DLEM for TRENDY

----Chengcheng Gang

- **Model name:**

DLEM (Dynamic Land Ecosystem Model)

- **Lead PI or contact person and her/his affiliation:**

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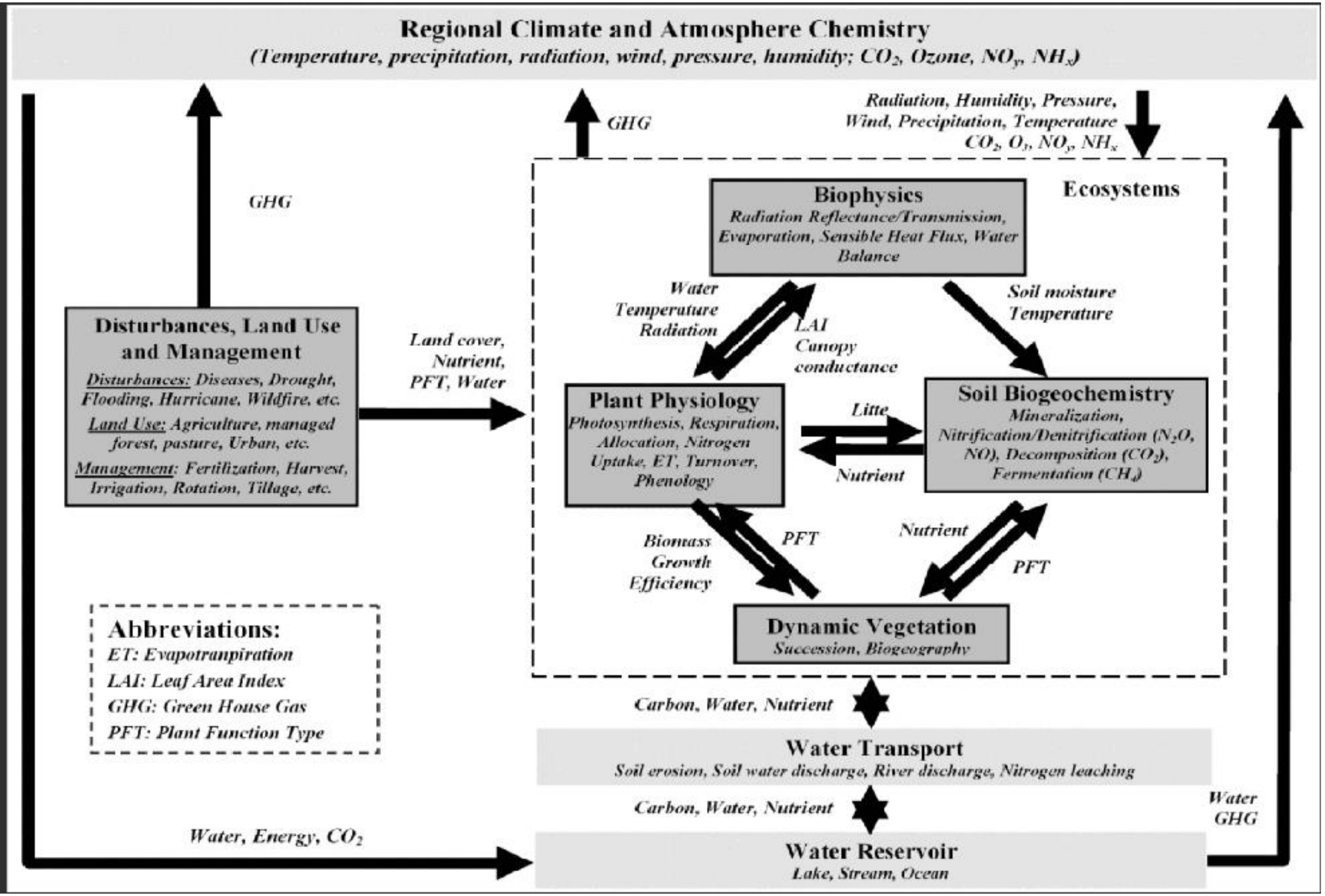


The simplified framework of Dynamic Land Ecosystem Model (DLEM)

The DLEM has five core components:

- Biophysics,
- Plant physiology,
- Soil biogeochemistry,
- Vegetation dynamics,
- Disturbance. Land use and management

Tian, H., *et al.* 2010. *Forest Ecology and Management*

- ## Static or dynamic vegetation:

DLEM does not simulate “natural vegetation”. It assumes up to four natural vegetation types coexist in one grid. The fraction of natural vegetation was estimated according to cropland area in each grid.

