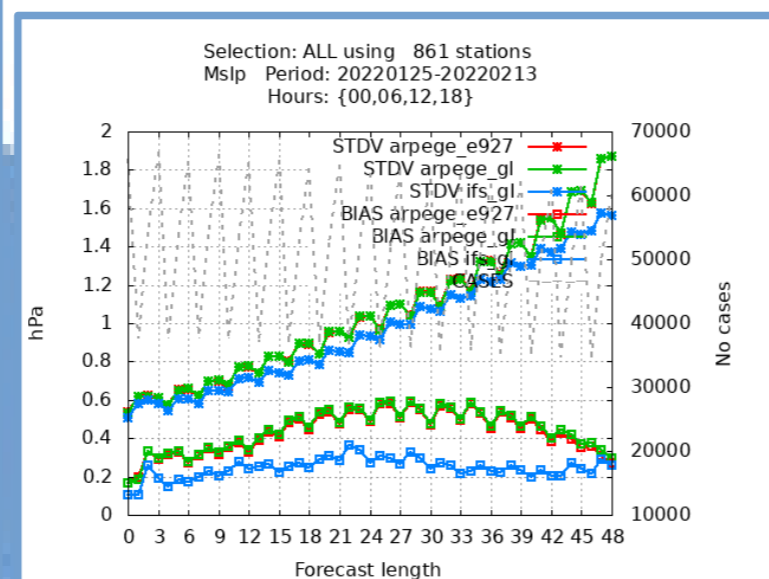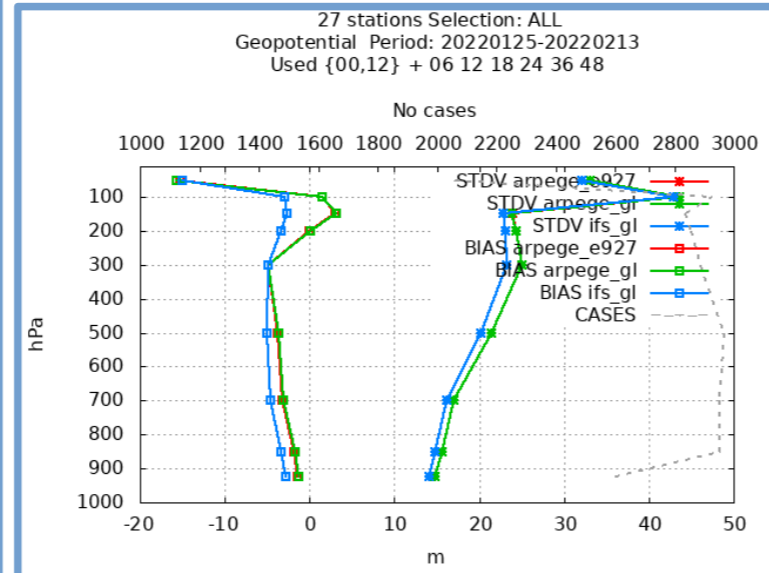## Introduction

In the dawn ot times gl was created as a tool to interpolate HIRLAM data to be used as boundaries for AROME. Over the years it has evolved to do a bit more and the main usage today is FA to GRIB conversion, interpolation of IFS boundaries, analysis increment diagnostics and extraction for verification.

The code is available as a part of HARMONIE under util/gl and requires ecCodes, NetCDF and several libraries from the model for FA support and spectral transforms. For access and full documentation visit:
- https://github.com/Hirlam/Harmonie
- https://hirlam.github.io/HarmonieSystemDocumentation/dev/PostProcessing/gl/

Boundary interpolation

Although gl was initially developed to handle HIRLAM files it was early extended to handle IFS data in (rotated) latlon projection as well. This allowed existing data streams from ECMWF to be used both for HIRLAM and HARMONIE. Recently the functionality has been extended to handle ARPEGE files as generated by Meteo France for ACCORD members. A comparison over the operational MetCoOp domain shows no significant differences when comparing fullpos (arpege_e927) or gl (arpege_gl) interpolating ARPEGE data projected on a 8km grid using 65 levels. Note though that fullpos is faster thanks to the MPI support.

Postprocessing of parameters

Several diagnostic parameters have been implemented either as support functions for e.g. verification or comparison with IFS data or as a quick way to introduce parameters not yet available in fullpos.
- Interpolation to height/pressure levels
- Diagnostic parameters such as fog, clouds below 7500m, wind speed and direction, gust speed, (significant) cloud base, cloud top, mask of significant clouds, dew point temperature, helicopter triggered lightning index, transmittance, precipitation type, lightning intensity, visibility, probability of freezing rain, probability of thunder, boundary layer height, atmospheric icing, max wind (and level) in a column, CAT and related bottom/top/max values, BVF, several vertical integrals, cape and cin.

