Status of the TKE and the shallow convection scheme in the MF's models

E. Bazile
Y. Bouteloup, F. Bouyssel, S. Malardel and P. Marquet

ALADIN/HIRLAM 18th Workshop/All Staff Meeting
7-10 April, 2008 Brussels

CENTRE NATIONAL
DE LA RECHERCHE
SCIENTIFIQUE

METEO FRANCE
Toujours un temps d'avance

Context

· PBL parameterization : Louis (79) with a modified Ri for the shallow convection (Geleyn, 87) ➔ PBL is too dry, excess of mixing, fibrillation …

· GAME perspectives : Convergence for the physical parameterization between   ARPEGE/ALADIN NWP and ARPEGE-Climat.

· AROME project= ALADIN NH + Méso-NH physics with LBC from ALADIN-MF

· For the PBL: TKE scheme (based on CBR 2000) and the shallow convection scheme from AROME in ARPEGE/ALADIN NWP and in ARPEGE-Climat

· Advantages : share the problem. **Better consistency between AROME and ALADIN for the PBL**

· But more validations at various scales (500 km → 2.5 km), time-step (1800s – 60s), global budget, 1D comparison (Sodankyla, Cabauw etc …), 1D case GABLS, RICO, etc …

Some options in the HAA Galaxy …

	Arpege Aladin/MFoper	Arpege/ Aladin-MF tst	ALARO0	HIRLAM	AROME
Coeff K diffusion	Louis 79	CBR2000 (HL) With CCH02	Louis histo via p-TKE	CBR (HL)	CBR (FL) With CCH02
L Mixing length	Int. HCLA Troen & Mahrt	BL89 or Lenderink & Holtslag	Int. HCLA Ayotte	Lenderink & Holtslag	BL 89
Shallow convection	Modified Ri Geleyn 87	KFB (or EDKF end of 2008)	Geleyn 87 With p-TKE	Straco ou KF	KFB (or EDKF)
Clouds	Smith (90)	f0, f1, f2 Bougeault	Xu & Randall	Sundqvist ou RK	f0, f1, f2 Bougeault
Micro-Physics	Lopez mod ql,qi,qr,qs (PCS)	Lopez mod ql,qi,qr,qs (PCS)	ql,qi,qr,qs (PCS)	Sundqvist or RK	Ice3 5 variables
Convection	Bougeault 85	Bougeault 85 with limits or 3MT-deep (in plan)	3MT-deep	Straco ou KF	No
Ray.	ECMWF	ECMWF	New-Geleyn	Savirjavi	ECMWF

CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE

METEO FRANCE Toujours un temps d'avance

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

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

0.0667 → 0.126

0.16675 → 0.142

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

0.4 → 0.34

0.7 → 0.85

$$\frac{1}{\rho} \frac{\partial}{\partial z} \left(\rho \cdot C_e \cdot l \cdot \sqrt{\overline{e_T}} \cdot \frac{\partial e_T}{\partial z} \right)$$

From Cheng, Canuto, Howard (2002)
JAS 59 pp 1550-1565

CENTRE NATIONAL
DE LA RECHERCHE
SCIENTIFIQUE

METEO FRANCE
Toujours un temps d'avance

RMS WIND 7359 / RS Novembre 2007
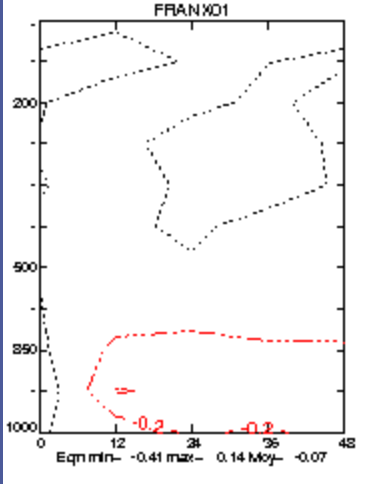
ALADIN 10km TKE+KFB+Lim. Deep Conv. (LDC) (exp=TKB)

TEMPERATURE 7359 / RS Novembre 2007

RMS WIND 737X / RS Novembre 2007
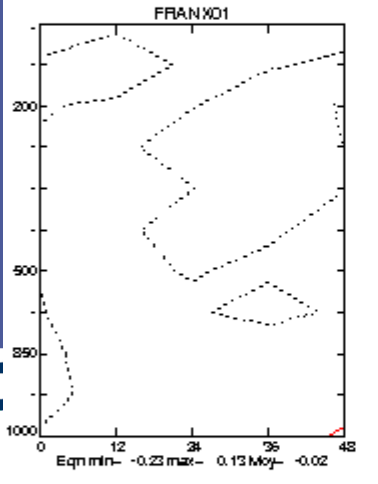
ALADIN 10km TKE+KFB+ LDC with CCH02 (Exp=TKB02)

TEMPERATURE 737X / RS Novembre 2007
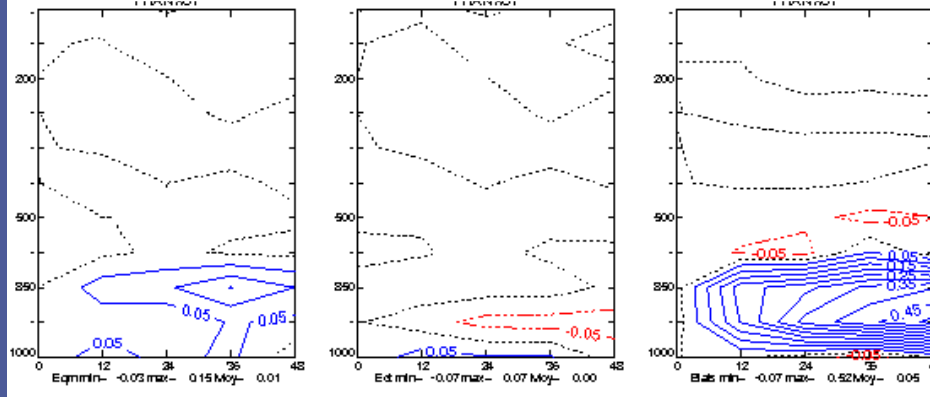
les
les
m1d_oper
m1d_TKE
m1d_TKE_CCH02

MOD_DU_VENT A 9H
ARPEGE/ALADIN

METEO FRANCE
Toujours un temps d'avance

Stability, fibrillation ?

