1D and 3D cloud evaluation at Météo-France

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Cloud working days
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Outline

- About physical parametrisations and forecaster's complains.

- Automatic ARPEGE and AROME extractions

- Example of one low clouds case over SIRTA

- 1D cases

About model's physics

	ARPEGE & LAM	ARPEGE & LAM (2017)	AROME-MF	HARMONIE-AROME
Surface	ISBA(Noilhan,Planton (89), Giard, Bazile(2000))	SURFEX (Masson et al., 13): surface modelling platform		
Radiation	RRTM (Mlawer, 97) + SW6* (Fouquart 80, Morcrette 01)			
Turbulence	1.5 order scheme prognostic TKE (Cuxart et al., 00)			HARATU (Van Meijgaard et al.,2012)
Mixing length	Non local, buoyancy based (Bougeault-Lacarrère, 89)			Lendering Holtslag (2004)
PBL thermals/shallow	KFB (Bechtold et al. 2001)	PCMT	PMMC09 (Pergaud et al., 09)	EDMFm (Siebesma et al.,2007)
Clouds	PDF based: (Smith, 90) or (Bougeault, 82)			+OCND2 (Ice)
Microphysics	Bulk scheme with 4 prog. var. (Lopez, 02)		ICE3 (Pinty and Jabouille, 98)	ICE3+OCND2
Convection	Moisture Convergence (Bougeault 85)	New scheme PCMT (5 prog. var) (Piriou et al., 07) and (Gueremy, 11)	×	×
Sub oro. effects	Catry-Geleyn (08)		×	×

Our forecaster's point of view

- 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 ? We are here to better understand this.

- 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 ?
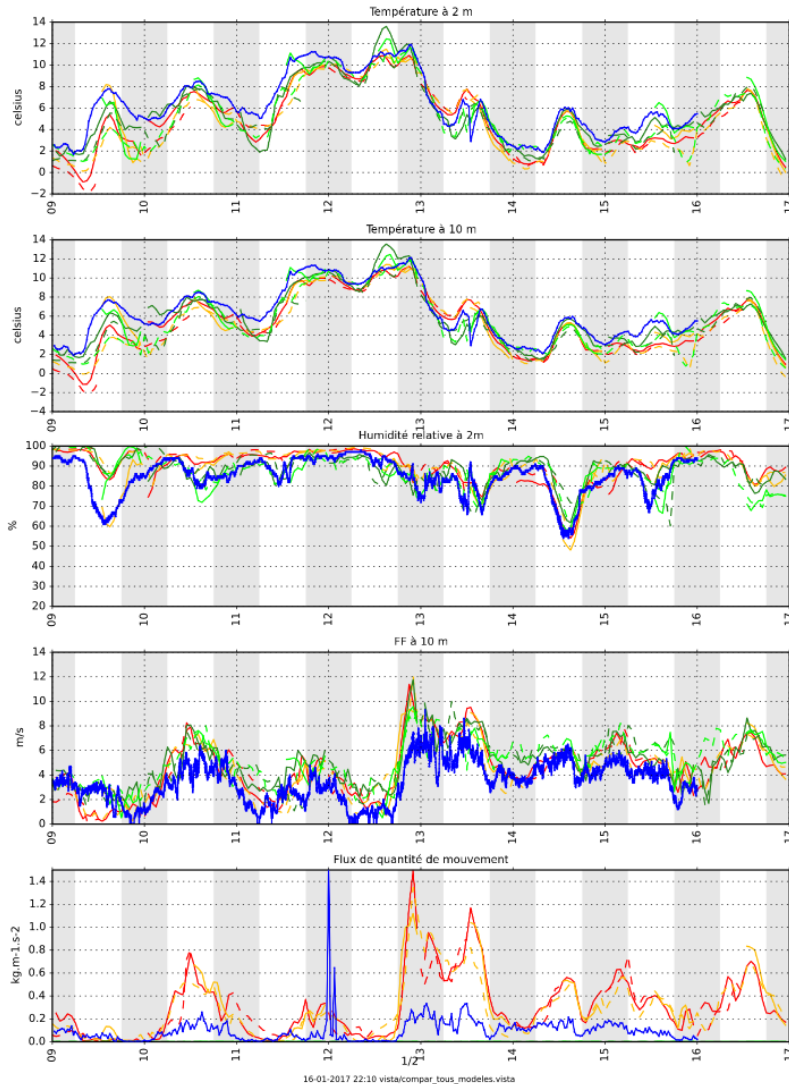
ARPEGE and AROME automatic extractions

- **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 june 2004), Lindenberg (since march 2005), Lannemezan (ocober 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 be used to initialize and drive 1D simulations
- No pb to provide you the files if you need them.

ARPEGE and AROME automatic extractions

- **Toulouse ARPEGE/AROME oper :**

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

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

16-01-2017 22:11 vista/compar_tous_modeles.vista
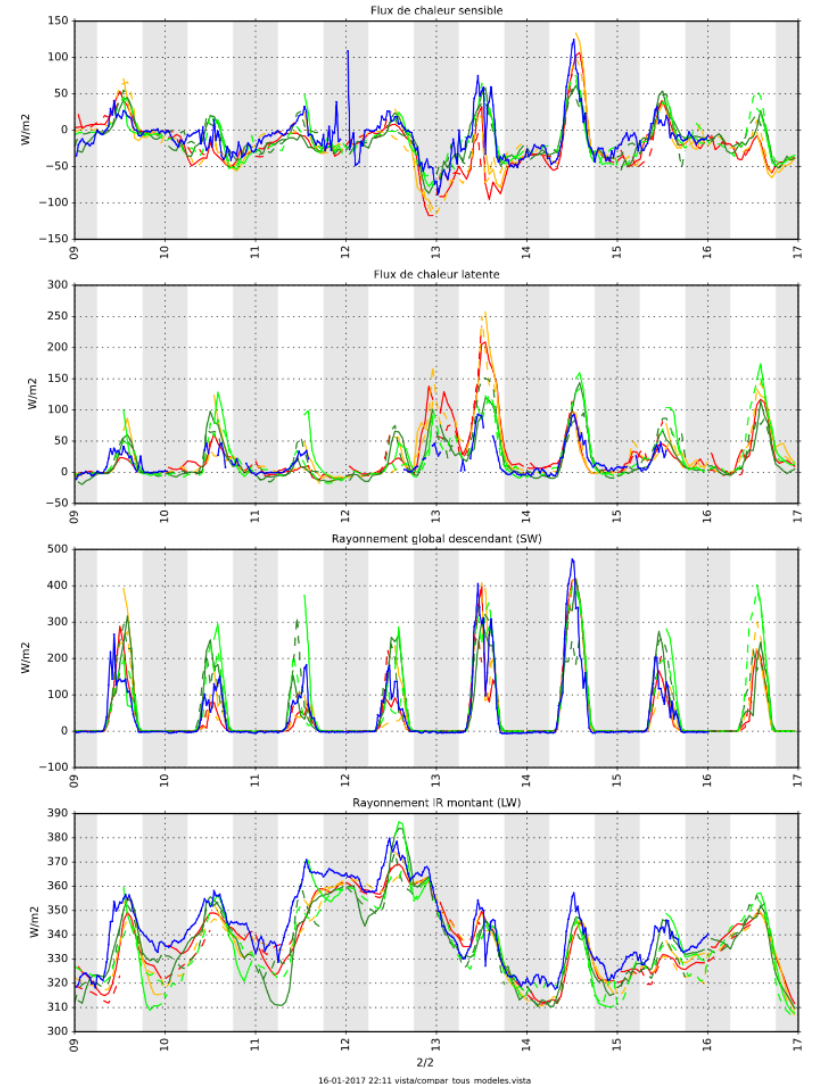
Small AROMEs coupled with AROME-France
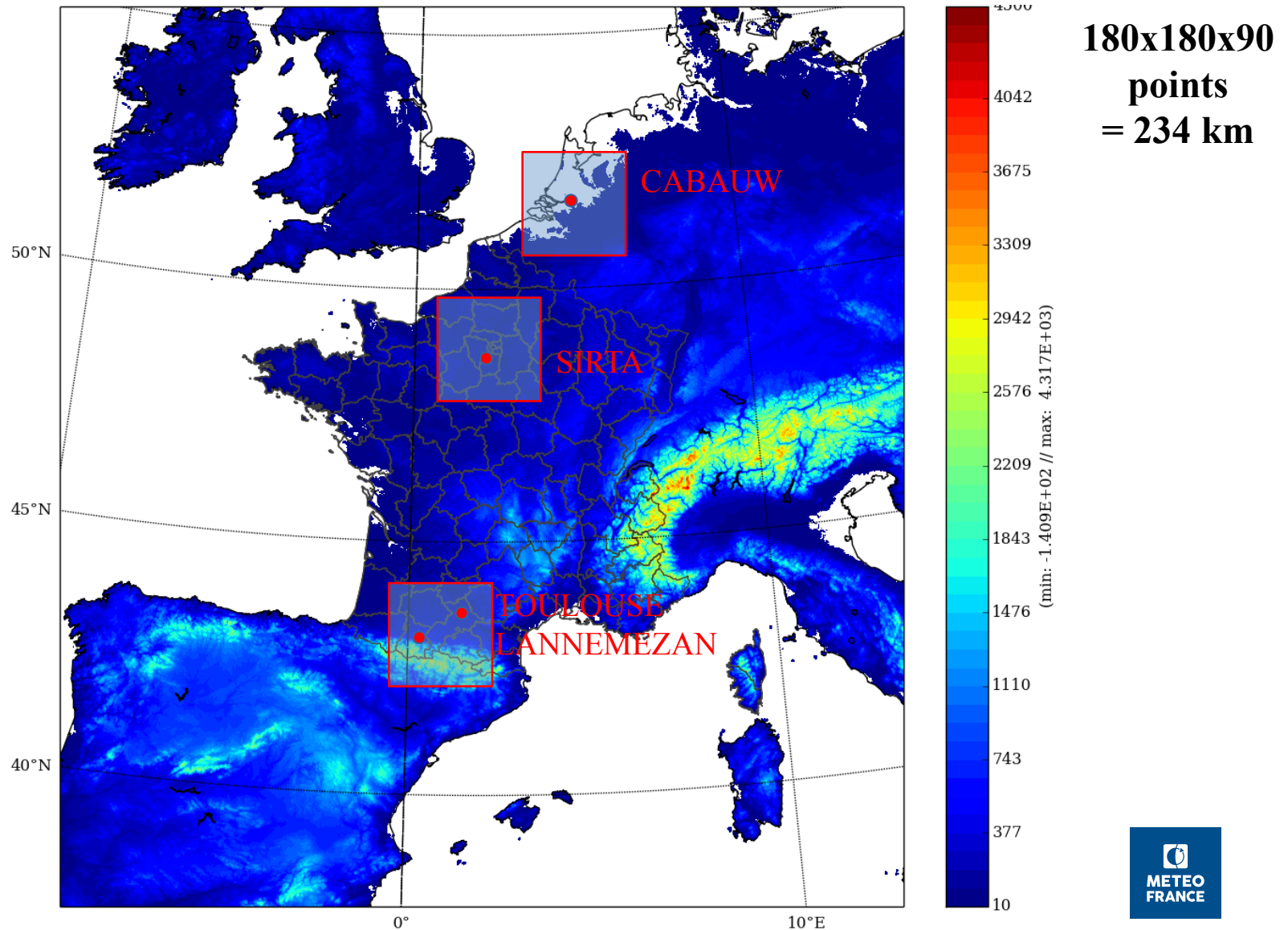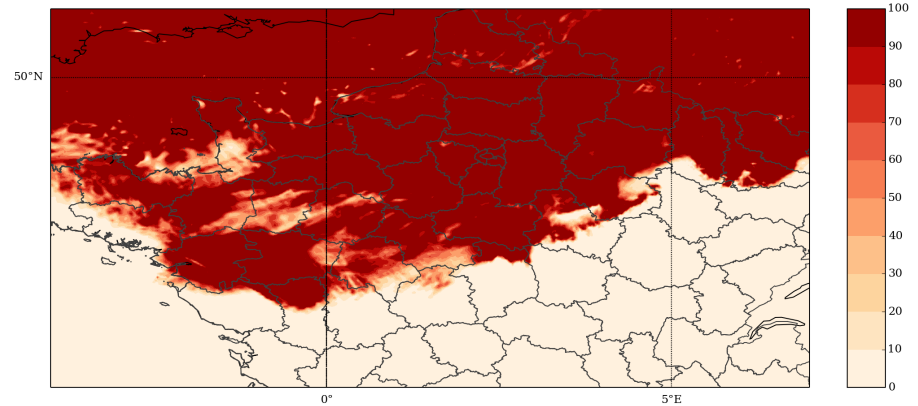
180x180x90 points = 234 km

An example of low clouds case ...
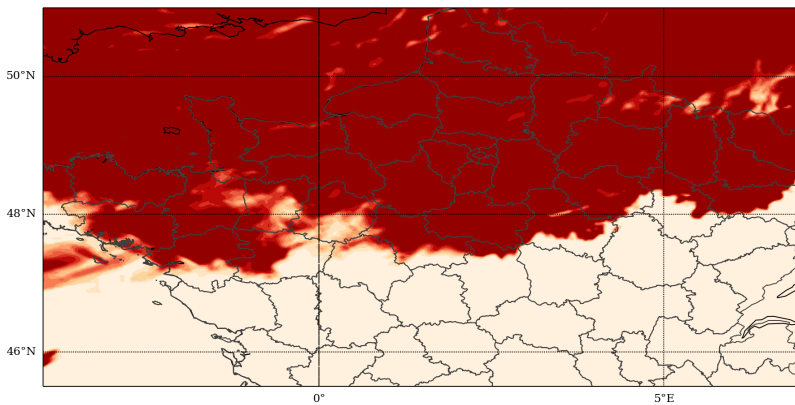
19th March 2016 @ 09TU:
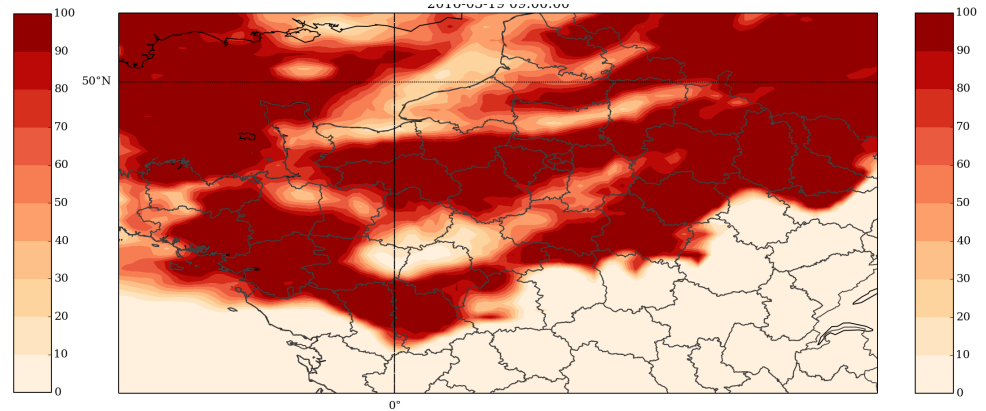
An example of low clouds case ...

