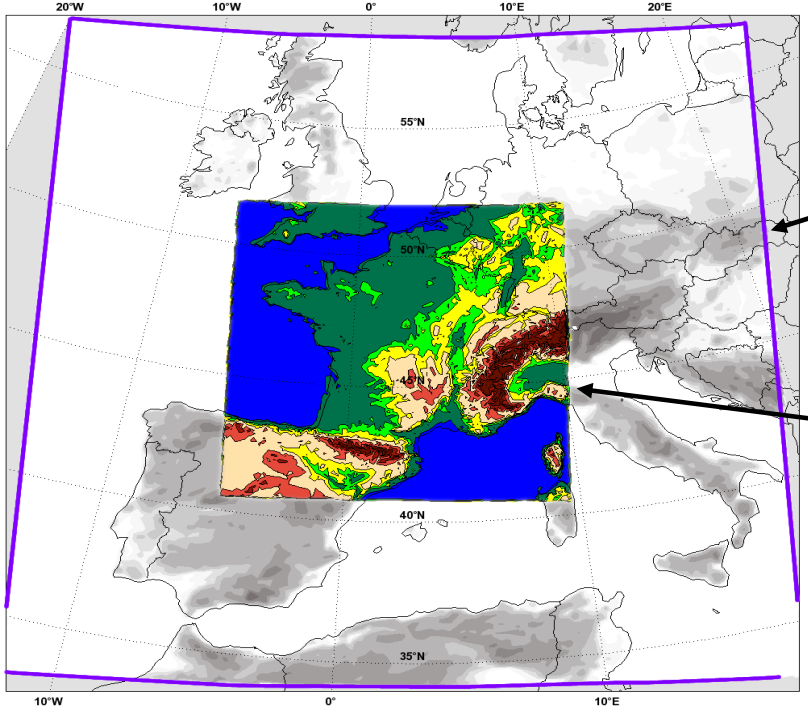
Status of AROME

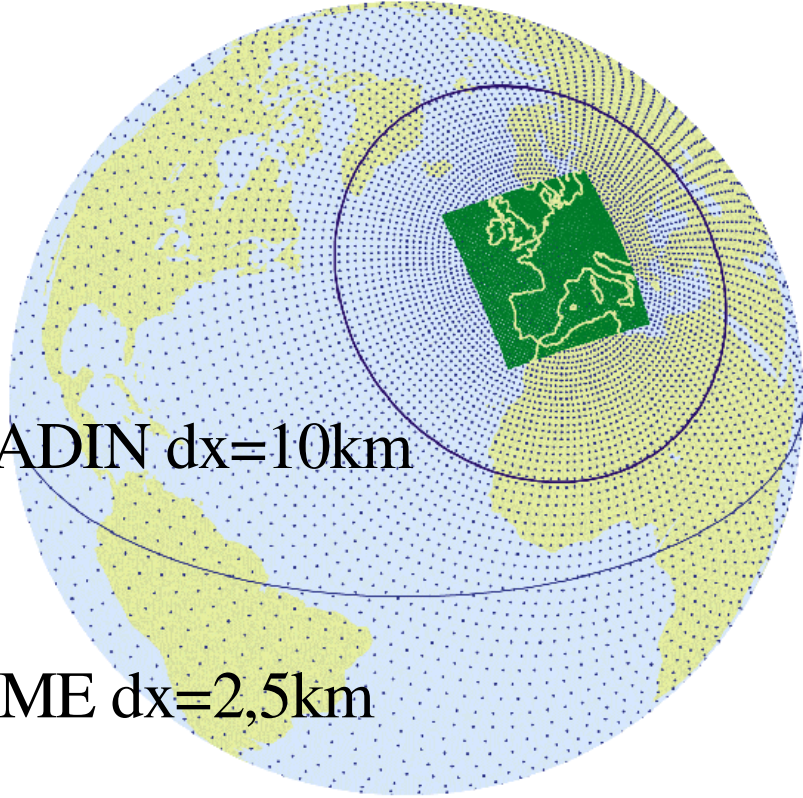
F. Bouttier and collaborators, CNRM, Météo-France, Toulouse

