A System to Measure the Data Quality of Spectral Remote Sensing Reflectance in Natural Waters

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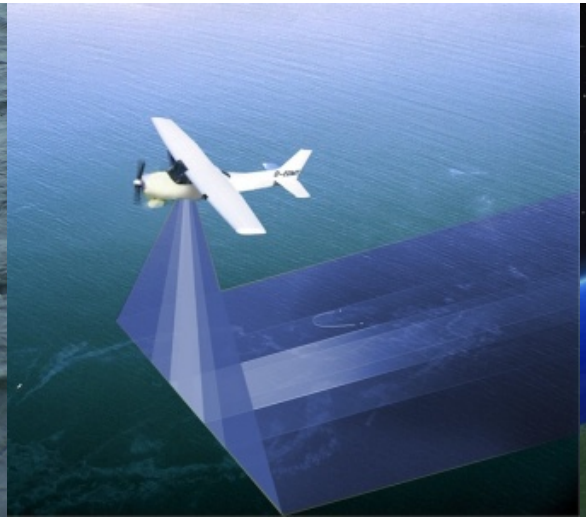
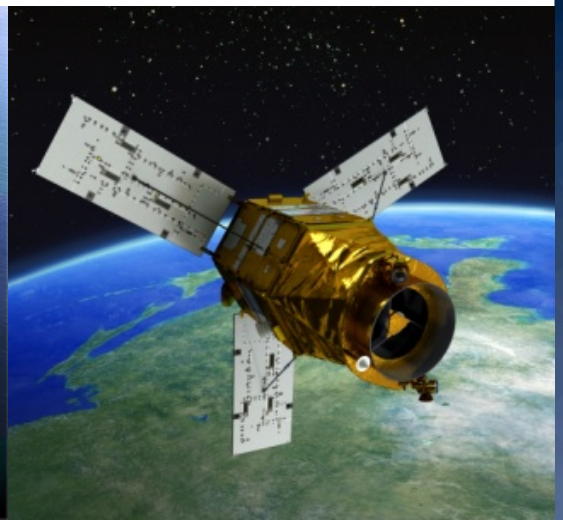
INTRODUCTION

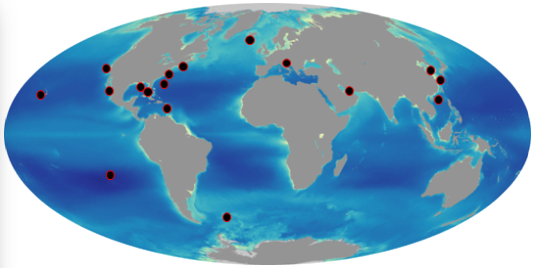
- **Remote sensing reflectance (Rrs) is a fundamental ocean color product**
- Quality of in situ data may be subject to calibration, strategies of deployment, data processing, cloudiness, wave focusing…
- Measurement errors/uncertainty of air- or spaceborne instruments include atmospheric correction, BRDF, white caps, glints, adjacency effect, bottom reflectance, etc.
- **So, to ensure good data quality for Rrs measurements is critical for appropriate interpretation of ocean color observations**

INTRODUCTION

- There are a number existing QA/QC procedures, e.g., NASA ocean color quality-flag system, QA systems for MOBY, and AERONET-OC
- Individual investigators collect, process and quality-control their data following certain protocols, which are usually dependent on instrument/software/operator
- **But there exists no general method to determine the data quality of given individual Rrs spectra**
- **The goal is to develop a QA system applicable to any individual Rrs spectrum measured in aquatic environments, independent of instrument systems, locations and operators.**

