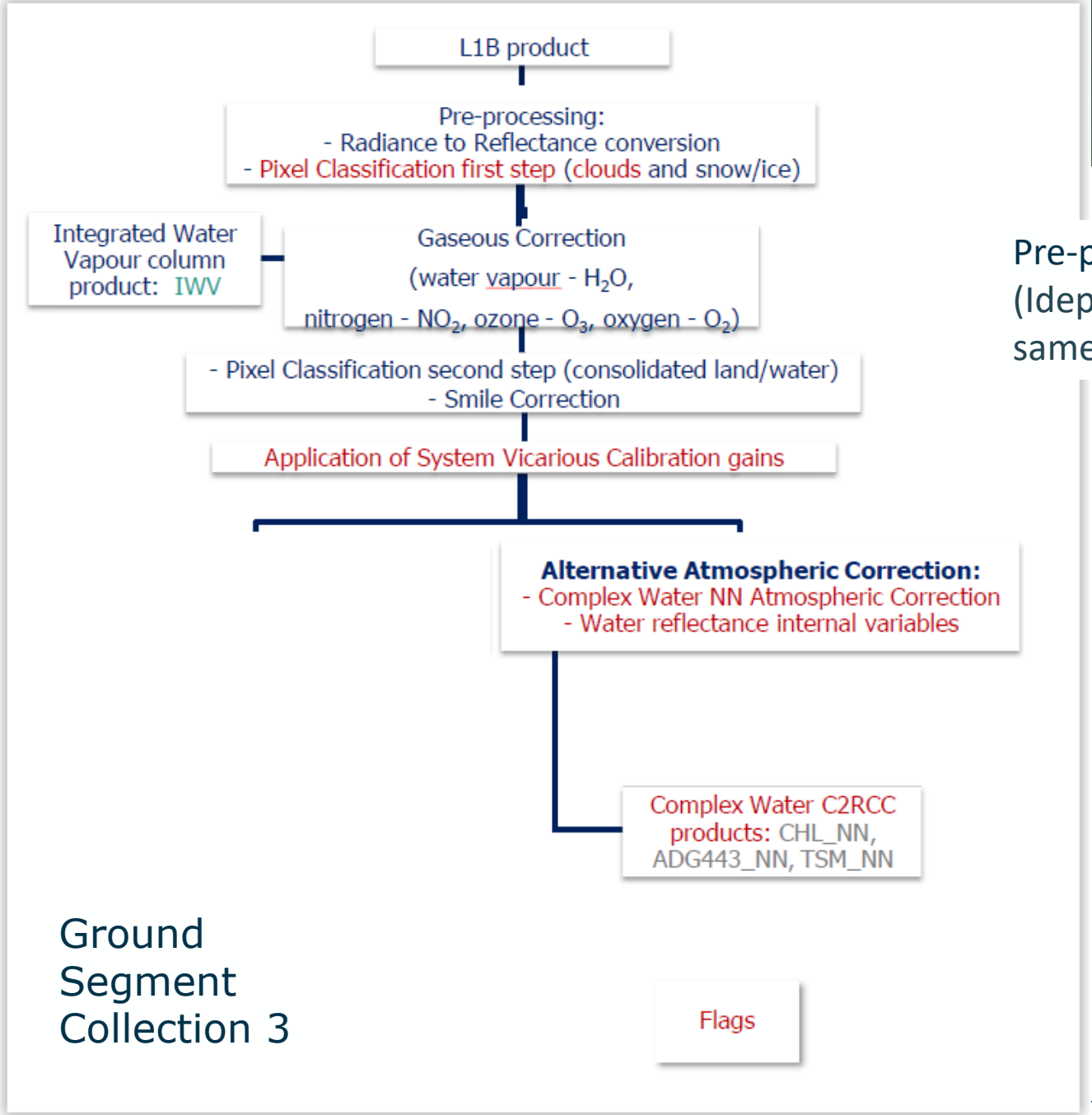
consistency !

- Available in L2 product
- Output in SNAP

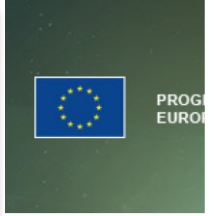
C2RCC in SNAP = AAC in IPF

C2RCC v2: SNAP 9 (and 8) default net & implemented in OLCI IPF (Collection 3)

- Bio-optical model - New exponent for ad spectrum (detritus)
- Extended training range and co-variance ranges
  - → Better coverage of specifically high backscatter water (river estuaries and lakes)
- Forward modelling → combination procedure for Hydrolight and CC atmosphere model
- Improved training sample and training process
  - Larger number of samples
  - noise in training data set and NN architecture combined to optimize noise reduction and overshooting of NNs (interpolation)
- → reduced noise in results
- → more plausible values specifically in open ocean waters



Ground Segment Collection 3

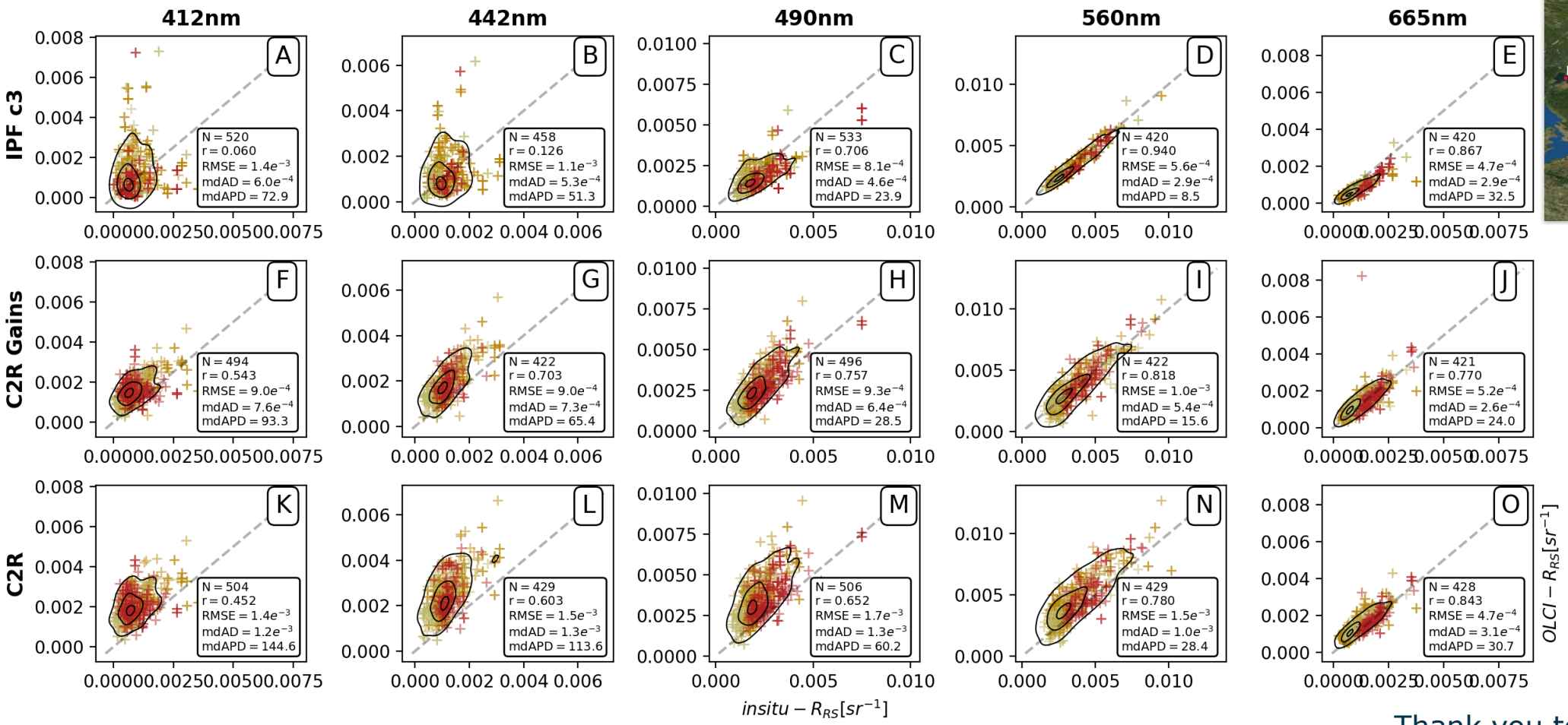


SNAP

Matchup procedure

- Remote sensing reflectances at AERONET-OC stations:
  - 5x5, with 1.5 std outlier removal and minimum of 13 valid pixels, +/- 3 hours, CV 20% based on 560 nm band
  - Median Absolute Deviation and Median Absolute Percentage Deviation
  - IPF: WQSF_lsb.CLOUD, WQSF_lsb.CLOUD_AMBIGUOUS , WQSF_lsb.CLOUD_MARGIN, WQSF_lsb.INVALID, WQSF_lsb.COSMETIC, WQSF_lsb.SATURATED, WQSF_lsb.SUSPECT, WQSF_lsb.HISOLZEN, WQSF_lsb.HIGHGLINT, WQSF_lsb.SNOW_ICE, WQSF_lsb.AC_FAIL, WQSF_lsb.WHITECAPS, WQSF_lsb.ADJAC, WQSF_lsb.OC4ME_FAIL, WQSF_msb.RWNEG_XX
  - C2RCC: pixel_classif_flags.IDEPIX_CLOUD, pixel_classif_flags.IDEPIX_CLOUD_BUFFER, pixel_classif_flags.IDEPIX_CLOUD_SHADOW, pixel_classif_flags.IDEPIX_SNOW_ICE, c2rcc_flags.Rhow_OOR, c2rcc_flags.Rtosa_OOR
- Chlorophyll in lakes:
  - 3x3 with 1.5 std outlier removal and minimum of 5 valid pixels, +/- 3 hours
  - Mean absolute Deviation and Mean Absolute Percentage Deviation
  - IPF: WQSF_lsb.CLOUD, WQSF_lsb.CLOUD_AMBIGUOUS , WQSF_lsb.CLOUD_MARGIN, WQSF_lsb.INVALID, WQSF_lsb.COSMETIC, WQSF_lsb.SATURATED, WQSF_lsb.SUSPECT, WQSF_lsb.HISOLZEN, WQSF_lsb.HIGHGLINT, WQSF_lsb.SNOW_ICE, WQSF_lsb.OCNN_FAIL
  - C2RCC: pixel_classif_flags.IDEPIX_CLOUD, pixel_classif_flags.IDEPIX_CLOUD_AMBIGUOUS, pixel_classif_flags.IDEPIX_CLOUD_BUFFER, pixel_classif_flags.IDEPIX_CLOUD_SHADOW, pixel_classif_flags.IDEPIX_SNOW_ICE, c2rcc_flags.Rhow_OOR, c2rcc_flags.Rtosa_OOR, c2rcc_flags.Cloud_risk, (c2rcc_flags.Rtosa_OOS and conc_chl<1)

Rrs matchups at Gustav Dalen (GDT), Helsinki Lighthouse (HLH), and Palgrunden (PAL)



