

Cross Calibration of SeaWiFS and MODIS Using On-orbit Observations of the Moon

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Meister¹, Charles McClain¹

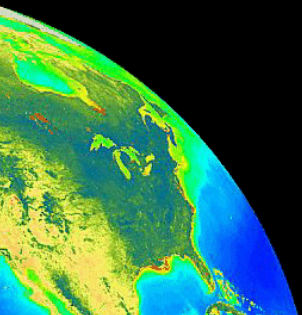
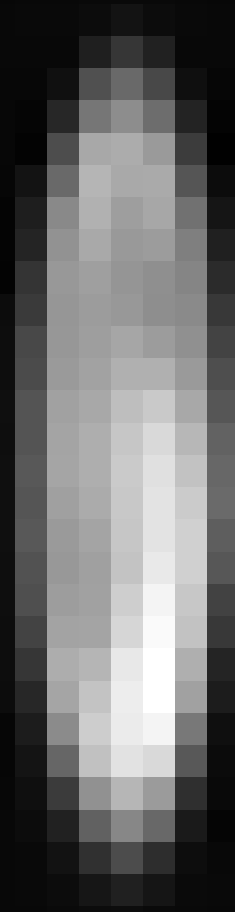
¹NASA Ocean Biology Processing Group

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MODIS Calibration Workshop

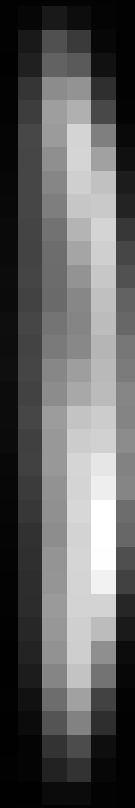
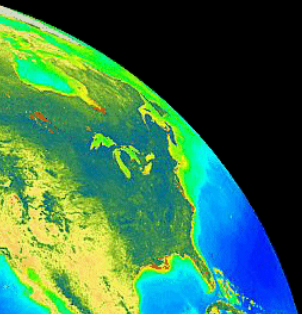


SeaWiFS Band 1



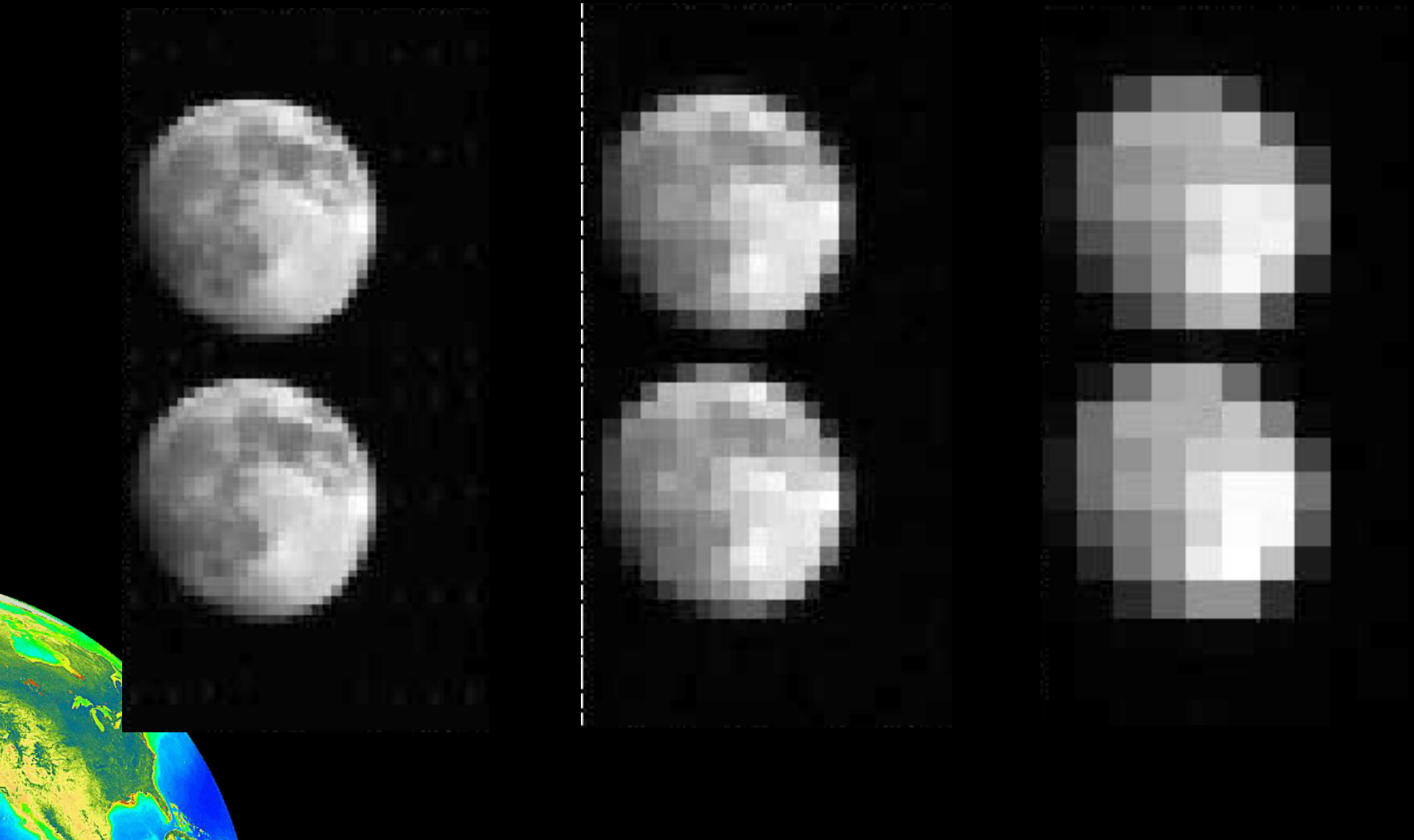
Aqua MODIS Band 8

Lunar Cal
Sequence



Detector 5 Composite

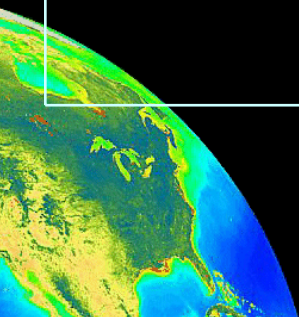
MODIS Band 2 (250m),
Band 3 (500m), Band 8 (1000m)



Lunar Observations

Instrument	Type	Phase Angle	Number	Time Range
SeaWiFS	Low Phase*	-6 to -8	83	Nov 97 – Apr 09
		+5 to +10	49	
	Cross Cal	-27.1	1	14 Apr 03
	High Phase	-27 to -49	26	Jul 04 – Dec 07
+27 to +65		32		
Terra MODIS	Scheduled*	+52 to +62	82	Mar 00 – Feb 09
	Cross Cal	-27.7	1	14 Apr 03
	Unscheduled	+55 to +82	297	Jul 00 – Dec 08
Aqua MODIS	Scheduled*	-51 to -58	61	Jul 02 – Apr 09
	Unscheduled	-54 to -80	171	Dec 02 – Dec 08

*Primary Radiometric Stability Monitor Observations



Band Comparisons

SeaWiFS	λ (nm)	MODIS	λ (nm)
Band 1	412	Band 8	412
Band 2	443	Band 9	442
		Band 3	468
Band 3	490	Band 10	487
Band 4	510	Band 11	530
Band 5	555	Band 12	547
		Band 4	554
Band 6	670	Band 1	647
Band 7	765		
Band 8	865	Band 2	857



