Towards AROME

Status and plans of the ALADIN-2 projects: ALARO, AROME, INTERFACES

+ a few words on maintenance

- The high-level strategy
- Maintenance & operations
- Local assimilation
- Coordinated physics with INTERFACES
- The ALARO transition project
- Status of AROME

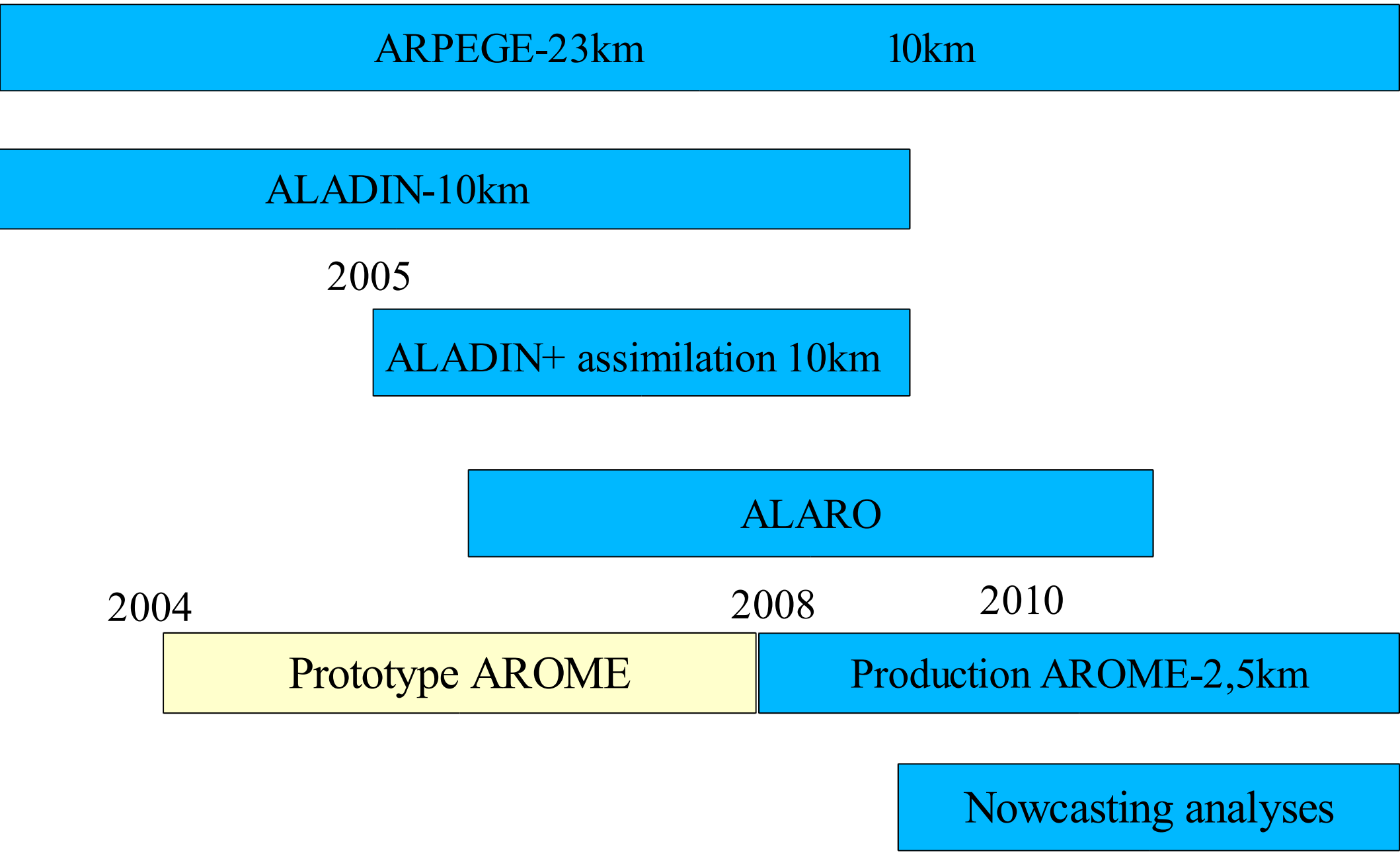
The strategy

- A necessary **modernization** to retain our forecast competitivity
- **New opportunities** for science & NWP applications
- Forecast improvement requires regular **upgrades of computers & telecoms**
- Requires change of habits, and **more complex coordination**
- The ALADIN-2 spirit: *to go from a unique ALADIN model framework to a multiple-model system, so that all centres can tune their system according to their resources.*

The spirit

- Continue the joint maintenance & the scientific network. **Expand** to accomodate HIRLAM and benefit from their workforce.
- **Simultaneous work** on ARPEGE/ALADIN, ALARO, AROME
- Coordination is kept by the use of **common software** (e.g. data assimilation) and a **modular approach** where software cannot be common (e.g. physics)

Evolution of available NWP systems



Maintenance aspects

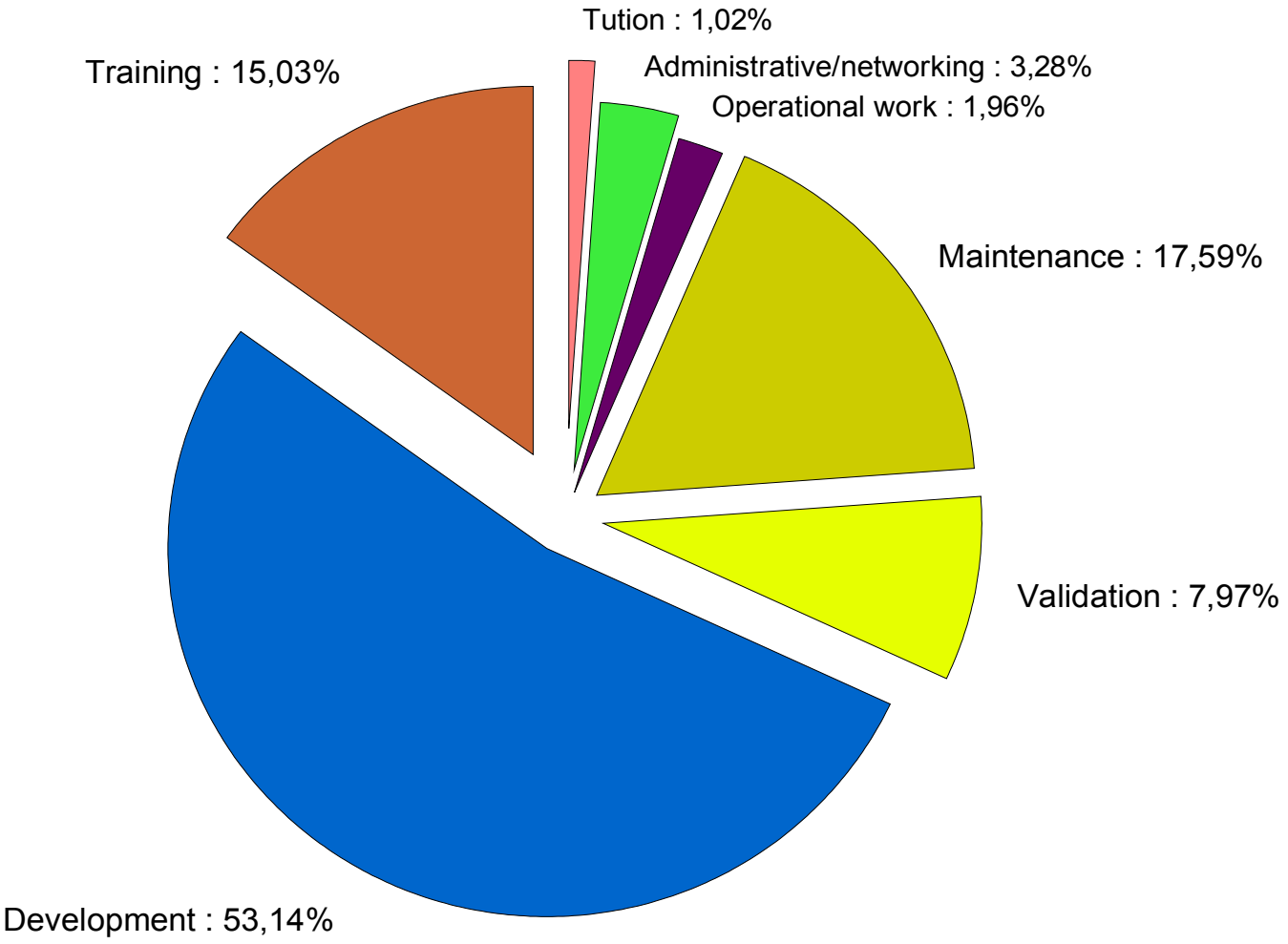
- no unusual increase in manpower requirements lately despite growing software complexity:
  - **MesoNH/Arome physics** (using common validation & versioning constraints)
  - **data assimilation** / Observation Database
- joint IFS cycles : now every 9 months
- **thanks to the partners** for their participation in the 'phasing' efforts = *the crux of ALADIN cooperation*
- ALADIN cycles now include working AROME (and SURFEX) software
- significant evolution in 2005/2006:
  - **maintenance workshop** in Budapest, Nov 2005
  - **ALARO physics:** new SURFEX surface modelling software and INTERFACES code structure
  - **HIRLAM:** setup of joint IFS/ALADIN/HIRLAM maintenance, with HIRLAM staff contribution on maintenance (to be defined)

Operational aspects

- ARPEGE new physics & resolution will imply **more coupling fields** (e.g. prognostic clouds), but most are not mandatory
- **SURFEX:** externalisation of common ALARO/AROME surface physics – big internal software change with some impact on operational aspects
- we can avoid forcing unwanted operational changes, but only if there is **local effort to upgrade local versions and to optimize coupling file strategy**
- work to make AROME user-friendly for remote operations is ongoing: we aim to ensure a **painless switchability** between ALADIN,ALARO,AROME (apart from the computer cost)

