

MODIS PIC algorithm (mod 23)

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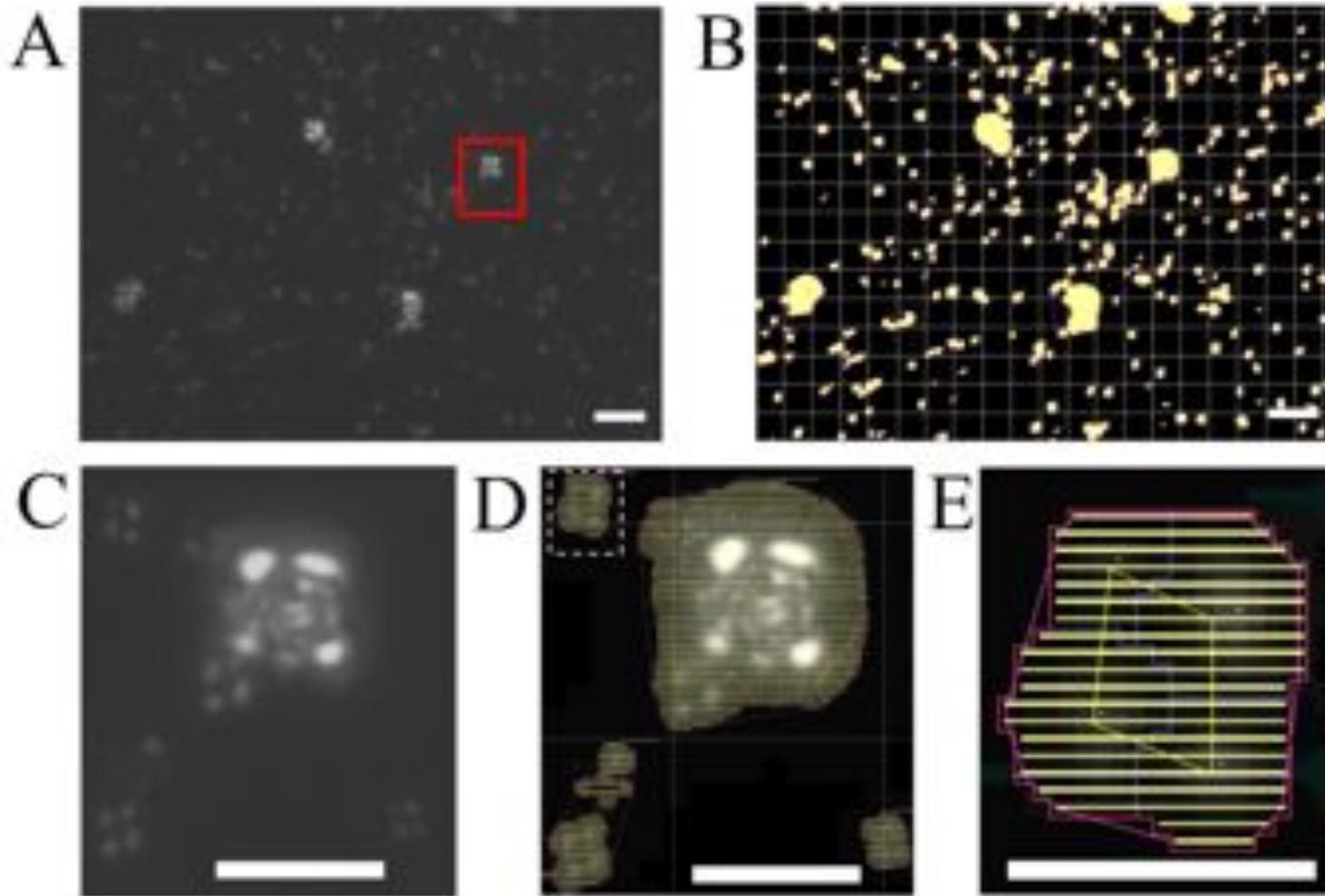
Progress

- Completed AMT19 in December 2009 (UK to Punta Arenas, Chile, our 6th AMT cruise).
- Processed AMT 18 (500 samples for PIC, POC, BSi, Chlorophyll, coccolithophore counts plus above-water radiometry, underway IOPs (spectral particle absorption/attenuation, spectral CDOM absorption/attenuation, backscattering and chlorophyll fluorescence).
- Improved automated technique for enumerating coccolithophores.
- Provided new updated coefficients to Goddard Ocean Color group for improved PIC algorithm (based on AMT cruises 15-18, Gas Ex III, and Patagonian Shelf COPAS expedition

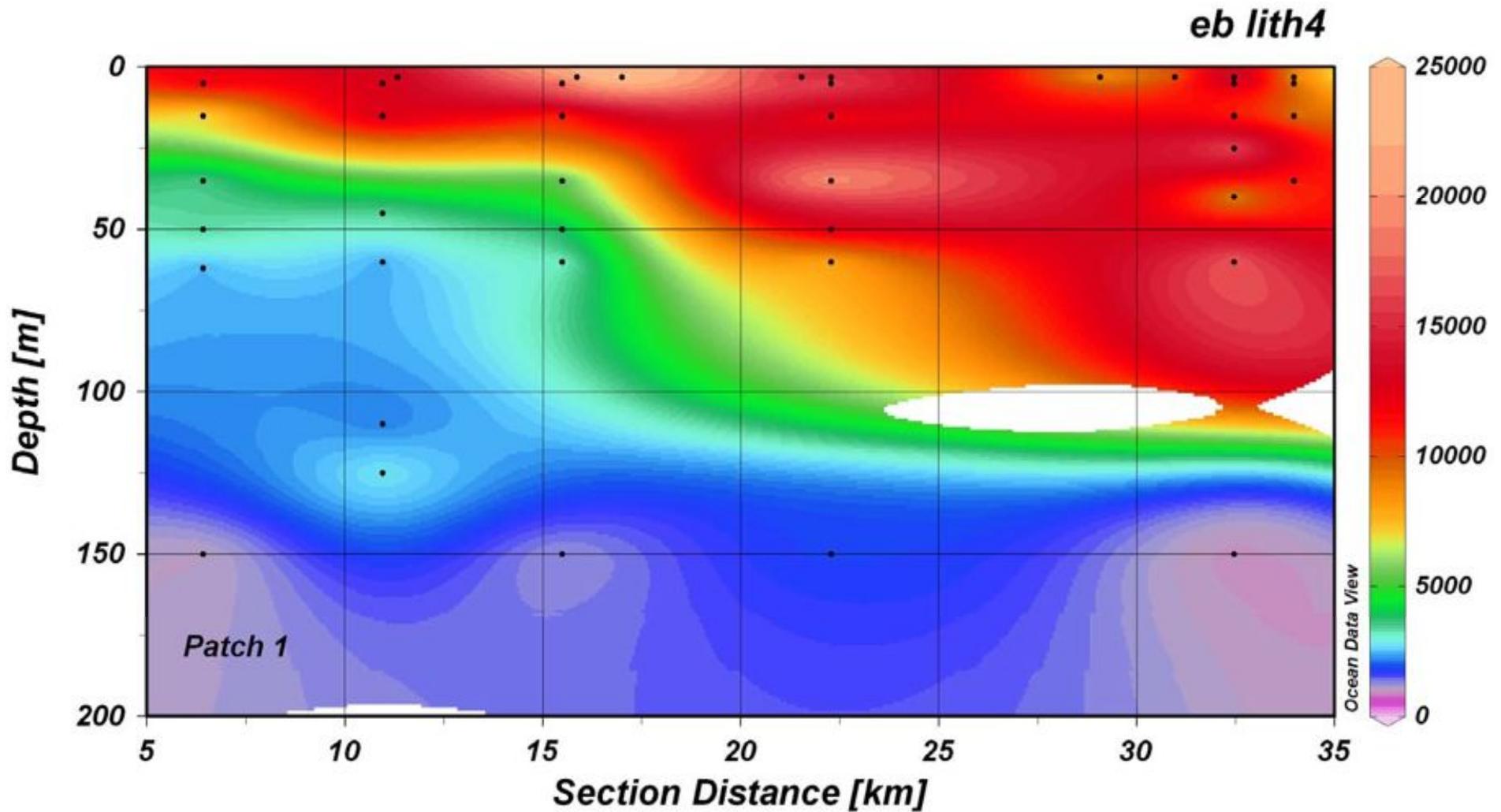
Progress (continued...)

