OceanColor Empirical Chlorophyll Analyses

The following are a variety of analyses conducted by the OceanColor group at NASA/GSFC to better understand and evaluate the sensitivity of the empirical chlorophyll algorithms used in SeaWiFS and MODIS-Aqua processing, as well as several related clear water (Case 1) radiance algorithms (Gordon et al. 1988, Morel 1988, and Morel and Maritorena 2001). The analyses are not presented in any particular order and notes and comments are posted when appropriate. Many of the analyses serve as a reference and background for evaluations conducted elsewhere. In general, the following questions initiated the activity:

- How sensitive are OC4v4 and OC3M [chl] to their input radiances?
- Does this sensitivity change as a function of [chl]?
- Over what [chl] range are the empirical chlorophyll algorithms - and clear water radiance models - valid?

Empirical chlorophyll algorithms for SeaWiFS and MODIS

Maximum-band-ratio (MBR) refers to the variable R, which varies with spectral shape

OC4v4 (SeaWiFS):

$$C_a = 10^{0.366 - 3.067R + 1.930R^2 + 0.649R^3 - 1.532R^4}, \text{ where } R = log_{10}\left(\frac{R_{rs}443 > R_{rs}490 > R_{rs}510}{R_{rs}555}\right)$$

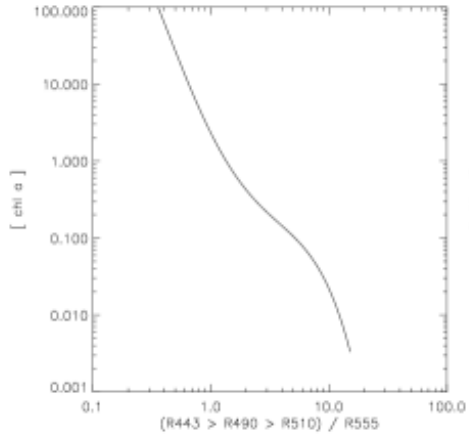
OC3M (MODIS):

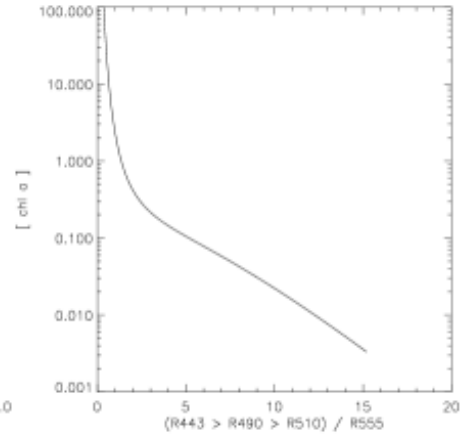
$$C_a = 10^{0.283 - 2.753R + 1.457R^2 + 0.659R^3 - 1.403R^4}, \text{ where } R = log_{10}\left(\frac{R_{rs}443 > R_{rs}488}{R_{rs}551}\right)$$

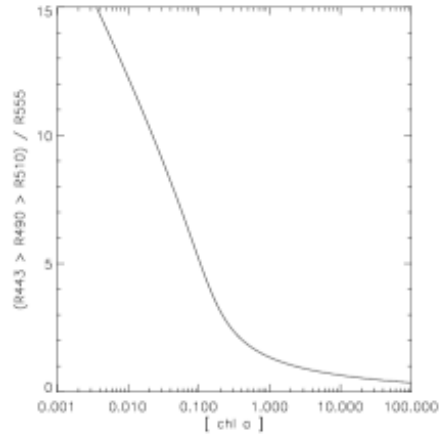
OC4 version 4

Various ways of displaying the functional form of OC4v4
Note that:

- High R for blue water and low [chl]
- Low R for green water and high [chl]



