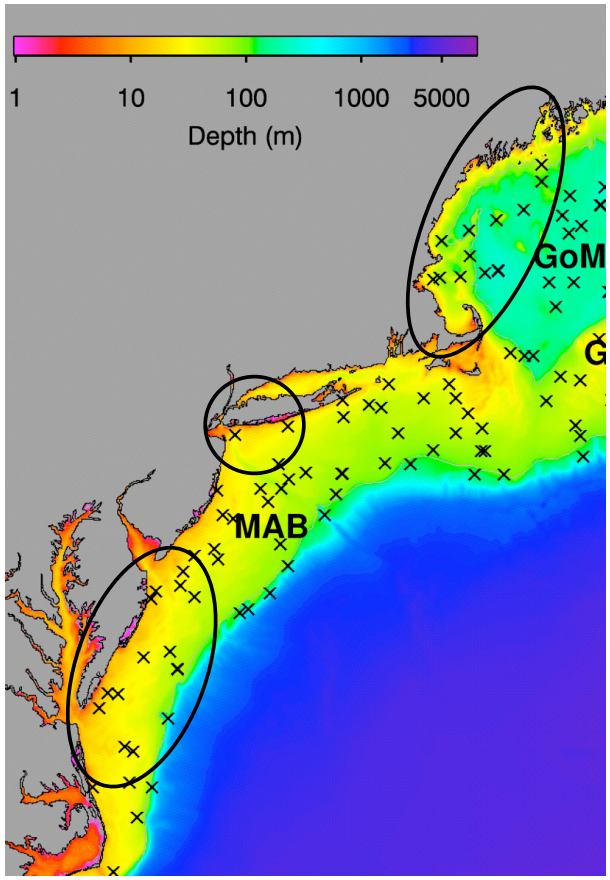
Development of Carbon Data Products for the Coastal Ocean: Implications for Advanced Ocean Color Sensors

Antonio Mannino

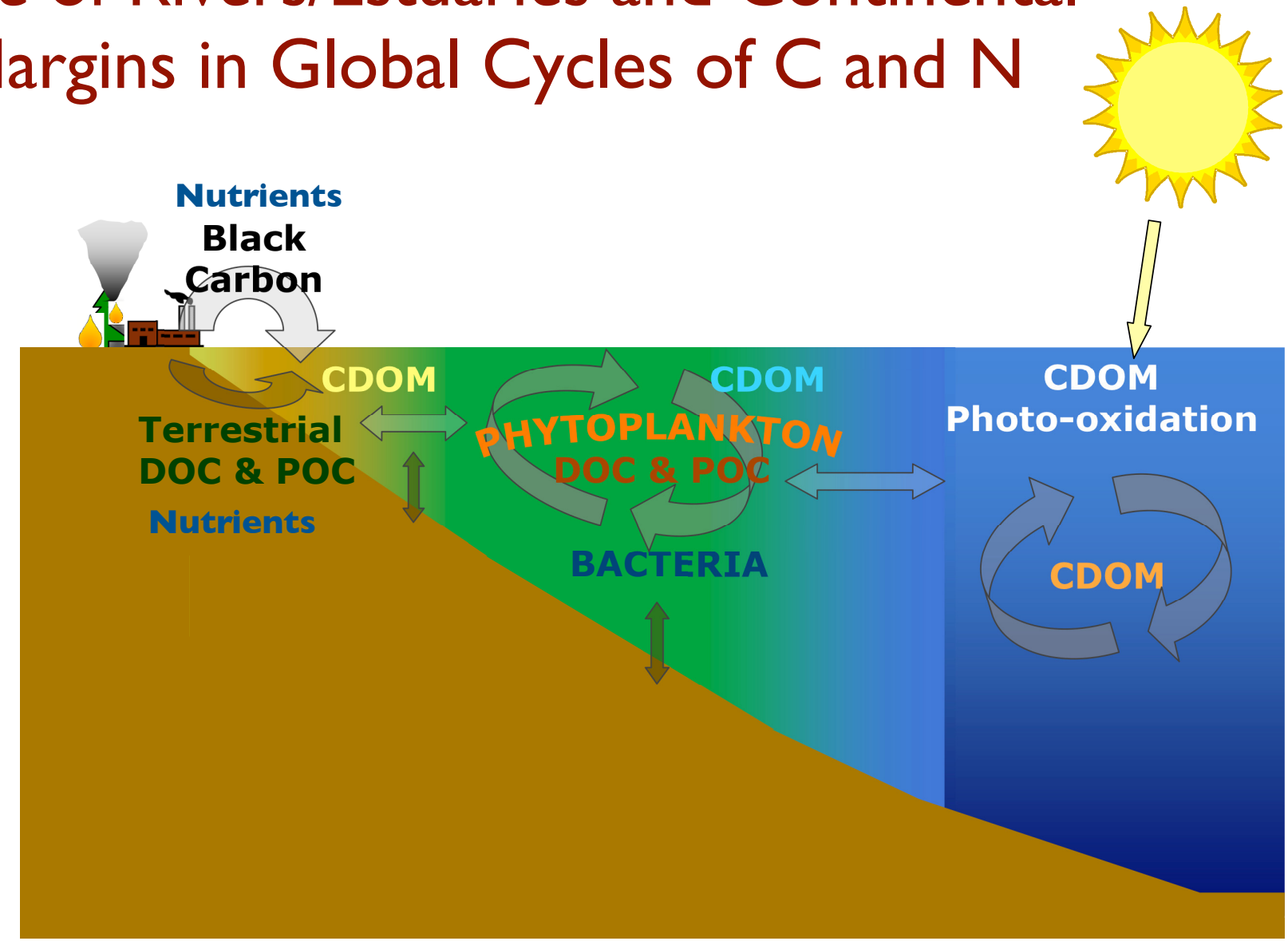
NASA Goddard Space Flight Center
Greenbelt, Maryland USA



- Field Activities & DOC Experiments
- Development of CDOM, DOC, POC, ... algorithms
- Products using MODIS Hi-Res SWIR atmospheric corrections
- NASA GEO-CAPE mission formulation studies

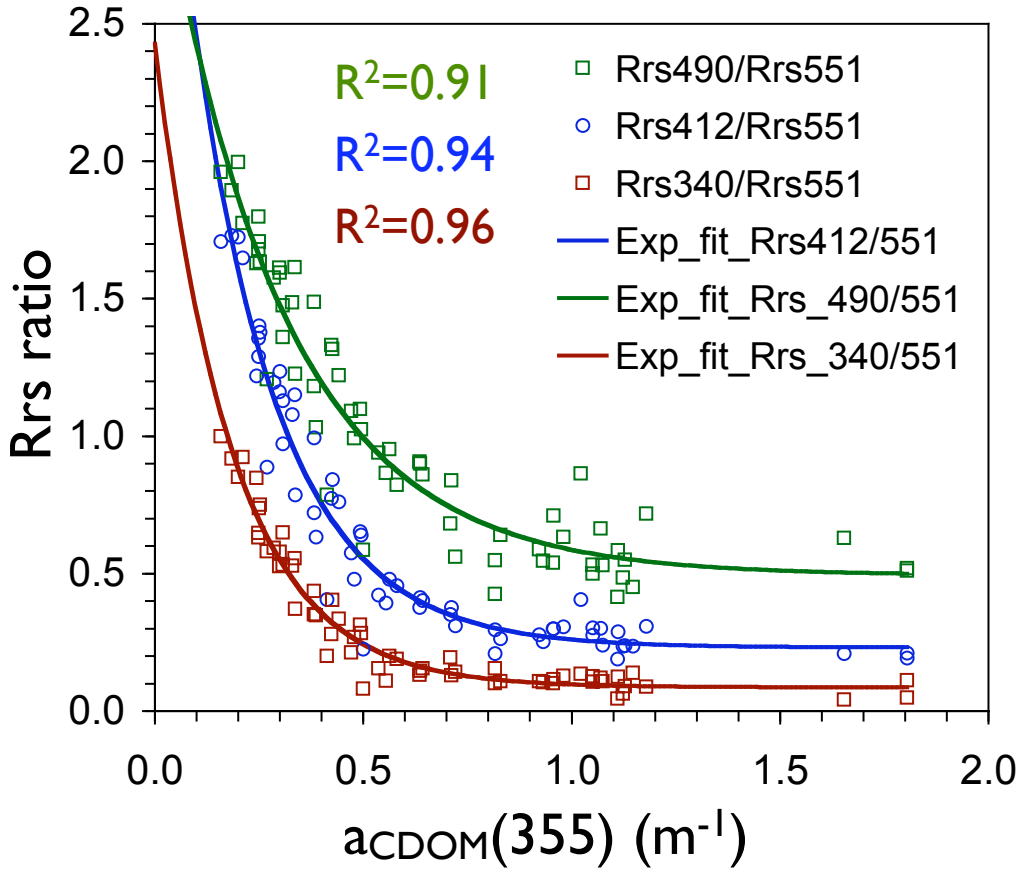
Acknowledgments: Stanford Hooker, Mary Russ, Xiaoju Pan, Randy Kawa

