NAME III (v1.3) Validation: Hekla February 2000 Eruption

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Introduction

This note briefly records the comparison of results from NAME III version 1.3 with those from NAME and from satalite imagry of the Hekla February 2000 eruption.

The eruption, starting at 18:17 UTC 26/02/00, was modelled as a 2 hour release. The source was represented as a vertical line extending from model ground level up to 11000 m above sea level. The pollutant was inert and neutrally buoyant. Nested regional (3 hourly) and global (6 hourly) met data are used. Unfortunately different release rates were used in the NAME and NAME III runs and therefore quantitative comparison of the concentrations is not possible at this time; however the spatial and temporal distribution of the plumes can be compared.

The complete NAME III input file has been included in Annex A.

Both runs were carried out on a 2.4 GHz Pentium PC running the Intel compiler under Linux. Table 1 shows the run times and memory usage for both NAME and NAME III.

Model	Run Time (seconds)	Memory (Mb)
NAME	4657	280
NAME III	4783	201

Table 1: Model run time and memory usage comparison.

Results

Figures 1 to 5 display concentrations output at 5 levels centered at 250, 2250, 4500, 7500 and 10500 m above sea level. The vertical depth of the layers is 500, 1500, 3000, 3000, 3000 m respectively. These figures show broad agreement with the NAME output shown in Figures 6 to 10. There are some noticeable differences but these are believed mainly due to the differences between using a tracer as done here and using volcanic ash, which has settling characteristics, as done in the NAME runs.

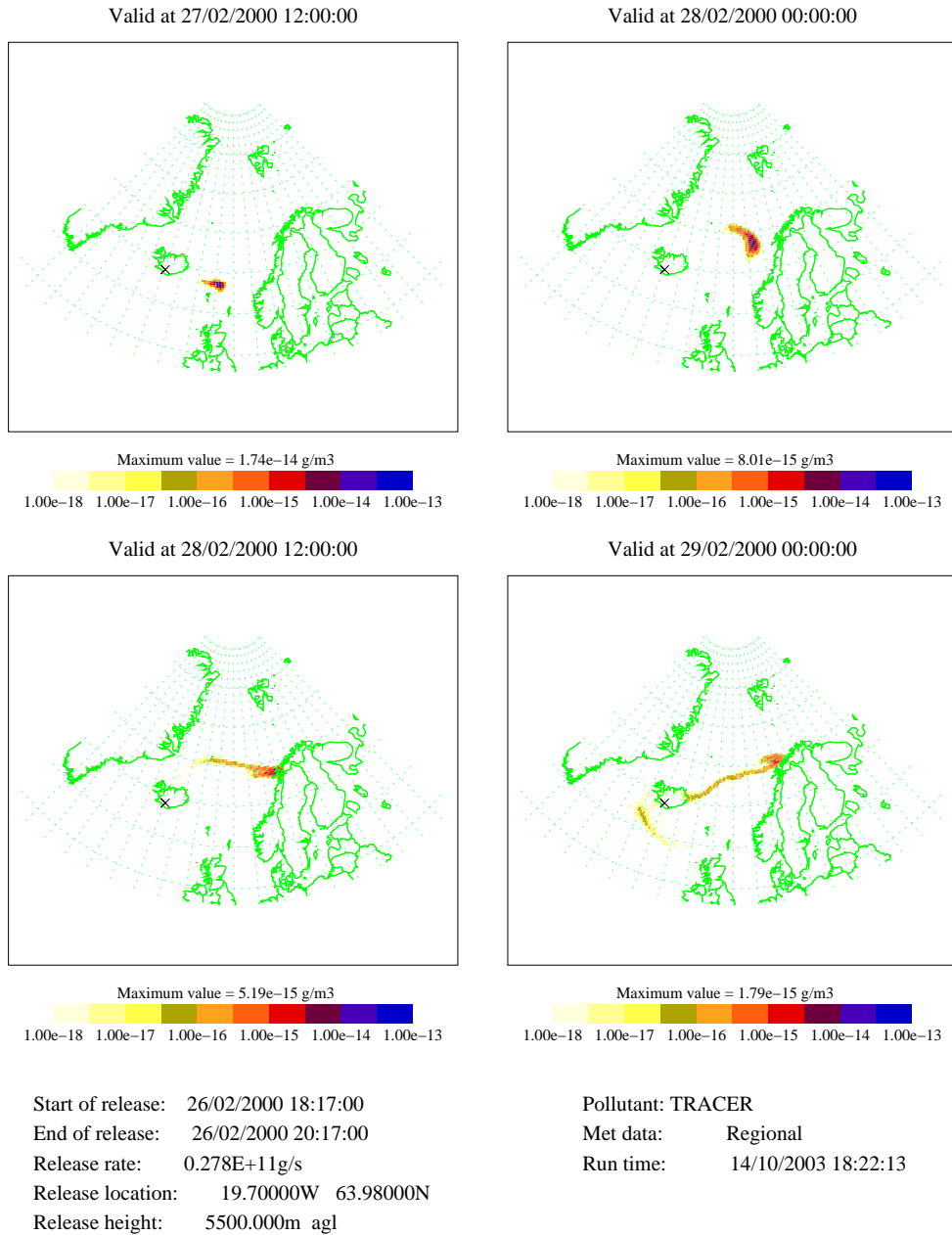Figure 11 shows TOMS (Total Ozone Mapping Spectrometer) imagery for 20:00 on 27/02/00 coinciding with the higher levels of results plotted from NAME III. TOMS uses an ultraviolet spectrum system which detects sulfur dioxide (SO 2) gas and provides volcanic cloud position data globally about once per day during daylight hours only. The general agreement is clear indicating that the model is performing sensibly.

A further source of information regarding this eruption originates from the instruments carried on board a NASA research plane that encountered the ash plume at 05:08 28/02/00 until 05:15. The plane was at 76.0° N 0.0 E flying at 37000 ft (11278 m). Figure 12 presents a time series plot from a volume located at 76.0° N 0.0 E with $\Delta x = 0.5°$ and $\Delta y = 0.3°$ at $z = 11250.0$ m $\Delta z = 500.0$ m. As can be seen the model correctly predicts the presence of the plume at this location during this time.

NAME III (version 1.3)

NAME III

Air Concentration: Output at 250.0000m asl

Valid at 27/02/2000 12:00:00

Maximum value = 1.74e−14 g/m3

1.00e−18 1.00e−17 1.00e−16 1.00e−15 1.00e−14 1.00e−13

Valid at 28/02/2000 00:00:00

Maximum value = 8.01e−15 g/m3

1.00e−18 1.00e−17 1.00e−16 1.00e−15 1.00e−14 1.00e−13

Valid at 28/02/2000 12:00:00

Maximum value = 5.19e−15 g/m3

1.00e−18 1.00e−17 1.00e−16 1.00e−15 1.00e−14 1.00e−13

Valid at 29/02/2000 00:00:00

Maximum value = 1.79e−15 g/m3

1.00e−18 1.00e−17 1.00e−16 1.00e−15 1.00e−14 1.00e−13

Start of release:	26/02/2000 18:17:00	
End of release:	26/02/2000 20:17:00	
Release rate:	0.278E+11g/s	
Release location:	19.70000W 63.98000N	
Release height:	5500.000m agl	

