Nimrod System
Documentation Paper No.2

Nimrod format for image and model field files

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Nimrod File Format

With the exception of raw observations and some constants, most files on the Nimrod system will be held in a standard format developed from the NDG format.

Each file consists of one or more records held in sequential format. Each record consists of a 512 byte header followed by a data array. The data array may be in integer format with 1,2 or 4 bytes per item or in real format with 4 bytes per item.

Each header and data block are bounded by Fortran housekeeping bytes consisting of a 4-byte integer describing the length of the block. For the header, this integer is always 512. For the data, this will be {number of columns} x {number of rows} x {Number of bytes for each data element}. The file therefore looks like this:

<Header block length><Header block><Header block length><Data block length><Data block><Data block length><EOF>

All Nimrod format files contain big-endian data.

The default values for each element of the header will be; -32767 for integer elements, -32767.0 for real elements, and a 'null' string for character elements. It is recommended that all input data files have their data origin at the top left hand corner whenever possible. However, routines for reading the contents of Nimrod files will contain the option to return a data array with the first element being either the top left or bottom left point of the image/field. The header is constructed as follows.

Data Type	Element number	Description of header element
Integer*2	**1-31**	**General header entries (Bytes 1-62)**
I*2	1.	VT year. VT is the Validity Time of the data. For data with a time-period of validity (e.g. precip accumulation over one hour), this is the end of the time-period.
I*2	2.	VT month.
I*2	3.	VT day.
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.
I*2	8.	DT month.
I*2	9.	DT day.
I*2	10.	DT hour.
I*2	11.	DT minute.
I*2	12.	=0 if data is of type real, =1 if data is of type integer, =2 if data is of type byte.

I*2	13.	Number of bytes for each data element (1, 2, or 4).
I*2	14.	Experiment number (user supplied) – must be a multiple of four. 0 for operational output. Number +1 for QV-nowcast and Number+2 for CDP outputs
I*2	15.	Horizontal grid type (0=NG, 1=lat/lon, 2=space view, 3=polar stereographic, 4=UTM32 (EuroPP), 5=Rotated Lat Lon, 6=other).
I*2	16.	Number of rows in field.
I*2	17.	Number of columns in field.
I*2	18.	Header file release number (2 for the first release of the Nimrod header).
I*2	19.	Field code number (includes data type).
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).
I*2	21.	Vertical co-ordinate of reference level eg. for thickness fields (values as for element 20).
I*2	22.	Number of elements, starting at element 60, which are used for data-specific information eg. calibration information only appropriate to a radar image. (this element previously indicated whether or not a supplied colour table is used).
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).
I*2	24.	Location of origin of data (0=top LH corner, 1=bottom LH corner, 2=top RH corner, 3=bottom RH corner).
I*2	25.	Integer missing data value.
I*2	26.	Period of interest for accumulation, average or probability (minutes) A value of +32767 indicates that element 159 holds this value in seconds rather than minutes.
I*2	27.	Number of Model Levels available for this parameter
I*2	28.	Projection biaxial ellipsoid [0 = Airy 1830 (NG), 1 = International 1924 (modified UTM-32), 2 = GRS80 (GUGiK 1992/19)].
I*2	29.	Ensemble member ID
I*2	30.	Origin model ID (1: nowcast, 2: radar, 11:UKV, 12:UK4, 13:NAE, 14:Global, 15:MOGREPS-EU, 16:MOGREPS-UK, 17:UK4-extended, 18:4km Italy UM

I*2	31.	Time averaging (LBPROC) Combinations of: 1: warm bias applied 2: cold bias applied 4: smoothed 8: only observations used 16: averaged over multiple surface types 32: scaled to UM resolution (e.g. winds) 128: accumulation or average 256: extrapolation 512: time-lagged 4096: minimum in period 8192: maximum in period

