Royal Netherlands
Meteorological Institute
Ministry of Infrastructure and the Environment

Experiences with MUSC in the KNMI Parameterization Testbed

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Thanks to Sylvie Malardel and Eric Bazile (MF)

Expectations and interests

MUSC

SCM routines in the repository of HARMONIE

Upgrade Testbed implementation from cycle 33 to 37

Better understanding of SURFEX

Physical parameterizations

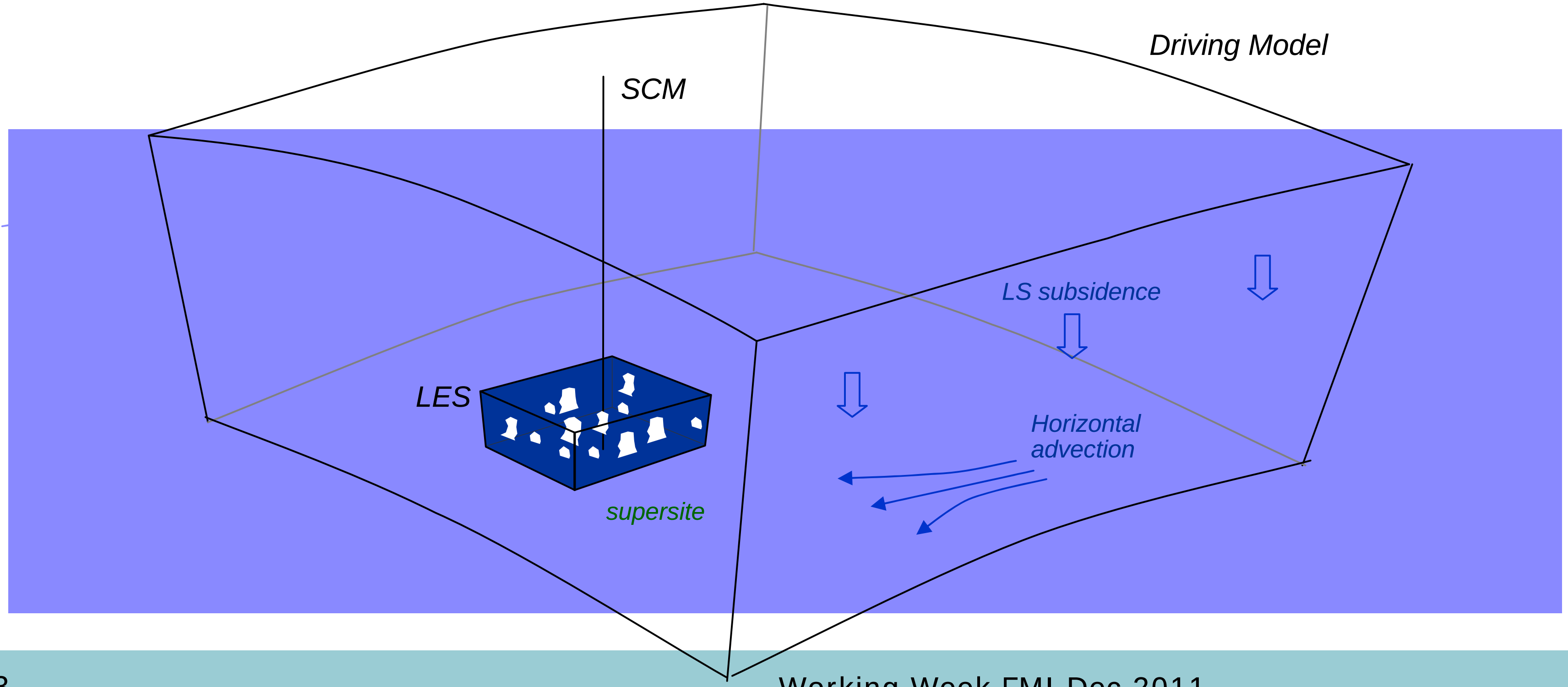
EDMF/EDKF convection

Stable boundary layer

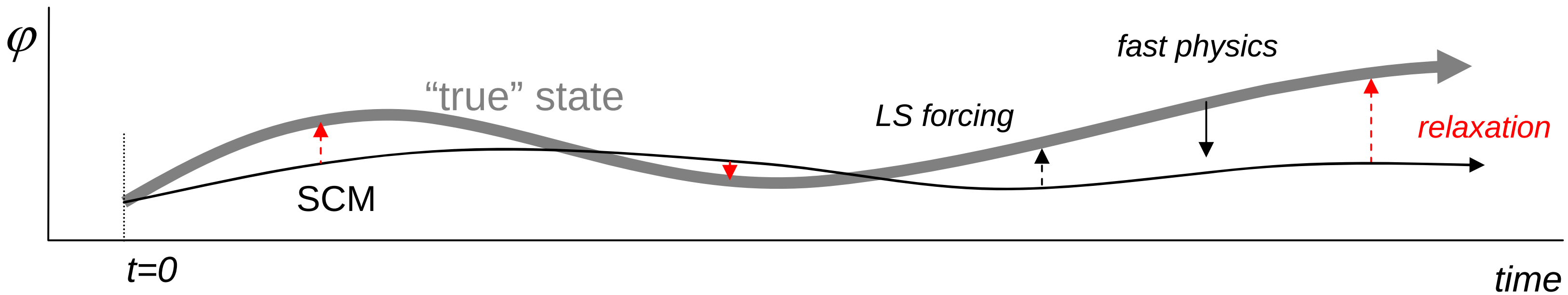
FLAKE lake module (SURFEX)

KPT

Daily run of SCM's
Dynamical tendencies from RACMO prescribed
Fast physical processes
Relaxation to driving model
Framework for quick experiments