USGS ROLO Model

Disk-integrated lunar irradiances

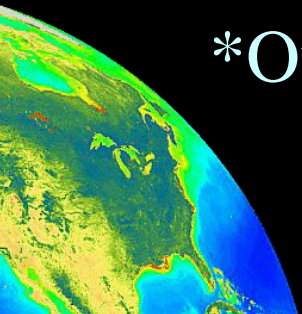
Geometric normalizations:

- Sun/Moon, SC/Moon distances
- Phase/Libration angles

Band pass normalizations:

- Relative spectral response

Oversampling Corrections



Comparisons over Wavelength

Mission-Long Cross Calibration

- SeaWiFS / Terra MODIS / Aqua MODIS

Single-Point Cross Calibration

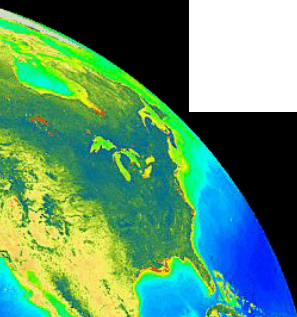
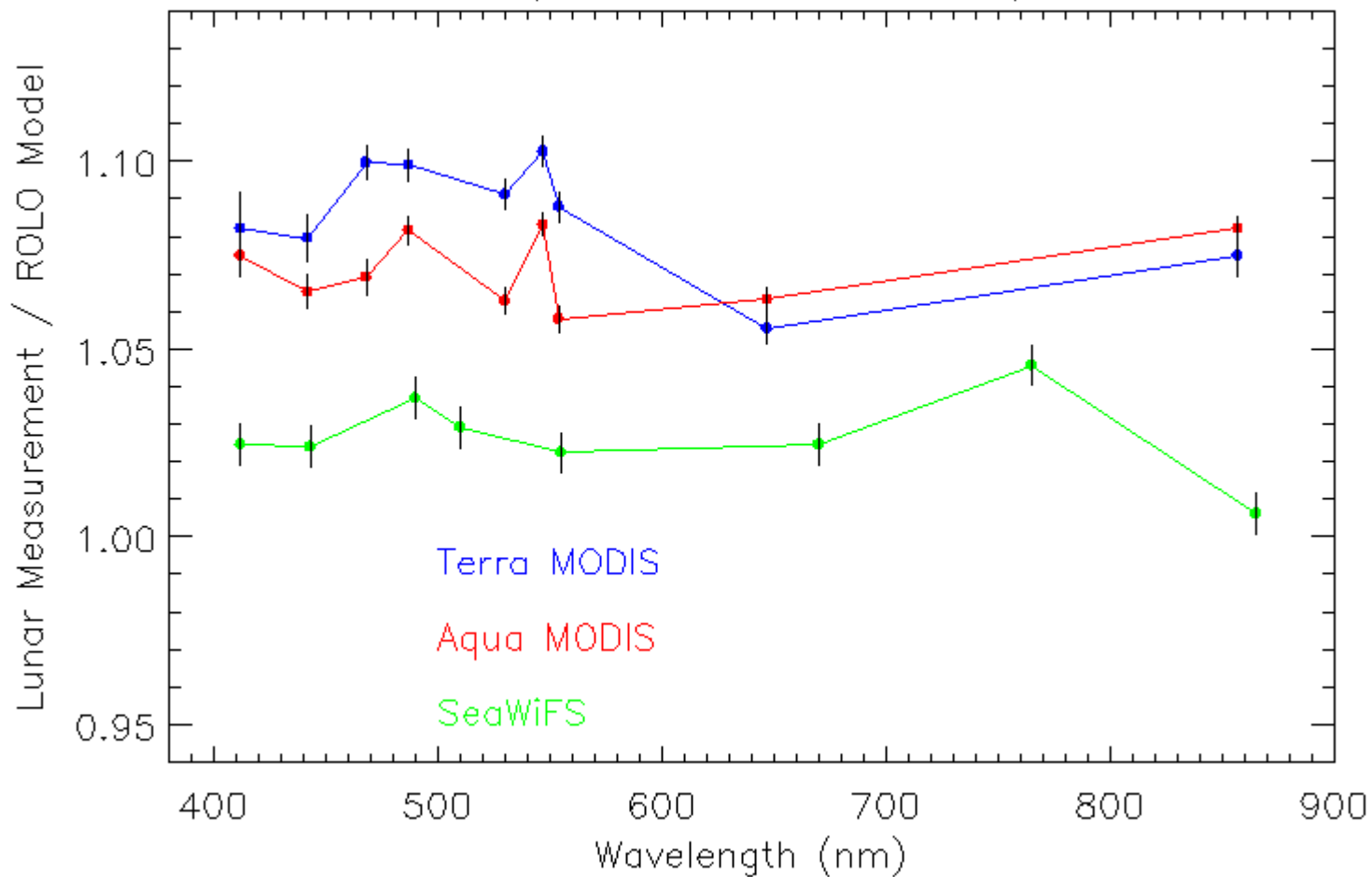
- SeaWiFS / Terra MODIS

Combined Comparison

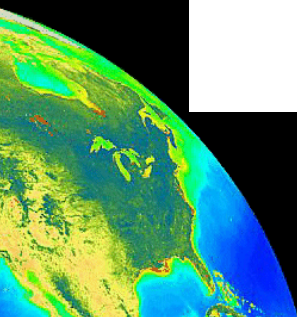
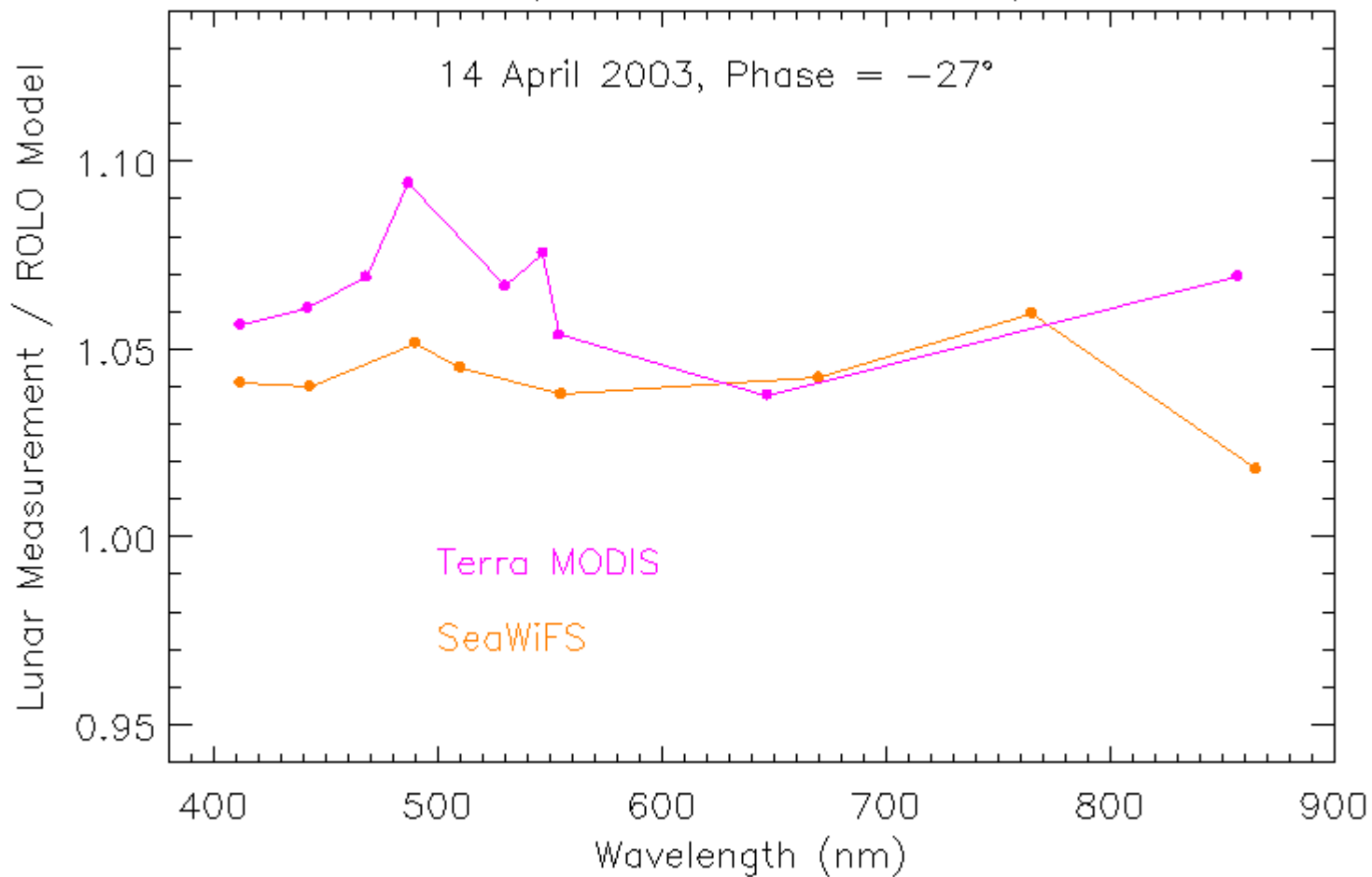
- SeaWiFS / Terra MODIS



