Anonymous Referee #1

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"Authors used ERS and Envisat data to show land subsidence in an airport. The technique is not well explained, and the InSAR results and correlation with ground water and precipitation are not well illustrated. This paper should be improved in the aspects of methods and data explanation."

AUTHORS RESPOND

The used technique is now better explained and the relation between InSAR, ground water level and precipitation is better expressed. Also the paper has benefitted from several other edits which hopefully improve its quality.

More specifically, concerning to the conventional technique in the end of line 20 page (4747) as it is following mentioned:

".The basic idea of the DINSAR approach is to separate the effects of surface topography and coherent displacement, permitting to retrieve displacement maps. This is achieved by subtracting the topography related phase, which is either simulated based on an available Digital Elevation Model (DEM), or estimated from an independent interferogram. The use of a DEM is usually more robust and operational and therefore more frequently used. From the complex valued interferograms, interferometric phases are only known Modulo 2p. Phase unwrapping to estimate an unambiguous differential interferometric phase is therefore an important required step. The accuracy of the deformation estimated from individual differential interferograms is mainly limited by the atmospheric path delay term (Wegmüller et. al. 2006)."

However, the technique of Persistent Scatters Technique (PSI) is well explained between the lines 25 – 27 page (4747) and lines 1 – 14 page (4748) respectively.

Anonymous Referee #1

"1, In table 1, please indicate track information for each SAR data instead of orbit, as different track data are involved and orbit can only show the same information as acquisition data."

AUTHORS RESPOND

Conspicuous information is mentioned regarding the track separately in the table's caption. If we would mention the track information instead of orbit it would be really redundant information and it is not needed at all. As the referee knows that the information of orbit is more important and needed.

Anonymous Referee #1

"2, Please also list the SAR data in track 279 in table 1, from which interferogram was generated and shown as Figure 4b."

AUTHORS RESPOND

We think that it does not need to list the data of track 279 in table one because all data in table one are corresponding to ascending track 143 that is why we have listed the details of the descending interferogram and its track information through the caption of the figure 4 separately.

Secondly regarding to the part two of the referee comment, in figure 4 one can find details and clear information is listed of two interferograms and from which SAR images have been generated as well as more details information is already mentioned in paragraph 4.2.1 page (4749).

Anonymous Referee #1

"3, please explain "normalized subsidence deformation rate LOS", does it mean the absolute deformation or the relative annual deformation rate? As shown in Figure 4, I think author should choose reference points to get absolute deformation results, on the other hand, in order to illustrate the short-term deformation, annual deformation rate is not reasonable. So please make sure the meaning of Figure 4. Besides, please also give the deformation result during the summertime in Lines 10-14 for

