ION GNSS 2011

FILLING IN THE GAPS OF RTK WITH REGIONAL PPP

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SESSION F3: PRECISE POSITIONING AND RTK FOR CIVIL APPLICATION

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OUTLINE

- RTK: Real Time Kinematic
- PPP: Precise Point Positioning
- Products for PPP
- Regional PPP
- Global VS Regional PPP, static mode
- RTK VS PPP, kinematic mode
- Conclusions and future work

RTK: REAL TIME KINEMATIC

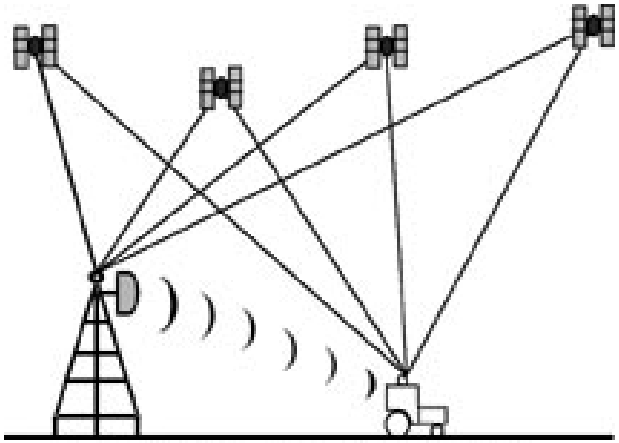
- Differential positioning technique based on the use of dual-frequency carrier phase measurements of GNSS signals where a base station receiver at a well known, calibrated location transmits signal corrections in real time to one or several rover receivers.

- RTK corrections compensate atmospheric delay, orbital and clock errors, etc, increasing positioning accuracy up to the centimeter level.

- Almost instantaneous convergence due to integer ambiguity determination.

- Limited corrections applicability due to decorrelation between base station and rover conditions (ionosphere, troposphere…).

- Enhancing methods such as VRS allows performing RTK positioning in reference station networks with distances of up to 40 km.



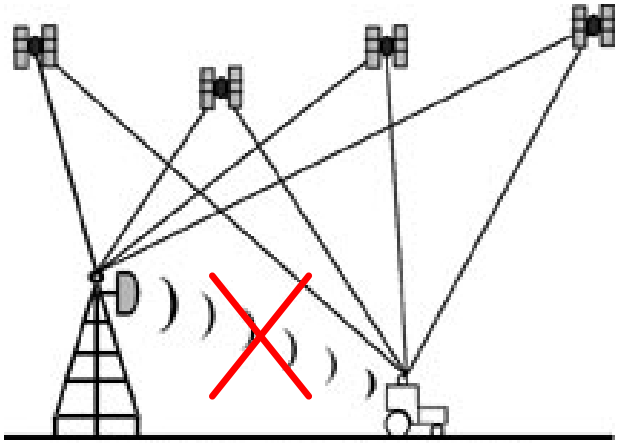
PPP: PRECISE POINT POSITIONING

- Absolute positioning technique based on undifferenced, dual-frequency observations coming from a single GNSS receiver, together with detailed physical models and corrections, and precise GNSS orbit and clock products calculated beforehand.

- Additional corrections used to mitigate systematic effects which lead to centimeter variations in the undifferenced code and phase observations; phase wind-up corrections, satellite antenna offsets, station displacements due to tides (earth and oceanic), etc.

- PPP has the advantage versus RTK in that no base station or network of base stations is necessary -> a PPP client is completely independent.

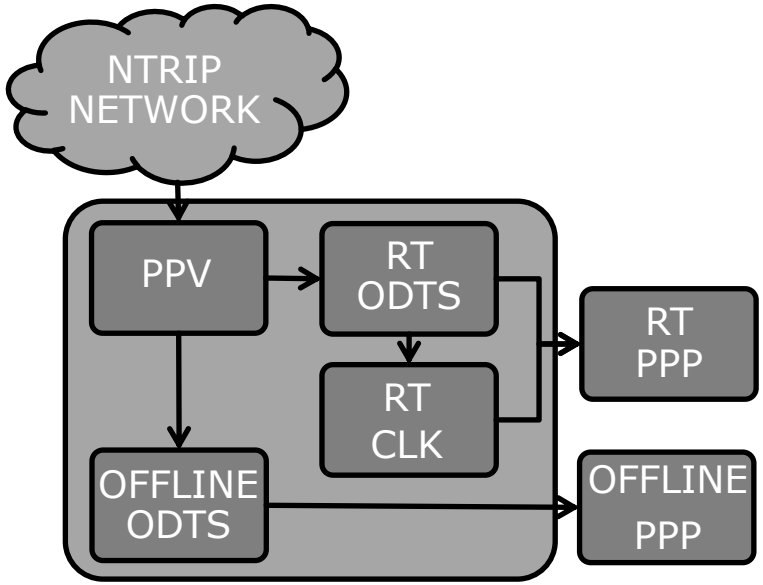
- Ambiguities need to be estimated (without further enhancements) -> Convergence time needed, longer than in RTK.



