Real-time Precise Point Positioning with Ambiguity Resolution for Geosciences

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Precise Point Positioning

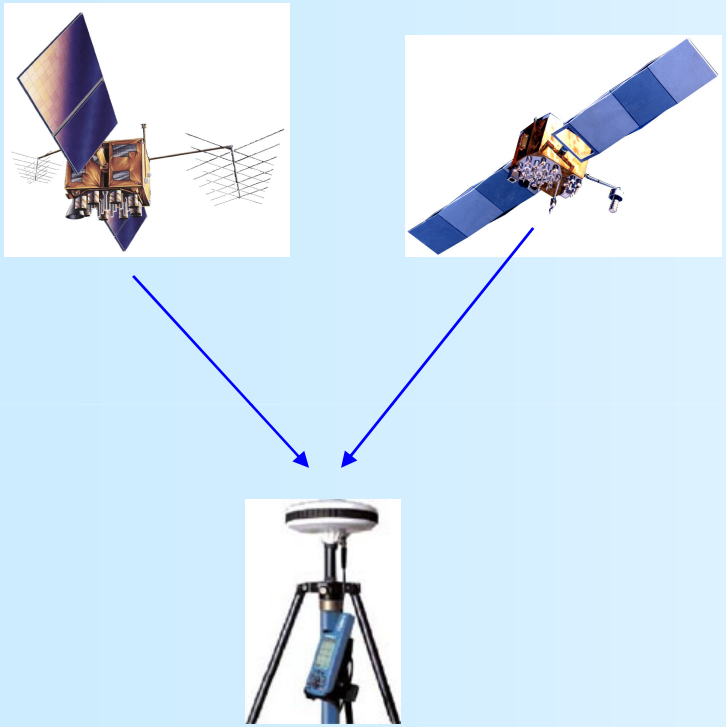
- Precise positioning at only a single station when precise satellite orbits and clocks are provided
  - Absolute positioning based on a sparse network
  - Homogeneous positioning accuracy on a global scale

- Current applications
  - Crustal deformation monitoring
  - Meteorology
  - Orbit determination of low Earth orbiters
  - Engineering surveying
  - Environmental applications

Precise Point Positioning

- Normal positioning accuracy
  - mm level using daily data in static PPP
  - dm level using hourly data in static PPP
  - dm level in real-time kinematic PPP
- Integer ambiguity resolution is ignored in PPP by most researchers in this field
- Integer ambiguity resolution has the potential to improve the positioning accuracy significantly