Level 60 : Abs (T1+T9-2T0)
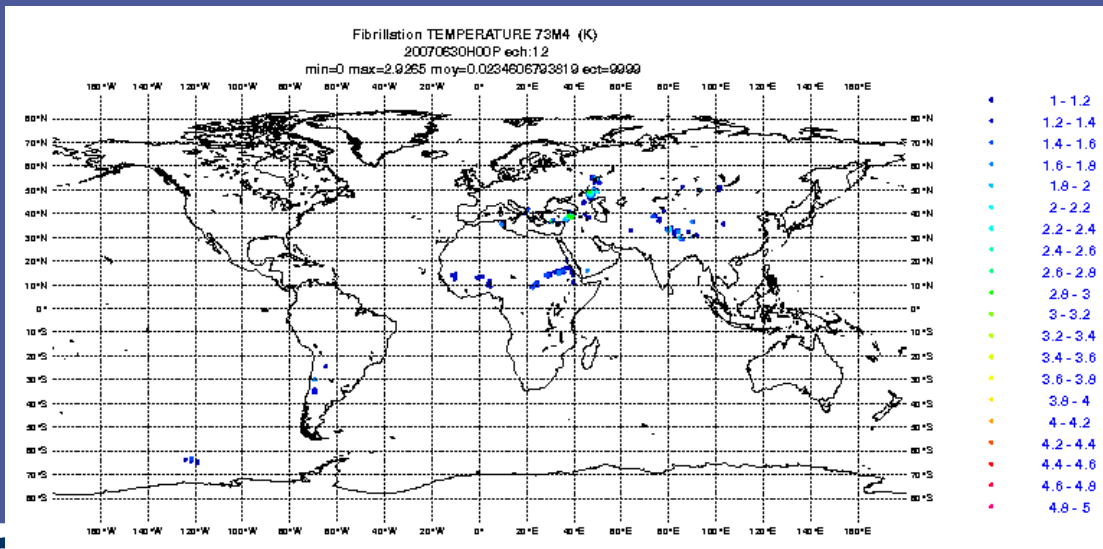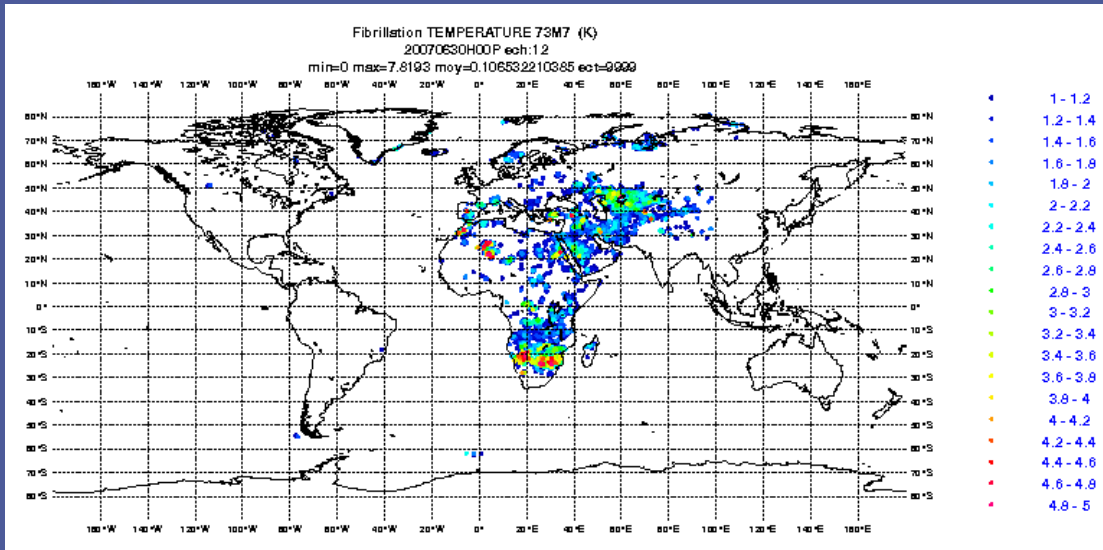
Oper with Louis and anti-fibrillation scheme max=7.8°C Mean=0.1

TKE (without anti-fibrillation scheme)+KFB+LDC Max=2.9°C mean=0.02

Brinkop & Roeckner has been coded and tested by Y. Bouteloup → very small impact→ not used