- Preparing for AMT 20 (departure October 2010)
UK → Punta Arenas
- Combined with previous results, we are now approaching the potential to examine changes in the ocean carbonate cycle at basin scales (of interest due to ocean acidification).
- Unexpected perk-BSi algorithm
- A paper has been revised for GRL on the variability in biogenic minerals in the sea

Advances in enumerating plated coccolithophores and coccoliths with CCC (Balch & Utgoff, 2009)



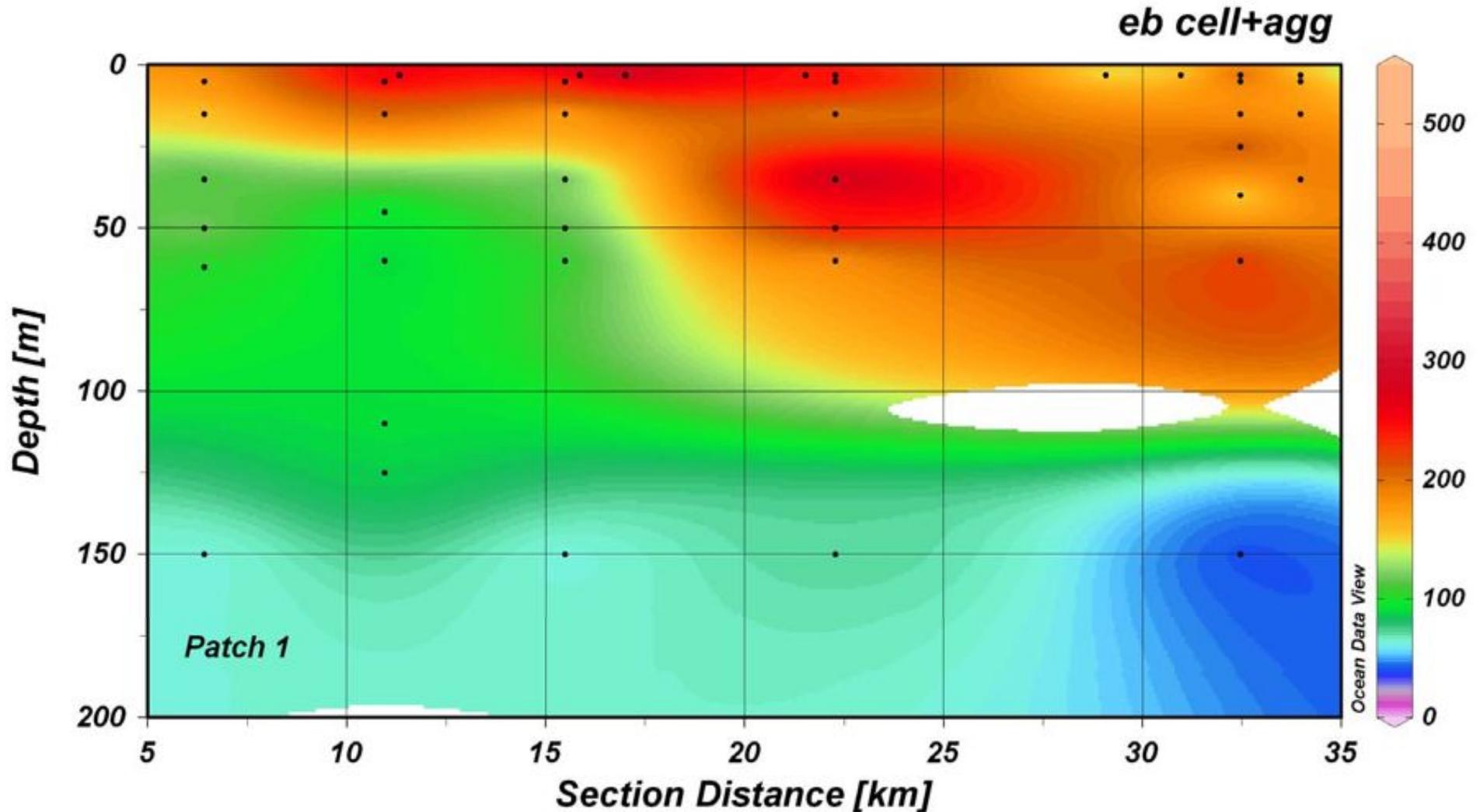
Detached coccoliths (per mL)



