Status and perspectives of the CBL in the ARPEGE/ALADIN-MF NWP system

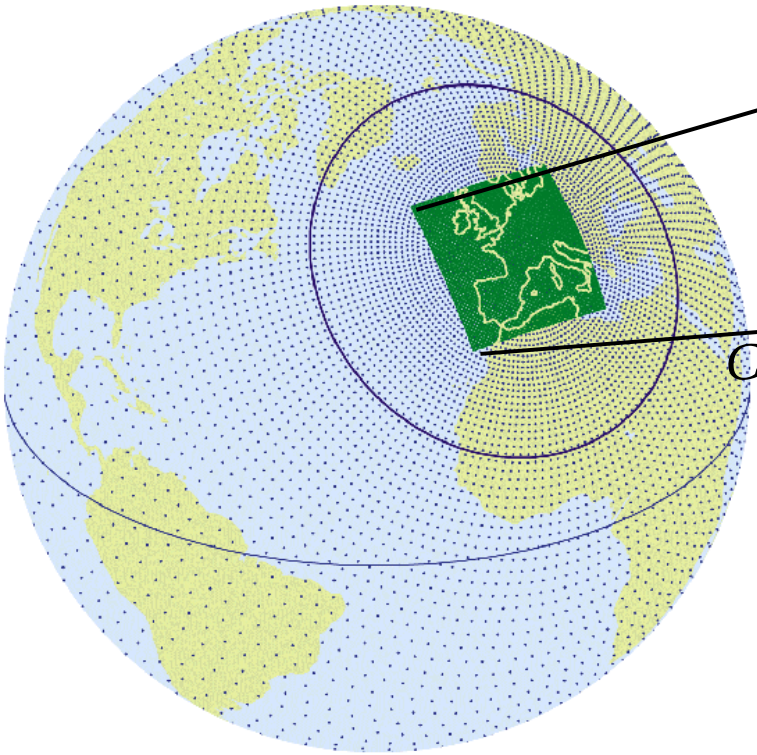
E. Bazile (GMAP), P. Marquet (GMGEC), S. Malardel(GMME)

GAME/CNRM (Météo-France/CNRS)

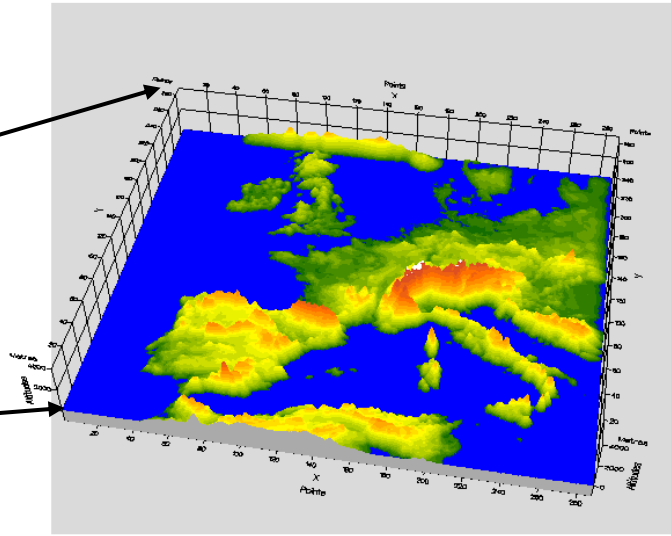
Outlines

- CBL in ARPEGE/ALADIN-MF
- TKE + shallow convection scheme (MF)
- 1D validation on GABLS (1 and 2), BOMEX, Eurocs Cu (ARM)
- 3D experiment in ARPEGE
- Problems
- Perspectives

Operational Weather forecasting at Météo-France: ARPEGE, ALADIN



Coupling



Limited Area Model ALADIN
2-day forecasts every 6 hours
dx=10 km on Europe dt=7mn
Stretched vertical grid with 46 levels
3DVar Data Assimilation system

Global ARPEGE
4-day forecasts every 6 hours dx=23km on Europe, 130km on South Pacific dt=15mn
Stretching and turning of the pole over the zone of interest
Stretched vertical grid with 46 levels
4DVar Data Assimilation system

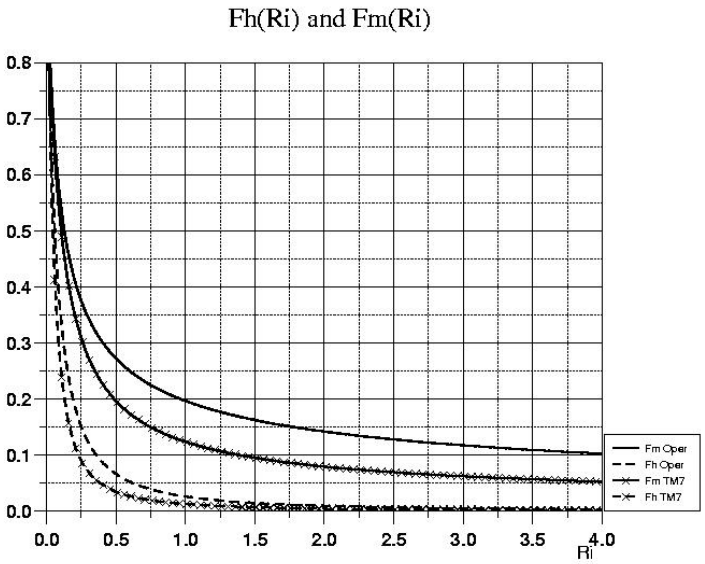
Summer 2007
dx=15 km on Europe, 80km on South Pacific
60 (or 70) levels
4DVar Data Assimilation system

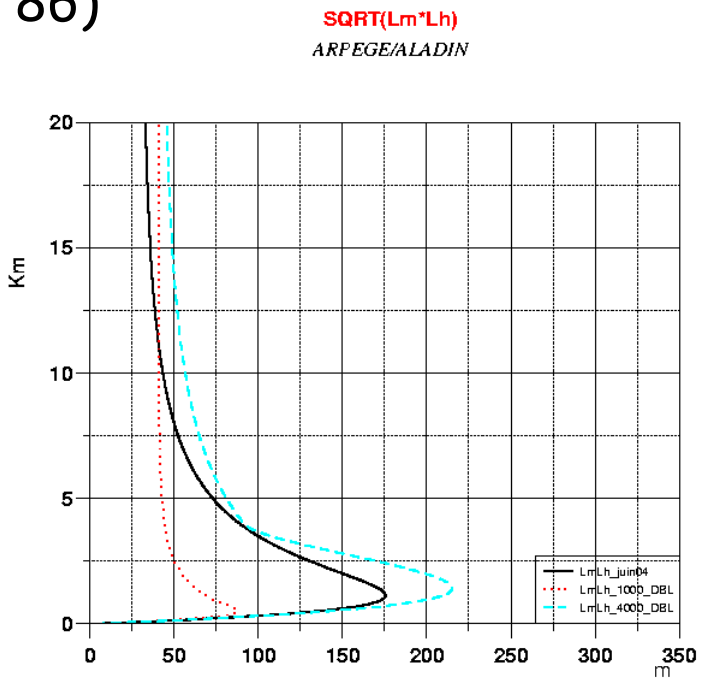
Vertical diffusion (Louis 81) and "shallow convection" (Geleyn 87)

$$K_m = l_m^2 \left| \frac{\partial \vec{U}}{\partial z} \right| F_m(R_i) \qquad K_\theta = l_m l_h \left| \frac{\partial \vec{U}}{\partial z} \right| F_h(R_i)$$

$$R_i = \frac{g}{C_p T} \cdot \frac{\partial s / \partial z}{(\partial u / \partial z)^2} + \frac{g}{C_p T} \cdot \frac{L \cdot \min(0, \partial (q - q_s) / \partial z)}{(\partial u / \partial z)^2}$$