Courtesy Y. Bouteloup

GPCI : Gewex Pacific Cross-section Intercomparison

Low-level clouds (%), ISCCP, ANN

Higher level clouds (%), ISCCP, ANN

Courtesy Cecile Hannay (NCAR)
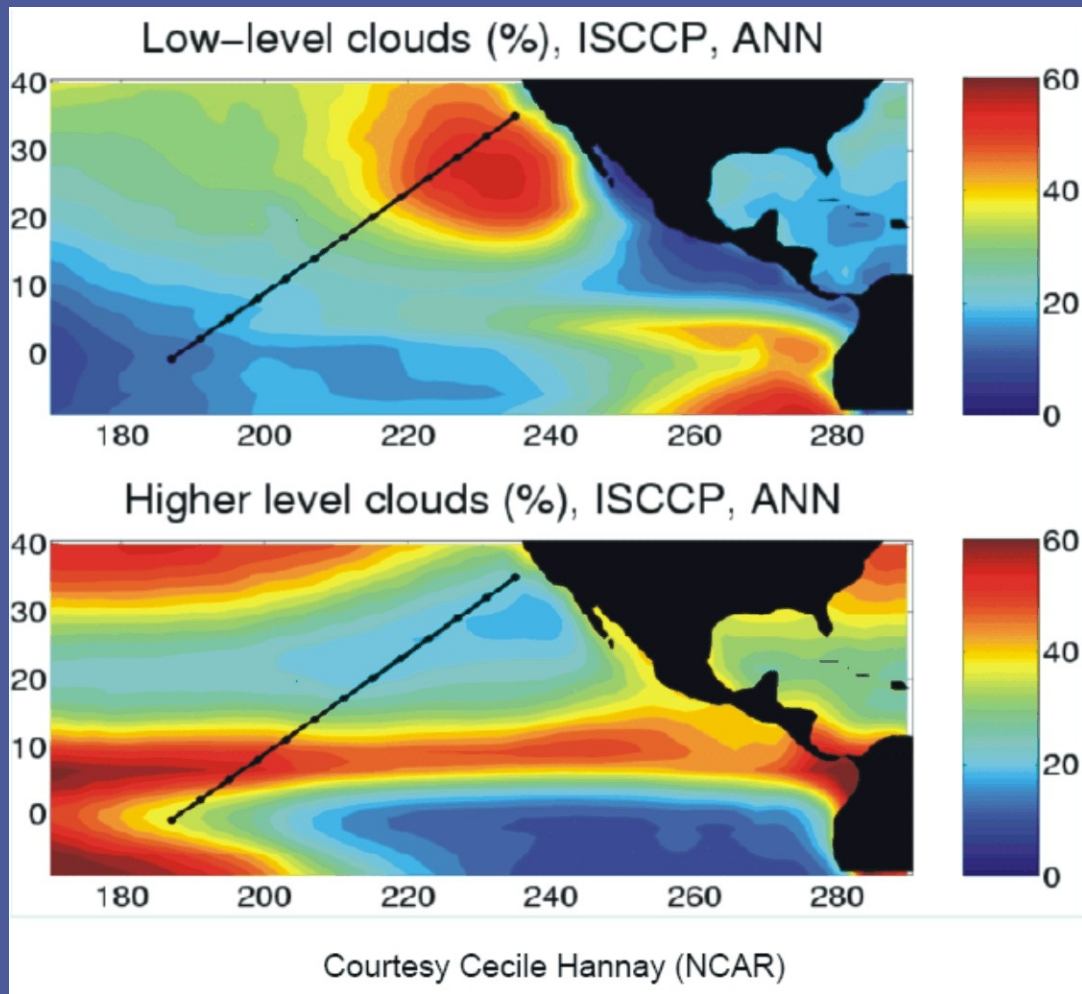
Cross section GCSS : 13 box 4°x3° 1S-173W → 35N125W (mean June 2007 96h-72h)
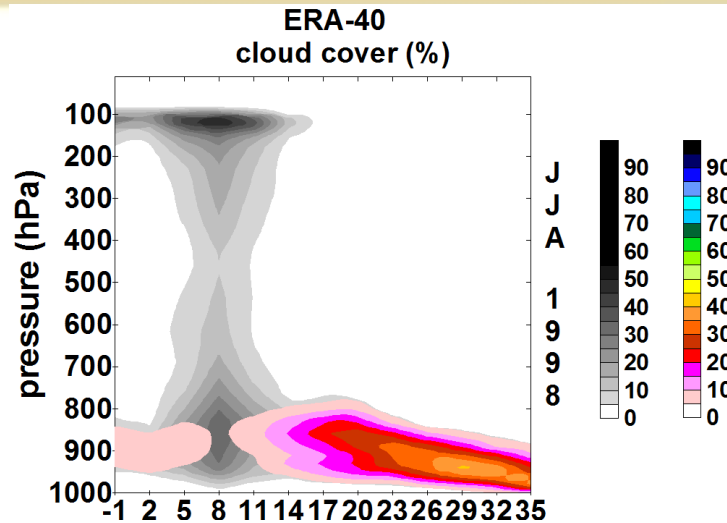
Oper

TKE+KFB+Lim. Deep
Conv (73HE)
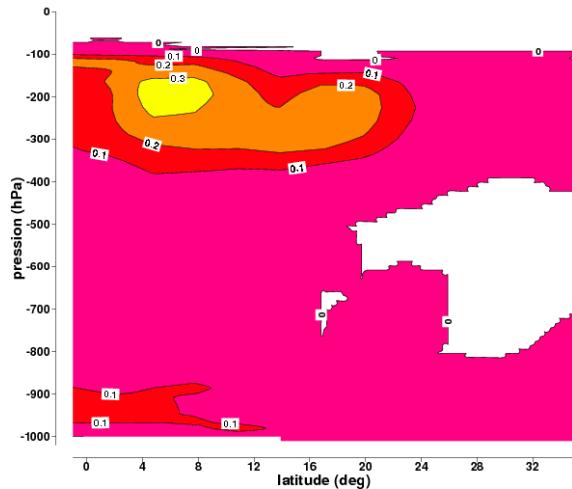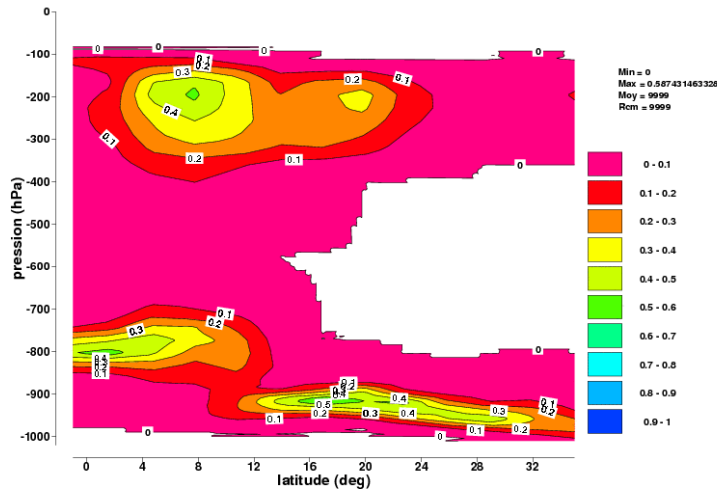
The Top-PBL-entrainment : Grenier (2001) → ARPEGE
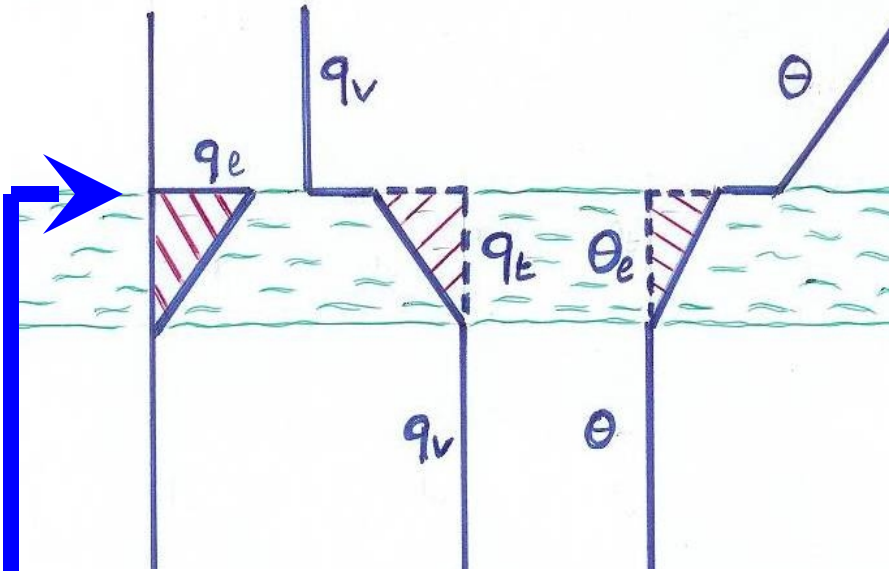
Vertical Diffusion of the
Betts variables : $\theta_{\_l}$ and $q_{\_t}$