19th March 2016 @ 15TU:

AROME Oper Base 00TU + 15H
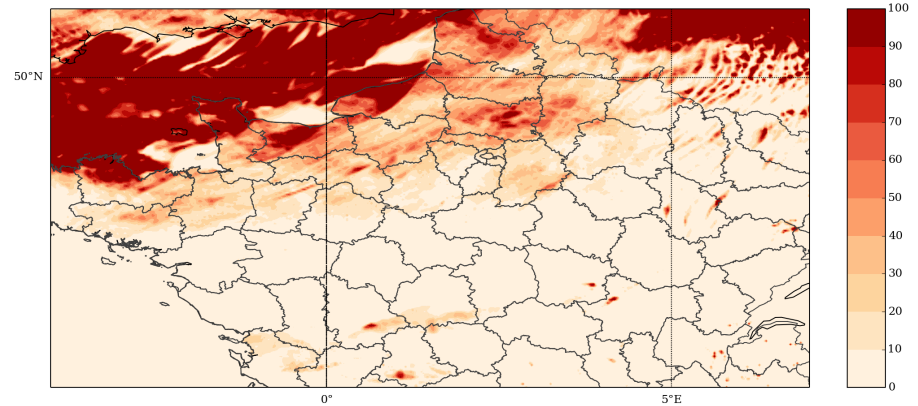
HARMONIE-AROME-KNMI Base 00TU + 15H
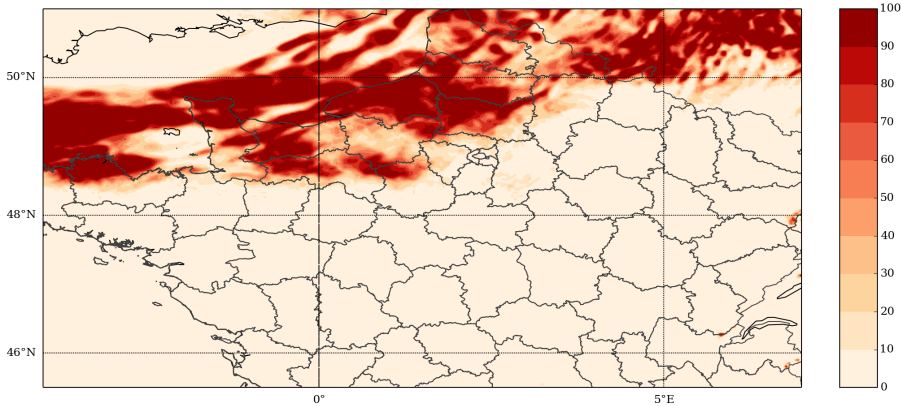
ARPEGE Oper Base 00TU + 15H
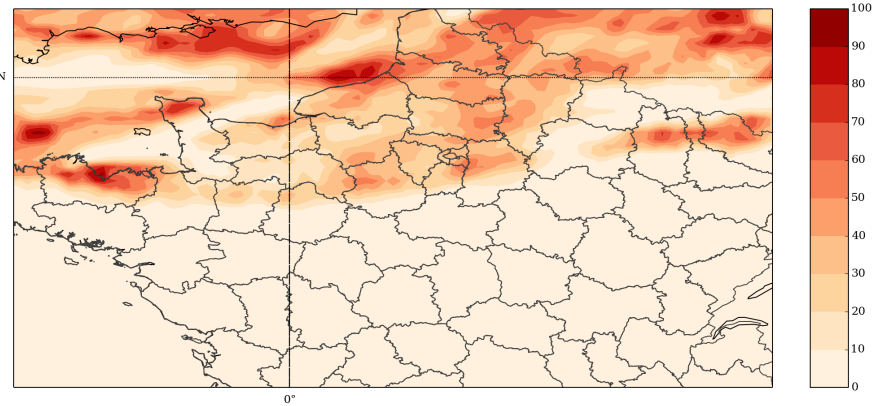
An example of low clouds case ...

19th March 2016 @ 15TU:

ARPEGE-PCMT Base 00TU + 15H

ARPEGE Oper Base 00TU + 15H

An example of low clouds case ...

19th March 2016 @ 15TU: experiments with AROME-SIRTA
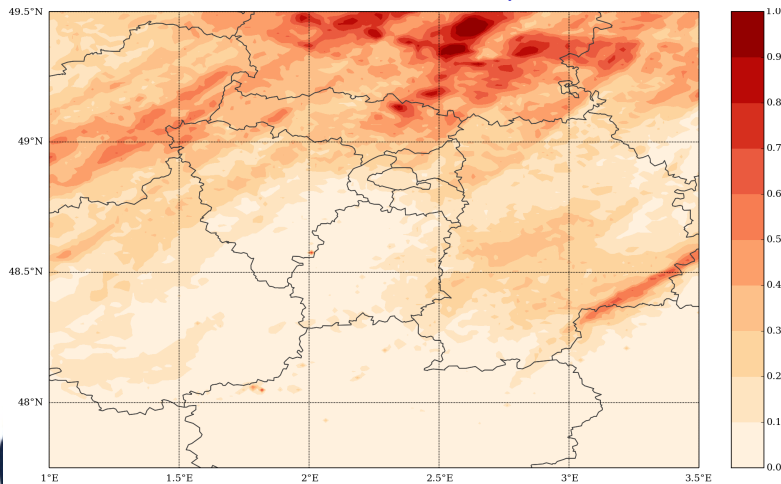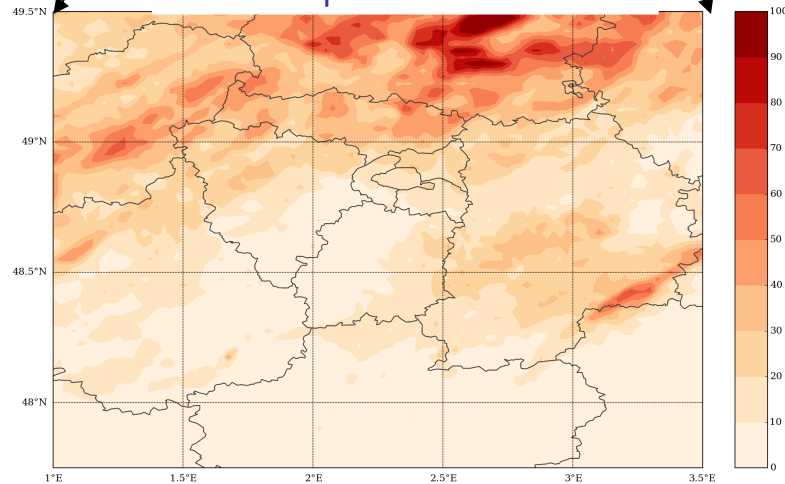
AROME-SIRTA reproduces well AROME-oper

About options in the code ...

Several options are available in 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 t
  unstable surface layer as the sum of horizontal fluxes

FIG. 1. Physical image sustaining the thermal plume model and corresponding vertical velocity w: diffusive turbulence in surface layer and coherent structures in mixed layer. Mass-flux f depends on entrainment of air inside the thermal from the surface layer a, above e, and detrainment from the plume d.

An example of low clouds case ...

19th March 2016 @ 15TU: experiments with AROME-SIRTA

G - 19/03/2016 @ 15

AROME-Site

AROME-Site no EDMF

AROME-Site + KFB
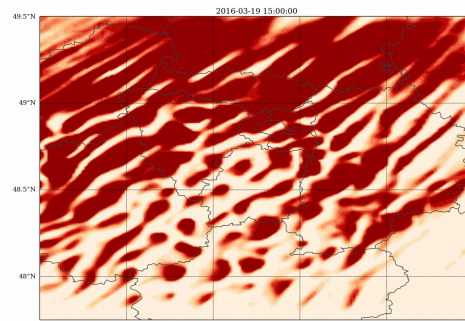
AROME-Site + BIGAU
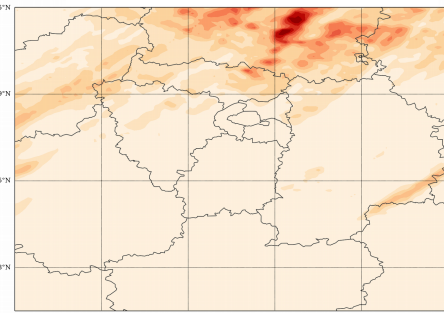
AROME-Site + Updraft=RHCJ
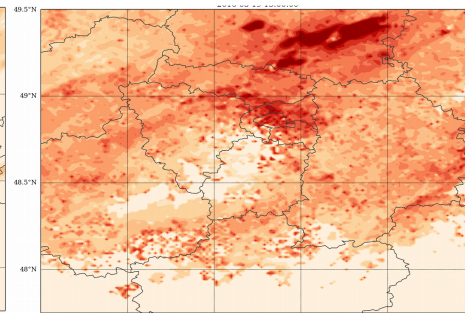
AROME-Site + Updraft=RAHA
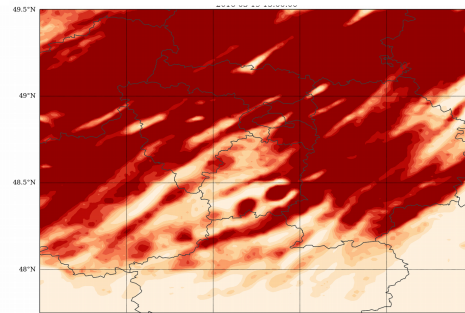
AROME-Site + Cloud=STAT
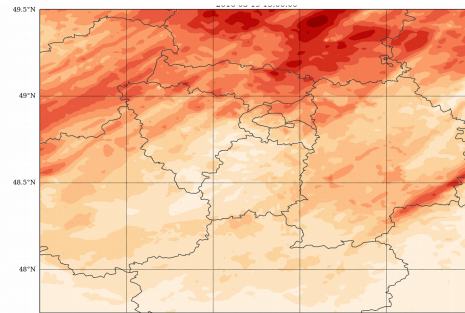
HARMONIE-AROME-KNMI
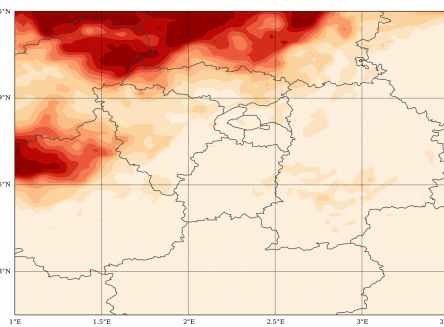
Several options are available ... but unfortunately the choice is not so easy.

Consistant with weak (KFB,RAHA)

strong(EDKF,DUAL,RHCJ) updrafts (Riette and Lac, 2016)

An example of low clouds case ...

- 19 March 2016 : Cloud water (16pts)

AROME-Site   AROME-Site no EDMF   AROME-Site + Updraft=RAHA

ARPEGE   ARPEGE+PCMT   Observation BASTA Radar
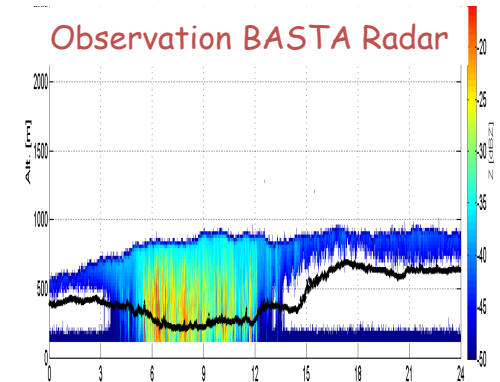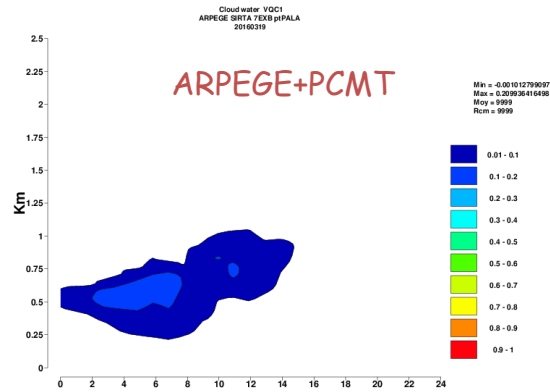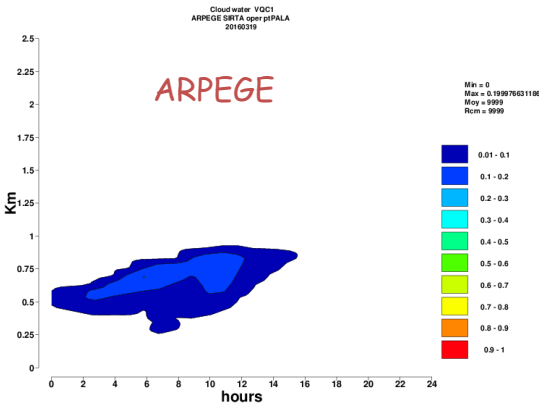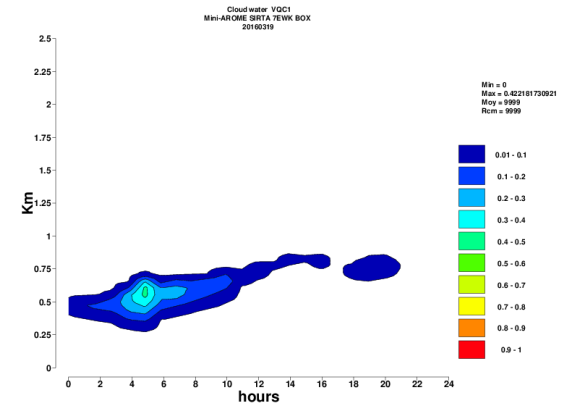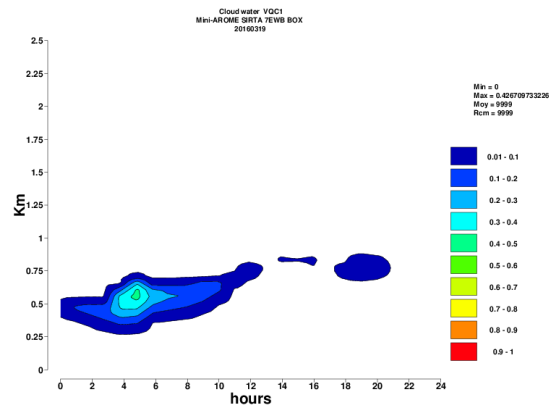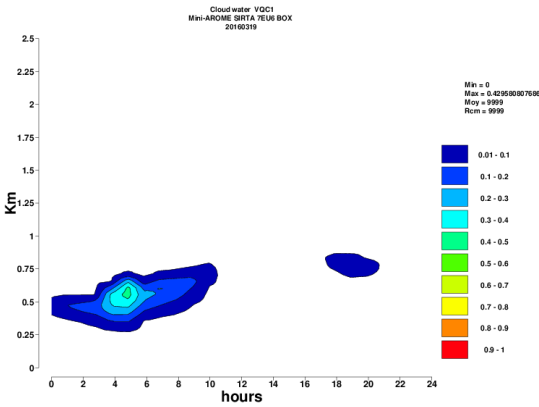
RAHA seems better but ...

