Sentinel-6 MF orbit determination at the Copernicus POD Service

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Copernicus POD Service

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copernicus
Europe's eyes on Earth

COPERNICUS POD Service

Copernicus Sentinel-1

Copernicus Sentinel-2

Copernicus Sentinel-3

Copernicus Sentinel-6 Michael Freilich

- Sentinel satellites are equipped with various Earth observation instruments
- Mission requirements demand high levels of orbital accuracy (**GPS**, DORIS+SLR only S-3 + S-6 (+**GAL**)) → **Copernicus POD Service**

Copernicus POD Service

- Consortium led by **GMV**, Tres Cantos, Spain
- **magicGNSS**, external GPS orbit and clock provider (NRT, STC), backup **DLR Reticle**
- **PosiTim**, QWG management, quality control, improvements, scientific outreach …
- **DLR, TUM, AIUB, TUD, GFZ** quality control, QWG members

=> More information and details on poster "Copernicus POD Service: Overview and status" by Fernández et al.

PosiTIM

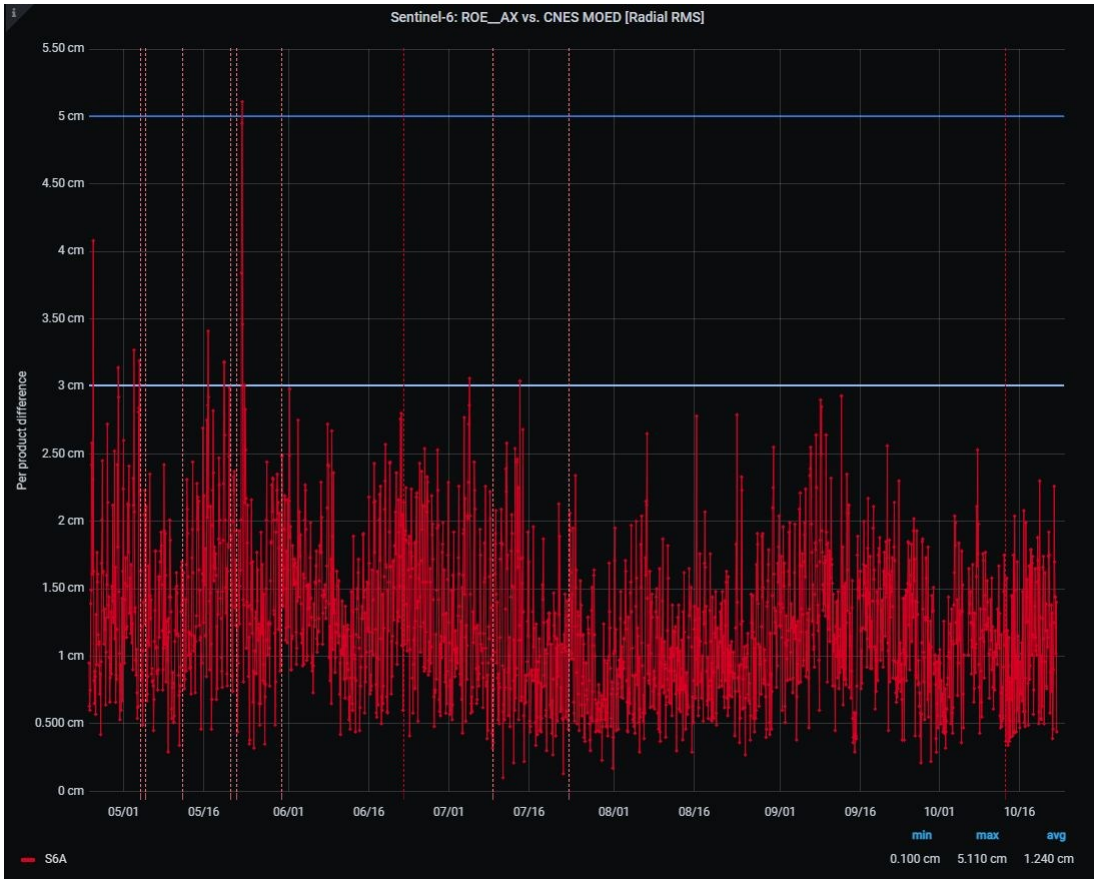
