K&C Science Report – Phase 1

ALOS Image Mosaics for Wetland Mapping

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***Abstract*—**

ALOS PALSAR, an orbiting L-band SAR launched by the Japanese Aerospace and Exploration Agency (JAXA) in 2006, has been pursuing a global observation strategy through its ALOS Kyoto and Carbon Initiative (ALOS KC) [6]. The objectives of the ALOS KC project, lead by JAXA, include systematic global scale acquisitions by ALOS PALSAR, and the production of products quantifying the geographic extent of forested, desert, and wetlands [2]. As a component of this task, large collections of dual polarization (HH and HV) data are being acquired over wetland areas around the globe. Through the NASA MEASURES program, JPL will be leading an effort to utilize this data to produce a global inundated wetlands product. One of the first steps will be to produce dual polarized continental-scale mosaics of SAR imagery. Image mosaics are desired to simplify image classification. However, flexibility in constructing the mosaic is required, in order to produce representative products. The distribution and visualization of the image mosaics and products is also an important component of this work.

***Index Terms*—ALOS PALSAR, K&C Initiative, Wetland Theme, Mosaic Theme, inundated wetlands**

I. Introduction

A. Science objectives

A NASA funded research task will be generating an Earth Science Data Record for global inundated wetlands. Wetland extent and dynamics will be characterized using ALOS PALSAR imagery and other sensors. The extent and seasonal, inter-annual, and decadal variation of inundated wetland area play key roles in ecosystem dynamics. Wetlands contribute approximately one fourth of the total methane annually emitted to the atmosphere and are identified as the primary contributor to inter-annual variations in the growth rate of atmospheric methane concentrations. Climate change is projected to have a pronounced effect on global wetlands through alterations in hydrologic regimes, with some changes already evident. In turn, climate-driven and anthropogenic changes to tropical and boreal peatlands have the potential to create significant feedbacks through release of large pools of soil carbon and effects on methanogenesis.

B. Image mosaics

In assembling the ALOS SAR mosaics for the global inundated wetlands product, the mosaics will be ortho-rectified to the SRTM DEM (where available). The images to be mosaicked will be lower resolution image ‘strips’, often thousands of kilometers along track, rather than image frames which are roughly as long along track as the cross track dimension. These image strips are produced as a special product of the ALOS KC project by the JAXA Earth Observation Research Center (EORC), and have a pixel spacing of under 100 meters. These acquisitions also include the cross-pol channel, for which the same georeferencing information may be used to project the imagery to the ground topography.

C. *Display and distribution of imagery and products*

The display of ortho-rectified Earth Imagery can be facilitated through Earth Image browsers such as Google Earth. These Earth image browsers are easy to use, and enable visual comparison of ALOS imagery and derived products with high-resolution optical imagery. They can also be a means for data discovery, in which you use the Earth image browser to geographically find the imagery or data that you require. They can provide a public presentation at multiple resolutions of ALOS imagery and data, which is important due to the simultaneously fine resolution and large geographic extent of the ALOS Kyoto and Carbon Initiative products. They also provide a platform for interaction with the data.

II. Description

A. *Relevance to the K&C drivers*

The Wetlands theme of the ALOS KC initiative [2] will utilize ALOS image mosaics that have been ortho-rectified and projected to a simple ground projection. This simplifies quantitative analysis (i.e. overlap regions are eliminated) and validation and verification (i.e. it is easy to geographically compare with validation data sets). The mosaic theme of the ALOS KC initiative therefore enables this work by producing ortho-rectified image products. The specific objective of ALOS KC phase 1 work was to produce prototype dual polarization mosaics of North and South America, and begin analysis of ScanSAR regions where rich multi-temporal image data will be acquired. Another objective of this work is to explore how this image data may be visualized and distributed using commonly available and easy to use tools for this purpose.

The most basic requirement for modeling regional to global methane or carbon dioxide emissions from wetlands is a digital wetlands map with an appropriate scale and classification scheme [2]. The ultimate results of this project to map the extent and dynamics of inundated wetlands will therefore improve our understanding of the carbon cycle as well as facilitate conservation of wetland areas simply by identifying the location and maximum and minimum extent of wetlands.

