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Capabilities and Potentialities of Implementation of GNSS Precise Point Positioning in Morocco

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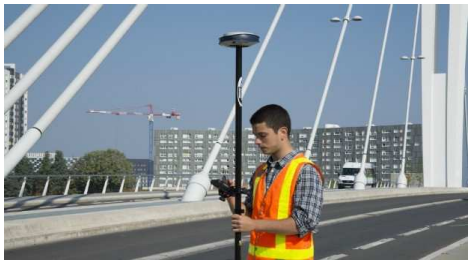
Outline

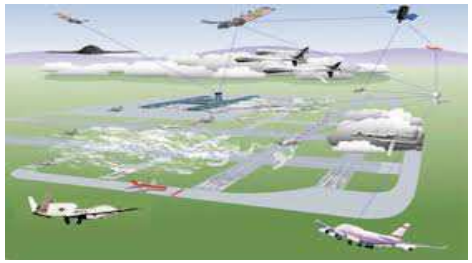
- Introduction
- Principal & Advantages of PPP
- Why is PPP promising for Morocco ?
- Examples of applications
- Summary

Introduction

- GNSS positioning accuracy is affected by various errors linked to either the satellite system, the receivers and the physical nature of the propagation environment.
- GNSS users have different positioning accuracy requirements.
- Applications have various operational constraints and performance demands.





Principal of PPP

- PPP is an approach able to provide position solutions at centimeter to decimeter level by combining the precise satellite positions and clocks with a dual-frequency GNSS receiver.
- If single-frequency receivers are used, the ionospheric correction must be provided.
- Measurement errors are mitigated using :
  - Advanced modeling techniques : signal combination for ionosphere effect
  - Models : troposphere effect
  - External precise GNSS products : satellite orbits and clock corrections, ionosphere for single frequency receiver users.

Advantages

- One receiver & No need for references

- Less labor, less equipment

- Positions calculated in global Datum ➔ homogeneity of determinations

- Growing applications : different accuracy requirements

PPP vs DGNSS

	PPP	DGNSS
Augmentation	Global	Local
Reference Station	Not required	Required Dependant Solution
Precise Orbit & Clock	Needed	Not required
Ionosphere information	Needed for Single frequency Apps	Cancelled out
Geophysical Models	Accounted for	Not considered
Labor Cost	Low	High
Equipment Cost	Low	High
Convergence Time	High	Low
Applications	Positioning & more	Positioning
Real Time Use	Limited	Widely used

Why is PPP promising?

❑ General context

- New & advanced algorithms
- Correction availability
- Wide range of applications
- Cost-effective solution
- Multi-constellation development

Why is PPP promising?

