HICO-Based NIR-red Algorithms for Estimating Chlorophyll-*a* Concentration in Inland and Coastal Waters – the Taganrog Bay Case Study

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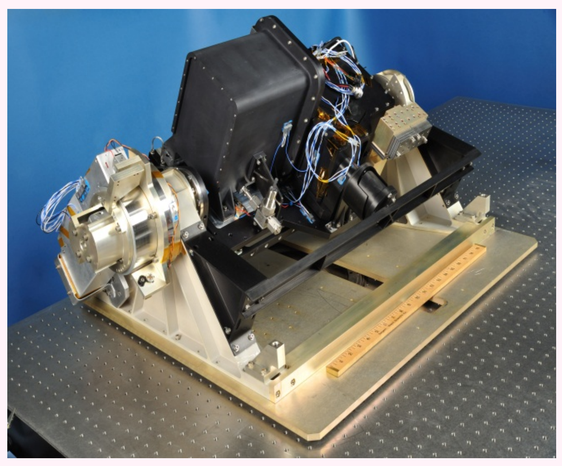
Introduction

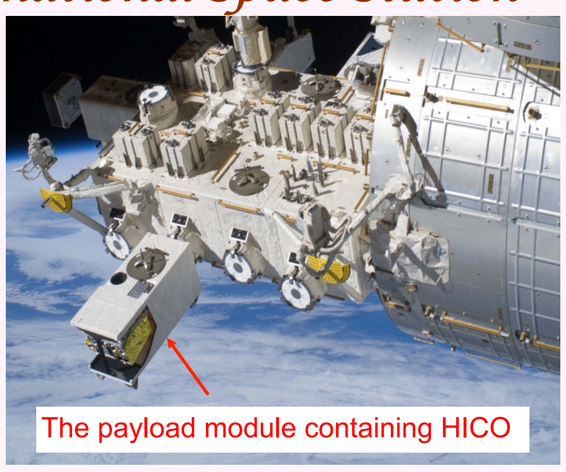
The goal was to test the operational potential of **HICO** (Lucke et al. 2011) for estimating chlorophyll (chl-*a*) concentration in coastal waters. Two-band and three-band NIR-red algorithms, which have been used very successfully with MERIS data (Moses et al. 2009; 2012), were applied to HICO data.

The results presented here demonstrate the strong potential of HICO as a reliable tool for monitoring coastal water quality, which is critically relevant for coastal ocean color research, especially with the recent demise of **MERIS**.

Nevertheless, there are inherent challenges in the operational ability of HICO.

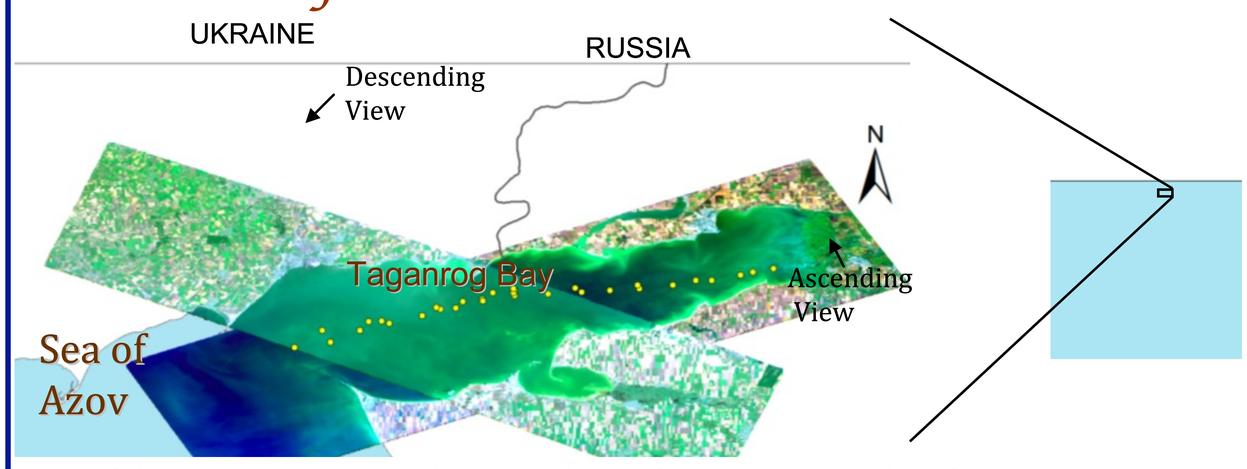
HICO Sensor – on the International Space Station





