Permafrost Ecosystem changes across the Arctic: Carbon and nutrients cycling in terrestrial-aquatic Environments
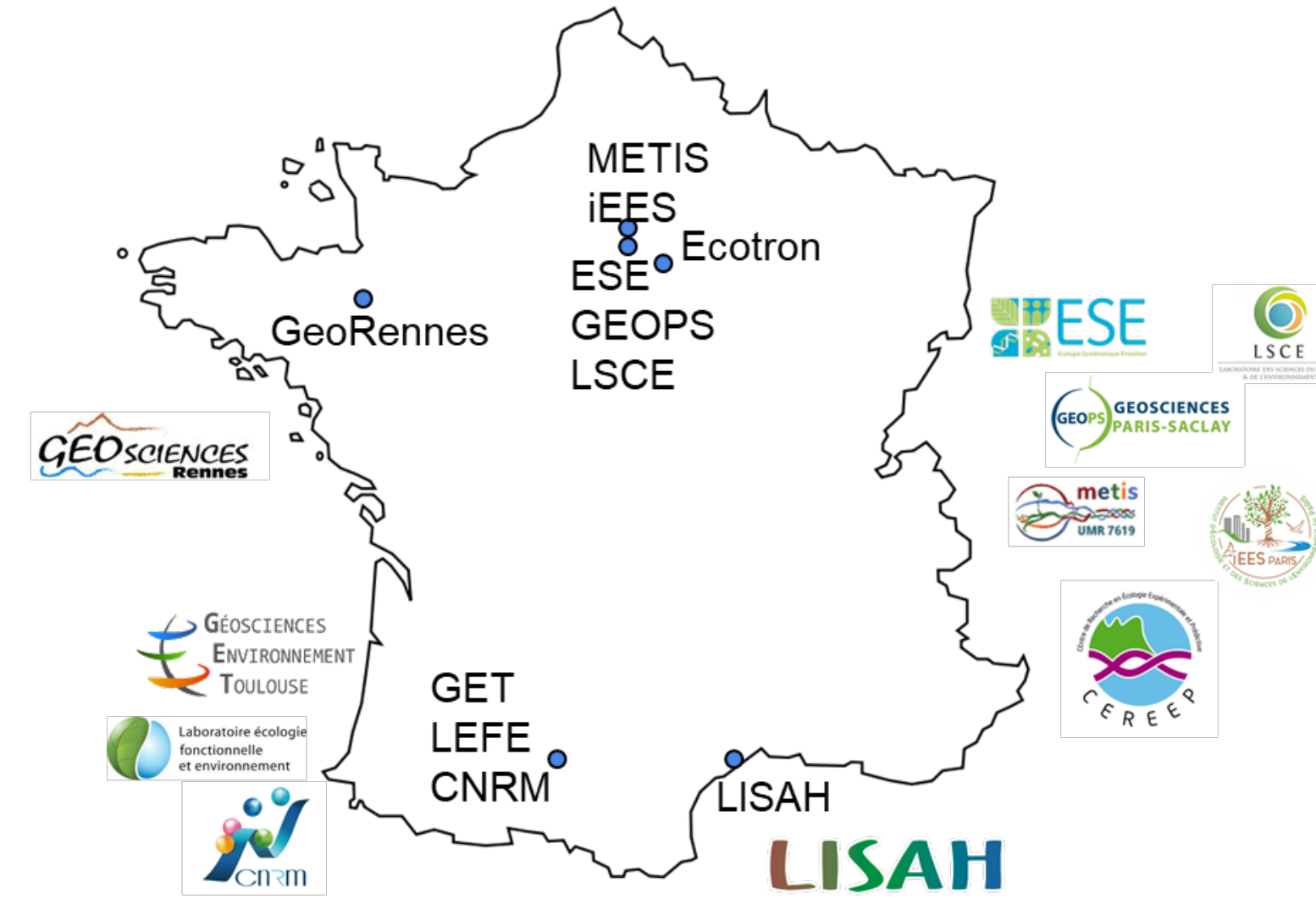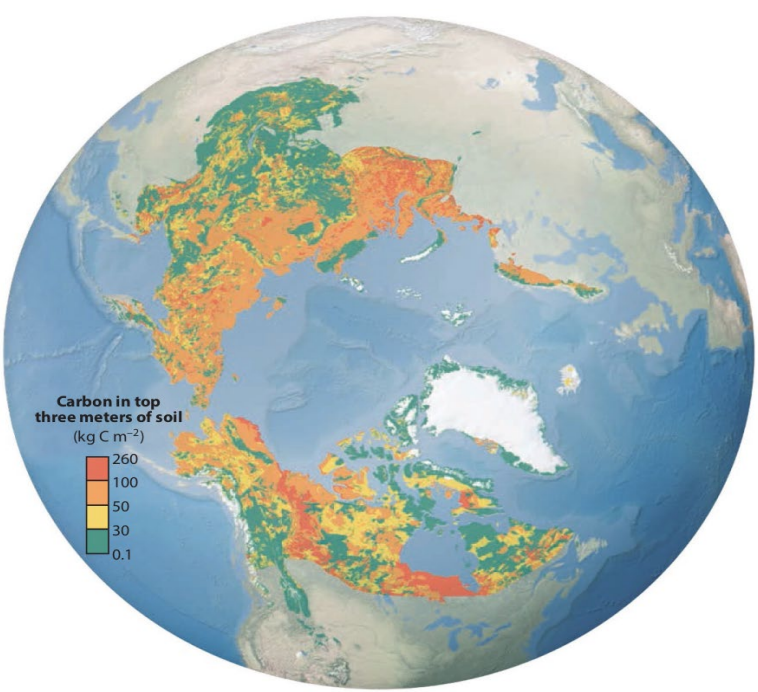
PEACE — Permafrost Ecosystem change across the Arctic Carbon and nutrients cycling in terrestrial-aquatic Environments

