Wind Stress Functions for Blowing Snow Initiation and Transport, in Vegetated Grids

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EXTENDED ABSTRACT

Adequate representation of snow processes in land surface schemes would improve General Circulation Model (GCM) simulations. The Canadian Land Surface Scheme (CLASS) and other land surface models lack blowing snow codes. A blowing snow sublimation parameterization recently formulated from simplifying assumptions and the PIEKTUK model results, omits micro-scale details, making it suitable for incorporation into CLASS. The parameterization is specific to non-vegetated surfaces and its adaptation for use in vegetated grids is being targeted here. The transport formula for PIEKTUK and the Prairie Blowing Snow Model (PBSM) are similar except for vegetation roughness represented only in the latter. This similarity provides the opportunity to formulate vegetated transport rates on the basis of PBSM results and to fit the formula to the new blowing snow sublimation parameterization to generate vegetated sublimation rates.

In this approach, a wind stress function influences threshold, or otherwise effective, velocities for testing blowing snow initiation at various vegetation exposures. For strong-wind situations a wind dependent stress function, formulated from the non-vegetated to vegetated wind stress ratio, generates transport rates comparable to those of the PBSM. These transport rates increase as a power function of the wind speed and are higher for smoother surfaces. With weaker winds blowing snow sublimation is limited to the upper canopy, hence the assessed depth of penetration of the effective wind, control the vegetated-grid blowing snow transport and sublimation rates. This depth derives from an empirical formula representing the relative within-canopy to canopy height wind stress, on the basis of previous measurements by others.

The resulting wind velocities of blowing snow initiation are temperature and roughness influenced. Together with the parameterized non-vegetated sublimation rates, these threshold velocity and transport functions allow us to represent blowing snow sublimation from vegetated grids via the Canadian Land Surface Scheme. As an application we note that parameterization of blowing snow sublimation with partial vegetation cover and roughness averaging, gives a slightly improved representation of the Resolute snow depth profile for 1966–1971. Our simple parameterization can be improved by the incorporation of snow ageing in the threshold wind velocity formula as for the improved PBSM model. We also suggest the modeling of snow densification due to wind packing, in CLASS, and the representation of its influence on the threshold velocity.

Key Words: Blowing Snow, Land Surface Schemes, Transport, Sublimation, Vegetation.

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