Breakdown of the ALADIN work of Toulouse "stagiaires" by type

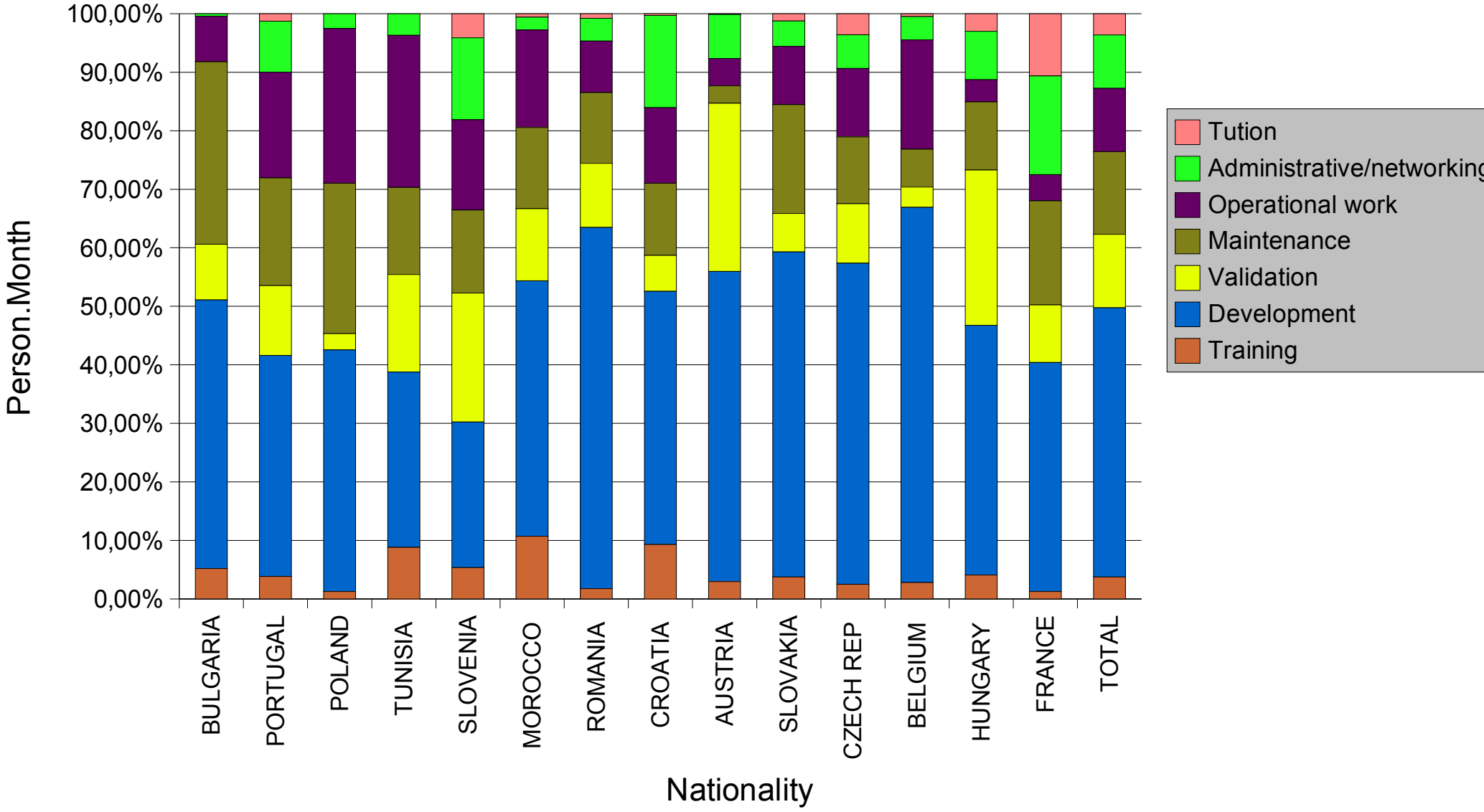
since July 1996



Updated on 20050701

Breakdown of the ALADIN effort by type and nationality

since July 2001



Updated on 20050701

The data assimilation

- A powerful tool: use your own observations to improve your own forecasts. Currently much better in ALADIN than e.g. MM5, WRF or COSMO.
- A **single system for everyone**: 3D-Var adapted to several resolutions and physics.
- Continued compatibility with ARPEGE and IFS = benefit from R&D on satellites
- Effort needed on **mesoscale datasets** (synops, radars, Meteosat, PGS, profilers...)
- Effort needed on local installation, because **the software is complex.**

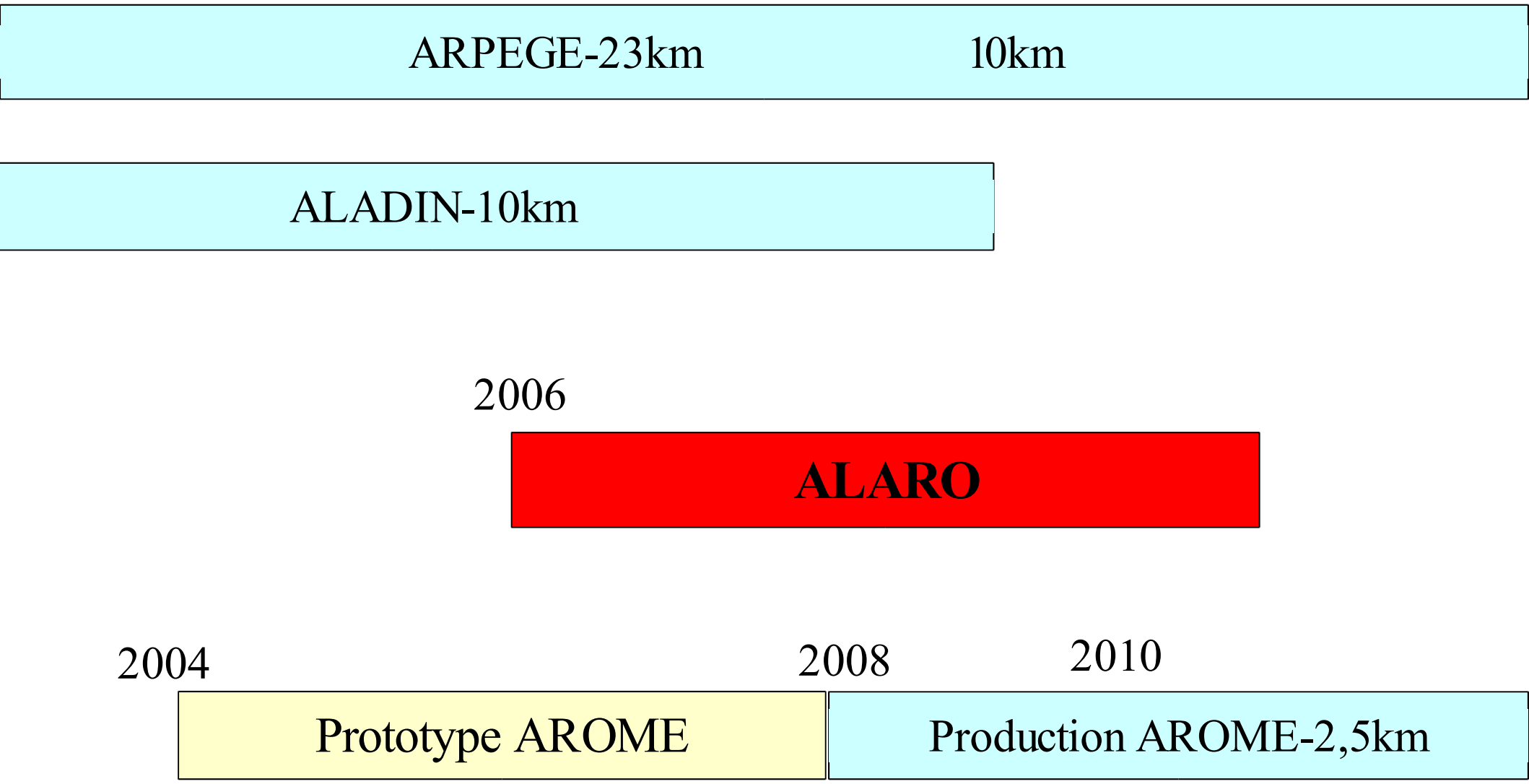
The INTERFACES project

- Aim: to facilitate **interchange of physics modules** between models (ALADIN, ALARO, AROME, HIRLAM)
- A 'plug and play' software interface, used by all models
- Facilitates **intercomparison and testing of various scientific ideas**
- Requires strict standardization of diagnostic software, and model thermodynamical hypotheses.
- A **long-term effort**
- cf. Oslo workshop in Dec 2005

The ALARO transition project

- Aim: to provide intermediate-complexity physics between ALADIN and AROME
- Designed to **work at resolutions between 5 and 10km** (the « grey zone » of deep convection)
- **New physics** are being developed (turbulence, convection…), emphasis on numerical quality & efficiency i.e. in **continuity with past ALADIN scientific work** on ALADIN physics
- The SURFEX surface physics software will soon (2006) be used in ALADIN, ALARO and AROME, with various options
- ALARO will replace the ALADIN model eventually
- ALARO will allow for varying local physics options, under common software.