Grenier (ARPEGE)

$$\langle e \rangle = z_i^{-1} \int_0^{z_i} e(z) dz$$

$$K_{\text{inversion}} \sim AL\langle e \rangle^{1/2} \frac{\langle e \rangle}{N_i^2 L^2}$$

$$A = A_1 \left(1 + A_2 \frac{Lq_l}{C_p \Delta\theta_{vl}}\right)$$

A_1 and A2 parameter :0.16/100

at this time

Courtesy P. Marquet

Coupe GCSS : 13 boites 4°x3° 1S-173W → 35N125W
(moy juin 2007 sur J4)
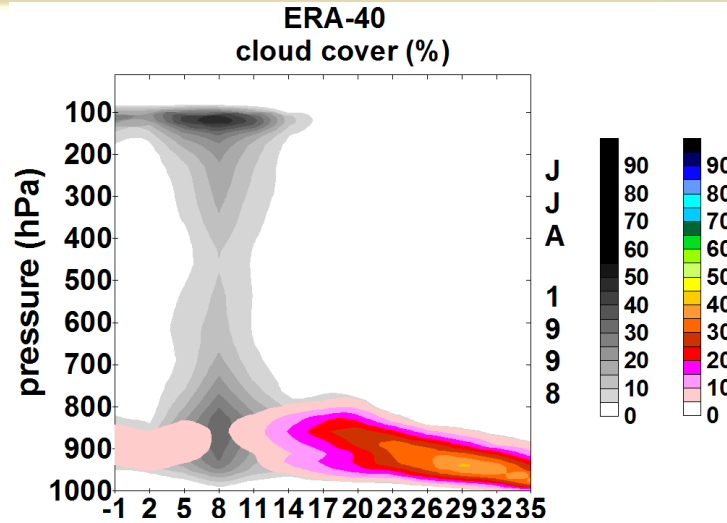
Oper

TKE+KFB+LDC+Top-Entr (73JN)

TKE+KFB+Lim. Deep Conv. (73HE)
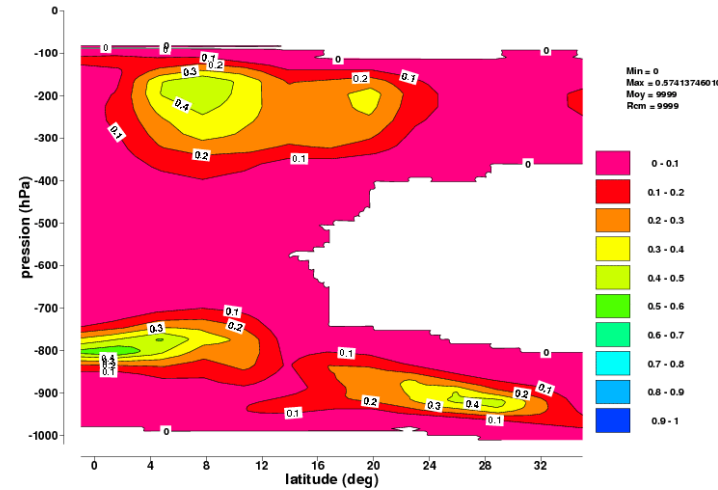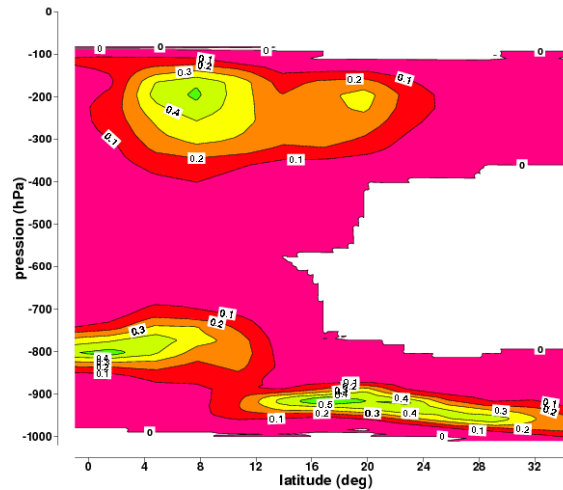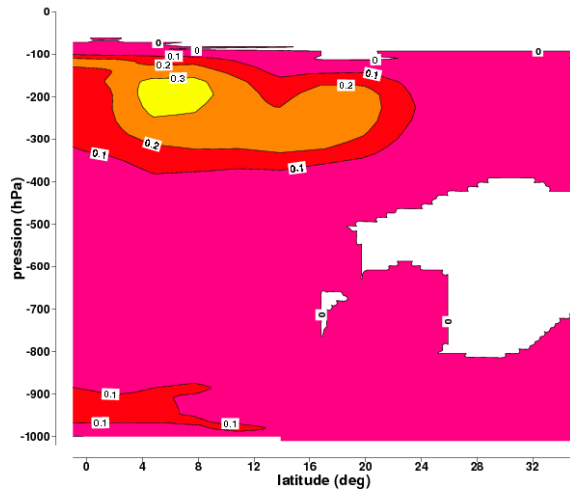
Low clouds June 2007

