LMDZ tutorial

Configurations, input files, forcing data

Formation LMDZ 2014
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LMD

Contents

- Configurations
- LMDZ with realistic physics
- Aqua-planet or all-land planet
- Relaxation to a 3D-temperature field

Configurations: many ways to use LMDZ

Coupling with another model

- Soil, vegetation, hydrology: Orchidée
  http://labex.ipsl.fr/orchidee
- Ocean, sea ice, marine biogeochemistry: Nemo
  http://www.nemo-ocean.eu
- Tropospheric chemistry, aerosols: INCA
  http://www-lsceinca.cea.fr
- Stratospheric chemistry: Reprobus
  Marchand et al., JASTP, 2012

Configurations of LMDZ itself

- 1 or 3 dimensions
- Nudging
- Zoom
- Realistic or idealized ”physical” part of the model

Use case:
LMDZ alone
3 dimensions
no nudging
realistic (terrestrial) physics

What is left to choose

- Some run-time parameters (among which concentration of greenhouse gases)
- Initial state
- Boundary (that is, surface) conditions
- Forcing atmospheric data: ozone field, fields of aerosols

Run-time parameters

- Chosen in text files which have suffix `.def`
- Home › Utilisateurs › Guides › LMDZ pas à pas › Utilisation comme boîte noire › Variables des fichiers .def

Run-time parameters (continued)

- Syntax:
  variable=value
  Case sensitive
  TRUE or FALSE for logical values
  Character values without quotes
  Comment lines start with #
  Example: gcm.def
- Semantic separation of run-time parameters among six .def files

Run-time parameters (continued)

- gcm.def: dynamics
  - Zoom: clon and clat (center), grossism[xy] (zooming factor), dzoom[xy] (range), tau[xy] (steepness of transition)
- physiq.def: parameterizations

Run-time parameters (continued)

- config.def: level of output, coupling with other models, radiative transfer, forcing data (ozone, aerosols, greenhouse gases)
  - No ocean model: type_ocean=force
  - No coupling with Orchidée: VEGET=bucket or VEGET=betaclim
  - Concentration of greenhouse gases: co2_ppm, ch4_ppb…
  - Number of calls to radiative transfer procedure, per day: nbapp_rad

Run-time parameters (continued)

- output.def: fine tuning of output (choice of variables, frequency...)
- run.def: length of the run, dates, calendar
  - Number of days of run: nday
  - Starting date: dayref (day number in the year) and anneeref
  - Calendar: calend (character variable)

Run-time parameters (continued)

- traceur.def: tracers
  - Special syntax
  - 1st line: number of tracers
  - Then one line per tracer, with a number identifying the advection scheme
  - For more information on available advection schemes: infotrac.F90

