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Global model inter-comparison with GOSAT L4A and support vector machine based estimates of biospheric variables

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Estimation of carbon exchange in terrestrial ecosystem associates with difficulties due to complex entanglement of physical, chemical, and biological processes: thus, the net ecosystem productivity (NEP) estimated from simulation often differs among process-based terrestrial ecosystem models. In addition to complexity of the system, validation can only be conducted in a point scale since reliable observation is only available from ground observations. With a lack of reliable spatial data, extension of model simulation to the global scale results in significant uncertainty in the future carbon balance and climate change. Greenhouse gases Observing SATellite (GOSAT), launched by the Japanese space agency (JAXA) in January, 2009, is the 1st operational satellite promised to deliver the net land-atmosphere carbon budget to the terrestrial biosphere research community. Using this information, the model reproducibility of carbon budget is expected to improve: hence, gives a better estimation of the future climate change.

Because of the direct association with climate change, improving estimation of global NEP is essential; yet, global gross primary productivity (GPP) and ecosystem respiration (RE) need to improve as well for further sophistication of ecosystem modeling. In the system of carbon cycle, GPP and RE are the true physiological quantities representing photosynthesis and respiration, and NEP is a byproduct of them. Since a major purpose of process-based ecosystem models is to clarify the mechanism of carbon cycle, it is important to invest efforts to refine GPP and RE as well.

Currently, the most reliable estimate of global GPP is provided by observation-based empirical upscaling with machine learning models [Jung et al. 2011]. Machine learning regression is based on a network of eddy covariance flux tower observation, in conjunction with global satellite remote sensing and meteorological data sets. Because of the high correlation with GPP, availability of long-term global observations of vegetation indexes (e.i. EVI, NDVI, and NDWI) from operational satellites makes performance of machine learning model finer in prediction of GPP. Because of limited availability of carbon pool data, however, it is difficult to induce equivalent performance in RE with machine learning models [Jung et al. 2011]. Instead of a direct estimation, combination of global GPP estimated by machine learning regression and NEP from GOSAT L4A would produce a more reliable budget of global RE.

This initial analysis is to compare a set of observation-based global carbon flux products, NEP from GOSAT L4A, GPP from support vector machine regression, and RE from a combination of them, with three types of TEMs and an inversion model: Biome-BGC (prognostic model), CASA (diagnostic model), LPJ (dynamic vegetation model), and Carbon Tracker (inversion model). Comparison was conducted with the standardized format based on GOSAT L4A: 42 sub-continental tiles and monthly temporal coverage from June 2009 to May 2010. Through the comparison, we discuss similarities and dissimilarities in (1) seasonal variations, (2) global and annual averages, (3) variability with climate (air temperature, precipitation, and solar radiation).

Reference

Jung, M., et al. (2011), Global patterns of land-atmosphere fluxes of carbon dioxide, latent heat, and sensible heat derived from eddy covariance, satellite, and meteorological observations, Journal of Geophysical Research, 116.

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