Improving Single Frequency Positioning Using SIRGAS Ionospheric Products

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SIRGAS

Outlook

- ✓Goal and motivations
- ✓Why in South America?
- ✓Workflow
- ✓Results for a test bed
- ✓Conclusions

Goal

✓Increase precise positioning accuracy for single frequency receivers.

Motivation

✓A large part of the GNSS technology users in Latin American have access only to single frequency receivers.

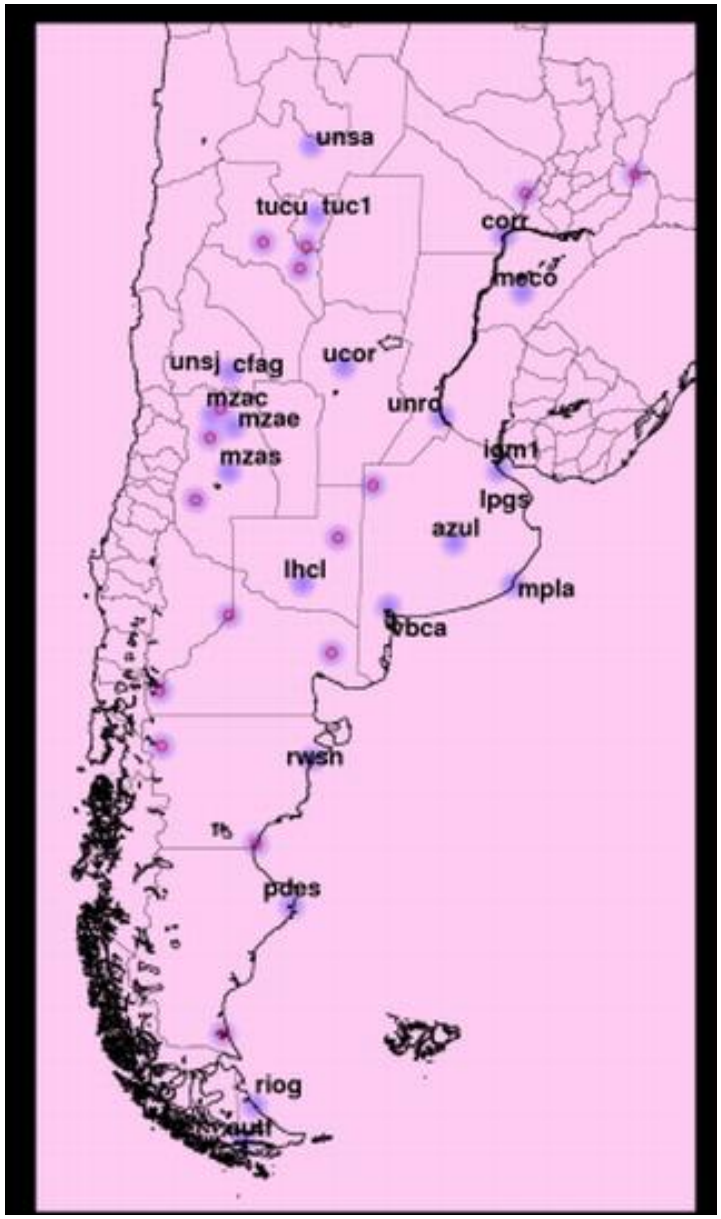
✓These receivers can not eliminate the ionospheric bias by combining signals.

Basic Facts

- ✓The ionosphere delay is the main error factor in positioning.
- ✓This delay can be mitigated with a differencing technique.
- ✓The technique lose effectiveness as the baseline increases.

Context in South America

- ✓Because of the size of the continent, the GNSS continuously operating reference stations (CORS) are usually more than 300 kilometers from each other.
- ✓Under this condition the relative positioning method is less effective.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Our proposal

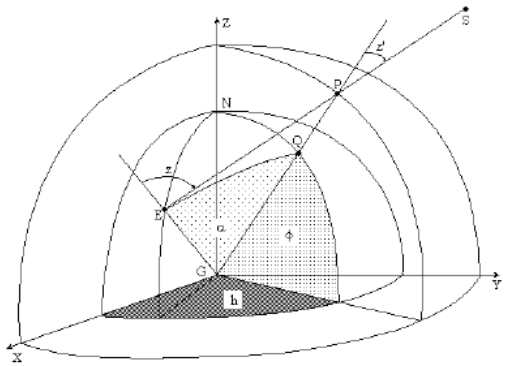
✓Use the CORS network already installed in order to produce ionospheric corrections for single frequency receivers.

