Western Region Technical Attachment
No. 92-31
September 29, 1992

THE VOLCANIC ASH FORECAST TRANSPORT AND DISPERSION (VAFTAD) MODEL

Introduction

As of September 1, 1992, the Western Region gained access to the Volcanic Ash Forecast Transport and Dispersion (VAFTAD) model developed by Jerome L. Heffter and Barbara J. B. Stunder at the NOAA Air Resources Laboratory (ARL). The VAFTAD model uses gridded data from either the Nested Grid Model (NGM) or the Aviation run of the Global Spectral Model (AVN) to produce an ash cloud trajectory and concentration forecast based on an initial volcanic eruption. Used primarily in the Alaska Region, the ash cloud forecasts are useful in the Western Region as well; aiding in aviation forecasts, forecasting smoke emissions from large wildfires, and forecasting ash cloud location and relative concentration from volcanic episodes.

Model Description

The VAFTAD model uses gridded model data (from either the NGM or AVN) obtained from the National Meteorological Center (NMC) twice daily. The gridded forecast data, which is obtained out to 48 hours in 6-h intervals, is used to advect the ash cloud from a given source using tri-linear interpolation of the gridded wind components. The particles are advected both vertically and horizontally via a modified Euler advection scheme in 1-h time steps, centered on the 6-h gridded wind sequence. Thus, the model dynamics and synoptic evolution are included in the ash cloud forecasts.

The VAFTAD model uses a constant point source for the volcanic ash emission and assumes an eruption duration of less than 3 hours. The transport and dispersion of the spherical volcanic ash particles, assumed to range in size from 0.1 to 100 microns, are calculated by the model shortly after the cloud has reached its maximum height (10's of minutes). The particle mass-size distribution within the ash cloud is based on data from the Mt. St. Helens eruption and applies to all layers within the ash cloud.

Ash particle fall (based on Stoke's Law) is added to the vertical advection during each 1-h iteration. A bivariate-normal distribution is assumed for dispersing the ash cloud and determining the model's ash concentration output. One important point is that the VAFTAD model is a dry model, therefore the dispersion and relative concentrations of particles do not reflect ash removal due to precipitation or moist processes.

Model Output

Before running the VAFTAD model, the user is prompted to choose which model to use as input (NGM or AVN), location of the volcano, maximum height of the ash cloud above sea level, and the date and time of the eruption. The maximum ash cloud height is

entered in feet above sea level (ASL) with station elevation being accounted for. The model then takes approximately 10 minutes to produce four consecutive 12-h forecasts (through 48 hours), plot the ash cloud location/concentration, and fax the data to the Western Region Headquarters.

The output for the model is illustrated in Figure 1. The model plots four panels per 12-h time frame, each representing a different vertical layer. Each of the panels (surface-15,000 feet, 15,000-25,000 feet, 25,000-35,000 feet, and 35,000-50,000 feet ASL) display the relative concentrations of ash particles within the respective layer in the form of a symbol. The symbols [· - + *] represent the particle concentrations within the layer from low to high, respectively (the origin of the eruption is represented by an "**O**"). Table 1 lists the absolute concentration of ash particles (gm^{-3}) corresponding to the symbols stated above.

Each model run includes four separate pages similar to Figure 1, representing each of the four 12-h forecast periods. For example, if the initial gridded data (from either the NGM or AVN) began at 1200 UTC on day 1, the output would consist of four 12-h panels:

(1) 1200 UTC/Day 1 - 0000 UTC/Day 2
(2) 0000 UTC/Day 2 - 1200 UTC/Day 2
(3) 1200 UTC/Day 2 - 0000 UTC/Day 3
(4) 0000 UTC/Day 3 - 1200 UTC/Day 3

The VAFTAD model produces 48 hour forecasts from the initial gridded data time given by the user, independent of the volcano eruption time. The VAFTAD model erupts the volcano at the time the user specifies. For example, if the eruption occurred at 0600 UTC on Day 3 above, the first three 12-h forecast panels would not show any ash cloud and the fourth would show the 6-h ash cloud trajectory/concentration.

