

Galileo Precise Orbit and Clock Determination, POD concept at ESOC

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ESA /ESOC – Navigation Support Office

Tour de l'IGS 6th Stop: Galileo Constellation Spotlight, 23/05/2023

ESA's Navigation Support Office



Navigation Support Office located at the European Space Operation Centre (ESOC)

One of the founding members of the IGS, and since more than 20 years involved in a variety of Precise Orbit Determination (POD) applications, with special focus on the Galileo constellation.

Our primary Galileo activities cover different POD aspect:

- Routine Galileo Precise Orbit Determination products
- Models development:
 - Satellite Orbit Dynamic modelling
 - Attitude and Clock modelling
- Special Orbit and Clock products for scientific analyses (e.g., Relativistic studies)
- Further analyses for Galileo such as:
 - metadata test & validation
 - clocks performance analysis



ESA / ESOC in Darmstadt, Germany ²



Dynamic POD approach, based on daily batch processing

Important for the accuracy of the Galileo products:

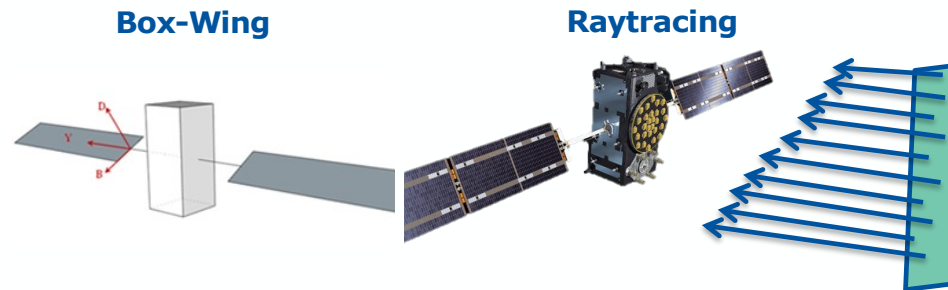
- Quality of the Galileo signals
- Satellite modelling
- Stations network geometry

Galileo Modelling at ESOC:

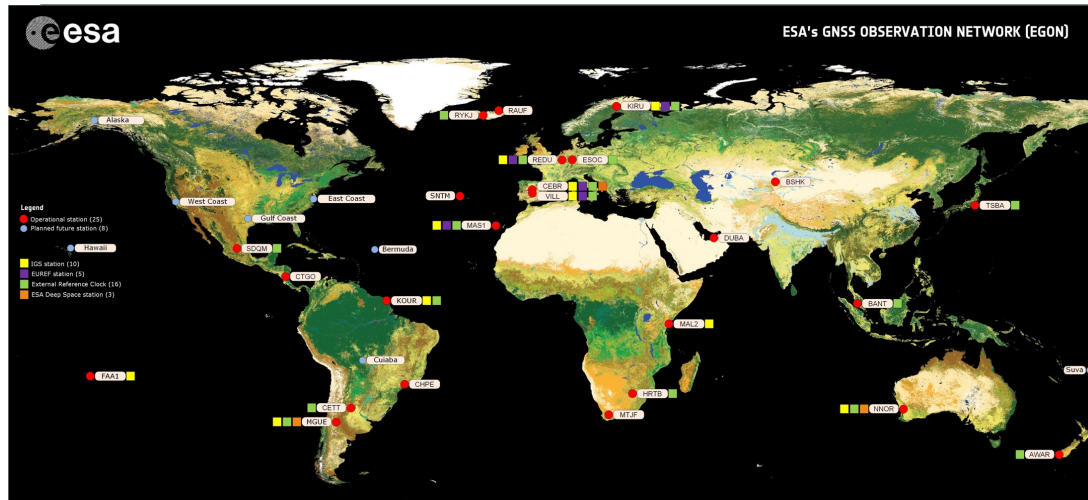
- Galileo orbital error is driven by the high area-to-mass ratio property
- ESOC models are considered of very good quality
- Galileo dynamic modelling in continuous improvement (*in the upcoming slides*)

GNSS area-to-mass ratio

GNSS SV	$\Delta A/m$ [m ² /kg]
Galileo FOC	0.0028
GPS III	0.0021
GPS IIR	0.0017
BDS-3 SECM	0.0016
GPS IIF	0.0015
BDS-3 CAST	0.0014

