Future of IERS Conventions models

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Philosophy of IERS Conventions models

- Three classes recognized:
  - accepted from geophysics
    - used *a priori* in space geodetic data analyses without adjustment
    - must be highly accurate (compared with observational accuracy)
    - e.g., solid Earth tide model
  - purely conventional
    - accepted for convenience of universal comparison of results
    - e.g., no-net-rotation datum of ITRF
  - other useful models
    - not strictly required in data analysis, but may be helpful
    - e.g., UT1 zonal tides model

- Generally, geophysical models should be independent of geodetic results
  - exceptions include nutation model

- Set of Conventions models & constants should be self-consistent

Major items under review

- ITRF
  - clarify rationale for contributions of time-varying displacements
  - possible datum updates
  - handling of geocenter motions

- Geopotential
  - new oceanic pole tide model

- Ocean tidal loading displacements
- Oceanic pole tide displacements
- Atmospheric pressure tidal displacements
- Improved model for subdaily EOP variations
- Updated tropospheric modeling

ITRF: Models for time-varying displacements

- Motion of a terrestrial point modeled as (see Chapter 4):

$$X(t) = X_o + V*(t - t_o) + \sum \delta X_i(t)$$

where

X_o = "regularized" coordinates at epoch t_o

V = secular velocity

$\delta X_i(t)$ = "conventional corrrections for high-frequency time variations (mainly geophysical)"

- $\sum \delta X_i(t)$ should explicitly include effects for solid Earth tides, ocean loading, pole tide, atmospheric loading, & geocenter motion.

- However, actual frequency range is not specified; complete models for atmospheric loading & geocenter motion are not provided in Conventions (2003).
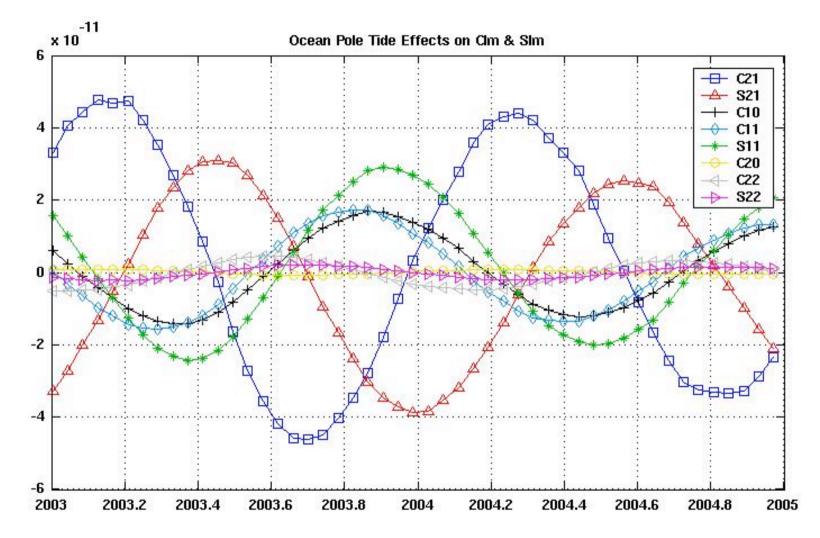
Recommendation for time-varying displacements

- Follow traditional practice for handling EOP variations.

- $\sum \delta X_i(t)$ should include only those effects which:
  - have known closed-form expressions with high *a priori* accuracy (mostly tidal)
  - have periods near 1 d or shorter (with some exceptions)

- $\sum \delta X_i(t)$ would therefore include:
  - ~12 & ~24 hr tidal displacements for solid Earth, ocean & atm loading
  - plus longer-period solid Earth & ocean loading tides, for consistency with past
  - plus longer-period solid Earth & oceanic pole tides
  - loading displacements *should* account for geocenter offsets
  - "permanent" solid Earth tide: Use "conventional tide free" quantities, for consistency with past practice

- All other time-varying displacements (mostly non-tidal) retained in time series of positions for interpretation by geophysicists & others.

