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Seasonality of Air-sea-ice-land Variables for Arctic Tundra in Northern Eurasia and North America

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The strength of tundra productivity trends as measured by the annual maximum Normalized Difference Vegetation Index (MaxNDVI) and time integrated NDVI (TI-NDVI) vary around the Arctic over the 1982-2008 period. Our analysis suggests that the timing of terrestrial vegetation growth is connected to seasonal patterns of sea-ice concentrations, ocean temperatures and land surface temperatures.

This study used SSMI estimates of sea ice concentration, based on a bootstrap algorithm and AVHRR radiometric surface temperature. Summer Warmth Index (SWI) was calculated as the sum from May to August of the degree months above freezing of surface temperature at each pixel and is an accepted measure of plant growth potential. The Normalized Difference Vegetation Index (NDVI) represents vegetation greenness and has been used extensively to monitor changes in the Arctic. The albedo of green plants varies with solar radiation wavelength, which is the basis for the NDVI index. The analysis was conducted within 50 km of the Arctic coastline to focus on the region of maximum maritime influence. Time series of regional sea-ice concentration, SWI and NDVI were constructed for the 50-km width domains for the Pan-Arctic, North America, Eurasia and Arctic subregions. Standard climate analysis techniques were applied to the regional time series to investigate the seasonality of sea ice, NDVI and SWI.

MaxNDVI has increased in the 50-km land domain contiguous to the Beaufort Sea by 17% since 1982, whereas it has only increased by 3% in the coastal Kara Sea region. Analysis of semimonthly MaxNDVI indicates that the vegetation greens up more rapidly in the spring in the Beaufort than the W. Kara and the Kara has slightly higher NDVI in the fall. The climatological weekly sea ice concentrations in 50-km coastal domain displays an earlier breakup in the Beaufort and a later freeze-up in the Kara Sea area. Regional differences in the seasonal cycle can in part explain the spatially varied trends of climate variables related to tundra vegetation.

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