

Sub-Daily ERP Investigations

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Sub-Daily ERP Investigations in 2019

Sub-daily ERP model investigations A bit of history.....



- Sub-daily ERP model investigations initially done in 2011
 - Used different models:
 - IERS (ortho_eop.f)
 - GOT4.7
 - TPXO7.1
 - Gipson, 2010a.hfeop_v3_cor6_bakcon
 - Gipson model only one to remove 14-day period in orbit overlap at that time
 - But nothing visible in ERPs nor CRDs
- Redone in 2016/2017 and presented at IGS and UAW WS in Paris 2017

Sub-daily ERP model investigations Test set-up 2019



- Boundary conditions:
 - To see the effect clearly at least 1 year of data needed
 - For station coordinates probably even longer period is needed
 - Testing should be quick in order to keep it interesting and stay motivated, ideally "overnight"
- Selected setup:
 - Use ESA/ESOC IGS Final processing set-up
 - Limited tracking station network to 100 stations
 - 2017 used 60 which seemed to be a bit low
 - Limited to GPS-only to save time
 - 2017 used GPS, GLONASS and Galileo
 - Do the preprocessing only once so that all test solutions use exactly the same data, the only difference between the runs is the sub-daily ERP model that is used

Processing set-up



- Processing settings identical to the ESA IGS Final processing
 - Used the full year of 2018
 - 2017 used the fully year of 2016
 - Normal 24 hour GPS-only processing runs
 - Limited to 100 tracking stations
 - 2016 test used GPS + GLONASS + Galileo
- Pre-processing done only in the first run to ensure all runs use the same data set. So all other runs skip the pre-processing
- Set-up such that the only difference between the runs is the sub-daily ERP model that is used.

Sub-daily ERP models used



- The following sub-daily ERP models were tested in 2019:
 - Bases solution IERS model using ortho_eop
 - Gipsons's VLBI 2016b solution using ortho_eop
 - Name: orthow_2016b_withlibra
 - Desai model using hfeop_xyu software
 - File: desai_model_jgrb51665-sup-0002-ds01.txt
 - Gipson model using hfeop_xyu software:
 - File: 2017a astro lib xyu.txt

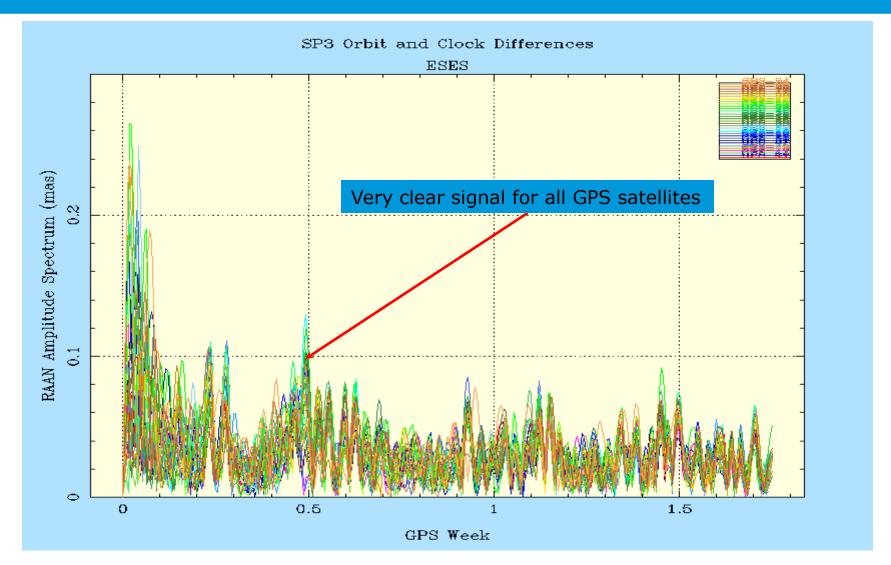
Sub-daily ERP model evaluations



- Look at orbit overlaps:
 - Radial, along-, and cross-track
 - Some signals cross-track but not very clear, and some signal in radial direction
 - Look at overlap of the Kepler elements
 - Very clear signal in right ascension of the ascending node (RAAN), small signals in semi-major axis.
- Still to be done:
 - Look at ERP differences to IERS pole series
 - Some signals in the pole rates and LOD
 - Look at repeatability of the station coordinates
 - And/or one year timeframe to little to separate signal from other station related effects

