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Natural and Anthropogenic C and N isotopic Trends in Trees growing near oil-sands developments

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Carbon and Nitrogen stable isotopes of tree-ring series have been shown to detect past air and soil pollution effects on forests in the contexts of point sources, highways or peri-urban regions. Here, we want to assess their potential to understand such changes near Canadian oil sands developments where truck fleets, oil upgraders, desulphurization and hydrogen plants, boilers, heaters and turbines have been expanding in a complex temporal and spatial fashion since 1967.

Black and white spruce trees [*Picea mariana* (Mill.) B.S.P., and *Picea glauca* (Moench) Voss] 135 years or older, were selected in three forest sites with distinct characteristics: a closed black spruce-dominated stand growing on a poorly drained podzol (pH= 4.0-5.1), 13 km north-east FROM the heart of operations (site 1); and two open white spruce-dominated stands growing on well drained brunisols 37 km south-east (pH=5.0-8.5, site 2) and 48 km east (pH=4.6-7.8, site 3) of operations. Growth rings were dated and separated at a resolution of 1 or 2 years for the 1880-2009 period. At all sites, the average cellulose δ^{xz}C values covering the 1880-1965 period show short-term variations mostly explained by regional climatic conditions, whereas the 1966-1995 series present similar short-term variations superimposed on a bell-shape trend covering the 1968-1996 period and peaking between 1978 and 1988. The 1998-2008 period shows a general rise. These δ^{13}C trends reflect changes in air quality and suggest that air contaminants emitted from oil-sands developments affected the photosynthetic functions of the studied trees, but that the foliar system was recovering between 1988 and 1996, perhaps due to the implementation of new emission targets regarding SO_2. The temporal δ^{15}N trends of treated wood are quite different from site to site, likely reflecting different local ecological and pedogeochemical conditions. During the operation period, site 1 shows a 1‰ rise in δ^{15}N values, site 2, an average decrease of 1.0‰ and site 3, a 0.5 increase followed by a 0.7 ‰ decrease. Our preliminary interpretation of these trends is that anthropogenic N increases the regional soil isotopic signal and dominates in trees of site 1 where soil N saturation is perhaps attained, favours miccorhizal fungi activities which release light N for the host trees growing under non-saturated conditions at site 2, and somehow generates intermediate conditions at site 3. The analyses of the statistical links between climatic parameters and the isotopic C and N responses during the pre-operation period are in progress in order to assess if predictive climatic models can be developed to project the natural isotopic behaviour in the recent period. Our current results suggest that ring δ^{15}N series from trees growing in dry boreal conditions display complex patterns which are difficult to interpret.