Geophysical excitation of diurnal prograde polar motion derived from different OAM and AAM data

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Data

- Geophysical data
  - Atmospheric and non-tidal oceanic effects
    - AAM (NCEP/NCAR Reanalysis, Kalnay E. et al., 1996)
    - OAM – barotropic model driven by $AAM_{NCEP/NCAR}$(Ponte R. and Ali A., 2002)
    - AAM (ERA-40 project http://www.ecmwf.int/research/era/Project/Plan/)
    - OAM – Ocean Model for Circulation and Tides driven by $AAM_{ERA\text{-}40}$(Seitz F., Stuck J., Thomas M., 2004)
- Astronomical data
  - VLBI observations (Astronomical Institute of St. Petersburg University)

Data description

Data	Time span	Temporal resolution
Atmospheric Angular Momentum (AAM) (NCEP/NCAR)	1948.0 –2005.0	6 h
Oceanic Angular Momentum (OAM) (R. Ponte)	1993.0 –2000.5	1h
Atmospheric Angular Momentum (ECMWF, ERA 40 project)	1963.0 – 2001.0	6 h
Oceanic Angular Momentum (Ocean Model for Circulation and Tides) (M. Thomas)	1963.0 – 2001.0	0,5 h
Geodetic excitation (calculated on the basis of ERP obtained from VLBI observations in Analysis Center of SPU)	1989.0 –2004.3	Uneven (3-5 min)

VLBI data analysis

- VLBI data: 1989.0 –2004.3
- Models: IERS Conv.2003
- Software: OCCAM 6.1
- Method of estimation: Least Square Collocation Method (LSCM)
- Estimated parameters:
  - Global parameters: radio sourses coordinates is fixed to ICRF Ext 2;
  - *daily parameters*: coordinates and velocities of stations, nutation parameters, clock rates and offsets, statistical expectations of stochastic parameters;
  - *stochastic parameters:* Earth Rotation Parameters (x,y coordinates of the pole,UT1-UTC), variations in clock behavior, zenith delays and troposphere gradients.

Covariance function of VLBI observations

- EOP have been modeled as pseudoharmonic oscillator excited by white noise. EOP covariance function [V.S. Gubanov et.al. (in russian) , 1997]:

$$q_w(\tau) = \sigma^2_{EOP}\, e^{-\alpha|\tau|}\, \frac{\cos(\beta\tau + \varphi)}{\cos(\varphi)}$$

where σ^2_{EOP} is a priori variance of stochastic process (solution A- $\sigma^2_{EOP} = 0.44 cm^2$; solution B - $\sigma^2_{EOP} = 4.4\, cm^2$);

τ - time shift given in parts of day $0 \le \tau \le 1$;

Other parameters have the following values:

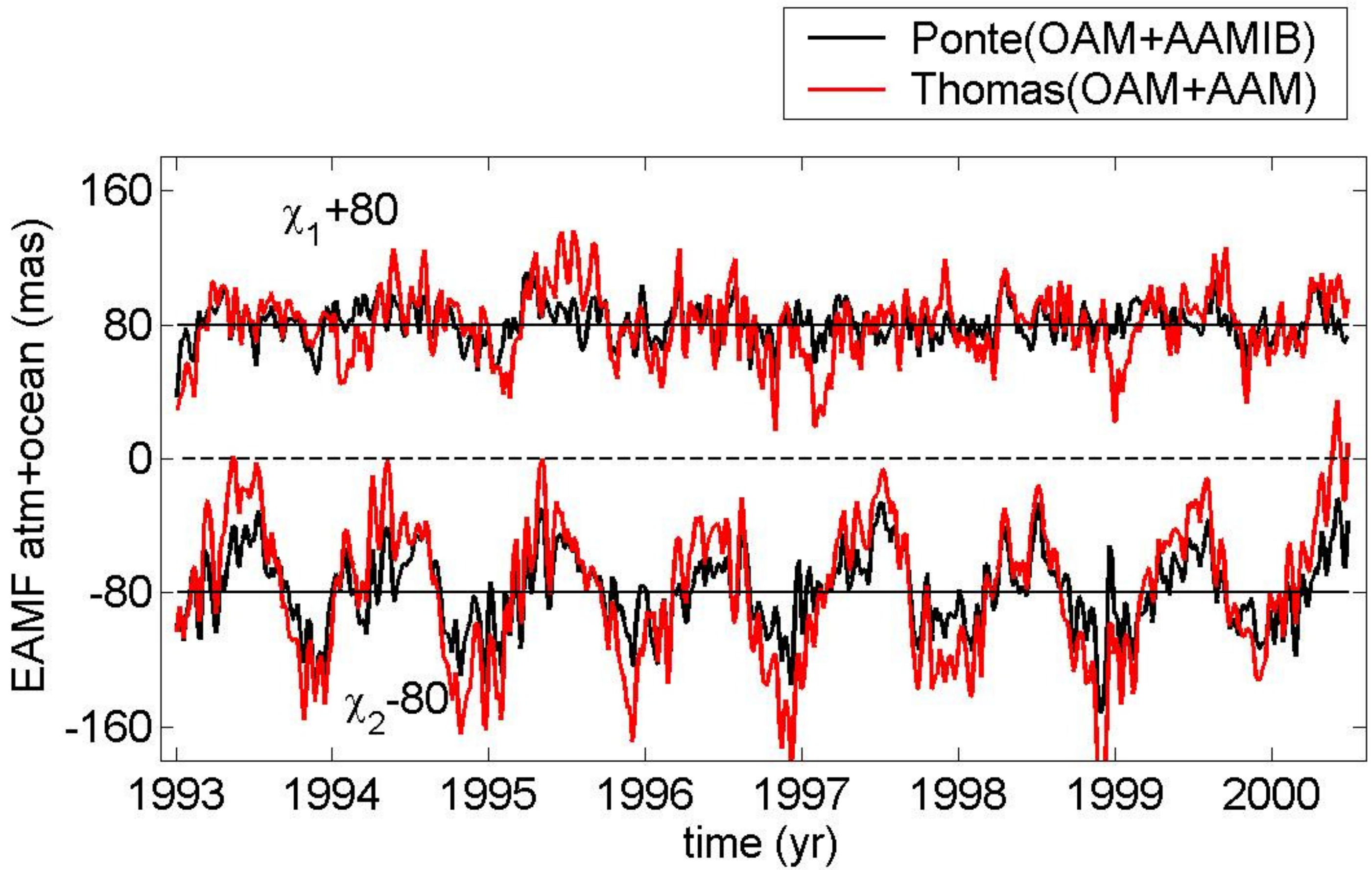
α =50 (1/day), β = 1 (cycle per day), φ = 0.3 rad.

Computation procedure

– All series have been considered at the same time span (1993.0-2000.5)
– Complex demodulation at frequency +1 cpsd:
  - $\chi' = -\chi e^{in\varphi}$, where $\varphi = GMST$, n = 1
– Smoothing by Gaussian filter;
– Least squares fit of model containing linear trend and a sum of sinusoids with periods 1 yr, 1/2 yr, 1/3 yr.

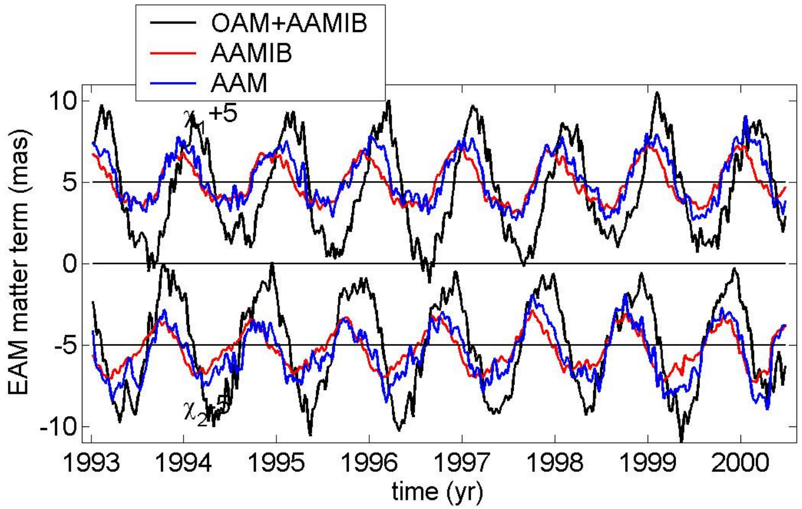
$$x + iy = a + bt + \sum_{i=1}^{3} A_i \exp\left(\frac{2\pi t}{i}\right) + B_i \exp\left(\frac{2\pi t}{i}\right)$$