prepared for ALADIN/HIRLAM ASM, Oslo Apr 07

1. Arome-France status
2. Advances in model
3. Advances in Data Assimilation
4. Conclusion: the next steps

ARPEGE: global grid (dots)
ALADIN-France: green square
AROME-France: below

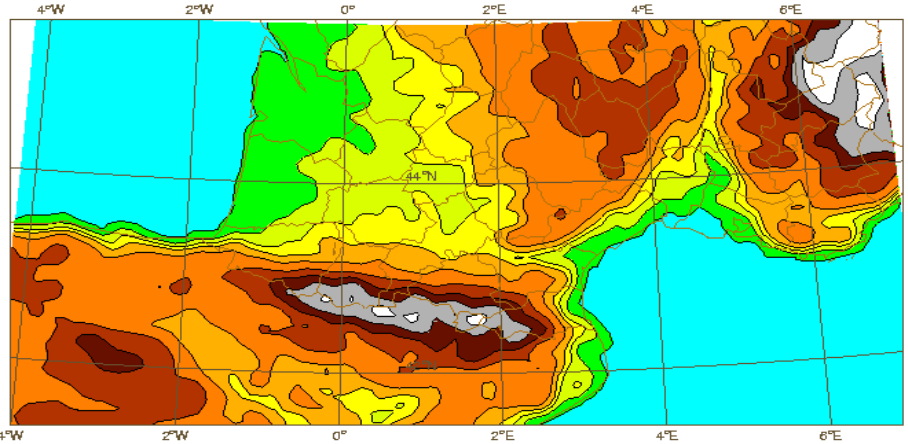


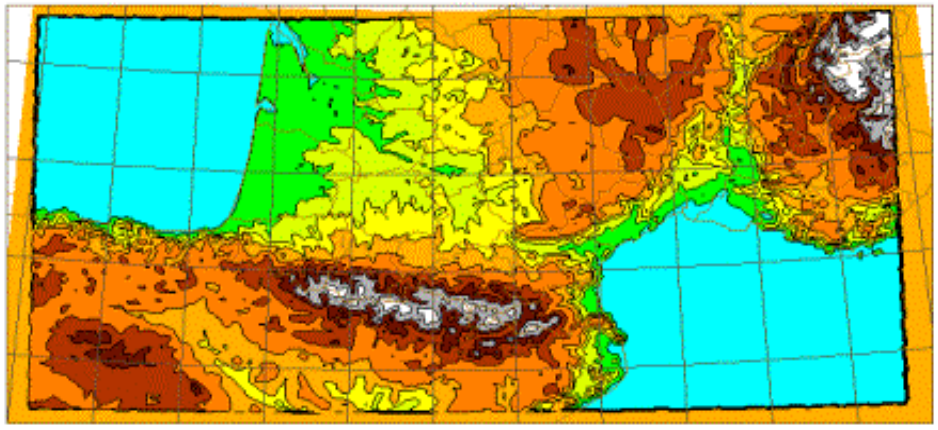


ALADIN dx=10km

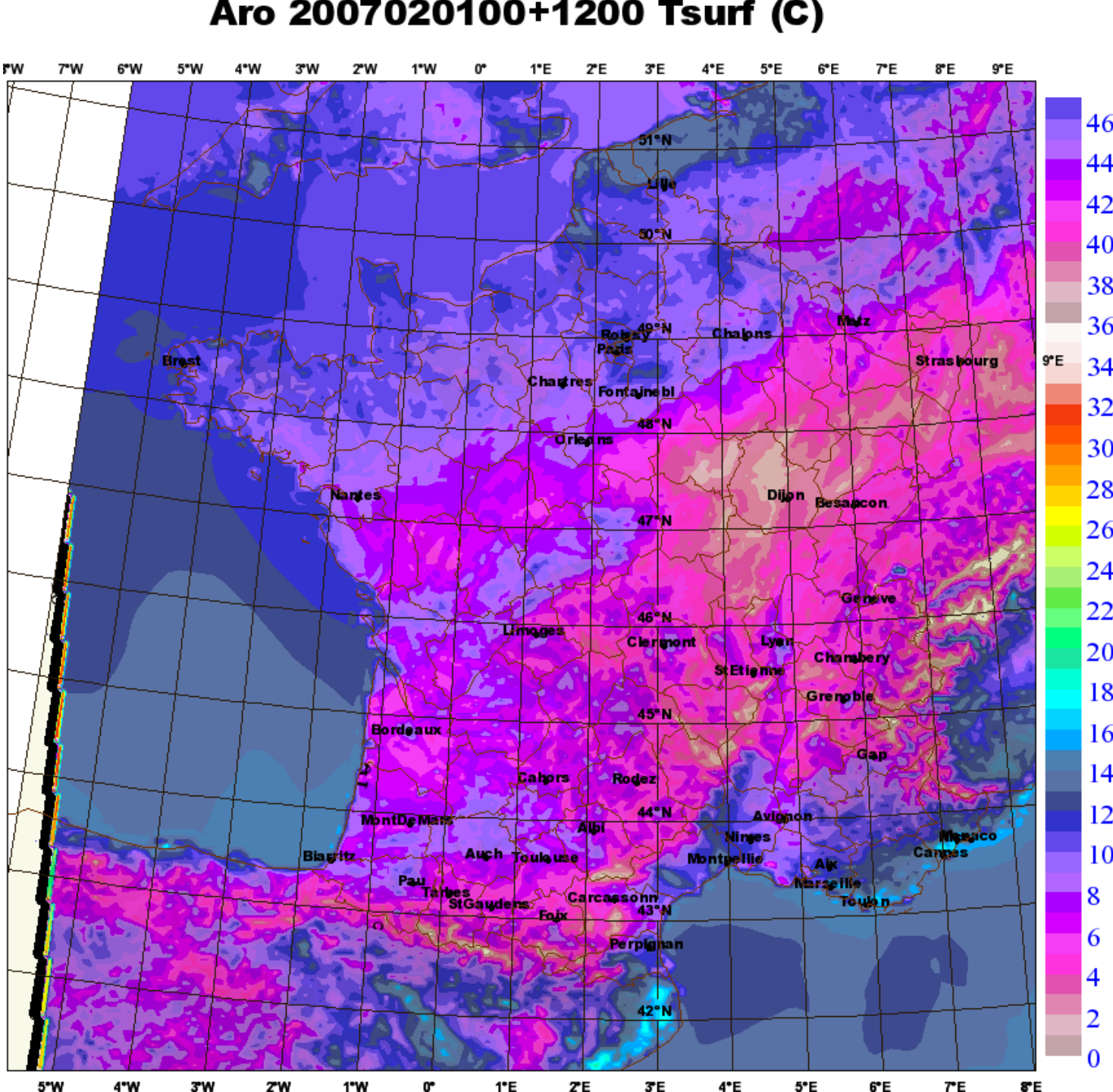
AROME dx=2,5km

ALADIN-France and Arome orographies



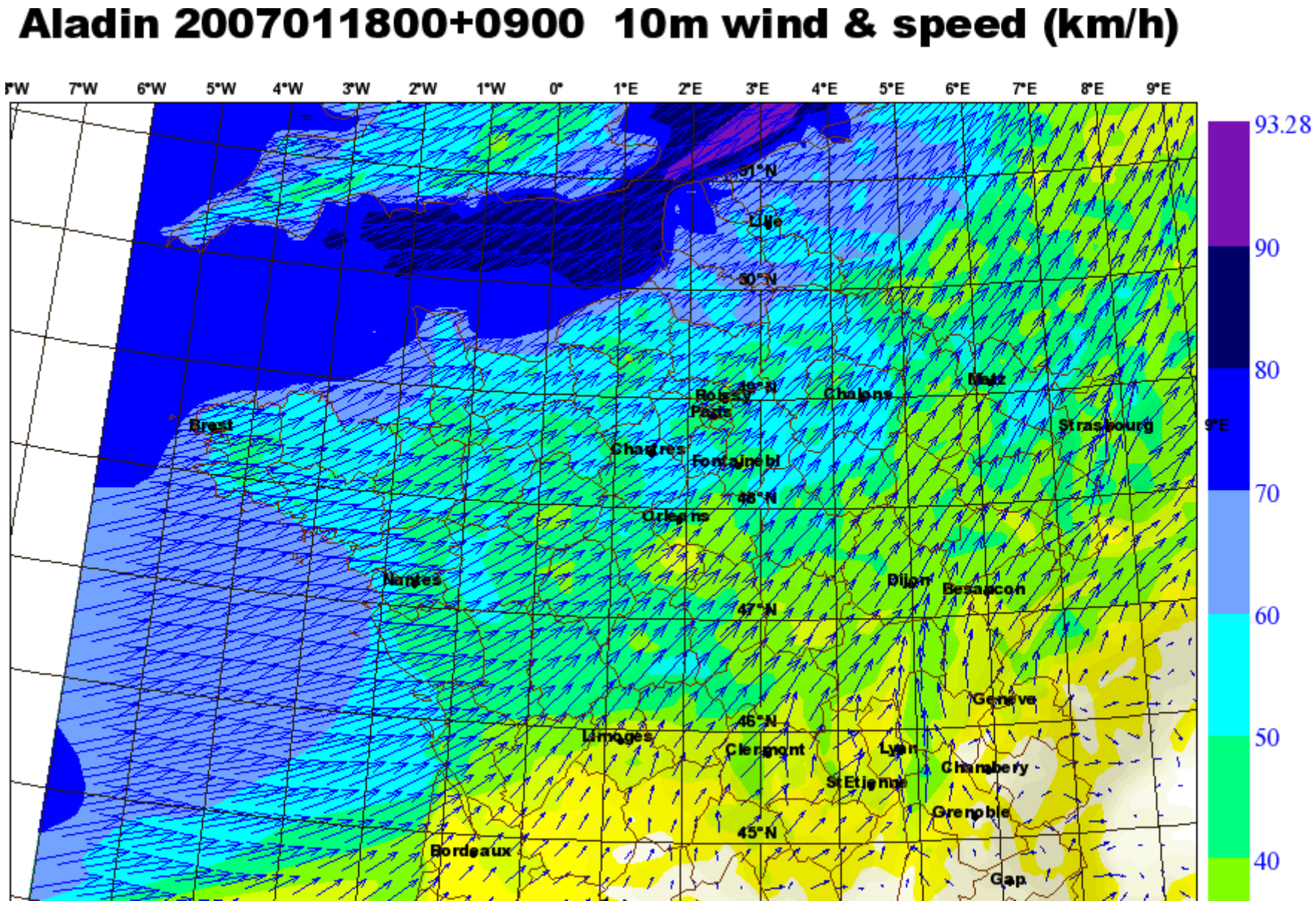


Arome-France forecast

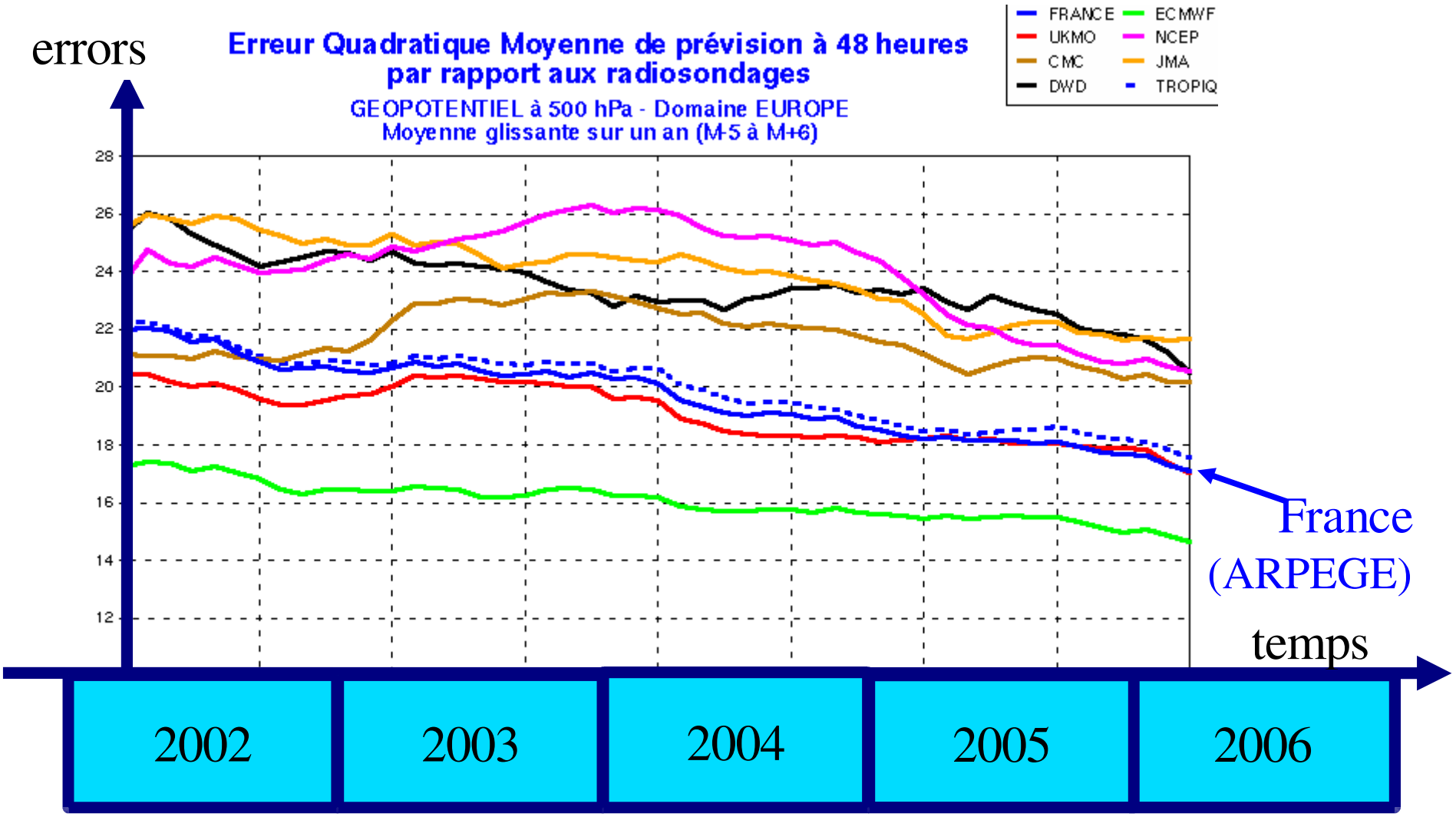


METEO FRANCE

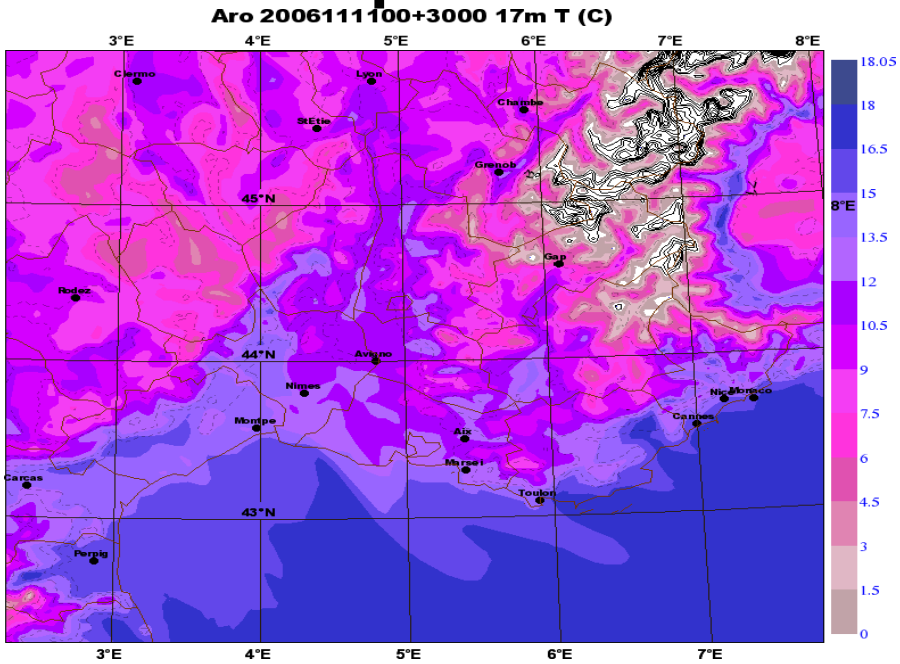
ALADIN's not dead ! e.g. a successful downscaling of winter storm (AROME is similar)

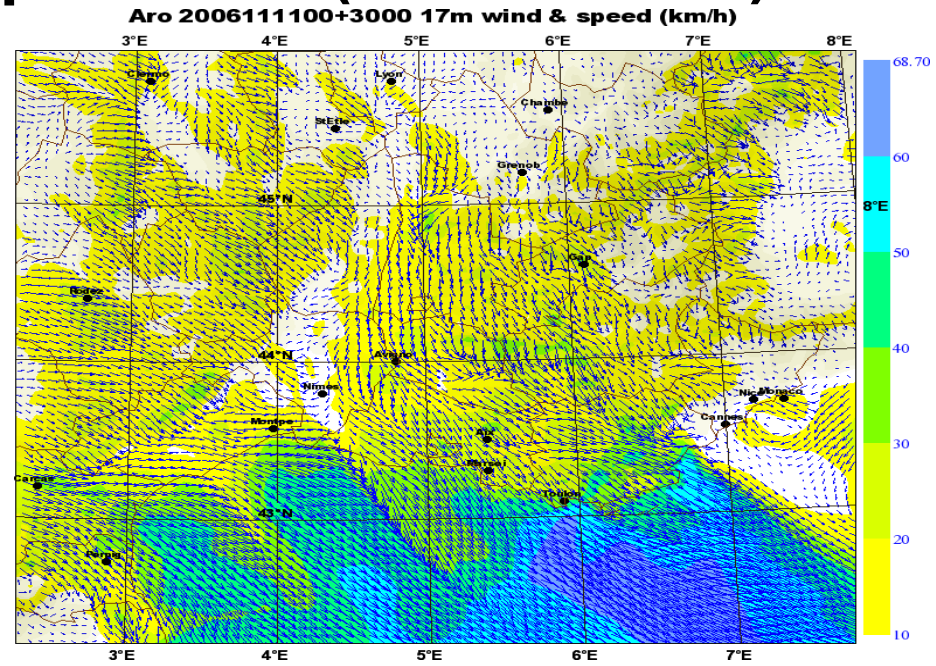


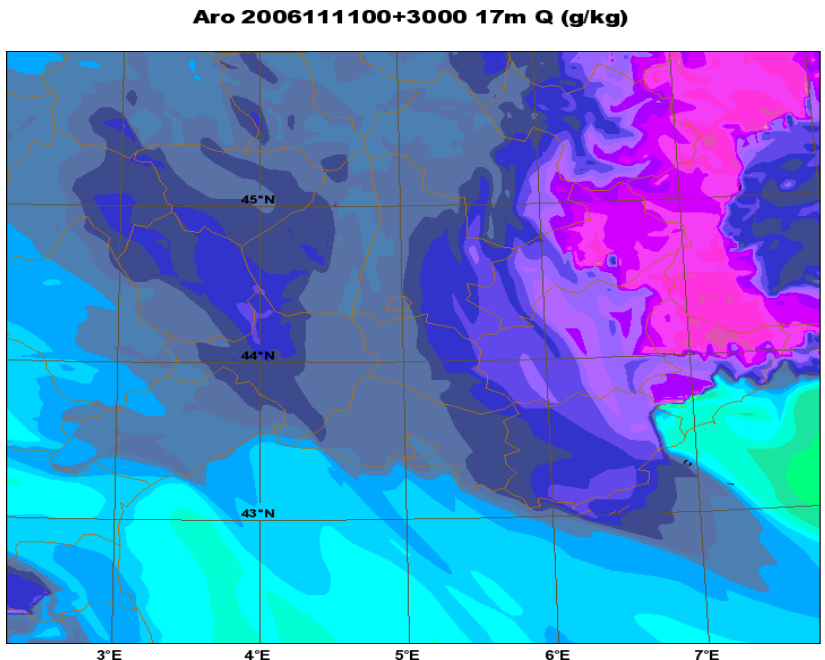
ARPEGE's not dead, either :
massive efforts & results in recent years
(and more to come !)

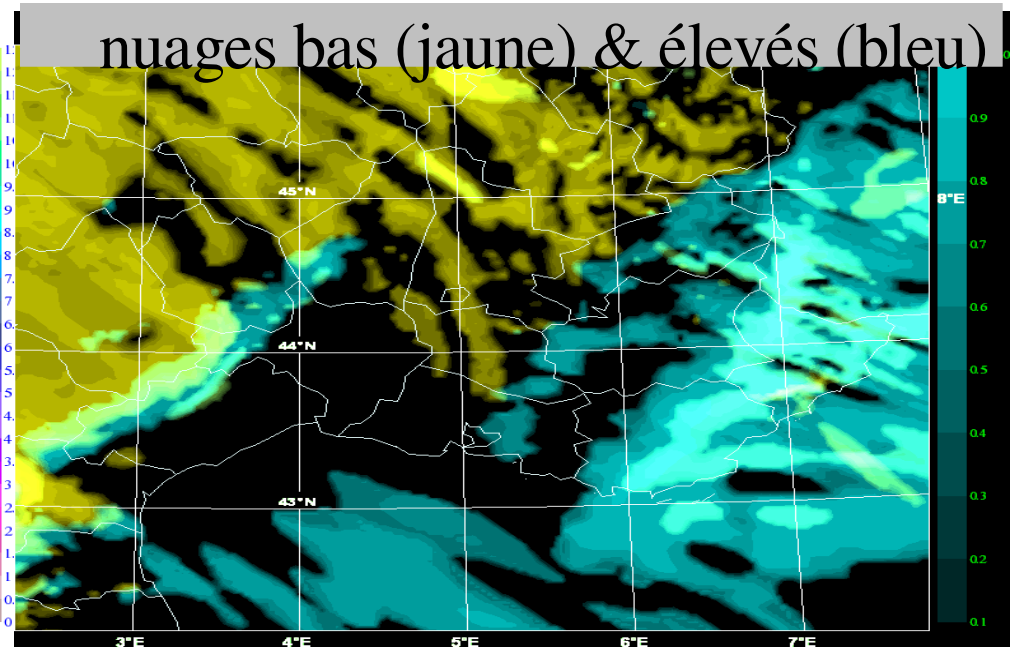


A sample of Arome output fields (Mistral case)