Pollutant: TRACER

Met data: Regional

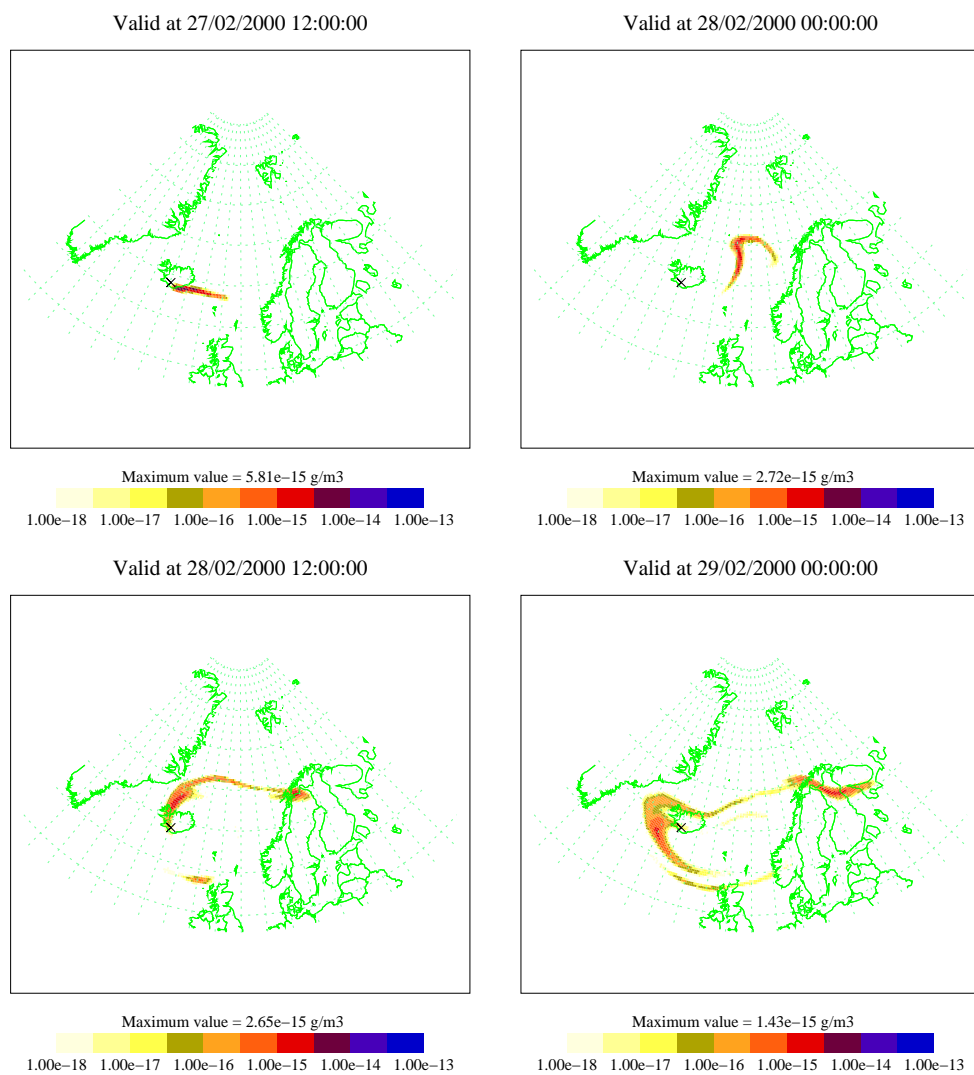Run time: 14/10/2003 18:22:13

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Figure 1: NAME III output for Hekla February 2000 eruption. Output grid $\Delta z = 500$ m centered at $z = 250$ m.

NAME III (version 1.3)

NAME III

Air Concentration: Output at 2250.000m asl

Valid at 27/02/2000 12:00:00   Valid at 28/02/2000 00:00:00

Maximum value = 5.81e−15 g/m3   Maximum value = 2.72e−15 g/m3

1.00e−18 1.00e−17 1.00e−16 1.00e−15 1.00e−14 1.00e−13

Valid at 28/02/2000 12:00:00   Valid at 29/02/2000 00:00:00

Maximum value = 2.65e−15 g/m3   Maximum value = 1.43e−15 g/m3

1.00e−18 1.00e−17 1.00e−16 1.00e−15 1.00e−14 1.00e−13

Start of release:	26/02/2000 18:17:00	
End of release:	26/02/2000 20:17:00	
Release rate:	0.278E+11g/s	
Release location:	19.70000W 63.98000N	
Release height:	5500.000m agl	

Pollutant: TRACER

Met data: Regional

Run time: 14/10/2003 20:55:18

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Figure 2: NAME III output for Hekla February 2000 eruption. Output grid $\Delta z = 1500$ m centered at $z = 2250$ m.
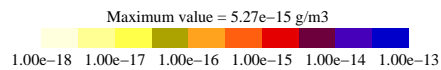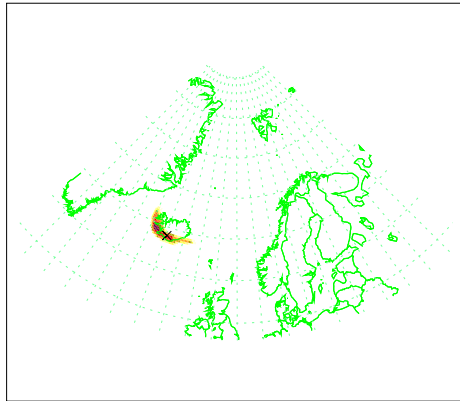
NAME III (version 1.3)

NAME III

Air Concentration: Output at 4500.000m asl

Valid at 27/02/2000 12:00:00

Maximum value = 5.27e−15 g/m3

1.00e−18 1.00e−17 1.00e−16 1.00e−15 1.00e−14 1.00e−13

Valid at 28/02/2000 00:00:00

Maximum value = 2.32e−15 g/m3

1.00e−18 1.00e−17 1.00e−16 1.00e−15 1.00e−14 1.00e−13

Valid at 28/02/2000 12:00:00

Maximum value = 1.40e−15 g/m3

1.00e−18 1.00e−17 1.00e−16 1.00e−15 1.00e−14 1.00e−13

Valid at 29/02/2000 00:00:00

Maximum value = 1.26e−15 g/m3

1.00e−18 1.00e−17 1.00e−16 1.00e−15 1.00e−14 1.00e−13

Start of release:	26/02/2000 18:17:00	Pollutant: TRACER
End of release:	26/02/2000 20:17:00	Met data: Regional
Release rate:	0.278E+11g/s	Run time: 27/10/2003 10:47:19
Release location:	19.70000W 63.98000N	
Release height:	5500.000m agl	

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Figure 3: NAME III output for Hekla February 2000 eruption. Output grid $\Delta z = 3000$ m centered at $z = 4500$ m.
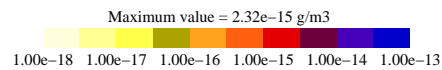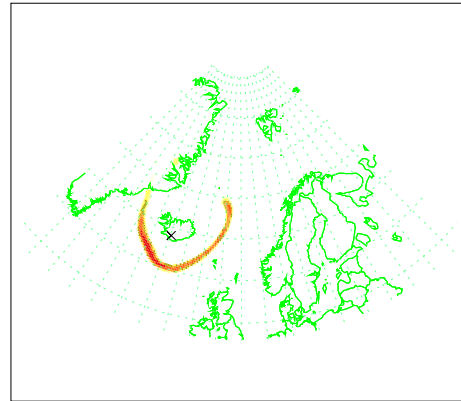
NAME III (version 1.3)
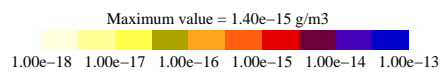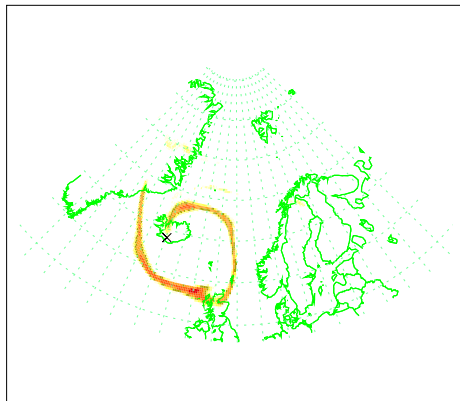
NAME III