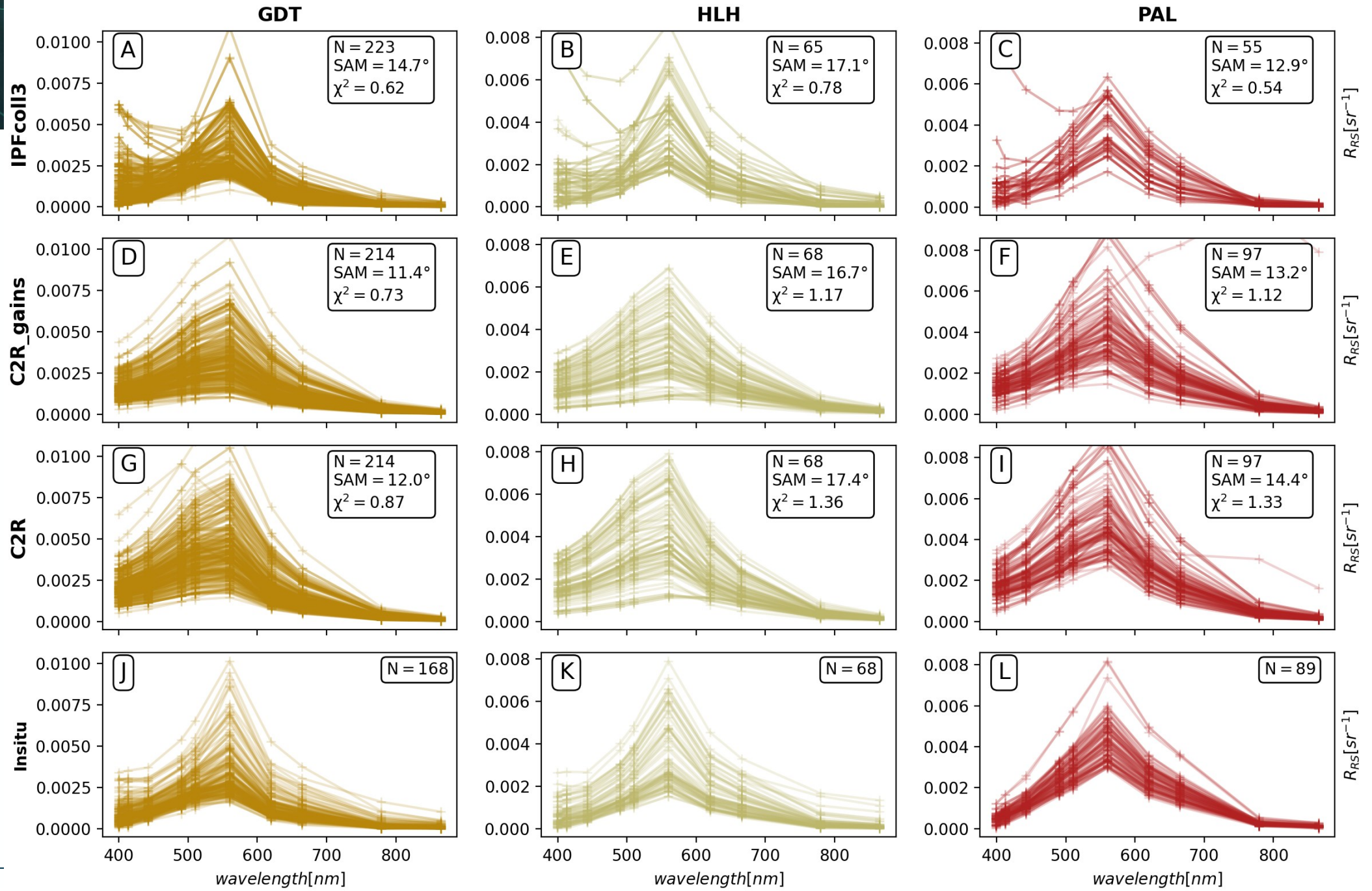
Thank you to the Aeronet-OC PIs for providing the in situ data!

Collection 3

C2RCC gains

C2RCC no gains

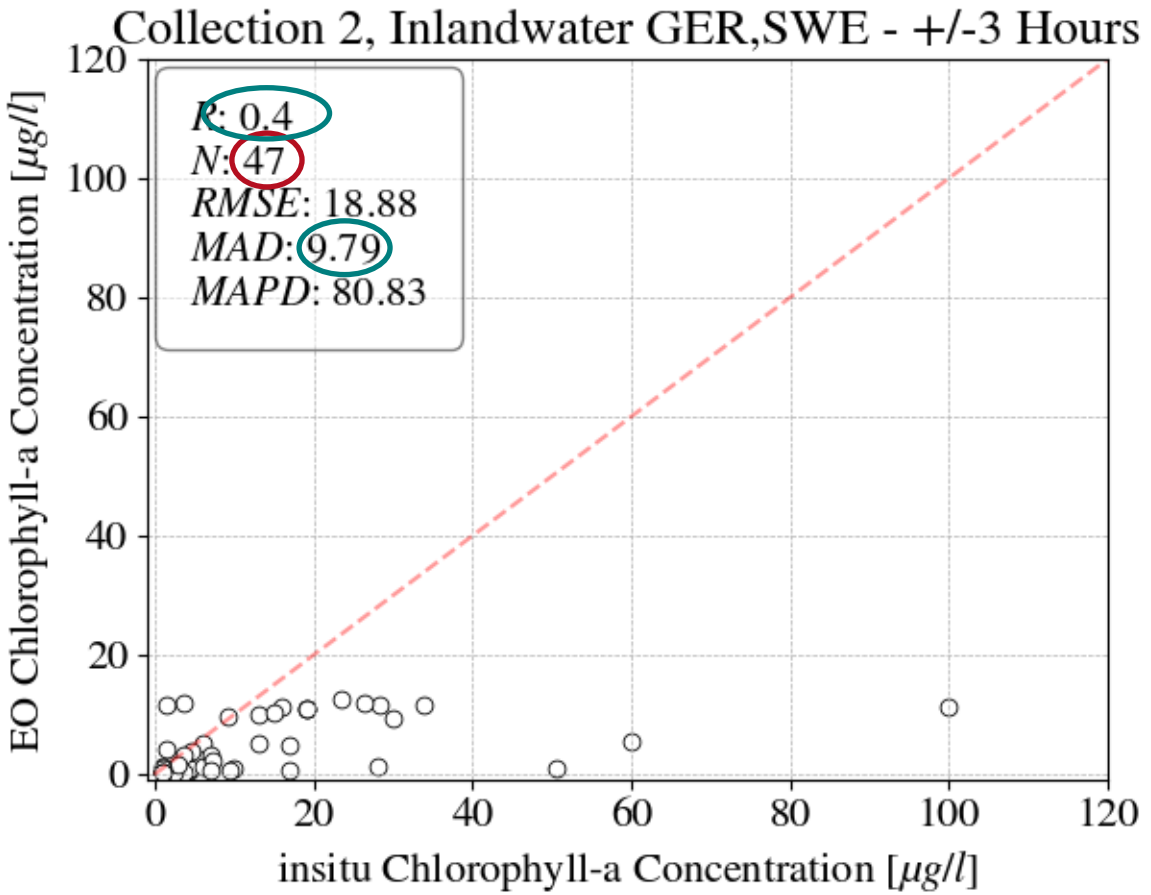
AERONET-OC

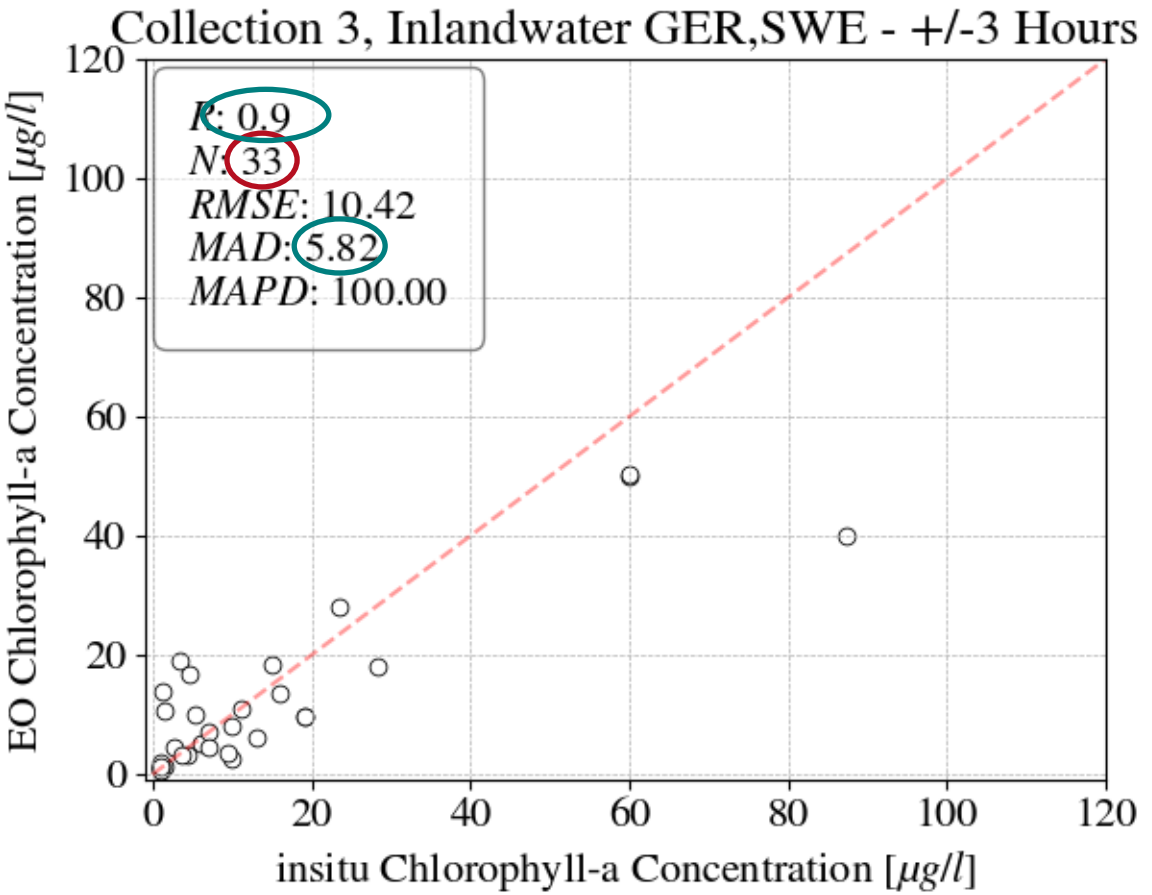


Validations Stations over inland waters

165 stations in lakes going along a low to high chlorophyll spectrum, as well as ranging from clear to brown (high CDOM) waters

