Application of MERRA-2 to investigate changes in snow depth in high mountains of Iran

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Summary

Snow plays a crucial role in the hydrological cycle, making it essential to measure various snow parameters especially in the mountainous regions that are characterized by high elevation. Understanding the spatio-temporal variability of snow parameters regionally is necessary to improve water resources management and risk assessment. Snow depth is an important property that is generally measured at meteorological stations. However, since snow gauge stations do not have a suitable spatial distribution and the number of these stations is very limited, traditional ground measurement methods do not have the efficiency for intermittent monitoring of snow physical characteristics. Hence, using the reanalysis data sets would be an alternative to study snow depth. This study investigates the temporal distribution of snow depth in four high mountainous regions in Iran for 41 years from 1980 to 2020, using the MERRA-2 reanalysis data. The study region includes the four highest mountain peaks over Iran, namely Damavand peak in the Alborz mountain range, Dena and Zardkooh peaks in the Zagros mountain range, and Hezar peak in Central mountain ranges in Kerman. Results show that the value of snow depth differs regionally and there is an annual variability. There is a slightly increasing trend in snow depth, however, the trend is not statistically significant during the 41-year period in all four studied regions. The maximum snow depth usually occurs in January. Alborz region (Hezar mountain) has the most (the lowest) snow duration, which indicates the role of temperature and latitude in the durability of snow in mountainous areas. Since the slight upward trend in snow depth is inconsistent with the global warming, it is likely that the applicability of MERRA-2 dataset for long-term studies has uncertainty. This can be caused by errors in forcing and shortcomings related to the model used in MERRA-2. Investigating the role of temperature and precipitation, as the main climatic drivers of error, shows that uncertainty in snow depth may be caused by the uncertain estimation of snowfall rather than temperature.

Keywords: Temporal distribution, snow depth, mountainous region, MERRA-2.

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