Latest PPP Efforts at UNB
(2007-2008)

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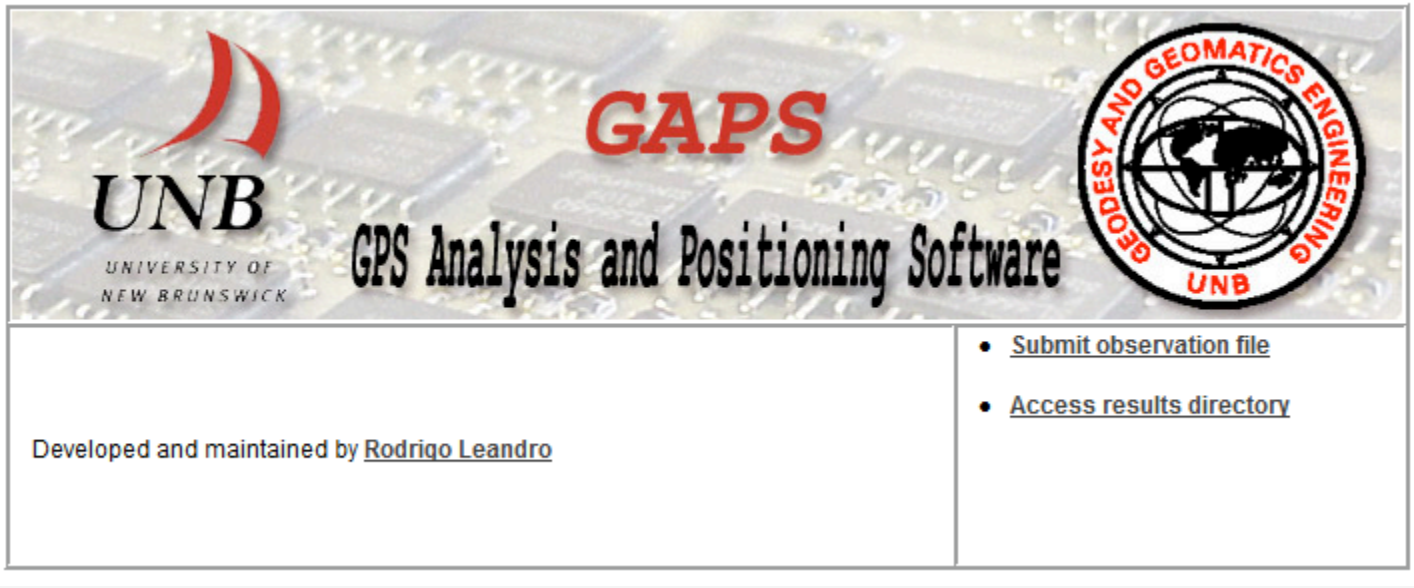
May 27 2008
GEOIDE Annual Conference
Niagara Falls, ON, Canada

Outline

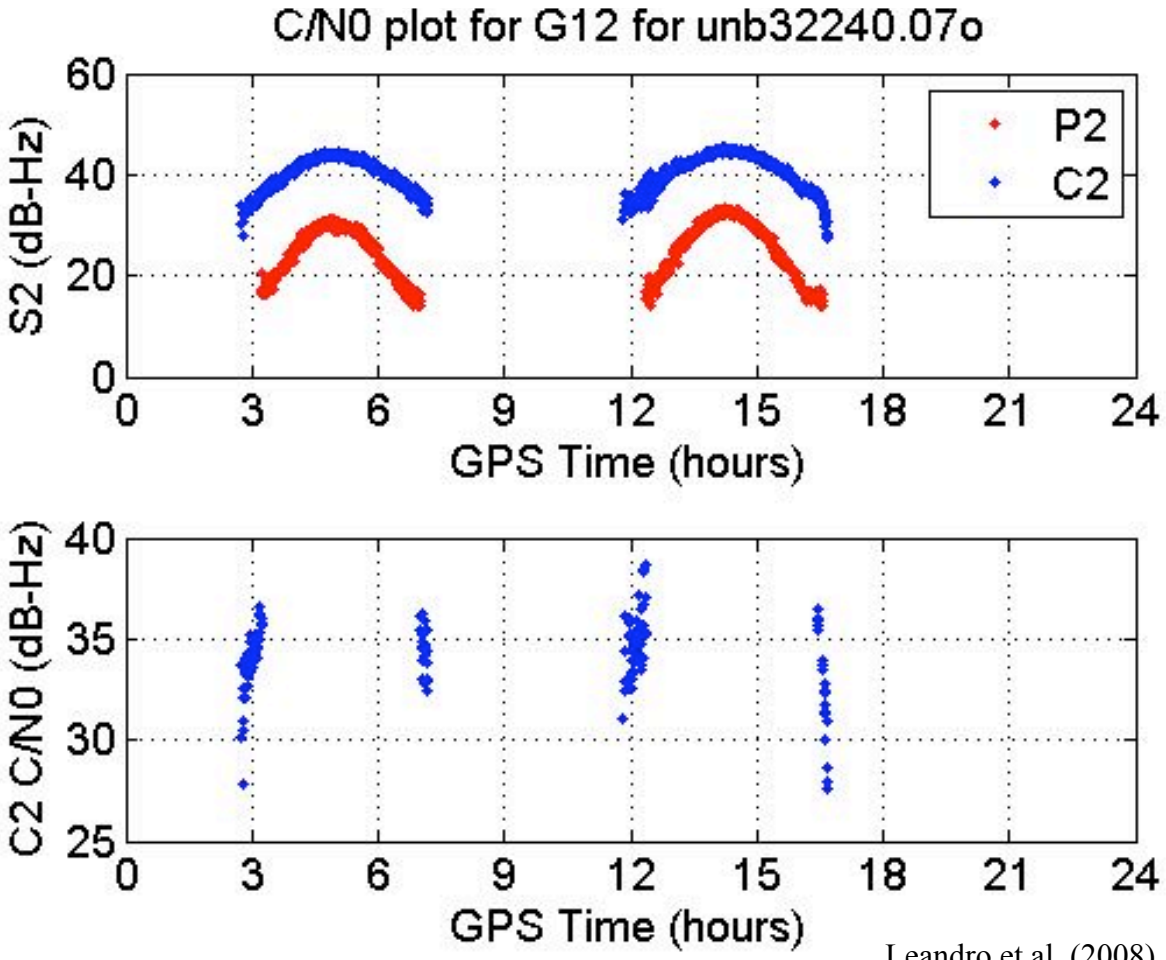
- Impact of L2C on PPP
- PPP-Based Ionosphere Activity Monitoring
- Wide Area Differential GPS - Precise Point Positioning (WADGPS-PPP)
- Ambiguity Resolution
- Future Work
- Topic for Discussion



