VIIRS observations of a *Karenia brevis* bloom in the Northeastern Gulf of Mexico in the absence of a fluorescence band

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Background & Objective

❑ **Background and motivation**

Although VIIRS has been shown to provide consistent products to continue MODIS observations, the lack of a fluorescence band hinders its ability to detect and quantify harmful algae blooms (HABs) in waters rich in colored dissolved organic matter (CDOM). Nearly all Chla retrieval algorithms suffer in CDOM-rich waters, and this is why MODIS nFLH has been used to detect HABs (or red tides) in the eastern Gulf of Mexico (GOM).

❑ **Objective**

The objective of this work is to develop a VIIRS suitable algorithm to produce nFLH-like products for CDOM-rich waters in the absence of a fluorescence band in order to continue MODIS observations for HABs.

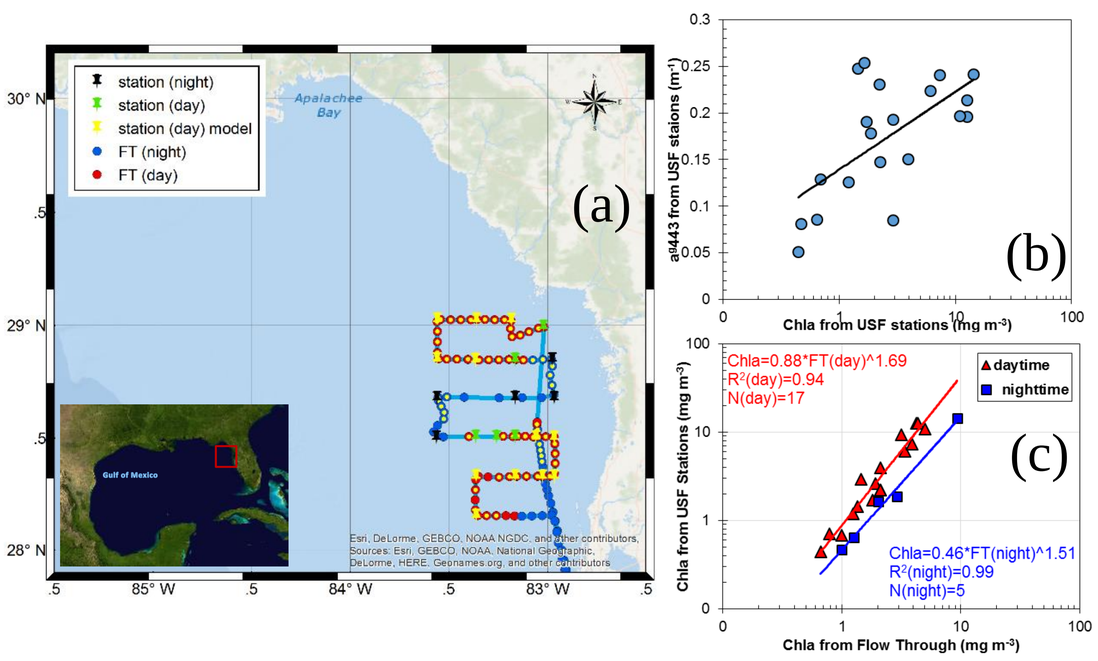

Fig. 1. (a) Study area of the northeastern GOM. (b) Chla and a_g443 determined from water samples. (c) Calibration of FWC flow-through data to Chla. The calibration was performed for daytime and nighttime separately.

Methods and Materials

❑ **In situ Data**

Two *in situ* datasets were collected collected independently from the northeastern GOM (Fig. 1a). Both were collected from one cruise survey (August 26-29, 2014) during a *Karenia brevis* bloom, but collected and measured by two groups using different instrumentation.

- USF collected water sample data at 22 stations to determine Chla (mg m^{-3}) and CDOM absorption at 443 nm (a_g(443), m^{-1})
- FWC collected flow-through Chla fluorescence along the ship transects, then calibrated into Chla using discrete water sample measurements.

