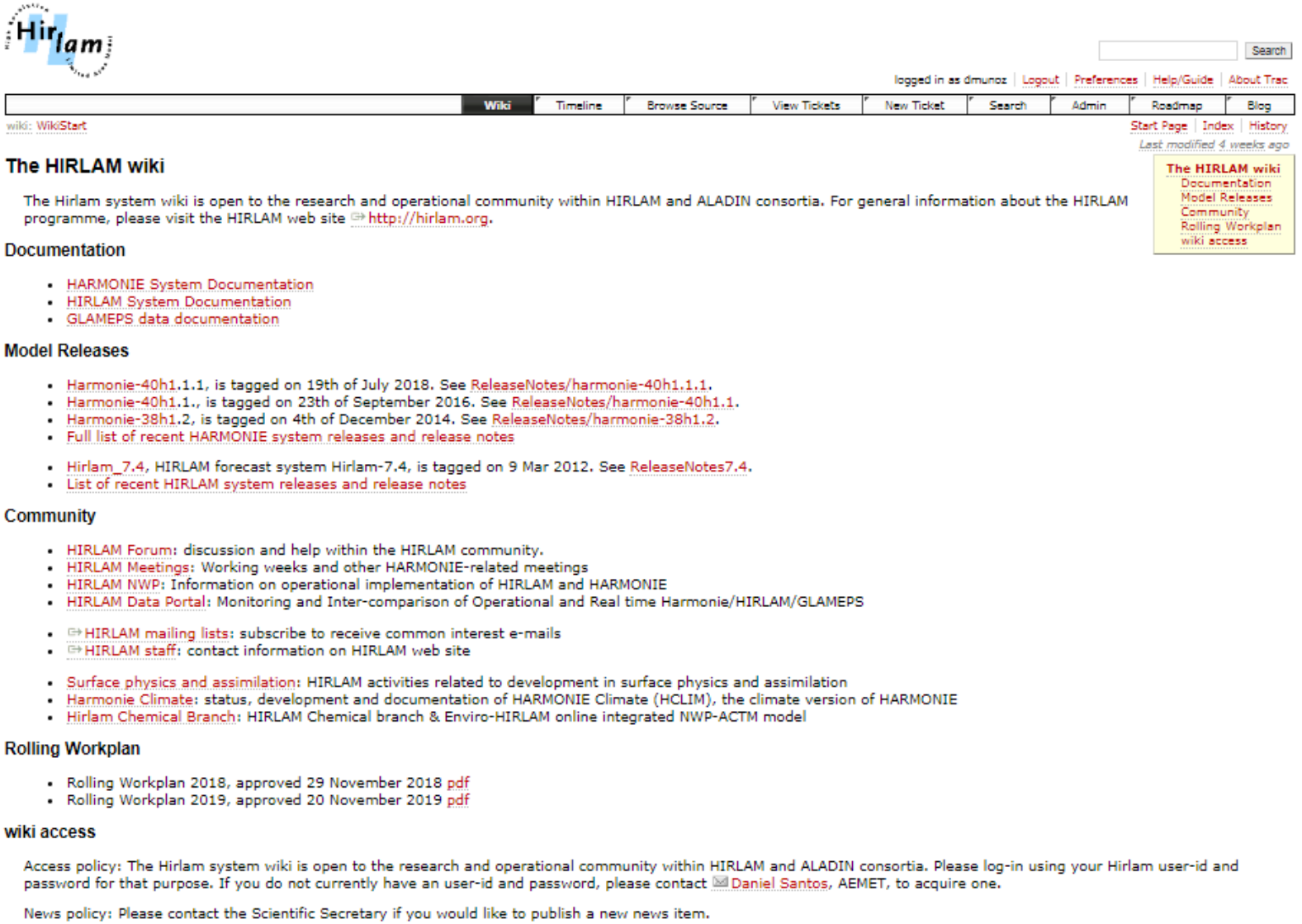
HARMONIE-AROME System

ALADIN/HIRLAM common data assimilation training week
The Hungarian Meteorological Service (OMSZ)
Budapest, Hungary

10-15 February 2019

HARMONIE-AROME System

- Our best source of info is: https://hirlam.org/trac/wiki



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The HIRLAM wiki

The Hirlam system wiki is open to the research and operational community within HIRLAM and ALADIN consortia. For general information about the HIRLAM programme, please visit the HIRLAM web site http://hirlam.org.

Documentation

- HARMONIE System Documentation
- HIRLAM System Documentation
- GLAMEPS data documentation

Model Releases

- Harmonie-40h1.1.1, is tagged on 19th of July 2018. See ReleaseNotes/harmonie-40h1.1.1.
- Harmonie-40h1.1., is tagged on 23th of September 2016. See ReleaseNotes/harmonie-40h1.1.
- Harmonie-38h1.2, is tagged on 4th of December 2014. See ReleaseNotes/harmonie-38h1.2.
- Full list of recent HARMONIE system releases and release notes

- Hirlam_7.4, HIRLAM forecast system Hirlam-7.4, is tagged on 9 Mar 2012. See ReleaseNotes7.4.
- List of recent HIRLAM system releases and release notes

Community

- HIRLAM Forum: discussion and help within the HIRLAM community.
- HIRLAM Meetings: Working weeks and other HARMONIE-related meetings
- HIRLAM NWP: Information on operational implementation of HIRLAM and HARMONIE
- HIRLAM Data Portal: Monitoring and Inter-comparison of Operational and Real time Harmonie/HIRLAM/GLAMEPS

- HIRLAM mailing lists: subscribe to receive common interest e-mails
- HIRLAM staff: contact information on HIRLAM web site

- Surface physics and assimilation: HIRLAM activities related to development in surface physics and assimilation
- Harmonie Climate: status, development and documentation of HARMONIE Climate (HCLIM), the climate version of HARMONIE
- Hirlam Chemical Branch: HIRLAM Chemical branch & Enviro-HIRLAM online integrated NWP-ACTM model

Rolling Workplan

- Rolling Workplan 2018, approved 29 November 2018 pdf
- Rolling Workplan 2019, approved 20 November 2019 pdf

wiki access

Access policy: The Hirlam system wiki is open to the research and operational community within HIRLAM and ALADIN consortia. Please log-in using your Hirlam user-id and password for that purpose. If you do not currently have an user-id and password, please contact Daniel Santos, AEMET, to acquire one.

News policy: Please contact the Scientific Secretary if you would like to publish a new news item.

HARMONIE-AROME System

Setup Phase	Runtime phase	Postprocesing phase	Verification phase
Working directories Domain definition Cycling and IC / BCs setups Physic setups Simulation type Namelists generation	Compilation Climate generation Initial/boundary data Observations Data Assimilation Digitial Filter Initialization Forecast Model Ensemble prediction (HarmonEPS) Climate simulations (HCLIM) Single column model (MUSC)	Convert data to GRIB Postprocessing with FULL-POS Postprocessing with gl Postprocessing with gl_grib_api Postprocessing with xtool Diagnostics Obsmon Calibration	Extract data for verification Deterministic verification (monitor) Ensemble verification (HARP) Multi-model Observation Verification Intercomparison Observations monitoring
Scripting	Scripting and Binaries	Scripting, Binaries and external packages	

Workflow monitoring

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Runtime phase

Compilation
Climate generation
Initial/boundary data
Observations
Data Assimilation
Digitial Filter Initialization
Forecast Model
Ensemble prediction (HarmonEPS)
Climate simulations (HCLIM)
Single column model (MUSC)

Postprocesing phase

Convert data to GRIB
Postprocessing with FULL-POS
Postprocessing with gl
Postprocessing with gl_grib_api
Postprocessing with xtool
Diagnostics
Obsmon
Calibration

Verification phase

Extract data for verification
Deterministic verification (monitor)
Ensemble verification (HARP)
Multi-model Observation
Verification Intercomparison
Observations monitoring

Scripting

Scripting and Binaries

Scripting, Binaries and external packages

Workflow monitoring

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Configure your experiment

- Create an experiment directory under $HOME/hm_home and use the master script Harmonie to set up a minimum environment for your experiment.

```
mkdir -p $HOME/hm_home/my_exp
cd $HOME/hm_home/my_exp
~hlam/Harmonie setup -r ~hlam/harmonie_release/tags/harmonie-40h1.1 -h ecgb-cca
```

  where
  - -r tells which version to use. There are several old versions kept on ecgb. Check the directories under `~hlam/harmonie_release` to see the available versions.
  - -h tells which configuration files to use. At ECMWF config.ecgb is the default one.
- This would give you the default setup which currently is AROME physics with CANARI+OI_MAIN surface assimilation and 3DVAR upper air assimilations with 3h cycling on a domain covering Denmark using 2.5km horizontal resolution and 65 levels in the vertical.
- Now you can edit the basic configuration file sms/config_exp.h to configure your experiment scenarios. Modify specifications for domainm, physics versions (AROME, ALARO), data locations, settings for dynamics, physics, domain, coupling host model etc. Read more about the options in here. You can also use some of the predefined configurations by calling Harmonie with the -c option:

```
~hlam/Harmonie setup -r PATH_TO_HARMONIE -h YOURHOST -c CONFIG -d DOMAIN
```

  where `CONFIG` is one of the setups defined in Harmonie_configurations.pm. If you give -c with out an argument or a non existing configuration a list of configurations will be printed.
- In some cases you might have to edit the general system configuration file, Env_system. See here for further information: HarmonieSystemDocumentation/PlatformConfiguration
- The rules for how to submit jobs on ecgb/cca are defined in Env_submit. See here for further information: HarmonieSystemDocumentation/PlatformConfiguration
- If you experiment in data assimilation you might also want to change scr/include.ass.

https://hirlam.org/trac/wiki/HarmonieSystemDocumentation/Harmonie-mSMS

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The Harmonie main script

The Harmonie script is the main user interface to the harmonie system. It is used to setup, start, check and control your experiment and environment. Below follows the most useful commands. There are other commands inherited from the HIRLAM environment that may or may not work. For a full list check Start, Actions, Actions.pl.

- `Harmonie setup [ -r REVISION ] [ -h HOST ] [ -d DOMAIN ] [ -c CONFIGURATION ] [ -l LEVELS ]` where:
  - REVISION is the path to the version of harmonie you are working with.
  - HOST is the name of the host you are working on. There should exist corresponding config-sh/config.HOST.
  - CONFIGURATION is one of the predefined configurations in scr/Harmonie_testbed.pl. It a fast way to setup your favourite configuration.
  - DOMAIN is one of the predefined domains in sms/config_exp.h
  - LEVELS is one of the predefined level definitions in scr/Vertical_levels.pl
- `Harmonie start DTG=YYYYMMDDHH [ LL=NNN|LLMAIN=NNN ] [ DTGEND=YYYYMMDDHH ] [ optional environment variables]` launches a cold start run.
  - DTG is the initial time of your experiment
  - LL is the forecast length. If you use LLMAIN it means you will run for the main cycles (00/12) for LLMAIN hours and FCINT (interval in hours between cycles) for the intermediate (06/18) cycles.
  - Several other optional variables can be given like
    - PLAYFILE=FILENAME use a different mSMS suite definition file. Default is harmonie.tdf
    - BUILD=yes|no to turn on and off compilation
    - CREATE_CLIMATE=yes|no to turn on and off generation of climate files
    - mSMS_WAIT=yes|no to let the start process wait until all jobs have finished. Useful if you start your run from inside a batch job.
    - Any environment variable that you would like to send to the system.
- `Harmonie prod` will continue from the DTG given in your progress.log file. The rest of the arguments is as for `Harmonie start`. This should be used to continue and experiment. It is assumed that a first guess file is available and the run will fail if this is not found.
- `Harmonie mon` will restart your mXCdp window and try to connect to an existing mSMS server.
- `Harmonie co [FILE|PATH/FILE]` will copy the request file from the version chosen in your setup (as pointed out in the config-sh/hm_rev file) to your local directory. If the PATH is not given a search will be done. If the name matches several files you will be given a list to choose from.
- `Harmonie install` will build your libraries and binaries but not start any experiment

https://hirlam.org/trac/wiki/HarmonieSystemDocumentation/TheHarmonieScript

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Model domain settings

For each domain we set variables related to the geometry and the resolution like:

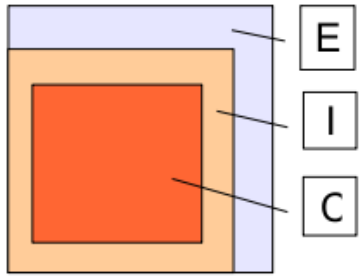
HARMONIE model domains are defined in settings in Harmonie_domains.pm. The following variables related to the geometry and the resolution are required:

- *TSTEP* is model timestep in seconds
- *NLON* is number of points in x-direction.
- *NLAT* is number of points in y-direction.
- *LONC* is the longitude of domain centre in degrees.
- *LATC* is the latitude of domain center in degrees.
- *LON0* is the reference longitude of the projection in degrees.
- *LAT0* is the reference latitude of the projection in degrees. If *LAT0* is set to 90, the projection is **polar stereographic**. If *LAT0* < 90, the projection is **lambert** unless LMRT=.TRUE..
- *GSIZE* is grid size in meters in both x- and y-direction.
- *EZONE* is number of points over extension zone in both x- and y-direction. Default value 11.
- *LMRT* switch for rotated Mercator projection. If LMRT=.TRUE. LAT0 should be zero.

NLON and *NLAT* should satisfy the equation $5^b * 3^d * 2^e$, where a-e are integers >= 0.

The default area is the Denmark domain (DKCOECP). The following values for C+I zone and truncation are calculated in Harmonie_domains.pm from the values above.

- *NDLUXG* is number of points in x-direction without extension (E) zone.
- *NDGUXG* is number of points in y-direction without extension (E) zone.
- *NMSMAX_LINE* is truncation order in longitude. By default (*NLON*-2)/2.
- *NSMAX_LINE* is truncation order in latitude. By default (*NLAT*-2)/2.
- *NMSMAX_QUAD* is truncation order in longitude. By default (*NLON*-2)/3. It is used to create filtered orography with lower resolution.
- *NSMAX_QUAD* is truncation order in latitude. By default (*NLAT*-2)/3. It is used to create filtered orography with lower resolution.



https://hirlam.org/trac/wiki/HarmonieSystemDocumentation/ModelDomain

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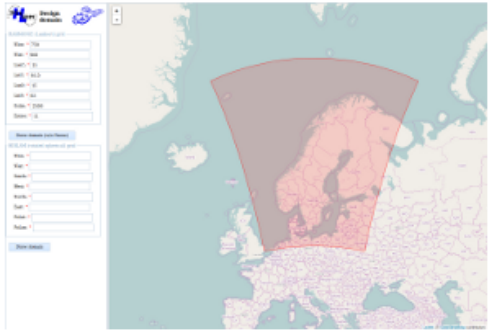
Domain creation tool

To help with the design of a new domain, there is an interactive tool that lets you experiment with the grid parameters described above, and visualize the resulting domain immediately on a map, see figure below.



Domain creation tool

At present, it only works for Lambert projection. Also, the background map projection is spherical mercator, which means that domains look distorted if they go far north (or south).

Creating a new domain

If you are happy with your new domain created with the help of the domain creation tool you can add it to Harmonie_domains.pm for your experiment, my_exp (assuming you have set up the experiment):

```
cd $HOME/hm_home/my_exp
PATH_TO_HARMONIE/config-sh/Harmonie co scr/Harmonie_domains.pm
#
# add domain information for new domain called MYNEWDOM in this file
#
vi scr/Harmonie_domains.pm
#
# set DOMAIN=MYNEWDOM in the experiment config file
#
vi sms/config_exp.h
```

https://hirlam.org/trac/wiki/HarmonieSystemDocumentation/ModelDomain

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There are several levels on configuration available in HARMONIE. The highest level of configuration is done in config_exp.h. It includes the environment variables, which are used to control the experimentation. In the following we describe the meaning of the different variables and are described in the order they appear in config_exp.h.

Host specific paths and environment variables for your system are defined in Env_system. Read more here.

Build options

```
# **** Build and bin paths ****
# Definitions about Build, should fit with hm_rev
BUILD=${BUILD-yes}                    # Turn on or off the compilation and binary build ( yes|no)
```

BUILD is a switch for compiling HARMONIE code (yes|no). The

```
case $MAKEUP in
   no)
                                                # Definitions about gmkpack, should fit with hm_rev
      BUILD_ROOTPACK=${BUILD_ROOTPACK-no}       # Build your own ROOTPACK if it doesn't exists (yes|n
                                                # This may take several hours!
                                                # Make sure you have write permissions in ROOTPACK di
      REVISION=40h1                             # Revision ( or cycle ) number, has to be set even fo
      BRANCH=trunk
      VERSION=01                                # Version of revision/branch to use
      OPTION=x                                  # Which gmkpack/arch/SYSTEM.HOST.OPTION file to use

      # Other things to compile with gmkpack
      OTHER_PROGRAMS="pertcma mten convert_ecoclimap soda pgd blend \
                      odbtools bator ioassign odbsql \
                      blendsur addsurf surfex mandalay \
                      prep lfitools sfxtools pregpssol"
   ;;
   yes)
   ;;
   *)
      echo "MAKEUP not valid or not set, Please set to yes/no in Env_system"
      exit
   ;;
esac
```

There are currently two ways of building the code. The choice is done through the environment variable *MAKEUP* in the config file for your particular system. The ALADIN style ⇨gmkpack or the more make like system Makeup. For makeup there are no explicit settings to be done in the experiment configuration. For gmkpack however there are some options:

- *REVISION* is the revision (or cycle) number, has to be set even for the trunk!
- *BRANCH* sets the rootpack branch
- *VERSION* is the version of revision/branch to use
- *OPTION* sets which gmkpack/arch/SYSTEM.HOST.OPTION file to use
- *OTHER_PROGRAMS* are other optional programs to be compiled with gmkpack
- *BUILD_ROOTPACK* Switch for building the rootpack when running HARMONIE install. Can be useful to turn off for debugging. (yes|no).

