Detection of blobs of water vapour and potential GNSS application for nowcasting

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Motivation

The objective of this work is to show the interest of GNSS for weather forecasts, especially for nowcasting. We focus on GPS observations (post-processing and sub-hourly solutions) with a time resolution of 15 to 5 minutes.

## Monitoring of the humidity field by GNSS observations

Improvement of IWV 2D field by GNSS gradients

without   with gradients

Radar precipitation

Depression so-called "Yvette" coming from Germany
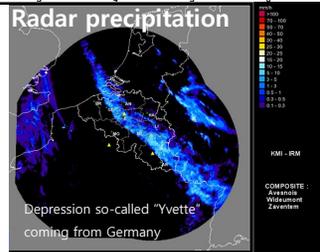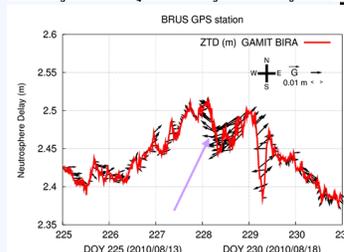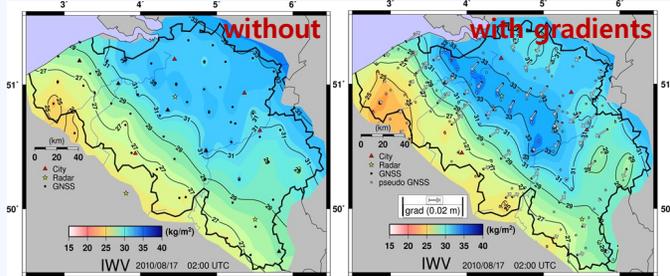
Using combined IWV$_{GNSS}$ and gradients, the monitoring of the humidity field. The meteorological situation and the location of water vapour blobs observed by GNSS show a good agreement with radar precipitation.

Local water vapour anisotropy monitoring by GNSS slant obs.

quiet condition   severe condition
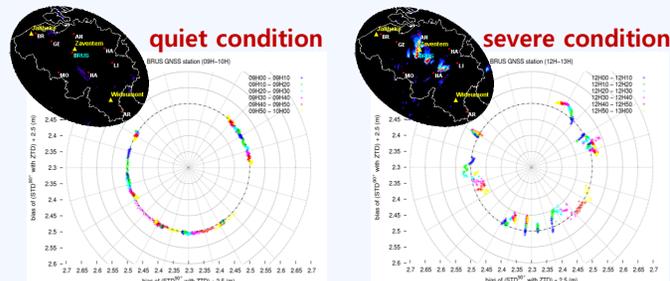
Using slant delay in direction of GNSS satellites, forecasters can monitor in near real-time the local anisotry induced by water vapour around a station.

Use of new products for nowcasting

NRT indicator of deep convection based on dry/wet contrast

ERPE

a) reference processing   c) fast processing

no alert   GNSS alert   12H35 utc
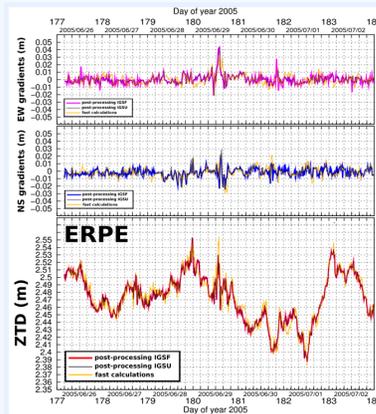
POST-PROCESSING vs SUB-HOURLY OBS.

Good agreement between post-processig and sub-hourly obs. of ZTD and gradients, with respectively bias (±std) of 2 (±8) mm and 1 (±4) mm.
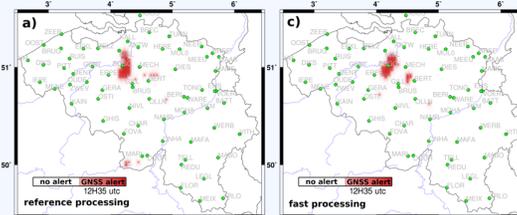
A meticulous observation of ZTD and gradients time-series have shown that a typical configuration (dry/wet contrast) can be observed before initiation of deep convection.

Using improvement of humidity field by gradients, we have established gridded map of GNSS alert with a high resolution (3 km X 3.5 km).

The conditions to obtain **GNSS alert of deep convection** at the time T are:

ZTD decrease of 0.008 m from T-30 min to T-15 min

ZTD increase of 0.015 m from T-15 min to T

For the rainfall event of 28-29 June 2005, the successful rates of our alert are 76.4% (post-processing) and 66.5% (sub-hourly solutions); (Brenot et al. 2013, ACP).

NRT indicator of tropospheric activity based on Ionosphere-Free Double Difference (IF-DD)

The disturbance of the GNSS signal induced by the troposphere can be isolated in the IF-DD time series and generate activity index.

IF-DD time series

Daily IF-DD index

For each station of a dense network (30 km x 30 km), the baselines between neighbouring stations have been considered to assess IF-DD indexes. These indexes can be used to monitor the tropospheric activity.

Image of IF-DD index

$T_{AB}^{ij}(t=t_0)$ $T_{AB}^{ij}(t=t_0+\Delta t)$

small-scale structure   troposphere

station B   station A

IF DDindex 2005/06/29/12H20min
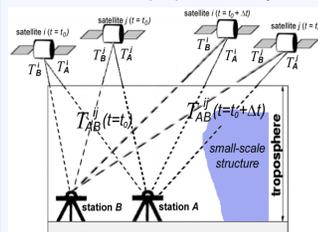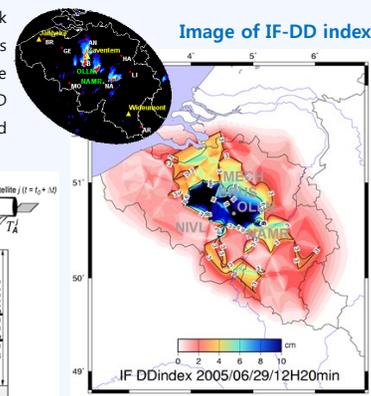
Potential use of GNSS tropospheric tomography

Using a priori from ALARO model, the potential use of GNSS tropospheric tomography has been studied (storm, 18 October 2011). Strong rainfalls induced a flood event in Brussels at 12PM. Three hours after, the storm threated the Belgium's Pukkelpop music festival and killed five after stage collapses.

Brussels   Pukkelpop