Spatiotemporal patterns of shrub growth in a warming high Arctic: a tale of diminishing regional spatial synchrony

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Summary:
Climate change is most pronounced in the Arctic, where plant and animal populations are often strongly influenced by environmental stochasticity. Theory suggests that if environmental (i.e. climate) drivers are synchronized over large distances, this spatial synchrony should also be reflected in the population synchrony of plants and animals (the “Moran effect”). Although spatial co-fluctuations in primary production may have implications for spatiotemporal dynamics across trophic levels, remarkably few studies have assessed the role of climate and climate change in shaping spatial synchrony in plants. Here, we used dendrochronological tools to analyse climate drivers and their role in the secondary growth synchronization of the widespread dwarf shrub Salix polaris across large distances in high Arctic Svalbard (time-span = 1989–2014, n = 16 sites, maximum distance = 293 km). Summer temperature had a strong positive effect on ring growth across the archipelago. Accordingly, annual ring growth was correlated across large distances (average between-site ρ = 0.23 [0.11:0.39]), and summer temperature explained a significant part of this spatial synchrony. Interestingly, there was a marked decline in spatial synchrony since the late 1990s. This coincided with a higher frequency of rain-on-snow events, which cause ground-icing and a negative effect on ring growth in some sites, but not others, introducing local heterogeneity in growth. Comparison with time-series of above-ground biomass production (1998–2014) revealed that annual ring-growth represents a suitable proxy of annual plant biomass of both S. polaris and the vascular community as a whole. This suggests that the observed spatiotemporal patterns in secondary plant growth likely reflect similar patterns in overall plant productivity. This study is the first to demonstrate the role of climate in synchronizing Arctic primary production over large distances, with implications for energy flow through high Arctic food webs.