Air Concentration: Output at 7500.000m asl

Valid at 27/02/2000 12:00:00

Valid at 28/02/2000 00:00:00

Maximum value = 3.37e−15 g/m3

1.00e−19 1.00e−18 1.00e−17 1.00e−16 1.00e−15 1.00e−14

Maximum value = 1.17e−15 g/m3

1.00e−19 1.00e−18 1.00e−17 1.00e−16 1.00e−15 1.00e−14

Valid at 28/02/2000 12:00:00

Valid at 29/02/2000 00:00:00

Maximum value = 7.49e−16 g/m3

1.00e−19 1.00e−18 1.00e−17 1.00e−16 1.00e−15 1.00e−14

Maximum value = 4.96e−16 g/m3

1.00e−19 1.00e−18 1.00e−17 1.00e−16 1.00e−15 1.00e−14

Start of release:	26/02/2000 18:17:00	
End of release:	26/02/2000 20:17:00	
Release rate:	0.278E+11g/s	
Release location:	19.70000W 63.98000N	
Release height:	5500.000m agl	

Pollutant: TRACER	
Met data:	Regional
Run time:	14/10/2003 23:27:33

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Figure 4: NAME III output for Hekla February 2000 eruption. Output grid $\Delta z = 3000$ m centered at $z = 7500$ m.

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NAME III (version 1.3)

NAME III

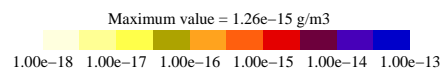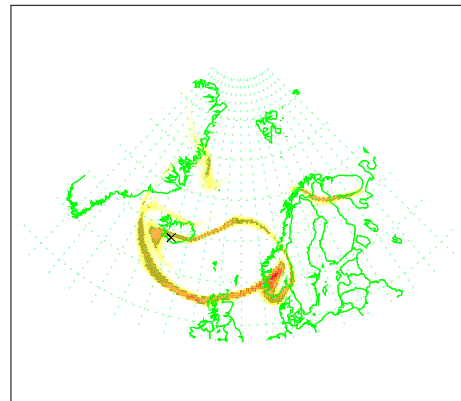## Air Concentration: Output at 10500.00m asl