Role of Rivers/Estuaries and Continental Margins in Global Cycles of C and N



Southern MAB CDOM Algorithm

2005 & 2006 in-water Radiometry Field Data

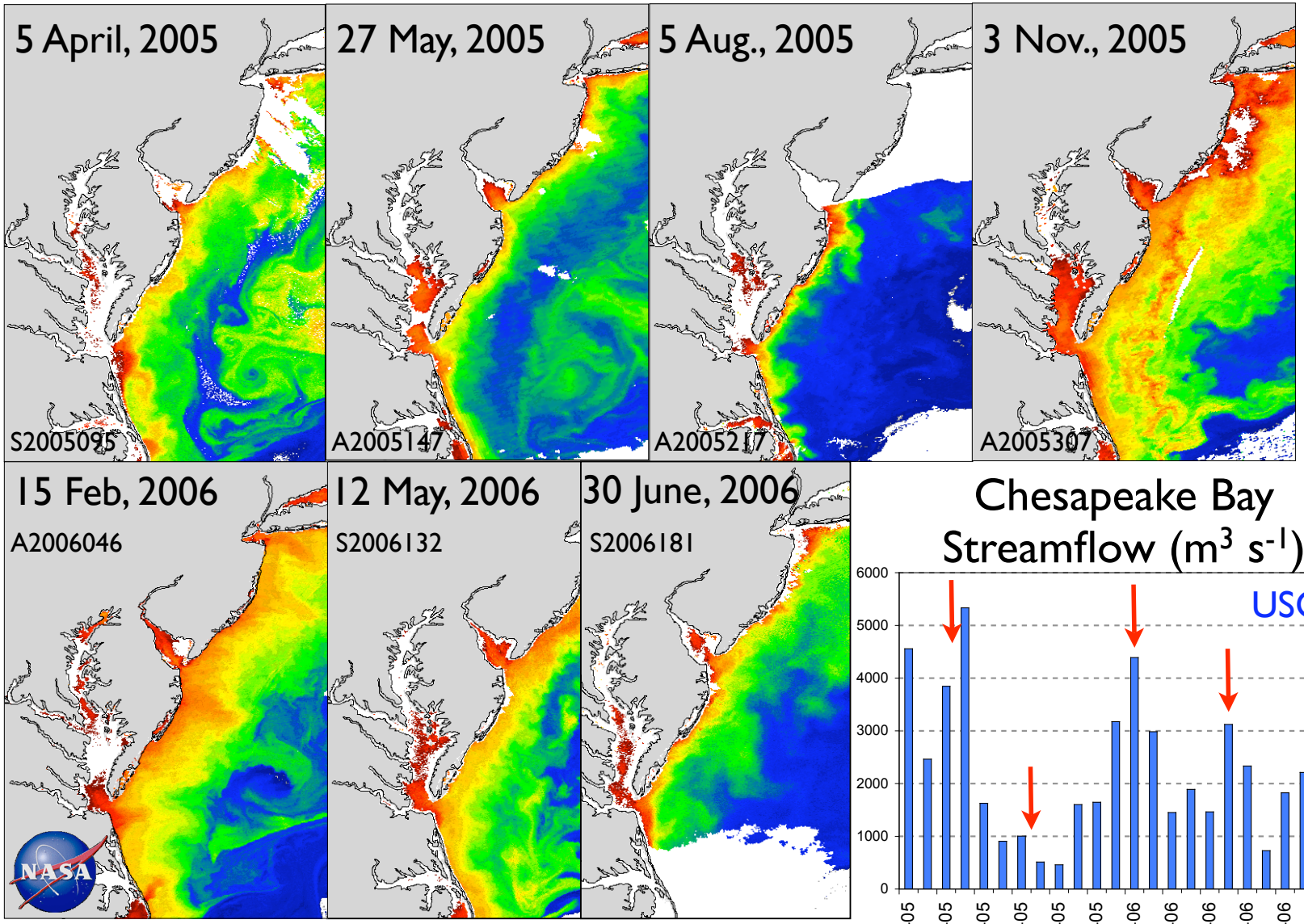


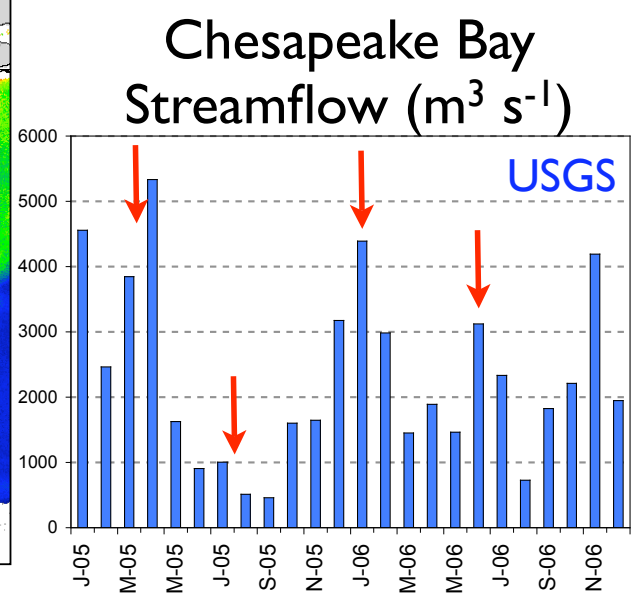
- Prefer to use Rrs(412/555) band ratio - but atmospheric correction issues for sensor retrieval of 412 nm band.
- OBPG expects 412nm band improvements after spring reprocessing.
- Algorithm range limited to range of field data.
- UV bands should yield more robust retrievals of CDOM.

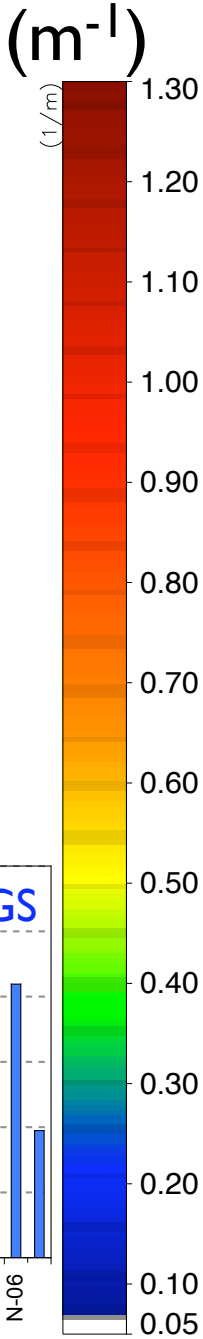
$a_{CDOM}(355) = \ln[(Rrs490/Rrs551 - 0.494)/2.7]/-3.371$

