Assessing the impact of a variable seawater depolarization ratio on IOP retrievals

Tim Moore (UNH, CoI)
Jim Sullivan (FAU, PI)
Mike Twardowski (FAU, CoI)

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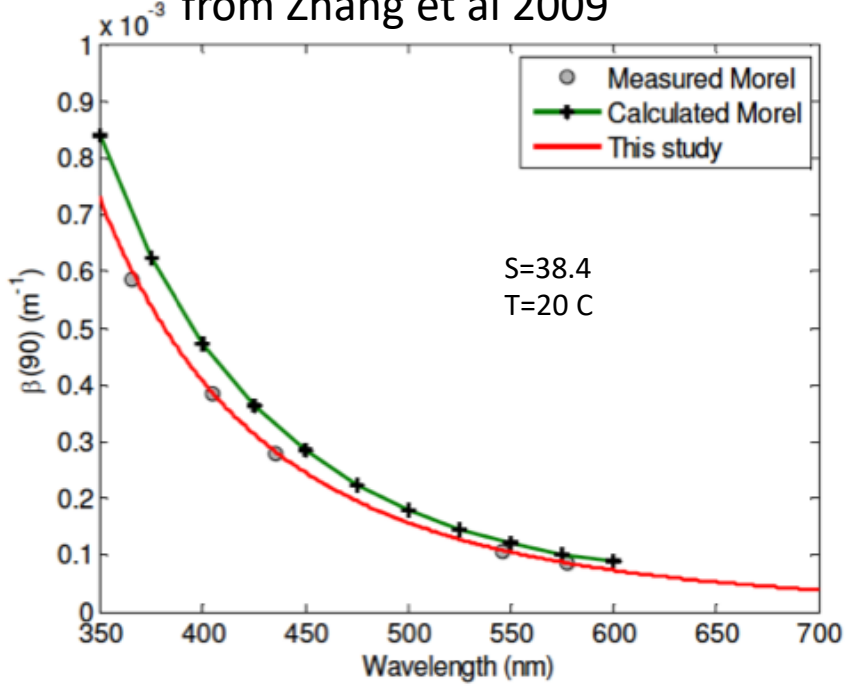
from Zhang et al 2009



- *Zhang et al 2009 developed a model for backscatter of seawater with temperature & salinity dependencies.*
- *The depolarization ratio, a model parameter, was kept constant at 0.039, although lab measurements (from 40-50 years ago) range from 0.01 to 0.09.*
- *The depolarization ratio is the ratio of horizontally polarized light to vertically polarized light in the scattered beam at 90°.*

from Werdell et al 2013

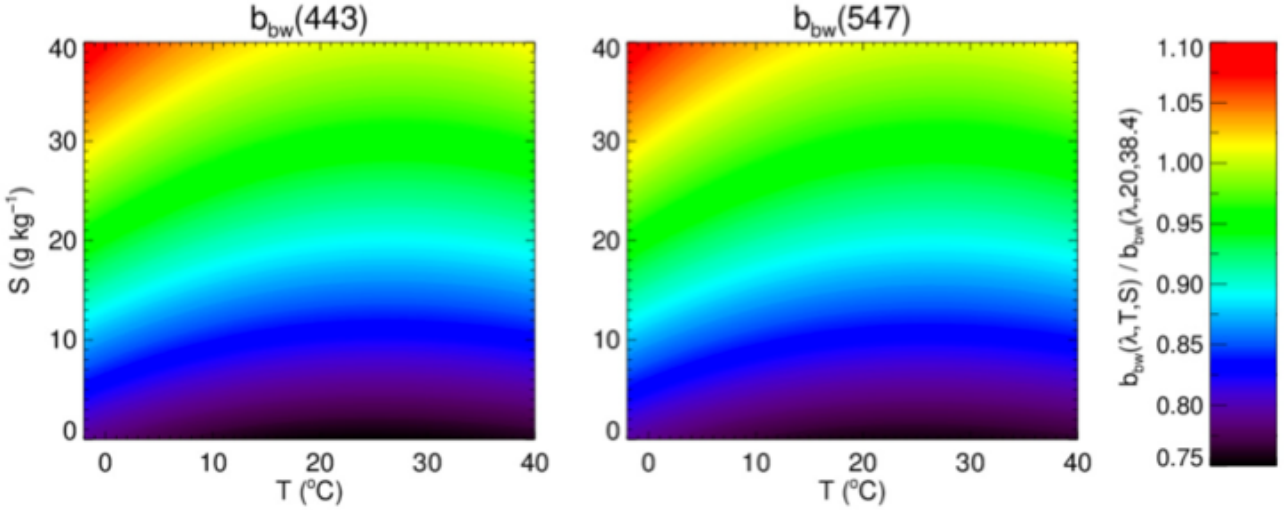
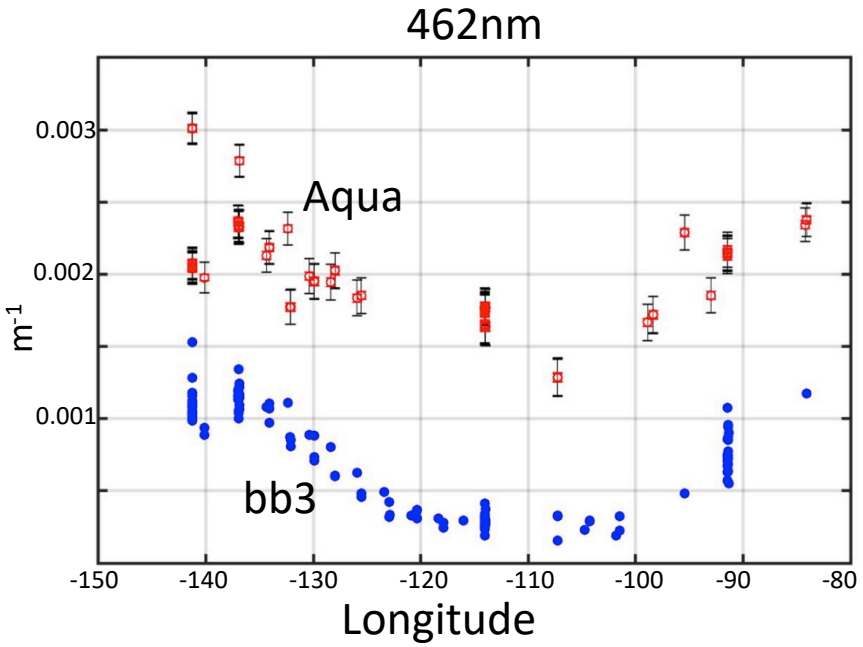


