Developments in large scale physics

Presented by Yves Bouteloup

14th ALADIN Workshop
Innsbruck, 1-4 June 2004

Modifications made in the operational suite

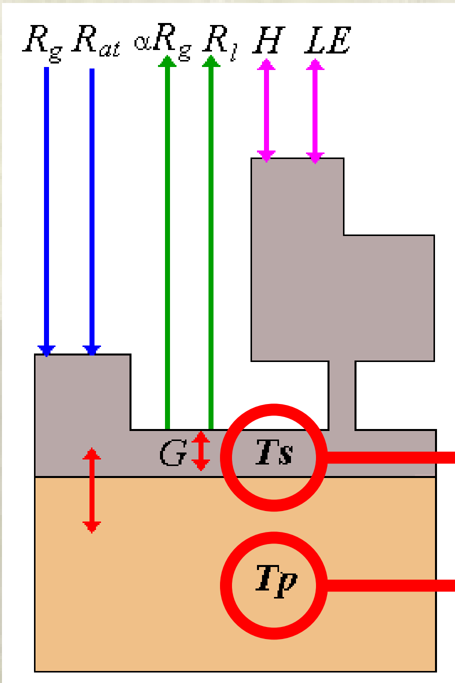
- *Change in the analyse of the soil moisture (over land)*
- *Change in the cloud scheme*
- *New radiation scheme : FMR15*

Presented by F. Bouyssel (Prague 2003)

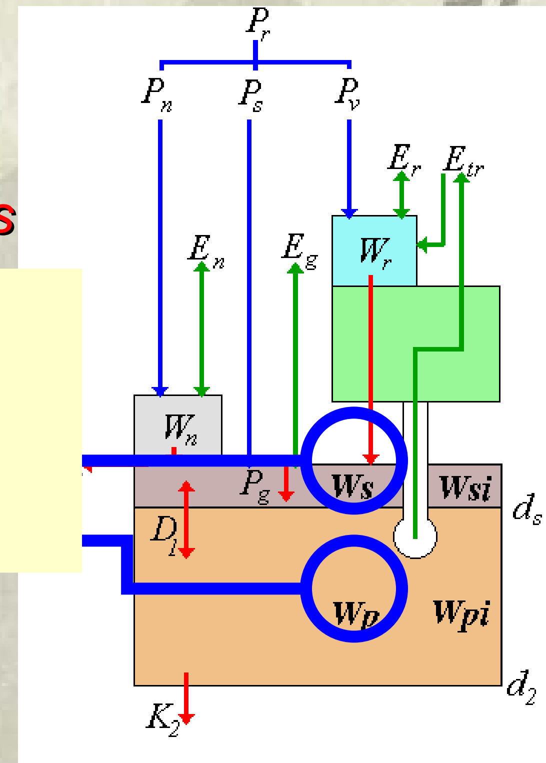
- *Pre-conditioning of second minimization*
- *Modifications without impact on forecasts :*
  - *New surface fields in DDH*
  - *Developments in order to use the new format of NESDIS SST files*
  - *Modifications in the codes for futur use*

Operational surface scheme (ISBA)

Thermal exchange



Hydrous exchange



Analysed parameters

Surface temperature

"Deep" temperature

Surface water contains

Total water contains

- A description of the soil and vegetation's characteristic at any grid point is given by a database (percentage of sand, clay, albedo, fraction of vegetation, foliar index …)

It's very important to have a good initialisation of soil moisture over land

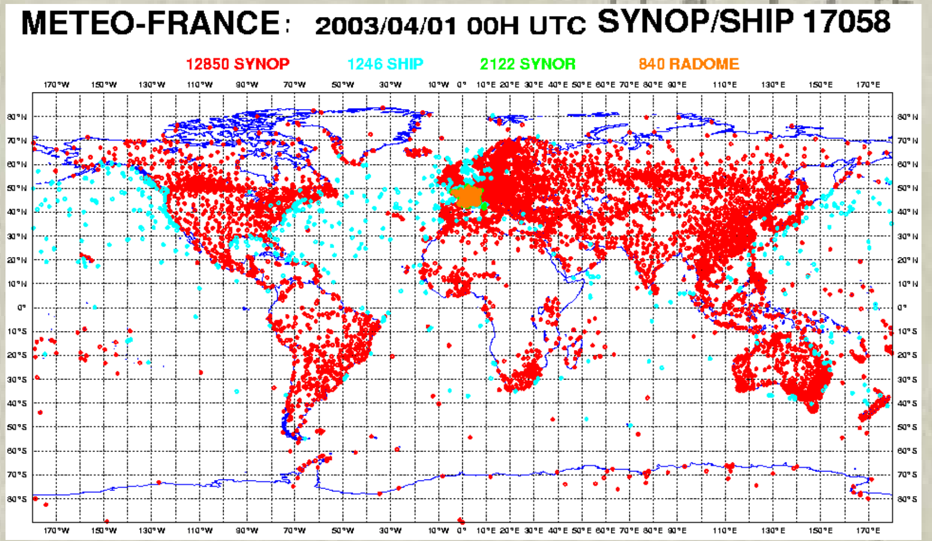
- The soil moisture has a very important impact in the distribution of the net heat surface solar flux between latent heat and sensible heat
- Has a large impact on the evolution of the PBL
- The variation of soil moisture has a time scale of several weeks.

Difficulties of soil moisture analyse :

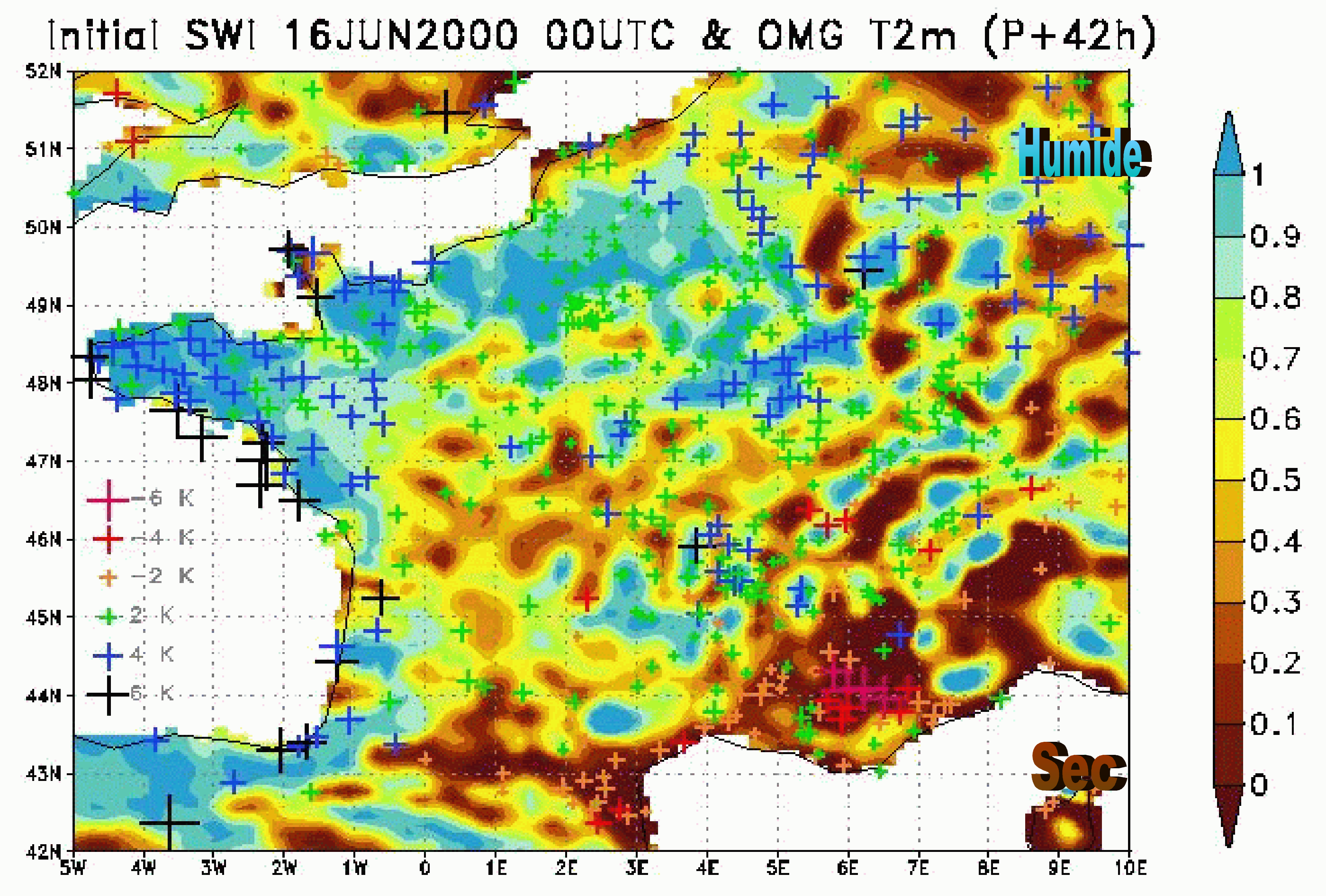
- No direct observation
- Large spatial variability

Useful observations :

