Validation of DNDC model for C fluxes and trace gas emissions under grassland ecosystems in the Central Great Plains

Miguel Arango[1], Charles Rice[1], Jean Steiner[2], Ali Saleh[3]

[1] Department of Agronomy Kansas State University, [2]USDA-ARS Grazinglands Research Laboratory, El Reno, OK, [3]Texas Institute for Applied Environmental Research, Stephenville, TX

Introduction

A number of process-based models have been used to estimate terrestrial C flux and storage and greenhouse gas emissions. Among those models the Denitrification Decomposition model has shown success simulating C fluxes and greenhouse (GHG) emissions from cropping as well as grazing systems. The Central Great Plains region provides a source of C fluxes as well as trace gas emissions which have to be estimated in order to propose appropriate strategies to mitigate GHG emissions. The objective was to evaluate the potentiality of DNDC to simulate net ecosystem exchange (NEE), ecosystem respiration (RE), gross primary production (GPP), and soil greenhouse gases (N_2O , CH_4 and CO_2 fluxes).

Methodology

Locations and Climate:
El Reno, OK (ARS-ER): Fine, mixed, thermic Udertic Paleustalf. Precipitation: 860mm
Konza Prairie LTER (Kansas State University): Udic Argiustoll, Florence series. Precipitation: 811mm

Soil Properties (SSURGO Database)

	pH	SOC kg/kg	Clay fraction	BD g/cm3	Field cap (wfps)
ARS-ER	6.5	0.0116	0.205	1.33	0.62
Konza	6.5	0.0174	0.277	1.22	0.6

Data inventory

	ARS-ER	Konza Prairie LTER
GPP, NEE, RE	2005-2006 (Ameriflux)	2007-2012 (Ameriflux)
Biomass	2005-2006 (Fischer et al., 2012)	1984-2012 Konza Prairie LTER Data
N_2O,CH_4,CO_2	Field campaign 2014 (Burned Native pasture –Native H/L)	Field campaign 2014 (Cattle grazing- burned-C1A/C3A)
Precipitation, Max and min temperature, and radiation	OK Mesonet	Konza Prairie weather station (AWE012), KS Mesonet

Data analysis

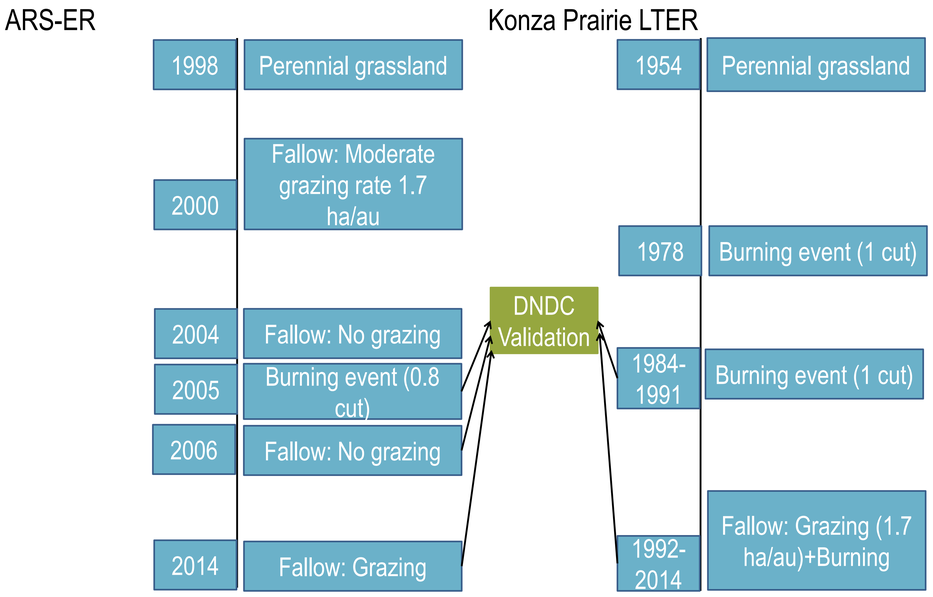
NEE, RE : Eddy covariance systems (Fischer et al., 2012)
GPP: Re-NEE

Biomass: ARS-ER Monthly plant material collection (Fischer et al., 2012)
KZ : End-of-season clips on core watershed 001D (Konza Prairie LTER Data PAB011)

