WAAS Technical Memorandum
William J. Hughes Technical Center
Pomona, New Jersey
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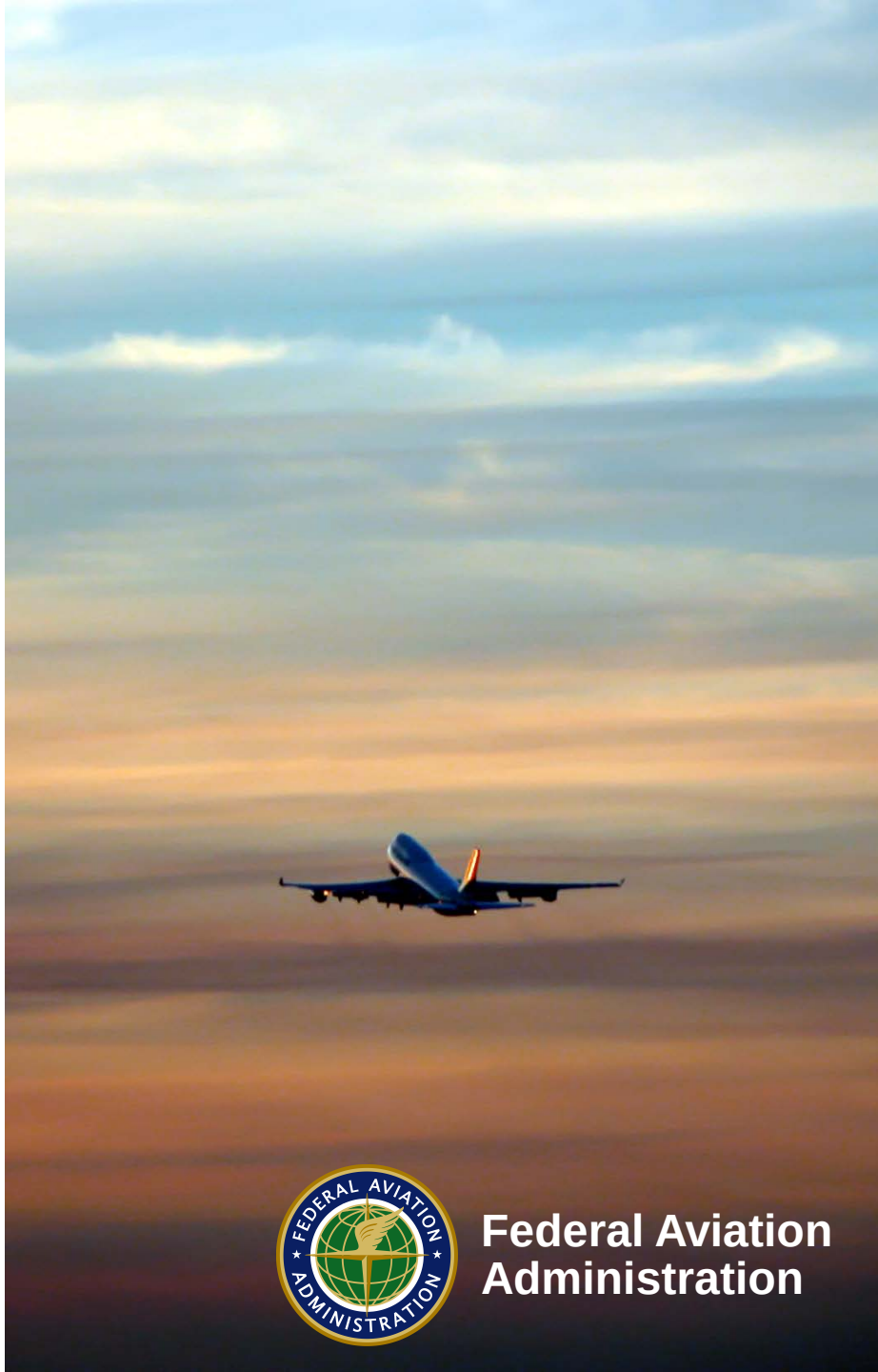
DR #138: UDREi Spikes to Not Monitored Observed on PRN 6