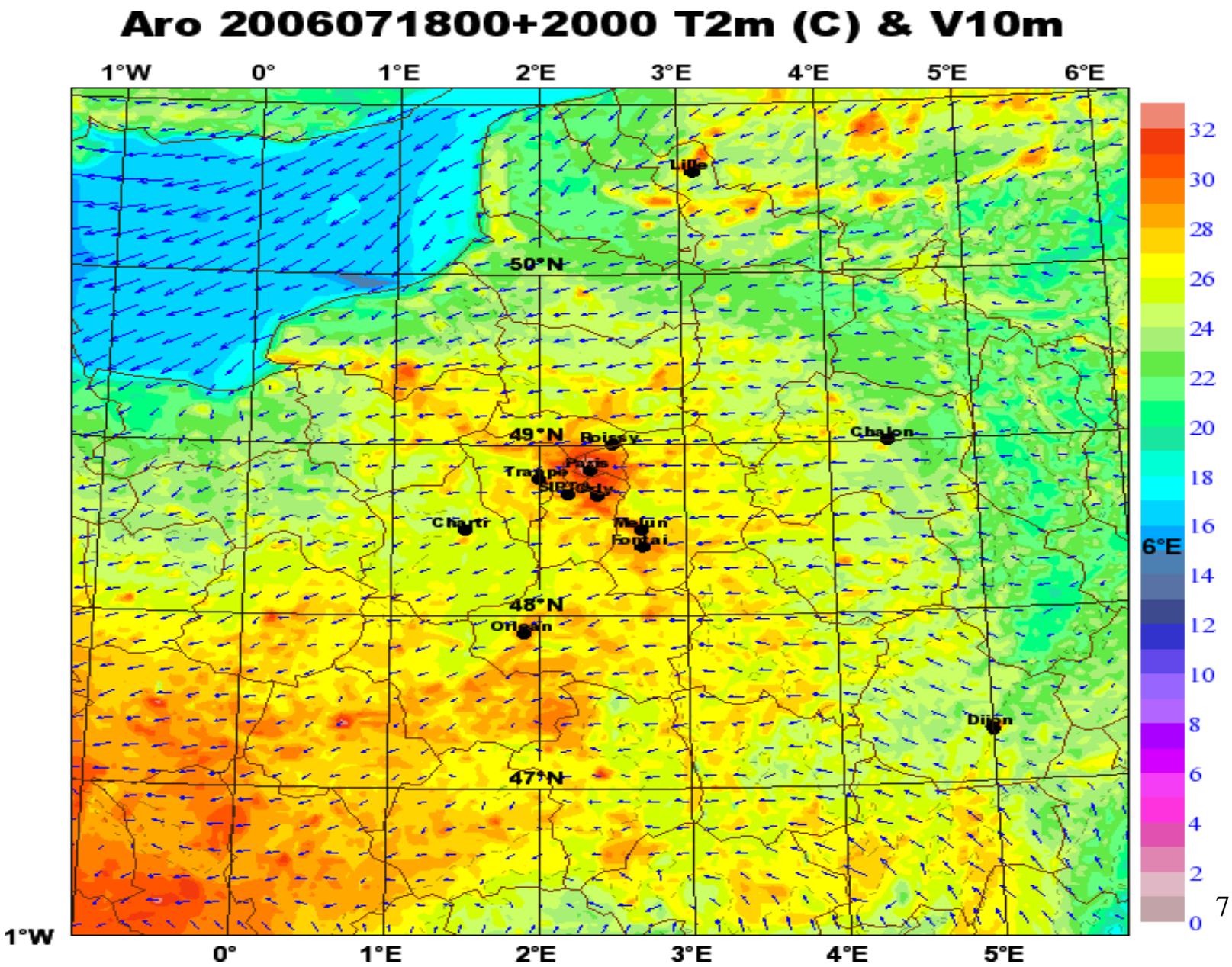








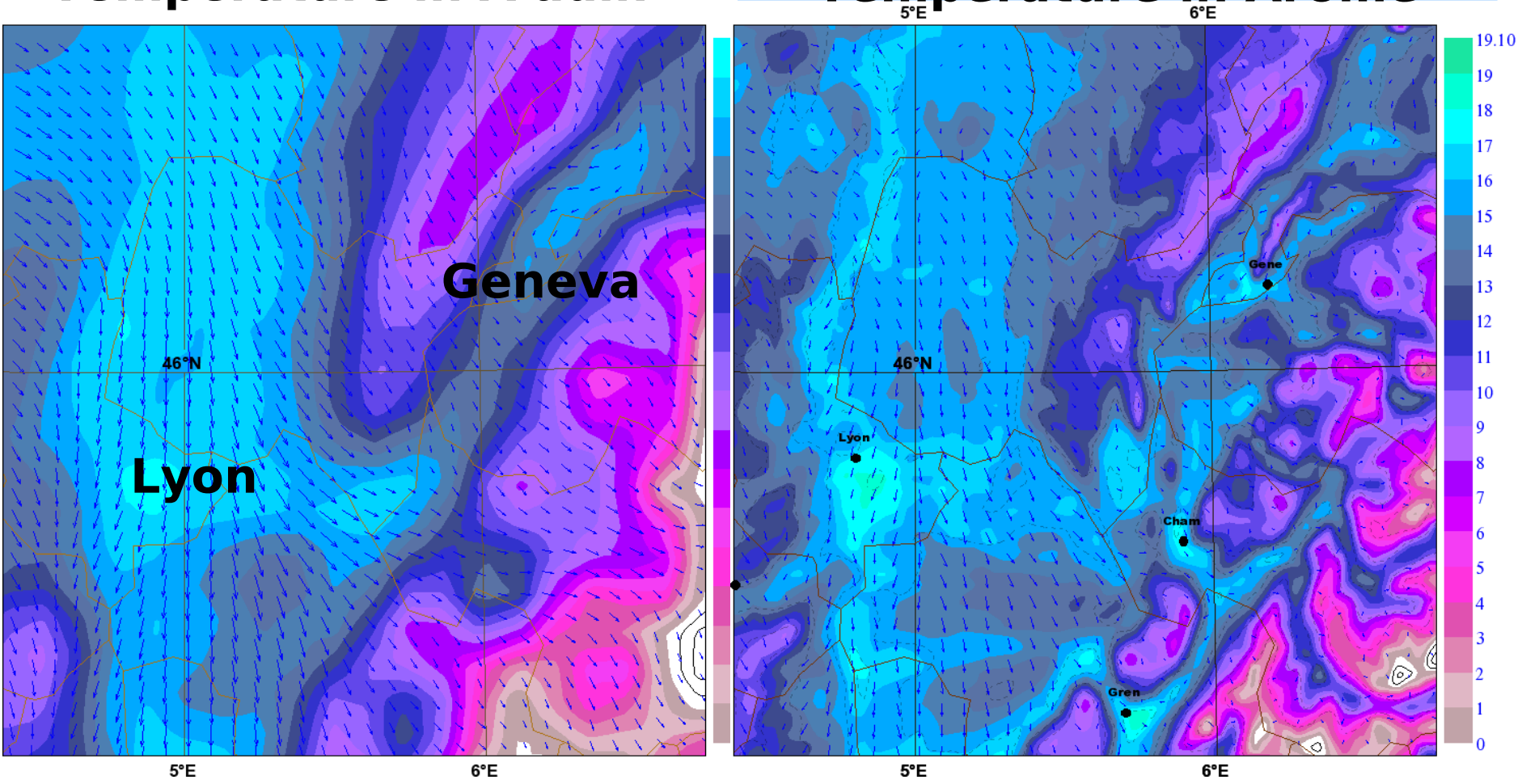
Important application: urban heat islands



High resolution has enormous impact near cities, valleys, mountains and big lakes

Temperature in Aladin

Temperature in Arome

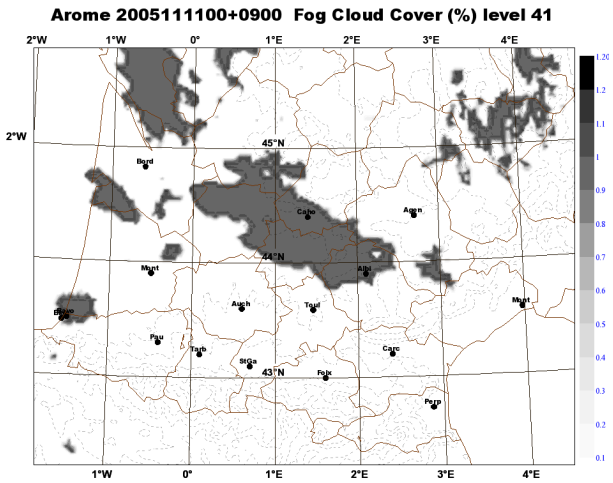


METEO FRANCE

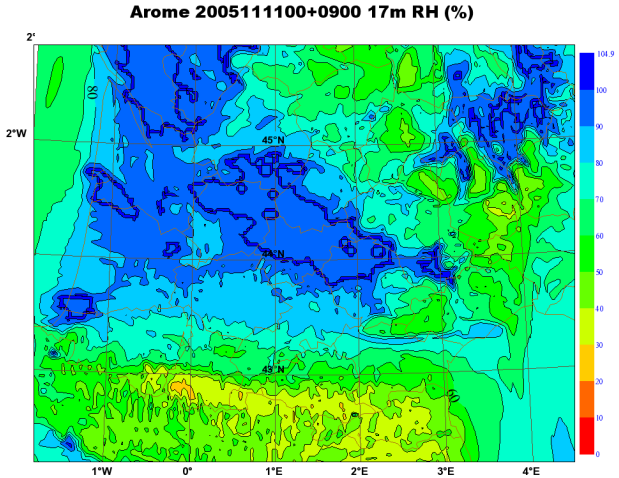
Explicit fog forecast: only in Arome (improved by droplet sedimentation)

