TECHNISCHE UNIVERSITÄT WIEN

Contribution of Galileo observations to improve the quality of daily and sub-daily earth rotation parameter estimates

Dzana Halilovic, Robert Weber

TU Wien, Department of Geodesy and Geoinformation, Higher Geodesy

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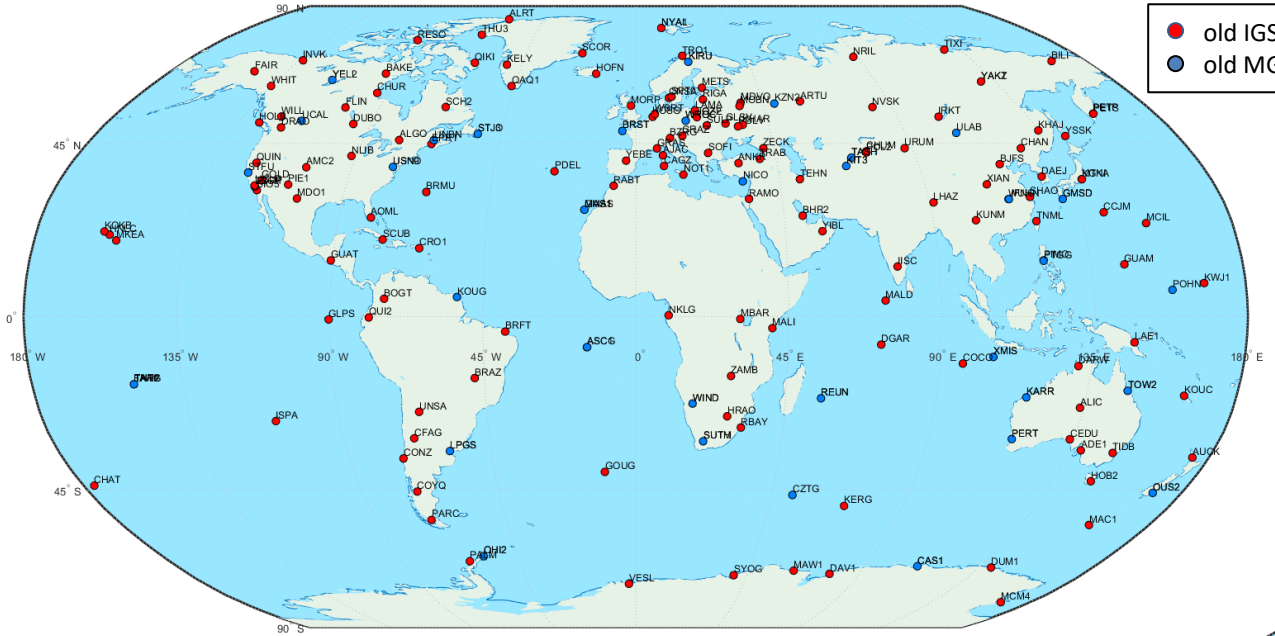
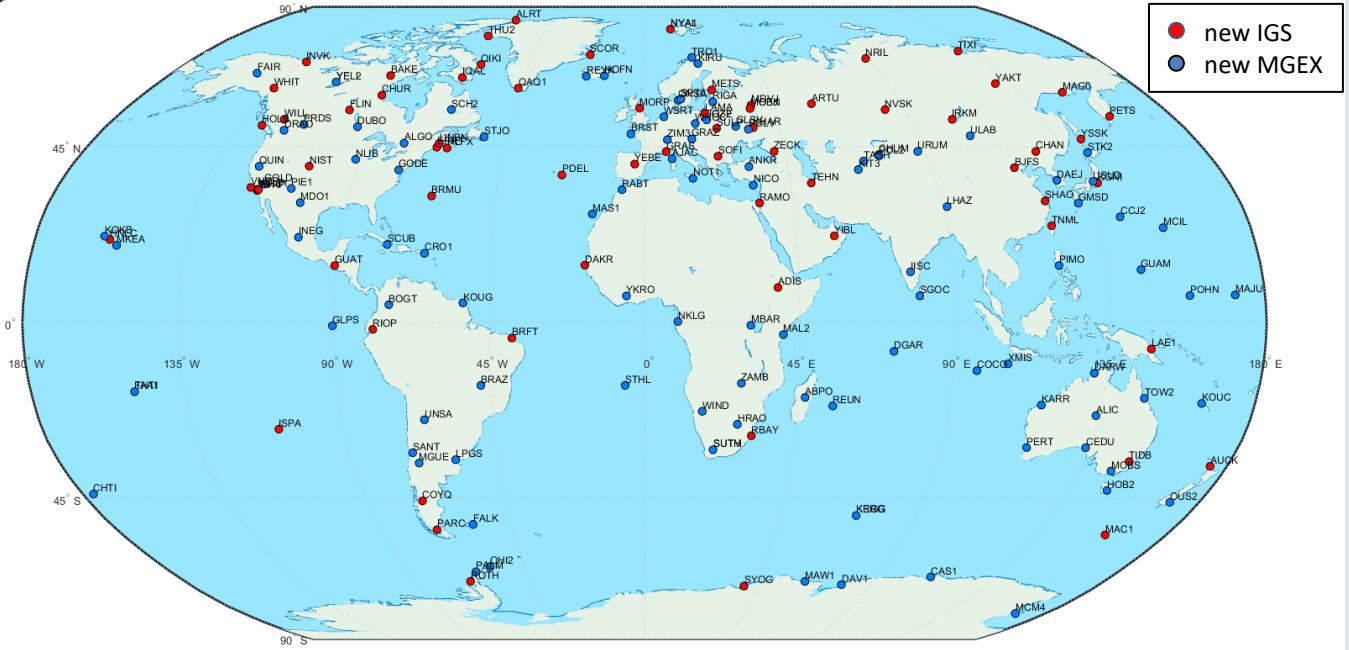
Old vs. New Dataset – Station selection



