What's new for ARPEGE/ALADIN since Utrecht 2009 ?

E. Bazile

with contributions from GMAP/OBS and GMAP/PROC

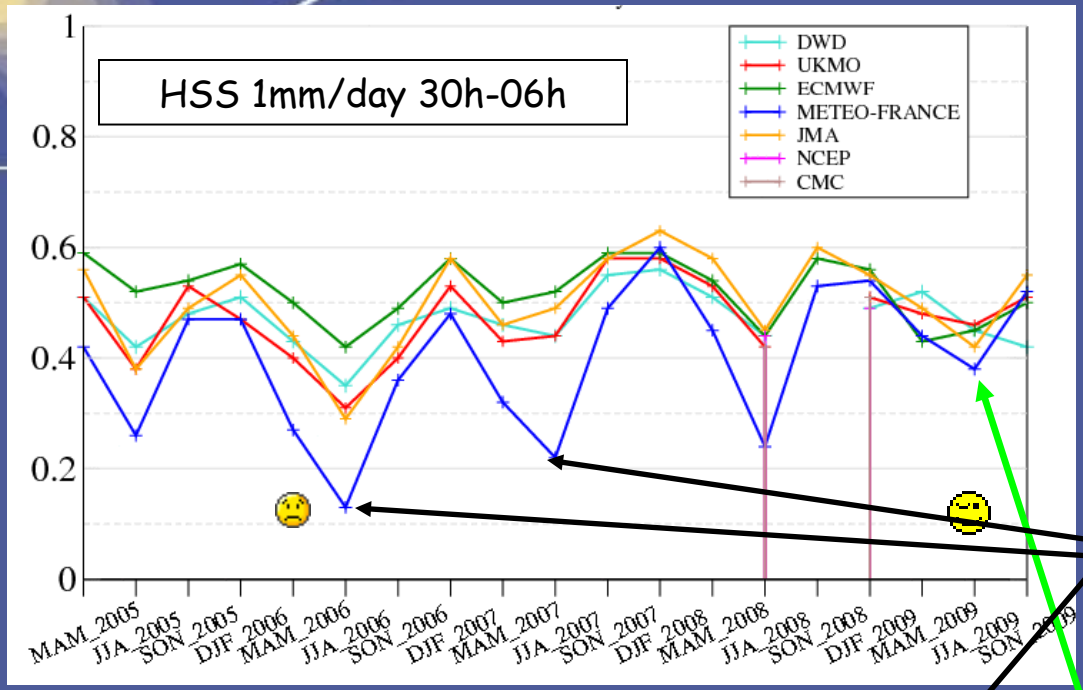
ASM HIRLAM -ALADIN
12-16 April, 2010 Krakow

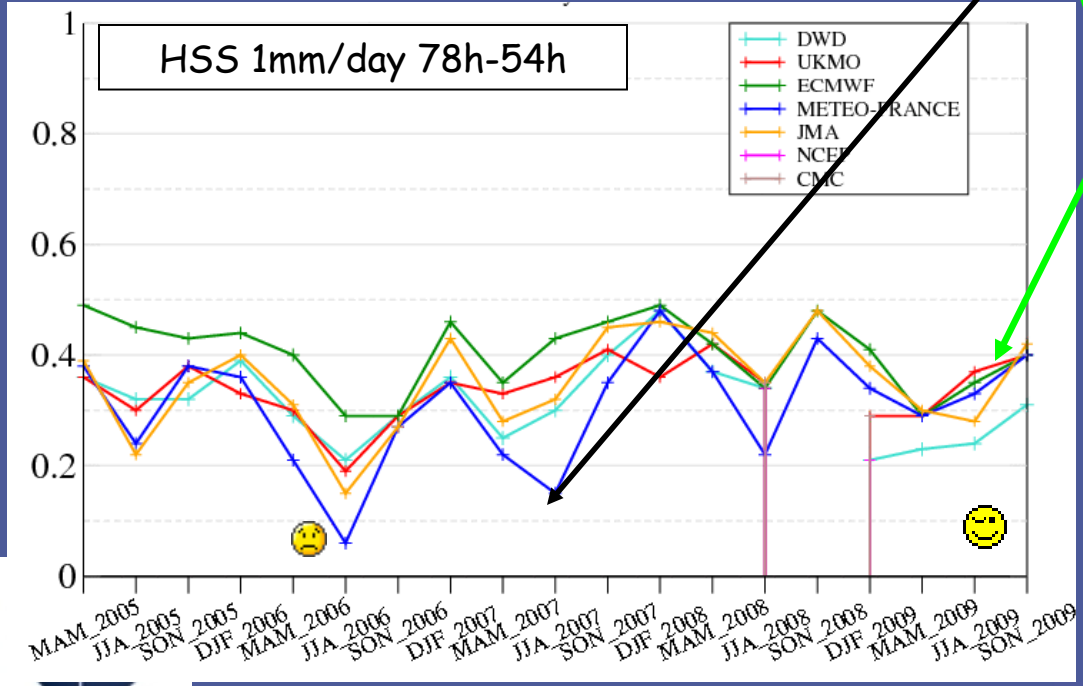
METEO FRANCE
Toujours un temps d'avance

Outline

- QPF performance of ARPEGE/ALADIN with the new physics used since Feb. 2009
- The new configuration of ARPEGE/ALADIN: operational since the 6th April 2010
- Wind gust
- Physics modifications
- Perspectives …

24h RR over France
Heidke Skill Score
(thanks to M. Amodei)





Too many small RR during summer (frequency bias about 60%).

Significantly improved for summer 2009

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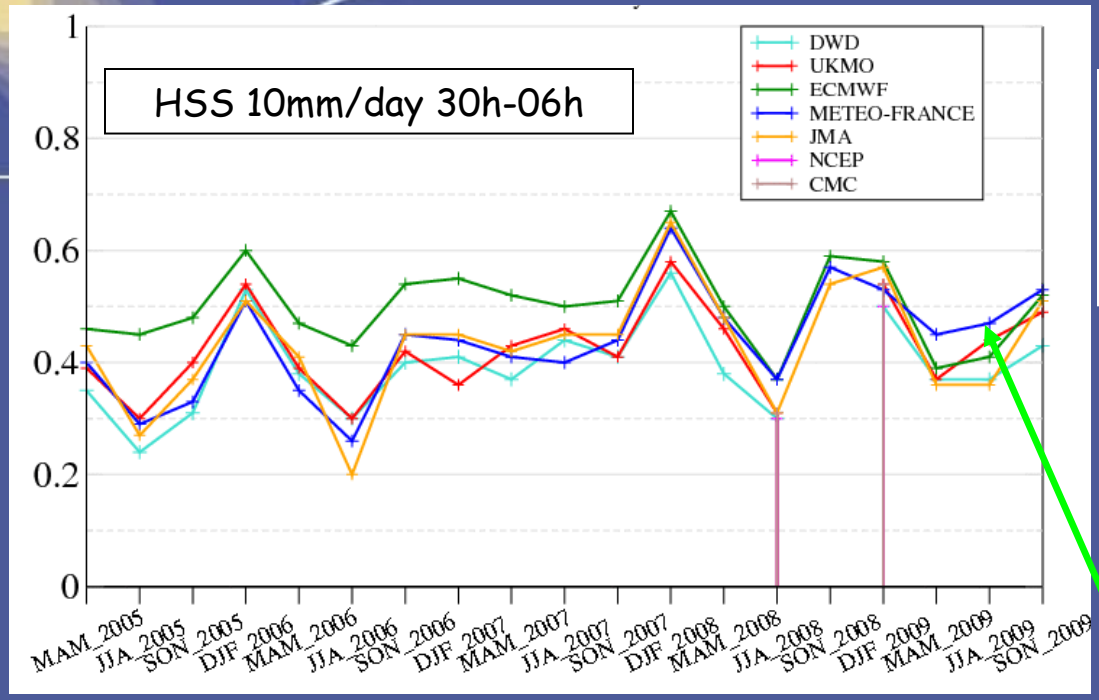
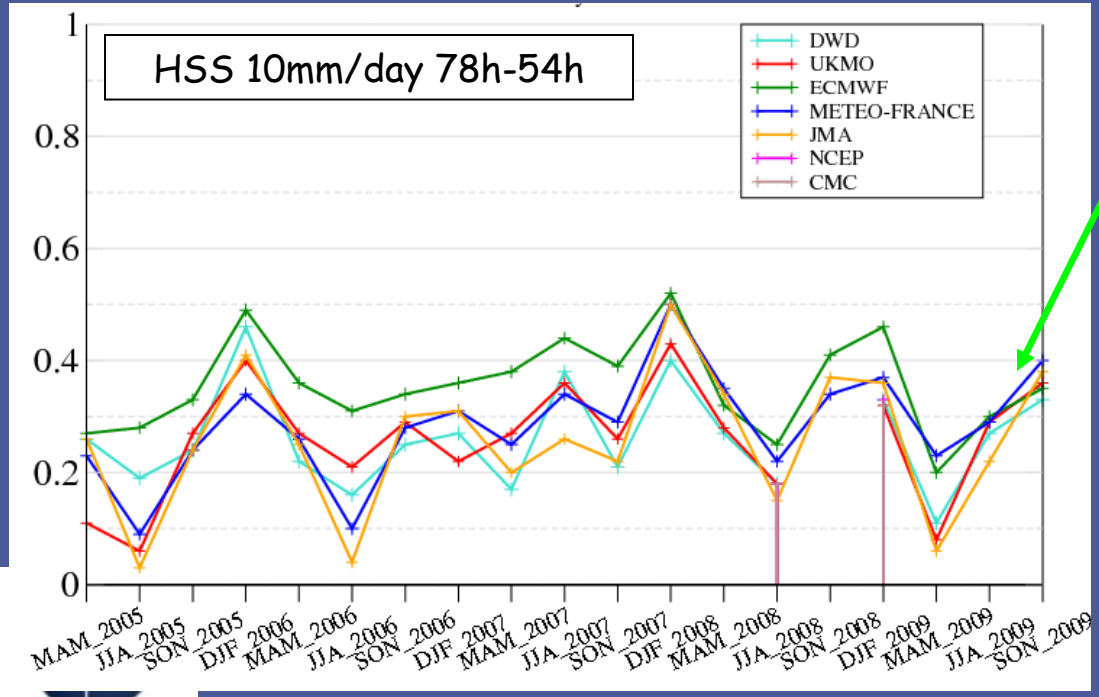
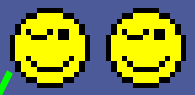
24h RR over France
Heidke Skill Score
(thanks to M. Amodei)