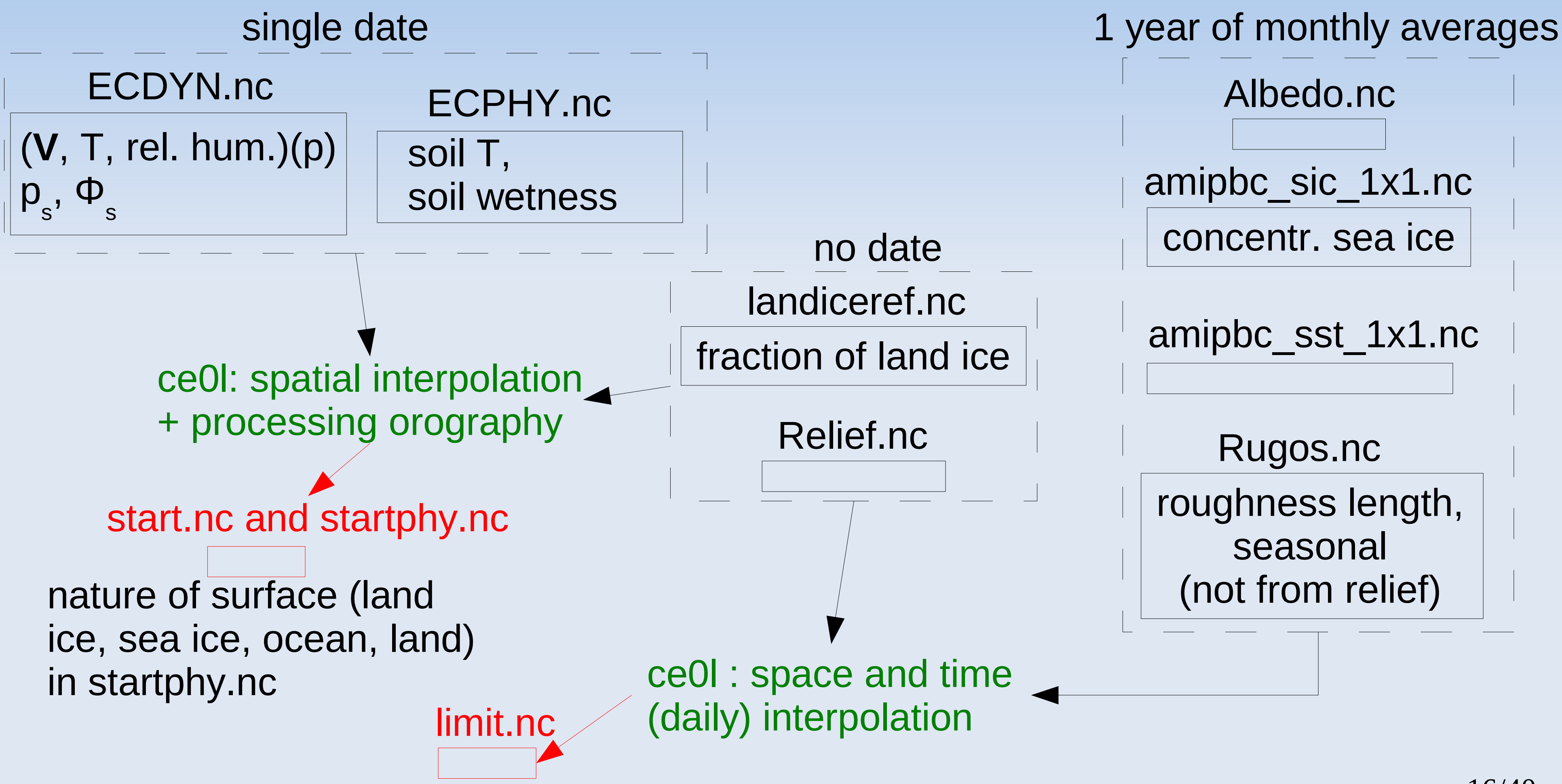
Initial state and boundary conditions

- Separate program: ce0l
  (ce0l stands for ”création état 0 limites”)
- Distributed with the program gcm, compiled with the same tools
- Run ce0l with the same .def files than those you want for gcm
  Exception: calendar

Initial state and boundary conditions (continued)

- ce0l creates 2 files for initial state:
  start.nc for the dynamics part of gcm
  startphy.nc for the physics part of gcm
- ce0l creates 1 file for 1 year of boundary conditions:
  limit.nc

Initial state and boundary conditions (continued)



Calendar

- Calendar is used in ce0l to create boundary conditions
- For years with constant length, 360 or 365 days:
  calend=earth_360d
  or
  calend=earth_365d
  Same value for ce0l and gcm

Calendar (continued)

- For the real calendar (with leap-years):
  - Run ce0l for each year you want boundary conditions for:
    calend=gregorian
    anneeref=<the right year>
  - For gcm: calend=earth_366d