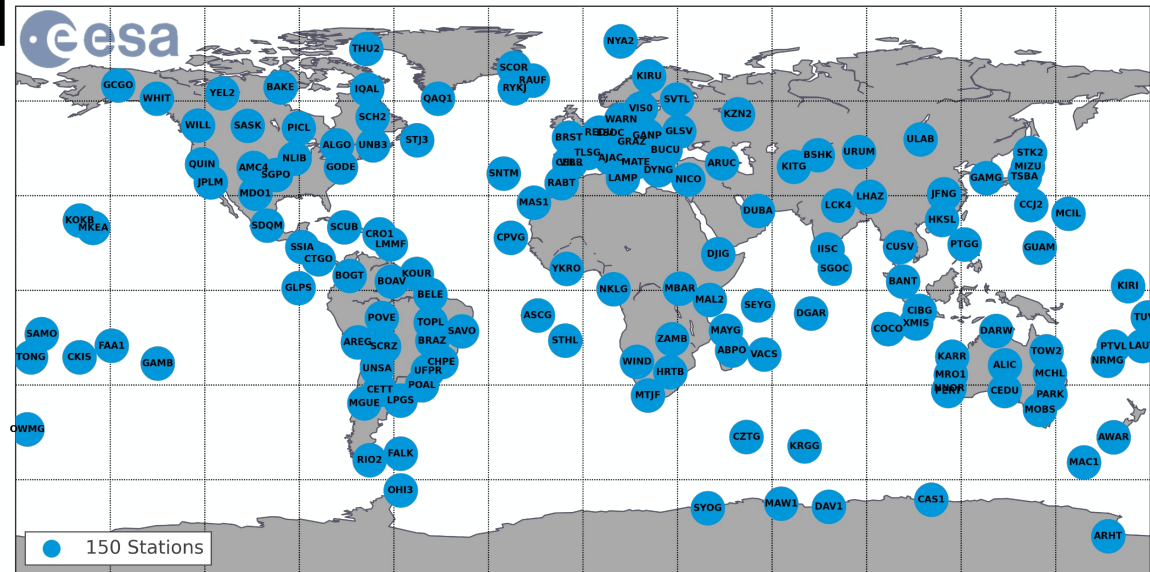


GNSS Observation Network for Galileo POD



ESA's GNSS Observation Network (EGON)
25 stations in operation
8 additional stations planned

