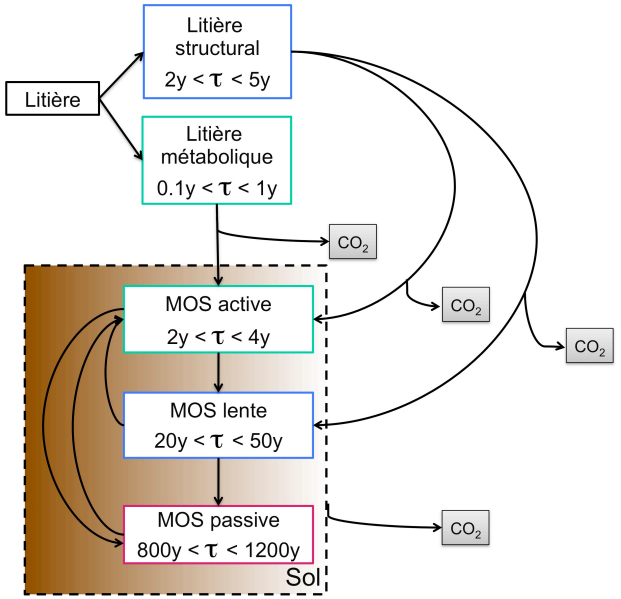
The soil carbon scheme in ORCHIDEE: presentation of the future developments



SOFIE LSCE/PKU Workshop from Monday, October 13- Tuesday, October 14, 2014

Bertrand Guenet

THE ORCHIDEE MODEL

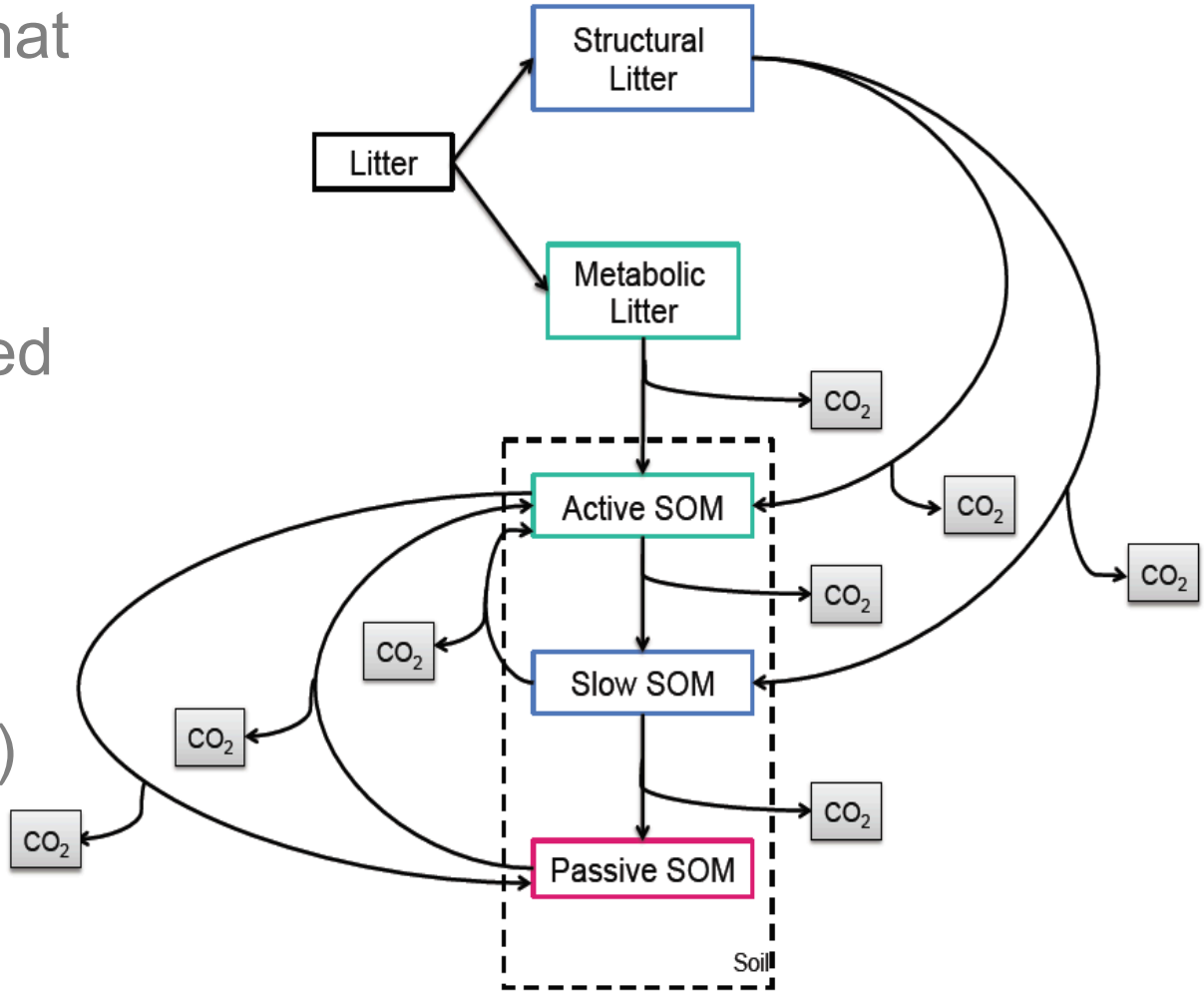
- Simulate Energy, Water and Carbon fluxes at the land surface/atmosphere interface.
- To be used for being the 'land surface' component of a Earth system model (IPSL-CM5).
- Global => to represent the main vegetation cover.
- For past, present and future climates
- Module of vegetation dynamic
- Process-based modelling

THE ACTUAL SOIL C MODULE

- CENTURY assumes that microbial biomass stay constant over the time.

