Current Limitations in DORIS POD & Preparations for the next ITRF

F.G. Lemoine

IDS AWG@ESOC, Darmstadt, Germany

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1. Review of ITRF2008 Modeling by AC's

2. Non-conservative modelling.

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)

AC	Gravity	Atmos. Gravity	Ocean Tides	Troposphere + Met Data + Mapping Function	Elev. Cutoff (Deg)
ESOC	EIGEN-GL05C (120x120)	NCEP	FES2004	GMF+GPT + GMF	10°
GAU	GGM02C	NCEP	GOT4.7	Hopfield + GPT+ Niell	12°
GOP	EIGEN-GL04S (100x100)	ECMWF	CSR3	GMF+ GPT + GMF	10°
GSC	EIGEN-GL04S1 (120x120)	ECMWF	GOT4.7	Hopfield + GPT+ Niell	10°
IGN	GGM03S (120x120)	-	FES2004	GMF+ formula +GMF	10°
INA	GGM01C (120x120)	-	CSR3	Lanyi+ formula+ Lanyi	15°
LCA	EIGEN-GL04S	ECMWF	FES2004	(1)	12°

(1) After 2002. Dry and Wet Interpolated from ECMWF grids; Before 2002, use DORIS Met. Data. Mapping function Guo and Langley (2003).

Table 3a, Valette et al., 2010.

AC Modelling summary, ITRF2008. (2)

AC	Solar Radiation Pressure Modelling	Atmosphere Density Model	Drag Coefficient Estimation	Planetary Radiation Pressure
ESOC	Envisat : ANGARA Doornbos et al. (2002) T/P & SPOT's : Box-wing	MSIS90	Cd/2.4 hrs	Knocke et al. (1988)
GAU	T/P, SP2, SP3 : GSFC(1) box-wing (untuned) SP4, SP5, Envisat : CNES box-wing (untuned) (2)	MSIS86	SPOT's & Envisat : Cd/6 hrs T/P : Cd/8hrs	Knocke et al. (1988)
GOP	N/A (3)	N/A (3)	(3)	N/A (3)
GSC	T/P, SP2, SP3 : GSFC (tuned) (1) SP4, SP5 : CNES (tuned) (2) Envisat : UCL, Sibthorpe (2006)	MSIS86	SPOT's & Envisat : Cd/2hrs. Cd/1hr 2001-2002 T/P : Cd/8 hrs	Knocke et al. (1988)
IGN	CNES box-wing (tuned) Gobinddass et al. (2009)	DTM94	SPOT's & Envisat : Cd/1hr T/P :Cd/day	Knocke et al. (1988)
INA	CNES box-wing (untuned) (2)	DTM94	SPOT's & Envisat : Cd/6hrs T/P : Cd/day	Not Applied
LCA	CNES box-wing (untuned) (2)	DTM94	T/P: Cd/12 hrs SPOT's & Envisat: Cd/4 hrs Cd/1 hr 2001-2002	Albedo & IR values from 6-hr ECMWF grids

(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)