Relaxation



Tau = 6h

Daily run of MUSC in KPT

Read netcdf driver file from RACMO (+72h)

Make namelists for MUSC

HARMONIE.nam -----> ascii2fa
PRE_PGD1.nam -----> arome_pgd
PRE_REAL1.nam -----> arome_prepsurf

Create fa (fichier Arpege) and surfex (lfi) inputfile
Run MUSC in two flavours (EDKF,EDMF)
Make netcdf output file
Postprocessing with ncl script

Namelist for ascii2fa

```
&NAM1D
  IFLEV= 60 ,       levels
  ZDELY=250000.,
  LNHDYN=.FALSE.,
  LALAPHYS=.T.,
 LREASUR=.T.,
 NFORC= 803 ,    number of forcings: 11x73
 LQCGRP    = .F.
 LQIGRP    = .F.
 LQRGRP    = .F.
 LQSGRP    = .F.
 LQGGRP    = .F.
 LCFGRP    = .F.
 LSRCGRP   = .F.
 LTKEGRP   = .F.
 IYEAR= 2011       year
 IMONTH= 11        month
 IDAY= 16          day
 IHH= 12           hour
 IMIN= 00          min
```

ETA vertical coordinates
A's
B's
ATMOSPHERE initial profile
Zorog orography
Ps
U,V
T
QV
FORCING every 1h, 72h ahead
UGEO u-component geowind
VGEO v-component geowind
TTEN advective tendency temperature
QTEN .. .. humidity
UTEN .. .. U-comp momentum
VTEN .. .. V-comp momentum
OMEGA large scale vertical movement
U profile from driving model, used for relaxation
V profile from driving model, used for relaxation
T profile from driving model, used for relaxation
QV profile from driving model, used for relaxation
SURFACE data only necessary for ISBA
Surface temperature
Surface snow
Surface water
..
..
etc

Namelist for forecast model MASTER

Dependency with forcings from ascii2fa

```
&NAM_GFL
YFORC_NL(1)%CNAME='FORC01',
YFORC_NL(2)%CNAME='FORC02',
YFORC_NL(3)%CNAME='FORC03',
YFORC_NL(4)%CNAME='FORC04',
YFORC_NL(5)%CNAME='FORC05',
YFORC_NL(6)%CNAME='FORC06',
YFORC_NL(7)%CNAME='FORC07',
YFORC_NL(8)%CNAME='FORC08',
YFORC_NL(9)%CNAME='FORC09',
YFORC_NL(10)%CNAME='FORC10',
YFORC_NL(11)%CNAME='FORC11',
YFORC_NL(12)%CNAME='FORC12',
YFORC_NL(13)%CNAME='FORC13',
YFORC_NL(14)%CNAME='FORC14',
YFORC_NL(15)%CNAME='FORC15',
YFORC_NL(16)%CNAME='FORC16',
YFORC_NL(17)%CNAME='FORC17',
YFORC_NL(18)%CNAME='FORC18',
YFORC_NL(19)%CNAME='FORC19',
YFORC_NL(20)%CNAME='FORC20',
YFORC_NL(21)%CNAME='FORC21',
YFORC_NL(22)%CNAME='FORC22',
YFORC_NL(23)%CNAME='FORC23',
YFORC_NL(24)%CNAME='FORC24',
                  ...
                  ...
YFORC_NL(803)%CNAME='FORC803'
```

PRE-PGD.nam for AROME_PGD

```
&NAM_PGDFILE          CPGDFILE='pgd_testbed',
/
&NAM_PGD_SCHEMES       CNATURE='ISBA',
                       CSEA='NONE',
                       CWATER='NONE', or 'FLAKE'
                       CTOWN='NONE',
/
&NAM_PGD_GRID          CGRID='CARTESIAN',
/
&NAM_CARTESIAN         XLAT0=   51.891 ,
                       XLON0=    4.817 ,
                       NIMAX=1 ,
                       NJMAX=4 ,
                       XDX=250000.,
                       XDY=250000.,
/
&NAM_ZS      XUNIF_ZS=0.,
/
&NAM_ISBA    XUNIF_CLAY=0.3585,
             XUNIF_SAND=0.3401,
/
&NAM_FRAC     LECOCLIMAP=.FALSE.,
              XUNIF_SEA=0.,
              XUNIF_WATER=0.,
              XUNIF_TOWN=0.,
              XUNIF_NATURE=1.,
/
```

Clay and sand fraction are important for the calculation of the Soil Wetness Index (SWI)

```
&NAM_DATA_ISBA       NTIME = 12 ,
           XUNIF_VEGTYPE(1)     = 0.,
           XUNIF_VEGTYPE(2)     = 0.,
           XUNIF_VEGTYPE(3)     = 0.,
           XUNIF_VEGTYPE(4)     = 0.,
           XUNIF_VEGTYPE(5)     = 0.,
           XUNIF_VEGTYPE(6)     = 0.,
           XUNIF_VEGTYPE(7)     = 0.,
           XUNIF_VEGTYPE(8)     = 0.,
           XUNIF_VEGTYPE(9)     = 0.,
           XUNIF_VEGTYPE(10)    = 1.,
           XUNIF_VEGTYPE(11)    = 0.,
           XUNIF_VEGTYPE(12)    = 0.,
           XUNIF_VEG(1,1)       = 1.,
           XUNIF_VEG(1,2)       = 1.,
           XUNIF_VEG(1,3)       = 1.,
           XUNIF_VEG(1,4)       = 1.,
           XUNIF_VEG(1,5)       = 1.,
           XUNIF_VEG(1,6)       = 1.,
           XUNIF_VEG(1,7)       = 1.,
           XUNIF_VEG(1,8)       = 1.,
           XUNIF_VEG(1,9)       = 1.,
           XUNIF_VEG(1,10)      = 1.,
           XUNIF_VEG(1,11)      = 1.,
           XUNIF_VEG(1,12)      = 1.,
           XUNIF_LAI(1,1)       = 2.,
           XUNIF_LAI(1,2)       = 2.,
           XUNIF_LAI(1,3)       = 2.,
           XUNIF_LAI(1,4)       = 2.,
           XUNIF_LAI(1,5)       = 2.,
           XUNIF_LAI(1,6)       = 2.,
           XUNIF_LAI(1,7)       = 2.,
           XUNIF_LAI(1,8)       = 2.,
           XUNIF_LAI(1,9)       = 2.,
           XUNIF_LAI(1,10)      = 2.,
           XUNIF_LAI(1,11)      = 2.,
           XUNIF_LAI(1,12)      = 2.,
```

