Scientists identify geographic sectors controlling the Hadley circulation

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Fig. 1 Regional diversity of tropical atmospheric meridional circulation across longitudes, was distinguished by climatology of vertical shear of meridional wind (V200-V850), with Hadleywise RMC reinforcing Hadley circulation (red solid lines) and anti-Hadleywise weakening of Hadley circulation (blue dashed lines). The dotted areas indicate global monsoon domains associated with diabatic heating over monsoon regions (shaded). Credit: Sun et al.

A Chinese-French team has pinpointed the zonal diversity of regional meridional circulations (RMC) in the tropics and distinctive roles in the interannual variability of Hadley circulation strength and its edges in boreal winter.

Hadley circulation is one of the most prominent atmospheric overturning circulation patterns, and its descending branches correspond to the world's desert regions. Much attention has been paid on validating the observed poleward migration of Hadley circulation since 1979 and stretching the subtropical dry zones toward high latitude. Scientists also note that Hadley circulation is a conventional and conceptual model based on the global zonal mean, and it inevitably obscures the regional diversity of the tropical atmospheric circulation along the zonal distributions. Therefore, scientific interest is rapidly shifting from detection and attribution of zonal mean tropical atmospheric circulation in a changing climate to the regional characteristics of Hadley circulation expanding.

Recently, a collaborative work led by Dr. SUN Yong and Prof. ZHOU Tianjun from Institute of Atmospheric Physics (IAP) with Prof. Laurent LI from Laboratoire de météorologie dynamique (LMD) and Prof. Ramstein GILLES and Dr. Tan NING from Laboratoire des sciences du climat et de l'environnement (LSCE) in France pinpointed the zonal diversity of regional meridional circulations (RMC) in the tropics and distinctive roles in the interannual variability of Hadley circulation strength and its edges in boreal winter.

At first, this study revealed the climatological diversity of tropical meridional circulation within global monsoon sectors (Fig.1), including thermally direct Hadleywise RMC (Fig.1 red solid lines) and anti-Hadleywise RMC (blue dashed lines) in the presence of diabatic heating and indirect RMC (blue dashed lines) in the absence of diabatic heating.

More importantly, they disentangle the geographic sectors that determine the interannual variability of Hadley circulation strength from those responsible for its southern and northern edges (Fig.2).

By further assessing the relative role of ENSO and mid-latitude eddies in the variability of Hadley circulation strength in Northern Hemisphere and its edges in both Hemispheres (Fig.2), they found that mid-latitude eddies explain large fraction of interannual variances of HC and the secondary is explained by ENSO. Furthermore, they separate the geographic sectors where dominant role played by mid-latitude eddies from those by ENSO.

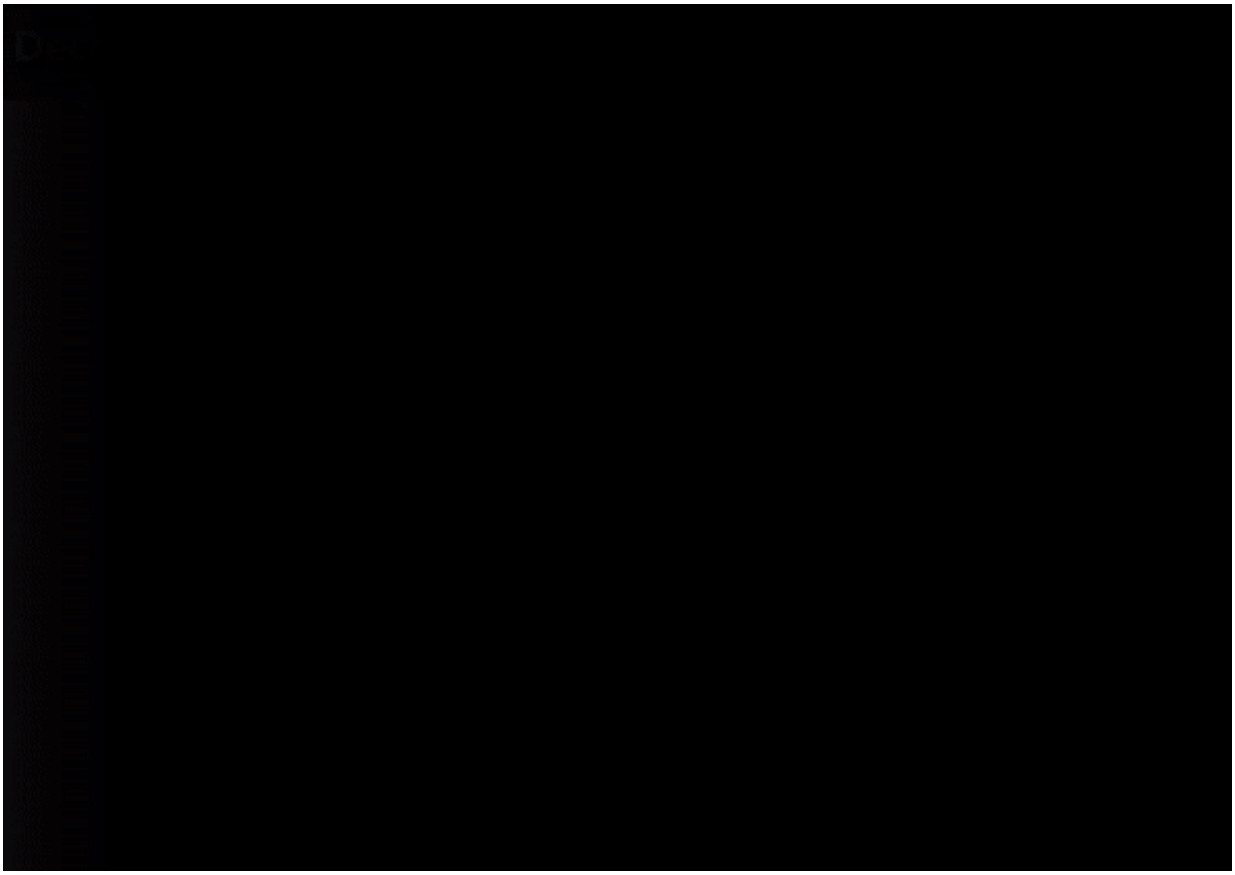

Fig. 2 Geographic decomposition of RMC determining the interannual variability of Hadley circulation strength in Northern Hemisphere (i.e., Northern

Hadley cell intensity), edges of Hadley circulation in Northern and Southern Hemispheres and the geographic sectors where dominant control of mid-latitude eddies versus ENSO are imposed in Northern Hadley cell intensity, edges of Hadley circulation in both Hemispheres. Credit: Sun et al.

More information: Yong Sun et al, Regional meridional cells governing the interannual variability of the Hadley circulation in boreal winter, *Climate Dynamics* (2018). DOI: 10.1007/s00382-018-4263-7