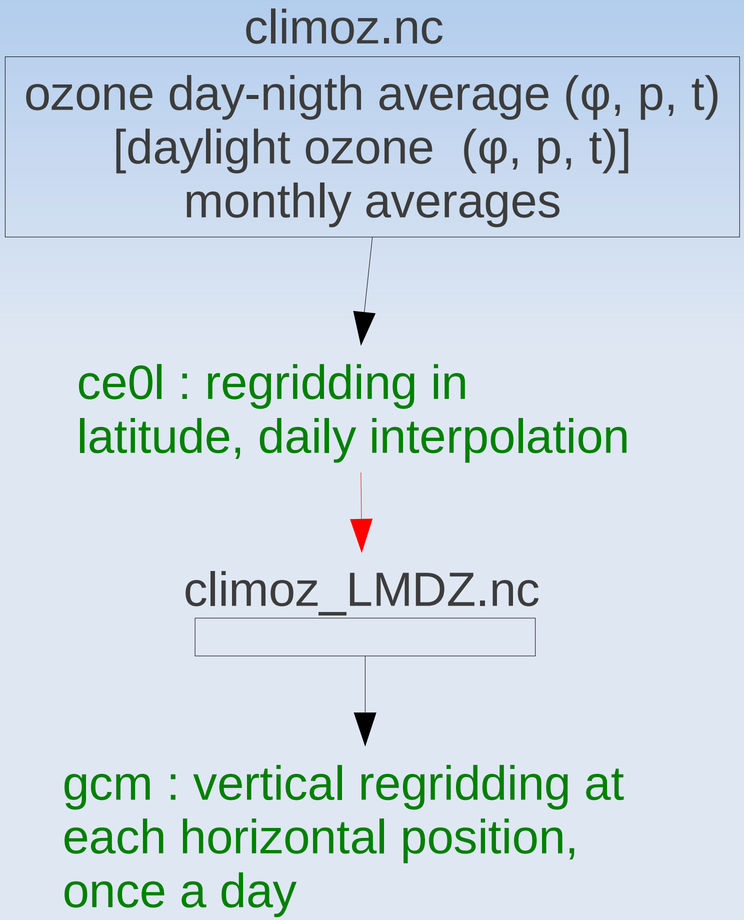
Ozone

- Run-time parameter in config.def:
  read_climoz = - 1, 0, 1 or 2
- 0: analytic expression for the ozone field (see ozonecm_m.F90)
- - 1 (use with solarlong0 = 1000): made symmetric with respect to the equator, for use with annual mean insolation

Ozone (continued)

- 1: read day-night average of ozone field from a file
- 2: also read daylight average from the same file (good idea if there are a few model layers in the mesosphere)

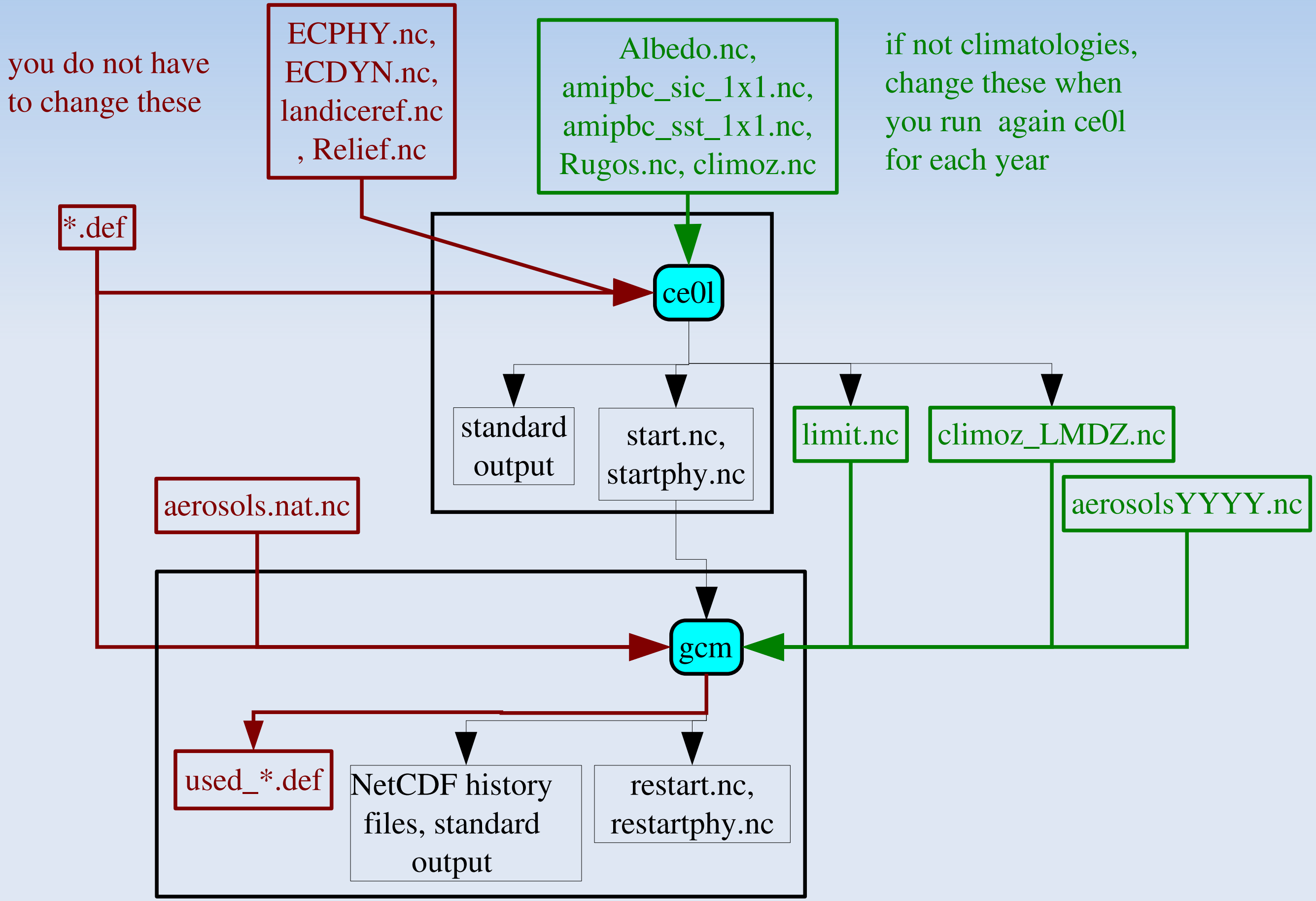
Ozone (continued)



