



Integrity modelling of tropospheric delay models

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The effect of the neutral atmosphere on signal propagation is routinely estimated by various tropospheric delay models in satellite navigation. Although numerous studies can be found in the literature investigating the accuracy of these models, for safety-of-life applications it is crucial to study and model the worst case performance of these models using very low recurrence frequencies.

The main objective of the INTEgrity of TROpospheric models (INTRO) project funded by the ESA PECS programme is to establish a model (or models) of the residual error of existing tropospheric delay models for safety-of-life applications. Such models are required to overbound rare tropospheric delays and should thus include the tails of the error distributions. Their use should lead to safe error bounds on the user position and should allow computation of protection levels for the horizontal and vertical position errors.

The current tropospheric model from the RTCA SBAS Minimal Operational Standards has an associated residual error that equals 0.12 meters in the vertical direction. This value is derived by simply extrapolating the observed distribution of the residuals into the tail (where no data is present) and then taking the point where the cumulative distribution has an exceedance level would be 10^{-7} . While the resulting standard deviation is much higher than the estimated standard variance that best fits the data (0.05 meters), it surely is conservative for most applications.

In the context of the INTRO project some widely used and newly developed tropospheric delay models (e.g. RTCA MOPS, ESA GALTROPO and GPT2W) were tested using 16 years of daily ERA-INTERIM Reanalysis numerical weather model data and the raytracing technique. The results showed that the performance of some of the widely applied models have a clear seasonal dependency and it is also affected by a geographical position.

In order to provide a more realistic, but still conservative estimation of the residual error of tropospheric delays, the mathematical formulation of the overbounding models are currently under development.

This study introduces the main findings of the residual error analysis of the studied tropospheric delay models, and discusses the preliminary analysis of the integrity model development for safety-of-life applications.