Geophysical Research Abstracts
Vol. 20, EGU2018-13720-1, 2018
EGU General Assembly 2018
© Author(s) 2018. CC Attribution 4.0 license.

Which mountains efficiently extract atmospheric moisture by deep convection?

Adel Imamovic, Linda Schlemmer, and Christoph Schär
Atmospheric and Climate Science, ETH Zürich, Switzerland (adel.imamovic@env.ethz.ch)

The elevated heating by mountains provides favorable conditions for the initiation of vigorous deep convection, in particular during episodes of weak synoptic forcing in the warm season. Complex orography contains features at all length scales that strongly affect precipitation patterns and statistics. In this study we aim to quantify the deep-convective response to a single mountain as a function of its extent and height using ensembles of idealized convection-resolving simulations with full physics parameterizations. To this end we conduct numerical experiments with a simplified land surface and a single Gaussian mountain and systematically evaluate the impact of heights ranging from 250 m to 1500 m and widths ranging from 5 km to 30 km. Additional experiments with locally perturbed soil moisture are conducted to quantify the role of patchy surface heat fluxes for mountain precipitation.

Despite the strong impact of the mountain height and mountain width on the timing of the diurnal cycle of precipitation, the total rain amount scales approximately linearly with the volume of the mountain. The mean rain intensity on the other hand reaches a maximum at a width of about 20 km for a fixed mountain height. This optimal horizontal scale results from a sensitive balance between the time scales of deep convection and the lateral moisture flux convergence driven by converging up-slope winds. Although the details of the thermal forcing substantially differ, the characteristics of the rain response to the mountain width are surprisingly similar to the response of rain to the horizontal scale of a tropical island (Cronin et al., 2014) or a dry soil anomaly (Taylor et al. 2014). In contrast, surface evaporation over the mountain monotonously decreases with mountain volume and can therefore be dismissed as significant contributor to the rain amount. This extends recent findings (Imamovic et al., 2017) that mountain evaporation (and therefore mountain soil moisture) is of minor importance for precipitation for mountains that exceed a certain height.

References:

Imamovic, A., Schlemmer, L., and Schär, C. (2017). Collective impacts of orography and soil moisture on the soil moisture-precipitation feedback. Geophysical Research Letters, 44, 11,682–11,691. https://doi.org/10.1002/2017GL075657