VAAC Operational Dispersion Model Configuration Snap Shot

Version 2

March 2016

Introduction

The VAACs are responsible for producing volcanic ash cloud analysis and forecasts to assist the aviation community in planning their operations and minimising risk. This function requires that the VAACs fuse volcanic activity and cloud observations, numerical weather prediction data and dispersion models and associated science within the process of producing the advisory.

The volcanic ash advisory consists of an analysis (T+0) and 18 hours of forecast. In recent times the aviation community has also requested, in an ad-hoc manner, that the VAACs or their supporting organisations provide longer-range forecasts out to T+24, T+36 and further.

Forecasting naturally requires the use of models. All VAACs use highly complex dispersion models to provide the basis of the forecast guidance that they issue. This note is intended to act a snap shot in time of the operational configuration of the VAAC dispersion models. This is therefore NOT and should NOT be used as guide to actual model capability as operational demands i.e. lack of reliable information, speed, etc dictate that certain functionality not be used.

For clarity the model set-up's are presented in a series of tables. It is however noted that the table format may limit the scope to explain more complex aspects. To aid in this there is a short description of certain elements preceding the tables, however for a full model description the reader is directed to the wider literature and documentation that is available.

Background

These tables were first compiled as part of the VAAC Best Practice process for the VAAC 'Inputs and Outputs' Modelling Workshop held at NCEP, Washington in November 2012.

Version 1 (Nov 2012) of this 'Snap Shot' document was part of the full Workshop report.

This document and these tables will be periodically updated, as part of the VAAC Best Practice process with the aim of stimulating discussion on operational practice and model utilisation.

This document represents the second version of this summary and was compiled in March 2016.

Current Operational Modelling Configuration

All VAACs, listed below, provided detailed written descriptions of their current operational modelling configurations.

- London VAAC
- Washington VAAC
- Anchorage VAAC
- Montreal VAAC
- Buenos Aires VAAC
- Darwin VAAC
- Toulouse VAAC
- Tokyo VAAC
- Wellington VAAC

Current Model Operational Configurations

This section contains tables summarising the VAAC's current **operational** model settings.

In order to present this information in such a concise form then 'default' or 'typical' settings may have been used. Where practical, note has been made where more 'advanced' operational user options are possible.

Preceding the tables are some brief notes summarising observations made during the compilation of these tables. These notes are not exhaustive and are intended only to aid the VAACs.

Point that could be expanded on in future snap shots:

- Source characterisation table "Ability to add in a distal 'plume' as a source" – Is this done using a concentration or not? The question relates to how the onward model forecast is interpreted i.e. even qualitative output involves contouring some value which is intrinsically linked to any input amount.

- Source characterisation table "Emitted parameter" – clarity is needed if total MER or a fraction and if so what fraction is emitted and over what particle size distribution.

- Species properties table "Non-Sphericity" – where non-sphericity is used it would be useful to note what value is used.

- Computational Details – while extrapolated times are given for ensembles, the practicality of performing them is dependent on a range of other factors. Ensembles represent a useful means of representing uncertainty in the forecast. Exploring options, scope and defining good practice for using ensembles would be a useful action.

- NWP Data Used by VAAC Dispersion Models – several changes have occurred at the VAACS resulting in improved NWP data being used. Work on understanding the relevant accuracy of the NWP data is needed in order to understand this source of uncertainty.

Source Characterization

Source term	London	Darwin	Buenos Aires	Montreal	Tokyo	Toulouse	Washington + Anchorage	Wellington
Horizontal location at source	Smithsonian Institution. Can be varied.	Smithsonian Institution. Can be varied.	Estimated from satellite imagery (hot spot) and corroborated using VORHISE (*)	Smithsonian Institution. Can be varied.	Smithsonian Institution. Can be varied.	A list of active volcanoes on Toulouse VAAC AoR with SI data, Can be varied	Smithsonian Institution. Can be varied.	Smithsonian Institution. Can be varied
Horizontal dimensions/ geometry at source	Δx=Δy=0	Δx=Δy=0	Grid node	Default radius =1 km but can be varied	Diameter = 0.4 x height above crater.	Δx=Δy= 2 deg. 4 x 4 grid cells used with non-uniform horizontal distribution.	Δx=Δy=0	Δx=Δy=0
Ability to add in a distal 'plume' as a source	No	No (functionality is included in Visual Weather interface but not operational)	No	Manual delineation of distal ash cloud used to initialize dispersion model. Includes definition of polygon boundaries, base and top.	When volcanic ash is detected from satellite image, a polygon drawn manually is used as horizontal geometry at the top of the ash.	No	Modelled ash may be horizontally moved or removed.	No
Bottom of source at volcano	Height of the vent taken from Smithsonian Institution. May be edited or bottom set to observed plume base	Height of the vent taken from Smithsonian Institution.	VORHISE (Summit?)	Height of the vent taken from Smithsonian Institution.	Crater >= 3,000 source bottom = crater; Crater < 3,000m & source top >= 10,000m, source bottom = 5,000m; Crater < 3,000m and source top < 10,000m, the bottom = 1,000m.	Height of vent/summit. May be edited.	Height of the vent taken from Smithsonian Institution.	Height of the vent.
Top of source	Based on observations	Based on observations	Based on observations	Based on observations	Based on observations	Based on observations	Based on observations	Based on observations
Vertical distribution	Uniform	Uniform	Suzuki distribution	Uniform by default, but other fixed distributions (e.g. umbrella, etc.) can be specified as well.	Suzuki distribution for plume. Uniform for manual cloud.	Uniform	Uniform	Uniform
Emitted parameter	Fraction of MER (g/hr) from Mastin or real MER value (g/hr)	MER of unit 1	Total MER (g/hr) from Woodhouse	Fraction of total MER from Sparks et al. (1997) or Mastin et al. (2009)	Total mass specified according to fourth power of plume height and duration	Fraction of MER from Mastin (g/hr)	MER of unit 1 (total)	Fraction of MER kg/s from Mastin et al 2009
Multiple Eruption phases	Yes	No	Yes	Yes	No	Yes	Yes	No