GAS-EXIII

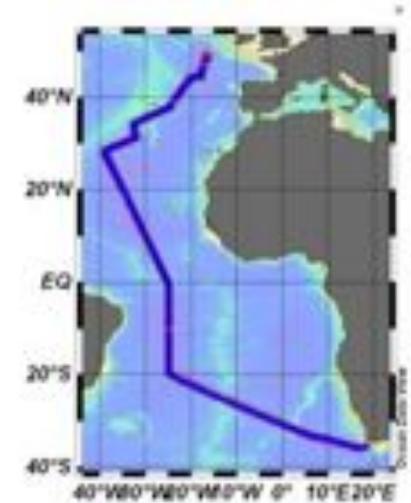
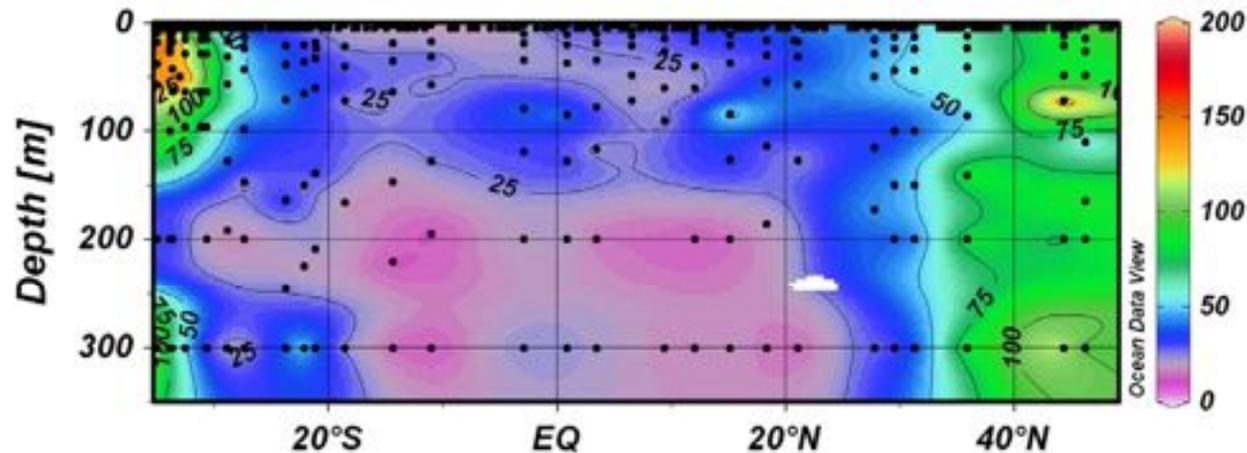
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MODIS meeting 1-26-10

Plated coccolithophores and aggregates (per mL)

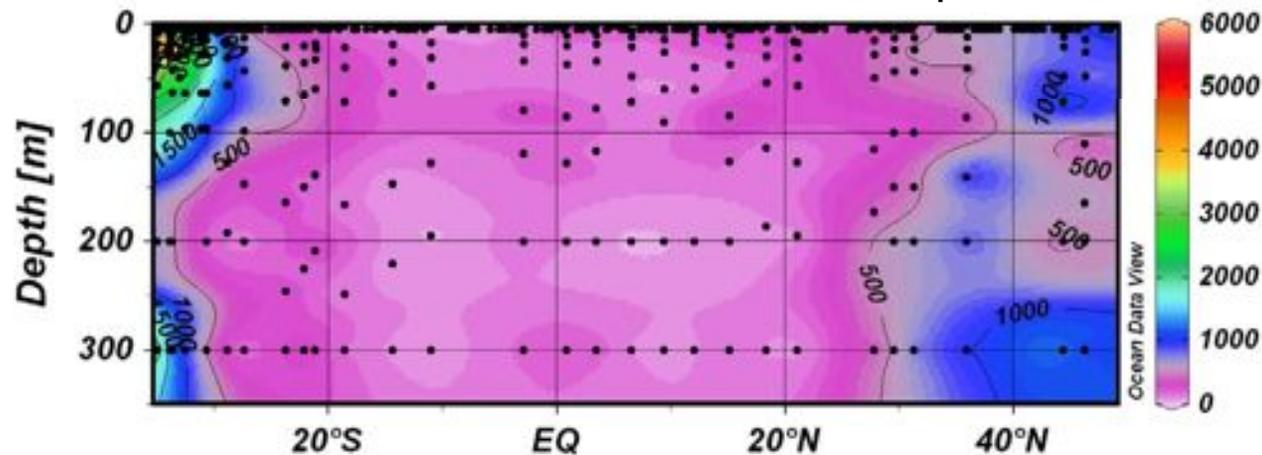


How abundant are coccolithophores and coccoliths across the Atlantic Ocean?