Evaluation of RAHA on longer period

15th March 2016 to 30th April 2016
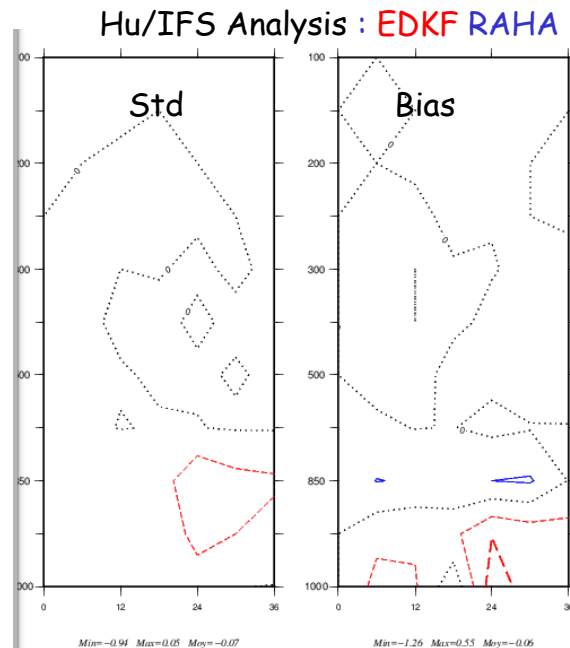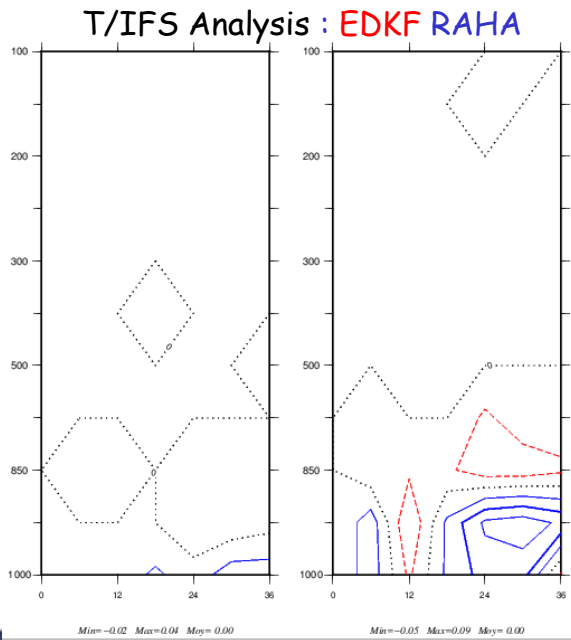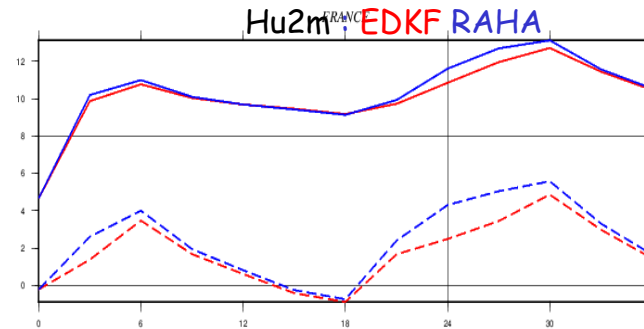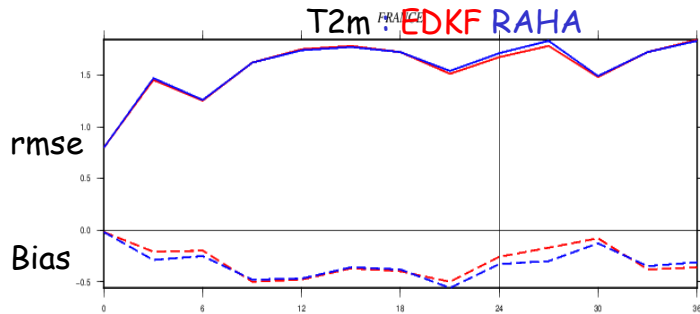
Objective scores not so good for RAHA / EDKF

Surface fluxes …

SWd

H

AROME Pt=urban

AROME Pt=veg

LE

IntQV
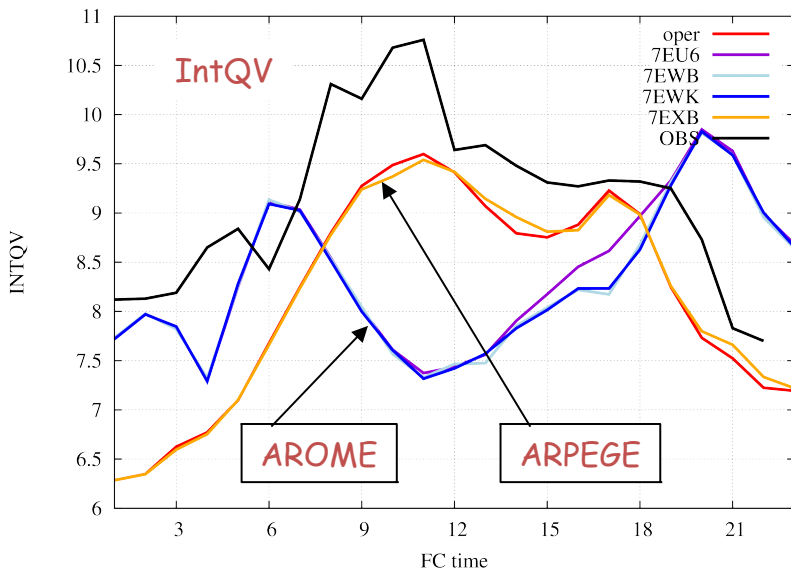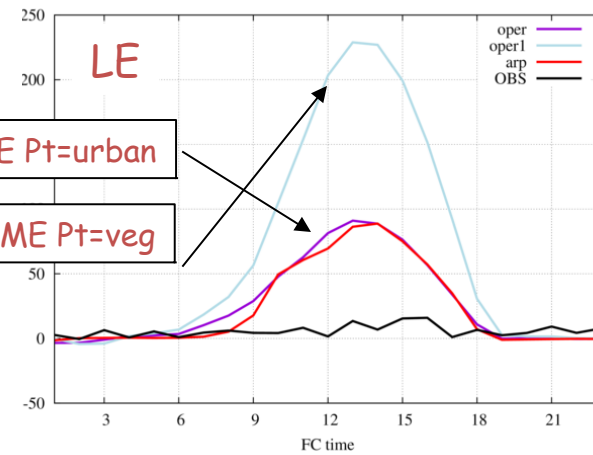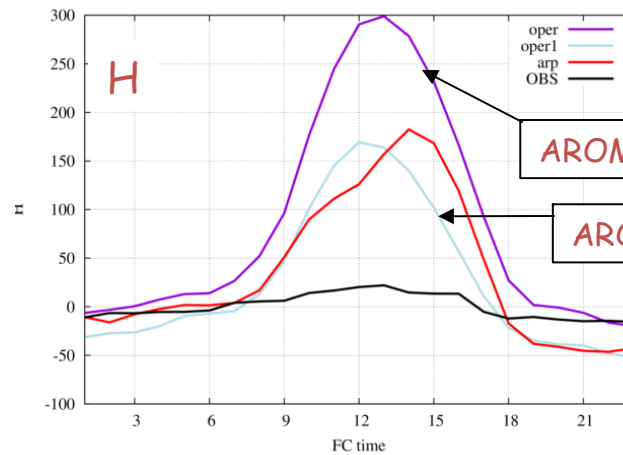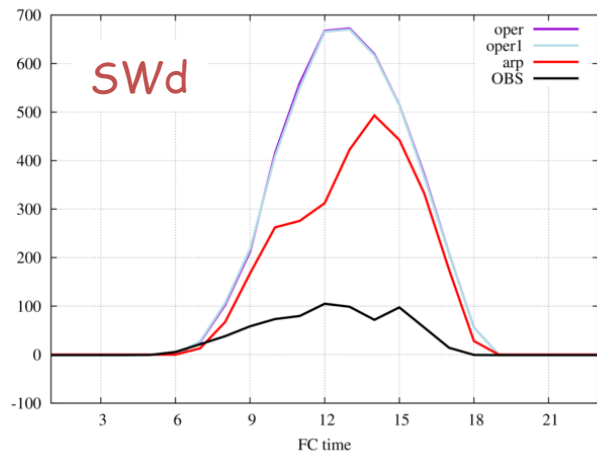
AROME

ARPEGE

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

T2m
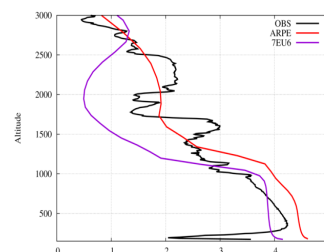
Qv (12TU Trappes RS)
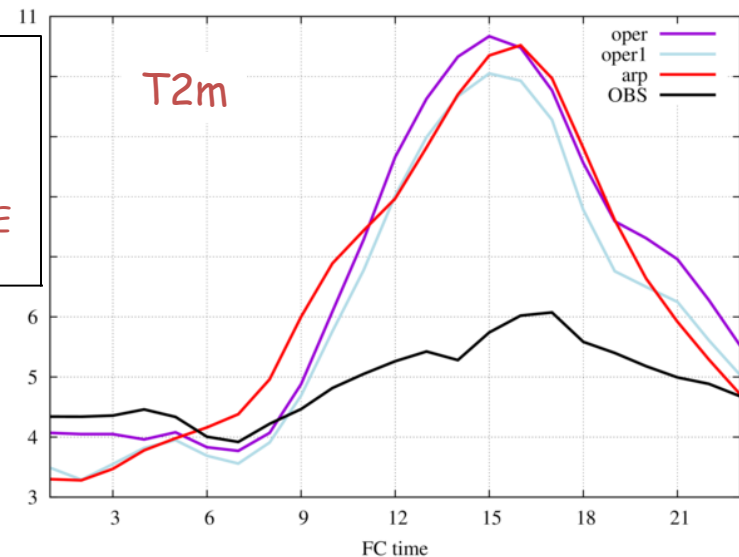
ASTEX lagrangian (13 june 1992, +40 h)
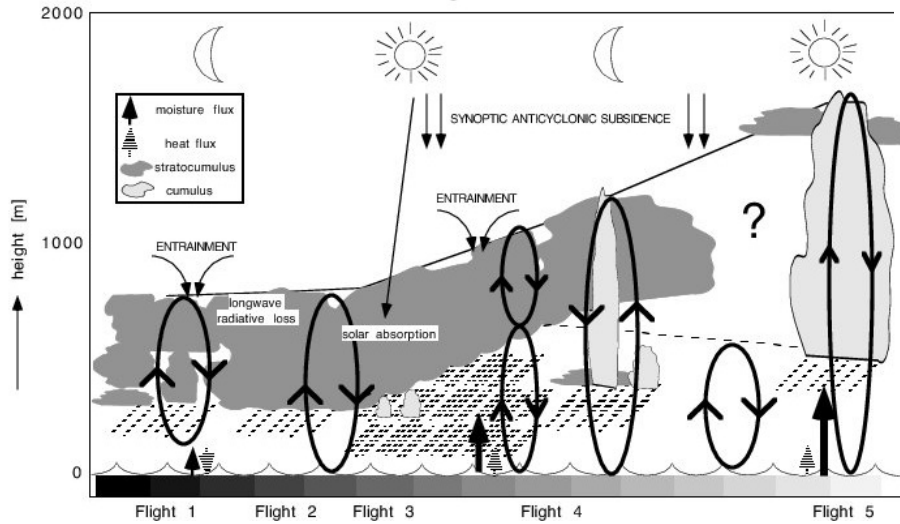
Qv (g/kg) Initial profile

T (K) Initial profile

L31
L70
L80

SST forcing (K)

Vertical velocity forcing (m/s)

4000m

12h, 24h, 36h, 40h

1500m
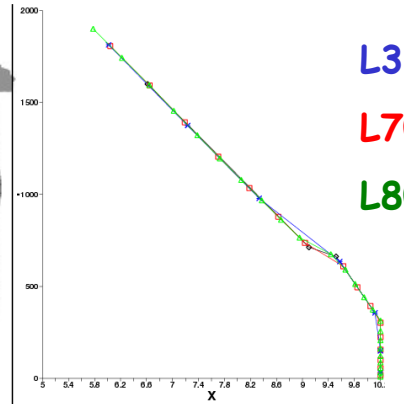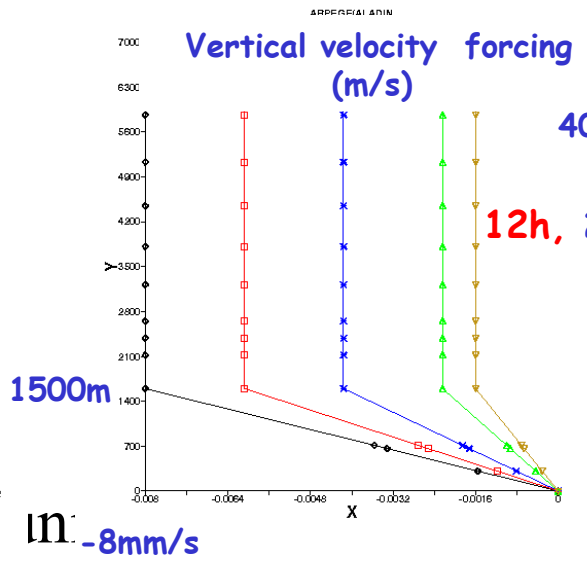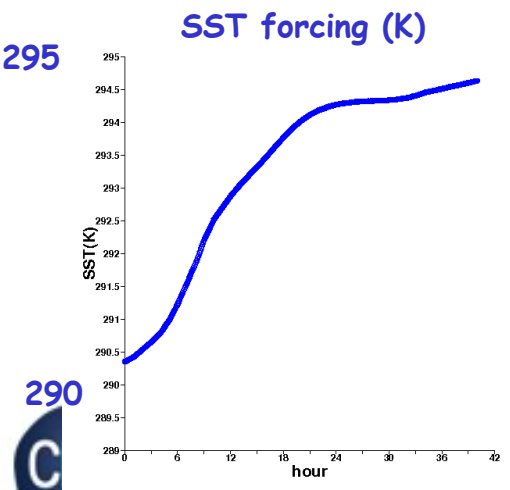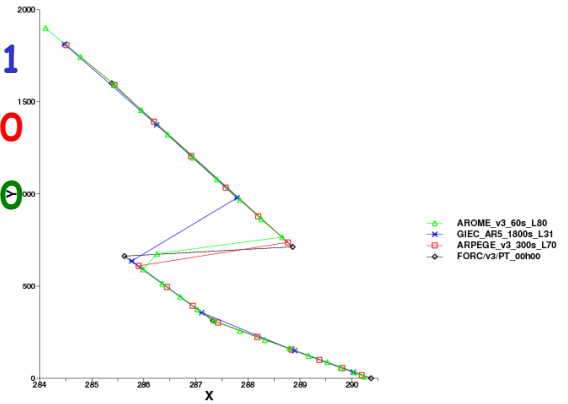
Temperature profiles (K)
Nudging above 4000m tau=12h

-8mm/s
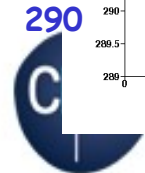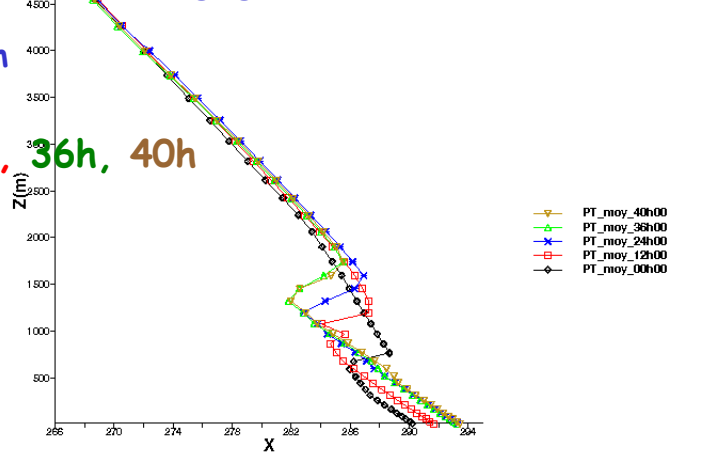
ASTEX_Lag: Cloud Cover

AROME cy35t2 L80 60s (results sent for the EUCLPISE intercomparison 2011)
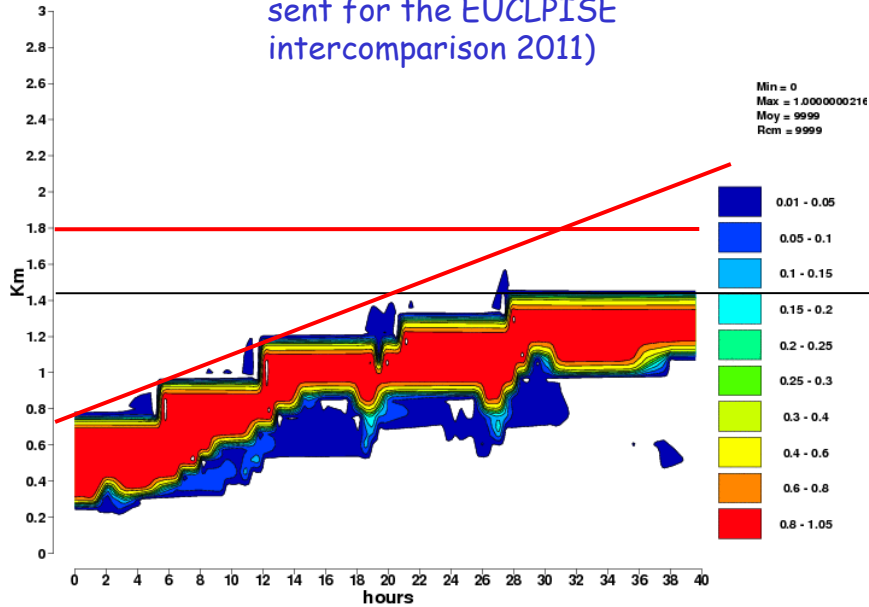
AROME cy38t1 L80 60s
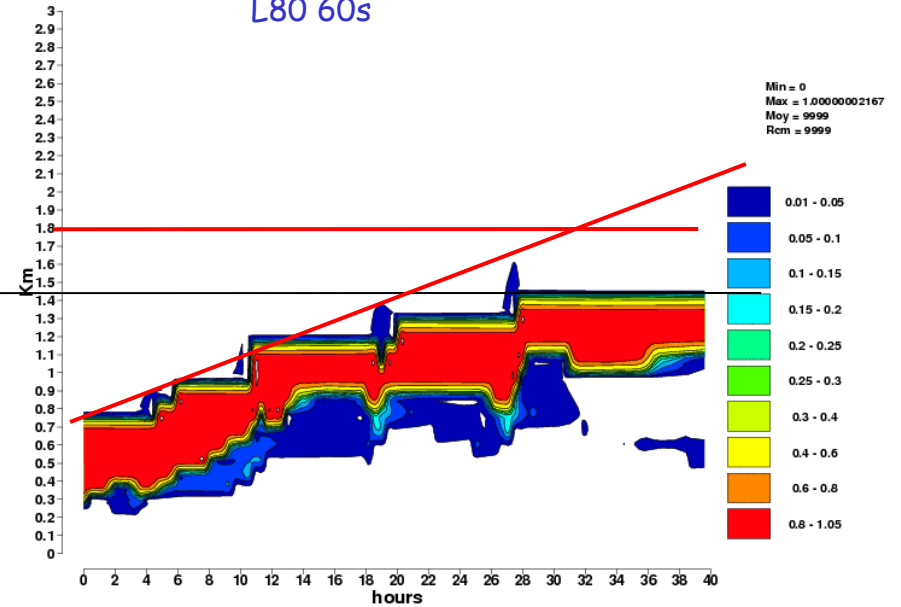
no differences between cy35t2 and cy38t1 for AROME.

