Improved Satellite Ocean Color Retrievals of Ocean Inherent Optical Properties and Biogeochemical Properties Utilizing the Capabilities of PACE

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PACE Science Team Meeting
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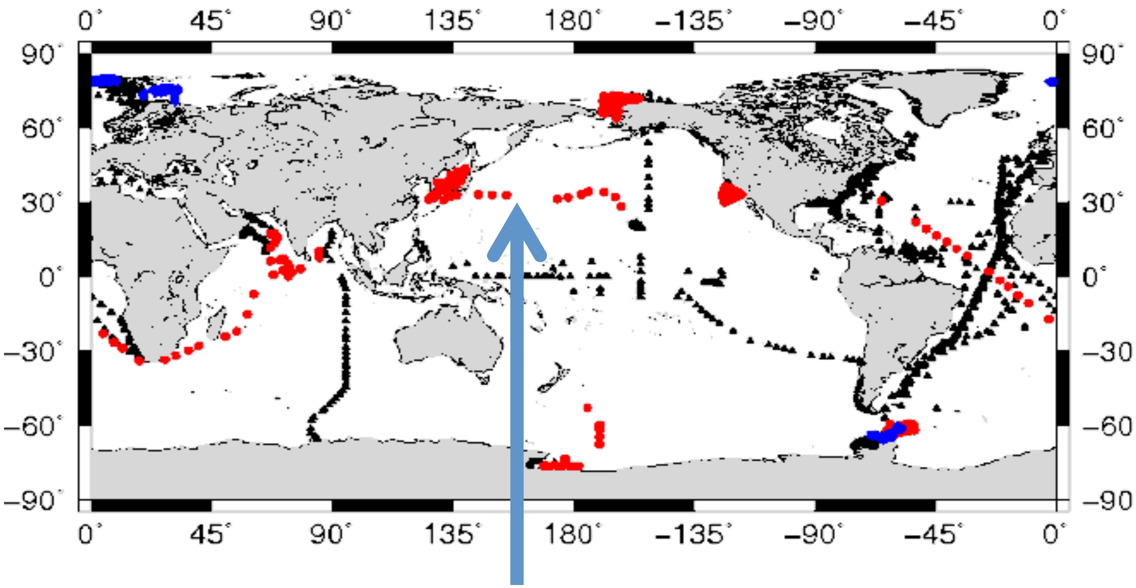
ACE Asia Massive Gobi Dust Event

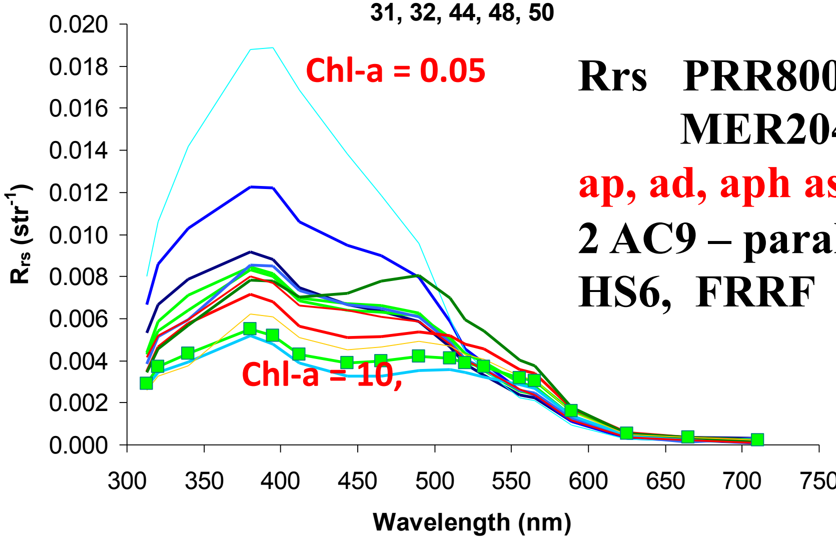
Aircraft Track

R/V Ron Brown

Large global data via vtrategic collaborations over 20 years
CalCOFI, JGOFS, AMLR, SIMBIOS, ONR JES, CCE LTER, NSF BWZ, ICESCAPE



