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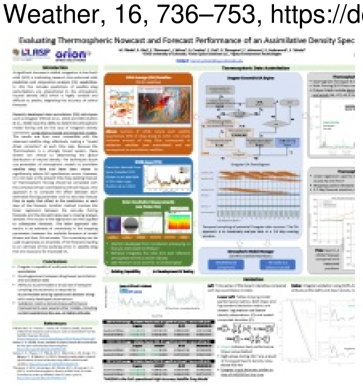
Poster
A significant increase in orbital congestion in low Earth orbit (LEO) is motivating research into enhanced orbit prediction and conjunction analysis (CA) capabilities. In LEO, this includes improvements in the specification and prediction of a perturbing force called ‘satellite drag’, caused by the satellite moving through the Earth’s Thermosphere. Satellite drag perturbations are proportional to the atmospheric neutral density (ND) which is highly variable and difficult to predict, degrading the accuracy of orbital forecasts.

Accordingly, the specification of the current and future neutral density environment in the thermosphere is a vital capability for the sustainable continuation of commercial, government, and military space operations. Recently developed data assimilation (DA) techniques such as IRIDEA (Sutton et al., 2018), and Dragster (Pilinski et al., 2016) have the ability to determine atmospheric model forcing and (in the case of Dragster) density corrections that are most compatible with the observed satellite drag, effectively making a “model driver correction” at each time step. The atmospheric model drivers or “forcing” include solar and geomagnetic indices/proxies that attempt to capture the amount of energy flowing into the Thermosphere. Because the Thermosphere is a strongly forced system, these drivers are critical to determining its state including the distribution of neutral density. The techniques above use ensembles of atmospheric models to assimilate satellite drag data and have been shown to significantly reduce ND specification errors. However, it is not clear at the present time how existing forecast of Thermospheric forcing should be correlated with the corrected drivers estimated by DA techniques. One approach is to compute the offset between each estimated forcing parameter and its zero-day forecast then to apply that offset to the predictions at each step of the forecast. Another method involves the linear regression between the zero-day forcing forecasts and the DA estimates over a moving analysis window. The results of the regression are then applied to subsequent forecasts. The latter approach also results in an estimate of uncertainty in the mapping parameters between the available forecasts of model drivers and their DA estimates. This uncertainty can be used to generate an ensemble of ND forecasts leading to an estimate of the evolving errors in satellite drag that are necessary for improved CA.

In this poster, we focus on evaluating Orion Space System’s Dragster nowcast and forecasts and comparing their performance to nowcasts and forecasts generated using other models. The models include the Space Force’s High Accuracy Satellite Drag Model (HASDM) which is also an assimilative tool. Non-assimilative approaches will also be compared and include the Jacchia-Bowman 2008 empirical model. Dragster assimilated orbital drag data from over 60 satellites archived by the Space Force. Forcing indices and proxies, as well as an archive of their forecast are provided by Space Environment Technologies. For validation, we use POD-derived data products from the European Space Agency’s Swarm satellite (not assimilated).

References:
Pilinski, M.D, G. Crowley, E. Sutton, M. Codrescu, Improved Orbital Determination and Forecasts with an Assimilative Tool for Satellite Drag Specification, Conference Proceedings, 50th Advanced Maui Optical and Space Surveillance Technologies, Maui, HI, 20-23 September, 2016, https://amostech.com/TechnicalPapers/2016/Poster/Pilinski.pdf

Sutton, E. K. (2018), A new method of physics based data assimilation for the quiet and disturbed thermosphere, Space Weather, 16, 736–753, https://doi.org/10.1002/2017SW001785



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