Methodology

- ✓Determine the slant total electron content (STEC) from dual frequency CORS.
- ✓Estimate STEC in the place the user is located.
- ✓Correct the single frequency observations.
- ✓Process the observations in a regular way.

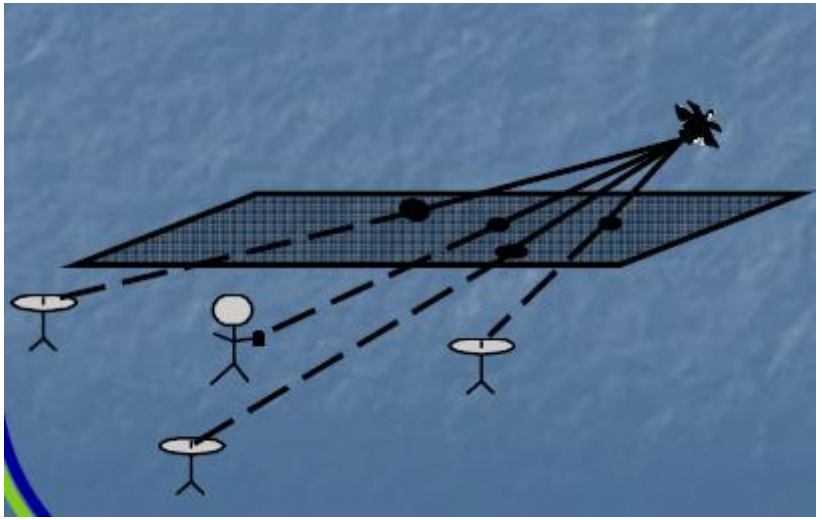
1st step: calculate STEC using LPIM

- ✓ Absolute STEC must be determined.
  - ✓ Receiver calibration
  - ✓ The estimation is done at the zero difference level
- ✓ We assume a thin shell model.



2nd step: Estimate STEC

- ✓ Estimate STEC
  - ✓ For each receiver – satellite observation
  - ✓ For each epoch



3rd step: Correct the observations

- ✓ We can correct measurements
  - ✓ Corrected C/A and Corrected L1
- ✓ We can generate new measurements
  - ✓ Simulated P2 and Simulated L2
- ✓ The user has a new RINEX file with less ionospheric bias