PI: Liudmila Shirokova

co-PI: Marie Alexis, Christine Delire, Julien Fouché, Laure Gandois, Antoine Séjourné

3 research institutes + 6 universities

Permafrost soils : a huge carbon stock under climate pressure

PEACE project main question : How do climate-driven degradation of permafrost and vegetation changes affect Arctic ecosystem C-N-P dynamics and transfers along the plant-soil-hydrosystem continuum?

1. Present-day permafrost properties & vegetation control the spatial distribution of C-N-P stocks

2. Permafrost degradation will **unlock amounts of N and P** in northern ecosystems

3. C-N-P availability, altered by thaw, is **desynchronized in space and time** and along the **soil-water continuum**.

4. Changes in C-N-P availability will control permafrost ecosystem **C sink** vs **source** potential

33% global soil organic C (0-3 m) + large N stock

CO_2 CH_4 N_2O CO_2 CH_4 N_2O

Permafrost gradual thaw
Heimans et al., 2022
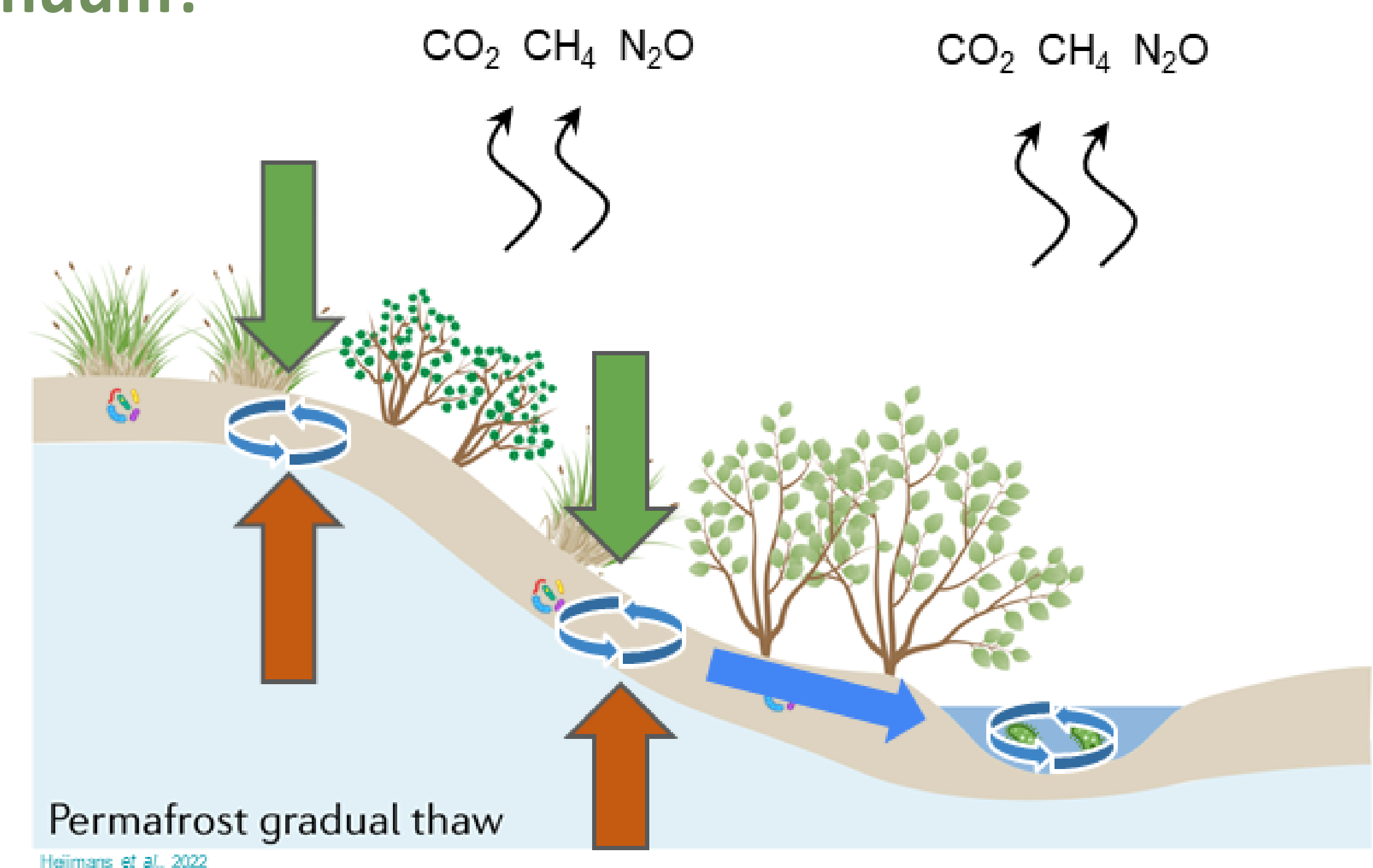
High spatial heterogeneity

The PEACE project integrated approach: (retro)-observation, experimentation and modelling

WP0 - Coordination, management, workshop organization
To the Arctic and Beyond: Arctic-thèque & innovative monitoring and modelling strategies to gather the FairCarboN community