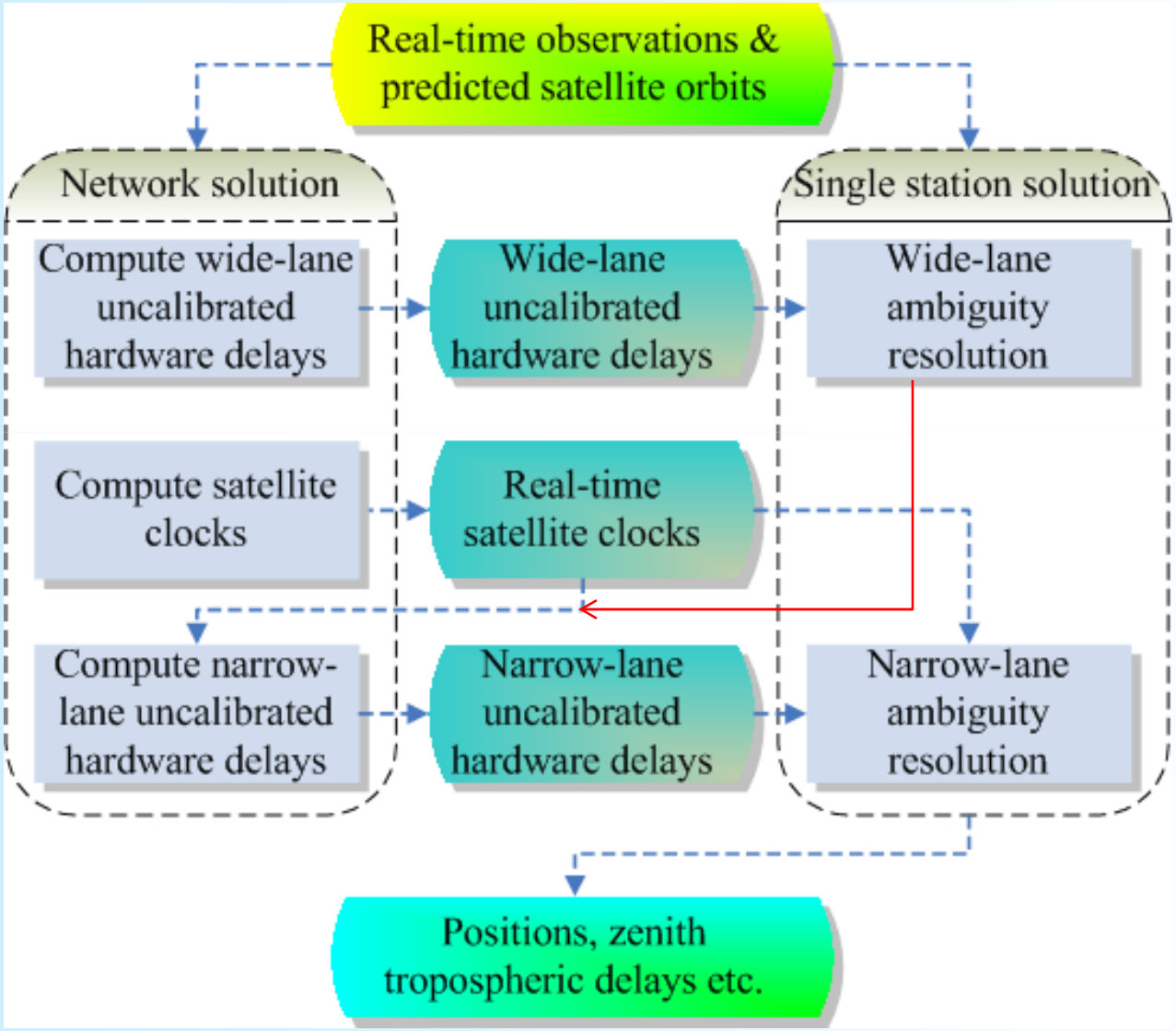
Ambiguity resolution in PPP



- Differencing between satellites to remove common errors in receivers
- However, no differencing to remove common errors in satellites

Determine the common errors in satellites using a network of stations

Ambiguity resolution in real-time PPP



