NAME III Documentation

Utilising RADAR Rainfall Data in NAME III

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1. Introduction

NIMROD, the Met Office Nowcasting System, determines and implements the optimum method of generating analysis and forecast guidance in the time range 0-6 hours for the UK and immediately surrounding areas, and the optimum method for producing cloud and rainfall fields for use in the initialisation of the Mesoscale model.

For many years the Atmospheric Dispersion Group have received a data feed from NIMROD, which, up until now, has been superfluous to the requirements of the group. However, needs for this data have subsequently been recognised, which, amongst other things, may enable the more accurate modelling of wet deposition fields in the groups NAME III model.

Consideration of the use of NIMROD output in NAME III has become more pertinent as a result of the planned migration of all NIMROD services to UKPP and EuroPP services when NIMROD is retired at the end of October/November 2008.

Ultimately this document aims to provide details of how radar data from NIMROD and subsequently UKPP could be utilised in NAME III, including a description of the data held in NIMROD, UKPP and EuroPP output files and methods of visualising radar data.

2. Pre-project status of NAME III and its use of NIMROD output

NAME III has been coded to read in NIMROD output files, primarily via the RadarMet.F90 and RadarFlow.F90 modules (which can be found in: file:/net/home/h03/apdg/NameIII/NameIIIDevVersions/Version5_2a/Code_NameIII/*.F90). This 'original' NAME III code (i.e. version 5_1) was tested using the NAME input file:
file:/net/home/h03/apdg/NameIII/NameIIIDevVersions/Version5_2a/Runs/in9.txt.

The radar met data used with this run can be found in:
P:\Dispersion\NameIII\NameIIILibrary\Data\NimrodData.

The NWP met data used with this run can be found in:
file:/net/home/h03/apdg/NameIII/NameIIIDevVersions/Version5_2a/Resources/Met/Met1.dat.

Note that there exist some bugs in the 'old' NAME III code when running with radar data and there are some errors in the in9.txt input file. Therefore any version of NAME III proceeding and inclusive of version5.2 should not be used in this context and nor should the input file, in9.txt. For further details, see Section 6.1 and 7.2.

For further information describing the requirements for running NAME III with radar data (previous to this piece of work) see the input file documentation (file:/net/home/h03/apdg/NameIII/NameIIILibrary/Documents/ModelDocs/md2_2_v10(Input).pdf). A Turbulence and Diffusion Note (No. 251), "Optimising the Use of Unified Model Precipitation in the NAME Dispersion Model", (Lucas, 1998) considers the use of radar data in NAME. Lucas, 1998 does not aid the use of

NIMROD output data in NAME but investigates the analysis precipitation fields of the UKMO NWP Unified Model (UM) and compares these with corresponding radar images in an effort to suggest a threshold for the rainfall, below which NAME would ignore the UM precipitation fields.

3. Description of radar output files

NIMROD output file format is described in the Nimrod System Documentation Paper No.2. This file can be found at: http://nimrod/pages/system_docs/NO2.DOC or in NIMROD_Doc_v1.9.doc under the 'RADAR' folder on my own network space. The Nimrod System Documentation Paper may prove more meaningful alongside a visual display of the content of a NIMROD output file (see Section 3.1 for details).

3.1 Understanding NIMROD, UKPP and EuroPP output files

The format of UKPP and EuroPP output files is exactly the same as NIMROD output files; all data is produced in NIMROD file format. The Post-processing and Impacts Team can convert these files into GRIB format, or images but other formats (e.g. PP) would require some development work. Table 1 below describes the NIMROD file format including the NAME III default values. Table 2 Appendix A, Table 3 Appendix B and Table 4 Appendix E describe the UKPP, EuroPP and Radarnet file formats, respectively. All 3 tables also include the NAME III default values, which, where different from the NIMROD default values, are highlighted in red type.

To view radar output files in text format, right click on the radar output file (in Konqueror), select "Open with" and type "khexedit" or alternatively, in a LINUX shell, type: $ khexedit <filename>. The data is primarily in binary format but in conjunction with the Nimrod System Documentation Paper, this data can be read and understood. To identify output in the form of Integer*2 (I*2), left click on the numbers in the black font and view the 'signed 16 bit' cell or 'unsigned 16 bit' cell at the foot of the khexedit window. In row 1 of a NIMROD output file the first two numbers start the file. The third number defines the year e.g. 2008; the fourth number defines the month, etc. Output of the form Real*4 (R*4), applies to four columns of binary data. To identify values of the form Real*4, left click on the left most column of the data in 'black' font and view the '32 bit float' cell entry at the foot of the khexedit window. Output of the form Character*8 (C*8) or Character*24 (C*24), apply to a single column of binary data. To identify text of the form Character*8 or Character*24, left click on the data column (which could be in 'black' or 'blue' font) and view the 'Text' cell entry at the foot of the khexedit window. Table 1, details the NIMROD file format, with an additional column detailing the default values (or examples of typical values) in the NIMROD output files received by the Atmospheric Dispersion Group.

In radar output files binary values of "-32767" imply a blank data entry. Column headings end at 00 04 94 76 (on row 19), inclusive. Precipitation data follows the file column headings. All precipitation data are in units of mm/hr * 32 and must be divided by 32 to ascertain the 'true' rainfall rate.

**Note that in all tables (Table 1-4) copied from the Nimrod System Documentation Paper No.2, there exists an error. Under "Element number" 45 and 46 it states that the

Easting and Northing, respectively, of true the origin (TM Projection) are in units of metres, however these are in fact in units of kilometres.

Table 1. NIMROD file format including NAME III default values

Data Type	Element number	Description of header element	NAME default values
Integer*2	**1-31**	**General header entries (Bytes 1-62)**	
I*2	1.	VT year. VT is the Validity Time of the data.	E.g. 2008
I*2	2.	VT month.	E.g. 10 (Oct)
I*2	3.	VT day.	E.g. 01
I*2	4.	VT hour.	E.g. 00
I*2	5.	VT minute.	E.g. 00
I*2	6.	VT second.	E.g. 00
I*2	7.	DT year. DT is the Data Time. It can be used for models, forecast images, or forecast data.	Same as VT
I*2	8.	DT month.	Same as VT
I*2	9.	DT day.	Same as VT
I*2	10.	DT hour.	Same as VT
I*2	11.	DT minute.	Same as VT
I*2	12.	=0 if data is of type real, =1 if data is of type integer, =2 if data is of type byte.	1, integer data type
I*2	13.	Number of bytes for each data element (1, 2, or 4).	2
I*2	14.	Experiment number (user supplied).	-32767 – blank
I*2	15.	Horizontal grid type (0=NG, 1=lat/long, 2=space view, 3=polar stereographic, 4=x/y grid, 5=other).	0, National Grid
I*2	16.	Number of rows in field.	435
I*2	17.	Number of columns in field.	345
I*2	18.	Header file release number (2 for the first release of the Nimrod header).	2
I*2	19.	Field code number (includes data type).	213
I*2	20.	Vertical co-ordinate type (0=height above orography, 1=height above sea-level, 2=pressure, 3=sigma, 4=eta, 5=radar beam number, 6=temperature, 7=potential temperature, 8=equivalent potential temperature, 9=wet bulb potential temperature, 10=potential vorticity, 11=cloud boundary, 12=levels below ground).	0, height above orography
I*2	21.	Vertical co-ordinate of reference level e.g. for thickness fields (values as for element 20).	-32767 – blank
I*2	22.	Number of elements, starting at element 60, which are used for data-specific information e.g. calibration information only appropriate to a radar image (this element previously indicated whether or not a supplied colour table is used).	0
I*2	23.	Number of elements, starting at element 109, which are used for data-specific information (previously this was the number of categories in colour table).	0
I*2	24.	Location of origin of data (0=top LH corner, 1=bottom LH corner, 2=top RH corner, 3=bottom RH corner).	0, top left hand corner
I*2	25.	Integer missing data value.	-32767 – blank
I*2	26.	Period of accumulation or average (minutes)	0
I*2	27.	Number of Model Levels	-32767 – blank

I*2	28.	Projection biaxial ellipsoid [0 = Airy 1830 (NG), 1 = International 1924 (modified UTM-32), 2 = GRS80 (GUGiK 1992/19)].	-32767 – blank
I*2	29.	Spare	-32767 – blank
I*2	30.	Spare	-32767 – blank
I*2	31.	Spare	-32767 – blank
Real*4	**32-59**	**General header entries (Bytes 63-174)**	
R*4	32.	Value of vertical co-ordinate (e.g. 500.0 for a 500hPa height field), or radar beam number (8888.0=sea-level, 9999.0=ground level or undefined). If the vertical co-ordinate type (element 20) is set to 3 or 4 then the value is set to model level number. For example, 3.0 for model level three or 2.5 for model level two and a half.	9999 – ground level or undefined (starts @ 46 1c, on the 5th row and the 3rd column)
R*4	33.	Value of reference vertical co-ordinate (e.g. 1000.0 for a 500 - 1000hPa thickness field)	-32767 – blank
R*4	34.	Northing or latitude or start line of first row of data (metres for NG, degrees for PS grids).	1.5475E+06
R*4	35.	Interval between rows i.e. pixel size. For PS images this will be the resolution in the y-direction at the standard latitude of 60 degrees North (metres or degrees).	5000
R*4	36.	Easting or longitude or start pixel of first point of first row of data (metres or degrees).	-4.024E+05
R*4	37.	Interval between columns ie. pixel size. For polar stereographic images this will be the resolution in the x-direction at the standard latitude of 60 degrees North (metres or degrees).	5000
R*4	38.	Real missing data value.	-32767 – blank
R*4	39.	MKS scaling factor for data (=100.0 for pressure in millibars).	8.68056E-09
R*4	40.	Data offset value.	0
R*4	41.	X-offset of model data from gridpoints (positive = to East, negative = to West).	0
R*4	42.	Y-offset of model data from gridpoints (positive = to North, negative = to South)	0
R*4	43.	Standard latitude or latitude of true origin (TM or PS projection) in degrees	49
R*4	44.	Standard longitude or longitude of true origin(TM or PS projections) in degrees	-2
R*4	45.	Easting of true origin (TM Projection) in metres** (units in error – see above for details)	400
R*4	46.	Northing of true origin (TM Projection) in metres** (units in error – see above for details)	-100
R*4	47	Scale factor on central meridian for TM Projections [NG = 0.9996012717, modified UTM-32 = 0.9996, GUGiK 1992/19 = 0.9993].	-32767 – blank
R*4	48 - 59.	To be used for general header entries. These elements were previously used for a colour table.	-32767 – blank
Real*4	**60-104**	**Data specific header entries (Bytes 175-354)** These elements were previously used for a colour table.	
R*4	60	Northing or latitude of top left corner of the image (metres for NG, degrees for PS grids)	-32767 – blank