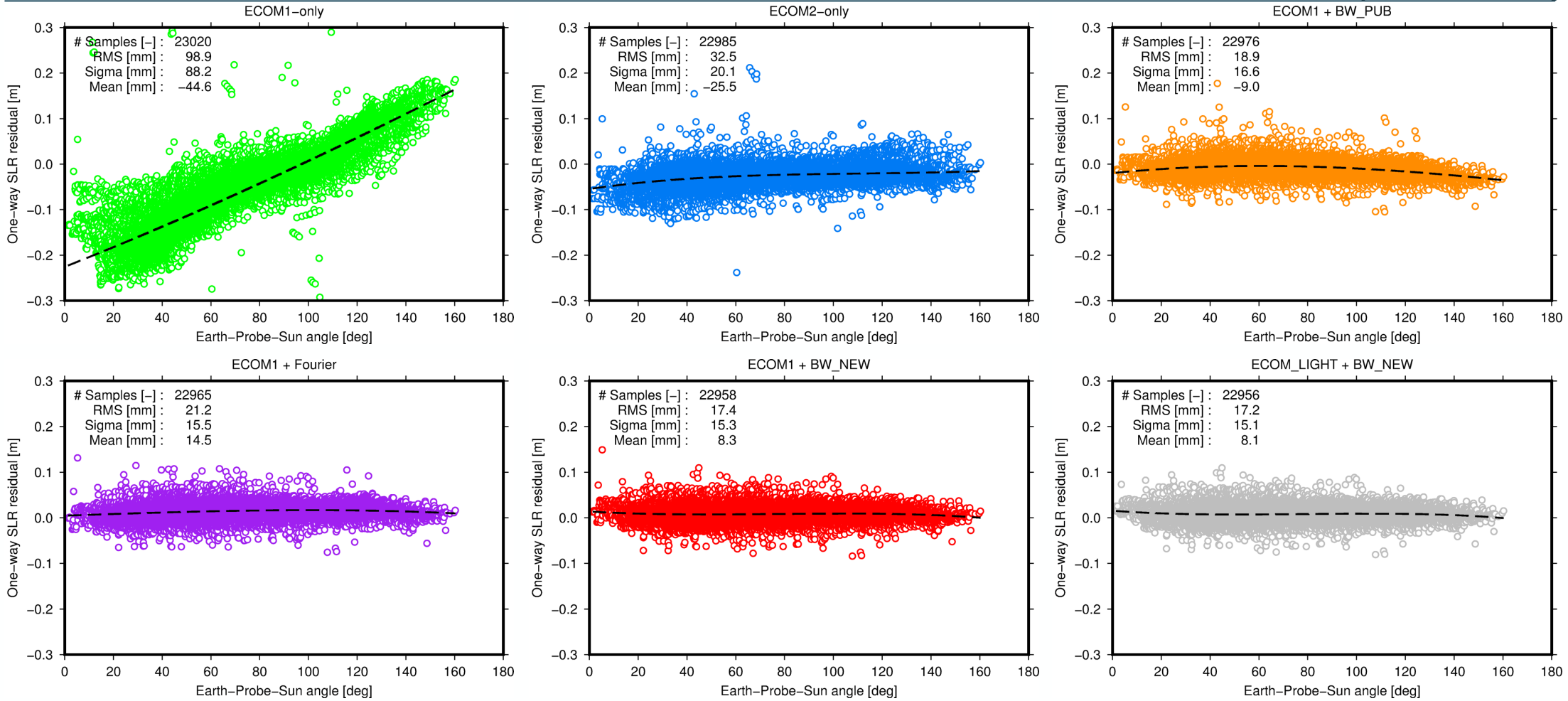
IGS station network combined with EGON for Galileo and other GNSS processing



SLR residuals of Galileo FOC* - continuously improved modelling



*Galileo IOV performs similarly



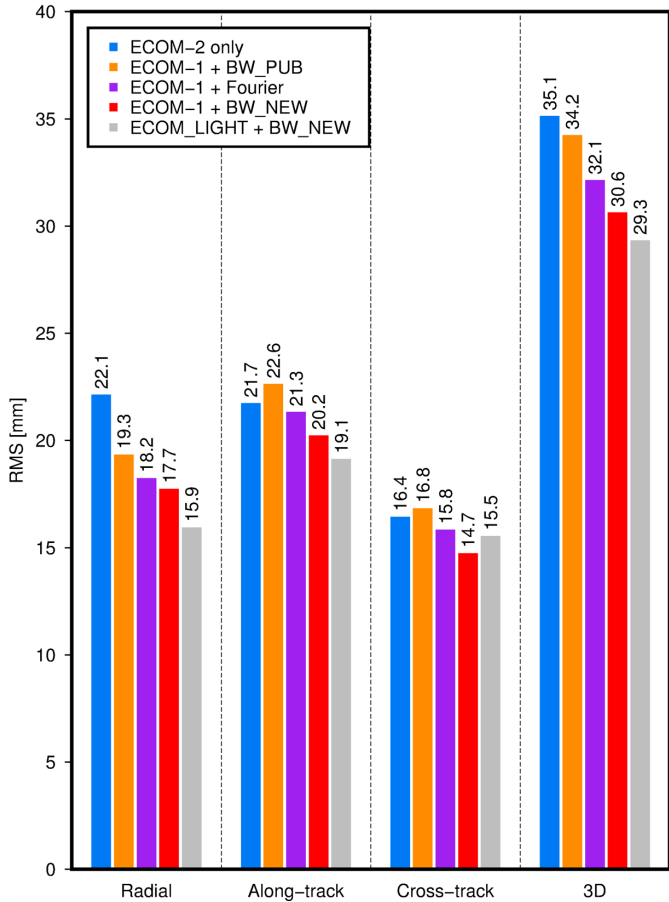
ESA's Non-Gravitational Force Models for One-Centimetre Orbit Determination Accuracy of Galileo Spacecraft, F. Dilssner et al, 8th International Colloquium. 2022



