ERA5 data documentation

Created by Karl Hennermann, last modified by Paul Berrisford on Mar 08, 2019

Introduction

Here we document the ERA5 dataset, which, eventually, will cover the period January 1950 to near real time (NRT). ERA5 data released so far covers the period from 1979 to 2-3 months before the present.

ERA5 was produced using 4D-Var data assimilation in CY41R2 of ECMWF's Integrated Forecast System (IFS), with 137 hybrid sigma/pressure (model) levels in the vertical, with the top level at 0.01 hPa. Atmospheric data are available on these levels and they are also interpolated to 37 pressure, 16 potential temperature and 1 potential vorticity level(s). "Surface or single level" data are also available, containing 2D parameters such as precipitation, 2m temperature, top of atmosphere radiation and vertical integrals over the entire atmosphere. The IFS is coupled to a soil model, the parameters of which are also designated as surface parameters, and an ocean wave model.

The ERA5 dataset contains one (31 km) high resolution realisation (HRES) and a reduced resolution ten member ensemble (EDA). Generally, the data are available at a sub-daily and monthly frequency and consist of analyses and short (18 hour) forecasts, initialised twice daily from analyses at 06 and 18 UTC. Most analysed parameters are also available from the forecasts. There are a number of forecast parameters, e.g. mean rates and accumulations, that are not available from the analyses.

The IFS and data assimilation

The model documentation for CY41R2 is at https://www.ecmwf.int/en/publications/search/?solrsort=sort_label%20asc&secondary_title=%22IFS%20Documentation%20CY41R2%22

The 4D-Var data assimilation uses 12 hour windows from 09 UTC to 21 UTC and 21 UTC to 09 UTC (the following day).

The model time step is 12 minutes for the HRES and 20 minutes for the EDA, though occasionally these numbers are adjusted to cope with instabilities.

Data organisation and access

The data are archived in the ECMWF data archive (MARS) and a pertinent sub-set of the data has been copied to the Climate Data Store (CDS). The data should be downloaded using the CDS API, which can obtain data from the CDS copy or from MARS. (Member State users can access the data using MARS directly, in the usual manner). Documentation on how to download ERA5 data using the CDS API can be found here.

The data can be accessed from MARS using the keywords class=ea and expver=0001. Subdivisions of the data are labelled using stream, type and levtype.

Stream:

- oper: HRES sub-daily
- wave: HRES waves sub-daily
- mnth: HRES synoptic monthly means
- moda: HRES monthly means of daily means
- wamo: HRES waves synoptic monthly means
- wamd: HRES waves monthly means of daily means

- enda: EDA sub-daily
- ewda: EDA waves sub-daily
- edmm: EDA synoptic monthly means
- edmo: EDA monthly means of daily means
- ewmm: EDA waves synoptic monthly means
- ewmo: EDA waves monthly means of daily means

Type:

- an: analyses
- fc: forecasts
- em: ensemble mean
- es: ensemble standard deviation

Levtype:

- sfc: surface or single level
- pl: pressure levels
- pt: potential temperature levels
- pv: potential vorticity level
- ml: model levels

The date and time of the data is specified with three MARS keywords, date, time and step. For analyses, step=0 hours so that date and time specify the analysis time. For forecasts, date and time specify the forecast start time and step specifies the number of hours since that start time. The combination of date, time and forecast step defines the valid time. For analyses, the valid time is equal to the analysis time.

In the CDS, analyses are provided rather than forecasts, unless the parameter is only available from the forecasts. The date and time of the data is specified using the validity date/time, so step does not need to be specified. For forecasts, steps between 1 and 12 hours have been used to provide data for all the valid times in 24 hours, see Table 0 below.

Table 0: the mapping, for forecasts, between MARS date, time and step and the CDS date and time

CDS		MARS				CDS		MARS		
date	time	date	time	step		date	time	date	time	step
date	00	date-1	18	06		date	12	date	06	06
date	01	date-1	18	07		date	13	date	06	07
date	02	date-1	18	08		date	14	date	06	08
date	03	date-1	18	09		date	15	date	06	09
date	04	date-1	18	10		date	16	date	06	10
date	05	date-1	18	11		date	17	date	06	11
date	06	date-1	18	12		date	18	date	06	12
date	07	date	06	01		date	19	date	18	01
date	08	date	06	02		date	20	date	18	02
date	09	date	06	03		date	21	date	18	03
date	10	date	06	04		date	22	date	18	04
date	11	date	06	05		date	23	date	18	05

Spatial grid

The ERA5 HRES atmospheric data has a resolution of 31km, 0.28125 degrees, and the EDA has a resolution of 62km, 0.5625 degrees. The data are available either as spectral coefficients with a triangular truncation of T639 (HRES) and T319 (EDA) or on a reduced Gaussian grid with a resolution of N320 (HRES) and N160 (EDA). These grids are so called "linear grids", sometimes referred to as TL639 (HRES) and TL319 (EDA).

The wave data are produced and archived on a different grid to that of the atmospheric model, namely a reduced latitude/longitude grid with a resolution of 0.36 degrees (HRES) and 1.0 degrees (EDA).

ERA5 data available from the CDS has been pre-interpolated to a regular latitude/longitude grid appropriate for that data.

The article Model grid box and time step might be useful.

Temporal frequency

For sub-daily data for the HRES (stream=oper/wave) the analyses (type=an) are available hourly. The short forecasts, run from 06 and 18 UTC, have hourly steps from 0 to 18 hours. For the EDA, the sub-daily non-wave data (stream=enda) are available every 3 hours but the sub-daily wave data (stream=ewda) are available hourly.

Wave spectra

The ERA5 wave model uses wave spectra with 24 directions and 30 frequencies (see "2D wave spectra (single)", Table 7), for more information see the article About ERA wave spectra.