Fig. 1. Ratios of $b_{bw}(\lambda,T,S)$ to $b_{bw}(\lambda,20,38.4)$ for 443 nm (left panel) and 547 nm (right panel) for the temperature and salinity ranges $-2 \le T \le 40°C$ and $0 \le S \le 40$ g kg^{-1}.

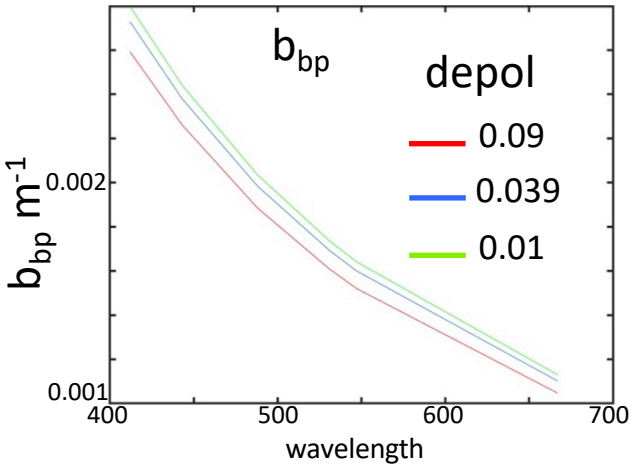
- *We explored the impact of varying the depol ratio on IOP retrievals from SAAs.*
- *We focused on the South Pacific, where impacts of variable seawater backscatter would be more strongly expressed in IOPs.*

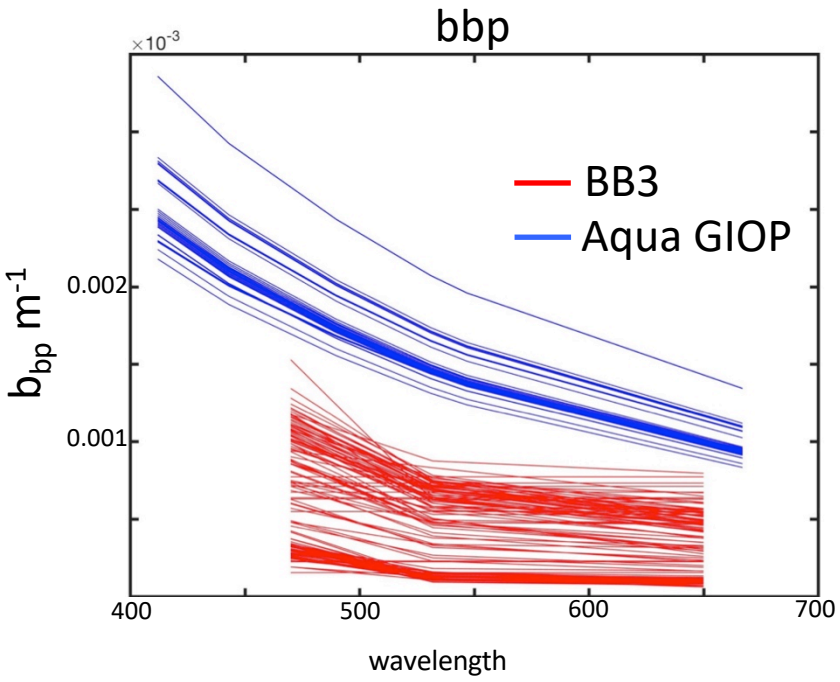
Analysis of depol impacts on retrievals from Modis-Aqua imagery South Pacific Nov 2004

