Snow Cover Spatio-temporal Patterns in the Tibetan Plateau based on Long Term Satellite Data

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Snow cover is an important parameter in investigations of climate, surface radiation budget and hydrology cycle. The Tibetan Plateau (TP) is one of the coldest places on the earth. In global scale, the long term characteristics of snow cover on the TP can support the analysis of the climate of our country and the Asian summer monsoon, even the global changes. In regional scale, it has great significance for the water supply of pastoral ecosystem, snow damage forecasting and flood forecasting. In the study, we developed an alternative approach with dynamic thresholds to produce snow cover products (1982-2012). Based on these products we analyzed the spatial and temporal variability in snow cover in the TP. The results are as follows: (1) Based on LTDR data and digital elevation model, we built a snow inversion model. The classification algorithm correctly identified the snow class at all stations in 93.9% of the cases. The classification quality reached a very good level (K=0.765). (2) For the entire TP, the monthly mean snow cover area (SCA) exhibited a bimodal distribution, with the maximum cover (29.4%) occurred in March, and the minimum cover (6.3%) in September. The SCA shows a steady decreasing trend from March to August and a steady increasing trend from September to next January. For the spatial variation, the four semi-arid ecological zones exhibited the same variation trend, while the humid/semi-humid ecological zone shows a clearly time leg.(3) According to YSCA statistic data, we found 1982,1984,1990,1997, 1998, 2003 and 2007 were abnormal snow cover year which can be associated to the former study. For the entire TP, the high snow cover occurred in 1982, 1997 and 2007, while vale values happened in 1984, 1990, 1998 and 2003. We divided the study period into two parts for the analysis over the all nine Eco-geographic regions (EGR). Comparing each EGR, we found HID1, HIC1, HIC2, HIB1 have a good agreement in the variation trend. We calculated annual SCD anomalies and showed the result as two terms according to YSCA variation characteristics. The central area of the TP was more changeable. This area was distributed around Tanggula mountains (Mts), also four Eco-geographic regions: HIC1, HIB1, the west both HID1 and HIC2. Nyainqtanglha Mts, Himalayas Mts and the west of Kunlun Mts had snow covers in most years, whereas the Qaidam basin and the southern Tibet valley (the deep valley between Himalayas and Gandise) exhibited were snow-free in most years. (4) Based on snow cover onset date and snow cover melted date for the completion of the TP, we found that snow phenology did not show zonal characteristics on latitude. Besides, snow cover begins or finishes melting from the hinterland of the Qinghai-Tibet Plateau to other areas. (5) Regressed YSCA with air temperature and precipitation, the relativity with temperature was negative in HIC1, HIB1, HIC2 and HIIA/B1 in snow-fall season (autumn and winter) and the relativity with precipitation was positive in HIC1, HID3, HIC2, HIB1, HIIC2 and HIIA/B1 in winter while the relationship of both temperature and precipitation is insignificant in spring probably due to relative high temperature in the snow-melt season. (6) By the comparison of snow distribution characteristics of each ecological zone, the results showed: Qinghai-Tibet Plateau Tanggula and its adjacent areas, the four semi-arid ecosystems partition, had the similar inter-annual fluctuation. These areas also showed a significantly negative correlation with temperature and a positive correlation with precipitation. It should be pointed that these areas included the source of the Yangtze River and the Yellow River (the Sanjiangyuan region), and the main grazing area, therefore, the research results exhibited a great benefit for the flood and snow disaster prediction.

Keywords: the Tibetan Plateau, snow cover , spatio-temporal patterns