Mean rates and accumulations

The accumulations in the short forecasts (from 06 and 18 UTC) of ERA5 are treated **differently** compared with those in ERA-Interim (where they are from the beginning of the forecast to the forecast step). In the short forecasts of ERA5 the accumulations are since the previous post processing (archiving), so for:

- HRES: accumulations are over the hour ending at the forecast step
- EDA: accumulations are over the 3 hours ending at the forecast step
- Monthly means of daily means (stream=moda/edmo): accumulations have been scaled to have units that include "per day", see section Monthly means

Mean rate parameters in ERA5 are similar to accumulations except that the accumulations have been divided by the length of the processing period in seconds to produce temporally averaged rates, so the units include "per second". For "surface or single level" parameters, the mean rates (Table 4) provide similar information to the accumulations (Table 3), but with the different units.

Mean rates and accumulations are not available from the analyses.

Mean rates and accumulations at step=0 have values of zero because the length of the processing period is zero.

Minimum/maximum since the previous post processing

In ERA5 there are some surface and single level parameters that are the minimum or maximum value since the previous post processing (archiving), see Table 5 below. So, for:

- HRES: the minimum or maximum values are in the hour ending at the forecast step
- EDA: the minimum or maximum values are in the 3 hours ending at the forecast step

Monthly means

Most parameters are also available as synoptic monthly means, for each particular time and forecast step, (stream=mnth/wamo/edmm/ewmm) and monthly means of daily means, for the month as a whole (stream=moda/wamd/edmo/ewmo). For the surface and single level parameters, there are some exceptions which are listed in Table 8.

Monthly means for analyses and instantaneous forecasts are created from data with a valid time in the month, between 00 and 23 UTC, which excludes the time 00 UTC on the first day of the following month. Monthly means for accumulations and mean rates are created from data with a forecast period falling within the month. For example, monthly means of daily means for accumulations and mean rates are created from contiguous data with forecast periods spanning from 00 UTC on the first day of the month to 00 UTC on the first day of the following month.

The accumulations in monthly means of daily means (stream=moda/edmo) have been scaled to have units that include "per day", so for accumulations in these streams:

- The hydrological parameters are in units of "m of water per day" and so they should be multiplied by 1000 to convert to $kgm^{-2}day^{-1}$ or $mmday^{-1}$.
- The energy (turbulent and radiative) and momentum fluxes should be divided by 86400 seconds (24 hours) to convert to the commonly used units of Wm^{-2} and Nm^{-2}, respectively.

Ensemble means and standard deviations

For the EDA sub-daily data (stream=enda/ewda), compared with HRES sub-daily data (stream=oper/wave), there are also ensemble means and standard deviations (type=em/es).

Ensemble standard deviation is often referred to as ensemble spread and is calculated as the standard deviation of the 10-members in the ensemble (i.e., including the control). It is not the sample stdv, so we divide by 10 rather than 9 (N-1).

Ensemble means and standard deviations contain analysed parameters when step=0, otherwise they contain forecast parameters. However, only surface and pressure level data (levtype=sfc/pl) contain forecast steps beyond 3 hours. There are no monthly means for ensemble means and standard deviations.

Data format

Model level fields are in GRIB2 format. All other fields are in GRIB1, unless otherwise indicated.

Level listings

Pressure levels:
1000/975/950/925/900/875/850/825/800/775/750/700/650/600/550/500/450/400/350/300/250/225/200/175/150/125/100/70/50/30/20/10/7/5/3/2/1

Potential temperature levels: 265/275/285/300/315/320/330/350/370/395/430/475/530/600/700/850

Potential vorticity level: 2000

Model levels: 1/to/137, which are described at https://www.ecmwf.int/en/forecasts/documentation-and-support/137-model-levels.

Parameter listings

Tables 1-6 below describe the surface and single level parameters (levtype=sfc), Table 7 describes wave parameters, Table 8 describes the monthly mean exceptions for surface and single level and wave parameters and Tables 9-13 describe upper air parameters on various levtypes. Information on all ECMWF parameters is available from the ECMWF parameter database.

Table 1: stream=oper/enda/mnth/moda/edmm/edmo, levtype=sfc: surface and single level parameters: invariants

count	name	units	shortName	paramId	an	fc
1	Lake cover	(0 - 1)	cl	26	x	x
2	Lake depth	m	dl	228007	x	x
3	Low vegetation cover	(0 - 1)	cvl	27	x	
4	High vegetation cover	(0 - 1)	cvh	28	x	
5	Type of low vegetation	~	tvl	29	x	
6	Type of high vegetation	~	tvh	30	x	
7	Soil type	~	slt	43	x	
8	Standard deviation of filtered subgrid orography	m	sdfor	74	x	
9	Geopotential	m**2 s**-2	z	129	x	x
10	Standard deviation of orography	~	sdor	160	x	
11	Anisotropy of sub-gridscale orography	~	isor	161	x	
12	Angle of sub-gridscale orography	radians	anor	162	x	
13	Slope of sub-gridscale orography	~	slor	163	x	
14	Land-sea mask	(0 - 1)	lsm	172	x	x

Table 2: stream=oper/enda/mnth/moda/edmm/edmo, levtype=sfc: surface and single level parameters: instantaneous

count	name	units	shortName	paramId	an	fc
1	Convective inhibition	J kg**-1	cin	228001		x
2	Friction velocity	m s**-1	zust	228003		x
3	Lake mix-layer temperature	K	lmlt	228008	x	x

