

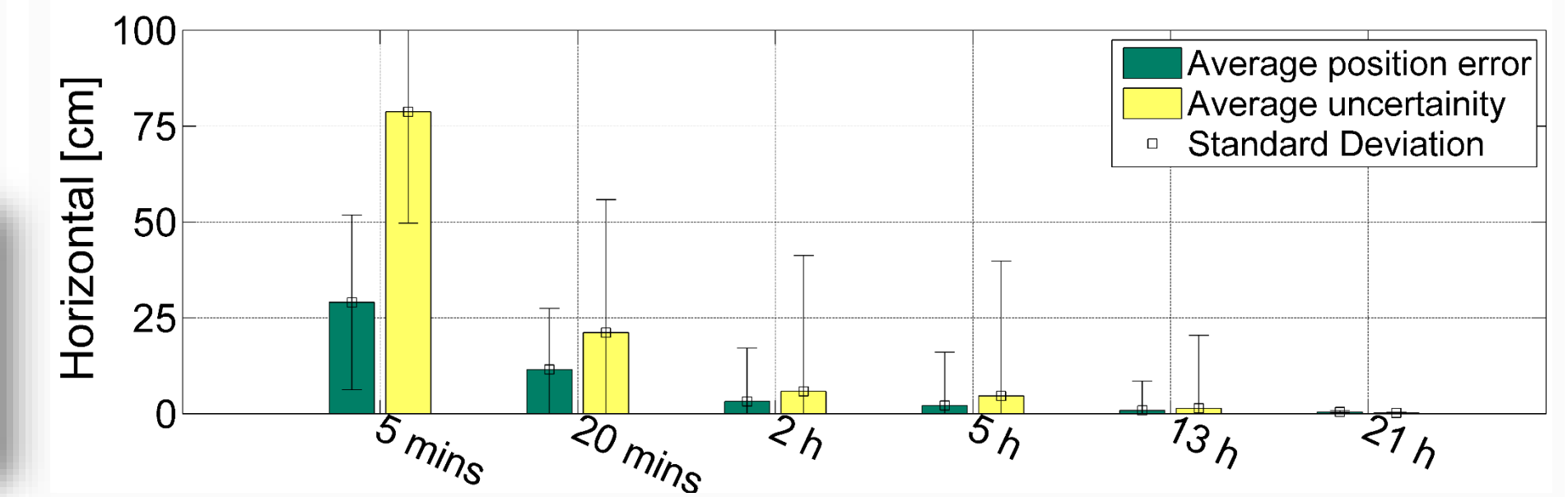
ASSESSING PPP POSITION UNCERTAINTY IN ONTARIO:

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How realistic are PPP uncertainties?

Integrated surveying specification

Average position error and internal position uncertainty at recommended minimum convergence period with error bars representing standard deviation.



Recommendations for quantity of data to be logged for PPP processing, based on time 95% of datasets took to achieve specified horizontal accuracy.

Application	Accuracy classification	95% confidence [cm]	Convergence period	95% sigma [cm]
Cadastral	Remote areas	100	5 min	78.7
	Rural areas	20	20 min	21.1
	Urban areas	5	2 hours	5.8
Geodetic	Control survey	2	5 hours	4.6
	Control survey	1	13 hours	1.4
	Control survey	0.5	21 hours	0.2

Conclusions and future work

- Conclusions:
- Within first hour, position uncertainty was pessimistic, suggesting estimated error larger than true error.
 - After one hour, more realistic position uncertainty achieved while still pessimistic.
 - From 18 to 24 hours, there was a strong positive correlation.