Radiometry data from Stan Hooker

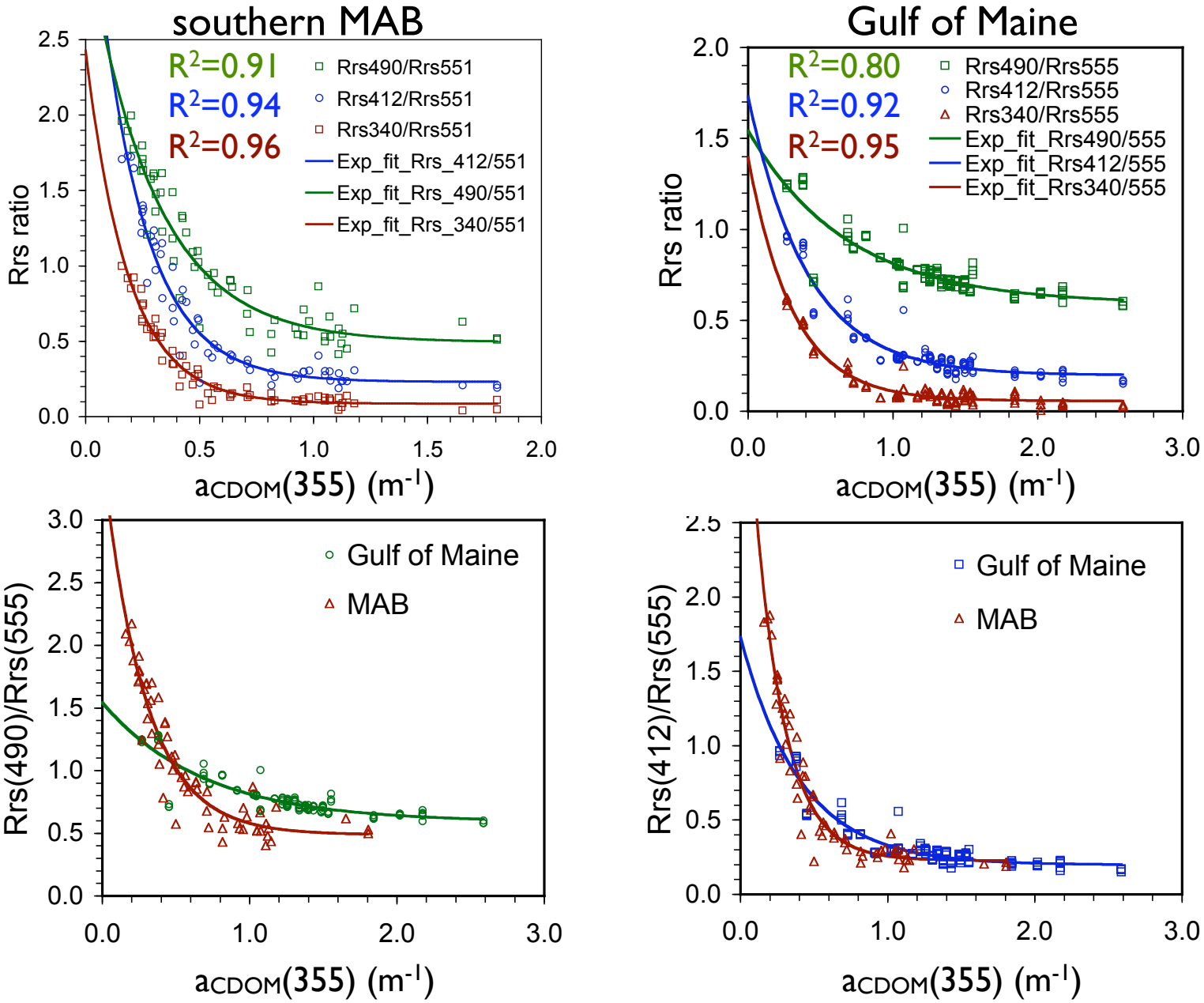
Satellite $a_{CDOM}(355)$





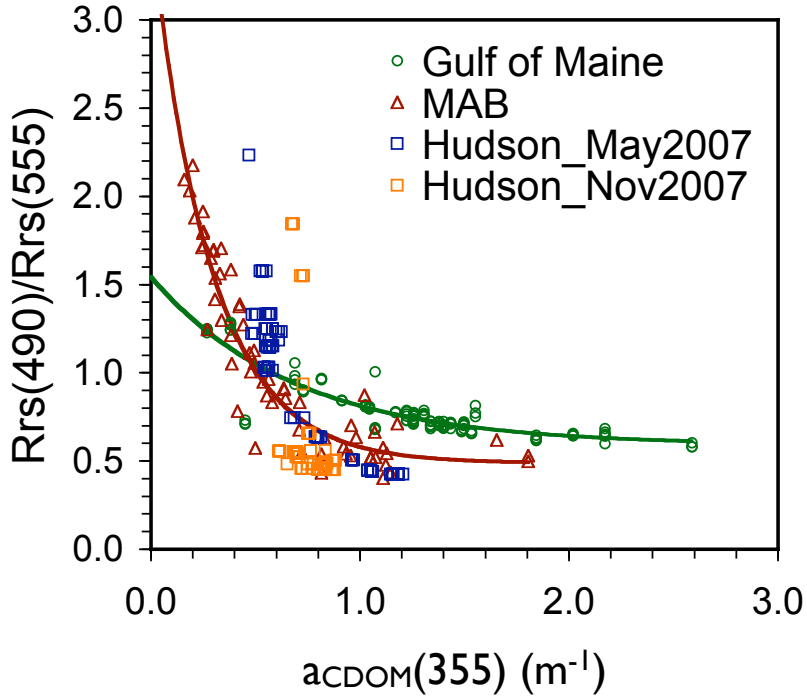


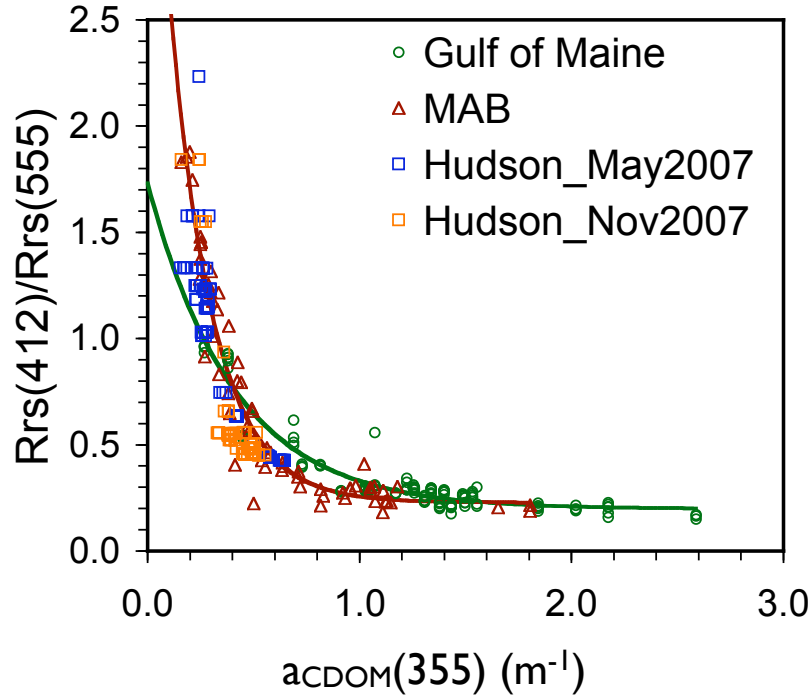
CDOM Algorithms from UV and VIS bands



Radiometry data from Stan Hooker

CDOM Algorithms from in-water VIS bands

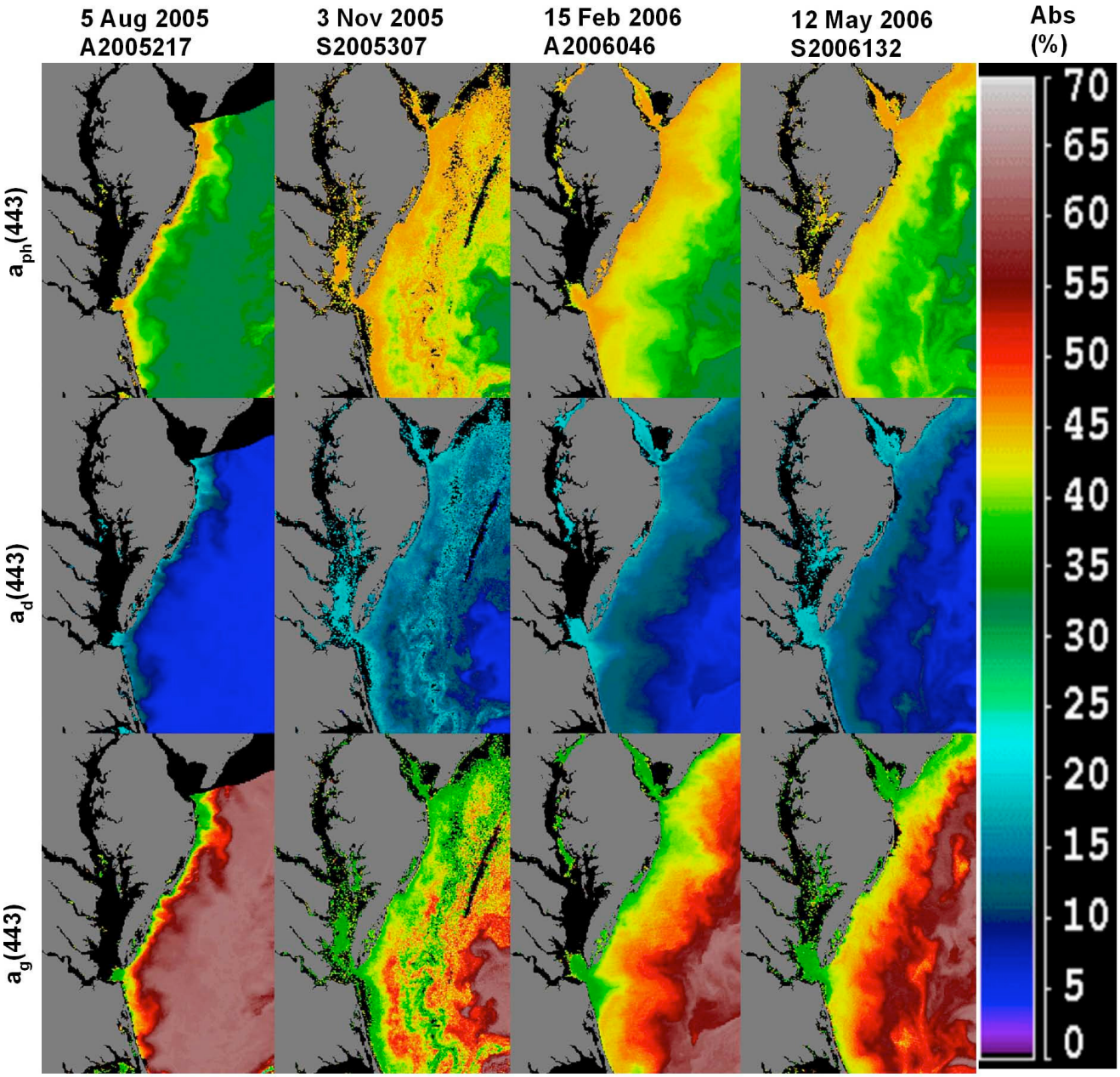


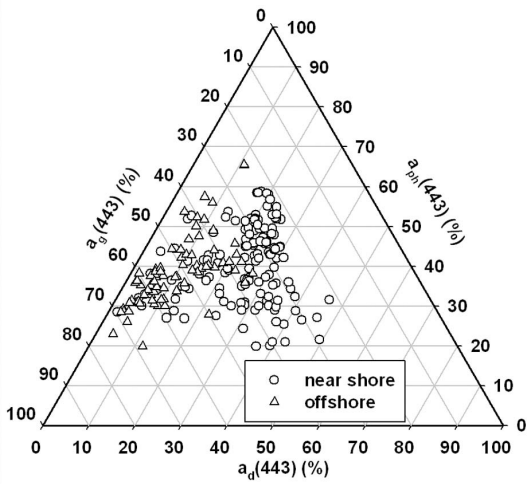


Rrs(412)/Rrs(555) band ratio yields very consistent relationship with CDOM abs. for all 3 regions compared to the Rrs(490)/Rrs(555) band ratio.

