Impact of HF-EOP models on SLR products

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IERS HF EOP ad-hoc working group
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HF EOP model validation

Motivation

- Issue of high-frequency EOP models raised at IERS Unified Analysis Workshop 2017 in Paris
- John Gipson agreed to chair the ad-hos IERS WG on HF EOP
- Up to now, only GNSS and VLBI tests were forwarded to John

- This presentation summarizes some findings for SLR based on an analysis done with our s/w DOGS-OC/-CS
  - Is SLR at all sensitive to HF EOP variations?
  - Which parameters are affected by HF EOP variations?
  - Which model is the best?

HF EOP models implemented in DOGS-OC

Model	Tides included	Libration included	Description
Artz_2011	96	Yes	VLBI model (Artz et al., 2011, DOI 10.1007/s00190-011-0457-z)
Artz_2012	96	Yes	GPS+VLBI model (Artz et al., 2012, DOI 10.1007/s00190-011-0512-9)
Desai	159	Yes	Desai and Sibois model
Gipson (no lib.)	70	No	John Gipson's VLBI tidal model (libration modeled acc. to IERS Conv. 2010 within DOGS-OC/-CS)
Gipson (lib.)	70	Yes	John Gipson's VLBI tidal model
EOT11a	71	Yes	Tidal correction model based on EOT11a (Jan Hagedoorn, GFZ)
FES2012	71	Yes	Tidal correction model based on FES2012 (Jan Hagedoorn, GFZ)
Hamtide	71	Yes	PREM tidal correction model by Jan Hagedoorn (GFZ)
IERS_2010	71	Yes	IERS2010 tidal correction model (IERS Conventions 2010)
Madzak	28	Yes	Altimetry-based ocean model tidal correction (Madzak et al. 2016, DOI: 10.1007/s00190-016-0919-4)

- In DOGS-OC, the sub-daily (high-frequency) EOP variations are modelled according to the IERS Conventions 2010.
  - Closure check: internal DOGS-OC-/CS and external IERS_2010 corrections should be identical

HF EOP model validation

SLR-only solution setup

- SLR observations to LAGEOS-1/-2, Etalon-1/-2
- weekly arcs between GS week 1564 (27.12.2009) and 2034 (30.12.2018) → 9 years

TEST 1: Precise Orbit Determination (POD)

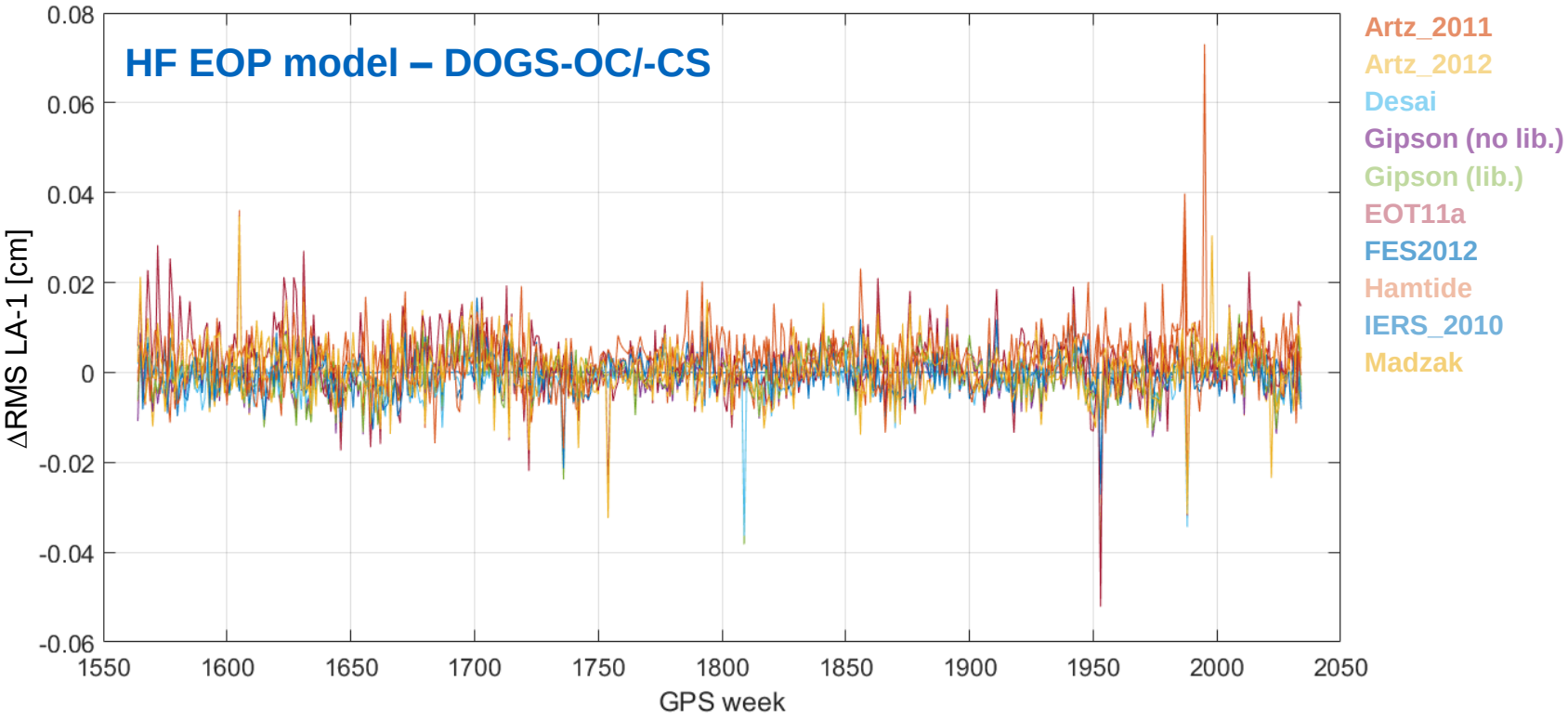
- Estimated parameters: initial state vector, SRP/ALB scaling factor, empirical accelerations (cosine/sine OPR in cross-/along-track + along-track daily polygon), TRF coordinates
- POD based on loose-constrained TRF solution

