MUSC: the 1D model for the HAAA Galaxy ?

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ALADIN/HIRLAM meeting
Norrköping, 5-8 April 2011

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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 …..

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mpa/turb/internals/turb_ver_thermo_flux.mnh
mpa/turb/internals/prandtl.mnh
mpa/turb/internals/shallow_mf.mnh
mpa/conv/internals/convect_trigger_shal.mnh
mpa/conv/internals/convect_closure_shal.mnh
mpa/conv/internals/convect_updraft_shal.mnh
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mse/internals/z0v_from_lai_2d.mnh

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ARPEGE/ALADIN/AROME/IFS/HARMONIE/MUSC
A NWP unified sofware

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.

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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

```
#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
```


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Output files:

- and after for "specific outputs" for 1D case :

For ARPEGE/ALAROO:
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)
```

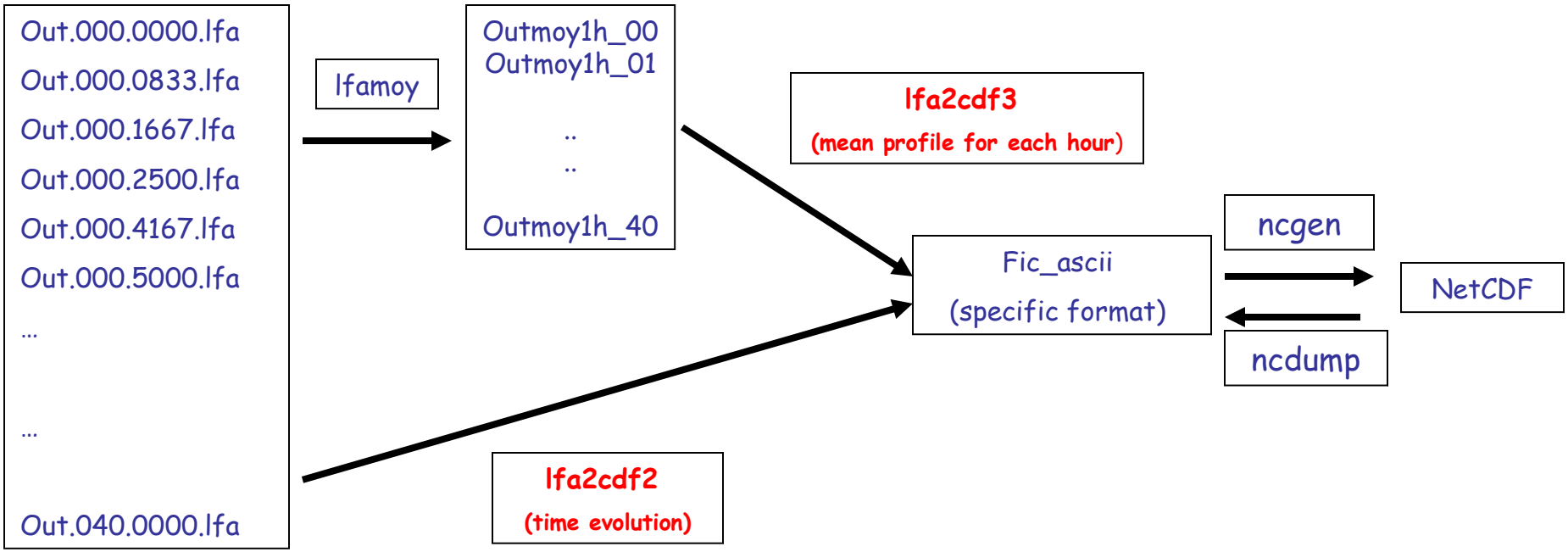
For AROME:
WRAROM (for 2d) and ECR1D

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*PPHI3(:,:,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:



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mse/internals/write_surft1_aro.mnh
mse/internals/z0v_from_lai_patch.mnh
mse/internals/z0v_from_lai_2d.mnh

Finally without the specific diagnostics for the 1D : only 17 routines are necessary to update MUSC and 32 routines for SURFEX 4.4 !