Oper
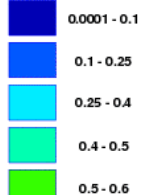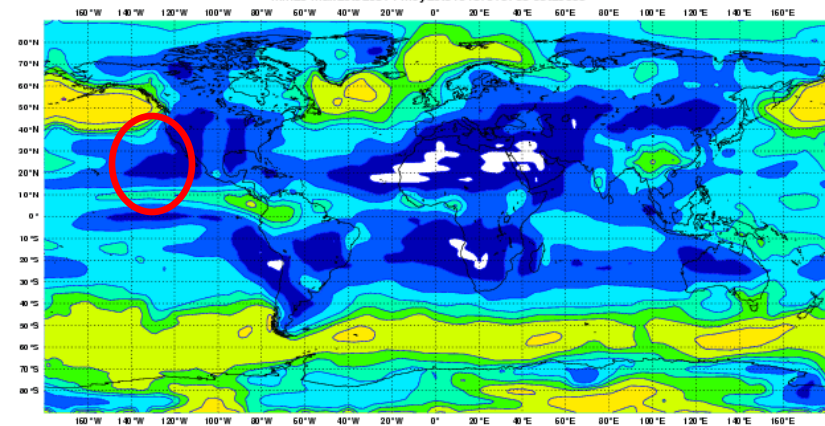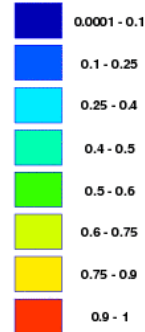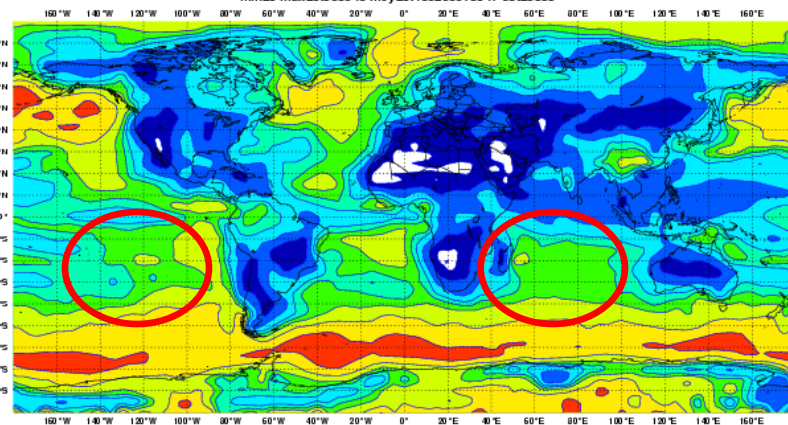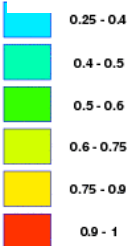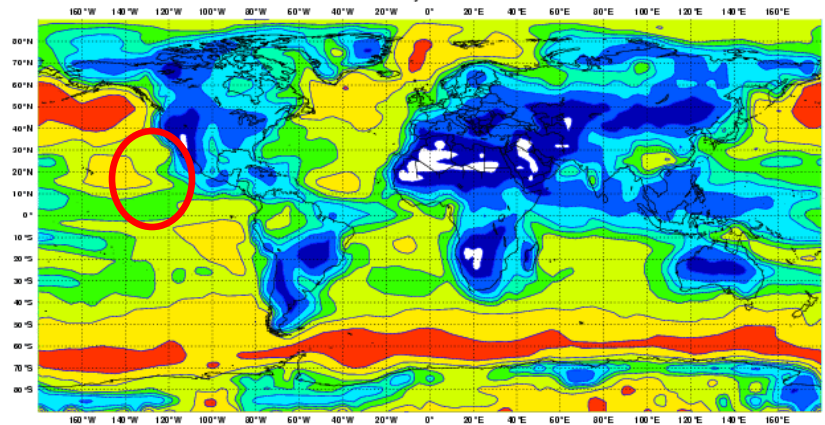
TKE+KFB+LDC+Top Entr