PBL height following (Tröen& Mahrt 86)
Mixing length depends on the PBLH





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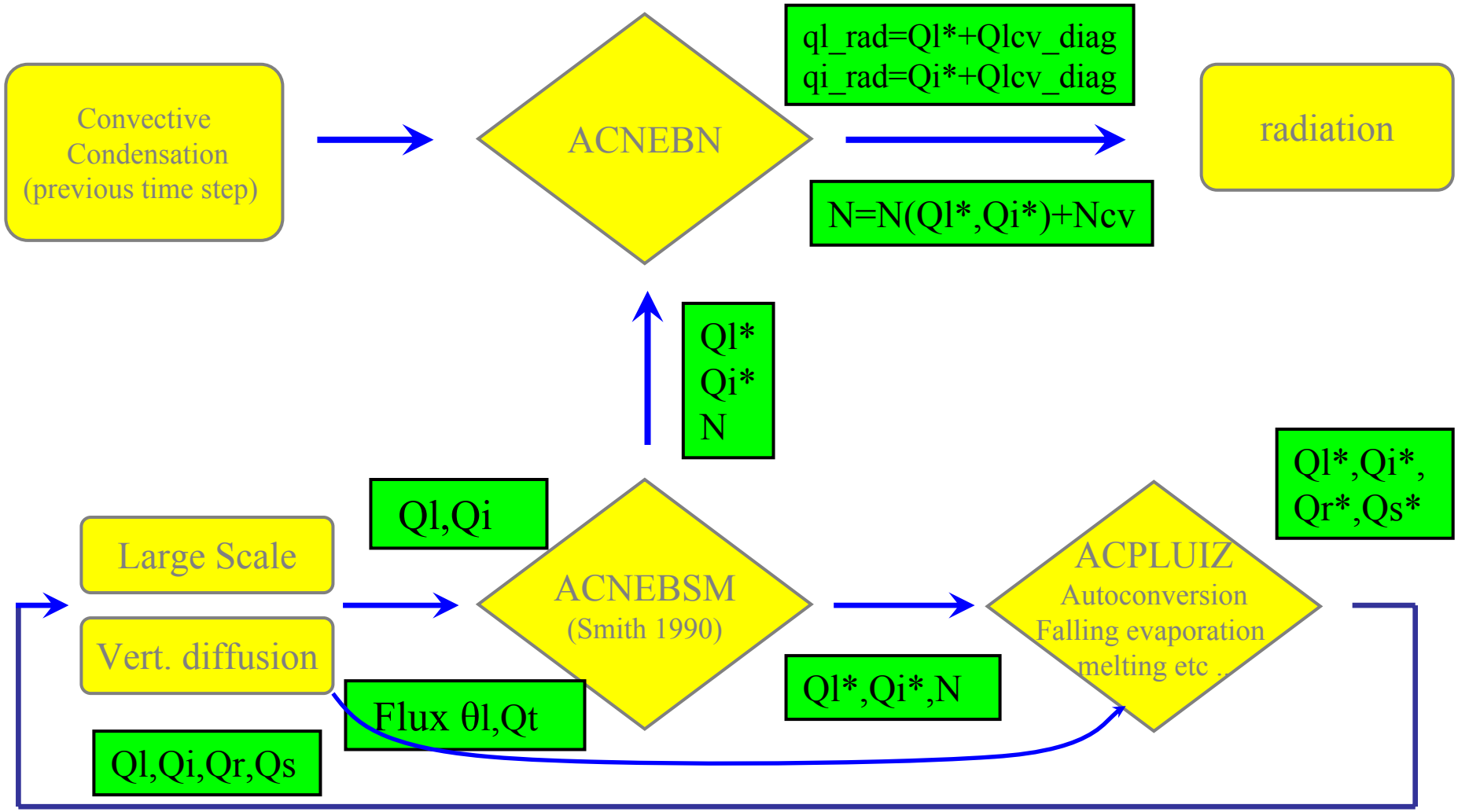
Precipitation and cloudiness



Thanks to Bouteloup Y., Bouyssel F.
(Aladin Bratislava Workshop, 2005)

TKE Scheme CBR(2000), BL(89), F0,F1 : Bougeault (81), F2 et λ3 Bougeault(82) and Bechtold(95)

The TKE scheme used in ARPEGE/ALADIN-MF has been developped by the climate group for ARPEGE-CLIMAT (P. Marquet's talk)

$$K_u = \alpha_u \cdot l \cdot \sqrt{\overline{e_T}}$$

$$K_h = \alpha_h \cdot \alpha_u \cdot l \cdot \sqrt{\overline{e_T}} \cdot \phi_h$$

Constant mixing length Redelsperger function

Louis's scheme

$$K_\chi = l_m \cdot l_\chi \left| \frac{\partial \vec{U}}{\partial z} \right| F_\chi(R_i)$$

$$1/\phi_h = 1 + \frac{1}{7.2} \cdot \frac{l^2}{\theta \cdot e_T} \cdot \frac{\partial \theta}{\partial (gz)}$$

$$\frac{\partial \overline{e}_T}{\partial t} = P_d + P_\theta - \frac{\partial \overline{w' e_T}}{\partial z} - c_\varepsilon \frac{\overline{e}_T^{3/2}}{l_\varepsilon}$$

TKE Scheme CBR(2000), BL(89), F0,F1 : Bougeault (81), F2 et λ3 Bougeault and Bechtold(95)

$$P_d = -(\overline{w'u'})\frac{\partial \bar{u}}{\partial z} - (\overline{w'v'})\frac{\partial \bar{v}}{\partial z} = \alpha_u \cdot l \cdot \sqrt{\overline{e_T}} \cdot \left(\left(\frac{\partial \bar{u}}{\partial z} \right)^2 + \left(\frac{\partial \bar{v}}{\partial z} \right)^2 \right)$$

$$P_\theta = \frac{g}{\theta_{vl}} \cdot (\overline{w'\theta_{vl}'}) = E_q(\overline{w'q_t'}) + E_\theta(\overline{w'\theta_l'})$$

Redelsperger and Sommeria(81), Bougeault (82) and Bechtold (93)

$$\theta_l = \theta \cdot \left(1 - \frac{L \cdot q_c}{C_p \cdot T}\right)$$

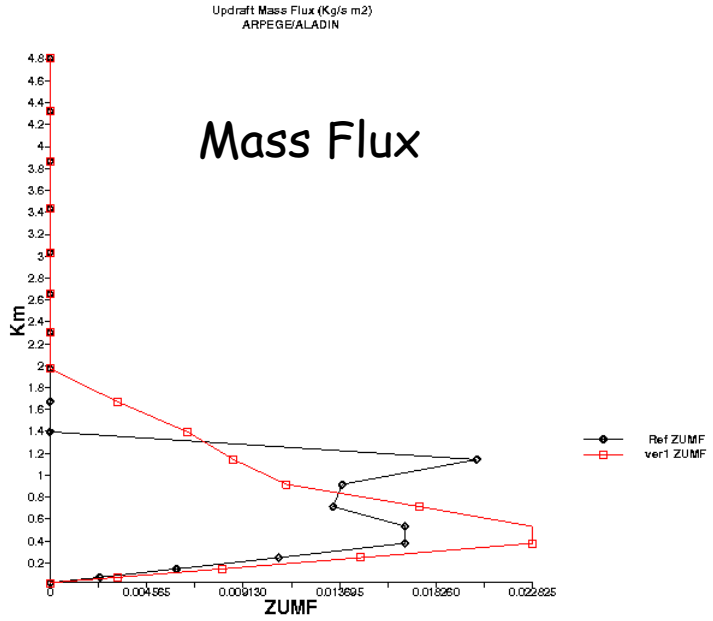
$$\theta_{vl} = \theta \cdot \left(1 + \left(R_v / R_d - 1\right) \cdot q - q_c\right)$$

$$(\overline{w'q_t'}) = -\alpha_\theta \alpha_u l \sqrt{\overline{e_T}} \cdot \frac{\partial \overline{q_t}}{\partial z} \cdot \phi_3$$

$$(\overline{w'\theta_l'}) = -\alpha_\theta \alpha_u l \sqrt{\overline{e_T}} \cdot \frac{\partial \overline{\theta_l}}{\partial z} \cdot \phi_3$$