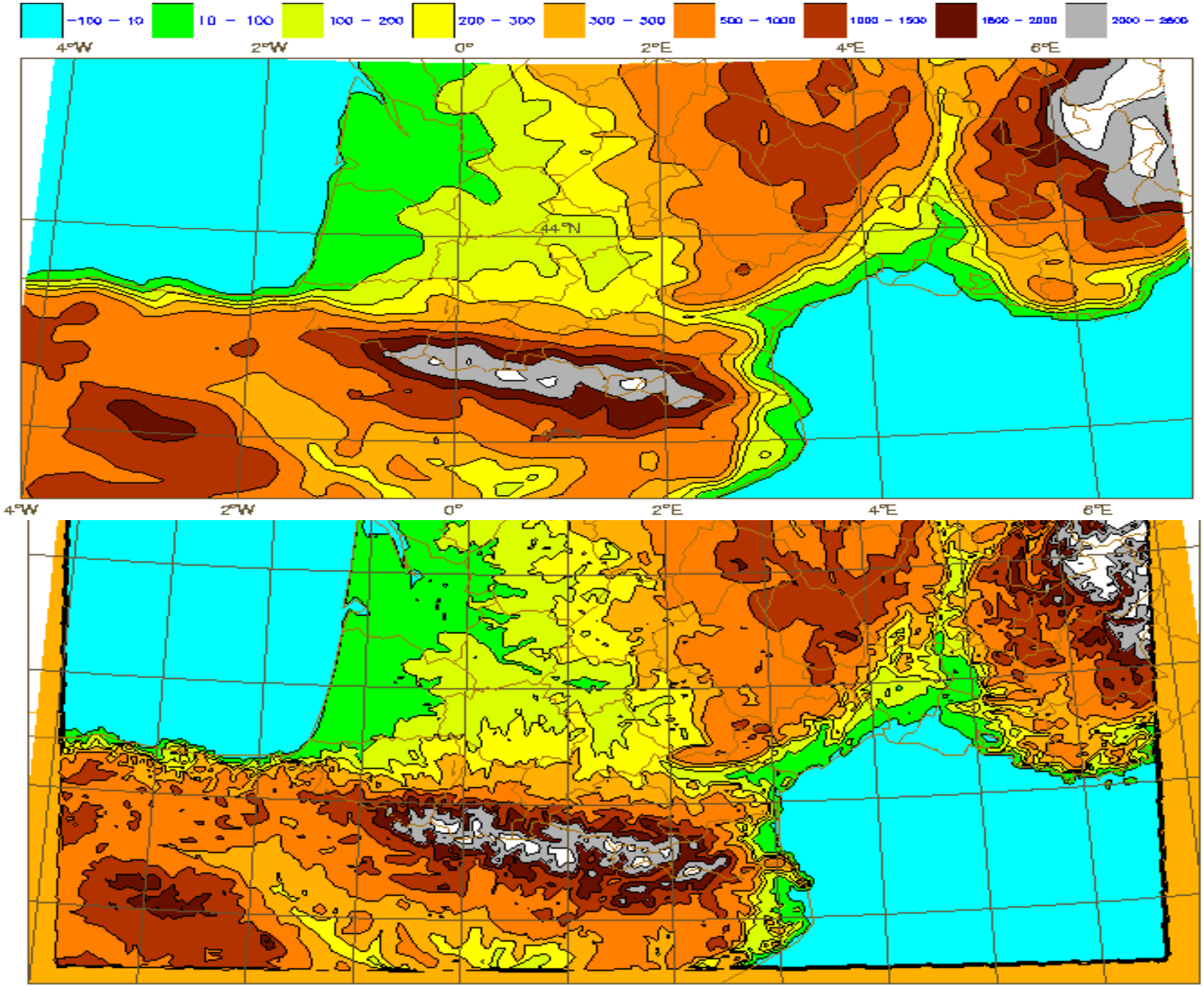
Evolution of available NWP systems



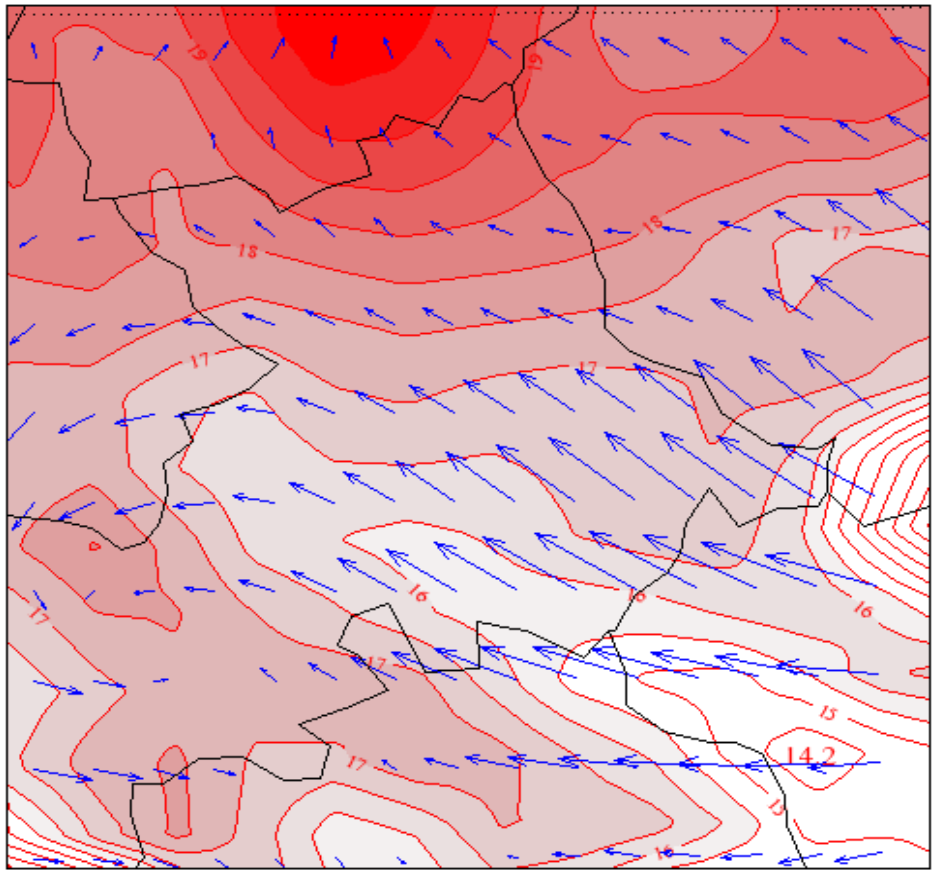
The AROME project

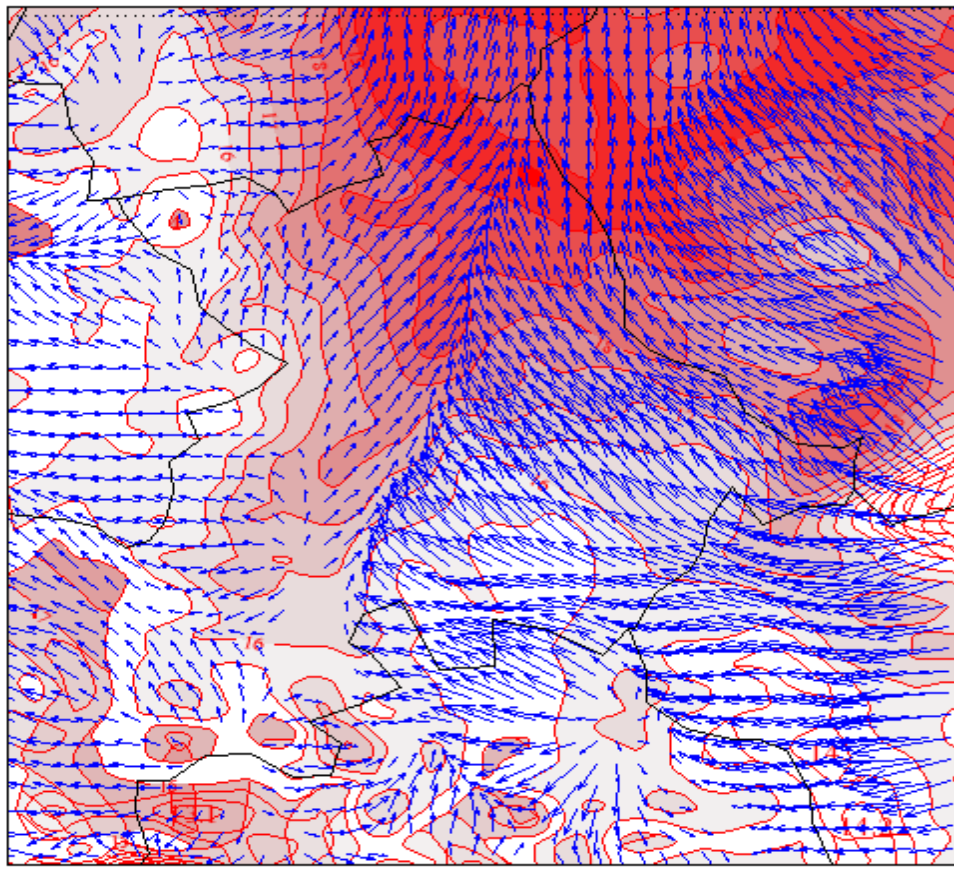
- Aim: to provide world-class forecast quality at convection-resolving resolutions (1 to 3km horizontally), competitive with e.g. WRF.
- Will offer large improvement in low-level and cloud/precipitation forecasts, important in dangerous weather situations
- The model runs everyday in France since May 2005: no model failure, very good forecast quality, numerical cost as expected. *Useful even on small domains and short ranges*.
- The operational ALADIN 3D-Var demonstrates the importance of local data assimilation for short-range forecast quality.
- Development priority in 2005/2006 will be on operational environment, clouds, and the use of observations at high resolution.
- Big demand for AROME products (wind farms, pollution, oceanography...)
- may be used by all partners eventually

