EURECA

Emissions de composés azotés
par les c**U**ltures à l'échelle régionale:
REtroaction sur le fonctionnement
des couverts via l'impact sur la
Chimie **A**tmosphérique sous différents
scénarios d'occupation des terres

LabEx BASC
Biodiversité, Agroécosystèmes, Société, Climat

INRA SCIENCE & IMPACT

AgroParisTech

ECOSYS - SADAPT

LSCE
LABORATOIRE DES SCIENCES DU CLIMAT & DE L'ENVIRONNEMENT

Projet soumis au Labex BASC, par des chercheurs du LSCE, d'ECOSYS et de SADAPT

Context

Key environmental changes include an increasing load of chemical pollutants (e.g. ozone, nitrogen compounds and aerosols), the on-going increase in atmospheric CO2 concentration and the predicted increase in severity and frequency of heatwave and drought events. Those major shifts in the environmental conditions could strongly put at risk the ecosystem functioning and the agro-ecosystem productivity.

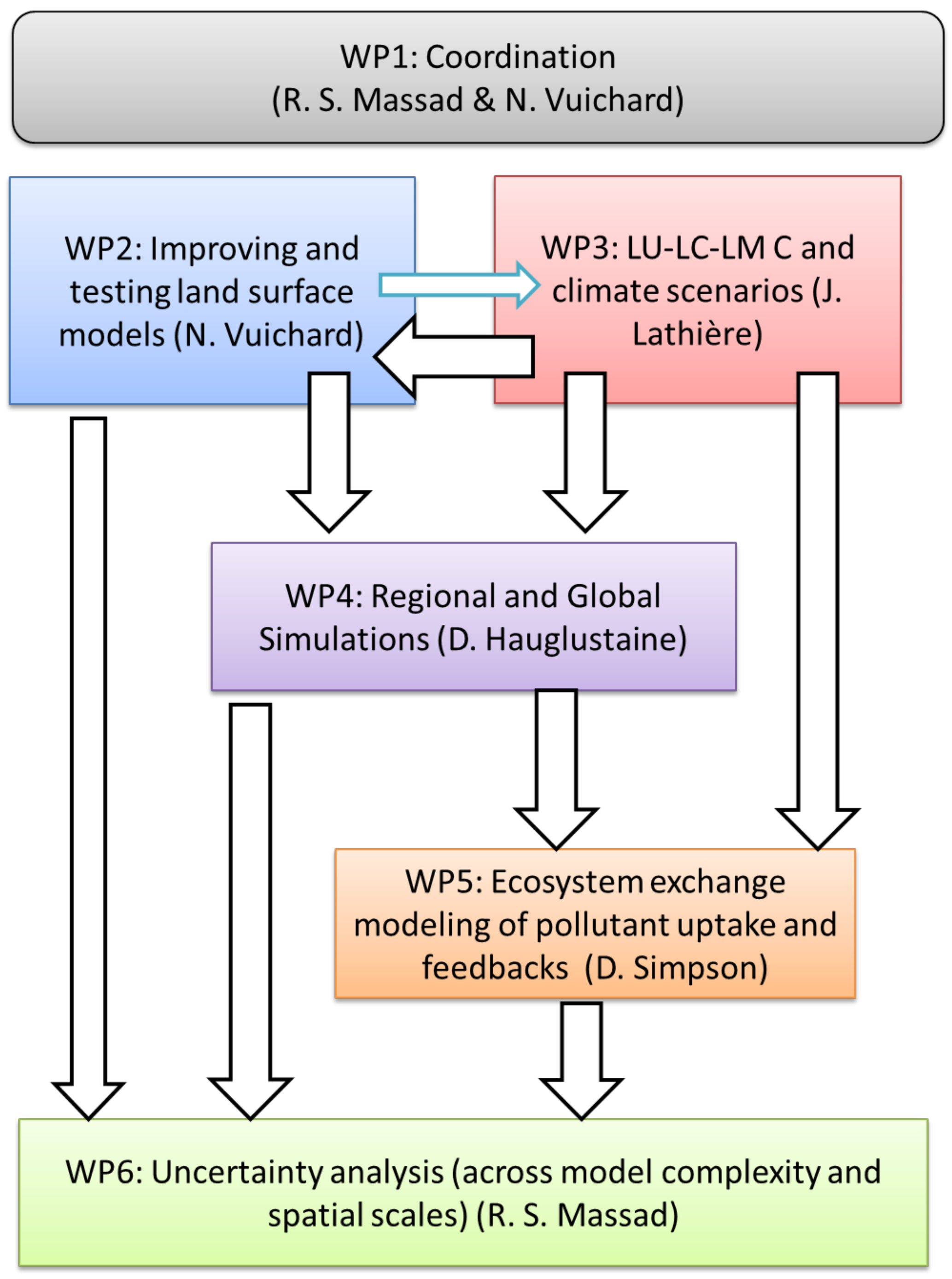
Despite its importance regarding to air quality and climate, the representation of emissions of reactive nitrogen from agricultural processes has been treated in a rudimentary manner in Earth System Models. A correction of these deficiencies is important to model the impact of a changing nitrogen cycle on atmospheric carbon, on atmospheric aerosol formation and for an accurate assessment of future air quality. To our knowledge, there are no modelling tools today able to account for the whole chain of effects and feedbacks, going from soil and vegetation emissions, to atmospheric concentration changes and chemistry, and back to effects on vegetation at the regional to global scale.

