WAAS Technical Report
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DR #125: Effect on WAAS from Iono Activity on September 12-13, 2014

GPS Week/Day: Week 1809 Day 5 & 6
(9/12/2014 & 9/13/2014)

Background

- **This presentation shows the effects on WAAS aviation users from the solar event on September 12-13, 2014**

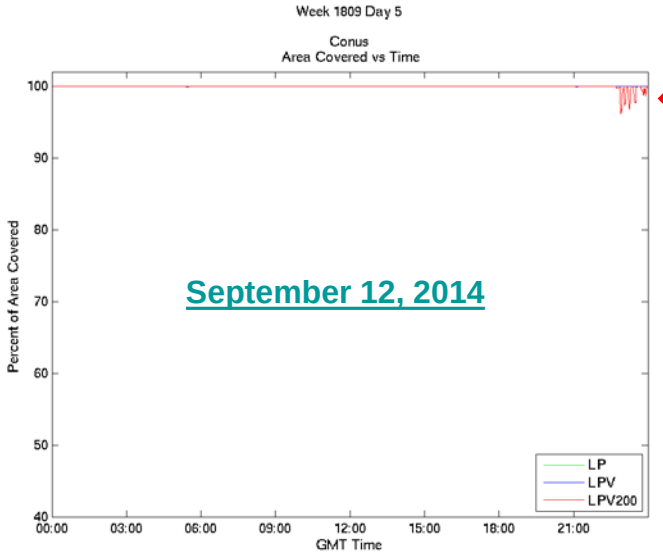
Kp Index

- **The Kp Index is a worldwide weighted average metric that is used to help define the magnitude of a geomagnetic storm**
  - The higher the value the more intense the storm
  - A value of 5 or more generally indicates a storm
- **The maximum Kp on September 12 was 7**
- **The maximum Kp on September 13 was 4**

Coverage vs. Time Charts

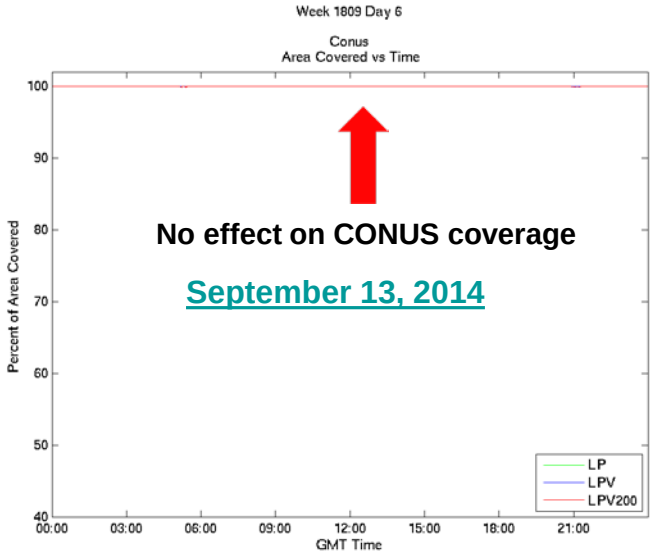
- **This event affected WAAS in Eastern Canada and northern CONUS late in the day (GMT time) on September 12 and continued to affect Canada into the first part of the day on September 13**
- **The following slides show LPV and LPV-200 coverage in Canada and CONUS vs. time for September 12 and September 13**

