Detection of long-term drifts of fluorescence sensors mounted in FerryBox Systems by Solid Secondary Fluorescence Standards

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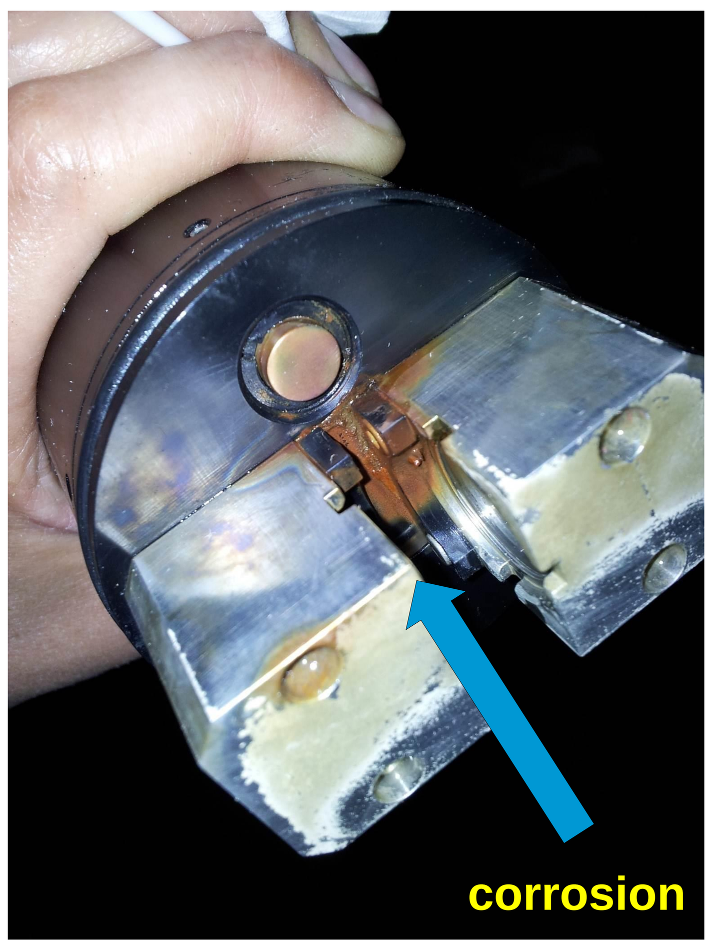

Fig.1: Corrosion on Scufa® sensor (Turner Designs, USA)

Introduction

Mounting FerryBox systems on Ships-Of-Opportunity (e.g. cargo ships or ferries) is a cost-effective way to obtain routine oceanographic data. One key parameter for understanding changes in marine ecosystems is monitoring variations in phytoplankton biomass. A commonly used approach is the measurement of *in vivo* chlorophyll-a fluorescence. However, fluorescence measurements are influenced by various sources of variability (e.g. species composition, light adaptation, physiological condition). In addition, changes in the physical condition of the sensor itself over time have to be taken into account. This is of special importance when sensors are used over a long period (month/years) as it is the case in FerryBox applications. Sensor drift can be either caused by corrosion (scratching of optical surfaces by mineral particles, accumulation of rust; Fig. 1), biofouling (Fig. 2), or by changes in the light source.

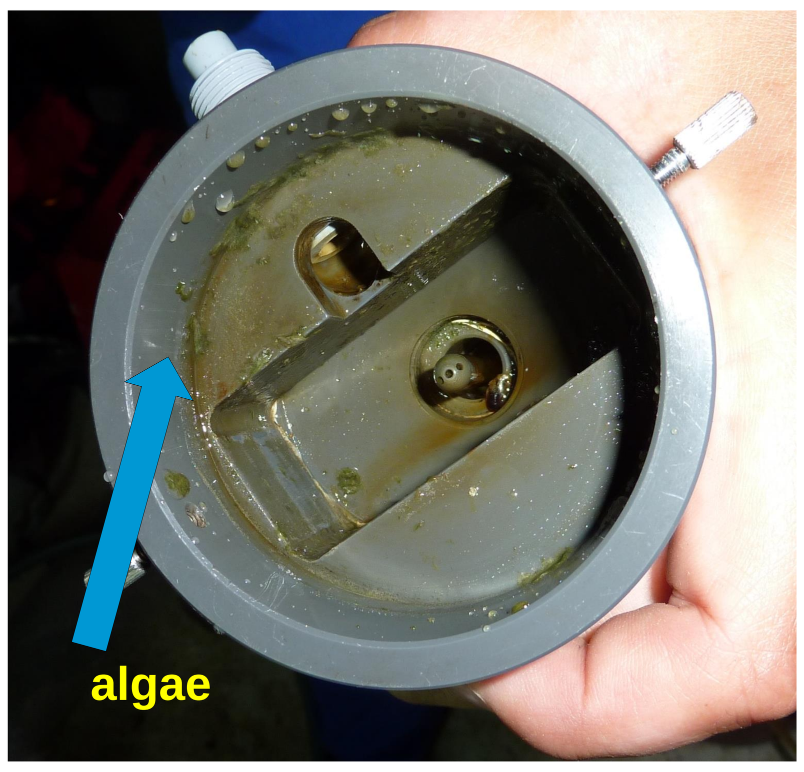

Fig.2: Biofouling, algae in Scufa® flow -through cap

Solid Secondary Standard

A proper way to test the sensor optics, especially when chl-a samples for comparison are unavailable, is to apply a Solid Secondary Standard. This allows to detect a baseline change of the sensor signal (drift). Keeping track of drift is essential to assess instrument stability and to provide means for correcting data. Otherwise chlorophyll fluorescence could be over- or under-estimated.