R*4	61	Easting or longitude of top left corner of the image (metres for NG, degrees for PS grids)	-32767 – blank
R*4	62	Northing or latitude of top right corner of the image (metres for NG, degrees for PS grids)	-32767 – blank
R*4	63	Easting or longitude of top right corner of the image (metres for NG, degrees for PS grids)	-32767 – blank
R*4	64	Northing or latitude of bottom right corner of the image (metres for NG, degrees for PS grids)	-32767 – blank
R*4	65	Easting or longitude of bottom right corner of the image (metres for NG, degrees for PS grids)	-32767 – blank
R*4	66	Northing or latitude of bottom left corner of the image (metres for NG, degrees for PS grids)	-32767 – blank
R*4	67	Easting or longitude of bottom left corner of the image (metres for NG, degrees for PS grids)	-32767 – blank
R*4	68	Satellite calibration co-efficient	-32767 – blank
R*4	69	Space count (satellite data)	-32767 – blank
R*4	70	Ducting Index	-32767 – blank
R*4	71	Elevation Angle	-32767 – blank and all entries up to 104 are blank
Character	**105-107**	**Character header entries (Bytes 355-410)**	
C*8	105[2].	Character string denoting the units of the field.	1/32 mm/hrrainanl (plus 17 spaces) (units of) (Starts @ ‘31 2f’; runs to ‘6e 6c)
C*24	106.	Character string to describe the source of the data.	
C*24	107.	Title of field.	precipitation rate (plus 6 spaces) (Starts @ ‘70 72’; runs to ‘74 65’)
Integer*2	**108-**	**Data specific header entries (Bytes 411-512)** These elements were previously used for a colour table.	
I*2	108.	The radar number for a single site image (set to zero for a radar composite).	8224
I*2	109.	The radar sites which have gone into forming a composite image. Each site is represented by a particular bit which is set to 1 if the site was available, and 0 if it was not. Radar site 1 will be represented by the least significant bit of element 109.	8224
I*2	110.	As element 110 for additional radar sites. This will only be required if the number of operational sites exceeds 16.	8224
I*2	111.	Clutter map number.	-32767 – blank

[2]、 *This element was originally 2 real*4 elements in the NDG header. The numbering of subsequent elements has therefore changed.*

I*2	112.	Calibration Type (0=uncalibrated, 1=frontal, 2=showers, 3=rain shadow, 4=bright band; the negatives of these values can be used to indicate a calibration which has subsequently been removed.	Blank and all subsequent 'data entries' are blank (51? data entries).
I*2	113.	Bright band height (units of 10m).	
I*2	114.	Bright band intensity. This is defined as the enhancement of the rainfall in the bright band relative to the rain beneath it.	
I*2	115.	Bright band test parameter 1. This is the percentage of sectors (24 in all) which have detected a possible bright band.	
I*2	116.	Bright band test parameter 2. This is the percentage of the sectors in entry 30 which agree with the bright band height of 28.	
I*2	117.	Infill Flag (for level 4.1)	
I*2	118.	Stop Elevation (for level 4.1)	
I*2	119-131	Used to duplicate real*4 general header entries 32-44 for data transfers to COSMOS (Note: All entries are $\times 10^{-3}$).	
I*2	132-139	Used to duplicate real*4 specific header entries 60-67 for data transfers to COSMOS (Note: All entries are $\times 10^{-3}$).	
I*2	140	Sensor identifier (Satellite data)	
I*2	141	Meteosat identifier (currently 5 or 6)	
I*2	143	Availability of synop meteosat and forecast alphas in combined alphas field (e.g. 111 all available, 100, only synop)	
etc.		The remaining space may be used for further data/application-specific entries.	

Table 2 Appendix A and Table 3 Appendix B detail the output file format and NAME III default values for UKPP and EuroPP radar data, respectively. Where the tabulated default values are different to those in Table 1 describing the NIMROD default values, they have been highlighted in red. The differences are summarised below.

The key differences impacting upon how NAME III input files, using NIMROD, UKPP or EuroPP rainfall rate output, would be set up include:

i) Number of rows of data: 435 for NIMROD, 704 for UKPP and 759 for EuroPP.
ii) Number of columns of data: 345 for NIMROD, 548 for UKPP and 639 for EuroPP.
iii) Start line of 1st row of data (metres): 1.5475E+06 for NIMROD, 1.222E+06 for UKPP and 3.795E+06 for EuroPP.
iv) Interval between rows of data (metres): 2000 for UKPP and 5000 for NIMROD and EuroPP.
v) Start line of 1st column of data (metres): -4.024E+05 for NIMROD, -2.38E+05 for UKPP and 0.0E+00 for EuroPP.
vi) Interval between columns of data (metres): 2000 for UKPP and 5000 for NIMROD and EuroPP.
vii) Latitude of true origin (degrees): 49 for NIMROD and UKPP and 50 for EuroPP.
viii) Longitude of true origin (degrees): -2 for NIMROD and UKPP and 9 for EuroPP.

The differences in the NIMROD, UKPP and EuroPP grids are highlighted in: http://vulcan.metoffice.com/~appc/Management/Projects/UK_1p5km_Project/Nimrod_domains.doc. However there are a number of parameters values in Nimrod_domains.doc which are not in agreement with those values in Tables 1 and 3 of this note. Firstly the bottom left corner grid point in a NIMROD output file is -622500, -402500 and not -622500, -238000. The standard longitude and domain size is 9^{o}E and 3195 km (E) by 3795 km (N) (as detailed in Table 3) as opposed to 3^{o}E and 2805 km (E) by 3795 km (N) (as detailed in Nimrod_domains.doc) (whereby EuroNimrod implies EuroPP), respectively. Furthermore the UTM co-ordinates of the true origin are 1750 km E and 1500 km N as opposed to 1400 km E and 1600 km N. The appropriate individuals have been made aware of these errors, which will be corrected and the documented updated in due course.

3.2 Radar Grid and Domain

NIMROD products are computed on a single National Grid domain, with two resolutions: a fine 5km mesh (supplied to the Atmospheric Dispersion Group), and a coarse 15km mesh. The domain is a close approximation to the Mesoscale Unified Model grid which is defined on a rotated latitude/longitude grid. The NIMROD grids have the following characteristics:-

- NW corner Nat. Grid: (-405km E, 1550km N), Lat/Long: (62.907^{o}N, 17.962^{o}W)
- NE corner (1320km E, 1550km N), (62.638^{o}N, 16.122^{o}E)
- SW corner (-405km E, -625km N), (43.864^{o}N, 12.004^{o}W)
- SE corner (1320km E, -625km N), (43.731^{o}N, 9.411^{o}E)
- Size (W-E, N-S) of projected domain: (1725km, 2175km)

5km mesh:

* Offset of grid point from edge of domain: 2.5km
* Number of (W-E, N-S) grid points: (345, 435)
* Total number of grid points: 150,075

15km mesh:

* Offset of grid point from edge of domain: 7.5km
* Number of (W-E, N-S) grid points: (115, 145)
* Total number of grid points: 16,675

Note that file column headers specify the grid point locations, i.e. the centres of grid squares, whereas the above specification is of the borders of the domain.

All UKPP rainfall rate output files have a resolution of 2 x 2 km (with the number of grid points = 704, 548, in the x and y domains, respectively), within a domain depicted by Figure 1 (smaller than the domain of the current EuroPP cutout feed) (taken from: http://exvwebsrva/~fppp/display_pages/precip_rate_anal.html). All EuroPP rainfall rate output files have a resolution of 5 x 5 km (with the number of grid points = 659, 739, in the x and y domains, respectively), within a domain depicted by Figure 2 (provided by Stephen Moseley). The Atmospheric Dispersion Group currently receives cut-out EuroPP data covering the same spatial and temporal

(15 minutes) domain as that used to define the discontinued NIMROD data feed. However, if required, UKPP rainfall rate data can be provided on timesteps of 5 minutes. The formatting the Post Processing and Impacts team perform on the EuroPP data received by the Atmospheric Dispersion Group includes the modification of the size of the domain and reprojecting the data onto the National Grid transverse Mercator (see Section 5 for further details). It would be less effort for the Post Processing and Impacts team and potentially more beneficial to the Atmospheric Dispersion Group if the data feed comprised of UKPP and/or EuroPP output on the full domain.

UKPP uses a 2km radar composite and EuroPP uses a 5km radar composite that also includes radar data from across Europe (where available). Where radar data is available, the analyses are exclusively radar data. Outside the composite Area of Radar Coverage (ARC), the NIMROD, UKPP and EuroPP rain analyses estimate surface rain rate from a combination of a background field, a satellite (MSG) inferred estimate of rain rate and surface weather reports (as in Figure 1, for example). For UKPP output, the background field used is the UK 4km model output. For EuroPP output, the background field used is NAE model output (on a 12 x 12 km grid). For a comparison of the UK "Rain Analysis" and the "1 km Composite" radar imagery see Figures 1 and 3, respectively (noting the minor temporal difference between images) or go to: http://nimrod/pages/Nimrod_rainanalysis.html. The quality of the data outside the composite ARC is deemed to be inferior to that inside the ARC.

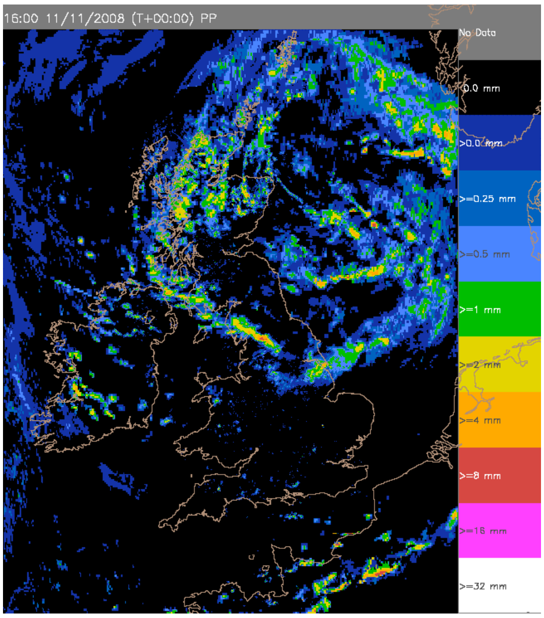

Fig 1. UKPP Domain

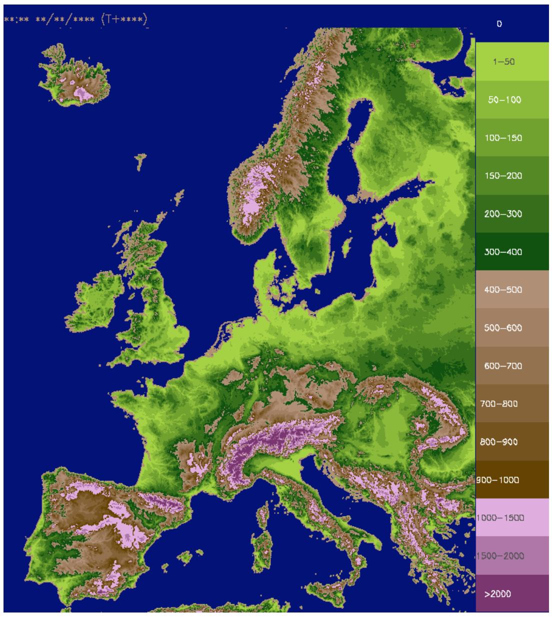

Fig 2. EuroPP Domain

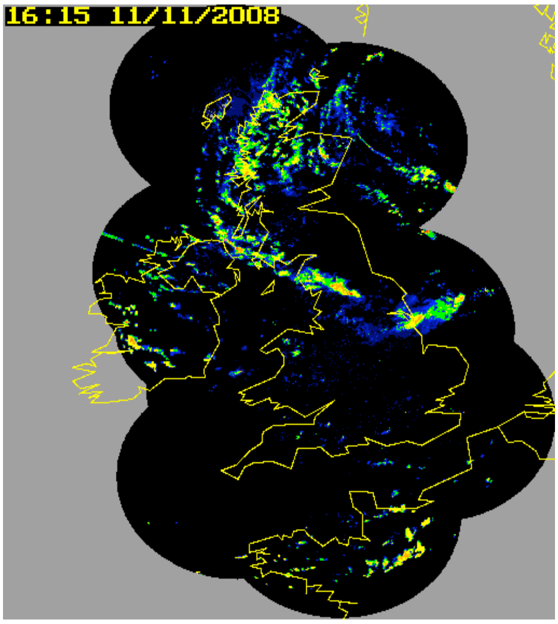

Fig 3. UK Area of Radar Coverage

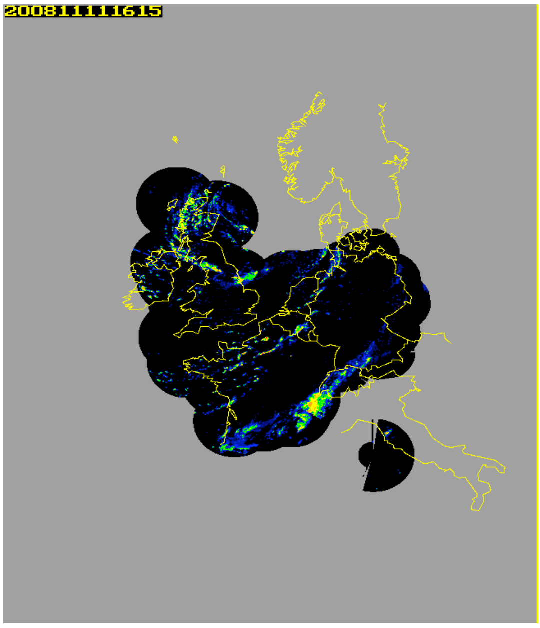

Fig 4. European Area of Radar Coverage

4. Visualising NIMROD, UKPP and EuroPP output data

Stephen Moseley has written a number of scripts which aid in the visualisation of radar output data. The method for utilising these scripts is described below.