COPERNICUS POD Service

Sentinel-6 MF POD

- Operational S6 MF orbit solution

⇒ NRT solution with 10 min latency and radial RMS of 5 cm

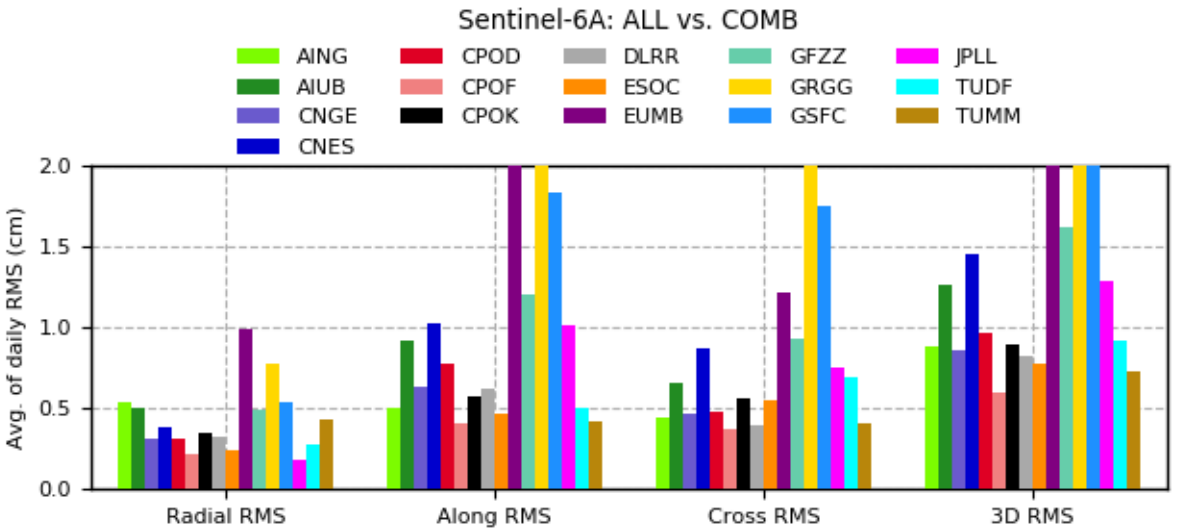
- GPS only solution
- GPS orbits and clocks from magicGNSS
- Comparison to CNES MOED shows consistency below 3 cm in radial RMS



Offline S6MF processing at CPOD Service

- Contribution to Regular Service Reviews (four per year) with an NTC-like solution (CPOD/CPOF)
- Galileo-only solution, ambiguity-fixed
- CODE Rapid orbit and clock (30 s) and bias products
- 32 h arc length
- 30 s sampling
- Estimated parameters:
  - state vector
  - CR fixed to 1.0
  - CD estimated
  - 16 CPR parameter sets
    along- + cross-track: const, sin, cos
- **CPOD: EIGEN-GRGS-RL04**
- **CPOF: COST-G FSM 2109**

- Original macro-model used



Offline S6MF processing at CPOD Service

- Additional studies and tests are performed offline to improve S6MF POD results

- Improvement of the macro model
- PODRIX: GPS and/or Galileo: some insights
- TRIG POD results

