

NCMRWF



UMRider

Version 1.0.1

<https://github.com/NCMRWF/UMRider>

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[Abstract: This document contains the UMRider usage details. UMRider is a utility to convert NCMRWF-UK MetOffice Unified Model outputs fileformat from fieldfiles to grib2 through parallel python. Through STASH code and cf_standard_name of variable we are extracting and converting to WMO-NCEP grib2 standard by setting correct GRIB2 Param Code (Discipline, Category, Number, type Of First Fixed Surface) and followed by creating Grads Control File by using g2ctl.pl scripts. Also created the NCMRWF Grib2 Local Table (which I created to produce grib2 files for 9 variables). Acknowledgement: I thank Mr. M.N.Raghavendra Sreevathsa , Scientist-E who made the serial python code initially in simple way to convert pp0 to grib2.]

ncum post operational v1.0.1

Source code : <https://github.com/NCMRWF/UMRider>

Releases : <https://github.com/NCMRWF/UMRider/releases/tag/v1.0.0>

UMRider has 3 modules in **g2utils** and 6 python scripts in **g2scripts** to create analysis/forecast grib2 files along with corresponding bsub bash scripts.

um2grib2.py module has capability to convert pp fieldsfiles format to grib2 through iris in embarrassing parallel mode.

UMRider supported analysis files (short forecast) are

1. 'qwqg00.pp0'
2. 'umglca_pb???'
3. 'umglca_pd???'
4. 'umglca_pe???'
5. 'umglca_pf???'
6. 'umglca_pi???'

UMRider supported forecast files (long forecast) are

1. 'umglaa_pb???'
2. 'umglaa_pd???'
3. 'umglaa_pe???'
4. 'umglca_pf???'
5. 'umglca_pi???'

Replace ??? with corresponding hours like 024, 048, ..., 240.

024 file contains either twenty four 1-hourly data or eight 3-hourly data and similarly for other files.

UMRider supports to create either 3-hourly grib2 files or 6-hourly (either 6th hour instantaneous or average/ accumulation of two 3-hourly data/six 1-hourly data) or 24-hourly (either 24th hour instantaneous or average/ accumulation of eight 3-hourly data/twenty four 1-hourly data). User will be able to control what they want in out grib2 file either 3-hourly data or 6-hourly data or 24-hourly data.

For example UMRider has configured for 6-hourly grib2 files, then

- It creates 4 analysis 6 hourly files (during 00, 06, 12, 18 UTC cycles)
- It creates 40 forecast 6 hourly files (000, 006, 012, ..., 234, 240 during 00 and 12 UTC cycles)
- Finally it creates ctl, idx files for all 44 grib2 files by using g2ctl.pl
- Also all 44 grib2 files variables are in same order (defined by user)

In this version v1.0.1 user will be able to control the following 25 arguments by exporting **setup.cfg** file into their environment variable called **UMRIDER_SETUP**

1. inPath
2. outPath
3. tmpPath
4. anl_step_hour
5. anl_aavars_reference_time
6. start_step_long_fcst_hour
7. max_long_fcst_hours_at_00z
8. max_long_fcst_hours_at_12z
9. latitude
10. longitude
11. targetGridResolution
12. pressureLevels
13. startdate
14. enddate
15. loadg2utils
16. overwriteFiles
17. anlOutGrib2FileNameStructure
18. fcstOutGrib2FileNameStructure
19. createGrib2CtlIdxFiles
20. convertGrib2FilestoGrib1Files
21. grib1FileNameSuffix
22. removeGrib2FilesAfterGrib1FilesCreated

23. createGrib1CtlIdxFiles
24. debug
25. setGrib2TableParameters
26. callBackScript

Also in this version v1.0.1 user will be able to control the variables by exporting vars.cfg file into their environment variable called **UMRIDER_VARS** . User defined variables and ordered will be retained in the out grib2 files (but pressure level variables comes first and followed by non-pressure level variables)

User will be able to control would they like to get 3-hourly or 6-hourly or 24-hourly forecast files.