Cloud top is underestimated by300/400m.

LES
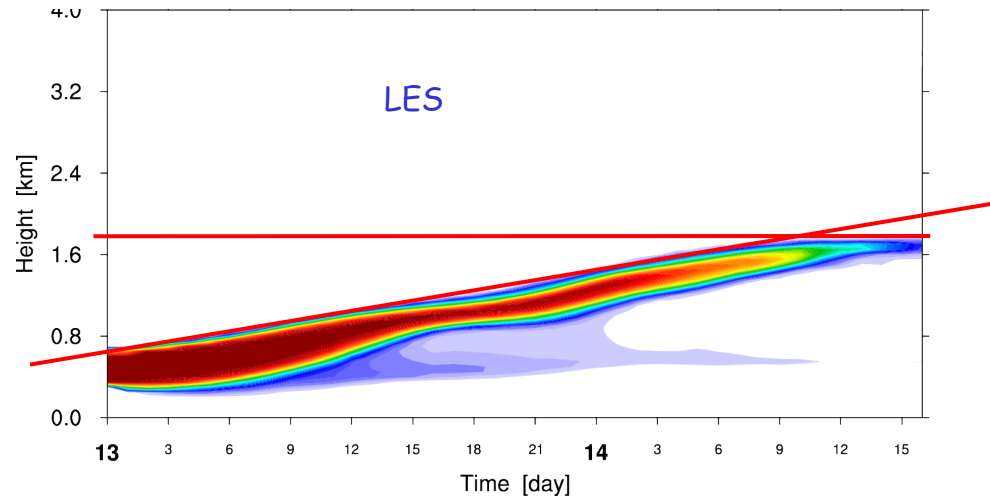
ASTEX_Lag: Cloud Cover

AROME-HARMONIE cy38h1
L80 60s
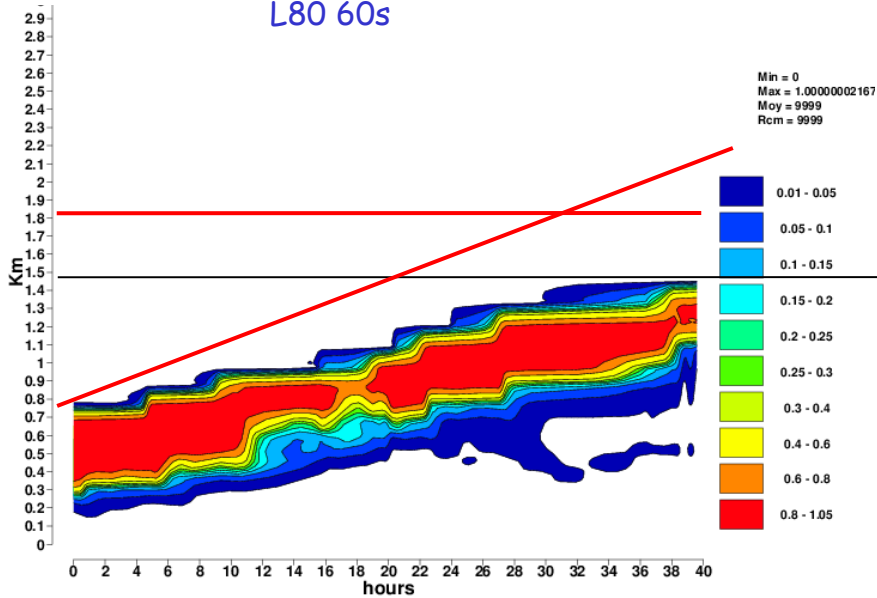
AROME cy41t1
L80 60s
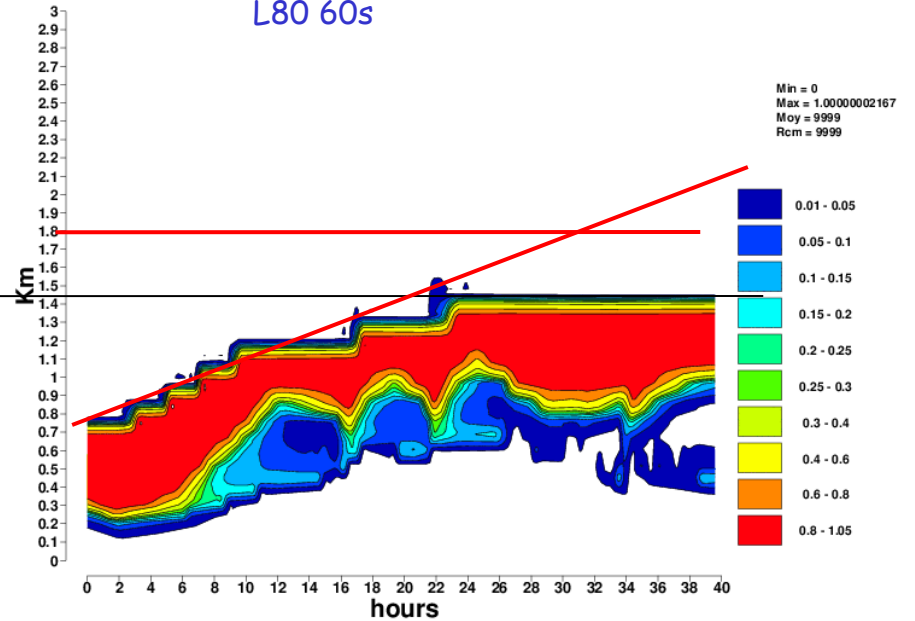
1. Cloud top is underestimated by300/400m also with AROME-HARMONIE

2. Change in AROME due to some modifications and bug corrections in the MF scheme and in micro-physics

LES
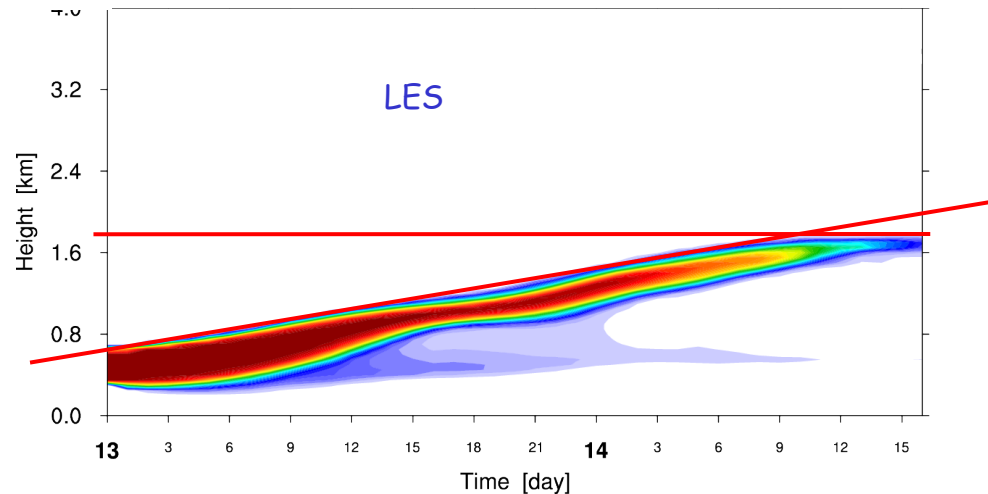
ASTEX_Lag: Cloud Cover

AROME-RHCJ cy41t1 L80 60s
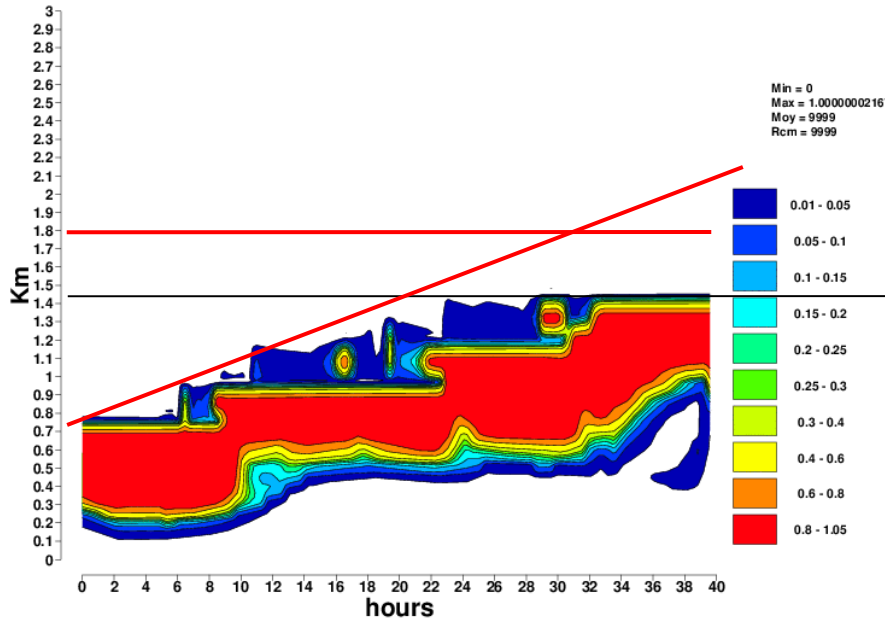
AROME-RAHA cy41t1
L80 60s

LES
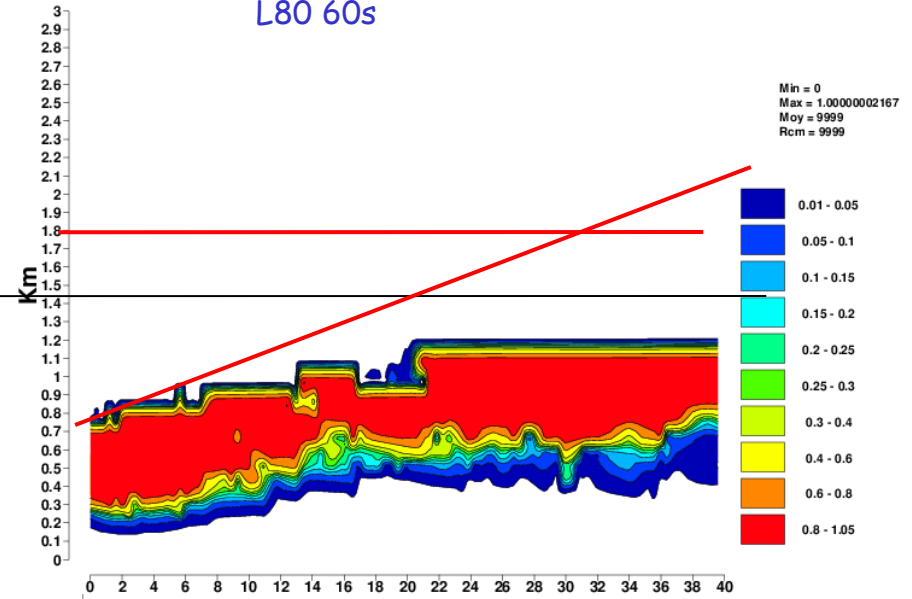
1. AROME with new entrainment from Rio et al (2010) also underestimates the cloud top by300/400m

2. With a new closure (RAHA) the MF is less active and the cloud top is lower
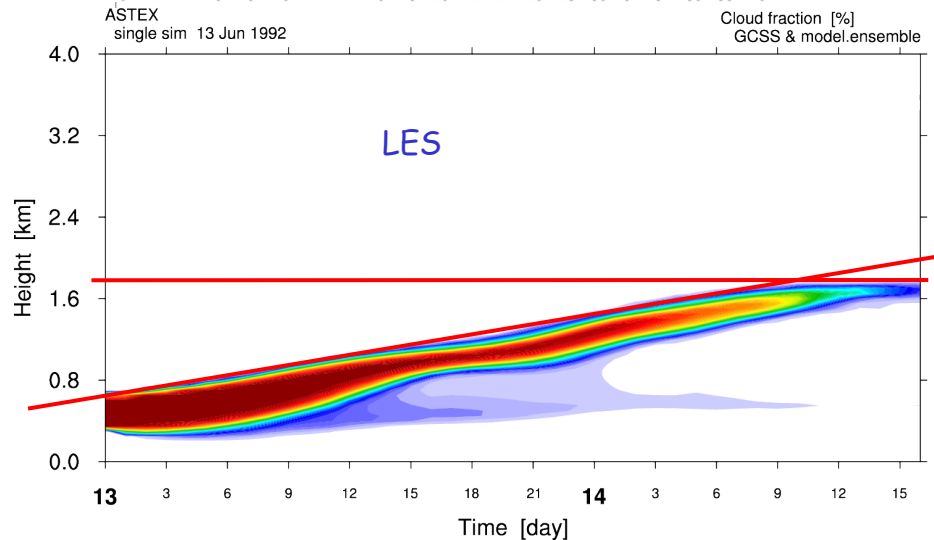
ASTEX_Lag: Cloud Cover

