The LMDZ Code

Code structure : general principles, ...

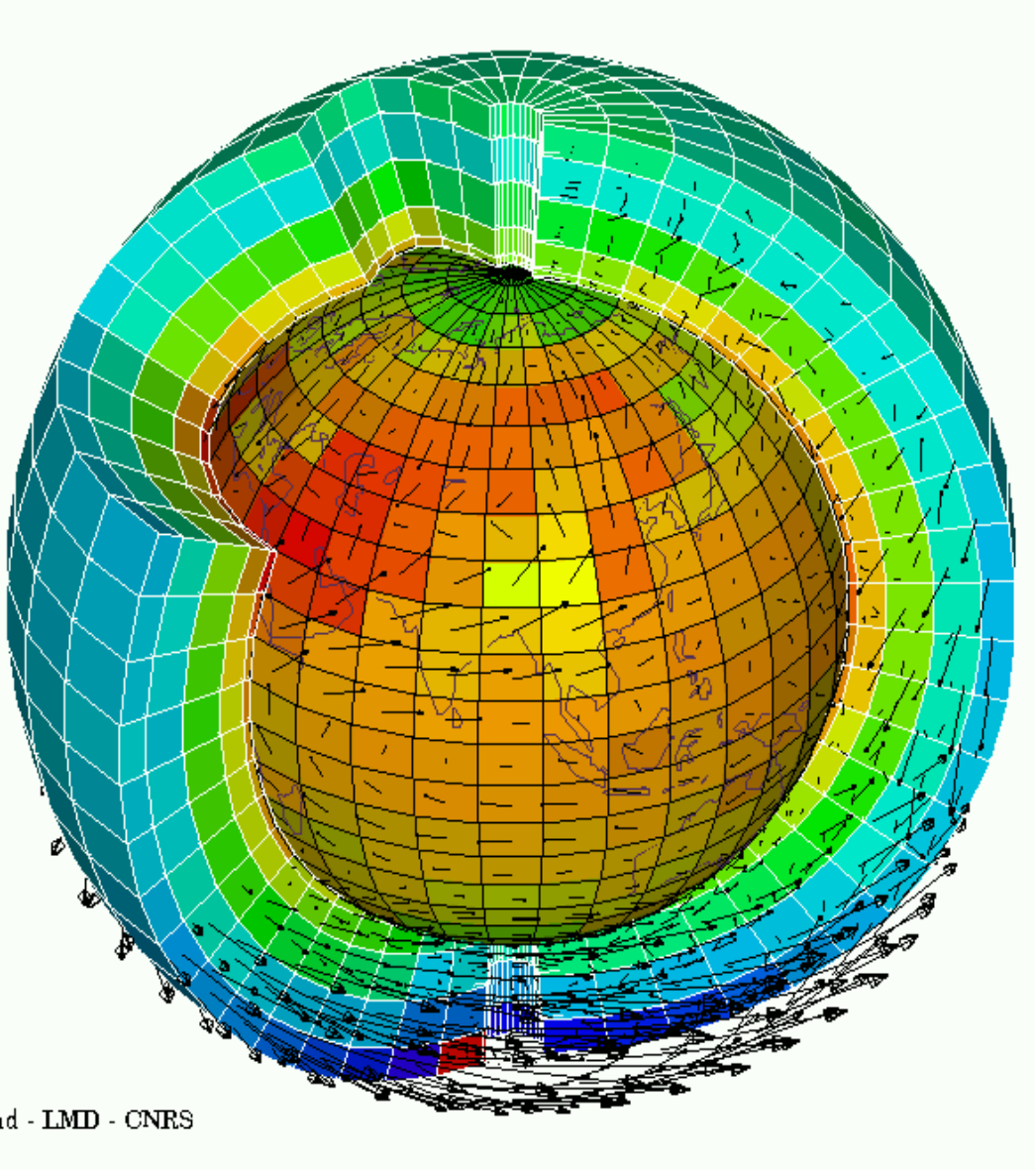
Code structure

Main principle : clear separation between the dynamical and physical modules

The dynamical module solves the general equations for atmospheric circulation

The physics module gathers all the physical parametrisations which compute the physical forcings of circulation and the details of the climate at each point of the grid (radiation, precipitation, interfaces with surfaces, …)

