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Effects of SO2 emissions in Alberta, Canada on lodgepole pine climate-growth relationships

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The growth response of trees to climate can be altered by other environmental changes that a tree may face including pollution or fertilization. In this study, the effect of spatial and temporal patterns sulfur dioxide (SO_2) emissions on climate-growth relationships of lodgepole pine (Pinus contorta) in two areas of Alberta, Canada was assessed. Twenty tree cores were collected in each of four stands per study area: two near a source of SO_2 emissions (sour gas processing facility) and two far from the source of emissions. To select important climate variables, the average standardized tree ring width of all trees in each area were first compared to monthly average temperature and total precipitation variables. For each important climate variable, response function analysis was conducted between standardized tree ring widths and climate in each of three SO_2 exposure time periods: a period pre-dating any emissions, a period of high emissions, and a more recent period of reduced emissions. Linear mixed models were used to compare response coefficients of tree ring widths to climate between exposure space (near or far from the source of emissions) and exposure time (no emissions, high emissions, reduced emissions) and the interaction between them. The absolute values of predicted ring widths in each exposure space and exposure time in each area were used as a response variable in a linear mixed effects model to assess the effects of SO_2 exposure on the magnitude of tree growth response to climate. SO_2 exposure time was a significant term in all climate-growth relationship models. Exposure space was significant in 13 out of 20 models, and the interaction between exposure time and exposure space was significant in 14 out of 20 models. The effects of exposure time and exposure space on climate-growth relationships were not consistent between climate variables. Overall, tree growth responded most strongly to climate in the high exposure time period. The increase in magnitude of climate-growth relationships in the high SO_2 exposure time period may indicate that trees stressed by sulfur deposition are not able to buffer the effects of climate, and are more susceptible to extreme weather conditions such as drought. However, the response to climate during the high emission period was greater far from the source of emissions than near the source of emissions; This could be because the historical addition of lime to stands near the sour gas processing facilities resulted in less sulfur stress. SO_2 emissions in Alberta may alter climate-growth relationships of lodgepole pine.