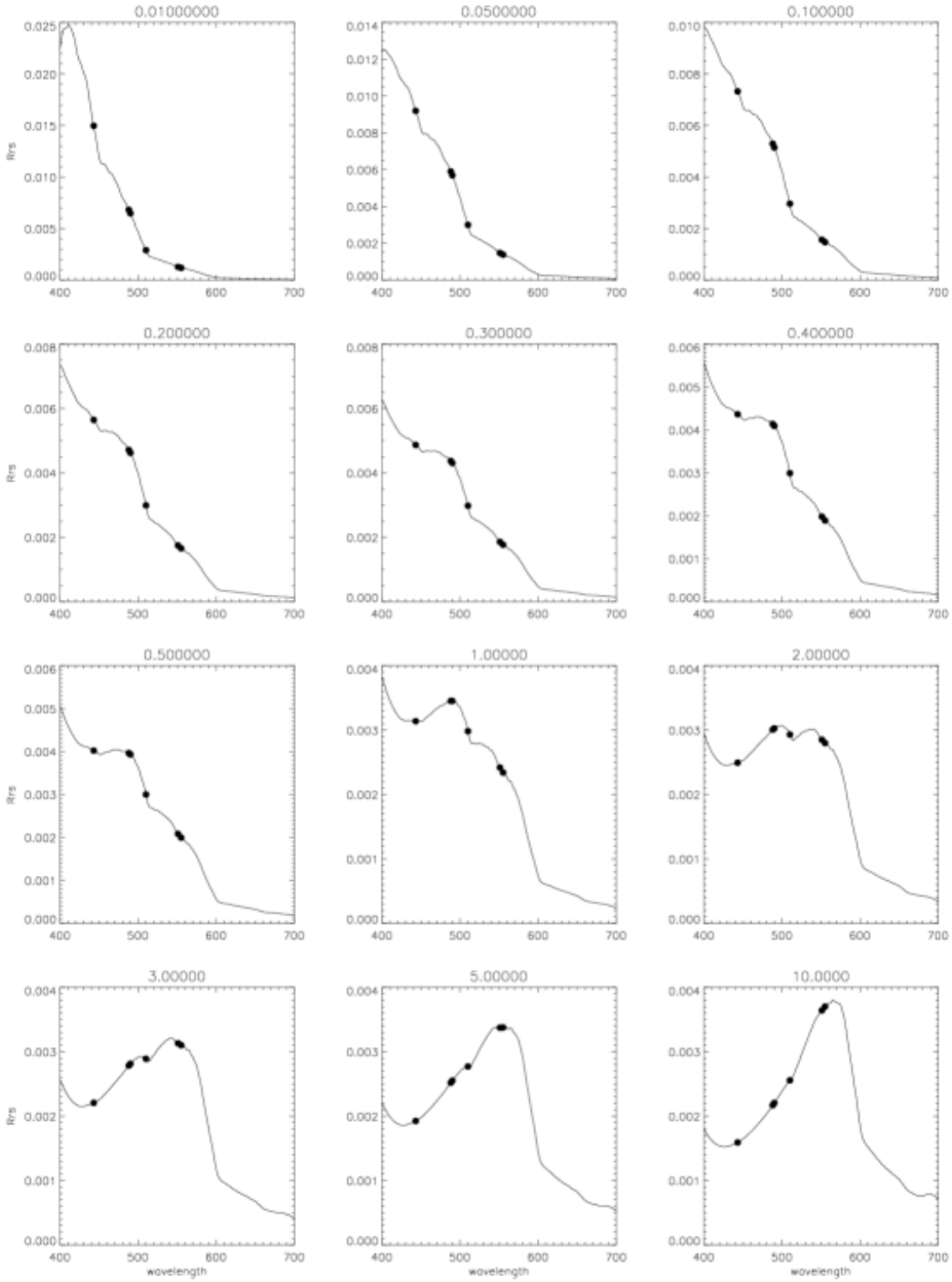




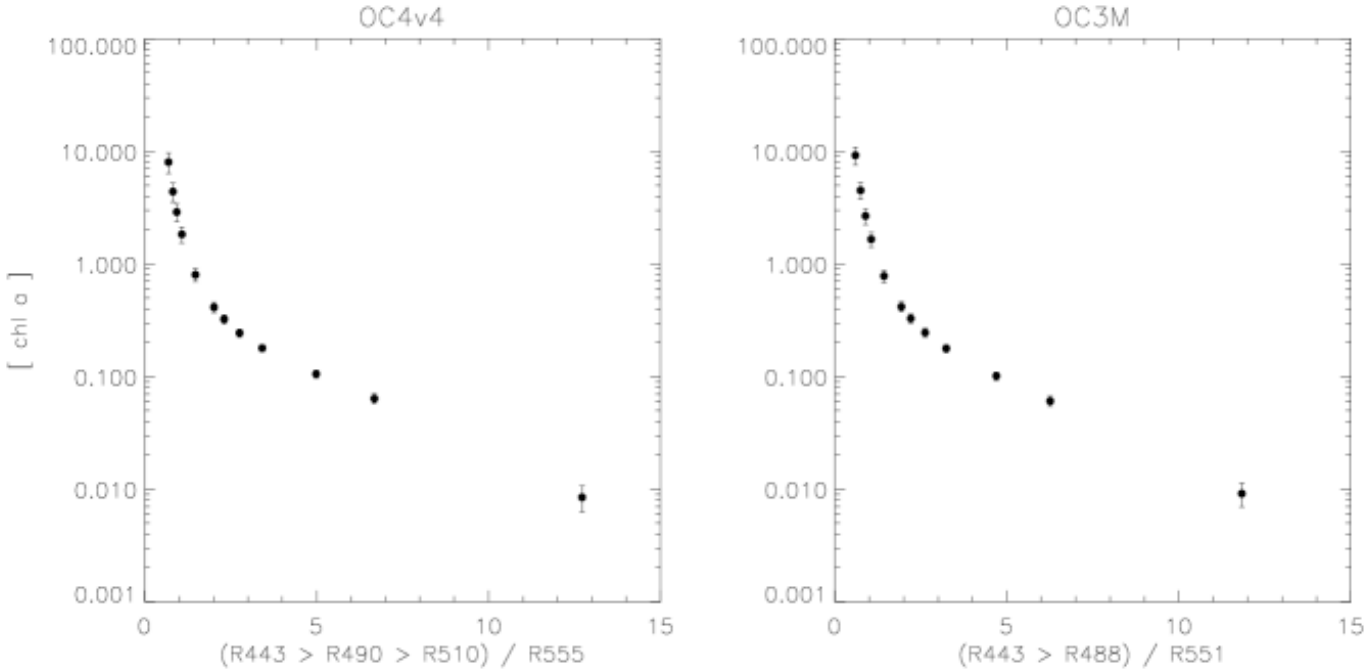
OC4 version 4 sensitivity to R-ratio

Model Rrs spectra using 12 [chl] values as input into the Morel and Maritorena 2001 clear water algorithm
Note that:

- MBR transitions from Rrs443 to Rrs490 between 0.5 and 1.0 mg/m^3
- MBR transitions from Rrs490 to Rrs510 between 2.0 and 3.0 mg/m^3



Calculate OC4v4 and OC3M [chl] with Rrs (dots) and Rrs varied by +/- 5% (bars)
Note that:
- [chl] 0.05 to 0.5 mg/m^3: ~ 8% difference
- [chl] 1.0 to 10.0 mg/m^3: ~18% difference

