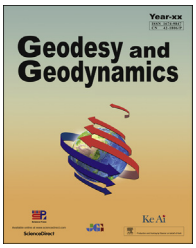
Ke Ai
ADVANCING RESEARCH
EVOLVING SCIENCE

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.keaipublishing.com/en/journals/geog;
http://www.jgg09.com/jweb_ddcl_en/EN/volumn/home.shtml



Detection of different-time-scale signals in the length of day variation based on EEMD analysis technique

Wenbin Shen[a,b,*], *Cunchao Peng*[a]

[a] *Department of Geophysics, School of Geodesy and Geomatics/Key Laboratory of Geospace Environment and Geodesy of Ministry of Education, Wuhan University, Wuhan 430079, China*
[b] *State Key Laboratory of Information Engineering in Surveying, Mapping and Remote Sensing, Wuhan University, Wuhan 430079, China*

ARTICLE INFO

Article history:
Received 17 January 2016
Accepted 9 March 2016
Available online 27 May 2016

Keywords:
Earth rotation
Variation of length of day
Ensemble empirical mode decomposition
Periodic signals
LOD fluctuation mechanism

ABSTRACT

Scientists pay great attention to different-time-scale signals in the length of day (LOD) variations ΔLOD, which provide signatures of the Earth's interior structure, couplings among different layers, and potential excitations of ocean and atmosphere. In this study, based on the ensemble empirical mode decomposition (EEMD), we analyzed the latest time series of ΔLOD data spanning from January 1962 to March 2015. We observed the signals with periods and amplitudes of about 0.5 month and 0.19 ms, 1.0 month and 0.19 ms, 0.5 yr and 0.22 ms, 1.0 yr and 0.18 ms, 2.28 yr and 0.03 ms, 5.48 yr and 0.05 ms, respectively, in coincidence with the results of predecessors. In addition, some signals that were previously not definitely observed by predecessors were detected in this study, with periods and amplitudes of 9.13 d and 0.12 ms, 13.69 yr and 0.10 ms, respectively. The mechanisms of the LOD fluctuations of these two signals are still open.

© 2016, Institute of Seismology, China Earthquake Administration, etc. Production and hosting by Elsevier B.V. on behalf of KeAi Communications Co., Ltd. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

How to cite this article: Shen W, Peng C, Detection of different-time-scale signals in the length of day variation based on EEMD analysis technique, Geodesy and Geodynamics (2016), 7, 180–186, http://dx.doi.org/10.1016/j.geog.2016.05.002.

* *Corresponding author*. Department of Geophysics, School of Geodesy and Geomatics/Key Laboratory of Geospace Environment and Geodesy of Ministry of Education, Wuhan University, Wuhan 430079, China.
E-mail address: wbshen@sgg.whu.edu.cn (W. Shen).
Peer review under responsibility of Institute of Seismology, China Earthquake Administration.

ELSEVIER Production and Hosting by Elsevier on behalf of KeAi

http://dx.doi.org/10.1016/j.geog.2016.05.002
1674-9847/© 2016, Institute of Seismology, China Earthquake Administration, etc. Production and hosting by Elsevier B.V. on behalf of KeAi Communications Co., Ltd. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

1. Introduction

The Earth rotation rate changes with time, which could be caused for instance by tidal friction, and the exchanges of angular momentum among the core, mantle, atmosphere, and oceans. Previous various analyses of time series of the length of day (LOD) variation (ΔLOD) data suggested quite a few of ΔLOD periodic signals [1–6], most of which are correlated with changes in atmospheric and oceanic angular momentum and some with tidal dissipation in the Earth–Moon and Earth–Sun systems.

As the Moon moves around the Earth, due to the tidal effects, the Earth's inertial moment tensor changes with the lunar orbital periods of 27.7 and 13.7 days. Hence, it is clear that there are variations in the LOD at the periods, charactering by 27.7 and 13.7 days [6]. Similarly, tidal deformation between the Earth and the Sun system may also causes various periods that are sensed to the Earth's orbit perturbation. It is responsible for about 10% of the annual and about 50% of the semiannual periods, and other causes could be the seasonal exchange of angular momentum among the solid Earth, atmosphere and the ocean [7]. A quasi-biennial oscillation was observed by many researchers [8–11]. The El Niño-Southern Oscillation in the troposphere-ocean system and the Quasi-Biennial Oscillation in the equatorial stratosphere, accounts for most of the observed quasi-biennial oscillation of LOD [8,9].