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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 → cumulus :**Astex + COMPOSITE case**
- Stable Boundary Layer : GABLS cases (**GABLS 1, 2 et 3**)

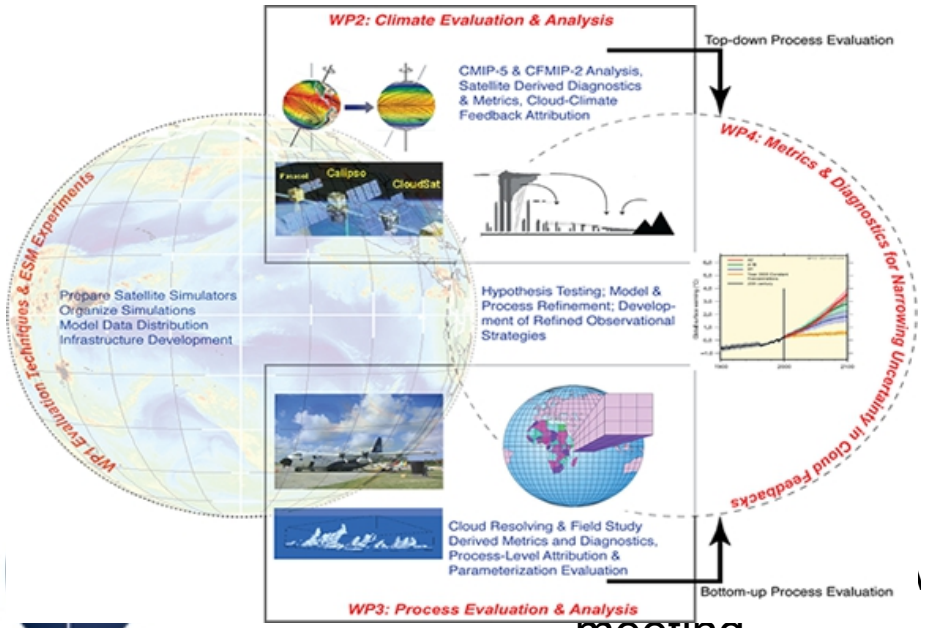
EUCLIPSE Project (2010-2014)

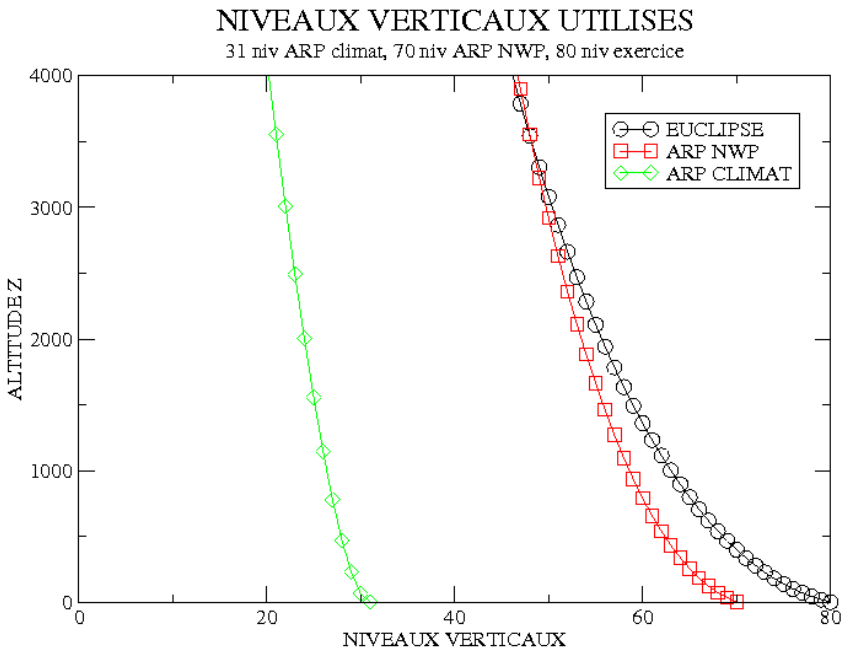
European Union Cloud Intercomparison, Process Study & Evaluation Project (coordinateur: P. Siebesma, KNMI)

- WP3: *Process evaluation and Analysis*

  Three intercomparison cases for 1D et LES :

  - **ASTEX Lagrangian (De Roode, van der Dussen, 2010) http://www.euclipse.nl/wp3/ASTEX_Lagrangian/Introduction.shtml**