By Rodrigo F. Leandro, Marcelo C. Santos and Richard B. Langley http://gaps.gge.unb.ca

Impact of L2C on PPP

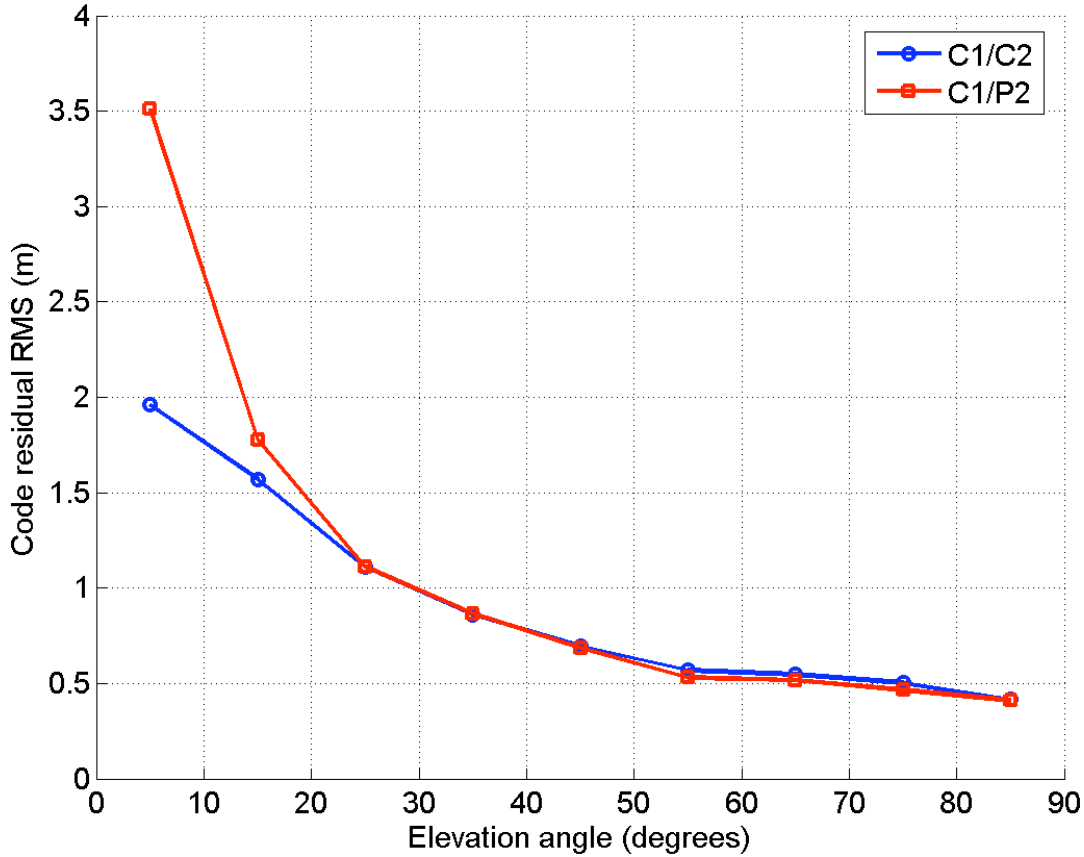
Additional measurements and their signal-to-noise ratio



Leandro et al. (2008)

Impact of L2C on PPP

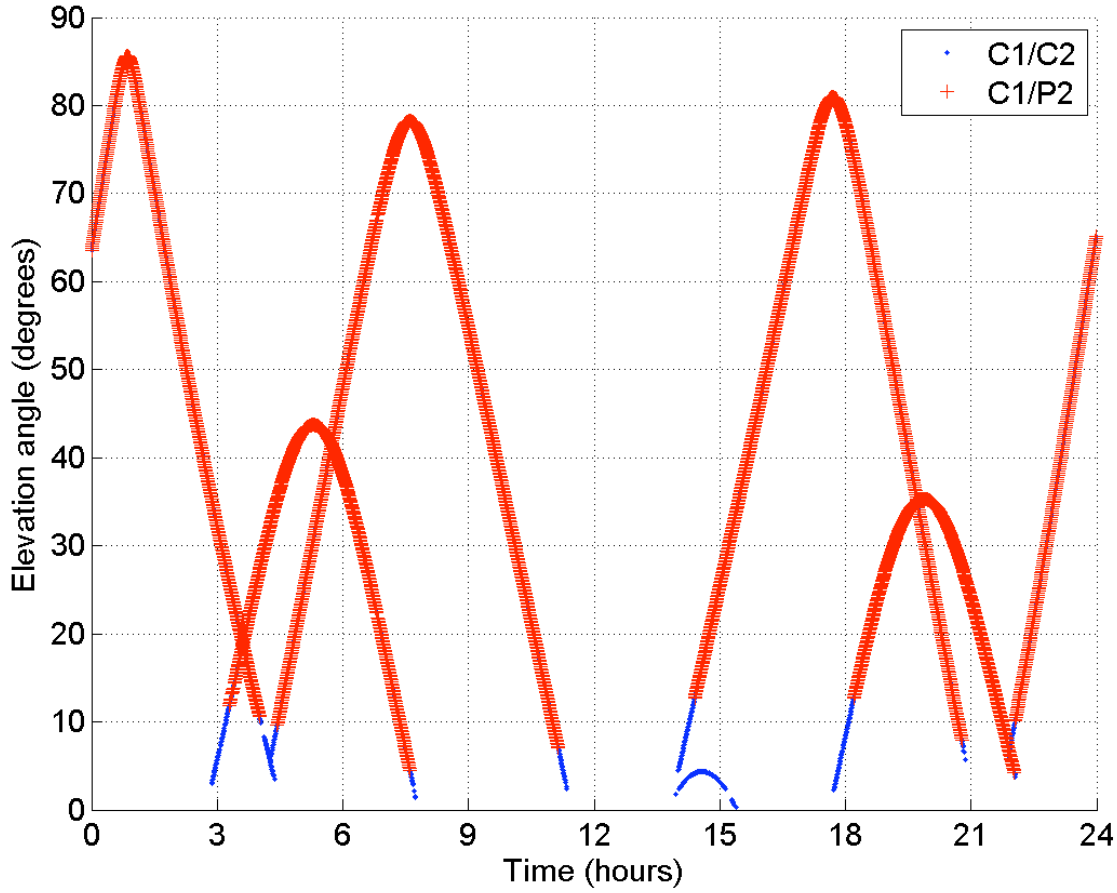
Comparison of iono-free code M+N using P2 and L2C (all IIR-M)