Impact of resolution increase: 10->2km



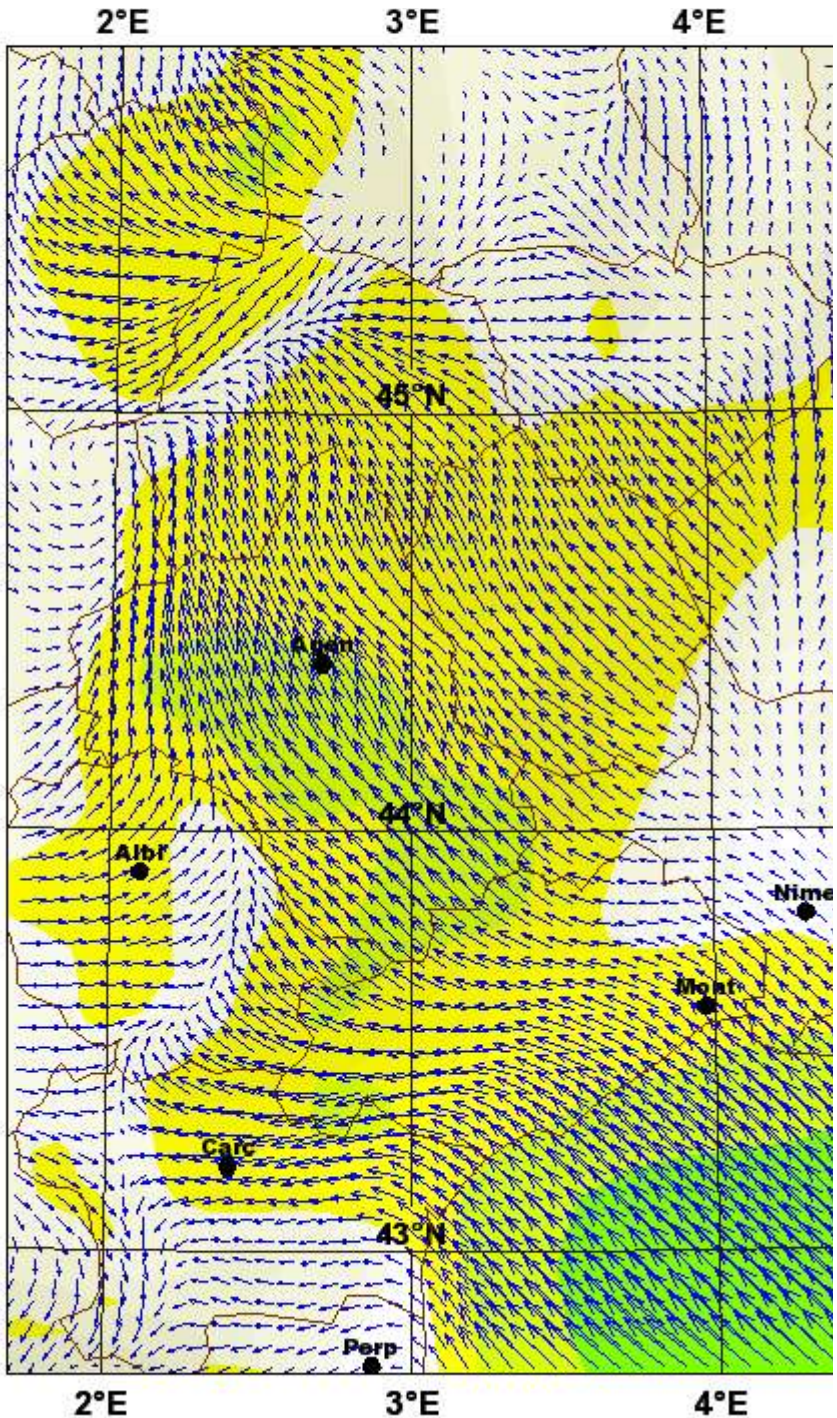
Impact of NWP model resolution: 10km vs 2.5km, fields of low-level wind (blue) and T (red) on the model grids

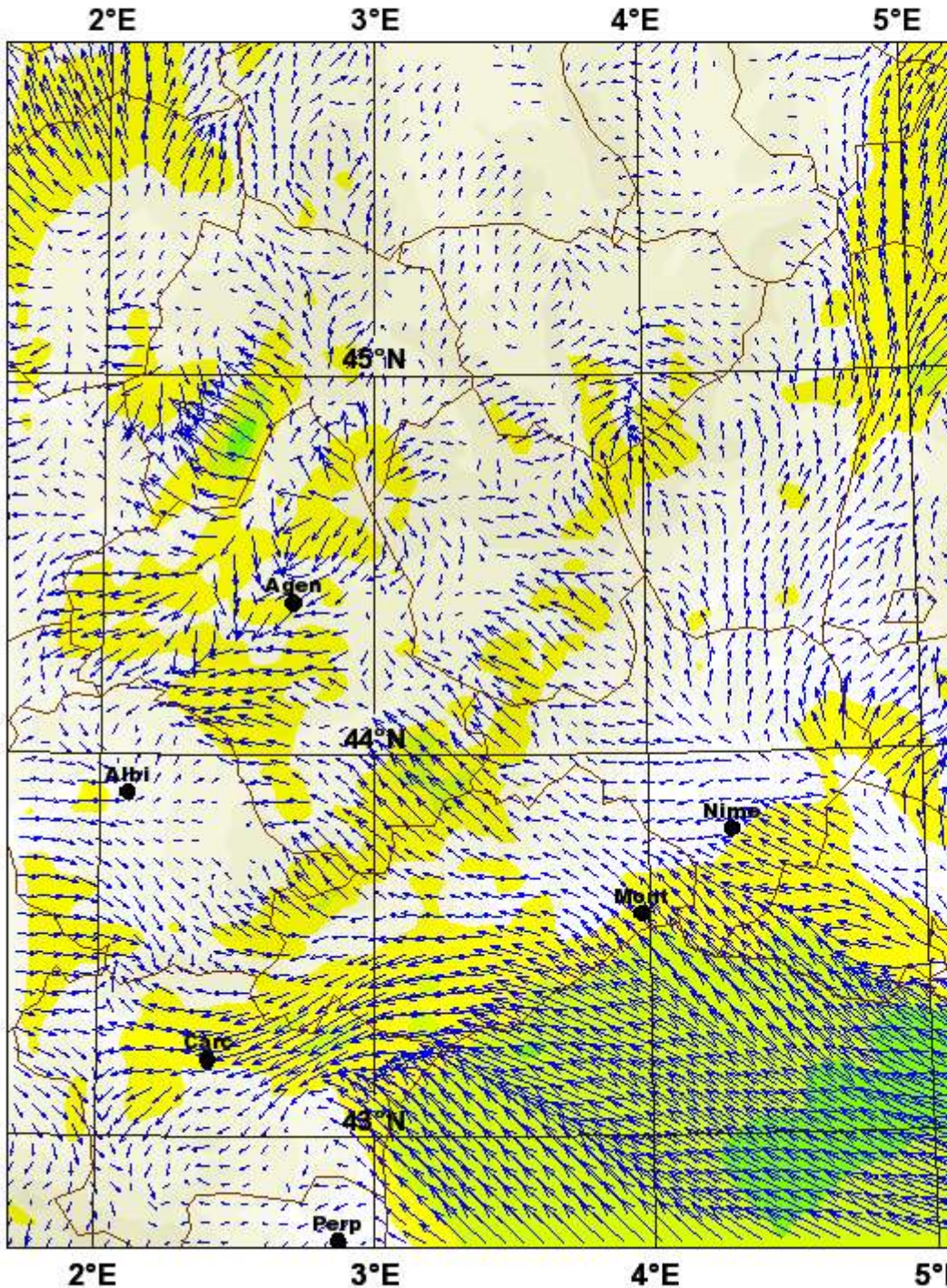




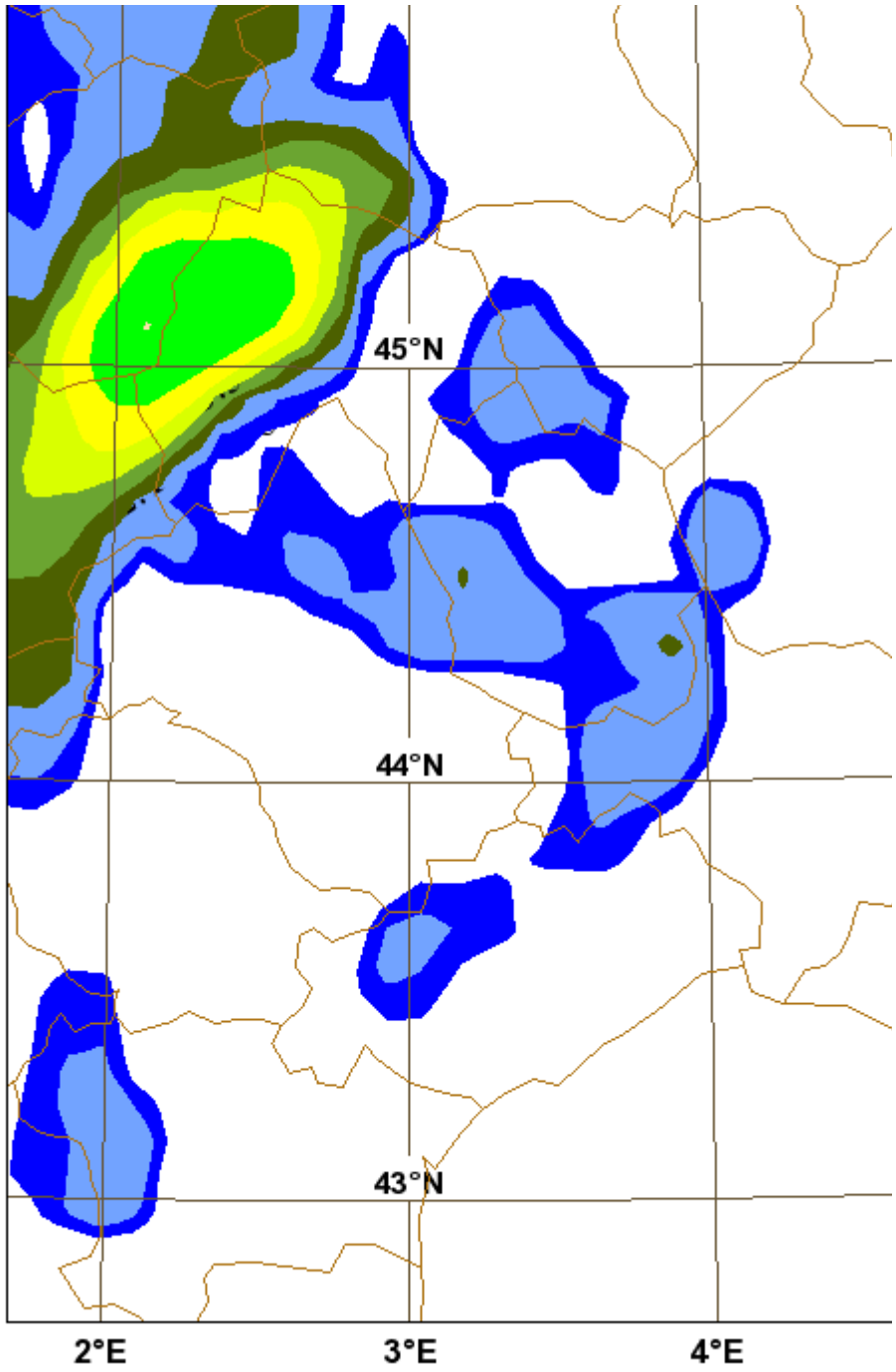
(different wind scaling in each figure)

