

Innovative Solutions from Leica Geosystems: VADASE

Presented at the FIG Working Week 2016,
May 2-6, 2016 in Christchurch, New Zealand

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CHRISTCHURCH, NEW ZEALAND 2-6 MAY 2016

Recovery

from disaster

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Innovative Solutions : Leica VADASE

Autonomous GNSS monitoring solution for fast movements
on-board a stand-alone GNSS receiver



Motivation & Background

Using GPS for Seismology ...

- Historically mainly to study long-term deformation, daily solutions (plate tectonics, crustal deformation, post-glacial rebound, subsidence)
- More recently research using kinematic post-processed using
 - Instantaneous differential positioning
 - Precise Point Positioning
 - Both methods not fully autonomous and not routinely available in real time

Aim to determine seismic displacements in real-time ...

- 1 cm accuracy / Global reference frame / within minutes after Event



Motivation & Background

University of Rome “Sapienza” - Geodesy and Geomatics division :

- Realised growing importance of GNSS in seismic application
- From 2009 started to exploit use of uncorrected GNSS measurements as simple & flexible real-time solution
- Goal:
Real-time site displacement from a single stand-alone GNSS receiver

- Idea: **VADASE**

Variometric Approach for Displacements Analysis Stand-Alone Engine



Motivation & Background

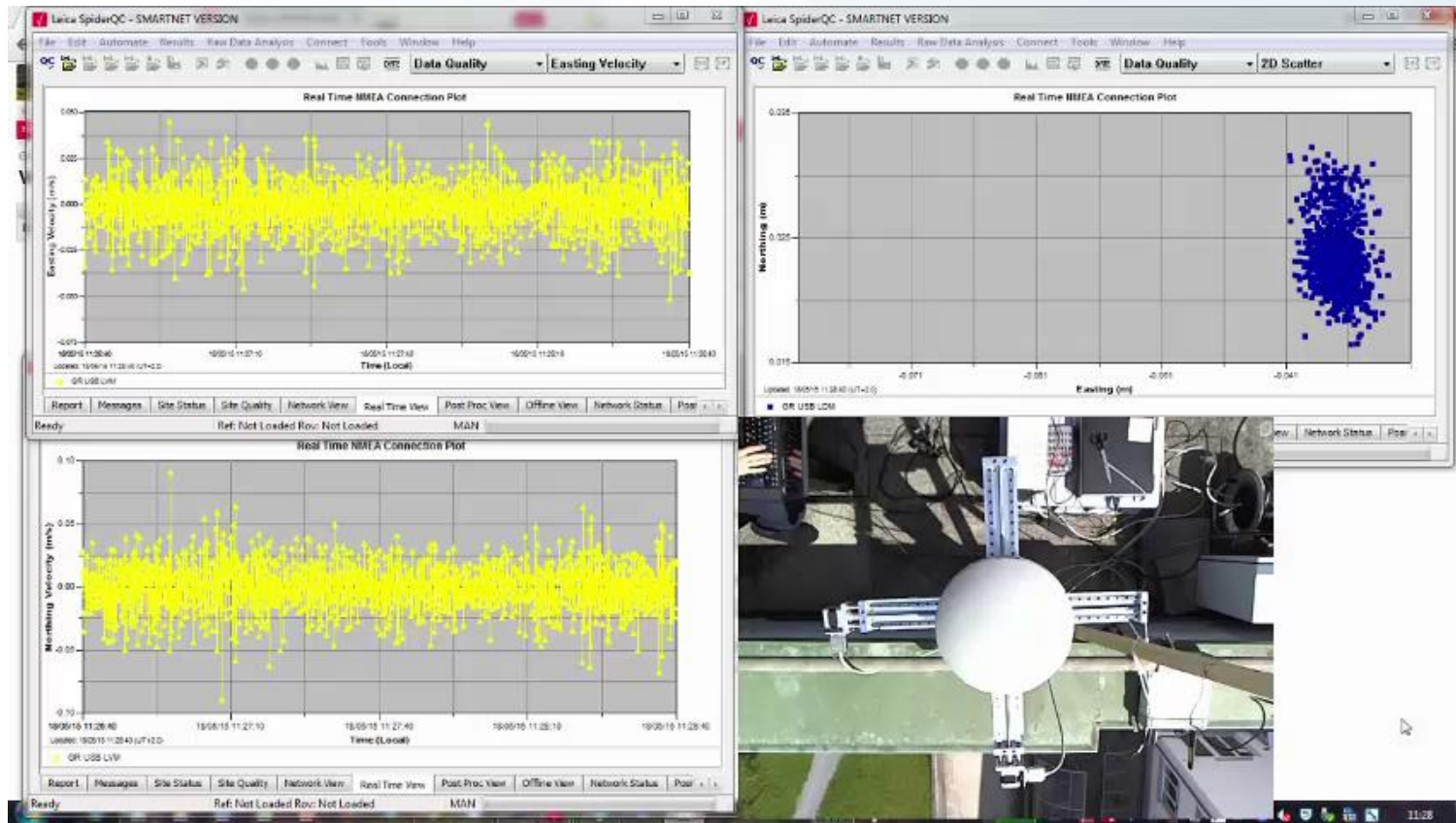
Technology applied:

- Velocity Estimation
 - Epoch-by-Epoch LSQ estimation of site velocity using high-rate (i.e. 1 Hz or more) carrier phases observations and broadcast orbits
- Waveform or Displacement determination
 - Integration of estimated velocities lead to high-rate site motion waveform and displacement information

→ No correction signal needed!



Application Examples: Leica Test Platform





Application Examples: Japan 2011 Earthquake

Studies performed by University of Rome - Earthquakes:

- Comparison of VADASE approach performed by post-processed data from various seismic events
- Example from Tohoku-oki earthquake / Mw 9.0, 11.03.2011 / 1 Hz data

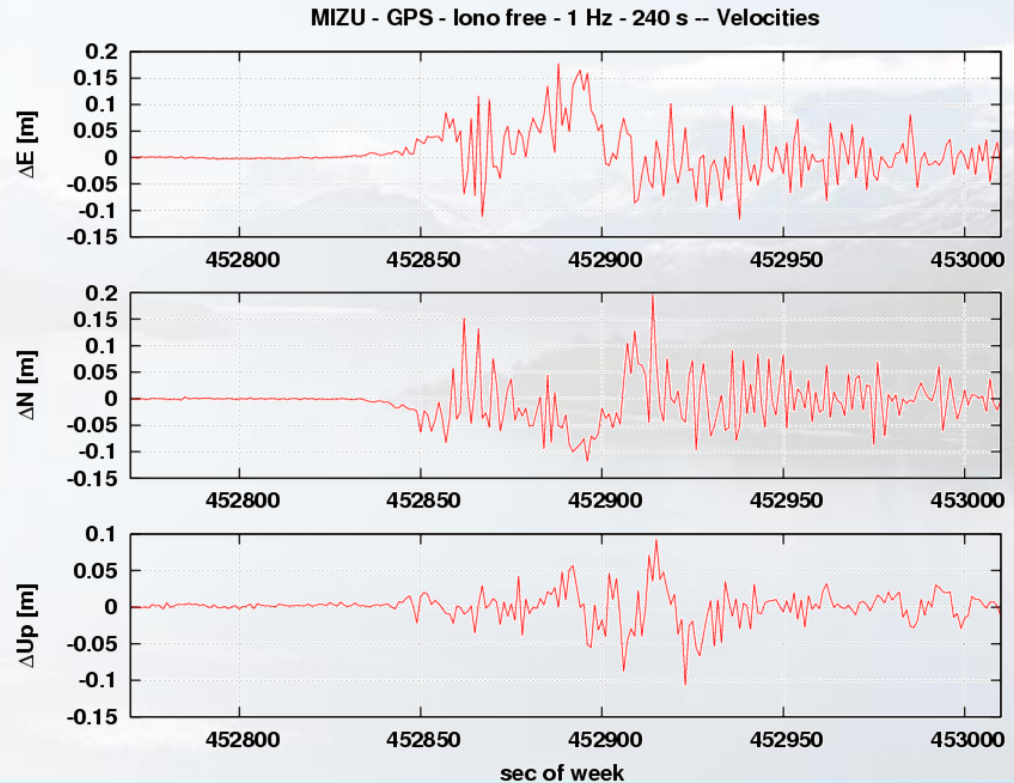




Application Examples: Japan 2011 Earthquake

Tohoku-oki earthquake / Mw 9.0, 11.03.2011

- Estimated velocities
- IGS Site “MIZU”
- 140 km from epicenter