easy comparison sake. As for Figure 4, we do see some fringe, but it is hard to say these fringes are deformation. More interferograms are needed to distinguish between the deformation and atmospheric artifacts."
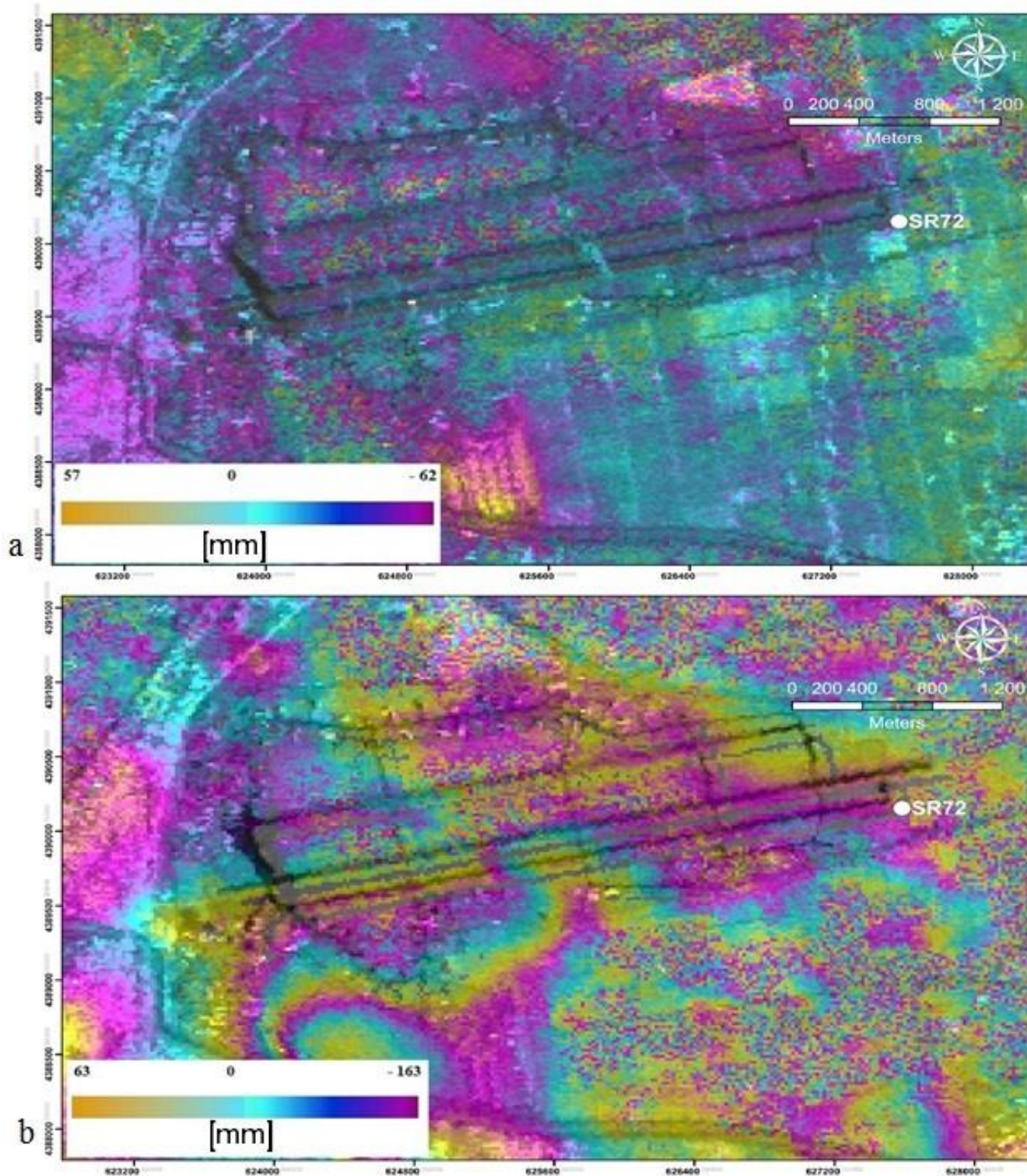
AUTHORS RESPOND

We agree with the referee regarding to this point [(3, please explain "normalized subsidence deformation rate LOS"…] Major editing of the paragraph 4.2.1 has been done and the legend of the (Figure 4) has been edited as well:

4.2.1 Short term changes

"Conspicuous patterns can be observed in the conventional SAR Inferometry images of the study area (Fig. 4). The perpendicular baseline in these analyses during the wintertime (Fig. 4a) is small (B$^\perp$ −66.80m) to avoid residual topographic effects and geometric de-correlation. The subsidence phase around the borehole and along most of the runways and especially the density of the subsidence phase to the north and east of the borehole are probably due to low groundwater level, since the depth of groundwater level was low (20.62 m). The chronologically deformation sequence of the considered SAR acquisition dates was −62mm LOS (Line of Sight). In the summertime analyses (Fig. 4b) the perpendicular baseline was too small for strengthening a precise analysis (B$^\perp$ −1.51 m). Clear interferometric fringes can anyhow be directed around the borehole SR72 and along all runways. The temporal sequence subsidence of the selected pairs was − 163 LOS that may be related to the lowering groundwater level (34.00 m) during the monitored part of the dry period."