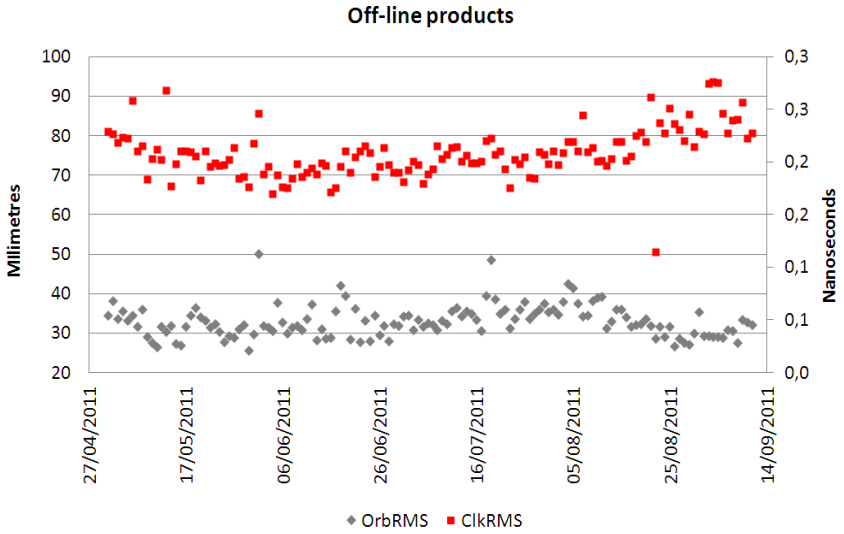
PRODUCTS FOR PPP

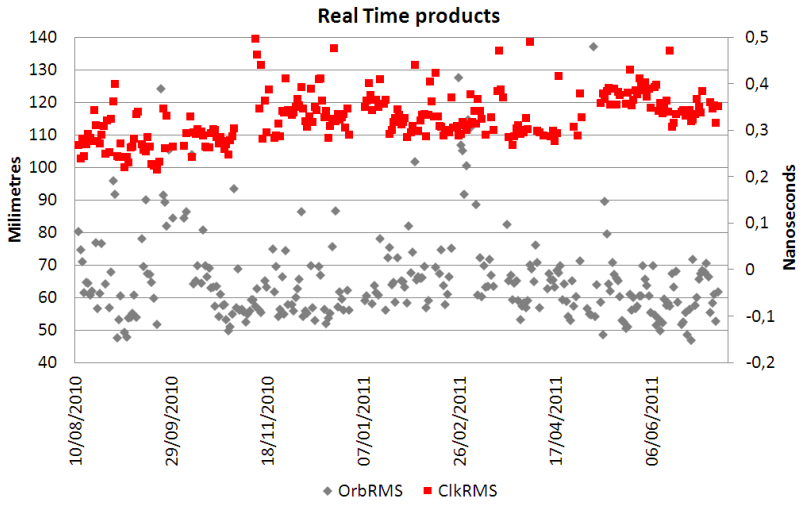
- GMV: Infrastructure for generation of precise GNSS orbits and clocks.

- Product comparison VS IGS:
  - **Real Time**: 0.3 ns and 6 cm for orbit vs IGS.
  - **Post-processing**: 0.2 ns and 3 cm for orbit vs IGS.



- Quality monitored via PPP.