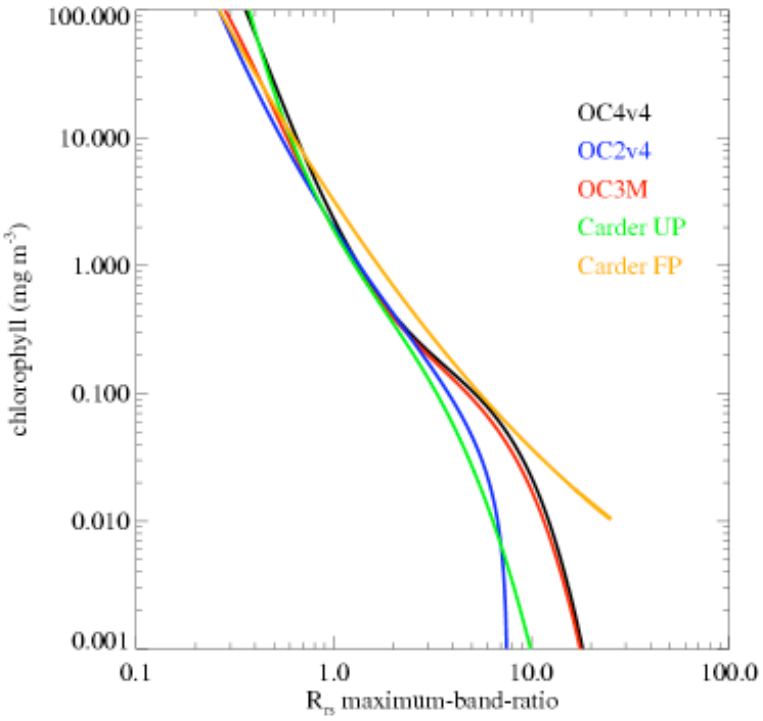


potential [chl] difference for 5% error in input Rrs

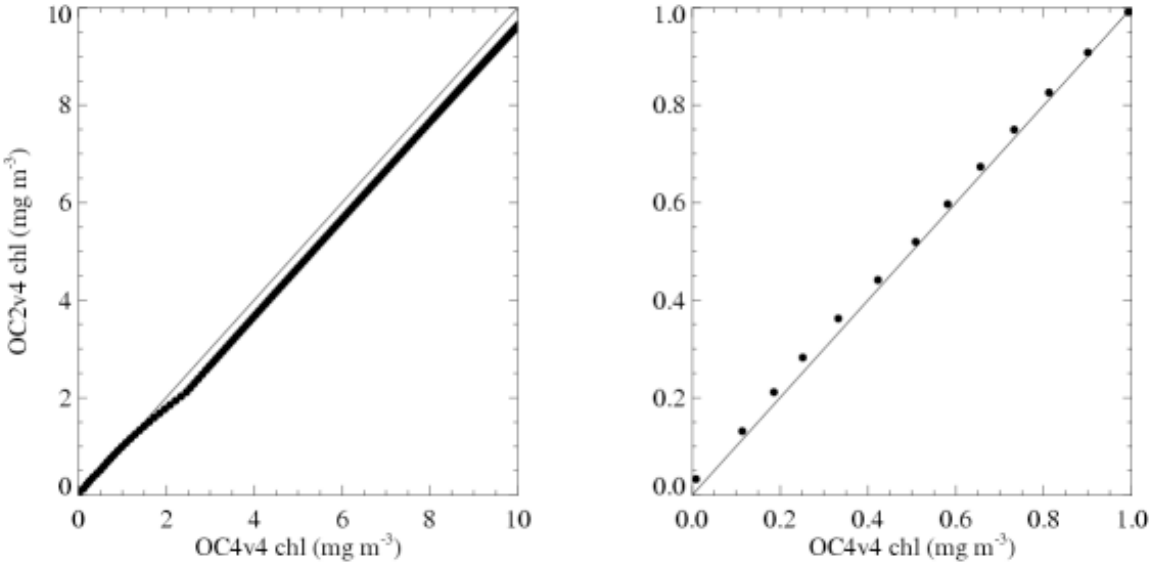
input chl	10	5	3	2	1	0.5	0.4	0.3	0.2	0.1	0.05	0.01
OC4v4 percent difference	21	19	18	16	13	10	9	8	7	8	10	26
OC3M percent difference	18	17	16	15	13	10	10	8	8	8	11	24

OC4 version 4 and other empirical chlorophyll algorithms

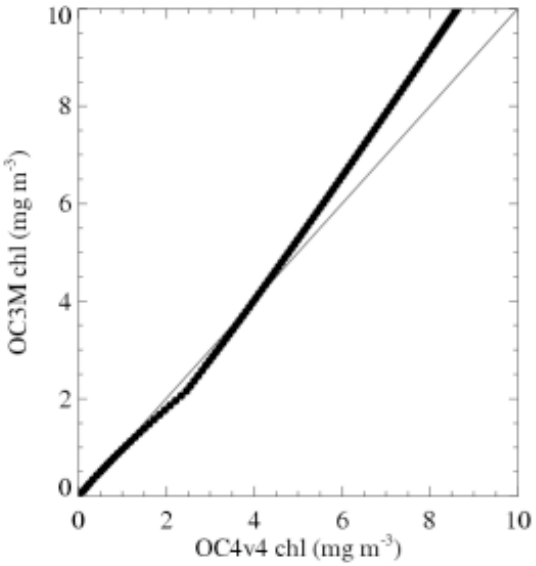
Display the functional form of various band-ratio algorithms
- Carder UP and FP indicate unpackaged and fully-packaged, respectively