TKE+KFB+LDC

ARPEGE with TKE+KFB+Top Entr+ Limited Deep Conv June 2007
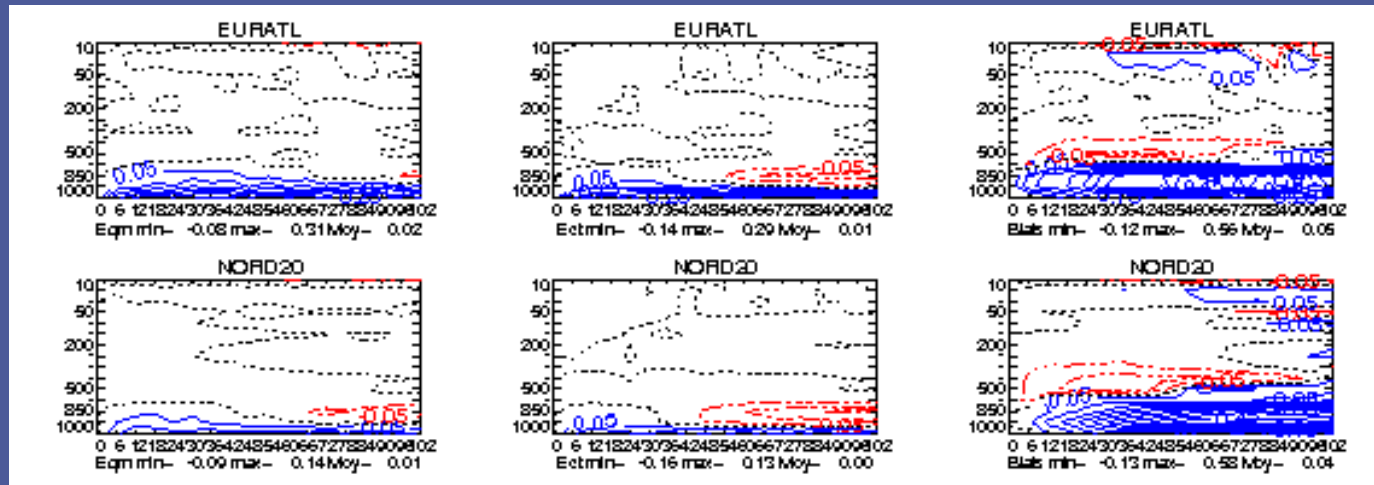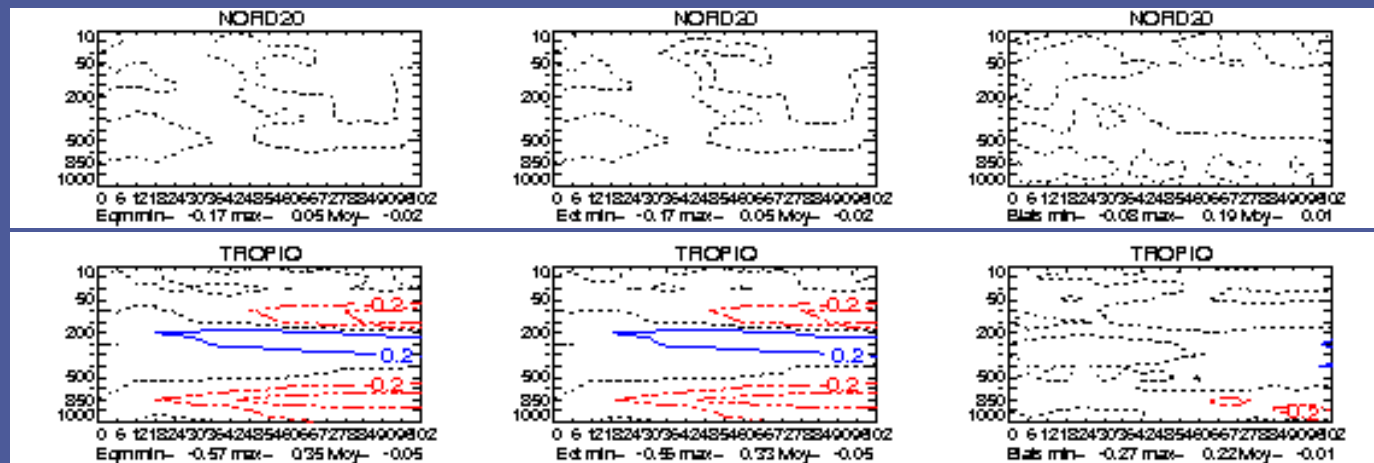
RR 24h (06TU-30TU) over France
June 2007
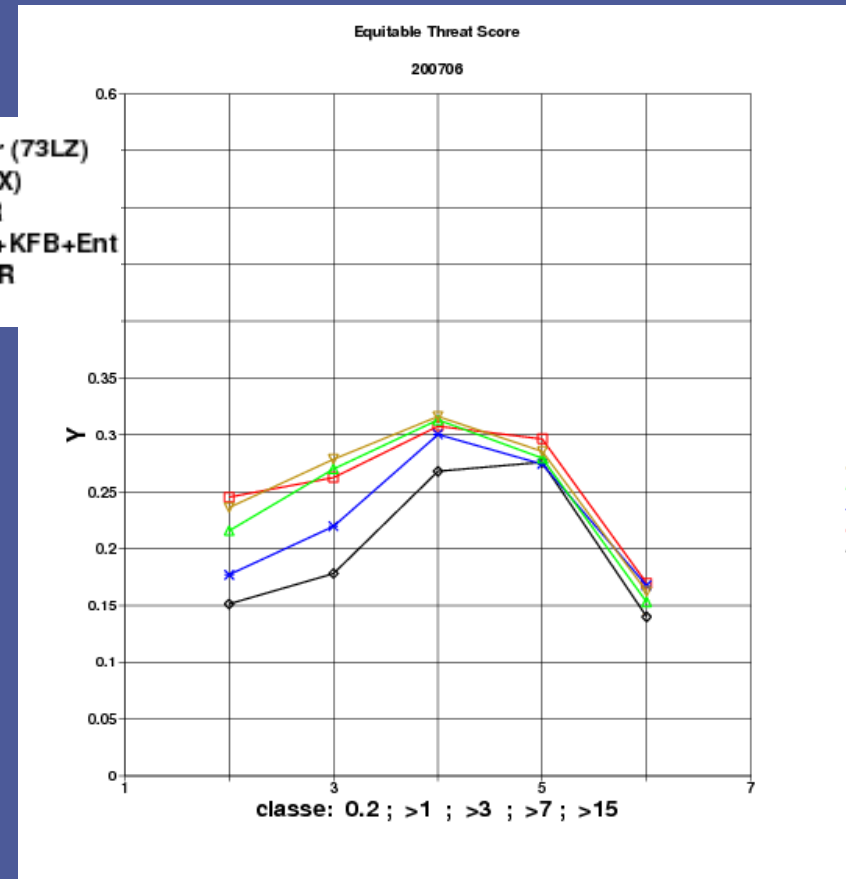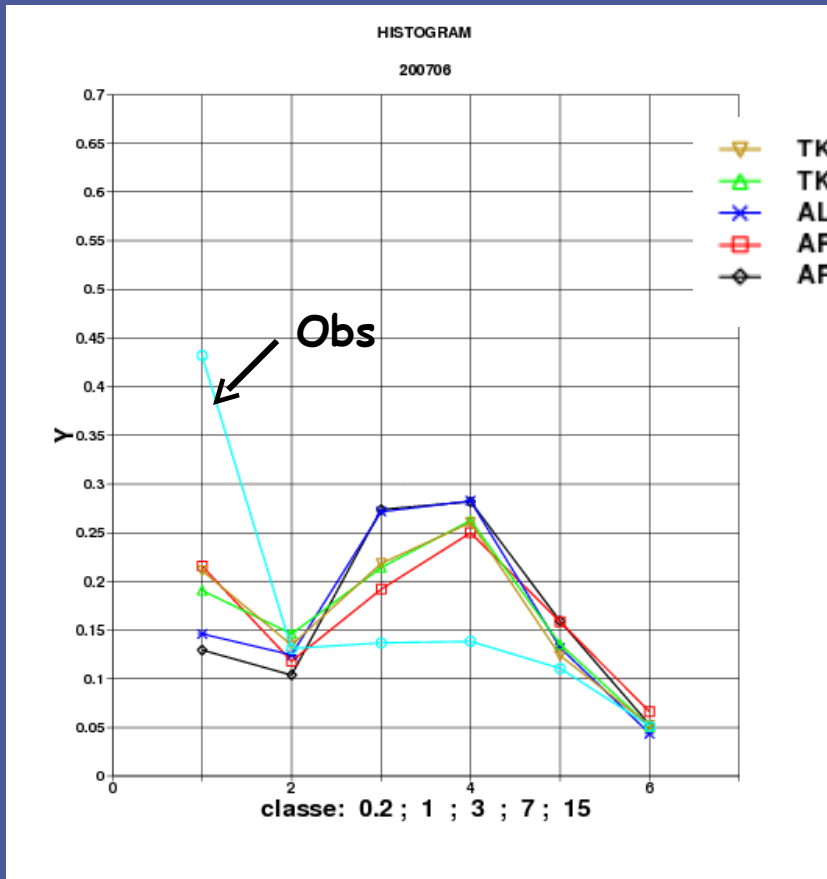