B. *Work approach*

The JAXA Earth Observation Research Centre (EORC) provides slant range image strips for use by the ALOS Kyoto and Carbon Initiative [2]. These image strips can be thousands of km in length, but have a reduced resolution compared to that obtained during standard processing. The calibration is the same as that performed during standard processing, but the file format is slightly different.

First step for image mosaicking is the ortho-rectification of the image data. For these results, we use the software package from Gamma Remote Sensing [7] to orthorectify the data to a supplied digital elevation model (DEM). The DEM data was constructed from the SRTM DEM, and other available DEM's outside of the SRTM coverage area [8]. Since the image strips extend across continental scale regions, we project the imagery to SRTM–like 'tiles' of topography information, approximately 1deg x 1 deg in size. The tiles are actually reconstructed from the SRTM data slightly larger than this to accommodate edge effects. The SRTM-like tiles of imagery may then be mosaicked into the desired larger regional image mosaics (see figure 1).

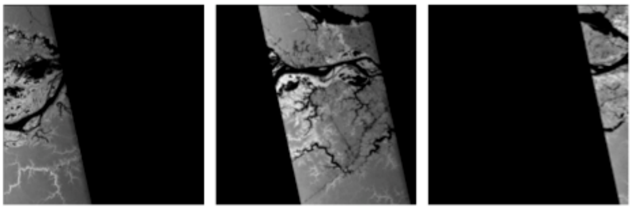

Figure 1: Three SRTM-like tiles (S04W062). This tile is imaged by ALOS on three image strips. During mosaicking, they would be assembled into a single image tile. . © *JAXA/METI*

Once the data has been ortho-rectified, the original strip map data may still be recalibrated, as an intermediate file describing the ortho-rectification is saved and may be reused. Some image strips require radiometric corrections due to a cross track systematic error. The tendency is that the brightness of the image falls off in the near and far range.

In order to assess the magnitude and character of the radiometric calibration, multiple single image strips were examined with similar results. The data were averaged in the along track direction for the entire duration of the image strips. Then, the mean and standard deviation of the image brightness was determined for each range pixel. After averaging over more than a thousand kilometres, the resultant mean trend for each image strip could represent the inverse of the required radiometric correction. As can be seen in figure 2, the nature of the trend for HH and HV are slightly different.

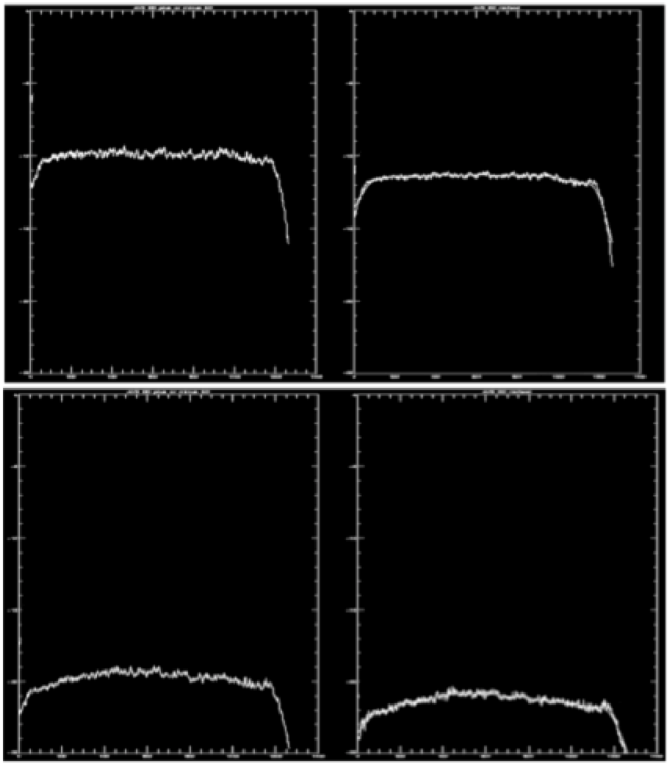

Figure 2: Top graph: mean HH cross track (range) radiometric trend. A) All data. B) Data within 1 standard deviation of mean. Bottom graph: mean HV cross track (range) radiometric trend. A) All data. B) Data within 1 standard deviation of mean.