Results: Drift

Figure 3 shows Solid Secondary Standard measurements from three FerryBoxes deployed on different routes over various time periods. In all cases a decrease of Secondary Standard signal was found (negative drift).

FerryBox	Time period	Total drift	Drift / year	Drift / day
Cuxhaven	522 days	54.8 %	40.9 %	0.11 %
Lybris Seaways	495 days	39.1 %	26.6 %	0.08 %
Hafnia Seaways	959 days	44.52 %	16.6 %	0.04 %

Drift slope appears to be related to the environmental conditions of the operating area. Furthermore, the drift behaves linearly (R^2 = 0.77 - 0.94), therefore it is possible to correct the raw fluorescence data (see Fig. 4).

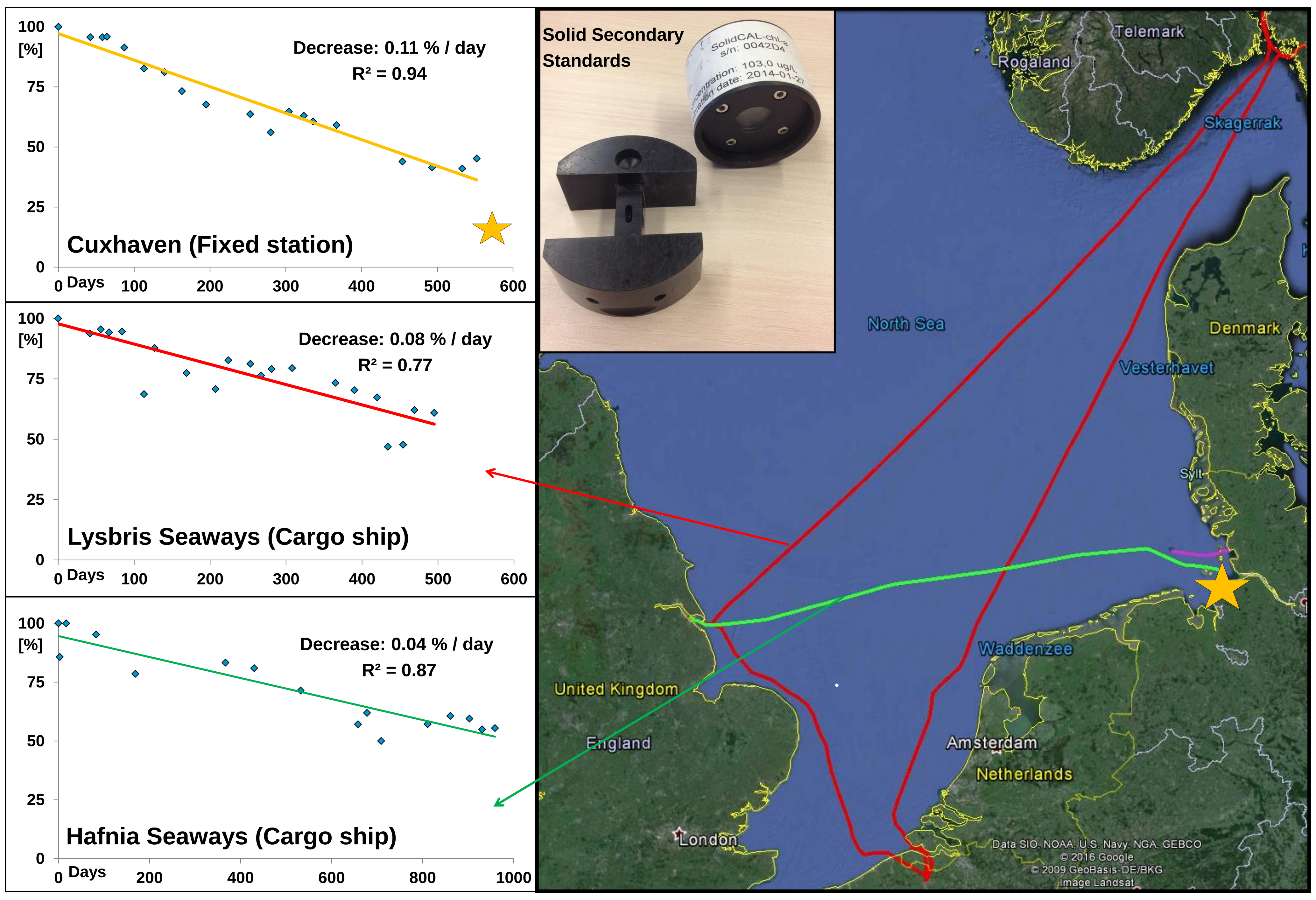

Fig.3: Drift percent / day; from Secondary Standard measurements on three different FerryBoxes

Results: Cleaning

In the inset of figure 4, chl-a fluorescence data from FerryBox Cuxhaven before and after cleaning show that even after more than one month of deployment there is no major change in the fluorescence signal of the sensor. This illustrates the effectiveness of the FerryBox´ autonomous wash cycle.