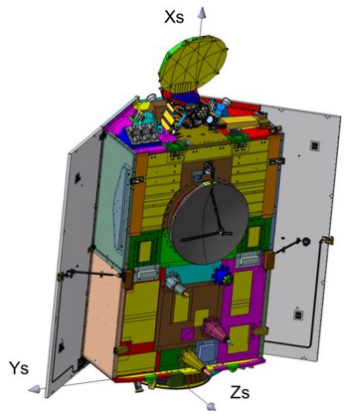
- **Improvement of the macro model**

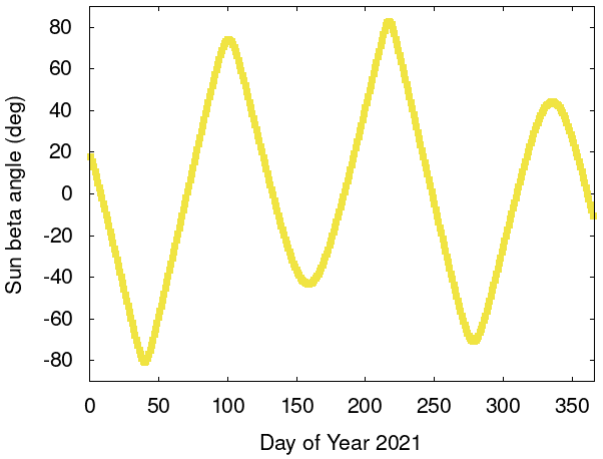
- Estimation of CR (and CD)
- No empirical CPR parameters estimated

=> CR estimation gives a hint how good the satellite macro model is

Sentinel-6A – satellite macro model

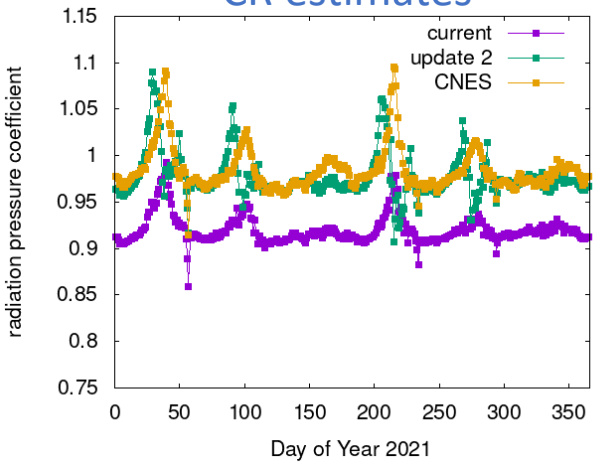
- Current satellite macro model in use:
  - 10 panels (Cullen et al.), some small modifications
- Updated model:
  - 12 panels (S6A POD context version 2.0 document), some small modifications
- CNES model:
  - 6 panels (presented at 11th Copernicus POD QWG meeting)