Radiometry data from Stan Hooker

Constituent Absorption in the Coastal Ocean



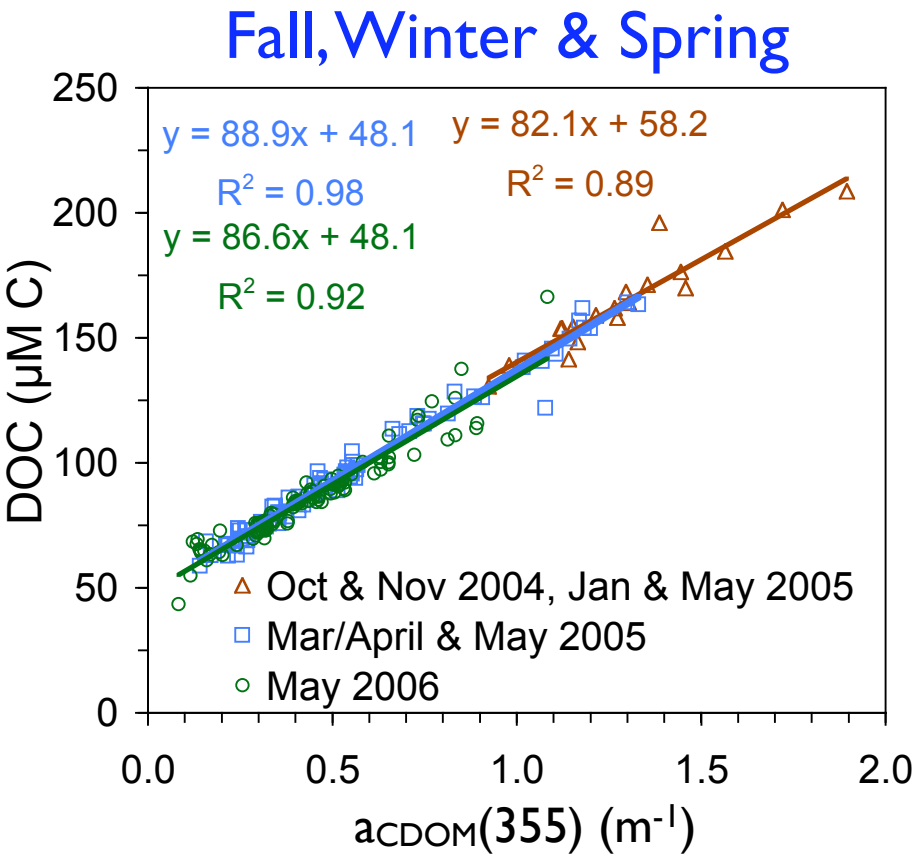


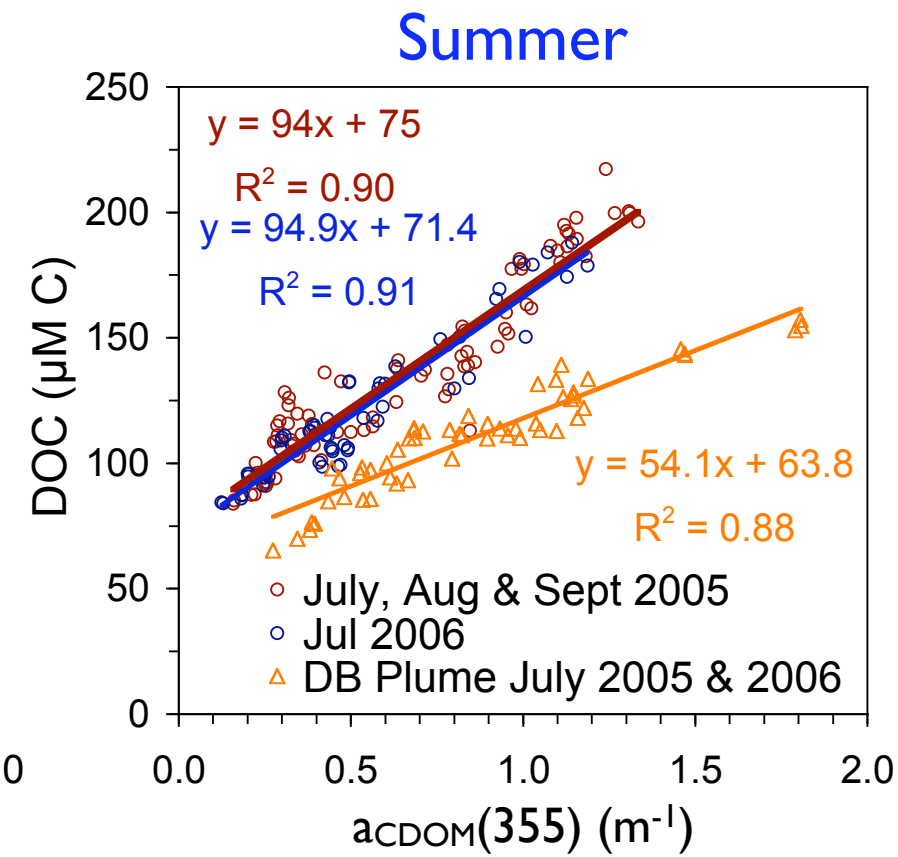
CDOM absorbs a significant portion of PAR which may impact PP and should be accounted for in PP models.

