National Physical Laboratory

Metrological support for QA4EO Development of FDRs and FRMs

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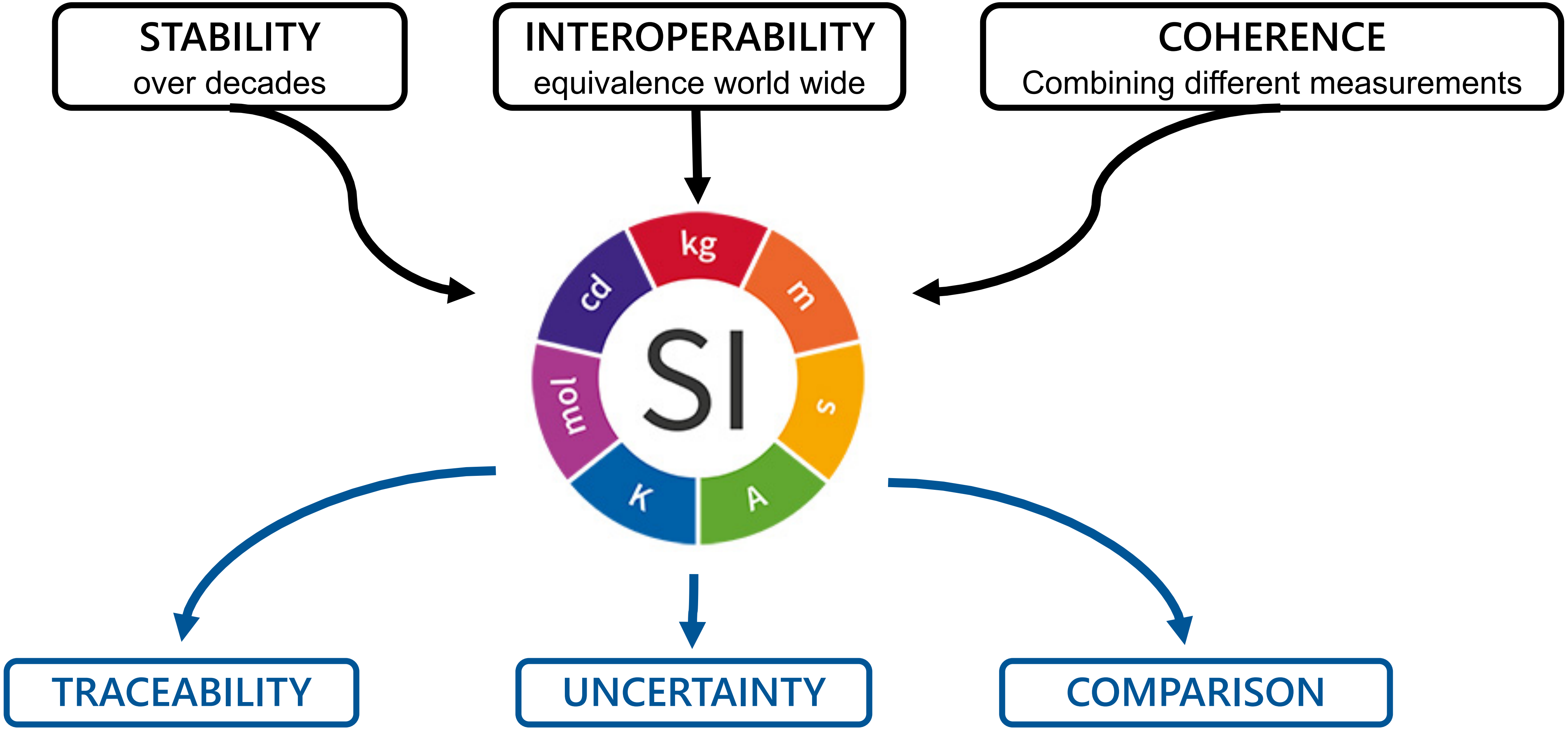
IDEAS-QA4EO

Role of metrology



Fundamental Data Record (FDR)
Fundamental Climate Data Record (FCDR)

