Intensity Variations in Potential Vorticity Streamers: Development Pathways, and Environmental Impacts in the North Atlantic Basin

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Potential vorticity streamers (PVSs) are elongated filaments of high PV air that can serve as channels for tropical-extratropical air mass exchange. PVSs often originate from anticyclonic Rossby wave breaking (AWB), where upstream low PV air is advected poleward over downstream high PV air in the upper troposphere. This flow evolution results in an elongated, positively tilted upper-tropospheric trough (i.e., PVS) downstream of the AWB axis. Subtropical PVSs modify the tropospheric environment by enhancing vertical wind shear (VWS) and moisture anomalies in their vicinity. These environmental changes in VWS and moisture play an important role in enhancing or suppressing different tropical cyclogenesis pathways in the Atlantic basin. Despite this knowledge, prior PVS climatologies have not investigated how these environmental variables change as PVSs fluctuate in size, intensity, or tilt during the tropical cyclone (TC) season. Moreover, it is unclear what role upstream environmental conditions play in the development of strong versus weak PVSs. This work is motivated by the lack of prior research investigating different intensity PVSs and how these intensity differences alter environmental variables important to TC activity in the Atlantic basin.

This study investigates PVSs in the Atlantic basin using the ERA-Interim reanalysis from 1979–2015. PVSs are identified using an algorithm from June–November on the 350-K isentropic surface bounded by the 2-PVU contour. This algorithm identifies PVSs as the high PV trough that occurs downstream of the AWB axis. PVSs are then sorted into strong and weak intensity categories using standardized PV anomaly averaged within the area of the PVS. Time lagged composites of diabatic heating, irrotational, and non-divergent wind are presented to illustrate the differences in upstream ridging that results in strong versus weak PVSs downstream. Strong and weak PVSs are also composited to reveal differences in VWS, precipitable water, and stability. In general, strong PVSs are preceded by a more amplified upstream ridge. After formation, strong PVSs have increased VWS anomalies equatorward of their trough axis, yet decreased precipitable water anomalies poleward of their trough axis. These environmental changes likely explain why TC seasons with more strong PVSs have decreased TC activity.