Aqua "matchups" with BIOSOPE cruise data (Oct – Dec, 2004) South Pacific (+/- 1 day, +/-25km) – more interested in longitudinal patterns



A typical pixel from the South Pacific



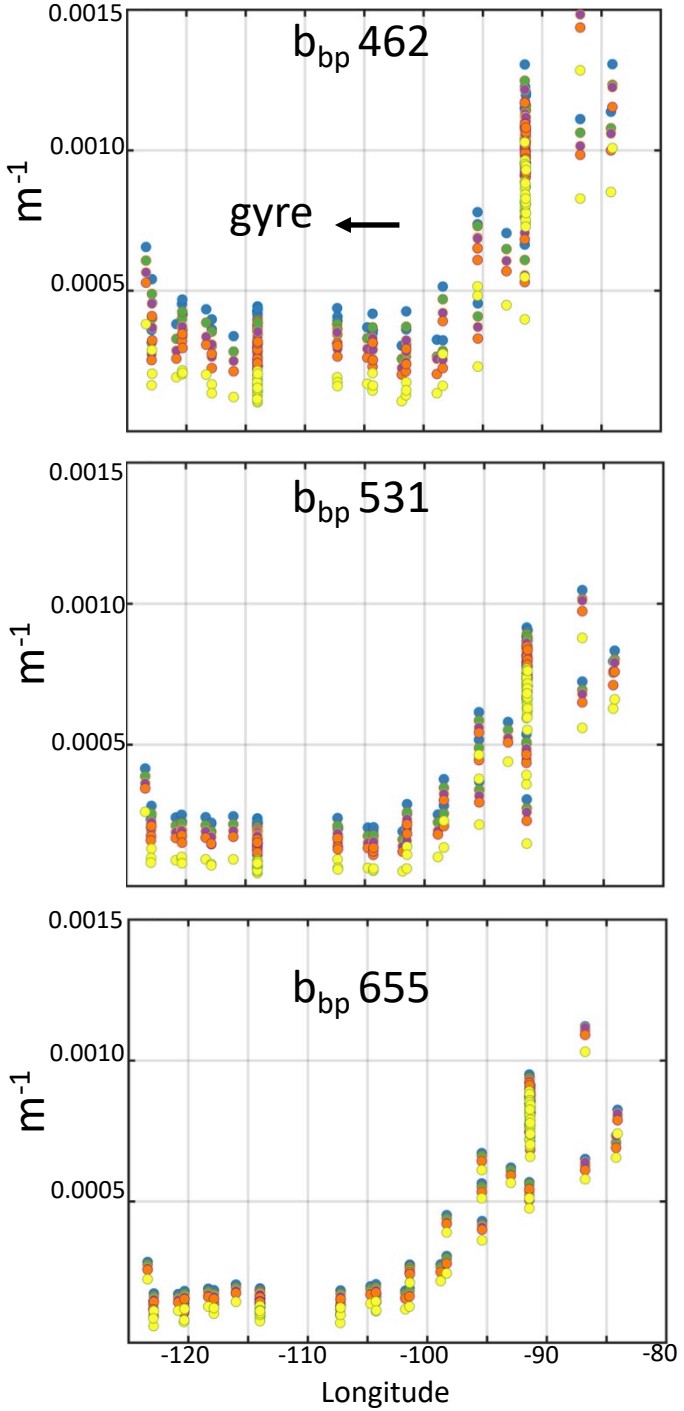


- Aqua GIOP retrievals from are higher than bb3.
- depol impacts amounts to a small percentage of variation in IOPs, but does not account for the large offset.

Impact of depol changes on GIOP retrievals from a single image. A2004306155500 South Pacific absolute relative error (%)

	Depol	bbp	adg	aph
	0.01	3.0	2.3	0.6
-30%	0.027	1.3	1.0	0.3
Default	0.039	N/A	N/A	N/A
+30%	0.051	1.3	1.0	0.3
	0.09	5.9	4.5	1.25

BIOSOPE Cruise Oct. 24, 2004 – Dec. 11, 2004 (west to east).

