A new numerical theory of Earth rotation

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Motivation

- currently used theories of Earth rotation
  - start from a theory for rigid Earth (REN2000, SMART97 etc.)
  - MHB2000 transfer function
  - IAU 2000 precession-nutation model (accuracy: $\sim 300 \mu$as)
- observation of Earth rotation with very high accuracy
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- our goal: a consistent relativistic model of Earth rotation
  - purely numerical
  - fully consistent with General Relativity
  - model for a 'realistic' Earth
Our relativistic model - scheme

- input data:
  - gravity field model e.g.: EGM2008
  - ephemerides e.g. DE421
  - atmosphere, ocean e.g. ERA40

- torque D
- tidal deformation
- mass redistribution
- relative angular momentum
- tensor of inertia I
- rotational deformation

- relativistic effects:
  - relativistic torques
    - geodetic precession
  - relativistic time scales
  - relativistic scaling

- output data: Euler angles: $\phi$, $\psi$, $\omega$ and their time derivatives in the GCRS

IAU General Assembly, JD 7, 28. August 2012
A 3-layered Earth - included effects in detail

- Rotational and tidal deformation
  - Using compliance parameters - Mathews et al. (1991)
  - Changes tensor of inertia ($\delta C_{13}, \delta C_{23}$)

- Coupling torques between layers
  - Gravitational, topographic and electromagnetic torques
  - Model from Mathews et al. (1991), Buffet et al. (2002)

- Inclusion of atmosphere and ocean
  - No tidal model, but re-analysis data (e.g. ERA 40)
  - Relative angular momenta and $\delta C_{13}, \delta C_{23}, \delta C_{33}$
rotational and tidal deformation
  ➔ using compliance parameters - Mathews et al. (1991)
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coupling torques between layers
  ➔ gravitational, topographic and electromagnetic torques
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inclusion of atmosphere and ocean
  ➔ no tidal model, but re-analysis data (e.g. ERA 40)
  ➔ relative angular momenta and $\delta C_{13}, \delta C_{23}, \delta C_{33}$

A lot of parameters for fitting!
Beyond Earth - relativistic rotation of other bodies

- highly accurate, relativistic models of e.g. Mercury of interest
- relativistic effects expected to be much larger

<table>
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<tr>
<th>body</th>
<th>geodetic precession [”” per century]</th>
<th>geodetic nutation [µas]</th>
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<td>Mars</td>
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</table>

- our code is ideal to study this
- mostly simple changes of constants etc.