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Seasonal variation of glacial melt proportion in the headwaters of the Ganges River: Preliminary results

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The effect of global warming on Hindu Kush- Himalayan (HKH) glaciers is of global concern as they are the source of many large rivers in the Indian subcontinent such as the Indus, Ganges, and Brahmaputra. Questions and concerns have been raised about the melting of the Himalayan glaciers, and how this will impact downstream water supplies, hydropower generation, irrigation, and food security issues. Of all the HKH glaciers, the Gangotri glacier located in the Uttarkashi district of the Garhwal Himalaya, India has received special attention as it is receding at an alarming rate of 30 m/year. The Gangotri glacier feeds the Ganges River, which drains nearly 1 million square kilometers of land surface in India and Bangladesh, and provides water security to half a billion people. Based on remote sensing data it has been estimated that the overall area of Gangotri glacier has shrunk by 6% between 1952 and 2006, and that the glacial terminus has receded by more than 850 m over the past 25 years. However, ground observation data aimed at studying the changing influence of the Gangotri glacier on the discharge of the Ganges River are still limited. Here we report preliminary observations of physical (temperature and conductivity) and chemical (major ion and trace element concentrations, pH, and dissolved oxygen) parameters of water samples near glaciated Ganges headwaters for the pre-monsoon (May), monsoon (August), and post monsoon (November) periods corresponding to 2014. We have characterized the seasonal δ18O and δ2H variability of the Ganges headwaters. The pre-monsoonal δ18O varied between -15.1‰ and -9.3‰ whereas the monsoonal δ18O varied between -14.9‰ and -5.7‰. The pre-monsoon δ2H varied between -105.4‰ and -61.5‰, whereas the monsoonal δ2H varied between -103.8‰ and -47.2‰. Our isotope-mixing model predicts significant seasonal (pre-monsoon, monsoon and post-monsoon) variability of glacial melt contributions to the total discharge. Water chemistry data also shows large variations in chemical characteristics that are possibly related to variability in flow volume and different source area contributions.