Geophysical Research Abstracts, Vol. 7, 07208, 2005
SRef-ID: 1607-7962/gra/EGU05-A-07208

Change detection for remote monitoring of underground nuclear testing: comparison with seismic and associated explosion source phenomenological data

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The analysis of open-source satellite imagery is in process of establishing itself as an important tool for monitoring nuclear activities throughout the world which are relevant to disarmament treaties, like e. g. the Comprehensive Nuclear-Test-Ban Treaty (CTBT). However, the detection of anthropogenic changes associated with underground nuclear activities, whether declared or clandestine, presents a difficult challenge, since it is necessary to discriminate subtle, often weak signals of interest on a background of irrelevant or uninteresting changes.

In this contribution we focus on the use of conventional multispectral satellite platforms with moderate ground resolution (Landsat TM, ASTER) to detect changes over wide areas.We chose the Nevada Test Site (NTS), USA, for a case study because of the large amount of available ground truth information. The analysis is based on the multivariate alteration detection (MAD) algorithm proposed by Nielsen et. al. (1998). The multispectral data are pre-processed by orthorectification, illumination angle correction and image registration. The technique is applied to historical underground nuclear explosions detonated at the NTS between 1984 and 1992. The detected change signals are compared with existing seismic data which include explosion times, locations, yields and depth of burial as well as documented data about surface collapse (subsidence) phenomena like e. g. crater depth and diameter. The comparisons aim at deriving the required detection thresholds for the satellite image data sets in terms of explosion size and at deriving possible scaling relations between change signals and

the visible explosion effects.

This work has been carried out in part within the framework of the Global Monitoring for Security and Stability Network of Excellence (GMOSS) initiated by the European Commission.