



fiducial reference
measurements for
satellite ocean colour

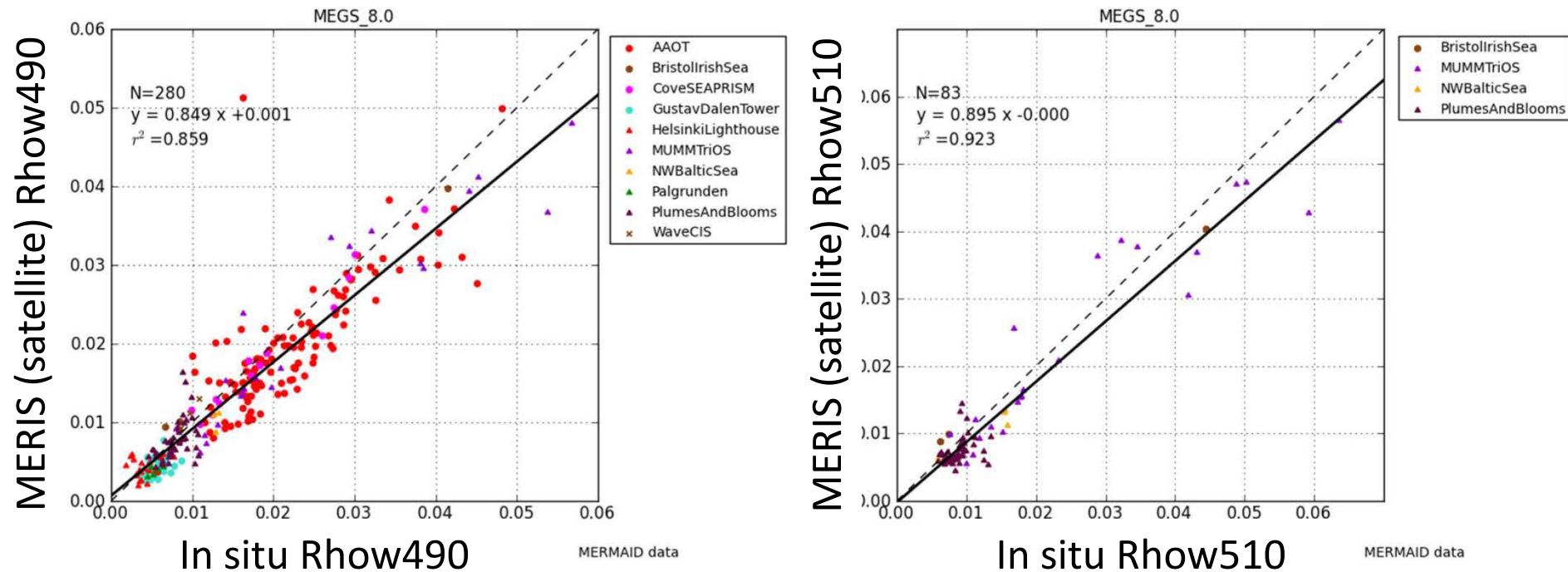


A review of **protocols** for Fiducial Reference Measurements used for Satellite Radiometric Validation

**“How to make a water reflectance measurement
(instrument deployment, data processing, uncertainty estimation)”**

Presented by Kevin Ruddick (RBINS) at FRM4SOC Final Workshop, 2018-10-04
with support from FRM4SOC partners, S3VT, NOAA/VIIRS cal/val et al ...

10 years of MERIS validation data, including a few years of AERONET-OC...



No uncertainty estimates!

Can we combine measurements from different teams?

In the Copernicus/Sentinel era Users/EU/ESA want better validation information

[MERIS 3rd reprocessing data validation report, ACRI, 2012]

Data courtesy of PIs (D. McKee, K. Ruddick, D. Siegel, S. Kratzer) and AERONET-OC PIs (G. Zibordi, G. Schuster, S. Kratzer, B. Gibson), matchup using MERMAID

Although this may seem a paradox, all exact science is dominated by the idea of approximation. When a man tells you that he knows the exact truth about anything, you are safe in inferring that he is an inexact man. Every careful measurement in science is always given with the probable error ... every observer admits that he is likely wrong, and knows about how much wrong he is likely to be.