In the general config file for your system, like config.ecgb-cca the path to the rootpack of gmkpack is defined as ROOTPACK.

```
BINDIR=${BINDIR-$HM_DATA/bin}                # Binary directory
```

BINDIR is the location of where your HARMONIE binaries will be installed. You can use this to point to binaries outside of your experiment.

https://hirlam.org/trac/wiki/HarmonieSystemDocumentation/ConfigureYourExperiment

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General settings

```
# **** Misc, defined first because it's used later ****

CNMEXP=HARM                              # Four character experiment identifier
WRK=$HM_DATA/$CYCLEDIR                   # Work directory
```

- *CNEXP*: experiment identifier used by MASTERODB
- *WRK* is the work directory. The suggested path on cca is $SCRATCH/hm_home/${EXP}/$CYCLEDIR

Archive settings (ECMWF)

Since $SCRATCH is cleaned regularly on cca and ecgb some files are transferred to ECFS for a more permanent storage by the scripts Archive_host1 and Archive_ecgb.

```
# **** Paths to archive ****
# We need to define ARCHIVE early since it might be used further down

ARSTRATEGY="medium"                      # Archive strategy
                                         # minimum: only logs and vfld file
                                         # medium: main results
                                         # maximum: everything

ARCHIVE_ROOT=$HM_DATA/archive            # Archive root directory
ECFSLOC=ectmp                            # Archiving site at ECMWF-ECFS: "ec" or ECFS-TMP "ectmp"
ECFSGROUP=hirald                         # Group in which to chgrp the ECMWF archive, "default" or "hirald"
EXTRARCH=$ARCHIVE_ROOT/extract           # Archive for fld/obs-extractions
```

- *ARSTRATEGY* Archiving strategy according to the following levels:
  - minimum: only logs and vfld file
  - medium: main results. All files needed to continue your experiment from data on ECFS.
  - maximum: everything
- *ARCHIVE_ROOT* is the path to forecast file archive. **Note that at ECMWF this directory is not a permanent storage**
- *EXTRARCH* is the path to field extraction archive. **Note that at ECMWF this directory is not a permanent storage**
- *ECFSLOC* Archiving site at ECMWF-ECFS (ectmp|ec) **Note that files archived on ectmp will be lost after 90 days.** If you wish your files to stay longer you should set ECFSLOC=ec.
- *ECFSGROUP* Group in which to chgrp the ECMWF archive, (hirald|default)

https://hirlam.org/trac/wiki/HarmonieSystemDocumentation/ConfigureYourExperiment

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Running Mode

```
# **** Running mode ****
RUNNING_MODE=research                  # Research or operational mode (research|operational)
                                       # operational implies that
                                       # - Not STAGE is done for MARS requests
                                       # - No assimilation is done if no obserations are found by Bator

SIMULATION_TYPE=nwp                    # Type of simulation (nwp|climate)
```

- *RUNNING_MODE* can be research or operational. Operational is more forgiving in the error handling and e.g. the assimilation will be skipped if Bator doesn't find any observations. Exceptions handled by the operational mode are written to `$HM_DATA/severe_warnings.txt`
- *SIMULATION_TYPE* Switch between nwp and climate type of simulation. The climate simulations are still in an experimental stage. See HARMONIE-Climate for cy40h for more information

Model domain settings

Horizontal domain settings. Further information is available here: HarmonieSystemDocumentation/ModelDomain

```
# **** Model geometry ****
DOMAIN=DKCOEXP                         # See definitions in scr/Harmonie_domains.pm
TOPO_SOURCE=gmted2010                  # Input source for orography. Available are (gtopo30|gmted2010)
                                       # For usage of gmted2010 check the documentation first
GRID_TYPE=LINEAR                       # Type of grid (LINEAR|QUADRATIC|CUBIC)
```

- *DOMAIN* defines your domain according to the settings in scr/Harmonie_domains.pm (DKCOEXP). The spectral truncation for your domain is determined from NLON and NLAT by scr/Harmonie_domains.pm. Further information on model domains are available in HarmonieSystemDocumentation/ModelDomain
- *TOPO_SOURCE*: Defines input source for model orography (gtopo30|gmted2010). Further information available here: hi-res topography
- *GRID_TYPE*: This variable is used to define the spectral truncation used (LINEAR|QUADRATIC|CUBIC). GRID_TYPE is used in scr/Climate and scr/Forecast

https://hirlam.org/trac/wiki/HarmonieSystemDocumentation/ConfigureYourExperiment

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Vertical levels

Set the number vertical levels to use. Further information is available here: HarmonieSystemDocumentation/VerticalGrid

```
VLEV=65                                 # Vertical level definition.
                                        # HIRLAM_60, MF_60,HIRLAM_40, or
                                        # BOUNDARIES = same number of levs as on boundary file.
                                        # See the other choices from scr/Vertical_levels.pl
```

- *VLEV* is the name of the vertical levels defined in Vertical_levels.pl (65). Further information is available here: Vertical Grid. If you intend to run upper air assimilation you must select the same domain and level definition for which you have derived structure functions. Read more here: Structure Functions

Forecast length

```
HH_LIST="00-21:3"                       # Which cycles to run, replaces FCINT
LL_LIST="12,3"                          # Forecast lengths for the cycles [h], replaces LL, LLMAIN
                                        # The LL_LIST list is wrapped around if necessary, to fit HH_LIST
```

- *HH_LIST*: Cycle interval and step between cycles
- *LL_LIST*: Forecast length of each cycle in HH_LIST. If necessary, LL_LIST list is wrapped around to fit HH_LIST.

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Forecast model

Higher level forecast model settings.

```
# **** High level forecast options ****
NAMELIST_BASE="harmonie"                # Input for namelist generation (harmonie|alaro1)
                                        #   harmonie : The default HARMONIE namelist base nam/harmonie_namelists.pm
                                        #   alaro1   : For ALARO-1 baseline with only a few configurations available
                                        #              nam/alaro1_namelists.pm
DYNAMICS="nh"                           # Hydrostatic or non-hydrostatic dynamics (h|nh)
VERT_DISC=vfd                           # Discretization in the vertical (vfd,vfe)
                                        # Note that vfe does not yet work in non-hydrostatic mode
PHYSICS="arome"                         # Main model physics flag (arome|alaro)
SURFACE="surfex"                        # Surface flag (old_surface|surfex)
DFI="none"                              # Digital filter initialization (idfi|fdfi|none)
                                        # idfi : Incremental dfi
                                        # fdfi : Full dfi
                                        # none : No initialization (AROME case)
LSPBDC=no                               # Spectral boundary contions option off(no) | on(yes)
LGRADSP=yes                             # Apply Wedi/Hortal vorticity dealiasing
LUNBC=yes                               # Apply upper nested boundary condition
```

- *NAMELIST_BASE*: Two different namelist sets are available (harmonie|alaro).
- *DYNAMICS*: Hydrostatic or non-hydrostatic dynamics (h|nh)
- *VERT_DISC*: Vertical discretization (vfd,vfe)
- *PHYSICS*: HARMONIE uses either AROME or ALARO for its forecast model physics (arome|alaro)
- *SURFACE*: Surface physics flag to use either the SURFEX or the ALADIN surface scheme(surfex|old_surface)
- *DFI*: Digital filter initialization switch (idfi|fdfi|none). idfi - incremental dfi, fdfi - full dfi, none - no initialization. See Digital filter for more information
- *LSPBDC*: Specify whether the boundary conditions are spectral or not (yes|no)
- *LGRADSP*: Switch to apply vorticity dealiasing (yes|no)
- *LUNBC*: Switch to apply upper boundary conditions (yes|no)

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Physics

Physics options.

```
# Highlighted physics switches
CISBA="3-L"                          # Type of ISBA scheme in SURFEX. Options: "3-L" and "2-L".
CROUGH="NONE"                        # SSO scheme used in SURFEX "NONE"|"'Z01D'"|"'BE04'"
SURFEX_SEA_ICE="none"                # Treatment of sea ice in surfex (none|sice)
MASS_FLUX_SCHEME=edmfm               # Version of EDMF scheme (edkf|edmfm)
                                     # Only applicable if PHYSICS=arome
                                     # edkf is the AROME-MF version
                                     # edmfm is the KNMI implementation of Eddy Diffusivity Mass Flux scheme for Meso-sca
HARATU="yes"                         # Switch for HARATU turbulence scheme (no|yes)
ALARO_VERSION=0                      # Alaro version (1|0)
```

- *CISBA*: If *SURFACE* is set to surfex this selects the type of ISBA scheme to use in SURFEX. (3-L|2-L). See surfex_namelists.pm for more info.
- *CROUGH*: If *SURFACE* is set to surfex this selects the sub-grid scale orography scheme used in SURFEX. (NONE|Z01D|BE04). See surfex_namelists.pm for more info.
- *SURFEX_SEA_ICE*: Treatment of sea ice in surfex (none|sice). See surfex_namelists.pm for more info.
- *MASS_FLUX_SCHEME*: If *PHYSICS* is set to arome choose the mass flux scheme to be used by AROME; edkf to use the AROME-MF scheme or edmfm to use the KNMI developed scheme
- *HARATU*: Switch to use the *HARATU* turbulence scheme
- *ALARO_VERSION*: If *PHYSICS* is set to alaro select version of ALARO to use (0|1)

https://hirlam.org/trac/wiki/HarmonieSystemDocumentation/ConfigureYourExperiment

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Assimilation

Data assimilation settings. More assimilation related settings, in particular what observations to assimilate, can be found in include.ass

```
# **** Assimilation ****
ANAATMO=3DVAR                          # Atmospheric analysis (3DVAR|4DVAR|blending|none)
ANASURF=CANARI_OI_MAIN                 # Surface analysis (CANARI|CANARI_OI_MAIN|CANARI_EKF_SURFEX|none)
                                       # CANARI           : Old style CANARI
                                       # CANARI_OI_MAIN   : CANARI + SURFEX OI
                                       # CANARI_EKF_SURFEX : CANARI + SURFEX EKF ( experimental )
                                       # none             : No surface assimilation
ANASURF_MODE="before"                  # When ANASURF should be done
                                       # before           : Before ANAATMO
                                       # after            : After ANAATMO
                                       # both             : Before and after ANAATMO (Only for ANAATMO=4DVAR)
INCV="1,1,1,1"                         # Active EKF control variables. 1=WG2 2=WG1 3=TG2 4=TG1
INCO="1,1,0"                           # Active EKF observation types (Element 1=T2m, element 2=RH2m and element 3=Soil moi

MAKEODB2=no                            # Conversion of ODB-1 to ODB-2 using odb_migrator

SST=BOUNDARY                           # Which SST fields to be used in surface analysis
                                       # BOUNDARY         : SST interpolated from the boundary file. ECMWF boundaries util
                                       #                    HIRLAM and HARMONIE boundaries applies T0M which should be SST
LSMIXBC=no                             # Spectral mixing of LBC0 file before assimilation
[ "$ANAATMO" = 3DVAR ] && LSMIXBC=yes
JB_INTERPOL=no                         # Interpolation of structure functions from a pre-defined domain to your domain
```

- *ANAATMO*: Atmospheric analysis (3DVAR|4DVAR|blending|none)
- *ANASURF*: Surface analysis (CANARI|CANARI_OI_MAIN|CANARI_EKF_SURFEX|none). See surfex_namelists.pm for more info.
- *ANASURF_MODE*:When the surface should be called (before|after|both)
- *INCV*: Active EKF control variables. 1=WG2 2=WG1 3=TG2 4=TG1 (0|1)
- *INCO*: Active EKF observation types (Element 1=T2m, element 2=RH2m and element 3=Soil moisture) (0|1)
- *MAKEODB2*: Option to convert ODB-1 databases to ODB-2 files for DA monitoring
- *SST*: which sea surface temperature field to use in the surface analysis
- *LSMIXBC* Spectral mixing of LBC0 file before assimilation (no|yes)
- *JB_INTERPOL* Interpolation of structure functions from a pre-defined domain to your domain (no|yes). Note that this has to be used with some caution.

https://hirlam.org/trac/wiki/HarmonieSystemDocumentation/ConfigureYourExperiment

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Observations

```
# **** Observations ****
OBDIR=$HM_DATA/observations             # Observation file directory
RADARDIR=$HM_DATA/radardata             # Radar observation file directory
SINGLEOBS=no                            # Run single obs experiment with observation created by scr/Create_single_obs (no|ye

USE_MSG=no                              # Use MSG data for adjustment of inital profiles, EXPERIMENTAL! (no|yes)
MSG_PATH=$SCRATCH/CLOUDS/               # Location of input MSG FA file, expected name is MSGcloudYYYYMMDDHH
```

- *OBDIR*: Defines the directory that your (BUFR) observation files (obYYYYMMDDHH) are to read from
- *RADARDIR*: Defines the directory that your (OPERA HDF5) radar observation files are to be read from. BALTRAD OPERA HDF5, MF BUFR and LOCAL files are treated in scr/Prepradar
- *SINGLEOBS* Run single obs experiment with synthetic observation created by [source:trunk/harmonie/scr/Create_single_obs scr/Create_single_obs) (no|yes)
- *USE_MSG*: Use MSG data for adjustment of inital profiles, EXPERIMENTAL! (no|yes)
- *MSG_PATH*: Location of input MSG FA file, expected name is MSGcloudYYYYMMDDHH. Note that the pre-processing software to generate input files is not yet included in HARMONIE

https://hirlam.org/trac/wiki/HarmonieSystemDocumentation/ConfigureYourExperiment

HARMONIE-AROME System

You are here for a reason !!!

HARMONIE-AROME System

Data assimilation flow chart

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Boundaries and initial conditions

Settings for generation of lateral boundaries conditions for HARMONIE. Further information is available here:
HarmonieSystemDocumentation/BoundaryFilePreparation

```
# **** Lateral boundary conditions ****
HOST_MODEL="ifs"                        # Host model (ifs|hir|ald|ala|aro)
                                        # ifs : ecmwf data
                                        # hir : hirlam data
                                        # ald : Output from aladin physics
                                        # ala : Output from alaro physics
                                        # aro : Output from arome physics

HOST_SURFEX="no"                        # yes if the host model is run with SURFEX
SURFEX_INPUT_FORMAT=lfi                 # Input format for host model run with surfex (lfi|fa)

NBDMAX=12                               # Number of parallel interpolation tasks
BDLIB=ECMWF                             # Boundary experiment, set:
                                        # ECMWF to use MARS data
                                        # RCRa  to use RCRa data from ECFS
                                        # Other HARMONIE/HIRLAM experiment

BDDIR=$HM_DATA/${BDLIB}/archive/@YYYY@/@MM@/@DD@/@HH@   # Boundary file directory,
                                                        # For more information, read in scr/Boundary_strategy.pl
INT_BDFILE=$WRK/ELSCF${CNMEXP}ALBC@NNN@                 # Interpolated boundary file name and location

BDSTRATEGY=simulate_operational # Which boundary strategy to follow
                                # as defined in scr/Boundary_strategy.pl
                                #
                                # available            : Search for available files in BDDIR, try to keep forecast consistency
                                #                        This is ment to be used operationally
                                # simulate_operational : Mimic the behaviour of the operational runs using ECMWF LBC,
                                #                        i.e. 6 hour old boundaries
                                # same_forecast        : Use all boundaries from the same forecast, start from analysis
                                # analysis_only        : Use only analysises as boundaries
                                # era                  : As for analysis_only but using ERA interim data
                                # latest               : Use the latest possible boundary with the shortest forecast length
                                # RCR_operational      : Mimic the behaviour of the RCR runs, ie
                                #                        12h old boundaries at 00 and 12 and
                                #                        06h old boundaries at 06 and 18
                                # enda                 : use ECMWF ENDA data for running ensemble data assimilation
                                #                        or generation of background statistic.
                                #                        Note that only LL up to 9h is supported
                                #                        with this you should set your ENSMSEL members
                                # eps_ec               : ECMWF EPS members (on reduced gaussian grid)
                                #                      : Only meaningful with ENSMSEL non-empty, i.e., ENSSIZE > 0

BDINT=1                         # Boundary interval in hours

SURFEX_PREP="yes"                # Use offline surfex prep facility (Alt. gl + Fullpos + prep )
```

https://hirlam.org/trac/wiki/HarmonieSystemDocumentation/ConfigureYourExperiment

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Ensemble mode settings

```
# *** Ensemble mode general settings. ***
# *** For member specific settings use msms/harmonie.pm ***
ENSMSEL=                              # Ensemble member selection, comma separated list, and/or range(s):
                                      # m1,m2,m3-m4,m5-m6:step    mb-me == mb-me:1 == mb,mb+1,mb+2,...,me
                                      # 0=control. ENSMFIRST, ENSMLAST, ENSSIZE derived automatically from ENSMSEL.
ENSINIPERT=                           # Ensemble perturbation method (bnd). Not yet implemented: etkf, hmsv.
ENSCTL=                               # Which member is my control member? Needed for ENSINIPERT=bnd. See harmonie.pm.
ENSBDMBR=                             # Which host member is used for my boundaries? Use harmonie.pm to set.
ENSMFAIL=0                            # Failure tolerance for all members.
ENSMDAFAIL=0                          # Failure tolerance for members doing own DA. Not implemented.
SLAFK=1.0                             # best set in harmonie.pm
SLAFLAG=0                             # --- " ---
SLAFDIFF=0                            # --- " ---

# *** This part is for EDA with observations perturbation
PERTATMO=none                         # ECMAIN  : In-line observation perturbation using the default IFS way.
                                              # CCMA    : Perturbation of the active observations only (CCMA content)
                                              #           before the Minimization, using the PERTCMA executable.
                                              # none    : no perturbation of upper-air observations

PERTSURF=none                         # ECMA    : perturb also the surface observation before Canari (recommended
                                      #         : for EDA to have full perturbation of the initial state).
                                      # model   : perturb surface fields in grid-point space (recursive filter)
                                                  # none    : no perturbation for surface observations.

FESTAT=no                             # Extract differences and do Jb calculations (no|yes)
```

- *ENSMSEL* Ensemble member selection, comma separated list, and/or range(s):

  # m1,m2,m3-m4,m5-m6:step mb-me == mb-me:1 == mb,mb+1,mb+2,...,me # 0=control. ENSMFIRST, ENSMLAST, ENSSIZE derived automatically from ENSMSEL.