ARPEGE cy35t2 L80 300s
(results sent for the EUCLPISE
intercomparison 2011)
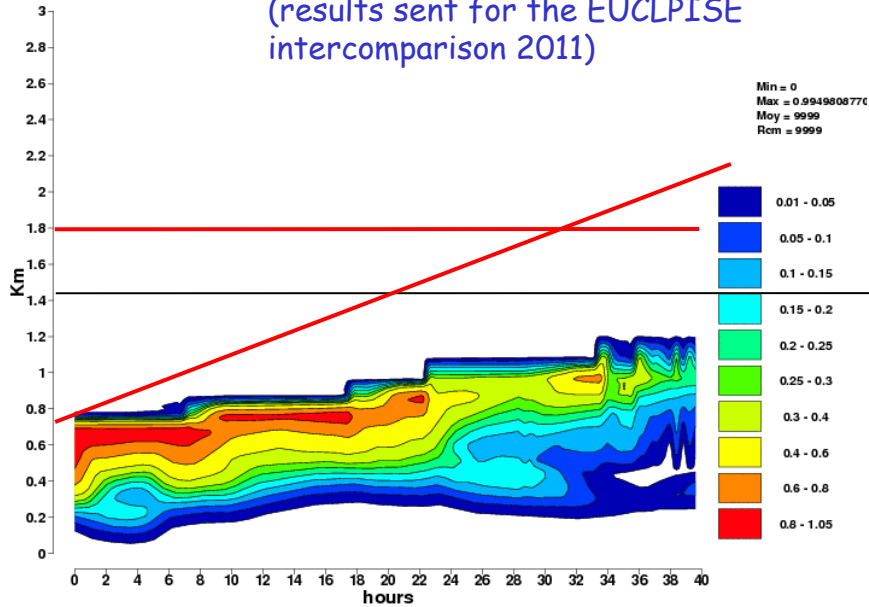
ARPEGE cy38t1
L80 300s
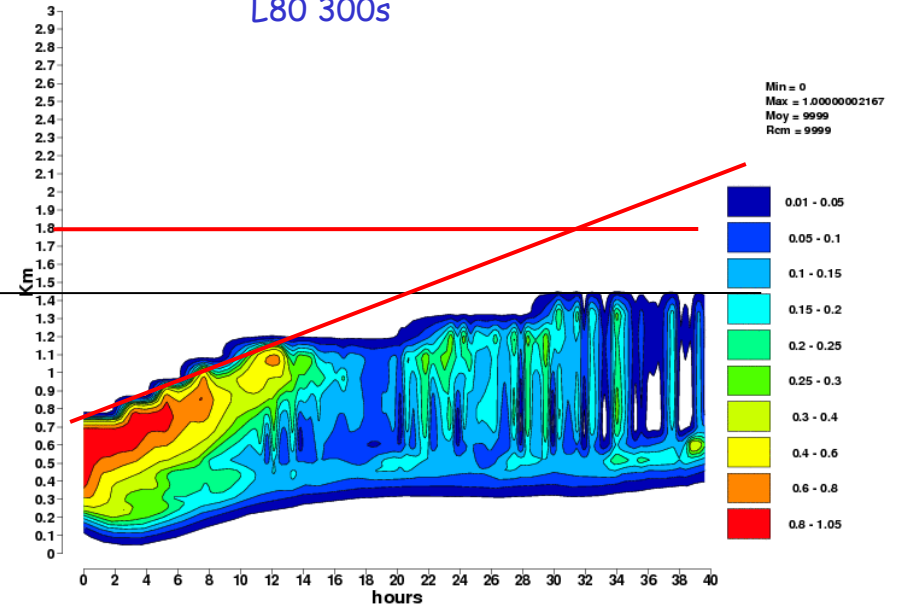
Cy38t1 improves the cloud top and the cloud growth during the first 12hours. The low cloud layer is present, nevertheless the cloud cover is underestimated and also the cloud top by 300/400m.

LES
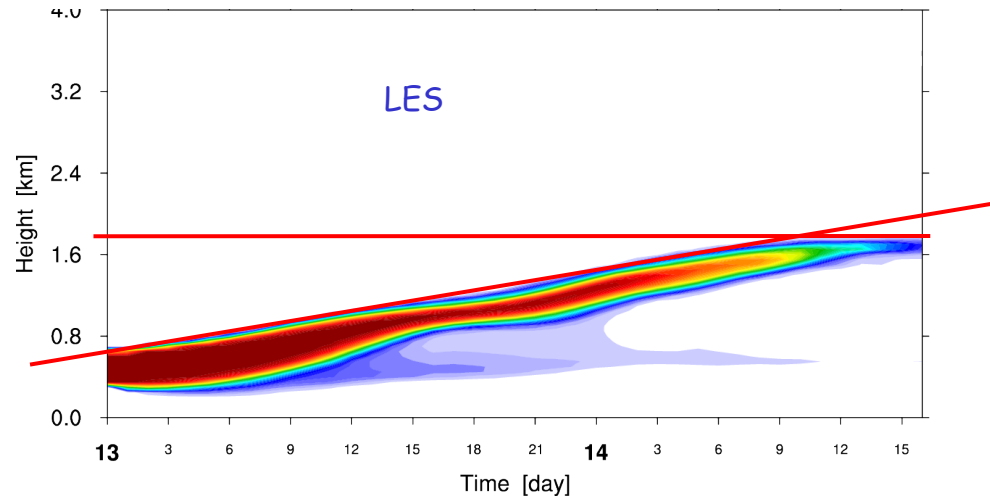
ASTEX_Lag: Cloud Cover

ARPEGE cy41t1 L80 300s
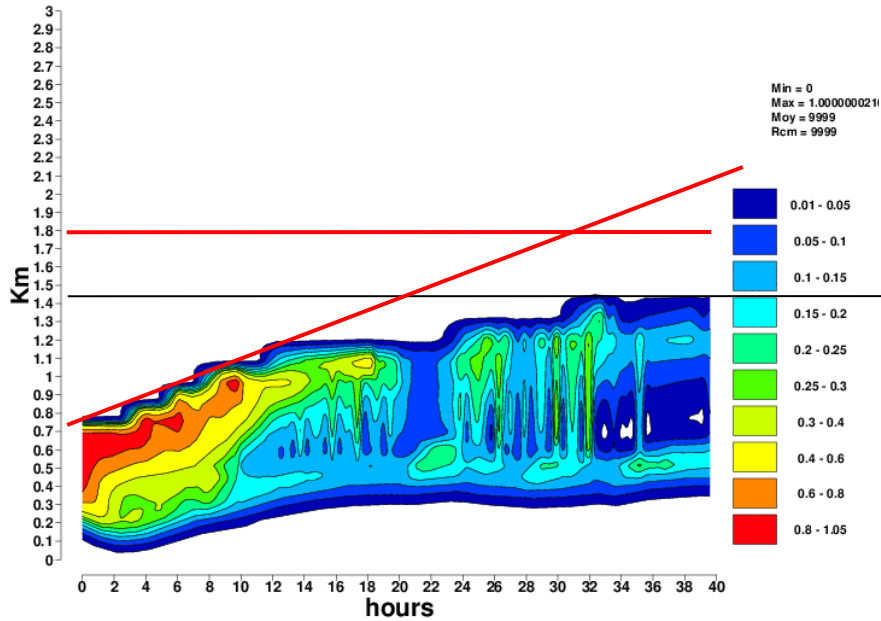
ARPEGE_PCMT cy41t1 L80 300s
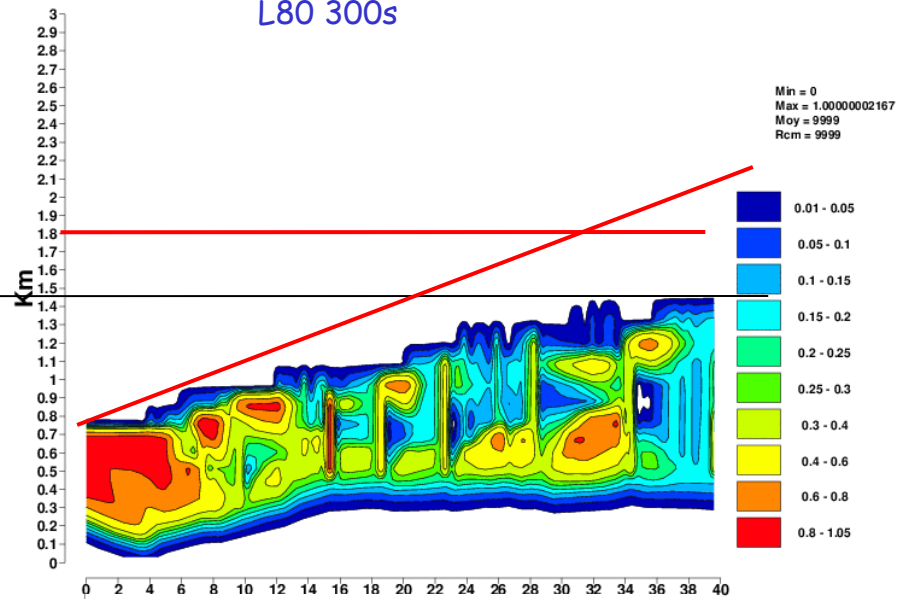
Very preliminary results with PCMT without any specific tunings → reasonable results, underestimate the cloud top as ARPEGE-Oper
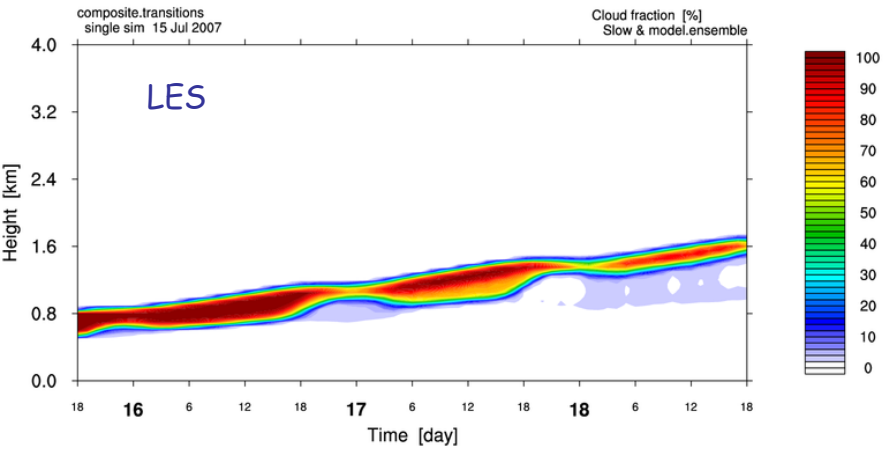

LES
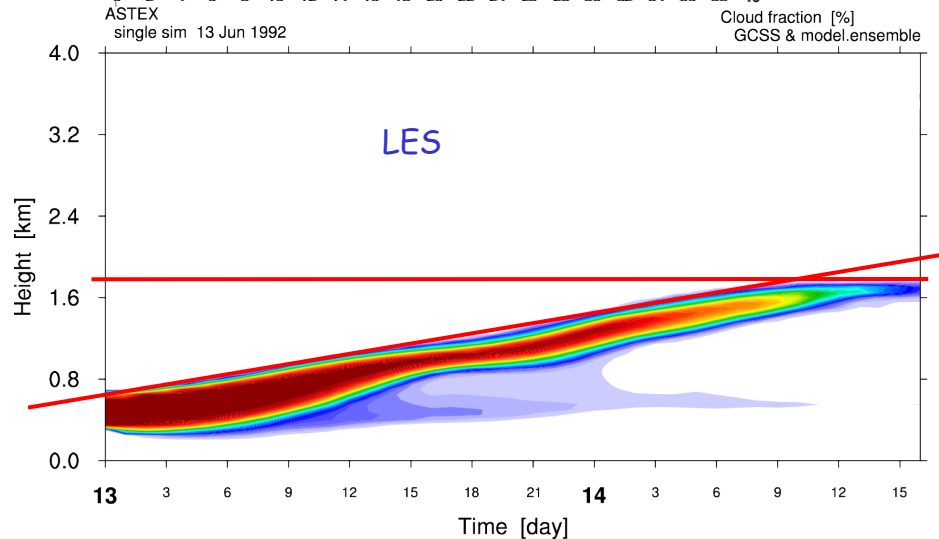
ASTEX Composite (15 July, 3days)
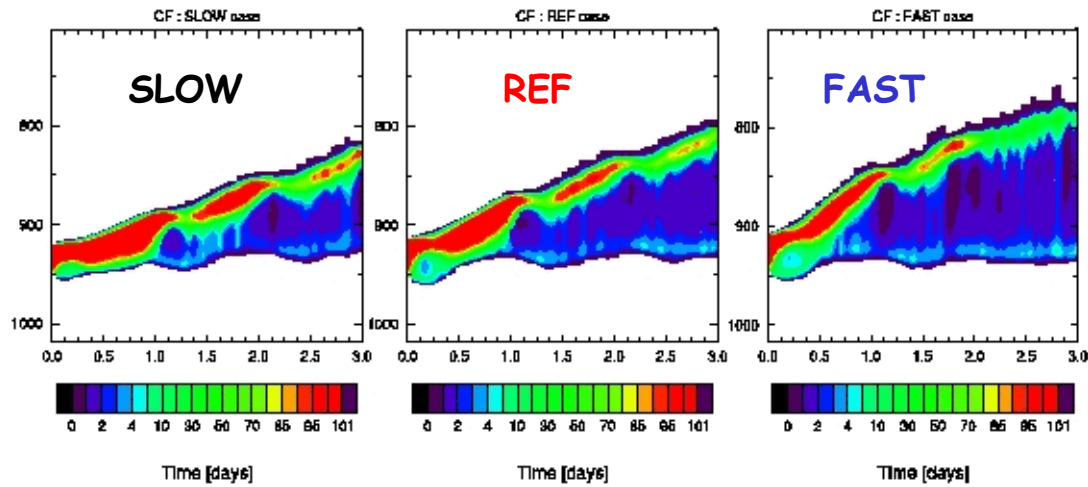
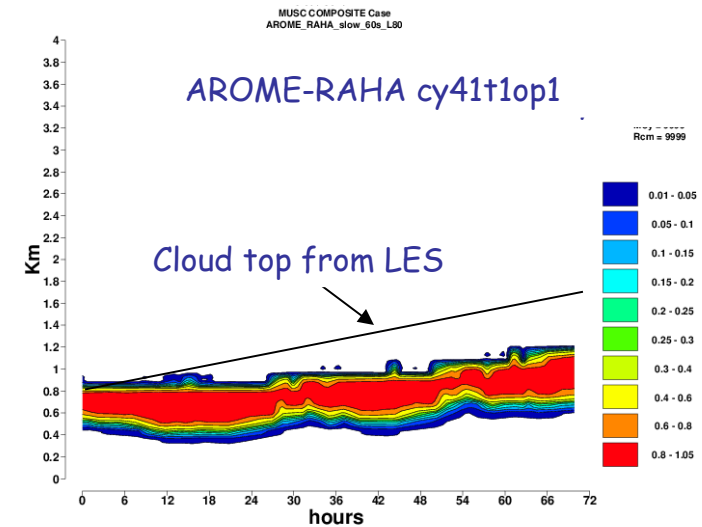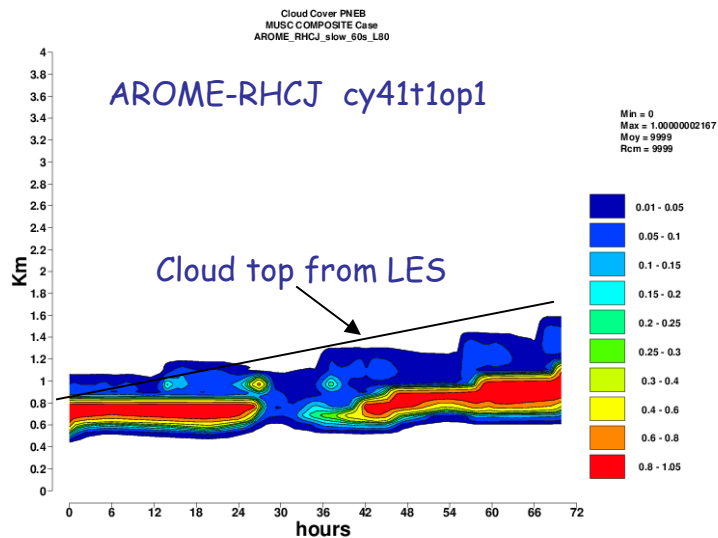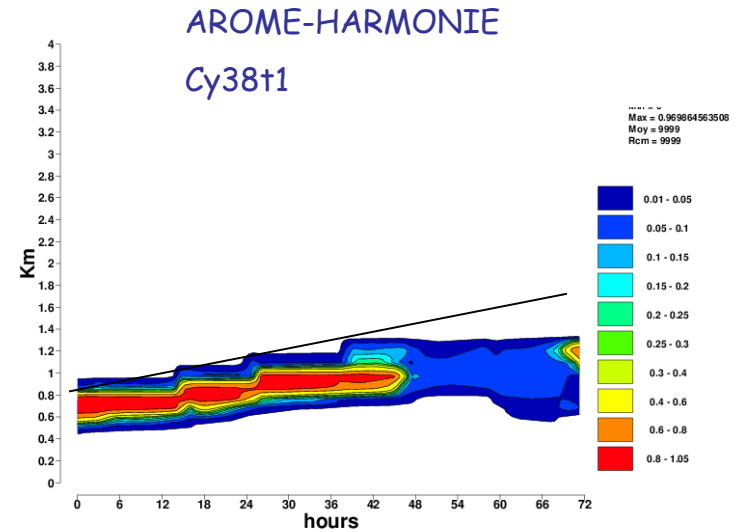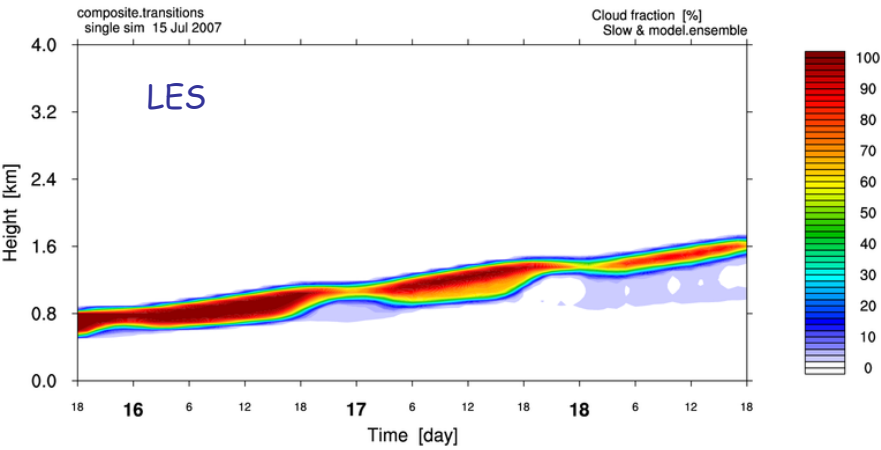Evolutions temporelles de la fraction nuageuse pour les 3 types de transitions lente, de référence et rapide obtenues avec le LES de l'UCLA.