4	Lake mix-layer depth	m	lmld	228009	x	x
5	Lake bottom temperature	K	lblt	228010	x	x
6	Lake total layer temperature	K	ltlt	228011	x	x
7	Lake shape factor	dimensionless	lshf	228012	x	x
8	Lake ice temperature	K	lict	228013	x	x
9	Lake ice depth	m	licd	228014	x	x
10	UV visible albedo for direct radiation	(0 - 1)	aluvp	15	x	x
11	Minimum vertical gradient of refractivity inside trapping layer	m**-1	dndzn	228015		x
12	UV visible albedo for diffuse radiation	(0 - 1)	aluvd	16	x	x
13	Mean vertical gradient of refractivity inside trapping layer	m**-1	dndza	228016		x
14	Near IR albedo for direct radiation	(0 - 1)	alnip	17	x	x
15	Duct base height	m	dctb	228017		x
16	Near IR albedo for diffuse radiation	(0 - 1)	alnid	18	x	x
17	Trapping layer base height	m	tplb	228018		x
18	Trapping layer top height	m	tplt	228019		x
19	Cloud base height	m	cbh	228023		x
20	Zero degree level	m	deg0l	228024		x
21	Instantaneous 10 metre wind gust	m s**-1	i10fg	228029		x
22	Sea ice area fraction	(0 - 1)	ci	31	x	x
23	Snow albedo	(0 - 1)	asn	32	x	x
24	Snow density	kg m**-3	rsn	33	x	x
25	Sea surface temperature	K	sst	34	x	x
26	Ice temperature layer 1	K	istl1	35	x	x
27	Ice temperature layer 2	K	istl2	36	x	x
28	Ice temperature layer 3	K	istl3	37	x	x
29	Ice temperature layer 4	K	istl4	38	x	x
30	Volumetric soil water layer 1	m**3 m**-3	swvl1	39	x	x
31	Volumetric soil water layer 2	m**3 m**-3	swvl2	40	x	x
32	Volumetric soil water layer 3	m**3 m**-3	swvl3	41	x	x
33	Volumetric soil water layer 4	m**3 m**-3	swvl4	42	x	x
34	Convective available potential energy	J kg**-1	cape	59	x	x
35	Leaf area index, low vegetation	m**2 m**-2	lai_lv	66	x	x
36	Leaf area index, high vegetation	m**2 m**-2	lai_hv	67	x	x
37	Neutral wind at 10 m u-component	m s**-1	u10n	228131	x	x
38	Neutral wind at 10 m v-component	m s**-1	v10n	228132	x	x
39	Surface pressure	Pa	sp	134	x	x
40	Soil temperature level 1	K	stl1	139	x	x

41	Snow depth	m of water equivalent	sd	141	x	x
42	Charnock	~	chnk	148	x	x
43	Mean sea level pressure	Pa	msl	151	x	x
44	Boundary layer height	m	blh	159	x	x
45	Total cloud cover	(0 - 1)	tcc	164	x	x
46	10 metre U wind component	m s**-1	10u	165	x	x
47	10 metre V wind component	m s**-1	10v	166	x	x
48	2 metre temperature	K	2t	167	x	x
49	2 metre dewpoint temperature	K	2d	168	x	x
50	Soil temperature level 2	K	stl2	170	x	x
51	Soil temperature level 3	K	stl3	183	x	x
52	Low cloud cover	(0 - 1)	lcc	186	x	x
53	Medium cloud cover	(0 - 1)	mcc	187	x	x
54	High cloud cover	(0 - 1)	hcc	188	x	x
55	Skin reservoir content	m of water equivalent	src	198	x	x
56	Instantaneous large-scale surface precipitation fraction	(0 - 1)	ilspf	228217		x
57	Convective rain rate	kg m**-2 s**-1	crr	228218		x
58	Large scale rain rate	kg m**-2 s**-1	lsrr	228219		x
59	Convective snowfall rate water equivalent	kg m**-2 s**-1	csfr	228220		x
60	Large scale snowfall rate water equivalent	kg m**-2 s**-1	lssfr	228221		x
61	Instantaneous eastward turbulent surface stress	N m**-2	iews	229	x	x
62	Instantaneous northward turbulent surface stress	N m**-2	inss	230	x	x
63	Instantaneous surface sensible heat flux	W m**-2	ishf	231	x	x
64	Instantaneous moisture flux	kg m**-2 s**-1	ie	232	x	x
65	Skin temperature	K	skt	235	x	x
66	Soil temperature level 4	K	stl4	236	x	x
67	Temperature of snow layer	K	tsn	238	x	x
68	Forecast albedo	(0 - 1)	fal	243	x	x
69	Forecast surface roughness	m	fsr	244	x	x
70	Forecast logarithm of surface roughness for heat	~	flsr	245	x	x
71	100 metre U wind component	m s**-1	100u	228246	x	x
72	100 metre V wind component	m s**-1	100v	228247	x	x
73	Precipitation type	code table (4.201)	ptype	260015*		x
74	K index	K	kx	260121*		x
75	Total totals index	K	totalx	260123*		x

*GRIB2 format

Table 3: stream=oper/enda/mnth/moda/edmm/edmo, levtype=sfc: surface and single level parameters: accumulations

count	name	units	shortName	paramId	an	fc
1	Large-scale precipitation fraction	s	lspf	50		x
2	Downward UV radiation at the surface	J m**-2	uvb	57		x
3	Boundary layer dissipation	J m**-2	bld	145		x
4	Surface sensible heat flux	J m**-2	sshf	146		x
5	Surface latent heat flux	J m**-2	slhf	147		x
6	Surface solar radiation downwards	J m**-2	ssrd	169		x
7	Surface thermal radiation downwards	J m**-2	strd	175		x
8	Surface net solar radiation	J m**-2	ssr	176		x
9	Surface net thermal radiation	J m**-2	str	177		x
10	Top net solar radiation	J m**-2	tsr	178		x
11	Top net thermal radiation	J m**-2	ttr	179		x
12	Eastward turbulent surface stress	N m**-2 s	ewss	180		x
13	Northward turbulent surface stress	N m**-2 s	nsss	181		x
14	Eastward gravity wave surface stress	N m**-2 s	lgws	195		x
15	Northward gravity wave surface stress	N m**-2 s	mgws	196		x
16	Gravity wave dissipation	J m**-2	gwd	197		x
17	Top net solar radiation, clear sky	J m**-2	tsrc	208		x
18	Top net thermal radiation, clear sky	J m**-2	ttrc	209		x
19	Surface net solar radiation, clear sky	J m**-2	ssrc	210		x
20	Surface net thermal radiation, clear sky	J m**-2	strc	211		x
21	TOA incident solar radiation	J m**-2	tisr	212		x
22	Vertically integrated moisture divergence	kg m**-2	vimd	213		x
23	Total sky direct solar radiation at surface	J m**-2	fdir	228021		x
24	Clear-sky direct solar radiation at surface	J m**-2	cdir	228022		x
25	Surface solar radiation downward clear-sky	J m**-2	ssrdc	228129		x
26	Surface thermal radiation downward clear-sky	J m**-2	strdc	228130		x
27	Surface runoff	m	sro	8		x
28	Sub-surface runoff	m	ssro	9		x
29	Snow evaporation	m of water equivalent	es	44		x
30	Snowmelt	m of water equivalent	smlt	45		x
31	Large-scale precipitation	m	lsp	142		x
32	Convective precipitation	m	cp	143		x
33	Snowfall	m of water equivalent	sf	144		x
34	Evaporation	m of water equivalent	e	182		x
35	Runoff	m	ro	205		x
36	Total precipitation	m	tp	228		x

