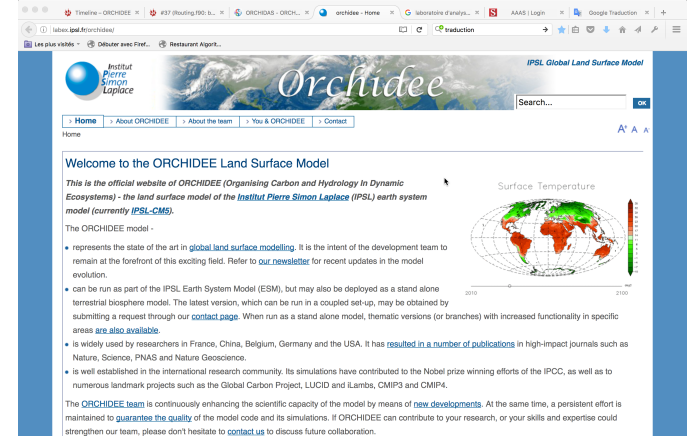


The ORCHIDEE project

- COLLABORATIVE effort with many contributors !!
- More than 15 permanents and over 30 CDDs
 - Several laboratories but mainly from IPSL
- YOU will include new processes or change some of them
 - ➔ It should benefit to the ORC project
- Never forget:
 - ➔ The current ORC model that will allow your research results from a huge team work !

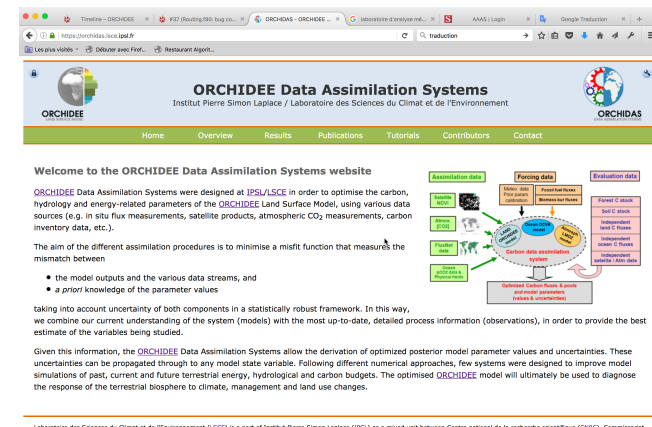
Several web sites...

- Official web site :
for external people



- Wiki web site: contains all what you need
<https://forge.ipsl.jussieu.fr/orchidee/wiki>

- Web site for Data Assimilation
<https://orchidas.lsce.ipsl.fr/>



- Web site for ref simulation visualisation
<https://orchidas.lsce.ipsl.fr/mapper/>

Specific documents

➤ <https://docs.google.com/document/d/13R22r1fx0JoYKCojG1k3IM2C18RWuFNvxoYKdtacJEI/edit>

Contain some information on:

- ✧ Governance
- ✧ Project and articles
- ✧ List of all people working with ORCHIDEE (with their activity)
=> Everyone to update

➤ <https://sharebox.lsce.ipsl.fr/index.php/s/AhJk0Bk6rdySXKL>

Contain recently submitted ORC articles

Several mailing lists

➤ ORCHIDEE-DEV:

All users and developpers.

Main list to exchange information

➤ ORCHIDEE-PROJECT:

Restricted mainly to permanent people plus few CDDs « main developpers »..

➤ ORCHIDEE-HELP

To use with parsimony..

➔ Find all lists under : <https://listes.ipsl.fr/sympa/home>
(you can subscribe directly on the web site)

« Animation »

- ORC – DEV meeting every 2-3 months on specific scientific and technical topics
- Irregular « annual retreat »
next one not decided yet..
- Project meeting every Tuesday (restricted):
 - ➔ Summary accessible to everyone
(need to be log on to see the summary)

<https://forge.ipsl.jussieu.fr/orchidee/wiki/GroupActivities/Meetings/Weekly>

Coding guidelines..

- A document that summarizes the MAJOR RULES that you NEED TO FOLLOW when developing new code
 - NEEDED to get support from the group
 - NEEDED if you want your code to be further used and included in the main ORC version
 - You are welcome to suggest new coding rules...
- ➔ **Access coding guidelines under :**
<https://forge.ipsl.jussieu.fr/orchidee/wiki/Documentation>
- ➔ **Make use of SVN to develop your own branch**

Use of the “Help”

- TO BE USED SPARINGLY... (as little as you can)
- FIRST: Dig as much as you can into the code..
- SECOND: check the WIKI
- THIRD: ask your main advisor
- FOURTH: Ask your colleague/neighbour
- THEN: post a message to “orchidee-help@ipsl.jussieu.fr
- AS A RETURN, please:
 - Try to write a little summary of the answer to your question on the WIKI (if relevant)
 - Use the “How to ?” section

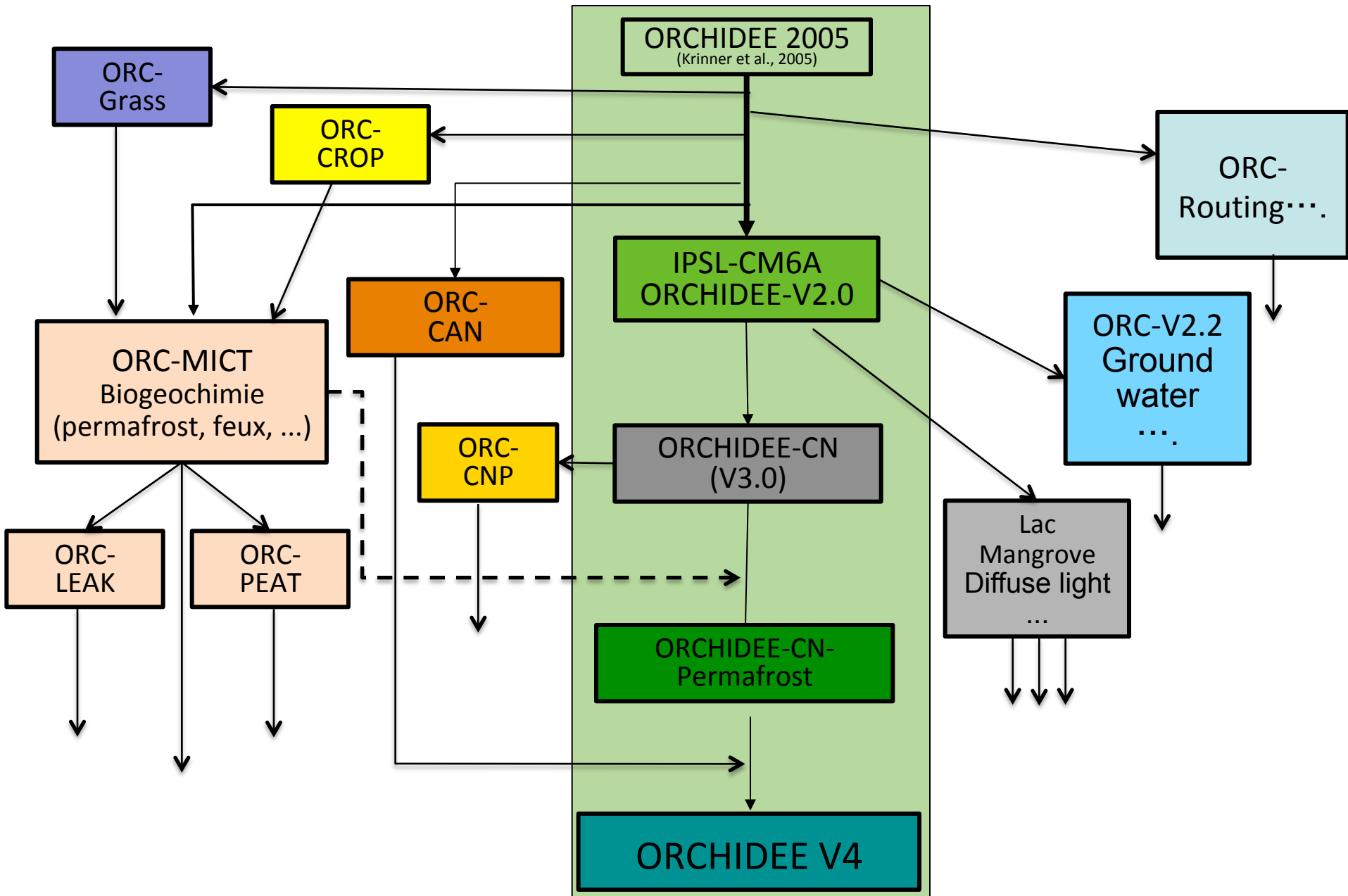
Fair Use policy

- To ensure “reward” to developers of new physical modules and people maintaining the code (including drivers)
- New developments are not “free” to use : fair use should include/propose co-authorship to the developers
- Reward the “difficult” and less visible technical maintenance and improvement of the code
- Try to prevent “competition” within the ORC group