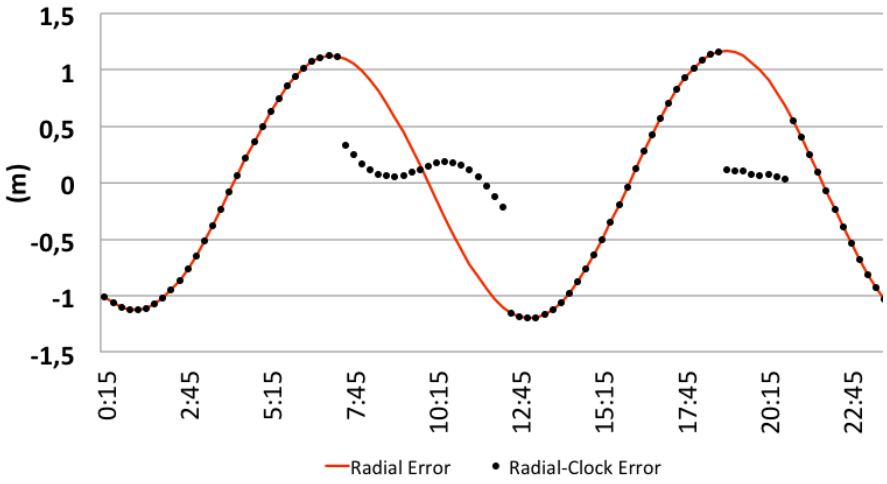


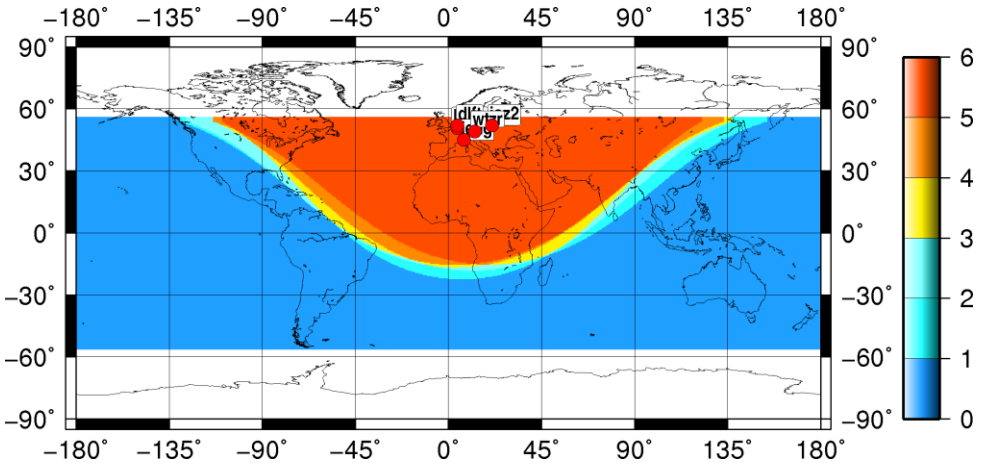
REGIONAL PPP

- PPP normally conceived as global positioning technique. Regional positioning providers do not necessarily need global coverage.

- PPP products from <u>global network</u>:
  - Good performances everywhere
  - Data collection complex and expensive

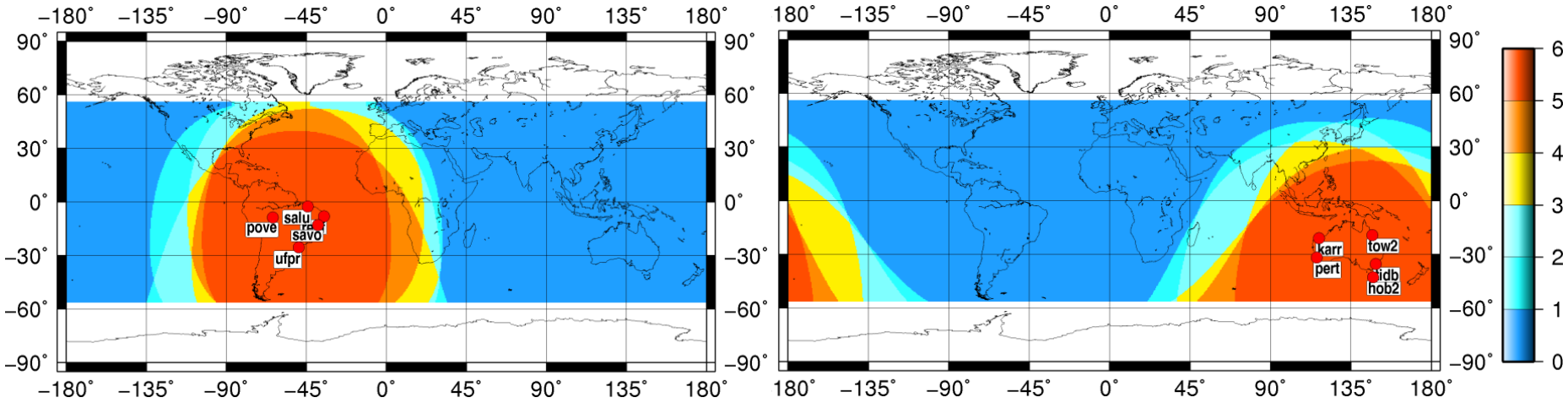
- **Alternative** -> Products from <u>regional network:</u>
  - Range error good in coverage error only
  - More feasible solution for service provider