No link between WL and NL???

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A prototype of real-time PPP system

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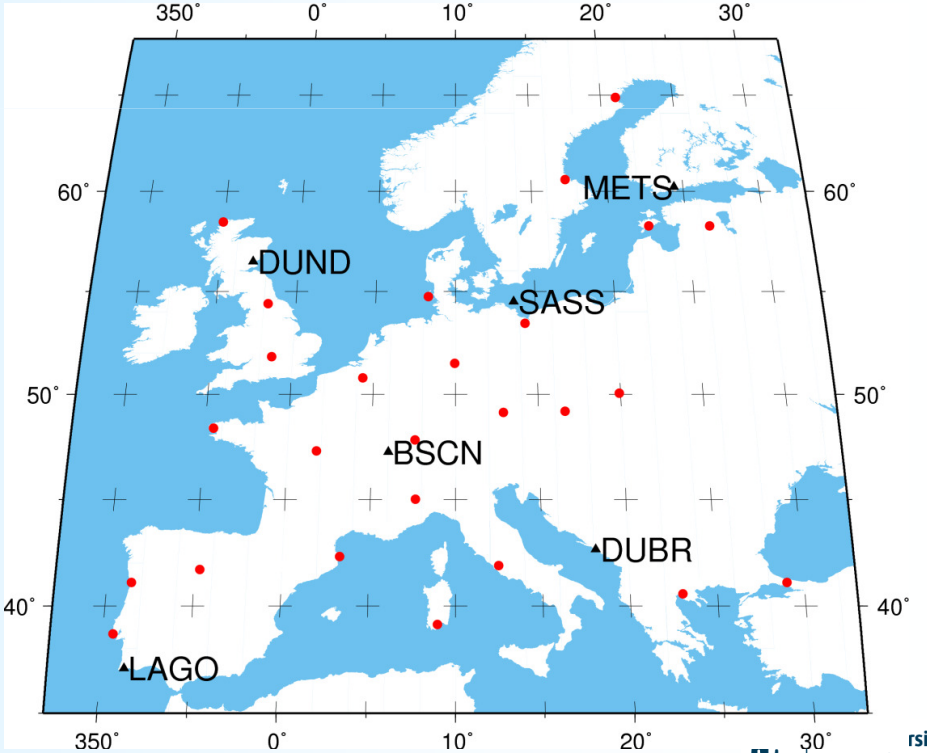
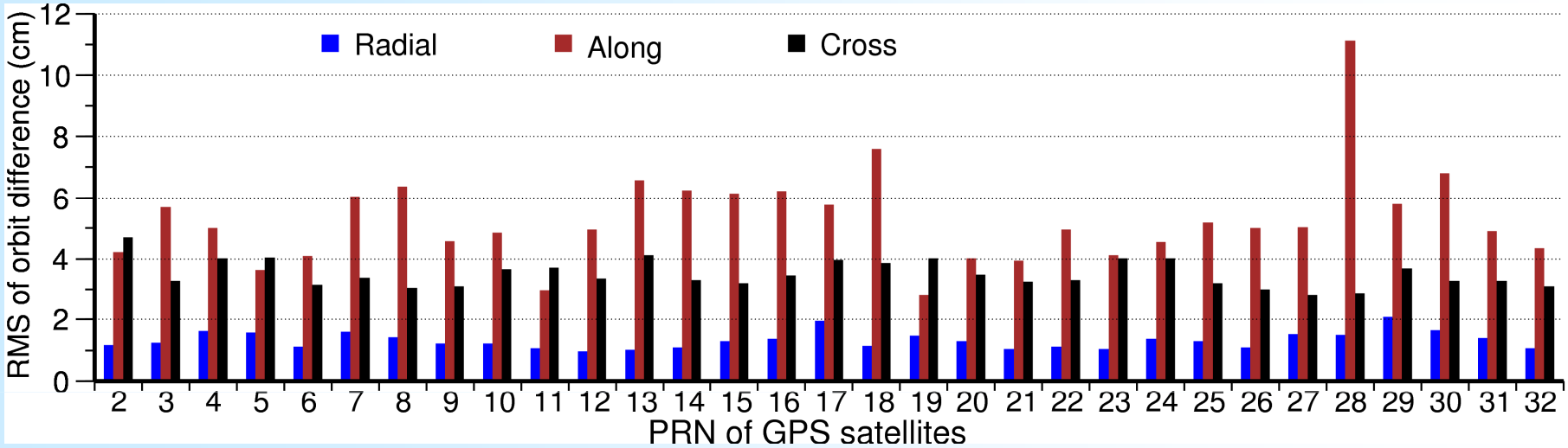
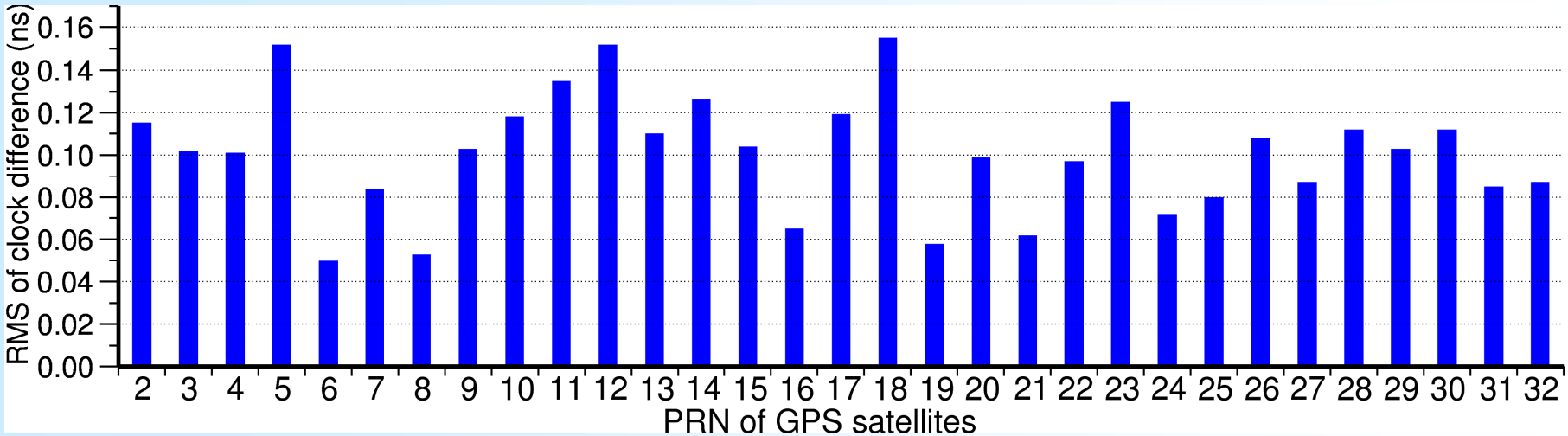
Continental real-time PPP