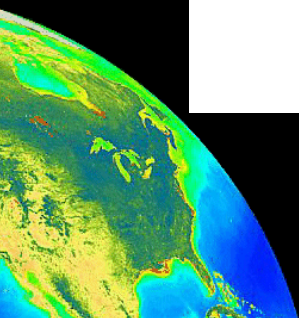
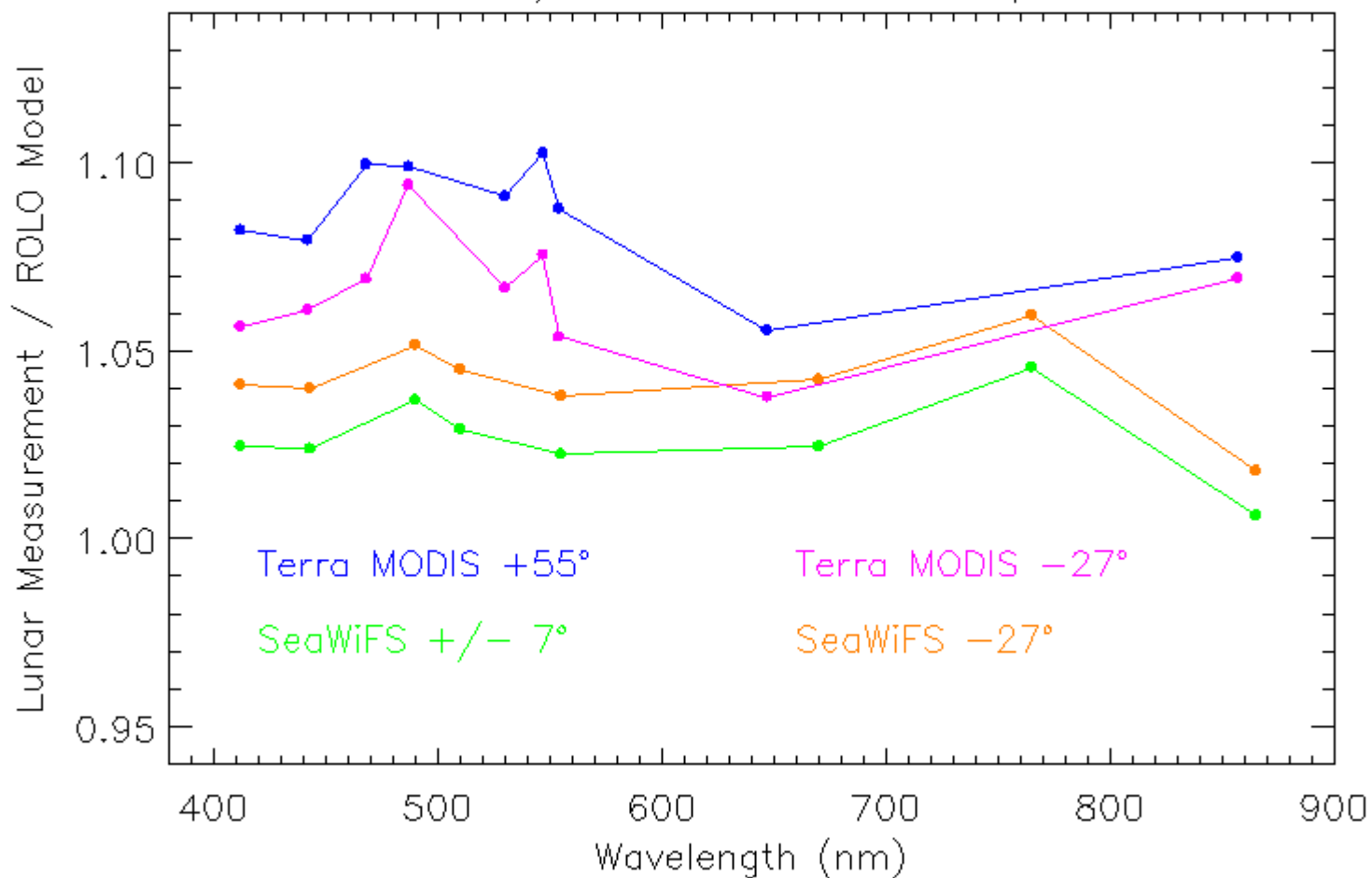
SeaWiFS / MODIS Lunar Comparison



SeaWiFS / MODIS Lunar Comparison

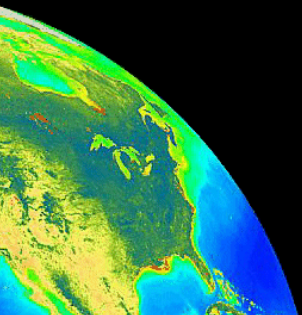


SeaWiFS / MODIS Lunar Comparison



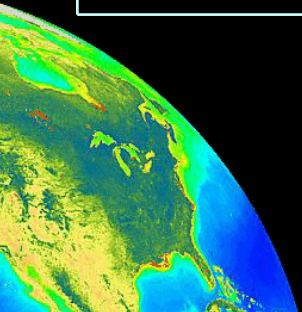
Terra/Aqua MODIS Biases

Band	λ (nm)	Bias (%)
8	412	0.7 ± 1.1
9	442	1.3 ± 0.8
3	468	2.8 ± 0.6
10	487	1.6 ± 0.6
11	530	2.7 ± 0.5
12	547	1.8 ± 0.5
4	554	2.8 ± 0.5
1	647	0.7 ± 0.5
2	857	0.7 ± 0.6



