Meso-NH environment
&
Experiments design

MesoNH Tutorial Class 1-4 December 2025

MESONH simulation = succession of elementary steps

Elementary steps :

1. Production of 2D physiographic file (PGD)
   - PREP_PGD
   - PREP_NEST_PGD
2. Production of 3D init and coupling files
   - PREP_IDEAL_CASE
   - PREP_REAL_CASE
   - SPAWNING
3. Forecast run
   - MESONH
4. Post-processing
   - DIAG
   - SPECTRE

IDEAL CASE

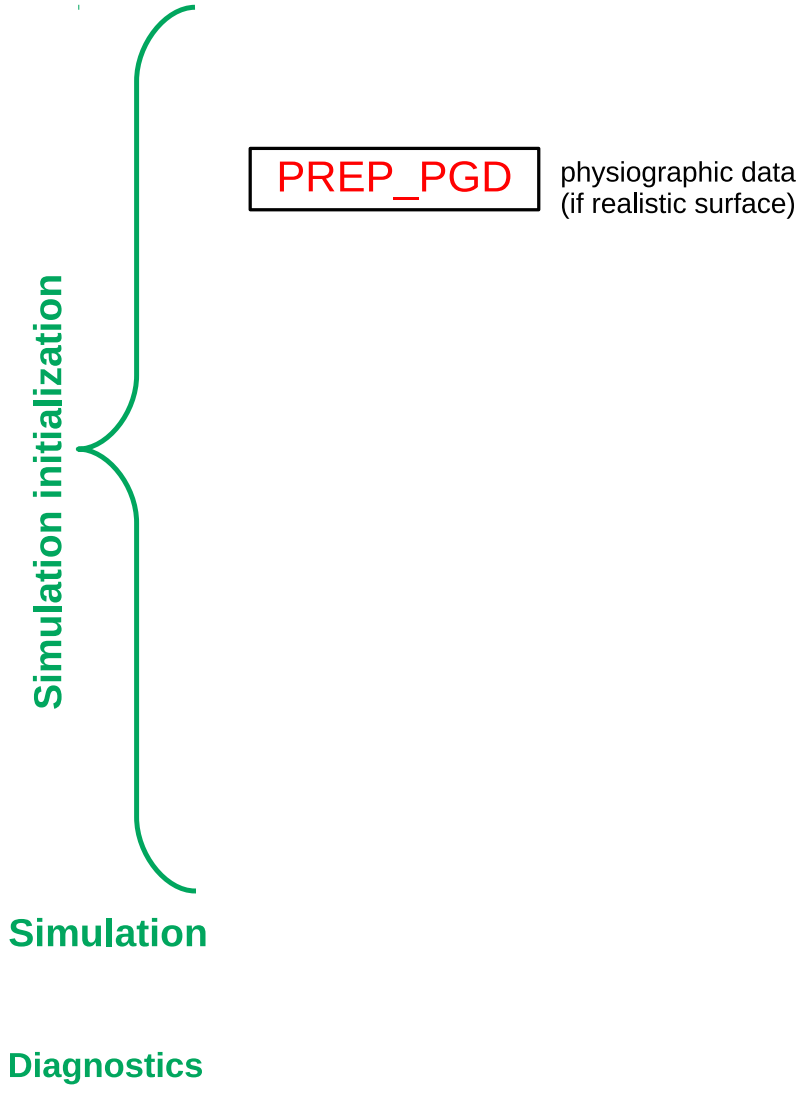
REAL CASE

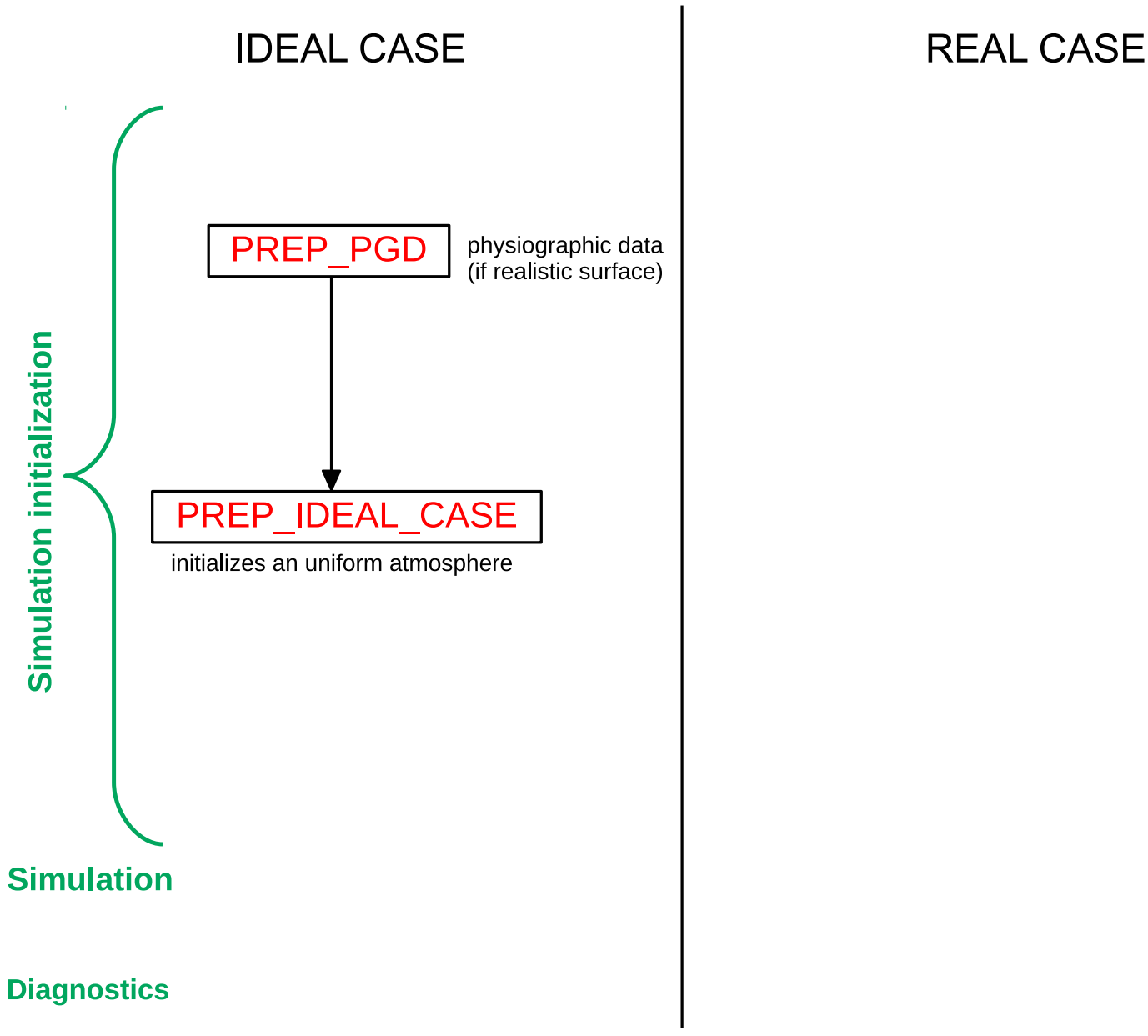
Simulation

Diagnostics

IDEAL CASE

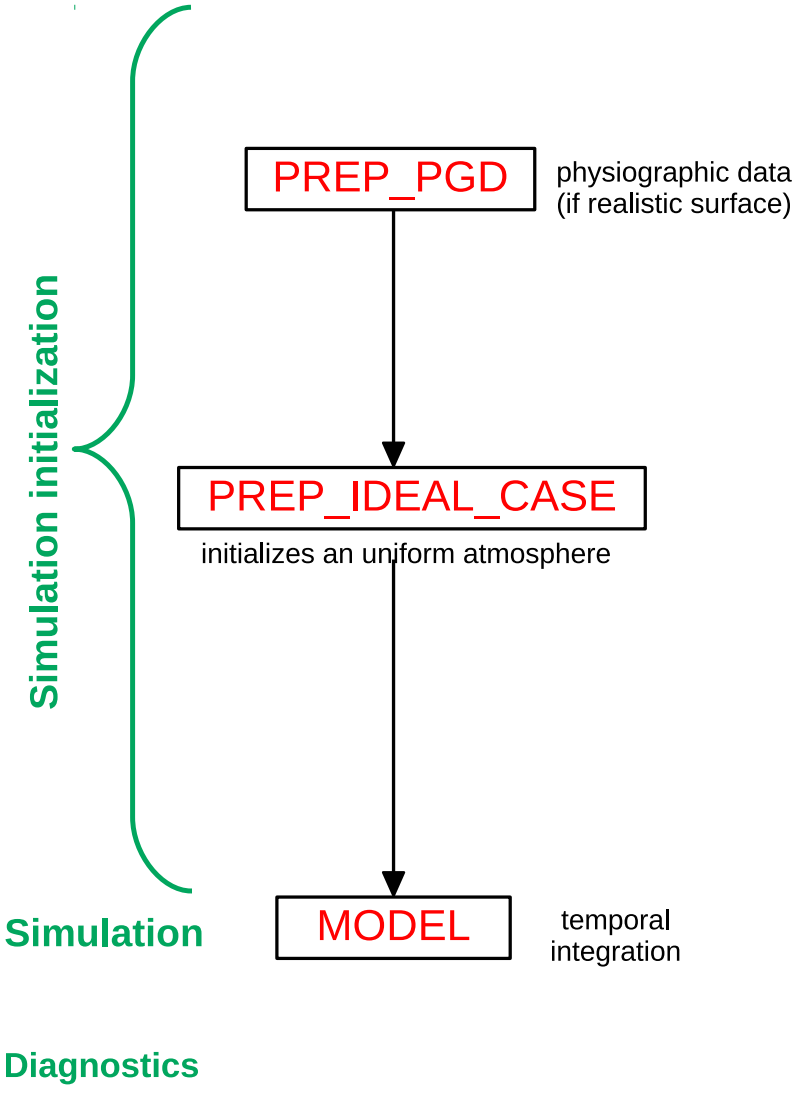
REAL CASE




IDEAL CASE
REAL CASE
PREP_PGD
physiographic data
(if realistic surface)
PREP_IDEAL_CASE
initializes an uniform atmosphere
Simulation initialization
Simulation
Diagnostics