However, when three strips were mosaicked together after correction for the inverse of this average radiometric trend, figure 3 shows that while this correction improves the radiometric accuracy required for a usable image mosaic, there are still changes in the radiometry in the near/far range overlap regions that appear to change along the image track.

The final image mosaics will have a pixel spacing of 1 arcseconds, but the resolution of the data will be approximately 100 m.

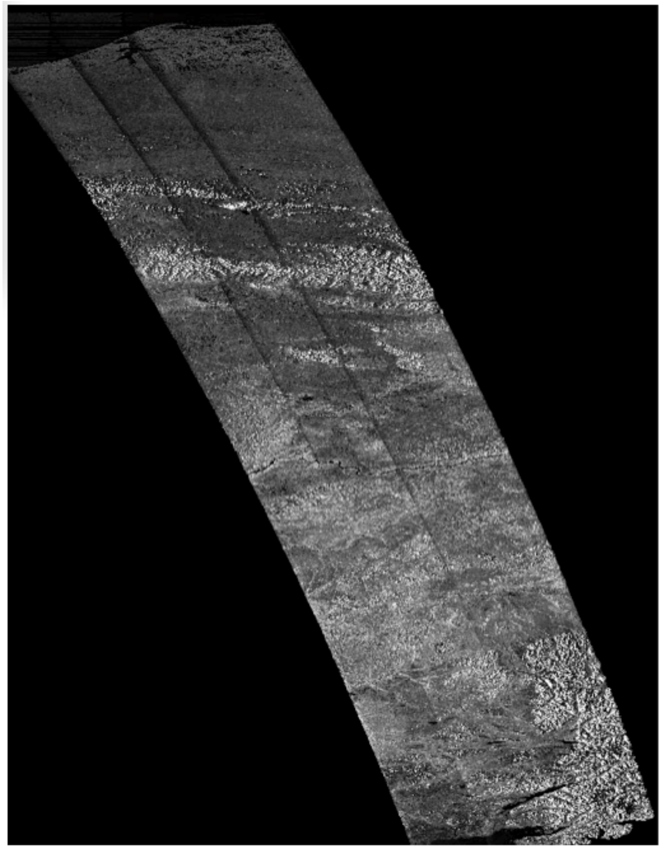

Figure 3: Mosaic of three ALOS image strips (Alaska). © JAXA/METI

Once the image mosaics are generated, the display of ortho-rectified Earth imagery can be facilitated through Earth image browsers such as Google Earth. These Earth image browsers are easy to use, and enable visual comparison of ALOS imagery and derived products with high-resolution optical imagery. They can also be a means for data discovery, in which you use the Earth image browser to geographically find the imagery or data that you require. They can provide a public presentation at multiple resolutions of ALOS imagery and data, which is important due to the simultaneously fine resolution and large geographic extent of the ALOS Kyoto and Carbon Initiative products. They also provide a platform for interaction with the data.

As can be seen in Figure 4, it is possible to control what resolutions are visible to the user. As the user zooms into the image, progressively higher resolution imagery may be seen.

Figure 5 shows how the imagery may be annotated, and displayed simultaneously with other imagery, such as Landsat imagery, which can be quite useful in interpretation of the data.

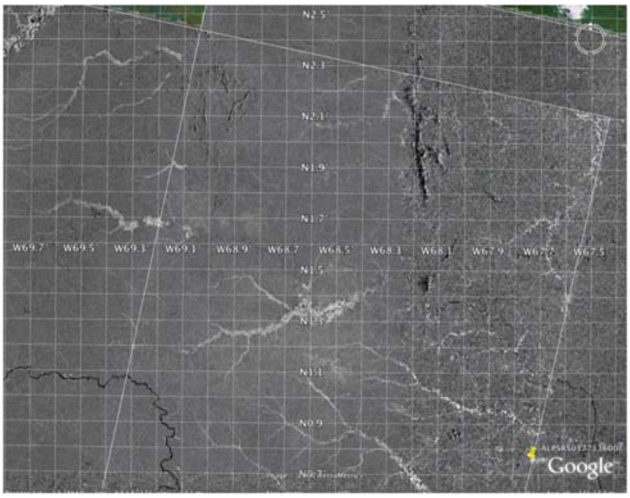

Figure 4 Imagery may be displayed at full resolution using Earth image browsing software. © JAXA/METI

