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The dominant roles of the regional Hadley cell variability in boreal winter Hadley circulation

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Much attention has been focused on the recent poleward shift of Hadley circulation (HC). There have been no consensuses on the cause of this shift. In this study, we aim to demonstrate the cause of interannual variability of HC edges as well as HC strength, especially to isolate the key regions determining the HC edges from the dominant regions on HC strength base on four reanalysis datasets and Atmospheric Model Intercomparison Project (AMIP) datasets involved in Coupled Model Intercomparison Project phase 5 (CMIP5). Both observation and simulations confirm the roles of regional Hadley cells (RHCs) in charge of the interannual variability of northern Hadley cell intensity (NHCI) as well as southern Hadley cell edge (SHCE) and northern Hadley cell edge (NHCE).

ENSO drives a stronger and narrower HC associated with intensified HC in tropics and weakened HC in subtropics during El Niño, but for La Niña the situation is opposite. Furtherly, it is the RHC over Eurasia (30 S∼30 N, 30 W∼155 E; RHC-Eurasia) under the under the modulation of midlatitude eddy related to ENSO events that mainly contributes the interannual variability of NHCE in boreal winter. The RHC over the Central Pacific (30˚S∼30˚N, 155˚E∼230˚E; RHC-CP) under the local control of ENSO-induced tropical diabatic heating largely determines the interannual variability of NHCI in boreal winter. the RHCs over the two domains (Eastern Pacific: 30 S∼30 N, 230 E∼ E; RHC-EP and Western Atlantic: 30 S∼30 N, 70 W∼30 W; RHC-WA) under the local control of ENSO-induced meridional temperature gradient exert the dominant roles in the interannual variability of SHCE in boreal winter.