Changes to ECMWF's grids in 2016

26th EGOWS – ECMWF Reading: 29 Sep - 1 Oct 2015

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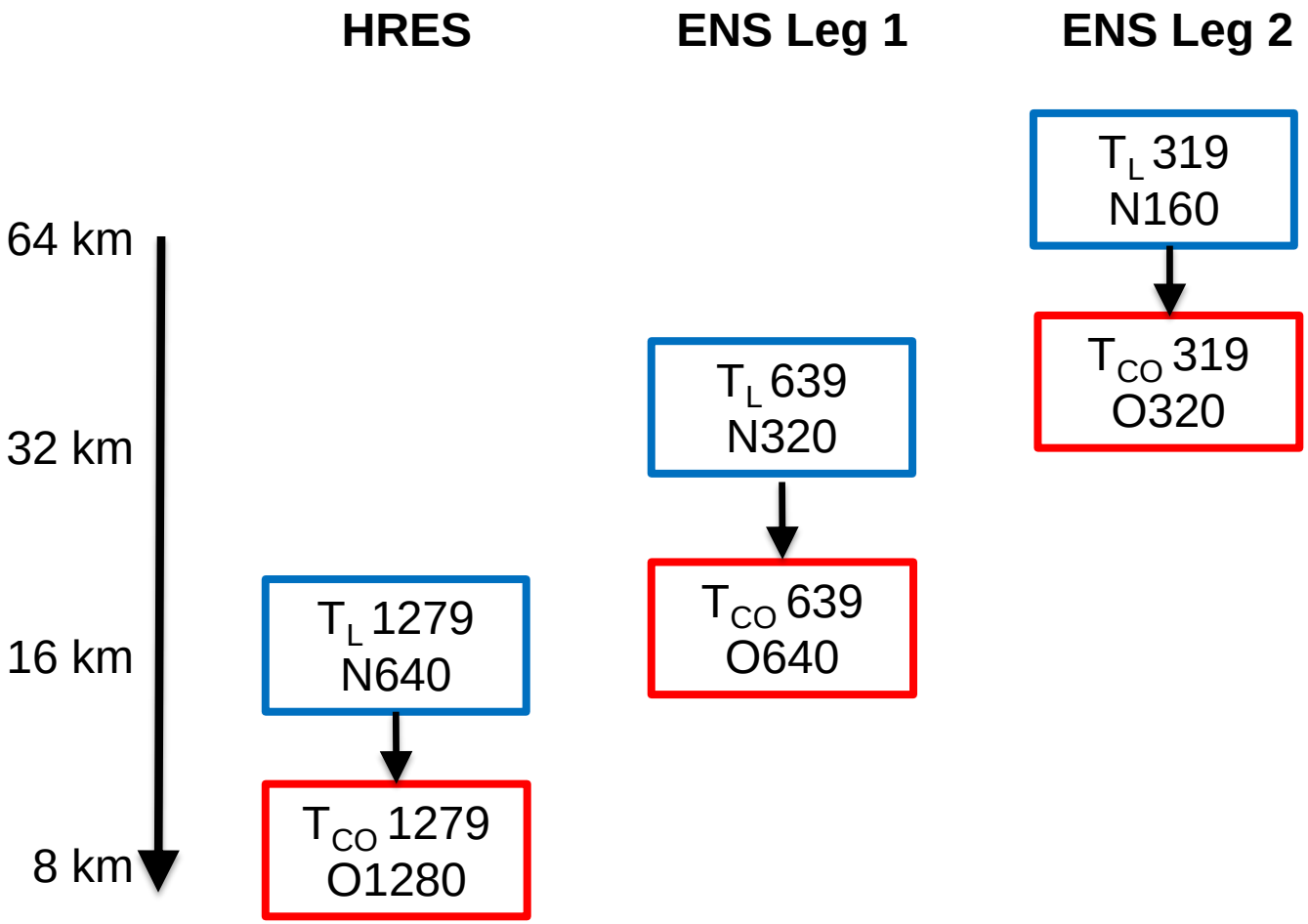
ECMWF User Support Section

ECMWF

Horizontal resolution increase planned for early 2016



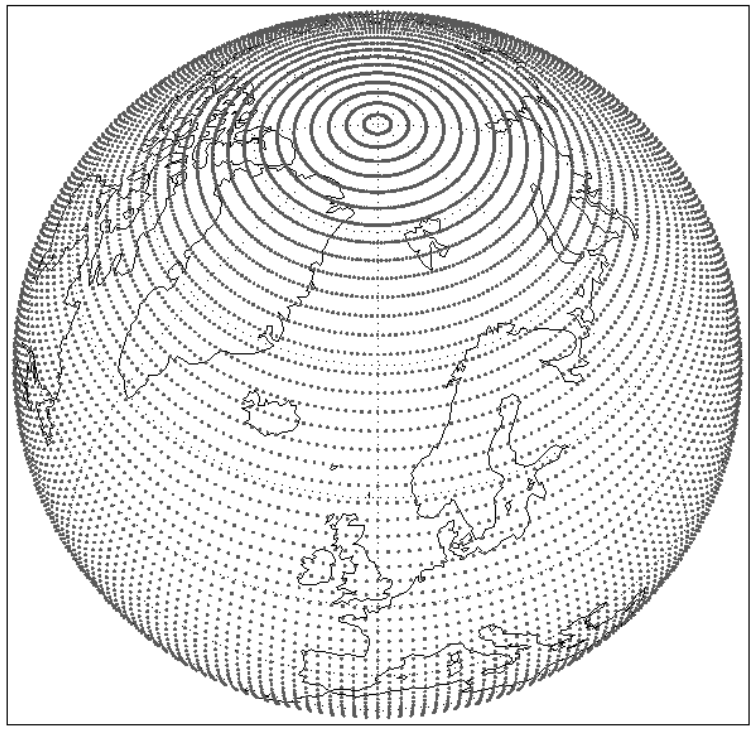
Resolution increase achieved by:

- representing the shortest wave by four (“cubic”) instead of two (“linear”) grid points ($T_L \rightarrow T_C$)
- Using the octahedral grid ($T_C \rightarrow T_{CO}$, N → O)

T_L xxx	spectral linear
T_{CO} xxx	spectral cubic octahedral
Nxxx	original reduced Gaussian
Oxxx	octahedral reduced Gaussian

Gaussian grids of order *N*

Regular (full) grid



No point at pole

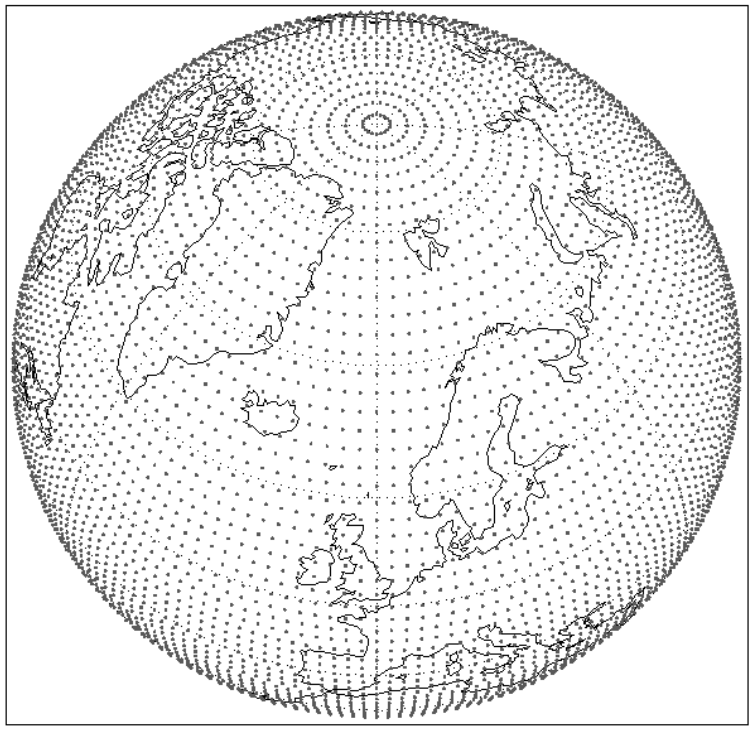
N latitude lines between pole and equator

Latitude lines not evenly spaced

No latitude line at equator

Symmetric about equator

Original reduced grid



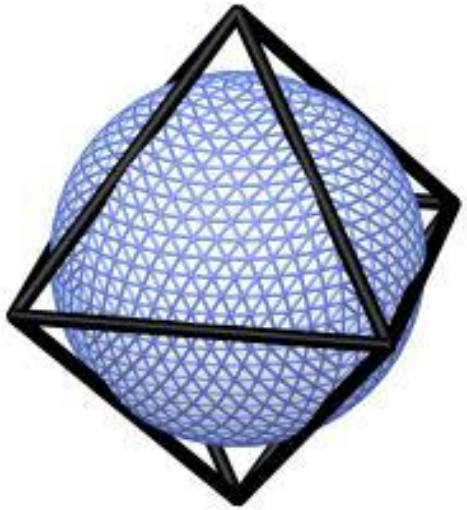
4*N* longitude points at each latitude

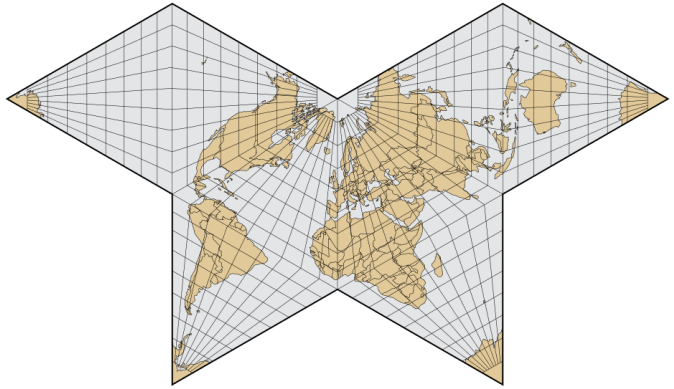
4*N* longitude points close to equator

Fewer longitude points towards poles

What is the octahedral grid ?

- The octahedral grid is a form of reduced Gaussian grid
- Inspired by the Collignon projection
- Latitude points:
  - same as the original reduced Gaussian grid
- Longitude points:
  - computed by a new formula
  - stored in the GRIB header PL array
- More continuous reduction in the number of longitude points
- More variation in zonal resolution

