TEMPERATURE, COLOR AND DEFORMATION MONITORING OF VOLCANIC REGIONS IN NEW ZEALAND

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New Zealand is home to many active and potentially active volcanoes. Mt Ruapehu is one of the most active volcanoes and is also the site of two major commercial ski-fields, including the largest in the country, Whakapapa. The site is economically valuable to the region and provides a popular recreation facility for New Zealanders and international visitors. As eruptions and lahars are potentially hazardous to both people and property in the area, the volcano is continually monitored using in-situ and remote sensing techniques. Satellite remote sensing offers the potential for monitoring several aspects of volcanic activity. Ground deformation measurements using synthetic aperture radar are frequently practiced and well understood. Global thermal anomaly identification using MODIS and AVHRR sensors is also operational. Ash and gas clouds can be detected by a number of sensors. Several techniques are used in New Zealand for monitoring volcanic regions both within the country in the greater region covered by the Wellington Volcanic Ash Advisory Centre (VAAC). The data source and technique used is dependent on not only the process of interest, but also the temporal and spatial characteristics of the sensor. For example, OMI is acquired and processed on a daily basis to retrieve middle tropospheric SO_2, though very little spatial detail is available.

To map and monitor patterns of deformation at Mt Ruapehu and in the Taupo Volcanic Zone, we have been testing ALOS PALSAR. Ten images were acquired and processed (HH polarization) spanning 1st Jan 2007 – 5th Apr 2008 and covering the SW edge of the Taupo Volcanic Zone and Mt Ruapehu. The coherence of the processed interferogram was high except in regions covered by snow at the summit of Mt Ruapehu. Differential interferograms were successfully unwrapped and a variety of localized signal was observed. It is anticipated that most signal is noise caused by inaccuracies in the DEM that was used for removing topographic phase. However, some seasonal vegetation effect (due to volume scattering) is also observed on some images. No deformation due to volcanic activity has yet been detected, and the work will continue when a high resolution and high accuracy DEM is available or when more PALSAR images are acquired.

Temperature variations at the crater lake at the summit of Mt Ruapehu now also monitored on a continual basis using ASTER thermal infra red imagery. Testing was undertaken to determine the utility of MODIS for monitoring temperature changes preceding and following a minor eruption in 2007, but was unsuccessful due to relatively low temperature variability and the coarse scale of MODIS pixels. Our work continues to utilize ASTER imagery where available for Mt Ruapehu and also for Raoul Island, an active offshore volcano to the north of New Zealand. Approximately one cloud free image per month of each volcano is obtained.

Finally we also report the preliminary findings from using Hyperion imagery for assessing the chemical composition of the crater lakes at Mt Ruapehu and Raoul Island. Mt Ruapehu has a single crater lake that varies in colour according to the level of upwelling, and Raoul Island has two lakes of blue and green in colour. In situ chemical analysis of the water at Mt Ruapehu close to the time of image capture in 2003 was available for comparison. Atmospheric correction using ENVI/IDL FLAASH was applied to both data sets and the data were spectrally subset to remove bad bands, resulting in 158 individual spectral bands over the visible, NIR and SWIR regions. Spectra from the Mt Ruapehu Crater Lake were compared with a nearby dam in the absence of any open water in the scene. Spectra from the Raoul Island lakes were compared with surrounding sea water. Differences in the spectra are clearly apparent, but it is too early to ascertain whether the resolution (spatial, spectral, radiometric and temporal) of Hyperion is sufficient to provide a viable means of monitoring changes. In particular, only a single cloud free scene over each of these volcanoes was available in the archive, which is clearly inadequate for monitoring purposes. Additional scenes will be required to better evaluate the potential of this type of monitoring.

It is important to continue monitoring over short and long time scales to better understand the phenomena of temperature and colour variations as well as deformations as an indicator of potentially hazardous volcanic activity. By combining ASTER with MODIS imagery, it is possible to better characterise small scale and low level thermal activity. While colour variations are apparent in Hyperion imagery, more data is required to determine if this information could also supplement our understanding of volcanic activity and potential precursors to an eruption. SAR has been used very successfully in the past for deformation mapping, and although the utility of PALSAR in the New Zealand region has yet to be fully realised.