IMPACT OF THE ADDITION OF THE OCEAN TO THE ATMOSPHERIC EXCITATION OF POLAR MOTION ON VARIABILITY OF SPECTRA AND CORRELATION WITH POLAR MOTION

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ABSTRACT. Impact of the addition of the ocean to the atmospheric excitation of polar motion on variability of spectra of polar motion and correlation with polar motion is investigated. Variations of the seasonal and subseasonal spectra of the atmospheric and joint atmospheric plus oceanic excitation functions of polar motion and their time variations are computed by the Fourier Transform Function and compared. These spectra are very similar. Correlations between geodetic and either atmospheric or joint atmospheric plus oceanic excitation functions are computed in four spectra bands range from 10 to 500 days. In all cases correlation coefficients for joint atmospheric plus oceanic excitation functions are higher and more stable than for atmospheric excitation function.

1. INTRODUCTION

Atmosphere and ocean have been shown to excite variations in polar motion at intraseasonal, seasonal and interannual periods (Brzeziëski, 2003;Gross et al, 2003; Nastula and Ponte, 1999; Ponte at al., 1998; Ponte and Ali, 2002). Adding oceanic angular momentum (OAM) to atmospheric angular momentum (AAM) increases a correlation coefficient with the observed by geodetic techniques excitation of polar motion, but there is still significant discrepancy between modeled excitation and the observed. Here emphasis is placed on the aspect of time variability of spectra and correlation coefficient. We are interested in results of adding the OAM to AAM on spectra and correlation coefficient with the observed data.

2. DATA

In the analyses we use the following series of data:

-Geodetic polar motion, IERS CO4 (IERS 2001) with the sampling interval 1 day and the data span: 1982.0 - 2002.0,

-Geodetic polar motion, combined solution COMB2002 of Gross (2003), with the sampling interval 12 hours and the data span: 1962 to 2003,

- Reanalyses Atmospheric Angular Momentum (AAM,) with the sampling interval 6 hours and the data span: 1948 to 2003 (Kalnay et al., 1996),

- Ocean Angular Momentum MIT model -P98 (Ponte et al., 1998) with the sampling interval 5 days and data spam 1985.0-1996.3,

- Ocean Angular Momentum ECCO JPL model - GO3 (Gross et al., 2003) with the sampling interval 1 day and the data spam 1980.0-2000.2.

3. ANALYSES

We analyse influences of Ocean Angular Momentum - OAM on the spectra of polar motion and their time variations. Correlations between geodetic polar motion excitation function computed from polar motion with polar motion excitation functions of different OAM models and AAM as well were studied also.

3.1 SPECTRA

Spectra of geodetic, atmospheric and join atmosperic+oceanic excitation functions of polar motion were computed by the Fourier Transform function. In this case the IERS C04 pole coordinates were used to compute the geodetic excitation function. All three spectra seen in Figure 1 have the same character. In all these spectra there are the oscillations with periods of about 40, 50, 60, 120, 180 days. These oscillations in the spectra of combined series of AAM+OAM are the most energetic ones. It means that the AAM and OAM variations play in concert in this part of spectra.

The time variable spectra of the AAM and AAM+OAM excitation functions of polar motion were computed by the Fourier Transform Band Pass Filter - FTBPF (Kosek, 1995) in three spectra ranges 20-90, 90-230, 230-500 days (Fig. 2). For these computations P98 OAM Model was used. Time variations of the most energetic oscillations with periods of 360, 180, 120, 60, 40 days are similar in both cases. 5-6 years oscillations of amplitudes of these oscillations is seen. The short period oscillations with periods of 40 and 60 days seem to be a little stronger in the case of the OAM+AAM excitation functions than in the case of the AAM excitation function alone.

3.2 CORRELATIONS

In order to check impact of OAM excitation function of polar motion on variations of polar motion correlations between the geodetic excitation functions of polar motion and AAM as well as AAM+OAM excitation functions were computed for two different models of OAM, P98 and GO3. In this case the COMB2002 pole coordinates data are used. Computed correlations in 4 different spectra ranges are shown in Fig. 3 and Table 1.

Table 1: Correlation between time series of geodetic excitation and either atmospheric of joint atmospheric and oceanic excitation. Complex correlation is expressed by its magnitude. Spectral range 10 - 90 days.

Series	Correlation		
	χ_1	χ_2	$\chi_1 + i\chi_2$
Period,	1988.0 $\longrightarrow$ 1996.3		
P98+AAM	0.73	0.80	0.78
G03+AAM	0.78	0.86	0.84
AAM	0.55	0.71	0.67

Correlations between geodetic and AAM+OAM excitation functions are very high and in the case of the annual and semiannual range of spectra correlations coefficients are higher than in the case of GEOD/AAM. For period ranges 150-90, 90-10 days correlation coefficients are slightly lower from previous ones and more variable. Their variability is not so strong as in the case of AAM alone.