This **v1.0.1** supports for following productions

1. NCUM Global Post Production
2. NCUM Indian Region Post Production
3. NCUM Global OSF (Ocean State Forecast) Model Input Production
4. NCUM Global HYCOM Model Input Production
5. NCUM Global VSDB Input Production

NCUM Global Post Production				
Inpath :	/gpfs3/home/umfest/NCUM/fest/			
Outpath :	/gpfs3/home/umfest/NCUM/post/	Resolution : 0.25X0.25 degree		
No of Variables :	63 (63 – analysis & 61 – forecast)		Out data frequency : 6-hourly	
Infile Type	UTC	No of grib2 outfiles	No of parallel processors used	Time taken to complete (app.)
Analysis File	00	1	6	4 minutes
Analysis File	06	1	4	3 minutes
Analysis File	12	1	4	3 minutes
Analysis File	18	1	4	3 minutes
Forecast Files	00	40	40	14 minutes
Forecast Files	12	20	20	11 minutes

Table 1 : Details of NCUM Global Post Production which has been implemented at Bhaskara, NCMRWF

NCUM Indian Region Post Production				
Inpath :	/gpfs3/home/umfest/NCUM/fcst/			
Outpath :	Suggest outpath	Resolution : 0.25X0.25 degree		
No of Variables :	63 (63 – analysis & 61 – forecast)		Out data frequency : 6-hourly	
Infile Type	UTC	No of grib2 outfiles	No of parallel processors used	Time taken to complete (app.)
Analysis File	00	1	6	3 minutes
Analysis File	06	1	4	2.5 minutes
Analysis File	12	1	4	2.5 minutes
Analysis File	18	1	4	2.5 minutes
Forecast Files	00	40	40	11 minutes
Forecast Files	12	20	20	8 minutes

Table 2 : Details of NCUM Indian Region Post Production which will be implemented at Bhaskara, NCMRWF. All variables are same as Table1 except the latitude (20S to 60N), longitude (20E to 140E) extracted from Global output.

NCUM Global OSF Model Input Production				
Inpath :	/gpfs3/home/umfest/NCUM/fcst/			
Outpath :	Suggest outpath	Resolution : 0.25X0.25 degree		
No of Variables :	14		Out data frequency : 6-hourly	
Infile Type	UTC	No of grib2 outfiles	No of parallel processors used	Time taken to complete (app.)
Analysis File	00	1	6	30 seconds
Analysis File	06	1	4	30 seconds
Analysis File	12	1	4	30 seconds
Analysis File	18	1	4	30 seconds
Forecast Files	00	40	40	2 minutes
Forecast Files	12	DO NOT REQUIRED AT THE MOMENT		

Table 3 : Details of NCUM Global OSF Model Input Production which will be implemented at Bhaskara, NCMRWF.

NCUM Global HYCOM Model Input Production				
Inpath :	/gpfs3/home/umfcst/NCUM/fest/			
Outpath :	Suggest outpath	Resolution : 0.25X0.25 degree		
No of Variables :	13	Out data frequency : 3-hourly		
Infile Type	UTC	No of grib2 outfiles	No of parallel processors used	Time taken to complete (app.)
Analysis File	00	2	6	30 seconds
Analysis File	06	2	4	30 seconds
Analysis File	12	2	4	30 seconds
Analysis File	18	2	4	30 seconds
Forecast Files	00	56	56	2 minutes
Forecast Files	12	DO NOT REQUIRED AT THE MOMENT		

Table 4 : Details of NCUM Global HYCOME Model Input Production which will be implemented at Bhaskara, NCMRWF.

NCUM Global VSDB Input Production				
Inpath :	/gpfs3/home/umfcst/NCUM/fest/			
Outpath :	Suggest outpath	Resolution : 0.25X0.25 degree		
No of Variables :	6	Out data frequency : 24-hourly		
Infile Type	UTC	No of grib1 outfiles	No of parallel processors used	Time taken to complete (app.)
Analysis File	00	1	2	30 seconds
Analysis File	06	DO NOT REQUIRED AT THE MOMENT		
Analysis File	12	DO NOT REQUIRED AT THE MOMENT		
Analysis File	18	DO NOT REQUIRED AT THE MOMENT		
Forecast Files	00	7	8	2 minutes
Forecast Files	12	DO NOT REQUIRED AT THE MOMENT		

Table 5 : Details of NCUM Global VSDB Input Production which will be implemented at Bhaskara, NCMRWF.

UMRider Setup Configure Options

setup configure file: Used to setup indata path, outdata path, temporary path to run the um2grb2 python parallel scripts which will create analysis and forecast files.

