Comment on "Possible association between anomalous geomagnetic variations and the Molise Earthquakes at Central Italy during 2002" by Takla et al. (2011)

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Abstract

Takla et al. (2011) documented the observation of seismogenic precursory signals in the geomagnetic field components of L'Aquila station (LAQ) which occurred before the 2002 Molise earthquakes. Here these claims are reviewed taking into account the geomagnetic index ΣKp time-series and by means of data coming from the Geomagnetic Observatory of L'Aquila where the LAQ station is located. This review shows that before the Molise earthquakes the anomalous behaviour of LAQ geomagnetic field components was actually caused by a possible thermal drift of the instrumentation. In conclusion there is no firm relation between the earthquakes occurrence and the observed magnetic anomalous signatures documented by Takla et al. (2011)

Keywords: Geomagnetic field, Magnetic anomalies, Earthquake precursors, Short-term earthquake prediction.

1. Introduction

Many studies claim the observation of seismogenic electromagnetic anomalous signals before the earthquakes occurrence. Several researchers also suggest that these anomalies are possible candidates for developing short-term earthquake prediction capabilities. Short-term earthquake prediction is one of the challenges of the scientific community. To be useful, earthquake prediction requires reproducible precursors which provide real-time information regarding intensity, location and time of the predicted earthquake. Thus, a considerable caution should be adopted before maintaining the observation of seismogenic signals, and the authenticity of possible earthquake precursors needs to be carefully checked. In addition, a constructive criticism of the results is needed. A very important question should be: Is the observed anomaly a reliable earthquake precursor?

2. Comments

Takla et al. (2011), hereafter cited as TAK, documented the observation of long-term anomalous variations in the geomagnetic field components possibly associated with two Mw5.7 earthquakes which occurred respectively on 31 October and 1 November 2002 in the Molise region, Italy. The authors analyze geomagnetic data coming from Circum-pan Pacific Magnetometer Network (CPMN) stations of L'Aquila (LAQ), Italy, Hermanus (HER), South Africa, Popov Island (PPI), Russia, and Learmonth (LMT), Australia (you can refer to Fig.1 by TAK for the location of the four CPMN stations). According to the authors HER is almost the conjugate station of LAQ, whereas LMT is almost the conjugate station of PPI. All the stations are equipped with ring core type fluxgate magnetometers (1Hz sampling rate). LAQ station is located within the INGV (Italian Instituto Nazionale di Geofisica e Vulcanologia) Geomagnetic Observatory of L'Aquila (hereafter cited as INGVAQ), and it is the closest station to the epicentres area (about 140km of distance). TAK compare geomagnetic field data coming from the two pairs of conjugate stations in order to detect possible seismogenic signals at LAQ. The study of TAK documented the occurrence of a long-term magnetic anomalous behaviour in LAQ data which started four months before the Molise earthquakes. According to TAK, large anomalies are present in all the three geomagnetic field components of LAQ station. The maximum amplitude of these anomalies is -40nT, 50nT, and 20nT in the H, D, and Z components respectively. H, D, and Z are the variations in nT of the geomagnetic field components in the NS, EW, and vertical direction. Panels (b) - (e) of Fig. 1 show the H component daily average variations during 2002 at the four CPMN stations as reported by TAK. According to the authors the dash-dot rectangle highlights an anomalous decrease in the amplitude of the H component of LAQ instrument (see Fig. 1b, solid black curve). The horizontal solid red line can be used as reference to better visualize the amplitude anomaly. They point out that the amplitude decrease is not present in the H component of HER station. Furthermore, contrary to the pair of conjugate stations LAQ-HER, the pair PPI-LMT does not show a similar behaviour. The authors conclude that the LAQ anomaly was caused by stress accumulation which induced enhancement of the lithospheric conductivity during the preparation process of the Molise earthquakes.

Here TAK results are investigated in order to throw light on the real origin of their claims. This study takes into account geomagnetic field data coming from an independent fluxgate magnetometer of INGVAQ and the global geomagnetic activity level by means of ΣKp index. In Fig. 1 the INGVAQ H component, the geomagnetic index ΣKp time-series, and the local external temperature T are superimposed onto the original view. The figure shows that the H component time-series of INGVAQ, HER, PPI, and LMT stations have a similar behaviour. The panel (a) of the figure shows that there is a strict correspondence between the INGVAQ H component and ΣKp time-series. These remarks suggest that the variation of geomagnetic field H component in the four stations INGVAQ, HER, PPI, and LMT is mainly caused by the global geomagnetic activity level. Moreover, no local seismogenic anomalous signature (both pre-seismic and co-seismic) can be found in INGVAQ data by a visual inspection of the H component time-series. In addition, the gradual decrease observed in the H component of LAQ station is not confirmed by the INGVAQ independent instrument. Consider that the distance between LAQ instrument and the INGVAQ fluxgate is less than one hundred of meters. In light of this, we can suppose that the gradual decrease of the LAQ H component could be caused by instrument malfunction. As a matter of fact, panel (b) of Fig. 1 shows a clear correspondence between the trend of the temperature T and the H component time-series of LAQ instrument. This correspondence suggests that the temperature increase which occurred during summer 2002 could have caused a thermal drift of LAQ instrumentation. Similar conclusions, here not reported, can be also stated regarding the magnetic anomalies claimed to be occurred in the D and Z components. In conclusion, relating the long-term anomalous behaviour of the LAQ geomagnetic field components to the Molise earthquakes is undoubtedly an incorrect assumption.