Lemoine et al., DORIS AWG, Darmstadt, May 26-27, 2010
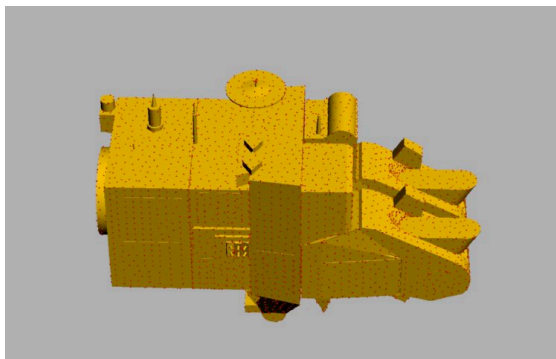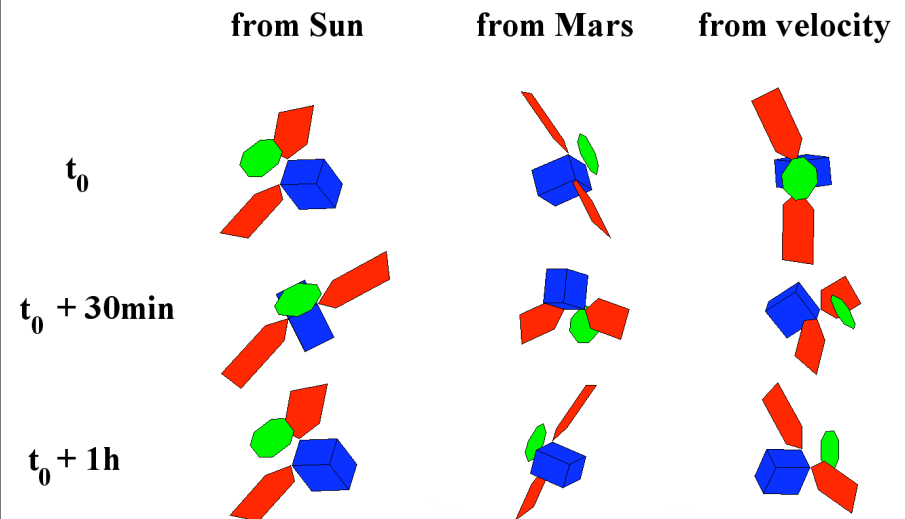
Table 3b, Valette et al., 2010.

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 otide 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
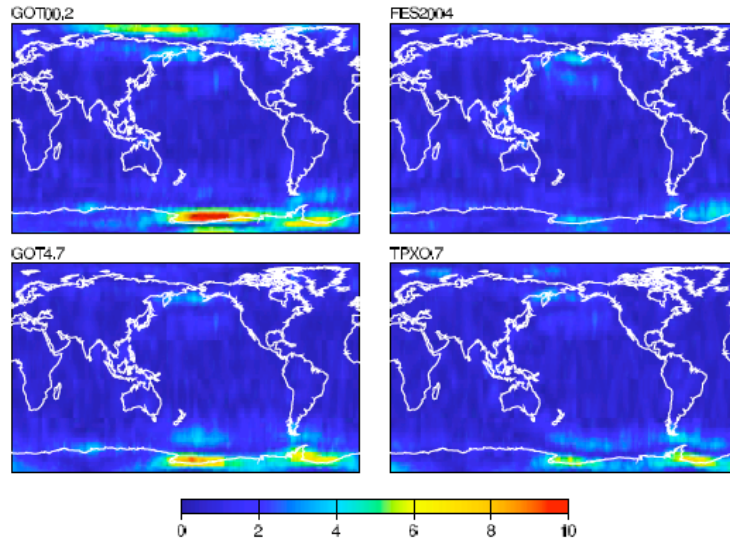
(Ray et al., JGR 2009)

