Validation of an OLCI Fluorescence Product

S3VT Meeting 2019

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Spectral Earth - SE

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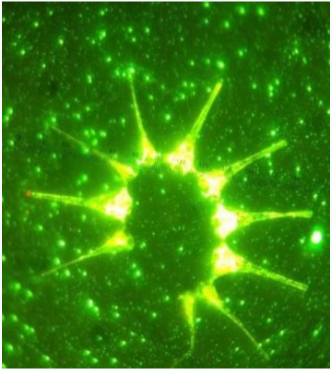
The Fluorescence Algorithm

Why retrieve Chlorophyll Fluorescence in water?

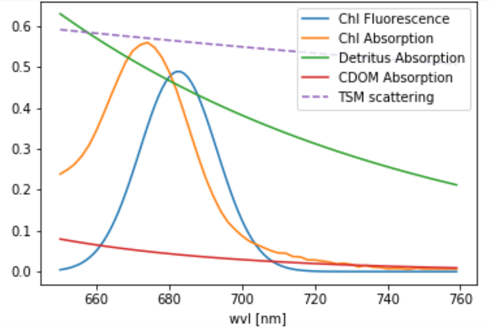
Quantification of solar-induced phytoplankton Fluorescence has two main advantages in marine bio-geochemistry studies:



- **improvement of the chlorophyll retrieval**, customarily based on the detection of the chlorophyll absorption signal
- **additional information** on phytoplankton physiological state, biomass and maximum layer depth

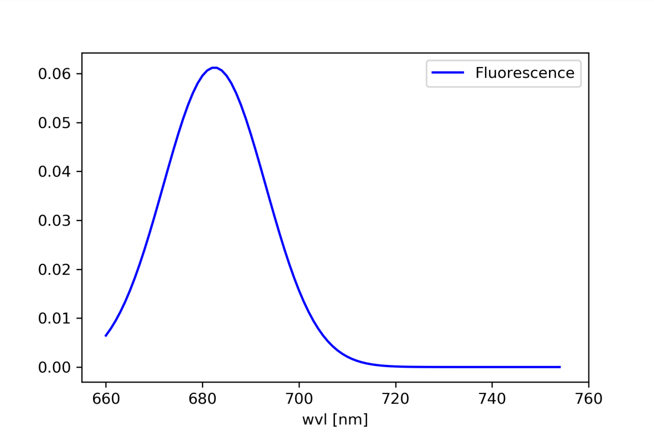
Idea behind the OC-FLUO Algorithm

Use **OLCI's extended spectral capabilities** in order to develop an algorithm, which is working also in **complex waters**, where current algorithms fail!



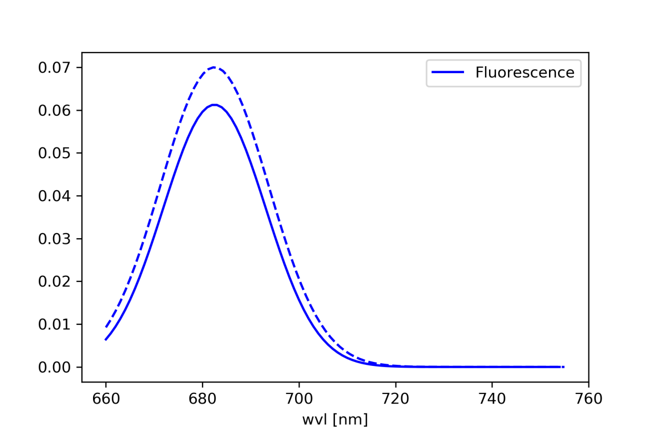
Spectrum is effected by diverse optically active substances in the water →Spectral separation of chlorophyll fluorescence, absorption and other substances.