ACE Asia Stations
1, 14 15, 16, 17, 18, 28,
31, 32, 44, 48, 50



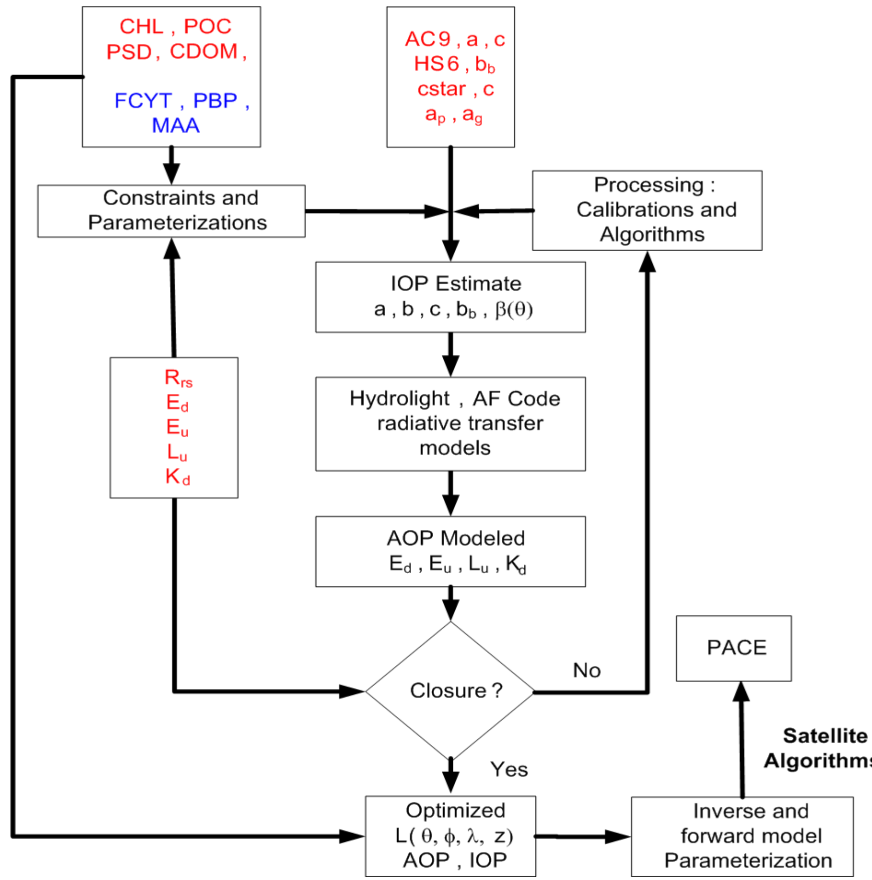
Rrs PRR800 UV-Vis, 19-λ
MER2040 12-λ,
ap, ad, aph as 300-800 nm
2 AC9 – parallel, unfiltered
HS6, FRRF

In situ Optics	# Stations
PRR600	76
PRR800	744
MER1012	150
MER2040	310
MER2048	333
SPMR	37
AC9	817
HS6	813
FRRF	452

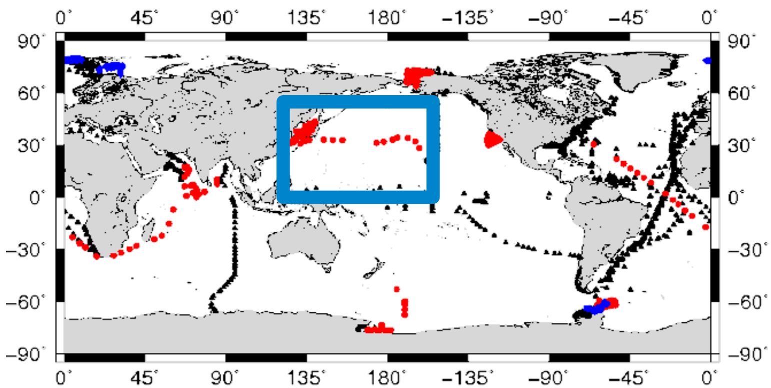
Water Samples	# Samples
ap	7616
as	6001
CHN	3955
Coulter Counter	679
Cyanobacteria	316
Nutrients	4375
Pigments Fluor	19703
Pigments HPLC	6416
PvE	1093
TSM	541
Flow Cytometry	4470
MAA	1376
PBP	809