surfex

PRE-PGD.nam cont'd

```
XUNIF_Z0(1,2)       = 0.15,
                  XUNIF_Z0(1,3)       = 0.15,
                  XUNIF_Z0(1,4)       = 0.15,
                  XUNIF_Z0(1,5)       = 0.15,
                  XUNIF_Z0(1,6)       = 0.15,
                  XUNIF_Z0(1,7)       = 0.15,
                  XUNIF_Z0(1,8)       = 0.15,
                  XUNIF_Z0(1,9)       = 0.15,
                  XUNIF_Z0(1,10)      = 0.15,
                  XUNIF_Z0(1,11)      = 0.15,
                  XUNIF_Z0(1,12)      = 0.15,
                  XUNIF_EMIS(1,1)     = 0.99,
                  XUNIF_EMIS(1,2)     = 0.99,
                  XUNIF_EMIS(1,3)     = 0.99,
                  XUNIF_EMIS(1,4)     = 0.99,
                  XUNIF_EMIS(1,5)     = 0.99,
                  XUNIF_EMIS(1,6)     = 0.99,
                  XUNIF_EMIS(1,7)     = 0.99,
                  XUNIF_EMIS(1,8)     = 0.99,
                  XUNIF_EMIS(1,9)     = 0.99,
                  XUNIF_EMIS(1,10)    = 0.99,
                  XUNIF_EMIS(1,11)    = 0.99,
                  XUNIF_EMIS(1,12)    = 0.99,
                  XUNIF_DG(1,1)       = 0.01,
                  XUNIF_DG(1,2)       = 0.72,
                  XUNIF_DG(1,3)       = 1.89,
```

Definition of the depth of the

Model layers in the bottom

```
XUNIF_ROOTFRAC(1,1)  = -999.,
                  XUNIF_ROOTFRAC(1,2)  = -999.,
                  XUNIF_ROOTFRAC(1,3)  = -999.,
                  XUNIF_RSMIN(1)       = 40.,
                  XUNIF_GAMMA(1)       = 0.0,
                  XUNIF_WRMAX_CF(1)    = 0.2,
                  XUNIF_RGL(1)         = 100.,
                  XUNIF_CV(1)          = 2.E-5,
                  XUNIF_Z0_O_Z0H(1)    = 10.,
                  XUNIF_ALBNIR_VEG(1)  =   0.1858 ,
                  XUNIF_ALBVIS_VEG(1)  =   0.1858 ,
                  XUNIF_ALBUV_VEG(1)   =   0.1858 ,
                  XUNIF_ALBNIR_SOIL(1) =   0.1858 ,
                  XUNIF_ALBVIS_SOIL(1) =   0.1858 ,
                  XUNIF_ALBUV_SOIL(1)  =   0.1858 ,
                  XUNIF_GMES(1)        = 0.001,
                  XUNIF_RE25(1)        = 0.00000015,
                  XUNIF_BSLAI(1)       = 0.25,
                  XUNIF_LAIMIN(1)      = 1.0,
                  XUNIF_SEFOLD(1)      = 31536000.,
                  XUNIF_GC(1)          = 0.,
                  XUNIF_DMAX(1)        = 0.1,
                  XUNIF_F2I(1)         = 0.3,
                  XUNIF_H_TREE(1)      = 20.,
                  XUNIF_CE_NITRO(1)    = 4.85,
                  XUNIF_CF_NITRO(1)    = -0.24,
                  XUNIF_CNA_NITRO(1)   = 2.8,
 /
```

PRE_REAL.nam (AROME_PREPSURF)

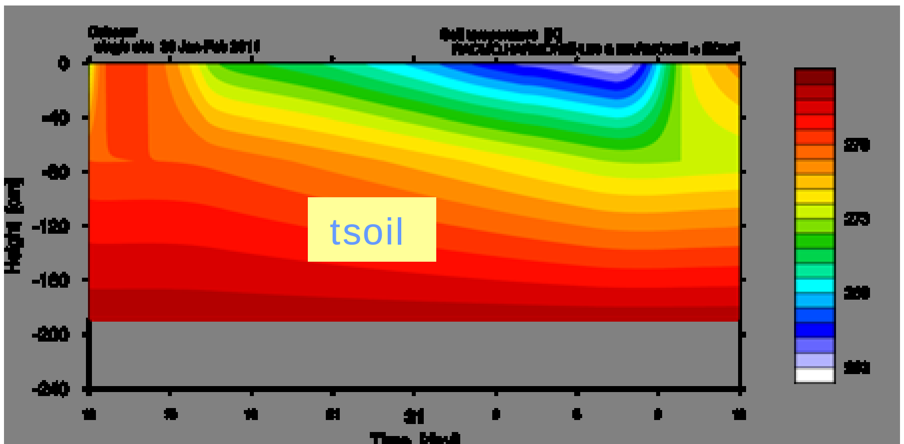
```
&NAM_FILE_NAMES HPGDFILE ='AROME_PGD' , CINIFILE='AROME_PREPSURF' /
&NAM_PREP_SURF_ATM  NYEAR=2009 , NMONTH=3 , NDAY=10, XTIME=0. /
&NAM_PREP_ISBA XHUG_SURF=0.49, XHUG_ROOT=0.43, XHUG_DEEP=0.41, XTG_SURF=282.5, XTG_ROOT=280.15,
      XTG_DEEP=277.15 /
&NAM_CH_ISBAN CCH_DRY_DEP='NONE' /
```

