Using non-polar time and latitude variations for earthquake prediction

Hu Hui¹, Z. Malkin², Li Chunxiao¹, Su Youjin³, Wang Rui¹

¹Yunnan Observatory, Academia Sinica, Kunming, 650011, P.R. China
²Pulkovo Observatory, St. Petersburg 196140, Russia
³Seismological Bureau of Yunnan Province, Kunming 650224, P.R. China
E-mail: huhui@mail.ynao.ac.cn

Abstract. As was shown in several earlier studies, the results of optical astronomical observations of the time and latitude variations can be affected by the earthquakes. Such connection can be used, in particular, for earthquake prediction. In this work, we investigate the connection between the non-polar time and latitude variations, i.e. residuals between the observed values and those computed from the Earth rotation parameters provided by the IERS, and earthquakes occurred in vicinity of the Yunnan observatory in 2010-2016. It is shown that this connection can be effectively used for forecasting of the earthquakes in short-time perspective.

1. Introduction

Optical astronomical observations of the time and latitude variations conducted during many decades are the main source of investigation of the Earth rotation at long-time scale. These observations are referred to the plumb line direction, and therefore are subject of errors caused by the plumb line variations. One of the reasons of such variations is impact of the large earthquakes, which can be caused, in particular, by the motion of the groundmasses before earthquake. (Zhang 1981). In this study, we consider the connection between the time and latitude variations and earthquakes, and test its application to the forecasting of earthquakes. For this purpose, we compute the time and latitude residuals for a certain optical astrometric instrument as the difference between the observed values and effects of Earth rotation, such as rotational rate and polar motion. Since the great earthquake M=7.8 occurred in Tangshan, China in 1976, we have carried out research on the correlation between optical astronomical time-latitude residuals and earthquakes. Through more than 40 years study of time-latitude observations at 11 observatories around the world, significant synchronization anomalies of optical astronomical time-latitude residuals are found and observed within 2-3 months before occurrence of earthquakes M≥6.0 occurring within 700 km around the observatories, and vice versa no such synchronization anomalies are observed (Li et al., 1978; Zhang, 1981). Therefore, since 2010, we formally put this method into earthquake prediction practice, it now appears that the result is very good, neither false, nor omission.
2. Forecasting practice since 2010

We have established a set of forecasting procedures based on a multi-year study (Hu et al., 2016). Since February of 2010, at the beginning of each month we provide a report to the Earthquake Prediction Research Center of Yunnan Province listing the dates of anomalies point of a value of each 5 days of astronomical time-latitude residual until end of proceeding, for forecasting research purposes. From the monthly reported data in 2010-2015, the observational situation of photoelectric astrolabe of Yunnan Observatory was very good. Besides anomalies in March 2013 and March, May and September 2014 before earthquakes, there were no other anomalies (see Fig. 1). Therefore from the situation in 2010-2015 there is neither false nor fail report.

Two anomalies among the four observed anomalies appeared before the Yingjiang earthquake M=6.1 on 2014-05-30. The second anomaly occurred just a few days before Yingjiang earthquake on 2014-05-30. Why we believe that the anomaly in March of 2014 corresponds to the Yingjiang earthquake on 2014-05-30, and the other anomaly in May corresponds to the Ludian earthquake M=6.5 on 2014-08-03? This is based on out previous research for many astrometric observations over the world. We found that the anomalies of astronomical time-latitude residuals generally appear weeks to several months before the earthquake. For the anomalies of astronomical time-latitude residuals of the photoelectric astrolabe of Yunnan Observatory and the strong earthquakes around it, the time lag generally is 2-3 months. Therefore based on above-mentioned analyses we think that the anomalies on March and May of 2014 most likely respectively correspond to the Yingjiang earthquake M=6.1 on 2014-05-30 and the Ludian earthquake M=6.5 on 2014-08-03.

The distances from the epicenters of the Lushan, Yingjiang, Ludian, and Jinggu earthquakes to the Yunnan Observatory are respectively 580 km, 480 km, 240 km, and 280 km, their orientations are respectively 12 degrees north east, 10 degrees north west, north east of 20 degrees and 48 degrees south west (Fig. 2). Upon appearing of the four anomalies before the four time earthquakes, we provided reports on the anomalies of astronomical time-latitude residual to the Earthquake Prediction Research Center of the Yunnan Province before these four earthquakes. This proves that the anomaly of astronomical time-latitude residual can provide effective warning sign for earthquake occurrence around observatory station, thus deserves attention and further study.

4. Discussion

From the data in Fig. 1, the continuity of curve of astronomical time-latitude residual is not good. The is because the observation optical astrometric instruments carry out only in the night of sunny and few clouds, whether in Kunming, every year from May to October is the rainy season, which seriously affect the continuity of optical astronomical time-latitude residuals data.
Forecasting earthquake by the anomalies of optical astronomical time-latitude residuals at present can still only give accurate early warning information. For instance, it is forecasted that there will be a strong earthquake of M≥6.0 occurred within 700 km around the observatory in the next 2-3 months. Since development and occurrence of earthquakes is an extremely complex geophysical process, any single means can all not give accurate forecasts. To forecast earthquakes accurately, including all the three elements, time, place and magnitude, it must take the approach of comprehensive analysis by multiply methods and observations by multiple means.

References


Fig. 1. Residuals of astronomical time (a) and latitude (b) observations with photoelectric astrolabe of Yunnan Observatory from 2010.0 to 2016.05. Marks show large earthquakes:

1. 2013-04-20, Lusha, M=7.0;
2. 2014-05-30, Yingjiang, M=6.1;
3. 2014-08-03, Ludian, M=6.5;
Fig. 2. Geological structure of the Xikang-Yunnan fault block with earthquakes marked. We mark the date and magnitude of the earthquakes but not the accurate locality because many earthquakes have occurred in the same location.