TEST 2: Estimation of ∆XPO, ∆ YPO, and ∆ LOD w.r.t. IERS 14 C04

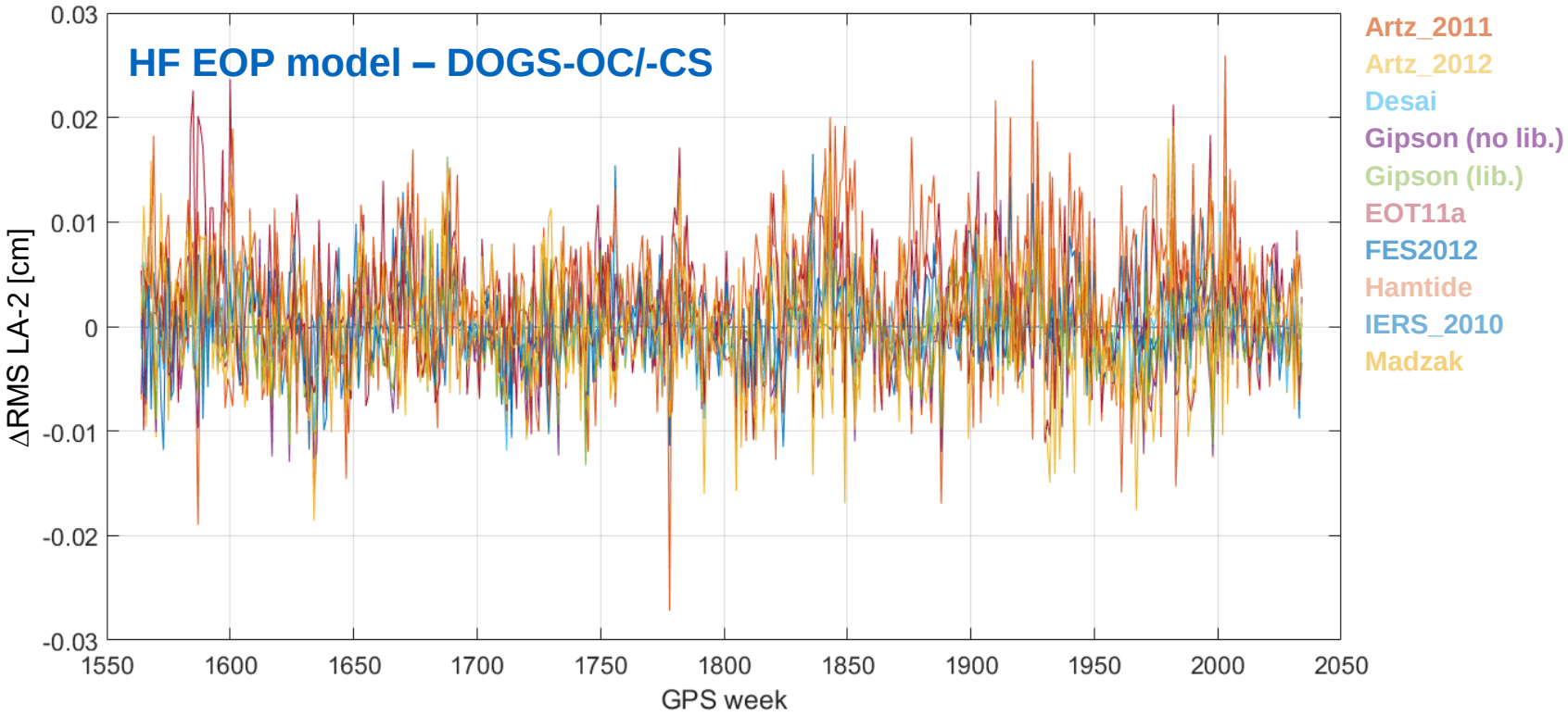
- Estimated parameters: TRF coordinates, XPO, YPO, LOD
- Datum realized weekly through NNR condition of ILRS core network

