Derivation of Inherent Optical Properties from Satellite Top of Atmosphere Measurements in Optically Complex Waters

Principal Investigator

Susanne Craig, Dalhousie University, CERC.OCEAN

Collaborators

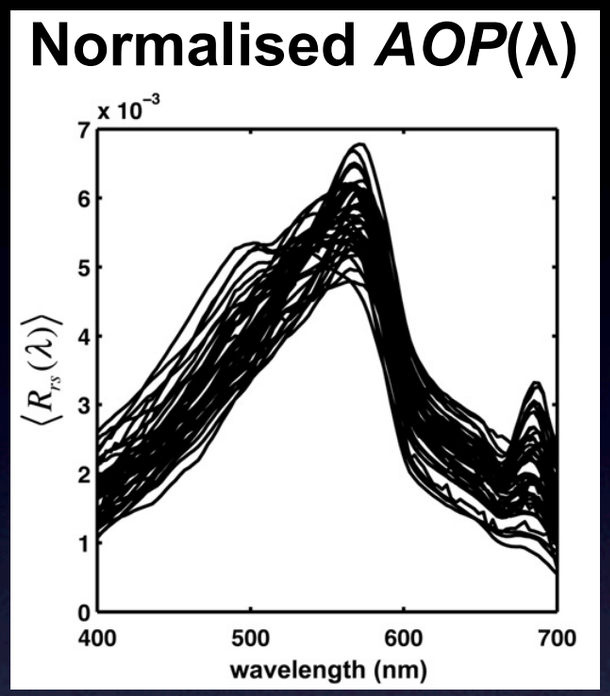
Zhongping Lee, University of Massachusetts, Boston

