

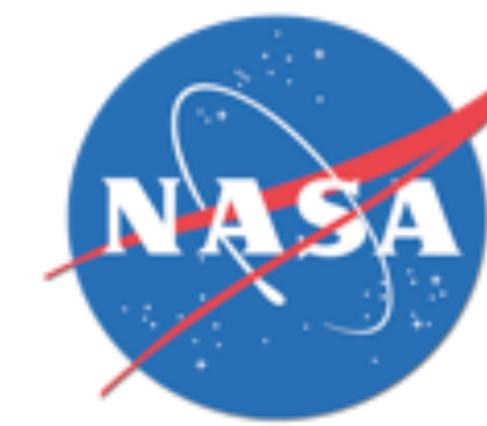
# Pigment Algorithms

# Outline: Pigment Algorithms

---

- SeaBASS and NOMAD
- **Semi-Analytic (Quasi-Analytical) Algorithms**
  - e.g., **Garver-Siegel-Maritorena Algorithm**
- **Empirical Algorithms**
  - CZCS
    - band switching
  - SeaWiFS
    - chlor\_a (**OC4**)
  - MODIS
    - chlor\_a (**OC3M**)
  - MERIS
    - chlor\_a (OC4E)
  - OCI (**algorithm for low chl open-ocean waters**)

# SeaBASS: A Data Archive of Directly Observed $R_{RS}$ , measured chlorophyll and other pigments



# SeaBASS

## SeaBASS

*SeaWiFS Bio-optical Archive and Storage System*

[Home](#)[Information](#)[Data Archive](#)[Search Tools](#)[Validation Analysis](#)[Contact Us](#)

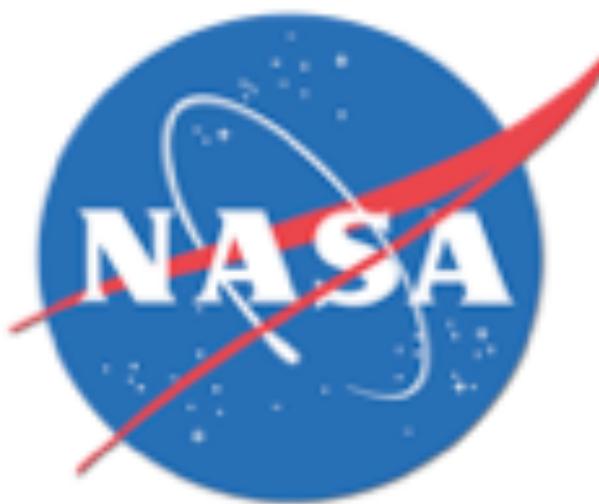
## Frequently Asked Questions

### **Are any SeaBASS data available for public use?**

Following the NASA Earth Science Data and Information Policy, all SeaBASS data are publicly available, for research and educational use only. Data collected prior to 1 January 2000 have also been released to the NOAA [National Oceanographic Data Center](#). Anyone incorporating SeaBASS data into their research is expected to acknowledge SeaBASS, NASA, and the original data contributor(s).

Additionally, public optics and pigment data are available on the [NOMAD](#) and [SeaBAM](#) home pages, and public pigment data are available via the [Historical Pigment Database](#) search engine.

<http://seabass.gsfc.nasa.gov>



## Introduction

NOMAD is a publicly available, [global](#), high quality in situ bio-optical data set for use in ocean color algorithm development and satellite data product validation activities. Data products include coincident observations of water-leaving radiances and chlorophyll a concentrations, along with relevant metadata, such as the date, time, and coordinates of data collection and binary processing [flags](#). Inherent optical properties (IOPs; e.g., spectral absorption and backscattering coefficients) and aerosol optical thicknesses have been or will be included in the near future. Data are available via two online mechanisms, a digital text file and a customizable search engine, both provided below. Additional background details, such as the motivation for creating such a data set, and a historical perspective of such data sets, are provided in the reference listed below.

NOMAD is available data set for research uses only. It was compiled by the [NASA Ocean Biology Processing Group](#) at Goddard Space Flight Center, Maryland, USA, using generous data contributions from the ocean color research community. Source bio-optical data are available online via a suite of SeaBASS Search Engines. Optimum interpolation (OI) sea surface temperature (SST) data were acquired from the [NOAA Climate Diagnostics Center](#). ETOPO2 water depths were acquired from the [NOAA National Geophysical Data Center](#). NOMAD Data access and use are governed by the [SeaBASS Data Access Policy](#). Please direct comments, questions, and identified outliers to the [SeaBASS Administrator](#).