37	Convective snowfall	m of water equivalent	csf	239		x
38	Large-scale snowfall	m of water equivalent	lsf	240		x
39	Potential evaporation	m	pev	228251		x

Accumulations are described in section Mean rates and accumulations. The accumulations in monthly means of daily means (stream=moda/edmo) have been scaled to have units that include "per day", so for accumulations in these streams:

- The hydrological parameters are in units of "m of water per day" and so they should be multiplied by 1000 to convert to kg m^{-2} day^{-1} or mm day^{-1}.
- Energy (turbulent and radiative) and momentum fluxes should be divided by 86400 seconds (24 hours) to convert to the commonly used units of W m^{-2} and N m^{-2}, respectively.

Table 4: stream=oper/enda/mnth/moda/edmm/edmo, levtype=sfc: surface and single level parameters: mean rates

count	name	units	shortName	paramId	an	fc
1	Mean surface runoff rate	kg m**-2 s**-1	msror	235020		x
2	Mean sub-surface runoff rate	kg m**-2 s**-1	mssror	235021		x
3	Mean snow evaporation rate	kg m**-2 s**-1	mser	235023		x
4	Mean snowmelt rate	kg m**-2 s**-1	msmr	235024		x
5	Mean large-scale precipitation fraction	Proportion	mlspf	235026		x
6	Mean surface downward UV radiation flux	W m**-2	msdwuvrf	235027		x
7	Mean large-scale precipitation rate	kg m**-2 s**-1	mlspr	235029		x
8	Mean convective precipitation rate	kg m**-2 s**-1	mcpr	235030		x
9	Mean snowfall rate	kg m**-2 s**-1	msr	235031		x
10	Mean boundary layer dissipation	W m**-2	mbld	235032		x
11	Mean surface sensible heat flux	W m**-2	msshf	235033		x
12	Mean surface latent heat flux	W m**-2	mslhf	235034		x
13	Mean surface downward short-wave radiation flux	W m**-2	msdwswrf	235035		x
14	Mean surface downward long-wave radiation flux	W m**-2	msdwlwrf	235036		x
15	Mean surface net short-wave radiation flux	W m**-2	msnswrf	235037		x
16	Mean surface net long-wave radiation flux	W m**-2	msnlwrf	235038		x
17	Mean top net short-wave radiation flux	W m**-2	mtnswrf	235039		x
18	Mean top net long-wave radiation flux	W m**-2	mtnlwrf	235040		x
19	Mean eastward turbulent surface stress	N m**-2	metss	235041		x
20	Mean northward turbulent surface stress	N m**-2	mntss	235042		x
21	Mean evaporation rate	kg m**-2 s**-1	mer	235043		x
22	Mean eastward gravity wave surface stress	N m**-2	megwss	235045		x
23	Mean northward gravity wave surface stress	N m**-2	mngwss	235046		x
24	Mean gravity wave dissipation	W m**-2	mgwd	235047		x
25	Mean runoff rate	kg m**-2 s**-1	mror	235048		x
26	Mean top net short-wave radiation flux, clear sky	W m**-2	mtnswrfcs	235049		x
27	Mean top net long-wave radiation flux, clear sky	W m**-2	mtnlwrfcs	235050		x

28	Mean surface net short-wave radiation flux, clear sky	W m**-2	msnswrfcs	235051		x
29	Mean surface net long-wave radiation flux, clear sky	W m**-2	msnlwrfcs	235052		x
30	Mean top downward short-wave radiation flux	W m**-2	mtdwswrf	235053		x
31	Mean vertically integrated moisture divergence	kg m**-2 s**-1	mvimd	235054		x
32	Mean total precipitation rate	kg m**-2 s**-1	mtpr	235055		x
33	Mean convective snowfall rate	kg m**-2 s**-1	mcsr	235056		x
34	Mean large-scale snowfall rate	kg m**-2 s**-1	mlssr	235057		x
35	Mean surface direct short-wave radiation flux	W m**-2	msdrswrf	235058		x
36	Mean surface direct short-wave radiation flux, clear sky	W m**-2	msdrswrfcs	235059		x
37	Mean surface downward short-wave radiation flux, clear sky	W m**-2	msdwswrfcs	235068		x
38	Mean surface downward long-wave radiation flux, clear sky	W m**-2	msdwlwrfcs	235069		x
39	Mean potential evaporation rate	kg m**-2 s**-1	mper	235070		x

The mean rates in Table 4 provide similar information to the accumulations in Table 3, except that they are expressed as temporal averages instead of accumulations, and so have units of "per second". The hydrological parameters are in units of "kg m^{-2} s^{-1}" and so they can be multiplied by 86400 seconds (24 hours) to convert to kg m^{-2} day^{-1} or mm day^{-1}.