11 Nov 2005

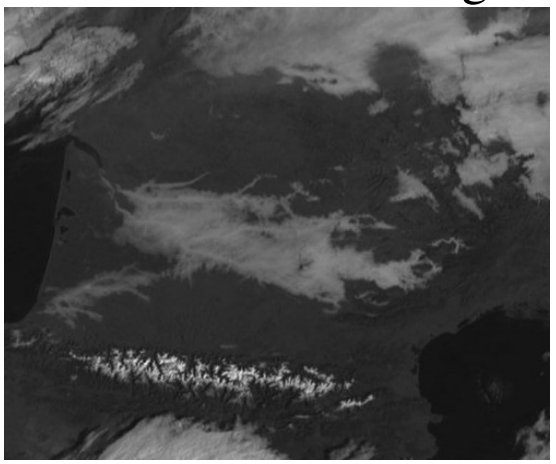
Arome forecast



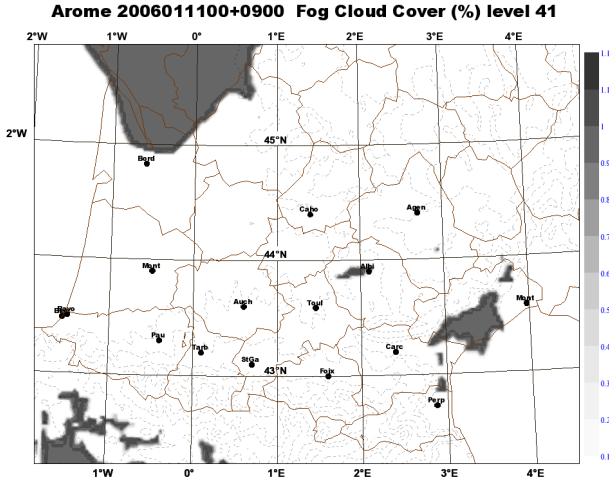
relative humidity forecast

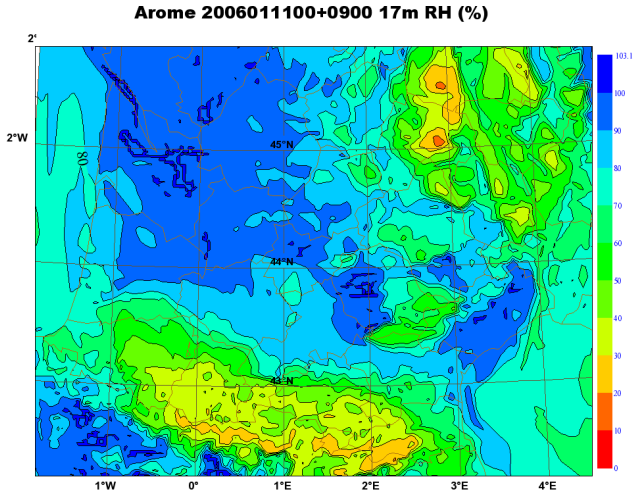


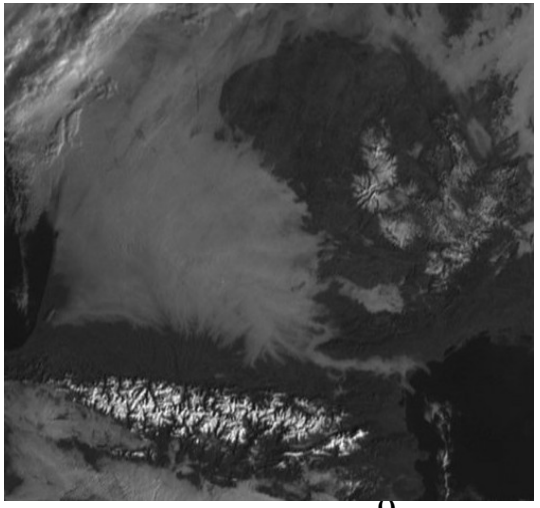
satellite visible image



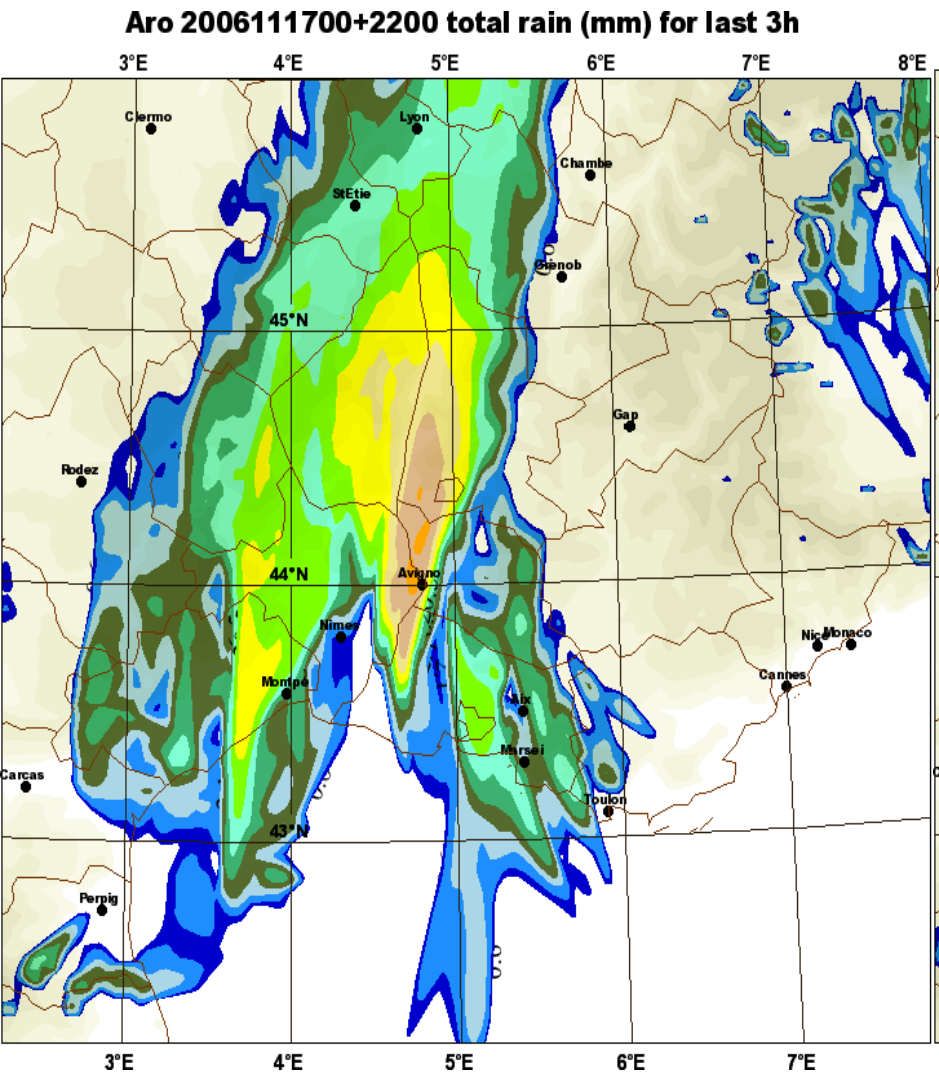
11 Jan 2006

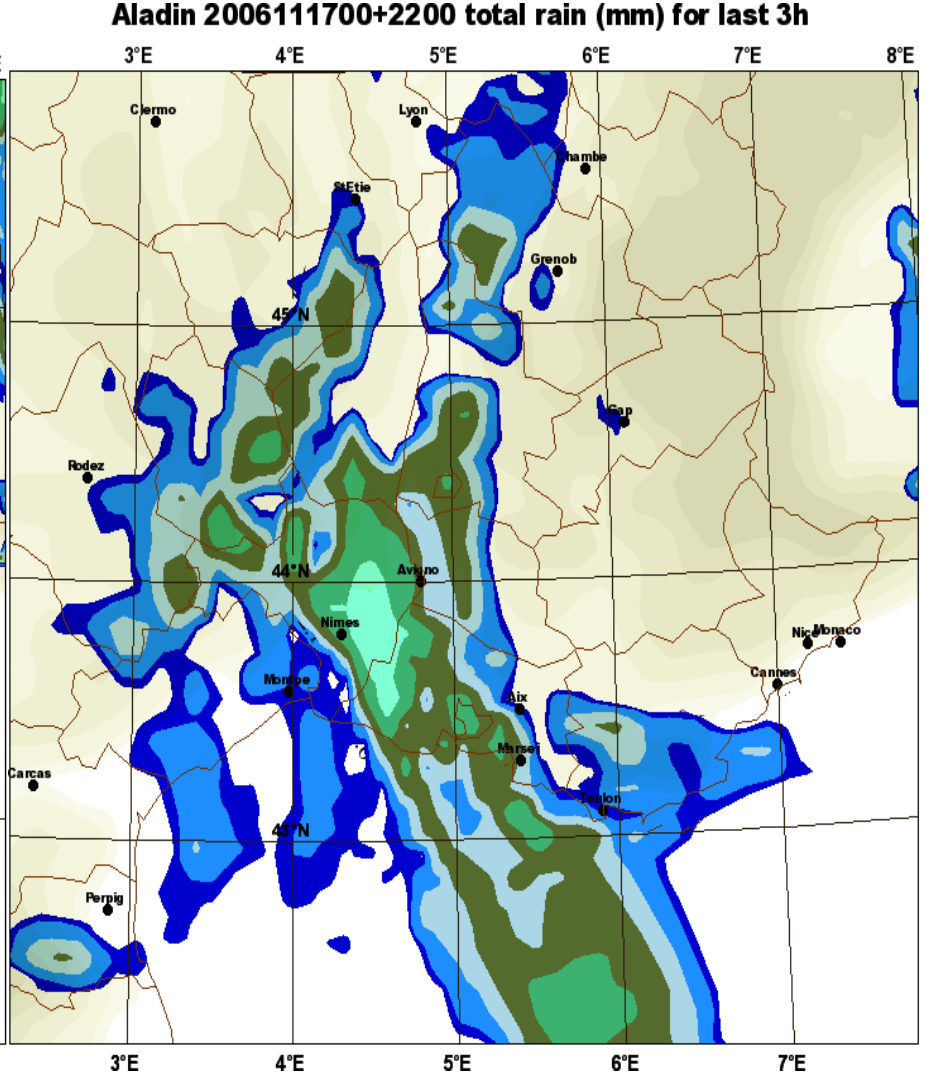




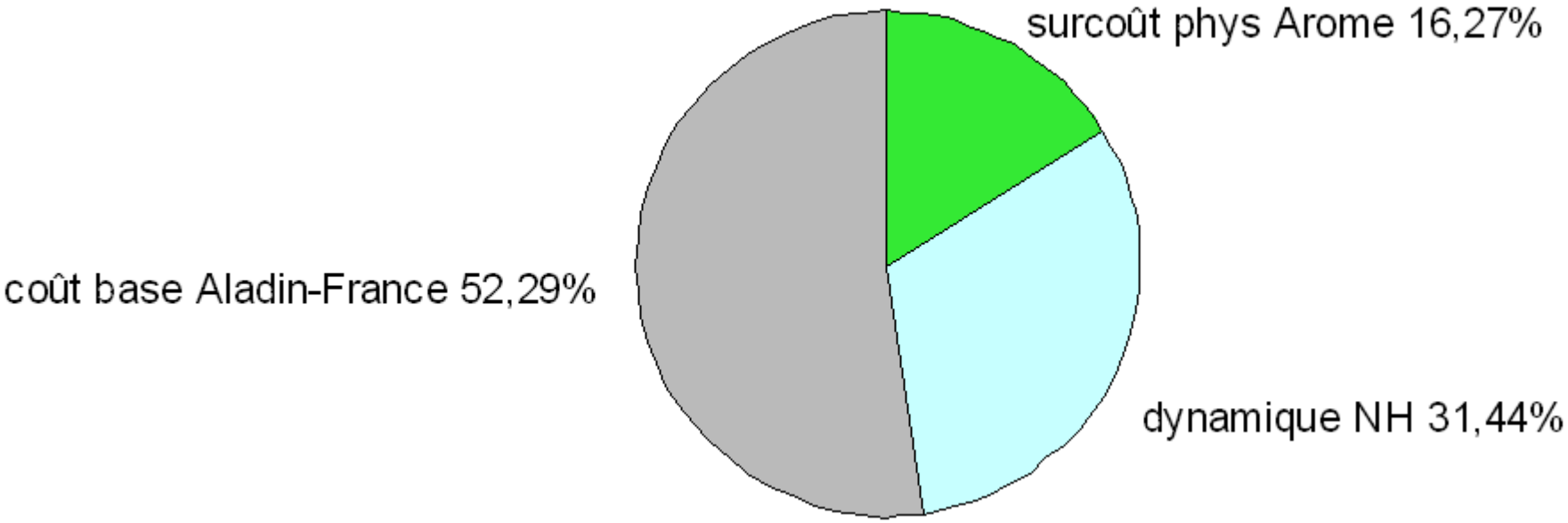


Arome vs Aladin in a common Mediterranean precipitation case

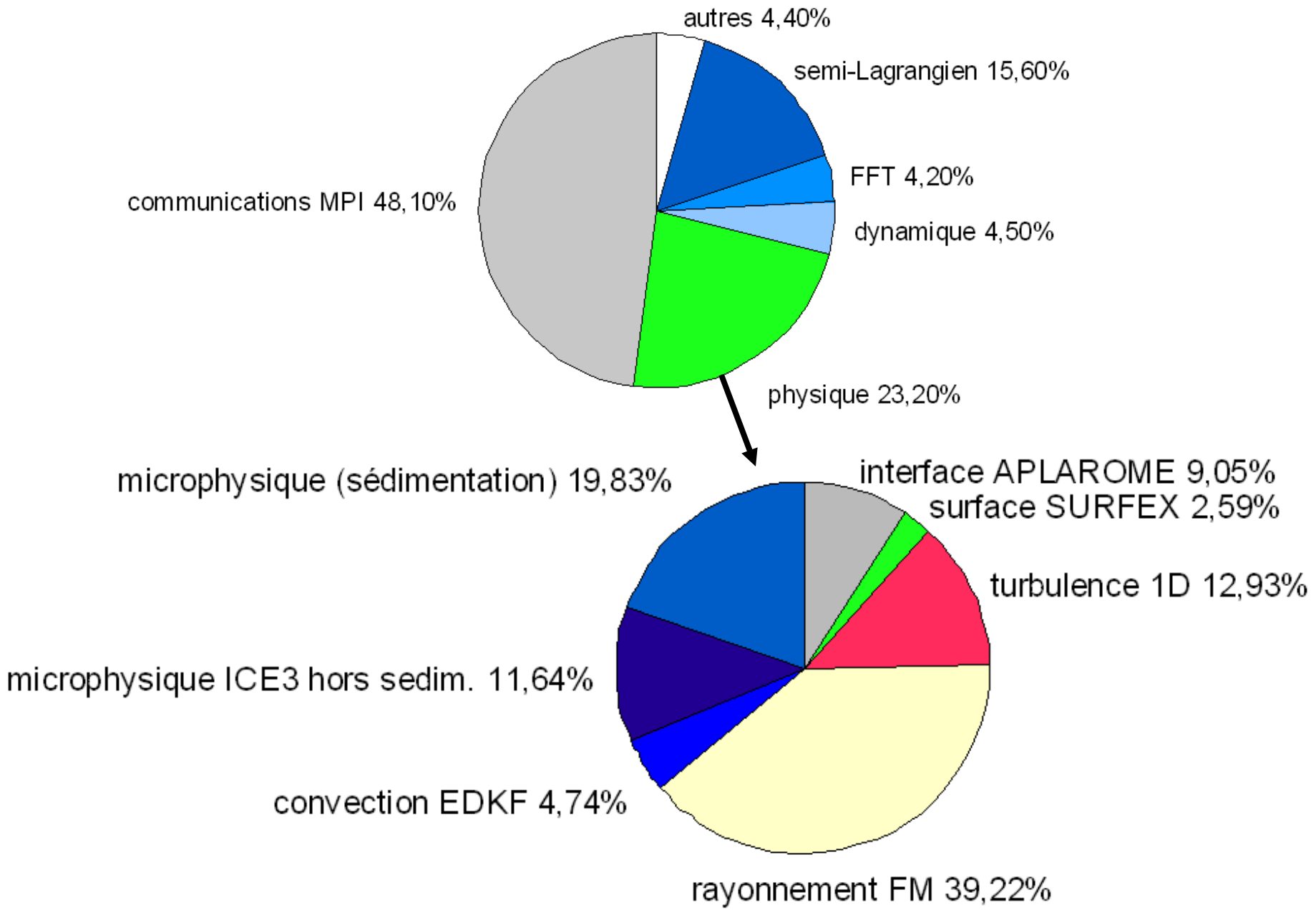




Model timing on NEC: cost of Arome timestep vs Aladin-France

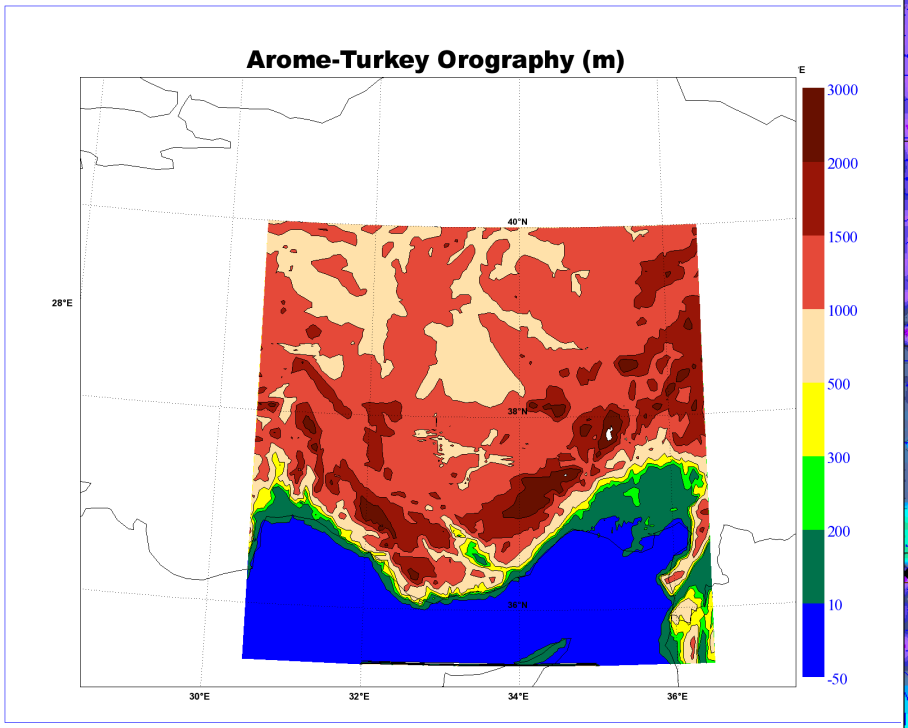


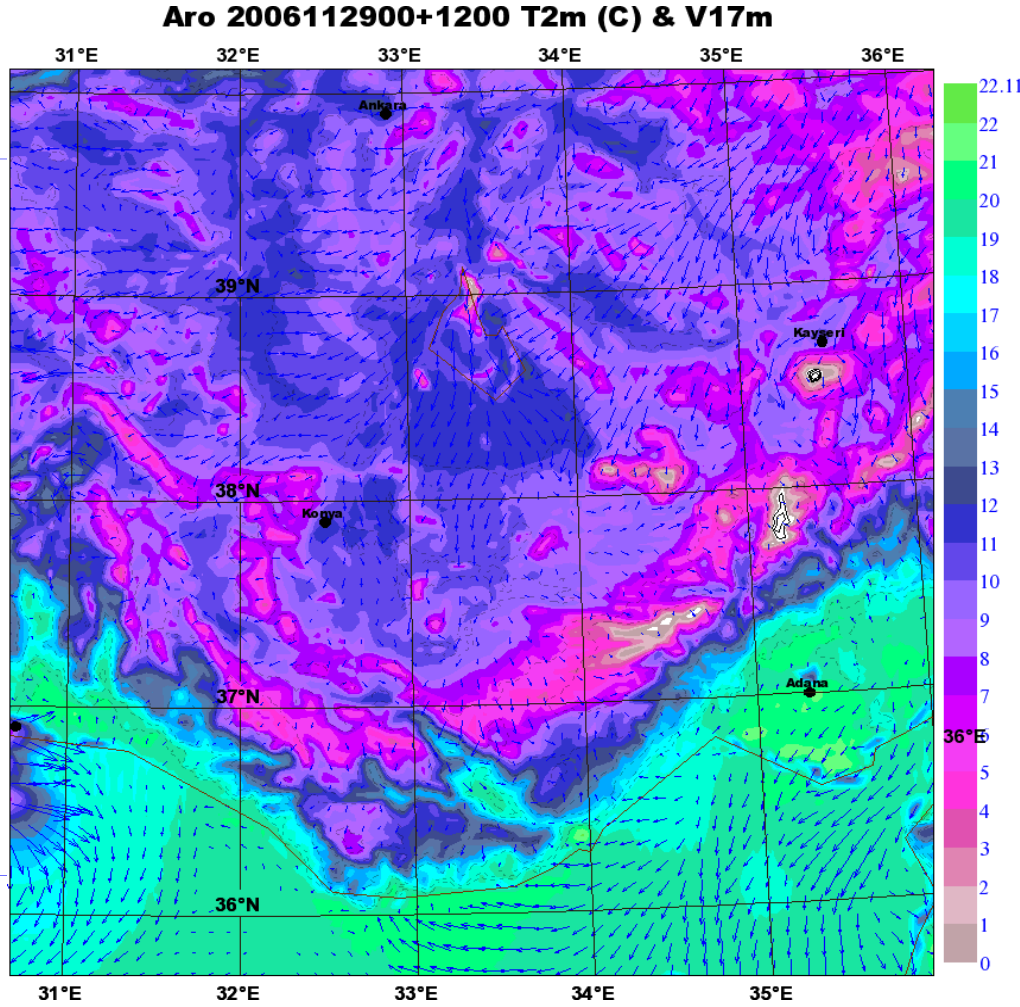
CPU cost breakdown: total & physics



