Wu et al. (cited as WU16 below) investigate the possible occurrence of precursors of the 6 April 2009 L'Aquila earthquake in atmospheric and soil parameters (cited as ASPR below) by means of retrospective analyses of assimilation datasets (soil moisture, soil temperature, near-surface air temperature, and precipitable water) and in ground-based observations of temperature and atmospheric aerosol, as well as in seismic data. The authors show preearthquake changes that they interpret as possible precursors of the earthquake.
Reports of earthquake precursors have a serious social responsibility because they motivate the idea that in the future we will able to predict earthquakes. Thus, the identification of actual and reproducible precursors is the key point for evaluating the potentiality of an earthquake prediction method.

Even if the subject of WU16 is very timely, as there are still debates on the existence of earthquake precursors, on their detection, as well as on possible methods of earthquake prediction, the manuscript shows many weaknesses that cast serious doubts on the seismogenic origin of the reported preearthquake changes. Below there are some remarks on how the authors introduce the topic of earthquake precursors and on their analysis of ASPR. This brief comment does not address the analysis of seismic data.

1) The introduction section of WU16 is very one sided in favor of earthquake precursors and does not correctly introduce the state-of-the-art in the search for precursors. The authors in support of their findings quote papers claiming the observation of precursors of the 2009 L'Aquila earthquake. Thus, in WU16 the authors report that a l*arge number of the precursory anomalies of the 2009 L'Aquila EQ were reported.* In fact, what they claim is not correct. All the changes (in any geophysical parameter) identified to precede the earthquake of L'Aquila are to be considered only alleged precursors because actual evidence of the relationship between these changes and the earthquake has never been provided. Moreover, the authors seem to show a poor knowledge of the recent literature in the topic of earthquake precursors, as well as of the studies on the precursors of the L'Aquila earthquake. Below there are some examples that show how the Introduction section of WU16 is biased.

- The authors, while mentioning Biagi et al. (2009) as a paper showing an actual precursory anomaly in LF radio signals, are unaware that Biagi and his co-authors (see Biagi et al., 2010) refute their previous findings reported in Biagi et al. (2009).

- WU16 quote Eftaxias et al. (2009) as report of actual precursors of the 6 April earthquake. Eftaxias et al. (2009) show electromagnetic anomalies at the Greek station of Zante (800 km away from L'Aquila) that they claim to be precursors. Note that analysis of data from L'Aquila area did not identify any electromagnetic and co-seismic signature that may be actually recognized as seismogenic, and alleged precursory signatures claimed to be identified in these local data have been shown to be actually unrelated to the earthquake (see Biagi, 2009, 2010; Masci, 2012; Masci and De Luca, 2013; Masci and Di Persio, 2012; Villante et al., 2010).

- WU16, while mentioning papers proposing possible physical mechanisms for the generation of preearthquake electromagnetic signals, are unaware of recent laboratory experiments on fluid-saturated rock samples that do not support the hypothesis that electromagnetic signals may be generated during the slow stress accumulation that may occur prior to earthquakes (see Dahlgren et al., 2014).

2) One of the main shortcomings of WU16 is the identification of precursory signatures in ASPR (see Section 2). In general, the authors do not provide a rigorous qualitative definition of what constitutes an anomaly, nor do they show if the alleged anomalies appear only before the earthquake, or whether they appear frequently, more or less at random.

– Page 6, row 182: Why preearthquake anomalies are more remarkable at 06:00 UTC?

– Assimilation datasets

The method used by WU16 for identifying pre-earthquake anomalies cannot be considered a valid method to find earthquake precursors. For example, in Figure 2.1 there is no physical reason that ($\mu+2\sigma$) and ($\mu+1.5\sigma$) represents the "normal background" above which seismogenic anomalies may be isolated.

Still, the existence of a quasi-temporal synchronism is not very significant in order to claim a possible seismogenic origin of the reported anomalies because, as can be seen in Fig. 2.1, there is usually a correspondence between the changes in the ASPR parameters. STL1, e.g., shows a positive correlation with TMP2 during all the period shown in the figure.

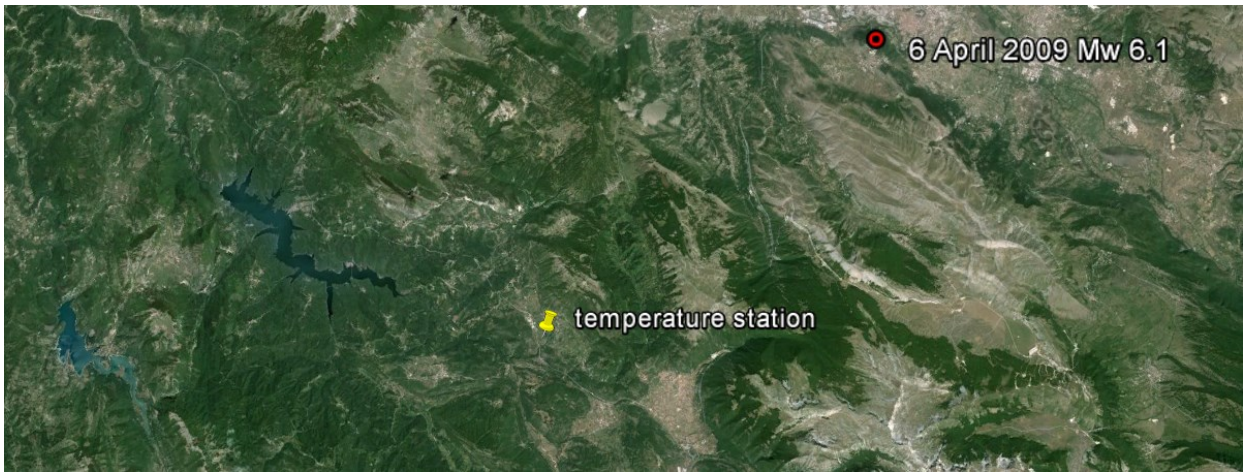
The authors show just over one month of data before the L'Aquila earthquake. Instead, they should demonstrate that actual seismogenic anomalies appear only before the earthquake, ruling out that these anomalies appeared frequently during the previous years.