— Bertrand Russell

In *The Scientific Outlook* (1931), 42.

(For “man/he” read “scientist/s/he”. For “error” read “uncertainty”)

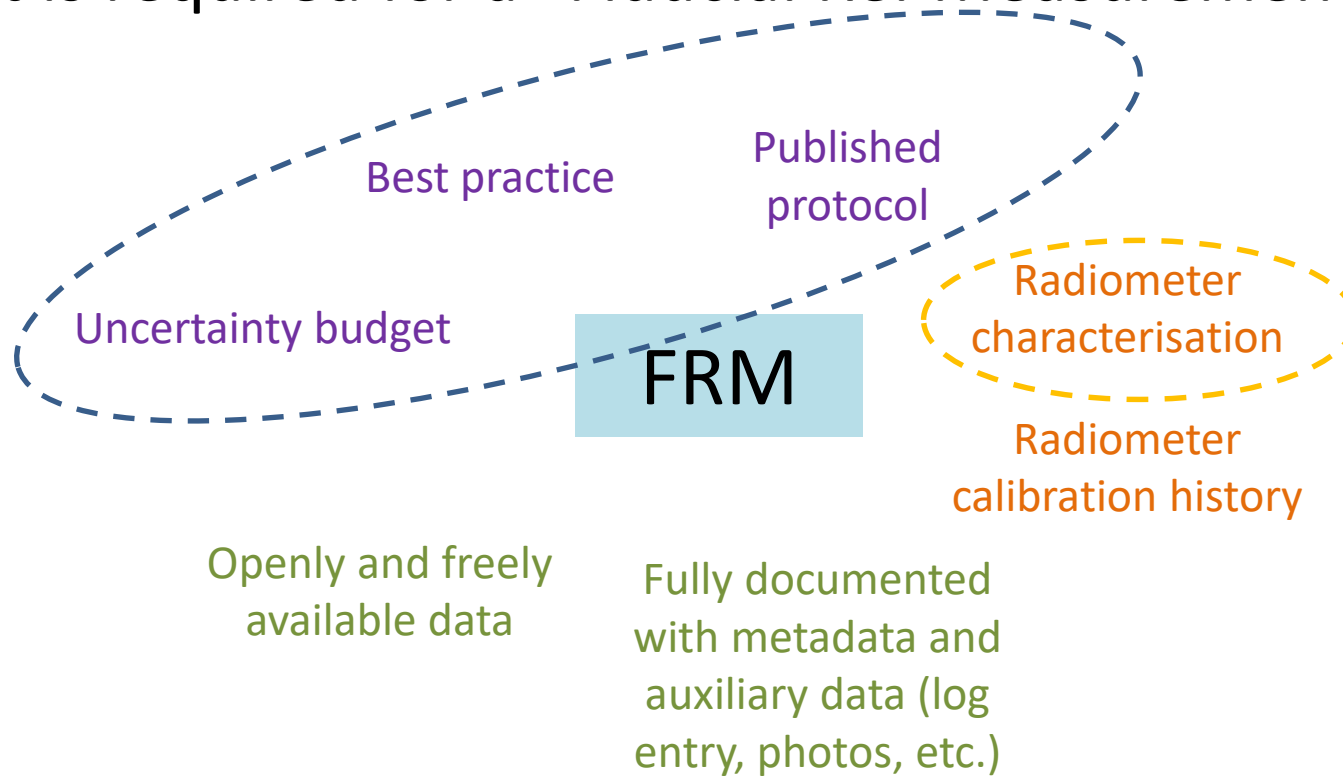
No person will deny that the highest degree of attainable accuracy is an object to be desired, and it is generally found that the last advances towards precision require a greater devotion of time, labour, and expense, than those which precede them.

