WAAS Technical Report
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DR#80: Ionospheric Scintillation caused High Position Error at Fairbanks and Kotzebue
GPS Week/Day: Week 1520 Day 5 (February 27, 2009)

Discussion:

On February 27, 2009 (GPS Week 1520 Day5), a maximum vertical error of 8.0 meters was observed at the Fairbanks WRE-A (Thread 1) at TOW 468505 as seen in Figure 1. WRE-B and WRE-C (Thread's 2 and 3) had vertical errors of 1.1 and 4.2 meters respectively. All three threads started dropping satellites from the navigation solution from 468350 to 468460.

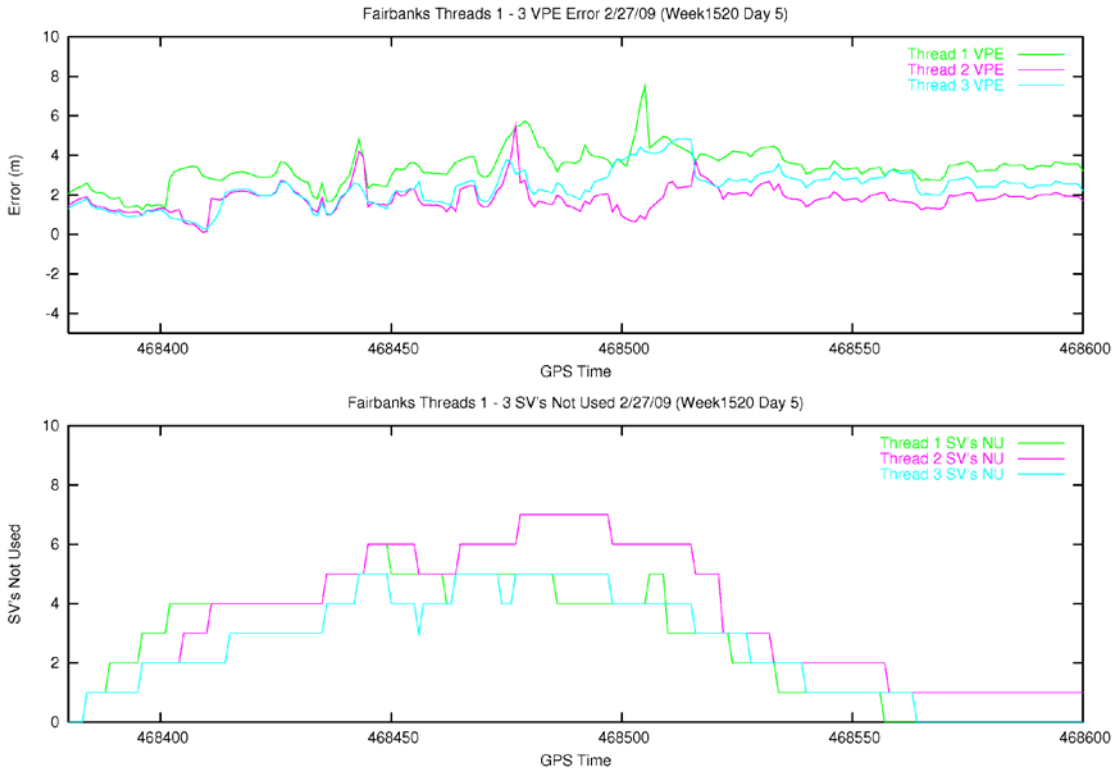

Figure 1 - Fairbanks Threads 1 - 3 VPE and SVs Not Used

The WRE-A maximum error occurred just before PRN28 was dropped from the navigation solution at 468506. Figures 2, 3, and 4 show the Relative Tracking Error for PRN17 (control) and PRN28 for all the threads. The Relative Carrier Tracking error is the difference between the L2 Carrier measurement (pseudorange) and the estimated true range with an arbitrary bias.