3. Conclusions

Takla et al. (2011) claim the observation at LAQ station of possible magnetic seismogenic long-term anomalous variations in the geomagnetic field components which occurred before the 2002 Molise earthquakes. Here, by means of data coming from the INGV Geomagnetic Observatory of L'Aquila it is shown that the anomalous variations of LAQ geomagnetic field components are probably caused by instrument malfunction. Therefore, no seismogenic signature in the geomagnetic field components of LAQ station can be unequivocally stated before the 2002 Molise earthquakes.

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References

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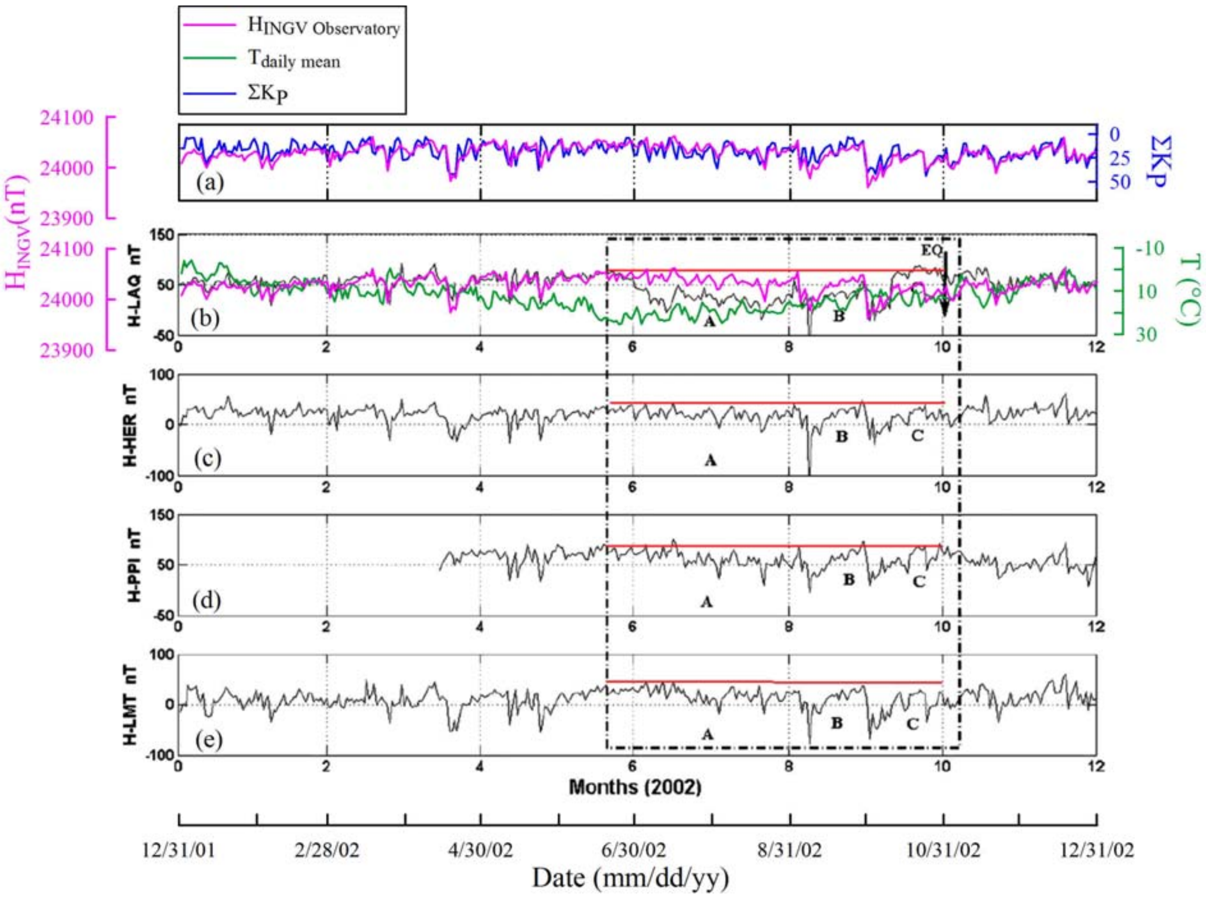

Fig. 1. (a): daily values time-series of the geomagnetic field H component coming from the INGV Geomagnetic Observatory of L'Aquila (INGVAQ) compared with the ΣKp index time-series. (b) - (e): daily values time-series of the geomagnetic field H component variation at the CPMN stations LAQ, HER, PPI, and LMT as reported by Takla et al. (2011) (a reproduction of Takla et al. 2011, Fig. 2). The INGVAQ H component time-series, and the local external temperature, are also superimposed onto panel (b). See text for details.