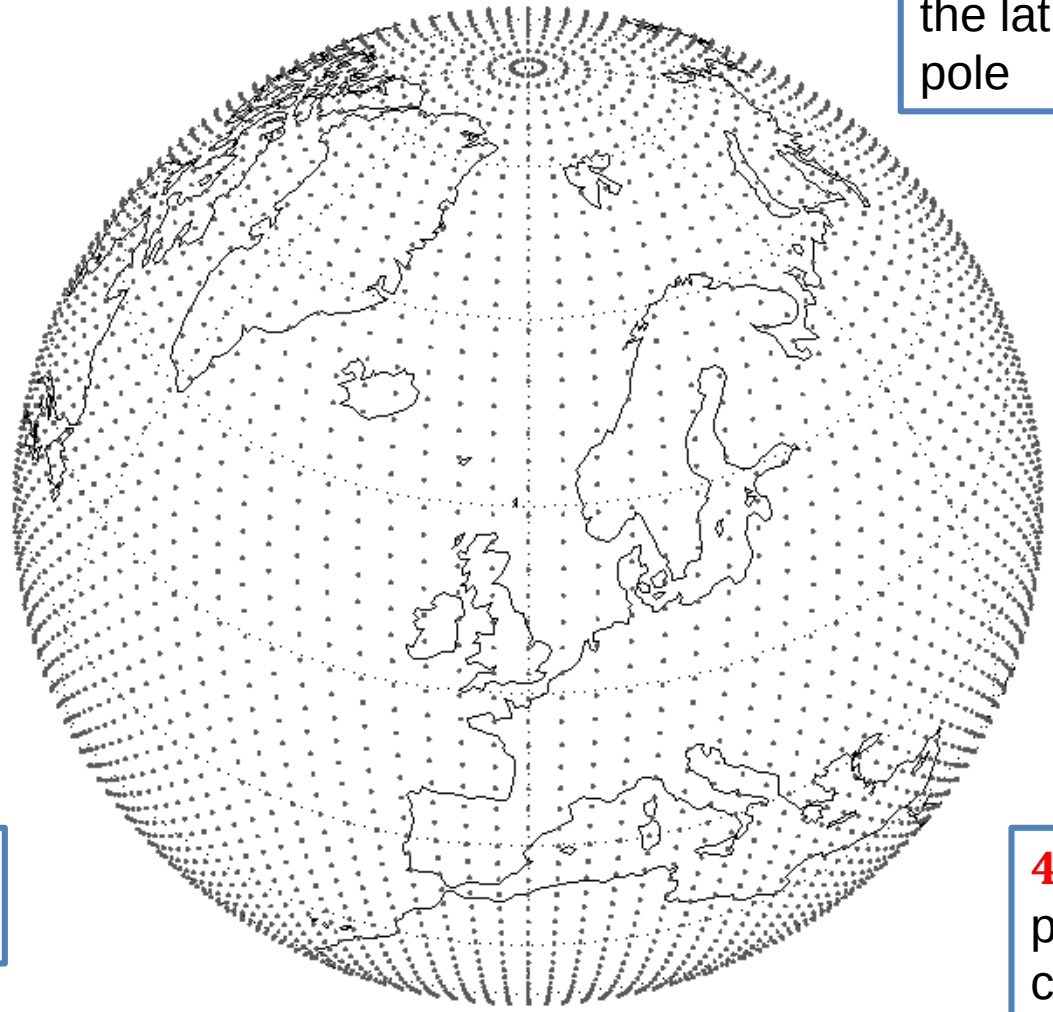




Octahedral reduced Gaussian grid

20 longitude points at the latitude nearest the pole

Same N latitude lines between pole and equator as regular and original reduced Gaussian grids



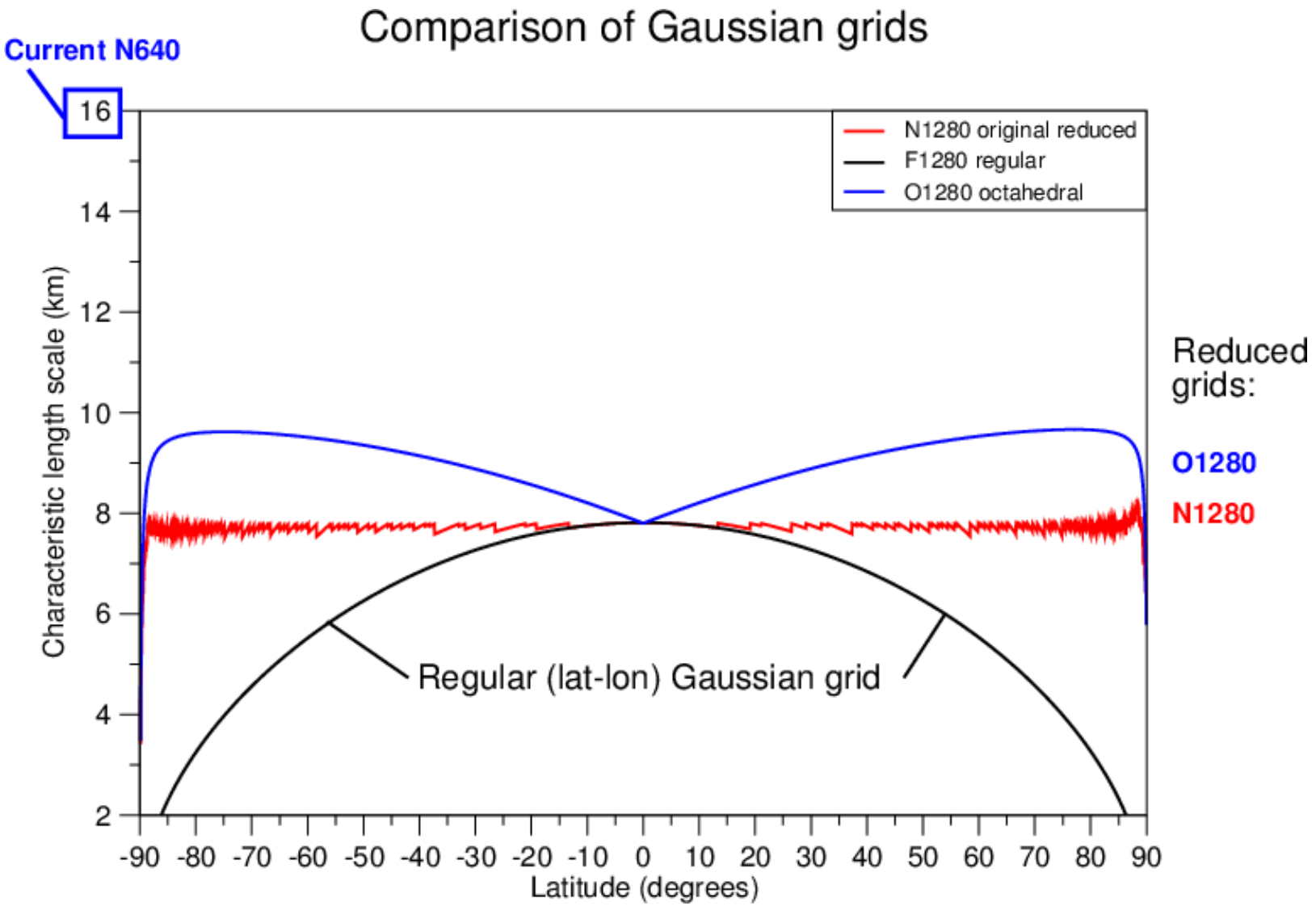
$4\,i + 16$ longitude points at latitude line i