Future Work:

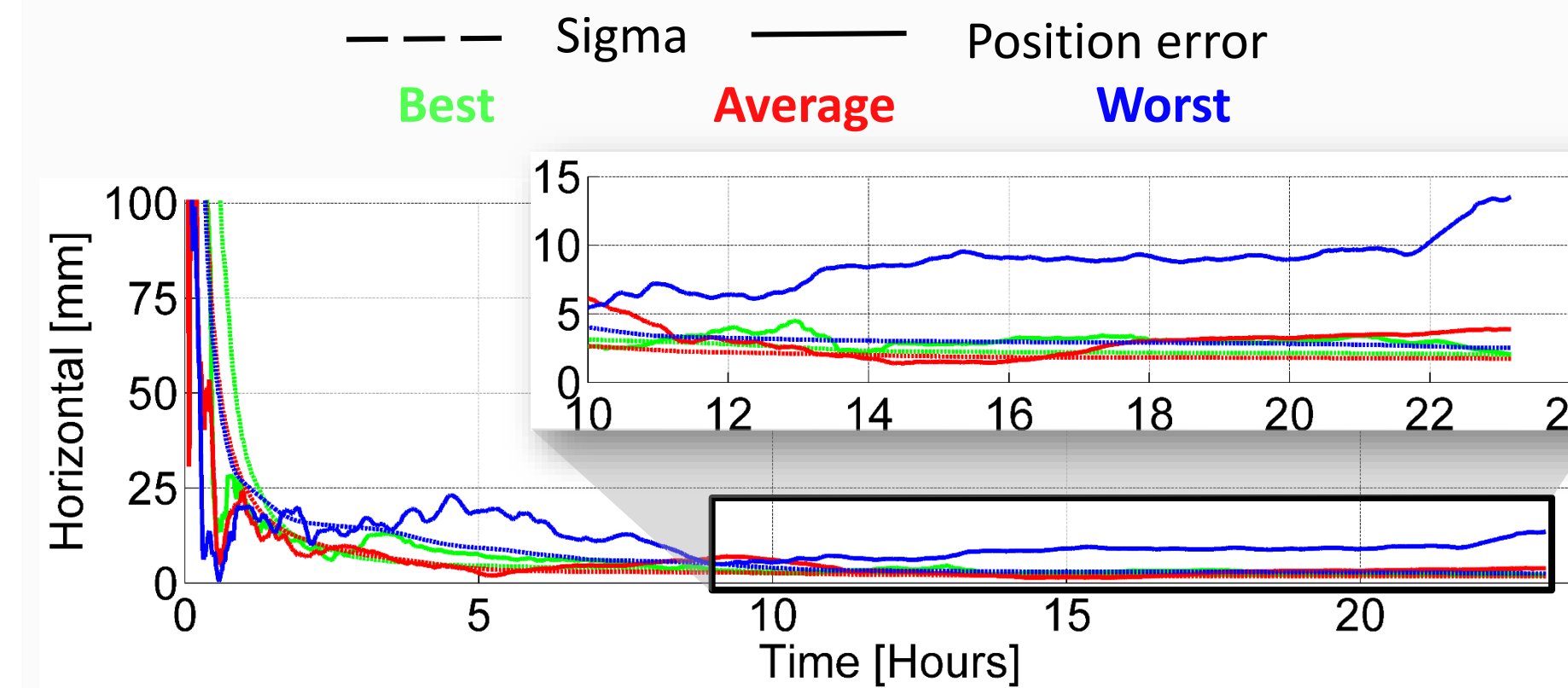
- Further analysis of position uncertainty during initial convergence.
- Introduce more realistic stochastic model.

