Abstracts

Last update: August 10, 2010

Sunday, August 8th, 2010

10:00am-11:00am *Seismic tremors and magma wagging during explosive volcanism*, Mark Jellinek, University of British Columbia

Volcanic tremor, persisting for tens of seconds to weeks, is a low frequency (i.e., 0.1- 7Hz) seismic phenomenon and a ubiquitous feature of explosive volcanism. Prior to the start of a major eruption, these oscillations can occur in concert with ground deformation indicative of volcano pressurization probably related to a buildup of magmatic gas. Volcanic tremor is, thus, of particular value for eruption forecasting. Most models for volcanic tremor rely on specific properties of the geometry, structure and constitution of volcanic conduits as well as the gas content of the erupting magma. Because neither the initial structure nor the evolution of the magma-conduit system will be the same from one volcano to the next, it is surprising that tremor characteristics are so consistent among different volcanoes. Indeed, this universality of tremor properties remains a major enigma. Here we employ the contemporary view that silicic magma rises in the conduit as a columnar plug surrounded by a highly vesicular annulus of sheared bubbles. We demonstrate that, for most geologically relevant conditions, the magma column will oscillate or ``wag'' against the restoring ``gas-spring'' force of the annulus at observed tremor frequencies.
In contrast to previous models, the magma wagging oscillation is relatively insensitive to the conduit structure and geometry, thereby predicting the narrow band of tremor frequencies observed around the world. Moreover, the model predicts that as an eruption proceeds there will be an upward drift in both the maximum frequency and the total signal frequency bandwidth, the nature of which depends on the explosivity of the eruption, as observed.

11:20am-12:00pm *Some ways of modeling pyroclastic density currents (PDCs): Montserrat*, Sonja Melander, State University of New York at Buffalo

Soufriere Hills Volcano on the island of Montserrat has been extensively studied since its eruption commenced in 1995. Pyroclastic density currents (PDCs) present a direct hazard to the population and infrastructure of the island, most frequently forming from dome collapse. Several different models have been used to assess the potential hazard of PDCs resulting from dome collapse at Montserrat and at other locations: Flow3D, TITAN2D, VolcFlow, LAHARz (PFz), and PYROFLOW, which all differ in their inputs and solution methods. These models can be combined with pyroclastic surge estimation techniques and ensemble methods for combining numerous model runs into an annual probability of inundation to more comprehensively assess PDC inundation hazard.

12:00am-12:40pm *The geology (and blood, sweat, and tears) behind geophysical model inputs: Modeling pyroclastic flow hazards on Montserrat*, Sarah Ogburn, State University of New York at Buffalo

Soufriere Hills Volcano on the island of Montserrat, West Indies has been erupting for nearly 15 years. Five terrestrial and two maritime zones, designated by the Montserrat Volcano Observatory and the government of Montserrat, are used to control access to various locations on the island, based on the current hazard level. These hazard zones can be delineated based on geophysical modeling, but the margin for error when using these models is very small, as approximately 1200 people live within, or close to, several of the zones along the Belham Valley. Geophysical models are sensitive to user input friction values, initial geometries, and topography. There are a variety of methods, with varying degrees of error and difficulty, for obtaining these model inputs from the field. Often these data collection methods are unreliable and dangerous, but good alternatives involving remote sensing are becoming more feasible. The ever-changing nature of volcanic eruptions can make data collection difficult, especially for new eruptions, but historical data from volcanoes around the world can provide valuable guidance.

2:35pm-4:00pm *Extreme Events in Volcanic Risk Assessment*, Robert L Wolpert, Duke University / Susie Bayarri, University of Valencia

We view a particular pyroclastic flow as "catastrophic" at a particular location s (such as the town of Plymouth or the Bramble Airport on the island of Montserrat) if the maximum depth at that location exceeds some threshold value, like 10cm or 1m. The simulation program TITAN-2D is capable of predicting whether or not that happens for any specified volume of flow $V>0$ at any initiation angle $0\le \phi \le 2\pi$, by solving approximations to the partial differential equations governing granular flow on the specific topography (as recorded in a Digital Elevation Map, or DEM). The solution takes approximately an hour of computing time, making it impractical to find the solutions for thousands or millions of (V,ϕ) pairs.