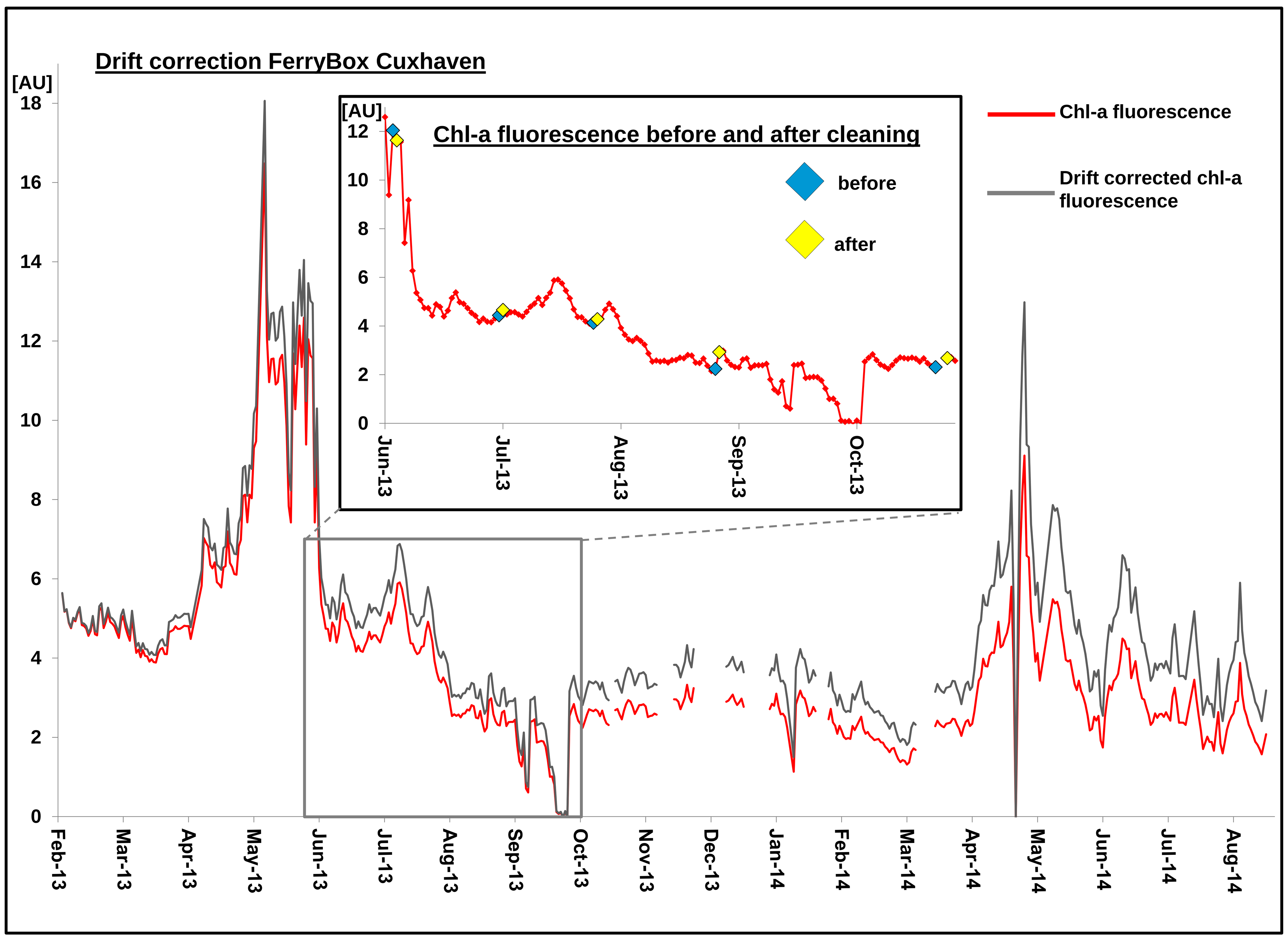

Fig.4: Drift correction using the Secondary Standard measurements from FerryBox Cuxhaven. Chl-a fluorescence signals before and after cleaning

Conclusions

The solid secondary standard is an easy and practical tool for checking the stability of optical sensors within the normal maintenance and can be used to correct sensor drift. Compared to the more time-consuming procedure of calibrating the sensor with *in vivo* samples, the solid secondary standard is the more convenient approach. This is especially the case if the chl-a signal is primarily used to observe variations in phytoplankton biomass rather than to determine an exact chl-a concentration.

Outlook

To achieve verified chl-a measurements it is essential to:

- Calibrate the raw chl-a fluorescence with field chl-a samples
- Verify the drift and achieve qualitative measurements
- Use the Secondary Standard measurements and compare them to measured chl-a samples in the laboratory

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