Acknowledgements

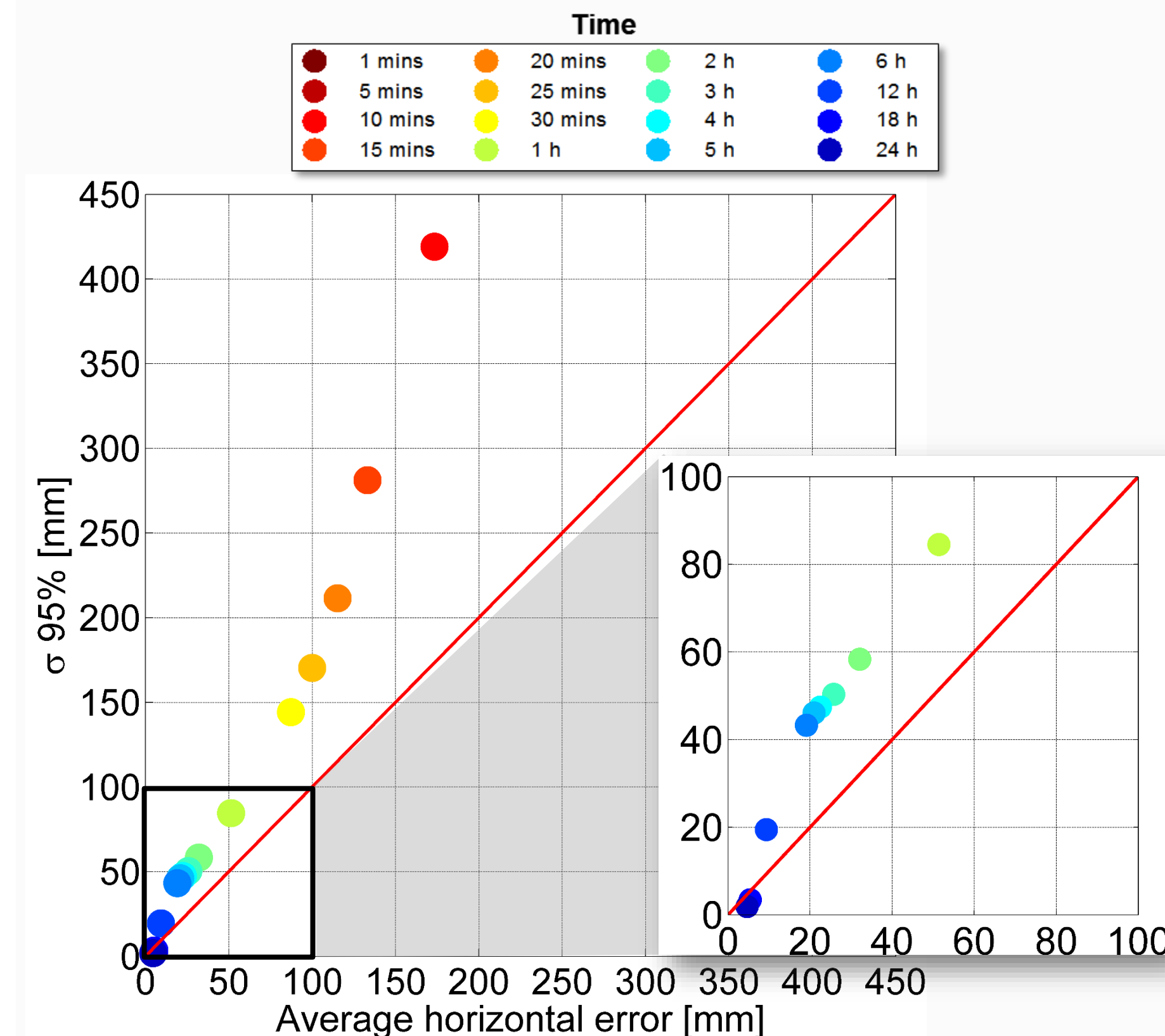
Thanks to MTO and NSERC for funding, to Leica, Cansel and TOPCON for reference station data, and NRCAN for estimated reference station coordinates.

PPP horizontal position uncertainty

Of ~4500 datasets processed, “best”, “average” and “worst” datasets selected based on difference between position error and position uncertainty after 24 hours of processing. Best and average are very similar, indicating excellent performance.



Correlation plots compare average position uncertainty and error in horizontal component, from ~4500 datasets, at epochs: 1, 5, 10, 15, 20, 25, 30 minutes, 1, 6, 12, 18 and 24 hours. During convergence, average position uncertainty was overly pessimistic suggesting estimated uncertainty was worse than true horizontal error. From 18 to 24 hours, there was a strong positive correlation.

