Time-lag effects of forest ecosystem response to climate change in continental dry climate zones over the circum-Arctic; a multiple approach using satellite images and tree-rings analyses

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Circumboreal forest ecosystems are exposed to a larger magnitude of warming in comparison with the global average, as a result of warming-induced environmental changes. Understanding the sensitivity of tree growth to climate in these ecosystems is an important factor in the accuracy of future projections of the terrestrial carbon cycle, and also of global climate. However, it is not certain how these ecosystems respond to these changes.
In this study, we compared past 30 years spatio-temporal variation of Global Inventory Modeling and Mapping Studies (GIMMS) satellite derived normalized difference vegetation index NDVIg, its recent successor version NDVI3g, and tree-ring width index (RWI) on International Tree-Ring Data Bank (ITRDB) over circum-arctic region (>50N) with respect to relationship with climate change. The comparisons are conducted for linking those indices each other and for obtaining better estimate of vegetation activity response to climate change.
We calculate correlation coefficients between those indices and both previous and current year meteorological data, for each grid/site, and higher correlation coefficients were considered as actual response of forest ecosystem. Given the time lag effects of RWI or NDVI response to climate change, above indices in continental dry regions such as inner Alaska and Canada, southern part of Europe and southern sections of the Rena river basin in eastern Siberia tend to show significant negative correlation with summer temperature of previous year, suggesting further reduction of ecosystem carbon uptake with future warming.
Our findings highlight that the time lag effects of forest ecosystem response to climate change significantly affects relationships between both NDVI and RWI, and climate variables and it therefore should be incorporated into future carbon cycle studies. Otherwise, future projection of forest ecosystem carbon uptake may be overestimated under expected future further warming.

Keywords: Arctic and sub-Arctic ecosystems, carbon cycle, tree ring, remote sensing

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