Implementation of IFS Cycle 47r3

Description of the upgrade

Cycle upgrade 47r3 will bring improvements to the assimilation and observations usage and a significantly improved physical basis for moist processes, necessary to facilitate further development of the Integrated Forecasting System (IFS) and future application at convection-permitting resolutions.

The upgrade will bring more accurate upper air fields, particularly tropical winds, as well as precipitation in convective regimes. Several new convection-related products will be available and systematic errors are reduced for wind gusts and visibility for fog and precipitation.

Implemented: 06 UTC run on 12 Oct 2021

#IFS47r3 #newfcsystem @ECMWF

News

07 Mar 2022 Change to GRIB 2 Master Tables Version with the fix implemented on 22 Feb 2022

17 Feb 2022 Fix of low-level T/q in fog conditions announced

13 Oct 2021 Cycle 47r3 has been implemented with the 6 UTC run on 12 October 2021

06 Oct 2021Information on meteorological impact updated and a document on 47r3 Impact on Surface Weather representation published

22 Sept 2021 Specific information on peak wave period published

14 Sept 2021

- Release Candidate test data and products are available now
- Recording and slides of the latest webinar Cycle 47r3 overview added

08 Sept 2021 ENS and HRES scorecards have been added

01 Sept 2021 Updated recommended software versions and information on test data from release candidate added

26 Aug 2021 Specific information on new CAPE and CIN parameters published

25 Aug 2021 A *webinar* giving an updated overview of Cycle 47r3 with a focus on the scientific developments, the meteorological impact and new products has been scheduled for

13 September 2021, 15:00 UTC

To join please register on the event page.

06 Aug 2021 Changes to the grid descriptions of analysis parameters ci and sst

15 Jul 2021

- Implementation moved to 12 October
- Beta test data available now

07 Jul 2021 Recording and slides of the webinar Cycle 47r3 overview and more information on the met eorological impact are now available.

23 Jun 2021 IFS Cycle 47r3 content and implementation timeline announced. The new cycle will be introduced in a first webinar on

6 July 2021 at 8:00 UTC: Join the webinar on Zoom

A recording of the webinar will be made available after the event

Timeline of the implementation

Contents of this page

Related links

- News article
- Forecast scorecards
- Operational forecast configurations
- Forecast User Guide
- Detailed IFS documentation

Gliffy Macro Error

You do not have permission to view this diagram.

Datasets affected

- HRES (day 1-10)
- ENS (day 1-15)
- HRES-WAM (day 1-10)
- ENS-WAM (day 1-15)
- ENS-extended (day 16-46)

Resolution

Unchanged from previous IFS cycle.

	Component	Horizontal resolution		Vertical resolution [levels]
Atmosphere	HRES	O1280	~9 km	137
	ENS	O640	~18 km	137
	ENS extended	O320	~36 km	137
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

Assimilation

- New RTTOV coefficients for hyperspectral infrared (IR) sounders
- New height reassignment for low level AMVs
- Add representativeness error in the total observation error for Aeolus
- Weak-constraint 4D-Var active in the stratosphere for the EDA system

Observations

- Assimilation of all-sky AMSU-A

Model

- A more consistent formulation of boundary layer turbulence, shallow convection and sub-grid cloud including:
    - Simplified and more consistent treatment of sub-grid cloud saturation adjustment
    - Consistent treatment of subgrid cloud from boundary layer turbulent mixing without separate statistical cloud scheme
    - Consistent computation of mixing height for unstable turbulent boundary layer and convection scheme
    - Change from double to single iteration of turbulent mixing scheme
- New method for computing inversion strength based on moist entropy for distinguishing stratocumulus and cumulus cloud
- Limit to convective overshoot based on tropopause stability
- New parametrized deep convection closure with an additional dependence on total advective moisture convergence
- Change from exponential-exponential cloud vertical overlap to random-exponential overlap in closer agreement with observations
- Include vapour deposition process for growth of falling snow particles
- Change from linear to cubic interpolation for cloud liquid, ice, rain and snow semi-Lagrangian departure point calculations, including 3D quasi-monotone limiter
- Interpolation of cloud and precipitation to radiation grid changed from in-cloud to grid-mean

All IFS cycles

- Terminology for IFS testing
- Implementation of IFS Cycle 49r1
- 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

- Inclusion of full supersaturation adjustment in the ensemble SPPT stochastic perturbations
- Mass-weighting and relaxation timescale introduced for ensemble SPPT stochastic perturbations
- Revised simplified moist physics and associated tangent-linear and adjoint
- Bug fix for vertical interpolation of 3D aerosol climatology
- Improved calculation of extinction coefficients for near-surface visibility in fog, rain and snow
- Revised gustiness parametrization
- Improved calculation of the peak wave period for multi-peaked ocean wave spectra

Meteorological impact

- Extratropical upper-air geopotential and wind in the first few days of the forecast improved by a few percent
- Tropical upper-air winds throughout the medium-range improved by up to 7%, reducing with lead time
- Tropical upper-air temperature improved in HRES, but degraded CRPS in ENS due to small (~0. 2K) increase in bias. Low level temperatures (including 850hPa and 2m) temperature approximately neutral versus observations but degraded versus analysis over subtropical ocean.
- Tropical Cyclones: 10% improvement in position error in HRES and ENS and weaker central pressure
- Improved MJO prediction and amplitude
- More realistic precipitation PDF in strongly convective regimes
- Increased convective precipitation (reduced dry bias) in arid regions
- Increase in small scale structure for cloud and precipitation but total cloud cover degraded
- Reduced biases for wind gusts and for visibility in fog, rain and snow

The separate document 47r3 Impact on Surface Weather representation highlights the changes with 47r3 in the characteristics of many frequently used forecast fields and products.