Leandro et al. (2008)

Impact of L2C on PPP

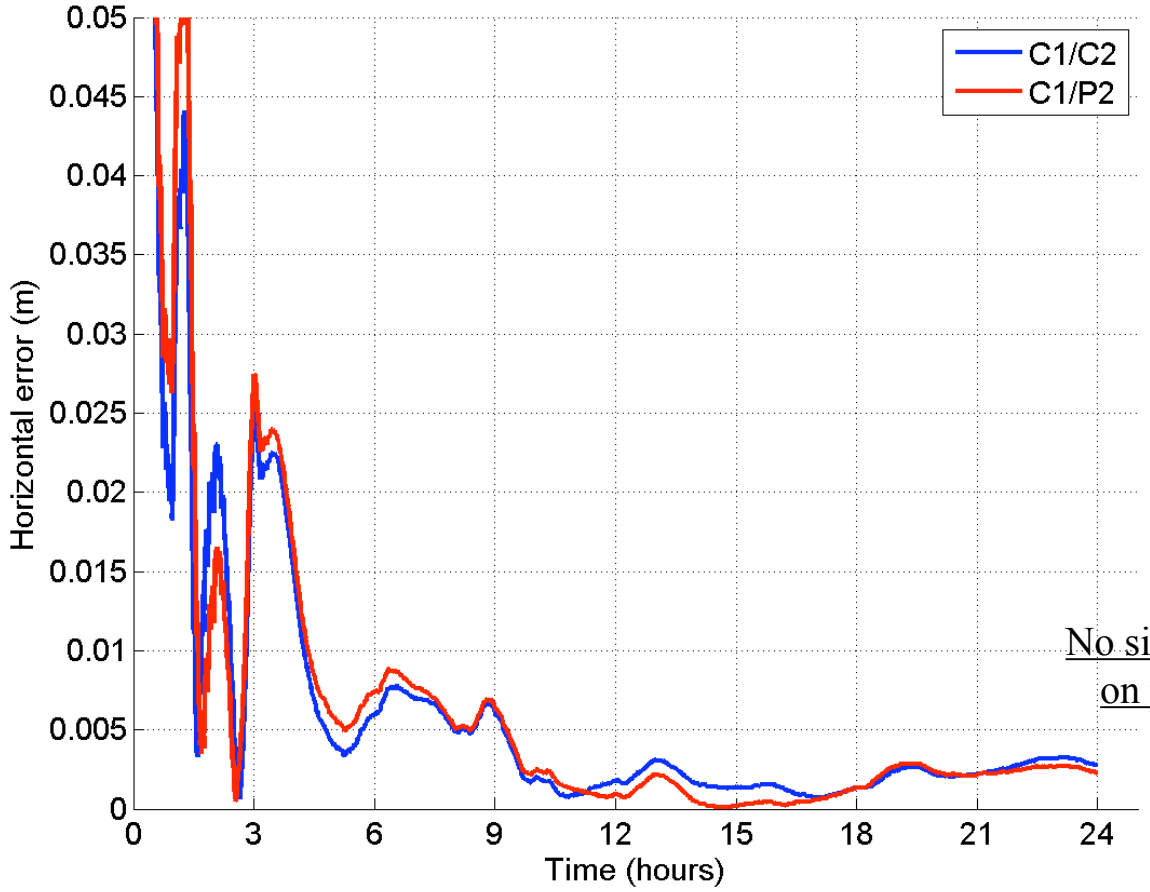
Additional measurements and their elevation angle



Leandro et al. (2008)

Impact of L2C on PPP

Static PPP run using L2C and L2P(Y) (horizontal)



No significant improvement on positioning accuracy

Leandro et al. (2008)

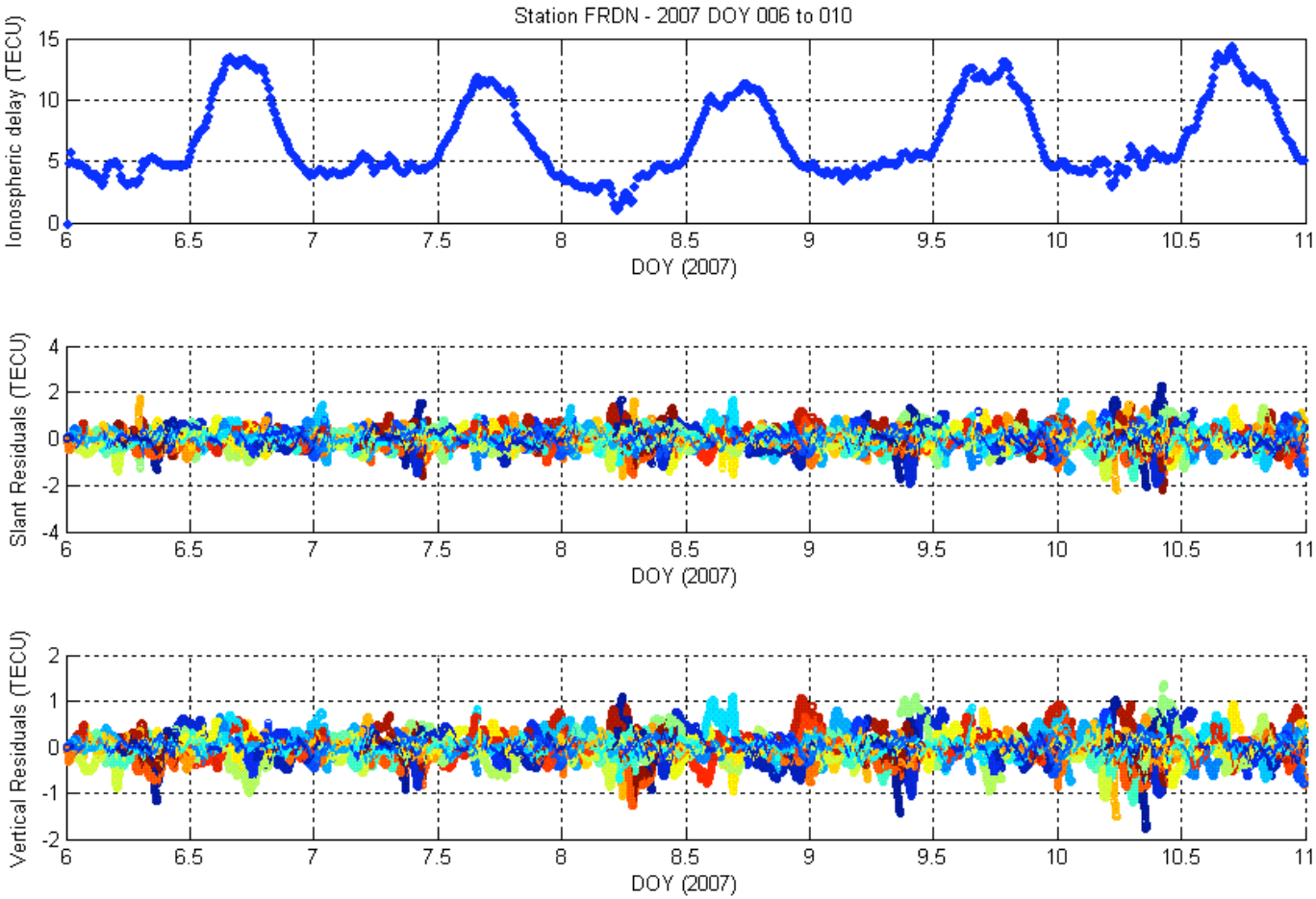
- Local Ionospheric Delay Model with a Single Receiver