- *ENSINIPERT* Ensemble perturbation method (bnd). Not yet implemented: etkf, hmsv, slaf.
- *ENSMFAIL* Failure tolerance for all members. Not yet implemented.
- *ENSMDAFAIL* Failure tolerance for members doing own DA. Not yet implemented.
- *ENSCTL* Which member is my control member? Needed for ENSINIPERT=bnd. See harmonie.pm.
- *ENSBDMBR* Which host member is used for my boundaries? Use harmonie.pm to set.
- *SLAFK* Perturbation coefficients for SLAF, experimental
- *SLAFLAG* Time lag for boundaries in SLAG, experimental

  For member dependent settings see msms/harmonie.pm.

- *PERTATMO* Observation perturbation with three options
  - ECMA: In-line observation perturbation using the default IFS way.
  - CCMA : Perturbation of the active observations only (CCMA content) before the Minimization, using the PERTCMA executable.
  - none : no perturbation of upper-air observations

https://hirlam.org/trac/wiki/HarmonieSystemDocumentation/ConfigureYourExperiment

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Climate file settings

Climate file generation settings. Further information is available here: HarmonieSystemDocumentation/ClimateGeneration

```
# **** Climate files ****
CREATE_CLIMATE=${CREATE_CLIMATE-yes}    # Run climate generation (yes|no)
CLIMDIR=$HM_DATA/climate                # Climate files directory
BDCLIM=$HM_DATA/${BDLIB}/climate        # Boundary climate files (ald2ald,ald2aro)
                                        # This should point to intermediate aladin
                                        # climate file in case of hir2aro,ifs2aro processes.

# Physiography input for SURFEX
ECOCLIMAP_VERSION=2.2                   # Version of ECOCLIMAP for surfex (1,2)
                                        # Available versions are 1.1-1.5,2.0-2.2
SOIL_TEXTURE_VERSION=FAO                # Soil texture input data FAO|HWSD_v2
```

- *CREATE_CLIMATE*: Run climate generation (yes|no). If you already have a full set of climate files generated in CLIMDIR you can set this flag to no for a faster run.
- *CLIMDIR*: path to the generated climate files for your specific domain. The input data for the climate generation is defined by HM_CLDATA defined in Env_system -> config-sh/config.YOURHOST
- *BDCLIM*: path to intermediate climate files
- *ECOCLIMAP_VERSION* is the version of ECOCLIMAP to be used with SURFEX. Available versions are 1.1-1.5,2.0,2.1,2.2. See surfex_namelists.pm for more info.
- *SOIL_TEXTURE_VERSION* Soil texture input data (FAO|HWSD_v2). See surfex_namelists.pm for more info.

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Forecast output

```
# **** Archiving settings ****
TFLAG="h"                                 # Time flag for model output. (h|min)
                                          # h   = hour based output
                                          # min = minute based output

[ "$TFLAG" = "min" ] && GRIB_TIME_UNIT=13  # GRIB_TIME_UNIT=0 1 min time unit
                                           # GRIB_TIME_UNIT=1 hourly time unit (default)
                                           # GRIB_TIME_UNIT=13 15 min time unit
                                           # GRIB_TIME_UNIT=14 30 min time unit
                                           # see scr/Makegrib

# The content of HWRITUPTIMES, VERITIMES, SWRITUPTIMES, PWRITUPTIMES should be:
#   - hours   if TFLAG="h"
#   - minutes if TFLAG="min"

# Writeup times of # history,surfex and fullpos files
# Comma separated list, and/or range(s):
# t1,t2,t3-t4,t5-t6:step    tb-te == tb-te:1 == tb,tb+1,tb+2,...,te

if [ -z "$ENSMSEL" ] ; then
  HWRITUPTIMES="00-21:3,24-60:6"          # History file output times
  VERITIMES="00-60:1"                     # Verification output times, may change PWRITUPTIMES
  SWRITUPTIMES="00-06:3"                  # Surfex ouput times
  PWRITUPTIMES="00-60:3"                  # Postprocessing times
else
  # EPS settings
  HH_LIST="00-18:6"                       # Which cycles to run, replaces FCINT
  LL_LIST="36"                            # Forecast lengths for the cycles [h], replaces LL, LLMAIN
  HWRITUPTIMES="00-06:3"                  # History file output times
  VERITIMES="00-60:3"                     # Verification output times, may change PWRITUPTIMES
  SWRITUPTIMES="00-06:3"                  # Surfex ouput times
  PWRITUPTIMES="00-60:3"                  # Postprocessing times
fi
```

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```
SURFEX_OUTPUT_FORMAT=fa                 # Output format for surfex (fa|lfi)
SURFEX_LSELECT="yes"                    # Only write selected fields in surfex outpute files. (yes|no)
                                        # Check nam/surfex_selected_output.pm for details.
                                        # Not tested with lfi files.
SURFEX_DUMP_STATE_STEPS=""              # Output steps for which we dump the full surfex model state
                                        # Only meaningful if SURFEX_LSELECT=yes
INT_SINI_FILE=$WRK/SURFXINI.$SURFEX_OUTPUT_FORMAT       # Surfex initial file name and location
ARCHIVE_ECMWF=yes                       # Archive to $ECFSLOC at ECMWF (yes|no)

# **** Postprocessing/output ****
IO_SERVER=no                            # Use IO server (yes|no). Set the number of cores to be used
                                        # in your Env_submit
POSTP="inline"                          # Postprocessing by Fullpos (inline|offline|none).
                                        # See Setup_postp.pl for selection of fields.
                                        # inline: this is run inside of the forecast
                                        # offline: this is run in parallel to the forecast in a separate task


FREQ_RESET=3                            # Reset frequency of max/min values in hours, controls NRAZTS

# **** GRIB ****
CONVERTFA=no                            # Conversion of FA file to grib/nc (yes|no)
ARCHIVE_FORMAT=grib                     # Format of archive files (grib|nc). nc format yet only available in climate mode
RCR_POSTP=no                            # Produce a subset of fields from the history file for RCR monitoring
                                        # Only applicable if ARCHIVE_FORMAT=grib
MAKEGRIB_LISTENERS=1                    # Number of parallel listeners for Makegrib
                                        # Only applicable if ARCHIVE_FORMAT=grib
```

https://hirlam.org/trac/wiki/HarmonieSystemDocumentation/ConfigureYourExperiment

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Verification and monitoring

Online verification

```
# **** Obs verification ****
VERIFY=no                          # Run verification in the experiment (yes|no)
OBSEXTR=bufr                       # Extract observations from BUFR (bufr|vobs|none)
                                   # bufr = create vobs file from BUFR files
                                   # vobs = copy pre-extracted vobs file from VOBSDIR
VOBSDIR=$EXTRARCH                  # Local directory of pre-extracted vobs files
FLDEXTR=yes                        # Extract model data for verification from model files (yes|no)
FLDEXTR_TASKS=1                    # Number of parallel tasks for field extraction
VFLDEXP=$EXP
VER_SDATE=$DTGBEG                  # Start verification date in format ($DTGBEG|YYYYMMDDHH)
                                   # applicable if VERIFY=yes
                                   # applicable if VERIFY=yes
```

- *VERIFY*: Main switch for running verification during the epxeriment. (yes|no) (Experimental)
- *OBSEXTR*: Extract observations for verification from BUFR (yes|no)
- *VOBSDIR*: Local directory of pre-extracted vobs files
- *FLDEXTR* Extract model data for verification from model files (yes|no)
- *FLDEXTR_TASKS*: Number of parallel tasks for field extraction
- *VFLDEXP*:
- *VER_SDATE* Start verification date in format ($DTGBEG|YYYYMMDDHH)

Read more about the verification package here

https://hirlam.org/trac/wiki/HarmonieSystemDocumentation/ConfigureYourExperiment

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Observation monitoring and general diagnostics

```
# *** Observation monitoring ***
OBSMONITOR=obstat:plotlog              # Create Observation statistics plots
                                       # Format: OBSMONITOR=Option1:Option2:...:OptionN
                                       # obstat: Daily usage maps and departures
                                       # plotlog: IFS log statistics
                                       #  - Grid point and spectral norms evolution
                                       #  - Cost function evolution, if applicable
                                       #  - Observation usage from the minimization, if applicable
                                       # no: Nothing at all
                                       #
                                       # The assimilation related monitoring is
                                       # Only active if ANAATMO != none
```

OBSMONITOR Selection for observation statistics plots

- obstat Observations usage. Read more here.
- plotlog IFS log statistics
  - Grid point and spectral norms evolution
  - CPU cost
  - Surface assimilation increments, if applicable
  - Cost function evolution, if applicable
  - Observation usage from the minimization, if applicable
- no No monitoring

Note that this is only active if ANAATMO != none

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Start your experiment

Launch the experiment by giving start time, DTG, end time, DTGEND

```
~hlam/Harmonie start DTG=YYYYMMDDHH DTGEND=YYYYMMDDHH
                                # e.g., ~hlam/Harmonie start DTG=2012122400 DTGEND=2012122406
```

If successful, mini-SMS will identify your experiment name and start building your binaries and run your forecast. If not, you need to examine the mSMS log file $HM_DATA/mSMS.log. $HM_DATA is defined in your Env_system file. At ECMWF `$HM_DATA=$SCRATCH/hm_home/$EXP` where `$EXP` is your experiment name. Read more about where things happen further down.

Continue your experiment

If your experiment have successfully completed and you would like to continue for another period you should write

```
~hlam/Harmonie prod DTGEND=YYYYMMDDHH
```

By using `prod` you tell the system that you are continuing the experiment and using the first guess from the previous cycle. The start date is take from a file progress.log created in your $HOME/hm_home/my_exp directory. If you would have used `start` the initial data would have been interpolated from the boundaries, a cold start in other words.

Making local changes

Very soon you will find that you need to do changes in a script or in the source code. Once you have identified which file to edit you put it into the current $HOME/hm_home/my_exp directory, with exactly the same subdirectory structure as in the reference. e.g, if you want to modify a namelist setting

```
~hlam/Harmonie co nam/harmonie_namelists.pm        # retrieve default namelist harmonie_namelists.pm
vi nam/harmonie_namelists.pm                       # modify the namelist
```

Next time you run your experiment the changed file will be used. You can also make changes in a running experiment. Make the change you wish and rerun the `InitRun` task in the mXCdp window. The InitRun task copies all files from your local experiment directory to your working directory `$HM_DATA`. Once your `InitRun` task is complete your can rerun the task you are interested in. If you wish to recompile something you will also have to rerun the `Build` tasks. Read more about how to control and rerun tasks in mini-SMS from mXCdp here.

https://hirlam.org/trac/wiki/HarmonieSystemDocumentation/Harmonie-mSMS

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Directory structure

ecgb

On ecgb, you can follow the progress of the runs on **$SCRATCH/hm_home/my_exp**

- Working directory for the current cycle under **YYYYMMDD_HH**
- Archived files under are in **$SCRATCH/hm_home/my_exp/archive**
  - A **YYYY/MM/DD/HH** structure for per cycle data is used
  - All logfiles under **archive/log**
- On ecgb log files per task are found under /cca/perm/ms/$COUNTRY/$USER/HARMONIE/my_exp. All logfiles are also gathered in html files named like e.g. HM_Date_YYYYMMDDHH.html which are archived in **$SCRATCH/hm_home/my_exp/archive/log** on ecgb.
- Verification data available on the permanent disk /hpc/perm/$GROUP/$USER/HARMONIE/archive/$EXP/archive/extract
- If you have the verification switched on you will find the working directory in **$SCRATCH/hm_home/$EXP/archive/extract/WebgraF**

cca

More complete results and the main data are available on cca:$SCRATCH/hm_home/my_exp. Under these directories you will find:

- All binaries under **bin**
- IFS libraries, object files and source code under **gmkpack_build** if you build with gmkpack or under **lib/src** if you build with makeup
- Scripts, config files, sms and msms definitions under **lib/**
- Utilities such as gmkpack, gl and the verification package under **lib/util**
- Climate files under **climate**
- Working directory for the current cycle under **YYYYMMDD_HH**
  - If an experiment fails it is useful to check the IFS log file, NODE.001_01, in the working directory of the current cycle ($HM_DATA/YYYYMMDD_HH). The failed job will be in a directory called something like Failed_this_job.
- Archived files under **archive**
  - A **YYYY/MM/DD/HH** structure for per cycle data
    - ICMSHHARM+NNNN and ICMSHHARM+NNNN.sfx are atmospheric and surfex forecast output files
- Verification input data under **extract**. This is also stored on the permanent disk /perm/$GROUP/$USER/HARMONIE/archive/$EXP/archive/extract

https://hirlam.org/trac/wiki/HarmonieSystemDocumentation/Harmonie-mSMS

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ECFS

- Since the disks on cca/ecgb are cleaned regularly we need to store data permanently on ECFS, the EC file system, as well. There are two options for ECFS, ectmp and ec. The latter is a permanent storage and first one is cleaned after 90 days. Which one you use is defined by the ECFSLOC variable. To view your data type e.g.

```
els ectmp:/$USER/harmonie/my_exp
```

- The level of archiving depends on ARSTRATEGY in sms/config_exp.h. The default setting is medium which will give you one**YYYY/MM/DD/HH** structure per cycle data containing:
  - Surface analysis, ICMSHANAL+0000
  - Atmospheric analysis result MXMIN1999+0000
  - Blending between surface/atmospheric analysis and cloud variable from the first guess ANAB1999+0000
  - ICMSHHARM+NNNN and ICMSHHARM+NNNN.sfx are atmospheric and surfex forecast output files
  - PFHARM* files produced by the inline postprocessing
  - Logfiles in a tar file logfiles.tar
  - Observation database and feedback information in odb_stuff.tar.
- Climate files are stored in the **climate** directory
- One directory each for **vfld** and **vobs** data respectively for verification data

https://hirlam.org/trac/wiki/HarmonieSystemDocumentation/Harmonie-mSMS

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Cleanup of old experiments

Once you have complete your experiment you may wish to remove code, scripts and data from the disks. Harmonie provides some simple tools to do this. First check the content of the different disks by

```
Harmonie CleanUp -ALL
```

Once you have convinced yourself that this is OK you can proceed with the removal.

```
Harmonie CleanUp -ALL -go
```

If you would like to exclude the data stored on e.g ECFS (at ECMWF) or in more general terms stored under HM_EXP (as defined in Env_system) you run

```
Harmonie CleanUp -d
```

to list the directories intended for cleaning. Again, convince yourself that this is OK and proceed with the cleaning by

```
Harmonie CleanUp -d -go
```

NOTE that these commands may not work properly in all versions. Do not run the removal before you're sure it's OK

You can always remove the data from ECFS directly by running e.g.

```
erm -R ec:/YOUR_USER/harmonie/EXPERIMENT_NAME
or
erm -R ectmp:/YOUR_USER/harmonie/EXPERIMENT_NAME
```

- For more information about cleaning with Harmonie read here
- For more information about the ECFS commands read here

https://hirlam.org/trac/wiki/HarmonieSystemDocumentation/Harmonie-mSMS

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Climate generation
Initial/boundary data
Observations
Data Assimilation
Digitial Filter Initialization
Forecast Model
Ensemble prediction (HarmonEPS)
Climate simulations (HCLIM)
Single column model (MUSC)

Postprocesing phase

Convert data to GRIB
Postprocessing with FULL-POS
Postprocessing with gl
Postprocessing with gl_grib_api
Postprocessing with xtool
Diagnostics
Obsmon
Calibration

Verification phase

Extract data for verification
Deterministic verification (monitor)
Ensemble verification (HARP)
Multi-model Observation
Verification Intercomparison
Observations monitoring

Scripting

Scripting and Binaries

Scripting, Binaries and external packages

Workflow monitoring

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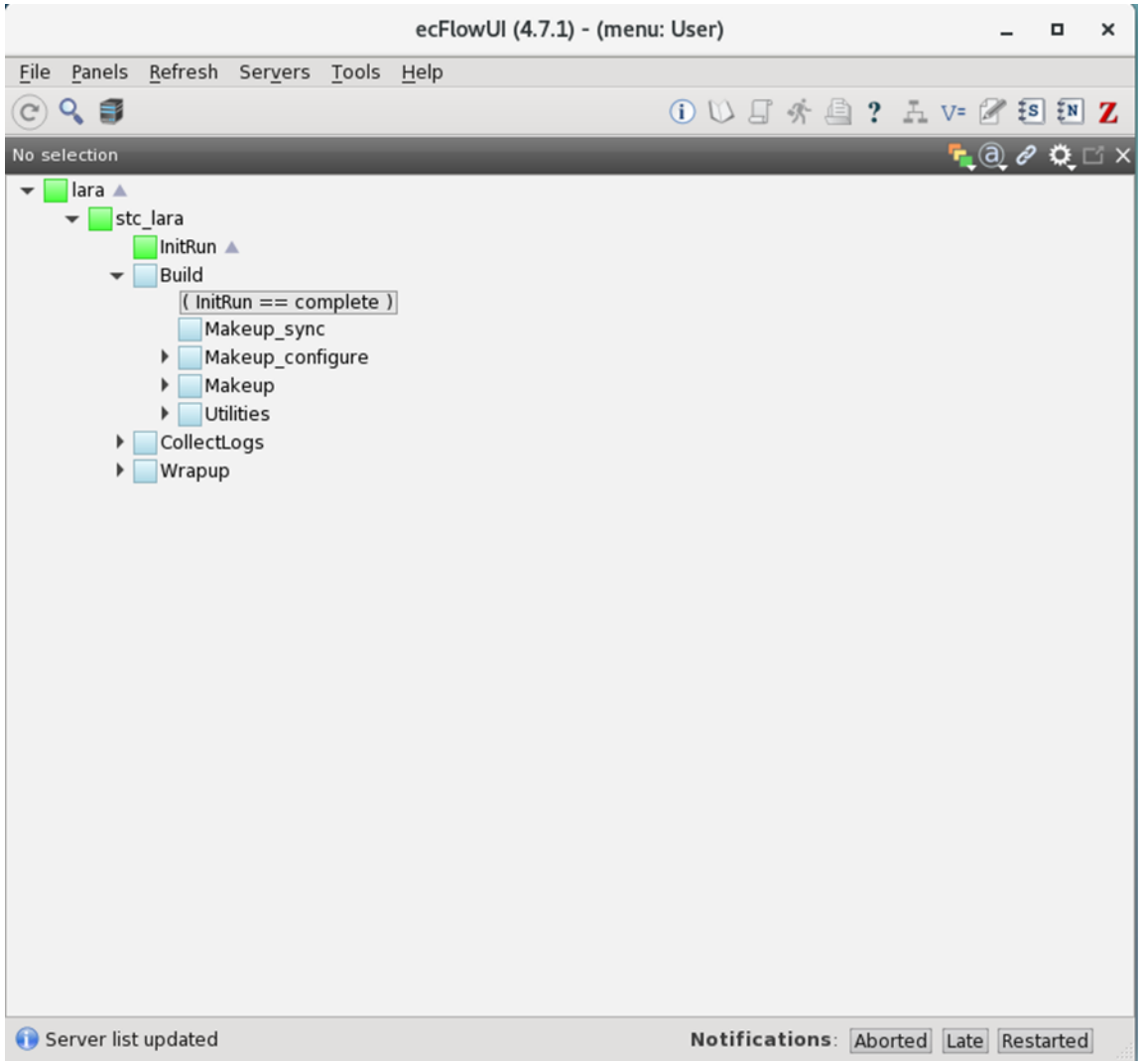
Ensemble prediction (HarmonEPS)
Climate simulations (HCLIM)
Single column model (MUSC)

Scripting and Binaries

Workflow monitoring



HARMONIE-AROME System

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Observations
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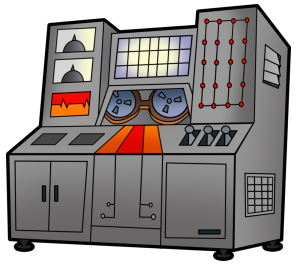
Forecast Model
Ensemble prediction (HarmonEPS)
Climate simulations (HCLIM)
Single column model (MUSC)

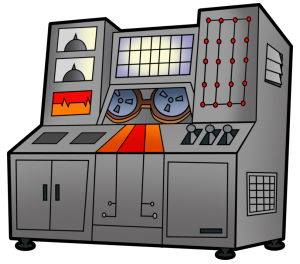
Scripting and Binaries

Workflow monitoring

InitRun



ecgb



cca/ccb

$HOME/hm_home/$EXP

rsyc

$SCRATCH/hm_home/$EXP

rsyc

$SCRATCH/hm_home/$EXP

HARMONIE-AROME System

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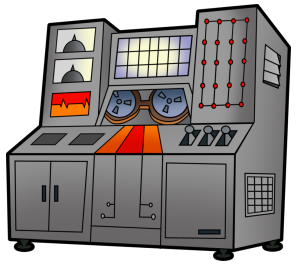
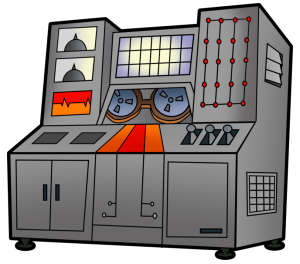


ecgb

CollectLogs

Wrapup



cca/ccb

SBU.log.../scratch/ms/es/sp2b/hm_home/stc16_40h111/

File Edit Search Preferences Shell Macro Windows Help