from Pan et al. 2008

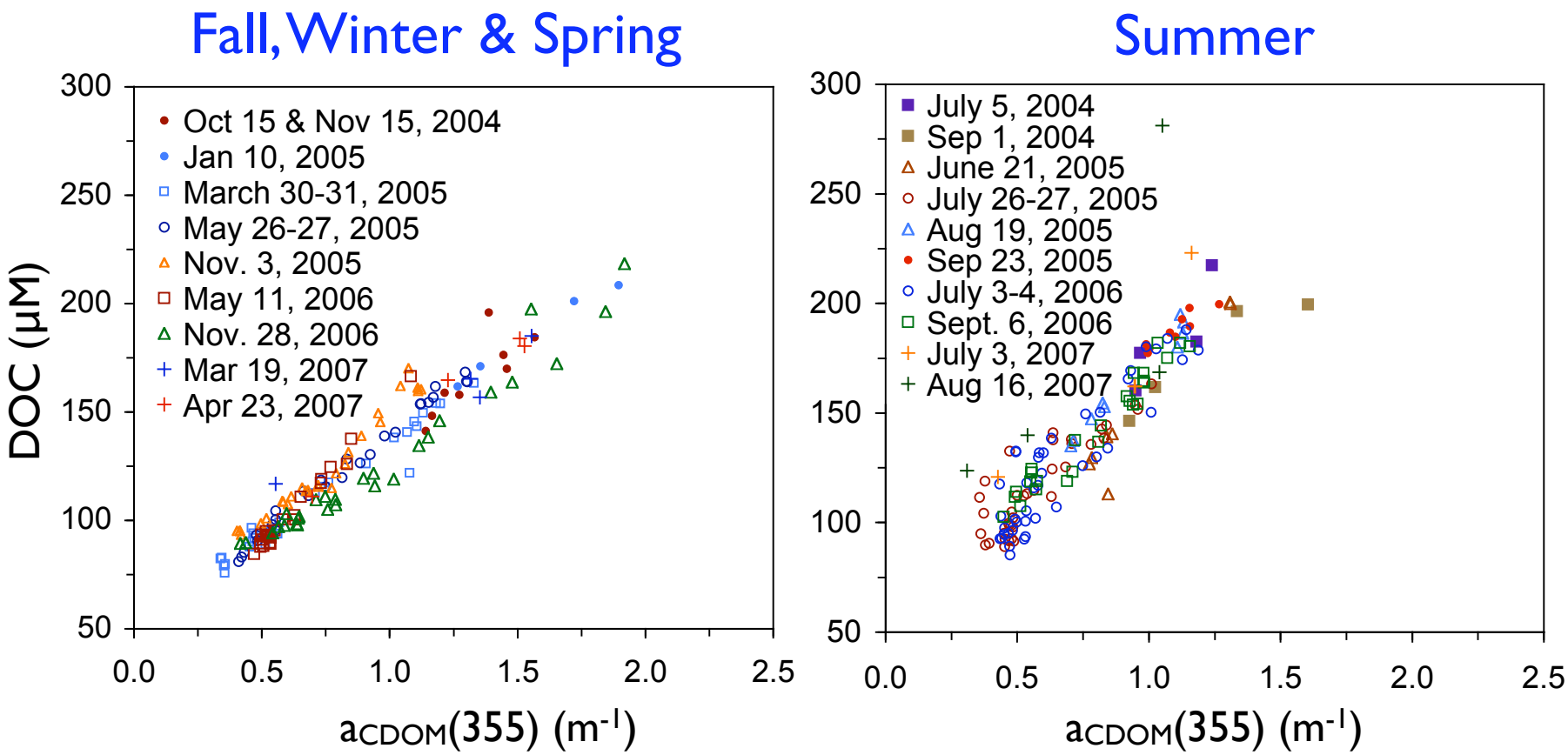
DOC vs CDOM Interannual Consistency

Chesapeake Bay & coastal ocean

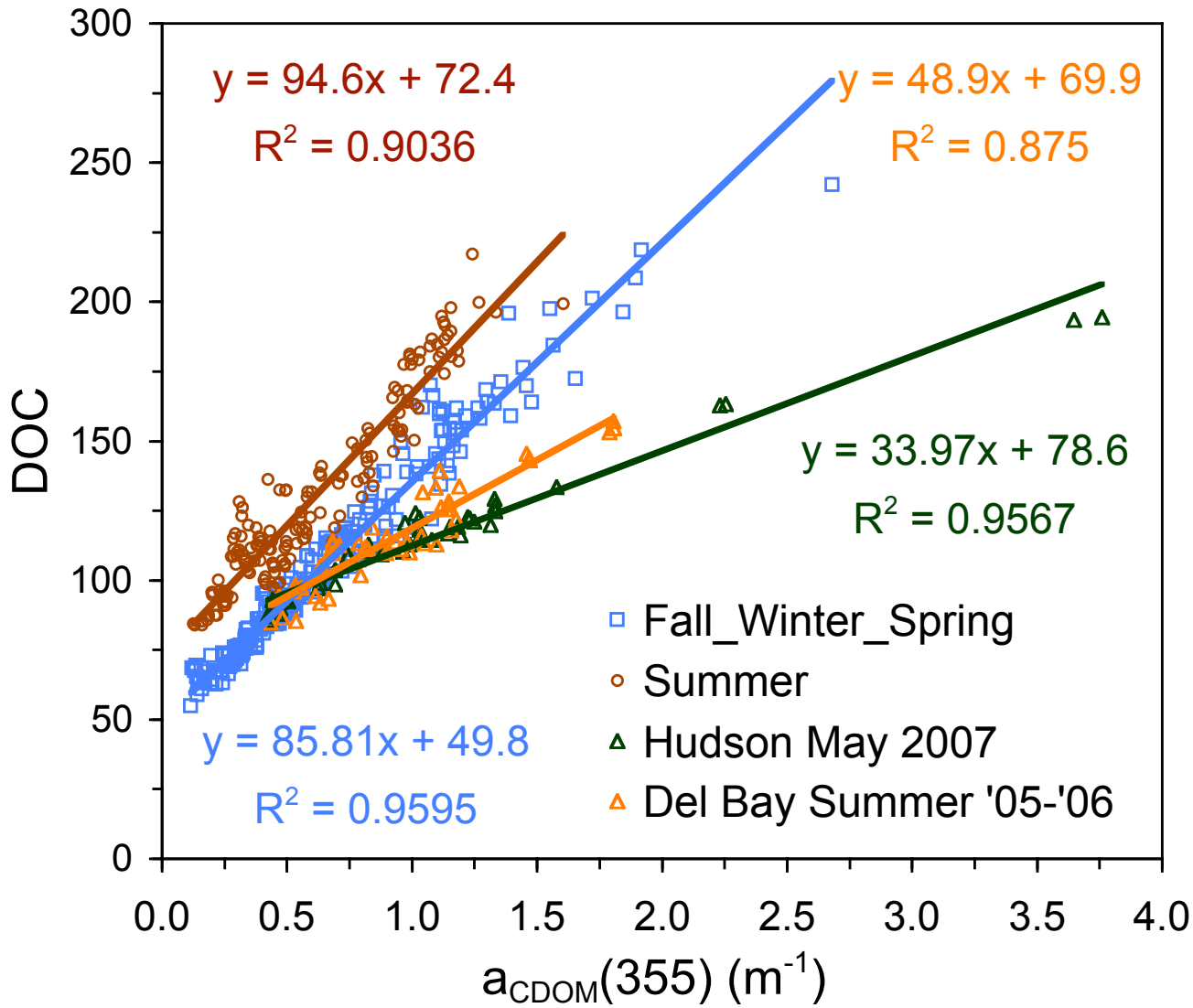




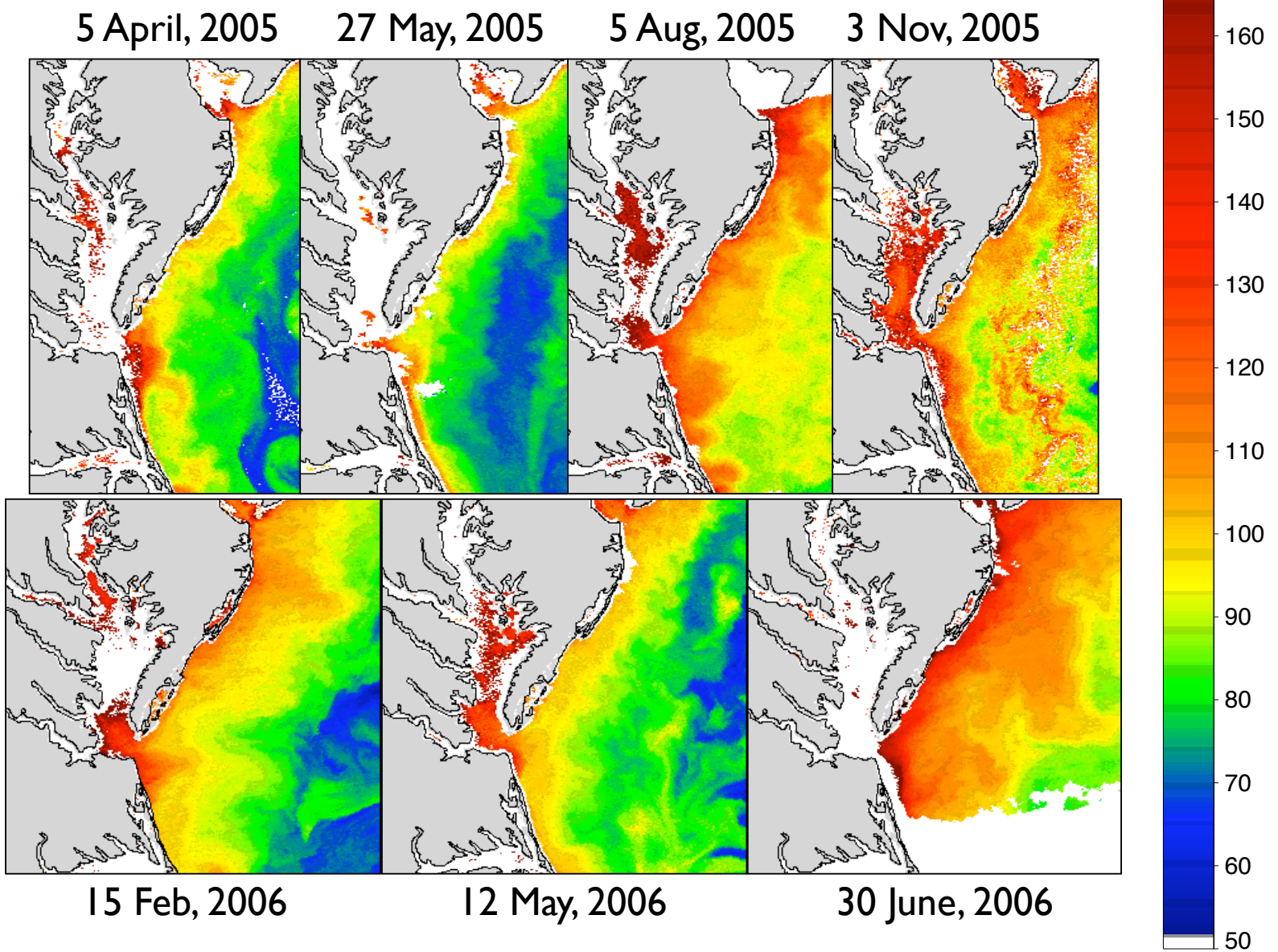
Ches Bay Mouth & Plume



DOC vs CDOM Relationships in MAB

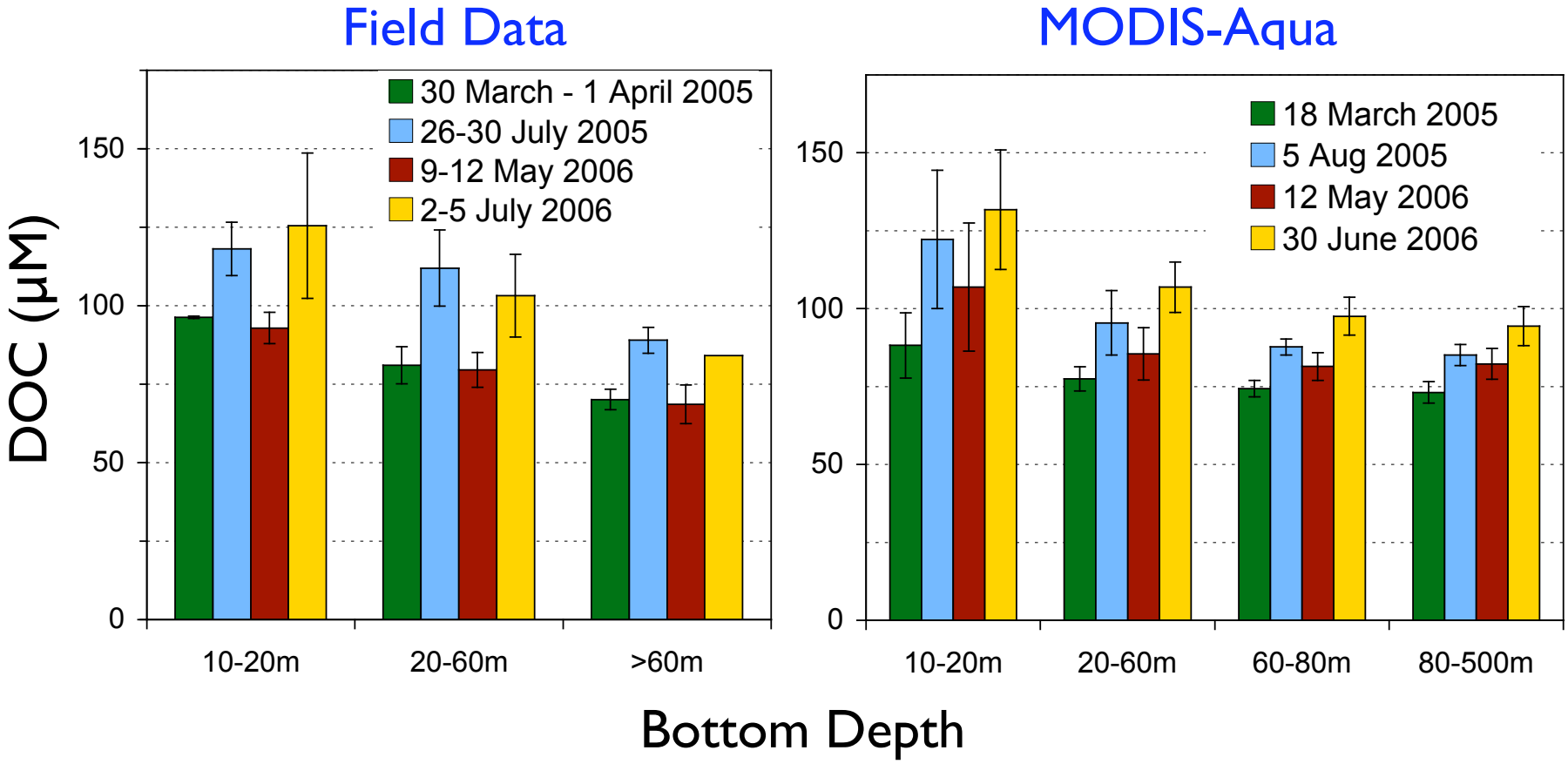


Satellite DOC



Net Ecosystem Production of DOC