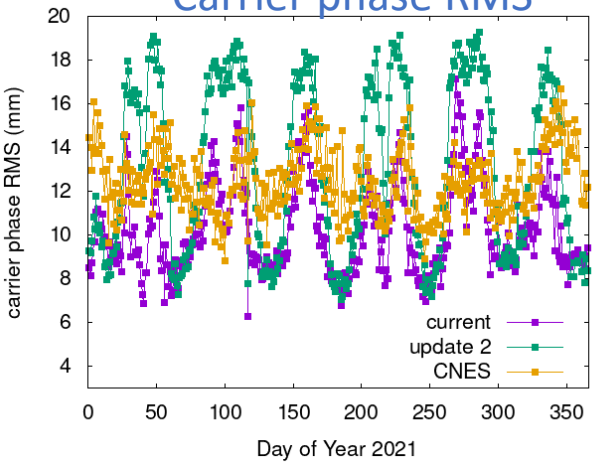


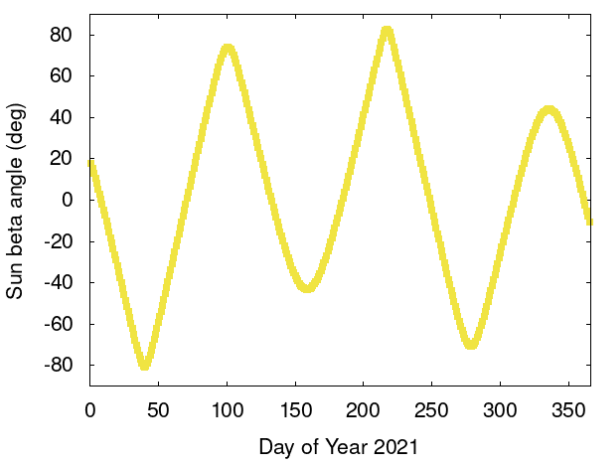
CR (and CD) estimation – further tests

CR estimates



Carrier phase RMS

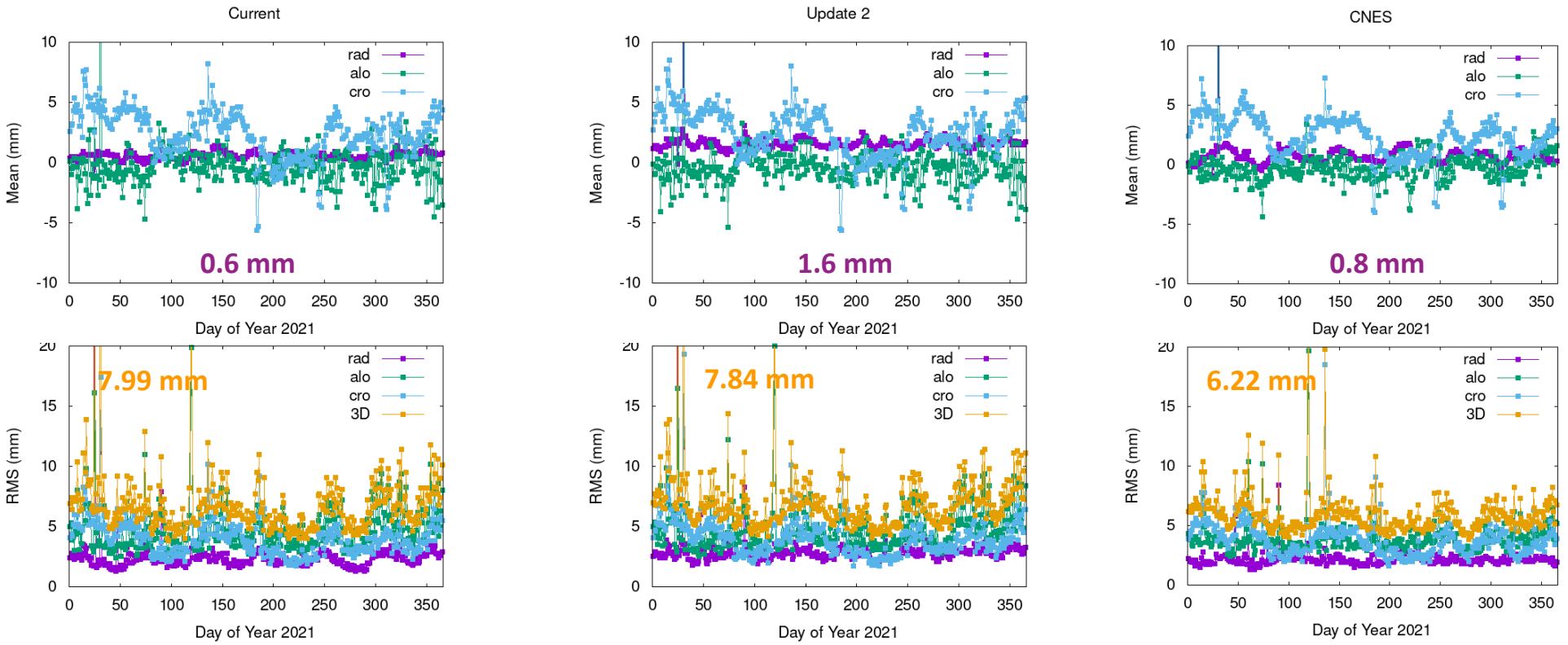




- CR estimates are closer to 1.0 for **Update 2 and CNES**
- Carrier phase RMS shows least variations for **CNES** model
- **Mean of CR (days 113-194):**
  - **Current**: CR = 1.0 (operational setting)
  - **Update 2**: CR = 0.97
  - **CNES**: CR = 0.98

