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Uncertainty Modeling of Acceleration-derived Thermosphere Observations

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Abstract

Precise GNSS and accelerometer measurements allow for deriving in-situ thermosphere density and crosswind observations. Such observations serve as the basis for constructing empirical thermosphere models and benchmark in assessing thermosphere models and other observations. If density observations would become available with sufficiently low latency, they could be assimilated into thermosphere models for operational applications. Several density and crosswind observation datasets are available from the CHAMP, GRACE, GOCE, Swarm, and GRACE-FO missions. However, they are typically provided without information on the uncertainty of the observations. In addition to measurement noise, errors in modeling radiation pressure, atmospheric temperature and composition, thermospheric wind, and the aerodynamic force coefficient vector, including gas-surface interactions, significantly influence the uncertainty. Due to the number and diversity of error sources, quantifying the observational uncertainty is a complex task. We present a method for analyzing these error sources and quantifying their impact on thermosphere density and crosswind observations, which is under development for the Community Coordinated Modeling Center (CCMC). We apply the method to GRACE and GRACE-FO density and crosswind observations to demonstrate its capabilities to realistically specify the observational uncertainty. Further, we illustrate how the method can be used to predict the skill of future missions to observe thermosphere density. In the case of GNSS measurements, we also assess the achievable along-track resolution of GNSS-derived thermosphere density observations.