4rd step: Conventional processing

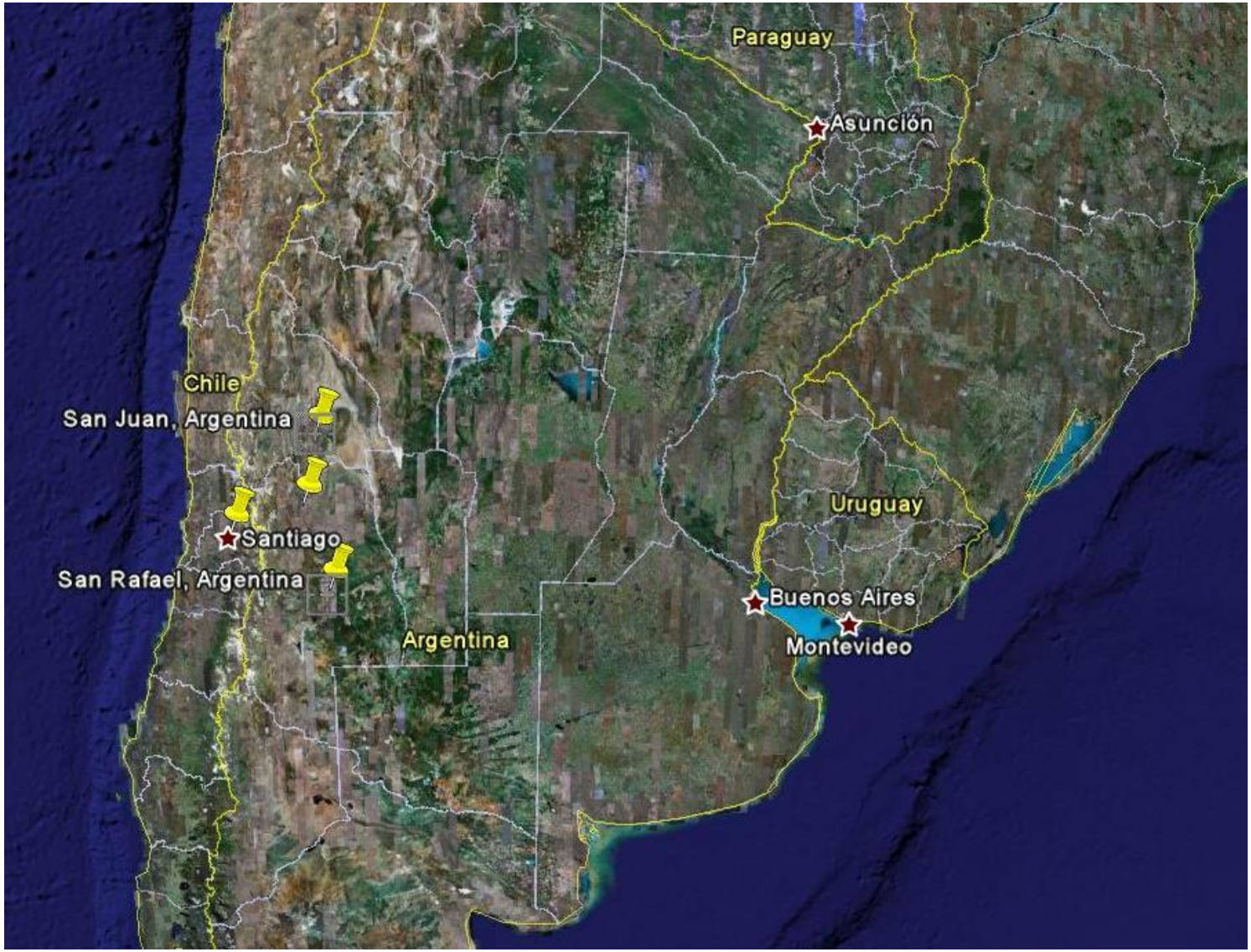
- ✓ Positioning is performed using the software that the user usually uses.
- ✓ We have extended the CORS – user's distance.

Evaluation

- In the position domain
  - Code and phase
  - Static and cinematic
- Comparison
  - Single frequency solution
  - Corrected solution
  - Ion free solution