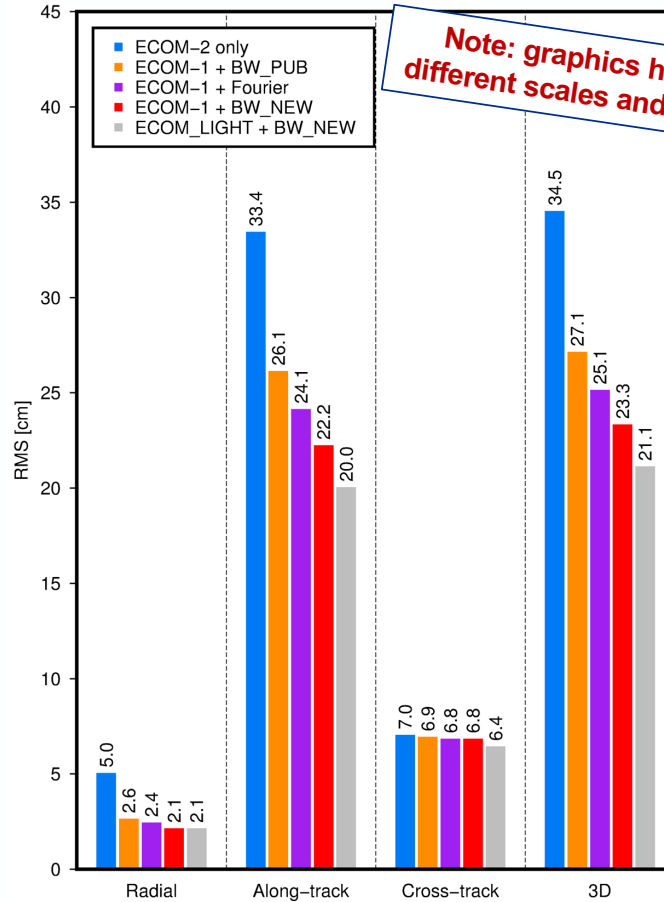
Galileo FOC orbit error – continuously improved modelling



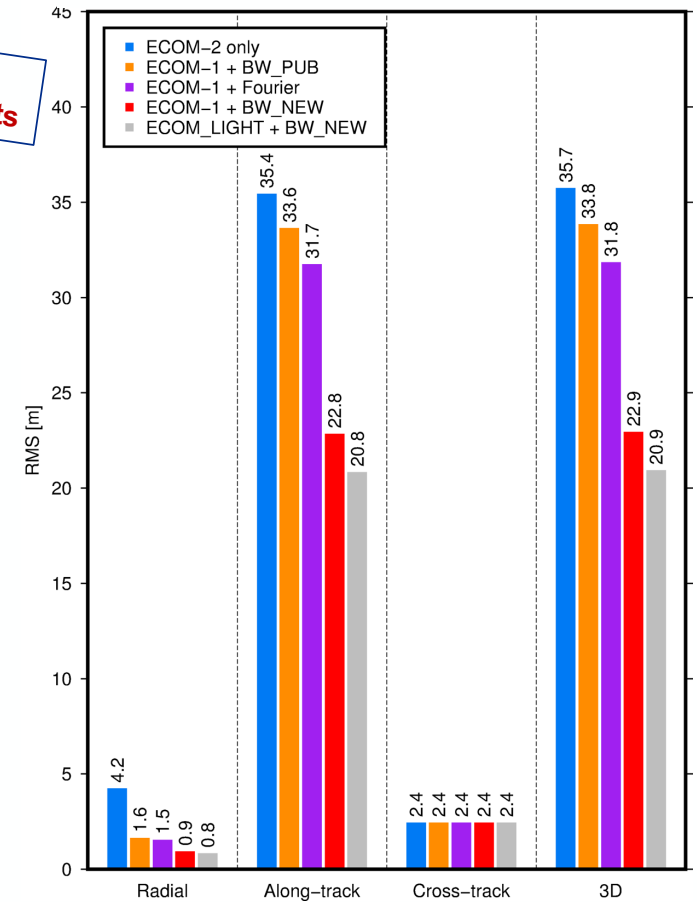
Orbital Overlaps (mm)



Orbital Prediction error after 1 day (cm)



Orbital Prediction error after 14 days (m)