Ocean pole tide – New IERS model
from S. Desai + J. Chen, J. Ray, J. Ries, J. Wahr

- Centrifugal effect of polar motion on the oceans.
- Chandler wobble and annual variations.
- Desai (JGR 107, 2002) equilibrium model.
- Pole tide needs a definition of « conventional mean pole »
  => To Be Done at the same time.
- Corrections to the spherical harmonic coefficients
  - order of magnitude: ΔC_{nm}, ΔS_{nm} several times 10^{-11}
- Loading effect can reach 1.8 mm vertical displacement

- Conventions update implementation:
  - in Chapter 6 (Geopotential) done
  - in Chapter 7 (Displacements) underway
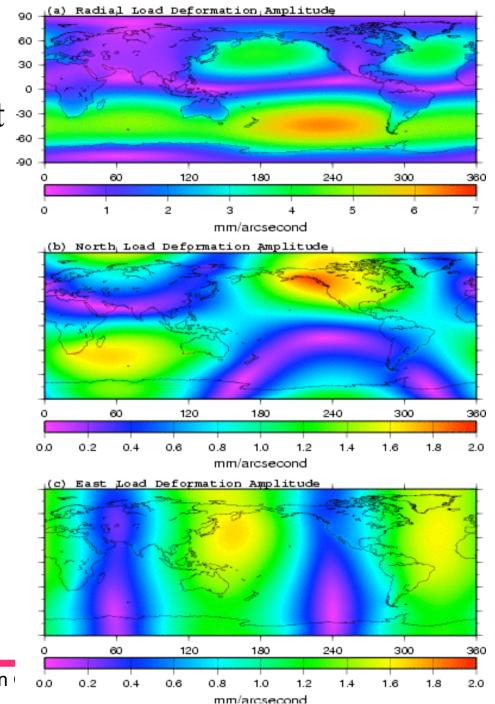- See following presentation

Ocean Pole Tide: order of magnitude on geopotential
(from J. Chen)

Ocean pole tide: order of magnitude on displacement
(from S. Desai)

Can reach (and exceed)
1.8 mm (vertical)
0.5 mm (horizontal)

(a) Radial Load Deformation Amplitude

mm/arcsecond

(b) North Load Deformation Amplitude

mm/arcsecond

(c) East Load Deformation Amplitude

mm/arcsecond

Ocean tidal loading

from H-G. Scherneck, D. Agnew, M. Bos, and others

- New ocean models added at OTL service by Scherneck & Bos:
  - FES2004 & TPXO.7.0
  - improved over older models, esp near Antarctica

- New routine by Agnew recommended to compute N,E,U displacements
  - spline interpolation used to compute admittances for 141 tides
  - precision estimated to be about 1%

- OTL service also added geocenter motions for each ocean model

- Conventions update: Chapter 7 not yet revised
- See following presentation

Atmospheric tidal loading
from T. vanDam, R. Ray, and others

- Diurnal heating induces surface pressure oscillations
- S1 and S2 tides (but poorly sampled in global met models)
- Ray and Ponte (Annales Geophysicae 21, 2003) model
- http://www.ecgs.lu/atm
  - Grid values + interpolation
  - On-line calculator
- Amplitude up to 1.5 mm (mostly near equator)

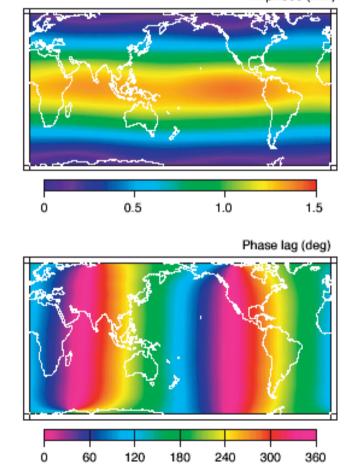- Conventions update: Testing underway

Atmospheric tidal loading: order of magnitude
(from T. vanDam, R. Ray)

Figure 1: Amplitude (in mm) and phase (in degrees) of the predicted vertical surface displacement from the S_1 and S_2 atmospheric tides from the *Ray and Ponte* model [2003].