Goal is to provide optimized hyperspectral global data for model development and evaluation

- Data, QC, Details
- IOP/AOP methods and processing
- Forward Model parameterization
- Inverse Modeling
- Collaborations

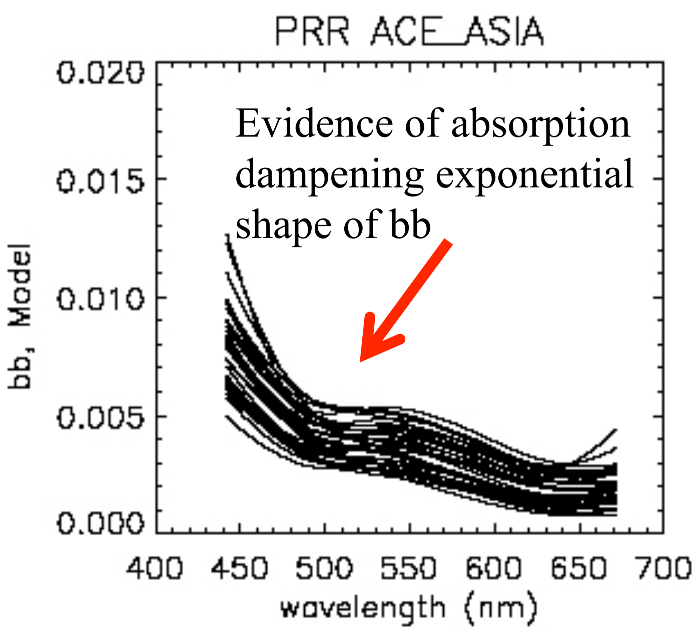


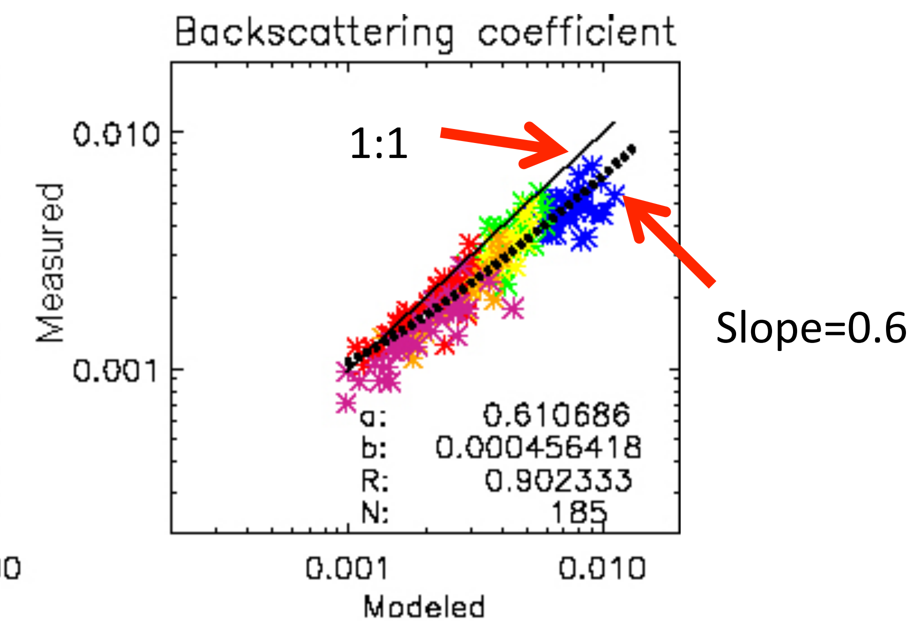
Hyperspectral extension applied to ACE-ASIA data
Narrow focus on detailed analysis of one of detailed cruise