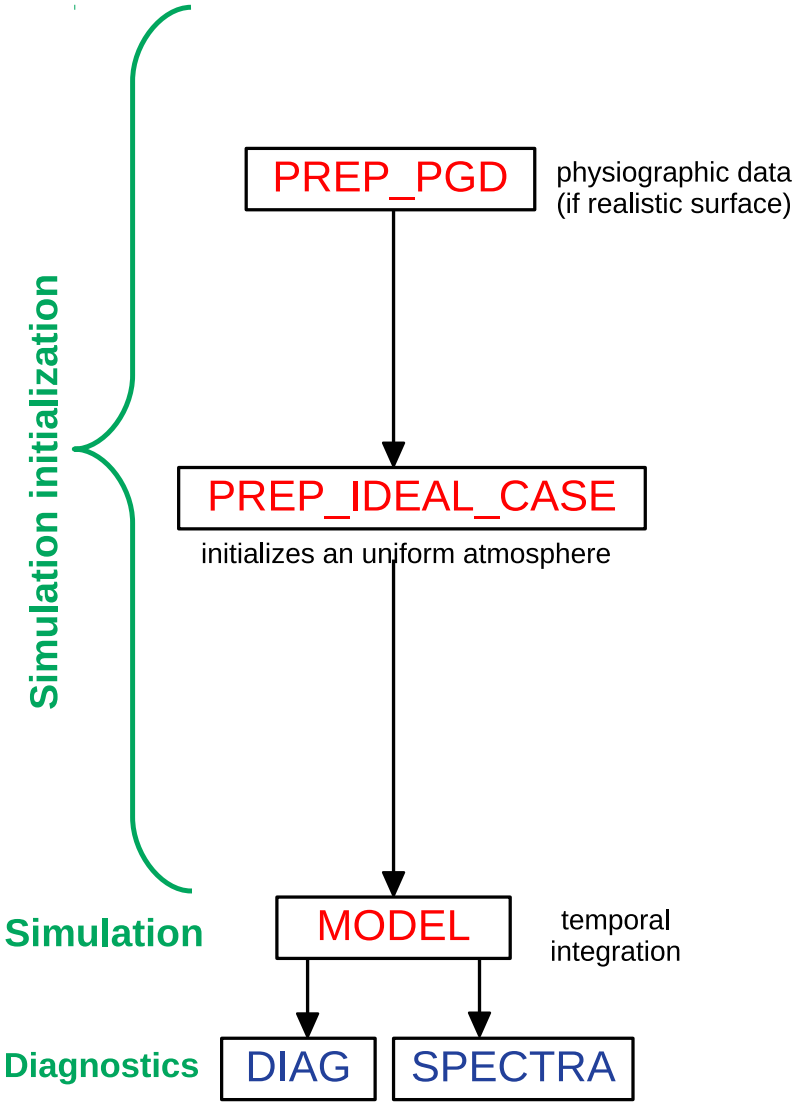
IDEAL CASE

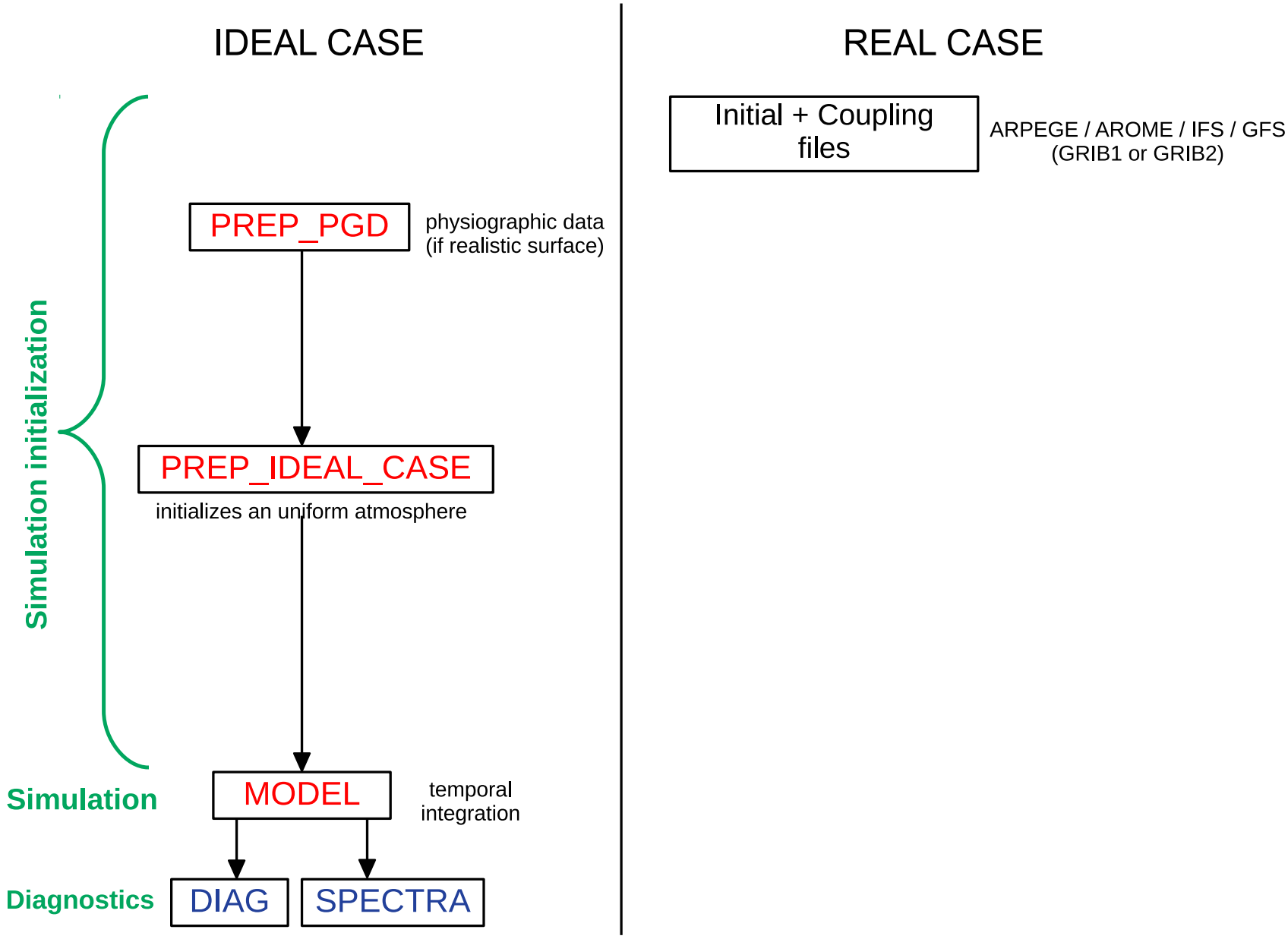
REAL CASE

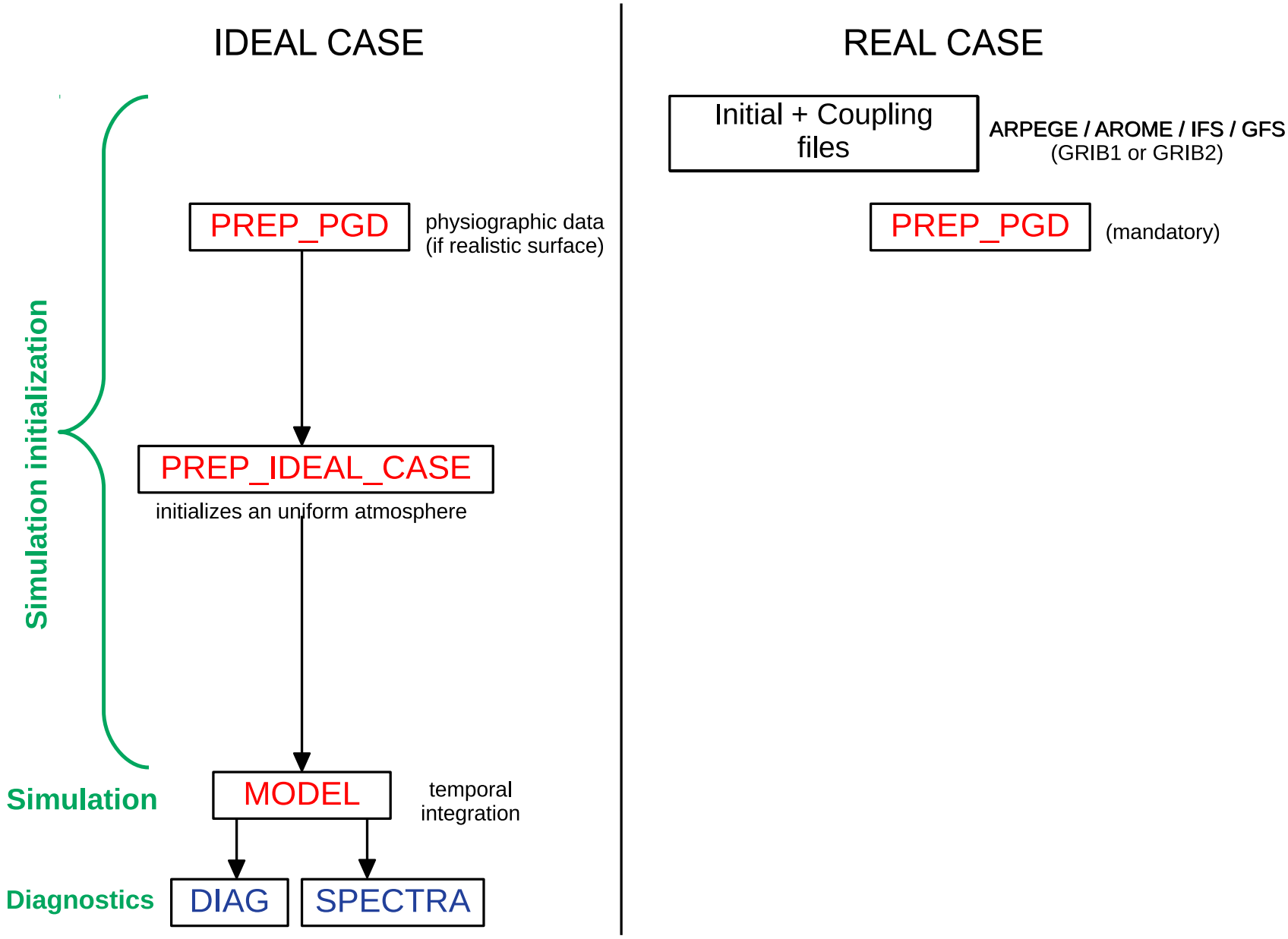


IDEAL CASE

REAL CASE




IDEAL CASE
REAL CASE
Initial + Coupling files
ARPEGE / AROME / IFS / GFS
(GRIB1 or GRIB2)
Simulation initialization
PREP_PGD
physiographic data
(if realistic surface)
PREP_IDEAL_CASE
initializes an uniform atmosphere
Simulation
MODEL
temporal
integration
Diagnostics
DIAG
