Spatial scale effects on surface-atmosphere radiative coupling

Govaerts Y.[1*], S. Schunke[1], V. Leroy[1] and M. Luffarelli[1]

[1] *Rayference SRL, Brussels, Belgium*

***Corresponding author e-mail**: yves.govaerts@rayference.eu

The retrieval of scattering and absorption atmospheric properties from space observations is heavily affected by surface conditions as these two media are tightly radiatively coupled. Surface reflectance represents the lower boundary conditions of the radiative transfer system that needs to be solved to retrieve atmospheric properties. The understanding and quantification of this radiative coupling is of paramount importance to accurately retrieve either surface or atmospheric properties. Scattering processes in the atmosphere can essentially be described by the Mie solution to the Maxwell's equations with some adaptations to account for the phase function of non-spherical particles. A similar approach has been implemented to represent light reflection at the surface, accounting however for the mutual shadowing by elements interacting with the radiation such as plant leaves. This approach however limits the representation of the vegetation to a flat and homogeneous medium. This assumption is very restrictive and does not allow to account for the wide range spatial scales occurring over terrestrial surfaces. The geometric optics theory is more versatile to describe shadowing effects between surface scattering elements such as leaves, trees, or the topography according to the considered scale.

Coupled surface-atmosphere 1D radiative transfer model used for the processing of satellite data represent these multi-scale scattering processes limiting surface description to homogeneous cases. The consequences of this approach will be illustrated with Eradiate, a 3D radiative transfer model developed by Rayference. This model relies on the Monte Carlo ray tracing technique which allows to explicitly account for both the Mie and the geometric optic theories with virtually no limitation on their possible combinations. Results of sensitivity analyses at different scales will be illustrated with very realistic 3D scenes under different types of atmospheres, simulating both ground and space-based observations.