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- Long → multidecadal
- Stabilised → combining results from multiple sensors (harmonised)
- Uncertainty quantified → enough information to propagate uncertainties properly to the next level
- Calibrated to physical units and located in time and space → ready to be used
- With all instrument and ancillary data used to calibrate and to determine uncertainty → with what is needed for long term data preservation

Why F(C)DRs and CDRs (TDPs)

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Long Term Data Preservation

- Store all information needed by future scientists to understand data set
- Records origin of data sources
- Records calculation methods
- Records basis of uncertainty and error covariance
- Provides robust basis for long term data records

Today's applications

- Have information needed to propagate F(C)DR into higher level products
- Harmonised set of data from sequential sensors to evaluate long-term trends
- Sufficient uncertainty information in as simple a form as possible
- Provides robust basis for applications

STEPS TO AN FDR

OR TDP OR FCDR OR CDR

1 hour seminar given twice. Recording available on demand

MEASURAND 01

Define the measurand and measurement function

TRACEABILITY 02

Establish the traceability with a diagram

UNCERTAINTY 03

Evaluate each source of uncertainty and fill out an effects table

HARMONISE 04

If appropriate recalibrate / harmonise against a reference

CALCULATE 05

Store relevant information in a Full FCDR for future users

LTDP STORE 06

Store relevant information in a Full FCDR for future users

EASY VERSION 07

Create a simplified version with summarised uncertainty information

"How to" guide almost complete – draft available on request

Training course now* available @ www.npl.co.uk/e-learning
*now = end of week

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Climate Data Records from Satellites

Grades

Dashboard

Course catalogue

My courses

Climate Data Records from Satellites

Uncertainty Analysis for Earth Observation

Climate Data Records from Satellites: A Metrological Approach

Overview ••• Modules 1 2 Complete ••• Resources •••

Course Overview

Have you ever wondered about the true reliability of the satellite data that you're using?

To ensure that data sets can be relied upon, it is important to have a full understanding of the uncertainties. Currently, however, uncertainty information in historical satellite data is either absent or lacks rigour. While historical sensors can provide critical information of the state of the planet during a period of relatively rapid climatic change, science and society need to know the degree of certainty that can be ascribed to an environmental change inferred from historical Earth Observation data.

This is a problem to which metrology can provide solutions.

In this course, we will explore how approaches from metrology can help Earth Observation practitioners to develop quantitative characterisation of uncertainty in Earth Observation data.

We will consider how the discipline of metrology can help support the defensible interpretation of observed long-term change through the provision of guidance, principles and tools for uncertainty analysis and propagation.

Specifically, we present a systematic method of presenting pixel-level uncertainty and error correlation information for the **Fundamental Climate Data Record** (FCDR) so that it can be used for **Climate Data Record** (CDR) generation.