Tropospheric propagation models

- Expert panel being formed to review current recommendations
    - for optical techniques (section 9.1)
    - for radio techniques (section 9.2)

- GMF mapping proposed by J. Boehm et al. to replace NMF for radio techniques
    - eliminates some regional errors (esp Antarctica & East Asia)
    - annual error in NMF attenuated

- Conventions update: Chapter 9 under review

Other pending issues

- Geocenter motions
  - not yet included in ITRF ← → ICRF transformations
  - not yet well defined or specifications given for realizations
  - current recommendations are inconsistent

- Improved model for subdaily EOP variations
  - current model is old & does not account for atmosphere tides
  - explicit EOP interpolation procedure not given in Conventions

- Documentation of technique-specific effects
  - VLBI thermal expansion model needs reference temperatures
  - effects for other techniques neglected

- Documentation of analysis models in SINEX files
  - would require greater standardization
  - already done by ILRS to some extent

IERS Conventions update: electronic access

- Conventions Center web site at the BIPM
  - http://tai.bipm.org/iers/
  - Provides access to the older versions (1996) and (2003): pdf files + all available subroutines and electronic version of tables.
  - Conventions update
    http://tai.bipm.org/iers/convupdt/convupdt.html
  - Conventions discussion forum: http://tai.bipm.org/iers/forum

- Conventions update web site provides
  - Up to date version of chapters, software, data sets including
    - correction of mistakes
    - new versions, after approval by the IERS DB

http://tai.bipm.org/iers/convupdt/convupdt_c6.html

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IERS Conventions update: Chapter 6
Geopotential
Working version last updated 13 March 2006: see List of updates

Text of chapter 6: Tex file, Postscript file, PDF file.

Figures (eps format) for Chapter 6.

Files for Chapter 6.

- desaiscopolecoef.txt.gz - Table of coefficients for the ocean pole tide model (gzipped). Provided by S. Desai.

- desaiscopole2004.txt - Test run for the ocean pole tide model. Provided by S. Desai.

List of updates

- 13 March 2006: Main changes with respect to previous version of the chapter: New section 6.3 on Oceanic pole tide (from S. Desai and J. Chen). Information on the treatment of degree 1 harmonic coefficients is given in the beginning of the chapter (from J. Ries).

- 23 September 2005: Corrections with respect to previous version of the chapter: In section 6.3, the reference epoch for value C20 has been corrected (noted by E.C. Pavlis).

- 18 November 2004: Corrections with respect to previous version of the chapter: The caption of Table 6.3b has been corrected (from S. Bettadpur and V. Dehant). Unnumbered equations at end of section 6.2 have been corrected (noted by S.Y. Zhu).

Conventions update | Conventions 2003 | Conventions 1996
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Site last updated 16 March 2006

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Forum	Messages	Topics	Last message
IERS Conventions - User discussion forum Users are invited to offer their comments, critiques, corrections, etc, in any of the following topics			
+ Conventions updates Updates to the IERS Conventions (2003)	1	1	Thu, 16 March 2006
+ Celestial Reference Frame International Celestial Reference System (ICRS) & its realizations	0	0	none
+ Terrestrial Reference Frame International Terrestrial Reference System (ITRS) & its realizations	1	1	Thu, 22 April 2004
+ Transformations & EOPs Reference frame transformations & Earth orientation parameters	23	7	Mon, 23 January 2006
+ Tidal Rotations Conventional models for rotational variations due to tides	3	2	Wed, 16 June 2004
+ Geopotential Earth's gravity field and its tidal variations	15	8	Thu, 16 March 2006
+ Station Displacements Conventional models for geophysical displacements in the Earth's surface	6	6	Thu, 22 April 2004
+ Tropospheric Delays Models for the propagation delays due to tropospheric (neutral) constituents	0	0	none
+ General Relativity General relativistic models for space-time coordinates, equations of motion, & VLBI time delay	4	2	Tue, 28 September 2004
+ Other Topics Miscellaneous issues, procedures, numerical constants, etc.	4	4	Mon, 10 May 2004
+ Forum usage Some information on using the Forum	3	2	Wed, 25 August 2004

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European Geosciences Union GA, Vienna, 3-7 April 2006

Conclusions

- Work on the IERS Conventions should ensure
  - Inclusion of all effects that can be modeled with adequate uncertainty
  - Internal consistency

- Envision IERS workshop on Conventions in 2007 (TBD)
- Topics currently under work (e.g. atmospheric tidal loading, mapping function,...) should be ready by 2007
- Longer-term projects are
  - Technique dependent effects
  - Documentation of models
- Conventions should be used by Analysis centers, for the generation of IERS products.