Coverage vs. Time – September 12-13 2014 in CONUS



WAAS coverage affected late in the day

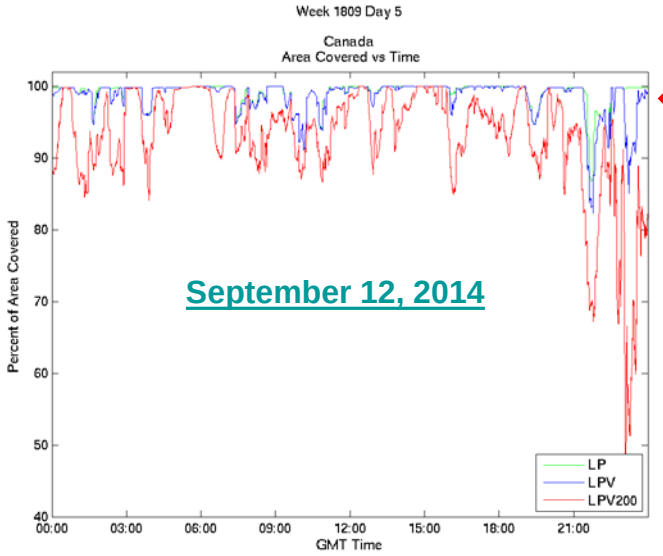
[September 12, 2014]



No effect on CONUS coverage

[September 13, 2014]

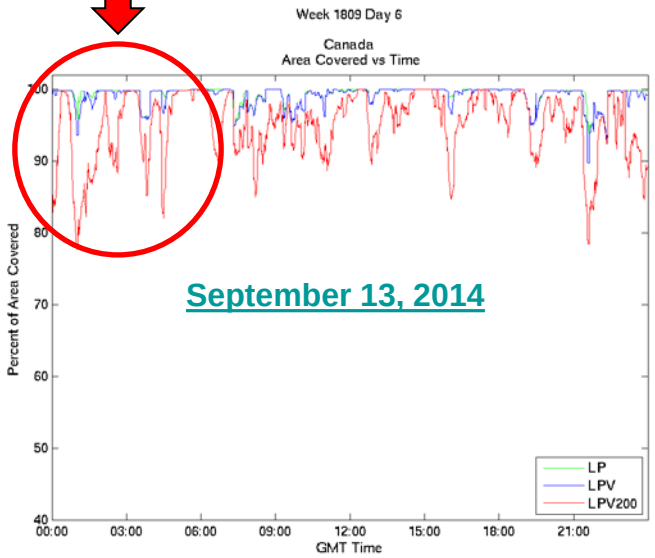
Coverage vs. Time – September 12-13 2014 in Canada



WAAS coverage affected late in the day

[September 12, 2014]