```
Total SBU for             Date 2014101812:     0.000
Total SBU for  MakeCycleInput 2014101812:     0.255
Total SBU for  Postprocessing 2014101812:     0.177
Total SBU for            Build 2014101812:   193.519
Total SBU for             Date 2014101812: 22224.152
Total SBU for  MakeCycleInput 2014101812:   189.330
Total SBU for  Postprocessing 2014101812:    42.233
```

HARMONIE-AROME System

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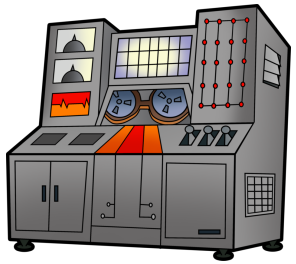
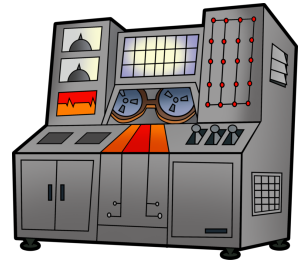


CollectLogs

Wrapup



ecgb

cca/ccb

log files of HARMONIE cycle 2014101812

Files are ordered according to last modification time. Reference to failed jobs (if any) is at the end of this document.

- /hpc/perm/ms/es/sp2b/HARMONIE/stc16_40h111/Date/Hour/Cycle/PostAnalysis/Archive_odb.1
- /hpc/perm/ms/es/sp2b/HARMONIE/stc16_40h111/Date/Hour/Cycle/StartData/FirstGuess.1
- /hpc/perm/ms/es/sp2b/HARMONIE/stc16_40h111/Date/Hour/Cycle/PostAnalysis/Makegrib_an.1
- /hpc/perm/ms/es/sp2b/HARMONIE/stc16_40h111/Date/Hour/Cycle/StartData/Prep_ini_surfex.1
- /hpc/perm/ms/es/sp2b/HARMONIE/stc16_40h111/Date/Hour/Cycle/Forecasting/Listen2Forecast/Process1/Listen2file.1
- /hpc/perm/ms/es/sp2b/HARMONIE/stc16_40h111/Date/Hour/Cycle/Forecasting/Listen2Forecast/Listen.1
- /hpc/perm/ms/es/sp2b/HARMONIE/stc16_40h111/Date/Hour/Cycle/Forecasting/Forecast.1
- /hpc/perm/ms/es/sp2b/HARMONIE/stc16_40h111/Date/Hour/CollectLogs.1

/hpc/perm/ms/es/sp2b/HARMONIE/stc16_40h111/Date/Hour/Cycle/PostAnalysis/Archive_odb.1

```
[profile.ecmwf-INIT] session is -bash on ccappn029 at Fri 20190111_220452 = 1547244292

[profile.ecmwf-INFO] HOME=/home/ms/es/sp2b=/home/ms/es/sp2b

[profile.ecmwf-INFO] PERM=/perm/ms/es/sp2b=/perm/ms/es/sp2b

[profile.ecmwf-INFO] SCRATCH=TEMP=/scratch/ms/es/sp2b=/lus/snx11062/scratch/ms/es/sp2b

[profile.ecmwf-INFO] SCRATCHDIR=TMPDIR=/lus/snx11062/TMP/JTMP/63/sp2b.8554820.ccapar.20190111T214906