SeaWiFS/MODIS Biases

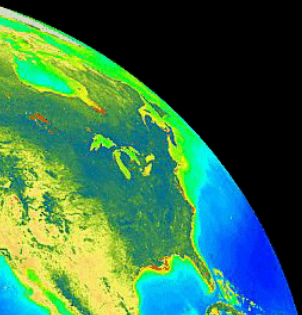
SeaWiFS	MODIS	Terra Bias (%)	Aqua Bias (%)	Terra Cross (%)
Band 1	Band 8	5.6 ± 1.1	4.9 ± 0.8	1.5
Band 2	Band 9	5.4 ± 0.8	4.0 ± 0.7	2.0
Band 3	Band 10	6.0 ± 0.7	4.3 ± 0.7	4.0
Band 4	Band 11	6.0 ± 0.7	3.3 ± 0.6	2.1
Band 5	Band 12	7.8 ± 0.7	5.9 ± 0.6	3.6
Band 5	Band 4	6.4 ± 0.7	4.9 ± 0.6	1.5
Band 6	Band 1	3.0 ± 0.7	3.8 ± 0.6	0.4
Band 8	Band 2	6.8 ± 0.8	7.5 ± 0.6	5.0



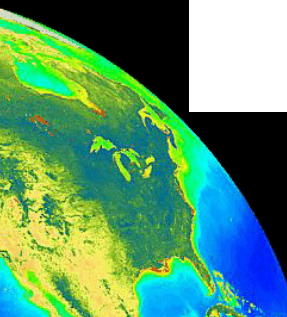
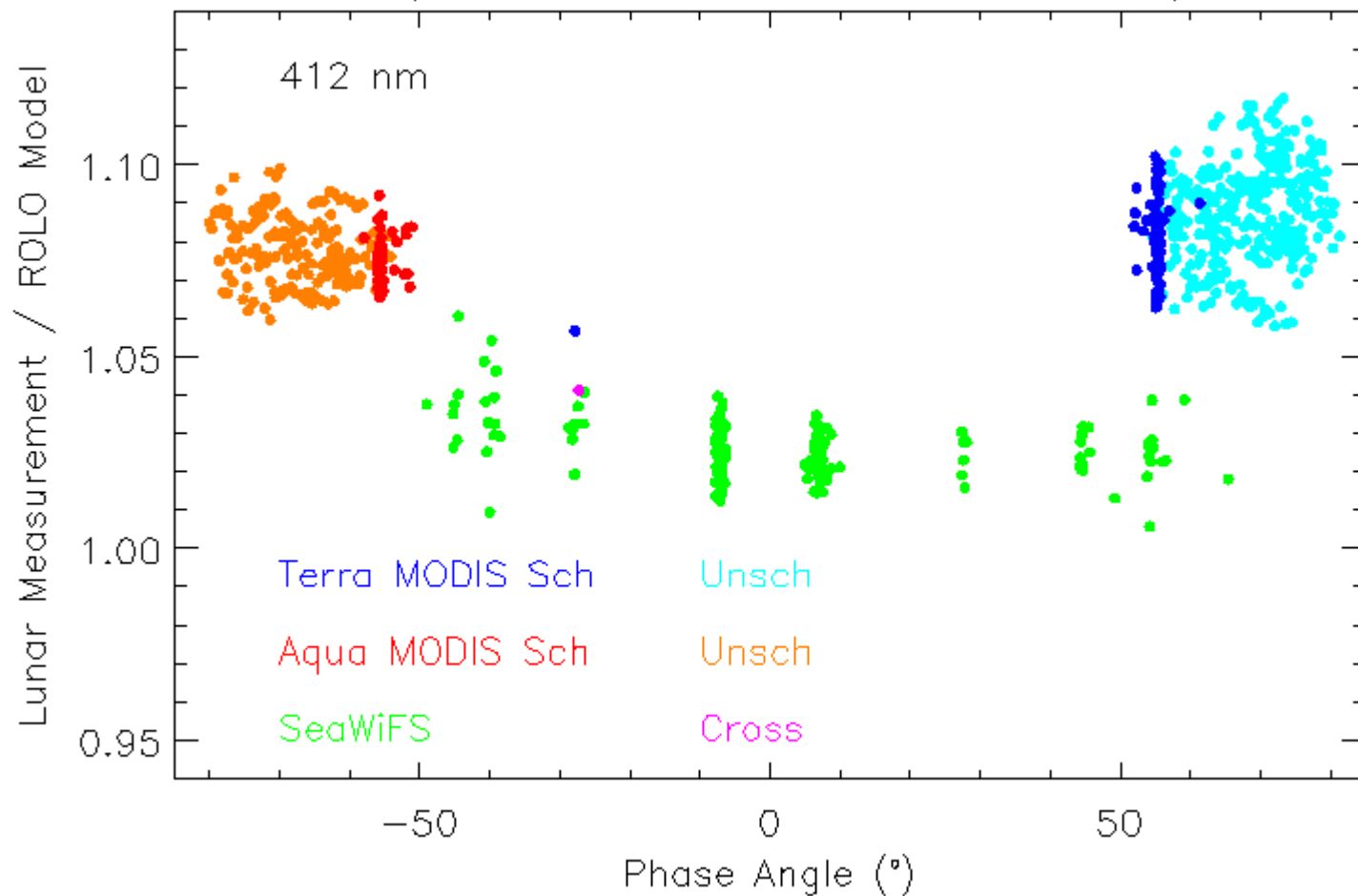
Comparisons over Phase Angle

Is there a residual phase angle dependence in the
ROLO Model?