**SeaBASS** is a database of measurements collected by many research groups in order to develop and validate satellite ocean-color algorithms.

The **NOMAD** data set, described by Werdell and Bailey [2005], is a subset of SeaBASS specifically compiled for bio-optical algorithm development, as it contains coincident measurements of Chl, Rrs, and other data collected simultaneously in the global oceans.

Werdell, P. J., and S. W. Bailey (2005), An improved in-situ bio-optical data set for ocean color algorithm development and satellite data product validation, *Remote Sens. Environ.*, 98, 122–140

# Semi-Analytical Pigment Algorithms

Based on the Numerical Inversion of the Expression(s) Relating  $R_{RS}$  to back scattering ( $b_b$ ) and absorption (a)

---

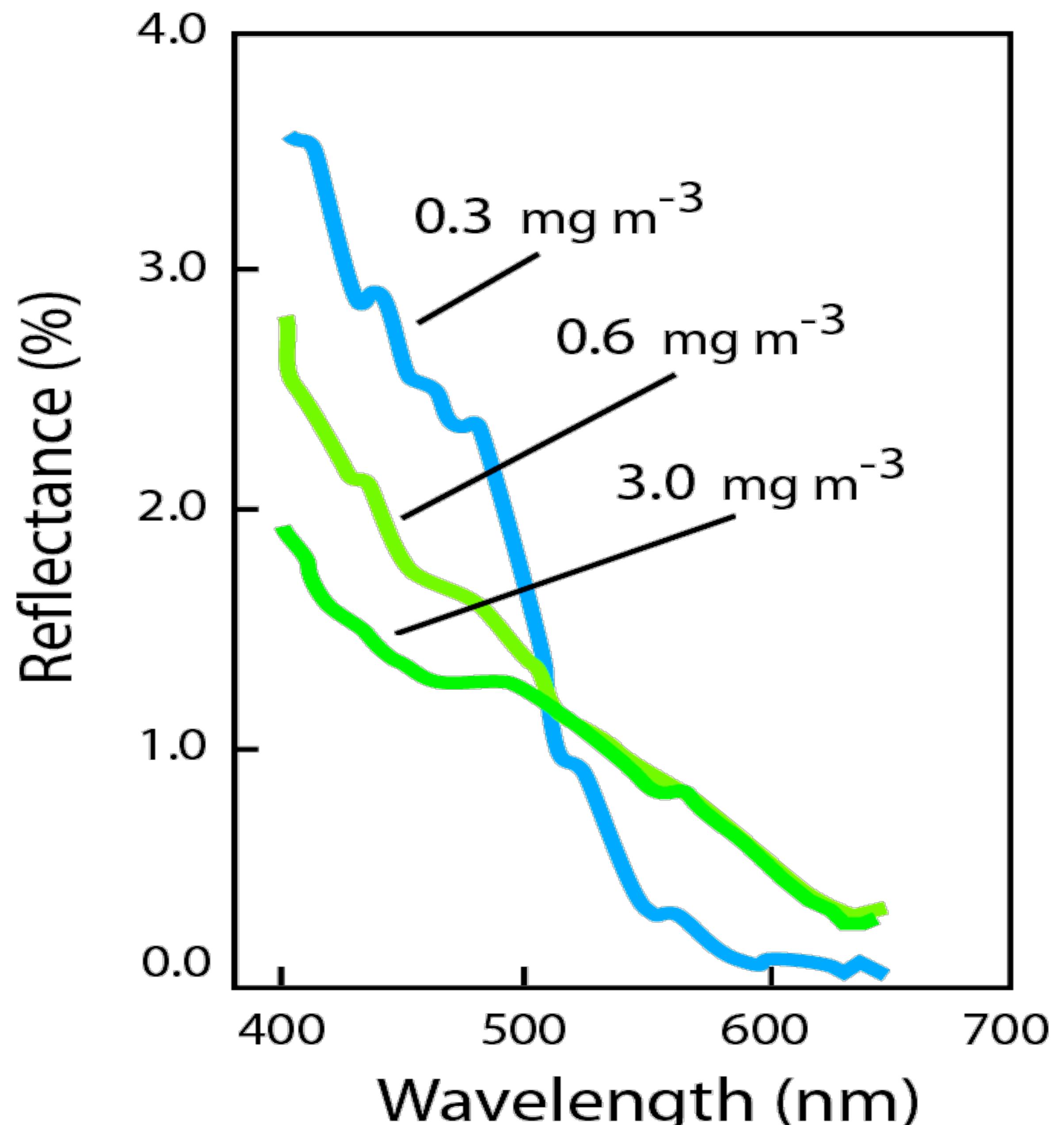
$$R_{RS}(\lambda_i) = \frac{f}{Q} \frac{b_w(\lambda_i) + b_{ph}(\lambda_i) + b_d(\lambda_i)}{a_w(\lambda_i) + a_{ph}(\lambda_i) + a_d(\lambda_i) + a_g(\lambda_i)}$$