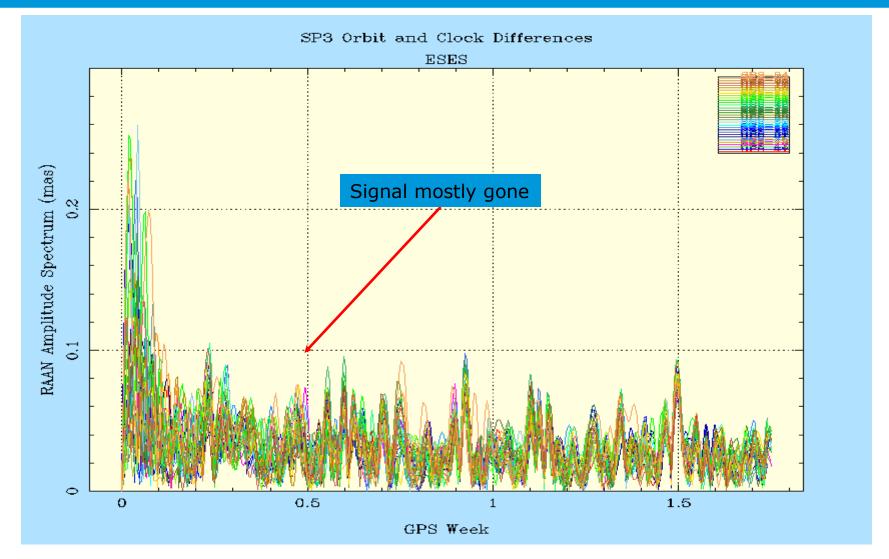
GPS Amplitude Spectrum Model: IERS Right Ascension of the Ascending Node





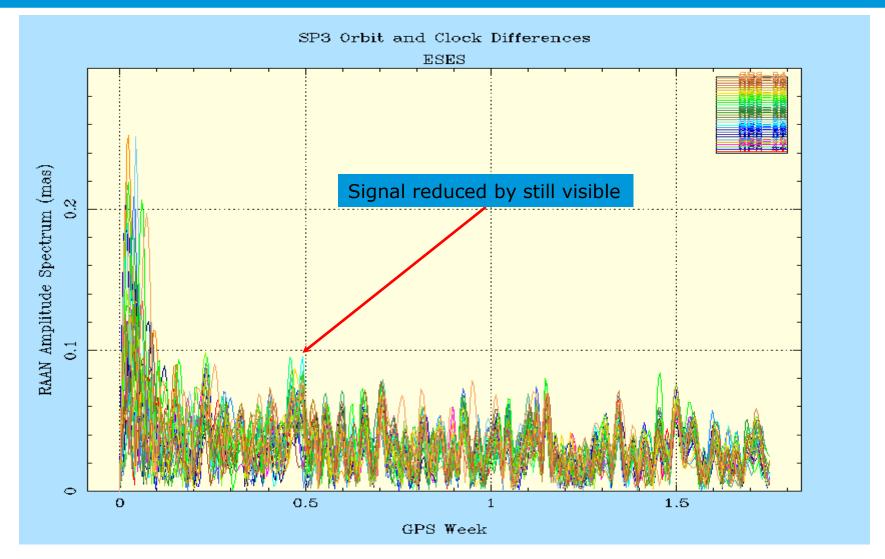
Model: Gipson orthow_2016b_withlibra Right Ascension of the Ascending Node