Data → MODELS

$$Rrs(\lambda) = f\ [\,a(\lambda),\ bb(\lambda)\,]$$

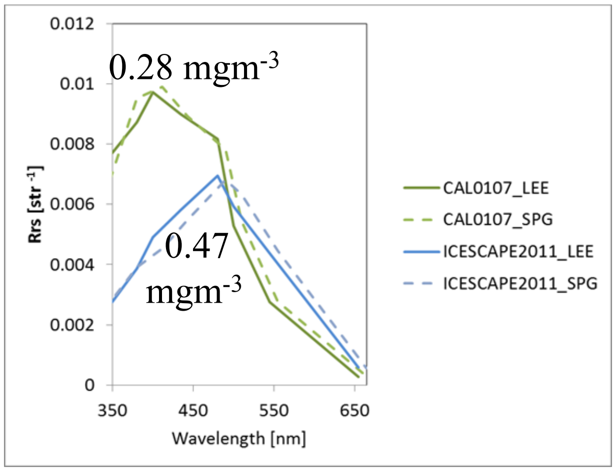


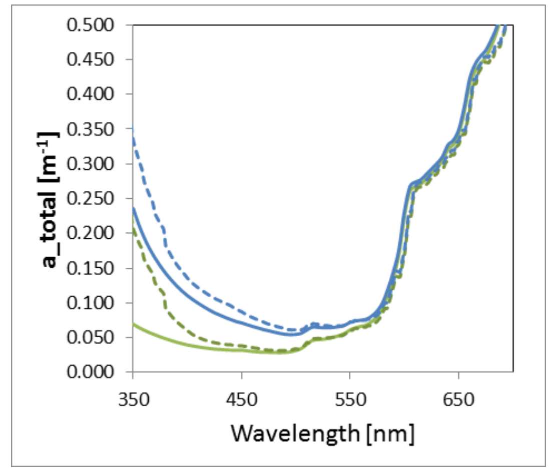


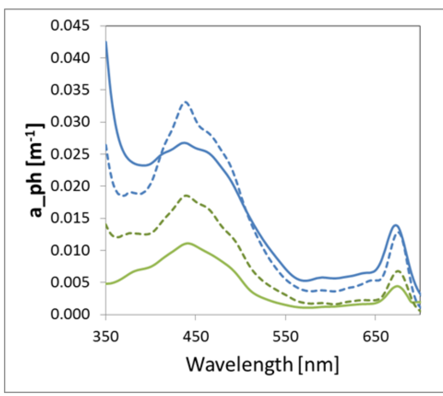
Slope of 0.6 between measured and modeled bb
Since *a* >> *bb* a small error in *a* can result in large error in *bb*

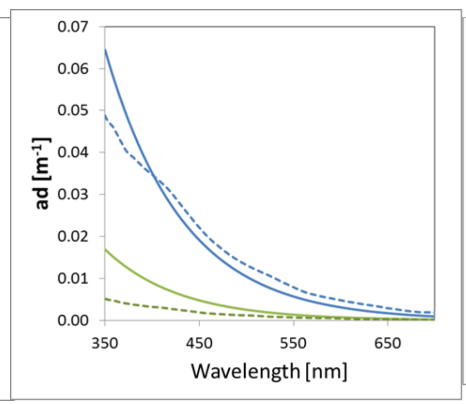
Example of Collaboration within team

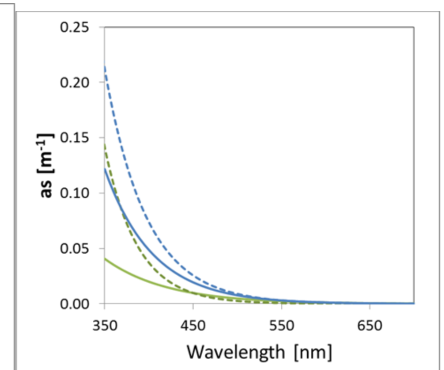
- Evaluate Lee hyperspectral Rrs and basis absorption
- Compare modeled vs observed for two very different regions
- California Current (CalCOFI) and Arctic (ICESCAPE)





