

Common standards for SCM/LES simulations

Proposal from the DEPHY community

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and the DEPHY community

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Why a common standard for SCM/LES input?

Main objectives:

- Facilitate the sharing and traceability of SCM/LES cases among the modeling community
 - Ease the implementation of new cases in each SCM/LES
 - Share experience, choices in the way cases are implemented in our SCM/LES
 - Ensure the consistency of SCM/LES simulations when comparing them, and thereby, gather the process and modeling communities
 - Make it easier for a model user to develop and test its own SCM cases
 - *Also a way to formalize the forcing types of a single-column model (and to some extent LES)*
-
- All the details of a SCM/LES case in one self-documented file
 - Gather and document SCM/LES cases in one (possibly interactive) place

Note however:

- *Seek for a format as general as possible, but which may not be able to include everything*
- Many things can be automatized from such a file but careful checks of physical consistency should be done
- Output standard format also needs to be thought about: useful for sharing common tools (atlas, tuning tools...)
 - For this week and for facilitating the exchanges, a (short) proposal :
https://docs.google.com/spreadsheets/d/1KoCMARVRMoRr31TxN9XBMufuJG8SxggC5OLHN_1twmU/edit#gid=0

A few principles (so far)

- Naming the cases: CASES/SUBCASE. e.g. ARMCU/REF, RICO/SHORT, SANDU/REF, SANDU/FAST, AYOTTE/24SC...
- Everything in a unique self-documented netCDF file
- Each SCM/LES should ideally have an inline/offline interface to this unique file to prepare and run the case/subcase simulation
- Per case/subcase:
 - A **first 'DEF' file** containing the case setup as close as possible to the one defined in the reference paper, used in the reference intercomparison...
 - A **second 'SCM-enabled' file** making the case implementation easier in usual SCM (variable conversion, common grid, interpolation/extrapolation...) and possibly in LES
 - **Traceability** of the 'DEF' file construction and of the passage from 'DEF' to 'SCM'
- Possibly benefit from previous initiatives (e.g., SCM/LES intercomparisons, GCSS/GASS, individual centers) and other community formats (CF, CMIP...)
- Whenever possible, being easily upgradeable
- Facilitate co-development of related tools

Main features of the proposed standard

Version 0: [https://github.com/GdR-DEPHY/DEPHY-SCM/blob/master/DEPHY Format Version 0.pdf](https://github.com/GdR-DEPHY/DEPHY-SCM/blob/master/DEPHY%20Format%20Version%200.pdf)

Version 1 (on construction, for discussion): <https://docs.google.com/document/d/118xP04jB9HO7Y2LqWk3HZpZ9n3CFuigzimLI7Ug8vO4/edit>

First implementation: <https://github.com/GdR-DEPHY/DEPHY-SCM>

Available cases: ARMCU/REF, AYOTTE/*, RICO/SHORT, SANDU/REF, GABLS1, GABLS4/*, DYNAMO/NSA3A

Base on Python 2, with a Case object. *Only a few required Python packages (numpy, scipy, netCDF4, matplotlib).*

GdR-DEPHY / DEPHY-SCM

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No description, website, or topics provided.

63 commits 2 branches 0 packages 0 releases 3 contributors

Branch: master New pull request Create new file Upload files Find file Clone or download

GdR-DEPHY Add GABLS4 STAGE3/STAGE3-SHORT		Latest commit 4796821 2 days ago
ARMCU	Bugfix in advective forcing for DYNAMO/NSA3A	8 days ago
AYOTTE	Update AYOTTE READMEs	2 months ago
DYNAMO	Bugfix in advective forcing for DYNAMO/NSA3A	8 days ago
GABLS1	Add GABLS4 STAGE3/STAGE3-SHORT	2 days ago
GABLS4	Add GABLS4 STAGE3/STAGE3-SHORT	2 days ago
RICO	Update RICO with DEPHY format version 0	5 months ago
SANDU	Update SANDU with DEPHY format Version 0	5 months ago
utils	Add other AYOTTE cases (Fleur Couvreur)	2 months ago
.gitignore	Update ARMCU readme	7 months ago
DEPHY_Format_Version_0.pdf	Add DEPHY format document for v0	5 months ago
README.md	Some update and corrections	6 months ago
test	Bugfix in advective forcing for DYNAMO/NSA3A	8 days ago

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Create new file

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Branch: master DEPHY-SCM / ARMCU / REF /