- Stations: max 208 possible
  (approx. 191 per day)
  - IGS: 174
  - MGEX: 34
- NNR constrain: 75
- With ~16 Galileo + ~30 GPS satellites per day, the contributional part of Galileo observations amounts max ~10%

- Stations: max 176 possible
  (approx. 165 per day)
  - IGS: 176
  - MGEX: 104 (up to 55 per day)
    - all 104 MGEX stations overlap with IGS list
      (if MGEX is not available for a day, IGS is used instead if available)
- NNR constrain: 75 (updated station list)
- Contributional part of Galileo observations amounts max ~24%



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Old vs. New Dataset – Characteristics

Campaign	Erpnet
Software	Bernese v5.2
Processing Period	Jul - Dec 2017 (doy 184 – doy 363) → Jan 2017 – Jun 2018 (doy 002 2017 – 180 2018)
Type of Solution	1-Day/3-Day Solution (1 hour time resolution)
Satellite system	GPS-Galileo/GPS
Observations	Phase and Code
A priori Orbits and EOP	ESOC Multi-GNSS Final Products
Station Position and Station Velocities	ITRF2014
Absolute Antenna Model	IGS14
Station Network	191 Site observations daily (NNR → 75 stations) → 165 Site observations daily (NNR → 75)
Processing Mode	Double Differences
Ambiguity Resolution	QIF & WL/NL
Earth's Gravity	EGM2008_SMALL
Planetary Ephemerides	DE405
A priori Solar Radiation Pressure	C061001 (Code Model COD9801, Springer et al. 98)
Subdaily Pole Model	IERS2010XY (based on Ray 1994, XY - values)
Nutation Model	IAU2000R06
Solid Earth Tide Model	TIDE2000 (IERS2000)
Ocean Tides	OT_FES2004
Site - specific Correction for Ocean Tidal Loading	FES2004
Solar Radiation Pressure model	9 Par. ECOM Model : 4 parameters constrained, 5 ECOM parameters fitted (D0, Y0, B0, Bc, Bs)

* Green rows indicate updates in the dataset: old setup written in grey, new setup written in green