REFERENCE DATA

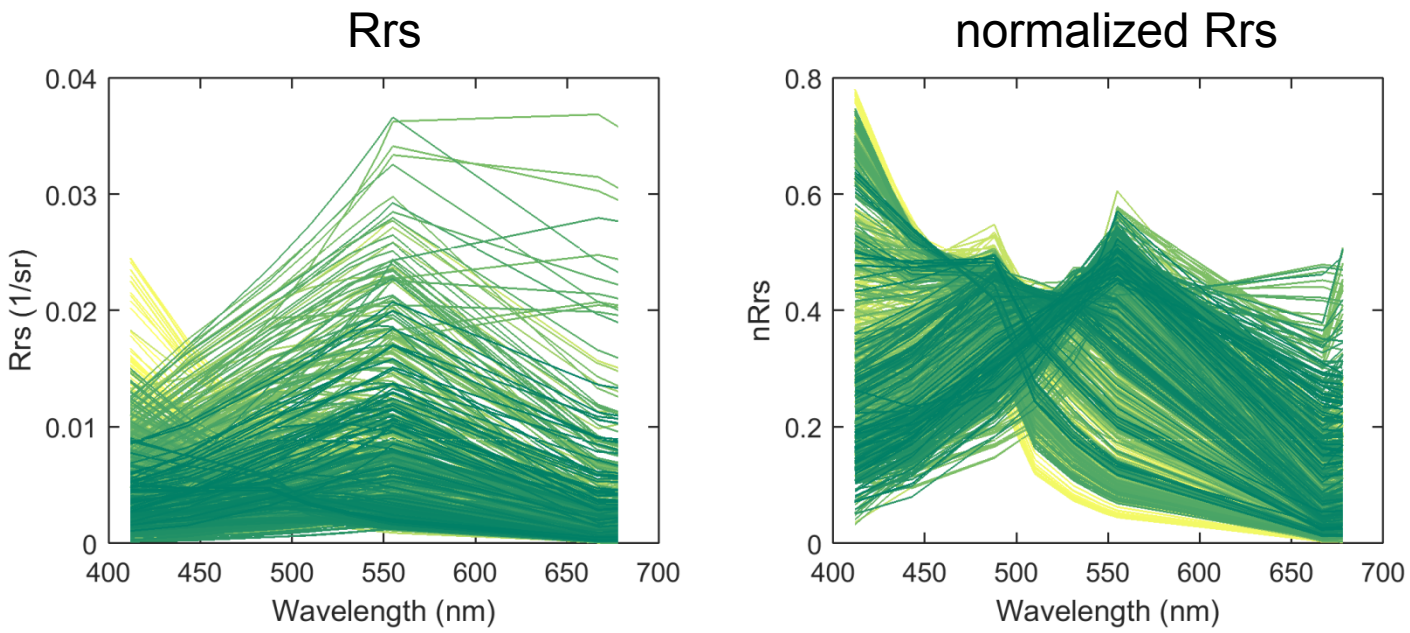


Sources of data:

- AERONET-OC
- NASA GEO-CAPE
- NASA PACE
- NOAA VIIRS
- RaDyO
- BIOSOPE

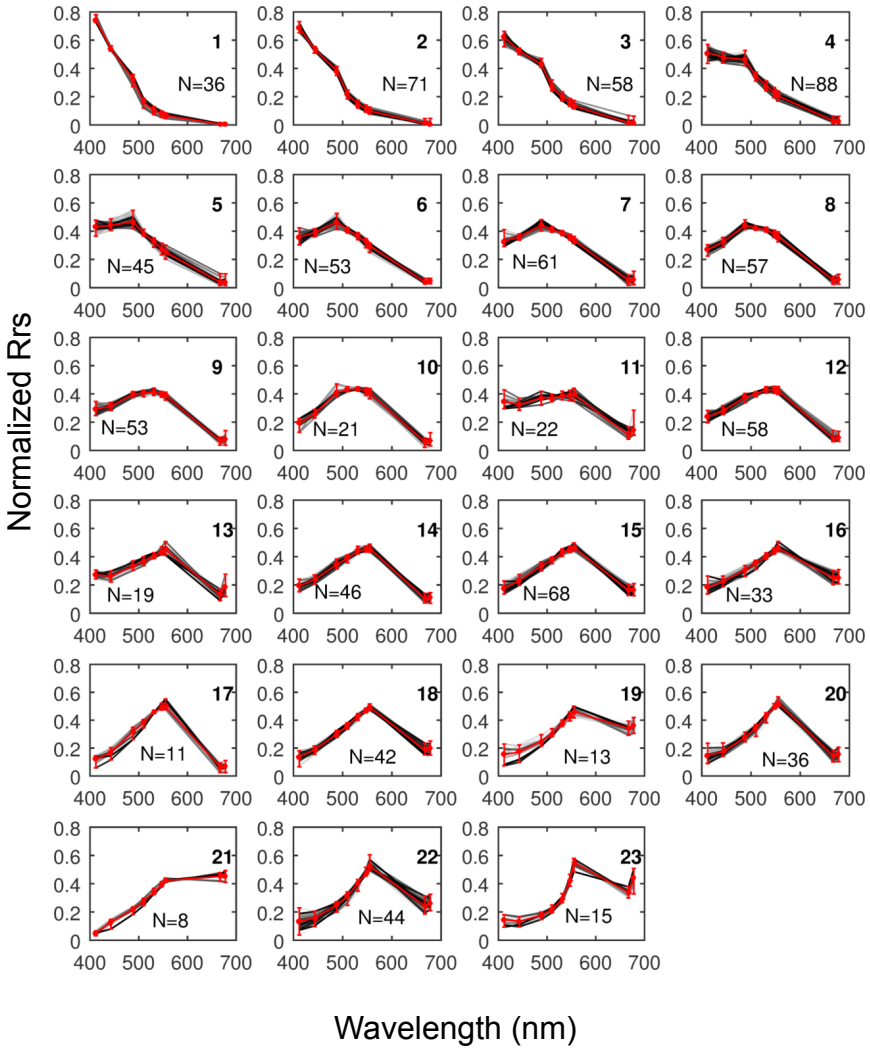
…

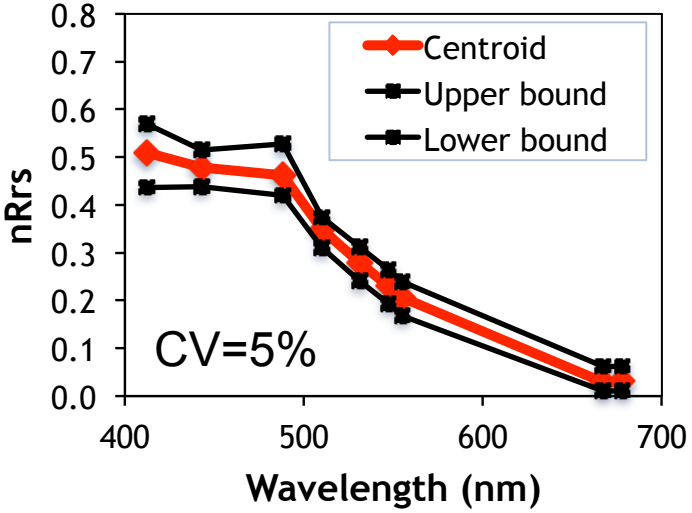
WATER CLASSIFICATION



- Rrs spectra at wavelengths (412, 443, 488, 510, 531, 547, 555, 667, and 678 nm) are extracted and normalized
- Numbers of clusters are determined by GAP method
- Normalized Rrs spectra are clustered with K-means approach (cosine distance);

