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Foreword

Atmospheric rivers in the Australia-Asian region

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In recent years, more and more attention has been focused on the atmospheric river (AR) diagnosis and its application in characterising atmospheric moisture transport between the tropics and the extratropics. Significant research (see, for example, references in Ye *et al.* 2020) has been conducted over North America due to a close association between ARs and extreme rainfall events over the west coast. More studies are beginning to emerge over other parts of the globe such as, for example, along the South American coasts and parts of Europe. There are hundreds of AR studies being published each year from meteorological and hydrometeorological communities worldwide. However, there are only very limited AR studies in our region even though we have a significant number of synoptic events, such as Northwest Cloud Bands (NWCBs), which share some common features as described by the AR concept. Therefore, it is very pleasing to see this collaboration between scientists in the Australian Bureau of Meteorology and the China Meteorological Administration focused on this series of AR diagnostic studies over the Australia-Asian (A-A) region. I commend the strong scientific leadership and significant efforts of Dr. Huqiang Zhang and his collaborators in conducting this important research and further developing their studies into six manuscripts in this Research Front of the *Journal of Southern Hemisphere Earth Systems Science*. I believe they will attract more interest from our research community and lead to further investigations of this important topic.

I agree with the authors that the term ‘atmospheric river’ may create the wrong impression that the research is about ‘rivers’ in the sky, when in fact it refers to a narrow band of strong horizontal water vapour transport concentrated in the lower troposphere. As the authors point out, the use of the word ‘river’ comes from the fact that the amount of atmospheric vapour flux associated with such a structure is about the same volume as for river flows on the ground. In this Research Front, the researchers have comprehensively documented their analysis of ARs in our region. They have conducted detailed observational case studies of AR characteristics operating in the A-A region and their differences to ARs reported for the North American middle and high latitudes (Ye *et al.* 2020). They have applied backward trajectory analysis to explore the atmospheric moisture source for such ARs and highlighted tropical moisture as the primary contributor to the corresponding rainfall generated in the extratropics. They have investigated the potential links between ARs in East Asia and over the Australian continent and used such connections to explain the seasonality of NWCBs and ARs in our region (Xu *et al.* 2020*a*). They have further proposed a mechanism associated with teleconnections in the subtropical highs of both hemispheres to explain these connections. They have also assessed the potential of using ARs to link model skill (both NWP and seasonal forecast) in forecasting these strong moisture transports with their forecasts of extreme rainfall in both countries (Chen *et al.* 2020; Liang *et al.* 2020). The authors also developed AR databases over China and Australia for a 30-year period using manual detections (Wu *et al.* 2020). These datasets were used to document the seasonality, interannual variations of ARs in both regions and identify some significant trends over China which are consistent with observed changes in its extreme rainfall characteristics. Finally, they reported on a study, using a suite of CMIP5 models, assessing the skill of current climate models in simulating ARs derived from reanalysis data, and the potential changes in ARs under a warmed climate (Xu *et al.* 2020*b*). Furthermore, they reported on some changes which are different from those reported for other regions due to the response of the Western Pacific Subtropical High to global warming.

The results from this collaborative project provide convincing evidence of the value of applying AR diagnostics to gain a better understanding of atmospheric moisture transports affecting our weather and climate. The studies also show the potential of using ARs to improve model rainfall forecasts. Many studies, including my own research on the impacts of tropical oceans such as the meridional Indian Ocean Dipole on our weather and climate, have already shown the influence of the tropics on the dynamics and moisture conditions in our middle and high latitudes. The application of AR diagnostics provides an additional tool in understanding these relationships. I acknowledge the amount of work needed to conduct these studies which was made possible through this collaborative project. As the authors acknowledge, there is still more work that could be done using this analysis technique. The AR database of Wu *et al.* (2020) is a very valuable resource and there is scope for developing it further by, for example, introducing automatic detections of ARs and incorporating the diagnosis as part of the routine operational products in

NWP and seasonal forecast systems. There is also scope for using this analysis in the climate change context to better understand the competing effects of changes in the atmospheric circulation and atmospheric moisture content on our projection of rainfall changes in our region.

Again, I congratulate the team for their efforts and achievements. It was my pleasure to serve as the Guest Editor for this Research Front and I look forward to seeing similar fruitful collaborations in the future.

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