



# 1D and 3D evaluation of PBL schemes for low clouds

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# Outline

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- About physical parametrisations and forecaster's complains.
- Automatic ARPEGE and AROME output on site observations
- Example of one low clouds case over SIRTA
- 1D cases
- Some « concrete actions » after the CWW in Toulouse Jan 2017



# Our forecaster's point of view

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- At Météo-France, tendency of AROME to under-estimate low clouds over sea and over land.
  - With HARMONIE-AROME, it is the reverse. Why ? Initial conditions ? Physics ?
  - Since April 2015 (High resolution) ARPEGE has also a tendency to underestimate low clouds. Less StratoCumulus over ocean. Is it due to horizontal/vertical resolution ? Other things ?
- Cloud Workshop or Cloud Working Days : Toulouse, Jan 2017



# About options in the code ...

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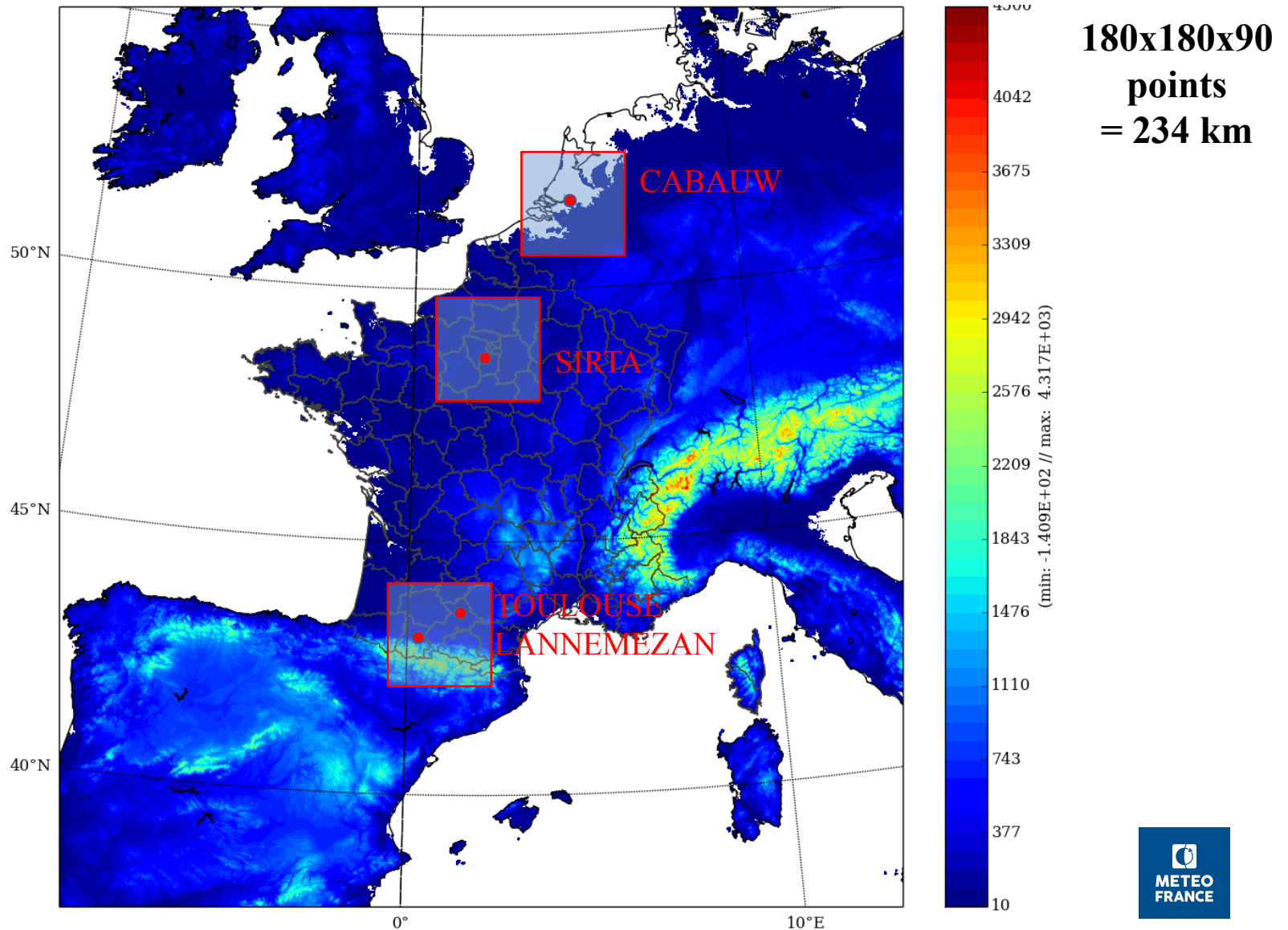
## Several options are available in ARPEGE-AROME-HARMONIE

([AROME-MF](#), [HARMONIE](#), [OPTIONAL](#)):

- CMF\_CLOUD : DIRE, STAT, BIGAU (Bi-Gaussian : new pdf for the cloud).
- CMF\_UPDRAFT='EDKF'
  - 'DUAL'
  - 'RHCJ': Rio et al (2010) modified vertical velocity, entrainment and detrainment
  - 'RAHA': Closure from Rio and Hourdin (2010): The mass flux is computed at the top of the unstable surface layer as the sum of horizontal fluxes
- KFB Scheme for ARPEGE and AROME
- Turbulence :
  - CBR with EDKF, DUAL, RHCJ and RAHA
  - HARATU with DUAL
- PCMT for ARPEGE
- ALARO physics



# Small AROMEs coupled with AROME-France



# ARPEGE/AROME automatic extractions for several sites

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## ■ ARPEGE : NetCdf and ASCII files

- NetCdf : vertical profiles prognostic variables, fluxes, advections, w ...
- ASCII : Only surface fields : T2m, T30m, Rh, ff, SWD, LWU,H, LE, evap, mom., LWd, Swu, ...
- SIRTA (67%veg, et 33% bare soil), Cabauw, Toulouse (since 2004), Lindenberg (since 2005), Lannemezan (october 2004), Dome-C (09/2011), ARM-SGP (03/2005, used in CAUSES)...

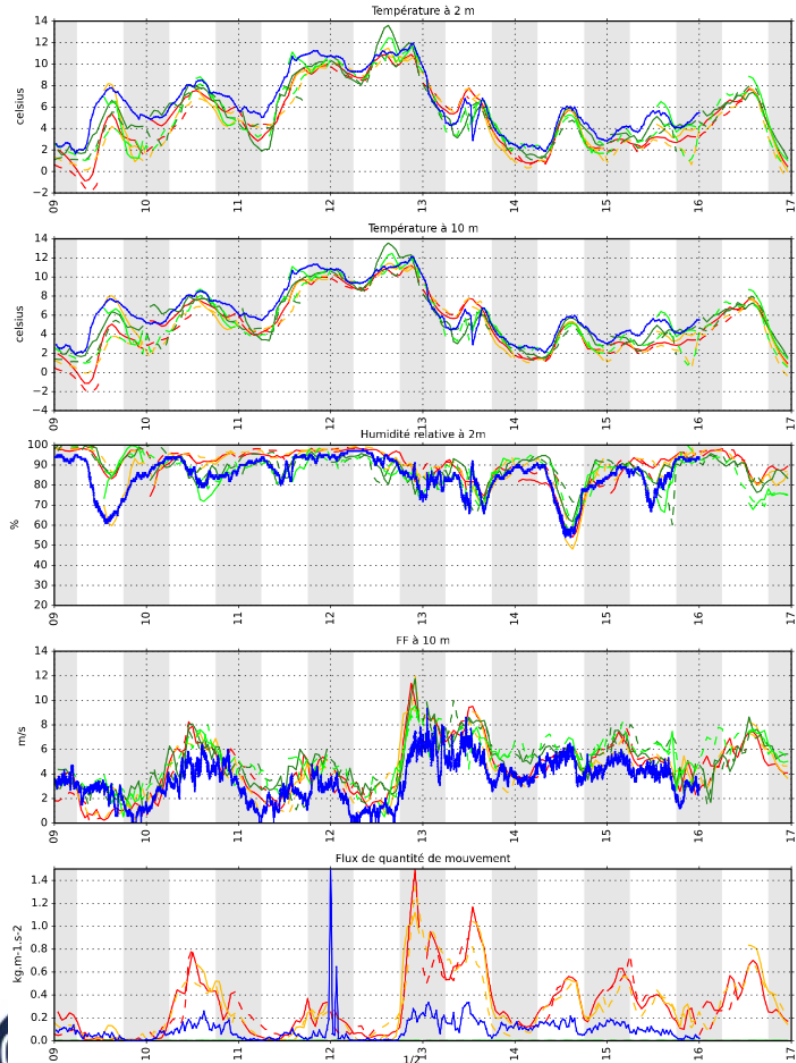
## ■ AROME :

- 12 points from OPER (Surface fields in **ASCII**) : SIRTA (2pts: closest one 67% town and 33 % veg, other one 100% veg) Cabauw, Lindenberg, Col de Porte, Lac blanc (since July 2015)
- 4 sites with dedicated small AROME domains (config OPER) starting (and coupled) from ARPEGE (Sodankyla since Jan 2014) or AROME-France (Toulouse, SIRTA, Cabauw, Lannemezan since Oct 2015). It allows to produce vertical profiles outputs (**DDH** files) 16 points around the observation site (will be soon converted in **NetCdf** as in ARPEGE), and **Ascii** surface fields.
- Vertical profiles and DDH files could also be used to initialize and drive 1D simulations or LES !



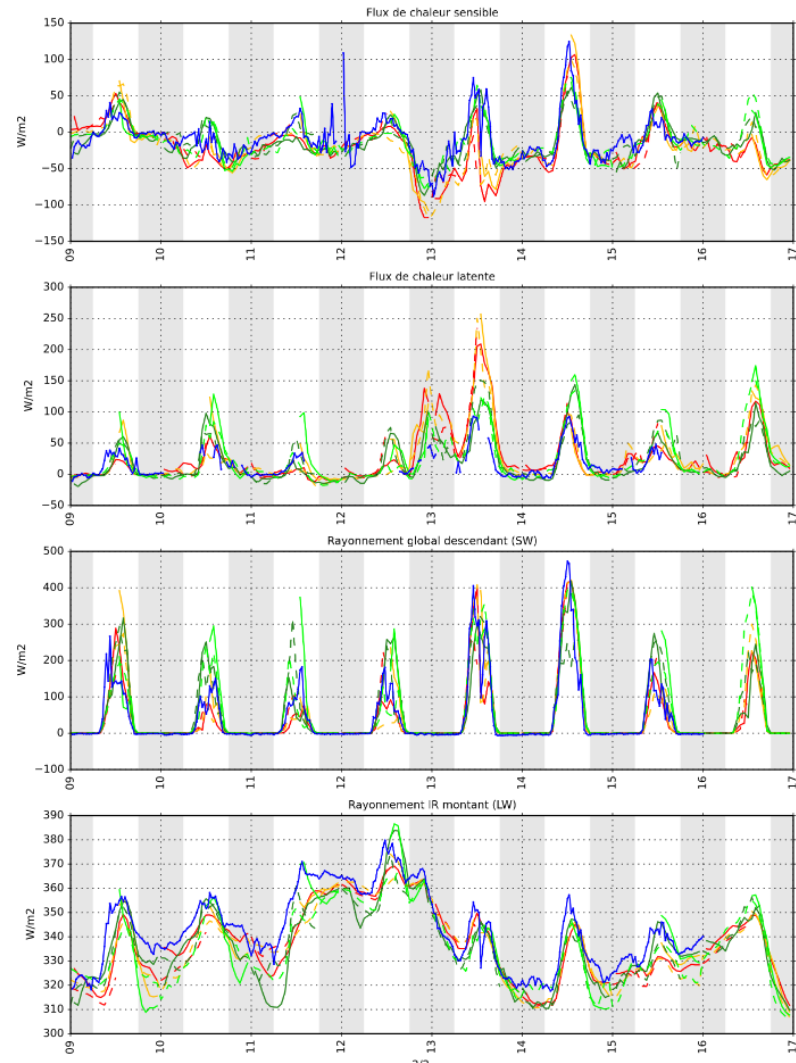
# ARPEGE and AROME automatic extractions