The OC-FLUO Algorithm



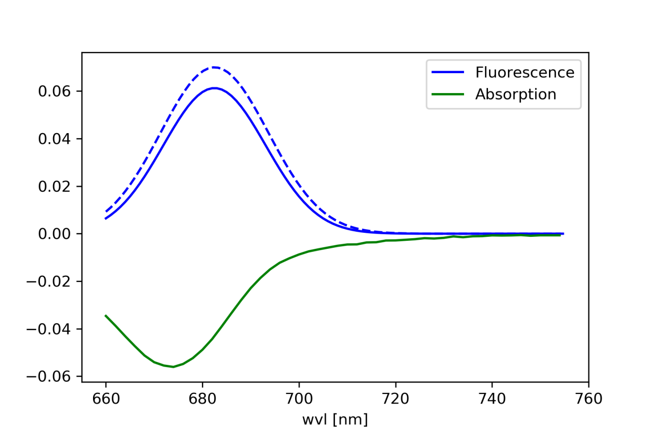
The OC-FLUO Algorithm

$F_W \cdot e^{((\lambda-\lambda_F)^2/w_F)}$



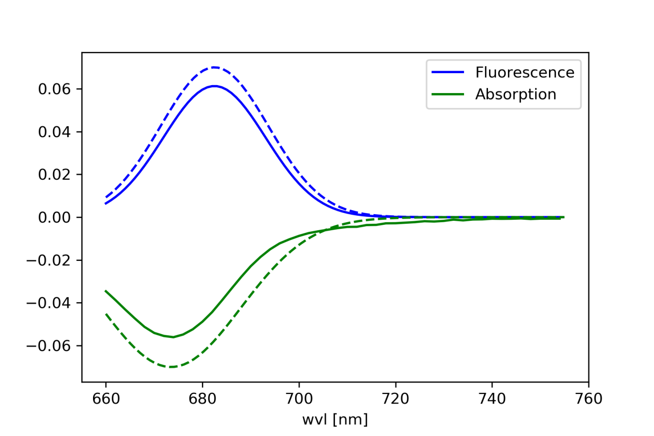
The OC-FLUO Algorithm

$F_W \cdot e^{((\lambda - \lambda_F)^2 / w_F)}$



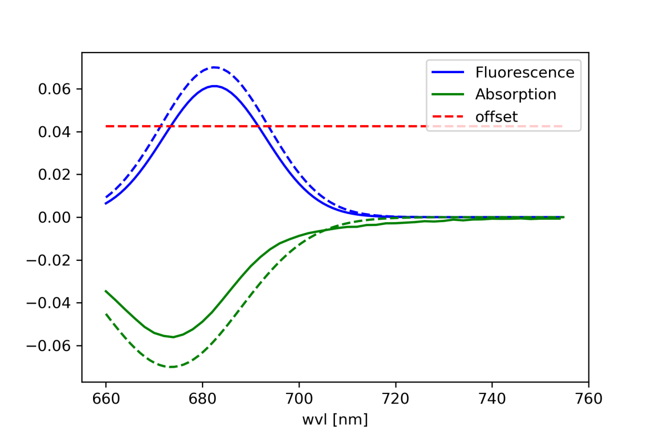
The OC-FLUO Algorithm

$$A \cdot e^{((\lambda-\lambda_A)^2/w_A)} + F_w \cdot e^{((\lambda-\lambda_F)^2/w_F)}$$



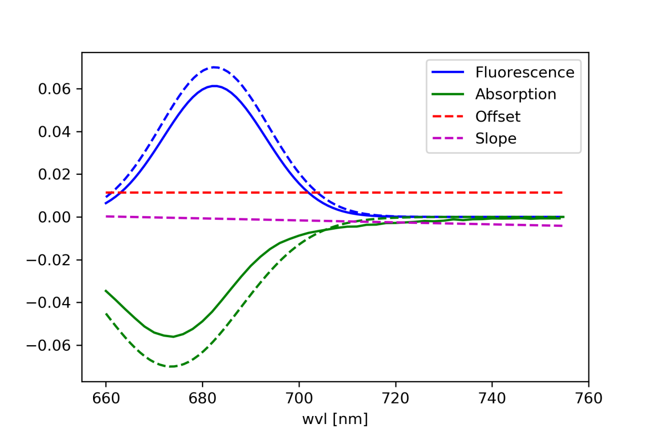
The OC-FLUO Algorithm

$$O + A \cdot e^{((\lambda-\lambda_A)^2/w_A)} + F_w \cdot e^{((\lambda-\lambda_F)^2/w_F)}$$



