Detailed information of implementation of IFS cycle 41r2

On 8 March 2016, ECMWF upgraded the horizontal resolution of its analyses and forecasts.The upgrade has a horizontal resolution that translates to about 9 km for HRES and the data assimilation (the outer loop of the 4D-Var) and to about 18 km for the ENS up to day 15. The resolution of the ENS extended (day 16 up to day 46) is about 36 km.

A new cycle of the IFS has been introduced to implement the horizontal resolution upgrade. This cycle is labelled 41r2 and includes a number of enhancements to the model and data assimilation listed herein. The detailed specification of the resolution upgrades included in IFS cycle 41r2 are:

- Introduction of a new form of the reduced Gaussian grid, the **octahedral grid**, for HRES, ENS and ENS Extended;
- Horizontal resolution of the HRES increased from T_L1279 / N640 to T_{CO}1279 / O1280, where subscript C stands for cubic and O for octahedral, with a model time step of 450s;
- Horizontal resolution of the ENS increased from T_L639 / N320 to T_{CO}639 / O640 for ENS (Days 0 - 15) with a model time step of 720s and from T_L319 / N160 to T_{CO}319 / O320 for ENS Extended (Days 16 - 46) with a model time step of 1200s;
- For the medium-range ENS there will no longer be a decrease of resolution at day 10: the ENS Days 11 - 15 will be run at the same T_{CO}639 / O640 resolution as ENS Days 0 - 10;
- Increase of the HRES-WAM resolution from 0.25 to 0.125 degrees and the ENS-WAM Days 0 - 15 from 0.5 to 0.25 degrees;
- Horizontal resolution of the EDA outer loop is increased from T_L399 to T_{CO}639 with its two inner loops increased from T_L159 / T_L159 to T_L191 / T_L191, respectively;
- Horizontal resolution of the three 4DVar inner loops is increased from T_L255 / T_L255 / T_L255 to T_L255 / T_L319 / T_L399, respectively.

These upgrades

- **do not** include any increase in the vertical resolution;
- **do not** apply to the ECMWF seasonal forecasting system;
- **do not** apply to the standalone wave model (HRES-SAW);
- **do** apply to products from the Boundary Condition Optional Programme.

During the Release Candidate test phase forecast data will be made available close to real time via

- product dissemination
- ecCharts
- MARS

The page will be updated as required. It was last changed on 8 April 2016.

For a record of changes made to this page please refer to Document versions.

Further information and advice regarding the upgrade can be obtained from User Support.

Timetable for implementation

The planned timetable for the implementation of IFS cycle 41r2 is as follows:

Date	Event
4 Nov 2015	Initial announcement to Member States and other forecast users
8 Dec 2015	Availability of test data in dissemination
14 Jan 2016	Test data in dissemination available at upgraded resolution
9 Feb 2016	Update of default software versions at ECMWF
8 Mar 2016	Expected date of implementation

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

Horizontal resolution upgrade

The 2016 horizontal resolution upgrade has been developed with a trade-off between resolution and computational costs in mind. A number of options of how to produce the most effective combination of horizontal resolutions between 4D-Var, EDA, HRES and ENS have been tested to establish computing costs and to derive possible efficiency gains.

The most viable option found was to change from the current linear reduced Gaussian grid (with spectral truncation denoted by T_L) to a cubic reduced Gaussian grid (denoted T_C). With the cubic reduced Gaussian grid, the shortest resolved wave is represented by four rather than two grid points. With this approach, the spectral truncation is unchanged but the grid-point space resolution is increased to more accurately represent the physical processes and advection. In the current operational configuration of the IFS (cycle 41r1) a build-up of energy at the shortest scales is mitigated by a lower-than-nominal resolution of the orography, strong horizontal diffusion and a de-aliasing filter. In IFS cycle 41r2 this is much less of an issue. The T_C configuration also substantially improves mass conservation.

In order to reduce the computational cost further, the use of a new octahedral reduced Gaussian grid (prefix 'O') with spectral truncation denoted by T_{CO} has been adopted. The octahedral grid applies a new rule for computing the number of points per latitude circle and is globally more uniform than the previously used reduced Gaussian grid (prefix 'N'). It is based on a new mesh that also allows for future implementations of a hybrid spectral/grid-point model. The computational cost is reduced by about 25% compared to the cubic grid as fewer grid point calculations are needed.

Meteorological content of IFS cycle 41r2

Data assimilation:

- Compute scale-dependent hybrid **B** (background error covariance) by adding samples from latest EDA forecast to static climatological **B** with increasing weight of today's EDA for smaller wavelengths (30% up to T63, growing to a maximum 93% at T399).
- The EDA now cycles its own background error and covariance estimates, rather than using climatological estimates.
- Change to use the Sonntag equation for saturation vapour pressure in humidity observation operators to improve saturation calculation for very cold temperatures (colder than -40C).
- Assimilation of aircraft humidity data implemented.

Satellite:

- GPSRO (radio occultation) observation errors based on a physical error propagation model are increased by 25% to account for missing sources of error (e.g. observation error correlations, forecast model error). Improves lower stratosphere/tropopause winds and temperatures.
- Activated SSMIS F-18 humidity sounding channels over ocean and extended all-sky assimilation to snow covered land surfaces.
- Improved specification of AMSU-A observation errors based on satellite (due to instrument noise characteristics and ageing) and situation (cloud, orography) thereby increasing the number of observations assimilated.
- Improved aerosol detection and screening for IASI infrared satellite data.
- Increased use of Atmospheric Motion Vectors (AMVs), including extension in latitudinal coverage from geostationary platforms from 60 to 64 degrees zenith angle and addition of Meteosat mid-height AMVs derived from infrared imagery.
- Revised data selection (screening) of cold-air outbreaks in low-peaking all-sky microwave channels to allow more data to be assimilated.
- Updated microwave observation operator coefficient files (54-level RTTOV files with latest spectroscopy)

Numerics:

- Changed from a linear reduced Gaussian to a cubic octahedral reduced Gaussian grid for HRES, ENS and 4DVAR outer loops. The spectral truncation is unchanged.
- For the EDA, the spectral truncation of the outer loop is increased from T_L399 to $T_{CO}639$ with the corresponding cubic octahedral reduced Gaussian grid.
- Increased semi-lagrangian departure point iterations from 3 to 5 to remove numerical instabilities near strong wind gradients, particularly improving East Asia (downstream of the Himalayas) and improved representation of tropical cyclones.
- Changed formulation of the horizontal spectral diffusion to a spectral viscosity with significantly reduced damping at the small scales.
- Removed dealiasing filter on rotational part of the wind as no longer needed for cubic grid (no aliasing).
- Reduced diffusion in the sponge layer near the top of the model (above level 30) scaled by grid resolution rather spectral resolution, due to new cubic grid.