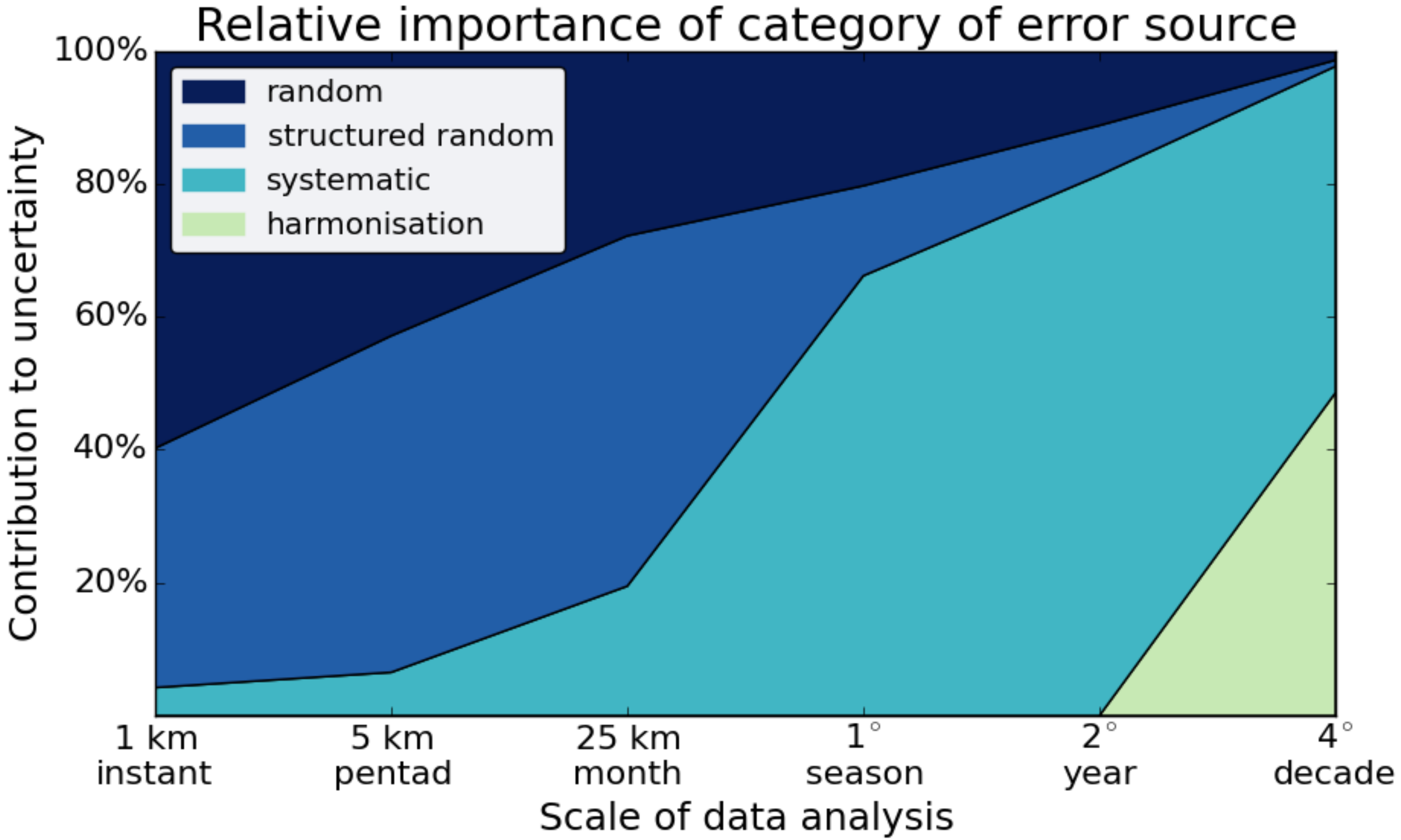


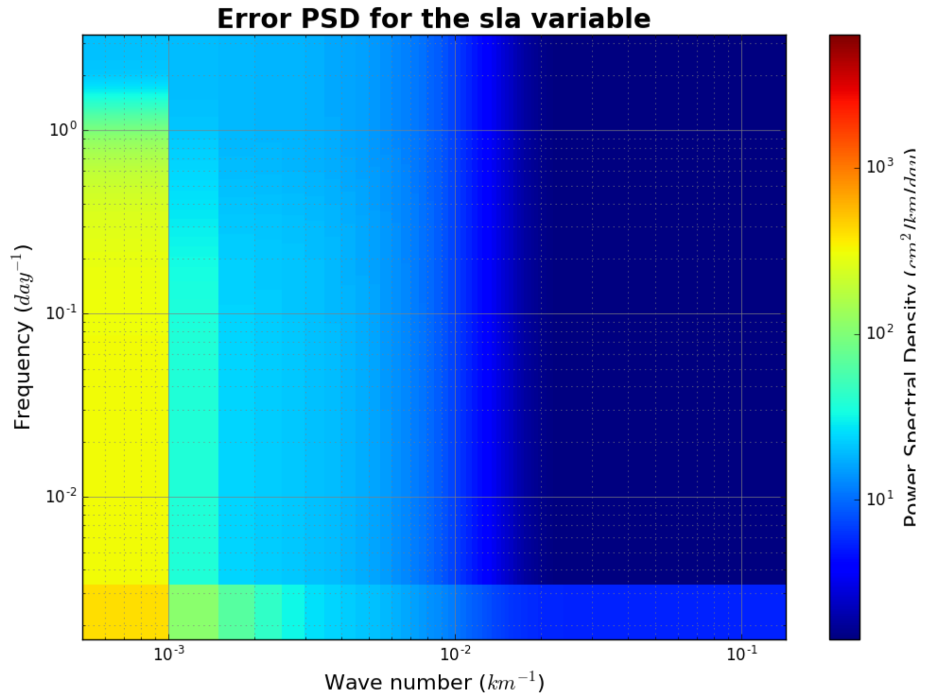
Image: Chris Merchant. http://dx.doi.org/10.6084/m9.figshare.1483409