Test bed

- ✓ 10 days, 24 hours.
- ✓ Mid latitude.
- ✓ Non disturbed solar conditions.
- ✓ Distance between GPS receivers 200 to 300 Km.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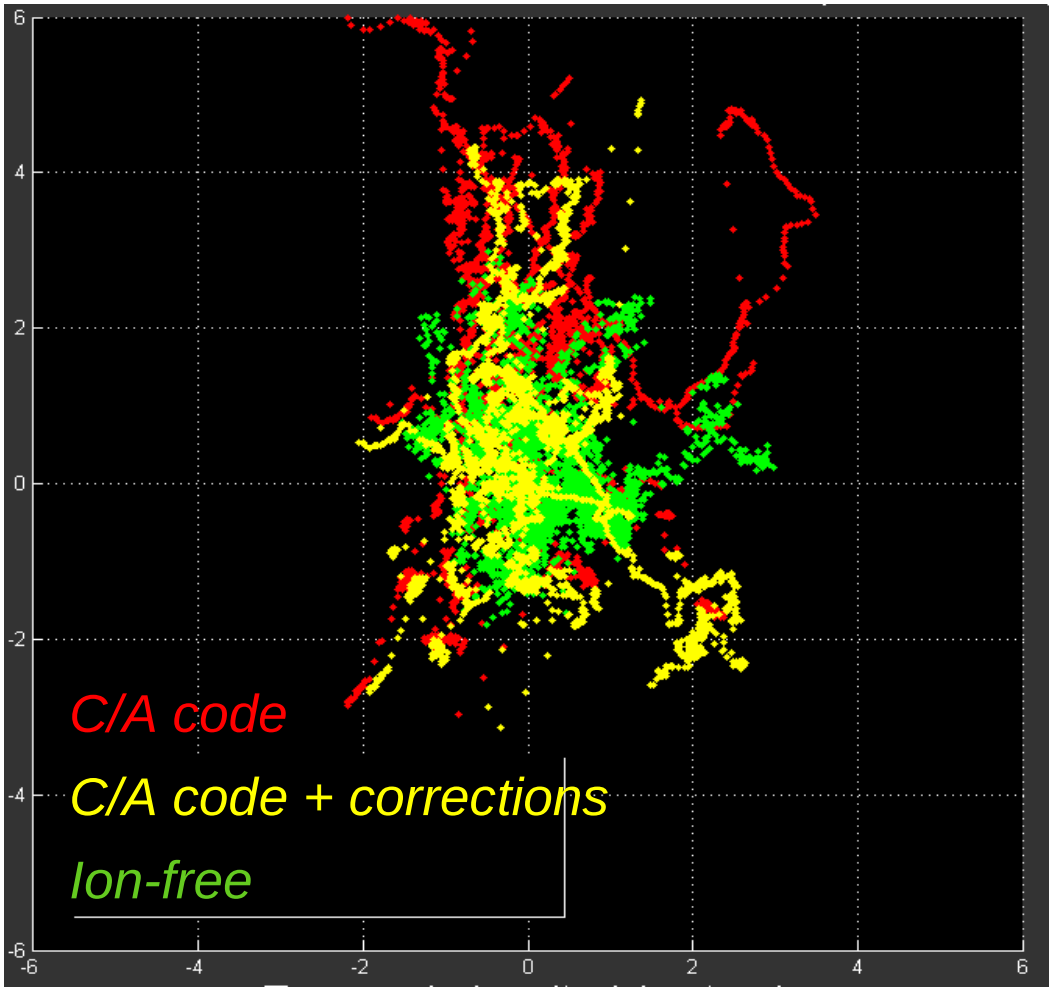
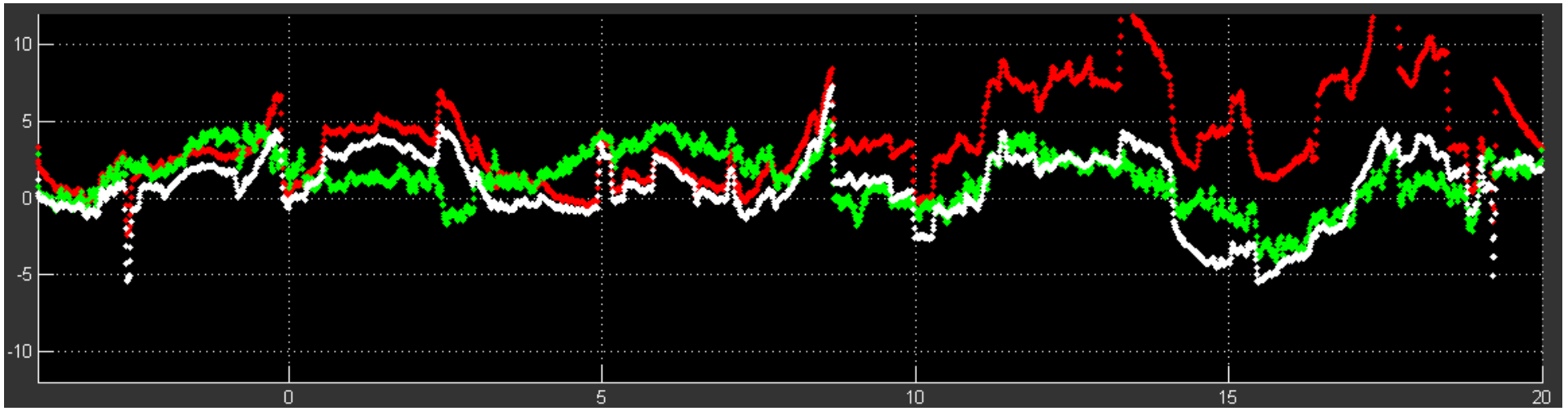
Chile
San Juan, Argentina
Santiago
San Rafael, Argentina
Argentina
Uruguay
Buenos Aires
Montevideo