ARPEGE ( 00H: rouge, 12H : orange) - AROME ( 00h : vert foncé, 12H: vert clair) - Station Metepole-flux (bleu) du 09/01/2017 au 16/01/2017



16-01-2017 22:10 vista/compar\_tous\_modeles.vista

ARPEGE ( 00H: rouge, 12H : orange) - AROME ( 00h : vert foncé, 12H: vert clair) - Station Metepole-flux (bleu) du 09/01/2017 au 16/01/2017



16-01-2017 22:11 vista/compar\_tous\_modeles.vista

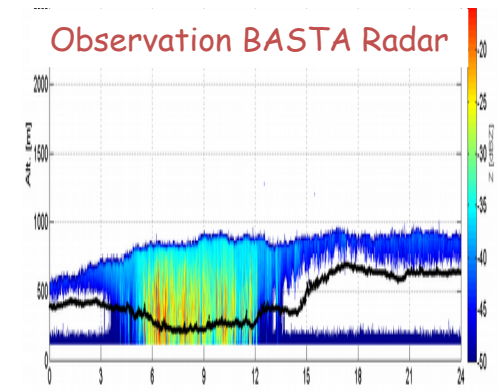
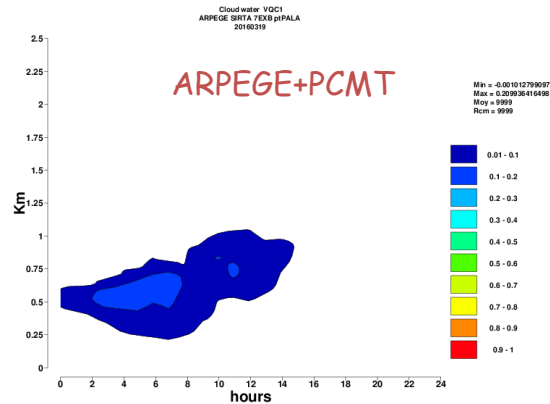
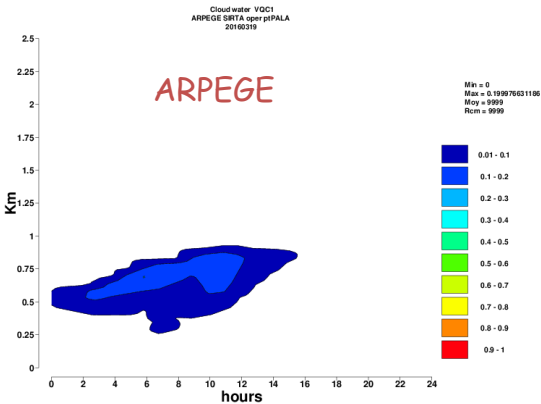
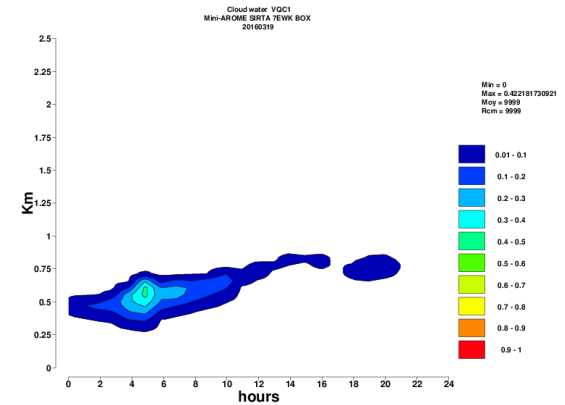
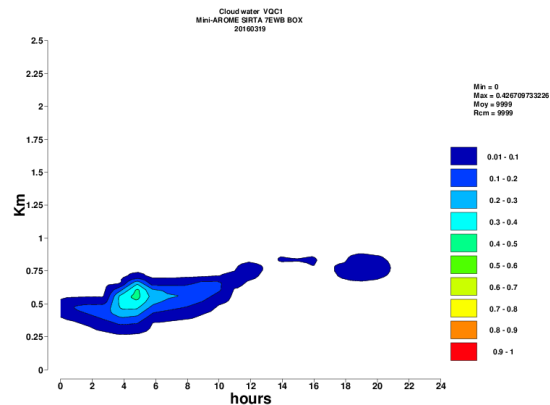
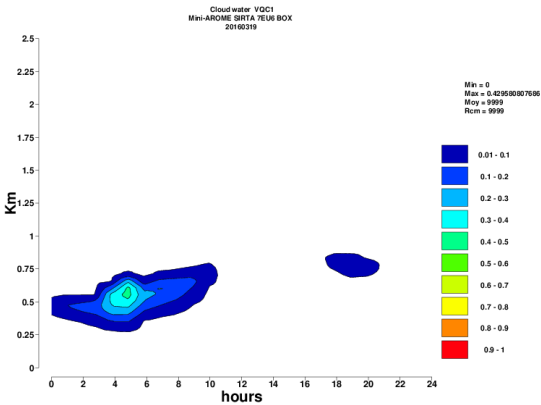
# An example of low clouds case ...@ Sirta

- 19 March 2016 : Cloud water (16pts)

AROME-Site

AROME-Site no EDMF

AROME-Site + Updraft=RAHA

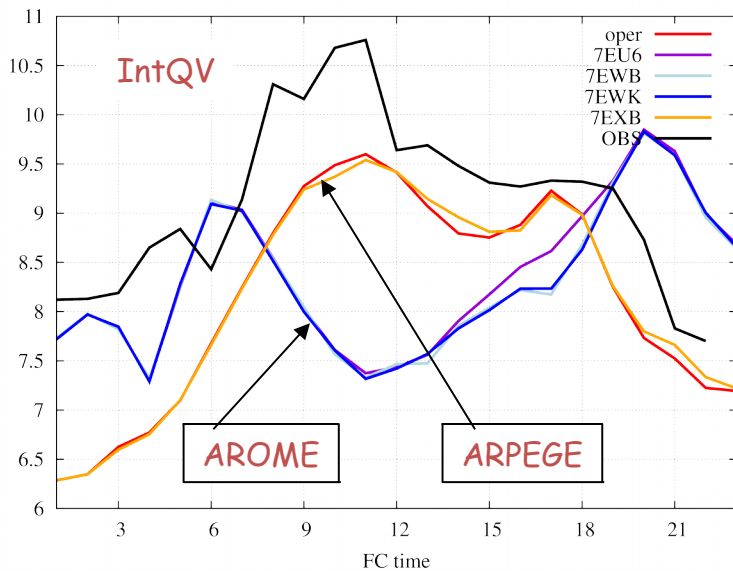
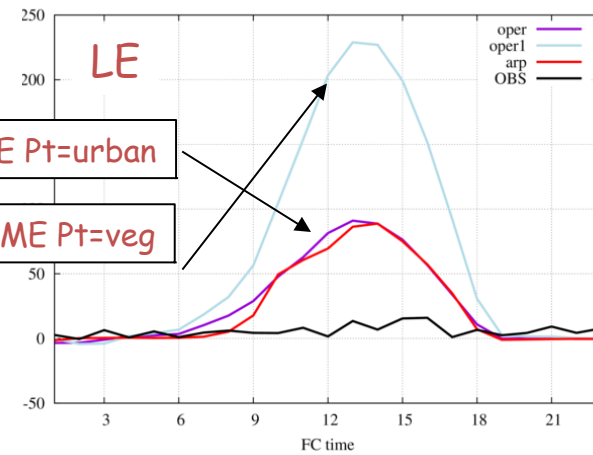
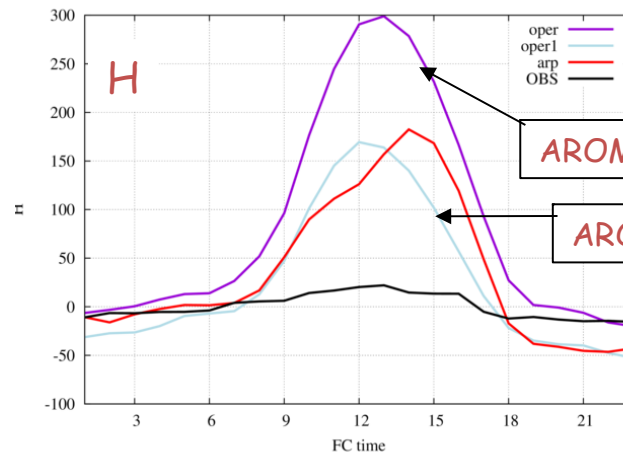
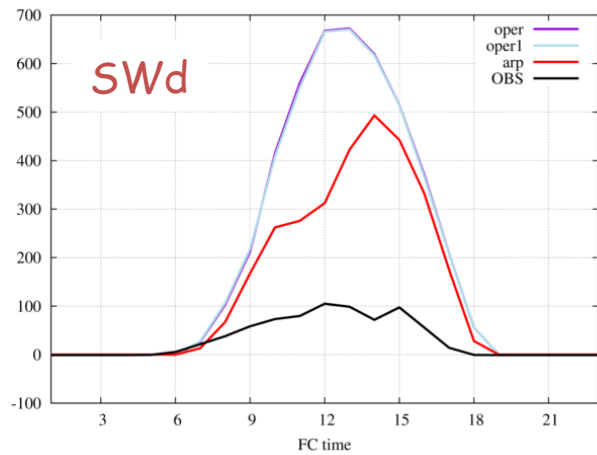


RAHA seems better but ... it is not the case for a longer period !