A Gaussian Emulator is a very simple but very quick mathematical model to make intelligent interpolations of the TITAN-2D Simulator. Once ``trained" to an initial widely-spread set of (V,ϕ) values, the Emulator will replicate exactly the TITAN-2D values at parameter values where the model was run, and will give estimated values at other points with an attendant measure of uncertainty.

Using the Emulator for the TITAN-2D Simulator we begin by constructing the Risk Contour function $\Psi(\theta)$ which gives, for each possible initiation angle ϕ, the minimum volume V for a Pyroclastic Flow that will be catastrophic (i.e., generate a flow of at least the threshold depth at the site of interest).

For risk assessment, we need to compute the probability of the region defined by the Risk Contour function, and we need to take into account the frequency and severity of catastrophic events. Toward this end, we build a stochastic and statistical model for estimating the Risk --- the probability of a catastrophic Pyroclastic Flow in t years, for each value of $0 < t < 50$.

This entailes specifying the joint distribution for the number of flows in any specified time interval; the distribution for the volume of those flows; and the distribution for the initiation angle of those flows.

In this talk we describe our progress to date on this work-in-progress, and the directions in which we are extending our initial work.

Monday, August 9th, 2010

8:30am-9:15pm, *Approaches to rogue wave statistics*, Johannes Gemmrich, University of Victoria

The media often present accounts of "rogue waves", though the meaning of the term is often left undefined. Technically, the term is reserved for those waves in the tail of the probability distribution. A common definition for rogue waves defines them as waves with height $H \geq 2.2\ H_s$, where the significant wave height H_s is the average of the one third highest waves.

The interest in understanding the probability density functions of the wave height in a certain area is twofold: i) to provide risk assessments for mariners and offshore structures, and, ii) to test various physical processes that could lead to the development of those extreme waves.

Wave records are seldom long enough to establish reliable statistics for these infrequent events. Here, I use Monte-Carlo simulations to address some open questions that arise in the analysis of wave data and the assessment of rogue wave occurrences.

9:45am-10:30am *Mathematical modelling of hydrogen fuel cells*, Brian Wetton, University of British Columbia

Hydrogen Fuel Cells can efficiently convert Hydrogen fuel and air to electrical power with zero emissions. This talk concerns Polymer Electrolyte Membrane Fuel Cells (PEMFC). A general overview of how these devices are constructed and how they work is given. PEMFCs are fundamentally multi-scale. The central component of a PEMFC (the Membrane Electrode Assembly or MEA) has micron scale. The MEA is made of composite layers which must facilitate selective multiphase transport of reactants to and products from catalyst sites. The need for composite materials with these selective transport properties is a recurring theme in energy conversion and storage applications. MEAs are built into unit cells which are then arranged in stacks. The micro-components have behaviour determined by their structure on the nano-scale. Modelling stack level behaviour from component models and components from their nano-scale structure are both of interest and are illustrated with examples.

10:30am-11:15am *Risk assessment in groundwater hydrology*, Roger Daniel Beckie, University of British Columbia

Risk assessment is commonly used by practicing engineers and geoscientists to decide the best alternative from a set of options to manage groundwater contamination. Most of these assessments are performed in a classical risk-cost-benefit context, where the option with the lowest cost is selected. These assessments require probabilities of failure, which typically are the probability that contamination will exceed some regulatory threshold at a compliance point or surface. Contaminant transport is typically assessed with groundwater models, where the uncertainty in geological properties is the primary source of uncertainty. The greatest challenge is to adequately describe geological uncertainty from limited subsurface data, and then to propagate that uncertainty through models of groundwater flow and transport. In the past twenty years, a number of analytical and numerical modeling based methods have been developed in the field of geostatistics to address this problem. Geological uncertainty can be described either by a few moments of a spatial probability distribution, or by an ensemble of equiprobable realizations of properties on a spatial grid. Derived distribution methods, both analytical and numerical, or Monte Carlo methods are used to translate the geological uncertainty into the probability distribution of the contaminant. In practice, the profound geological uncertainty found at most sites, and a general lack of statistical tools in the profession, inhibits the application of many of these methods of analysis in all but the most high-value projects. Consequently, ad-hoc assessments are made or overly conservative options selected for most routine projects.

1:15pm-2:30pm *Modeling and Computing Geophysical Mass Flows*, Bruce Pitman, State University of New York at Buffalo

This talk will show the derivation of the equations governing pyroclastic and debris flows, and will review the computational methods used in performing numerical simulations. A tutorial paper with details will be provided.