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The MÉRA Data Archive

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1 Introduction

This document describes the data produced by the Met Éireann reanalysis project called MÉRA (Met Éireann ReAnalysis). MÉRA is a very high resolution reanalysis of Ireland's climate covering the period 1981-2015 and is continuing in real time. Outputs are updated on a monthly basis once ERA-Interim data have been released.

The MÉRA project began in late 2014 in order to produce a high quality, high resolution climate reanalysis of the Irish climate. The MÉRA reanalysis system uses the HARMONIE-AROME 38h1.2 configuration of the shared ALADIN-HIRLAM Numerical Weather Prediction System (AHNS). This version of AHNS was released in December 2014. Production of reanalysis data for the period 1981-2015 completed in February 2017. The MÉRA reanalysis project is documented in Gleeson et al. (2017) and Whelan et al. (2017).

MÉRA products described in this technical report include:

- Analysis and forecast fields from the atmospheric model at or near the surface
- Analysis and forecast fields from the atmospheric model on levels at fixed heights above the model surface
- Analysis and forecast fields from the atmospheric model on standard pressure levels
- Analysis and forecast fields from the atmospheric model at the nominal model top
- Vertical integrations of analysis and forecast fields from the atmospheric model
- Analysis and forecast fields from the surface model
- Observation feedback information from surface and upper-air data assimilation

2 Reanalysis Data

2.1 Model grid definition

The MÉRA atmospheric model is configured to run using the following grid definitions:

- The domain projection is a Lambert conformal conic grid with the domain centre at (53.5° N, 7.5° W) the reference latitude at 53.5° N and the reference longitude at 5.0° E.
- The limited area domain has 540 grid-points in the x -direction and 500 grid-points in the y -direction. An 11-point extension zone is required by the model leaving a computational domain of 529 grid-points in the x -direction and 489 grid-points in the y -direction.
- The domain has a horizontal grid-spacing of 2.5 km at the centre of the domain.
- The atmospheric model is defined on 65 vertical levels with a model top of 10 hPa.

The model domain is centred over the island of Ireland and covers Ireland, the United Kingdom and an area of northern France. The domain is the same as has been used operationally by Met Éireann since 2011.

2.2 Product definition

The MÉRA production suite uses a three-hour forecast cycle with surface and upper-air data assimilation. Three-hour forecasts are produced for each cycle except midnight (00 Z) when a 33-hour forecast is produced. This provides a long forecast each day and is used for the purpose of producing

consistent precipitation forecasts. A data assimilation window of 90 minutes is used for each analysis so that the 12:00 UTC analysis uses observations made between 10:30 UTC and 13:30 UTC.

WMO (World Meteorological Organization) FM92 GRIB Edition 1 (WMO, 1994) is used to represent all analysis and forecast fields. All MÉRA GRIB 1 data are encoded using Met Éireann’s local version of table 2 version number 253.

2.3 Archive structure

Currently all MÉRA data are stored in a flat file structure on ECMWF’s Data Handling System (ECFS). A subset of the data are available for external users to download.

As already mentioned, MÉRA analysis and forecast gridded data are encoded in GRIB 1 format. The data for each parameter are gathered into monthly files using the following naming convention:

MERA_PRODYEAR_YYYY_MM_IOP_TYP_LEV_TRI_STR

- YYYY: Year (%Y, four-digits, e.g. 2015)
- MM: Month (%m, two-digits, e.g. 01 January, 02 February, ...)
- IOP: Indicator Of Parameter (indicatorOfParameter); e.g. 11 indicates temperature
- ITL: Indicator of Type of Level (indicatorOfTypeOfLevel), see Table 1
- LEV: Level indicator (level); depends on ITL value
- TRI: Time range indicator (timeRangeIndicator), see Table 2
- STR: MÉRA data stream, see Table 3

For example the file named *MERA_PRODYEAR_2015_12_11_105_2_0_ANALYSIS* contains analyses from December 2015 of temperature at 2 m above ground.

ITL	Description
5	Level of adiabatic condensation lifted from the surface
8	Nominal top of atmosphere
20	Isothermal level
100	Isobaric surface
103	Specified altitude above mean sea level
105	Specified height level above ground
111	Depth at or below land surface
200	Entire atmosphere (considered as a single layer)

Table 1: List of level types (indicatorOfTypeOfLevel) used in MÉRA GRIB 1

TRI	Description
0	Instantaneous
2	Specific time period
4	Accumulation

Table 2: List of time-range indicators (timeRangeIndicator) used in MÉRA GRIB 1

STR	Description
ANALYSIS	Analysis output at 00 Z, 03 Z, 06 Z, ... , 21 Z
FC3hr	1-, 2- and 3-hour forecast data
FC33hr	1- to 33-hour forecasts from each 00 Z cycle

Table 3: List of MÉRA data streams

3 Output Parameters

MÉRA analyses and forecasts produce 221 parameters that are archived on a monthly basis. The majority of MÉRA output data are produced directly by the forecast model using *FULL-POS* (ECMWF, 2013) software which is included in AHNS. Some parameters are produced using *gl*, an external format conversion, interpolation and post-processing tool also available in AHNS. Parameters produced by *gl* are indicated by an asterisk in the parameter tables in the following sub-sections.