Lower than normal coverage during first part of the day

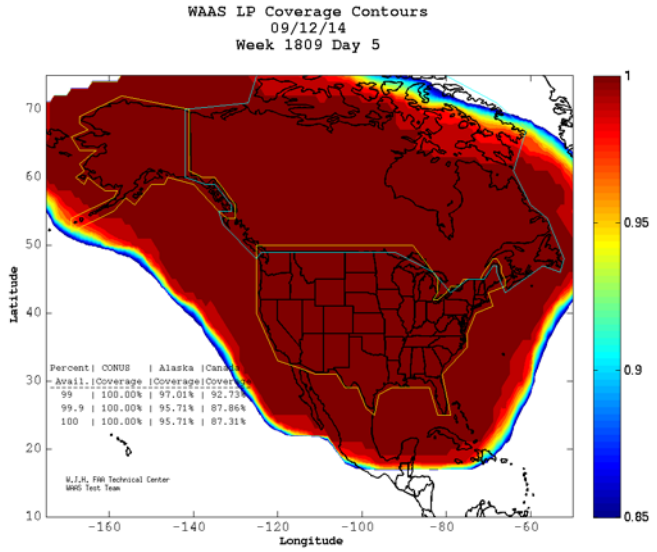


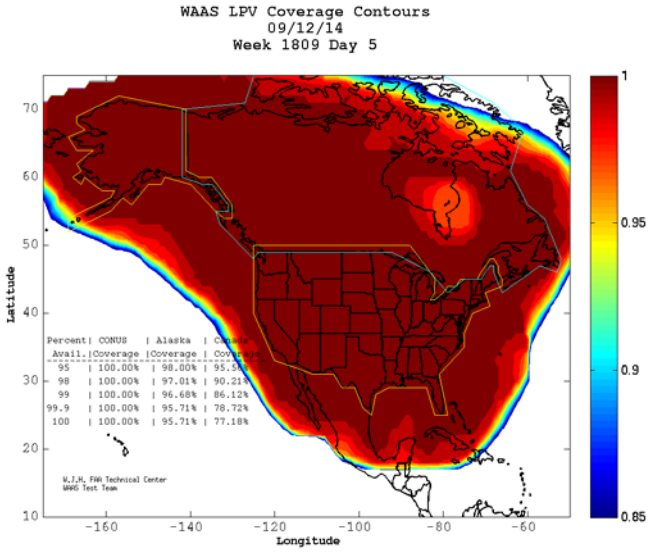
[September 13, 2014]

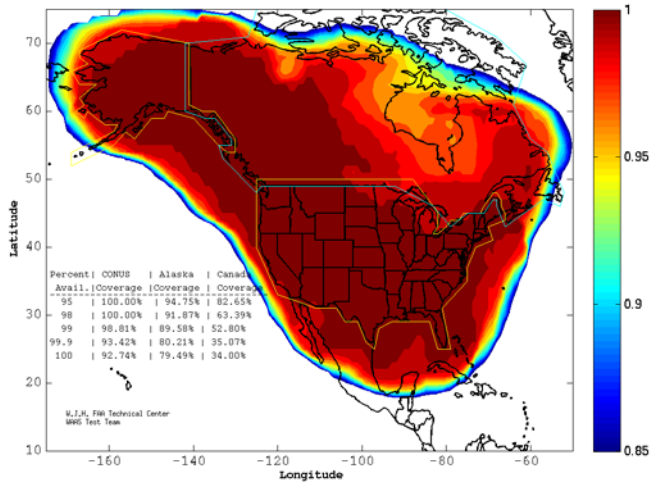
Coverage Charts

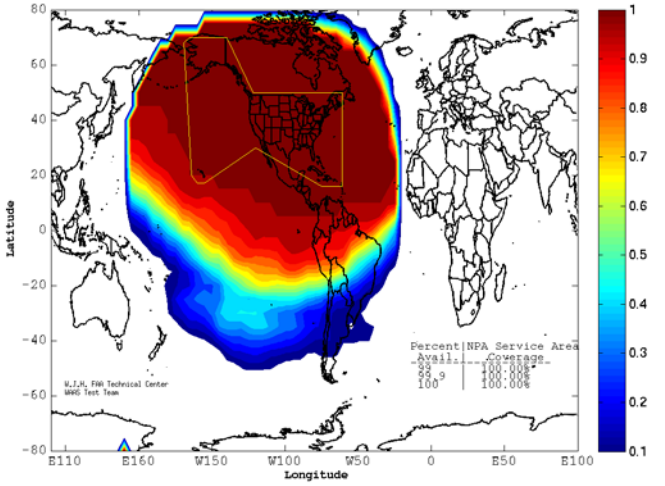
- **The next two slides show the LP, LPV, LPV-200, and RNP 0.1 coverage for September 12 - 13**
- **LPV, LP, and RNP – 0.1 coverage is unaffected by this event in CONUS**
  - LPV affected in Canada