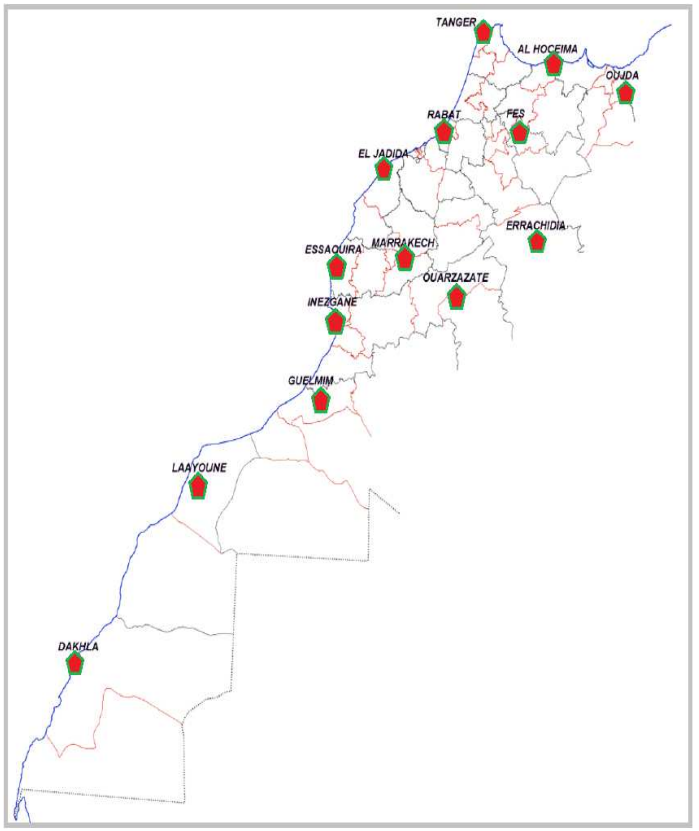
❑ National context

- In Morocco, the use of PPP techniques is highly required because of several reasons :
  - The National State of Geodetic Network Densification characterized by a big rate of destruction. This lead to a lack of references in many areas.
  - The huge market of single frequency equipments for applications requiring sub-meter (to centimeter) accuracy : Mapping, Agriculture, Forestry, Land Delimitation, Surveying.
- Many processing approaches are used depending on the application sector : Static or Kinematic Positioning in Post Processing or Real Time.
- In many applications in Morocco single frequency receivers are used.

Why is PPP promising?

Permanent Reference Stations

- Research & applications in Geodesy, Surveying and Mapping :
  - ANCFCC.
- Application and geodynamic research, monitoring tectonic plates African and Eurasian :
  - CNRST,
  - UNAVCO,
  - Universities.
- Meteorology, Water Vapor estimation :
  - Directorate of National Meteorology.



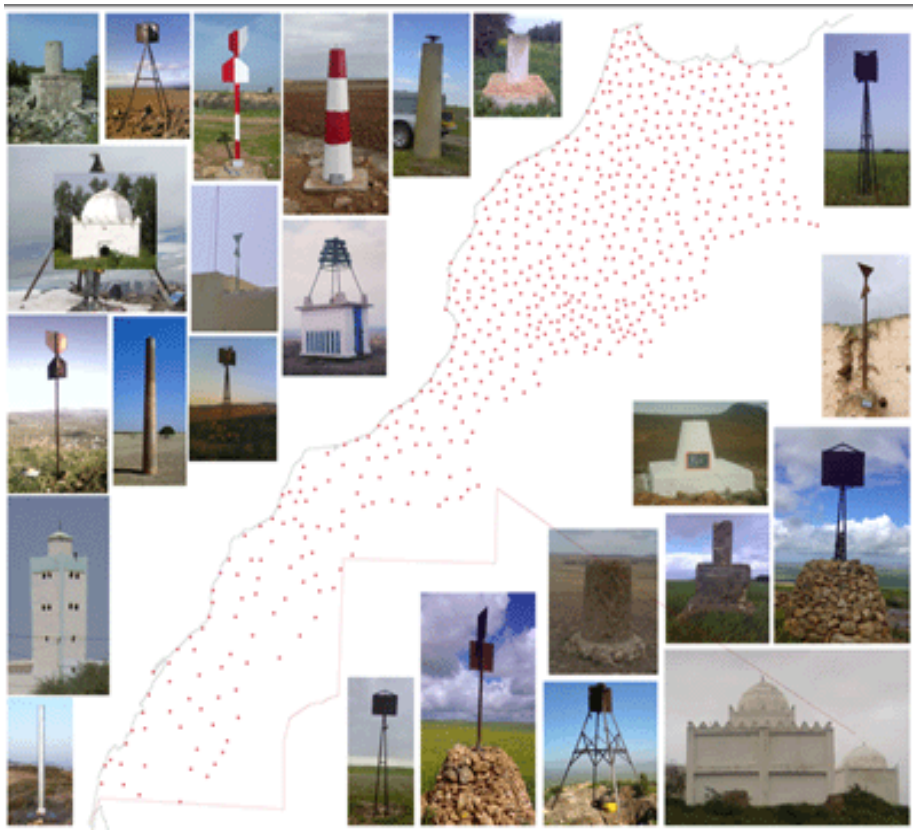
Example of applications

- Geodesy & surveying
- Water management & Dams monitoring
- Transportation
- Agriculture
- Land registration