Physics:

- Improved representation of radiation-surface interactions with approximate updates every timestep on the full resolution grid leads to a reduction in 2m temperature errors near coastlines.
- Included surface-tiling for long-wave radiation interactions to reduce occasional too cold 2m temperature errors over snow.
- Improved freezing rain physics and an additional diagnostic for freezing rain accumulation during the forecast.
- Introduced resolution dependence in the parametrization of non-orographic gravity wave drag, reducing with resolution and improving upper stratospheric wind and temperature for HRES and ENS.
- Changed the parcel perturbation for deep convection to be proportional to the surface fluxes, reducing overdeepening in tropical cyclones.
- Increased cloud erosion rate when convection is active, to reduce cloud cover slightly and improve radiation, particularly over the ocean.
- Improvements of linear physics used in the data assimilation for gravity wave drag, surface exchange and vertical diffusion, improving near-surface winds over ocean in the short-range.
- Correction to solar zenith angle for the sunshine duration diagnostic. For clear sky days the sunshine duration increases by 2 hours, now in good agreement with observations. For cloudy days, sunshine duration may now be overestimated due to an existing underestimation of cloud optical thickness.
- Improved solar zenith angle calculation removes stratospheric temperature dependence on radiation timestep and reduces anomalous small amplitude fluctuations in incoming solar radiation around the equator.

Ensemble:

- Modified SKEB (Stochastic Kinetic Energy Backscatter) stochastic physics necessary for the new cubic grid, removing the numerical dissipation estimate from the dissipation rate. Reduces ensemble spread slightly, but this is then consistent with reduced error (RMSE) in the new cycle.
- Modified singular vector calibration to compensate for increased variance from the higher resolution EDA.

Meteorological impact of the new cycle

Comparison of scores between IFS cycle 41r2 and IFS cycle 41r1 for HRES and ENS can be found in the IFS cycle 41r2 scorecard.

Upper air

The new model cycle (41r2) provides improved HRES and ENS performance throughout the troposphere. In the HRES there is a significant reduction of forecast errors in upper-air fields in the extra-tropics. Error reductions on the order of 2-3% 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 2 hours (0.08 days). Improvements are seen both in verification against the model analysis and verification against observations. In the tropics, evaluation against model analysis shows an apparent degradation in the short and near-medium range, mostly due to a more active analysis resulting from the increase in resolution of the EDA. Verification against observations, however, gives neutral to positive results in the tropics, except for temperature at 500 hPa, which shows a slight degradation.

The root mean square error (RMSE) and anomaly correlation for temperature are both improved in the extra-tropics, but there is a small (0.2 K) mean cooling in the upper troposphere. As the mean geopotential in the lower stratosphere is sensitive to changes in the vertically integrated tropospheric temperature, this shows up as an increased RMSE for geopotential at 100 hPa. The upper air scores over East Asia are significantly better associated with an improved representation of the flow downstream of the Himalayas due to the new cubic grid and more stable numerics. The overall kinetic energy spectra of the model is significantly improved with an increase in the energy towards the smaller scales.

Changes in skill of the ENS are generally similar to the HRES, with improvements in the extra-tropics on the order of 2-3% (CRPS reduction), and degradations in the tropics when verified against analysis. 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 ~0.2 days. The overall kinetic energy spectra of the model is significantly improved with an increase in the energy towards the smaller scales.

Weather parameters

The increased resolution leads to a better representation of coastlines and orography with potential for improved local prediction. The new model cycle yields consistent gains in forecast performance in the tropics and extra-tropics for 2m temperature, 2m humidity, and 10m wind speed. Precipitation forecasts are slightly improved in the extra-tropics and slightly deteriorated in the tropics. Mostly neutral results are found for forecasts of total cloud cover.

The increase in forecast skill for 2m temperature as measured by the reduction of RMSE is about 3% in the northern hemisphere extra-tropics and 1% in the tropics. There is a mean cooling in the northern hemisphere of about 0.05 K. Changes to the calculation of radiative fluxes lead to particular improvements in near coastal 2m temperatures at places where surface conditions vary abruptly.

For 2m dewpoint, RMS error reductions of 2% are observed in the NH, and neutral results are obtained for the tropics. There is an overall reduction of 2m dewpoint on the order of 0.05 to 0.1 K.

The RMSE for 10m wind speed improves by about 2% overall. There is no significant change in the mean in the northern hemisphere, and a reduction on the order of 0.05 m s^{-1} in the tropics.

Forecast skill for 24 hour precipitation totals shows an overall slight improvement in the northern hemisphere, and a small (1%) degradation in the tropics. This degradation in the tropics is seen in the SEEPS score but not in the RMSE.

Total cloud cover shows improvements in RMSE on the order of 0.5% in the tropics and neutral results in the extra-tropics.

There is a substantial reduction in localized (unrealistic) precipitation extremes over orography. The improvement is due to the cubic grid representation and modifications in the semi-Lagrangian advection scheme.

Tropical cyclones

The structural representation of tropical cyclones is improved with a more clearly defined eye and better resolved rainbands. Evidence from case studies shows that the increase in resolution leads to improved forecasts of tropical cyclone intensity in the ENS. Initial ensemble spread is also improved for tropical cyclones by the increased resolution in the EDA. For HRES, the tropical cyclone impact of the resolution change is smaller. Case studies show a better representation of the precipitation pattern around the core of tropical cyclones in the new cycle. This improvement is due to changes in model numerics (move to cubic grid and changes in the semi-Lagrangian scheme).

