ERS-ENVISAT CROSS-INTERFEROMETRY RESULTS OVER THE JANGTSEKIANG DELTA IN CHINA

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ABSTRACT

In this contribution we report on ERS-ENVISAT Tandem (EET) CInSAR results over the Jangtsekiang delta, north of Shanghai, China. Over the very flat delta area, the interferometric phase nicely shows smallest variations in the surface topography, thanks to its excellent sensitivity with a height ambiguity below 5m. Abrupt height changes of a few meters are clearly visible in the cross interferograms. One of the pairs was acquired at low tide. Over the exposed tidal flats the interferometric coherence is high because both scenes are acquired during the same low tide within 28 minutes. Thanks to its high sensitivity to topography the EET CInSAR phase shows details of the elevation of the tidal flats.

1. INTRODUCTION

In 2002 ESA launched the ENVISAT satellite with the Advanced SAR (ASAR). ENVISAT is operated in the same orbits as the ERS-2, preceding ERS-2 by approximately 28 minutes. One of the ASAR modes, namely IS2 at VV-polarization corresponds closely to the ERS SAR mode, except for the slightly different sensor frequency used. A unique opportunity offered by these two similar SAR instruments operated in the same orbital configuration is ERS – ENVISAT cross-interferometry (CInSAR). At perpendicular baselines of approximately 2 kilometers the look-angle effect on the reflectivity spectrum compensates for the carrier frequency difference effect. As was shown with examples over Germany, the Netherlands, Italy, and Switzerland [1] CInSAR has a good potential to generate accurate DEMs over relatively flat terrain.

In this contribution we report on ERS-ENVISAT Tandem (EET) CInSAR results over the Jangtsekiang delta, north of Shanghai, China. Figure 1 shows an overview of the area.

2. DATA AND PROCESSING

For our study three suited EET pairs, as listed in Table 1, were available.

Table 1: EET CInSAR parameters of pairs selected over Jangtsekiang delta. Indicated are the perpendicular baseline component, $B_\perp$, and the Doppler Centroid difference, dDC.

track	date	$B_\perp$[m]	dDC[Hz]
275	*20081207*	*1460*	*320*
003	*20081223*	*1443*	*407*
275	*20090215*	*2168*	*970*

For this area we had the SRTM 3” DEM available as a possible height reference. The SRTM DEM was used to remove overall phase trends (baseline refinement). We did not use it, though, as the height reference for the differential interferogramms, but preferred to use a constant height as reference. This permitted avoiding artifacts related to variations and noise at meter scale which are present in the SRTM DEM.

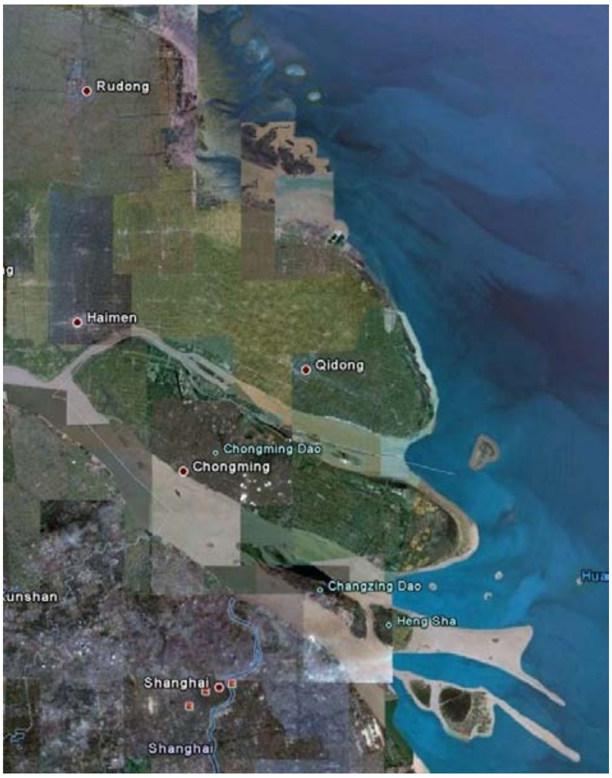

Figure 1 Jangtsekiang delta area, China. Overview from GoogleEarth.

