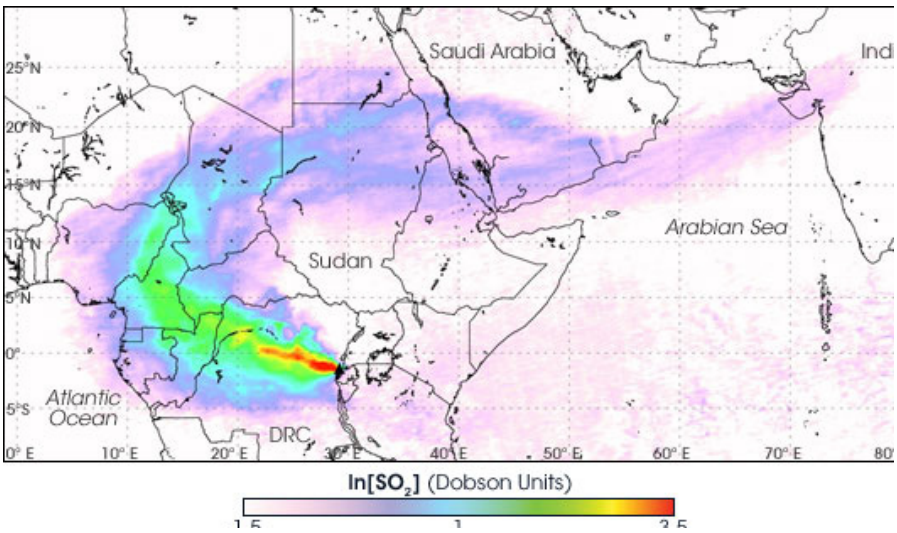
JCET
The Joint Center for Earth Systems Technology

JCET NEWS

Volume 4, Issue 2 Fall 2006

JCET Keeping an Eye on the Most Active Volcanoes in the World

Simon Carn of JCET leads the Virunga Volcanic SO_2 Emissions Research (VISOR) project, which monitors emissions from Nyamuragira and Nyiragongo, the active, alkaline volcanoes in the Virunga region of the western arm of the East African Rift in DR Congo. Along with his colleagues Gregg Bluth and Elisabet Head (Michigan Tech), Jim Luhr (Smithsonian Institution), and Georgina Sawyer (Cambridge University), Carn is using a combination of remote sensing and fieldwork to develop a complete record of emissions from the Virunga volcanoes as well as creating an up-to-date map of the recent lava flows. The combination of remote sensing data and *in-situ* data collected with the assistance of Congolese scientists at the Goma Volcano Observatory (GVO) allows for validation of the satellite-based measurements, which cover much more territory than the field instruments alone. Petrological analysis of historical eruptive products of Nyamuragira and Nyiragongo will be used to determine the extent of magma degassing during eruptions. These data will be combined with the remotely sensed SO_2 measurements to assess the relationship between melt sulfur loss and measured SO_2 production for a series of eruptive events; thus shedding new light on the incidence of excess sulfur emissions at non-arc, alkaline volcanoes, and into the behavior of sulfur and other volatiles in alkali-basaltic magmas.



Mount Nyamuragira erupted on November 27, 2006 at 10pm local time. The Ozone Monitoring Instrument on NASA's Aura satellite tracked the emission of sulfur dioxide from November 28 to December 4, 2006.

Sulfur dioxide (SO_2) emissions from non-arc volcanoes constitute a significant component of the global volcanic sulfur budget, and have been assumed to scale directly with erupted lava volume (i.e., there is no 'excess sulfur'). However, to date there have been very few efforts to prove this, particularly for alkaline volcanoes. Both Nyamuragira and Nyiragongo are prodigious sulfur emitters, the former during its frequent effusive eruptions and the latter via persistent passive degassing since 2002. To date there has been no concerted attempt to link these SO_2 emissions with magma production, or to investigate the origin of the exceptional SO_2 output.

Broader impacts of this study include: strengthening of international collaborative links between groups in the USA, Africa, and Europe; a valuable infusion of expertise and collaborative activity for African scientists at GVO, which has suffered many years of neglect and civil unrest; outreach projects in Goma using satellite data acquired for the project; and the addition of exotic volcanic rock compositions to the National Rock Collection archive at the Smithsonian Institution, for future research efforts.

This research is being sponsored by the National Science Foundation's Petrology and Geochemistry program and the National Geographic Society. Simon Carn is an Assistant Research Scientist with JCET.

Recent Publications by JCET Faculty

According to the 11th JCET Annual Report, JCET faculty were responsible for more than 300 refereed papers, conference presentations, and posters in the 05-06 reporting period. Here are some of the most recent publications from the 06-07 period (JCET affiliated researchers listed in bold font):

Koren, I., Y.J. Kaufman, R. Washington, M.C. Todd, Y. Rudich, **J.V. Martins** and D. Rosenfeld (2006), **The Bodélé depression: a single spot in the Sahara that provides most of the mineral dust to the Amazon forest**, *Environ. Res. Lett.* (October 2006), 1-5, DOI:10.1088/1748-9326/1/1/011001. About 40 million tons of dust are transported annually from the Sahara to the Amazon basin. Saharan dust has been proposed to be the main mineral source that fertilizes the Amazon basin, generating a dependence of the health and productivity of the rain forest on dust supply from the Sahara. Here we show that about half of the annual dust supply to the Amazon basin is emitted from a single source: the Bodélé depression located northeast of Lake Chad, approximately 0.5% of the size of the Amazon or 0.2% of the Sahara. Placed in a narrow path between two mountain chains that direct and accelerate the surface winds over the depression, the Bodélé emits dust on 40% of the winter days, averaging more than 0.7 million tons of dust per day.