See also Comparison of Tropical Cyclone forecast performance between IFS cycle 41r2 and IFS cycle 41r1 for HRES.

Wave forecast

Results for ocean wave height are positive, except for a deterioration in the very short range (day 1) in the tropics when verified against the analysis. A similar short-range degradation is seen for 10m wind speed over ocean areas. This is due to an increase in activity of the low-level wind and wave analyses associated with the move from T_L1279 to $T_{CO}1279$. When verified against observations (buoys), no degradation is seen. Wave period has a mixed signal and may require some retuning in the next cycle.

Monthly forecast

Results suggest a generally neutral effect on upper-air and near surface skill scores in the tropics and for the MJO. For extra-tropical skill there is a slight improvement coming from the change to a cubic grid. Tropical cyclone sub-seasonal prediction is also improved.

Data assimilation / analysis

The kinetic energy spectrum has changed in the analysis even more than for the HRES. Whereas the analysis used to have less energy in the smaller scales compared to the forecast, both now have the same improved energy spectra. The background error variances derived from the higher-resolution EDA are larger in many areas, particularly in the tropics, leading to closer analysis fit to observations. Observation-minus-background departure statistics have improved for wind profile data.

Technical details of the new cycle

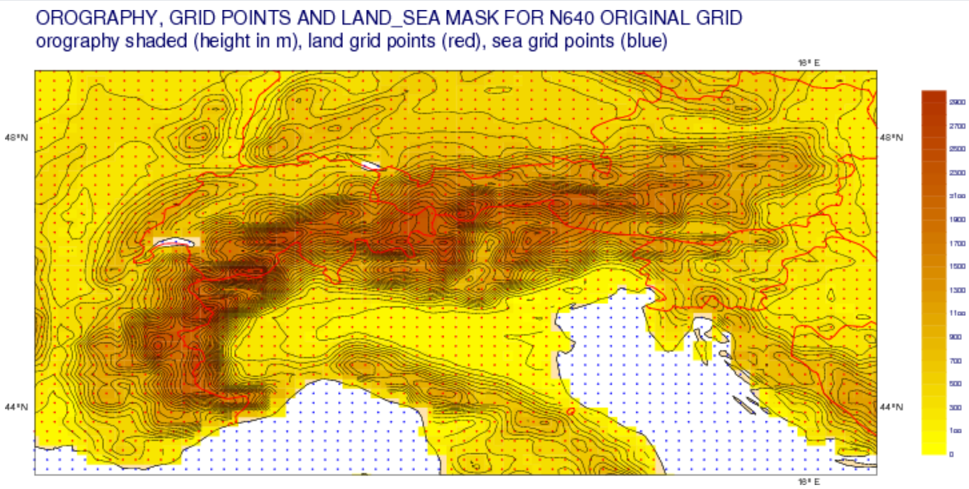
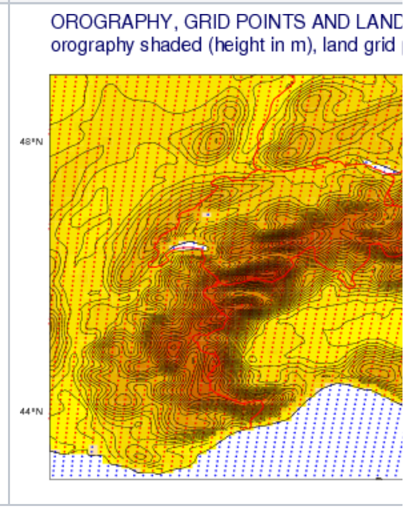
Changes to resolution and the use of the octahedral reduced Gaussian grid

See IFS cycle 41r2 resolution changes for a technical summary of the resolution changes for the atmospheric, wave and ocean component models of HRES and ENS.

IFS cycle 41r2 introduces a new form of the reduced Gaussian grid, the **octahedral grid**, for both HRES and ENS. See Introducing the octahedral reduced Gaussian grid for further details.

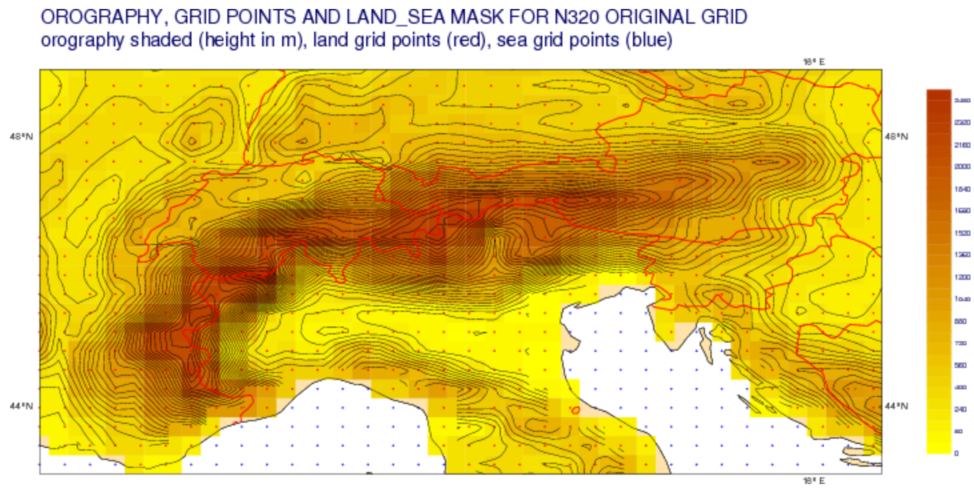
The figures below show the grid spacing and orography fields in a cylindrical projection for HRES, ENS and ENS Extended comparing old (41r1, left) and new (41r2, right) resolutions over a region covering the Alps (43.0°S to 49.0°N, 4.5°E to 17.0°E).

