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Further assessment of the UNB Neutral Atmosphere Process-Noise Model

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The UNB neutral atmosphere process-noise model was developed as a way to improve and fine-tune GNSS positioning Kalman filters by enhancing the stochastic model accuracy and representation of reality. This model takes advantage of the fact that the estimation of the neutral atmospheric delay (NAD) is widely carried out as a random-walk process. An initial approximate value is provided, followed by corrections, whose magnitude is driven by the process noise parameter. In several precise point positioning (PPP) applications, both commercial and scientific, values between 2 and 5 mm/sqrt(h) are applied as process-noise, driving the high variation of the hydrostatic portion of the NAD parameter. The UNB neutral atmosphere process-noise model utilizes a global grid of ideal process-noise values, based on a 10-year processing of 43 International GNSS Service (IGS) stations and the behavior of the carrier-phase and pseudorange residuals. The goal of this study is to apply the calculated grid to a set of 3 stations in equatorial, mid-latitude and arctic regions for a complete assessment of coordinate repeatability, post-adjustment residuals and water vapor estimation compared against radiosondes. For the coordinate repeatability, 5 years of daily data of each station will be processed using the REPRO$_3$ products provided by the Jet Propulsion Laboratory (JPL) Analysis Center. The horizontal, vertical and three-dimensional repeatability will then be calculated to assess whether the use of the process-noise model increases the long-term coordinate stability. For the post-adjustment residuals, the Shapiro-Wilk normality test as well as RMS metrics will be used to assess whether the stochastic model better represents the physical behavior of the estimated quantities. Finally, for the water vapor estimation, epochs coinciding with close-by radiosonde launches will be used to assess whether the accuracy of the NAD measurements is improved. All the computations are being performed in the Compute Canada clusters, dividing the task into several dozens of computers to achieve the solution in a timely manner. Preliminary processing results of the year 2013 show that pseudorange residual RMS values can be up to 17% smaller with an optimal process-noise value for example at the IGS station UNB3 when compared to the default 5 mm/sqrt(h) value. The carrier-phase RMS shows improvements up to 11%. Furthermore, with this assessment, the use of the UNB neutral atmosphere process-noise model can be validated and perhaps recommended for scientific applications of GNSS PPP, especially those who make use of the filter by-products, such as receiver clocks and atmospheric delays.