University of Zurich[UZH]

Department of Geography

Airborne-based CAL/VAL of satellite-based Imaging Spectrometers – Lessons Learned during CHIME-SBG Airborne Campaign 2021

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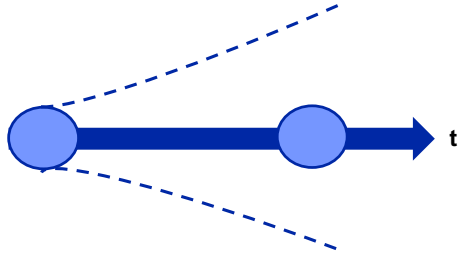
https://ares-observatory.ch/esa_chime_mission_2021/

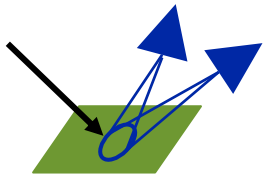
Ingredients for future airborne & in situ CAL/VAL of space-based imaging spectrometers

- Operational flight planning: Synchronization matrices



- Temporal Sampling: Length scales of processes

- Spatial Sampling: Spatial matchups



- Angular Sampling: BRDF compensation

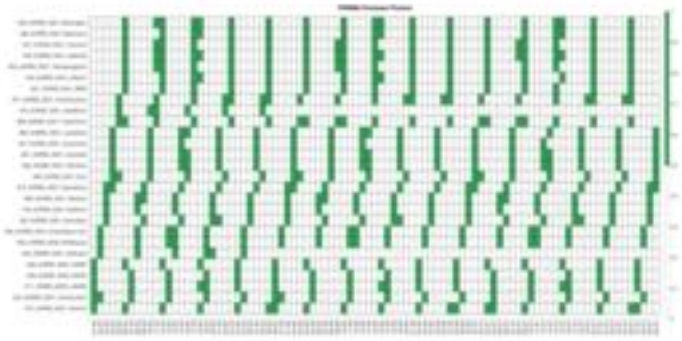
- Standardisation and Automation: Spectral Information Systems

- Traceability and Uncertainty Analysis: international compatibility of data

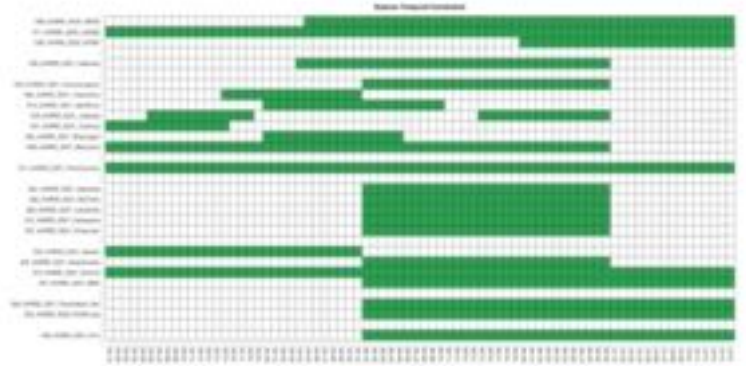
FLT Decision Concept: Synchro Matrix Fusion