  - **COMPOSITE (Sandu et al., 2010) http://www.mpimet.mpg.de/en/mitarbeiter/irina-sandu/transition-cases.html**
  - CGILS (Zhang et al., 2008)



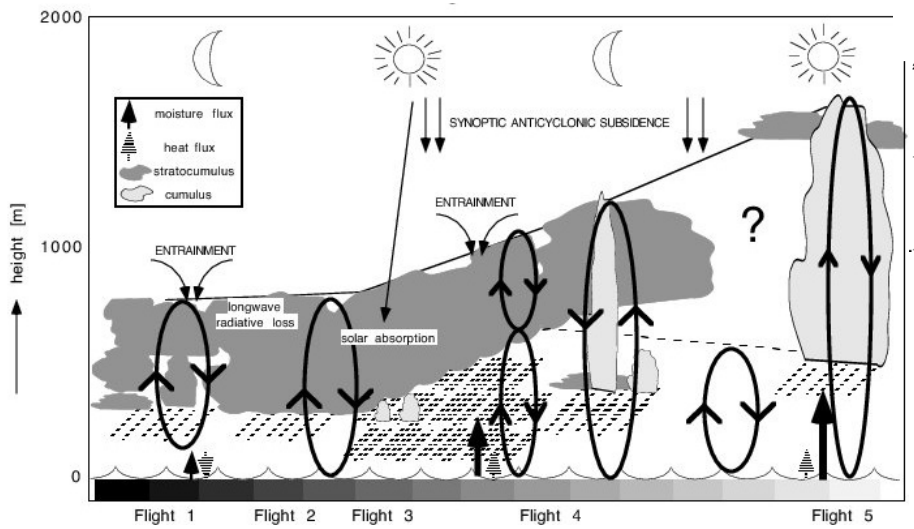


meeting

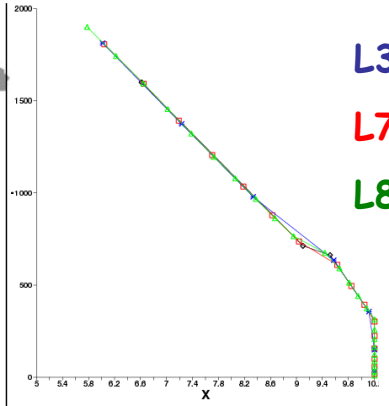
Physics in MUSC

	ARPEGE/ALADIN	AROME	ARPEGE GIEC AR5	ALARO0
Coeff K diffusion	TKE – CBR2000 (HL) modified for Ku	TKE – CBR2000 (FL) modified for Ku	TKE-2.0/Mellor-Yamada 82 (Ricard Royer-93)	E-TKE
L Mixing length	BL89	BL 89	Profil quadratique (Lenderink et Holtslag, 2004)	Int. HCLA Ayotte
Shallow convection	KFB Bechtold et al 2000	EDKF Pergaud et al 2009	Via les TKE-2.0 + PDF humides (RR 93)	Geleyn 87 With e-TKE
