Elimination of the extension zone from grid-point computations

M. Hortal

Introduction

The spectral transform package was produced by Mats Hamrud at ECMWF and it was aimed at the global version of the IFS, where there is not the concept of extension zone and therefore all the points needed for the transforms are meteorologically active points (the points included in the grid-point part of the model).
The limited area version of the transform package was made by Gabor Radnoti by translating in the most straightforward way the global version and therefore it included in grid-point space all the points needed for the spectral representation of the fields, therefore including the extension zone.
As a result of this, the computations in grid-point space were made also over the extension zone, although later modifications avoided the assignement of some points to actual processors and some others were excluded from the computations but remained as part of the grid-point representation of every field. After the grid-point computations any result over the extension zone were overwritten by the biperiodization procedure, this procedure being necessary in the limited area version of the model in order to produce periodic fiends to which the Fourier Transform can be applied.
The biperiodization is made in grid-point space and therefore it needs communications between all processors, which makes the biperiodization a very expensive procedure. This procedure is applied not only before a spectral transform but also before any writing out of grid-point fields to a file, in order to have all the grid-point fields with the same information than the spectral fields.
On the other hand, a narrow extension zone (normally a width of 11 points is used for this zone) allows an influence, during the 4D-Var assimilation, of the observations close to the boundary of the inner (C+I) area on the opposite boundary, which is unphysical. Extending the width of the extension zone makes the model more expensive unnecessarily.

Aim of the modification

The aim of the proposed modification is two-fold.

- On the one side, the elimination of the extension zone from the grid-point representation of fields avoids the unnecessary computations which are performed in grid-point space and allows, with very little overhead, to increase the width of the extension zone. This increase will avoid the influence of observations close to the boundary of the area to influence the points on the opposite boundary.
- The periodization will be performed after the transpositions needed for the spectral transforms, making them therefore always one-dimensional and avoiding the need of extra communications between processors, as all the points needed for the computation of the cubic spline joining the two ends of the array to be given to the FFT, will be in the same processor already.

Another effect of the modification is that all fields will be written out in grid-point format, excluding the extension zone. This will save space if the extension zone is wide

and does not increase much the size of the spectral fields if the extension zone is narrow.
At the moment the width of the extension zone has to be equal in the x and in the y directions but this can be changed in the future.

Technical details

The option of not including the extension zone in the grid-point computations will be controlled by the switch LNOEXTZ in module YOMDIM. Inside the transform package, the corresponding switch will be an element of the type RALD, called RALD%LNOEXTZ.
The quantities NGPTOT and NGPTOTG will refer to the number of points in C+I rather than in C+I+E. So does NLOENG(:), but NDLON will continue to be the number of points in a row in C+I+E and NDGLG (and NDGENG) the number of rows in C+I+E.
In the transform package, the elements of D and G, such as G%NDGL will refer to the C+I+E zone while the elements of RALD will refer to C+I.
The tables NSTA and NONL will point to positions inside the C+I, so the spectral transforms will only produce values for grid-points not inside the E zone.

With the switch LNOEXTZ set to .FALSE. the results of a forecast, 3D_Var, 4D_Var and DFI are bit identical to the ones obtained before the introduction of the modifications.

The modified subroutines and the modifications themselves constitute the contents of changeset 8874 in the HIRLAM wiki pages.