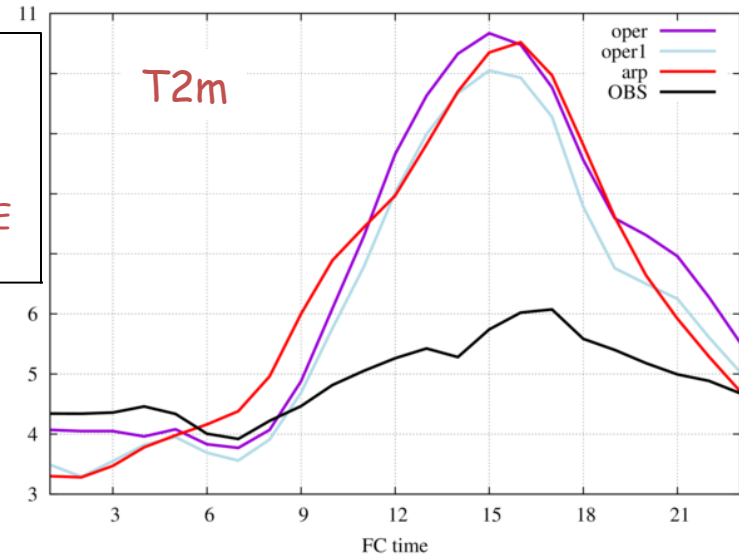




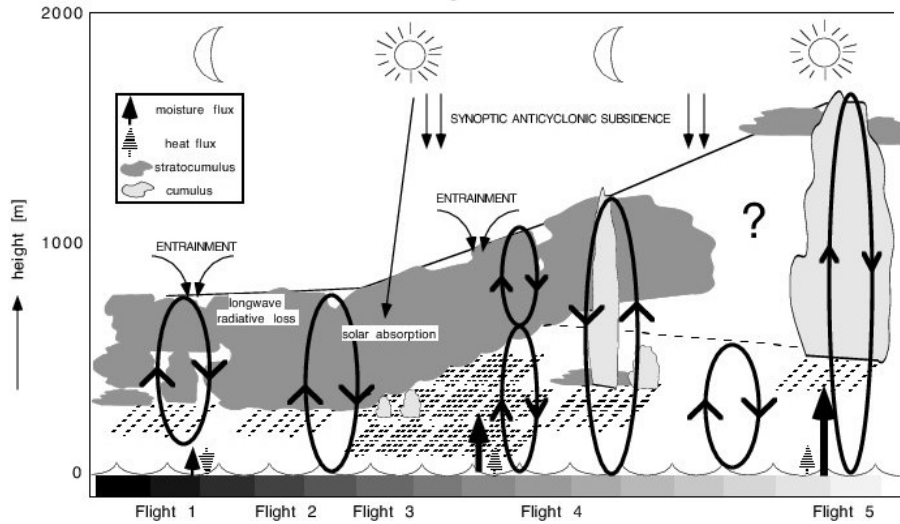
# Surface fluxes comparisons @ SIRTA ...



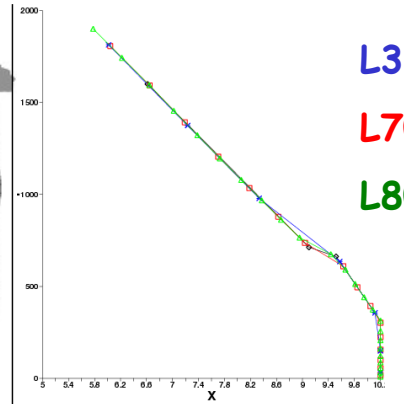
Same T2m between AROME and ARPEGE with a lower SWd (200W/m2) for ARPEGE but less H+LE than AROME !



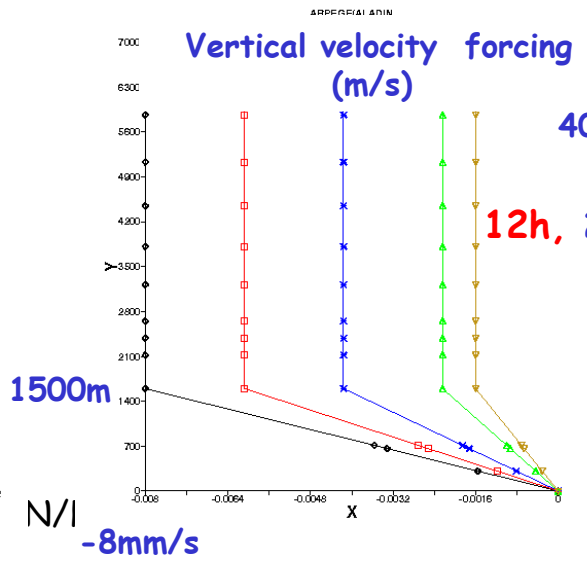
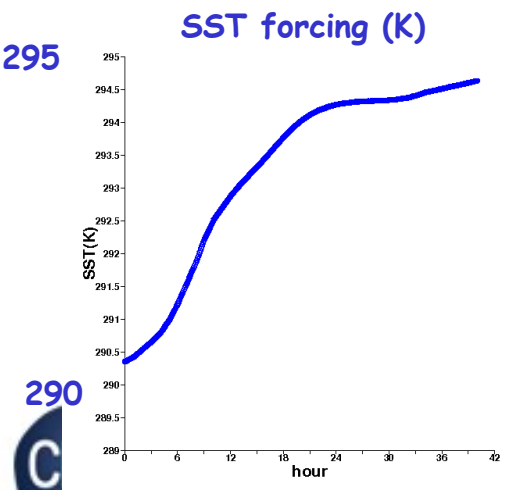
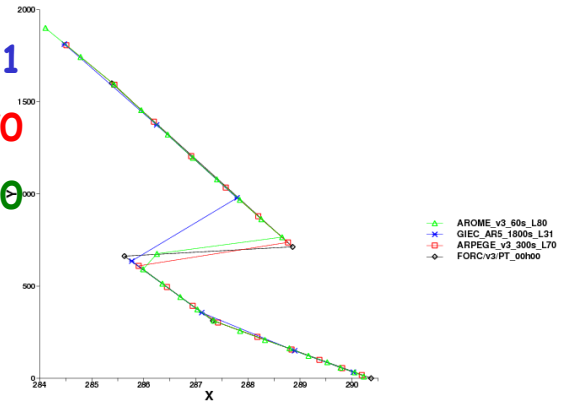
# ASTEX lagrangian (13 June 1992, +40 h)



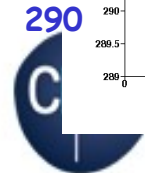
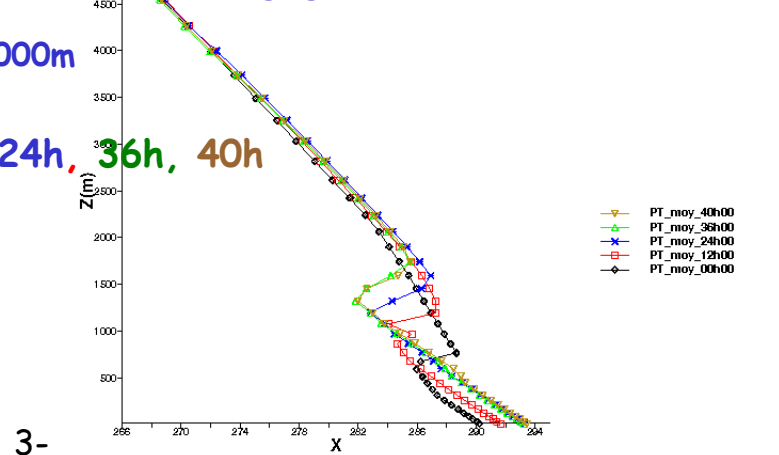
$Q_v$  (g/kg) Initial profile



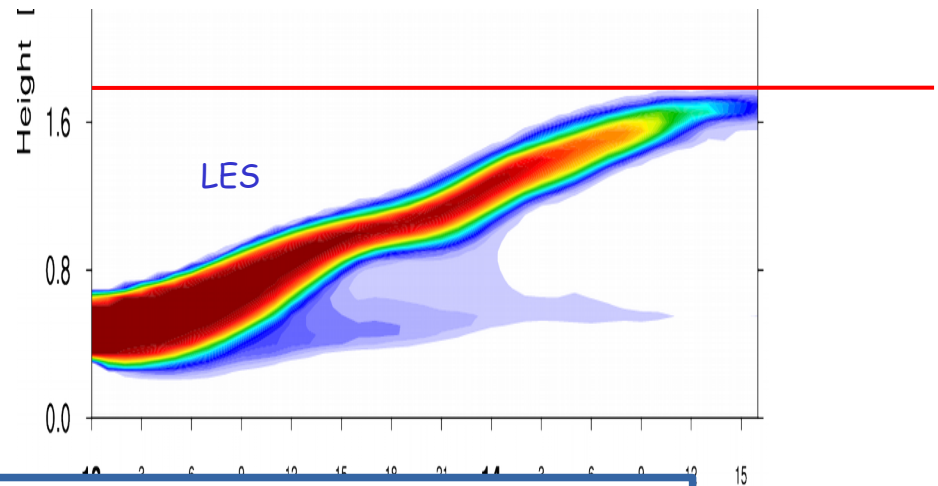
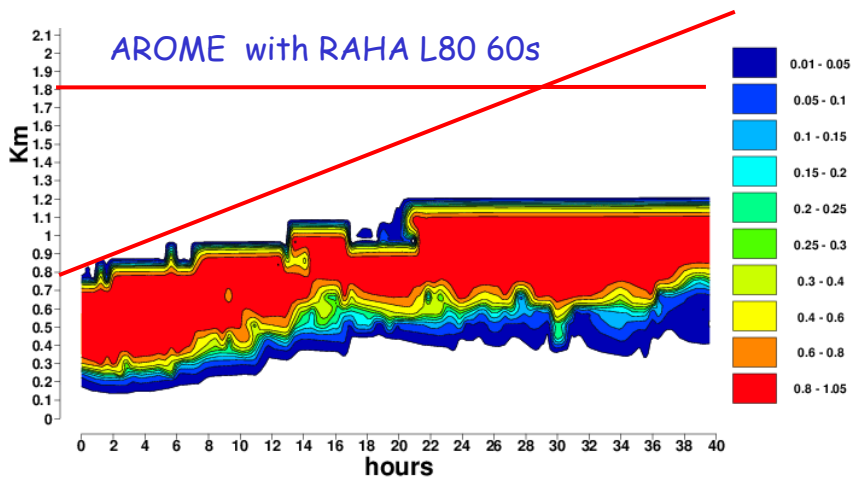
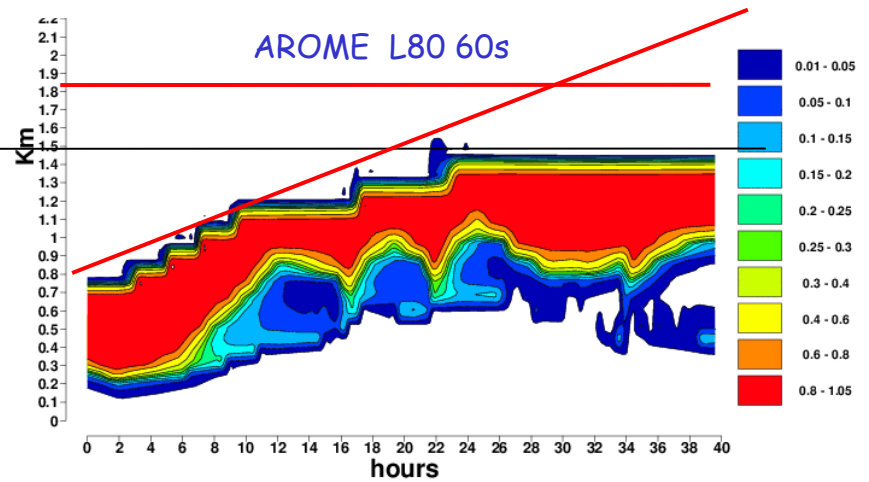
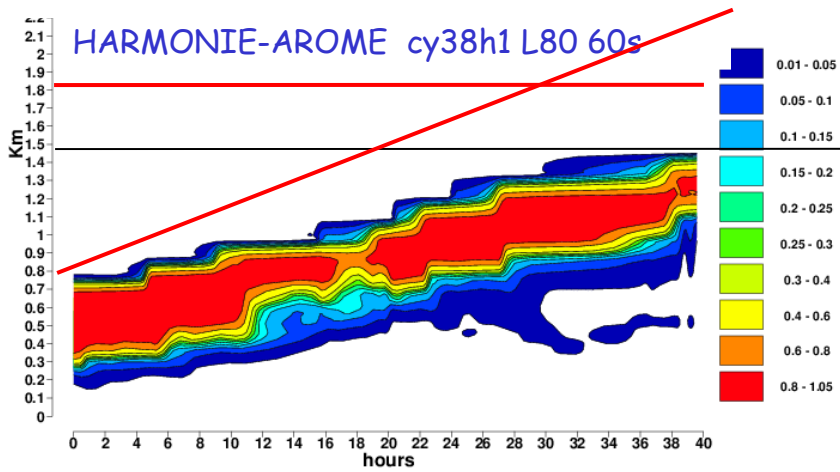
T (K) Initial profile