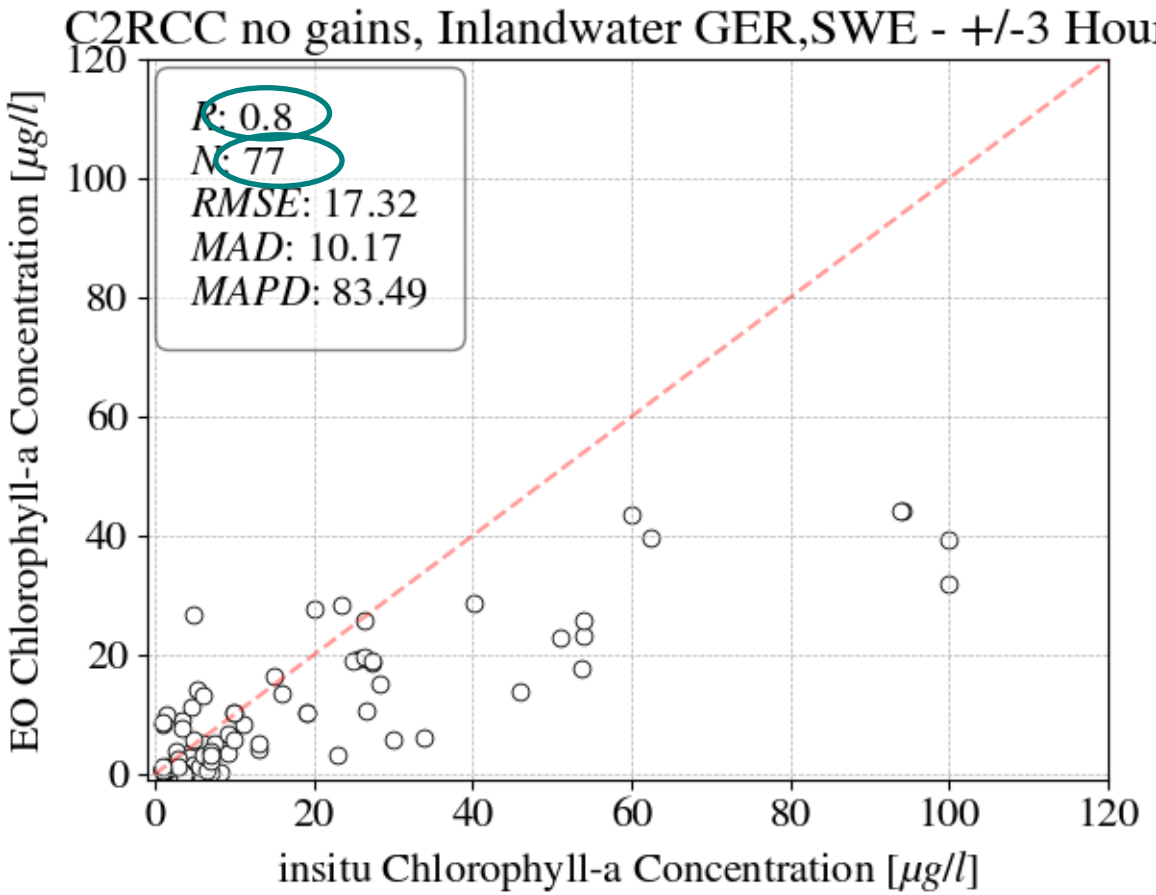
Scatter Plots CHL_NN Collection 2 (left) compared to CHL_NN AAC Collection 3 (right)

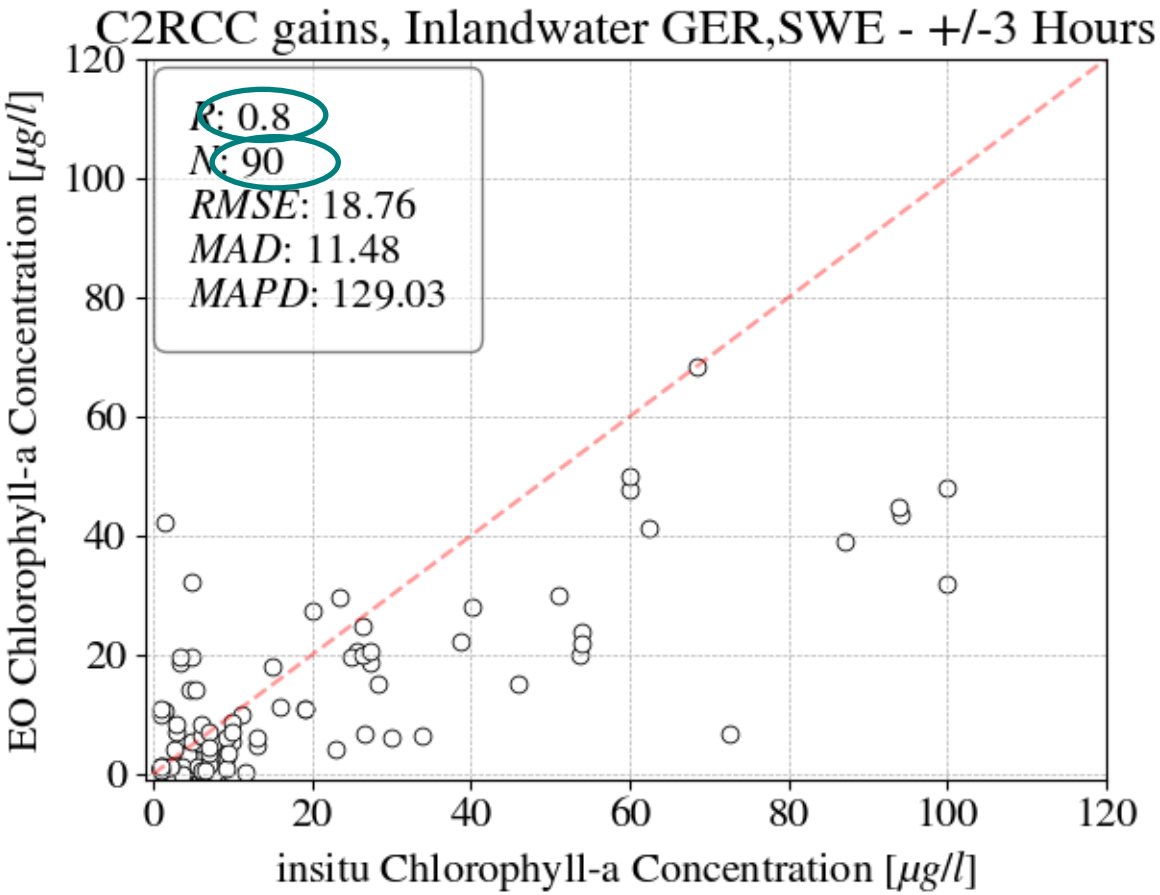




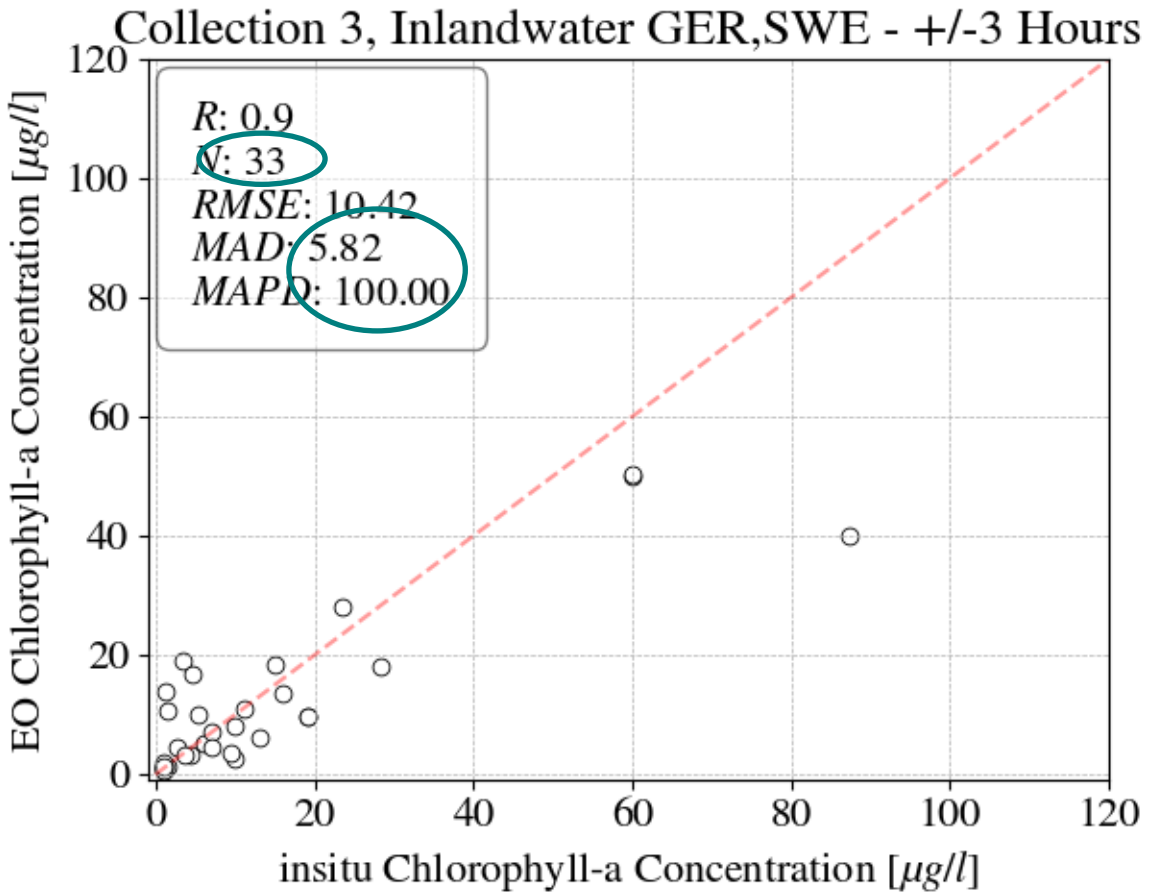
Loss of valid data but large improvement in statistics