6 Day WX FCST Synchro Matrix (90% Sun)

PRISMA Access Synchro Matrix



Scientific Constraints per TGT Synchro Matrix



Constraints Fusion

CAA Permit Status

```
countries_without_
permit = {'NLD'};
```

Crew rest constraints

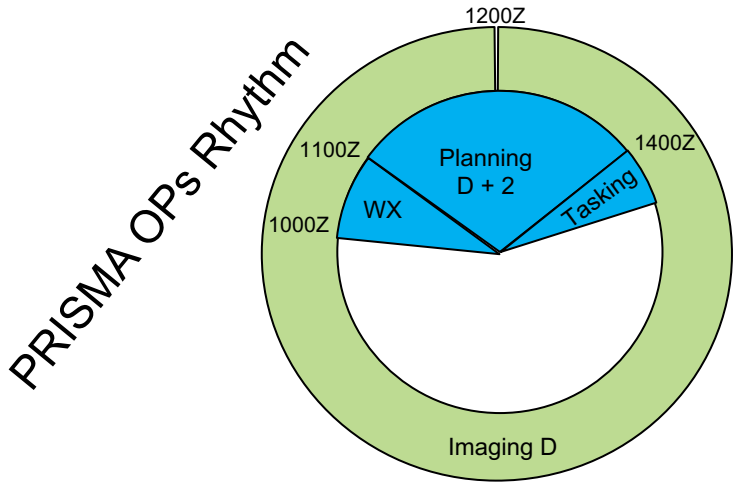
Fused Decision Matrix

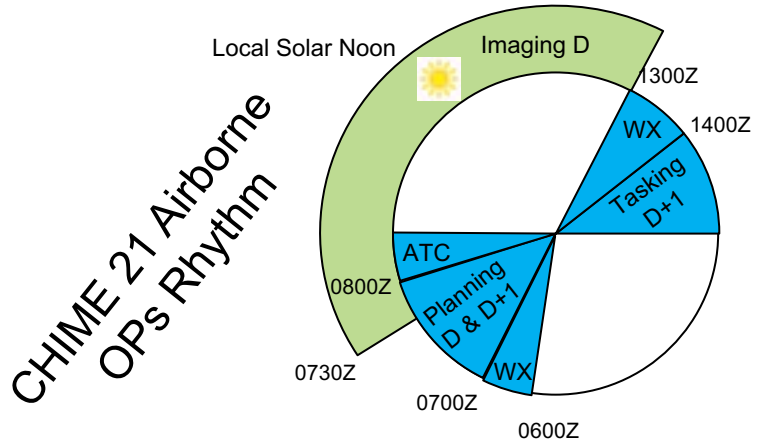
FLT Decision Concept: Synchro Matrix Fusion

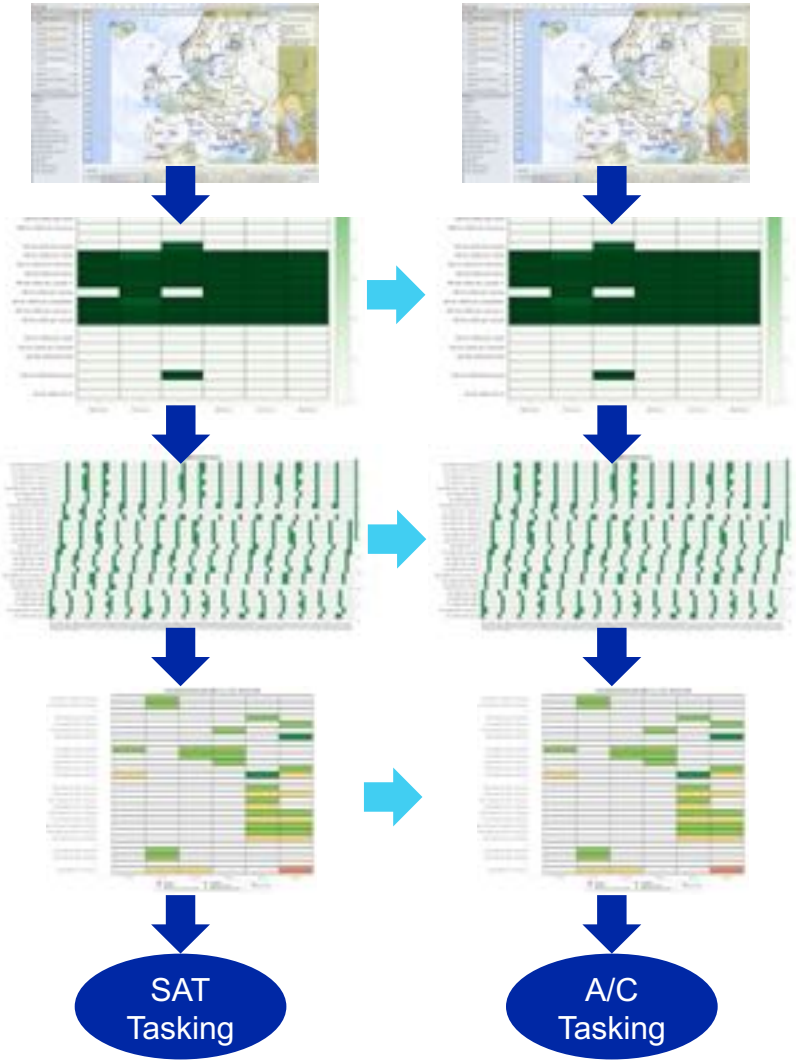
Status Quo	Working Matlab code for specific input data formats

