International Ocean Colour Science Meeting 2017

Advancing Global Ocean Colour Observations

# Multi-water algorithms and algorithm performance assessment

## IOCS 2017 - Breakout Workshop #7

Co-chairs: Ewa Kwiatkowska (EUMETSAT), Bridget Seegers (NASA/USRA), Carsten Brockmann (Brockmann Consult), Tim Moore (Uni. New Hampshire), Blake Schaffer (US-EPA), Susanne Craig (Dalhousie University)

# Workshop agenda

**14:00 - 14:05 Session introduction** E. Kwiatkowska (EUMETSAT) and B. Seegers (NASA)

**Part I: Multi-Water Algorithms and Algorithm Performance Assessment**

**14:05 - 14:15 User requirements for blended multi-water products**
Stewart Bernard (CSIR)

**14:17 – 14:27 Overview of atmospheric correction methods for open-ocean, coastal and inland water transitions**
Menghua Wang (NOAA)

**14:29 – 14:39 Overview bio-optical algorithms for open-ocean, coastal and inland water transitions**
Daniel Odermatt (Odermatt & Brockmann GmbH)

**14:41 – 14:51 Assessing algorithm performance and blending in the context of optical water classes**
Thomas Jackson (PML)

**14:53 – 15:03 Needs and approaches to algorithm assessment**
Rick Stumpf (NOAA)

BREAK

**Part II: Moderated Discussion Multi-water and Algorithm Assessment** Moderators: co-chairs

**15:20 – 15:50 Multi-water algorithms**

**15:50 – 16:20 Algorithm assessment**

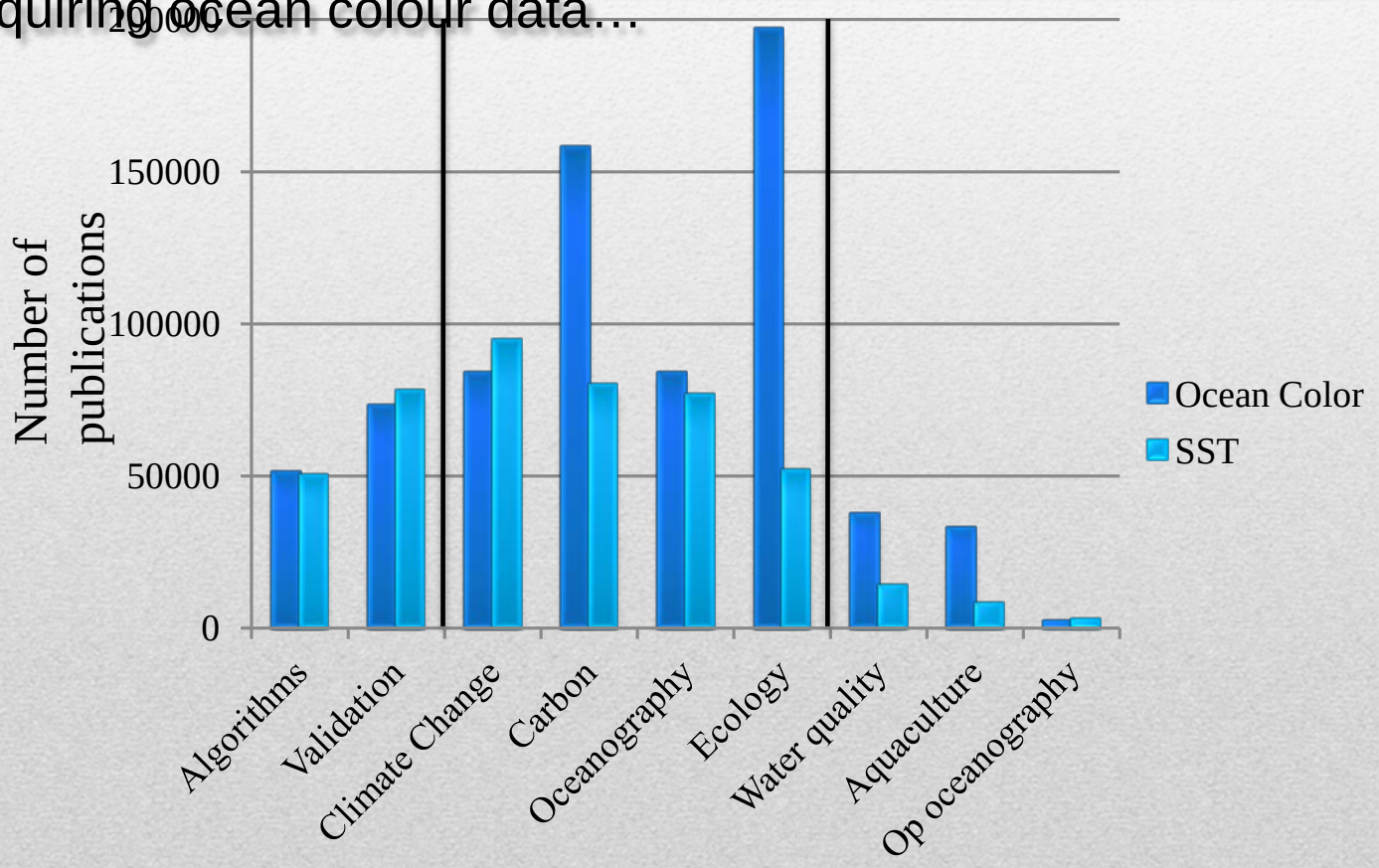
**16:30 – 16:45 Formulation of Actions and Recommendations**