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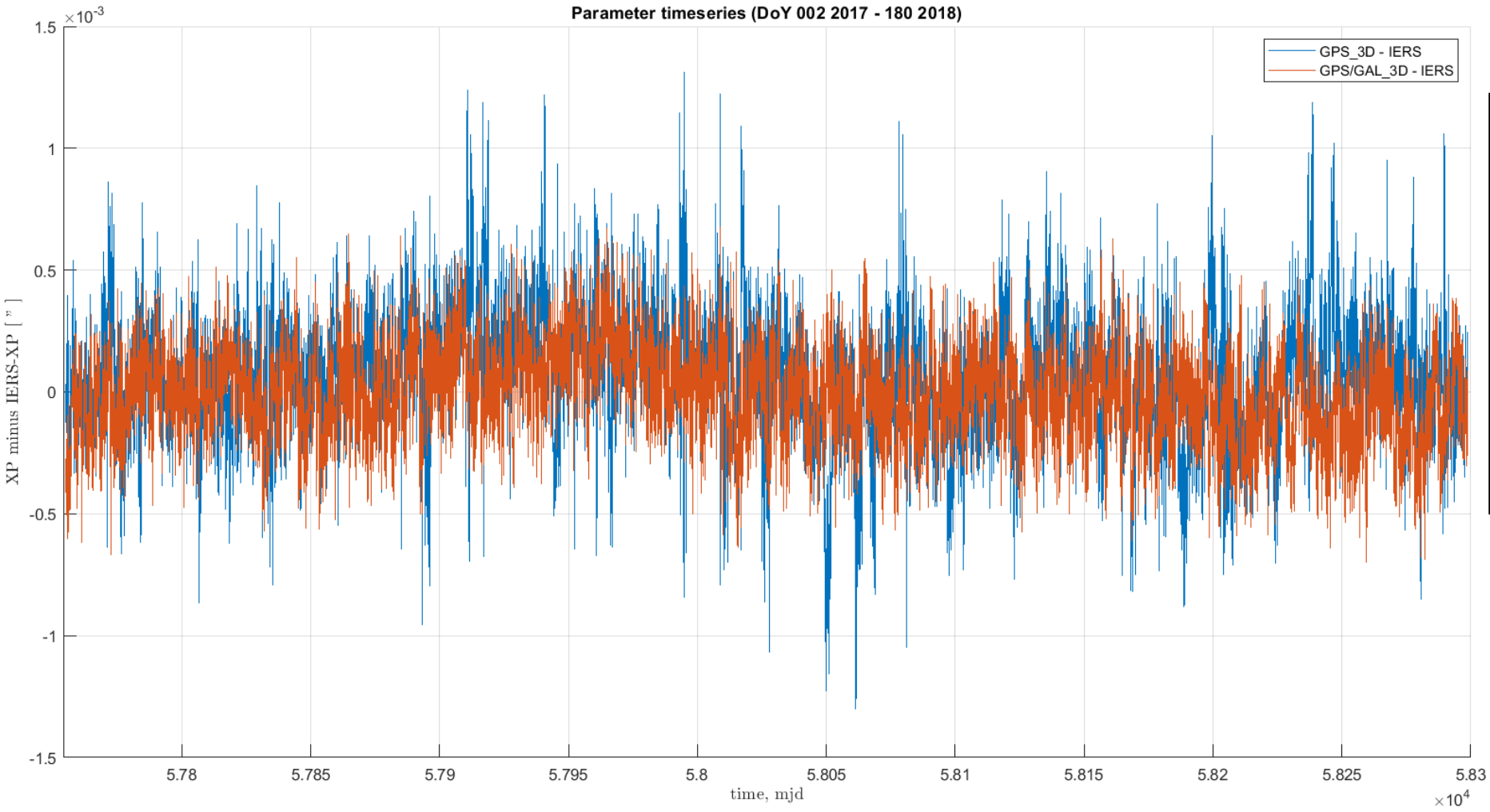
Polar motion time series (X pole)

(Jan 2017 - Jun 2018) w.r.t. IERS2010



Statistics			
GNSS		GPS/GAL (mas)	GPS (mas)
NEW DATASET			
MAX	(abs.)	0,70	1,31
STD	(+/-)	0,20	0,27
MEAN	(abs.)	0,16	0,21
OLD DATASET			
MAX	(abs.)	0,65	1,28
STD	(+/-)	0,20	0,28
MEAN	(abs.)	0,16	0,21