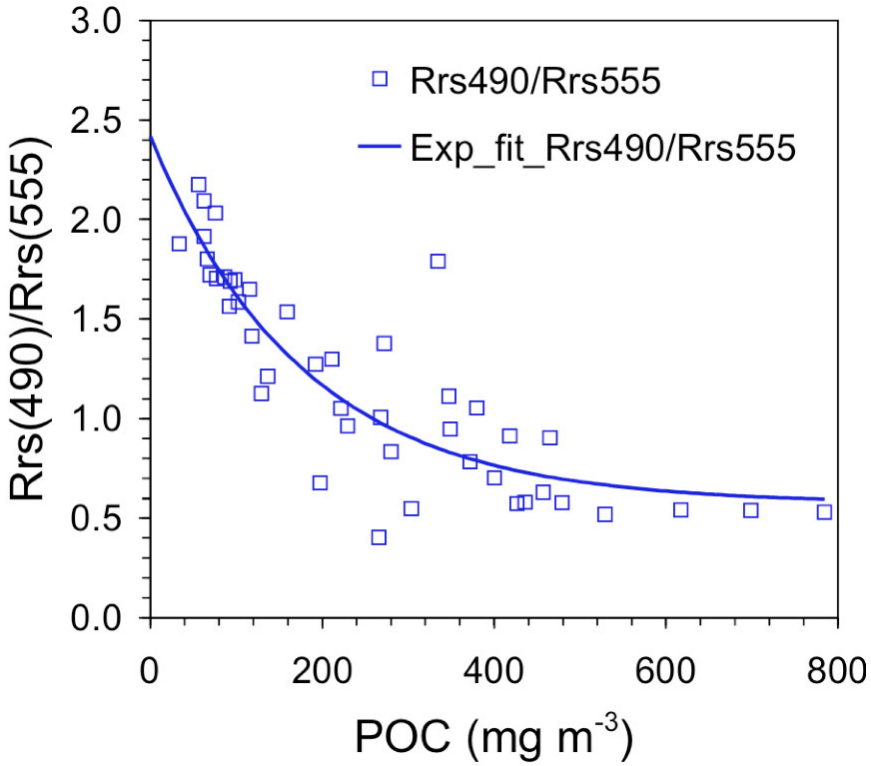
southern MAB

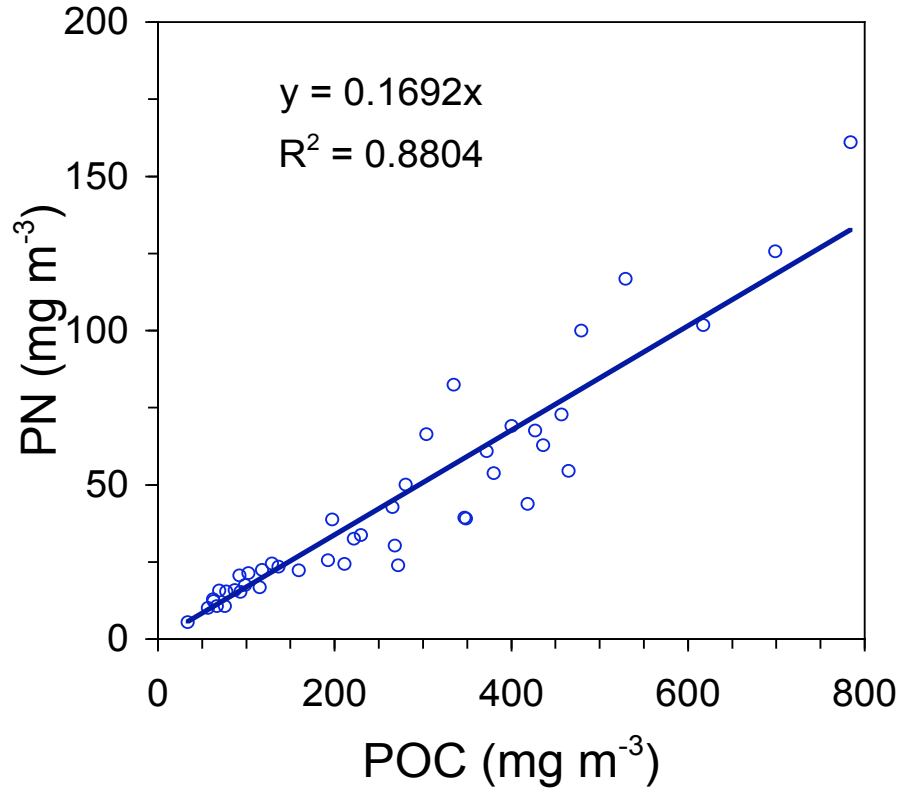


- Seasonal DOC increase of 12-30 µM C from spring to summer
- Winter DOC inventory in southern MAB of 1.2 Tg C

POC & PN algorithm development

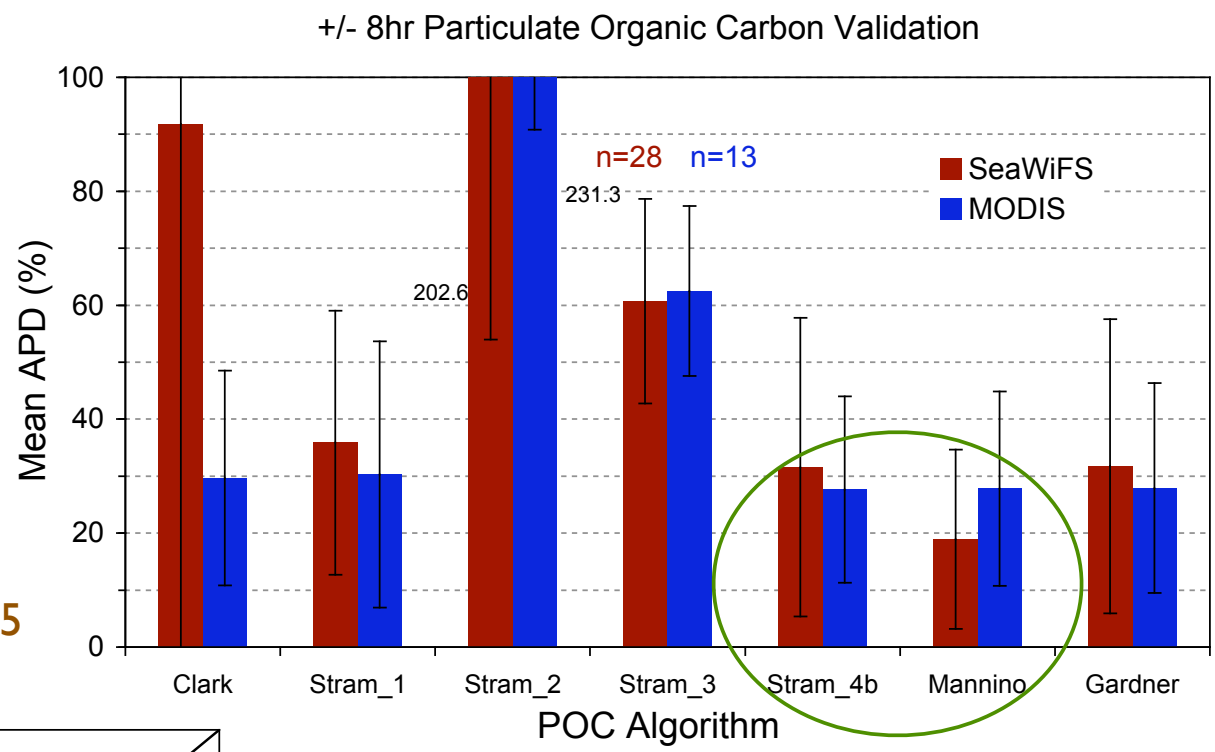
southern MAB



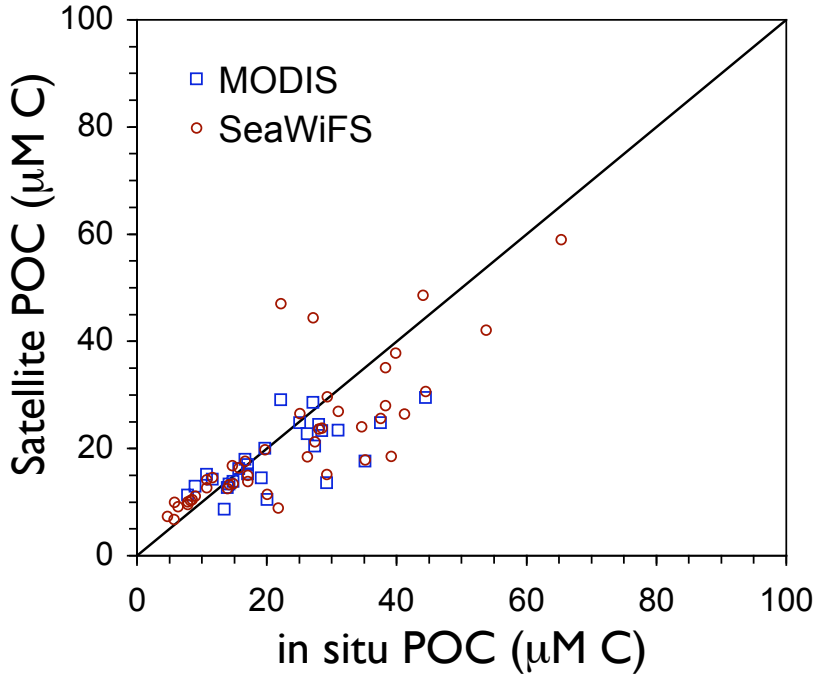


Soon, additional data from Hudson plume & Gulf of Maine.

