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Global moisture hotspots for terrestrial precipitation: the variabilities and possible linkages to climatic events and human activities

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As the world population continues to rise under global warming, it becomes increasingly urgent to understand the climate system and atmospheric water cycle, which could be beneficial for assessing future freshwater resources and land-use management. Recent endeavors by the regional studies were put to identify the source-receptor network and synoptic-scale moisture transport in major river basins worldwide affected by monsoons. Notably, growing studies suggest the transboundary upwind moisture sources are, in fact, very crucial to the intensity and variability of precipitation in the downwind areas, which arouses the call for international governance over land-use and water management. Recognizing the need for international governance on moisture sources from different regional studies and considering results from many moisture-sink-orientated studies, it, however, remains largely unclear where exactly are the moisture source hotspots that are shared by most countries and societies. Such information would better facilitate the international attention, effort and policymaking to safeguard those influential moisture hotspots. Further, more scientific questions need to be addressed: how these global moisture hotspots vary in time and space for the past few decades, and how would these changes be attributed to the known climate events and even human activities.

To these ends, we utilize a state-of-the-art three-dimensional Lagrangian model, the FLEXible PARTicle dispersion model (FLEXPART), to homogeneously divide the atmosphere into six million parcels with roughly equal masses and simulate their movements from 1971 to 2010. Instead of focusing on a particular sink region, all the moisture released over land is backtracked to construct a map of moisture hotspots throughout seasons. As surprising as it may seem, the results suggest the majority of global moisture source hotspots for land precipitation are also terrestrial, especially those located in the Amazon rainforest, the Congo rainforest, the Ganges river basin, the Mekong river basin and the Yangtze River basin. Most of these hotspots also situate in monsoonal domains where their strengths vary significantly across seasons. Given also significant interannual variabilities and long-term trends in the strength of these globally shared moisture hotspots, we suspect that climatic events, global warming and urbanization processes could be attributable to the changes in the hotspots. Findings from this work would advance our knowledge of the location of global moisture hotspots that are key to the precipitation over land. Understanding the possible linkages between the hotspots' changes and climatic events and

human-related activities could benefit long-term planning of regional and international strategies for securing freshwater resources.