The output is similar to the NGM's 12-h quantitative precipitation forecast (QPF) which is also based on a 12-h forecast period. Figure 1b offers a comparison to Figure 1a using the AVN model gridded data which, unlike the NGM, can be used for any eruption within the Northern Hemisphere. The NGM (190 km grid spacing) does provide better grid resolution than the AVN model (380 km grid spacing) input and should be used when the volcanic eruption occurs within the nested grid domain, (i.e. any Western or Alaska Region eruption).

Using the assumptions and conditions stated above, the model can be run well before details of the eruption are known (such as total mass ejected, exact eruption duration, and particle size distribution). Thus, the model output becomes a useful tool for both nowcasts and forecasts, especially for aviation concerns, since it provides a good first guess as to the location and density of the ash cloud. Since the maximum ash cloud height is one of the variable input parameters, large-scale smoke emissions can also be tracked by reducing the cloud height value to one which is representative of the boundary layer (approximately 2500 feet + station elevation ASL). Although the particle size distribution and dispersion is formulated towards ash clouds, wildfire smoke particles (diameter of approximately 1 micron) do reside within the VAFTAD model size spectrum (0.1-100 microns).

Availability and Access to the Data

Currently, the VAFTAD model is run via remote access (external modem) to an IBM RISC System/6000 located at the NOAA ARL in Silver Spring, Maryland. The user logs onto the RISC computer and is prompted for model input (previously discussed). Once the user input is completed, the model executes the 48-h forecast run and automatically faxes the output to the user.

Due to the model's recent development, the dissemination process for the VAFTAD output is still in its early phases. The current time frame for the model output to become a regular product via NMC dissemination is the later part of 1993. For now, and this could possibly change in the near future, the VAFTAD output is received by two parties in the Western Region: Dan Baumgardt (WRH-SSD) and the CWSU Auburn.

At this time, Dan Baumgardt from the Western Region Headquarters-SSD is the focal point for running the VAFTAD model. If events warrant and a particular office would like access to the model output for forecasting concerns (versus public inquires), please contact Dan first. If he cannot be reached at SSD or the request is during off hours, Bob Jackson at the CWSU Auburn can be contacted at (206) 931-5401. The VAFTAD model results are currently faxed to Auburn from the National Environmental Satellite, Data, and Information Service (NESDIS) and can be forwarded to a requesting station if needed. WRH-SSD has the authorization to run the model, however the CWSU in Auburn only receives the output when NESDIS runs the model and sends it directly to them. If SSD is contacted, the output will be faxed to the requesting office within approximately 30 minutes in the four panel, 48-h forecast format previously described.

Any questions or comments regarding the VAFTAD model and its output should be directed to Dan Baumgardt at the Western Region Headquarters-SSD, (801) 524-5131.

References

Heffter, J. L., and B.J.B. Stunder, 1992: A Brief Description of the Volcanic Ash Transport and Dispersion (VAFTAD) Model. NOAA Air Resources Laboratory, Silver Spring, MD.