Mound and Buffett observed an about 6-year variation in the LOD [12]. They explained it as an exchange of angular momentum arising from gravitational coupling between the mantle and core. The decadal fluctuation in LOD has been long discovered, but its excitation mechanism is still open. Four different couplings between core and mantle, namely, electromagnetic, topographic, viscous and gravitational couplings, might explain the decadal LOD variation [13–17].

With the development of observation technology, the ΔLOD time series with high precision is available. In this paper, we analyzed the latest time series of ΔLOD using the ensemble empirical mode decomposition (EEMD) technique [18–20] to detect ΔLOD signals with various periods. EEMD is an effective analysis tool, which has successful applications in geoscience [11,21–23].

2. Data

The time series of ΔLOD that we use in this study is released by International Earth Rotation Service (IERS) Earth Orientation Centre (http://datacenter.iers.org/eop/-/somos/5Rgv/latest/214). It spans from 1st of January, 1962 to 1st of March, 2015, with sampling rate at 1 d, as shown by Fig. 1. Parameters in the series are with respect to IAU 2006/2000A precession-nutation model and consistent with International Terrestrial Reference Frame 2008 [24]. Compared to the old version, the new version has an impressive higher precision in 2 orders [25–27].

IERS provides rapid, monthly and long term Earth orientation data in the form of bulletins or data files. The time series of ΔLOD used in this study are contained in a long term Earth orientation data file. It has been recorded since 1846. However, the data collected in the period before 1962 have relatively poor precision, because at that period precise atomic clocks were not yet applied. Hence, in this study we use time series after 1962.

3. Method

Empirical mode decomposition (EMD) was proposed by Huang et al. [18,19]. This method is to decompose the data according to their intrinsic characteristic scales into a number of intrinsic mode function (IMF) components.

The EMD can decompose time series into many IMFs whose instantaneous frequency and instantaneous amplitude

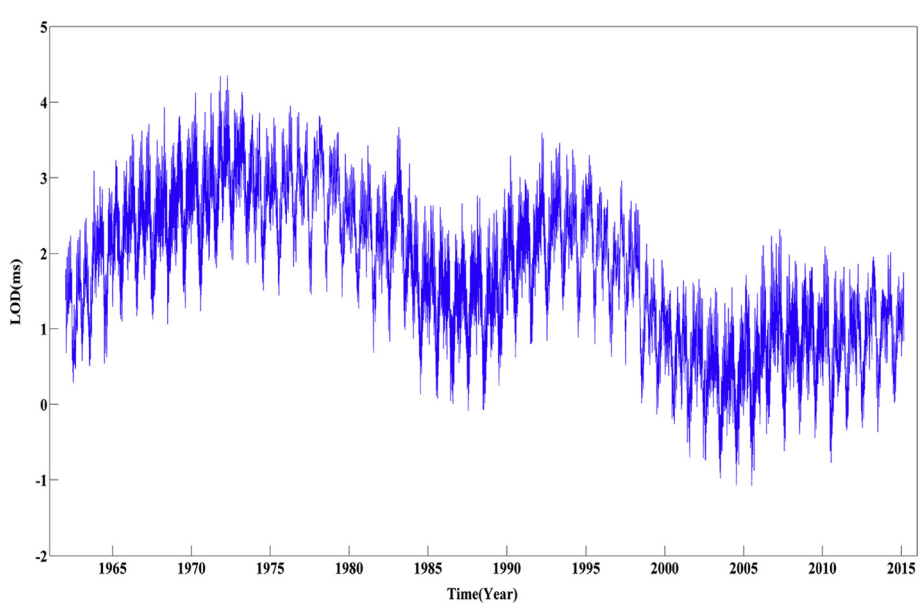


Fig. 1 – Length of day variation (ΔLOD) from 1st of January, 1962 to 1st of March, 2015.

Download English Version:

https://daneshyari.com/en/article/4683540

Download Persian Version:

https://daneshyari.com/article/4683540

Daneshyari.com