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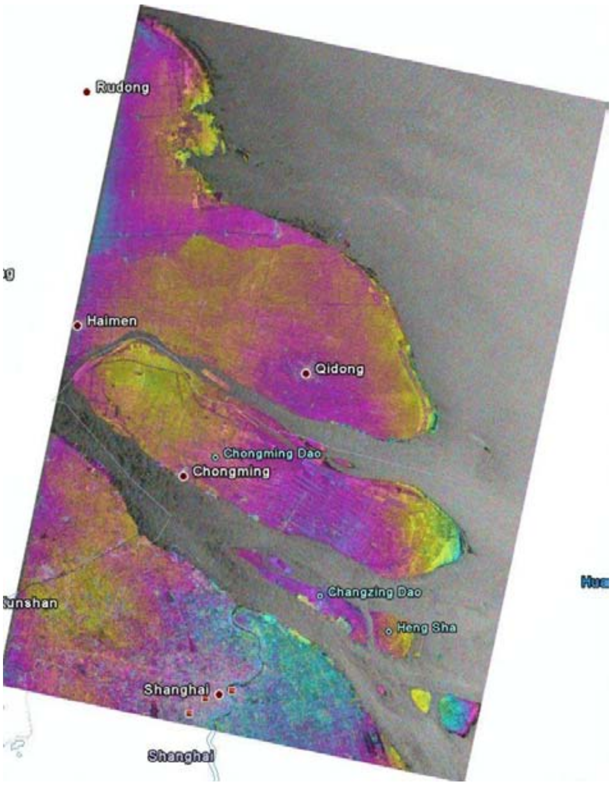

Figure 2 Jangtsekiang delta area, China. EET cross-interferogram relative to a constant reference height, track 003, 23-Dec-2008, dt 28min., $B_\perp$ 1443m.

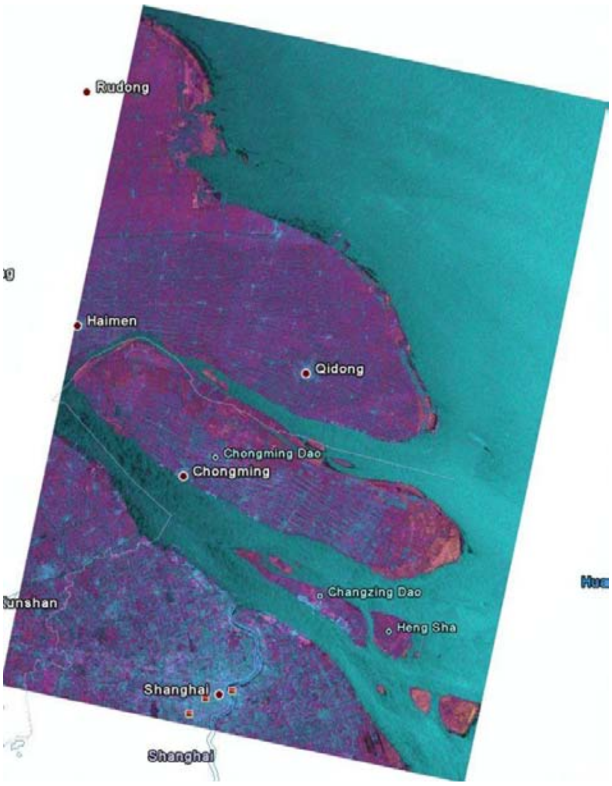

Figure 3 Jangtsekiang delta area, China. EET cross-interferogram coherence, track 003, 23-Dec-2008, dt 28min., $B_\perp$ 1443m. Blue colors represent low coherence, red intermediate and yellow high coherence.

In the processing common band filtering was applied for both the azimuth and range spectra. In the latter the effect of the frequency difference between ERS (5.3 GHz) and ENVISAT ASAR (5.331 GHz) was taken into account.

3. RESULTS

The suited EET pair available in track 003 covers the very flat agricultural area in the Jangtse Delta as well as parts of Shanghai and its surroundings. Figure 2 shows the cross-interferometry phase relative to a constant height reference.

Over the very flat delta area, the interferometric phase nicely shows smallest variations in the surface topography, thanks to its excellent sensitivity with a height ambiguity of 7m. Abrupt height changes of a few meters are clearly visible. For more gentle phase variations it is not clear if the cause is the topographic height or a varying phase delays in the atmosphere. Over the city area the phase looks noisy, which is not surprising considering the 7m ambiguity height of this pair.

In the coherence image (Figure 3), field boundaries are clearly visible. Possibly this is because of water channels which are present. Overall the coherence is not very high over the cultivated fields. The likely explanation for this is the vegetation present. Higher coherence values are observed along the coast and for dry tidal flats.