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GdR-DEPHY Bugfix in advective forcing for DYNAMO/NSA3A Latest commit ee8743f 8 days ago		
..		
check_old	Update ARMCU/REF with DEPHY Format Version 0	5 months ago
images	Bugfix in advective forcing for DYNAMO/NSA3A	8 days ago
ARMCU_REF_DEF_driver.nc	Update ARMCU/REF with DEPHY Format Version 0	5 months ago
ARMCU_REF_SCM_driver.nc	Update ARMCU/REF with DEPHY Format Version 0	5 months ago
README.ipynb	Update ARMCU/REF with DEPHY Format Version 0	5 months ago
README.md	Update organization + make it work for RICO/SHORT	6 months ago
driver_DEF.py	Update ARMCU/REF with DEPHY Format Version 0	5 months ago
driver_SCM.py	Some update and corrections	6 months ago

README.md

ARM Cumulus case - 22 June 1997

Further information [here](#).

Main features of the proposed standard

Example with ARMCU/REF: Diurnal cycle of shallow cumulus over land, observed over the US SGP ARM site on 21-22 June 1997 (Brown et al. 2002, Lenderink et al. 2004).

See also <https://github.com/GdR-DEPHY/DEPHY-SCM/tree/master/ARMCU/REF>

Initial state

z	θ	r_t	u	v
(m)	(K)	(g kg ⁻¹)	(m s ⁻¹)	(m s ⁻¹)
0	299.00	15.20	10	0
50	301.50	15.17	10	0
350	302.50	14.98	10	0
650	303.53	14.80	10	0
700	303.70	14.70	10	0
1300	307.13	13.50	10	0
2500	314.00	3.00	10	0
5500	343.20	3.00	10	0

$$\rho e = 0.15 \left(1 - \frac{z}{150} \right) \text{ kg m}^{-1} \text{ s}^{-2} \text{ if } z < 150\text{m}$$

$$= 0 \text{ if } z \geq 150\text{m}$$

Boundary conditions

Time	H	LE
(UTC)	(W m ⁻²)	(W m ⁻²)
11:30	-30	5
15:30	90	250
18:00	140	450
19:00	140	500
21:30	100	420
00:00	-10	180
02:00	-10	0

Large-scale forcing

Wind geostrophic forcing +

$$\left. \frac{\partial \theta}{\partial t} \right|_{\text{LS}} = \left. \frac{\partial \theta}{\partial t} \right|_{\text{adv}} + \left. \frac{\partial \theta}{\partial t} \right|_{\text{rad}} = A_\theta + R_\theta \quad \text{if } z < 1000\text{m}$$

$$= (A_\theta + R_\theta) \left(1 - \frac{z - 1000}{2000} \right) \quad \text{if } 1000 \leq z < 3000\text{m}$$

$$= 0 \quad \text{if } z \geq 3000\text{m}$$

Time	A_θ	R_θ	A_{r_t}
(UTC)	(K h ⁻¹)	(K h ⁻¹)	(g kg h ⁻¹)
11:30	0.000	-0.125	0.080
14:30	0.000	0.000	0.080
17:30	0.000	0.000	-0.040
20:30	-0.080	0.000	-0.100
23:30	-0.160	0.000	-0.160
02:30	-0.160	-0.100	-0.300

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Case definition: use of global attributes

```
:case = "ARMCU/REF" ;
:title = "Forcing and initial conditions for ARM-Cumulus case - Original
definition" ;
:reference = "http://projects.knmi.nl/eurocs/ARM/case_ARM_html ; Brown et
al. (2002, QJRM5)" ;
:author = "R. Roehrig" ;
:version = "Created on Tue Jan 21 15:46:09 2020" ;
:format_version = "DEPHY SCM format version 0" ;
:modifications = "" ;
:script = "DEPHY-SCM/ARMCU/REF/driver_DEF.py" ;
:comment = "" ;
:startDate = "19970621113000" ;
:endDate = "19970622020000" ;
:adv_temp = 0 ;
:adv_theta = 1 ;
:adv_thetal = 0 ;
:rad_temp = 0 ;
:rad_theta = "adv" ;
:rad_thetal = 0 ;
```

