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Solid Earth Discussions

Interactive comment on "Monitoring surface deformation of deep salt mining in Vauvert (France), combining InSAR and levelling data for multi-sources inversion" *by* Séverine Liora Furst et al.

Séverine Liora Furst et al.

severine.furst@univ-smb.fr

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Answer to reviewer #1

This paper is interesting, and certainly worth publishing. In the past, only vertical displacements were measured above brine caverns fields. Satellites provide much more information, opening the way for a more comprehensive analysis of subsidence data.

We have changed the manuscript to include most of your advice. However, as Reviewer 2 suggested new formulations and a modified structure, some of the corrections were no longer relevant. Hereafter, we have addressed specific answers to your comments.

It is suggested to add (at the end of the paper) a vertical cross sections along a selected profile (similar to Figure 3) in which both horizontal and vertical displacements are represented. A few changes are suggested below.

We think that it would be more difficult and redundant with Figure 7 to represent the vertical and horizontal displacement along a profile. Besides, considering that the combined dataset provides a unique and dense spatial distribution of the velocity rate, the representation of the horizontal displacements along a profile would be a loss of information. Instead, we added arrows corresponding to horizontal velocities on Figure 7.

L.34: No, when cavern pressure is kept constant and smaller than geostatic, the stress distribution reaches a steady-state distribution which is not geostatic. "until the cavern volume vanishes"

We have changed accordingly.

L.48: this sentence is unclear. To my knowledge, this model (SALT_SUBSID) takes

into account the difference between geostatic pressure and cavern (fluid) pressure, which is not assumed to be zero. Old versions of Van Sambeek's software were used to predict subsidence above salt mines, in which the pressure is zero.

We agree with you and modified the manuscript.

L.131: " until lithostatic ": no, brine pressure is released before lithostatic (geostatic) pressure is reached.

In the case of Vauvert, wells are closed when salt saturation is insufficient. Hence, the brine pressure increases at well heads. Nowadays, the company is asked to release the pressure of abandoned wells.

L.320. In the reviewer's opinion, the mathematical functions should be provided in the paper (in an Appendix?)

The mathematical functions are already known, published and used in the literature. We think that they are not essential to the understanding of the procedure and would add too much to an already long manuscript. They can be found in Okada (1992).

L.324: explain which parameters are concerned.

We have specified the concerned parameters.

L.437: these sentences are confusing. Salt extraction does not generate subsidence per se. Creep closure (volume loss) does. A relation exists between extraction rate and subsidence rate; however, creep closure rate must be taken into account, and a large part of the effect of salt extraction is deferred. L.448: This issue is difficult (see above). In fact, there are two aspects here: (1) is the subsidence a deferred (not instantaneous) effect of salt extraction? (it is) (2) is the stress distribution similar to the linear elastic

distribution at some distance from the caverns? (maybe).

We agree that creep closure should be taken into account in the subsidence process. However, it implies visco-elastic processes and time-dependent deformation. Levelling survey have been performed since the beginning of the exploitation, and data show instantaneous response to the salt extraction. We assume that most of the short-period (1-2 years) signals is produced by the instantaneous (i.e elastic) response, but we admit that some of the subsidence may come from a deferred signal. Unfortunately, we do not have the stress distribution out of the wells.