

Presented at the FIG Working Week 2016,  
May 2-6, 2016 in Christchurch, New Zealand

# Performance of Real-time Precise Point Positioning in New Zealand

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## FIG Working Week 2016

CHRISTCHURCH, NEW ZEALAND 2-6 MAY 2016

Recovery

from disaster

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## Real-time Correction Streams for PPP Processing

- IGS Real-time Streams
  - RTNet (BKG)
  - HPGNSSC (NRCAN)
  - RETINA (ESA/ESOC)
  - magicGNSS (GMV)
  - PPP-Wizard (CNES)
  - etc
- Commercial PPP Services
  - RTX (Trimble)
  - Starfix (Fugro)
  - Apex (Veripos)
  - etc



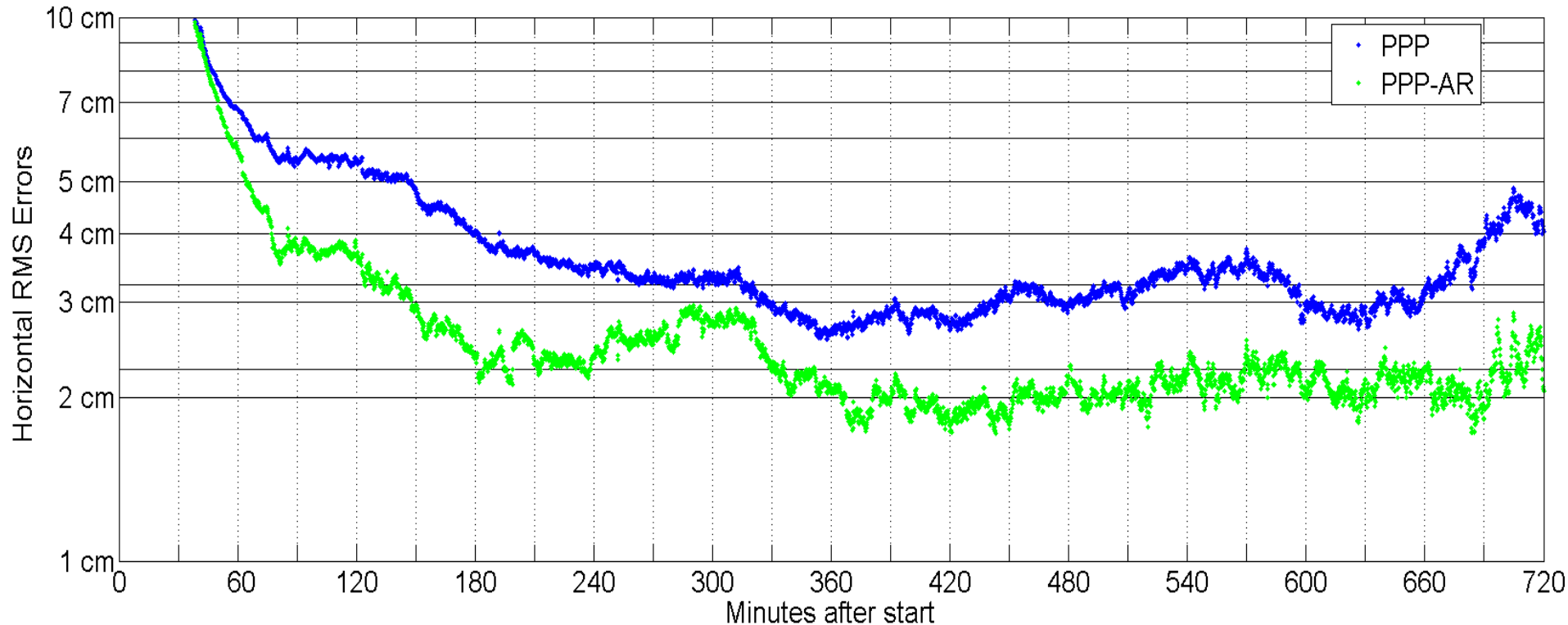
