



HYSPLIT model description and operational set up for benchmark case study

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Workshop on Ash Dispersal Forecast and Civil Aviation
Geneva, Switzerland
October 18-20, 2010



HYSPLIT model

HYbrid Single-Particle Lagrangian Integrated Trajectory model

advection/diffusion
in Lagrangian
framework;
concentrations
calculated in Eulerian
framework

Default is 3-d particle ...
originally simulations began
with one particle (puff) that
split into multiple puffs with
time; then particles in
vertical, puffs in horizontal;

a single trajectory
represents the path of
one air parcel but does
not represent dispersion;
a set of trajectories
calculated with turbulent
wind components can
visually approximate
dispersion



HYSPLIT model

- separate trajectory and dispersion executables
- wide range of simulations related to atmospheric transport and dispersion of pollutants and hazardous materials, and deposition to the surface
- volcanic ash, radioactive material, wildfire smoke, dust, air pollutants, etc.
- used for volcanic ash forecasting by NOAA National Weather Service (NWS) in support of U.S. Volcanic Ash Advisory Centers
- can be run interactively on on ARL's READY (Real-time Environmental Applications and Display sYstem, <http://ready.arl.noaa.gov/>) web site, or it can be installed on a PC and run using a graphical user interface (GUI).
- input meteorology is 3-d, gridded, formatted in ARL/HYSPLIT-format
- HYSPLIT system includes template programs to convert meteorology to ARL/HYSPLIT format, and various output display and post-processing programs



HYSPLIT model

“Operational setup” here refers to the benchmark run,
not operations for U.S. VAAC

Main differences

- source term
- output averaging time
- for VAAC, model output is guidance



Input file: CONTROL (basic inputs)

00 02 26 18	←	Model run start time (Y M D H)
2		
63.98 -19.67 1500	}	← Latitude, Longitude
63.98 -19.67 12000		Vertical line source from 1.5 to 12 km
73	←	
0	←	Run duration
27000.	←	Meteorological model vertical velocity
1		
../metdata/ hekla_met.bin	←	Model top
8	←	1 meteorology file, ECMWF
p001		
6.9E12		
1.1667		
00 02 26 18 20	}	8 particle size bins
cont...		
		first bin labeled "p001"
		Emission rate 6.9E12 mg/h
		Emission duration (1 h 10 min)
		Emission start (Y M D H M)



Input file: CONTROL

cont...

p002

1.56E13

1.1667

00 02 26 18 20

p004

1.90E13

1.1667

00 02 26 18 20

p008

2.25E13

1.1667

00 02 26 18 20

p016

7.95E13

1.1667

00 02 26 18 20

p032

2.92E14

1.1667

00 02 26 18 20

p062

3.60E15

1.1667

00 02 26 18 20

p125

3.84E15

1.1667

00 02 26 18 20

Particle bins 2-8, each with own mass emission rate



Input file: CONTROL

cont.

3

65.0 -19.0

0.10 0.10

4.0 12.0

./

cdump_dep_0p1

1

0

00 02 26 18 20

00 00 00 00 00

0 12 00

cont.

3 output concentration/deposition grids

Center latitude, longitude

Spacing lat, lon

Span

Output filename

Number of output levels

Height (0 for deposition)

Sample start time

Sample end time

0=average; hour, minutes of average



Input file: CONTROL

cont.

70.0 0.0

0.25 0.25

90. 180.

./

cdump_conc_6h

4

3048 6096 9144 10668

00 02 26 18 20

00 00 00 00 00

0 6 00

75.0 -5.0

0.25 0.25

5. 5.

./

cdump_conc_vert_0p25

11

1000 2000 3000 4000 5000 6000 7000 8000 9000 10000 11000

00 02 27 21 20

00 02 28 11 20

0 2 00

Output grid #2

6-hourly output

4 levels (FL100, 200, 300, 350)

Output grid #3

2-hourly

11 levels



Input file: CONTROL

cont.

8

1.0 2.6 1.0

0.0 0.0 0.0 0.0 0.0

0.0 0.0 0.0

0.0

0.0

For each of 8 particle size bins

- particle diameter (microns), density, shape factor
- dry deposition velocity, molecular weight, etc.
- wet deposition constants
- half-life
- resuspension



Input file: CONTROL

cont.