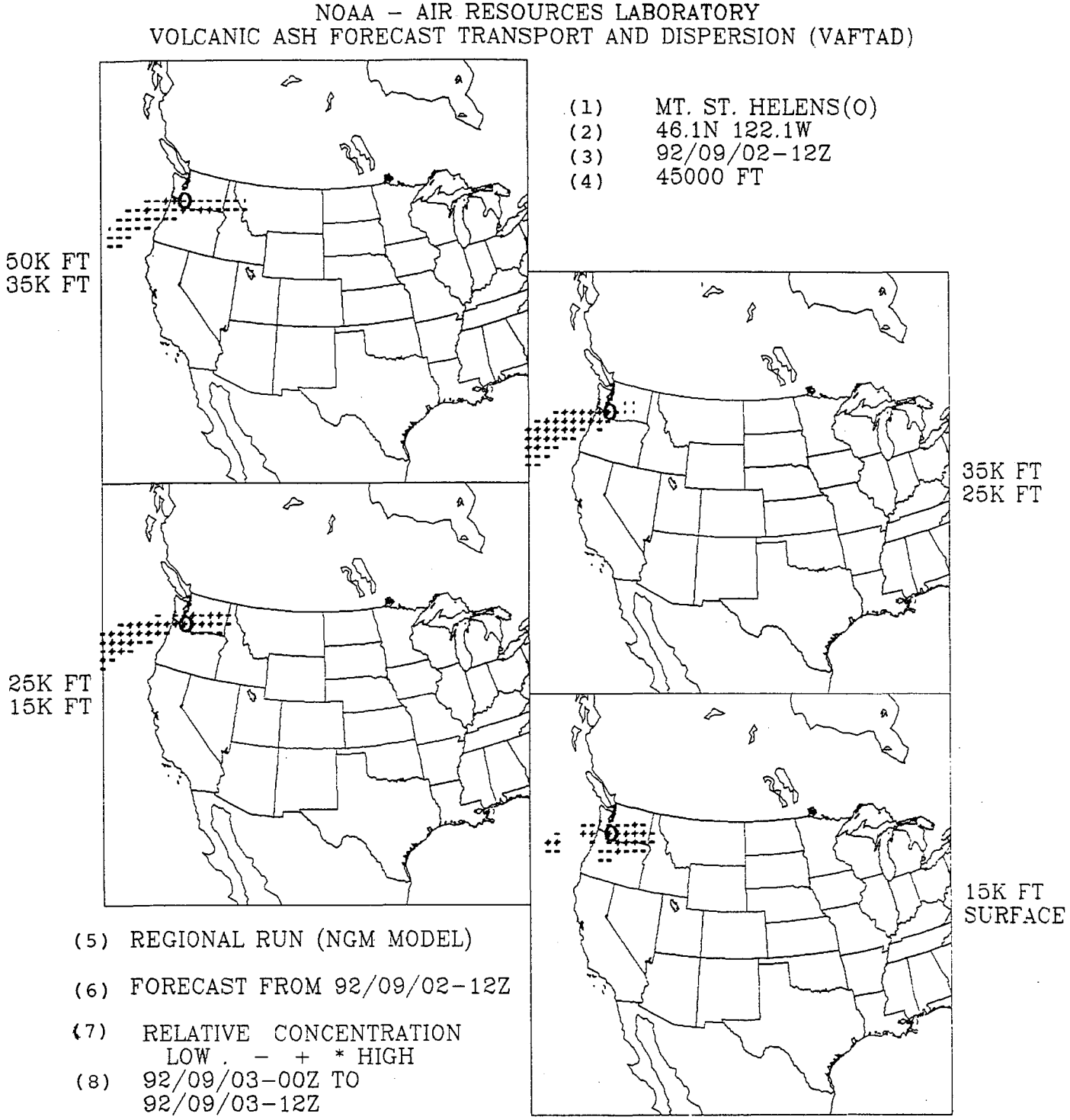
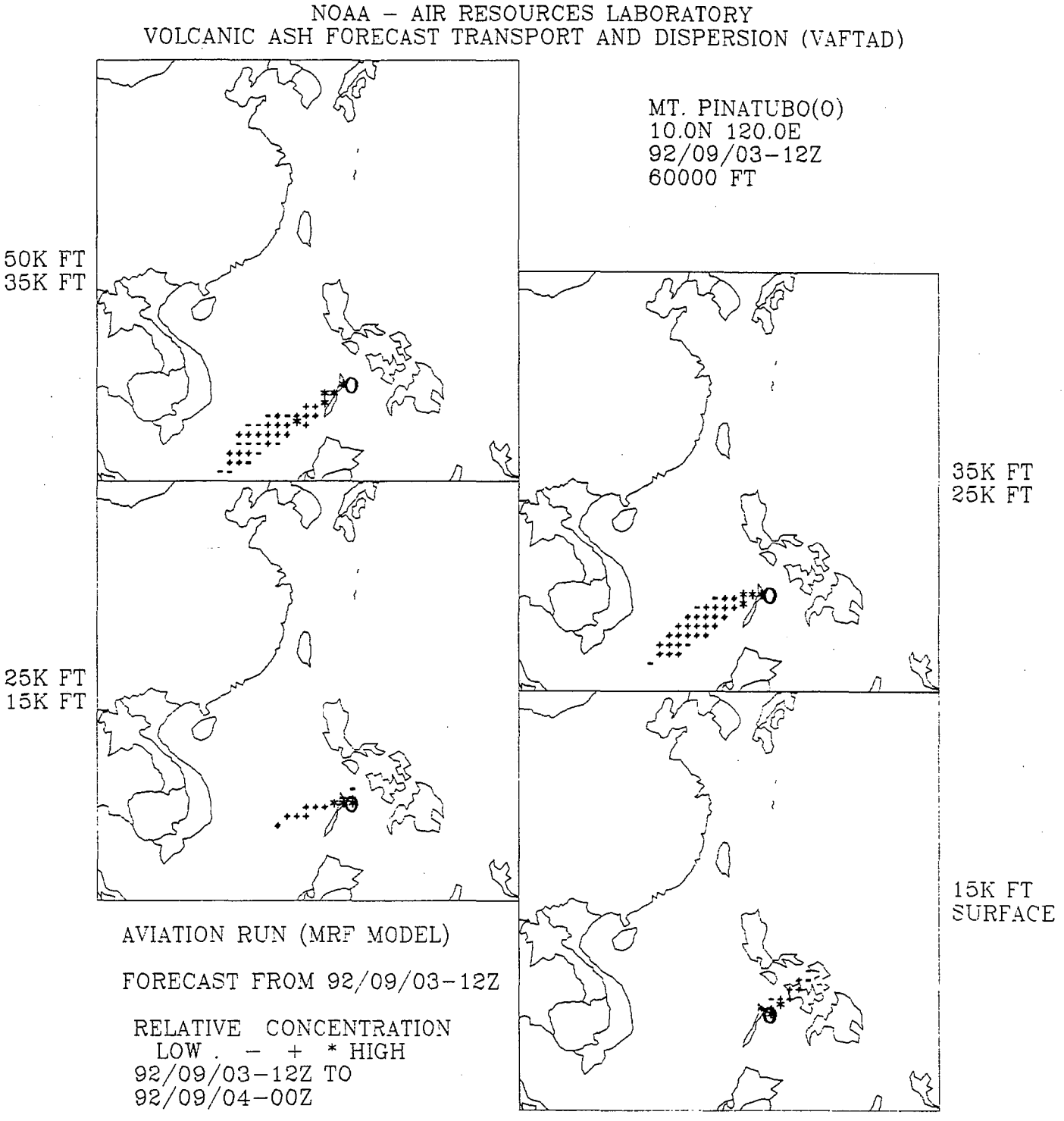