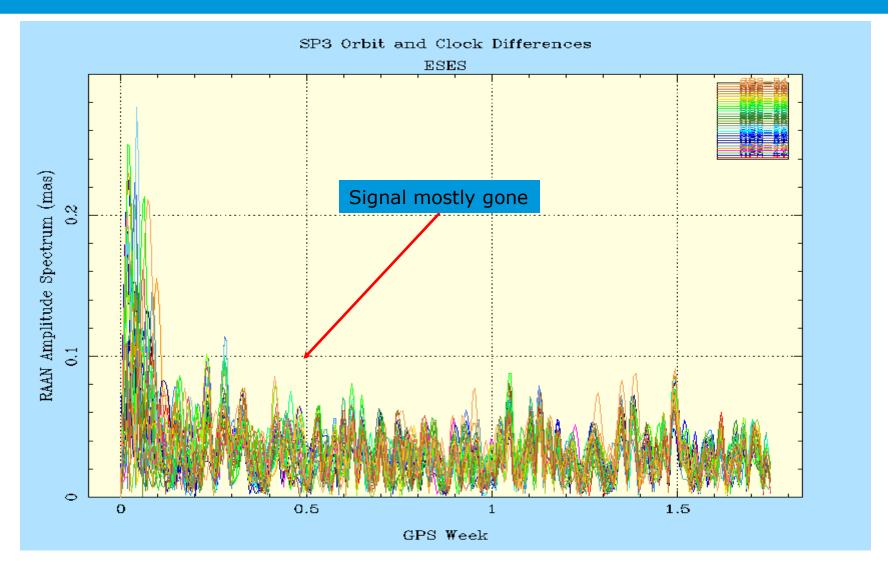
desai_model_jgrb51665-sup-0002-ds01.txt esa **Right Ascension of the Ascending Node**





Model: 2017a_astro_lib_xyu.txt Right Ascension of the Ascending Node





Sub-daily ERP model conclusions



- The results confirm what we saw in 2011 and 2017
- 14 day period most clearly seen in RAAN
 - Indicates largest model errors to be in UT/LOD?
- 14 day period in RAAN completely gone with Gipson model(s)
- Desai model clearly an improvement over the IERS model
 - Gipson model seems to remove more at the 14 day period.



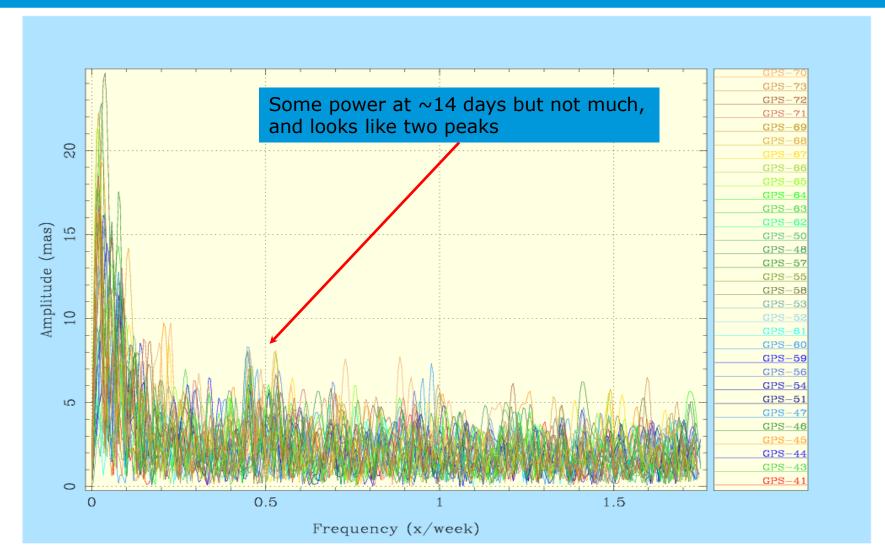
After this slide follow the old results from to 2017 testing