## INFO ------------------------------------------------------------------------------
## INFO  This is the ECMWF jobfilter (v3.00)
## INFO  +++ Please report issues to calldesk, cdk@ecmwf.int +++
## INFO  configuration info:
## INFO  /usr/local/apps/pbs_tools/bin/ecqsub: size: 94677, mtime: Wed Jul  5 09:58:42 2017
## INFO  /usr/local/apps/pbs_tools/config/ecqsub.conf (/usr/local/apps/pbs_tools/config/ecqsub.conf): size: 6309, mtime: Mon Sep 18 09:30:40 2017
## INFO  /usr/local/apps/pbs_tools/config/multicomplex.conf (/usr/local/apps/pbs_tools/config/multicomplex.conf): size: 3944, mtime: Fri Feb  9 11:45:17 2018
## INFO  /usr/local/apps/pbs_tools/config/ecqsub_rules.conf (/usr/local/apps/pbs_tools/config/ecqsub_rules.conf): size: 20522, mtime: Tue Dec 11 18:07:36 2018
## INFO  /usr/local/apps/pbs_tools/config/system_sessions.conf (/usr/local/apps/pbs_tools/config/system_sessions.conf): size: 1487, mtime: Wed Jan  9 12:51:50 2019
## INFO  system logfile is: /usr/local/apps/pbs_tools/logs/ecqsub.log.20190111
## INFO ------------------------------------------------------------------------------
## INFO
## INFO Time at submit: Fri Jan 11 21:49:05 2019 (1547243345.99) on cca-il1:/home/ms/es/sp2b
## INFO invoked as: '/opt/pbs/13.0.403.161593/bin/qsub' '-'
## INFO IN: #PBS -q ns
## INFO IN: #PBS -j oe
## INFO IN: #PBS -N Archive_odb
```

HARMONIE-AROME System

Runtime phase

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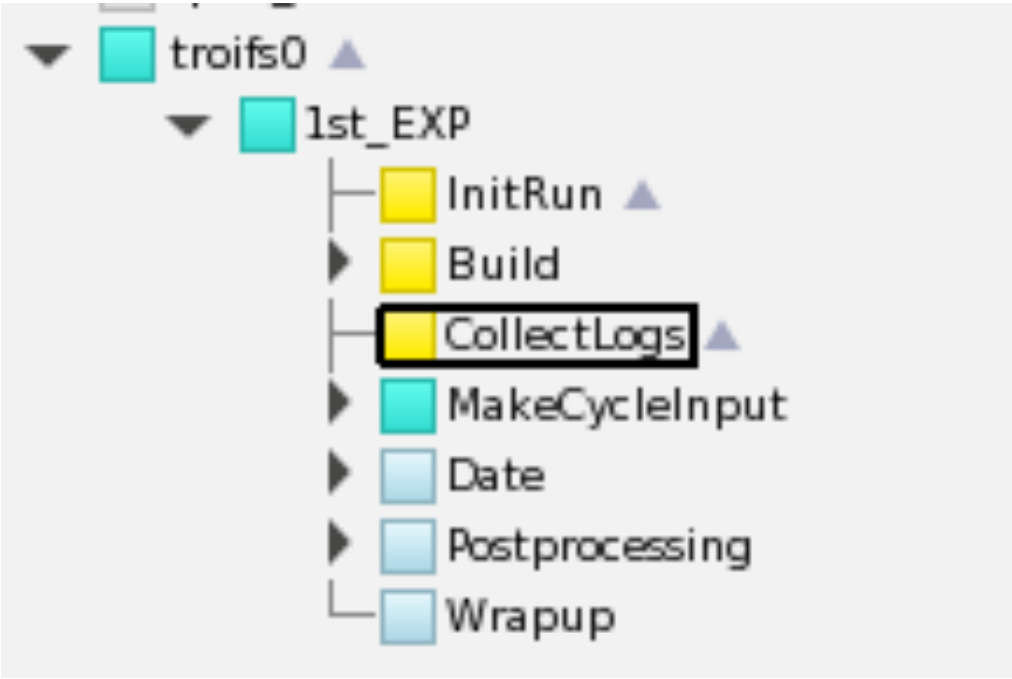

Scripting and Binaries

Workflow monitoring

HARMONIE-AROME System

Runtime phase

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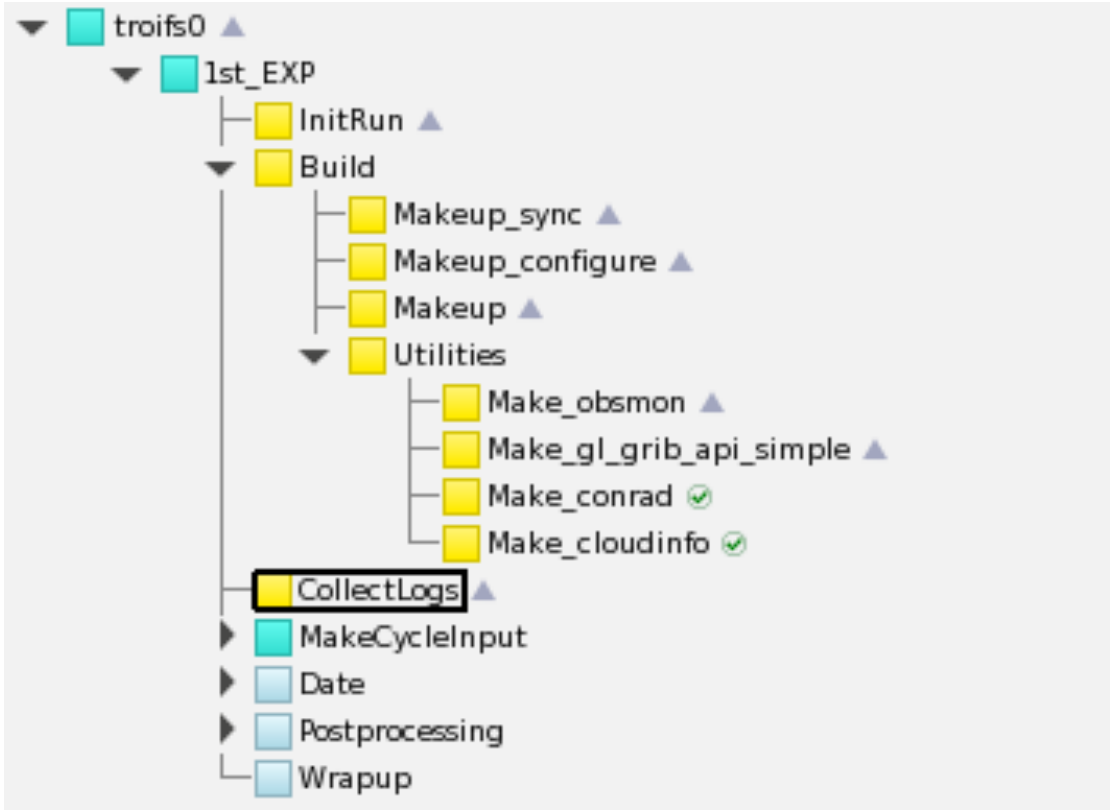

Scripting and Binaries

Workflow monitoring

HARMONIE-AROME System

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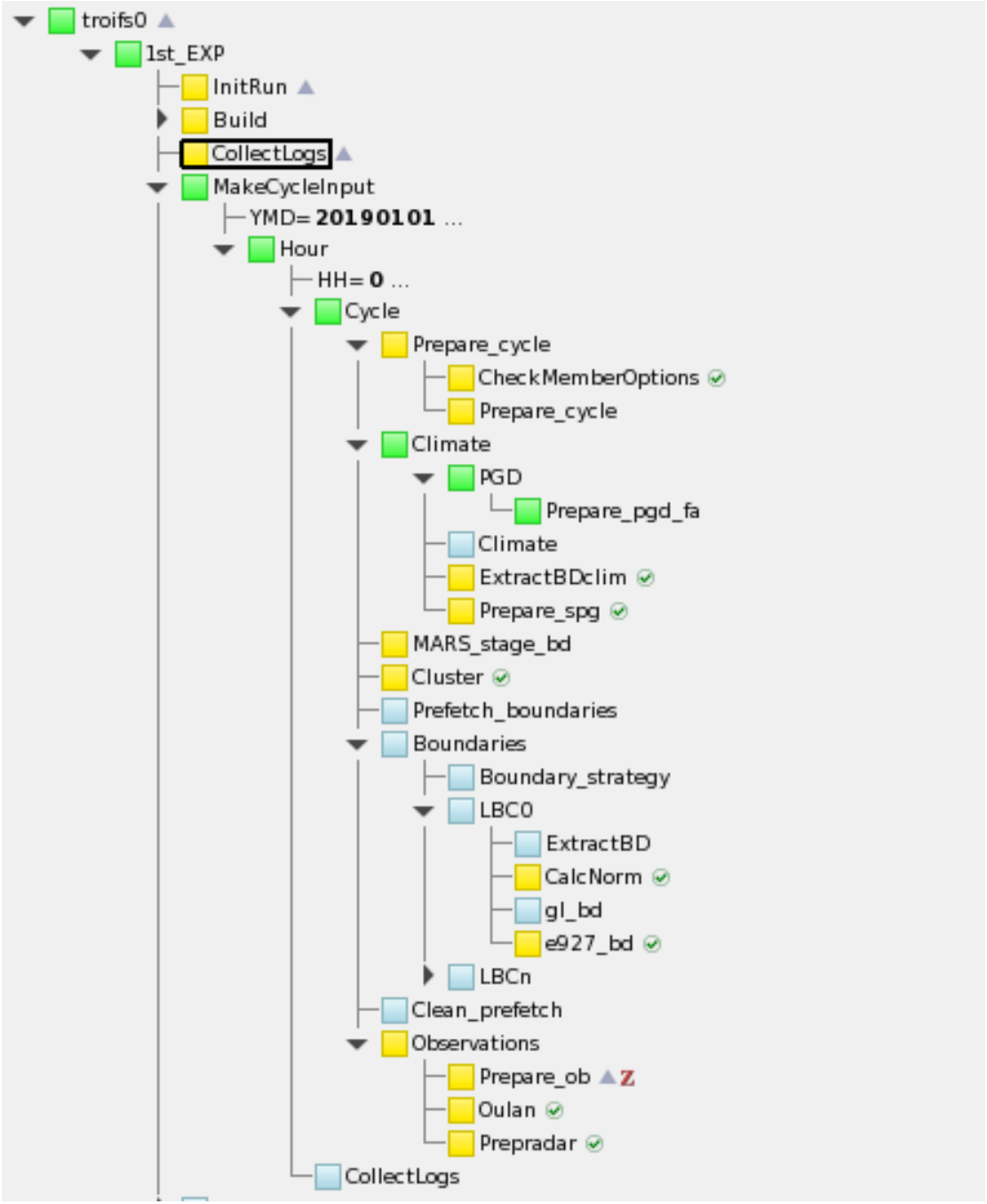
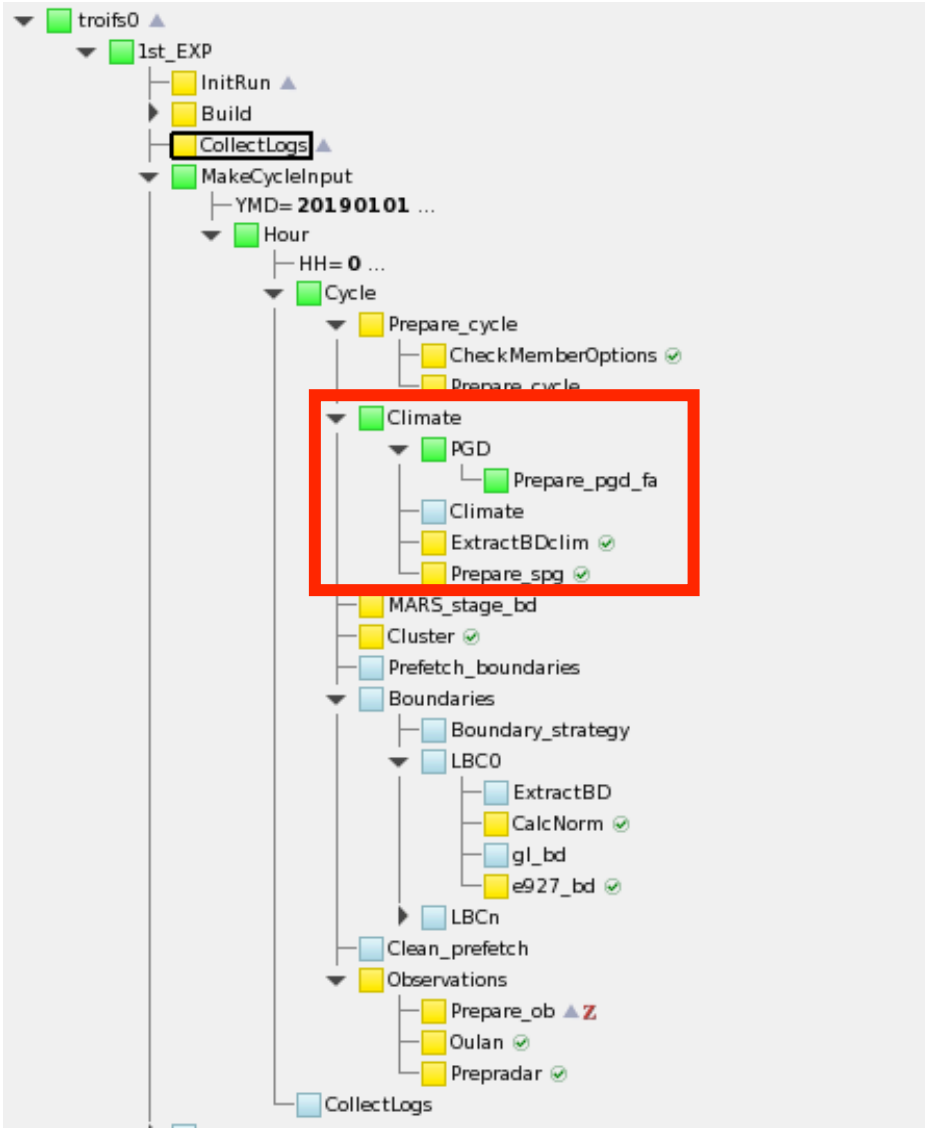
Scripting and Binaries

Workflow monitoring



HARMONIE-AROME System

Runtime phase



Climate

The generation of climate files includes two parts. The first part is the generation of climate files for the atmospheric model, the so called e923 configuration. The second part is the generation of the physiography information for SURFEX. In the following we describe how it is implemented in HARMONIE.

Input data for climate generation

The location of your input data for the climate generation is defined by the **HM_CLDATA** environment variable defined in the config.yourhost file. At ECMWF the climate data is stored on cca here: `cca:/ms_perm/hirlam/harmonie_climate`

Information on what data to download is available here: HarmonieSystemDocumentation. The input data contains physiography data, topography information and climatological values determined from a one year ARPEGE assimilation experiment with a resolution of T79.

Preparation of SURFEX physiography file

At present the most applied configuration is to run with SURFEX as the surface scheme. SURFEX needs information about the distribution of different available tiles like nature, sea, water and town. The nature tile also needs information about type of vegetation and soiltypes. The main input sources for this are found at SURFEX physiographic maps.

The data base for SURFEX-file preparation is located under HM_CLDATA/PGD

- ecoclimats_v2.* : Landtypes
- gtopo30.* : Topography
- sand_fao.* : Soil type distribution
- clay_fao.* : Soil type distribution

The generation of SURFEX physiography file (**PGD.lfi**) is done in Prepare_pgd. The script creates the namelist OPTIONS.nam based on the *DOMAIN* settings in Harmonie_domains.pm. Note that the SURFEX domain is only created over the C+I area. In the namelist we set which scheme that should be activated for each tile.

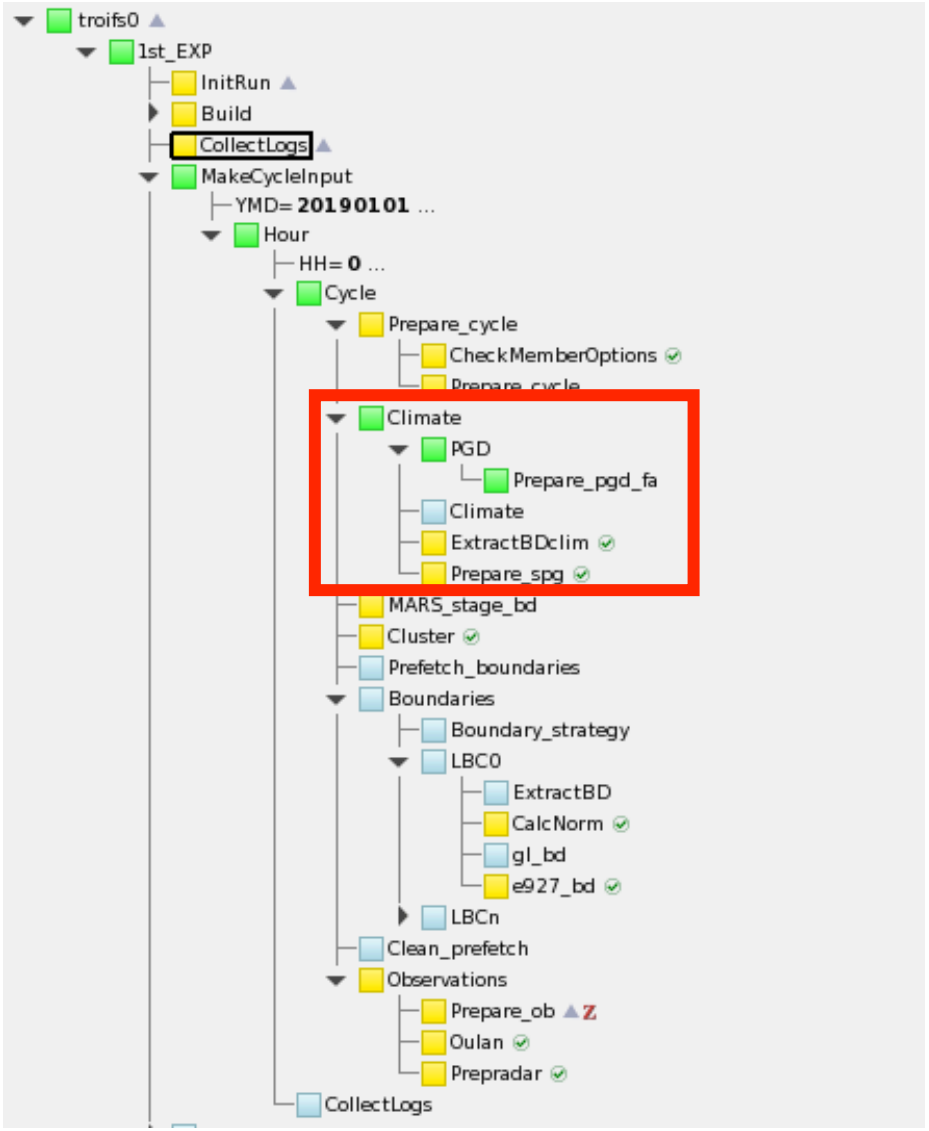
	Tile			
PHYSICS	Nature	Sea	Water	Town
AROME	ISBA	SEAFLX	WATFLX	TEB
ALARO	ISBA	SEAFLX	WATFLX	Town as rock

The program PGD produces one SURFEX physiography file (**PGD.lfi**), which is stored in *CLIMDIR* directory.

To make sure we have the same topography input for the atmospheric part we call Prepare_pgd two times. One time to produce a PGD.lfi for SURFEX and a second time to produce a PGD.fa file that can be used as input for the climate generation described below. Note that for the atmosphere the topography will be spectrally filtered and the resulting topography will be imposed on SURFEX again.

HARMONIE-AROME System

Runtime phase



Generation of a non SURFEX climate file

Climate is a script, which prepares climate file(s) for prefered forecast range. Climate files are produced for past, present and following month. The outline of **Climate** is as follows:

- Check if climate files already exists.
- Creation of namelists. The definition of domain and truncation values is taken from Harmonie_domains.pm.
- Part 0: Read the PGD.fa file generated by SURFEX and write it to Neworog
- Part 1: Filter Neworog to target grid with spectral smoothing to remove 2dx waves.
- Part 2: generation of surface, soil and vegetation variables, without annual variation.
- Part 3: creation of monthly climatological values and modification of albedo and emissivity according to the climatology of sea-ice limit.
- Part 4: definition and modification of the vegetation and surface characteristics
- Part 5: modification of fields created by step 2 and 4 over land from high resolution datasets (for each month)
- Part 6: modification of climatological values

The result is climate files for the previous, current and next month. The files are named after their month like **m01**, **m02** - **m12** and stored in *CLIMDIR*.

Further reference ⇨e923

HARMONIE-AROME System

Runtime phase

Boundary strategies

There are a number of ways to chose which forecast lengths you use as boundaries. The strategy is determined by BDSTRATEGY in sms/config_exp.h and there are a number of strategies implemented.

- available : Search for available files in BDDIR adn try to keep forecast consistency. This is ment to be used operationally since it will at least keep your run going, but with old boundaries, if no new boundaries are available.

- simulate_operational : Mimic the behaviour of the operational runs using ECMWF 6h old boundaries.
- same_forecast : Use all boundaries from the same forecast, start from analysis
- analysis_only : Use only analyses as boundaries. Note that BDINT cannot be shorter than the frequency of the analyses.
- latest : Use the latest possible boundary with the shortest forecast length
- RCR_operational : Mimic the behaviour of the RCR runs, ie
  - 12h old boundaries at 00 and 12 and
  - 06h old boundaries at 06 and 18
- jb_ensemble : Same as same_forecast but used for JB-statistics generation. With this you should export JB_ENS_MEMBER=some_number
- eps_ec : ECMWF EPS members (on reduced Gaussian grid). It is only meaningful with ENSMSEL non-empty, i.e., ENSSIZE > 0

HARMONIE-AROME System

Runtime phase

- HOST_MODEL : Tells the origin of your boundary data
  - ifs : ecmwf data
  - hir : hirlam data
  - ald : Output from aladin physics, this also covers arpege data after fullpos processing.
  - ala : Output from alaro physics
  - aro : Output from arome physics
- BDINT : Interval of boundaries in hours
- BDLIB : Name of the forcing experiment. Set
  - ECMWF to use MARS data
  - RCRa to use RCRa data from ECFS
  - Other HARMONIE/HIRLAM experiment
- BDDIR : The path to the boundary file. In the default location `BDDIR=$HM_DATA/${BDLIB}/archive/@YYYY@/@MM@/@DD@/@HH@` the file retrieved from e.g. MARS will be stored in a separate directory. On could also consider to configure this so that all the retrieved files are located in your working directory `$WRK` . Locally this points to the directory where you have all your common boundary HIRLAM or ECMWF files.