Valid at 27/02/2000 12:00:00

Maximum value = 1.18e−15 g/m3

1.00e−19 1.00e−18 1.00e−17 1.00e−16 1.00e−15 1.00e−14

Valid at 28/02/2000 00:00:00

Maximum value = 1.64e−15 g/m3

1.00e−19 1.00e−18 1.00e−17 1.00e−16 1.00e−15 1.00e−14

Valid at 28/02/2000 12:00:00

Maximum value = 6.87e−16 g/m3

1.00e−19 1.00e−18 1.00e−17 1.00e−16 1.00e−15 1.00e−14

Valid at 29/02/2000 00:00:00

Maximum value = 2.94e−16 g/m3

1.00e−19 1.00e−18 1.00e−17 1.00e−16 1.00e−15 1.00e−14

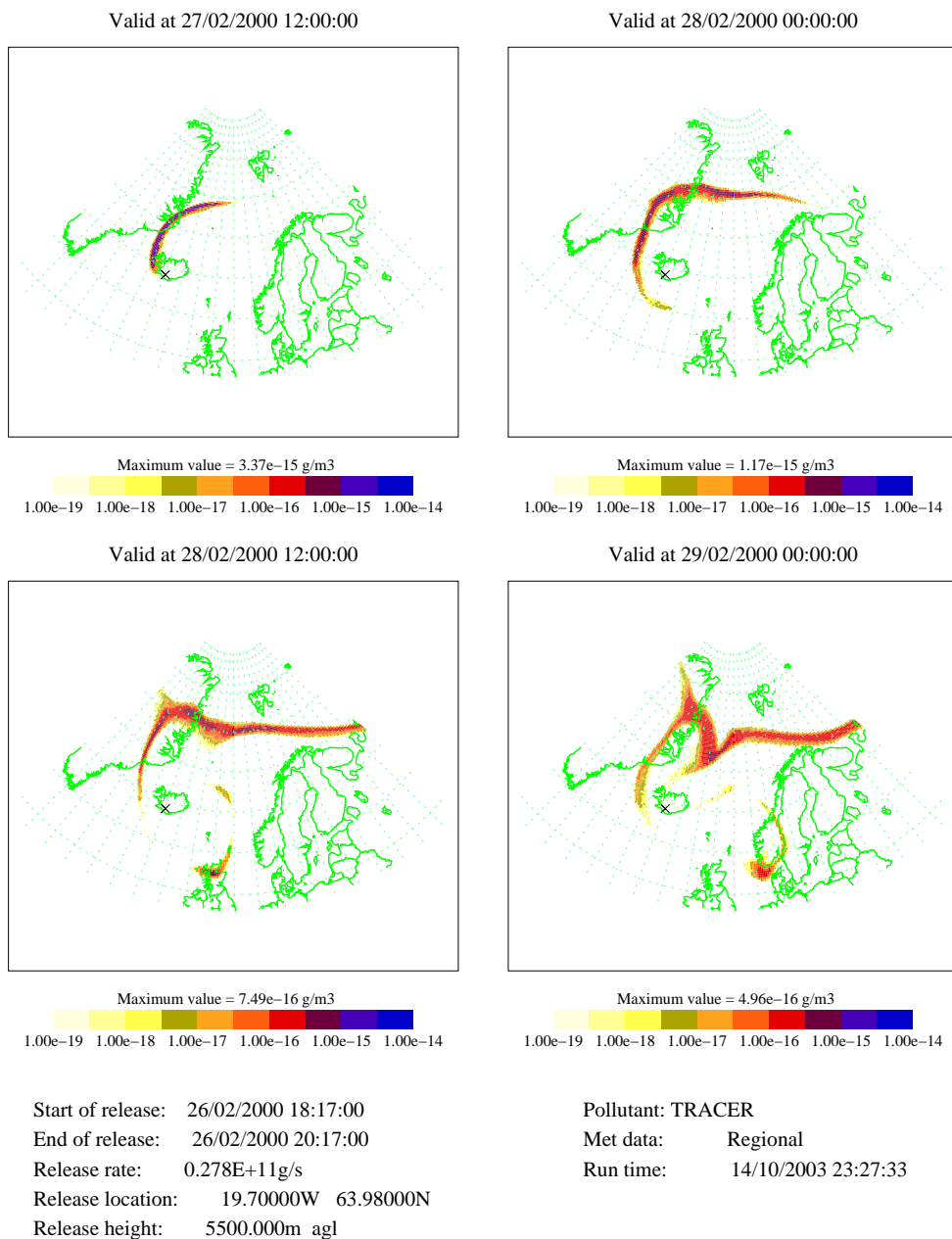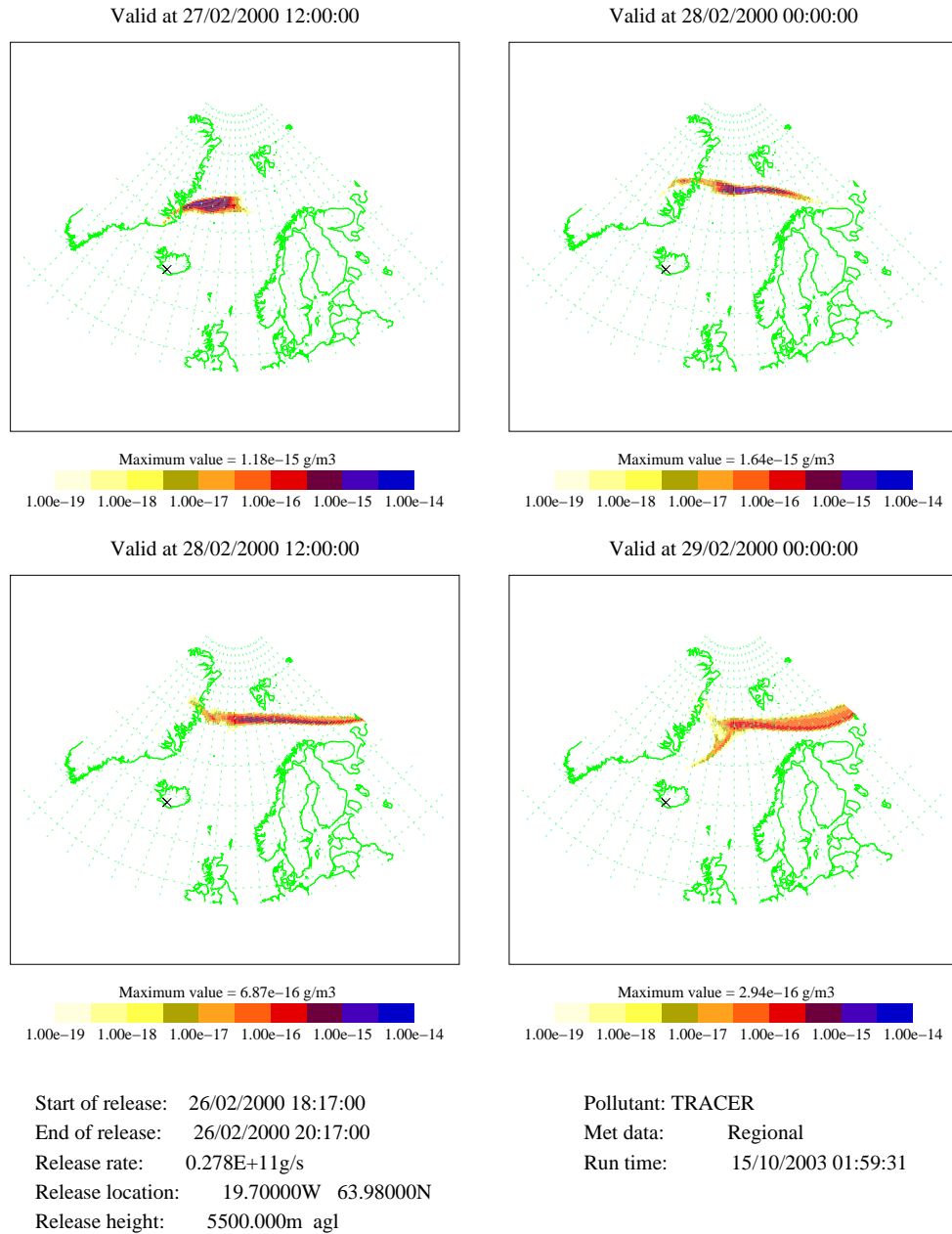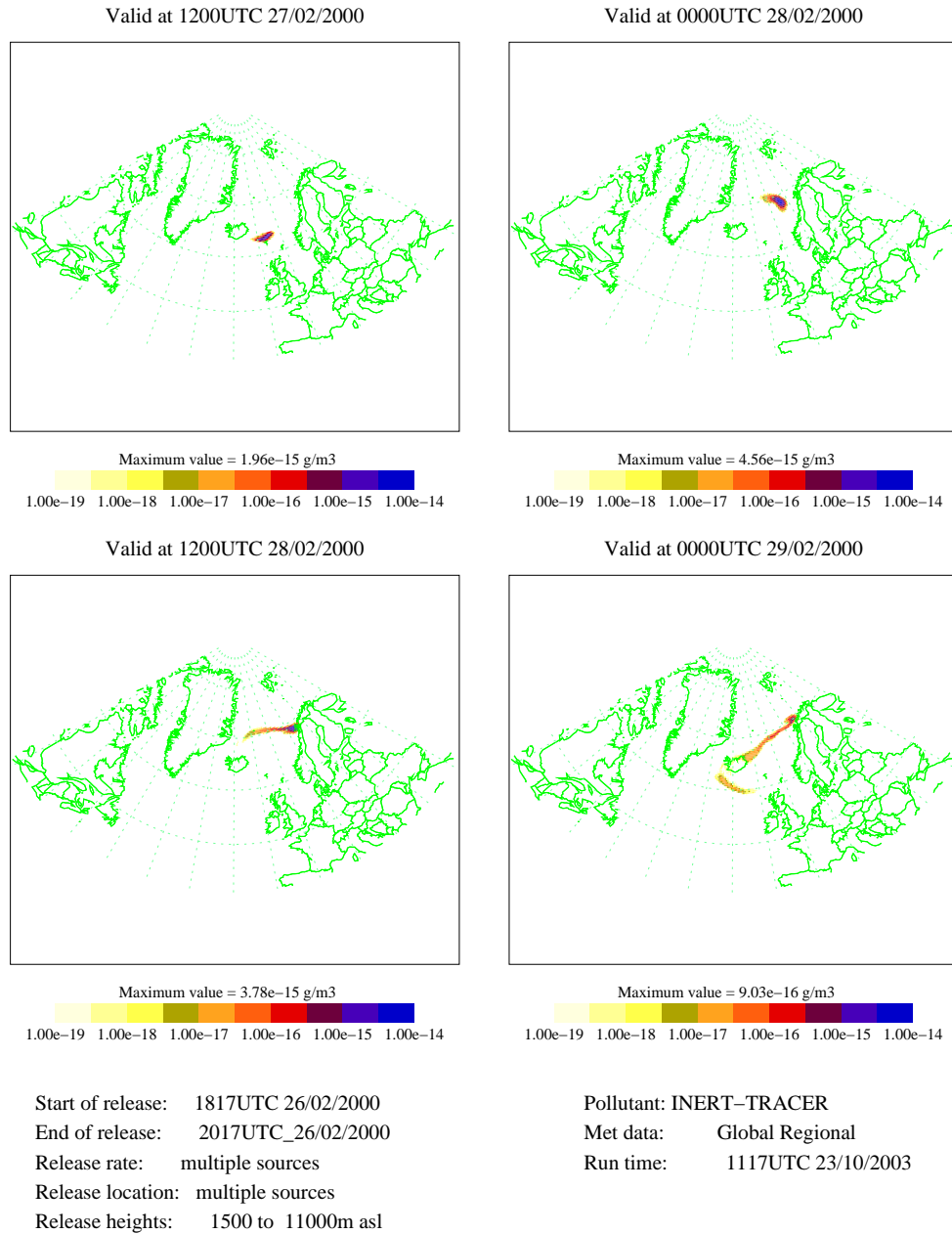|			
Start of release:	26/02/2000 18:17:00	Pollutant: TRACER	
End of release:	26/02/2000 20:17:00	Met data:	Regional
Release rate:	0.278E+11g/s	Run time:	15/10/2003 01:59:31
Release location:	19.70000W 63.98000N		
Release height:	5500.000m agl		

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Figure 5: NAME III output for Hekla February 2000 eruption. Output grid $\Delta z = 3000$ m centered at $z = 10500$ m.

Figure 6: NAME output for Hekla February 2000 eruption. Output grid $\Delta z = 500$ m centered at $z = 250$ m.