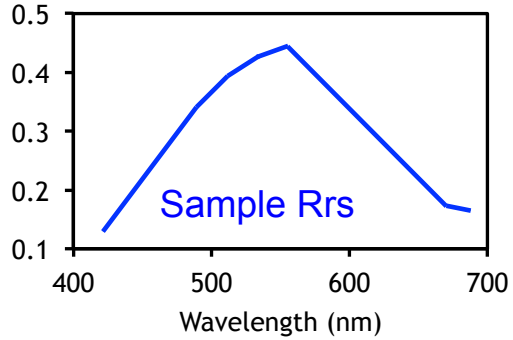
23 WATER TYPES

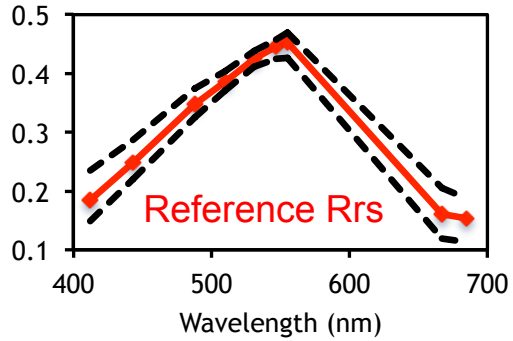


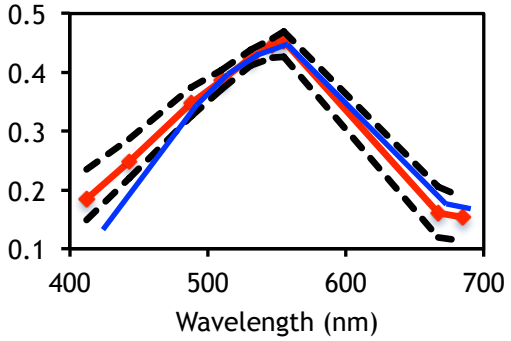


- 23 water types, with characteristic Rrs spectral shapes
- Within each cluster, nRrs spectra vary over a narrow range about their centroids

SCORE METRIC: 3 STEPS







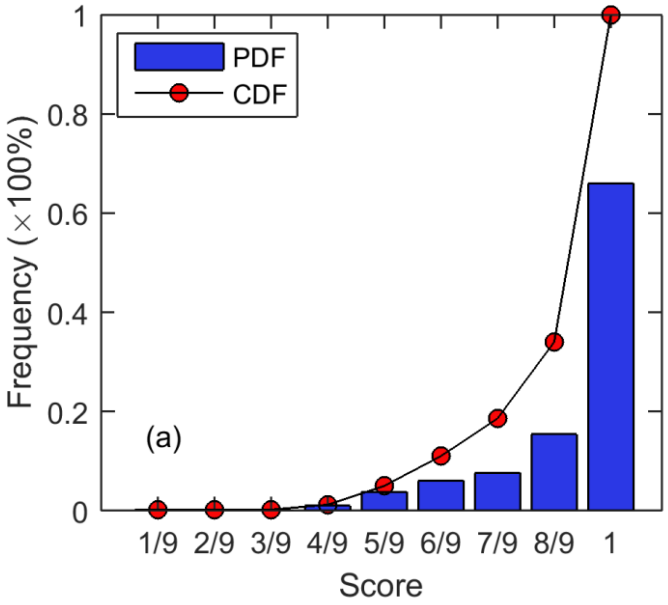
- Step 1:
  Normalizing Rrs spectra to be comparable to 23 references
- Step 2:
  To decide which water type it should be classified to, using spectral angle mapper
- Step 3:
  Compare with the upper and lower bounds, band by band, and compute the total score

- **A score is assigned to each Rrs spectrum, representing the percentage of the total number of good-quality bands**
- **It varies between 0 and 1, with 1 corresponding to the best quality, and 0 the most questionable quality**

