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Blending Earth Observation with models: data assimilation and crops

Earth Observation promises large-scale agricultural monitoring, offering insights into crop development over the growing season. A key challenge is interpreting indirect Earth Observation (EO) measurements such as reflectance, radiance, brightness temperature, and backscatter in terms of biophysical variables relevant to crop monitoring, including leaf area index, leaf pigments, and soil moisture. "Estimating these variables and their uncertainties is insufficient because they are interdependent through physiological processes such as photosynthesis and partitioning, where biophysical variables serve only as diagnostics.

Crop growth models (CGMs), on the other hand encompass a description of these processes, parameterized for different crops, and are generally driven by meteorological, soil and management forcings. CGMs necessarily have many parameters, and while they are able to capture general trends in development, they are often unable to be accurate at the field or sub-field scale due to unmodelled local variation. Acknowledging this suggests that CGM predictions will have large uncertainties associated with them.

An optimal approach should integrate diagnostic variables with CGM predictions of vegetation dynamics to produce site-relevant analyses that also capture physiological process evolution. Robust techniques that blend uncertain observations with uncertain models to produce a combined uncertainty-weighted estimate are generally called data assimilations.

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