PRN17 was dropped from the navigation solution by all three threads before the satellite's increasing Relative Carrier Tracking error had a significant impact on the VPE. Thread 1 did not drop PRN28 from the solution when the Carrier Tracking error started to increase; keeping PRN28 in the solution led to the high VPE. In contrast, Threads 2 and 3 dropped PRN28 from the solution right after PRN28's Carrier Tracking error started to increase.

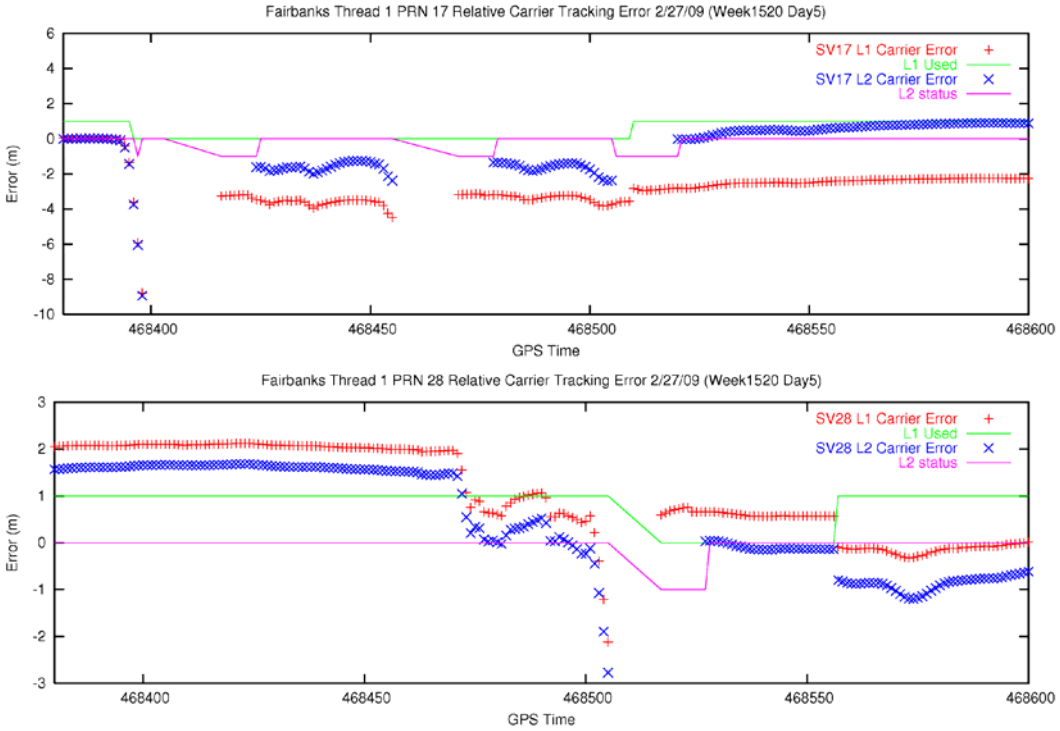

Figure 2 - Fairbanks Thread 1 PRN17 and 28 Relative Tracking Error

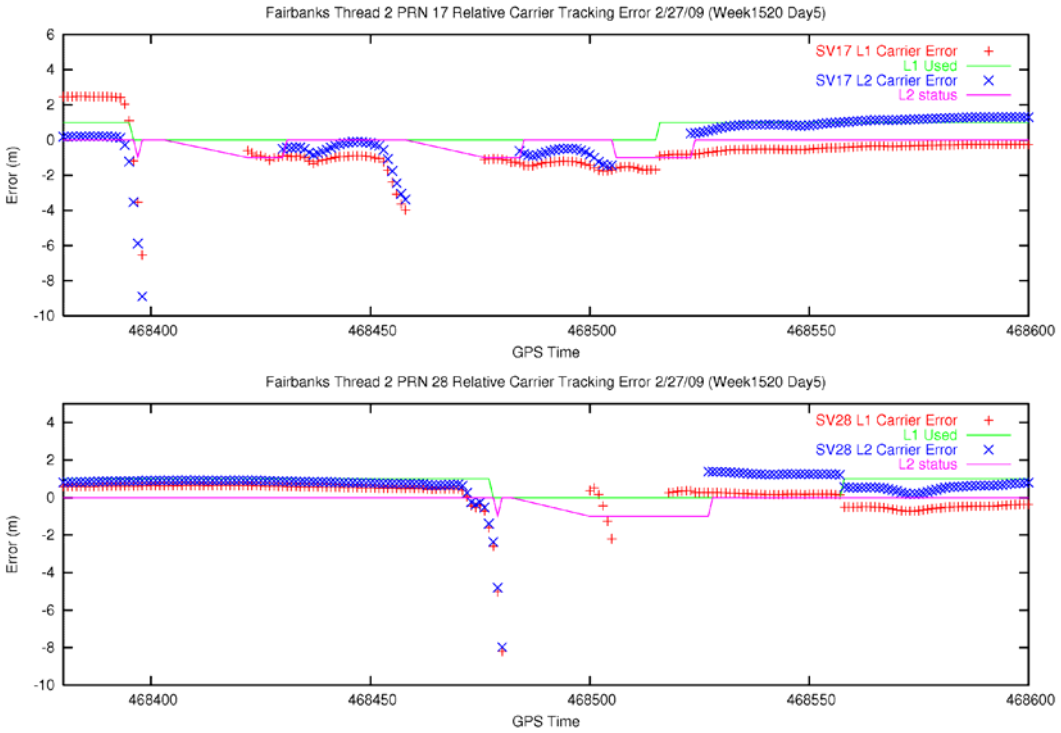

Figure 3 - Fairbanks Thread 2 PRN17 and 28 Relative Tracking Error

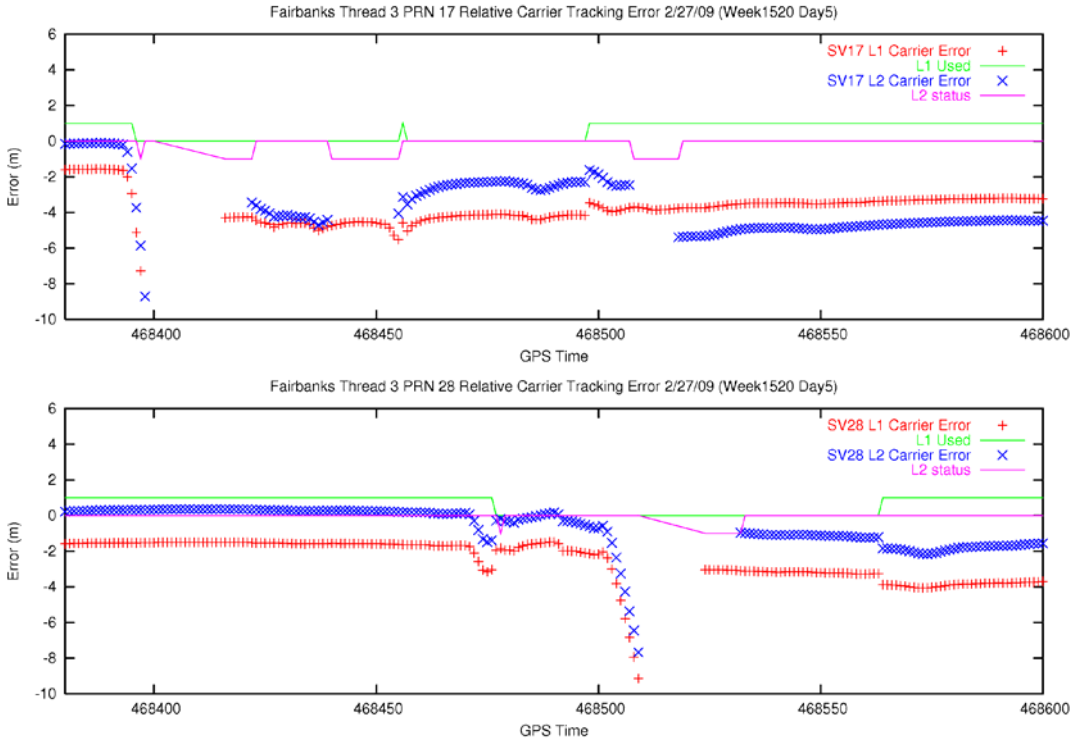

Figure 4 - Fairbanks Thread 3 PRN17 and 28 Relative Tracking Error

On the same day, a maximum vertical error of 7.2 meters was observed at the Kotzebue WRE-A (Thread 1) at TOW 468480 as seen in Figure 5. WRE-B and WRE-C (Thread's 2 and 3) had vertical errors of 2.4 and 5.4 meters respectively. All three threads started dropping satellites from the navigation solution starting at 468476.

PRN17 and PRN27 were dropped from the navigation solution for Threads 1 to 3 at the time of the max vertical error. Figure 6 shows the Relative Tracking Error for PRN17 and PRN27 for Thread 1. Analysis of Thread 1 data showed as the PRN17 Relative Carrier Track error changed from -1 to -4 meters from 468470 to 468476, the Thread 1 VPE increased from 2 to 4 meters before PRN17 was dropped from the solution. The PRN27 Relative Carrier Track error changed from -1 to -4 meters from 468473 to 468480 increasing the Thread 1 VPE from 4 to 7 meters. The Thread 3 VPE was affected the same way. The Thread 2 maximum VPE was 2.4 meters at 468479, PRN27 was dropped from the solution 1 second prior to Threads 1 and 3, thus decreasing the effect of the PRN27 Carrier Track error on the VPE.