VALIDATIONS

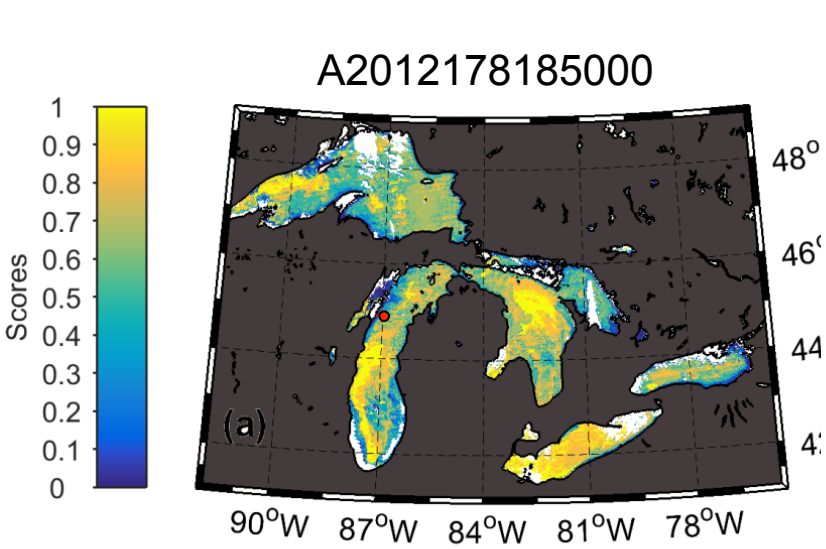
Simulated Rrs

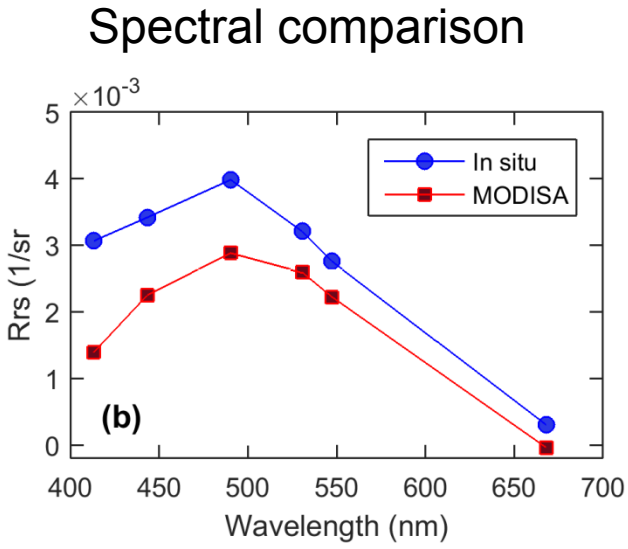
Frequency distribution of scores



- Hydrolight simulated Rrs with IOCCG published IOPs (N=500)
- 85% of data have scores>0.9
- Only 6 data points have scores<0.5
- Different combinations of wavelengths (corresponding to SeaWiFS, MODISA, VIIRS, Landsat-8) are tested. No significant impacts are found