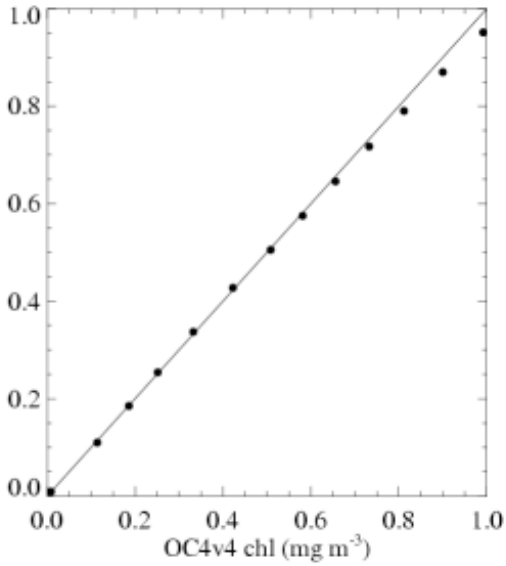


Compare OC4v4 with OC2v4 using modeled Rrs (Morel and Maritorena 2001)



Compare OC4v4 with OC3M using modeled Rrs (Morel and Maritorena 2001)

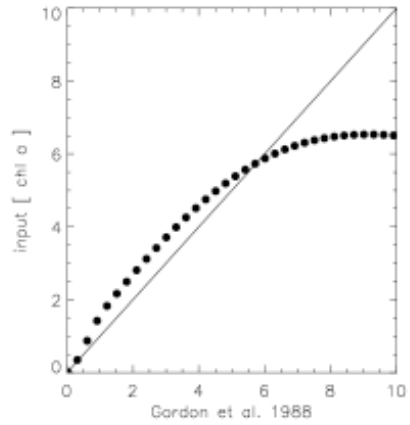


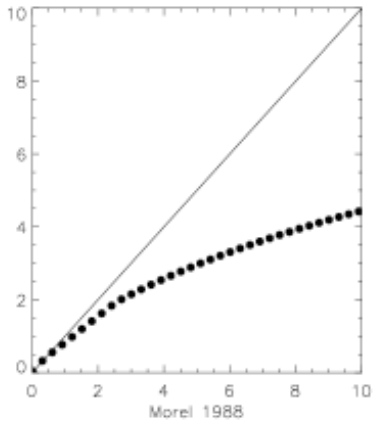


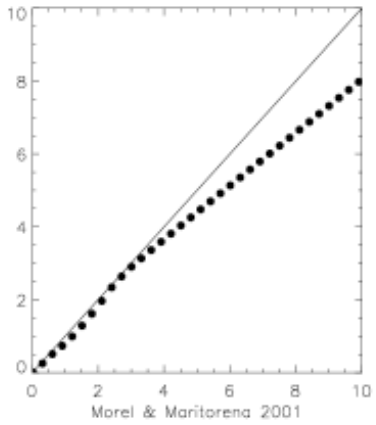
OC4 version 4 and varying clear water radiance models

Model Rrs spectra using [chl] from 0.01 to 10 mg/m^3 and three clear water models
- Gordon et al. 1988
- Morel 1988
- Morel and Maritorena 2001

Calculate OC4 [chl] using the Rrs data and compare with input [chl]