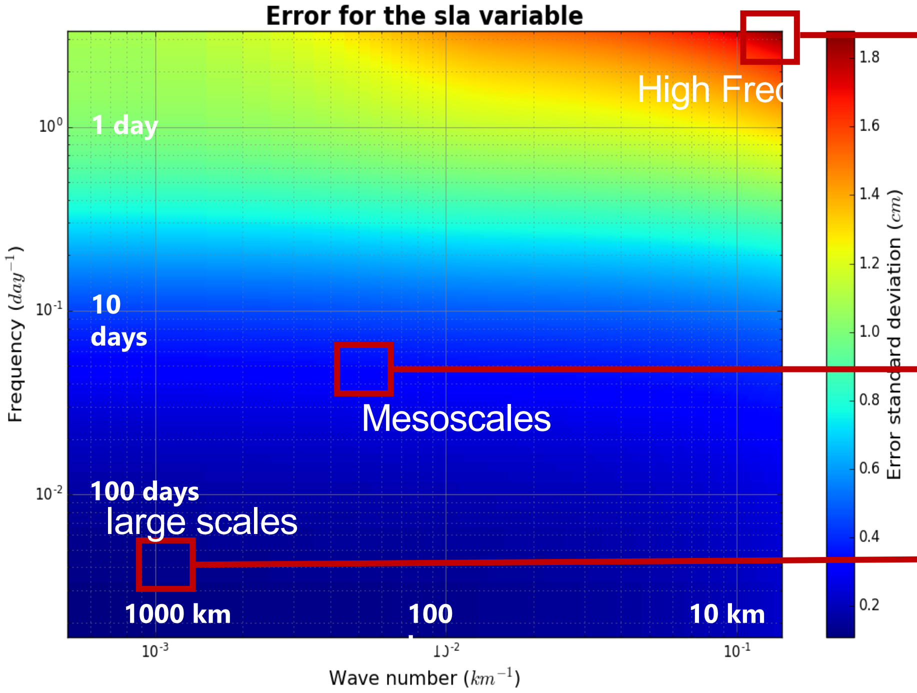
Sentinel-3 Performances over ocean

Slide by Pierre Thibault, CLS
Presented at OSTST Oct 2019

SAR Ku, Closed Burst
B=320 MHz
Rad 2 chanels (23/36)
Aux. Band = C band

Error Source	STD (cm)	Spatial correlation length	Temporal correlation length	References
Altimeter Random error	1,2	0 km	0 day	S3 performance doc (CLS)
SSB Noise	0,3	300 km	Inf.	S3 performance doc (CLS)
SSB correlated	0,1	100 km	1 day	Tran & al, 2019
Ionosphere	0,15	600 km	0 day	S3 performance doc (CLS)
Wet Troposphere	1	50 km	1 hour	Brown & al, 2015; Stum & al, 2011
Dry Troposphere	0,2	600 km	2 days	S3 performance doc (CLS)
Mean Sea Surface	0,5	1 km	Inf.	Pujol & al, 2018
Ocean Tides	1	1000 km	< 1 day	Lyard & al, 2018
Orbit solution	1,5	> 10 000 km	< 1 day	Ollivier & al, 2018; Couhert & al, 2015