4.1 Viewing radar output data in PV WAVE

Below is a step by step guide to viewing NIMROD, UKPP and EuroPP output in PV WAVE.

Firstly add two filepaths to your profile to enable you to easily access/call Stephen Moseley's scripts which enable the display of radar data (in NIMROD format) in PV WAVE. To do this, go to your own directory (e.g. /home/h05/appb) and type:

```
$ ls –a
```

This enables you to view all files including hidden files. Then type:

```
$ nedit .profile
```

This enables you to open an edit window of your profile. Then type:

```
export WAVE_PATH=~cfst/wavelinux/
PATH=$PATH:~cfst/binlinux/
```

at the end of the code at the bottom of the edit window. Save the changes.

Secondly, navigate to the directory of the files you want to visualise in PV WAVE.

You may need to type:

```
$ . ~/.profile
```

before you are able to run PV WAVE.

To run PV WAVE, type:

```
wave
```

The basic command is:

```
WAVE> display,'./','200810010300_nimrod_ng_rainanl_rainrate',/scr
```

To add a key, type:

```
WAVE> display,'./','200810010300_nimrod_ng_rainanl_rainrate',/scr,/key
```

To identify the pixel values and pixel positions in the plots using the mouse, type:

```
WAVE> display,'./','200810010300_nimrod_ng_rainanl_rainrate',/scr,/mouse
```

To change the scale of the plot, type:

```
WAVE> display,'./','200810010300_nimrod_ng_rainanl_rainrate',/scr,Scale=2
```

To zoom into a particular region of the plot, type:

```
WAVE> display,'./','200810010300_nimrod_ng_rainanl_rainrate',/scr,
zoom=[50.,-4.,100,1]
```

To create image files of the plots, type:

```
WAVE> display,'./','200810010300_nimrod_ng_rainanl_rainrate',/scr,/gif
```

If the user wishes to create tif or png image files as opposed to gif image files, simply replace gif with tiff or png, respectively.

Further commands are detailed in ‘display.pro’ which can be found under Stephen Moseley’s homepage: /home/h04/cfst/wavelinux/display.pro (and can be opened in nedit).

If the user types ‘mouse’ in the display command, additional information is provided in the header at the top of the display window. The left most value details the precipitation rate in mm/hr x 32. There exists an option to zoom in to a region of the display (see above for details). Upon zooming in to a region of the display and magnifying the image, care should be taken to ensure that the rainfall rate depicted by the colour of the pixel over which the mouse is “hovering” is in agreement with the rainfall rate detailed in the display header. The second and third columns of the display window header apply to the position of the mouse in the x and y fields, respectively. The position x,y = 1,1 lies in the top left hand corner of the graphic. When visualising NIMROD output the x and y axis are 345 pixels and 435 pixels in length, respectively. Each pixel is 5000 x 5000 metres, in size. As a result of left clicking on the display the user is able to zoom in and further magnify the image. Right clicking on the display ‘locks’ the image, preventing any further magnification. There is no option for using the mouse to zoom out of the image.

4.2 Alternative methods for viewing radar output data

Two other scripts for visualising radar output data, ‘drawanim’ and ‘anim’ are detailed here (developed by Stephen Moseley). The primary application of these scripts is to animate sets of data files. The scripts do not require the user to run PV WAVE.

To draw and animate NIMROD, UKPP or EuroPP output data the user should type:

```
$ drawanim <file/files>
```

This creates and displays radar data as gif files in a similar format as produced by PV WAVE. By default, place names are added to the images.

If the gif files have previously been created, to animate radar gif files the user should type:

$ anim <file/files>

The user can scroll forwards or backwards (in time) through the individual display windows by right or left clicking, respectively, on the image. The time and date of each image is detailed in the display window header. Updating the users profile (as described above) will enable the use of these scripts; however they can be found in /home/h04/cfst/binlinux.

5. Migration of radar data feed

As of Monday 20th October 2008 at 1300 (+/- 1 hour) all files received by the Atmospheric Dispersion Group were migrated from NIMROD to EuroPP services. There are minimal differences between the two data feeds and none of the differences which do exist, impact upon the method used to run NAME III with radar data (see Section 7 for details). The only difference with regard to the content of the file lies in 'Element Number' 27. The NIMROD feed assumes the number of model levels is blank however the EuroPP cutout feed assumes the number of model levels = 1.

The 'new' data feed received by ADG as of 20/10/08 is a cutout of the EuroPP dataset, on the same domain and grid as the NIMROD dataset. This requires the Post processing and Impacts Team to perform a degree of processing as the EuroPP full domain is on a Universal Transverse Mercator projection, UTM32. The data is reprojected onto the National Grid transverse Mercator, analogous to the superceded Nimrod data feed, before being sent to ADG's server. Note that the UKPP data is projected onto the National Grid transverse Mercator in the first instance. The filenaming convention also remained the same following the migration from NIMROD to EuroPP services (yyyymmddhhmm_nimrod_ng_rainanl_rainrate).

6. NAME III Updates

Following the implementation of the original code in NAME III to enable NIMROD output data to be read in and utilised, negligible testing was performed. Since this update, numerous other modifications to NAME have occurred, whilst NIMROD output data has been used minimally, if at all, in NAME. Modifications have been made to the NAME III code to ensure NAME has the capability to utilise radar data. Details of these updates are provided in Section 6.1. Analysis and testing of NAME input files was performed. Furthermore, NIMROD data was used in conjunction with other forms of met data (single site and NWP) to ensure compatibility across met data types for model runs utilising radar data.

6.1 NAME III coding updates

Versions of NAME III preceding and inclusive of version 5.2 should not be used for dispersion runs utilising radar output data due to bugs in the code. Instead NAME III version 5.3 should be used, whereby the bugs, detailed below, have been resolved.

In the subroutine “UpdateRadarMet” in the RadarMet.F90 module there existed a bug in the secondary met update and all subsequent met updates. The “MetTime” was not being updated successfully. The line of code:

MetTime = MetTime + RadarMet%Dt

was implemented to correct this bug.

In the subroutine “ReadFFE” in the RadarMet.F90 module there existed a bug. The code was expecting to read in total rainfall rate data (which includes all forms of rain, including orographically enhanced rainfall) AND orographically enhanced rainfall rate data from separate files. However the orographic data (which has not been supplied to the Atmospheric Dispersion group for many years) is currently surplus to requirements. All references to the orographically enhanced rainfall dataset have therefore been removed from the code. Reasons why orographically enhanced rainfall rate data files were originally read in to NAME are postulated in Section 6.2.

6.2 Radar data and wet deposition

The “WetDeposition” subroutine in Particle.F90 module includes a line of code which, if the topographic height above sea level is greater than 150 (units of metres are assumed) and the particle height is less than 1000 (units of metres are assumed) (i.e. if Flow%Topog > 150.0 .And. Particle%X(3) < 1000.0), increases washout (by applying larger scavenging coefficients) i.e. as a result orographically enhanced rainfall. The old NIMROD data feeds and current EuroPP cutout data feeds received by the Atmospheric Dispersion Group account for all forms of rainfall, including orographically enhanced rainfall. Checks should be made to ensure that there is no double counting of wet deposition resulting from orographically enhanced rainfall. One possible reason for reading orographically enhanced rainfall rate data into NAME III is so that the contribution can be removed from the total rainfall rate and therefore ensuring that orographically enhanced rainfall does not contribute twice to wet deposition fields. In the ‘original’ NAME code, if a non-zero precipitation value in the orographic enhanced rainfall data field was observed, the equivalent value of the total precipitation was scaled by -1 (using a variable called orogflag). It appears from the comments in the code in the “RadarMet.F90” module (“ReadFFE” subroutine) that where rainfall was used elsewhere in the code (e.g. in the wet deposition subroutine), negative precipitation values would be flagged up, identified as including a contribution from orographically enhanced rainfall, and utilised in the code accordingly, before reverting back to a positive rainfall rate value. However there is no evidence of such an approach in the “WetDeposition” subroutine (“Particle.F90” module) of the ‘old’ version of the NAME III code.

If it was discovered that there does exist double counting of wet deposition as a result of orographically enhanced rainfall, an approach akin to that described above could be implemented or an alternative approach could be applied, based on the utilisation of an IF statement such that if radar met data is used, the orographically enhanced scavenging coefficients are ignored.

The Atmospheric Dispersion Group may wish to consider the best approach for modelling wet deposition when using radar data. When Helen Webster updates the modelling of wet deposition in NAME III it may be opportune to also consider how radar data is used in the estimation of wet deposition.

7. Running NAME III using radar data

NAME III version 5_3 (or subsequent versions of NAME) should be used when modelling atmospheric dispersion whilst using radar data.

7.1 Accessing radar data for use in NAME III

The Atmospheric Dispersion Group currently receive a feed of radar data from the Post processing and Impacts Team. All data feeds are written to name-d: /name/data/input/nimrod/. The data feed comprise of rainfall rate averaged over 15 minutes periods (yyyymmddhh00, …hh15, …hh30 and …hh45) and encompasses the period from add date when ADG started receiving radar data feed to the current date. The current file naming convention is: yyyymmddhhmm_nimrod_ng_rainanl_rainrate. It is important to note that NAME III is currently constrained to reading in radar data which complies to only this filename format. This file naming convention is used for the NIMROD feed and the EuroPP cutout feed. Despite the fact that the latter data feed does not result from the Met Office's NIMROD Nowcasting System, "nimrod" remains a component of the filename, allowing radar data to continue to be read into NAME III. Superficially there is nothing to distinguish files from the superseded NIMROD data feed and the current EuroPP cutout data feed. UKPP and EuroPP on the full domain have different naming conventions which NAME III is currently unable to accommodate. Therefore to run NAME III with UKPP or EuroPP on their full domains the same filename format must be adopted as for NIMROD output files. Clearly in the future the NAME III code should be updated to account for different filenames associated with different types of radar data (but firstly the types of radar data which ADG require for running with NAME III must be determined). For the time being care must be taken when renaming UKPP and EuroPP files as NIMROD files; the danger being that when returning to such files at a later date they are mistaken for NIMROD files.

