Implementation of IFS Cycle 43r1

#newfcsystem

Contents of this page

Related links

- Forecast scorecards
- Forecast User Guide
- Detailed IFS documentation

Description of the upgrade

IFS Cycle 43r1 is an upgrade with many scientific contributions, including changes in data assimilation (both in the EDA and the 4DVAR); in the use of observations; and in modelling. Moreover, ENS hourly fields will be available up to T+90 for the Boundary Conditions optional programme. See 'Impact on Users' below for further information. Please note that hourly ENS fields will not be added to the Real Time Catalogue.

With this cycle upgrade, the medium-range ensemble and its monthly extension see a major upgrade in the dynamical ocean model (NEMO): the resolution is increased from 1 degree and 42 layers to 0.25 degrees and 75 layers (ORCA025Z75). Furthermore, NEMO model version v3.4.1 with the interactive sea-ice model (LIM2) is implemented. The ocean and sea-ice components of the ENS initial conditions are provided by the new ocean analysis and reanalysis suite ORAS5, which uses the new ocean model and revised ensemble perturbation method.

Implemented: **22 November 2016**

News

Latest change (23.11.2016): IFS Cycle 43r1 was implemented in operations on Tuesday 22 November 2016.

- This is to confirm the implementation of IFS Cycle 43r1 in operations yesterday, Tuesday 22 November 2016. The monthly forecast extension to the ensemble will be run with the new IFS cycle for the first time on Thursday 24 November 2016.
- ECMWF thanks all users for their efforts to prepare their systems for the change by using our test datasets.

Previous change (15.11.2016): The implementation date is confirmed as Tuesday 22 November 2016.

- The first operational run using the new cycle will be the 06 UTC analysis and forecast in the Boundary Conditions Optional Programme on 22 November followed by the 12 UTC main assimilation and forecast.
- The monthly forecast extension to the ensemble will be run with IFS Cycle 43r1 for the first time on Thursday 24 November 2016.
- In order to manage the transition, changes to dissemination requirements will be suspended from 09:00 UTC on 21 November 2016 to 09:00 UTC on 22 November 2016.

Timeline of the implementation

The planned timetable for the implementation of IFS Cycle 43r1 is as follows:

Date	Event
22 Sep 2016	Initial announcement via e-mail to Member States contact points
Week beginning 24 Oct 2016	Start of release candidate test phase: data available in dissemination, MARS and ecCharts
22 Nov 2016	Expected date of implementation

The timetable represents current expectations and may change in light of actual progress made.

Datasets affected

- HRES
- ENS
- HRES-WAM
- HRES-SAW
- ENS-WAM

Resolution

Resolutions in bold increased/changed from previous IFS cycle.

	Component	Horizontal resolution		Vertical resolution [levels]
Atmosphere	HRES	O1280	~9 km	137
	ENS	O640	~18 km	91
	ENS extended	O320	~36 km	91
Wave	HRES-WAM	0.125°	~14 km	-
	ENS-WAM	0.25°	~28 km	-
	ENS-WAM Extended	0.5°	~55 km	-
Ocean	NEMO 3.4	**0.25°**	~28 km	**75**

Meteorological content

Data Assimilation methodology (atmosphere, land and ocean)

- The sea-surface temperature (SST) perturbations used in the EDA have been upgraded to a recently developed climatology based on the HadISST.2 dataset. This makes the perturbations statistically consistent with the error characteristics of the analysis cycles.
- The EDA-derived background error estimates used in 4DVAR are now computed at spectral resolution T_L399 (previously T_L159) and a new wavelet-based filtering algorithm is used to control sampling noise. The background error variance has been increased by ~16%.
- The weak constraint option of 4DVAR has been reactivated using a model error forcing term active in the stratosphere above 40 hPa and a new estimate of the model error covariance matrix.
- The land surface assimilation of SYNOP screen level observations now accounts for the vertical distance between the observations and model grid points. A new vertical structure function has been introduced that follows the approach used at Environment Canada and at Météo-France in MESAN-SAFRAN. The vertical correlation is expressed as a Gaussian function, consistent with that used for snow depth analysis. This gives more weight to observations from stations that are vertically closer to the model grid point (and less to observations less representative of the model altitude).
- A new ocean analysis/re-analysis (ORAS5), based on NEMOVAR with a higher-resolution version of the ocean model NEMO (0.25 degrees with 75 vertical layers: ORCA025Z75) has been implemented. This uses the same ocean model version (NEMO v3.4.1) as ENS. ORAS5 uses a new perturbation strategy for the surface fluxes and to simulate observation errors. It also includes an improved quality-control scheme for ocean observations. Sea ice is assimilated within NEMOVAR, with a weakly coupled assimilation to the ocean dynamics. The analyses have been run from 1975 and continue in real-time to provide initial conditions for the ENS forecasts and re-forecasts.