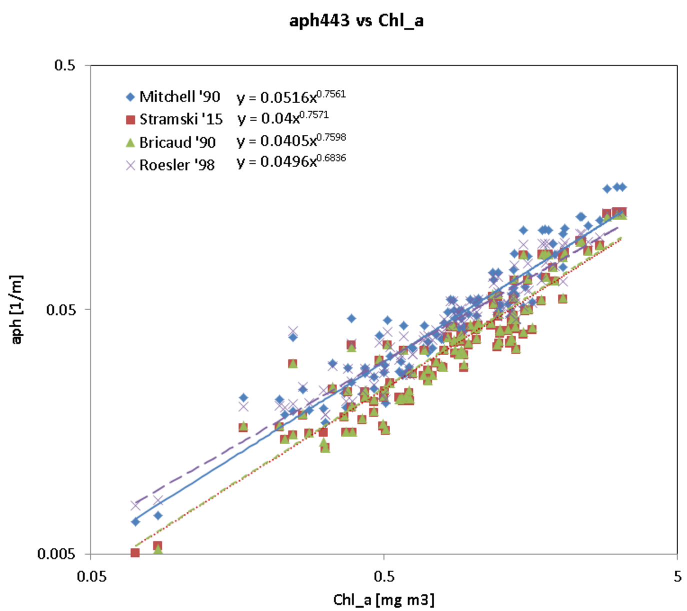


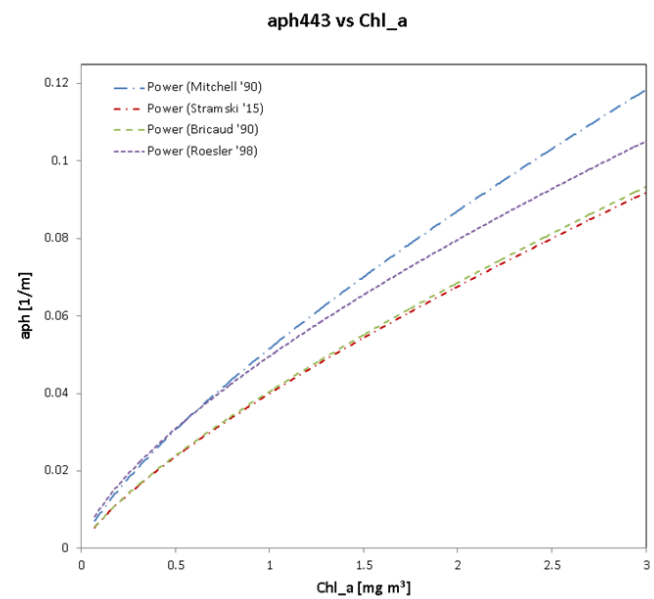




Very similar Rrs but differences in absorption for the model and observed
What is status of the available global data set for particle absorption?

Exploring uncertainty in particle absorption based on published methods for raw data processing
Power function fits of aph(443) vs chl-a
4 published processing methods
Mitchell ‘90, Bricaud ‘90, Roessler ‘98 Stramski ‘15





- NASA SeaBASS / NOMAD have particle absorption results with no raw data or specification of processing methods
- How to evaluate the methods in an independent way?
- Can we use chl-a to get a better understanding?
- In blue not easy to independently evaluate which is best since detrital absorption and accessory pigment absorption can be large relative to chl-a absorption

Exploring uncertainty in particle absorption based on published methods for raw data processing