- Given  $R_{RS}$  measurements at 5 different wavelengths, the 5 unknowns ( $b_w$  and  $a_w$  have been determined with careful lab measurements) + prior knowledge of the spectral shape of  $a_{ph}$ ,  $a_d$  and  $a_g$ , the 5 unknown IOPs above can then be determined.
- After getting  $a_{ph}$  from step 1, use prior knowledge of specific absorption ( $a^*_{ph}$ ) of chlorophyll (where  $a^*_{ph} = a_{ph}/\text{mg-chl}$ ) to get chlorophyll concentration from satellite derived  $a_{ph}$ .

Subscripts:  $w$ ,  $ph$ ,  $d$  and  $g$  are for water, phytoplankton, detritus and dissolved organic matter.  $L_w$  = water leaving radiance,  $E_d$  = downwelling radiance.

## Empirical Algorithms

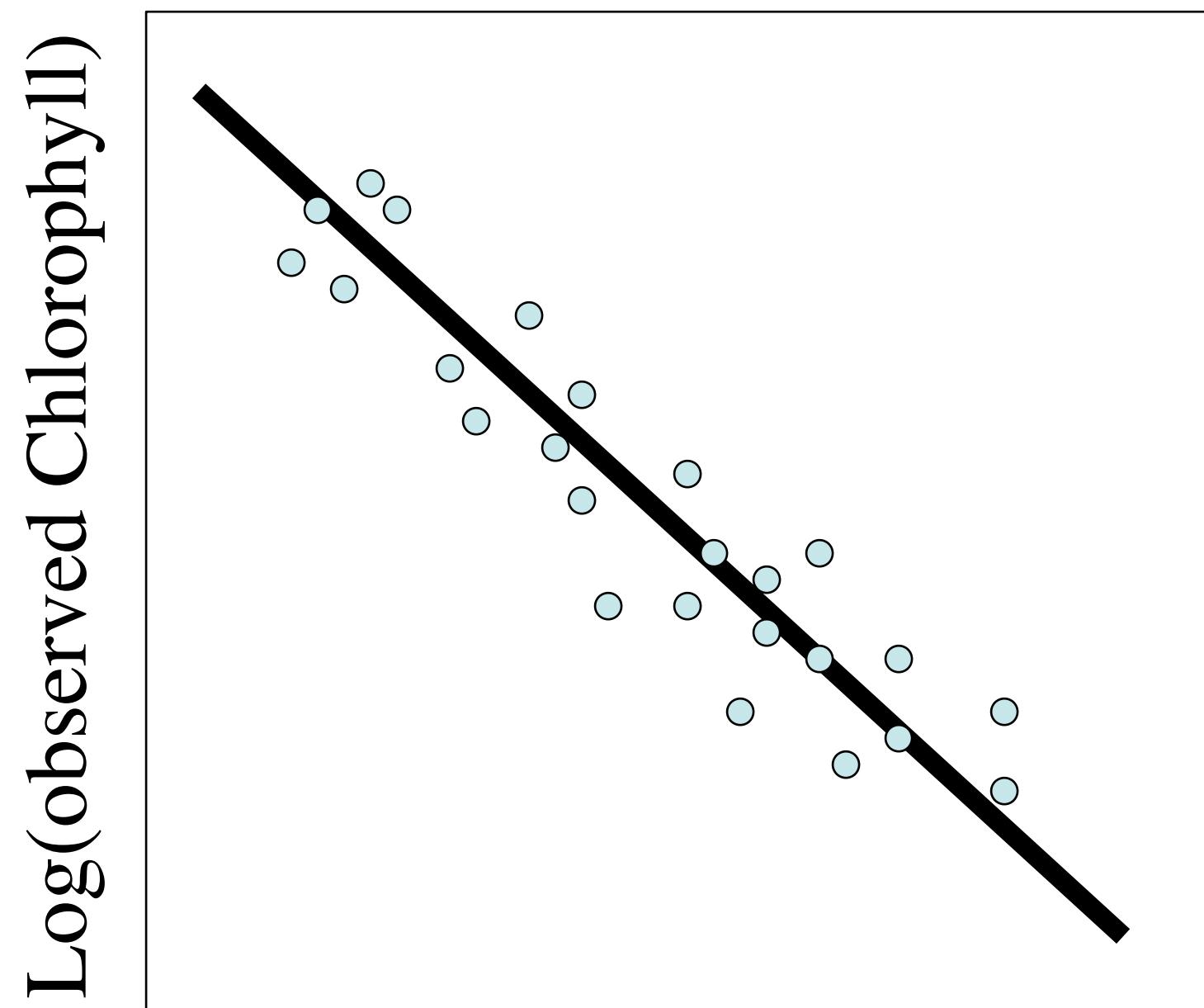
Have an underlying theoretical basis that stems originally from direct observations of Clark et al. (1970)