— Charles Babbage

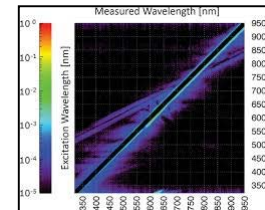
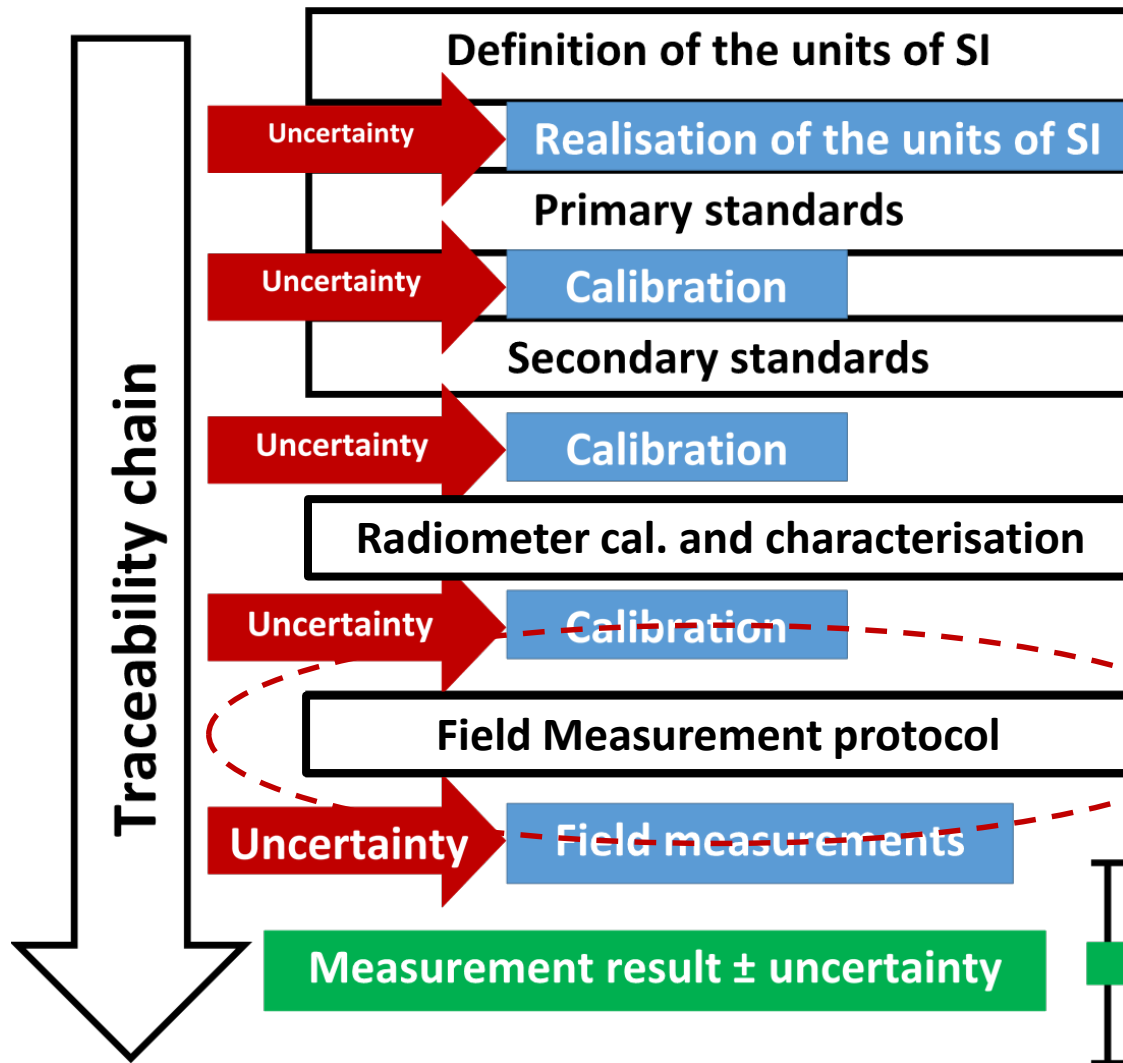
Reflections on the Decline of Science in England (1830), 167.

