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Regional control on the interannual variability of intensity and extent of the Hadley circulation in boreal winter

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The Hadley circulation (HC) has conventionally been considered as thermally direct circulation with uniform zonal distribution. However, the meridional circulation in the tropics is far from uniform, including the thermally direct cells associated with the global monsoon (GM) heating and indirect cells in the absence of diabatic heating as GM domains. This study aims at highlighting the dominant control of regional meridional cells (RMCs) on the interannual variability of HC strength and boundaries in boreal winter, and also demonstrating the mechanisms of ENSO and mid-latitude eddies in the key sectors that are responsible for the intensity of HC in Northern Hemisphere (NHCI) and HC edges in Northern and Southern Hemisphere (i.e. NHCE and SHCE).
Our results derived from ERA-Interim reanalysis and climate models involved in Coupled Model Intercomparison Project Phase 5 (CMIP5) show that diversity of RMCs control the interannual variability of NHCI and HC edges (NHCE and SHCE). Both ENSO and mid-latitude eddies can go through their respective regions on the control of the variability of NHCI and HC extents. ENSO imposes thermal control on the variability of NHCI through Central Pacific (CP) diabatic heating off the equator, while mid-latitude eddies influence NHCI by the significant propagation of stationary wave into tropical CP and North Africa of Eurasia (EA). ENSO can drive the variability of NHCE by shifting the latitudinal position of North America jet toward Western Atlantic (WA), while significant penetration of mid-latitude eddies through EA into northern subtropics control variability of NHCE. The driven role of ENSO in the variability of SHCE goes through EA by altering meridional thermal contrast between tropical Southern Indian Ocean and mid-latitude Southern Atlantic. Eastern Pacific (EP) and WA are eddy-dominant sectors on the variability of SHCE, with a deeper penetration of southern mid-latitude waves into WA than that into EP.