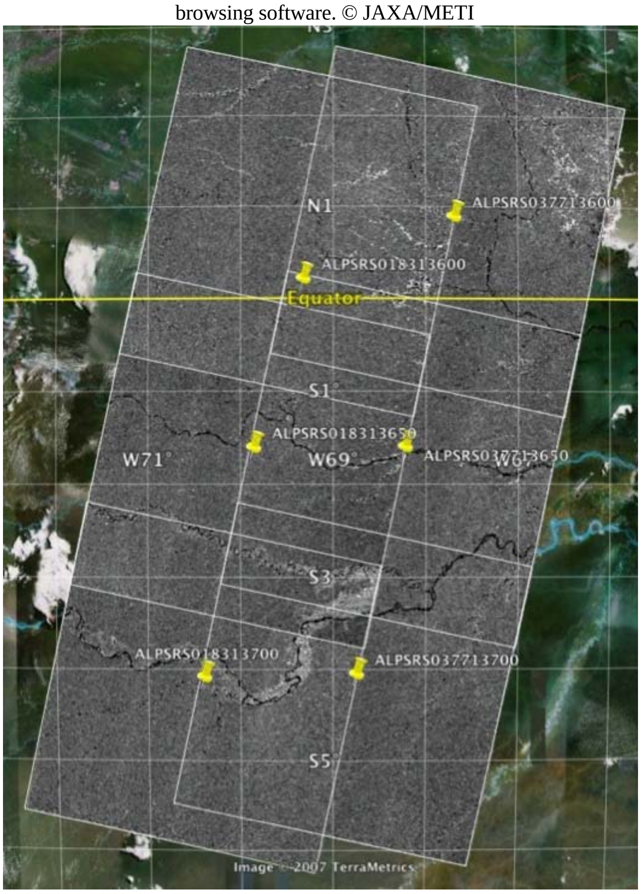

Figure 5. ALOS PALSAR image frames annotated and displayed within Google Earth. © JAXA/METI

It is also possible to view the ALOS imagery and products within an web browser. However, again, the large geographic extent and fine resolution constrain how this may be best implemented. Figure 6 shows an example of a zoomable interface, in which the regional scale imagery has been subdivided into geographic tiles that may be carefully examined within a standard web browser.

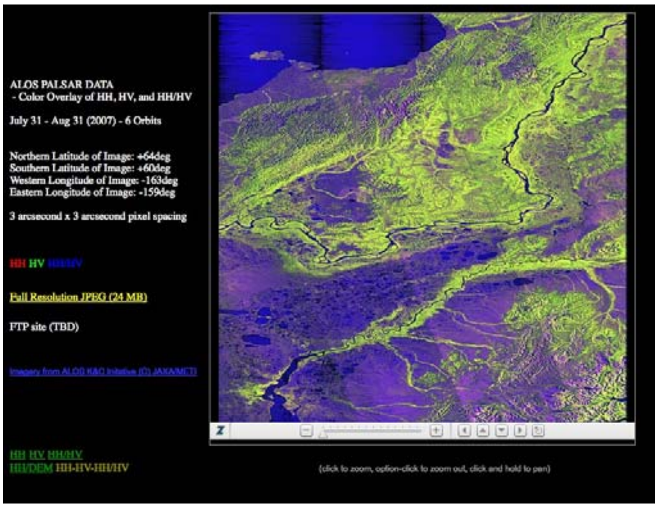

Figure 6. ALOS image mosaic subdivided into a geographic tile, and displayed within a web browser with a zoomable interface. ALOS K&C © JAXA/METI

C. *Satellite and ground data*

The ortho-rectification of the dual polarization ALOS PALSAR data is dependent on the DEM reference used. For this work, the SRTM 90 DEM from CGIAR-CSI [8,9] was oversampled to one arcsecond pixel spacing and padded to overlapping and padded DEM tiles. The ALOS dual polarization data is in the slant range projection from the JAXA EORC, and is from Summer 2007.

