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# Using different solutions for radiative transfer of solar-induced fluorescence in a land surface model

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Chlorophyll fluorescence (ChlF) takes place in green leaves of the plants during photosynthesis. It has therefore been proposed that ChlF can be used to track the photosynthetic activity of plants and the current possibility to observe sun-induced chlorophyll fluorescence (SIF) via remote sensing provides an unprecedented tool to monitor terrestrial photosynthesis at global scale. However, the relationship between photosynthesis and ChlF is not linear at all scales and is partly controlled by the non-photochemical quenching - which dissipates excess energy as heat. The relationship between the photochemical and fluorescence yields changes when the photochemical quenching is dominating at low irradiance conditions or at high stress conditions. Interpretation of observed SIF is complicated by its dependence on incoming absorbed radiation, observation geometry and radiative transfer of SIF photons within the canopy. To fully exploit remotely sensed SIF to estimate photosynthesis at ecosystem and global scales, it is important to account for these aspects through modelling that include ecosystem processes.

In this work we have implemented a ChlF model into a state-of-the-art land surface model QUantifying Interactions between terrestrial Nutrient CYcles and the climate system (QUINCY) simulating the terrestrial energy, water and biogeochemical cycles of carbon, nitrogen and phosphorus. The simulation of radiative transfer is highly influential for the simulated SIF signal, but the complex solutions of radiative transfer are computationally too heavy, making them impractical approaches at global scale. Therefore, we have investigated different radiative transfer techniques for the SIF signal of varying complexity at site scale in Niwot Ridge, U.S. The most complex solution is based on the mSCOPE and Fluspects model, that explicitly calculates signal transfer. The intermediate solution is based on a two-stream flux approach and the most simple is using a simple fraction for the escape ratio of SIF. Our aim is to assess which solution is most suitable for simulating the SIF signal at different scales and also test different formulations for modelling of non-photochemical quenching.