Standalone positioning

Horizontal coordinates

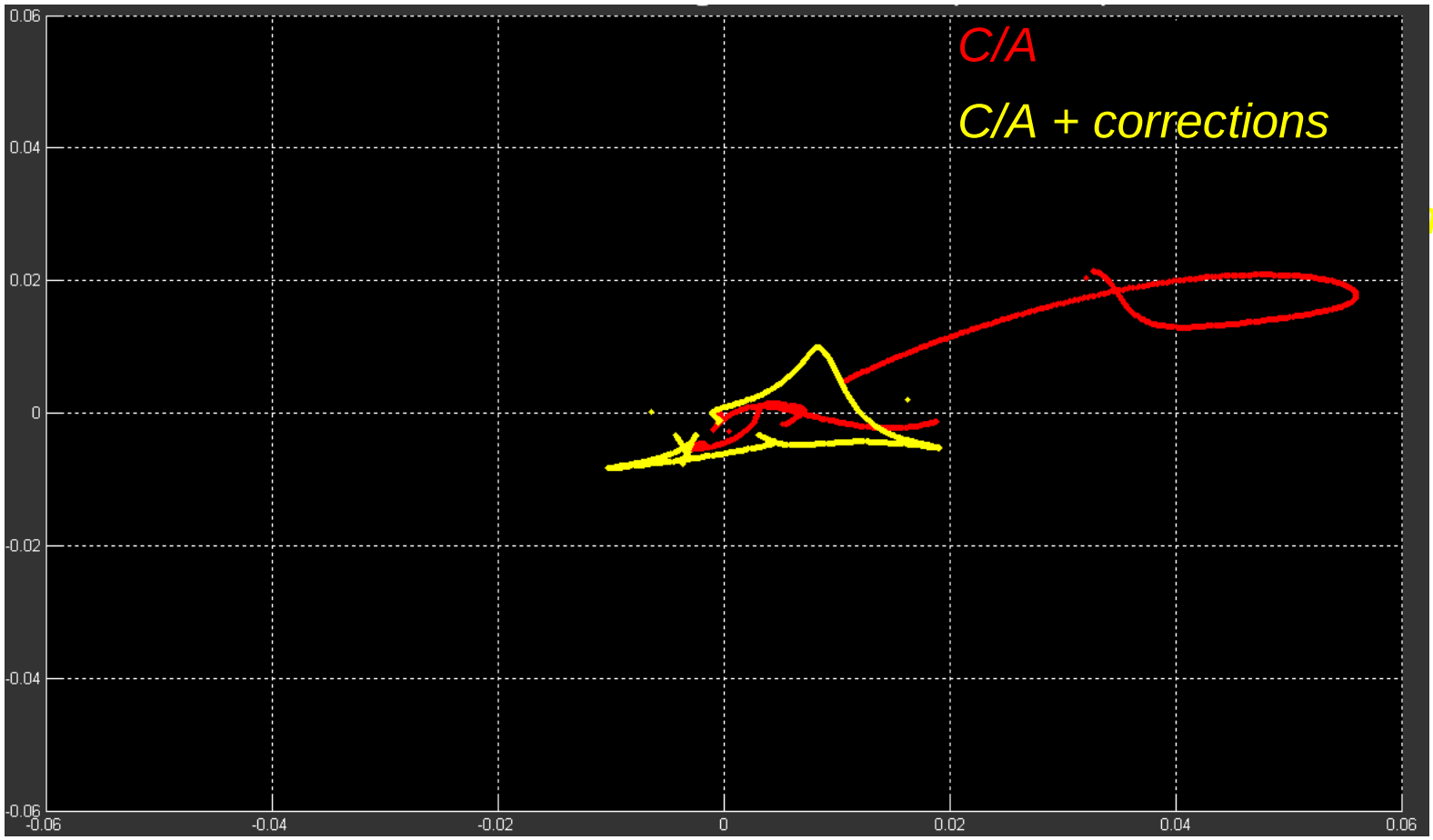


Vertical component