- ## Number of plant functional types：16

Tundra (T);
Boreal Broadleaf Deciduous Forest (BBDF);
Boreal Needleleaf Evergreen Forest (BNEF);
Boreal Needleleaf Deciduous Forest (BNDF);
Temperate Broadleaf Deciduous Forest (TBDF);
Temperate Broadleaf Evergreen Forest (TBEF);
Temperate Needleleaf Evergreen Forest (TNEF);
Temperate Needleleaf Deciduous Forest (TNDF);
Tropical Broadleaf Deciduous Forest (TrBDF);
Tropical Broadleaf Evergreen Forest (TrBEF);
Deciduous Shrub (Dshrub); Evergreen Shrub (Eshrub);
C3 grassland (C3G); C4 grassland (C4G);
Wetland; (peatlands and wetlands)
Cropland (114 crops, such as soybean, cotton, corn, rice, wheat, sorghum, etc.)

Source: *https://www.isimip.org/impactmodels/details/25/#tab_isimip2b*

- **What disturbances are simulated (e.g., land use or fire etc.)?**

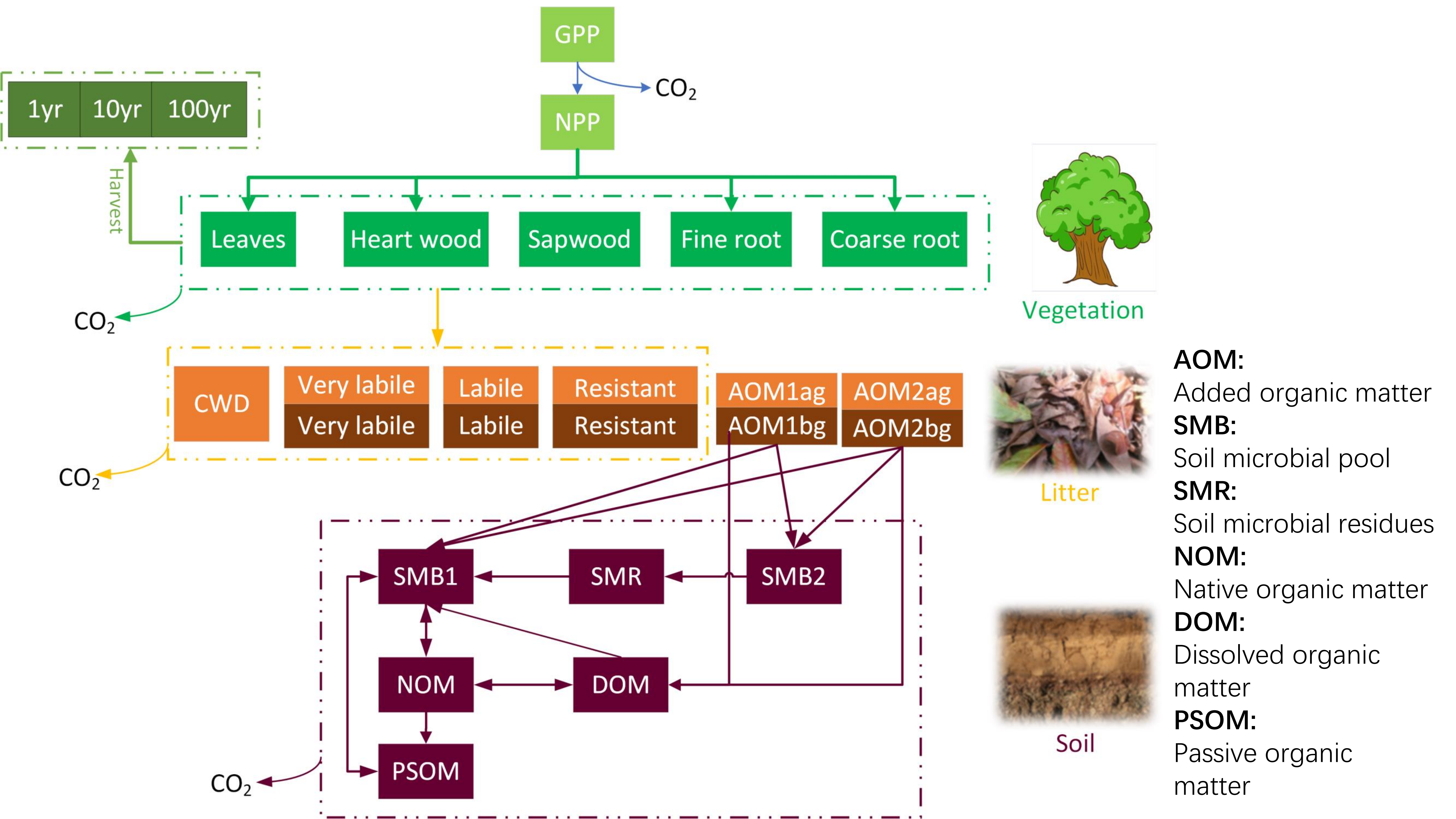
LUCC, wildfire. Fire module is not activated in TRENDY.