From Stewart Bernard (CSIR)

# End Users

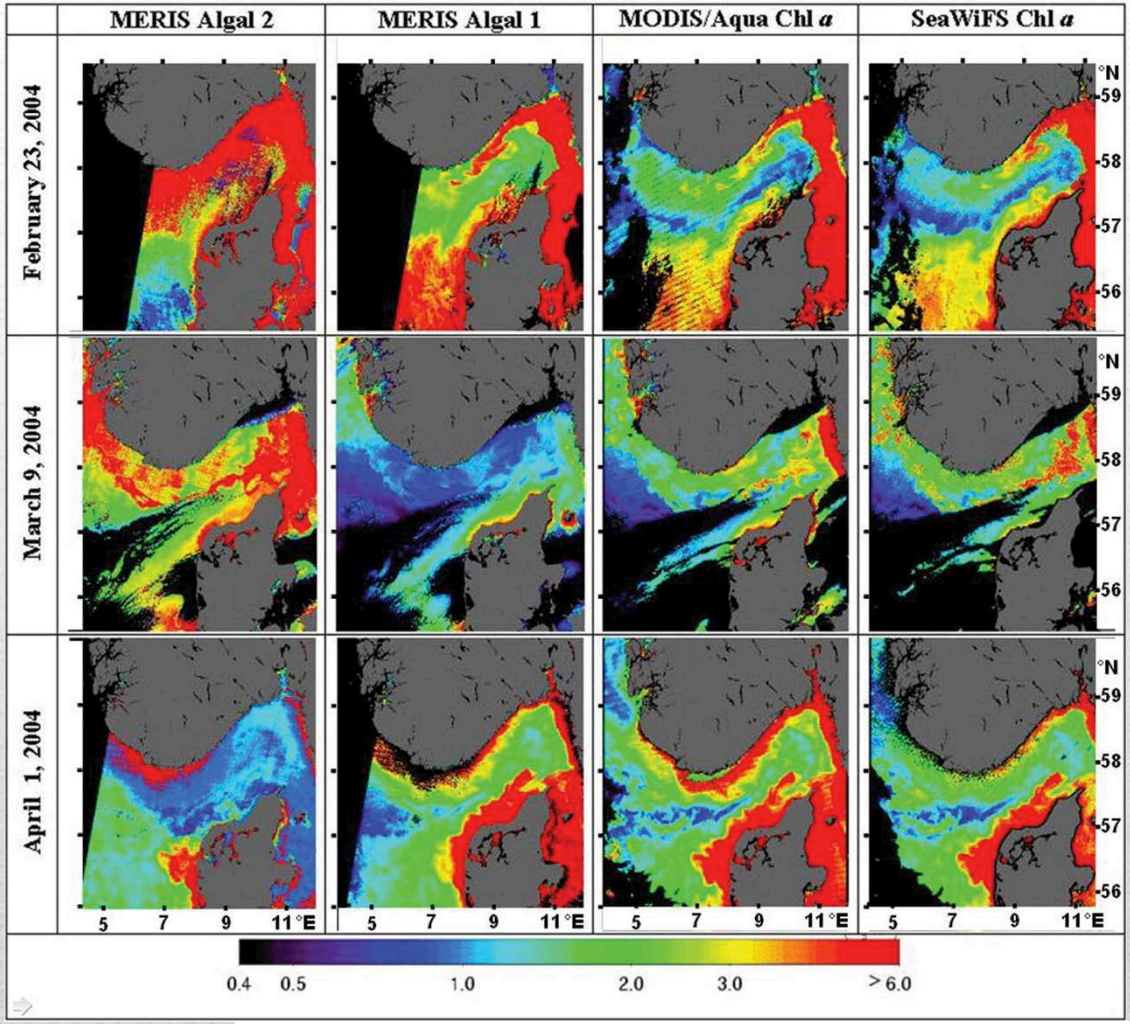
I'd like a nice simple ocean colour chlorophyll product please, one that works everywhere?

