Reply to Comment on se-2021-88

Anonymous Referee #1

Referee comment on "A functional tool to explore the reliability of micro-earthquake focal mechanism solution for seismotectonic purposes" by Guido Maria Adinolfi et al., Solid Earth Discuss., https://doi.org/10.5194/se-2021-88-RC2, 2021

General comments

R1: *The work provides a valid tool for testing the reliability of seismic networks in determining fault plane solutions. This is profitable in seismotectonic studies and is strictly relevant to the goals of the Solid Earth special issue. The proposed method has been applied to microearthquakes recorded by the ISNet seismic network in Southern Italy in the period 2005-2011. The authors used a Bayesian approach that jointly inverts the P/S long-period spectral level ratios and the P polarities to infer the fault-plane solutions. They also describe an application to the ISNet catalogue. The work is well presented, the subdivision into paragraphs is appropriate, the methodology is clearly stated, as well as results and conclusions. I suggest minor revisions.*

A: We thank the referee for his/her detailed revision work. We greatly appreciated his/her suggestions and support. We followed the referee's advices to improve the quality of the manuscript.

Specific comments

R1: *Lines 267-269: "In order to overcome this limitation, we used an empirical relationship to define the number and the distance of the seismic stations that record a seismic signal as function of magnitude, once its epicentral location (grid node) and depth are fixed." If the authors used an empirical relationship, it should be given. Actually, later in the text they state that they chose for each magnitude bin the median values of the distance of the farthest triggered seismic station and of the number of P-wave polarities. Please, clarify this point.*

A: We agree with the Referee and we add one sentence in L314-317 in order to clarify the empirical approach. Moreover, we modified the "Method" (now "Methodology") paragraph adding the steps of the proposed methodology to clarify our analysis.

R1: *Lines 382-388: "Using the results of our simulations, we classified the focal mechanism provided by De Matteis et al., (2016) according to a quality code based on the resolution of fault kinematics (Table 2). In fact, we assigned to focal mechanisms of Irpinia instrumental seismicity a quality A, B and C for solutions corresponding to FM3, FM2 and FM1 kinematics, respectively. The quality A, B and C correspond to the average value of KA misfit (FM1=4.5° FM2=3.1°, FM3=2.4°) calculated for M1, M2 and M3 magnitudes using D3 dataset and considering earthquakes at 10 km depth with 5% gaussian errors." The authors indicated multiple factors that influence the goodness of the fault plane solution, such as the magnitude, the observables from waveforms, network geometry, the noise level. They should point out that this is an example of application of the method, and that the proposed classification only concerns the type of mechanism. I would suggest giving more emphasis to this paragraph.*

A: We thank the Referee and we greatly appreciate his/her suggestion. We added a sentence in the Conclusion paragraph in L479-480.

Technical corrections

R1: *Lines 29-30: "We applied this methodology, by computing synthetic data, to the local seismic network operated in the Campania-Lucania Apennines" I suggest changing to: "We applied this methodology, by computing synthetic data, to the local seismic network **operating** in the Campania-Lucania Apennines"*

*Line 46: "After the earthquake location, origin time and dimension are identified" I suggest changing to: "After the earthquake location, origin time and dimension **source** are identified"*

*Line 53: Please, change "become" to "**becomes**".*

*Line 61: Please, change "so much so that" to "**so much that**".*

*Lines 69-71: "These features are employed in a very simple way by several algorithms to constrain the geometry of the earthquake faulting estimating the angular parameters strike, dip and rake" I suggest changing to: "These features are employed in a very simple way by several algorithms to constrain the geometry of the earthquake faulting, **through** estimating the angular parameters strike, dip and rake"*

*Line 78: "in time or in the frequency domain" I suggest to change to: "in **the** time or in the frequency domain"*

*Lines 85-86: Please, change "affect" to "**affects**" and "the resolution errors refer to the capability" to "the resolution errors **that are referred** to the capability"*

Lines 90-92: "In the case of focal mechanism, number of seismic stations, as well as seismic network geometry, and velocity structure of the crust influence the resolution and the reliability of the retrieved model" I suggest to change to: "In the case of focal mechanism, the number of seismic stations, as well as the seismic network geometry, and the velocity structure of the crust influence the resolution and the reliability of the retrieved model"

*Line 99: "In fact, its geometry may resolve" I suggest to change to: "In fact, **a given** geometry may resolve"*

*Line 102. I suggest to change "features" to "**constraints**"*

*Lines 103-104: "So, the number of seismic stations, the size and geometry of network are defined after a preliminary phase based on the specific seismological target is evaluated" I suggest to change to: "So, the number of seismic stations, the size and geometry of network are defined after a preliminary phase based on **the evaluation of the specific seismological target**"*

*Line 107: Please, change "is represented only by strongest earthquakes" to " is represented only by **the** strongest earthquakes"*

*Line 110: I suggest to change "we must increase the number of seismic stations for area unit building a dense seismic network" to: "we must increase the number of seismic stations for area unit **by** building a dense seismic network"*

Line 118. "synthetic data measurements" seems conflicting, measurement is used for real data.