III. Results and Summary

Figure 7 shows a mosaic of the imagery from North America, without radiometric correction. This mosaic shows that while there are occasional gaps in coverage, the coverage during this period (summer 2007) was comprehensive and of good quality.

Figure 8 and figure 9 show that these data reveal fine target features at the high resolution of the final image mosaics. Once the dual polarization mosaics are completed, the use of this data in combination with multi-temporal ScanSAR mosaics of wetland regions around the world will lead to the creation of a record of the extent and dynamics of inundated wetlands for most of the worlds major wetland regions. This work is only possible using an L-band SAR with a global and multi-temporal observation strategy such as employed by ALOS [6].

In future work, the regions outside of North and South America will be processed and analyzed.

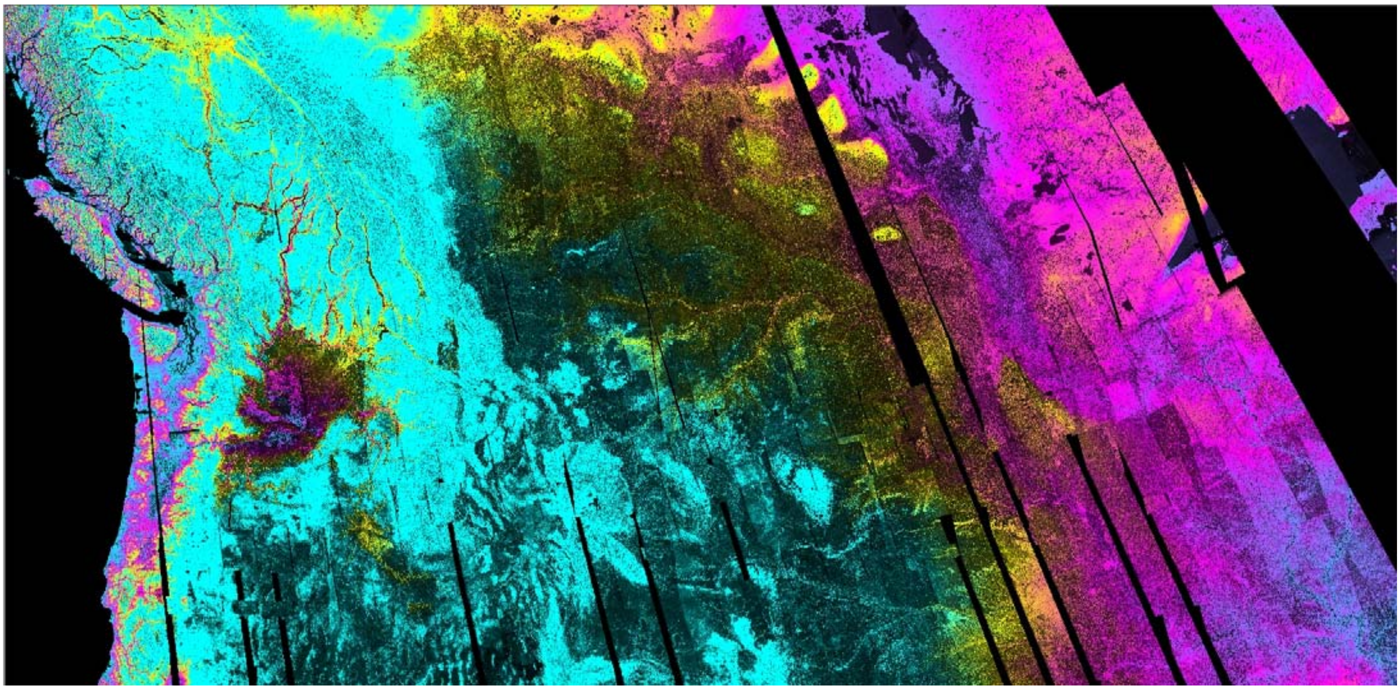

Figure 7. Image mosaic of Northern North America. Color contours correspond to ground topography. Image brightness corresponds to ALOS PALSAR HH. ALOS K&C © JAXA/METI