N_2O,CH_4 and CO_2: Static chamber methodology. Weekly sample collection.
Flux estimated Hutchinson-Mosier and Linear equations (Pedersen et al., 2010) using 4 sampling points (R library HMR). Significant fluxes are reported ($p<0.05$).
Mean daily fluxes were estimated using a lineal mixed model with repeated measures approach in Proc Mixed (SAS 9.3)

Model Simulations and evaluation

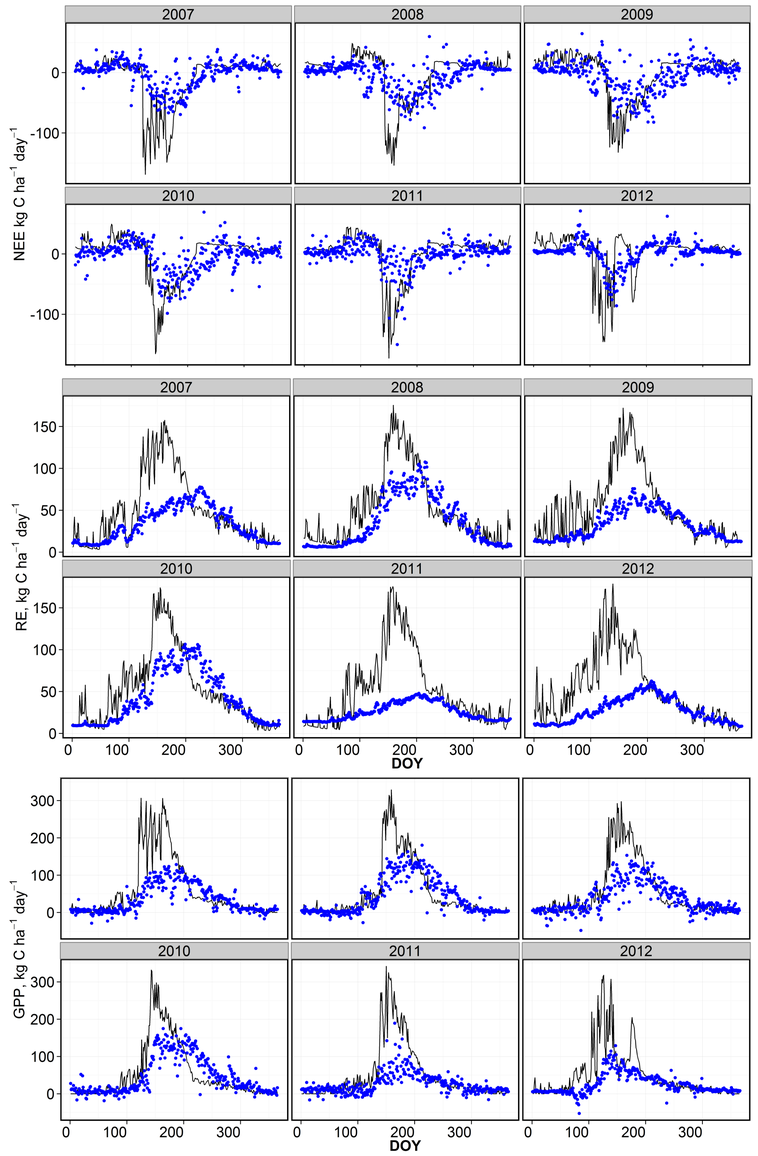
Model: DNDC version 9.5 (Li et al., 1992)