TEST 1

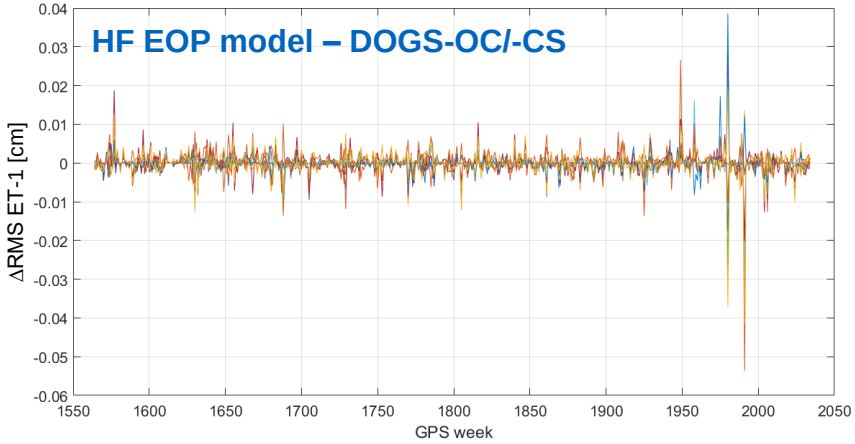
HF EOP impact on LA-1 SLR-RMS (obs. residuals)



HF EOP impact on LA-2 SLR-RMS (obs. residuals)



HF EOP impact on ET-1/-2 SLR-RMS (obs. residuals)



Artz_2011
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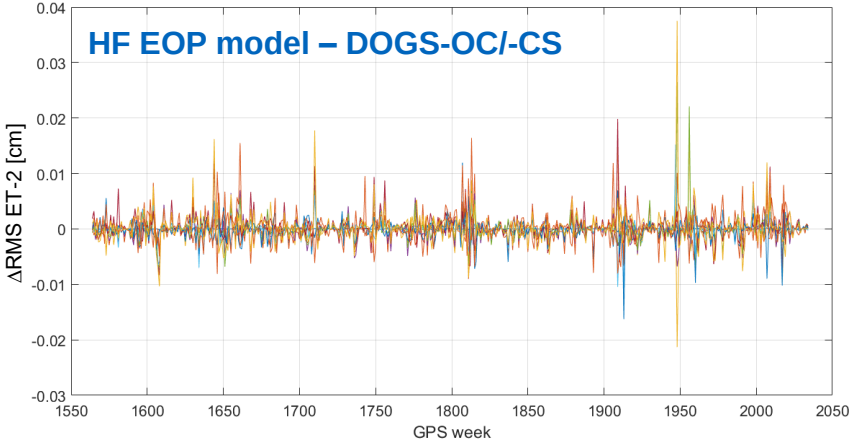
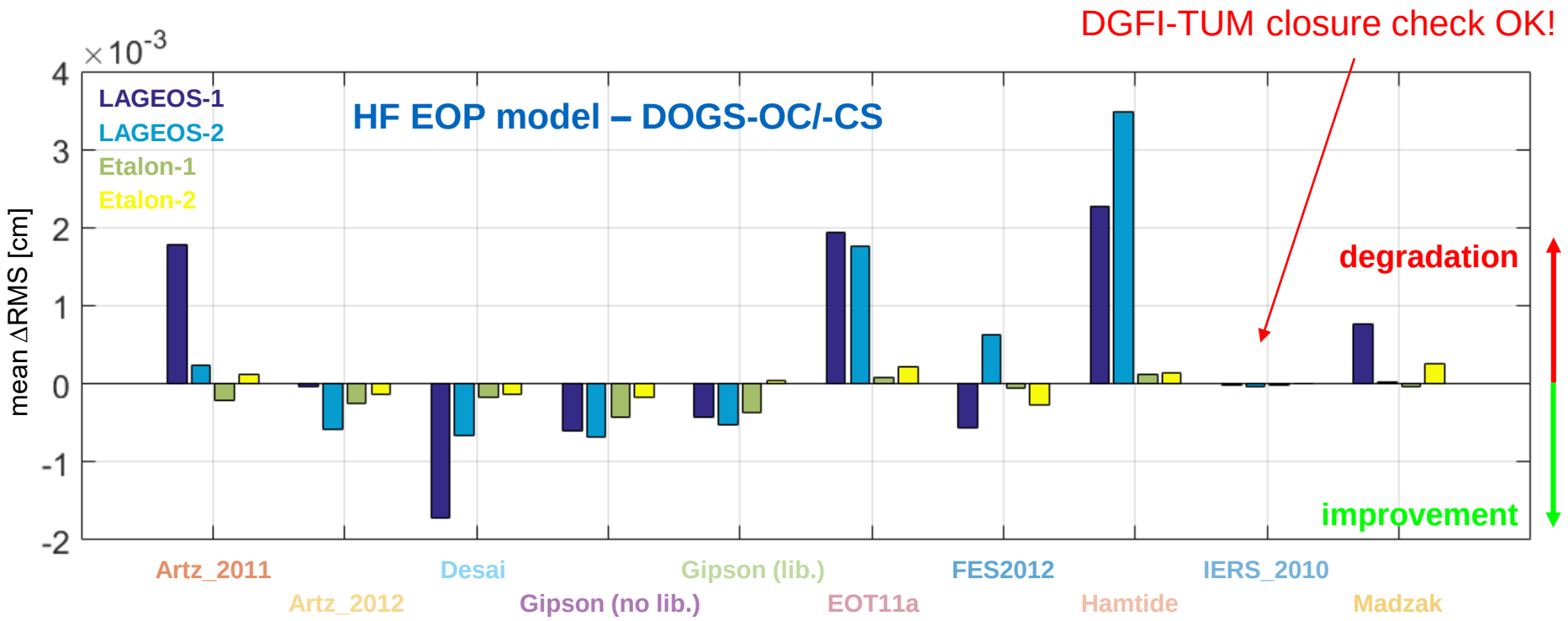