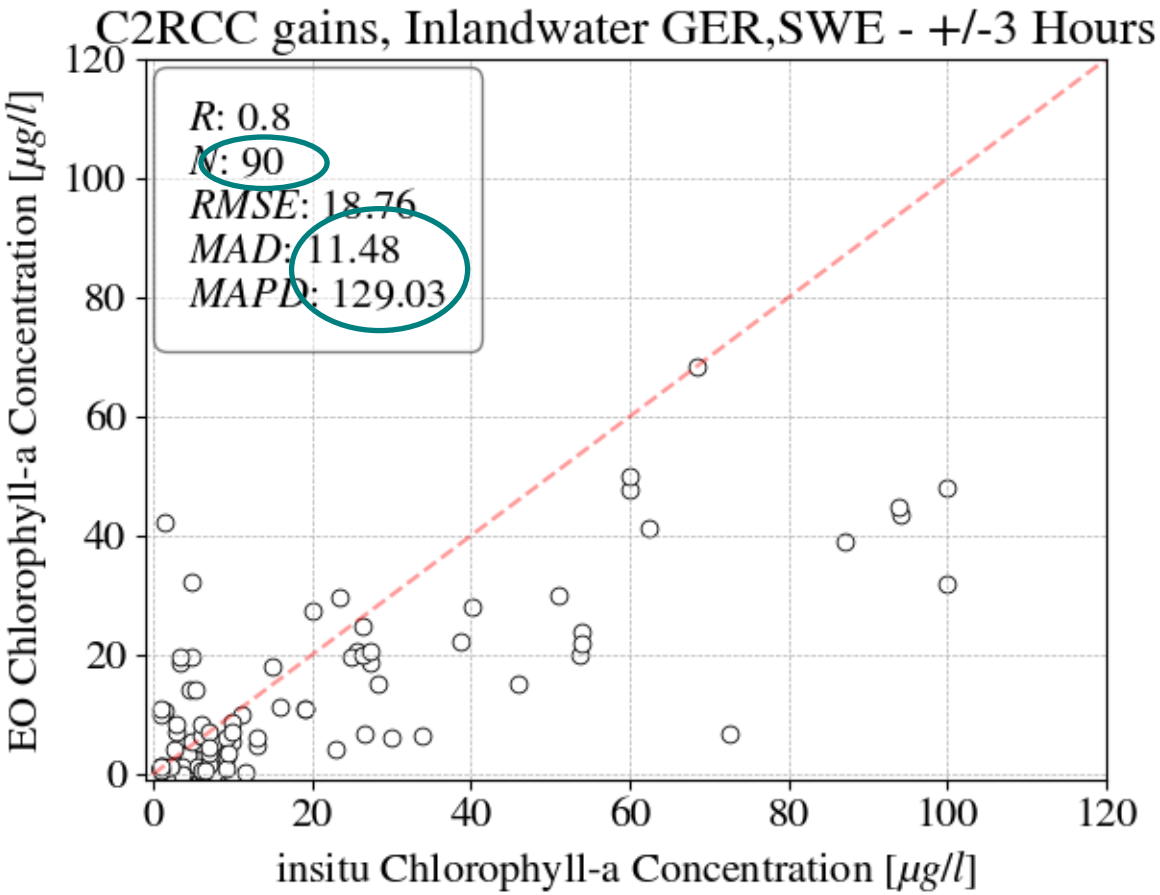
Scatter Plots C2RCC no gains 2 (left) compared to C2RCC gains (right)





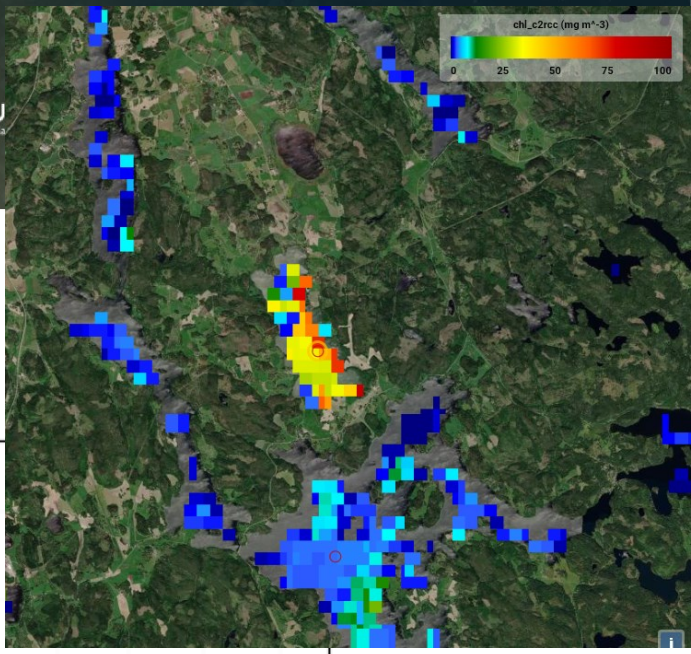
Comparison between CHL_NN Collection 3 (left) and C2RCC gains (right)

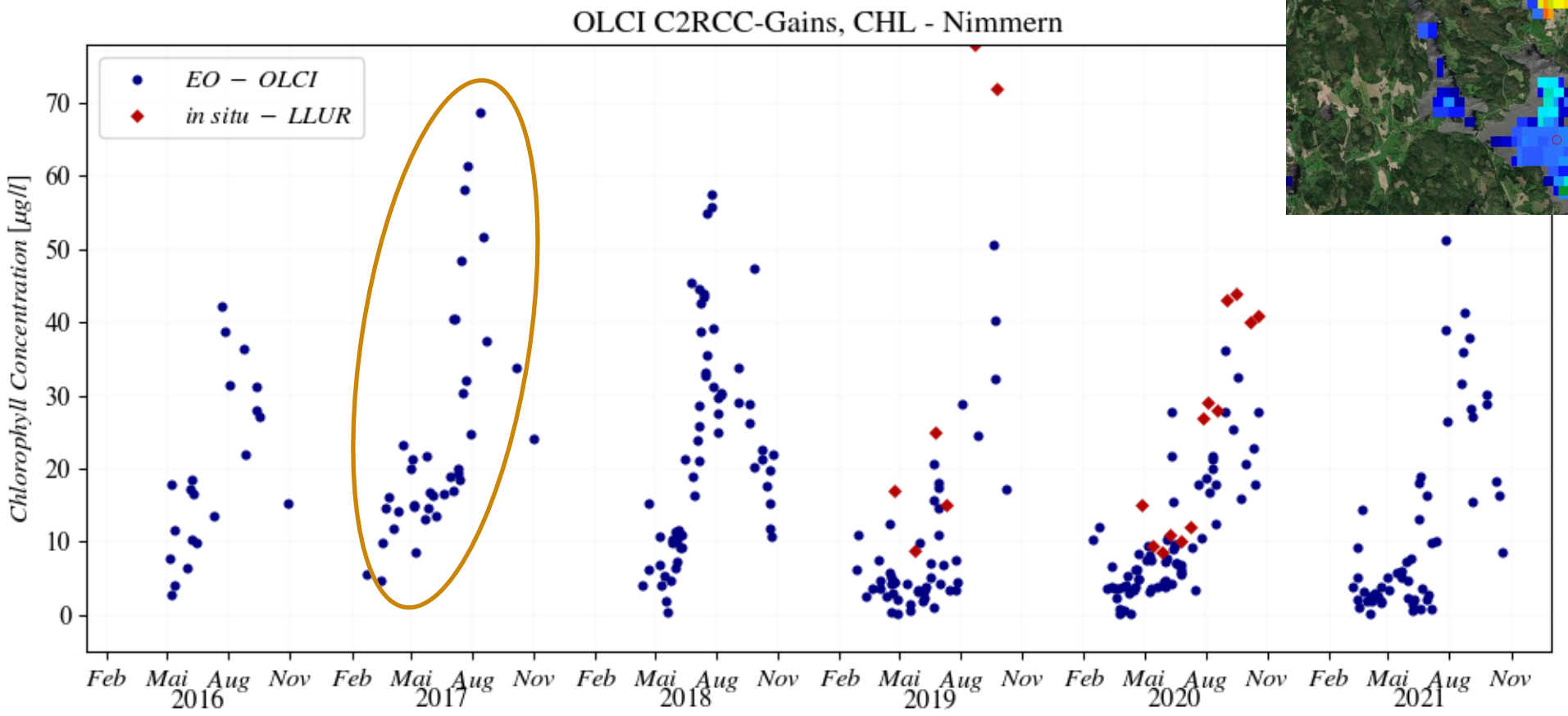




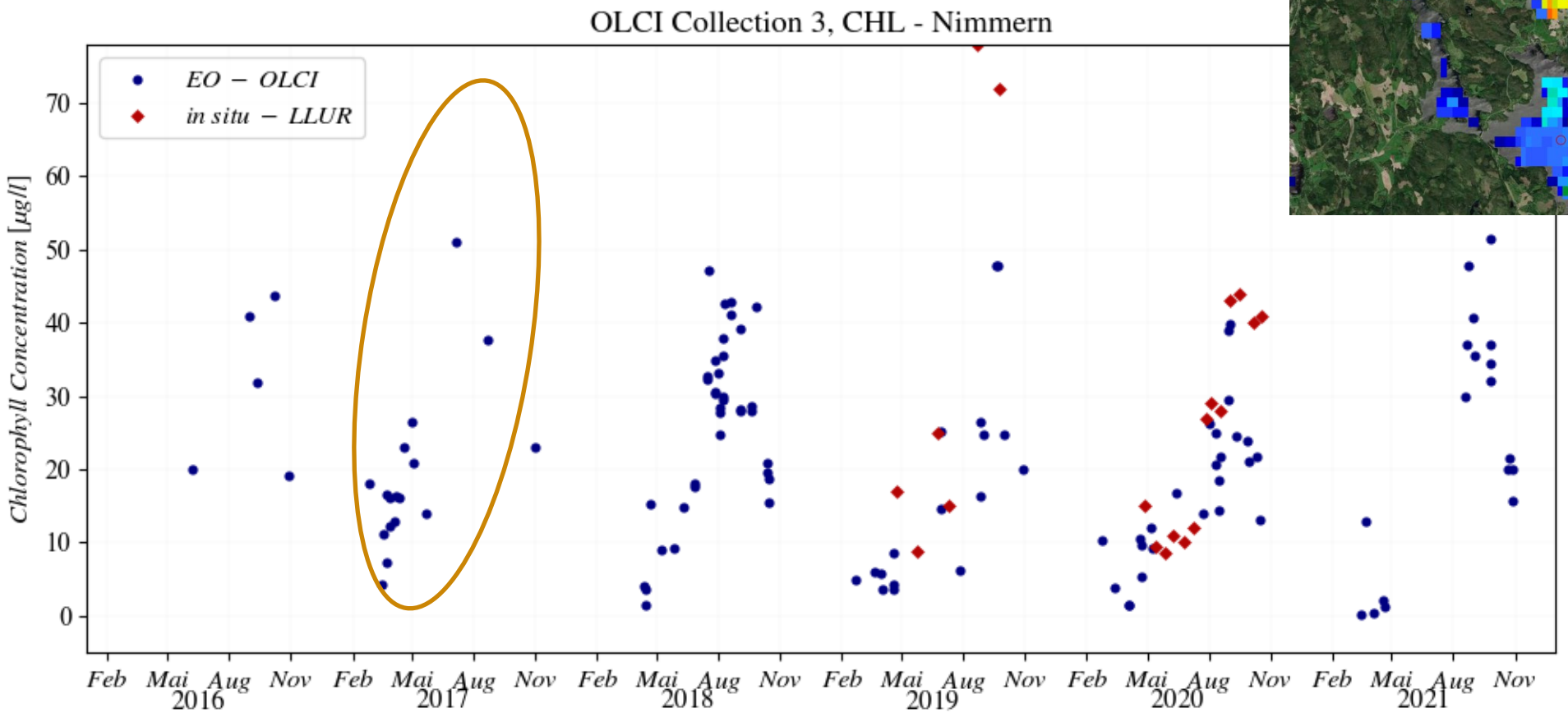
→ Different matchup numbers (different flagging applied) 3x less for Collection 3 but statistics comparatively less different