Answering the second point raised by the referee "As for Figure 4, we do see some fringe, but …". First of all we wanted to reveal whether the ground deformation was caused by long- or short term impacts corresponding to the groundwater level fluctuation. Unfortunately we couldn't get more inteferograms with short interval time and most of them have residual phases because of long perpendicular baseline that is why have been skipped from the study. However to discriminate between real signals and artificial has been detected, by comparing different pairs of images spanning different intervals of time.

The legend for colors in (Figure 4) has been edited (mm):

Anonymous Referee #1

"4, As for Figure 5, if you say the deformation and uplift information, please also indicate the reference points region where no any deformation occurred during the monitoring period."

AUTHORS RESPOND

We agree with the Referee and the figure of reference point has been added and the caption of this figure has been changed.
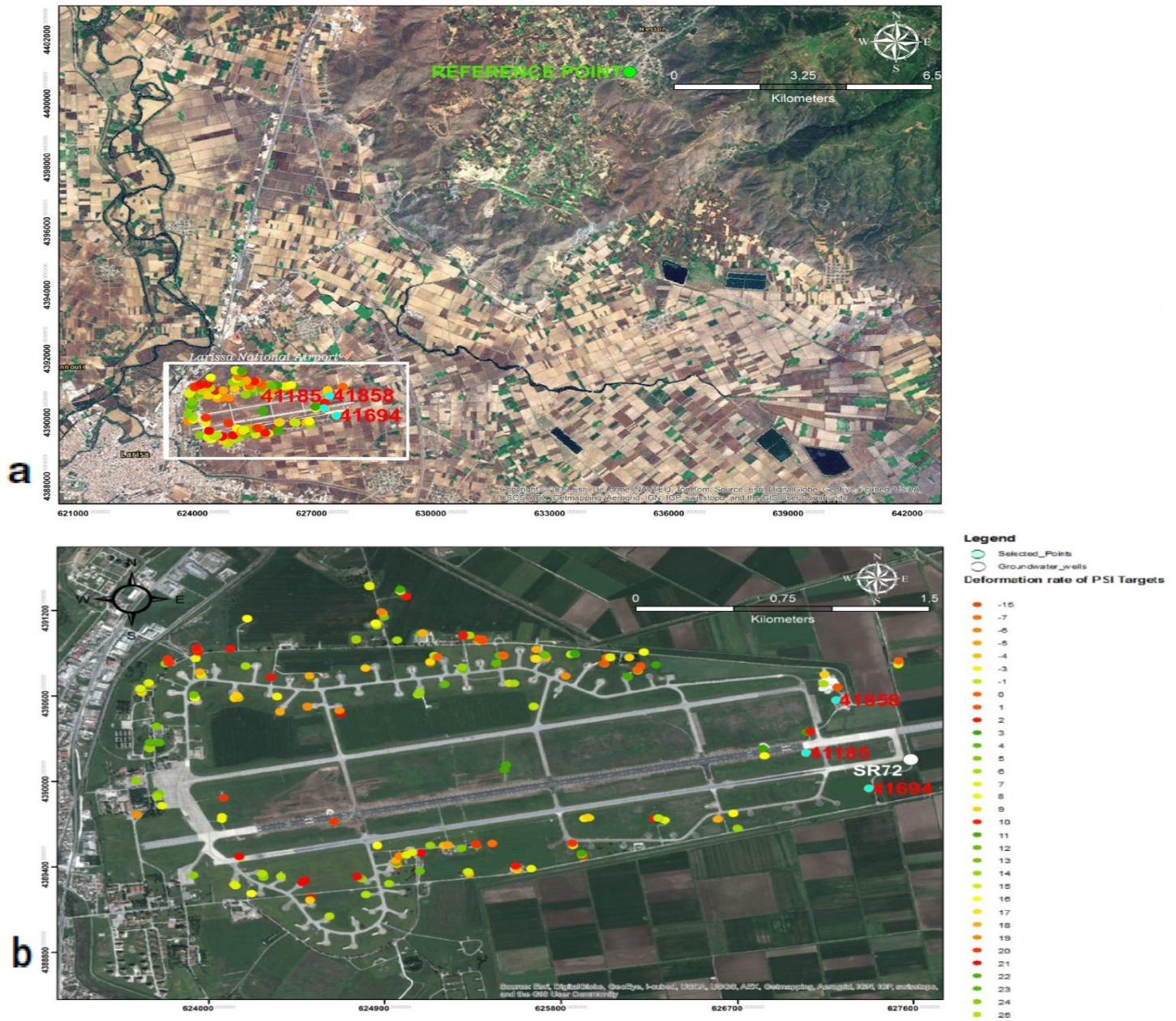
Figure 5. Average LOS velocity image along the runway and areas of Larissa National Airport for the period 1995 to 2006. b is an enlarged view. The image has been saturated at ±0.1myear−1 for visualization purposes. The numbered persistent scatterers with cyan color have been extracted and analyzed to evaluate time series of ground deformation. Background is base map world imagery white point is the borehole R72.

