GENERATION OF CLASSICAL DINSAR AND PSI GROUND MOTION MAPS ON A CLOUD THEMATIC PLATFORM

Oscar Mora[(1)], Patrick Ordoqui [(2)], Laia Romero [(3)]

(1) ALTAMIRA INFORMATION, Còrsega 381-387, 08037 Barcelona (Spain), Email: oscar.mora@altamira-information.com

(2) ALTAMIRA INFORMATION, Còrsega 381-387, 08037 Barcelona (Spain), Email: patrick.ordoqui@altamira-information.com

(3) ALTAMIRA INFORMATION, Còrsega 381-387, 08037 Barcelona (Spain), Email: laia.romero@altamira-information.com

ABSTRACT

This paper presents the experience of ALTAMIRA INFORMATION uploading InSAR (Synthetic Aperture Radar Interferometry) services in the Geohazard Exploitation Platform (GEP), supported by ESA. Two different processing chains are presented jointly with ground motion maps obtained from the cloud computing, one being DIAPASON for classical DInSAR and SPN (Stable Point Network) for PSI (Persistent Scatterer Interferometry) processing. The product obtained from DIAPASON is the interferometric phase related to ground motion (phase fringes from a SAR pair). SPN provides motion data (mean velocity and time series) on high-quality pixels from a stack of SAR images. DIAPASON is already implemented, and SPN is under development to be exploited with historical data coming from ERS-1/2 and ENVISAT satellites, and current acquisitions of SENTINEL-1 in SLC and TOPSAR modes.

1. THE GEOHAZARDS TEP

The Geohazards Exploitation Platform or GEP [1] aims to support the exploitation of satellite EO for geohazards. It follows the Supersites Exploitation Platform (SSEP), originally initiated in the context of the Geohazard Supersites & Natural Laboratories initiative (GSNL).

The geohazards platform is sourced with elements (data, tools, and processing including InSAR) relevant to the Geohazards theme and related exploitation scenarios [1]. The portal is a data processing facility, where it is possible to create a new processing service or add and re-use existing processing services, process data, access and reproduce processing jobs. ALTAMIRA INFORMATION has implemented its classical DInSAR processing chain, known as DIAPASON and is currently working on the SPN PSI chain in the platform, as it is depicted in Fig. 1.

2. DINSAR - DIAPASON ON THE GEP

Classical DInSAR DIAPASON tool has been uploaded to the GEP, providing interferometric generation capabilities for ERS, ENVISAT and Sentinel-1 data [2]. In the case of Sentinel-1 the processing can be performed for the TOPSAR background mode, as well