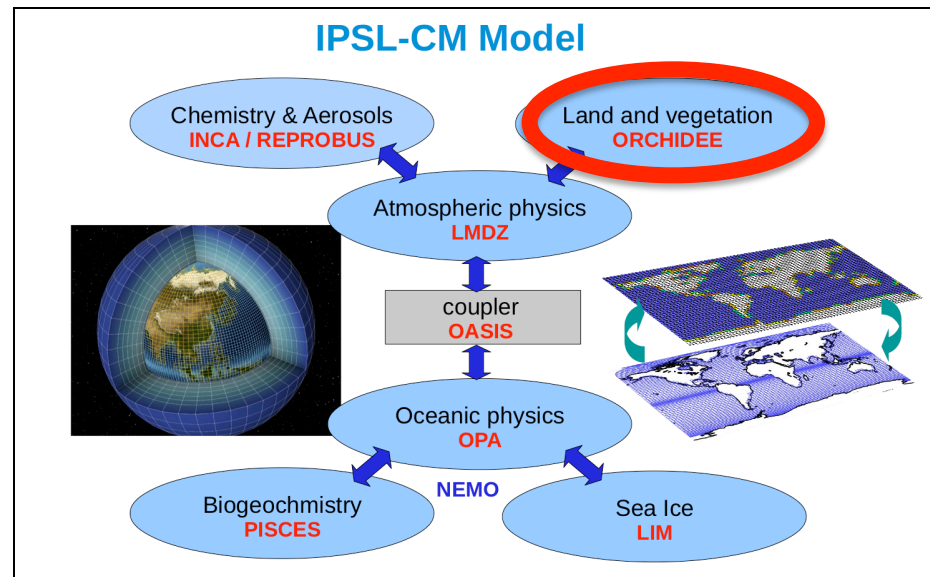
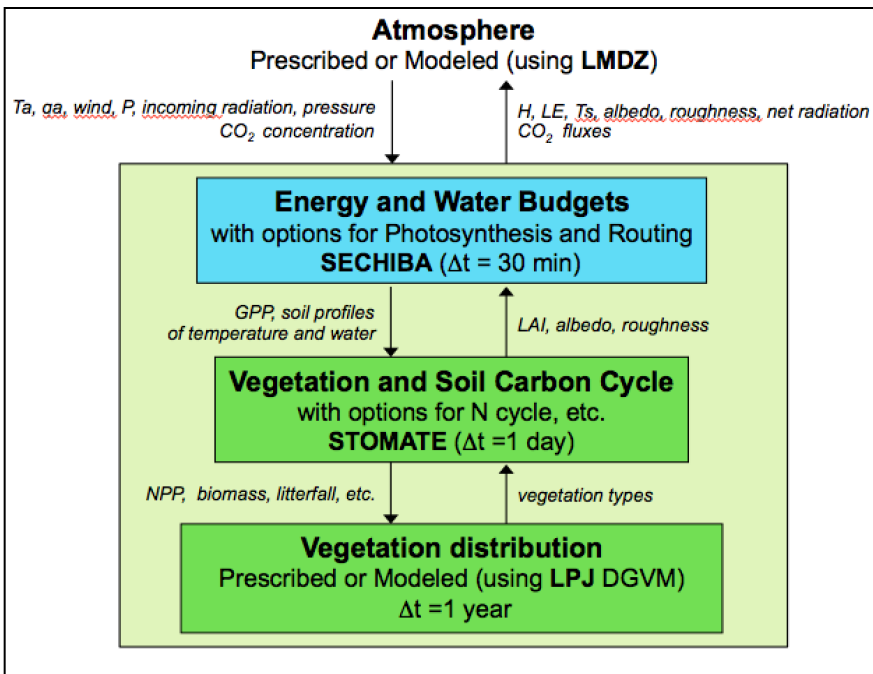
→ Access from the wiki:

<https://forge.ipsl.jussieu.fr/orchidee/wiki/GroupActivities/UseOfORCHIDEEpolicy>

ORCHIDEE branches



Le modèle ORCHIDEE: récent & futur développements

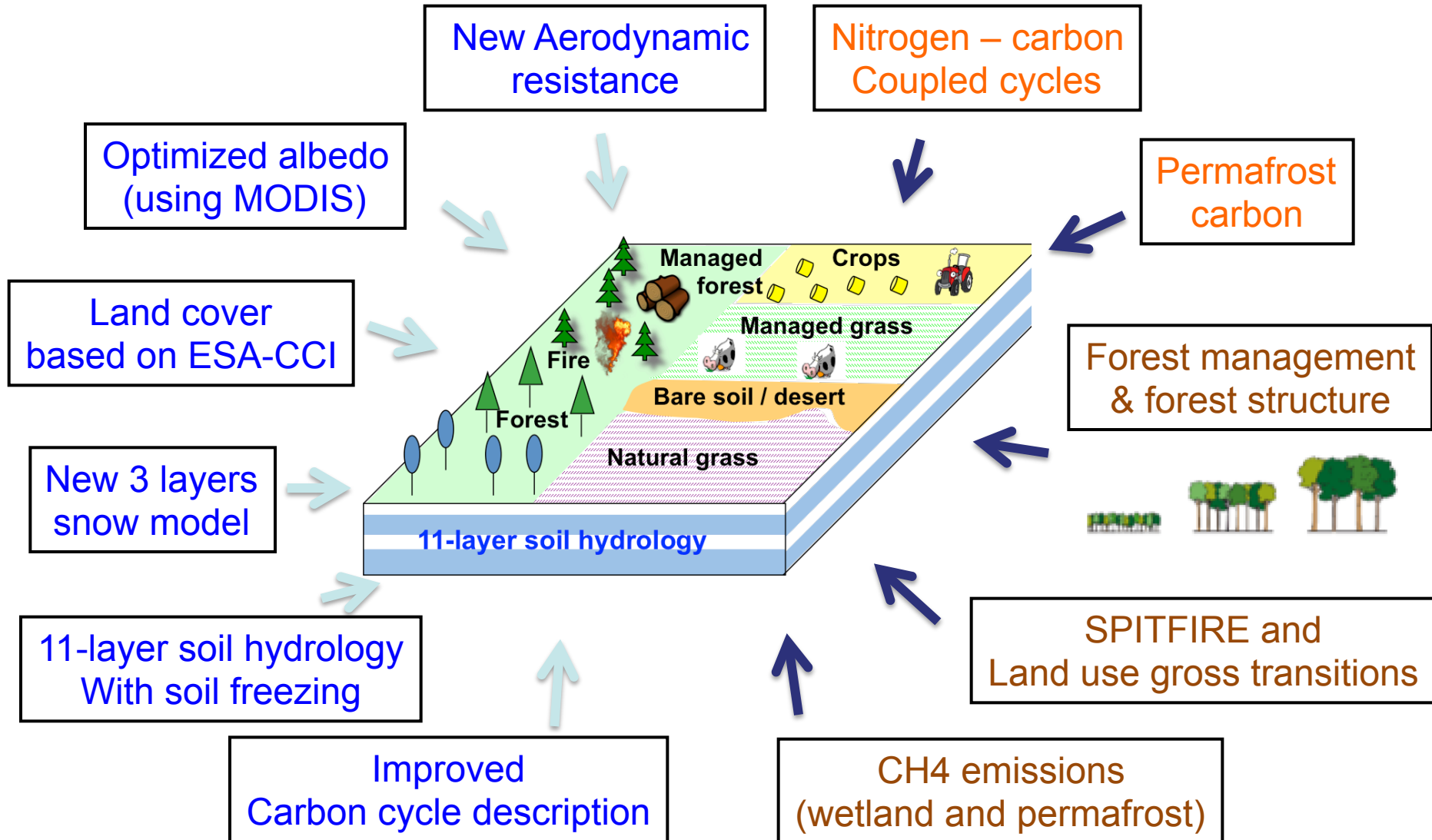


ORCHIDEE recent developments (for CMIP6)

Implemented: V1

Recent: V1.5

Merging



Other Mature/Ongoing developments

Biophysical

Biogeochemical

Lake model (FLAKE)

Nitrogen – Phosphorus - Carbon coupled cycles

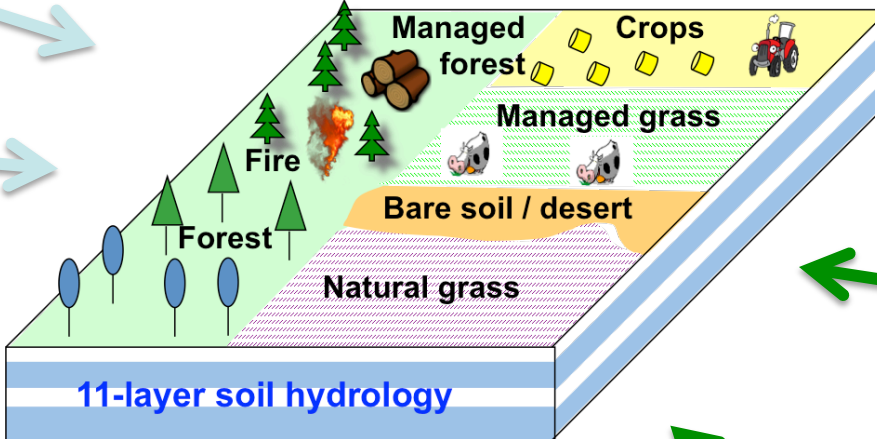
Soil Carbon discretization

Irrigation

Termokarst lake

Crop model (wheat, corn, rice,...)