$$\Phi_{gf} = \Phi_1 - \Phi_2 = I + \lambda_{gf} N'_{gf} + e_{gf}$$

$$N'_{gf} = N_{gf} + \frac{dpb_r - dpb^s}{\lambda_{gf}}$$

$$I = M(I_{v,0} + \Delta\phi \nabla I_{v,\phi} + \Delta\lambda \nabla I_{v,\lambda})$$

PPP-Based Ionospheric Activity Monitoring



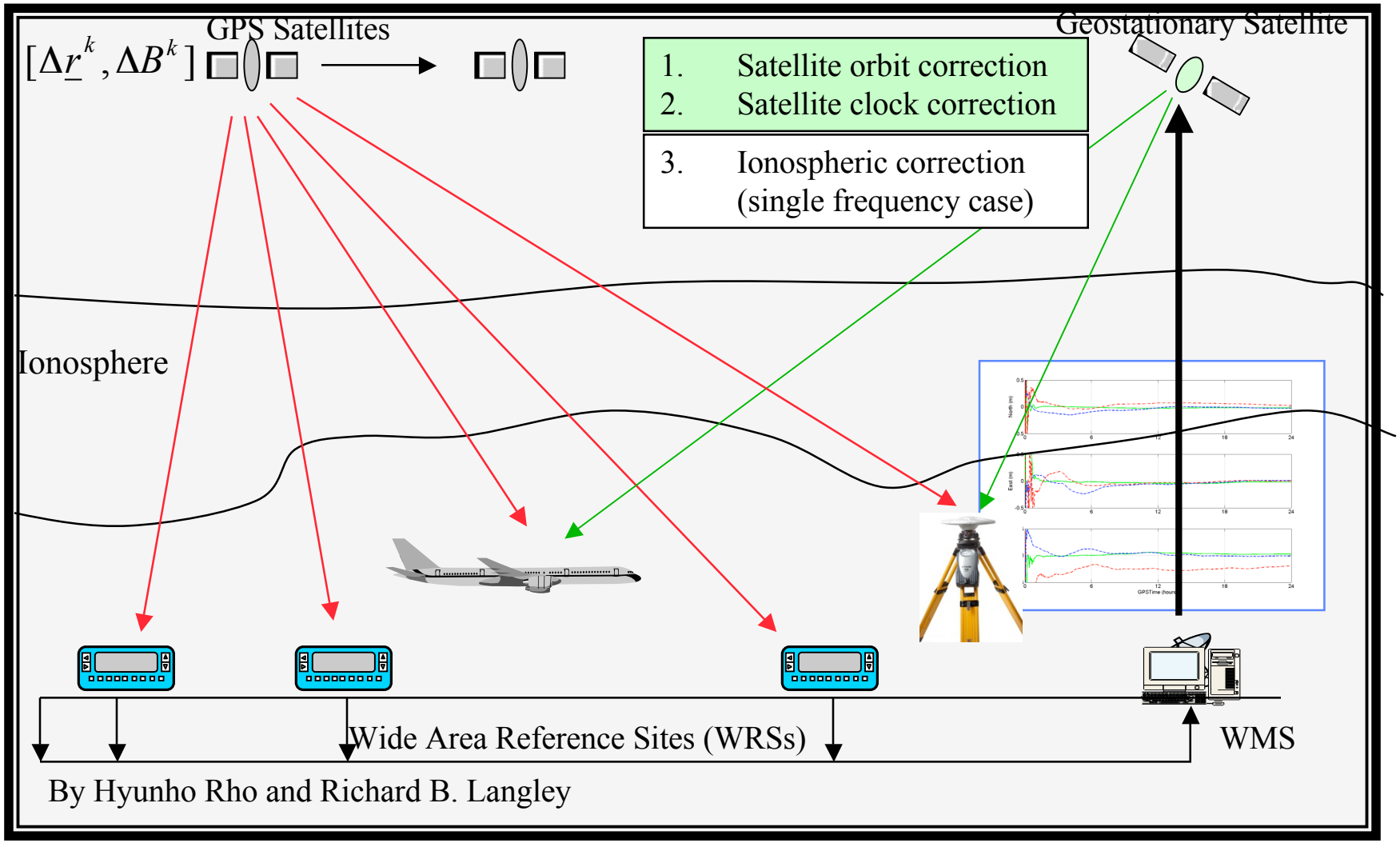
Leandro et al. (2007)