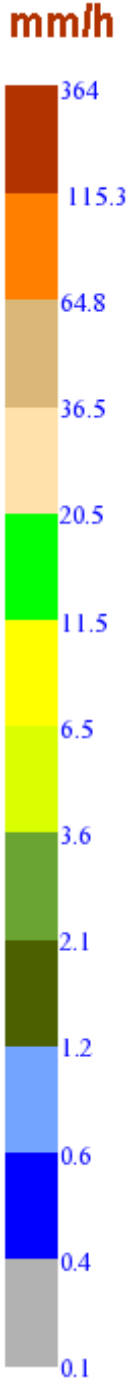
Impact of resolution on wind forecast (left:10km, right:2.5km)

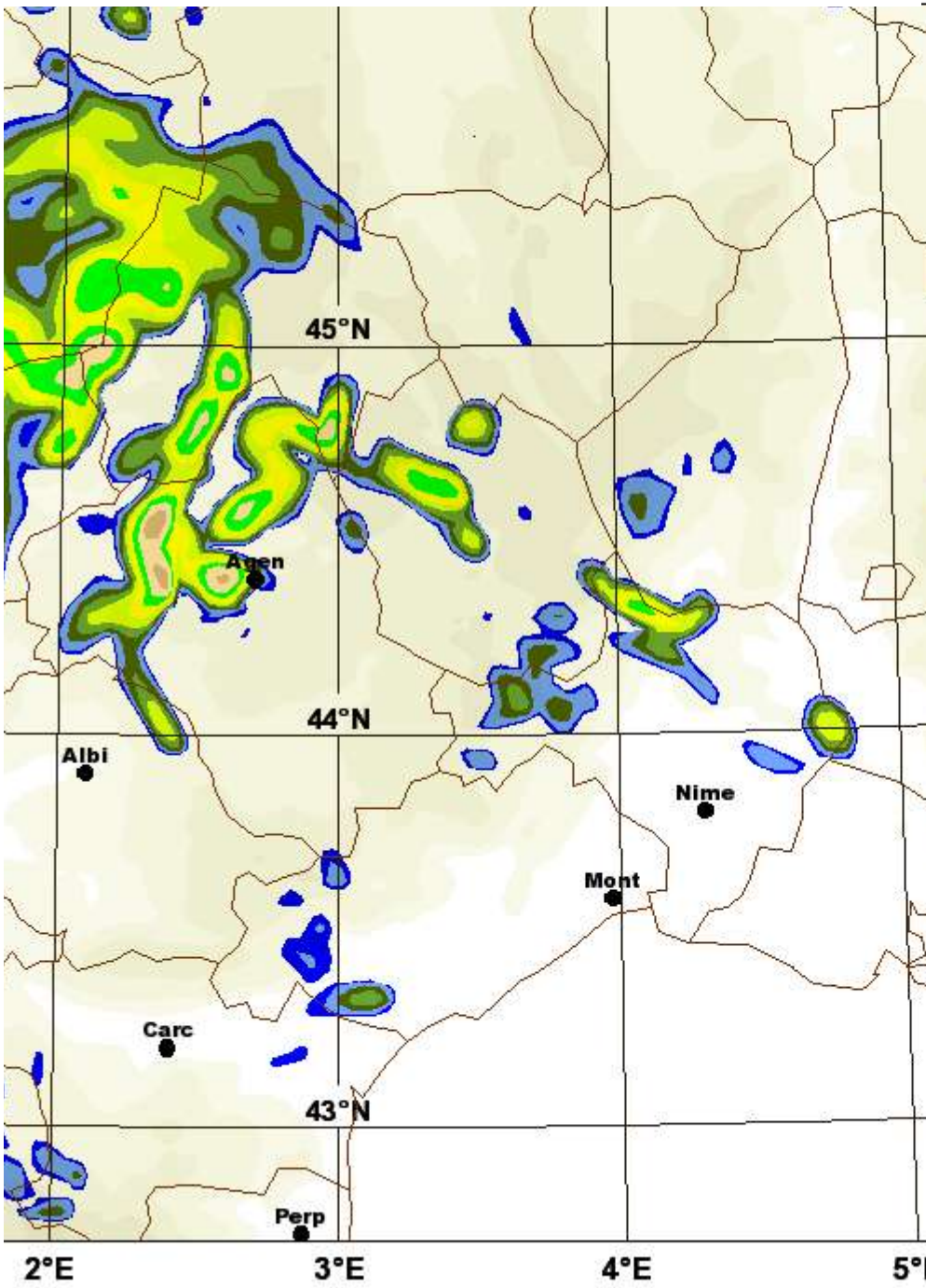




Inpact of resolution on precipitation forecast (left:10km,right:2.5km)







Example of kilometric-scale NWP model: AROME

- a mesoscale convection-permitting NWP system built from ECMWF's IFS, Europe's ALADIN, and France's Meso-NH models
- Efficient spectral, semi-Lagrangian, semi-implicit NH compressible **numerics** to allow fast real-time production (long timestep)
- Reasonably sophisticated **physics**: prognostic TKE turbulence, 5-species prognostic cloud microphysics, RRTM-IR/FM radiation, tiled surface scheme with soil, vegetation, lakes, sea, snow, town energy balance, high-quality ECOCLIMAP physiographies
- With own **data assimilation** using radar, satellite, in situ operational observations on top of the global networks
- 1-way nesting in 10-km ALADIN data assimilation, itself nested in 20-km ARPEGE global 4DVar assimilation

Arome microphysics (clouds+precip)

Microphysics ICE3 : 6 water species = vapour, cloud water, cloud ice, rain, snow, graupel

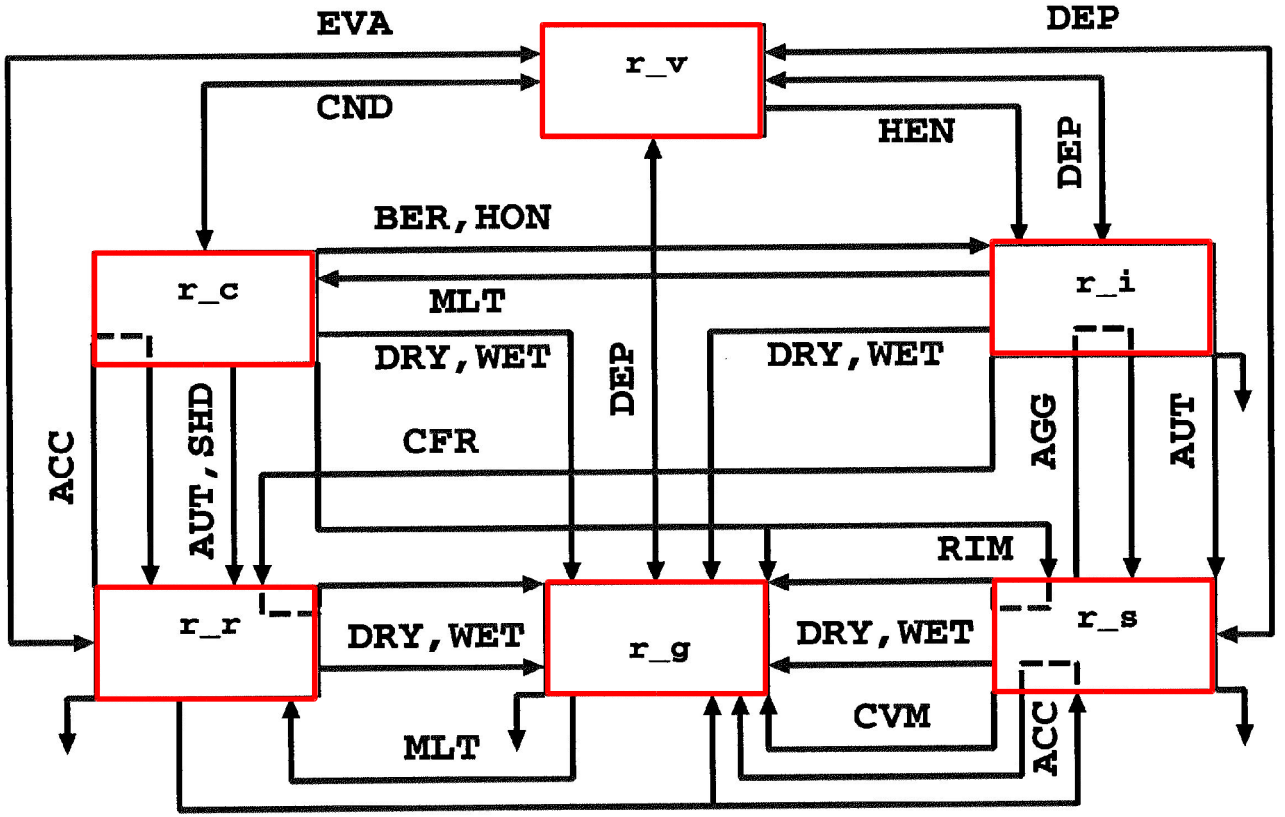
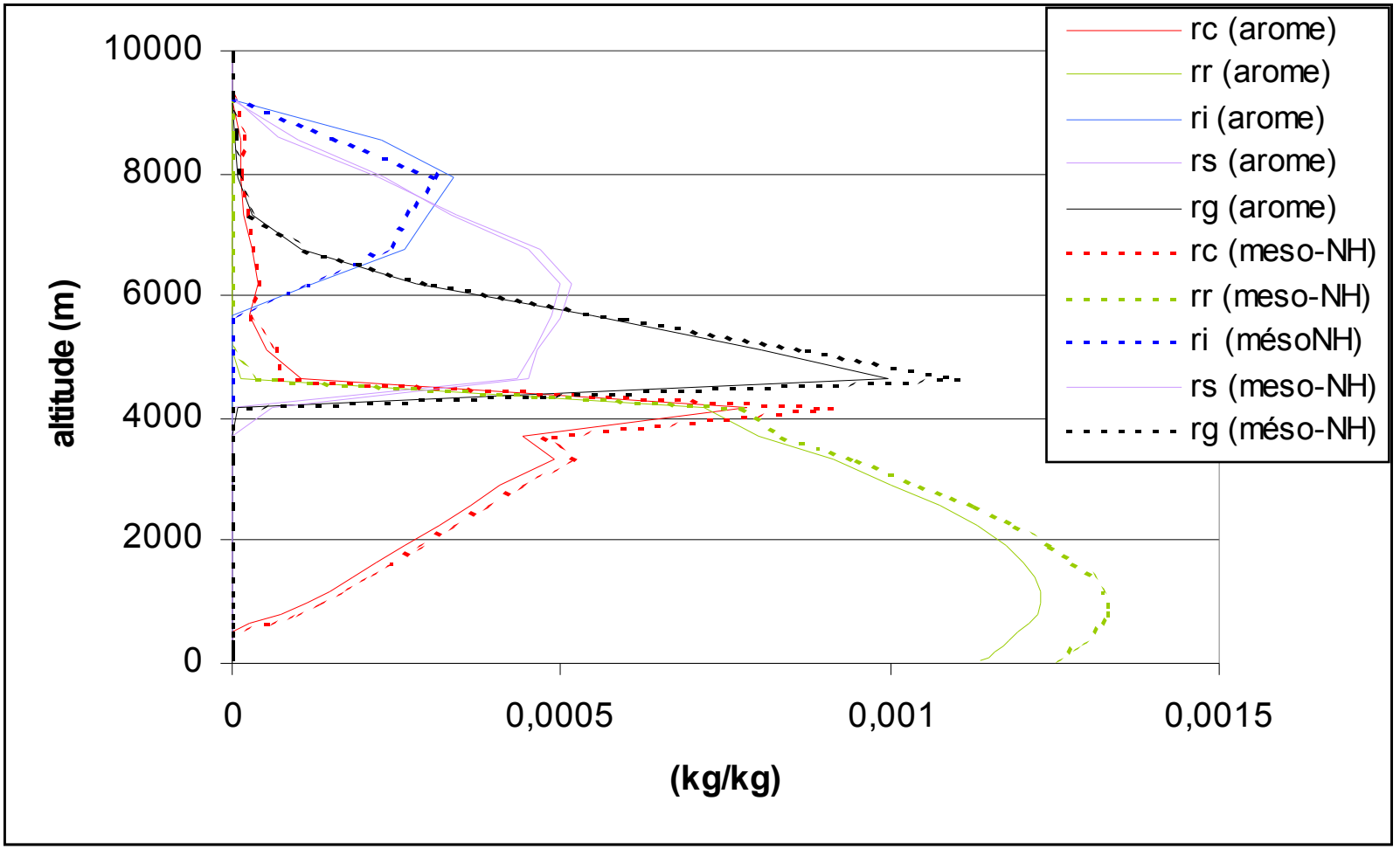


