Montane bogs—peat-forming ecosystems located in high elevation and receiving their water supply mostly from meteoric waters—are unique archives of past environmental changes. Studying these ecosystems and their responses to recent climate warming will help improve our understanding of the sensitivity of high-elevation peatlands to regional climate dynamics. Here, we report a post-bomb radiocarbon-dated, high-resolution, and multi-proxy record in Laobaishan bog (LBS), a mountaintop bog from the Changbai Mountains Range in Northeast China. We analyzed plant macrofossils and testate amoebae of a 41-cm peat core dated between 1970 and 2009 to document the ecohydrological response of peatland to the anthropogenic warming in recent decades. We quantitatively reconstruct the surface wetness changes of LBS bog using the first axis of the detrended correspondence analysis (DCA) of plant macrofossil assemblages and depth to water table (DWT) inferred by transfer function of testate amoebae assemblages. We distinguished two hydroclimate stages: the moist stage before the 1990s and the rapidly drying stage since the 1990s. During the moist stage, plant macrofossils were characterized by the low abundance of *Sphagnum capitifolium* and *Polytrichum strichum* that prefer dry habitats, and testate amoebae assemblages were dominated by low abundance of dry-adapted *Assulina muscorum* and *Corythion dubium*. High score of first axis and low DWT also suggested a moist habitat at LBS. After the transition into the drying stage, the abundance of *S. capitifolium* and *P. strichum* increased and that of *A. muscorum* and *C. dubium* showed similar trend. Score of first axis and DWT reconstructions show that LBS have experienced rapid surface desiccation since the 1990s. Based on the high-resolution gridded reanalysis data, these ecohydrological changes occurred with a rapid increase in temperature (~1°C) but without notable change in total precipitation during the growing season (May–September) since the 1990s. Besides, backward trajectory analysis showed no apparent changes in atmospheric circulation pattern since the 1990s, supporting our interpretation that the ecohydrological changes in LBS bog were induced by climate warming. These results demonstrate that the plant communities, microbial assemblages, and peatland hydrology of montane peatland show a sensitive response to climate warming that might be in larger amplitude than the low-elevation areas.