test on Turkey

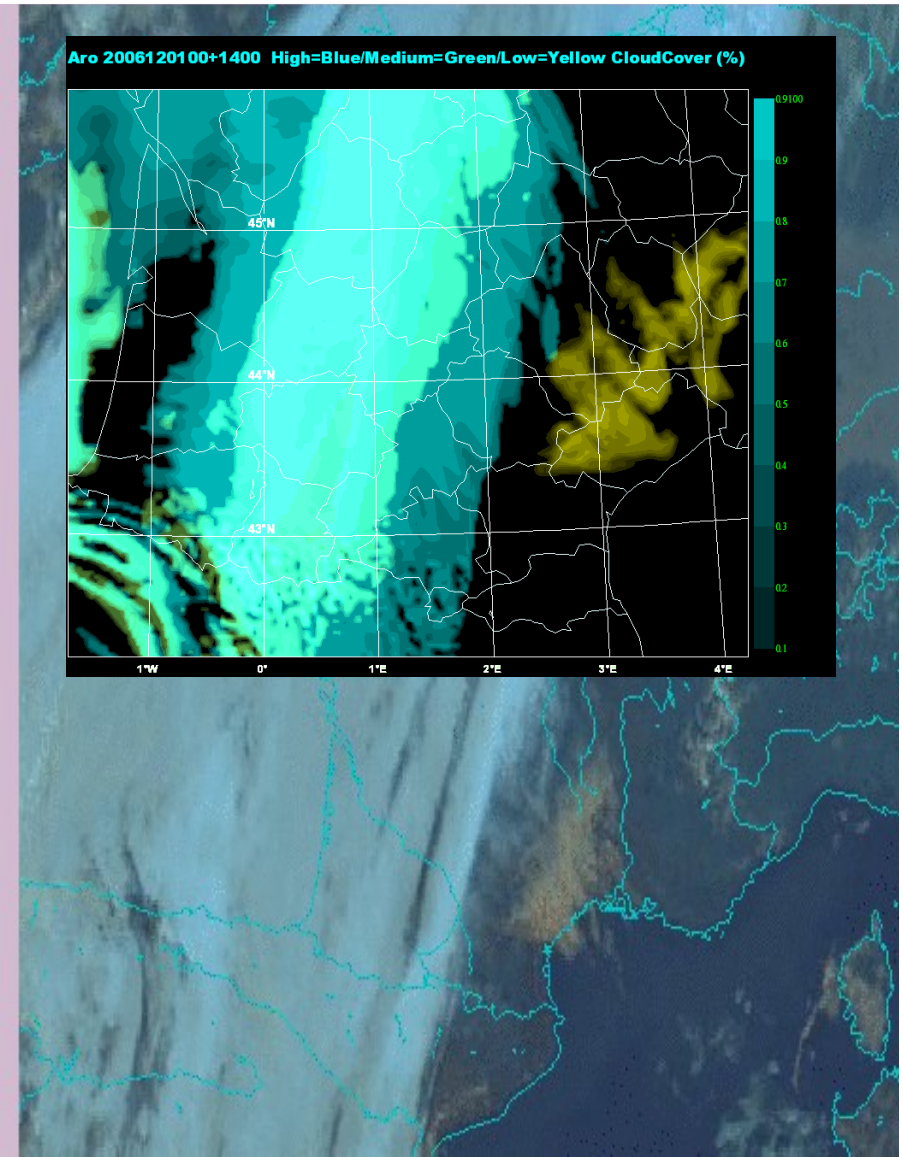
(also done: African convection [AMMA], Nordic countries, Tropical cyclones...)



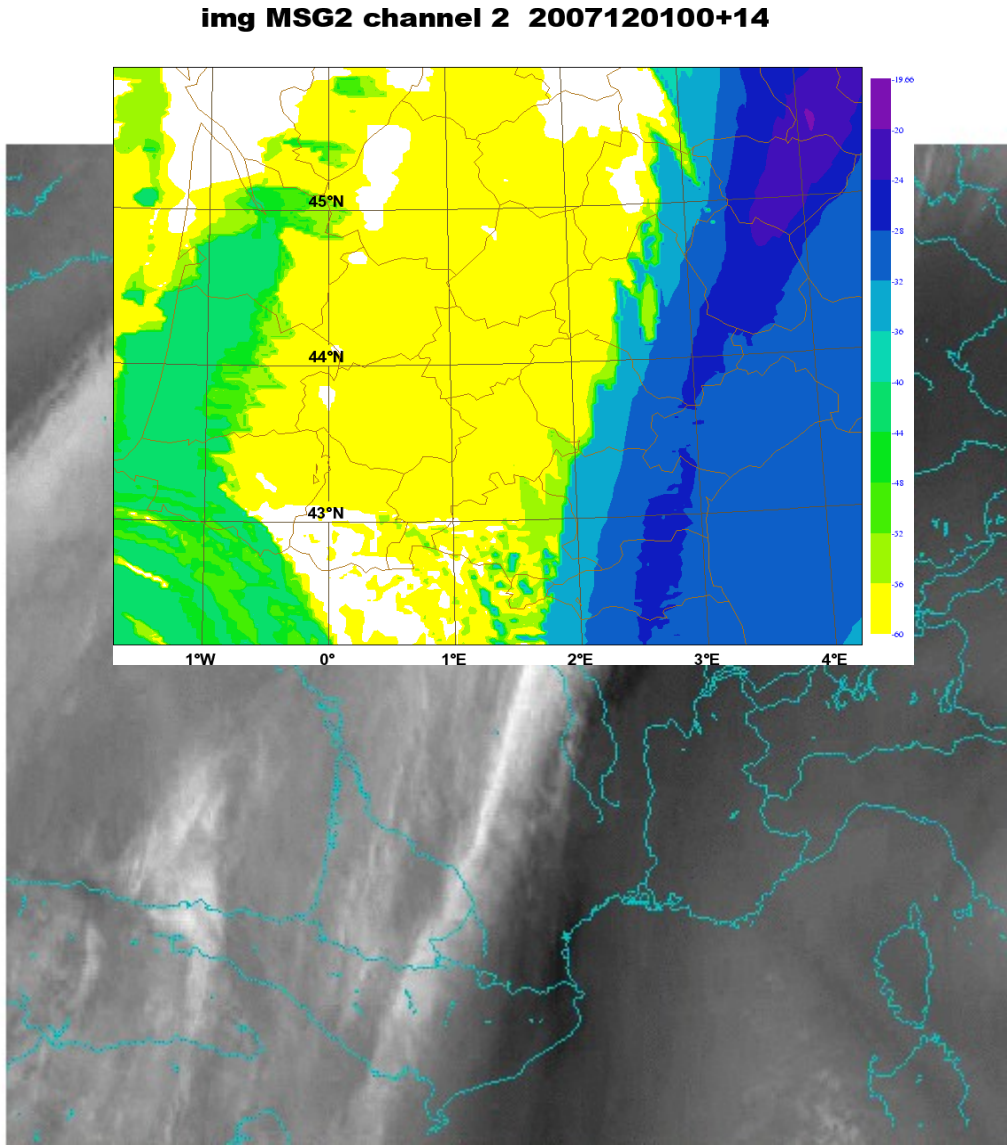


Satellite image simulation from Arome using RTTOV

Arome clouds (yellow=low)



Simulated satellite image (vapour channel 6.2)

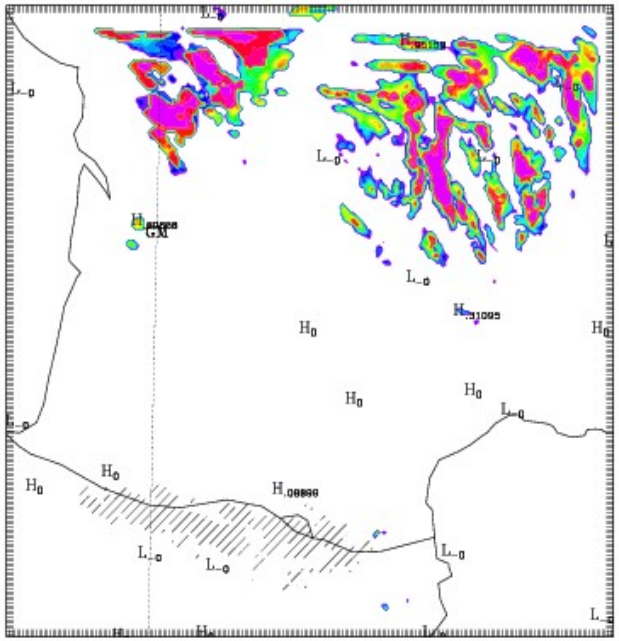


Work on subgrid cloud representation: introduction of mass flux closure into the 'EDKF' shallow convection scheme

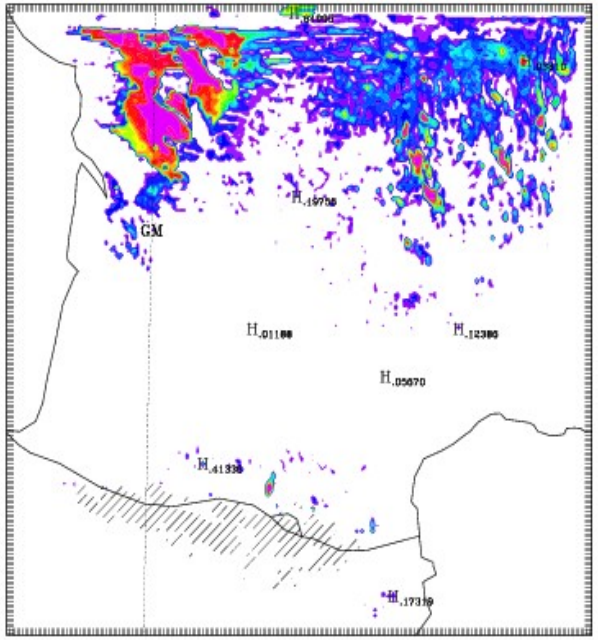
(S. Malardel, M. Lopes, P. Soares, P. Siebesma)

cloud content at 1500m on 6/6/6, 11hUTC

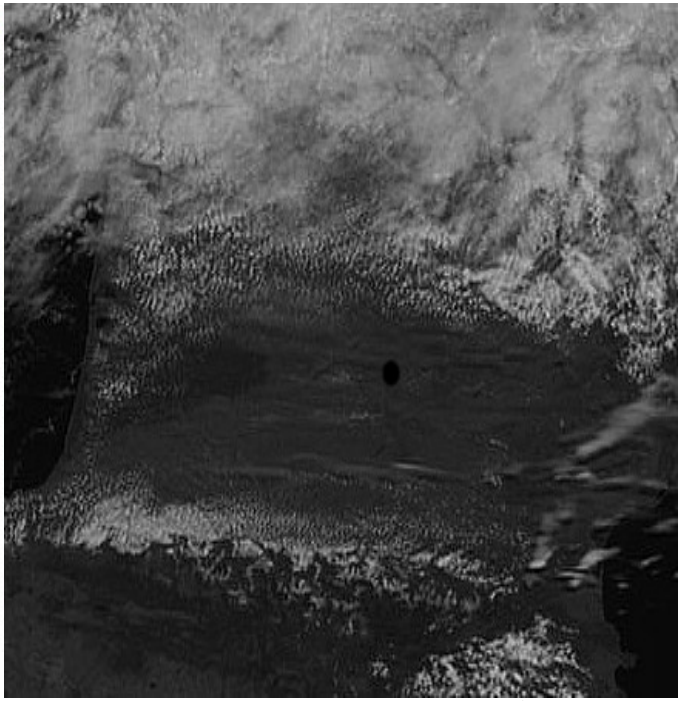
before



after



Meteosat image (visible)