Power function fits of aph(675) vs chl-a

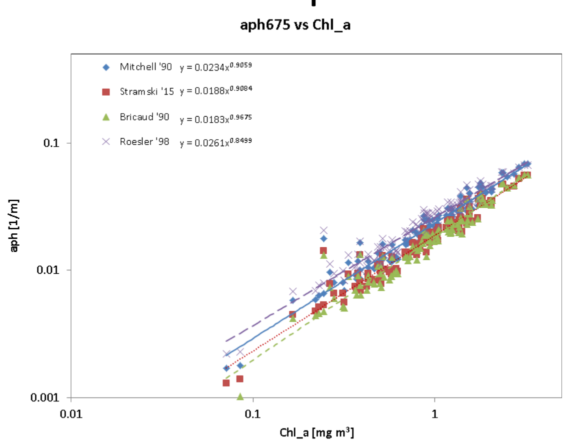
At chl-a peak of 675 detritus and accessory pigment contributions small

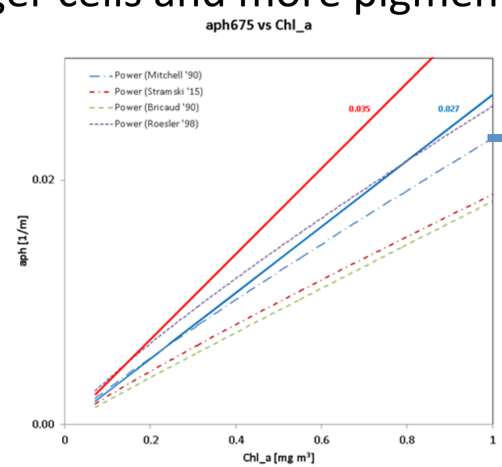
Near surface low nutrient high light samples should approach upper limit of chl-a specific absorption a*ph = 0.027 m2/mgchl-a determined on chl-a/c cultures (Johnsen et al. Moisan and Mitchell) or 0.03 for chla/b cultures Sosik and Mitchell)

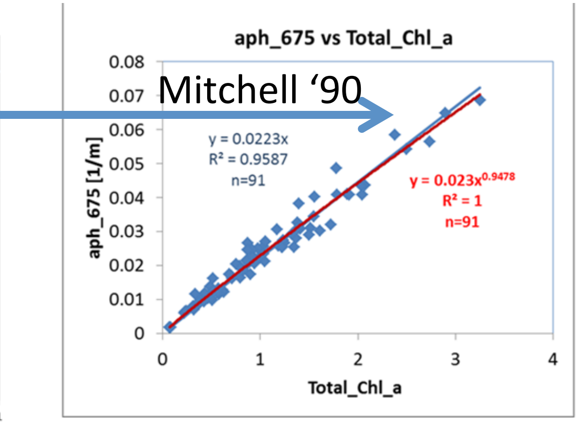
Thus at 675 the different methods for processing can be evaluated independently

For ACE-Asia:

- *Roessler '98 tends to overestimate the expected upper limit
- *Bricaud '90 and Stramski 15 fall far below expected upper limit
- *Mitchell '90 is close to upper limit for chl a/c and trends below at higher chl-a as expected with larger cells and more pigment packaging



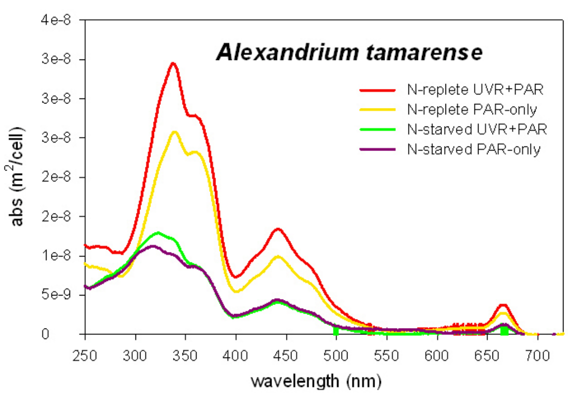




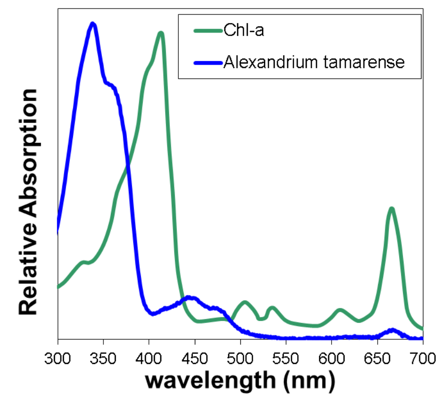
*Mitchell '90 slope of aph(675) vs chl-a is reasonable relative to lab studies