Clark et al. 1970

# Empirical Algorithm (Band Ratio)

High chlorophyll concentrations is associated with  
Low blue over green reflectance



$$\text{Log}(CHL) = c_o + c_1 \text{Log}\left(\frac{R_{RS}(\lambda_1)}{R_{RS}(\lambda_2)}\right)$$

$$\text{Log}\left(\frac{R_{RS}(\lambda_1)}{R_{RS}(\lambda_2)}\right) \xleftarrow{\quad\quad\quad} \begin{array}{c|c} & \text{blue} \\ \hline & \text{green} \end{array}$$

# SeaWiFS Empirical Algorithm (OC4)

$$Chla = a_4 + 10^{(a'_0 + a'_1 X + a'_2 X^2 + a'_3 X^3)}$$

Where....

$$X = \log\left(\frac{R_{RS}(443) > R_{RS}(490) > R_{RS}(510) >}{R_{RS}(555)}\right)$$

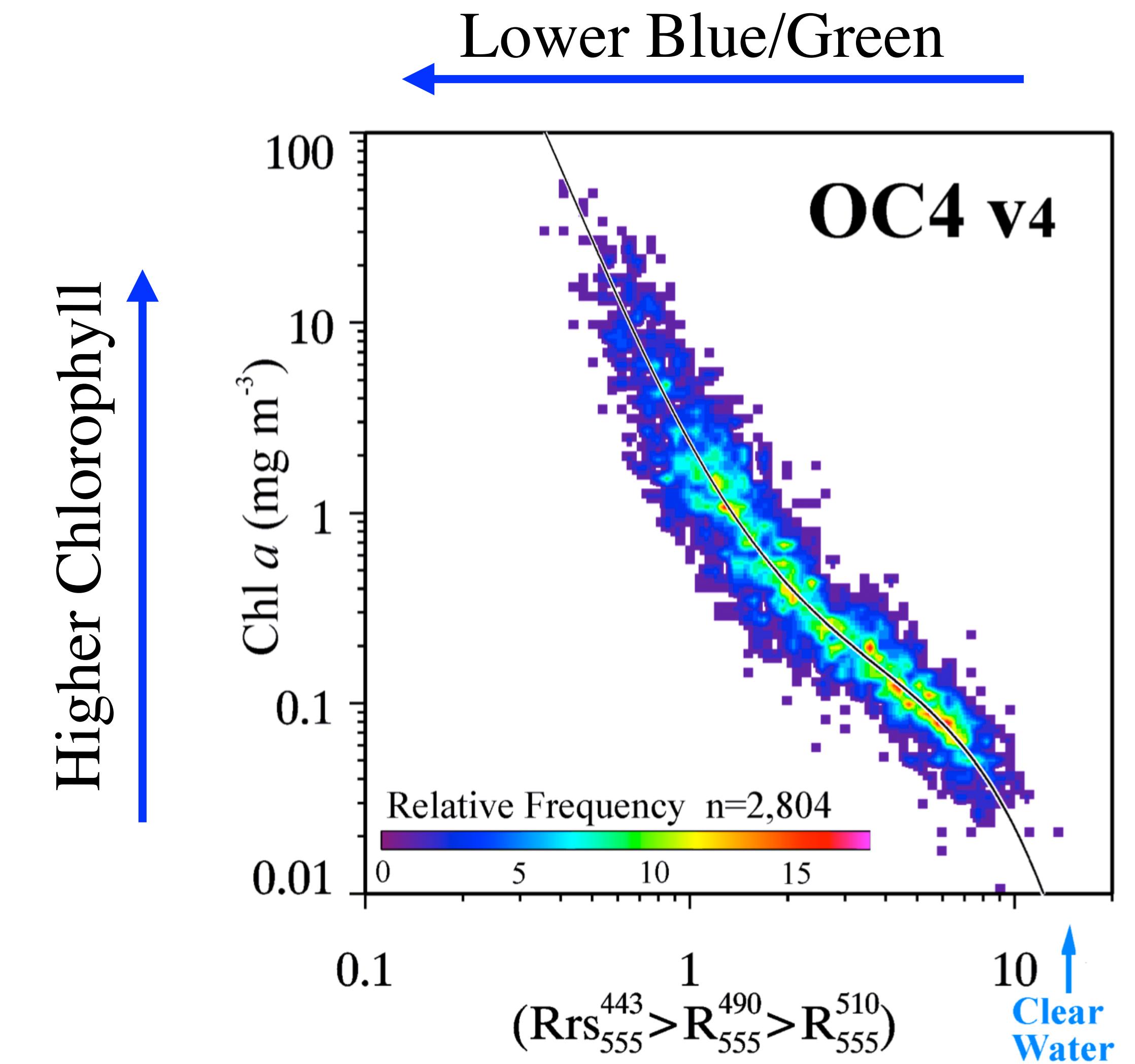
Note...

