Towards Models and Standards for the Next ITRF

F.G. Lemoine
IDS Analysis Working Group Meeting
Prague, Czech Republic
May 31 – June 1, 2012
New standards & data

Improvements based on experience with ITRF2008
1. Update to Radiation pressure modelling, macromodels (SRP …).  
2. Parameterization for Atmospheric drag.  
3. Update to Troposphere modelling; GMF/GPT or VMF1.  

Force & measurement model improvements
1. New static geopotential model based on GRACE+GOCE?  
2. Time-varying geopotential?  
3. Ocean Tides (also Ocean Loading).  
4. DPOD2008 – with fixes for problems identified in operational combination.  
5. IERS2010 standards.

Data
1. New satellite data (Jason-2, Cryosat2).  
3. How to handle SPOT-5/SAA issue?  
4. More rigorous attention to a priori deletes (e.g. DPOD2008).
### AC Modelling summary, ITRF2008

<table>
<thead>
<tr>
<th>AC</th>
<th>Gravity</th>
<th>Atmos. Gravity</th>
<th>Ocean Tides</th>
<th>Troposphere + Met Data + Mapping Function</th>
<th>Elev. Cutoff (Deg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESOC</td>
<td>EIGEN-GL05C (120x120)</td>
<td>NCEP</td>
<td>FES2004</td>
<td>GMF+GPT + GMF</td>
<td>10°</td>
</tr>
<tr>
<td>GAU</td>
<td>GGM02C</td>
<td>NCEP</td>
<td>GOT4.7</td>
<td>Hopfield + GPT+Niell</td>
<td>12°</td>
</tr>
<tr>
<td>GOP</td>
<td>EIGEN-GL04S (100x100)</td>
<td>ECMWF</td>
<td>CSR3</td>
<td>GMF+ GPT + GMF</td>
<td>10°</td>
</tr>
<tr>
<td>GSC</td>
<td>EIGEN-GL04S (120x120)</td>
<td>ECMWF</td>
<td>GOT4.7</td>
<td>Hopfield + GPT+Niell</td>
<td>10°</td>
</tr>
<tr>
<td>IGN</td>
<td>GGM03S (120x120)</td>
<td>-</td>
<td>FES2004</td>
<td>GMF+ formula +GMF</td>
<td>10°</td>
</tr>
<tr>
<td>INA</td>
<td>GGM01C (120x120)</td>
<td>-</td>
<td>CSR3</td>
<td>Lanyi+ formula+Lanyi</td>
<td>15°</td>
</tr>
<tr>
<td>LCA</td>
<td>EIGEN-GL04S</td>
<td>ECMWF</td>
<td>FES2004</td>
<td>(1)</td>
<td>12°</td>
</tr>
</tbody>
</table>


**IGN, INA**: Apply Atmospheric Gravity.  
**GSC, GAU**: Update Troposphere mapping Function.
Radial Annual Signal, Jason Orbit

NCEP-6hr

ECMWF-3hr + (T-UGO)

Hydrology (GLDAS)

ECMWF-3hr+ (T-UGO) +GLDAS
Ocean Tide Modelling

For dynamical application & ocean loading.

New Tide Models since ITRF2008.

• GOT4.8 (Corrects minor S2 error in GOT4.7)
• EOT11a
• TPX07.2, TPX07.2Atlas.
• FESXX?

Site of Duncan Agnew, SPOTL -> software to compute ocean loading parameters by station.
New Geopotential Models

Complicated – because one has to select a static model (e.g. GRACE + GOCE+others) and a time-variable gravity parameterization that will work 1993-2012.

ICGEM (Potsdam)
URL:  http://icgem.gfz-potsdam.de
New Geopotential Models

Recent Geopotential Models (examples)
- GOCO2S. (Goce, Grace, Lageos, Champ, 2011)
- EIGEN6S (Goce, Grace, Lageos, 2011)
  - Secular, Annual, Semi-annual terms to 50x50 – Rate terms do not project well beyond period over which they are determine – not just C20.
- GO_CONS_GCF_2_DIR_R3 (Goce, Grace, Lageos, 2011)
### AC Modelling summary, ITRF2008. (2)

<table>
<thead>
<tr>
<th>AC</th>
<th>Solar Radiation Pressure Modelling</th>
<th>Atmosphere Density Model</th>
<th>Drag Coefficient Estimation</th>
<th>Planetary Radiation Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESOC</td>
<td>Envisat : ANGARA Doornbos et al. (2002) T/P &amp; SPOT's : Box-wing</td>
<td>MSIS90</td>
<td>Cd/2.4 hrs</td>
<td>Knocke et al. (1988)</td>
</tr>
<tr>
<td>GAU</td>
<td>T/P, SP2, SP3 : GSFC(1) box-wing (untuned) SP4, SP5, Envisat : CNES box-wing (untuned) (2)</td>
<td>MSIS86</td>
<td>SPOT’s &amp; Envisat : Cd/6 hrs T/P : Cd/8hrs</td>
<td>Knocke et al. (1988)</td>
</tr>
<tr>
<td>GOP</td>
<td>N/A (3) N/A (3) (3) N/A (3)</td>
<td>N/A (3)</td>
<td>(3)</td>
<td>N/A (3)</td>
</tr>
<tr>
<td>IGN</td>
<td>CNES box-wing (tuned) Gobiaddass et al. (2009)</td>
<td>DTM94</td>
<td>SPOT’s &amp; Envisat : Cd/1hr T/P : Cd/day</td>
<td>Knocke et al. (1988)</td>
</tr>
<tr>
<td>INA</td>
<td>CNES box-wing (untuned) (2)</td>
<td>DTM94</td>
<td>SPOT’s &amp; Envisat : Cd/6hrs T/P : Cd/day</td>
<td>Not Applied</td>
</tr>
<tr>
<td>LCA</td>
<td>CNES box-wing (untuned) (2)</td>
<td>DTM94</td>
<td>T/P: Cd/12 hrs SPOT’s &amp; Envisat Cd/4 hrs Cd/1 hr 2001-2002</td>
<td>Albedo &amp; IR values from 6-hr ECMWF grids</td>
</tr>
</tbody>
</table>

(1) See Le Bail et al. (2010) for GSFC macromodel summaries.
(2) CNES macromodels available from the IDS data centers.
(3) No exact models for non-conservative forces. Empirical constant and harmonic parameters in Sun and y-directions; Stochastic parameters along-track every 15 minutes (Stepanek et al., 2006).

Table 3b, Valette et al., 2010.
Nonconservative Force Modelling

• ACs who did not adopt/use tuned macromodels, in ITRF2008 should update models – especially if the OPR amplitudes are high wrt other ACs. (INA, GAU).

• **Drag Parameterization:**
  For ~800 km satellites (SPOTs, Envisat)
  cd 2-4 hrs (low F10.7)
  cd 1-2 hrs (high F10.7, near solar maximum)
DORIS System Time Bias

- Origin – is that DORIS time system is offset from SLR produces along-track bias (e.g. Zelensky et al., JoG 2006).
- Discernible on all satellites with SLR+DORIS.
- Use SLR+DORIS derived time biases at least for TOPEX;

SLR/DORIS vs DORIS-only Orbit Differences

TOPEX

Le Bail et al., 2010
DORIS System Time Bias (TOPEX)
DORIS System Time Biases (2011)