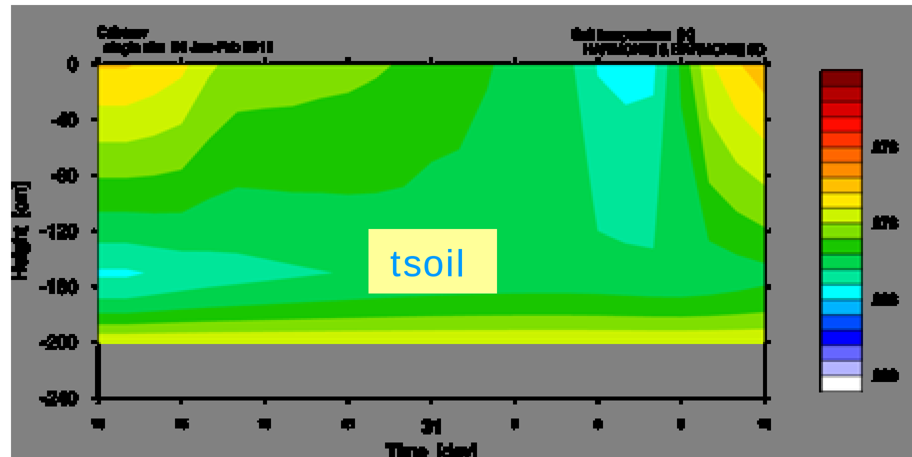
SWI

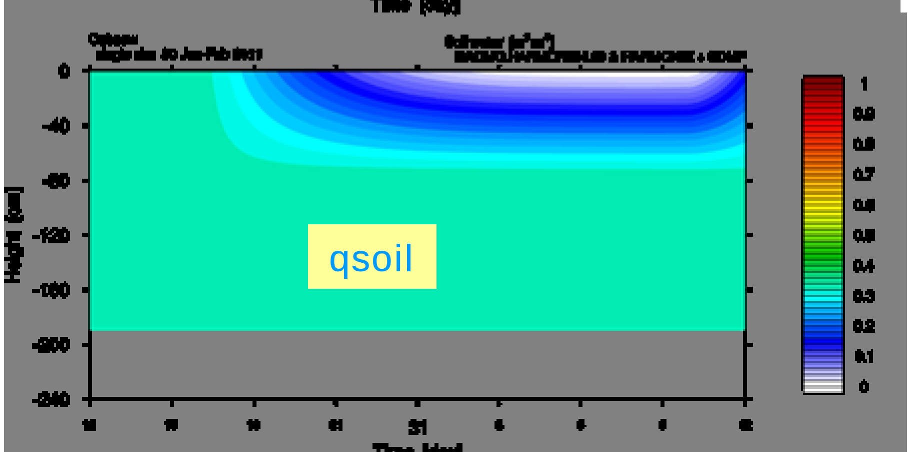
Tsoil

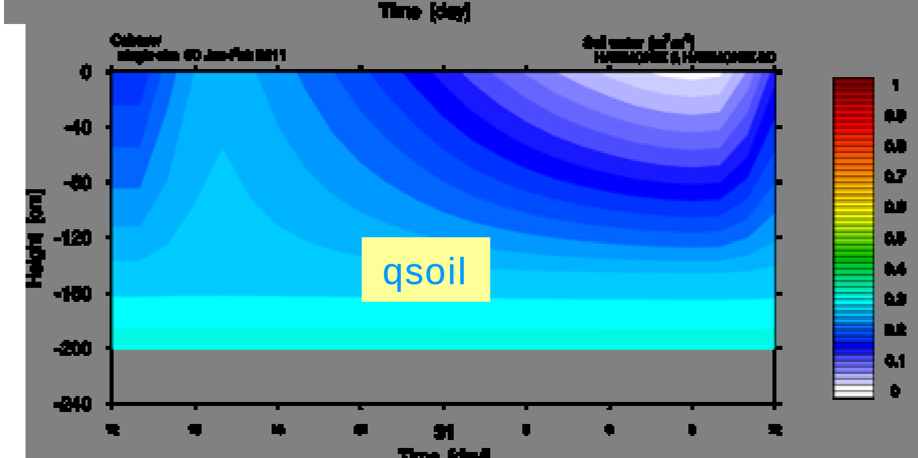
surfex

1D cycle 33t1 (left) versus 3D cycle 36h1 (right)









QUESTIONS:

1. Cycles of 1D and 3D are not similar, does this explain the different results?
2. ISBA has two layers, Boone et al. made an extension to three layers, only for humidity, but not for temperature (Personal communication Mahfouf). What is the significance of the third temperature layer?
3. ISBA is used in Force-Restore mode. How to apply initial data from a Diffusive Surface scheme (RACMO/TESSEL)?
4. How do I get SOIL ICE in the LFI outputfile?