ASTEX Composite (15 July, 3days) : SLOW

LES

AROME cy35t2 L80 60s (results sent for the EUCLPISE intercomparison 2011)

AROME cy38t1

Cloud top from LES
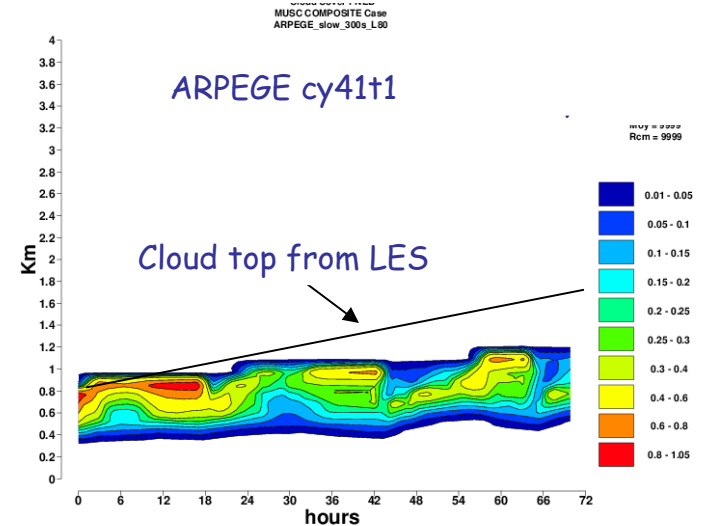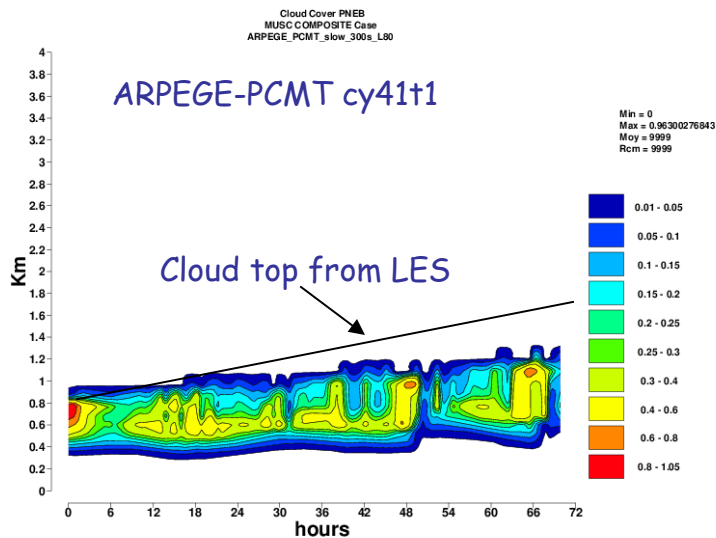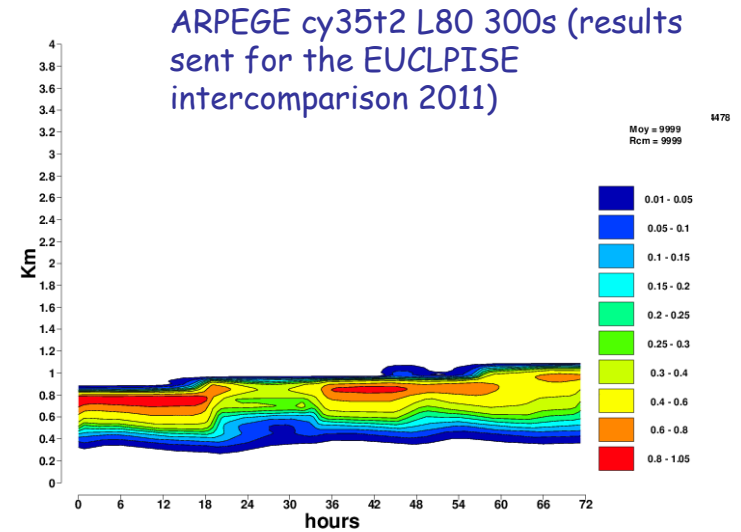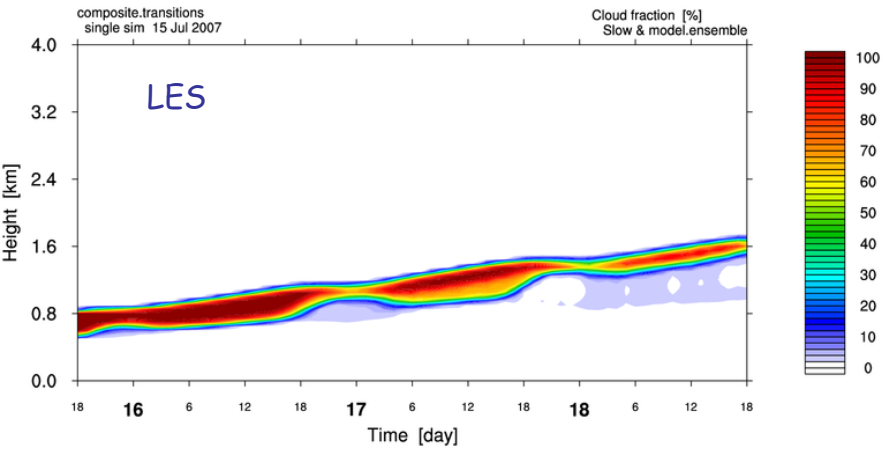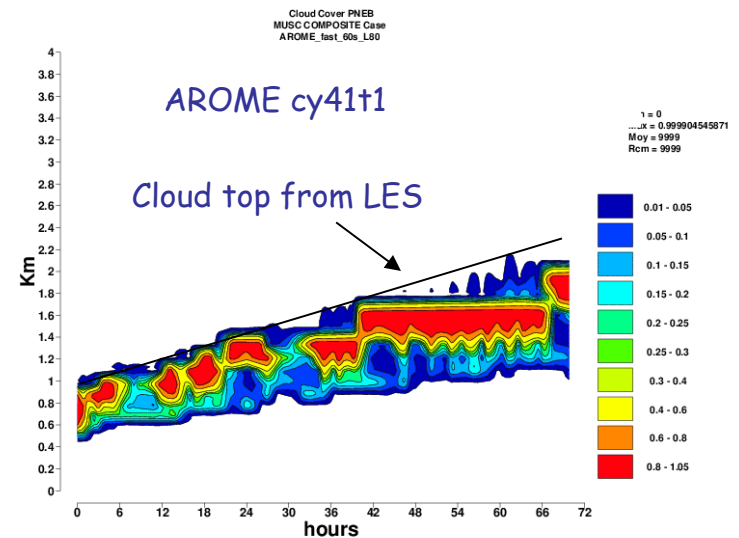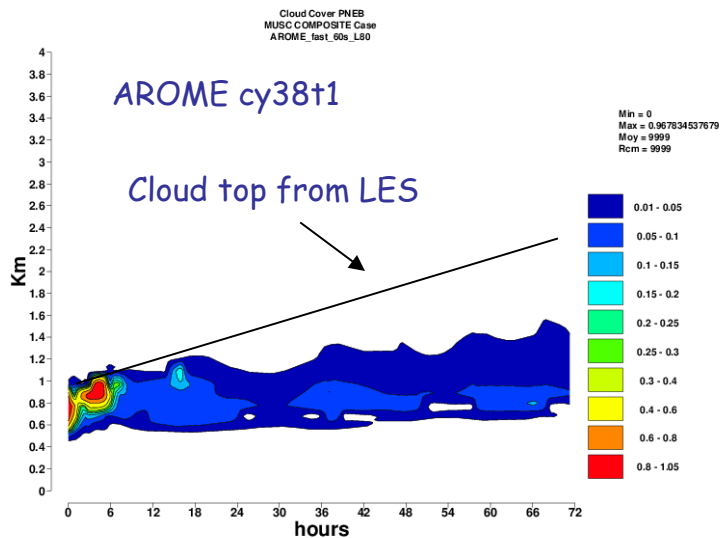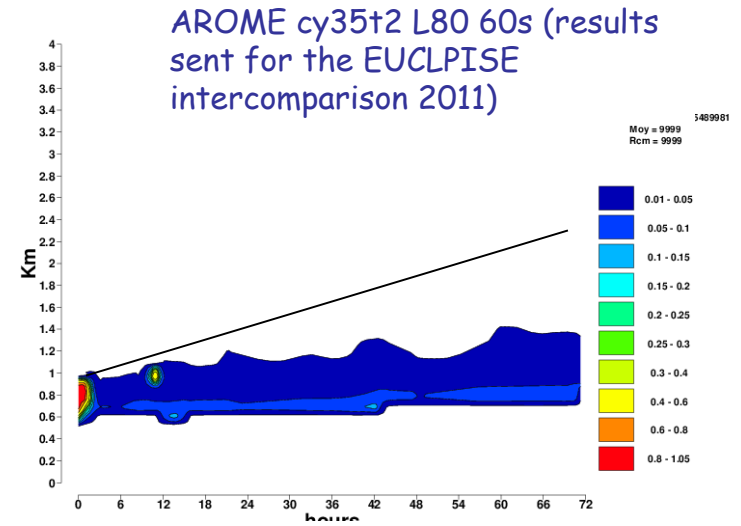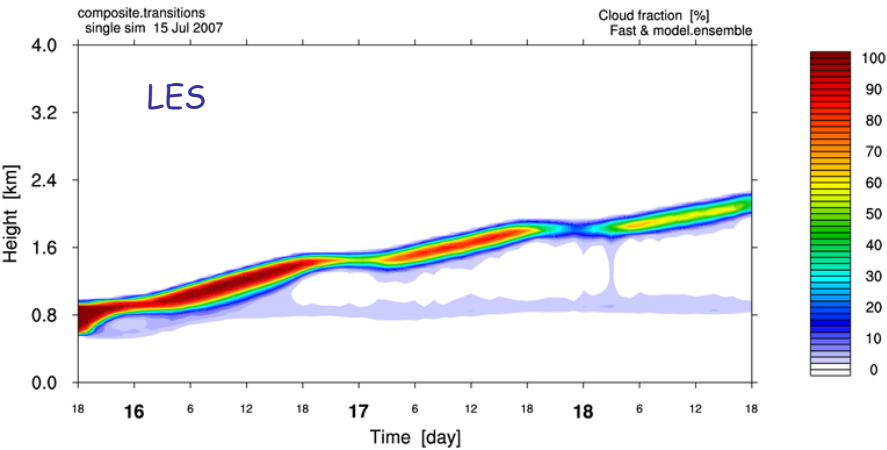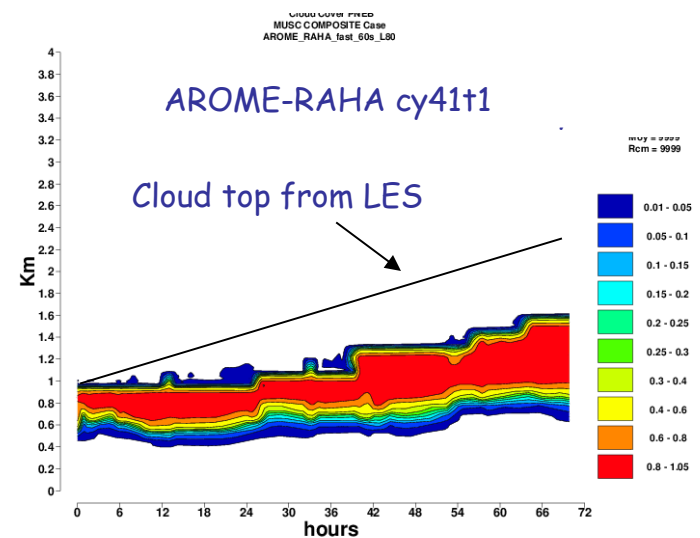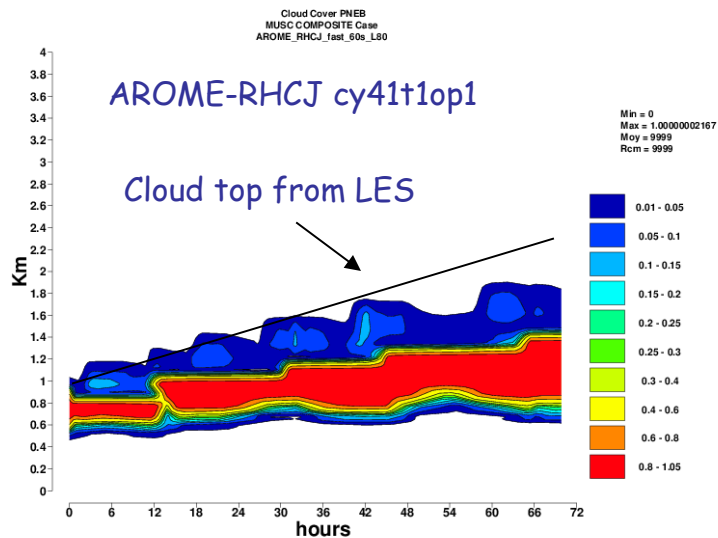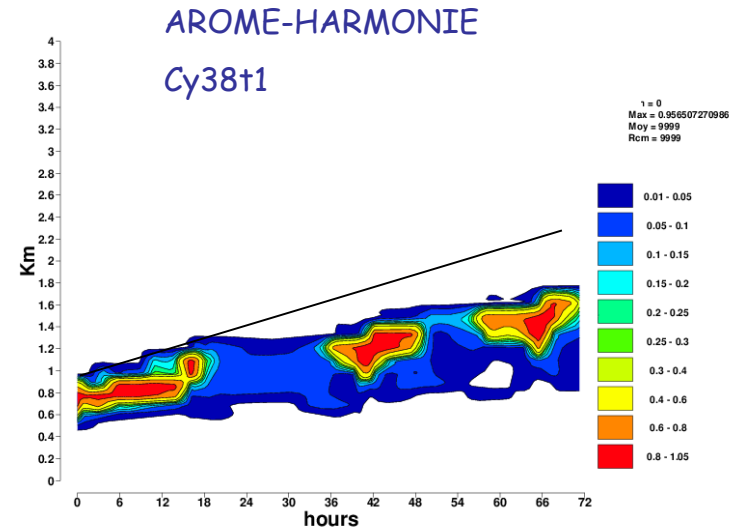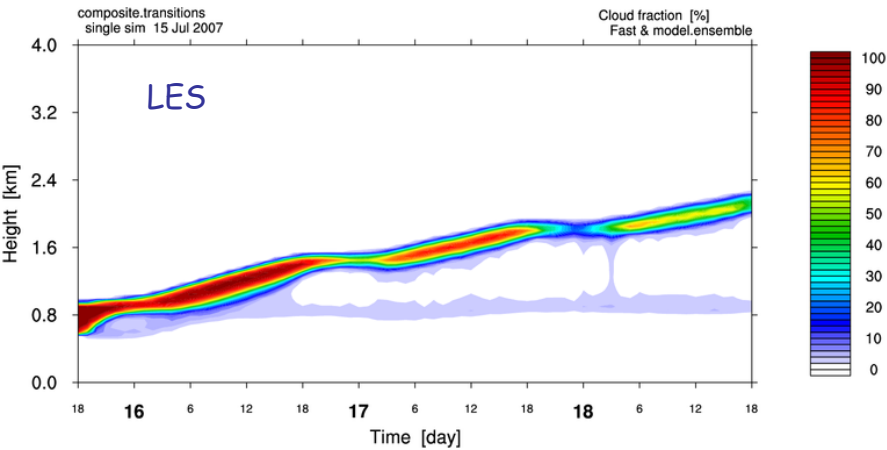
AROME cy41t1op1

