

HICO Data User Agreement

Between the

Naval Research Laboratory

And

The HICO Data User Principal Investigator

Issued on: HICO-based water transparency Mapping in Pearl River Estuary (PRE) of South China

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Note that approval of a data user proposal does not imply Navy S&T financial support.

Proposal

Title : HICO-based water transparency Mapping in Pearl River Estuary (PRE) of South China

Primary Application Domain: Coastal Zones

Secondary Application Domain: coastal wetland vegetation mapping

Abstract/project summary

Water transparency is a useful index of water quality or productivity and is used in many environmental studies. Because of the complicated constituents and rapid variation in coastal water, it is difficult to retrieve its water transparency. HICO data have much greater spatial, spectral resolution and high Signal to Noise Ratio than current space borne ocean color imagers, and the data are of great interest for studying the dynamics of the coastal ocean waters. And to solve the difficulty to retrieve coastal water transparency, we adapt and develop semi-analytical and empirical algorithms to estimate the water transparency in Pearl River Estuary (PRE) of South China from HICO products by combined analysis of in situ water spectra and radiative transfer simulations. The development of the algorithms is based on the use of a comprehensive in situ bio-optical and spectra dataset. The algorithms will be validated using an extensive set of in situ measurements of the Secchi depth in synchronism with the satellite. Coastal wetland vegetation is dominant coastal ecosystems in subtropical and tropical regions throughout the world, so we will investigate the capability of HICO remote-sensing methods for mapping coastal wetland vegetation as well.

1 Statement of work/project description

Coastal waters are important recreational and life resources that add to the economic vitality and quality of life of people. Unfortunately, water quality of the coastal waters around the world is becoming degraded by a variety of anthropogenic causes. As an important indicator of water quality, it is simple and relatively low cost to get water transparency. So water transparency is frequently being chosen to identify the trends of coastal water conditions.

Originally, the algorithms proposed to estimate the ocean transparency from remotely sensed data are empirical. Using ocean color data, Prasad et al. (1998) proposed a relationship between the Secchi depth and the ratio of two water-leaving radiances. But he didn't calibrate the empirical algorithm with simultaneous in situ measurements of Secchi depths and water-leaving radiances. Kratzer et al. (2003) proposed an empirical relationship with measurements realized in the Baltic Sea to obtain ZSD (Secchi disk depth) from the vertical diffuse attenuation coefficient at the wavelength 490nm ($K_d(490)$ in m^{-1}), which is a standard product for some ocean color sensors. In parallel to the ocean retrieval algorithms, Kloiber et al. (2002) tested some relationships between the Secchi depth and simultaneous measurement by Landsat sensors. Several combinations of spectral reflectance and spectral band ratios were tested and a sensitivity analysis provided an optimal form for Landsat multispectral data. We can see that at present the researcher in inland water transparency still follows the ocean color method, which mainly used Thematic