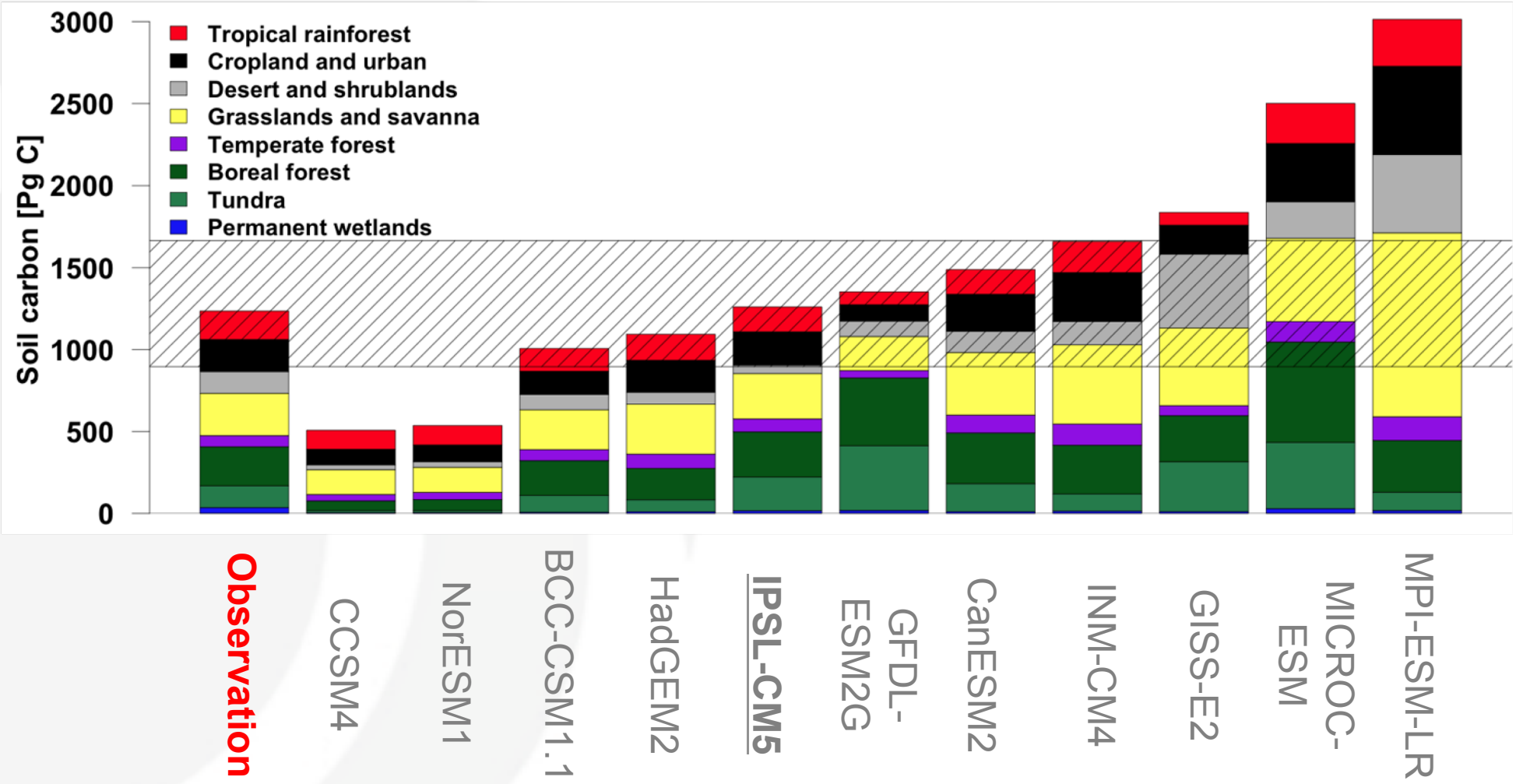
- Mineralization controlled by soil C and not by microbial C

