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NO EMISSIONS FROM SOILS IN TROPICAL CONDITIONS

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Nitric oxide (NO) emissions from soils represent an important part of total NO emissions (around 40%, an amount comparable to fossil fuel combustions, [5]).

NO emissions from soils have been shown to be influenced by soil water content and soil temperature. Indeed, most studies of NO emissions use parameterizations elaborated with these two variables, associated with the rate of fertilization [1] or nitrogen content [2], [3]. Other factors have been identified as major controllers in field measurements worldwide (pH, soil texture, associated vegetation), but are not yet considered together into emission models because of their highly non linear relations, as well as their high variability in time and space. This study presents a new method of parameterization linking NO emissions and their influential parameters (classical variables + new parameters detailed below) in a non linear way using a neural network technique. The neural network calculation is optimized through a learning process carried out on specific and appropriate databases. In order to be representative of different situations, the neural network needs to be developed upon data issued from diverse types of climates, soils and ecosystems. We first present the network principle, then the tropical and temperate databases (locations, contents, specificities). Afterwards, we present the results obtained by the network in two different cases: 2 equations are found, the first one concerning only the tropical (Hombori, Mali) data base, the second concerning all data bases (tropical + temperate).In the first equation, NO flux is described using 5 variables, namely soil surface temperature, surface WFPS, soil temperature at depth 20-30 cm, air moisture and wind speed, and in the second equation, NO flux is described using soil surface temperature, surface WFPS, soil temperature at depth 20-30 cm, air temperature, fertilization rate, sand percentage in the soil, pH, and wind speed.

The resulting equations are then introduced in the SVAT (Surface Vegetation Atmosphere Transfer) model, ISBA-Ags [4]. Modeled results are compared with experimental measurements collected in Hombori (Mali) during the AMMA campaign (see Figure 1) in the two cases (tropical only and tropical + temperate data bases). Estimated fluxes agree quite well with experimental fluxes, showing the capability of the SVAT to reproduce a slight increase in NO emission after the rain (moisture stimulation) in the two cases.

Network results are compared to 2 different parameterizations, given by Williams (1992), and Yienger & Levy (1995) (resp. W92 and YL95). We conclude that W92 is not adapted for tropical soil temperature because of an overestimation of fluxes due to the fact that this parameterization is only based on exponential temperature variation, and forgets rain effect.
YL95 does not take into account temperature effect in tropical conditions for dry soils, and does not reproduce any variations except moisture stimulation after rainfall events. The network equation presents the advantage of including temperature and moisture effect, plus other soil parameters.

Our results show that new parameterizations can be found for the NO emission from soils, taking into account a large set of parameters implied in the N cycle in soils. ISBA-Ags remains a generalist interface between soil and atmosphere, allowing an easy coupling with chemistry transport models. This will be the further step of our work, in order to quantify the impact of NO emissions on atmospheric chemistry

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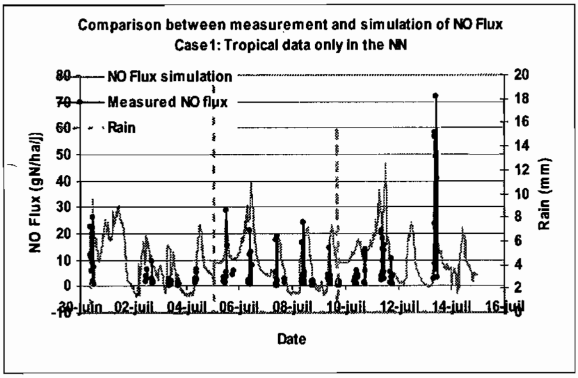

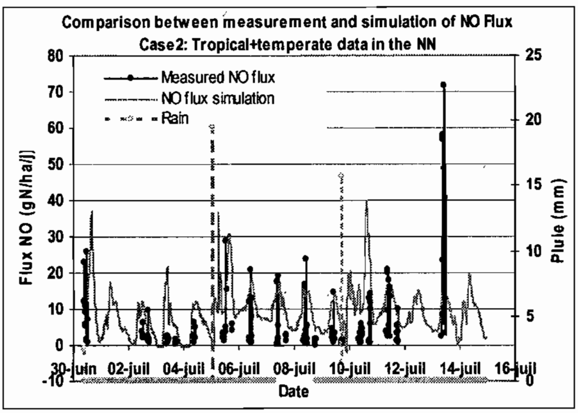

Figure 1 : Two different equations, resulting from the NN are introduced in ISBA-Ags (grey line), and compared with measurements in Hombori, Mali (black line). Grey dashed line corresponds to rain events. First case takes into account tropical data only, second case uses mixed data bases from tropical and temperate regions, and gives a universal character to the equation, that could be used in other types of soils and climates.

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Convective wind system with aerosols, named “haboob”, Hombori in Mali, West Africa.