Impact of the lower thermospheric winter-to-summer residual circulation on thermospheric composition

*Liying Qian¹, Jia Yue²,³

1. University Corporation for Atmospheric Research, 2. Center for Atmospheric Science, Hampton University, 3. ESSIC, University of Maryland College Park

Gravity wave forcing near the mesopause drives a summer-to-winter residual circulation in the mesosphere and a reversed, lower thermospheric winter-to-summer residual circulation. We conducted modeling studies to investigate how this lower thermospheric residual circulation impact thermospheric composition ($O/N_2$). We found that the upwelling associated with the residual circulation significantly decreases $O/N_2$ in winter and the downwelling in summer slightly increases $O/N_2$. Consequently, the residual circulation reduces the summer-to-winter latitudinal gradient of $O/N_2$, which causes the simulated latitudinal gradient of $O/N_2$ to be more consistent with observations. The smaller summer-to-winter latitudinal gradient of $O/N_2$ would decrease the ionosphere winter anomaly in model simulations, which would bring the simulated winter anomaly into better agreement with ionospheric observations. The lower thermospheric residual circulation may be a process that has been largely ignored but is very important to the summer-to-winter latitudinal gradients, as well as annual/semiannual variations in the thermosphere and ionosphere.

Keywords: Thermosphere Circulation, Thermosphere Composition, Ionosphere Winter Anomaly