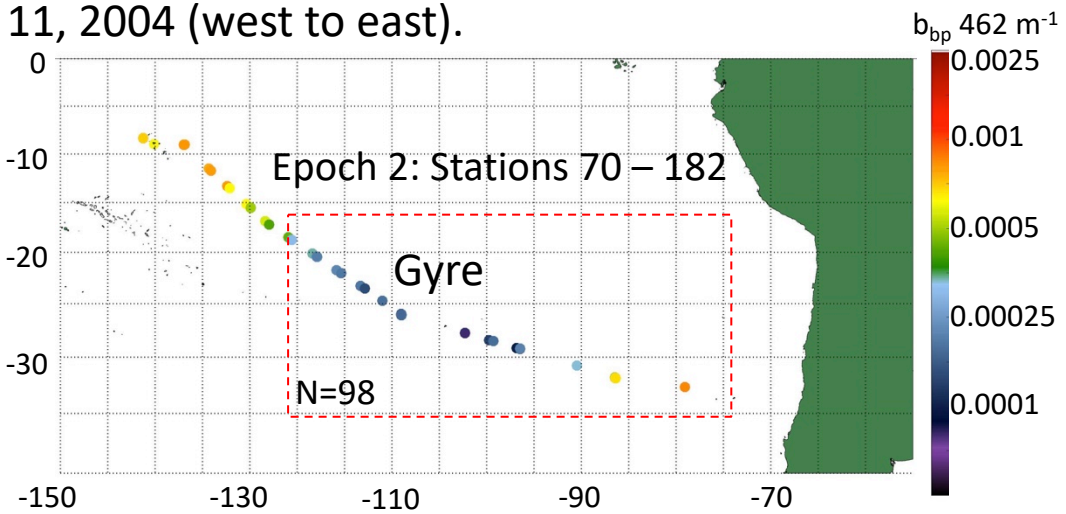


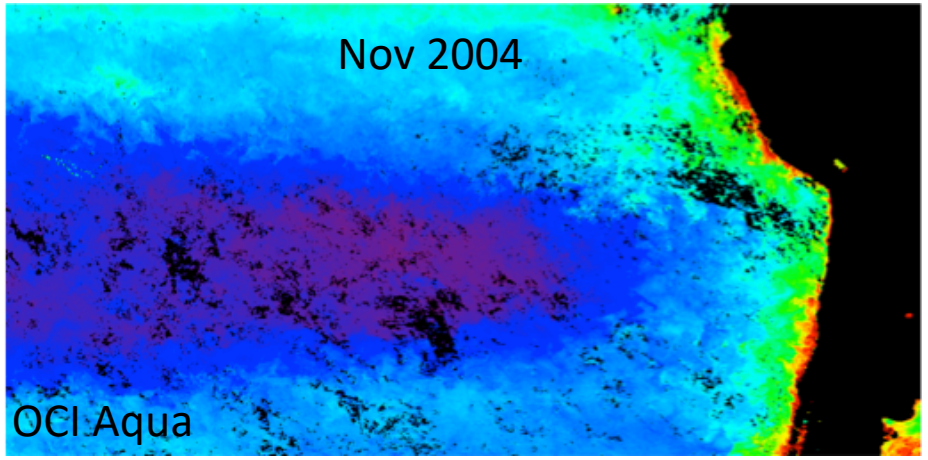
Depol

- 0.01
- 0.027
- 0.039
- 0.051
- 0.09

Absolute % difference of bbsw relative to bbsw (depol=0.039)

Depol	all waves
0.01	4.8
0.027	2.0
0.039	N/A
0.054	2.1
0.09	9.3





Absolute percent difference of bbp relative to b_{bp} (depol=0.039)

Depol	462	531	665
0.01	20.7	20.1	9.1
0.027	8.6	8.5	3.8
0.039	N/A	N/A	N/A
0.051	8.8	8.7	3.9
0.09	33.8	37.3	17.6

- *bbp data are derived coefficients requiring bbsw.*
- *in situ* bbp from BIOSOPE re-calculated with Zhang bbsw model.
- Variations +/- 10% within expected depol ranges (0.027-0.051 likely)

Default SAA's changing depol only using in situ Rrs (BIOSOPE)

BIOSOPE South Pacific (N=44) absolute relative difference (%)