Some remaining signals in series

Figure: Xp – IERS2010

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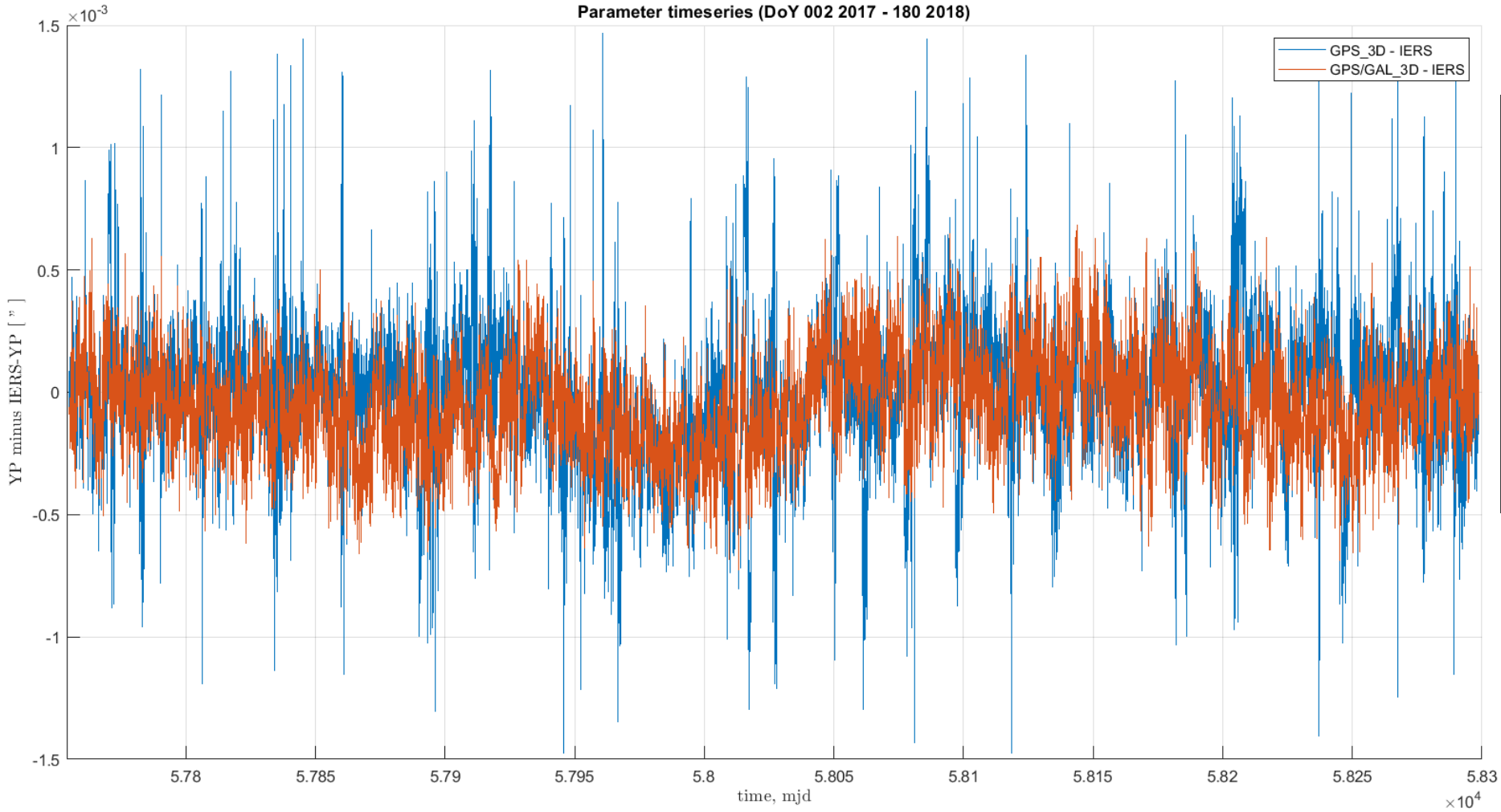
Polar motion time series (Y pole)