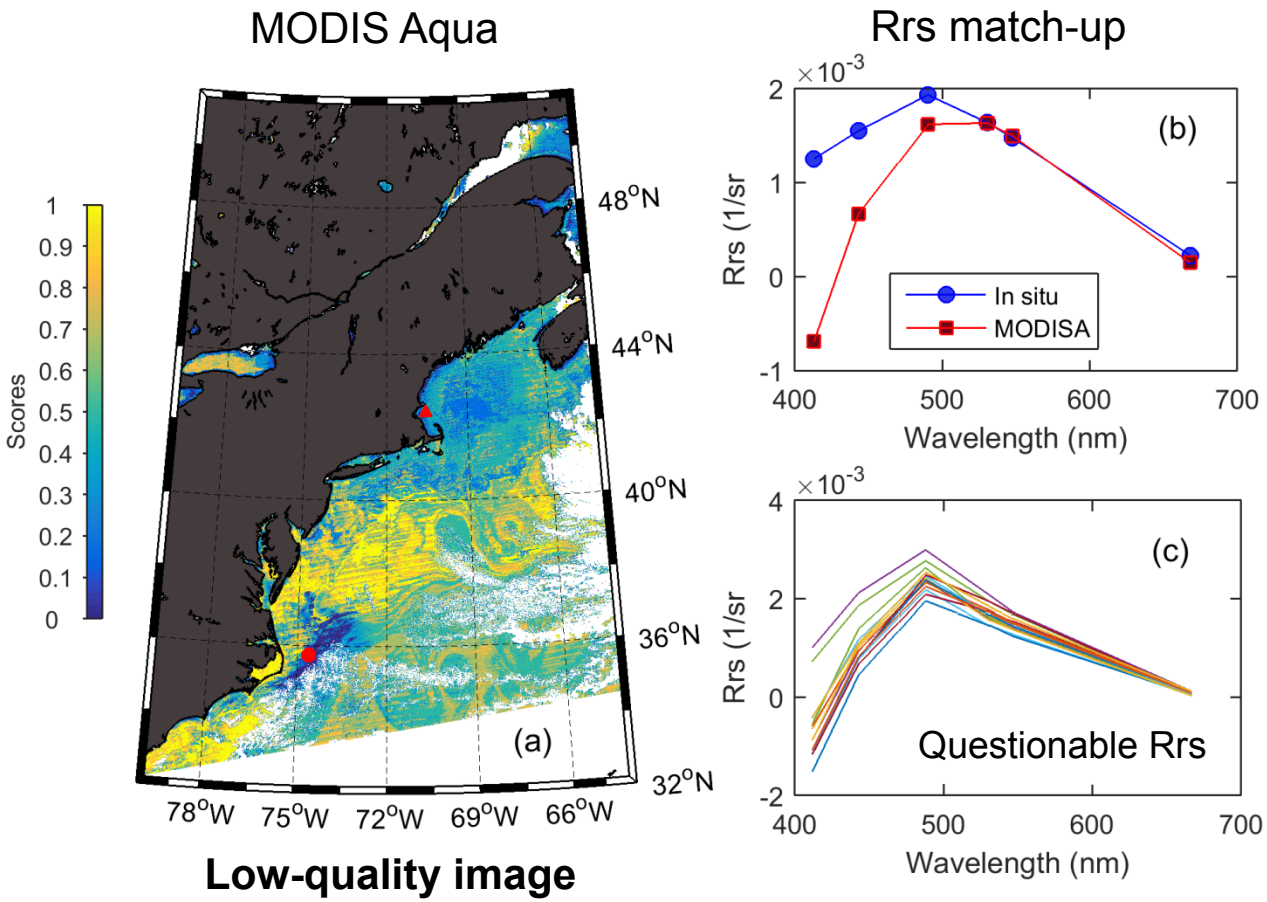
INLAND WATERS





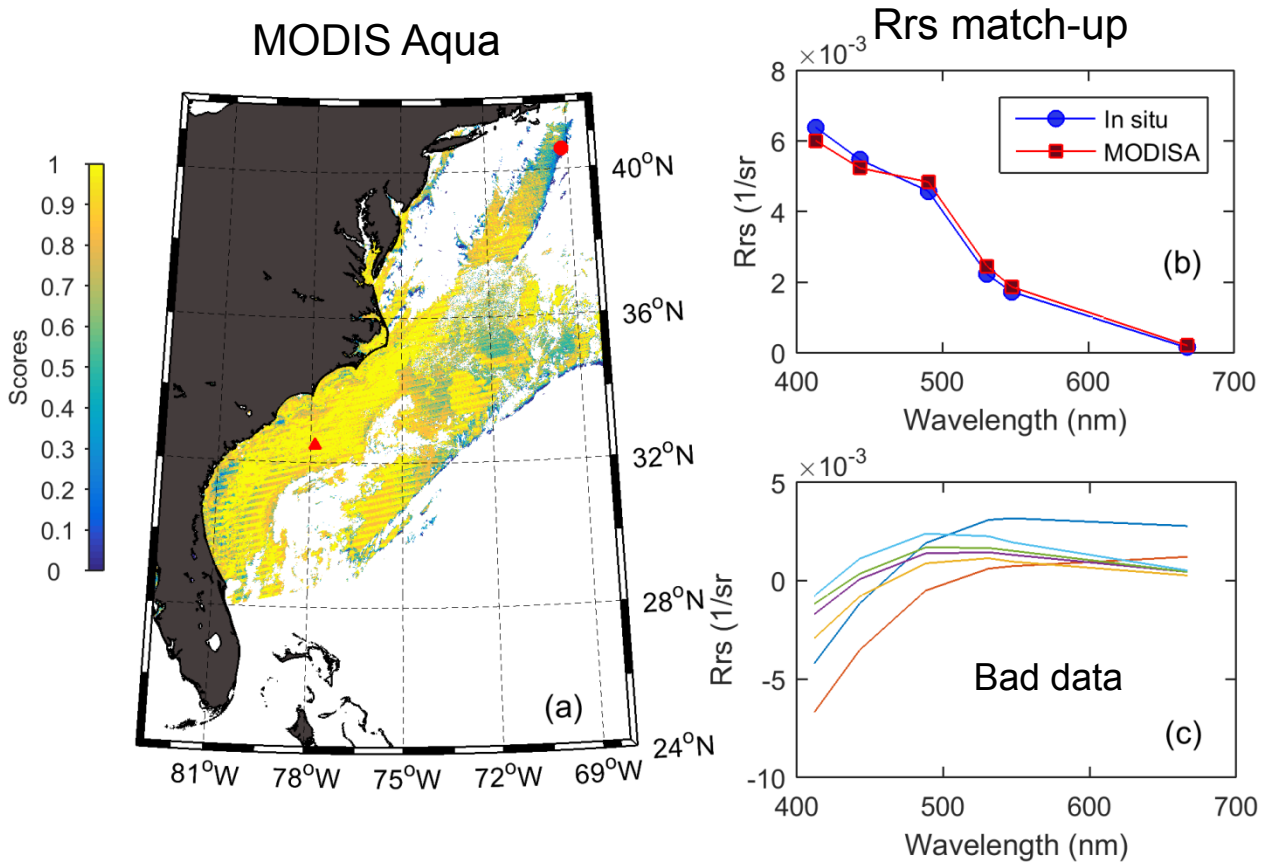
- Most of pixels are found with high scores
- Pixels close to shorelines/islands have low scores (<0.5)
- In situ measurement confirms the low-score result
- The scoring results complement with NASA data quality flag-system