THANK YOU

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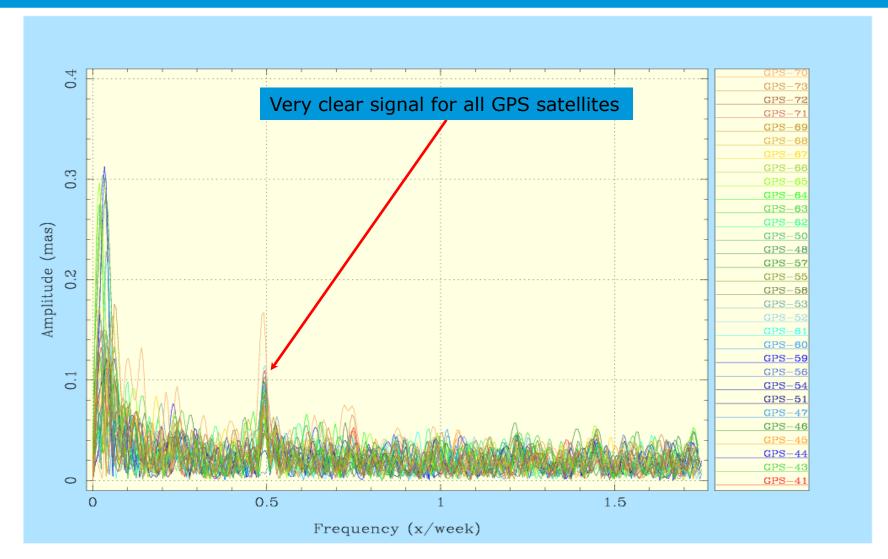
GPS Amplitude Spectrum IERS Model: Cross-track orbit overlaps





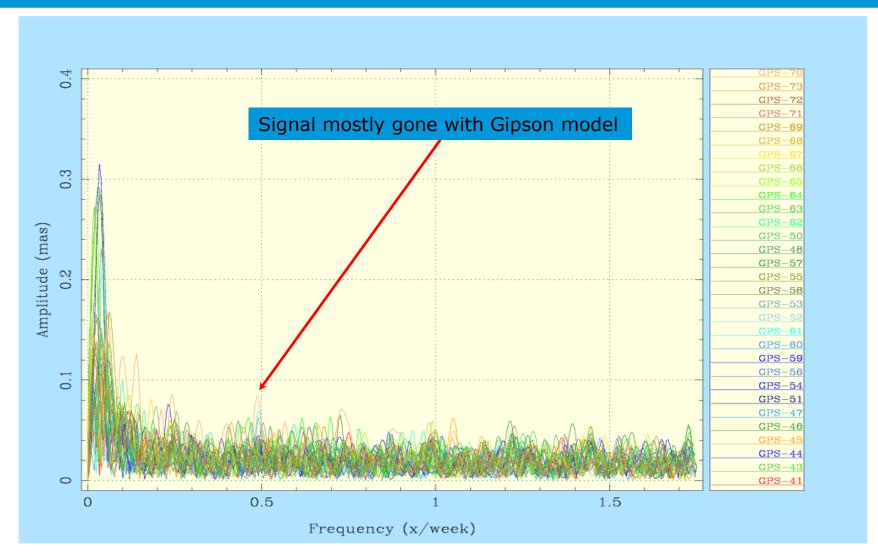
GPS Amplitude Spectrum IERS Model: Right Ascension of the Ascending Node