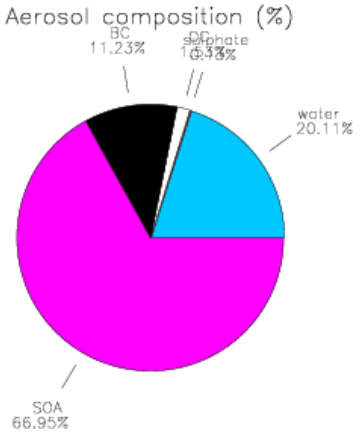


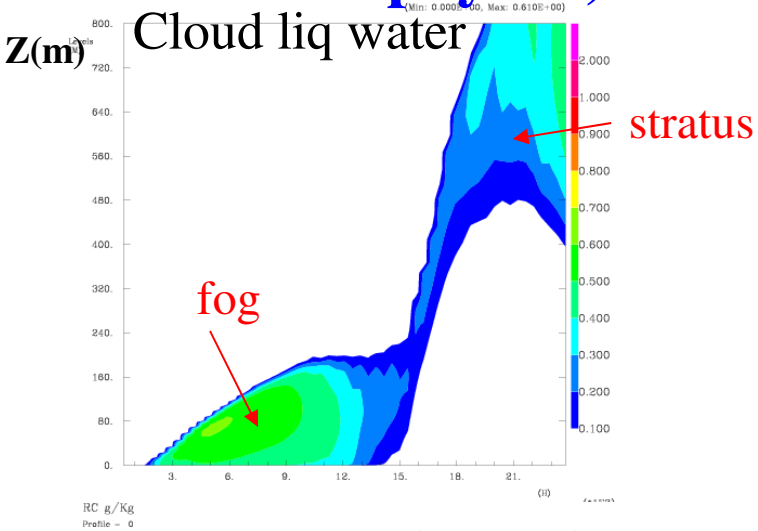
METEO FRANCE

Work on fog sensitivity to the aerosol specification

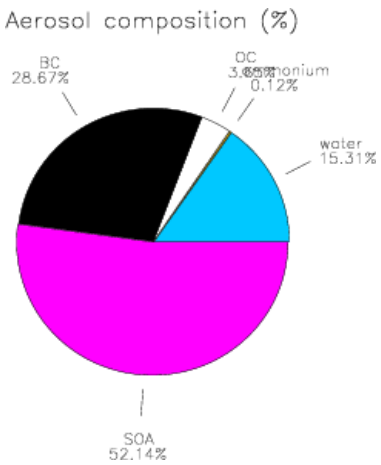
(research tests with Méso-NH & ORILAM physics)

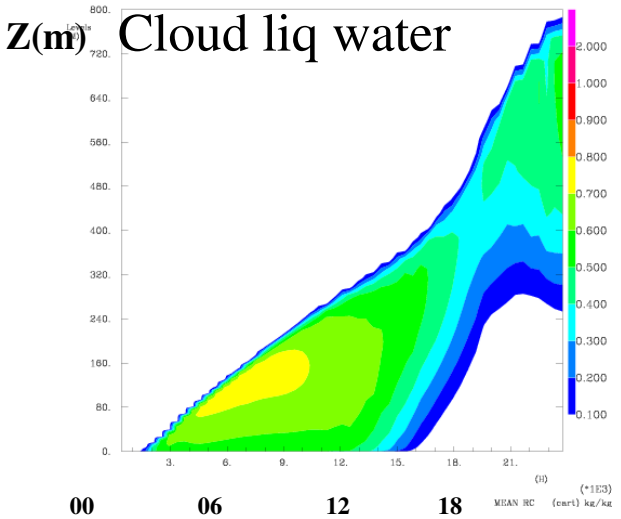
countryside aerosols





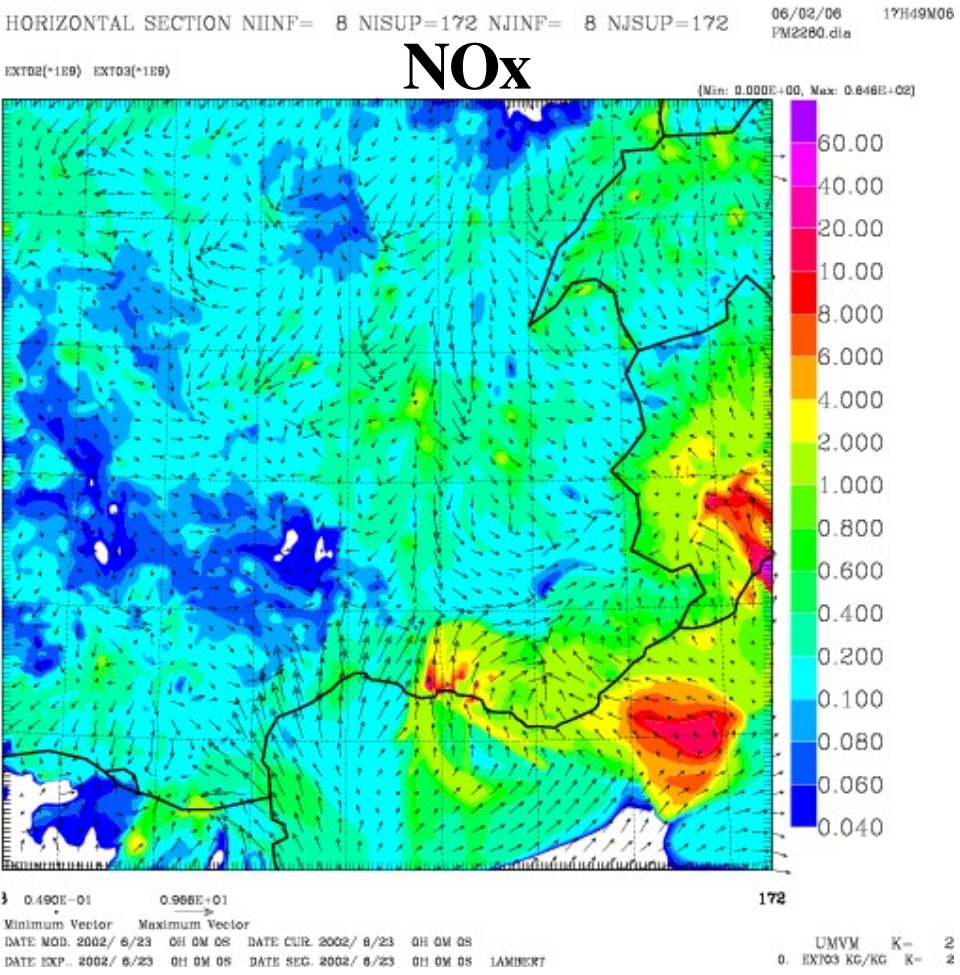
urban aerosols

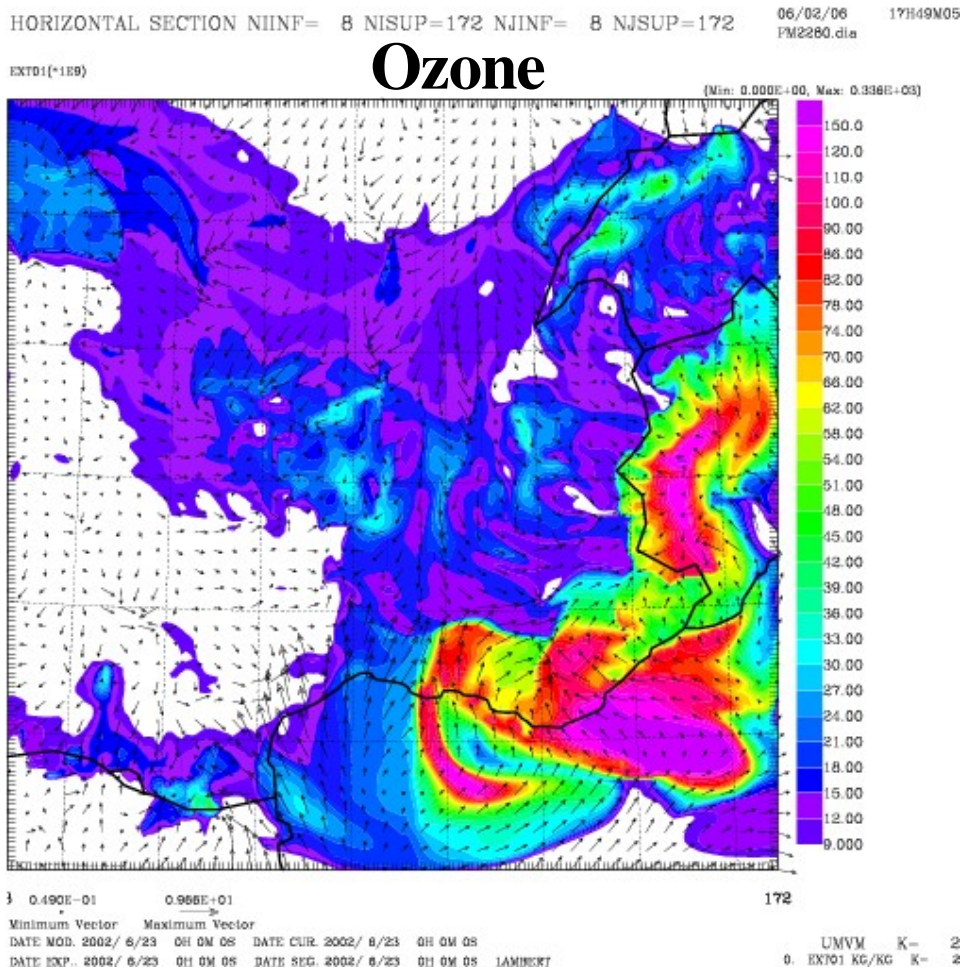




(communication P. Tulet)

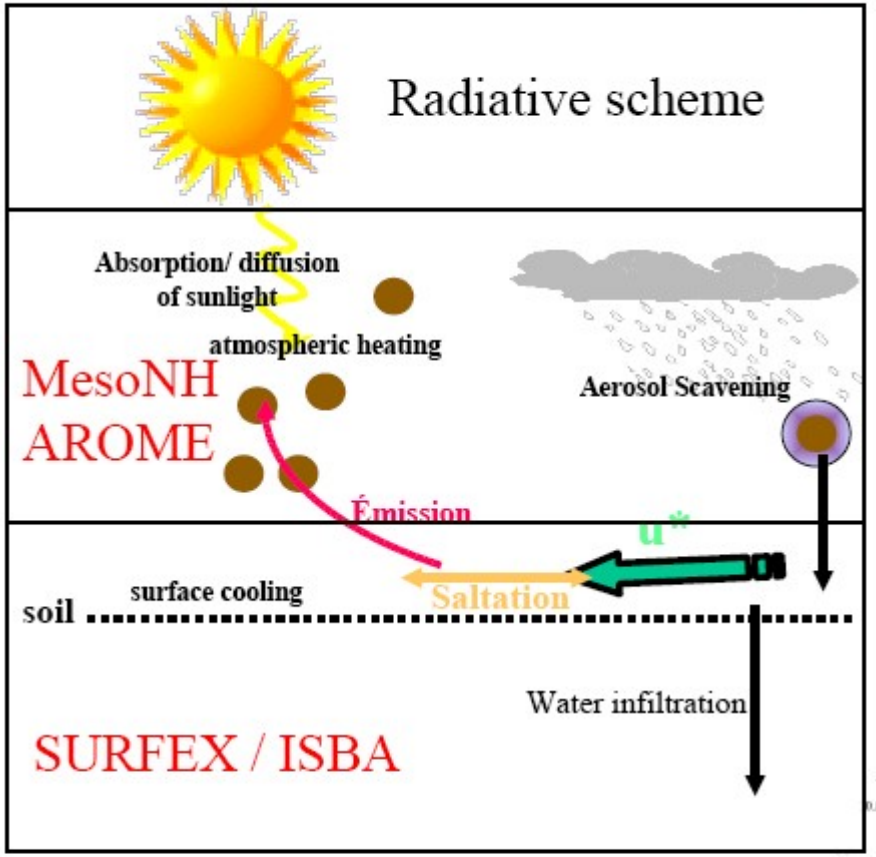
Arome-chemistry - 24/6/2001 14 UTC on Marseilles (38 h forecast)

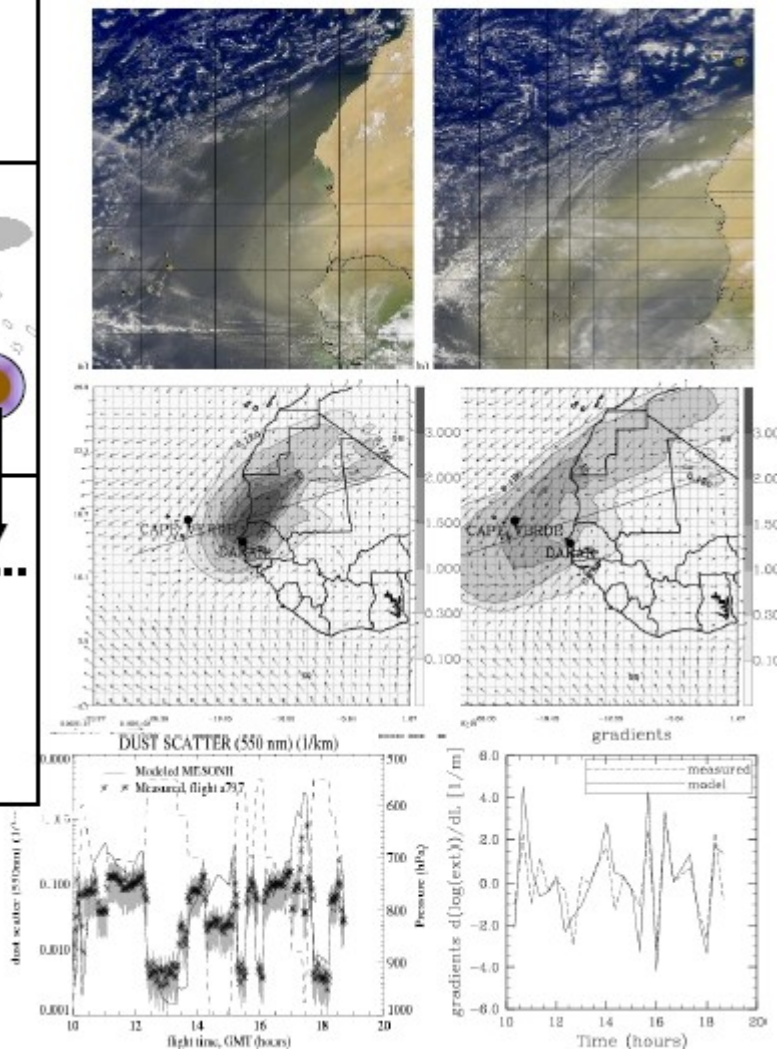




SURFEX option: dust

Desertic Dust (on-line coupling)





