Portuguese Activities related with ES1206 GNSS4SWEC

overview of the GNSS-meteorology status in Portugal
GNSS - Meteorology status

**Areas of Research:**

a) GPS data processing for tropospheric products using GIPSY-OASIS; Improvement on the solutions via testing different parameterizations;

b) Improvement of a software for water vapor tropospheric tomography;

c) Analysis of the influence of a-priori values on the derived ZTD solutions;

d) Correlation between (ocean and atmospheric) loading and PWV.
Ongoing Projects
NUVEM
New methods to Use GNSS Vapor Estimates for Meteorology of Portugal

NUVEM (EXPL/GEO-MET/0413/2013) is funded by the Portuguese National Science Foundation (FCT);

Started in March 2014 - September 2015.
Nuvem Project

Objective: Include GNSS-PWV estimates in Portugal’s Weather Forecasting Centre, especially in the decision process for warning of extreme weather situations.

To achieve such objective, NUVEM is divided in two major components:

a) development and implementation of methods to compute accurate estimates of ZTD (Zenith Total Delay) and derived PWV (Precipitable Water Vapor) in near real time.

b) integration of these estimations in the nowcasting operations done at IPMA (Portuguese Meteorological Service).

Portugal:
- RENEP [http://www.dgterritorio.pt/cartografia_e_geodesia/geodesia/redes_geodesica/renep/]
- SERVIR [http://www.igeoe.pt/servir/servir.asp]

and neighboring networks in Spain:
- IGN [http://www.fomento.es]
- Galicia [http://www.cartogalicia.com/]
- Castilla and Leon [http://gnss.itacyl.es]
- Andalucia [http://www.juntadeandalucia.es/obraspublicasytransportes/redandaluzadeposicionamiento/rap/]

NUVEM Project

The flowchart of the processing system

- Ultra Rapid Orbits
- Station 1
- Station N
- SEGAL GPS Processing (GIPSY-OASIS)
- ZTD
- 24h slide window
- < 5min
- <=30s per station
- SEGAL PWV (Hourly Solution)
- IPMA
- T&P

6 Hours

Hourly
Get each hour new data from all GNSS stations in list and try to get missing data at earlier hours

Log of missing data

List of GNSS stations

GIPSY/OASIS analyses each hour all available data for the last 30 hours.

Script to convert 5 minute ZTD of last hour into PWV values which are send directly to IPMA.

IPMA puts T & P (ECMWF/AROME) on SEGAL server every 3 hours which are interpolated.

Cron job +0min

Cron job +0min

Cron job +16min

Cron job +14min

Cron job 2min cycle
Heavy rain – 26 November 2014, Lisbon

Precipitation began around 12 pm, the GNSS-PWV began to detect few hours before, that had not been predicted by the models used by IPMA.
Nuvem project
Nuvem project

Heavy Rain – 26 November 2014, Lisbon
Nuvem project

Weather front – 03/11/2014
Statistics of received data from 25-27 September 2015 (72 hours)

<table>
<thead>
<tr>
<th>Network</th>
<th>Nr. Stations</th>
<th>Delay (min)</th>
<th>Missing (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extremadura</td>
<td>11</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>IGN</td>
<td>20</td>
<td>0-11</td>
<td>3.5</td>
</tr>
<tr>
<td>SERVIR</td>
<td>28</td>
<td>0-2</td>
<td>13.2</td>
</tr>
<tr>
<td>RENEP</td>
<td>45</td>
<td>0</td>
<td>2.2</td>
</tr>
</tbody>
</table>
Obtained Results

- Setup of a dedicated SERVER
- Data retrieval from GNSS Networks
- Orbits retrieval
- PWV computation
- Delivery to IPMA

- Increase of relevant information for weather predictions
- Improvement of the weather nowcasting in Portugal

Automated
is operational!

Please Visit: http://nuvem.di.ubi.pt
Periodic Loading effects in tropospheric delays

1) The Earth's surface deforms due to the weight of the ocean tides (OTL).

2) If this loading effect is not taken into account during the GPS processing, ZTD errors of up to 10 mm can occur.

3) However, OTL corrections are not perfect, especially at coastal sites where OTL is several cm and mismatches between predicted and actual OTL can reach the cm level.

4) Using the latest ocean tide models and an improved elastic model of the Earth, better OTL and therefore better ZTD estimates will be produced for selected coastal sites.

Difference in vertical ocean tide loading (computed using tide model FES2004, harmonic M2) using the standard PREM and modified PREM elastic Earth model. The blue dots represent GNSS stations that will be analysed in this project (Bos et al., 2015).

In the figure the differences in OTL values reach 5 mm. However, this is only for 1 tidal period although the largest one (period M2 = 12.45 hours). The same happens at other tidal frequencies and if you add them all up together you reach the centimeter level mentioned in the bullet points.
ALEX project is a campaign of hydro-meteorological observations over the Alqueva lake, one of the largest dams and artificial lakes in Europe. It includes observations of the water column, atmospheric column, and water-air interface. It was also installed 15-station GNSS network to study the diurnal cycle of water evaporation.

more info:  
http://www.alex2014.cge.uevora.pt/
the end...