COASTAL/OCEANIC WATERS



- This image is typical of low-quality ocean color measurements
- Rrs matchups in Massachusetts Bay confirms the low-score observations

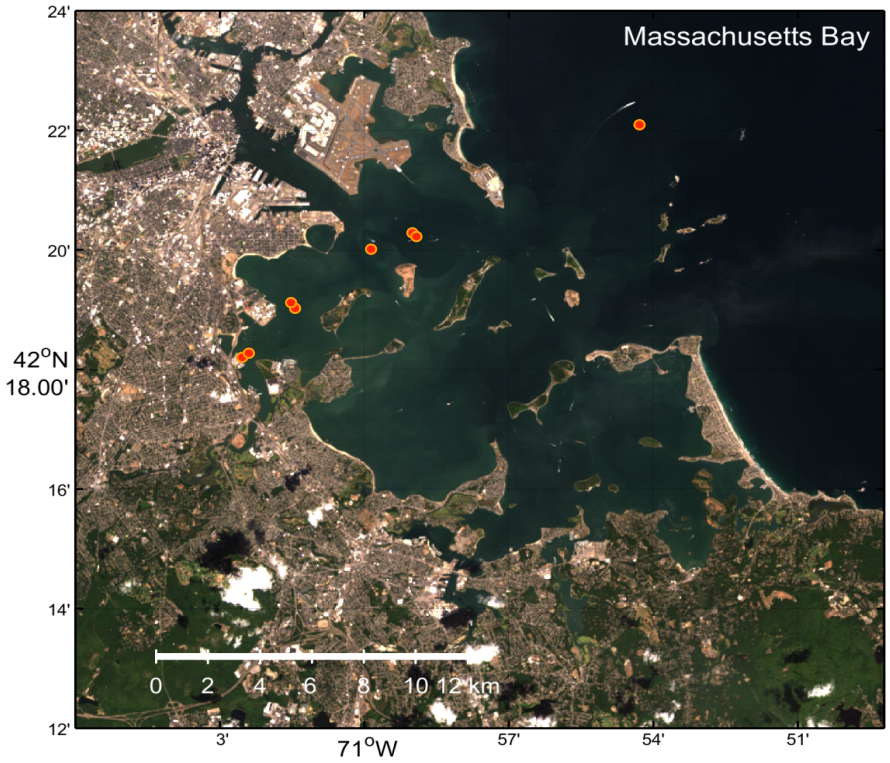
COASTAL/OCEANIC WATERS

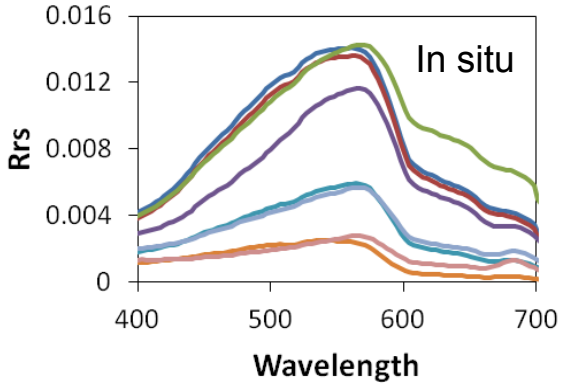


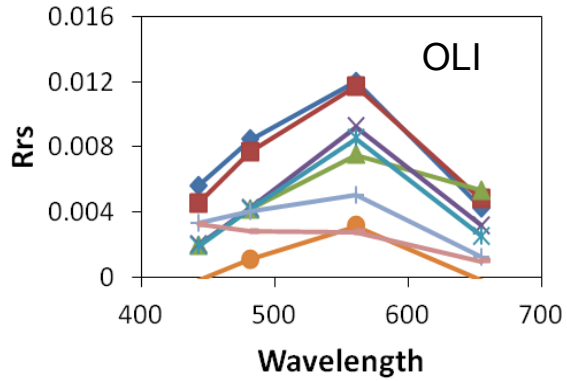
- This image is typical of high data quality throughout!
- Rrs matchups in the offshore water (Gulf Stream) confirms the high-score observations