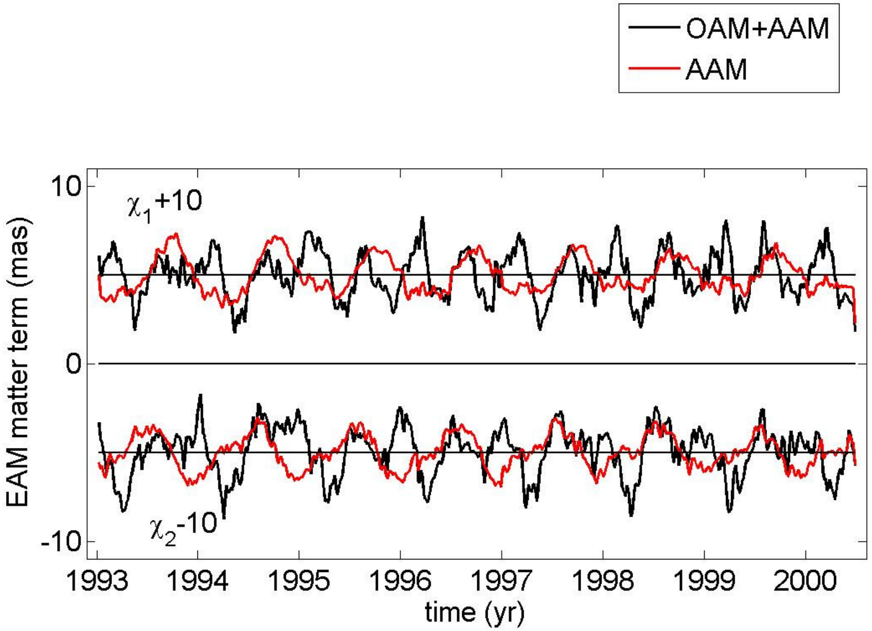
Comparison of long-term content of geophysical series



Comparison of short-term content of geophysical series

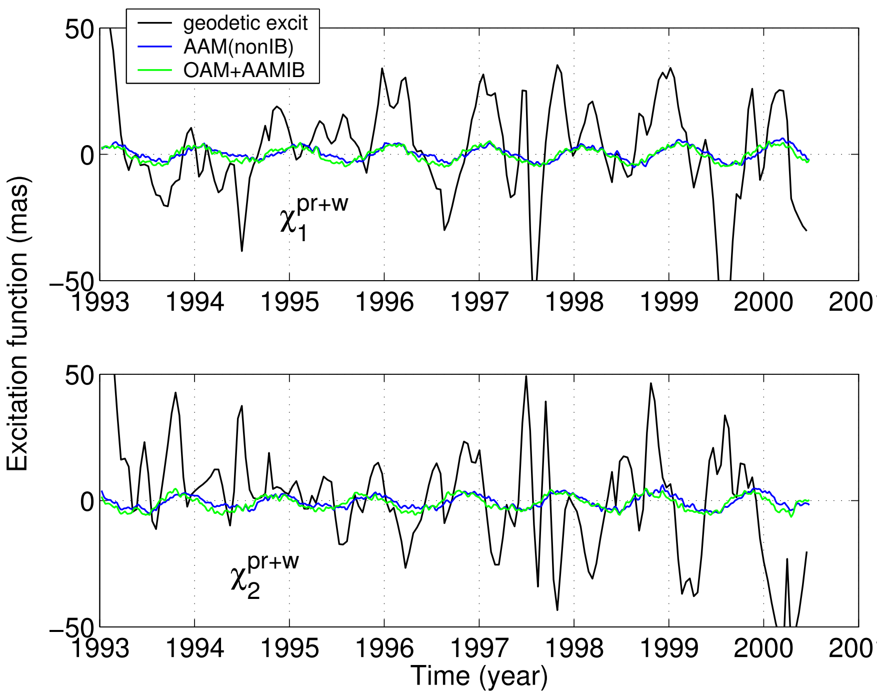
- Matter terms of OAM and AAM and motion terms of OAM from both sets of geophysical data are comparable;
- Motion terms of AAM from ERA 40 estimations is about twice more powerful then from NCEP/NCAR estimations;