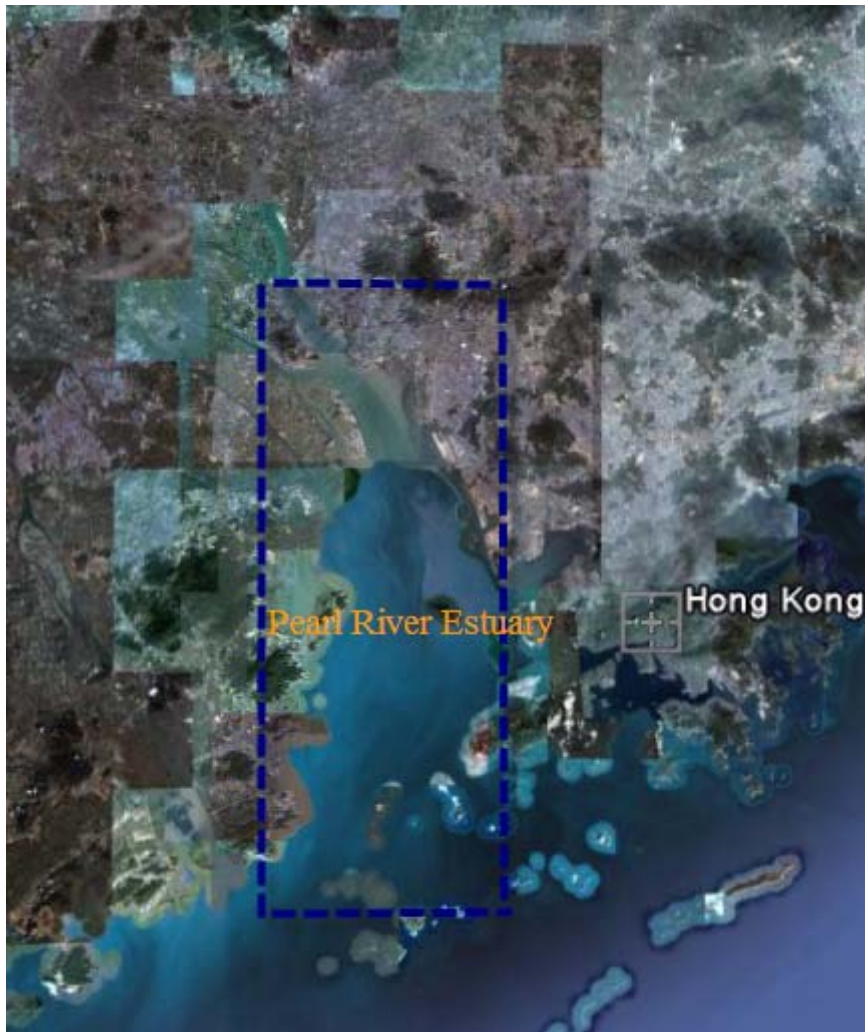
Mapper (TM) data to monitoring the water quality, based on traditional empirical method. The spectral conditions of coastal waters are complicated and the water is changing constantly, so it has great challenge in studying the complexity and dynamics of the coastal waters. HICO data have much greater spatial (90 m) , spectral (87 channels , Spectral Channel Width 5.73 nm) resolution and high Signal to Noise Ratio (> 200 to 1 for a 5% surface Albedo) than current space borne ocean color imagers, and the data are of great interest for studying the dynamics of the coastal ocean and inland waters. To aim at the complicated spectral conditions in coastal water, several hyperspectral processing methods are being employed to enhance the correlation between water transparency and processed spectra. Based on the correlation analysis, the model for retrieving coastal water transparency is being formed for the hyperspectral data. However, Kloiber et al.(2002) found that it is difficulty to obtain a standard model for all images, which shows the limits of empirical algorithms. Up to the present efforts to produce standard prediction equations for water quality parameters applicable to images collected on different dates at the same location have not been successful. Compared to empirical algorithms, the semi-analytical algorithms use approximations of the radioactive transfer that relate inherent optical properties (IOPs), and apparent optical properties (AOPs) or radiometric quantities, in addition to empirical relationships. And we will investigate semi-analytical algorithm to estimate the water transparency from hyper-spectral HICO remote sensing data as well.

Pearl River estuary is situated between latitude 21.6791°N and 23.49729°N and longitude 113.54253°E and 113.9971°E in the middle coast zone of Guangdong Province (South China). This location is close to South China Sea. Pearl River estuary is a typical class of coastal water. According to scientific investigation, the water transparency in Pearl River estuary is relatively low, only having 3 to 10 meters((<http://www.eedu.org.cn/Article/kepu/earth/ocean/200410/2859.html>)). So it is necessary to monitor its water transparency. Chen Lei (2011) studied the relationship between seawater clarity and water-leaving reflectance spectra of seawater in the Pearl River Estuary, and found that the power regression equation fitted by the negative natural logarithm values of water-leaving reflectance spectra of seawater at 559 nm can receive better results. As present, scientific researches have been doing to figure out the COD, chlorophyll-a, TSS and other important water quality parameters. However, there is only a few remote sensing researches on the Secchi depth of Pearl River Estuary.

Coastal wetland vegetation is dominant coastal ecosystems in subtropical and tropical regions throughout the world, so we will investigate the capability of HICO remote-sensing methods for mapping coastal wetland vegetation as well.

We request the HICO data at Pearl River Estuary in South China with 90m spatial resolution and 87 channels (400-900nm).

Center coordinates of Study Site. (decimal degrees) : 113.7698°E, 22.5882°N;



2. Biographical sketch and available facilities

Biographical sketch

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Education:

Visiting Scholar: Florida State University

Ph.D. - Chinese Academy of Sciences (CAS)

2005, Institute of Remote Sensing Applications, China.

M.Sc. - Peking University

1992, Institute of Remote sensing and GIS

B.Sc. - Jiangxi Normal University

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Infrastructure

There are ASD field spectral Measurement Services 350-2500nm, real-time differentially corrected GPS (Trimble PRO XRS) with 1 m accuracy, YSI Multi-parameter water analyzer, Double frequency sounder with GPS (**HD-28T**) in Guangzhou Institute of Geography. Remote sensing image processing and analysis equipment and GIS Software and development tools are also available to complete this work.

Projects granted

- 1) The 863 National Youth Fund Subject "The research of sea visibility by remote sensing technology", 2002-2004.
- 2) The national natural science fund project "Salinity remote sensing and simulation of Pearl River estuary and its spatial differentiation" (40771160), 2008-2012, PI.
- 3) In January 2008, Science and technology plan pilot projects of Guangdong Province " the key technology of salt water hyperspectral remote sensing monitoring and its application in the Pearl River estuary " (2005 B33303005), 2005-2007,PI completed.