- 14-bit data with 350 – 1080 nm spectral coverage at 5.73 nm spectral resolution
- 42 km x 192 km spatial coverage, with 96 m resolution at nadir viewing angle
- transpired from a written set of requirements to a spacecraft-ready system in 16 months

Data & Study Area



Map of the Taganrog Bay, with screenshots of HICO images taken from the sensor's ascending and descending orbits overlaid. The yellow dots represent the stations where in situ measurements were taken.

The HICO images were atmospherically corrected using **TAFKAA**.

In situ data were collected on the Taganrog Bay during four campaigns between July and September 2012, covering 31 stations.

Chl-*a* Data (31 stations):

Units	Min	Max	Median	Mean
mg m^{-3}	27.06	172.77	97.35	94.15

NIR-red Algorithms

NIR-red models based on HICO spectral channels at locations closest to the NIR and red spectral channels of MERIS were,

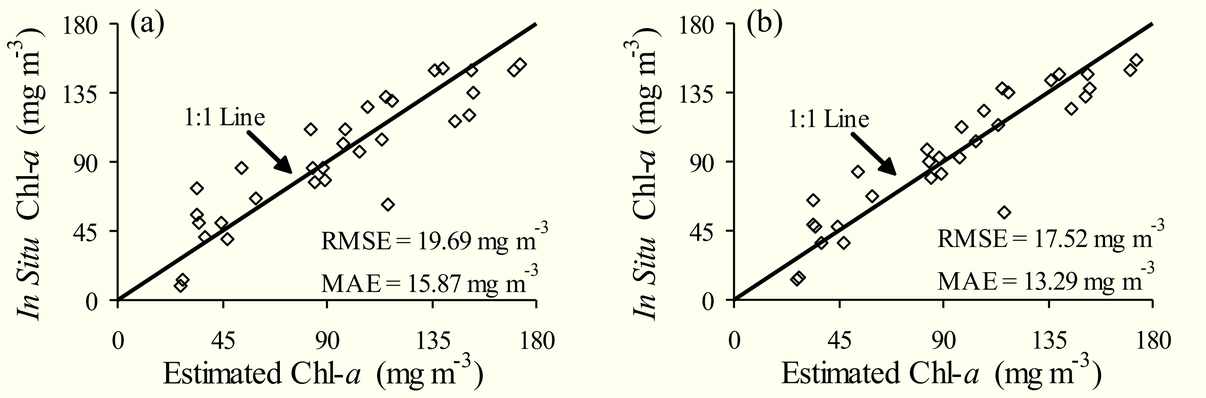
Two-band HICO NIR-red model: $$\text{Chl-}a \propto \left[\bar{R}_{665}^{-1} \times R_{708}\right] \quad (1)$$

Three-band HICO NIR-red model: $$\text{Chl-}a \propto \left[\left(\bar{R}_{665}^{-1} - R_{708}^{-1}\right) \times R_{754}\right] \quad (2)$$

