STANDARDS AND INTEROPERABILITY FOR GLOBAL DEMS

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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-TMSG (Terrain Mapping Sub-Group) 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 (DEMs). The use of a set of test sites for assessing spaceborne DEMs is discussed further in a companion paper in the session on "Global DEM Interoperability: ASTER GDEM: initial assessment" at the IGARSS 2009 conference [1]. This work is concerned with the establishment of standards for the interoperability of DEMs. A detailed report produced for the GEO task DA-07-01 on "Global DEM interoperability" [2] describes the sources of global DEMs, their validation and recommendations concerning interoperability following an international workshop held in Beijing, PR China on 2 July 2008. Key points are discussed from this report and subsequent resolutions/recommendations which were agreed by the CEOS and GEO Plenaries held in November 2008 in Beijing and Bucharest respectively.

For any practical applications of global DEMs, such as CFIT (Controlled Flight in Terrain), there is an urgent need to specify accuracy, reliability and completeness as well as the precision in a standardized format so that DEMs from different spaceborne sources (and in rare cases, national mapping sources, where such metrics are available) can be merged together. Existing global spaceborne DEMs, such as from the NASA-DoD SRTM mission [3] are incomplete. Although there have been attempts to fill in these gaps using sophisticated feathering/mosaicing techniques, this is difficult to achieve and maintain similar DEM characteristics. For example, DEMs derived from InSAR tend to show speckle effects due to the nature of the sensing technique whilst stereo-optical techniques tend to show pits and other artifacts due to round-off errors in the image matching techniques. Therefore if InSAR and stereo-DEMs are fused to fill in gaps in SRTM at 90m or ASTER GDEM at 30m [4] they will show different noise characteristics. There is therefore a need to define interoperability standards beyond simple data formats such as GEOTIFF [5] which ISO TC 911 have adopted as a transferable image format.

2. STATISTICAL MEASURES AS CARRIERS OF STANDARDS

CEOS-WGCV-TMSG defined the best practices for DEM assessment [6] in the mid 1990s which was most recently revised in 2003. These methods had been employed in the surveying and photogrammetric community for some 30 years and were taken wholesale for application to spaceborne DEMs. The trouble is that many such methods failed to take into account the huge amount of data, particularly when dealing with global DEMs. Using a few checkpoints to assess the accuracy of a photogrammetric height model makes little sense when applied to DEMs with millions of height grid-points. The standard toolkit of the geomatics community is to use a higher accuracy source of height points such as kinematic GPS, trig-points and other spot-heights (such as national elevation benchmarks) and most commonly DEMs (preferably at least 3 times but preferably an order of magnitude) as "ground truth" and then difference these from the spaceborne DEM under study to obtain a bias (height difference), standard deviation of height residuals and higher order statistics such as skewness or kurtosis [7]. More recently, colleagues at JPL [8] have developed several new methods for structure and correlation functions which borrow heavily from the engineering literature employed for signal processing. However, although these statistical measures are helpful when comparing different DEM sources they do not fully characterize the errors described above. There is therefore a need to develop new techniques and a corresponding language to convey such measures to be used for the purpose of employing different global DEM sources for practical applications. The aviation industry has a great deal of experience in doing this for the onboard CFIT systems being developed for eventual use with onboard GPS systems which may be able to be translated into standards consistent with the CEOS-WGCV-Q4EO standards which are the subject of

this special session. However, there is need for a great deal more research to be done before such standards can be easily defined and implemented.

3. RECOMMENDATIONS FOR GLOBAL DEM INTEROPERABILITY

A number of recommendations and proposed actions have been drawn from the body of this report and an international workshop held at IRSA, Beijing, PR China on 2 July 2008. Nine of these were associated with gap-filling, fifteen with validation and five with dissemination and interoperability. The most significant in terms of resource needs is that associated with the public reporting of DEM errors and a commitment by the relevant space agencies to fix the problems. A proposal was agreed to set up a moderated "Known Issues" pages and support responses to repair and correct notified errors in the global DEM. It is planned that the sister WG on Information Systems and Services (WGISS) will be tasked with implementing this for the proposed global ASTER DEM described in [1].

4. CONCLUSIONS

As more and more global DEMs become available [2] at resolutions from 90m (SRTM), ASTER (30m) and down to one-third of an arc-second (around 10m at the equator) from the upcoming TeraSAR-X extension called TANDEM-X, there is an increasing need to establish agreed international standards for DEM quality assurance which the Q4EO guidelines and framework can support before spaceborne DEMs will be adopted by operational communities such as avionics and citizens can rely on in their everyday lives.

6. REFERENCES

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