- Precipitations (pluvio, radars)
- SYNOP (T2m,H2m)
- Satellite observations (MW,IR)



Correlation between T2m errors and soil moisture for a 42 hours range forecast
17 june 2000 at 18h



Operational surface analyse

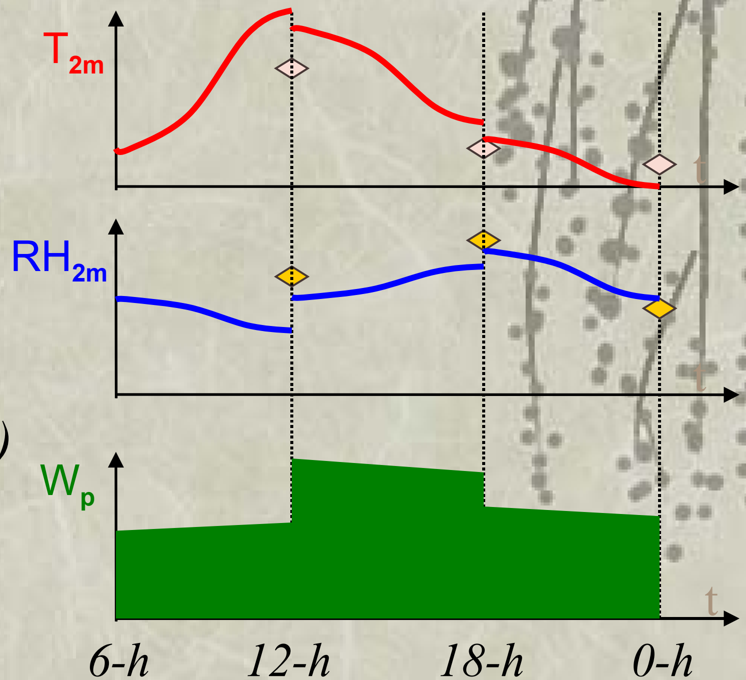
1) First an optimal analyse of T2m et H2m

$$\Delta T_{2m} = T_{2m}{}^{a} - T_{2m}{}^{f} \qquad \Delta RH_{2m} = RH_{2m}{}^{a} - RH_{2m}{}^{f}$$

2) Then correction of the surface variables (T_s, T_p, W_s, W_p) using 2m difference between analyse values and observations.

$$T_s^a - T_s^f = \Delta T_{2m}$$
$$T_p^a - T_p^f = \Delta T_{2m} / \beta$$
$$W_s^a - W_s^f = \alpha_{WsT} \Delta T_{2m} + \alpha_{WsRH} \Delta RH_{2m}$$
$$W_p^a - W_p^f = \alpha_{WpT} \Delta T_{2m} + \alpha_{WpRH} \Delta RH_{2m}$$

$$\alpha_{Wp/sT/RH} = f\,(t, veg, LAI/Rs_{min}, texture, atm.cds.)$$



Modifications introduced in the surface analyse

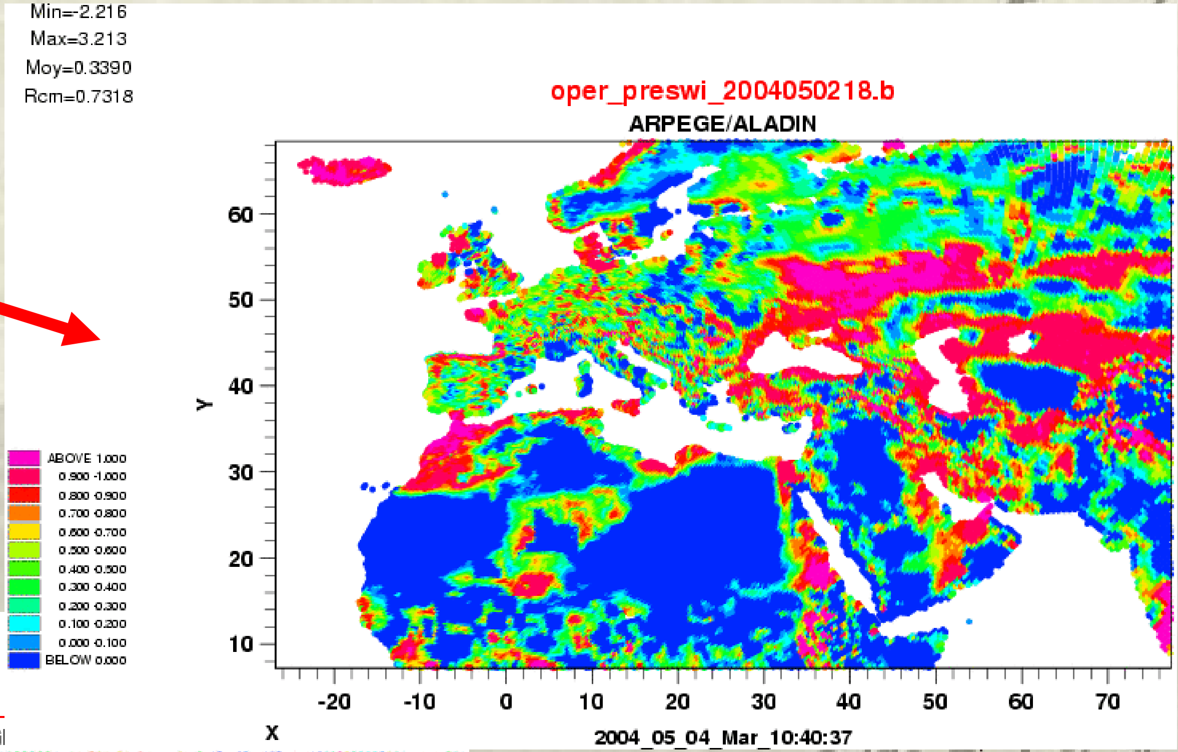
- spatial smoothing of soil wetness index
- new statistical scheme for background error (for 2m fields)
- reduced corrections for deep soil moisture, dividing by 2 the coefficients
- removal of time smoothing
- taken into account of the solar zenithal angle into the optimal coefficients

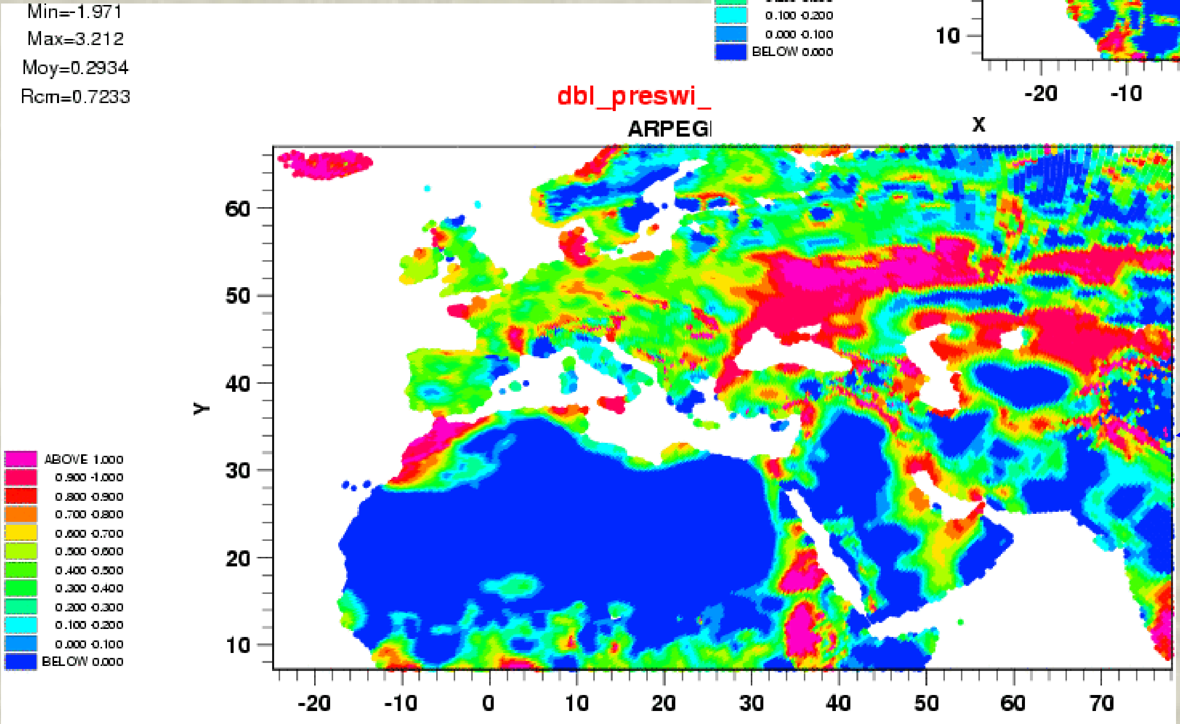
These modifications were proposed along last years by Stjepan Ivatek-Sahdan, Agnesz Mika and François Bouyssel (ALADIN Newsletter 21 and 22) and they were evaluated by Adam Dziedzic and François Bouyssel in a cheap assimilation suite along June 2003 (Newsletter 24)

The suite is based on a blending between the modified surface and low-level fields and the large-scale upperair analysis increments from the operational 4d-var assimilation suite.

