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GPS data coming from regional ground-based GPS networks are routinely analyzed for Near Real Time applications all based on IGS Ultra Rapid Products. During the last years, two NRT data streams have been set-up in Europe under **E-GVAP and EUREF** umbrella. E-GVAP is set up to provide European GPS delay and water vapour measurements for operational meteorology working in close collaboration with the European geodetic community. In the EUREF Analysis Workshop held in Padua 2006, it was discussed about a NRT processing useful for a quick monitoring of the EPN station coordinates. In this European scenario ASI is an E-GVAP and EUREF NRT Analysis Center delivering regional GPS products based on IGS Ultra Rapid orbits which are updated four times daily. The accuracy of NRT tropospheric estimates ranges from 5mm to 15mm (standard deviation) if they are compared to radiosonde observations and it is of the order of 1-2 cm (3DRMS) if NRT coordinates are compared to EUREF rapid ones. But, could the accuracy of such regional NRT products be improved if IGS delivers Ultra Rapid orbits more frequently for example eight times daily? To get an answer, we investigate if NRT estimates accuracy is a function of the hour of the day and how it degrades at the late boundary of the time span of the considered IGU products (if a degradation is detected).

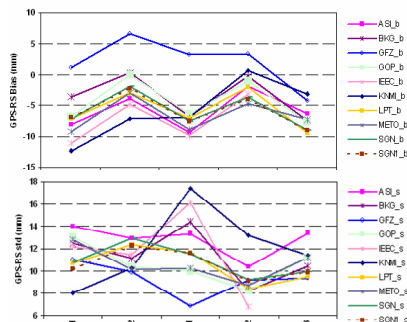
## NEAR REAL TIME ZTD MONITORING



ASI ground-based NRT ZTD network

ASI delivers GPS ZTD estimates of ~70 sites to E-GVAP data center on hourly basis.

On daily basis a European network of ~120 sites is analyzed in post-processing (PP) in Precise Point Positioning fixing JPL fiducial-free products with GIPSY-OASIS II 4.04. The main goal of the PP solutions is to provide both ZTD estimates for climate applications and station coordinates, which will be fixed, in the NRT data processing when enough accuracy (height coordinates repeatability < 9mm) is reached.



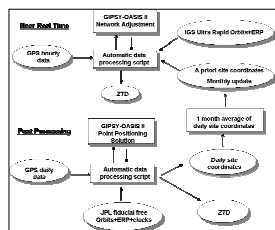
Example of monthly ZTD bias and std of the residuals between different GPS ZTD time series coming from E-GVAP analysis centers and radiosonde observations for Cagliari (Italy, Sardinia Island) is shown on the left.

It can be noticed that radiosondes are drier than GPS, for all the analysis centers except GFZ. GFZ is still applying relative PCV while all the others absolute ones.

This outcome is confirmed also by the other E-GVAP Sites.

For NRT ZTD estimates a standard technique of network adjustment is applied with the following characteristics

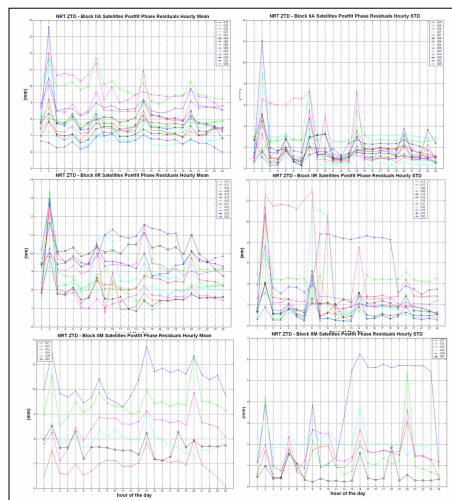
- data 24h sliding windows shifted by 1 hour, 5 min sampling rate, 10 deg cut-off
- IGU orbits fixed update 4-times daily
- site coordinates fixed to values provided by combining 1 month of daily PP solutions, updated every 30 days for taking into account the tectonic movements of the area
- ZTD products extracted from the last hour
- ocean loading FES2004
- absolute satellite & station PCV starting from May 2007



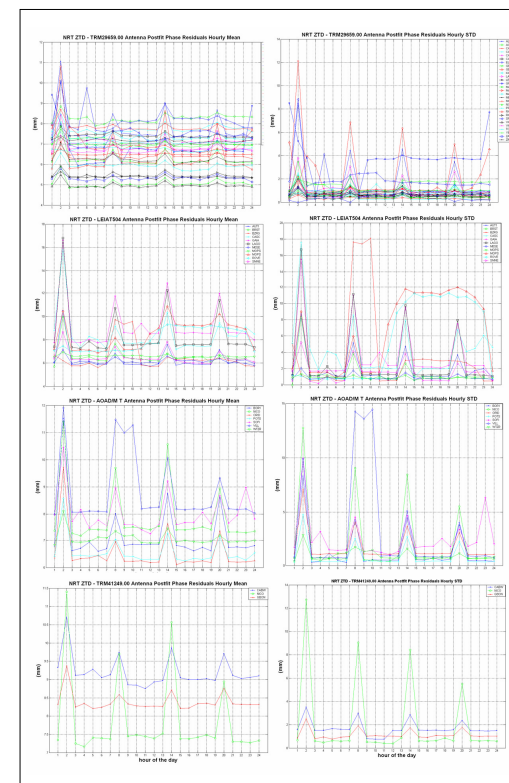
Analysis scheme for ZTD generation NRT and PP

The analysis of the hourly post-fit residuals can be used to investigate if there exists a dependency from the hour of the day in the estimated ZTD and if there is a degradation at the late boundary of the time span of the considered IGU products.