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Deterministic and fuzzy verification methods for a hierarchy of numerical models

Amodei and Stein, Meteorol. Appl. 16: 191-203 (2009)

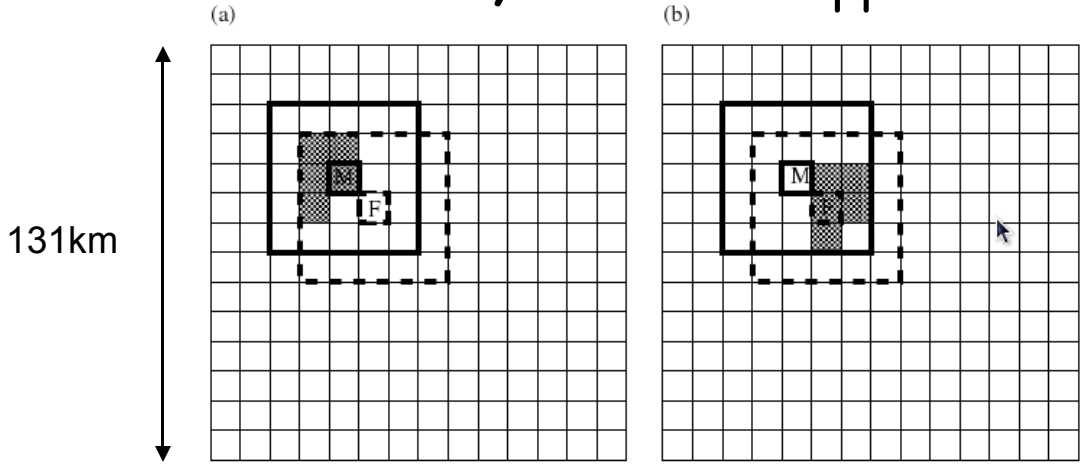


Figure 2. Binary image of precipitation events for observation (a) and forecast (b). Grid points where an event occurs are coloured in grey and the other points are white. Large squares correspond to the neighbourhood around two different points M and F. Solid line is used for point M and dashed line for point F.

For the first strategy, $P(rr > t)$ is compared with the observed occurrence at the central location $I(rr > t)$ defined by:

$$I(rr > t) = 1 \; if \; rr > t$$
$$= 0 \; else. \qquad (6)$$

For instance, $I(rr > t)$ is 1 for point M and 0 for F (Figure 2(a)).

P(rr>rr_t)=5/25=0.2 at the points M and F

BSS_SO = Brier Skill Score on a Single Observation

The score for the whole domain and temporal period is the Brier score BS_SO defined by:

$$BS\_SO = \frac{1}{DD} \sum_{dd=1}^{DD} \frac{1}{N(dd)} \sum_{i=1}^{N(dd)} (P(rr > t) - I(rr > t))^2, \qquad (7)$$

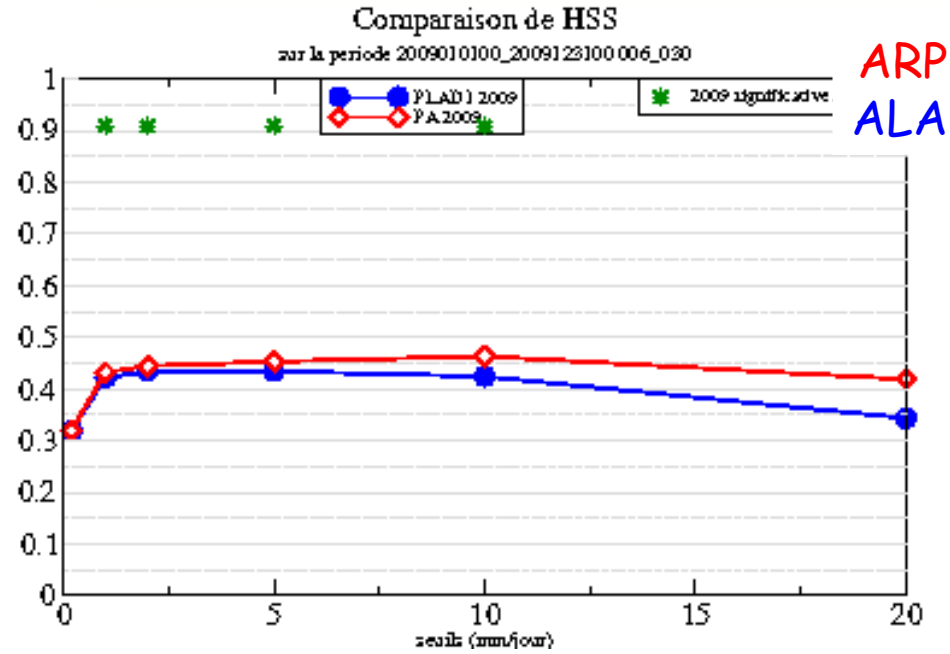
where SO means single observation, DD is the number of days of the temporal period and $N(dd)$ the number of verification points for day dd. $(BS\_SO)_p$ is the Brier score for a persistence forecast.