$$ALOG10(Chla) = C + (a'_0 + a'_1 X + a'_2 X^2 + a'_3 X^3)$$

So, plotting  $\log_{10}(\text{chl})$  versus  $\log_{10}(R_{rs}(\text{"blue"})/R_{rs}(555\text{nm}))$  will be a third-order polynomial

Note that **OC4** refers to an automatic band-switching ocean color algorithm that **uses 4 bands**

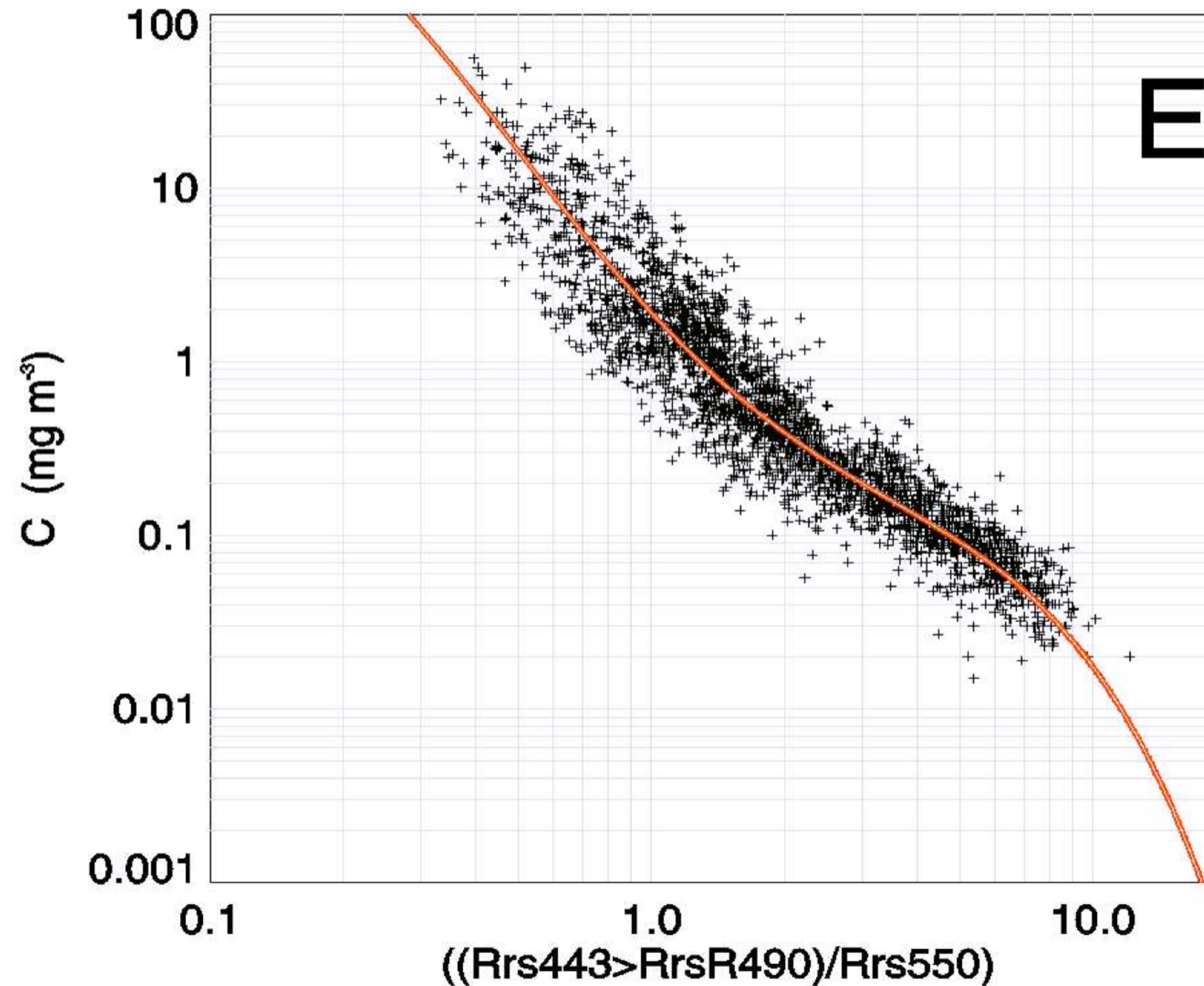
# SeaWiFS Algorithm (OC4)



Note that the axes are Log Scale

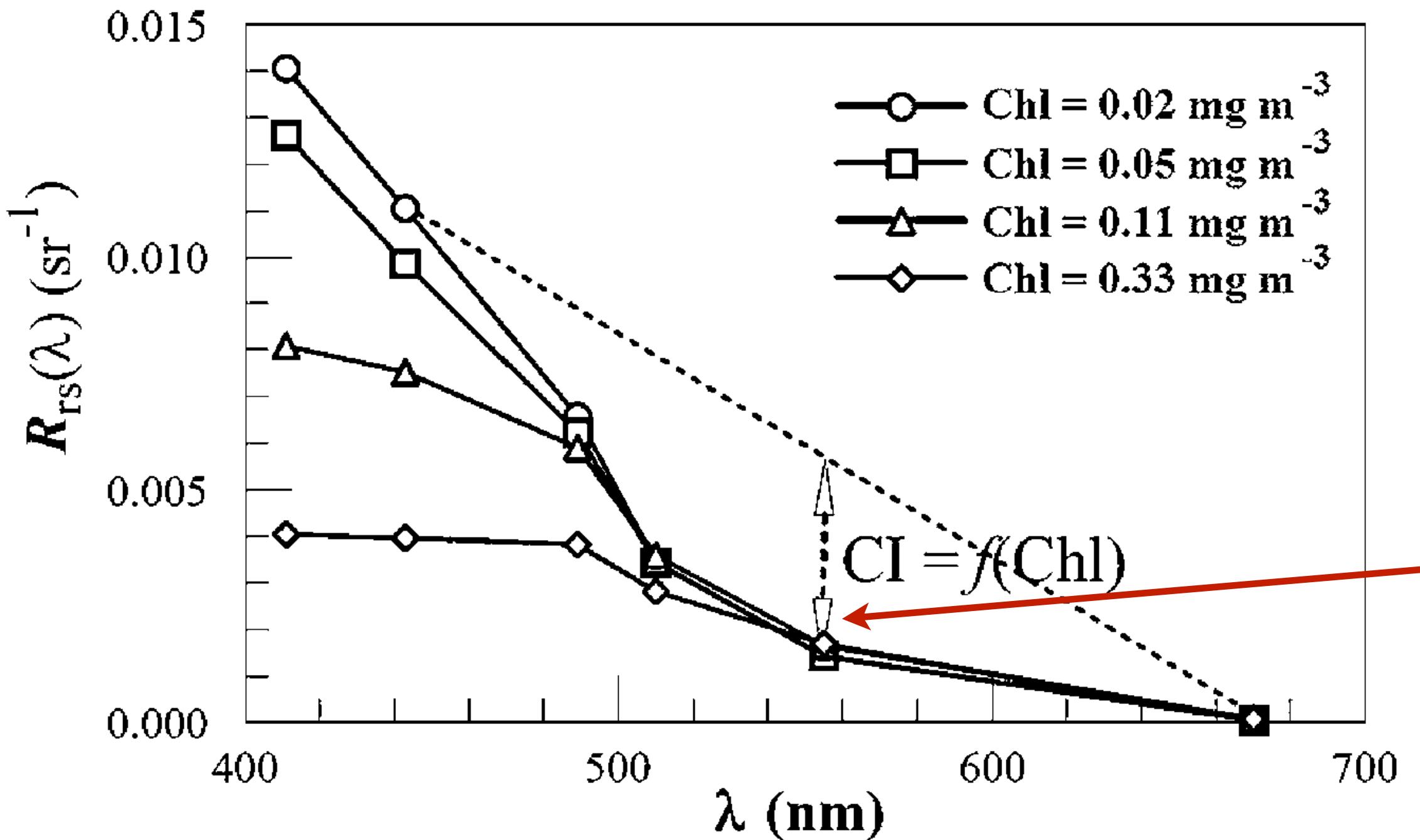
# MODIS (OC3M) (SeaWiFS Analog)