- Effect of temperature and moisture very (too?) simple



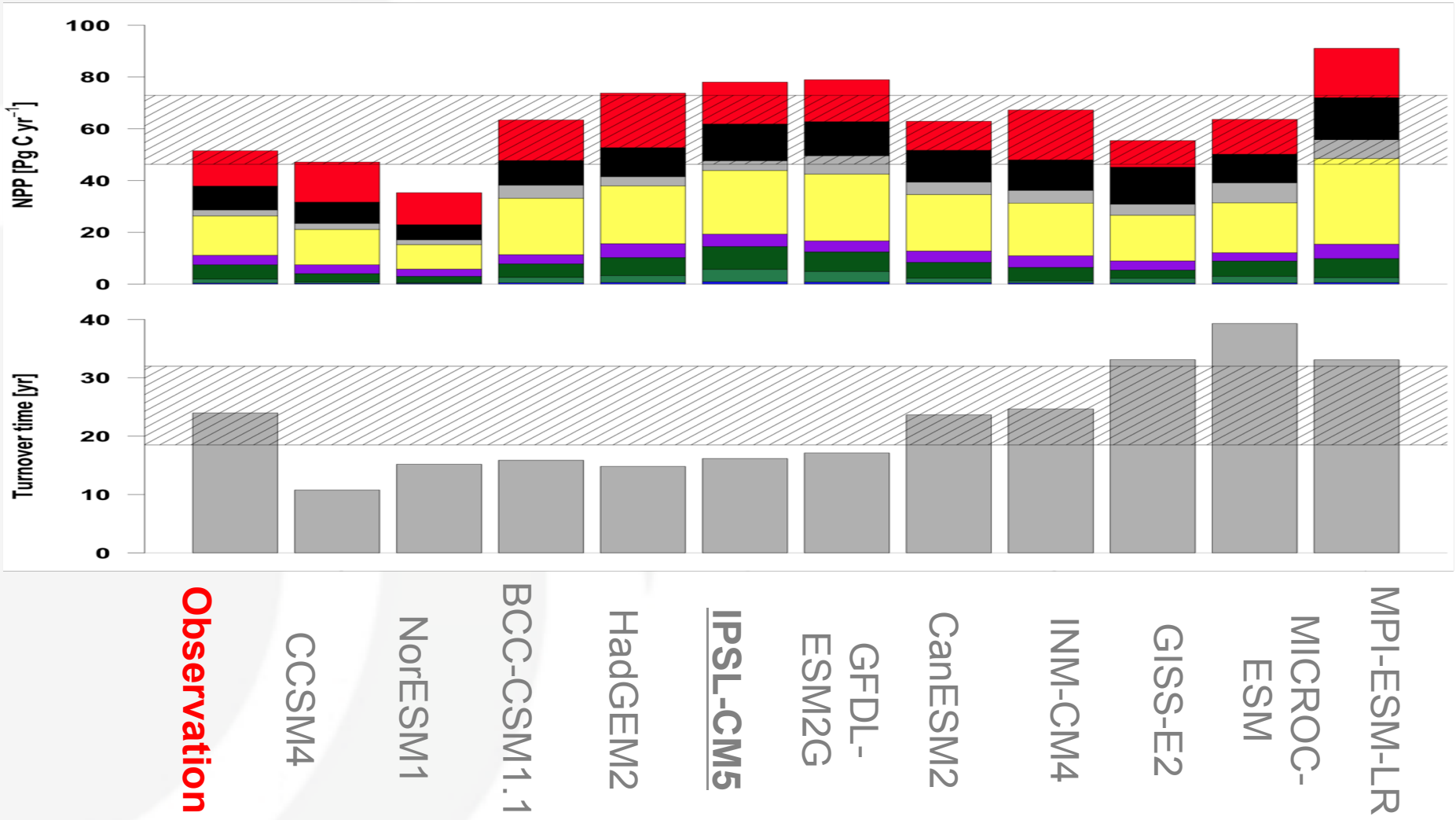
$$\frac{\partial SOC}{\partial t} = I - k \times SOC \times \theta \times \tau$$

HOW GOOD ARE EARTH SYSTEM MODELS TO REPRESENT SOIL C STOCK



Todd-Brown et al. (2013)

HOW GOOD ARE EARTH SYSTEM MODELS TO REPRESENT SOIL C STOCK



Todd-Brown et al. (2013)

SEVERAL IMPORTANT MECHANISMS ARE STILL MISSING

Biology

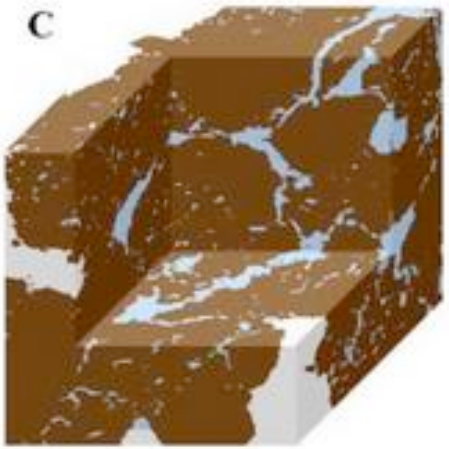
http://cropandsoil.oregonstate.edu

Chemistry

	p-Hydroxyl phenols	Vanillyl phenols	Syringyl phenols	Cinnamyl phenols
Aldehydes	*p*-Hydroxybenzaldehyde	Vanillin	Syringaldehyde	
Ketones	*p*-Hydroxyacetophenone	Acetovanillone	Acetosyringone	*p*-Coumaric acid
Acids	*p*-Hydroxybenzoic acid	Vanillic acid	Syringic acid	Ferulic acid