DOC – DIC transport by river



Grassland management

Peatland model (CH₄)

New boreal PFTs (Mosses, lichens, shrubs)

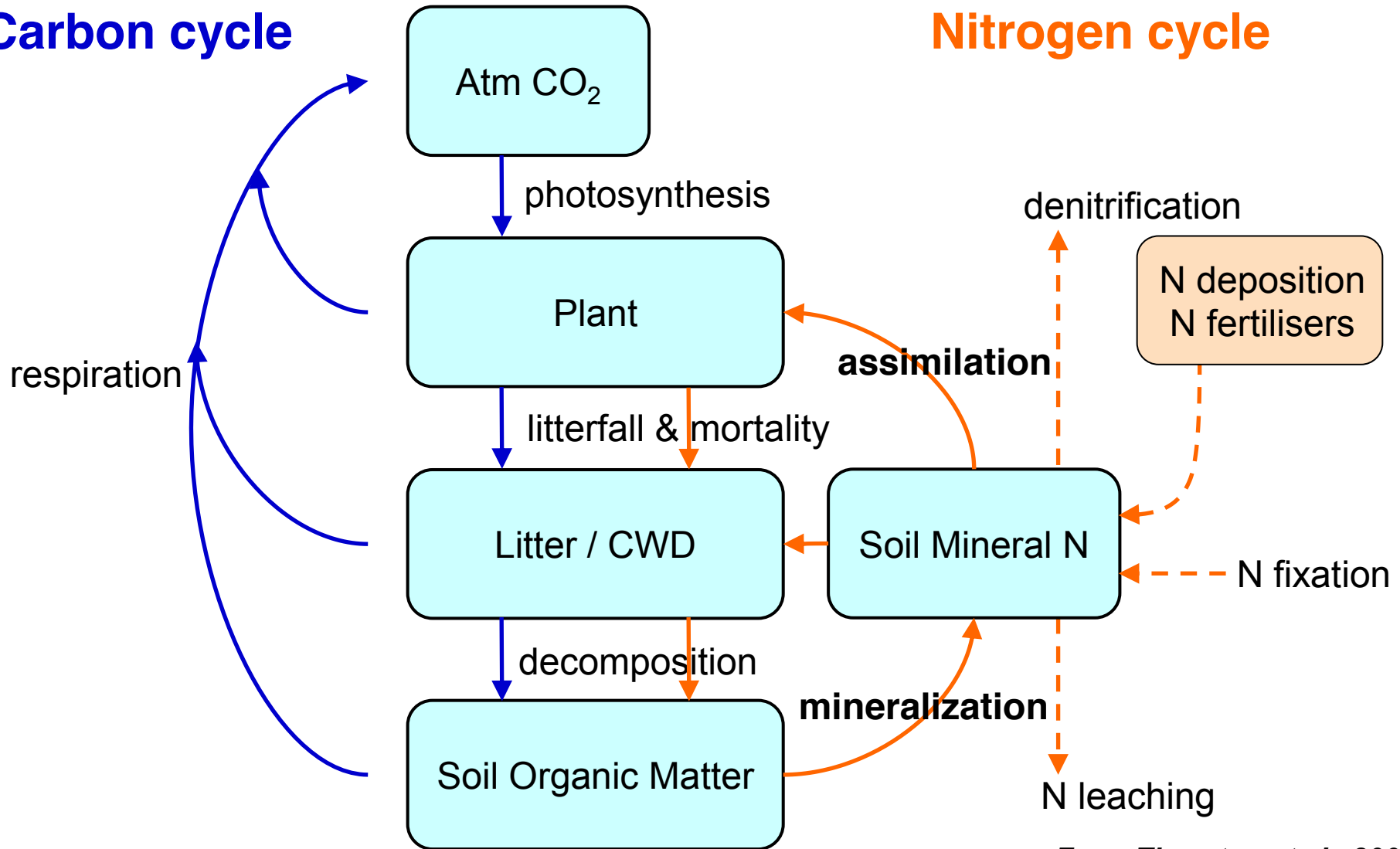
Plant Traits

Herbivory (large herbivore)