Increases by 4 points at each latitude line from pole towards the equator

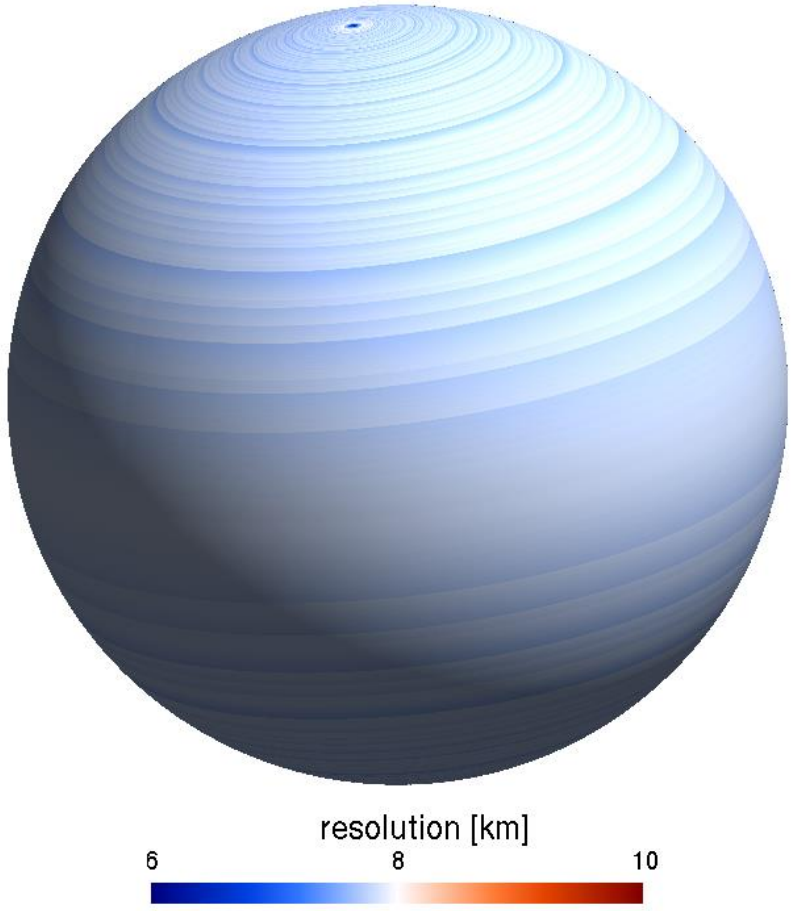
Total number of points = $4\,N(\,N + 9)$

