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Detection of the significant geomagnetic field signals in the interannual variations of Length-of-Day using wavelet method

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The previous studies indicated that the most of the interannual variations in Length-Of-Day (*LOD*) could be explained by the joint effects of *ENSO* (EI Nino-Southern Oscillations) and *QBO* (Quasi-Biennial Oscillation) phenomenon in the atmosphere. Due to the limit of the used methods, those results cannot give the "time-frequency" coherence spectrum between *ENSO* and *LOD*, and cannot indicate in which specific periods the weak coherence occurred and difficult to give the reliable reason. This paper uses Daubechies wavelet with 10 order vanishing moment to analyze the *LOD* monthly time series from 1962 to 2011. Based on cross-wavelet and wavelet coherence methods, the analysis of the time-frequency correlations between *ENSO* and *LOD* series (1962-2011) on the 1.3$\sim$10.7 year scales is given. We have extracted and reconstructed the *LOD* signals on 1.3$\sim$10.7year scales. The result shows that there is obvious weak coherence on both biennial and 5$\sim$8 year scales after 1982 relative to before 1982. According to the previous works, the biennial weak coherence is due to *QBO*, but the weak coherence on 5$\sim$8 year scales cannot be interpreted by the effects of *ENSO* and *QBO*. In this study, the Geomagnetic field signals (can be characterized as *Aa* index) are introduced, we have further extracted and reconstructed the *LOD*, *ENSO* and *Aa* signals in 5-8.0 year band using wavelet packet analysis. Through analyzing the standardized series of the three signals, we found a linear time-frequency formula among the original observation series: $LOD(t,f) = \alpha ENSO(t,f) + \beta Aa(t,f)$. This study indicates that the *LOD* signals on 5.3$\sim$8.0 year scales can be expressed in term of linear combination of *ENSO* and *Aa* signals. Especially after 1982, the contributions of ENSO and *Aa* to *LOD* respectively reach about 0.95*ms* and 1.0*ms*.The results also imply that there is an obvious Geomagnetic field signal in interannual variations of *LOD*. Furthermore, after considering the geomagnetic field signal correction, the Pearson correlation coefficient between *LOD* and *ENSO* will increase from 0.51 to 0.98. Consequently, we can conclude that the weak coherence after 1982 on 5.3-8.0 year scales between *LOD* and *ENSO* is mainly due to the disturbance of *Aa* signal, and the observed *LOD* series is the result of the interaction between *ENSO* and geomagnetic field signals.