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Copernicus Cal/Val synergy among current and future optical missions

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- Current Cal/Val activities are limited and insufficiently harmonized between different missions
- Project objective:
  - define a holistic solution for all Copernicus Sentinel missions for current and **upcoming Sentinel-missions**
  - exploit existing synergies between the missions
- What we did:
  - overview of existing calibration and validation sources and means
    - ✓ for sensor calibration and characterization as well as for product quality
  - identified gaps in the current cal/val practice
    - ✓ Copernicus Cal/Val maturity
  - proposing long-term solutions
    - ✓ Required developments in terms of technologies and instrumentation, Cal/Val methods, instrumented sites and dissemination service
- Based on experience from
  - many experts
  - different working groups gathering
    - ✓ European Space Agencies, Copernicus Services, measurement networks, International partners

Optical Component Copernicus Cal/Val Maturity

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Calibration and Characterization

- Main weak point: Pre-flight characterization
  - ✓ missing measurement uncertainties
  - ✓ improve SI-traceability (broken due to the impact of launch)
  - ✓ often inconsistent with observed in-flight performances
- Lessons learned:
  - ✓ better rely on in-flight characterization
    (tandem phases, inter-comparison with reference sensor, straylight from Moon observations, yaw maneuvers for diffuser characterization)
  - ✓ on-board spectral calibration or characterization for optical sensors is considered a weak point for current missions
- Geometric calibration of TIR channels limited (lack of permanent geometric features)

Optical Component Copernicus Cal/Val Maturity Overall Assessment

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Product quality

- Validation:
  - ✓ very heterogenous validation maturity level among Sentinel core products
  - ✓ L1 generally higher maturity than L2
- Uncertainties
  - ✓ prognostic per pixel uncertainties mostly not provided
  - ✓ very large effort needed to develop, generalize, produce and validate uncertainties
  - ✓ uncertainty need to be propagated through the whole processing chain, including L3 and L4 Copernicus services products
  - ✓ mission requirements have to be refined and updated accordingly
- Required R&D efforts for validation
  - ✓ to improve models for natural scenes
    (Rayleigh method, Pseudo-Invariant Calibration Sites, the Moon, Deep Convective Cloud)
  - ✓ to improve RTMs
  - ✓ to improve cloud and cloud shadow masks
  - ✓ to improve validation methodologies for fire products
  - ✓ to improve Cal/Val methods for surface reflectance

Optical Component Copernicus Cal/Val maturity Overall Assessment

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- Reference measurements:
  - Level of confidence established by the validation depends on the quality of the reference data
  - lack of SI traceable reference measurements and FRM
    - ✓ poor representativeness (surface reflectance)
      --> progressively develop an operational network providing hyperspectral directional reflectance validation products
    - ✓ poor timeliness and temporal sampling (chlorophyll concentration, fire radiative power)
    - ✓ inadequate accuracy (sea surface level, CO2 concentration)
      reference data should have an uncertainty lower than the product under test
  - a concerted reference data collection strategy and coordination body at Copernicus level is needed