Geodesy & Surveying

Problem

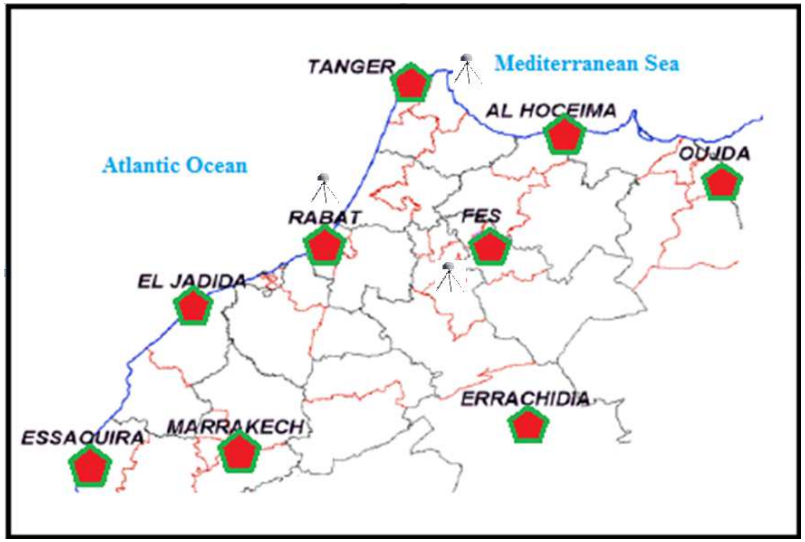
- Widespread phenomenon destruction of reference stations (60%)
- Existence of various local reference systems and not homogenous (difference reaching meter)
- Lack of baseline points in some regions with high economic potential
- Additional densification cost at the beginning of each infrastructure project.



Experimentation

- Experimentation configuration :
  - Use of precise satellite orbit and clock products (IGS).
  - The relativistic satellite clock correction.
  - The satellite phase wind-up correction.
  - The phase-center variations of satellite and receiver antennas.
  - Solid tides corrections and the differential code biases of the satellites.
  - The wet component of the tropospheric delay has been considered as an unknown parameter.
  - A Kalman Filter method is used for the estimation of the parameters.
  - Single frequency analysis & dual-frequency analysis.

GNSS Stations used for experimentation



STATION ID	LOCATION	POSITION WGS 84
RABT	Rabat	Lat 33° 59' 53" N Long 6° 51' 15" W
IFR1	Ifrane	Lat 33° 31' 01" N Long 5° 07' 37" W
TETN	Tetouan	Lat 35° 33' 42" N Long 5° 21' 47" W

Results, Static SF, Rabt Station

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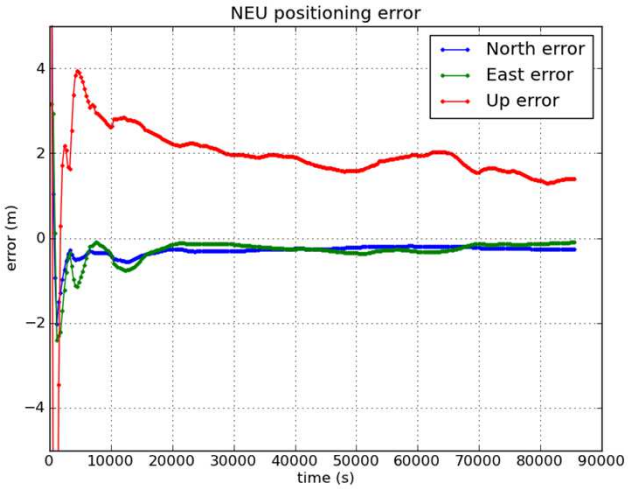
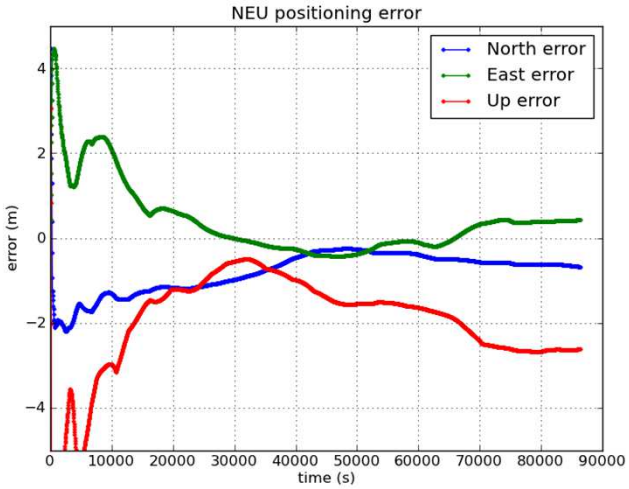
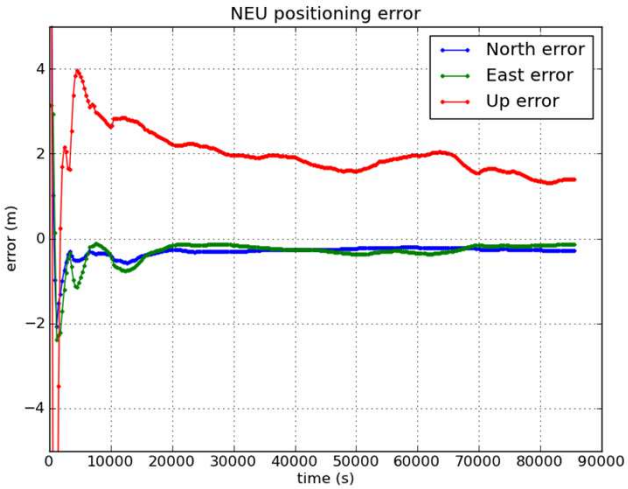