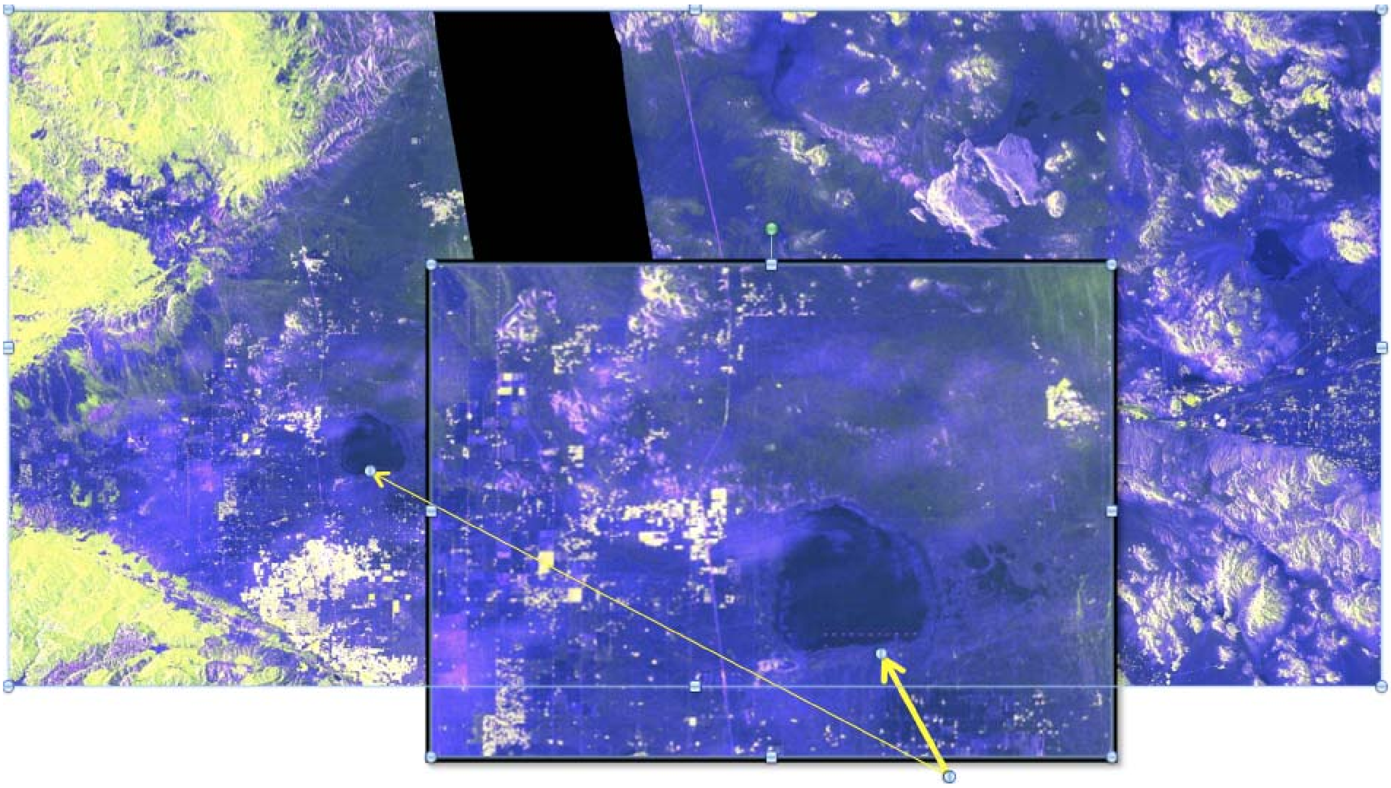

Figure 8: Mohave Desert in Southern California, USA. Rosamond Corner reflector array is visible. Colors correspond to HH – Red, HV – Green, HH/HV – Blue. © JAXA/METI