*Lines 245-246: "As shown in Figure 2b, splitting the range of the data into equal-sized bins, we selected the focal mechanism corresponding to the most populated class" I suggest to change to: "As shown in Figure 2b, splitting the range of the data into equal-sized bins, we selected the focal mechanism corresponding **to the median value** of the most populated class"*

Line 248: I suggest to use: "Then, we decided to test"

*Line 252. I suggest to change "and 3) those of the 2nd, 3rd, 4th bins" to: "and 3) those of the 2nd, 3rd, 4th **most** populated bins"*

A: Done.

R1: *Lines 277-278: "The median value of the distance of the farthest station is then used to select the seismic stations for which synthetic data are calculated." Was this value used as a threshold value? Would the authors, please, specify.*

A: We added a sentence (L314-317) to better clarify this point.

R1: *Lines 349-350: "On contrary, only for M1 focal mechanisms there is no improvement because the number of P-wave polarities is the same for both D2 and D3 datasets (Table 1)" D2 dataset only includes P/S spectral level ratios, I don't understand the sense of this sentence.*

A: We follow the referee's comment to clarify this point adding a sentence in L334-335. In our analysis, when D2 is simulated, in order to solve the verse ambiguity of the slip vector, a P-wave polarity is added to the earthquake data that will be inverted for the focal mechanism. As shown in Table1, for depth of 10 km, the number of P-wave polarities is 1. So, D2 and D3 datasets are the same for M1, with only one P-wave polarity.

R1: *Lines 418-419: "The methodology described in this work can be a valid tool to design or to test the performance of local seismic networks, operated to monitor natural or induced seismicity" I suggest to change to: "The methodology described in this work can be a valid tool to design or to test the performance of local seismic networks, **aimed at monitoring** natural or induced seismicity"*

Lines 421-422: "Although it is a theoretical study, many earthquake scenarios with several magnitude, locations and noise conditions can be simulated to mimic the real seismicity" It seems that the authors want to lessen the theoretical aspect of their research, but this does not make sense. The theoretical approach allows to explore the reliability of the estimates of FMs obtained from experimental data; this is well expressed in the paper.

*Line 832: "Figure 9. FME (strike, dip and dake error) maps" Typing error: **rake** instead of dake.*

A: Done. Thanks for the support.

R1: *I don't always agree with the succession of figures. I would present figure 11 after figure 6, as well as figure 12 after figure 10. Furthermore, a table that summarizes the simulation parameters for each map could be useful for the reader: Figure No., type of map, dataset, magnitude bin, depth,…*

A: We thank the Referee for his/her suggestion, but we prefer not to change the order of the figures. This order derives from a logic scheme that we followed in the main text to describe the analysis and the effects of the selected parameters. Additionally, as correctly suggested, we inserted the following table that summarizes the simulation parameters for each map and can facilitate the readability.

Figure No.	Map	Focal Mechanism Solution	Magnitude Bin	Depth	Noise Level	Dataset
4	Kagan angle misfit	FM1, FM2, FM3	M3	10 km	5%	D1
5	Kagan angle misfit	FM1	M1, M2, M3	10 km	5%	D2, D3
6	Focal mechanism parameter misfit	FM1	M1, M2, M3	10 km	5%	D3
7	Kagan angle average	FM1	M1, M2, M3	10 km	5%	D2, D3
8	Kagan angle standard deviation	FM1	M1, M2, M3	10 km	5%	D2, D3
9	Focal mechanism error	FM1	M1, M2, M3	10 km	5%	D3
10	Kagan angle misfit	FM1, FM2, FM3	M1, M2, M3	10 km	5%	D3
11	Focal mechanism parameter misfit	FM1	M1, M2, M3	5 km	5%	D3
12	Kagan angle misfit	FM1	M1, M2, M3	10 km	30%	D3

Table 2