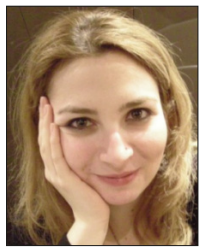
DETERMINATION OF PERIODIC VARIATIONS IN SUB-DAILY GPS POSITIONS OF VOLCANIC AREAS

G. Akay, P. Dare, R.B. Langley

University of New Brunswick, Department of Geodesy and Geomatics Engineering, Fredericton, New Brunswick

Deformation caused by a volcano (e.g., from volcanic activity) can be a good indicator of volcanic processes; ground deformation measurements using geodetic tools can be useful to monitor this movement. This study concentrates on detecting short-term movements occurring during both low activity periods and the eruptive stages of a volcano on the island of Montserrat by using sub-daily (epoch-by-epoch) GPS data processing approaches. The GPS data are obtained from UNAVCO for stations surrounding the Soufrière Hills Volcano during the May 20, 2006, volcanic eruption period and during the Fall 2012 period (a period of lower activity). In order to analyze hidden periodicities within the data, Least Squares Spectral Analysis has been used. Our results show that the sub-daily peaks are located at near diurnal and semidiurnal tidal constituents (K1 and K2) with up to 5 mm amplitude.

La déformation causée par un volcan (par de l'activité volcanique, p. ex.) peut être un bon indicateur de processus volcaniques. Pour capter ce mouvement, il peut être utile de mesurer les déformations du sol à l'aide d'outils géodésiques. Le présent article porte sur la détection de mouvements à court terme qui ont lieu à la fois pendant les périodes de faible activité et pendant les phases éruptives d'un volcan sur l'île de Montserrat, en utilisant des approches infraquotidiennes (époque par époque) de traitement de données GPS. Les données GPS sont obtenues auprès d'UNAVCO pour les stations entourant le volcan de la Soufrière pendant la période d'éruption du 20 mai 2006 et celle de l'automne 2012 (une période d'activité plus faible). L'analyse spectrale par la méthode des moindres carrés a été utilisée pour analyser les périodicités dissimulées parmi les données. Nos résultats démontrent que les périodes infraquotidiennes d'intensité maximale se situent près des composantes de la marée diurnes et semi-diurnes (K1 et K2) avec une amplitude atteignant 5 mm.



Gözde Akay
gozde.akay@unb.ca

Peter Dare
dare@unb.ca

Richard B. Langley
lang@unb.ca

1. Introduction

Geodetic space techniques, mainly GPS (Global Positioning System), are important tools to study ground deformations caused by natural phenomena because they can provide continuous three dimensional positions in all weather conditions. Since volcanic areas are dangerous environments, GPS measurements, especially as part of permanent GPS networks (which can be operated without human interaction after their establishment), have many advantages over other techniques that require direct human presence.

The usual approach in crustal deformation analysis is to estimate daily positions, even though GPS receivers are able to collect data at much higher rates (e.g., one observation every few seconds). This strategy is well-suited for slow deformations. However, higher rate position estimations are required for some deformation-monitoring studies such as those of volcanoes [*Larson et al.* 2010]. During the eruptive phases of volcanoes, ground movements are increased, especially in the hours to days prior to an eruption. Therefore, an epoch-by-epoch solution is preferred in order to detect movements, which can be possible precursors of volcanic activity.

Conventional diurnal position estimates ignore the sub-daily variations and the periodic components [*Ramirez et al*. 2008]. However, *Penna and Stewart* [2003] showed how un-modelled errors in diurnal and semidiurnal tidal frequencies propagate to daily GPS solutions in semiannual and annual periods. Unfortunately, the characteristics of sub-daily noise are not very well known. *King et al*. [2008] analysed data collected between 2000 and 2006 for approximately 90 International Global Navigation Satellite Systems (GNSS) Service (IGS) sites. They estimated site coordinates every

dx.doi.org/10.5623/cig2014-203