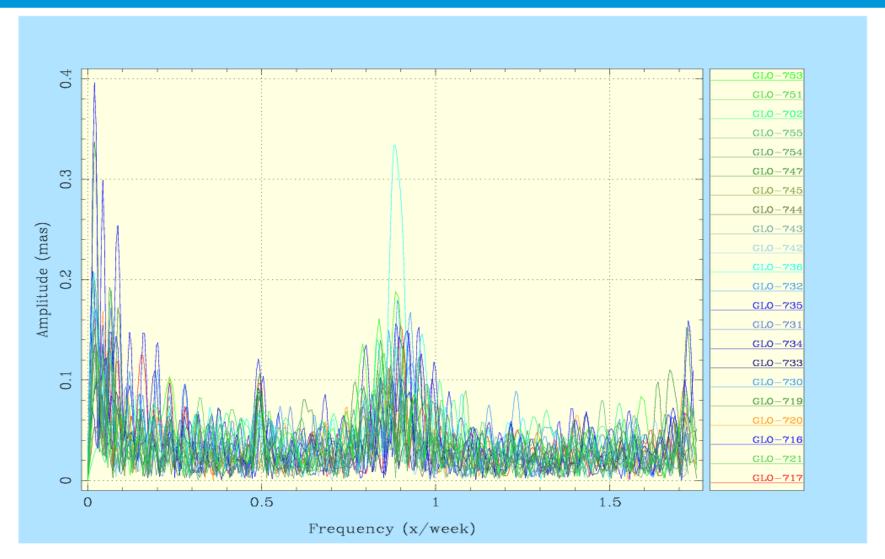
RAAN Amplitude Spectrum for GPS: Gipson model





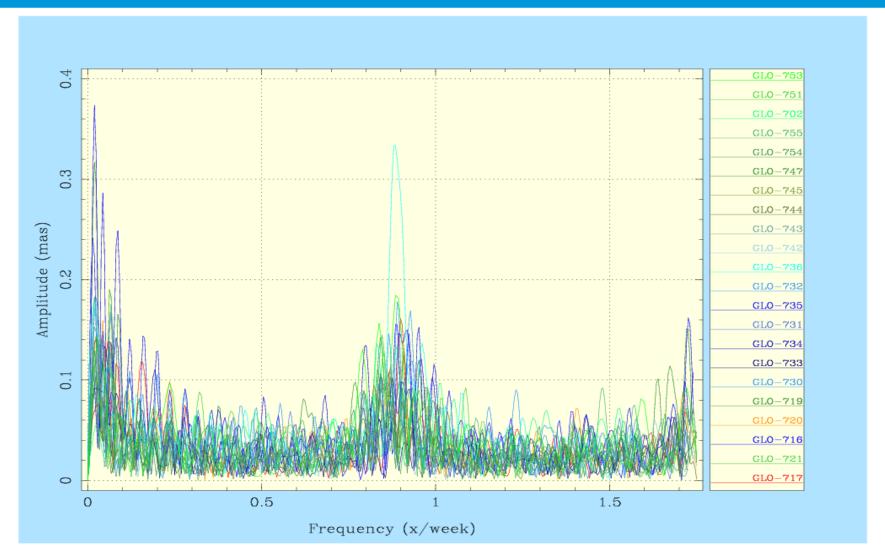
RAAN Amplitude Spectrum for GLONASS: IERS model





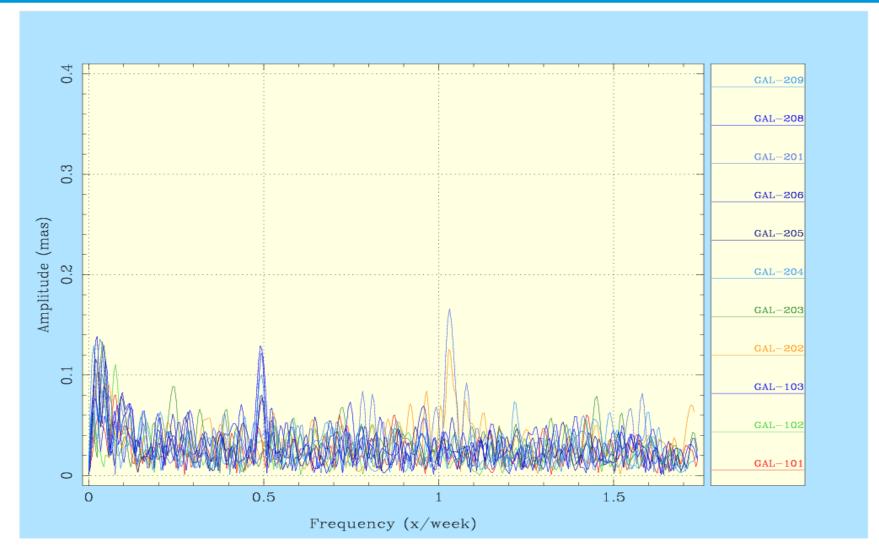
RAAN Amplitude Spectrum for GLONASS: Gipson model





