MUSC: the 1D model for the HAAA Galaxy?

E. Bazile (CNRM/GMAP) and I. Beau (CNRM/GMGECE)
MUSC but previously SCUM

- SCUM (Single Column Unified Model) was not really “commercial” = dirt, dross, rubbish so now... MUSC for Modèle Unifié Simple Colonne in French or in English .... at the end!

- MUSC exists since the cy32 (developed by S. Malardel) but since her departure the maintenance and the development have been postponed or done for specific 1D intercomparison GABLS3 or physics validation (TKE+KFB)

- The main advantage of MUSC should be “to be fully integrated” in the 3D model but unfortunately for several reasons (time, manpower, surfex version, forcing options etc ..) it is not the case!

The current status: almost integrated excepted for 78 routines in src/local but .....
ALADIN/HIRLAM meeting
Norrköping, 5-8 April 2011
GLOBAL (variable mesh or not) or LAM (choice made by NAMELIST) or 2D

Two dynamical cores (choice made by namelist)

- Hydrostatic
- Non hydrostatic

A set of physical packages (choice made by NAMELIST)

- Hirlam
- ALARO
- ARPEGE-NWP
- ARPEGE/CLIMAT
- ALADIN
- AROME
- IFS

3D/4D Variational Algorithmic structure

Obs operators

OI assimilation scheme
Used only for surface

Thanks to Y. Bouteloup.
Current status (cy35t2_op1)

- For the EUCLIPSE project: 2 cases have been added ASTEX Lagrangian and the COMPOSITE case.
- Several forcings types are now available:
  - Geostrophic wind
  - Advection for T, Q, U/V
  - Nudging for T, Q, U/V
  - Vertical advection (from W)
- For the surface, with SURFEX (4.4):
  - By sensible and latent heat fluxes (init_ideal_flux.mnh)
  - By Ts/qs over land or by a varying SST
  - New albedo option Marat Khairoutdinov for the COMPOSITE case.
- Y. Bouteloup has developed an option to force the surface by the fluxes without SURFEX (36t1_op1) for ARMCu.

In red: done recently for EUCLIPSE
Output files:

• ICMSH, DDH and LFA files used already in the previous 1D model
• For the LFA file in cpg.F90

```fortran
#include "open_output_lfa.intfb.h"

!  ------------------------------------------------------------------
IF (LHOOK) CALL DR_HOOK('CPG',0,ZHOOK_HANDLE)
    CALL OPEN_OUTPUT_LFA
    |
    |
    CALL LFAFER(86)
!  ------------------------------------------------------------------
9990 FORMAT(1X,'ARRAY ',A10,' ALLOCATED ',8I8)
9991 FORMAT(1X,'ARRAY ',A10,' DEALLOCATED ')
9992 FORMAT(1X,'ARRAY ',A13,' ALLOCATED ',8I8)
9993 FORMAT(1X,'ARRAY ',A13,' DEALLOCATED ')

!  ------------------------------------------------------------------
IF (LHOOK) CALL DR_HOOK('CPG',1,ZHOOK_HANDLE)
END SUBROUTINE CPG
```
Output files:

• and after for “specific outputs” for 1D case:

For ARPEGE/ALARO0:
WRSCMR (for 2d) and ECR1D

SUBROUTINE RADLSW

#include "wrscmr.intfb.h"
#include "ecr1d.intfb.h"

CALL WRSCMR(86,'ZLW_DNCS',ZLW_DNCS,KLON,KLEV+1)
ZALB(:)=ZSW_UP(:,KLEV+1)/MAX(0.0001_JPRB,ZSW_DN(:,KLEV+1))
CALL ECR1D(86,'ALB_EFF',ZALB,1,KLON)

For AROME:
WRAROM (for 2d) and ECR1D

SUBROUTINE TURB_VER_THERMO_FLUX(

!*       2.4  Storage in LES configuration
!
! Copie de Kh pour MUSC
ZA = DZM(PTHLP)
WHERE (ZA==0.) ZA=1.E-6
ZA = - ZFLXZ / ZA * PDZZ
ZA(:,;IKB) = XCSHF*PHI3(:,;IKB)*ZKEFF(:,;IKB)
CALL WRAROM(86,'ZKH',ZA(:,1,IKB:IKU),IIU,IKE)
CALL WRAROM(86,'WTHL_tur',ZFLXZ(:,1,IKB:IKU),IIU,IKE)
! Fin modif MUSC
Output files:

- To provide NetCDF files for the EUCLIPSE project from the LFA files, some converters have been written:

  - `Out.000.0000.lfa`
  - `Out.000.0833.lfa`
  - `Out.000.1667.lfa`
  - `Out.000.2500.lfa`
  - `Out.000.4167.lfa`
  - `Out.000.5000.lfa`
  - ...
  - `Out.040.0000.lfa`

  - `lfamoy`
  - `Outmoy1h_00`
  - `Outmoy1h_01`
  - `Outmoy1h_40`

  - `lfa2cdf3`
  - `lfa2cdf2`
  - `lfamoy` (mean profile for each hour)
  - `Fic_ascii`
  - `ncgen`
  - `ncdump`

  - `NetCDF`
Finally without the specific diagnostics for the 1D:
only 17 routines are necessary to update MUSC
and 32 routines for SURFEX 4.4!
1D Cases potentially available in MUSC (cy35t2)