GIOP

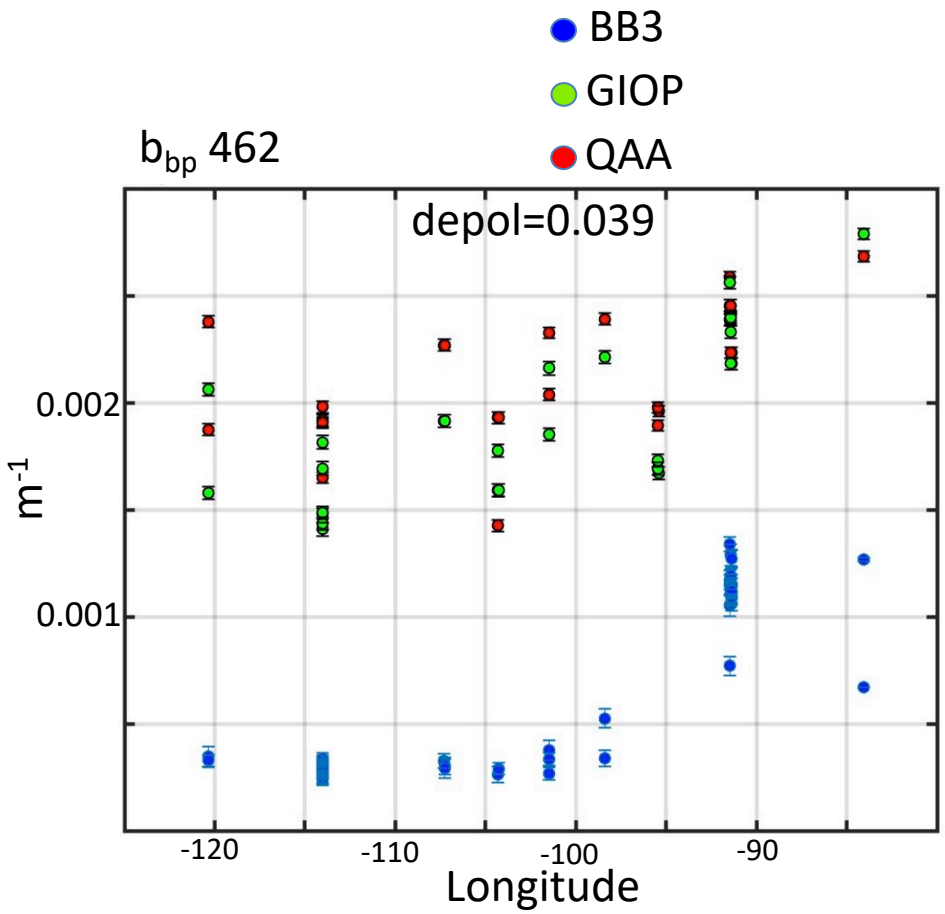
Depol	bbp	aph	adg
0.01	3.4	1.0	2.3
0.027	1.4	0.5	1.0
0.039	N/A	N/A	N/A
0.051	1.4	0.5	1.0
0.09	6.5	1.7	4.4

QAA

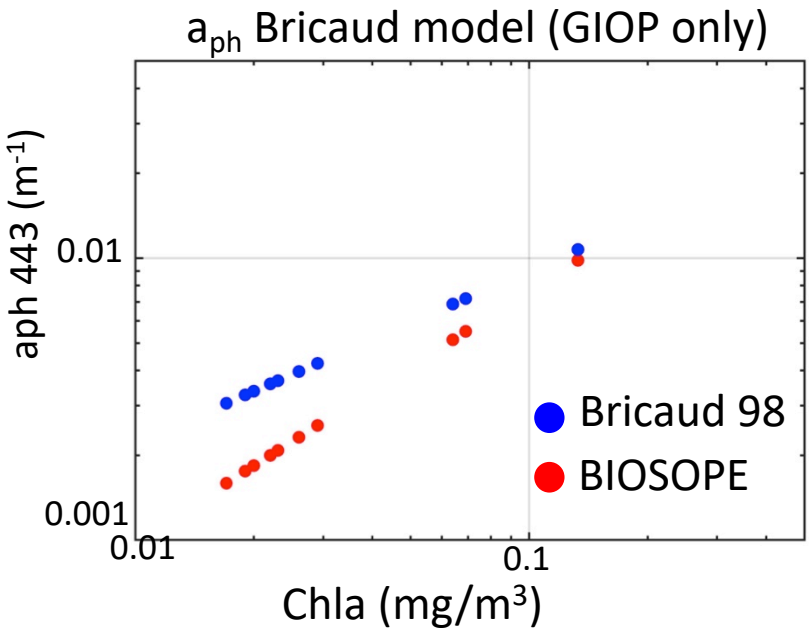
Depol	bbp	aph	adg
0.01	2.8	1.0	2.5
0.027	1.2	0.4	1.0
0.039	N/A	N/A	N/A
0.051	1.2	0.4	1.0
0.09	5.4	2.0	4.8

- Comparisons relative to depol=0.039 (default).
- On same order as satellite retrievals (expected – Rrs similar).

