



# Improving PPP static and cinematic positioning by combining GPS and Galileo data.

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# Questions Addressed in this presentation

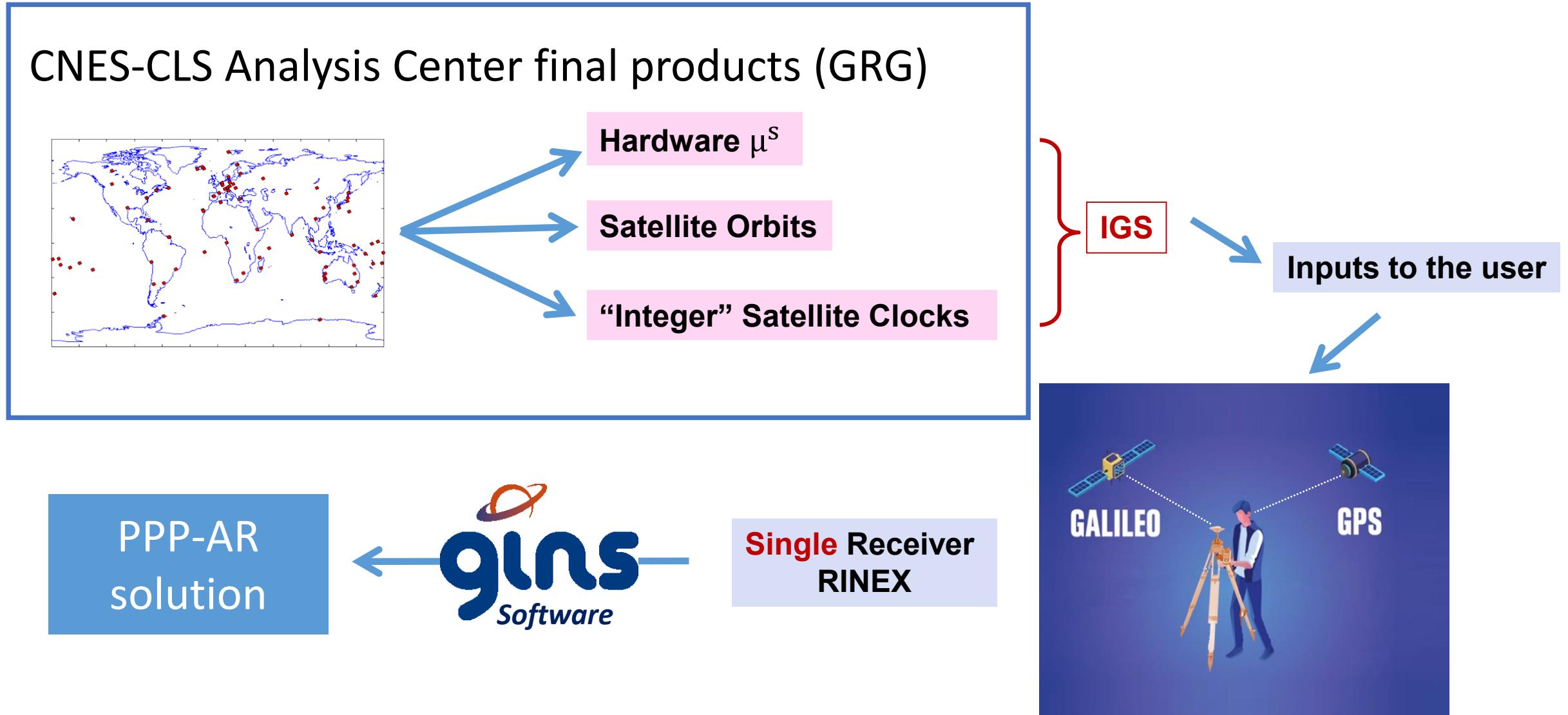
Comparison of :

- GPS, Galileo and GPS+Galileo
- PPP and PPP-AR
- Static and kinematic (post-processed) solutions

- Impact of fixing ambiguities?
- Impact of including Galileo?