: 1.86 cm @ very short scales

= 0.34 cm @ meso scales

= 0.11 cm @ large scales

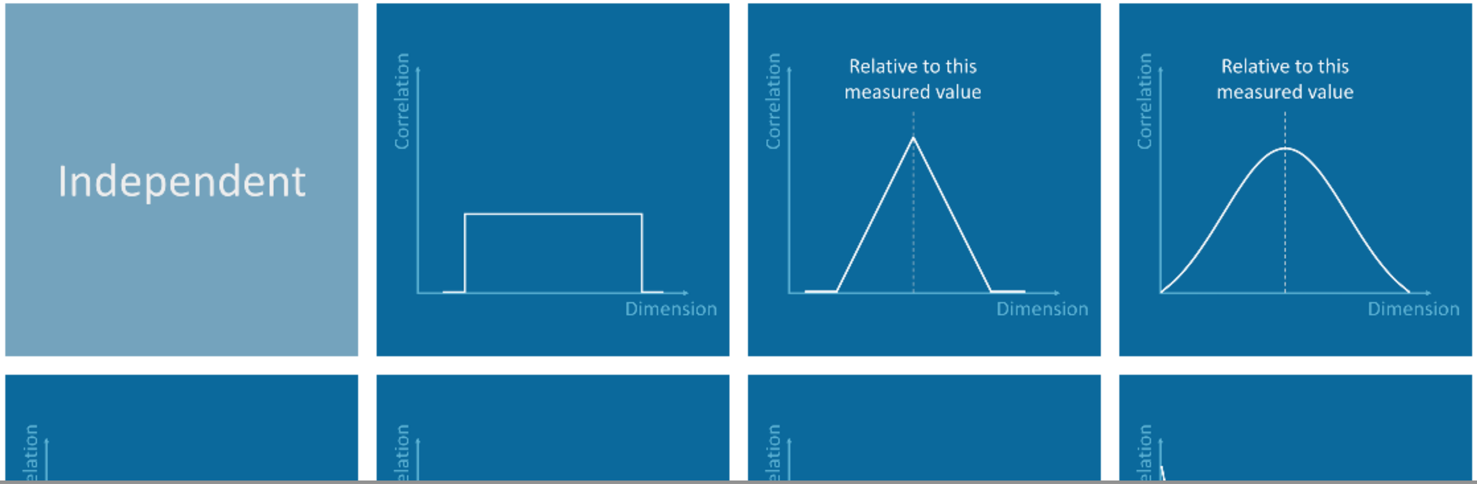
Training course pre-view

much longer timescales as the orbital parameters drift.

Error correlation forms and correlation scale

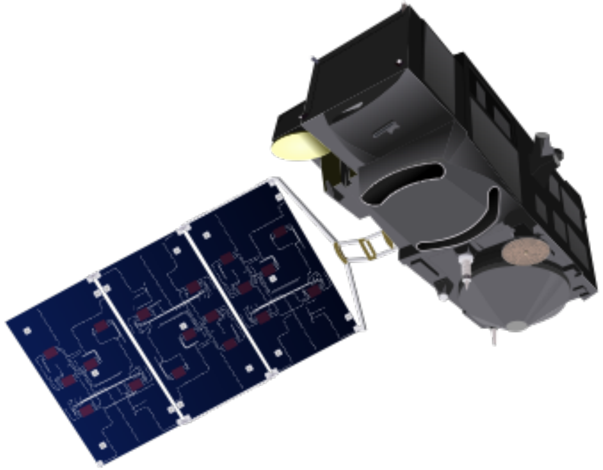
Across a spatial or temporal dimension where correlation does occur, the error correlation structure can take various forms, depending on the origin of the common component of error. A number of possible error correlation forms are listed below – it does not attempt to describe every possible situation perfectly, but is meant to be a menu of error correlation forms that are sufficiently close to those expected in reality that they can represent the expected error correlation in practical cases. The error correlation form describes the correlation coefficient between any two measured values in the dimension for which it is defined.