(*) VORHISE: Volcano Data Base, includes local characterization, and other sources (Smithsonian- Sernageomin- Bristol University- National Geographic Institute of Argentina)

Species Properties

Species Information	London	Darwin	Buenos Aires	Montreal	Tokyo	Toulouse	Washington + Anchorage	Wellington
Particulate (P) or Gas (G)	P	P	P	P	P	P	P	P
Single size (S), Particle Size Distribution (PSD)	PSD	PSD	PSD	N/A; S, PSD	PSD	S, PSD	PSD*	PSD
PSD range (micro metres)	Default of 0.1-100; Can be varied if data available.	0.1 - 100	Based on eruption type. Usually 8 to 1 phi: 3.9 - 500	N/A; Several options	10.0 - 100	0.1 - 100	0.6 - 20	0.65 - 65
Number of bins	6 continuous	6 discrete	Based on eruption type. Usually 6	N/A; Several options	80	6	4 discrete	5 discrete
Density (kg/m3)	2300	2300	Based on eruption type. Usually 1000-2200	N/A; 2500	1900-2300[1]	2300	2500	2500
Non-Sphericity	No	Yes	Yes	N/A; No	Yes	No	No	No

Greyed out text indicate user selectable but non-default options.

Montreal VAAC's default option is to model volcanic ash as a non-sedimenting particle (i.e. is not subject to gravitational settling) Several default characteristic are therefore marked as N/A as they are not applicable in this situation. Montreal VAAC is able to model, as user selectable options, a number of particle characteristics and these are indicted in grey.

Washington/Anchorage has an option to remove any of the 4 particle size bins, at downwind times, not at the start of the eruption. See above "Ability to add in a distal 'plume' as a source"

1 Dependent on particle size.

NWP Data Used by VAAC Dispersion Models

	London	Darwin	Buenos Aires		Montreal	Tokyo	Toulouse	Washington + Anchorage	Wellington
NWP data source name	MetUM	ACCESS-G (APS2), ACCESS-R (APS1)	ETA/SMN (For FALL3D)	GFS 1 degree (For HYSPLIT)	GDPS (Global), RDPS (Regional), HRDPS (High Resolution)	JMA GSM	ARPEGE; IFS	GFS/GDAS; NAM option	GFS, IFS, WRF-ARW
Temporal resolution used (hours)	3	3	3	3	3, 1 option	3	3	3	3, 3, 1
Horizontal resolution (Lon,Lat)	0.234 x 0.156 deg	~ 40 km; ~ 12 km	25 km	~ 13 km	25; 10; 2.5 km	0.1875 x 0.1875 deg	0.5, 0.5 deg	0.5 deg; 0.5 deg; 12 km	0.5 deg; 0.125 deg; 4 km
Horizontal extent (Global, Regional)	G	G; R	R	G	G; R; R	G	G	G; R; R	G; G; R
Vertical levels used	59	71; 61	38	26 pressure levels	30 (58 possible)	100	28; 20	56; 26	27; 11; 51
Max altitude	~30 km asl	~ 80 km asl	25 hPa (~30 km)	10 hPa (~31 km)	~21 km; (~32 km)	0.01 hPa (~85 km)	10 hPa (~30 km)	13 hPa (~ 28 km); 50 hPa; 50 hPa (~21 km)	10 hPa (~ 30 km)
NWP forecast length (hours)	144	240	72	24 (Run at 00 UTC)	144/240; 48/54; 48	84 or 264	84; 84 or 180	384 total (84-hr at 0.5 deg, then 1 deg res); 48	192; 240; 60
Update frequency (hours)	12	6	12	24	12; 6; 6	6	12	6	6; 12; 6

VAAC BUENOS AIRES has an operational dispersion model FALL3D forced by the NWP called ETA/SMN and also runs remotely the Hysplit model at ARL website.

