IERS Working Group on HF-EOP

John Gipson, Chair
NVI,Inc/NASA GSFC

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Washington, DC
Issues & Recent Results

Current IERS model of HF-EOP is ~ 20 years old and based on tidal models.

- Madzak (2016) derived a model based on satellite altimetry data and showed it was better for VLBI
- Desai and Sibois (2016) derived a model based TPX0.8 and showed that it worked better in GNSS
- Springer (2017) used an empirical model provided by Gipson derived from VLBI data. This reduced GNSS residuals.

All this suggests the IERS model is no longer adequate and needs to be updated.
Formation & Goals of Working Group

An ad hoc Working Group on ‘Diurnal and semi-diurnal Earth orientation variation’ was established as an outgrowth of the 2017 JULY GGOS/IERS UAW in Paris.

At the 2017 IERS Directing Board meeting the working group was put under the auspices of the IERS.

This working group includes representatives of all space geodetic techniques.

The WG will evaluate a suite of models and make recommendations to the IERS.

John Gipson  NVI, Inc./NASA GSFC
IERS Working Group on Diurnal and Semi-diurnal EOP Variations

This page is meant to facilitate communication among the members of the IERS Working Group on Diurnal and Subdiurnal Earth Orientation Variation. It is maintained by John Gipson, chair of this Working Group, and IVS Analysis Coordinator. This has the following subdirectories:

- **Models** of diurnal and sub-diurnal EOP variation in IERS format.
- **Software** and output used to generate HFEOP from different models.
- **Memos** written by members of the working group.
- **Presentations** related to our work
- **Papers** related to our work
- **Archived WG mail** Must be a WG member to access.

The position of the IVS Analysis Coordinator is currently supported by NASA GSFC.
# Models to be tested

## Tidal Models

<table>
<thead>
<tr>
<th>Model</th>
<th>Source</th>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>IERS Conventions</td>
<td>Based on TPX 0.4</td>
<td>Current</td>
</tr>
<tr>
<td>Desai and Sibois</td>
<td>Based on TPX 0.8.</td>
<td>Better on GNSS</td>
</tr>
<tr>
<td>Madzak et al</td>
<td>Tidal model</td>
<td>Better on VLBI</td>
</tr>
<tr>
<td>Ray</td>
<td>Based on TPX 0.9</td>
<td>Newer tide model</td>
</tr>
<tr>
<td>Lyard</td>
<td>FES2014</td>
<td>Newer tide model</td>
</tr>
</tbody>
</table>

## Empirical Models

<table>
<thead>
<tr>
<th>Model</th>
<th>Source</th>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gipson</td>
<td>Derived from VLBI data</td>
<td>Fit using VLBI, better on GNSS</td>
</tr>
<tr>
<td>Artz et al</td>
<td>Derived from VLBI and GNSS</td>
<td>Untested on other techniques</td>
</tr>
</tbody>
</table>

1. We welcome other promising candidates.
2. All of the models are fairly similar.
3. *We need your help to test!*

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Comparison of Two Models

UT1 Predictions

August 2008

GOT4  JMG(ALL)
Comparison of Two Models

Difference in UT1

August 2008

GOT4-JMG(ALL)
Comparison of Two Models

Difference in UT1

August 2008

GOT4-JMG(ALL)

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Some GPS Results

PLTGEN PLOT

Amplitude RaAN (mas)

Frequency (1/weeks)

IERS model

Courtesy Tim Springer
Some GPS Results

PLTGEN PLOT

Amplitude RaAN (mas)

Frequency (1/weeks)

Gipson 2010
VLBI model

Courtesy
Tim Springer

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Some VLBI Tests

Applying IERS model reduces baseline scatter.

All following tests use CONT17 data set.
Each point is the difference in baseline scatter between ‘None’-IERS. If a point is above the axis, then IERS is better. Below, then ‘None’ is better.