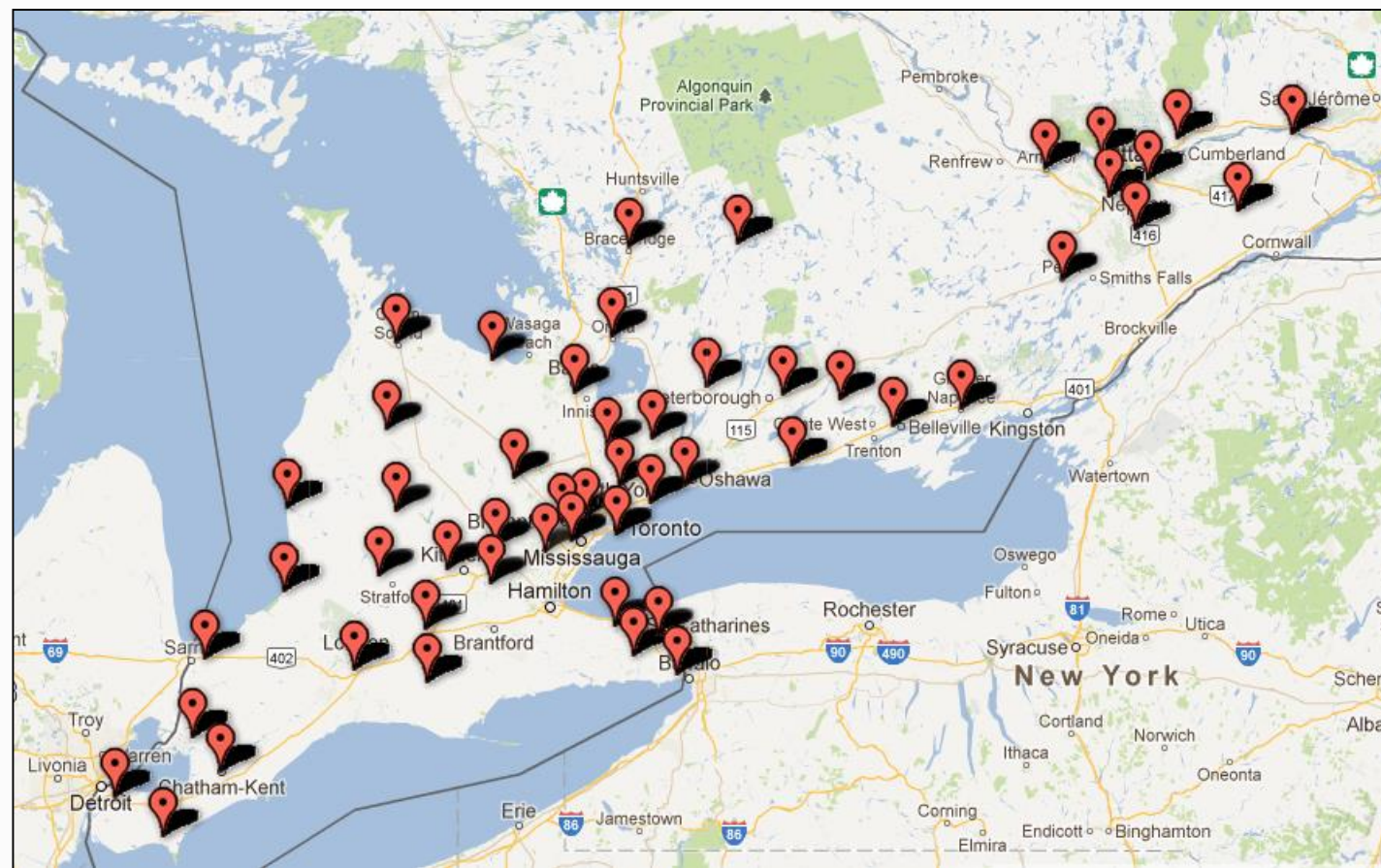


Introduction and objectives

Software-determined position uncertainty is main indicator of solution accuracy in PPP, as a reference solution may not available. Research presents novel analysis of PPP uncertainty realism in southern Ontario, and quantifies data collection periods necessary to meet integrated survey specifications.

