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Modeling tree growth and stable isotope ratios of white spruce in western Alaska.

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Summer temperatures are assumed to exert a dominant control on physiological processes driving forest productivity in interior Alaska. However, despite the recent warming of the last few decades, numerous lines of evidence indicate that the enhancing effect of summer temperatures on high latitude forest populations has been weakening. First, satellite-derived indices of photosynthetic activity, such as the Normalized-Difference Vegetation Index (NDVI, 1982-2005), show overall declines in productivity in the interior boreal forests. Second, some white spruce tree ring series strongly diverge from summer temperatures during the second half of the 20th century, indicating a persistent loss of temperature sensitivity of tree ring proxies. Thus, the physiological response of treeline forests to ongoing climate change cannot be accurately predicted, especially from correlation analysis. Here, we make use of a process-based dendroecological model (MAIDENiso) to elucidate the complex linkages between global warming and increases in atmospheric CO_2 concentration [CO_2] with the response of treeline white spruce stands in interior Alaska (Seward). In order to fully capture the array of processes controlling tree growth in the area, multiple physiological indicators of white spruce productivity are used as target variables: NDVI images, ring widths (RW), maximum density (MXD) and newly measured carbon and oxygen stable isotope ratios from ring cellulose. Based on these data, we highlight the processes and mechanisms responsible for the apparent loss of sensitivity of white spruce trees to recent climate warming and [CO_2] increase in order to elucidate the sensitivity and vulnerability of these trees to climate change.