The OC-FLUO Algorithm

$$L_{TOA}(\lambda) = O + S \cdot \lambda + A \cdot e^{((\lambda-\lambda_A)^2/w_A)} + F_w \cdot e^{((\lambda-\lambda_F)^2/w_F)}$$



Input and Output

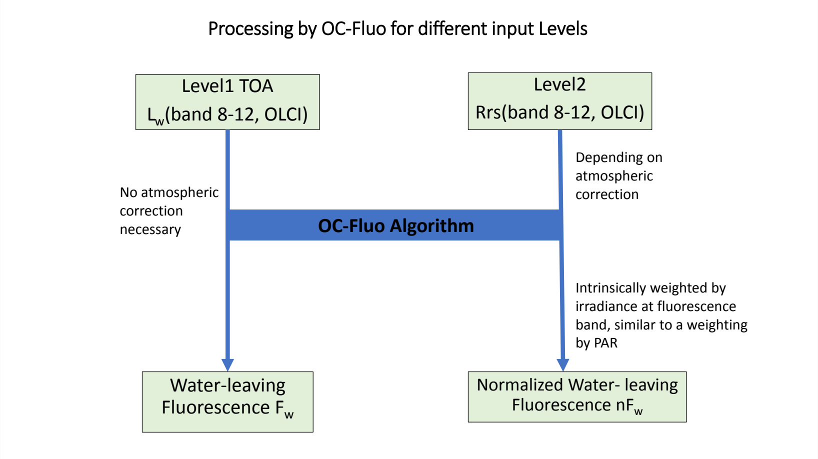


Figure 1: Processing by OC-Fluo for different input and output Levels

$$R_{rs}(\theta, \phi, \lambda) \equiv \frac{L_W(\theta,\phi,\lambda)}{E_d(\lambda)} \quad (\mathrm{sr}^{-1})$$

Variability of Chlorophyll Fluorescence

Theory	• variation in the chlorophyll-a pigment concentration • photoinhibition • phytoplankton species • physiological states • layering of the phytoplankton
Empiricism	• relationship between FLH and chlorophyll can vary by a factor of eight [Borstad, 1985] • correlation within a particular study region quite good • strong diel cycle in in situ measured fluorescence lifetime (fluorescence efficiency)