SPECTRA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REAL CASE
Initial + Coupling files
ARPEGE / AROME / IFS / GFS
(GRIB1 or GRIB2)
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physiographic data
(if realistic surface)
PREP_PGD
(mandatory)
Simulation initialization
PREP_IDEAL_CASE
initializes an uniform atmosphere
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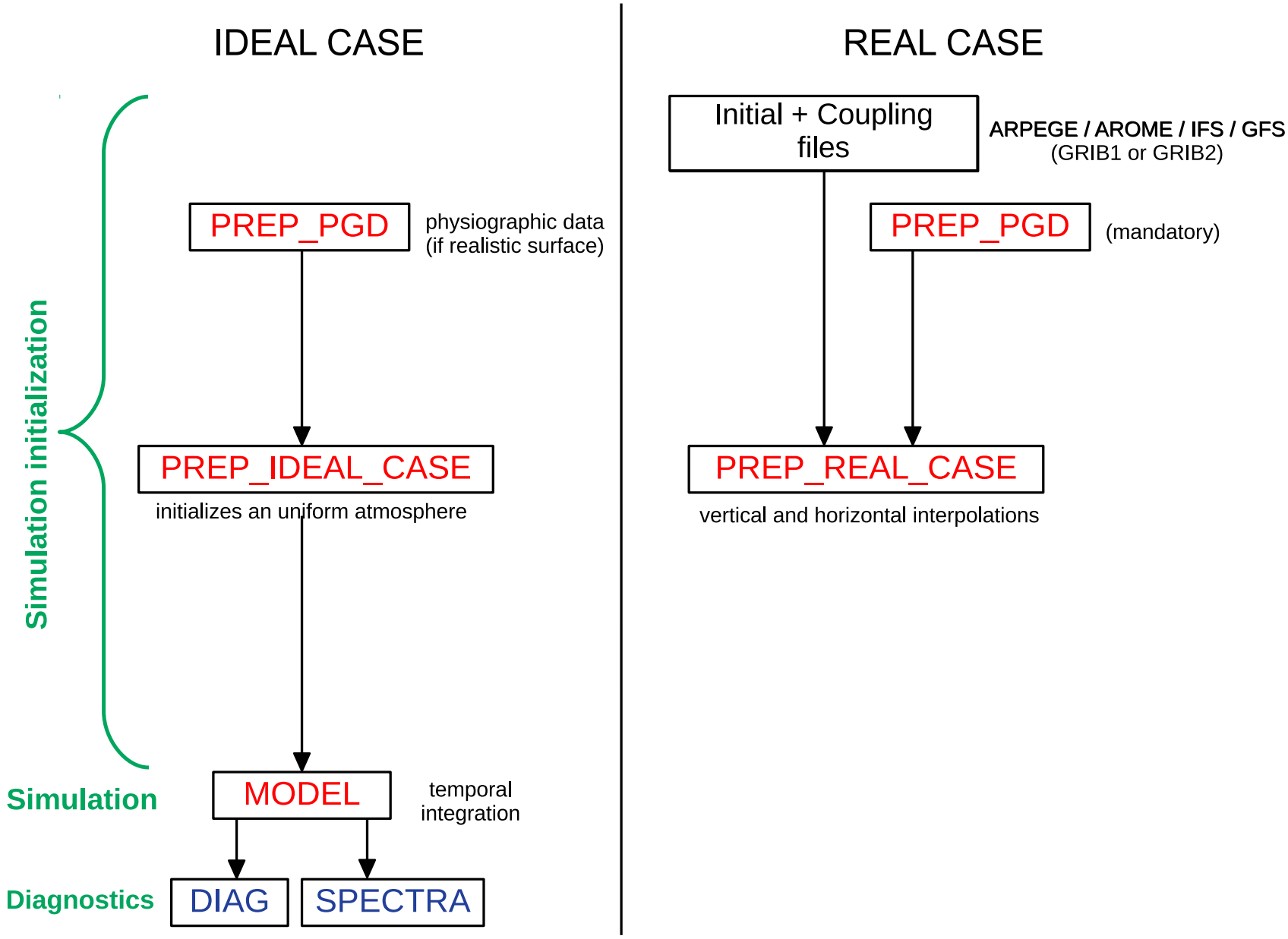
