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# Influences of multiple layers of air temperature differences on tidal forces and tectonic stress before, during and after the Jiujiang earthquake

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ABSTRACT

Using the air temperature data of the National Center for Environmental Prediction (NCEP), we compared multiple layers of air temperature differences before, during and after the Jiujiang earthquake, and explored its relationship with the additive tectonic stress caused by celestial tide-generating force (ATSCTF). The earthquake occurred at the 1 of 4 high phases of ATSCTF, while the temperature rise came from land surface to high sky. It indicated that the tide force could trigger an earthquake when the tectonic stress was in critical status, and the air temperature rise reflected the terra stress change modulated under the tidal force. During the shock period of ATSCTF, the distribution of air temperature changes both near land surfaces and upper multi-layers along the active fault zones showed a tectonic disturbance pattern of calm before earthquake, rise during earthquake, calm after earthquake as well as a heat distribution pattern of the surface air warmed by land, uplifted by heat flux, cooled and dissipated in the sky. The pattern of changes obeyed the rule of thermal rise of rocks broken under stress loading and the principle of atmospheric thermal dynamic diffusion in vertical. We argued that an earthquake may also be a reason for air temperature differences rather than a simple weather process. At the same time, the rise of air temperature was synchronized with the ATSCTF fluctuant, which showed that tidal force had a particular indicative significance for the identification of temperature anomaly on seismic faults. Because of the mechanical characteristics of the study of earthquake thermal anomalies, it could help to identify the earthquake thermal anomalies and the climatic thermal anomalies, and provided a clear time-indication for the choice of the background temperature in the seismic thermal anomaly recognition.

## 1. Introduction

There are numerous studies and reports about thermal anomalies on the earth's surface, which occurred just before an earthquake and can be explored using satellite remote sensing technology. It is thought that the evaluation of thermal changes in the atmosphere at a certain distance from the surface of a seismogenic zone is worth studying (Mogi, 1984; Gorny et al., 1988; Tramutoli et al., 2001; Andrew et al., 2002; Ouzounov and Freund, 2004; Arun et al., 2008). Qiang et al. (1999) took the large infrared enhancement area observed in the direct visual interpretation satellite thermal images as the impending earthquake anomaly. Yang and Guo (2010) gained the time-series figure of difference temperature by subtracting the temperature data at the same time of different days, and plotted a figure to pick up the Thermal Infra-Red (TIR) anomaly. Zhang et al. (2010) used a wavelet transform method to process the brightness temperature data, and used the different wavelet transform criterion functions and window sizes of the Fourier Transformation to obtain different TIR anomalies. Another approach named Robust Satellite Technique (RST), which is based on a statistical definition of "TIR anomalies", TIR anomalies can be identified as deviations from those "normal" conditions (Tramutoli et al., 2005). Most of them preferred statistical methods to evaluate the thermal infrared radiation (TIR) data obtained via remote sensing technology over an earthquake-prone zone (Tramutoli et al., 2005). However, some researchers have questioned its usefulness (Matthew Blackett et al., 2011). They argued that statistical methods depended on the availability of a large amount of historical data and usually couldn't reliably measure small thermal changes occurring prior to an earthquake. In addition, if large amounts of clouds were present over an epicenter, the penetration of infrared waves became difficult, making a TIR-based measurement of temperature less reliable for seismic studies. Although it was possible to eliminate the impact of clouds by digital filtering of image data, the clouds

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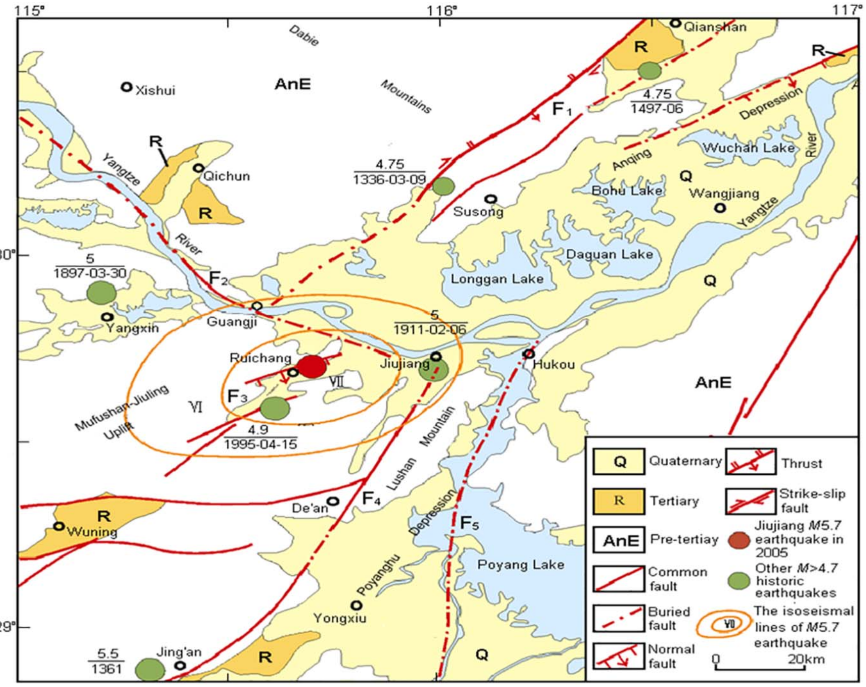


**Fig. 1.** Seismogenic tectonic in Jiujiang earthquake area (Li et al., 2008).
F1, Lujiang-Guangji fault; F2, Xiangfan-Guangji fault; F3, Dingjiashan-Langjunshan-Guilinqiao-Wuning fault; F4, Jiujiang-Jing'an fault; F5, Hukou-Xin'gan fault.