- **Number of carbon pools:**

6 living pools (leaf, heartwood, sapwood, fine root, and coarse root)

7 litter pools (Coarse Woody Debris (CWD), aboveground very active litter, aboveground middle active litter, aboveground resistant litter, belowground very active litter, belowground middle active litter, and belowground resistant litter. These seven pools were regrouped into four added organic matter pools.)

6 soil pools (three microbial pools, and three slow carbon pools)


GPP
CO_2
NPP
1yr
10yr
100yr
Harvest
Leaves
Heart wood
Sapwood
Fine root
Coarse root
Vegetation
CO_2
CWD
Very labile
Very labile
Labile
Labile
Resistant
Resistant
AOM1ag
AOM1bg
AOM2ag
AOM2bg
Litter
CO_2
SMB1
SMR
SMB2
NOM
DOM
PSOM
Soil
CO_2
AOM:
Added organic matter
SMB:
Soil microbial pool
SMR:
Soil microbial residues
NOM:
Native organic matter
DOM:
Dissolved organic matter
PSOM:
Passive organic matter

$$\frac{dLITC}{dt} = VEGC_{loee,\ lit} + VEGC_{loss,\ mort} + r_{luccrt} VEGC_{loss,\ lucc} + r_{harves\,tr\,t} VEGC_{loss,\ harvest} - LITC_{loss,\ dec} - LITC_{loss,\ dist}$$

$$LITC_{loss,\ dec} = \sum_i \left(k_{lit}^i f^i(T) C_{LIT}^i\right) f(W) f(N)$$

$$f^i(T) = \begin{cases} 0 & for\ T \leqslant -10^oC \\ e^{308.56\left(\frac{1}{71.02} - \frac{1}{T+46.02}\right)} & for\ T > -10^oC \end{cases}$$

$$f(W) = \begin{cases} 1 & for\ vwc_{opt\min} \leqslant vec \leqslant vec_{opt\max} \\ \dfrac{vwc(vwc - 1)}{vwc(vwc - 1) - (vwc - vwc_{opt\min})^2} & for\ vwc > vec_{opt\min} \\ \dfrac{vwc(vwc - 1)}{vwc(vwc - 1) - (vwc - vwc_{opt\max})^2} & for\ vwc > vec_{opt\max} \end{cases}$$