C & N land interactions

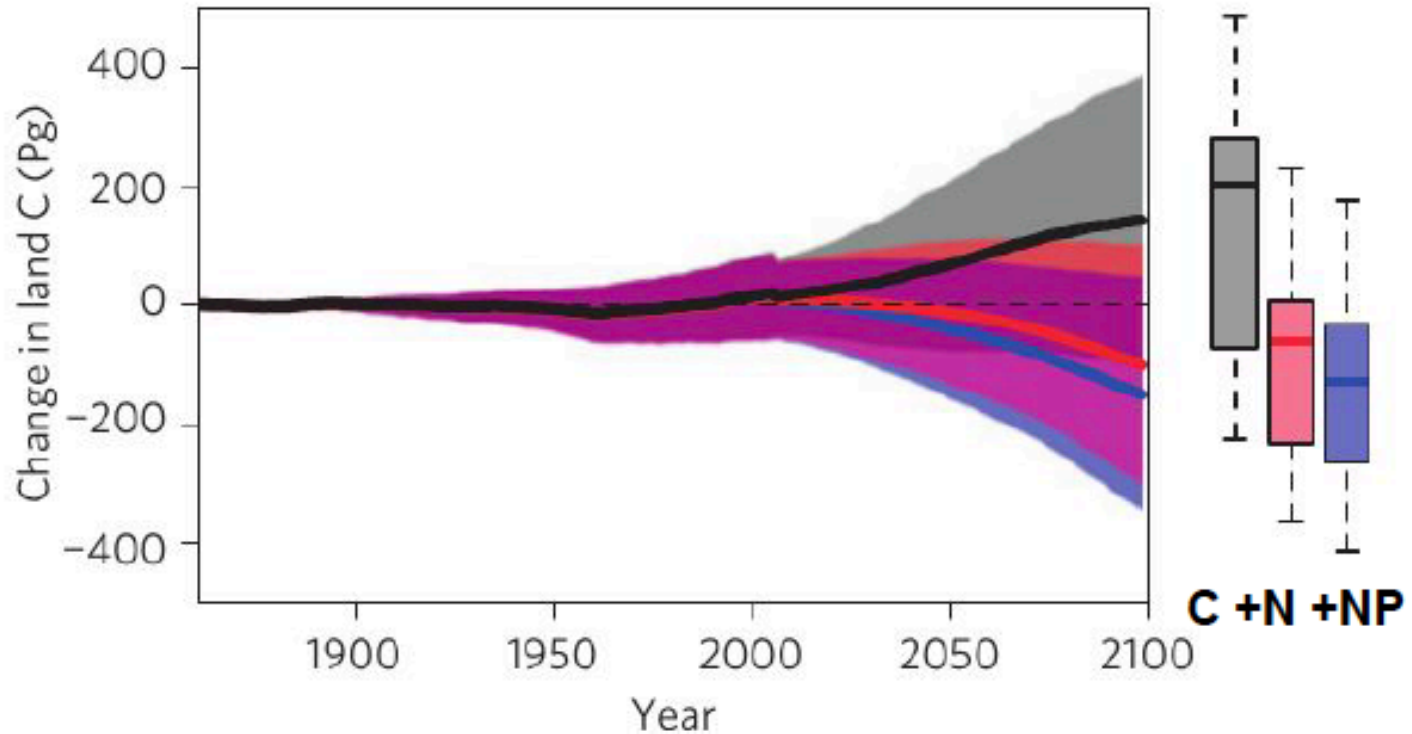
Carbon cycle

Nitrogen cycle



From Thornton et al., 2009

Adding the Phosphorus cycle



Wieder et al., Nat. Geosc., 2015

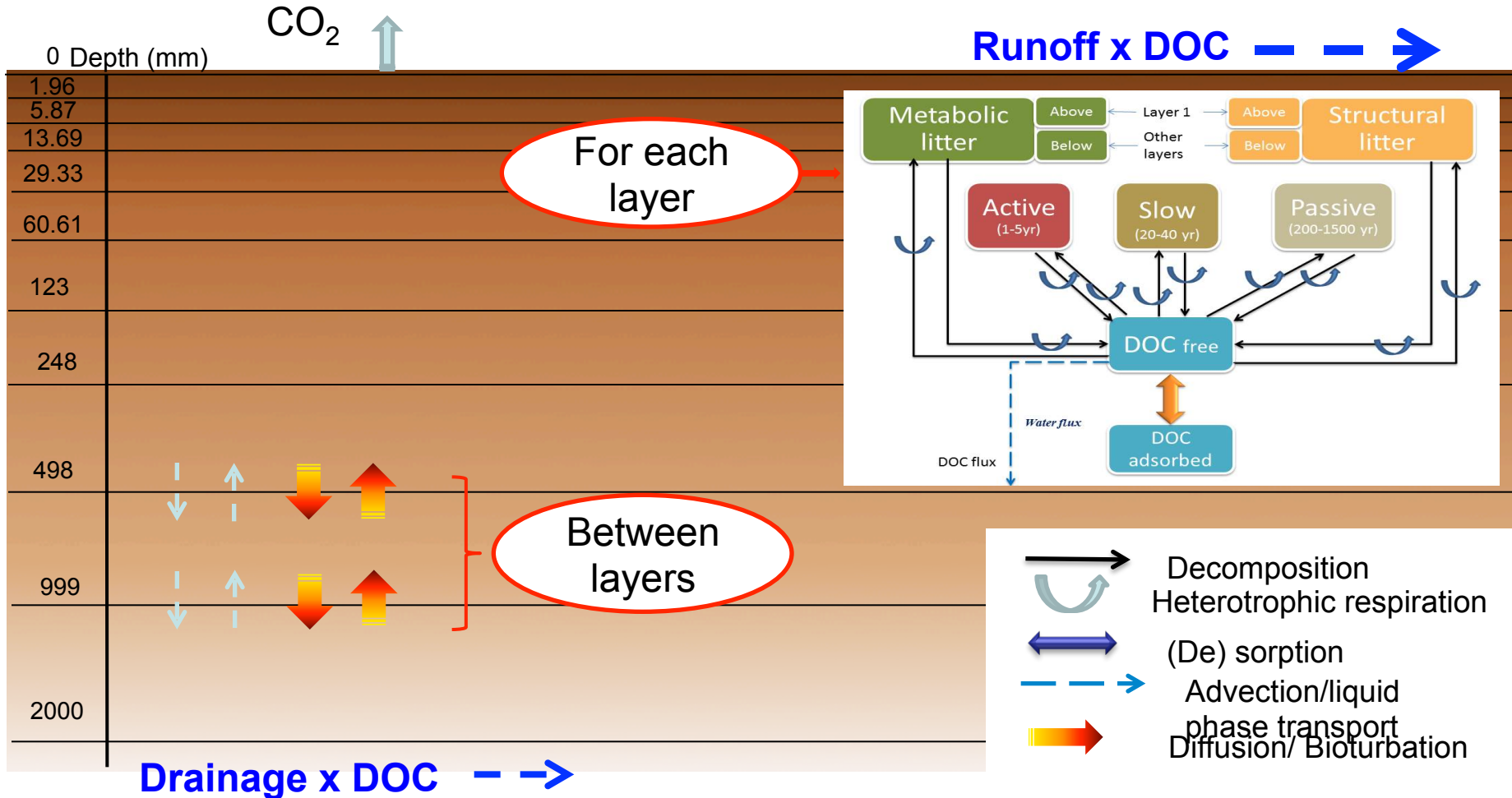
➔ Work done with ORCHIDEE-CNP version : Goll et al. 2017

A new soil carbon model..

- Discretized soil carbon (11 layers) + new pools introduced (DOC)

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

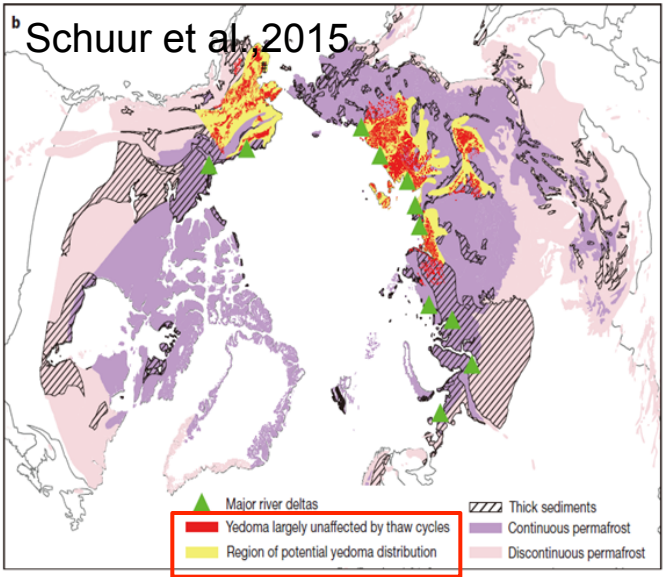
- New decomposition scheme (priming):



Permafrost : Modeling Yedoma organic carbon formation

Yedoma: organic-rich, ice-rich, thick deposits in permafrost region

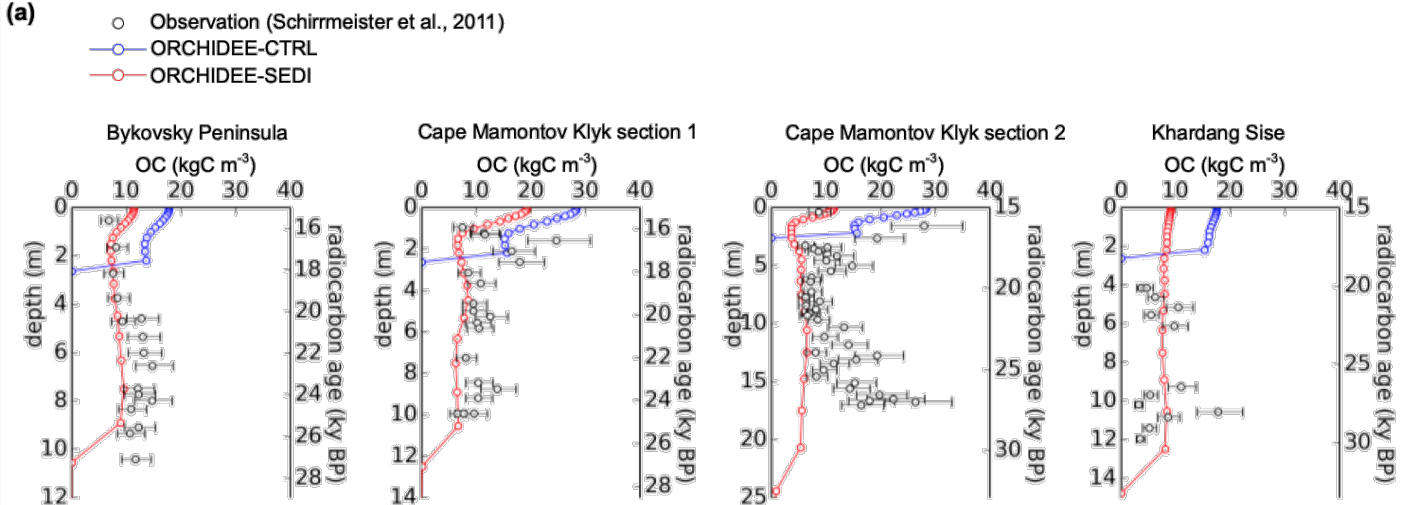
Dan Zhu et al.



Area: ~1.3 million km²
C stock: 300-550 PgC

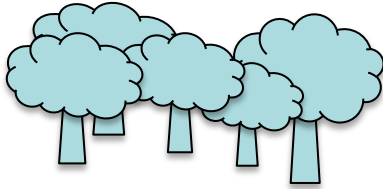
- **Large ice content: 50-80 vol%**
- **Ancient carbon: accumulated during last ice age (~60-15 kyr)**
- **Depth 5-50m, C contents ~2%**
- **Formation condition: sedimentation**

The new model can reproduce vertical profiles of Yedoma organic carbon

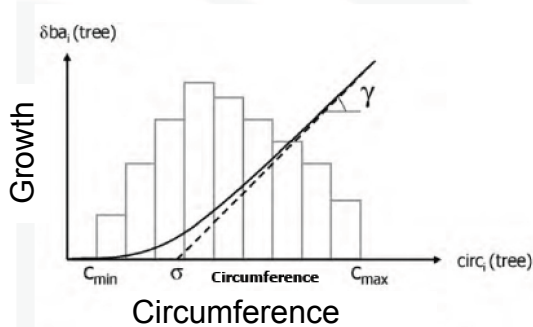


Forest management and stand description

Include diameter & age classes



Allocation : "big get bigger"