Observations

- Radiance assimilation will now take the viewing geometry more fully into account, by evaluating the radiative transfer along slantwise paths (instead of vertically). This is done for all clear-sky sounder radiances when interpolating model fields to observation locations.
- A better treatment of observation uncertainty for IASI and CrIS has led to updated observation error covariance matrices and a change of ozone anchor channels in bias correction.
- The channel selection for the hyperspectral infrared instrument CrIS has been revised and now uses 117 rather than 77 channels
- The aerosol detection scheme for IASI has been revised making it independent of the bias correction. The scheme is also applied to both CrIS and AIRS.

Model changes

- A new CAMS ozone climatology is now used, consisting of monthly means of a re-analysis of atmospheric constituents (CAMSiRA) for the period 2003 to 2014.
- Changes to boundary layer cloud for marine stratocumulus and at high latitudes.
- Modifications to surface coupling for 2 metre temperature.
- Assimilation of snowfall from the NEXRAD RADAR network over the USA.
- New model output fields include four cloud and freezing diagnostics (for aviation), a new direct-beam solar radiation diagnostic and improvements to the sunshine duration diagnostic.

Medium-range/monthly ensemble (ENS)

All IFS cycles

- Terminology for IFS testing
- Implementation of IFS Cycle 48r1
- Implementation of IFS Cycle 47r3
- Implementation of IFS Cycle 47r2
- Implementation of IFS Cycle 47r1
- Implementation of IFS cycle 46r1
- Implementation of IFS cycle 45r1
- Implementation of Seasonal Forecast SEAS5
- Implementation of IFS cycle 43r3
- Implementation of IFS Cycle 43r1
- Implementation of IFS cycle 41r2
- Introducing the octahedral reduced Gaussian grid
- Horizontal resolution increase
- Boundary-Condition Programme ENS at 06 and 18 UTC
- Implementation of IFS Cycle 41r1
- IFS cycle upgrades pre 2015

- The horizontal and vertical resolutions of the ocean model (NEMO v3.4.1) used by ENS is increased from 1 degree and 42 layers to 0.25 degree and 75 layers (ORCA025Z75). An interactive sea-ice model (the Louvain-la-Neuve Sea Ice Model - LIM2) is introduced so that sea-ice cover evolves dynamically. Previously it was persisted for 15 days; over the next 30 days of the forecast, it was relaxed towards the climatology of the previous 5 years.
- Ocean initial conditions are taken from ORAS5 instead of ORAS4.
- A global fix for tendency perturbations in the stochastic model error scheme SPPT to improve global momentum, energy and moisture conservation properties.
- The land initial conditions of the ENS re-forecasts are taken from a new land surface simulation at the native ENS resolution (T_{CO}639, ~16km), replacing the previous configuration that used ERA-Interim/Land (at T_L255 resolution, ~80 km)

Meteorological impact

Upper air

The new model cycle provides improved high-resolution forecasts (HRES) and ensemble forecasts (ENS) throughout the troposphere and lower stratosphere. In the extra-tropics, error reductions of the order of 0.5-1% are found for most upper-air parameters and levels. The improvement in the primary headline score for the HRES (lead time at which the 500 hPa geopotential anomaly correlation drops below 80%) is about 1 h.

Improvements are most consistently seen in verification against the model analysis. In the tropics, there is a small degradation (both against analysis and observations) of temperature near the tropopause in terms of root mean square error (RMSE) but not in terms of anomaly correlation. This is due to a slight cooling caused by a modification in the treatment of cloud effects in the vertical diffusion scheme, which overall leads to improved cloud cover. While there is a consistent gain for upper-air parameters on the hemispheric scale, some continental-scale areas, such as North America and East Asia, show statistically significant improvements only at some levels and for some parameters.