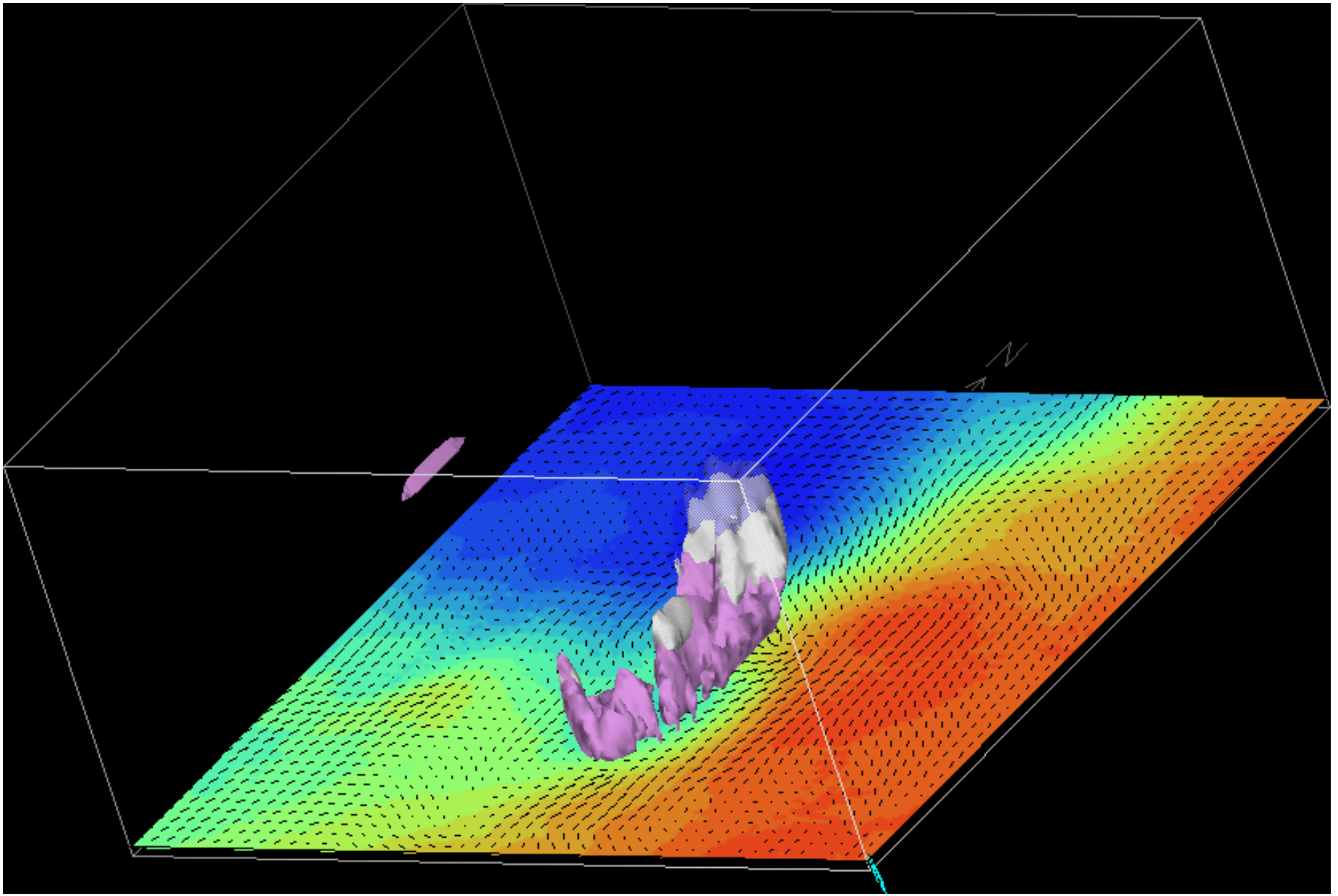
Diagram of the microphysical processes for mixed phase cloud in the present scheme

Vertical structure of a deep convective cloud as seen with the ICE3 species



Arome MCS simulation (04-08-94 15 to 18 UTC)

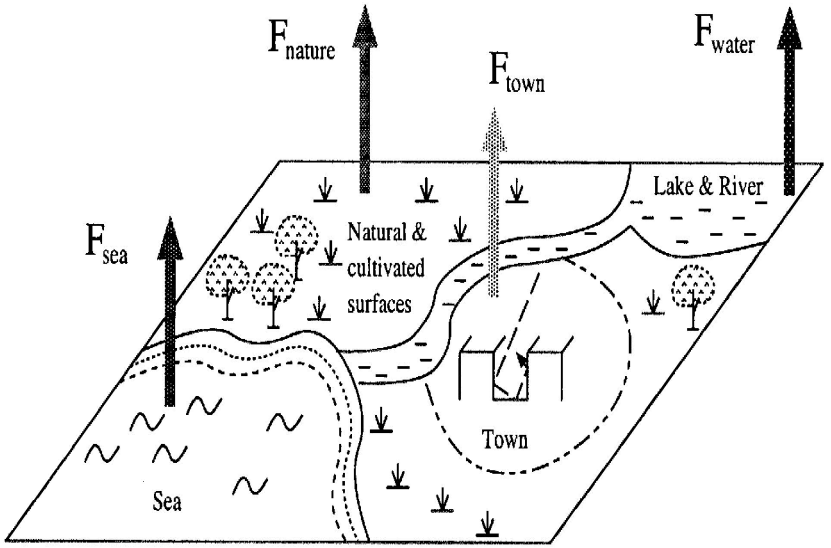
2,5 km / dt=15s / domain 144 * 144 / analysis Diagpack + Humidity bogus



Arome physics: surfaces

Surface : towns = TEB (Masson, 2000)
vegetation = ISBA (Noilhan and Planton, 1989)
sea/lakes: Charnock closure, make model, ocean mixing layer

