

METEOROLOGICAL INTERPRETATION OF TRANSIENT LOD CHANGES

Y. MASAKI
Geographical Survey Institute
1, Kitasato, Tsukuba, Ibaraki, 305-0811, JAPAN
e-mail: ymasaki@gsi.go.jp

ABSTRACT. The Earth's spin rate is mainly changed by zonal winds. For example, seasonal changes in global atmospheric circulation and episodic changes accompanied with El Niños are clearly detected in the Length-of-day (LOD). Sub-global to regional meteorological phenomena can also change the wind field, however, their effects on the LOD are uncertain because such LOD signals are expected to be subtle and transient. In our previous study (Masaki, 2006), we introduced atmospheric pressure gradients in the upper atmosphere in order to obtain a rough picture of the meteorological features that can change the LOD. In this presentation, we compare one-year LOD data with meteorological elements (winds, temperature, pressure, etc.) and make an attempt to link transient LOD changes with sub-global meteorological phenomena.

1. INTRODUCTION

The Earth's spin rate is sensitive to atmospheric zonal motion at a global scale. In observed LOD excess, various types of transient signals which are superimposed on seasonal variations are detected. LOD changes associated with El Niño events are famous examples on episodic LOD signals occurred by meteorological phenomena. The southern oscillation index (SOI) is a good indicator for such LOD changes because the SOI is strongly correlated with activity of El Niños (e.g., Chao (1984), Dickey et al.(1999)).

Then, what are other transient LOD signals attributable to? Do other meteorological indices can also explain LOD changes? Since such transient changes are also detected in the atmospheric angular momentum (AAM) functions, they must reflect atmospheric phenomena.

Geodetic observation may have potential tasks on monitoring Earth's climate changes in near future. It is important to know what becomes detectable through geodetic observation.

We compare one-year-data of the LOD excess for 2005 with meteorological data or meteorological indices which describe the atmospheric circulation status at a sub-global scale. These indices are expected to have close relations to the zonal flow of the atmosphere.

2. ANALYSIS METHOD

Meteorological data used in this study is the NCEP-DOE reanalysis data. Since episodic signals produced by transient atmospheric phenomena are overwhelmed by seasonal signals, mean seasonal variation averaged over 25-year-data (1979-2003) is subtracted from the original time-series data.

Since seasonal variation of UT1 is well approximated by the UT2 function, we subtract UT2 from UT1. The Earth's spin rate is expressed in the LOD excess.

3. RESULTS AND DISCUSSION

We show meteorological data (wind velocity anomalies from the mean value and meteorological indices which represent the atmospheric status at a sub-global scale) for 2005 in Fig. 1.

So far, some events in the LOD can be explained by meteorological indices, however, no strong relations between meteorological indices (except for the SOI) and the LOD excess have been found. A brief summary on the results for two meteorological indices is shown below:

Blocking index: A blocking index represents blocking activity in the westerlies at mid- or high latitudes. When a strong blocking occurs, we can see the negative zonal wind anomaly at high latitudes

(Figure 1 (a)). However, its effect on the Earth's spin rate is small (Figure 1 (b)) because of the smaller effect on the angular momentum change by winds blowing at higher latitudes.

Arctic Oscillation: In theory, a positive Arctic Oscillation (AO) index intensifies the polar jet and weakens the subtropical jet. In early spring of 2005, the AO index turns negative. Around the same time, the SOI also turns negative. Both indices intensify increase in the LOD excess, the opposite case of 1989 (de Viron et al.(2001)) but for a shorter duration.

Meteorological indices used in this study mainly describe the atmospheric status at mid- or higher latitudes. Therefore, even if they certainly affect the wind field at higher latitudes in Figure 1 (a), their effects on the LOD become smaller (Figure 1 (b) and (c)) because excitation efficiency depends on the latitude. The well-known index, SOI, describes the atmospheric status at low latitudes where the atmosphere efficiently excites the Earth's spin rate variation, the index strongly correlates with the LOD changes.

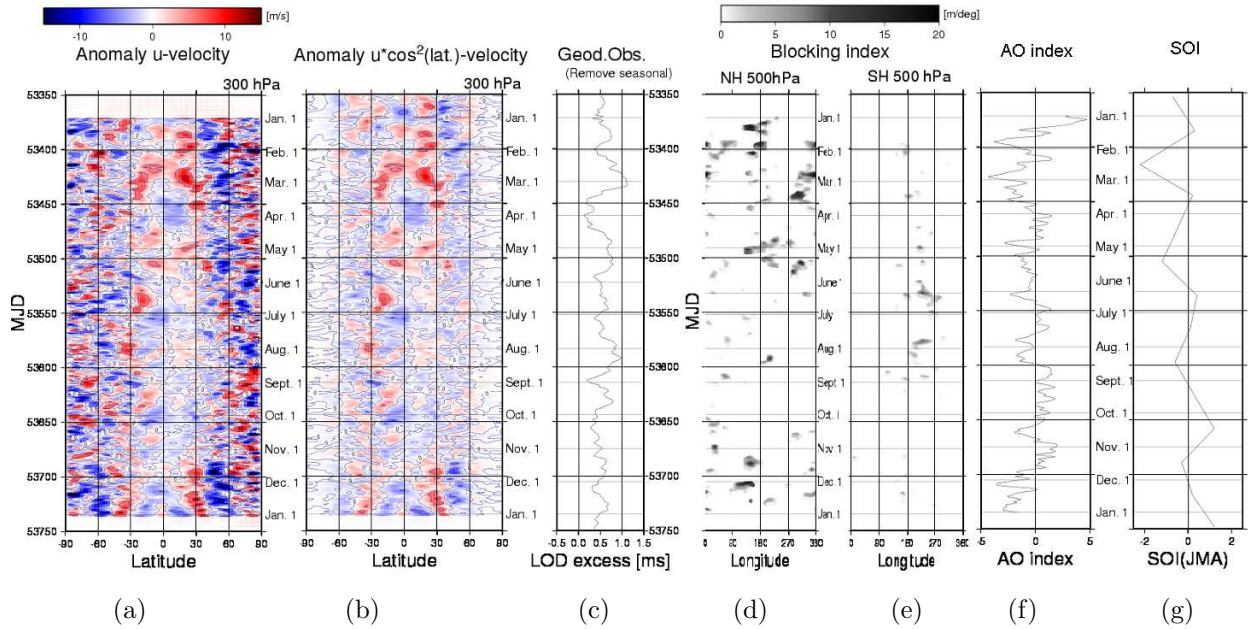


Figure 1: Meteorological data and the Earth's spin rate (converted into the LOD excess) for 2005. In the left three panels, seasonal variations are removed from the original data. Wind data are zonally averaged. From left to right: (a) latitude dependence of zonal wind velocity anomaly at 300 hPa (b) same as (a), but multiplied by $\cos^2(\text{latitude})$, in order to easily read contribution to the axial AAM function from the plot (c) LOD excess (seasonal (UT2) contribution is removed). The right four panels show meteorological indices which describe the atmospheric circulation status at a sub-global scale. (d/e) the NH/SH blocking index (f) the arctic oscillation (AO) index (calculated by the CPC/NCEP) (g) the southern oscillation index (SOI) (calculated by the JMA).

4. REFERENCES

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