Observations based on data from April 22nd – April 24th



Introduction

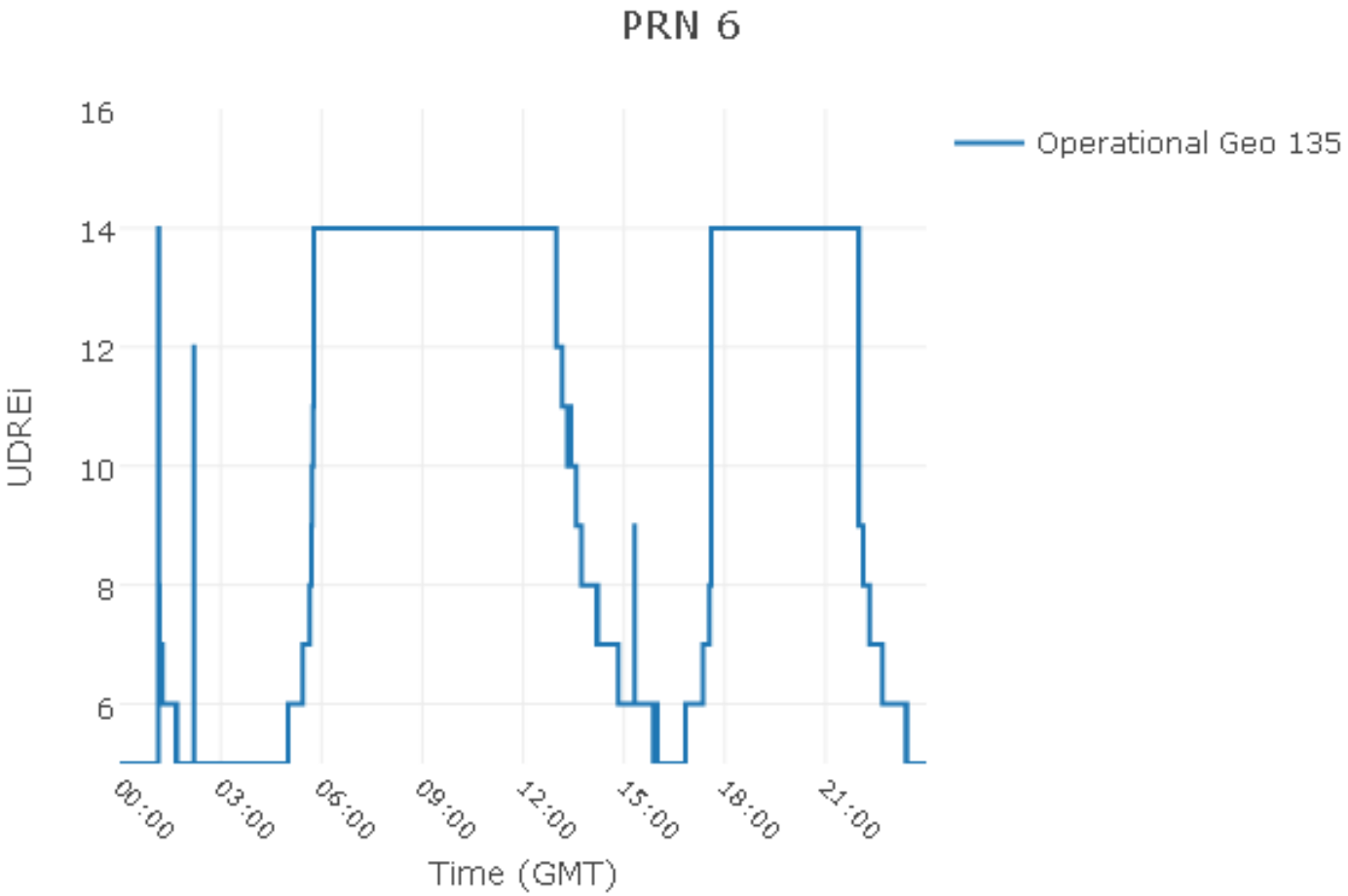
- **WAAS set PRN 6 UDREi to Not Monitored (UDREi = 14) on the following 3 days: April 22nd, April 23rd, and April 24th, 2017**
- **On April 24th all WAAS reference station (WRS) receivers tracking PRN 6 experienced a signal anomaly and set L1 status invalid**
  - 6 WRS receivers lost track of PRN 6 while it was well viewed
- **On April 23rd 40 of 47 WRS receivers set L1 status invalid for 1 second**
  - All 47 WRS receivers experienced signal anomaly
- **On April 22nd no WRS receivers set L1or L2 status invalid**
  - Signal anomaly observed

PRN 6 UDREi set to Not Monitored

- **April 24th a WAAS SV Alert on PRN 6 set the UDREi from 5 to 14 at 01:09:01 GMT (TOW 90559 - see slide 4)**
  - Took ~ 30 minutes to get back to UDREi floor
  - PRN 6 set to Not Monitored for previous 2 days
    - April 23rd there was an SV Alert
    - April 22nd there was no SV Alert

- **April 24th WAAS LPV200 service affected in western CONUS, increasing daily California outage**
  - Airports in California that do not normally have any service outages, experienced a 6- 8 minute LPV200 service outage

PRN 6 UDREI
April 24th, 2017



PRN 6 UDREi set to Not Monitored (cont'd)

- **Analysis of data from Tech Center SV glitch process and WRS receiver navigation solution showed the following receiver performance**

  - There was a total of 113 receivers tracking PRN 6
  - 01:08:43 GMT (TOW90541) - 6 receivers experience 2 – 8m L1/L2 carrier anomaly (see slide 7) YFB-C, OTZ-B, OTZ-C, BRW-B, BRW-C, MTP-C
  - 01:08:45 GMT (TOW 90543) - 6 receivers above stop tracking PRN 6
  - 01:08:49 GMT (TOW 90547) - 6 receivers above reacquire PRN 6 in track list with L1 status invalid and pseudorange/carrier anomalous (see next slide) until 01:09:07 GMT (TOW 90565)
  - 01:08:55 GMT (TOW 90553) - All 113 receivers set L1 status invalid for 1 - 2 seconds with L1/L2 carrier anomaly (~0.2m for receivers that maintained track) (see slide 8)
  - 01:09:01 GMT (TOW 90559) - WAAS sets PRN 6 UDREi to Not Monitored
  - 01:09:07 GMT (TOW 90565) - 6 receivers set L1 status valid
  - 01:09:13 GMT (TOW 90571) - 6 receivers set L2 status valid
  - 01:09:56 GMT (TOW 90614) - Receivers that did not lose track of PRN 6 start using PRN 6 in nav solution, with all receivers tracking using PRN6 in nav solution by 01:10:07 GMT (TOW 90625)

