Simulation of the forest dynamics and material cycle after typhoon disturbance using the Spatially Explicit Individual-Based Dynamics Global Vegetation Model (SEIB-DGVM)

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Typhoon, one of the major disturbances in temperate coastal areas, drastically affects forest dynamics and material cycling. After the typhoon, large number of gaps was formed, and canopy density was reduced, light transmission was enhanced. The primary productivity, hydrological characteristics, carbon and nutrient cycling, vegetation regeneration, community succession, species composition and structure, ecosystem stability were also severely affected (Sano et al., 2010; Lin et al., 2011; Kauffman et al., 2010). Therefore, the research of forest dynamics and material cycling after disturbance is critically important. Dynamic global vegetation model (DGVM) has been developed to simulate vegetation dynamics, energy and material cycles under the climate change (e.g. LPJ, CLM–DGVM, SEIB–DGVM, etc.). Especially, SEIB–DGVM has a great advantage that can represent the three–dimensional forest structure based explicitly with local competition among individual trees on the virtual forest stand (Sato et al., 2007; Guan et al., 2014). To understand the disturbance effect on the forest ecosystem, here we simulate the vegetation dynamics and carbon cycles by SEIB–DGVM in deciduous mixed forest, formerly Larch plantation until typhoon destruction, in Tomakomai Flux Research site with validation to the field measured data.

The study site was Tomakomai Flux Research Site in the Tomakomai National Forest in southern Hokkaido, Japan (42°44’ 13.1” N, 141°31’ 7.1” E, 125m above sea level). After Typhoon No.5 in 1954, during 1957–1959, the site was planted several tree species: Japanese larch (*Larix Kaempferi Sarg.*), Birch (*Betula ermanii* and *B. platyphylla*), Japanese elm (*Ulmus japonica*), Spruce (*Picea jezoensis*). Dominant understory species were Fern (*Dryopteris crassirhizoma*, *D. austriaca*), Pachysandra terminalis and Hydrangea petiolaris. In 2004, typhoon SONGDA landed Japan, 90% of the trees were blew down at Tomakomai Flux Research Site. (Hirano et al., 2017). Mean annual temperature and mean annual precipitation from 2005 to 2015 at this site were 6.38℃and 1408.18mm respectively. The climatic data are download from the Japan Meteorological Agency. The validation eddy flux and biomass data are taken by previous studies (Sano et al., 2010 etc.).

The SEIB–DGVM simulates the establishment, the competition with others, and the death of individual tree on spatial explicit 30m X30m virtual forest stand. Since this research focuses on simulate forest dynamics after typhoon, we cut off the fire component to exclude the interference of the fire. To get the carbon storages equilibrium, the model was spun–up for 1000 years, repeatedly using 30 years’ climate data from 1901 to 1930 with constant atmospheric CO_2 concentration in 1900. After spin–up, we set four continuous simulation periods: 1901–1959 as historical period with AMeDAS–based climate, 1959–2004 as plantation one with AMeDAS based climate, 2004–2016 as disturbance one with Eddy flux tower–based climate; 2016–2100 as future one with MIROC–AR5 based climate. We will show the preliminary results on simulated time courses in carbon fluxes (GPP, NPP, R_{eco}, NEP), carbon storages, and composition of species diversity especially between woody and grass PFTs . The destruction of canopy trees may reduce the competition for the understory trees and the formation of gaps case new allocation such as light, carbon and soil nutrients to accelerate the entry of invasive species into natural forest. The PFT diversity of ecosystems increased with the recovery of community.

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