viStaMPS: THE InSAR COLLABORATIVE PROJECT

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ABSTRACT

The viStaMPS software is a collaborative scientific project that was created with three major purposes: (1) facilitate the usage by users non familiar with the specificities of the programming language that supports StaMPS; (2) implement several visualization tasks not available in the StaMPS standard approach (avoiding that each user develop its own code for visualization and interpretation purposes) and (3) create a collaborative research project, continuously under development counting on the dynamism of its users to improve and/or add new features.

1. INTRODUCTION

Many free-of-charge (freeware or open-source) and commercial software packages exist. Due to its proven reliability, free distribution and usage among the scientific community, Stanford Method for Persistent Scatterers/Multi-Temporal Interferometry implementtation (StaMPS/MTI) is widely used for ground deformation monitoring.

In this paper, viStaMPS is presented, a collaborative project, materialized into a visual application developed to enhance the visualization, manipulation and exportation of StaMPS results. The proposed tool is made available for non-commercial applications only and can be downloaded from http://vistamps.utad.pt.

The viStaMPS currently available version (v1.1.1) [1] is being used by more than 400 researchers worldwide. Briefly, v1.2 will be released with an extensive range of new features that will be depicted in more detail throughout this paper.

In order to maintain full compatibility with StaMPS package, which is constantly suffering improvements, both groups collaborate closely.

Fig. 1 presents the viStaMPS v1.2 main window, which is divided in three main areas: A (Data Processing), B (Data Visualization/Manipulation) and C (output). Each operation can be accessed through different buttons and options located on the application panels. Depending on the selections made, buttons and/or parameters can be toggled between active/inactive states.

In the next sections viStaMPS main features will be depicted focusing mostly on the new features and updates.

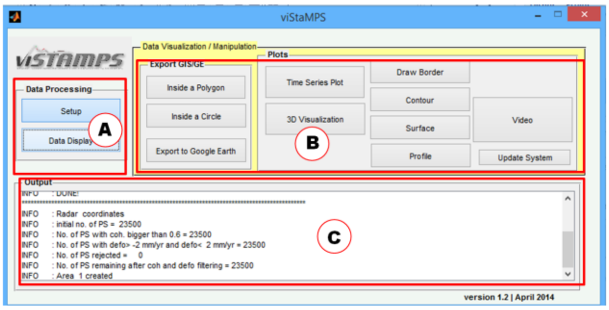

Figure 1. viStaMPS main window

2. DATA PROCESSING

viStaMPS Data Processing section is composed by two buttons (`Setup` and `Data Display`). Most options presented in Fig. 1 are inactive the first time viStaMPS

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is run. This is due to the fact that the work folder has not yet been set. This process allows the selection of the desired folder (StaMPS project folder), the identification of the orbit type (asc/desc) and the definition of the `Scale Factor` and `Distance` parameters (Fig.2).

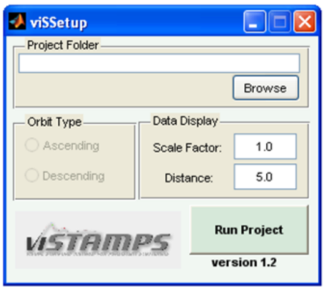


Figure 2. viStaMPS data processing: Setup window

When `Data Display` button is pressed a new window appears (Fig. 3). This window is divided into two main parts. The upper part (highlighted in blue/green) contains the parameterizations related to LOS velocity and height data display, both in radar and geographic coordinates. The parameterizations of LOS velocity data display allows: (A) Background and coordinates selection; (B) Available options for Data to Display and Value type selection (the main estimations can be removed from the displayed results); (C) Slide bar for filtering the points according to the coherence threshold selected; and (D) Definition of the minimum and maximum deformation rates to be displayed.