=> new orbit solutions are generated with 6 CPR sets added, CR fixed to values listed above, CD = 1.0 fixed

Comparisons to combined RSR#23 orbit



- Orbit comparisons (very large outliers removed) to combined RSR#23 orbit give preference to the solutions using the CNES macro model.
- Radial mean of **1.6 mm** for **Update 2** solution is larger than for other solutions (0.1 mm for **Update 1**; 0.6 mm for **Current** solution)

SLR validation (one-way)

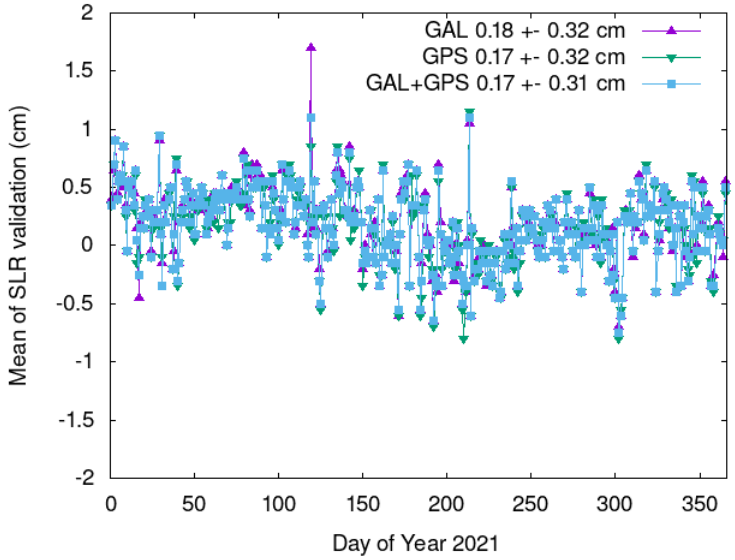
	Mean (mm)	RMS (mm)
Current	2.0	8.9
Update2	1.2	8.8
CNES	1.8	8.7

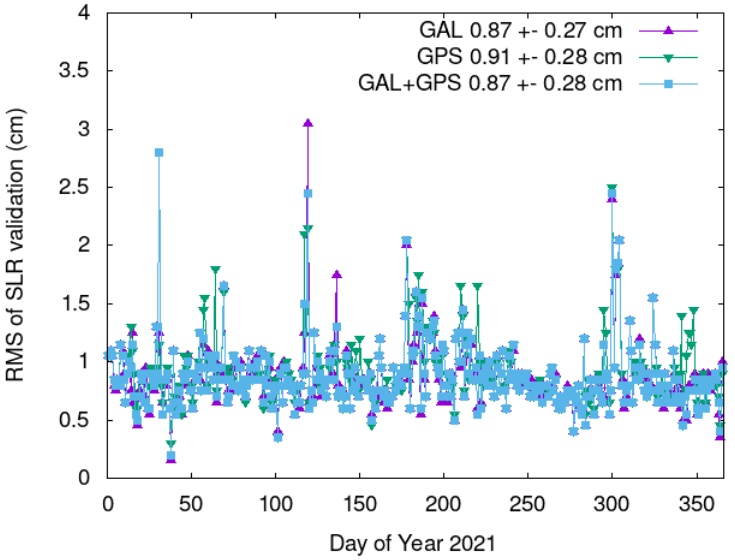
- 12 selected stations, no range biases or station coordinate corrections estimated
- SLR validation gives no real preference, results are very similar

⇒ Satellite macro model has few impact on the orbit accuracy

⇒ Decision on which satellite macro model will be used in future is not yet taken.