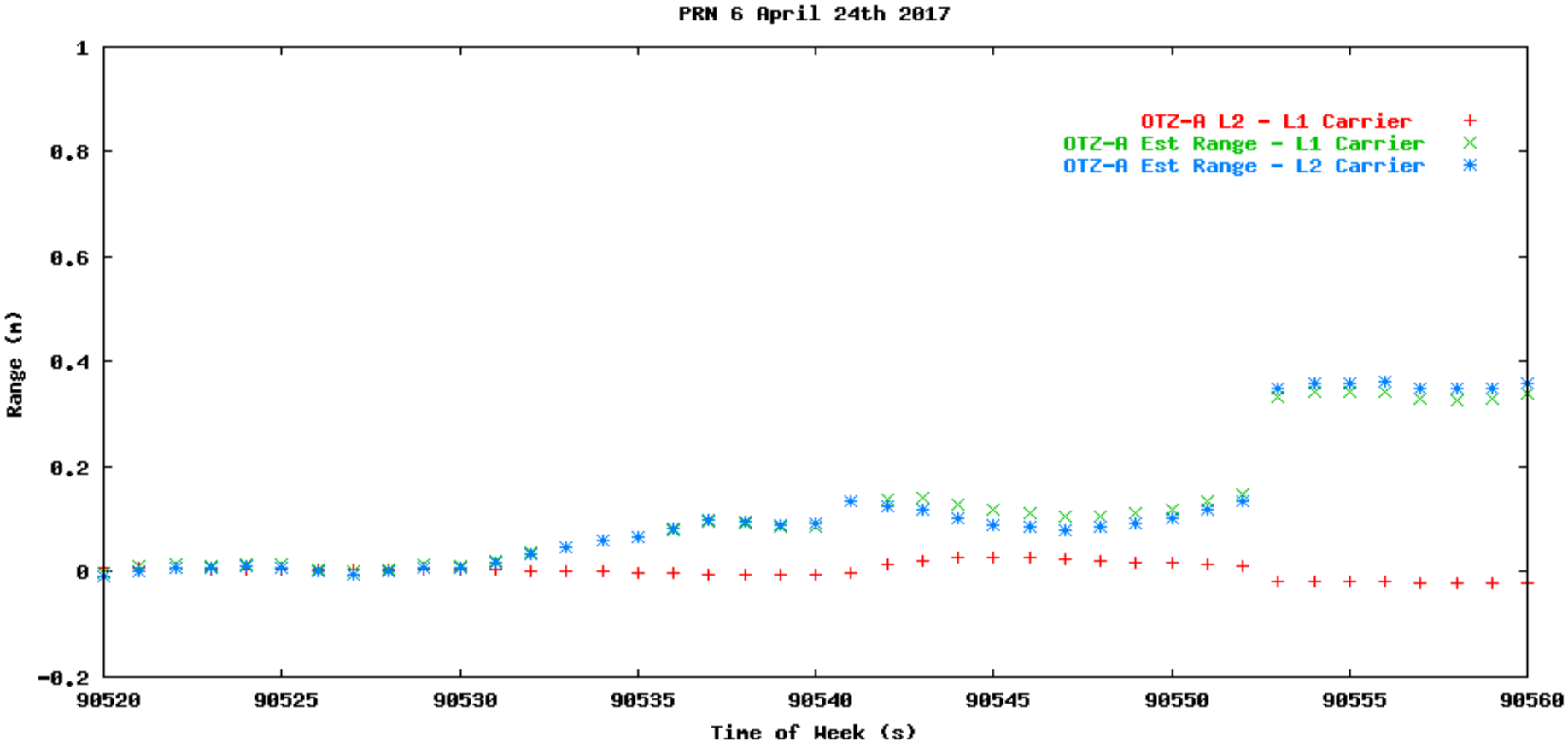
- **Further analysis on WRE receiver OTZ-A and OTZ-B was conducted as representative of all receiver performance**

Kotzebue – A and B
PRN 6 - L1 and L2 Carrier

- **OTZ-A maintained track of PRN 6 but set L1 status invalid**
  - L1 status invalid set according to receiver satellite status flags
- **OTZ-A experienced L1/L2 carrier changes (see slide 8) at 01:08:55 GMT (TOW – 90553) when all WREs reported L1 status invalid.**
  - Started to deviate from Estimated Reference Range at 01:08:34 (TOW 90532)
  - Reference Range is the distance from the corrected PRN position to surveyed receiver location
- **OTZ-B loss track of PRN 6 for 4 seconds**
- **OTZ-B reacquired tracking of PRN 6 and had bad measurements on L1 and took an additional 25 seconds to track L2 (see slide 9)**
  - L1 pseudorange measurement was ~22.0e6 meters when it started tracking PRN 6 from 01:08:49 GMT to 01:09:07 GMT compared to ~22.6e6 meters before it loss track, causing ~600,000m difference in L1 pseudorange measurement.
  - L1 carrier measurement had anomalous output (i.e. -1500m) during the same timeframe
  - Started tracking L2 at 01:09:13 GMT