Various other applications

- Calculate analysis increments and average over longer periods with xtool using NetCDF/FA/GRIB files
- Produce forcing files for MUSC, providing an ASCII interface to testing of academic cases
- Produce files for verification from FA/GRIB/BUFR files to be used either by harp or monitor
- Inject orography from 923 files to PGD files
- Combine NetCDF/FA/GRIB data for the MSG ingest process
- domain_prop allows quick checks on domains and fields

If you're in a hurry

```
gl file [-n namelist_file] [-o output_file] -[lfgmicpsdtqzv]

gl [-f] file, list the content of a file, -f for FA/lfi files
-c    : Convert a FA/lfi file to grib ( -f implicit )
-of GRIB[1|2] : Specify output format
-z    : List a NetCDF file, (experimental)
-nc   : Convert a FA file to NetCDF output without E-zone
-musc : Convert a MUSC FA file ASCII ( -c implicit )
-s    : Decrease verbosity
-v    : Increase verbosity
-g    : Prints extra grib/cadre/lfi info
-m    : Prints min,mean,max,stdv of the fields
-tp   : Prints the GRIB parameter usage
-t    : Prints the FA/lfi/GRIB table (useful)
-q    : Cross check the FA/lfi/GRIB table
-igs  : Set lignore_shortname=T. Use indicatorOfParameter
        instead of shortName for selection

gl file -n namelist_file : treat file according to namelist_file
```

A working namelist example

```
&naminterp
infile = 'ICMSHHARM+0024'
input_format = 'FA'
output_format = 'MEMORY'
output_type = 'APPEND'
maxfl = 2,
exclkey%faname = 'SNNNPRESS.DEPART'
pppkey%shortname = 'hti'
pppkey%level = 0
pppkey%levtype = 'entireAtmosphere'
lphys_area = T,
/
&naminterp
infile = 'PFHARMMETCOOP25D+0024'
input_format = 'FA'
output_format = 'MEMORY'
output_type = 'APPEND'
lignore_duplicates = T,
/
&naminterp
input_format = 'MEMORY',
output_format = 'GRIB',
outfile = 'example1.grib1',
readkey%faname = 'INTSURFGEOPOTENT'
/
&naminterp
input_format = 'MEMORY',
output_format = 'GRIB1',
outfile = 'example2.grib1',
readkey%faname = 'SNNNTEMPERATURE'
Istart=300, istop=-300,
Jstart=400, jstop=-400
/
&naminterp
input_format = 'MEMORY',
output_format = 'GRIB2',
outfile = 'example3.grib2'
readkey%faname = '#','CLSTEMPERATURE',
readkey%pid = 51,-1,
readkey%level = 2,-1
readkey%levtype = 'heightAboveGround','#'
outgeo%gridtype = 'crop'
outgeo%south = 55., outgeo%west = 10.
outgeo%north = 65., outgeo%east = 25.
/
&naminterp
input_format = 'MEMORY',
output_format = 'GRIB2',
outkey%nbit = 16,
packingtype = 'grid_ccsds',
outfile = 'example4.grib2',
readkey%shortname = 'hti'
readkey%level = 0
readkey%levtype = 'entireAtmosphere'
outgeo%gridtype = 'regular_ll'
outgeo%south = 52.5, outgeo%west = 0.
outgeo%nlon = 300, outgeo%nlat = 150,
outgeo%dlon = 0.05, outgeo%dlat = 0.05,
order = 1,
/
&naminterp
input_format = 'MEMORY',
output_format = 'GRIB2',
outfile = 'example5.grib2',
readkey%shortname='z',
readkey%levtype='heightAboveGround',
readkey%level=  0,
outgeo%gridtype = 'lambert'
outgeo%south = 57.5, outgeo%west = 0.,
outgeo%nlon = 50, outgeo%nlat = 50,
outgeo%dlon = 20000, outgeo%dlat = 20000,
outgeo%projlon = -15.
outgeo%projlat = 65, outgeo%projlat2 = 65
order = 1, lresample = T,
/
&naminterp
input_format = 'MEMORY',
output_format = 'GP_ASCII',
outfile = '',
readkey%shortname = 'q'
readkey%level = -1
readkey%levtype = 'hybrid'
outgeo%gridtype='regular_ll'
outgeo%nlon = 3, outgeo%nlat = 1,
linterp_field = F,
gplat = 57.375,57.35,57.60
gplon = 13.55,13.55,14.63
/
```

Talking to python

In experimental versions of gl the main routines have been interfaced to python using f2py in order to combine the existing interpolation and file handling with e.g. output to sqlite or json more easily handled in python. Such development may be useful to e.g. produce data for harp.

Read several files

The IO-server outputs several files which can be assembled using FAcat . We can also read the distributed files with gl and output a single GRIB file. The functionality can also be used to join e.g. the history and fullpos files to a single GRIB file. To the left we see how to read two files, postprocess a variable, and store them in memory. We also see how to exclude fields and how to skip fields existing in both files. The lphys_area flag removes the E-zone from the history file.

Field selection and cropping

Field selection is done through the readkey, either by specifying the FA name or GRIB parameters. For FA model level fiels we can select all using "SNNN" for the faname. We can also combine FA names and grib parameters like in example3.

The output domain size can be reduced by giving an offset or by geographical corners using gridtype=crop.