The Brier skill score BSS_SO is then deduced by:

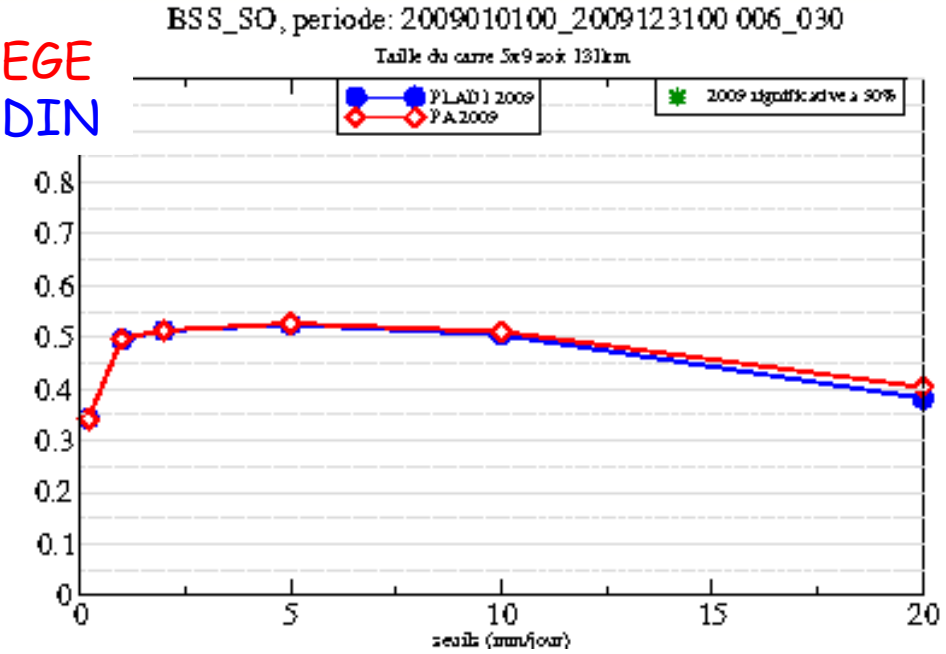
$$BSS\_SO = 1 - \frac{BS\_SO}{(BS\_SO)_p} \qquad (8)$$

24h precipitation (30h-06h) over France

01012009 → 31122009



ARPEGE
ALADIN

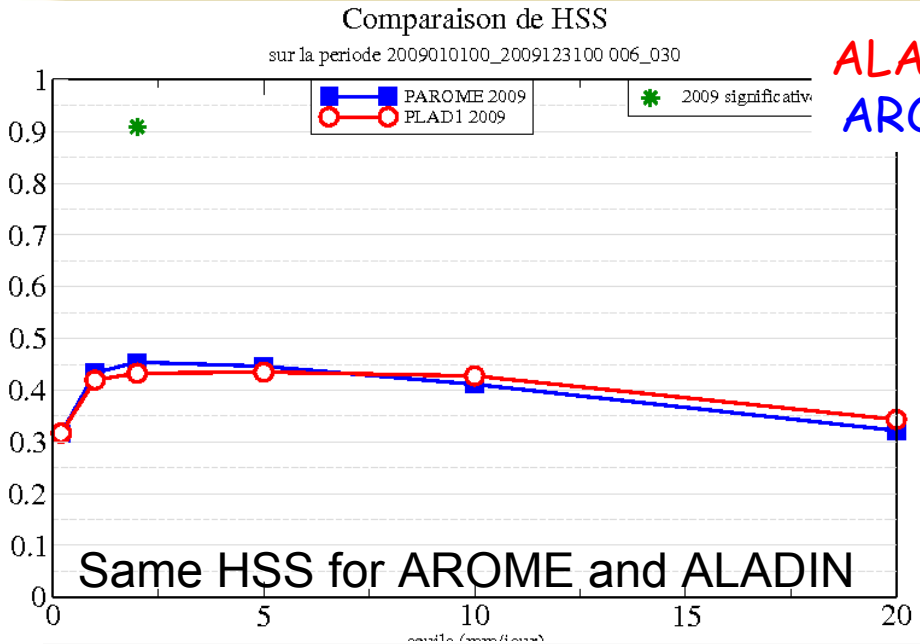


The fine scale computed by ALADIN increases the double penalty → HSS is better for ARPEGE

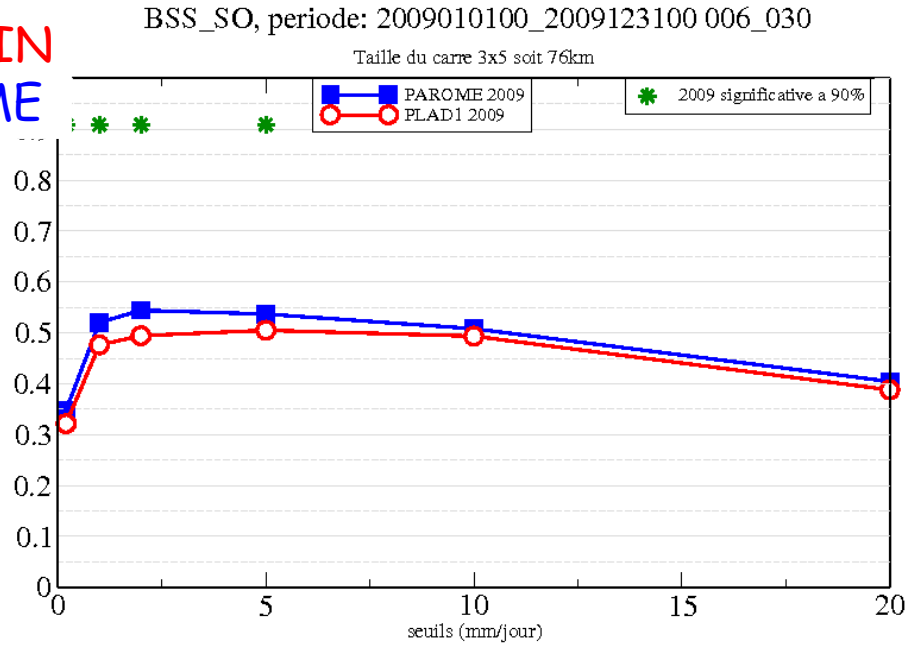
The BSS_SO (computed on 131km) shows that ARPEGE and ALADIN have in fact the same performance for the QPF.

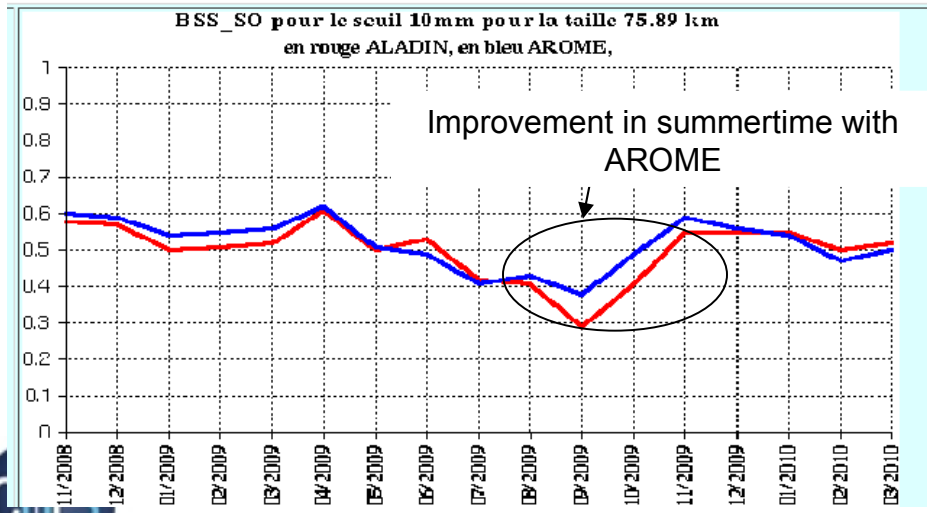
* Differences statistically significant 90%