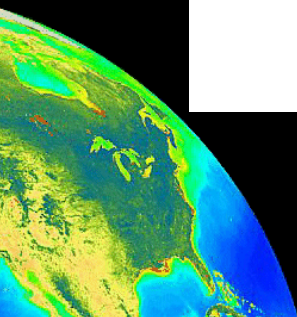
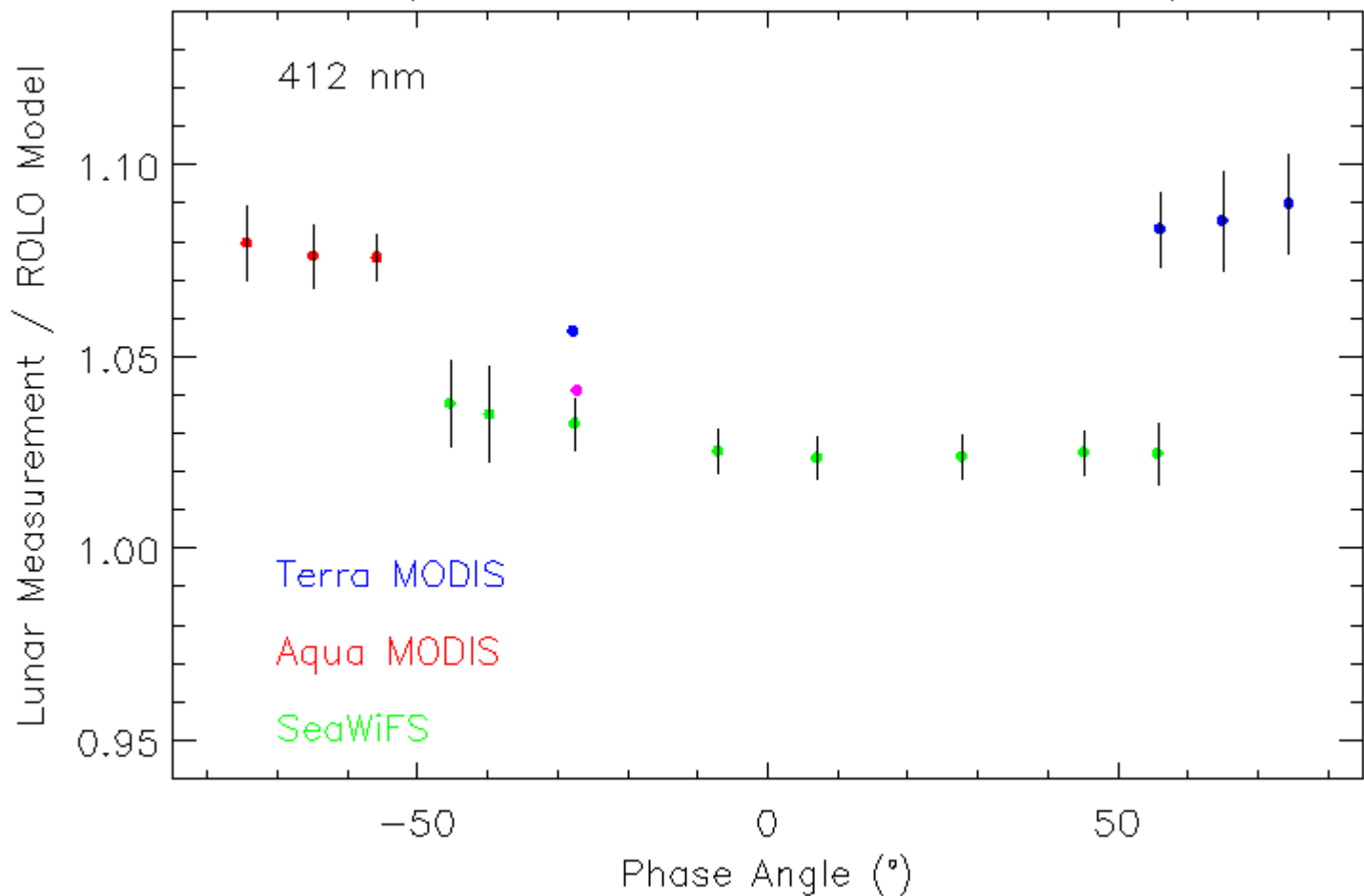
412 nm Band (SeaWiFS B1, MODIS B8)



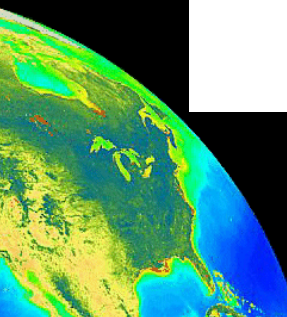
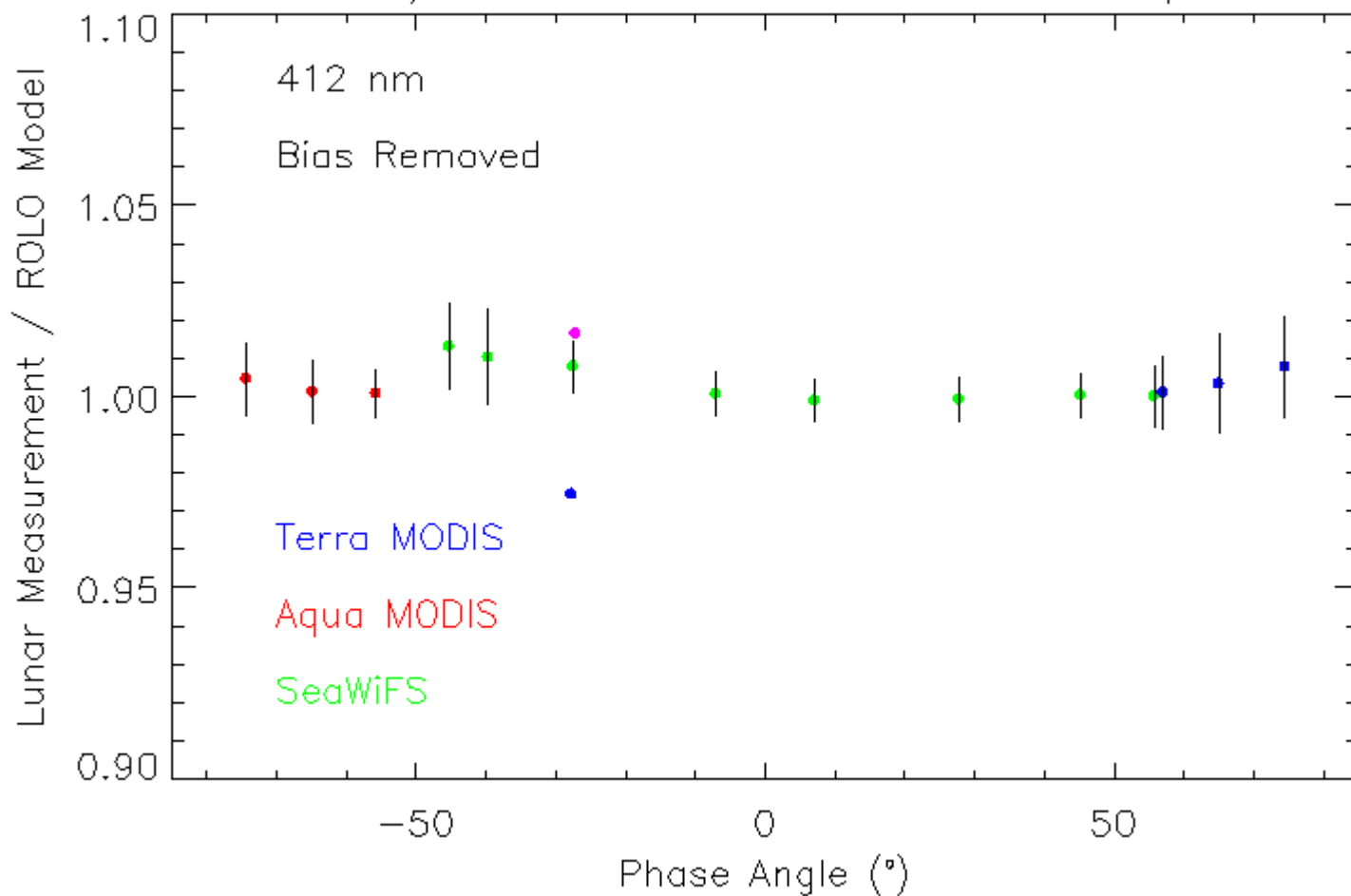
SeaWiFS / MODIS Lunar Calibration Comparison



SeaWiFS / MODIS Lunar Calibration Comparison



SeaWiFS / MODIS Lunar Calibration Comparison



Summary

Cross calibration using the Moon

- Estimate relative biases in on-orbit calibration at the top of the atmosphere
- Biases for SeaWiFS / Terra MODIS / Aqua MODIS

ROLO Model shows no residual phase dependence

Oversampling correction is primary source of noise in lunar observations: coherent between bands

Long term calibration time series:

- Allows mitigation of errors in a single observation
- Maximizes radiometric stability