SPECTRA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REAL CASE
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(if realistic surface)
PREP_IDEAL_CASE
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temporal
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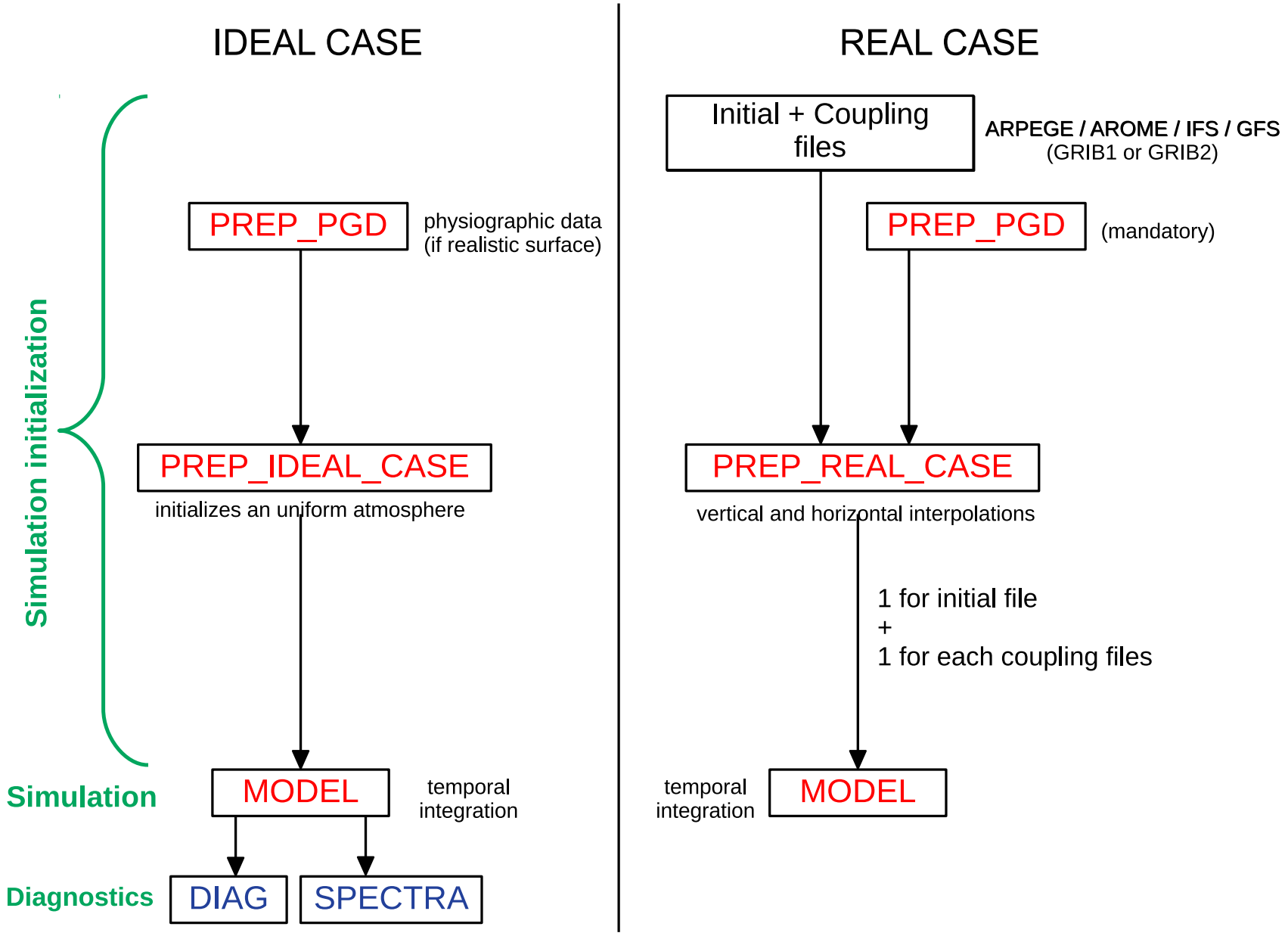
SPECTRA
Initial + Coupling
files
ARPEGE / AROME / IFS / GFS
(GRIB1 or GRIB2)
PREP_PGD
(mandatory)
PREP_REAL_CASE