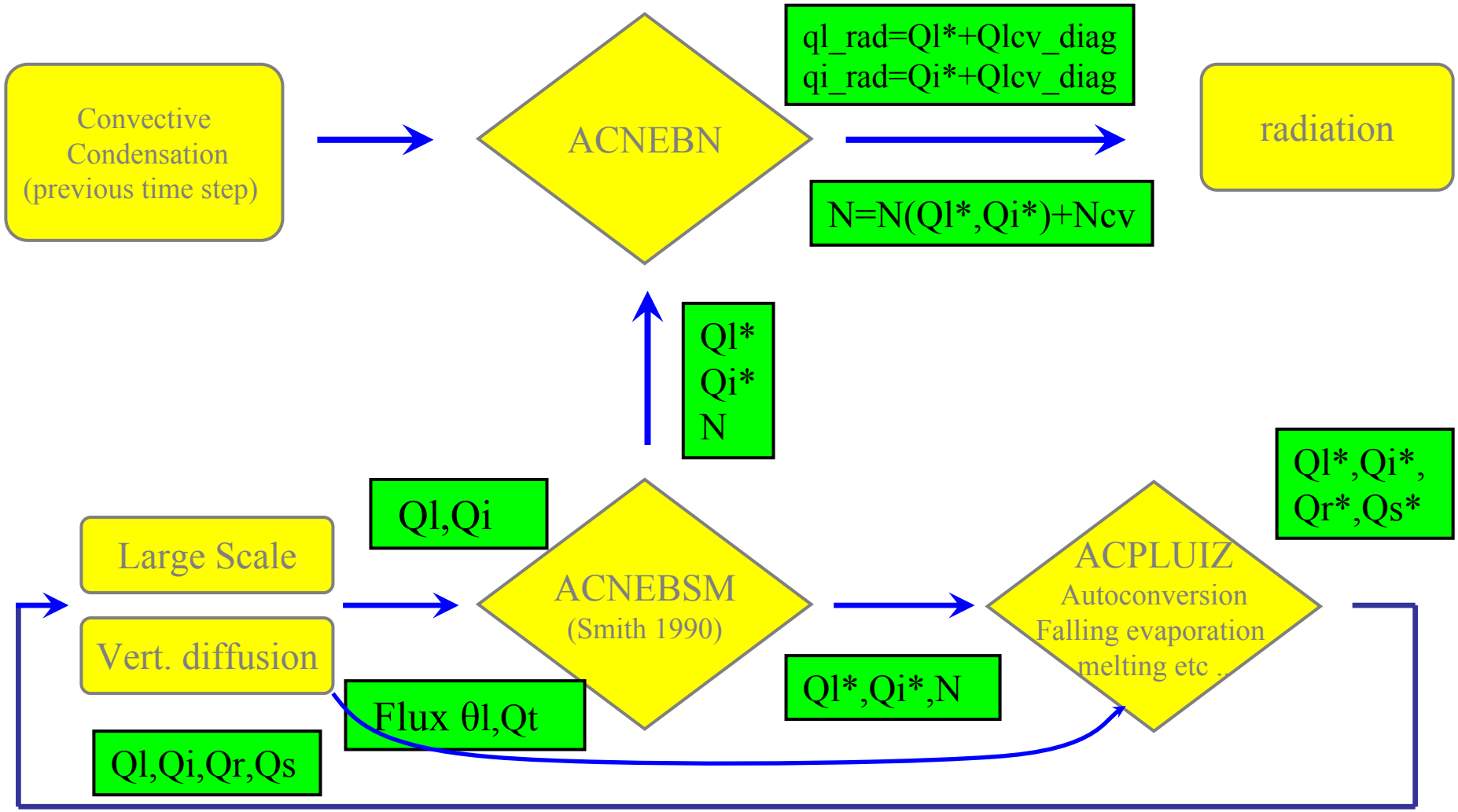
Shallow convection from AROME/MesoNH (Bechtold et al, 2001)

	Default(black)	Ver1 (red)
Entrainment coef Xentr =	0.02	0.015
Adjustment time =	3h	3h
Temperature perturbation=	0.2 K	0.3 K



Mass Flux

Precipitation and cloudiness



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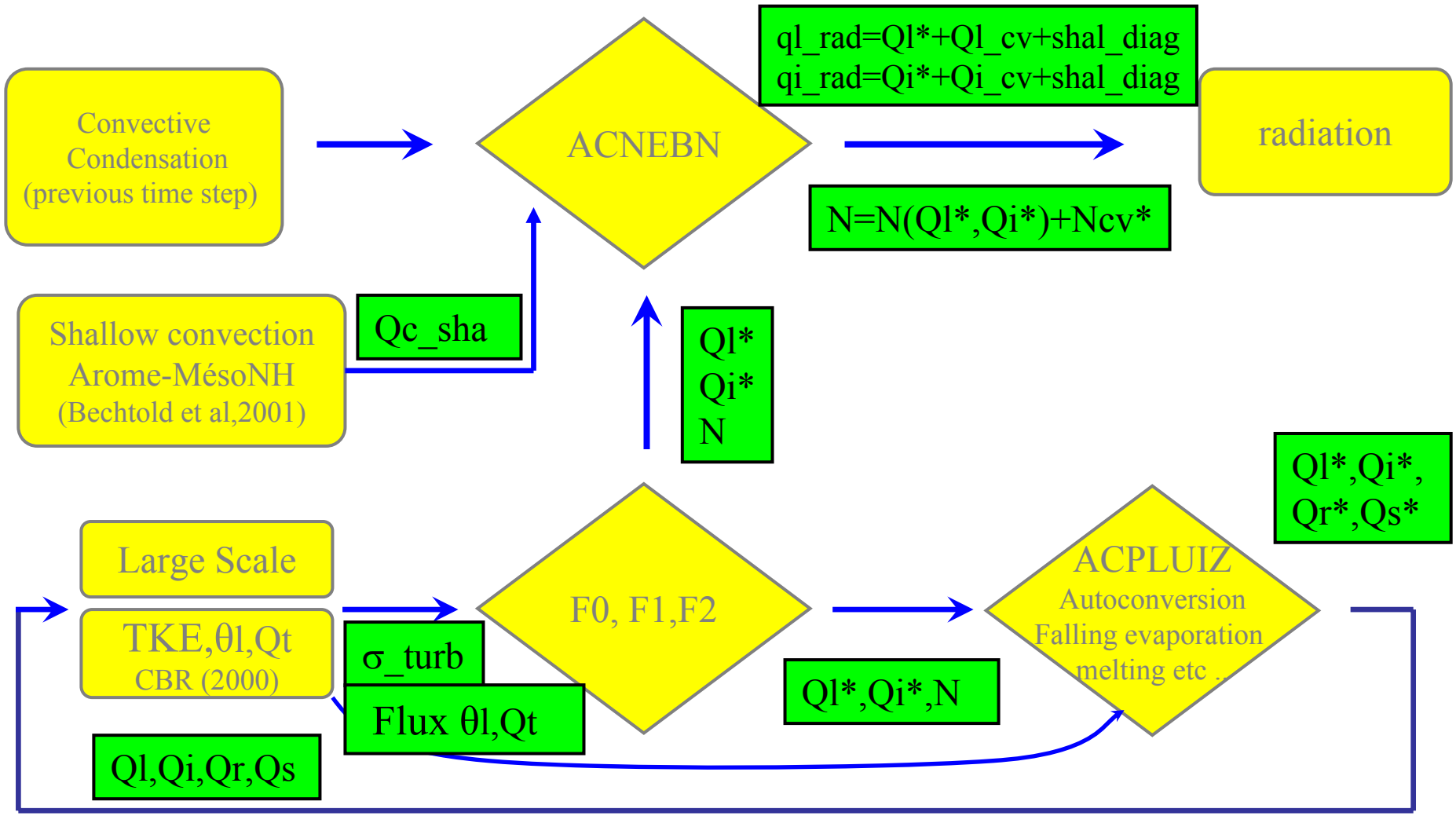
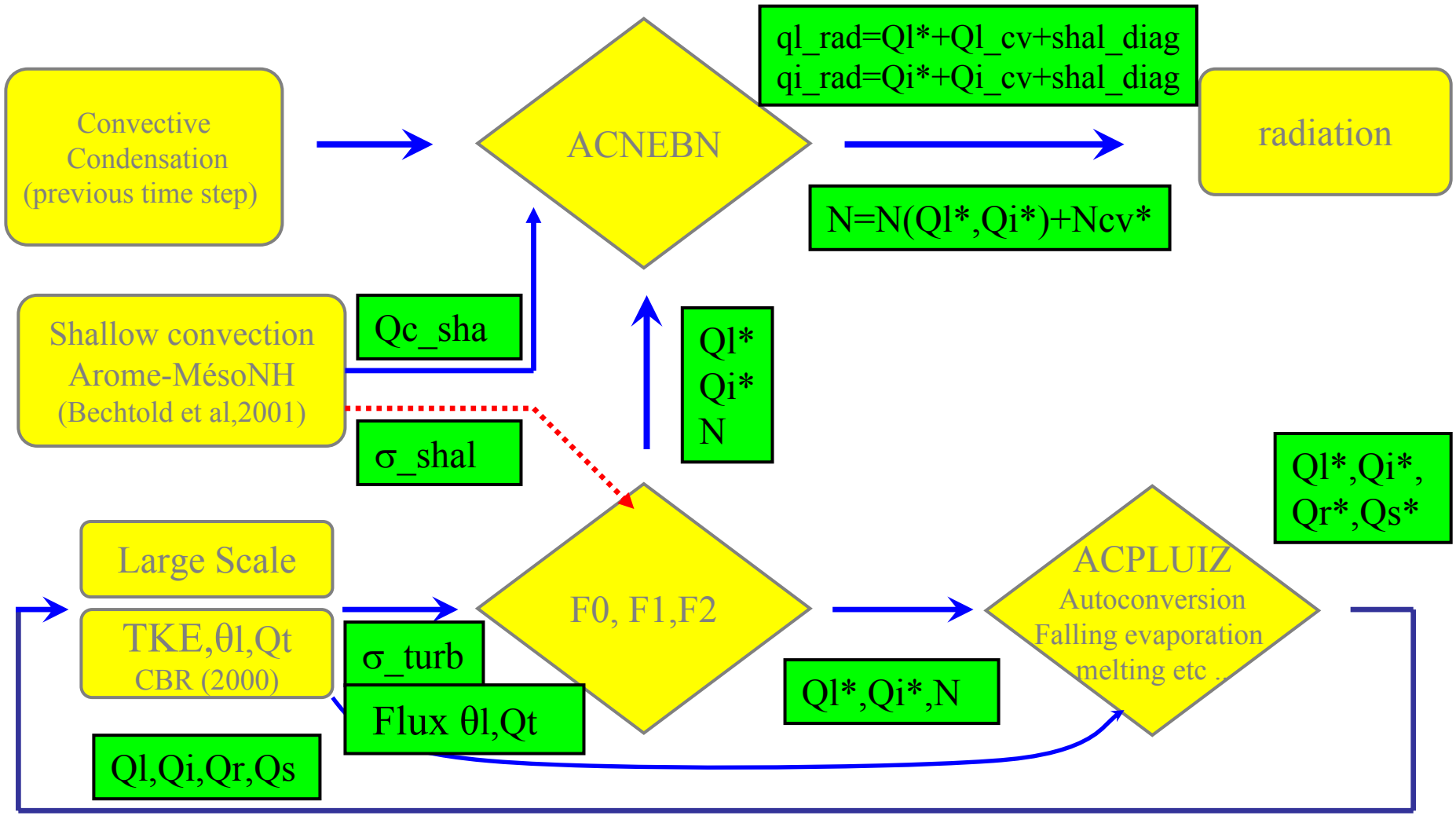
Precipitation and cloudiness with TKE and Méso-NH/AROME shallow convection



