First Zenith Total Delay and Integrated Water Vapour Estimates from the Near Real-Time GNSS Data Processing Systems at the University of Luxembourg

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Abstract
Since June 2011, the University of Luxembourg has started in collaboration with the University of Nottingham a PhD project entitled “The Potential of Precipitable Water Vapour Measurements using Global Navigation Satellite Systems (GNSS)”, which is funded by the Fonds National de la Recherche (FNR) Luxembourg. The research objectives of the project are to study the potential for improvements in short-term weather forecasts and long-term climate variability for Luxembourg and the Greater Region by inclusion of the observations from Global Navigation Satellite Systems (GNSS) in the existing techniques. To achieve the research objectives, systems are being set up at the University of Luxembourg which process ground-based GNSS data for the provision of zenith total delay (ZTD) and integrated water vapour (IWV) estimates in real-time, near real-time and post-processing modes. Through collaboration with the Administration du cadastre et de la topographie (Luxembourg) and the service public de Wallonie (Belgium), the coverage of the available GNSS permanent networks is improved over the primary project area, although also data from other European and global networks are processed. The meteorological analysis of the PWLUX products is supported through collaborations with the Meteorological Service of the University of Nottingham and the EUMETNET project E-GVAP.

In this study, we present the first ZTD and IWV estimates obtained from the near real-time processing systems in development at the University of Luxembourg. In a preliminary evaluation we compared their performance to some state-of-the-art systems already in operation and found that ZTD estimates agree up to a few millimeters and IWV estimates agree at the sub-millimeter level.

The Project

Research Objectives

• To study the impact of GNSS data on meteorological short-term forecasting.
• To improve forecasts for aviation and general public.
• To provide availability of ZTD and IWV estimates for remote sensing applications.
• To improve understanding of local and regional climate and its variability.

Expected Outcomes

• Zenith Total Delay (ZTD) estimates for extreme weather periods
• 2D climatological maps of ZTD and IWV
• Climate Monitoring
• Long-term trends/time series of ZTD and IWV
• GNSS technology development

Technical Developments (at University of Nottingham)

• A post processing system for IWV estimation
• A near real-time (NRT) processing system for IWV estimation
• A real time (RT) processing system for IWV estimation

The Near-Real-Time Processing Systems

System Type: Hourly NRT Sub-hourly NRT
Update Cycle 1 Hour 15 minutes
Processing Engine Bernese GPS Software 5.0 Bernese GPS Software 5.0
Development Language(s) Perl, Python Perl, Python
Input Raw Data RINEX 2.11 Real-time stream
Input Products TIDEX, Rapid Lastools, Rapid
Antenna Calibration Absolute Absolute
Input Meteorological Data Hourly data file from UK MetOffice Sub-hourly data file from UK MetOffice
Outputs ZTD estimates IWV estimates

Table 1 Features of the NRT processing systems at the University of Luxembourg

Table 2 List of GNSS data providers

Network Region
SPSLUX Luxembourg
WALCORS Wallonië (Belgium)
RGP (Belgium) France
OSGB+Geonet UK
CPG (UK) Europe
IGSO (Global)

Table 3 RMS values of the difference between ZTD and IWV estimates obtained from ULUX and IES2 for the period of 22-23 February 2012

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Table 5 List of GNSS data providers

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Table 6 List of GNSS data providers

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Table 7 List of GNSS data providers

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Table 8 List of GNSS data providers

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Table 9 List of GNSS data providers

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Table 10 List of GNSS data providers

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