Clouds	Smith(90)	f0, f1, f2 Bougeault (82)	RR-93: PDF/f0,f1, f2; Bougeault (82)	Xu & Randall
Micro-Physics	Lopez mod ql,qi,qr,qs (PCS)	Ice3 5 variables	Kessler-Smith (1990)	ql,qi,qr,qs (PCS)
Convection	Bougeault 85 with modifications	No	Bougeault, 85 (figé V3: cycle 18)	3MT-deep
Radiation	ECMWF: LW=RRTM SW=Morcrette (93)	ECMWF: LW=RRTM SW=Morcrette (93)	ECMWF: LW=RRTM SW=Morcrette (93)	New-Geleyn

ASTEX lagrangian (13th, June 1992, +40 h)



Qv (g/kg) Initial profile

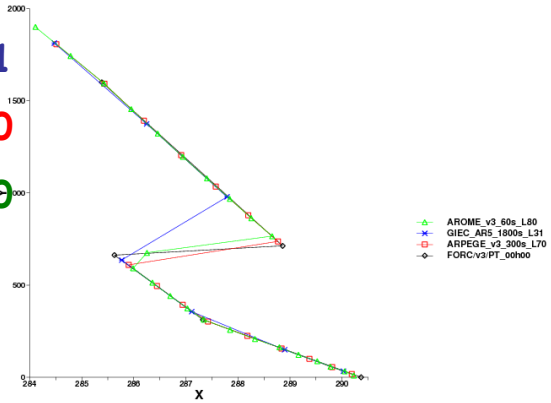


L31

L70

L80

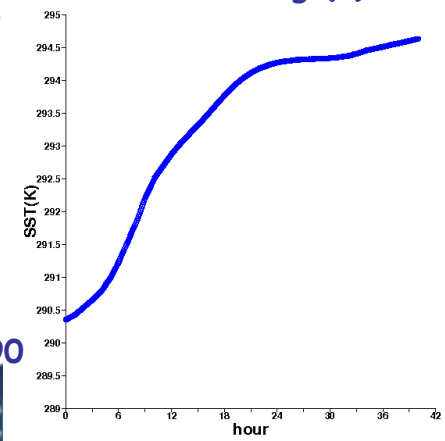
T (K) Initial profile



