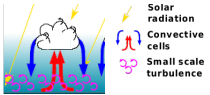
1. Modélisation physique

Modèles conceptuels



Inspiration

Analyse

Observations

Evaluation

Modèles mathématiques

$$\frac{dI^+}{d\tau} = \gamma_1 I^+ - \gamma_2 I^- - \pi F \omega_0 \gamma_3 e^{-\tau/\mu_0}$$

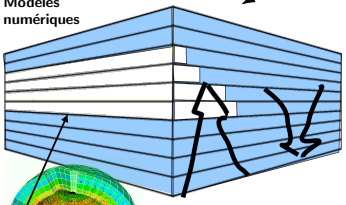
$$\overline{\rho w' \psi'} = f(\psi_{th} - \psi) - K_z \frac{\partial \psi}{\partial z}$$

Cas d'études

Forçages au format commun

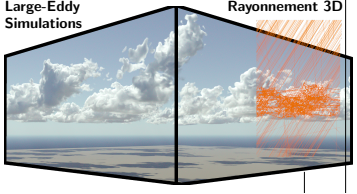
2. Simulations détaillées

Modèles numériques



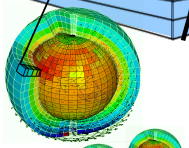
Large-Eddy Simulations

Rayonnement 3D



Références

3. Evaluation et Calibration



Apprentissage

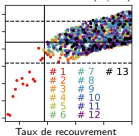
Processus Gaussiens

Prédictions

History Matching

Réduction de l'espace des paramètres

Flux solaire en surface sous des cumulus (W/m^2)



Taux de recouvrement

1. Cas d'étude

(a) Définition au format commun

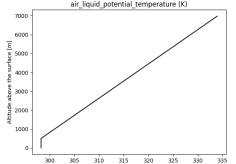
https://github.com/gdr-dephy/dephy-scm

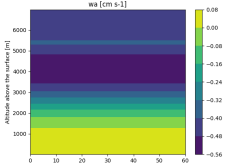
input: fichier driver_DEF.py

```
################################################
# 1. General information about the case
################################################

# 60h
start_date = "20200201000000"
end_date  =  "20200203120000"
Zorog = 0

from datetime import datetime
timeref = datetime.strptime(start_date, "%Y%m%d%H%M%S")

case = Case('BOTANY/%s'%scase,
            lat=13.1,
            lon=-52,
            startDate=start_date,
            endDate=end_date,
            surfaceType='ocean',
            zorog=Zorog)

case.set_title("Forcing and initial conditions for BOTANY case - %s case ; no thlqt nudging"%scase)
case.set_reference("Cloud Botany, Jansson et al. 2023, https://doi.org/10.1029/2023MS003796")
case.set_author("N Villefranque")
case.set_script("DEPHY-SCM/BOTANY/%s/driver_DEF.py"%scase)

################################################
# 2. Initial state
################################################

# Surface pressure
ps = 101605.
case.add_init_ps(ps)

# Initial profiles
file="profiles_init.txt"

# Altitude, theta_l, qt, u, w_ls
z, thl, qt, u, w_ls   = np.genfromtxt(file,dtype=float,skip_header=0,usecols=[0,1,2,3,4]).transpose()

# Wind initial profiles
case.add_init_wind(u=u, v=u*0, lev=z, levtype='altitude')

# Temperature
case.add_init_thetal(thl, lev=z, levtype='altitude')
```

output: fichier netCDF + figures

```
        float wa(time_wa, lev_wa) ;
                wa:standard_name = "upward_air_velocity" ;
                wa:units = "m s-1" ;
                wa:coordinates = "time_wa zh_wa lat lon" ;
        float orog(time_orog) ;
                orog:standard_name = "surface_altitude" ;
                orog:units = "m" ;
                orog:coordinates = "time_orog lat lon" ;
        float ts_forc(time_ts_forc) ;
                ts_forc:standard_name = "forcing_surface_temperature" ;
                ts_forc:units = "K" ;
                ts_forc:coordinates = "time_ts_forc lat lon" ;
        float z0(time_z0) ;
                z0:standard_name = "surface_roughness_length_for_momentum_in_air" ;
                z0:units = "m" ;
                z0:coordinates = "time_z0 lat lon" ;
        float alb(time_alb) ;
                alb:standard_name = "surface_albedo" ;
                alb:units = "1" ;
                alb:coordinates = "time_alb lat lon" ;
        float emis(time_emis) ;
                emis:standard_name = "surface_longwave_emissivity" ;
                emis:units = "1" ;
                emis:coordinates = "time_emis lat lon" ;

// global attributes:
                :case = "BOTANY/MNH045" ;
                :title = "Forcing and initial conditions for BOTANY case - MNH045 case ; no thlqt nudging"
                :reference = "Cloud Botany, Jansson et al. 2023, https://doi.org/10.1029/2023MS003796" ;
                :author = "N Villefranque" ;
                :version = "Created on Fri Apr 18 11:55:06 2025" ;
                :format version = "DEPHY SCM format version 1" ;
```