7.2 NAME III example input files for utilising radar data

The archived NAME III input file example for use when running NAME with radar data, in9.txt, (which can be found in: file:/net/home/h03/apdg/NameIII/NameIIIDevVersions/Version5_2a/Runs/in9.txt) should not be used as an example template. Instead example input files, located in: Z:\home\h03\apdg\NameIII\NameIIIDevVersions\Version5_2a\Runs and called:

i) Example_Nimrod_with_SS_met.txt
ii) Example_Nimrod_with_NWP_met.txt
iii) Example_UKPP_with_SS_met.txt
iv) Example_EuroPP_with_SS_met.txt

should be used. The filenames are self-explanatory but relate to using NIMROD data with single site met data; NIMROD data with NWP met data; UKPP data with single site met data; and EuroPP data with single site met data, respectively.

The files: in9_10.txt (/home/h05/appb/RADAR/Useful_Runs), in9_11.txt (/home/h05/appb/RADAR/Useful_Runs), in9_13.txt (/home/h05/appb/RADAR/UKPP) and in9_14.txt (/home/h05/appb/RADAR/EuroPP) should replicate i-iv, above.

The key blocks in any NAME III input file utilising radar output data are highlighted below. The example below is applicable to running NAME III with NIMROD or EuroPP cutout data files received by ADG.

```
Horizontal Coordinate Systems:
Name,        Type, Pole Lat, Pole Long, Angle,  x-Origin,  y-Origin, x-unit,  y-unit
NimrodCoord,   4,     49.0,      -2.0,   0.0, -802500.0, 1647500.0, 5000.0, -5000.0

Radar Met Module Instances:
Name,        H-Coord,       Nimrod Folder,  nX,  nY,    dT
Nimrod, NimrodCoord, ..\Resources\Nimrod, 345, 435, 00:15

Radar Flow Module Instances:
Name,   Met Module,    Met,     H-Coord,        Domain
Nimrod,  Radar Met, Nimrod, NimrodCoord, Nimrod Domain

Flow Order: Update
Flow Module, Flow
Radar Flow,  Nimrod
NWP Flow,    Mesoscale_Flow

Flow Order: Convert
Flow Module, Flow
NWP Flow,    Mesoscale_Flow

Flow Order: Flow
Flow Module, Flow
NWP Flow,    Mesoscale_Flow

Flow Order: Cloud
Flow Module, Flow
NWP Flow,    Mesoscale_Flow

Flow Order: Rain
Flow Module, Flow
Radar Flow,  Nimrod
NWP Flow,    Mesoscale_Flow

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

In the ‘Radar Met Module Instances’ block it is important that nX (horizontal X grid size), nY (horizontal Y grid size) and dT (time step) are set to 345, 435 and 00:15, respectively for NIMROD output or EuroPP cutout; set to 548, 704 and 00:15 for UKPP output on the full domain; and set to 639, 759 and 01:00 for EuroPP output on the full domain. Note that although NIMROD and UKPP output are defined on the UK National Grid Co-ordinate System, the default UK National Grid Co-ordinate System cannot be assumed under the ‘Horizontal Co-ordinate System:’ block because the ‘Radar Met Module Instances:’ block does not include the capability to define dX and dY (grid size). The problem arises because the Function ‘HCoord_UKNationalGridM’ and the Function ‘HCoord_UKNationalGrid1’, applicable to UK National Grid (m) and UK National Grid (100m), respectively, by default assume units of 1 x 1 metre and 100 x 100 metres, respectively. Thus there is no option to define the radar grid by anything other than the default e.g. a grid a 2000 x 2000 metres or 5000 x 5000 metres cannot be assumed by this method.

In the ‘Flow Order’ blocks it is important that the Radar Flow is considered before the NWP Flow (or Single Site Flow). This ensures that the NIMROD rainfall data is considered preferentially to the NWP (or single site) rainfall data.

If using the NAME III input files referenced above and exactly the same met data (which can be found in /home/h05/appb/RADAR/ or the folders therein), then the only likely changes to the NAME input file before running NAME III include: updating the “Folder” column key under the “Output Options:” block; updating the filepath under the “Nimrod Folder” column key under the “Radar Met Module Instances:” block; and updating the filepath under the “Met File” column key under the “Single Site Met Module Instances:” block.

If using different single site or NWP met data and NIMROD data then temporal parameters in the NAME III input files are likely to change such as “Temporal Grids:” block, “Start Time” and “Stop Time” in “Sources:” block etc.

8. Passing radar data through the NAME III code

Radar data is passed around the NAME III code as follows:

Data read into RadarMet.F90 -> Call: UpdateRadarMet in Mets.F90
-> Call: UpdateMets in Flows.F90
-> Call: UpdateMetsFlows in Case.F90
-> Call: RuntoRestartDumpOrSuspendOrEndOfCase in MainNameIII.F90
-> RunToSyncTimeOrMetFlowUpdateOrEndOfCase, in Case.F90
-> Call: ProcessAndOutputResults in Output.F90
-> Call: OutputFields in Output.F90.

9. Testing and Analysis of NAME III and it’s ability to utilise radar data

A number of approaches were applied to test the example input files and NAME III code to ensure radar data is successfully read into and used in NAME.

9.1 Testing that radar data is successfully passed through the NAME III code

Checks were made to ensure that the NIMROD output data was correctly being read into NAME III and passed around the code by including Precipitation Rate as an output requirement in all NAME III runs. Write statements were added to the NAME III code at each stage the radar data is passed to another module or subroutine as detailed in Section 8. All tests were successfully completed.

9.2 Testing that radar data is correctly used in NAME III

Radar data could be very valuable when estimating wet deposition concentrations. Fields of wet deposition were plotted to test the application of radar data in NAME III. The geographical extent of the source of the release was set to be equal to the domain of the radar data. The release was instantaneous and included a large number of particles (5 million), such that the resulting wet deposition field should replicate the geographical variability in the precipitation. This is realised in Figures 5 and 6.

Figure 5 depicts the rainfall rate output from the NIMROD file: 200810010000_nimrod_ng_rainanl_rainrate (and was produced by applying the approach detailed in Section 4.1 above), applicable to the period 00:00-00:15 on the 1st October 2008. Figures 6-8 all detail the wet deposition concentration (integrated over a 15 minute period between 00:00-00:15). Figure 6 assumes Mesoscale NWP met data (HP200810010000.MESUM5) for all parameters barring rainfall which is defined by the NIMROD dataset. Figure 7 assumes Mesoscale NWP met data (HP200810010000.MESUM5) only. Figure 8 assumes 4km NWP met data (HP200810010000.4KM50L_UM6.pp) only. All NWP met data is applicable to the period 00:00-01:00 on the 1st October 2008. Note that single site met data was also considered in conjunction with NIMROD rainfall data, however is not plotted because, over the relatively short timescales considered here, the fields of wet deposition were virtually identical to those plotted in Figure 6.

On comparison of Figures 5 and 6 it is evident that the wet deposition field, utilising rainfall rate data from NIMROD, is analogous to the rainfall rate field derived from the NIMROD output file. This gives confidence that the NIMROD output data is being appropriately utilised within NAME III. On comparison of Figures 6-8 it is evident that the fields of wet deposition across the full domain are in general agreement. It is apparent however that on a regional scale the NWP met data is inclined to predict rainfall, where in contrast, the NIMROD output suggests there is no rainfall, for example, central and south-east England. It is not clear which representation of the precipitation is closer to the ‘truth’, however it is acknowledged that radar output has a tendency to neglect drizzle. Furthermore on a local scale there exists more detail in the NIMROD output, for example in Cumbria whereby the rainfall rate observed in the NIMROD dataset is variable between heavy rainfall and no rainfall. In contrast the NWP met data estimates widespread heavy rain over this area.

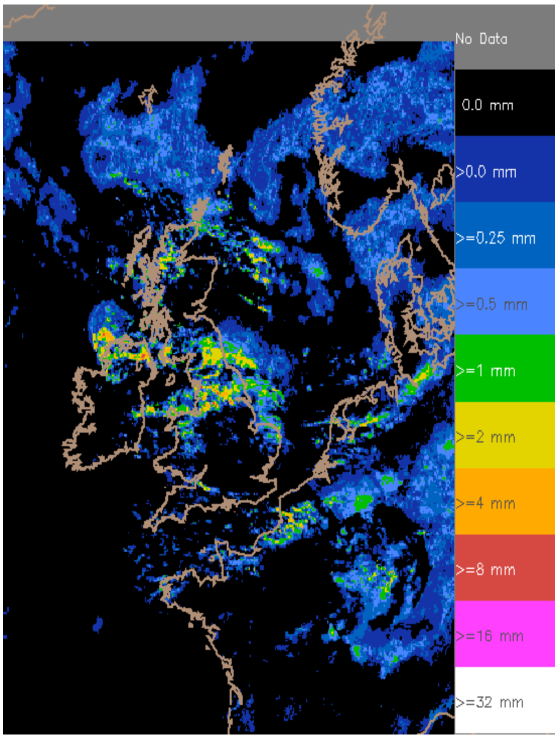

Fig 5. Rainfall rate output from NIMROD

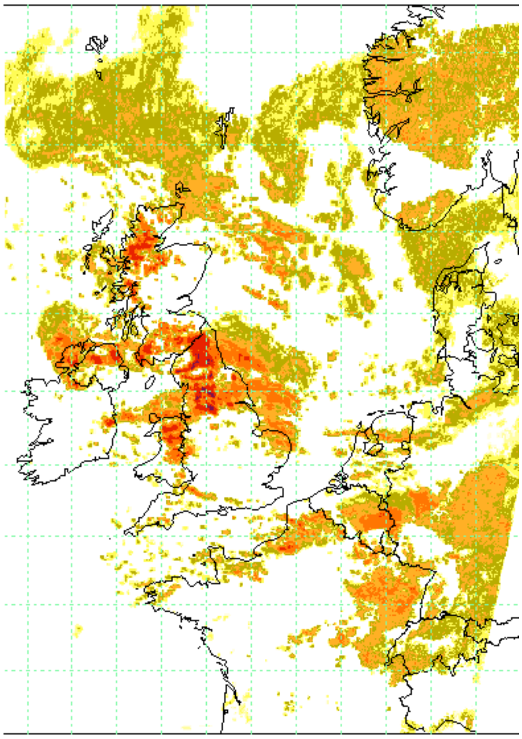

Fig 6. Wet Deposition Field utilising NIMROD Output

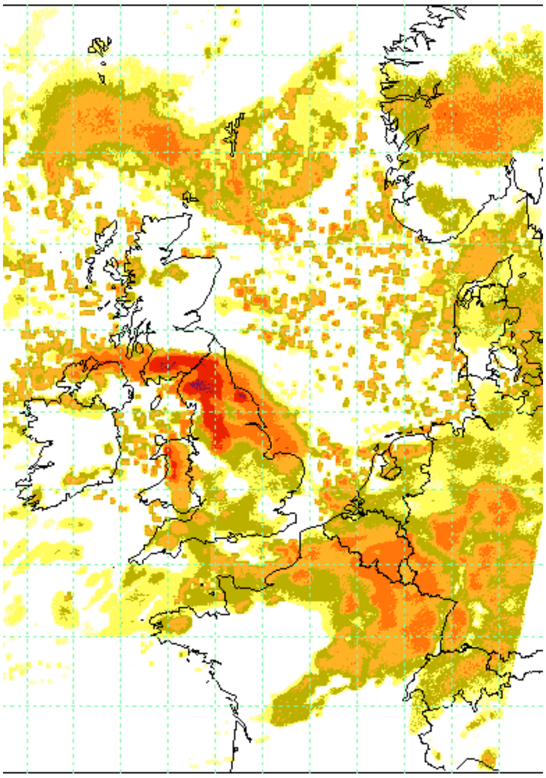

Fig 7. Wet Deposition Field utilising Mesoscale NWP Met data only

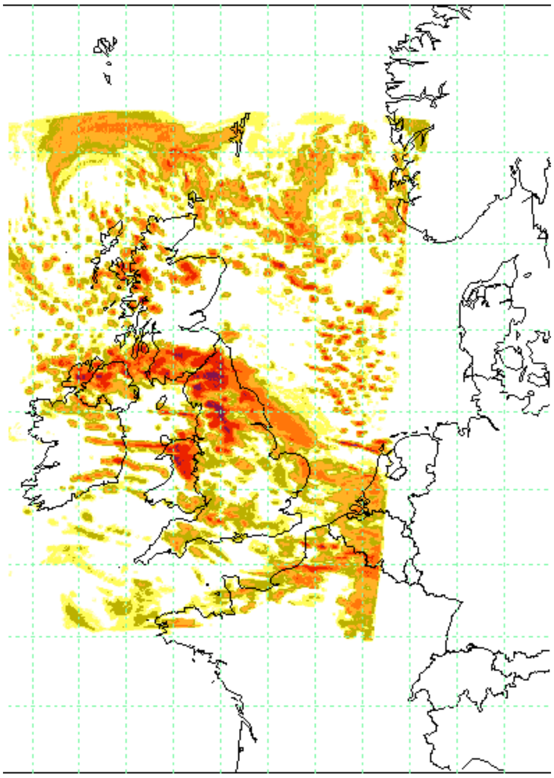

Fig 8. Wet Deposition Field utilising 4km NWP Met data only

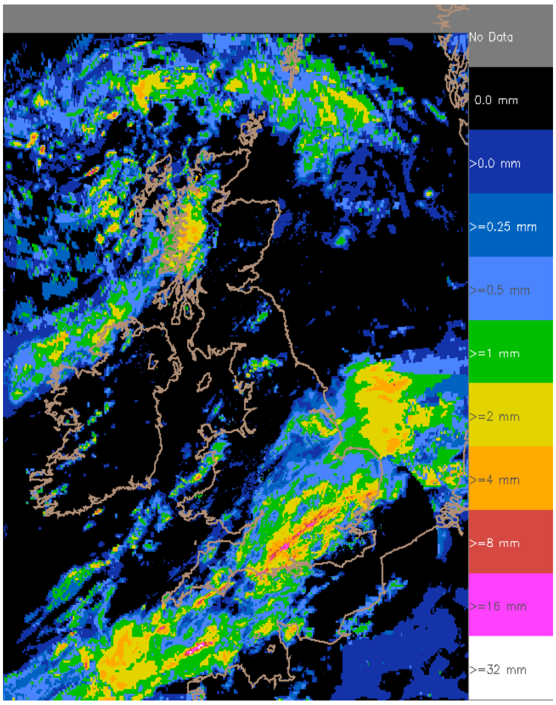

Fig 9. Rainfall rate output from UKPP (full domain)

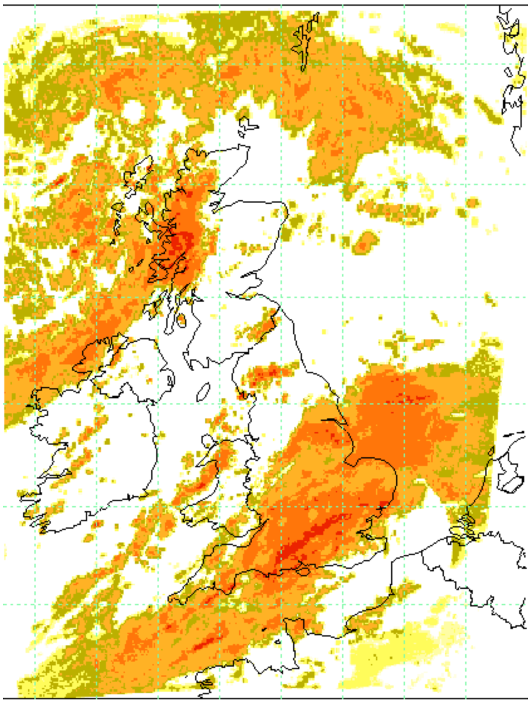

Fig 10. Wet Deposition Field utilising UKPP Output (full domain)

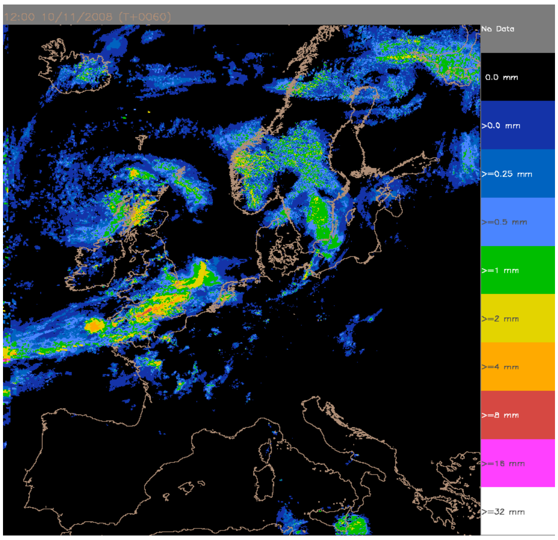

Fig 11. Rainfall rate output from EuroPP (full domain)

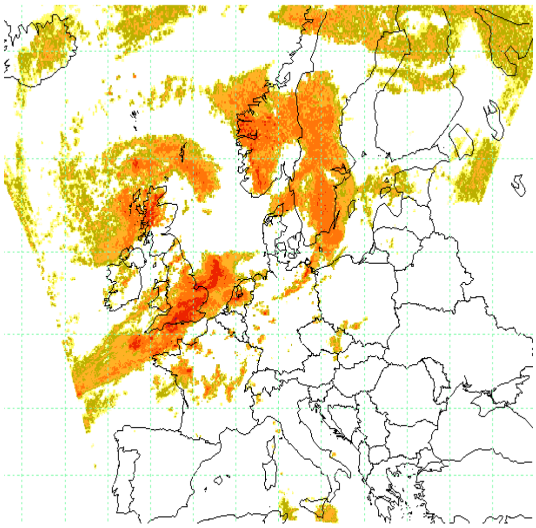

Fig 12. Wet Deposition Field utilising EuroPP Output (full domain)

For the purposes of testing Figures 5-8 give confidence in the use of radar data in NAME III, however they do not provide a comprehensive indication of the differences between using rainfall rate from radar output in NAME III and using rainfall rate from NWP met and no general conclusions can be drawn from these figures. It would be worthwhile to perform a study to identify the differences in NAME III output as a result of using the different rainfall rate data. Consideration should include comparisons of frontal, convective and orographic rainfall. This was not performed here due to a lack of time.

10. UKPP and EuroPP cloud data

Estimates of wet deposition in NAME III require cloud related data, as well as information regarding rainfall and ‘flows’. The data required includes cloud base height and cloud top height for both dynamic and convective cloud types and also the fractional amount of cloud for convective cloud types. The cloud base and cloud top heights are required to determine the spatial position of a particle relative to cloud and therefore to determine the appropriate scavenging (washout) coefficients to be applied to such a particle.

