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Local moisture recycling across the globe

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Atmospheric moisture recycling describes how moisture evaporated from land precipitates over land. It explains how shifts in terrestrial evaporation due to land cover changes may affect precipitation and freshwater availability across scales. Recycling at regional and continental scales has been studied using different methods, such as offline and online moisture tracking models and bulk recycling models. Although recycling at regional and continental scales is relatively well understood, it has only recently become possible to study local moisture recycling across the globe. Recent developments in offline moisture tracking resulted in a dataset including a 10-year climatology (2008-2017) of atmospheric moisture connections from evaporation source to precipitation sink at a spatial scale of 0.5° (Tuinenburg et al., 2020). We used this data to calculate the local moisture recycling ratio, which we define as the fraction of evaporated moisture that precipitates within a distance of 0.5° (typically 50 km) from its source. Furthermore, we identify variables that correlate with the local moisture recycling ratio to assess its underlying processes. On average, 1.7% (st. dev. = 1.1%) of terrestrial evaporated moisture returns as local precipitation annually. However, there is large spatial and temporal variability with peak values over mountainous and wet regions and in summer. Wetness (i.e., precipitation and precipitation minus evaporation), orography, latitude, convective available potential energy, wind speed and total cloud cover have moderate to strong correlations with the local moisture recycling ratio. Interestingly, we find peaks in the local moisture recycling ratio at latitudes where air ascends due to the Hadley cell circulation (i.e., at 0° and 60°). These results suggest that wet regions characterized by ascending air and low wind speeds are favourable for high local moisture recycling ratios. This knowledge can be used to strategically recycle water using nature-based solutions or irrigation to minimize the usage of freshwater availability. For example, for the tropics and mountainous regions globally, and for the Mediterranean regions on the Northern Hemisphere, an increase in evaporation through for example, regreening has a relatively large contribution to local precipitation due to the relatively large local moisture recycling ratios here. These results suggest the potential to enhance freshwater availability with land cover changes, e.g., regreening.

References

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