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Observations of Stratospheric Concentric Gravity Waves and Concentric Traveling Ionospheric Disturbances over the U.S.

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This work investigates the distributions of coincident stratospheric concentric gravity waves (GWs) observed by AIRS and concentric traveling ionospheric disturbances (TIDs) detected by GNSS-TEC during the four seasons of 2022 to illustrate the mesoscale vertical coupling between the lower atmosphere and ionosphere. We compared these disturbances in the stratosphere and ionosphere with tropospheric weather conditions, including convective available potential energy (CAPE) and locations of extratropical cyclone's centers, as well as background winds in the thermosphere. Epicenters of the concentric TIDs associated with stratospheric concentric GWs correspond to areas with high CAPE over the central-to-east U.S. (~60-110° W) in summer and over the southern U.S. (south of ~40° N) in spring and fall. On the other hand, in fall, winter, and spring, the epicenters over the northern U.S. (north of ~40° N) appeared in the south of high extratropical cyclone activity areas, corresponding to the centers of extratropical cyclones. These results suggest that the potential sources of concentric GWs driving TIDs over the continental U.S. were convection during the four seasons, although weather phenomena associated with the convection varied by season. Convection over the central-to-eastern U.S. in summer and the southern U.S. in spring could be linked to thunderstorms. On the other hand, convection over the northern U.S. from fall to spring could be induced by warm and wet air advection associated with extratropical cyclones. Over the North Atlantic Ocean in fall, hurricanes could induce convections. We also found that concentric TIDs are linked to 67% of the stratospheric concentric GW events, indicating that convection is a significant TID source in the lower atmosphere, contributing to the lower atmosphere-ionosphere vertical coupling. The thermospheric wind influences the local time and horizontal distribution of the concentric TIDs. Specifically, the thermospheric wind during daytime is weaker than that at nighttime, leading to a higher occurrence rate of concentric TIDs during daytime.