WP2 –SPATIALITY
Spatial distribution of the C-N-P?

C-N-P stocks & OM compositions
Fouché, Bouchez et al., 2021

WP3 – PROCESSES
Mineralization, leaching and storage effect on stoichiometry cascade?
GHG emissions
Microbial role
C-N-P cascade
Temperature

WP1 – ARCTIC-THEQUE database: Spatial and temporal heterogeneity of C-N-P stocks & fluxes?

WP4 – CONNECTIVITY & TEMPORALITY
Permafrost degradation control on C-N-P lateral fluxes?
C-N-P lateral and temporal fluxes
Gandois et al., 2021

WP5 – MODELLING
Impact of C-N-P evolution on C stocks in the Arctic under climate change ?
Delire et al., 2020

WP2 : Julien Fouché

2.1 to analyse C-N-P stocks in plants, permafrost soils and ground ice, from the surface to 3 m deep for ~50 sampling points in ~20 sites
2.2 to characterise OM composition in plants and soils

WP1 : Antoine Séjourné, Maialen Barret

1.1 Standardisation of open access data and data collection
1.2 Web database construction and open long-term access
1.3 Maintenance of data management plan

WP5 :Christine Delire, Xavier Raynaud, Laurent Orgogozo, Bertrand Decharme
5.1: Statistical modelling of relationships between measured variables.
5.2: Organic matter modelling derived from physically based models.