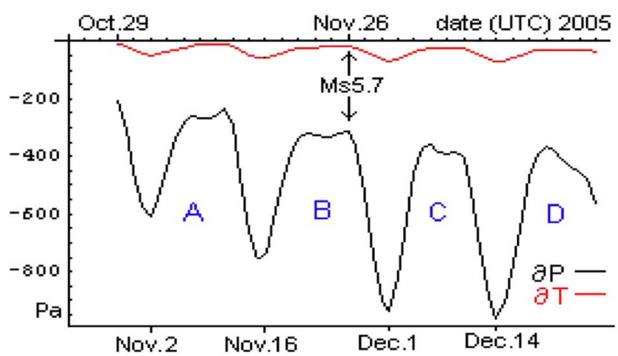


**Fig. 2.** The change of ∂P, ∂T in ATSCTF model for the Jiujiang earthquake in 2005.

around the epicenter had significant energy, which itself was an important indicator in predicting an earthquake (Morozova, 2000, 2012; Wu et al., 2008, 2013; Guo and Wang, 2008; Guo and Yang, 2013). Therefore, the choice of methodology and the availability of background data significantly influenced the outcomes of seismic studies.

Seismic activities always lead to atmospheric warming, with heat originating from the ground, followed by atmospheric uplift, diffusion, and finally dissipation in the sky. It is known that the properties of the atmosphere differ with altitude. The rise in air temperature is caused by one of the three mechanisms: advection, radiation, and convection. If we identify the thermodynamics of air temperature caused by local surface heating rather than by remote atmospheric advection, it would help us understand the thermal anomalies caused by earthquakes.

Earthquakes occur due to mechanical processes taking place inside the earth. Therefore, it is necessary to introduce mechanics in studying the relationship between thermal anomalies and earthquakes. An important stress parameter that is considered an essential mechanical factor in triggering an earthquake is tidal force, which causes tectonic stress in the rocks to reach critical breaking point (Heaton, 1975; Kilston and Knopoff, 1983; McNutt and Beavan, 1981). Hence, the action of tidal force on temperature before, during, and after an earthquake deserves our attention.

In this paper, we evaluate the changes in additive tectonics stress caused by celestial tide-generating force (ATSCTF) at the epicenter of the Jiujiang Ms5.7 earthquake. The relationships among successive air temperature changes before, during, and after earthquake around the epicenter at different altitudes, the tidal force, and seismic tectonic stress state were analyzed by using the air temperature data of the National Center for Environmental Prediction (NCEP).

## 2. Tectonic environment of the Jiujiang earthquake

An earthquake of magnitude 5.7 occurred at 00:49:52 (UTC) at 29.7 N, 115.7E in the City of Jiujiang, China on November 26, 2005. The epicenter was located at the juncture of two main tectonic units, with the Qinling-Dabie orogenic belt lying in its north and the Yangtze paraplatform lying in its south. Several groups of regional faults existed near the epicenter: the NE-trending Lujiang-Guangji fault (southern segment of the Tan-Lu fault zone) and the NW-trending Xiangfan-Guangji fault in the north of epicenter; the NE-trending Dingjiashan fault and Langjunshan-Gulinqiao-Wuning fault; the NE-trending Jiujiang-Jing'an fault, and Hukou-Xin'gan fault in the south of epicenter (see Fig. 1).

## 3. Action of ATSCTF

The model of the Additive Tectonic Stress from Celestial Tide-generating Force (abbreviated as ATSCTF) defines the additional tidal stress (i.e. ∂P and T) at the epicenter along the main pressure (P-axis) and tension stress (T-axis), respectively. Three types of ATSCTF actions are identified on the epicenter that trigger the earthquake (Ma et al., 2008, 2012): (1) Stress increases, the earthquake occurs at both tops of ∂P, ∂T; (2) Stress decreases, the earthquake occurs at the both bottoms of ∂P, ∂T; and (3) Stress sometimes increases and sometimes decreases, the earthquake occurs at the time when ∂P and ∂T, one is in the top, the other is in the bottom. For Jiujiang earthquake, the same ATSCTF model was used. We calculated the ∂P and ∂T for the period from October 29 to December 28, 2005 (see Fig. 2). Four cycles of low-high-low fluctuant in time (marked A, B, C, and D respectively) were identified