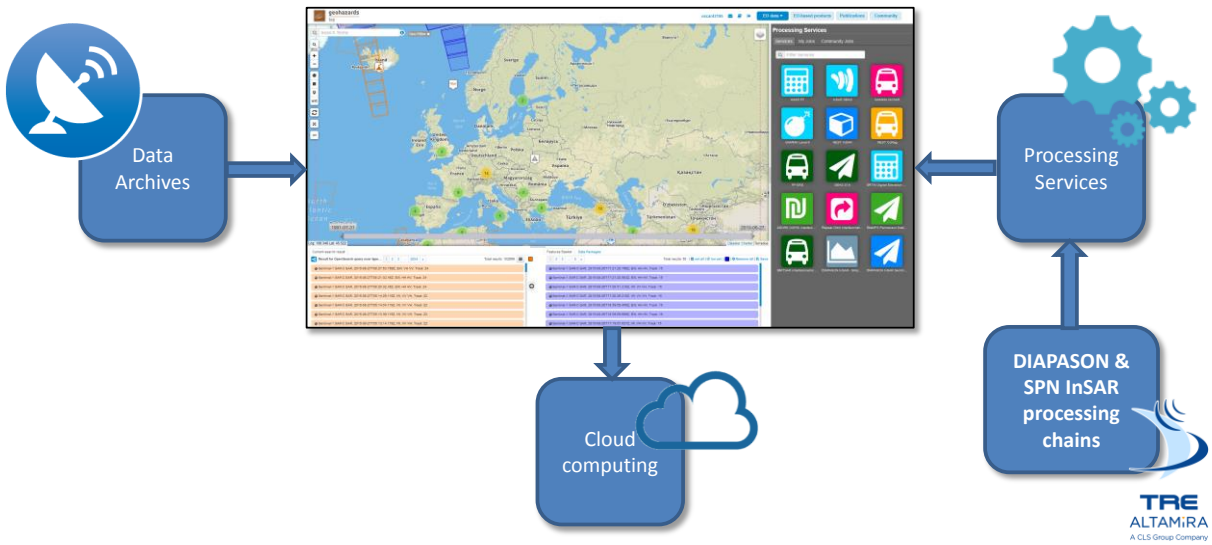

Figure 1. The Geohazard Exploitation Platform (GEP) with DIAPASON and SPN processing chains.

as the less usual SLC format. DIAPASON on the GEP has been implemented in a user-friendly way, giving the option to the user to tune some simple parameters, such as the polarization or the phase filter level.

The generation of differential interferograms, after co-registration of master and slave images, is performed using the 90m SRTM Digital Elevation Model, for the removal of the topographic component. After job finishes, the user can visualize and download the result files from the web platform. As presented in the following Figures, DIAPASON generates outputs for amplitude, coherence and phase, which can be downloaded in GeoTiff format for further processing.

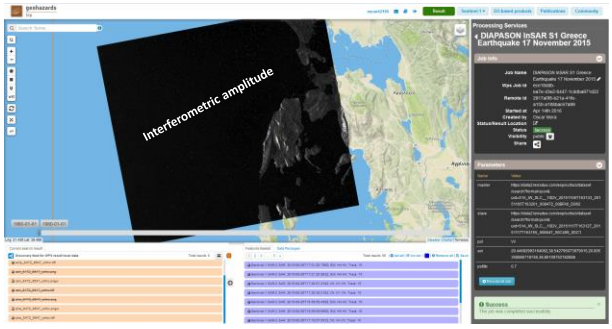

Figure 2. Screenshot of DIAPASON amplitude result.

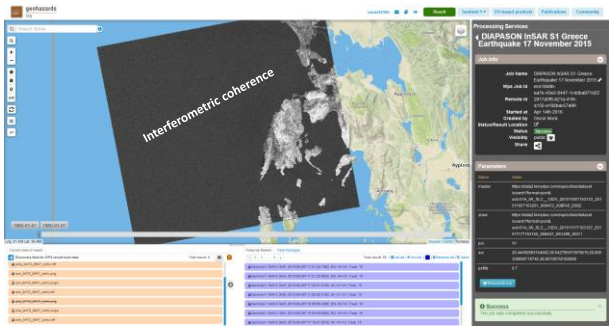

Figure 3. Screenshot of DIAPASON coherence result.

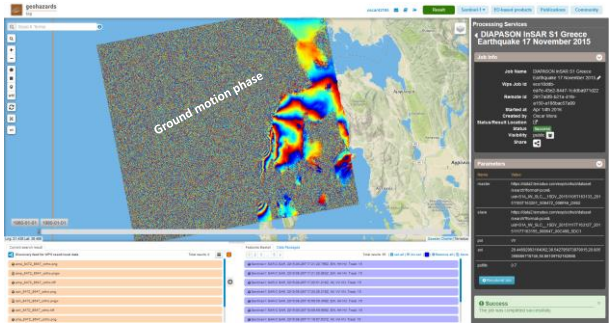

Figure 4. Screenshot of DIAPASON phase result.

Fig. 5 and 6 present two interferograms, in ascending and descending orbits, processed in the GEP. These results correspond to Sentinel-1 image pairs before and after the sequence of earthquakes occurred in Japan in April 2016.

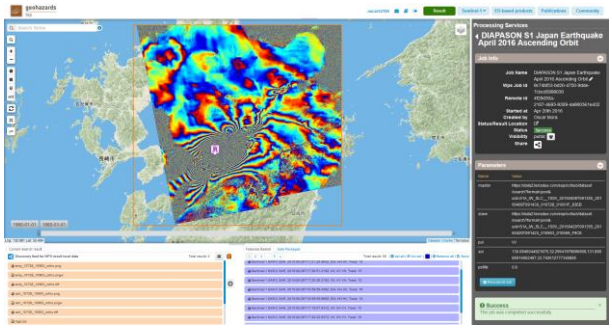

Figure 5. DIAPASON ascending interferogram of Japan earthquakes.