Special routines for MUSC

```
-- arp
|   |-- adiab
|   |   |-- cp_forcing.F90
|   |   |-- cpg_dyn.F90
|   |   |-- cpg_gp.F90
|   |   |-- gpcty_forc.F90
|   |   |-- gpgeo.F90
|   |   |-- gppreh.F90
|   |   |-- gpxyb.F90
|   |-- module
|   |   |-- yomlsforc.F90
|   |   |-- yom_ygfl.F90
|   |-- namelist
|   |   |-- namlsforc.h
|   |-- setup
|   |   |-- suarg.F90
|   |   |-- suarpio.F90
|   |   |-- sugridua.F90
|   |   |-- sulsforc.F90
|   |-- utility
|   |   |-- wrgp2fa.F90
```

```
-- xrd
    |-- fa
    |   |-- facadi.F
    |   |-- facine.F
    |   |-- faienc.F
    |   |-- faipar.F
```

```
|-- mse
|   |-- dummy
|   |-- externals
|   |   |-- aroini_surf.mnh
|   |-- internals
|   |   |-- coupling_tsz0_n.mnh
|   |   |-- flake_interface.mnh
|   |   |-- ini_data_param.mnh
|   |   |-- isba.mnh
|   |   |-- tsz0.mnh
|   |   |-- z0v_from_lai_0d.mnh
|   |   |-- z0v_from_lai_1d.mnh
|   |   |-- z0v_from_lai_2d.mnh
|   |   |-- z0v_from_lai_patch.mnh
```

Routines for EDMF and cloud scheme

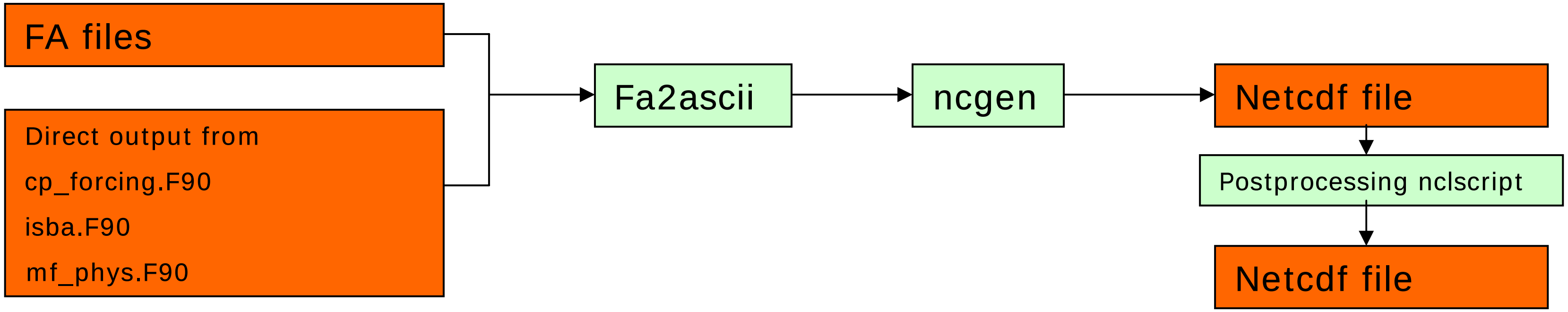
```
|-- mpa
|   |-- micro
|   |   |-- externals
|   |   |   |-- aro_adjust.mnh
|   |   |-- interface
|   |   |   |-- aro_adjust.h
|   |   |-- internals
|   |   |   |-- condensation.mnh
|   |   |   |-- ice_adjust.mnh
|   |   |   |-- rain_ice.mnh
|   |   |-- module
|   |       |-- modi_condensation.mnh
|   |       |-- modi_ice_adjust.mnh
|   |-- turb
|       |-- externals
|       |   |-- aro_shallow_mf.mnh
|       |   |-- aro_turb_mnh.mnh
|       |-- interface
|       |   |-- aro_shallow_mf.h
|       |   |-- aro_turb_mnh.h
|       |-- internals
|       |   |-- ini_cturb.mnh
|       |   |-- shallow_mf.mnh
|       |   |-- tke_eps_sources.mnh
|       |   |-- turb.mnh
|       |   |-- turb_ver_dyn_flux.mnh
|       |   |-- turb_ver_thermo_flux.mnh
|       |-- module
|           |-- modi_shallow_mf.mnh
|           |-- modi_turb.mnh
```

```
--arp
|   |-- phys_dmn
|   |   |-- apl_arome.F90
|   |   |-- mf_phys.F90
|   |-- phys_ec
|   |   |-- aro_vdfhght.F90
|   |   |-- vdfhghtnn.F90
|   |   |-- vdfparcel.F90
|   |   |-- vdfpdftable.F90
```

OUTPUT FA → NETCDF

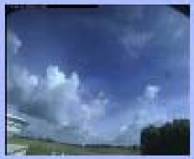
Was difficult to change the content of FA and LFI file
Extra output was created by adding write statements in the relevant routines.

Postprocessing with ncl script (Vamp.Vdir.wvp.lwp.iwp.swi)



KPT graphical interface

http://www.knmi.nl/~neggers/KPT



KNMI Parameterization Testbed

ID

Location:
- Cabauw
- Schiphol Airport
- Chilbolton Observatory
- Lindenberg
- Palaiseau (SIRTA)
- ARM (Southern Great Plains)
- ATEX (Cabo Verde)
- ASTEX (North-Eastern Atlantic)
- BOMEX (Barbuda)
- Composite transition - Slow

Composite:
- Single forecasts
- Monthly means
- Quarterly means
- Yearly means
- Conditional means

Date:
- 2011030300
- 2011030312
- 2011030400
- 2011030412
- 2011030500
- 2011030512
- 2011030600
- 2011030612
- 2011030700
- 2011030712

SCM

LES

OBS

AROME/HARMONIE physics

- Radiation.
- Convection/Turbulence.
- Microphysics of warm clouds.
- Microphysics for atmospheric ice.
- Sub-grid condensation (Cloud scheme).
- Surface processes (SURFEX package).