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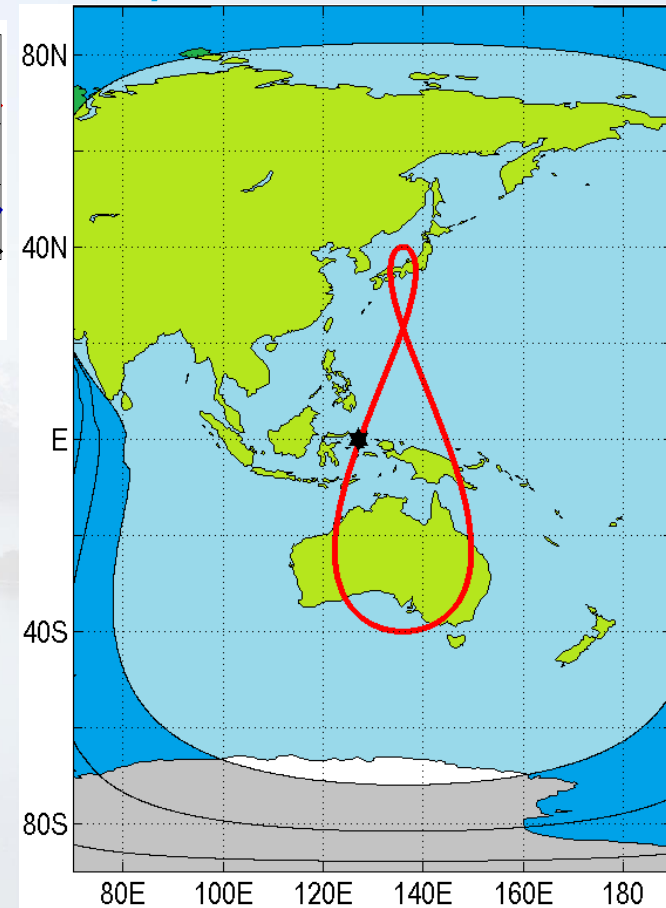
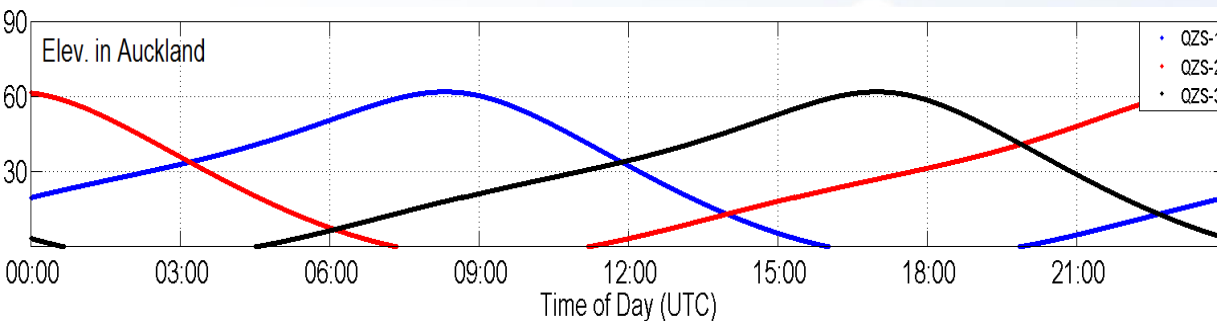
## Real-time PPP Accuracy



**PPP and PPP-AR positioning in Australia (ALIC, CEDU, DARW, HIL1, HOB2, KARR, MOBS, TBOB, TOOW, TOW2). 12-18 September 2014**



## Japanese Quasi-Zenith Satellite System (QZSS)



- Currently one (QZS-1) satellite in orbit
- Operational phase by 2018 (3 IGSO + 1 GEO)
- LEX: L-band experimental signal (L6 signal), 2000 bps
- MADOCA corrections messages for PPP are currently under testing for transmission on LEX signal

\*MADOCA - Multi-GNSS Advanced Demonstration tool for Orbit and Clock Analysis (MADOCA) software