The research papers, books about this topic

- [1] Shui-sen Chen, Wenrui Huang, Hongqing Wang, Dan Li. Remote sensing assessment of sediment re-suspension during Hurricane Frances in Apalachicola Bay, USA. (Remote Sensing of Environment, Vol.113(12), 2009: pp. 2670-2681, DOI information: 10.1016/j.rse.2009.08.005);
- [3] Shuisen Chen*, Ligang Fang, Hongli Li, Weiqi Chen, Wenrui Huang. Evaluation of a three-band model for estimating Chlorophyll-a concentration in tidal reaches of the Pearl River Estuary, China. *ISPRS Journal of Photogrammetry & Remote Sensing*, Vol.66(3), 2011: pp 356-364, DOI: 10.1016/j.isprsjprs.2011.01.004.
- [4] Wenrui Huang, Debraj Mukherjee, Shuisen Chen. Assessment of Hurricane Ivan Effects on Chlorophyll-a in Pensacola Bay by MODIS-250m Remote Sensing. *Marine Pollution Bulletin*, Vol. 62(3), March 2011, pp 490-498.
- [5] Shui-sen Chen, Wenrui Huang, Weiqi Chen, Hongqing Wang. Remote Sensing Analysis of Rainstorm Effects on Sediment Concentrations in Apalachicola Bay,USA. *Ecological Informatics*, In Press, 2010, 10.1016/j.ecoinf.2010.12.001
- [8] Ligang Fang; Shuisen Chen*; Hongqing Wang; Junping Qian; Lixin Zhang. Detecting Marine Intrusion into Rivers using EO-1 ALI Satellite Imagery: A Case Study in Modaomen Waterway, Pearl River Estuary, China. *International Journal of Remote Sensing* , Vol.31 (15), 2010 : pp. 4125 - 4146. DOI: 10.1080/01431160903229218)
- [9] SHUISEN CHEN*, LIGANG FANG, LIXIN ZHANG, Wenrui Huang. Remote sensing of turbidity in seawater intrusion reaches of Pearl River estuary- A case study in Modaomen waterway of Pearl River Estuary, China (*Estuarine, Coastal and Shelf Science*, Vol. 82(1), 2009: 119-127)[SCI]
- [10] Li-gang FANG, Shui-sen CHEN*, Dong Li, Hong-li LI. Use of reflectance ratios as a proxy for coastal water constituent monitoring in the Pearl River Estuary (*SENSORS* 2009, 9, 656-673; doi:10.3390/s90100656 [ISSN 1424-8220]) [SCI]

- [11] Shui-sen CHEN*, Liang-fu CHEN, Qin-huo LIU, Xia LI, Remotely Sensing and GIS-based Integrated Analysis of Coastal Changes and their Environmental Impacts in the Lingding Bay of the Pearl River Estuary, South China, *Ocean and Coastal Management*, Vol.48(1), 2005 :pp. 65-83
- [12] Xinghua Xue, Shuisen Chen etc., A Review of Linear Spectral Mixing Model in Remote Sensing Applications, *Journal of Information & Computational Science*, Volume 1 (3) , 2004: 361-368(EI)

In situ and other data

We have carried out an in-situ experiment and collect the water quality parameter (Secchi depth, COD and chlorophyll-a, TSS etc), water depth, surface spectra (ASD: 350-2500nm) for 19 sites, and MODIS image. The inherent optical property (IOP) which is used in the semi-analytical algorithms is available in the internet. More in-situ data will be collected once the HICO image is scheduled for programming.

3. Output and deliverables

In the study, complicated band computation is being used to protrude the characteristic of clarity and increase the precision of inversing result. The two goals below will be completed:

- 1) The precision of inversing clarity result will be better than 80%.
- 2) At least, one article will be published using this data.
- 3) We will produce the coastal wetland vegetation mapping and the transparency mapping in the Pearl River Estuary of South China.

The algorithms for new products will be returned to the HICO program finally. We will attend the annual HICO team meeting to present our research results.

4. References

Prasad, K. S., et al. (1998). Ocean color algorithms for estimating water clarity (Secchi depth) from SeaWiFS. *Journal of Advanced Marine Science and Technology Society*, 4, 301–306.

Kloiber, S. M., et al. (2002). A procedure for regional lake water clarity assessment using Landsat multispectral data. *Remote Sensing Of Environment*, 82, 38–47.

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The Hyperspectral Imager for the Coastal Ocean (HICO): Policy for Data Distribution to University and International Collaborators.

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