1. Cas d'étude

(b) Génération namelist Meso-NH, mode SCM / CRM / LES

https://github.com/gdr-dephy/dephy-mnh

```
python convert.py -c BOTANY -s MNH045 -g ../grilles/grille_BOTANY_4km.txt -m SCM -i ../../dephy-scm/ -v 2
```

Sortie de la commande python convert.py

```
>> ####### SETUP SUMMARY #######
>> casename            : BOTANY
>> subcasename         : MNH045
>> sim_mode            : SCM
>> input_dir           : ../../dephy-scm
>> output_dir          : ./
>> grid_file           : ../grilles/grille_BOTANY_4km.txt
>> htexplo PPE file    : None
>> read_zorog?         : 0
>> deactivate EDKF?    : 0
>> ECMWF rad scheme?   : 0
>> A. Marcel version?  : 0
>> ICE3 microphysics?  : 0
>> A. Maison surface?  : 0
>> 3D budgets?         : 0
>> Rain deactivated?   : 0
>> Precip for Cath?    : 0
>> Seaflux model       : ECUME6
>> verbosity           : 2
>>
######### INIT CASE #########
casename BOTANY self.type moistshcv
>> <Case BOTANY/MNH045 (BOTMN) of type moistshcv>
>>
######## READ FC FILE #######
>> FC filename: ../../dephy-scm/BOTANY/MNH045/BOTANY_MNH045_DEF_driver.nc
>> start_date: 2020-02-01 00:00:00 UTC
>> end_date:   2020-02-03 12:00:00 UTC
```

Diff EXSEG LES vs. SCM

```
!   XTSTEP = 1.,
!   CPRESOPT = 'ZRESI',
--- 125,126 ----
!   XTSTEP = 30.,
!   CPRESOPT = 'CRESI',
***************
*** 133 ****
!   XT4DIFU = 300.,
--- 133 ----
!   XT4DIFU = 9000.,
***************
*** 154,155 ****
!   CDCONV = 'NONE',
!   CSCONV = 'NONE',
--- 154,155 ----
!   CDCONV = 'KAFR',
!   CSCONV = 'EDKF',
***************
*** 170,171 ****
!   CTURBLEN = 'DEAR',
!   CTURBDIM = '3DIM',
--- 170,171 ----
!   CTURBLEN = 'BL89',
!   CTURBDIM = '1DIM',
```

(c) Faire tourner Meso-NH...

1. Cas d'étude

(d) Convertir les sorties au format standard Dephy

Script `convert_MNH571_to_DEPHY` (en cours ... e.g. option moyenne temporelle)

```
villefranquen@px0110t317:~/work/presentations$ convert_MNH571_to_DEPHY -i $DMNH/BOTANY-ECUM6MNH045/BOTMN.1.SEG00.000.nc -o BOTANY-ECUM6MNH045_SCM_dephy.nc
villefranquen@px0110t317:~/work/presentations$ ncdump -h BOTANY-ECUM6MNH045_SCM_dephy.nc
netcdf BOTANY-ECUM6MNH045_SCM_dephy {
dimensions:
        time = UNLIMITED ; // (720 currently)
        time_budget = UNLIMITED ; // (60 currently)
        levf = 130 ;
        S_N_direction = 1 ;
        W_E_direction = 1 ;
variables:
        double levf(levf) ;
                levf:long_name = "position z in the transformed space" ;
                levf:units = "m" ;
        double time(time) ;
                time:long_name = "time axis for LES budgets" ;
                time:calendar = "standard" ;
                time:units = "seconds since 2020-02-01 " ;
        double time_budget(time_budget) ;
        double u(time, levf, S_N_direction, W_E_direction) ;
                u:_FillValue = 999. ;
                u:long_name = "zonal component wind" ;
                u:units = "m s-1" ;
        double v(time, levf, S_N_direction, W_E_direction) ;
                v:_FillValue = 999. ;
                v:long_name = "meridional component wind" ;
                v:units = "m s-1" ;
        double pf(time, levf, S_N_direction, W_E_direction) ;
                pf:_FillValue = 999. ;
                pf:long_name = "pressure" ;
                pf:units = "Pa" ;
        double rho(time, levf, S_N_direction, W_E_direction) ;
                rho:_FillValue = 999. ;
                rho:long_name = "density" ;
                rho:units = "kg m-3" ;
        double theta(time, levf, S_N_direction, W_E_direction) ;
                theta:_FillValue = 999. ;
                theta:long_name = "potential temperature" ;
                theta:units = "K" ;
        double thl(time, levf, S_N_direction, W_E_direction) ;
                thl:_FillValue = 999. ;
                thl:long_name = "liquid potential temperature" ;
                thl:units = "K" ;
        double thetav(time, levf, S_N_direction, W_E_direction) ;
                thetav:_FillValue = 999. ;
                thetav:long_name = "virtual potential temperature" ;
                thetav:units = "K" ;
        double rt(time, levf, S_N_direction, W_E_direction) ;
                rt:_FillValue = 999. ;
```