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



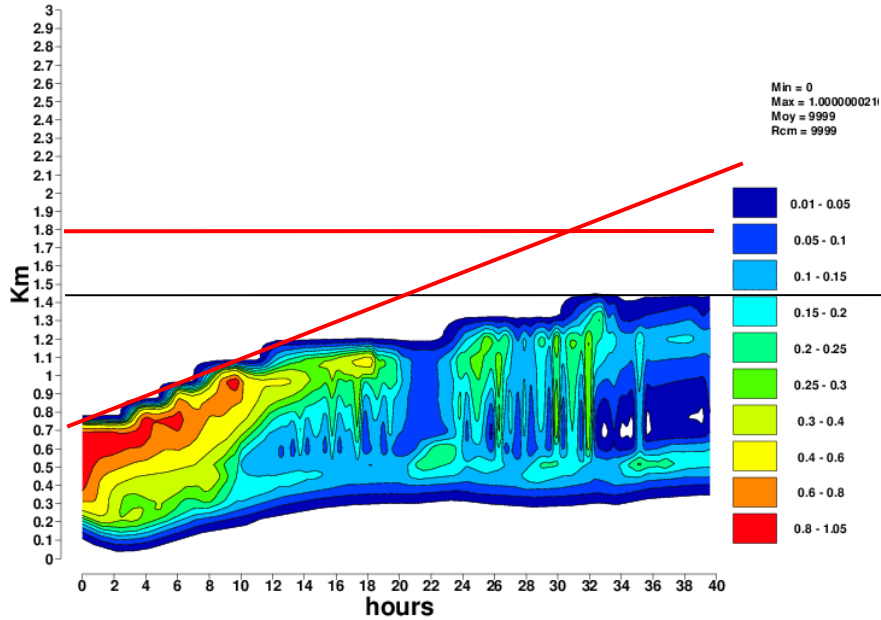
# ASTEX\_Lag: Cloud Cover



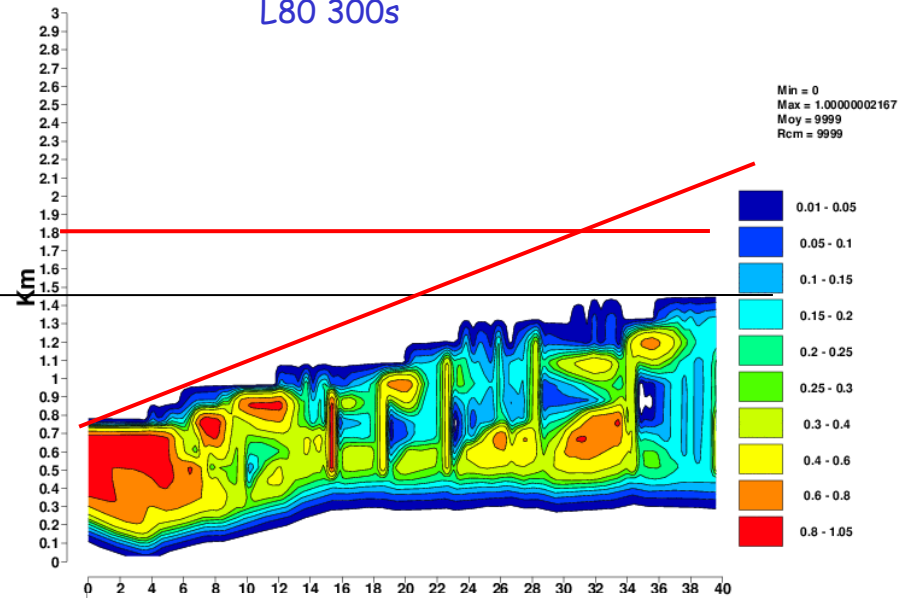
Cloud top is underestimated by 300/400m for both models and more with RAHA

# ASTEX\_Lag: Cloud Cover

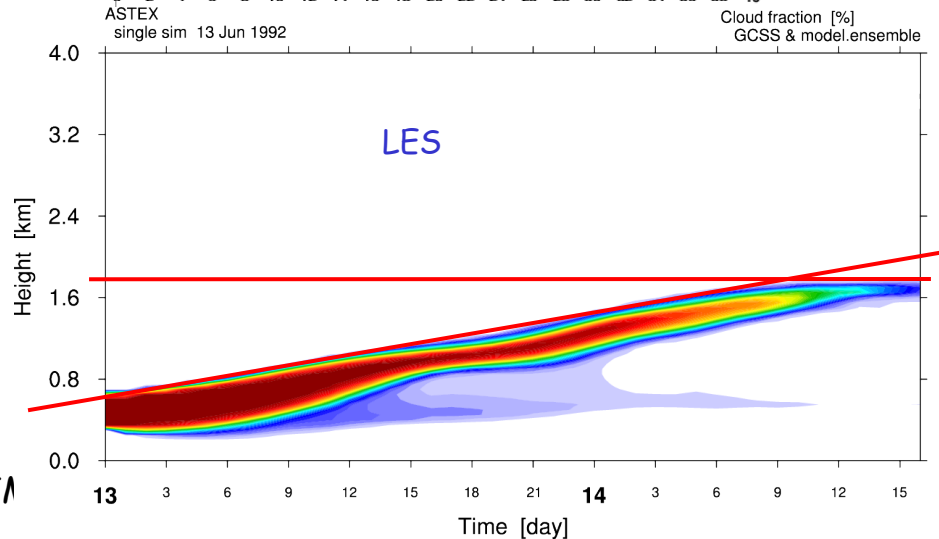
ARPEGE cy41t1 L80 300s



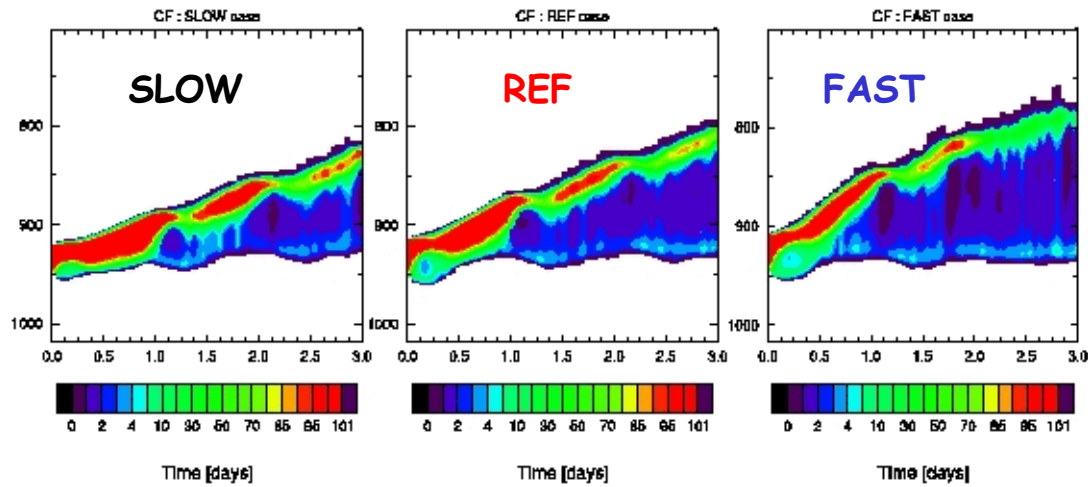
ARPEGE\_PCMT cy41t1 L80 300s



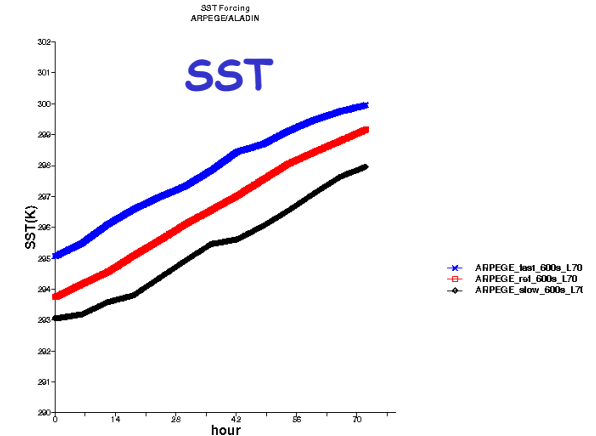
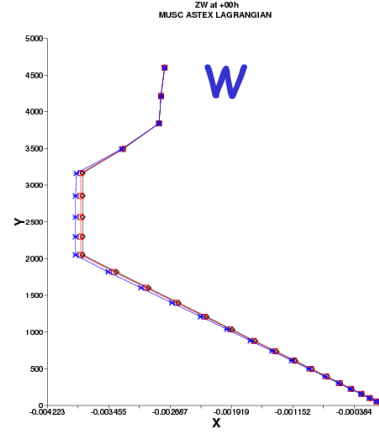
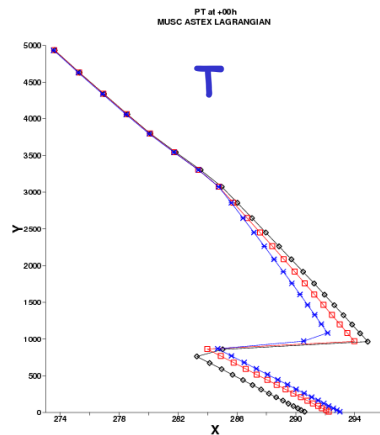
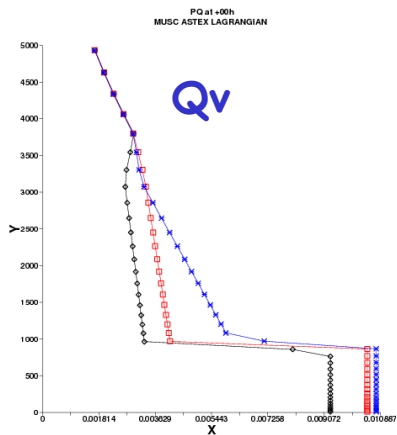
Very preliminary results with PCMT without any specific tunings → reasonable results, underestimate the cloud top as ARPEGE-Oper



