Geophysical Research Abstracts, Vol. 9, 10544, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-10544

Topographic, meteorologic, and canopy controls on the scaling characteristics of the spatial distribution of snow depth fields

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LIDAR snow depths, bare ground elevations (topography), and elevations filtered to the top of vegetation (topography + vegetation) in five 1-km^2 areas are used to determine whether the spatial distribution of snow depth exhibits scale invariance, and the control that vegetation, topography and winds exert on such behavior. The one-dimensional and mean two-dimensional power spectra of snow depth exhibit power law behavior in two frequency intervals separated by a scale break located between 7 m and 45 m. The spectral exponents for the low frequency range vary between 0.1 and 1.2 for the one-dimensional spectra, and between 1.3 and 2.2 for the mean two-dimensional power spectra. The spectral exponents for the high frequency range vary between 3.3 and 3.6 for the one-dimensional spectra, and between 4.0 and 4.5 for the mean two-dimensional spectra. Such spectral exponents indicate the existence of two distinct scaling regimes, with significantly larger variations occurring in the larger scales regime. Similar bilinear power law spectra were obtained for the fields of vegetation height, with crossover wavelengths between 7 m and 14 m. Further analysis of the snow depth and vegetation fields, together with wind data support the conclusion that the break in the scaling behavior of snow depth is controlled by the scaling characteristics of the spatial distribution of vegetation height when snow redistribution by wind is minimal and canopy interception is dominant, and by the interaction of winds with features such as surface concavities and vegetation when snow redistribution by wind is dominant.