Figure 1a. VAFTAD model ash cloud output using the NGM gridded data. Heights in thousands of feet located to the side of each of the four vertical layer panels. Numbers in parentheses indicate: (1) Volcano name (2) Lat/Lon of Volcano (3) Eruption time (4) Ash cloud top (5) Input model data used (6) Initial time forecast began (7) Concentration scale (8) 12 hour forecast period data is valid for. **(b)** Same as (a), however for MT. Pinatubo using the AVN gridded data.

(b)


NOAA – AIR RESOURCES LABORATORY
VOLCANIC ASH FORECAST TRANSPORT AND DISPERSION (VAFTAD)
MT. PINATUBO(O)
10.0N 120.0E
92/09/03-12Z
60000 FT
50K FT
35K FT
35K FT
25K FT
25K FT
15K FT
15K FT
SURFACE
AVIATION RUN (MRF MODEL)
FORECAST FROM 92/09/03-12Z
RELATIVE CONCENTRATION
LOW . - + * HIGH
92/09/03-12Z TO
92/09/04-00Z

LOW	"	.	"	is			$< 10^{-18}$
	"	-	"	is	10^{-18}	to	10^{-16}
	"	+	"	is	10^{-16}	to	10^{-14}
HIGH	"	*	"	is	$> 10^{-14}$		

Table 1. Absolute ash concentrations (gm^{-3}) corresponding to the VAFTAD output symbols for an eruption mass loading of 1 gram (default).