Objectives

The main objective of the proposed project is to demonstrate the capability to link and model the interactions and feedbacks between dynamic ecosystem models, atmospheric transport and chemistry models and a multi-layer 1 D canopy chemistry exchange model. We will develop a modelling framework that may be relevant for regional to global applications.

In this project, we will quantify the impact of changes in land cover and agricultural practices on (1) nitrogen compounds emissions, (2) the subsequent formation of secondary pollutants in the atmosphere (ozone and aerosols), and (3) their impact on ecosystems functioning and crop yields and how this feedbacks into nitrogen compounds emissions and air pollution. The system is in fact dynamic, where ecosystem functioning is impacted by atmospheric chemistry, which will in turn impact crop yield and hence agricultural practices. Describing and analysing those interactions and feedbacks at different spatial scales and developing modelling approaches capable of tackling such a dynamic system is key for predicting future global changes.

Work Program



WP2

In this work-package we propose to focus on four main types of gaseous compounds: NH3, NOx, O3 and VOCs and to develop a mechanistic approach to model the exchange of those reactive species from different ecosystem types under various climatic conditions. This work-package will be subdivided in two tasks (i) Modelling reactive N compounds emissions from the agricultural sector by means of process-based models; and (ii) impact of chemical pollutants on vegetation functioning.

WP3

A full set of scenarios to be used by the different models will be prepared regarding land-cover, land-use, and climate conditions. A starting point will be to consider the scenarios developed especially for the IPCC Reports, widely used in the environment modeling community. Moreover, specific scenarios for land-cover and land-use change will be built in order to carry out sensitivity studies. One particular scenario for instance could focus on the limitation of fertilizer use.

WP4

In order to bridge the gap between the needs of scientifically complex canopy models and large-scale 3-D CTMs, a new 1-D surface exchange model, called ESX, was developed (Simpson & Tuovinen, 2014, 2016). The ESX model will be used to downscale the results of the EMEP model across a large number of sites across Europe. We will estimate the fluxes of ozone and N-compounds, and estimate the importance of bi-directional processes and in-canopy chemistry on stomatal-update and deposition.

WP5

The global LMDz-INCA model will be used under the scenarios defined in WP3 in order to investigate the impact of agricultural emissions on atmospheric composition and climate accounting for the long-range transport of pollutants. Furthermore, the impact of these changes in ozone surface concentration and nitrogen deposition fields will be used in ORCHIDEE in order to investigate the impact of pollutants on terrestrial ecosystems and on calculated emissions.

WP6

The aim of this work package is to bring together and synthesize results of previous work packages for comparing different model approaches for surface modelling (ORCHIDEE-CN, CERES-EGC, Surfatm, ESX) to observations as well as chemistry and transport modelling (EMEP, LMDz-INCA) at different spatial scales and to analyse the impacts and feedbacks on ecosystem functioning resulting from the downscaling simulations described in WP5.

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