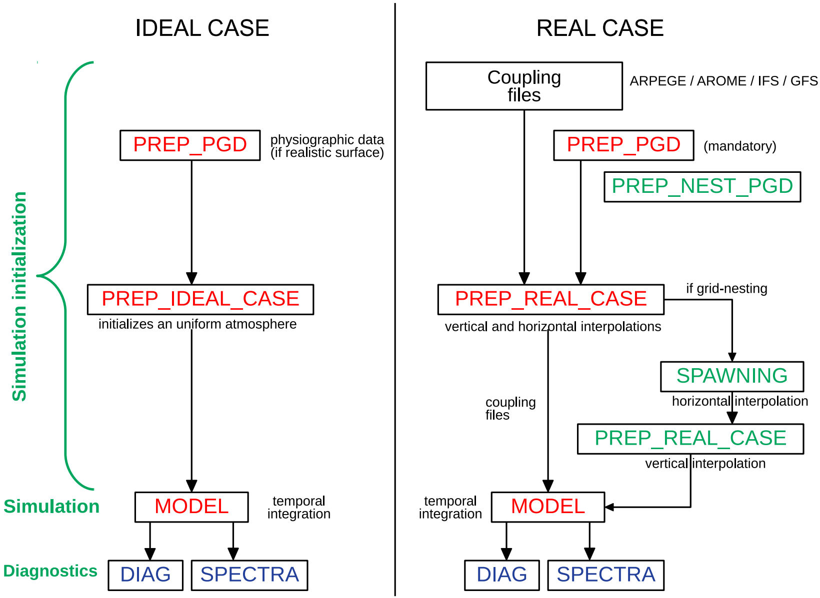
Ideal case

MesoNH Tutorial Class 1-4 December 2025


IDEAL CASE
REAL CASE
Simulation initialization
PREP_PGD
physiographic data
(if realistic surface)
PREP_IDEAL_CASE
initializes an uniform atmosphere
Simulation
MODEL
temporal
integration
Diagnostics
DIAG
SPECTRA
Coupling
files
ARPEGE / AROME / IFS / GFS
PREP_PGD
(mandatory)
PREP_NEST_PGD
PREP_REAL_CASE
if grid-nesting
vertical and horizontal interpolations
SPAWNING
horizontal interpolation
coupling
files
PREP_REAL_CASE
vertical interpolation
temporal
integration
MODEL
DIAG
SPECTRA

Interests

- theorical study :
  from initial idealised fields
  in 1D,2D,3D configuration
  in cartesian geometry or conformal projection
- tests of validation

How does it work ?

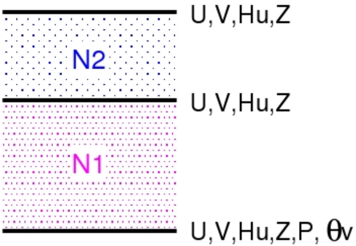
The user

1. specifies an uniform atmosphere from a profile
2. can add a perturbation
3. initializes the surface fields : idealised or realistic

Uniform state

Vertical profile defined by :

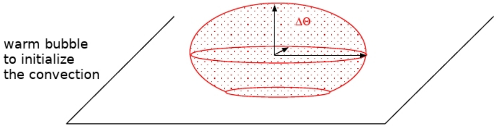
- some layers with constant Brunt-Väisälä frequency, wind and humidity at the interfaces : **CIDEAL='CSTN'**



- or data from a radio-sounding : **CIDEAL='RSOU'**

Analytical perturbations

- on thermodynamic fields



- on potential temperature : white noise for LES simulations
- on non-divergent components of the wind

namelist &NAM_PERT_PRE
to modify according to the user's needs : routine set_perturb.f90

Forcing terms

1D chronological serie to impose a large-scale environment :

- constant translation of the domain, geostrophic forcing (u_{frc},v_{frc})
- vertical transport : w_{frc}
- horizontal transport : $\left.\frac{\partial\theta}{\partial x}\right|_{frc}$, $\left.\frac{\partial\theta}{\partial y}\right|_{frc}$, $\left.\frac{\partial r_v}{\partial x}\right|_{frc}$, $\left.\frac{\partial r_v}{\partial y}\right|_{frc}$
- newtonian force : u_{frc}, v_{frc}, θ_{frc}, r_{vfrc}
- tendency : $\left.\frac{\partial\theta}{\partial t}\right|_{frc}$, $\left.\frac{\partial r_v}{\partial t}\right|_{frc}$, $\left.\frac{\partial u}{\partial t}\right|_{frc}$, $\left.\frac{\partial v}{\partial t}\right|_{frc}$