$$vwc_{opt\min} = vwc_{wp} + \frac{vwc_{fc} - vwc_{wp}}{4}$$

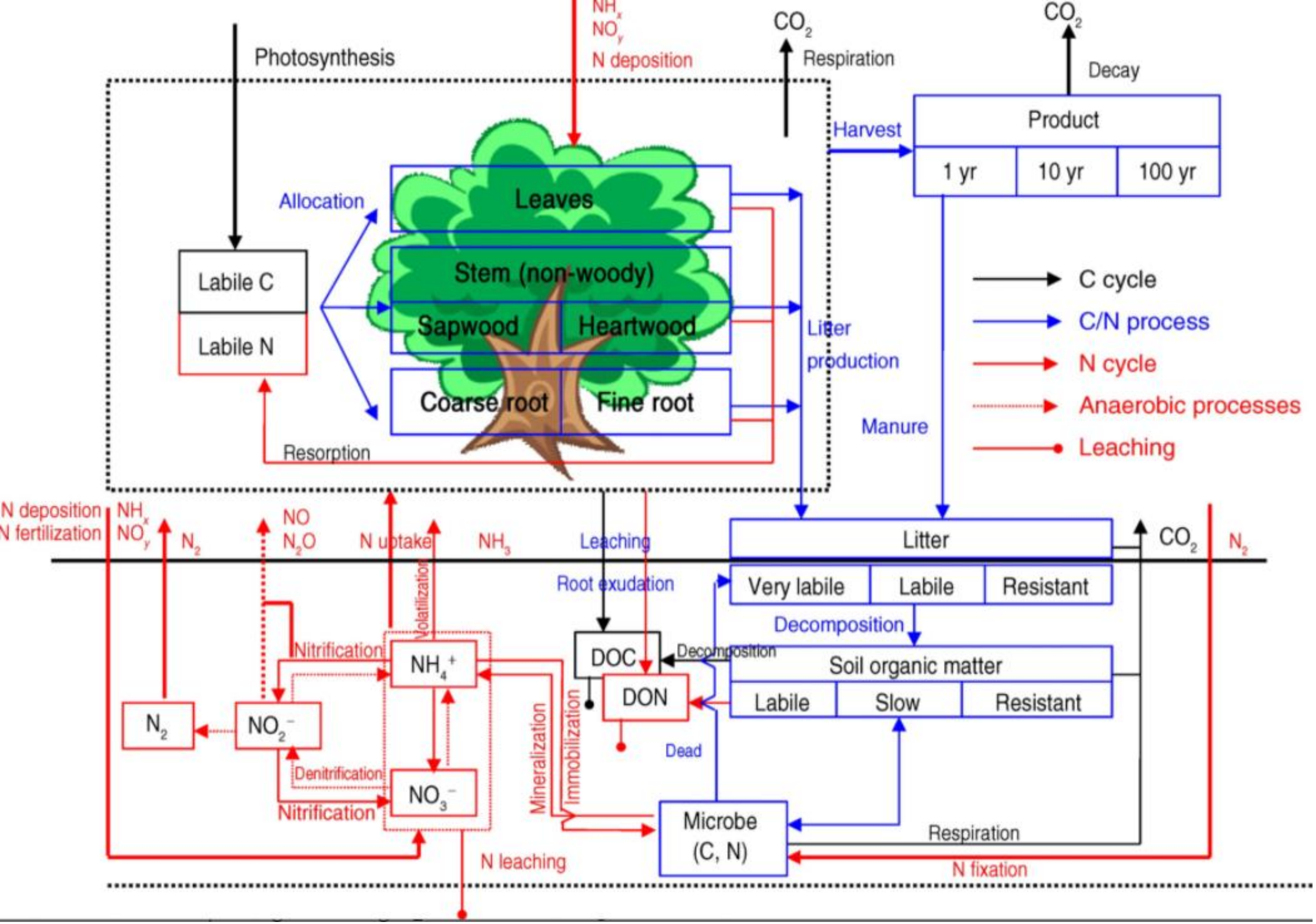
$$vwc_{opt\min} = vwc_{wp} + \frac{vwc_{fc} - vwc_{wp}}{4}$$

$$f(N) = 0.9 + 0.1\sqrt{8.5/CN_{som,\ r}}$$

$$\frac{dC_{SOM}}{dt} = k_{tr} LITC_{loss,\ dec} + k_{gppdoc} GPP + k_{tr\,prd} PRD_{decom} - k_{rh} SOMC_{decom} - k_{luccsomcrt} C_{xom} - DOC_{loss,\ microb} - DOC_{loss,\ me\,th\,ane}$$