LDC=Deep convection only for clouds
greater than 3000m

27/06/2007 RR 30h-06h
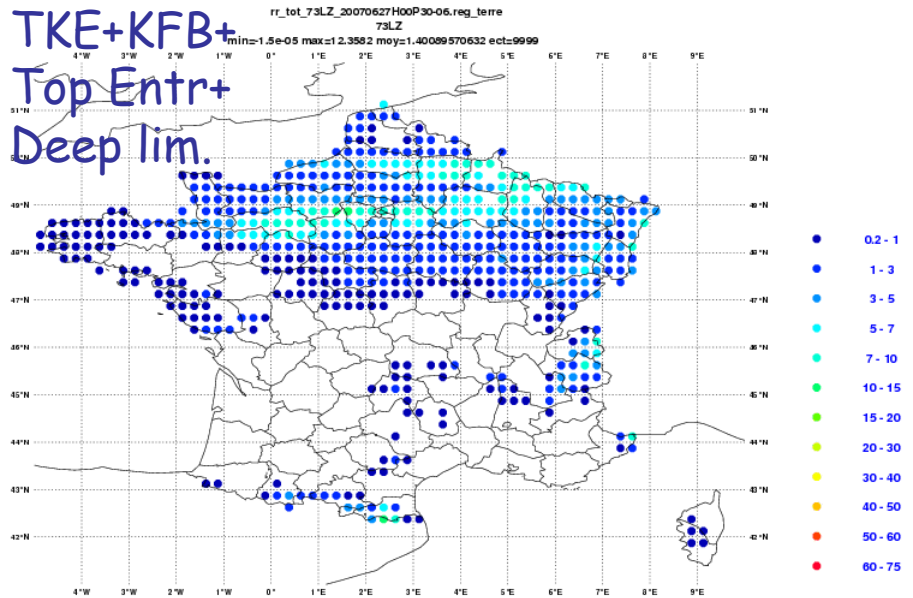

Obs from raingauge
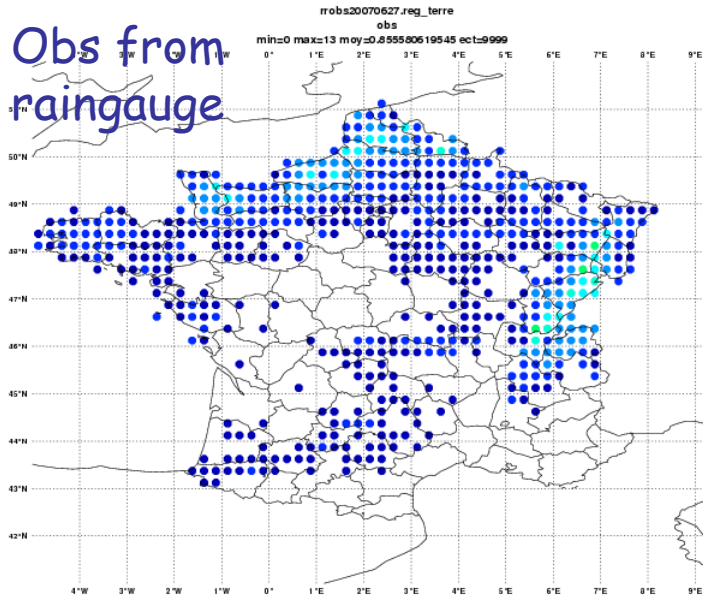
ALADIN-MF Oper
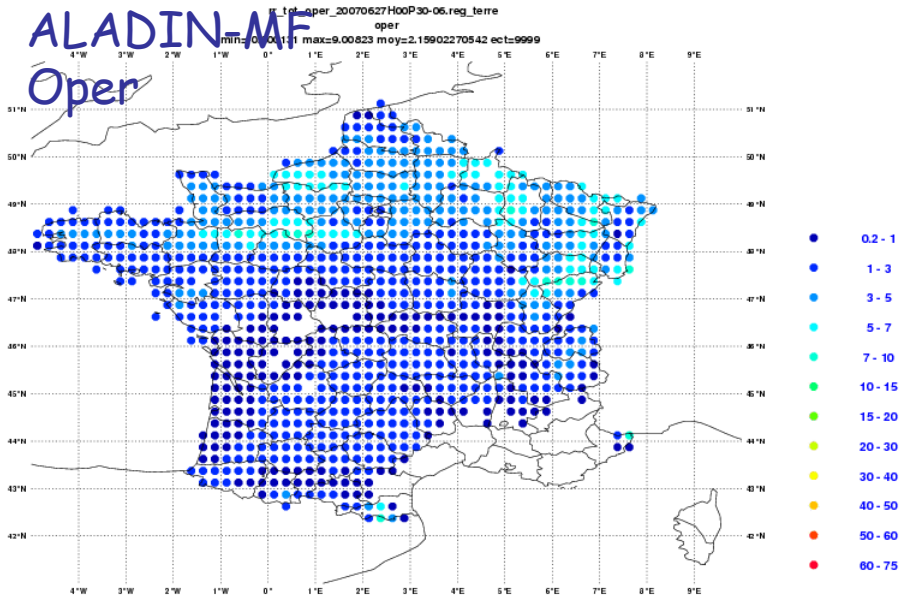
TKE+KFB+ Top Entr+ Deep lim.