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BEGIN OF UMRIDER SETUP CONFIGURE FOR um2grb2 SCRIPTS

1. *inPath* model pp filesfiles path

inPath = /gpfs3/home/umfcst/NCUM/fcst/

2. *outPath* model grib2 files path

outPath = /gpfs3/home/umfcst/NCUM/post/

3. *tmpPath* working directory (used to create temporary log files)

tmpPath = /gpfs4/home/umtid/tmp/um2grb2/logs/

4. *anl_step_hour* analysis step/interval hours. By default it takes 6 hour which mean um2grb2 produce 6 hourly instantaneous and/or 6 hourly average and/or 6 hourly accumulation values analysis files. If user specified as 3 then it will extract only 3 hourly instantaneous fields. By default model produced 3 hourly average/accumulation.

anl_step_hour = 6

5. *anl_aavars_reference_time* takes either '**analysis**' or '**shortforecast**'. When some variables are taken from previous cycle short-forecast (average/accumulation) vars, the reference time need to be set as either current '**analysis**' reference cycle (utc) or previous cycle's '**shortforecast**' reference time. '**shortforecast**' gives exactly based on which utc that variable has processed, whereas '**analysis**' shift reference time utc as actual analysis utc time. Note : This option applicable only to average/accumulation vars in analysis grib2 files. By default it takes 'shortforecast' argument.

anl_aavars_reference_time = analysis

6. *start_step_long_fcst_hour* long forecast start hour and forecast step/interval hours . By default it takes 6 hour which mean um2grb2 produce 6 hourly instantaneous and/or 6 hourly average and/or 6 hourly accumulation values. If user specified as 3 or 24 then it will extract only 3 or 24 hourly instantaneous fields and for calculate average/accumulation for 24 hourly. By default model produced 3 hourly average/accumulation. # Note: the average and accumulation supports only for either 3 or 6 or 24 hours!!!

start_step_long_fcst_hour = 6

7. maximum long forecast hours at 00utc cycle (*max_long_fcst_hours_at_00z*) produced by NCUM model for 10days forecast 240hour (by default 240 hours)

max_long_fcst_hours_at_00z = 240

8. maximum long forecast hours at 12utc cycle (*max_long_fcst_hours_at_12z*) produced by NCUM model for 5days forecast 120hour (by default 120 hours)

max_long_fcst_hours_at_12z = 120

9. *latitude* is required latitude which user wants to extract from the model global data. By default it takes *None* (i.e. extract model global latitudes). User can specify their required *latitude* in tuple. For eg : *latitude* = (-30, 30) will extract only latitudes from 30S to 30N.

latitude = None

10. *longitude* is required longitude which user wants to extract from the model global data. By default it takes *None* (i.e. extract model global longitudes) User can specify their required longitude in tuple. For eg : *longitude* = (60, 100) will extract only longitude from 60E to 100E. Note : Model requires longitude should specified based on (0 to 360), and not by (-180 to 180.) In future I may fix it, if user wish to specify longitude by within range of (-180, 180)

longitude = None

11. *targetGridResolution* is resolution in degree (1 degree = 100km approx) if *targetGridResolution* is set to *None*, then model resolution will be kept in the grib2 file. This must be a *number* or *None*.

targetGridResolution = 0.25

12. *pressureLevels* is required pressure levels slice / extract only particular set of pressure levels from model pressure levels. User can specify either one or more levels. By default it takes *None*, i.e. it will extract all the model pressure levels.

eg 1 : *pressureLevels* = [850] -> extract 850 hPa only

eg 2 : *pressureLevels* = [850, 500, 200] -> extract only 850, 500 & 200 hPa levels only.

Note 1 : These pressure slice levels applicable to all the pressure level variables.

Note 2 : At the moment pressure levels interpolation is not supported!

pressureLevels = None

13. By default *startdate* takes argument as *YYYYMMDD* (which means it assume today's date), But user can specify the different *startdate* by following the same format. for eg, *startdate* = 20151209 # then it will execute the scripts for 09-Dec-2015. *startdate* = *YYYYMMDD* # then it will execute the scripts for today's date.

Note : However **UMRIDER_STARTDATE** environment variable will override this startdate option.

startdate = YYYYMMDD

14. By default *enddate* is *None*. User can specify different *enddate* (but > startdate) i.e. for only specified date / one date, user needs to control only in the *startdate* and *enddate* must be *None*. If user want to execute the um2grib2 conversion for the range of dates,

then user need to set the lower *startdate* end higher *enddate*. *enddate* could be even *YYYYMMDD*, but make sure that *startdate* is lower than *enddate*.