Start and end dates
of the simulation

Indicate what should
be read in the file

Radiative term is already
included in large-scale
advection of theta (+
radiation is deactivated)

```
:adv_qv = 0 ;
:adv_qt = 0 ;
:adv_rv = 0 ;
:adv_rt = 1 ;
:forc_w = 0 ;
:forc_omega = 0 ;
:forc_geo = 1 ;
:nudging_u = 0 ;
:nudging_v = 0 ;
:nudging_temp = 0 ;
:nudging_theta = 0 ;
:nudging_thetal = 0 ;
:nudging_qv = 0 ;
:nudging_qt = 0 ;
:nudging_rv = 0 ;
:nudging_rt = 0 ;
:zorog = 314. ;
:z0 = 0.035 ;
:surfaceType = "land" ;
:surfaceForcing = "surfaceFlux" ;
:surfaceForcingWind = "z0" ;
```

Indicate what should
be read in the file
(advectations,
geostrophic wind)

No nudging

Surface forcing is given by
surface fluxes. Surface wind
stress is computed using
the given z_0

Main features of the proposed standard

So far, implemented forcing:

	ARMCU/REF	AYOTTE/24SC	RICO/SHORT	SANDU/REF	DYNAMO/NSA3A	
adv_temp/theta/thetal	1	0	1	0	1	
rad_temp/theta/thetal	adv	adv	adv	0	0	
adv_qv	1	0	1	0	1	
forc_w	0	0	1	1	0	
forc_omega	0	0	0	0	1	
forc_geo	1	1	1	1	0	
<hr/>						
nudging_u/v	0	0	0	0	10800.0	} in seconds
nudging_temp/theta/thetal	0	0	0	3600.0	10800.0	
nudging_qv	0	0	0	3600.0	10800.0	
p_nudging_u/v	-	-	-	-	110000.0	} in Pascals
p_nudging_temp/theta/thetal	-	-	-	71481	5000	
p_nudging_qv	-	-	-	71481	5000	
z_nudging_u/v	-	-	-	-	0	} in meters
z_nudging_temp/theta/thetal	-	-	-	3000	20693	
z_nudging_qv	-	-	-	3000	20693	
<hr/>						
zorog	314.0	0.0	0.0	0.0	0.0	
z0	0.035	0.16	-	-	-	
surfaceType	land	land	ocean	ocean	ocean	
surfaceForcing	surfaceFlux	surfaceFlux	ts	ts	ts	
surfaceForcingWind	z0	z0	-	-	-	

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Example with ARMCU/REF: Diurnal cycle of shallow cumulus over land, observed over the US SGP ARM site on 21-22 June 1997 (Brown et al. 2002, Lenderink et al. 2004).

See also <https://github.com/GdR-DEPHY/DEPHY-SCM/tree/master/ARMCU/REF>

Initial state

Axes

```
double t0(t0) ;
    t0:long_name = "Initial time" ;
    t0:units = "seconds since 1997-06-21 11:30:00" ;
    t0:calendar = "gregorian" ;
double lat(lat) ;
    lat:long_name = "Latitude" ;
    lat:units = "degrees_north" ;
double lon(lon) ;
    lon:long_name = "Longitude" ;
    lon:units = "degrees_east" ;
double lev_X(lev_X) ;
    lev_X:long_name = "altitude for variable X" ;
    lev_X:units = "m" ;
```

Variables

```
float ps(t0, lat, lon) ;
    ps:long_name = "Surface pressure" ;
    ps:units = "Pa" ;
float u(t0, lev_u, lat, lon) ;
    u:long_name = "Zonal wind" ;
    u:units = "m s-1" ;
float v(t0, lev_v, lat, lon) ;
    v:long_name = "Meridional wind" ;
    v:units = "m s-1" ;
float theta(t0, lev_theta, lat, lon) ;
    theta:long_name = "Potential temperature" ;
    theta:units = "K" ;
float rt(t0, lev_rt, lat, lon) ;
    rt:long_name = "Total Water mixing ratio" ;
    rt:units = "kg kg-1" ;
float tke(t0, lev_tke, lat, lon) ;
    tke:long_name = "Turbulent kinetic energy" ;
    tke:units = "m2 s-2" ;
```

Main features of the proposed standard

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See also <https://github.com/GdR-DEPHY/DEPHY-SCM/tree/master/ARMCU/REF>

Boundary conditions and large-scale forcing

Axes

```
double time_X(time_X) ;
    time_X:long_name = "Forcing time for variable X" ;
    time_X:units = "seconds since 1997-06-21 11:30:00" ;
double lat(lat) ;
    lat:long_name = "Latitude" ;
    lat:units = "degrees_north" ;
double lon(lon) ;
    lon:long_name = "Longitude" ;
    lon:units = "degrees_east" ;
double lev_X(lev_X) ;
    lev_X:long_name = "altitude for variable X" ;
    lev_X:units = "m" ;
```