- INT_BDFILE : is the full path of the interpolated boundary files. The default setting is to let the boundary file be removed by directing it to `$WRK`.
- INT_SINI_FILE : The full path of the initial surfex file.

There are a few optional environment variables that could be used that are not visible in config_exp.h

- EXT_BDDIR : External location of boundary data. If not set rules are depending on HOST_MODEL
- EXT_ACCESS : Method for accessing external data. If not set rules are depending on HOST_MODEL
- BDCYCLE : Assimilation cycle interval of forcing data, default is 6h.

More about this can be bounds in the Boundary_strategy.pl script.

The bdstrategy file is parsed by the script ExtractBD.

- ExtractBD Checks if data are on *BDDIR* otherwise copy from EXT_BDDIR. The operation performed can be different depending on HOST and HOST_MODEL. IFS data at ECMWF are extracted from MARS, RCR data are copied from ECFS.
  - Input parameters: Forecast hour
  - Executables: none.

In case data should be retrieved from MARS there is also a stage step. When calling MARS with the stage command we ask MARS to make sure data are on disk. In HARMONIE we ask for all data for one day of r forecasts (normally four cycles) at the time.

HARMONIE-AROME System

Runtime phase

Using gl

If you use data from HIRLAM or ECMWF gl_grib_api will be called to generate boundaries. The generation can be summarized in the following steps:

- Setup geometry and what kind of fields to read depending on HOST_MODEL
- Read the necessary climate data from a climate file
- Translate and interpolate the surface variables horizontally if the file is to be used as an initial file. All interpolation respects land sea mask properties. The soil water is not interpolated directly but interpolated using the Soil Wetness Index to preserve the properties of the soil between different models. The treatment of the surface fields is only done for the initial file.
- Horizontal interpolation of upper air fields as well as restaggering of winds.
- Vertical interpolation using the same method (etaeta) as in HIRLAM
  - Conserve boundary layer structure
  - Conserve integrated quantities
- Output to an FA file (partly in spectral space)

gl_grib_api is called by the script gl_bd where we make different choices depending on **PHYSICS** and **HOST_MODEL**

When starting a forecast there are options to whether e.g. cloud properties and TKE should be read from the initial/boundary file through *NREQIN* and *NCOUPLING*. At the moment these fields are read from the initial file but not coupled to. gl reads them if they are available in the input files and sets them to zero otherwise. For a Non-Hydrostatic run the non-hydrostatic pressure departure and the vertical divergence are demanded as an initial field. The pressure departure is by definition zero if you start from a non-hydrostatic mode and since the error done when disregarding the vertical divergence is small it is also set to zero in gl. There are also a choice in the forecast model to run with Q in gridpoint or in spectral space.

It's possible to use an input file without e.g. the uppermost levels. By setting `LDEMAND_ALL_LEVELS=.FALSE.` the missing levels will be ignored. This is used at some institutes to reduce the amount of data transferred for the operational runs.

HARMONIE-AROME System

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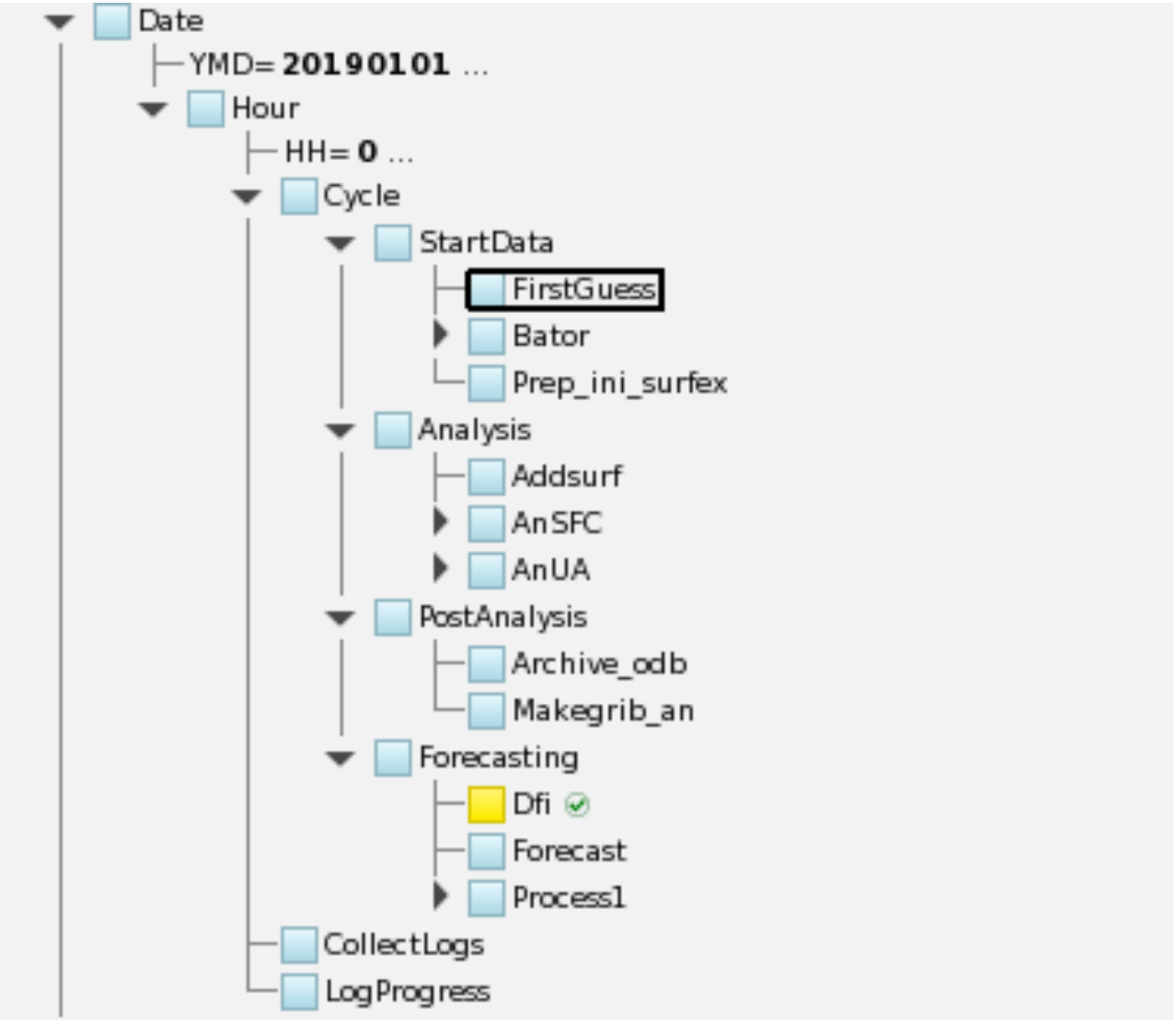
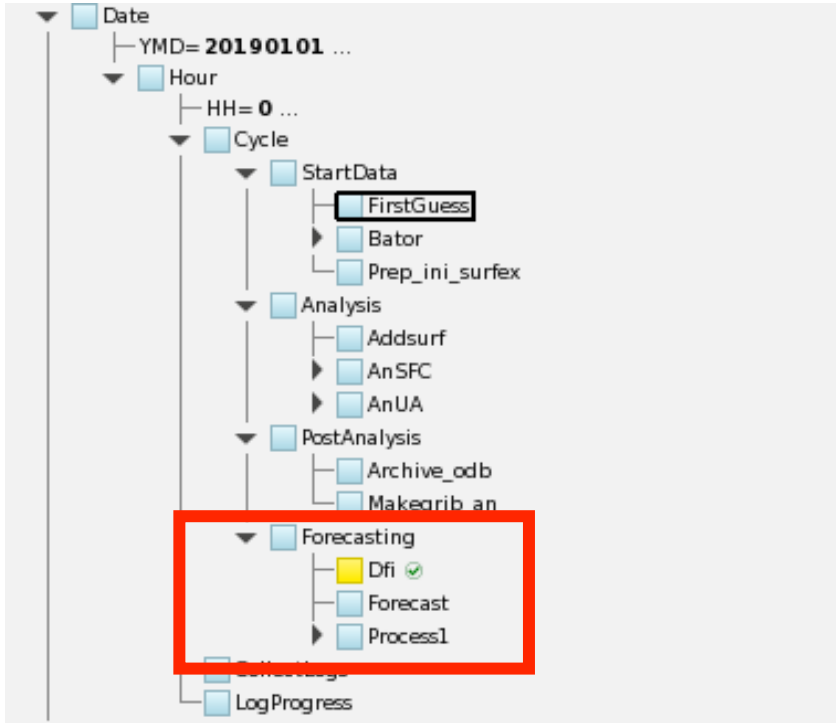
Scripting and Binaries

Workflow monitoring



HARMONIE-AROME System

Runtime phase



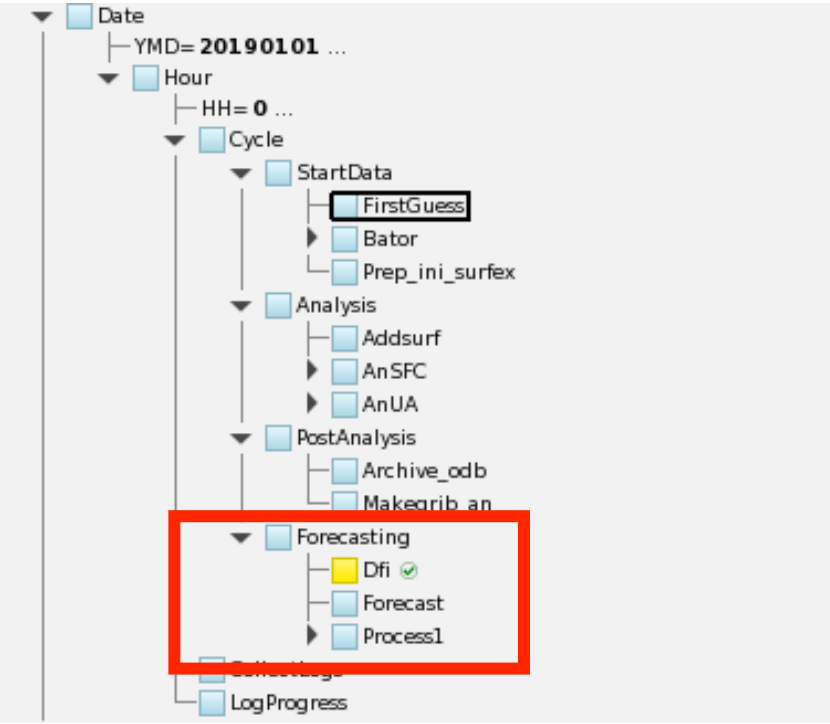
Forecast

Forecast is the script, which initiates actual forecast run (ALADIN/AROME/ALARO depending on *FLAG* and *PHFLAG*).

- Input parameters: none.
- Data: Boundary files (**ELSCF***-files). Initial file (**fc_start**). If data assimilation is used, **fc_start** is the analysis file. In case of dynamical adaptation, **fc_start** is the first boundary file. In case of AROME, Surfex initial file (**SURFXINI.lfi**) is also needed (Prep_ini_surfex).
- Namelists: namelist templates nam/namelist_fcst${FLAG}_default are fetched based on *FLAG* and *PHFLAG*. The templates are completed in Forecast based on the choices of *NPROCX*, *NPROCY* (see submit.ecgb), *TFLAG*, *OUTINT*, *BDINT* and *REDUCELFI*. In case of AROME also the namelists to control SURFEX-scheme (TEST.des and EXSEG1.nam) are needed.
- Executables: as defined by *MODEL*.
- Output: Forecast files (spectral files **ICMSHALAD+***). In case of AROME, Surfex files containing the surface data (**AROMOUT_*.lfi**).

HARMONIE-AROME System

Runtime phase



Forecast namelists

The current switches in the HARMONIE system (in config_exp.h) provide only very limited possibility to control the different aspects of the model. If the user wants to have more detailed control on the specific schemes etc., one has to modify the variety of the namelists options.

In general, the different namelist options are documented in the source code modules (e.g. src/arp/module/*.F90). Below is listed information on some of the choices.

NH-dynamics/advection/time stepping:

- A detailed overview of the such options has been given by Vivoda (2008).

Upper air physics switches

- Switches related to different schemes of ALADIN/ALARO physics, yomphy.F90.
- Switches related to physics schemes in AROME yomarphy.F90.
- Switches to tune different aspects of physics, yomphy0.F90, yomphy1.F90, yomphy2.F90 and yomphy3.F90
- Switches related to HIRLAM physics, yhloption.F90 and suhloption.F90.

Initialization switch

- Initialization is controlled by namelist *NAMINI/NEINI*, yomini.F90.

Horizontal diffusion switches

- Horizontal diffusion is controlled by namelist *NAMDYN/RDAMP**, yomdyn.F90. Larger the coefficient, less diffusion.

MPP switches

- The number of processors in HARMONIE are given in submit.HOST. These values are transfered in to yomct0.F90 and yommp.F90.

Surface SURFEX switches

- The SURFEX scheme is controlled through namelist settings in surfex_namelists.pm. The different options are described here.

Archiving

Archiving has a two layer structure. Firstly, all the needed analysis forecast and field extract files are stored in *ARCHIVE* directory by Archive_fc. This is the place where the postprocessing step expects to find the files.

At ECMWF all the requested files are stored to ECFS into directory *ECFSLOC* by the script Archive_ECMWF

HARMONIE-AROME System

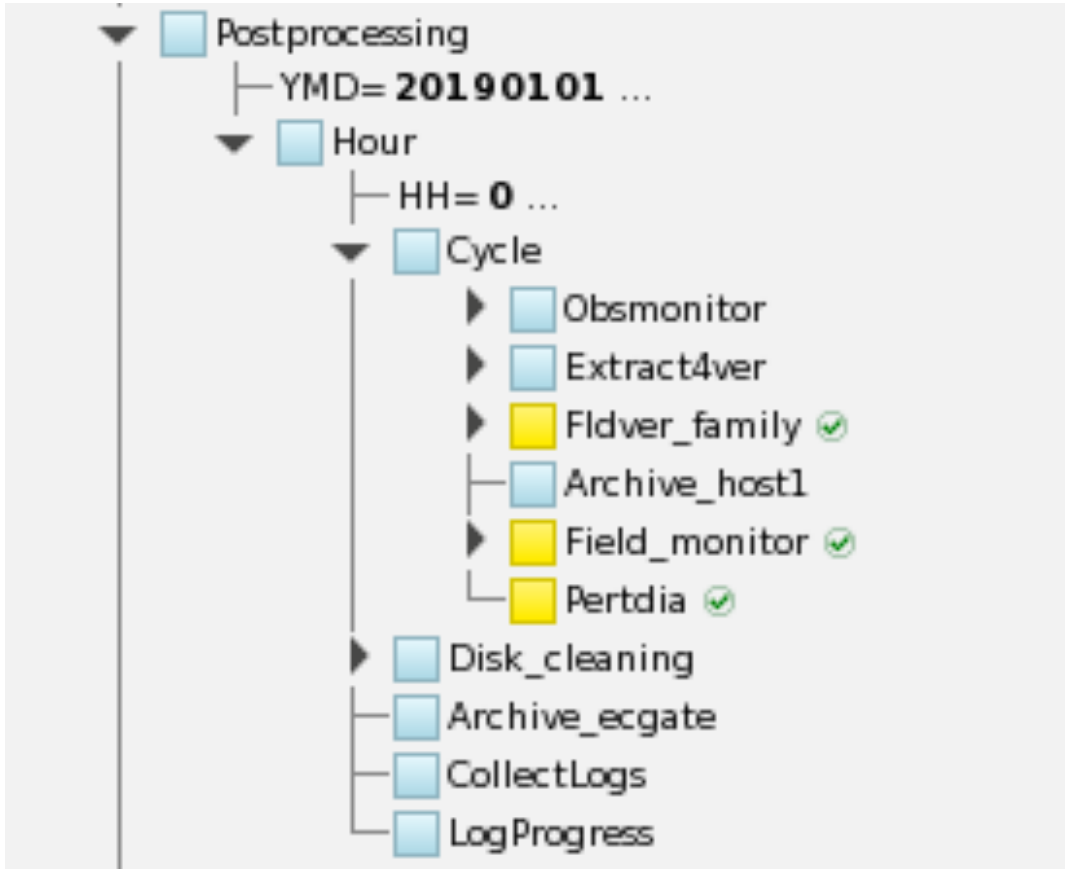
Runtime phase

Postprocesing phase

Convert data to GRIB
Postprocessing with FULL-POS
Postprocessing with gl
Postprocessing with gl_grib_api
Postprocessing with xtool
Diagnostics
Obsmon
Calibration

Verification phase

Extract data for verification
Deterministic verification (monitor)
Ensemble verification (HARP)
Multi-model Observation
Verification Intercomparison
Observations monitoring

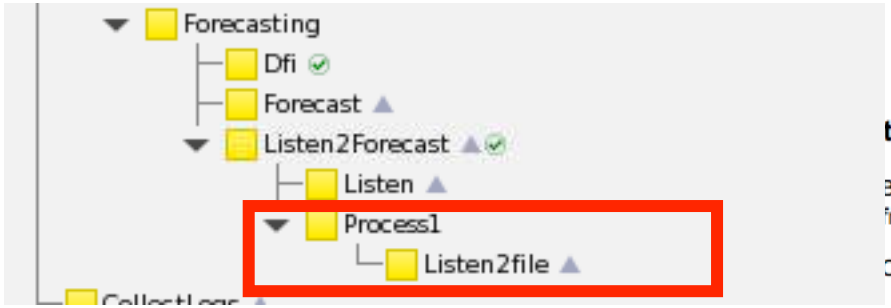


Scripting, Binaries and external packages

Workflow monitoring

HARMONIE-AROME System

Runtime phase



sms/config_exp.h
Details

FA --> GRIB

HIRLAM/HARMONIE users are more used to dealing with the GRIB data. The default HARMONIE output is in FA format. Users have the option to convert HARMONIE FA format files to GRIB1 or NETCDF. Note that the NETCDF conversion is still experimental.

sms/config_exp.h

The option to convert model output to GRIB can be selected in the trunk/harmonie/sms/config_exp.h file:

```
# **** GRIB ****
CONVERTFA=yes                          # Conversion of FA file to grib/nc (yes|no)
ARCHIVE_FORMAT=grib                    # Format of archive files (grib|nc). nc format yet only av
```

tails

By setting ARCHIVE_FORMAT to *grib* the gl tool will be called from the Makegrib_gribex script to convert HARMONIE output from FA to GRIB.

Conversion of FA/lfi files to grib by gl:

```
   gl [-c] [-p] FILE [ -o OUTPUT_FILE ] [ -n NAMELIST_FILE ]

   gl -c FA/LFI-FILE -- converts the full field (including extension zone)
   gl -p FAFILE      -- excludes the extension zone ( "p" as in physical domain only)
```

By default, **Makegrib_gribex** removes the biperiodic zone from FA files and creates GRIB files. HARMONIE data is produced on a Lambert projection. GRIB data can be interpolated onto different projections using gl_grib_api. Further information is available in the gl documentation.

Forecast output is converted from FA to GRIB in Makegrib_gribex using the following command:

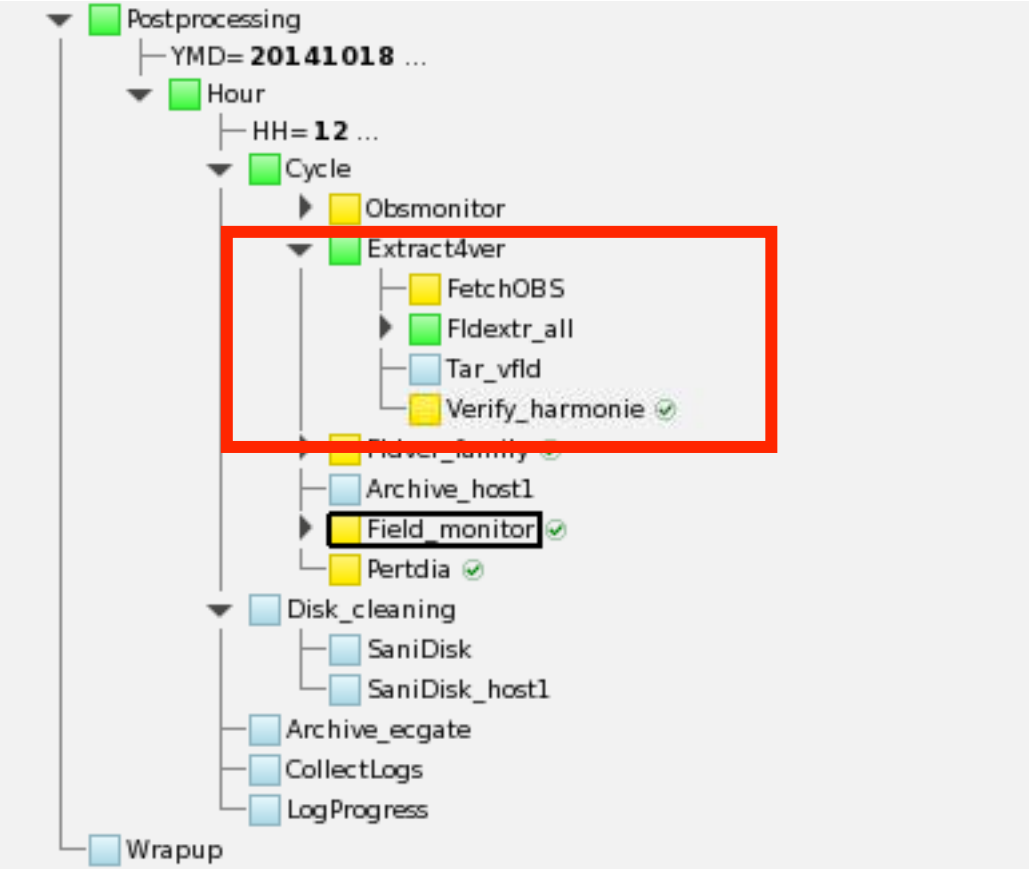
```
$MPPGL $BINDIR/gl -p $1 -o $2 -n namelist_makegrib${MG} || exit
```

where

- $1 is the input HARMONIE FA-file (ICSMHHARM+${ffff}, $ffff is the forecast minute/hour)
- $2 is the output HARMONIE GRIB file (fc${DATE}${HH}+${FF}grib)
- namelist_makegrib${MG} is

HARMONIE-AROME System

Runtime phase



Verification

Before we can run the verification we need to extract data for each geographical point and produce files in a format that the verification program can use. In HARMONIE there are two programs, one fore extracting model data (fldextr_grib_api) and one for observations (obsextr). Both are part of the gl_grib_api package.

fldextr is capable of extracting data from several sources (HARMONIE/HIRLAM/IFS and produces so called vfld-files in ASCII format. The main tasks of the program is to:

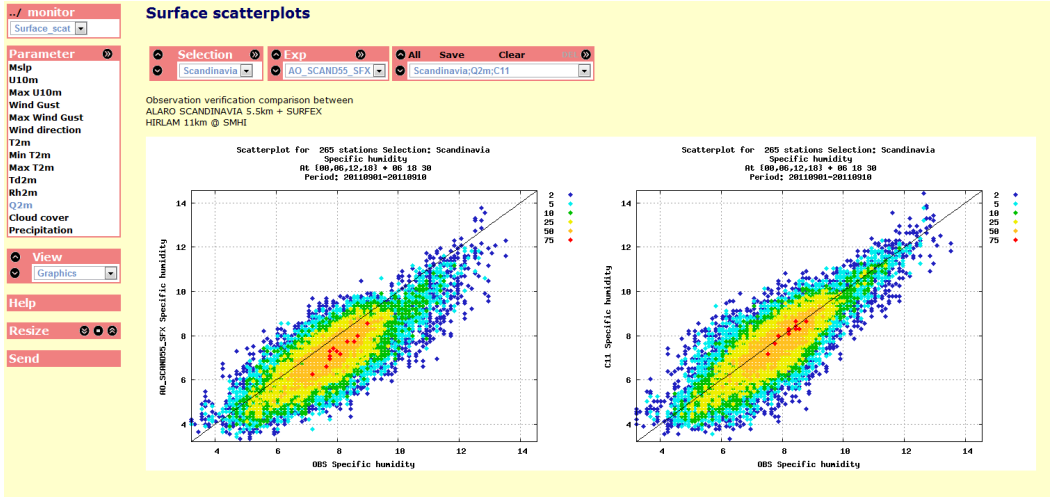
- Recalculates rh,td to be over water
- Interpolates to geographical points according to a synop.list and temp.list
- Does MSLP,RH2M,TD2M calculations if the are not available in the input file
- Optional fraction of land check.
- Interpolates to pressure levels for TEMP data.

obsextr extracts conventional observations from BUFR data and creates a vobs file similar to the vfld file. It:

- Reads SYNOP and TEMP
- LUSE_LIST controls the usage of a station list

HARMONIE-AROME System

Verification Monitor



The verification package in HARMONIE is designed to be a self contained stand alone package dealing with pre-extracted model and observational data. The package calculates several standard verification scores such as:

- Error as function of forecast lead time summarises the bias and rms error and their growth rate over a set of forecasts
- Time sequences and vertical profiles show how your data or error characteristic is distributed in time or in the vertical
- Error charts and tables show how some error is distributed in space, and stationwise linear correlation
- Scatter plots show the correspondence between forecast and observed values
- Mean diurnal cycles show how your mean error changes in the course of the day
- Histograms show the correspondence between the distributions of forecast and observed values
- Student t-test to show how reliable differences between different experiments are

In addition there are a number of scores based on contingency tables like:

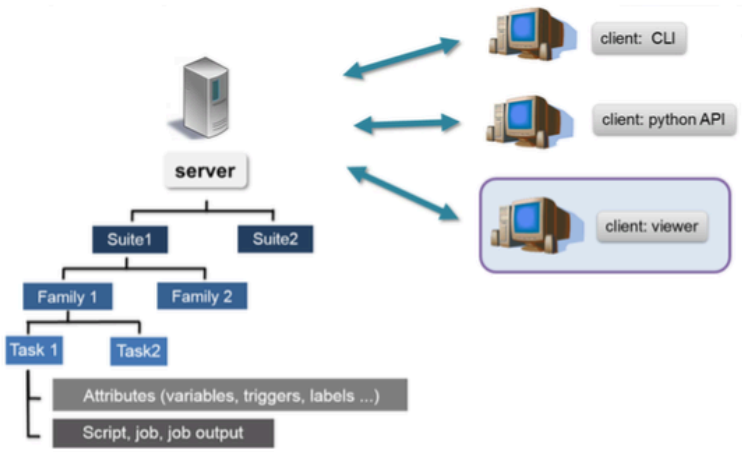
- **Frequency bias (bias score)**: (h+fa)/(h+m); Compares the frequency of predicted events to the frequency of observed events. *Range: 0 -> infinite. Perfect score: 1*
- **Hit rate (probability of detection)**: h/(h+m); What fraction of the observed events were correctly forecast. *Range: 0 to 1. Perfect score: 1.*
- **False alarm ratio**: fa/(h+fa); What fraction of the predicted events did not occur. *Range: 0 to 1. Perfect score: 0.*
- **False alarm rate**: fa/((cn+fa); What fraction of the observed "no" events were incorrectly forecast as "yes". *Range: 0 to 1. Perfect score: 0.*
- **Threat score**: h/(h+m+fa); How well did the forecast "yes" events correspond to the observed "yes" events. *Range: 0 to 1. Perfect scrore: 1.*
- **The Equitable threat score** takes into account the number of random hits (R) and is less sensitive to climatology: ETS=(hR)/(h+m+faR), R=(h+m)(h+fa)/(h+m+fa+cn). Often used in verification of precipitation. *Range: -1/3 to 1, 0 indicates no skill. Perfect score: 1.*
- **HansenKuipers score**: (h/(h+m) fa/(fa+cn)), How well did the forecast separate events from nonevents. *Range: -1 to 1, 0 indicates no skill. Perfect score: 1.*
- **Extreme Dependency Scores**: What is the association between forecast and observed rare events? *Range: -1 to 1, 0 indicates no skill. Perfect score: 1*

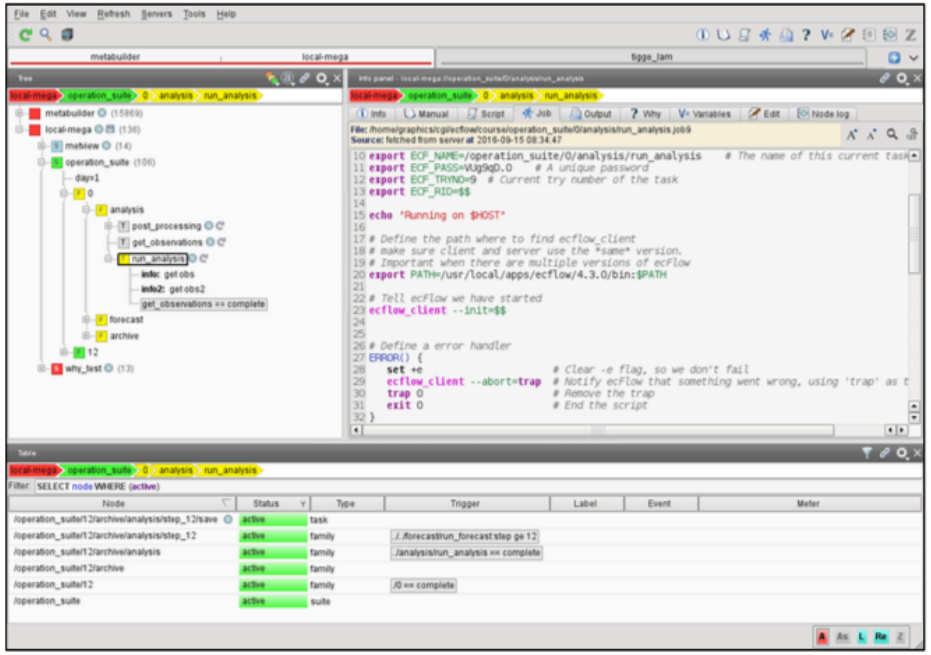
A more detailed explanation about verification can found at http://www.cawcr.gov.au/projects/verification/

ECFLOW and ECFLOW_ui

What is ecFlowUI?