24h precipitation (30h-06h) over France
01012009 → 31122009



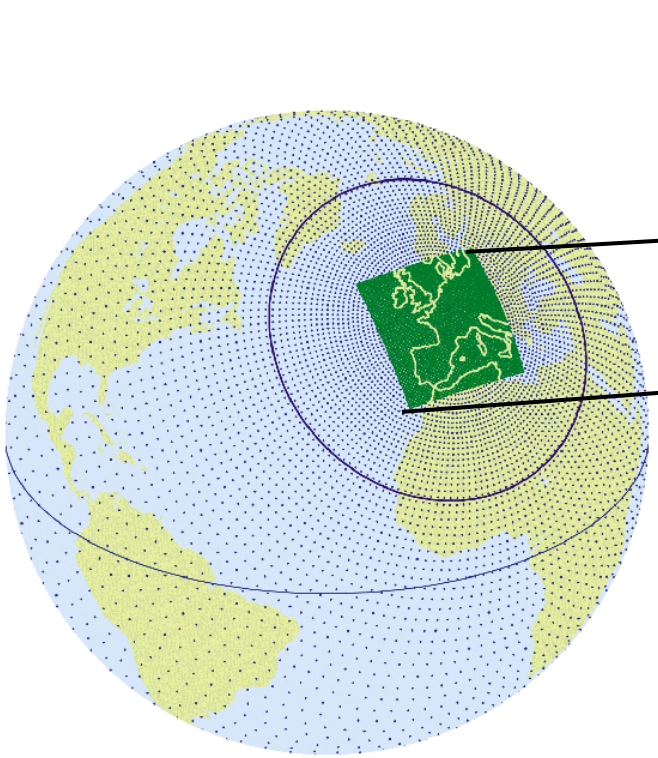
ALADIN
AROME





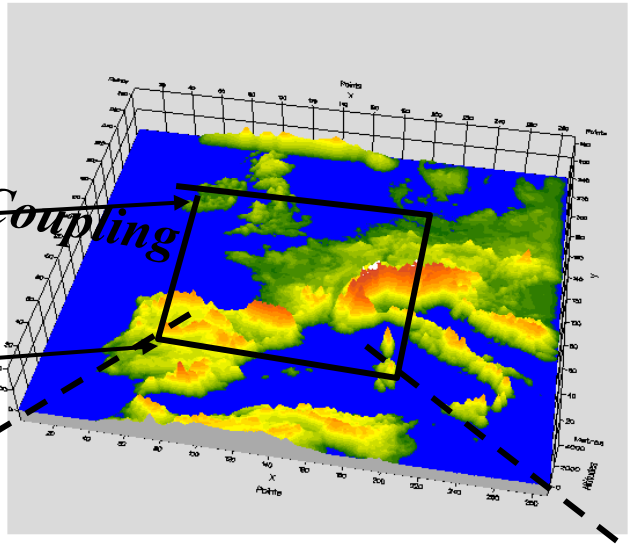
BSS_SO (computed 76km) shows an improvement with AROME for RR<5mm.
For heavy rain, the score difference is not significant

Operational Weather forecasting at Météo-France:
ARPEGE and AROME since the April,6 2010



Coupling

Coupling



Cloud Resolving Model AROME 2010
Currently under development
1h to 30 h forecasts
dx=2.5 km over France
3DVar Data Assimilation system

Global ARPEGE
4-day forecasts every 6 hours dx=10km on Europe, 55km on South Pacific dt=10mn
Stretching and turning of the pole over the zone of interest
Stretched vertical grid with 70 levels
4DVar Data Assimilation system

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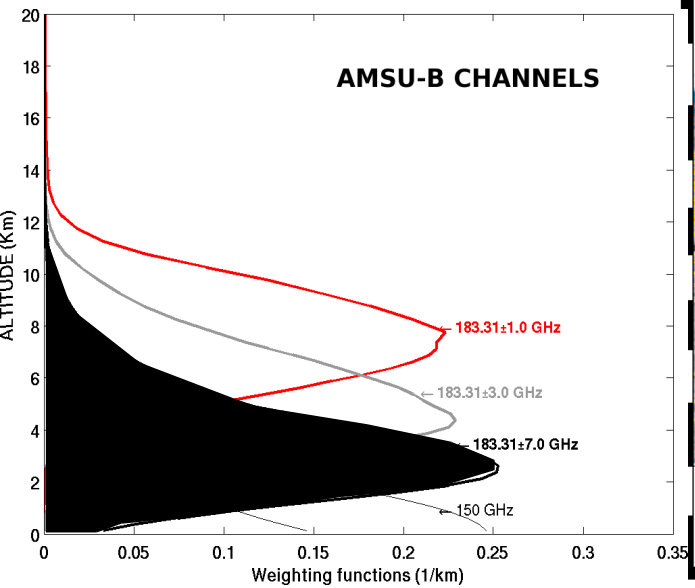
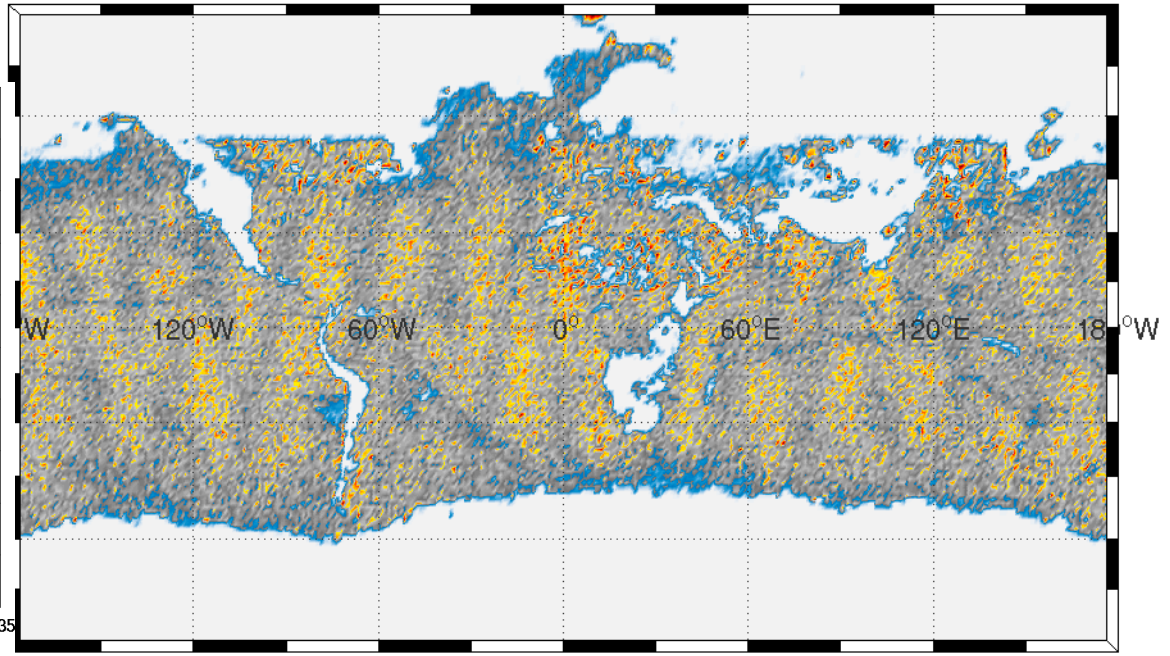
Overview of improvements in the use of observations

- T107 L60 25 iter and T224 L60 30 iter → T107 L70 25iter and T323 L70 30iter (62Km)
- Increase in the horizontal density for all radiance data (250km to 125km thinning) + use of RTTOV-9 + small changes in bias correction
- Additional IASI channels (4 surface and 9 water vapour)
- Assimilation of AMSU-B-channel 5 over land
- Use of NOAA-19 (HIRS and AMSU-A)
- Use of MODIS water vapour winds in polar areas
- Use of Radar reflectivities (in Arome only) ← Y. Seity's talk

New usage of AMSU-B channel 5 (183.31 ± 7.0 GHz) in ARPEGE
Indirect measurements of temperature and humidity over land





Density of assimilated observations (1deg x 1deg)

5 10 15 20 25 30 35 40 45

One of the limitations: large uncertainties about the surface description (emissivity and surface temperature) over snow and sea-ice

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Physics modifications

- 70 vertical levels: 20 levels instead of 14 levels below 3000m
- Dt=600s for ARPEGE (10km) regarding to 450s for ALADIN-MF at 7.5km
- Advection of the TKE (vertical interpolation to put TKE on FL and then go back to HL for the physics) → only positive impact on the wind gust field
- Remove the surface boundary condition of the TKE as it is in AROME
- Remove the top PBL entrainment
- Harmonisation of the wind gust computation between ARPEGE/ALADIN and AROME based on the TKE instead of the friction velocity for ARPEGE/ALADIN. Maximum of the wind gust on 1hour.