Cloud top from LES

ASTEX Composite (15 July, 3days) : SLOW

Réunion DEPHY2 « Nuages et précipitation »
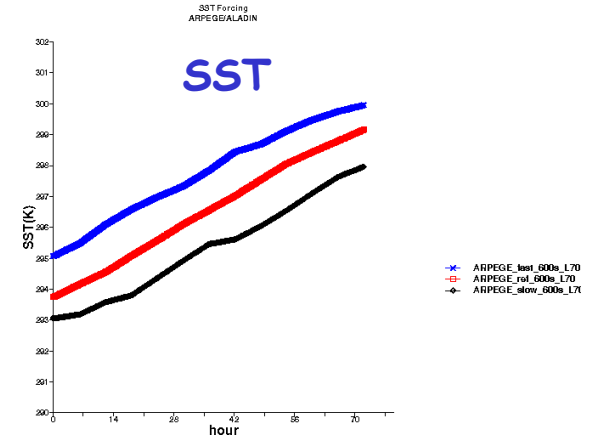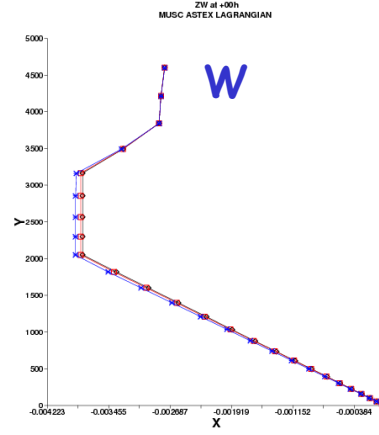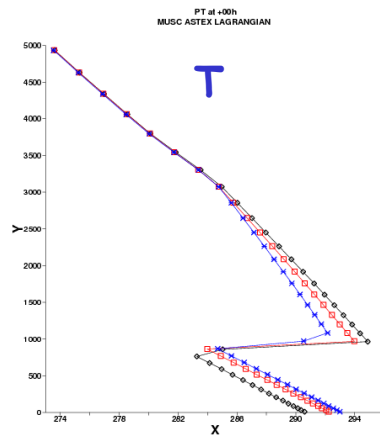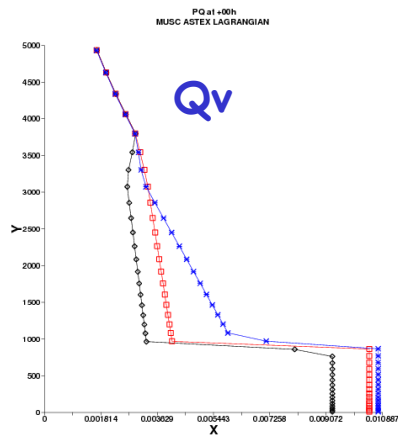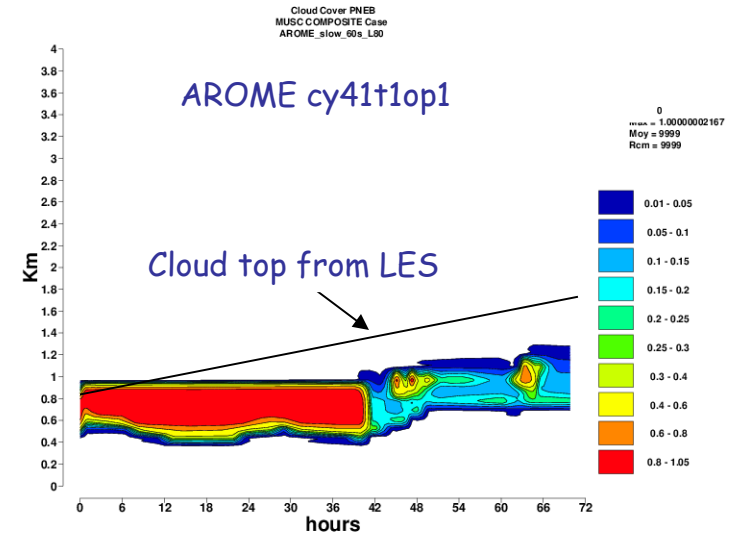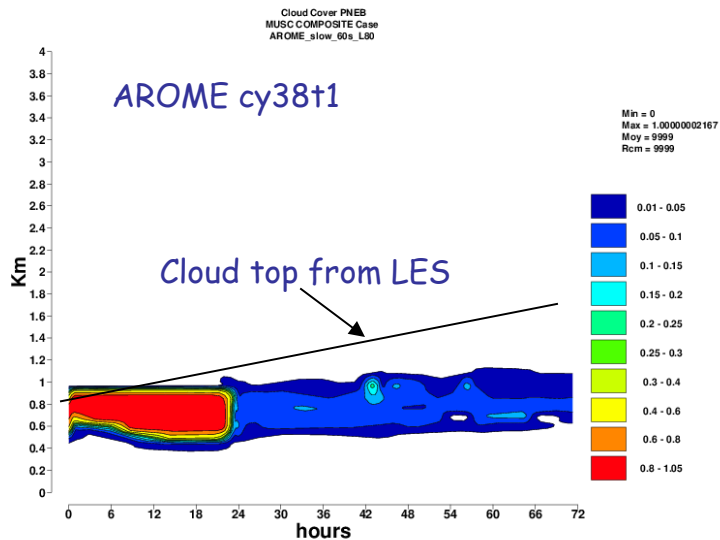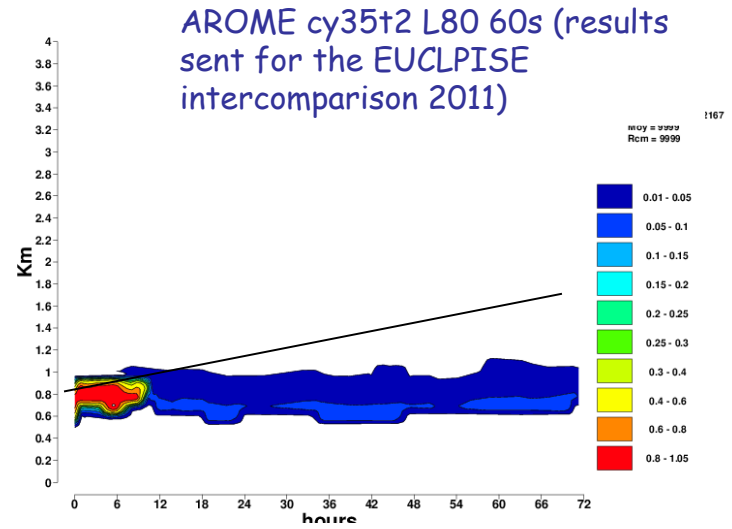
ASTEX Composite (15 July, 3days) : SLOW

ARPEGE cy35t2 L80 300s (results sent for the EUCLPISE intercomparison 2011)

ASTEX Composite (15 July, 3days) : FAST

LES

AROME cy35t2 L80 60s (results sent for the EUCLPISE intercomparison 2011)

AROME cy38t1
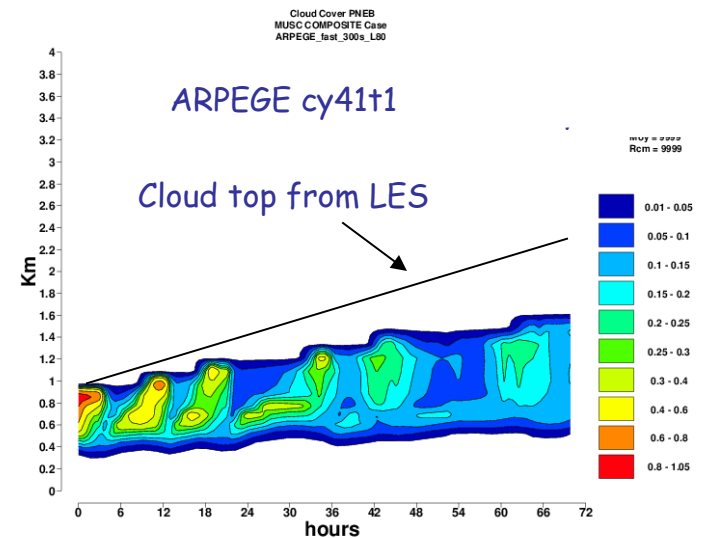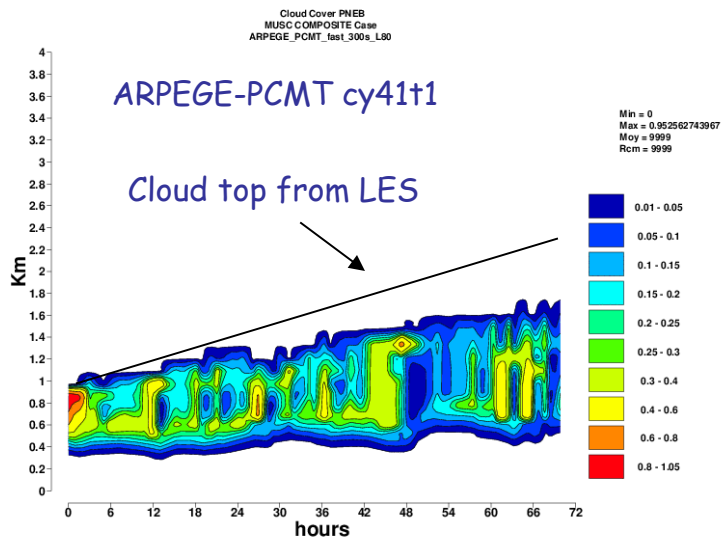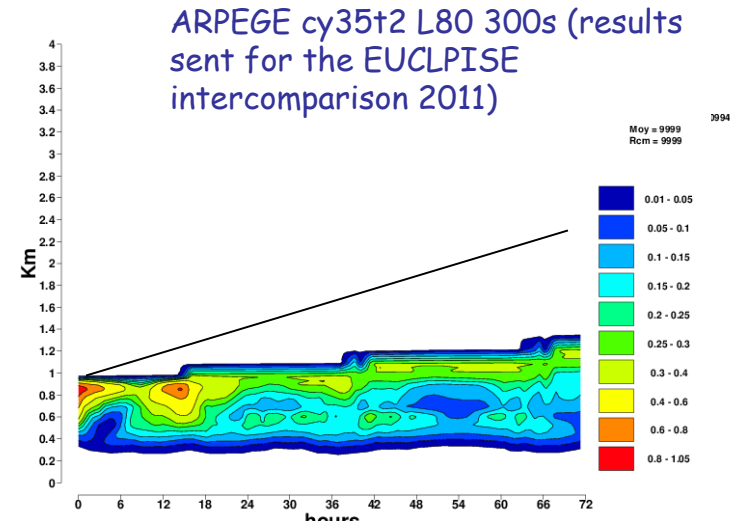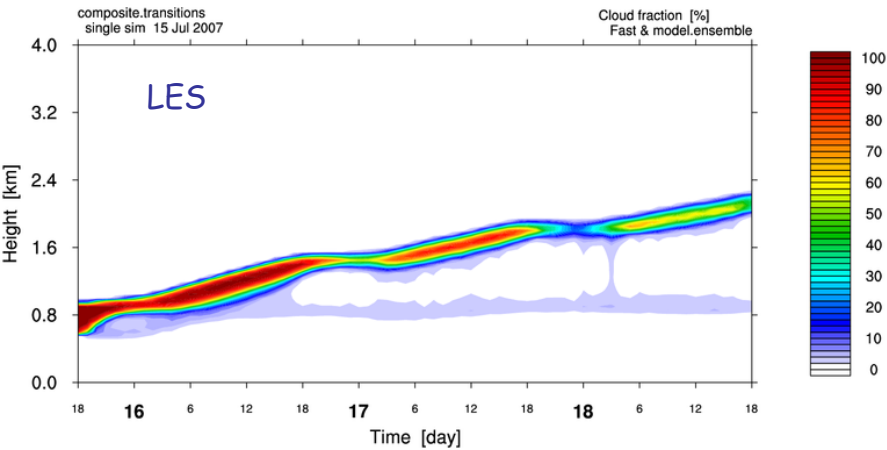
Cloud top from LES

AROME cy41t1

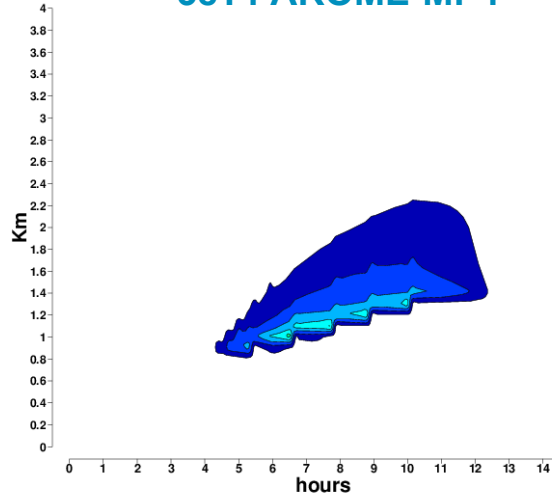Cloud top from LES

ASTEX Composite (15 July, 3days) : FAST

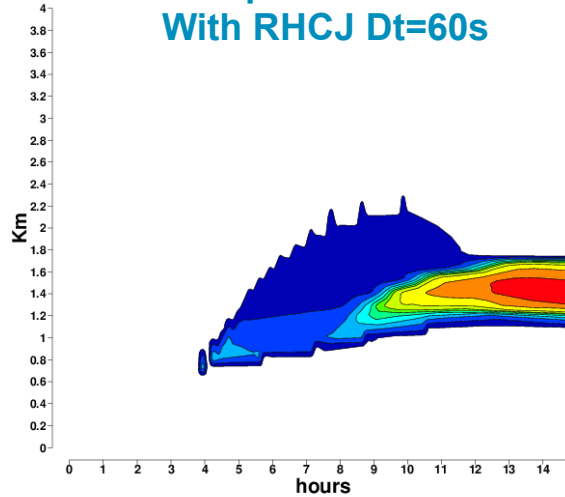# ASTEX Composite (15 July, 3days) : FAST
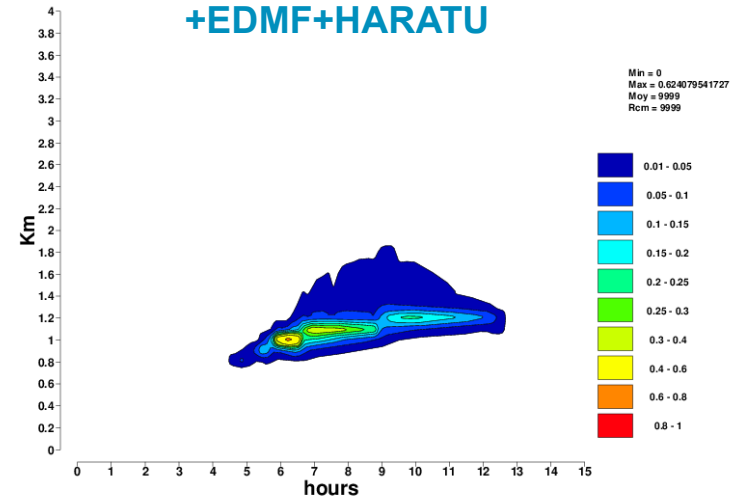
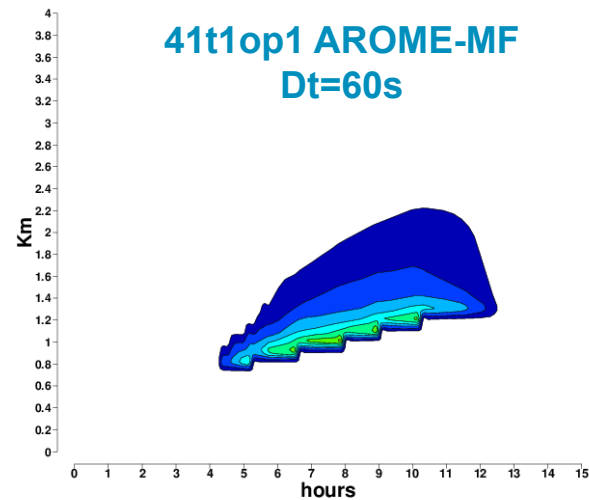# ARM-Cu Case : Cloud Cover