Real*4	**32-59**	**General header entries (Bytes 63-174)**
R*4	32.	Value of vertical co-ordinate (eg. 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.
R*4	33.	Value of reference vertical co-ordinate (eg. 1000.0 for a 500 - 1000hPa thickness field)
R*4	34.	Northing or latitude or start line of first row of data (metres for NG, degrees for PS grids).
R*4	35.	Interval between rows ie. 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).
R*4	36.	Easting or longitude or start pixel of first point of first row of data (metres or degrees).
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).
R*4	38.	Real missing data value.
R*4	39.	MKS scaling factor for data (=100.0 for pressure in millibars).
R*4	40.	Data offset value.
R*4	41.	X-offset of model data from gridpoints (positive = to East, negative = to West).
R*4	42.	Y-offset of model data from gridpoints (positive = to North, negative = to South)
R*4	43.	Standard latitude or latitude of true origin(TM or PS projection) in degrees
R*4	44.	Standard longitude or longitude of true origin(TM or PS projections) in degrees
R*4	45.	Easting of true origin (TM Projection) in metres
R*4	46.	Northing of true origin (TM Projection) in metres
R*4	47	Scale factor on central meridian for TM Projections [NG = 0.9996012717, modified UTM-32 = 0.9996, GUGiK 1992/19 = 0.9993].
R*4	48	Threshold value (e.g. for probabilities and percentiles).
R*4	49 - 59.	To be used for general header entries.

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)
R*4	61	Easting or longitude of top left corner of the image (metres for NG, degrees for PS grids)
R*4	62	Northing or latitude of top right corner of the image (metres for NG, degrees for PS grids)
R*4	63	Easting or longitude of top right corner of the image (metres for NG, degrees for PS grids)
R*4	64	Northing or latitude of bottom right corner of the image (metres for NG, degrees for PS grids)
R*4	65	Easting or longitude of bottom right corner of the image (metres for NG, degrees for PS grids)
R*4	66	Northing or latitude of bottom left corner of the image (metres for NG, degrees for PS grids)
R*4	67	Easting or longitude of bottom left corner of the image (metres for NG, degrees for PS grids)
R*4	68	Satellite calibration co-efficient
R*4	69	Space count (satellite data)
R*4	70	Ducting Index
R*4	71	Elevation Angle
R*4	72	Neighbourhood size (km) for probabilities
R*4	73	Radius of interest (km) for probabilities
R*4	74	Recursive filter strength α (for probabilities)
R*4	75	Fuzzy threshold parameter
R*4	76	Fuzzy duration of occurrence
R*4	77-104	Spare
Character	**105-107**	**Character header entries (Bytes 355-410)**
C*8	105[1].	Character string denoting the units of the field.
C*24	106.	Character string to describe the source of the data.
C*24	107.	Title of field.
Integer*2	**108-159**	**Data specific header entries (Bytes 411-512)** Table 1: Radar-specific entries
I*2	108.	The radar number for a single site image (set to zero for a radar composite).
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.
I*2	110.	As element 110 for additional radar sites. This will only be required if the number of operational sites exceeds 16.
I*2	111.	Clutter map number.

[1] *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.
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.
I*2	159	Period of interest for accumulation, average or probability (seconds) Only used when element 26 is set to +32767
Integer*2	**108-159**	**Data specific header entries (Bytes 411-512)** Table 2: Probability-specific entries (when element 48 is set)
I*2	108.	Indicator of threshold type specified in element 48 1: probability of event greater than threshold 2: probability of event less than threshold 3: distribution percentile threshold

I*2	109.	Probability method. Combinations of: 1: AOT (At any one time) over a time window of interest (this is the average probability over the time window) 2: ST (SomeTime) over the time window of interest (this is the maximum probability over the time window) 4: AT (All Time) over a time window of interest (this the probability that the threshold will (not) be exceeded for a certain total duration over the time window). 8: AOL (Any One Location over the region of interest (this is the average probability over the region) 16: SW (SomeWhere) over the region of interest (this is the maximum probability over the region)
I*2	110.	Number of iterations of the recursive filter
I*2	111.	Number of ensemble members this field represents
I*2	112.	Duration of occurrence in window of interest (window of interest is element 26)
etc.		The remaining space may be used for further data/application-specific entries.
I*2	159	Period of interest for accumulation, average or probability (seconds) Only used when element 26 is set to +32767

Integer*2	**108-159**	**Data specific header entries (Bytes 411-512)** Table 3: Tile surface specifications
I*2	114.	Indicator of surface tile type 1 Broadleaf Tree 2 Needleleaf Tree 3 C3 Grass 4 C4 Grass 5 Crop (Not available from UM – MOSES only) 6 Shrub 7 Urban 8 Water 9 Soil 10 Ice

Integer*2	**108-159**	**Data specific header entries (Bytes 411-512)** Table 4: Radiation type specifications
I*2	115.	Indicator of radiation type. Combinations of: 2 clear-sky radiation 4 direct radiation 8 diffuse radiation 16 downward radiation 32 upward radiation 64 instantaneous ("corrected")

Notes :

1. The field code number (19) will identify the type of data. For example, Meteosat IR readings or weather radar returns. Numbers 1-400 are reserved for unified model field codes as used in (CF) FieldsFiles. A list of field type codes is as appendix A.