vertical and horizontal interpolations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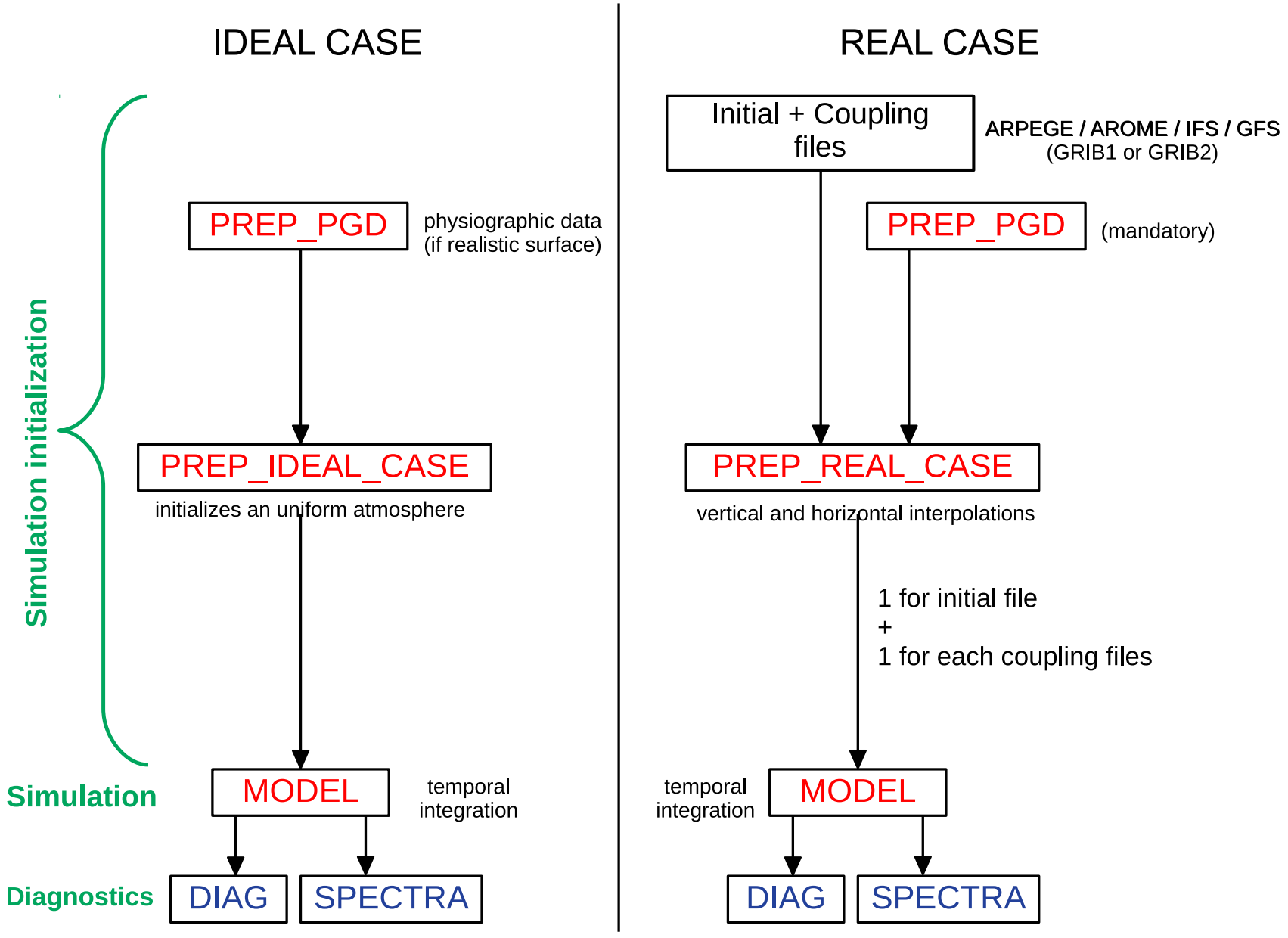
PREP_PGD
(mandatory)
PREP_REAL_CASE
vertical and horizontal interpolations
1 for initial file
+
1 for each coupling files
temporal
integration
MODEL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integration
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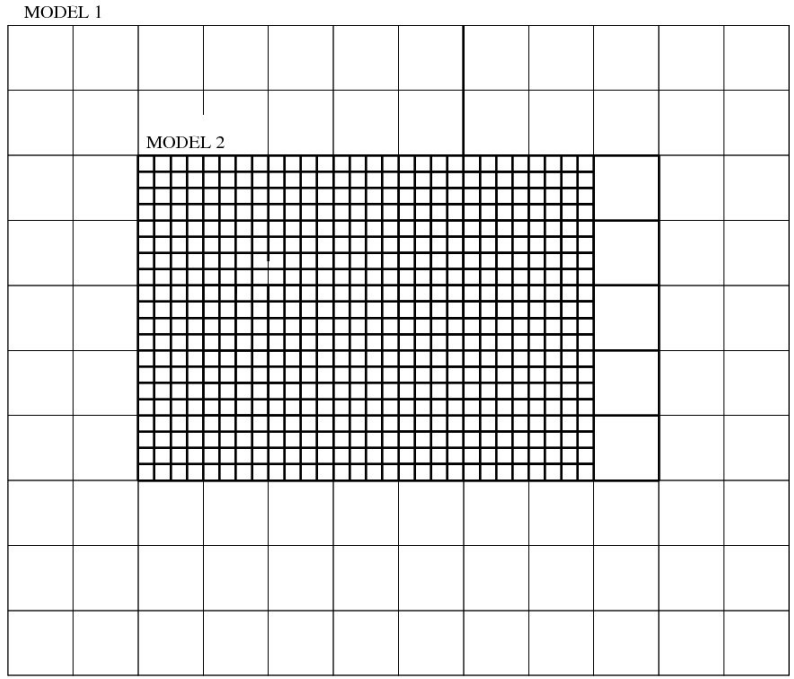
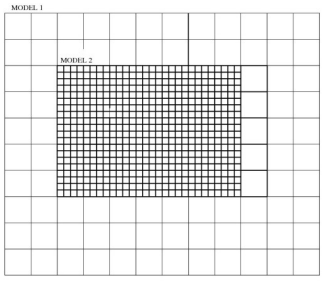
two-domain simulation