Convection scheme, differences

EDKF (Pergaud et al, 2009)

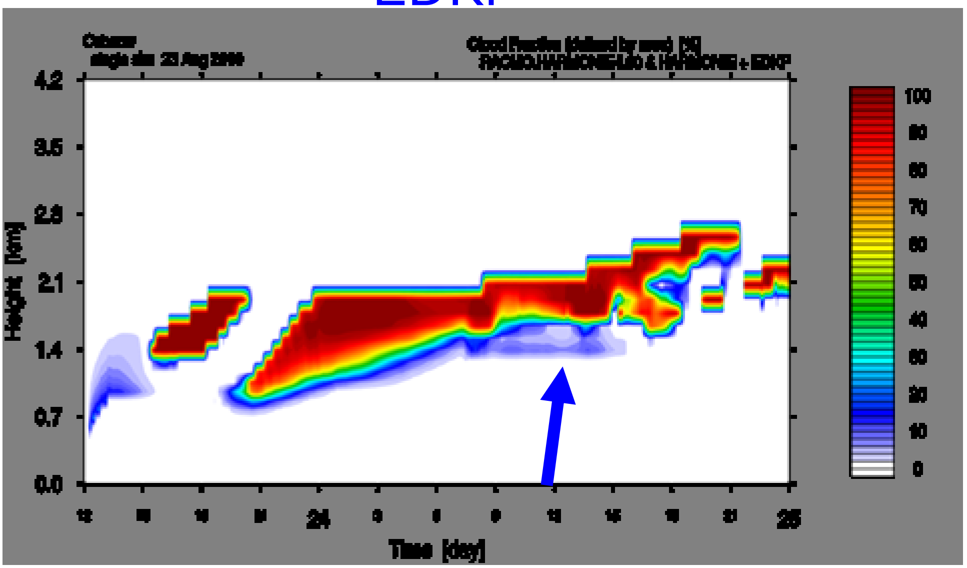
- One updraft
- Lateral entrainment/detrainment (Kain Fritsch, 1990)

EDMF

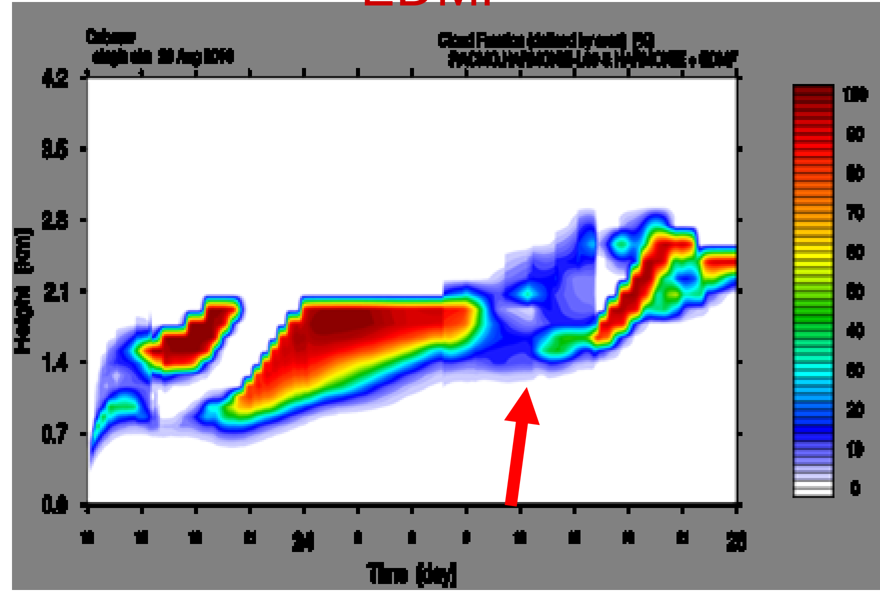
- Two updrafts (Neggers et al, 2008)
- Lateral entrainment/detrainment (De Rooy and Siebesma, 2008)