(Jan 2017 - Jun 2018) w.r.t. IERS2010

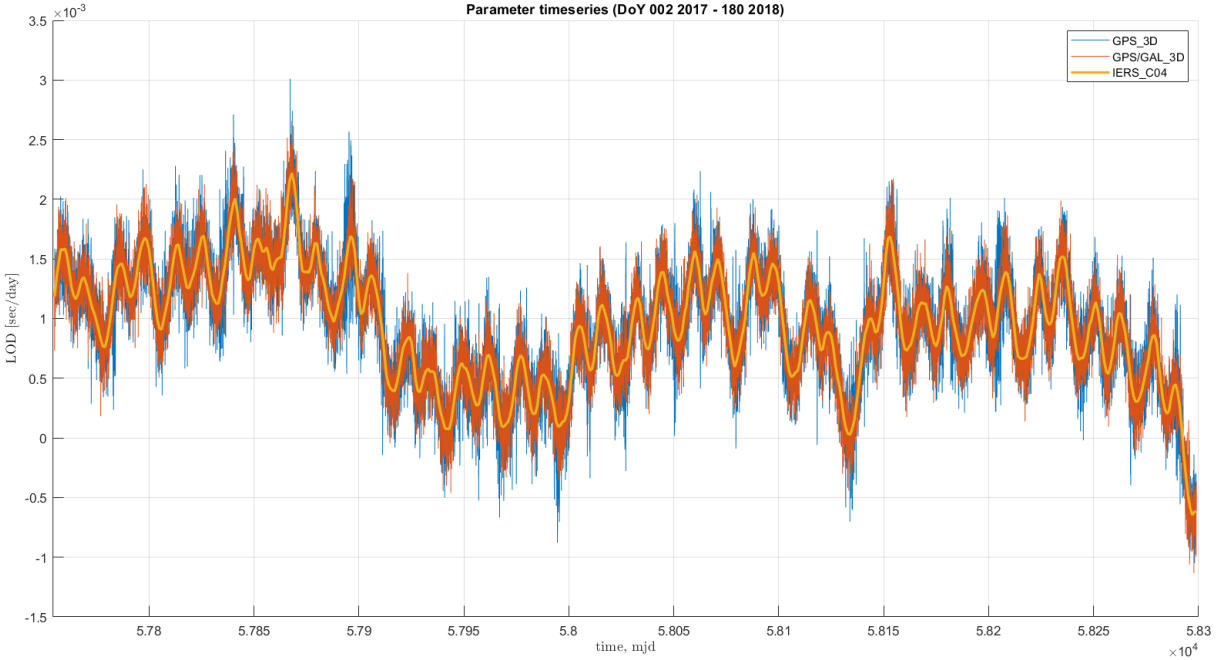


Statistics		GPS/GAL (mas)	GPS (mas)
GNSS			
NEW DATASET			
MAX	(abs.)	0,73	1,48
STD	(+/-)	0,21	0,29
MEAN	(abs.)	0,17	0,21
OLD DATASET			
MAX	(abs.)	0,74	2,55
STD	(+/-)	0,21	0,53
MEAN	(abs.)	0,17	0,35

Figure: Yp – IERS2010

LOD time series

(Jan 2017 - Jun 2018) w.r.t. IERS2010



Statistics			
GNSS		GPS/GAL (ms/day)	GPS (ms/day)
NEW DATASET			
MAX	(abs.)	0,66	0,99
STD	(+/-)	0,18	0,23
MEAN	(abs.)	0,14	0,18
OLD DATASET			
MAX	(abs.)	0,57	0,97
STD	(+/-)	0,17	0,23
MEAN	(abs.)	0,13	0,18

Figure: Raw LOD

- LOD timeseries show satisfying agreement w.r.t. IER2010 in both solutions
- Smaller noise shown in combined solution

