EL NIÑO SIGNAL IN LOCAL AND GLOBAL ATMOSPHERIC TORQUES

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1. INTRODUCTION

The atmosphere exchanges angular momentum with the solid Earth, inducing changes in the Earth's orientation parameters (e.g., Burnes et al., 1983) and in the Earth's rotation by means of interaction torques. Those torques are due to the pressure acting upon both the topography and on the Earth's bulge, to the gravitational attraction between the masses of the solid Earth and the atmosphere, and to frictional forces related to the wind stress in the atmosphere. Here we wish to determine if the presence of an El Niño event has an influence upon the various torques that effect the dynamic interactions between atmosphere and solid Earth.

In de Viron et al. (1998), the mathematical expression of the pressure and the gravitational torque are given. It is shown that only the effect of the bulge of the potential induce a non negligible torque. The gravitational torque induced by the flattening of the potential is proportional to the pressure torque on the equatorial bulge. So, the analysis of the gravitational torque will not give additional information, and will not be considered here.

We have investigated the three quantities for the equatorial components (related to polar motion). In this case we compute the pressure torque on the local topography, the friction torque, and the pressure torque on the Earth's bulge. For the axial component (related to length of day fluctuations) we only compute the pressure torque on the local topography and the friction torque because the bulge will not induce an effect for this component.

We have computed torques between 01 March 1980 and 30 November 1995 from the surface data of the NASA Goddard Earth Observing System Data Assimilation System (GEOS-1 DAS; Schubert et al., 1993). During this study period, four different El Niño events occurred. The subject of this paper is to observe torques during the El Niño periods, and to determine if they are significantly different from other events.

2. DATA ANALYSIS

To see if the torque presents abnormal variation during an El Niño event, we have computed the mean variance of the torque as a function of the day in the year. We have drawn separately the mean variance during El Niño years and non-El Niño years for the X and Y components (polar motion) in Figs. 1 and 2 and for the Z component (length of day) in Fig. 3.

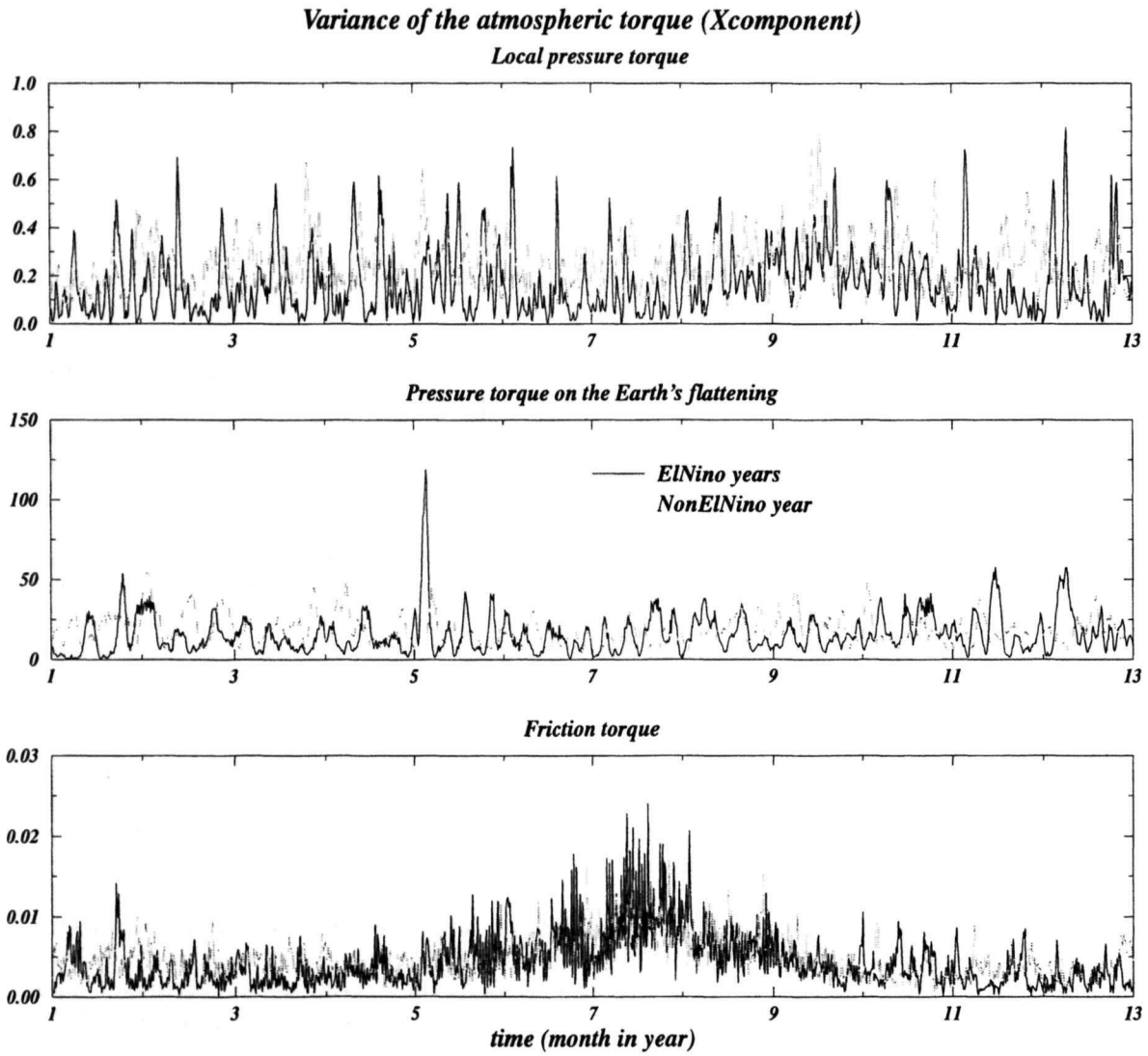
Variance of the atmospheric torque (Xcomponent)
Local pressure torque
1.0
0.8
0.6
0.4
0.2
0.0
1
3
5
7
9
11
13
Pressure torque on the Earth's flattening
150
100
50
0
ElNino years
NonElNino year
Friction torque
0.03
0.02
0.01
0.00
time (month in year)