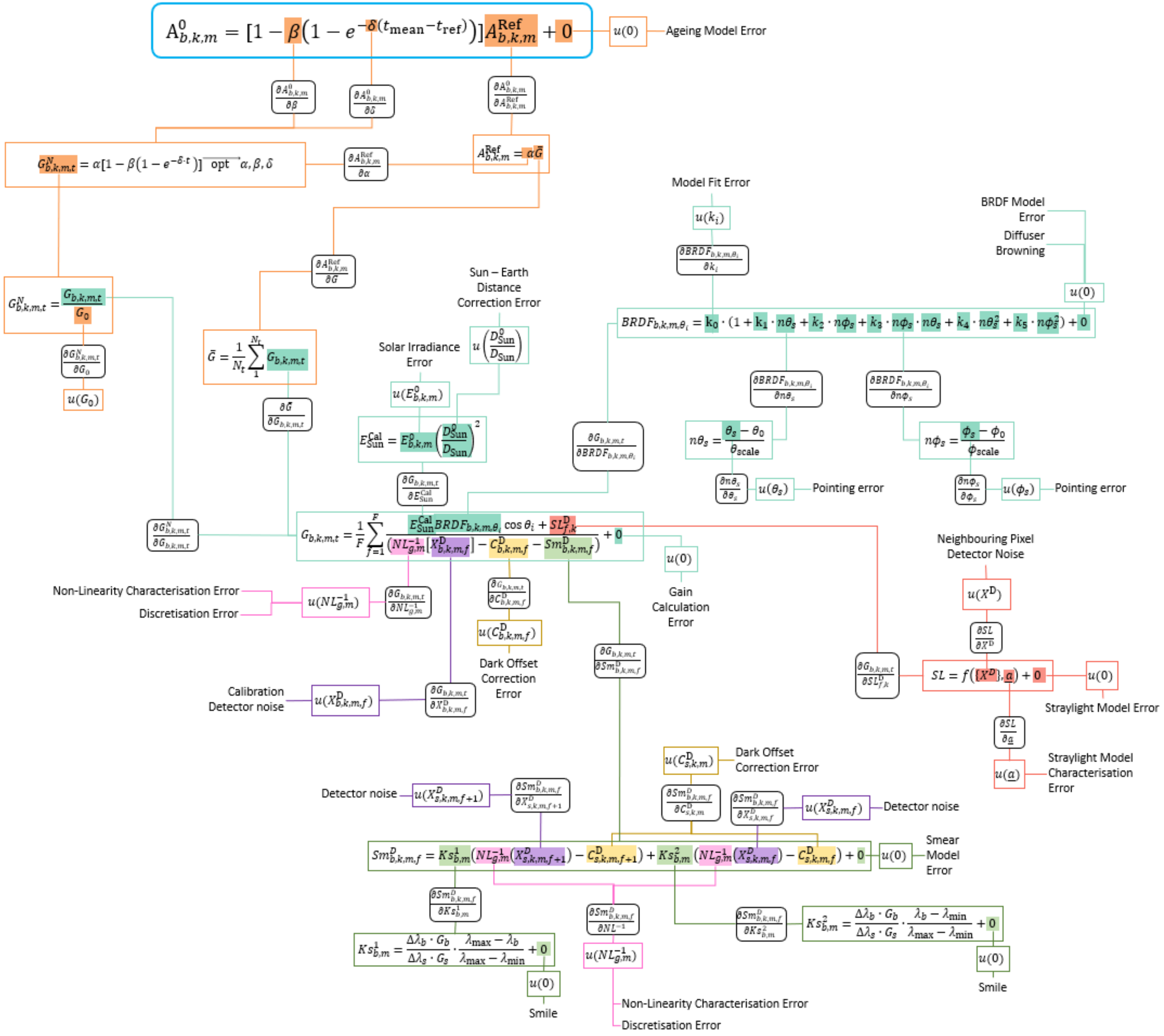
Click or tap on the graphics in the **optional** activity below to explore the different error correlation forms.