Currently neither cloud data nor details of the height from which the rain is falling are included in the NIMROD, UKPP or EuroPP datasets received by the Atmospheric Dispersion Group, however it is apparent that this data is available if required (see Appendix D for details). Cloud related information would be of use for all runs utilising radar data. This data would be beneficial for runs utilising a combination of radar and single site met data, whereby the latter can include only cloud cover amount and not cloud base and cloud top height. NWP met data includes cloud base and cloud top height, however there may be occasions where a combination of radar and NWP met data results in the latter indicating the presence of no cloud but at the same location the former indicating rain. In this instance no rain will be considered. Under such circumstances it would clearly be beneficial for runs utilising NWP met data, to also read in UKPP or EuroPP cloud data.

If single site met data and radar data are used in a single run, then in order to estimate fields of wet deposition, the amount of cloud cover must be set in the Single Site Met input file. For such a run, the amount of cloud cover defined is set to the dynamic fractional amount of cloud. The convective fractional amount of cloud is assumed to be 0. The convective cloud base and cloud top are assumed to be -1, which implies that there exists no convective cloud. If the dynamic fractional cloud amount is 0 then the dynamic cloud base height and dynamic cloud top height are both set to -1. If the dynamic fractional cloud amount is non zero then the dynamic cloud base height and dynamic cloud top height are set to 2000 m and 6000 m, respectively.

11. Summary and Future work

This document details of how radar data from NIMROD and subsequently EuroPP services could be utilised in NAME III, including a description of the data held in NIMROD, UKPP and EuroPP output files and methods of visualising radar data. Details of how to run NAME III with radar data can be found in Section 7 of the note.

Areas for future work include:

i) ADG should consider whether it wishes to continue receive the EuroPP cutout data feed or rivert to data feeds of UKPP and/or EuroPP on the full domains.

ii) The Atmospheric Dispersion Group may wish to consider the best approach for modelling wet deposition when using radar data. When Helen Webster updates the modelling of wet deposition in NAME III it may be opportune to also consider how radar data is used in the estimation of wet deposition. This should include checks to ensure that there is no double counting of wet deposition resulting from orographically enhanced rainfall.

iii) In the future the NAME III code should be updated to account for different filenames associated with different types of radar data (not just NIMROD file names).

iv) Modify the 'Radar Met Module Instances:' block to include the capability to define dX and dY (grid size) explicitly here.

v) For the purposes of testing Figures 5-8 give confidence in the use of radar data in NAME III, however they do not provide a comprehensive indication of the differences between using rainfall rate from radar output in NAME III and using rainfall rate from NWP met and no general conclusions can be drawn from these figures. It would be worthwhile to perform a study to identify the differences in NAME III output as a result of using the different rainfall rate data. Consideration should include comparisons of frontal, convective and orographic rainfall.

vi) Currently neither cloud data nor details of the height from which the rain is falling are included in the NIMROD, UKPP or EuroPP datasets received by the Atmospheric Dispersion Group, however it is apparent that this data is available if required. A feed of cloud related information may be of use for runs utilising radar data?

vii) UKPP output (and NIMROD output) does differentiates between 10 precipitation types, including different types of rain, freezing rain, hail, sleet and snow, plus unknown and dry conditions. A feed differentiating between precipitation types may be of use?

viii) Validation of NIMROD, UKPP and EuroPP rainfall rate data would be of interest to ADG. Contact Stephen Moseley in an effort to ascertain details of validation.

12. Useful Contacts

Stephen Moseley – main contact re the use of NIMROD, UKPP and EuroPP output data.

Stuart Reed – secondary contact re the use of NIMROD, UKPP and EuroPP output data.

Clive Pierce – contact for orographic enhancement in UKPP and EuroPP output data.

Robert Scovell – contact for Radarnet.

Alison Smith - Project Manager for the planned migration of all NIMROD services to UKPP and EuroPP services when NIMROD was retired at the end of October/November 2008.

Melissa Brimecombe – Project team member for the migration of all NIMROD services to UKPP and EuroPP services when NIMROD was retired at the end of October/November 2008. Tasked with the job of documenting the end-users/external customers who receive products originating from NIMROD.

Appendix A – UKPP file format

Table 2 describes the UKPP file format (analogous to the NIMROD file format), including the NAME III default values. Where the UKPP default values are different from the NIMROD default values, they are highlighted in red type.

Table 2. UKPP (full domain) file format including NAME III default values

Data Type	Element number	Description of header element	NAME default values
Integer*2	**1-31**	**General header entries (Bytes 1-62)**	
I*2	1.	VT year. VT is the Validity Time of the data.	E.g. 2008
I*2	2.	VT month.	E.g. 10 (Oct)
I*2	3.	VT day.	E.g. 01
I*2	4.	VT hour.	-
I*2	5.	VT minute.	-
I*2	6.	VT second.	-
I*2	7.	DT year. DT is the Data Time. It can be used for models, forecast images, or forecast data.	Same as VT
I*2	8.	DT month.	Same as VT
I*2	9.	DT day.	Same as VT
I*2	10.	DT hour.	Same as VT
I*2	11.	DT minute.	Same as VT
I*2	12.	=0 if data is of type real, =1 if data is of type integer, =2 if data is of type byte.	1, integer data type
I*2	13.	Number of bytes for each data element (1, 2, or 4).	2
I*2	14.	Experiment number (user supplied).	-32767 – blank
I*2	15.	Horizontal grid type (0=NG, 1=lat/long, 2=space view, 3=polar stereographic, 4=x/y grid, 5=other).	0, National Grid
I*2	16.	Number of rows in field.	704
I*2	17.	Number of columns in field.	548
I*2	18.	Header file release number (2 for the first release of the Nimrod header).	2
I*2	19.	Field code number (includes data type).	213
I*2	20.	Vertical co-ordinate type (0=height above orography, 1=height above sea-level, 2=pressure, 3=sigma, 4=eta, 5=radar beam number, 6=temperature, 7=potential temperature, 8=equivalent potential temperature, 9=wet bulb potential temperature, 10=potential vorticity, 11=cloud boundary, 12=levels below ground).	0, height above orography
I*2	21.	Vertical co-ordinate of reference level e.g. for thickness fields (values as for element 20).	-32767 – blank
I*2	22.	Number of elements, starting at element 60, which are used for data-specific information e.g. calibration information only appropriate to a radar image (this element previously indicated whether or not a supplied colour table is used).	0
I*2	23.	Number of elements, starting at element 109, which are used for data-specific information (previously this was the number of categories in colour table).	0
I*2	24.	Location of origin of data (0=top LH corner, 1=bottom LH corner, 2=top RH corner, 3=bottom RH corner).	0, top left hand corner
I*2	25.	Integer missing data value.	-32767 – blank
I*2	26.	Period of accumulation or average (minutes)	0
I*2	27.	Number of Model Levels	1

I*2	28.	Projection biaxial ellipsoid [0 = Airy 1830 (NG), 1 = International 1924 (modified UTM-32), 2 = GRS80 (GUGiK 1992/19)].	-32767 – blank
I*2	29.	Spare	-32767 – blank
I*2	30.	Spare	-32767 – blank
I*2	31.	Spare	-32767 – blank
Real*4	**32-59**	**General header entries (Bytes 63-174)**	
R*4	32.	Value of vertical co-ordinate (e.g. 500.0 for a 500hPa height field), or radar beam number (8888.0=sea-level, 9999.0=ground level or undefined). If the vertical co-ordinate type (element 20) is set to 3 or 4 then the value is set to model level number. For example, 3.0 for model level three or 2.5 for model level two and a half.	9999 – ground level or undefined (starts @ 46 1c, on the 5th row and the 3rd column)
R*4	33.	Value of reference vertical co-ordinate (e.g. 1000.0 for a 500 - 1000hPa thickness field)	-32767 – blank
R*4	34.	Northing or latitude or start line of first row of data (metres for NG, degrees for PS grids).	1.222E+06
R*4	35.	Interval between rows i.e. pixel size. For PS images this will be the resolution in the y-direction at the standard latitude of 60 degrees North (metres or degrees).	2000
R*4	36.	Easting or longitude or start pixel of first point of first row of data (metres or degrees).	-2.38E+05
R*4	37.	Interval between columns ie. pixel size. For polar stereographic images this will be the resolution in the x-direction at the standard latitude of 60 degrees North (metres or degrees).	2000
R*4	38.	Real missing data value.	-32767 – blank
R*4	39.	MKS scaling factor for data (=100.0 for pressure in millibars).	8.680556E-09
R*4	40.	Data offset value.	0
R*4	41.	X-offset of model data from gridpoints (positive = to East, negative = to West).	0
R*4	42.	Y-offset of model data from gridpoints (positive = to North, negative = to South)	0
R*4	43.	Standard latitude or latitude of true origin (TM or PS projection) in degrees	49
R*4	44.	Standard longitude or longitude of true origin(TM or PS projections) in degrees	-2
R*4	45.	Easting of true origin (TM Projection) in metres (units in error – should be in kilometres)	400
R*4	46.	Northing of true origin (TM Projection) in metres (units in error – should be in kilometres)	-100
R*4	47	Scale factor on central meridian for TM Projections [NG = 0.9996012717, modified UTM-32 = 0.9996, GUGiK 1992/19 = 0.9993].	-32767 – blank
