

# Preparing Nudging Data for ECHAM using CDOs

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## 1 Purpose

Currently, spectral nudging files for ECHAM are prepared using the software package INTERA provided by Ingo Kirchner. We would like to replace INTERA by CDOs.

## 2 General remarks

INTERA provides a number of different options that will affect the outcome of the interpolation. We here always assume that INTERA is used with the command line options `-hum` and `+cse`. This implies that INTERA does the vertical interpolation for a moist atmosphere (option `-hum`, input nudging data includes specific humidity), and uses a special correction of land surface temperature based on the conservation of dry static energy (option `+cse`). By default, INTERA also does the vertical interpolation on the high resolution grid of the input files (option `-csi high` is default). See <http://wekuw.met.fu-berlin.de/~IngoKirchner/nudging/nudging/> for the INTERA manual.

## 3 CDO implementation

This section gives a sequence of `cdo` commands to generate spectral nudging data for ECHAM from ECMWF analysis data. We assume that the ECMWF analysis data comes in the two files `input.gp` and `input.sp`. The file `input.gp` contains the specific humidity (code 133) on a reduced Gaussian grid (N80) that corresponds to spectral truncation T106. The file `input.sp` contains the spectral representations in truncation T106 of

- the geopotential (code 129),
- the logarithm of surface pressure (code 152),

- atmospheric temperature (code 130),
- relative vorticity (code 138),
- divergence (code 155).

Resolution of the generated spectral nudging data for ECHAM is T31L39. The surface geopotential (orography multiplied by Earth gravitational acceleration,  $g$ ) of this target resolution must be provided in the file `oro_T31`; the A and B coefficients of the vertical levels of this target resolution in the ASCII file `vct_T31L39`. The latter is readily generated using `cdo vct`.

Adapting this recipe to different resolutions of the ECMWF input or the generated ECHAM spectral nudging data should be straightforward.

```

1 # 1. Preparation of meteorological input data of the
2 # ECMWF analysis
3 # note: 1. the gridpoint data is transformed to full
4 #         Gaussian grid with cdo option -R
5 #         2. relative vorticity and divergence are transformed
6 #         to horizontal winds to be consistent with INTERA
7 #         3. cdo rempaeta demands grid point variables,
8 #         therefore the spectral data is converted to
9 #         gridpoint space
10 #        4. input data is merged into one file
11 cdo -R copy input.gp temp1
12 cdo sp2gp -dv2uv input.sp temp2
13 cdo merge temp1 temp2 input
14 rm -f temp1 temp2
15
16 # 2. Interpolate orography of ECHAM horizontal resolution to
17 # higher horizontal resolution of input data
18 # note: to be consistent with INTERA, this is done
19 #       in spectral space by filling the spectral
20 #       coefficients above T31 with zeros
21 cdo sp2gp -sp2sp,106 -gp2sp oro_T31 oro_T106
22
23 # 3. Do vertical interpolation using cdo remapeta
24 cdo remapeta,vct_T31L39,oro_t106 input temp
25
26 # 4. Postprocess the result of cdo remapeta:
27 # - delete specific humidity
28 # - calculate divergence and relative vorticity
29 #   from horizontal winds
30 # - transformation to spectral space
31 # - truncate spectral coefficient to T31
32 cdo sp2sp,31 -gp2sp -uv2dv -delcode,133 temp output_T31L39
33 rm -f temp

```

The generated file output\_T31L39 contains the interpolated fields of the following variables on the ECHAM T31L39 grid:

- the geopotential (code 129),
- the logarithm of surface pressure (code 152),
- atmospheric temperature (code 130),
- relative vorticity (code 138),
- divergence (code 155).

## 4 Quality check of the CDO implementation

To check the quality of the above procedure, we compared the result of the CDO implementation to the result produced by INTERA using ECMWF analysis data for January 2003. The analysis data is in resolution N80/T106 with 60 vertical levels, the ECHAM spectral nudging data in resolution T31L39. The maximum absolute differences (over the whole atmosphere and time period of one month) between the fields generated by CDO and the INTERA are listed in Table 1.

## 5 Open issues

- cdo remapeta gives warning “Output humidity at level 52 out of range (min=-3.63232e-21 max=0.0181785)!”
- can CDOs transform surface fields like surface temperature similar to INTERA using box-averaging?

Table 1: Maximum absolute differences (over the whole atmosphere and time period of one month) between the fields generated by CDO and the INTERA. Input is January 2003 of the ECMWF analysis in N80/T160L60 resolution, output resolution is T31L39.

variable	maximum absolute difference
surface ln of surface pressure	0.007 (surface pressure difference of 0.7%)
surface geopotential	13.3 m <sup>2</sup> s <sup>-2</sup>
temperature	0.6 K
u-wind	0.58 ms <sup>-1</sup>
v-Wind	0.35 ms <sup>-1</sup>