Grini et al, 2006

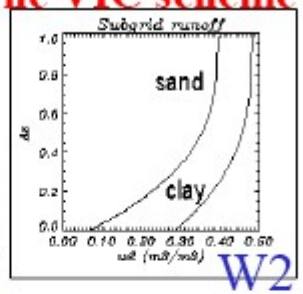
METEO FRANCE

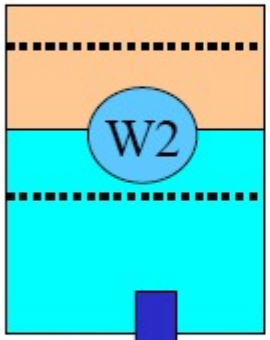
SURFEX option: hydrology

Surface Run off and drainage parameterizations

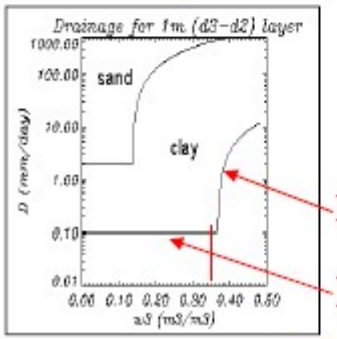
The VIC scheme

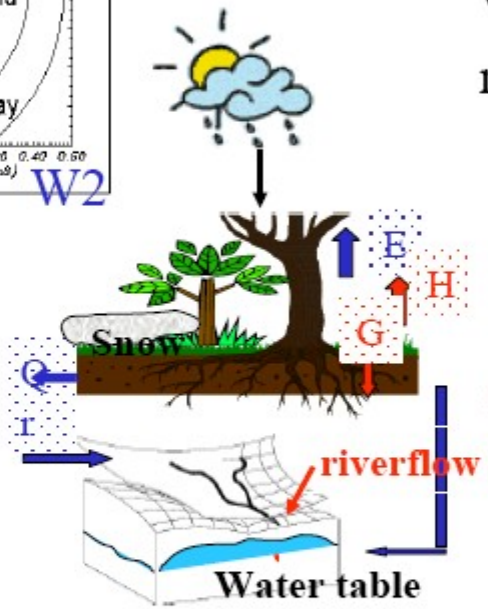
Surface runoff





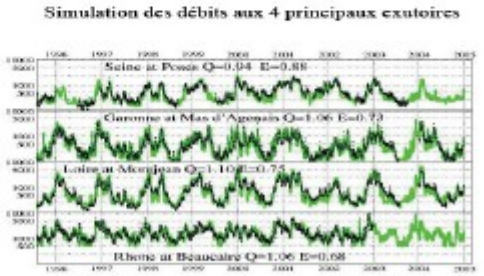
Drainage





the SIM model

Validation with observed river flows



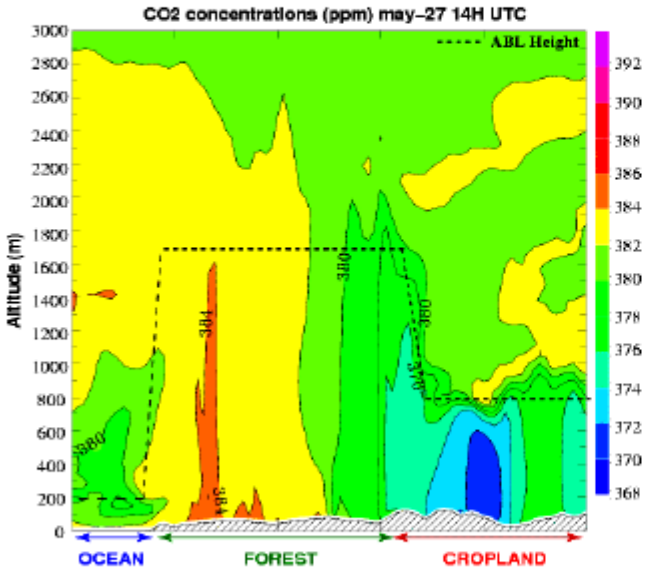
Simulated riverflows of large basins

(Habets et al. 99)

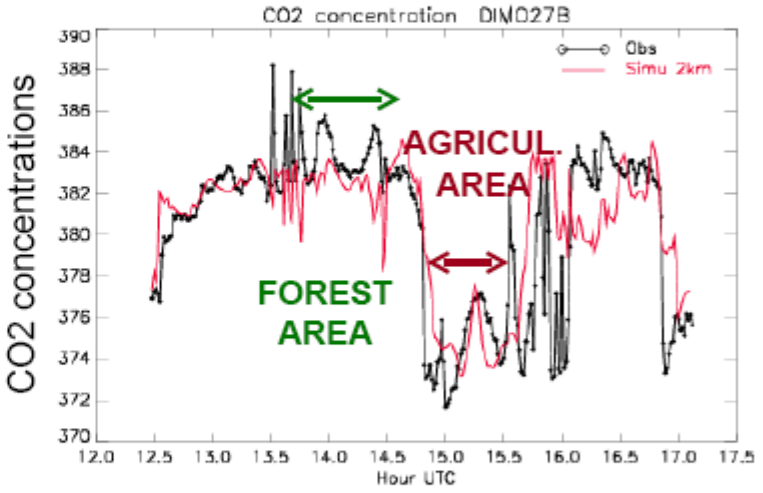
METEO FRANCE

SURFEX CO2 flux option (ISBA-A-gs)

Atmospheric CO_2 modeling with MesoNH coupled with Isba-A-gs
(Ceres , may-June 2005)



Simulated CO2 concentrations (ppm) 14HUTC



Comparison of Simulated and obesrved CO2 concentrations (ppm) 14HUTC

Other model improvements

(not shown here)

- **tests on diffusion (SLHD)**
- **sedimentation in microphysics**
- **fixes in SURFEX clim preparation and PBL postprocessing (big impact on T2m biases)**
- **hail, cirrus**
- **3MT convection**
- **software portability & optimisation**

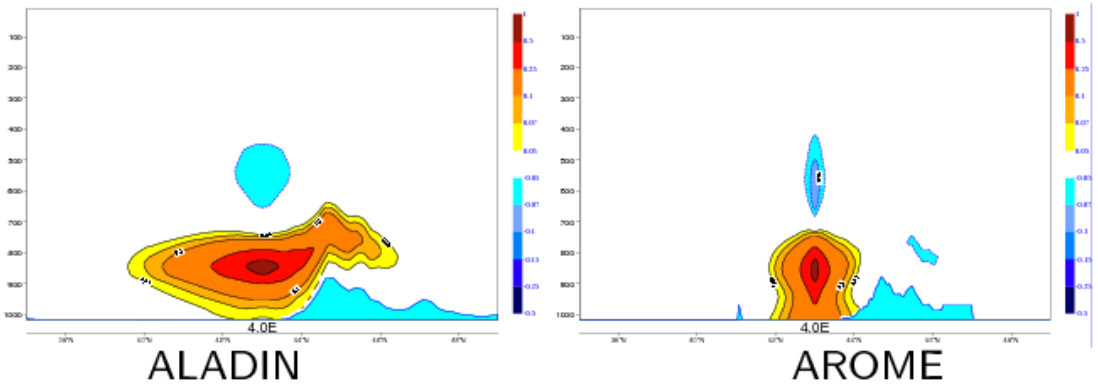
Advances in data assimilation

- a priority, slowed down by migration to NEC in MF, and the complexities of (radar) obs management
- real-size assimilation experiments have just started (P. Brousseau)
- (nice) recent radar assimilation results using ALADIN
- 3D-FGAT eagerly awaited: good for frequent obs

Calibration of Jb error statistics

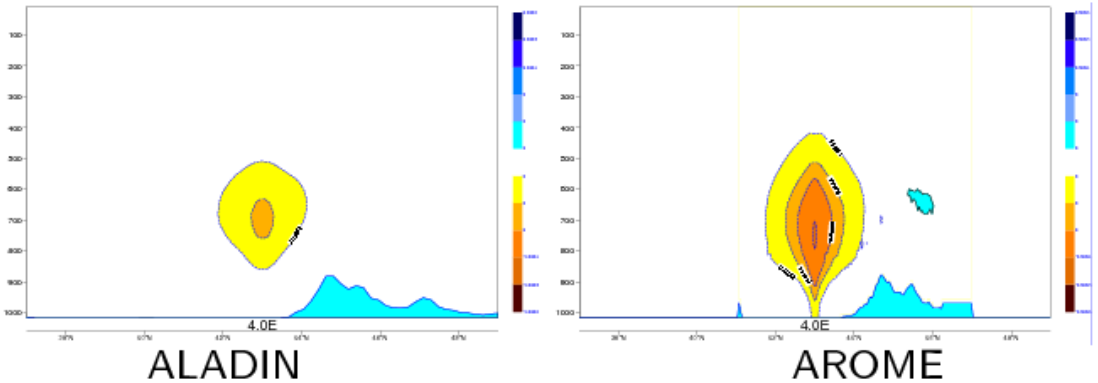
Fine-scale, using Arome ensemble forecasts (P. Brousseau, L. Berre)

Single observation of temperature by radiosonde at 850 Hpa : temperature increment



ALADIN AROME

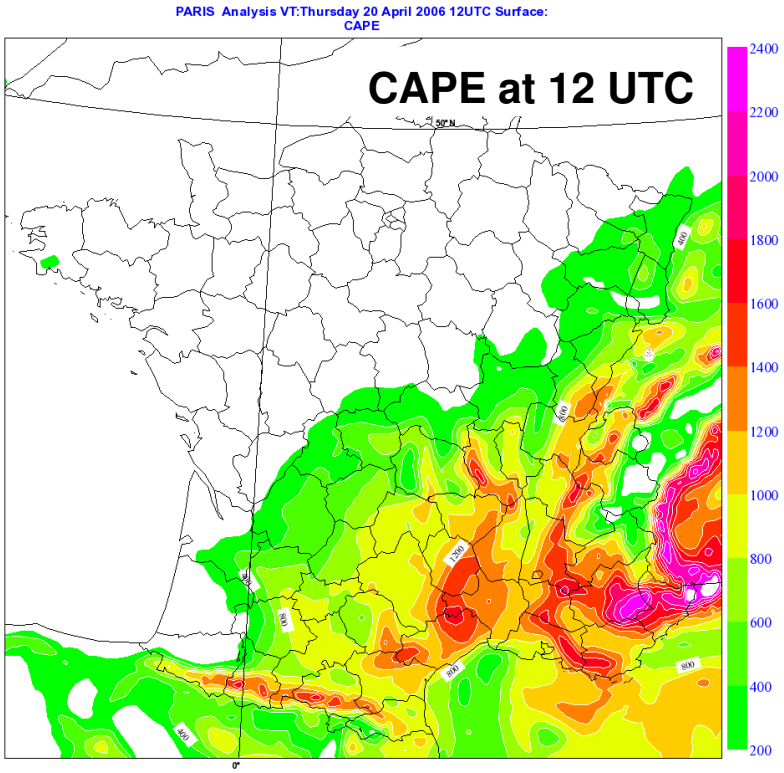
Single observation of radiance by HIRS channel 15 : humidity increment

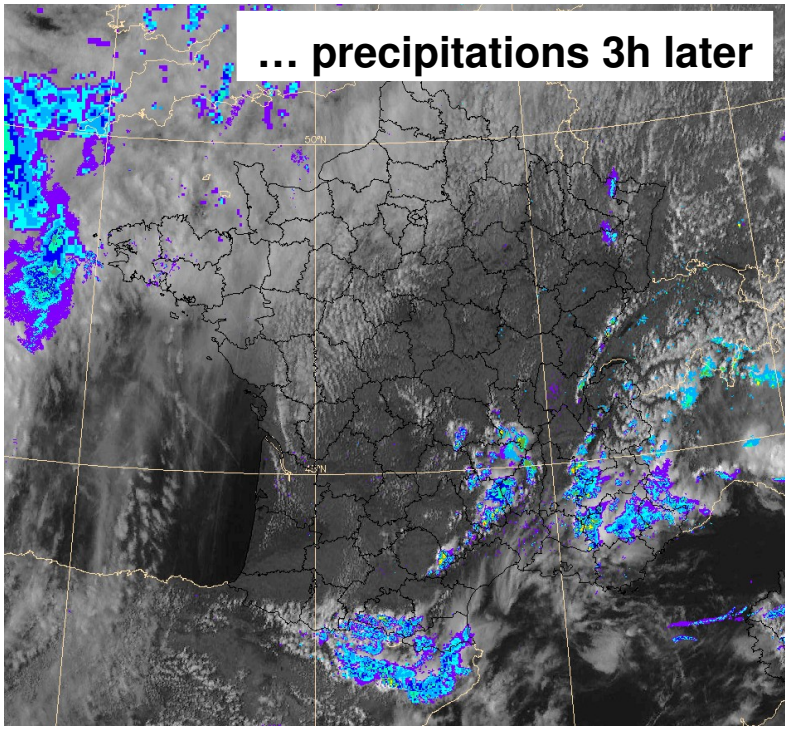


ALADIN AROME

3D-Var analysis for nowcasting (Ludovic Auger)

- based on ALADIN 3DVar
- uses all the observations available for ALADIN, plus the 10m wind
- **provides hourly analyses** of Hu_{2m} , T_{2m} , U_{10m} , CAPE and MOCON over France