Thevenot et al., 2010

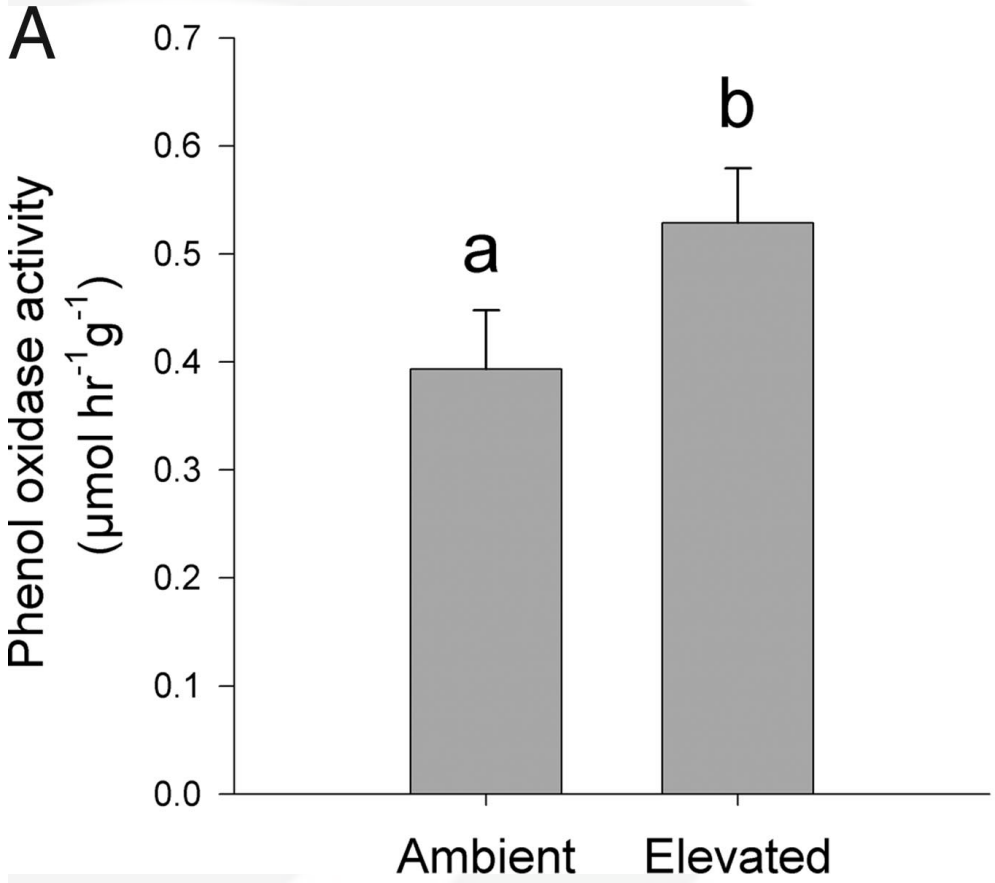
Physics

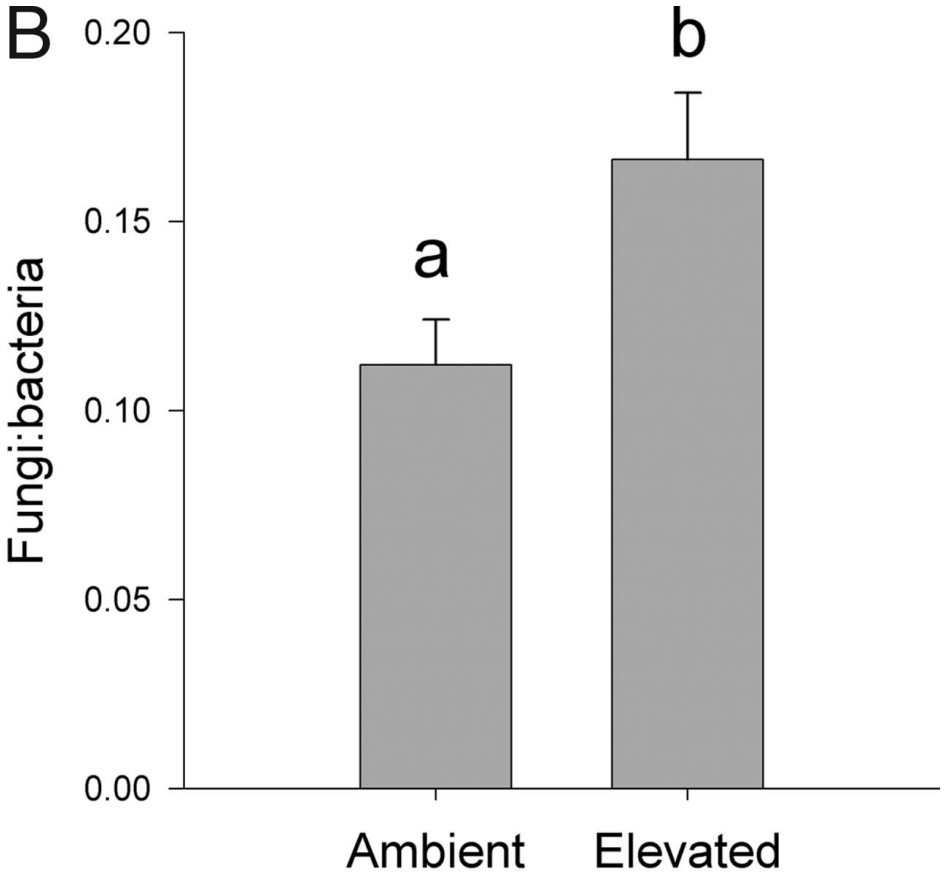


http://www.abdn.ac.uk

MICROBIAL ACTIVITY

- Microbial biomass, community structure and functioning is sensitive to climate change, land use change, etc.