GPS and/or GAL observations

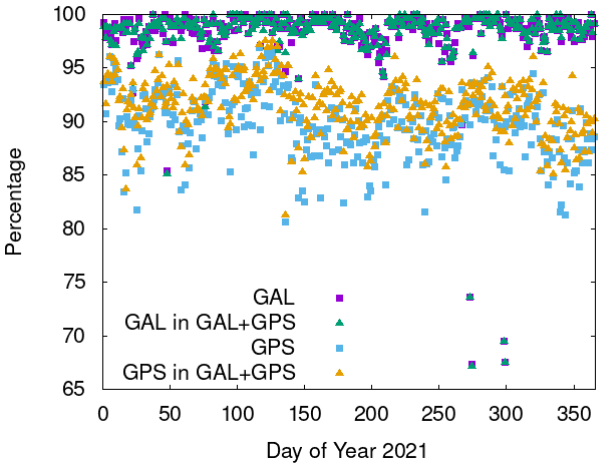




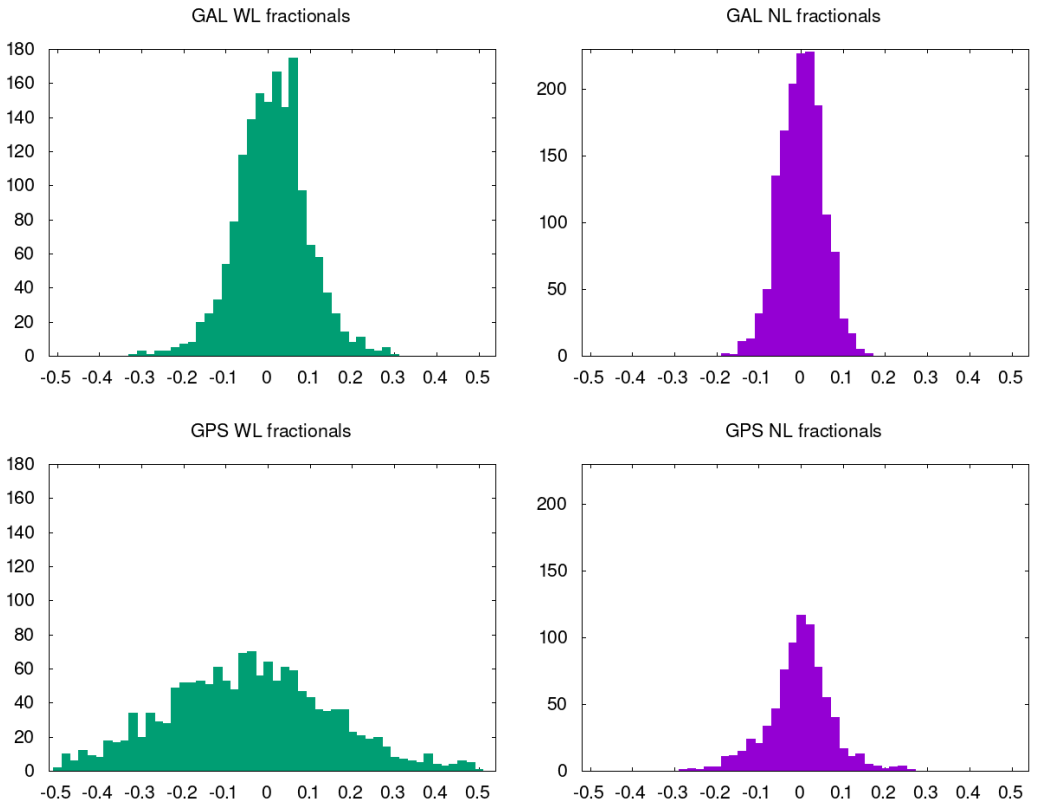
- Observations from 12 well behaving SLR stations are used
- Orbit accuracy is below **one cm** for all three solutions

- SLR validation of GPS-only, GAL-only, and GPS+GAL is very similar
- Some RMS “peaks” for the GPS-only solution are reduced in the combined GPS+GAL solution