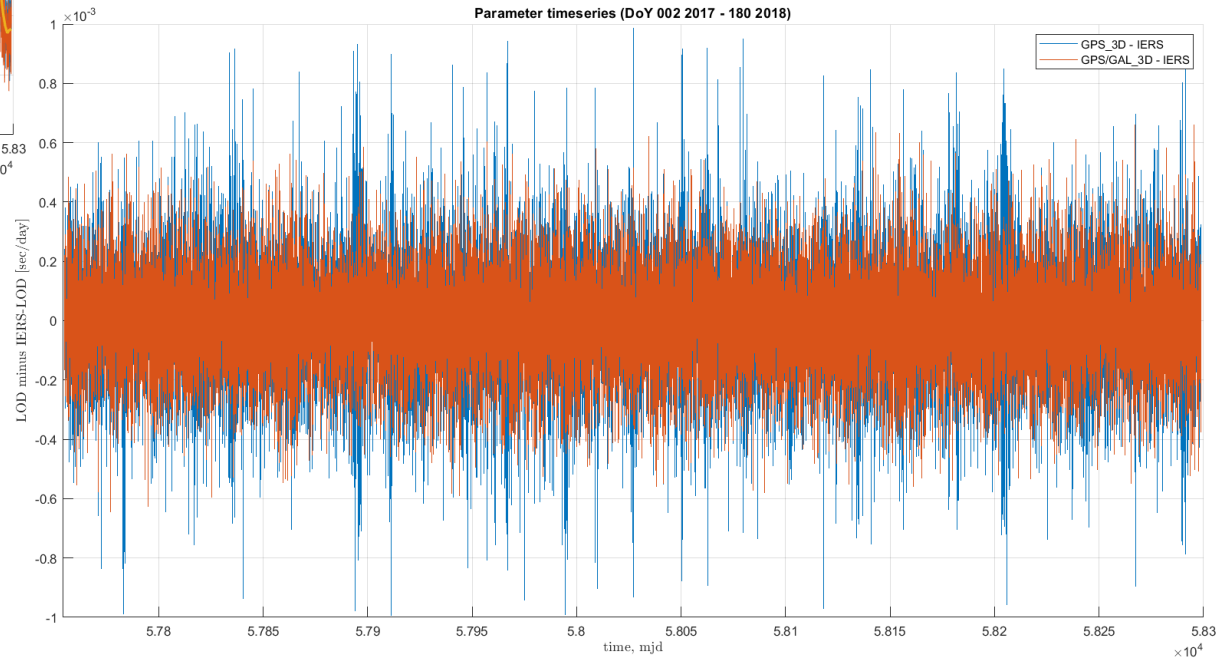


Figure: LOD – IERS2010

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Amplitude spectrum

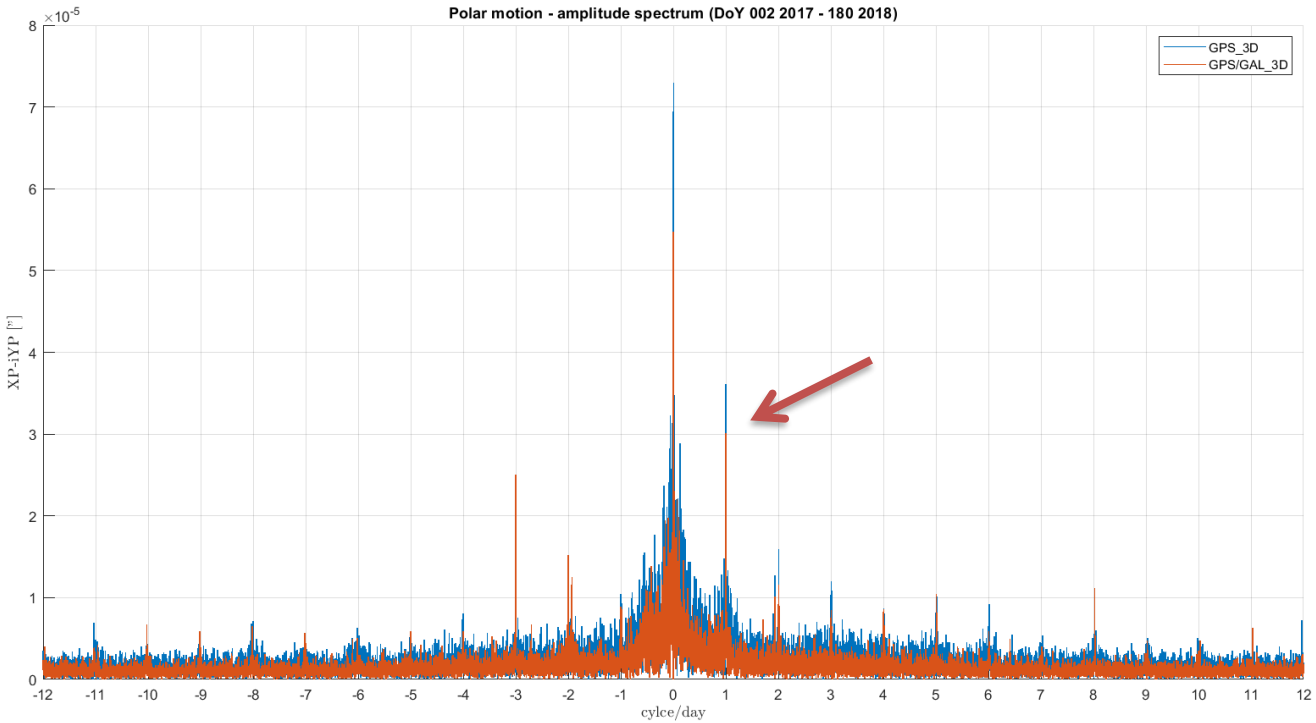

Figure: X,Y-Pole amplitude spectrum
GPS (blue) vs. GPS/GAL (red)

- High peak in prograde diurnal band
- Artefacts from data sampling visible
- Improvement in noise level when using GPS/GAL compared to GPS