Differential positioning using code

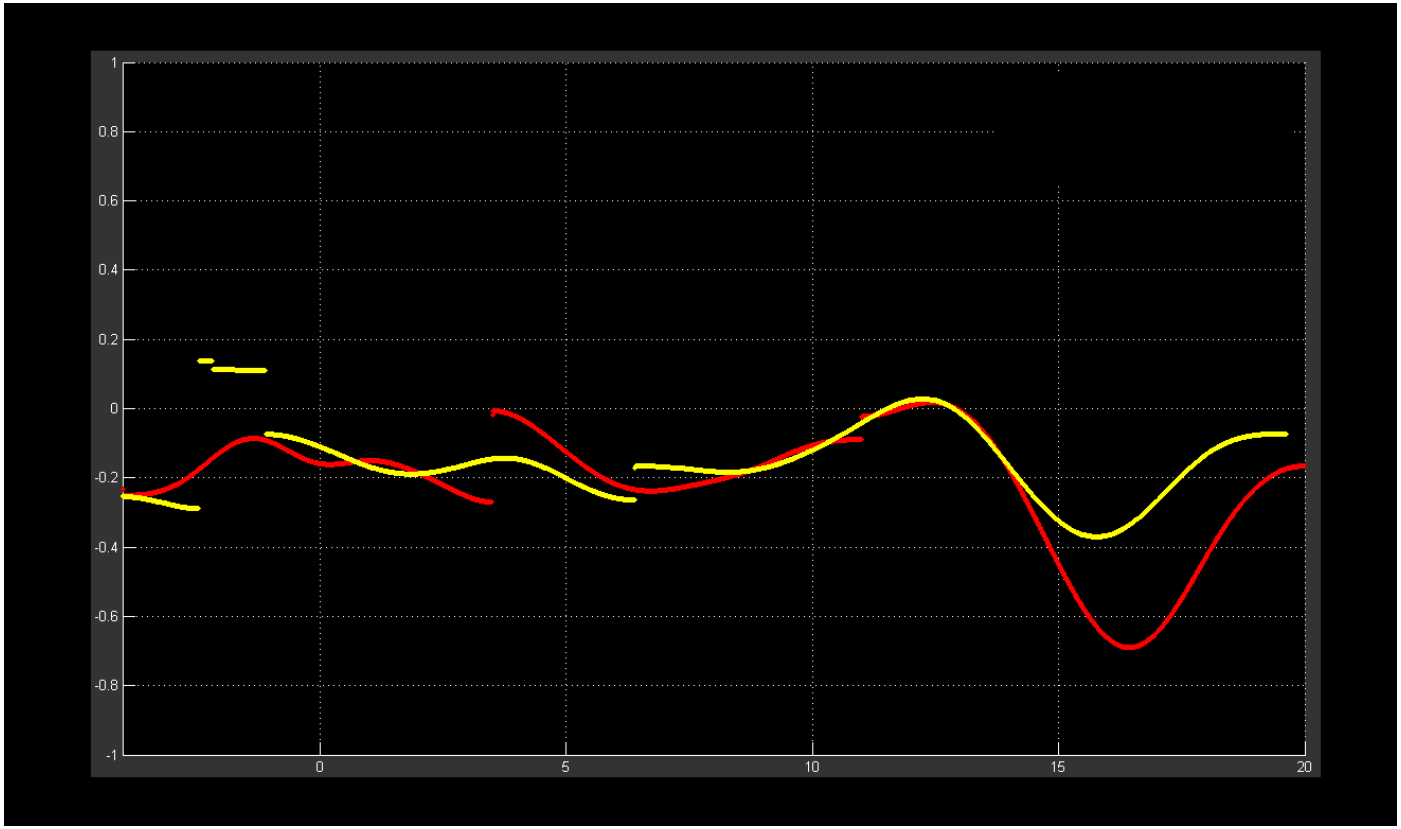
Horizontal coordinates



Delta North (meters)