Mean HF EOP impact on SLR-RMS (obs. residuals)



HF EOP impact on SLR-RMS (obs. residuals)

Findings:

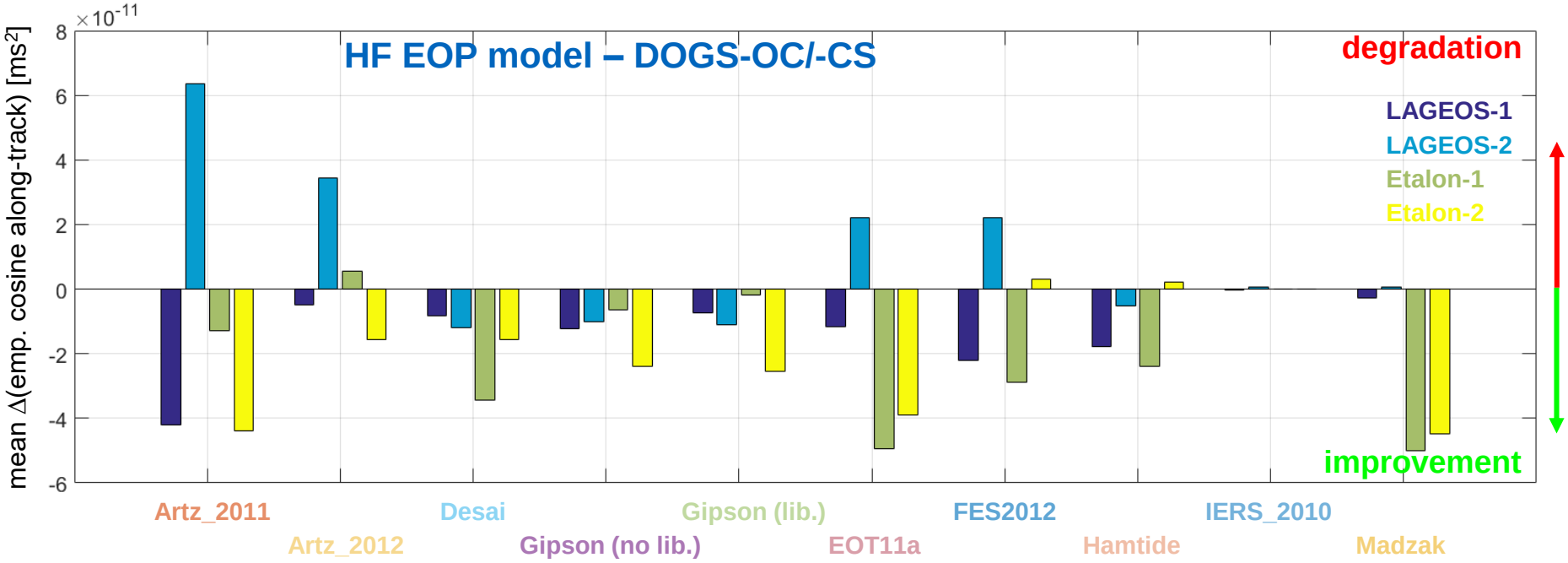
- Closure check for internal DOGS-OC/-CS and external IERS_2010 correction is OK
- Impact on RMS is rather small
- LAGEOS satellites are more affected than the Etalons
  - Impact of HF EOP does not depend on satellite altitude but on temporal distribution of observations during a day → higher impact on more dense LAGEOS observations
- Largest improvement of SLR-RMS obtained for **Desai** and **Gipson model**