Trapped moisture in the cloud layer

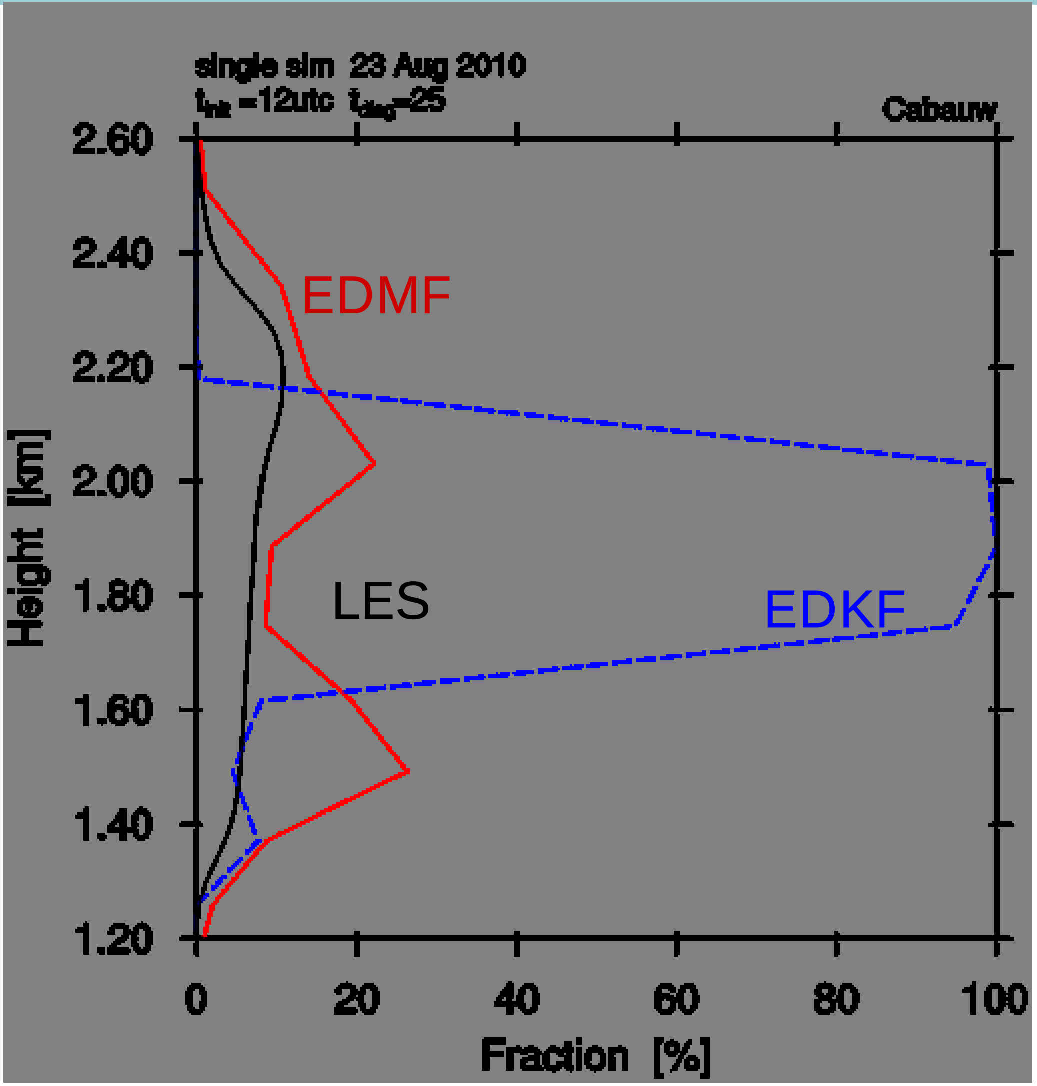
EDKF



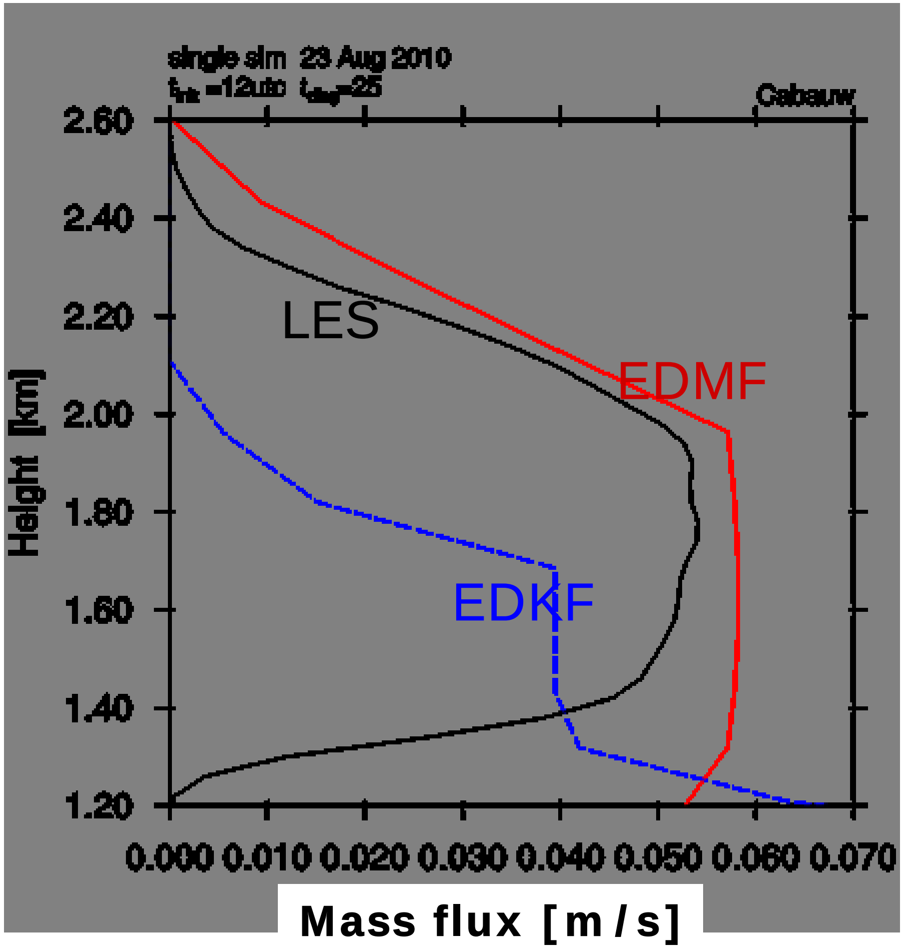
EDMF



Trapped moisture in the cloud layer

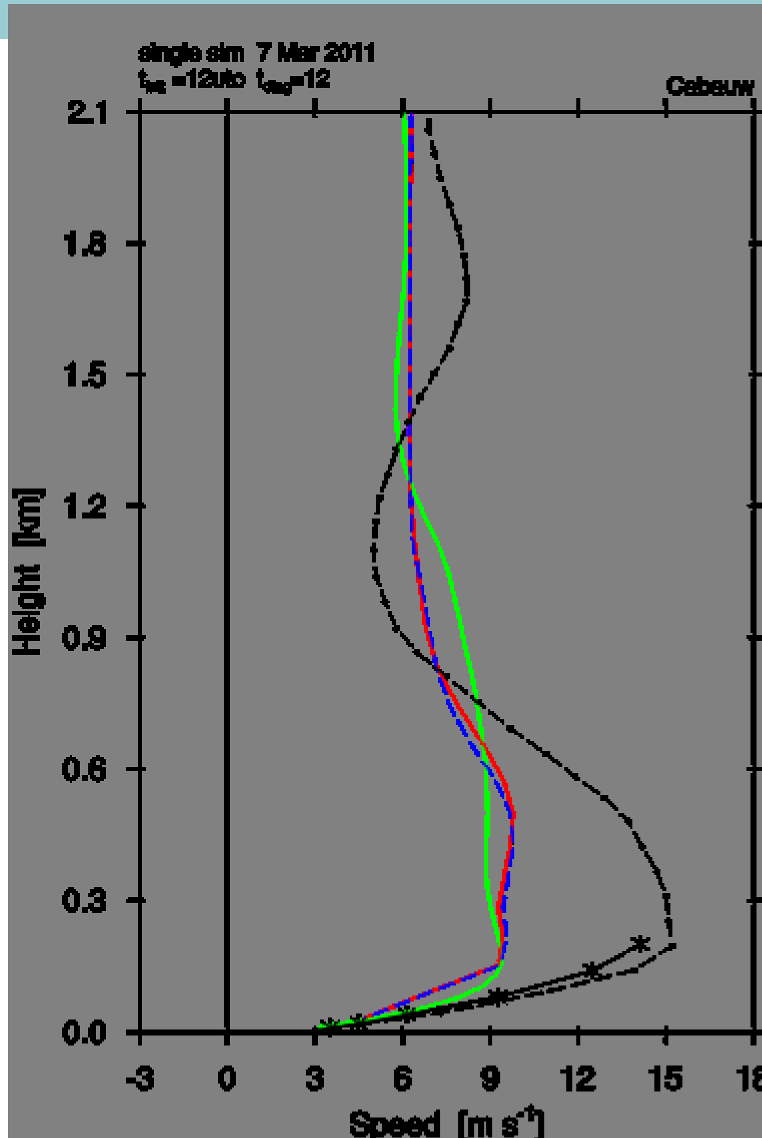


Trapped moisture in the cloud layer



In EDKF updraft stops too early due to lack of heat coagulation. Moisture was trapped in a too shallow layer.

Windprofile stable ABL



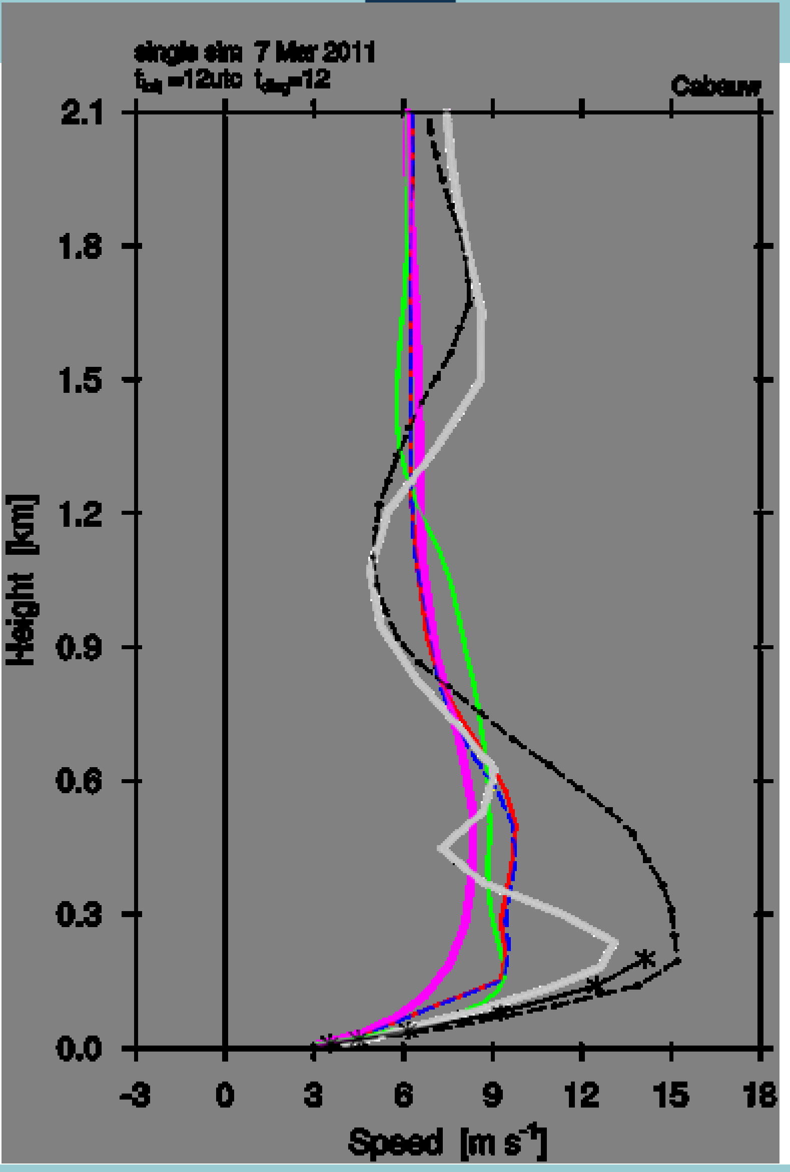
EDKF

EDMF

WRF TEMF

OBS

Windprofile stable ABL



EDKF

EDMF

WRF TEMF

3D RACMO

3D HARMONIE

OBS

Conclusions

SCM and KPT are useful tools

- Good framework for quick detailed diagnostics
- Model has been improved (bug fixes)
- New parameterizations have been succesfully tested

Outlook

- Further integration of 1D and 3D model
    - same cycle
    - Advective tendencies from the same host model
    - Relaxation to the same host model
- Standardization of tools