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Terrain effects on microwave emission transmission of snowpack and snow depth retrieval

Tao Che and Liyun Dai
Northwest Institute of Eco-Environment and Resources, Chinese Academy of Sciences, Lanzhou, China (chetao@lzb.ac.cn)

The existing snow depth products have mainly focused on influence of varying snow characteristics and forests, while neglecting the complicated mountainous terrain. Therefore, examining the influence of mountainous terrain on microwave radiation transmission of snowpack is beneficial for improvement of snow depth retrieval algorithms in mountainous areas. In this study, we established microwave emission transfer model of snowpack in Mountainous areas within the framework of MEMLS, thereafter, called MEMLS-T. MEMLS-T considers the influence of complicated terrain on the microwave radiation transmission of snowpack from three perspectives: 1) the varied hill slopes alter the local incidence angle; 2) the diverse hill slopes and aspects induce the polarization rotation; 3) The reduced sky visibility in mountainous regions results in an escalation of downward background radiation reaching the snow surface, as a consequence of the illumination from neighboring slopes. We simulate brightness temperatures at varying sky visibilities, slopes and aspects using MEMLS-T, and find that, in compared with flat terrain, brightness temperature gradient decreases in mountainous area, and the extent of reduction depends on complexity (Figure 1). The brightness temperatures are simulated based on various spatial resolutions of DEM and integrated into a grid of 6.25km×6.25km. The results reveal that coarser DEM results in greater sky visibility (Figure 2) and higher brightness temperature (Figure 3). Therefore, a fine DEM is necessary to simulate the brightness temperatures in mountainous areas. Additionally, the observation footprints vary with satellites and frequencies, resulting in discrepancies in snow depth retrieval and temporal consistency.

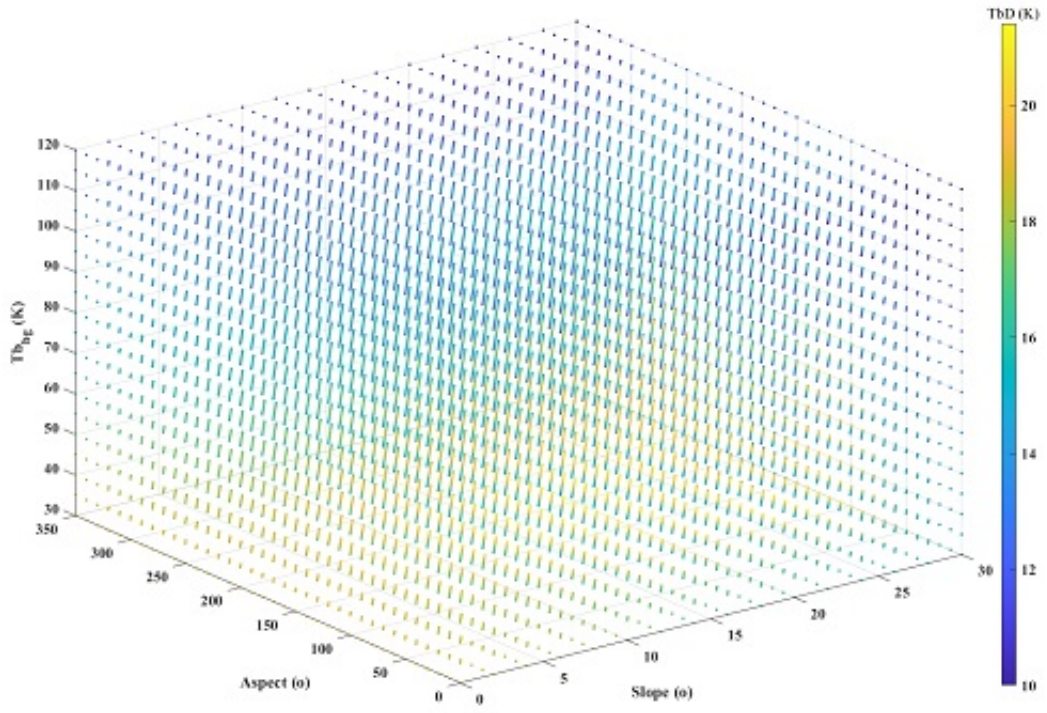

figure 1Brightness temperature difference between K and Ka bands varies with aspect, slope and sky radiation

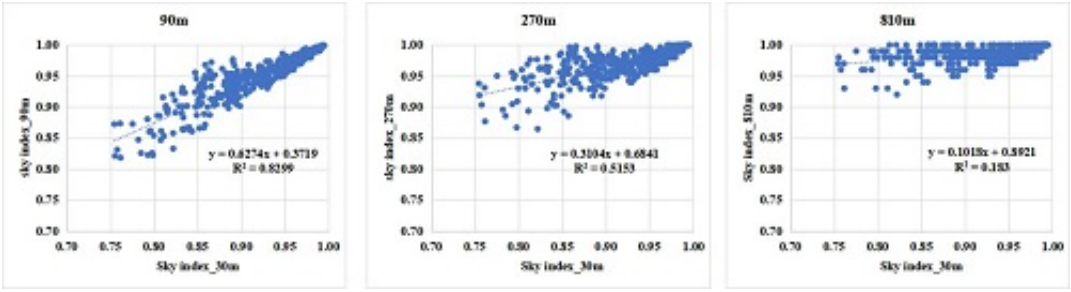

figure 2 Comparison of sky visibility obtained from DEMs with different resolutions.

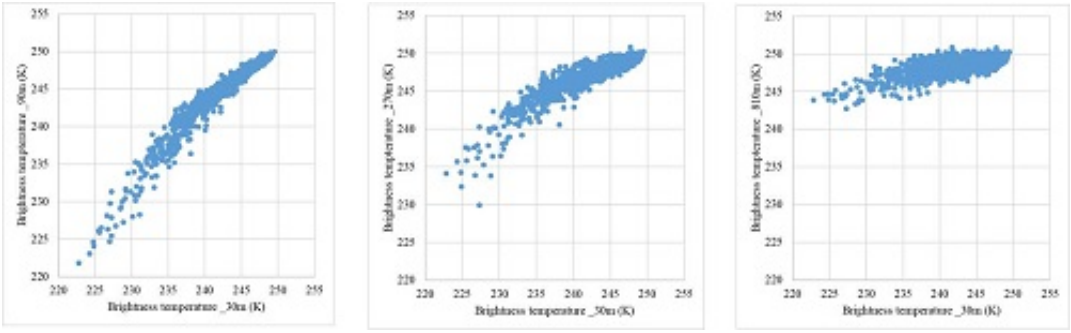

Figure 3 Comparison of brightness temperature simulated from DEMs with different resolutions