+Coupling with hydrological models



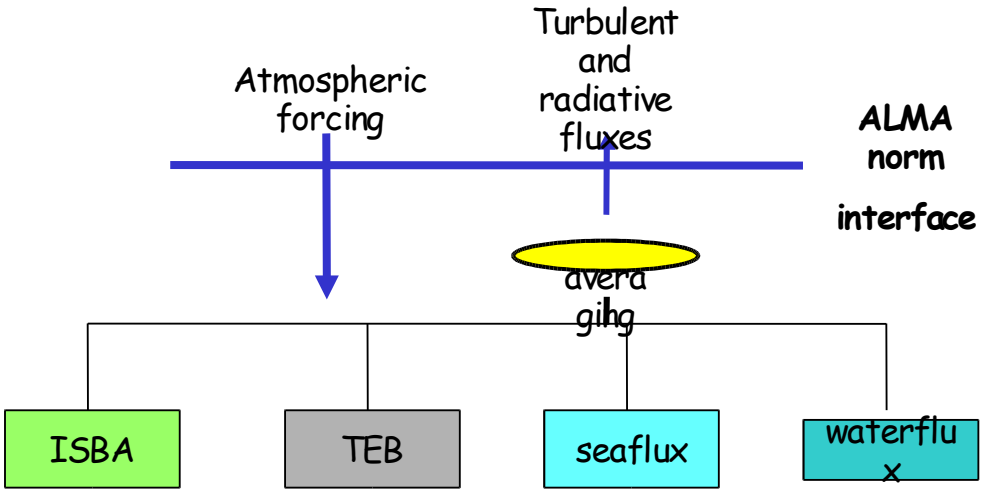
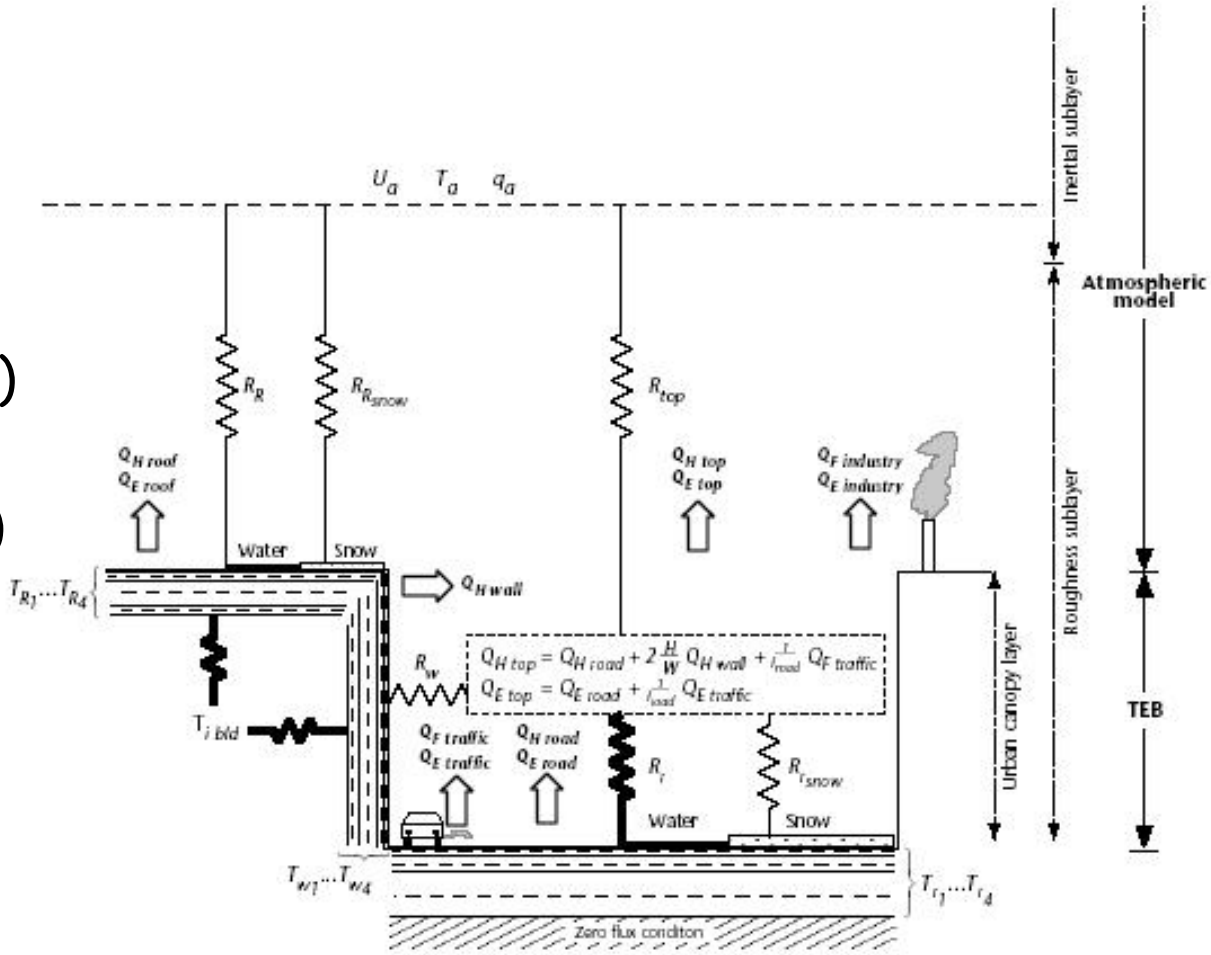


Figure 15.1: Partitioning of the MESO-NH grid box, and corresponding turbulent fluxes. F stands either for M (momentum flux), H (sensible heat flux), LE (latent heat flux), $S^{\uparrow}$ (the reflected solar radiation) or $L^{\uparrow}$ (the upward longwave radiation).

AROME physics: town model

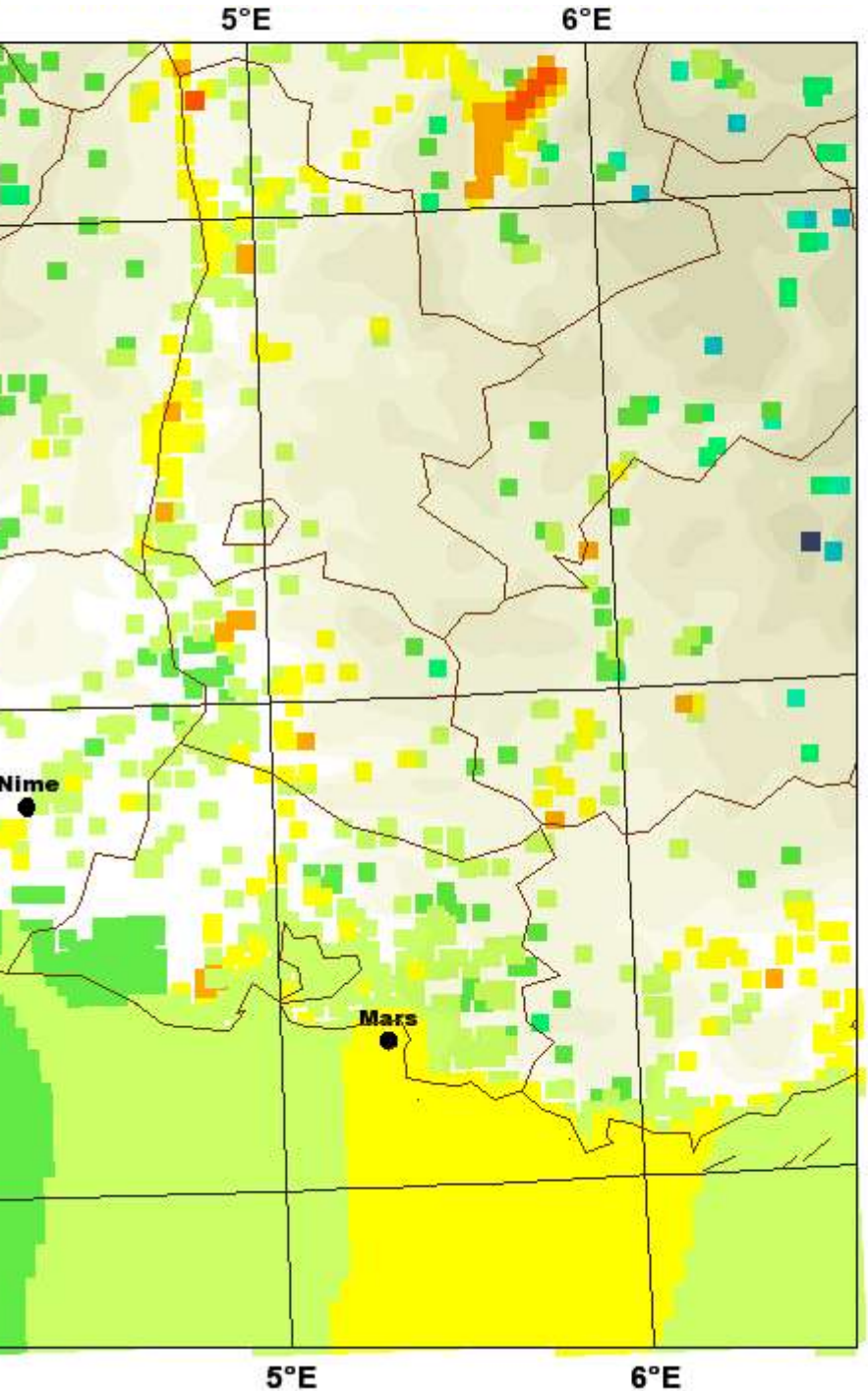
Town Energy Balance (TEB)