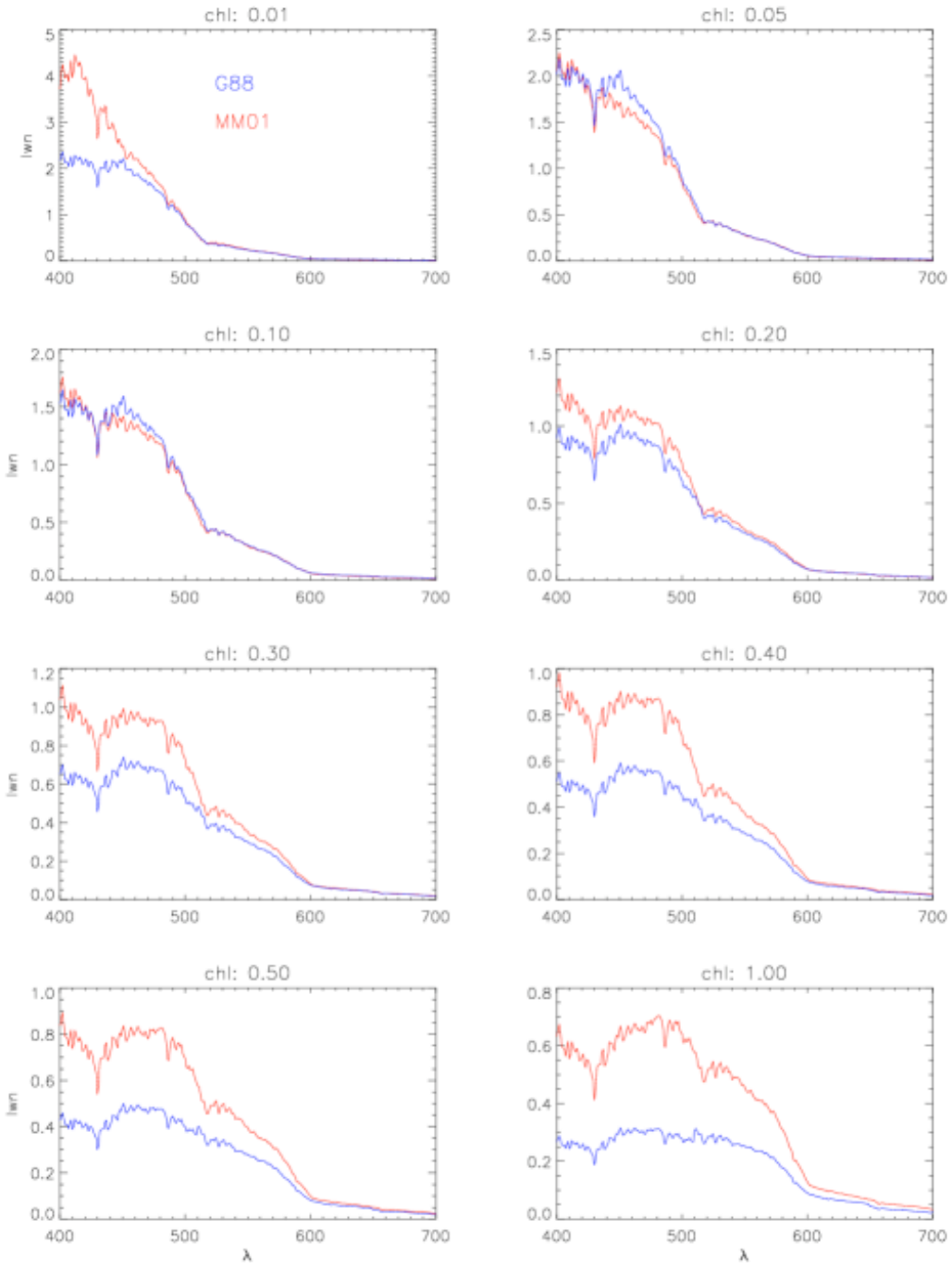




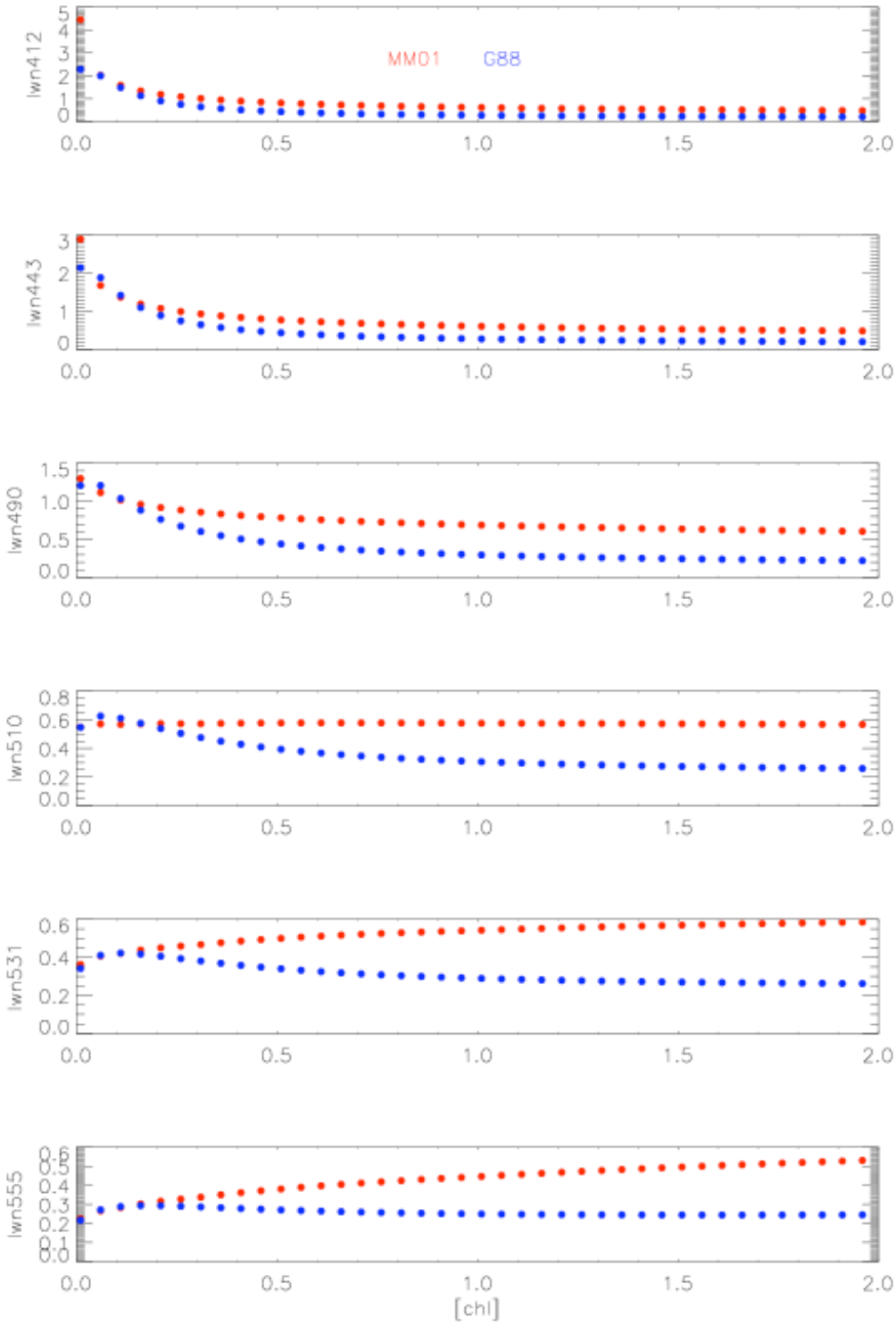


Varying clear water radiance models

Compare Lwn spectra from two clear water radiance models: Gordon et al. 1988 and Morel and Maritorena 2001



Compare Lwn output from two clear water radiance models: Gordon et al. 1988 and Morel and Maritorena 2001



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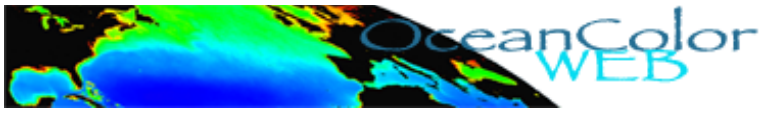

Author/Site Curator: Jeremy Werdell
Responsible NASA Official: Charles McClain
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