GLOBAL VS REGIONAL PPP (1)

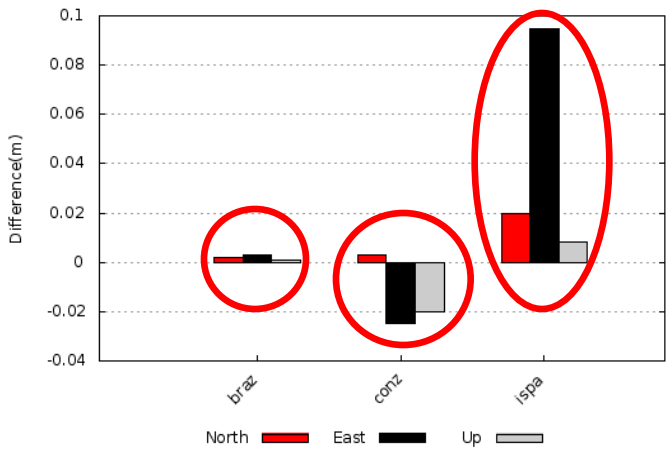
- Only local accuracy of reference products needed for high PPP quality.
- 24 hour PPP comparison with IGS final products and regional products.
- Regional products generated with 5 IGS stations in Australia and Brazil via ***magicGNSS*** tool.
- Limited coverage, but enough for regional positioning.

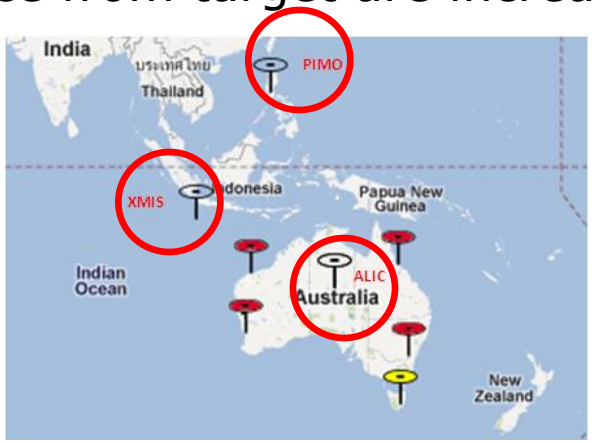


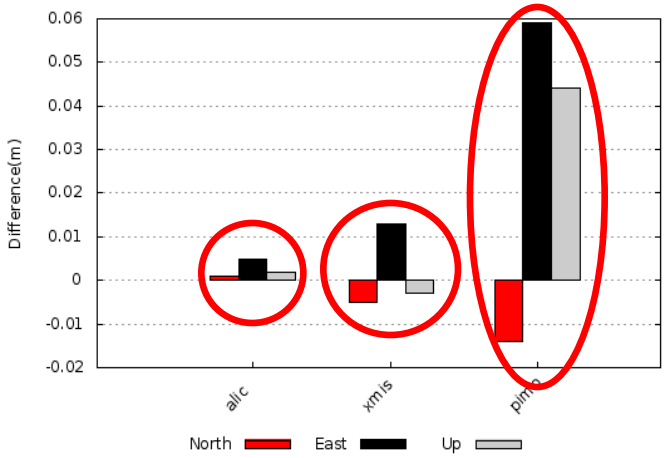
GLOBAL VS REGIONAL PPP (2)

- Comparable position accuracy within the target country with respect to global PPP. **Few millimetres error**.

- Position accuracy degradation as distance from target are increases.







RTK VS PPP, POST-PROCESSING (1)

- Open field terrestrial trajectory, June 23rd 2010, around 2.5 km, without obstacles that may reduce the visibility, of around 30 minute of duration.

