WAAS Technical Report
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Pomona, New Jersey
3/25/08

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DR# 67: GIVE Monitor Trips Set IGPs to Storm State in Alaska Region
GPS Week/Day: Week 1468 Day 4 (February 28, 2008)

Discussion:

On February 28, 2008, several C&V GIVE Monitor Trips caused Ionospheric Grid Points (IGPs) in Alaska and the northwestern part of Canada to be set to storm state (GIVE = 45). This caused a loss of LPV service in that region for approximately 0.5 hours. According to the NOAA Space Weather Prediction Center, there were isolated minor storm periods observed at middle latitudes and minor to major storm periods observed at high latitudes. The planetary Kp Index, which quantifies disturbances in the horizontal component of earth's magnetic field, had a measurement of 5, indicating storm-level geomagnetic activity. The geomagnetic activity caused the GIVE at several IGPs to go to 45 meters, also known as "storm state." GIVE monitor trips are listed in Tables 1 and 2. ZLA was the selected source for the entire day.

Table 1: ZLA GIVE Monitor Trips

UTC Time	Band	IGP	Latitude	Longitude
11:13:39	0	199	45	-145
11:13:42	1	25	50	-140
11:25:00	9	10	60	-135
11:25:08	9	76	65	-150
11:25:08	9	77	65	-140
11:26:50	9	76	65	-150
11:26:50	9	77	65	-140

Table 2: ZTL GIVE Monitor Trips

UTC Time	Band	IGP	Latitude	Longitude
11:26:50	9	76	65	-150

Figure 1 shows the IGP Status at 11:30:09 GMT on February 28, 2008, when all of the IGPs listed in table 1 had GIVE values of 45. The GIVE values in the CONUS region were set to 4.5 meters or below during this time. In Canada and at high latitudes, GIVE values were elevated due to geomagnetic activity.