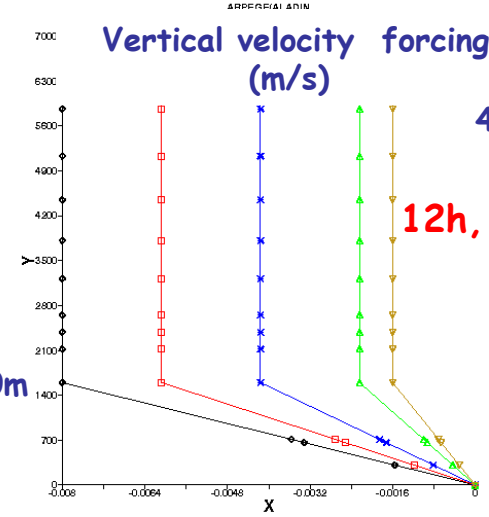
SST forcing (K)

295

290



Vertical velocity forcing (m/s)



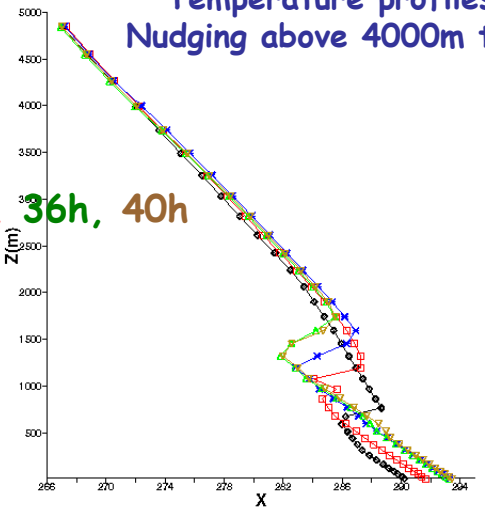
4000m

1500m

12h, 24h, 36h, 40h

-8mm/s

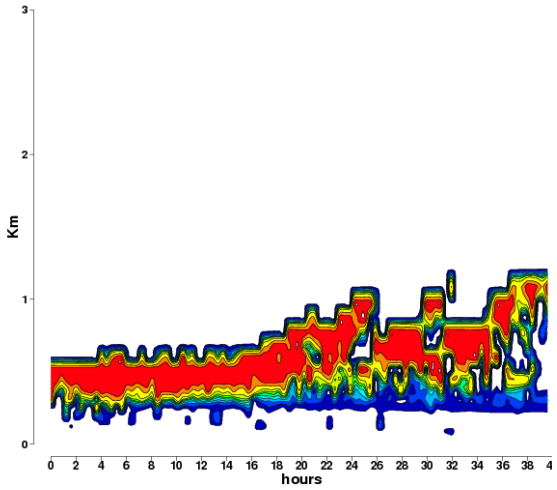
Temperature profiles (K)
Nudging above 4000m tau=12h



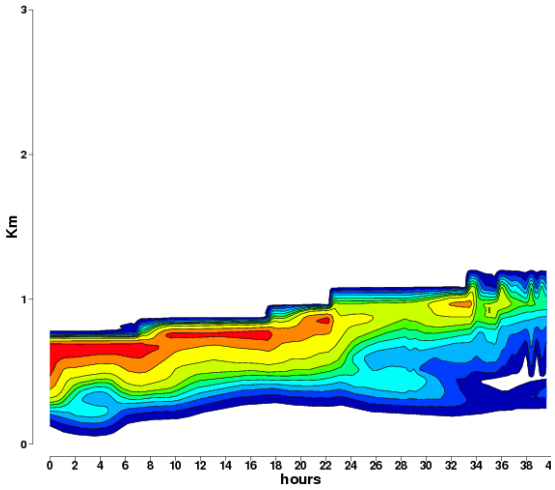
meeting

ASTEX Lagrangian

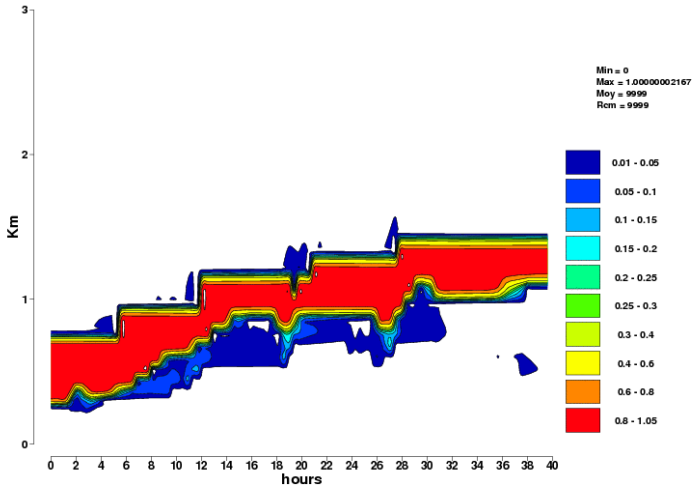
Cloud Cover ARPEGE GIEC AR5



Cloud Cover ARPEGE NWP

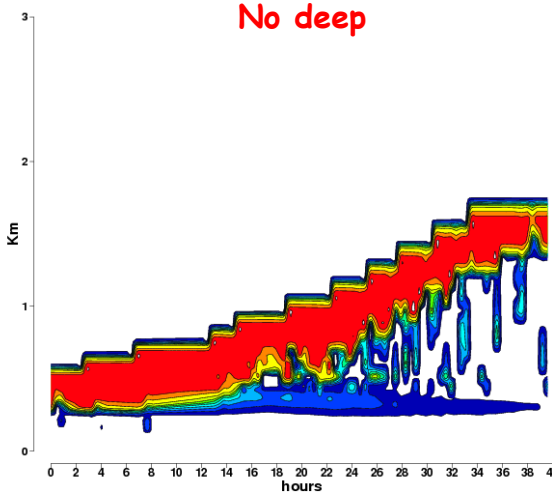


Cloud Cover AROME 60s

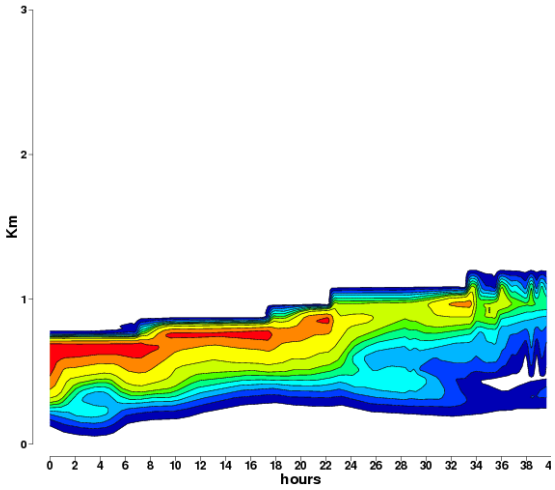


ASTEX Lagrangian

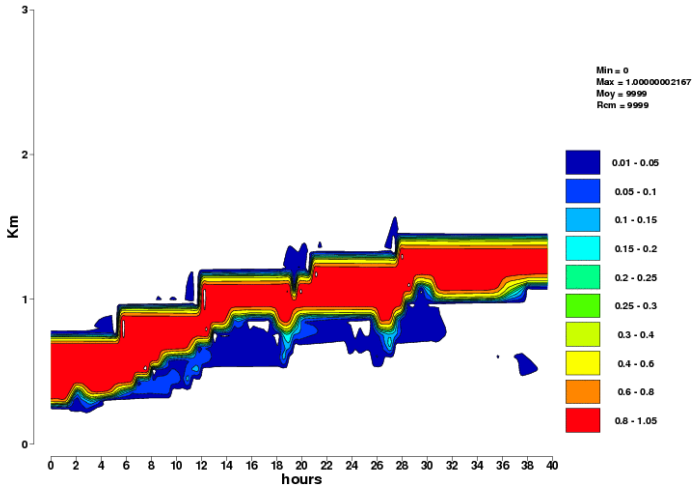