It is known from previous studies (Kolaczek et al., 2003) that the correlations between geodetic and AAM excitation functions are disturbed by El Niño/ La Niño phenomena. One can notice that the correlation between AAM+OAM and geodetic excitation functions of polar motion is not so sensitive on El Niño/ La Niña impacts.

4. CONCLUSIONS

Analyses show the similarity of the spectra of seasonal and subseasonal variations of polar motion excitation functions of AAM and combined AAM plus OAM.

There are high correlations between geodetic and combined atmospheric plus oceanic excitation functions of polar motion in period ranges from 10 - 500 days. The coefficients of the correlation between geodetic and combined atmospheric plus geodetic excitation functions are always higher and more stable then in the case of correlation between atmospheric and geodetic excitation functions.

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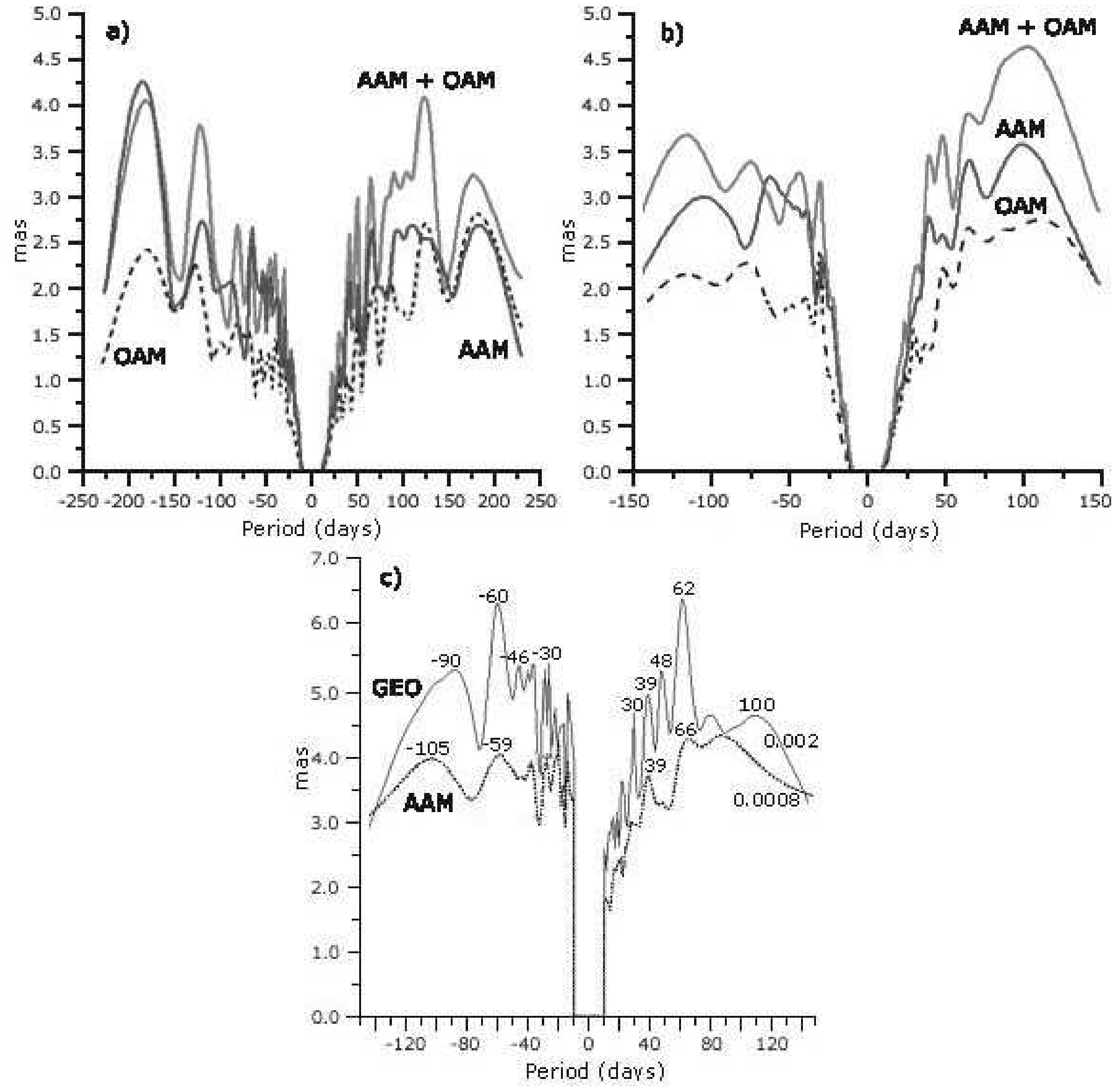

Figure 1: Spectra of the atmospheric (AAM), oceanic (OAM), and atmospheric plus oceanic (AAM + OAM) excitation functions computed by FTBPF with (a) the parameter $\lambda = 0.006$ (b) the parameter $\lambda = 0.015$. (c) The FTBPF amplitude spectrum of the geodetic excitation functions (GEO) pole coordinates and AAM excitation function computed with the parameters $\lambda = 0.002$, and $\lambda = 0.0008$, respectively.

