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Atmospheric Chemistry and Physics Discussions

Interactive comment on "The complex dynamics of the seasonal component of Earth's surface temperature" *by* A. Vecchio et al.

Anonymous Referee #1

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This paper argues for a role of orbital variations over the instrumental time period in modulating the phase of the annual cycle of surface temperature. The authors analyze temperature records from the United States Historical Climatology Network using the Empirical Mode Decomposition (EMD). They identify excursions in seasonal timing as excursions in the phase of the j=1 Intrinsic Mode Function (IMF). The fundamental result is given in Figure 4, which shows a relationship between the time history of inclination of the moon's orbit (which is closely related to nutation of the Earth's rotation axis), and the number of stations with identifiable excursions in the phase of the annual cycle of surface temperature in a given year (as identified using the EMD).

This is an intriguing result and should be published. The annual cycle represents by far the largest source of variability in the instrumental temperature record, and attri-

bution of causes of variability in this annual rhythm are of first order importance for understanding climate variability. Orbital modulation of the annual cycle in surface temperature by processes other than the tropical year over timescales as short as the instrumental record would represent an important finding. While the physical interpretation of the Vecchio et al.'s findings is not 100% clear, they make the strongest case I am aware of for nutational influence.

Specific Comments:

(1) The fact that EMD does not capture seasonal oscillations in 1 mode seems to call into question the appropriateness of EMD for analyzing the seasonal cycle. The authors do address this in the text, and the apparent presence of a relationship with nutation suggests that the decomposition is physically meaningful. However, it is not altogether clear how to physically interpret the number of instantaneous frequency excursion events of an IMF that only partially describes the seasonal component of variability (in combination with a second mode). Figure 2 seems to indicate that the method used here essentially detects instances in which seasonal variability (transiently) switches from the j=1 to the j=2 mode. It is not clear why the seasonal cycle at times is transiently expressed in the j=2 mode rather than the j=1 mode, nor how we should physically interpret these events, which appear to have some relationship with nutational variability.

(2) P: 15543, line 6: Need to clarify how criteria B is evaluated and what is meant by "identifies the duration of each anomaly". As written it reads as if the criteria is reached when theta(t) is small, which makes little sense. It may make sense to only use criteria A.

(3) Criteria A defines an "occurrence" as a time when the local frequency is greater than two standard deviation of its average. Anomalies in phase could, in principle, be either direction (that is, represent either positive or negative excursions in instantaneous frequency). Are anomalies towards small instantaneous phase also seen? Or

are all large local extrema in instantaneous frequency in the positive direction?

(4) P: 15539, line 19: Thomson [1995] showed a local trend in phase towards later seasons at Central England. There was no indication of a global phase trend towards later seasons in his work.

(5) P: 15541, line 14: “The 66% of stations show an anomalous seasonal oscillation characterized by intermittent local decreases of the amplitude of the j=1 mode”. How is this assessed? Is this according to criteria A given below? I.e. 66% of station contain at lease one type A “occurrence”?

(6) P: 15543, line 13: “phase-shift events undoubtedly show an oscillating behavior characterized by a period of about P=18.9 +/- 0.2 yr”. Need to explain how time period of 18.9 was recovered from values shown in figure 3, and basis for statement that the peak is “undoubtable”. Are there any other significant peaks?

(7) P: 15543, line 18 and Figure 4: From visual inspection, there clearly appears to be a relationship between the inclination of the moon’s orbit relative to the equatorial plane and the occurrence of annual cycle phase anomalies in the US historical climatology record. However, a quantitative comparison should be made as well and the significance of the relationship should be evaluated.

(8) Figure 4: In figure caption, how “period of modulation” and it’s uncertainty are calculated should be explained. Two methods for assessing the “period of modulation” are referred to, but only one number is reported. How are peaks picked for method A (and how is uncertainty assessed)? Does “by Fourier transform” for method B mean that a significant spectral peak has been found near 1/18.7 years in the periodogram of time series B? Is this the only peak?

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 15537, 2010.