Substantial and growing operational and scientific user community
requiring ocean colour data…



From Stewart Bernard (CSIR)

# Much variability in “equivalent” products between sensors and algorithms




Chlorophyll distribution in North Sea and Skagerrak region as retrieved by the MERIS Algal 2, MERIS Algal 1, MODIS/Aqua Chl

**Inter–comparison of ocean colour data products during algal blooms in the Skagerrak**

A. Folkestad ✉, L. H. Pettersson & D. D. Durand

Pages 569-592 | Published online: 04 Dec 2010

# Summary

- For highly turbid coastal and inland waters, we need the **SWIR** bands with high SNR performance (over ocean, low signal), i.e., at ~100-200.
- For strongly absorbing aerosols (usually over coastal and inland regions):
  - ✓ We would like to have UV bands for **absorbing aerosol detection**, and
  - ✓ It is required to have **aerosol vertical profile information** (e.g., accuracy to ~100-500 m) for carrying out atmospheric correction.
  - ✓ We also need **realistic absorbing aerosol models**, e.g., dust model, for generating proper aerosol lookup tables.

# Overview of Bio-optical Algorithms

**Band ratio algorithms, Algorithm blending, Vertical non-uniformities, Neural Network algorithms**

Hieronymi et al. (2017): OLCI NN Swarm

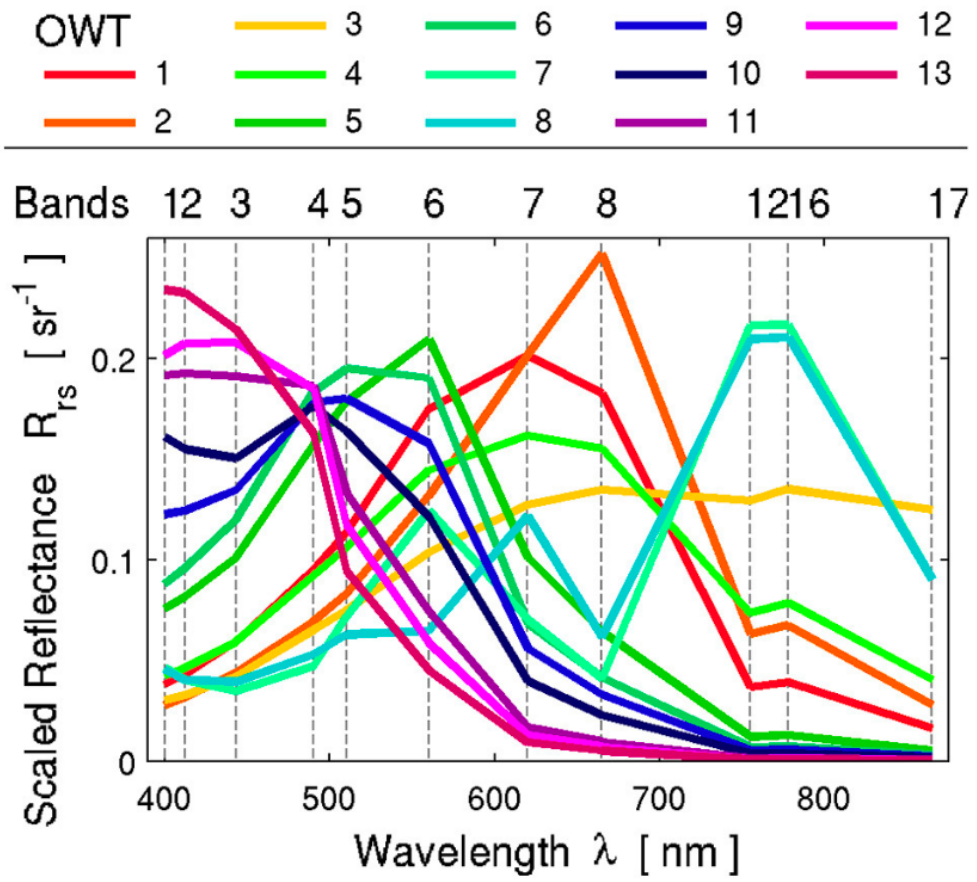
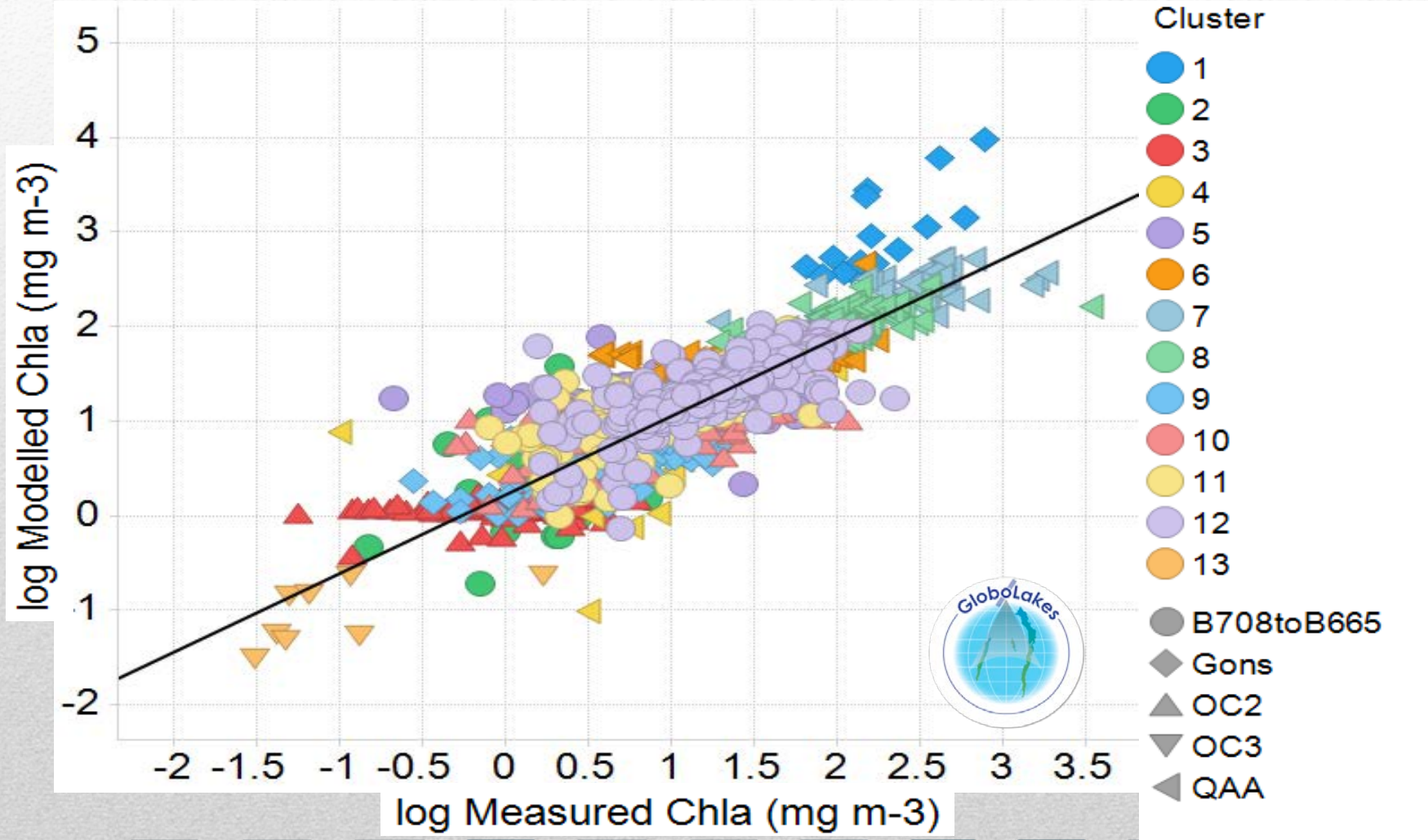



