Impact of Imperfect Orbit on Ground-based GPS Atmospheric Sounding Applications

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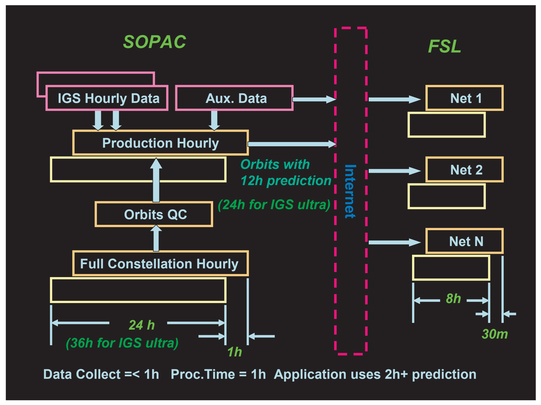
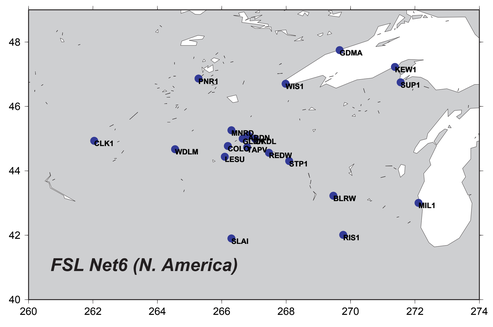
Introduction

For near real-time GPS applications, such as ground based GPS meteorology, the quality of satellite orbits plays a very important role. However, there are a few practical factors that may affect the quality of rapidly produced orbits which in turn have negative impact on the applications. This study assesses the severity of the impact by considering some of most commonly encountered problems. Those problems may involve satellite reposition, satellite performance degradation, or over rejecting satellites during orbit QC; data supply interruption or missing of data from geographically important locations.



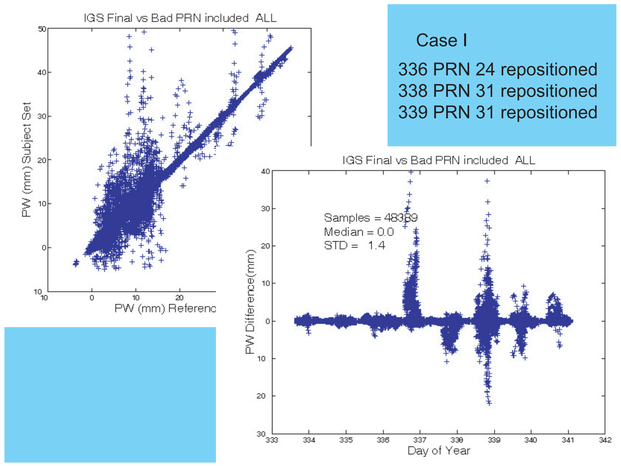
SOPAC Hourly Processing Scheme

Two 24 hour session processing batches are running in parallel starting every hour. Process A uses data from all available satellites regardless their performance. Process B only uses data from those satellites that are identified as good behaving ones through previous session of process A. The orbits with prediction produced from process B will be delivered to client agencies for their applications. The purports for having process A is not to let data from poor behaving satellite contaminate the solutions of process B and also to include previously rejected satellite as soon as they are behaving normal. Some application, like ground based GPS/MET, usually runs using much shorter span of data. Within that time frame, only handful satellites are viewable. Less observation may weaken the solutions.