Coccolithophores + coccolith aggregates per mL

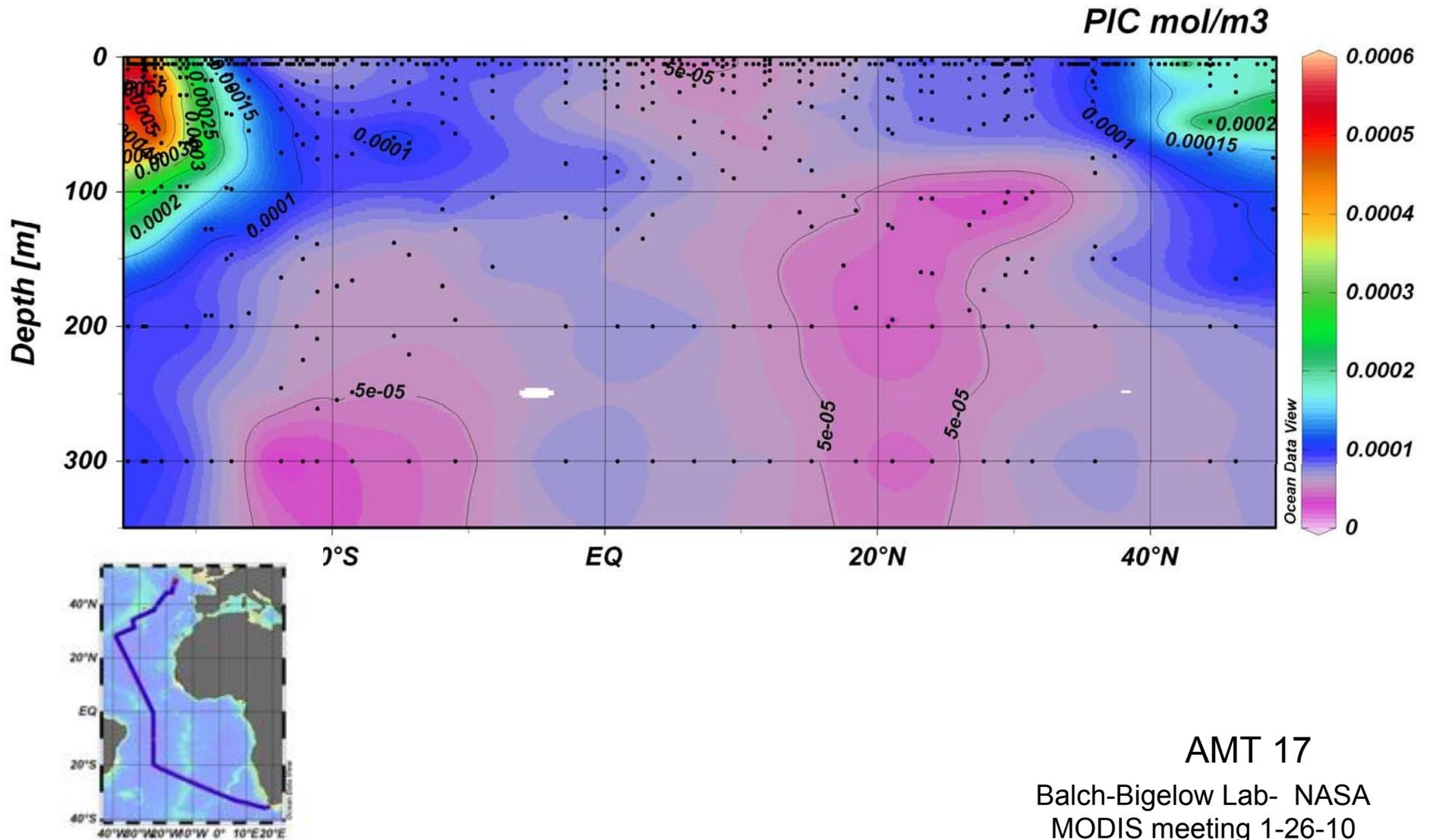


Coccoliths per mL



AMT 17

Patterns of PIC show a similar pattern across the entire Atlantic?



AMT 17

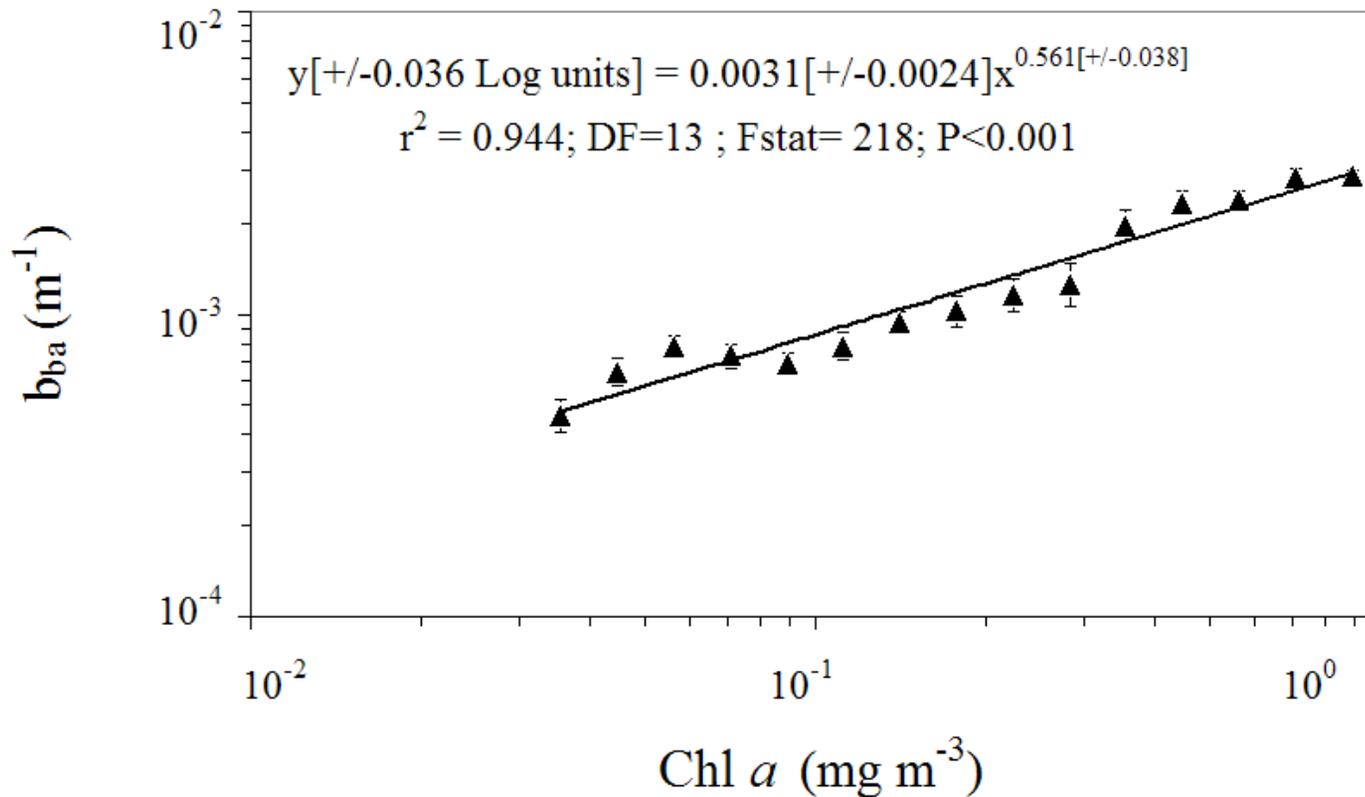
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Status of the algorithm

- Through this work we are now understanding the dynamic range of PIC in the Atlantic basin
- The analytical ICPAA technique for 0.5L samples is getting close to its limit of detection (50ppb) in the S. Atlantic Gyre
- Microscopy is well above its level of detection!
- We revised algorithm coefficients based on AMT cruises, Gas-ExIII and COPAS'08; these coefficients will be incorporated into the new processing
- RMS error, bias