$\mathbf{4\,N + 16}$ longitude points at latitude lines closest to equator

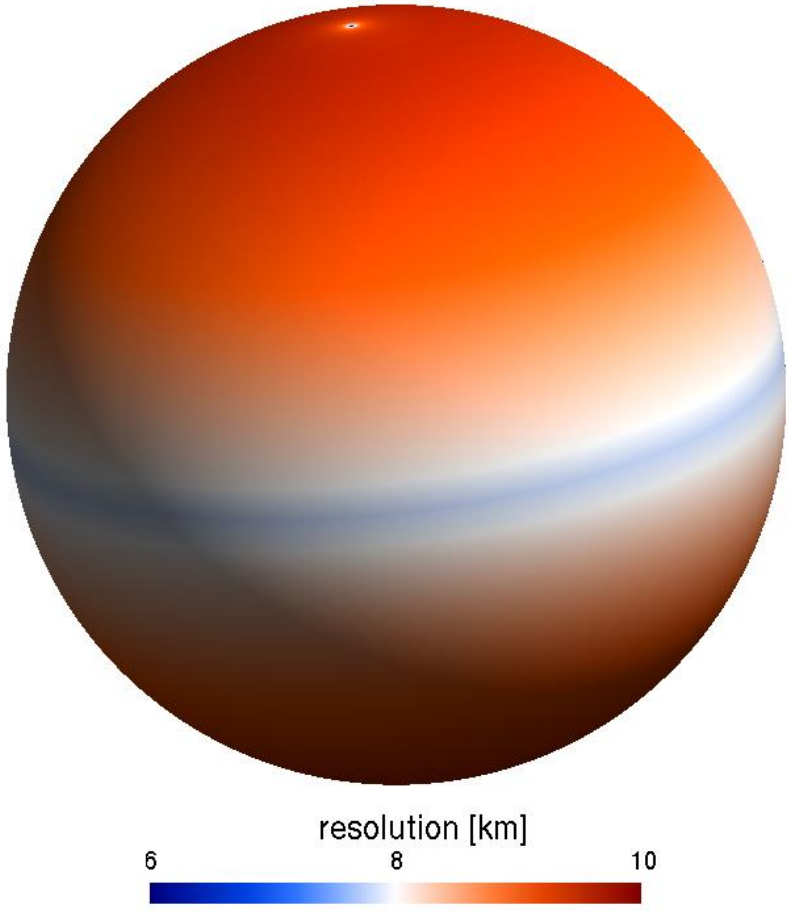
Comparison of zonal variation



Comparison of zonal variation

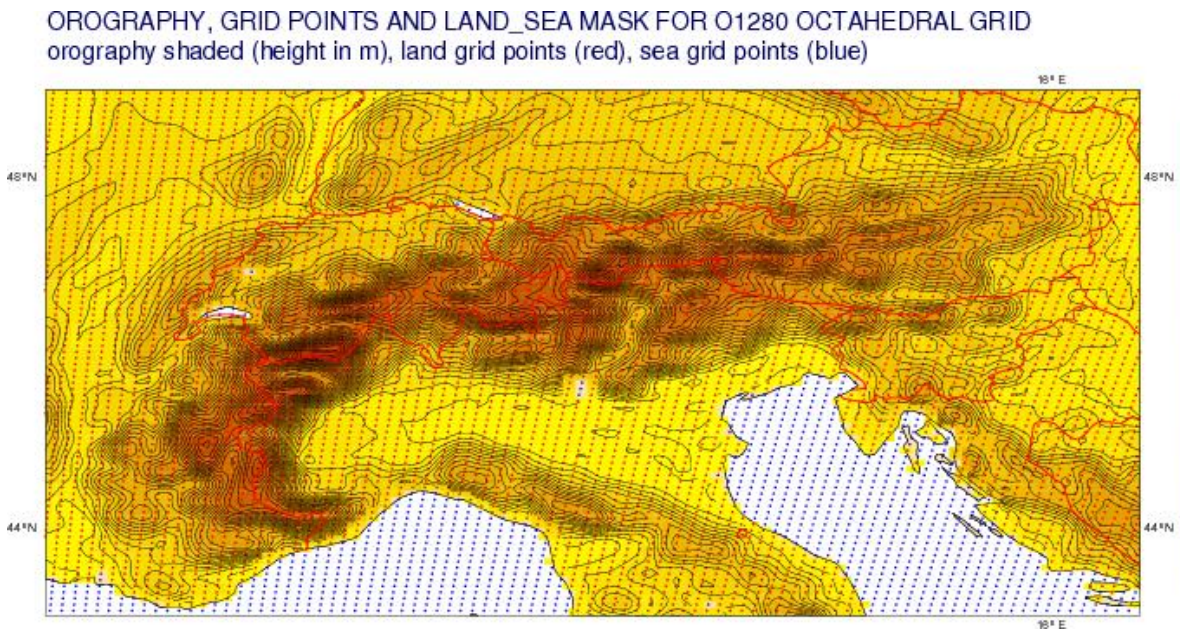


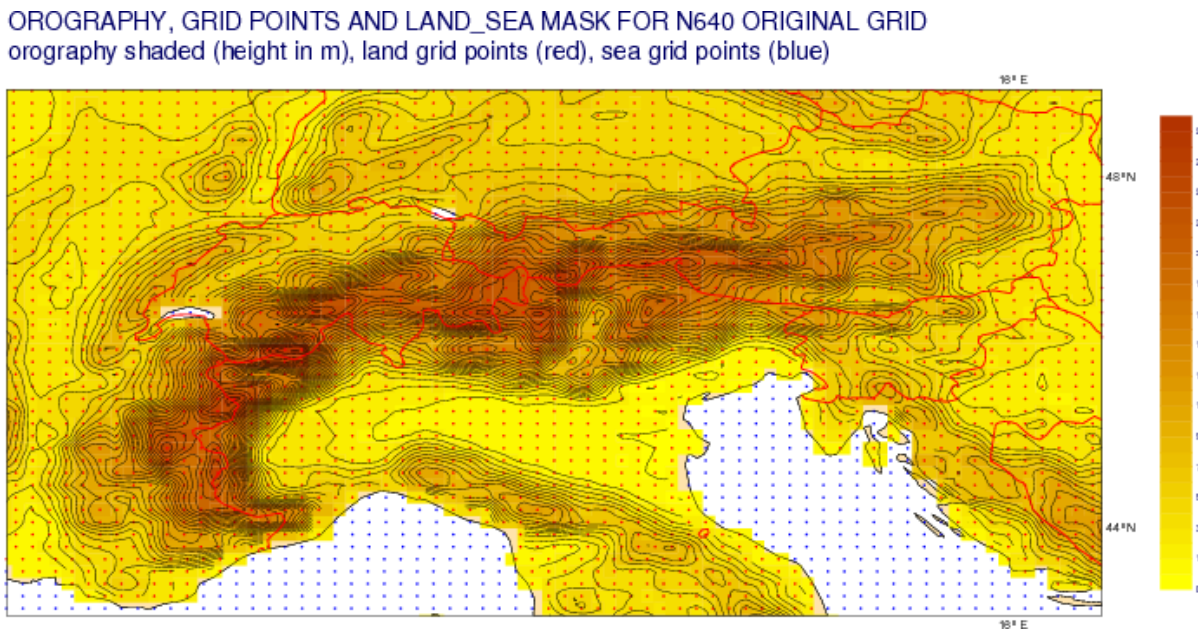