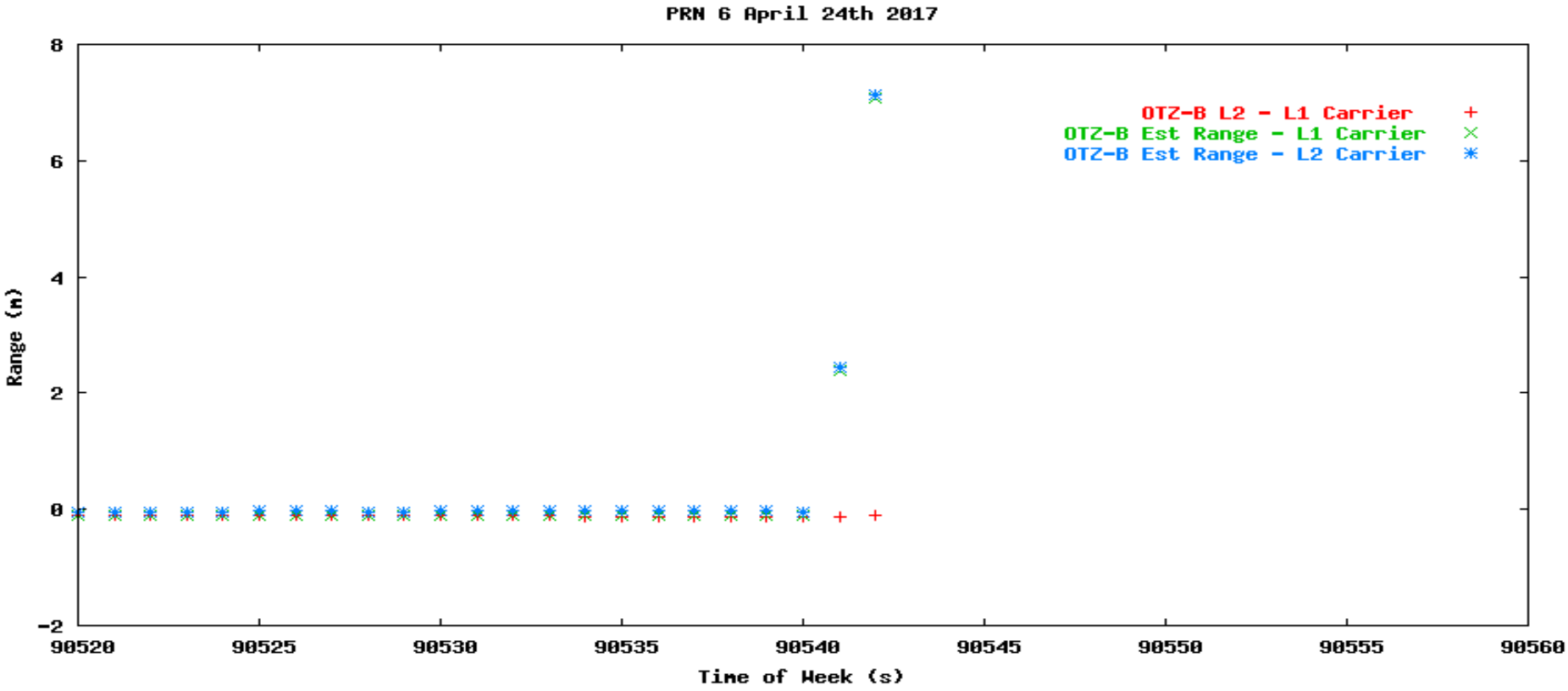
OTZ-A
PRN 6 - L1 and L2 Carrier

- OTZ-A did not lose track
- Plot adjusted for carrier phase ambiguity



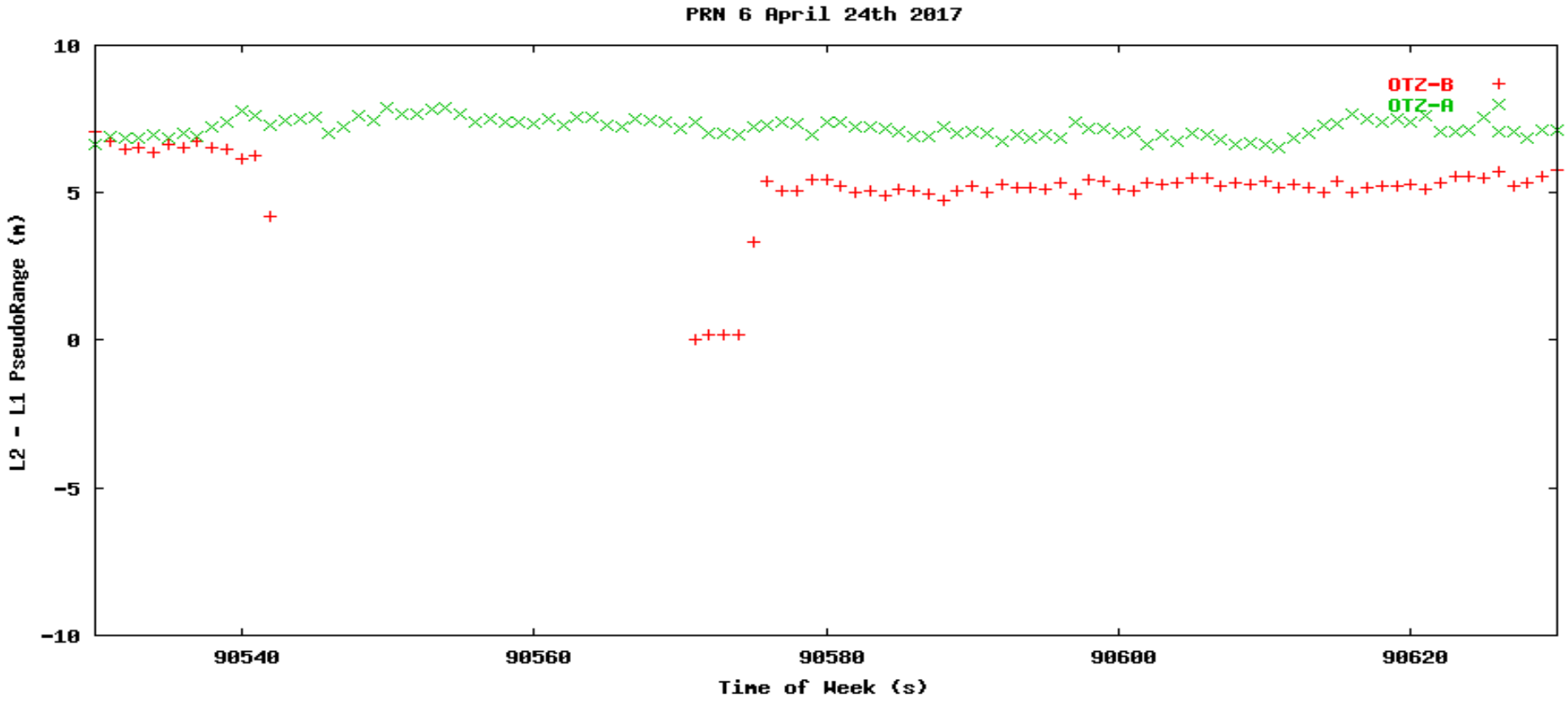
OTZ-B
PRN 6 - L1 and L2 Carrier

- 2 – 8m cycle slip on both L1 and L2 signal.
- 'Est Range' - Estimated (Reference) Range
  - corrected PRN position to surveyed receiver location
- Plot adjusted for carrier phase ambiguity



Kotzebue – A and B
PRN 6 L2 – L1 PseudoRange

- **OTZ-B reacquires PRN 6 at TOW 90547 with L1 pseudorange ~600,000m off from previous range (not shown on plot)**
- **L2 not tracking yields a large negative L2 - L1 pseudorange until L2 starts tracking at 90571**