2. The grid descriptor elements in the header (elements 34 & 36) will refer to the location of the **centre of the pixel** for image data, and to the **gridpoint position** for model data. Wind components u & v are often 'staggered' in model grids, the appropriate X and Y offsets must be specified in elements 41 and 42 of the header.
   The DT (Data Time) specified in elements 7 to 11 should be set to -32767 for basic images. For forecast images, DT will refer to the time of the base image from which forecasts are done. For model files, T+0 initial fields should have DT equal to VT, in forecast fields DT will refer to the T+0 initial field from which forecasts are made.

3. In handling polar stereographic images, it is assumed that the South Pole is the reference pole, the standard latitude is given in entry 43, and the downward longitude in entry 40. The origin of the image is specified by latitude and longitude in entries 34 & 36. These values, together with the resolution at standard latitude (entries 35 & 37), and the number of rows and columns in the field (entries 16 & 17), are enough to completely define a PS image.

4. The above scheme preserves the generality of the first section of the header. Elements 1 to 31 are I*2 entries which are not data or application-specific. It is proposed that elements 32 to 59 inclusive should be similarly reserved R*4 entries. The data-specific elements should thus be placed in elements 60-104 if they are Real, and beginning at element 108 if they are integer.

Appendix A

Field code numbers

Red entries indicate changes to a field code at versions 2.4 and 2.5 of this document
Blue entries indicate field codes not in use as of version 2.4 of this document
The Filename tag column indicates the Met Office file each field is stored in

Field code	Description	Filename tag
2	3D Height	height
3	3D Temperature	temperature
4	850hPa w-bulb pot temp	temperature
5	Wind U	winduv
5	Wind U smoothed	
6	Wind V	winduv
6	Wind V smoothed	
8	RH	relhumidity
12	MSLP	pressure
13	Pressure anomaly	pressure
18	Surface temperature	soil
24	Sea surface temperature	sst
27	Snow fraction	preciptype
28	Snow probability	preciptype
29	Fog probability	fog
50	Freezing level	height
58	Screen temperature	temperature
61	Precip accumulation	precipaccum
63	Precip rate	precip
64	Dynamic rain rate	precip
65	Dynamic snow rate	precip
66	Convective rain rate	precip
67	Convective snow rate	precip
73	Orography	height
74	Coastline (land-sea mask)	
79	3D Cloud	cloud
80	Cloud top brightness temperature	
86	Convective cloud cover	cloud
87	Convective cloud base	cloud
88	Convective cloud top	cloud
89	Cloud top temperature	cloud
90	Total sunshine	radiation
91	Radiation (SW)	radiation
92	Radiation (LW)	radiation
93	Radiation (total)	radiation
94	Unused	
95	Unused	
96	Radiation (UV)	radiationuv
100	Critical precip rate	snow
101	Snow melting level (ASL)	frzlev
102	Rain level (ASL)	frzlev
121	Snow depth	snow
122	Screen water temperature	visibility
133	Screen total water content	visibility
144	Screen vapour pressure	soil