Next Steps	• Definition of interfaces (APIs) with satellite operators to receive:
	  • TLE's for orbit propagations
	  • Programming of acquisitions for targets as function of WX
	• Synchronisation of planning processes between agencies
	• Communication of decisions processes and thresholds
	• Push notifications for CAL/VAL teams

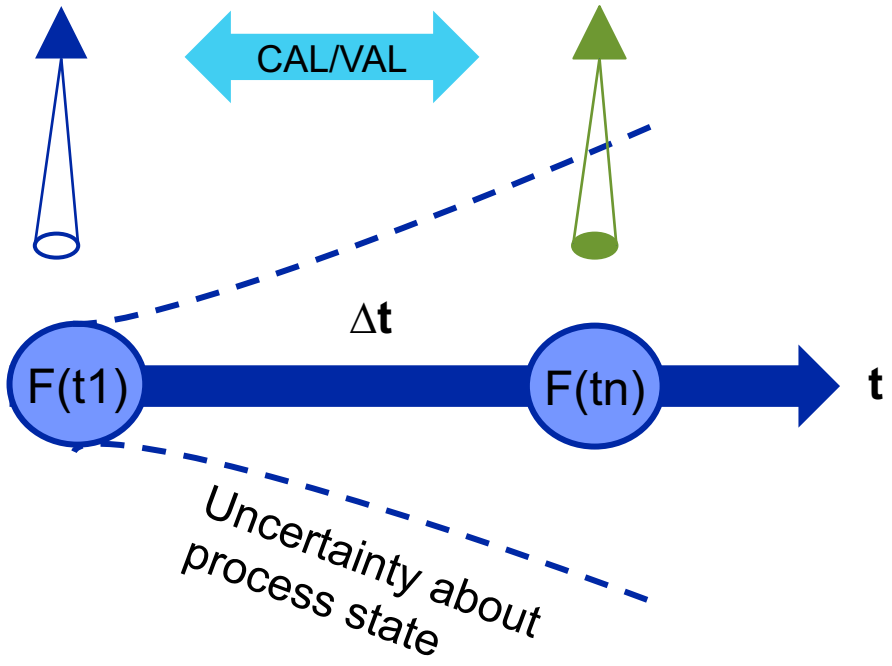
Goal	Allows sychronisation of: • WX models • SAT and airborne acquisitions