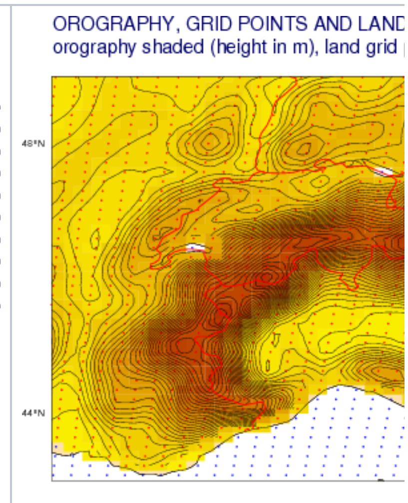
HRES

Old: N640 original reduced Gaussian grid (~16 km resolution)	New: O1280 octahedra
	

ENS

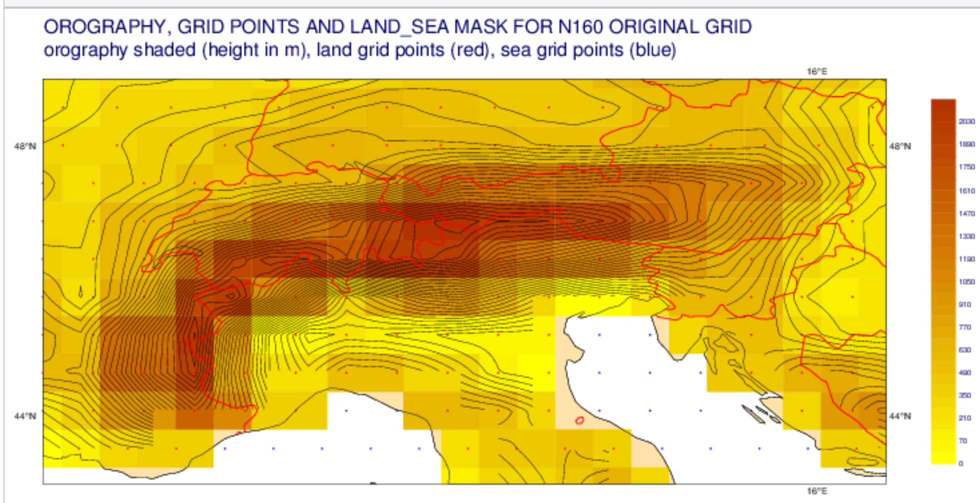
Old Day 0 - 10: N320 original reduced Gaussian grid (~32 km resolution)	New Day 0 - 15: O640 octah

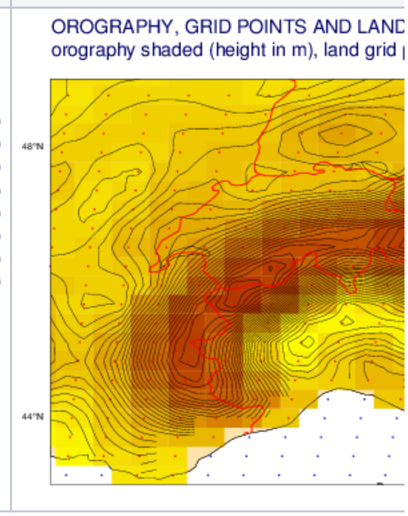




Old Day 11 - 46 : N160 original reduced Gaussian grid (~64 km resolution)

New Day 16 - 46: O320 octah





⚠ The octahedral reduced Gaussian grid has a slightly lower resolution than the corresponding original reduced Gaussian grid with the same number of latitude lines. For example, the O640 grid has a resolution of ~18 km whereas the resolution of the N640 grid is ~16 km.

Changes to GRIB encoding

Grid description

The increase in horizontal resolution for HRES and ENS is reflected in changes to the GRIB headers. For the model reduced Gaussian grid these are documented in the table below.

GRIB 1 Section 2 Octets	GRIB 2 Section 3 Octets	grib_api key	HRES		ENS		ENS Extended	
			Old	New	Old (Day 0 - 10)	New (Day 0 - 15)	Old (Day 11 - 46)	New (Day 16 - 46)
9-10	35-38	Nj	1280	**2560**	640	**1280**	320	**640**
11-13	47-50	latitudeOfFirstGridPointInDegrees	89.892	**89.946**	89.784	**89.892**	89.570	**89.784**
18-20	56-59	latitudeOfLastGridPointInDegrees	-89.892	**-89.946**	-89.784	**-89.892**	-89.570	**-89.784**
21-23	60-63	longitudeOfLastGridPointInDegrees	359.859	**359.929**	359.718	**359.860**	359.437	**359.722**
26-27	6-7	N	640	**1280**	320	**640**	160	**320**
33-nn	35-nn	pl	N640	**O1280**	N320	**O640**	N160	**O320**

Model identifiers

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

GRIB 1	GRIB 2	grib_api key	Component	Model ID

Section 1 Octets	Section 4 Octets			Old	New
6	14	generatingProcessIdentifier	Atmospheric model	145	**146**
			Ocean wave model	111	111
			HRES stand-alone ocean wave model	211	211

Note that the identifiers for the wave models have not changed.

The identifiers have also not been updated for a a number of HRES analysis products arising from the surface analysis:

paramId	shortName	name
31	ci	Sea-ice cover
33	rsn	Snow density
34	sst	Sea surface temperature
141	sd	Snow depth
167	2t	2 metre temperature
168	2d	2 metre dewpoint temperature

The identifiers for these 6 surface analysis parameters will be updated to 146 during the week beginning 14 March 2016.

GRIB edition 1 message size

Users may note that the value stored in Octets 5-7 of Section 0 (Indicator Section) used to specify the total message length of a GRIB edition 1 message does not correspond to the actual size of the message. This is the result of a convention used by ECMWF to encode fields in GRIB edition 1 where the size of the binary data section (Section 4) is too large to be stored in the header. This convention is used whenever the binary data section is larger than 8388607 bytes (Hex 7F FF FF). The correct message length, taking into account this convention, is reported by the grib_api key "totalLength". Similarly, the length of Section 4 (Binary Data Section) reported correctly by the grib_api key "section4Length".

Changes to forecast products

Increased field sizes

The size of the Gaussian grid point fields produced have increased by a factor of 3 while the size of the spectral fields remains unchanged. When retrieving data via MARS or dissemination, if no spectral truncation or grid resolutions are specified, fields are provided at model resolution.

In particular, users should be aware of the increase in memory and CPU time needed to process the increased resolution (grid-point) fields and adjust their programs and batch scripts appropriately. Increase in data volume provides a summary of the field sizes at the new horizontal resolutions.