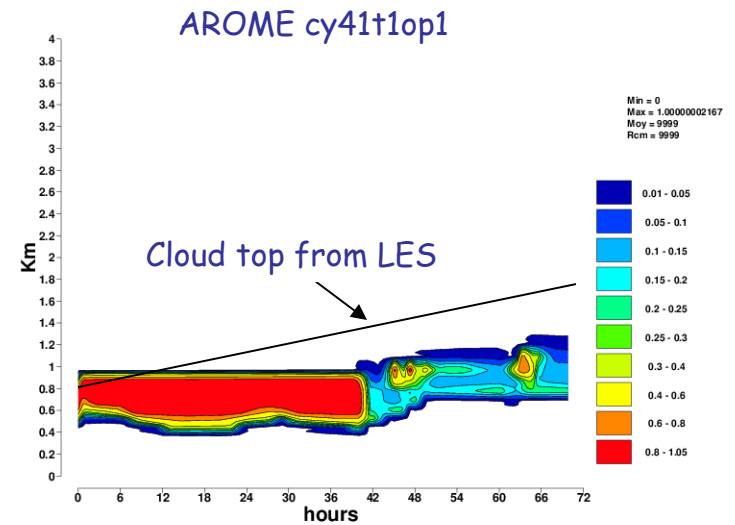
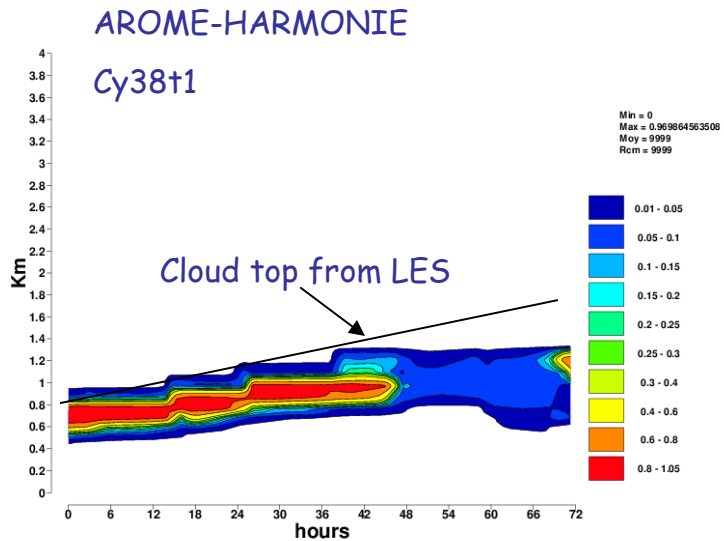
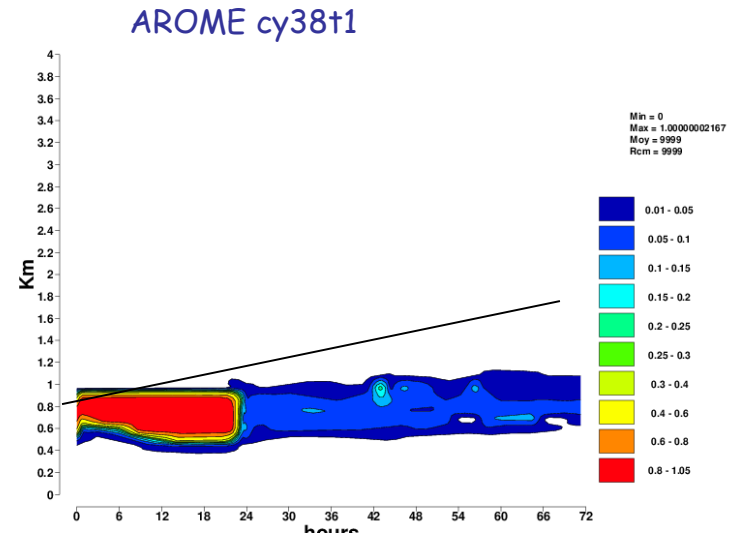
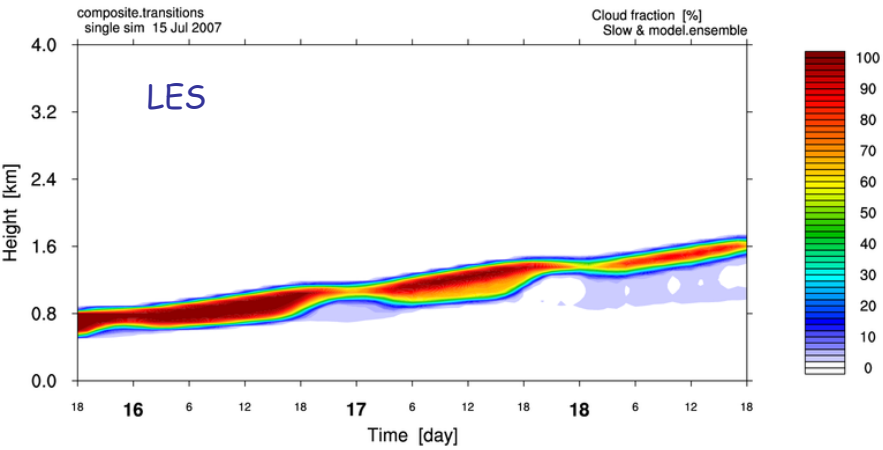
# ASTEX Composite (15 July, 3days)



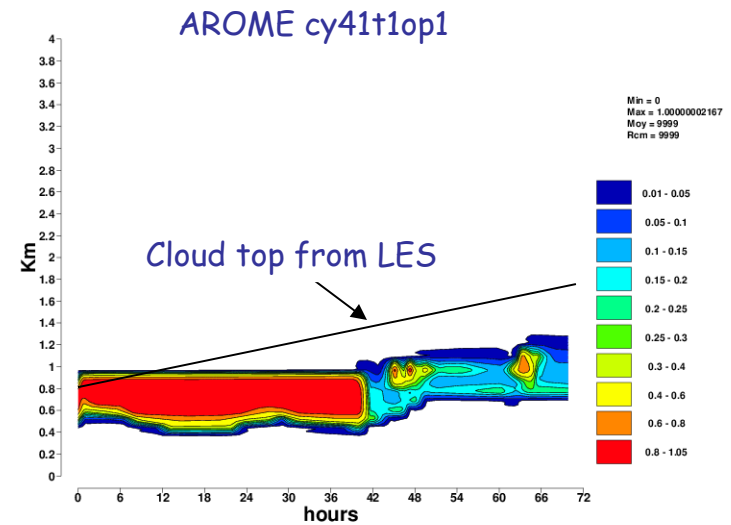
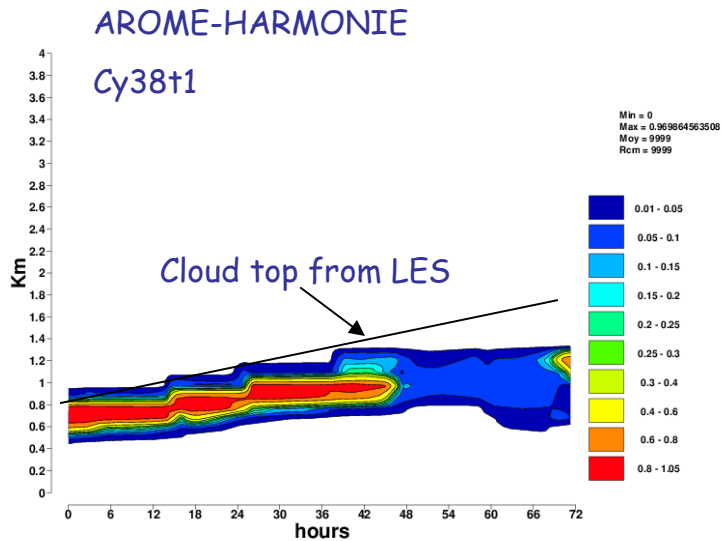
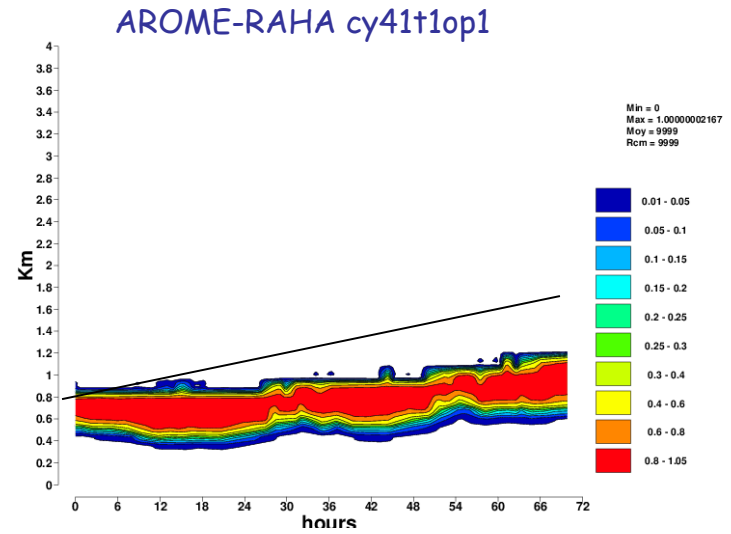
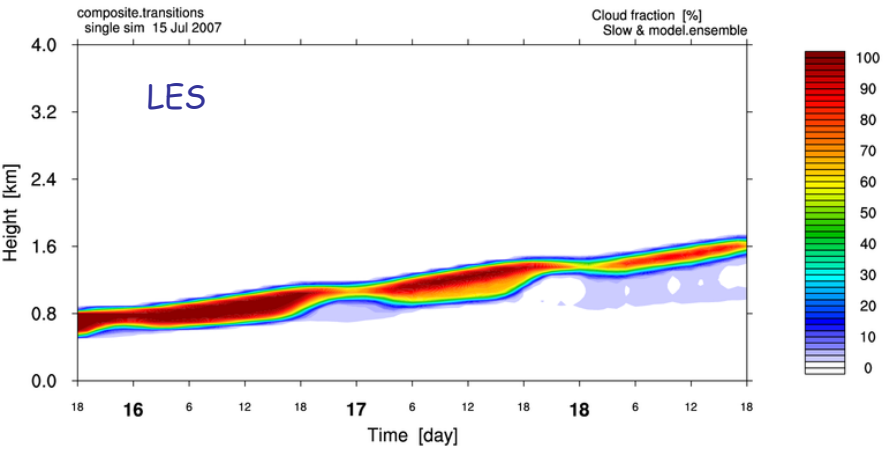
Evolutions temporelles de la fraction nuageuse pour les 3 types de transitions lente, de référence et rapide obtenues avec le LES de l'UCLA.



