

# Development and Validation of NCAR Whole Atmosphere Community Climate Model with Thermosphere/Ionosphere Extension (WACCM-X)

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The NCAR Whole Atmosphere Community Climate Model with Thermosphere/Ionosphere Extension (WACCM-X) has been developed to study the solar impact on the Earth system, to understand and quantify couplings between atmospheric layers through chemical, physical and dynamical processes, and to investigate the implications of the couplings to climate (downward coupling) and to space environment (upward coupling). This talk discusses recent development of WACCM-X, including newly implemented modules of ionospheric electrodynamics, O<sup>+</sup> transport and plasma temperatures, as well as modification of model dynamical core for the thermosphere, where mean molecular mass and specific heats are variables. With the interactive ionosphere modules and the improved dycore, we have made extensive simulations to validate the thermosphere and ionosphere results. The thermospheric compositional structure are in good agreement with climatology. Atmospheric tides, which are important in controlling the dynamics, transport and electrodynamics in the upper atmosphere but were underestimated in earlier versions of WACCM-X, are now well resolved and are in good agreement with observations. Ionospheric plasma densities, including the equatorial ionization anomaly (EIA) and zonal and vertical ExB drifts are found to be in good agreement with observations. Variabilities from day-to-day to seasonal scales and solar cycle dependence are also examined.

Keywords: Whole atmosphere model, space weather, lower and upper atmosphere coupling