For eg : *startdate* = 20151209 and *enddate* = 20160114 , then um2grb2 conversion program executes from 09-dec-2015 to 14-jan-2016.

Note : However **UMRIDER_ENDDATE** environment variable will override this *enddate* option.

enddate = None

15. Load g2utils from '*system*' python which has installed through setup.py (OR) Load g2utils from '*local*' previous directory for the operational purpose, where normal user don't have write permission to change the g2utils! So *loadg2utils* argument should be either *system* (default) or *local*.

loadg2utils = local

16. If *overwriteFiles* option is '*True*' then existing output final files (if any) will be deleted from outPath and re-creating freshly. If *overwriteFiles* option is '*False*' and all output final files are already exists in the outPath, then program will be exited without re-creating the output files. If partially created files exist (like few hours outfiles only exist or intermediate nc files) then by default make *overwriteFiles* option as *True* (though *False* as passed to *overwriteFiles* option).

overwriteFiles = True

17. *anlOutGrib2FilesNameStructure* and *fcstOutGrib2FilesNameStructure* takes list of string naming arguments to construct out file names. um2grb2 will just concatenate the arguments, by replacing 3 predefined naming structure ('*HHH*', '*YYYYMMDD*', '*ZZ*') with its corresponding values/numbers in place of it.

'*H*' - forecast hours

'*D*' - forecast days (applicable only for multiples of 24 hours)

Note : Either '*H*' or '*D*' valid, not both!

'*YYYYMMDD*' - forecast reference date

'*%d/%m/%y*' - Alternate to above '*YYYYMMDD*' option. User can specify any acceptable time *strftime* format. um2grb2 will figure it by finding '%' symbol.

'*Z*' - forecast reference utc time (optional)

If user wants to 3 digit filled hours, then they need to specify as 3 times '*HHH*'. If they specify 2 digit filled hours (say '*HH*' only), but forecast hours have 3 digit, then by default it will assume as 3 digits but for single digit hour, it will fill 0 as prefix to make it as 2 digit. same option for utc '*Z*'.

'*pXp*' - latitude x longitude grid resolution

Note : * will not be included in the name of the final out grib2 files.

eg1 : ('um_ana', '_', '*HHH*', 'hr', '_', '*YYYYMMDD*', '_', '*ZZ*', 'Z', '.grib2') this will produce grib2 files as 'um_ana_006hr_20160208_12Z.grib2'

eg2 : ('fcs', '_', '*HH*', 'h', '_z', '*YYYYMMDD*', '.grib2') this will produce grib2 files as 'fcs_06h_z20160208.grib2'

eg3 : ('prg', '*D*', '00z', '%d%m%y*', '.grib2') will produce grib2 files as 'prg100z080216.grib2'

eg4 : ('prg', '*D*', '00z', '%d%m%y*', '_', '*pXp*', '.grib2') will produce grib2 files as 'prg100z080216_0p17x0p17.grib2' in case of *targetGridResolution = None* (i.e modelResolution) or as 'prg100z080216_2p5x2p5.grib2' in case of *targetGridResolution = 2.5* Defining analysis grib2 fileName structure. Must be in single line.

anlOutGrib2FileNameStructure = ('um_ana', '_', '*HHH*', 'hr', '_', '*YYYYMMDD*', '_', '*ZZ*', 'Z', '_', '*pXp*', '.grib2')

18. Defining forecast grib2 fileName structure. Must be in single line.

fcstOutGrib2FileNameStructure = ('um_prg', '_', '*HHH*', 'hr', '_', '*YYYYMMDD*', '_', '*ZZ*', 'Z', '_', '*pXp*', '.grib2')

19. If *createCtlIdxFiles* is *True* then um2grib2 module will create grads control files and its index files for each and every grib2 files by using g2ctl.pl

createGrib2CtlIdxFiles = True

20. If *convertGrib2FilestoGrib1Files* is *True* then using '*cnvgrib -g2l*' command line um2grib2 module will convert grib2 file to grib1 files. *CAUTION*: it may produce invalid variables names, grib1 param code for few variables which are produced by this um2grib2 conversion tool!!!

