Current Limitations in DORIS POD & Preparations for the next ITRF

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Issues

1. Review of ITRF2008 Modeling by AC’s
3. Troposphere modelling.
4. New gravity models, static & time-variable; New ocean tide models, esp. for S2?
5. DORIS system time-bias.
6. Atmosphere & Hydrological loading.
7. Phase maps for DORIS antennae, ground or spacecraft?
8. Nonlinear motion for stations? DPOD2008?
AC Modelling summary, ITRF2008. (1)

<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-GL04S1 (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>


Table 3a, Valette et al., 2010.
<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 Doomnes 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/8 hrs</td>
<td>Knocke et al. (1988)</td>
</tr>
<tr>
<td>GOP</td>
<td>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) Gobinddass 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 model improvements?

All AC’s used DTM94 or MSIS86. Use newer atmosphere models? (e.g. GRACE-derived; or JB2006, Bowman et al., 2008-J. Atmos. Sp. Physics)

UCL models for SPOT’s & Cryosat-2?

Self-shadowing as in Mazarico et al., 2009, J. Spacecraft Rockets, for MRO?

Spacecraft attitude at three different orbital positions - view from different directions.
**Troposphere modelling**

- Errors in mapping functions propagate directly into scale of solutions. ==> Use GMF or VMF rather than older models; Test application at lower elevation angles.

- Test application of tropospheric gradients?

- Test application of temporal constraints by station? E.g. The SPOT & Envisat satellites are sun-synchronous with time at descending node close to ~22:00 hrs solar time. Why not use this information to our advantage?
New Geopotential Models

• New (static) geopotential models with GOCE and/or GOCE+GRACE data will soon be available.

• New time-variable solutions, e.g.
  • CNES version2 solutions (*Bruinsma et al.*, 2010).
  • GFZ & CSR & other (TU Delft, GSFC?) analysis centers regularly produce monthly GRACE solutions.

• All AC’s should update to current-state of the art tide models (FES2004, GOT4.7, EOTxx, TPX06).

• S2 modelling (or possible mismodelling) could affect all the sun-synchronous satellites.

• Improvements in individual ocean tide models may be important for application of ocean loading corrections at certain locations (Greenland, Antarctica).
Tide Constituent Residuals from GRACE  
(Ray et al., JGR 2009)

Current tide models have problems in specific areas e.g. some shallow seas, Antarctic Peninsula, Arctic .... That might affect ocean loading corrections for nearby stations ... Use improve Oload corrections for stations in these areas? IERS special bureau for loading? Other sources?
DORIS system time-bias (wrt. SLR)

SLR/DORIS vs DORIS-only Orbit Differences

TOPEX

Envisat

- But what to do for the SPOT satellites?

Le Bail et al., 2010

DORIS POD Limitations, Lemoine et al., DORIS AWG, Darmstadt, May 26-27, 2010
Nonlinear motions for stations

Gps-derived Concepcion earthquake displacement field

Relaxation (uplift) due to ice melt in Greenland; see Khan & Wahr et al., 2010, GRL.

• A measurable displacement at Santiago

Results with ign09wd01.stcd for Thule …
Our near-term objectives should be to improve our non-conservative force modelling & the troposphere modelling as this will likely yield the most benefits … But there are other issues.