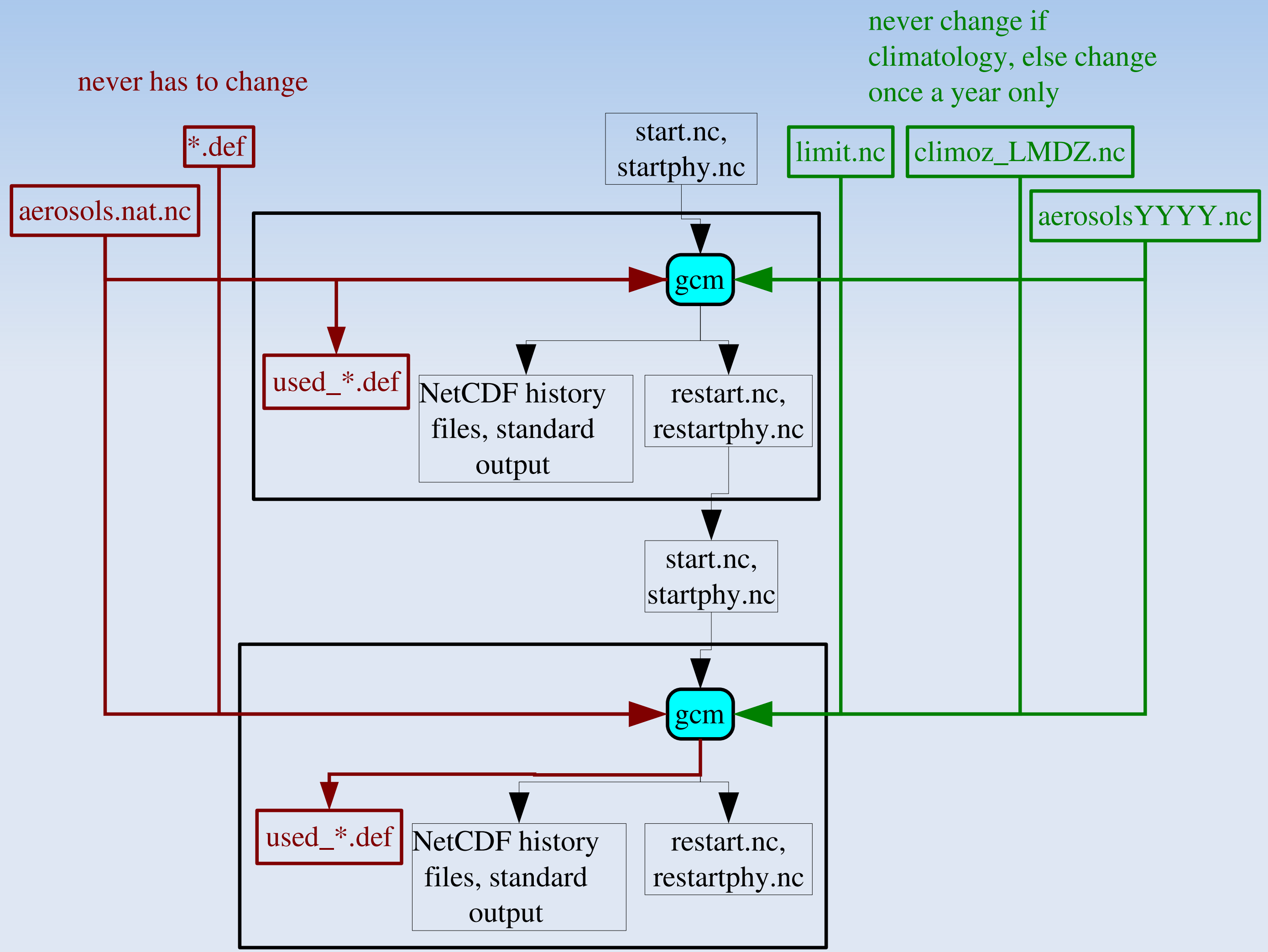
Aerosols

Cf. presentation by Olivier BOUCHER

Putting it all together



Chaining one-month runs



Where do you get the input files ?

Run-time parameters

Template .def files are distributed with LMDZ source files

- Directory DefLists
- physiq.def_L39_AR40.0: 39 levels, physics used for AR4, old physics
- physiq.def_L39_NPv3.2: new physics of AR5
- physiq.def_L59_NPv4.12: new physics of AR6 (still evolving)

Initial state and boundary conditions

NetCDF files required by ce0l are in:

- http://www.lmd.jussieu.fr/~lmdz/LMDZ_Init
- DODS server http://dods.extra.cea.fr/work/p86ipsl/IGCM/STORAGE/INIT/ATM

Forcing data for CMIP 5

- A lot of data, for pre-industrial, historical or future simulations (with different scenarios)
- NetCDF files are stored at the national supercomputing centers, IDRIS and CCRT, so you need to find access to them

Forcing data for CMIP 5: ozone

- ergon:~rpsl035/IGCM/INIT/ATM/LMDZ/Ozone/HYBRIDE/v2.clim/tro3_${year}.new.nc
- Wiki
  http://forge.ipsl.jussieu.fr/igcmg/wiki/InfosOzone

Forcing data for CMIP 5: aerosols

- ergon:~rpsl035/IGCM/BC/ATM/LMDZ/LMD9695/AR5/HISTORIQUE/aerosols_11YearsClim_${year}_v5.nc
- Each file contains all aerosol types.
- Wiki http://forge.ipsl.jussieu.fr/igcmg/wiki/InfosAerosol

Aqua-planet or all-land-planet

Definition

- Zero relief
- Only one type of surface globally : either land or ocean
- Surface temperature is:
  - forced for an aqua-planet
  - computed for a land-planet (we still have to choose an initial field)

Selecting the aqua- or land-planet

- Run-time parameter iflag_phys (integer) in gcm.def
  Choose iflag_phys ≥ 100 (instead of default value 1 for Earth surface, full physics)
- iflag_phys = 101 to 114, 120, 121: aqua-planet