154	Screen dew point temperature	temperature
155	Obs vis screen	visibility
155	Visibility	visibility
156	Worst visibility	visibility
157	Obs fog mask	visibility
161	Cloud base height	cloud
172	Cloud cover	cloud
173	Low/Med/High Cloud cover	cloudcomp
174	Low/Med/High Cloud cover for VW	cloudcomp
185	Snow melt	snow
190	Soil temperature	soil
191	Soil moisture	soil
192	Unfrozen soil water	soil
193	Frozen soil water	soil
194	Soil moisture deficit	soil
195	Surface run-off	surfroff
196	Total run-off	soil
197	Potential evaporation	soil
198	Evaporation	soil
199	Excess precipitation	soil
200	Subsurface run-off	subsroff
201	Soil moisture availability	soil
202	Surface conductance	soil
203	Surface/canopy water	soil
204	Evapotranspiration from soil	soil
205	Pressure	pressure
206	Wet bulb freezing level	frzlev
207	Cloud top height	cloud
208	CAPE	cape
209	Orographic roughness	ancil
210	Nominal half-peak-to-trough	ancil
213	Precipitation rate	precip
214	Precipitation accumulation	precip
215	HRA catchment maps	ancil
216	Accumulation warnings	
217	Radar data in dbZ	
218	Snowfall accumulation	soil
219	Rainfall accumulation	soil
221	Aerosol	visibility
222	Downwind sectors	
230	MODIS	
231	MODIS	
232	MODIS	
233	MODIS	
234	MODIS	
235	MODIS	
236	MODIS	
261	FSI	
262	FSI	
263	FSI	
264	FSI	
265	FSI	
266	FSI	
300	Boundary layer height	height

301	Tile surface temperature	soil
302	Tile screen temperature	soil
303	Sensible surface heat flux	radiation
310	River flow	rivers
311	River flood indicator	rivers
312	River depth	rivers
313	River width	rivers
314	River flow in	rivers
315	River base flow in	rivers
316	Surface store	rivers
317	Subsurface store	rivers
401	Satellite	
402	Satellite	
403	Satellite	
404	IR cloud top temperature	
405	Satellite rain rate	
406	Satellite	
407	Satellite snow cover	
410	Rain forecast area map	
420	Rain fraction	
421	Precipitation type	preciptype
422	Lightning rate	convection
423	Snow probability	snow
424	Riming rate	snow
425	Prob of rain	probofrain
426	Prob of rain > 0.5mm/hr	
427	Prob of rain > 4.0mm/hr	
428	Prob of large hail	
429	Prob of tornado	
430	Prob of severe thunderstorm	
431	Hail size	
450	Area of raar coverage	
451	Prob of no rain	
452	Prob of anaprop	
453	Orographic enhancement	precip
454	Radar beam infilling map	
455	Radar anaprop climatology	
456	Radar heirarchy map	
457	Radar domain map	
458	Radar weights field	
459	Radar overlap maps	
501	Wind speed shear	convwind
502	Absolute helicity	convection
503	Tornado index	convection
504	Directional wind shear	convwind
505	CAPE	cape
506	Precipitable water	convection
507	Lifted index	convection
508	Low level jet U&V	convwind
514	Low level jet V component	convwind
509	Low level jet curvature	convwind
510	Lightning index	convection
511	Davies parameter	convection
512	Hail size	convection

513	Convective inhibition	cape
599	Triggered lightning	convection
701	Ozone	airquality
702	Nitric Oxide	airquality
704	Nitrogen Dioxide	airquality
710	Carbon Monoxide	airquality
771	Sulphur Dioxide	airquality
772	PM10 (large particles)	airquality
773	PM2.5 (small particles)	airquality
774	Air quality index	airquality
800	Peak convective gust	convwind
801	Wind gust (knots)	wind
802	Wind gust (beaufort)	wind
803	Wind U&V	wind
804	Wind speed (knots)	wind
805	Wind speed (beaufort)	wind
806	Wind direction	wind
807	Pressure anomaly	pressure
808	Pressure gradient anom for U wind	pwindproc
809	Pressure gradient anom for V wind	pwindproc
810	Vegetative roughness	pwindproc
811	Frictional velocity	pwindproc
812	Outer layer wind speed	pwindproc
813	Inner layer wind speed	pwindproc
814	Reference wind speed	pwindproc
815	Reference height	pwindproc
816	Wave number	pwindproc
817	Wind gust	wind
818	Geostrophic pressure gradient ratio	
819	Geostrophic pressure gradient dir diff	
824	Wind gust (shear)	wind
820	Wind hc	wind
821	Wind gust risk	wind
822	Wind speed	wind
823	Roughness adjustment mask	wind
900	Boundary layer height	height
901	Tile surface temperature	soil
910	Theta level 1	
8229	Unfrozen soil water	soil
8230	Frozen soil water	soil