

Spatial Variation of Snow Densities over the Third Pole, Pan-Third Pole and Arctic

WENYU ZHAO^{1,2}, TINGJUN ZHANG¹, YIJING LIU¹, BENBEN LIANG¹, YANHUA SUN¹,
AND QING WEI¹

ABSTRACT

Snow density is essential to extensive applications for validations of satellite remote sensing products and numerical modelling outputs, surface hydrological processes, and water resource assessments. Very often, snow density was treated as a constant throughout the region and even over time due to limited ground-based measurements. The primary objective of this study is to investigate spatial changes and variations of snow density across the Third Pole, pan-Third Pole, and Arctic using *in situ* measurements of snow depth and snow water equivalent from 881 sites and stations over 70 years. The results demonstrate that snow density had a large spatial variability from the Arctic to the Third Pole. The Third Pole presented the lowest average snow density of 138 ± 61 kg/m³, Arctic displayed the highest average snow density of 223 ± 54 kg/m³, while average snow density for the pan-Third Pole was 159 ± 52 kg/m³. The lowest mean snow density over the Third Pole is mainly because of frequent, fresh but non-stable snow cover throughout winter months, while the highest mean snow density across the Arctic is due mainly to stable snow cover over a whole winter with compacted and mature snow cover. On monthly basis, monthly snow density showed a significantly continuous increase from the October towards the June in Arctic. The seasonality of snowfall also changed greatly over the three areas. There was frequent light snowfall in autumn and late spring but very limited from November to February over the Third Pole, while snowfall was relatively heavier snowfall throughout the winter and spring in the Arctic. Snowfall patterns and amounts are the major difference to explain the density difference between the Third Pole and the Arctic.

¹ Key Laboratory of West China's Environment (DOE), College of Earth and Environmental Sciences, Lanzhou University, Lanzhou, 730000, China

² Chair in Hydrology and Climatology, Institute of Geography, Heidelberg University, Germany