Daily JPL Processing of 1200+ Ground-Based GPS Receivers to Estimate Interfrequency Biases and Other Practical Applications

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As the number of ground and space-based receivers tracking the Global Positioning System (GPS) steadily increases, it is becoming possible to monitor changes in the ionosphere continuously and on a global scale with unprecedented accuracy and reliability. At the time of writing this abstract (March 2006), there are more than 1200 globally-distributed dual-frequency GPS receivers available using publicly accessible networks including, for example, the International GPS Service (GPS) and Continuously Operating GPS Stations (CORS).

To take advantage of the vast amount of GPS data, researchers use a number of techniques to estimate satellite and receiver interfrequency biases and the total electron content (TEC) of the ionosphere. Most techniques utilize grid methods, spherical harmonic expansion or basis function coefficient sets to separate the hardware-related biases from the ionospheric contribution. These methods often have a limitation of using up to a couple of hundred GPS receivers, utilizing a sequential least squares or Kalman filter approach to estimate satellite and receiver interfrequency biases as nuisance parameters. The biases are then later removed from the measurements to obtain unbiased TEC.

In our approach to calibrating GPS receiver and transmitter interfrequency biases, we take advantage of all available GPS receivers using a new processing algorithm, based on the Global Ionospheric Mapping (GIM) software developed at the Jet Propulsion Laboratory. This new capability is designed to estimate receiver biases for all stations. In this new approach, we solve for the instrumental biases by modelling the ionospheric delay and removing it from the observation equation using pre-computed GIM maps. The pre-computed GPS maps use about 200 globally-distributed GPS receivers to establish the “background” used to model the ionosphere at the remaining 1000 GPS sites.

To demonstrate this new technique we show three particular applications to which we have applied the algorithm. 1) We estimate satellite and receiver interfrequency biases for all 1200 GPS receivers on a daily basis and compare them to the interfrequency biases delivered as the official IGS product. 2) We demonstrate this automated tool to investigate quiet and storm-time ionospheric behaviour for e.g., the Wide Area Augmentation System (WAAS) and other scientific studies. 3) We apply the technique to extract ionospheric signatures at the 0.1 TECU level caused by seismic-ionospheric interaction during a seismic event such as the December 26, 2004 Sumatra Earthquake event.