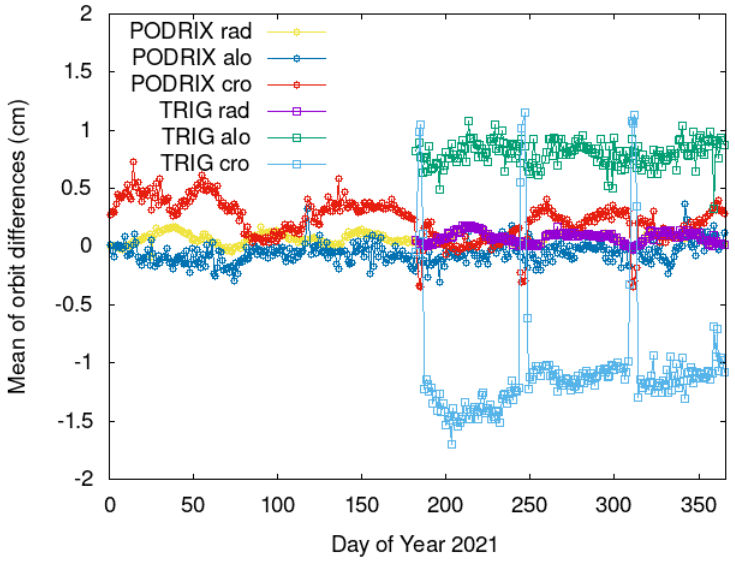
GPS and/or GAL observations

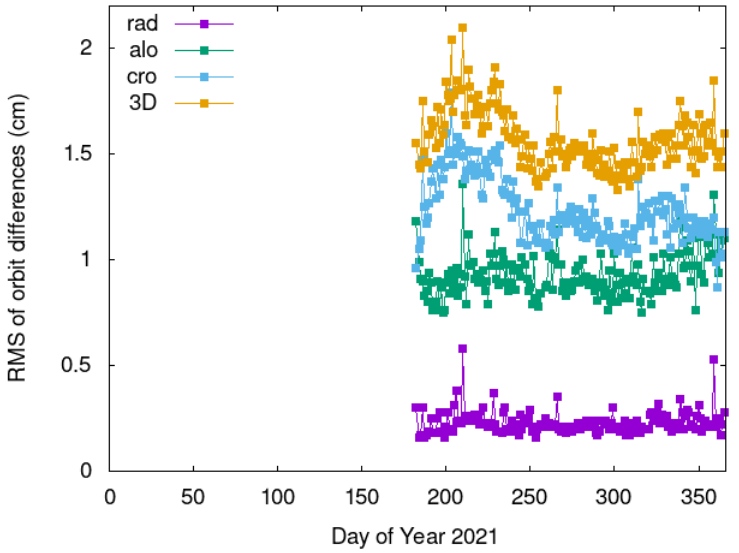


- Carrier phase ambiguity fixing works much better with Galileo!
- GPS fractionals have a much worse distribution (note: mix of L2P(Y) and L2C => not solved)



TRIG POD results

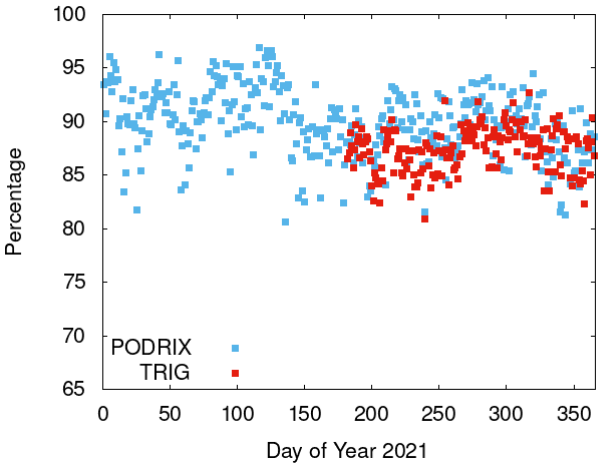




- 1 Jul – 31 Dec 2021
- L1W & L2W
- Same orbit parametrization as for PODRIX processing used
- No TRIG PCVs applied