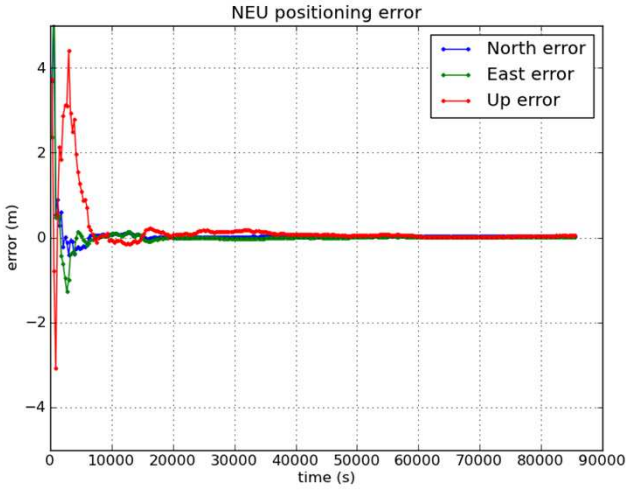
Precise products



Broadcast corrections



Rapid products



Precise & GRAPHIC corrections

Results, Static DF, Rabt station

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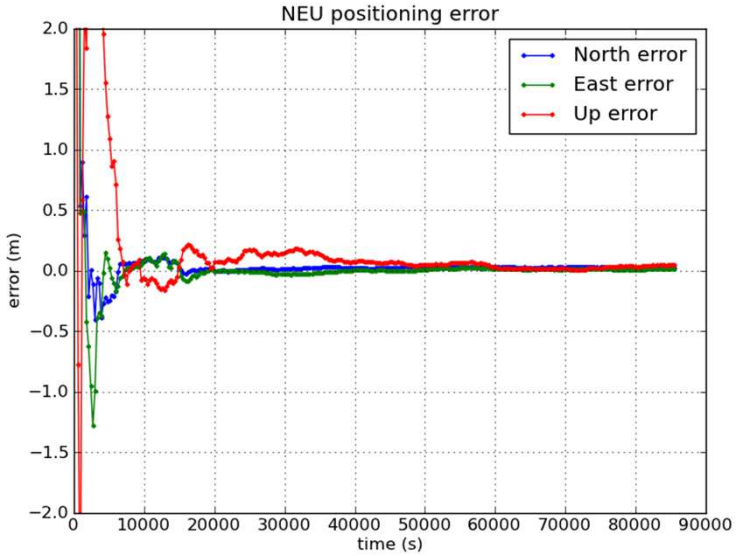
Precise products



