

## Continued Access to Data from the Hyperspectral Imager for the Coastal Ocean (HICO)

Naval Research Laboratory Office of Naval Research Oregon State University NASA ISS Program Office

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## **HICO Background**

- Designed and built by the Naval Research Laboratory in 18 months for <\$5 million</li>
  - \* Sponsored by the Office of Naval Research
  - \* Launch and operate the first spaceborne coastal maritime Hyperspectral Imager (HSI) optimized for coastal environmental characterization
  - \* Demonstrate scientific and naval utility of maritime HSI from space
  - \* Serve as a pathfinder for future spaceborne hyperspectral imagers
- \* Built primarily with Commercial-Off-The-Shelf parts
- \* Located on the International Space Station

### **HICO Performance Specifications**

Parameter	HICO Performance	Rationale
Architecture	Offner spectrometer, silicon FPA	Airborne heritage
Spectral Range	400 to 900 nm	Water-penetrating wavelengths plus Near IR for atmospheric correction
Spectral Readout	1.9 or 5.7 nm	Resolve coastal spectral features
Signal-to-Noise Ratio for water-penetrating wavelengths	> 200 to 1 for 5% albedo (10 nm spectral bins)	Provides adequate Signal to Noise Ratio after atmospheric removal
Polarization Sensitivity	< 5% (430-900 nm)	Insensitive to scene polarization
Ground Sample Distance	~100 m	Adequate for most coastal ocean features
Scene Size	~50 x 200 km	Capture the scale of coastal dynamics
Cross-track pointing	+ 45 to - 30 deg	Increase scene access frequency
Scenes per orbit	1-2 maximum	Data transmission constraints

## Milestones / Accomplishments

- \* 5 years on orbit: mid-September 2009 2014
- \* 10,000 images collected
- \* About 100 separate, on-going projects, each with multiple target sites, for dozens of countries
- \* Originally run by the Navy, then transitioned to NASA sponsorship in January 2013
- \* Two dozen refereed publications, plus numerous conference publications on HICO and HICO data
- \* Full hyperspectral imagery available to researchers world-wide Locations and descriptions on next 2 slides
  - \* NASA's Ocean Color Website: <u>http://oceancolor.gsfc.nasa.gov</u>
  - \* OSU's HICO Website: <u>http://hico.coas.oregonstate.edu</u>

Hyperspectral Imager for the Coastal Ocean

#### Log In

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Home Sensor Design & Heritage Calibration Specifications The HICO Team Projects Image Galleries Meetings Publications & Presentations Contact Us

#### Operations

Orbit Targets Schedule

#### Data

Archive Search Data NASA Archive (HDF5) Info Data Characteristics

Working with the Data

#### Help

FAQs NASA HICO forum

### OSU Web Site: http://hico.coas.oregonstate.edu

- Great tutorials about the sensor, ISS orbit, data, publications, meetings, etc.
- \* Display of all target sites where data was collected
  \* Google Earth view or List by Name
- \* Searchable data archive
  - \* By location (target name), date range
  - \* Results show thumbnail images and/or text information
  - \* Can download data in ENVI format directly or directly link to NASA Ocean Color website for HDF5 format

NASA

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Targets Schedule

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#### Data Access

Overview Level 1&2 Browser Level 3 Browser Direct Data Access Data File Search Data Subscription OPeNDAP SeaBASS Field Data How to Cite Other Resources

Missions & Sensors OceanColor Forum Support Services Documentation Quality Assessment Software & Tools External Partners About Us

### NASA Web Site: http://oceancolor.gsfc.nasa.gov

- Includes wide variety of information on ocean color, including data from other sensors, such as MODIS, MERIS, VIIRS
  - Can do cross-sensor studies
- \* Searchable data archive
  - \* By date, named region, map search
  - Results show thumbnail images
  - \* Can download HDF5 format
    - \* Requires EOSDIS account

## Example Target Locations: Europe and North Africa



### Some Top Targets

- \* Over 100 images: Broad Bay, NZ; AAOT; Lake Baikal
- Over 50 images: Tokyo Bay, Paranagua Bay, Straits of Gibraltar, Cape Town, Han River, Freshwater Beach AUS, Sea of Azov, Lake Erie, Tiburon CA, Monterey Bay, Columbia River mouth, East Sound WA, Canary Islands, Puerto Rico, Antwerp
- Other popular sites: Lake Acigol Turkey, Straits of Bosporus, MOBY (Kaneohe Bay), Amazon River mouth, La Plata River, Gironde Estuary, Fukushima, Malacca Strait, Halifax, Bermuda

## Worldwide Distribution of Collections



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# HICO High Signal to Noise Ratio<sub>n</sub>



## HICO Results Compare Well to MODIS standard



Chlorophyll-a concentration (mg/m3) standard product from NASA

Chlorophyll-a concentration using NRL's atmospheric correction and standard chlorophyll algorithm shows excellent match, but better detail and no saturation at coast

12

### Differentiation of Photosynthetic Pigments Lake Kinneret, Israel on 3/11/2013



Presented at CoastColour and SeaSWIR User Consultation Meeting held at EUMETSAT in Darmstadt, Germany on 9-10 May 2013





<u>HICO</u>

- Spectral resolution
   separates pigment
   absorption features
- Spatial resolution reveals variability

### <u>MODIS</u>

Shows general patchiness PIGMENTS

Toxic: harmful to humans

## International Disaster Charter Response<sup>4</sup>

HICO Image of Mozambique flooding near the capital on 2/3/2013



**HICO** image provides scale for context of water flowing well outside the banks of established rivers.

Heavy rains in early 2013 led to extensive flooding in Mozambique. By 20 Feb, at least 113 people had been killed and over 185,000 people had been temporarily displaced by the floods.

### **HICO Data Summary**

- VNIR Hyperspectral data
  - \* 350 1080 nm (400 900 nm recommended) at 5.7 nm resolution
- \* Spatial footprint is 50 x 200 km, with ~100m pixels
- Focus on coastal oceans
- \* 5 years of operations on International Space Station
  - \* Sept 2009 Sept 2014
- \* Pre- and post-launch calibration documented
  - \* Some inconsistencies remain, possibly due to polarization sensitivity
- \* ~10,000 images archived in 2 locations
  - \* NASA's Ocean Color Website: <a href="http://oceancolor.gsfc.nasa.gov">http://oceancolor.gsfc.nasa.gov</a>
  - \* OSU's HICO Website: <a href="http://hico.coas.oregonstate.edu">http://hico.coas.oregonstate.edu</a>