New model output parameters

An additional diagnostic for freezing rain accumulation during the forecast is introduced. CAPE-Shear, previously introduced for the EFI, will be provided also for the HRES and ENS. A new wave product will also be introduced. The availability of test data for these new parameters is indicated in the table below will be updated as the products become available.

paramId	shortName	name	units	GRIB edition	Component	Test data available	Dissemination	Proposed for Catalogue
228216	fzra	Accumulated freezing rain	m	1	HRES / ENS	✓	✓	TBC
228044	capes	Convective available potential energy shear	m^2/s^2	1	HRES / ENS	✗	TBC	TBC
140120	sh10	Significant wave height of all waves with period larger than 10s	m	1	HRES-WAM / ENS-WAM / HRES-SAW	✓	TBC	TBC

Correction to solar zenith angle for the sunshine duration diagnostic

A correction has been made to the solar zenith angle for the sunshine duration diagnostic (shortName: sund; paramId 189). For clear sky days the sunshine duration increases by 2 hours, now in good agreement with observations. For cloudy days, sunshine duration may now be overestimated due to an existing underestimation of cloud optical thickness.

Correction to the interpolation method used for the precipitation type diagnostic

A correction has been made to the interpolation method used by both MARS and product generation for the precipitation type diagnostic (shortName: ptype; paramId 260015) introduced at IFS cycle 41r1. Users of this product on interpolated grids will obtain a field where the index-nature is preserved as integer values. Previously, the interpolated product contained erroneous non-integer values.

The meaning of the integer values of the precipitation type diagnostic is as follows: 1=rain, 3=freezing rain, 5=snow, 6=wet snow, 7=sleet, 8=Ice pellets.

Discontinued ENS Calibration / Validation forecasts

The two specific ENS Calibration / Validation forecasts (MARS class="OD", STREAM=ENFO, class="CV") are discontinued with the implementation of IFS cycle 41r2. They are no longer needed, as the IFS cycle 41r2 medium-range ENS will run with a consistent resolution throughout the 15 days.

Discontinued ENS variable resolution overlap products

The current ENS variable resolution overlap products from both atmosphere and wave forecasts and hindcasts (MARS class="OD", STREAM=EFOV, STREAM=EFHO, STREAM=ENWH, EWHO) provided from day 9 to 10 are discontinued. Overlap data is provided instead from day 14 to 15 for ENS Extended only, when it is run, twice per week on Mondays and Thursdays.

Simulated satellite images

Simulated satellite images available operational as charts from the ECMWF web site and as GRIB fields from MARS have been enhanced significantly at IFS cycle 41r2. See Simulated satellite data for further information about the enhancements made and how to access the updated products.

ENS meteograms

The ENS meteogram facility has been upgraded. The interfaces, both via the web and Metview 'meteogram' macro function, are compatible with the previous version. However, the coordinates of the nearest grid points used for the ENS meteograms will have changed with the change of grid and resolution. Users should review and, if necessary, update the latitude-longitude points used for the station locations.

Users of the 10-day HRES ("classic") meteogram product available only via the Metview 'meteogram' macro function as type='10_days_metgram' should note that this plot type has been discontinued with the introduction of the octahedral grid.

Software

The ECMWF software stack has been upgraded to support the octahedral grid. This includes upgrades to GRIB_API , EMOSLIB, MARS, Metview, Magics and product generation (dissemination). On 9 February the default versions on all ECMWF systems (ecgate, cca and ccb) have been updated as follows:

- GRIB API to version 1.14.5
- EMOSLIB to version 4.3.7
- Metview to version 4.6.4
- Magics to version 2.26.2

On the same day, the default version of MARS was updated to use these libraries. For further details, see Change of default versions of ECMWF software packages on 9 February 2016.

> All software versions are subject to change depending on the results of ongoing testing. The current status of the software versions needed to process fields on the octahedral grid are detailed on this page.

MARS - the meteorological archive

MARS has been adapted to support retrieval of data on the octahedral reduced Gaussian grid. Users can test the retrieval of IFS cycle 41r2 test data on ECMWF systems with the command:

```
mars <retrieve request>
```

MARS language changes (MARS and dissemination)

The MARS post-processing keyword 'GRID' now accepts values comprising a letter denoting the grid name followed by an integer (the grid number) representing the number of latitude lines from pole to equator. For example, use:

- GRID = N640 to specify output on the original reduced Gaussian grid with 640 latitude lines between pole and equator;
- GRID = F640 to specify output on the full (or regular) Gaussian grid with 640 latitude lines between pole and equator;
- GRID = O640 to specify output on the octahedral reduced Gaussian grid with 640 latitude lines between pole and equator.

Not all grid names and grid number combinations are supported. MARS requests specifying an unsupported grid will **fail**. For example, a retrieval request with GRID=N1280 or GRID=O124 will return an error. See Gaussian Grids supported by MARS and Dissemination for a list of the Gaussian grid names and numbers supported for MARS retrievals.

In addition, the MARS post-processing keywords GAUSSIAN=REDUCED and GAUSSIAN=REGULAR are **deprecated**.

- If the GAUSSIAN keyword is used along with, e.g. GRID=O640, GRID=N640 or GRID=F640 then it is ignored.
- A MARS request with GRID=640, GAUSSIAN=REDUCED returns the original reduced Gaussian grid with 640 latitude lines between pole and equator (equivalent to GRID=N640).

- Similarly, a MARS request with GRID=640, GAUSSIAN=REGULAR returns the full (regular) Gaussian grid with 640 latitude lines between pole and equator (equivalent to GRID=F640).
- A MARS request with GRID=640 only (no GAUSSIAN keyword) returns the full (regular) Gaussian grid with 640 latitude lines between pole and equator (equivalent to GRID=F640).

MARS requests specifying GRID=AV will return the model grid. After the implementation of IFS cycle 41r2, this will be O1280 for HRES, O640 for ENS (Day 0 - 15) and O320 for ENS Extended (Day 16 - 46).

The MARS keyword RESOL=N128 was used to truncate products from ENS Day 0 - 10 to the N=128 original reduced Gaussian grid of ENS Day 11 - 15 prior to interpolation to regular latitude-longitude grids. Following the horizontal resolution upgrade, anyone using this intermediate interpolation method should use RESOL=O320 to truncate O640 ENS Days 0 -15 products to the O320 octahedral grid of ENS Extended (Days 16 - 46).

