TADA, a mechanistic model for carbon, nitrogen and water cycles in cropland and grassland ecosystems

Delhez Laura[(1)]*, Dumont Clément[(1)], Vandewattyne Félix[(1)], Longdoz Bernard[(1)]

[(1)] University of Liege, Gembloux Agro-Bio Tech,
TERRA – Teaching and Research Centre
* Contact: delhez-l@hotmail.com

OBJECTIVES

The aim of this work was the development of a modeling tool adapted to croplands and grasslands in order to improve our understanding of the temporal variability of GHGs exchanges over the ICOS sites. For this purpose, three master theses have focused on the simulation of the carbon, nitrogen and water cycles of grassland and cropland ecosystems.

STUDY SITES

The Lonzée Terrestrial Observatory (LTO) is an intensively managed crop with a 4-year rotation cycle (sugar beet, winter wheat, seed potato, winter wheat). The Dorinne Terrestrial Observatory (DTO) is a permanent grassland grazed by Belgian Blue cattle.

MODEL DESCRIPTION

Based on the forest model ASPECTS[1], the developed model, named TADA (*Terrestrial Agroecosystems Dynamics Analysis*), simulates the carbon, nitrogen and water cycles for grassland and cropland ecosystems. This unidimensional model assesses the temporal evolution of the reservoirs content which are represented by the solid line boxes in the following figure.

MODEL DIAGRAM

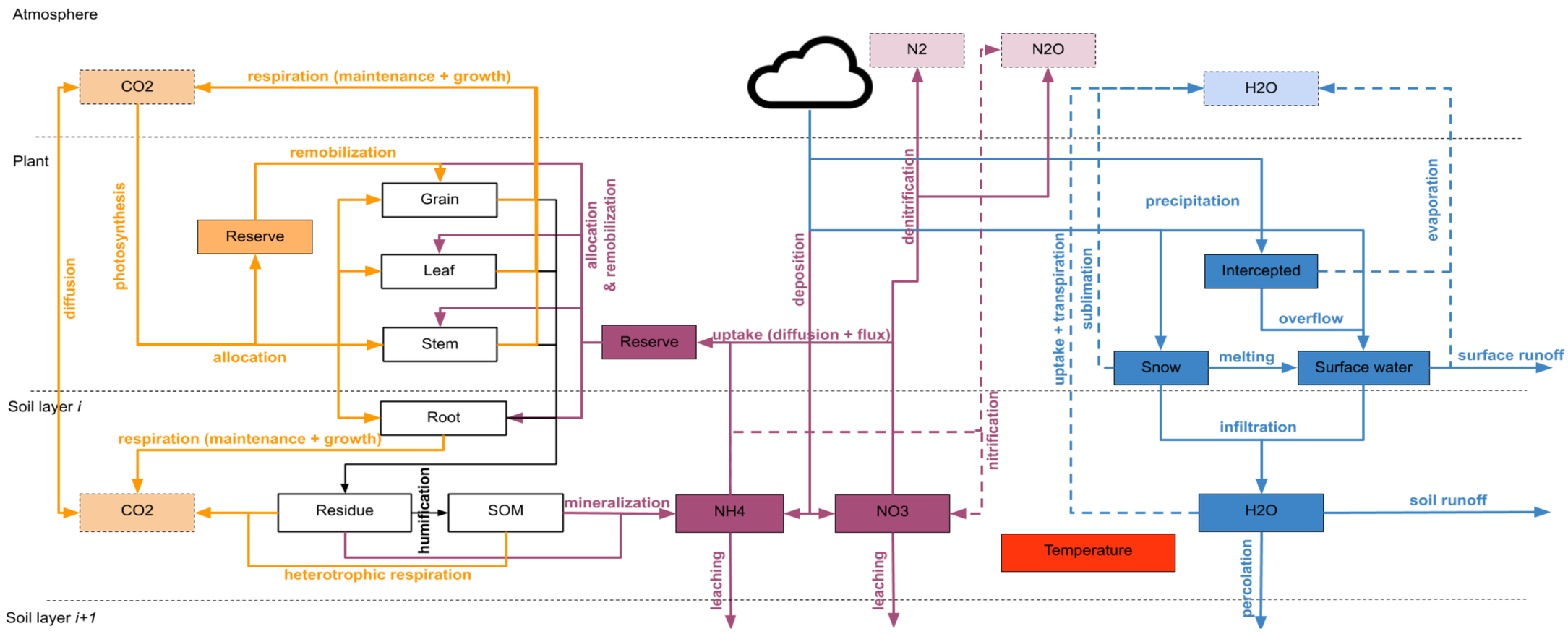

Figure 1: Diagram of the reservoirs simulated by the TADA model

Orange stands for carbon, purple for nitrogen, blue for water and black stands for both carbon and nitrogen. Note that the impact of management and grazing is not represented but can intervene in different parts of this diagram. For instance, the addition of fertilisers can be represented as an input flux in the NH_4 and NO_3 reservoirs.