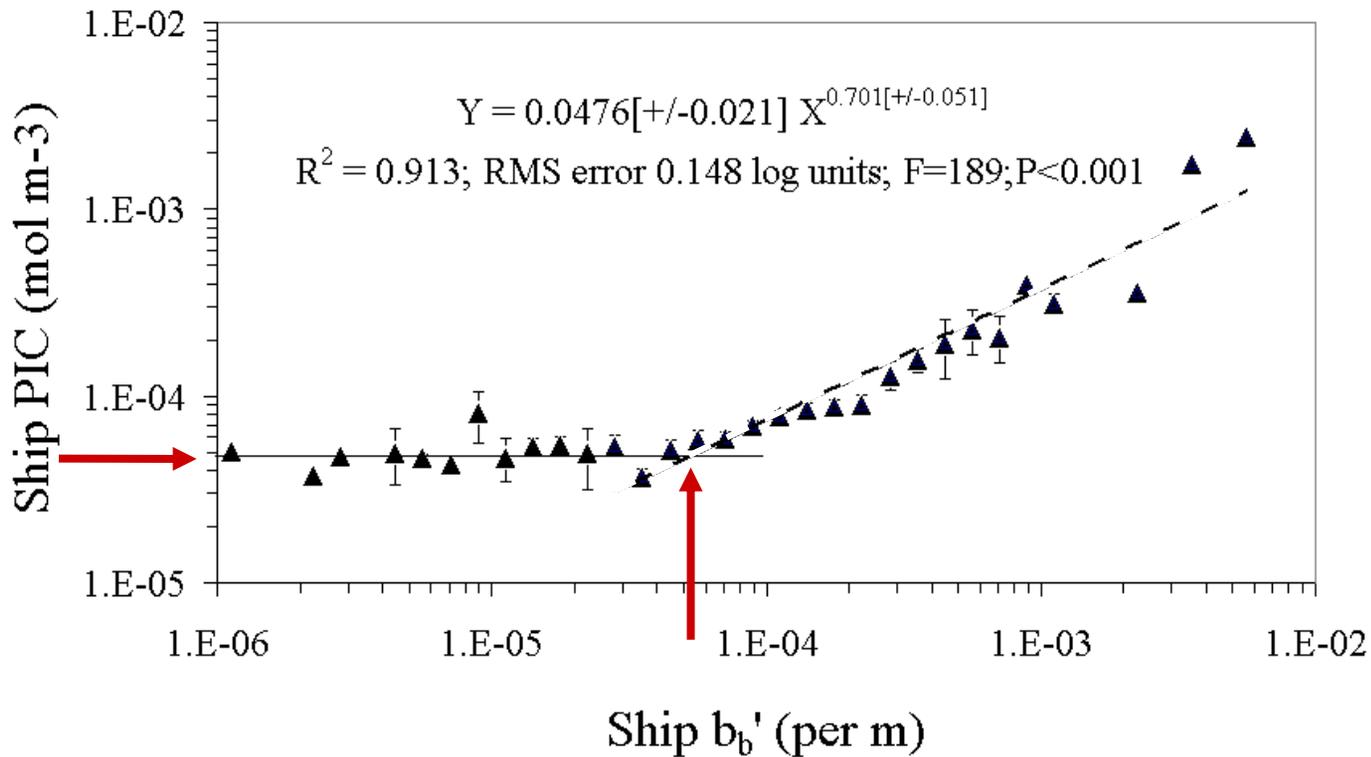
The mean relationship between chlorophyll and $b_{bp\ acid}$ is critical to our ability to separate POC b_{bp} from PIC b_{bp} . Note, we bin the data in the algorithm to improve signal to noise

