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Empirical study on the relationship between aerodynamic roughness length and albedo with canopy structure

J. CHO (1), P. J. -F. Yeh (1), S. Miyazaki (2), T. Oki (1), S. Kanae (1), and W. Kim (3)

(1) Institute of Industrial Science, The University of Tokyo, Tokyo, Japan (cho@rainbow.iis.u-tokyo.ac.jp), (2) National Institute for Environmental Studies, Tsukuba, Japan, (3) National Institute for Agro-Environmental Sciences, Tsukuba, Japan

Surface albedo and aerodynamic roughness length, which partition surface net radiation into energy fluxes, are critical land surface properties for biosphere–atmosphere interactions and climate variability. Previous climate model studies on the impacts of land cover changes such as deforestation have indicated that these properties are key functional land factors in affecting boundary conditions in global climate simulations. However, these parameters are in general not easy to measure; also their explicit functional relations with other commonly measured land surface properties were seldom reported in literature. Thus their specification in climate models is traditionally based on prescribed look-up tables according to a rough classification of dominant vegetation types. This approach may not be sufficiently precise for climate modeling application considering large spatial heterogeneity involved at the global scale, and dynamic vegetation transition in the interannual to decadal timescales.

In this study, we explore theoretical and empirical relationship between aerodynamic roughness length and albedo by means of canopy structural parameters (i.e. frontal area index, rugosity, leaf area index and canopy height), using the empirical data from 49 measurement sites worldwide covering various vegetated surfaces. Base on these data, an inverse nonlinear relationship between roughness length and albedo is found. It is shown that this observed relationship can be empirically related to vegetation structure parameters such as leaf area index and canopy height, which are relatively easier to be measured. The obtained relationship has the implication for enhancing the satellite-based estimate of land surface parameters (especially roughness length) and for improving land surface parameterization in climate models.