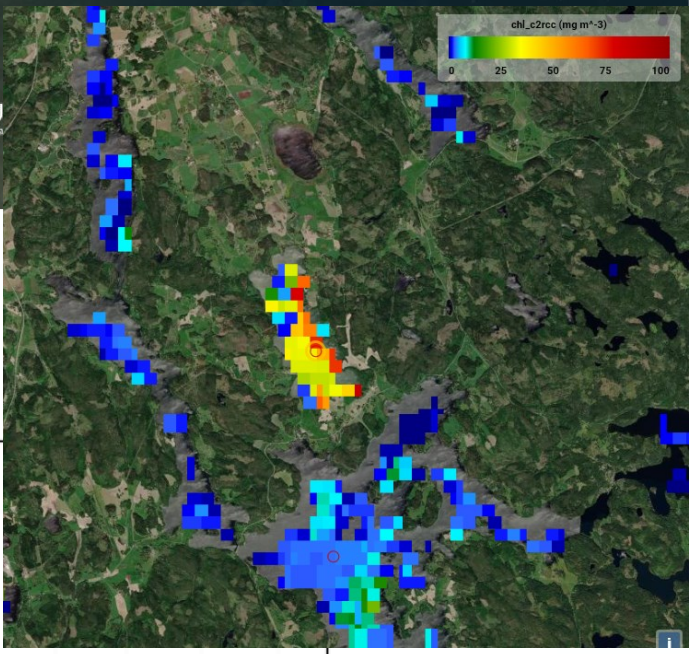
Timeseries Comparisons – C2RCC gains



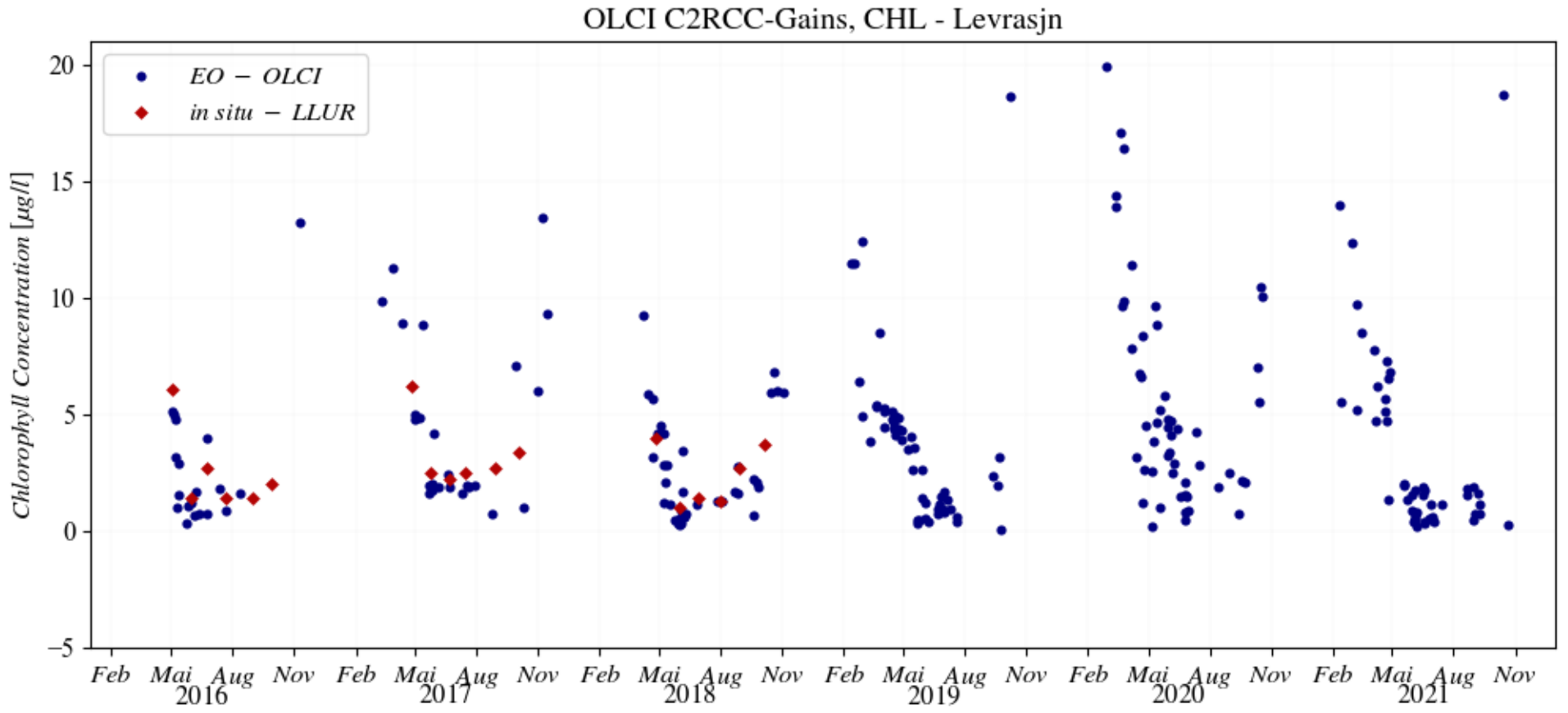


Timeseries Comparisons – CHL_NN Collection 3

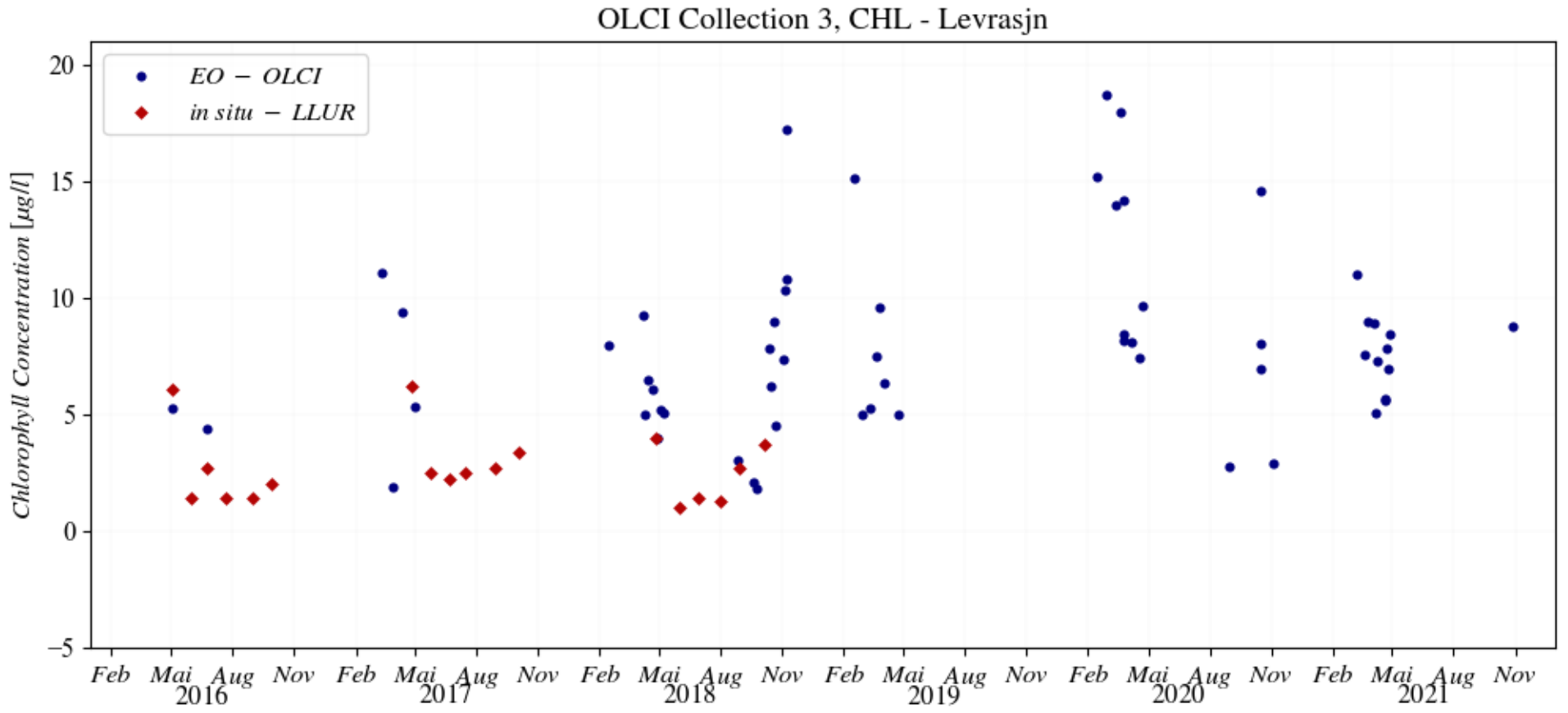




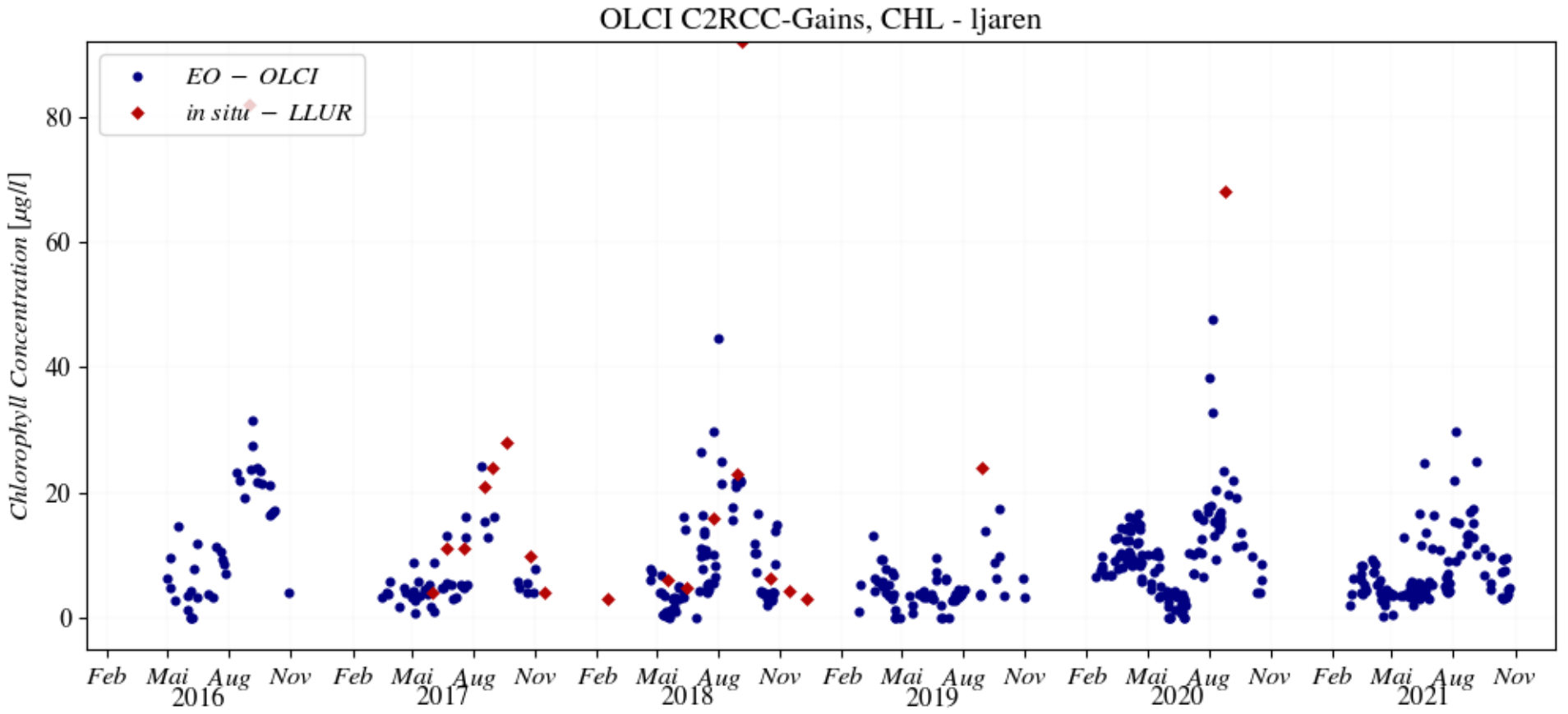
Timeseries Comparisons – C2RCC gains