Dispersion Model Processes

	London	Darwin	Buenos Aires	Montreal	Tokyo	Toulouse	Washington + Anchorage	Wellington
Dispersion model name	NAME III	HYSPLIT	Fall3D	MLDP0n	JMA GATM	MOCAGE Accident	HYSPLIT	HYSPLIT
Wet deposition	Yes	No	No	Yes (In cloud only)	Yes (In cloud only)	Yes	Yes, option to turn off	Yes
Sedimentation	Yes	Yes	Yes	No; Optional	Yes	Yes	Yes	Yes
Gravitational settling	Reynolds number dependent + Cunningham	Ganser	Terminal (Ganser 1993)	N/A; Stokes	Terminal	Stokes	Stokes + Cunningham	Ganser
Dry deposition	Yes	Yes	Yes	Yes; Yes	Yes	Yes	Yes	Yes
Aggregation	No	No	No	No	No	No	No	No
Vertical winds	NWP	NWP	NWP	NWP	NWP	NWP	NWP	NWP

Greyed out text indicate user selectable but non-default options.

Dispersion Model Outputs

	London	Darwin	Buenos Aires	Montreal	Tokyo	Toulouse	Washington + Anchorage	Wellington
Output Resolution	40 km	0.1 deg	25 km	1-50 km	N/A	0.5 deg	0.25 & 0.1 deg	0.1 deg
Vertical layers	22 x 25FL deep layers (From 000 to FL550)	Layers in m (From FL000-550) in user defined increments	2D slice at: FL50, 100, 150, 200, 250, 300	SFC-FL200, FL200-350, FL350-600, SFC-FL600 7 x 2 km deep layers form SFC-14 km	Particle location (x, y, z) plots	15 pressure levels + FL000-200, 200-350, 350-550	3 layers in m. Approx: FL000-200, 200-350, 350-550.	FL50, 100, …350, 400
Exact FL	Yes	No	No (grid level approximation)	Yes	No	No (grid level approximation)	No	No
Quantity	g/m3, g/m2, base, top, age	g/m3, gm2	g/m3, g/m2	g/m3; g/m2	N/A	g/m3, g/m2	g/m3, with respect to unit source	g/m3, g/m2, base, top
Standard plotting projections	Lat/Lon - cylindrical	Lat/Lon - cylindrical	Lat/Lon	Orthographic; Others	Polar	lat/lon - Cartesian linear/cylindrical	Dependent on volcano latitude	lat/lon - cylindrical
Standard forecast length (hours)	120	24	72	72	18	84 - 180	48	24
Time interval	6 (3 hourly for first 9 hours)	1 (variable)	1	1 (Variable)	1	6 (1 hourly for first 24h)	1, 6 & 12	3
Time Ave (hours)	6 ending at valid time	1	1	1 ending at valid time (Same as output interval)	N/A (0)	0 (Eulerian Model)	1 ending at valid time	1
Standard model update frequency (re-run of disp. model)	6 hourly	6 hourly (variable)	12 hourly HYSPLIT every 6 hours.	6 hourly	6 hourly	6 hourly	6 hourly	6 hourly

Greyed out text indicate user selectable but non-default options.

Computational Details

	London	Darwin	Buenos Aires (FALL3D)	Montreal	Tokyo	Toulouse	Washington + Anchorage	Wellington
Run time	5 min, 30 min	5 min	30 min	5 min	5 min	20 min	~ 2 min dispersion model; 2 mins post-processing	5-30 min (running 9 member ensemble)
Forecast length (hours)	24, 120	24	72	72	18	84, 180	48	24
Platform	x86 Linux	X86 Linux	SGI Origin	IBM Power 7	HITACHI SR16000	x86 Linux	IBM AIX	x86 Linux
Parallel	Yes	No	Yes	Yes	No	Yes	Yes	No (Each ensemble member on own core though)
Cores	12	1	15	32	1	24	8	1 (8 for ensemble members)
Run Time for 24 hours (estimate from above)	5 min	5 min	10 min	1.5 min	6.5 min	5.5 min	1 min	5 min
Core time (run time * cores)	60	5	150	48	6.5	132	8	5

Model run times extrapolated for a 10 member ensemble.

Run time	~ 50 minuts (24 hour forecast), ~ 5 hr (120 hrs forecast)	~ 50 min	~ 2→5 hr	~ 20 min	~ 1 hr	~ 3 hr	~ 45 min	~ 30 min

Model run times vary depending on a number of factors including forecast duration and other model configuration options. The table above reports the current forecast duration and associated model run times at each of the centers. Due to the wide range of settings these times are not directly comparable. The ensemble times are a simple extrapolation of these times and are provided as a very crude indication of the increasing computer resource requirements that ensemble approaches may require. Decisions on exact ensemble forecast duration, number of members, model configurations and the ability to run multiple models simultaneously will mean that elapsed times vary considerably from those arrived at through such a simple extrapolation.