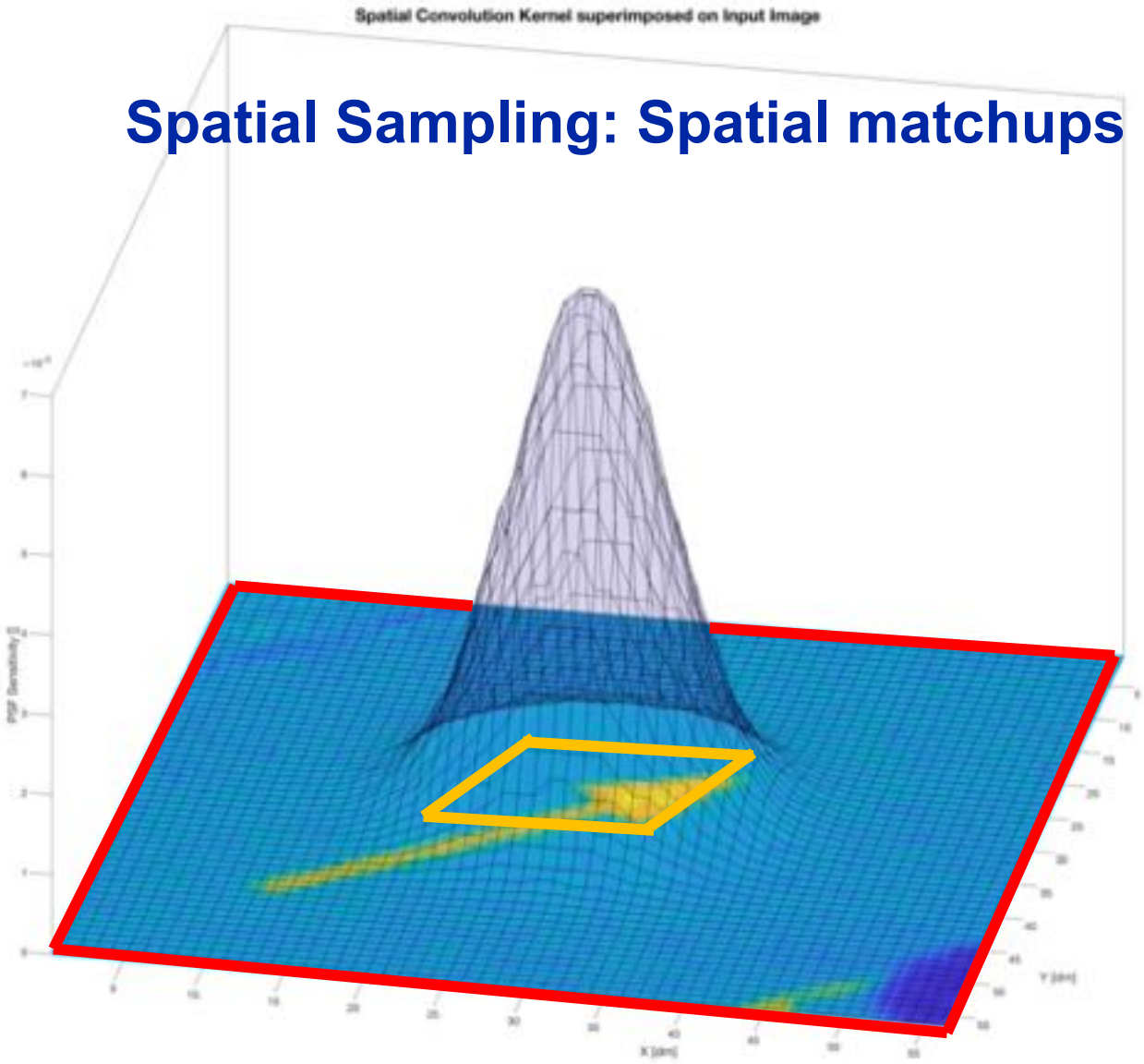


Temporal Sampling: Length scales of processes



Status Quo	Educated Guess: • Vegetation: <= 1 day • Soils et al: <= 3 days
Next Steps	• What is the rate of change of a process? • How large can Δt be to still allow CAL/VAL?
Goal	Allows decisions about: • Target priorities (temporal) • Max Δt between spatial matchups