NAME version 807

Hekla 2002 – 2hr release

From 1500 – 3000m asl Air concentration

Valid at 1200UTC 27/02/2000

Valid at 0000UTC 28/02/2000

Maximum value = 8.10e−15 g/m3

1.00e−18 1.00e−17 1.00e−16 1.00e−15 1.00e−14 1.00e−13

Maximum value = 1.89e−15 g/m3

1.00e−18 1.00e−17 1.00e−16 1.00e−15 1.00e−14 1.00e−13

Valid at 1200UTC 28/02/2000

Valid at 0000UTC 29/02/2000

Maximum value = 1.69e−15 g/m3

1.00e−18 1.00e−17 1.00e−16 1.00e−15 1.00e−14 1.00e−13

Maximum value = 1.29e−15 g/m3

1.00e−18 1.00e−17 1.00e−16 1.00e−15 1.00e−14 1.00e−13

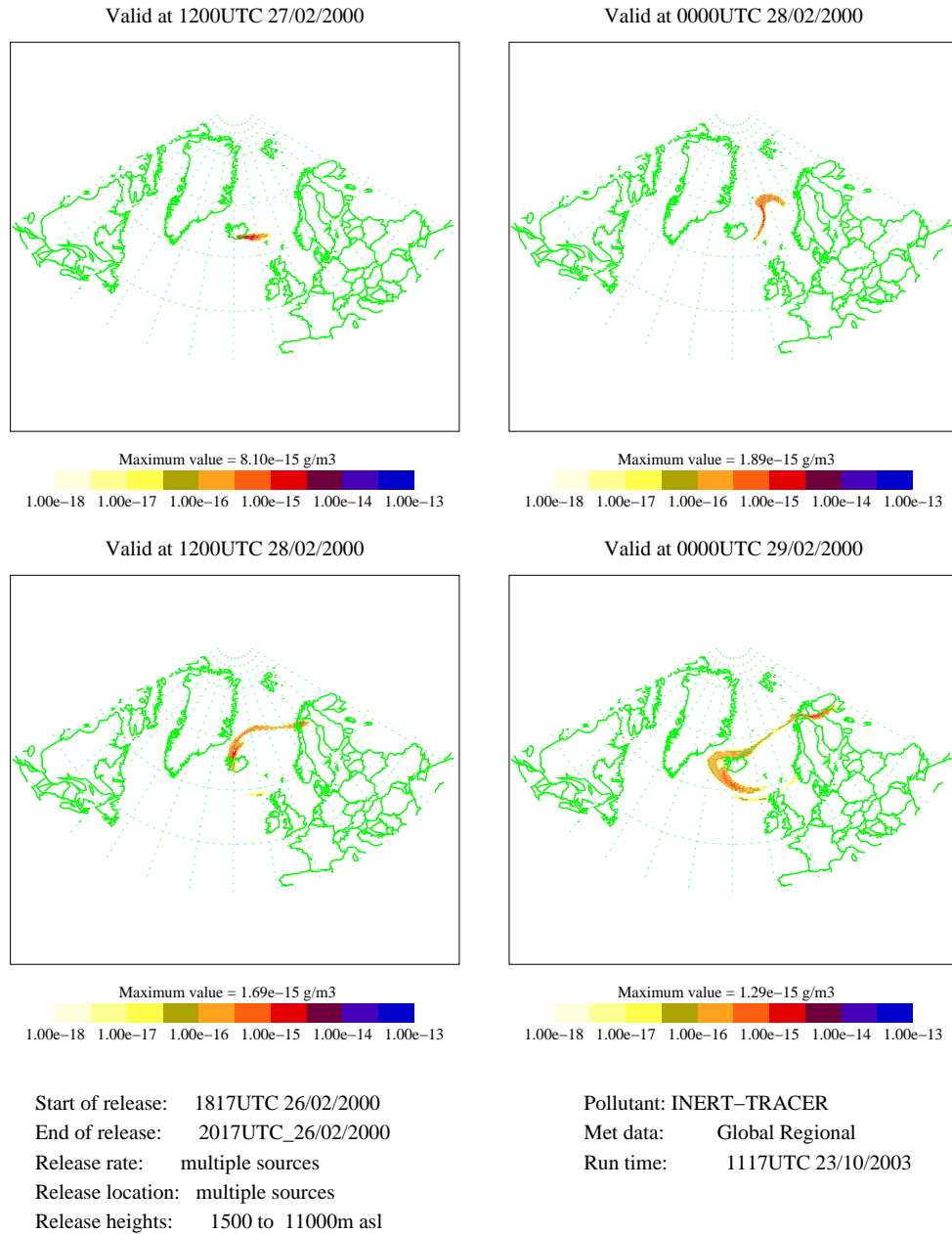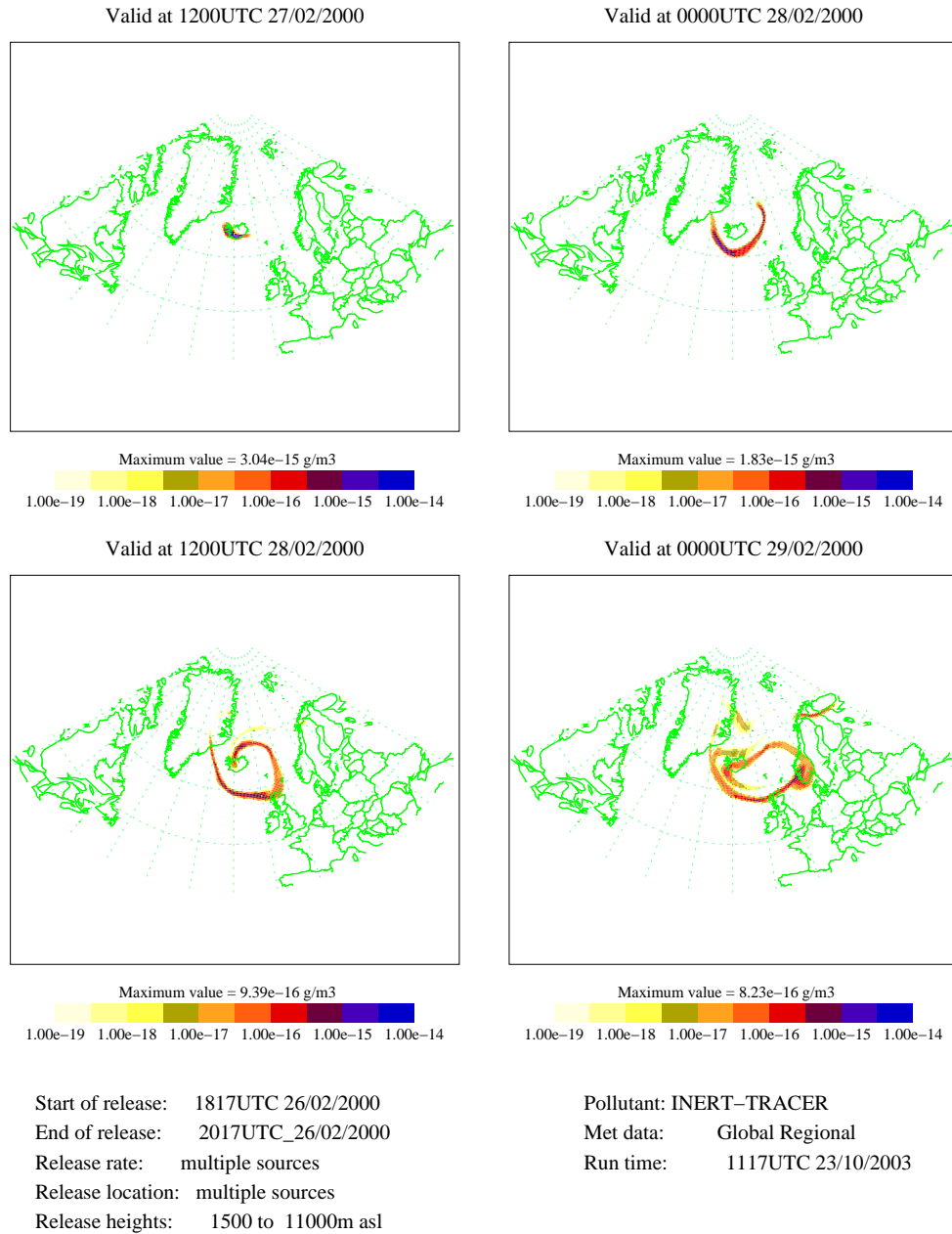|			
Start of release:	1817UTC 26/02/2000	Pollutant:	INERT−TRACER
End of release:	2017UTC_26/02/2000	Met data:	Global Regional
Release rate:	multiple sources	Run time:	1117UTC 23/10/2003
Release location:	multiple sources		
Release heights:	1500 to 11000m asl		

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Figure 7: NAME output for Hekla February 2000 eruption. Output grid $\Delta z = 1500$ m centered at $z = 2250$ m.