- **Convective Boundary Layer:** IHOP (2002), Wangara, Ayotte, AMMA 5/06/2006

- **Cumulus:** ARM (21/06/1997), BOMEX, RICO-composite

- **Stratocumulus:** FIRE-I (juillet 1987)

- **Oceanic Deep Convection:** TOGA-COARE

- **Continental Deep Convection:** ARM (27-28/06/1997), AMMA 10/07/2006 (project FP7/EMBRACE; ANR/DECAF)

- **Stratocumulus transition to cumulus:** Astex + COMPOSITE case

- **Stable Boundary Layer:** GABLS cases (GABLS 1, 2 et 3)
EUCLIPSE Project (2010-2014)

European Union Cloud Intercomparison, Process Study & Evaluation Project (coordinateur: P. Siebesma, KNMI)

- WP3: Process evaluation and Analysis
  
  Three intercomparison cases for 1D et LES:
  
  - ASTEX Lagrangian (De Roode, van der Dussen, 2010)
  
  - COMPOSITE (Sandu et al., 2010)
    http://www.mpimet.mpg.de/en/mitarbeiter/irina-sandu/transition-cases.html
  
  - CGILS (Zhang et al., 2008)
## Physics in MUSC

<table>
<thead>
<tr>
<th>Coeff K diffusion</th>
<th>ARPEGE/ALADIN</th>
<th>AROME</th>
<th>ARPEGE GIEC AR5</th>
<th>ALAROO</th>
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<tr>
<td></td>
<td>TKE - CBR2000 (HL) modified for Ku</td>
<td>TKE - CBR2000 (FL) modified for Ku</td>
<td>TKE-2.0/Mellor-Yamada 82 (Ricard Royer-93)</td>
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<td>BL89</td>
<td>BL 89</td>
<td>Profil quadratique (Lenderink et Holtslag, 2004)</td>
<td>Int. HCLA Ayotte</td>
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<th>L Mixing length</th>
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<tr>
<td></td>
<td>KFB Bechtold et al 2000</td>
<td>EDKF Pergaud et al 2009</td>
<td>Via les TKE-2.0 + PDF humides (RR 93)</td>
<td>Geleyn 87</td>
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<td>With e-TKE</td>
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<tr>
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<td>Smith(90)</td>
<td>f0, f1, f2</td>
<td>RR-93: PDF/f0, f1, f2; Bougeault (82)</td>
<td>Xu &amp; Randall</td>
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<td>Bougeault (82)</td>
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<td>Lopez mod qI,qI,qR,qS (PCS)</td>
<td>Ice3 5 variables</td>
<td>Kessler-Smith (1990)</td>
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<td>Bougeault, 85 (figé V3: cycle 18)</td>
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<td>ECMWF: LW=RRTM SW=Morcrette (93)</td>
<td>New-Geleyn</td>
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</table>
ASTEX lagrangian (13th, June 1992, +40 h)

Qv (g/kg) Initial profile
T (K) Initial profile

SST forcing (K)
Vertical velocity forcing (m/s)
Temperature profiles (K)
Nudging above 4000m tau=12h
ASTEX Lagrangian

Cloud Cover ARPEGE GIEC AR5

Cloud Cover ARPEGE NWP

Cloud Cover AROME 60s
ASTEX Lagrangian

Cloud Cover ARPEGE GIEC AR5
No deep

Cloud Cover ARPEGE NWP

Cloud Cover AROME 60s

LWP Kg/m2

Thanks to S. De Roode
ASTEX Lagrangian

Cloud Cover ARPEGE GIEC AR5
No deep

Cloud Cover ARPEGE NWP

Cloud Cover AROME 60s

LWP Kg/m2

Total buoyancy fluxes 08h

Thanks to S. De Roode
COMPOSITE Case (15th July, 3 days forecast)

LES (UCLA) Cloud cover evolution for the 3 transitions slow, ref and fast

Qv

T

W

SST

ALADIN/HIRLAM meeting
COMPOSITE Case (15th July, 3 days forecast)
COMPOSITE Case (15th July, 3 days forecast)

Cloud Cover ARPEGE PNT

Cloud Cover ARPEGE GIEC AR5
No deep

Cloud Cover AROME 60s

Liquid Water Path Kg/m²
Conclusions

- **MUSC** has now almost all the forcings necessary for several cases: ARMCu, BOMEX, GABLS(1-3), ASTEX Lagrangian and COMPOSITE.

- **Weaknesses:**
  - no deep convection case available
  - only on cy35t2_op1
  - Many modifications on SURFEX v4.4 but SURFEX v5 is used on cy36t1 and version 7 is under construction
  - For the diagnostics: needs to put on each new version the diagnostics necessary for the 1D case (Km, wthl, etc ... )
Possible perspectives

• Phase the modifications on a CY37T2 or CY38
• Put all the modifications for SURFEX in V7
• Add a logical (LMUSC) for the specific diagnostics used in 1D in the physics subroutine.
  • IF (LMUSC) CALL WRSCRM or WRAROM
• Add new cases: deep convection,...
• Thanks to the LES results and/or observations → an improved understanding of the behaviour of our physical packages → That’s in fact the main GOAL of this tool!
Thanks for your attention
Questions?

So, long life to MUSC model
a Marvellous Useful Single or “Simple” model!