Figure 4. Amplitudes (μm) at the O_1 tidal frequency in 4 years of GRACE range residuals, based on four different prior models of ocean tides. Locations having significant amplitudes suggest errors in tide models.
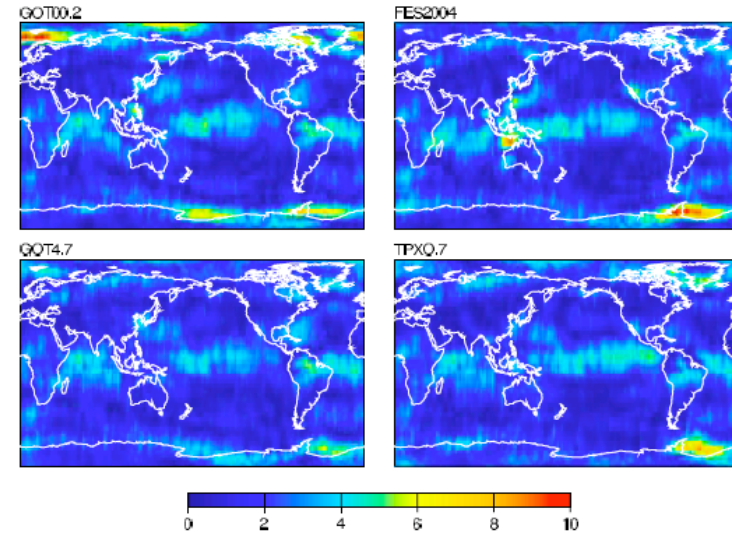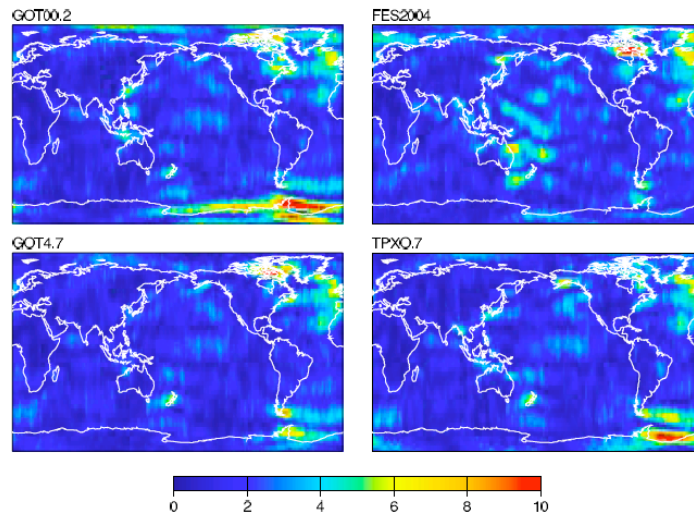

Figure 6. As in Figure 4 except for the S_2 constituent. The large low-latitude bands are suggestive of errors in the ECMWF atmospheric S_2 tide which was used for all four cases.