PRN 6 UDREi set to Not Monitored

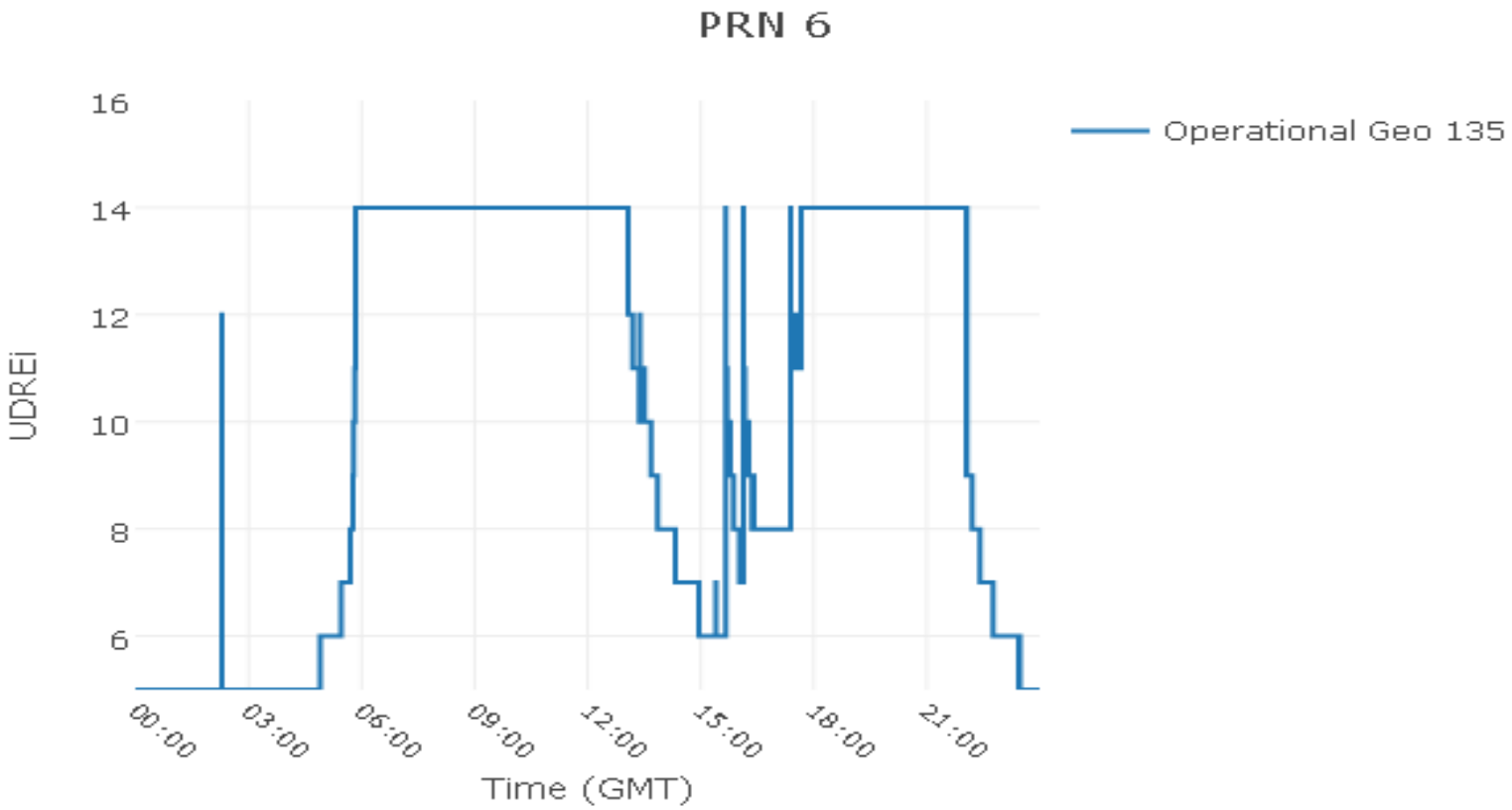
(April 23rd 2017)

- **On April 23rd 2 WAAS SV Alerts of PRN 6 set the UDREi for PRN 6 from 6 to 14 at 15:39:43 GMT (TOW 56401) and 16:08:24 GMT (TOW 58122 - see slide 12)**
  - UDREi returned to 8, normal pass UDREi goes to 5

- **No affect to WAAS service**

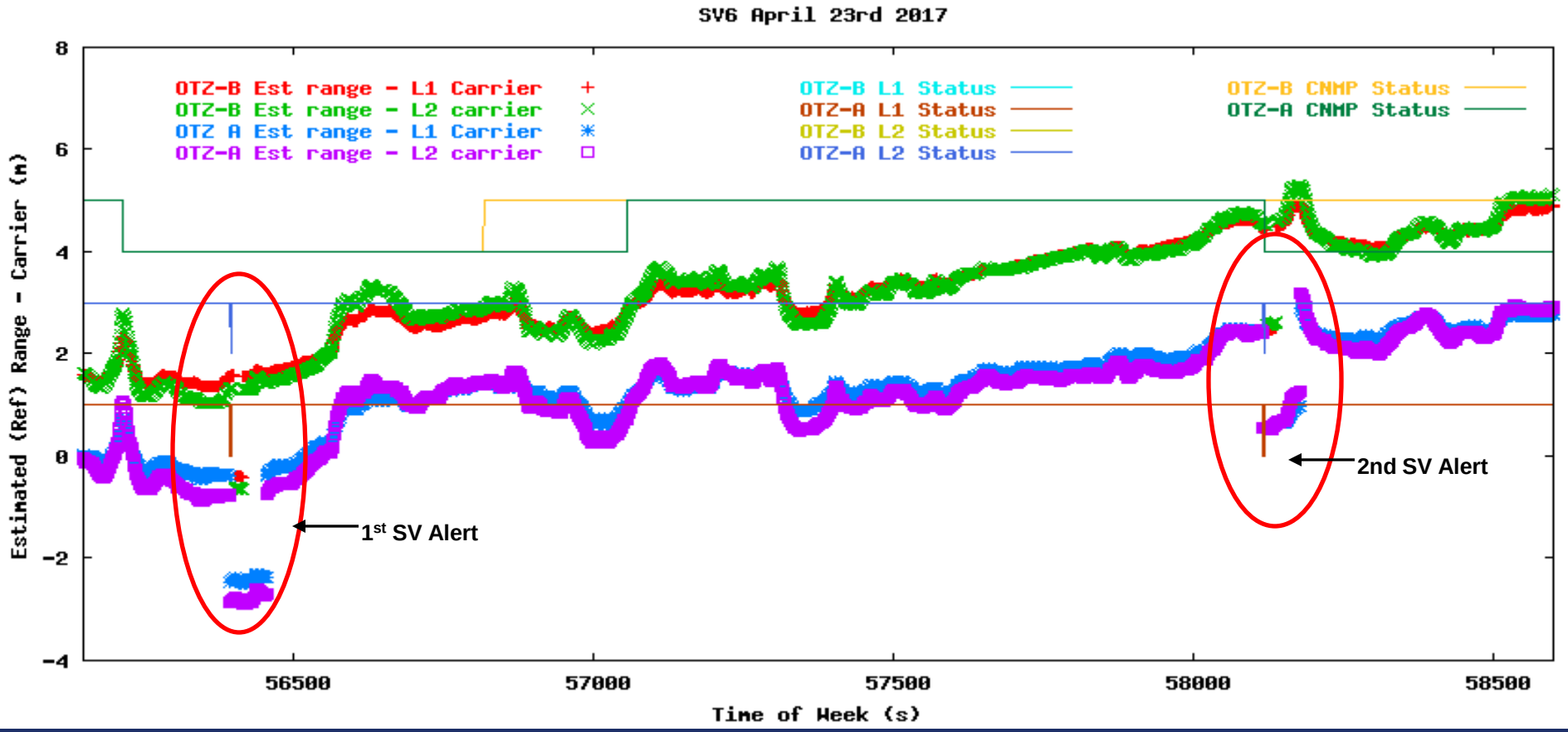
- **40 of 47 WRS' set L1 status invalid at 15:39:37 GMT (TOW 56395), 35 of 37 WRS' set L1 status invalid at 16:08:19 GMT (TOW 58117)**
  - OTZ-A set L1 status invalid
  - OTZ-B set L1 status valid

