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IS TUNDRA PRODUCTIVITY RESPONSIVE TO CHANGES IN SEA ICE EXTENT IN THE ARCTIC?

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The sharp decline in sea ice extent, concentration, and volume observed on a pan-Arctic scale during the last decades leaves urgent questions regarding its effects on regional/global climate and on ecological processes. Changes in tundra productivity have been associated with sea ice dynamics on the basis that most tundra ecosystems lay close to the sea. Although some studies have addressed the potential effect of sea ice decline on terrestrial arctic ecosystem primary productivity (Bhatt *et al.*, 2010), a comprehensive and clear picture of the mechanisms and regional/pan-Arctic patterns remains elusive due to the lack of a sea ice/tundra productivity homogeneous pattern.
Our study design proposed two ways in which sea ice might influence tundra productivity: ***1)*** via cold air advection during the growing season (direct/weather effect); ***2)*** via changes in regional climate induced by changes in sea ice (indirect/climate effect). Here the direct/weather effect hypothesis is tested on a pan-Arctic scale: that is, tundra productivity is only coupled with sea ice when sea ice remains close enough from land vegetation during the growing season for cold air advection to limit temperatures locally.
Bi-weekly Normalised Difference Vegetation Index (third-generation GIMMS-NDVI3g data; Tucker *et al.*, 2005) was used as a proxy for primary productivity, and sea ice data was extracted from a spatially explicit daily sea ice extent data for the Arctic derived from a variety of sensors (NASA/JAXA dataset: http://kuroshio.eorc.jaxa.jp/JASMES/climate/index.html). The study period is 1981-2013 (included). The potential sea ice/tundra productivity coupling was statistically described at high spatial (8km) and temporal (15-day periods) resolutions. The type of arctic vegetation was also taken into account in the analysis of vegetation/sea ice coupling.
Results offer a mechanism that successfully explains patterns of NDVI trends as related with sea ice extent, and its heterogeneous spatial dynamics. An empirical threshold distance for cold air advection is described.
The use of longer-term datasets (1900-2013) for Yamal Peninsula – with sea ice extent obtained from Polyakov *et al.* (2003) and tundra productivity obtained from a *S. lanata* regional dendrochronology (Forbes *et al.*, 2010; Macias-Fauria *et al.*, 2012) – further confirmed the findings and enabled the translation of observed spatial patterns into varying temporal relationships between tundra productivity and sea ice extent as a function of distance to sea ice. This is important as some Arctic regions were sea ice has receded from land earlier might be seen as a valid analogue for future vegetation responses to sea ice in regions were sea ice is still abundant during the growing season. The indirect/climate effect of sea ice on tundra productivity remains to be tested.

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