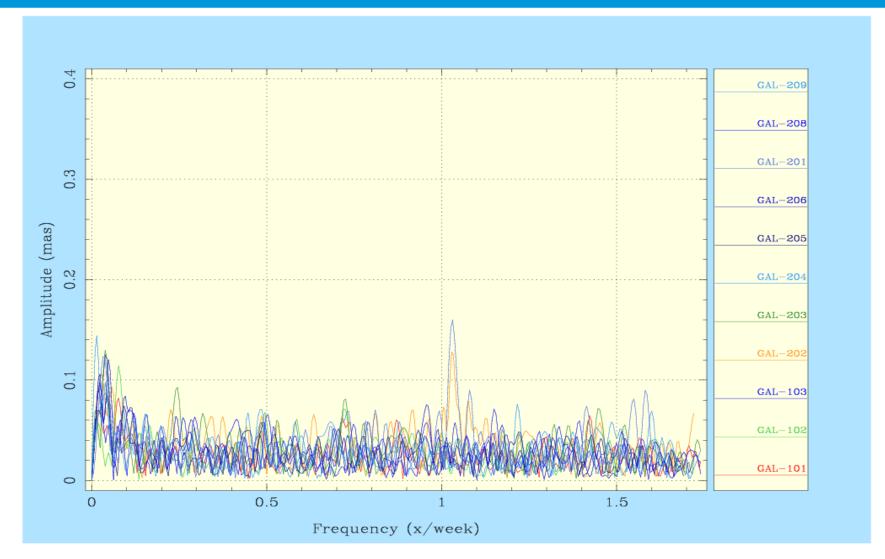
RAAN Amplitude Spectrum for Galileo: IERS model





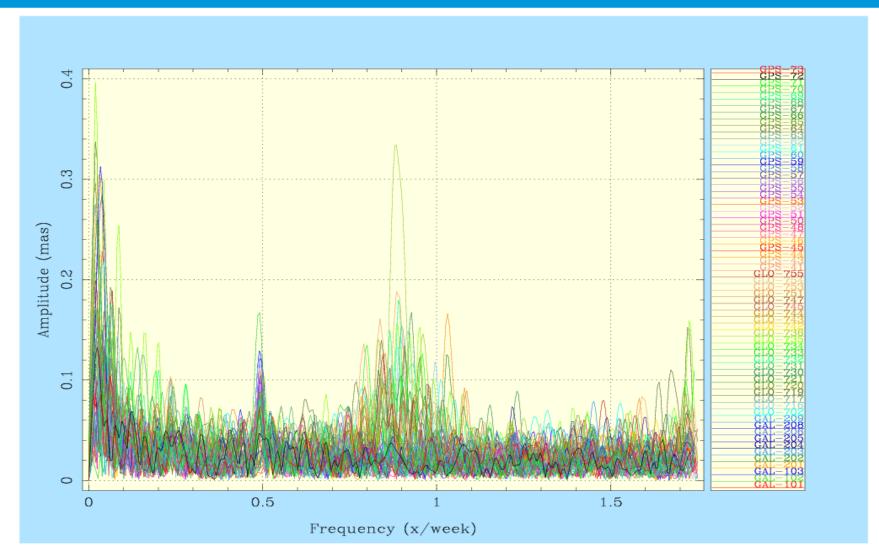
RAAN Amplitude Spectrum for Galileo: Gipson model





