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The Motivation for automated hyperspectral

10 years of MERIS water validation, including a few years of AERONET-OC…

Water reflectance 490nm

Data acquisition must be AUTOMATED

[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
The Motivation for land surface reflectance

1. TOA radiance
2. Surface Reflectance
3. Chlorophyll a, Suspended particle conc. etc.
3. LAI, NDVI, FAPAR, land class types, etc.

Quality of user products depends on quality of upstream CAL and A/C
The Motivation for land surface reflectance


"Correcting optical remote sensing data for artefacts of sun-sensor geometry is essential to isolate the response of global vegetation to seasonal and interannual climate variability."

RBINS Lesson learned from ENVISAT/MERIS and ACIX-1...-2:

• To compare atmospheric correction algorithm performance need surface reflectance data
• Modelling atmospheric path reflectance from AERONET aerosol measurements is not enough.

Surface reflectance ESSENTIAL (aerosols "nice to have")

Need multiple sun/viewing geometries to develop and validate BRF models

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The H2020/HYPERNETS project

HYPERNETS multi-head hyperspectral Radiometer

HYPERNETS Autonomous System

Radiometer Calibration
monitoring

LED

Pan & Tilt

Validation of surface reflectance at all spectral bands of all optical missions inc.
Sentinel-2A&B, Sentinel-3A&B, MODIS-A&T, VIIRS, Landsat-8, Pléiades-2A&B,
PROBA-V, CHRIS, ENMAP, PRISMA, SABIAMAR, etc. ... + nanosats

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User data requirements - Status

- Strong need for in situ measurements to validate surface reflectance:
  - VISNIR: 380-1020nm at 5nm (or 1nm!)
  - SWIR: 1000-2500nm at 5-10nm
  - Temporal: Every ~10-30 minutes during daylight (if no power limit)
  - Spatial/angular:
    - Nadir+"full" nadir/azimuth angles up to 60°
    - + hemispherical and target cameras
  - Direct/diffuse irradiance ratio
  - Aerosols

Surface reflectance - acquisition protocol

Downwelling irradiance +
+ Nadir upwelling radiance
+ angular upwelling radiances

[Kuester, 2014]

For consolidation by FRM4VEG ...
Radiometer instruments - status

(requirement: radiometer can be mounted on pan-tilt for full zenith- and azimuth-pointing)

New HYPSTAR® radiometer [TARTU] + pan-tilt sys [LOV]
A word about calibration and characterisation


**Network plan**
1. Annual abs cal + monitoring
2. Full char at KO + ?monitoring? to trigger re-char

**Absolute radiometric cal**
+ Thermal sens.
Angular response (esp. cosine)
Non-linearity
Straylight
DF
Polarisation sens.

**Traceability chain**
- Definition of the units of SI
- Realisation of the units of SI
- Primary optical standards
- Calibration
- Secondary optical standards
- Calibration & characterisation
- Field ocean colour radiometers
- Field OCR measurements
- Measurement result ± uncertainty

Measurement protocols
Comparisons
Validation Test sites

Land types
- Forest
- Grassland
- Agricultural
- Desert
- Snow
  (N+S hemisphere)

Testing in 2021-22
Looking for long-term sustainability

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User requirements clarified (hyperspectral, automated, network)
Instrument designed+built, 7 prototypes delivered to partners
System (PC+pan/tilt+) designed+built, 7 prototypes delivered to partners
Land & water network processor prototype completed
Test sites prepared for first tests Dec2020
Satellite data processing: matchup automation and improvement A/C
Project finishes Oct 2022 ... but clear long-term need for this network of val sites
Conclusions

General:

• **Surface reflectance data** is essential for land product validation

• **Autonomous hyperspectral network** is most cost-effective (multi-mission context)

• **Zenith- and azimuth-pointing system** enables full BRF (as well as "parking" to protect when not measuring)

• Need for **consolidation of protocols and uncertainty estimation** (FRM4VEG)

Priority:

• **Stabilise funding of val site operations**

  (if no-one is acquiring data you can forget the other "issues")
Thank you for your attention! Questions/Comments?

Don’t miss IGARSS2021 Special Session on "The future for validation of satellite-derived water and land surface reflectance"  
(Brussels 11-16 Jul 2021!)

- User requirements for the new generation of satellite missions, including high spatial (e.g. metre scale), high temporal (e.g. geostationary), high spectral (e.g. hyperspectral) and super spectral (from UV to SWIR) missions, and including cubesat constellations.
- Networking of in situ measurements
- Calibration and characterisation of ground-based instruments
- Developing technologies for ground-based measurements
- Improvements in data acquisition and processing protocols
- Quality Assurance and Quality Control of measurements used for satellite validation
- Estimation of ground-based measurement uncertainties
- The rôle of Unmanned Airborne Vehicles (spatial heterogeneity, topography, etc.)