For this, we focus on 5 GPS weeks (1471-1475/08MAR16-08APR19). We consider, as shown below, both the satellites and the receivers and we calculate hourly post-fit residuals mean and std values w.r.t every hour of the day.



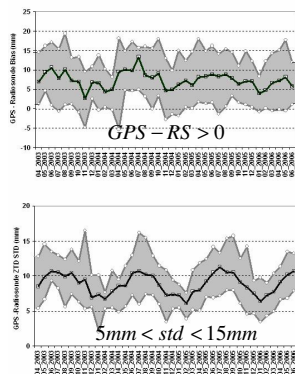
Receivers Post-fit Phase residuals.



NRT ZTD estimates have been validated against radiosonde observations.

Monthly variation in NRT ZTD bias (right/top) and std (right/bottom) of GPS versus radiosonde for 13 stations (black line) using ZTD estimates for the period April 2003-June 2006.

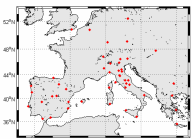
The gray area lies between the minimum and maximum values (Pacione and Vespe, JTECHA, Vol. 25, No. 5, pages 701-714).



For this comparison relative PCV were applied during data reduction.

In the case of ZTD estimates (with site coordinates fixed) the hourly post-fit phase residuals show an increase in the mean and std values just one hour before switching to the new IGU products that is at 02:00, 08:00, 14:00, 20:00 UTC. The increase in the std shows that the process gets less stable at these hours of the day.

## NEAR REAL TIME SITE COORDINATES MONITORING



ASI ground-based NRT site coordinates network

ASI delivers site coordinates estimates of ~40 sites to EUREF on hourly basis with the aim to establish a near-real time processing for a quick monitoring of the EPN stations.

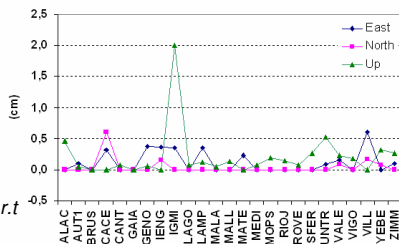
Site performance is monitored with a delay of less than 2 hours.

For NRT site coordinates a standard technique of network adjustment is applied

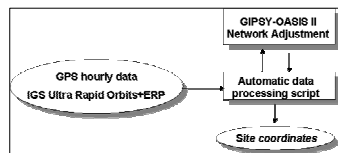
- data 24h sliding windows shifted by 1 hour, 5 min sampling rate, 10 deg cut-off
- IGU orbits fixed update 4-times daily
- ZTD and horizontal gradients estimated
- Ocean loading FES2004
- Absolute satellite & station PCV
- Reference frame IGS05

A free network solution is done, minimal inner constraints and an Helmert transformation are applied for the TRF definition.

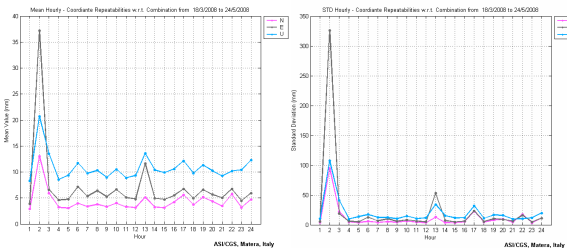
Hourly IGS05 sinex files are compared w.r.t EUREF rapid weekly solutions and site having residuals larger than  $\pm 2.5\text{cm}$  east/north and  $\pm 3.5\text{cm}$  up are detected and removed. If the site belongs to ASI network an alert is send to the station manager.



Example of hourly residuals w.r.t EUREF rapid solution



Analysis scheme for NRT Site coordinates



3 EUREF analysis centers ASI, BKG and LPT are delivering hourly sinex files which are then combined in order to get EUREF hourly solution. The contributing solutions have different characteristics and are obtained with Bernese (BKG and LPT) and GIPSY (ASI) SW.

EUREF hourly coordinates repeatability over 3-month period are taken into account to compute hourly mean and std values. The plots, reported below, show an instability at 02:00 UTC which is related to the considered period.

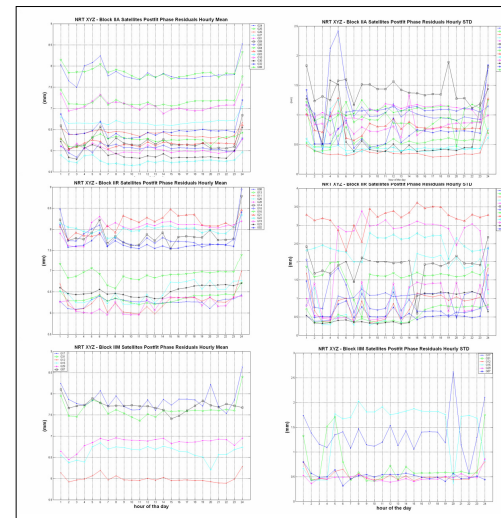
Also for the site coordinates the analysis of the hourly post-fit residuals can be used to investigate if there exists a dependency from the hour of the day and if there is a degradation at the late boundary of the time span of the considered IGU products.

5 GPS weeks (1471-1475/08MAR16-08APR19) are considered and mean and std values are computed w.r.t every hour of the day.

In the case of site coordinates NRT monitoring (when site coordinates and ZTD are estimated together) the hourly post-fit phase residuals don't show any instability related to the late boundary of the time span of the considered IGU products. While there seems to be an increase in the mean and std at midnight and in the first hours of the day.

Further investigation is required to confirm these outcomes considering different/longer time period and estimates coming from other ACs using different processing strategies.

## Satellite Post-fit Phase residuals



## Receivers Post-fit Phase residuals.