David Miller, NRL

PACE Science Team Meeting 14-16 January 2015, College Park Marriott, MD

Algorithm Background

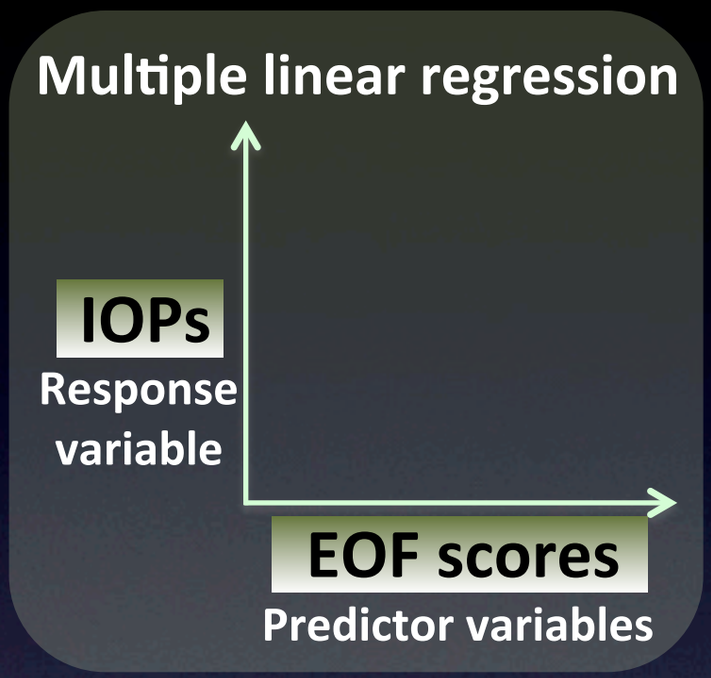
1. Hyperspectral AOP



2. EOF analysis

EOF scores

3. Model to estimate IOPs

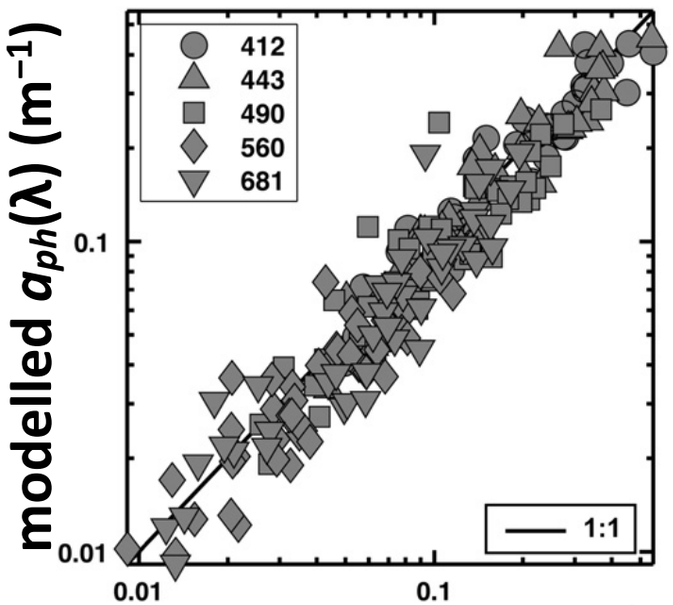


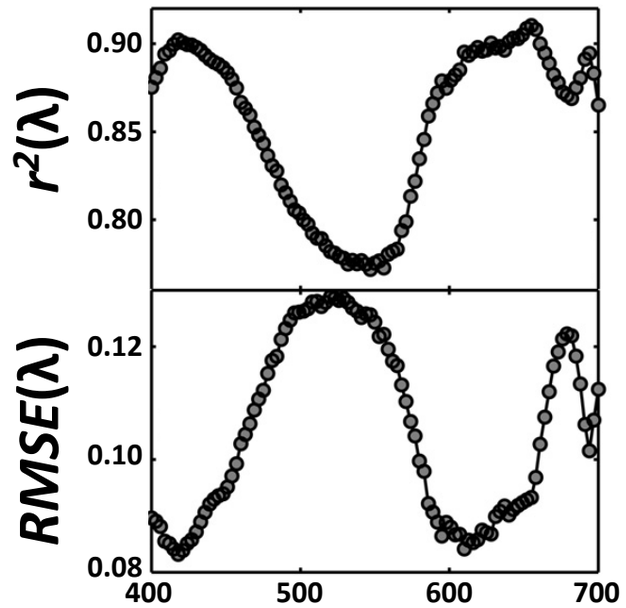
Craig et al. (2012), RSE, 119, 72-83

- Developed using in situ **hyperspectral** measurements
- Empirical orthogonal function (EOF) analysis identifies independent (orthogonal) modes of variance
- EOF scores of the modes that explain ~98% variance were used as independent variables in models of IOPs