Testing

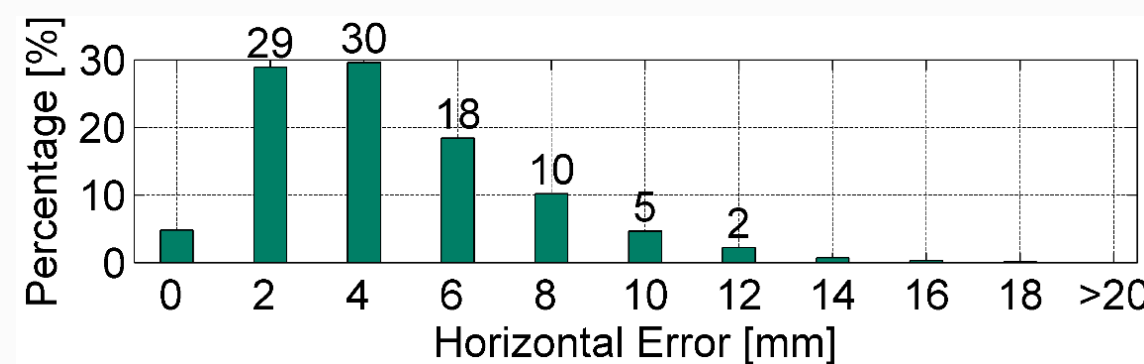
Data collected from 55 reference stations over three months in 2011. “Truth” position solutions computed from data by NRCAN Bernese relative GPS data processing. PPP solutions computed using York-PPP software developed at York, based on NRCAN on-line software.



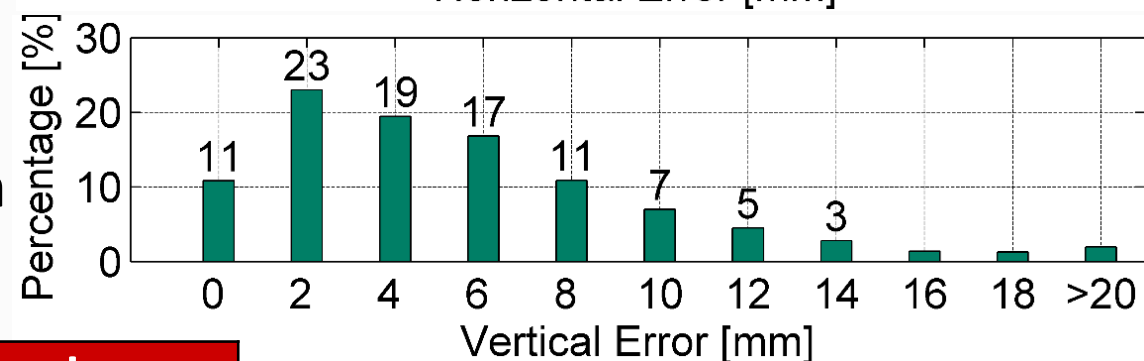
Accuracy of PPP

Distribution of PPP horizontal and vertical position error after 24 hours of data collection are illustrated for sample size of ~4500.

99% of results have horizontal error ≤ 20 mm



99% of results have vertical error of ≤ 50 mm



Position component	max	mean	std dev	rms
Northing	10	1	3	3
Easting	18	1	5	5
Horizontal	14	1	6	6
Vertical	50	-2	10	10
3D	58	10	8	10
units:mm				

Average difference between PPP and “truth” solution is 1 mm in horizontal and -2 mm in vertical. PPP horizontal accuracy is 6 mm and vertical accuracy is 10 mm.