Example 1

Example 2

Example 4

Example 3

Example 5
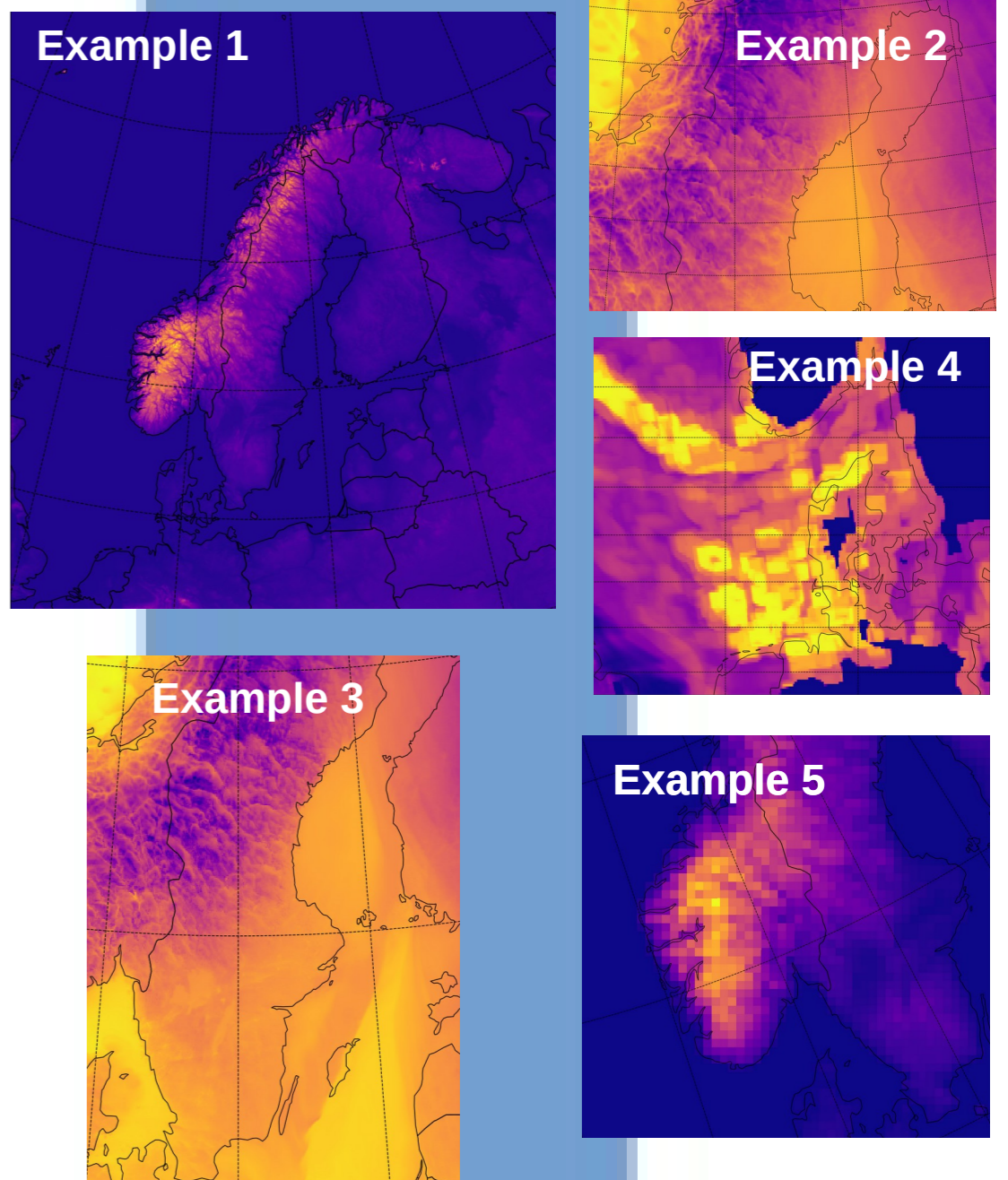
Interpolation and packing

The output can be projected on any of (rotated) latlon, lambert, polarstereographic or (rotated) mercator grid. Interpolation type is given by order=0,1,2,3 for nearest, linear, quadratic or cubic interpolation. Interpolation to a coarser grid can be accompanied with the lresample flag taking the average of the input cells.

For grib output we can set the output accuracy using nbit. With GRIB2 comes a range of packing options and packingtype=grid_ccsds is used with good performance in HARMONIE. In the final namelist we see how to output to several geographical points using gridtype=regular_ll, linterp_field=F and a tailored output format.

Output to NetCDF

In the climate version of HARMONIE, HCLIM, gl is used to convert to NetCDF fomat following the CORDEX standard. Some postprocessing, such as de-accumulation of fluxes and calculating derived fields, is done in the conversion from FA to NetCDF with gl and xtool to further reduce the cost of CMORization afterwards.

FA translation and EcCodes coupling

gl translates ~1500 FA fields to GRIB were a wast majority are SURFEX related fields. The translations are defined in gl/inc/trans_tab.h. A similar translation for netcdf fields. For a correct usage and interpretation of shortName it's important to have the gl defined tables in the ECCODES_DEFINITION_PATH. The internal tables for gl are found under gl/definitions.