Residence time of nitrogen deposit in a nival subalpine catchment using the hyper-resolution ParFlow-CLM-EcoSLIM critical zone model.

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Mountain regions represent a particular challenge for critical zone modelling as snowpack interacts with soils, vegetation, surface water and atmosphere and plays a primary role on the water transfers but also on the carbon and nitrogen cycles. Indeed, in these environments ecosystems are adapted to a snow regime under change due to the rise in the 0°C isotherm. In addition, atmospheric nitrogen deposition, a product of industrial activity carried by valley winds and mesoscale atmospheric circulation, already impacts some high-altitude ecosystems by modifying nutrient flows (nitrogen and carbon in particular). These combined forcings could lead to major ecosystem changes (distribution of water, carbon and nitrogen flows, growth rates, species, etc.). Anticipating this evolution, and the associated flows (CO2, nitrogen, water) under this double constraint, remains problematic due to the lack of adapted models.

In this study, we use the Parflow/CLM/Ecoslim model on a small (17ha) nival subalpine catchment close to Lautaret Pass (French Alps) where meteorological and hydrological parameters are measured together with snowpack survey and chemical concentrations measurements in the air, the rivers, the snowpack the vegetation and the ground. Simulations are constrained by a spatially distributed forcing and evaluated from snowpack dynamic and ET measurements. The simulations allow us to estimate the Nitrogen quantities that can be processed by vegetation and those drained in river flows. The estimation of the residence times is then calculated from the velocity field in the catchment. The wide snow cover time distribution leads to wide distribution resident time for any particle deposit. This can impact nitrogen chemical history and any other chemical compounds in the snow pack and the ground even for such small scales.