Example: Fluorescence Retrieval in the German Bight

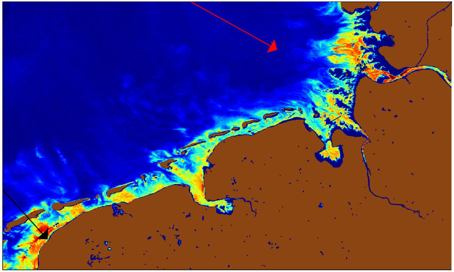


Figure 2: F_w from Level1 data in the German Bight, May 2017

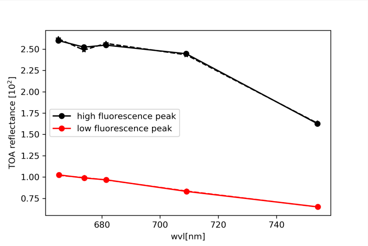


Figure 3: Measured and reproduced spectrum with high and low F_w

Example: Fluorescence Retrieval in the German Bight

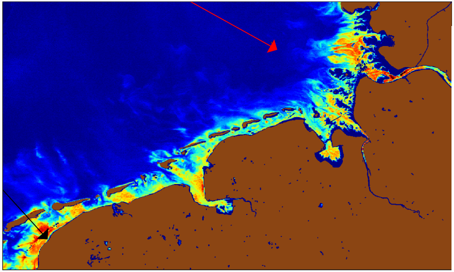


Figure 4: F_w from Level1 data in the German Bight, May 2017

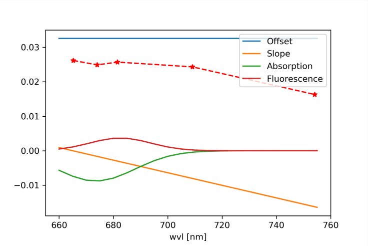


Figure 5: Components of the reproduced spectrum with high F_w

Example: Fluorescence Retrieval in the German Bight

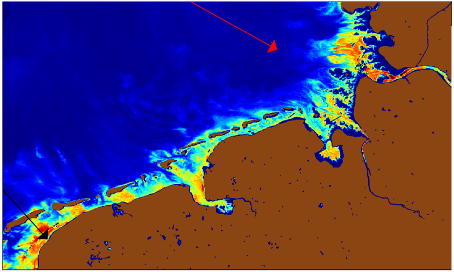


Figure 6: F_w from Level1 data in the German Bight, May 2017

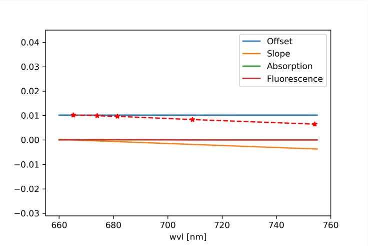
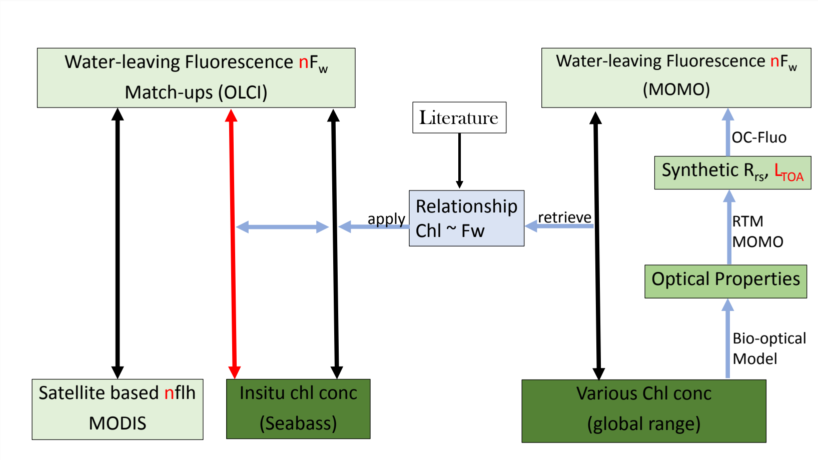


Figure 7: Components of the reproduced spectrum with low F_w

Validation of the Fluorescence Product

Validation Approach



Fluorescence/Concentration Correlation in Literature and from RTM

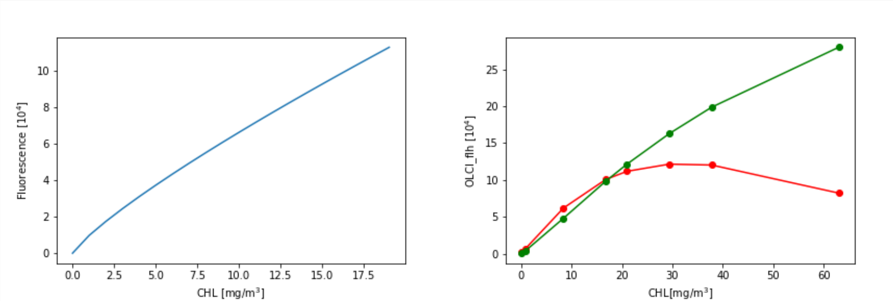


Figure 8: Empirical relationship of Chlorophyll fluorescence and concentration derived in BABIN et al. [1996] , relation from RTM simulations of Rrs using bio-optical model from Bricaud et al. [2010] (MERIS band setting, OLCI band setting)