Algorithm Performance

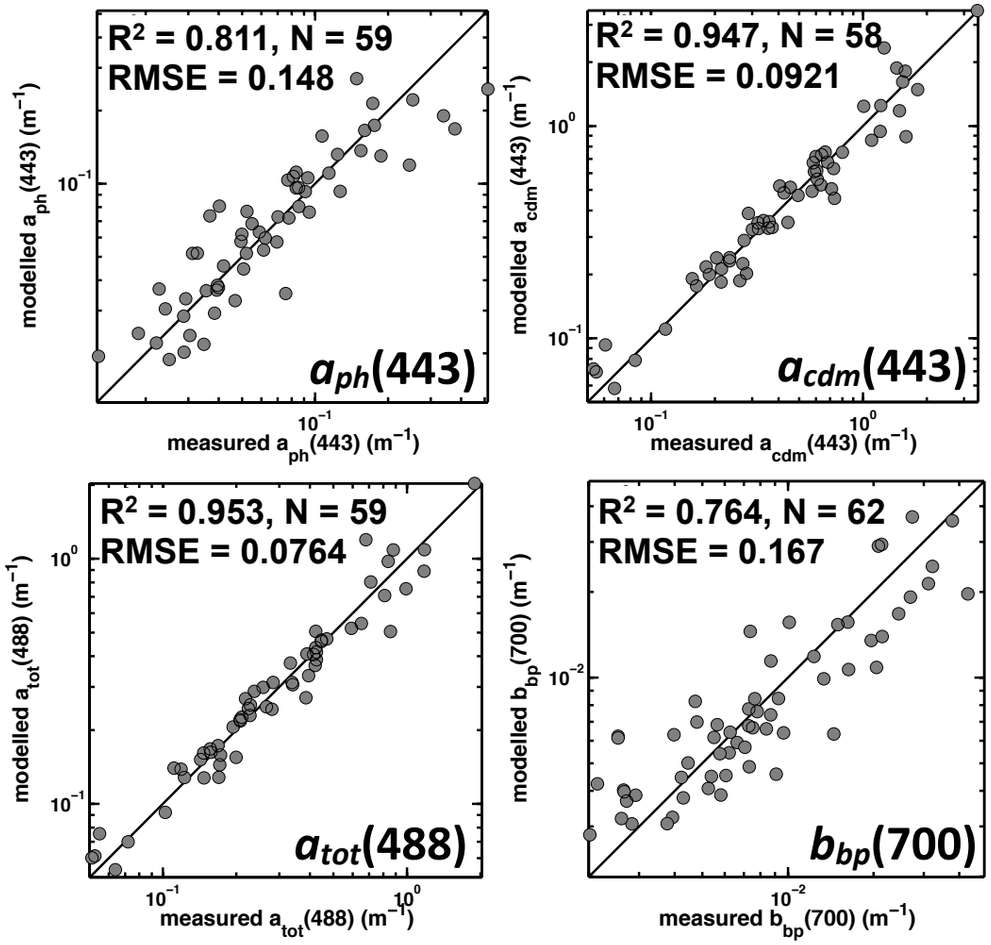
Bedford Basin, Canada





Absorption is heavily dominated by CDOM at both study sites

Big Bend, FL

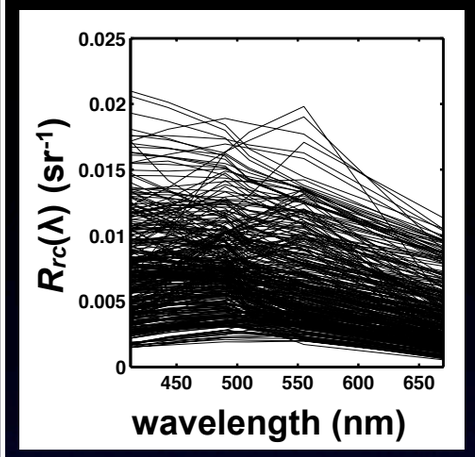


Craig et al. (2012); Craig, Cannizzaro, Hu et al. (in prep)

- Region-specific, *in situ* hyperspectral models applied to waters where standard approaches perform poorly
- Models showed excellent performance
- Satellite-derived models show comparable performance