Whiteman, D. N., B. Demoz, **P. Di Girolamo**, **J. Comer**, I. Veselovskii, **K. Evans**, Z. Wang, M. Cadirola, K. Rush, G. Schwemmer, B. Gentry, **S. H. Melfi**, B. Mielke, D. Venable, and T. Van Hove (2006), **Raman Lidar Measurements during the International H2O Project. Part I: Instrumentation and Analysis Techniques**, *J. Atmos. Ocean. Tech., 23*(2) (February 2006), 157–169, DOI: 10.1175/JTECH1838.1. The NASA GSFC Scanning Raman Lidar (SRL) participated in the International H_2O Project (IHOP), which occurred in May and June 2002 in the midwestern part of the United States. The SRL received extensive optical modifications prior to and during the IHOP campaign that added new measurement capabilities and enabled unprecedented daytime water vapor measurements by a Raman lidar system. Improvements were also realized in nighttime upper-tropospheric water vapor measurements. The other new measurements that were added to the SRL for the IHOP deployment included rotational Raman temperature, depolarization, cloud liquid water, and cirrus cloud ice water content. In this first of two parts, the details of the operational configuration of the SRL during IHOP are provided along with a description of the analysis and calibration procedures for water vapor mixing ratio, aerosol depolarization, and cirrus cloud extinction-to-backscatter ratio. For the first time, a Raman water vapor lidar calibration is performed, taking full account of the temperature sensitivity of water vapor and nitrogen Raman scattering. Part II presents case studies that permit the daytime and nighttime error statistics to be quantified.

Engel-Cox, J. A., **R. M. Hoff**, **R. Rogers**, F. Dimmick, A. C. Rush, J. J. Szykman, J. Al-Saadi, **D. A. Chu**, and E. R. Zell (2006), **Integrating lidar and satellite optical depth with ambient monitoring for 3-dimensional particulate characterization**, *Atmos. Environ., 40*(40) (December 2006), 8056-8067, doi:10.1016/j.atmosenv.2006.02.039. A combination of in-situ $PM_{2.5}$, sunphotometers, upward pointing lidar and satellite aerosol optical depth (AOD) instruments have been employed to better understand variability in the correlation between AOD and $PM_{2.5}$ at the surface. Previous studies have shown good correlation between these measures, especially in the US east, and encouraged the use of satellite data for spatially interpolating between ground sensors. This work shows that cases of weak correlation can be better understood with knowledge of whether the aerosol is confined to the surface planetary boundary layer (PBL) or aloft. Lidar apportionment of the fraction of aerosol optical depth that is within the PBL can be scaled to give better agreement with surface $PM_{2.5}$ than does the total column amount. The study has shown that lidar combined with surface and remotely sensed data might be strategically used to improve our understanding of long-range or regionally transported pollutants in multiple dimensions.

Welcome to New Employees

We warmly welcome **Mr. Breno Imbiriba**, **Mr. Ruben Delgado** and **Mr. Derek Stivers**, who have all joined JCET since our last newsletter. Mr. Imbiriba is a Visiting Research Associate working with Dr. Larrabee Strow, and is currently finishing his Ph.D. in Physics at the University of Maryland, College Park. Mr. Delgado is a part-time Research Associate working in Dr. Raymond Hoff's lidar laboratory. He is completig his Ph.D. in Chemistry from the University of Puerto Rico. Finally, Mr. Stivers is a Business Specialist supporting the Clouds and Precipitation Research Focus Group as well as scientists in our sister center, GEST. Mr. Stivers obtained his B.S. in Business Administration from the University of Maryland University College this year.

Congratulations, Graduates!

Two students mentored by JCET faculty have recently completed their Ph.Ds. **Dr. Hai Zhang** successfully defending his thesis, "A Global ETA Model on Quasi-Uniform Grids," in May. His advisor was JCET fellow Dr. Wallace McMillan. Dr. Zhang has since joined JCET as a Research Associate, working with Dr. Ray Hoff on the 3D-AQS project. In November, **Dr. Michele Comer** was awarded the Ph.D. after her presentation on "Retrieving Carbon Monoxide Abundance from the Atmospheric Infrared Sounder (AIRS)." Dr. Wallace McMillan also served as Dr. Comer's advisor. Dr. Comer is working for the Science, Technology, Engineering, Mathematics (STEM) Project, a partnership between UMBC and Baltimore County Public Schools (BCPS) . The project focuses on closing the achievement gap in STEM areas for students in high poverty schools.

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