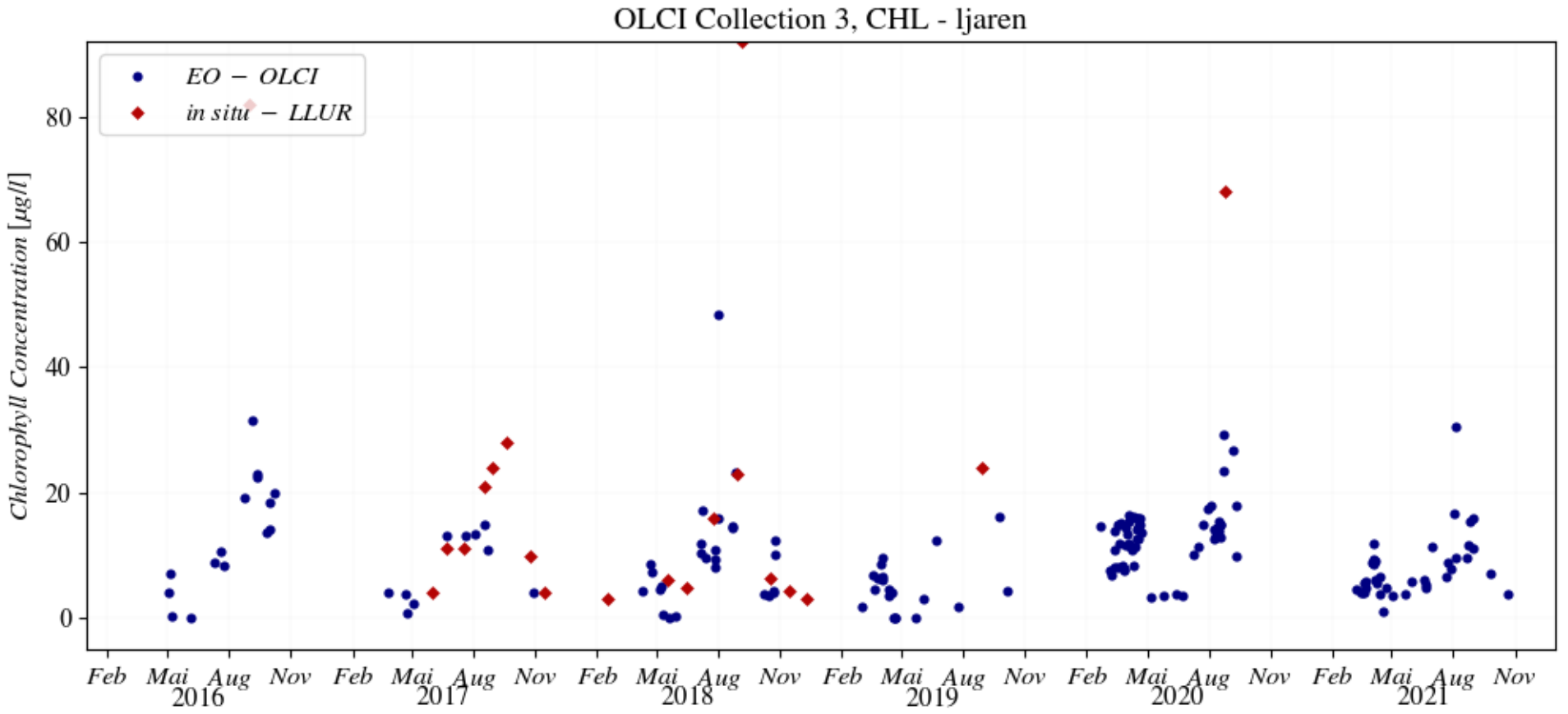
Timeseries Comparisons – CHL_NN Collection 3



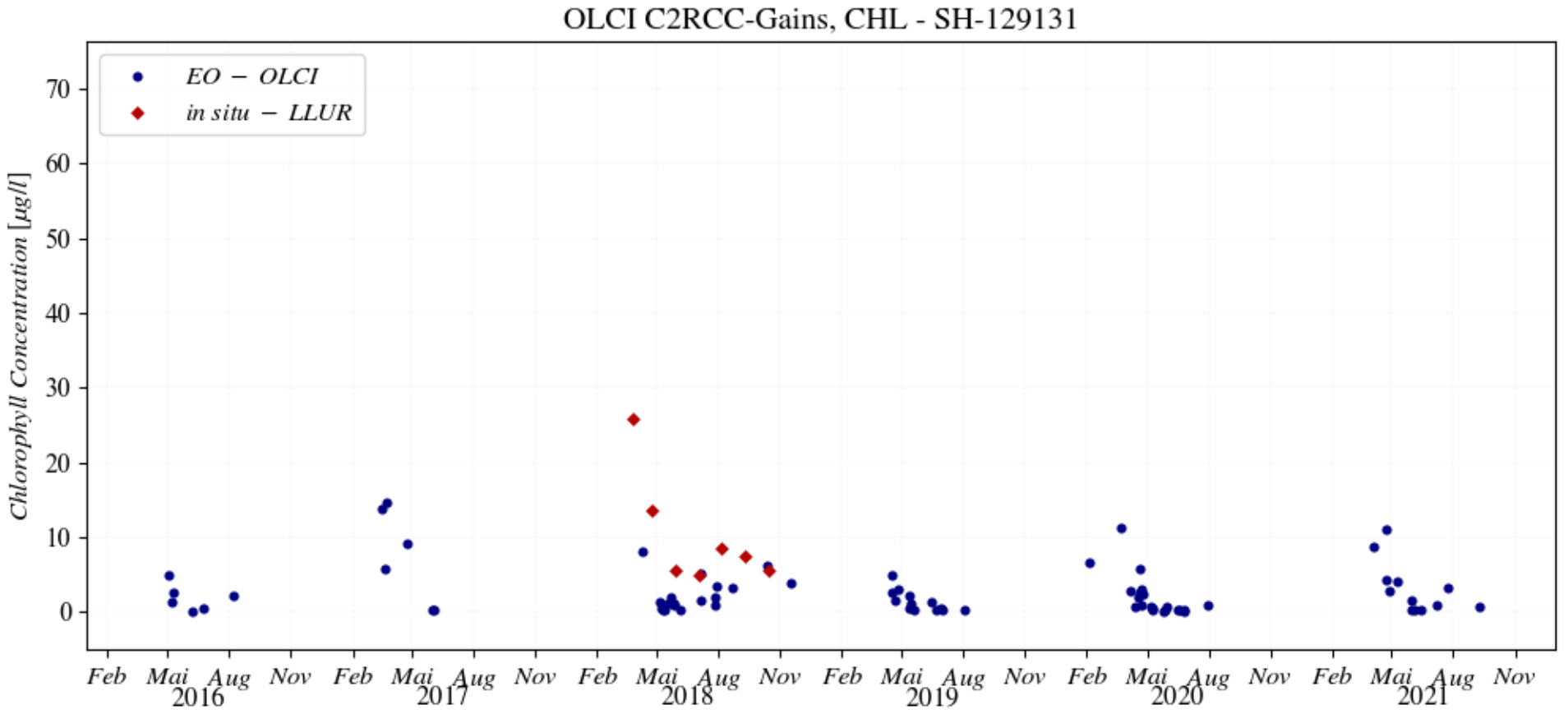
Timeseries Comparisons – C2RCC gains



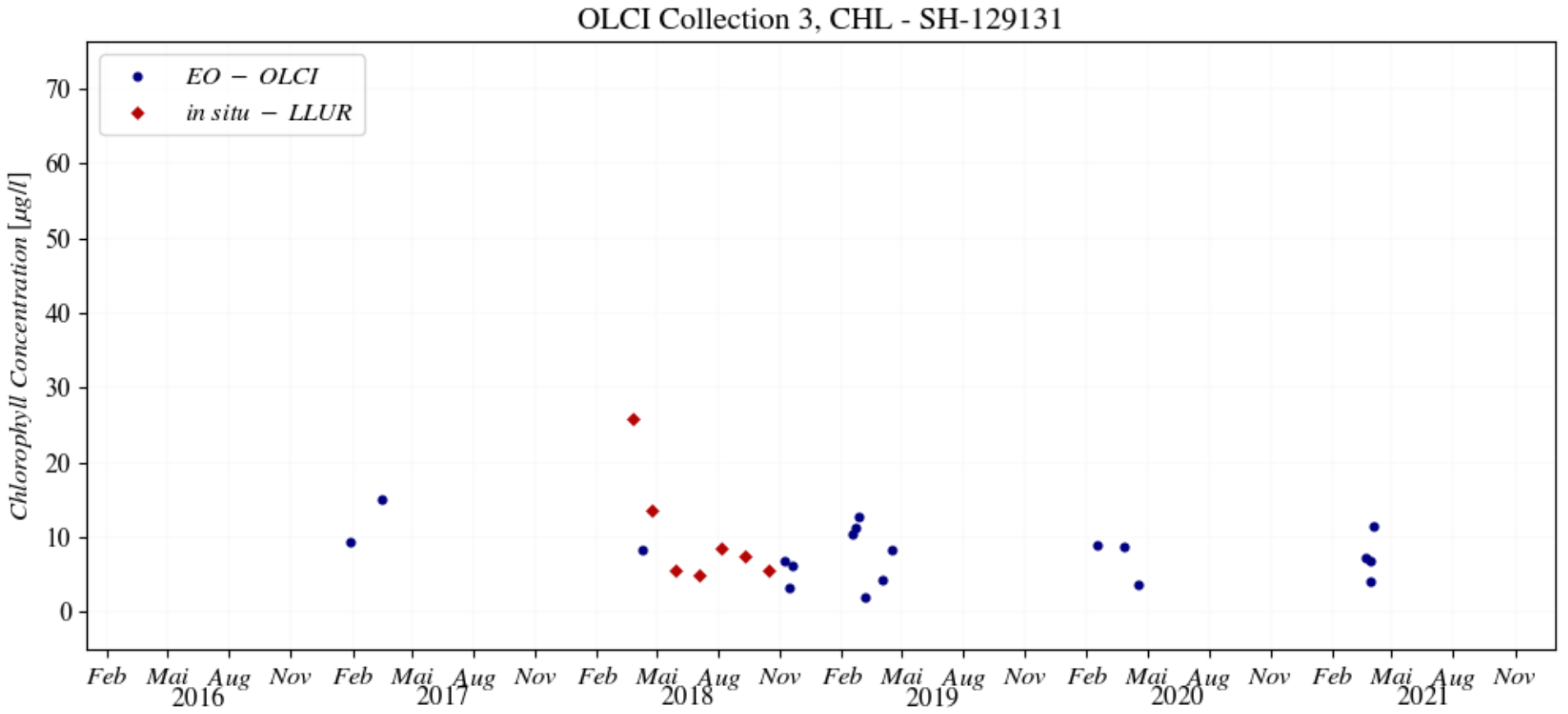
Timeseries Comparisons – CHL_NN Collection 3