Increases in upper-air skill of the ENS are generally similar to the HRES, with a substantial gain for mean sea level pressure. The improvement in the primary headline score for the ENS (lead time at which the CRPSS of the 850 hPa temperature drops below 25%) is small (of the order of 0.5 h). The spread-error relationship is generally improved, partly due to reduced error and partly due to increased spread. For some parameters this improvement is quite significant, such as the 850 hPa wind speed in the tropics, where the under-dispersion is reduced by about 20% in the medium range.

Weather parameters and waves

The new model cycle yields consistent gains in forecast performance in the tropics and extra-tropics for total cloud cover, mostly due to a reduction of the negative bias in low cloud cover.

Changes in precipitation over land areas are small and overall neutral.

The increase in forecast skill for 2m temperature is most pronounced in the short and medium range, where it amounts to ~1% reduction of the RMSE in the northern hemisphere extra-tropics, and up to 2% over some land areas such as Europe and North America. In the tropics there is an increase of 0.5-1% in the RMSE for 2m temperature, connected to a slight increase of the overall cold bias at low latitudes. In the ENS there is a significant improvement in 2m temperature amounting to a 3% reduction in the continuous ranked probability score (CRPS) in Europe.

There is an increase of the RMSE of 2m humidity by about 1% in winter associated with the introduction of limited evapotranspiration when the uppermost soil layer is frozen. This change contributes to the improvements in 2m temperature.

10m wind speed shows error reductions of 0.5-1% over the ocean, leading to improvements in significant wave height and mean wave period, especially in the tropics and southern hemisphere. Over land areas, changes in 10m wind speed forecast skill are generally neutral to slightly positive.

Monthly forecast

Verification results show a modest positive effect on skill scores although the differences are not statistically significant. There is a substantial improvement in the skill scores for the Madden-Julian Oscillation (MJO), corresponding to a gain in lead time of 0.5-1 day at a forecast range of 4 weeks. Also, MJO spread is increased, bringing it closer to the RMSE. Verification of precipitation against analysis shows some degradation in the tropics which is not statistically significant, and a reduction of precipitation biases in the northwest Pacific.

Sea ice

The new cycle introduces a prognostic sea-ice model, leading to a significant reduction of the RMSE of sea ice fraction in the later medium range.

Evaluation

Comparison of scores between IFS Cycle 43r1 and IFS Cycle 41r2 for HRES can be found in the IFS Cycle 43r1scorecard.

New and changed parameters

New parameters

New model output fields for HRES and ENS comprise four cloud and freezing diagnostics (for aviation), and a new direct-beam solar radiation diagnostic

In addition, eight new wave model output fields are provided.

- The magnitude and direction of the wave energy flux that is responsible for the impact of the waves on coastlines and offshore structures.
- Significant wave height of all waves in six different period ranges to help with detection of low-frequency wave energy.

All the new output fields are available at the usual post-processing time steps except where specified otherwise in the table:

- HRES: forecast - hourly up to T+90, 3-hourly from T+93 to T+144 and 6 hourly from T+150 to T+240.
- HRES-WAM and HRES-SAW: analysis and forecast - hourly up to T+90, 3-hourly from T+93 to T+144 and 6 hourly from T+150 to T+240.
- ENS and ENS-WAM: hourly up to T+90, 3-hourly from T+93 to T+144 and 6 hourly from T+150 to T+360.
- ENS-extended and ENS-WAM-extended: 6 hourly from T+366 to T+1104.

Further technical information is provided in the table.

paramId	shortName	name	description	units	GRIB edition	Component	Test data available	Dissemination	ecCharts	Proposed for Catalogue
260109	ceil	Ceiling	Cloud-base height relative to the ground (at least 50% cloud in one layer)	m	**2**	HRES / ENS	✓	✓	TBC	✓
228046	hcct	Height of convective cloud top	See 43r1 new parameters: Height of convective cloud top	m	1	HRES / ENS	✓	✓	TBC	✓
228047	hwbt0	Height of zero-degree wet-bulb temperature	See 43r1 new parameters: Height of zero-degree (and one-degree) wet-bulb temperature	m	1	HRES / ENS	✓	✓	TBC	✓
228048	hwbt1	Height of one-degree wet-bulb temperature	See 43r1 new parameters: Height of zero-degree (and one-degree) wet-bulb temperature	m	1	HRES / ENS	✓	✓	TBC	✓
47	dsrp	Direct solar radiation	Incident on a plane perpendicular to the sun's direction. This is an accumulated field.	J/m^2	1	HRES / ENS NB: only forecast	✓	✓	TBC	✓
140112	wefxm	Wave energy flux magnitude	Integral over all frequencies and directions of the product of the group speed and the two-dimensional energy wave spectrum.	W/m	1	HRES-WAM / ENS-WAM / HRES-SAW	✓	✓	TBC	✓