NAME version 807

Hekla 2002 – 2hr release

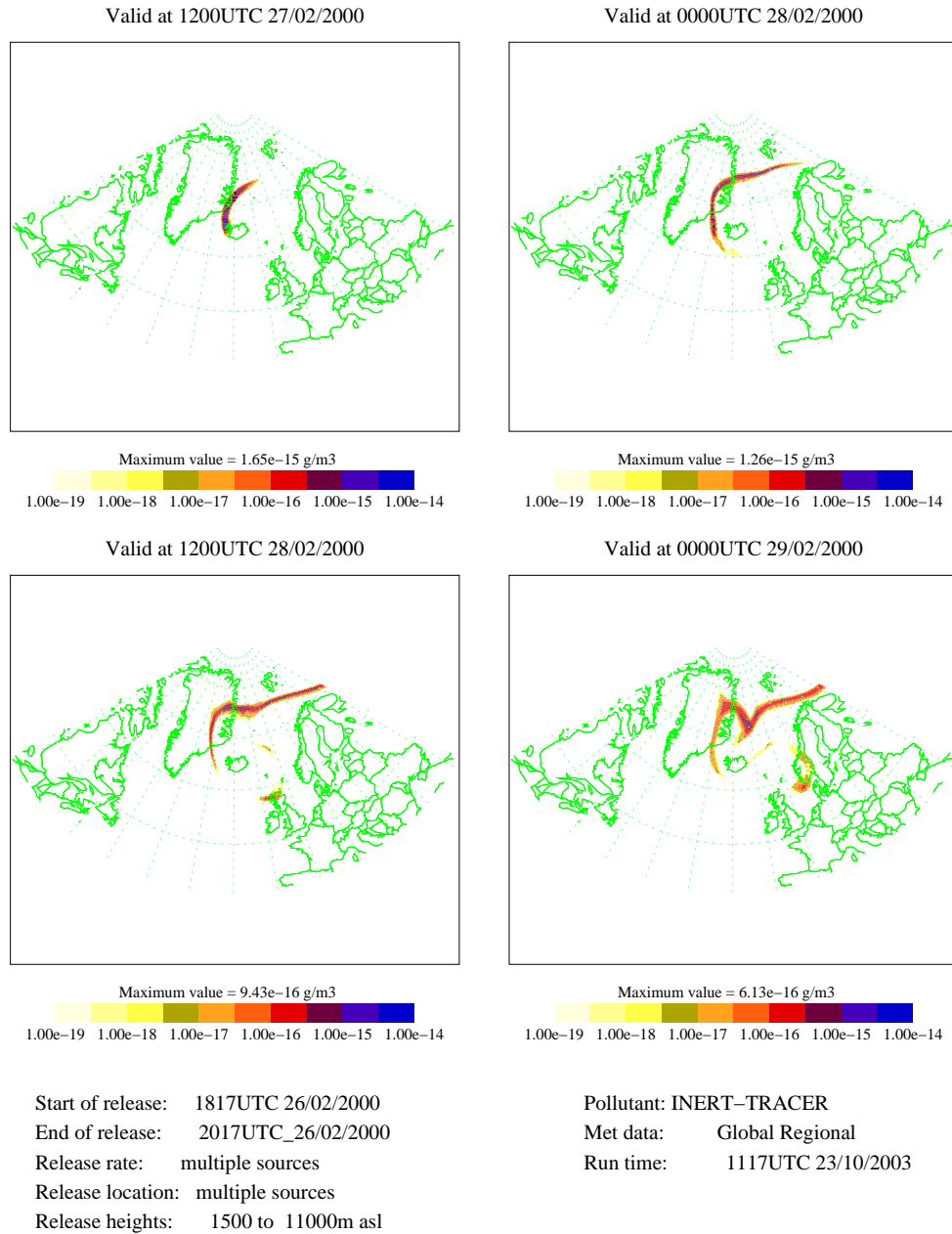From 3000 – 6000m asl Air concentration

Valid at 1200UTC 27/02/2000

Valid at 0000UTC 28/02/2000

Maximum value = 3.04e−15 g/m3

1.00e−19 1.00e−18 1.00e−17 1.00e−16 1.00e−15 1.00e−14

Maximum value = 1.83e−15 g/m3

1.00e−19 1.00e−18 1.00e−17 1.00e−16 1.00e−15 1.00e−14

Valid at 1200UTC 28/02/2000

Valid at 0000UTC 29/02/2000

Maximum value = 9.39e−16 g/m3

1.00e−19 1.00e−18 1.00e−17 1.00e−16 1.00e−15 1.00e−14

Maximum value = 8.23e−16 g/m3

1.00e−19 1.00e−18 1.00e−17 1.00e−16 1.00e−15 1.00e−14

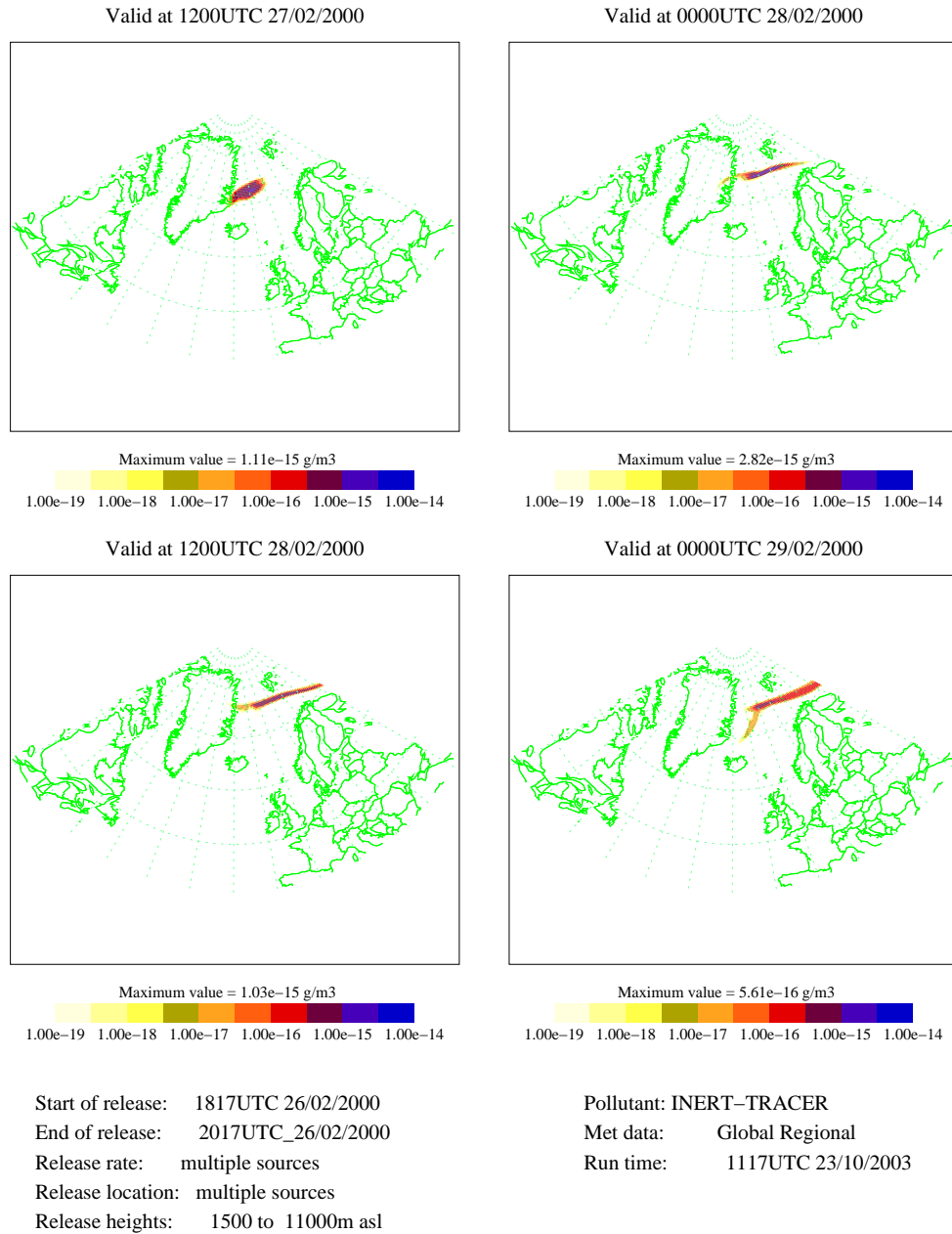|			
Start of release:	1817UTC 26/02/2000	Pollutant:	INERT−TRACER
End of release:	2017UTC_26/02/2000	Met data:	Global Regional
Release rate:	multiple sources	Run time:	1117UTC 23/10/2003
Release location:	multiple sources		
Release heights:	1500 to 11000m asl		