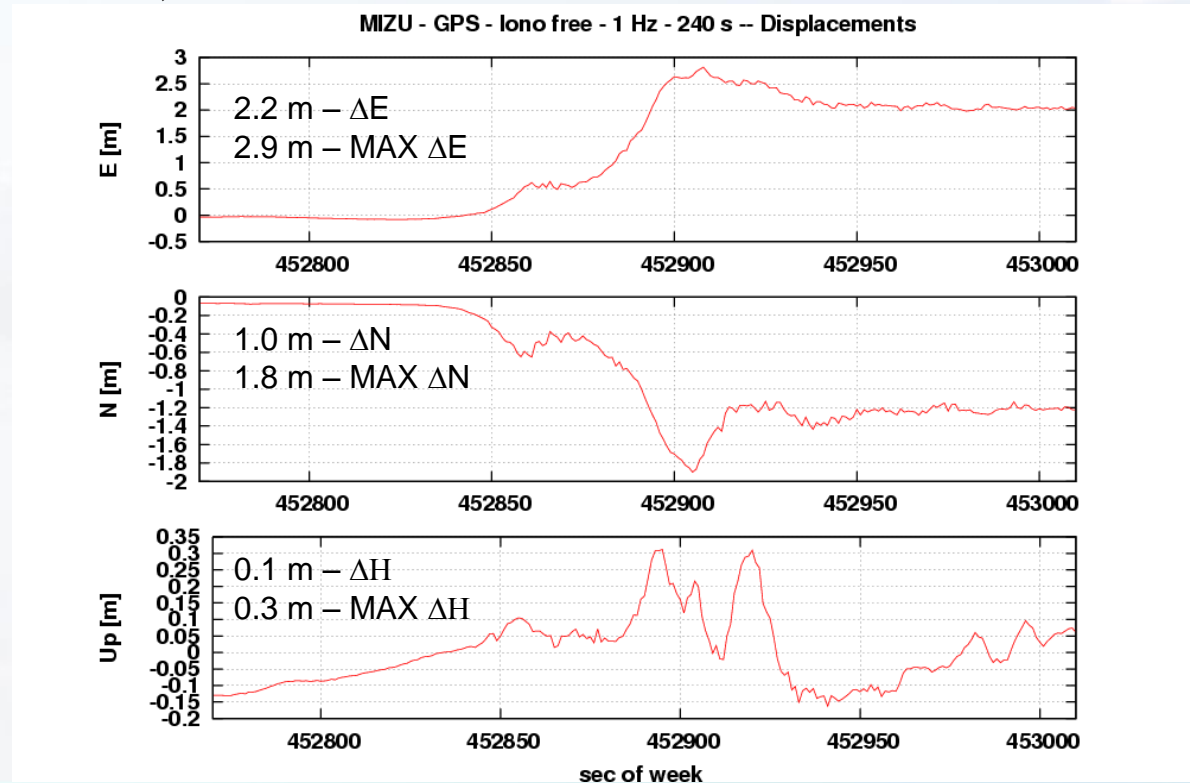


Application Examples: Japan 2011 Earthquake

Tohoku-oki earthquake / Mw 9.0, 11.03.2011

- Integrated velocities
→ Displacement

3.4 m Total horizontal displacement





Application Examples: Japan 2011 Earthquake

Tohoku-oki earthquake / Mw 9.0, 11.03.2011

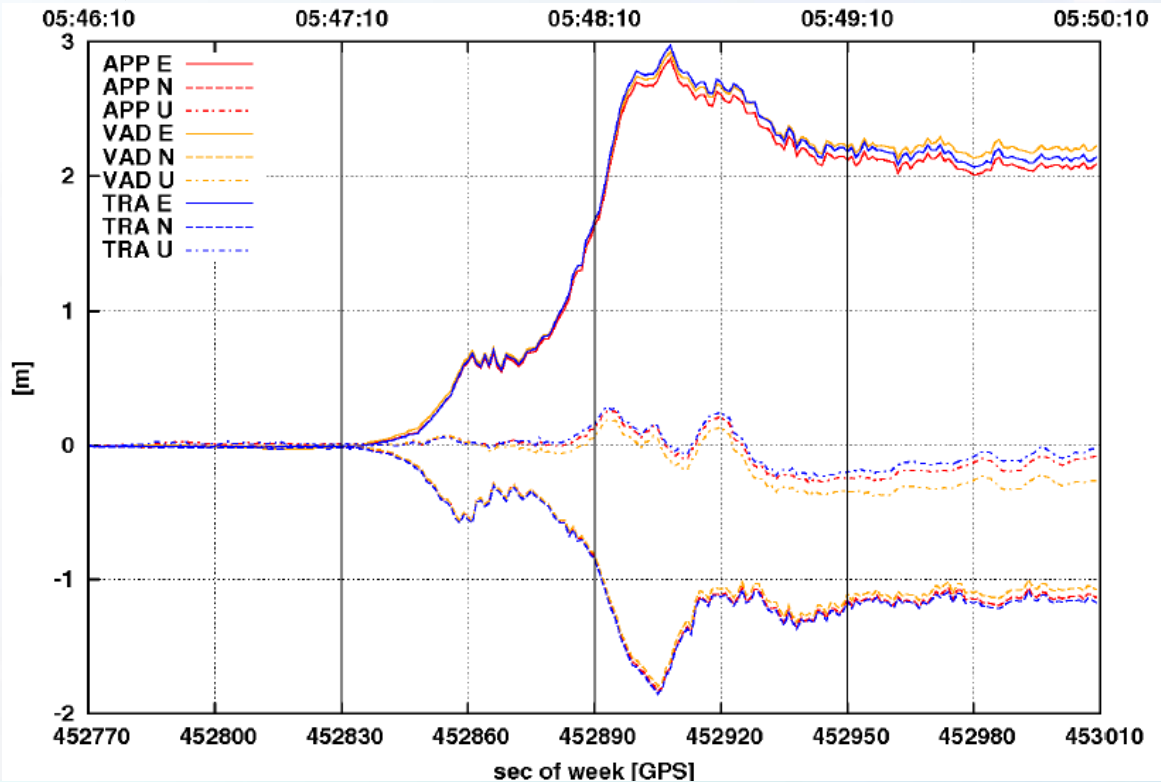
- Comparison with :

TRACK = Diff. Pos.

APP = PPP solution

Correlation coeff. higher than 0.90

RMSE within 5 cm (plane)





Use Cases

Innovative real-time motion detection for various applications

- Seismology
 - co-seismic displacements and waveforms retrieval
- Early warning systems
 - Natural or man-made hazards (volcanic, earth quake / tsunami, fracking, ...)
 - Safety monitoring for infrastructure elements (railways, highways, etc.) close to potential hazard (landslides, etc.).
- Monitoring
 - Structural and geotechnical engineering monitoring (buildings, skyscrapers, dams, oil platforms etc.);
 - Oscillations monitoring for different type of structures
 - Permanent GNSS network reference station “accident” monitoring...



VADASE : An innovative solution

Benefits: Simple - Efficient – Reliable - Robust

- Fast, relative displacements at high data rates
- Over short intervals of a few minutes, with high accuracy of ~2-4 cm
- Fully autonomous - Stand alone receiver – No correction signal needed

Conclusion

- Complement to other GNSS solutions for real time displacement detection, when continuous correction stream cannot be guaranteed
- Addresses potential new customer & applications in research and academia
- Opens potentially new applications in GNSS structural monitoring
- Provides alternate autonomous monitoring for reference stations