(e) Exploiter !

- variables à plat dans les fichiers de sortie
- mêmes noms dans les sorties LES et modèles 1D
- scripter un max d'opérations (reproductibilité, documentation)
- facilite les intercomparaisons modèles, tests de sensibilité...
- et les expériences de tuning des paramètres

2. Ensembles aux paramètres perturbés et calibration

(a) Définir le fichier de paramètres à explorer

```
villefranquen@px011ot317:~/work/tuning/htune$ cat models/MESONH/params/param_botany
XENTR_MF    0 0.5  0.44987109008137  linear
XSIGMA_MF   0 10   1.71745449617201  linear
XSIGMA_ENV 0 10    7.940088350003    linear
XALPHA_MF   1 5    2.61637244585754  linear
XDETR_DRY   0 0.35 0.100478994406288 linear
XENTR_DRY   0.1 0.55 0.33382656172427  linear
XBRIO       0 0.2   0.148315150622263 linear
XAADVEC     0.05 0.2  0.146655604534058 linear
XCED        0 0.2   0.175951638125672 linear
VSIGQSAT    0 0.1  0.02               linear
XCLOUD_FRAC_STD 0 2 1.0               linear
```

(b) Définir les métriques et lancer l'expérience

```
metrics=BOTANY_MNH066_zav-400-600-theta_35_37
metrics=$metrics,BOTANY_MNH066_zav-400-600-rv_35_37
metrics=$metrics,BOTANY_MNH066_nebmax_35_37
metrics=$metrics,BOTANY_MNH045_zav-400-600-theta_35_37
metrics=$metrics,BOTANY_MNH045_zav-400-600-rv_35_37
metrics=$metrics,BOTANY_MNH045_nebmax_35_37

./bench.sh -model MESONH -setup_opts ADRIEN \
           -waves '1 2 3' \
           -metrics $metrics \
           -param param_botany -wdir BOTANYMESONH-MNH \
           -sample_size_next_design 100
```

2. Ensembles aux paramètres perturbés et calibration

(a) Définir le fichier de paramètres à explorer

```
villefranquen@px011ot317:~/work/tuning/htune$ cat models/MESONH/params/param_botany
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XSIGMA_MF   0 10   1.71745449617201  linear
XSIGMA_ENV 0 10   7.940088350003    linear
XALPHA_MF   1 5    2.6163724485754   linear
XDETR_DRY   0 0.35 0.1004780944406288 linear
XENTR_DRY   0.1 0.55 0.33382656172427  linear
XBRIO       0 0.2   0.148315150622263 linear
XAADVEC     0.05 0.2   0.146655604534058 linear
XCED        0 0.2   0.175951638125672 linear
VSIGQSAT    0 0.1   0.02              linear
XCLOUD_FRAC_STD 0 2 1.0               linear
```

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```
metrics=BOTANY_MNH066_zav-400-600-theta_35_37
metrics=$metrics,BOTANY_MNH066_zav-400-600-rv_35_37
metrics=$metrics,BOTANY_MNH066_nebmax_35_37
metrics=$metrics,BOTANY_MNH045_zav-400-600-theta_35_37
metrics=$metrics,BOTANY_MNH045_zav-400-600-rv_35_37
metrics=$metrics,BOTANY_MNH045_nebmax_35_37

./bench.sh -model MESONH -setup_opts ADRIEN \
           -waves '1 2 3' \
           -metrics $metrics \
           -param param_botany -wdir BOTANYMESONH-MNH \
           -sample_size_next_design 100
```

(c) L'outil htexplo travaille...

- Echantillonne des vecteurs de paramètres
- Génère des namelists Meso-NH pour les cas associés aux métriques
- Fait tourner Meso-NH pour ces cas et ces namelists
- Calcule les métriques de référence sur les LES ou les lit dans un fichier
- Focalise sur l'espace de paramètres acceptables
- Fait des figures d'analyse pour les ensembles de simuls
- Fait la vaisselle