The LMDZ Code



From a numerical standpoint : equations are solved on two types of grid

- a 3D grid for the dynamics
- a 2D grid for the physics

The interface between the two modules (and the two types of grids) is accomplished in a specific routine : « calfis.F/calfis_loc.F »

The LMDZ Code

The clear partition between two modules (the dynamics and the physics of the model enables us to use the same dynamical package with different physics package :

- physics describing other planetary atmospheres
- other terrestrial physics package (WRF/MAR/simplified/parametrised/idealised, …)

This partition also allows the use of other dynamical packages (WRF/parallelised, ...) with a common physics package, the 1D LMDz model being a special case of this substitution.

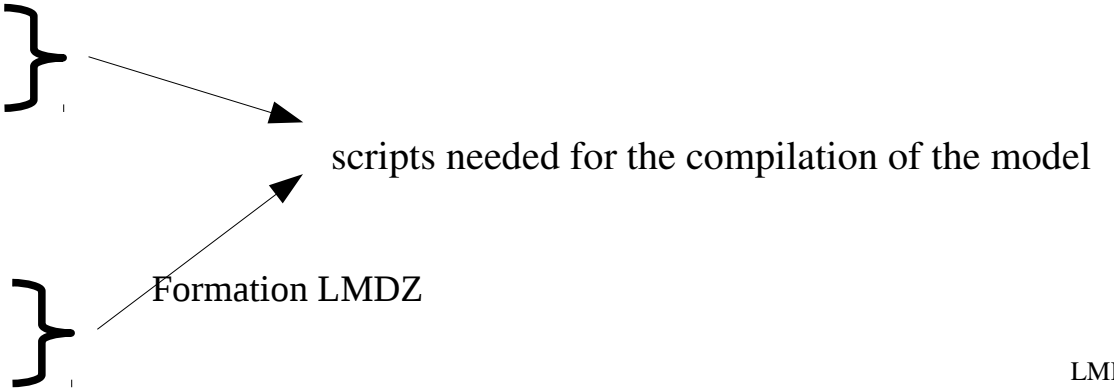
The outlay of the source code reflects this partition between modules and facilitates the use of the LMDz code in different configurations.

Switching between different dynamical cores and physics packages is faciliated by a clearly defined interface.