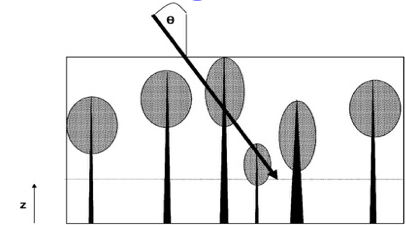


➔ Impact of climate,
Forest management,
Land Use Change
on European NBP

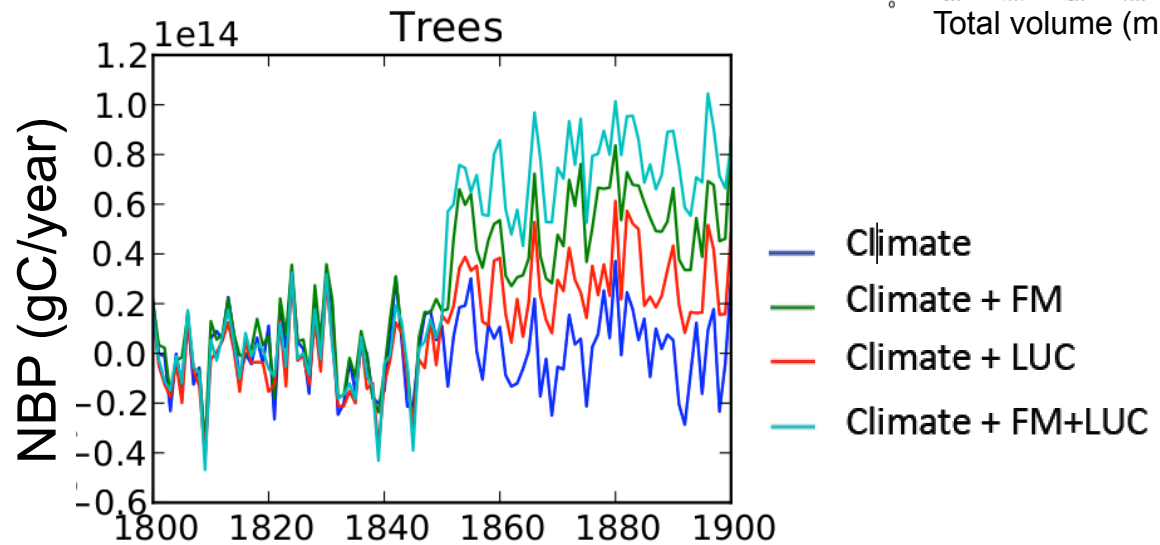
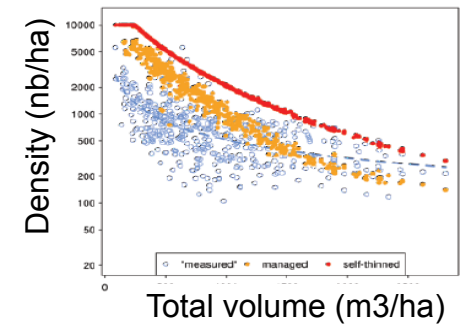


(Naudts et al., 2015)

Accounts for gaps (PGAP)

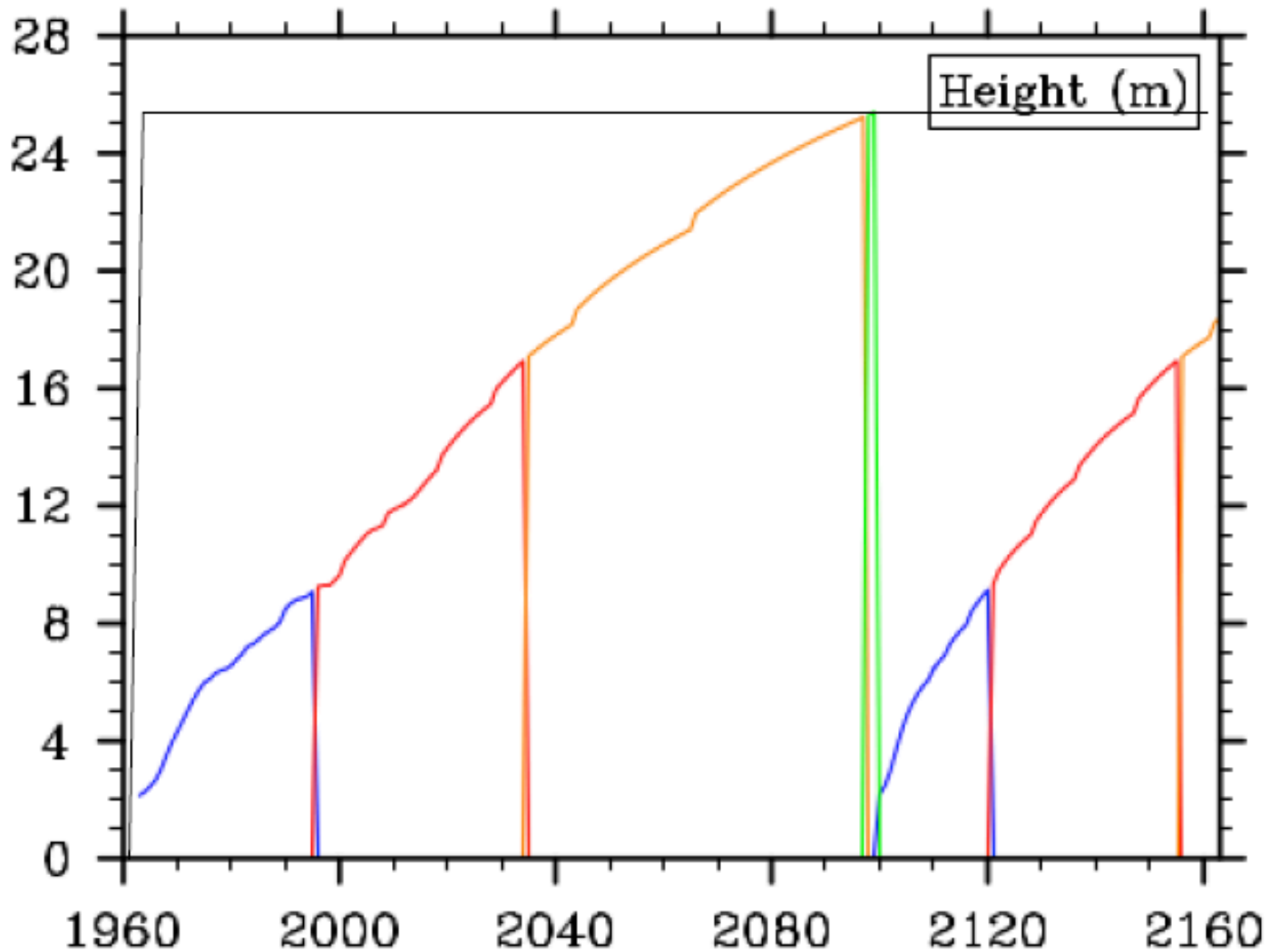


Mortality from self-thinning



Forest management and stand description

Simulating the canopy



Gross land use change



Deforestation



Shifting cultivation

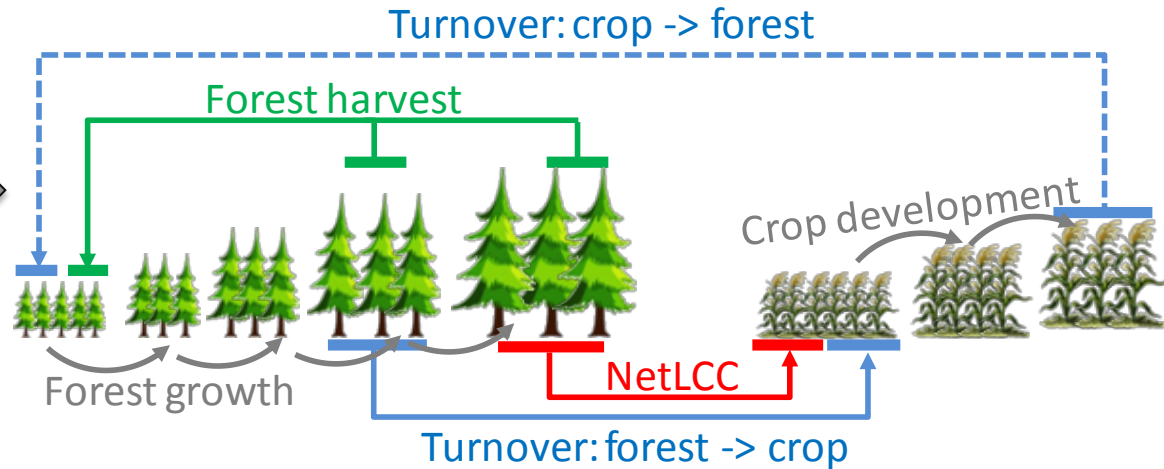
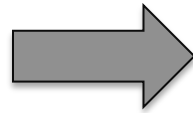