DIFFUSE RADIATION

Improvement of the radiative routine already present in ASPECTS

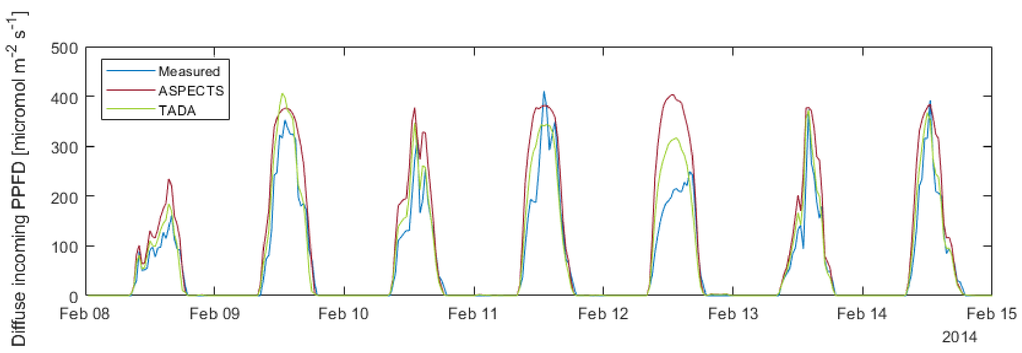

Figure 2: Modelled and measured diffuse PPFD (LTO)

The radiative routine estimates the diffuse and direct components of the solar global radiation and converts them into PPFD.
In the TADA model, the clearness index is taken into account for the diffuse/direct partitioning. This provides a better representation of the diffuse PPFD. However, the TADA model shows some deficiencies during days whose conditions are similar to clear sky conditions, as on Feb 12.

GROSS PRIMARY PRODUCTIVITY

Comparison between the modelled GPP and the estimated GPP on the ICOS site

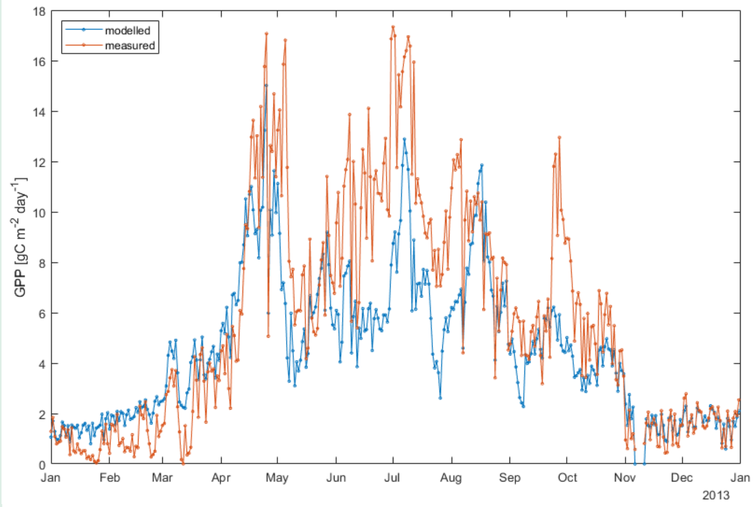

Figure 3: Evolution of daily GPP (DTO)

- Accurate seasonal variability
- Underestimation around June
- Missed peak in late September (supposedly related to scattered livestock dropping which is still not modelled by TADA)

This graph was also drawn for the cropland ecosystem (LTO) but showed poor results due to an incorrect calibration.

CONCLUSION AND PERSPECTIVES

The TADA model provides coherent results but several processes still need to be improved. This modelling project, initiated by three master theses, is still ongoing with a PhD thesis dedicated to the further development of this model, notably in taking better account of droughts and in improving the processes of carbon and nitrogen mineralisation, nitrification and denitrification.

[1] Rasse et al. (2001), 'Modelling short-term CO fluxes and long-term tree growth in temperate forests with ASPECTS', *Ecological modelling*, **141**, 35-52