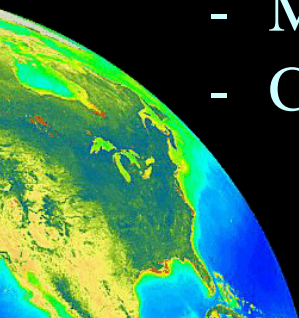
Implications

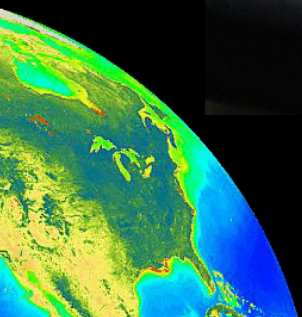
Importance of the USGS Photometric Model of the Moon (ROLO Model) for the on-orbit calibration of remote sensing instruments

Future instruments should be designed to observe the Moon without band saturation

Operations concepts for future missions:

- Maximize number of lunar observations
- Minimize phase angle range of the observations
- Consistent oversampling factors



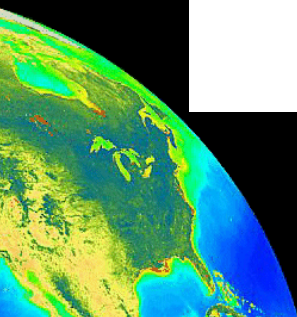
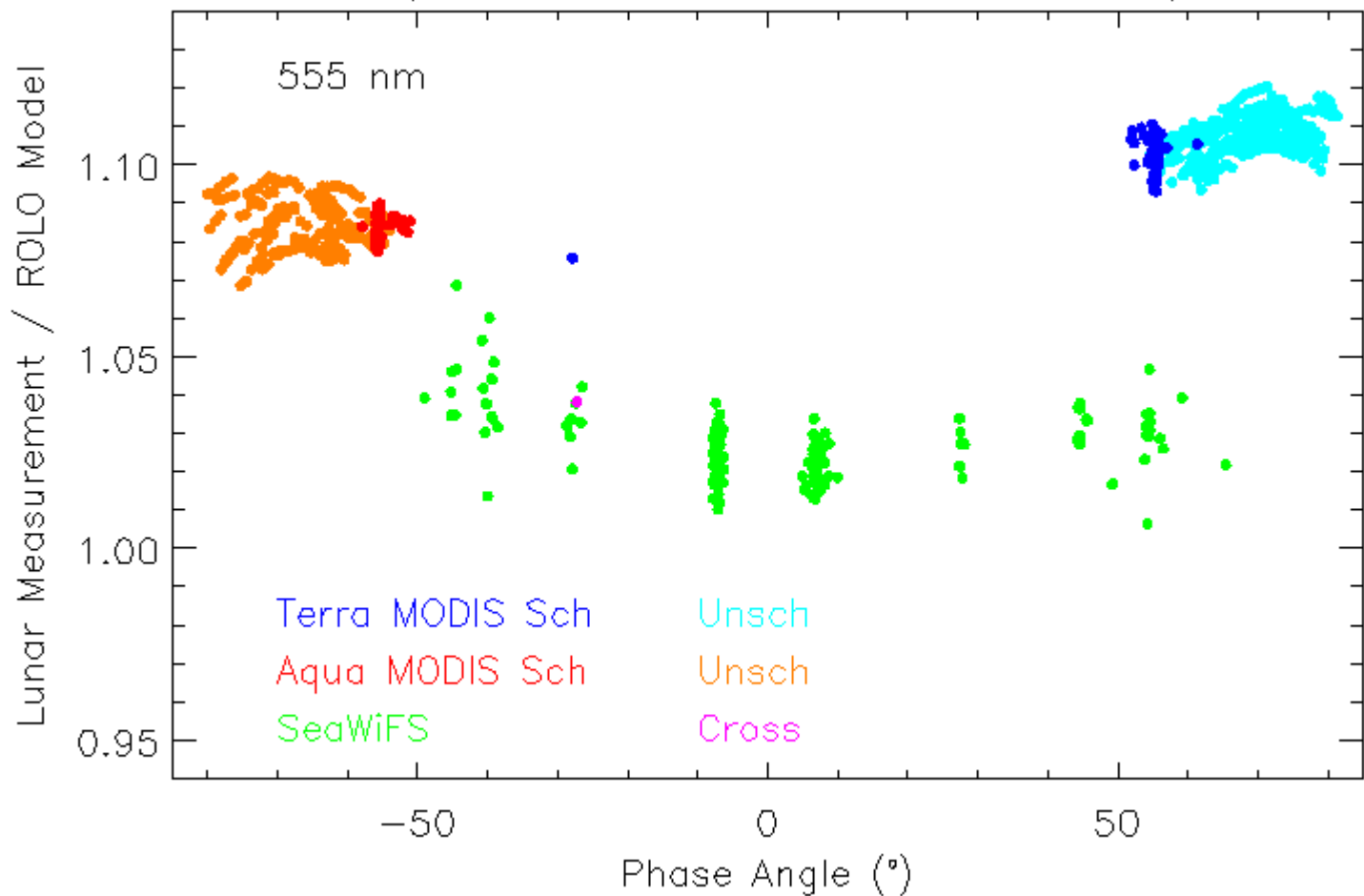


Questions?