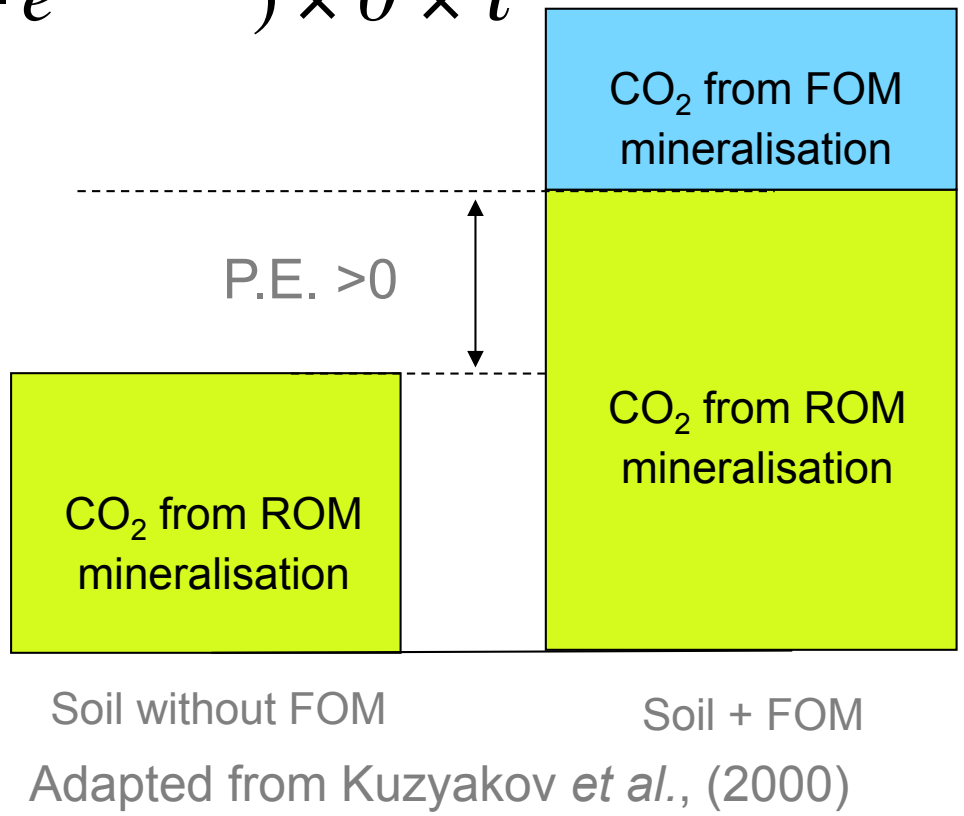
Carney et al., 2007

A NEW SCHEME OF DECOMPOSITION

Based on Wutzler and Reichstein (2008) and adapted by Guenet et al., (2013)

$$\frac{\partial SOC}{\partial t} = I - k_{SOC} \times SOC \times (1 - e^{-c \times FOC}) \times \theta \times \tau$$