EOF Algorithm for Top of Atmosphere Measurements

1. NOMAD Rayleigh-corrected R_{rs}

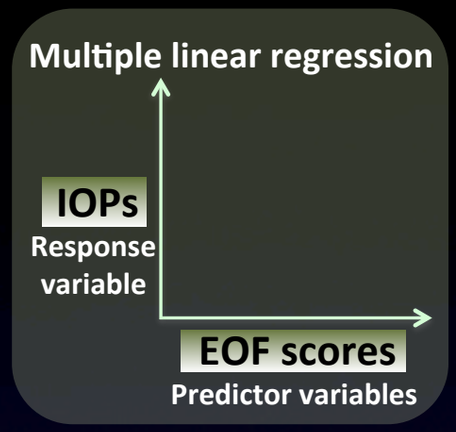


2. EOF analysis

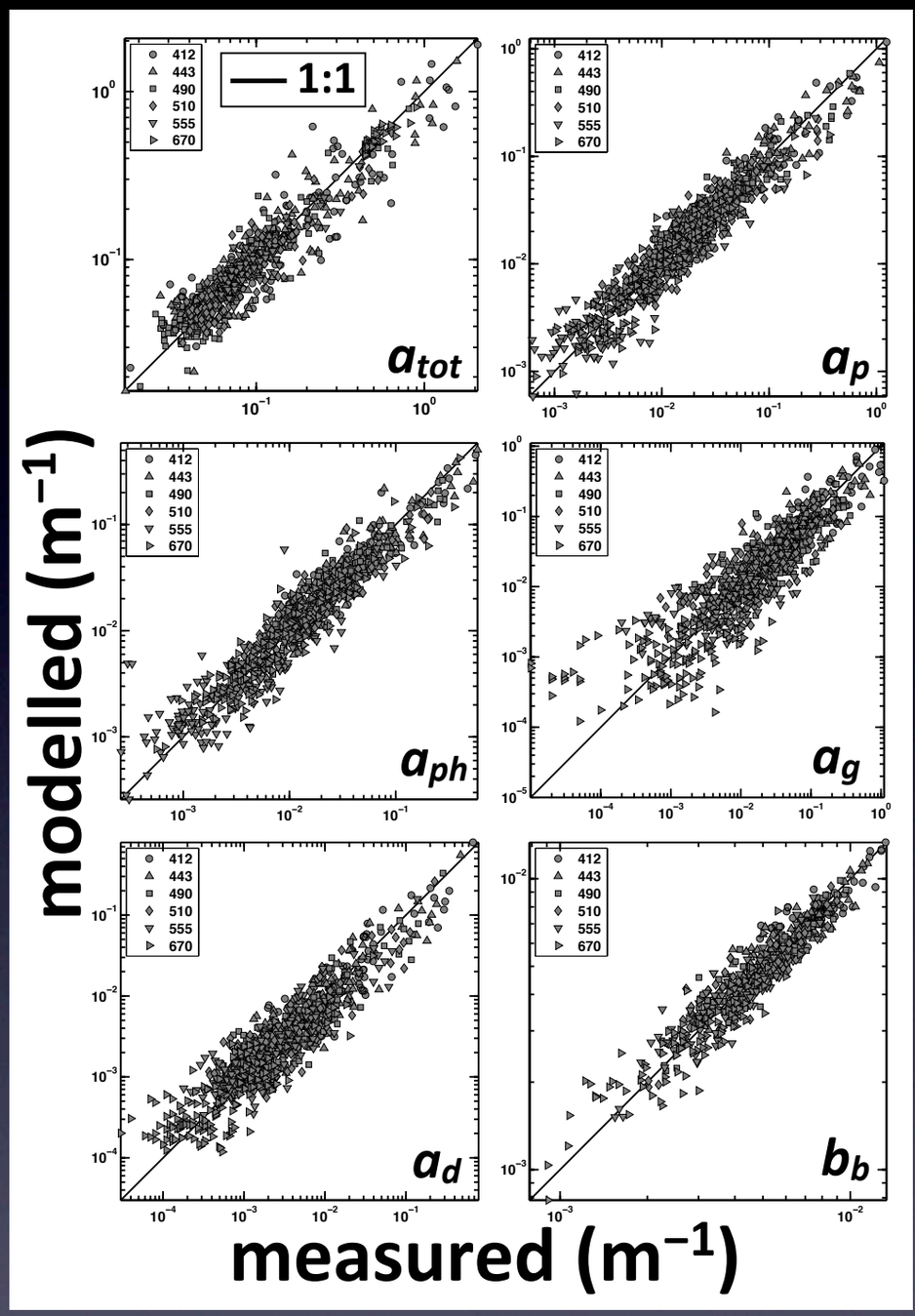
stepwise selection of EOF scores

N.B. Spectra are UN-NORMALISED*

3. Model to estimate IOPs



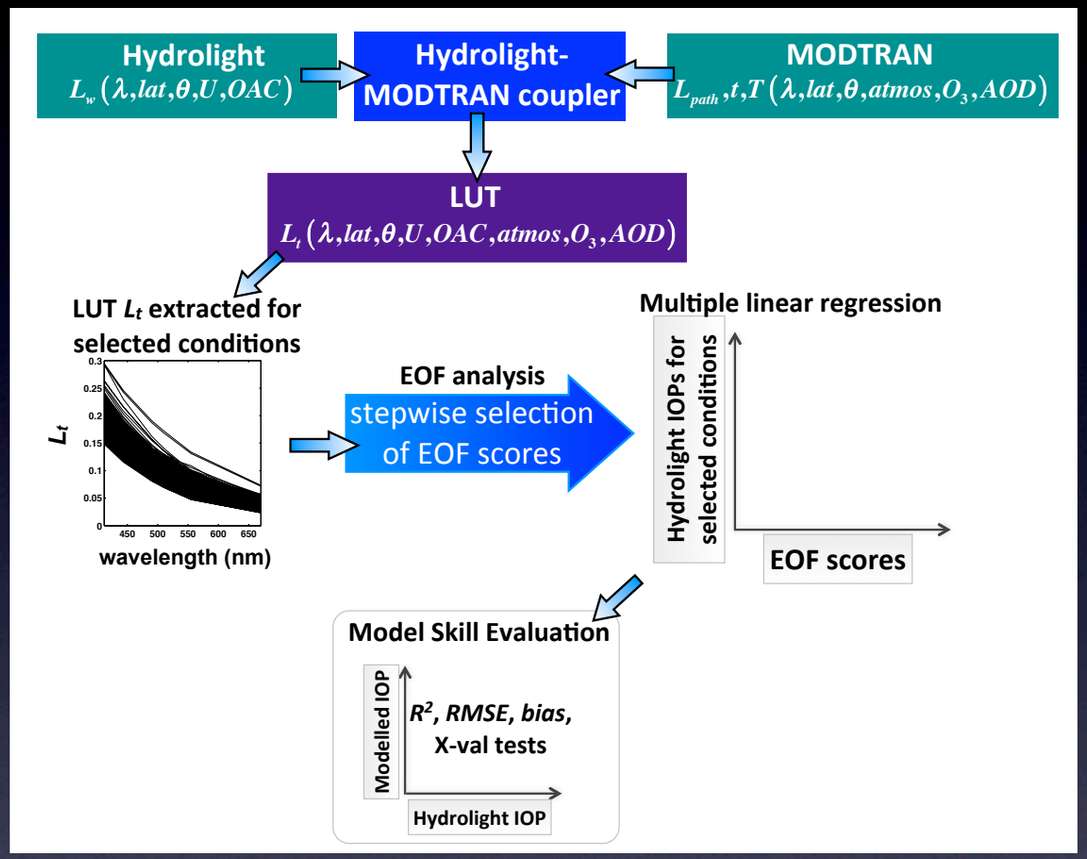
NOMAD TOA satellite to in situ data provided by Jeremy Werdell, GSFC
R_{rc} data processed by Liang Feng & Chuanmin Hu, USF



- Models accurately estimate IOPs with statistics comparable to GIOP
- Cross validation confirms models are robust & not overtrained
- Rayleigh-corrected reflectance models perform similarly to EOF R_{rs} models (not shown)
- EOF ρ_t models also perform similarly (e.g. r^2 reduced by few %)
- Encouraging similar results found for a small MERIS dataset where atmospheric correction is typically extremely challenging (not shown)

Activities Proposed for PACE ST

1. Comprehensive characterisation of TOA EOF model using a synthetic dataset



- TOA radiances generated using Hydrolight-MODTRAN coupler (Pahlevan et al. 2014) ➙ multi-dimensional LUT
- LUT provides the means to:
  - conduct sensitivity analyses
  - characterise best ways to train & implement the model: global, water type, spectral shape, regional???

2. Model development and assessment using HICO & CASI datasets

3. Pseudo-simulation of a hyperspectral NOMAD dataset

➡ This may now be unnecessary if Jeremy Werdell is producing a 'real' hyperspectral NOMAD

Summary

- A straightforward, computationally inexpensive approach to derive accurate models for IOPs from top of atmosphere satellite products has been developed
- Offers a means to derive ocean colour products in scenarios where it may otherwise not be possible - water optical complexity, challenges in achieving atmospheric correction (coastal & inland water bodies)

Fit with PACE IOP ST and Team as a Whole

- The approach is likely to be most valuable in optically complex waters, e.g. coasts, inland. The PACE SDT identified several coastal science questions.
- Consult IOP colleagues to identify where the EOF approach may be most useful ➙ quantitatively compare its performance with other IOP algorithms - uncertainties
- Welcome input and suggestions from AC subgroup on how best to simulate 'challenging' atmospheric scenarios