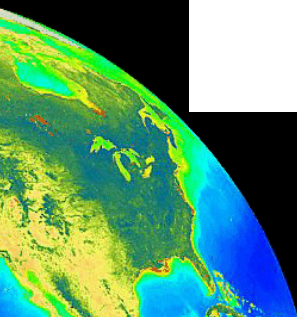
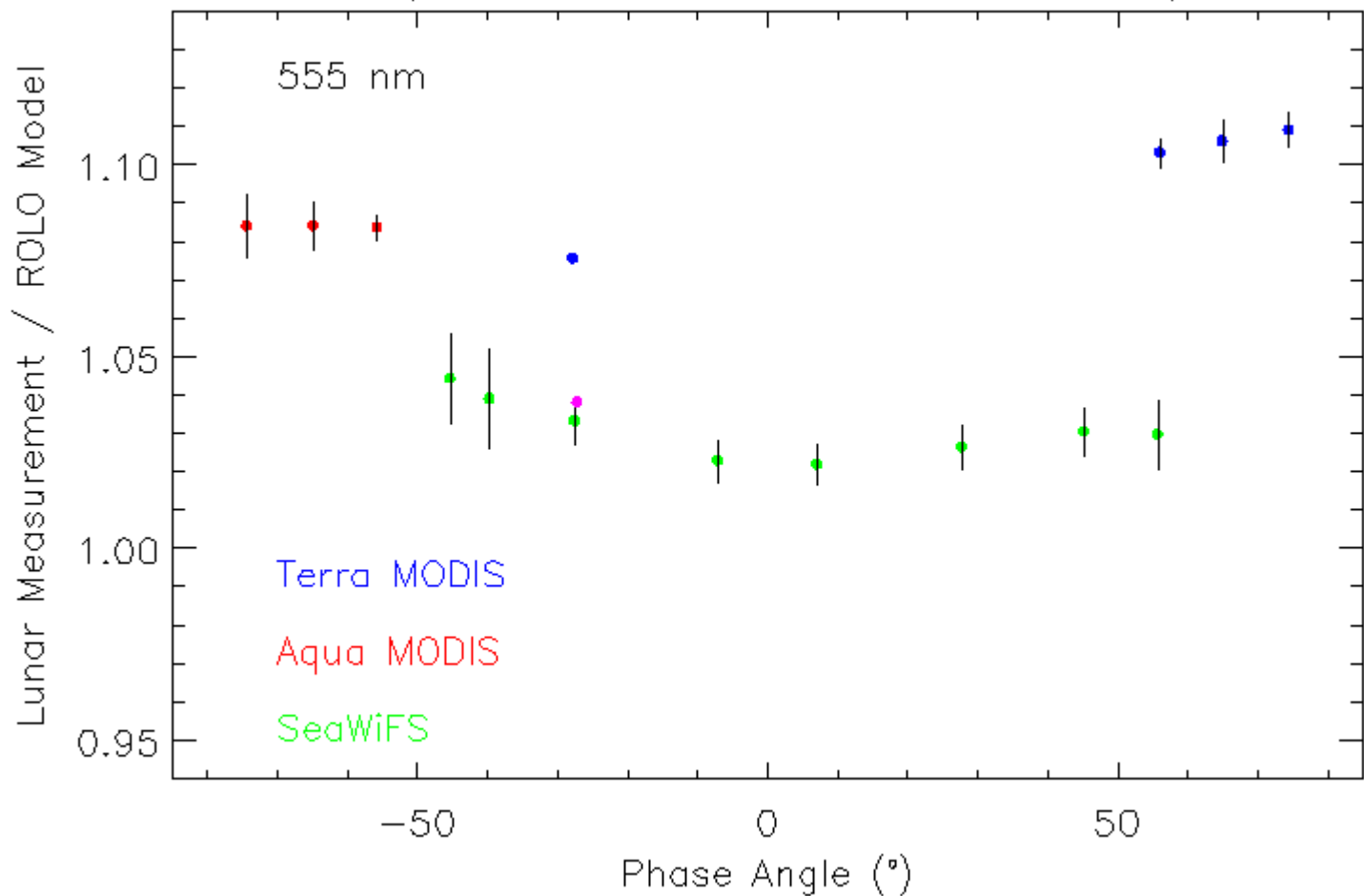
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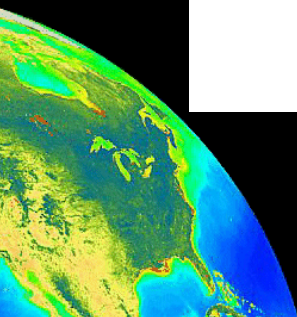
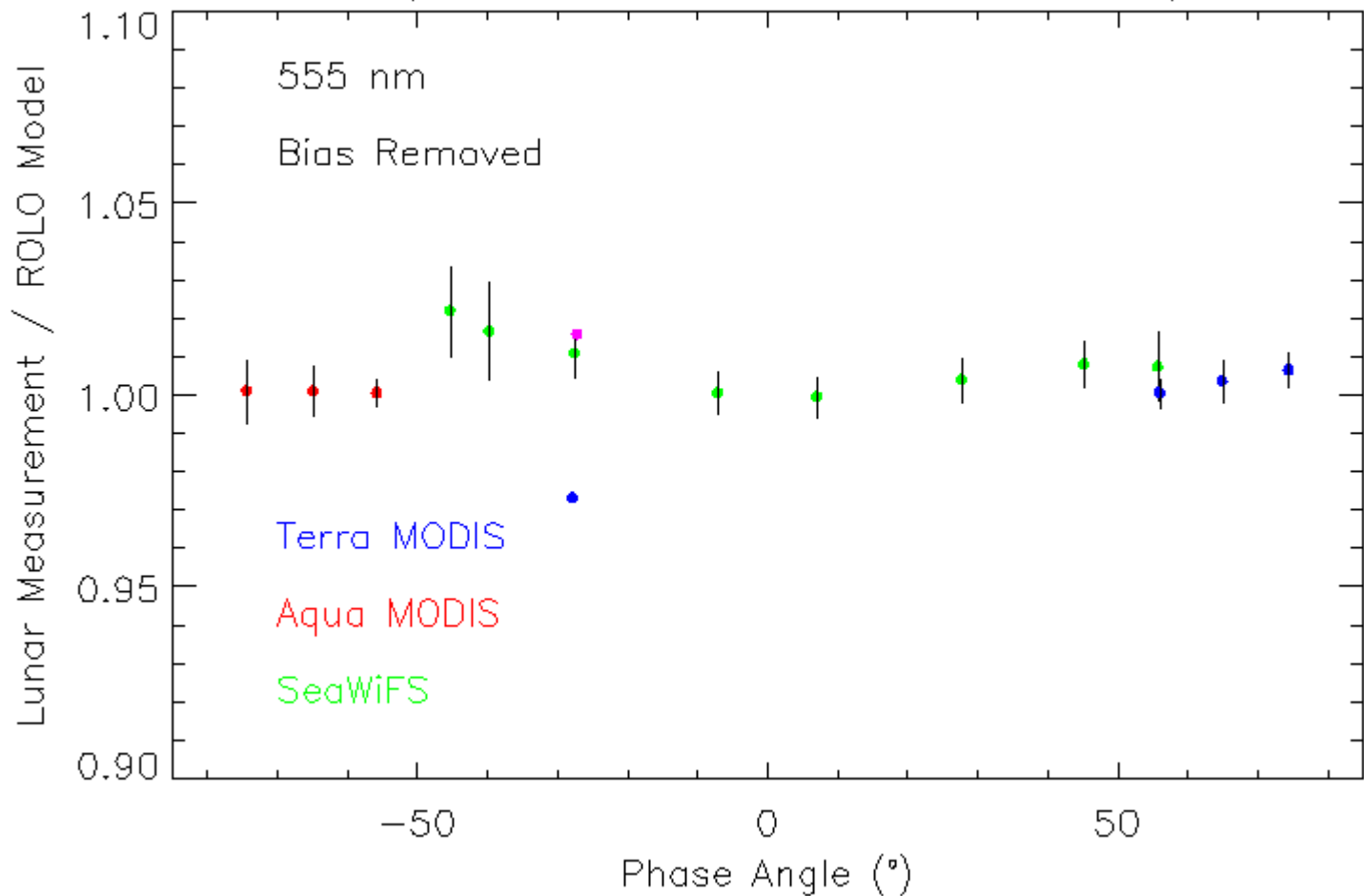
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