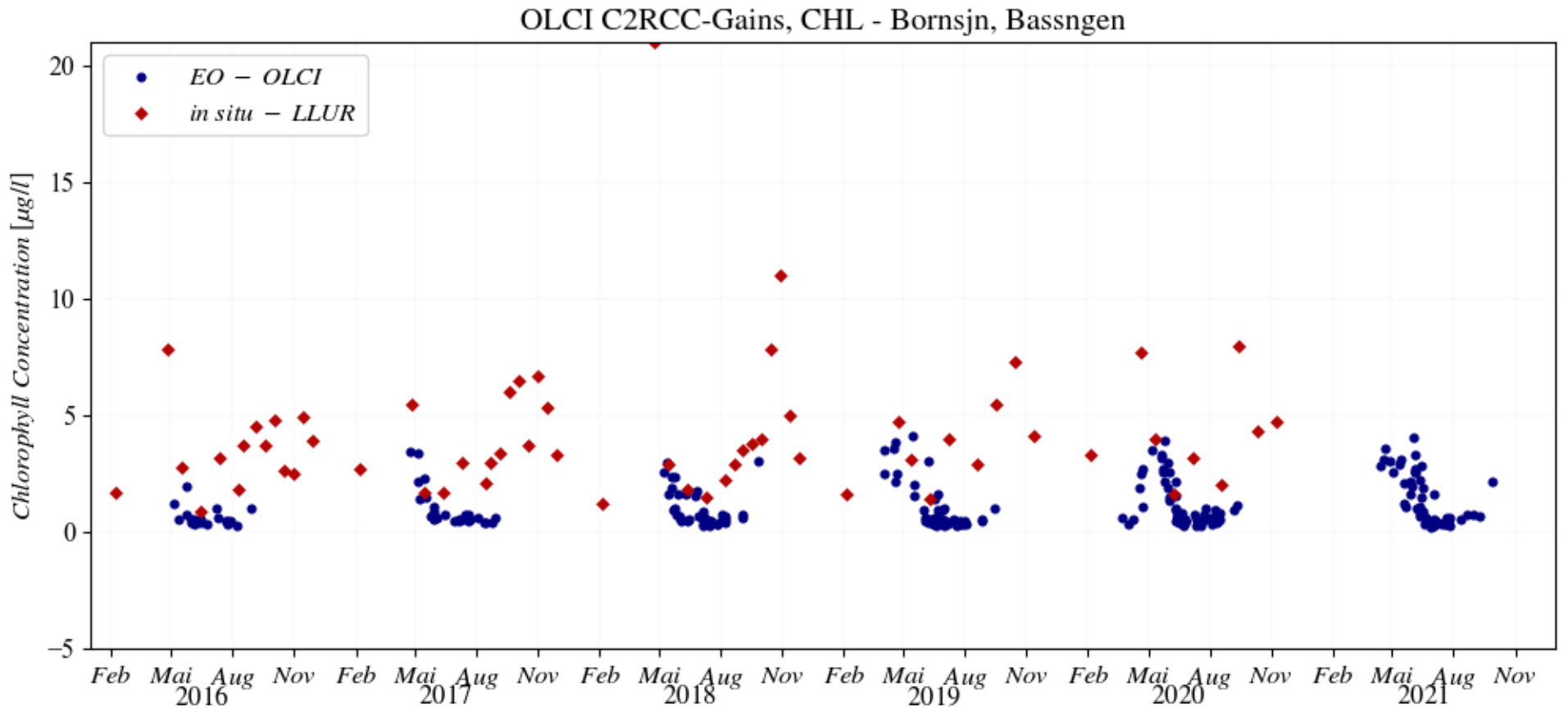
Timeseries Comparisons – C2RCC gains



Timeseries Comparisons – CHL_NN Collection 3



Timeseries Comparisons – C2RCC gains

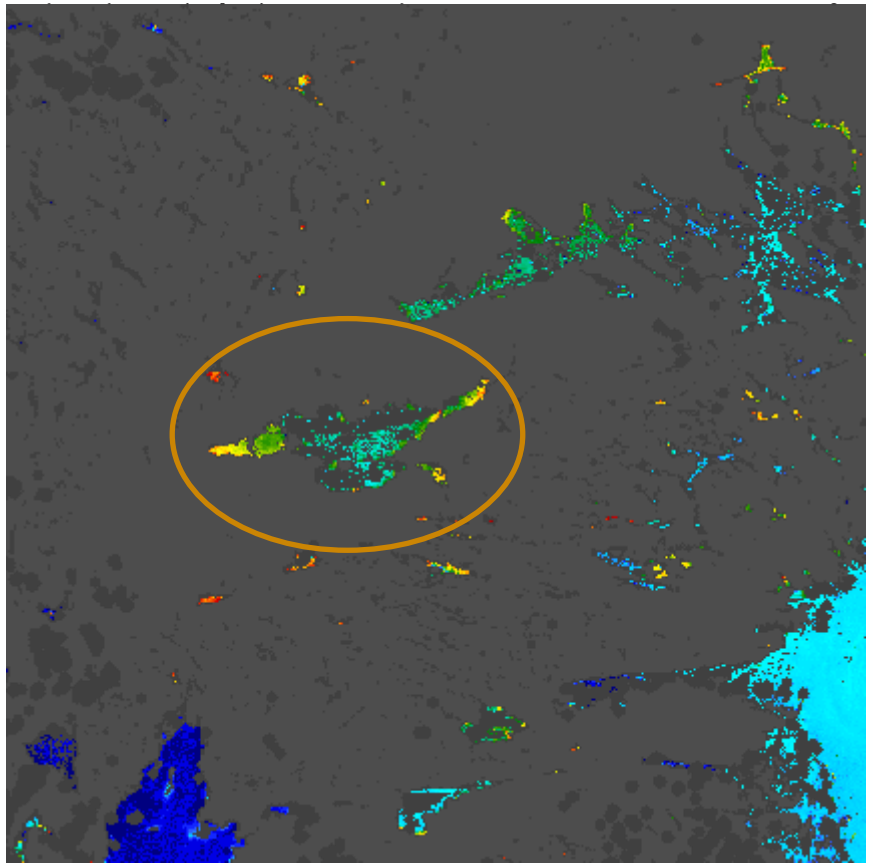


RGB

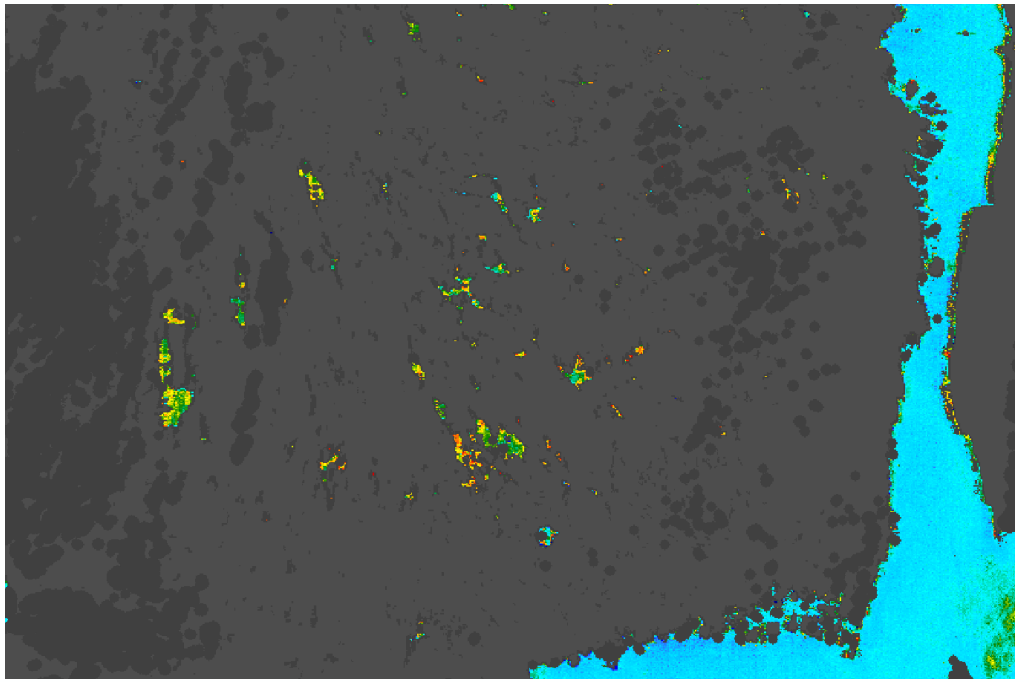
19.08.2020

22.09.2022

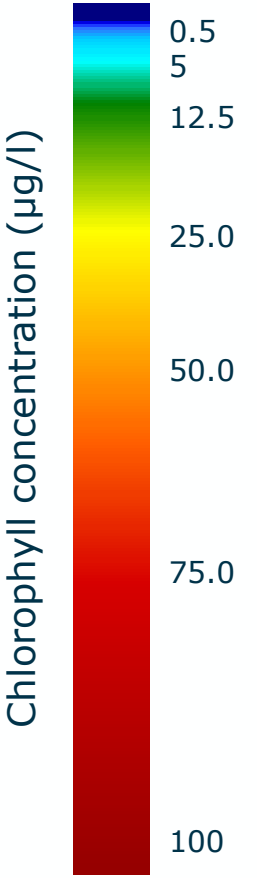
CHL_NN Coll3



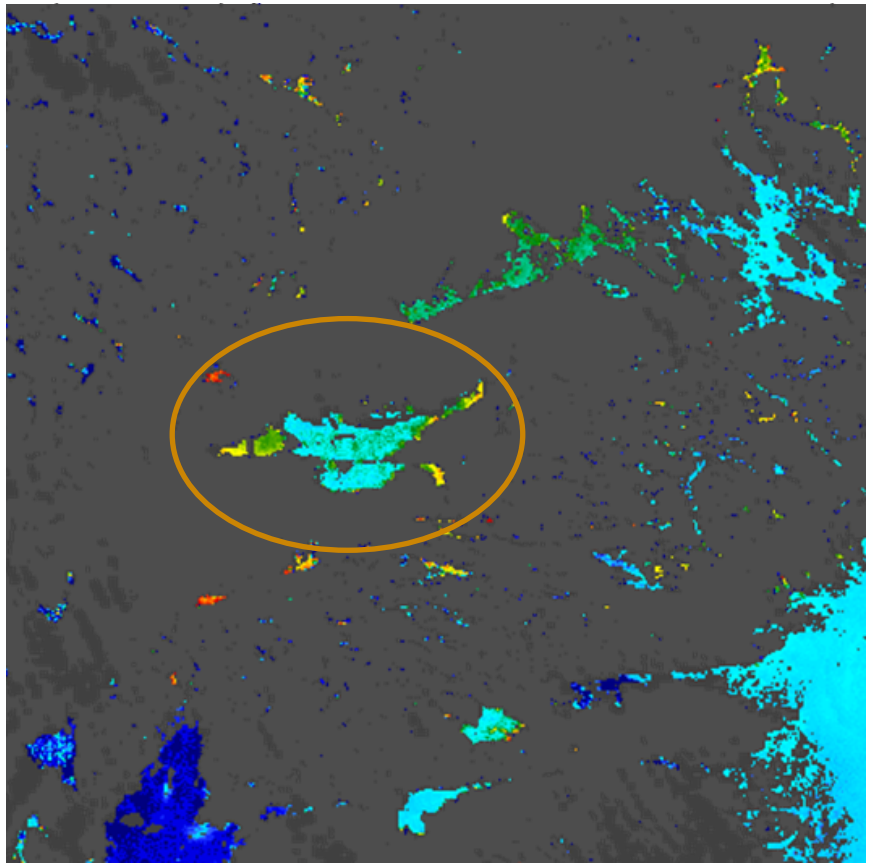
19.08.2020



22.09.2022



CHL C2RCC gains



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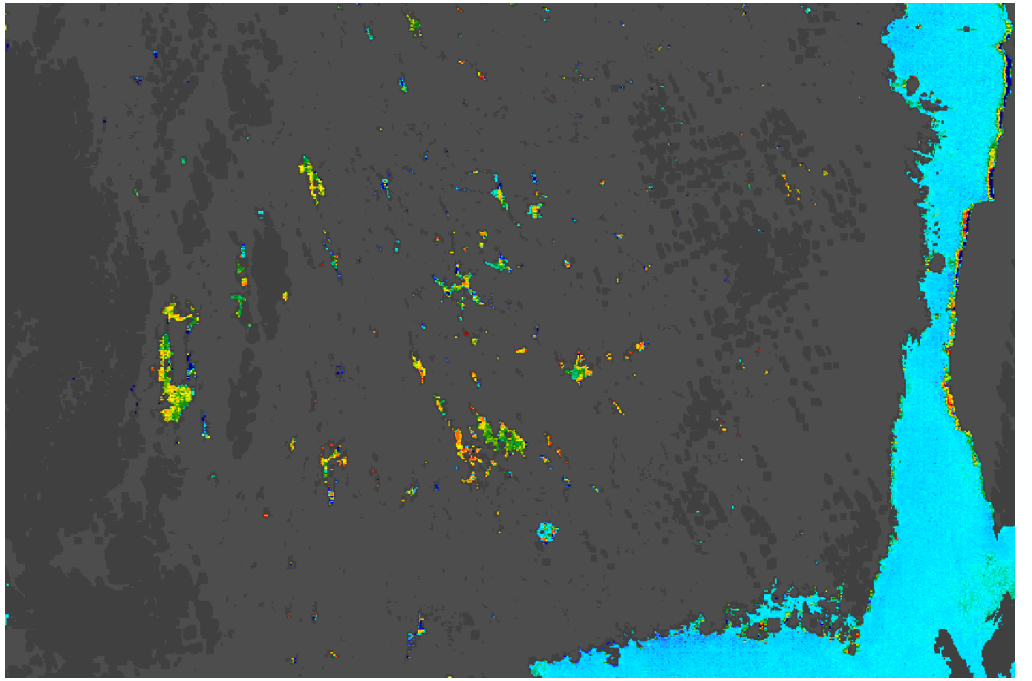
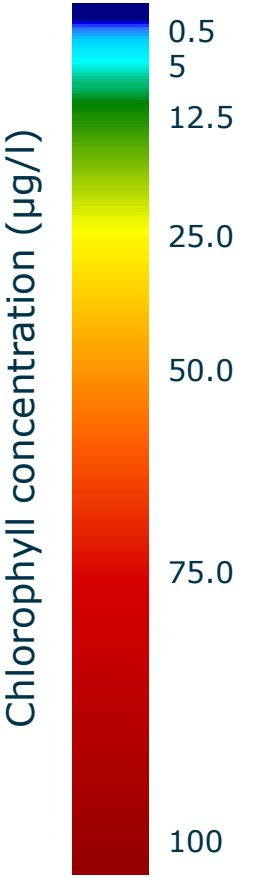
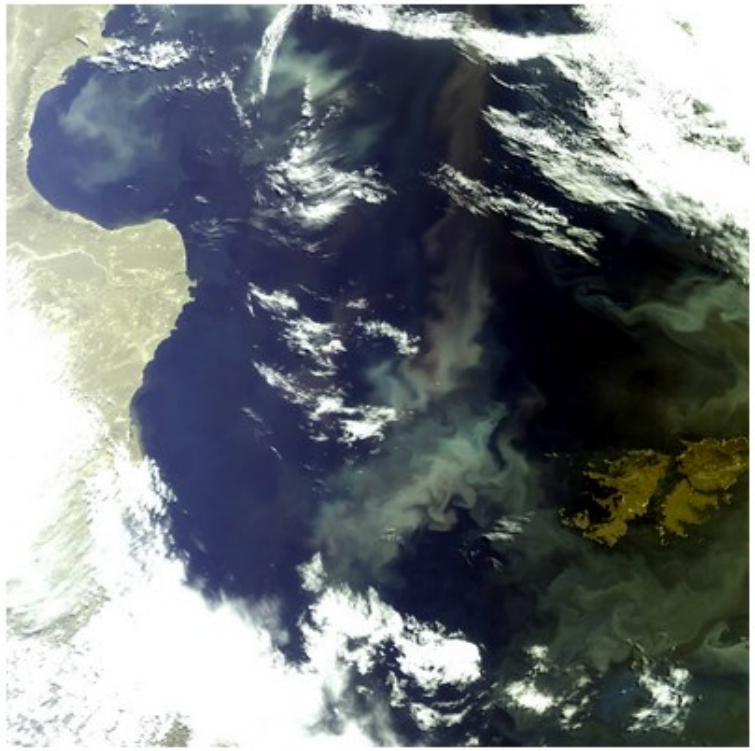


22.09.2022

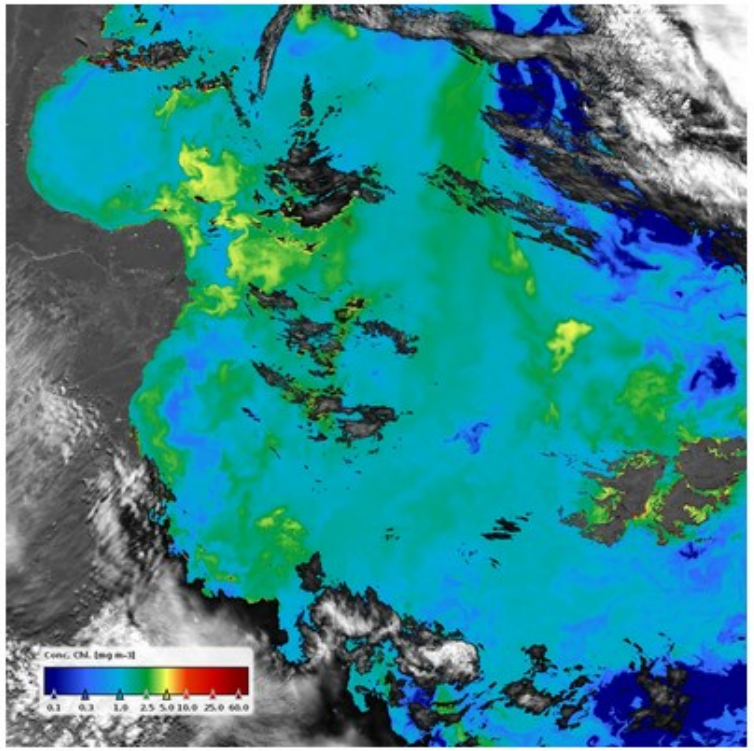


C2RCC Community Project

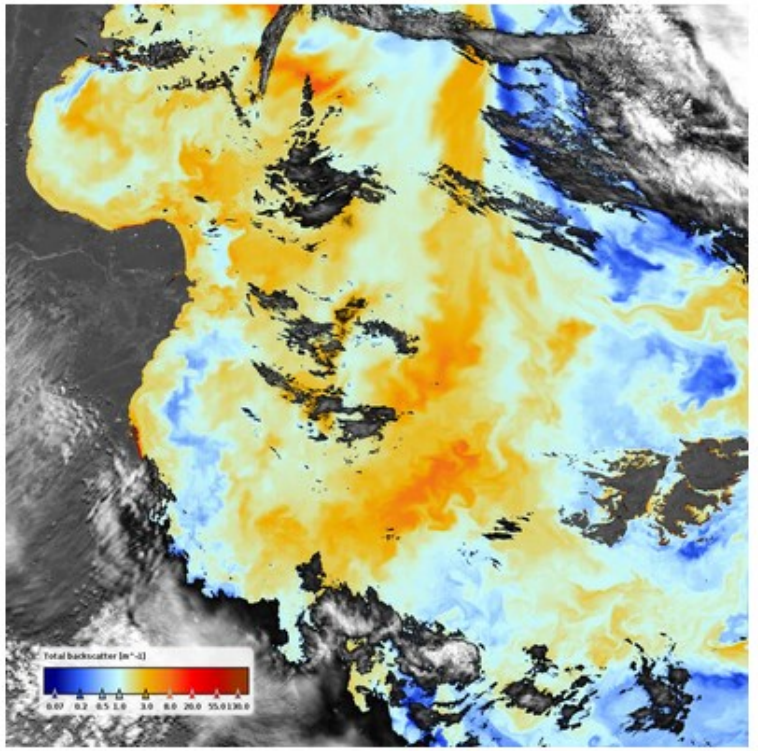
Atmospheric correction and in-water processing of optical earth observation data



Atmospheric correction and retrieval of water constituents from optical satellite imagery acquired by a variety of sensors



Available for all relevant optical satellite imagery.



Open source code, plug-in to the SNAP toolbox and maintained by the Water Colour Community.

C2RCC Community Project – https://c2rcc.org

Operator freely available through SNAP toolbox - Source code freely available on Github

Since 2022 water colour community is entrusted (completely) with C2RCC as a Community Project:

- models that link optical with biogeochemical parameters (assess and use optical properties of both gases and water constituents)
- optical water type classification (OWT)
- phytoplankton diversity
- training datasets derived by RT modelling (well referenced to IOPs)
- trained neural nets (AC, AAN, forward and inversion for water constituents, uncertainties…)
- applicability to new sensors

Commitment to support the Community Project from Brockmann Consult, M. Hieronymi and R. Röttgers (HEREON), Petra Philipson (Brockmann Geomatics) and K. Sorensen (Ocean Optics)

Join us and get involved : hello@c2rcc.org

Conclusions

CHL_NN Coll3 clearly improves for lakes and coastal waters

High chlorophyll concentrations underestimated by CHL_NN (often Cyanobacteria blooms)

Flagging is key – no news but good to point out again

Not only match-ups are telling the story - Users are interested in temporal evolution of their lakes, thus time series analyses are very important for validation and user acceptance