AMT 15, 16, 17, 18, GasExIII, COPAS



b_b' vs ICPAA PIC estimates

AMT 15, 16, 17

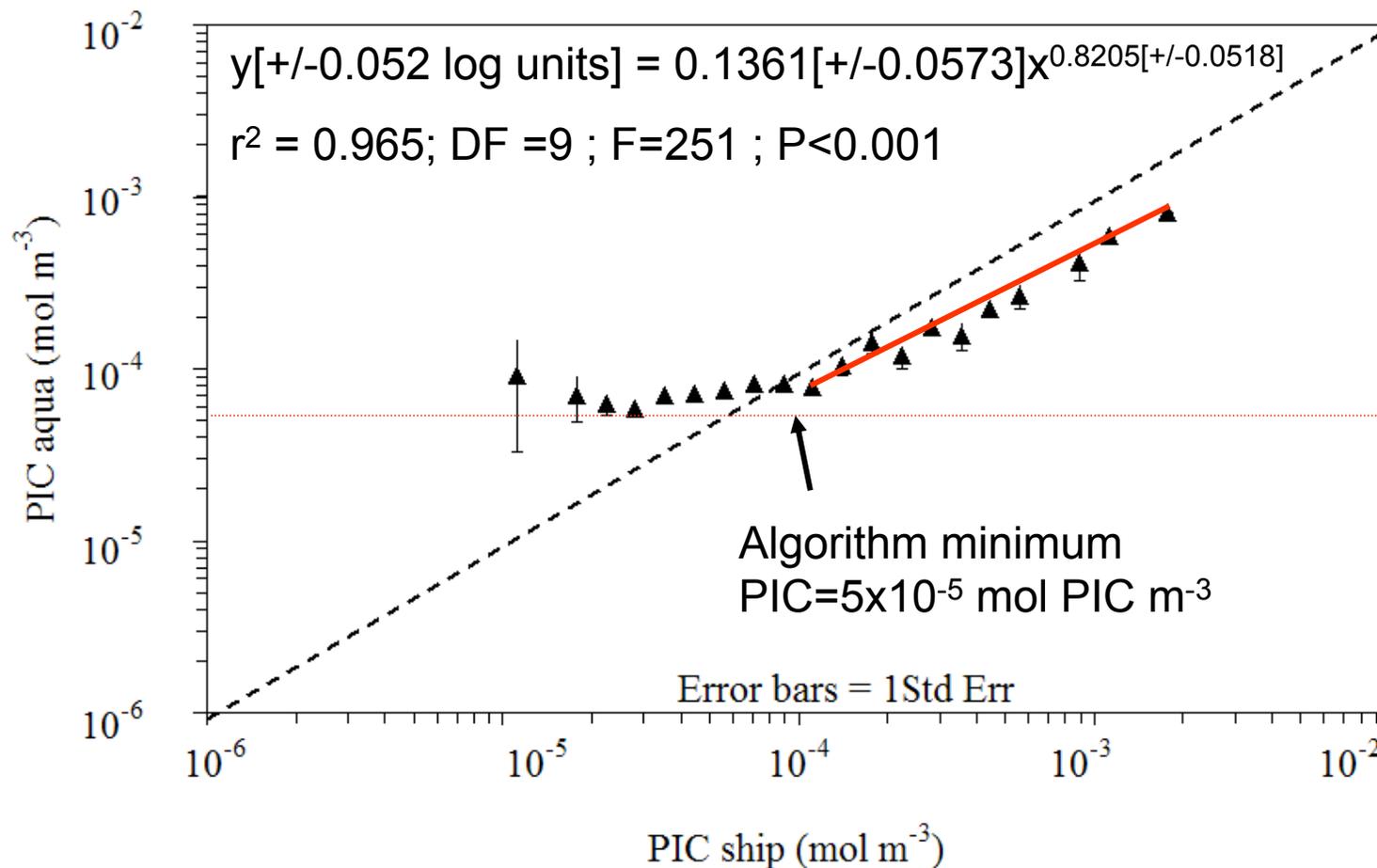


Lowest
obs
values
 5×10^{-5}
mol
 m^{-3}
PIC

Optical technique linear down to $b_b' = 5 \times 10^{-5} m^{-1}$

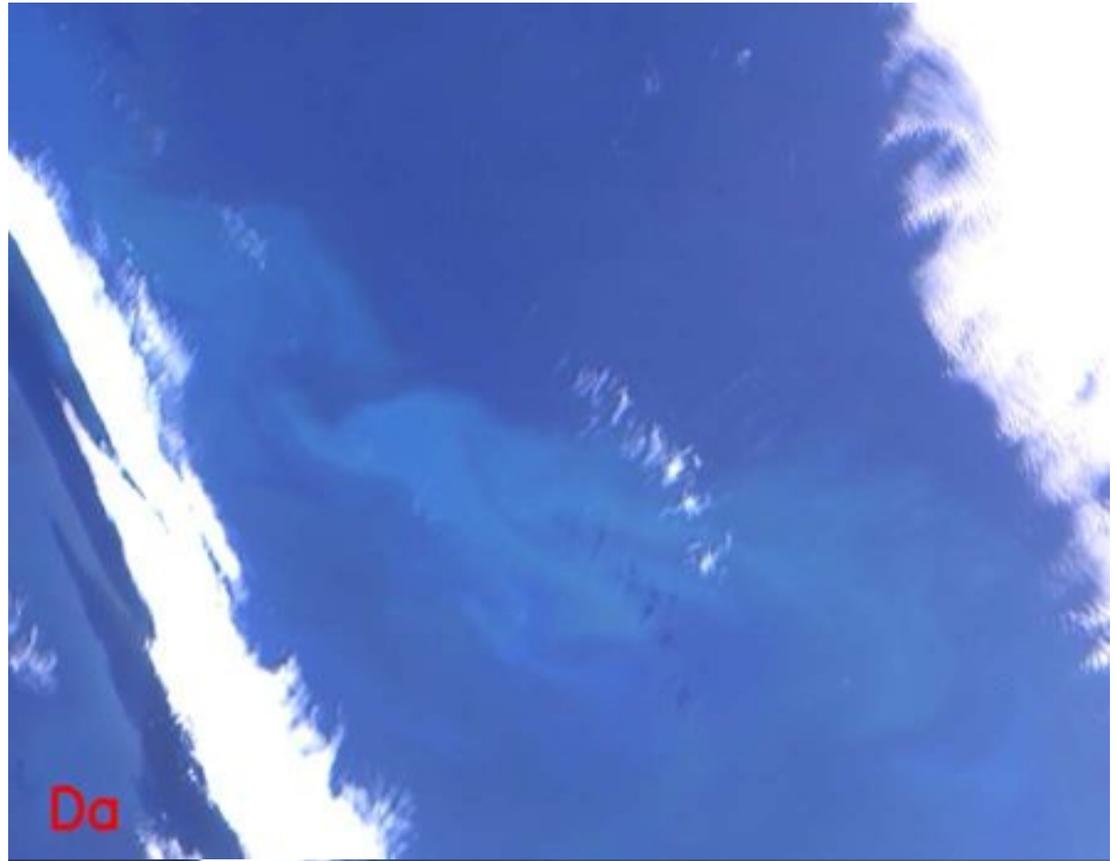
For binned results for AMT 15, 16 and 17 (n=528 surface values total)

AMT 15-17



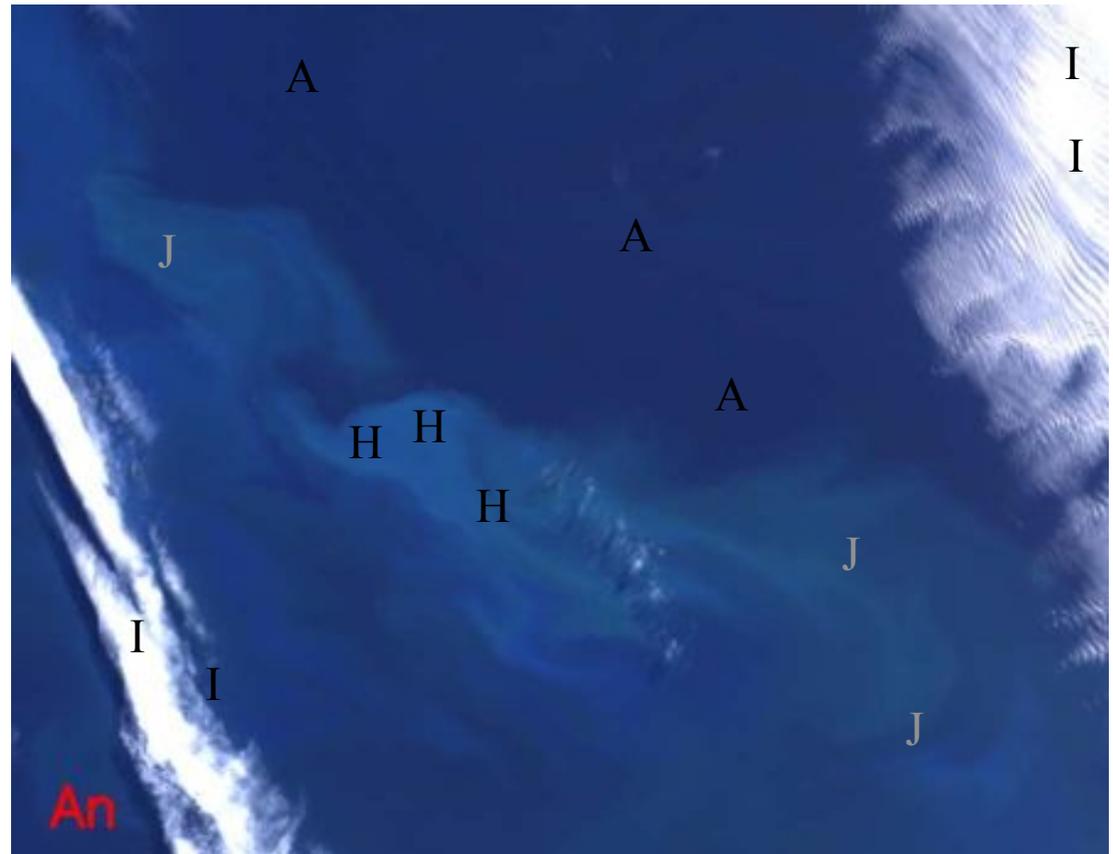
Adding MISR (Multiangle Imaging SpectroRadiometer) data to improve our detection of coccolithophore blooms