Cloud Cover ARPEGE GIEC AR5 No deep



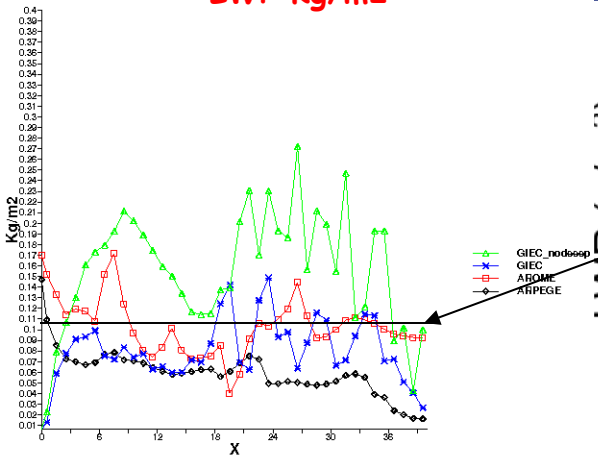
Cloud Cover ARPEGE NWP

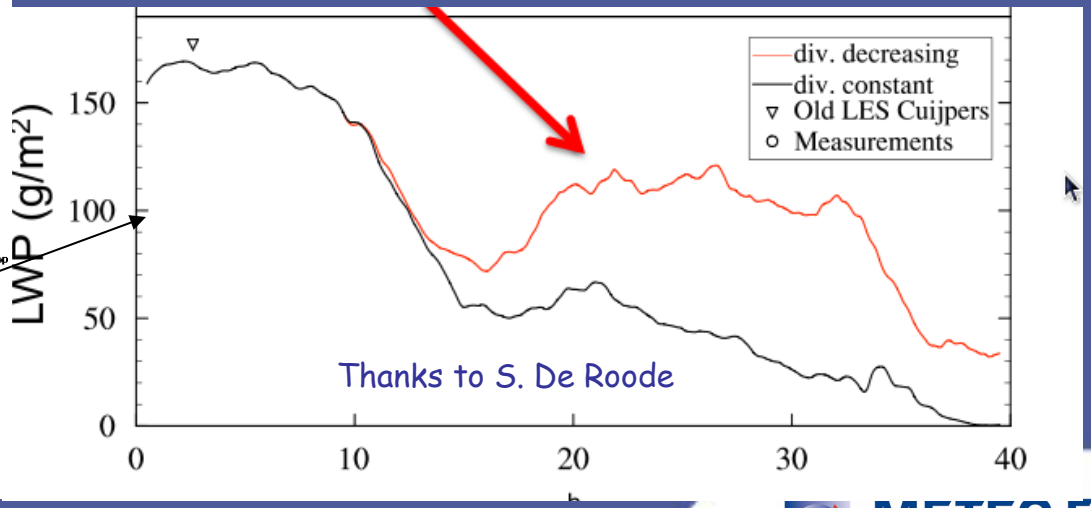


Cloud Cover AROME 60s



LWP Kg/m2





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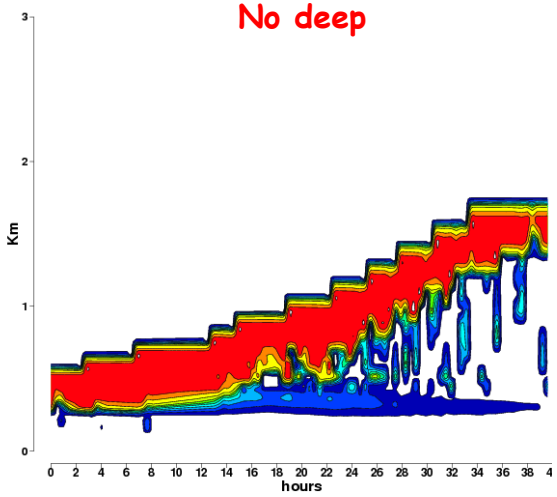
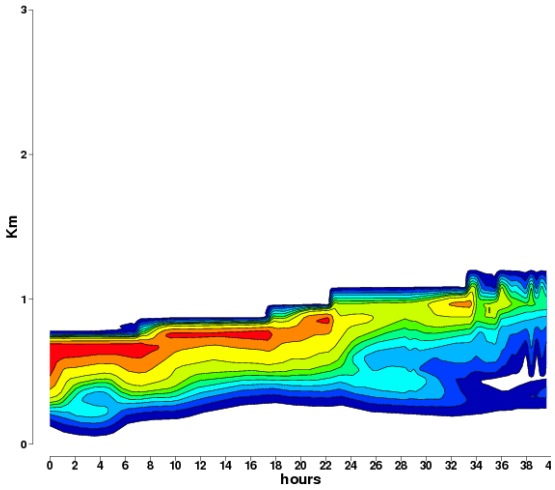
ASTEX Lagrangian

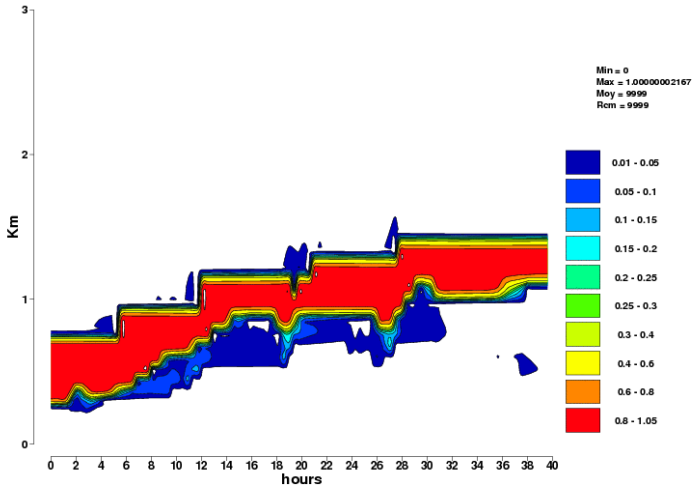
Cloud Cover ARPEGE GIEC AR5 No deep



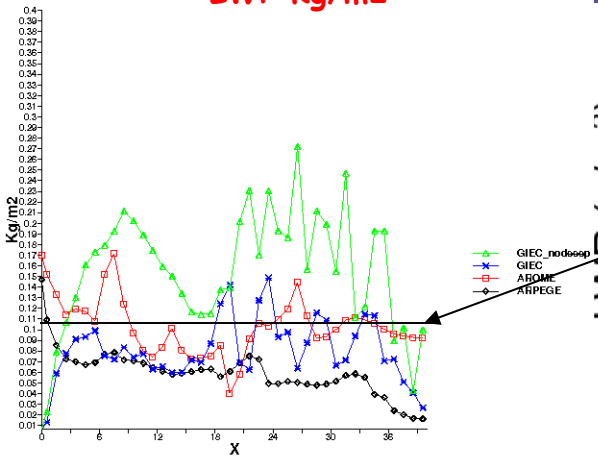
Cloud Cover ARPEGE NWP

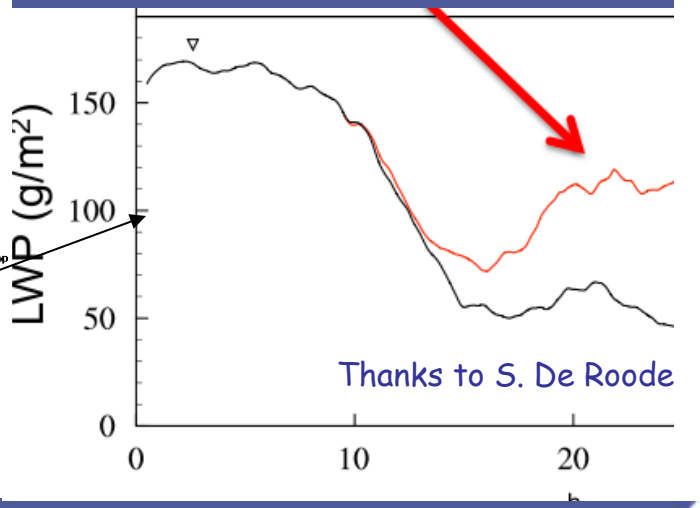


Cloud Cover AROME 60s

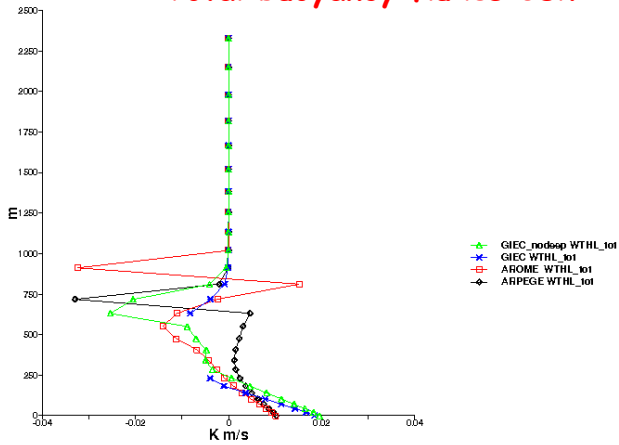


LWP Kg/m2





Total buoyancy fluxes 08h