R*4	48 - 59.	To be used for general header entries. These elements were previously used for a colour table.	-32767 – blank
Real*4	**60-104**	**Data specific header entries (Bytes 175-354)** These elements were previously used for a colour table.	
R*4	60	Northing or latitude of top left corner of the image (metres for NG, degrees for PS grids)	-32767 – blank

R*4	61	Easting or longitude of top left corner of the image (metres for NG, degrees for PS grids)	-32767 – blank
R*4	62	Northing or latitude of top right corner of the image (metres for NG, degrees for PS grids)	-32767 – blank
R*4	63	Easting or longitude of top right corner of the image (metres for NG, degrees for PS grids)	-32767 – blank
R*4	64	Northing or latitude of bottom right corner of the image (metres for NG, degrees for PS grids)	-32767 – blank
R*4	65	Easting or longitude of bottom right corner of the image (metres for NG, degrees for PS grids)	-32767 – blank
R*4	66	Northing or latitude of bottom left corner of the image (metres for NG, degrees for PS grids)	-32767 – blank
R*4	67	Easting or longitude of bottom left corner of the image (metres for NG, degrees for PS grids)	-32767 – blank
R*4	68	Satellite calibration co-efficient	-32767 – blank
R*4	69	Space count (satellite data)	-32767 – blank
R*4	70	Ducting Index	-32767 – blank
R*4	71	Elevation Angle	-32767 – blank and all entries up to 104 are blank
Character	**105-107**	**Character header entries (Bytes 355-410)**	
C*8	105[3].	Character string denoting the units of the field.	1/32 mm/hrrainanl (plus 17 spaces) (units of) (Starts @ ‘31 2f’; runs to ‘6e 6c)
C*24	106.	Character string to describe the source of the data.	
C*24	107.	Title of field.	precipitation rate (plus 6 spaces) (Starts @ ‘70 72’; runs to ‘74 65’)
Integer*2	**108-**	**Data specific header entries (Bytes 411-512)** These elements were previously used for a colour table.	
I*2	108.	The radar number for a single site image (set to zero for a radar composite).	8224
I*2	109.	The radar sites which have gone into forming a composite image. Each site is represented by a particular bit which is set to 1 if the site was available, and 0 if it was not. Radar site 1 will be represented by the least significant bit of element 109.	8224
I*2	110.	As element 110 for additional radar sites. This will only be required if the number of operational sites exceeds 16.	8224
I*2	111.	Clutter map number.	-32767 – blank

[3] *This element was originally 2 real*4 elements in the NDG header. The numbering of subsequent elements has therefore changed.*

I*2	112.	Calibration Type (0=uncalibrated, 1=frontal, 2=showers, 3=rain shadow, 4=bright band; the negatives of these values can be used to indicate a calibration which has subsequently been removed.	Blank and all subsequent 'data entries' are blank (51? data entries).
I*2	113.	Bright band height (units of 10m).	
I*2	114.	Bright band intensity. This is defined as the enhancement of the rainfall in the bright band relative to the rain beneath it.	
I*2	115.	Bright band test parameter 1. This is the percentage of sectors (24 in all) which have detected a possible bright band.	
I*2	116.	Bright band test parameter 2. This is the percentage of the sectors in entry 30 which agree with the bright band height of 28.	
I*2	117.	Infill Flag (for level 4.1)	
I*2	118.	Stop Elevation (for level 4.1)	
I*2	119-131	Used to duplicate real*4 general header entries 32-44 for data transfers to COSMOS (Note: All entries are $\times 10^{-3}$).	
I*2	132-139	Used to duplicate real*4 specific header entries 60-67 for data transfers to COSMOS (Note: All entries are $\times 10^{-3}$).	
I*2	140	Sensor identifier (Satellite data)	
I*2	141	Meteosat identifier (currently 5 or 6)	
I*2	143	Availability of synop meteosat and forecast alphas in combined alphas field (e.g. 111 all available, 100, only synop)	
etc.		The remaining space may be used for further data/application-specific entries.	

Appendix B – EuroPP file format

Table 3 describes the EuroPP file format (analogous to the NIMROD file format), including the NAME III default values. Where the EuroPP default values are different from the NIMROD default values, they are highlighted in red type.

Table 3. EuroPP (full domain) file format including NAME III default values

Data Type	Element number	Description of header element	NAME default values
Integer*2	**1-31**	**General header entries (Bytes 1-62)**	
I*2	1.	VT year. VT is the Validity Time of the data.	E.g. 2008
I*2	2.	VT month.	E.g. 10 (Oct)
I*2	3.	VT day.	E.g. 01
I*2	4.	VT hour.	E.g. 12
I*2	5.	VT minute.	-
I*2	6.	VT second.	-
I*2	7.	DT year. DT is the Data Time. It can be used for models, forecast images, or forecast data.	Same as VT
I*2	8.	DT month.	Same as VT
I*2	9.	DT day.	Same as VT
I*2	10.	DT hour.	E.g. 11
I*2	11.	DT minute.	Same as VT
I*2	12.	=0 if data is of type real, =1 if data is of type integer, =2 if data is of type byte.	1, integer data type

I*2	13.	Number of bytes for each data element (1, 2, or 4).	2
I*2	14.	Experiment number (user supplied).	0
I*2	15.	Horizontal grid type (0=NG, 1=lat/long, 2=space view, 3=polar stereographic, 4=x/y grid, 5=other).	0, National Grid
I*2	16.	Number of rows in field.	759
I*2	17.	Number of columns in field.	639
I*2	18.	Header file release number (2 for the first release of the Nimrod header).	2
I*2	19.	Field code number (includes data type).	213
I*2	20.	Vertical co-ordinate type (0=height above orography, 1=height above sea-level, 2=pressure, 3=sigma, 4=eta, 5=radar beam number, 6=temperature, 7=potential temperature, 8=equivalent potential temperature, 9=wet bulb potential temperature, 10=potential vorticity, 11=cloud boundary, 12=levels below ground).	1, height above sea-level
I*2	21.	Vertical co-ordinate of reference level e.g. for thickness fields (values as for element 20).	0
I*2	22.	Number of elements, starting at element 60, which are used for data-specific information e.g. calibration information only appropriate to a radar image (this element previously indicated whether or not a supplied colour table is used).	0
I*2	23.	Number of elements, starting at element 109, which are used for data-specific information (previously this was the number of categories in colour table).	0
I*2	24.	Location of origin of data (0=top LH corner, 1=bottom LH corner, 2=top RH corner, 3=bottom RH corner).	0, top left hand corner
I*2	25.	Integer missing data value.	-32767 – blank
I*2	26.	Period of accumulation or average (minutes)	-32767 – blank
I*2	27.	Number of Model Levels	1
I*2	28.	Projection biaxial ellipsoid [0 = Airy 1830 (NG), 1 = International 1924 (modified UTM-32), 2 = GRS80 (GUGiK 1992/19)].	-32767 – blank
I*2	29.	Spare	-32767 – blank
I*2	30.	Spare	-32767 – blank
I*2	31.	Spare	-32767 – blank
Real*4	**32-59**	**General header entries (Bytes 63-174)**	
R*4	32.	Value of vertical co-ordinate (e.g. 500.0 for a 500hPa height field), or radar beam number (8888.0=sea-level, 9999.0=ground level or undefined). If the vertical co-ordinate type (element 20) is set to 3 or 4 then the value is set to model level number. For example, 3.0 for model level three or 2.5 for model level two and a half.	9999 – ground level or undefined (starts @ 46 1c, on the 5th row and the 3rd column)
R*4	33.	Value of reference vertical co-ordinate (e.g. 1000.0 for a 500 - 1000hPa thickness field)	-32767 – blank
R*4	34.	Northing or latitude or start line of first row of data (metres for NG, degrees for PS grids).	3.795E+06
R*4	35.	Interval between rows i.e. pixel size. For PS images this will be the resolution in the y-direction at the standard latitude of 60 degrees North (metres or degrees).	5000

R*4	36.	Easting or longitude or start pixel of first point of first row of data (metres or degrees).	0.0E+00
R*4	37.	Interval between columns ie. pixel size. For polar stereographic images this will be the resolution in the x-direction at the standard latitude of 60 degrees North (metres or degrees).	5000
R*4	38.	Real missing data value.	-32767 – blank
R*4	39.	MKS scaling factor for data (=100.0 for pressure in millibars).	8.680556E-09
R*4	40.	Data offset value.	0
R*4	41.	X-offset of model data from gridpoints (positive = to East, negative = to West).	0
R*4	42.	Y-offset of model data from gridpoints (positive = to North, negative = to South)	0
R*4	43.	Standard latitude or latitude of true origin (TM or PS projection) in degrees	50
R*4	44.	Standard longitude or longitude of true origin(TM or PS projections) in degrees	9
R*4	45.	Easting of true origin (TM Projection) in metres (units in error – should be in kilometres)	1750
R*4	46.	Northing of true origin (TM Projection) in metres (units in error – should be in kilometres)	1500
R*4	47	Scale factor on central meridian for TM Projections [NG = 0.9996012717, modified UTM-32 = 0.9996, GUGiK 1992/19 = 0.9993].	-32767 – blank
R*4	48 - 59.	To be used for general header entries. These elements were previously used for a colour table.	-32767 – blank
Real*4	**60-104**	**Data specific header entries (Bytes 175-354)** These elements were previously used for a colour table.	
R*4	60	Northing or latitude of top left corner of the image (metres for NG, degrees for PS grids)	-32767 – blank
R*4	61	Easting or longitude of top left corner of the image (metres for NG, degrees for PS grids)	-32767 – blank
R*4	62	Northing or latitude of top right corner of the image (metres for NG, degrees for PS grids)	-32767 – blank
R*4	63	Easting or longitude of top right corner of the image (metres for NG, degrees for PS grids)	-32767 – blank
R*4	64	Northing or latitude of bottom right corner of the image (metres for NG, degrees for PS grids)	-32767 – blank
R*4	65	Easting or longitude of bottom right corner of the image (metres for NG, degrees for PS grids)	-32767 – blank
R*4	66	Northing or latitude of bottom left corner of the image (metres for NG, degrees for PS grids)	-32767 – blank
R*4	67	Easting or longitude of bottom left corner of the image (metres for NG, degrees for PS grids)	-32767 – blank
R*4	68	Satellite calibration co-efficient	-32767 – blank
