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Variability in seasonal freeze-thaw in the terrestrial high latitudes: characterization with spaceborne microwave remote sensing

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Landscape transitions between seasonally frozen and thawed conditions occur each year over roughly 50 million square kilometers of Earth's Northern Hemisphere. These relatively abrupt transitions represent the closest analog to a biospheric and hydrologic on/off switch existing in nature, affecting surface meteorological conditions, ecological trace gas dynamics, energy exchange and hydrologic activity profoundly. We utilize time series satellite-borne microwave remote sensing to examine spatial and temporal variability in seasonal freeze/thaw cycles for the pan-Arctic basin and Alaska. Regional measurements of spring thaw and autumn freeze timing are derived using daily brightness temperature measurements from the Special Sensor Microwave Imager (SSM/I), the Advanced Microwave Scanning Radiometer on EOS (AMSR-E), and the SeaWinds-on-QuikSCAT scatterometer. We examine relationships between freeze/thaw timing as related to sensor, satellite overpass time, and landcover. Spatial and temporal patterns in regional freeze/thaw dynamics show distinct differences between North America and Eurasia, and boreal forest and Arctic tundra biomes. Classification differences between AM and PM overpass data average approximately 5 days for the region, though both appear to be effective surrogates for monitoring annual growing seasons at high latitudes. Timing of the primary spring thaw event determined from early evening acquisitions generally precedes that determined from early morning data acquisitions for arctic tundra and boreal forest landscapes. Grasslands in the southern margins of the pan-Arctic watershed show opposite patterns for active and passive sensors. This difference in day/night thaw timing observed by radars vs.

radiometers may arise from differences in the influence of vegetation on the surface energy budget across biomes.

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