April 23, 2017 - UDREi PRN 6



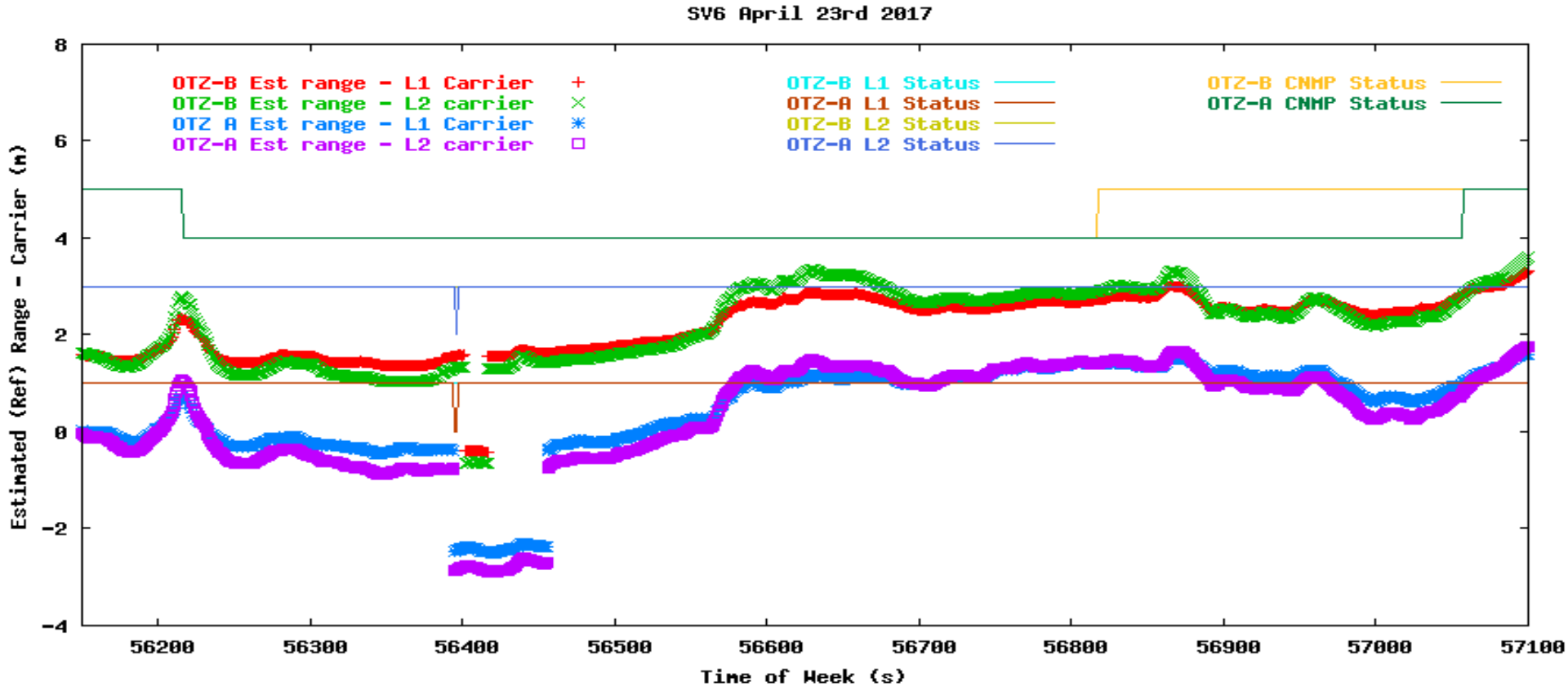
Kotzebue – A and B (elev 48)
PRN 6 - L1 and L2 Carrier vs Est Range

- 'Est Range' - Estimated (Reference) Range
  - Corrected PRN position to surveyed receiver location
- Plot adjusted for carrier phase ambiguity
  - OTZ-B carrier and Status series adjusted with an offset for visualization
- CNMP status – Tech Center CNMP algorithm processing