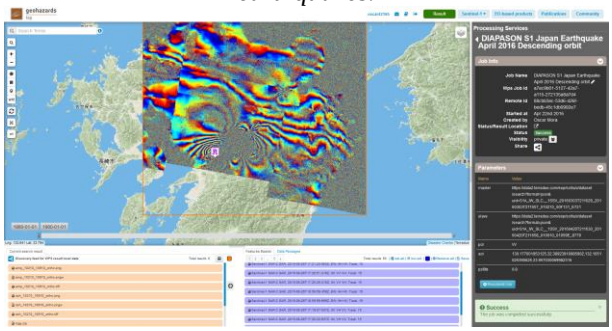

Figure 6. DIAPASON descending interferogram of Japan earthquakes.

As example of post-processing of DIAPASON GEP interferograms, Fig. 7 shows the Line Of Sight (LOS) motion obtained from the ascending and descending orbits. Using this information, the West-East and Up-Down ground motion maps are obtained, as Fig. 8 presents. The geometric combination of opposite orbits allows the decomposition of LOS radar measurements into horizontal and vertical directions. This final result provides valuable information about the real motion of surface after the earthquake. In the case of Fig. 8 the strong horizontal component of displacement is clearly visible.

The combination of Sentinel-1A and the future Sentinel-1B satellites, jointly with the usage of the GEP will give the users the possibility of a rapid generation of interferograms for this kind of events.

During the pilot project phase of GEP, several users have been selected to test the functionalities of DIAPASON. These users will generated differential interferograms for different events in order to validate the quality and utility of interferograms generated online in the GEP.

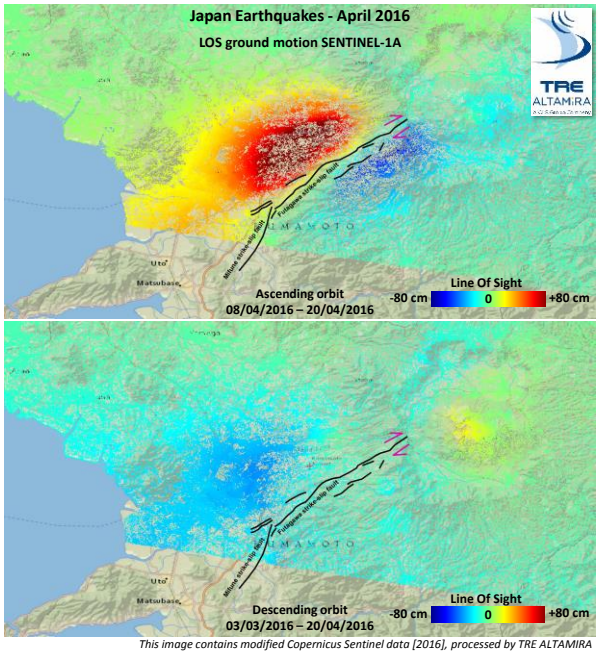

Figure 7. Ascending and Descending LOS motion maps of Japan's earthquake.

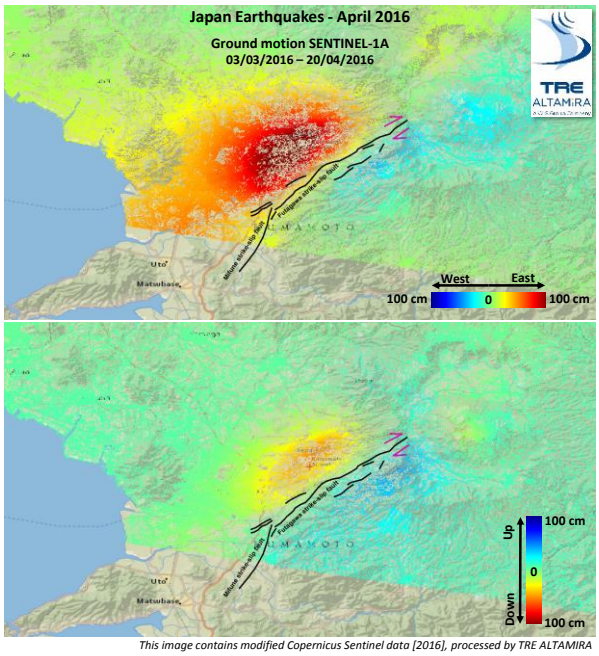

Figure 8. West-East and Up-Down motion maps of Japan's earthquake, using ascending and descending orbits.

