# Prise en compte du cycle de l'azote dans le modèle ORCHIDEE

impact sur la productivité primaire brute

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#### Human-induced changes on C & N cycles



# **ORCHIDEE-CN** version

- Inclusion of the features from OCN (Zaehle & Friend, 2010)
  - N cycle
  - C/N interactions
  - Allocation scheme with short- / long-term reserve pool
- Into the trunk version of ORCHIDEE (Peylin et al., in prep.)
  - New hydrological scheme : 11-layeer, 2m depth, accounts for deep drainage
  - New snow model and soil freezing process
  - New background albedo based on MODIS data
  - New parameterization of the roughness length



## C & N land interactions



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# Photosynthesis scheme

- Based on Farquahr model
- Vc<sub>max</sub> : photosynthetic capacity (µmol CO<sub>2</sub> m<sup>-2</sup> s<sup>-1</sup>)

$$Vc_{max} = NUE \times N_L$$

with *NUE* the Nitrogen Use Efficiency (PFT-dependent) and  $N_L$  the leaf N content (gN m<sup>-2</sup><sub>[leaf]</sub>)





# Leaf C/N ratio

- A key variable of the N-version
- Varies across two constrained boundaries : CN<sub>leaf,min</sub> and CN<sub>leaf,max</sub>
- C/N allocation





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1 How does the N-version perform @ site level and @ global-scale ?

- ② Does it increase the model predictive skill at simulating GPP fluxes at site and the inter-site differences ?
- (3) How does it change the modelled GPP response to elevated  $CO_2$ ?
- ④ What has been the contribution of the C/N interactions on the GPP evolution over the 20<sup>th</sup> century ?





### Model evaluation @ fluxnet sites





#### Model evaluation @ global scale





CN<sub>leaf</sub> variations over time and across site



CNfix-time configuration

**CNfix-timePFT configuration** 



#### Does it improve the predictive skill ?

Mean Square Error of Daily GPP flux



#### Modelled vs. Observed Annual GPP flux



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### GPP response to eCO<sub>2</sub>

2xCO2





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#### Impact on Water Use Efficiency

2xCO2



CNdyn

**CNfix** 



# Drivers of the GPP

 Based on the NMIP protocol (N<sub>2</sub>O Model Intercomparison Project)



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# Role of the C/N interactions on GPP

Additive scenarios



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#### Mean increase compared to preindustrial era

- ~ 25% without N inputs increase, with C/N interactions
- ~ 50% with N inputs, with C/N interactions
- ~ 50% with CN fixed to pre-industrial values (= no C/N interactions)

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## Role of the C/N interactions on GPP



2000

1960

Year





- Overall good performances at simulating GPP fluxes at site-level and globally
- Accounting for C/N interactions does not substantially improve the predictive skill of the model for present-day conditions
- The GPP response to elevated-CO2 is significantly different across model configurations (w and wo C/N)
- Over the historical period, N acted as a factor limiting GPP increase over forests, while it fostered the GPP increase over grass- and croplands