Original reduced Gaussian N1280



Octahedral reduced Gaussian O1280

Land-sea mask and orography: HRES

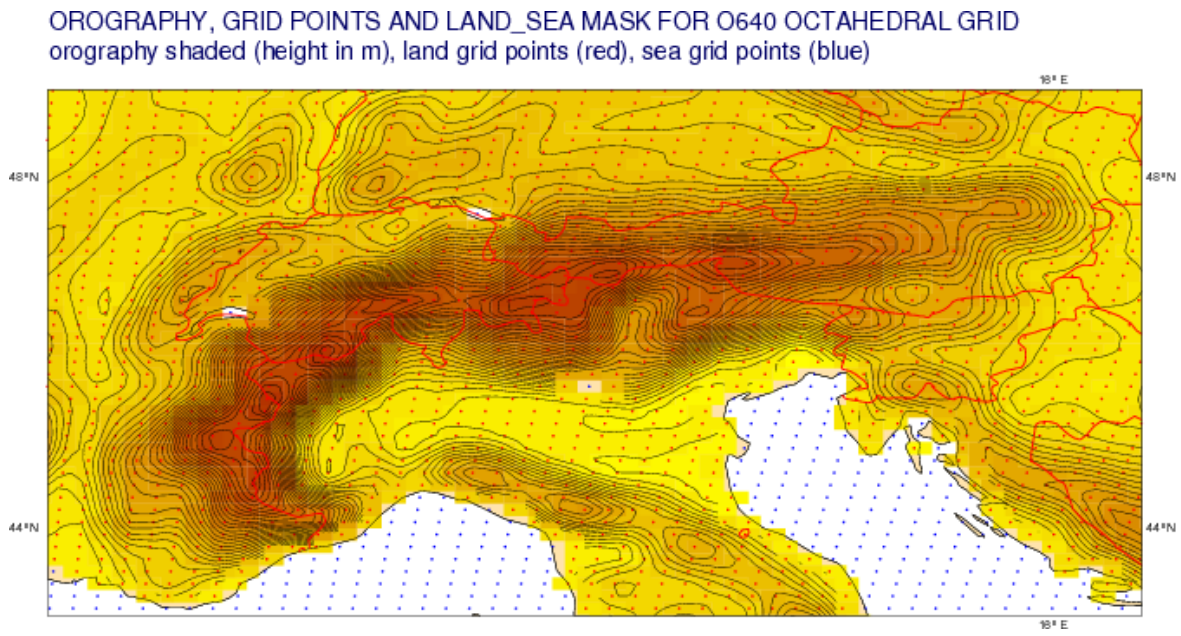


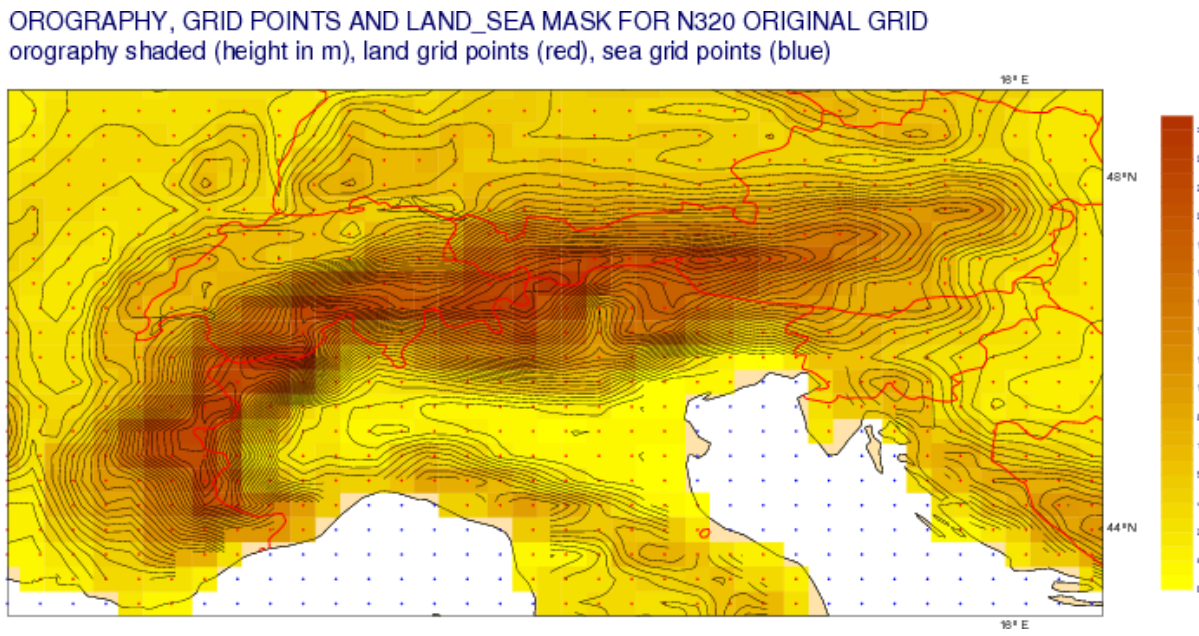


New: O1280 (~9km)

Current: N640 (~16km)

