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Greening dynamics of vegetation in the high latitudes: case study of the George river basin (Nunavik, Canada) from 1985-2015 Landsat data

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Rapidly increasing temperatures in the Arctic and decreasing of snow cover duration have led to longer growing seasons and changing soils for the vegetation dynamics. Arctic greening trends are well documented (Fraser et al., 2011; Tremblay et al., 2012), and recently enhanced on the tundra (Bjorkman et al., 2018) and permafrost evolution (Jafarov et al., 2018). In this context, Remote Sensing offers a unique tool for estimating the high latitude vegetation evolution in the long-term, i.e. the Landsat archive since the 80's (Ju and Masek, 2016). Spectral indices derived from visible and infra-red wavelengths provide relations that can be used to quantity vegetation properties, as the well-used Normalized Difference Vegetation Index (NDVI). Considerable advances in optical sensors technology (high spatial and temporal resolution) now unable us to track climate impact on the Arctic/Subarctic environments and changes in the physical properties of its components at broad spatial scales. Here, we propose a case study of optical remote sensing application to vegetation, in the aim to: (i) estimate the plant species dynamics over a 30-year time-period, and (ii) track their local evolution patterns, by means of in situ observations. This study is part of a participatory Program (OHMi/Nunavik) including Québec / France partnership in collaboration with the Inuit community of Kangiqsualujjuaq (Aquabio/Imalirijiit project) and supported by the Canadian "Polar Knowledge" program. The application area is located in Nunavik, northern Québec (Canada), and concerns the George River catchment (565 km length, 41 700 km^2). This large river basin covers vegetation from boreal forest (South) to arctic tundra (North). Local study sites are focused from the Kangiqsualujjuaq village (Ungava Bay); up to 300 km south, along the main river and its tributaries.
Methods: surface reflectance Landsat bands were gathered for the three years 1985, 2000 and 2015 (respectively Landsat missions 5, 7 and 8). For each period of interest, the best August cloud free scenes were chosen and mosaicked to create a cloud free mosaic covering the study area. NDVI bands were calculated and compared after cloud and water masking. NDVI trends were compared between the main vegetation types following the newly released "Ecological mapping of the vegetation of northern Quebec" (MRNFP, 2018). Field observations and helicopter survey were also conducted for validation during summer 2018.
Results reveal a clear greening trend at the river basin scale. Although greening was observed across the whole latitudinal gradient, the relative NDVI increase was stronger on the northern half of the study area, mostly covered with tundra and subarctic vegetation. In particular, sparsely vegetated zones dominated by rocks had the greatest relative NDVI increase, which may be caused by improved growth of established prostrate vegetation over the past 30 years. Clear browning trends were only observed along riverbeds and near human communities.
Future work: newly developed Normalized Anthocyanins Reflectance Index (NARI) using Sentinel-2 red-edge bands (689 to 719 μm) will enable us to map Ericaceous-dominated shrubland expansion in Arctic/Subarctic environments at large scale, and will improve our understanding of their contribution to the greening dynamics.