EGU21-15196
https://doi.org/10.5194/egusphere-egu21-15196
EGU General Assembly 2021

Epistemic and aleatoric uncertainty maps in high resolution biophysical parameter retrieval

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Biophysical parameters such as the Leaf Area Index (LAI), Fraction Absorbed Photosynthetically Active Radiation (FAPAR) and Canopy Water Content (CWC) are key inputs for ecological, meteorological and agricultural applications and models. Moreover, LAI and FAPAR are considered Essential Climate Variables (ECVs) which are feasible for global climate observation. Within this context, there are two main issues to achieve a reliable biophysical variable retrieval: cloud contamination and oversimplified uncertainties from the operational products. We propose a methodology based on a hybrid method which inverts a radiative transfer model (PROSAIL) with artificial neural networks (ANN) to produce 30m resolution continuous time series of biophysical variables (FAPAR, LAI, FVC, CWC, CCC) over large areas. To obtain gap free input reflectance data, we used a cloud optimized fusion algorithm (HISTARFM) combining MODIS and Landsat information. In addition, HISTARFM provides realistic uncertainty estimates along with the fused reflectances. This valuable information allows us to carry out an exhaustive uncertainty analysis considering the aleatoric uncertainty (data error) that needs to be propagated through the ANN, and the epistemic uncertainty (model error). We validate our biophysical retrieval with operational MODIS and Copernicus products. This study is performed over the contiguous US (CONUS) area with Google Earth Engine (GEE). The proposed retrieval methodology combined with the unprecedented GEE computational power allows to obtain high spatial resolution biophysical products and realistic uncertainty estimates to capture the needed spatial detail and adequately monitor croplands and heterogeneous vegetated landscapes at very broad scales.