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Assimilation of high resolution satellite imagery into the 3D-CMCC forest ecosystem model

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The use of satellite observations for the accurate monitoring of the terrestrial biosphere has been carried out since the very early stage of remote sensing applications. The possibility to observe the ground surface with different wavelengths and different observation modes (namely active and passive observations) has given to the scientific community an invaluable tool for the observation of wide areas with a resolution down to the single tree. On the other hand, the continuous development of forest ecosystem models has permitted to perform simulations of complex ("natural") forest scenarios to evaluate forest status, forest growth and future dynamics.
Both remote sensing and modelling forest assessment methods have advantages and disadvantages that could be overcome by the adoption of an integrated approach.
In the framework of the European Space Agency Project KLAUS, high resolution optical satellite data has been integrated /assimilated into a forest ecosystem model (named 3D-CMCC) specifically developed for multi-specie, multi-age forests.
3D-CMCC permits to simulate forest areas with different forest layers, with different trees at different age on the same point. Moreover, the model permits to simulate management activities on the forest, thus evaluating the carbon stock evolution following a specific management scheme. The model has been modified including satellite data at 10m resolution, permitting the use of directly measured information, adding to the model the real phenological cycle of each simulated point. Satellite images have been collected by the JAXA ALOS-AVNIR-2 sensor. The integration schema has permitted to identify a spatial domain in which each pixel is characterised by a forest structure (species, ages, soil parameters), meteo-climatological parameters and estimated Leaf Area Index from satellite. The resulting software package (3D-CMCC-SAT) is built around 3D-CMCC: 2D / 3D input datasets are processed iterating on each point of the analysed domain to create a set of monthly/ yearly output maps.
The integrated approach has been tested on the "Parco Nazionale dei Monti Sibillini, Italy". The high correlation showed between observed and computed data can be considered statistically meaningful and hence the model can be deemed a good predictor both for high resolution and for short period of simulation.
Moreover the coupling satellite data at high resolution and field information as input data have shown that these data can be used in the 3D-CMCC Forest Model run. These data can be also successfully used to simulate the main physiological processes at regional scale and to produce with good accordance with measured and literature data, reliable output to better investigate forest growth, dynamic and carbon stock.