HF EOP impact on orbit parameters

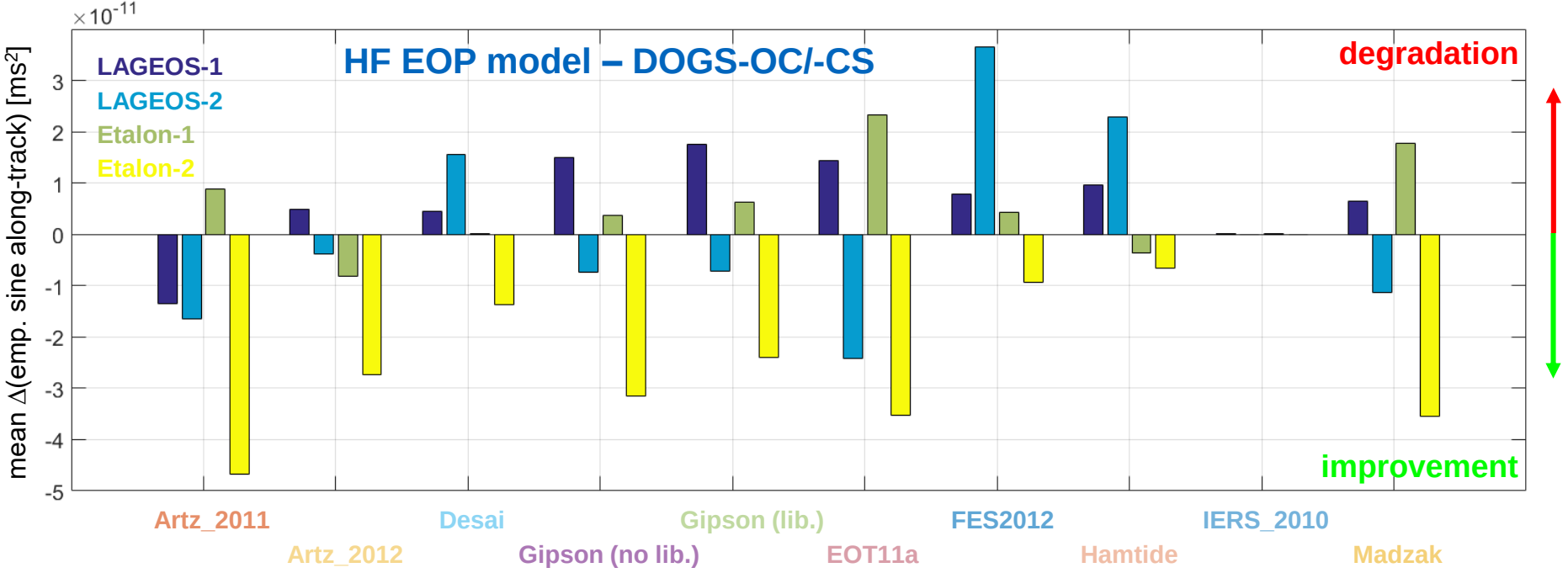
Evaluation criteria:

- Estimated empirical accelerations (cosine/sine OPR in cross-/along-track + along-track daily polygon) should be as small as possible
- Solar radiation pressure (SRP) and Earth albedo (ALB) scaling factors should be equal to one

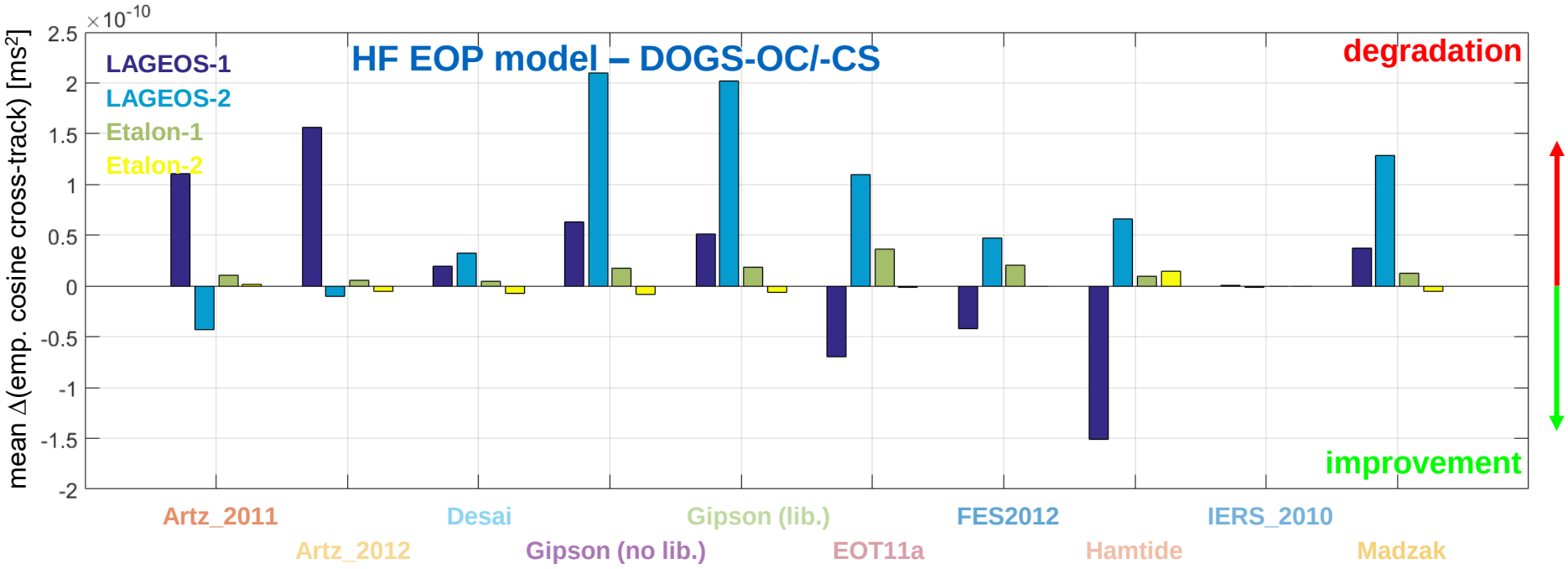
Mean HF EOP impact on emp. accelerations