  iflag_phys = 201 to 214, 220, 221: land-planet
- Different T_s fields, constant for aqua-planet, initial value only for land-planet

Selecting the aqua- or land-planet (continued)

- See (analytic) definition of the 14 T_s fields in procedure profil_sst (file phyaqua_mod.F90)
- Note: all the T_s fields are symmetrical with respect to the equator

Initial state and boundary conditions

- You do not go through the ce0l step
  - Set run-time parameter read_start to FALSE in gcm.def
    gcm creates an initial state
  - gcm also creates a file limit.nc for boundary conditions
- gcm creates restart.nc and restartphy.nc so switch read_start to TRUE for the next run

Forcing data

- For an aquaplanet, it may be a good idea to use adapted sun position, ozone and aerosol fields, symmetrical about the equator
- read_climoz = - 1 and solarlong0 = 1000
- No symmetrical aerosol field ready so either create it yourself or set:
  flag_aerosol = 0

Idealized physics: relaxation to a given 3-dimensional temperature field

Selecting temperature relaxation

Set run-time parameter iflag_phys=2 in gcm.def

- Analytic definition of the 3D equilibrium temperature field
- Damping of low-level wind to represent boundary-layer friction
- From Held and Suarez (1994)
- Some run-time tuning parameters (relaxation time…), see inicademic.F90

Initial state, no boundary condition

- You do not go through the ce0l step
  - Set run-time parameter read_start to FALSE in gcm.def
    gcm creates an initial state
  - No file limit.nc
- gcm creates restart.nc and restartphy.nc so switch read_start to TRUE for the next run

Note

- No other forcing data
- You do not use physiq.def, config.def nor output.def
- You can bypass compilation of physics files with option -p nophys of makelmdz[_fcm] → much quicker compilation