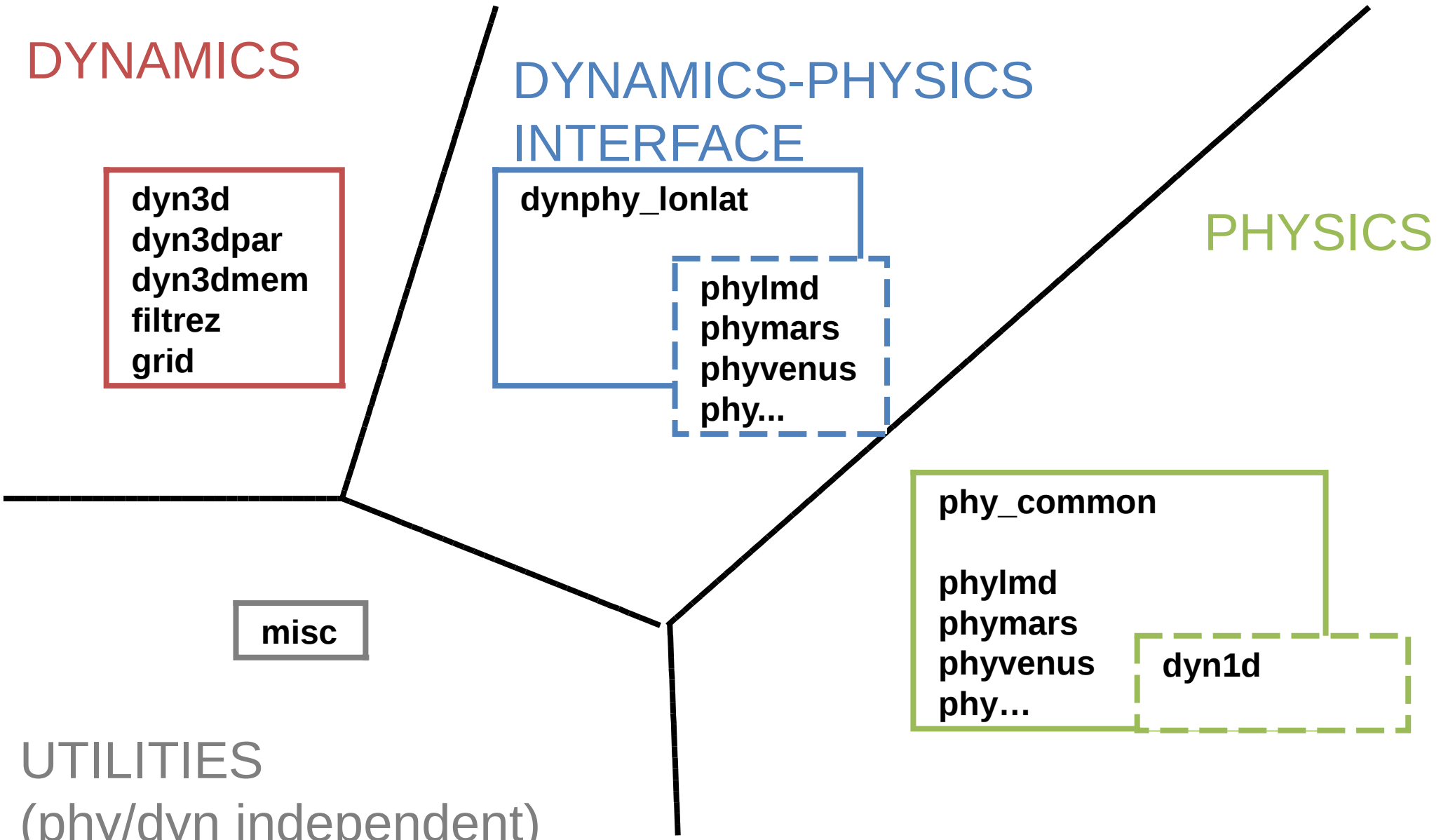
The code is written in Fortran. It started life as Fortran IV code, some majors parts are still in « F77 » fortran but a F90 compiler is used and all present developments are coded in F90 (at the least). In all, it represents some 760000 lines of code in some 2100 routines.

The LMDZ Code

- arch ← compilation configuration files
- DefLists ← execution configuration files
- libf ← Source code
  - dyn3d ← dynamical module (sequential)
  - dyn3d_common ← dynamical module (common routines)
  - dyn3dmem ← dynamical module (parallelised localised)
  - ~~dyn3dpar~~ ← dynamical module (parallelised) OBSOLETE
  - dynlonlat_phylonlat ← interface
  - filtrez ← filter
  - grid ← grid definition
  - misc ← miscellaneous utilities
  - obsolete ← obsolete routines for historical purposes
  - phy_common ← physics common modules
  - phydev ← physics module devt
  - phylmd ← physics module 3D terrestrial
  - phymar ← physics module MAR
- tools ← utilities
- 000-README
- beta_crf.data
- bld.cfg
- build_gcm
- create_make_gcm
- Licence_CeCILL_V2-en.txt
- Licence_CeCILL_V2-fr.txt
- ~~makegcm~~
- makelmdz
- makelmdz_fcm



The LMDZ Code



The LMDZ Code

phy_common

•contains routines common to all physics packages phy… , e.g.:

- mod_phys_lmdz_[mpi|omp]* (MPI/OpenMP organization)
- ioipsl_getin_p_mod (getin_p)
- abort_physic
- print_control (lunout, prt_level)
- geometry_mod (lon,lat,cell_area)
- regular_lon_lat_mod (info on global lon-lat grid for outputs)
- mod_grid_phy_lmdz (nbp_lon, nbp_lat, nbp_lev, klon_glo, grid_type, nvertex)

