**Motivation**

The terrestrial biosphere is the most uncertain and variable component of the global carbon cycle [1]. Part of reducing that uncertainty comes with better modeling the cropland share of the terrestrial carbon cycle.

**Model-data integration method**

We use the WOFOST crop growth model [2] to represent the water-limited crop growth (our model first guess) of various crop species over Europe. We then integrate European grain yield observations to scale crop growth down to observed levels.

![Graph showing tested values of scaling factors and their impact on grain yield along the growing season.](image1)

**Optimization outcome:**

We compute one optimum scaling factor per region, year and crop species. We then obtain optimized crop fluxes at 25x25 km resolution.

![Graph showing optimum scaling factors and their impact on J-J-A monthly mean GPP.](image2)

**Cropland carbon balance:**

We add an exponential function of temperature for soil respiration [3] to the WOFOST fluxes: \[ \text{NEE} = \text{GPP} + R_{\text{crop}} + R_{\text{soil}} \] (eq. 1)

**Validation at various sites**

Fig. 3: One year of modeled and observed daily GPP and TER (gC m\(^{-2}\) d\(^{-1}\)) at five FluxNet sites located in three major European climate zones: Mediterranean (Italy), Temperate (Belgium, France, Germany), and Cold (Finland).

The optimized WOFOST model is able to represent the cropland-specific timing (short growing season of 2-3 months) and magnitude (10-30 gC m\(^{-2}\) d\(^{-1}\)) of the daily CO\(_2\) exchange above croplands.

It is moreover able to simulate cropland fluxes within three of the most important climate zones of Europe.

![Graph showing one year of modeled and observed daily GPP and TER.](image3)

**Validation of multi-annual CO\(_2\) exchange**

Fig. 4: 10 years of observed and simulated GPP, TER, NEE fluxes at the Belgian FluxNet site Lonzee.

The optimized WOFOST model is able to represent the inter-annual variability of NEE.

![Graph showing 10 years of observed and simulated GPP, TER, NEE.](image4)

**Take-home message**

To our knowledge, this is the first study attempting to use grain yield as an additional stream of data to constrain cropland NEE. The optimized WOFOST model performs great against FluxNet observations of GPP, TER and NEE.

**Current and future steps**

Currently:

- drought case study

Mid- to long-term:

- feed cropland NEE to a forward or inverse atmospheric model (e.g. WRF or CarbonTracker Europe), see the improvement on the CO\(_2\) mole fractions or posterior CO\(_2\) fluxes
- addition of a harvest module and lateral transport of carbon scheme for a full carbon balance [4]
- carbon fluxes made available through the ICOS carbon portal

![Map showing monthly mean NEE of cultivated grain maize.](image5)

**References**