Soil wetness index for 2 may 2004

OPER





DBL

Modifications of the soil moisture analyse : impact on the scores

Experiments with a "simplified" assimilation cycle :

* 2 month in summer : 1/5/2003 to 3/7/2003

* 2 month in winter : 1/12/2003 to 3/2/2004

Scores of the surface parameters forecast :

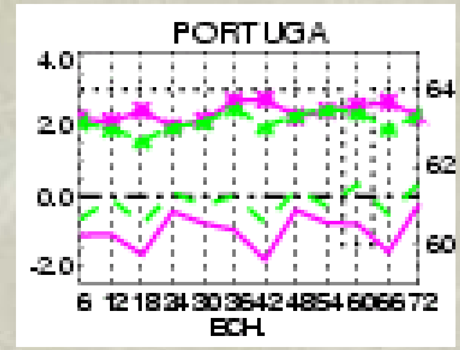
* neutral on 10m wind and surface pressure

* neutral on T2m and H2m in winter

* improvment on T2m and H2m in summer over Europe, neutral elsewhere

Scores SYNOP
16 forecast 96h
15/06/03 to
3/07/03

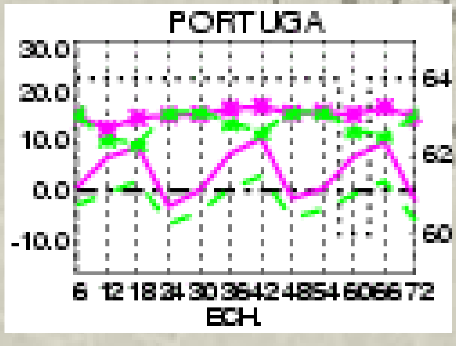
T2m



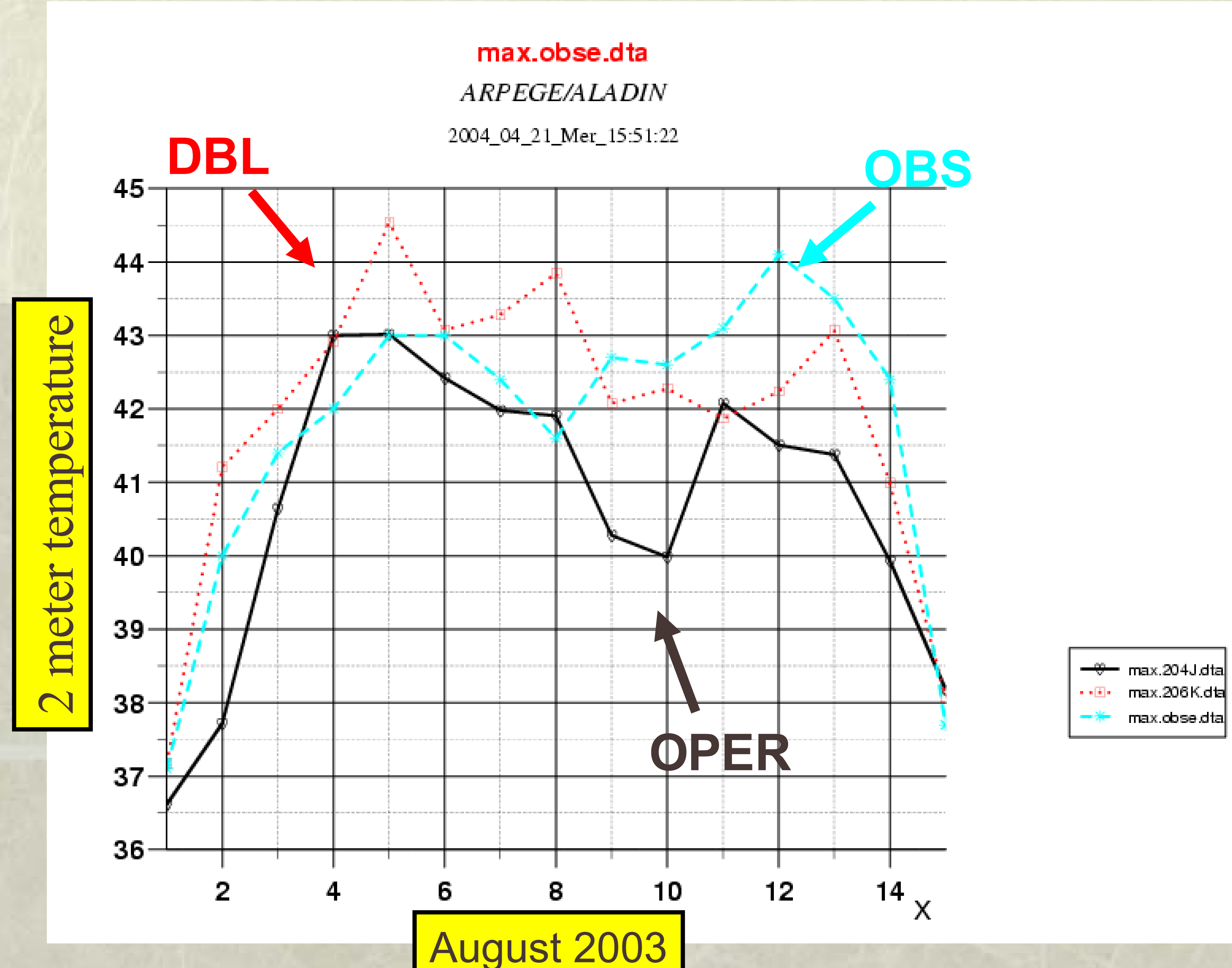
DBL

OPER

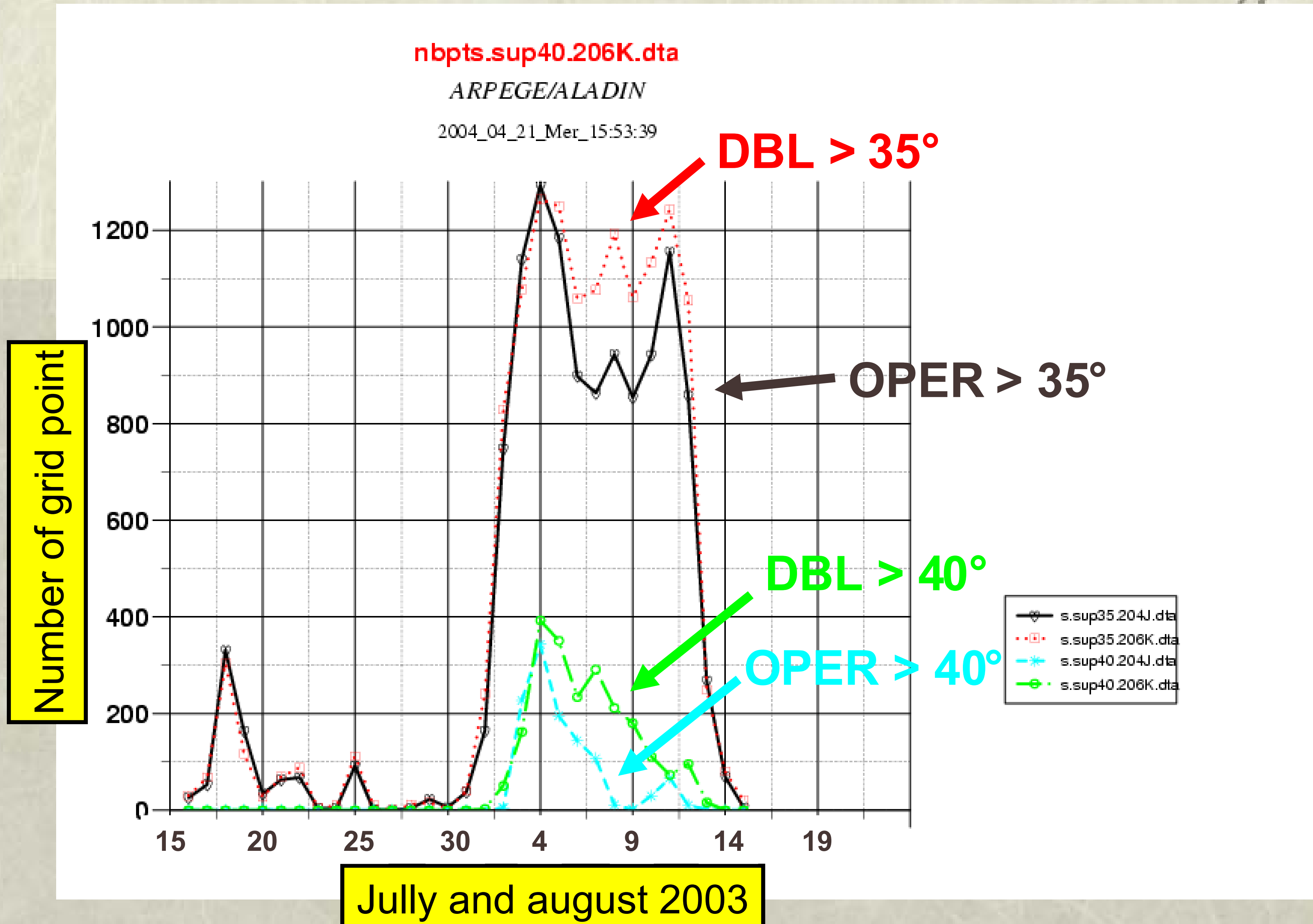
H2m



Behaviour of the double suite during 2003 midsummer heat : Maximum forecast temperature over France