PHYSICS

dyn1d (subdir of phy…)

•contains 1d main program (lmdz1d.F90 or testphys1d.F or rcm1d.F…) and a couple of relevant dynamical routines (links from dyn3d)

•Uses physics routines from ../phy…

phy_common

phylmd
phymars
phyvenus
phy…

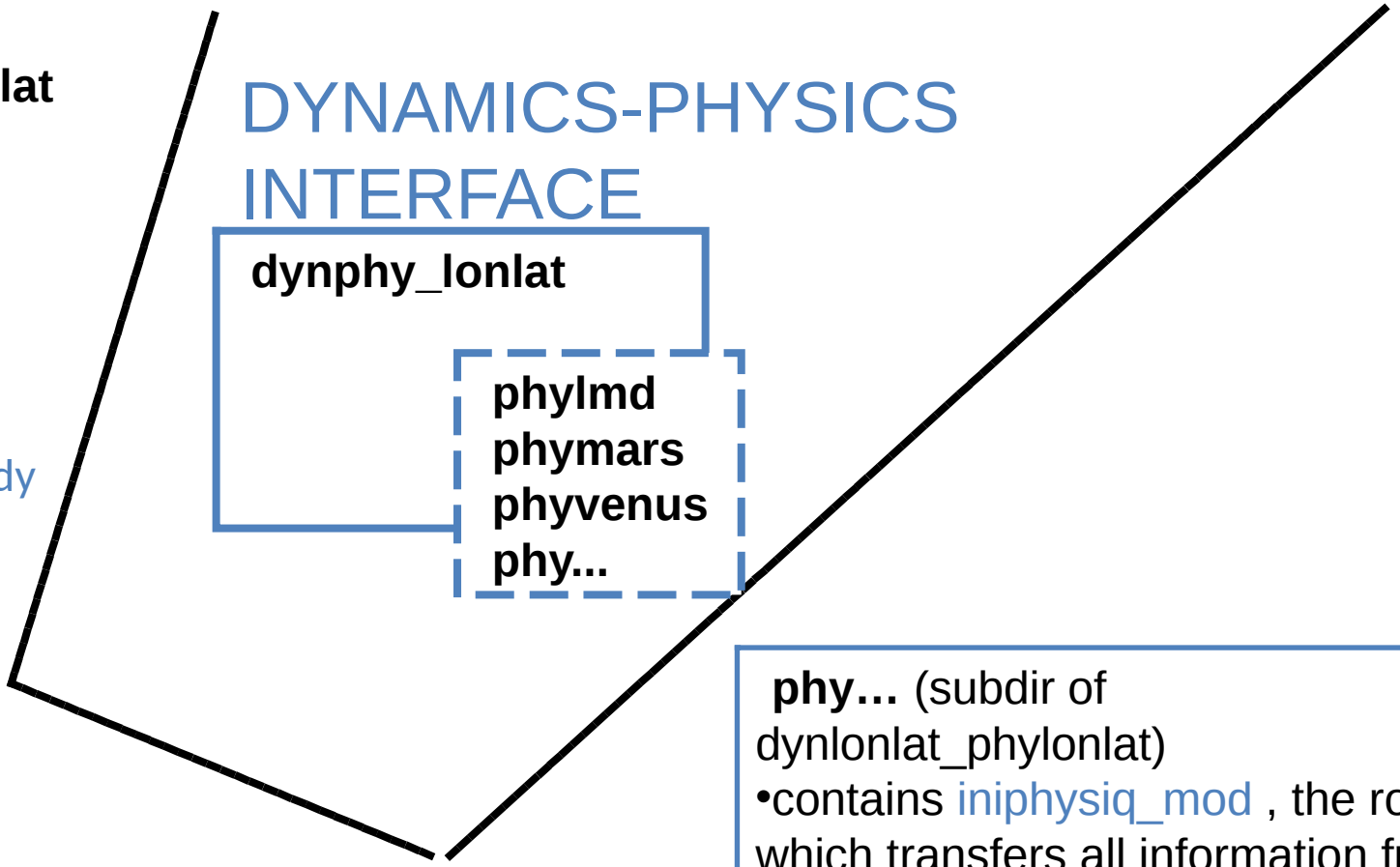
dyn1d

The LMDZ Code

dynlonlat_phylonlat

•Relies on both dynamics and physics:

- calfis[_p|_loc]
- gr_dyn_fi[_p]
- gr_fi_dyn[_p]
- mod_interface_dyn_phy



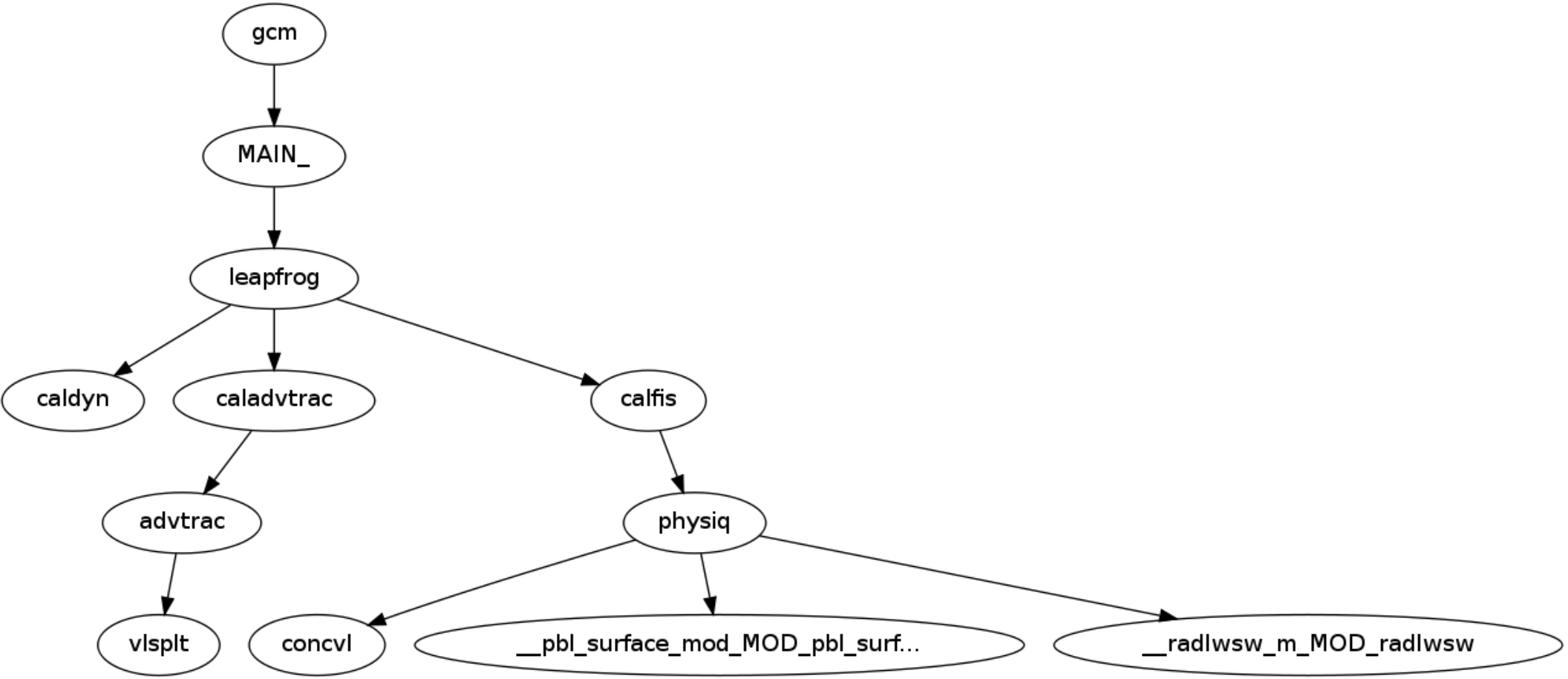
phy… (subdir of dynlonlat_phylonlat)

•contains iniphysiq_mod , the routine which transfers all information from the dynamics to the physics required to initialize the physics (r, g, tracer names, global grid layout, etc.)