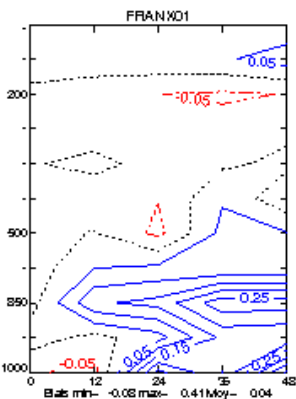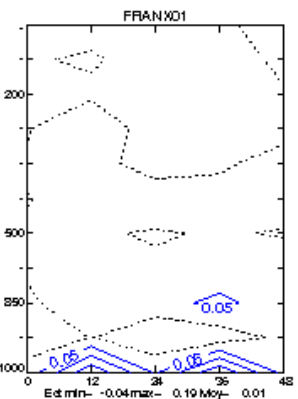# ALADIN-MF/ALADIN+TKE+KFB+Top E.+ Deep Lim
June 2007

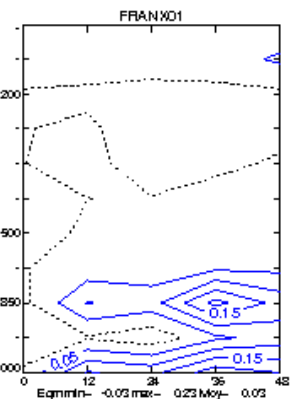# ALADIN-MF/ALADIN+TKE+KFB+Top E.+ Deep Lim
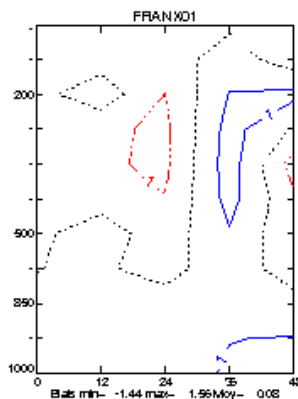## June 2007

Europe Rel. Hum

Europe Wind

France Rel. Hum

France Wind

Conclusions

- **TKE +KFB + Top Entr + Limitation of the Deep Convection: stable, no instability (same time step), no fibrillation or at least very small**

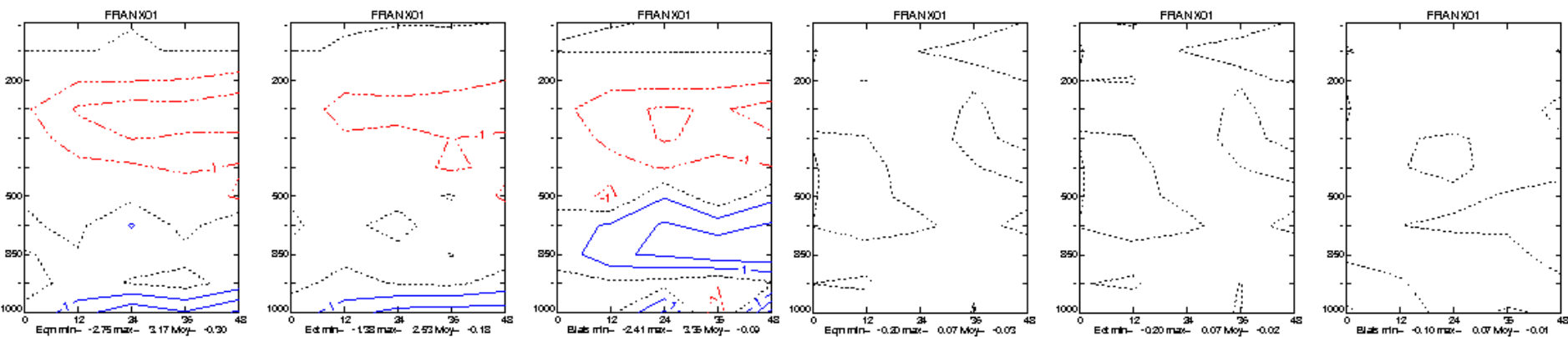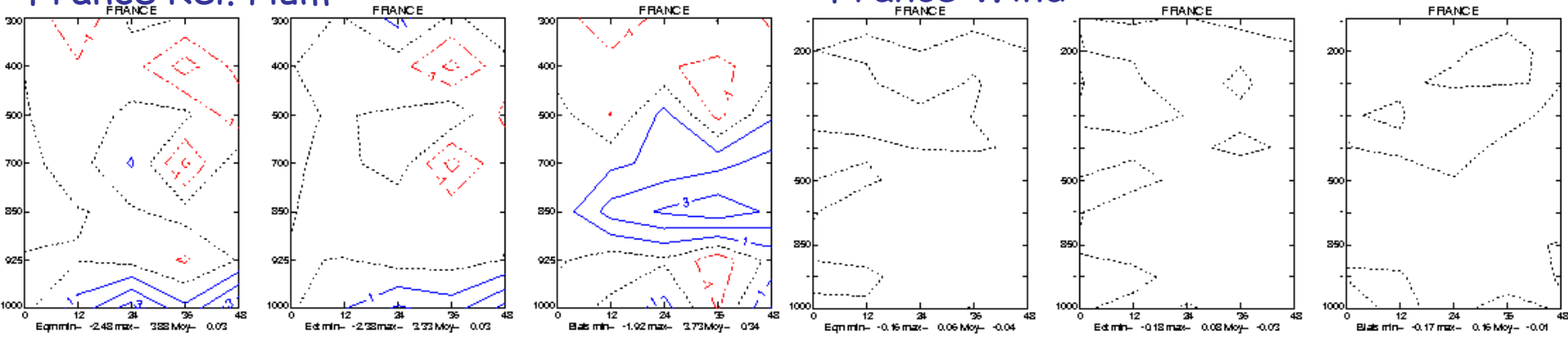- **In cycle 33T0 : ECMWF radiation code is more efficient (R. El Khatib) minus 10% for the total cost compared to the cy32. For a 54h forecast(proc=2):**

> **ALADIN-oper (cy32)   = 4200s,**
> **ALADIN-oper (cy33t1)   = 3780s,**
> **ALADIN+TKE+KFB..(cy33t1) = 4200s,**

> **ALARO-0–3MT (cy33t1) = 4650s to be confirmed**

> **ALARO-0+3MT (cy33t1) = 4750s to be confirmed**

- **Clear improvement of the temperature, the relative humidity in the PBL, precipitation distribution and QPF but there is again a problem for the wind in the tropics**

CENTRE NATIONAL
DE LA RECHERCHE
SCIENTIFIQUE

METEO FRANCE
Toujours un temps d'avance

Perspectives

- Short term: $g/\theta_v \overline{w'\theta_v'}$ TKE thermal production from the shallow convection KFB → impact on the wind on the tropics ?

- EDKF will be available in ARPEGE/ALADIN for evaluation during summer 2008

- Parallel test for the new PBL package before summer 2008 in ARPEGE/ALADIN with an open question for the use of ECUME (less evaporation over sea for strong winds)

- 3MT evaluation in ALADIN will start but before we should probably check carefully APLPAR for the consistency with the new PBL package in particular the link with the PBL clouds.