Spatiotemporal Variations of Snow Cover in the Mongolian Plateau Based on MODIS Data: Post-print

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Abstract

Utilizing daily snow cover products MOD10C1 and MYD10C1 from Terra and Aqua satellites for the period September 1, 2002 to May 31, 2017, we extracted information on snow cover days, snow cover area, snow onset date, and snow end date for the Mongolian Plateau, obtained the distribution and variation trends of snow cover characteristics over the Mongolian Plateau, and simultaneously, combined with temperature data from 108 ground meteorological observation stations on the Mongolian Plateau, analyzed the relationship between snow cover variation characteristics and temperature in the study area. The results indicate that: (1) The average snow cover days on the Mongolian Plateau ranges between 60–90 d, the snow onset date is mainly distributed between day 315–335, the snow end date is mostly concentrated between day 31–61, the snow onset date in the eastern part of the Mongolian Plateau shows a significant advancing trend, and the snow end date in the southwestern region shows a significant advancing trend. (2) Snow cover area exhibits a "single-peak" pattern during the snow season, with January being the month of maximum snow cover area, and the annual average snow cover area shows a weak declining trend. (3) The maximum snow cover area shows significant correlation with temperature, and the critical temperature for stable snow cover area is approximately between -11°C and -8°C. (4) Temperature is an important factor influencing the variation of snow cover characteristics.

Full Text

Preamble

Abstract: This study extracted snow cover days (SCD), snow cover onset dates (SCOD), snow cover melting dates (SCMD), and snow cover area (SCA) in the Mongolian Plateau using daily snow cover products MOD10C1 and MYD10C1

derived from Terra and Aqua satellites from September 1, 2002, to May 31, 2017. Temperature data from 108 weather stations across the plateau were used to analyze the relationship between snow cover characteristics and temperature. The pixel discrimination method was employed to identify snow-covered pixels, and the pixel accumulation method was used to obtain annual snow cover days of the plateau. The results show as follows: (1) The average SCD in the Mongolian Plateau ranged between 60 and 90 days, and it was correlated well with latitude. The SCD in the eastern region showed a slight upward trend and the southwestern region showed a significant downward trend. The SCOD in the plateau was mainly distributed between 315 and 335 days, and SCOD in the east of the plateau showed a clear trend of moving early. (2) SCA reached its maximum value in January, and the average SCA fluctuated greatly and there was a weak downward trend overall. (3) The maximum coverage area of snow has a significant correlation with temperature. From September to December, the average temperature was dropped by around 10℃ per month, and the temperature was relatively stable from December to February. From February to May, the average temperature was risen by around 10℃ per month. (4) There is a significant negative correlation between SCD and temperature. SCMD has a significant positive correlation with temperature. A higher correlation can indicate that temperature is a key factor affecting snow cover. The paper used MODIS data to analyze the spatial and temporal distribution and changes of snow cover in the Mongolian Plateau, and could provide reference for the subsequent changes in water resources and vegetation growth in the Mongolian Plateau. At the same time, this paper also shows the dynamic changes of snow in the Mongolian Plateau during the years and the relationship with temperature, which provides a basis for disaster prevention and animal husbandry in the Mongolian Plateau.

Keywords: Mongolian Plateau; snow cover; MODIS; climate change; temperature

1 Introduction

1.1 Study Area

The Mongolian Plateau is located between 87°40 -122°15 N and 37°46 -53°08 E [Figure 1: see original paper]. The region has a typical temperate continental monsoon climate, with cold and dry winters, and hot rainy summers. The terrain is high in the west and low in the east, with an average elevation of approximately 1580 m. The plateau includes vast grassland and desert landscapes, with annual precipitation of about 200 mm.

1.2 Data Sources

1.2.1 MODIS Snow Cover Data The study utilized MODIS daily snow cover products MOD10C1 (Terra) and MYD10C1 (Aqua) covering the period from 2002 to 2014 for Terra (7 years) and 2011 to 2013 for Aqua (2 years). The

data were obtained from the National Snow and Ice Data Center (NSIDC). The MOD10C1 product provides daily snow cover data at 0.05° resolution. The combined use of Terra and Aqua products improved data availability and reduced cloud contamination [27]. The study period spanned from September 1, 2002, to May 31, 2017, encompassing 108 snow seasons.

Snow cover identification was performed using the pixel discrimination method. The MODIS snow cover products provide a classification value for each pixel, where values 200–254 represent various snow conditions. Pixels with values in this range were classified as snow-covered pixels. The pixel accumulation method was then applied to calculate annual snow cover days across the plateau.

1.3 Methods

Snow cover parameters were extracted following the methods of Liu et al. [28] and Yang et al. [29-30]. The primary parameters included:

- **Snow Cover Days (SCD):** Total number of days with snow cover in a year
- **Snow Cover Onset Dates (SCOD):** Julian day when snow cover begins
- **Snow Cover Melting Dates (SCMD):** Julian day when snow cover disappears
- **Snow Cover Area (SCA):** Spatial extent of snow-covered area

Validation was conducted using ground observations from meteorological stations. The accuracy assessment followed the methodology of Hall et al. [25] and Wang et al. [26].

shows the classification values and meanings for image pixels, while presents the accuracy verification results.

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Note: Figure translations are in progress. See original paper for figures.