IDEAL CASE

REAL CASE

Simulation initialization



Flat surface only

PREP_IDEAL_CASE

initializes an uniform atmosphere

SPAWNING

horizontal interpolation
mod 1 to mod2

Simulation

MODEL

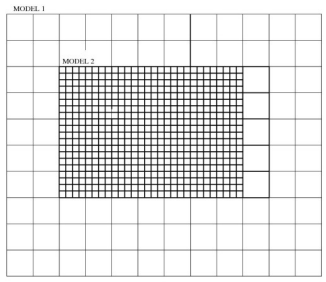
temporal
integration

Diagnostics

DIAG

SPECTRA

IDEAL CASE



Flat surface only

Simulation initialization

PREP_IDEAL_CASE

initializes an uniform atmosphere

SPAWNING

horizontal interpolation
mod 1 to mod2

Simulation

MODEL

temporal integration

Diagnostics

DIAG

SPECTRA

REAL CASE

Initial + Coupling files

ARPEGE / AROME / IFS / GFS
(GRIB1 or GRIB2)

PREP_PGD

PREP_REAL_CASE

vertical and horizontal interpolations

1 for initial file
+
1 for each coupling files

master domain

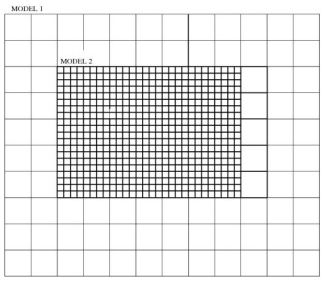
temporal integration

MODEL

DIAG

SPECTRA

IDEAL CASE



Flat surface only

Simulation initialization

PREP_IDEAL_CASE

initializes an uniform atmosphere

SPAWNING

horizontal interpolation
mod 1 to mod2

Simulation

MODEL

temporal
integration

Diagnostics

DIAG

SPECTRA

REAL CASE

Initial + Coupling files

ARPEGE / AROME / IFS / GFS
(GRIB1 or GRIB2)

PREP_PGD

N times

PREP_NEST_PGD

Orography matching

PREP_REAL_CASE

vertical and horizontal interpolations

1 for initial file
+
1 for each coupling files

master domain

temporal
integration

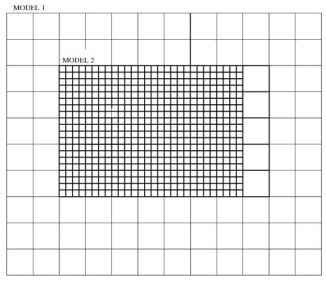
MODEL

DIAG

SPECTRA

IDEAL CASE

Simulation initialization



Flat surface only

PREP_IDEAL_CASE

initializes an uniform atmosphere

SPAWNING

horizontal interpolation
mod 1 to mod2

Simulation

MODEL

temporal integration

Diagnostics

DIAG

SPECTRA

REAL CASE

Initial + Coupling files

ARPEGE / AROME / IFS / GFS
(GRIB1 or GRIB2)

