THE APPROACH FOR COMBINING DEM ACQUISITIONS FOR THE TANDEM-X DEM MOSAIC

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Abstract. For the global TanDEM-X DEM the whole world will be acquired by at least two coverages. Thereby on the one hand phase unwrapping errors are reduced by applying the dual-baseline method and on the other hand a low noise level is ensured even for difficult areas like forests and steep terrain. During DEM mosaicking, the single interferometric DEMs are merged together. This paper focuses on the combination of heights in overlapping areas with significant height differences. The challenge here is to choose the most reliable height value. The improvement applying this strategy in contrast to simple averaging and the general benefit of using more than one acquisition is shown by means of some example mosaics.

Keywords: TanDEM-X, InSAR, mosaicking, DEM

1. INTRODUCTION

Within the TanDEM-X mission [1] a large amount of SAR interferometric acquisitions (data takes) is being currently acquired in order to derive a global digital elevation model. For the final DEM at least two coverages and over difficult areas like forests or steep terrain even three or four coverages will be acquired. The different coverages are acquired with different baselines (resp. height of ambiguities) in order to apply the so-called dual-baseline phase unwrapping method and thus to reduce phase unwrapping errors [2], [3]. The first global coverage and some additional coverages over regions with low coherence are already available. They will deliver the input data for regional intermediate TanDEM-X DEM products. As interferometric raw DEMs are affected by systematic errors, mainly offsets and tilts, a least-squares adjustment is conducted using tie-points between neighbouring acquisitions and ICESat points as ground control points [4], [5]. During the DEM mosaicking, the previously estimated geometric corrections are applied. The corrected height values of different acquisitions are weighted by the height error and averaged.

2. DEM MOSAICKING WORKFLOW

The DEM mosaicking processor implemented at DLR's ground segment merges several interferometric raw DEMs to geo-cells of a size of 1°x1°. Besides the DEM several additional layers like amongst others the height error mask (HEM), the consistency mask, the amplitude mosaic and the water indication mask are created. In the mosaicking workflow also an evaluation of the results is performed. Therefore the differences to SRTM, ICESat points and – if available - GPS tracks and high resolution reference DEMs are computed and checked by an operator.

One main challenge during the DEM mosaicking is to detect larger inconsistencies between overlapping heights and afterwards to choose the best height in order to avoid averaging inconsistent heights. Therefore two kind of errors are distinguished: phase unwrapping (PU) errors, which can be detected, if two heights differ of more than half of the height of ambiguity, and other inconsistencies due to changes of terrain and vegetation or random errors in the DEM. Inconsistencies of the second category are detected by adding an error bar (consisting of the HEM value and a variable threshold) to both heights and checking, if theses error bars do not overlap. If any inconsistency is detected, it will be annotated in the consistency mask.

Choosing the most reliable acquisition, the height which is processed using the dual-baseline method is preferred, except its HEM value exceeds a certain threshold. In this case, the height acquired with the bigger height of ambiguity, which is more reliable especially over forests, is chosen.

3. EVALUATION OF THE TANDEM-X DEM MOSAIC

In Figure 1 a subset of geo-cell 44°N 142°E (Hokkaido, Japan) is shown. There the terrain is steep and forested. In Figure 1 (bottom) the differences to SRTM are shown (water areas are excluded and shown in gray). In the mosaic of the first coverage a PU error occurs, which is not present in the additional coverage. By merging first and additional coverage, the DEM pixels with the PU errors are correctly detected and left out. In this case, the additional coverage was more accurate than the first, whereas in other areas like in another subset of this geo-cell shown in Figure 2 (top), the DEM heights of the additional acquisition are very noisy, which is presumably due to snow (see amplitude mosaic shown in Figure 2, bottom). There a lower SAR signal is received, which also causes higher HEM values. As the heights of the raw DEMs are weighted by the HEM, only the good values are propagated to the DEM mosaic.

Figure 1: TanDEM-X DEM mosaic (top) and differences between TanDEM-X DEM and SRTM (bottom) for steep and forested terrain (44°N 142°E)