8

1.0 2.6 1.0

0.0 0.0 0.0 0.0 0.0

0.0 0.0 0.0

0.0

0.0

For each of 8 particle size bins

- particle diameter, density, shape factor
- dry deposition velocity, molecular weight, etc.
- wet deposition constants
- half-life
- resuspension

1.9 2.6 1.0

3.9 2.6 1.0

7.8 2.6 1.0

15.6 2.3 1.0

31.25 2.1 1.0

62.5 1.8 1.0

125. 1.6 1.0

Rest of particle size bins (maximum 125 microns)



Input file: SETUP.CFG (model configuration, additional inputs)

&SETUP

initd = 0,

numpar = 30000,

isot = 1,

kmsl = 1,

ndump = 6,

ncycl = 6,

poutf = 'PARDUMP',

/

3-d particle simulation

Number of particles

Turbulence flag

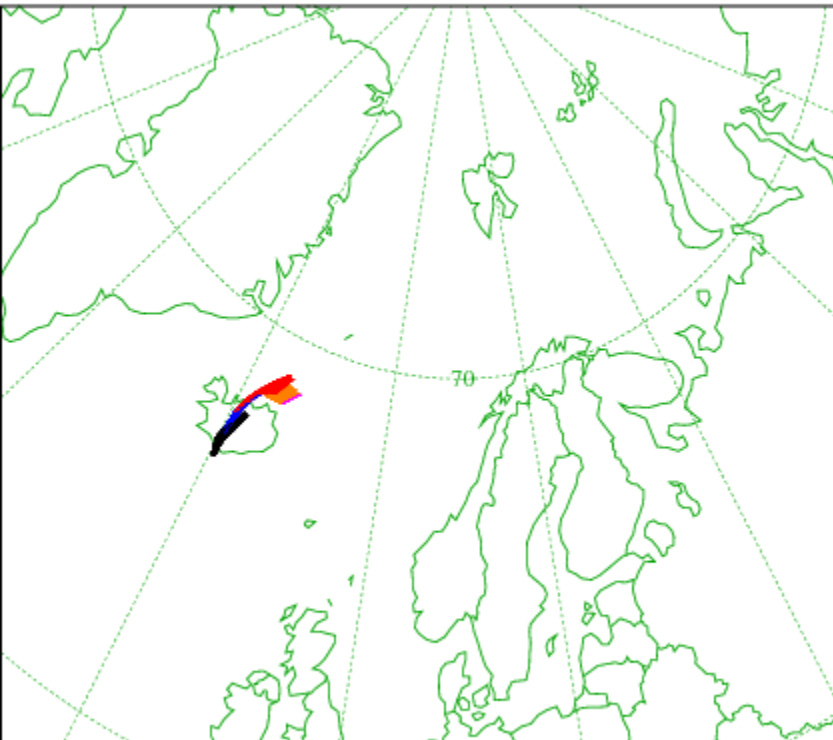
Input heights above sea level

Particle output file

Benchmark results – particle positions, concentrations

NOAA HYSPLIT MODEL

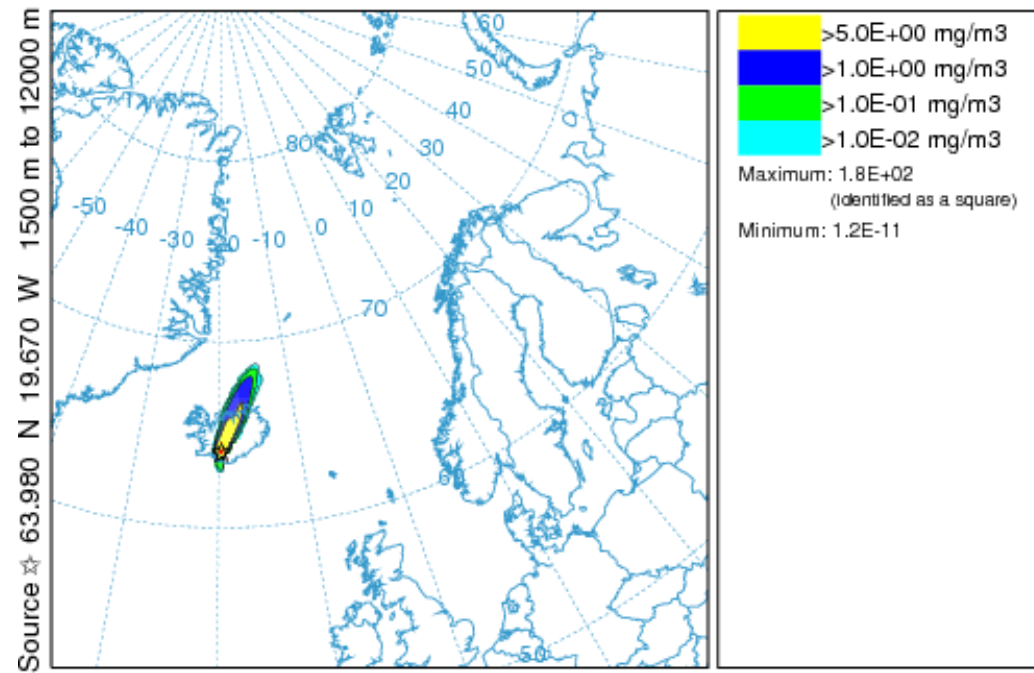
PARTICLE POSITIONS AT 00 UTC 27 Feb 00