Table 5: stream=oper/enda, levtype=sfc: surface and single level parameters: minimum/maximum

count	name	units	shortName	paramId	an	fc
1	10 metre wind gust since previous post-processing	m s**-1	10fg	49		x
2	Maximum temperature at 2 metres since previous post-processing	K	mx2t	201		x
3	Minimum temperature at 2 metres since previous post-processing	K	mn2t	202		x
4	Maximum total precipitation rate since previous post-processing	kg m**-2 s**-1	mxtpr	228226		x
5	Minimum total precipitation rate since previous post-processing	kg m**-2 s**-1	mntpr	228227		x

Table 6: stream=oper/enda/mnth/moda/edmm/edmo, levtype=sfc: surface and single level parameters: vertical integrals (not available for type=em/es) and total column

count	name	units	shortName	paramId	an	fc
1	Vertical integral of mass of atmosphere	kg m**-2	vima	162053	x	x
2	Vertical integral of temperature	K kg m**-2	vit	162054	x	x
3	Vertical integral of kinetic energy	J m**-2	vike	162059	x	x
4	Vertical integral of thermal energy	J m**-2	vithe	162060	x	x
5	Vertical integral of potential+internal energy	J m**-2	vipie	162061	x	x
6	Vertical integral of potential+internal+latent energy	J m**-2	vipile	162062	x	x
7	Vertical integral of total energy	J m**-2	vitoe	162063	x	x
8	Vertical integral of energy conversion	W m**-2	viec	162064	x	x
9	Vertical integral of eastward mass flux	kg m**-1 s**-1	vimae	162065	x	x
10	Vertical integral of northward mass flux	kg m**-1 s**-1	viman	162066	x	x
11	Vertical integral of eastward kinetic energy flux	W m**-1	vikee	162067	x	x

12	Vertical integral of northward kinetic energy flux	W m**-1	viken	162068	x	x
13	Vertical integral of eastward heat flux	W m**-1	vithee	162069	x	x
14	Vertical integral of northward heat flux	W m**-1	vithen	162070	x	x
15	Vertical integral of eastward water vapour flux	kg m**-1 s**-1	viwve	162071	x	x
16	Vertical integral of northward water vapour flux	kg m**-1 s**-1	viwvn	162072	x	x
17	Vertical integral of eastward geopotential flux	W m**-1	vige	162073	x	x
18	Vertical integral of northward geopotential flux	W m**-1	vign	162074	x	x
19	Vertical integral of eastward total energy flux	W m**-1	vitoee	162075	x	x
20	Vertical integral of northward total energy flux	W m**-1	vitoen	162076	x	x
21	Vertical integral of eastward ozone flux	kg m**-1 s**-1	vioze	162077	x	x
22	Vertical integral of northward ozone flux	kg m**-1 s**-1	viozn	162078	x	x
23	Vertical integral of divergence of cloud liquid water flux	kg m**-2 s**-1	vilwd	162079	x	x
24	Vertical integral of divergence of cloud frozen water flux	kg m**-2 s**-1	viiwd	162080	x	x
25	Vertical integral of divergence of mass flux	kg m**-2 s**-1	vimad	162081	x	x
26	Vertical integral of divergence of kinetic energy flux	W m**-2	viked	162082	x	x
27	Vertical integral of divergence of thermal energy flux	W m**-2	vithed	162083	x	x
28	Vertical integral of divergence of moisture flux	kg m**-2 s**-1	viwvd	162084	x	x
29	Vertical integral of divergence of geopotential flux	W m**-2	vigd	162085	x	x
30	Vertical integral of divergence of total energy flux	W m**-2	vitoed	162086	x	x
31	Vertical integral of divergence of ozone flux	kg m**-2 s**-1	viozd	162087	x	x
32	Vertical integral of eastward cloud liquid water flux	kg m**-1 s**-1	vilwe	162088	x	x
33	Vertical integral of northward cloud liquid water flux	kg m**-1 s**-1	vilwn	162089	x	x
34	Vertical integral of eastward cloud frozen water flux	kg m**-1 s**-1	viiwe	162090	x	x
35	Vertical integral of northward cloud frozen water flux	kg m**-1 s**-1	viiwn	162091	x	x
36	Vertical integral of mass tendency	kg m**-2 s**-1	vimat	162092	x	
37	Total column cloud liquid water	kg m**-2	tclw	78	x	x
38	Total column cloud ice water	kg m**-2	tciw	79	x	x
39	Total column supercooled liquid water	kg m**-2	tcslw	228088		x
40	Total column rain water	kg m**-2	tcrw	228089	x	x
41	Total column snow water	kg m**-2	tcsw	228090	x	x
42	Total column water	kg m**-2	tcw	136	x	x
43	Total column water vapour	kg m**-2	tcwv	137	x	x
44	Total column ozone	kg m**-2	tco3	206	x	x

Table 7: stream=wave/ewda/wamo/wamd/ewmm/ewmo: wave parameters

count	name	units	shortName	paramId	an	fc
1	Significant wave height of first swell partition	m	swh1	140121	x	x