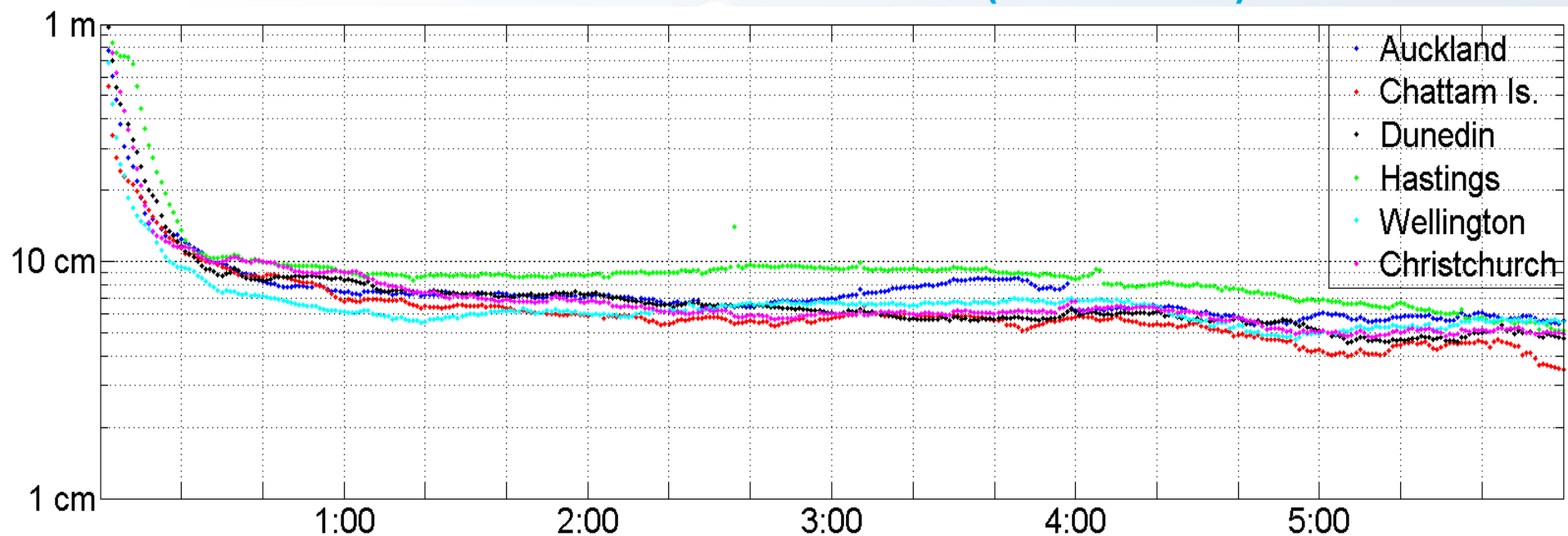


## MADOCA Corrections:

- Orbits STD, GPS / GLO: 5.51 cm / 5.75 cm
- Clocks STD, GPS / GLO: 4.81 cm / 9.47 cm
- Signal in Space Range Errors (SISRE) accuracy: GPS / GLO
  - Tokyo: 5.0 cm / 8.8 cm
  - Dunedin: 4.8 cm / 14.4 cm
  - Chatham Island: 4.8 cm / 15.2 cm
  - Auckland: 4.8 cm / 15.6 cm



## Performance of Real-time MADOCA-PPP (Horizontal)



- Horizontal positioning accuracy using MADOCA-PPP corrections
- Horizontal accuracy  $\approx$  10 cm after 30 minutes
- No significant differences between Dunedin (black line) and other stations



