簡略な植生モデルによる植物生産力の年々変動の評価
Evaluation of interannual variations in primary productivity by a simple vegetation model

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In a terrestrial ecosystem, heterotrophs depend on primary productivity, which is affected by climate change. Various types of process-based models have been developed to estimate primary productivity, resulting in growing understanding about the roles of terrestrial ecosystems in material circulations and energy flows. However, meteorological constraints on phenology that influence seasonal changes in primary productivity are still uncertain. Prognostic leaf growth models are possible to contribute to interpret the mechanisms. We developed a process-based vegetation model driven by simple climate variables to estimate primary productivity. Using this model, we examined the spatiotemporal variability in primary productivity and the timing of leaf onset and fall.
This model consists of four submodules: (1) energy and water balance, (2) water-carbon exchange, (3) allocation of assimilated carbon, and (4) phenology. Photosynthesis and evapotranspiration rates are computed forced by simple meteorological variables (*i.e.* air temperature, solar radiation, precipitation, relative humidity, and wind speed) at a 30-min interval in (1) and (2). The computed primary productivity is then transmitted to (3) and (4) wherein leaf growth is calculated at a one-day interval. Leaf growth is computed based on meteorological resources and allocations of assimilated carbon. The proposed model considers the differences in biophysical and ecophysiological traits among plant functional types.
First, we examined interannual variations in gross primary productivity (GPP) at some flux tower sites. We used meteorological and biochemical data observed at flux towers and those archived in FLUXNET. Second, we evaluated spatiotemporal variability in GPP in Monsoon Asia. Gridded meteorological data from general circulation models (GCMs) were spatially interpolated to the resolution of vegetation distribution data. We examined the influences of the interannual variations in climate on GPP and leaf phenology.
The proposed model captured seasonal changes in the measured GPP per site. The estimates of interannual variations were rather comparable to the measurements. For example, the reduction in GPP due to a cool and wet summer in 2003 at Fujiyoshida was greatly reproduced. Although the model estimated a low GPP at Appi in the same year, the measured value was the greatest in 2000-2006. This discrepancy occurred possibly because the model ignores species-specific traits. However, the model comprehensively reproduced temporal changes in GPP in response to climate variations. The results of the experiment suggest GPP at the peak of leaf growth affects the growth after that and therefore annual GPP.
The total annual GPP in Monsoon Asia varied in response to interannual climate variations. There were some areas, where the interannual variability in GPP was large. This result shows that the GPP in these areas are sensitive to climate variations. In this presentation, we will discuss how climate variability affects the GPP through leaf phenology.

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