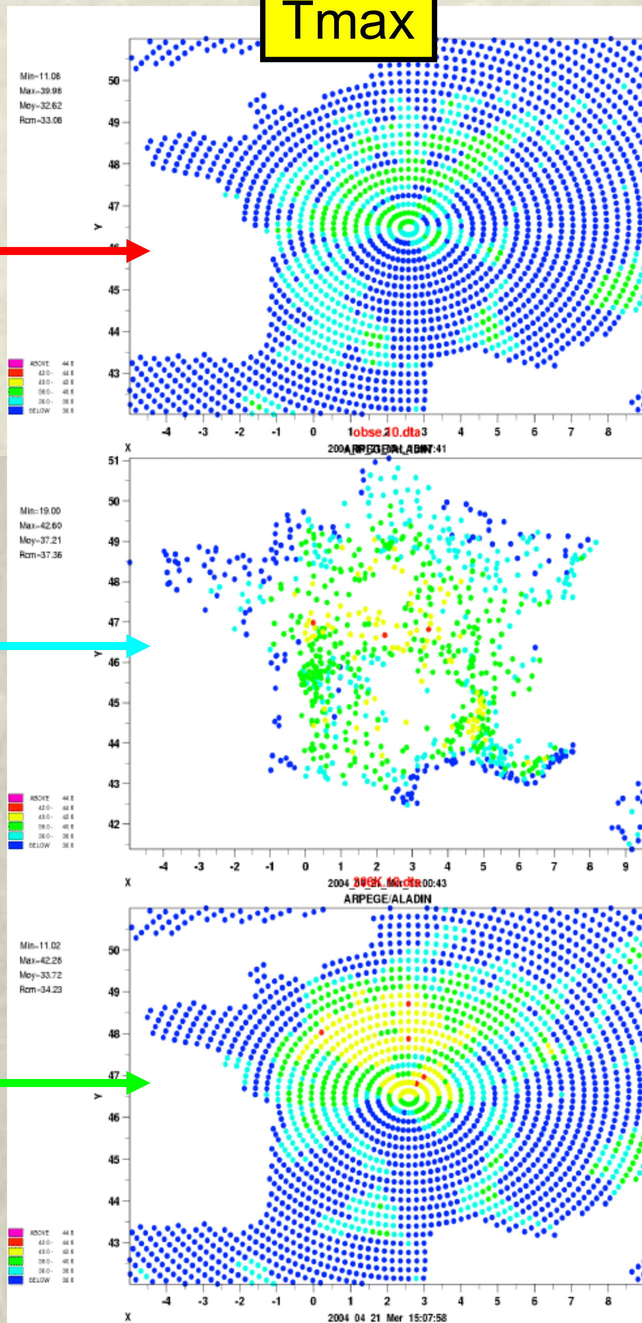


Behaviour of the double suite during 2003 midsummer heat
Number of grid point with Tmax > 35° or 40°