Shifting cultivation



Wood harvest

Gross land use change with age cohorts



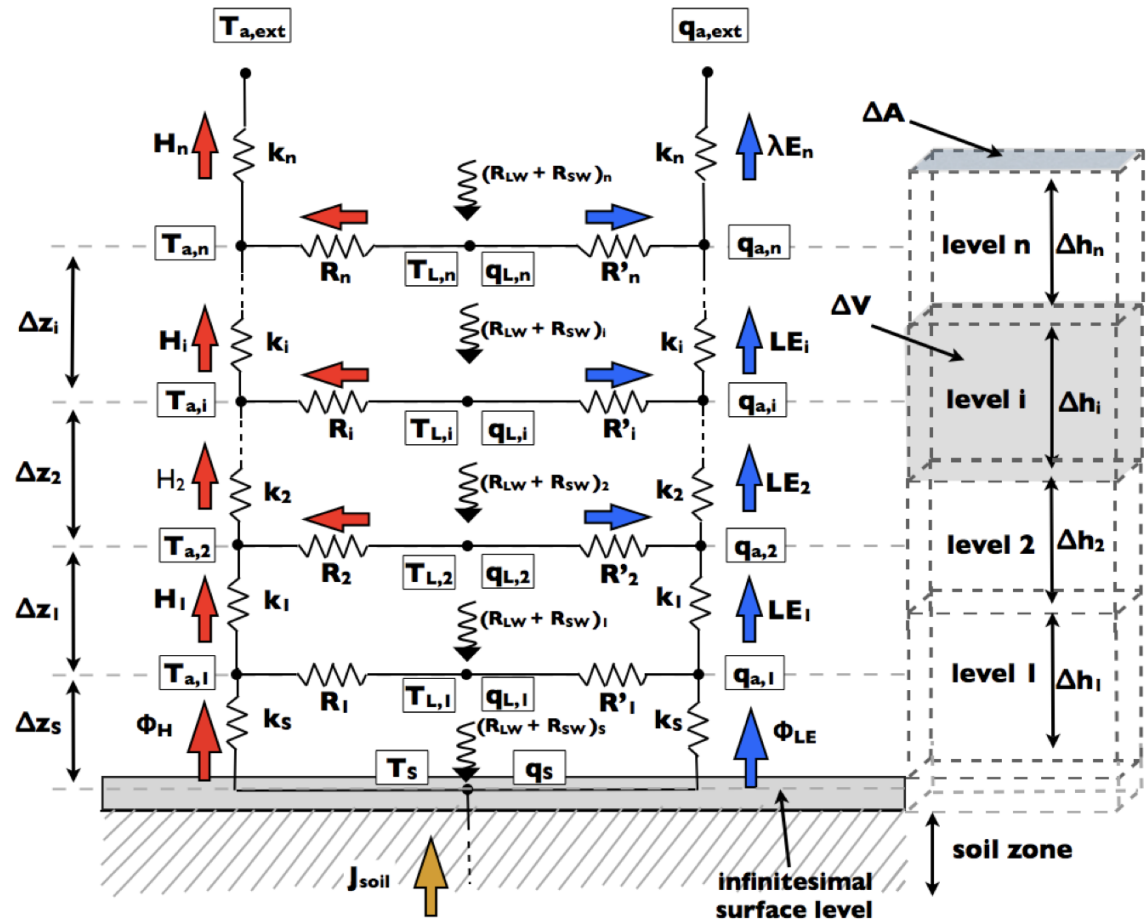
Factorial simulations

Simulations	Net LCC	Turnover	Harvest
S0 (S'0)			
S1 (S'1)	✓		
S2 (S'2)	✓	✓	
S3 (S'3)	✓	✓	✓

→ allow to quantify the contributions of different land use change processes (net change, land turnover or shifting cultivation and wood harvest).

Vertical multi-layers scheme..

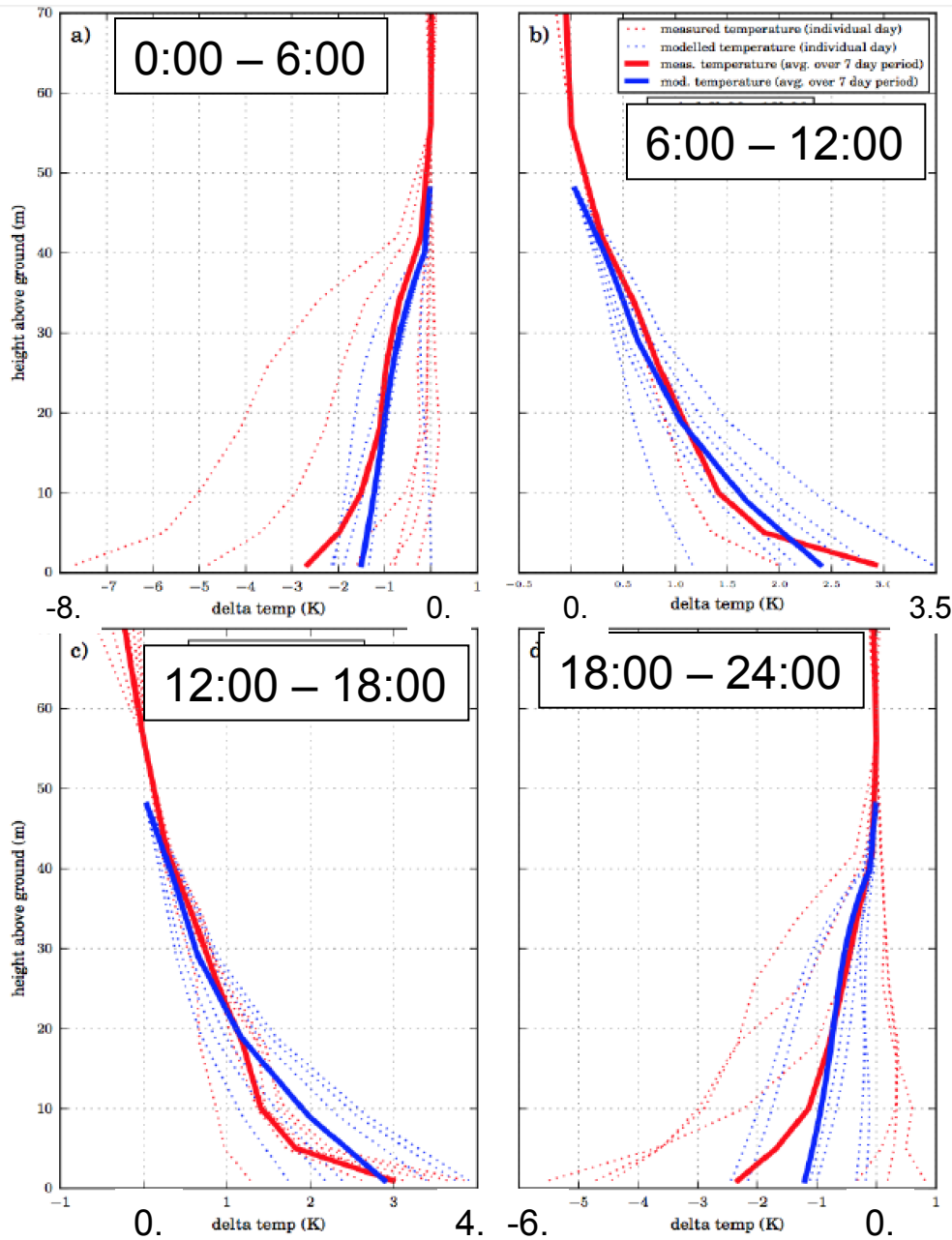
- Free number of layers
- E / W / C exchange at each level
- Turbulence mixing within air canopy
- Light penetration following Pgap model



Implementation constraints :

- Coupling with plant growth / harvesting module (variable plant height)
- Implicit coupling with Atmospheric model (30' step)
- Parametrisation of intra-canopy turbulence