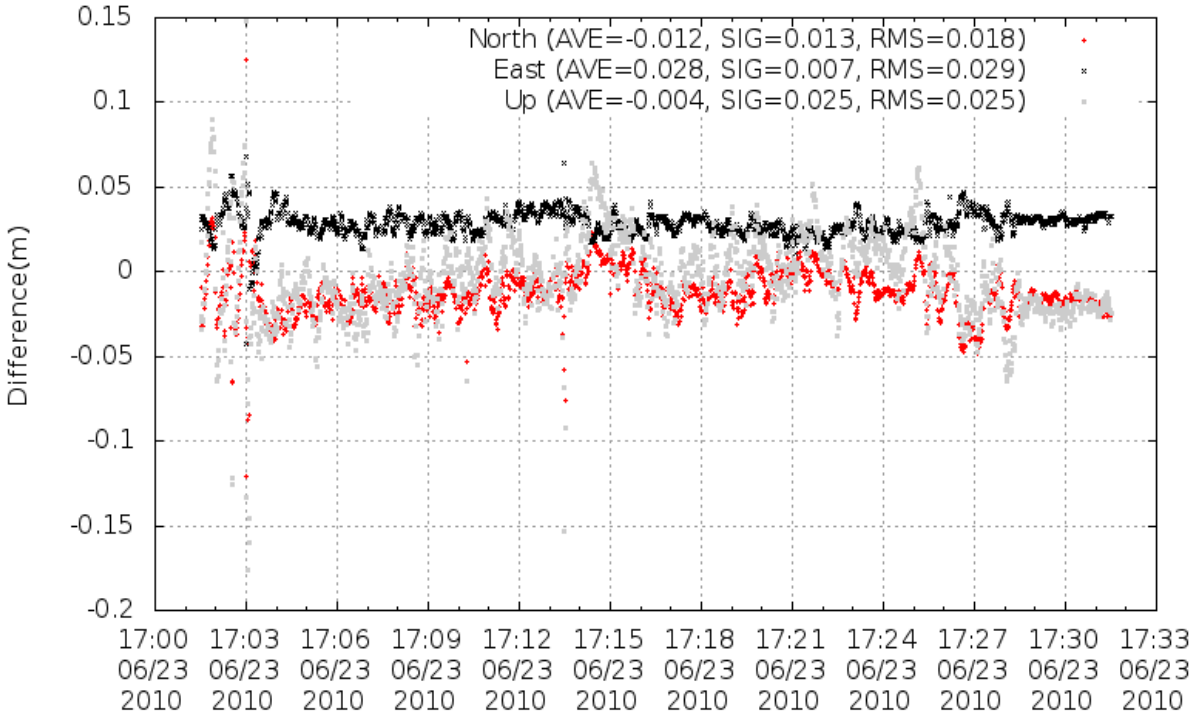
- PPP: Regional network composed of 8 IGS stations in Europe.

- RTK: GAP1 (1 km from trajectory) used as base station.

RTK VS PPP, POST-PROCESSING (2)

- The rover estimated both by regional PPP and RTK using GAP1 as base station.

- Performances of the two positioning techniques comparable throughout all the trajectory (**RMS position error in all 3 components is below 3cm**).



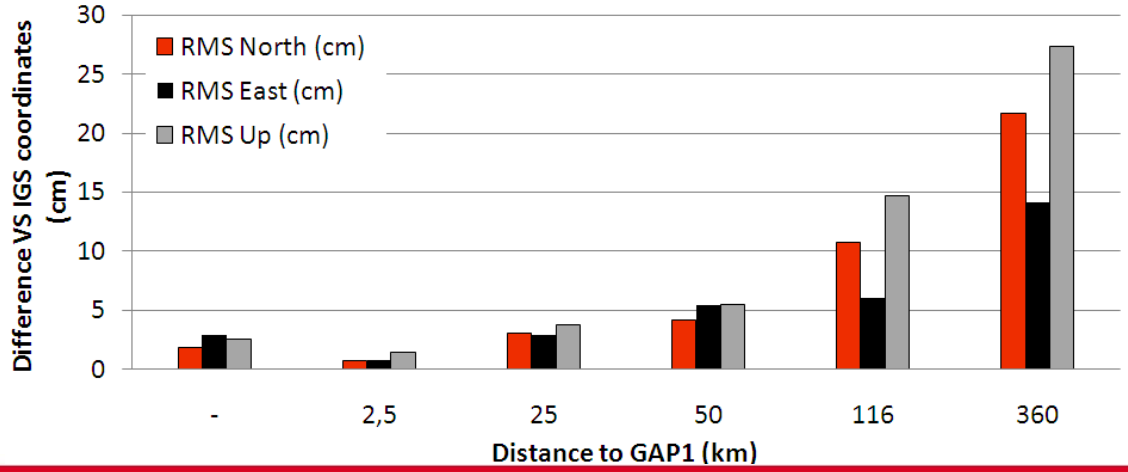
RTK VS PPP, POST-PROCESSING (3)

- RTK based on single base station require few kilometres distance to ensure position accuracy.