- Graphical user interface to **ecFlow**
- Developed at ECMWF
- Displays and allows interaction with ecFlow suites

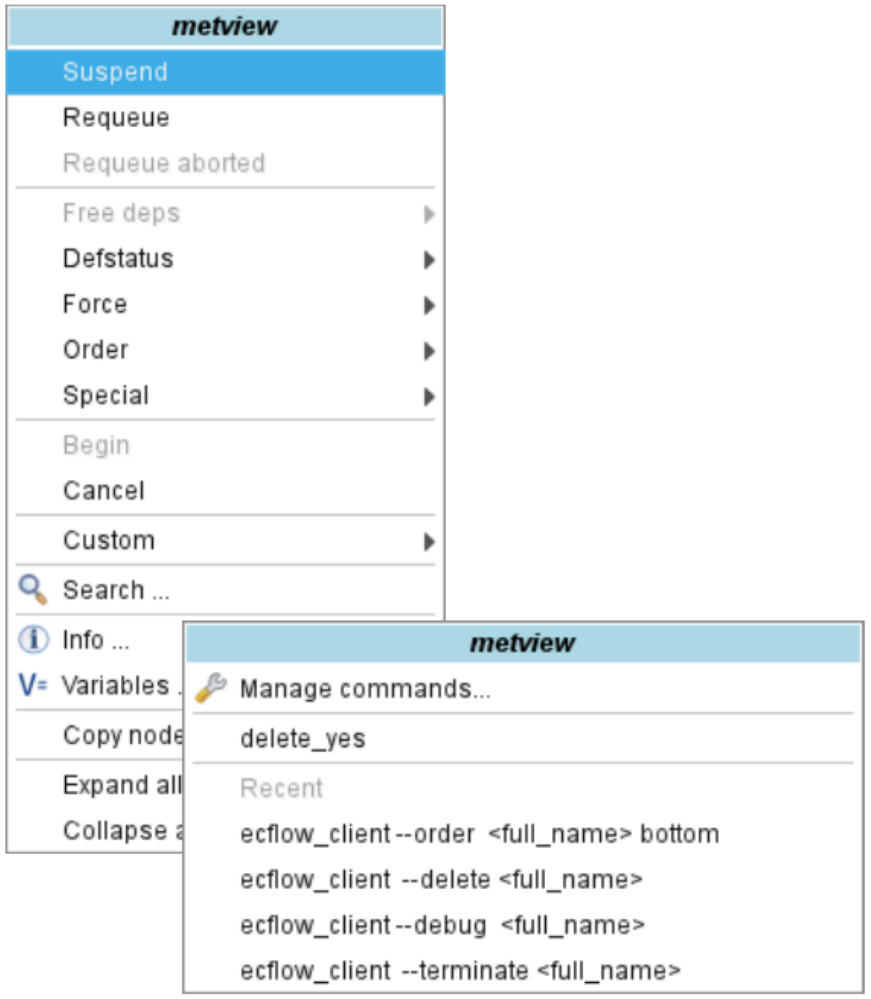




ECFLOW and ECFLOW_ui

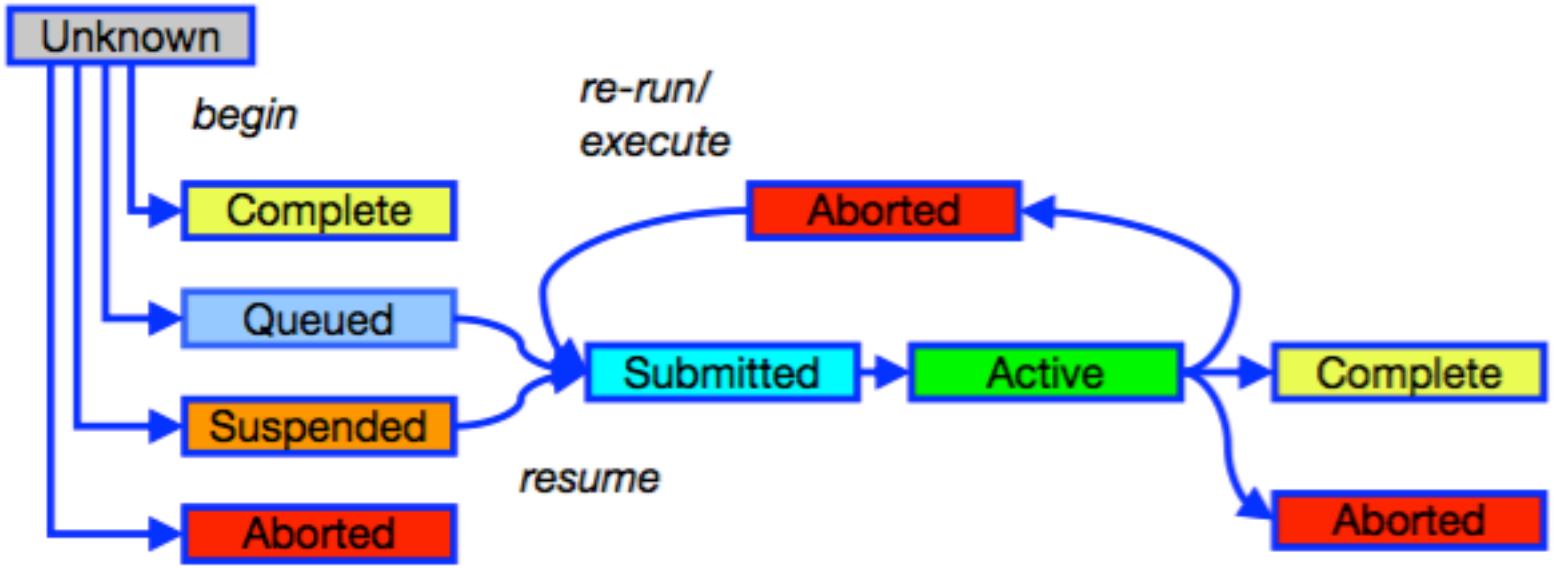
Custom commands

- The node context menu provides node-sensitive commands
- If you know the ecFlow commands, you can add your own
- Context menu -> Custom… -> Manage commands…



ECFLOW and ECFLOW_ui

Important Concepts: Status Flow (2/2)



ECFLOW and ECFLOW_ui

Execute, rerun and requeue

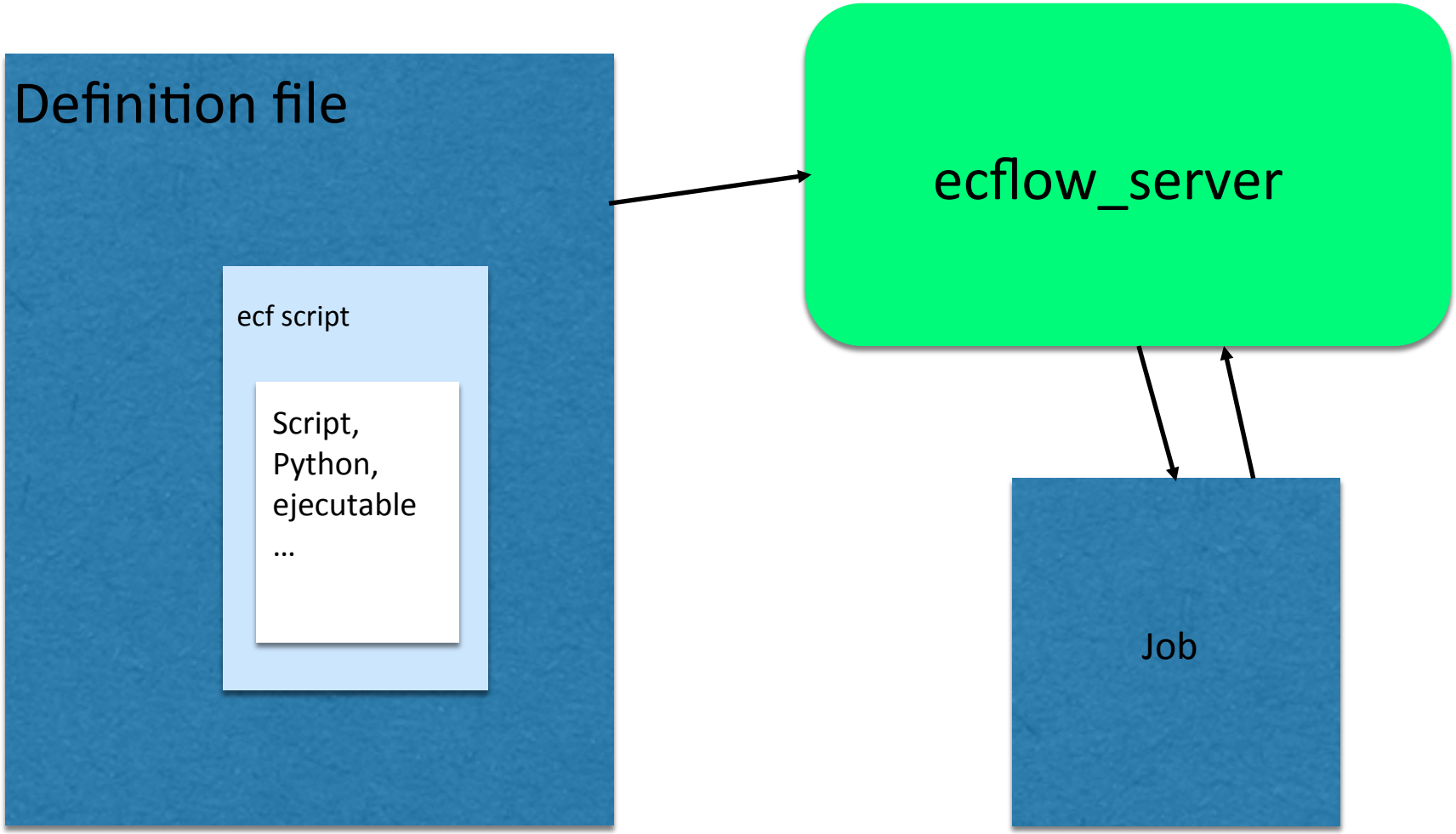
Creado por Avi Bahra, modificado por última vez en dic 06, 2018

In ecflow_ui it is important to understand the distinction between execute, rerun and re-queue.

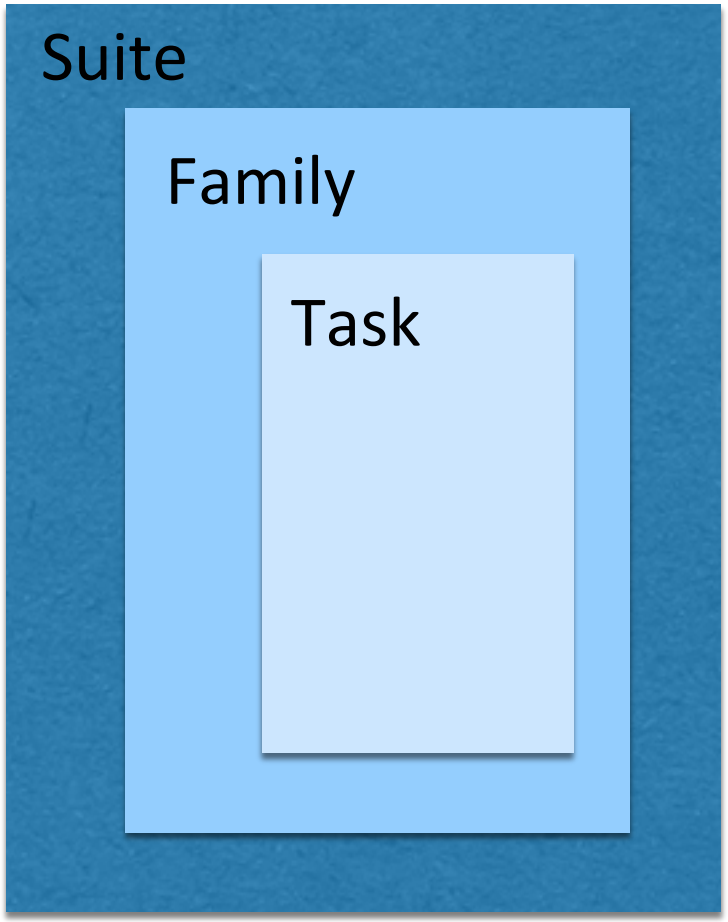
These options are available with the right mouse button over a task.

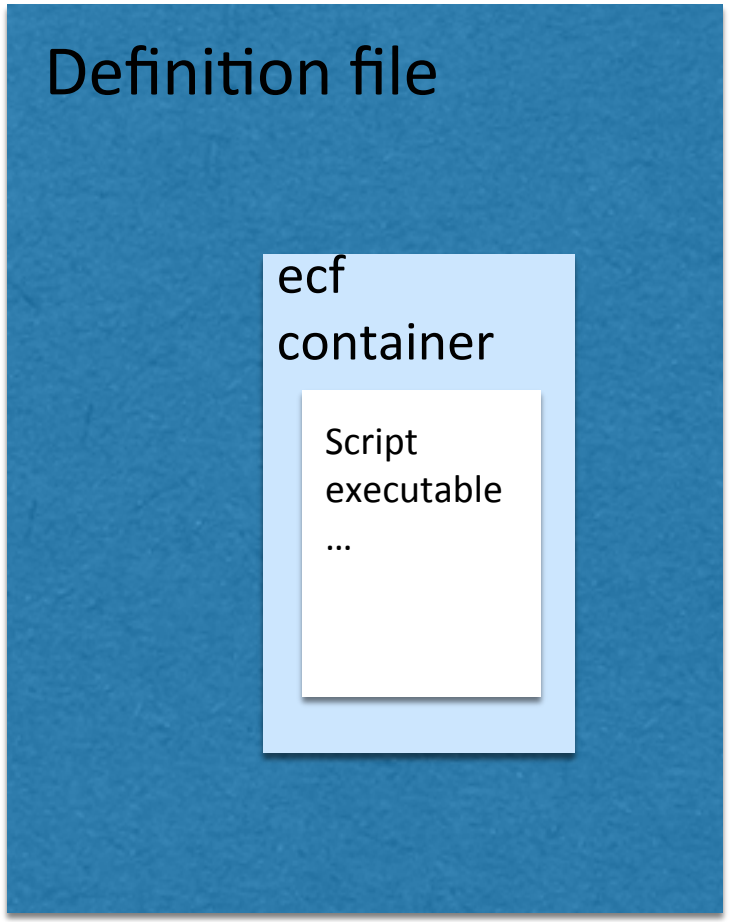
- Execute: This means run the task immediately. (Hence ignores any dependency that hold the task).
  This option preserves the previous output, from the job. You should see output files **t1.1**, **t1.2**, **t1.3**, each time the task is run.
- Rerun: This places the task, back into the queued state.
  The task will now honour any dependencies that would hold the job. i.e. time dependencies, limits, triggers, suspend, etc.
  (You will be introduced to these terms later on in the tutorial)
  If the task does run, the previous output, is preserved.
- Re-queue: This resets the task back to the queued state.
  If the task has a default status, this is applied. The task output number is reset, such that next output will be written to **t1.1**.
  This will **overwrite** any existing output with that extension,when the task runs.
  Any subsequent calls to execute or rerun will now **overwrite** the output files, **t1.2**,**t1.3** etc.

ecFLOW

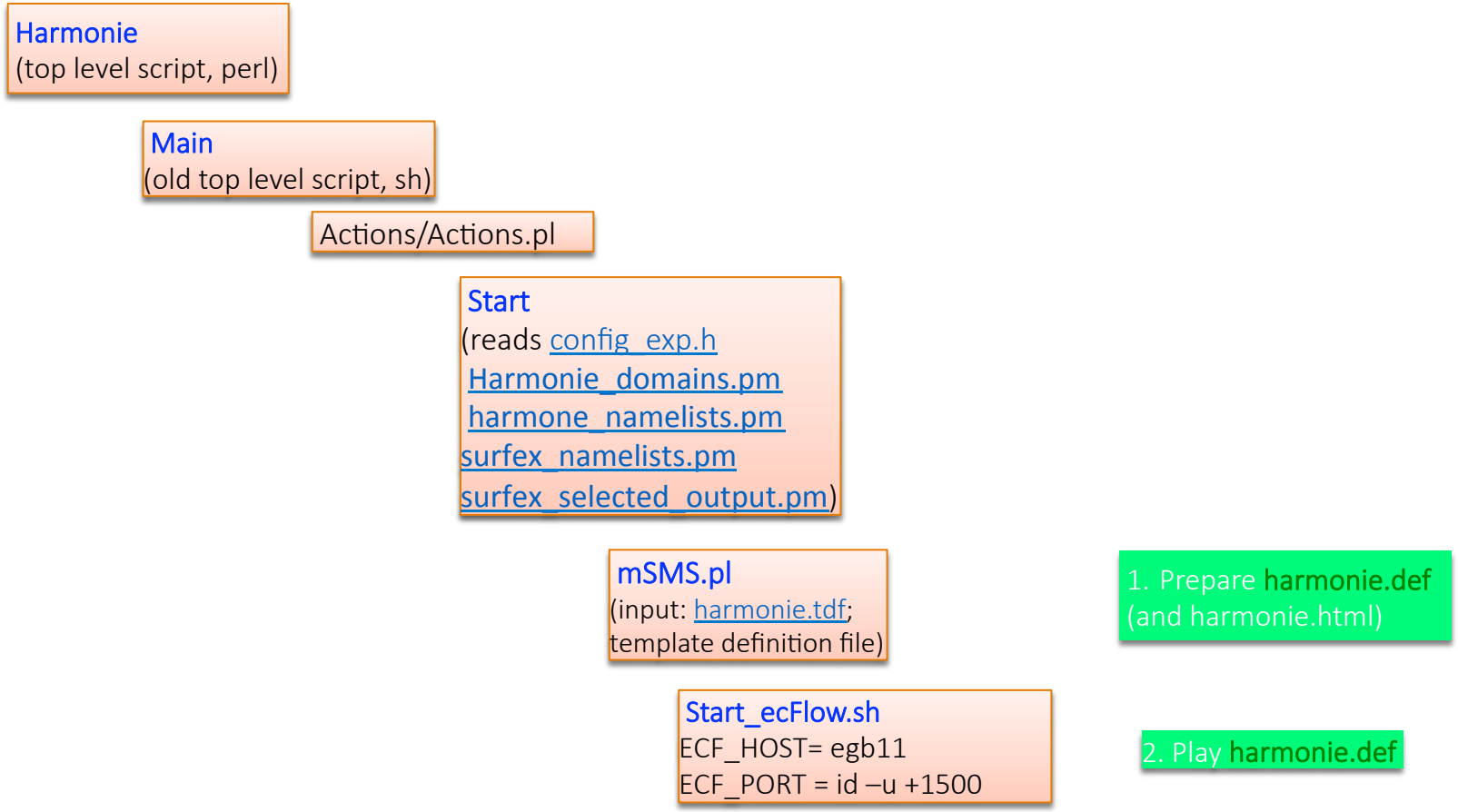

Definition file
ecf script
Script,
Python,
ejecutable
…
ecflow_server
Job

ecFLOW


Suite
Family
Task


Definition file
ecf
container
Script
executable
…

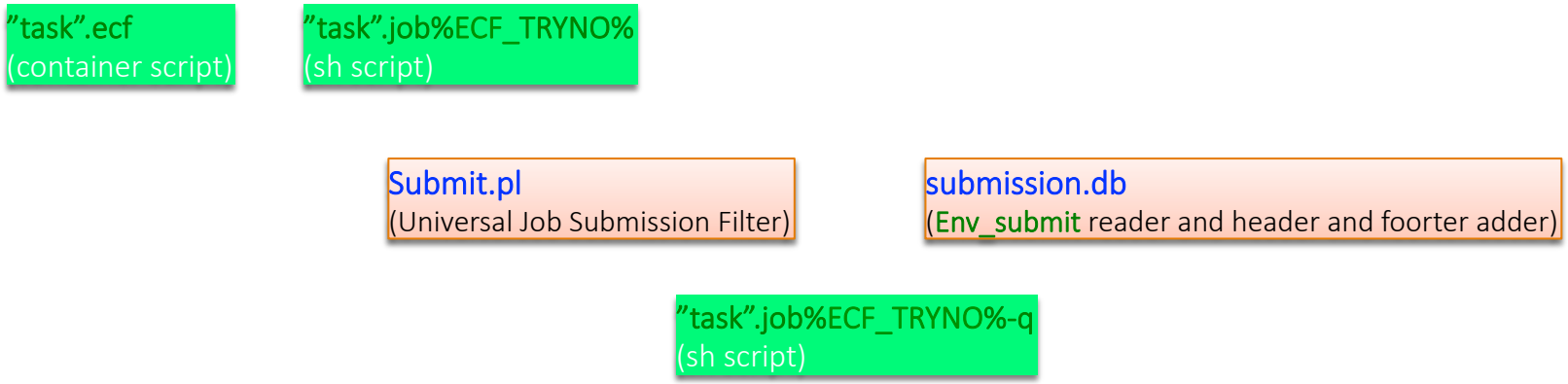
HARMONIE-AROME scripting system sequence



HARMONIE-AROME scripting task execution

- **%ECF_TRYNO%** is the attempt number of the task. %ECF_TRYNO% runs from 1 to **%ECF_TRIES%** (default 1) for automatically submitted tasks, but %ECF_TRIES% is ignored for tasks that are rerun through the GUI.

- **"task".job%ECF_TRYNO%-q**. Headers (for the queueing system) and footers might have been added.

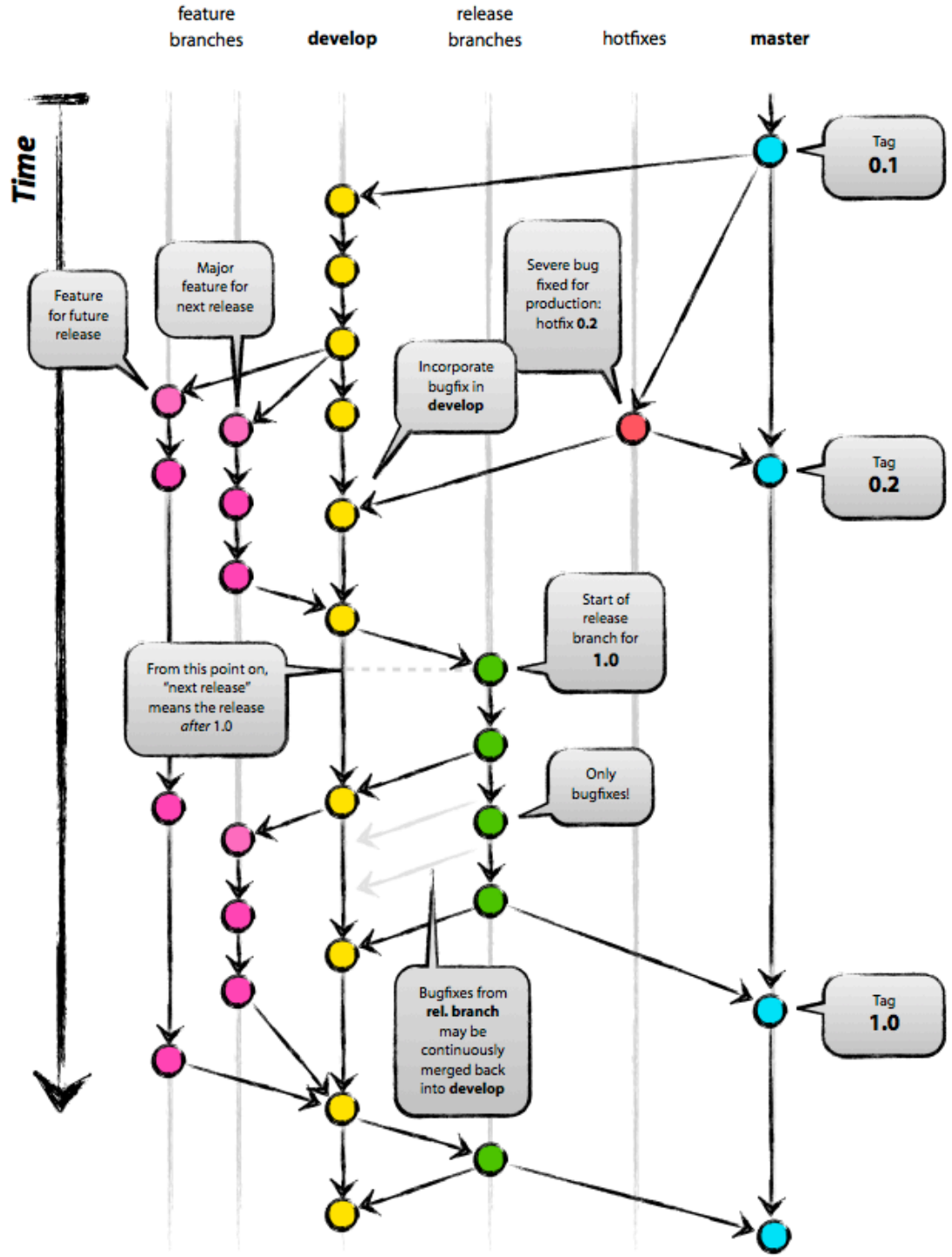


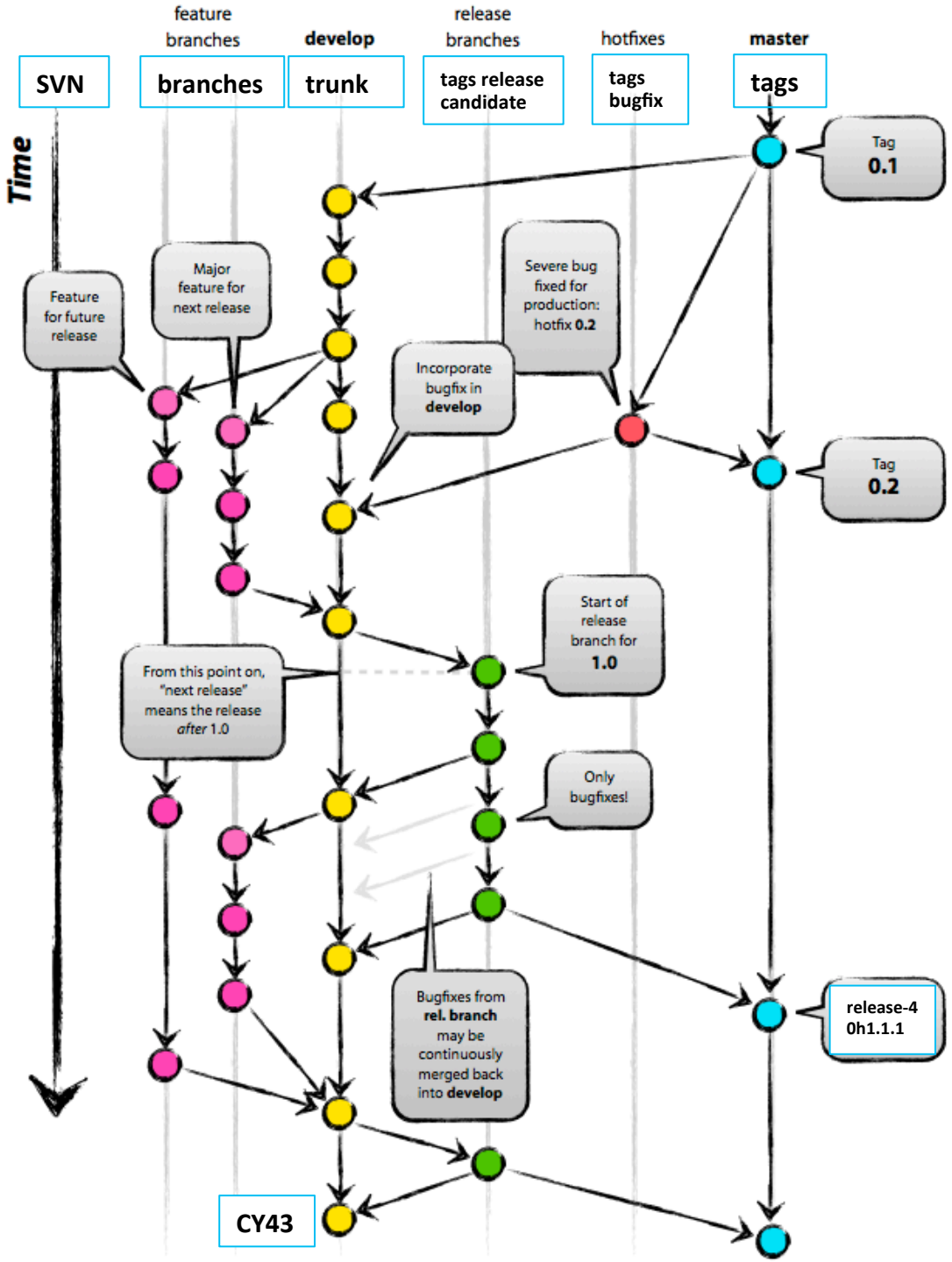
ecFLOW vs mSMS

ecFLOW	*mSMS*
Server/Client	*batch Script*
Dynamical suite def	*Static suite def*
Python/CDP	*CDP*
*Scripts *.ecf*	*Scripts *.sms*
More control and options	*Few options*

ecFLOW vs mSMS

- **ecflow_server** The schedule a daemon runs continuously(nohup &)
- **ecflow_client** Command line interface with ecFlow Child commands updtate the task state in ecflow_server
- **Python API**
- **ecflowview** or **ecflow_UI** ecFlow GUI
- **Several experiments and servers can be monitored with the same viewer**
- More than one experiment is not allowed with the same name monitored in the same server.


feature branches
develop
release branches
hotfixes
master
Time
Tag 0.1
Feature for future release
Major feature for next release
Severe bug fixed for production: hotfix 0.2
Incorporate bugfix in develop
Tag 0.2
Start of release branch for 1.0
From this point on, "next release" means the release after 1.0
Only bugfixes!
Bugfixes from rel. branch may be continuously merged back into develop
Tag 1.0


feature branches
develop
release branches
hotfixes
master
SVN
branches
trunk
tags release candidate
tags bugfix
tags
Time
Tag 0.1
Feature for future release
Major feature for next release
Severe bug fixed for production: hotfix 0.2
Incorporate bugfix in develop
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From this point on, "next release" means the release after 1.0
Only bugfixes!
Bugfixes from rel. branch may be continuously merged back into develop
release-40h1.1.1
CY43

List of Equivalent Commands in Git and Subversion

Git	Subversion
git add <file>	svn add <file> (only if the file is not tracked yet)
git blame <file>	svn blame <file>
git show <rev>:<file>	svn cat -r <rev> <file>
git clone <URL> <target_name>	svn checkout <URL> <target_name>
git commit -a	svn commit
git rm <file>	svn delete <file>
git diff <file>	svn diff <file>
git show HEAD:<directory>	svn list <directory>
git merge	svn merge
git checkout <file or directory>	svn revert <file or directory>
git checkout HEAD	svn switch <url> or svn revert <file>
git checkout <branch>	svn switch <url>
git status	svn status
git pull	svn update
git init	svnadmin create
git fetch	svn update
git reset --hard	svn checkout -r <revision> url://path/to/repo
git stash	No equivalent, may be released in SVN 1.10?, possibly in 2017
git revert <commit_hash|tag|branch_name>	svn merge -r UPREV:LOWREV . undo range svn merge -c -REV . undo single revision