Anonymous Referee #1

"5, As ERS data and Envisat data are combined for PS calculation in this paper, can you say some detailed and special consideration on this technique, because the carrier frequencies are a little bit different."

AUTHORS RESPOND

We agree with the Referee opinion and we could add the following paragraph in the beginning of paragraph (4.2.2) as it is following mentioned:

"The datasets used within this research are derived from two different satellites: ERS and ENVISAT; and because of the differences between career frequencies of two SAR sensors consequently, an essential step to implement is the image co-registration of the two datasets.

According to (Perissin, and et. al., 2006) the conditions under which the PSs identified by ERS can be continued by Envisat are then theoretically determined and experimentally validated. Moreover, this analysis shows that acquisitions characterized by different frequencies can be used to identify the slant-range position of scatterers with high sub-cell accuracy (tens of centimeters). From the processing side, a very precise images co-registration step is required.

A straightforward idea of image co-registration is to select one image as a master (reference image) and thereafter, transform all the other slave images onto it in order to facilitate obtaining the slave images for the geometrical characteristics of the master image at sub-pixel accuracy. Two attempts have been performed by choosing a master image from ERS-1/2 and by implementing co-registration of four modes in order to obtain its geometrical characteristics.

The ERS-1 image with orbit number 20672 and date 19950628 was selected as the master image and co-registration with four modes was implemented between ERS-1/2. Thereafter, co-registration of ENVISAT/ERS was done by performing many program procedures, which is called the lookup table approach. This approach allows the user to take into account the different range and azimuth sampling, which is not the case when using the traditional cross-correlation algorithm. Therefore, it is possible to check the accuracy of the co-registration through the final model of standard deviation, which must not be more than 0.1 and 0.8 in range and azimuth, respectively."

Anonymous Referee #1

"6, In the 5th section, only two conventional SAR interferograms can hardly reveal seasonal land deformation, while long-term PS results can not only show long-term deformation pattern, but monthly changes, because denser deformation results have been recovered."

AUTHORS RESPOND

Unfortunately we couldn't get more inteferograms with short interval time and most of them have residual phases because of long perpendicular baseline that is why have been skipped from the study. However these two interferograms were the best, and we would disagree with the Referee in the point that two interferograms hardly reveal seasonal land deformation. These two interferograms can be used to illustrate ground deformation during the wet and dry periods.

Anonymous Referee #1

"7, Page 8-9, Lines 16-27; Lines 1-20 has little relevance to this topic, you may delete them."

AUTHORS RESPOND

We would like to disagree with Referee in this point and we believe that the paragraph has a lot of relevance to our topic.

Anonymous Referee #1

"8, the title, "high resolution" is not fit to this paper. I recommend major revision before the consideration of publish."

AUTHORS RESPOND

We gratefully disagree with the Referee in the point of the title changing and we prefer the title as it is now, because our work is focusing on small scale which is represented by the airport. We are, however,

open for suggestions made by the Editor. As to major revision of the manuscript, we would say that this has now been made by the authors.

Finally we would like to thank referee 1 for her/his constructive comments and criticism.