Behaviour of the double suite during 2003 midsummer heat

Tmax

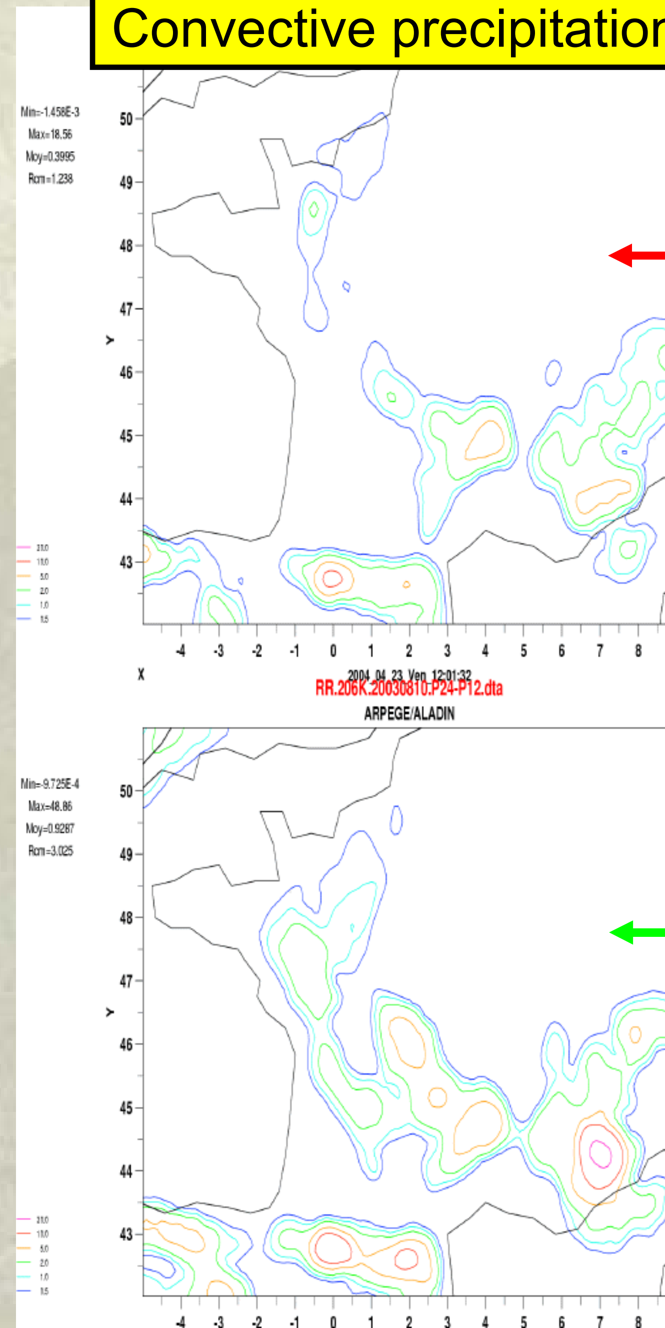


OPER

OBS

DBL

Convective precipitation

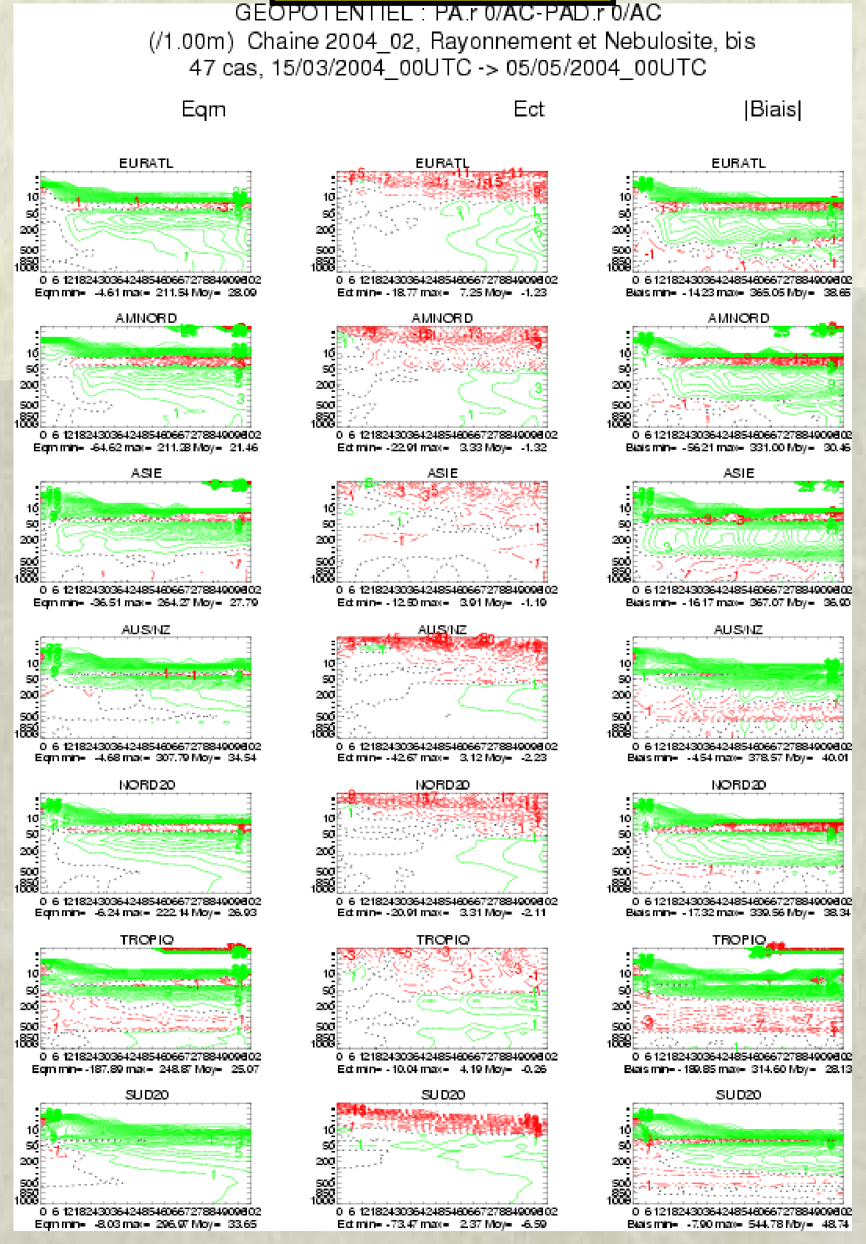


OPER

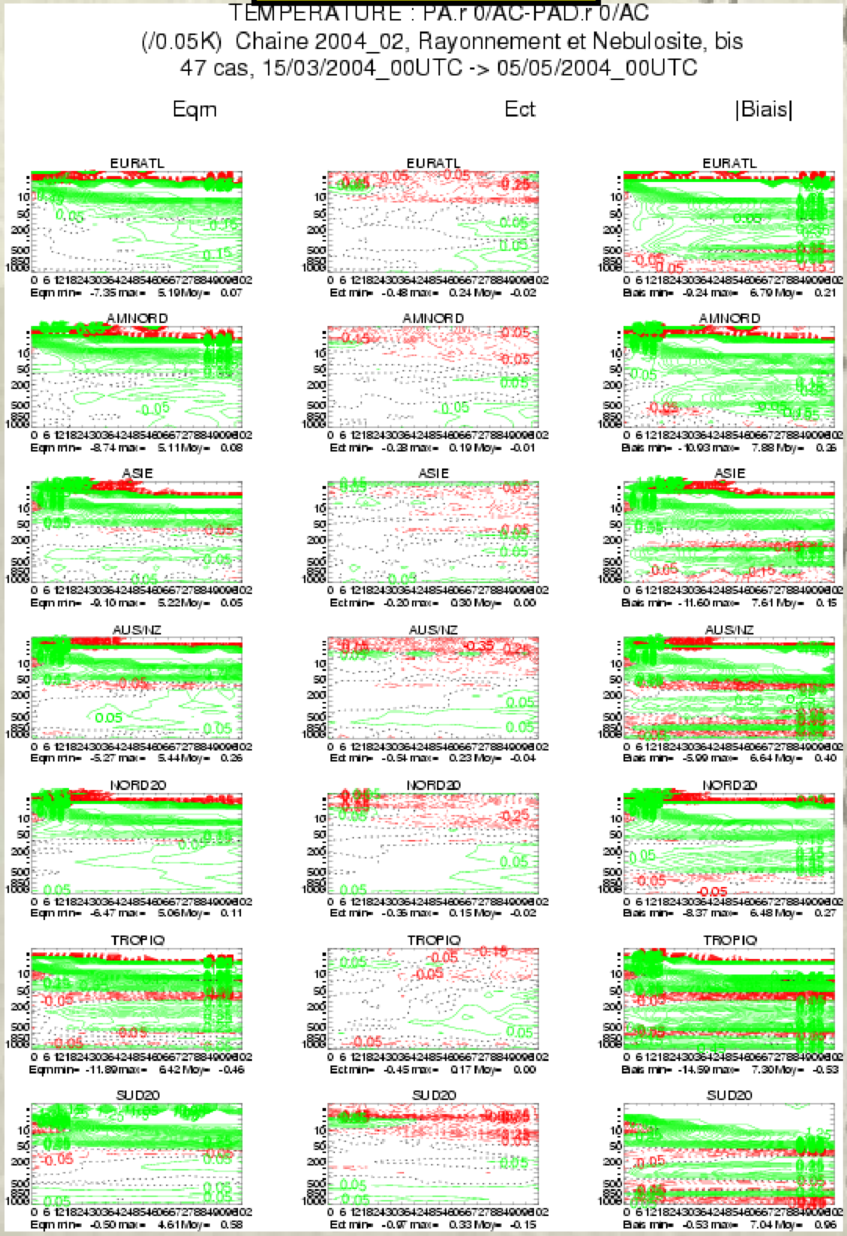
DBL

Scores of the double suite (AC)