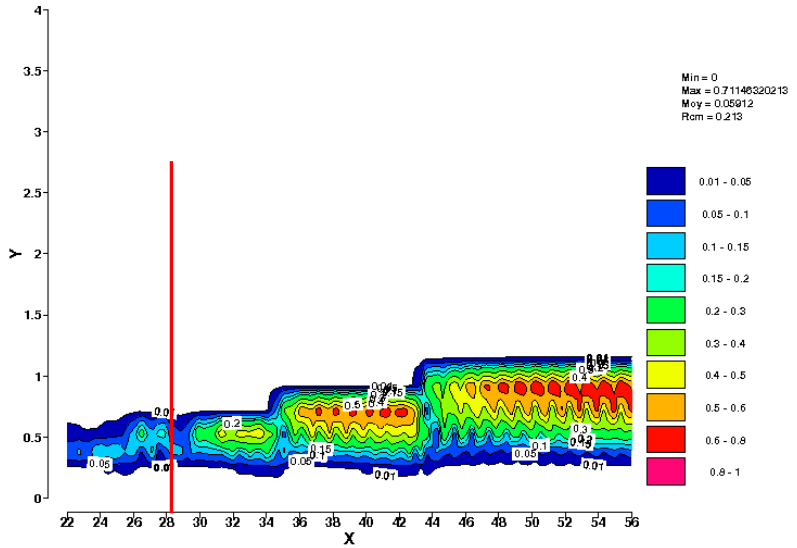
Precipitation and cloudiness with TKE and Méso-NH/AROME shallow convection

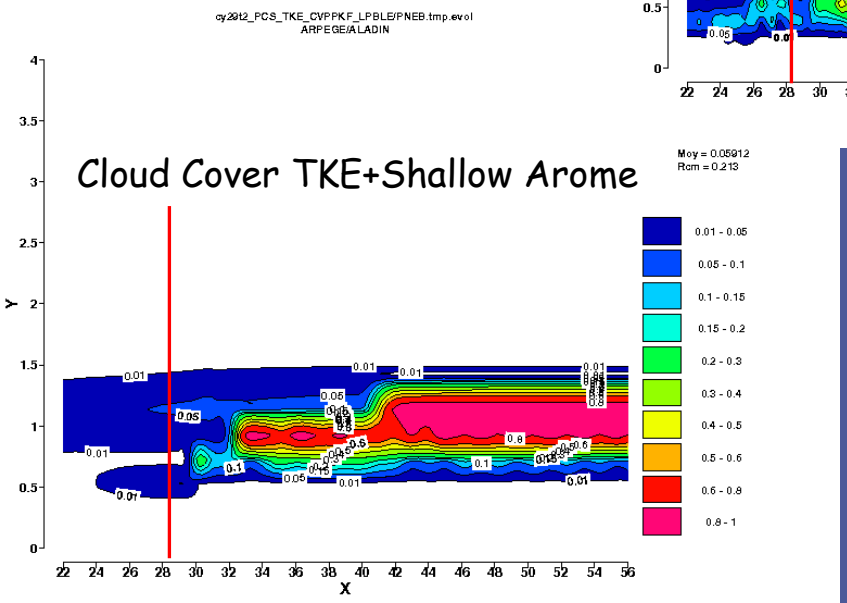


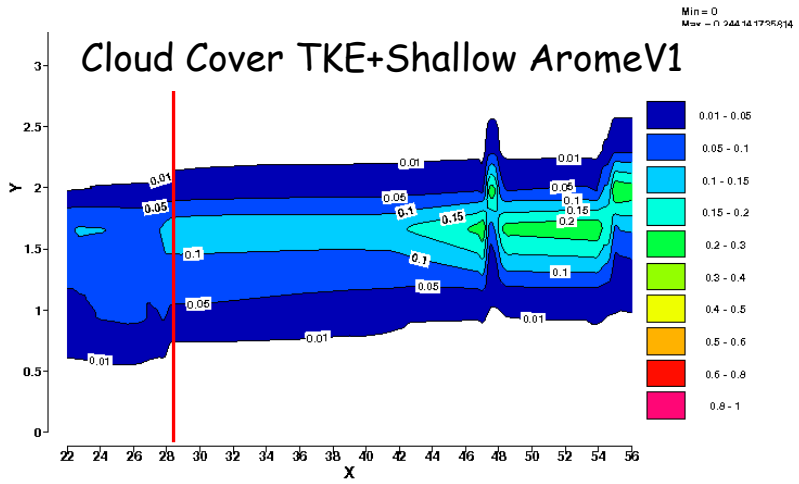
GCSS WG-1 BOMEX case: Shallow cumulus clouds
Fc +36h
dt=900s operational vertical resolution 19l below 5000m..

