**Volcanic Ash Forecast Processes and Actions**

The source of the initial report can drive the actions taken by the forecaster; generally some quick assessment of the potential threat and validity of the report will drive the first actions taken. In some cases pilot reports (PIREPs) need to be verified, especially for shallow or low plumes which are sometimes incorrectly interpreted—such as lee clouds off of a volcano’s dome. Other PIREPs at middle and high levels can usually be taken verbatim and used to immediately contact the CWSU and FAA and to issue an eruption SIGMET. The latter example would be the case for domestic volcanoes; the situation gets more complicated for Kamchatka volcanoes. For this discussion, we will focus on the process used for Alaskan Volcanoes.

Additional information that maybe known ahead of time (i.e. Redoubt 2009, Augustine 2006) is the volcano’s status; information produced by USGS which is generally available for monitored volcanoes. In the case of Redoubt and Augustine, many agencies in the state and federal government were aware of an eminent eruption of the volcano. However, the science behind predicting eruptions is still evolving and there are certainly surprises (i.e. Okmok 2008). These situations can dictate the immediate actions taken by a forecaster. In the case of Okmok’s initial eruption, it was so explosive there was no doubt to the validity.

The first action taken is to call the CWSU/FAA to allow them as much time as possible to divert aircraft in potential risk areas. During normal duty hours we would call the CWSU and they would coordinate with the FAA in the ARTCC (they are co-located). After hours, we would call the ARTCC directly. This is followed by an eruption SIGMET stating that a specific volcano may have erupted to the reported flight level (if known). We strive to have the eruption SIGMET issued within 5 minutes. Sometimes that is not possible, but that is the goal. From here, it is a fact finding mission to produce the volcanic ash (VA) SIGMET and (volcanic ash advisory) VAA. Meteorological model data, satellite imagery and other tools that are in AWIPS are used along with the VA dispersion model information. The forecaster has to make a lot of decisions, often in a short period of time, based on what information he has available at the point in time. The forecaster-in-the-loop is almost an understatement for this type of activity.

This process generally includes asking the Center Weather Service Unit (CWSU) to provide any additional PIREPs of known ash flight levels, as well as, calling Alaska Volcano Observatory (AVO) for their perspective and expertise in satellite-ash interpretation. This combination can, in most cases, give us the spatial extent of the ash in the atmosphere. This first step in obtaining a good gauge of where the ash is currently located is paramount in our ability to forecast its movement. Determining ash cloud tops-heights is a very important step and can be challenging. The use of satellite temperature techniques and sounding data are most often used. PIREPS are also part of the mix as well as WSR-88D information. When an eruption is in vicinity of RADAR, that information is used as the initial eruption height. The information from the 88-D radar is initially quite accurate; however, the plume height changes with time. For example, the initial eruption height (usually the highest value measured by the radar) will reflect the steam and other particles emitted to a certain level, but within a few volume scans, the main ash plume will be seen at a lower level (i.e. initial eruption height of 50 KT feet and then the bulk of main plume can be seen at perhaps 40 or 45KT feet).

At the same time as the coordination is ongoing, we will be running the PUFF and HYSPLIT models for forecast input. The HYSPLIT model (**Hybrid Single Particle Lagrangian Integrated Trajectory Model)** is the “official” model in use by the US VAACs. This involves calling the SDM (Senior Duty Meteorologist) in Washington DC to run the model and then they provide us with the output. The PUFF model (not an acronym) is an unofficial web-based model that is quick and easy for the forecaster to use at their workstation. This quick method provides a fairly reliable “first guess” to use for preparing warning and advisory products. Dispersion models used operationally have a number of set parameters that can produce over or under estimates of the amount of ash in the atmosphere. It is a standard practice for the US VAACs to compare the model’s output to what we can see or infer from satellite interpretation. This quality control often times produces the best combination of forecast tools with observed VA. This assessment is done qualitatively and on-the-fly as time is critical for the issuance of the VAA and VAG (graphical VAA) We would generally like to produce these two products within 20-25 minutes following the eruption SIGMET. Note that new tools that we have recently developed will allow us to get the VAAs and VAGs out sooner than 20-25 minutes. The Washington VAAC is not a Met Watch Office (MWO); therefore they are not required to issue a SIGMET. They will issue the VAAs and VAG right away, usually within about 5 minutes.

Continued assessment of the model’s output is also necessary to assure correct movement and speed of the VA. Generally, an hour or so into the SIGMET time, forecasters can verify that the spatial and temporal calculations are accurate. In one case (again Redoubt 2009), the ash moved south during an eruption much more quickly than was forecast by the models. This assessment allowed forecasters to re-position SIGMET polygons and VAA forecasts to produce a much more accurate forecast over the next 6 to 18 hours.

Each case is unique when dealing with volcanic eruptions and forecasts. The meteorological activity, the type of volcano, eruption, particles being emitted, location, observation, and data available are all major factors in the threat assessment and the outcome of the forecast.