The Chlor\_a\_2 algorithm was proposed by the developers of the OC4.v4 SeaWiFS algorithm. It was called OC3M (3 band, M for MODIS)



# chl\_oci

## algorithm for low chl waters

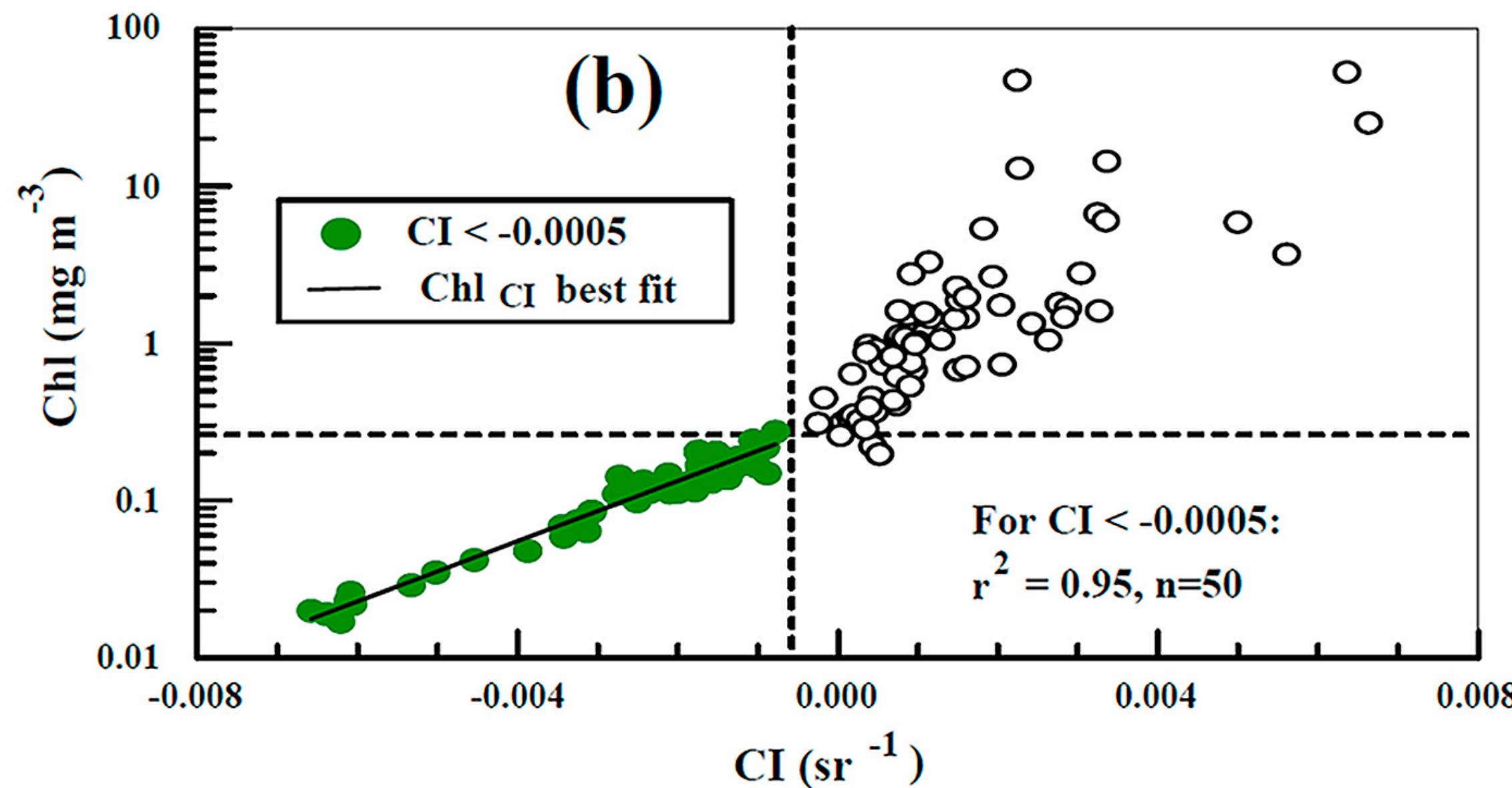


CI is defined as the relative height of  $R_{rs}(555)$  from a background level

i.e., difference between  $R_{rs}(555)$  and a baseline formed linearly between  $R_{rs}(443)$  and  $R_{rs}(670)$

$$Chl = 10^{a+bCI}$$

$$\text{Or... } \log_{10}(Chl) = a + bCI$$



Hu, C., Z. Lee, and B. Franz (2012), Chlorophyll a algorithms for oligotrophic oceans: A novel approach based on three-band reflectance difference, *J. Geophys. Res.*, 117, C01011, doi:10.1029/2011JC007395

## For the 2014.0 reprocessing –

A significant change has been implemented for the **default chlorophyll algorithm (chlor\_a)**, wherein the current standard OC3/OC4 band ratio algorithm **has been merged with the ocean color index (OCI)** of Hu et al. (2012). As described in the paper, this refinement is restricted to relatively clear water ( $\text{Chl} < 0.3 \text{ mg/m}^3$ ).

Due to concerns raised within the community with respect to this algorithm change, we will also continue to produce the standard OC3/OC4 chlorophyll product to support community evaluation. This legacy chlorophyll product will be available in the Level-2 and Level-3 products as **chl\_ocx**, in parallel with the updated chlor\_a product.