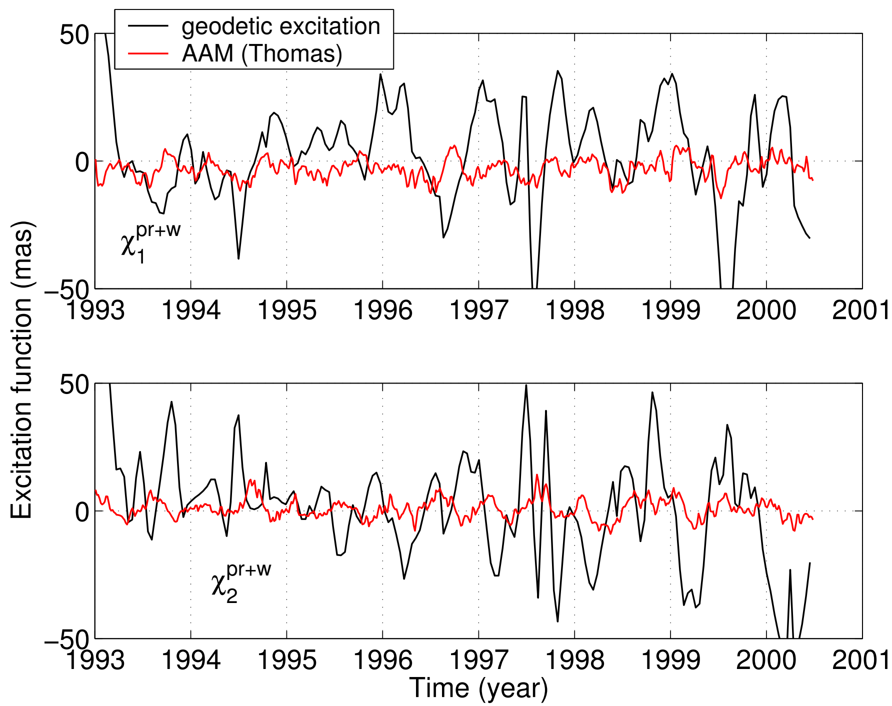




Excitation of prograde diurnal polar motion

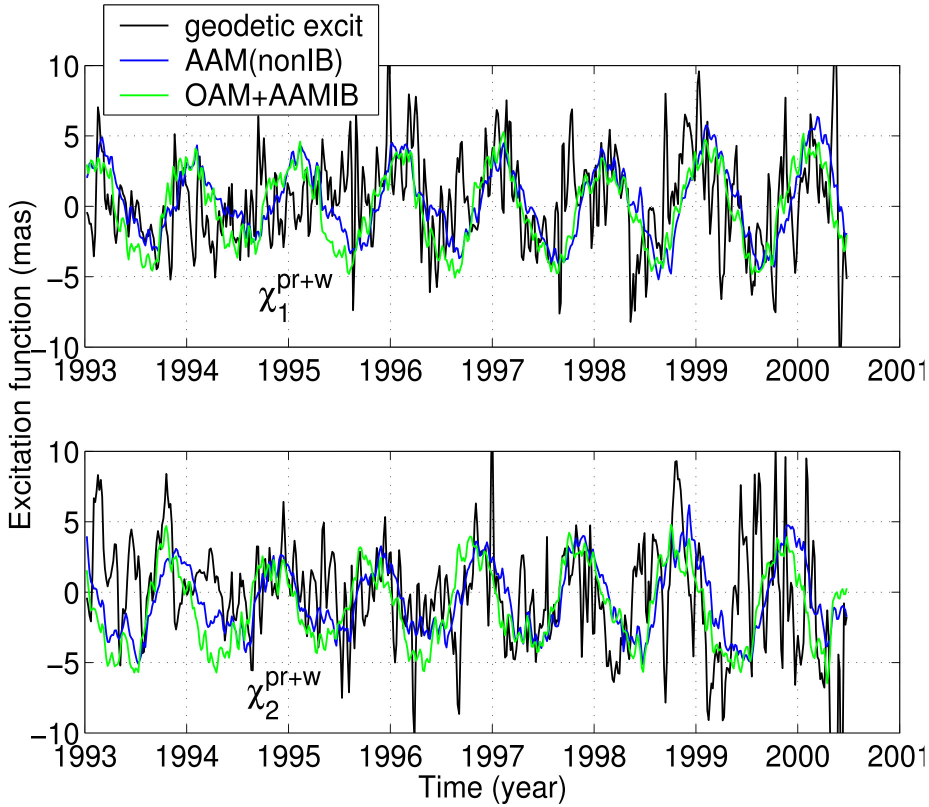
Geodetic excitation based on the polar motion calculated with σ^2=4.4 cm^2