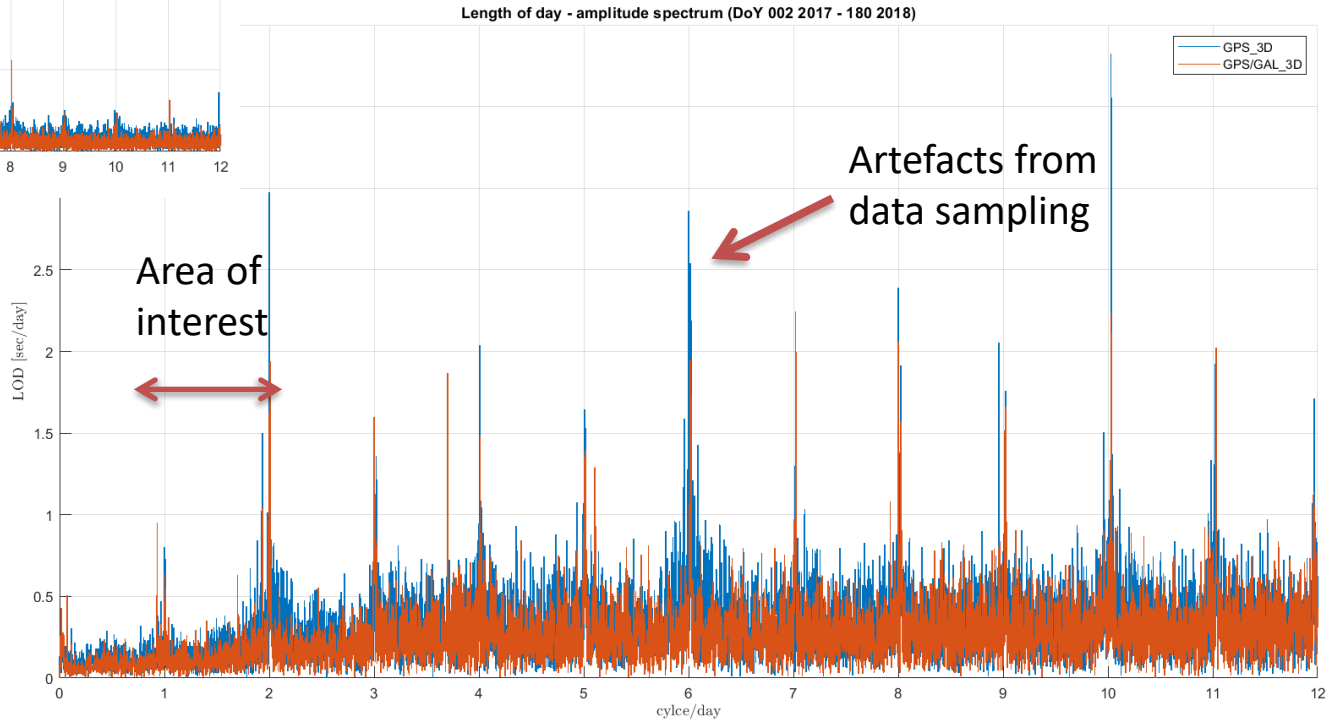

Figure: LOD amplitude spectrum
GPS (blue) vs. GPS/GAL (red)

- Combined spectrum shows smaller noise floor than GPS only
- Artefacts still remain

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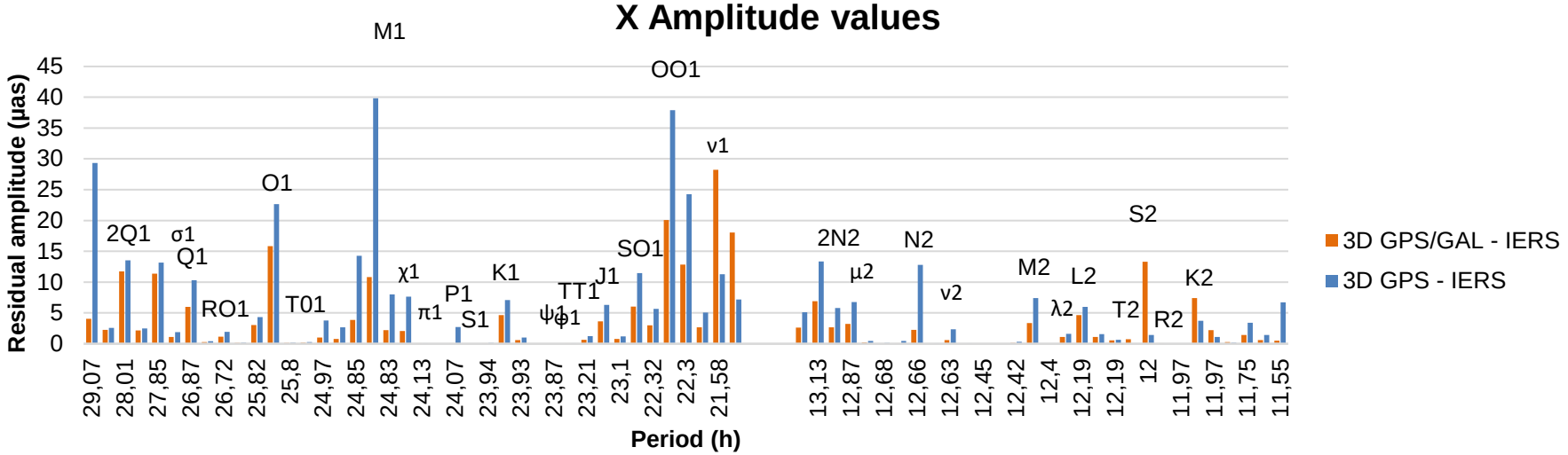
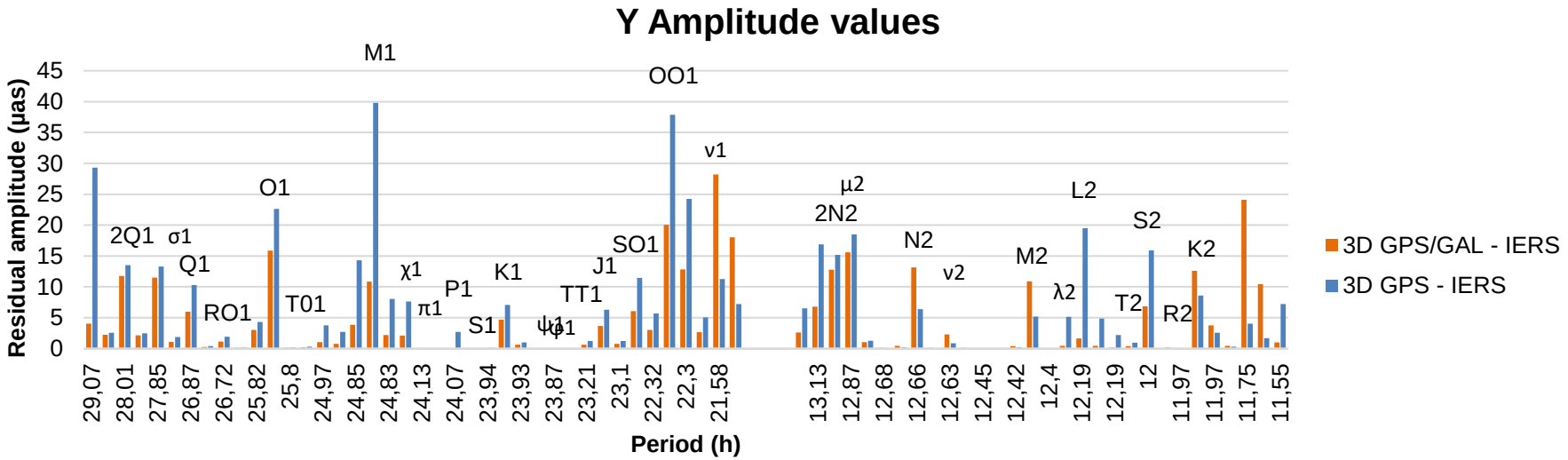
Estimation of Tidal Wave Corrections