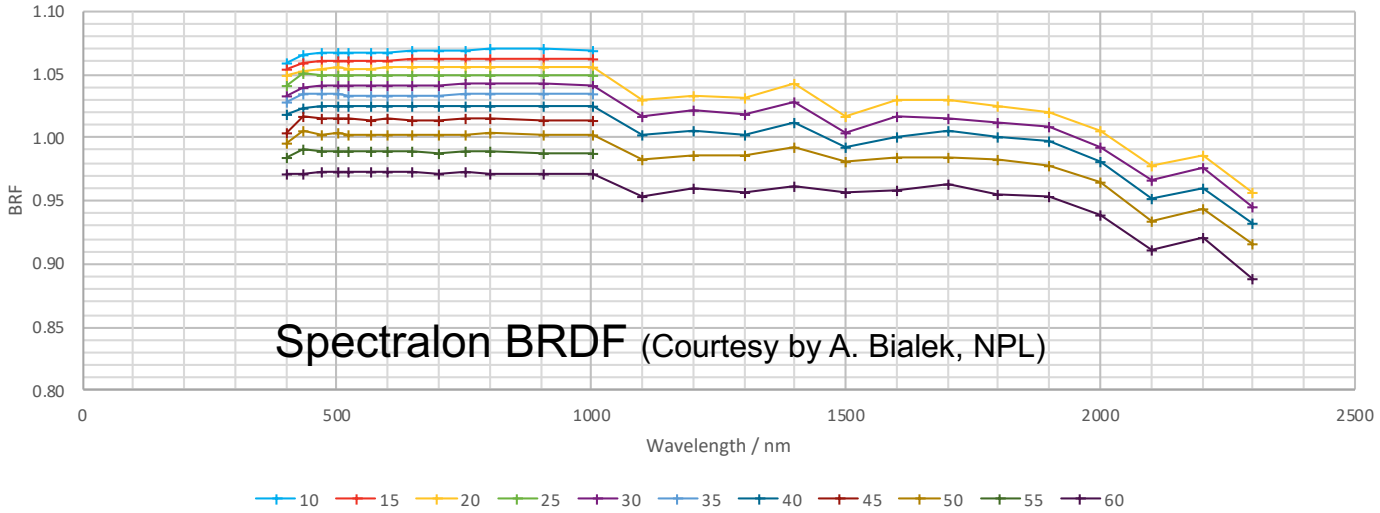
Spatial Sampling: Spatial matchups



Status Quo	Educated guess of CAL/VAL site selection: • At least 3 x the pixel size pf TGT system • Homogenous
Next Steps	• Make PSFs readily available through a tool that can convolve high resolution imagery • Geolocation uncertainty of imagers is needed • Tool to compute rating of suitability of sites
Goal	Streamlined selection of CAL/VAL sites by in situ and airborne teams respectively

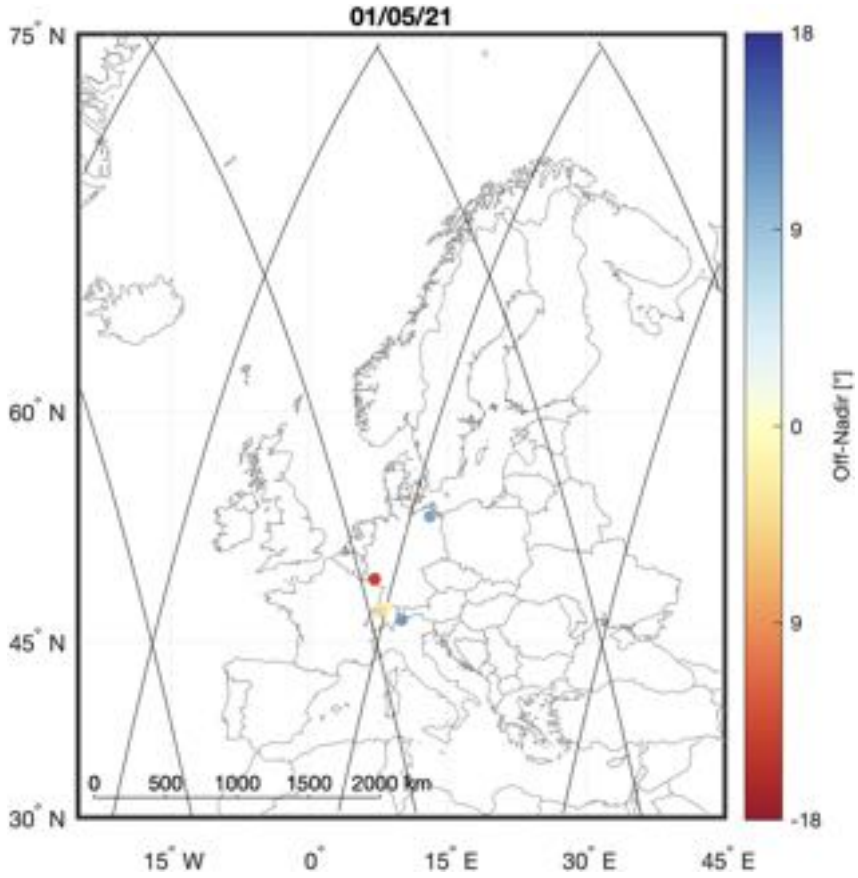
10m FWHM Convolution Sim.