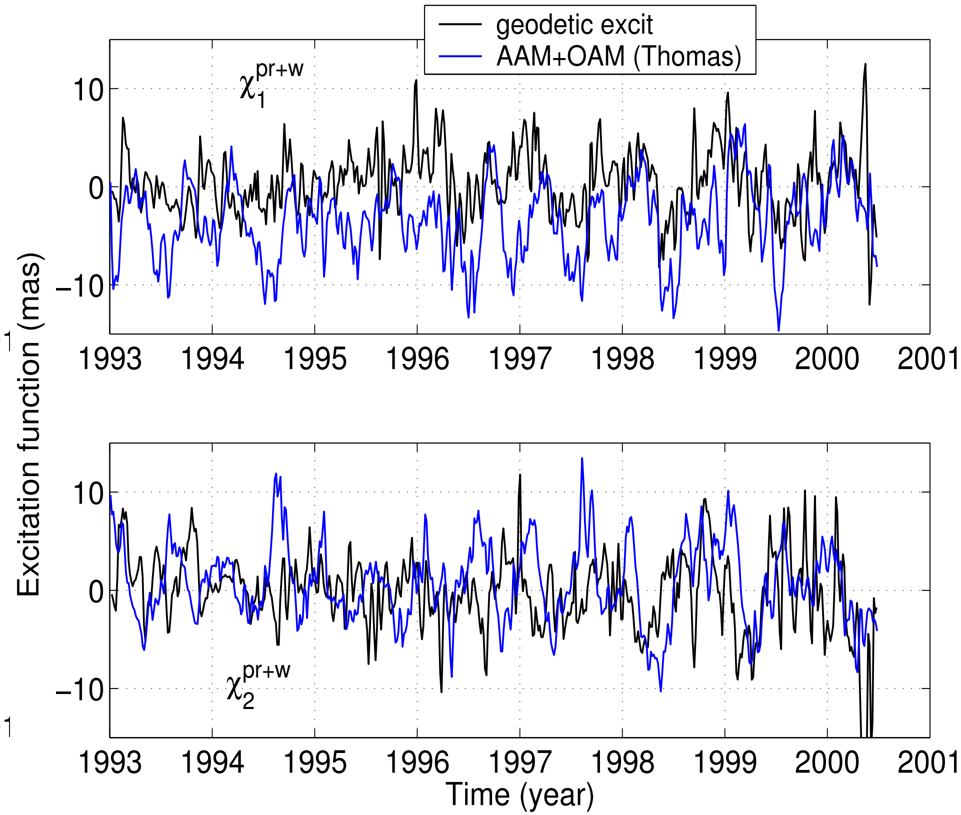




Excitation of prograde diurnal polar motion

Geodetic excitation based on the polar motion calculated with σ ²=0.44 cm². Correlation coefficients are about 0.3-0.4.





Atmospheric (NCEP/NCAR) and nontidal oceanic contribution (R.Ponte) S_1 component

	Excitation function		Polar motion	
	A(mas)	φ	A(μas)	φ
Solution B	14.1	16.3	33.3	-163.7
Solution A	2.04	12.8	4.8	–167.2
AAM (pr)	2.03	12.6	4.9	– 169.7
OAM (pr)	3.28	66.5	7.9	–115.8
OAM+AAM (pr)	3.99	43.9	9.4	-136.1

Atmospheric (ERA 40) and nontidal oceanic contribution (M. Thomas) S_1 component

	Excitation function		Polar motion	
	A(mas)	φ	A(μas)	φ
Solution B	14.1	16.3	33.3	-163.7
Solution A	2.04	12.8	4.8	–167.2
AAM (pr)	2.1	17.7	5.0	– 162.3
OAM (pr)	1.4	59.1	3.3	–120.9

Conclusions

- Both AAM series reveal good agreement in prograde diurnal frequency band;
- Agreement of OAM series in the same frequency band is worse;
- Amplitude and phase of the S_1 term as they seen from VLBI and AAM (matter term) reveal very good agreement. This agreement became better after 1996;

Conclusions

- The best agreement between geodetic and geophysical excitation is achieved when estimation of EOP is performed with an a priori dispersion $\sigma^2 = 0.44$ cm^2 . However, comparison (Kudryashova M. et. al., EVGA 2007 proceedings) of VLBI series obtained in Astronomical Institute of St. Petersburg University and in GSFC reveal that these series are in better agreement if the former series is calculated with a larger a priori dispersion (4.4 cm^2).
- Author is very grateful to Descartes Nutation advisory board