REVISITING A POSSIBLE RELATIONSHIP BETWEEN SOLAR ACTIVITY AND EARTH ROTATION VARIABILITY

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ABSTRACT. A variety of studies have searched to establish a possible relationship between the solar activity and earth variations (Danjon, 1958-1962; Challinor, 1971; Currie, 1980, Gambis, 1990). We are revisiting previous studies (Bourget et al, 1992, Abarca del Rio et al, 2003, Marris et al, 2004) concerning the possible relationship between solar activity variability and length of day (LOD) variations at decadal time scales. Assuming that changes in AAM for the entire atmosphere are accompanied by equal, but opposite, changes in the angular momentum of the earth it is possible to infer changes in LOD from global AAM time series, through the relation : delta (LOD) $(ms) = 1.68\,10^{-29}$ delta(AAM) $(kg\,m^2/s)$ (Rosen and Salstein, 1983), where delta(LOD) is given in milliseconds. Given the close relationship at seasonal to interannual time's scales between LOD and the Atmospheric Angular Momentum (AAM) (see Abarca del Rio et al., 2003) it is possible to infer from century long atmospheric simulations what may have been the variability in the associated LOD variability throughout the last century. In the absence of a homogeneous century long LOD time series, we take advantage of the recent atmospheric reanalyzes extending since 1871 (Compo, Whitaker and Sardeshmukh, 2006). The atmospheric data (winds) of these reanalyzes allow computing AAM up to the top of the atmosphere; though here only troposphere data (up to 100 hPa) was taken into account.

1. RESULTS AND DISCUSSION

Both the low frequency term of AAM (LF AAM), as the annual and semiannual amplitude modulation (AN-A AAM and SA-A AAM) present power at interannual, decadal and interdecadal time scales. Some analyses are described. We show on the following figures the decadal band pass filtered times series of each of the signals. The decadal cycle of Semi Annual amplitude is inverted (-SA-A). The comparison between the decadal oscillation in Solar Activity (SUN) and these in the LF AAM and AN-A terms (Fig A and Fig B) show that both series appears to phase shift through times. Clearly in phase opposition to the solar activity forcing at the turn of 19th to 20th century in phase from 1955-1985 and out of phase since then (at the turn of the 20th to 21th century) when the decadal signal in AAM lengthens (see Abarca del Rio et al., 2003). Interestingly the comparison with the inverted decadal modulation of the semiannual cycle (Fig C), show that both signals appears to be somehow in phase or varies accordingly from roughly 1920 to 1990, extending herein precedent findings (Bourget et al, 1992)

2. CONCLUSION

The analysis performed here shows that both the low frequency signals in AAM as the annual and semiannual amplitude modulation present interannual to secular time scales. We concentrate our study particularly in the so-called Schwabe cycle (9-13 yr periods) in solar activity where the different terms in AAM, low frequency, the modulation of the annual and semiannual cycle do also presents a cycle at these times scales. The comparison with the decadal cycle in the SUN shows that only the decadal cycle in the semiannual cycle modulation presents an homogeneous phase shift with the SUN for almost 70 years (1920-1990), therefore extending precedent findings (see Bourget et al, 1992). We will finally conclude as on our precedent paper (Abarca del Rio et al., 2003) in this field: "The present results indicate the need for better understanding of atmospheric dynamics at decadal time scales. It seems that the coming years will be fruitful in this regard, given the advent of extended and improved atmospheric and solar data".

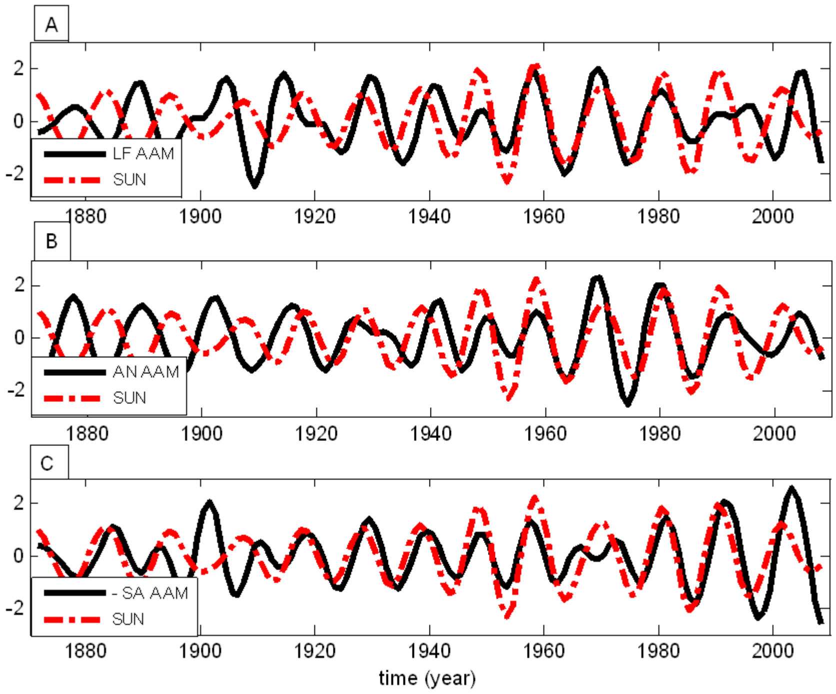

Figure 1: Decadal band pass filtered times series, from up to bottom of: Solar Activity (SUN; as represented by the Sunspots number), the Low Frequency AAM (LF AAM) Annual and Semiannual amplitude modulation (AN AAM and SA AAM respectively. The decadal cycle of Semi Annual amplitude is inverted (-SA-A).

3. REFERENCES

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