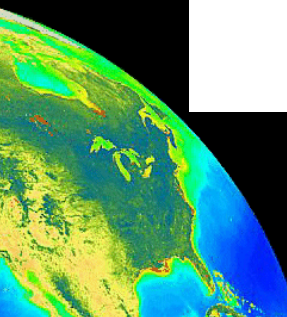
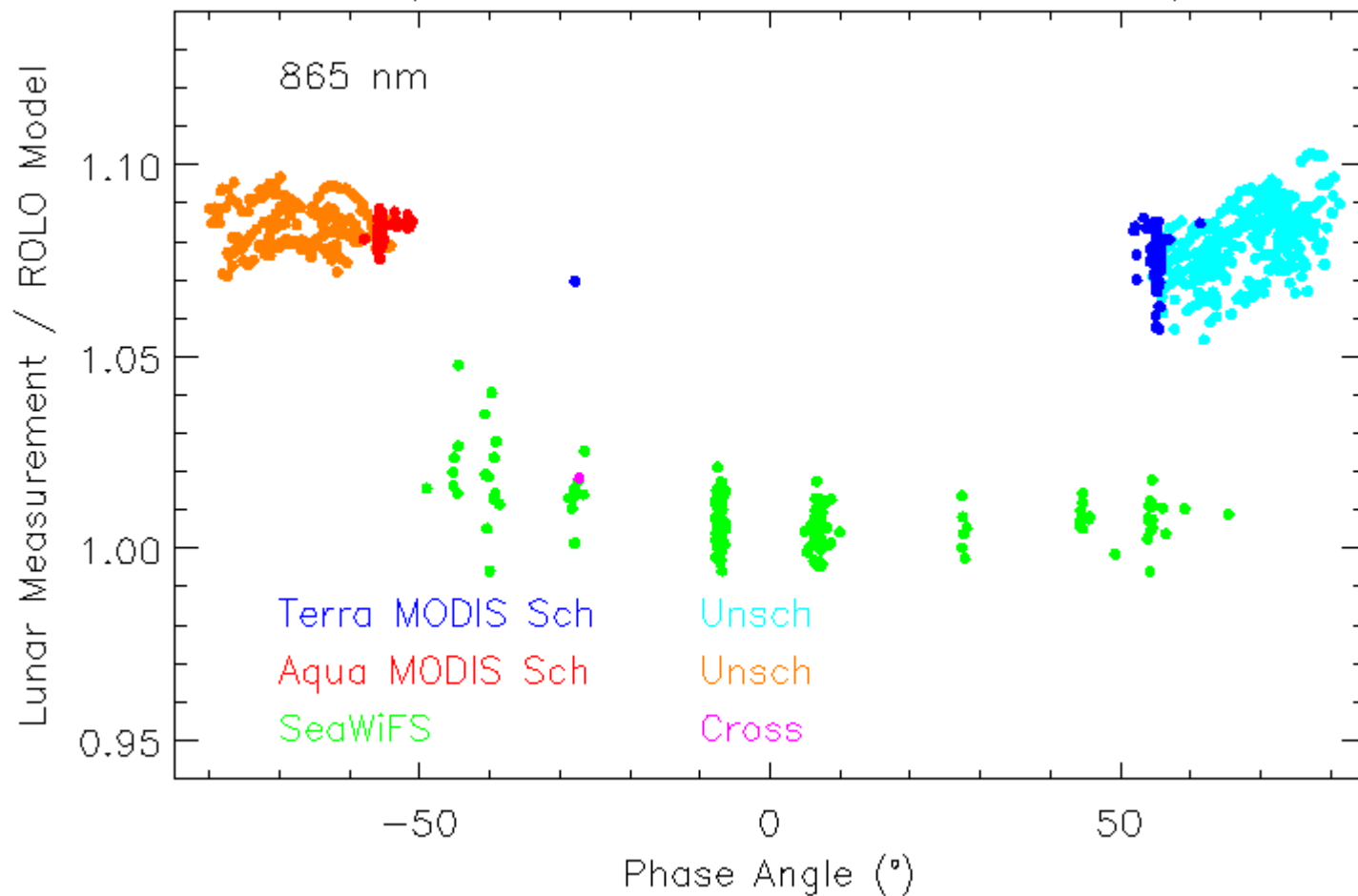
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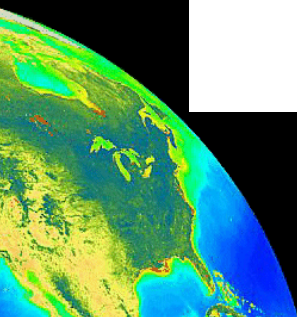
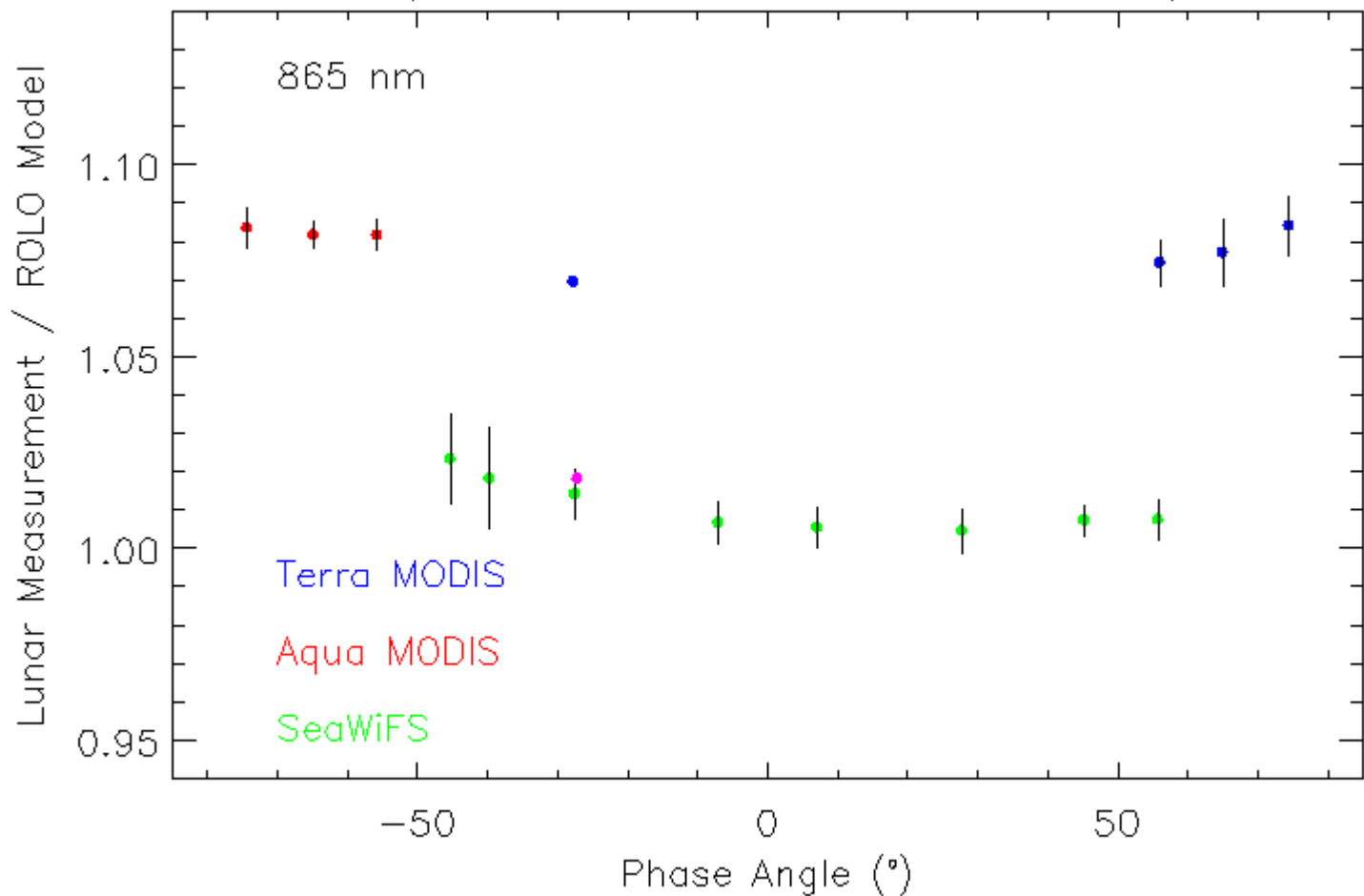
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