Geopotential

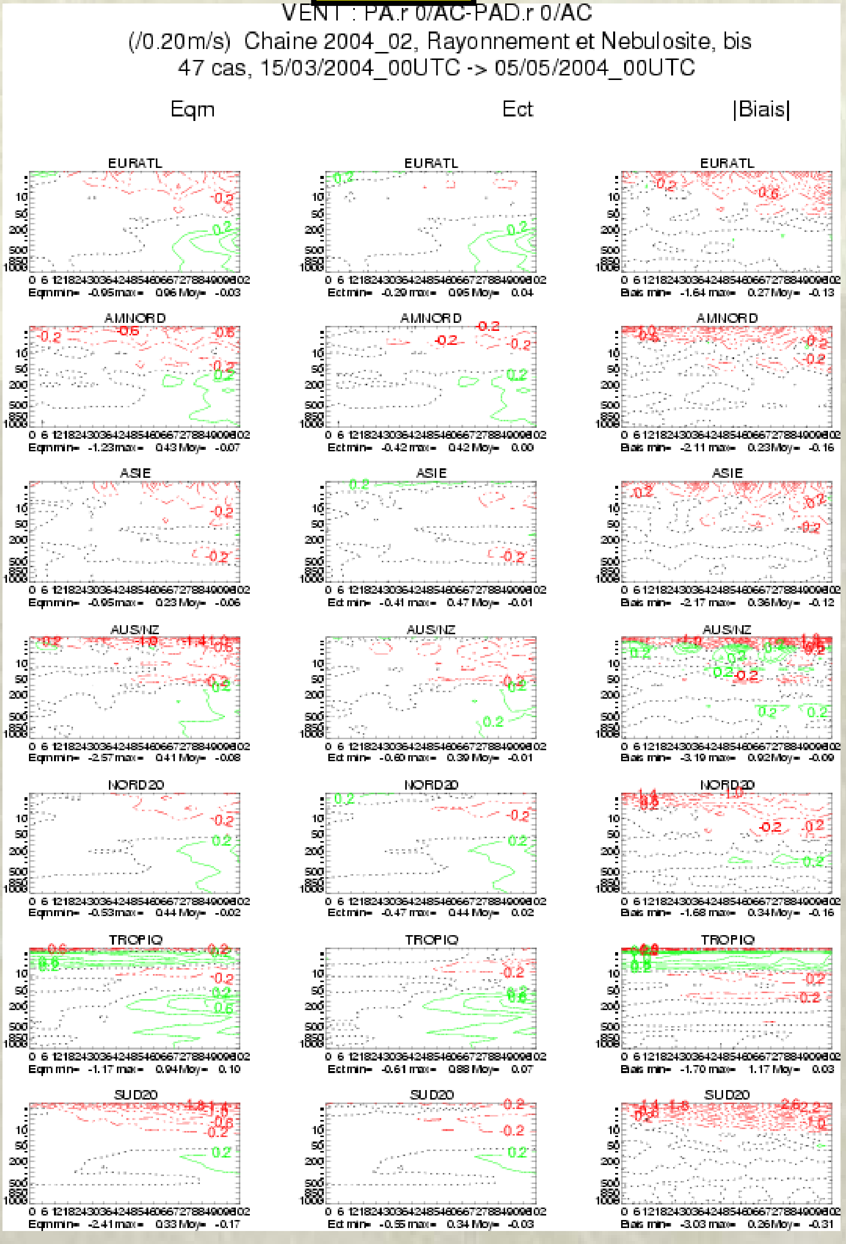


Temperature

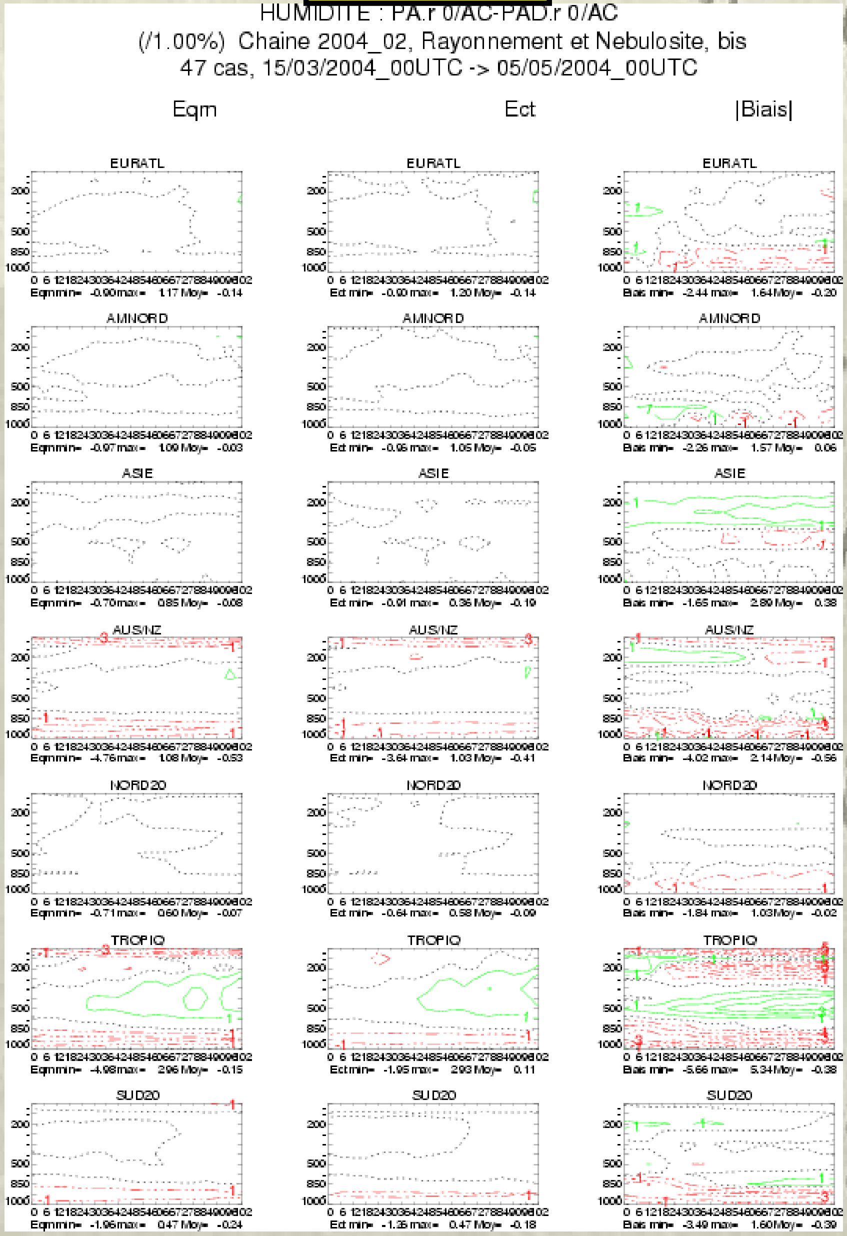


Scores of the double suite (AC)

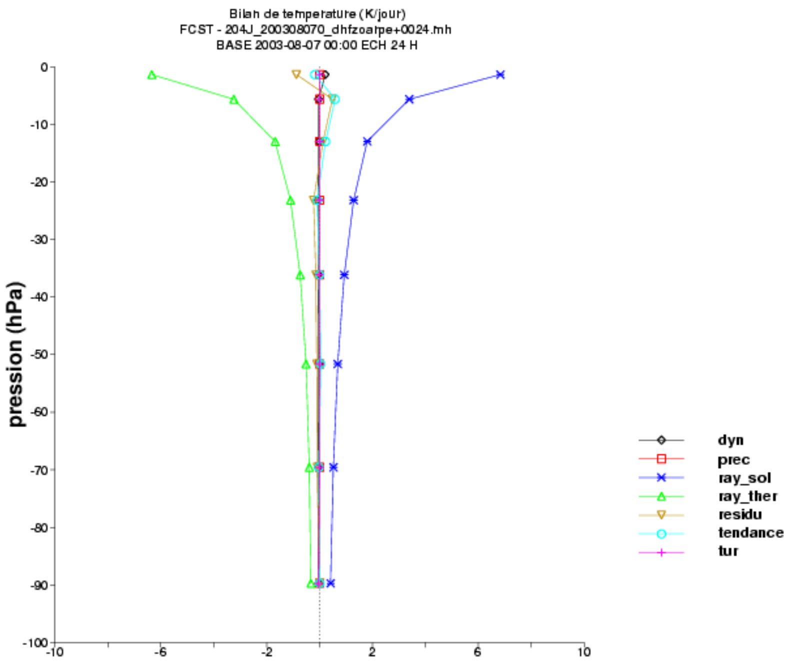
Wind

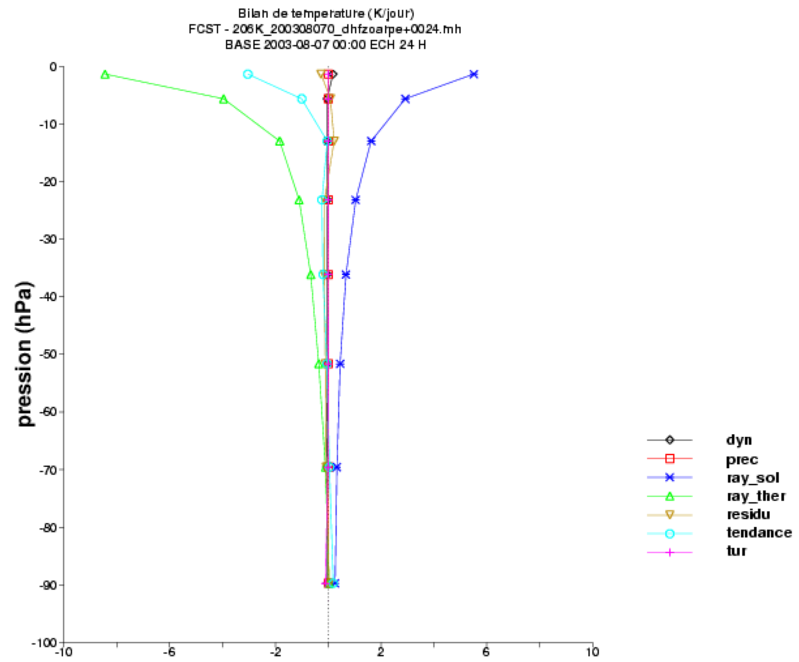


Moisture



Excessive cooling on the 2 first levels of the model





oper

double

Prospects

1) In operation since 24 of may

2) Next experimental suite :

- Use of UGAMP climatology for ozone (excessive cooling)
- Use of aerosols climatology
- Variable mixing length for turbulence

3) Medium time prospects … :

- Collaboration between GMGEC (Climat) and GMAP on new schemes for turbulence (TKE), microphysic (Lopez) and convection (Gérard, Gueremy ???)

The UGAMP climatology

The UGAMP ozone climatology has been built up by Dingmin Li and Keith P. Shine at the department of meteorology of the University of Reading.

It's a 4-dimensional distribution of atmospheric ozone resulting from the combination of several observational data sets.

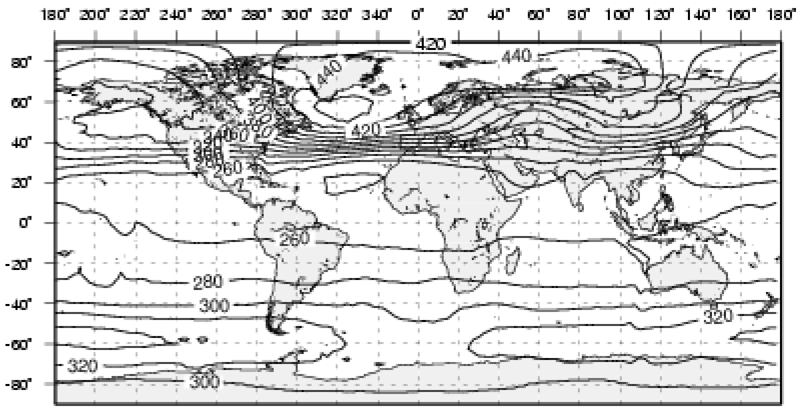
These data sets include satellite observations (SBUV, SAGE II, SME, TOMS) as well as ozone sonde data provided by the Atmospheric Environment Service of Canada. This global climatology covering five years (1985 to 1989),

For more details see :
Li, D. and K. P. Shine : A 4-dimensional Ozone Climatology for UGAMP Model, UGAMP Internal Report 35, April 1995.
Or :
http://badc.nerc.ac.uk/data/ugamp-o3-climatology

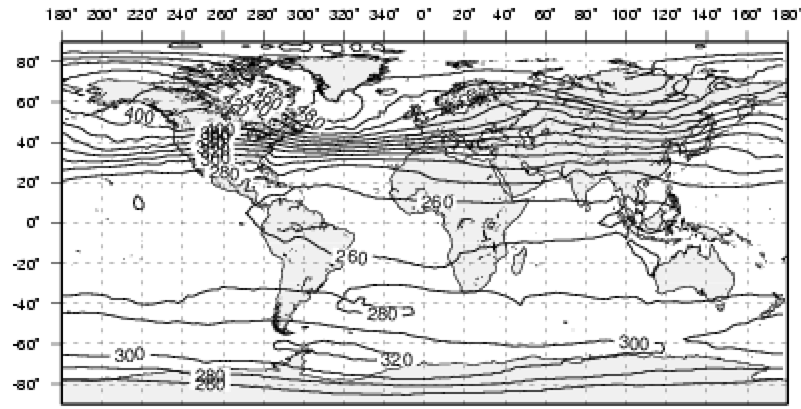
UGAMP climatology : total ozone in dopson

(ARPEGE/ALADIN value : 284 DU)