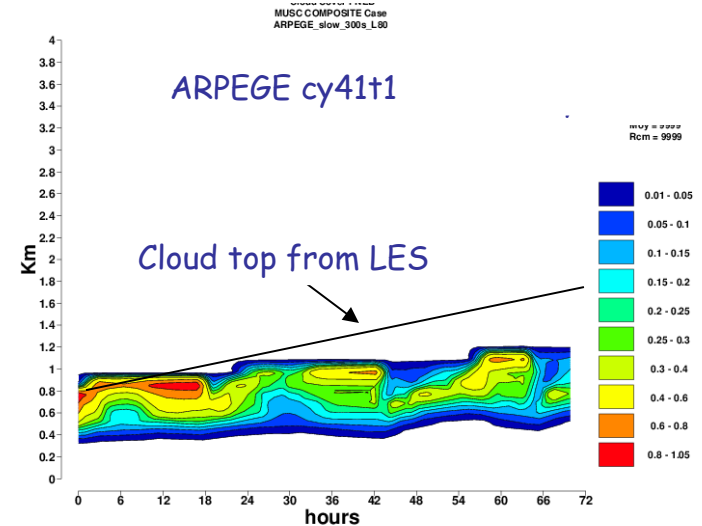
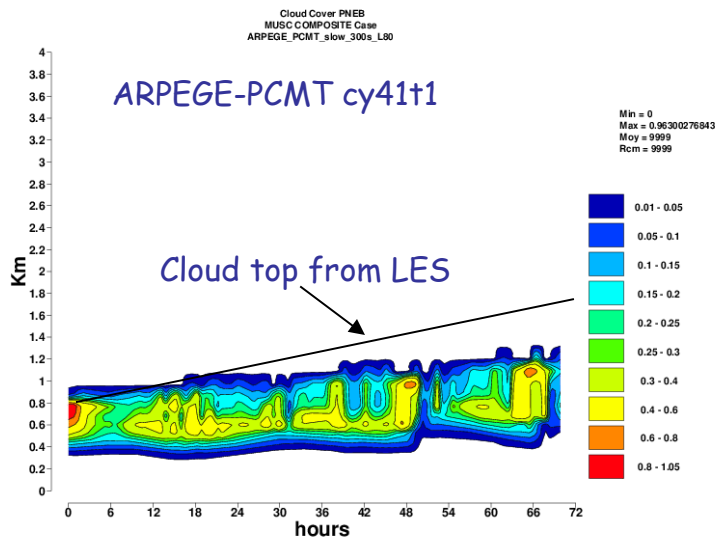
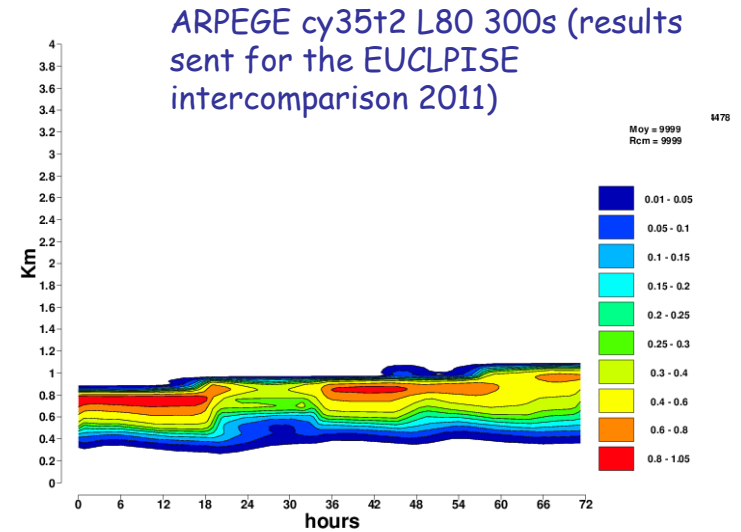
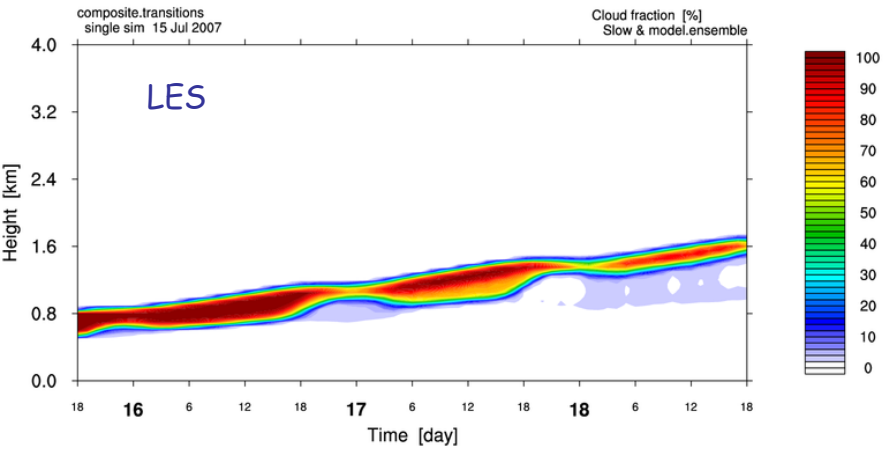
# ASTEX Composite (15 July, 3days) : SLOW



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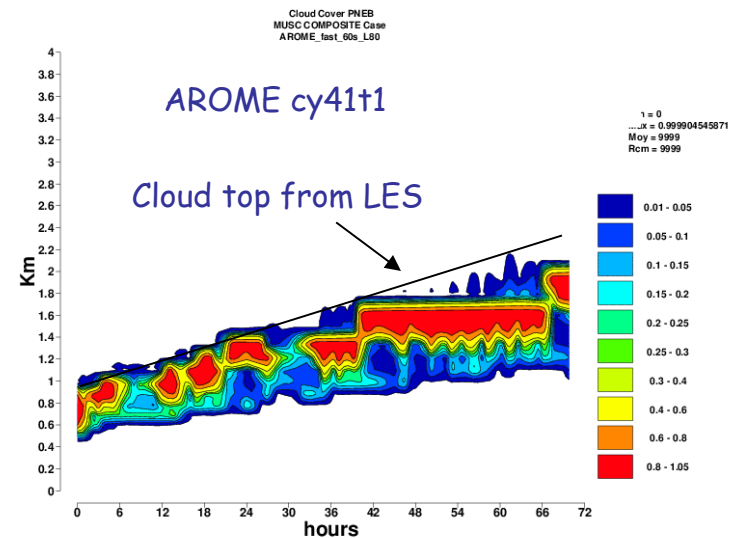
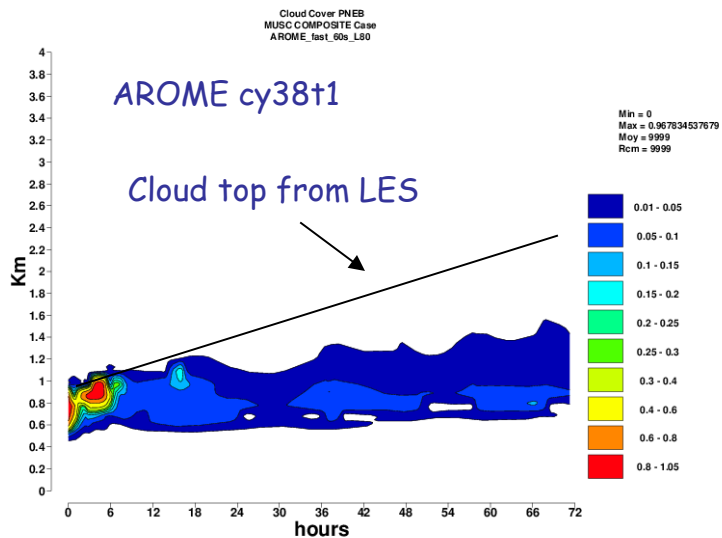
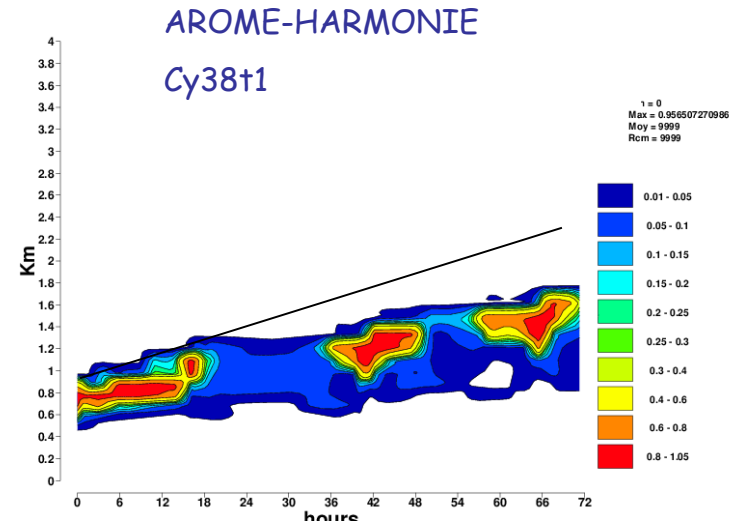
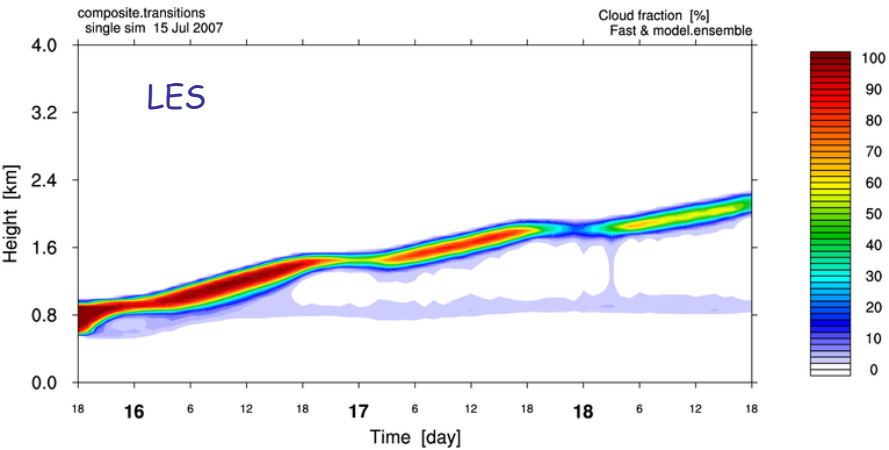