PPP-Based Ionospheric Activity Monitoring

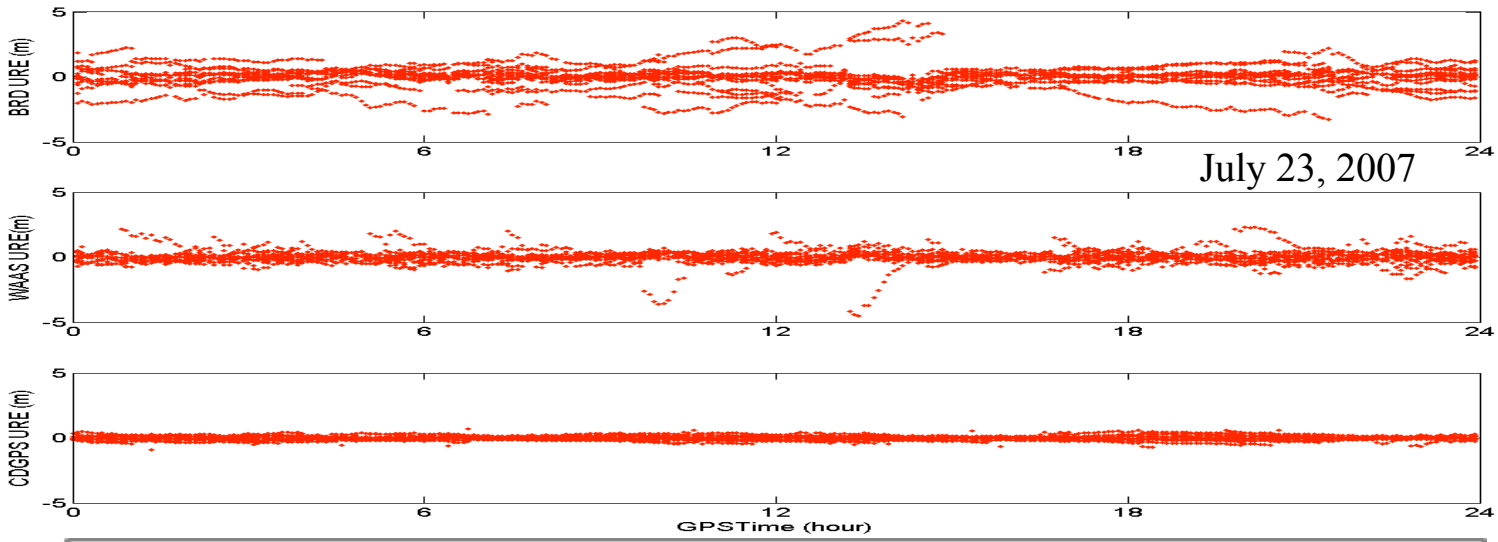
- Advantages
  - Stand alone receiver
  - Pure carrier-phase based estimations
  - Static or kinematic mode
  - Suitable for real time applications

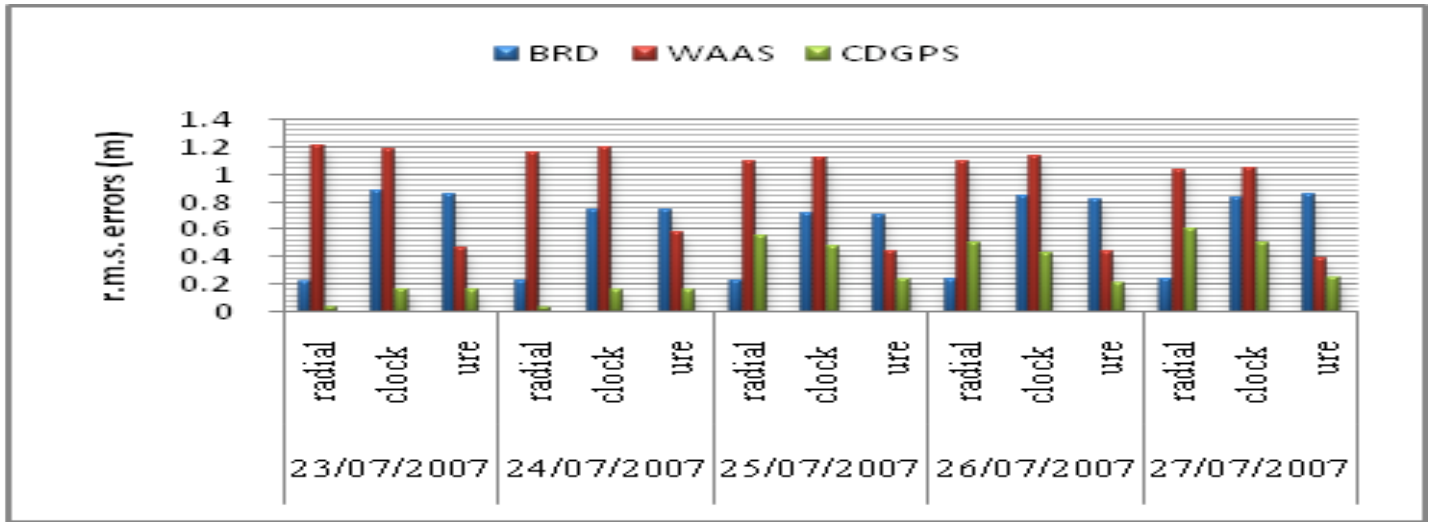
- Drawbacks
  - Strong geometry dependence
  - Not adequate for iono map generation
  - Convergence time issue

WADGPS-PPP


GPS Satellites
$[\Delta \underline{r}^k, \Delta B^k]$
Geostationary Satellite
1. Satellite orbit correction
2. Satellite clock correction
3. Ionospheric correction (single frequency case)
Ionosphere
Wide Area Reference Sites (WRSs)
WMS
By Hyunho Rho and Richard B. Langley

