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ABSTRACT FOR AGU 2023

The overlooked role of westerly moisture as a source of summer rainfall in the hyperarid Atacama Desert

Authors: José Vicencio Veloso, Christoph Böhm, Jan Schween, Ulrich Löhnert, and Susanne Crewell

Institute of Geophysics and Meteorology, University of Cologne, Germany

The Atacama receives significantly less precipitation than other deserts such as the Namib and Sahara. The persistent absence of water preserves the record of environmental change (e.g., precipitation characteristics), making it an invaluable proxy for studying the evolution of life on Earth. Due to the scarcity of in-situ measurements and difficulties in satellite remote sensing, information on precipitation characteristics is limited even for the present climate. Therefore, there are gaps in our understanding, especially for summer precipitation. During this season, moisture transport offshore Atacama's coast could potentially trigger rainfall inland. To test this hypothesis, we identified 96 summer (November-March) rainfall events in the period 1961-2020 using 4 rain gauge stations and classified the synoptic conditions according to their similarities in circulation and moisture transport using the ERA5 reanalysis.

The majority of rainfall episodes (83%) are associated with a stronger than normal and southward displaced Bolivian High in the upper troposphere and an anomalous 850 hPa low-pressure system off the coast of Atacama. The cyclonic circulation triggers moist northerlies along the southeastern Pacific in an elongated structure. Through composite analysis and a detailed case study (January 2019) using regional-scale high-resolution weather simulations (WRF), ground-based remote sensing at Iquique, and weather stations, we investigated the local circulation associated with these rain events. Daytime heating of the western slope of the Andes results in moisture transport inland. Topographically induced uplift leads to cloud formation and precipitation in the eastern Atacama. Moisture from the Pacific can even reach the western Altiplano, suggesting that the effect is not limited to the desert. A nocturnal return flux at ~3 km above sea level feeds moisture, clouds, and causes rainfall in the coastal region. To further investigate how this rainfall mechanism has changed in the current climate, we performed a trend analysis of circulation and water vapor using ERA5. Potential links with climate change (such as Hadley cell expansion) and impact on precipitation are also explored.