Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

ACG37-03 会場:201A 時間:5 月 21 日 14:45-15:00

衛星データを複合利用したモデル-データ統合による陸域炭素循環モデルの改善のフレームワーク
A model-data integration framework to a terrestrial ecosystem model using multiple satellite-based constraints.

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Various satellite-based spatial products, such as evapotranspiration (ET) and gross primary productivity (GPP), are now available by integration of ground observation and satellite observation. Therefore, effective use of these multiple spatial products to terrestrial biosphere models is an important step toward better simulation of terrestrial carbon and water cycles. However, due to the complexity of terrestrial biosphere models with a large number of model parameters, the application of these spatial data sets to terrestrial biosphere models is difficult.

In this study, we show an effective but simple framework to refine a terrestrial biosphere model, Biome-BGC, using multiple satellite-based products as constraints, and tested it in the monsoon Asia region (60E-180E and 80N-10S) covered by eddy-covariance observations. The framework is based on the hierarchical analysis (Wang et al. 2009) with model parameter optimization constrained by satellite-based spatial data . The Biome-BGC model is separated into several tiers to minimize the freedom of model parameter selections and maximize the independency from the whole model. For example, the snow sub-model is first optimized using satellite-based snow cover product, followed by soil water sub-model optimized by satellite-based ET (estimated by an empirical upscaling method), photosynthesis model optimized by satellite-based GPP, and respiration and residual carbon cycle models optimized by biomass data.

As a result of initial assessment, we found that the most of default sub-models (e.g. snow, water cycle and carbon cycle) showed large deviations from satellite-based products; however, these biases were removed by applying the method. For example, gross primary productivities were overall underestimated in boreal and temperate forest and overestimated in tropical forests. However, the parameter optimization scheme successfully reduced these biases. Our analysis shows that terrestrial carbon and water cycle simulations in monsoon Asia were greatly improved, and the use of multiple satellite observations with this framework is an effective way for improving terrestrial biosphere models. We also found that respiration fluxes, biomass, and soil carbon data, which are currently unavailable, are also important to constrain simulated terrestrial carbon cycles and generation of these products are urgent.

キーワード: 陸域生物圏モデル, リモートセンシング, 最適化, 炭素循環, 水循環
Keywords: terrestrial biosphere model, remote sensing, optimization, carbon cycle, water cycle