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The role of Rossby wave breaking for annual and extreme precipitation in (semi)arid regions

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Precipitation can have large dual societal impacts in regions with a dry climate. On the one hand, extreme precipitation can induce catastrophic floods, and on the other hand, replenish scarce fresh water resources. In contrast to wet extratropical regions, the atmospheric processes that lead to precipitation formation in the dry subtropics are often overlooked by the scientific community. In this study we address the role of Rossby wave breaking for annual and extreme precipitation in (semi)arid regions. To this end, we quantify the contribution of Rossby wave breaking to extreme precipitation days and annual precipitation amounts in regions with different degrees of aridity. Rossby wave breaking is represented by potential vorticity (PV) streamers and cutoffs on isentropic surfaces using ERA-Interim reanalysis data, while precipitation is used from the global precipitation measurement (GPM) integrated multi-satellite retrieval product IMERG for the period of 2001-2018. We show that the relevance of Rossby wave breaking for precipitation increases from humid to hyper arid regions. More specifically, equatorward breaking Rossby waves contribute to a large fraction of annual and extreme precipitation in regions on the pole-westward flanks of world's most arid regions where most precipitation occurs in the cool season. In contrast, precipitation in the equator-eastward parts of these arid regions has a negative association with Rossby wave breaking, implying that the tropical forcing governs the precipitation formation which occurs in these regions predominantly in the warm season. The results suggest that breaking Rossby waves are of key importance for precipitation in (semi)arid regions that undergo a drying in a warming climate, underlining the need to better understand the response of wave breaking to global warming.