•contains utility programs to generate/modify/process initial conditions, e.g. ce0l, newstart, …

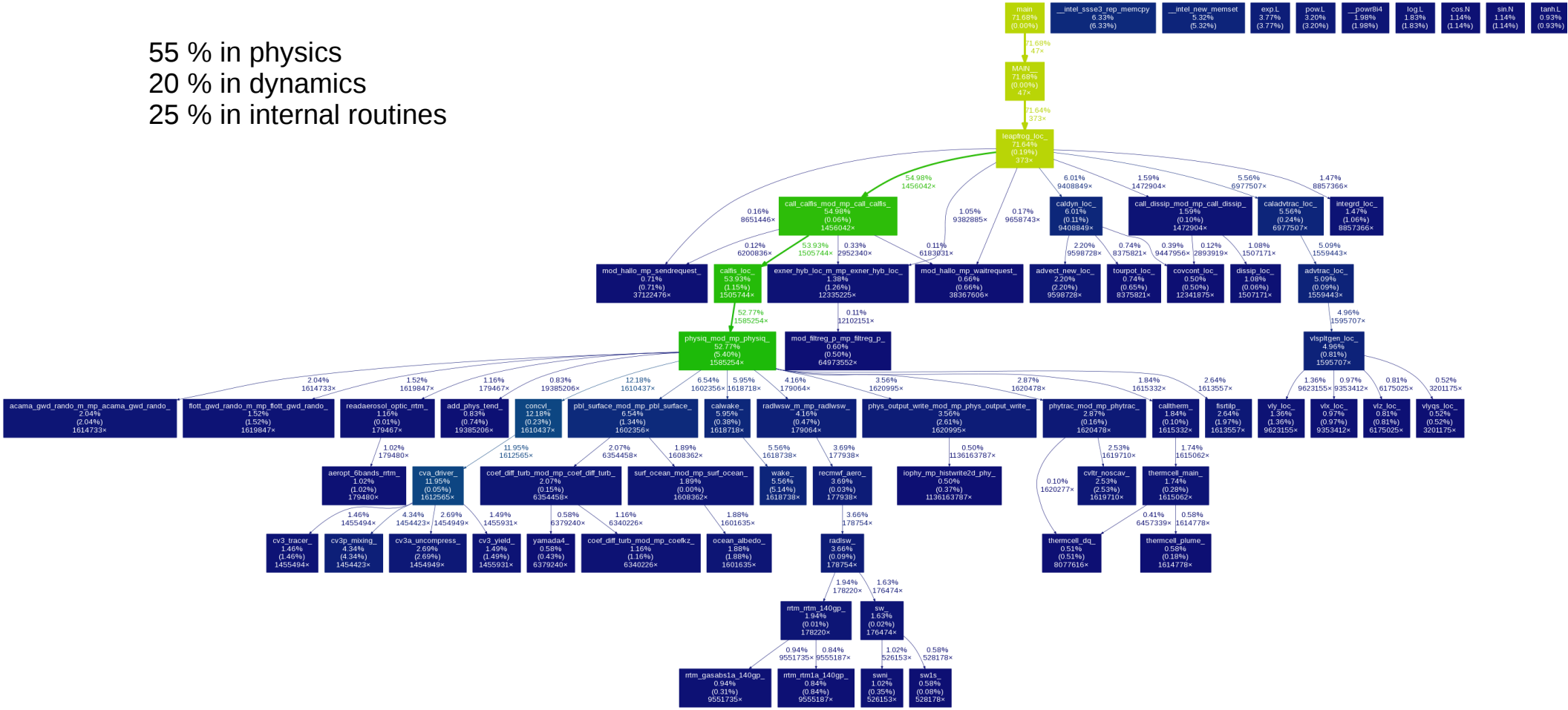
The LMDZ Code

Also see http://www.lmd.jussieu.fr/~lmdz/LMDZ5/doxy_201512/html/em_2gcm_8_f90.html



The LMDZ Code

55 % in physics
20 % in dynamics
25 % in internal routines



Formation LMDZ