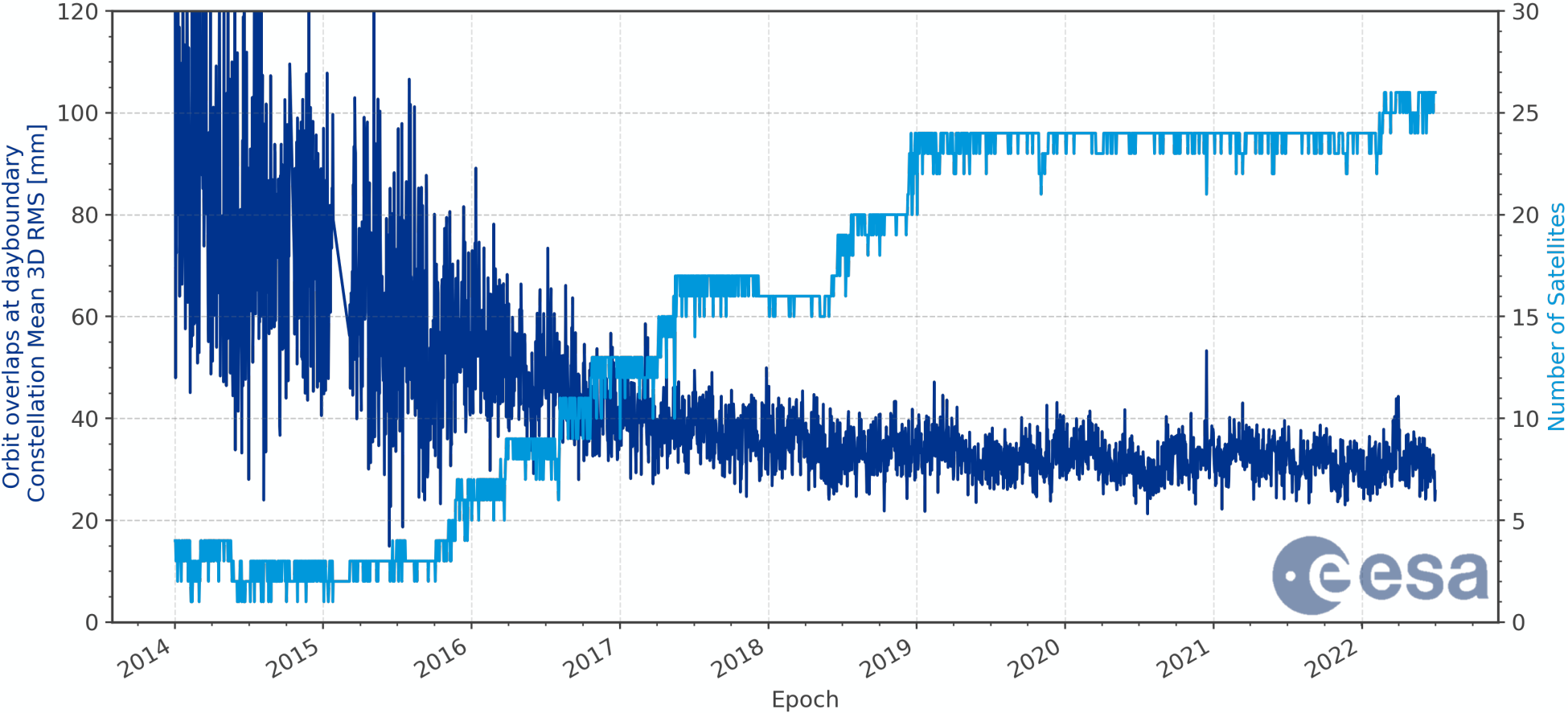
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Continuous improvement of Galileo products