2	Mean wave direction of first swell partition	degrees	mwd1	140122	x	x
3	Mean wave period of first swell partition	s	mwp1	140123	x	x
4	Significant wave height of second swell partition	m	swh2	140124	x	x
5	Mean wave direction of second swell partition	degrees	mwd2	140125	x	x
6	Mean wave period of second swell partition	s	mwp2	140126	x	x
7	Significant wave height of third swell partition	m	swh3	140127	x	x
8	Mean wave direction of third swell partition	degrees	mwd3	140128	x	x
9	Mean wave period of third swell partition	s	mwp3	140129	x	x
10	Wave Spectral Skewness	dimensionless	wss	140207	x	x
11	Free convective velocity over the oceans	m s**-1	wstar	140208	x	x
12	Air density over the oceans	kg m**-3	rhoao	140209	x	x
13	Normalized energy flux into waves	dimensionless	phiaw	140211	x	x
14	Normalized energy flux into ocean	dimensionless	phioc	140212	x	x
15	Normalized stress into ocean	dimensionless	tauoc	140214	x	x
16	U-component stokes drift	m s**-1	ust	140215	x	x
17	V-component stokes drift	m s**-1	vst	140216	x	x
18	Period corresponding to maximum individual wave height	s	tmax	140217	x	x
19	Maximum individual wave height	m	hmax	140218	x	x
20	Model bathymetry	m	wmb	140219	x	x
21	Mean wave period based on first moment	s	mp1	140220	x	x
22	Mean wave period based on second moment	s	mp2	140221	x	x
23	Wave spectral directional width	dimensionless	wdw	140222	x	x
24	Mean wave period based on first moment for wind waves	s	p1ww	140223	x	x
25	Mean wave period based on second moment for wind waves	s	p2ww	140224	x	x
26	Wave spectral directional width for wind waves	dimensionless	dwww	140225	x	x
27	Mean wave period based on first moment for swell	s	p1ps	140226	x	x
28	Mean wave period based on second moment for swell	s	p2ps	140227	x	x
29	Wave spectral directional width for swell	dimensionless	dwps	140228	x	x
30	Significant height of combined wind waves and swell	m	swh	140229	x	x
31	Mean wave direction	degrees	mwd	140230	x	x
32	Peak period of 1D spectra	s	pp1d	140231	x	x
33	Mean wave period	s	mwp	140232	x	x
34	Coefficient of drag with waves	dimensionless	cdww	140233	x	x
35	Significant height of wind waves	m	shww	140234	x	x
36	Mean direction of wind waves	degrees	mdww	140235	x	x
37	Mean period of wind waves	s	mpww	140236	x	x
38	Significant height of total swell	m	shts	140237	x	x

39	Mean direction of total swell	degrees	mdts	140238	x	x
40	Mean period of total swell	s	mpts	140239	x	x
41	Mean square slope of waves	dimensionless	msqs	140244	x	x
42	10 metre wind speed	m s**-1	wind	140245	x	x
43	Altimeter wave height	m	awh	140246	x	
44	Altimeter corrected wave height	m	acwh	140247	x	
45	Altimeter range relative correction	~	arrc	140248	x	
46	10 metre wind direction	degrees	dwi	140249	x	x
47	Wave spectral kurtosis	dimensionless	wsk	140252	x	x
48	Benjamin-Feir index	dimensionless	bfi	140253	x	x
49	Wave spectral peakedness	dimensionless	wsp	140254	x	x
50	2D wave spectra (single)	m**2 s radian**-1	2dfd	140251*	x	

*for 30 frequencies and 24 directions

Table 8: stream=mnth/moda/edmm/edmo, levtype=sfc or wamo/wamd/ewmm/ewmo: monthly mean surface and single level and wave parameters: exceptions from Tables 1-7

count	name	units	shortName	paramId	an	fc
1	UV visible albedo for direct radiation	(0 - 1)	aluvp	15	x	no mean
2	UV visible albedo for diffuse radiation	(0 - 1)	aluvd	16	x	no mean
3	Near IR albedo for direct radiation	(0 - 1)	alnip	17	x	no mean
4	Near IR albedo for diffuse radiation	(0 - 1)	alnid	18	x	no mean
5	Magnitude of turbulent surface stress	N m**-2 s	magss	48		x
6	Mean magnitude of turbulent surface stress	N m**-2	mmtss	235025		x
7	10 metre wind gust since previous post-processing	m s**-1	10fg	49		no mean
8	Maximum temperature at 2 metres since previous post-processing	K	mx2t	201		no mean
9	Minimum temperature at 2 metres since previous post-processing	K	mn2t	202		no mean
10	10 metre wind speed	m s**-1	10si	207	x	x
11	Maximum total precipitation rate since previous post-processing	kg m**-2 s**-1	mxtpr	228226		no mean
12	Minimum total precipitation rate since previous post-processing	kg m**-2 s**-1	mntpr	228227		no mean
13	Altimeter wave height	m	awh	140246	no mean	
14	Altimeter corrected wave height	m	acwh	140247	no mean	
15	Altimeter range relative correction	~	arrc	140248	no mean	
16	2D wave spectra (single)	m**2 s	2dfd	140251	no	

		radian**-1			mean		

Table 9: stream=oper/enda/mnth/moda/edmm/edmo, levtype=pl: pressure level parameters: instantaneous

count	name	units	shortName	paramId	an	fc
1	Potential vorticity	K m**2 kg**-1 s**-1	pv	60	x	x
2	Specific rain water content	kg kg**-1	crwc	75	x	x
3	Specific snow water content	kg kg**-1	cswc	76	x	x
4	Geopotential	m**2 s**-2	z	129	x	x
5	Temperature	K	t	130	x	x
6	U component of wind	m s**-1	u	131	x	x
7	V component of wind	m s**-1	v	132	x	x
8	Specific humidity	kg kg**-1	q	133	x	x
9	Vertical velocity	Pa s**-1	w	135	x	x
10	Vorticity (relative)	s**-1	vo	138	x	x
11	Divergence	s**-1	d	155	x	x
12	Relative humidity	%	r	157	x	x
13	Ozone mass mixing ratio	kg kg**-1	o3	203	x	x
14	Specific cloud liquid water content	kg kg**-1	clwc	246	x	x
15	Specific cloud ice water content	kg kg**-1	ciwc	247	x	x
16	Fraction of cloud cover	(0 - 1)	cc	248	x	x

Table 10: stream=oper/enda/mnth/moda/edmm/edmo, levtype=pt: potential temperature level parameters: instantaneous

count	name	units	shortName	paramId	an	fc
1	Montgomery potential	m**2 s**-2	mont	53	x	
2	Pressure	Pa	pres	54	x	
3	Potential vorticity	K m**2 kg**-1 s**-1	pv	60	x	
4	U component of wind	m s**-1	u	131	x	
5	V component of wind	m s**-1	v	132	x	
6	Specific humidity	kg kg**-1	q	133	x	
7	Vorticity (relative)	s**-1	vo	138	x	
8	Divergence	s**-1	d	155	x	
9	Ozone mass mixing ratio	kg kg**-1	o3	203	x	