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Figure 8: NAME output for Hekla February 2000 eruption. Output grid $\Delta z = 3000$ m centered at $z = 4500$ m.

Figure 9: NAME output for Hekla February 2000 eruption. Output grid $\Delta z = 3000$ m centered at $z = 7500$ m.

NAME version 807

Hekla 2002 – 2hr release

From 9000 – 12000m asl   Air concentration

Valid at 1200UTC 27/02/2000

Maximum value = 1.11e−15 g/m3

1.00e−19 1.00e−18 1.00e−17 1.00e−16 1.00e−15 1.00e−14

Valid at 0000UTC 28/02/2000

Maximum value = 2.82e−15 g/m3

1.00e−19 1.00e−18 1.00e−17 1.00e−16 1.00e−15 1.00e−14

Valid at 1200UTC 28/02/2000

Maximum value = 1.03e−15 g/m3

1.00e−19 1.00e−18 1.00e−17 1.00e−16 1.00e−15 1.00e−14

Valid at 0000UTC 29/02/2000

Maximum value = 5.61e−16 g/m3

1.00e−19 1.00e−18 1.00e−17 1.00e−16 1.00e−15 1.00e−14

Start of release:	1817UTC 26/02/2000		Pollutant: INERT−TRACER	
End of release:	2017UTC_26/02/2000		Met data:	Global Regional
Release rate:	multiple sources		Run time:	1117UTC 23/10/2003
Release location:	multiple sources			
Release heights:	1500 to 11000m asl			

Met Office (GMR) Crown copyright

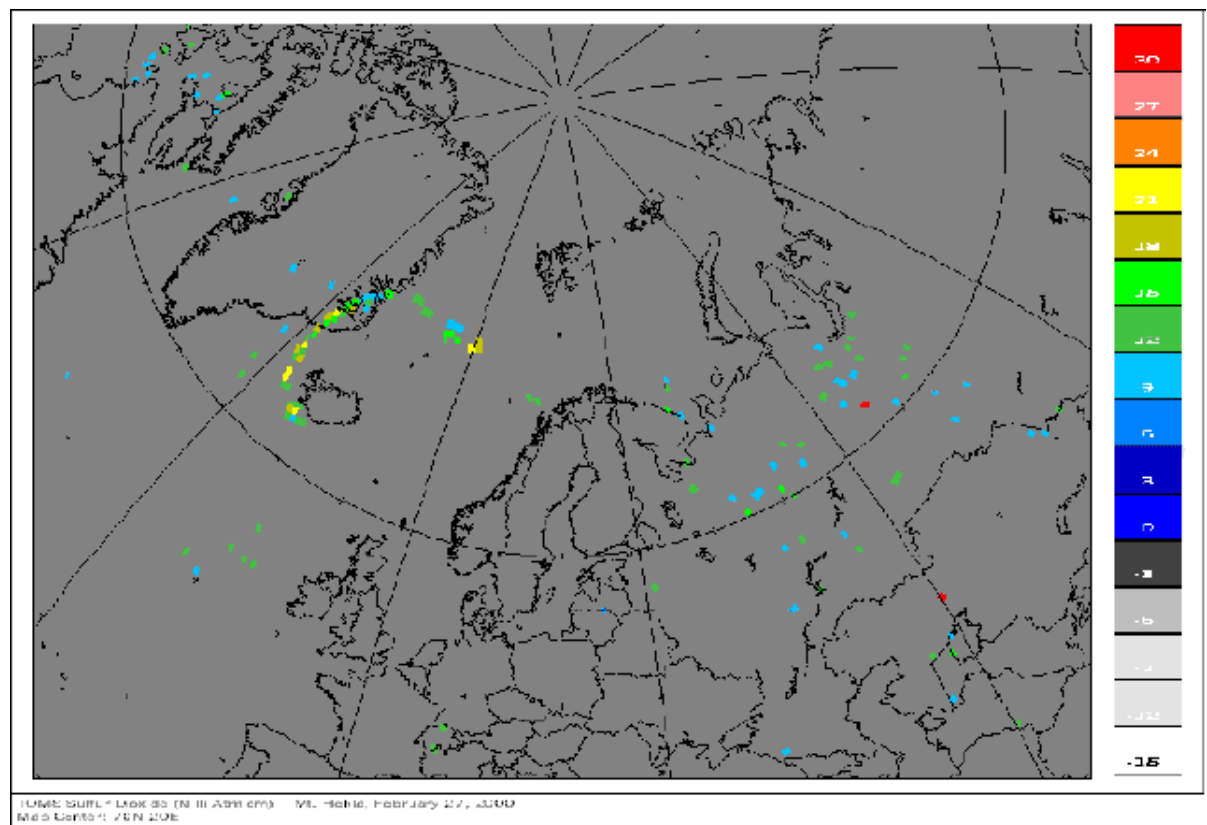Figure 10: NAME output for Hekla February 2000 eruption. Output grid $\Delta z = 3000$ m centered at $z = 10500$ m.

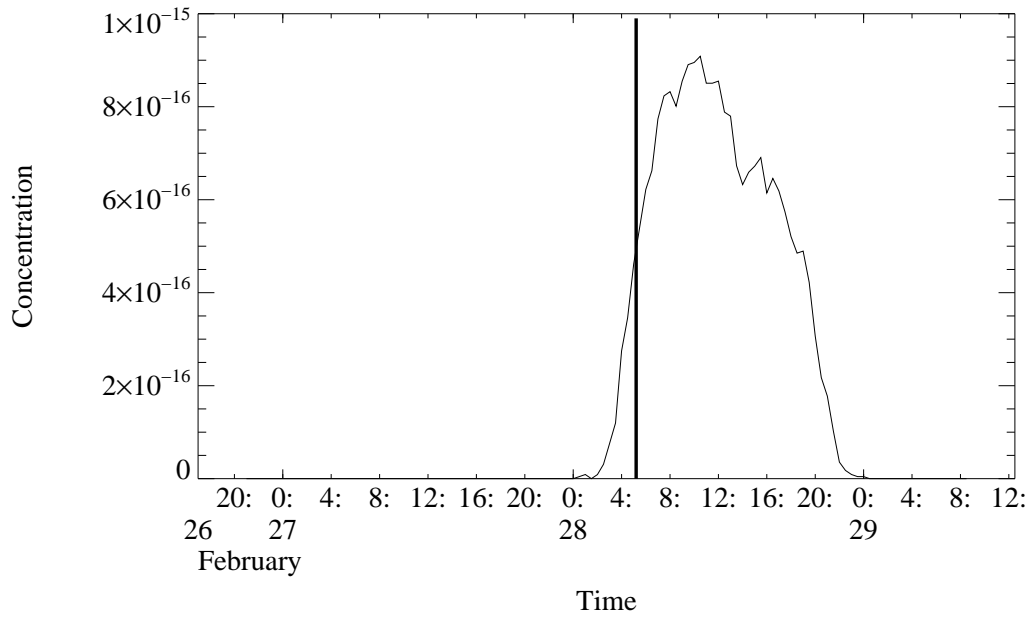Figure 11: TOMS image 27/02/00 20:00.

