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AR-tracks: A new comprehensive global catalog of atmospheric rivers

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Atmospheric rivers (ARs) are filaments of extensive water vapor transport in the lower troposphere. They play a crucial role in the global water cycle and are a main source of fresh water for the mid-latitudes. However, very intense and persistent ARs are important triggers of heavy rainfall events and have been associated with natural and economical damage. Further motivated by their high impacts, in the last decade occurrences of ARs have been intensively studied, detection algorithms have been developed, and multiple AR catalogs have been produced. As a common approach, the detection of ARs is based on localizing anomalous atmospheric transport of moisture, usually by setting an absolute threshold on vertically integrated vapor transport (IVT) and/or vertically integrated water vapor (IWV) fields. Behind this methodology, there is the implicit assumption of stationary atmospheric moisture levels, which is not necessarily true for long periods under the context of a warming atmosphere. Also, these thresholds have proven to vary regionally which results in often excluded low-level ARs.

Here, we introduce *AR-tracks*, a global, high-resolution catalog of atmospheric rivers that we have developed based on the Image-Processing-based Atmospheric River Tracking (IPART) algorithm, using IVT estimates of the ERA5 reanalysis data set. As opposed to conventional detection methods, IPART calculates anomalies of the IVT field at the synoptical spatiotemporal scale of ARs and is, therefore, free from magnitude thresholds and stationarity assumptions. The resulting catalog displays a list of AR events, with a spatial resolution of 0.75° x 0.75° and a temporal resolution of 6 hours, covering the period between 1979 and 2019. For each AR, we provide common parameters such as the time and location of the landfall, the respective IVT value, the area, the width, and the length of the AR. Moreover, we also track the contour and the axis of each AR, the position of the centroid, and the proportion of the AR that is located over ocean and land, and over the different continents.

To show the potential of this new catalog, we study the spatiotemporal variability of European ARs between 1979-2019, analyzing the robustness of our results for distinct parameter choices in the definition of *AR-tracks*. We also use a novel power spectral measure to identify periodic cycles in the occurrence of European ARs, revealing spatially heterogeneous seasonal and multi-annual periodicities. Finally, we discuss the role of land-falling ARs as a trigger of heavy precipitation

events in the regional domain.

With the extensive data we provide in this new catalog, we aim at contributing to the further understanding of the role of ARs in global climate dynamics, as long-lived ARs having cross-continent tracks can be reliably traced through their tropical/subtropical origins to high-latitude landfall, and novel topics such as inland penetration of ARs can be studied.