0-500m	5
500m-1000m	3
1000m-1500m	2
1500m-2000m	2
2000m-3000m	2

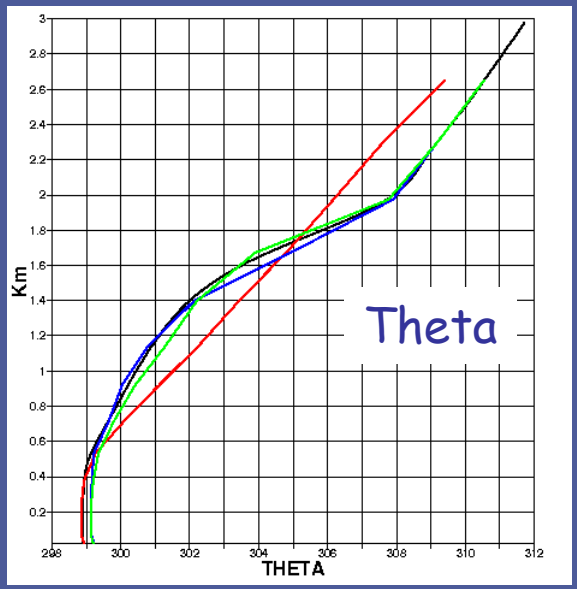
Cloud Cover Arpege/Aladin-MF

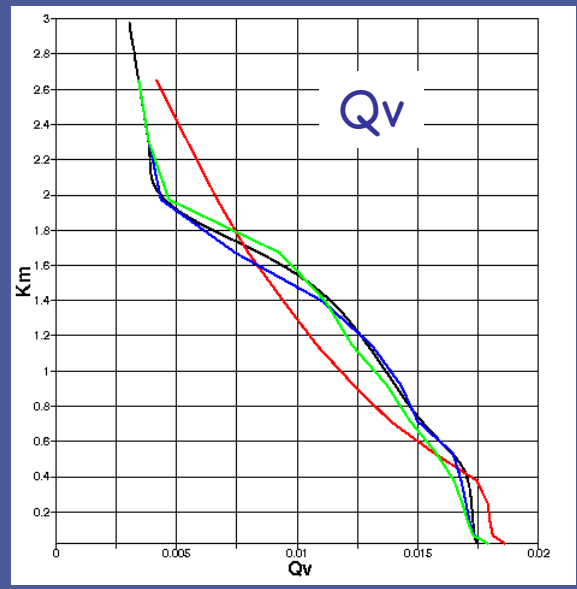


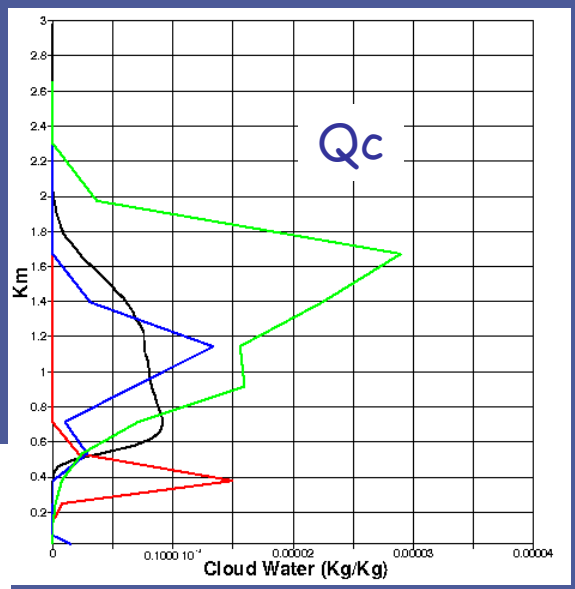


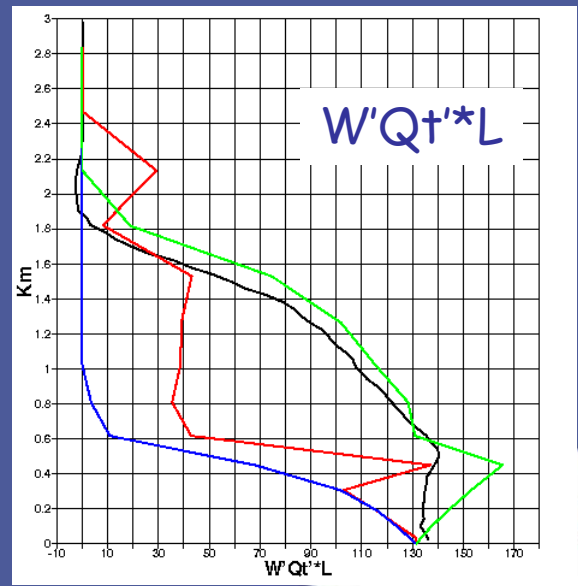


GCSS WG-1 BOMEX case: Shallow cumulus clouds
Fc + 5-6h.









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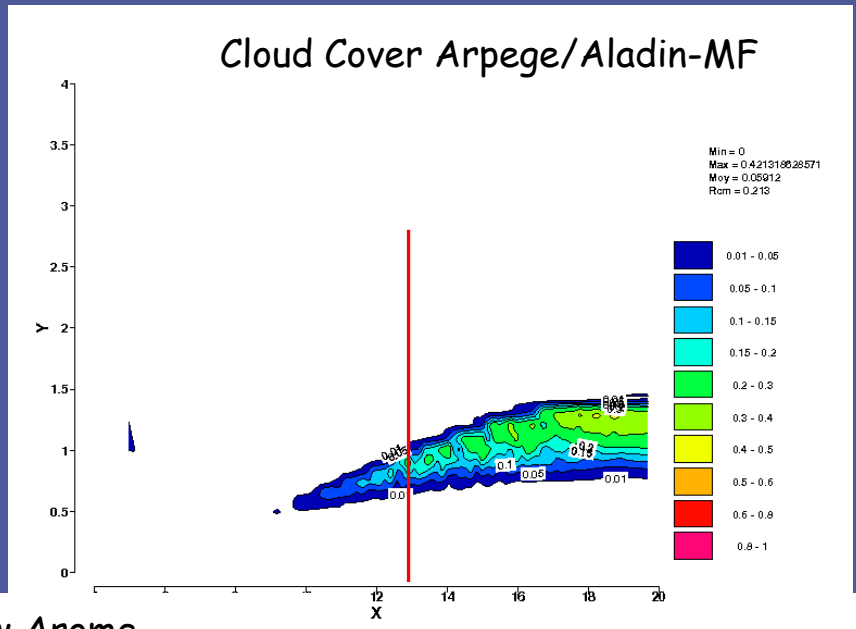
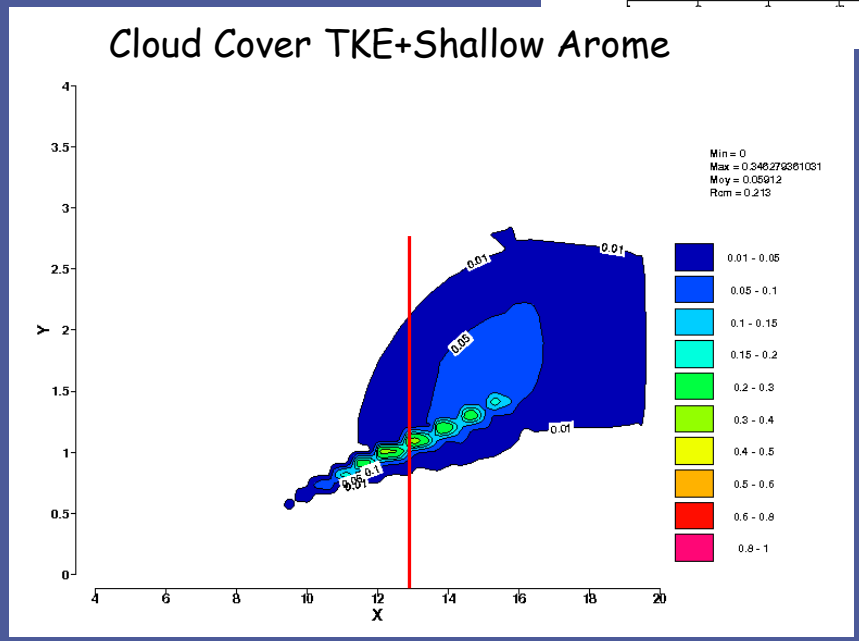
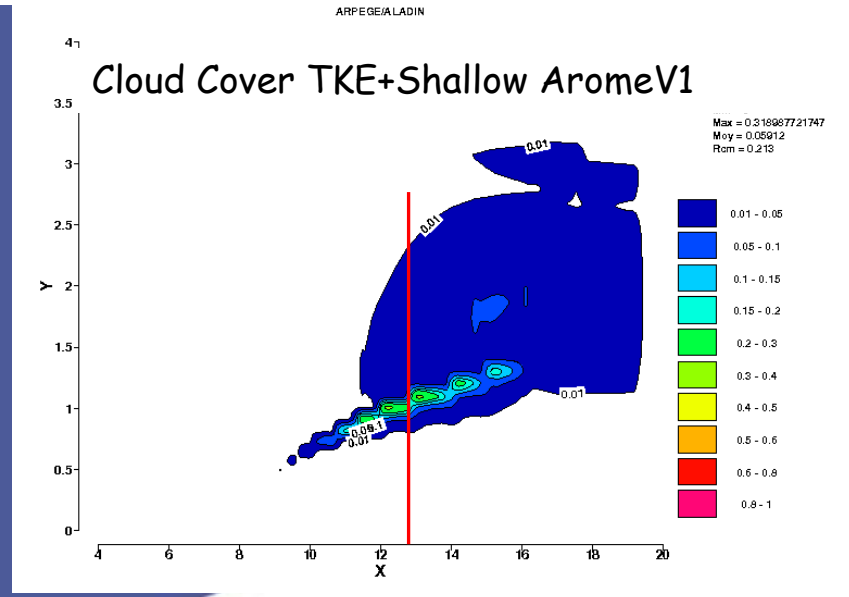
EUROCS/CUMULUS (ARM) 40L below 4000m dt=240s