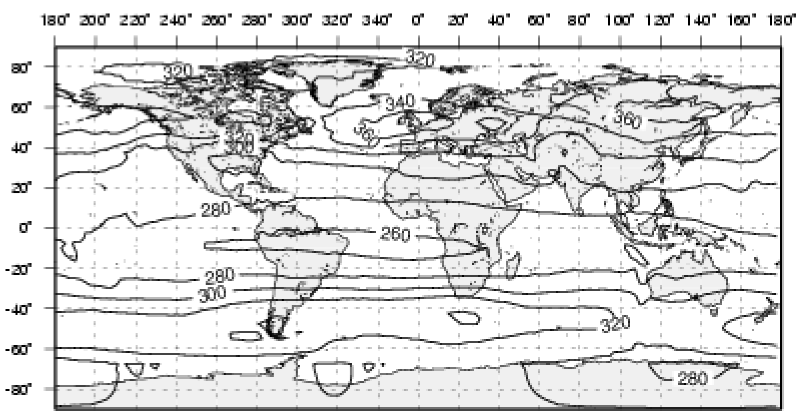
january



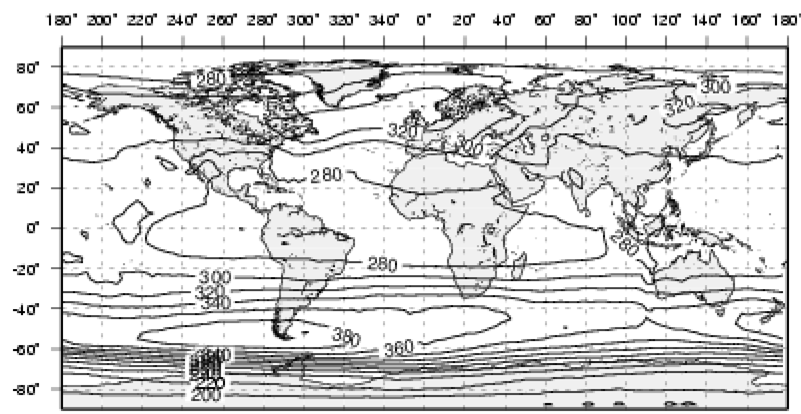
march



july



september



Use of the UGAMP climatology

The same analytical formula is used :

$$\int_0^p q_{o_3} dp = \frac{a}{1 + (b/p)^{c/2}}$$

In ARPEGE /ALADIN a=0.06012, b=3166 and c=3
This work is similar to the one made by Rada & al (2000)
in Bucharest but with a climatology

The new system try to fit the formula to the climatology under 3 constraints :

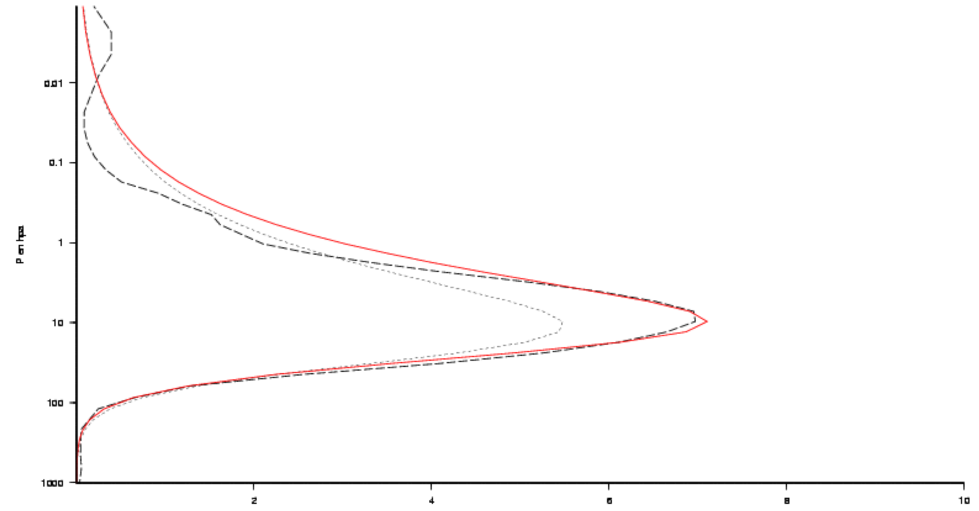
-- Total ozone is conserved
-- Altitude of maximum
-- Value of the maximum in DU/hpa

Rada C., A. Sima and M. Caian, 2000 : Ozone Profile Fitted to Bucharest Measured Data, ALADIN Newsletter 18, 51-57

Sometimes the result is very good:

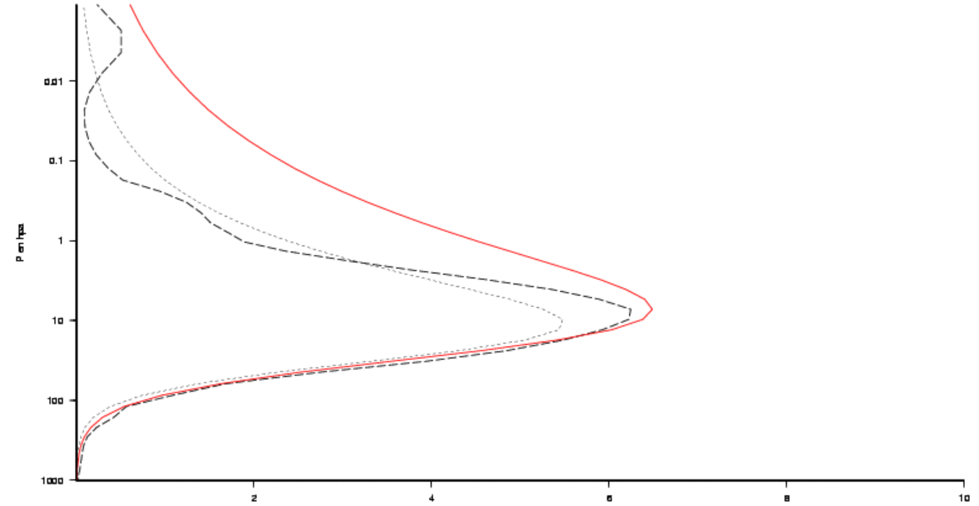
Arpege/aladin profile (dot)
Climatology (dash)
Fitted profile (red solid)

July 0°E 20°N



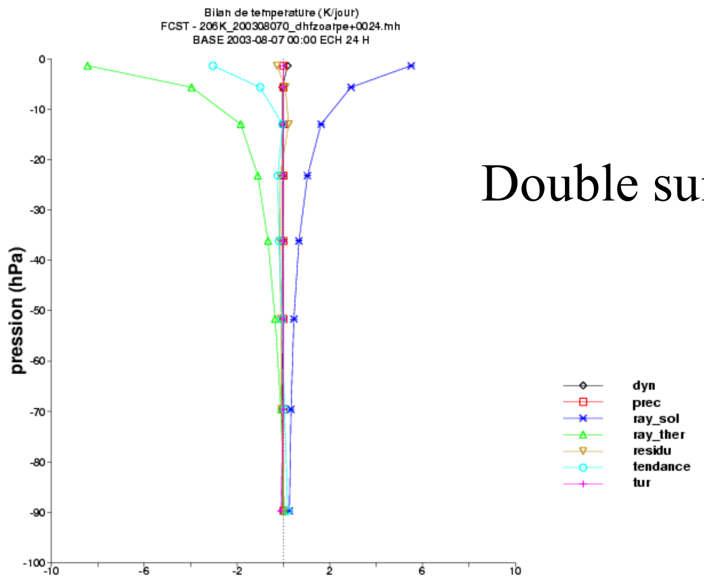
Sometimes it's not perfect !

July 0°E 45°N

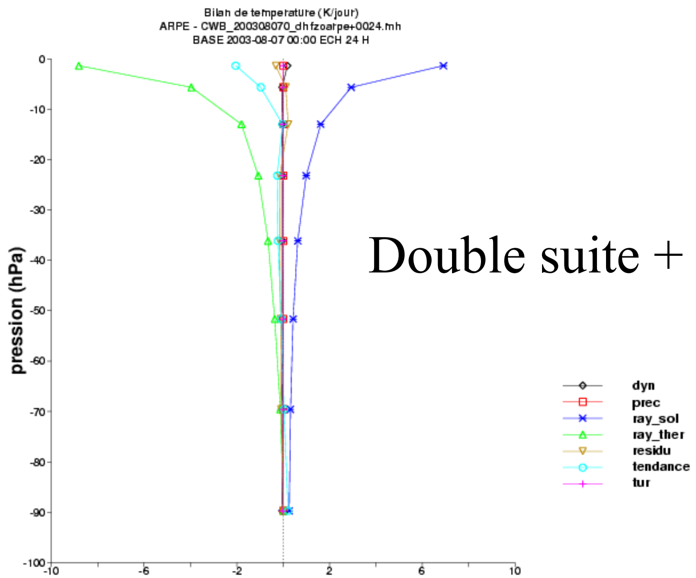


Global impact of the new ozone profiles

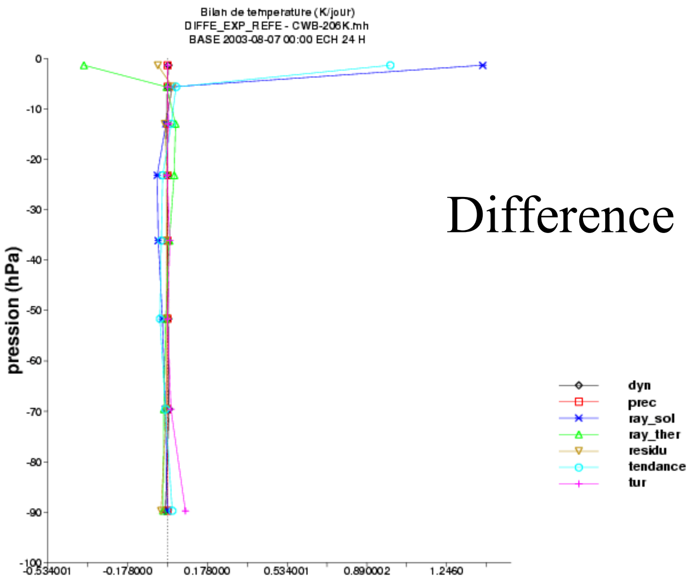
Double suite



Double suite + UGAMP



Difference



Modifications of the turbulence scheme
(work of Eric Bazile on a GABLS case)