Figure 1: WAAS Ionospheric Grid Point Status on February 28, 2008

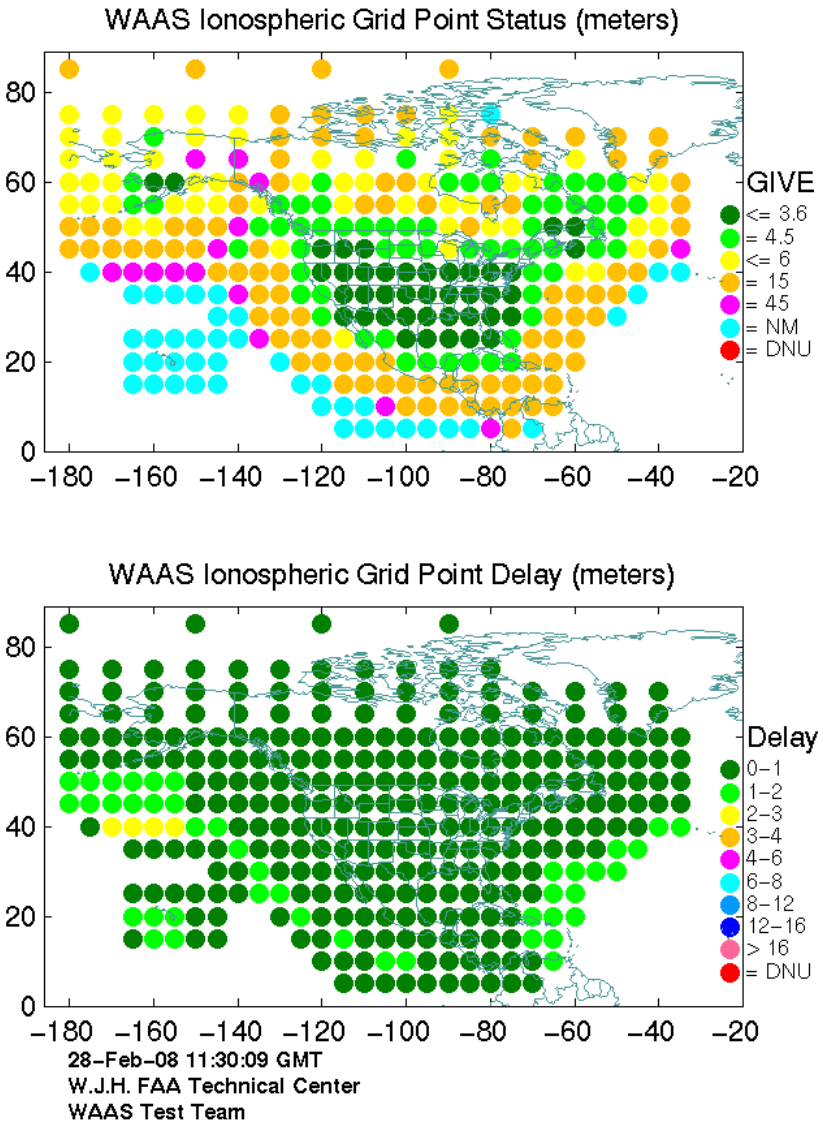
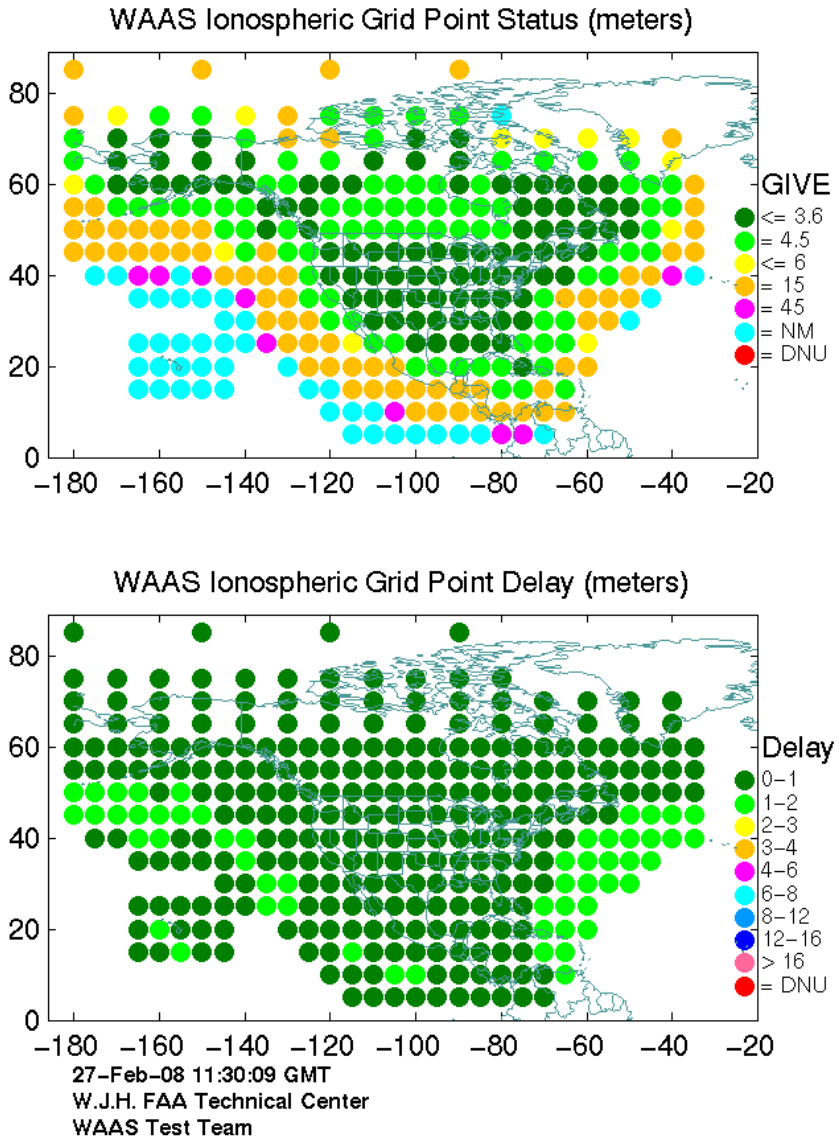


Figure 2 shows IGP Status on February 27, 2008 at the same time of day. The GIVE values on this day at the northern latitudes have much lower values than on February 28, 2008 because there was no significant geomagnetic activity this day.