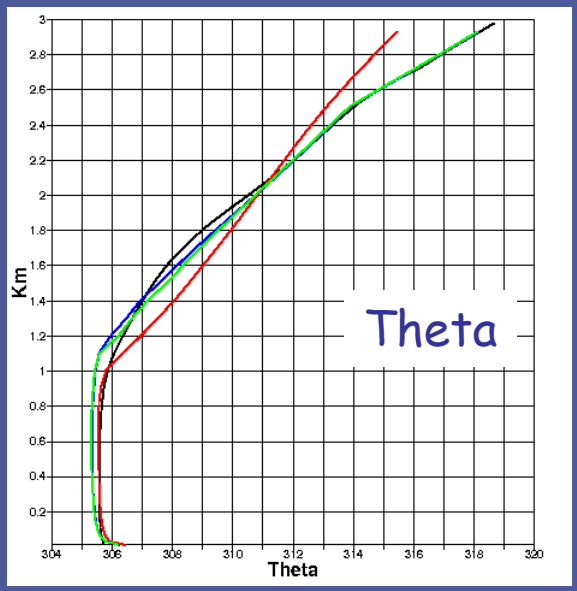
0-500m	10
500m-1000m	6
1000m-1500m	5
1500m-2000m	5
2000m-3000m	7

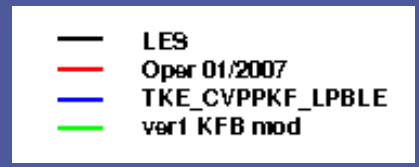


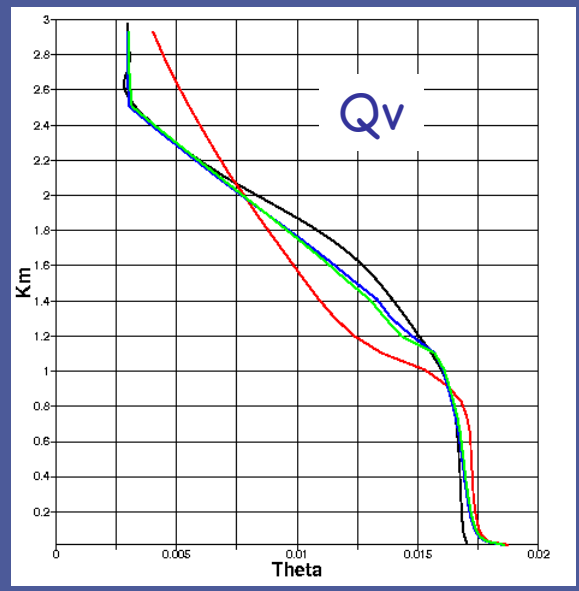


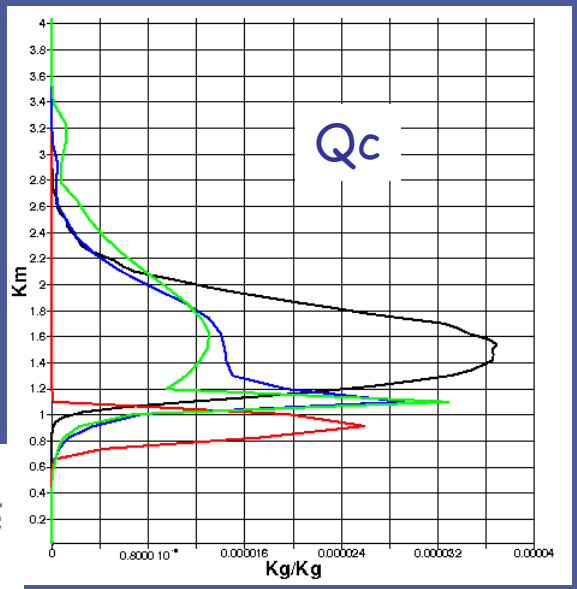


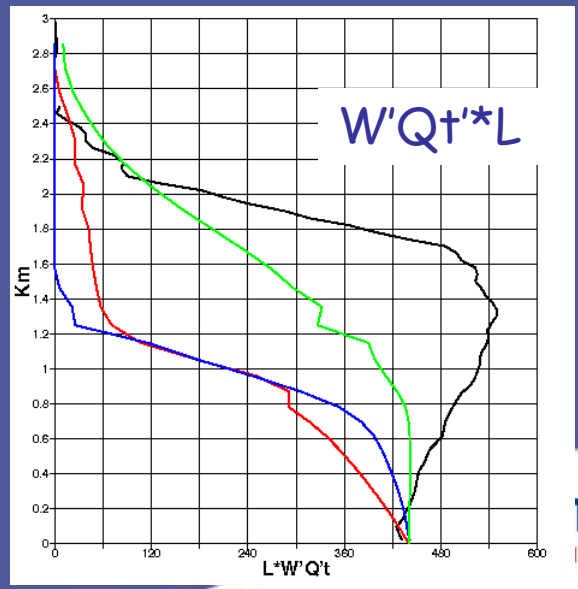
EUROCS/CUM (ARM) 40L below 4000m dt=240s Fc +8h-9h