R*4	69	Space count (satellite data)	-32767 – blank
R*4	70	Ducting Index	-32767 – blank
R*4	71	Elevation Angle	-32767 – blank and all entries up to 104 are blank

Character	105-107	Character header entries (Bytes 355-410)	
C*8	105[4].	Character string denoting the units of the field.	mm/hr*32Merged (plus 18 spaces) (units of) (Starts @ '6d 6d'; runs to '65 64)
C*24	106.	Character string to describe the source of the data.	
C*24	107.	Title of field.	Rainrate forecast (plus 7 spaces) (Starts @ '52 61'; runs to '73 74')
Integer*2	**108-**	**Data specific header entries (Bytes 411-512)** These elements were previously used for a colour table.	
I*2	108.	The radar number for a single site image (set to zero for a radar composite).	-32767 – blank
I*2	109.	The radar sites which have gone into forming a composite image. Each site is represented by a particular bit which is set to 1 if the site was available, and 0 if it was not. Radar site 1 will be represented by the least significant bit of element 109.	-32767 – blank
I*2	110.	As element 110 for additional radar sites. This will only be required if the number of operational sites exceeds 16.	-32767 – blank
I*2	111.	Clutter map number.	-32767 – blank
I*2	112.	Calibration Type (0=uncalibrated, 1=frontal, 2=showers, 3=rain shadow, 4=bright band; the negatives of these values can be used to indicate a calibration which has subsequently been removed.	Blank and all subsequent 'data entries' are blank (51? data entries).
I*2	113.	Bright band height (units of 10m).	
I*2	114.	Bright band intensity. This is defined as the enhancement of the rainfall in the bright band relative to the rain beneath it.	
I*2	115.	Bright band test parameter 1. This is the percentage of sectors (24 in all) which have detected a possible bright band.	
I*2	116.	Bright band test parameter 2. This is the percentage of the sectors in entry 30 which agree with the bright band height of 28.	
I*2	117.	Infill Flag (for level 4.1)	
I*2	118.	Stop Elevation (for level 4.1)	
I*2	119-131	Used to duplicate real*4 general header entries 32-44 for data transfers to COSMOS (Note: All entries are $\times 10^{-3}$).	
I*2	132-139	Used to duplicate real*4 specific header entries 60-67 for data transfers to COSMOS (Note: All entries are $\times 10^{-3}$).	
I*2	140	Sensor identifier (Satellite data)	
I*2	141	Meteosat identifier (currently 5 or 6)	

4、 *This element was originally 2 real*4 elements in the NDG header. The numbering of subsequent elements has therefore changed.*

I*2	143	Availability of synop meteosat and forecast alphas in combined alphas field (e.g. 111 all available, 100, only synop)
etc.		The remaining space may be used for further data/application-specific entries.

Appendix C – UKPP and EuroPP precipitation data

When modelling wet deposition, the form of the precipitation is likely to impact upon the wet deposition field. NAME III currently accounts for precipitation greater than 270 K and less than or equal to 270 K, which in affect account for rain and snow, respectively.

UKPP output does not differentiate between dynamic and convective met, including precipitation. However UKPP output (and NIMROD output) does differentiates between 10 precipitation types, including different types of rain, freezing rain, hail, sleet and snow, plus unknown and dry conditions. This is produced by NIMROD and UKPP by way of a precipitation type diagnostic file. For details go to: http://exvwebsrva/~fppp/display_pages/precip_type_anal.html and http://nimrod/pages/precip_forecast.html. An outline of the operational post processing scheme for determining precipitation type can be found at: http://fcm9/projects/PostProc/wiki/PostProcDocType. The precipitation type scheme also outputs a snow fraction field, which indicates what fraction of the precipitation is expected to fall as snow rather than rain.

The rain analysis is output in the following bands: 0-0.25, 0.25-0.5, 0.5-1.0, 1-2, 2-4, 4-8, 8-16, 16-32, > 32 and Sat. rain (assumed to be in units of mm/hr). For further details go to:
http://nimrod/pages/Nimrod_rainanalysis.html.

The range of outputs from NIMROD are extensive. For details go to:
http://nimrod/pages_dynamic/file_list.html. It is apparent that a similar set of output is produced from UKPP.

It would clearly be of use to consider any validation of UKPP output data. Stephen Moseley advised that little validation has been undertaken. This is partly because the UKPP output is a relatively new source of data and they have not yet got round to undertaking any validation (validation has been undertaken for the NIMROD 15 x 15 km output, however subsequent changes in the methods of the post-processing, have resulted in these validation studies being of little use). Furthermore validating post-processed output is not straightforward as the nature of post-processing implies the use of most, if not all 'types' of data when deriving the output fields, leaving little data left/remaining to validate the output against. Awaiting details of any validation uncovered by Stephen Moseley.

Automated precipitation type identification is not possible in Radarnet (see Appendix E for further details). In the long term it is hoped that this will be possible by replacing the older radars with the newer dual-polarisation radars which perform much better. However, there has been some work done on automated precipitation identification in the Met Office, for example the Neural Network Cloud Classifier: http://nimrod/gandolf/pages/gandolf_nncc_new.html.

Appendix D – UKPP and EuroPP cloud data

In Section 10 it was identified that it may be of use to retrieve cloud data. Cloud data is available from NIMROD. For example the nowcasting service can provide hourly forecasts of cloud cover, cloud cover below 15000 ft, cloud base (5 oktas) – i.e. less than 60m, less than 90m, less than 210m,…., less than 1500m and greater than 1500m, and cloud base (3 oktas) – at the same heights as for cloud base (5 oktas) (from t+0 to t+6 hours) (http://nimrod/pages/cloud_products.html).

Also towering convection – cloud depth 5-10,000 ft, 10-15,000 ft and > 15000 ft are output from NIMROD (http://nimrod/pages/towering_convection.html).

The range of outputs from NIMROD are extensive. For details go to: http://nimrod/pages_dynamic/file_list.html. The cloud data includes European as well as UK data. All cloud related fields produced by NIMROD and listed within the link above are available from UKPP and EuroPP but at the new resolutions (2 x 2 km and 5 x 5 km, respectively). Stephen Moseley advised that fractional amount of cloud cover, cloud base height and cloud top height can all be ascertained from UKPP output, primarily from cloud analysis and UM cloud analysis products but also from Meteosat VIS and IR products and for forecasts, from UM Mesoscale/Global integrated 3-D and 2-D fields.

Operationally (for the Operational Numerical Weather Prediction), the Met Office runs a number of configurations of its Unified Model. These range from the global model, with a mid-latitude resolution of ~40 km, down to a high resolution 4 km UK model. UKPP data uses the UK 4km model. The UK 4km model can explicitly model convection and therefore does not consider convective and dynamic clouds separately. Thus UKPP output includes fractional cloud amount, cloud base height and cloud top height, however no account is made of whether the cloud is convective or dynamic. In contrast, because NIMROD used NWP met data on larger grids (possibly NAE 12 x 12 km grids) the model could not model convection explicitly (modelled instead by parameterisations?) and therefore the NIMROD model output did differentiate between convective and dynamic cloud.

In practice data describing the range of heights over which the precipitation is falling from would provide a suitable alternative to cloud base height and cloud top height data. It is unclear whether Radarnet could provide this information.

Appendix E - Radarnet

Table 4 below details the Radarnet file format, which is very similar, and infact is based upon to the NIMROD file format. Those sections of the table which differ from the NIMROD data are highlighted in red type.

Note that "-32767" implies a blank data entry. The heading ends at 00 04 94 76 (on row 19), inclusive. The precipitation data follows the file heading. All precipitation data are in units of mm/hr * 32 and must be divided by 32 to ascertain the 'true' rainfall rate.

Table 4. Radarnet file format including NAME III default values

Data Type	Element number	Description of header element	NAME default values
Integer*2	**1-31**	**General header entries (Bytes 1-62)**	
I*2	1.	VT year. VT is the Validity Time of the data.	E.g. 2008
I*2	2.	VT month.	E.g. 10 (Oct)
I*2	3.	VT day.	E.g. 01
I*2	4.	VT hour.	-
I*2	5.	VT minute.	-
I*2	6.	VT second.	-
I*2	7.	DT year. DT is the Data Time. It can be used for models, forecast images, or forecast data.	Same as VT
I*2	8.	DT month.	Same as VT
I*2	9.	DT day.	Same as VT
I*2	10.	DT hour.	Same as VT
I*2	11.	DT minute.	Same as VT
I*2	12.	=0 if data is of type real, =1 if data is of type integer, =2 if data is of type byte.	1, integer data type
I*2	13.	Number of bytes for each data element (1, 2, or 4).	2
I*2	14.	Experiment number (user supplied).	-32767 – blank
I*2	15.	Horizontal grid type (0=NG, 1=lat/long, 2=space view, 3=polar stereographic, 4=x/y grid, 5=other).	0, National Grid
I*2	16.	Number of rows in field.	2175
I*2	17.	Number of columns in field.	1725
I*2	18.	Header file release number (2 for the first release of the Nimrod header).	2
I*2	19.	Field code number (includes data type).	213
I*2	20.	Vertical co-ordinate type (0=height above orography, 1=height above sea-level, 2=pressure, 3=sigma, 4=eta, 5=radar beam number, 6=temperature, 7=potential temperature, 8=equivalent potential temperature, 9=wet bulb potential temperature, 10=potential vorticity, 11=cloud boundary, 12=levels below ground).	5, radar beam number
