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Modeling the impacts of warming on the long-term trends in ecosystem productivity in arctic regions of North America

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Rises in average air temperatures for the Arctic region in particular have been twice as rapid as the global average during the last century. Despite a general warming in most arctic regions, there is large spatial and temporal variation in this warming that affects the productivity of different ecosystems. In this study, we investigated long-term (1979 – 2010) spatial and temporal trends of air temperature change in northern higher latitudes of North America using climate data from the North American Regional Reanalysis (NARR) with 3-hourly time step at spatial resolution of 0.25 degrees. The NARR climate data were used to drive a comprehensive mathematical ecosystem model ecosys which simulated land-atmosphere energy and carbon exchange. Trend analysis of temperatures in different regions of the arctic shows a contrasting pattern along latitudinal and longitudinal gradients. The highest warming trend was observed in the northeast arctic with a trend of +0.72 0C decade-1, demonstrating amplified warming in the Arctic in the recent decades. Gross primary productivity (GPP), net primary productivity (NPP) and leaf area index (LAI) increased in most parts of the northern ecosystems supporting the hypothesis that higher latitudes and cooler regions tend to have greater gains in carbon attributed to warming over the last three decades. However, negative feedback was also observed in parts of Alaska. In annual scale net carbon uptake was increasing by spatial average of 0.22 gCm-2yr-1. Spatial average active layer depth (ALD) has shown an increase in most part of the region, with an average of 2.3cm decade-1. Further warming could increase the deepening of the ALD that could expose the huge volume of carbon beneath the permafrost and accelerate the rate of carbon losses.