convertGrib2FilestoGrib1Files = False

21. If *grib1FileNameSuffix* is '*.grib1*', then grib1 files will endswith '*.grib1*' (default). otherwise will whatever string assigned will be added at the end of grib1 file names. None will add nothing to grib1 file names at the end of it.

grib1FileNameSuffix = '.grib1'

22. If *removeGrib2FilesAfterGrib1FilesCreated* is *True*, then grib2 files will be deleted and kept only grib1 files. By default *False*.

removeGrib2FilesAfterGrib1FilesCreated = False

23. If *createCtlIdxFiles* is *True* then um2grib2 module will create grads control files and its index files for each and every grib1 files by using grib2ctl.pl

createGrib1CtlIdxFiles = False

24. This *debug* option should be either *True* or *False*. This will just print extra information like variables details, shape, execution process, etc.,

debug = False

25. This *setGrib2TableParameters* option takes list of tuples which may contain WMO-Grib2 table parameters and its value. This means, the grib2 table parameter options will be overwritten as per user's setting in this option.

eg1 : *setGrib2TableParameters* = [('centre', 28), ('subCentre', 0)]

The above two options will be set to out grib2 files.

eg2 : *setGrib2TableParameters* = [('shapeOfTheEarth', 0)]

The above option will be set to out grib2 files.

CATUION : User must be aware on what are they setting in this option and its causes in out grib2 files! By default this option takes None.

setGrib2TableParameters = None

26. This *callBackScript* option takes any user defined script (any script)! User should provide absolute or relative path of their script and make sure that script is self-executable with shebang and executable permission! After successfully created out grib2 files, this *callBackScript* will be executed with possibly command line keyword arguments as follows

KWargs : (*date*, *outpath*, *oftype*, *utc*) where

'*date*' -> out files processed date,

'*outpath*' -> out files path,

'*oftype*' -> 'analysis' or 'forecast'

'*utc*' -> UTC cycle value in string ('00' or '06' or '12' or '18')

For eg : *callBackScript* = imd_mfi_rename_g2files_and_put_into_ftp.sh

callBackScript = None

END OF UMRIDER SETUP CONFIGURE FOR um2grb2 SCRIPTS

UMRider Vars Configure Options

vars configure file: Used for the purpose of um2grb2 conversion of only needed NCUM model out variables. um2grb2 python parallel scripts will create analysis and forecast files, by conveting to gri2 file only for the following cf_standard_name and varSTASH coded vars.

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Updated : 01-Feb-2016

BEGIN OF UMRIDER VARS CONFIGURE FOR um2grb2 SCRIPTS

Pressure Level Variable names & STASH codes

('geopotential_height', 'm01s16i202')
('x_wind', 'm01s15i243')
('y_wind', 'm01s15i244')
('upward_air_velocity', 'm01s15i242')
('air_temperature', 'm01s16i203')
('relative_humidity', 'm01s16i256')
('specific_humidity', 'm01s30i205')

Non Pressure Level Variable names & STASH codes

('tropopause_altitude', 'm01s30i453')
('tropopause_air_temperature', 'm01s30i452')
('tropopause_air_pressure', 'm01s30i451')
('surface_air_pressure', 'm01s00i409')
('air_pressure_at_sea_level', 'm01s16i222')
('surface_temperature', 'm01s00i024')
('relative_humidity', 'm01s03i245')
('specific_humidity', 'm01s03i237')
('air_temperature', 'm01s03i236')
('dew_point_temperature', 'm01s03i250')
('atmosphere_convective_available_potential_energy_wrt_surface', 'm01s05i233')
('atmosphere_convective_inhibition_wrt_surface', 'm01s05i234')
('high_type_cloud_area_fraction', 'm01s09i205')
('medium_type_cloud_area_fraction', 'm01s09i204')
('low_type_cloud_area_fraction', 'm01s09i203')
('x_wind', 'm01s03i209')
('y_wind', 'm01s03i210')
('visibility_in_air', 'm01s03i247')
('precipitation_amount', 'm01s05i226')
('stratiform_snowfall_amount', 'm01s04i202')
('convective_snowfall_amount', 'm01s05i202')
('stratiform_rainfall_amount', 'm01s04i201')
('convective_rainfall_amount', 'm01s05i201')