Land-sea mask and orography: ENS Leg 1

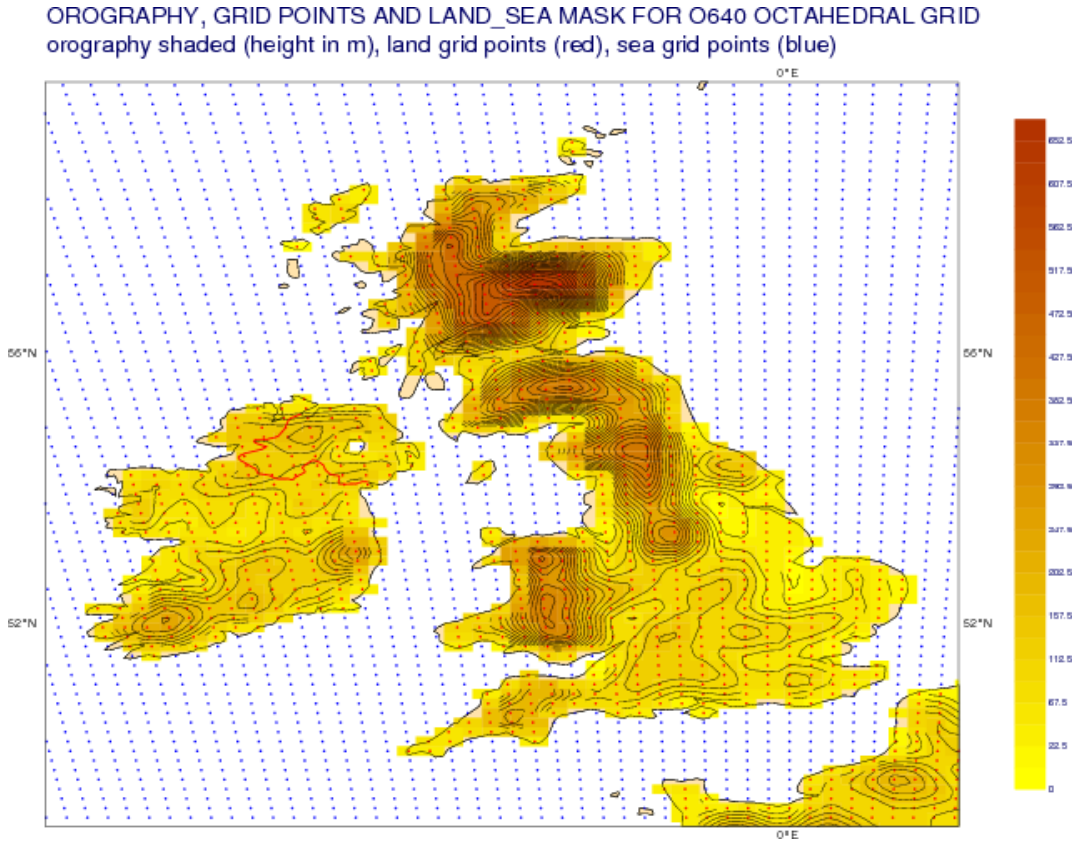




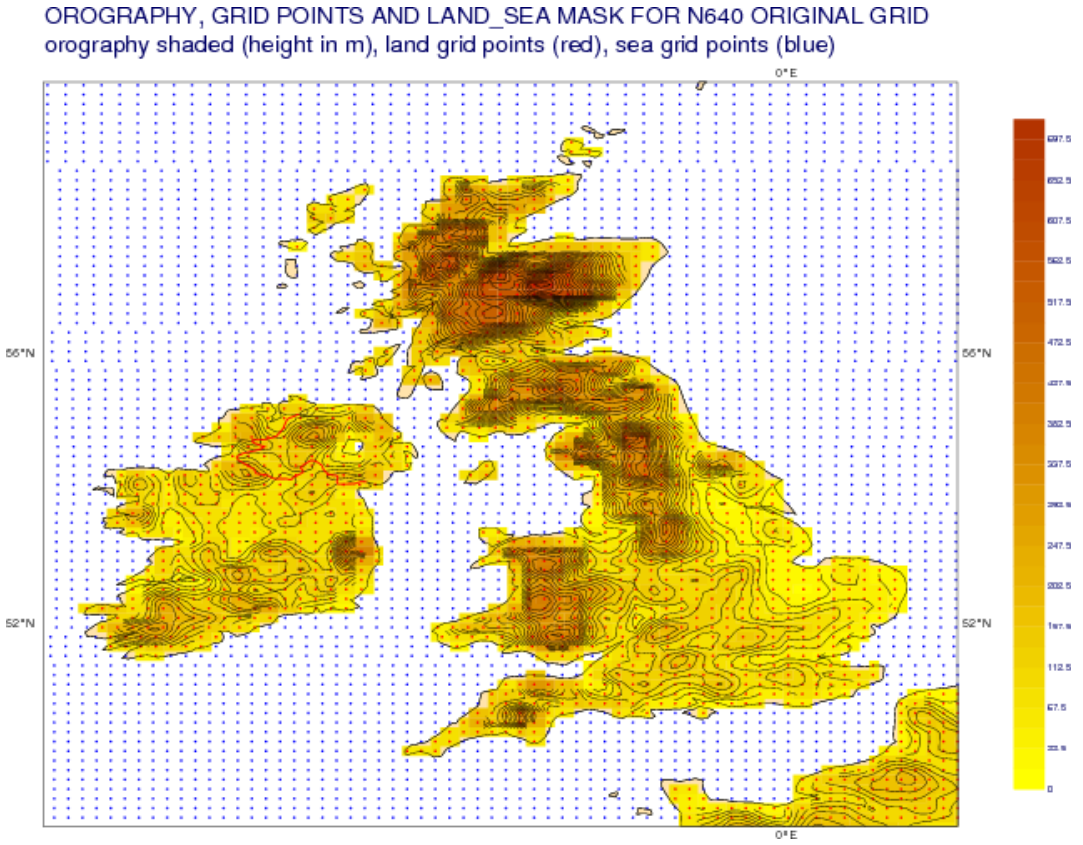
New: O640 (~18km)

Current: N320 (~32km)

Land-sea mask and orography: O640 versus N640



Octahedral: O640 (~18km)



Original: N640 (~16km)

What about regular latitude-longitude grids ?