$$SOMC_{decom} = \sum_i (k_{som}^i f^i(T) C_{SOM}^i) f(W) f(N)$$

Tian, H., *et al*. 2010. ACTA GEOGRAPICA SINICA



The coupling of C and N cycles. Lu, C., et al. (2012), Ecological Applications

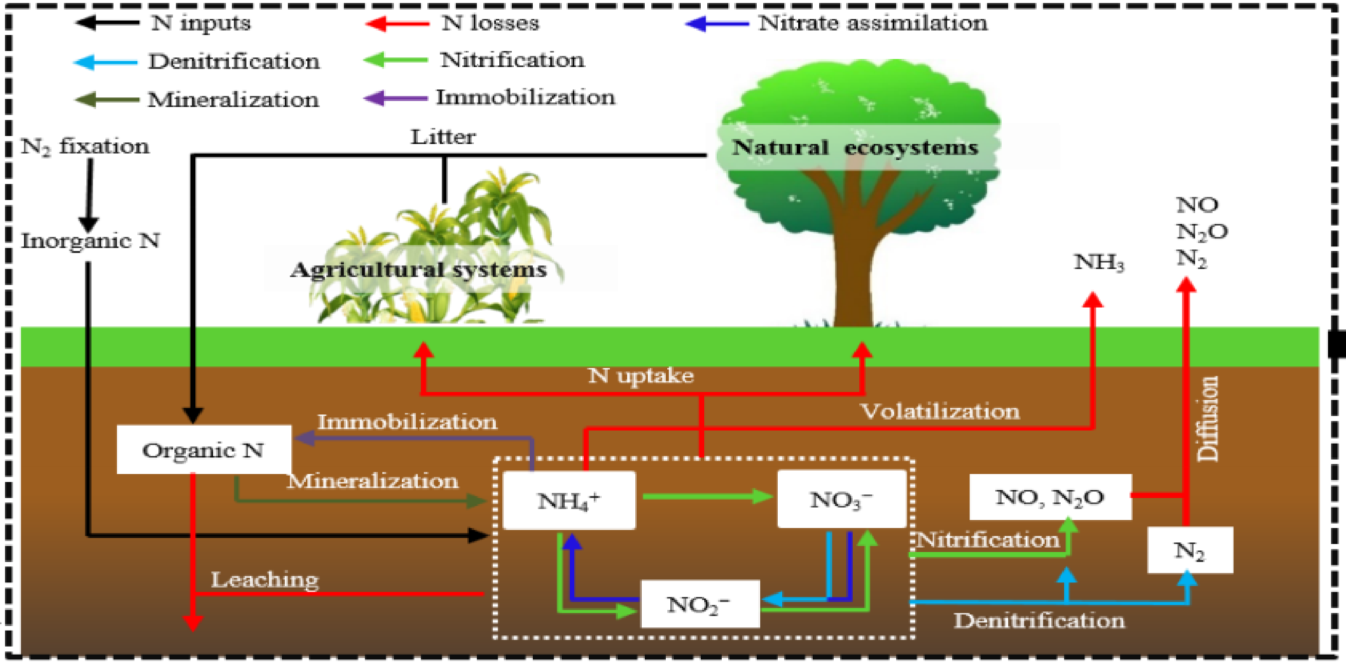
Framework of N_2O Model Intercomparison Project (NMIP)

Model input data

- Climate (Temperature, precipitation, radiation, etc.)
- CO_2 concentration
- N deposition
- N fertilizer use
- Manure N use
- Irrigation
- Land cover and land use
- Soil texture
- topography (elevation, slope, aspect, etc.)

Model calibration & evaluation

- Field observations
- Statistical extrapolation
- Inversion models



Participating Models: CLM-CN, DLEM, LM3V-N, O-CN, LPJ-GUESS, ORCHIDEE, ORCHIDEE-CNP, TRIPLEX-GHG, VISIT

Objective 1

Unravel the major controlling processes of N_2O fluxes and the uncertainties from model structure and parameters