Figure 2: WAAS Ionospheric Grid Point Status on February 27, 2008



Impacts to WAAS Performance:

The disturbances in the Earth's ionosphere, caused by the geomagnetic storm on February 28, 2008, had an effect on performance of the WAAS system. Because the GIVE values of IGPs located at (65, -140) and (65, -150) were set to storm state, the Vertical and Horizontal Protection Levels became elevated at Fairbanks, AK and Anchorage, AK. These two locations were directly affected by the IGPs being set to storm state because of their proximity. Since the Vertical Protection Level exceeded 50m at both Fairbanks and Anchorage during the time when the IGPs were set to storm state, LPV service was lost there from GPS Time of Week (TOW) 386738 to GPS TOW 388753. At the following update of the GIVEs, the IGPs at (65, -140) and (65, -150) were removed from storm state. This caused horizontal and vertical protection levels to be significantly lowered and LPV service at Fairbanks and Anchorage resumed.

Figure 3 shows a plot of the Vertical Protection Levels at Fairbanks and Anchorage during the LPV outage

Figure 3: Vertical Protection Levels at Fairbanks and Anchorage, AK

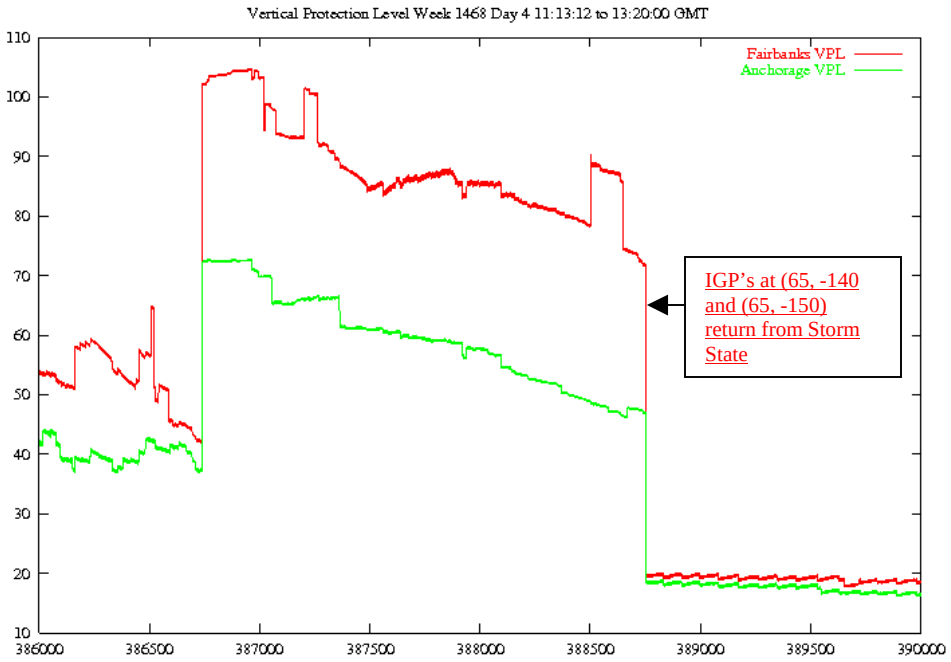
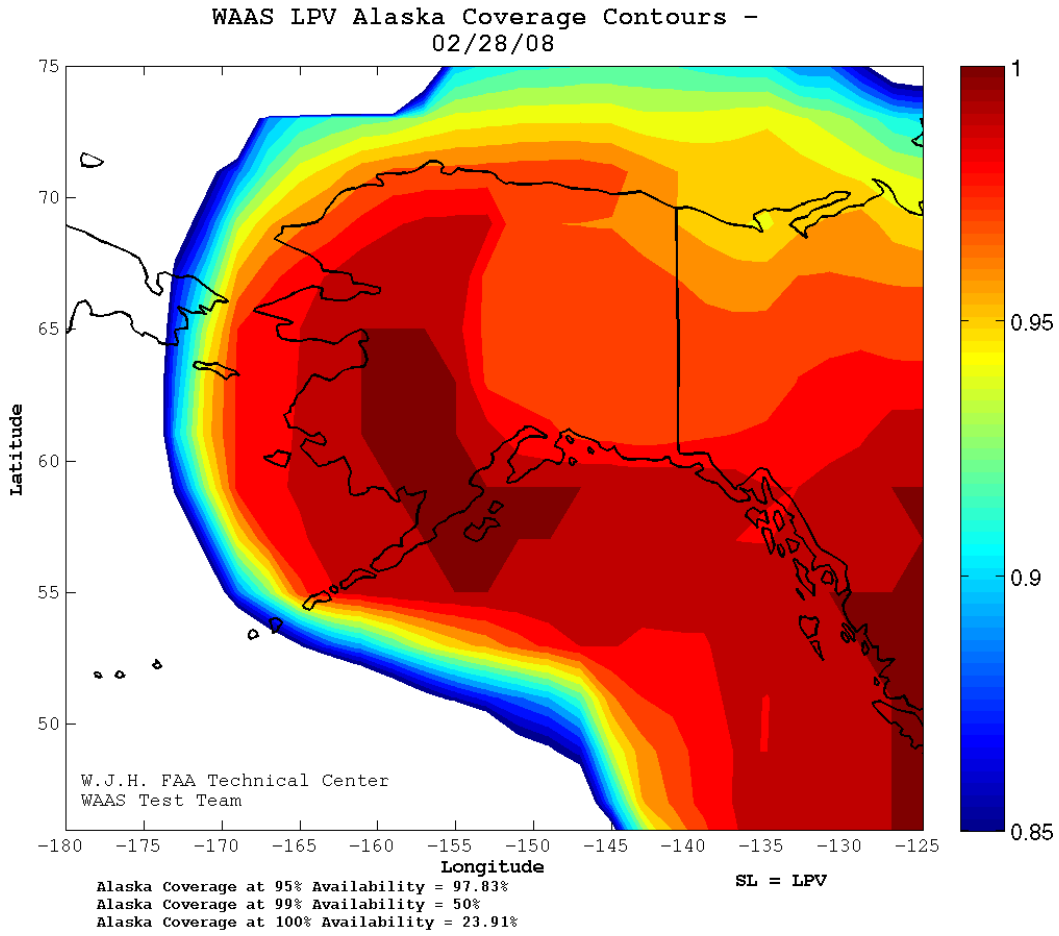


