INITIAL ASSESSMENT OF ASTER DEMS OVER THE CEOS-WGCV-TMSG TEST SITES IN EUROPE AND CHINA

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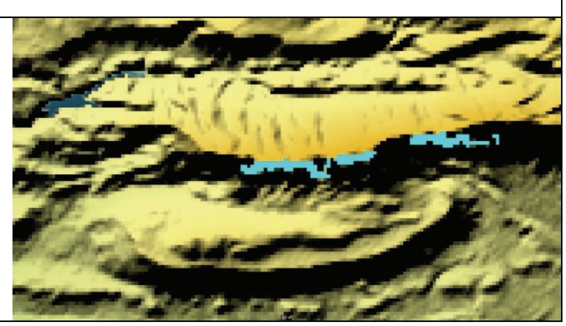
1. INTRODUCTION

The CEOS (Committee on Earth Observing Systems) Working Group on Calibration/Validation was set-up in 1987. CEOS-WGCV is concerned with the establishment of guidelines on best practices and the creation of a set of test sites which can be employed for validation of spaceborne sensor-derived Digital Elevation Models. The creation of best practices is discussed further in a companion paper in the Q4EO session at the IGARSS 2009 conference [1]. This work is concerned with the use of some of the CEOS-WGCV-TMSG (Terrain Mapping Sub-group) test sites in Eurasia for assessment of ASTER DEMs. In this abstract a short report is included on work completed in 2007 [2] on an assessment of the individual ASTER DEMs and their fusion using a "perfect cloud screening" algorithm. In the final paper, an assessment of (part of) the same areas using the final ASTER GDEM being created by Dr Fujisada-san of SilCAST Corporation on contract to METI and NASA will be reported as a result of the outcomes of the Announcement of Collaborative Opportunity (ACO) from USGS [3]. This ACO closes on 5 January 2009 and the successful applicants will be notified on 12 January 2009 according to the ACO.

ASTER 30m DEMs were provided by NASA over 4 CEOS-WGCV-TMSG test sites: Aix-en-Provence, Barcelona, Three Gorges and Puget Sound. We report here on experiments to assess the best method to (a) merge the most cloud-free single 30m ASTER DEMs with 90m SRTM to create a 30m DEM over the Three Gorges; (b) merge a stack of 30m ASTER DEMs by cloud clearing using a fixed threshold over Aix-en-Provence; (c) merge a stack of 30m ASTER DEMs by pre-screening for water and cloud features using an existing DEM over Barcelona. In each case, independent "ground truth" DEMs were employed to assess the quality of the input ASTER DEMs and their fused derivative products.

2. CEOS-WGCV-TMSG TEST SITES

Table 1 lists the characteristics of the "ground truth" and shows an illustration of colourised (by height) hill-shaded SRTM DEMs of the datasets employed for the study reported here. Areas highlighted in blue show gaps in the 3 arc-second (≈90m) SRTM DEMs. For each area, all the ASTER scenes with 0-10% cloud cover were selected. The SiLCAST software at USGS was employed in an "on-demand" mode to generate the DEMs. [4] . Accuracy comes from the analysis described later.

Short-name	Extent (lon)	Extent (lat)	Validation datasets	Number USGS ASTER DEMs	Mean ± standard deviation number	ICEDS WMS image taken from http://iceds.ge.ucl.ac.uk
Aix-en-Provence Europe (F)	5.528-5.685ºE	43.502-43.560ºN	Aerial top-of-canopy Pitkin DEM (UCL), DTM (IGN)	12	-10.3 ±30.13m 95,865	

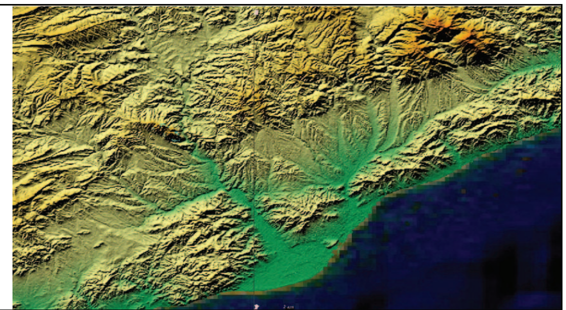
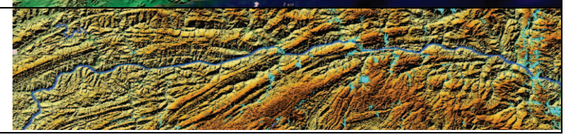
Barcelona Europe (ES)	1.5-2.75ºE	41.25-41.82ºN	Aerial top-of-canopy DEM (ICC)	10	-3.15 ±16.37m 3,813,039	
Three Gorges Asia (China)	108.252-111.302ºE	30.638-31.229ºN	CASM 50m DTM, kGPS	13	1.74 ±19.72m 3,000	

Table 1. Summary of characteristics for 2 European and 1 Asian CEOS-WGCV-TMSG test sites.

3. METHODS

Each ASTER DEM was first checked for co-registration with other ASTER scenes covering the same area using the ENVI® image processing environment. Linked image displays using flickering and false colour compositing were employed for visualizing and measuring the offsets. For all 3 areas, there was a small misregistration error of around 1 pixel which is probably due to errors in the camera pointing. No correction was performed for this error, as none is indicated to be used by SilCAST for the ASTER GDEM. For the Three Gorges (3G) area, a simplified system was employed [5] to fuse the SRTM and ASTER DEMs. This included cloud detection from DEM differencing and fusion to fill in cloud gaps using SRTM interpolated up to 30m. For the Aix en Provence area, severe problems were found in co-aligning the individual ASTER DEMs with the ground truth due to an issue with an unknown datum shift in the French Lambert Zone 3 data. A fixed height threshold was used to detect clouds as only 6 out of 12 were free of these. For the Barcelona area, a land-water mask [6] derived from SRTM and Landsat data was required to remove ASTER height points from water and the ground truth" photogrammetrically derived DEM was this time employed to detect clouds and artifacts in several of the input ASTER DEMs. In all cases missing or cloudy data were replaced by IEEE NaN and issues with ENVI® meant that a special IDL programme had to be written as a workaround to ensure that NaN were ignored in any statistical fusion process.

4. RESULTS

The resultant 3G DEM included horizontal and vertical striations associated with the SRTM interpolation for areas missing in the ASTER, particularly as there was one area where no ASTER scenes with cloud cover <10% were available. Unfortunately when scenes are averaged together for all 3 sites, the resultant mean DEMs demonstrated a smearing of the fine 30m resolution. For the AeP area, a fixed threshold did not entirely remove the clouds and this is shown in the final results in the table above. Even in Barcelona, the edges of the areas identified as clouds resulted in artifacts in the resultant fused DEMs. In all 3 cases there are pit artifacts which can be seen in the final DEM.

5. CONCLUSIONS

The resultant DEMs show that merging multiple near cloud-free ASTER DEMs can result in fine-scale resolution DEMs. However, issues associated with clouds and small artifacts cannot so easily be removed from the final product and that misregistration between individual ASTER DEMs results in smearing of the 30m resolution in the final product.

6. REFERENCES

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