Improving the global Eruption Source Parameters Database:

Where do we go from here?

By

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An effort is underway to review and restructure the Eruption Source Parameters Database for the world's volcanoes. Before embarking on this effort however, we would appreciate input and comments from members of the Volcanic Ash Advisory Centers, as potential users of the database itself.

Eruption source parameters or ESPs are those parameters such as plume height, eruption duration, erupted volume, and grain-size distribution, used as inputs to volcanic ash-cloud models. Immediately prior to an eruption modelers, are almost completely blind to possible eruptive behavior. To constrain this behavior, we generally draw from previous events and historical activity. Consequently, constraining ESPs for poorly-known volcanoes is more challenging during the unrest phase. During an eruption, knowledge of the value of most parameters is still incomplete when initiating a forecast simulation. Some parameters, like plume height, can be directly observed, though observations may not be accurate or even available. Others, such as grain-size distribution, eruption duration, or the vertical distribution of mass in the plume, must still be inferred from previous events.

Uncertainties in source parameter values are a key factor limiting the accuracy of ash-cloud model forecasts. This critical limitation was noted during the first IAVWOPSG meeting in 2004 (Conclusion 1/24). The issue was raised again during the second meeting in 2005, and it was concluded (Conclusion 2/27) that the United States Member would be tasked to devote a year of research to improving the quality of eruption source parameters used in VAAC forecast models. Thus in April 2007, the U.S. Geological Survey (USGS) organized a workshop on this topic at the Cascades Volcano Observatory in Vancouver, Washington. A special session was also organized at the 2007 American Geophysical Union meeting, resulting in the publication of a special volume on volcanic clouds by the *Journal of Volcanology and Geothermal Research* (v. 259., 2009). A key paper in that volume [*Mastin et al.*, 2009a], coauthored by representatives from all nine VAACs, described a multidisciplinary effort to improve source parameter estimates during eruptions. Following the eruptive crisis at Eyjafjallajökull volcano in 2010, this paper became a focus of global attention in renewed efforts to improve forecast accuracy.

The 2009 paper identified nine eruption types, characterized by a specific magma type and eruption size. Each eruption type was assigned a characteristic plume height, duration, erupted volume, and mass fraction of fine ash in the erupted debris. An eruption type of "medium silicic (S2)", for example, based on the 1992 Spurr (Alaska) eruptions [*Neal et al.*, 1995], was assigned a plume height of 11 km above the vent, a duration of 3 hours, a dense-rock volume of 15 million cubic meters, and a grain-size distribution that contains 40% ash finer than 63 microns. A sister publication [*Mastin et al.*, 2009b] included a spreadsheet that assigned eruption types to each of the 1,500 volcanoes in the Smithsonian Institution's Global Volcanism Database. The assignments were based on patterns of eruptive behavior of each volcano, or, for volcanoes that had not erupted in historical time, on the type of volcano or magma type.

The database was intended to provide source parameters for simulations in cases where no observations were available. For example,

- Before an eruption, for volcanoes that are in a state of unrest, to anticipate where ash might go if they erupted that day.
- In the first minutes of an eruption, when no direct observations are available (e.g. when seismicity suggests an eruption but no satellite data are available).
- For source parameters, such as grain-size distribution, vertical distribution of mass, or duration, that are not observable or unknown early in an eruption.

Following the 2010 eruption of Eyjafjallajökull, the International Volcanic Ash Task Force reviewed limitations to model forecast accuracy. Among the recommendations that came out of those meetings was one (Recommendation 2/8) to improve the ESP database. Possible action on this item was discussed during meetings of the Volcanic Ash Scientific Advisory Group in 2013 (VASAG-4) and in 2015 (VASAG-6). The British Geological Survey (BGS) offered to commit time and resources to this effort.

In early 2016, the BGS and the USGS (author of the earlier reports), as part of the Global Volcano Model network, started meeting to discuss possible improvements. In March 2016, the coauthors of this report, all leading ash-cloud modelers, convened a teleconference to discuss possible improvements to the ESP database. Such improvements could include:

- Posting the database online, where a current version is accessible to modeling groups.
- Allowing qualified users to update it, as patterns of activity at a volcano change, or as our knowledge of a volcano's behavior improves.
- Making source parameters customizable, so that plume height, erupted volume, etc. can reflect the values at that volcano, rather than being forced into generalized "type" values.
- For probabilistic modeling, adding options to enter multiple scenarios or prescribe probability density functions for input parameters.
- Developing streamlined integration of the database with operational models.

While daily pre-eruption simulations are run at many volcano observatories, usually by specialists with authoritative knowledge of the volcano at hand, VAACs generally have less familiarity with volcanoes. To our knowledge, pre-eruptive simulations are not generally conducted by VAACs. There may be few cases when an eruption is known to be ongoing but no observations constrain source parameters. During an eruption the database could be updated with the most recent observations (e.g. plume height) with a frequency dictated by the official reports produced by the Volcano Observatory (VONA)

Before updating, an overriding question is whether an improved database would be used and input from VAAC representatives would be appreciated regarding the following questions:

1) Have you used the ESP database to assign source parameters to volcanoes for modeling?
2) Do you use dispersion model output based on the ESP database inputs from your affiliated researchers? How do you collect that information?
3) In your estimation, what fraction of model forecasts are run with no direct observations that can constrain, for example, plume height?
4) In those cases, how do you assign plume height? Would guidance from a database be beneficial?
5) Would you use such a database more frequently if it contained informed guidance on non-observable parameters, such as eruption duration or grain-size distribution, that was based on knowledge of that volcano? How do you currently assign such parameters?
6) Would you use such a database more frequently if data were easily accessible, for example by integration into a model specific interface?
7) Do you run pre-eruptive model simulations? If so, under what circumstances? How do you assign source parameters?
8) Would you consider helping improve the database, for example by revising source parameters for volcanoes in your region that erupt frequently?

9) Given the particular interest of VAACs on fine particulate and far-range dispersal, which other parameters should be included in the database (e.g. fraction and distribution of aggregates, mass eruption rate, etc)?

Your responses will help us decide how to improve this resource.

References

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