WADGPS-PPP: Orbit and Clock Corrections

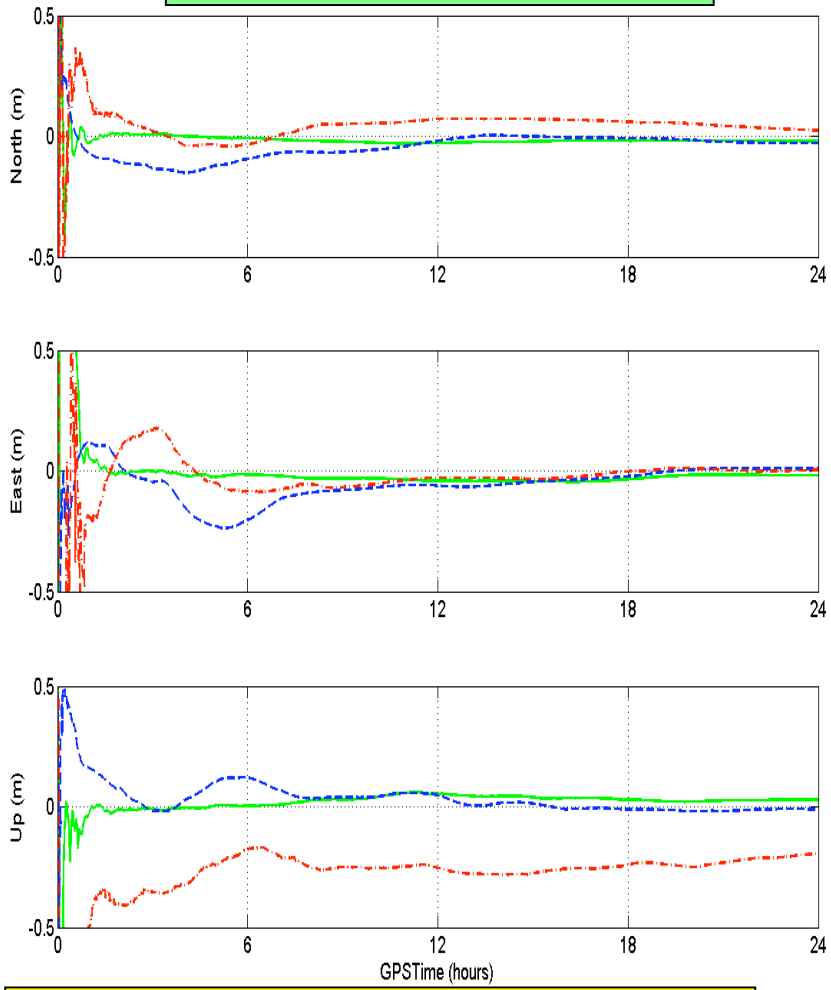




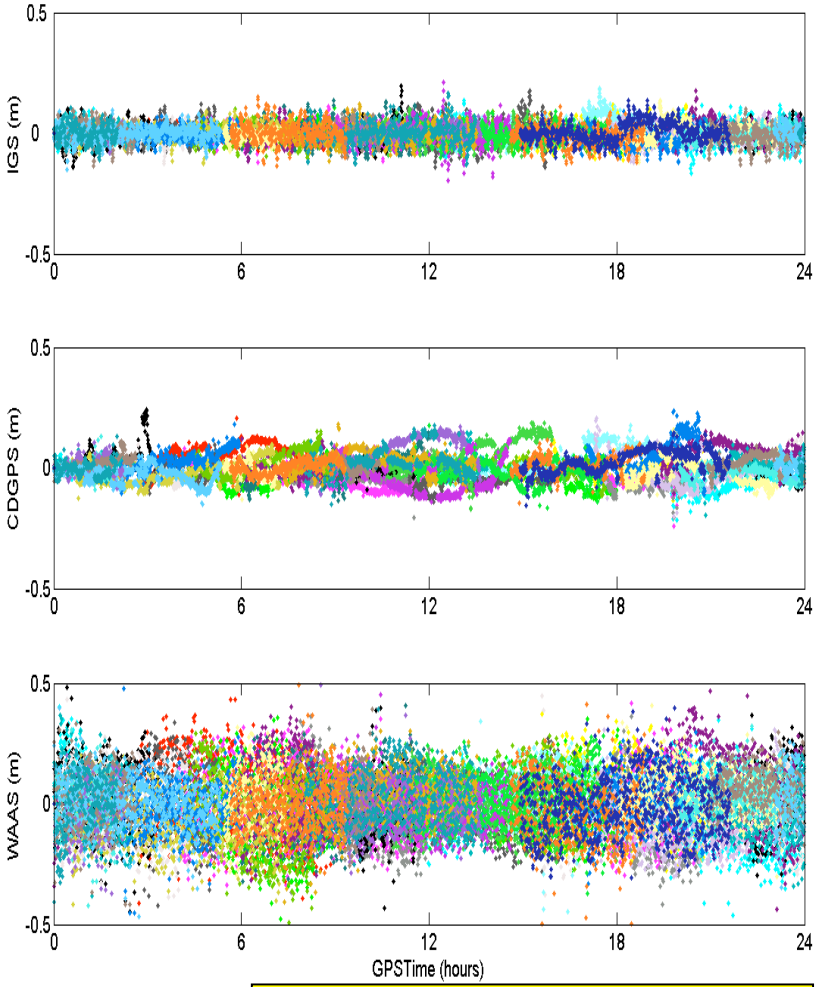
Rho and Langley (2007)

WADGPS-PPP:Positioning Results

Position Convergence (Static)



Phase residuals

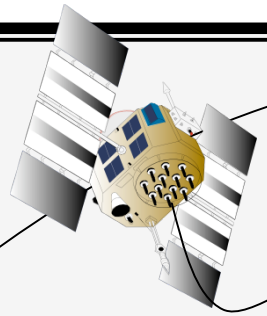


Green: IGS, Blue: CDGPS , Red: WAAS

Rho and Langley (2007)