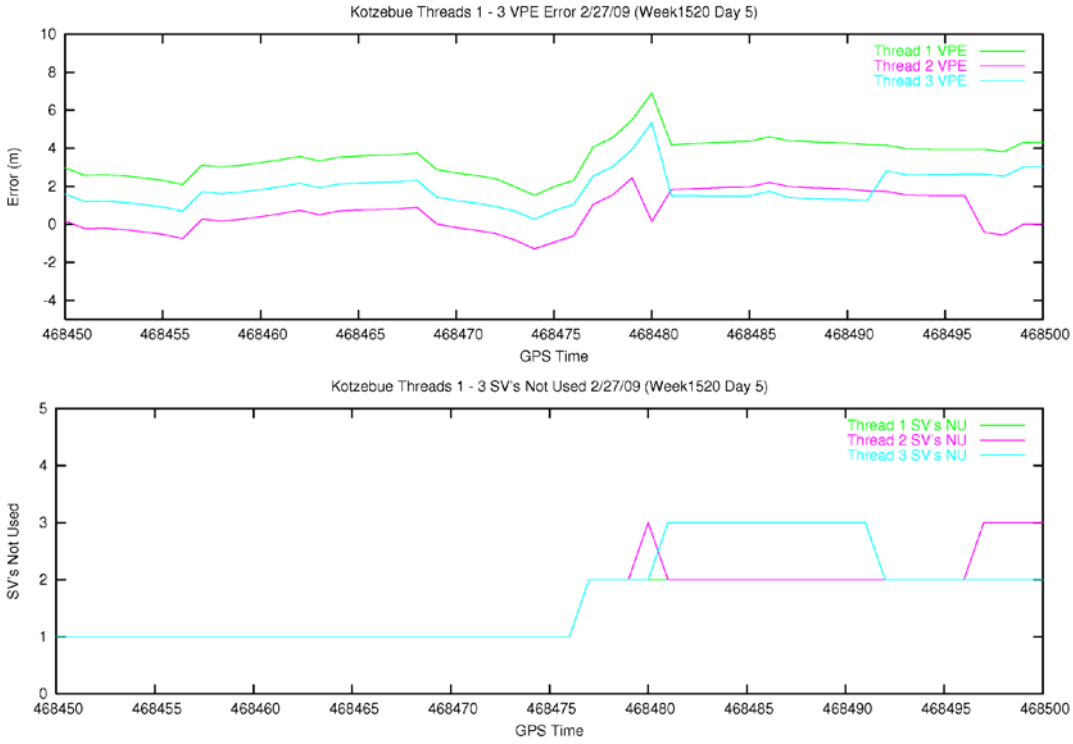

Figure 5 - Kotzebue Threads 1 - 3 VPE and SVs Not Used

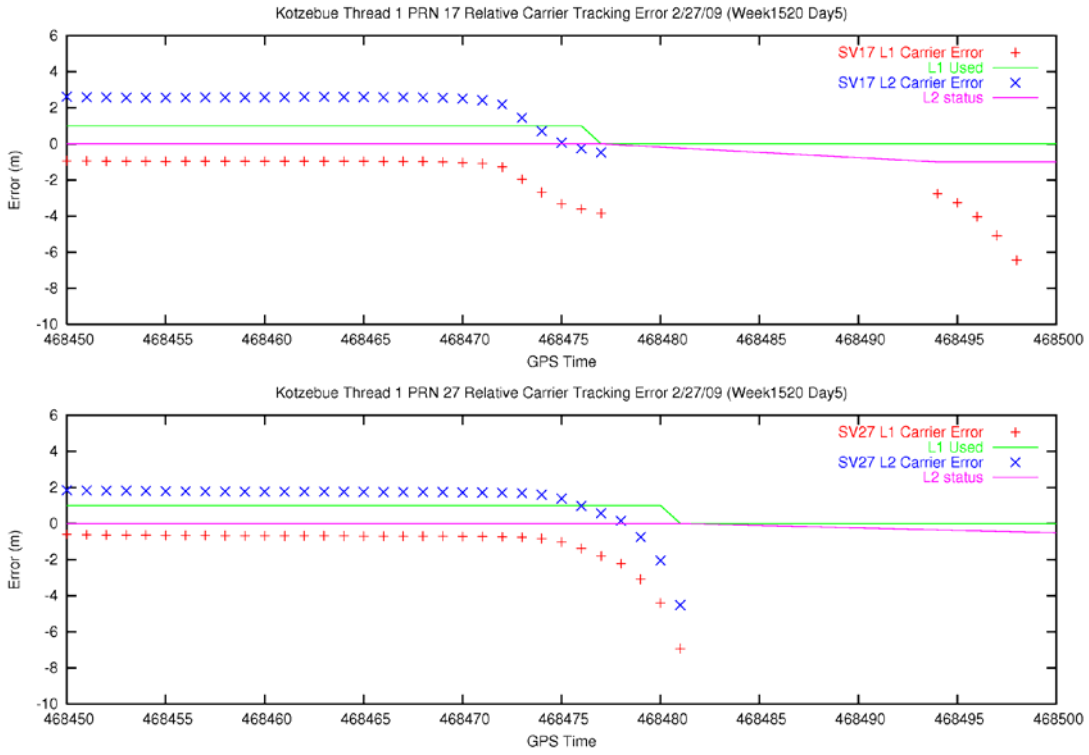

Figure 6 - Kotzebue Thread 1 PRN17 and 27 Relative Tracking Error

Conclusion:

On GPS Week 1520 Day5, Ionospheric scintillation caused a loss of satellite tracking at Fairbanks and Kotzebue. Since all three threads at both sites experienced the same tracking performance at the same time, receiver malfunction has been ruled out as a cause of satellite measurement errors. The resulting WAAS accuracy and LPV availability at these locations are reflective of what WAAS users can experience during Ionospheric condition, therefore the data should be included in the evaluation.