Implementation of concepts – Example Sentinel 3 OLCI

- Work of Jacob Fahy and Sam Hunt
- Supporting the MPC

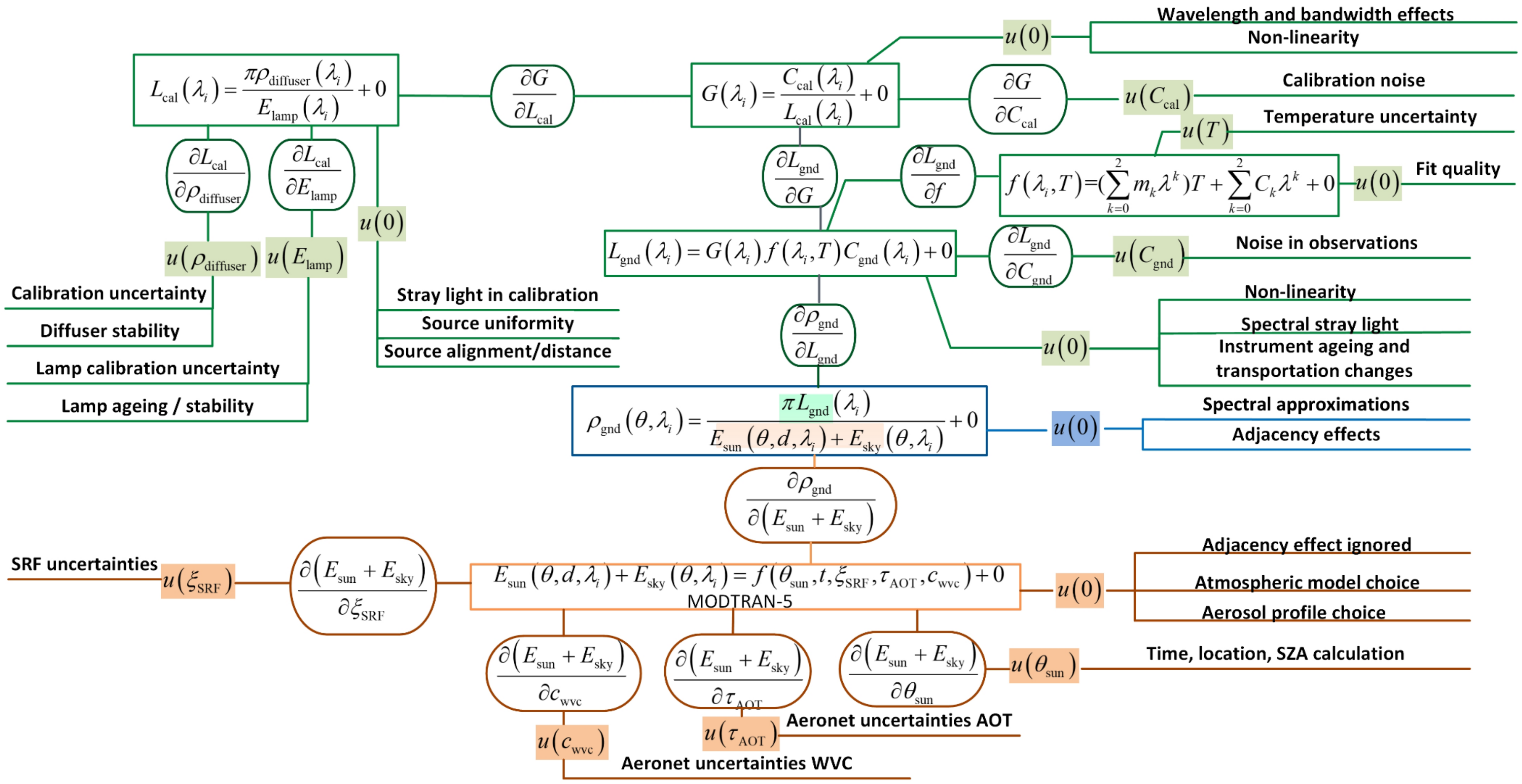




OLCI Radiometric Calibration Uncertainty Tree Diagram

Applications to ground-based measurements

Remote Sens. **2020**, *12*(11), 1696; https://doi.org/10.3390/rs12111696



Consultancy available to any project partner on any relevant topic!

Summary

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- NPL is in the project to support metrological methods for all participants
- Training courses, good practice guides, methodologies – available now and under development (and being standardised internationally)
- Metrological support to any part of the project available