Satellite versus in situ POC Validation in southern MAB



Stramska & Stramski 2005
4b algorithm

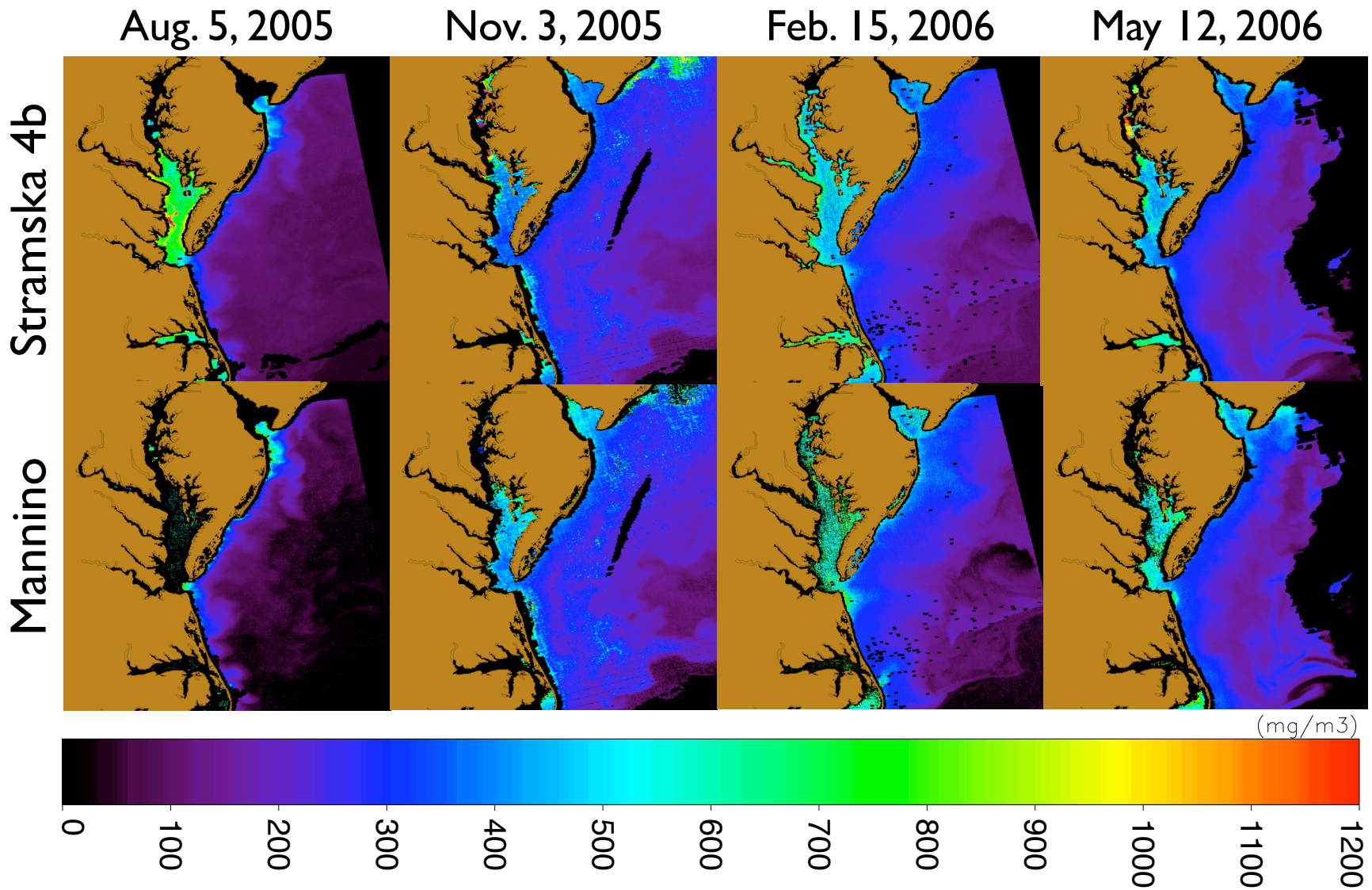


APD - Absolute Percent Difference

MODIS: APD = 22.6 ± 17%

SeaWiFS: APD = 27 ± 22%

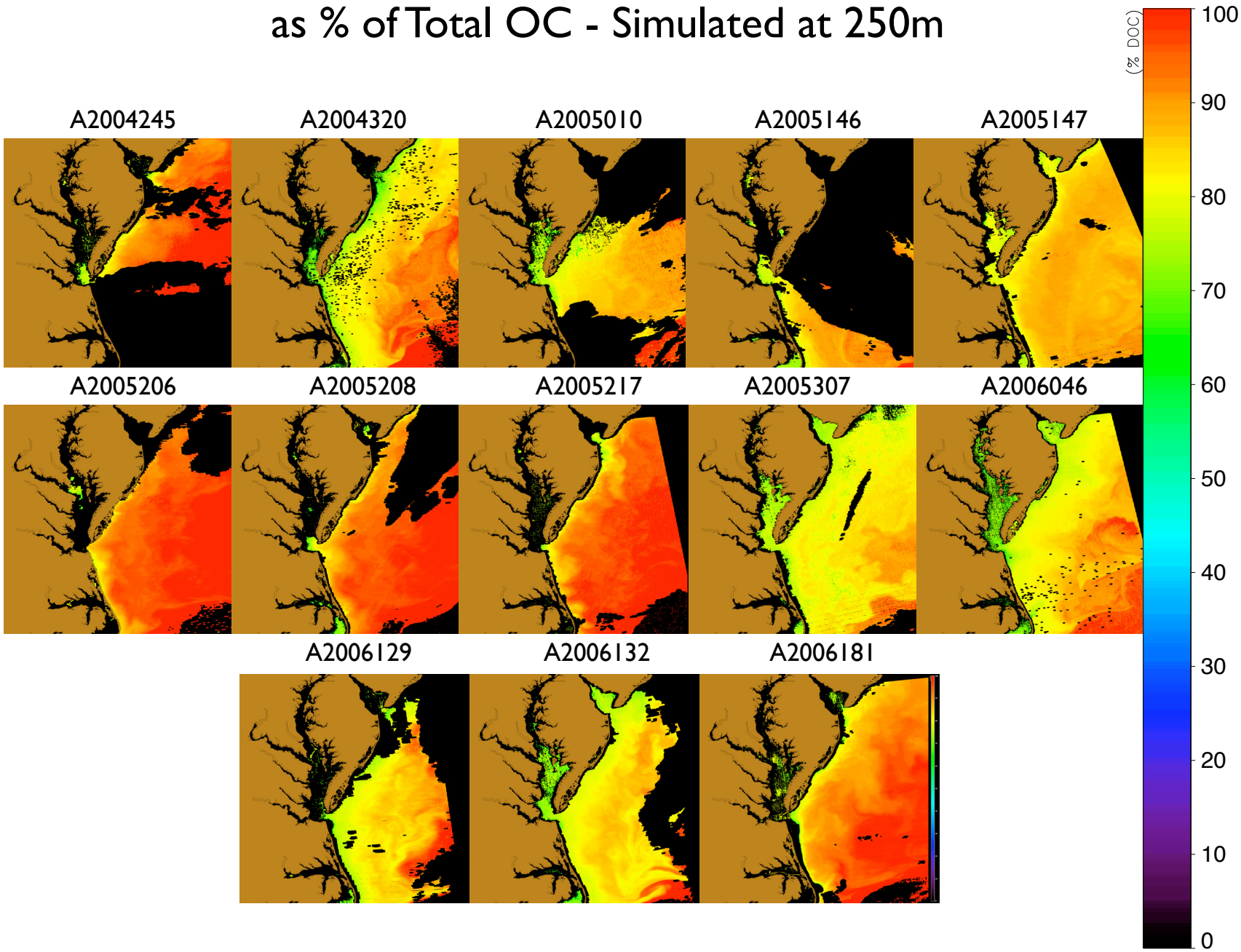
POC Algorithm Comparison



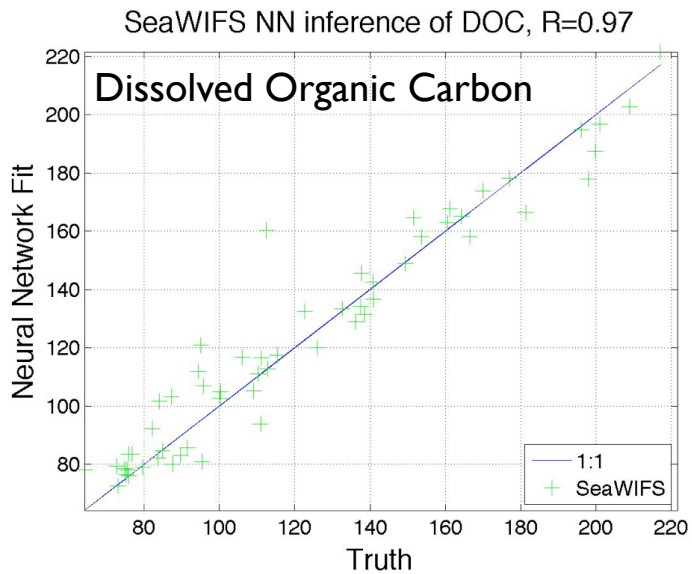
MODIS - High Resolution

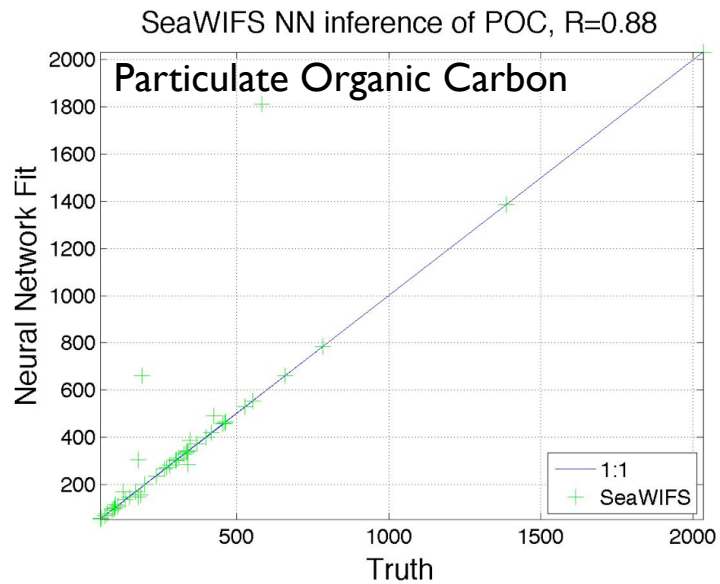
Stramska lower POC nearshore, but higher POC offshore than Mannino

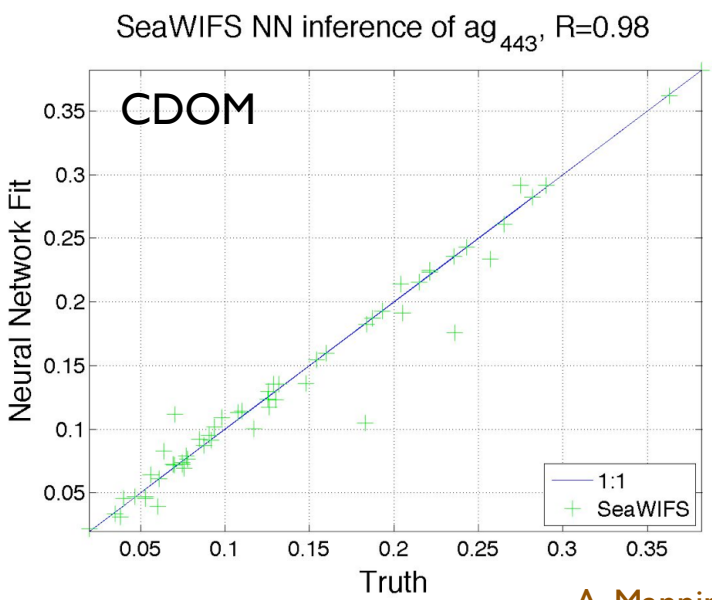
MODIS-Aqua Dissolved Organic Carbon (DOC) as % of Total OC - Simulated at 250m

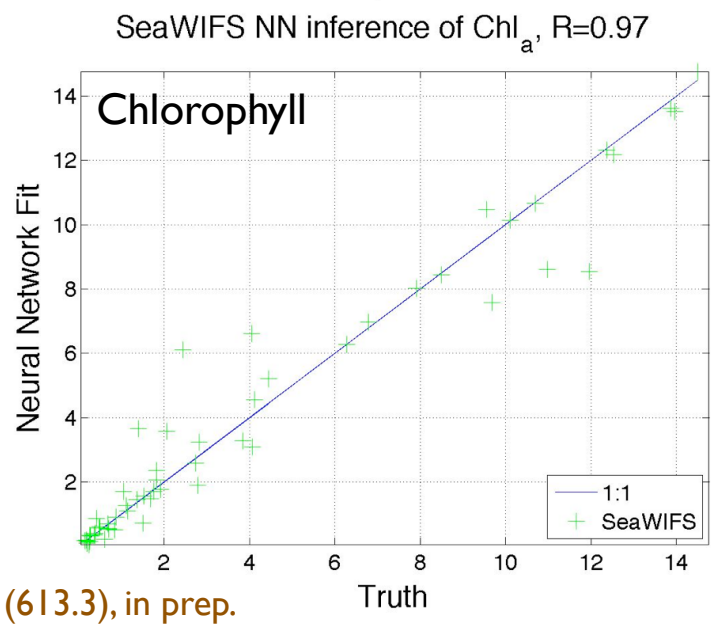


New Approach to Coastal Ocean Algorithms
Neural Networks using ALL satellite VIS bands