# ASTEX Composite (15 July, 3days) : SLOW

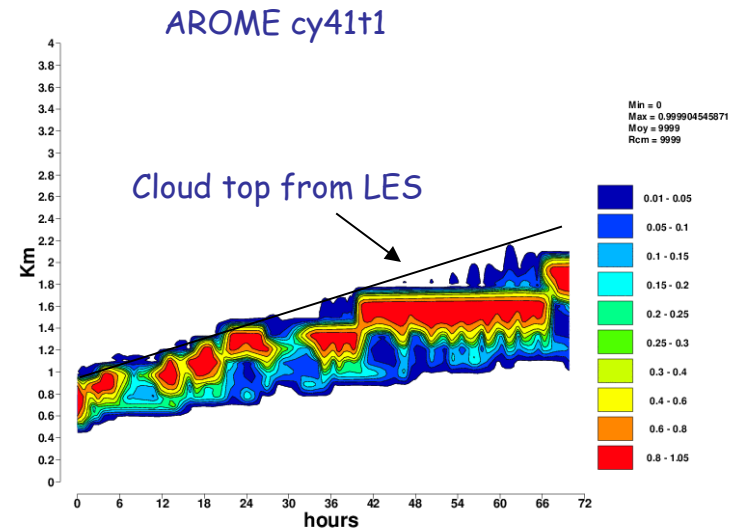
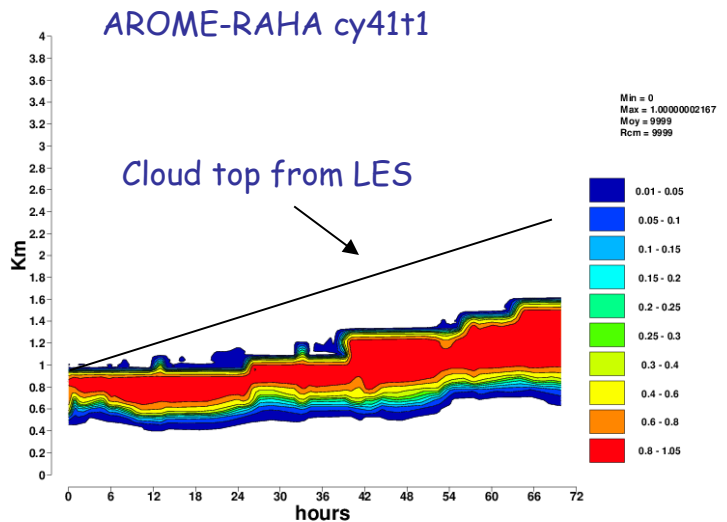
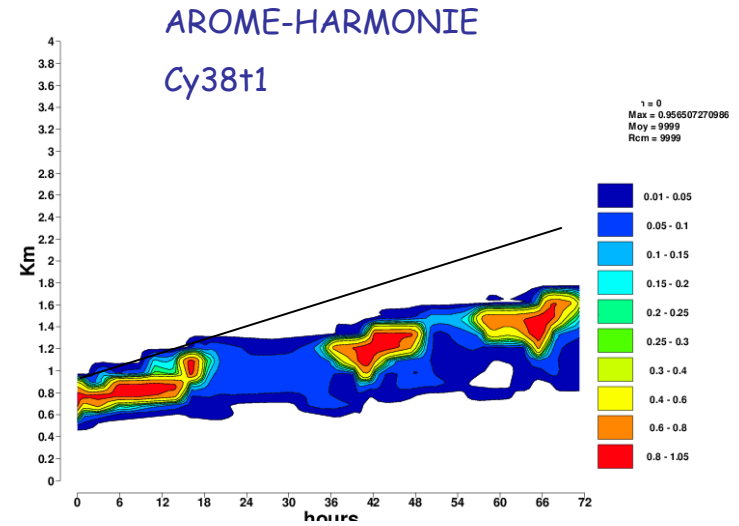
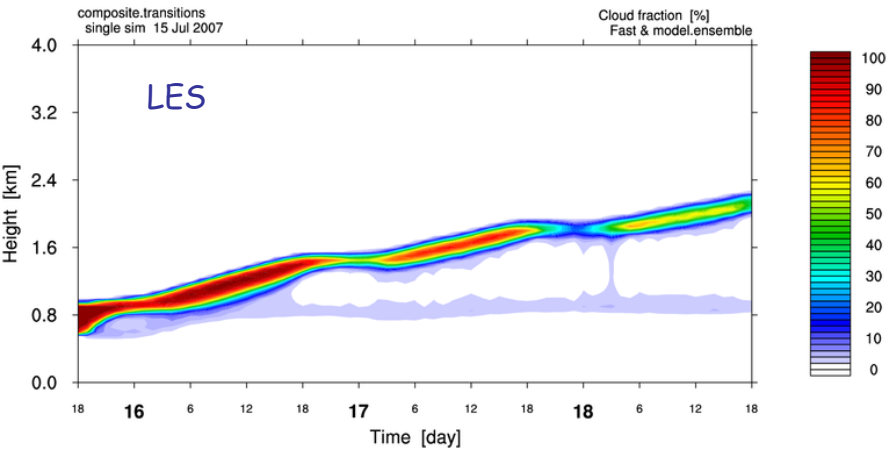




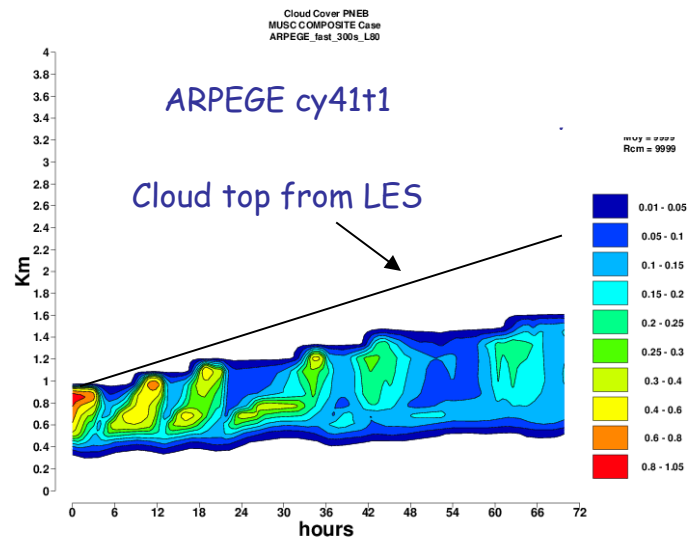
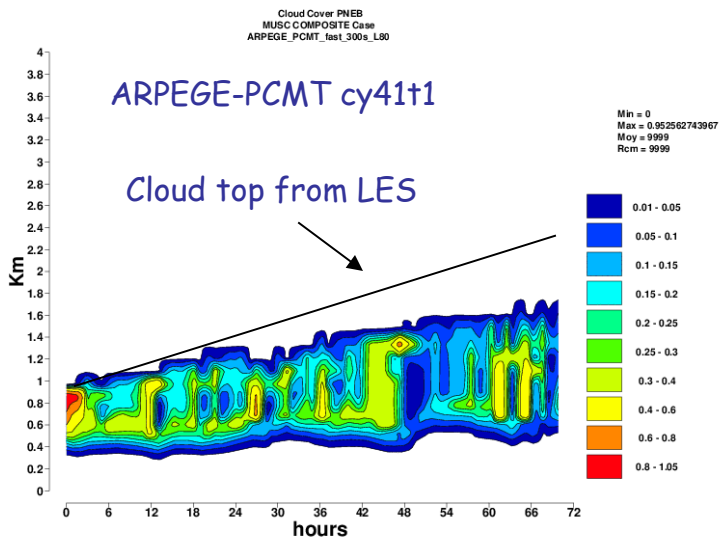
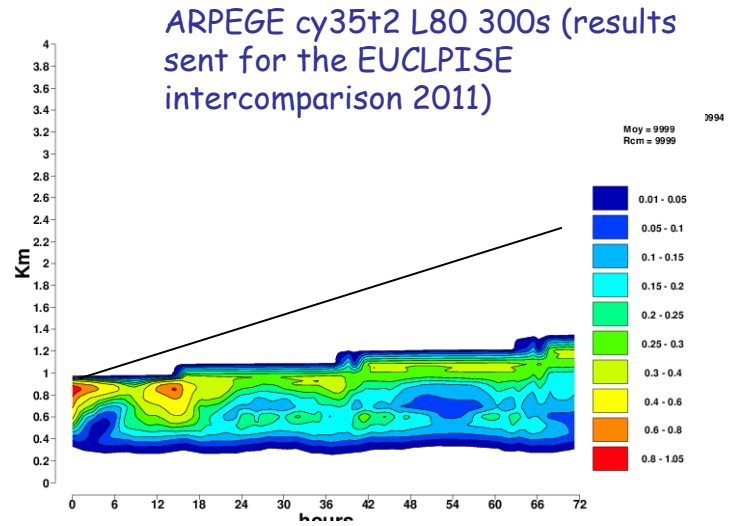
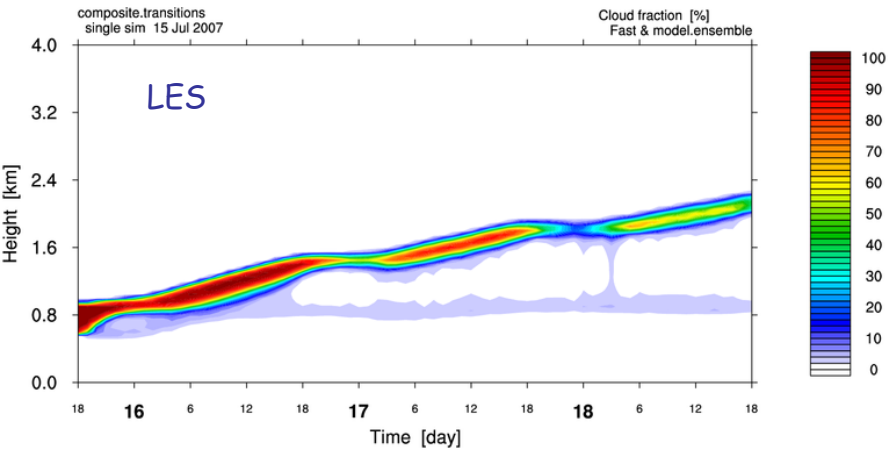
# ASTEX Composite (15 July, 3days) : FAST



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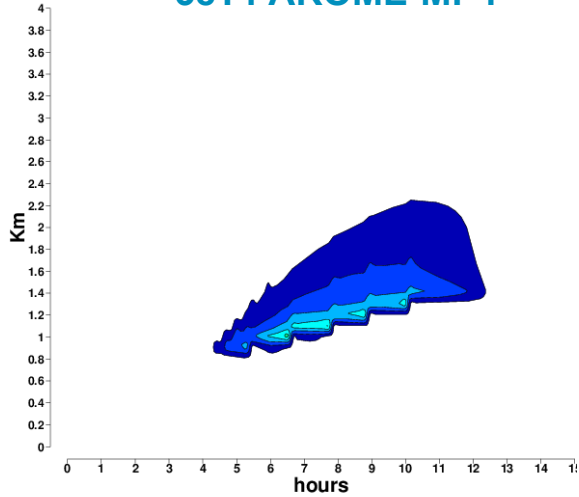


# ASTEX Composite (15 July, 3days) : FAST

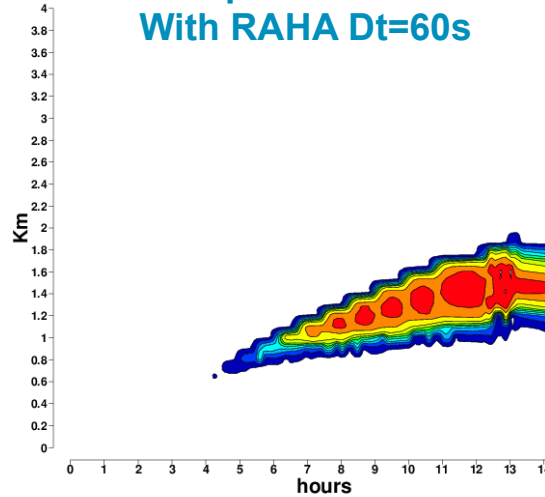


# ARM-Cu Case : Cloud Cover

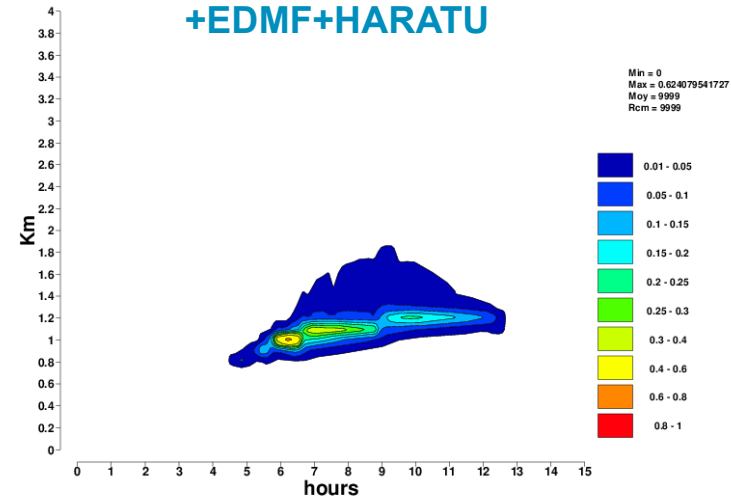
38T1 AROME-MF :