- ECMWF plans to disseminate
  - HRES data at multiples of 0.0625˚ x 0.0625˚
  - ENS Leg1 / Leg 2 data at multiples of 0.125˚ x 0.125˚ / 0.25˚ x 0.25˚
- Grid increments of 0.0625˚ cannot be encoded precisely in GRIB edition 1 (milli-degree limitation)

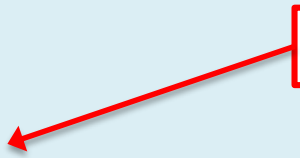
- ECMWF proposes **not** to encode the grid increments of 0.0625˚ in the GRIB header !
  - Appropriate bits of the Resolution and component flags will be set to 0 indicating increments not given
  - i and j direction increments (Di, Dj) will be set to MISSING
- Users will need to compute increments for themselves
  - grib_api will compute these for you:

Coded keys:	iDirectionIncrement=MISSING	jDirectionIncrement=MISSING
Computed keys:	iDirectionIncrementInDegrees=0.0625	jDirectionIncrementInDegrees=0.0625

- Same encoding will apply to **BOTH** GRIB edition 1 and GRIB edition 2 fields !

GRIB edition 1 Grid Description Section

```
==============   SECTION_2 ( length=32, padding=0 )    ==============
1-3         section2Length = 32
4           numberOfVerticalCoordinateValues = 0
5           pvlLocation = 255
6           dataRepresentationType = 0 [Latitude/Longitude Grid (grib1/6.table) ]
7-8         Ni = 5760
9-10        Nj = 2881
11-13       latitudeOfFirstGridPoint = 90000
14-16       longitudeOfFirstGridPoint = 0
17          resolutionAndComponentFlags = 0 [00000000]
18-20       latitudeOfLastGridPoint = -90000
21-23       longitudeOfLastGridPoint = 359938
24-25       iDirectionIncrement = MISSING
26-27       jDirectionIncrement = MISSING
28          scanningMode = 0 [00000000]
29-32       padding_grid0_1 = 4 {
                      00, 00, 00, 00
                    } # pad padding_grid0_1
```



grib_api key:

ijDirectionIncrementGiven=0

GRIB edition 2 Grid Definition Section

```
==============   SECTION_3 ( length=72, padding=0 )    ==============
1-4         section3Length = 72
5           numberOfSection = 3
6           sourceOfGridDefinition = 0 [Specified in Code table 3.1
   (grib2/tables/5/3.0.table) ]

...

31-34       Ni = 5760
35-38       Nj = 2881
39-42       basicAngleOfTheInitialProductionDomain = 0
43-46       subdivisionsOfBasicAngle = MISSING
47-50       latitudeOfFirstGridPoint = 90000000
51-54       longitudeOfFirstGridPoint = 0
55          resolutionAndComponentFlags = 0 [00000000]
56-59       latitudeOfLastGridPoint = -90000000
60-63       longitudeOfLastGridPoint = 359938000
64-67       iDirectionIncrement = MISSING
68-71       jDirectionIncrement = MISSING
72          scanningMode = 0 [00000000]
```

Bits 3 & 4 set to 0

grib_api key:

ijDirectionIncrementGiven=0

ECMWF software stack

- grib_api
  - Full support of the octahedral grid is provided from grib_api 1.14.2
  - Older versions can decode the octahedral grid
  - Upgrade recommended for users of the grib_find_nearest routine
- EMOSLIB
  - EMOSLIB 420 provides preliminary support for the octahedral grids
  - Final testing before release to users and applications
- Metview
  - Current versions of Metview can plot fields on the octahedral grid
  - A new version will provide full support
- MARS
  - A MARS client is being prepared with full support for the octahedral grids

- **All versions subject to change depending on testing**
- **Check the cycle upgrade page for up-to-date information !**

What should I watch out for ?

- Check array dimensions for any hard-coded ‘4N’
  - There are now 4N + 16 points at the latitude lines nearest the equator
- Check that the number of points at each latitude is read from the PL array
- If using HRES data at 0.0625˚ x 0.0625˚ resolution check how grid increments are obtained
  - No issue for ENS or HRES data at lower resolutions
- Increased resolution means increased data volumes

Reduced (model) grid:	N640 → O1280	x3
Regular latitude-longitude:	0.0125˚ x 0.125˚ → 0.0625˚ x 0.0625˚	x4
Spherical harmonics:	$T_L1280 \rightarrow T_{CO}1280$	x1

- Consider requesting compressed data in dissemination – gives ~30% saving on average !

Where can I get test data ?

- Examples of the new land-sea masks and orography fields are available from the ECMWF anonymous ftp server:
  - HRES (O1280): ftp://ftp.ecmwf.int/pub/landseamask/lsmoro_cy41r2_O1280.grib
  - ENS Leg 1 (O640): ftp://ftp.ecmwf.int/pub/landseamask/lsmoro_cy41r2_O640.grib
  - ENS Leg 2 (O320): ftp://ftp.ecmwf.int/pub/landseamask/lsmoro_cy41r2_O320.grib
- Test data will soon be available in MARS
- Test data in dissemination will be made available at a later date

Watch this space !

- ECMWF Forecast User space
  => Planned changes to the forecasting system
    => Horizontal resolution increase
      https://software.ecmwf.int/wiki/display/FCST/Horizontal+resolution+increase