# GNSS products and software from GRGS/CNES group



# (Post-)Processing Strategy

## Static Mode:

- Network of 50 IGS stations
- Duration: 23 weeks (DOY 195-356 2019)
- Position sampling : daily
- Data sampling : 300s

## Kinematic Mode:

- Network of 50 IGS stations
- Duration: 1 week (DOY 42-48/2019)
- Position sampling : 300 sec
- Data sampling : 30s

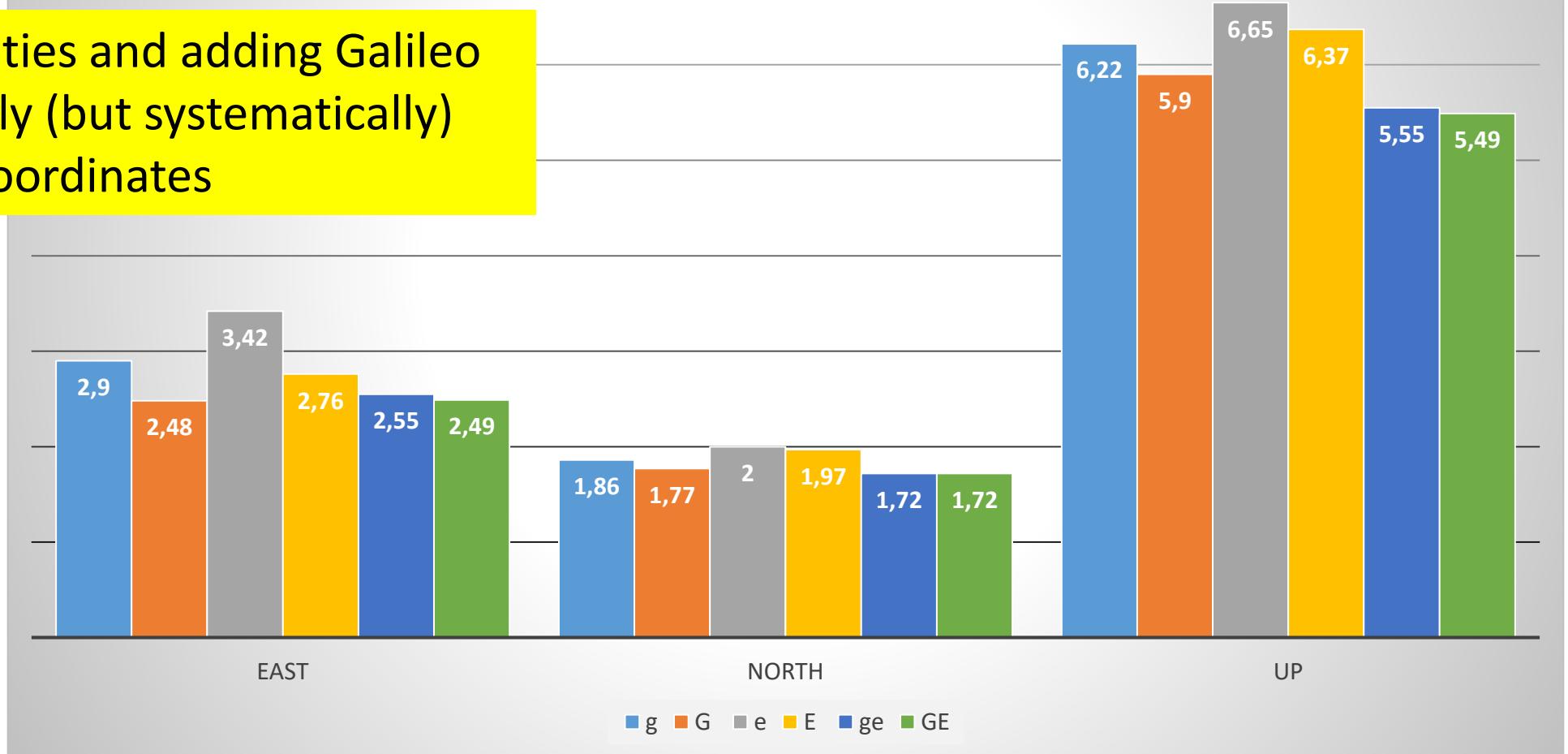
## Ambiguity fixing:

