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Controls on the variability of dust emission from the Bolivian Altiplano from a Nevado Illimani firn core record

Content

The Nevado Illimani ice core (16°S, 68°W, 6,350 m asl) archives paleoclimatic and paleoenvironmental proxies of the Bolivian Altiplano, a high-altitude semi-arid plateau in the tropical Andes. Geochemical and mineralogical data showed that the dust deposited in Illimani comes mainly from sediments present in the Altiplano. In addition, geochemical analyzes of aerosols in association with trajectory models show that dust transported from the Altiplano reaches the Argentinian Pampas, the Southern Ocean and the Eastern Antarctic Plateau, influencing air quality, ocean fertilization and ice core records, respectively. Dust records from Illimani have already revealed changes in the Altiplano dust source strength during climate transitions. Furthermore, records from the 20th century revealed a correlation between dust and seasonal precipitation in the Altiplano, showing that drier conditions in this area tend to increase ice core dust concentrations. In addition, dust concentration also depends on many other factors, including snow accumulation, dust source strength, and transport processes. In this study we show that the interannual variability of dust concentration at Illimani is mainly influenced by changes in wind patterns during the dry-wet season transition in the Altiplano. There are important knowledge gaps in understanding the mechanisms involved in emission rates, transport and deposition of dust in the Altiplano. Here, we aim to explore the mechanisms that are responsible for dust emission variability. For this, a joint expedition recovered a firn core (IL2017, depth 23.8 m) from Illimani in June 2017, as part of the Ice Memory project. We measured the IL2017 dust content using a Beckman Coulter Multisizer 4 measuring the particle distribution from 2 to 60 µm. We dated the IL2017 via annual layer counting based on its well-preserved seasonal proxies; the age of the core ranged from 1999 to 2016. We define the dry season as the layers with the highest concentrations of dust, usually about two orders of magnitude more concentrated.

During the dry season, we observed a close relationship between dust concentration and snow accumulation rate, which allows us to confirm that dry deposition predominates in this location. Using monthly products from different reanalysis models, we compared the IL2017 dust record with climatic and environmental conditions in the Altiplano. We observed significant correlations at the 95% level between dust concentration, mean surface wind speed (r=0.51) and mean mid-tropospheric westerly wind speed (r=0.69) during October and November, which marks the dry-wet transition period. Accordingly, the westerly winds over the Altiplano hampers the regional transport of moisture from the Amazon and is associated with strong surface winds, leading to high dust emission. These evidences indicate that the timing of the dry-wet transition may have a significant influence on the variability of dust emission in the Altiplano.

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