Development of Data Assimilation System for Atmospheric Density to Improve Satellite's Orbit Prediction Accuracy

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Satellite's orbit prediction with high accuracy requires atmospheric drag prediction with high accuracy, because there is a slight atmosphere in a low-orbital environment. The atmospheric drag can be calculated from the atmospheric density, the ballistic coefficient (mass, cross-sectional area, drag coefficient) of each satellite, but the uncertainty of the atmospheric density is considered to occupy most of the uncertainty of atmospheric drag prediction.
Several atmospheric density models have been proposed so far. Although observation information in low orbit environments is very limited, the models are based on slight satellite observation information. However, it is difficult to predict the atmospheric density with high accuracy, and the satellite operator improves the accuracy of orbit prediction by estimating correction amount based on the orbit determination value.
Since 2018, JAXA has started to develop the atmospheric density reanalysis system (data assimilation system). This system realizes the reanalysis of the atmospheric density from the atmospheric density observation, which is averaged atmospheric density on the satellite locus, and atmospheric density models. The averaged atmospheric density on the satellite locus can be estimated based on orbit information of TLE (two-line element) of each satellite provided by NORAD in the United States. The atmospheric density model uses the NRLMSIS-00 model and the Jacchia-Bowman 2008 model usually used in the orbit field. As data assimilation methods, the ensemble Kalman filter and the ensemble transformed Kalman filter are implemented.
In this presentation, we introduce the details of the atmospheric density reanalysis system and show the results of the twin experiment (numerical experiment) being advanced as system verification.

Keywords: Satellite orbit prediction, Atmospheric density, Data assimilation