WIND GUST

ARPEGE/ALADIN
(before 6 April 2010):

$$U_{gust} = U_{10m} + \alpha \cdot \Delta G$$

10

$$\Delta G \equiv \alpha \; u_* \; / \; F(Z_{0\lim} ; Z_0)$$

$$F(Z_{0\lim} ; Z_0) = \sqrt{1 + \left[\frac{\ln(1+10/Z_{0\lim})}{\ln(1+10/Z_0)} \right]^2}$$

ARPEGE/ALADIN/AROME now :

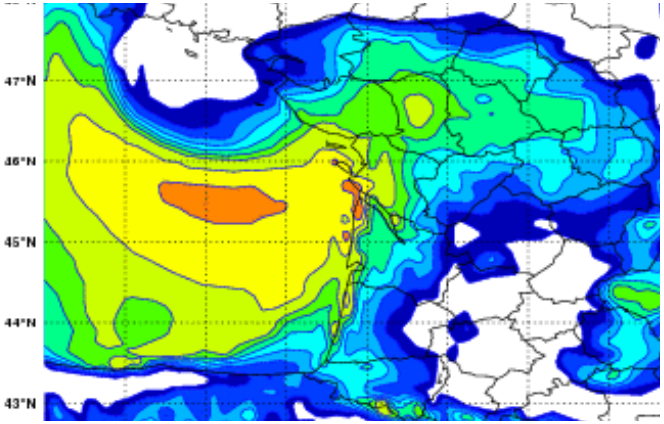
$$U_{gust} = U_{10m} + \alpha \cdot \sqrt{TKE_{HTKERAF}}$$

3.5

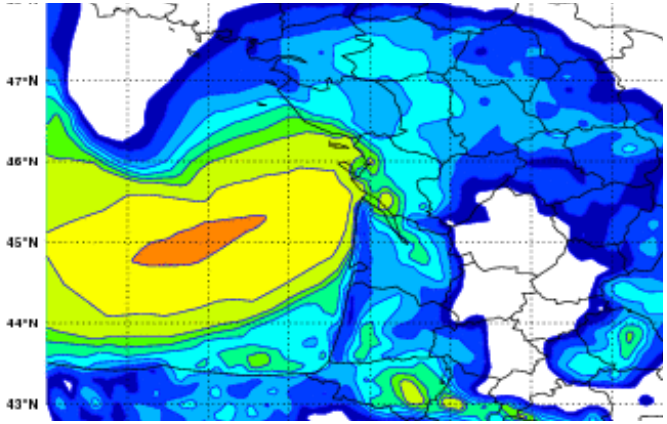
TKE height=20m (namelist)

WIND GUST

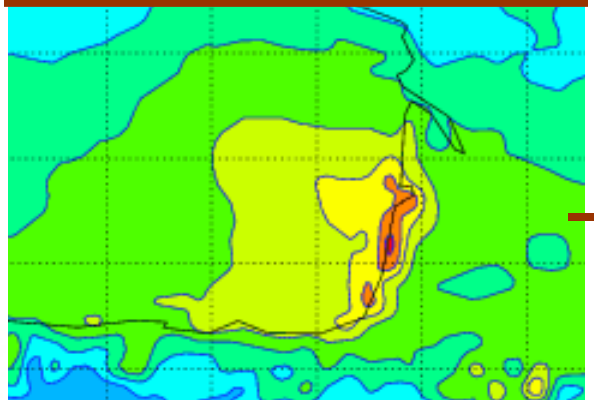
Wind gust based on u*
ALADIN old oper Base:
27th Feb 2010 + 25h



Max Wind gust on 1H based
on TKE ALADIN new oper
Base: 27th Feb 2010 + 25h

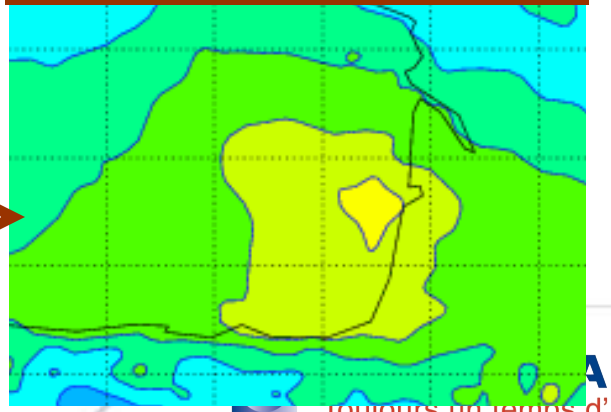


Wind gust
TKE not advected



24/01/2009

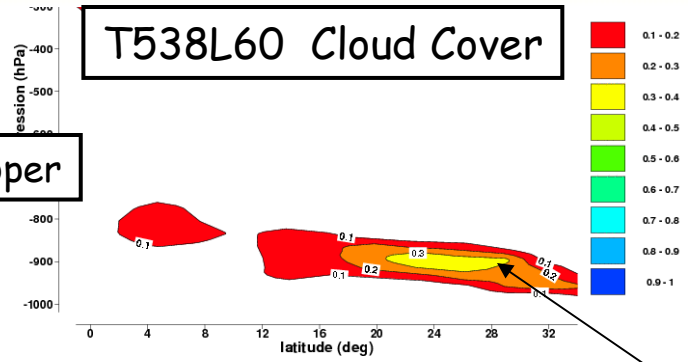
Wind gust
TKE advected



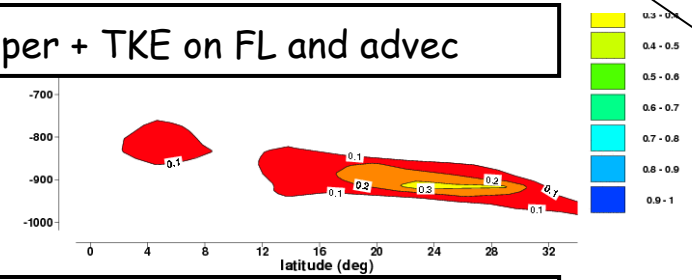
Physics modifications impact on the Gewex Pacific Cross-section Intercomparison (July 2009)

T538L60 Cloud Cover

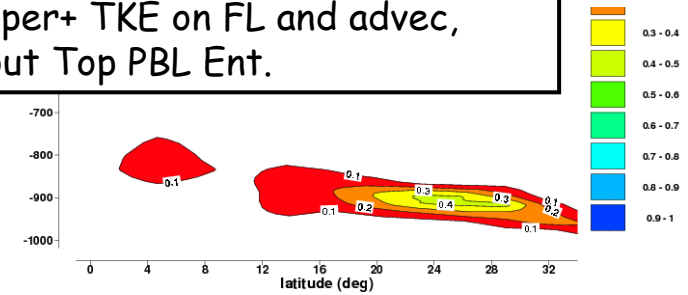
Old oper



Old oper + TKE on FL and advec

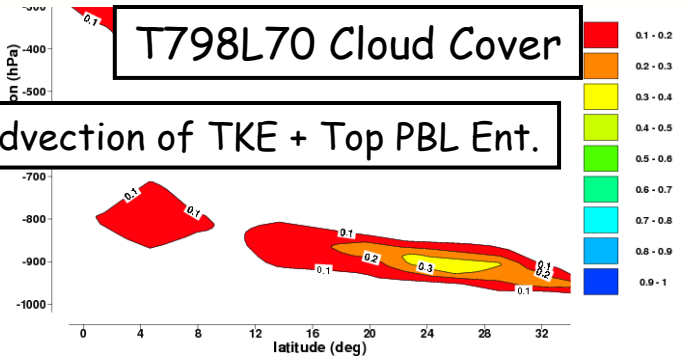


Old oper+ TKE on FL and advec, without Top PBL Ent.

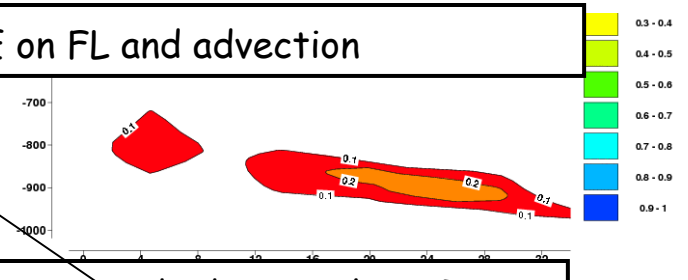


T798L70 Cloud Cover

No advection of TKE + Top PBL Ent.