In track 275 two suited EET pairs were acquired (see Table 1). Comparing the cross-interferograms along the coast shows significant differences between the two pairs (Figures 4-7). For the first pair (7-Dec-2008) the backscattering shows indications on the topography and structure in the tidal flats. For the second pair (15-Feb-2009) parts not covered with water can clearly be discriminated from the water covered parts. In the cross-interferograms the phase is completely noisy over water covered areas. For the first EET pair that is the case for most of the tidal flats, for the second pair much of the tidal flats show high coherence. Obviously, both scenes are acquired quite close the tidal minimum. The height ambiguity is around 4m per phase cycle for the second EET pair indicating that the sea surface is about 4 meter lower than during the acquisition of the first EET pair.

Figure 4 ENVISAT backscatter over tidal flats at high tide on 7-Dec-2008.

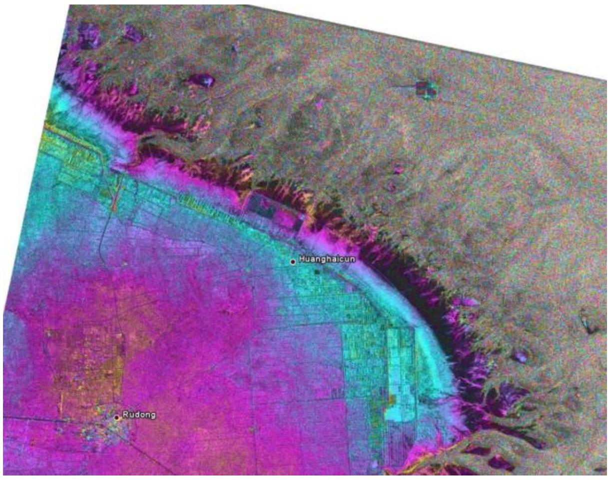

Figure 5 EET cross-interferogram over tidal flats at high tide on 7-Dec-2008.

Figure 6 ENVISAT backscatter over tidal flats at low tide on 15-Feb-2009.

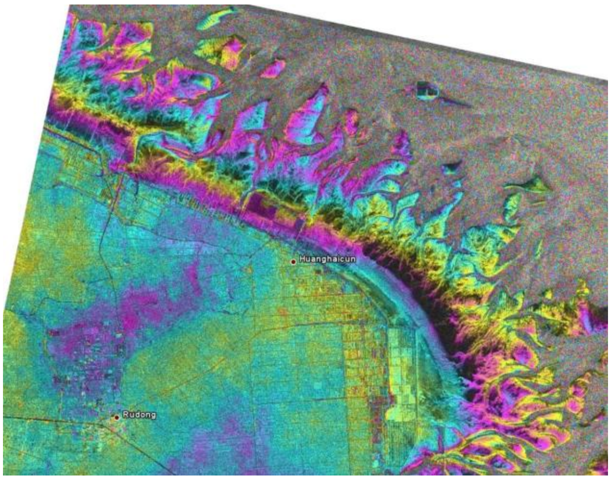

Figure 7 EET cross-interferogram over tidal flats at low tide on 15-Feb-2009.

4. DISCUSSION AND CONCLUSIONS

In this contribution we reported on EET CInSAR results achieved over the Jangtsekiang delta, north of Shanghai, China. Over the very flat delta area, the interferometric phase nicely shows smallest variations in the surface topography, thanks to its excellent sensitivity with a height ambiguity around 7m. Abrupt height changes of a few meters are clearly visible in the cross interferograms. For more gentle phase variations it is not clear if the cause is the topographic height or a varying phase delays in the atmosphere.

In the coherence field boundaries are clearly visible. Possibly this is because of irrigation channels which are present. Overall the coherence is not very high over the cultivated fields. The likely explanation for this is the vegetation present. Higher values are observed along the coast and for dry tidal flats.

One of the pairs was acquired at low tide. Over the exposed tidal flats the interferometric coherence is high because both scenes are acquired during the same low tide within 28 minutes. The shape of the dry part of the tidal flats is clearly visible with coherence level very clearly above the low level observed over water. The width of the tidal flats is several kilometres. In between the dry or exposed parts there are water channels. The interferometric phase shows details of the elevation of dry parts of the tidal flats. Water and very smooth dry surfaces show both very low backscattering and can be confused in the backscatter images. Furthermore, the details on the elevation provided by EET CInSAR is not available from backscatter alone. We conclude from this example that EET CInSAR has a good potential for the mapping of surface topography in tidal flats.

5. Acknowledgments

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6. REFERENCES

[1] Wegmüller U., M. Santoro, C. Werner, T. Strozzi, A. Wiesmann, and W. Lengert, "DEM generation using ERS–ENVISAT interferometry", Journal of Applied Geophysics Vol. 69, pp 51–58, 2009, doi:10.1016/j.jappgeo.2009.04.002.