Evaluation

Scorecards presenting the new cycle performance are regularly updated:

- HRES scorecard
- ENS scorecard

New and changed parameters

New parameters

The table contains the list of parameters expected to be available with the model implementation. They will be available as part of the test data.

Param ID	Short name	Name	Units	Component & type	GRIB edition	Lev. type	MARS	Added to catalogue	ecCharts	Diss.
228045[1]	trpp	Tropopause pressure	Pa	HRES FC	2	sfc	✓	✓	TBD	✓
228020	degm10l	-10 degrees C isothermal level (atm)	m	HRES FC ENS CF/PF	1	sfc	✓	✓	TBD	✓
228131	u10n	Neutral wind at 10 m u-component	m s^{-1}	ENS CF/PF	1	sfc	✓	✓	TBD	✓
228132	v10n	Neutral wind at 10 m v-component	m s^{-1}	ENS CF/PF	1	sfc	✓	✓	TBD	✓
228231[2]	mlcape50	Mixed-layer CAPE in the lowest 50 hPa	J kg^{-1}	HRES FC ENS CF/PF	2	sfc	✓	✓	TBD	✓

228232[2]	mlcin50	Mixed-layer CIN in the lowest 50 hPa	J kg^{-1}	HRES FC ENS CF/PF	2	sfc	✔	✔	TBD	✔
228233[2]	mlcape100	Mixed-layer CAPE in the lowest 100 hPa	J kg^{-1}	HRES FC ENS CF/PF	2	sfc	✔	✔	TBD	✔
228234[2]	mlcin100	Mixed-layer CIN in the lowest 100 hPa	J kg^{-1}	HRES FC ENS CF/PF	2	sfc	✔	✔	TBD	✔
228235[2]	mucape	Most-unstable CAPE	J kg^{-1}	HRES FC ENS CF/PF	2	sfc	✔	✔	✔	✔
228237[2]	mudlp	Departure level of the most unstable parcel expressed as Pressure	Pa	HRES FC ENS CF/PF	2	sfc	✔	✔	TBD	✔
260290	cat	Clear air turbulence (CAT)	$m^{2/3}$ s^{-1}	HRES FC	2	ml	✔	✔	TBD	✔

[1]Please note that the current MARS client, built with MIR 1.7.2, will issue a warning when interpolating parameter 228045 (Tropopause pressure). As MIR uses the default interpolation for this parameter in any case, this warning can be ignored and will be addressed in a future version of the MARS client.

[2]For more details see 47r3 new parameters: CAPE and CIN

Changes to existing GRIB parameters

In Cycle 47r3 the grid descriptions for the surface fields ci and sst in the analysis are now identical to those of the land-sea mask (lsm).

Param ID	Short Name	Name	Component & type	GRIB edition	Level type	GRIB 1 Section 2 Octets	ecCodes key	47r2	47r3
31	ci	Sea ice area fraction	HRES AN	1	sfc	21-23	longitudeOfLastGridPoint	359930	**359929**
34	sst	Sea surface temperature	HRES AN	1	sfc	21-23	longitudeOfLastGridPoint	359930	**359929**

Technical content

Changes to GRIB encoding

The GRIB model identifiers (generating process identification number) for cycle 47r3 will be changed as follows:

GRIB 1 Section 1 Octets	GRIB 2 Section 4 Octets	ecCodes key	Component	Model identifier	
				47r2	47r3
6	14	generatingProcessIdentifier	Atmospheric model	152	**153**
6	14	generatingProcessIdentifier	Ocean wave model	117	**118**

For **all** parameters in GRIB 2 the Master Tables Version Number will be changed as follows:

GRIB 2 Section 1 Octets	ecCodes key	Master Tables Version Number	
		47r2	47r3
10	tablesVersion	5	**27/28**

The modification implemented with the 6 UTC run on 22 Feb 2022 included an update to the newer ecCodes package 2.24.2 which makes use of the latest standard, with tables version 28, rather than version 27. This change will be transparent in terms of ecCodes usage. As tables version 28 is backward compatible with version 27, all output data can still be handled with the software versions recommended below. Users will only see a difference if they check the tables version explicitly.