Variables

```
float ug(time_ug, lev_ug, lat, lon) ;
    ug:long_name = "Geostrophic zonal wind" ;
    ug:units = "m s-1" ;
float vg(time_vg, lev_vg, lat, lon) ;
    vg:long_name = "Geostrophic meridional wind" ;
    vg:units = "m s-1" ;
    lev_theta_adv:units = "m" ;
float theta_adv(time_theta_adv, lev_theta_adv, lat, lon) ;
    theta_adv:long_name = "Potential large-scale advection" ;
    theta_adv:units = "K s-1" ;
float rt_adv(time_rt_adv, lev_rt_adv, lat, lon) ;
    rt_adv:long_name = "Total water mixing ratio large-scale advection" ;
    rt_adv:units = "kg kg-1 s-1" ;
float sfc_sens_flx(time_sfc_sens_flx, lat, lon) ;
    sfc_sens_flx:long_name = "Surface sensible heat flux" ;
    sfc_sens_flx:units = "W m-2" ;
float sfc_lat_flx(time_sfc_lat_flx, lat, lon) ;
    sfc_lat_flx:long_name = "Surface latent heat flux" ;
    sfc_lat_flx:units = "W m-2" ;
```

Main features of the proposed standard

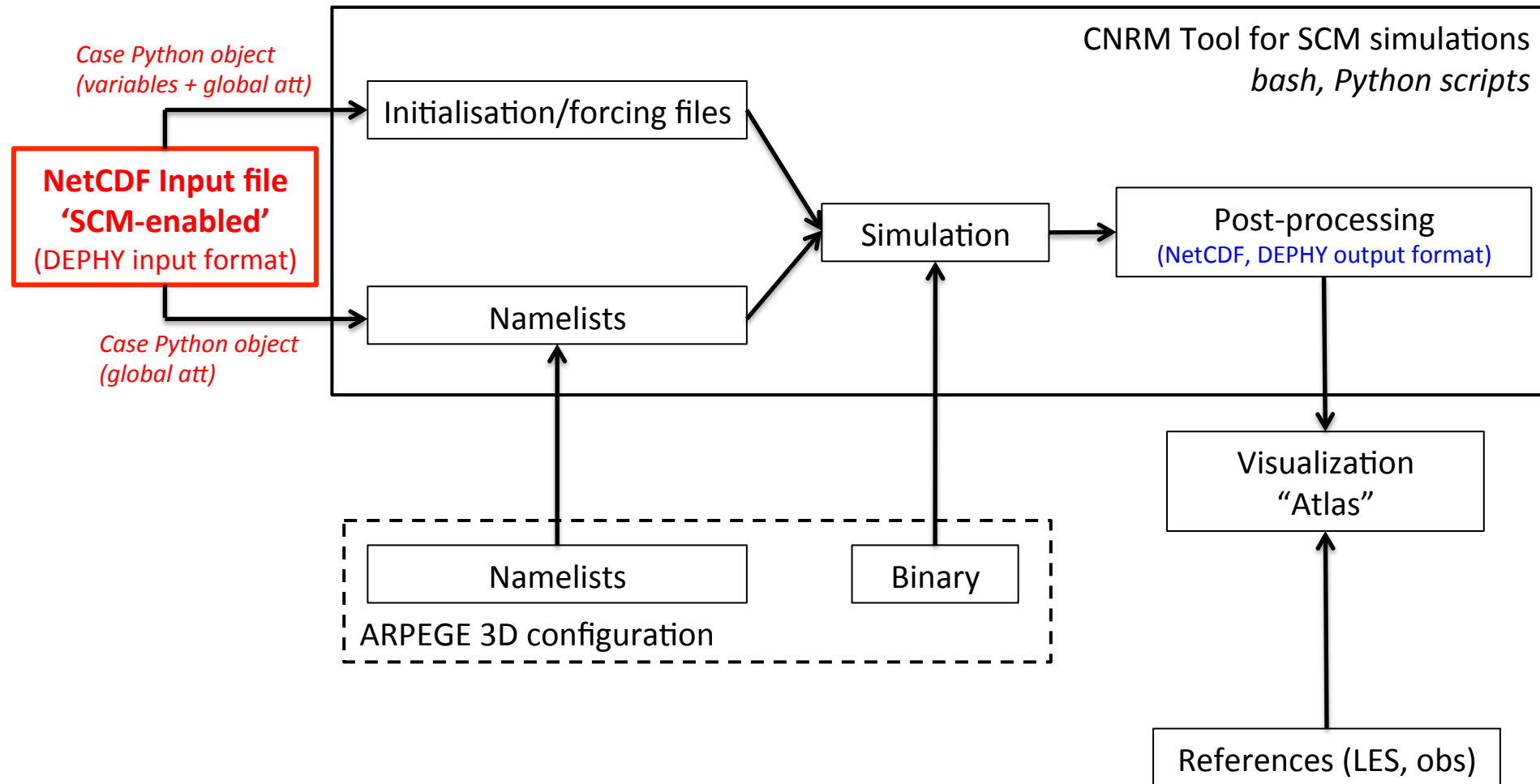
Going from the 'DEF' to 'SCM-enabled' file:

- Philosophy : provide a more simple file, mostly ready to use by any SCM
(Or provide the tool that helps to do it)
- Same level axis for all variables, thus interpolation, possibly on a fine vertical grid, and with conservative variables
- Same time axis for all forcing variables (thus time interpolation)
- Consistently compute all variables that could be required by any SCM (e.g., temp, theta, thetal...)
- Possibly extrapolate over the whole atmosphere, add 'missing' variables...

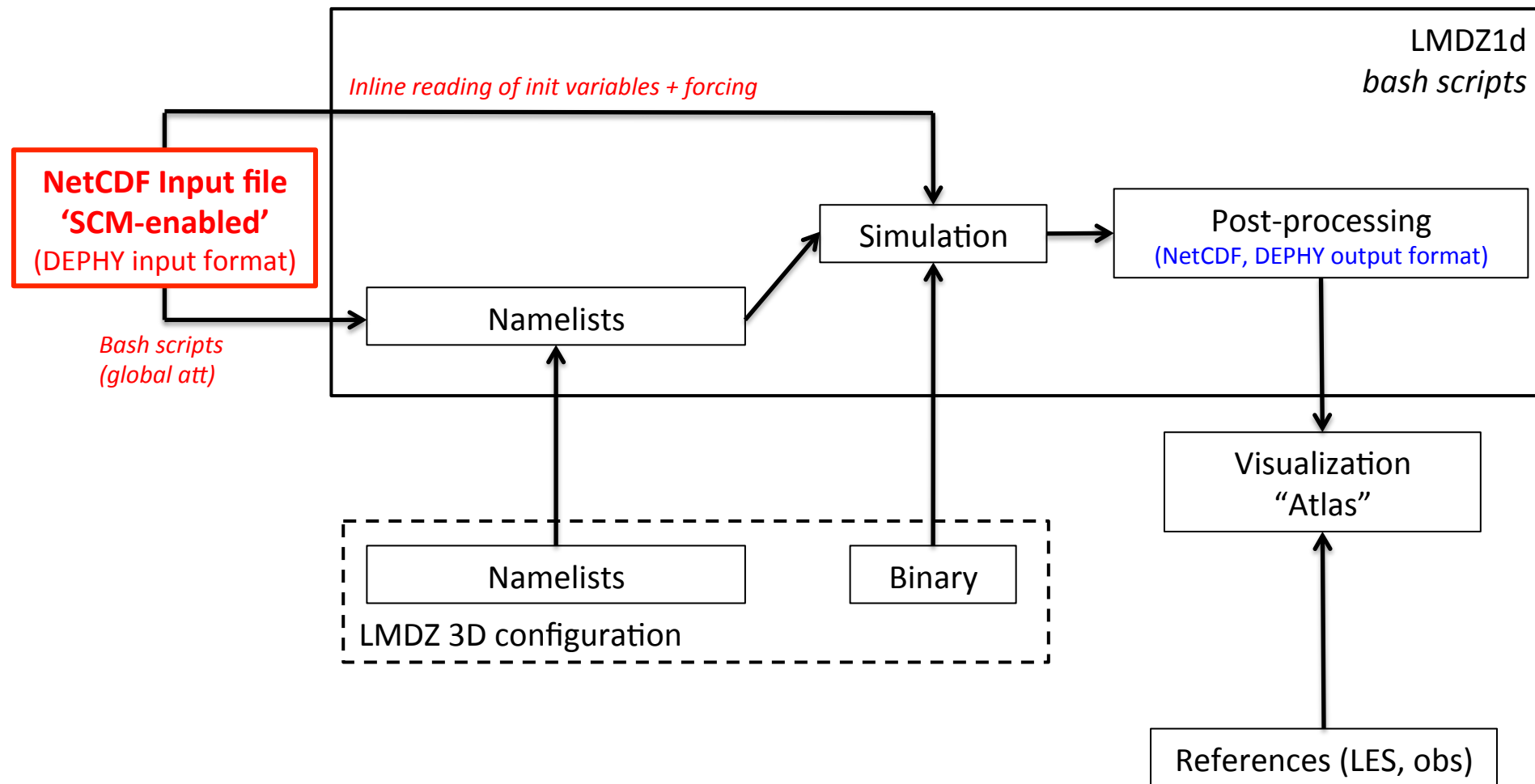
Presently for ARMCU/REF:

- 10-m vertical resolution from surface to 6 km
- 30-min time resolution
- Computations of pressure on z levels, of temperature from theta, q_t from r_t , add thetal=theta, $q_l=q_i=0...$
- Add a surface temperature (dummy right now, but to be improved using the ARM observations)
- Extrapolation to be thought about (reanalysis? standard atmosphere?)

Application within the CNRM SCM workflow



Application within the LMDZ SCM workflow



Conclusions and points for discussion

Input format

- A proposal from the DEPHY community that can serve as a basis for a wider use
- Strongly open to discussion and evolution, once we have agreed on the basic principles
- *But maybe not seek for a format, which can include everything*

Features that can be easily updated/included

- startDate/endDate writing convention
- z0 -> z0m and z0h as variables possibly evolving with time; same for albedo; zorog -> orog(lat,lon)
- Domain size information as a global attribute (length scale?)
- Variables to initialize microphysics schemes (just need to agree on variable names)
- Radiation variables; radiative forcing
- Nudging timescale profiles rather than global attribute

A clear weakness yet: Surface properties, physical variables and forcing...

Open questions

- Files or/and tool to go from DEF to SCM with each user implementing its model specificities (variables, state equations...)?
- Convention? CF whenever possible?
- SCM vs LES? Information about specific configurations (e.g., RCE)?
- Vertical interpolation and extrapolation?
- Advection: total vs horizontal/vertical
- lat/lon time evolution for Lagrangian case

Conclusions and points for discussion

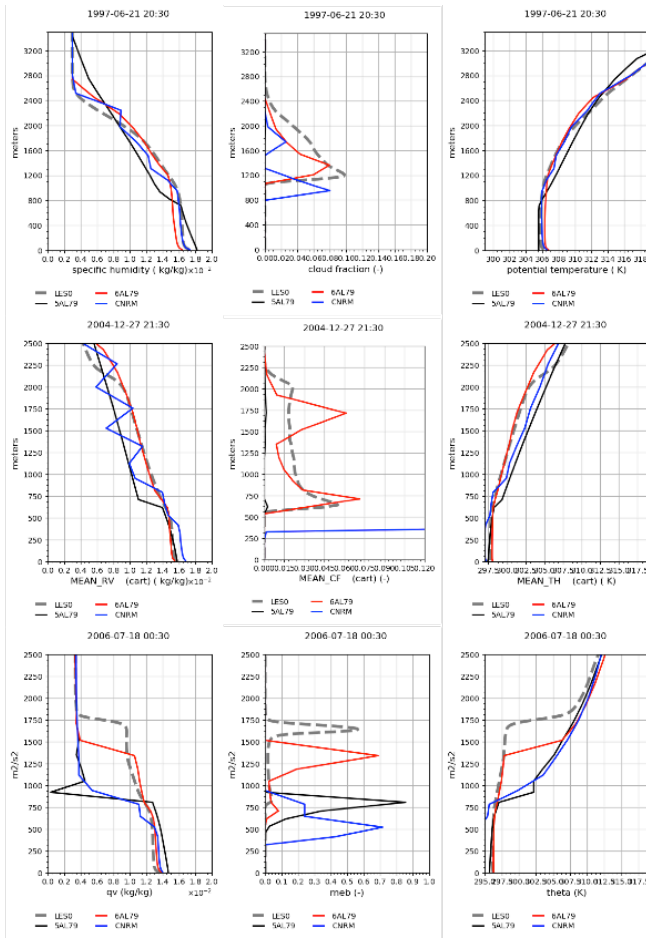
Output format

- Useful if one wants to build/share SCM atlas tools
- A proposal for, at least, the week (~DEPHY)
 - Used within the small LES/SCM comparison tool provided by DEPHY

ARMCU/REF

RICO/SHORT

SANDU/REF



LES/SCM comparison, ARMCU/REF case, SCM 6AL79
Cloud fraction

