On Estimating the CO2 Fluxes for Whole Agricultural and Forest Area in South Korea using Flux Measurement-based Data-driven Technology

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Problem statement

- To reliably estimate the CO2 fluxes for whole agricultural and forest area in South Korea using the flux data from the observation networks and data-driven approach.

Objective

- To reliably estimate the CO2 fluxes for whole agricultural and forest area in South Korea using the flux data from the observation networks and data-driven approach (i.e., the flux data from the observation networks and data-driven approach).

Experimental design

- Target variables: (Daily) ET (mm), GPP (g C m⁻² s⁻¹), RE (g C m⁻² s⁻¹), NEE (g C m⁻² s⁻¹)
- Input data: satellite data (or modeling) are widely used.

Results (case study 1) – Site level estimation in HFK (Temporal extrapolation)

- In Koflux, the Haenam Farmland (HFK) has the site record (from July 2002 to present) of carbon/water/energy flux measurement using eddy covariance technique in agricultural lands including rice paddy, beans and sesame fields.
- The long-term database at the HFK is vital to better understand how the farmlands have adapted and been managed particularly in 2007 and 2014, which hinder the researchers from analyzing the decade-longtime series data.

Fig. 1. KoFlux Network.

- KoFlux is a regional Korean network of long-term micrometeorological flux measurement sites, launched in 2002, to measure the CO2/H2O fluxes of Korean agricultural lands and forests.
- The eddy covariance method that directly observes the net exchange of mass and energy between the surface and the atmosphere is alternative.
- However, the eddy covariance-based monitoring systems are expensive to establish and maintain, so the number of observation systems have to be limited. Therefore, the methods of upscaling via linkage between observation data and satellite data (or modeling) are widely used.
- We intend to estimated the carbon uptake of the whole agricultural and forest area in South Korea using the flux data from the observation network and data-driven approach.

Fig. 2. Time series of daily integrated NEE and ET for the HKF site.

- The general gap-filling method is impractical to apply for such long gaps. Recently, data-driven approach (i.e., interpolating/extrapolating EC measurements via available networks temporarily/ spatially using machine learning technique) is used to estimate terrestrial CO2/H2O fluxes. Such an approach can be applied to our case after appropriate modifications.
- In this study, we evaluate an applicability of data-driven approach to the filling of long gaps in flux data (i.e., gross primary production, GPP, ecosystem respiration, (NEE), and evapotranspiration (ET)).

Fig. 3. Statistical parameters for error assessment of the experiments 1-1 and 1-2. MBE and RMSE indicate mean bias error and root mean squared error, respectively. Slope and r are from linear regression analysis.

Fig. 4. Statistical parameters for error assessment of the experiments 2-1, 2-2, 2-3, and 2-4.

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