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Application of Automatic Differentiation technique to retrieve land surface parameters and associated uncertainties from satellite products.

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We present a computer efficient software package enabling us to assimilate operational remote-sensing flux products (BHRs) into a state-of-the-art two-stream radiation transfer scheme, suitable for climate models, and we discuss its applicability to large products datasets. The package implements the adjoint and Hessian code, generated using automatic differentiation techniques of a cost function balancing (1) the deviation from the a priori knowledge on the model parameter values and (2) the misfit between the observed remote sensing fluxes and the two-stream model simulations. The individual weights of these contributions are specified notably via covariance matrices of the uncertainties in the a priori knowledge on model parameters and the measurements. The proposed procedure delivers a Gaussian approximation of the PDFs of the retrieved model parameters values. The a posteriori covariance matrix is further exploited to evaluate, in turn, the posterior probability density functions of the radiant fluxes simulated by the two-stream model, including those that are not measured (e.g. the fraction absorbed in the ground).

Our application, already validated through the comparison with FLUXNET in situ data, illustrates the capability of the inversion package to retrieve the two-stream model parameters (such as the effective LAI and the albedo of the vegetation background) as well as to assess a meaningful partitioning of the solar fluxes between the soil, vegetation and atmosphere layers, along the year in an operational way, for both sensors and for large geographical regions.