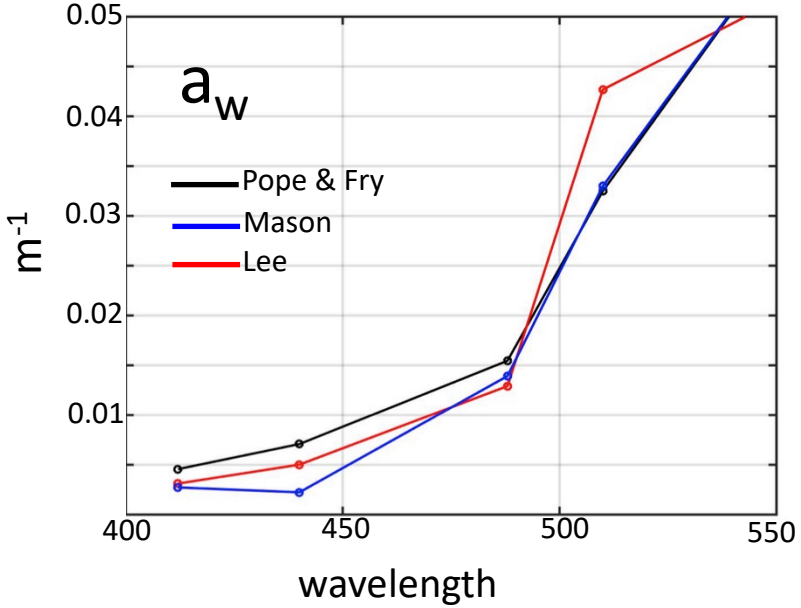
- In situ Rrs from 3 radiometers were matched with IOP measurements.
- Rrs were processed with GIOP and QAA to assess impacts of depol on IOPs.
- Same longitudinal pattern as Aqua matchups.

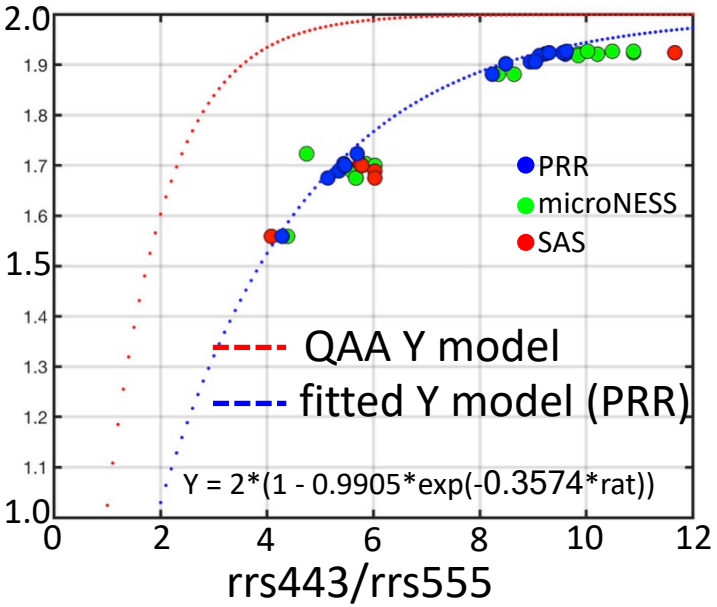


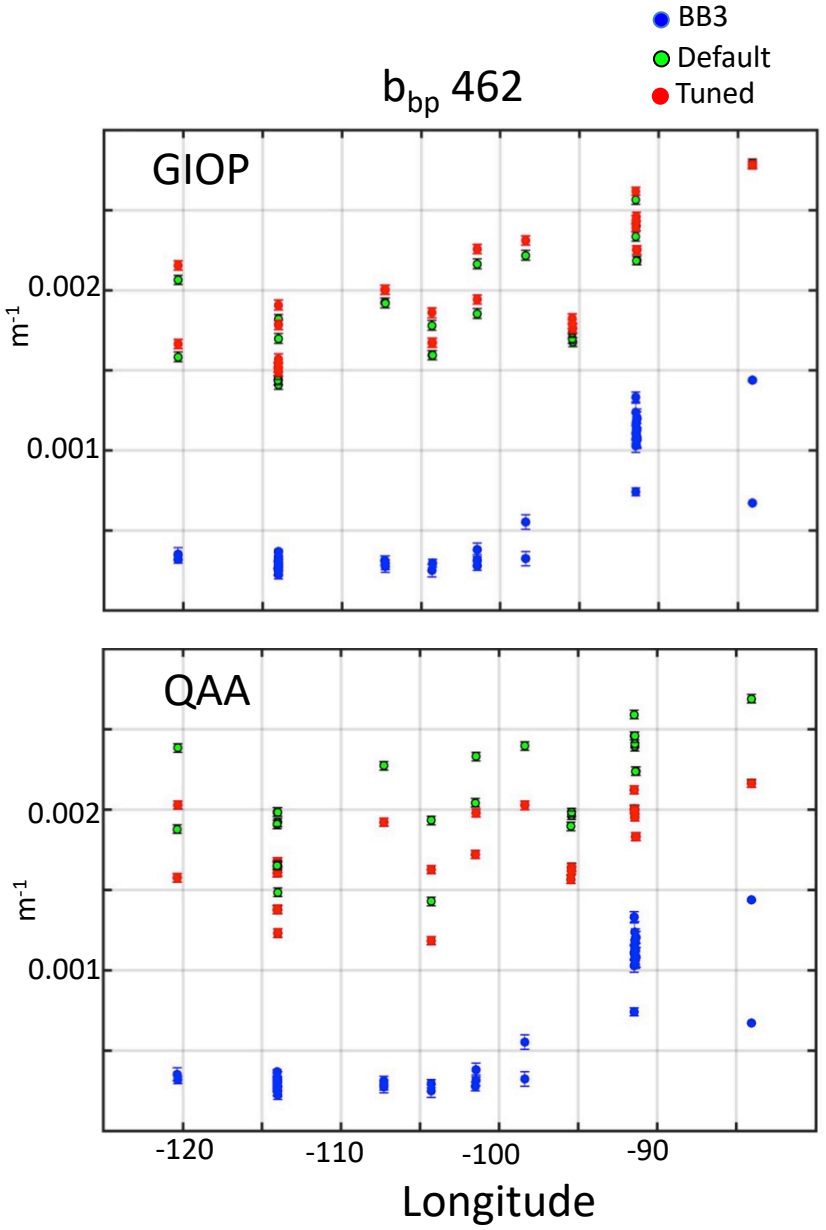
Other changes in IOP model parameters were examined with BIOSOPE data