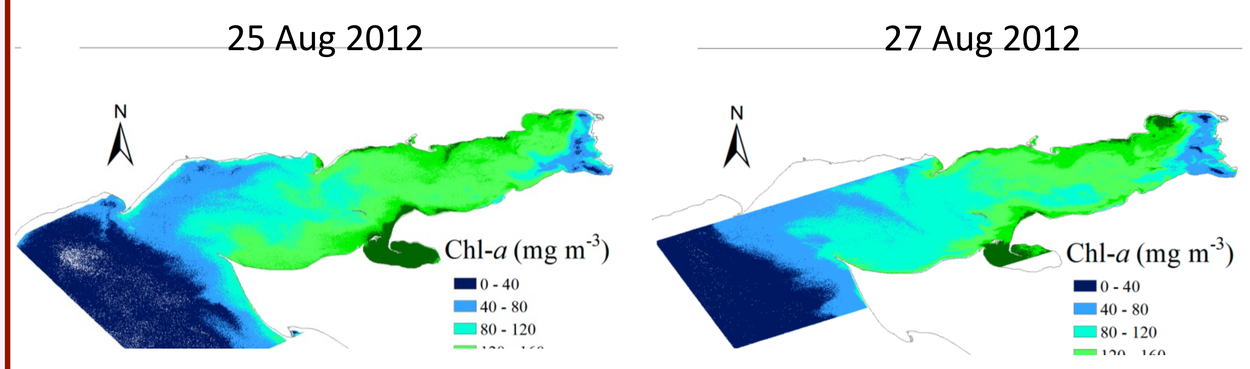
Note: $\bar{R}_{665}$ is the average of the reflectances at 662 nm and 668 nm.

Chl-a Estimates

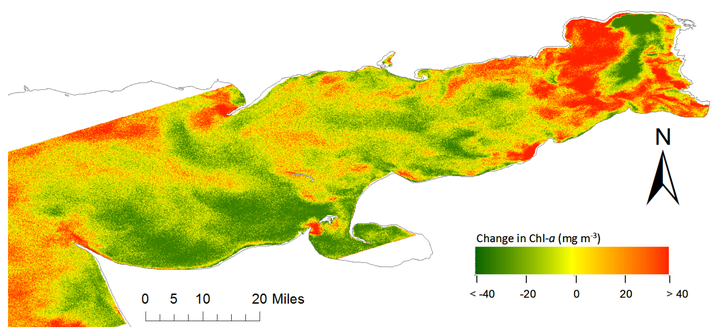
Chl-*a* = 326.32(2-Band) – 286.83 **Chl-*a* = 508.67(3-Band) + 36.524**



Chl-*a* concentrations measured *in situ* versus chl-*a* concentrations estimated using the HICO-based (a) two-band and (b) three-band NIR-red algorithms, after leave-one-out cross validation.



The chl-*a* estimates were remarkably accurate across the multi-temporal dataset in spite of the high spatial and temporal variations of chl-*a* concentration in the bay.



Changes in the chl-*a* concentration in the Taganrog Bay between 25 Aug and 27 Aug 2012, as estimated using the HICO-based two-band NIR-red algorithm. Positive values indicate higher chl-*a* concentrations and negative values indicate lower chl-a concentrations on 27 Aug.

Challenges

- Second order light in the near infrared wavelengths.
- No on-board light source for continual post-launch calibration; vicarious techniques adopted.
- Post-launch shifts observed in the spectral and radiometric characteristics of the sensor; the shifts are corrected for through continual comparison with concurrently acquired MODIS data.
- The back-illuminated CCD on HICO's focal plane array causes spectral etaloning, pronounced more in the NIR region; data are smoothed with a Gaussian filter to minimize etaloning effects.
- HICO orbits around the earth ~ 16 times per day; constraints on data transmission at the ISS limits image acquisition to only one image per orbit, leading to a maximum of 16 images per day.
- Due to the nature of the ISS' orbit, repeat coverage of the same area occurs only intermittently; the pointing capability of HICO helps improve coverage in high-priority regions.

Conclusion

In spite of the constraints on the operational ability of HICO, the results demonstrate its strong potential as a tool for remotely monitoring water quality in inland, estuarine, and coastal waters, which is of critical relevance especially with the demise of MERIS.

References

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