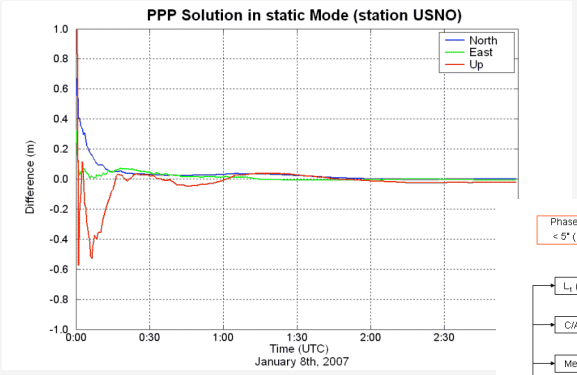
Algonquin Park, July 23, 2007

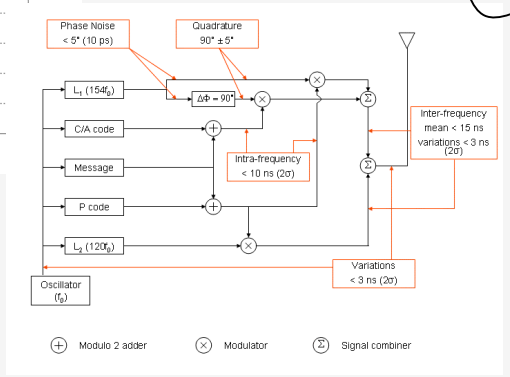
Ambiguity Resolution

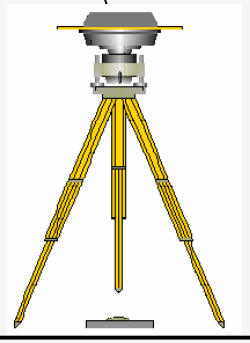


- **Receiver Phase Bias Calibration**

- **Satellite Phase Bias Calibration**







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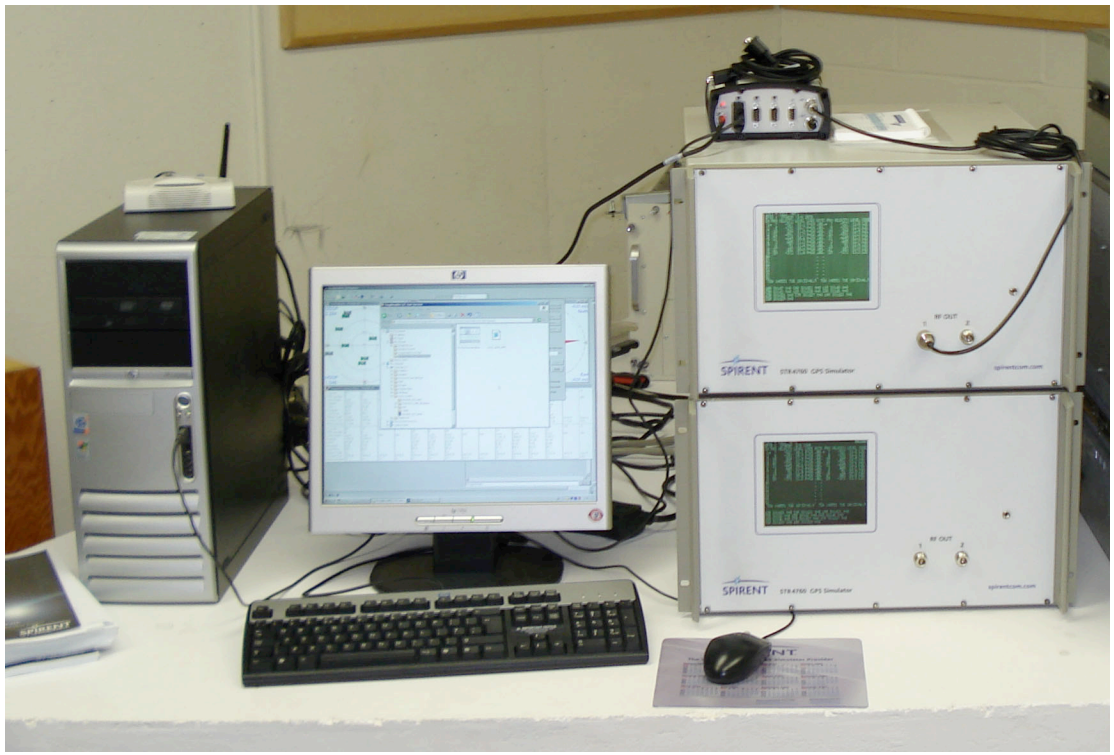
Ambiguity Resolution

- Receiver Phase Bias Calibration



Banville et al. (2008)

Use a GPS signal simulator

↓

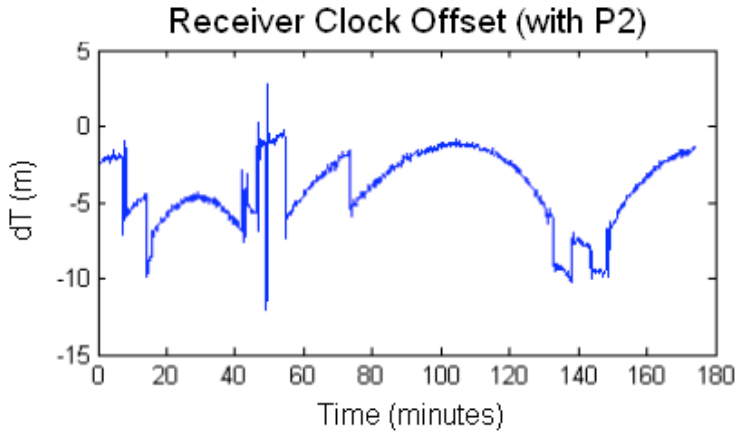
Generate "errorless" phase and code observations

