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Produced by the NASA Center for Aerospace Information (CASI)
Gas Concentration Mapping of Arenal Volcano using AVEMS

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Introduction

The Arenal Volcano Emission Mass Spectrometer (AVEMS) System developed by NASA-Kennedy Space Center in collaboration with the National Center for Atmospheric Research (NCAR) and CENAT Costa Rica was used for mapping the gas emissions of Arenal, a volcano in Costa Rica, during March 2009. The system consists of a gas analysis instrument and a data collection and ground data with a computer for handling data. The gas analysis instrument is a 200 Da quadrupole mass analyzer with a volume of 0.200 cm³, which resolves 200 W of peak detection, to a 30 amplitude. It is designed to monitor and quantify up to 16 gases in a single analyte.

The in-situ gas data collected in this work consists of helium, carbon dioxide, sulfur dioxide, and nitrogen, and was acquired in conjunction with GPS data which was processed with the Progammable Geopositioning System to generate gas concentration data. The model predicted the concentration of gases in the atmosphere and determined the flow patterns using the wind data from the previous day and the predicted emissions.

System Description

The automated AVEMS system is designed for deployment on an aircraft and has a mass of 0.200 kg. It includes a 200 Da quadrupole mass analyzer with a volume of 0.200 cm³. The instrument was also equipped with GPS for geolocation and was capable of monitoring and quantifying up to 16 gases in a single analyte.

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Map Generation and 3D visualizations

The gas concentration data collected with AVEMS during the different flights contains geographical location attributes (Latitude, Longitude, Altitude) colored 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 2009 campaign was combined with 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 model ground and overlaid with the gas concentration data. In this way, characteristics related to the flight path direction and location of the volcanic plume are visible in the 3D model.

Conclusions

AVEMS demonstrated its usefulness in aerial plume analysis at Arenal volcano, presently the most active Costa Rican volcano. Several 3D gas concentration visualizations were acquired for several gases. These 3D maps now serve to model plume direction and variability to predict possible impact on urban areas and crops in the area close to the volcano, as well as it is used as a guide for aircraft operation near the volcano. Other applications of AVEMS, used during the CARTA 2009 campaign included ground-based seismic and vent gas analysis. Also, the concentration of radon gas around urban areas was measured at multiple times to provide temporal information as well.

Acknowledgments

We would like to thank the "Servicio de Vigilancia Aerea" and Mr. Federico Canizar for their support on sending the aircraft and flying the different aircrafts during the CARTA 2009 campaign. We would like to acknowledge the CR-USA Foundation, the National Council for Research, FUNDENAT, the Ministry of Science and Technology, the Dirección General de Aeronave, CICANUM, the VICOOR, the CICANUM-UCR, and the Engineering Department at Kennedy Space Center for their support on this project.