Table 11: stream=oper/enda/mnth/moda/edmm/edmo, levtype=pv: potential vorticity level parameters: instantaneous

count	name	units	shortName	paramId	an	fc
1	Potential temperature	K	pt	3	x	

2	Pressure	Pa	pres	54	x	
3	Geopotential	m**2 s**-2	z	129	x	
4	U component of wind	m s**-1	u	131	x	
5	V component of wind	m s**-1	v	132	x	
6	Specific humidity	kg kg**-1	q	133	x	
7	Ozone mass mixing ratio	kg kg**-1	o3	203	x	

Table 12: stream=oper/enda/mnth/moda/edmm/edmo, levtype=ml: model level parameters: instantaneous

count	name	units	shortName	paramId	an	fc
1	Specific rain water content	kg kg**-1	crwc	75	x	x
2	Specific snow water content	kg kg**-1	cswc	76	x	x
3	Eta-coordinate vertical velocity	s**-1	etadot	77	x	x
4	Geopotential*	m**2 s**-2	z	129	x	x
5	Temperature	K	t	130	x	x
6	U component of wind	m s**-1	u	131	x	x
7	V component of wind	m s**-1	v	132	x	x
8	Specific humidity	kg kg**-1	q	133	x	x
9	Vertical velocity	Pa s**-1	w	135	x	x
10	Vorticity (relative)	s**-1	vo	138	x	x
11	Logarithm of surface pressure*	~	lnsp	152	x	x
12	Divergence	s**-1	d	155	x	x
13	Ozone mass mixing ratio	kg kg**-1	o3	203	x	x
14	Specific cloud liquid water content	kg kg**-1	clwc	246	x	x
15	Specific cloud ice water content	kg kg**-1	ciwc	247	x	x
16	Fraction of cloud cover	(0 - 1)	cc	248	x	x

*Only archived on level=1.

Table 13: stream=oper/enda/mnth/moda/edmm/edmo, levtype=ml: model level parameters: mean rates

count	**name**	**units**	**shortName**	**paramId**	**an**	**fc**
1	Mean temperature tendency due to short-wave radiation	K s**-1	mttswr	235001		x
2	Mean temperature tendency due to long-wave radiation	K s**-1	mttlwr	235002		x
3	Mean temperature tendency due to short-wave radiation, clear sky	K s**-1	mttswrcs	235003		x
4	Mean temperature tendency due to long-wave radiation, clear sky	K s**-1	mttlwrcs	235004		x
5	Mean temperature tendency due to parametrisations	K s**-1	mttpm	235005		x
6	Mean specific humidity tendency due to parametrisations	kg kg**-1 s**-1	mqtpm	235006		x
7	Mean eastward wind tendency due to parametrisations	m s**-2	mutpm	235007		x
8	Mean northward wind tendency due to parametrisations	m s**-2	mvtpm	235008		x

count	name	units	shortName	paramId	an	fc
9	Mean updraught mass flux*	kg m**-2 s**-1	mumf	235009		x
10	Mean downdraught mass flux*	kg m**-2 s**-1	mdmf	235010		x
11	Mean updraught detrainment rate	kg m**-3 s**-1	mudr	235011		x
12	Mean downdraught detrainment rate	kg m**-3 s**-1	mddr	235012		x
13	Mean total precipitation flux*	kg m**-2 s**-1	mtpf	235013		x
14	Mean turbulent diffusion coefficient for heat*	m**2 s**-1	mtdch	235014		x

*These parameters provide data for the model half levels, at the interfaces of the model layers.

Observations

The observations (satellite and in-situ) used as input into ERA5 are listed below.

Satellite Data

Sensor	Satellite	Satellite agency	Data provider+	Measurement
Satellite radiances (infrared and microwave)				
AIRS	AQUA	NASA	NOAA	BT
AMSR-2	GCOM-W1*	JAXA		BT
AMSRE	AQUA*	JAXA		BT
AMSUA	NOAA-15/16/17/18/19, AQUA, METOP-A/B	NOAA,ESA,EUMETSAT		BT
AMSUB	NOAA-15/16/17	NOAA		BT
ATMS	NPP	NOAA		BT
CRIS	NPP	NOAA		BT
HIRS	TIROS-N, NOAA-6 /7/8/9/11/14	NOAA		BT
IASI	METOP-A/B	EUMETSAT/ESA	EUMETSAT	BT
GMI	GPM	NASA/JAXA		BT
MHS	NOAA-18/19, METOP-A/B	NOAA, EUMETSAT/ESA		BT
MSU	TIROS-N, NOAA-6 to 12, NOAA-14			BT
MWHS	FY-3-A/B	NRSCC		BT
MWHS2	FY-3-C	CMA		BT
MWTS	FY-3A/B	NRSCC		BT
MWTS2	FY-3C	CMA		BT
SSM/I	DMSP-11*/13*/14*/15*	US Navy	NOAA,CMSAF*	BT
SSMIS	DMSP-16/17/18	US Navy	NOAA	BT
SSU	TIROS-N, NOAA-6/7/8/9/11/14	NOAA		BT
TMI	TRMM	NASA/JAXA		BT