	GPS	Galileo	GPS+Galileo
FLOAT	g	e	ge
FIXED	G	E	GE

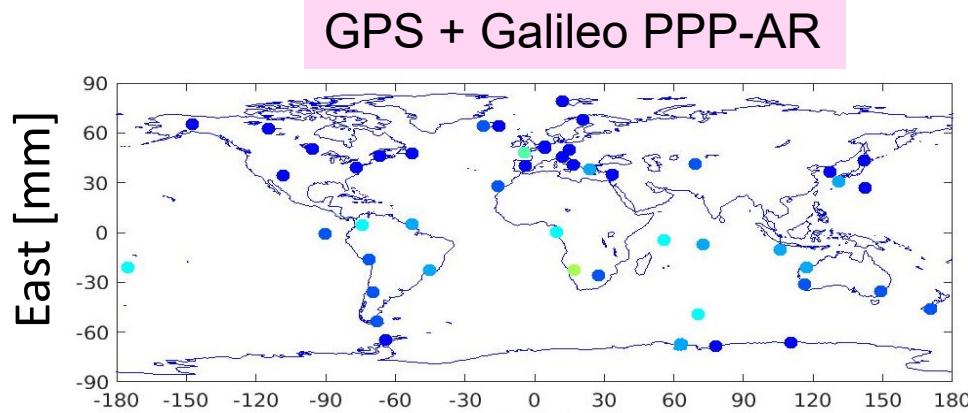
# Static solution

## RMS Global Daily Repeatability (mm) 50 stations x 23 weeks

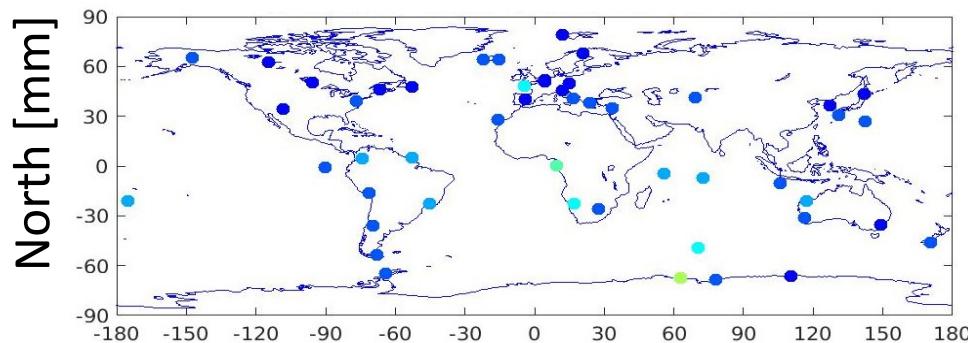
- Fixing ambiguities and adding Galileo improves lightly (but systematically) static (daily) coordinates



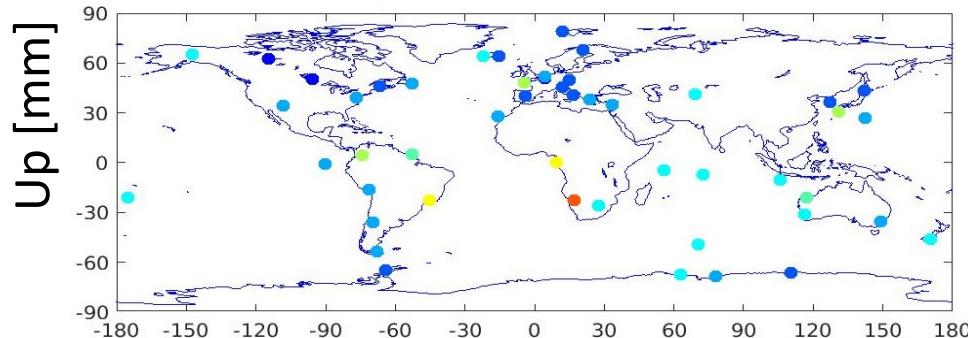
# Kinematic solution



Vs.  
GPS  
PPP-AR  
**-28%**



**-33%**



**-30%**

Global Network RMS (1  $\sigma$  values) :

	Mode	East [mm]	North [mm]	Up [mm]
Galileo	PPP	17,0	14,6	33,1
	PPP-AR	13,7	12,2	30,8
GPS	PPP	11,8	9,4	26,0
	PPP-AR	9,3	8,3	24,0
GPS + Galileo	PPP	7,9	6,1	17,2
	PPP-AR	<b>6,7</b>	<b>5,6</b>	<b>16,8</b>

► Adding Galileo improves kinematic GPS positioning by ~30 %

*Katsigianni et al. 2019*

# Summary

- Galileo IGS/GRG products are reaching GPS standards opening the way to precise Galileo PPP processing (Katsigianni et al. 2018)
  - Fixing ambiguities and adding Galileo data into GPS processing impact much more significantly kinematic positioning compare to static (daily) solutions
  - Adding Galileo improves kinematic GPS positioning by ~30 %
  - Perspectives:
    - Post-REPRO3 IGS products will be based on more consistent satellite and ground stations antenna PCO/PCV corrections
    - 4 more Galileo satellites should be launched in 2021
- This will benefit to combined GPS+Galileo PPP solutions

## References:

Katsigianni, G., Loyer S., Perosanz F., Mercier F., R. Zajdel, K. Sosnica, Improving Galileo orbit determination using zero-difference ambiguity fixing in a Multi-GNSS processing. Adv. Space Res. (2018),  
<https://doi.org/10.1016/j.asr.2018.08.035>

Katsigianni G., Loyer S., Perosanz F., PPP and PPP-AR Kinematic Post-Processed Performance of GPS-Only, Galileo-Only and Multi-GNSS", Remote Sensing, 11,21,2477 (2019) <https://doi.org/10.3390/rs11212477>