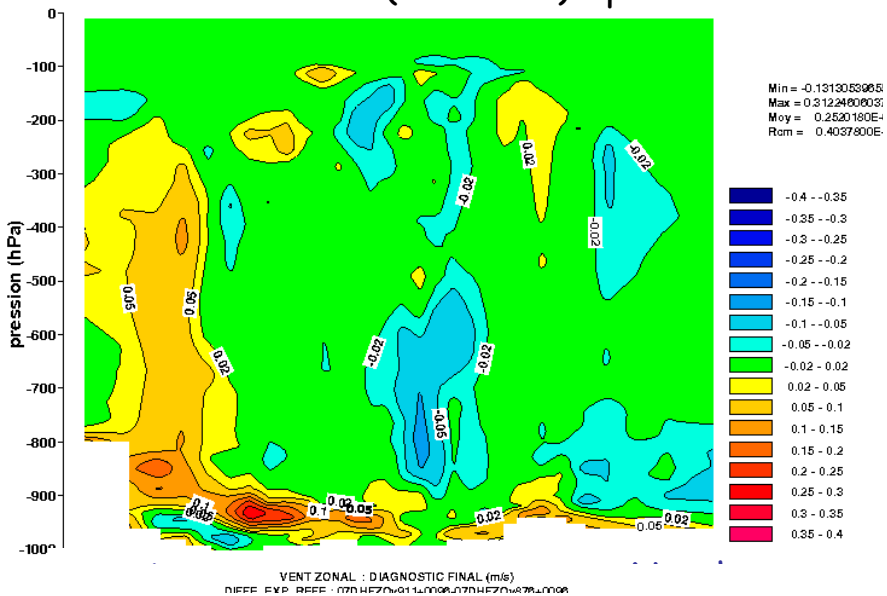




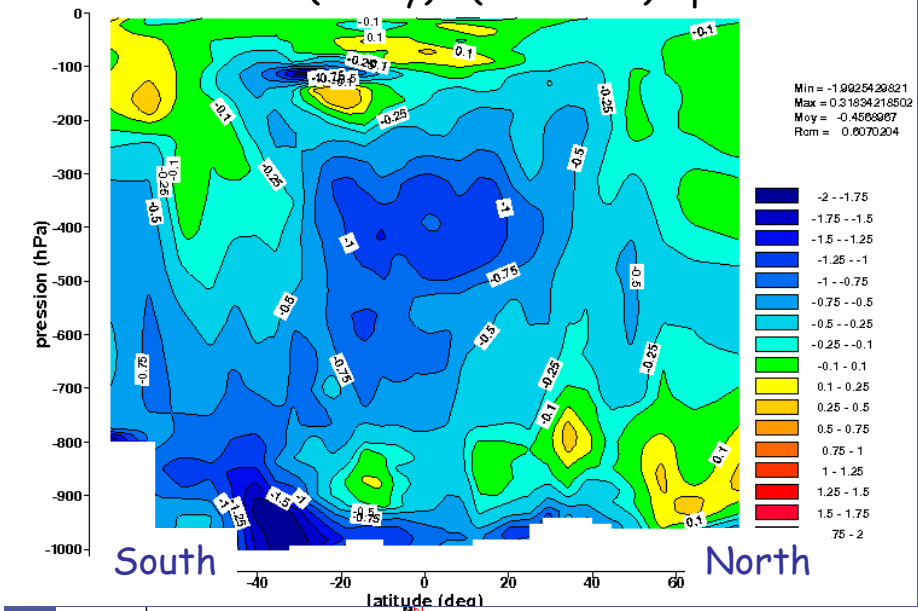


3D Experiment

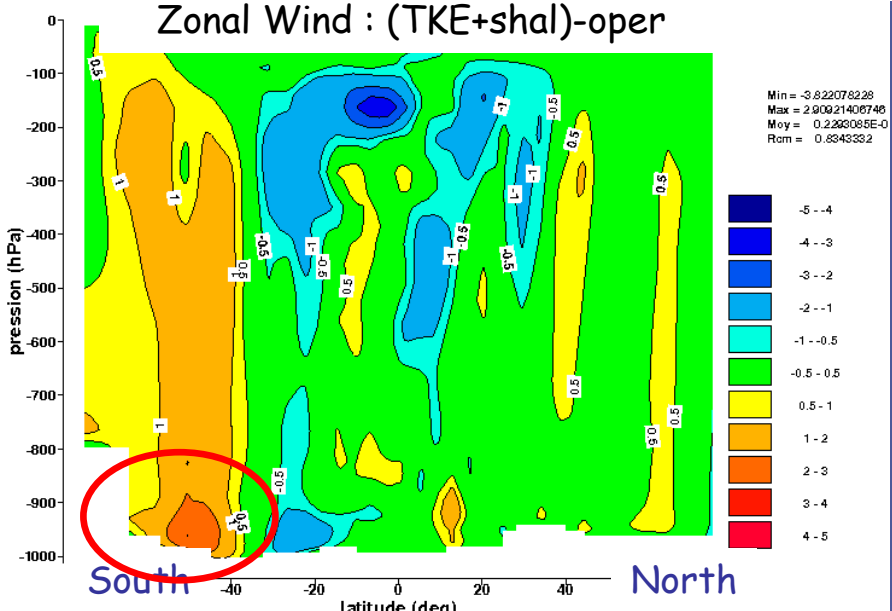
Cloud Cover: (TKE+shal)-oper



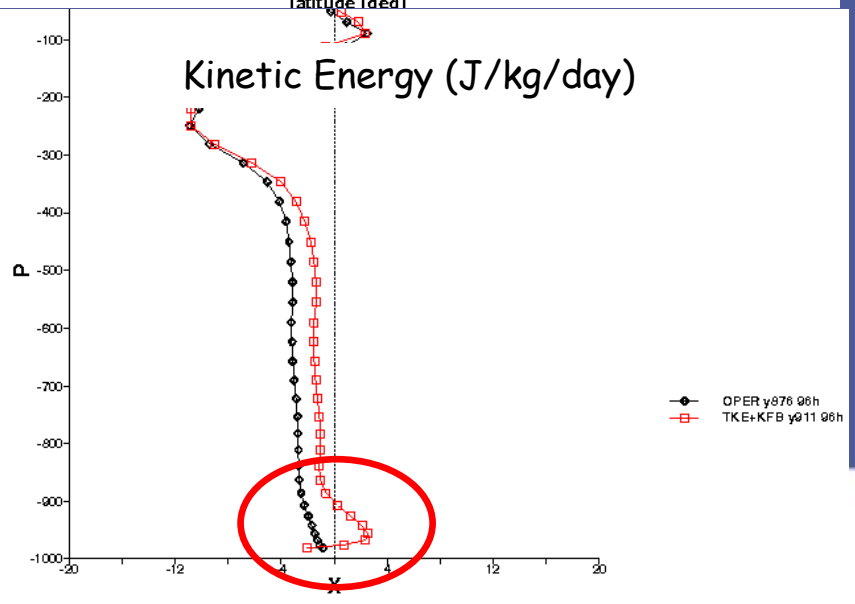
dT/dt (K/day) : (TKE+shal)-oper



Zonal Wind : (TKE+shal)-oper

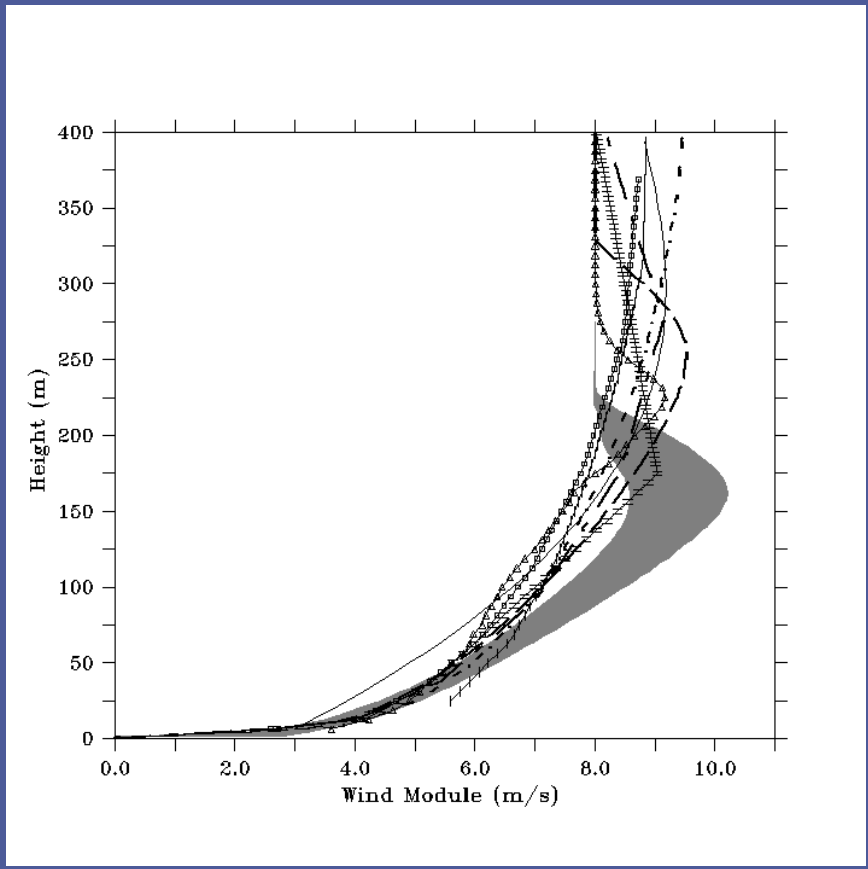


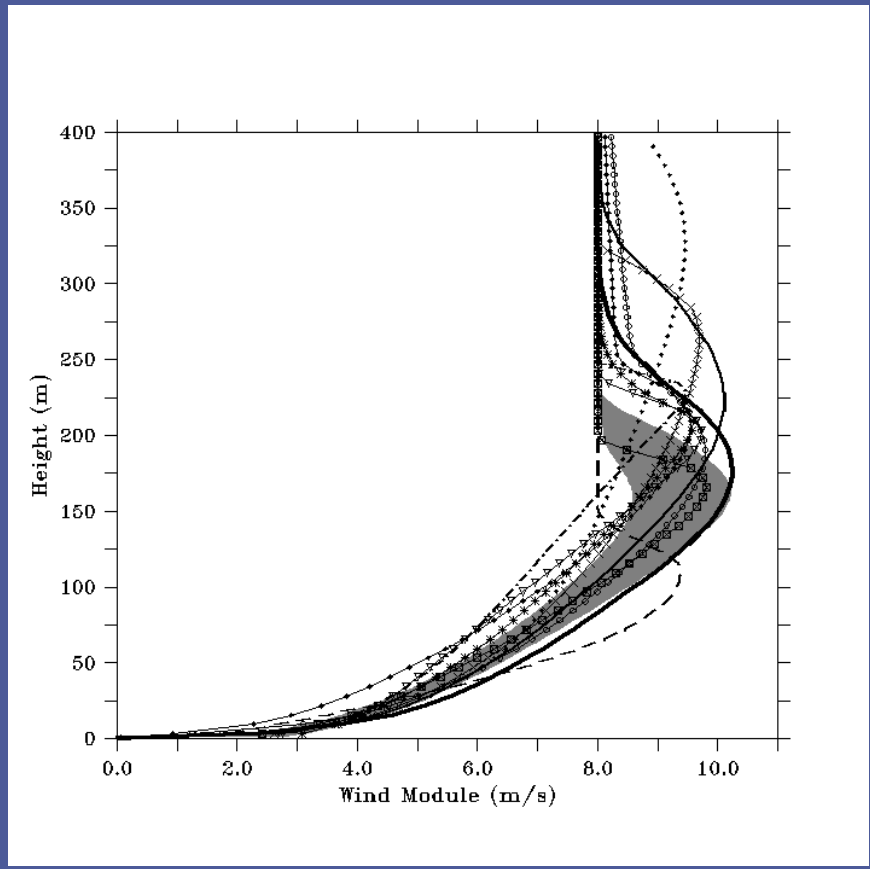
Kinetic Energy (J/kg/day)



