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Nitrogen isotopes in Tree-Rings – An approach combining soil biogeochemistry and isotopic long series with statistical modeling

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Monitoring atmospheric emissions from industrial centers in North America generally started less than 25 years ago. To compensate for the lack of monitoring, previous investigations have interpreted tree-ring N changes using the known chronology of human activities, without facing the challenge of separating climatic effects from potential anthropogenic impacts. Here we document such an attempt conducted in the oil sands (OS) mining region of Northeastern Alberta, Canada. The reactive nitrogen (Nr)-emitting oil extraction operations began in 1967, but air quality measurements were only initiated in 1997. To investigate if the beginning and intensification of OS operations induced changes in the forest N-cycle, we sampled white spruce (Picea glauca (Moench) Voss) stands located at various distances from the main mining area, and receiving low, but different N deposition. Our approach combines soil biogeochemical and metagenomic characterization with long, well dated, tree-ring isotopic series. To objectively delineate the natural N isotopic behaviour in trees, we have characterized tree-ring N isotope (15N/14N) ratios between 1880 and 2009, used statistical analyses of the isotopic values and local climatic parameters of the pre-mining period to calibrate response functions and project the isotopic responses to climate during the extraction period. During that period, the measured series depart negatively from the projected natural trends. In addition, these long-term negative isotopic trends are better reproduced by multiple-regression models combining climatic parameters with the proxy for regional mining Nr emissions. These negative isotopic trends point towards changes in the forest soil biogeochemical N cycle. The biogeochemical data and ultimate soil mechanisms responsible for such changes will be discussed during the presentation.