- Analysis of the RTK performance degradation with respect to the distance between the rover and the base station.

- RTK process performed using as base station 5 different base stations.

- No base station available within less that 25 km from the rover/receiver -> regional PPP may me a better choice.



RTK VS PPP, REAL TIME (1)

- PPP is not a differential technique, it cannot resolve (without enhancements) integer carrier phase ambiguities -> **Longer convergence period than RTK**.

- Real time scenario for PPP and RTK comparison. 46 minutes data from GAP1 receiver via NTRIP.

- RTK: rtklib tool retrieves observation data from GAP1 and IGNE stations via NTRIP protocol. IGNE used as base station.

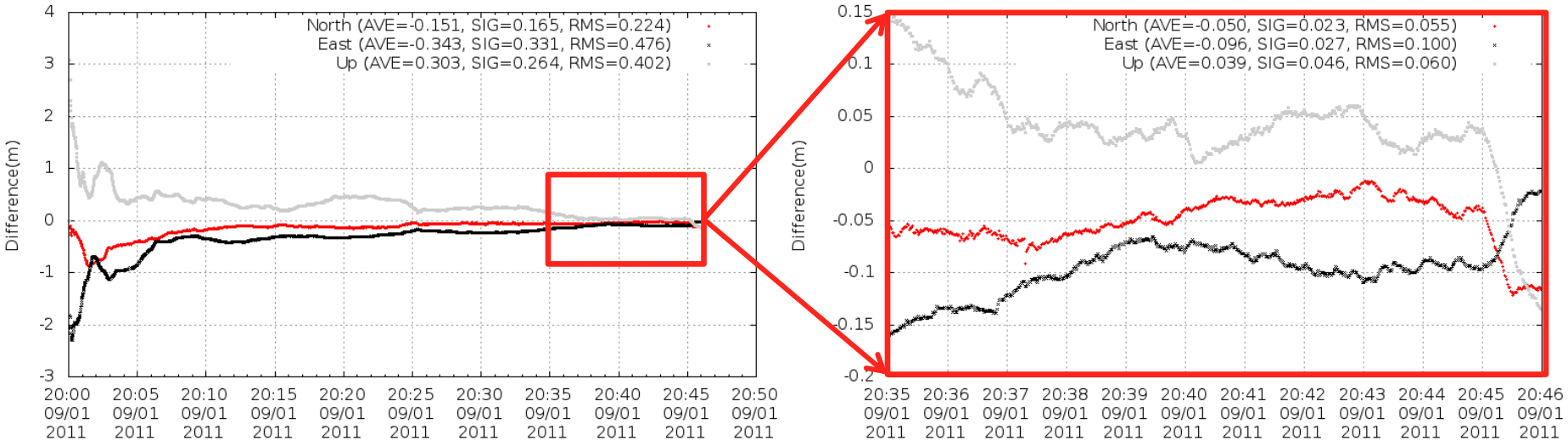
- PPP: GMV's core infrastructure used to generate real time products based on NTRIP European station network.

RTK VS PPP, REAL TIME (2)

- Comparison between the estimated coordinates for GAP1 station both with RTK and PPP in real time for the 46 minute observation period.

- PPP real time technique require longer convergence time than RTK due to the ambiguity estimation problem.

- After 35 minutes, real time PPP and RTK converge with comparable accuracy to the post-processing case.



CONCLUSSIONS, FUTURE WORK

- Regional PPP has shown comparable positioning accuracy to PPP with global products and RTK, both with static and kinematic data.

- Regional PPP has shown to be a plausible solution for obtaining high position precision for local environments with minimal investment and avoiding external dependency.

- Regional PPP can be used as a valid complement for areas with RTK coverage but sparse base station density.

- Convergence time needed by PPP in real time applications needs to be improved so that it can be a plausible alternative to RTK.

- PPP and RTK performances in real time with a moving rover still remains to be tested.

Thank you

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