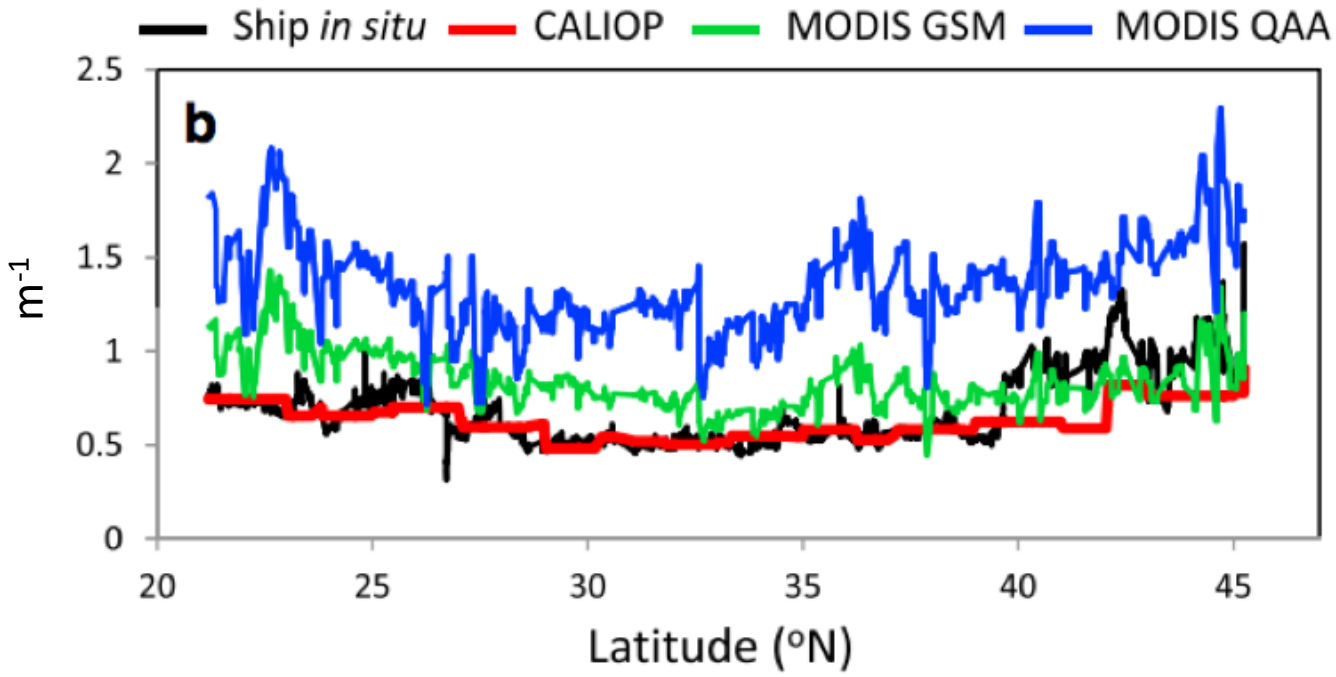


- New a_{ph} power-law coefficients from A. Bricaud specific to BIOSOPE data.
- New aw values from Mason.
- New bbp slope relationship derived from Rrs.



