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Atmospheric mechanisms controlling extreme winter precipitation in the Altiplano

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During the austral winter (June-August, JJA), precipitation events in the Altiplano (20°S-15°S, > 3000 m.a.s.l.) are uncommon. These events are responsible for damaging road infrastructure and devastating entire crop fields, loss of cattle, and even for the loss of human lives. Thus, an analysis of these events and the understanding of their precursory atmospheric mechanisms are of high importance to diminish their negative impacts. In this study, using 90 rain-gauge stations in the northern Altiplano, we identified days with a precipitation value above the percentile 90 (P90) for the 1979-2014 period. These days were considered as extreme precipitation events. If consecutive single events are separated by a gap of 5 days, we decided to consider those as a new single event. Thus, it was cataloged 129 extreme precipitation events over the northern Altiplano. Moreover, we found that 56 events lasted only for one day (EV1), 28 events for 2 days (EV2), and 45 events for at least 3 days and a maximum of 12 days (EV3). In order to understand the atmospheric mechanisms associated with these extreme events, we used the K-means cluster analysis in the geopotential height at 500 hPa (ERA-Interim) for days inside EV1, EV2 and EV3, respectively. Then, composite analyses of atmospheric circulation at 850, 500 and 200 hPa were done for each cluster group. We observe that two cluster groups in EV1, EV2, and EV3, respectively (98 events in total), are characterized by anomalies of winds, temperature and geopotential height resembling a cutoff low system over the eastern Pacific between 30°S-10°S at 200 and 500 hPa. Over South America, we observed that these events are also associated with southerly cold air intrusions arriving at 20°S and a moistened lower troposphere over the western Amazon. Indeed, the lower troposphere moistening over the western Amazon in previous days seems to be necessary to sustain long-lasting events. One cluster group in EV1 (8 events) and EV2 (6 events), respectively, is associated with southerly cold air intrusions to the east of the Andes originating at

high latitudes, and arriving in equatorial regions. In addition, 17 events belonging to EV3 are associated with an anomalous South American Low-Level Jet at 850 hPa and atmospheric anomalies at 200, 500 and 850 hPa, resembling the cutoff low system over the eastern Pacific between 30°S and 10°S.