Roughness characterization of and turbulent boundary layer flow over flat snow surfaces

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TI: Roughness Characterization of and Turbulent Boundary Layer Flow over flat Snow Surfaces

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AB: The surface roughness is essential for all turbulent exchange processes within the lower part of the atmospheric boundary layer. Consequently, a proper representation of the surfaces roughness is needed in every mathematical description of near surface mass-, energy- and momentum exchange processes. Considering the vertical mean velocity profile of turbulent boundary layer flow, this is done by assigning an aerodynamic roughness length z_0 to the surface. We followed two procedures to describe the roughness of freshly fallen snow surfaces. First, photographs of snow surfaces have been taken and evaluated using digital image analysis giving snow surface contour line coordinates. Applying structure functions to the snow surface coordinates and statistical fitting procedures, resulted in classes of surface characteristic length scales and scaling exponents. These results allow to identify the deposition process of snow fall as scaling exponents corresponded to that of Ballistic Deposition. Moreover, the resulting characteristic length scales can be assigned to typical particle size and aggregation size length scales consistent with results found by Lowe et al. (2007) and Manes et al. (2008). Second, aerodynamic roughness lengths z_0 have been estimated from log-law fitting of velocity profiles over the snow surfaces measured in the SLF cold atmospheric boundary layer wind tunnel. The aerodynamic roughness lengths found are in general agreement with available literature data and suggest the presence of aerodynamically rough regimes with flow independent z_0. In the synthesis of both approaches, we found evidence for a linear relationship between one class of surface characteristic length scales, which is associated with typical snow particle sizes, and aerodynamic roughness lengths z_0. The correlation with the aggregation length scale is weaker for the few (4) samples analyzed thus far. The relatively weak pronounced scale separation between particle and aggregation size scales as found from the random field approach analysis can serve as a possible explanation.

DE: [0736] CRYOSPHERE / Snow
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DE: [3322] ATMOSPHERIC PROCESSES / Land/atmosphere interactions
DE: [3394] ATMOSPHERIC PROCESSES / Instruments and techniques
SC: Atmospheric Sciences (A)
MN: 2009 Fall Meeting

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