Coverage Plots – September 12, 2014

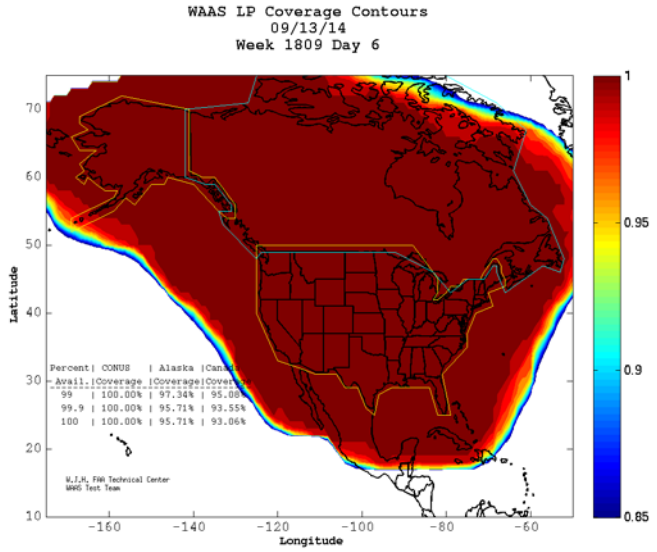


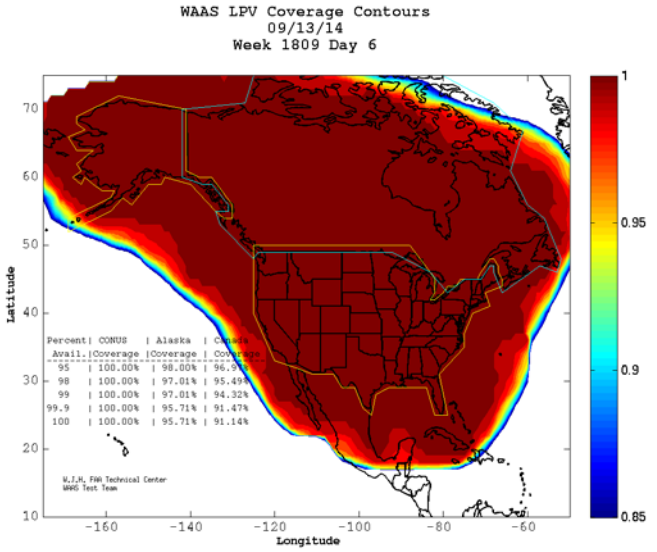


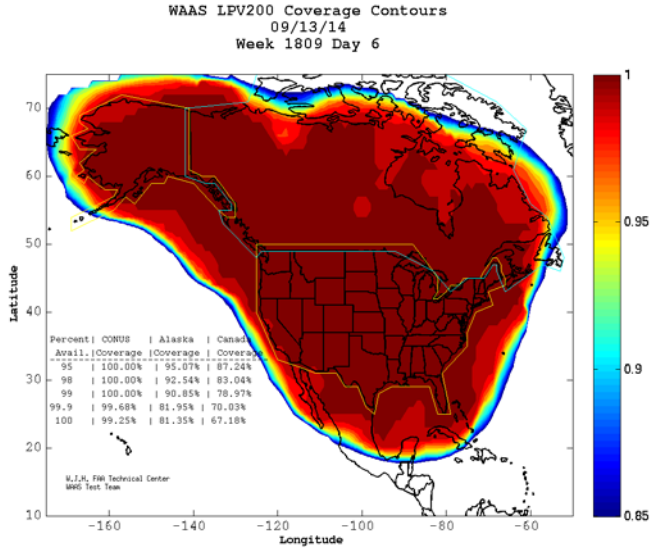


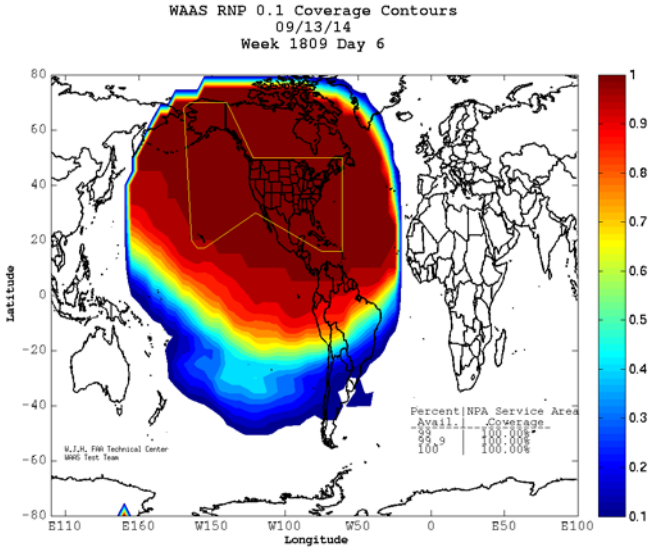


Coverage Plots – September 13, 2014





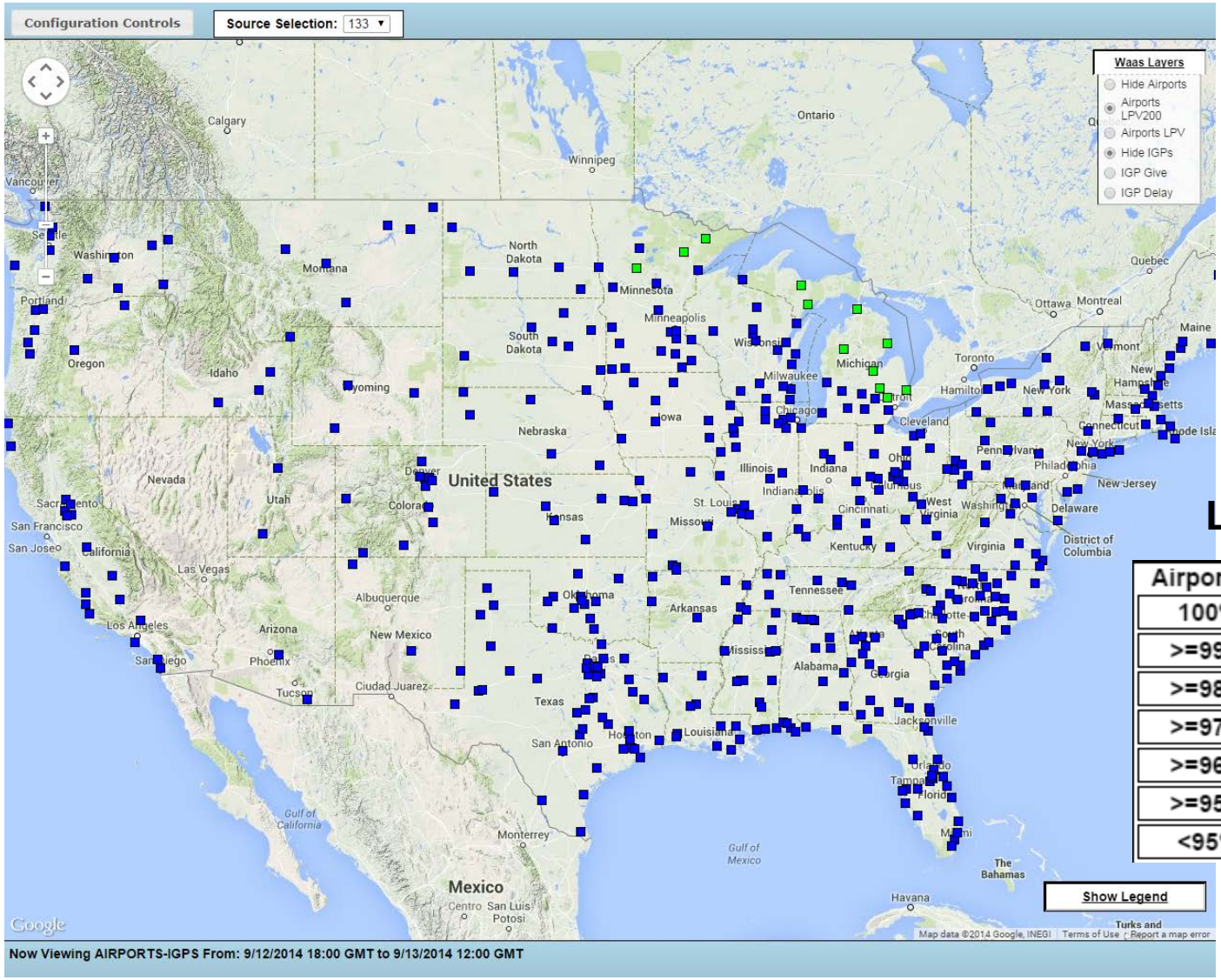




Airport Outages

- **Each airport is represented by a square on the map**
  - A blue square means there was no loss of service at that airport
  - A green square means the availability at that airport was greater than 99% for the time period selected
- **The next chart shows the airports that had an outage on September 12 due to this iono activity**