PREP_PGD

N times

PREP_NEST_PGD

Orography matching

PREP_REAL_CASE

vertical and horizontal interpolations

1 for initial file
+
1 for each coupling files

master domain

N-1 times

SPAWNING

PREP_REAL_CASE

sub-domains

temporal integration

MODEL

DIAG

SPECTRA

IDEAL CASE	REAL CASE
1 domain	1 domain

IDEAL CASE	REAL CASE
1 domain 001_prep_ideal_case 002_run_mesonh	1 domain 12h forecast with 1 coupling file every 3h

IDEAL CASE	REAL CASE
1 domain 001_prep_ideal_case 002_run_mesonh	1 domain 001_prep_pgd 002_prep_real_case x5 (1 init + 4 cpl) 003_run_mesonh 12h forecast with 1 coupling file every 3h
2 domains	2 domains

IDEAL CASE	REAL CASE
1 domain 001_prep_ideal_case 002_run_mesonh	1 domain 001_prep_pgd 002_prep_real_case x5 (1 init + 4 cpl) 003_run_mesonh 12h forecast with 1 coupling file every 3h
2 domains 001_prep_ideal_case 002_spawning_D1_to_D2 003_run_mesonh	2 domains

IDEAL CASE	REAL CASE
1 domain 001_prep_ideal_case 002_run_mesonh	1 domain 001_prep_pgd 002_prep_real_case x5 (1 init + 4 cpl) 003_run_mesonh 12h forecast with 1 coupling file every 3h
2 domains 001_prep_ideal_case 002_spawning_D1_to_D2 003_run_mesonh	2 domains 001_prep_pgd_D1 002_prep_pgd_D2 003_prep_nest_pgd

IDEAL CASE	REAL CASE
1 domain 001_prep_ideal_case 002_run_mesonh	1 domain 001_prep_pgd 002_prep_real_case x5 (1 init + 4 cpl) 003_run_mesonh 12h forecast with 1 coupling file every 3h
2 domains 001_prep_ideal_case 002_spawning_D1_to_D2 003_run_mesonh	2 domains 001_prep_pgd_D1 002_prep_pgd_D2 003_prep_nest_pgd 004_prep_real_case_D1 x5 (1 init + 4 cpl) 005_spawning_D1_to_D2 006_prep_real_case_D2 007_run_mesonh

IDEAL CASE	REAL CASE
1 domain 001_prep_ideal_case 002_run_mesonh	1 domain 001_prep_pgd 002_prep_real_case x5 (1 init + 4 cpl) 003_run_mesonh 12h forecast with 1 coupling file every 3h
2 domains 001_prep_ideal_case 002_spawning_D1_to_D2 003_run_mesonh	2 domains 001_prep_pgd_D1 002_prep_pgd_D2 003_prep_nest_pgd 004_prep_real_case_D1 x5 (1 init + 4 cpl) 005_spawning_D1_to_D2 006_prep_real_case_D2 007_run_mesonh
3 domains 001_prep_ideal_case 002_spawning_D1_to_D2	

IDEAL CASE	REAL CASE
1 domain 001_prep_ideal_case 002_run_mesonh	1 domain 001_prep_pgd 002_prep_real_case x5 (1 init + 4 cpl) 003_run_mesonh 12h forecast with 1 coupling file every 3h
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3 domains 001_prep_ideal_case 002_spawning_D1_to_D2 003_spawning_D2_to_D3 004_run_mesonh	3 domains

IDEAL CASE	REAL CASE
1 domain 001_prep_ideal_case 002_run_mesonh	1 domain 12h forecast with 1 coupling file every 3h 001_prep_pgd 002_prep_real_case x5 (1 init + 4 cpl) 003_run_mesonh
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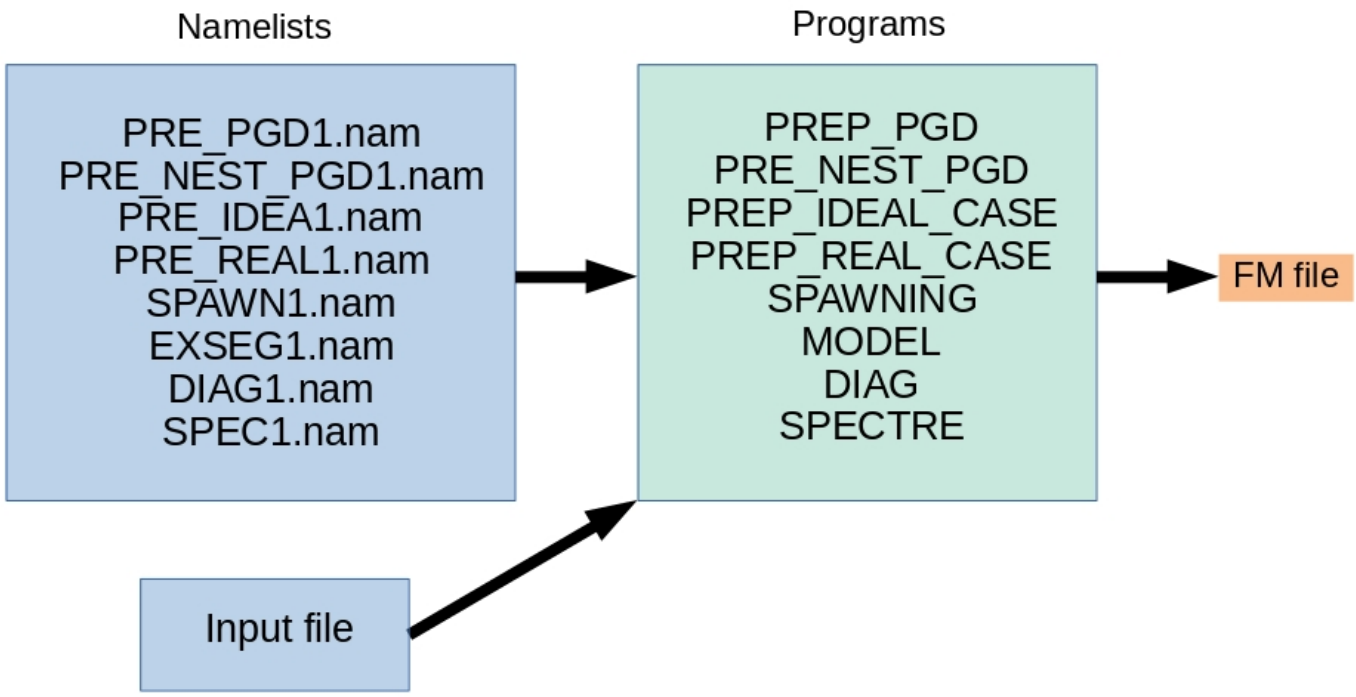
Program and Namelists