Validation on in situ Match-ups

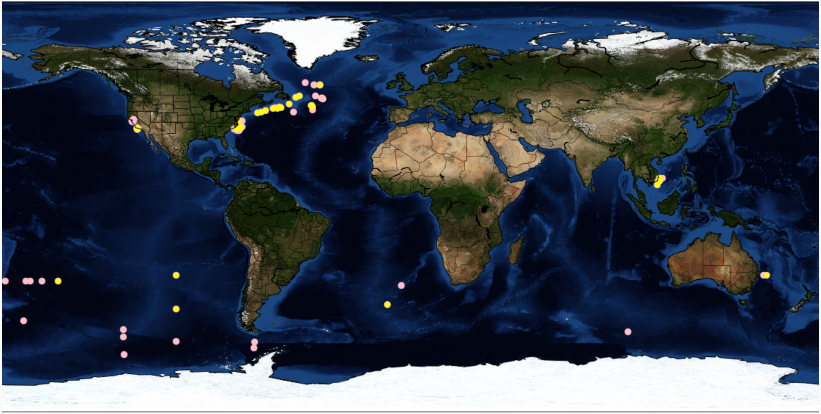


Figure 9: HPLC measurements with OLCI match-ups, extracted from the SeaBASS database (Ilaria, pers. communication), the yellow dots passed the filter as described in Werdell and Bailey [2005].

Validation of F_w from Level1 Data

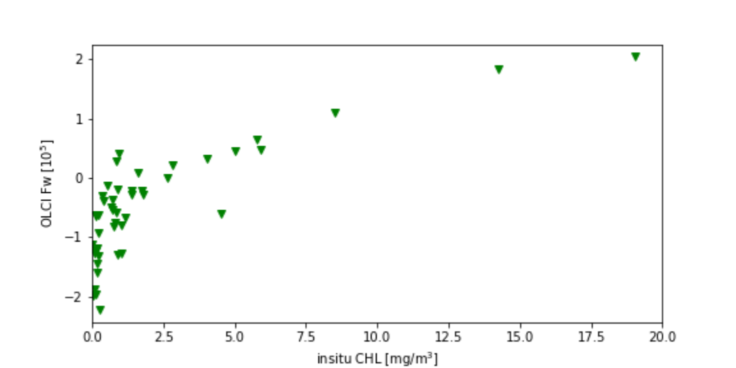


Figure 10: F_w over in situ Chl concentration from global HPLC measurements retrieved from OLCI Level1

- good correlation above 2.5mg/m^3 in situ chlorophyll
- offset for F_w probably caused by missing water vapour correction (in prep.)

Validation of nF_w from Level2 Data

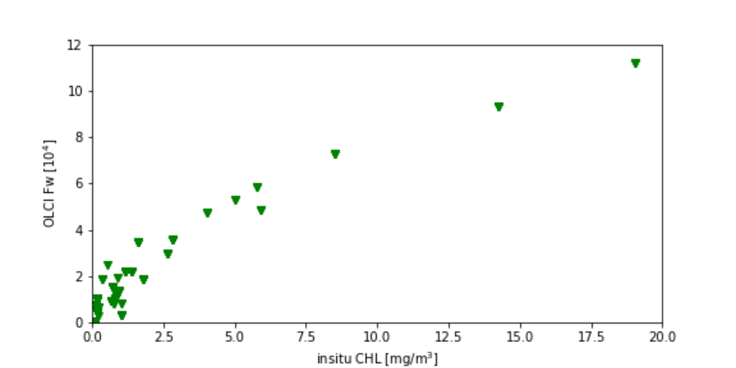


Figure 11: nF_w over in situ Chl concentration from global HPLC measurements retrieved from OLCI Level2 Rrs

- correlation below 2.5mg/m^3 in situ chlorophyll slightly better
- no offset necessary

Conclusions and Open Questions

Conclusions

- Good correlation of F_w from Level1 Data as well as F_w from Level2 Data to global insitu Chlorphyll
- Consistent relation between Chlorophyll concentration and fluorescence from literature, RTM and OLCI/insitu comparison

Open Question

- Which study region should be object to validation?
- Requests: Complex water, accompanying in situ measurements,...