- 1-Hz data from EUREF-IP project on Day 188 in 2008
- 25 reference stations are selected with inter-station distances larger than 250 km
- 6 stations are chosen as 'rover' stations to conduct real-time PPP with ambiguity resolution



Orbit and clock accuracy in real time
final IGS products as truth





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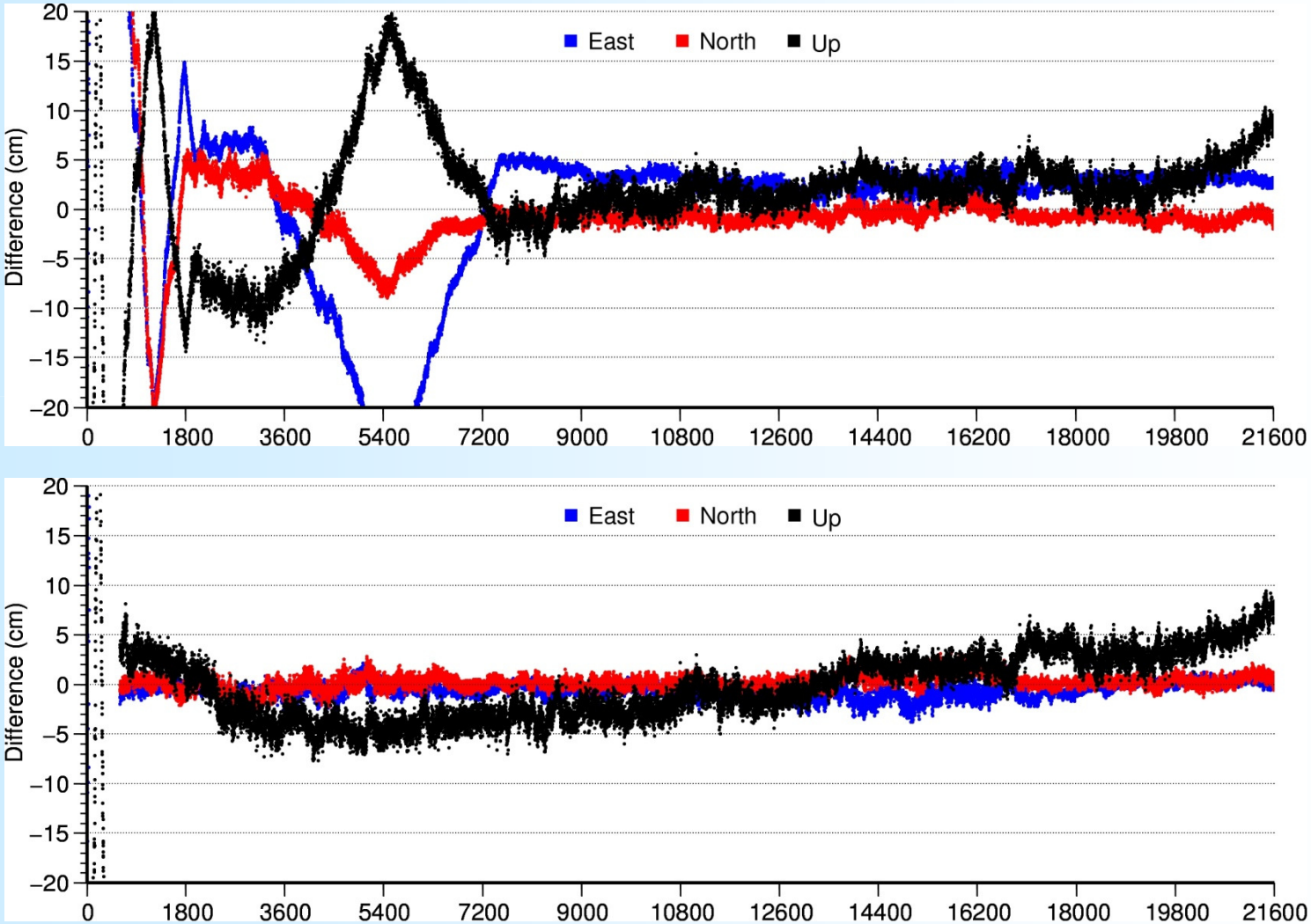
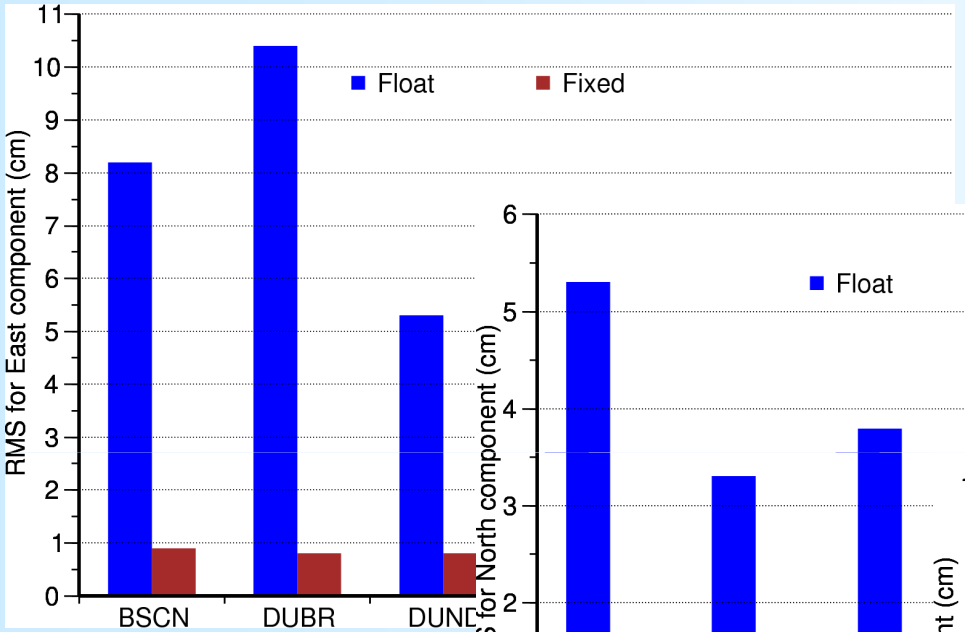
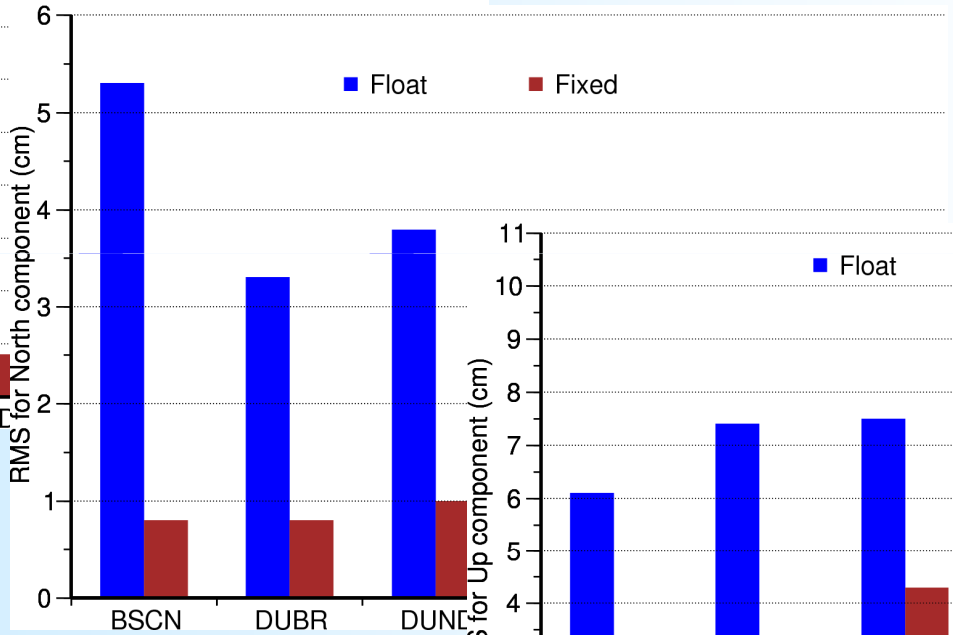
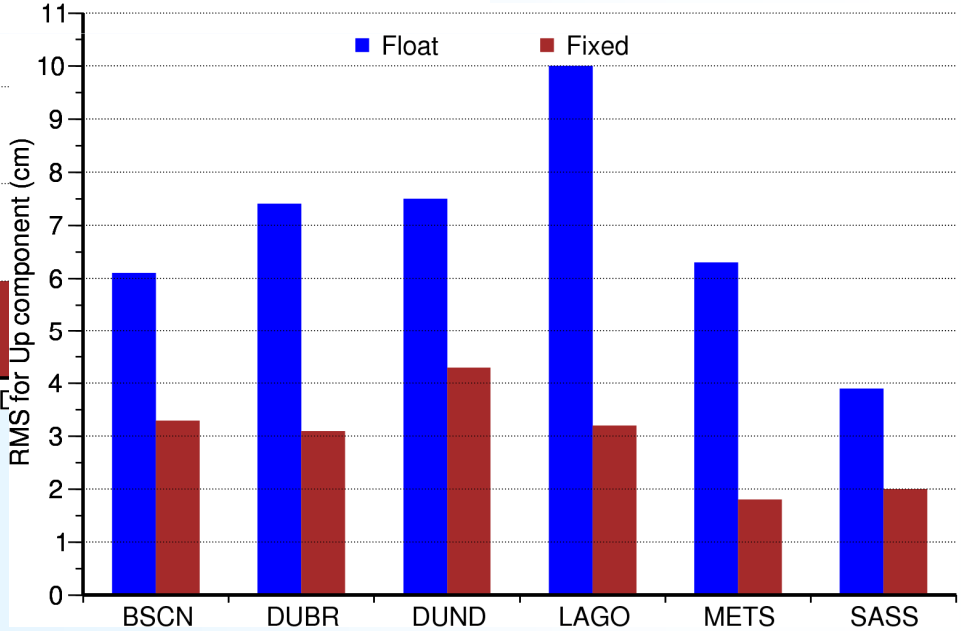
Kinematic positioning at station BSCN