A measurement result is complete only when it is accompanied by a statement of the associated uncertainty [Wikipedia, Measurement Uncertainty, 2017]

What is required for a “Fiducial Ref Measurement (FRM)”?



1. Review of measurement protocols
2. Review of existing ocean colour radiometer characterisation/calibration/performance





fiducial reference measurements for satellite ocean colour

Technical Report TR-1 "Measurement Requirements and Protocols when Operating Fiducial Reference Measurement (FRM) Ocean Colour Radiometers (OCR) used for Satellite Validation"

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Document reference FRM4SOC-TR1

Project ESA – FRM4SOC

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Deliverable D-60 (Technical Report TR-1)

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Version DRAFT #0-22 – post S3VT and post-NOAA/VIIRS review

Date issued 11 December 2017

	Prepared by	...	Contractor	Customer
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Document delivered to ESA as v1.0 (draft#0-22) in Dec2017

Many Comments received from:

- Sentinel-3 Validation Team
- NOAA/VIIRS cal/val team
- IOCCG executive
- Other scientists

The document is complete (113 A4 pages) and reviewed by ~25 scientists

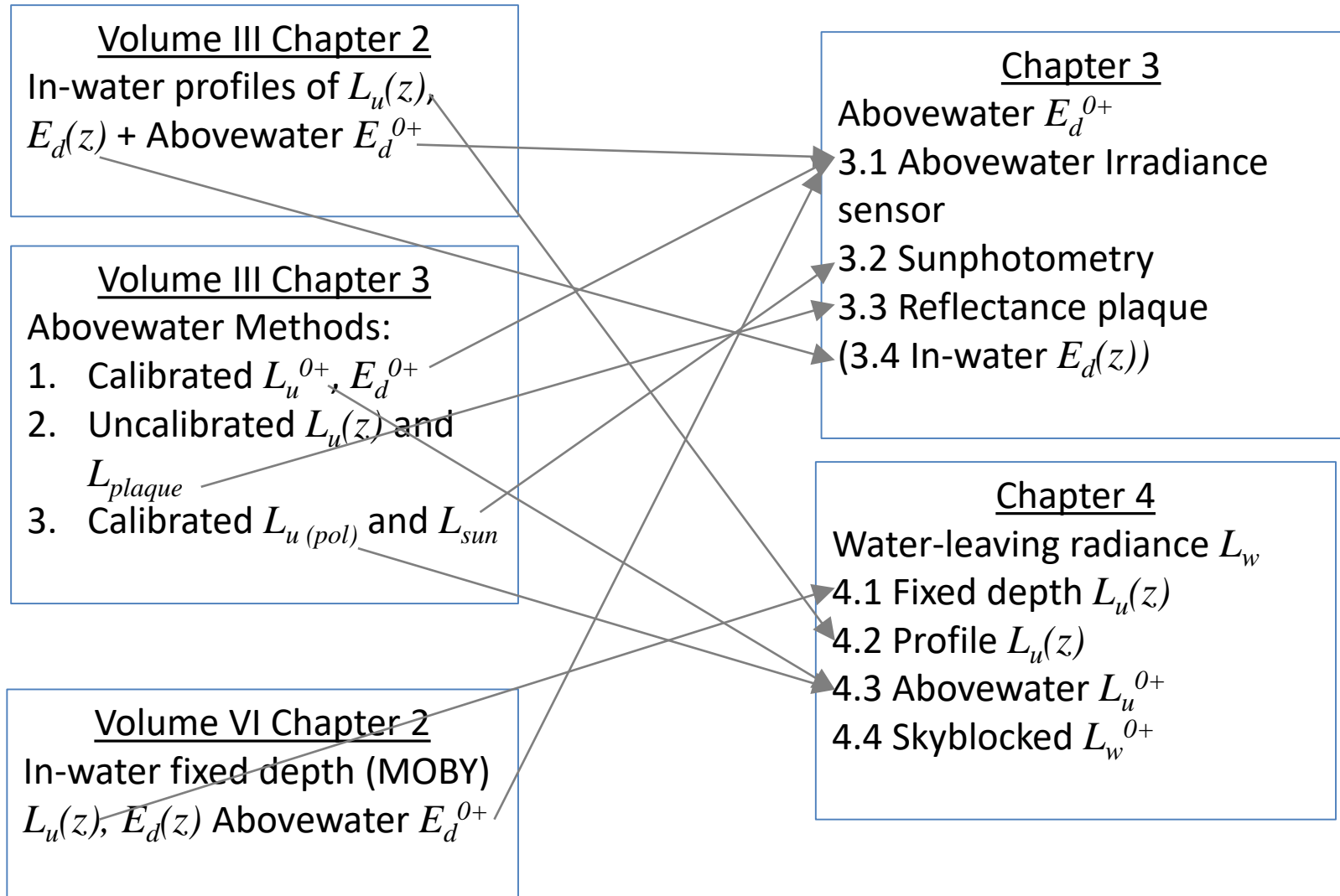
Preparing for public distribution

Heritage from NASA Protocols (2004)

- **Total Respect** for the extremely useful and authoritative NASA Protocols (2004). We cannot replace or update them!
 - From NASA-2004 to FRM4SOC-2017, what is new?
 - Many **new scientific papers**
 - **Maturing of abovewater radiometry** (but still significant diversity)
 - Consensus that **Ed0+ should be measured abovewater (Yes?)** ... restructuring Ed, Lw methods
 - **From supervised to unsupervised** measurements (data/year and data/person-day), e.g. MOBY/BOUSSOLE ... AERONET-OC ... drifting systems