Sensor	Satellite	Satellite agency	Data provider+	Measurement
MVIRI	METEOSAT 5/7	EUMETSAT/ESA	EUMETSAT	BT
SEVIRI	METEOSAT-8*/9*/10	EUMETSAT/ESA	EUMETSAT	BT
GOES IMAGER	GOES-8/9/10/11/12/13/15	NOAA	CIMMS,NESDIS	BT
MTSAT IMAGER	MTSAT-1R/MTSAT-2	JMA		BT
AHI	Himawari-8	JMA		BT
Satellite retrievals from radiance data				
MVIRI	METEOSAT-2*/3*/4*/5*/7*	EUMETSAT/ESA	EUMETSAT	wind vector
SEVIRI	METEOSAT-8*/9*/10	EUMETSAT/ESA	EUMETSAT	wind vector
GOES IMAGER	GOES-4-6/8*/9*/10*/11*/12*/13*/15*	NOAA	CIMMS*,NESDIS	wind vector
GMS IMAGER	GMS-1*/2/3*/4*/5*	JMA		wind vector
MTSAT IMAGER	MTSAT-1R*/MTSAT2	JMA		wind vector
AHI	Himawari-8	JMA	JMA	wind vector
AVHRR	NOAA-7 /9/10/11/12/14 to 18, METOP-A	NOAA	CIMMS,EUMETSAT	wind vector
MODIS	AQUA/TERRA	NASA	NESDIS,CIMMS	wind vector
GOME	ERS-2*	ESA		Ozone
GOME-2	METOP*-A/B	ESA/EUMETSAT		Ozone
MIPAS	ENVISAT*	ESA		Ozone
MLS	EOS-AURA*	NASA		Ozone
OMI	EOS-AURA*	NASA		Ozone
SBUV,SBUV-2	NIMBUS-7*,NOAA*9/11/14/16/17/18/19	NOAA	NASA	Ozone
SCIAMACHY	ENVISAT*	ESA		Ozone
TOMS	NIMBUS-7*,METEOR-3-5,ADEOS-1*,EARTH PROBE	NASA		Ozone
Satellite GPS-Radio Occultation data				
BlackJack	CHAMP,GRACE*-A/B,SAC-C*	DLR,NASA/DLR,NASA/COMAE	GFZ,UCAR*	Bending angle
GRAS	METOP-A/B	EUMETSAT/ESA	EUMETSAT	Bending angle
IGOR	TerraSAR-X*, TanDEM-X, COSMIC*-1 to 6	NSPO/NOAA	GFZ,UCAR*	Bending angle
Satellite scatterometer data				
AMI	ERS-1,ERS-2	ESA		Backscatter sigma0
ASCAT	METOP-A/B*	EUMETSAT/ESA	EUMETSAT/TU Wien	Backscatter sigma0, soil moisture index
OSCAT	OCEANSAT-2	ISRO	KNMI	Backscatter sigma0

Sensor	Satellite	Satellite agency	Data provider+	Measurement
SEAWINDS	QUIKSCAT	NASA	NASA	Backscatter sigma0
Satellite Altimeter data				
RA	ERS-1*/2*	ESA		Wave Height
RA-2	ENVISAT*	ESA		Wave Height
Poseidon-2	JASON-1*	CNES/NASA	CNES	Wave Height
Poseidon-3	JASON-2	CNES/NOAA/NASA/EUMETSAT	NOAA/EUMETSAT	Wave Height
SIRAL	CRYOSAT-2	ESA		Wave Height
AltiKa	SARAL	CNES/ISRO	EUMETSAT	Wave Height

* reprocessed dataset
+ when different than the satellite agency

In-situ data, provided by WMO WIS

Dataset name	Observation type	Measurement
SYNOP	Land station	Surface Pressure, Temperature, wind, humidity
METAR	Land station	Surface Pressure, Temperature, wind,humidity
DRIBU/DRIBU-BATHY/DRIBU-TESAC	Drifting buoys	10m-wind, Surface Pressure
SHIP	ship station	Surface Pressure, Temperature, wind, humidity
Land/ship PILOT	Radiosondes	wind profiles
American Wind Profiler	Radar	wind profiles
European Wind Profiler	Radar	wind profiles
Japanese Wind Profiler	Radar	wind profiles
TEMP SHIP	Radiosondes	Temperature, wind, humidity profiles
DROP Sonde	Aircraft-sondes	Temperature, wind profiles
Land/Mobile TEMP	Radiosondes	Temperature profiles
AIREP	Aircraft data	Temperature, wind profiles
AMDAR	Aircraft data	Temperature, wind profiles
ACARS	Aircraft data	Temperature, wind profiles, humidity
WIGOS AMDAR	Aircraft data	Temperature, wind profiles

Snow data

Dataset name	Observation type	Measurement
SYNOP	Land station	Snow depth
Additional national reports	Land station	Snow depth
NOAA/NESDIS IMS	Merged satellite	Snow cover (NH only)

Guidelines

The following advice is intended to help users understand particular features of the ERA5 data:

- Sea surface temperature and sea-ice cover (see Table 2 above) are available at the usual times, eg hourly for the HRES, but their content is only updated once daily.
- Mean rates and accumulations at step=0 have values of zero because the length of the processing period is zero.

Known issues

At the time of writing (January 2019) we are aware of these issues with ERA5:

- ERA5 shows too strong tropical jet in the mesosphere
- ERA5 has poor fit to radiosonde temperatures in the lower stratosphere indicating some cold bias
- Although small values of ensemble spread correctly mark more confident estimates than large values, numerical values are over confident
- The Potential Evaporation field (pev, parameter Id 228251) is largely underestimated over deserts and high-forested areas. This is due to a bug in the code that does not allow transpiration in case no low vegetation type is present.
- Wind values are far too low on pressure levels at the poles in the Climate Data Store (CDS)
- Resolved issues
  - Wrong values of U/V on pressure levels in the Climate Data Store (CDS)

This list will be updated as we become aware of further issues in ERA5.

How to cite ERA5

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References

Operational global reanalysis: progress, future directions and synergies with NWP

Further ERA5 references are available from the ECMWF e-Library.

Related articles

ERA5 data documentation

What is ERA5

Sea level daily gridded data for the global ocean from 1993 to present: What does "vDT2018" file extension mean?

How to download ERA5

C3S ERA5: Web API to CDS API

era5 c3s known-issues