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The effect of northern forest expansion on evapotranspiration overrides that of a possible physiological water saving response to rising CO_2: Interpretations of movement in Budyko Space

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During the last six decades, forest biomass has expanded in the Northern Eurasian basins, mainly due to forest management. This expansion should imply an increasing effect on evapotranspiration. However, increasing global CO_2 emissions also trigger physiological plant water saving responses that induce an opposite effect on evapotranspiration. The dominant long-term and large-scale effect on evapotranspiration is still a matter of debate. In this study, we determined the dominant effect on evapotranspiration in Northern forests during the period 1961–2012 by studying change-effects on the ratio of actual evapotranspiration to precipitation, known as the evaporative ratio. We used the Budyko framework of water and energy availability at the basin scale to study the hydroclimatic movements in Budyko space of 65 Swedish basins. We found that changes in the evaporative ratio in 60% of these basins could not be explained by climatic changes in precipitation and potential evapotranspiration. In both the temperate and boreal basin groups studied, a positive residual effect on the evaporative ratio counteracted the negative climatic effect. Furthermore, temporal change of this residual effect during the period 1961–2012 agreed with that of the standing forest biomass in both the temperate and boreal basin groups as well as with that of the forest cover area in the temperate group. Hence, our long-term and regional-scale results indicate that a positive effect on evapotranspiration from the increasing forest biomass overrode any possible negative stomatal water saving response from increasing atmospheric carbon dioxide concentration. Thus, we suggest that forest expansion is the dominant driver of long-term and large-scale evapotranspiration changes in Northern forests.