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Climate impacts of a greener north

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Satellite remote sensing, in-situ field observations, and aerial photographs all indicate that an increase of vegetative greenness is occurring in the northern high latitudes, apparently in response to the warming climate in recent decades. In order to identify the impacts on the climate system of a greening north, we employed the atmospheric general circulation model ARPEGE-CLIMAT to conduct a series of simulations, including one control and two sets of sensitivity experiments. The first set of sensitivity experiments was used to investigate overall climate impacts of a greener north, both vegetation coverage and leaf area index were increased by 20% poleward of 60˚N to mimic the manifestation of vegetation changes in the real world, and by 60% and 100% to represent potential aggressive scenarios of vegetation change. The increased greenness in the northern high latitudes leads to a warmer and wetter climate. Surface air temperature shows a marked increase by about 2˚C during spring and early summer and about 1˚C during the rest of the year, when greenness was increased by 100%. Precipitation and evaporation also show a notable increase of about 10% during the summer. To identify relative roles of respective elements of the vegetation changes in contributing to the above-mentioned impacts, we conducted a second set of sensitivity experiments, in which we either only increased vegetation coverage (color) or only increased leaf area index (production) over the land poleward of 60˚N. Their comparisons with the control experiment suggest that the “color” makes significant contribution to the warmer atmosphere while the “production” does not. Increased “production” leads to an enhancement of precipitation, including both convective and large scale components. Although the “color” does not have an obvious impact on total precipitation, it changes its partitioning, with an increase in convective precipitation and a decrease in large scale precipitation.