Surface fields

- Orography (namelist &NAM_CONF_PRE) :
  - idealised : flat (CZS='FLAT'), sinusoidal (CZS='SINE') or bell-shaped (CZS='BELL')
  - real : discretised (CZS='DATA') or read in a MesoNH PGD file
- Physiographic data (land-sea mask, type of cover SST, LAI, lay, sand...)
  - idealised : uniform
  - realistic : MesoNH PGD
- Prognostic fields (ground temperatures `TG_SURF, _ROOT _DEEP`, water contents `WG_SURF, _ROOT _DEEP`)
  - idealised : uniform
  - realistic : from a file from an operational model or from a MesoNH file

PREP_IDEAL_CASE

PREP_IDEAL_CASE

- computation of the horizontal grid (cartesian or conformal) and vertical one
- interpolation of the atmospheric fields with respect to :
  - hydrostatic balance
  - possible geostrophic balance
  - correction of u, v, w by the pressure solver

  to verify the ground condition and the anelastic constraint
- computation of the profiles of the reference state (anelastic approximation)
- writing in a NetCDF file of all the fields necessary for a simulation (prognostic : u, v, w, θ, r_v diagnostic P, surface fields)

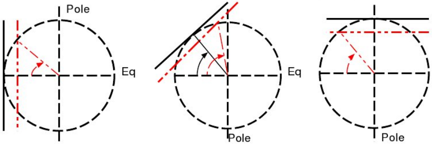
Choice of the horizontal grid

- number of points : $\texttt{IMAX} = 2^p * 3^q * 5^r$, $\texttt{JMAX} = 2^s * 3^t * 5^u$
- meshes : `DELTAX, DELTAY` (in meters)

1 2 3 4 5 6 8 9 10 12 15 16 18 20 24 25 27 30 32 36 40 45 48 50 54 60 64 72 75 80 81 90 96 100 108 120 125 128 135 144 150 160 162 180 192 200 216 225 240 243 250 256 270 288 300 320 324 360 375 384 400 405 432 450 480 486 500 512 540 576 600 625 640 648 675 720 729 750 768 800 810 864 900 960 972 1000 1024 1080 1125 1152 1200 1215 1250 1280 1296 1350 1440 1458 1500 1536 1600 1620 1728 1800 1875 1920 1944 2000 2025 2048 2160 2187 2250 2304 2400 2430 2500 2560 2592 2700 2880 2916 3000 3072 3125 3200 3240 3375 3456 3600 3645 3750 3840 3888 4000 4050 4096 4320 4374 4500 4608 4800 4860 5000 5120 5184 5400 5625 5760 5832 6000 6075 6144 6250 6400 6480 6561 6750 6912 7200 7290 7500 7680 7776 8000 8100 8192 8640 8748 9000 9216 9375 9600 9720 10000 10125 10240 10368 10800 10935 11250 11520 11664 12000 12150 12288 12500 etc

- Domain geometry
  - a **cartesian geometry** (`LCARTESIAN=T`) : Earth sphericity isn't take in account (for small scale phenomena),
  - **conformal projection**.

	Mercator	Lambert Conforme	Stéréographique Polaire
	(cylindrique)	(conique)	(plane)

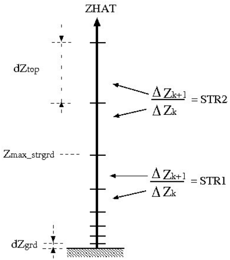


	XRPK=0	0<XRPK<1	XRPK=1
		(-1<XRPK<0)	(XRPK=-1)
tangent	(XLAT0=0)	(0<XLAT0<90)	(XLAT0=90)
sécant	(0<XLAT0<90)	(0<XLAT0<90)	(0<XLAT0<90)
domaines :	lat. tropicales	lat. tempérées	lat. polaires

Choice of the vertical grid

number of points : `KMAX`
discretisation :

