



**PUFF – Volcanic Ash Dispersion Modeling
PUFF-AFWA Version 3.00
Support Plan Document**



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1 Introduction

1.1 Purpose

This document is the support plan document for the PUFF volcanic ash dispersion modeling programs, which predict the geographical distribution of volcanic ash from an eruption versus time. It provides an outline of the resources necessary to install, run, and evaluate the PUFF application system.

1.2 Background

PUFF is a volcanic ash dispersion prediction tool. PUFF was developed at the Geophysical Institute, University of Alaska Fairbanks and used by the Alaska Volcano Observatory (AVO) for volcano monitoring. Initially, PUFF was a research tool conceived by Dr. Hiroshi Tanaka for predicting the movement of eruption clouds. Dr. Craig Searcy conceived and developed the present version of PUFF as part of his PhD program. This version is used by the National Weather Service (NWS) and AVO to track volcanic eruption clouds.

Refinements in the Graphical User Interface (GUI) and data conversions were implemented by The Johns Hopkins University Applied Physics Laboratory (JHU/APL) in a joint project with the University of Alaska. JHU/APL is responsible for modifying the program and/or developing supporting utilities to facilitate its deployment at the Air Force Weather Agency (AFWA) site at Offutt AFB, NE. An additional responsibility is to develop a basic documentation set including this document. The system is currently in operation at the Air Force Weather Agency (AFWA).

1.3 Overview

The PUFF program models the dispersion of volcanic ash from an eruption and provides predictions of ash particle locations (latitude/longitude/altitude) versus time given eruption characteristics and wind field forecasts produced by another model. The PUFF application suite comprises five executable programs (puff, afwa2puff, puffgui, puffview, and ashdump) that provide the modeling capability; input data preprocessing; a graphical user interface (GUI) for model run specification; a GUI for viewing results; and utilities for viewing summaries of binary file contents. The application is written in C++, while the associated GUI functions are largely handled via the Tool Command Language (Tcl) scripts employing Toolkit (Tk) Motif widgets. The application suite can be hosted on Unix systems.

The PUFF model predicts the movement of ash particles ejected from a volcano versus time. The operator may select from a number of different initial conditions for the ash distribution and particle size. Particle locations are computed for each integration step (typically 5 minutes), with a snapshot of all particle locations at a given summation time (typically one or more hours) being written to an ash file.

For input, PUFF requires the name of a volcano, eruption characteristics, and forecasts of wind speeds for the time period of interest. The wind speed data must be available in gridded binary (GRIB) files. At AFWA, these required wind GRIB files are produced by a variety of models. PUFF's afwa2puff program converts the GRIB file outputs of the various wind models to U and V wind velocity versus geopotential height files. The U and V files serve as inputs for PUFF's volcanic ash tracking model. PUFF's puffview program displays a map of the area surrounding the volcano of interest overlaid with a graphical depiction of the ash distribution and overlaid with location identifier labels (pushpins). The PUFF volcanic ash tracking model outputs a series of ash files in Network Common Data (netCDF) format, describing the ash distribution over time.

The processes used in the model and an analysis of model results versus observations are given in “PUFF: A high-resolution volcanic ash tracking model,” (see reference 1).

1.4 Components

Table 1-1 identifies and provides a brief description of the roles of the PUFF application suite components.

Table 1-1 PUFF Suite Executables

Executable	Role
puff	Contains the volcanic ash dispersion model and is executed for each model run.
puffgui	GUI invoked by the operator and used to specify model parameters and select source wind data for use by the model; automatically invokes afwa2puff (wind data conversion), puff (model), and puffview (view results) as necessary.
puffview	GUI normally invoked automatically by puffgui following a model run. This displays a map of an area surrounding the volcano of interest overlaid with a graphical depiction of the ash distribution and overlaid with location identifier labels (pushpins).
ashdump	Utility normally invoked by puffview to extract data from the ash files produced during the model run. It can also be invoked from the command line by a knowledgeable operator to inspect ash data.
afwa2puff	Utility normally invoked by puffgui to convert wind speed data contained in gridded binary (GRIB) files into a form usable by the puff executable. Can also be invoked from the command line to automate source wind file creation.

1.5 Document Organization

Section 1 describes the scope of the PUFF application system.

Section 2 lists applicable references.

Section 3 provides an outline of the resources necessary to install, run, and evaluate the PUFF application system.

Sections 4-7 have evaluation and transition topics.

Section 8 provides a list of acronyms and abbreviations.

