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Phenological record based on ground observation and remote sensing in support of climate-smart forestry

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The phenological phases, such as flowering, bud break and growth reactivation, occur in primary and secondary meristems, determining the annual plant development and consequently plant growth. Climate change may impact tree growth, altering the response of trees to disturbances. A better understanding of the events that occur at meristem level and the relationship with environmental drivers is required for planning mitigation and adaptation strategies. The effect of climatic factors, such as temperature and precipitation, on plant growth can be used to establish a link between climatic changes and phenological responses, thus providing reliable predictions about plant responses with a long-term perspective.
We analysed the phenology of meristems in conifers along latitudinal and altitudinal gradients in boreal forests of Quebec (Canada), composed by balsam fir and black spruce. Micro-cores were collected with the aim to analyse the xylem phenology, while the bud phenology was studied through direct and satellite observations.
The correlation between the phenological phases of bud development and the xylem differentiation was investigated. This relationship was also analysed considering long-term chronologies of xylem growth and the timing of plant phenology detected by Normalized Difference Vegetation Index (NDVI). Furthermore, the relationships between xylem phenology and temperature was explored.
The results obtained provided new knowledge on the dynamics of spring phenology and novel information on the synchronisms between the two meristems for boreal tree species. The analysis of long-term chronologies demonstrated that the timing of xylem formation can be suitably estimated at wide geographical scale using remote sensing data.
This study deepened some aspects of the mechanisms and factors that affect xylogenesis, the links with wood production and consequently tree growth. These aspects may elucidate the dynamics of carbon storage in wood tissue, with possible impacts on wood quality. The timing and dynamics of xylem formation studied locally and estimated at the large scale represent a suitable tool for accurately assessing the temporal variation of carbon sequestration, and are important for modelling purposes. Finally, this approach may support the task for developing useful indicators for climate-smart forestry.