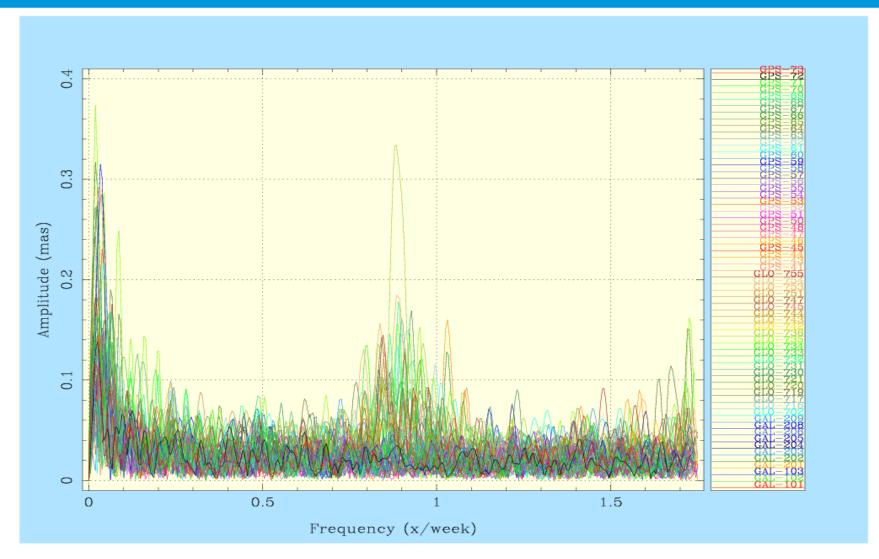
RAAN Amplitude Spectrum for ALL: IERS model





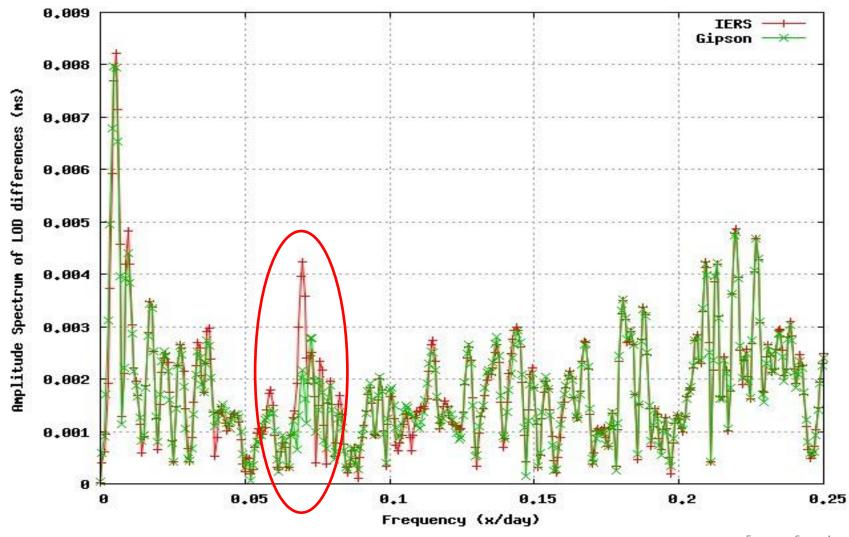
RAAN Amplitude Spectrum for ALL: Gipson model