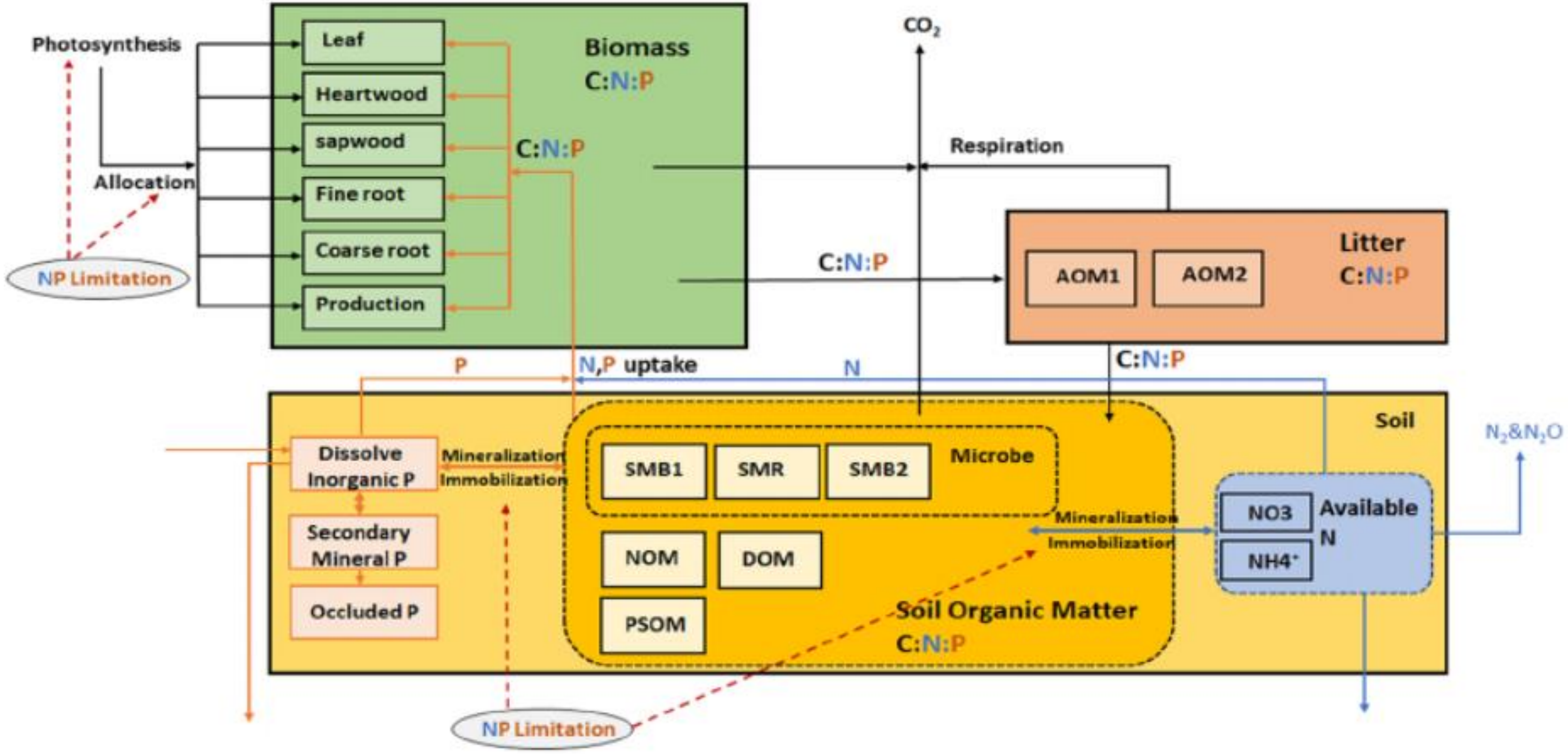
Objective 2

Quantify spatial and temporal patterns of global/regional N_2O fluxes, and attribute the relative contributions of multiple environmental factors

Objective 3

Provide a bench-marking estimate of global and regional N_2O budgets through synthesizing multi-source data

NMIP benchmarks for model performance and data evaluation



The P cycle in DLEM. Wang Z., et al. (2021), JAMS.

- **Outputs for TRENDY**

The results are not open accessible.

MAIN CONCERNS:

Not all the pool information, how to quantify the relations between various pools;

$$\frac{dX(t)}{dt}=\mathbf{B}U(t) - \mathbf{A}\xi\mathbf{C}\, X(t)$$

The scenario to be used?