140113	wefxd	Wave energy flux mean direction	Spectral mean direction over all frequencies and direction of the product of the group velocity vector and the two-dimensional energy wave spectrum.	Degree true	1	HRES-WAM / ENS-WAM / HRES-SAW	✓	✓	TBC	✓
140114	h1012	Significant wave height of all waves with periods within the inclusive range from 10 to 12 seconds	Significant wave height of all waves with periods within the inclusive range from 10 to 12 seconds, where the significant wave height is defined as 4 times the square root of the integral over all directions and all frequencies between 1/12 and 1/10 Hz of the two-dimension wave spectrum	m	1	HRES-WAM / ENS-WAM / HRES-SAW	✓	✓	TBC	✓
140115	h1214	Significant wave height of all waves with periods within the inclusive range from12 to 14 seconds	Significant wave height of all waves with periods within the inclusive range from 12 to 14 seconds, where the significant wave height is defined as 4 times the square root of the integral over all directions and all frequencies between 1/14 and 1/12 Hz of the two-dimension wave spectrum	m	1	HRES-WAM / ENS-WAM / HRES-SAW	✓	✓	TBC	✓
140116	h1417	Significant wave height of all waves with periods within the inclusive range from 14 to 17 seconds	Significant wave height of all waves with periods within the inclusive range from 14 to 17 seconds, where the significant wave height is defined as 4 times the square root of the integral over all directions and all frequencies between 1/17 and 1/14 Hz of the two-dimension wave spectrum	m	1	HRES-WAM / ENS-WAM / HRES-SAW	✓	✓	TBC	✓

140117	h1721	Significant wave height of all waves with periods within the inclusive range from 17 to 21 seconds	Significant wave height of all waves with periods within the inclusive range from 17 to 21 seconds, where the significant wave height is defined as 4 times the square root of the integral over all directions and all frequencies between 1/21 and 1/17 Hz of the two-dimension wave spectrum	m	1	HRES-WAM / ENS-WAM / HRES-SAW	✓	✓	TBC	✓
140118	h2125	Significant wave height of all waves with periods within the inclusive range from 21 to 25 seconds	Significant wave height of all waves with periods within the inclusive range from 21 to 25 seconds, where the significant wave height is defined as 4 times the square root of the integral over all directions and all frequencies between 1/25 and 1/21 Hz of the two-dimension wave spectrum	m	1	HRES-WAM / ENS-WAM / HRES-SAW	✓	✓	TBC	✓
140119	h2530	Significant wave height of all waves with periods within the inclusive range from 25 to 30 seconds	Significant wave height of all waves with periods within the inclusive range from 25 to 30 seconds, where the significant wave height is defined as 4 times the square root of the integral over all directions and all frequencies between 1/30 and 1/25 Hz of the two-dimension wave spectrum	m	1	HRES-WAM / ENS-WAM / HRES-SAW	✓	✓	TBC	✓

The following new variable resolution parameter is also provided in the ensemble forecast variable resolution overlap stream (STREAM=EFOV) at T+360 (STEP=360) from the Monday and Thursday runs of the ensemble forecast monthly extension.

paramId	shortName	name	description	units	GRIB edition	Component	Test data available	Dissemination	ecCharts	Proposed for Catalogue
230047	dsrpvar	Direct solar radiation (variable resolution)	Variable resolution companion to dsrp.	J/m^2	1	ENS (STREAM=EFOV)	✓	✓	TBC	✓

Technical content

Upgrade to the dynamical ocean model

The medium-range ensemble and its monthly extension see a major upgrade in the dynamical ocean model. The main changes are summarised in the table.