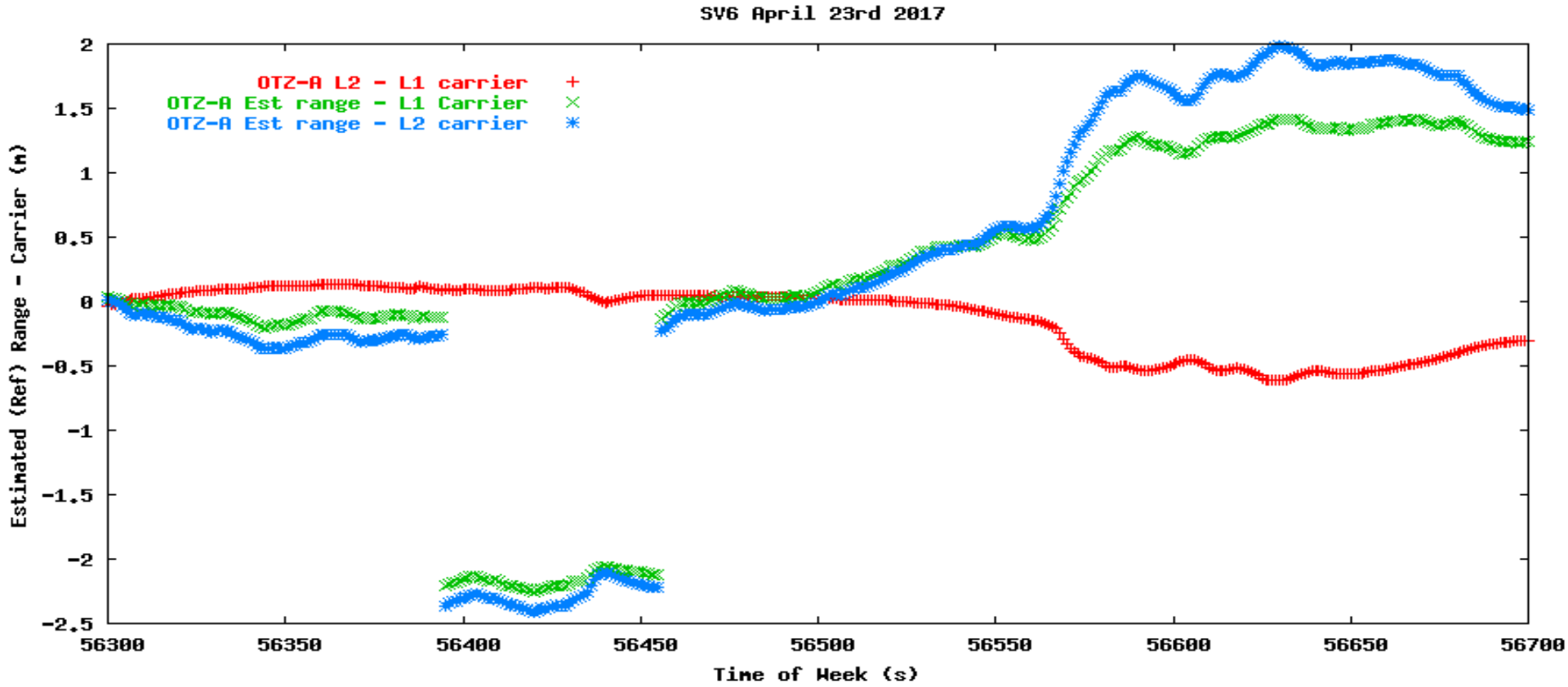
Kotzebue – A and B
PRN 6 - L1 and L2 Carrier vs Est Range (cont'd)

- 'Est Range' - Estimated (Reference) Range
  - Corrected PRN position to surveyed receiver location
- Plot adjusted for carrier phase ambiguity
  - OTZ-B carrier and L1/L2/CNMP Status' adjusted with an offset for visualization
- CNMP status – Tech Center CNMP algorithm processing



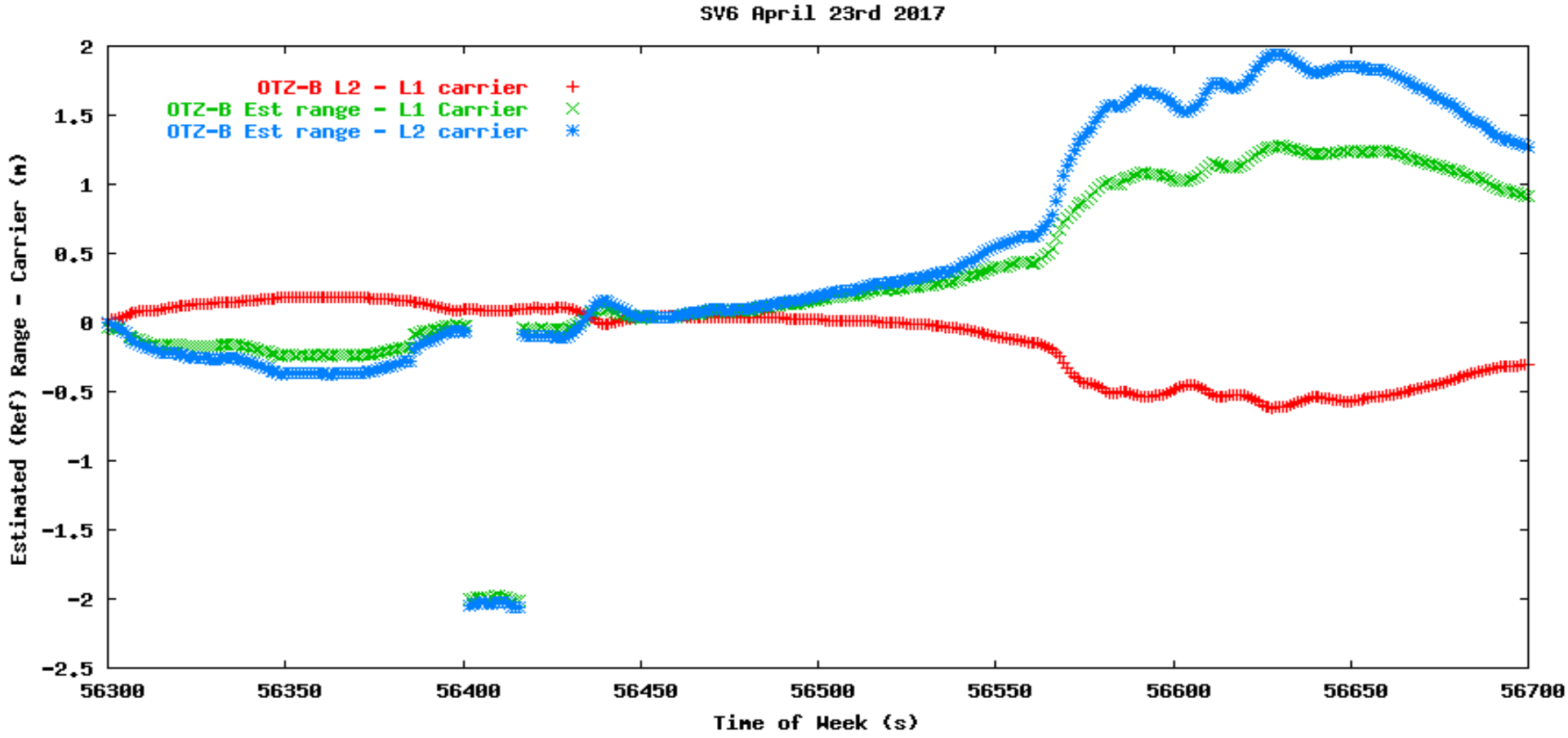
Kotzebue – A
PRN 6 - L1 and L2 Carrier vs Est Range

