

Analysis of the Physical Mechanisms behind the Weddell Sea Anomaly using a Physics-based Data assimilation Model

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The Weddell Sea Anomaly (WSA) is a mid-latitude F region ionosphere phenomena taking place over the regions west of the Antarctic Peninsula. It is most prominent during local summer, is characterized by larger electron densities at night than at noon and completely disappears during winter. Though the WSA has been known for several decades, its generation mechanism is not fully understood and its modeling remains a challenge. In the current study the GPS radio occultation measurements from the six FORMOSAT-3/COSMIC satellites combined with a physics-based data assimilation model of the ionosphere were used to understand the physical mechanism behind the WSA generation. The data assimilation model is the Global Assimilation of Ionospheric Measurements Full-Physics model (GAIM-FP) that covers the altitude range from 90 to 20,000 km, includes six ion species (NO^+ , O_2^+ , N_2^+ , O^+ , H^+ , He^+), is based on the International Geomagnetic Reference Field (IGRF), and allows for inter-hemispheric flow. The model uses an Ensemble Kalman filter approach and provides the 3-dimensional electron density distribution throughout the ionosphere and information about the physical drivers, including the magnetic meridional wind, neutral composition and electric fields. The geographic zonal and meridional winds were inferred from the magnetic meridional wind based on a decoupling procedure that considers the longitudinal variation of magnetic declination and wind decomposition into zonal harmonics. The separate wind components were used to study their effects on the generation of the anomaly. In addition the production, loss and transport processes were separately analyzed to establish the relative role of the various physical processes that cause the WSA.