❑ **Satellite images**

Both VIIRS and MODIS/Aqua data were obtained from NASA GSFC, and processed by the SeaDAS 7.0.2 software package to generate:

- VIIRS Level-2 products: Rrs (sr^{-1}); Chla from the OC3 algorithm
- MODIS AQUA Level-2 products: Rrs (sr^{-1}); nFLH (mW cm^{-2} μm^{-1} sr^{-1})

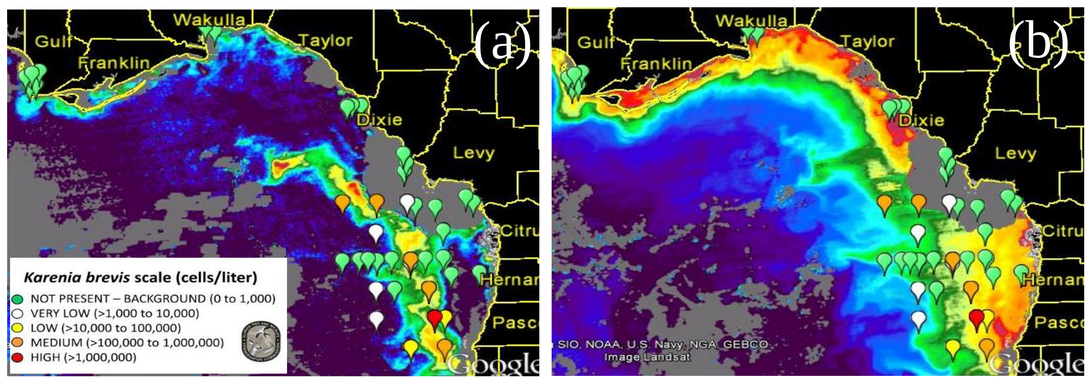

Fig. 2. MODISA nFLH and Chla images on 2 Sept 2014 (a and b) annotated with *K. brevis* cell counts between Aug 27 and Sept 3 (a and b). The images show that nFLH can serve as a better index than Chla for bloom detection (Hu et al., 2005 & 2015).

Results

- A recently developed Red-Green-Chlorophyll-Index (RGCI) approach was applied to concurrent (±4 hours) VIIRS Rrs data and field-measured Chla to develop a local Chla algorithm (Fig. 3a).
- The algorithm was validated using independent Chla data collected from the flow-through system, with mean relative uncertainties of ~56% for Chla ranging between 0.5 and 20 mg m^{-3} (Fig. 3b, R^2 = 0.78, N = 75).
- Further comparison with concurrent MODISA nFLH imagery showed that VIIRS RGCI Chla also provided similar spatial patterns as MODISA nFLH (Fig. 4).
- MODIS and VIIRS were diagnosed to see why the algorithm worked (Fig. 5).

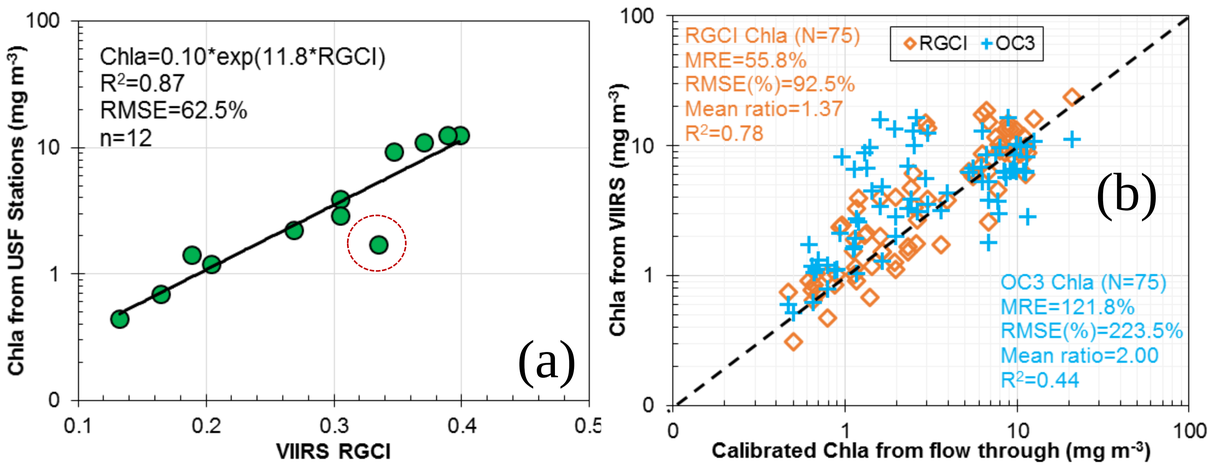

Fig. 3. (a) Relationship between VIIRS-derived Red-Green Chla Index (RGCI) and surface water Chla. (b) Comparison of VIIRS RGCI Chla with calibrated flow-through Chla. For reference, the VIIRS default OC3 is also included.

