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Assimilating Earth observation data across the UK for estimating greenhouse gas budgets

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Successful monitoring of biogenic greenhouse gas emissions at regional scale requires a research framework that brings together knowledge about the spatiotemporal variability of gas fluxes under current and anticipated environmental and anthropogenic conditions. In this framework, knowledge about emissions derived from finer spatiotemporal scales is aggregated to calibrate and validate models operating at coarser scales, while top-down estimates of surface biophysical conditions are used to constrain models operating at finer scales.
A key challenge in forming this framework is finding a solid basis to link process-based knowledge of individual research sites with Earth Observation (EO) data covering the landscape at approximately a 500m to 1km resolution. Approaches to provide for this link have often considered data from individual satellites or overflights, posing important limitations on the number of observations available through space and time, especially for regions frequently covered in clouds.
A novel approach considers a data assimilation scheme through which a vast set of data from a constellation of satellites can be used to inform upon the biophysical state of the land surface. The simultaneous use of these data in a data assimilation scheme requires normalization with respect to the various instrument specifications, including bandpass and sun-sensor-target geometry at times of overpass.
In this study we demonstrate a linear mapping of spectral reflectances across an array of satellites, including the Moderate Resolution Imaging Spectroradiometer (MODIS), the Medium Resolution Imaging Spectroradiometer (MERIS), Sentinel 2 (S2), and Vegetation (VGT). The implications of this linear mapping scheme on data availability for the estimation of biophysical characteristics and associated uncertainties are discussed.