See: [http://oceancolor.gsfc.nasa.gov/MEETINGS/OCRT\\_May2014/140505/franz\\_ocrt2014.pdf](http://oceancolor.gsfc.nasa.gov/MEETINGS/OCRT_May2014/140505/franz_ocrt2014.pdf)



**OceanColor**  
**WEB**

ABOUT MISSIONS DATA DOCS SOFTWARE & TOOLS SERVICES GALLERY FORUM

**OCEAN BIOLOGY**  
DISTRIBUTED ACTIVE ARCHIVE CENTER

1996. As a Distributed Active Archive Center (DAAC), we support the Ocean Biology Processing Group (OBPG) at NASA's Goddard Space Flight Center. Our responsibilities include the collection, processing, calibration, validation of ocean-related products from a large number of temporal and satellite-based remote-sensing missions providing ocean color, sea surface temperature, and sea surface salinity data to the international research community since 1996. As a Distributed Active Archive Center (DAAC) known as the Ocean Biology DAAC (OB.DAAC), we are responsible for the archive, including those from historical missions and partner space organizations.

**Technical Docs**  
NASA Technical Reports  
Users Guides  
White Papers  
MODIS Docs (historical)  
Sensor Spectral Information  
**Data**  
Filenaming Convention  
How to Cite  
**Processing History**  
**Community Engagement**

Meetings/Workshops  
Outreach & Education  
**Products**  
Level 1, 2, & 3 Definitions  
Format Specifications  
Product Status by Mission  
**Algorithm Descriptions**  
**Ancillary Sources**

**Forums**  
Ask a Question  
Search Forum Archive

## Salton Sea

