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Drivers of changes in the permafrost late shoulder season

Cécile Osy[1], François Massonnet[2], and Sophie Opfergelt[3]
[1]Earth and Life Institute, UCLouvain, Louvain-la-Neuve, Belgium (cecile.osy@uclouvain.be)
[2]Earth and Life Institute, UCLouvain, Louvain-la-Neuve, Belgium (francois.massonnet@uclouvain.be)
[3]Earth and Life Institute, UCLouvain, Louvain-la-Neuve, Belgium (sophie.opfergelt@uclouvain.be)

The Arctic has been warming two to four times more rapidly than the global mean in the last decades – a phenomenon known as Arctic Amplification. This warming induces changes for the whole cryosphere, including the permafrost. A first-order marker of permafrost health is the timing of snowfall compared to the timing of the freezing of the upper soil layer, which together determine the length of its late shoulder season. The late shoulder season of permafrost is the period after plant senescence and before the freezing of the active layer of the permafrost. Its length depends on the air temperature, but also on the timing of snowfall. The snow insulates the ground from the atmosphere, and snow cover will delay the freezing of the ground if it falls before the air temperature drops below freezing point. On the other hand, if the snowfall occurs after the ground freezing, it is expected that the freezing will be more persistent and will reach deeper soil layers more rapidly.

There is to date no large-scale view of the late shoulder season characteristics in the Arctic permafrost regions and how this shoulder season is evolving in a warming Arctic. Here, a study of the temporal variability of the late shoulder season of the permafrost is proposed. To that end, the temporality of the first relevant snowfall and freeze of the top layer of the ground is studied from 1950 to 2020 in the ERA5-Land reanalysis. The temporal trends will be spatialized to account for the spatial heterogeneity of the study area, and to study which variables other than the snow (vegetation, topography, ...) influence the length of the shoulder season. The surface pressure and atmospheric circulation in the ERA5 reanalysis is also looked at to explain punctual extreme events and interannual trends..