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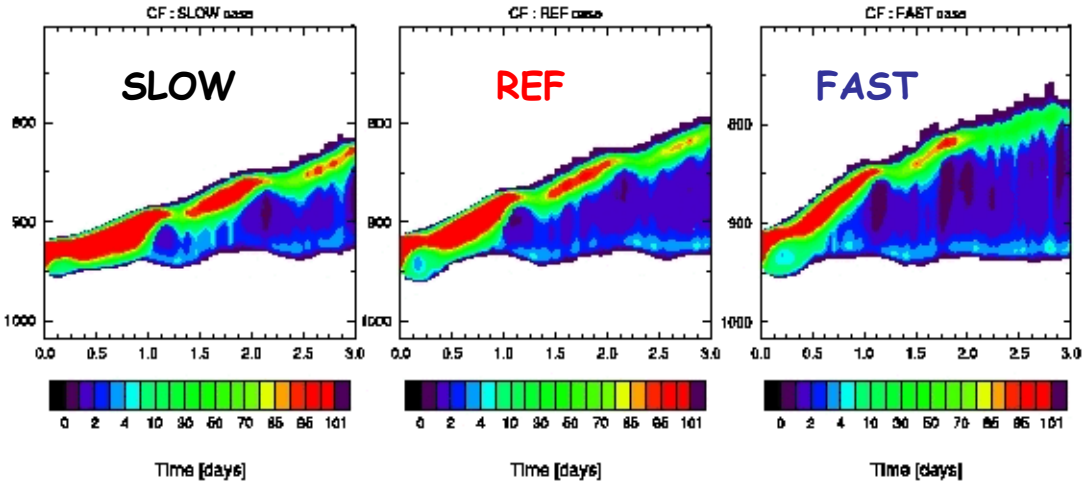
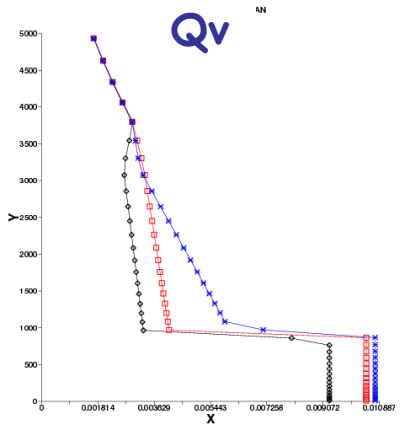
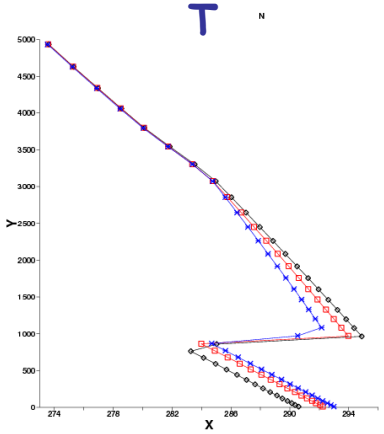
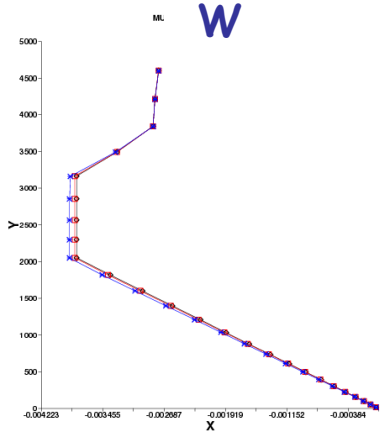
COMPOSITE Case (15th July, 3 days forecast)

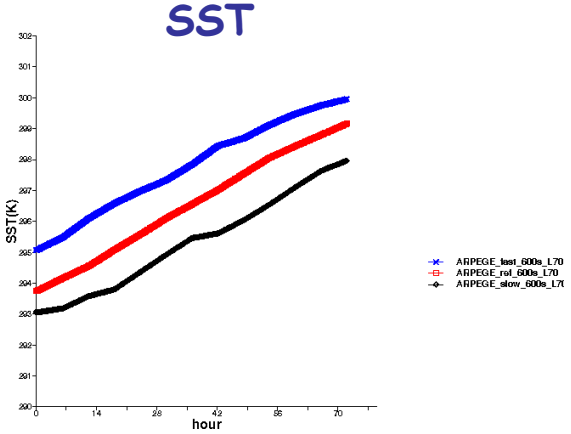


LES (UCLA) Cloud cover evolution for the 3 transitions slow, ref and fast

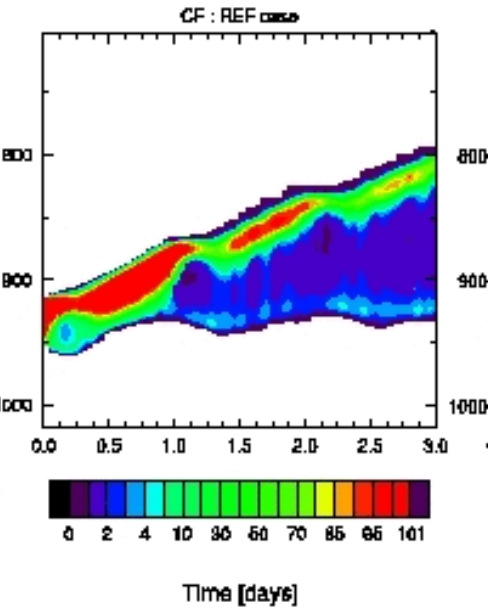




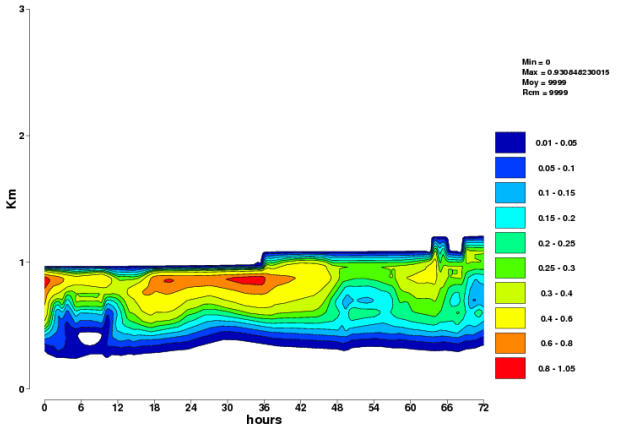




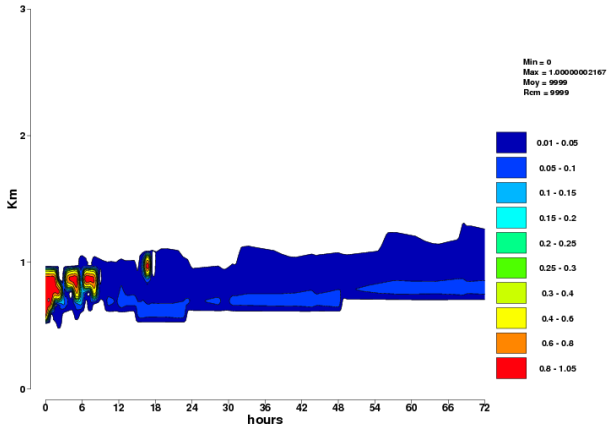
COMPOSITE Case (15th July, 3 days forecast)



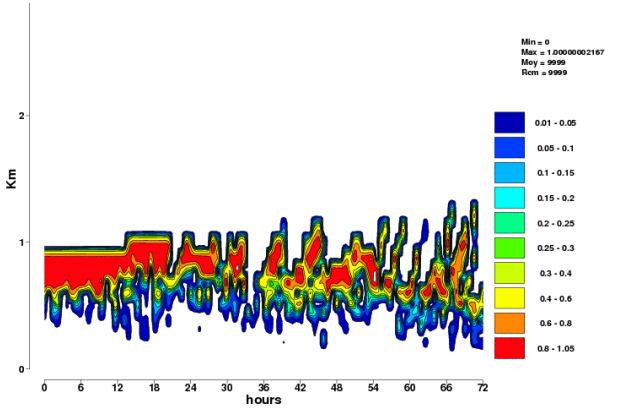
Cloud Cover ARPEGE NWP