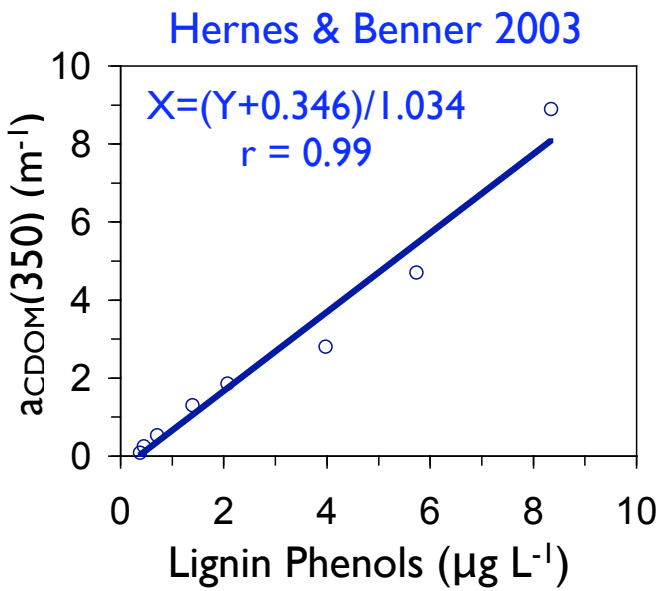


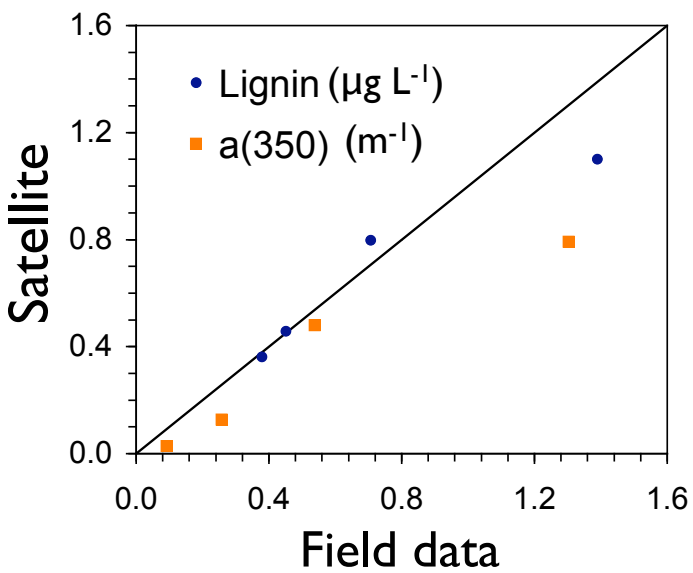




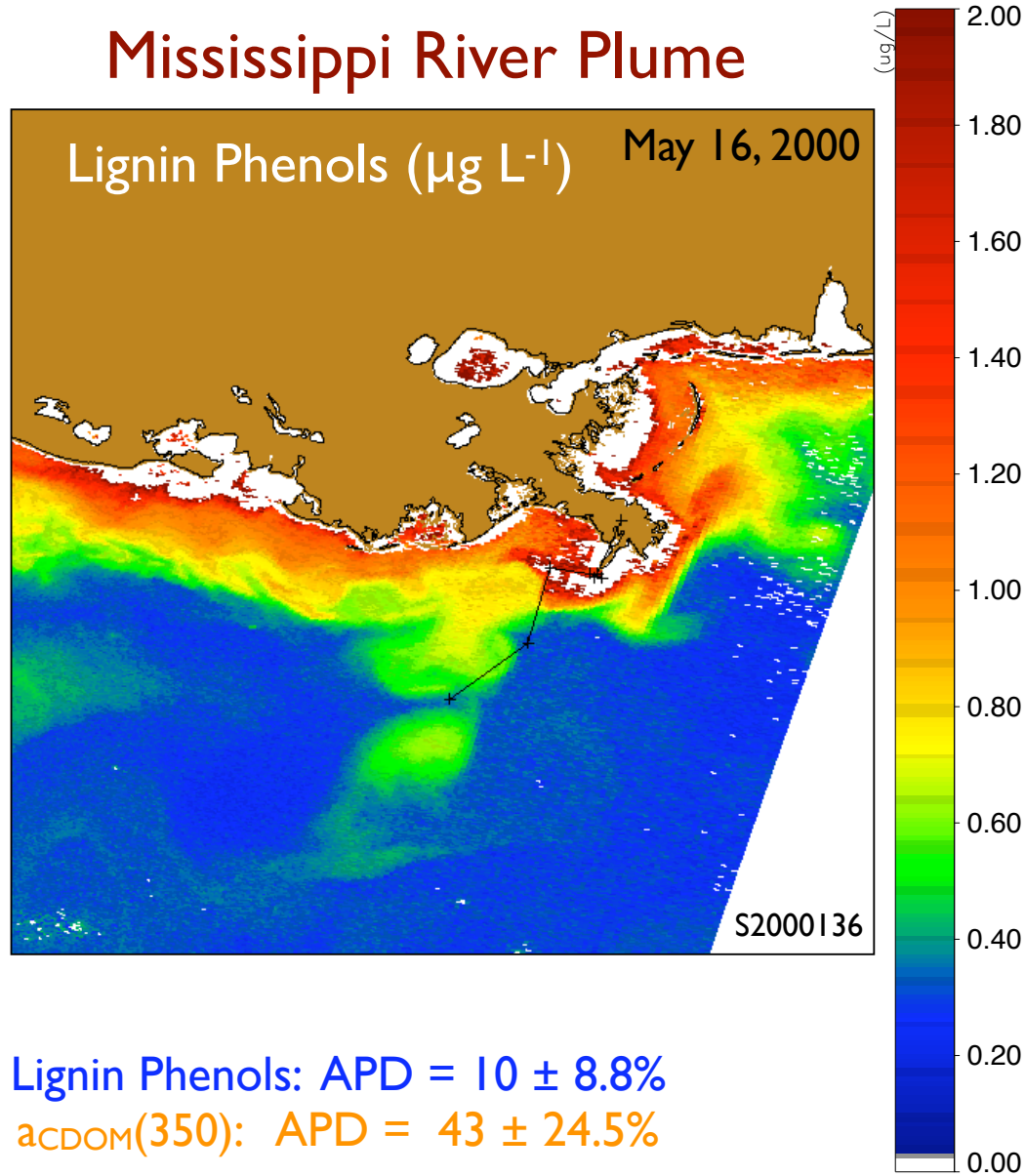
A. Mannino & D. Lary (613.3), in prep.

Terrigenous DOM from Space





Mississippi River Plume



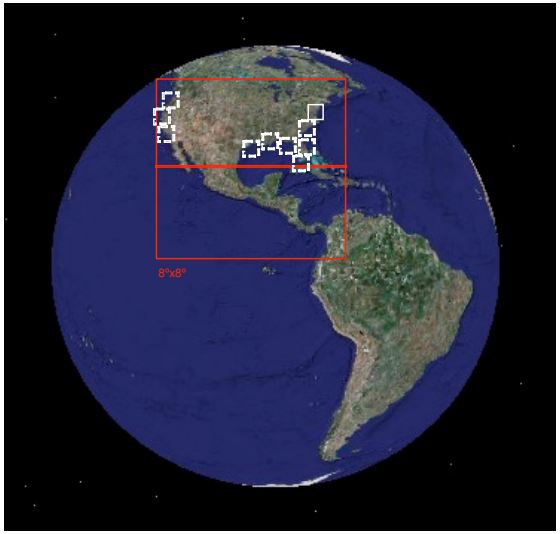
Lignin Phenols: APD = 10 ± 8.8%

$a_{CDOM}(350)$: APD = 43 ± 24.5%

Summary

- CDOM - DOC relationships suggest variable source components for estuaries within the MAB and Gulf of Maine
- Processes that influence CDOM include river discharge, photooxidation in late Spring-Summer, and wind-induced vertical mixing in Autumn-Winter.
- DOC distributions are regulated by river discharge, ecosystem productivity in Spring-Summer, and ocean circulation
- Satellite retrieval of CDOM, DOC, POC, PN & dissolved lignin phenols allows us to quantify seasonal and interannual variability of coastal ocean carbon processes
  - Terrestrial/riverine/estuarine export of carbon
  - Seasonal net ecosystem production of DOC
  - POC and DOC inventories

GEO-CAPE Mission Concept



Mission is combination of

1) Medium-resolution (5 km) continental scanning instrument - designed for atmospheric chemistry.

2) High-resolution (~300m) regional scanning spectrometer.

- Programmable geosynchronous multi-disciplinary observatory.

NRC Decadal Survey recommended GEO-CAPE as a Tier 2 mission to study Coastal and Atmospheric Pollution Events.

- Projected earliest launch of Tier 2 missions is 2020.

<u>Key Issues:</u> Temporal scale, atmospheric corrections for Ocean Color, and enhanced spatial & spectral resolution.

GEO Sensor Requirements - GSFC

	Coastal Ocean	Atmosphere	Biosphere
Spectral Bands (nm)	340-1100, 1240, 1640	300-480, 400-600, 2300, 4600	400-1300, 2000-2300
SNR	>1000 in UV-VIS	1000	>800
Spectral Resolution	1-5 nm	<1 nm UV 1-2 nm Vis	5-10 nm
Spatial Resolution	100-300 m	>1 km	<250 m
Temporal Resolution	3-6 / day	~ hourly	3-6 / day
Spatial Coverage	~320 km ocean adjacent to coast; Estuaries, bays, large lakes and river mouths	200 km Polluted urban areas	200 km Ecosystem area
Radiometric Stability	<0.1% band-to-band 0-10 hours	<0.1% band-to-band 0-10 hours	<0.1% band-to-band 0-10 hours

Acknowledgments

- NASA New Investigator and Interdisciplinary Science Programs
- NASA Ocean Biology & Biogeochemistry Program
- NOAA - WaCOOL-BIOME program
- P. Hernes
- KC Filippino, P. Bernhardt, M. Mulholland
- Ocean Biology Processing Group