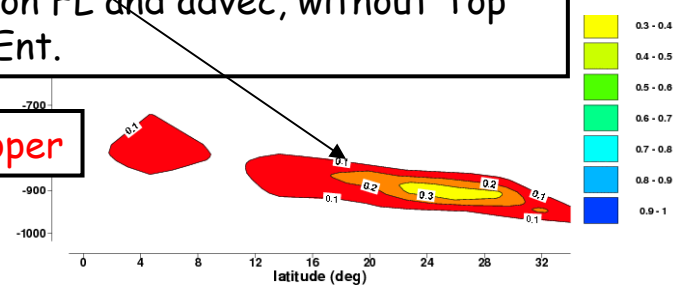


TKE on FL and advection

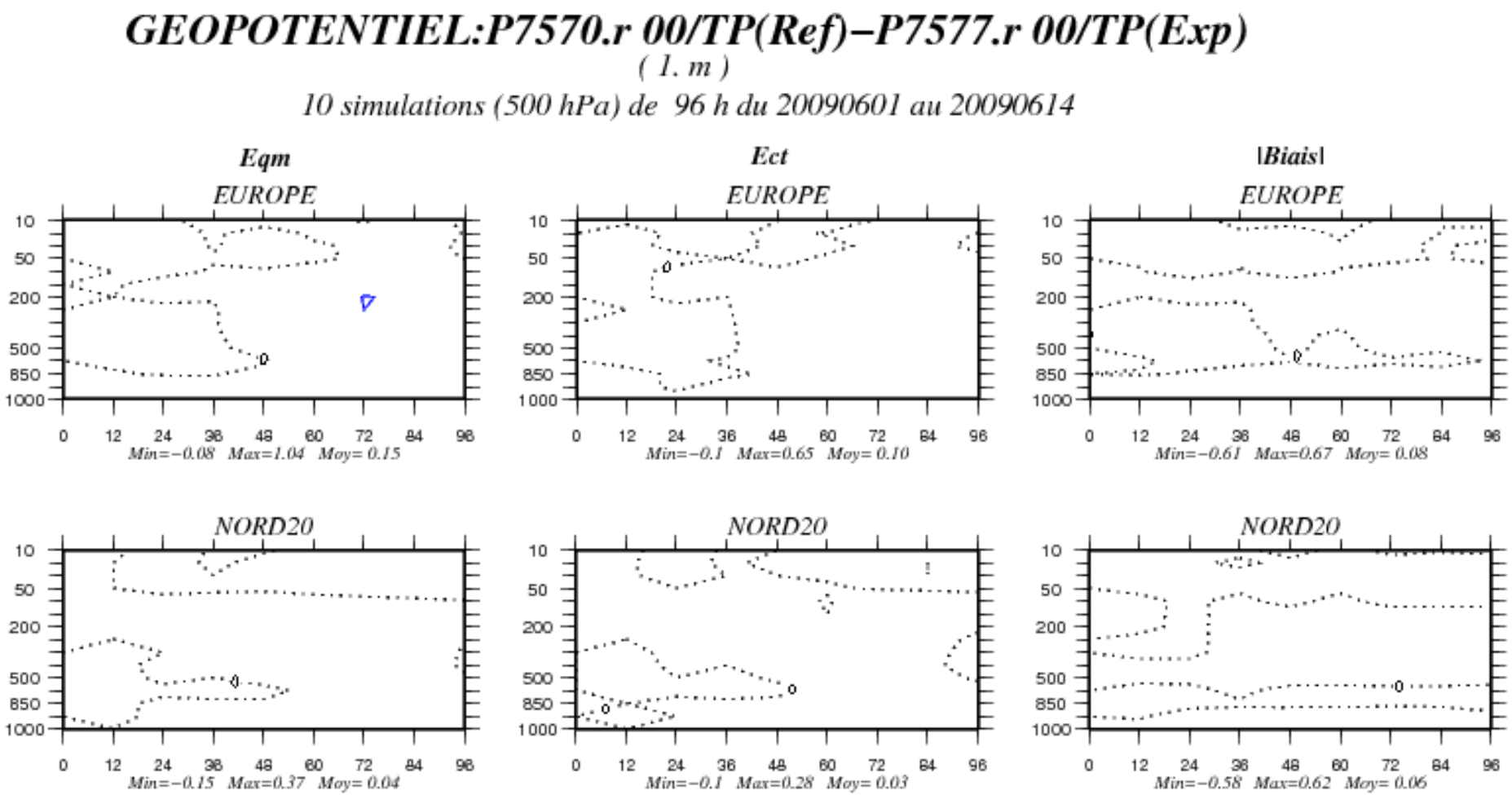


TKE on FL and advec, without Top PBL Ent.

New oper

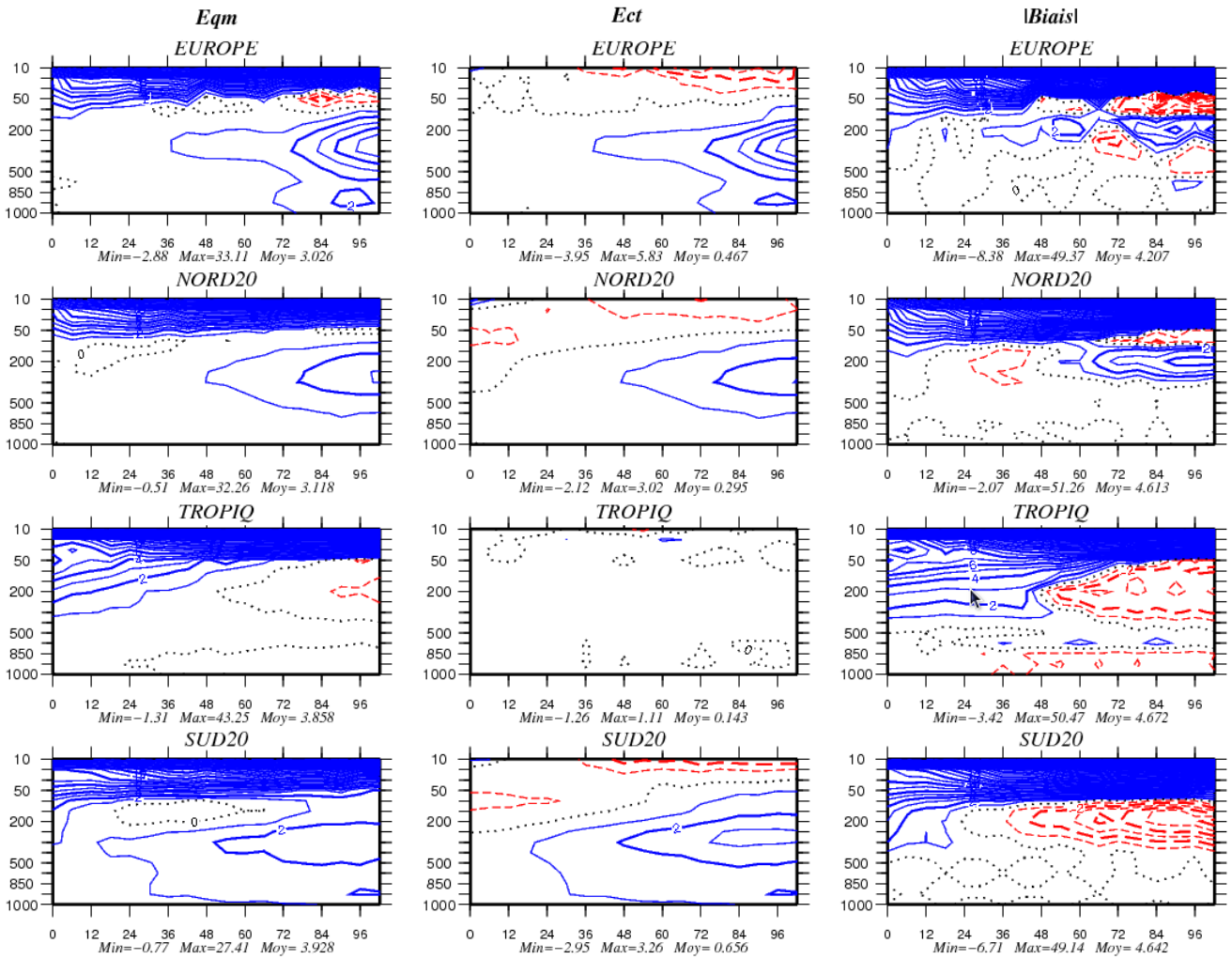


Physics modifications impact on scores …



ARPEGE T798L70 VS T538L60
GEOPTENTIAL VS ECMWF Analysis

(1. m) Chaine 2009_03: Hautes Resolutions: Obs + Modeles
125 simulations de 102 h du 20091123 au 20100405



