Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

AGE04-P27 Room:Convention Hall Time:May 20 17:15-18:30

Predicting Soil CO_2 dynamics in the vadose zone of Andisol in Western suburb of Tokyo

KATO, Chihiro[1*], NISHIMURA Taku[1], IMOTO Hiromi[1], MIYAZAKI Tsuyoshi[1]

[1]University of Tokyo

Soil retains two to three times more carbon (C) than the atmosphere dose[1)]. To simulate the soil CO_2 dynamics, the effects of soil respiration on C storage, which is sensitive to soil temperature and moisture, must be evaluated quantitatively. Model investigations of soil CO_2 dynamics have been conducted mainly for forest soils. Recently, C capture and storage by soil has been recognized as a function of agricultural field, and capacity of C storage in arable land has been discussed. For example, compost application to agricultural field has been attempted to increase C storage in soil. The objective of this study is to predict soil CO_2 dynamics in the arable land using HYDRUS[2)].

For model validation, continuous monitoring has conducted at Institute for Sustainable Agro-ecosystem Services of the University of Tokyo (ISAS) in western suburb of Tokyo. The soil of 0 to 35 cm under the surface was Kuroboku andisol, and below it to 100cm, Tachikawa loam andisol was distributed. A 10 m square bare area was prepared for study site. Soil moisture and temperature at eight depths and soil CO_2 concentration at three depths were measured every 20 minutes from Jul. 2010 to Sept. 2011. CO_2 efflux from the surface was measured with closed chamber method in both summer and winter. Meteorological data was obtained from ISAS and AMeDAS station located in Fuchu city, near the field.

In the simulation, considering the vertical distribution of dry bulk density and soil texture, simulation area was divided in three layers i.e. cultivated, hardpan and Tachikawa loam layer, respectively. Durner-Mualem model[3)] was employed for soil hydraulic function and parameters were determined by inverse analysis with evaporation method[4)]. Volumetric water content at saturation Q_s is an important parameter to predict diffusion of CO_2 through air filled pores in a variably saturated soil. In this study, porosity of the field soil was employed asQs. Chung and Horton[4)] model was used for soil thermal conductivity. Parameters for CO_2 production were referred to Buchner et al.[5)].

Simulation of soil CO_2 dynamics, including CO_2 production and transport, was conducted using HYDRUS-1D from 1st Jan. 2010 to 30th Sept., 2011. In the model, since CO_2 production rate is affected by soil moisture and temperature, HYDRUS first simulates the soil water and heat transport and then production and transport of CO_2 are predicted.

Initial conditions (I.C.s) were determined with preliminary calculation from 1st Jan. to 31st Dec., 2010. Boundary conditions (B.C.s) for water movement were hourly observed rainfall and daily evaporation rate which had been calculated with meteorological sub model of HYDRUS. Separately calculated soil surface temperature using meteorological data and energy balance equations were given for thermal B.C.. Atmospheric CO_2 concentration was applied for B.C. of CO_2. The final results of the preliminary calculation were employed as I.C.s for exact numerical simulation. Then simulated values were compared with monitored data for model validation.

The model could describe well the daily and seasonal variation of soil moisture, temperature and CO_2 concentration. Predicted CO_2 concentration at the hardpan layer was higher than other layers because of the small diffusivity of dense hardpan layer. This phenomenon had been observed in other field where hardpan layer existed[6)]. Predicted cumulative CO_2 flux for a year was also comparable to the value which was estimated with observed data. HYDRUS could simulate the soil CO_2 dynamics in arable land well.

References 1)Sundquist, 1993, Science, 934-941; 2)Simunek et al., 2008, Vadose Zone J. 7:587-600 3)Durner, 1994, Water Resour. Res, 30:211-223 4)Chung & Horton, 1987, Water Resour. Res. 23:2175-2186 5) Buchner et al., 2008, J. of Hydrol., 361, 131-14 6)Fujikawa et al., 2000, Trans. JSIDRE, 225, 111-118

Keywords: Soil CO_2 dynamics, Field monitoring, Numerical simulation