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Changes in North American Snow packs for 1979-2004 Detected from the Snow Water Equivalent data of SMMR and SSM/I Passive Microwave and related Climatic Factors

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Changes to the North American (NA) snow packs for 1979-2004 were detected from snow water equivalent (SWE) retrieved from SMMR and SSM/I passive microwave data using the non-parametric Kendall's test, which agrees with predominantly negative anomalies in both snow cover and SWE observed in the Northern Hemisphere since the 1980s and significant increase in the surface temperature of North America (NA) observed since the 1970s. In NA, about 30% of detected decreasing trends of SWE for 1979-2004 are statistically significant, which is about 3 times more than detected increasing trends of SWE that are statistically significant. Significant decreasing trends in SWE are more extensive in Canada (mainly east of the Canadian Rocky Mountains) than in the US, where such decreasing trends are mainly found along the American Rockies. The overall mean trend magnitudes are about -0.4 to -0.5 mm/year which translates an overall reduction of snow depth of about 4 to 13 cm in 26 years (depending on whether the average snowpack density of was 250 gm/cm3 or 100 gm/cm3) which can significantly impact regions relying on spring snowmelt for water supply. From detected increasing (decreasing) trends of gridded temperature (precipitation) based on the North American Regional Reanalysis (NARR) dataset and the University of Delaware dataset for NA, their respective correlations with SWE data, global-scale decline of snow cover and warming temperature trends cited in the literature, and longer rainfall seasons, etc., it seems the extensive decreasing trends in SWE detected mainly in Canada are more caused by increasing temperatures than by decreasing precipitation. However, climate anomalies could also play a role to part of the detected trends, as PC1 of NA's SWE is found to be correlated to the Pacific Decadal Oscillation (PDO) index, and marginally correlated to the Pacific North American (PNA) pattern.