## Comparison, MDC1 vs CLK81 vs CLK9B

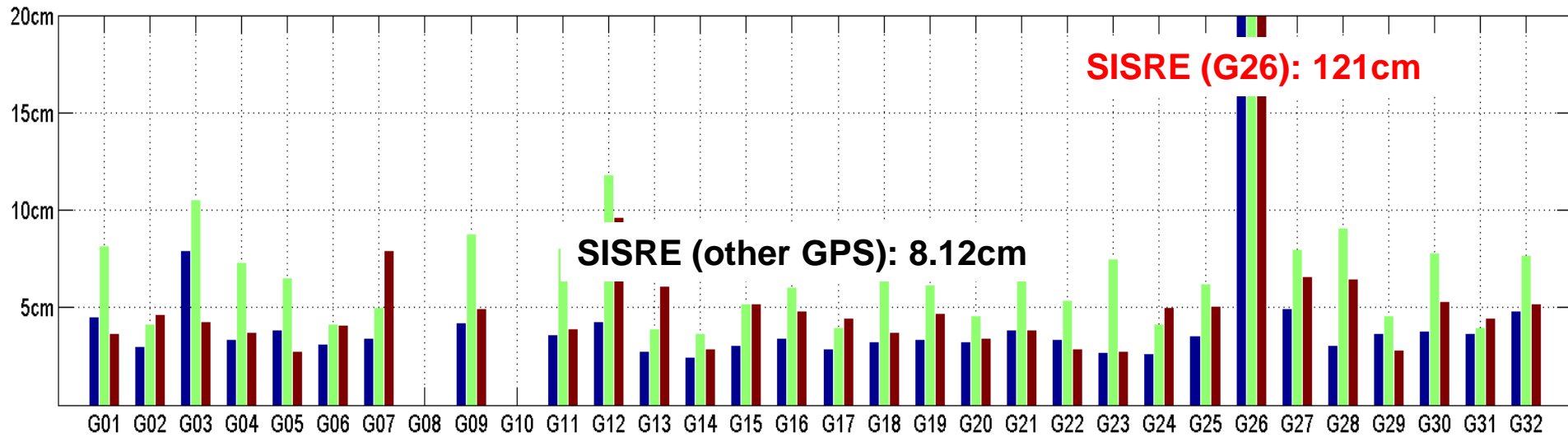
	Auckland	Chath. Is.	Dunedin	Hastings	Wellington	Yaldhurst
<b>MDC1 (cm)</b>	H: 6.1	5.8	6.3	7.4	6.2	6.6
	V: 10.3	7.5	11.4	9.7	9.7	11.5
<b>CLK81 (cm)</b>	H: 8.7	10.8	9.2	9.9	9.8	9.8
	V: 12.3	11.8	13.5	12.4	12.1	13.6
<b>CLK9B (cm)</b>	H: 5.0	3.4	4.3	5.3	5.0	4.6
	V: 7.7	8.1	10.6	8.1	7.4	9.7

- MADOCA (MDC1) and CLK9B (CNES) provide comparable solutions
- < 10 cm horizontal accuracy after 30 minutes of convergence
- ~ 10 cm vertical accuracy after 1 hour of convergence
- CLK81 (GMV) has outliers





## Outlier Satellite



- GMV products included one GPS satellite with high level of error, G26
- Research on integrity monitoring and autonomous detection of 'troubled' satellites is needed



## Summary

- PPP is an attractive PNT technique due to its fairly low of infrastructure requirements.
- A number of real-time correction streams for PPP are now available, both publicly and commercially.
- MADOCA corrections message is being tested for delivery via the QZSS LEX (L6) signals.
- Sub-decimeter level horizontal accuracy can be achieved within 30 minutes, independent of the rover location within the QZSS coverage area.
- Other publicly available real-time correction streams (from the IGS, i.e. CNES) provide comparable PPP results.



## Acknowledgements

- Cooperative Research Centre for Spatial Information (CRCSI), Australia *Project 1.22 “Satellite Delivery of Augmented Positioning Data for PPP and PPP-RTK Services in Australia and New Zealand”*
- Geoscience Australia (GA)
- Land Information New Zealand (LINZ)
- Department of Environment, Land, Water and Planning (DELWP)
- Position Partners Pty Ltd
- Fugro Satellite Positioning Pty Ltd
- Japan Aerospace Exploration Agency, Japan
- French Government Space Agency (CNES), France
- International GNSS Services (IGS)

Thank You