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The role of temperature and temperature-induced drought on forest productivity in the Northern Countries

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Forests play an important role in the climate system and the global carbon cycle and is of considerable socioeconomic importance for Northern countries. For example, Sweden has pursued more intensive forest harvesting as a way of fulfilling the requirements of the EU renewable energy directive. Due to ecological and economical role of forests, it is imperative to better understand the physical and biological processes leading to potential changes in productivity.
There is no consensus regarding the net effect of raising temperatures on vegetation productivity in this area. There exist the idea that in response to warmer temperatures, forests located in cold regions may benefit from longer growing seasons and, consequently, become more productive. However, radial growth and wood density measurements suggest that in recent decades, there has been a “divergence” between warming and tree growth, with localized shifts to a negative relationship between temperature and growth. This unexpected adverse response of forests in northern areas under warming is consistent with the fact that they are becoming more vulnerable to warm-related disturbances including temperature-induced drought stress.
Here we focus on satellite NDVI record as an indicator of greenness vegetation across the Northern Countries for the period 2000 to present and explore corresponding relationships with high-resolution gridded climate data from E-OBS. By focusing on the whole Sweden, we were able to assess whether the role played by each climatic driver (precipitation, temperature and a dryness index) differed in different locations. In particular, a Partial Least Square (PLS) regression analysis was conducted to investigate the model component structure among the potential drivers explaining the annual variations of the mean NDVI observed during the growing season. We observed how forests respond differently to climatic drivers and their extremes when the increasing temperature occurs together with water stress. We also observed differences in the linkages between temperature and growth depending on when the temperature increases (within or outside the growing season).