EMOSLIB

EMOSLIB versions from 000420 onwards provide support for interpolation of input octahedral grids to any of the previously supported grids as well as spherical transforms to the new octahedral grids. For further information about how to use EMOSLIB to interpolate to the octahedral reduced Gaussian grid see Changes in version 000420.

Starting from EMOSLIB 000410 **calls to GRIBEX are no longer supported.**

Any call to GRIBEX will result in ABORT'ed code with the following error message:

```
GRIBEX: functionality superseded by GRIB_API.
ABORTX : Routine GRIBEX has requested program termination.
```

Any code that still relies on GRIBEX should be migrated to use GRIB API at your earliest convenience.

EMOSLIB version 4.3.7 is the current default and includes additional performance improvements and bug fixes and users are strongly recommended to update to this version.

A bug has been fixed which will change results for interpolations from global grid point fields to regular lat-lon or regular Gaussian grids. The problem and the specific cases where differences can occur are described in Bug fix implemented in EMOSLIB 4.3.x.

We are happy that these changes are correct but further evaluation by ECMWF is ongoing. If further issues are found then these will be addressed and an updated version of EMOSLIB released. Therefore we ask users **to test and evaluate EMOSLIB 4.3.7 carefully before using it operationally**.

GRIB API

Full support for the octahedral grid is provided from GRIB API 1.14.5 and this is default version used at ECMWF since 9 February 2016. Users of the grib_find_nearest routine and the new simulated satellite products (not yet available) will need to upgrade to this version.

Older versions of GRIB API can decode the octahedral grid successfully but users are advised to use at least GRIB API version 1.12.3.

All GRIB API versions are available for download from GRIB API releases.

Metview

Metview versions from 4.6.0 provide support for processing and visualising fields on the octahedral reduced Gaussian grid - see Metview Version 4.6 Updates. Users wishing to install this version on their local systems are recommended to link with EMOSLIB 4.3.7 and GRIB API 1.14.5 or to use the The Metview Source Bundle 2016.01.0 or newer.

Magics

Magics versions from 2.26.0 provide support for visualisation of products on the octahedral reduced Gaussian grid. Users are recommended to upgrade to Magics 2.26.2 which is the default version in use on ECMWF systems since 9 February 2016 and can be downloaded from the Magics Releases page.

Dissemination

The MARS language changes described above apply also to the web based dissemination requirements tool. In particular, the specification of Gaussian grid products has changed in the MARS language

- GAUSSIAN=regular,GRID=640 changes to GRID=F640
- GAUSSIAN=reduced,GRID=640 changes to GRID=N640

New octahedral grid based products can be requested by specifying GRID=O1280, etc.The following grid numbers are supported for all Gaussian grid names - full (F-grids), original reduced (N-grids) and octahedral reduced (O-grids) :

HRES	1280	640	400		256	200	160	128	80	48	32
ENS (Days 0 - 15)		640		320		200	160	128	80	48	32

ENS-Extended (Days 16 - 46)				320		200	160	128	80	48	32

As before, any sub-area of the global field is supported

Two specific ENS Calibration / Validation forecasts (MARS class="OD", STREAM=ENFO, class="CV") are discontinued with the implementation of IFS cycle 41r2. Any dissemination requirements requesting these products will be taken out of dissemination streams by ECMWF on the day of 41r2 cycle implementation.

ENS variable resolution overlap products (MARS class="OD", STREAM=EFOV, EFHO, ENWH and EWHO) provided currently from day 9 to 10 are also discontinued. Thus, all EFOV, EFHO, ENWH and EWHO requirements will be taken out of dissemination streams by ECMWF by the end of March 2016. Until that date, ECMWF will continue to provide compatibility products ast STEP=240. Users of these products are encouraged to change their requirements at the earliest opportunity to make best use of the harmonised resolution of the ENS products up to and including day 15.

New overlap data, provided from day 14 to 15 for ENS Extended run, will have to be requested by users themselves once 41r2 cycle has been implemented.

Since there is no ENS resolution change for Days 0-15 in the IFS cycle 41r2, requesting of field resolution truncation in dissemination for Days 0-10 is no longer needed. The MARS keyword RESOL=N160 was used to truncate products from ENS Days 0-10 to the N=160 original reduced Gaussian grid of ENS Days 11-15 prior to interpolation to regular latitude-longitude grids. Users are strongly advised to remove any such truncation request from their dissemination requirements.

Nearest GRID point coordinates for Weather parameter requests will change. Member and Co-operating States will need to choose new GRID points coordinates or rely on interpolation.

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 41r2 test data by using the special 'events' set up for this purpose:

identifier	Name	Description
1490	e_ms090	At this stage, the e-suite step 090 (HRES-BC) has been generated.
1491	e_ms144	At this stage, the e-suite step 144 (ENS-BC) has been generated.
1492	e_ms240	At this stage, the e-suite step 240 (HRES) has been generated.
1493	e_ms360	At this stage, the e-suite step 360 (ENS) has been generated.
1494	e_mslaw	At this stage, the e-suite step law (HRES-SAW) has been generated.
1495	e_ms1104	At this stage, the e-suite step refc (REFORECAST) has been updated.

For these events, MSJ_EXPVER environment variable is set to 0069 and can be used to specify the IFS cycle 41r2 test data any MARS retrievals.

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

Users with scripts subscribed to the fc00hmetgram or fc12hmetgram events for the HRES "classic" meteogram should note that the product is discontinued with the introduction of IFS cycle 41r2. See ENS meteograms above for details. Jobs subscribed to this event will not be triggered following the implementation of IFS cycle 41r2. Anyone using this event to trigger scripts that undertake processing other than the plotting of the HRES meteograms are advised to use instead the fc00h240 and fc12h240 events.

Options 2 and 3

Option 2 or 3 time-critical applications can be tested with the IFS cycle 41r2 test data retrieved from MARS or received in Dissemination.