Figure 12: NAME III time series of concentration at 76.0° N 0.0 E with $\Delta x = 0.5°$ and $\Delta y = 0.3°$ at $z = 11250.0$ m $\Delta z = 500.0$ m. Vertical line indicates the time that the NASA plane intercepted the plume at this location.

Annex A: NAME III input file.

```
Main Options:
Absolute or relative time?, Fixed met?, Time of fixed met, Flat Earth?
                absolute,         No,                   ,           No

Multiple Case Options:
Multiple Cases?, Multiple Sets of Dispersion Options?,
No,                                       No,

Output Options:
Folder
.\Hekla_out6\

Input Files:
File names
..\..\..\..\Met\UMMetDefnRH.txt
..\..\..\..\Met\UMMetDefnGH.txt

Array: ZGridArray
Array Values
250.0
500.0
750.0

Horizontal Coordinate Systems:
Name,    Type, Pole Lat, Pole Long, Angle, x-Origin, y-Origin, x-unit, y-unit
HCoord1,   1,     90.0,      0.0,   0.0,      0.0,      0.0,    1.0,    1.0

Vertical Coordinate Systems:
Name,    Type, Unit
ZCoord1,   1,  1.0
asl,       2,  1.0

Horizontal Grids:
Name,   H-Coord, nX,  ny,    dx,    dy,     x0,   y0
HGrid4, HCoord1, 250, 130,  0.4,  0.25,  -50.0, 53.0

Vertical Grids:
Name,   Z-Coord, nz,    dz,      z0
ZGrid2, ZCoord1, 66,  25.0,    0.0
ZGrid4,     asl,  1, 3000.0, 7500.0

Temporal Grids:
Name,        nt,        dt,                  t0
TGrid4.1,    20, 03:00:000, 26/02/2000 21:00:000

Domains:
Name, H-Coord,      X Min,      X Max,      Y Min,      Y Max, H Unbounded?, Z-Coord,    Z Max,
D1,   HCoord1,       -1.0,        1.0,       -1.0,        1.0,          Yes, ZCoord1, 25000.0,
D2,   HCoord1, -100000.0,   100000.0, -100000.0,   100000.0,           No, ZCoord1, 25000.0,
D3,   HCoord1,      -31.0,       50.0,       20.0,       80.0,           No, ZCoord1, 25000.0,


            Z Unbounded?,         Start Time,       End Time,  Max Travel Time
```

```
                   Yes,   26/02/2000 00:00,         infinity,        240:00:01
                   Yes,   26/02/2000 00:00,         infinity,         infinity
                   Yes,   26/02/2000 00:00,         infinity,         infinity


Species:
Name, Type, Half Life, Molecular Weight, Diameter, Density, Resistance Rc
SO2,  Gas,    Stable,                28,          ,   1.0,          1.0

Sources:
Name,          Shape, H-Coord, Z-Coord,        X,      Y,      Z,    dX,    dY,      dZ, Angle, Diameter,
Hekla, Rectangular, HCoord1, ZCoord1,   -19.70, 63.98, 5500.0,   0.0,   0.0, 11000.0,   0.0,          ,

          Source Strength, Time Dependency, Plume Rise?, Temperature, Volume Flow Rate, Flow Velocity,
            SO2   1.0   g,                ,         No,         0.0,              0.0,              ,

            NParticles, Max Age, Top Hat,       Start Time,        Stop Time
             1000000, 20000.0,      No, 26/02/2000 18:17, 26/02/2000 20:17


Output Requirements - Fields:
Name,         Species, Source, Group, H-Grid, Z-Grid,   T-Grid, BL Average, T Average, Sync?, Graph?,
Conc,                ,       ,      ,       , ZGrid2, TGrid4.1,        No,        No,   No,   Yes,
Conc,                ,       ,      , HGrid4, ZGrid4, TGrid4.1,        No,        No,   No,    No,
PuffCentres,         ,       ,      ,       , ZGrid2, TGrid4.1,        No,        No,   No,   Yes,

          Screen?, Disk?, Stat?, Plot Scale, Separate File, Output Group
              No,    No,   No,        0.01,             T,           F1
              No,   Yes,   No,        0.01,             T,           F2
              No,    No,   No,        0.01,             T,           F1



Output Requirements - Fields:
Name,         Species, Source, Group,    T-Grid, H-Coord, Z-Coord, T Average, Sync?, Graph?,
NParticles,          ,       ,      , TGrid4.1, HCoord1, ZCoord1,        No,   Yes,    No,
NPuffs,              ,       ,      , TGrid4.1, HCoord1, ZCoord1,        No,   Yes,    No,
#particle steps,  ,       ,      , TGrid4.1,        ,        ,        No,   Yes,    No,
#puff steps,    ,       ,      , TGrid4.1,        ,        ,        No,   Yes,    No,

          Screen?, Disk?, Stat?, Output Group
              Yes,    No,     No, F3
              Yes,    No,     No, F3
              Yes,    No,     No, F3
              Yes,    No,     No, F3



Output Requirements - Sets of Particle/Puff Details:
 Name, Particles?, Puffs?, First Particle, Last Particle, First Puff, Last Puff, T-Grid, H-Coord,
Set 1,        No,   Yes,              1,             1,         1,         1,        , HCoord1,

        Z-Coord, Sync?, Graph?, Screen?, Disk?
        ZCoord1,   No,     No,      No,   Yes
```

```
Sets of Dispersion Options:
Skew Time, Velocity Memory Time, Inhomogeneous Time, DeltaOpt, Puff Time, Sync Time,
    00:00,              00:00,              00:00,          1,     00:00, 00:15:00,

    Computational Domain, Puff Interval,Deep Convection?, Radioactive Decay?,
                   D1,          00:15,              No,                  No,

    Dry Deposition?, Wet Deposition?, Meander?
              No,          No    ,      Yes



NWP Met Module Instances:
Name,     Min B L Depth, Max B L Depth, Use NWP BL Depth, RESTOREMET, DELETEMET,
Regional,         80.0,        4000.0,              No,         No,       No,
Global,           80.0,        4000.0,              No,         No,       No,

          Met Folder, Met Definition Name
        ..\..\..\Met\,            Regional
         ..\..\..\Met,             Global

NWP Flow Module Instances:
Name,     Met Module,      Met, Domain
Regional,    NWP Met, Regional,     D3
Global,      NWP Met,   Global,     D2

Flow Order: Update
Flow Module, Flow
NWP Flow,    Regional
NWP Flow,    Global

Flow Order: Convert
Flow Module, Flow
NWP Flow,    Regional
NWP Flow,    Global

Flow Order: Flow
Flow Module, Flow
NWP Flow,    Regional
NWP Flow,    Global

Flow Attributes:
Name,    Flow Order
Update,  Update
Convert, Convert
Flow,    Flow
```