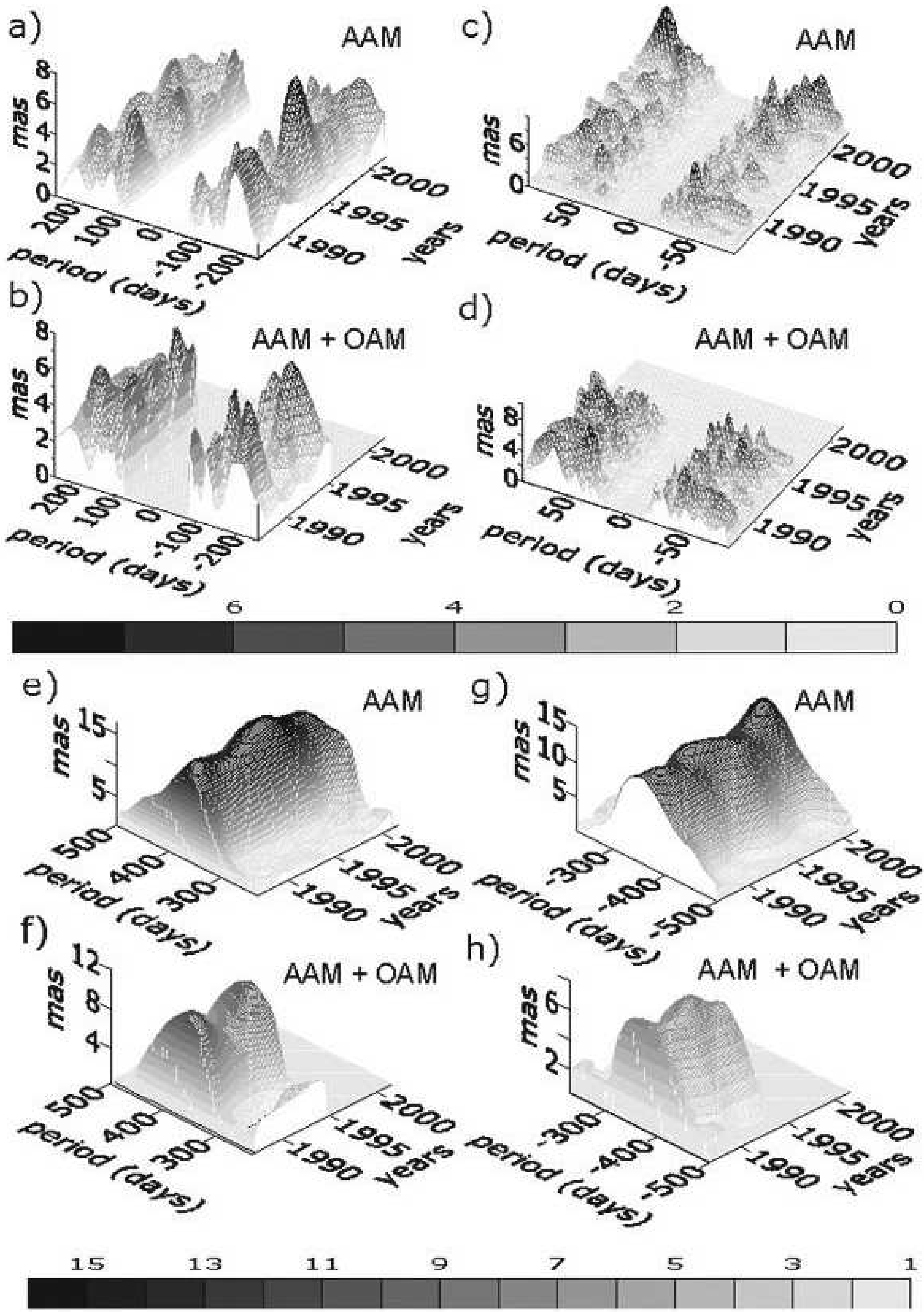

Figure 2: Time variable spectra of the AAM (a),(c),(e),(g) and of the AAM + OAM (b),(d),(f),(h)computed by the FTBPF with; (a)-(d) $\lambda = 0.006$; (e)-(h) $\lambda = 0.003$, in the three spectra bands with period renges: 10–90, 90–230 and 230–500 days.

