Data-Driven Estimation of Soil Respiration in Japan

*Hina Yamanuki[1], Kazuhito Ichii[1,2], Naishen Liang[2], Munemasa Teramoto[2], Jiye Zeng[2], Kentaro Takagi[3], Takashi Hirano[3], Sachinobu Ishida[4], Masaaki Naramoto[5], Toshiaki Kondo[6], kaneyuki Nakane[7], Masahiro Takagi[8]

1. Center for Environmental Remote Sensing, Chiba University, Chiba, Japan, 2. National Institute for Environmental Studies, Tsukuba, Japan, 3. Hokkaido University, 4. Hirosaki University, 5. Shizuoka University, 6. Japan International Research Center for Agricultural Sciences, 7. Hiroshima University, 8. University of Miyazaki

Terrestrial biosphere plays an important role on determining atmospheric CO2 concentration and climate changes. Yet, spatial and temporal patterns of atmosphere-land CO2 exchanges were not sufficiently clarified. Among various processes of terrestrial carbon fluxes (e.g. photosynthesis and respiration), fluxes relating to soil is one of the least understandable ones. Soil Respiration (SR), the sum of root respiration and heterotrophic respiration, is one of the most essential components of soil carbon cycles. So far, various efforts were conducted to understand SRs. Many observation stations directly measure SR using chambers. Using these observation data and literature survey, several studies estimated spatial and temporal patterns of SR at global scales based on simple semi-empirical equations. However, the database (Soil Respiration Database; SRDB) used in these global scale studies contains inconsistently observed datasets. These inconsistency will produce additional uncertainties in estimated fluxes.
The largest SR observation network across Asia developed and maintained by NIES, Japan can be a good candidate to estimate spatial and temporal variations in SR across Asia. These observations are conducted with consistent observation protocol and quality controls. Therefore, we attempted to estimate SR in Japan with observation data which are in one of the largest data set unified their methods, and remote sensing data by using machine learning. We used eight sites data across Japan and conducted empirical (data-driven) upscaling using random forest regression and MODIS sensor data.
We confirmed that our approach reasonably estimates spatial and temporal variasions in SR across Japan. We tested two experiments at site-level using (1) remote sensing based input data only and (2) remote sensing based input data and site measurements (soil temperature and air temperature). Site-level experiments shows good performance of the model (e.g. R= 0.73 –remote sensing only and R=0.79 remote sensing + site observation) even if input data are remote sensing based only. Spatial and temporal estimation also shows reasonable seasonal variation in SR.

Keywords: Soil Respiration, Carbon Cycle, Observation Network, Machine Learning, Remote Sensing

©2020. Japan Geoscience Union. All Right Reserved.