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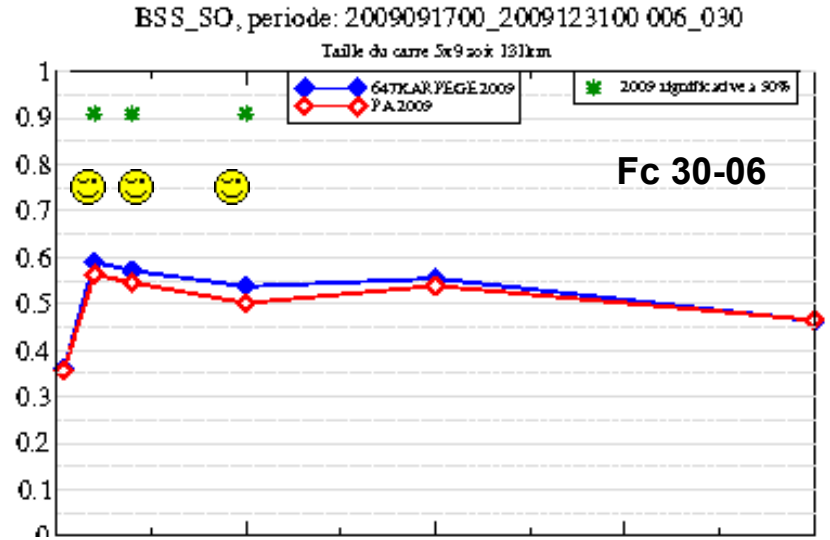
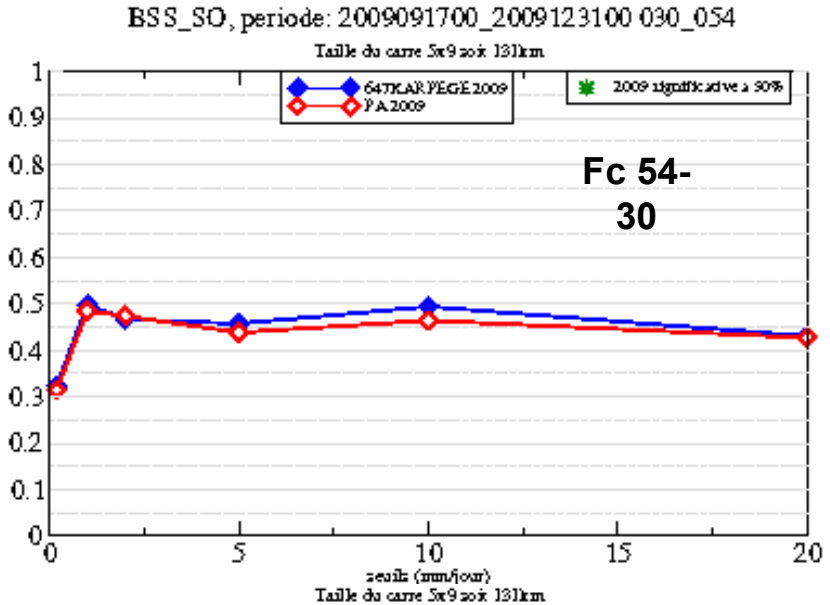
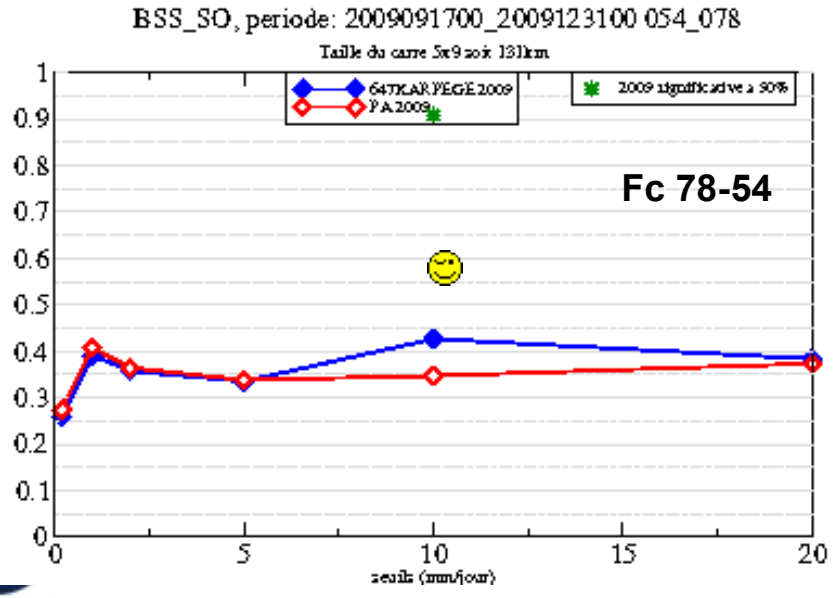
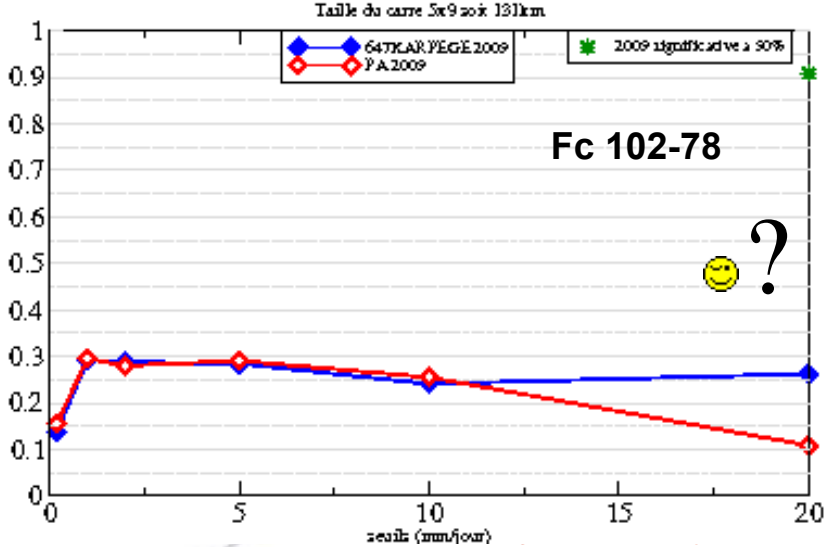
QPF 20090917-20091231 (blue new oper)









Impact of the Cut-off
Nov.2009 → Feb.2010 (120 forecast)