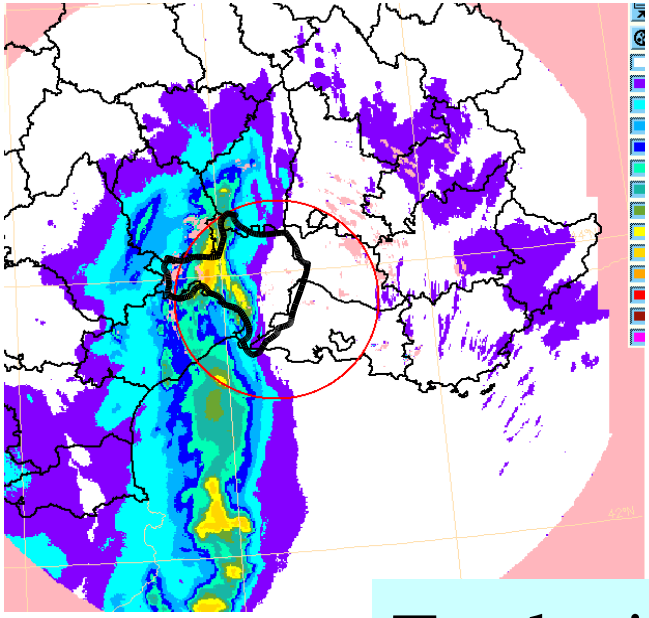


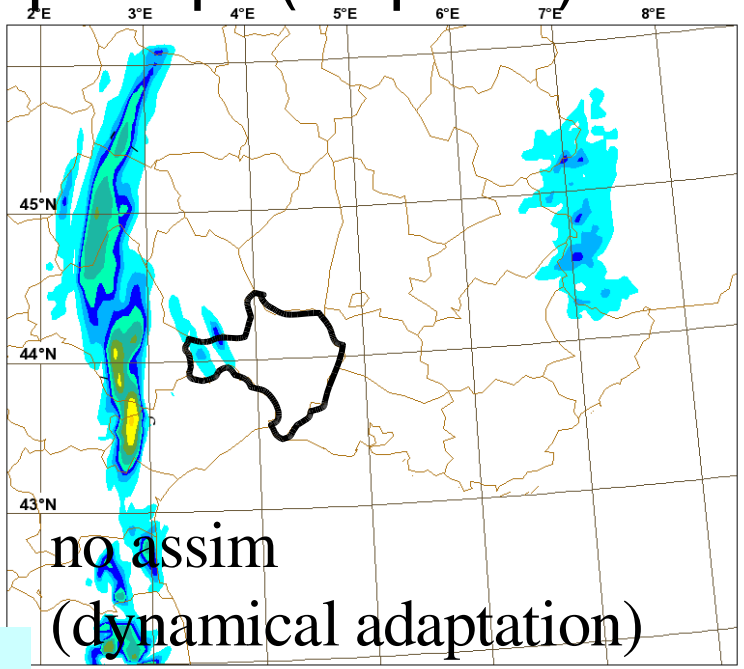


⇒ **Frequent observations of the boundary layer are very useful in that case**

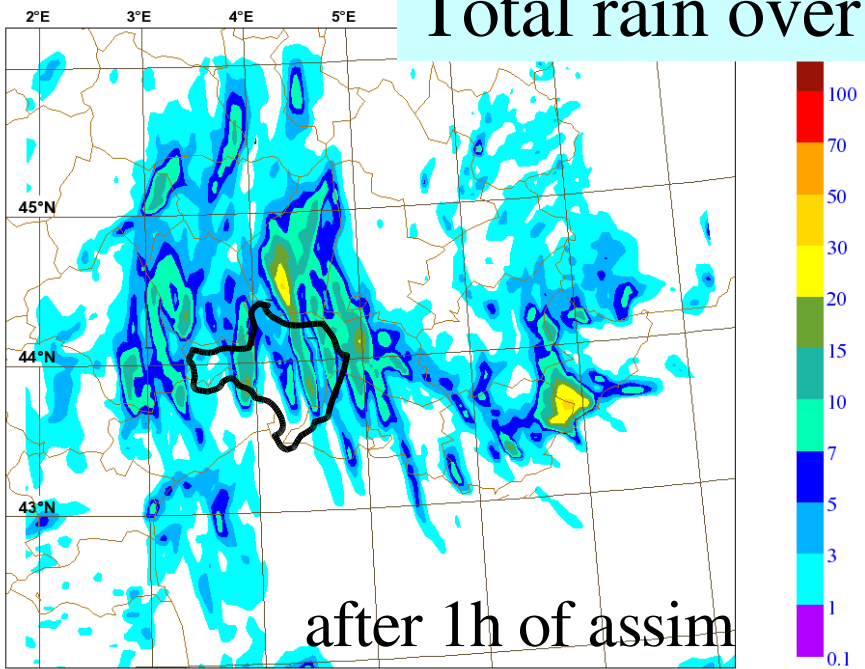
… soon operational

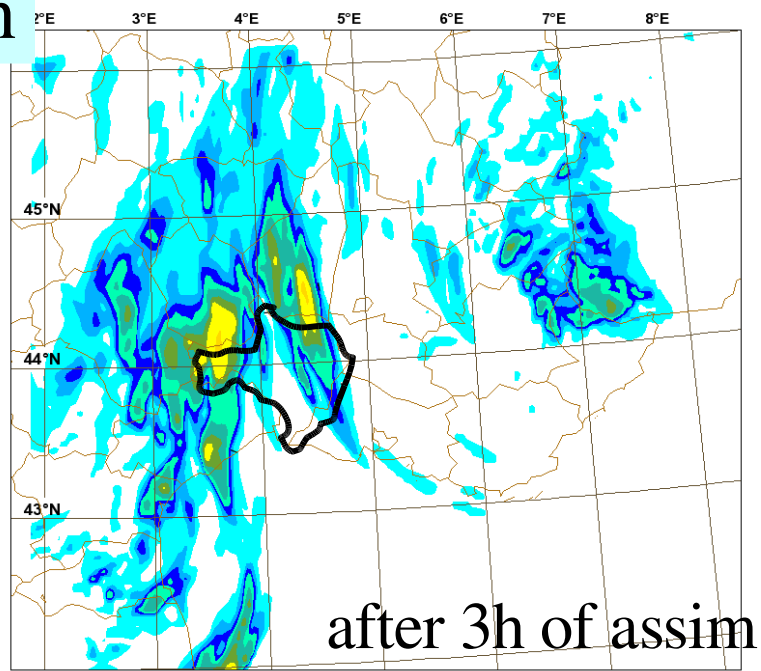
effect of assimilation on precip (Sept 05)





Total rain over 3h





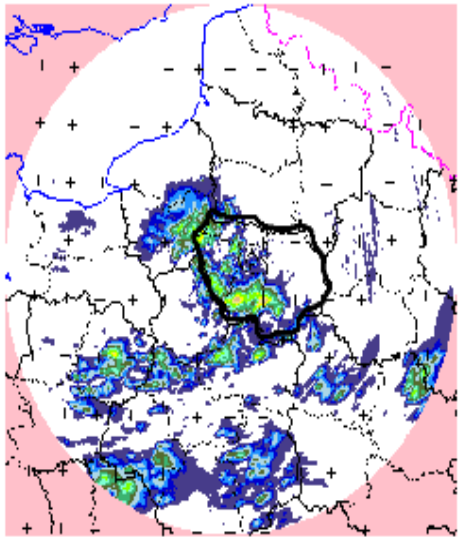
Impact of Doppler radar assimilation

(assimilation in Aladin + Arome adaptation so far)

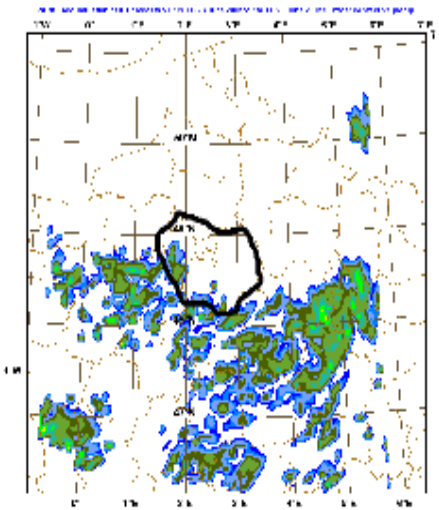
(Arome DA tests have just started)

Case of 23 Juin 2005 over Paris

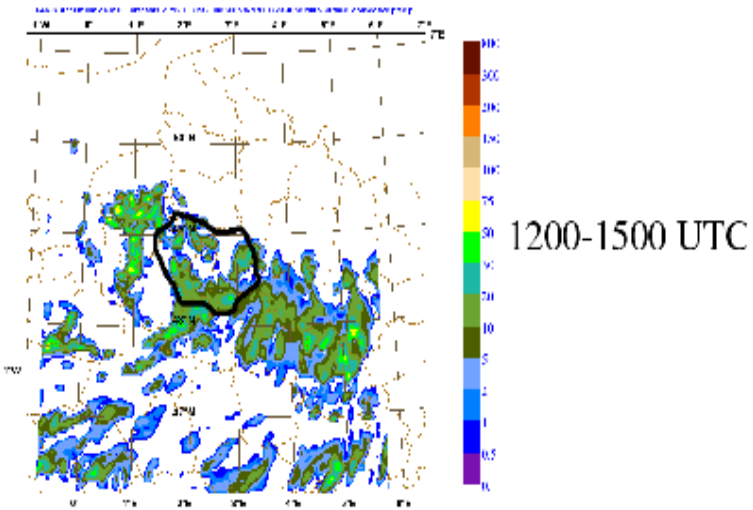
Thunderstorms, not forecast by AROME adaptation, nor by ALADIN alone.



RADAR



AROME



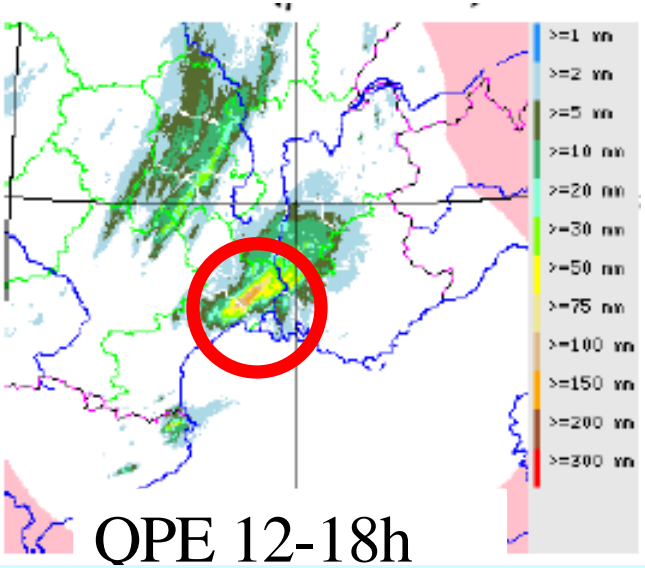
AROME RUC 3h

1200-1500 UTC

Impact of radar reflectivity (humidity inversions) using real data

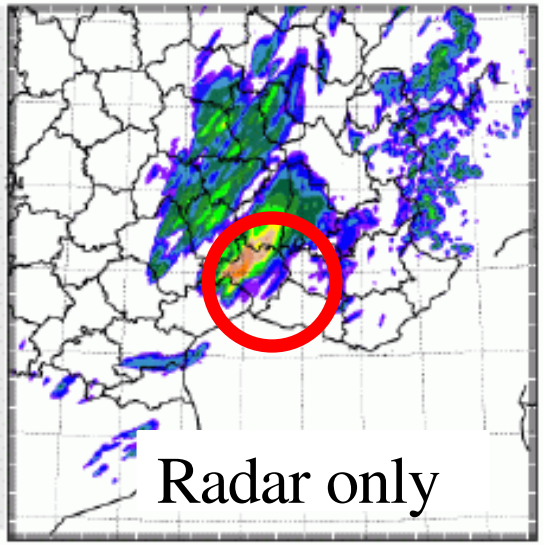
Case study

A flash food event in southeastern France : 8-9 september 2002 : assimilation of reflectivity f



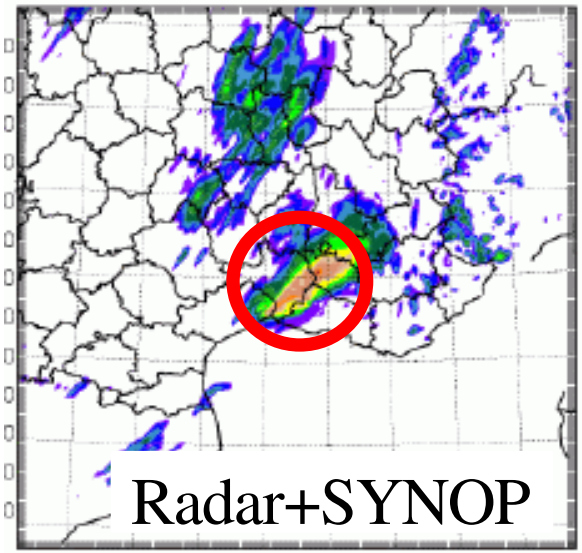
OPE 12-18h

Convection triggered by a low level cold pool wedged by orography:
⇒ Reflectivity assimilation improves the forecast but is unable to shift the main precipitating cell above the cold pool edge, SYNOP assimilation is necessary



Radar only

No assimilation



Radar+SYNOP

Priorities for improvement

- **humidity and cloud initialisation** (use obs of clouds and rain, physical moist initialization)
- vertical structure of the boundary layer (with **higher vertical resolution)**
- fix problems near **lateral boundaries & in narrow valleys**
- more work on **clouds and turbulence,** esp. stratiform clouds and fog
- develop high resolution **surface analysis** (soil moisture, snow...)
- cost savings by **improving algorithms** in the physics (sedimentation) and **parallelisation**

Conclusion: future work

- carry on improving **model performance: physics**
- current focus on the **quality of postprocessing**
- current experimentation with **full-resolution data assimilation and radars**
- 2007 priority on **computer optimization** for big 'France' domain (parallelisation)
- studies on **higher-resolution model; cloud/humidity analysis**
- carry on modernisation of **common physics/dynamics interface**