Availability of IFS cycle 41r2 test data

Test data in MARS

IFS cycle 41r2 test data are available in MARS. The data are available with experiment version is 0069 (MARS keyword EXPVER=0069). The data can be accessed in MARS from:

- HRES (class=od, stream=oper, expver=69)
- Wave HRES (class=od, stream=wave, expver=69)
- ENS (class=od, stream=enfo, expver=69)
- WAM ENS (class=od, stream=enfo, expver=69)

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

Only data from 12 UTC on 9 November 2015 have been produced with the corrected land-sea mask and other climatological fields.

An error in the precipitation type diagnostic (ptype, 260015) in the test data was corrected for the 12 UTC run on 8 Dec 2015. Cold phase precipitation types were missing or misrepresented. The precipitation type diagnostic should therefore only be used after this date.

All registered users of ECMWF computing systems will be able to access the test data sets in MARS. Users of our operational real time forecasts without access to our systems can contact our Data Services to obtain test data.

Please use the Contact us form to report any problems you find during your testing.

Test data in dissemination

Since 8 December 2015, IFS cycle 41r2 test Dissemination data is available through the test dissemination system, close to real time. Up to 14 January 2016, IFS cycle 41r2 dissemination products were based on users' operational dissemination requirements, backwards compatible with the IFS cycle 41r1.

On 14 January 2016, additional IFS cycle 41r2-specific dissemination functionality was made available. Users can request dissemination products from a new 0.1 degree base grid from the high resolution forecast as well as 0.2 degree based grid from the ENS (days 1 to 15) and 0.4 degree based grid from the ENS Extended run. In addition, 0.125 degree based grid products are available from the global coupled wave model, 0.25 degree based products from the ENS-WAM and 0.1 degree based products from the HRES-SAW model. Users can also request data on the octahedral grid.

How to request dissemination of IFS cycle 41r2 test data

The IFS cycle 41r2 test products are available on the ECPDS as version number 69. The test products are generated daily, shortly behind real-time from both the 00UTC and 12UTC runs and based on the IFS cycle 41r2 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:

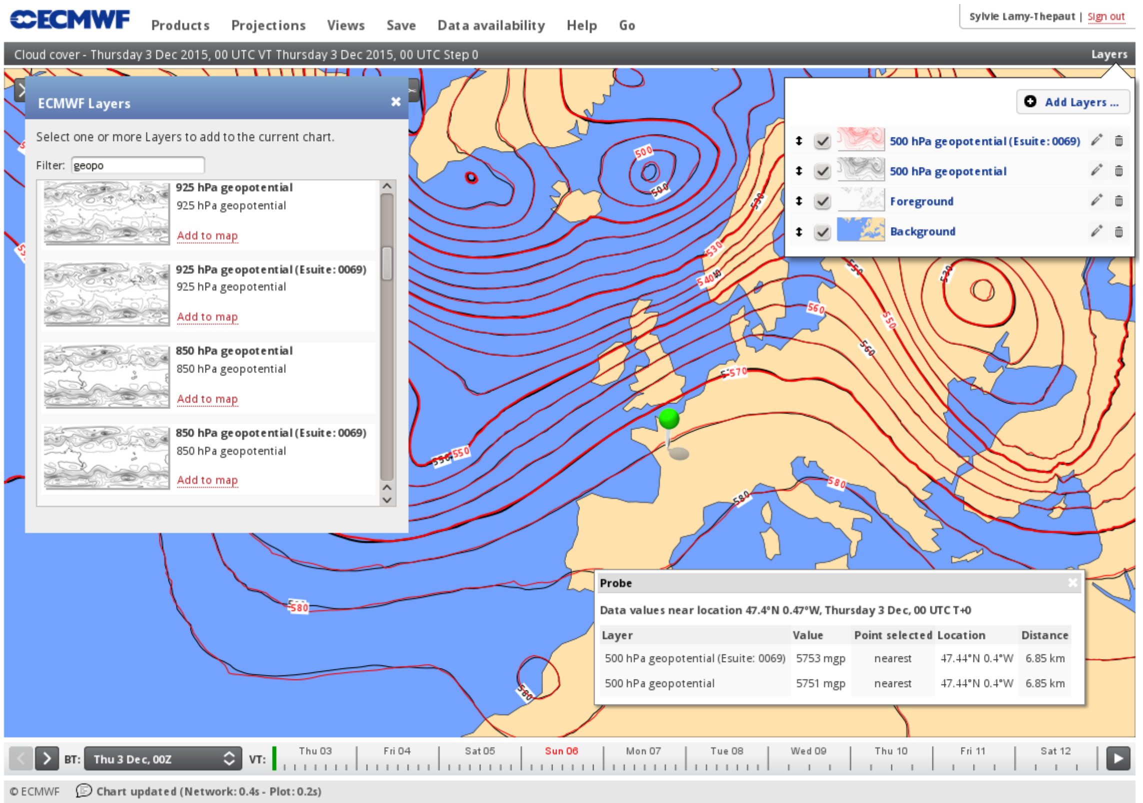
- Internet transfers: 193.61.196.104 (ecpds-xma.ecmwf.int) 193.61.196.105 (ecpds-xmb.ecmwf.int)
- RMDCN transfers: 136.156.8.132 (mspds-dm4.ecmwf.int)