Angular Sampling: BRDF

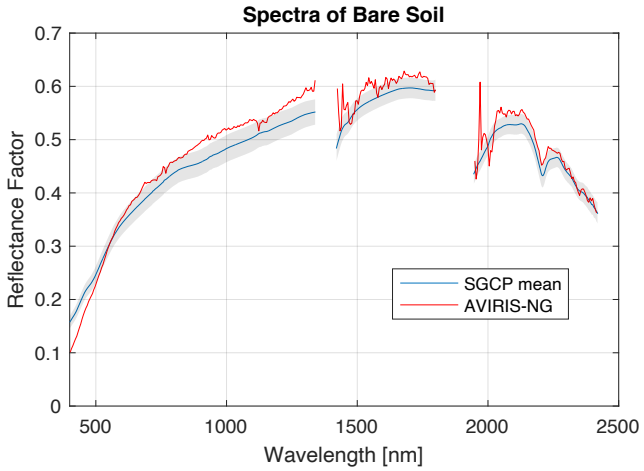


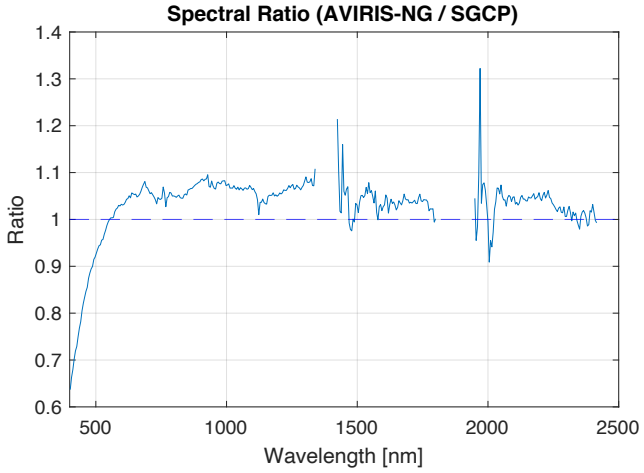
Status Quo	Some kernels for various land surfaces exist, e.g. MODIS BRDF Models. Are they sufficient?
Next Steps	• Enabling CAL/VAL with different observational angles • Validate and update kernels to match smaller pixel sizes • Establish uncertainty budgets
Goal	• CAL/VAL is taking BRDF into account • BRDF related uncertainties are known and reported

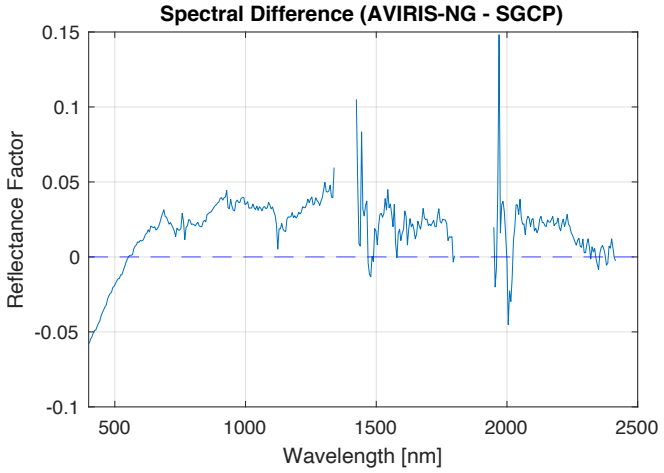
PRISMA Roll Angle Considerations



Standardisation and Automation: Imagery CAL/VAL



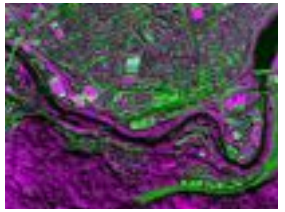




SPECCHIO

SGCPs
(Spectral Ground Control Points)

CAL/VAL Tool



IMG Cube

Status Quo	Solution of airborne CAL/VAL implemented at RSL
Next Steps	• Interface definitions • Product standardisations • Shared algorithms • Uncertainty propagation
Goal	CAL/VAL can be done internationally in an automated fashion

Traceability and Uncertainty Analysis

- Identical worldwide
- Century-long stability
- Absolute accuracy

Achieved through:
- Traceability
- Uncertainty Analysis
- Comparison

Status Quo	Abysmal: *To our knowledge, no complete, traceable analysis and propagation of uncertainty from L0 or L1 to L2, L3 or L4 exists for any current EO processing chain. **
Next Steps	• Implement uncertainty propagation into EO chains • Educate the remote sensing community • Supply tools for uncertainty support
Goal	• All measurements and derived products come with uncertainties • End users can deal with uncertainties

* Mittaz, J., Merchant, C. J., Woolliams, E. R., 2019. Applying principles of metrology to historical Earth observations from satellites. Metrologia 56(032002), 28.

https://earth.esa.int/eogateway/documents/20142/37627/1_Metrology_Nigel_Fox_et_al_.pdf/067000f5-b5b9-06d6-21a5-996516cea5c6

Questions?

https://ares-observatory.ch/esa_chime_mission_2021/