  - Time period is from 9/12/14 18:00:00 GMT to 9/33/14 12:00:00 GMT
  - There was one airport in North America (Opinaca Airport (CPN8) in Canada) that had an LPV outage. Airport not shown on map
    - Outage lasted 38 minutes (22:57:14 to 23:35:14 GMT)
  - Several airports the Great Lakes region of CONUS had LPV-200 outages
    - These airports have a published procedure down to LPV-200 minima
- **There were no LPV or LPV-200 outages at any airports on September 13 due to this iono event**

Airports with LPV-200 Outages (Green Squares) on September 12



Legend

Airport Availability (%)	
100%	
>=99%	
>=98%	
>=97%	
>=96%	
>=95%	
<95%	

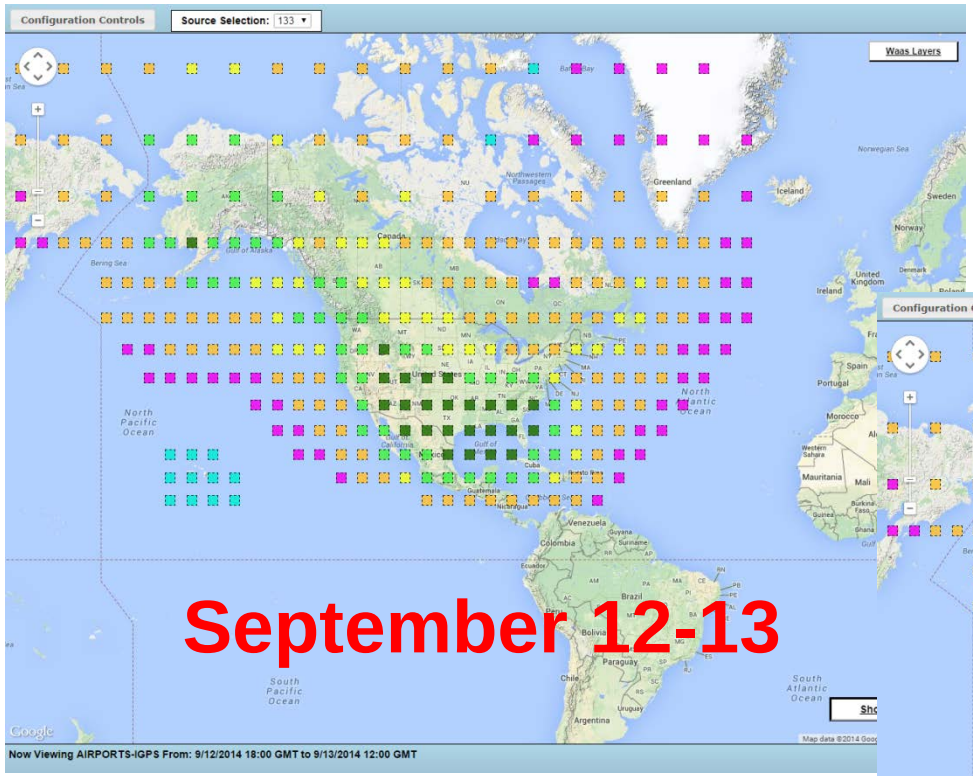
Ionosphere Grid Points

- **The next slide shows the maximum IGP GIVE**
  - The figure on the left is for September 12 18:00:00 to September 13 12:00:00
  - The figure on the right is for September 14 18:00:00 to September 15 12:00:00
    - The maximum Kp for September 14-15 was 1
    - The IGP GIVE values for this time period can be considered typical
- **IGP GIVE values are elevated on September 12-13 compared to September 14-15 in eastern Canada and north central CONUS**