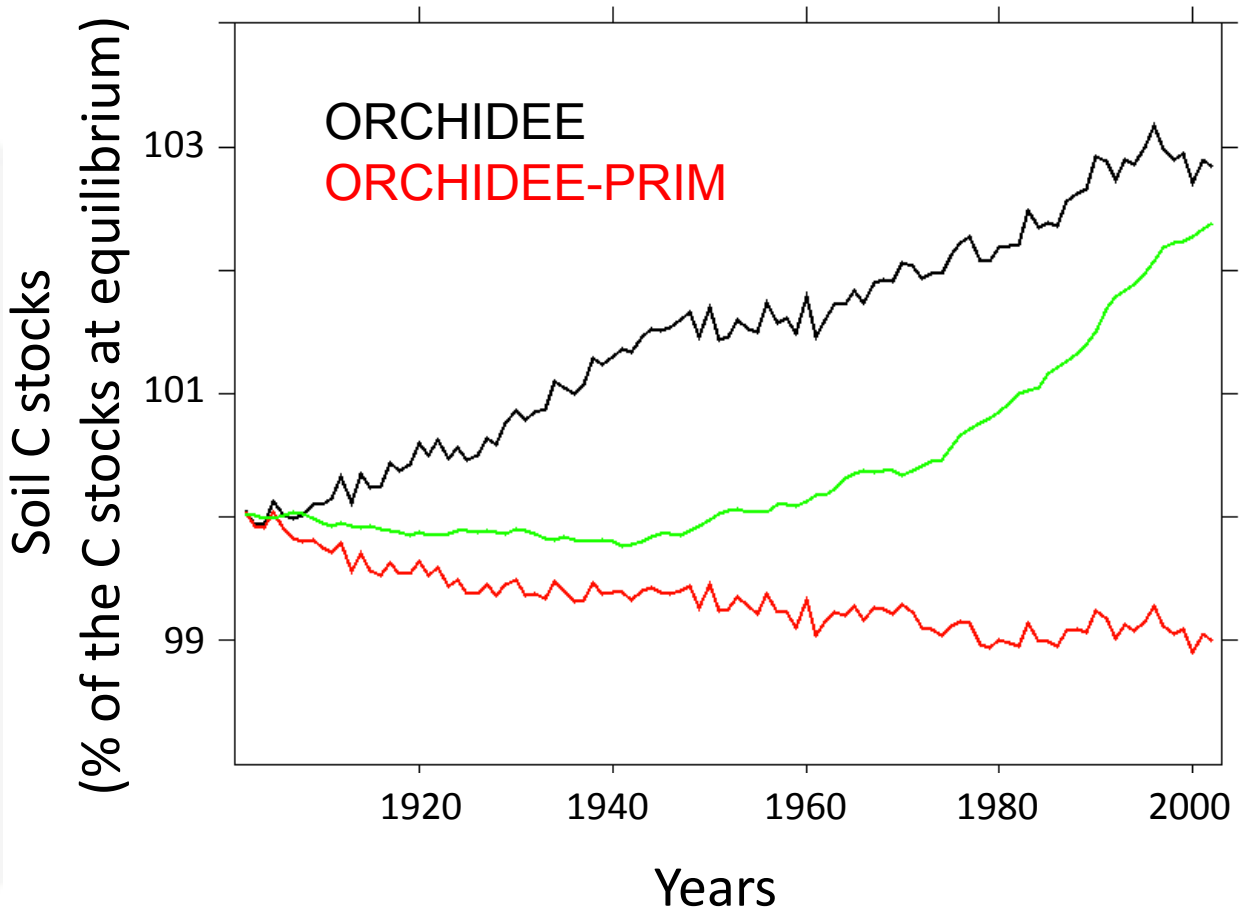
- Such approach is able to reproduce priming effect
- Assumes that microbial biomass is always in equilibrium with FOC



Adapted from Kuzyakov *et al.*, (2000)

