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Gas Concentration Mapping of Arenal Volcano using AVEMS

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ARENAL VOLCANO, AERIAL FOTO

Airbone Volcanic Emission Mass Sectrometer (AVEMS)

ARENAL VOLCANO, 3D Model. CARTA RC-10 photo and SRTM data

SOLOY 206 the two , aircrafts used ... AVEMS instrument

Introduction

The Airborne Volcanic Emissions Mass Spectrometer (AVEMS) System developed by NASA-Kennedy Space Center and deployed in collaboration with the National Center for Advanced Technology (CENAT) and the University of Costa Rica was used for mapping the gaseous plume of Arenal Volcano, the most active volcano in Costa Rica. These measurements were conducted as part of the CARTA (Costa Rica Airborne Research and Technology Application) mission during March 2005.

The CARTA 2005 mission, involving multiple sensors and aircraft, used three different planes collecting data over all of Costa Rica. The AVEMS collected ground data with a digital camera, an analog photographic camera, a multispectral scanner (MASTER) and a hyperspectral sensor (HYMAP). A second aircraft, a King Air 200 from DoE, mounted with a LIDAR based instrument, targeted topography mapping and forest density measurements. A small aircraft, a CESSNA Navajo from Costa Rica, integrated with the AVEMS instrument and designed for real-time measurements of air pollutants from both natural and anthropogenic sources was flown over the volcanoes.

System Description:

The improved AVEMS system is designed for deployment via aircraft, car or hand-transport. The 86 pound system employs a 200 Da quadrupole mass analyzer, has a volume of 92,000 cm3, requires 350 W of power at steady state, can operate up to an altitude of 41,000 feet above sea level (–66 C, 50 torr). The system uses on-board gas bottles on site calibration and is capable of monitoring and quantifying up to 16 gases simultaneously.

The in-situ gas data in this work, consisting of helium, carbon dioxide, sulfur dioxide and acetone, was acquired in conjunction of GPS data which was plotted with the ground imagery, topography and remote sensing data collected by the other instruments, allowing the 3 dimensional visualization of the volcanic plume at Arenal Volcano.

The modeling of possible scenarios of Arenal's activity and its direct impact on the surrounding populated areas in now possible with the combined set of data, linking in-situ data with remote sensing data. The study also helps in the understanding of pyroclastic flow behavior in case of a major eruption.

AVEMS Design, Integration and Operation for Airborne Campaigns
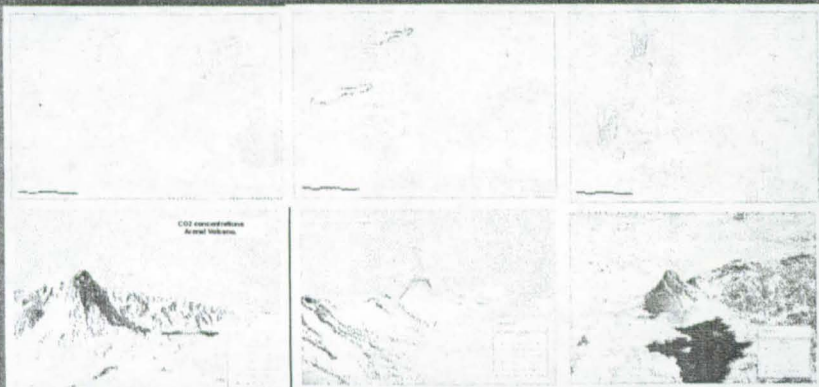
Map Generation and 3D visualizations:

The gas concentration data collected with AVEMS during the different flights, contains geographical location attributes (Latitude, Longitude, Altitude) obtained using a GPS. These data is the main input to locate spatially the information.

In order to model the plume location, which is not necessary visible to the human eye and poorly represented if it is plotted in two dimensions, digital elevation data obtained by other sensors during the CARTA 2005 campaign, topographic data generated by the Shuttle Radar Topographic Mapping (SRTM) Mission and remote sensing data from the LANDSAT satellite (both geo-referenced) are combined to produce a 3D ground model and overlaid with the gas concentration data. In this way, characteristics related to the flight path direction and position of the volcanic plume are visible in the 3D model.

Conclusions:

AVEMS demostrated its usefulness in aerial plume analysis at Arenal Volcano, presently the most active Costa Rican volcano. Several 3D gas concentration visualization were obtained for several gases. These 3D maps now serves to model plume direction and variability to predict posible impact on urban area and crops in the area closer to the volcano, as well as it is used as a guide for aircraft operation near the volcano. Other applications of AVEMS used during teh CARTA 2005 campaign included ground fumarole emission analysis. Also, the concentration of carbon dioxide around urban areas was measured spatially multiple times to provide temporal information as well.

Acknowledgments:

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CO2 concentrations Arenal Volcano.

He, CO2, SO2 Gas Concentration Maps (above) and 3D Visualzation of Volcanic Gaseous Emissions from Arenal Volcano (below) using AVEMS data, LANDSAT mutiespectral land coverage information and SRTM Digital Elevation Model

AVEMS team during CARTA 2005 Campaign: PRIAS-CENAT, NASA- KSC researchers and CICANUM-UCR students