38T1 AROME-MF :
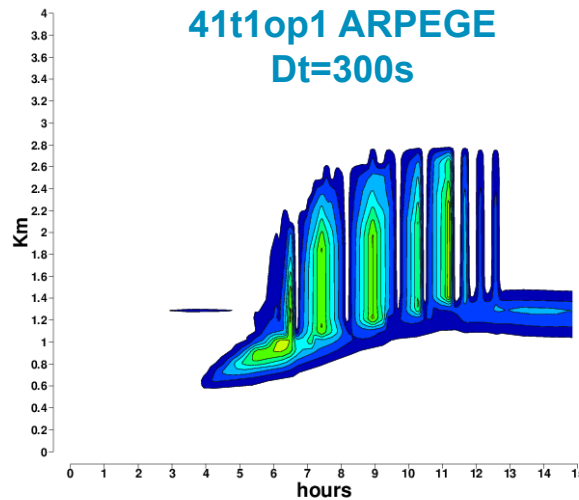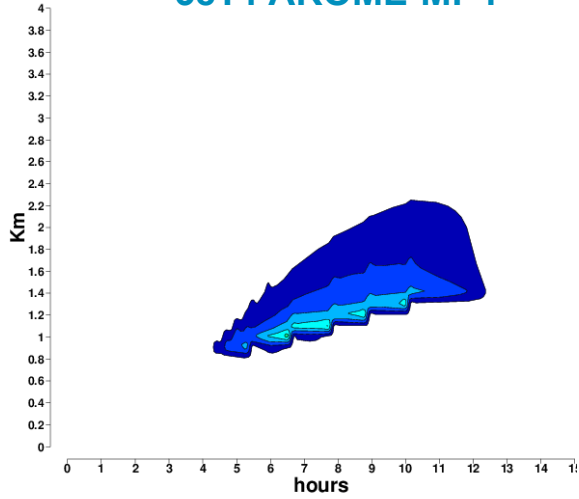
41t1op1 AROME-MF With RHCJ Dt=60s
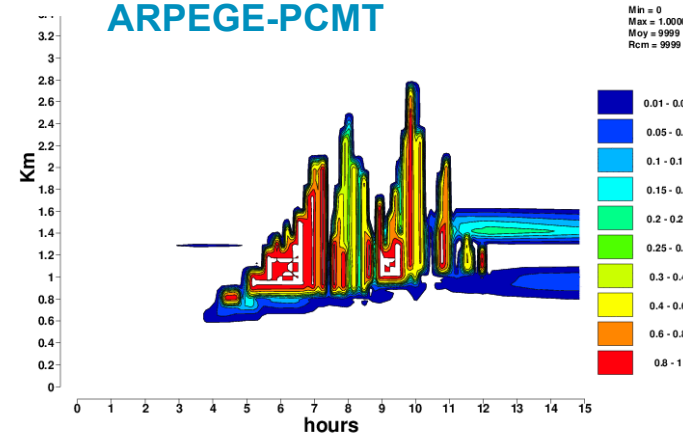
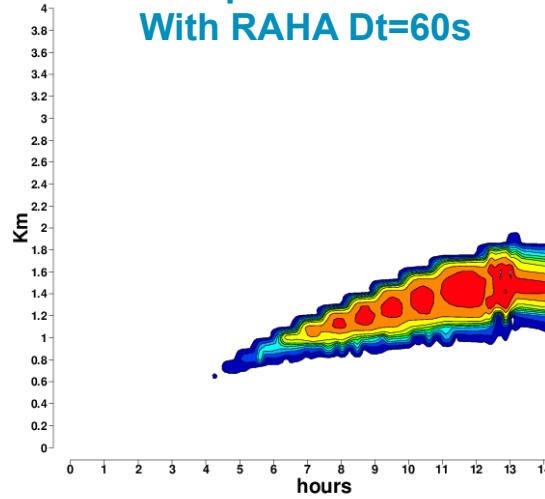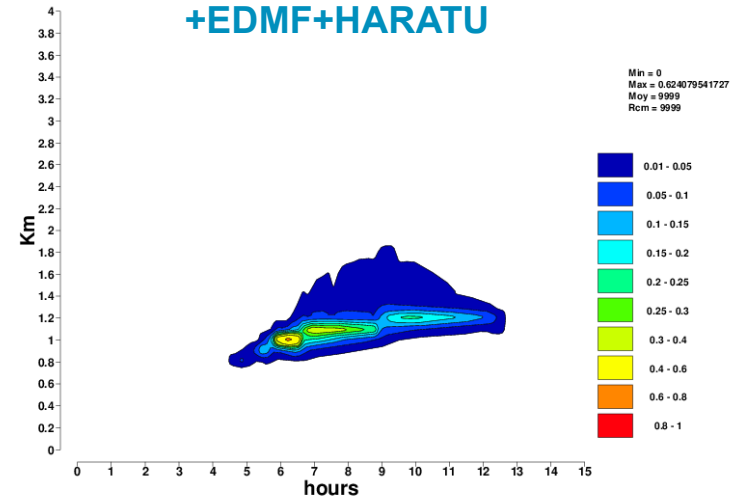**38T1 AROME-MF +EDMF+HARATU**

41t1op1 AROME-MF Dt=60s
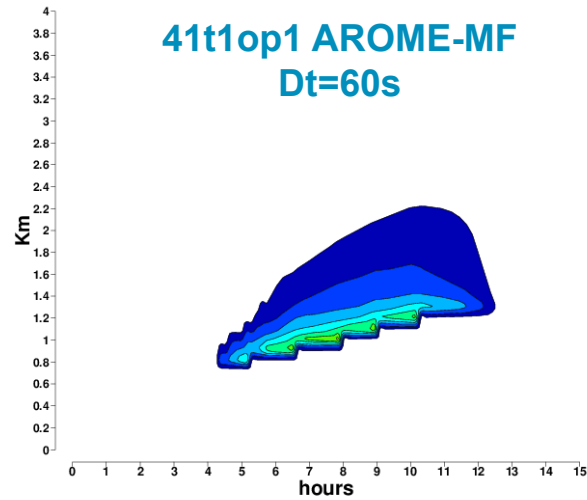
41t1op1 ARPEGE Dt=300s
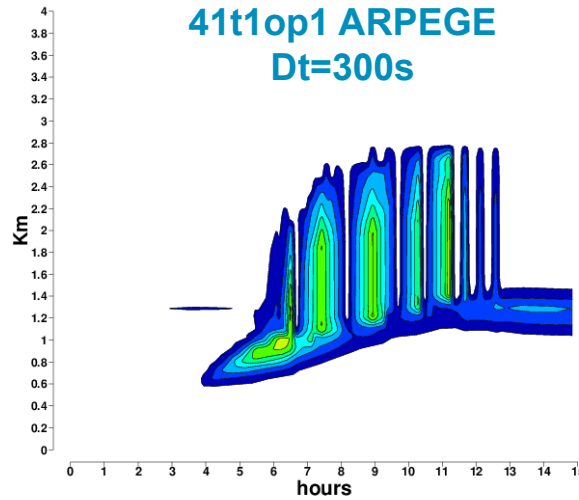
41T1op1 ARPEGE-PCMT

ARM-Cu Case : Cloud Cover
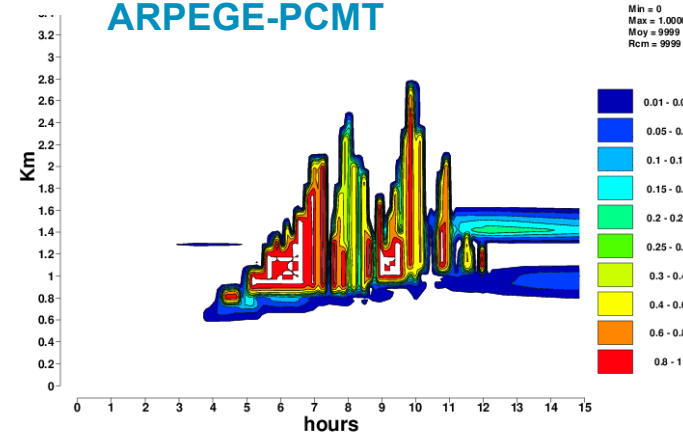
ARM-Cu Case : Cloud Water profile

Mean 7h-8h
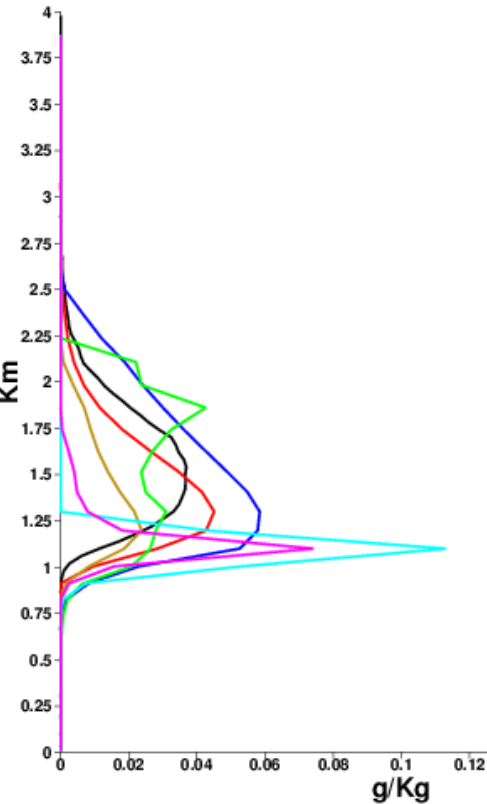
Mean 8h-9h
But Mean LES at 8h30

Mean 9h-10h

Legend:
- HARMONIE 38h1
- AROME-RAHA 41t1op1
- AROME-RHCJ 41t1op1
- ARPEGE+PCMT 41t1op1
- ARPEGE 41t1op1
- AROME 41t1op1
- LES+8h30
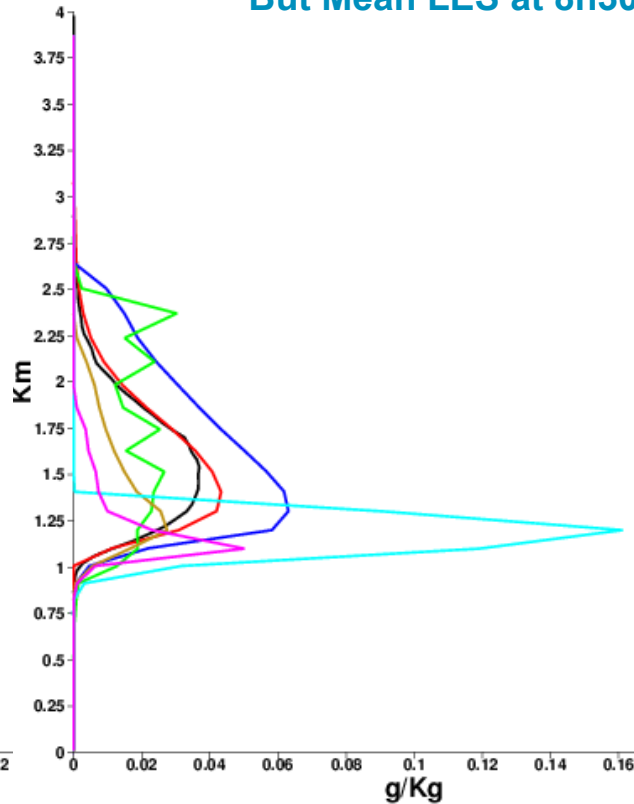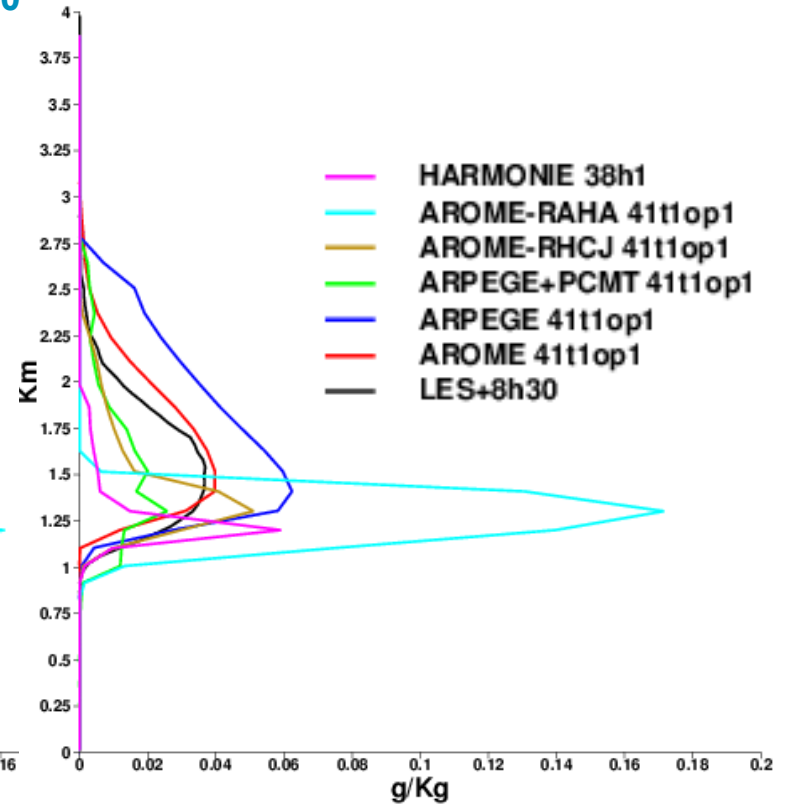
• **For ARM-CU other options available in AROME do not improve the ql profile, ARPEGE little over estimation and PCMT the integrated value is ok but the vertical distribution can probably be improved**

Conclusions / Perspectives

- Possible reasons of low cloud underestimation :
  - Pb in initialisation of planetary boundary layer < 500m
  - Microphysics problem (too active sedimentation ? And/or underestimated ql,qi ?
  - 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...)
  - Surface fluxes, ql, qi+qs, qv, clouds base height …
  - Small AROME domains.
  - Statistics on long periods in cloudy/not cloudy conditions..
  - Evaluation of other microphysics options (OCND2, LIMA ….)

- Use of various 1D cases : ARM-Cu, Astex, BOMEX, FIRE etc …
- Currently, no available option performs well on all 1D cases studied

1D and 3D cloud evaluation at Météo-France

Y. Seity, E. Bazile (CNRM) &
Jean-Charles Dupont (IPSL)

Cloud working days
Toulouse, 17 January 2017