- manual : list of levels `ZHAT(1), ZHAT(2), ..., ZHAT(NKMAX)`
- or analytical (logarithmic with z) : Computation of `ZHAT` from :



_ ΔZ at ground (ZDZGRD)
_ ΔZ at top (ZDZTOP)
_ STRetching ($0 \leq \Delta Z^{k+1}/\Delta Z^{k} < 10\%$) :
$ZSTRGRD$ for $z \in [0, ZZMAX\_STRGRD]$
$ZSTRTOP$ for $z > ZZMAX\_STRGRD$

Vertical grid

A program is available on the website (Miscellaneous section)

```
&NAM_VER_GRID NKMAX=30, number of points in Z
              YZGRID_TYPE='FUNCTN', FUNCTN or MANUAL
              ZDZGRD=60., ZDZTOP=700., ΔZ at ground/at top
              ZZMAX_STRGRD=2500., Height for streching change
              ZSTRGRD=9.,ZSTRTOP=7. /streching at ground/at top
```

```
 Enter nb of levels KMAX and the level ZMAX_STRGRD:
30 2500
 Enter mesh size at groud and at the top:ZGRD, ZTOP
60 700
  Enter low- and high- level stretching: SGRD, STOP:
9 7
 altitude           3  :    60.0000000      -    60.0000000
 altitude           4  :    125.400002      -    65.4000015
 altitude           5  :    196.686005      -    71.2860031
 altitude           6  :    274.387756      -    77.7017517
 altitude           7  :    359.082672      -    84.6949158
 altitude           8  :    451.400146      -    92.3174744
 altitude           9  :    552.026184      -    100.626038
 altitude          10  :    661.708557      -    109.682373
 altitude          11  :    781.262329      -    119.553772
 altitude          12  :    911.575928      -    130.313599
 altitude          13  :    1053.61780      -    142.041870
 altitude          14  :    1208.44348      -    154.825684
 altitude          15  :    1377.20349      -    168.760010
 altitude          16  :    1561.15186      -    183.948364
 altitude          17  :    1761.65552      -    200.503662
 altitude          18  :    1980.20447      -    218.548950
 altitude          19  :    2218.42285      -    238.218384
 altitude          20  :    2478.08081      -    259.657959
```

PRE_IDEA1.nam

```
&NAM_DIMn_PRE NIMAX=30, NJMAX=30 / number of points in i and j

&NAM_CONF_PRE LCARTESIAN=.TRUE., cartesian geometry
              CEQNSYS='LHE', choice of equation system
              CZS='BELL',   choice of orography
              CIDEAL='CSTN', type of initialisation of the atmosphere
              LPERTURB=.T. / add perturbation

&NAM_GRIDH_PRE XDELTAX=4 .E3, XDELTAY=4.E3,   mesh in X and Y
             XHMAX=1000., XAX=10.E3, XAY=10.E3  define
             NIZS=16, NJZS=16/                   the bell

&NAM_VER_GRID NKMAX=24, number of vertical levels
             ZDZGRD=500., ZDZTOP=500. / ΔZ at top and at ground

&NAM_PERT_PRE CPERT_KIND='TH',type of perturbation
              XAMPLITH=1.5,max amplitude for θ
              XCENTERZ=1500.,height for Δθmax
size of perturbationXRADX=10.E3,XRADY=10.E3, XRADZ=600. /
```

```
&NAM_LUNITn CINIFILE='BILAN.1' /
```
name of output file

```
&NAM_LBCn_PRE CLBCX = 2*"OPEN",
              CLBCY = 2*"OPEN" /
```
lateral boundary conditions

```
&NAM_VPROF_PRE CTYPELOC='IJGRID',
               NILOC=10, NJLOC=10,
               LGEOSBAL=.FALSE. /
```
variables to defined the profile, *localisation of vertical profile*, *no geostrophic balance*

CSTN	
2000 01 01 0.	*date*
2	*number of levels*
285.	θ_v *at ground*
100000.	*P at ground*
0. 20000.	*height at all levels*
10. 10.	*zonal wind component at all levels*
0. 0.	*meridian wind component at all levels*
0. 0.	*relative humidity at all levels*
0.01	*Brünt-Vaisala frequency at all layers*