3D Experiment

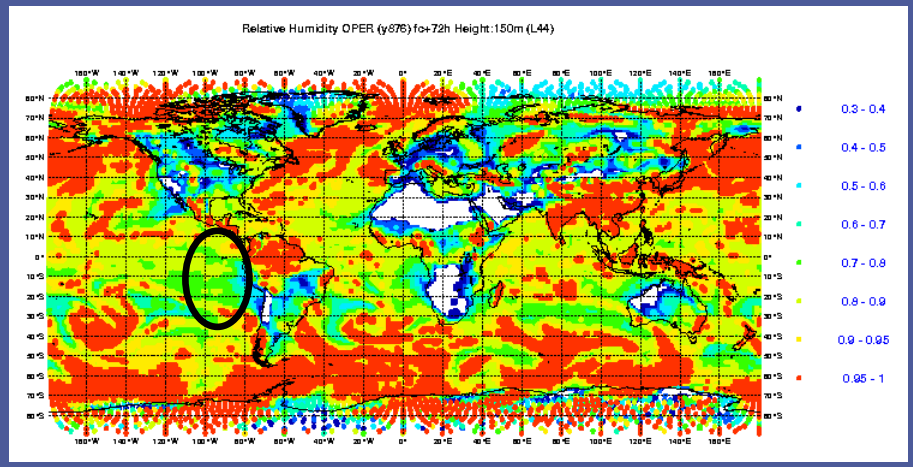
GABLS I Cuxart et al, 2006 BLM



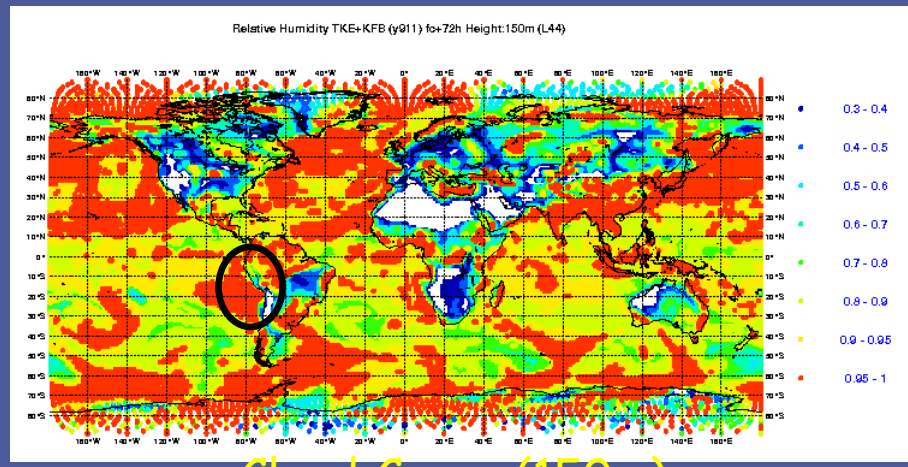


3D Experiment

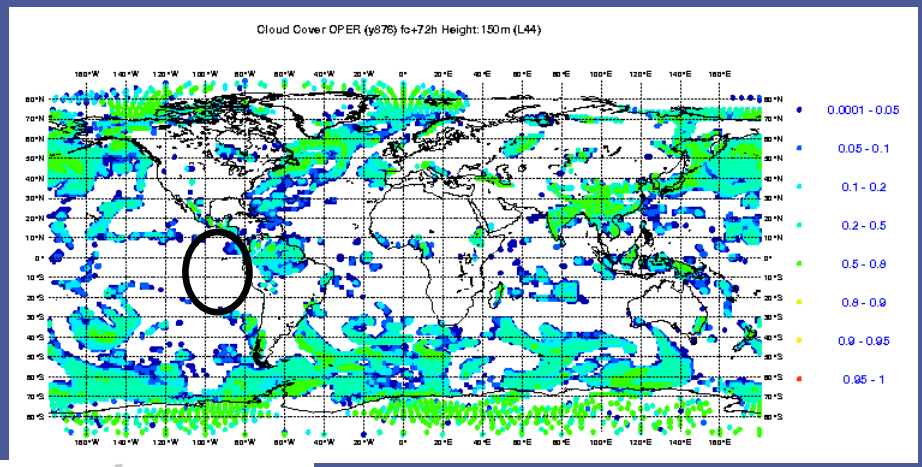
Relative humidity (150m)



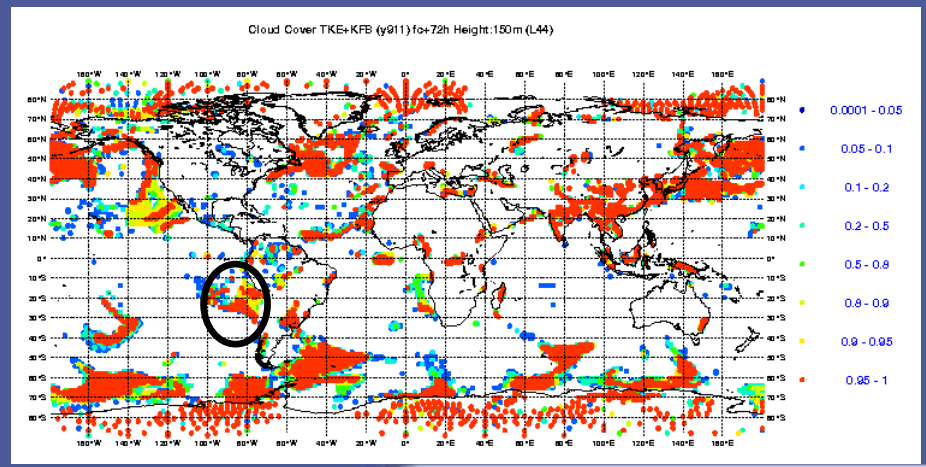
Relative humidity (150m) ver1



Cloud Cover (150m)



Cloud Cover (150m) ver1



Problems …

- Wind in the PBL only in 3D .
  - Winter hemisphere.
  - Related with the stable conditions? With GWD or orography?
- Cloud cover 0 or 1 near the surface (below 300m):
  - shallow convection: not enough active, problem with the trigger function ? (possible solution with the work done by Malardel, Pergaud and Masson)
  - Problem with the pdf function ? Sigma ? Do we need also a Sigma_shallow ? Probably ?

- And the unknown problem … with the first experiment with a 4DVAR assimilation

Perspectives

- Short term :
  - Evaluation of the new shallow scheme of AROME and comparison with KFB in our context: ARPEGE/ALADIN microphysics, time-step, horizontal resolution
  - Other Mixing length ? (Hirlam, CMC …)
  - F0, F1, F2 are very important.
  - Many interactions (mixing length, TKE, cloud cover function of L via sigma) ? Do we need more constraints ?

- Medium and long term:
  - when the short term will be finished !
  - 3MT ? 3MT-FP ? (Piriou's talk)
  - ??

Very shorth term
Dinner 19h30

La Mare aux Canards

17 years of serving home made regional specialities: Magret (duck breast), Cassoulet (a plentiful hot pot of beans with duck, pork and sausage, added with onions and a hint garlic), Foie gras (duck liver). "La Mare aux Canards" is situated near by the "Place du Capitole". Dishes are served in a pleasant and relaxing setting with the necessary professionalism .

MENU

****

DUCK SALAD

*****

PRESERVED DUCK OLD STYLE

or

SLICED DUCK BREAST and GREEN PEPPER SAUCE

or

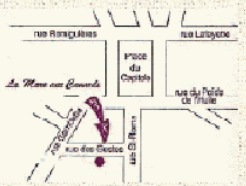
HOME MADE CASSOULET with CONFIT

or

SALMON with SORREL

*****

PEAR CHARLOTTE in red berries sauce



LA MARE AUX CANARDS
14, rue des Gestes 31000 TOULOUSE
Tél: 05.61.23.81.58 Fax: 05.61.63.82.69

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@ J.M. Piriou