a) First coverage b) Additional coverage c) First+Additional coverage

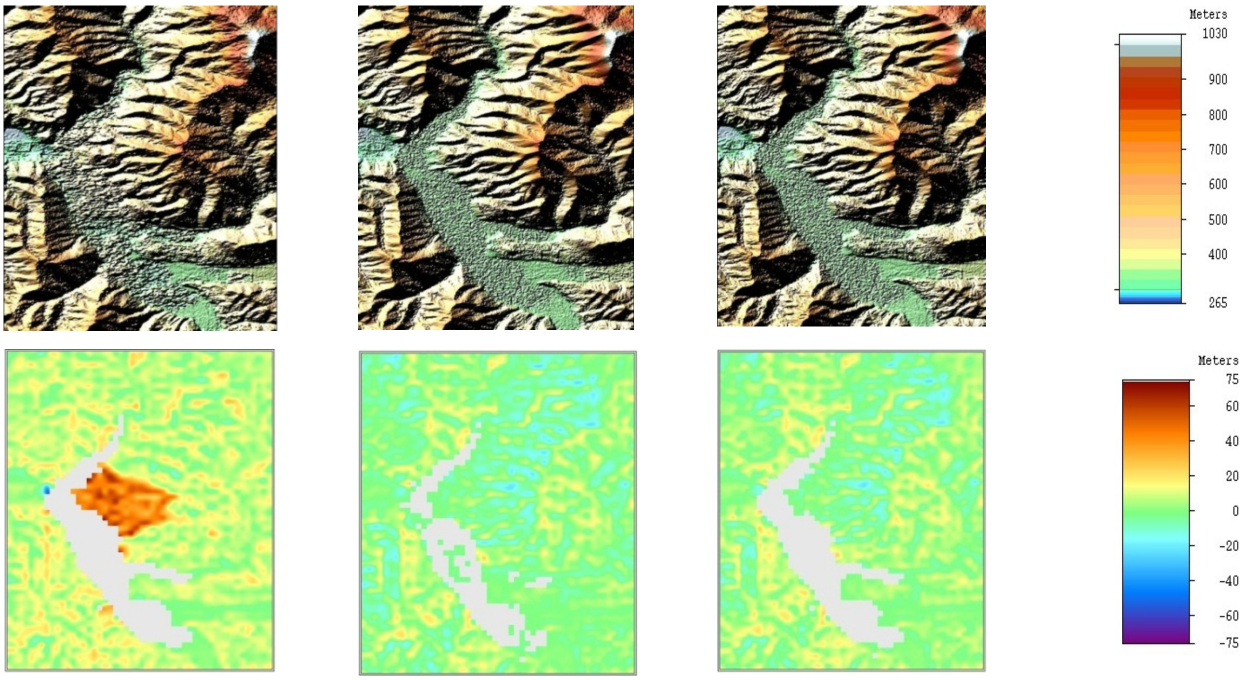
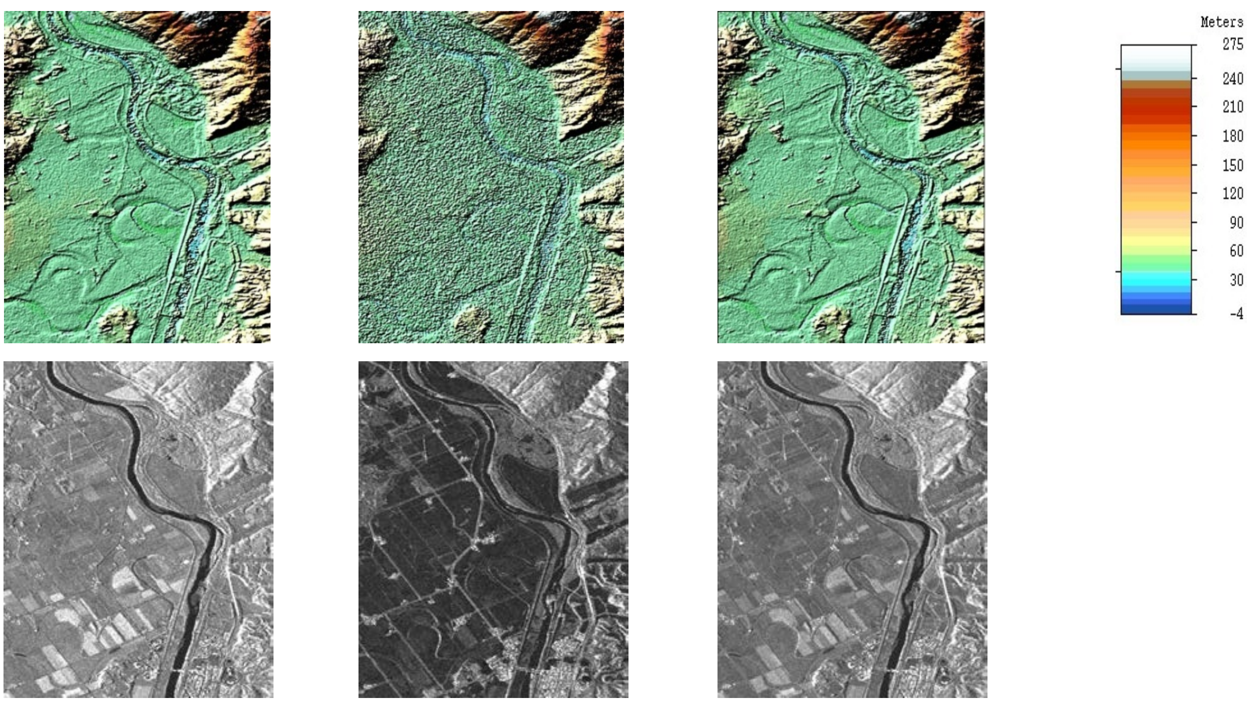


Figure 2: TanDEM-X DEM (top) and amplitude (bottom) mosaic for flat terrain (44°N 142°E)

a) First coverage b) Additional coverage c) First+Additional coverage



4. CONCLUSION

In this paper the DEM mosaicking workflow is described and several DEM mosaics using different acquisitions are compared. A main challenge during the DEM mosaicking is to detect inconsistencies between overlapping heights and afterwards to choose the best height. The examples shown in this paper prove that the procedure of mosaicking chooses reliable heights, so that the second or rather the additional acquisition improves the accuracy of the final TanDEM-X DEM mosaic.

5. LITERATURE

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