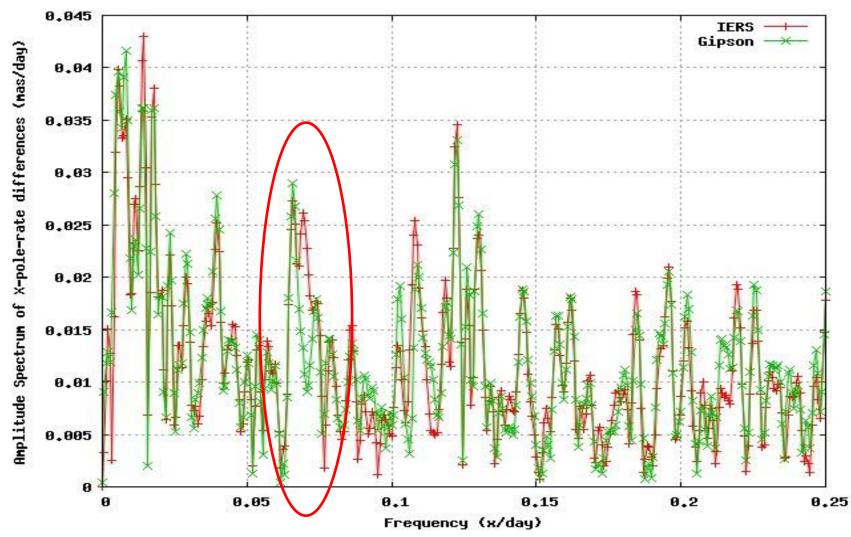
Amplitude Spectra: LOD





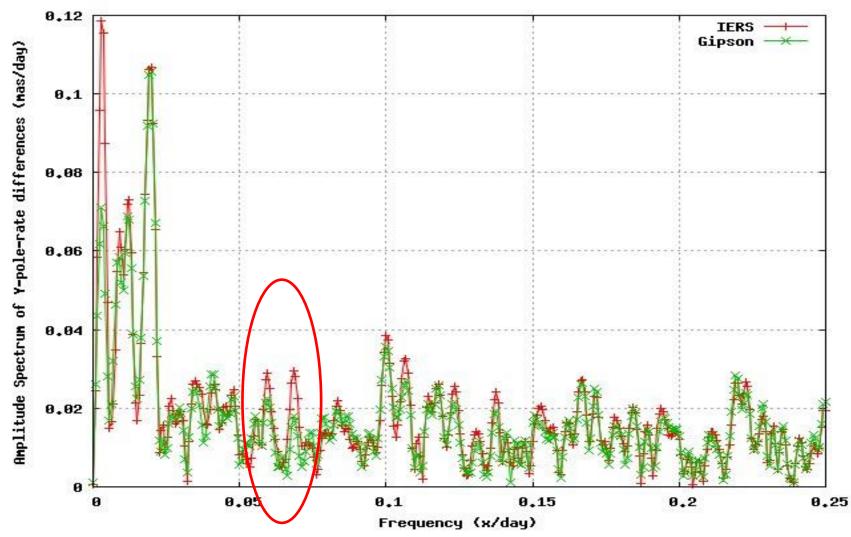
Amplitude Spectra: X-pole rate





Amplitude Spectra: Y-pole rate





Sub-daily ERP model conclusions



- The results confirm what we saw in 2011 with the 2010 Gipson model
- But in 2011 it was based only on using GPS, now we also included GLONASS and Galileo which gives more confidence in these results
 - Different orbital periods, altitudes, and inclinations and even the two "eccentric" Galileo satellites
- 14 day period most clearly seen in RAAN
 - Indicates largest model errors to be in UT/LOD?
- 14 day period in RAAN completely gone with both Gipson and Artz (Bonn) models
 - These models also reduce the 14-day peak in LOD
- Gipson model also reduces the 14-day peaks in X- and Y-pole rates
 - Artz (Bonn) models do not

Sub-daily ERP model way forward



- Real improvements offered by the Gipson model!
 - Only model of the 3 tested to also show improvements in the ERP rates
 - Gipson model holds the promise to significantly reduce the 14day periods observed in several of the IGS/GNSS products
- Model change has been proposed to the IERS conventions!
- A model derived from one of the latest ocean tidal models would be preferred but given the lack of such models the Gipson model does seem to offer a very suited alternative.
 - Fully acceptable for GNSS in general and the IGS in particular, and very much needed to reduce 14-day periods in the products
 - Should also be acceptable for IDS and ILRS
 - What about using it in the IVS?



THANK YOU

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