- 'Est Range' - Estimated (Reference) Range
  - Corrected PRN position to surveyed receiver location
- Plot adjusted for carrier phase ambiguity



Kotzebue – B
PRN 6 - L1 and L2 Carrier PRN 6

- ‘Est Range’ - Estimated (Reference) Range
  - Corrected PRN position to surveyed receiver location
- Plot adjusted for carrier phase ambiguity



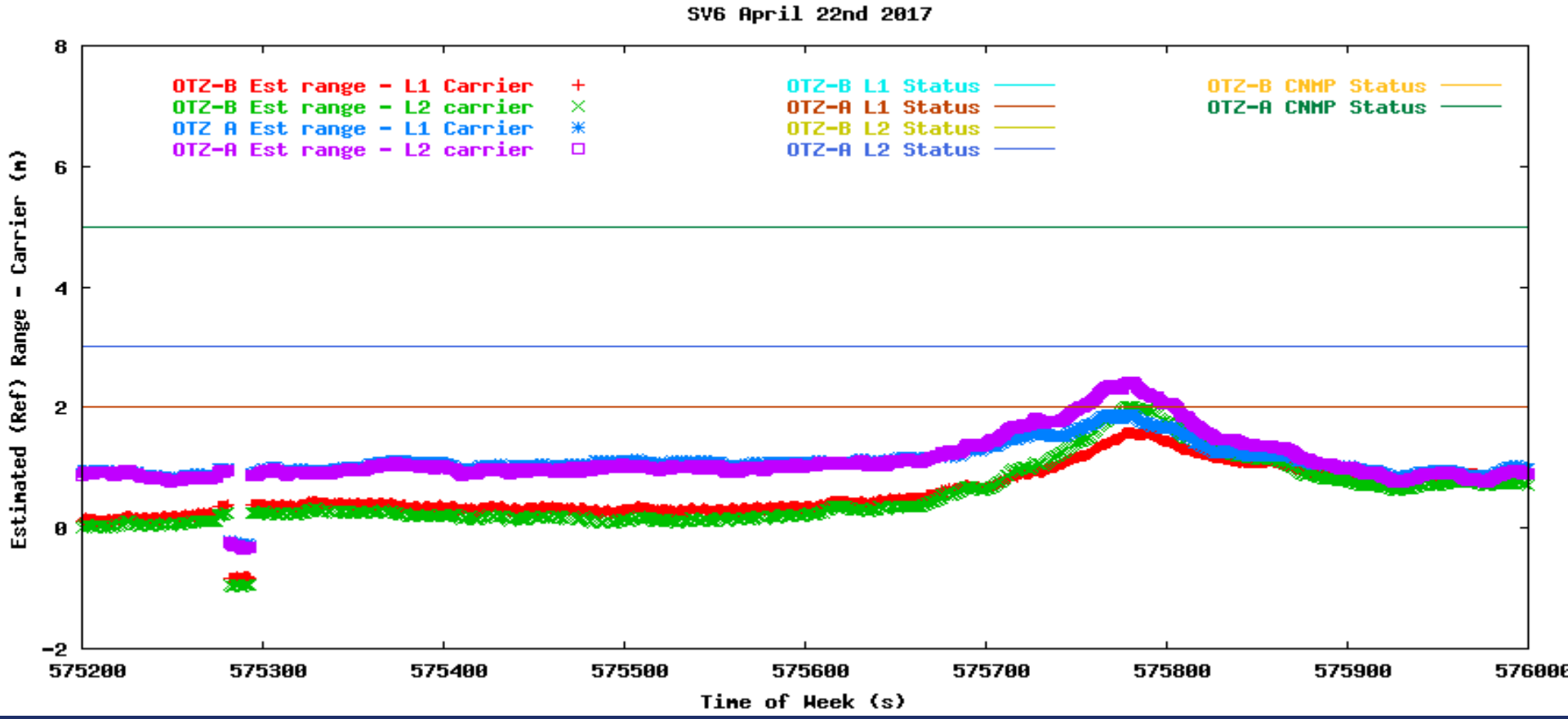
PRN 6 UDREi set to Not Monitored

(April 22nd 2017)

- **April 22nd WAAS set the UDREi for PRN 6 from 6 to 14 for 1 fast correction at 15:47:43 GMT (TOW 575281)**
  - No SV Alert
  - UDREi returned to 7, normal pass UDREi goes to 5
- **No affect to WAAS service**
- **Tech center processing showed no receivers set L1 or L2 signal status invalid**

Kotzebue – A and B (elev 48)
PRN 6 - L1 and L2 Carrier vs Est Range

- 'Est Range' - Estimated (Reference) Range
  - Corrected PRN position to surveyed receiver location
- Plot adjusted for carrier phase ambiguity
  - OTZ-A carrier and L1/L2/CNMP Status' adjusted with an offset for visualization
- CNMP status – Tech Center CNMP algorithm processing



Conclusion

- **The FAA Tech Center, as part of daily GPS and WAAS performance monitoring, observed WAAS setting the UDREi for PRN 6 to Not Monitored on April 22nd, April 23rd, and April 24th, 2017**
  - L1 and L2 signal anomaly was observed on all 3 days

- **Due to the time the event occurred on April 24th (01:09 GMT), there were minor impacts to LPV200 coverage in Western CONUS**

- **Tech Center SQM processing edited 1-2 seconds of numerous WREs from SQM algorithm due to pre-screening on the correlator measurements on all 3 days before the UDREi was set to Not Monitored**