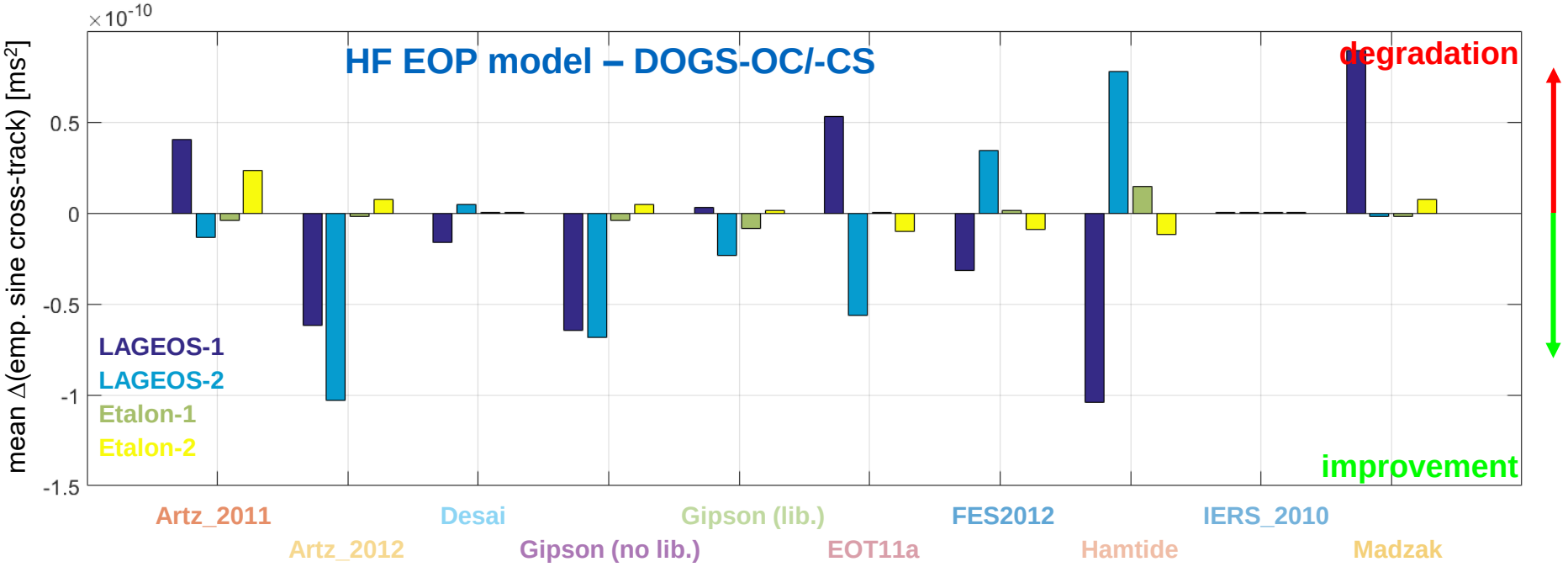
Mean HF EOP impact on emp. accelerations



Mean HF EOP impact on emp. accelerations



Mean HF EOP impact on emp. accelerations



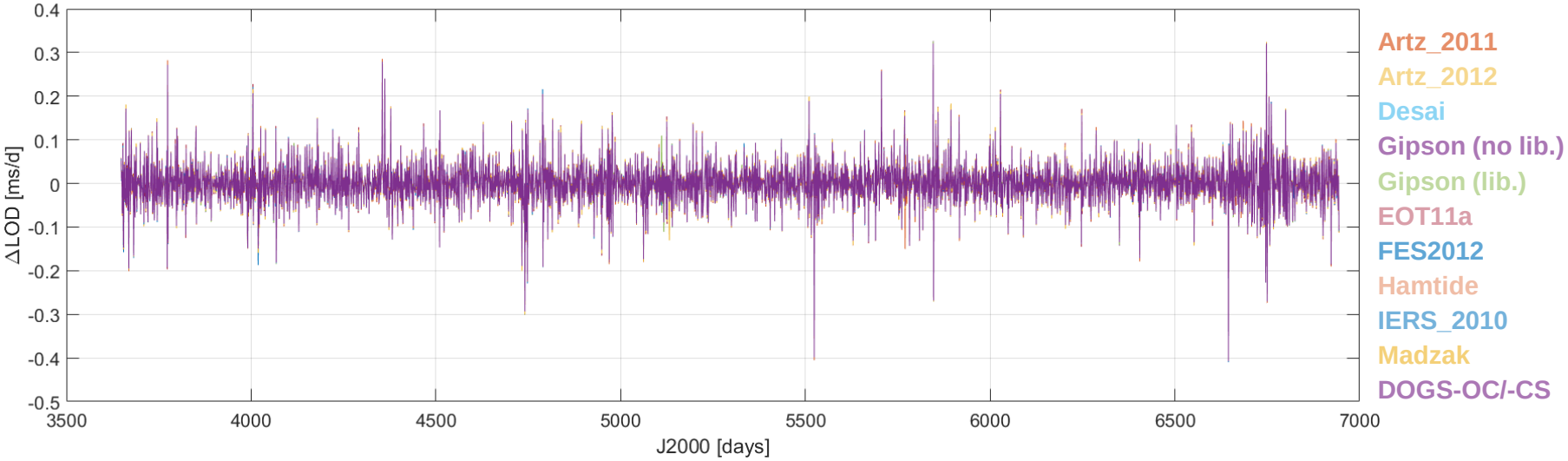
HF EOP impact on orbit parameters

Findings:

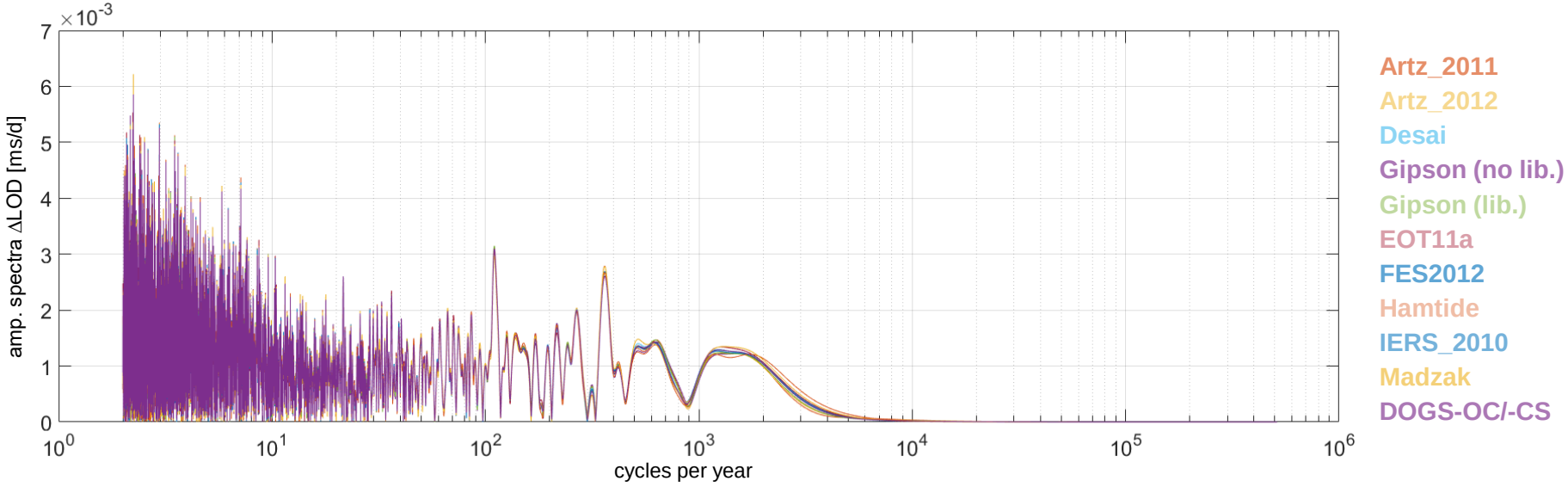
- cosine OPR along-track: Desai, Gipson, Hamtide, and Madzak beneficial
- sine OPR along-track: none clearly beneficial
- cosine OPR cross-track: none clearly beneficial
- sine OPR cross-track: Artz_2012 and Gipson beneficial
- along-track daily polygon: none clearly beneficial
- SRP and ALB scaling factors nearly not affected at all by HF EOP models

TEST 2

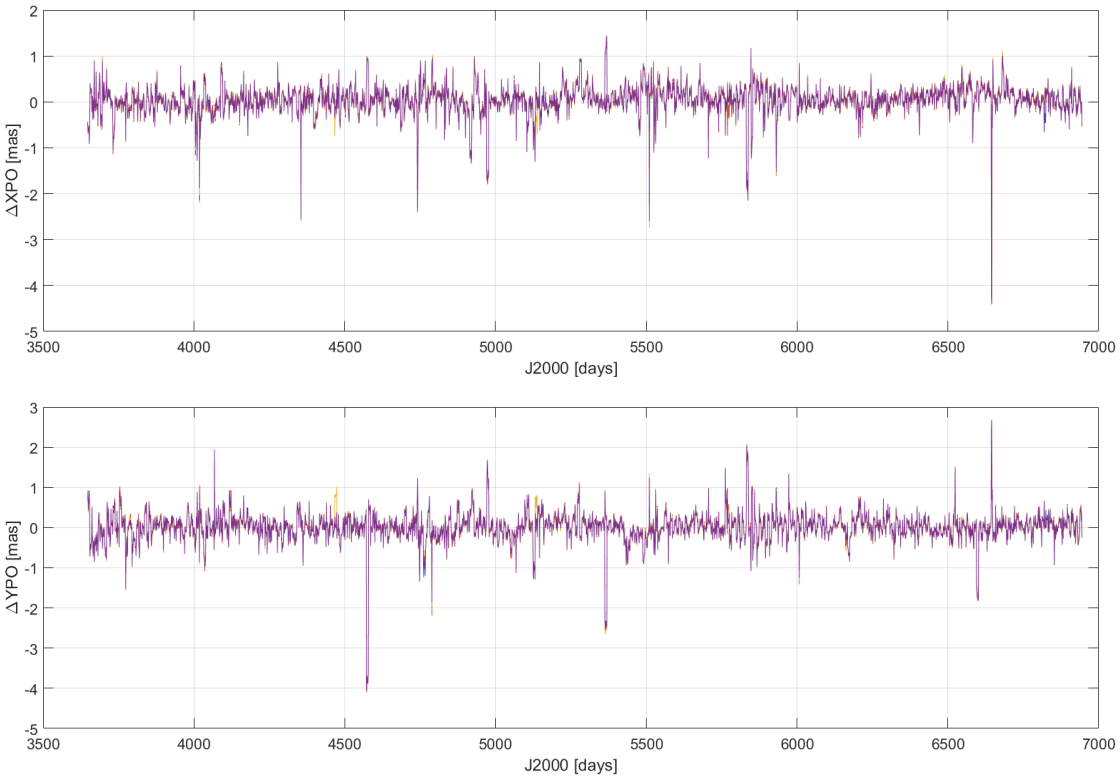
HF EOP impact on ΔLOD w.r.t. IERS 14 C04