A NEW SCHEME OF DECOMPOSITION

Such scheme modifies deeply the model behaviour

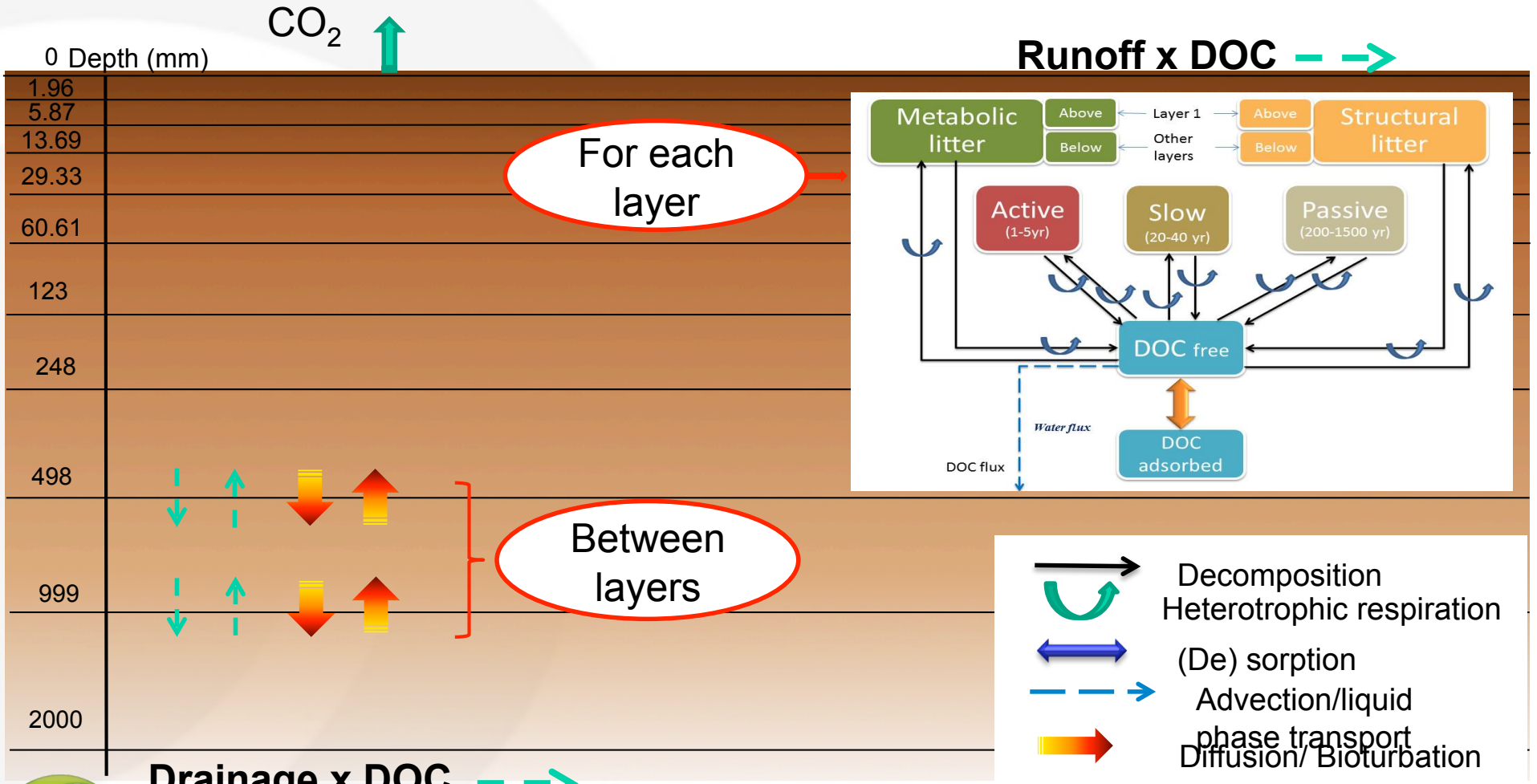


Soil Carbon discretization

- Any models used for CMIP5 represent the soil C profiles.
- A substantial part of the soil C stored in deep layers (Jobbagy and Jackson, 2000)
- Deep C dynamic different from surface C (Fontaine et al., 2007)
- In ORCHIDEE any C is lost by drainage or runoff instead of the importance of allochtonous C in the aquatic ecosystems functionning (Cole et al., 2007, Bianchi et al., 2011)

Soil Carbon discretization

Soil C discretized using the same layers than hydrology scheme (11 layers). A new pool introduced (DOC)



Soil Carbon discretization

- Adsorption of DOC following initial mass isotherms

$$DOC_{ads} = Kd \times DOC_{free}$$

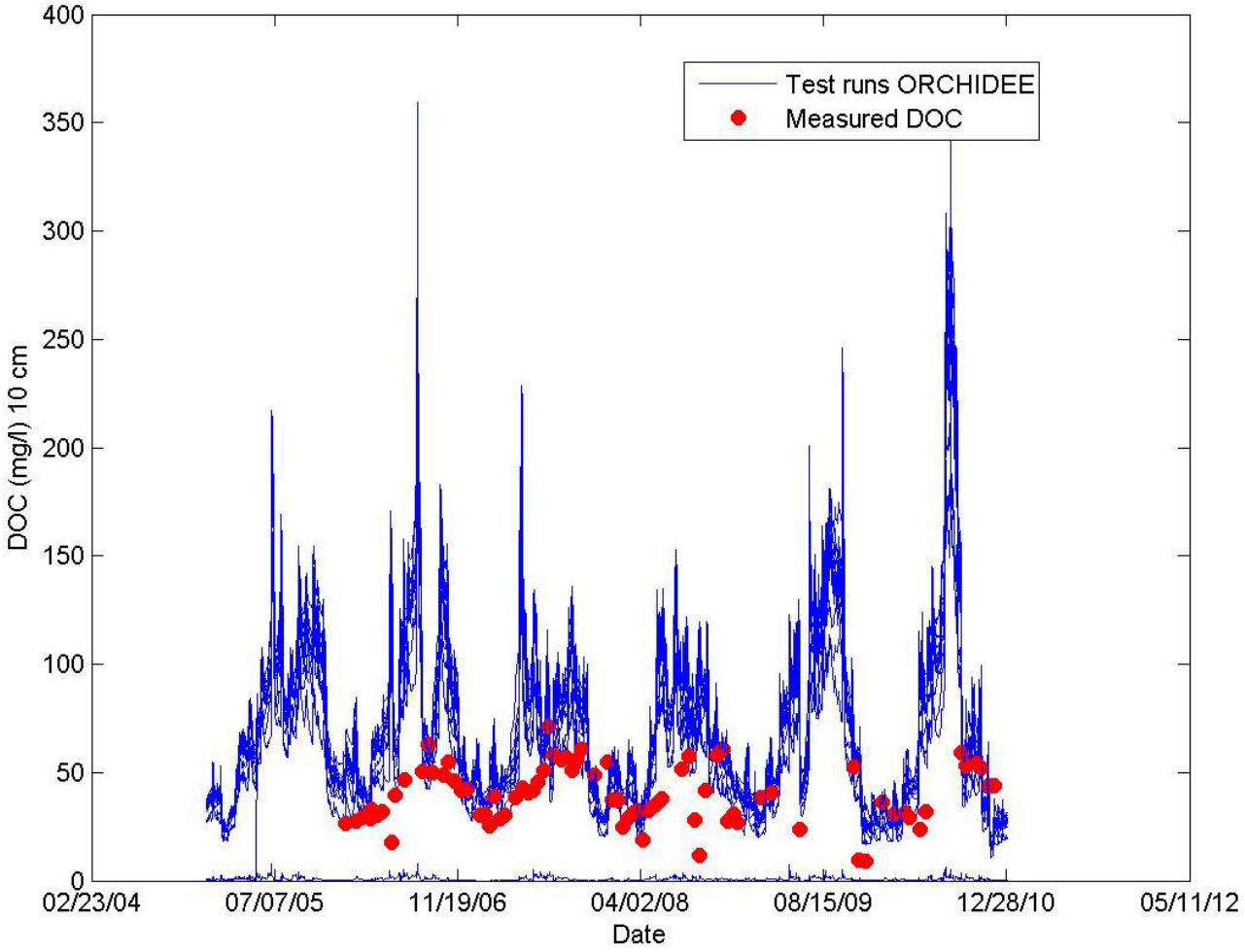
- DOC transported within the profile following the water movements (Futter et al., 2007) and exported following the runoff and the drainage fluxes
- POC and DOC transported using the second Fick's law