Reduction in scatter for 65/86 baselines. Average reduction is 0.94 mm

**IERS Model is better than no model.**

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Each point is the difference in baseline scatter between IERS – VLBI model.

Reduction in scatter for 49/86 baselines using Gipson.
Average reduction is 0.05 mm

Gipson is better
IERS vs FES2012 model

Reduction in scatter for 36/86 baselines with FES. Average reduction is -0.01 mm

IERS is better…
But really not much difference

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Reduction in scatter for 48/86 baselines with Desai & Sibois. Average reduction is 0.02 mm

Desai&Sibois is better

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Reduction in scatter for 46/86 baselines with Gipson. Average reduction is 0.03 mm
IERS-Gipson and Desai-Gipson

For VLBI analysis, Desai&Sibois better than current IERS.

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Take model as a priori, and then estimate residual tidal terms.

This was done using VieVs.

Best agreement is with Gipson… not too surprising, since this was derived from VLBI data.
WRMS of residuals from 1072 R1, R4 and CONT sessions from 2007-2016.

Gipson is best of empirical techniques. Desai & Sibois best of tidal models.

Nilsson used VieVs@GFZ
Can use the residual as a measure of the goodness of the model.

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RMS Signal  ~30 µs
RMS Residuals ~10 µs
Formal errors ~ 6 µs
## Residual Hourly EOP over all CONTS

<table>
<thead>
<tr>
<th>Model</th>
<th>X-pole μas</th>
<th>Y-pole μas</th>
<th>Total PM μas</th>
<th>UT1 μs</th>
<th>Total EOP μas</th>
</tr>
</thead>
<tbody>
<tr>
<td>IERS</td>
<td>107.1</td>
<td>114.0</td>
<td>110.4</td>
<td>7.66</td>
<td>111.90</td>
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<tr>
<td>Desai&amp;Sibois</td>
<td>105.4</td>
<td>110.4</td>
<td>107.8</td>
<td>7.57</td>
<td>109.80</td>
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<tr>
<td>EOT11a</td>
<td>114.5</td>
<td>119.9</td>
<td>117.1</td>
<td>8.60</td>
<td>121.20</td>
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<tr>
<td>FES2012</td>
<td>110.7</td>
<td>113.4</td>
<td>112.0</td>
<td>7.63</td>
<td>112.80</td>
</tr>
<tr>
<td>HAMTIDE</td>
<td>111.3</td>
<td>120.4</td>
<td>115.7</td>
<td>7.88</td>
<td>116.60</td>
</tr>
<tr>
<td>Madzak</td>
<td>112.3</td>
<td>114.7</td>
<td>113.5</td>
<td>8.03</td>
<td>115.90</td>
</tr>
<tr>
<td>Gipson</td>
<td>105.5</td>
<td>111.1</td>
<td>108.2</td>
<td>7.25</td>
<td>108.40</td>
</tr>
<tr>
<td>ABN_VLBI</td>
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<td>115.2</td>
<td>111.0</td>
<td>7.41</td>
<td>111.10</td>
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<tr>
<td>ABN_COMB</td>
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<td>110.5</td>
<td>108.5</td>
<td>7.33</td>
<td>109.00</td>
</tr>
</tbody>
</table>

**Best and worst results.**

Work done by Tobias Nilsson

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As a result of this and several other tests, Nilsson’s general conclusion is that the Desai & Sibois and Gipson models were best.
Conclusions/Next Steps

Testing of different models by VLBI groups is well underway and we have some preliminary results.

→ Desai is better than current IERS.
→ Not as good as Gipson.

Waiting for feedback from other VLBI and non-VLBI groups.

We need to agree on a model prior to ITRF2020—and IGS plans on beginning reprocessing in June 2019.

Won’t you please help!

John Gipson  NVI, Inc./NASA GSFC
Each point is the difference in baseline variance between None-IERS.

Reduction in variance for 65/86 baselines.
Average reduction is 15 mm^2

IERS Model is better than no model.