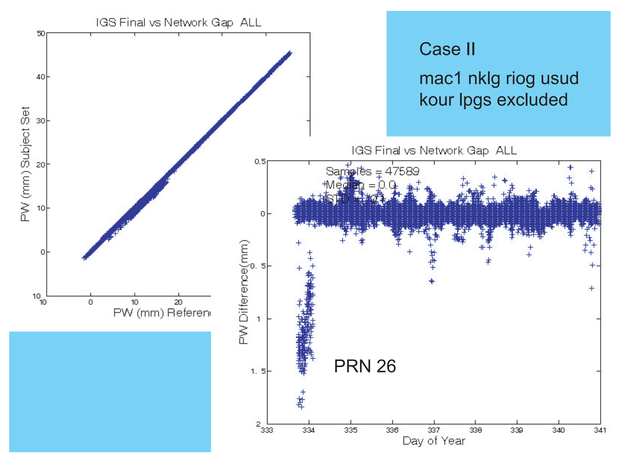


Experimento

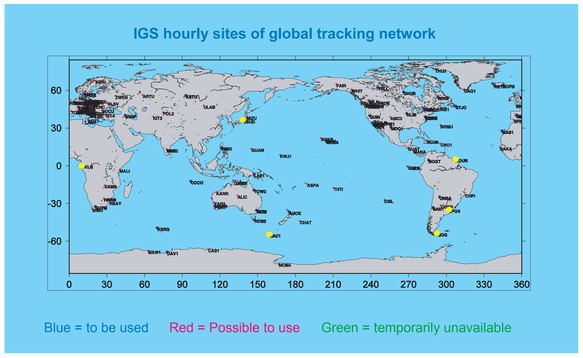
Five sets of hourly global orbit solutions and corresponding regional GPS/MET solutions were carried out for a chosen week when two satellites were repositioned:
I. Repositioned satellite included the orbit solutions
II. Some sites excluded
III. A few satellites included
IV. Data at the end of session removed
V. IGS filnal orbits (reference set)
The network configuration of GPS/MET solutions is shown the figure above.

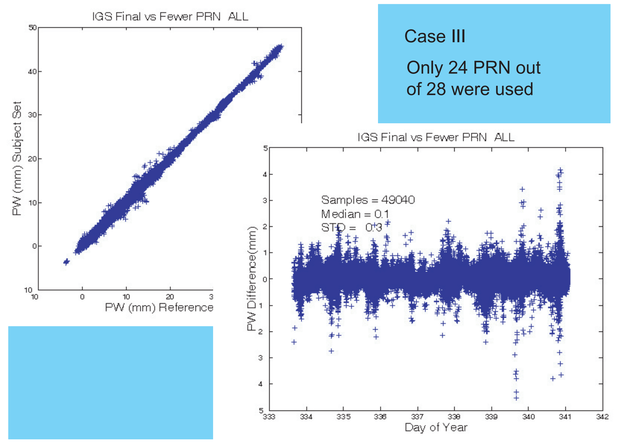


Case I: Since NRT applications use a part of predicted orbits, the delay parameters estimated will be severely contaminated as shown above. Therefore, it is important to reject problematic satellites well in advance.

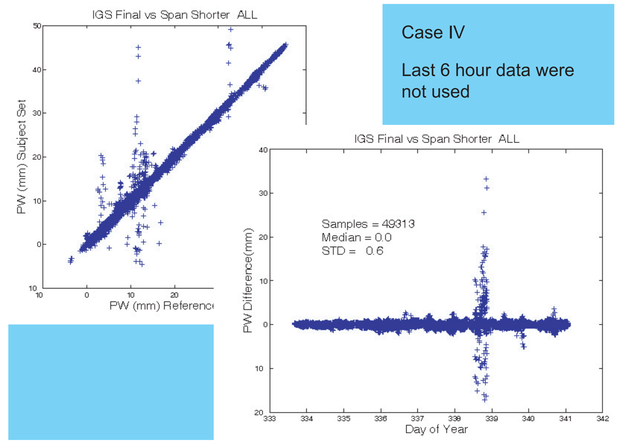


Case II: Poor orbit modeling may occur when there are observation missing from those geographically important sites in the global tracking network. The excluded sites (yellow circle in the map bellow) chosen in this example are based on real condition of current hourly data supply. Only one satellite was affected and the impact on application was small. However, impact may become considerably large when observations missing from more crucial locations.





Case III: It is not too unusual that a few satellites were rejected due to various reasons. This example simulates such a situation. With four satellites excluded, the impact on GPS/MET application is not too so large. However, this is only an average case. When those missing satellites all fall within one session of the application, the impact is expected larger.



Case IV: Sometimes data supply stream may stop, such as network interruption or server problems. This example simulates when data flow stopped for 6 hours which implies that the session of orbit solutions gets shortened from 24 hours to 18 hour. The impact on the GPS/MET application is not so large. It should be noted that the large scatter on day 338 is caused by a technical error that repositioned PRN 31 was included for 4 hours.

Summary

The inclusion of repositioned satellite will severely impact on NRT GPS/MET application, at up to 40 mm level of integrated perceptible water (PW) estimates, completely unacceptable for numerical forecasting. There are measures to prevent such an inclusion, such as using forecast warning and/or satellite health status message imbedded in the navigation message though they are not 100% reliable. The data availability, both in spatial and temporal terms, may result in PW scatter around 1.5 to 2 mm level. The reduced number of useable satellites, in the average cases, will also cause PW estimate to degrade at 1.5 to 2 mm level.