2 References

1. "PUFF: A high-resolution volcanic ash tracking model," Journal of Volcanology and Geothermal Research 80 (1998) pp1-16, Craig Searcy, Ken Dean, and William Stringer
2. "The WMO Format for the Storage of Weather Product Information and the Exchange of Weather Product Messages in Gridded Binary Form as used by NCEP Central Operations," Clifford H. Dey, U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service, National Centers for Environmental Prediction Office Note 388, GRIB (Edition 1), 10 March 1998.
3. "NetCDF User's Guide for C – An Access Interface for Self-Describing, Portable Data", Version 3, Russ Rew, Glenn Davis, Steve Emmerson, and Harvey Davies, Unidata Program Center, June 1997 - <http://www.unidata.ucar.edu/packages/netcdf/index.html>

3 Product Support Resources

3.1 Facilities

The PUFF software has been adapted for the AFWA facilities. No resources other than those listed in the following subsections will be required from these facilities.

3.2 Hardware

The PUFF software was developed for use on a SUN platform (see section 3.3 below for operating system requirements). For installation and operation of the software, access to a Sun platform with a color display, approximately 9 MB of disk space for software, 600 MB of disk space for test data and a CD drive for installation is required.

3.3 Software

The PUFF software was developed on and runs on the SUN computer under the Solaris operating system. An ANSI compliant compiler with STL (Standard Template Library) support is required (e.g. g++ 3.2.2).

Puff also requires the following "freeware" utility software to be available and to reside at /opt/production/upos/local/software/sun4 or be in the path:

GMT3.2	Generic mapping tool, used to draw postscript maps
ImageMagick-4.1.2	Used to convert to and from PS and bitmapped maps
Tix4.1.0	Tcl extensions support
blt2.4h	Widget set for tcl, used to graph widget in puffview
cmapf-c1.0	Used to convert from MM5 grids to lat/lon, and other projections
gs	(ghostscript) and supporting files
netcdf-3.4	netcdf support
tcl8.0.5	Tcl
tcl8.0.5-static	Tcl (static means you have to recompile it when it changes)
tk8.0.5	Tcl extension support
tk8.0.5-static	Tcl extension support

There are possible incompatibilities that may arise from version differences in the operating systems and the utility software. We do not expect problems arising from operating system minor version differences, as very few operating system services are used.

3.4 Data

The software supports AVN, NOGAPS, and MM5 input wind data files. These wind data files must be available for testing and evaluation. The format of wind data files is described in 'GRIB' see reference 2.

3.5 Personnel

3.5.1 Personnel required for installation

The installation process is expected to take less than 1 day. We request that the UNIX system administrator be responsible for the installation process. During this time, access to the individual(s) that will be evaluating the software will be required. The APL Transition Team will be available during this period, via email or telephone, to answer questions or troubleshoot.

3.5.2 Personnel required for evaluation

We recommend that one person be assigned to the evaluation at a level of effort conducive to the desired level of intensity of the evaluation. This person should be competent to evaluate the output of the software.

3.6 Error Handling

Currently, the error reporting mechanisms in the software displays errors in popup windows and in error log files along with additional information.

4 Recommended Procedures for Operation

The software as delivered is designed to run with human intervention. Default options are contained in the setup files (puff.args, puffview.args, ashdump.args, volcanos.txt, pushpins.txt, and pushpins.cfg). These can be edited by the user. Dynamically the user can respecify these options and set other options by the use of command line parameters or by making selections with a GUI window.

Note that if puff.args, puffview.args, or ashdump.args are modified, the PUFF program must be recompiled. With changes to volcanos.txt, pushpins.txt, or pushpins.cfg, the user only needs to restart PUFF.

5 Training

At the time of installation, the person(s) at AFWA conducting the evaluation will be shown how to operate the software. They will be able to ask questions while we are present or by phone or email after the installation team has left.

6 Anticipated Areas of Change

Configurable options that may change are contained in the user editable areas referenced in section 4, and thus can be made by AFWA personnel. Additional software changes can be made through the UPOS transition team's corrective action process. Contact JHU/APL to initiate the corrective action process.

7 Evaluation and Transition

The software is being delivered to AFWA for the purpose of evaluation. We will make resources available to support the evaluations conducted at AFWA. Additional requirements, documentation and training may be negotiated as a result of the evaluation. A UNIX system administrator will need to be available to monitor the installation and the acceptance testing for the 3.00 version of the PUFF software system. The details for installing the system can be found in the PUFF installation Procedures document.