**FIGURE 3 | Brightness-scaled remote sensing reflectances for 13 classes of optical water types.** Utilized OLCI bands are marked.

# Apply algorithms by water class

From Thomas Jackson

Water class based algorithm assessment and blending approaches are now being trialled for new applications e.g smaller water bodies such as lakes.



# multi-water algorithms discussion bits

- There is substantial and growing operational and scientific user community
- Non-specialist users require simple, ready-to-go products
- Need products that can deliver accurate transitions between open ocean, coastal waters, and inland waters

- SeaDAS provides the framework to explore a variety of approaches
- Atmospheric correction is a big problem in coastal/ inland waters, unless it's not being used at all
- Adjacency effect and shallow bottom influences must be remembered
- Ocean colour uptake can be improved if expert decisions on best algorithm selection are incorporated upfront into the products

# Multi-water algorithms recommendations

1. **Develop an atmospheric correction prototype processor for coastal and inland waters**

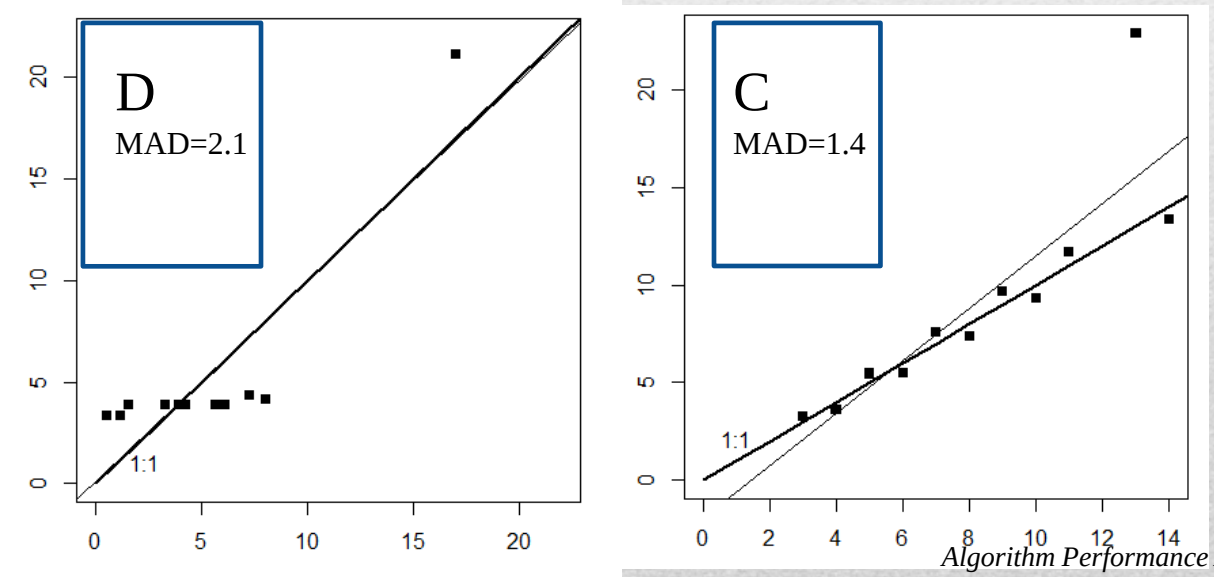
2. **Develop a prototype processor that will deliver accurate transitions between open ocean, coastal waters and inland waters**

- Set-up as a funded OCR-VC working group with specific deliverables
- Enable active collaboration of atmospheric correction experts
- Push science forward, explore new ideas, utilize sensor capabilities (this is NOT an algorithm shoot-out)
- Base new development on an existing framework / sand-box
- Develop for missions of participating OCR-VC agencies (e.g. OLCI, S2, VIIRS)
- Initial ambitious timeframe: 2-3 years

# Which is the better model?

| | Model D | | Model C |
|---|---|---|---|
| R-squared | 0.75 | | 0.75 |
| Slope | 1.0 | | 1.3 |
| RMSE | 2.5 | | 3.0 |
| bias | 0 | | 0.9 |