Mycosporine Amino Acid absorption in UV for a harmful dinoflagellate MAA very important in UV including 350-400

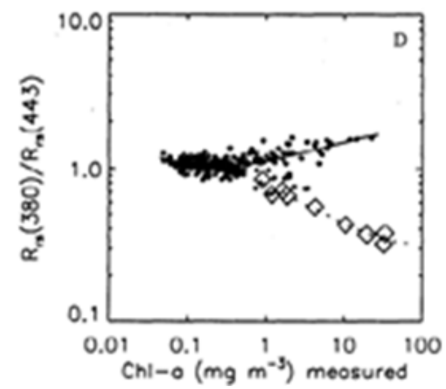
Whole cells



Methanol solutions
chl-a and *A. tamarense*



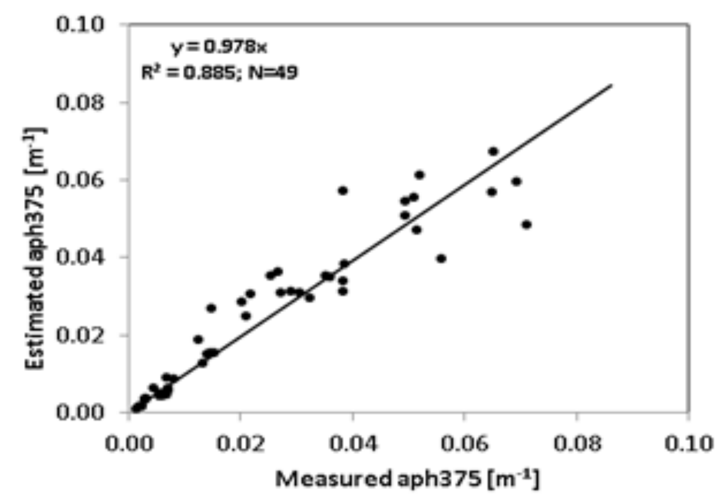
Kahru and Mitchell 1998
Red tide and CalCOFI



CalCOFI
Red Tide

- There is poor knowledge of the distribution of MAAs in the ocean and their effects on absorption and reflectance 350-400 nm
- Very strong effect of nutrient stress on MAA for A. tamarense
- MAA very significant UV effects for some harmful algae blooms
- More work needed on MAA and effects on UV reflectance and how this may be used for HABs and PFT

Including MAA with chl-a for modeling absorption in the UV



Comparison of estimated vs observed $a_{ph}(375)$ for oceanic samples. The estimate is based on a multiple linear regression of the concentration of MAAs and CHLA. The multiple regression using MAAs and CHLA is a better predictor than either MAAs or CHLA alone. Our initial concept for parameterization of a_{ph} will be to use multiple linear regression for MAA and CHLA to ensure robust forward and inverse models for a_{ph}.

Needs

- Better effort to integrate diverse observations for cruises like ACE Asia
  Aerosol profiles, lidar, UV-VIS AOP and IOP, Aircraft, Satellite

- Options for alternative processing and evaluation
  e.g. processing raw OD on filter to ap, ad, aph
  need raw data
  need a more thorough evaluation

- Robust instrumentation in UV / higher spectral resolution
  a, bb, c, VSF, Ed, Lu, Eu

- Collection and analysis of mycosporine amino acids and phycobiliproteins
  quantitative understanding in their contributions to absorption
  * integration of these into CHEMTAX framework for PFT
  * integration of these into forward and inverse optical models

- Collection of more complete optical and biogeochemical data sets