$$F_D = -D \times \frac{\partial^2 C}{\partial z^2}$$

- Work in progress to parameterize the model.

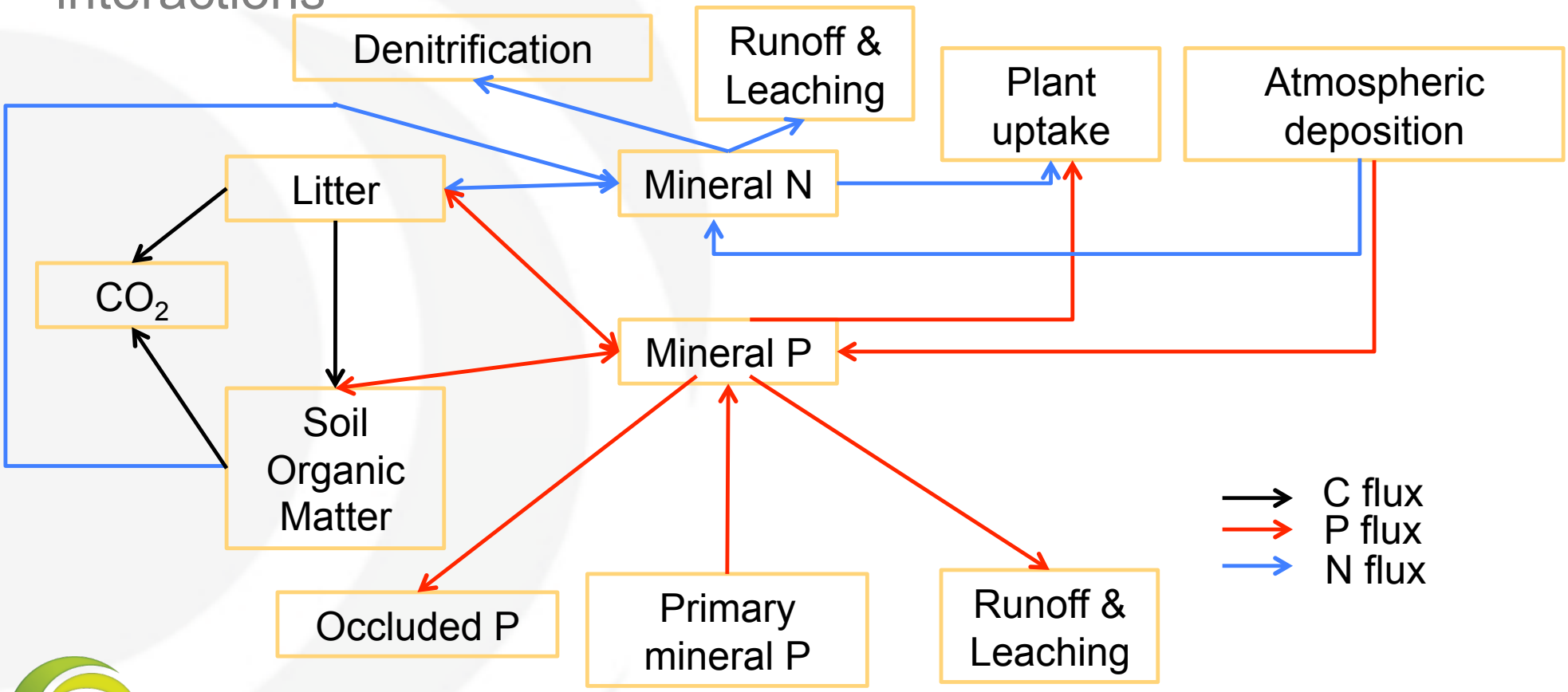
Soil Carbon discretization

- Simulation at the Braaschaat site in Belgium with default parameter find in the literature.



Next steps

- Each pool will be discretized
- Pool of DOC, DON, DOP will be explicitly represented
- CNP dynamics controlled by explicit representation of microbial interactions



THANKS FOR YOUR ATTENTION!