

# SIMULATING N<sub>2</sub>O EMISSIONS USING THE STICS SOIL-CROP MODEL IN LOW-INPUT CROPPING SYSTEMS IN SW FRANCE

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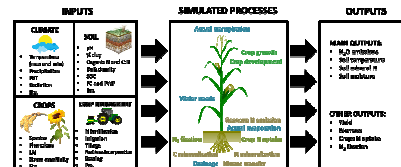
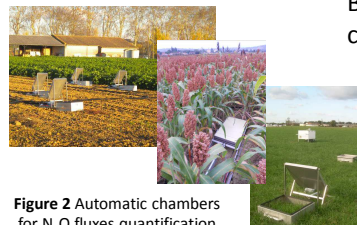
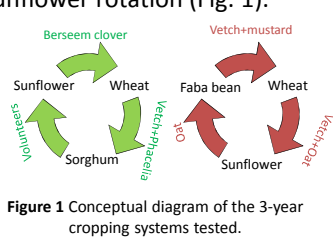
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## Introduction

- Soil N<sub>2</sub>O emissions account for ca. 40% of total agricultural greenhouse gas emissions in EU (Eur. Environ Agency, 2015).
  - Need to quantify N<sub>2</sub>O emissions and identify mitigation options, in particular in low input systems where N fertilizer is reduced.
  - Process based models are able to integrate a range of pedoclimatic conditions and agricultural management practices.
- Objective: test the ability of the soil-crop model STICS to simulate the emissions of N<sub>2</sub>O in low-input cropping systems**

## Materials and Methods

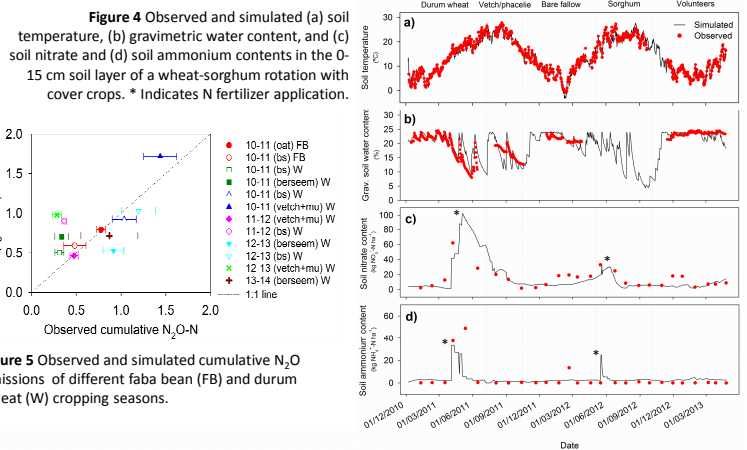
- MicMac cropping systems experiment (2010-): Auzeville, SW France (43.5 °N, 1.5 °W). Annual rainfall: 685 mm; Temperature: 13.7°C; PET: 905 mm.
- Cropping systems: 3-yr innovative prototypes (with or without cover crops) as an alternative to the traditional durum wheat-sunflower rotation (Fig. 1).
- N<sub>2</sub>O fluxes determined 4 times per day using automatic chambers (0.7 x 0.4 m) (Fig. 2) (Peyrard et al., 2016).
- Different N<sub>2</sub>O-driving variables measured: soil temperature, mineral N, water content and bulk density.
- Simulation of N<sub>2</sub>O using STICS model (Brisson et al., 1998; Bessou et al., 2010) (Fig. 3). Plant and soil parameters calibrated and evaluated on the site (Plaza-Bonilla et al., 2015).



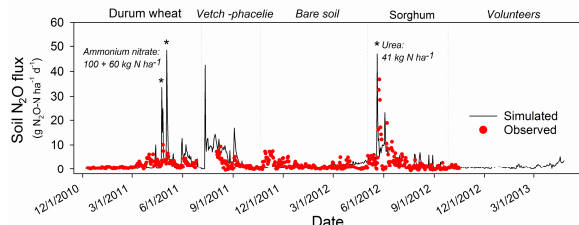
**Figure 3** STICS model functioning: inputs required, some simulated processes and outputs used.

## Results

- Our preliminary results show a fairly good capacity of the STICS model to simulate soil N<sub>2</sub>O emissions, in different cash crop and cover crop periods of such complex rotations in low-input cropping systems, including grain legumes and cover crops.
- STICS simulated reasonably well different N<sub>2</sub>O driving factors, such as soil temperature, and water, nitrate and ammonium contents in the 0-15 cm soil layer (Fig. 4).
- Simulated cumulative N<sub>2</sub>O emissions during different faba bean and durum wheat cropping seasons (2010-2011, 2011-2012, 2012-2013 and 2013-2014) showed similar ranges of magnitude (i.e. between 0.45 and 1.7 kg N<sub>2</sub>O-N ha<sup>-1</sup>) than observed ones (Fig. 5).
- STICS seemed able to capture the main trends of N<sub>2</sub>O emissions, with greater values at higher levels of soil nitrate during the growing season of crops and cover crop incorporation in the soil. However, the model predicted some peaks of N<sub>2</sub>O after N fertilizer application that were not observed in the field (Fig. 6) indicating that we still need to better understand the impact of driving variables on N<sub>2</sub>O emissions.



**Figure 5** Observed and simulated cumulative N<sub>2</sub>O emissions of different faba bean (FB) and durum wheat (W) cropping seasons.



**Figure 6** Observed and simulated N<sub>2</sub>O emissions dynamics of a durum wheat-sorghum rotation with vetch-phacelia as cover crop. \*Indicate nitrogen fertilizer applications

## Conclusions

Our preliminary results show the potential of the STICS soil-crop model to simulate the range of values of N<sub>2</sub>O emissions of such complex crop rotations with cover crops without great time investments in calibration.

Some improvement is still needed to better mimic the dynamics of emissions and obtain more precise estimations of the impact of agricultural management practices and cropping systems on N<sub>2</sub>O emissions.

### References

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