Correct decoding of all 47r3 GRIB 2 parameters requires ecCodes 2.23.0 or newer. **Users are encouraged to check their data processing with the test data provided.**

Software

The software packages listed below are required to provide full support for IFS Cycle 47r3 and will become the default on ECMWF platforms on Wednesday 6 October 2021, see Change of default versions of ECMWF software packages - October 2021:

ecCodes 2.23.0
Magics 4.9.0
Metview 5.13

CDO 1.9.10-01

Users are strongly encouraged to test their software applications and data processing chain with the new versions of the various software packages before this change.

Availability of 47r3 test data

Test data in MARS

IFS Cycle 47r3 beta test data is available from MARS with E-suite experiment version (expver) 0076 (MARS keyword EXPVER=0076):

- HRES (class=od, stream=oper, expver=76)
- HRES-WAM (class=od, stream=wave, expver=76)
- ENS (class=od, stream=enfo, expver=76)
- ENS-WAM (class=od, stream=waef, expver=76)

Only users registered with access to MARS will be able to access these test data sets. The data should not be used for operational forecasting. Please report any problems you find with this data via the ECMWF Support Portal.

The release candidate test data and products, available from 14 Sept 2021, will be generated daily, shortly behind operational high resolution and ensemble runs and based on the operational dissemination requirements. The availability of the test data does not follow any strict schedule.

For longer time series available beta test data from 15 April can be used, with a complete set of products from 23 August.

Test data in dissemination

Cycle 47r3 test data from the release candidate stage will be available through the test dissemination system, starting from the 00Z run on 14 Sept 2021. Users with access to ECPDS and the Products Requirements Editor (PREd) can login to the test system at https://ecpds-xmonitor.ecmwf.int/ (or https://msaccess.ecmwf.int:7443) and trigger the transmission of test products in the usual manner. 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) and 193.61.196.113 (ecpds-xmc.ecmwf.int)
- RMDCN transfers: 136.156.8.132 (mspds-dm4.ecmwf.int) and 136.156.8.133 (mspds-dm5.ecmwf.int)

The IFS Cycle 47r3 test products are available as version number 76 (file names ending with '76') and are intended to be generated shortly behind real-time. The test products will be based on the operational dissemination requirements from 13 Sept 2021 and will be available for HRES, HRES-WAM, ENS, ENS-WAM and ENS extended.

The new parameters of Cycle 47r3 listed above will become available in dissemination after the implementation date.

Any changes made in the test system will not be ported to operations on implementation day. **Access to the operational PREd will be closed at 9 UTC on 11 October. Any changes to the operational requirements can be implemented after 10 UTC on 13 October.**

If you don't have access to the ECPDS system or PREd or should you require any assistance with IFS Cycle 47r3 test dissemination products, please contact us via the Support Portal.

Graphical display of test data in ecCharts

Layers of IFS cycle 47r3 release candidate test data will become available in ecCharts on 14 Sept 2021. Cycle 47r3 layers are identified by the label "0076" in their title and a black border around test data layers for better visual identification. Please note that vertical profiles and meteograms in ecCharts will always be based on operational data. However, Cycle 47r3 based vertical profiles and meteogram will become available in the web charts browser, see below.

Web charts based on test data

The ENS meteograms and vertical profiles based on IFS cycle 47r3 release candidate test data will become available on 14 Sept 2021.

WMO Essential and Additional test data

IFS cycle 47r3 WMO Essential test data starting from the 00Z run on 14 Sept 2021is available at ftp://wmo:essential@xpds.ecmwf.int and WMO Additional test data at ftp://xpds.ecmwf.int using the relevant WMO user id and password.

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 47r3 test data by using the limited ECaccess '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.
1638	e_ms1104	At this stage, the e-suite step 1104 (ENS extended) has been generated.
1639	e_msrefc	At this stage, the e-suite step refc (REFORECAST) has been updated.

For these events, MSJ_EXPVER environment variable is set to 0076 and can be used to specify the IFS Cycle 47r3 test data in any MARS retrievals.

These events are intended for testing technical aspects only and should **not** be used for actual time-critical activities.

Options 2 and 3

Option 2 or 3 time-critical applications can be tested with the IFS Cycle 47r3 test data retrieved from MARS or received in Dissemination.

Resources

Video: Cycle 47r3 overview

Presentation slides

References

- Bechtold, P. R. Forbes, I. Sandu, S. Lang, M. Ahlgrimm, 2020: A major moist physics upgrade for the IFS. ECMWF Newsletter, 164, pp. 24-32. DOI:10.21957/3gt59vx1pb
- Bechtold, P., M. Bramberger, A. Dörnbrack, M. Leutbecher, L. Isaksen, 2021: Forecasting Clear Air Turbulence (CAT). *ECMWF Newsletter,* No 168
- David Duncan et al., Assimilation of AMSU-A in all-sky conditions. EUMETSAT/ECMWF Fellowship Programme Research Report, 2021
- Forbes, R, Laloyaux, P, Rodwell, M, 2021: IFS upgrade improves moist physics and use of satellite observations. *ECMWF Newsletter*, No 169
- All Physics developments and all new Grib parameters (algorithms) described in the IFS scientific documentation
- ECMWF News article "Forecast upgrade improves moist physics and use of satellite observations"