1st TERRABITES Symposium
Hamburg, Germany, 9-11 February 2010
TERRABITES-93

Assimilation of remote sensing data and operational constraints

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Global atmospheric models, originated 50 years ago to address the problem of numerical weather prediction, evolved in the past twenty years to earth system models (ESM), where the atmosphere dynamics module is coupled with ocean, sea ice, atmospheric chemistry, and land and vegetation modules.

In that context, it is unsurprising to witness the coming of age of assimilation of vegetation remote sensing data by earth system models. Variational multivariate techniques developed to define initial conditions of atmospheric models can be applied in a similar way to define the statistically optimal state of vegetation given an a-priori model background and the available remote sensing information.

The vegetation data assimilation problem is currently less mature than its atmospheric counterpart. Examples will be presented to illustrate the practical issues and more fundamental challenges the community is facing, taking developments in atmospheric data assimilation as a guiding paradigm. First of all, data from past mission that continues with present and future missions need to be dealt with by the assimilation methods, as a pre-requisite of defining a climate record continuing seamlessly with near-real time climate monitoring. Practical issues include: availability of data in the past and near-real time of data for current and future missions, sensor and platform characteristics, etc. Such considerations are crucial for the satellite agencies planning for future missions. Secondly, more fundamental challenges lie in the fact that, traditionally, vegetation information inferred from remote sensing data is drawn from visible (VIS) and near-infrared (NIR) bands, with no useful information from the surface in cloud-covered areas. Such limitation is best overcome by using multivariate methods, where the VIS and NIR data are combined with thermal infrared (TIR) and C- and L-band microwave channels. ESMs already strive to describe the surface hydrological and energy cycle consistently with a carbon cycle description and a multivariate data assimilation of the diversity of remote sensing information naturally fits in such framework. Thirdly, it is likely to be a trend towards assimilation of remote sensing radiances, rather than remote sensing derived vegetation products, but the benefits of the former approach need to be clearly demonstrated. Finally, instrument biases and model deficiencies need to be characterized: An important part of land/vegetation model developments in the next few years will be driven by data assimilation requirements.