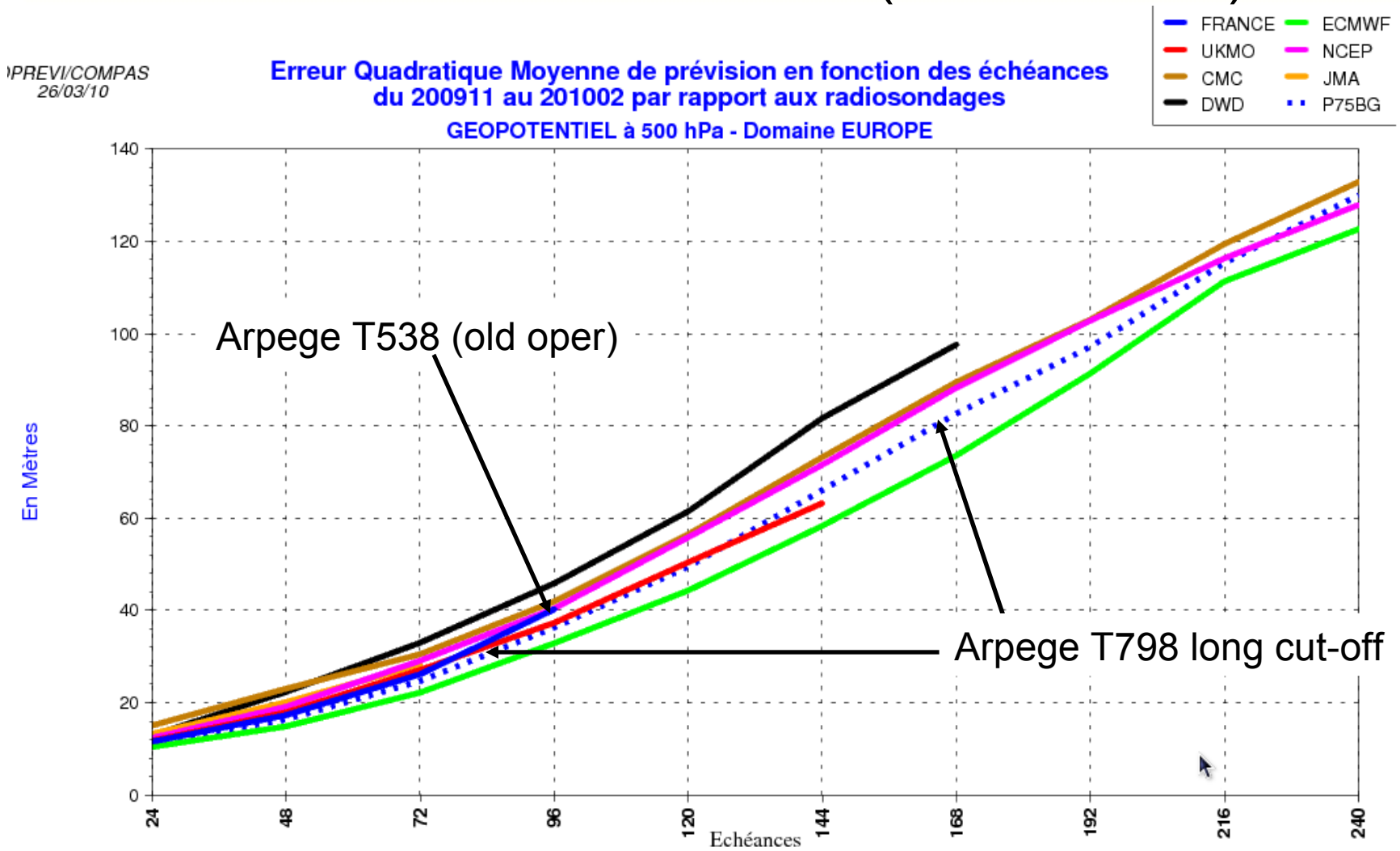
EUROPE
Nov-Dec-Jan-Feb 2010

RMS Z500	24h	48h	72h	96H
Oper	11.42	17.31	26.30	40.58
New-Oper	11.10	16.64	25.25	37.12
New-Oper Long cut-off	11.02	16.38	24.35	36.69

NORD 20
Nov-Dec-Jan-Feb 2010

RMS Z500	24h	48h	72h	96H
Oper	12.77	18.51	27.65	40.05
New-Oper	12.48	18.02	26.40	37.57
New-Oper Long cut-off	12.39	17.85	26.08	37.22

10 days forecast
Nov.2009 → Feb.2010 (120 forecast)



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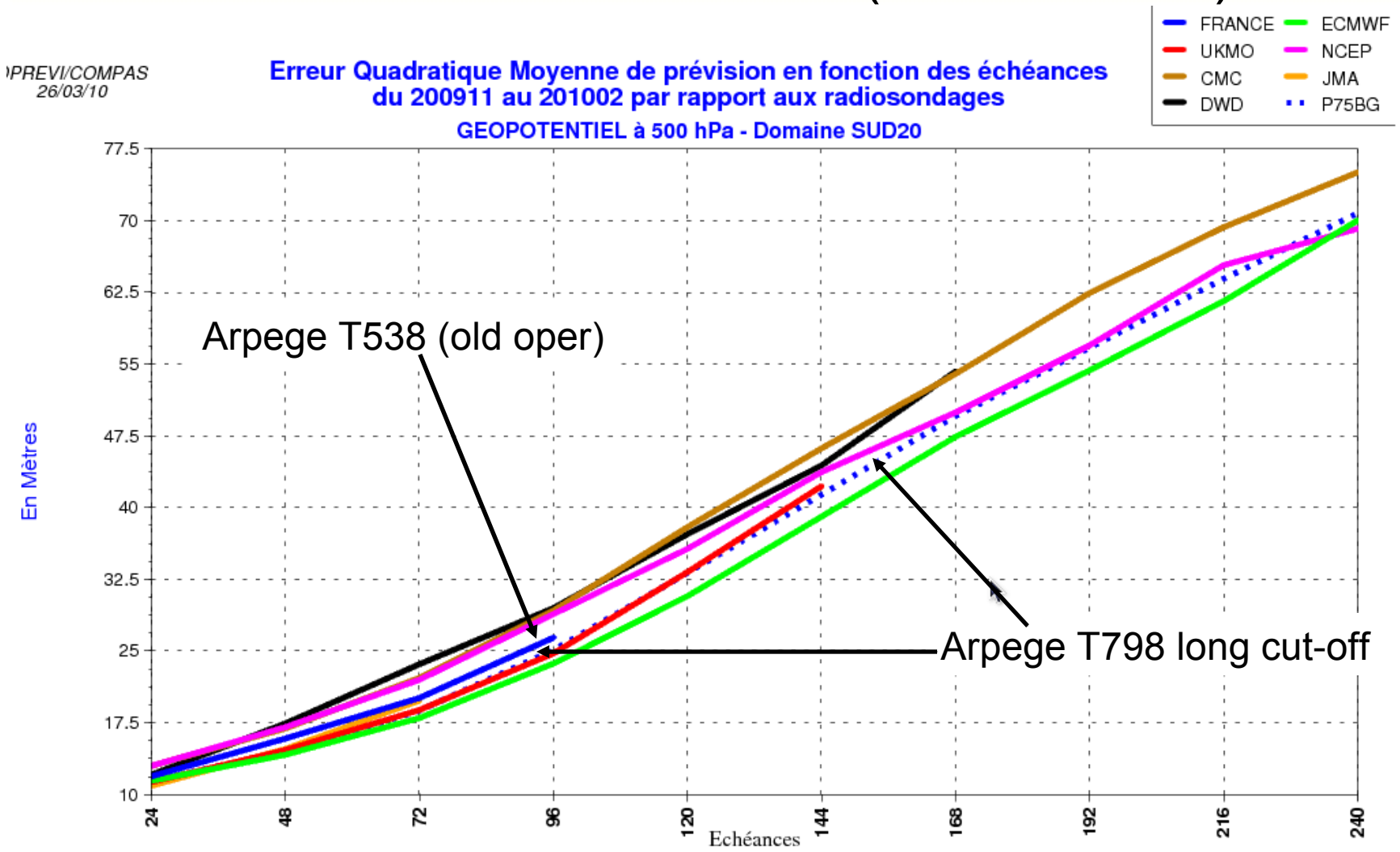

CONCLUSIONS

- Physics modifications
  - Neutral impact on scores
  - Advection of TKE: positive impact on the wind gust field
  - The new physics (used since Feb. 2009) is less sensitive to the vertical resolution and the time step than the previous one
- It is interesting to see the reasonable behaviour and the result of the 10-days forecast of the new ARPEGE version without specific tuning or study. It is very useful to see, in order to validate the physics, the long term bias of the model vs ECMWF, UK , NCEP etc ..
- The new horizontal resolution and the increased of the observation used in the 4Dvar explain the improvement of the new ARPEGE configuration (wind, T, Z)

Conclusions

- Modifications in the shallow convection scheme KFB:Wlcl and temperature perturbation function of TKE instead of constant → small impact
- 3MT deep is THE main objective for 2010
- Cloud scheme: Bougeault's pdf function , or the double gaussian function (E. Perraud Phd work) instead of Smith's pdf
- EDKF for the wind mixing and dry mixing