Fig. 1

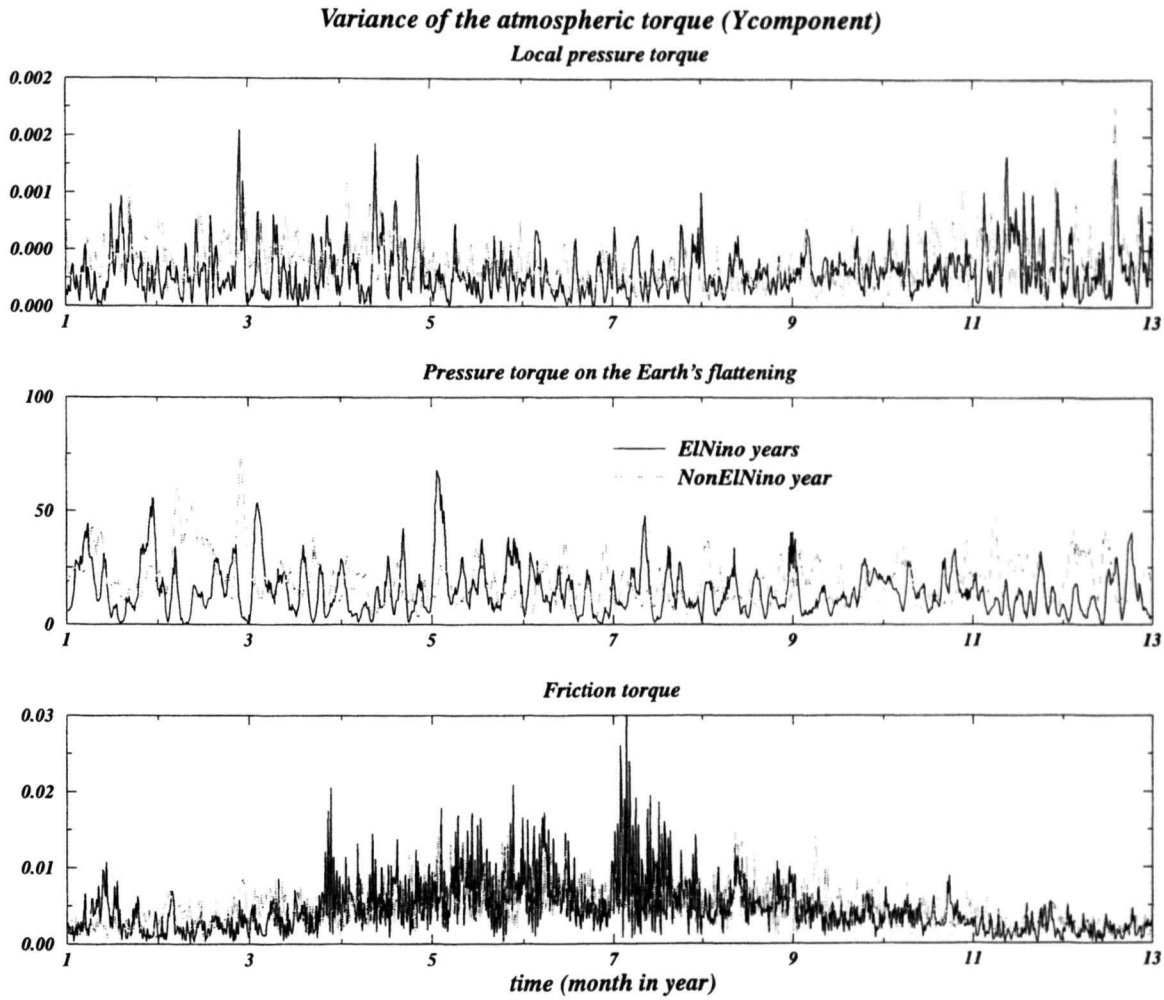
Variance of the atmospheric torque (Ycomponent)
Local pressure torque
0.002
0.002
0.001
0.000
0.000
1
3
5
7
9
11
13
Pressure torque on the Earth's flattening
100
50
0
ElNino years
NonElNino year
1
3
5
7
9
11
13
Friction torque
0.03
0.02
0.01
0.00
1
3
5
7
9
11
13
time (month in year)