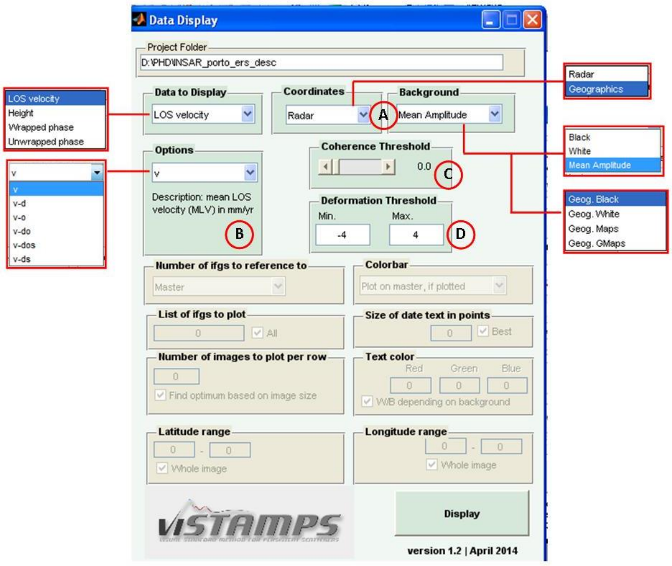


Figure 3. Display window and available options for Data to Display, Background and Options sections

In this new version of viStaMPS the results can still be plotted both in Radar and Geographic coordinates with different backgrounds, however new features have been implemented. Fig.4 presents a deformation map using a Google Maps Background generated automatically in geographic coordinates.

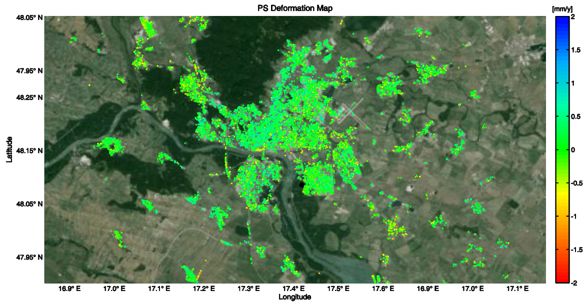


Figure 4. Example of a deformation map using geographic coordinates

The Google maps Background option has a particular interest because it provides high-resolution aerial or satellite images for most urban areas of the world at different zoom levels. In Fig. 5 it can be seen, in more detail, the centre of Bratislava, Slovakia.

Figure 5. Detail of Google Maps high-quality mapping

Fig. 6 shows another added feature available in this new version of viStaMPS, the possibility of plotting height maps. Selecting this option will only enable options A (background type) and D (height threshold) presented in Fig. 3, since they are the only options with application when plotting heights.

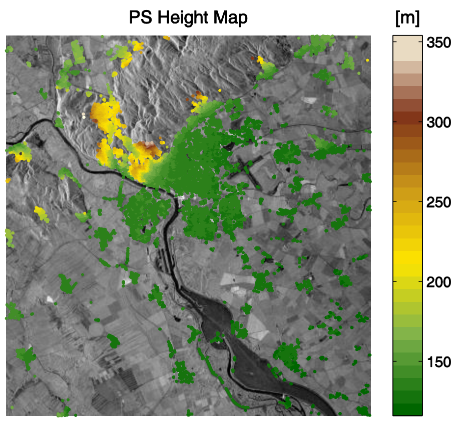
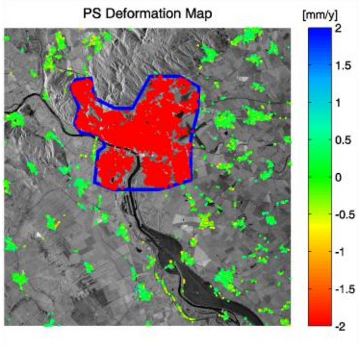


