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Mid-latitude flood and water scarcity patterns driven by variability of tropical-temperate moisture fluxes

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Understanding hydrological variability is a key step towards a comprehensive management of water resources and natural hazards. Changes in the magnitude and timing of precipitation are driven by climate variations which range from the decadal, to seasonal and to the finer time scales. While the role of ENSO, NAO and others have been broadly studied, in recent years, it has emerged that dynamics of tropical-temperate moisture transfers are more complex and influential than it has been previously considered. Specially, it has been detected that tropical-temperate moisture fluxes may produce very fine patterns of spatial structures in the form of atmospheric rivers (ARs). ARs are thought to be responsible of 90% of the tropical-temperate transfers and, at any given time, there are 4-6 ARs in each hemisphere. Past research on ARs highlights their significant contribution to total precipitation with most focus on western North America and West Europe. In particular, regional floods and recharge of water resources have been connected to their landfall. At the Global scale, a recent study has found occurrence of ARs in areas with traditional less attention such as South America, Central Europe, Asia and the east of Africa. However, the role that these finer structures of atmospheric variability play in regional and Global hydrology and the exposed population to resulting hydrological hazards remains yet to be characterized. In this study, we assess areas of the Globe exposed to drought and floods, driven by the absence or occurrence of ARs. By linking a land surface model and a hydrodynamic model we examine the surface hydrological response to AR occurrence. We show that in regions between >30N and <30S, over 60% of the observed low and high flows are attributed to ARs. At the same time, the variability of occurrence of low and high flow episodes is similarly connected to the absence or occurrence of ARs driven precipitation. As such, we estimate that about 500million people across the Globe are exposed to hydrological variability dictated by ARs. We expect that results presented here provide water managers, flood forecasters, relief planner and risk insurers a scientific and modelling framework that may aid in their decision process.