Figure 4 shows a 24-hour plot of LPV Service Availability Contours for February 28, 2008. Coverage in Alaska was significantly reduced because of the geomagnetic storm.

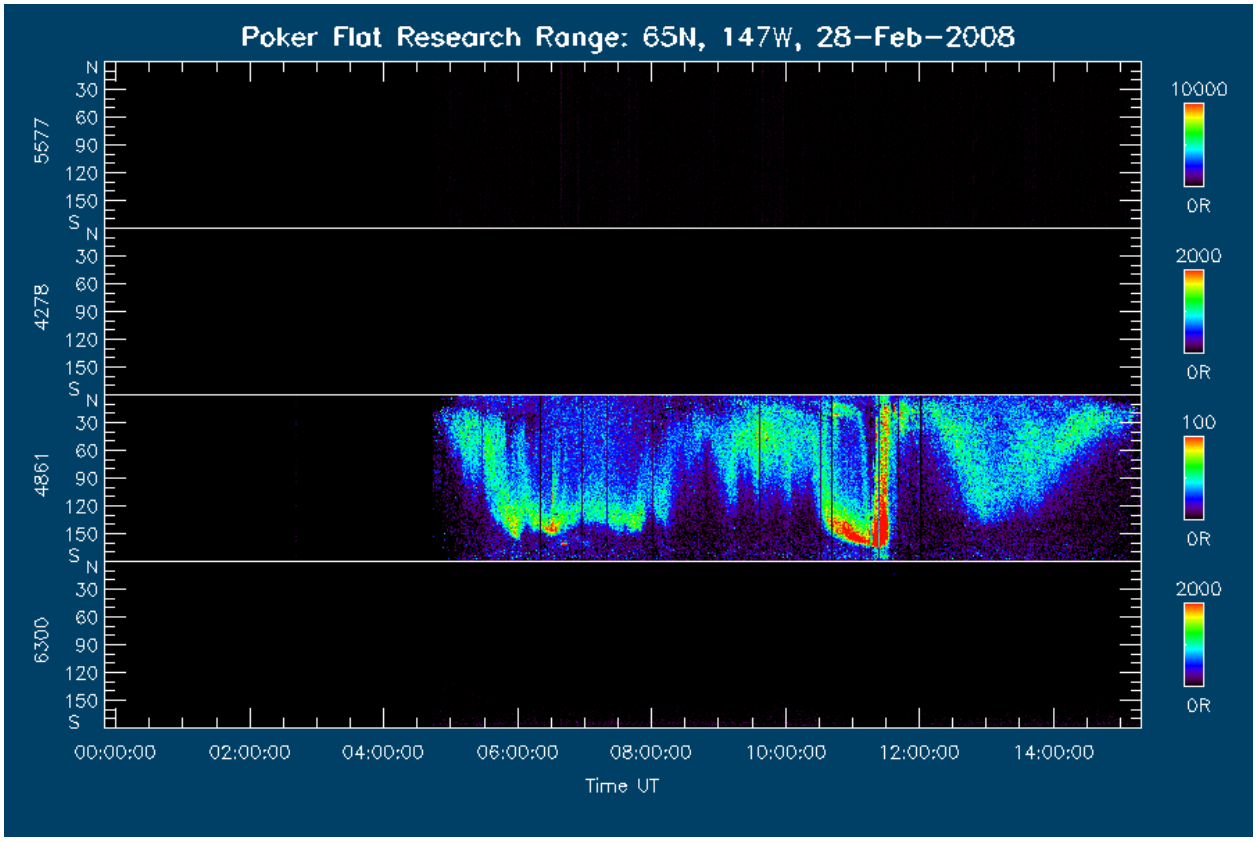
Figure 4: LPV Coverage on February 28th, 2008



Geomagnetic Activity:

On February 28th, 2008, IGPs were set to storm state because of increased levels of geomagnetic activity. The WAAS system determines ionospheric errors by modeling the ionosphere as a thin layer and measuring delay as signals propagate through it. When the system is unable to model the ionosphere in this way, WAAS sets IGPs to storm state, which effectively disables WAAS service.

According to the NOAA Space Weather Prediction Center, geomagnetic storm activity on February 28, 2008 was due to high speed solar wind interacting with the ionosphere. Figure 5 shows the results of the Meridian Scanning Photometer that is installed at the Poker Flat research range, located near Fairbanks, AK. The instrument determines the intensity of light along a line between the north and south magnetic poles. The field of view is approximately 1 degree by 180 degrees. This covers a narrow band of the sky from the magnetic north horizon to the magnetic south horizon. As can be seen in the plot, auroral activity was high across the entire north-south slice of the sky when GIVE monitor trips occurred (at 11:25 GMT)



Geomagnetic events that trigger IGPs to be set to storm state will become more common as we draw nearer to a solar maximum, which will occur around the year 2012. The National Center for Atmospheric Research has projected that the current solar cycle leading up to a solar maximum will be the strongest witnessed since 1958. Future impacts to WAAS service are anticipated as solar activity increases.

Conclusion:

GIVE monitor trips caused several IGPs in Alaska and Northwestern Canada to be set to storm state. This was due to increased levels of geomagnetic activity that was present in the Earth's atmosphere at that time. LPV service was affected from approximately 11:30 GMT to 12:00 GMT, due to high GIVE values of several IGPs. After geomagnetic activity decreased, GIVE values returned to normal levels and LPV service resumed.