Figure 6. Data Display window when the height value is selected

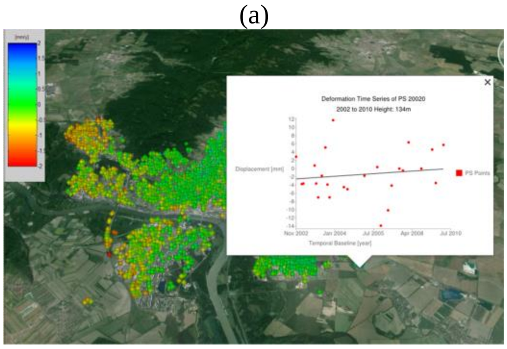
3. DATA VISUALIZATION AND MANIPULATION

3.1. Export to Google Earth

This new version still allows the exportation of the results to GE, however, it is now also possible to select a PS point in GE and get the corresponding time series and PS height. Fig. 7 presents this new feature.



(a)



(b)

Figure 7. Example of Google Earth image with the points exported. By clicking in any PS the displacement time series plot can be displayed.

3.2. Time Series Plot

It is possible to fit the time series to distinct deformation regimes, depending on the causes and type of the deformation and also restrict the time series range. Fig. 8 presents how to operate in order to select the fit polynomial approach and the rupture date(s).

3.3. Draw Border/Contour

This new feature allows drawing one or multiple borders that will be used to create surfaces, contours and profiles on the defined regions (Fig. 9).

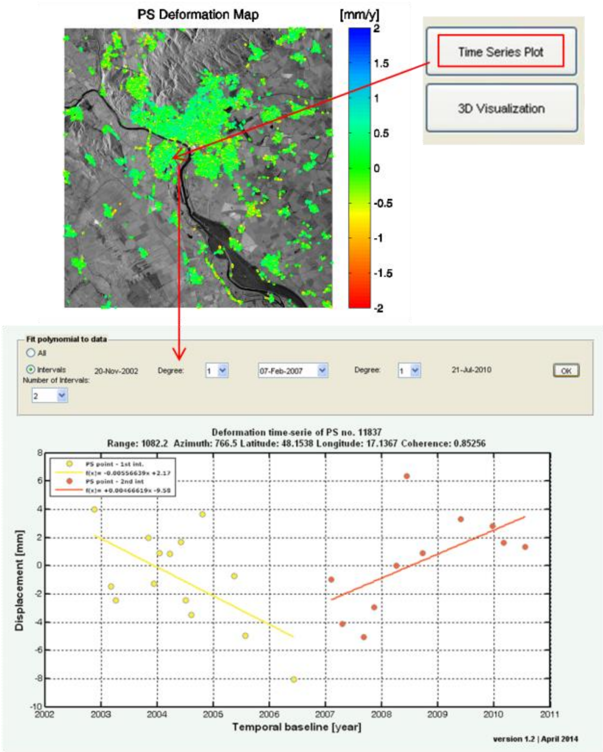


Figure 8. The new time series plot interface allowing choosing different deformation regimes that fit a specific time range

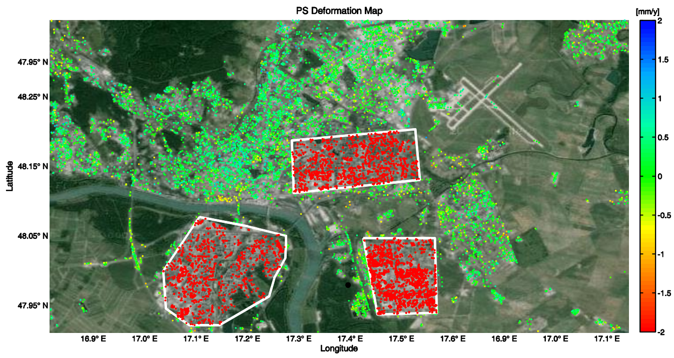


Figure 9. Areas definition to create contours/surfaces using Google Maps as background

Fig. 10 shows the deformation contours obtained in the selected areas defined in Fig. 9.