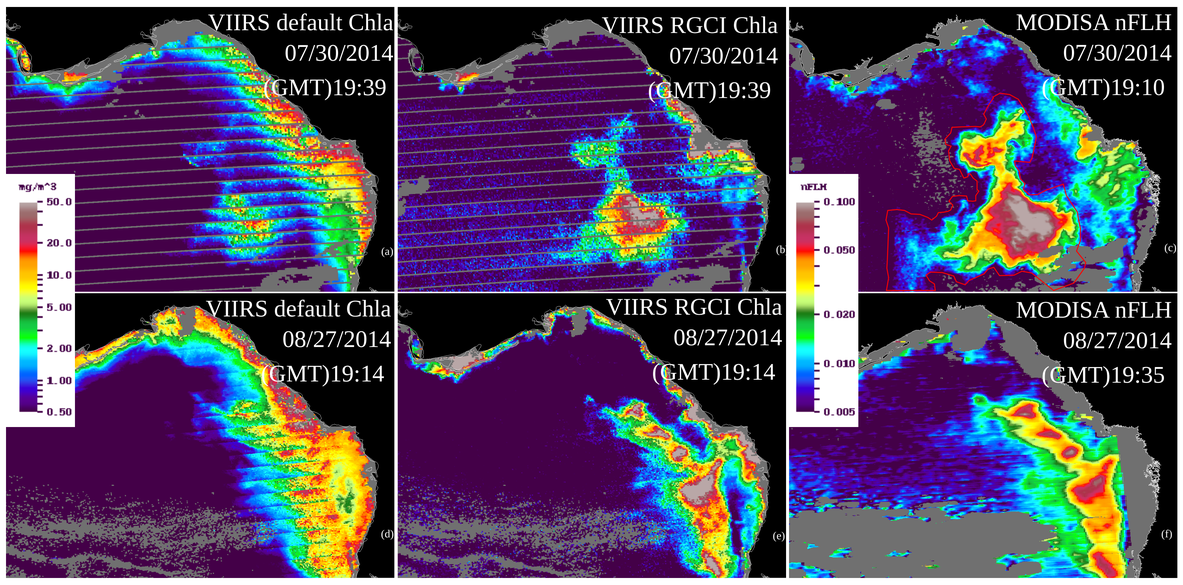

Fig. 4. Comparison between VIIRS default Chla (first column), VIIRS RGCI Chla (middle column), and MODISA nFLH images (last column) for two cases: 30 July 2014 (top panel) and 27 August 2014 (bottom panel).

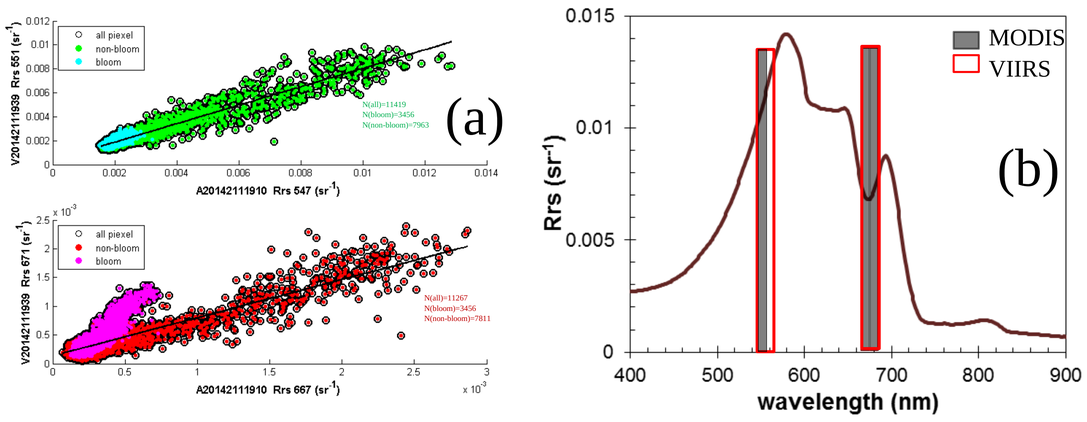

Fig. 5. (a) Comparison between MODISA and VIIRS Rrs data on 30 July 2014 (Fig. 4) for both bloom and non-bloom pixels. (b) MODISA and VIIRS green and red bands overlaid on a Rrs spectrum showing the partial overlap of the VIIRS band with the local Rrs peak.

Conclusions

- VIIRS RGCI may be used as a surrogate of MODISA nFLH in the absence of a fluorescence band for bloom detection in CDOM-rich waters.
- The success of RGCI may be partially attributed to the 20-nm bandwidth of the VIIRS 672-nm band that covers a portion of the solar stimulated fluorescence.

Acknowledgement and References

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