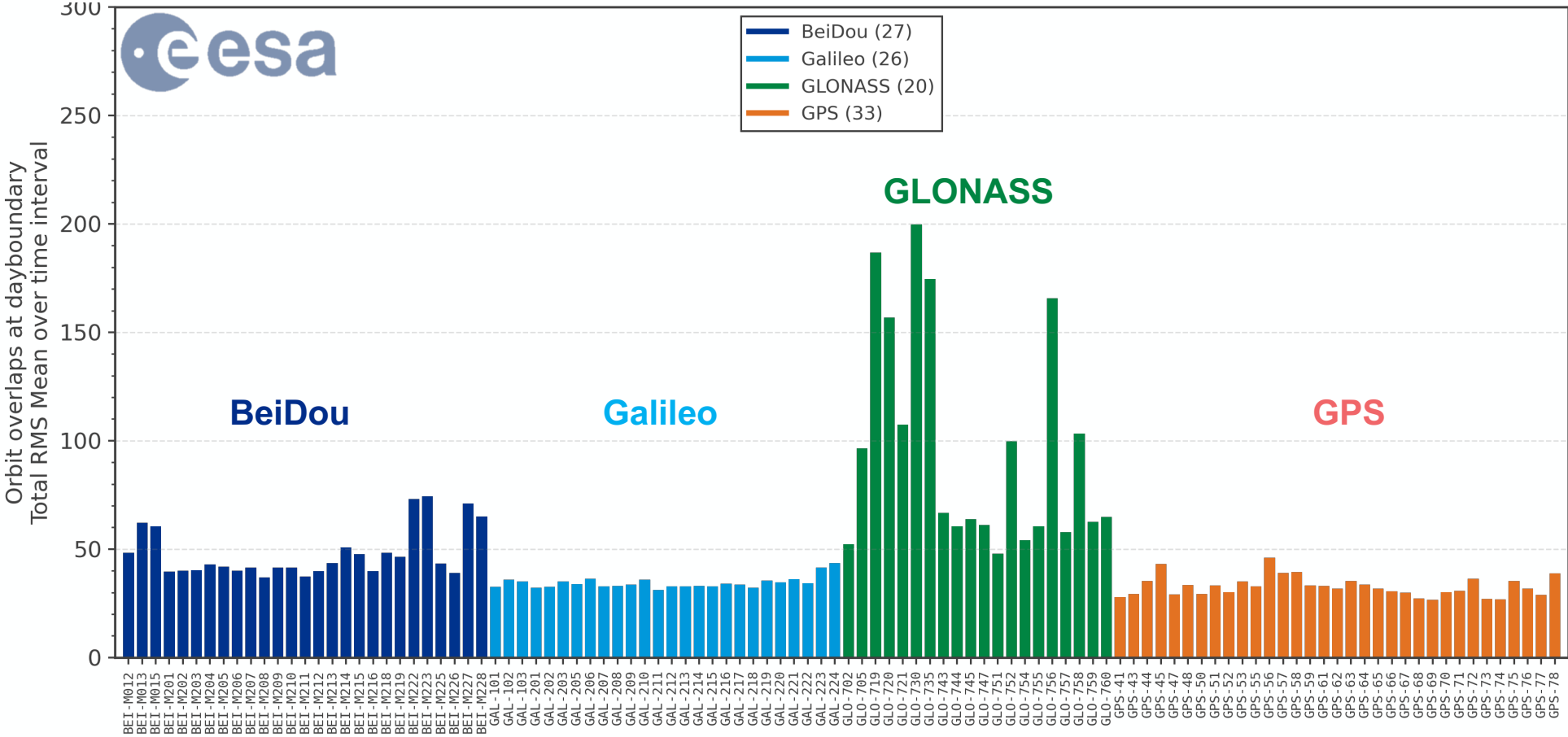
Development of Galileo orbit quality



Galileo performance compared to other constellations



Multi-GNSS day-boundary overlaps (mm)



Statistics based on ESOC MGNSS Final Products, 2022



Conclusions

The ESA/ESOC Navigation Support Office is dedicated to:

- continuously enhancing the quality and performance of Galileo and other GNSS products.
- actively contributing to the IGS by publishing and providing support for Galileo, GPS, and GLONASS products (IGS FINAL).
- offering Multi-GNSS products encompassing all constellations.

The products are published and accessible on our webpage: <http://navigation-office.esa.int/>

For the latest updates and communications regarding the release of new products, please monitor the following:

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To further enhance its services, the ESA/ESOC Navigation Support Office has embraced the Galileo measured Phase Center Offset (PCO) and Variations (PCV) from the public metadata*, following the upgrade to the new ITRF2020 realization,.

This approach is considered to have a more realistic interpretation, capturing the physical characteristics with greater accuracy.

*see Metadata presentation by F. Gonzales (ESA) 9

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Thanks for your attention.