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Possibility to discriminate snow types using brightness temperatures in the thermal infrared wavelength region

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Spectral emissivity of snow surface in the thermal infrared (TIR) wavelength region is an important parameter for monitoring snow surface temperature in the cold climate regions and also for the discrimination of clouds and underling snow surfaces in the Polar nights using satellite observed brightness temperature data. Past in-situ observations of snow emissivity revealed that the emissivity of snow surface can vary depending on snow types (Hori et al., 2006 in Remote Sensing of Environment). Fine dendrite snow exhibits high emissivity over 0.98 in TIR at all exitance angles (θ). As ice granules of snow surface become large, the snow emissivity in TIR decreases and exhibits a wavelength dependence due to the enhancement of Fresnel reflectance at the wavelength of around 12μm. In addition, the reduction of snow emissivity is further enhanced as the increase of exitance angle. For example, emissivities of coarse grain snow at the wavelength of 11μm and 12μm are 0.99 and 0.975 for the zenith direction (θ=0°) but 0.965 and 0.93 for the slant direction of θ=75°. In the case of sun crust snow, the wavelength and directional dependences of snow emissivity are further enhanced. As the extreme case emissivity of smooth bare ice surface can be approximated using the Fresnel reflectance theory. These snow type dependence of TIR emissivity as a function of wavelength and exitance angle is expected to make snow type discrimination possible using TIR brightness temperatures remotely sensed from space. In this study the possibility of snow type discrimination using TIR brightness temperatures is examined. Typical channels employed for satellite borne TIR image sensor locates at the wavelengths of 11μm and 12μm. The brightness temperature differences (BTD) at these two TIR channels (11μm-12μm) are calculated using the in-situ measured emissivities. The results showed that at the zenith direction the calculated BTD ranges from 0.5K for fine snow to 2K for bare ice, whereas the BTD ranges from 0.7K to over 4K at the slant direction of θ=75°. Thus, remotely sensed BTD ranges of around 1.5K at the zenith direction and 3.3K for the slant direction could be attributed to the difference of snow surface type. Considering the weak water vapor absorption in the atmosphere in the Polar Regions the BTD ranges is considered large enough to roughly discriminate snow surface type into three or four categories such as fine dendrite snow, middle to coarse grain snow, sun crust, and smooth bare ice. In this presentation, TIR emissive properties of several snow types are also visualized using images taken with a portable thermography camera.