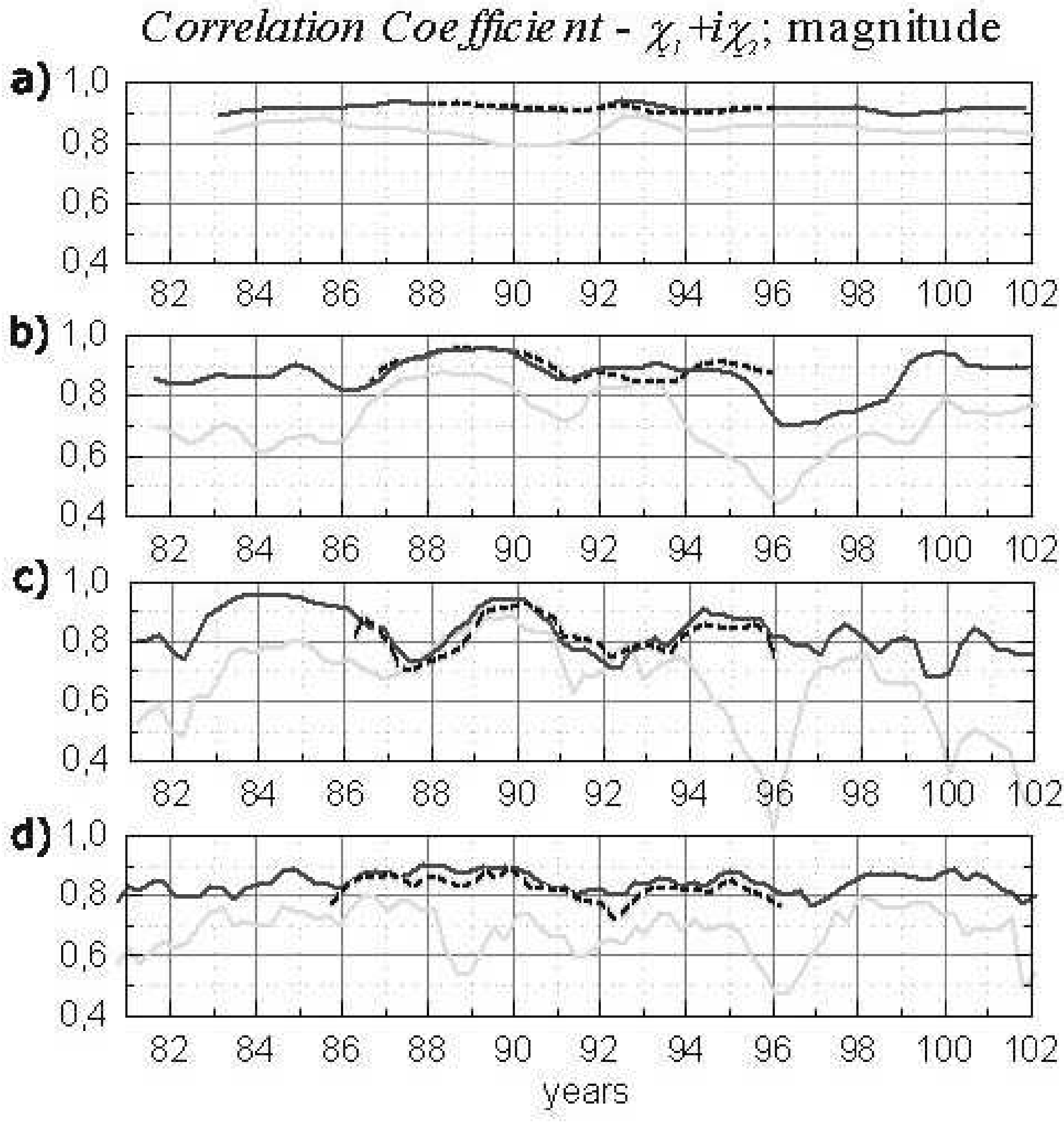

Figure 3: Correlation coefficients between the complex — valued equatorial components of geodetic (GEO) and either atmospheric or joint atmospheric and oceanic excitation functions for polar motion filtered by the Butterworth filter (a) 450-230 days, (b) 230-150 days, (c) 150–90 days, (d) 90–10 days intervals, starting each 100 days of a year since 1962, computed over (a) 2190 days, (b) 1095 days, (c) 730 days, (d) 540 days. Comparison is shown for the OAM P98 (dotted line), OAM G03 (black line), AAM (gray line)