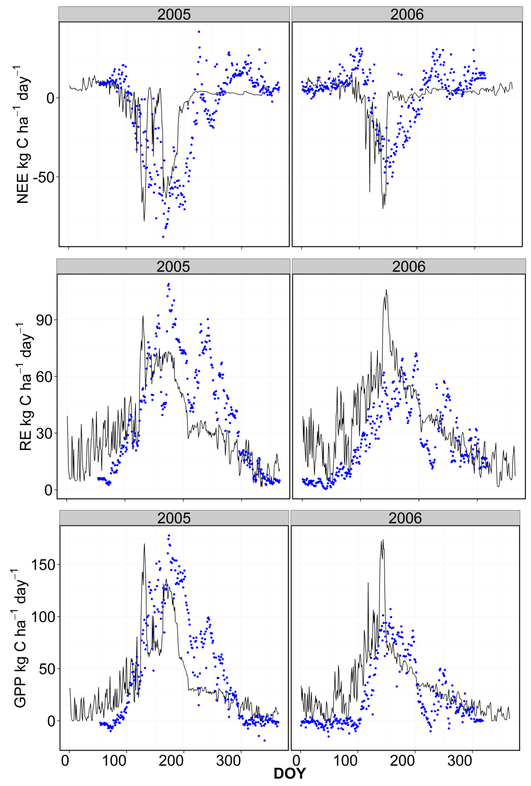
Model evaluation:
ME=Nash-Sutcliffe model efficiency coefficient. RMSE=Root mean square error.
R^2=Coefficient of determination

Results

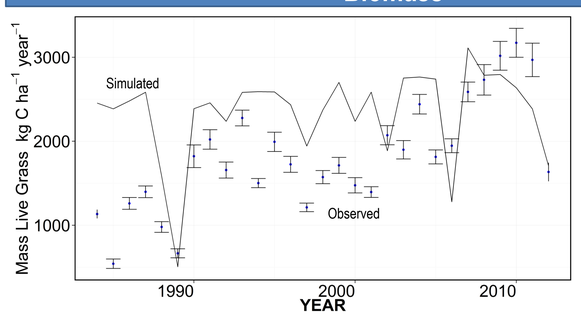
C fluxes - Konza Prairie LTER



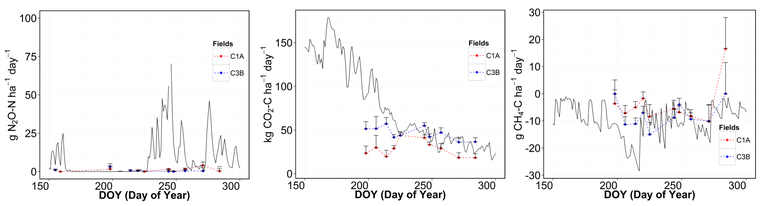
C fluxes- ARS-ER



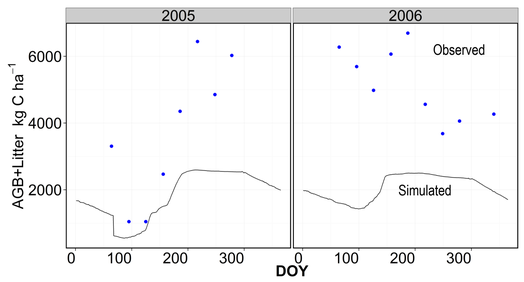
Biomass



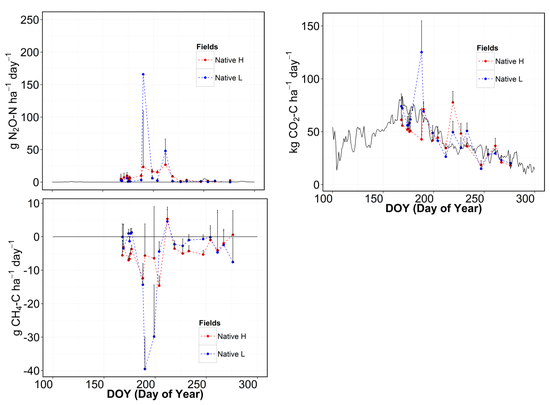
GHG emissions-2014



Biomass



GHG emissions-2014



Summary

•Even though DNDC was not successful simulating C and N fluxes from the Konza site (ME<0), the model was able to capture fluctuation in the end-of-season plant biomass due to changes in climate. DNDC simulated CH_4 uptake but still the model efficiency was not optimum (ME<0).

•DNDC successfully simulated C fluxes (ME>0) at ARS-ER site. As pointed out in other studies DNDC tends to perform better under higher emission locations such as ARS-ER site. Plant biomass (monthly measurements) as well as N_2O and CH_4 emissions were not captured appropriately by DNDC.

•Previous results suggest that the model requires calibration before validating C and N fluxes. DNDC has been used to simulate C and N fluxes mostly from cropping systems.

• Additional work is required to implement burning as well as better animal deposition events in grazing system.

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