Table 4 lists the instantaneous (time-range indicator equal to 0) parameters produced by the atmospheric model available at or near the surface:

Parameter	IOP	ITL	LEV	TRI	Units
Mean sea level pressure	1	103	0	0	Pa
Surface pressure	1	105	0	0	Pa
Surface temperature	11	105	0	0	K
2 m temperature	11	105	2	0	K
2 m relative humidity	52	105	2	0	%
u-component of 10 m wind	33	105	10	0	m s ⁻¹
v-component of 10 m wind	34	105	10	0	m s ⁻¹
Total cloud cover	71	105	0	0	(0 - 1)
High cloud cover	75	105	0	0	(0 - 1)
Medium cloud cover	74	105	0	0	(0 - 1)
Low cloud cover	73	105	0	0	(0 - 1)
Mixed layer depth	67	105	0	0	m
Direct shortwave irradiance [†]	116	105	0	0	W m ⁻²
Longwave irradiance [†]	115	105	0	0	W m ⁻²
Snow depth	65	105	0	0	kg m ⁻²
Visibility*	20	105	0	0	m
Total cloud cover (fog)	71	105	2	0	(0 - 1)
Icing index*	135	105	0	0	-
Precipitation type*	144	105	0	0	-
Cloud base*	186	200	0	0	m
Cloud top*	187	200	0	0	m
Lightning*	211	200	0	0	m ⁻³
Hail diagnostic	161	105	0	0	kg m ⁻²
Height of T' _w =0 isotherm	8	5	0	0	m
Height of 0° isotherm	8	20	27315	0	m

Table 4: List of instantaneous surface and single level parameters. [†] This parameter is named incorrectly in ECMWF GRIB definitions.

Table 5 lists the accumulated (time-range indicator equal to 4) parameters produced by the atmo-

spheric model available at or near the surface. All accumulations are initiated at the start of each forecast and are valid at the forecast step indicated in the data.

Parameter	IOP	ITL	LEV	TRI	Units
Total precipitation	61	105	0	4	kg m ⁻²
Rain	181	105	0	4	kg m ⁻²
Snow	184	105	0	4	kg m ⁻²
Graupel	201	105	0	4	kg m ⁻²
Sensible heat flux	122	105	0	4	J m ⁻²
Latent heat flux of evaporation	132	105	0	4	J m ⁻²
Latent heat flux of sublimation	244	105	0	4	J kg ⁻¹
Water evaporation	245	105	0	4	kg m ⁻²
Snow sublimation	246	105	0	4	kg m ⁻²
Net shortwave irradiance [†]	111	105	0	4	J m ⁻²
Net longwave irradiance [†]	112	105	0	4	J m ⁻²
Direct shortwave irradiance [†]	116	105	0	4	J m ⁻²
Longwave irradiance [†]	115	105	0	4	J m ⁻²
Global irradiance [†]	117	105	0	4	J m ⁻²
Direct normal irradiance	140	105	0	4	J m ⁻²
Momentum flux, v-component	125	105	0	4	N m ⁻²
Momentum flux, u-component	124	105	0	4	N m ⁻²

Table 5: List of accumulated surface parameters. [†] This parameter is named incorrectly in ECMWF GRIB definitions.

Table 6 lists parameters that are valid over a specified period of time (time-range indicator equal to 2) produced by the atmospheric model at or near the surface. All such parameters are valid for the previous forecast hour; e.g. the maximum temperature at forecast hour 24 is the maximum temperature between hours 23 and 24. These parameters are reset each hour by the forecast model.

Parameter	IOP	ITL	LEV	TRI	Units
Maximum temperature	15	105	2	2	K
Minimum temperature	16	105	2	2	K
Gust, u-component	162	105	10	2	m s ⁻¹
Gust, v-component	163	105	10	2	m s ⁻¹

Table 6: List of surface level parameters valid for a fixed period of time

Table 7 lists parameters that are available at the top of the atmosphere.