(July 2017- Dec 2017) – old dataset





X,Y – pole residual amplitudes

Corrections w.r.t. IERS up to:

- 30μas from GPS/GAL series
- 40μas from GPS series

Major constituents in the diurnal band:
2Q1, O1, M1 , OO1, v1

Major constituents in the semidiurnal band:
2N2, μ2, L2, S2

LOD residual amplitudes

Corrections w.r.t. IERS up to:

- 25μs/day from GPS/GAL
- 30 μs/day from GPS

Major constituents in the diurnal band:
M1 , OO1

Major constituents in the semidiurnal band :
M2, S2, K2

Conclusions

- New dataset (Jan 2017 – Jun 2018)
  - GPS/GAL combined data processing has clearly improved the estimated ERPs, i.e. overall better agreement with IERS2010 model compared to GPS only

- Old dataset (Jul 2017 – Dec 2017)
  - Improvement of tidal wave amplitude corrections determination using GPS/GAL

- New dataset vs. Old dataset
  - Similar ERP statistics when comparing the two GPS/GAL solutions
  - Visible improvement in the GPS only solution when comparing the ERP statistics of the new and old dataset

Recommendation: Processing of longer ERP time series based on combined GPS/GAL data

Future task: estimation of tidal wave corrections of the new dataset in order to analyze the possibilities of an improvement when using longer time series and an enlarged number of MGEX stations compared to the old dataset

References

- Petit, G. & Luzum, B. 2010, IERS Conventions 2010, ed. G. Petit & B. Luzum (IERS Technical Note No. 36)
- Rolf Dach, Simon Lutz, Peter Walser, Pierre Fridez: Bernese GPS Software Version 5.2, November 2015
- D. Horozovic, R. Weber, "Bestimmung von hochfrequenten Erdrotationsparametern unter Verwendung von GPS und Galileo Beobachtungsdaten"; Talk: Geodätische Woche 2018, Frankfurt; 2018-10-16 - 2018-10-18; in: "Abstract Book Geodätische Woche 2018", Abstract Book Geodätische Woche 2018, (2018)

Network station RINEX data:

- Igs (International GNSS Service): ftp://igs.ensg.ign.fr/pub/igs/data/campaign/mgex/daily/rinex3/
- CDDIS (Crustal Dynamics Data Information System): ftp://cddis.gsfc.nasa.gov/pub/gps/data/daily/
- ESOC MulltiGNSS Orbits and EOPs: http://navigation-office.esa.int/products/gnss-products/