Study on Construction of a Wetland Ecosystem and Carbon Transfer in the Closed Geosphere Experiment Facility

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Abstract

The Closed Geosphere Experiment Facility (CGEF) with high airtightness is designed to study carbon dynamics in terrestrial ecosystems, including the transfer and accumulation of radioactive carbon isotope (^{14}C) released from nuclear facilities to the environment. A wetland ecosystem dominated by *Phragmites australis*, which is widely found in cool-temperate brackish marsh near the spent nuclear fuel reprocessing plant in Rokkasho, Japan, was introduced into the CGEF where air temperature and CO_2 concentration are both controlled automatically. A mathematical carbon transfer and accumulation model (CTA model) which consists of photosynthesis and decomposition sub-models, having the structure of nine reservoir compartments (three plant, two litter, three soil, and one groundwater compartments), was developed to estimate the carbon dynamics in the wetland ecosystem. In addition, the gross primary productivity (GPP) model which calculates total photosynthesis of the wetland ecosystem from three environmental variables (light intensity, atmospheric CO_2 concentration, air temperature) was developed for the input sub-model for the CTA model. The Bayesian probabilistic inversion analysis and a Markov chain Monte Carlo (MCMC) technique were applied to determine parameters of these two models, using the data obtained from the two-year experiment in the CGEF. The CTA model was applied to a wetland ecosystem around Takahoko Lake which is located near the spent nuclear fuel reprocessing plant. The results showed that the model gave appropriate estimates of carbon reservoirs for the plant growing season. The seasonal variations in the amounts of leaf and stem biomass carbon were adequately simulated by the model. The changes in the amounts of soil carbon in microbial biomass and organic materials were properly estimated within the standard deviation of the observed data in a real wetland. Although the amounts of dissolved organic carbon were partly overestimated, the discrepancy of the estimates was corrected by the re-examination of the decomposition coefficient of dissolved organic materials in carbon reservoirs. It was ascertained that the currently developed CTA model is applicable for the short-term estimation of carbon transfer and accumulation in wetland ecosystems.

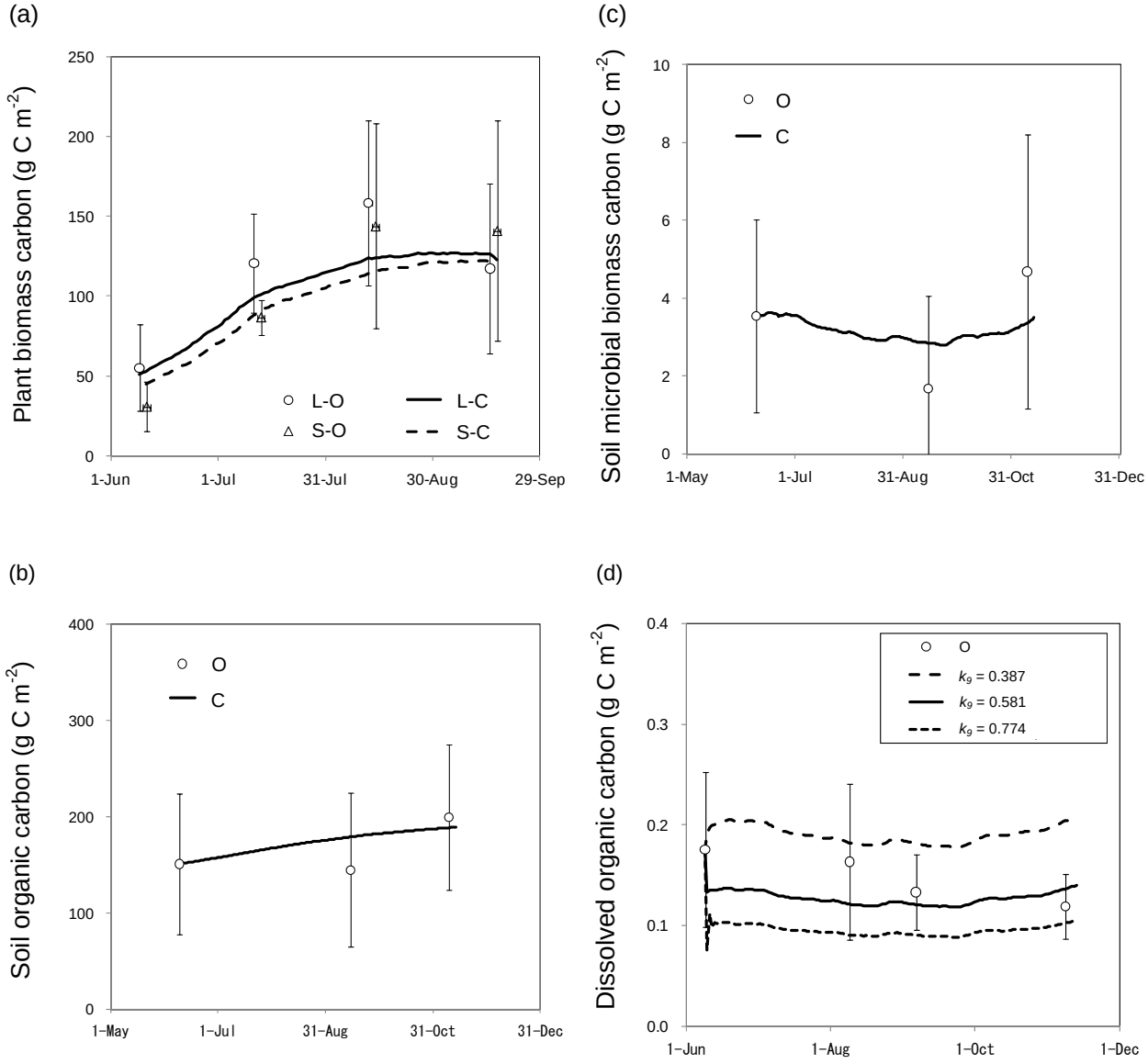

Fig. 1 Comparison between model estimates and observation in the real field for four carbon reservoirs. (a) Plant biomass carbon. L and S indicate leaf and stem biomass carbon, respectively. O and C represent observed and calculated values, respectively. (b) Soil organic carbon. (c) Soil microbial biomass carbon. (d) Dissolved organic carbon. k_9 means a decomposition coefficient of dissolved organic materials in carbon reservoirs.