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?
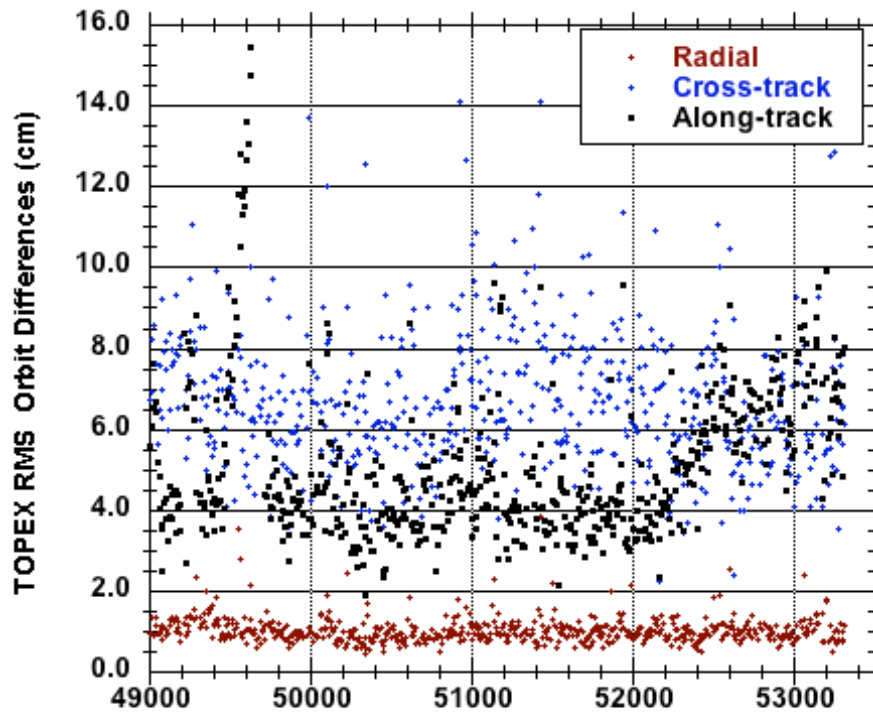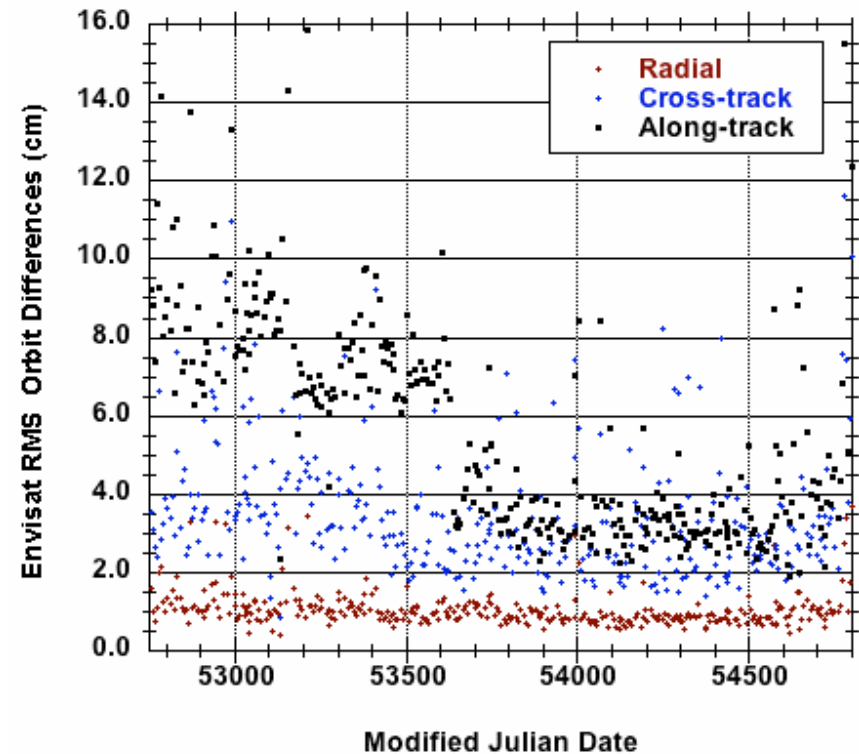
DORIS system time-bias (wrt. SLR)
SLR/DORIS vs DORIS-only Orbit Differences

TOPEX   Envisat

Le Bail et al.., 2010

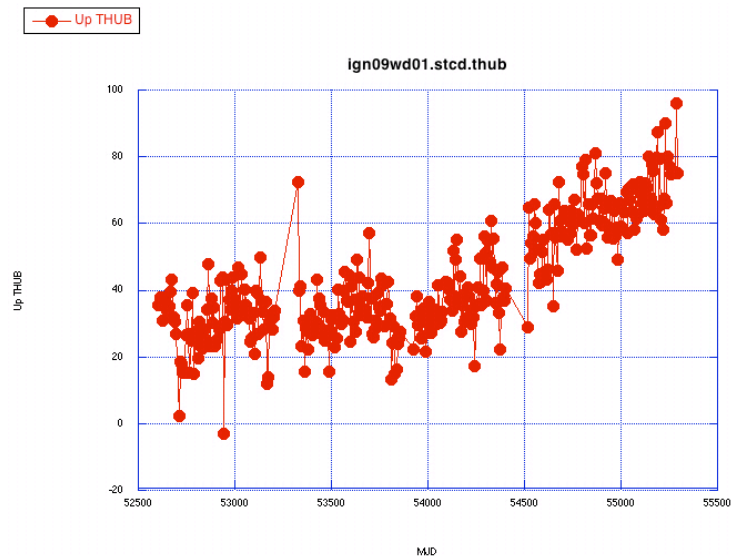## - But what to do for the SPOT satellites?

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.

Results with ign09wd01.stcd for
Thule …

• A measurable displacement at Santiago

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.