- Aboard Terra only
- 9 angles from 70° forward to 70° aft (70.5°, 60°, 45.6°, 26.1°, 0°)
- Wavelengths = 446.4, 557.5, 671.7, and 866.4 nm
- Calibrated, georeferenced



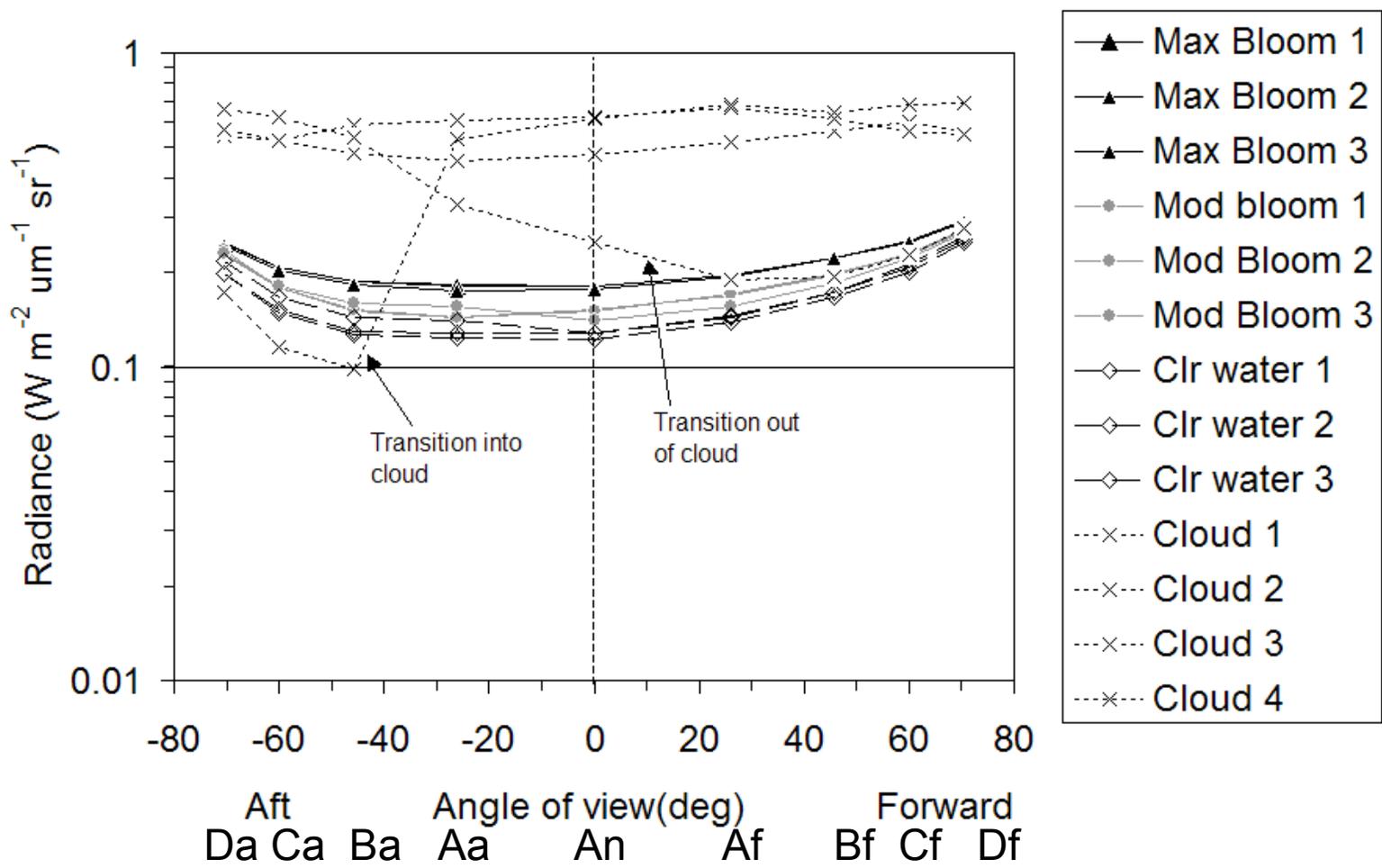
We extracted data at multiple locations

- 3 samples in maximum bloom
- 3 samples in moderate bloom
- 3 samples outside bloom
- 4 samples within clouds (one transitioning into cloud, one transitioning out of cloud)



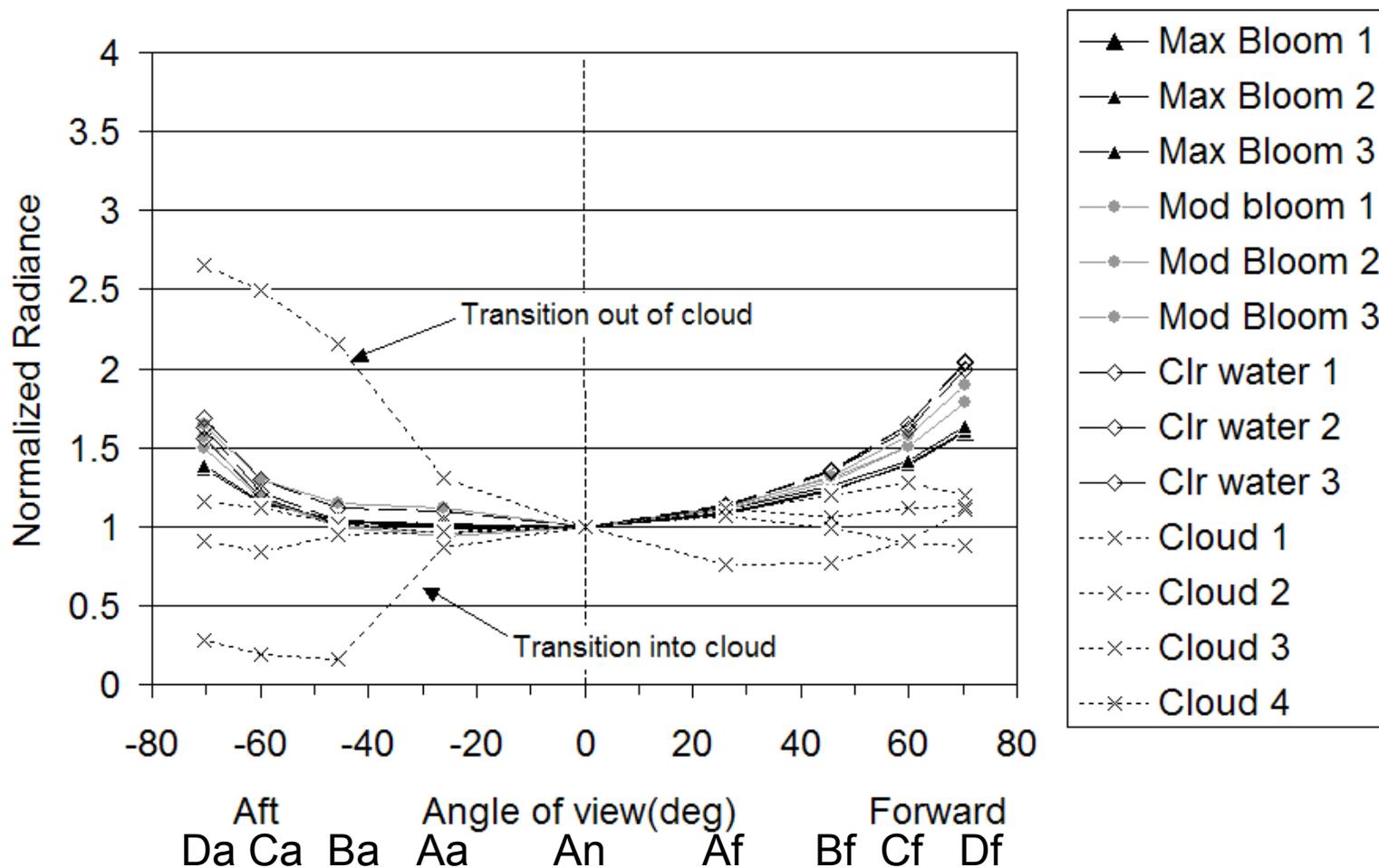
Clear differences in radiance magnitude in and outside bloom. Clouds well separated.