GABLS : GEWEX Atmospheric Boundary Layer Study
GEWEX : Global Energy and Water Cycle Experiment

J. Cuxart, A.A.M. Holtslag, R.J. Beare, E. Bazile, A. Beljaars, A. Cheng, L. Conangla, M. Ek, F. Freedman, R. Hamdi, A. Kerstein, H. Kitagawa, G. Lenderink, D. Lewellen, J. Mailhot, T. Mauritsen, V. Perov, G. Schayes, G-J. Steeneveld, G. Svenson, P. Taylor, S. Wunsch, W. Weng, and K-M. Xu (2004). Single-column model intercomparison for a stably stratified atmospheric boundary layer (in internal review)

Louis formulation for turbulence :

$$F_\psi = \frac{\rho K g \Delta\psi}{\Delta\phi}$$

with :

$$\begin{cases} K_m = L_m L_m \left|\frac{\partial V}{\partial z}\right| F_m(R'_i) \\ K_h = L_m L_h \left|\frac{\partial V}{\partial z}\right| F_h(R'_i) \end{cases}$$

Where R'_i is a function of the Richardson number R_i, of the mixing length L_h and z

Modifications of the turbulence scheme

- The mixing length becomes a function of the PBL height
- The PBL height is computed following Troen and Mahrt (1986)

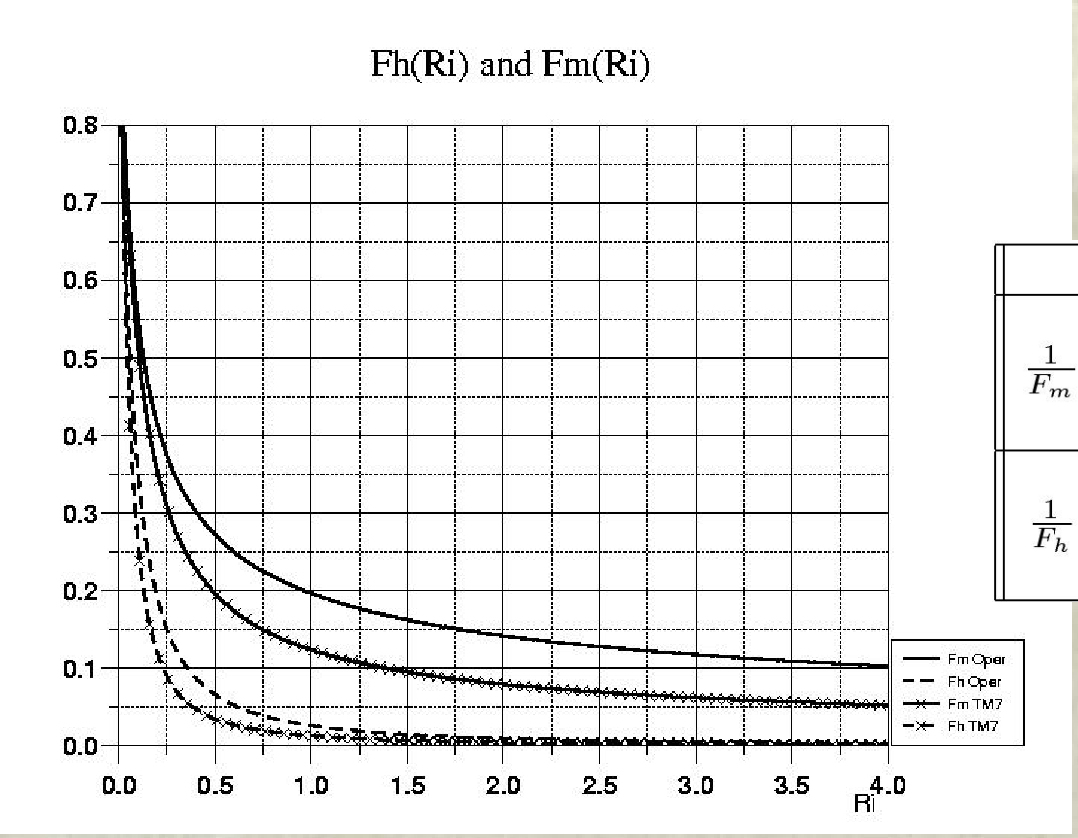
➔ Slight improvement of wind and temperature profiles in stable cases (1d)

- The function F_m and F_h has been modified

➔ Improvement on the GABLS case (better low level jet), and in 3d simulations

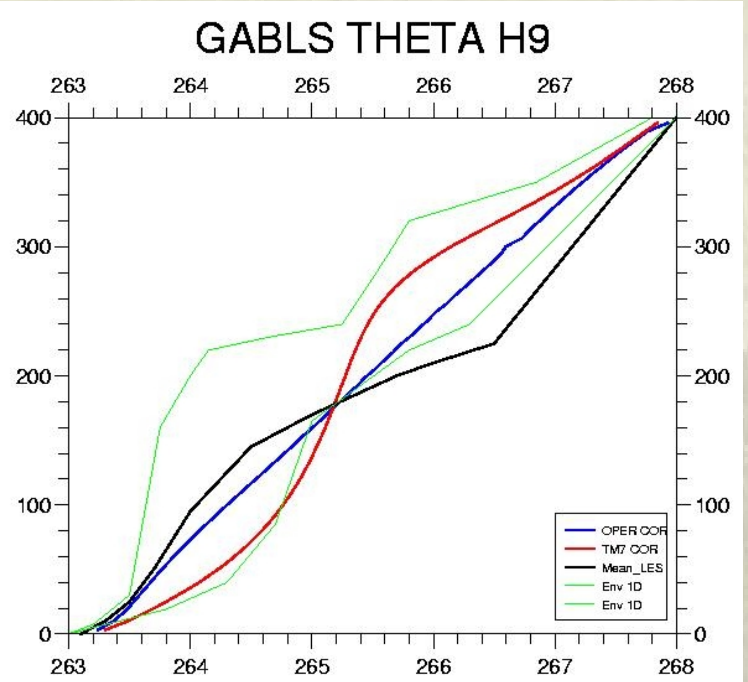
Troen I. And L. Mahrt, (1986). A simple model of the atmosphere boundary layer; sensitivity to surface evaporation. *Bound.-Layer Meteor.*, **37**:129-148.

Modifications of the function F_m and F_h

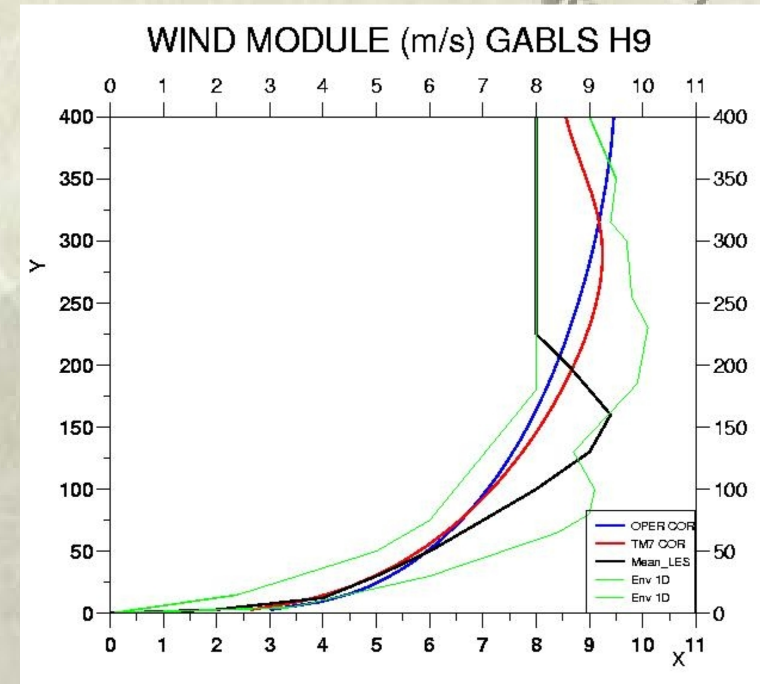


	$Oper \quad b = d = 5$	$Test \quad d = 1 \; b = 5 \; k = 5$
$\frac{1}{F_m}$	$1 + \frac{2bR_i}{\sqrt{1+dR_i}}$	$1 + \frac{2bR_i}{\sqrt{1+dR_i}}$
$\frac{1}{F_h}$	$1 + 3bR_i\sqrt{1 + dR_i}$	$1 + 3kbR_i\sqrt{1 + dR_i}$

Impact of the modifications of the turbulence scheme



Gabls case :
Wind ➔
⬅ theta



3d test 24 forecasts in january 2004 :
Improvement of 10m wind direction ➔