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Relating the geometric surface roughness of sea ice to its surface emissivity

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A formulation describing the ocean surface emissivity was modified to relate the geometric surface roughness to the emissivity of sea ice. A polarized rough emissivity is defined to be an ensemble average of specular emissivities of inclined infinitesimal facets. To deal with 'shadowing effect' and 'cross polarization effect' due to the observer-facet coordinate discrepancy, illumination function and rotation angle were introduced. We examined the direct (zero-order) emissivity contribution with an assumption that the facets have an isotropic Gaussian slope distribution. Numerical calculation was carried out at a 55° viewing angle, which is common in passive microwave sensors (e.g. AMSR-E), by allowing the typical range of refractive index for sea ice in the microwave region. The result shows that both vertical and horizontal components of the rough emissivity decrease with increasing refractive index. However, for the roughness dependency, the vertical component decreases with increasing roughness whereas the horizontal component increases. It is suggested that the emissivity does not increase monotonically with the roughness. It is thought that inclined facets contribute to the overall emissivity probably with the smaller magnitudes than the flat surface in which the vertical component likely has a maximum value at a 55° viewing angle (i.e. Brewster's angle). Tendencies of both components are found to be greater for larger refractive index. Results should be useful for studying behaviors of brightness temperature at microwave frequency higher than 6.9 GHz, such as Gradient Ratio (GR) and Polarization Ratio (PR).