Fig. 2

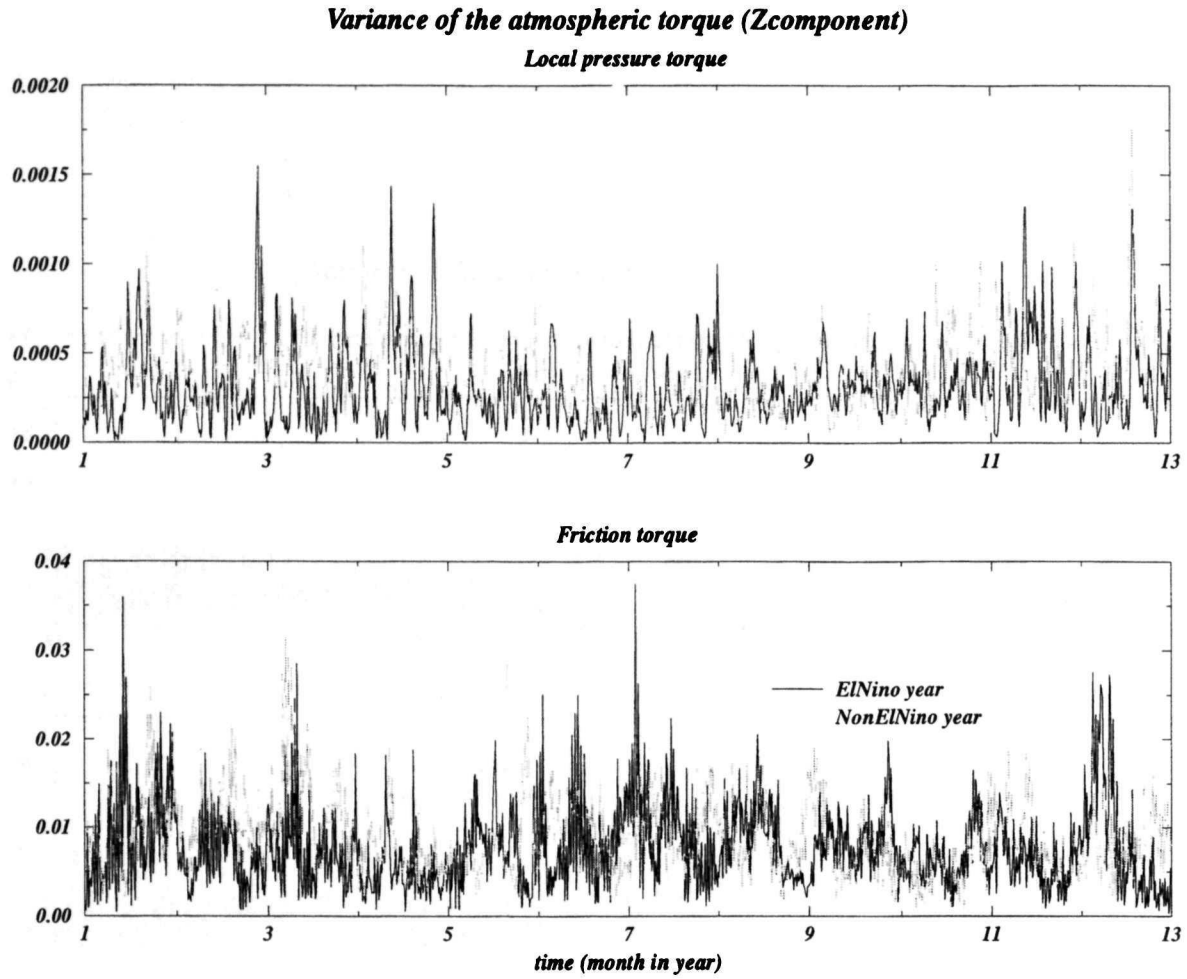

Fig. 3

In Figs. 1, 2, and 3, we can see that there are some peaks in the variance of the pressure torques, but these peaks show little distinction between years with and without an El Niño event.

It seems that the El Niño event does not produce a large anomaly in the equatorial pressure torques, both in local (pressure on local topography) and in global (pressure on ellipticity) forcing of the Earth. For the friction torques it is different; indeed the variations in the friction torque are much larger during the El Niño years than during the others, mostly during Northern Hemisphere summer (July and August).

3. CONCLUSION

There is no particular signal due to the El Niño event in the pressure torques, but El Niño seems to produce abnormally large values of the friction torque in all the three components. However, the friction torque is non-negligible only for the axial component.

4. REFERENCES

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