I*2	21.	Vertical co-ordinate of reference level e.g. for thickness fields (values as for element 20).	-32767 – blank
I*2	22.	Number of elements, starting at element 60, which are used for data-specific information e.g. calibration information only appropriate to a radar image (this element previously indicated whether or not a supplied colour table is used).	0
I*2	23.	Number of elements, starting at element 109, which are used for data-specific information (previously this was the number of categories in colour table).	11
I*2	24.	Location of origin of data (0=top LH corner, 1=bottom LH corner, 2=top RH corner, 3=bottom RH corner).	0, top left hand corner
I*2	25.	Integer missing data value.	-1 – no value
I*2	26.	Period of accumulation or average (minutes)	-32767 – blank
I*2	27.	Number of Model Levels	-32767 – blank

I*2	28.	Projection biaxial ellipsoid [0 = Airy 1830 (NG), 1 = International 1924 (modified UTM-32), 2 = GRS80 (GUGiK 1992/19)].	-32767 – blank
I*2	29.	Spare	-32767 – blank
I*2	30.	Spare	-32767 – blank
I*2	31.	Spare	-32767 – blank
Real*4	**32-59**	**General header entries (Bytes 63-174)**	
R*4	32.	Value of vertical co-ordinate (e.g. 500.0 for a 500hPa height field), or radar beam number (8888.0=sea-level, 9999.0=ground level or undefined). If the vertical co-ordinate type (element 20) is set to 3 or 4 then the value is set to model level number. For example, 3.0 for model level three or 2.5 for model level two and a half.	9999 – ground level or undefined (starts @ 46 1c, on the 5th row and the 3rd column)
R*4	33.	Value of reference vertical co-ordinate (e.g. 1000.0 for a 500 - 1000hPa thickness field)	-32767 – blank
R*4	34.	Northing or latitude or start line of first row of data (metres for NG, degrees for PS grids).	1.5495E+06
R*4	35.	Interval between rows i.e. pixel size. For PS images this will be the resolution in the y-direction at the standard latitude of 60 degrees North (metres or degrees).	1000
R*4	36.	Easting or longitude or start pixel of first point of first row of data (metres or degrees).	-4.045e+05
R*4	37.	Interval between columns ie. pixel size. For polar stereographic images this will be the resolution in the x-direction at the standard latitude of 60 degrees North (metres or degrees).	1000
R*4	38.	Real missing data value.	-1 – no value
R*4	39.	MKS scaling factor for data (=100.0 for pressure in millibars).	0
R*4	40.	Data offset value.	0
R*4	41.	X-offset of model data from gridpoints (positive = to East, negative = to West).	-32767 – blank
R*4	42.	Y-offset of model data from gridpoints (positive = to North, negative = to South)	-32767 – blank
R*4	43.	Standard latitude or latitude of true origin (TM or PS projection) in degrees	-32767 – blank
R*4	44.	Standard longitude or longitude of true origin(TM or PS projections) in degrees	-32767 – blank
R*4	45.	Easting of true origin (TM Projection) in metres	-32767 – blank
R*4	46.	Northing of true origin (TM Projection) in metres	-32767 – blank
R*4	47	Scale factor on central meridian for TM Projections [NG = 0.9996012717, modified UTM-32 = 0.9996, GUGiK 1992/19 = 0.9993].	-32767 – blank
R*4	48 - 59.	To be used for general header entries. These elements were previously used for a colour table.	-32767 – blank
Real*4	**60-104**	**Data specific header entries (Bytes 175-354)** These elements were previously used for a colour table.	
R*4	60	Northing or latitude of top left corner of the image (metres for NG, degrees for PS grids)	1.55E+06
R*4	61	Easting or longitude of top left corner of the image (metres for NG, degrees for PS grids)	-4.05E+05

R*4	62	Northing or latitude of top right corner of the image (metres for NG, degrees for PS grids)	1.55E+06
R*4	63	Easting or longitude of top right corner of the image (metres for NG, degrees for PS grids)	1.32E+06
R*4	64	Northing or latitude of bottom right corner of the image (metres for NG, degrees for PS grids)	-6.25E+05
R*4	65	Easting or longitude of bottom right corner of the image (metres for NG, degrees for PS grids)	1.32E+06
R*4	66	Northing or latitude of bottom left corner of the image (metres for NG, degrees for PS grids)	-6.25E+05
R*4	67	Easting or longitude of bottom left corner of the image (metres for NG, degrees for PS grids)	-4.05E+05
R*4	68	Satellite calibration co-efficient	-32767 – blank
R*4	69	Space count (satellite data)	-32767 – blank
R*4	70	Ducting Index	-32767 – blank
R*4	71	Elevation Angle	-32767 – blank and all entries up to 104 are blank
Character	**105-107**	**Character header entries (Bytes 355-410)**	
C*8	105[5].	Character string denoting the units of the field.	mm/h*32 (units of)
C*24	106.	Character string to describe the source of the data.	Plr single site radars
C*24	107.	Title of field.	Rainfall rate composite
Integer*2	**108-**	**Data specific header entries (Bytes 411-512)** These elements were previously used for a colour table.	
I*2	108.	The radar number for a single site image (set to zero for a radar composite).	0
I*2	109.	The radar sites which have gone into forming a composite image. Each site is represented by a particular bit which is set to 1 if the site was available, and 0 if it was not. Radar site 1 will be represented by the least significant bit of element 109.	-32767 – blank
I*2	110.	As element 110 for additional radar sites. This will only be required if the number of operational sites exceeds 16.	-32767 – blank
I*2	111.	Clutter map number.	0
I*2	112.	Calibration Type (0=uncalibrated, 1=frontal, 2=showers, 3=rain shadow, 4=bright band; the negatives of these values can be used to indicate a calibration which has subsequently been removed.	0
I*2	113.	Bright band height (units of 10m).	0
I*2	114.	Bright band intensity. This is defined as the enhancement of the rainfall in the bright band relative to the rain beneath it.	0
I*2	115.	Bright band test parameter 1. This is the percentage of sectors (24 in all) which have detected a possible bright band.	0
I*2	116.	Bright band test parameter 2. This is the percentage of the sectors in entry 30 which agree with the bright band height of 28.	0

[5] *This element was originally 2 real*4 elements in the NDG header. The numbering of subsequent elements has therefore changed.*

I*2	117.	Infill Flag (for level 4.1)	1
I*2	118.	Stop Elevation (for level 4.1)	-32767 – blank
I*2	119-131	Used to duplicate real*4 general header entries 32-44 for data transfers to COSMOS (Note: All entries are $\times 10^{-3}$).	-32767 – blank
I*2	132-139	Used to duplicate real*4 specific header entries 60-67 for data transfers to COSMOS (Note: All entries are $\times 10^{-3}$).	-32767 – blank
I*2	140	Sensor identifier (Satellite data)	-32767 – blank
I*2	141	Meteosat identifier (currently 5 or 6)	-32767 – blank
I*2	143	Availability of synop meteosat and forecast alphas in combined alphas field (e.g. 111 all available, 100, only synop)	-32767 – blank
etc.		The remaining space may be used for further data/application-specific entries.	-32767 – blank

Radarnet receives and processes all the incoming UK and European radar data. This data feed is received as 1km, 2km and 5km resolution data with increasing range as the resolution decreases. Radarnet merges these data together to give a 1km composite (it is thought that this is the highest resolution of rainfall data available within the Met Office). The 1km composite consists of 2175 x 1725 1km grid cells using the British National Grid projection. The top left corner lat / long coordinates are -17.97 deg. E and 62.92 deg. N (exactly the same domain as the NIMROD and EuroPP cutout data are output on). Radarnet currently uses the 'NIMROD' format to store the gridded data (as detailed in: http://nimrod/pages/system_docs/NO2.DOC and described in Section 3). There exists the flexibility to encode the data in other formats if necessary (eg some products are encoded in BUFR format, and in the long-term NetCDF format may replace the current NIMROD format). The version in use (as of November, 2008) is Radarnet-IV. The radar processing applied in preparation of the Radarnet-IV composite surface rain rate products (and therefore also NIMROD/UKPP/EuroPP analyses) involves amongst other things a VPR (Vertical Profile) correction which includes an orographic enhancement correction for low altitude, seeder-feeder enhancement. The area of radar coverage across the UK and Europe are detailed in Figures 3 and 4, respectively (taken from http://raduk/ and http://radeu/, respectively). The data is output on irregular domains as described by the Area of Radar Coverage although the grid itself is regular and the cells that have no coverage (which includes the area outside of the Area of Radar Coverage but within the area of the NIMROD domain) are marked as missing. This is due to the limitation of the range of the radar and the fact that there exist only a limited number of radar sites across the UK. Updates to the 1km composites are produced every five minutes and the radar data that is used in these composites is also updated every five minutes.

A paper, "Assessment of radar data quality in upland catchments" by Lewis and Harrison, 2007, details gauge-radar comparison techniques. The main focus of this work is not validation but it does contain significant information about how gauges can be used to validate radar data and therefore may be of interest. The paper can be found at: uplandpaper_submitted.pdf in /home/h05/appb/RADAR.

The most recent validation statistics produced on the Weather Radar Development Team's Operational machines can be found at:

http://raduk/composite_monitoring_tools.html (by selecting gauge-radar comparison statistics). Of particular interest is the RMSF (Root Mean Square Factor) value, the most important measure of the radar data quality that is used. There are further details about this in Lewis and Harrison, 2007.

Robert Scovell recommended speaking to Marion Mittermaier, an expert on validating radar data by using model data, for further information.