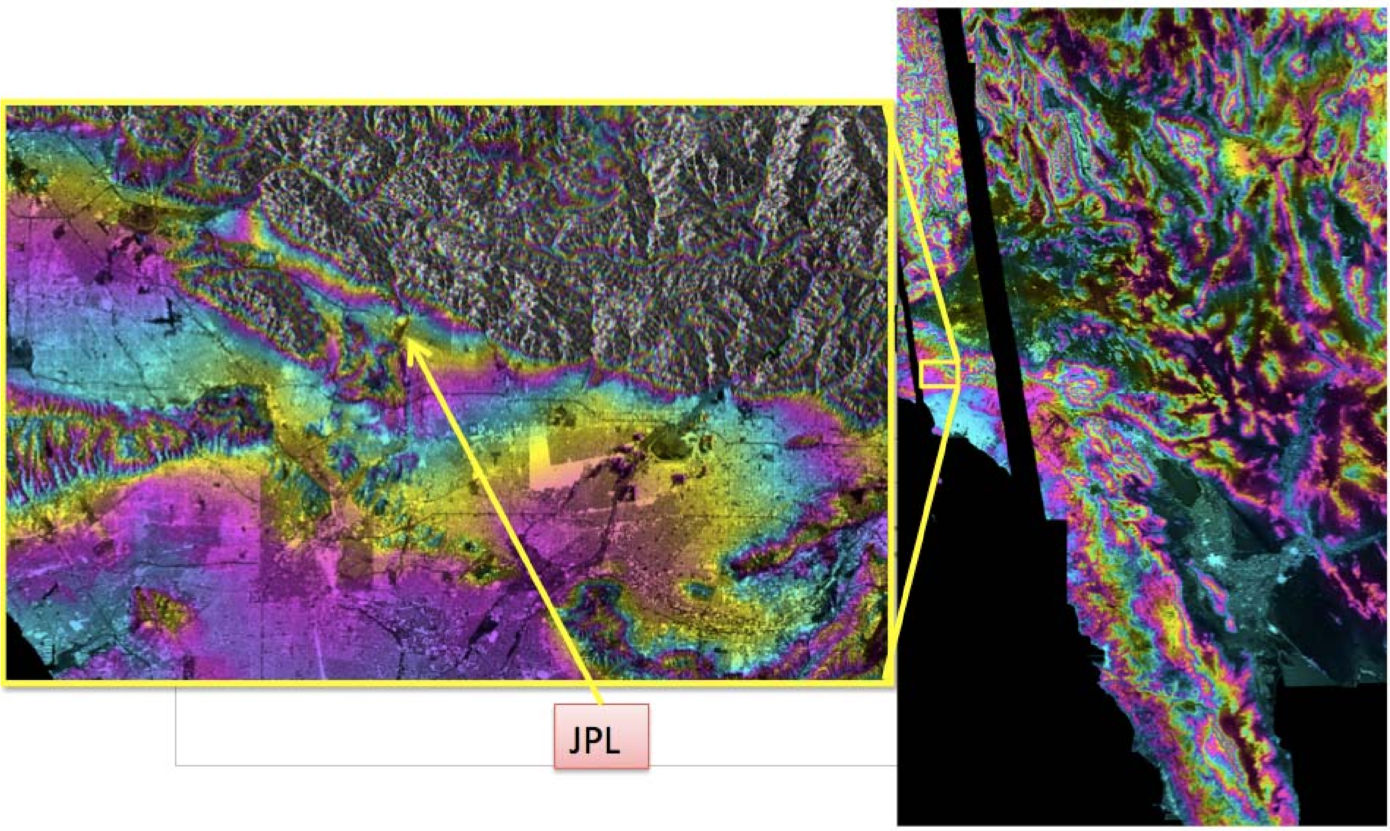

Figure 9: Los Angles, California, USA and the South Western USA. Brightness is HH image brightness, color contours corresponds to ground topography. ALOS K&C © JAXA/METI

IV. REFERENCES

ACKNOWLEDGEMENTS

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