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Changing ice sheets of the northern Indian Himalaya during last decades using LANDSAT (optical satellite image) and GRACE-Tellus (Monthly Mass Grid-Land) data.

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The northern Indian Himalaya region is distributed in three Indian states, Jammu & Kashmir, Himachal Pradesh & Uttaranchal. This part of Himalaya is covered by thousands of sq km of ice sheet which not only act as the source of many important rivers of the Indian subcontinent, also act as the major controlling factor of the climate condition of this region. In this study, highly efficient satellite data like LANDSAT optical satellite imageries and Grace-Tellus Monthly Mass Grid data have been used to assess the changes in the ice sheet in this area through last sixteen years. A combination of Normalized Difference Snow Index (NDSI) and supervised classification applied on the mosaiced satellite images of LANDSAT series of the year 2000 and 2016, in the month of February. The result shows along with a significant loss of the ice-covered area ($\sim$ 3500 Sq Km), while the ice sheet of the year 2016 is much more fragmented. To understand the dynamics of the thickness of the ice sheet of this area GRACE-Tellus Monthly Mass Grid data from the year 2002 to 2016 has been analyzed. A regression was carried out on the monthly mean data to extract the slope/trend of the annual change in mass/thickness of the ice sheet. The slope value was interpolated to understand the spatial variation. It has been observed that the rate of change in mass/thickness varies from +0.40 meters to -1.86 meters per year. The positive change is located mainly in the higher altitude above 33[U+25E6]north and the negative change mostly in the lower elevation. Significantly, the ice sheet of the lower part of Himachal Pradesh and Uttaranchal is losing its mass/thickness in an alarming rate which is having serious consequences on climate and agriculture of the region in coming years.

Key Words: Himalaya, Ice Sheet, LANDSAT, GRACE-Tellus