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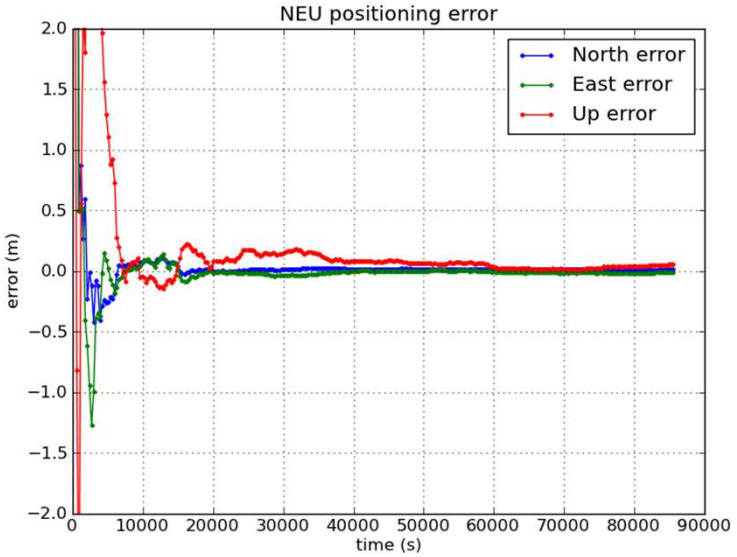
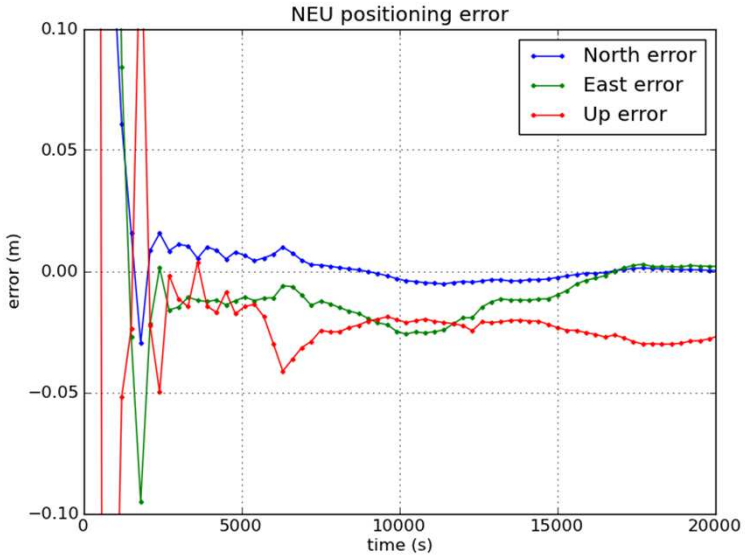


Results, Static DF, Rabt station

Precise products



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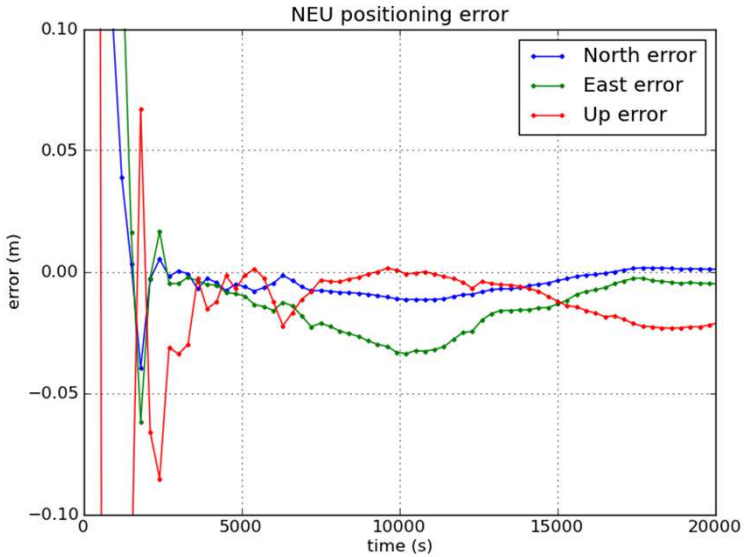
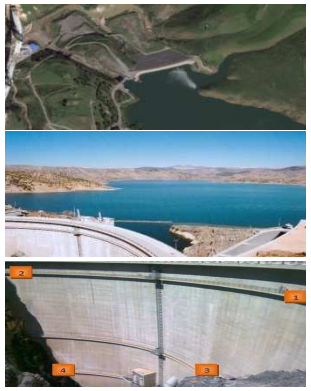


Water management and Dams monitoring



- The water sector is a main lever of economic and social development in Morocco.
- Problem of scarcity as well as spatial and temporal irregularity of water resources.
- Related the national strategy of water, GNSS constitutes an important technology for helping decision makers to better monitor water resources and infrastructures.
- PPP can help in the following activities:
  - Precise positioning in the process of monitoring the water facilities, especially dams.
  - Continuous and dynamic mapping of groundwater and surface water resources.
  - Management and plan of protection actions for vulnerable areas (vulnerability to water pollution, erosion and drought).