Namelists

Definition

- Input file for each program
- Use : set the parameters of the program
- Specific format

Format (Méso-NH)

- Name is fixed (except the number if grid-nesting)
- Avoid tabulating
- Contains sub-namelists (groups)
- Groups start by **&NAM_** and end with /
- If a group is not mentionned ⇒ default values

Lists of groups and options : **user's guide** (Méso-NH + SURFEX)

Namelists : example

```
&NAM_CONFIO   LCDF4=T,
              LLFIOUT=F,
              LLFIREAD=F/

&NAM_LUNITn   CINIFILE = "GABL4.1.ECH13.001",
              CINIFILEPGD='GABL4.1.ECH00.001PGD' /

&NAM_CONFn LUSERV=F/

&NAM_DYNn XTSTEP=0.75,XT4DIFU = 100. /

&NAM_ADVn  CUVW_ADV_SCHEME = "WENO_K",NWENO_ORDER=4,CTEMP_SCHEME='RKC4',
           CMET_ADV_SCHEME = "PPM_01", CSV_ADV_SCHEME = "PPM_01",/

&NAM_PARAMn  CTURB='TKEL', CRAD='NONE', CCLOUD='NONE', CSCONV='NONE',
             CDCONV='NONE'  /

&NAM_LBCn    CLBCX = 2*"CYCL", CLBCY = 2*"CYCL",
             XCPHASE = 10.0 /

&NAM_TURBn XIMPL=1., CTURBLEN='DEAR', CTURBDIM='3DIM',
           LTURB_FLX=T, LTURB_DIAG=T, LSUBG_COND=F,
           XKEMIN=1E-10,
           LSIGMAS=F, LSIG_CONV=F, LRMC01=T /

&NAM_CONF CCONF="RESTA", CEQNSYS ='DUR', LFLAT=T,
          NMODEL=1, NVERB=6, CEXP="GABL4", CSEG="ECH14",
          LFORCING=T, CSPLIT   = 'BSPLITTING',
          NHALO=1, JPHEXT=1 /

&NAM_CONFZ MPI_BUFFER_SIZE=800 /
```

Meso-NH files

MesoNH files format

NC (Netcdf)

format highly recommended

lfi

historical format

3 types of output files :

- synchronous backup
- synchronous on-demand output
- time series

with 2 parts :

- .des : descriptive ascii file (namelists used)
- .nc or .lfi : data + metadata

Backup files

Backup file = Synchronous file

- contains all the variables that describe the atmosphere **at a given time** on the whole domain
- allows communication between the different programs
- domain dimensions and time are identical for all the fields

In the simulation, a synchronous file allows to (re)start the model in several segments (**RESTART**)

Segments

A MESONH simulation can be divided in 1 or several **SEGMENTS**.

Why ?

- subdivide jobs (computing time limit $\Rightarrow$ supercomputer)
  - example : Instead of 1 segment of 24 hours, we can do 4 segments of 6 hours
- have a different number of domain in the segments
  - example : we can have a first segment of 6 hours with 1 domain and a second segment of 12 hours with 2 nested-domains

Backup files : NAM_BACKUP

Fortran name	Fortran type	default value
XBAK_TIME	real(:,:)	8*192* -999.
NBAK_STEP	integer(:,:)	8*192* -999
XBAK_TIME_FREQ	real(:)	-999.
XBAK_TIME_FREQ_FIRST	real(:)	0.
NBAK_STEP_FREQ	integer(:)	-999
NBAK_STEP_FREQ_FIRST	integer(:)	1
LBAK_BEG	logical	.FALSE.
LBAK_END	logical	.FALSE.
CBAK_DIR	character(len=512)	”

Time series

Time series

- contains some chosen variables (flux, tendency, mean) stored at **differents times** during simulation in a part of the domain
- activation of "on-line" diagnostics
- file name ends by .000

Available variables (refer to *Diagnostics* presentation)

- Budgets
- LES
- Aircrafts and balloons
- Stations and profilers

Examples of output files from the run

6 hours run with outputs every 2 hours

1 segment (no RESTART)

Synchronous files (backup)

```
CTRL0.1.SEG01.001
CTRL0.1.SEG01.002
CTRL0.1.SEG01.003
```

Time-series file

```
CTRL0.1.SEG01.000
```

3 segments (RESTART)

1st segment

```
CTRL0.1.SEG01.000
CTRL0.1.SEG01.001
```

2nd segment

```
CTRL0.1.SEG02.000
CTRL0.1.SEG02.001
```

3rd segment

```
CTRL0.1.SEG03.000
CTRL0.1.SEG03.001
```

Highly-frequent and smaller output

On demand smaller output files (optional)

- The user selects a few variables only $\Rightarrow$ smaller files
- NetCDF compression, single precision possible
- Use : huge domain and/or very frequent output (ex : 3D animation)
- Restart not possible from these files
- Available variables : same as in backup files

On-demand outputs : NAM_OUTPUT

Fortran name	Fortran type	default value
COUT_VAR	character(len=32)(:,:)	”
XOUT_TIME	real(:,:)	8*999* -999.
NOUT_STEP	integer(:,:)	8*999* -999
XOUT_TIME_FREQ	real(:)	-999.
XOUT_TIME_FREQ_FIRST	real(:)	0.
NOUT_STEP_FREQ	integer(:)	-999
NOUT_STEP_FREQ_FIRST	integer(:)	1
LOUT_BEG	logical	.FALSE.
LOUT_END	logical	.FALSE.
LOUT_REDUCE_FLOAT_PRECISION	logical	.FALSE.
LOUT_COMPRESS	logical	.FALSE.
NOUT_COMPRESS_LEVEL	integer	4
COUT_DIR	character(len=512)	”