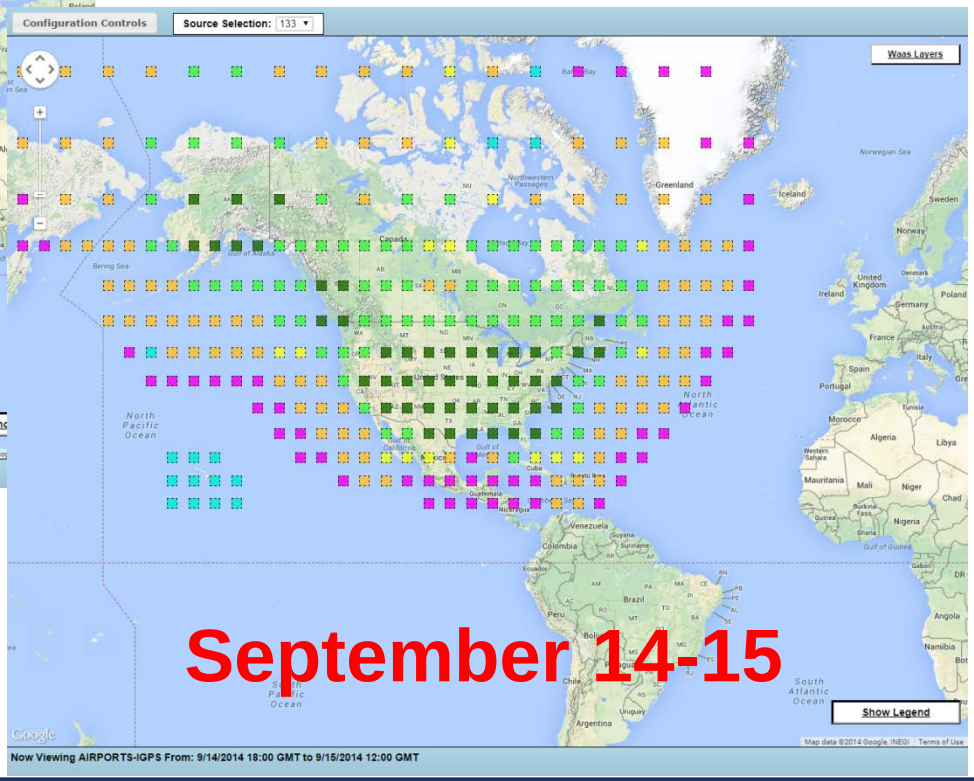
IGP GIVE Values

Legend

IGP Gives	
3.6	
4.5	
6	
15	
25	
45	



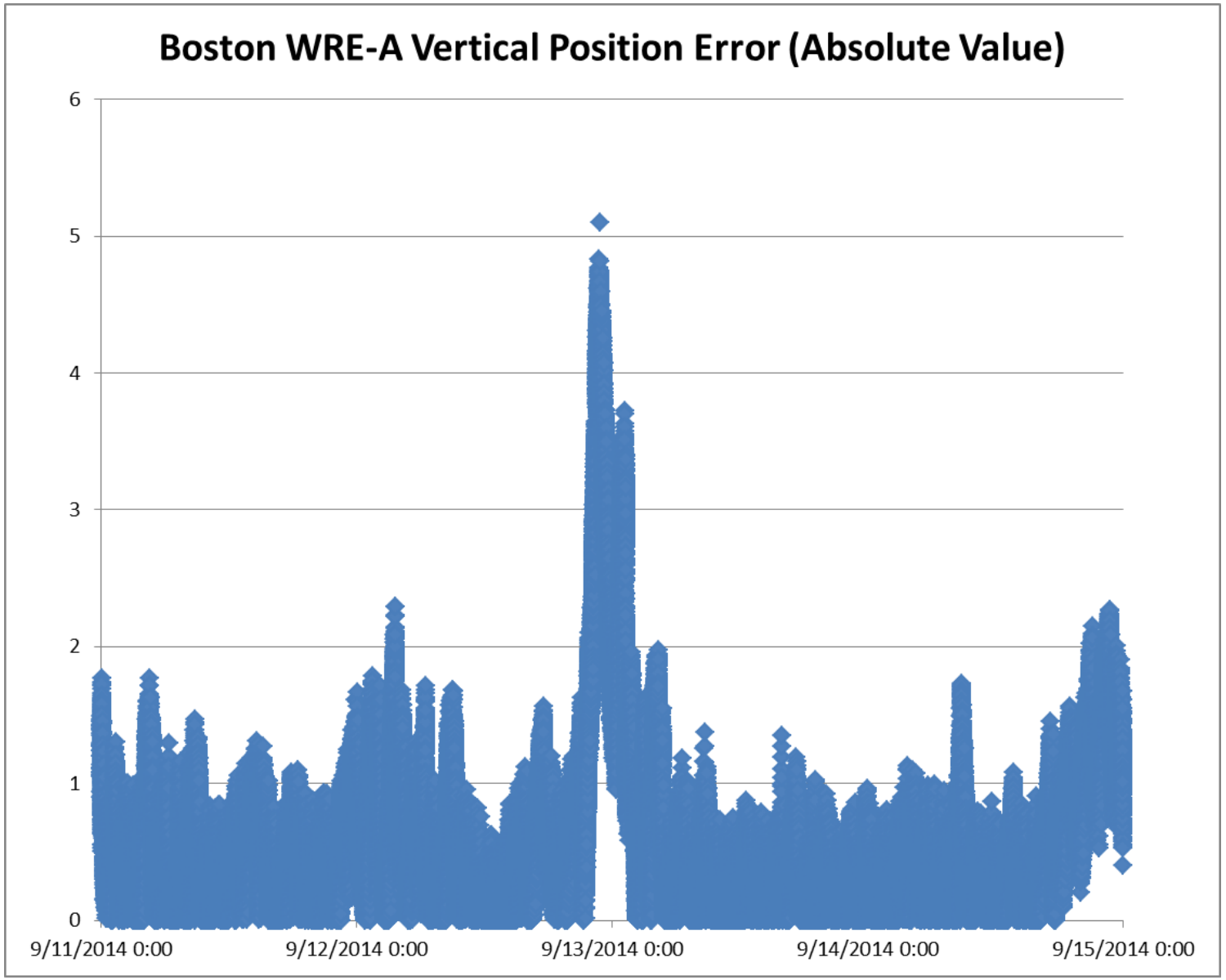
September 12-13



September 14-15

Position Error

- **During this event the position error increased above normal levels at some reference stations**
- **For example, the next slide shows the vertical position error at the Boston WRE-A receiver**
  - Data from September 11 – 14 shown
    - Highest vertical error occurs on September 12 at about 22:48 GMT at 5.1 meters.
      - Normally the maximum vertical error at Boston is around 2 meters
  - Absolute value of error shown
- **Largest vertical error observed was at Winnipeg on September 12 at 6.04 meters**
- **Other sites with higher than normal (vertical error > 0.5 meters different than typical) vertical errors include**
  - Minneapolis, Chicago, Winnipeg, Seattle, Gander, Boston, New York, and Billings


Boston WRE-A Vertical Position Error (Absolute Value)
6
5
4
3
2
1
0
9/11/2014 0:00
9/12/2014 0:00
9/13/2014 0:00
9/14/2014 0:00
9/15/2014 0:00

Conclusion

- **Iono activity affected WAAS coverage in Canada and northern CONUS**
  - LPV service in CONUS was unaffected by this event
  - LP and RNP 0.1 service was unaffected by this event
- **Coverage affected on September 12 and September 13, 2014**
  - Affect included the first few hours on September 12 and early in the day on September 13