LAYER (m): < 3000 < 6000 < 9000 < 12000 < 15000
 NUMBER OF PARTICLES ON GRID: 28301

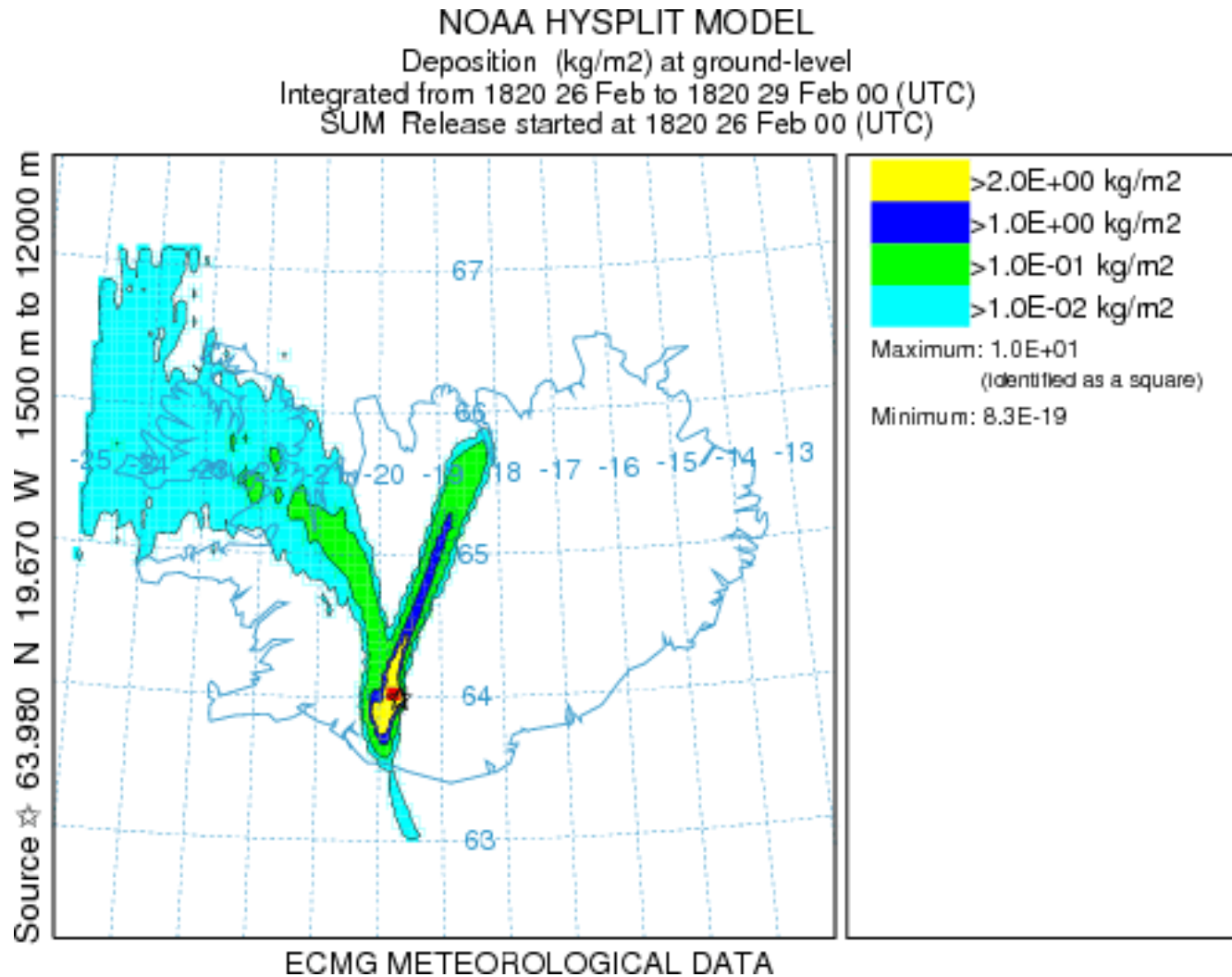
NOAA HYSPLIT MODEL

Concentration (mg/m³) averaged between 0 m and 10668 m
 Integrated from 1820 26 Feb to 0020 27 Feb 00 (UTC)
 SUM Release started at 1820 26 Feb 00 (UTC)



ECMG METEOROLOGICAL DATA

Benchmark results - deposition





Thank you



Extra info . . .



HYSPLIT model features

- Predictor-corrector advection scheme
- Linear spatial & temporal interpolation of meteorology from external sources
- Vertical mixing based upon SL similarity, BL Ri, or TKE
- Horizontal mixing based upon velocity deformation, SL similarity, or TKE
- Puff and particle dispersion computed from velocity variances
- Concentrations from particle-in-cell or top-hat/Gaussian distributions
- Multiple simultaneous meteorology and/or concentration grids