MISR; Patagonian Shelf Cocco Bloom; 446.4nm



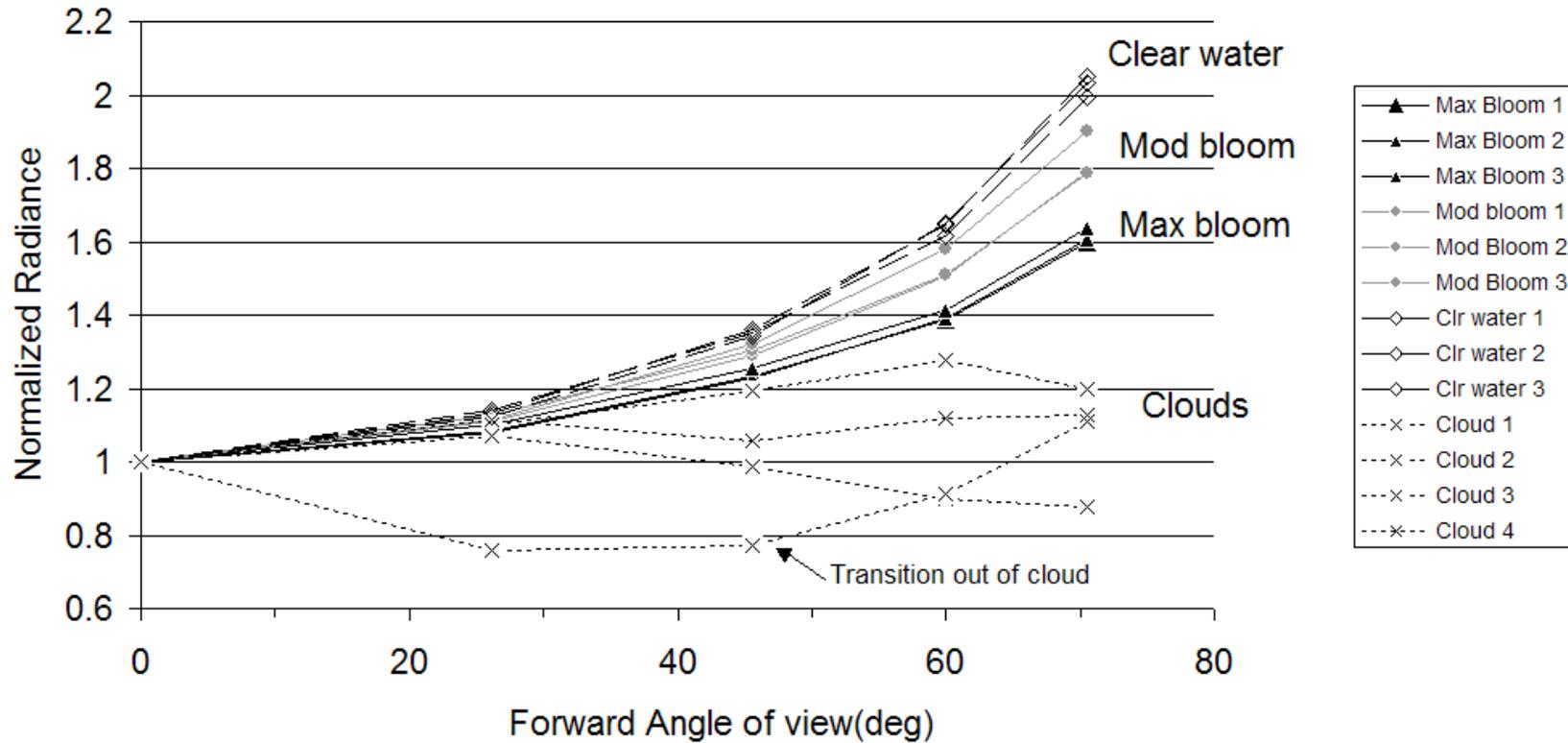
Normalize to nadir detector. Differences in shape of BRF in and out of bloom. Clouds are Lambertian reflectors...

MISR; Patagonian Shelf Cocco Bloom; 446.4nm



Focusing on shape in forward angles only...

MISR BRDFs; Patagonian Shelf Cocco Bloom; 446.4nm



An

Af

Bf

Cf

Df

Summary

- We have one more AMT cruise Sept '10 on our MODIS contract
- Through the AMT cruises (plus Gas-ExIII and COPAS'08), we have increased the amount of PIC data from oceanic regions for PIC algorithm development by 5X
- Relative to other ship-derived variables that we collect for algorithm validation (e.g. Chl a, POC), the PIC data set is miniscule, however!

Summary

- The AMT data provide a basin wide PIC/coccolithophore baseline for ocean acidification observations
- We have revised the PIC algorithm coefficients, and the revised algorithm will be reflected in the next Aqua reprocessing
- We are working with MISR data to improve our ability to identify coccolithophore blooms. Terra platform provides contemporaneous MISR and MODIS data

Thank you!