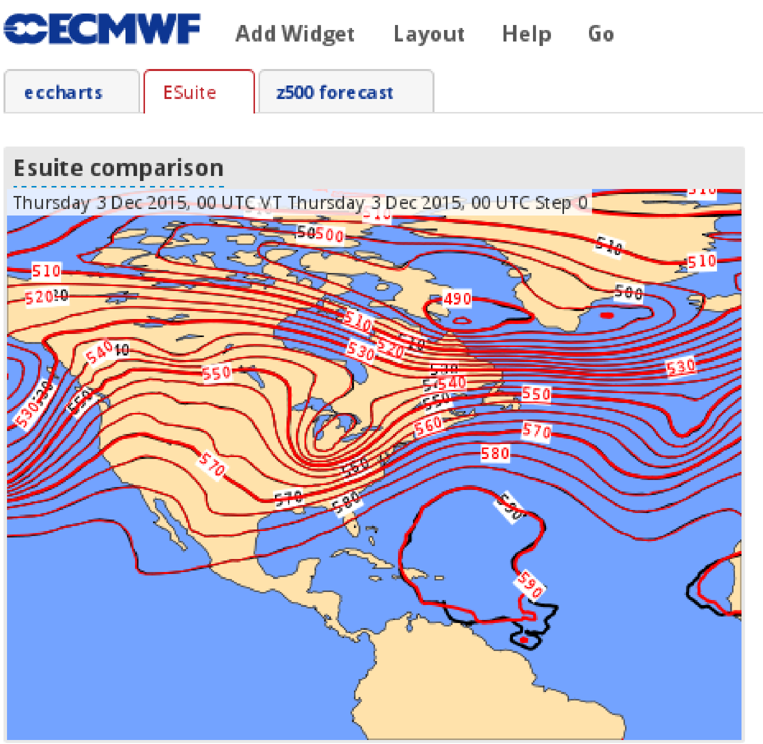
Should you require any assistance with IFS cycle 41r2 test dissemination products, please contact Unknown User (maj).

Graphical display of IFS cycle 41r2 test data using ecCharts

For the first time, ecCharts offers our forecast users new opportunities to inspect the IFS cycle 41r2 test data and compare with the operational forecast, as shown in the examples below. This facility is provided for testing purposes: the 41r2 test charts should not be relied upon for operational forecasting. Note in particular that the availability and timeliness of the 41r2 test data will vary, and can be considerably delayed with respect to the operational schedule. Any plot containing 41r2 test data will therefore be late compared to operational products.

IFS cycle 41r2 test data is accessible via the ecCharts layers menu, identified by the label "esuite 0069" as shown in the screenshot on the left. They can be displayed as any other layers of ecCharts, and they can be saved in the Dashboard, as seen in the screenshot on the right.

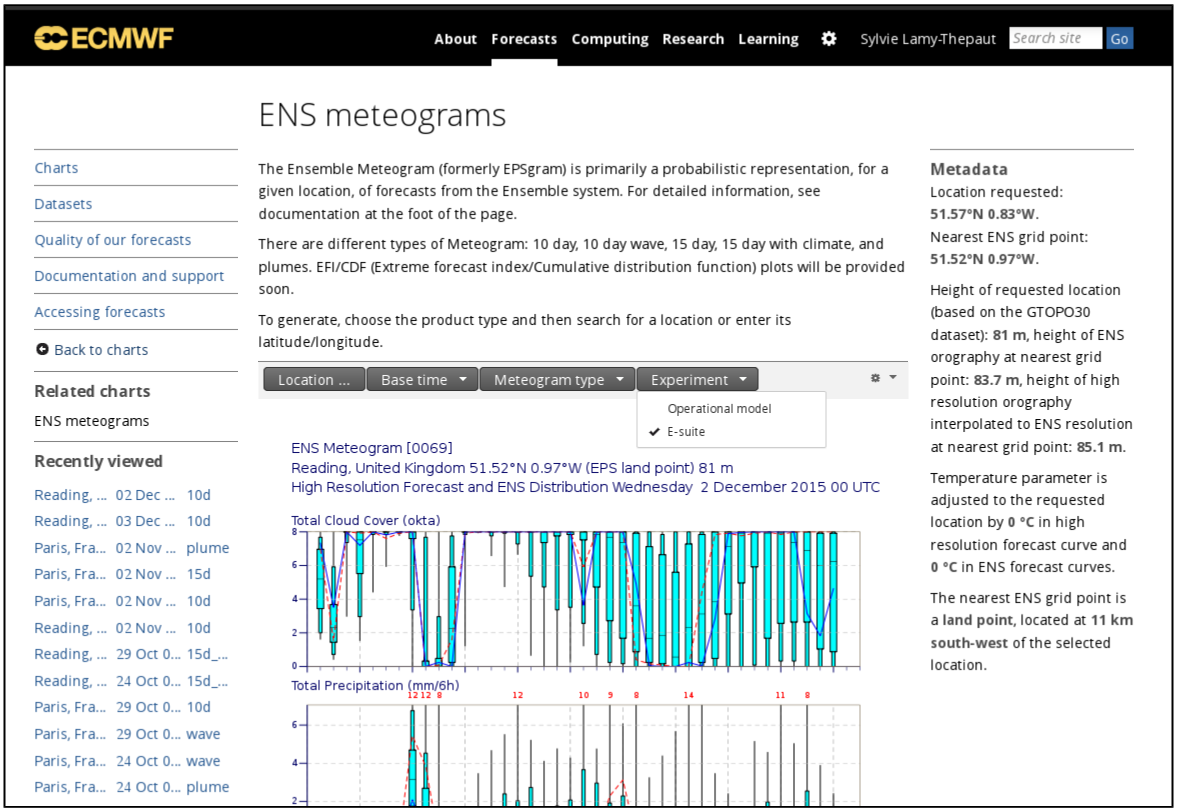




The point probe and time series tools will be also available for the 41r2 test data.

ENS meteograms based on IFS cycle 41r2 test data

ENS Meteograms based on IFS cycle 41r2 test data will be available after 9 December 2015. They can be plotted by choosing 'E-suite' under the Experiment tab on the interactive page ENS meteogram page provided under the ECMWF Forecast Charts page as shown in the screenshot below.



Contact us

If you experience any problems during your testing or have any questions about the planned upgrade then please use the Contact us form and include a description of your problem.

Document versions

Date	Reason for update
4 November 2015	• Initial version
8 December 2015	• Release Candidate test phase • Test data available in dissemination and ecCharts • ENS Days 11 - 15 will be run at the same resolution as ENS Days 0 - 10
14 January 2016	• Test data in dissemination now available at upgraded resolution - see Dissemination and Test data in dissemination.
10 February 2016	• Default software versions updated on all ECMWF platforms - see Software. • Testing framework for time-critical applications - see Time-critical applications. • ENS scorecard - see IFS cycle 41r2 scorecard.
10 March 2016	• Corrected wave model identifiers. These have **not** changed. • Updated Simulated Satellite Data • Tropical cyclone performance for HRES

8 April 2016	• Information about model time step for HRES, ENS and ENS-extended added.