Multitemporal-patch ensemble inversion of coupled surface-atmosphere radiative transfer models for land surface characterization

Claire Lauvernet[1], Frédéric Baret[1],
Laurent Hascoët[2], Samuel Buis[1] and François-Xavier Le Dimet[2]

[1] INRA (Institut National de Recherche Agronomique), France
[2] INRIA (Institut National de Recherche en Informatique et en Automatique), France

Abstract :

In the last few years, e ncouraging results using radiative transfer model inversion techniques were obtained for land biophysical variables retrieval. However, the inversion of radiative transfer models is a severely ill-posed problem that may lead to significant uncertainties in the biophysical variables estimates. The improvement of the performances of the inversion process requires more information to be exploited including better radiative transfer models, exploitation of proper prior information on the distribution of the canopy and atmosphere variables, knowledge of uncertainties in satellite measurements, as well as possible spatial and temporal constraints. In this study we focus on the use of coupled atmosphere- surface radiative transfer models (SMAC + S AIL + PROSPECT) to estimate some key biophysical variables from top of atmosphere canopy reflectance data. The inversion is achieved over an ensemble of pixels belonging to a spatial window where the aerosol properties are supposed to be constant, and over a temporal window of few days where vegetation state is assumed not to vary. The ensemble inversion scheme accounting for the spatial and temporal constraints is described. Top of atmosphere reflectance observations are simulated for 13 bands within the visible and near infrared domains. The coupled model is inverted with a variational method implementation

dedicated to solve very large inverse problems. It is based on the use of the adjoint model and a Quasi-Newton optimization technique with BFGS update.

The multitemporal-patch inversion approach exploiting the spatial and temporal constraints is compared to the classical instantaneous-local inversion applied on single pixel and date. The 'ensemble' approach shows significant performance improvements when retrieving aerosol optical thickness τ_{550} and some canopy characteristics (*LAI, LAI*$\times C_{ab}$ and *ALA)*. Conclusions are drawn on the interest of such approaches, and perspectives are given, with due attention to their applicability within operational algorithms.