3. PSI PROCESSING - SPN ON THE GEP

After the implementation of DIAPASON tool on the GEP, ALTAMIRA is developing its Persistent Scatterer Interferometry (PSI) tool for the web platform, known as Stable Point Network (SPN) [3-5].

The same philosophy as DIAPASON will be applied, for a robust and user-friendly service able to be successfully run by non-expert users.

In order to evaluate the commercial exploitation of PSI tools in the platform, ALTAMIRA will provide two different types of usage:

- Free mode: Ground motion maps at low spatial resolution (100 x 100 m) providing velocity information.
- Pay-per-use mode: Ground motion maps at medium spatial resolution (40 x 40 m) providing velocity and time series for measurement points.

The free mode is thought for a first experience in the PSI processing, being the user able to generate velocity ground motion maps using SAR images, without a strong background on SAR interferometry. The low spatial resolution will limit the capability to detect small motion patterns, but it will provide a good experience on the detection of large areas affected by surface displacement.

On the other hand, the pay-per-use mode will provide better spatial resolution maps (40 x 40 m) and time series of the point measurements, showing the non-linear component of displacement for the temporal period of monitoring. In this case, a secure payment system will be implemented in the web platform to have access to this level of PSI processing.

4. CONCLUSIONS

The availability of huge amounts of SAR data acquired by the Sentinel-1 constellation requires new processing methodologies, in order to extract the maximum benefit from them. The web platform processing appears as a solution, allowing the users to process data in the cloud, using the last acquired images and without the necessity to download any data.

In this paper the implementation of two InSAR processing chains have been presented. On one hand, the classical DInSAR DIAPASON software for the measurement of strong surface displacements. On the other hand, the current implementation of the SPN PSI processing chain, able to measure slow ground motion.

Successful results are presented for DIAPASON, with the rapid monitoring of April 2016 Japan earthquakes. In this case, ascending and descending orbits have been processed in the cloud, and these results have been used to create horizontal and vertical maps of ground displacement. This demonstrates the utility of this

platform for geohazard studies. It is important to remark that strong InSAR background is not necessary to operate the service in the web platform.

Finally, as continuity of DIAPASON, the SPN service is also presented. In this case, two modes will be offered to the GEP users. A free mode at low spatial resolution and for ground velocity monitoring, and a pay-per-use mode with higher spatial resolution and time series results. The commercial experience of ALTAMIRA will provide added value to GEP in order to study the future usage of these web processing platforms.

5. REFERENCES

1. Geohazards tep web portal. https://geohazards-tep.eo.esa.int

2. Arnaud A., Adam, N., Hanssen, R., Inglada, J., Duro, J., Closa, J. and Eineder M. (2003) ASAR ERS interferometric phase continuity. International Geoscience and Remote Sensing Symposium, 21-25 July 2003, Toulouse (France).

3. Duro J., Inglada, J., Closa, J., Adam, N. and Arnaud A. (2003) High resolution differential interferometry using time series of ERS and ENVISAT SAR data. FRINGE 2003, 1-5 December 2003, Frascati (Italy).

4. O. Mora, J. Granda, E. Bisecas, and A. Urdiroz, "TerraSAR-X high resolution SAR data: Ground motion and mapping applications for infrastructure, oil & gas and public domain health domain", in Proc. EUSAR, Friedrichshafen, Germany, 2008.

5. M. Crosetto, E. Biescas, J. Duro, J. Closa and A. Arnaud "Generation of Advanced ERS and ENVISAT Interferometric SAR Products Using the Stable Point Network Technique", Photogrammetric Engineering and Remote Sensing, 443-450, April 2008.