Geophysical Research Abstracts
Vol. 21, EGU2019-16746, 2019
EGU General Assembly 2019

Using nonlinear variable transformations to assimilate land surface albedo observations

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Surface albedo observations over vegetated areas can be inverted to retrieve parameters which determine the radiative transfer through the vegetation canopy, including leaf area index (LAI). Such inversions can be done using data assimilation methods but their applicability is often hindered by Gaussian assumptions because albedo, being a bounded variable, cannot be adequately described by a Gaussian distribution. In particular over densely vegetated areas, surface albedo in the visible domain reaches values below 0.05 and its distribution becomes highly skewed. This potentially leads to unphysical inversion results and biased estimates.

Nonlinear transformations can transform non-Gaussian, bounded variables into Gaussian, unbounded variables (Gaussian anamorphosis). When such transformations are not only applied to state variables and model parameters but also to observations, the question of how to transform the observation error variance arises. We present a new way to transform the observation error variance that retains the relation of the error variances in the physical space and compare it to a sampling-based method to transform the observation error.

Experiments are performed with a two-stream model for canopy radiative transfer and include twin experiments as well as the assimilation of real observations.