Positioning accuracy improvement







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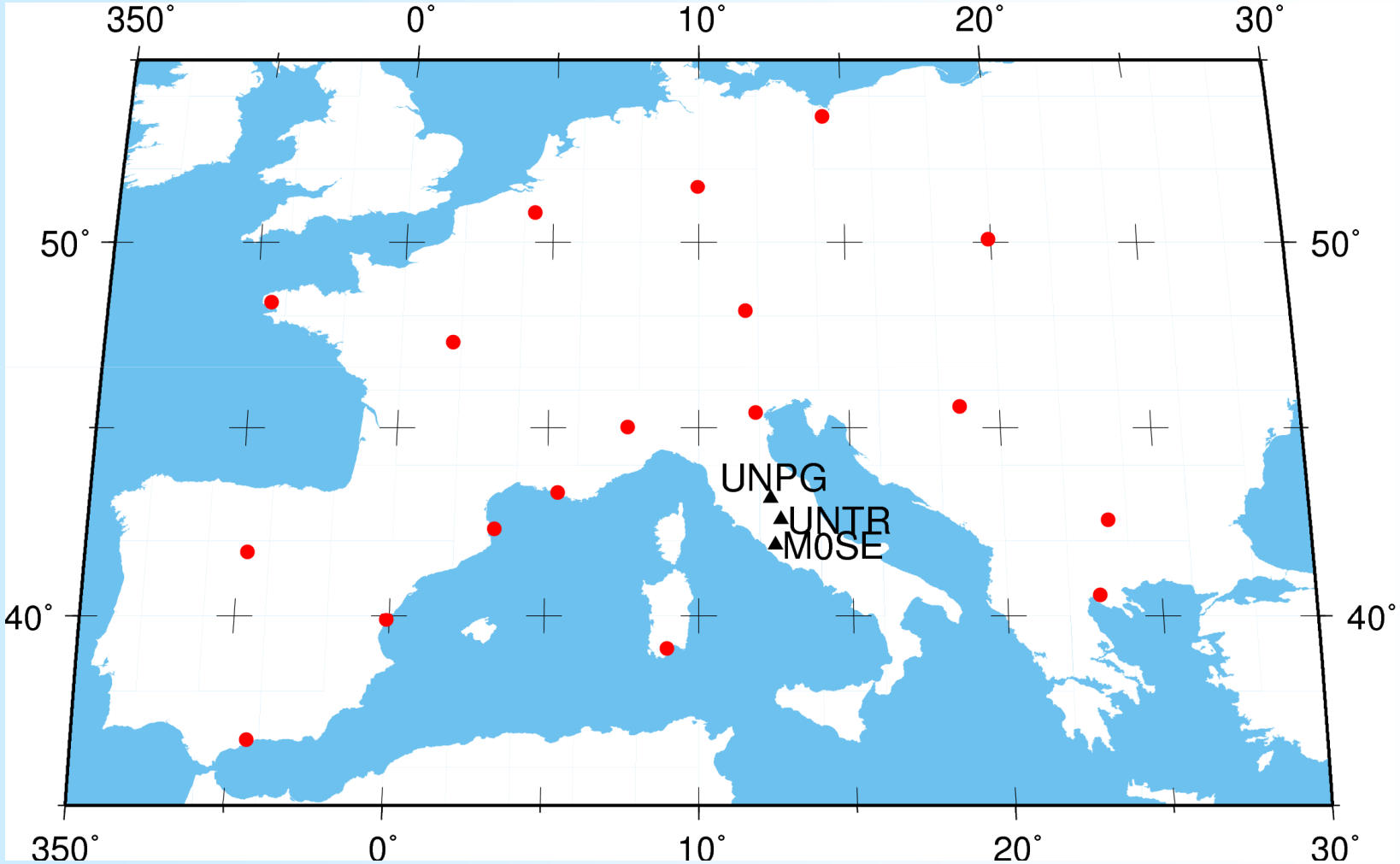
L'Aquila Earthquake on April 6th

Earthquake details (from USGS)	
Magnitude	6.3
Date-time	Monday, April 06, 2009 at 01:32:39 UTC
Location	42.334°N, 13.334°E
Depth	8.8 km (5.5 miles)
Region	Central Italy
Distances	75 km (45 miles) W of Pescara, Italy 85 km (55 miles) NE of Rome, Italy 115 km (75 miles) SE of Perugia, Italy 145 km (90 miles) S of Ancona, Italy