Temperature profile at Tumarumba site

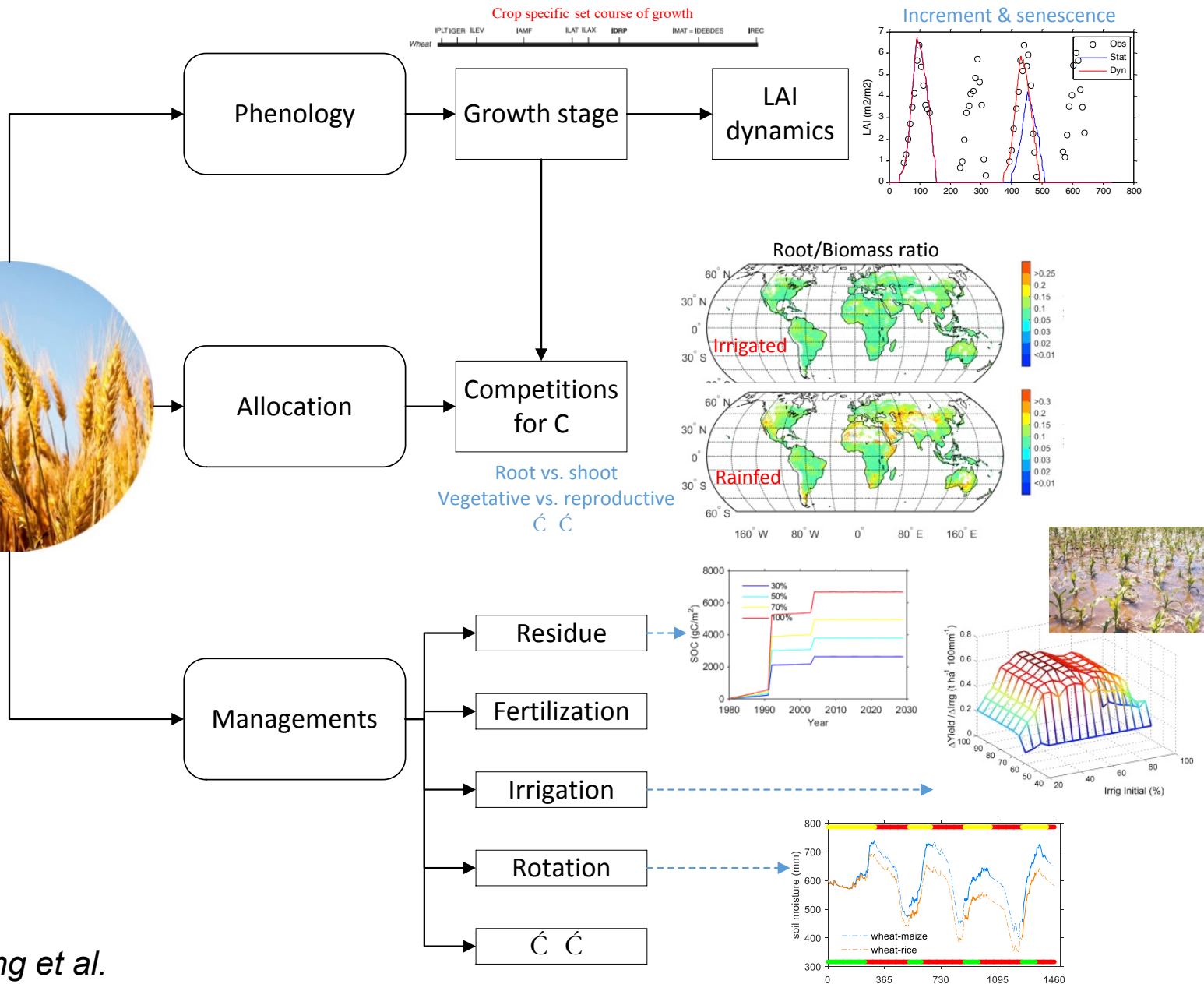


Observations

Model

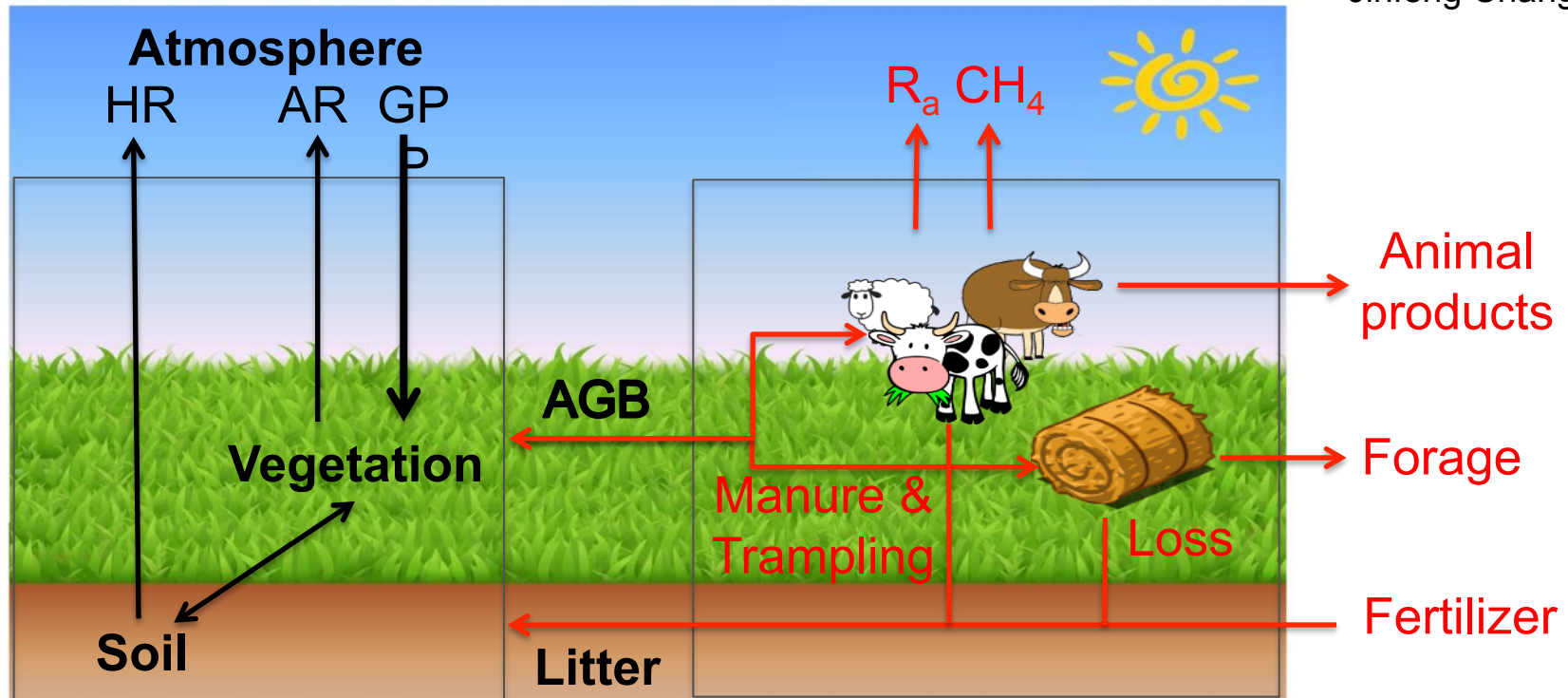
Daily temperature

Cultivated ecosystems : major crops



Grassland: from intensive pasture to rangeland

Jinfeng Chang et al.



ORCHIDEE

Management module from PaSim

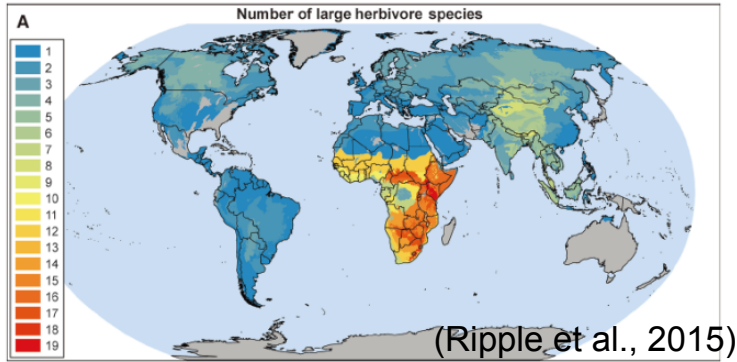
(Graux et al., 2012 ; Vuichard et al., 2007)

Applications:

- Grassland management optimization/adaptation (simulating potential productivity)
- Reconstruction of historical management intensity
- Long-term carbon and GHG balance of grassland ecosystem and livestock farm.
- Milk production simulation and projection.

Representing wild large herbivores

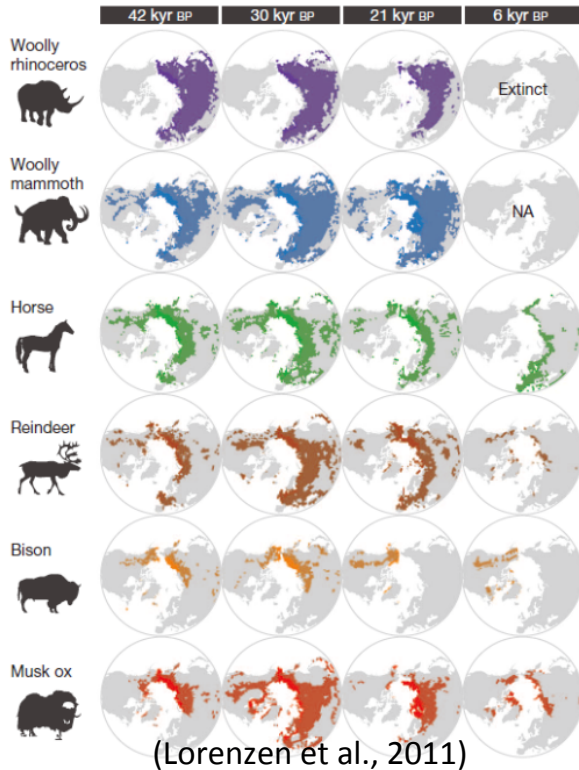
Large herbivores today



Bones preserved in yedoma deposits (Zimov et al., 2012)

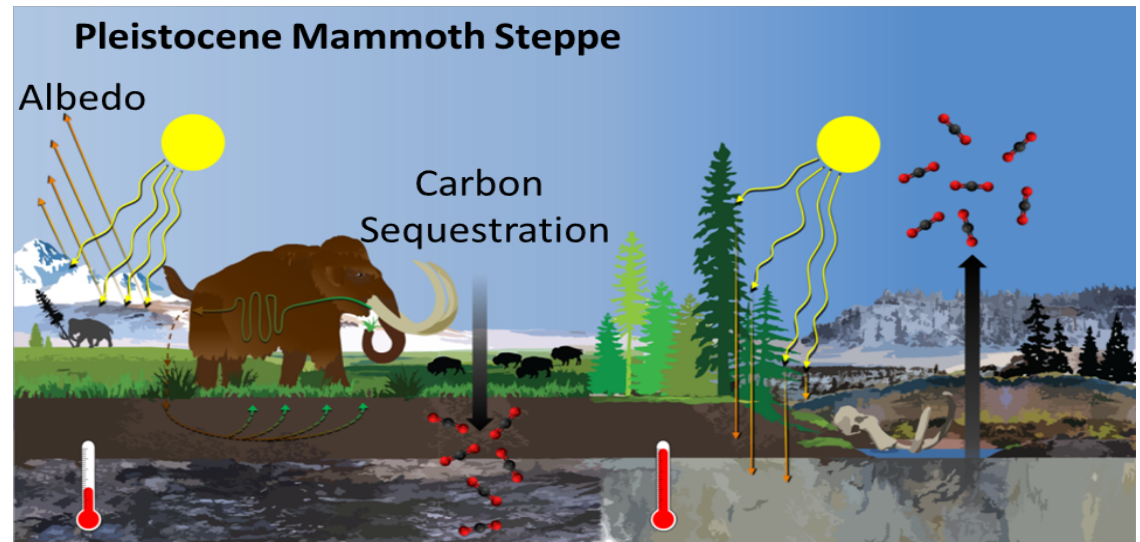
Herbivore biomass in the Arctic during 40~15 kyr BP:
 ~9000 kg/km²
 → comparable to today's African savannah