8 APPENDIXES

APPENDIX A – Acronyms and Abbreviations

AACGM	Attitude Adjusted Corrected Geomagnetic
ACE	Advanced Composition Explorer
AFCCC	Air Force Combat Climatology Center
AFOSR	Air Force Office of Scientific Research
AFRL	Air Force Research Laboratory
AFSCN	Air Force Satellite Control Network
AFSPACECOM	Air Force Space Command
AFSWC	Air Force Space Weather Center
AFWA	Air Force Weather Agency
AFWIN	Air Force Weather Information Network
AF/XOW	Air Force Director of Weather
APL	Applied Physics Laboratory of Johns Hopkins University
ASCII	American Standard Code for Information Interchange
ASPAM	Atmospheric Slant Path Analysis Model
AVHRR	Advanced Very High Resolution Radiometer
AVN	Aviation Model
AVO	Alaska Volcano Observatory
BATS	Biosphere-Atmosphere Transfer Scheme
CLASS	Canadian Land Surface Scheme
CME	Coronal Mass Ejections
COE	Common Operating Environment
DII	Defense Information Infrastructure
DMSP	Defense Meteorological Satellite Program
Dst	Disturbance, storm
ECMWF	European Center for Medium-Range Weather Forecasts
EIT	Extreme Ultraviolet Imaging Telescope
EVA	Extravehicular Activities
FAC	Field Aligned Currents
FNMOC	Fleet Numerical Meteorology and Oceanography Center
FSL	Forecast Systems Laboratory
FTP	File Transfer Protocol
GDS	Grid Description Section
GI	Geophysical Institute
GIC	Ground Induced Currents
GIF	Graphic Interchange Format
GIT	Georgia Institute of Technology
GMT	Generic Mapping Tools
GOLD	Geophysical On-Line Data
GOES	Geostationary Operational Environment Satellite
GRIB	Gridded Binary
GSE	Geocentric Solar-Ecliptic
GSFC	Goddard Space Flight Center

GUI	Graphical User Interface
HLBL	High Latitude Boundary Layer
IDL	Interactive Data Language
IMF	Interplanetary Magnetic Field
ISS	International Space Station
JHU	Johns Hopkins University
JHU/APL	Johns Hopkins University/Applied Physics Laboratory
Kp	Planetary Index of Geomagnetic Activity
LAN	Local Area Network
LAPS	Local Analysis and Prediction System
LASCO	Large Angle Spectroscopic Coronagraph
LEO	Low-attitude Earth Orbit
LSM	Land Surface Model
MATCH	Model of Atmospheric Transport and Chemistry
MeV	Million Electron Volts
MM5	Fifth Generation Mesoscale Model
NASA	National Aeronautics and Space Administration
NCAR	National Center for Atmospheric Research
NCEP	National Centers for Environmental Prediction
netCDF	Network Common Data Form
NGDC	National Geophysical Data Center
NGM	Nested Grid Forecast Model
NOAA	National Oceanic and Atmospheric Administration
NOGAPS	Navy Operational Global Atmospheric Prediction System
NRL	Naval Research Laboratory
NWP	Numerical Weather Prediction
NWS	National Weather Service
OWS	Operational Weather Squadron
PACE	Polar Anglo-American Conjugate Experiment
PBL	Planetary Boundary Layer
PCA	Polar Cap Absorption
PDS	Product Definition Section
PFRR	Poker Flat Research Range
PNG	Portable Network Graphics
PUFF	From Puff the Magic (ash spewing) Dragon
RBE	Radiation Belt Environment
SAA	South Atlantic Anomaly
SABER	Sounding of the Atmosphere using Broadband Emission Radiometry
SD	Space Department of the Applied Physics Laboratory
SDP	Software Development Plan
SEC	Space Environment Center
SEE	Solar EUV Experiment
SEON	Solar Electro-optical Observing Network
SEP	Solar Energetic Particles
SFOC	Space flight Operations Center

SOHO	Solar and Heliospheric Observatory
SPE	Solar Particle Event
STP	Solar Terrestrial Physics
SWOC	Space Weather Operations Center (Offutt)
SWXS	Space Weather Squadron
SXI	Soft X-ray Imager
Tcl	Tool Command Language
Tk	Toolkit
Tix	Tk Interface Extension
UAF	University of Alaska, Fairbanks
UCAR	University Corporation for Atmospheric Research
UCB	University of Colorado, Boulder
UPOS	University Partnering for Operational Support
UTC	Coordinated Universal Time
WDC	World Data Center
WF	Weather Flight
WMO	World Meteorological Organization
XDR	External Data Representation