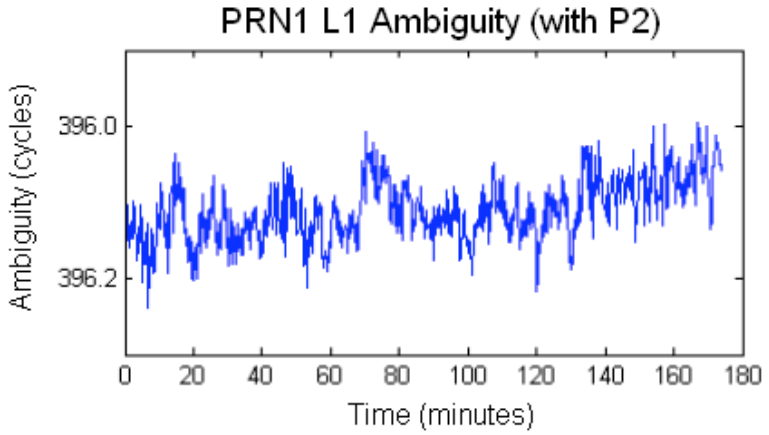
↓

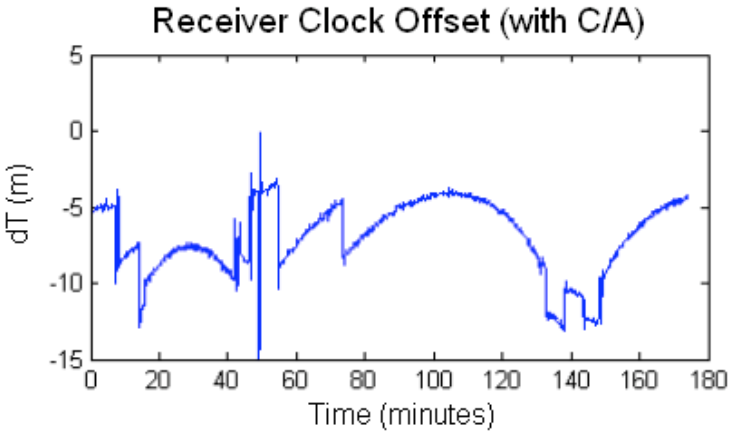
Isolate phase bias

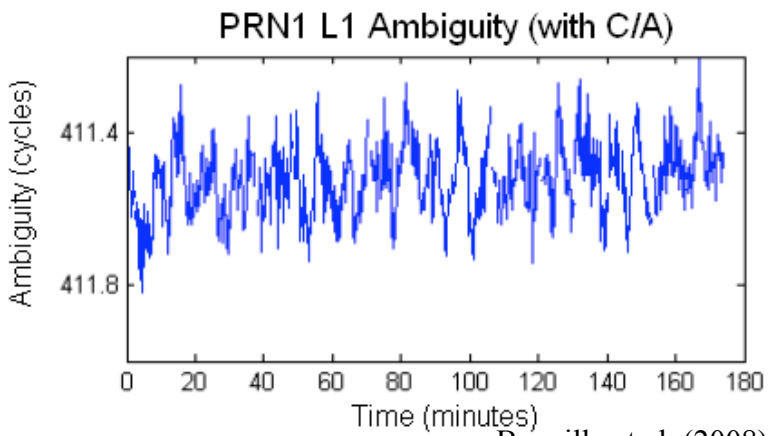
Ambiguity Resolution

- Receiver Phase Bias Calibration





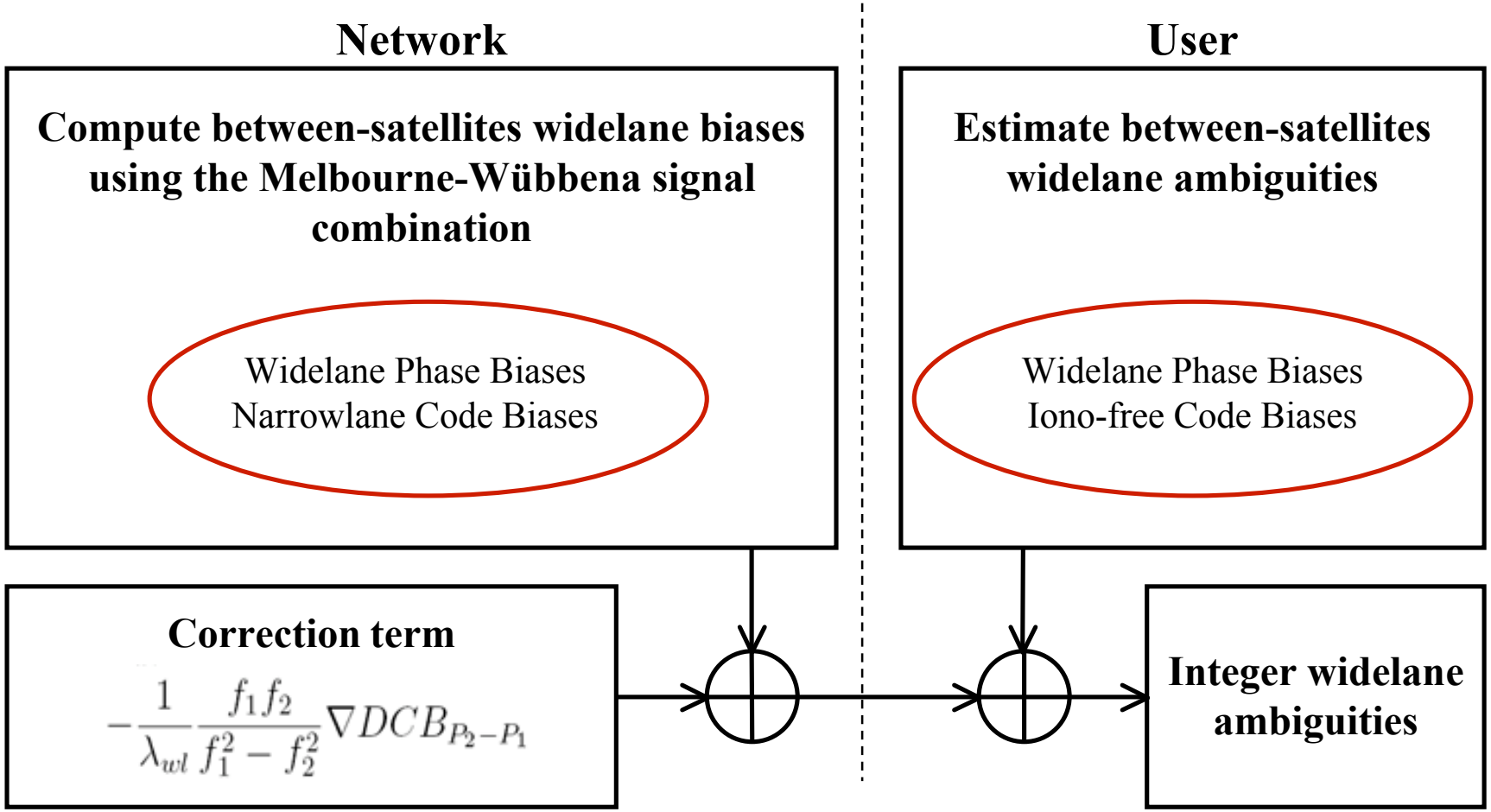




Banville et al. (2008)

Ambiguity Resolution

❑ Satellite Phase Bias Calibration (widelane example)



Future Work

- Analysis of L2C signal performance in more challenging environments (high multipath, less visibility, kinematic)
- Impact of shell height and degree of polynomial on ionosphere model
- GAPS Enhancements
  - Translation from MatLab to C++
  - Improved computational performance
  - Modernization-ready (handling of RINEX 3.00)

Topic for Discussion

- Standard Data Sets for PPP Software Testing ?
  - Purposes
    - Validate new software
    - Compare software / implementation strategies
    - Test new processing strategies
    - Identify limitations of PPP
  - Elements of comparison
    - Convergence time
    - Achievable accuracy
    - Precision vs accuracy
  - Selection of sets
    - Static / kinematic
    - Reference coordinates, data rate, IGS products to use, etc.

Acknowledgements

- Thanks to GEOIDE for funding Project 31

- Thanks to the GNSS Simulation and System Integration Laboratory at UNB for the signal simulator

References

- Banville, S., R. Santerre, M. Cocard, R.B. Langley (2008). *Satellite and Receiver Phase Bias Calibration for Undifferenced Ambiguity Resolution*. Presented at ION NTM 2008, San Diego, CA, January 28-30.
- Leandro R.F., M.C. Santos, R.B. Langley (2007). *PPP-based Ionospheric Activity Monitoring*. Presented at ION GNSS 2007, Fort Worth, TX, September 25-27.
- Leandro R.F., T. Thirumurthi, L. Sükeová, R.B. Langley, M.C. Santos (2008). *Analysis of the GPS L2C Signal Quality and its Impact on PPP Performance*. Presented at ION NTM 2008, San Diego, CA, January 28-30.
- Rho, H., R.B. Langley (2007). *The Usefulness of WADGPS Satellite Orbit and Clock Corrections for Dual-Frequency Precise Point Positioning*. Presented at ION GNSS 2007, Fort Worth, TX, September 25-27.