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('rainfall_flux', 'm01s05i214')
('snowfall_flux', 'm01s05i215')
('precipitation_flux', 'm01s05i216')
('fog_area_fraction', 'm01s03i248')
('toa_incoming_shortwave_flux', 'm01s01i207')
('toa_outgoing_shortwave_flux', 'm01s01i205')
('toa_outgoing_shortwave_flux_assuming_clear_sky', 'm01s01i209')
('toa_outgoing_longwave_flux', 'm01s02i205')
('toa_outgoing_longwave_flux_assuming_clear_sky', 'm01s02i206')
('surface_upward_latent_heat_flux', 'm01s03i234')
('surface_upward_sensible_heat_flux', 'm01s03i217')
('surface_downwelling_shortwave_flux_in_air', 'm01s01i235')
('surface_downwelling_longwave_flux', 'm01s02i207')
('surface_net_downward_longwave_flux', 'm01s02i201')
('surface_net_downward_shortwave_flux', 'm01s01i202')

# for the following two vars STASH is None, because it will be calculated by using
# net and down shortwave/longwave flux
('surface_upwelling_shortwave_flux_in_air', 'None')
('surface_upwelling_longwave_flux_in_air', 'None')

('atmosphere_boundary_layer_thickness', 'm01s00i025')
('atmosphere_optical_thickness_due_to_dust_ambient_aerosol', 'm01s02i422')
('moisture_content_of_soil_layer', 'm01s08i223'), # 4 layers

# single layer, this must be after 4 layers as in order
('soil_moisture_content', 'm01s08i208'), # single layer

## though moisture_content_of_soil_layer and volumetric_moisture_of_soil_layer
## has same STASH code, but we must include separte entry here.
('volumetric_moisture_of_soil_layer', 'm01s08i223'), # 4 layers

# single layer, this must be after 4 layers as in order
('volumetric_moisture_of_soil_layer', 'm01s08i208'), # single layer
('soil_temperature', 'm01s03i238')
('sea_ice_area_fraction', 'm01s00i031')
('sea_ice_thickness', 'm01s00i032')

# the snowfall_amount might be changed as liquid_water_content_of_surface_snow by convert
it into water equivalent of snow amount, before re-ordering itself.
('liquid_water_content_of_surface_snow', 'm01s00i023')

# the below one is for land-sea binary mask which should presents only in analysis files. so we
must keep this as the last one in the ordered variables!
('land_binary_mask', 'm01s00i030')

# the below one is for orography which presents only in analysis 00 file.
# so we must keep this as the last one in the ordered variables!
('surface_altitude', 'm01s00i033')

##### END OF UMRIDER VARS CONFIGURE um2grb2 SCRIPTS #####

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Future Releases of UMRider

ncum post operational v1.0.2

Currently I am working on umeps products (i.e. NCUM produces 45 ensembles at every 6-hourly and 24-hourly for next 10-days forecasts) and it will be included in the next version UMRider 1.0.2. It will produce all ensembles in single grib2 files (every 6-hourly / 24-hourly grib2 files should contain all its ensemble members).

ncum post operational v1.0.3

Currently I am working on um_reg products (i.e. NCUM_REG produces files at 4.5 km resolution over Indian region) and it will be included in the upcoming version UMRider 1.0.3. NCUM_REG produces in rotated lat,lon grid which needs to convert to regular lat, lon grids and also need to vertical interpolation from hybrid to standard pressure levels.

ncum post operational v1.0.4

User will be able to interact with UMRider via Graphical User Interface to convert any NCUM files to grib2, netCdf, pp files with all user defined UMRider options.

ncum post operational v1.0.5

Need to fix in iris to support the remaining variables which are all 'unknown' vars or unknown grib2 param code.

ncum post operational v1.0.6

Command line support to generate bsub scripts, invoke gui to customization and submit job.

ncum post operational v1.1.0

UMRider should supports for all partners of UK-MetOffice-Unified Model, not just limited to NCMRWF's NCUM.

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I thank Dr. Raghavendra Ashrit (Scientist – E) who tested UMRider out grib2 files by feeding to WRF-Noah Land Surface Model and pointed out the bugs in code.

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- Dr. A.Jayakumar (Scientist – C)
- Mr. M.Momin Imran Ali (Scientist – C)
- Dr. Sumit Kumar (Project Scientist – D)
- Dr. C.J. Johny (Project Scientist – C)
- Mr. Kuldeep Sharma (Project Scientist – C)
- Mr. Abhishek Lodh (Project Scientist – C)

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Regards,

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