– Ground-based datasets

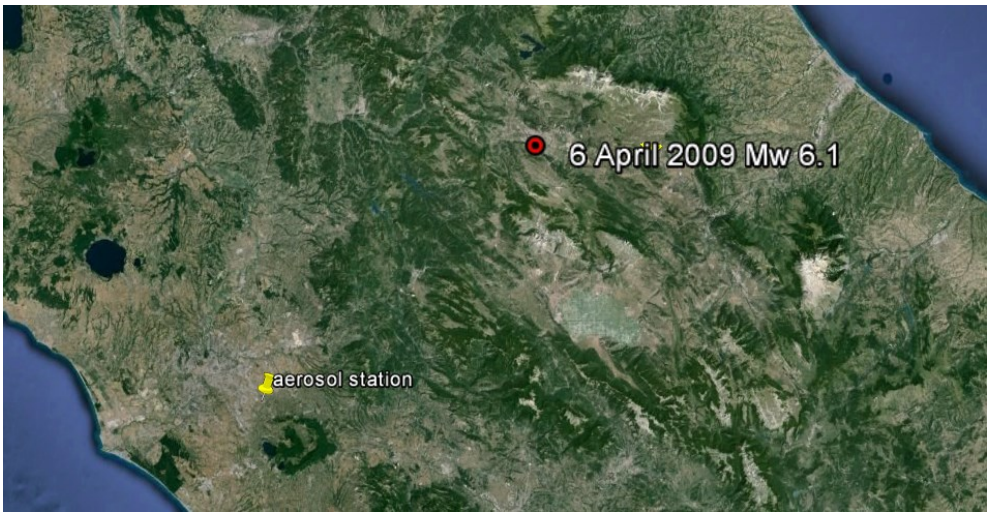
Once again the authors show just one month of data.

The ground based datasets shown in WU16 are not indicative of the climatic conditions of the L'Aquila area.

The air temperature station is close two lakes and is away from the fault that generated the earthquake (see the figure below)



The aerosol optical depth is obtained using data from a station very far from L'Aquila area. This station is in the highly urbanized area of the city of Rome close to the Ciampino airport (see the figure below).



3) What probably led the authors to look for precursors in a wide area is the paper by Dobrovolsky et al. (1979) where the authors report a theoretical formula for calculating the alleged preparation zone of the earthquake, a zone where physical phenomena should lead to the subsequent shock. Thus, this formula is usually used to support the observation of precursors away from the epicentral area. However, the theoretical formula of Dobrovolsky seems to be not supported by experimental evidence (see Masci and Thomas, 2014, 2015a, 2015b). Furthermore, if we accept that earthquake precursors may be observed in the area estimated by the Dobrovolsky's formula, this raises some doubts regarding the usefulness of precursors for developing short-term prediction capabilities of earthquakes. A prediction is a deterministic statement that a future earthquake of magnitude M will occur in a particular geographic region and in given period of time. For the Mw9.0 Tohoku-Oki, Japan, earthquake of 11 March 2011 the Dobrovolsky's formula estimates a preparation zone having a radius of 7413 km. Note that this represents approximatively one thirds of the Earth's surface. A precursor observed within this very wide area would not have been useful for predicting the Tohoku-Oki earthquake.

In summary, WU16 it is yet another paper that attempts to find earthquake precursors in geophysical parameters. Unfortunately, the authors do not provide any evidence that the identified pre-earthquake changes in ASPR are actually anomalous, and more importantly that their origin is actually seismogenic.

References:

- Biagi et al. (2009): doi:10.5194/nhess-9-1551-2009.
- Biagi et al. (2010): doi:10.5194/nhess-10-215-2010.
- Dahlgren et al. (2014): doi:10.1785/0120140144.
- Dobrovolsky et al. (1979): doi:10.1007/BF00876083.
- Eftaxias et al. (2009): doi:10.5194/nhess-9-1953-2009.
- Masci (2012): doi:10.5194/nhess-12-1717-2012.
- Masci and De Luca (2013): doi:10.5194/nhess-13-1313-2013.
- Masci and Di Persio (2012): doi:10.1016/j.tecto.2012.01.008.
- Masci and Thomas (2014):doi:10.1002/2014JA019896.
- Masci and Thomas (2015a): doi:10.1002/2015JA021336.
- Masci and Thomas (2015b): doi:10.1002/2015RS005734.
- Villante et al. (2010): doi:10.5194/nhess-10-203-2010.