Data & models

- 18 1-Hz stations from EUREF-IP project
- 3 1-Hz stations near the epicenter
- IGU predicted satellite orbits
- Zenith troposphere delays are estimated as a constant parameter within each hour

Network stations



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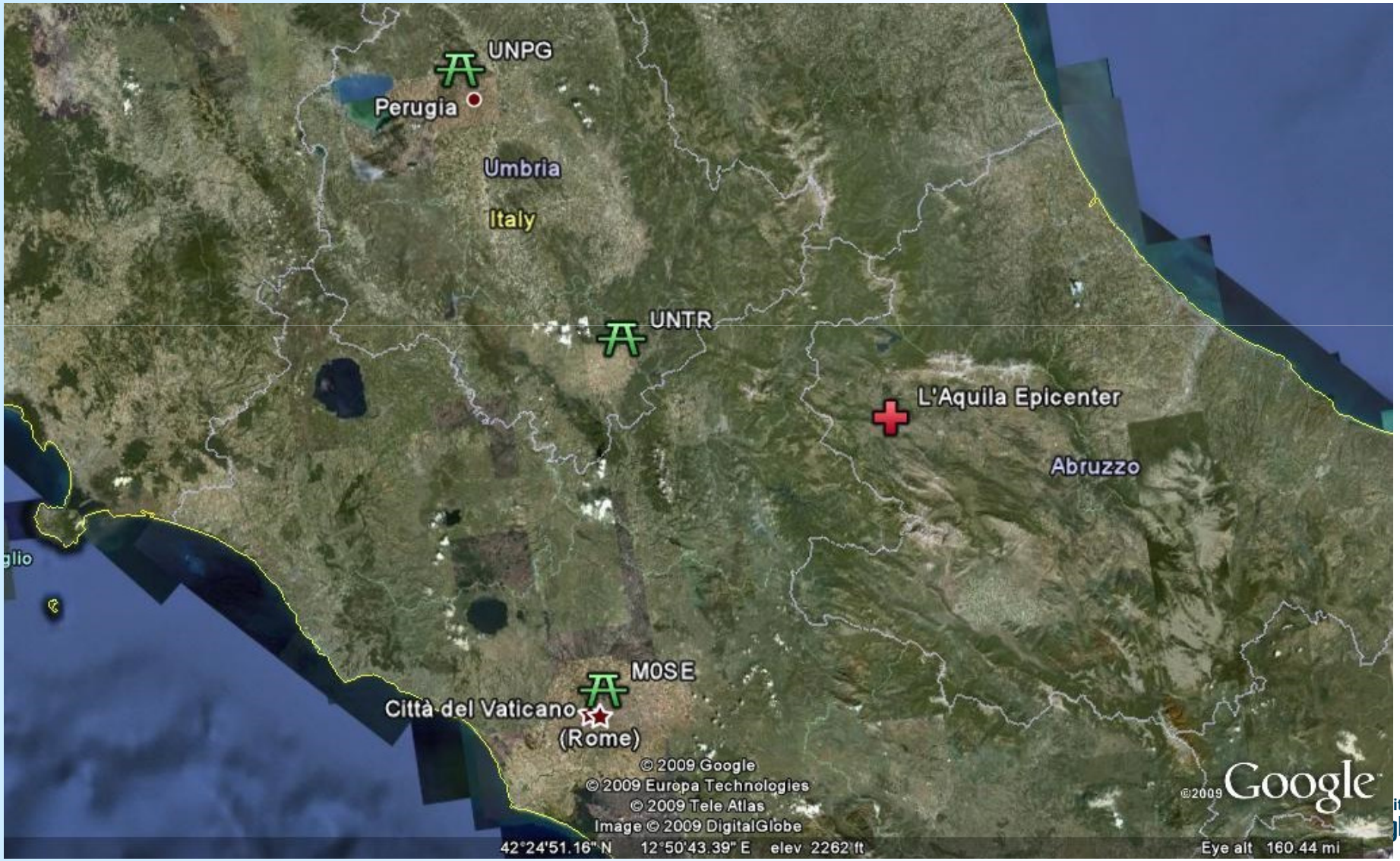
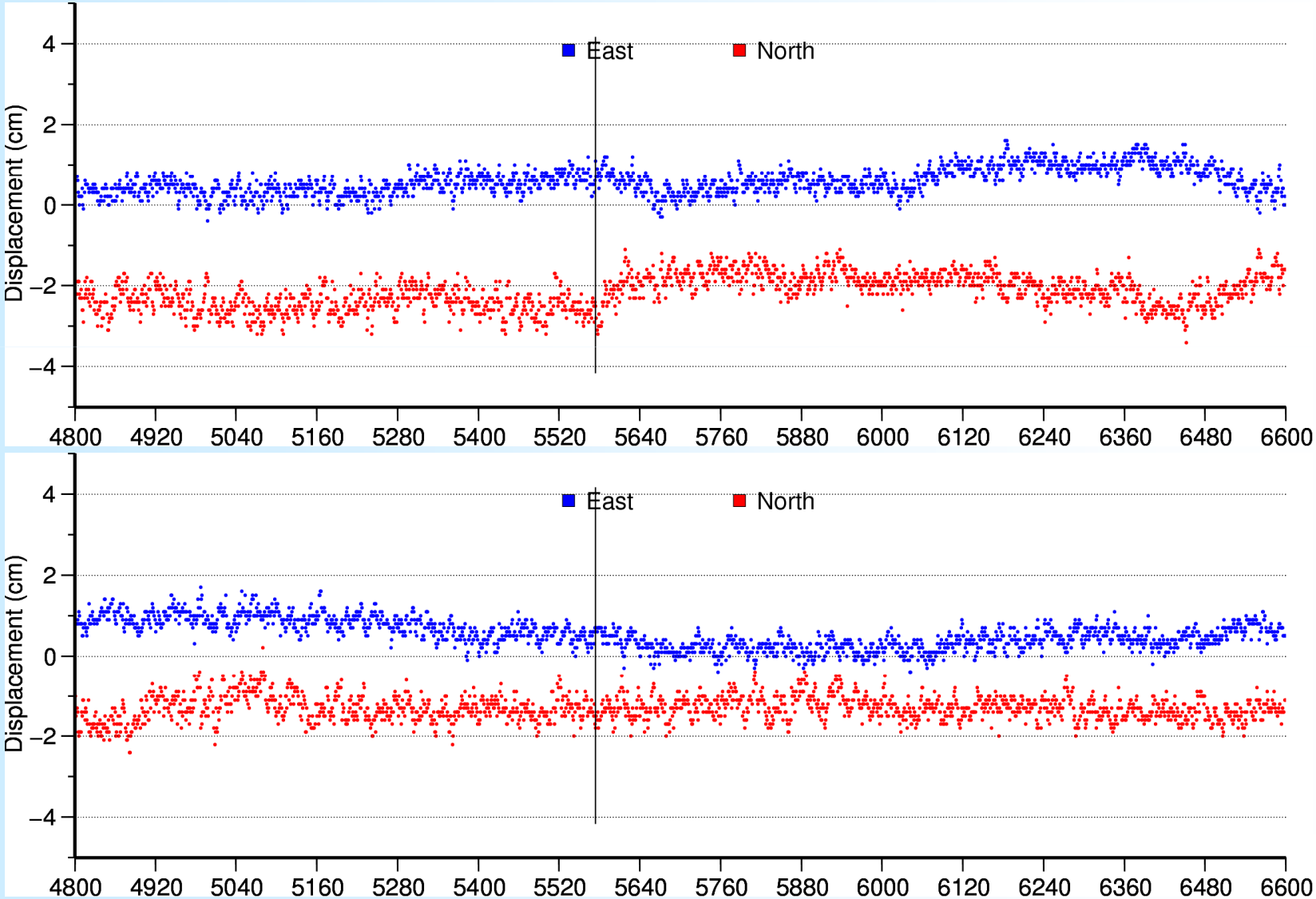
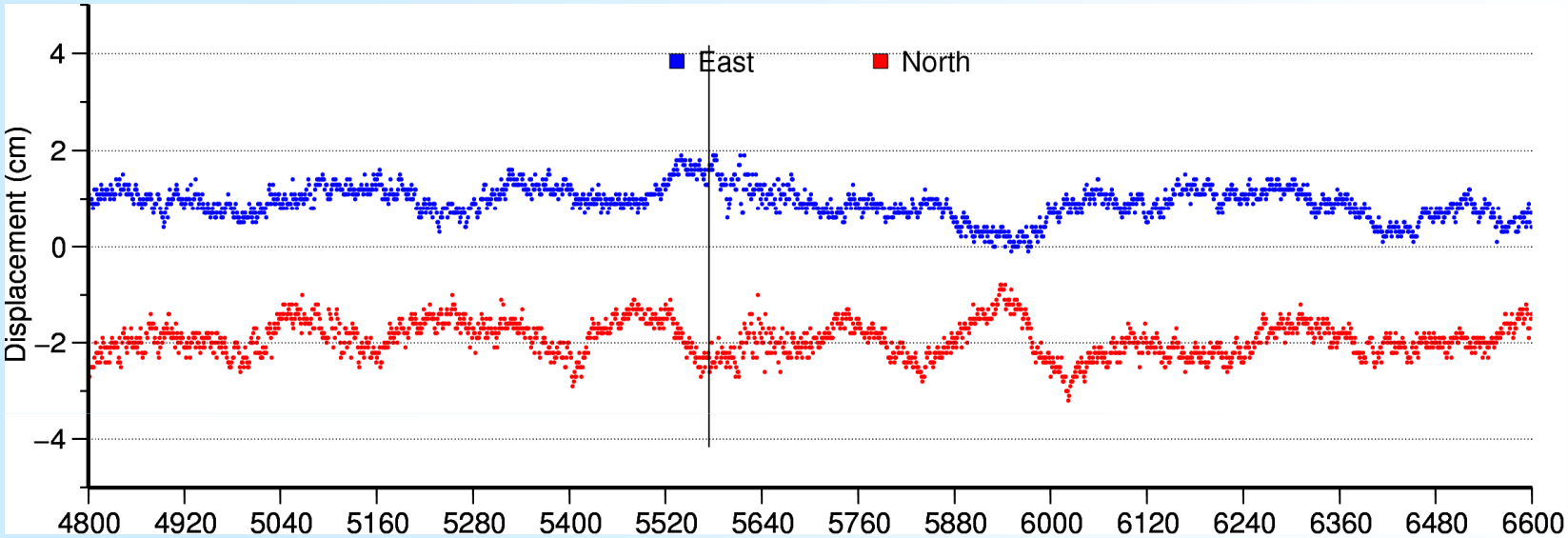
Location of 1 Hz stations