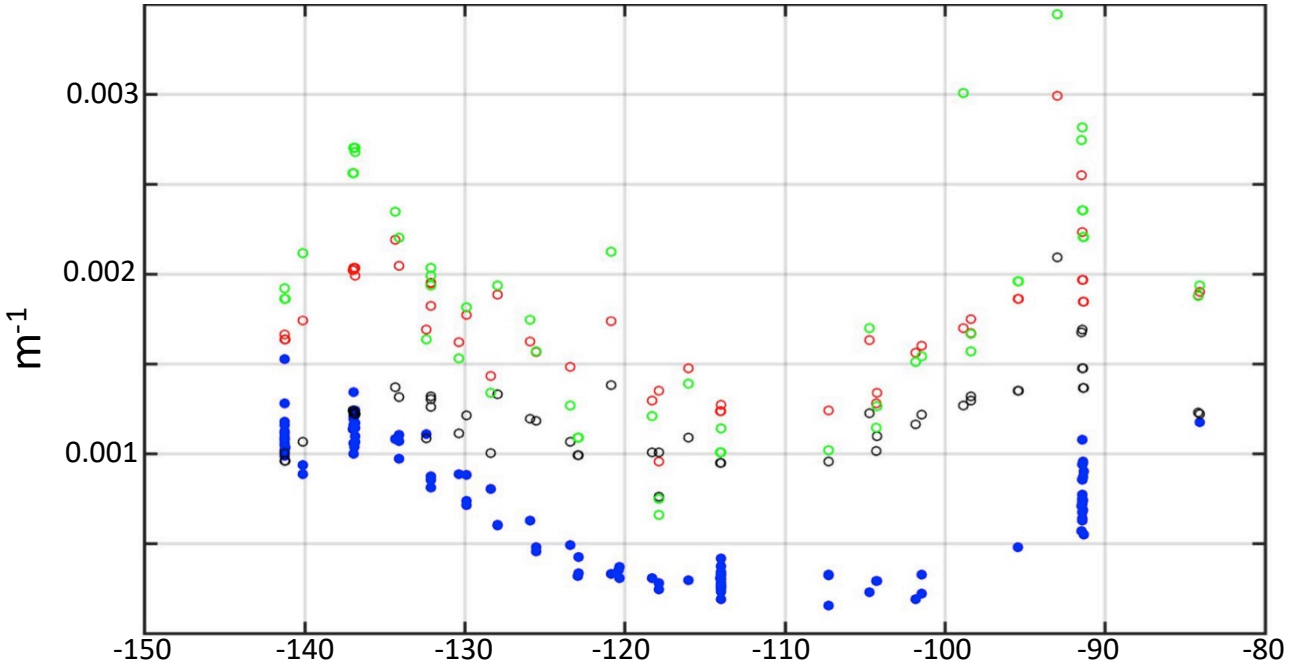






Behrenfeld et al 2013 GRL

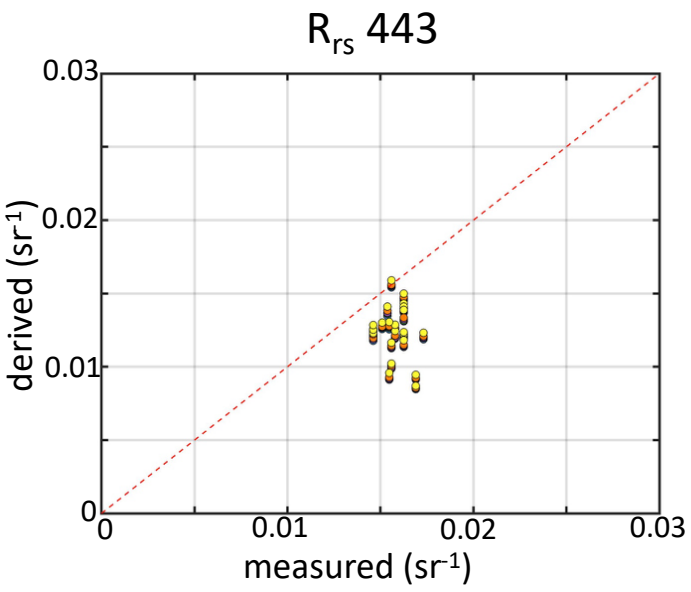
- Similar discrepancies with bbp distributions appear in Atlantic data from Behrenfeld et al 2013.
- Longitudinal trends for South Pacific/BIOSOPE data are also the same for bbp retrievals for SeaWiFS 4km.



SeaWiFS 4km matchups

- GSM
- GIOP
- QAA

Summary



- Seawater depolarization ratio has uncertainty in laboratory measurements, propagating into impacts on bbsw and all IOPs during SAA retrievals.
- Variations of IOPs are small, on the order of a few percent, increasing in clearer waters.
- Variations did not explain discrepency between measured and retrieved b_{bp} in South Pacific.
- This is interesting and requires further exploration - need to include Raman scattering in next iteration (happening now).