Impact of Satellite Orbit and Clock Quality on GPS Radio Occultation Data Processing

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The participation of EUMETSAT in the European Re-Analysis of global CLIMate observations (ERA-CLIM) project has instigated the radio occultation (RO) data reprocessing campaign. The ERA-CLIM project headed by the European Center for Medium-range Weather Forecasts (ECMWF) aims at reanalyses of in-situ and satellite observations in the effort to generate an accurate and consistent model of the past global evolution of the Earth's climate system, which in turn offers improvement in numerical weather prediction. Among the many ERA-CLIM deliverables to ECMWF, EUMETSAT is to provide reprocessed GPS radio occultation observations dating back to 2001. Thus the reprocessing campaign covers RO data processing from the CHAMP, COSMIC, MetOp, GRACE, and other available RO missions. One of the payloads on each of these satellites is the GPS instrument for satellite navigation and atmospheric sounding by radio occultation.In developing the RO data reprocessing strategy, an analysis has been performed in investigating the impact of using the interpolated 30s (from 5-mins clock products) and estimated 30s GPS clock final products from the IGS Analysis Center (IGSAC) in the precise orbit determination (POD) on the bending angle profile. The results demonstrated that the change in the quality of the POD product due to the interpolation error produces no significant impact on the bending angle profile. Thus a set of data from COSMIC (6 satellites) and MetOp have been processed, using the 5-min GPS final clock product, and their product quality assessed. The achievable satellite orbit and clock accuracy, and the performance of the resulting bending angles will be discussed. The complexities associated with the automation of the processing of the COSMIC GPS data as compared to other RO satellite missions with single GPS antenna will also be covered.A similar study has also been performed using different combinations of POD software packages from the German Space Operations Center (GSOC/DLR) and the European Space Operations Center (ESOC/ESA), and various GPS products: RETICLE from GSOC/DLR, operational GSN from ESOC/ESA, IGSAC rapid from Center for Orbit Determination Europe (CODE), and Broadcast Ephemerides (BCE) as transmitted by the GPS constellation. Different sets of MetOp satellite position and velocity products and of bending angles are generated. Results from the intercomparisons illustrate that the currently available ground processed RT/NRT GPS orbit and clock products are of sufficient quality to determine the along-track velocity with an accuracy better than 0.1mm/s, and the resulting bending angles are virtually indistinguishable from post processed products to an impact height (IH) of 60km.Furthermore the results from the simulated autonomous on-board (OB) POD process, using the GPS BCE, show that the bending angles generated in RT exhibit only minor degradation in performance at IH above 40 km with respect to the on-ground NRT bending angle product. For IH below 40 km, the difference in the on-board RT and the on-ground NRT bending angle profiles is negligible. From this preliminary assessment, it is noteworthy to state that it appears feasible to generate bending angles in RT using on-board RT orbit and clock resources at sufficiently good quality for RT dissemination in future RO missions.