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Atmospheric density models comparison and impact on orbit solutions of GRACE-1, Sentinel-1A, TerraSAR-X

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Satellites in Low Earth Orbit (LEO) are notably affected by the presence of the atmosphere, a predominant source of perturbations of the Keplerian motion at the altitudes of interest. For spacecraft of this class the main source of error in propagated trajectories is due to the mismodeling of the neutral density in the thermosphere and the associated drag force, which steadily decelerates orbital motion with both secular and periodic effects.
Thermospheric density varies significantly with space and time because of complex interactions between solar activity and the Earth's atmosphere and magnetic field. Properly reproducing this variability by means of empirical dynamic models has always represented a difficult task but is of vital importance for orbit determination and propagation. The present study shows the influence of different atmospheric density models, predicted space weather proxies, and their related uncertainties on the orbit solutions of representative satellite missions.
The study has been carried out by using a routine-like orbit propagation scenario applied to GRACE-1, Sentinel-1A, and TerraSAR-X, three LEO orbiting spacecraft with operational altitudes well spaced within the 400-700 km range. Archived space weather data predictions and some of the most recent and promising empirical atmospheric models (Naval Research Laboratory's NRLMSISE-00 and Jacchia-Bowman 2008) were used side-by-side with the well-known Jacchia 1971 model in order to assess potential gains in prediction accuracy. To evaluate the influence of solar variability on the atmospheric density models and associated orbit quality, two 2-month test time frames, in high and low solar activity periods, have been selected.
The scope of the presentation is a detailed comparison of atmospheric density models and their influence on the estimated orbits of GRACE-1, Sentinel-1A and TerraSAR-X.