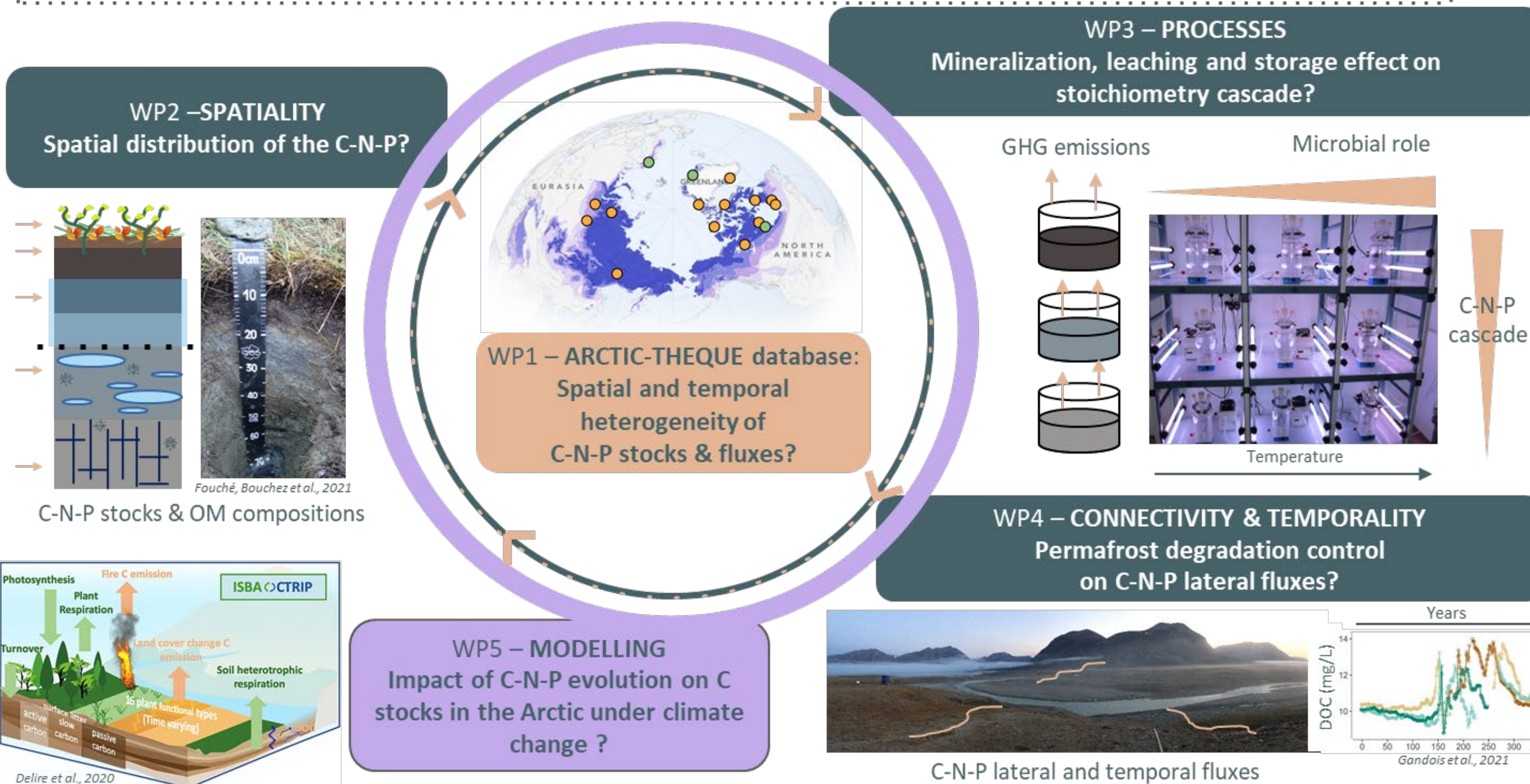**WP3 :Marie Alexis, Samuel Abiven, Liudmila Shirokova**
3.1 The plant-soil-hydrological continuum: Response of C and N emission and transfer to OM composition
3.2 N, P release due to the shift of water migration layer from organic towards mineral horizon for permafrost sites.
3.3 Consequences of seasonal shift for plant growth and N, P absorption vs. microbial degradation and immobilisation

WP4 : Laure Gandois, Antoine Séjourné, Camille Bouchez
4.1 Precise coupling of water sources with C-N-P along the terrestrial to aquatic continuum in degrading permafrost watershed (mineral and organic soils)
4.2 High frequency (1h) survey of DOC and NO3 concentrations in low and high flow conditions in degrading permafrost watershed (mineral and organic soils)