Figure 10. Contour deformation using Google Maps as background

3.4. Surface/Profile

The areas selected in Fig. 9 can be displayed as a 3-D shaded surface. Fig. 11 presents an example of this application. Drawing a line (or polyline) in this 3D surface allows the display of the deformation profile line, as presented in Fig. 12.

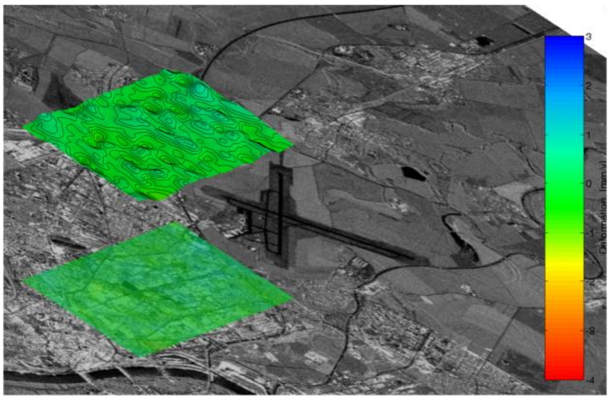


Figure 11. 3D deformation plot using Google Maps as background

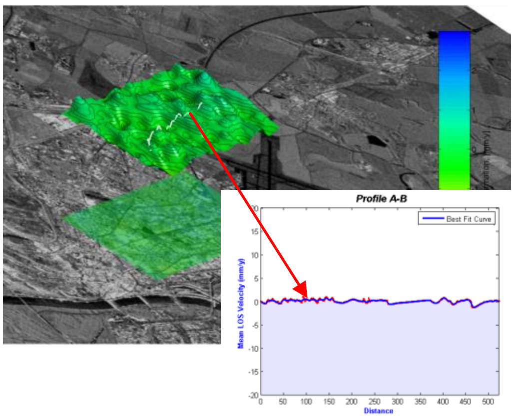


Figure 12. Deformation profile

3.5. Video

It is also possible to generate deformation videos covering the whole or part of the SAR time series. viStaMPS has the ability to generate videos with different scenarios at the processed area projecting the consequences of the deformation in the future, using the video interface presented in Fig. 13.

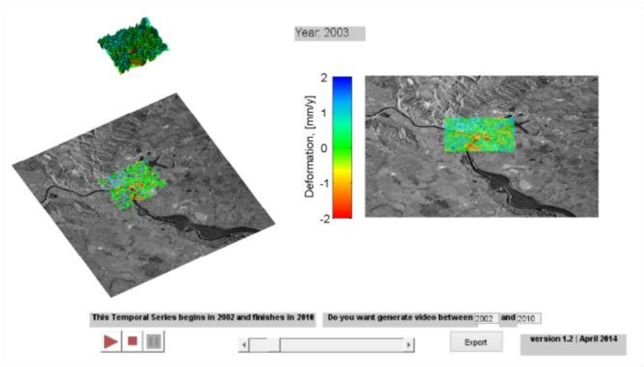


Figure 13. Video generation interface

4. CONCLUSIONS AND FUTURE WORK

In the near future the new Toolbox for Reducing Atmospheric InSAR Noise (TRAIN) [2] will be included. Future developments of viStaMPS will also include PS+SB visualization features. Finally, viStaMPS team would like to convert, also in a near future, the full StaMPS processing chain into a visual application.

5. ACKNOWLEDGEMENTS

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6. REFERENCES

1. Sousa, J. J., Magalhães, L. M., Ruiz, A. M., Sousa, A. M. R. & Cardoso, G. (2013). The viStaMPS tool for visualization and manipulation of time series interferometric results, series interferometric results. *Computers and Geosciences*, 52, 409–421, doi:10.1016/j.cageo.2012.11.012.

2. Bekaert, D.P.S., Hooper, A. & Wright, T. J. (2015). A spatially variable power law tropospheric correction technique for InSAR data. *Journal of Geophysical Research*, 120(2), 1345-1356, doi: 10.1002/2014JB011558.