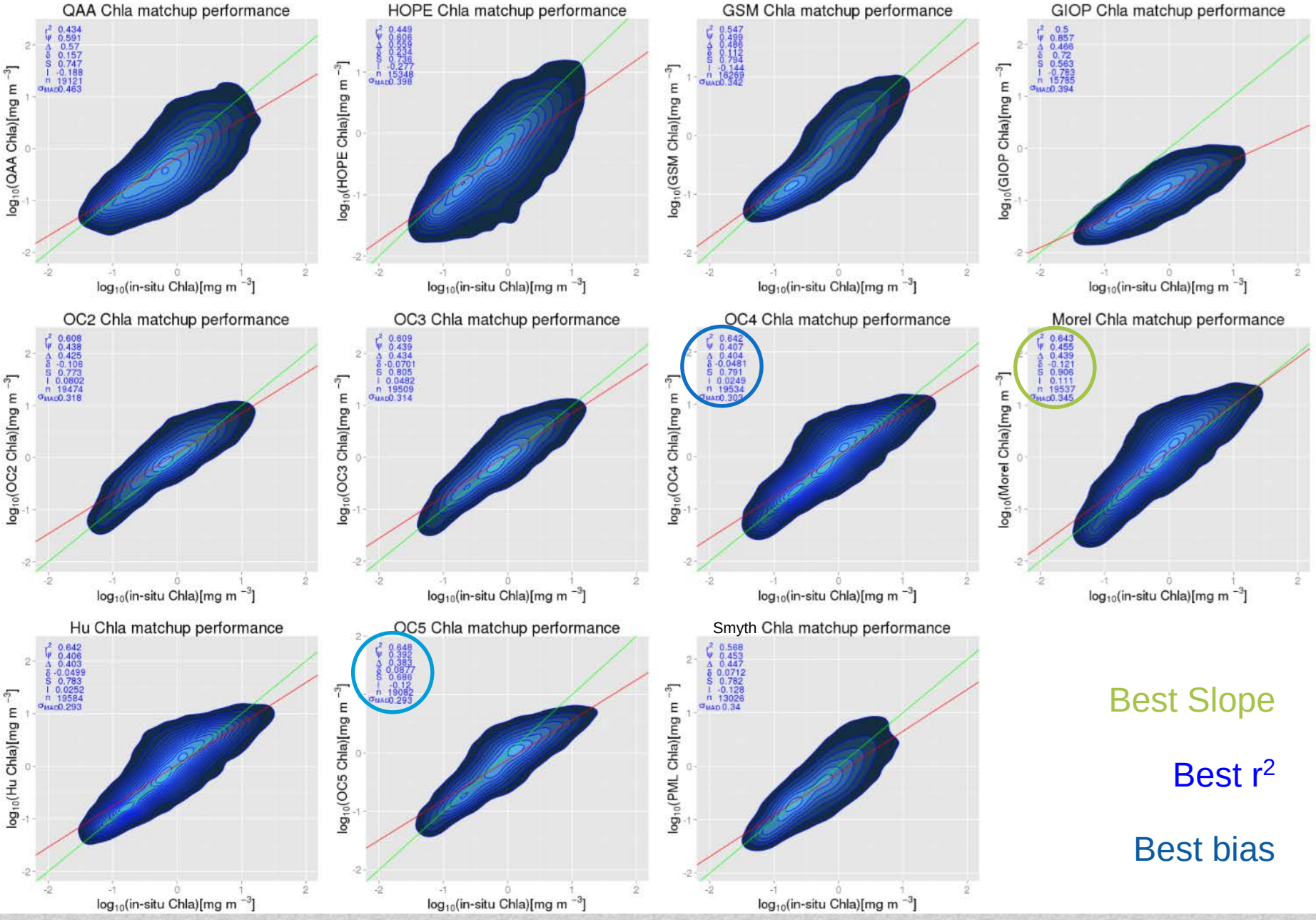
Graphics are essential
And
Mean square error
stats are not robust



From Thomas Jackson

PML | Plymouth Marine Laboratory

# Metric can determine 'best' algorithm




Best Slope

Best $r^2$

Best bias

Summary:

Assess algorithm performance through multi-metric approach rather than relying on a single measure of performance.

The multi-metric assessment is applicable (and required) for both atmospheric correction and in-water algorithms.

Consider what is important for the end users (number of retrievals, unbiased results, minimal error, IOPs?).

Techniques such as bootstrapping can allow insight into the robustness of results and the sensitivity to sample selection.

Questions? docs/news : http://www.esa-oceancolour-cci.org

data : https://www.oceancolour.org

# Discussion Bits from Algorithm Assessment

- Uncertainties should be explored as algorithms are developed. It is interesting and insightful to keep one's eye on the error propagation as you move through the steps of algorithm development.
- Collaborate with statisticians
- Spatial and spectral patterns in combination at inter and intra pixel variable to gain insight. Spatially map variance.
- Spatial and temporal performance.

# Algorithm performance recommendations

**Develop community recommendations on the standardization of statistical metrics to assess algorithm performance in water and on satellite data.**

-Define a core set of statistical metrics, with agreement on their meaning

- Establish guidelines on their conditions and appropriateness for use, which may be research question dependent

- Approach: Identify appropriate literature to develop consensus and gaps to guide publishing of new papers that build on that collection of work

# Algorithm performance Recommendations

**Develop a strategy to inform the community of best practices for performance assessment of algorithms.**

- Approach: Create a website providing best practices.

  Website should host 3 sections:

  1) The most up to date algorithm assessment literature

  2) A library of code/packages to ease the implementation of more robust algorithm assessment. And guidance about which metrics are valid and appropriate skill metrics, which is research question dependent.

  3) Provide a common data set to run algorithm to give first look at how it compares to the community set of algorithms.

- Community statistical training opportunities

- Timeframe: 1 year and updated yearly