COASTAL WATERS

Landsat-8/OLI







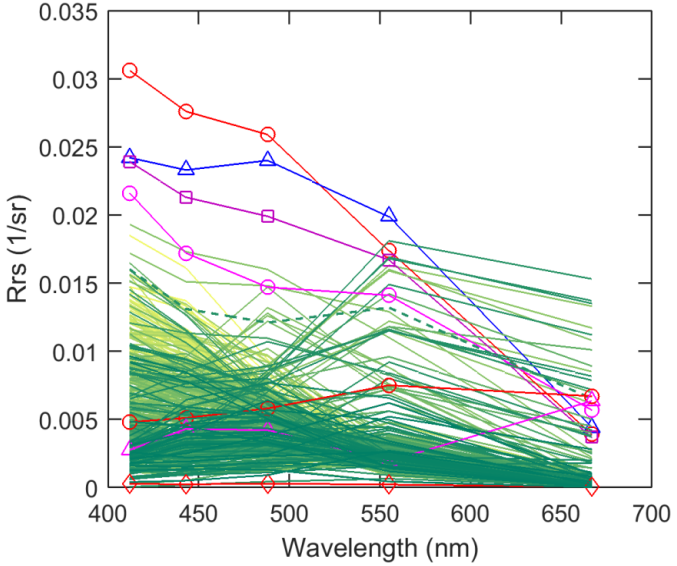
- Score metric is also applicable to Landsat-8/OLI for quality assessment
- Our matchups show an average score of 0.7 in Boston Harbor

Wei and Lee (2016), in prep

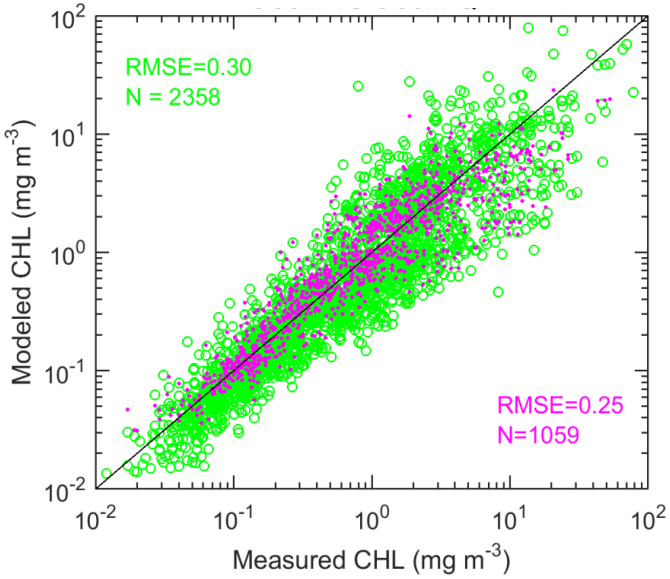
IN SITU MEASUREMENTS

- There are a great number of Rrs spectra archived in SeaBASS
- The data were collected over 20 years…
- It is critical to do a quality assessment before the data can be used
- An example sub dataset (NOMAD) of SeaBASS is tested below for demonstration purpose

SeaBASS/NOMAD



Chlorophyll a concentrations



SUMMARY

- A new quality assurance system is developed based on water type classification
- The system is for quality assurance of individual Rrs spectra
- It has been applied to satellite in-situ ocean color data
- This system (version 1) can be easily updated when more reliable measurements are available
- This system is best applicable to optically deep waters

ACKNOWLEDGEMENTS

- Collaborators: Giuseppe Zibordi, Chuanmin Hu, and Marlon Lewis
- This study is supported by NASA and NOAA projects
- Matlab script for the QA system is developed and available online: Http://oceanoptics.umb.edu/score_metric