

To: Ad Hoc Working Group on HF-EOP
From: John Gipson
Re: HF EOP models
Date: December 3, 2017

Summary

I have gathered some high-frequency EOP models and converted them to a common format. I have also written software to read in the models, compute the predicted HF-EOP variation, and write out the results. This memo describes the models and the software.

Model Format

The models are contained in ASCII text files. A “#” as the first character indicates a comment. Non-comment lines use the format of the 2010 IERS conventions to specify the tidal variation at some specific tidal line for X, Y, UT1 and LOD.

Column	What
1	Tidal name or ‘-’
2	Multiplier of GMST+pi
3-7	Multipliers of 5 fundamental nutation arguments.
8	Doodson description or ‘-’
9	Period (days)
10-11	X-pole Sine and Cosine variation (micro-arcseconds)
12-13	Y-pole Sine and Cosine terms (micro-arcseconds)
14-15	UT1 Sine and Cosine terms (microseconds)
16-17	LOD Sine and Cosine terms (microseconds)

The advantage of this format is that you only need a single line per tidal term.

An alternative is to specify tidal variation in terms of retrograde and prograde PM, and variation in UT1 and LOD.

Models

I have information for the following models in this format. I will add additional models if there is interest.

1. IERS2010_xyu.txt: 2010 IERS conventions. This is taken directly from the Technical note. This is essentially the 1996 model re-expressed in terms of tidal lines instead of orthotides.
2. desai_model_jgrb51665-sup-002-ds01.txt: Desai and Sibois model from: “Evaluating predicted diurnal and semi-diurnal tidal variations...” The only changes I have made are to add some comment lines.
3. Madzak_xyu.txt. This data is extracted from the paper “High frequency-Earth rotation variations deduced from altimetry based ocean models” by Madzak et al.
4. 2017a_astro. This is a model I derived using all available 24 hour sessions through November 30, 2017. Some recent VLBI sessions are absent from this because the data has not been correlated and analyzed. This model does NOT include the IERS libration model as an apriori. Stated another, the libration variation is included in the estimates.
5. 2017a_astro_lib. This is the same as 4, but includes the IERS libration model as an apriori.

Note that the HF-EOP variation consists of two-parts: The tidal variation, and libration.

- If you use models (1,2,3, 5) you should probably include IERS libration as an apriori.
- If you use model 4 you should not use the IERS libration

Software

I include a makefile, source code to compute the HF-EOP variation and some sample output. Here is a brief description of the programs/subroutines and what they do. You are welcome to adapt this code to your use, or to 'roll your own'. The code is standard free-format fortran90 code, and compiles under gfortran.

1. Makefile: gfortran makefile which makes the executable *compare_hf_eop*.
2. *compare_hf_eop_xyu.f*: Program to read in the models, calculate hf-eop variation, and write out the results.
3. *import_tides_xyu.f*. Read in the tidal models in the format specified above.
4. *ortho_eop_models.f*. Given the MJDAY (UTC), return the predicted variation in X,Y, UT1. This uses orthotides. There are a couple of options here. You can use the 1996IERS model, or a model based on VLBI data.
5. *calc_hf_eop_xyu.f*: Given the MJDAY (TT time) and Delta_t, and the model arguments and coefficients, calculate the predicted EOP variation *and* its time derivative.
 - a. This returns the array EOP which is (4,2). The first index labels (X, Y, UT1, LOD). The second index labels the variation or the time derivative.
6. *tide_angels.f*: Calculate GMST+pi and the fundamental arguments at some epoch.
 - a. This is called by *calc_hf_eop_xyu.f*. You need to specify MJDAY(TT) and Delta_t
7. *jd_to_date_1.f*: Convert the Julian date(UTC) to a string.
8. *compare_hfeop.txt*: This is the output of *compare_hf_eop_xyu*.
 - a. In addition to the 5 models specified above this also contains the 96IERS results. You can use this to see how well the models agree with each other.
 - b. There are slight variations between the two forms of the IERS model. The RMS difference in X-pole, Y-pole is about 1.5 micro-arcsecond, and in UT1 about 0.2 microseconds.