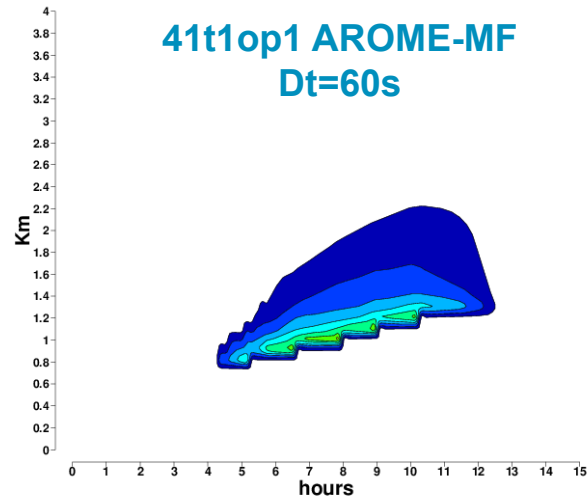
41t1op1 AROME-MF  
With RAHA Dt=60s



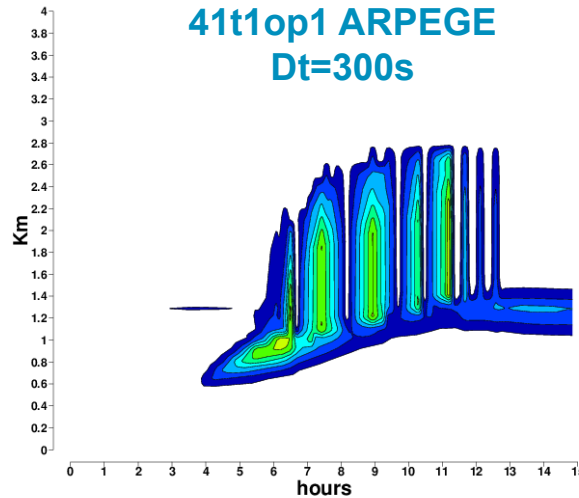
38T1 AROME-MF  
+EDMF+HARATU



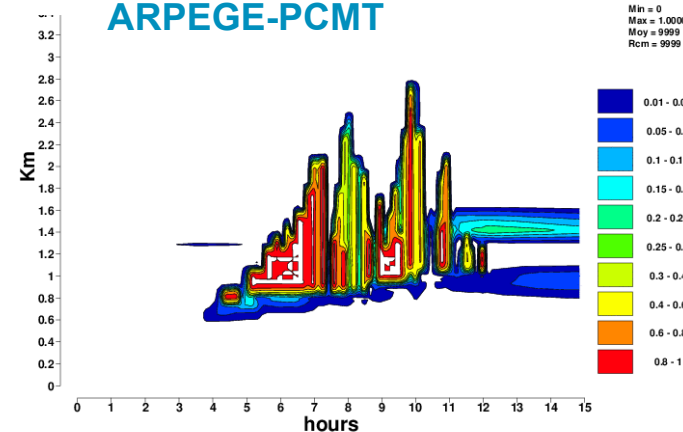
41t1op1 AROME-MF  
Dt=60s



41t1op1 ARPEGE  
Dt=300s

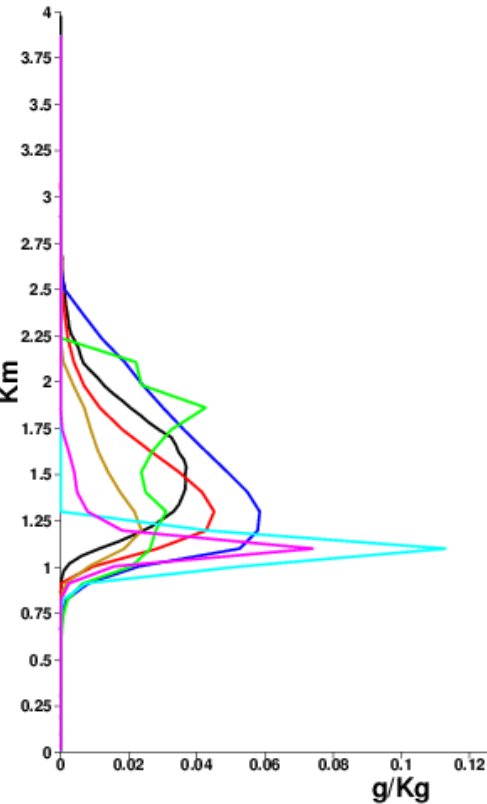


41T1op1  
ARPEGE-PCMT

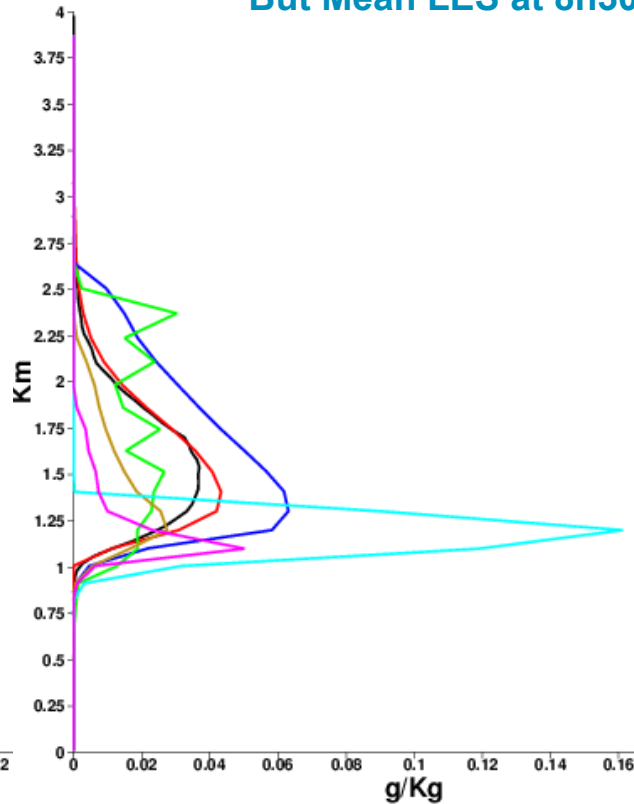


# ARM-Cu Case : Cloud Water profile

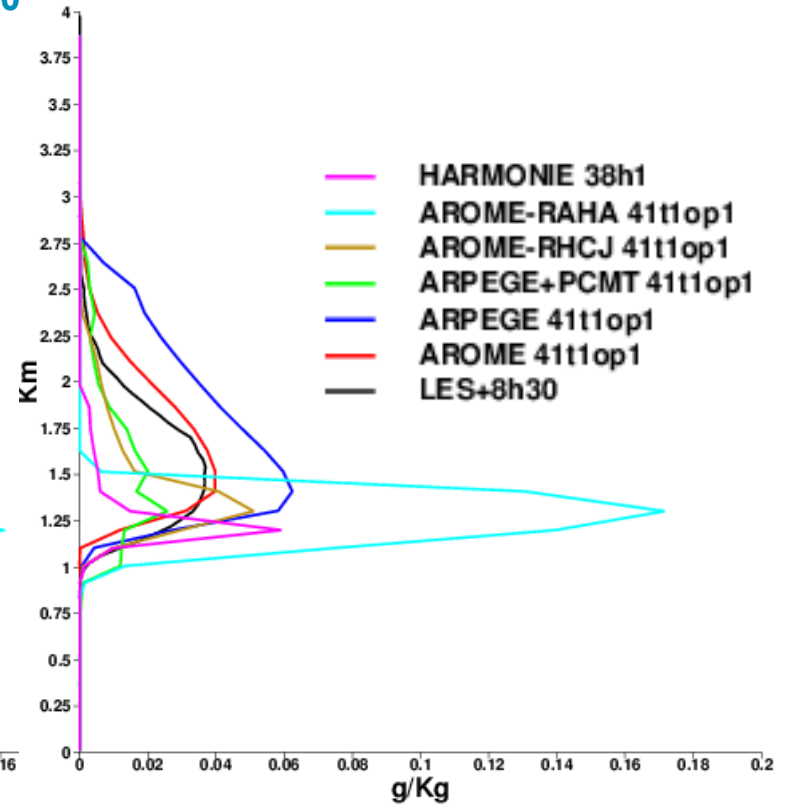
Mean 7h-8h



Mean 8h-9h  
But Mean LES at 8h30



Mean 9h-10h



- For ARM-CU other options available in AROME do not improve the ql profile, ARPEGE little over estimation and PCMT the integrated value is ok but the vertical distribution can probably be improved



# Conclusions / Perspectives

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- Possible reasons of low cloud underestimation :
  - Pb in initialisation of planetary boundary layer < 500m
  - Microphysics problem (too active sedimentation ? And/or underestimated  $q_l, q_i$  ?
  - To much diurnal mixing, interaction between mass-flux and turbulence ? Top entrainment ?
- Comparison of AROME / ARPEGE (for instance on SIRTa) but at other Cloudnet sites (such as CABAuw, Sodankyla...) and Meteopole
  - Surface fluxes,  $q_l$ ,  $q_i+q_s$ ,  $q_v$ , clouds base height ...
  - Small AROME domains.
  - Statistics on long periods in cloudy/not cloudy conditions..
  - Evaluation of other microphysics options (OCND2, LIMA ....)
  -
- **Currently, no available option performs better on all 1D cases and in 3D !! so ...we have some works but we have a nice tool with MUSC and all the cases to really understand the weaknesses**



# Summary of the Toulouse CWW Jan 2017

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- Fog : More high vertical resolution → increase the realism of horizontal advection for fog (Phd, A. Philip), missing deposition term in the micro-physics → now available in AROME in a research modset
- Interesting Stratus case in Hungary 21 Dec 2016. Underestimation and too rapid dissipation for AROME-Hu and less in AROME-Fr
- Use of the ceilometers to validate low clouds (D. Martin)
- Need to coordinate a common action for the Visibility : several possible formulae (MF contact point : I. Etchevers)
- Small 3D (180\*180) domain around site or for typical studies with LBC from ARPEGE-analysis :
  - MF can provide initial and LBC files : Bure, Cabauw, Hungary,... ?
  - Validation against site observation for Ql, Qi, surface radiation, lat, shf
- RR below cumulus with  $T < 0$  ..., Cellular Automata (no clear decision)



# Summary of the Toulouse CWW Jan 2017

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- Action around MUSC based on cy38 :
  - Thanks to the last Working days in Norrkoping Dec 2016 (Lisa, Wim, Yann and Eric) more 1D cases are now available and validated with cy38Hx and cy38Tx: GABLS1, GABLS4, ARMCu, Astex-Lag and Composite, Bomex
- For h side : solve the problem with HARATU for ideal case ( now solved by Wim)
- For t side : validate OCND2 (Y. Seity partly done)
- 1D cases RICO , and Fire (E. Bazile) : FIRE-1 now available
- Find a case with mixed phase ?
- Find a fog case : Cabauw case 20111119-22
  - ARPEGE NetCdf file available → need to create the forcing and the initial files (Wim, Eric and Lisa?)
- Next MUSC version : interest for a phased version with the operational version : cy42 for MF and 43h1.2 for HIRLAM → not the same version of SURFEX → so several potential problems for the surface forcings !