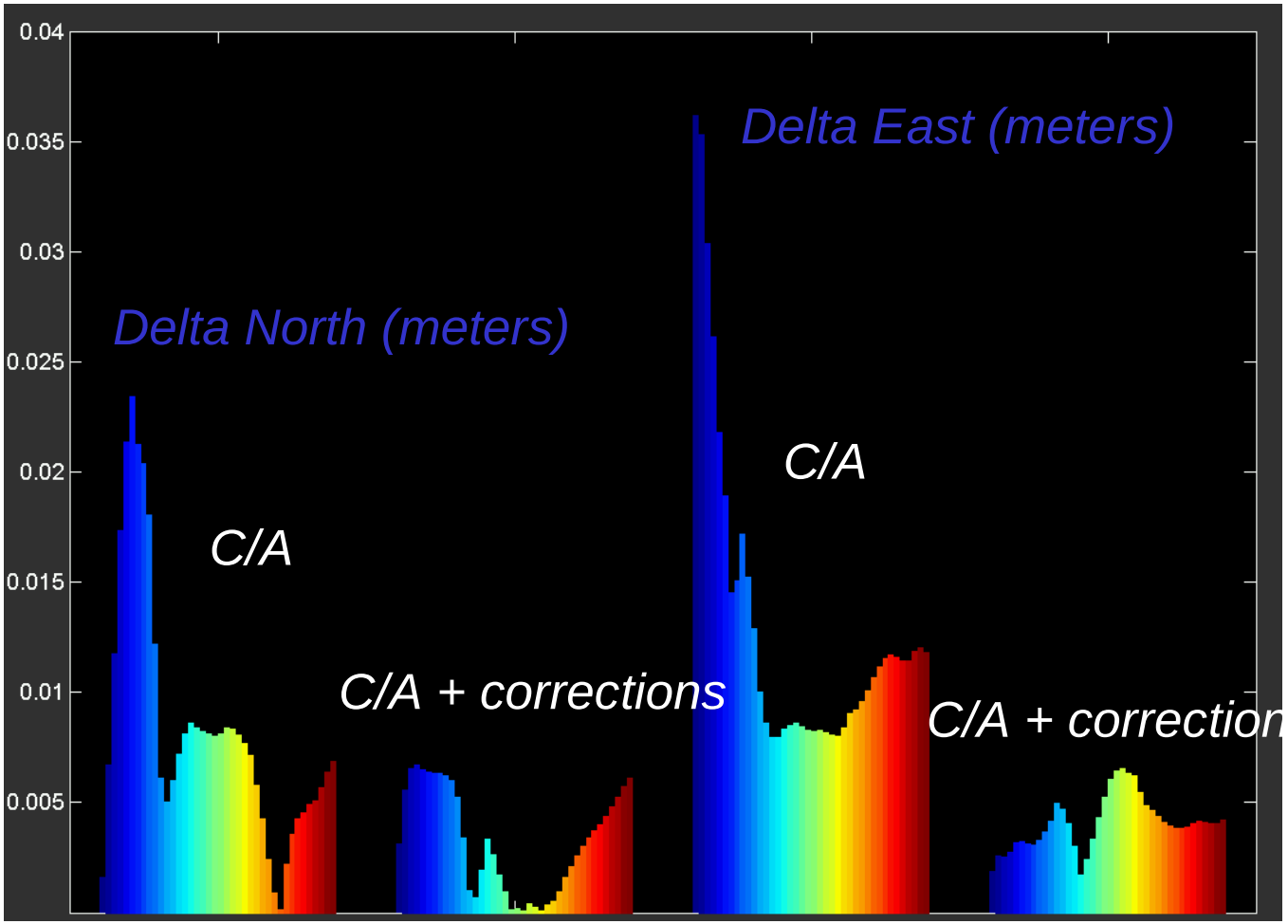
Delta East (meters)