	Old	New
Ocean model version	NEMO v3.4.1	NEMO v3.4.1
Configuration	ORCA1Z42	ORCA025Z75
Horizontal resolution	1.0°	0.25°
Vertical layers	42	75
Time step	3600s	1200s
Initial conditions	OCEAN4 using NEMO v3.0	OCEAN5 using NEMO v3.4.1
Sea-ice coupling	None	LIM2

ORAS5 complements the current ocean reanalysis system (ORAS4) until there is no longer need for the ORAS4 output.

Changes to GRIB encoding

Model identifiers

The GRIB model identifiers (generating process identification number) for the new cycle will be changed as follows:

GRIB 1 Section 1 Octets	GRIB 2 Section 4 Octets	grib_api key	Component	Model ID	
				Old	New
6	14	generatingProcessIdentifier	Atmospheric model	146	**147**
			Ocean wave model	111	**112**
			HRES stand-alone ocean wave model	211	**212**

Data Access

Hourly ENS data

This cycle sees the introduction of hourly fields up to T+90 for the ENS for the Boundary Conditions optional programme. These fields will not be available on the Real Time Catalogue.

With the introduction of hourly post-processing for the first 90 hours of the ENS, **the five accumulated surface variables (10m wind gusts, maximum and minimum 2m temperature, maximum and minimum total precipitation rate since the previous post-processing) will change to represent hourly accumulations instead of the currently operational 3-hourly accumulations**. For the rest of the forecast range, these products will remain unchanged providing three-hourly data to T+144, and six-hourly data to T+360.

Impacted model fields	Short name	ID
Maximum temperature at 2 m since previous post-processing	MX2T	201
Minimum temperature at 2 m since previous post-processing	MN2T	202
10 m wind gust since previous post-processing	10FG	49
Maximum total precipitation rate since previous post-processing	MXTPR	228226
Minimum total precipitation rate since previous post-processing	MNTPR	228227

Users of the dissemination wishing to continue using three-hourly accumulations are advised to change their requirements to request 10FG3, MX2T3, MN2T3, MXTPR3 and MNTPR3 (as replacement for the current 10FG, MX2T, MN2T, MXTPR, MNTPR). Alternatively they can contact Dragan Jokic (Member and Cooperating States) or Data Services (Commercial customers).

Users accessing these data via MARS should change their requests in the same way. They can also contact ECMWF User Support .

New delivery schedule for the ENS

We plan to bring forward the schedule for the delivery of the ENS data. This change will not be implemented together with the implementation of IFS Cycle 43r1 but is now scheduled for early January 2017. Further information on this will be given closer to the time.

Software

ecCodes replaces grib_api for encoding and decoding model output in GRIB.

EMOSLIB

EMOSLIB 443 is needed to interpolate successfully the wave energy flux mean direction (wefxd) parameter introduced at IFS Cycle 43r1.

GRIB API

GRIB API version 1.17.0 provides full support for the new model output parameters introduced in IFS Cycle 43r1.

Older versions of GRIB API can decode the IFS Cycle 43r1 products successfully but users are advised to use at least GRIB API version 1.14.5, which provides full support for the octahedral reduced Gaussian grid.

ecCodes

ecCodes version 2.0.0 provides full support for the new model output parameters introduced in IFS Cycle 43r1.

Availability of IFS 43r1 test data

Test data in MARS

Test data from the IFS Cycle 43r1 test suites are available in MARS. The data are available with E-suite experiment version (expver) 0070 (MARS keyword EXPVER=0070) starting from 06 UTC on 10 August 2016. As of 25 October 2016, the data are produced from the release candidate testing stage.

The data can be accessed in MARS from:

- HRES (class=od, stream=oper, expver=70)
- Wave HRES (class=od, stream=wave, expver=70)
- ENS (class=od, stream=enfo, expver=70)
  - 00 UTC cycle only
- ENS Wave (class=od, stream=waef, expver=70)
  - 00 UTC cycle only

Only registered users of ECMWF computing systems will be able to access the test data sets in MARS.

The data should not be used for operational forecasting. Please report any problems you find with this data to User Support.

Test data in dissemination

IFS Cycle 43r1 test data from the release candidate testing stage is available through the test dissemination system. All new model output parameters can be requested.