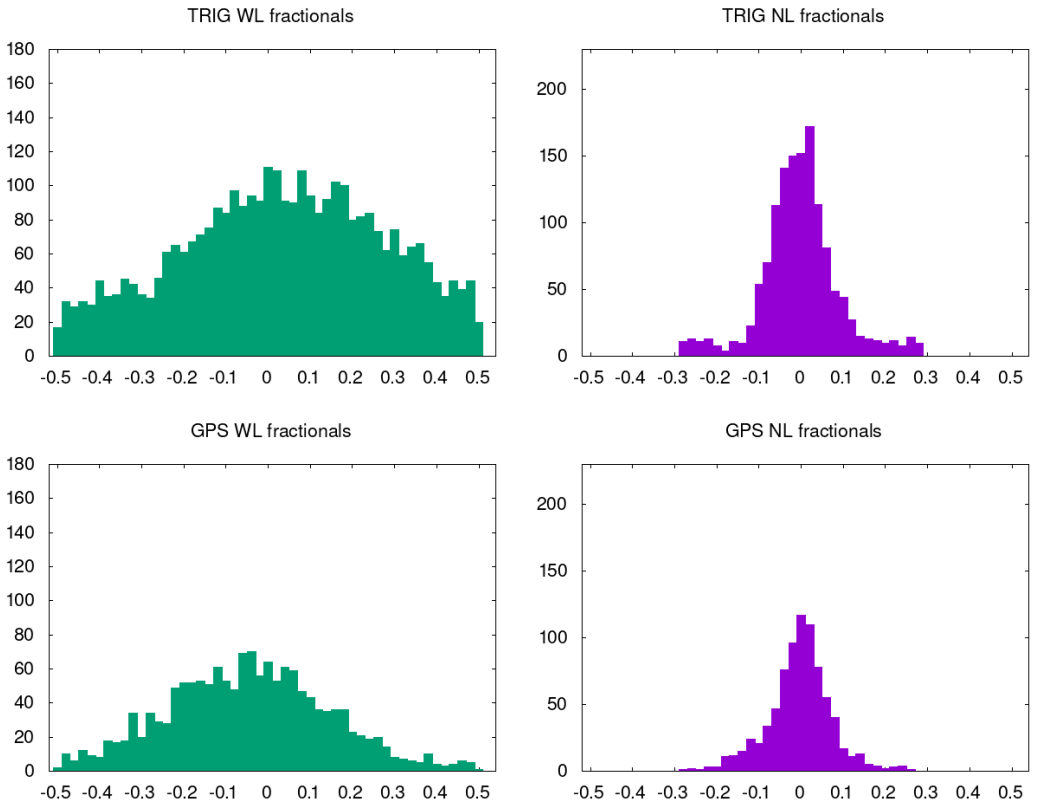
- Orbit comparison to combined RSR#23 orbit
- Mean offsets of PODRIX-derived orbit solutions added for comparison
- Mean offsets to combined RSR#23 orbit:
  - Radial: + 0.9 mm
  - Along-track: + 8.0 mm
  - Cross-track: - 11.9 mm

TRIG – ambiguity fixing



- GPS fractionals of TRIG observations are not much better than those of the PODRIX

=> Cause is not clear



Conclusions

- Sentinel-6MF offline processing at CPOD Service is used for testing new models and to improve orbit determination results
- Update of S-6 satellite macro model is foreseen; not yet clear which one will be used.
- GPS ambiguity fixing from both receivers (PODRIX and TRIG) shows some unexpected behaviour, but results are good and do not reflect this.
- TRIG POD results confirm offsets already reported by O. Montenbruck.

Thank you for your attention!

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