**Study aims**

This study aims to address the following questions:

1. What are the quality assurance requirements for biophysical EO-derived products for climate observations?
2. What are the requirements for field measurements and how can we determine if these accuracy requirements are met?
3. What can validated 3D models tell us about current accuracy requirements and the capability of EO products to meet them?
4. How well do 3D models represent the truth?
5. What can 3D models tell us about uncertainty in observation?

**Method: Building a model-based Quality Assurance (QA) Framework**

- **Application of field protocol in the use of a specified in-situ sensor**
- **Validated 3D model in round-robin and model inter comparison studies**
- **Monte Carlo Ray Tracing Radiative Transfer model, raytran, used to:**
  1. Simulate data measured by in-situ sensors
  2. Simulate the known true data values of the product, which can be used as the “reference” product
- **Data**
- **Retrieval algorithm**
- **In-situ sensor**
- **3D MCRT model**
- **3D modeling, given that we know the exact size, shape, location and orientation of scatterers, the exact “true” value of the target quantity can be computed**

**Conclusions**

3D modeling can be used in the context of validating EO-derived biophysical products to:

1. Provide uncertainty information
2. Benchmark the algorithms and methods used
3. Test conformity against accuracy requirements for field measurement protocols of land surface albedo, FAPAR and LAI
4. Identify specific contributions to uncertainty

**Digital Hemispherical Photography (DHP)** is one method of measuring in-situ LAI and FAPAR. The 3D MCRT model can be used to simulate fisheye images and then apply algorithms commonly applied in in-situ sensors (Can-Eye, GLA, Hemisview, Hemiflet, WinSCANOPY, Winphot).

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**Conclusions**

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**Leaf Area Index (LAI)**

**Fraction of Absorbed Photosynthetically Active Radiation (FAPAR)**

**Contributions to uncertainty in measuring FAPAR from Digital Hemispherical Photography (DHP):**

- Definition of FAPAR: white-sky, black-sky, blue-sky and algorithms used to compute them (Fig. 1)
- Solar Zenith Angles (SZA)
- Height of the DHP camera
- Sampling designs
- Plot size
- Number of samples
- Minimum separation distance from tree trunks (Fig. 3)
- Canopy type and heterogeneity (Fig. 2)

3D modeling can provide alternative means of uncertainty quantification. A model-based approach for quality assessment of field measurements and their protocols is capable of benchmarking canopy biophysical parameters against a precisely known true value, benefitting both validation and traceability communities for Earth Observation (EO). Such an approach is non-destructive and highly flexible, and is beneficial since it avoids comparing the field measurement validation products against a independent estimates that in reality cannot reflect the true value.