## Comments from Anonymous Referee #2

**This manuscript presents is a study about stress state estimations, which are crucial for determination of the minimal stress state of induced seismicity related to fluid injection. It is case study on the Illinois Basin Decatur Project (IBDP). Authors tackle the problem of stress calculation based on focal mechanism and additional stress parameters. Authors unveil the influence of the focal mechanism uncertainties as well as other crucial parameters such as friction coefficient and instantaneous shut-in pressure and the average of vertical stress for estimation minimum activation stress/pressure. The latter parameter is crucial in designing the injection operations and control the induced seismicity. I find this manuscript well designed and written. Authors clearly state the scientific problem and show possible solutions within assumed model and parameters.**

We greatly appreciate the positive evaluation from the reviewer.

**However, I have one general comment and some minor ones.**

'**You assumed constant friction during the whole injection and afterwards. What about friction coefficient changes due to injection? Maybe it would be informative to check the time evolution of the seismicity and injection and compare it with assumed permeability.**

Thank you for raising this interesting point. The assumption of constant friction Is a simplification due to the lack of direct measurement of the friction coefficient. We have now added a discussion paragraph to address this issue.

'Laboratory and filed studies (e.g., Marone, 1998) show that frictional properties can evolve during fluid injection due to changes in pore pressure and other interactions within the fault zone. Such effects, while not directly constrained in our study, may influence fault slip behavior. Our study focused on seismic events far from the injection where pressure changes (or velocity) due to the injection are very limited, hence the frictional properties are not likely in this case study.'

Marone (1998) shows that the frictional changes are caused by velocity or contact time changes in the fault zone. We do not see a process that can change these more than 1 km from the injection point.

**I miss the analysis of temporal behavior of the seismic activity with relation to injection time. Both clusters were activated after start of the injection, but with significant delay, which may be due to fluid or pore-pressure migration as well as cumulative stress changes due to consecutive injection volumes.'**

We thank the reviewer for this insightful comment; we agree that such an analysis would be highly valuable for understanding the underlying physical mechanisms at Decatur. However, we found that the uncertainties in event locations, particularly within Dataset 2 presented a big challenge to conducting a robust and conclusive space-temporal analysis. Pressure changes at Decatur were small, around 1 MPa at the injection well, and given the high permeability and thickness of Mt. Simon sandstone, the pressure changes at the location of the induced events are minor. Nonetheless, the triggering mechanism was likely related to pore pressure diffusion as the pressure front advanced away from the injection well and destabilized critically stressed faults.

**Minor remarks, which may help readers better understand the work and some questions and suggestions for authors:**

**Lines 62-67: This is a bit difficult to follow, when You compare stress gradient with Shmin value at particular depth, since reader may not know how these values are related to each other. I suggest to write it more straightforward and You should explain how horizontal stress gradient depend on depth in this area.**

Thank you for raising this point. We have rephrased the paragraph to more clearly describe the relationship between stress and depth, and added a short explanation of how stress gradients are used to estimate stress magnitudes at a given depth in this area.

**Lines 95-100: Maybe map with sensor location would allow reader to better get the geometry of the observation setup.**

Thanks for pointing this out. A new figure (Figure 1 (b)) has been added to show the spatial distribution of monitoring sensors and stations used in this study, including their depth when relevant.

**Lines 125-137: Focal mechanism quality may depend on many factors: two similar but different methods and different station setup and focal coverage may be one of these. I would like to get more info about the focal coverage and number of stations (picks) used in inversion.**

To provide further clarity, we have extended the "Dataset" section in the revised manuscript to include more detailed information regarding the focal mechanism determination for both datasets. However, we are not able to provide information on focal coverage and number of stations used in the inversion as the authors of the cited sources did not reveal this information.

For Dataset 1 (Langet et al.,2020), the focal mechanisms were inverted using P-wave amplitude and polarities from manually picked P-waves on vertical components of both downhole and surface arrays. While the exact number of picks per event is not explicitly listed in the main publication, the supplementary material for their paper provides a comprehensive list of seismic stations used in the study (Table S1 in the Supplementary Material). Furthermore, Table S3 in their Supplementary Material details quality factors for each event's focal mechanism, indicating the distribution of stations on the focal sphere. We have provided summary information on these inversions in the modified text.

For Dataset 2 (Williams-Stroud et al., 2020), the focal mechanisms were inverted using both P- and S-wave amplitudes using data primarily from surface stations. A consistent number of 12 stations were used for each event, with the number of P-wave picks ranging from 6 to 16 and S-wave picks ranging from 6 to 16.  Quantitative metrics such as azimuthal gap are not provided in the publicly available catalog for this dataset.

'- Dataset 1: … The locations of events were determined in a 1D velocity model, incorporating seismic data from the downhole geophone array and additional monitoring receivers from USGS and ISGS networks to improve the data accuracy. The combined use of surface and downhole sensors significantly enhances the station coverage over the focal sphere (Langet et al., 2020). The source mechanisms …

- Dataset 2: The second dataset of 26 most suitable events located throughout the reservoir is obtained from electronic supplement of Williams-Stroud et al. (2020) (Fig. 3 (b)). Events were located using data from surface stations of USGS and ISGS, with a consistent number of 12 stations utilized per event. The source mechanisms were inverted from both P- and S-wave amplitudes using a 1D velocity model and attenuation model (Staněk and Eisner, 2017). The number of P-wave picks for these inversions ranged from 6 to 16, and S-wave picks also ranged from 6 to 16.

Both datasets … whereas Dataset 2 had different station configurations (Williams-Stroud et al., 2020), primarily relying on surface stations. Consequently, the focal coverage for the events in Dataset 2 mainly constrained the horizontal distribution of ray path, which may lead to less constrained vertical control and ambiguities in the focal mechanism solution. We cannot assume the depths of Dataset 1…'