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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Modeling ground deformation associated with the destructive earthquakes occurring on Mt. Etna's southeastern flank in 1984" *by* Flavio Cannavò et al.

M. Bonafede (Referee)

maurizio.bonafede@unibo.it

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Please see the attached pdf file for displayed equations

Comments from Maurizio Bonafede – Department of Physics and Astronomy, University of Bologna, Italy

Introduction

The Timpe fault system (TFS), is thought to accommodate (1) volcanic inflation in the East flank of Mt Etna, due to magma input/output and (2) the motion of the major tectonic lineaments in the region: the Messina-Fiumefreddo and the Malta escarpment (with its Northern prosecution as the Tindari-Giardini lineament). Of course both

mechanisms (1) and (2) must be considered as interacting processes, and it is difficult to assess what proportion of either mechanisms is responsible for the observed slip of the TFS. The problem is particularly awkward due to

(i) the scarcity of geodetic data, acquired yearly in a limited number of campaigns from 1977 to 1980 and again only after the earthquakes in 1984, considerd in this study;

(ii) the presence of several recognized faults in the area (5 are mentioned as subfaults of the TFS, but others are present within a slightly larger domain, as shown in figure 1);

(iii) the mentioned role of volcanic inflation/deflation, often with short time scales, which superpose large transient signals to the presumably more regular tectonic motions.

(iv) the scarcity of coherent points in the Eastern flank, where SAR data (in the years following 1990) might (in principle) constrain a more uniformly distributed deformation field.

For instance, Trasatti et al. (2009, Geophys. J. Int., 177, 806-814 – doi: 10.1111/j.1365-246X.2009.04093.x) describe the deformation of Mt Etna during 1993-1997 in terms of volcanic inflation and a rigid body translation of a sliding sector of the eastern flank, between the Pernicana fault (N of TFS) and the TFS. They employed GPS, tilt an SAR data but did not attempt to split the E-sector in differently sliding subsectors because of the increasing number of unknown parameters in the inversion.

Main comments

(A) Several earthquakes struck the E flank of Mt Etna between 1980 and October 1984 (only one is mentioned in June 19-th, 1984 but it is not accounted for); these may add transient components unresolved in the geodetic data between 1980 and 1984). Furthermore, as said already, deformation in a volcanic environment cannot be assumed as a steady state process, being related to episodic inflation/deflation episodes. For this reason, the straight dashed lines shown in figure 4 are meaningless.

(B) The formula at line 192 is wrong (hopefully it is only a misprint, otherwise the inversion procedure should be re-executed): the last term should read ε_12 sin2δ (not ε_12 sinˆ2 δ). It must be stated clearly that the deformation computed in this way is the "equivalent" uniform deformation (as reported in figure 2.C) providing the same distance variations as the real non-uniform deformation, concentrated on the faults

(C) Why are data at benchmarks 4 and 9 not taken into account? The number of free parameters (10) is so close to the number of independent data (13) that it is difficult to assess the reliability of the inversion. The more so, since data were arbitrarily (if I understand correctly, according to statement A above) corrected assuming a steady-state creep (dashed lines in figure 4) which is not supported by real data. Furthermore, some fault parameters (fault depth, length, dip) are fixed a priori. The data clearly show post-seismic creep and a major creep event is mentioned before the earthquakes (page 6). What would be the result of the inversion if the real data (1984 minus 1980) were considered?

Minor points

1. line 44: better write "... along the Timpe Fault System" instead of "... along the Fiandaca fault".

2. Lines 83-84: the previously unpublished data ... have been reviewed in the wake of new knowledge acquired in the last two decades (explain: what new knowledge? is it the fault parameters mentioned al line 206?), enabling insights into Etna's eastern flank ...

3. The magnitude of the seismic events should be always stated when they are first mentioned.

4. line 297: I do not get the mentioned Mo values employing the magnitudes m=4.2 and m=3.9 mentioned in the text. Furthermore, these are duration magnitudes, not Richter magnitudes mL. In any case, it is clear that most of the fault displacement is

aseismic.

5. line 308: EMS VII is written here for the June '84 event while it is rated as VIII at page 6.

6. explain acronym TDF at line 323; I cannot find it elsewhere;

7. the acronym MF is employed for both the Messina-Fiumefreddo line and for Mascarello fault: consider revising.

8. Figure 2: consider reporting in the caption the acronyms of the faults. Eliminate topographic level lines from panel B. Write "instrumental epicenter" (instead of "analytic location") and "macroseismic epicenter" otherwise (if I understand correctly).

9. Figure 3 is unnecessary: consider deleting, leaving the web link in the text.

Please also note the supplement to this comment:
http://www.nat-hazards-earth-syst-sci-discuss.net/nhess-2015-312/nhess-2015-312-RC1-supplement.pdf

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