Large herbivores during late-Pleistocene

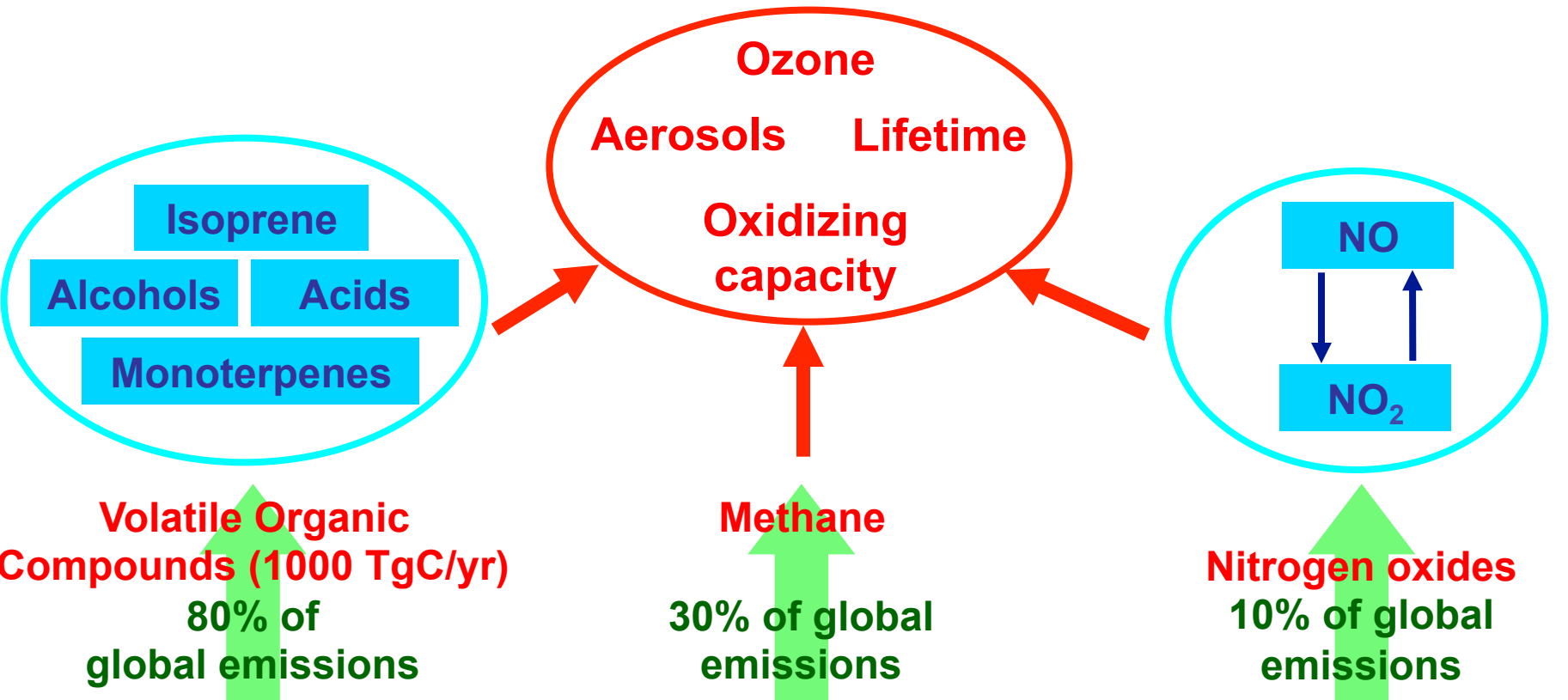


“keystone herbivore” hypothesis

(Owen-Smith, 1987; Zimov et al., 1995)



The terrestrial biosphere and atmospheric chemistry



Vegetation

O₃
NO_x



Wetlands

Isop.
OH



Soils - Cultures

Chemistry-vegetation retroactions

Atmospheric chemical composition

CO_2
Pollution: O_3 , NO_x , SO_2 and particles

Deposition



Deposition



Deposition



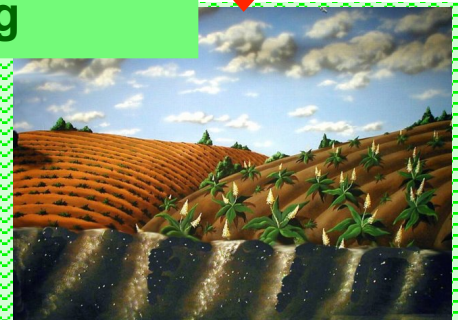
→ Growth, Distribution, Functioning



Vegetation

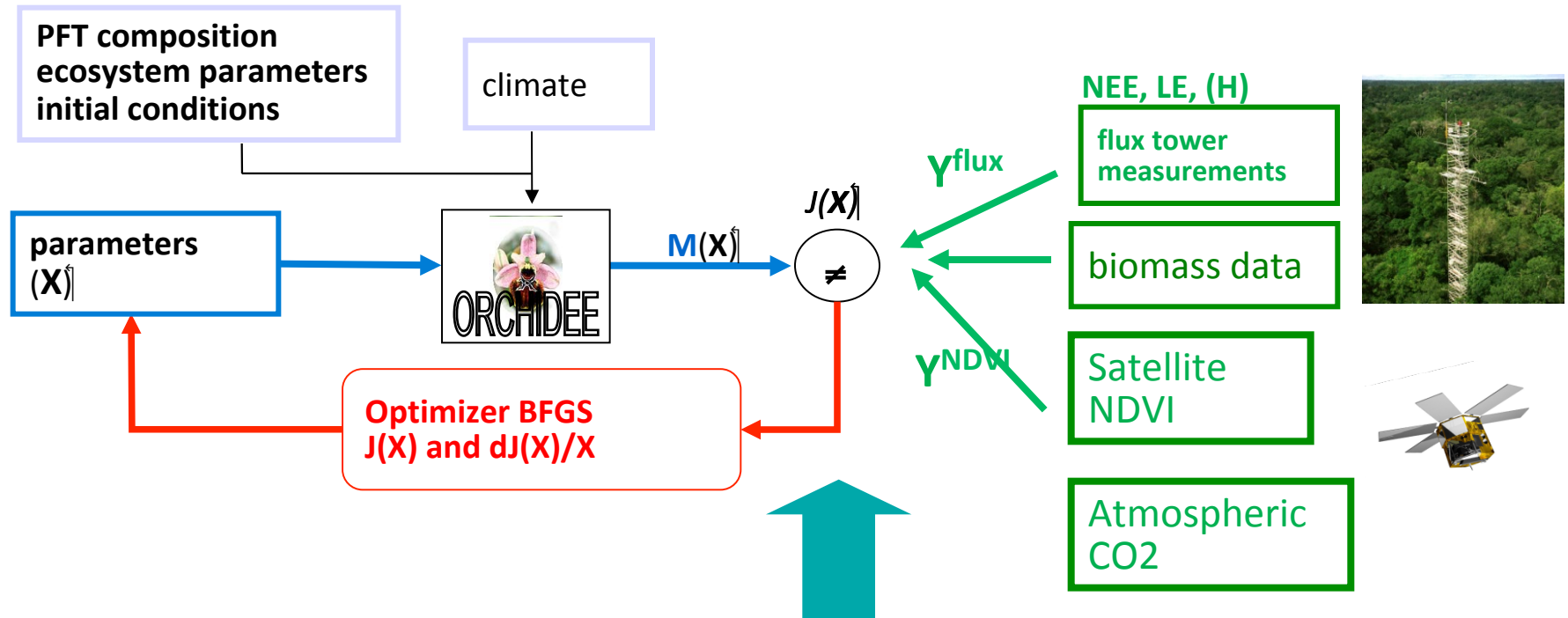


Wetlands



Soils - Cultures

Optimization of the model parameters..



- Cost function:**
$$J(x) = \frac{1}{2} \left[(y - M(x))^t R^{-1} (y - M(x)) + (x - x_b)^t P_b^{-1} (x - x_b) \right]$$

- Iterative minimization using either:**

- Variational approach (with Tangent Linear model for DJ/dx)
- Monte Carlo approach (Genetic Algorithm)