Cloud Cover AROME 60s



Cloud Cover ARPEGE GIEC AR5



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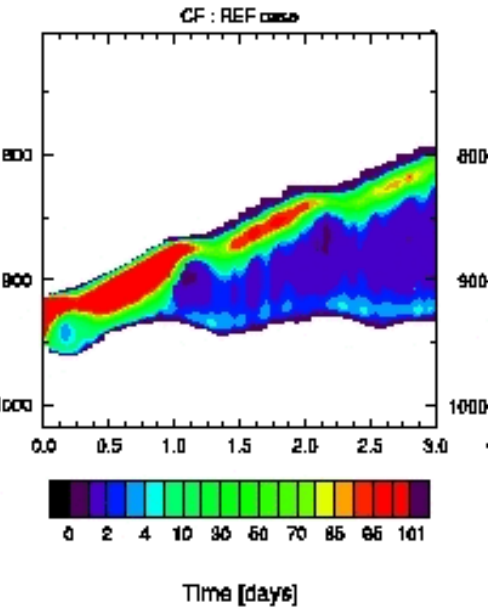
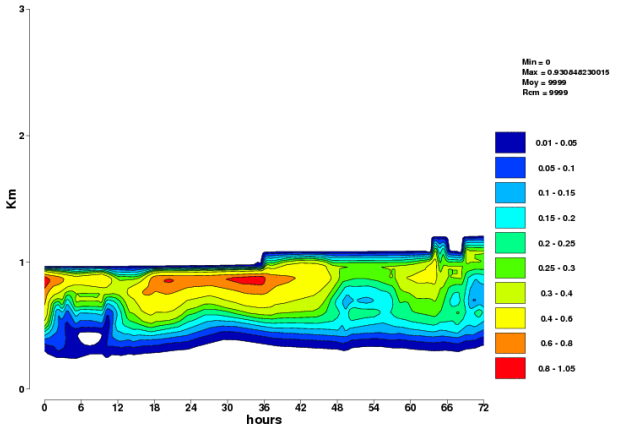
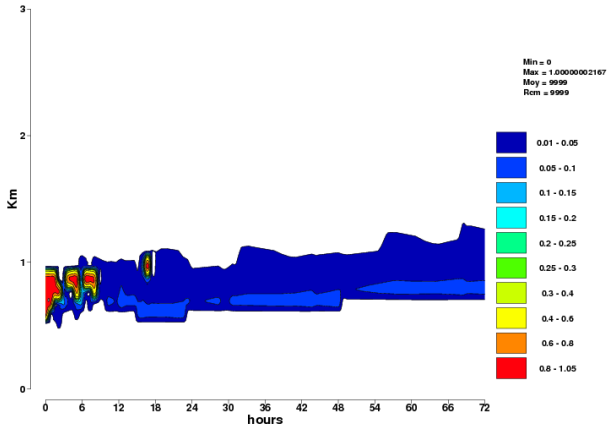
COMPOSITE Case (15th July, 3 days forecast)



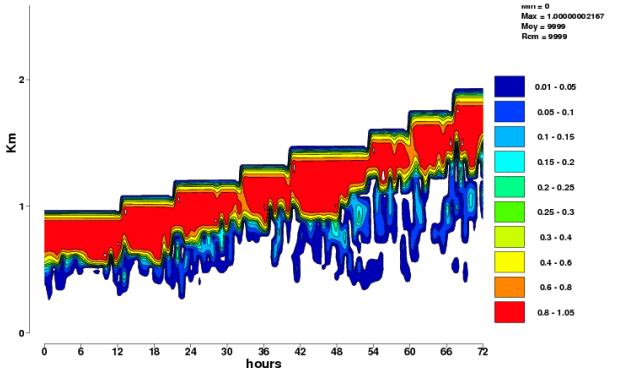
Cloud Cover ARPEGE PNT



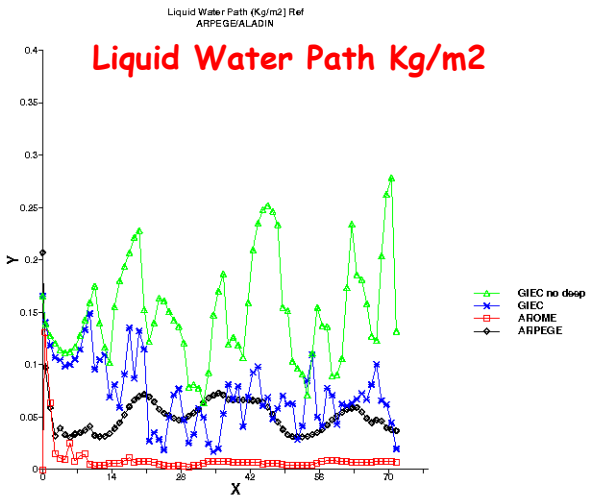
Cloud Cover AROME 60s



Cloud Cover ARPEGE GIEC AR5 No deep



Liquid Water Path Kg/m2



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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 !

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