Parameter	IOP	ITL	LEV	TRI	Units
Direct shortwave irradiance [†]	116	8	0	4	J/m ²
Net shortwave irradiance [†]	113	8	0	0	J/m ²
Net shortwave irradiance [†]	113	8	0	4	J/m ²
Net longwave irradiance [†]	114	8	0	0	J/m ²
Net longwave irradiance [†]	114	8	0	4	J/m ²

Table 7: List of parameters at top of atmosphere. [†] This parameter is named incorrectly in ECMWF GRIB definitions.

Table 8 lists the upper air parameters that are available at 12 heights above the surface: 30, 50, 60, 70, 80, 90, 100, 125, 150, 200, 300 and 400 m.

Parameter	IOP	ITL	LEV	TRI	Units
Temperature	11	105	LLL	0	K
U-component of wind	33	105	LLL	0	m s^{-1}
V-component of wind	34	105	LLL	0	m s^{-1}
Relative humidity	52	105	LLL	0	%

Table 8: List of upper-air parameters available on levels above the surface

The gl post-processing package produces pseudo-satellite products as described in Tijm (2004). The pseudo-satellite parameters available in the MÉRA data archive are listed in Table 9.

Parameter	IOP	ITL	LEV	TRI	Units
Cloud top temperature (IR)*	136	105	0	0	K
T_b (WV)*	137	105	0	0	K
T_b (WV) + cld corr*	138	105	0	0	K
Cloud water reflectivity (VIS)*	139	105	0	0	-

Table 9: Pseudo-satellite products

Parameters that are vertically integrated through the model atmosphere are listed in Table 10.

Parameter	IOP	ITL	LEV	TRI	Units
Precipitable water	54	200	0	0	kg m^{-2}
Rain*	181	200	0	0	kg m^{-2}
Snow*	184	200	0	0	kg m^{-2}
Graupel*	201	200	0	0	kg m^{-2}
Cloud ice*	58	200	0	0	kg m^{-2}
Cloud water*	76	200	0	0	kg m^{-2}

Table 10: Vertically integrated parameters

Upper-air data are available on 13 pressure levels. Table 11 lists the upper-air parameters that are available at the following pressure levels: 100, 200, 300, 400, 500, 600, 700, 800, 850, 900, 925, 950 and 1000 hPa.

Parameter	IOP	ITL	LEV	TRI	Units
Geopotential	6	100	PPP	0	$\text{m}^2 \text{s}^{-2}$
Temperature	11	100	PPP	0	K
U-component of wind	33	100	PPP	0	m s^{-1}
V-component of wind	34	100	PPP	0	m s^{-1}
Vertical velocity	40	100	PPP	0	m s^{-1}
Relative humidity	52	100	PPP	0	%
Cloud ice	58	100	PPP	0	kg m^{-2}
Cloud water	76	100	PPP	0	kg m^{-2}

Table 11: List of upper-air parameters available on pressure levels.

Table 12 lists the parameters produced by the surface model available at or below the ground. For temperature level 800 is used for surface temperature and 801 for deep soil temperature. For soil moisture and ice, level 800 is used for the surface, 801 for root level and 802 for deep soil.

Parameter	IOP	ITL	LEV	TRI	Units
Temperature	11	105	LLL	0	K
Soil moisture content	86	105	LLL	0	kg m ⁻³
Surface soil ice	193	105	LLL	0	m ³ m ⁻³

Table 12: Surface model parameters

4 Observations Feedback

Observations feedback from MÉRA OI (surface) and 3D-Var analyses are archived at Met Éireann. These data are made available in ODB-2 format, a flat file format with modern API used at ECMWF for storing observations and observation feedback data. MÉRA feedback data are gathered in yearly files using the following naming convention:

strODBTYYYY.odb

- str: data assimilation - "3dv" for 3D-Var or "can" for surface OI.
- ODBT: observation database *ECMA* or *CCMA*. See Saarinen (2004) for more details.
- YYYY: Year (%Y, four-digits, e.g. 2015).

5 Product Access

The datasets are archived at Met Éireann. There is currently a 1-month sample of some of the data available to external users at <http://www.met.ie/climate-ireland/mera.asp>

Table 13 lists some suggested software packages for working with MÉRA data.

Package	format	web
ecCodes	GRIB	https://software.ecmwf.int/wiki/display/ECC/
CDO	GRIB	https://code.mpimet.mpg.de/projects/cdo/
NCL	GRIB	https://www.ncl.ucar.edu/
ODB-API	ODB	https://software.ecmwf.int/wiki/display/ODBAPI

Table 13: Suggested software packages for usnig MÉRA data

The full dataset was published on 26th May 2017 under the creative commons Attribution 4.0 International (CC BY 4.0) license, which means the data will be free to share and adapt for any purpose. Any use of the data will require attribution. To register for updates on full release e-mail mera@mera.ie

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