Vertical component

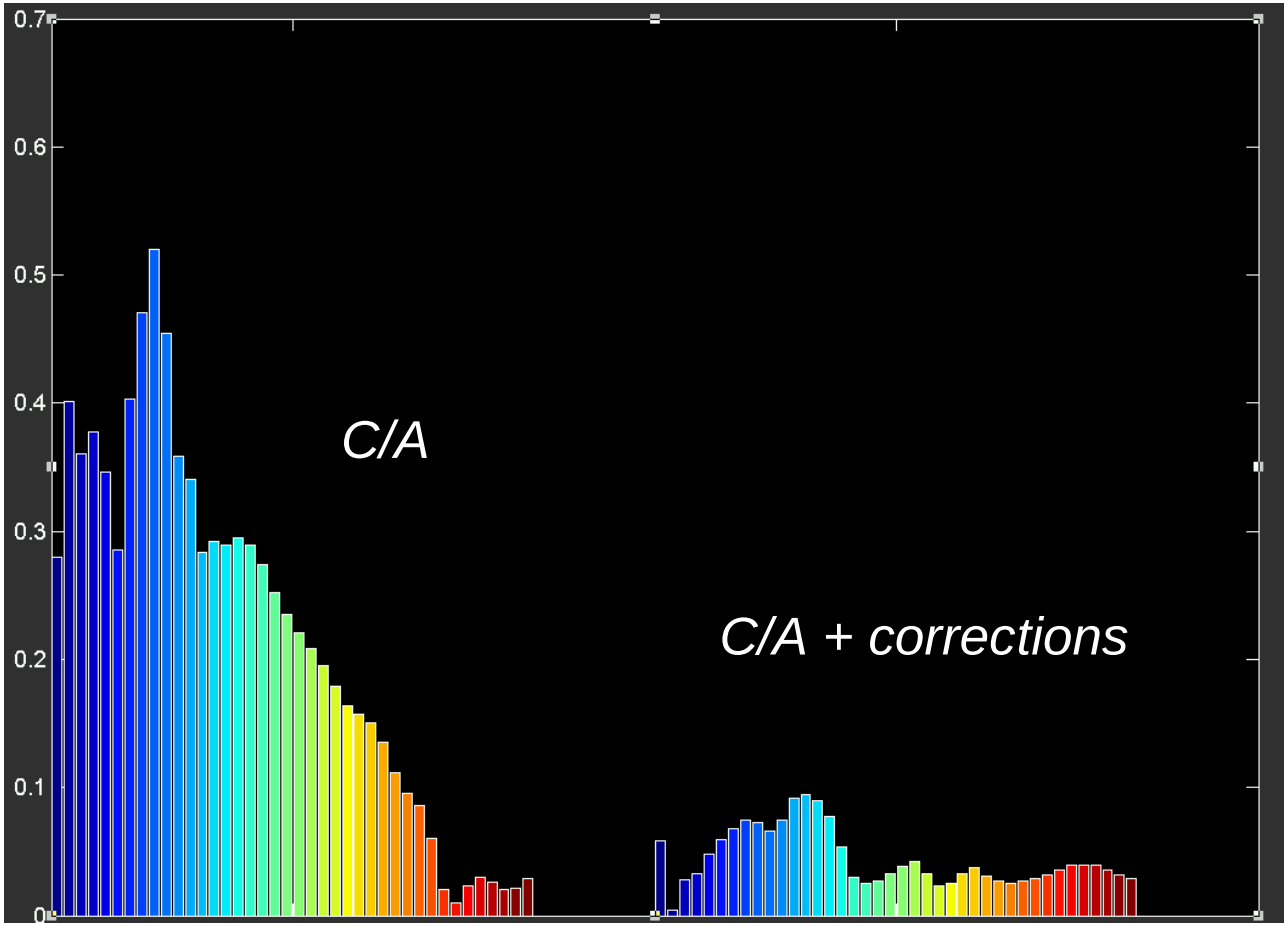


Differential positioning using carrier phase

Horizontal coordinates



Vertical component



Conclusions

- ✓ It is possible to:
  - ✓ Mitigate the ionospheric effect on L1.
  - ✓ Extend the separation between the user and a CORS station.
- ✓ When corrections are applied:
  - ✓ The horizontal errors are reduced more than 40%.
  - ✓ The vertical errors are reduced almost 60%.
- ✓ 95% of the time the corrected observations present errors below.
  - ✓ 1 centimeter for the horizontal coordinates.
  - ✓ 10 centimeters for the height.

Extended utility