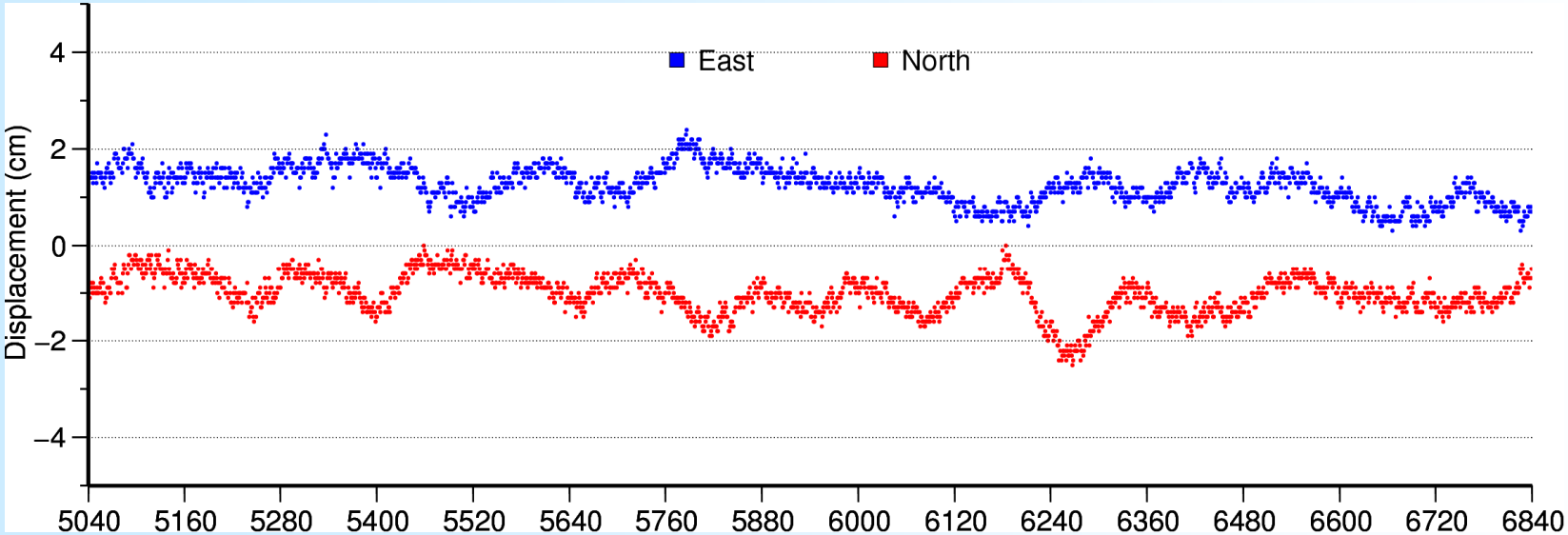
Station displacement at UNPG & UNTR



Station displacement at MOSE



Day 096



Day 095

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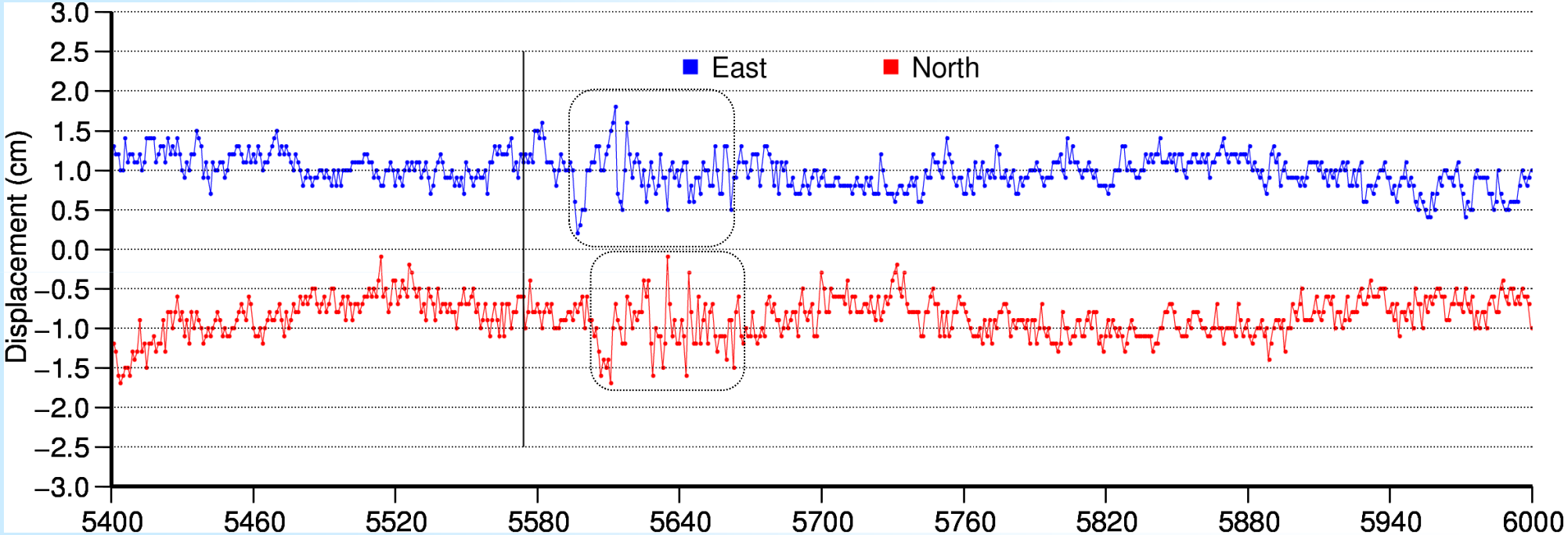
Displacement during the Earthquake



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Conclusions

- Integer ambiguity resolution contributes significantly to the improvement of the positioning accuracy in real-time PPP
- A prototype real-time PPP system for crustal deformation can be built
- Real-time PPP with ambiguity resolution has successfully determined the displacement caused by Earthquake in L'Aquila

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Thank you for your attention!

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