 - Growing availability and need to validate **high res sat data** => no conceptual differences but different conditions (inland and coastal: bottom reflectance, high attenuation, very shallow, surrounding trees/buildings/terrain, fetch-limited surface gravity waves, etc.)
 - AND instead of providing instructions on how to make measurements
- FRM4SOC “just” requires a validated estimate of total uncertainty**

NASA Ocean Optics
Protocols 2003/4

FRM4SOC Protocols
structure



Scope of FRM4SOC protocols doc

- "just" **measurements protocol +data processing**, NOT instrument cal/performance
- +space-time characteristics
- Broad range of validation conditions
 - Not just "ocean" optics, but also coastal, inland ("aquatic", "air-water interface")
 - Horizontal variability (onshore/offshore gradients, patchy waters, etc.)
 - Vertical variability (stratified, shallow plumes, etc.)
 - Various atmosphere, wave, sun conditions
 - Bottom reflectance
- All sensors (S3, VIIRS, MODIS ... S2, Pléiades, Doves)
- **Everywhere where sat data is used we need validation**
- **No single "best" method, need uncertainty estimation**

CONCLUSIONS

- **FRM4SOC Protocols Summary** reviews all families of method for Lw and Ed measurement in context of **uncertainty estimation**
(checklist, explanations, key references and guidance)
- v1 (draft #0-22) delivered to ESA in Dec2017 after comments of S3VT and VIIRS cal/val team, further comments received via IOCCG Exec
- Public distribution planned **end-November 2018**

FRM4SOC and IOCCG protocols

- IOCCG draft protocols doc for public comment
- FRM4SOC and/or IOCCG?
 - Different scope
 - Different style
 - ~20% overlap, Similar reference list
- Room for both FRM4SOC and IOCCG documents
- Readers can benefit from different "takes"

Uncertainty estimate validation

Uncertainty estimate
validation

NO

YES

Water
Reflectance