Example of results (SMBA Dam, Rabat, 2014)

N° Roundel	σ X (m)	σ Y (m)	σ H (m)
200/201	0.003	0.003	0.004
202/203	0.003	0.002	0.004
204/205	0.002	0.002	0.004
206/207	0.003	0.002	0.004
208/209	0.002	0.002	0.004
210/211	0.004	0.003	0.006
212/213	0.002	0.002	0.004
214/215	0.002	0.002	0.005
216/217	0.002	0.002	0.004
218/219	0.002	0.002	0.004
220/220	0.002	0.002	0.004
236/237	0.005	0.005	0.005
238/239	0.006	0.004	0.013
240/241	0.002	0.002	0.004
242/243	0.002	0.002	0.004
244/245	0.006	0.005	0.011
246/247	0.004	0.003	0.007
248/249	0.006	0.005	0.007

Transportation

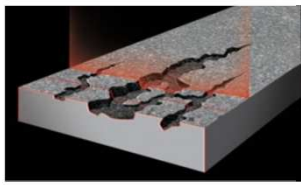
- Improve safety, enhance mobility capabilities, and optimize the use of infrastructures and resources.
- Acquisition of position data accurately and reliably, allowing policy makers to make well-founded decisions.
- In this segment, important needs are :
  - Transport mapping and traffic information gathering.
  - Optimization of the use of transport infrastructures.
  - Monitoring of urban transportation and support the reduction of urban congestion.
  - Organization of Street parking.
  - Road and highway pricing.

Road degradation monitoring

- Reduce congestion problems due to poor road conditions.
- Enhance road-safety verification.
- Identify and locate potentially dangerous points or black-spots.
- Assess the influence of road conditions on accident forensics.
- Support the monitoring of road construction conformity by contractors.
- Identify the location, type and extent of damage to enable decisions regarding budget and the optimization of maintenance interventions.





Agriculture

- National Strategy "Green Morocco Plan "
  - implantation of sustainable agriculture;
  - diversification of the production and increasing of farmers' incomes;
  - management and protection agricultural water resources;
  - protection of the environment through the rational use of chemicals.
- PPP is highly recommended to help farmers develop the most effective strategies to enhance the production.
  - Help the real estate delimitation.
  - Accurate real time data collection about fields and facilities to support fields and yields mapping.
  - Provide precise machine guidance and accurate field navigation to support applying site-specific treatments.
  - Protect the environment and increase agricultural production by GNSS-based precise application of chemical products.
  - Efficiency in the use of irrigation water by the precise identification of the location and the time of irrigation.

Land Registration

- Important progress has been made to improve land registration procedure in Morocco.
- The total area of registered lands at the national level has doubled since 2003, rising from 5 million hectares to more than 10 million hectares since 2013.
- A new Law offers the possibility to the State to open areas for mandatory registration of the national territory.
- Such an opportunity will mobilize lands that serve as a base for social and economic development projects.
- Most areas targeted are rural and suffer from luck of geodetic reference stations.
- GNSS-PPP is an opportunity to boost the land registration opérations.

Land Registration

Where PPP is promising ?

- Densification of the references network.
- Image ortho-rectification.
- Regular surveying of land boundaries & Establishing Cadastral maps;
- Support for the consolidation of cadastral and Land Registration Databases.

Benefits :

- Legal, Economic, Social and Technical benefits.
- Valuation of land ownership & settlement of disputes.
- Sanitize and mobilize land for investment purposes & Contribute to the national initiative for human development.
- Control and protect the land resources of the state and private property.

Summary

- PPP : Promising for many economic segments.
- Need to develop RTK applications.
- The implementation of new GNSS Infrastructure.
- Development of algorithms and applications tailored to specific needs to support the use of GNSS PPP positioning in Static, Kinematic, Post-Processing and Real Time use.
- The dissemination of local products for GNSS Community.
- National provider for corrections, especially Local ionosphere corrections.

THANK YOU FOR YOUR ATTENTION

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