MODEL

EXSEG1.nam

```
&NAM_LUNITn CINIFILE = "BILAN.1" /initial file

&NAM_DYNn XTSTEP = 40.,   time step (s)
          CPRESOPT = "CRESI", LITRADJ = T,pressure solver
horizontal LHORELAX_UVWTH = T, LHORELAX_RV = T,
relaxation NRIMX = 6, NRIMY = 6, XRIMKMAX = 0.0005,
          LVE_RELAX = T,vertical relaxation
          /

&NAM_ADVn CUVW_ADV_SCHEME = "WENO_K" ,advection scheme for U,V
          NWENO_ORDER=5 , CTEMP_SCHEME='RK53'
          CMET_ADV_SCHEME = "PPM_01", /for θ,r,TKE

&NAM_PARAMn CCLOUD = "ICE3",CTURB = "TKEL",
              microphysic        turbulence
             CDCONV = "KAFR",CSCONV = "NONE",
              deep convection  shallow convection
             CRAD = "ECMW" /radiative scheme
```

```
&NAM_PARAM_KAFRn XDTCONV = 300., NICE = 1,
parameters for convection KAFR  LDIAGCONV = F /

&NAM_PARAM_RADn XDTRAD = 1800., XDTRAD_CLONLY = 900.,
parameters for radiative scheme LCLEAR_SKY = F /

&NAM_TURBn CTURBDIM = "1DIM", CTURBLEN = "BL89",
turbulence       LSUBG_COND = F,
parameters       LTURB_FLX = F, LTURB_DIAG = F /

&NAM_LBCn CLBCX = 2*"OPEN", CLBCY = 2*"OPEN" /

&NAM_CONF CCONF = "START", configuration START or RESTA
          CEQNSYS = "LHE", Equation system
          NMODEL = 1, NVERB = 5,  number of models / verbosity
          CEXP = "CTRL0", CSEG = "SEG01",
          LLG = T /

&NAM_DYN XSEGLEN = 10800., segment length (s)
         XASSELIN = 0.2, LCORIO = T,
         XALKTOP = 0.001, XALZBOT = 14000. /
          parameters for vertical relaxation
```

```
&NAM_BACKUP XBAK_TIME(1,1) = 3600,  backup files
            XBAK_TIME(1,2) = 7200, XBAK_TIME(1,3) = 10800/

&NAM_BUDGET CBUTYPE='CART', XBULEN=600., XBUWRI=1800.
 parameters  NBUIL=50, NBUIH=60, NBUJL=50,
 for         NBUJH=65, NBUKL=2, NBUKH=10,
 BUDGET      LBU_KCP=F, LBU_ICP=T, LBU_JCP=T /

&NAM_BU_RTH LBU_RTH=T, CBULIST_RTH(1)="ALL"  budget for θ

&NAM_CONFIO LCDF4=T LLFIOUT=T LLFIREAD=F / IO netcdf/FM

&NAM_LES /  LES diagnostics

&NAM_SERIES /  temporal series

&NAM_BLANKn /
```

Name of backup file

Backup files from the run are named :

`CEXP.NMODEL.CSEG.00n`

`CEXP` et `CSEG` must have EXACTLY 5 characters

Example :

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

synchronous files

all the variables at a given time

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

time-series files

temporal series, budget....

Simulations with SURFEX

PRE_IDEA1.nam :

With an input PGD file

```
&NAM_GRn_PRE CSURF='EXTE' /

&NAM_REAL_PGD CPGD_FILE = 'REUNION_PGD_1km5',
              LREAD_ZS= T, LREAD_GROUND_PARAM= T /

&NAM_LUNITn CINIFILE = 'REUNION_IDEA',
            CINIFILEPGD = 'REUNION_PGD_1km5' /
```

Without an input PGD file : 2 files in output(initial + PGD)

```
&NAM_GRn_PRE CSURF='EXTE' /

&NAM_LUNITn CINIFILE = 'REUNION_IDEA',
            CINIFILEPGD = 'REUNION_PGD_1km5' /
```

EXSEG1.nam :

```
&NAM_LUNITn CINIFILE = "BILAN.1" /
```

initial file

```
            CINIFILEPGD = "REUNION_PGD_1km5" /
```

PGD file associated to the initial file