HF EOP impact on ΔLOD w.r.t. IERS 14 C04 (spectra)



HF EOP impact on ΔXPO/ΔYPO w.r.t. IERS 14 C04



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Gipson (lib.)
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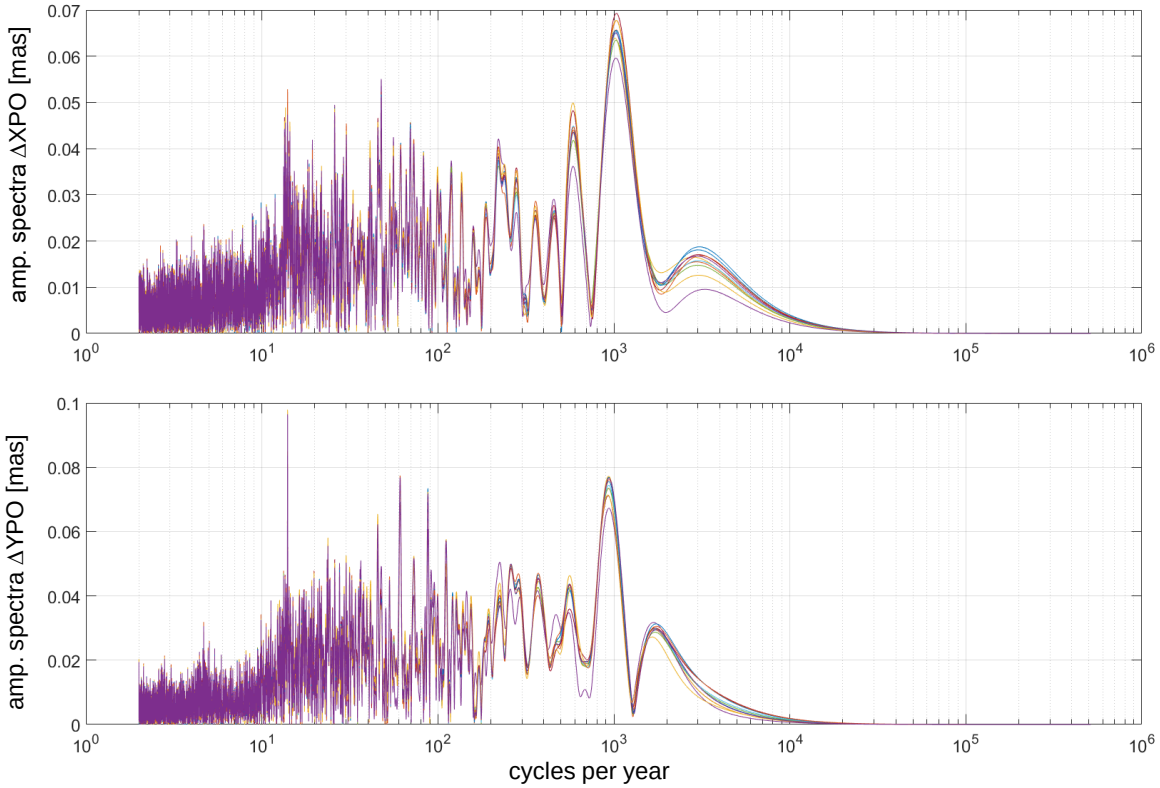
Hamtide
IERS_2010
Madzak
DOGS-OC/-CS

HF EOP impact on ΔXPO/ΔYPO w.r.t. IERS 14 C04 (spec.)



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DOGS-OC/-CS

HF EOP impact on orbit parameters

Findings:

- no significant impact of HF EOP models on ERP at all

HF EOP model validation

Questions from the beginning:

- **Is SLR at all sensitive to HF EOP variations?**
  - Yes, the SLR orbits are sensitive whereas the final ERP do not differ at all
- **Which parameters are affected by HF EOP variations?**
  - RMS of the observation residuals and empirical accelerations are affected
- **Which model is the best?**
  - Desai and Gipson seem to perform slightly better than the rest

General recommendation:

- Within the SLR analysis, it doesn’t really matter which HF EOP model is used
- Desai seems to be favorable since it is a model based on external (non-geodetic) data