Comparison of Arctic Tundra Bioclimate Subzones and AVHRR Surface Temperature, and Relationship to NDVI

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In order to understand the effect of climate change on arctic vegetation, we need to understand how temperature has influenced existing vegetation distribution. The Arctic Tundra Bioclimate Zone was divided into five different bioclimate subzones as part of the Circumpolar Arctic Vegetation Map (CAVM), in an effort to delineate areas with similar vegetation. However, temperature data are sparse in the Arctic, so these subzones were generalized, based on widely scattered ground climate station data and interpreted from available information about plant distribution in the Arctic, an admittedly somewhat circular process.

In this study, an independent source of temperature data, surface temperatures derived from AVHRR satellite data, was compared with the CAVM bioclimate subzones. AVHRR surface kinetic temperature data were summarized into monthly means by NASA (Comiso 2003). Summer temperatures for the earliest ten years of the satellite record (1982-1992) were used to calculate mean summer warmth index (SWI). SWI is the sum of the monthly means above 0 ˚C, and correlates well with tundra plant growth. SWI data were grouped into 5 classes corresponding to tundra bioclimate subzones: Bioclimate Subzone A = < 6 ˚C, B = 6-9 ˚C, C = 9-12 ˚C, D = 12-20 ˚C and E = 20-35 ˚C.

The classes based on the satellite SWI data are much more spatially heterogeneous than the CAVM subzones. Although the classes show the same general decrease in SWI with latitude as the bioclimate subzones, inclusions of adjacent subzones occurring within each CAVM-mapped bioclimate subzone class. The SWI also incorporates the effect of elevation, so that mountain ranges are especially heterogeneous. CAVM bioclimate subzones were mapped using the zone at the base of the mountain, with an understanding that the effective subzone would change to a cooler one with every increase of approximately 333 m. Actual elevation bands could not be mapped at the 1:7.5 M scale.

Summer warmth index for two warm, relatively cloud-free summers, 1993 and 1995 were compared with AVHRR Normalized Difference Vegetation Index (NDVI) for the same period. The NDVI data were calculated from two-week composites of data from 11 July to 30 August, 1993 and 1995. Results were compared with a previous analysis comparing NDVI with CAVM bioclimate subzones (Raynolds in press).

References:

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