How to request dissemination of IFS Cycle 43r1 test data

The IFS Cycle 43r1 test products are available on the ECPDS as version number 70. The test products are generated daily, shortly behind real-time from both the 00UTC and 12UTC runs and based on the IFS Cycle 43r1 test data for HRES, ENS, WAM, ENS_WAM and HRES-SAW.

Users of ECMWF dissemination products can trigger transmission of test products by logging in to the test ECPDS system at https://ecpds-xmonitor.ecmwf.int/ in the usual manner. In order to receive the test products, users have to have their firewall open to the relevant ECPDS Data Movers:

- Internet transfers: 193.61.196.104 (ecpds-xma.ecmwf.int) 193.61.196.105 (ecpds-xmb.ecmwf.int)
- RMDCN transfers: 136.156.8.132 (mspds-dm4.ecmwf.int)

Should you require any assistance with IFS Cycle 43r1 test dissemination products, Member and Cooperating states should contact Unknown User (maj) and Commercial customers should contact Data Services.

Graphical display of IFS Cycle 43r1 test data using ecCharts

Forecast users can use ecCharts to inspect the IFS Cycle 43r1 test data and compare with the operational forecast. This facility is provided for testing purposes: the 43r1 test charts should **not** be relied upon for operational forecasting. Note in particular that the availability and timeliness of the 43r1 test data will vary, and can be considerably delayed with respect to the operational schedule. Any plot containing 43r1 test data will, therefore, be late compared to operational products.

Some of the new model output fields will be added to ecCharts when ready.

The following layers are missing for the new cycle and will become available on 26 October 2016:

- Wind speed related layers
- Minimum 2 metre temperature and Maximum 2 metre temperature
- 850 hPa wet bulb potential temperature

IFS Cycle 43r1 release candidate test data is accessible via the ecCharts layers menu, identified by the label "(Esuite: 0070)".

ENS meteograms based on IFS Cycle 43r1 test data

ENS Meteograms based on IFS Cycle 43r1 test data are available. They can be plotted by choosing 'New cycle (IFS43r1)' under the Experiment tab on the interactive page ENS meteogram page provided under the ECMWF Forecast Charts page.

Time-critical applications

Option 1 - simple time-critical jobs

Member State users of the "Simple time-critical jobs" framework can test that their scripts will work with the IFS Cycle 43r1 test data by using the special 'events' set up for this purpose:

1633	e_ms090	At this stage, the e-suite step 090 (HRES-BC) has been generated.
1634	e_ms144	At this stage, the e-suite step 144 (ENS-BC) has been generated.
1635	e_ms240	At this stage, the e-suite step 240 (HRES) has been generated.
1636	e_ms360	At this stage, the e-suite step 360 (ENS) has been generated.
1637	e_mslaw	At this stage, the e-suite step law (HRES-SAW) has been generated.
1638	e_ms1104	At this stage, the e-suite step 1104 (ENS-MOFC) has been generated.
1639	msrefc	At this stage, the e-suite step refc (REFORECAST) has been updated.

For these events, MSJ_EXPVER environment variable is set to 0070 and can be used to specify the IFS Cycle 43r1 test data any MARS retrievals.

These events are intended for testing technical aspects only and should **not** be used for operational forecasting.

Options 2 and 3

Option 2 or 3 time-critical applications can be tested with the IFS Cycle 43r1 test data retrieved from MARS or received in Dissemination.

Resources

ECMWF Newsletter Number 150: https://www.ecmwf.int/en/newsletter/150/meteorology/new-ifs-cycle-brings-sea-ice-coupling-and-higher-ocean-resolution

Document versions

Date	Reason for update
19.09.2016	• Initial version
22.09.2016	• Initial announcement to Member States
04.10.2016	• Update to data availability. • Update to new model output parameters.
18.10.2016	• Meteorological impact added. • Update to new model output parameters.
24.10.2016	• Release candidate test data available in MARS, dissemination and ecCharts
28.10.2016	• Update to new model output parameters (link to description of hcct)
01.11.2016	• Update to the Meteorological content of the new cycle.
07.11.2016	• Updated information on implementation of new delivery schedule for the ENS.
15.11.2016	• Confirmation of 22 November 2016 as implementation date.
23.11.2016	• Confirmation of implementation of IFS Cycle 43r1 in operations on Tuesday 22 November 2016.