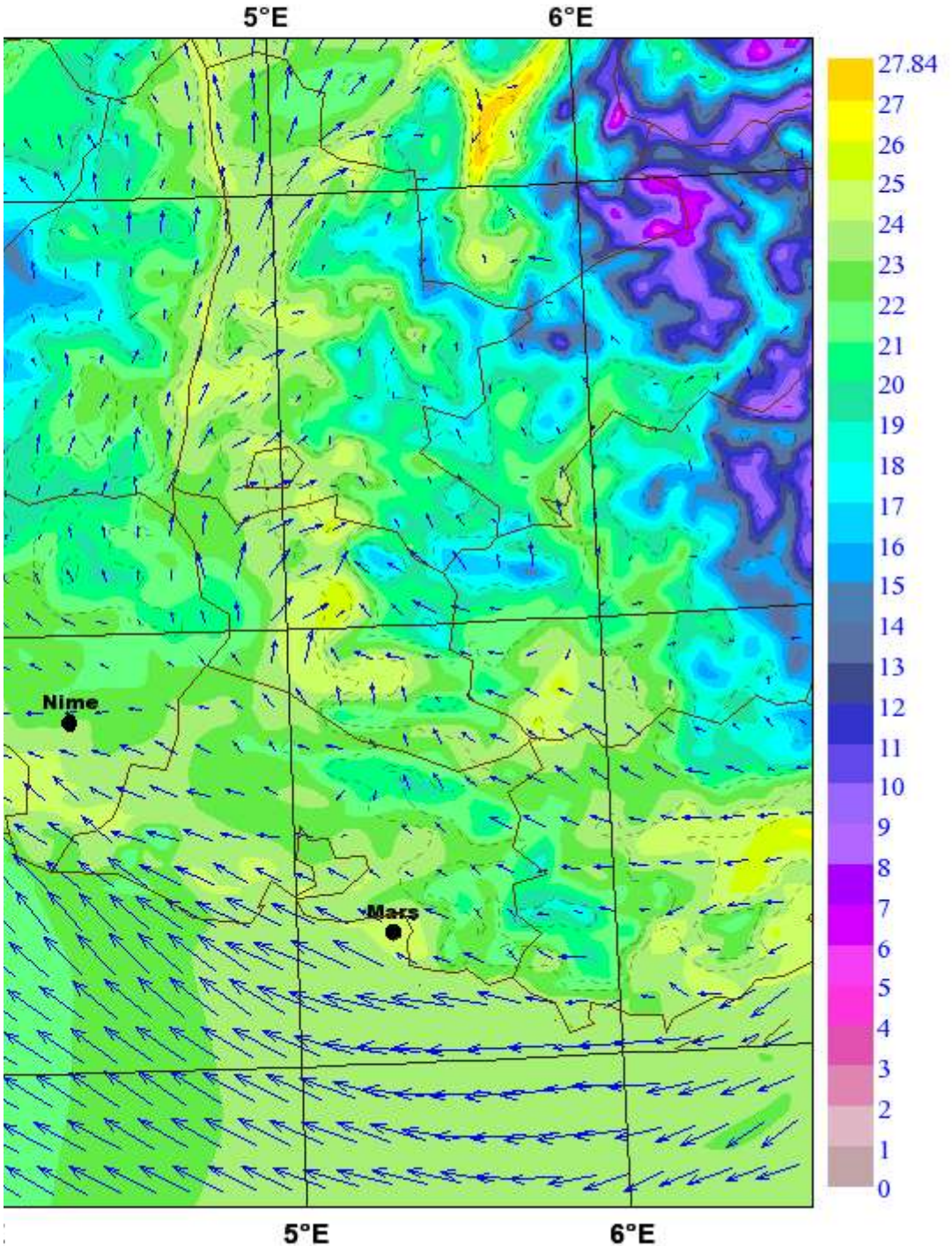
- urban canyon concept
- trapping of radiation
- heat storage (walls, roads, roofs)
- Urban hydrology
- Anthropogenic fluxes (heating...)



Documentation : http://www.aero.obs-mip.fr/~mesonh/

Surface temperature : cities & 2.5km gridboxes





AROME physics: surfaces

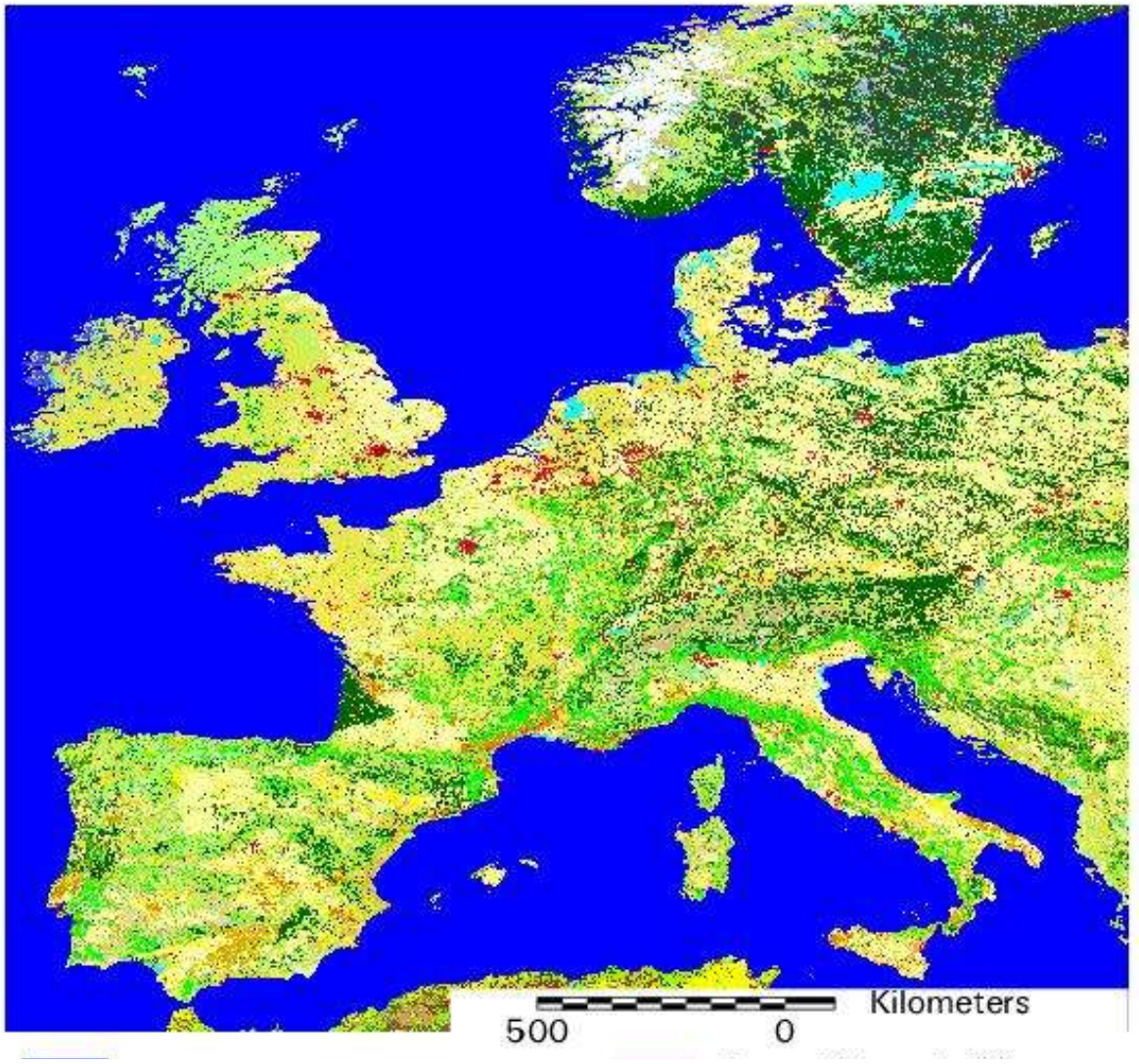
Surface physiographies (interfaced with TEB, ISBA) derived from the Ecoclimap ecosystems database (Masson, 2003)

242 surface types

+

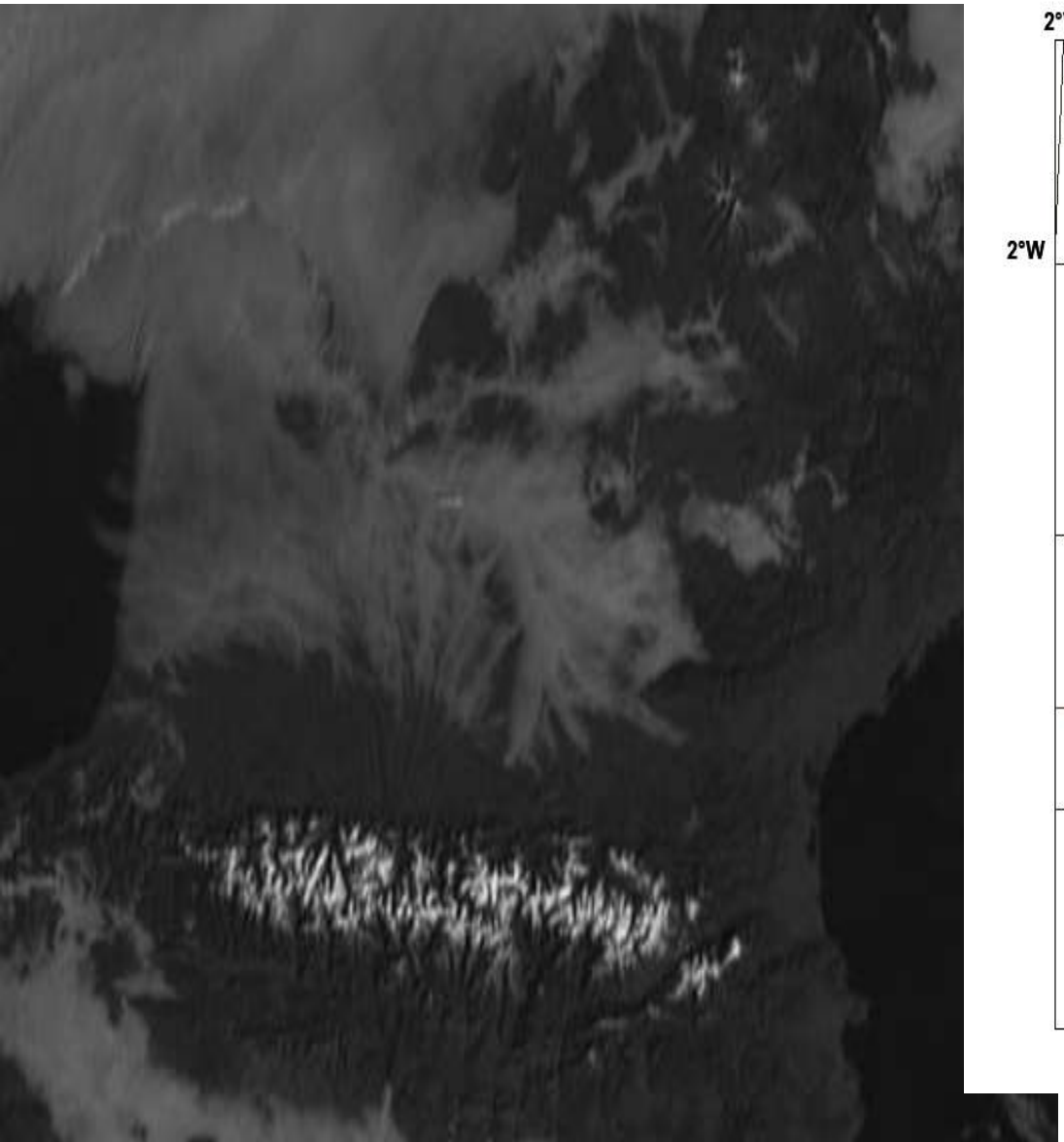
fractional covers inside 1-km squares

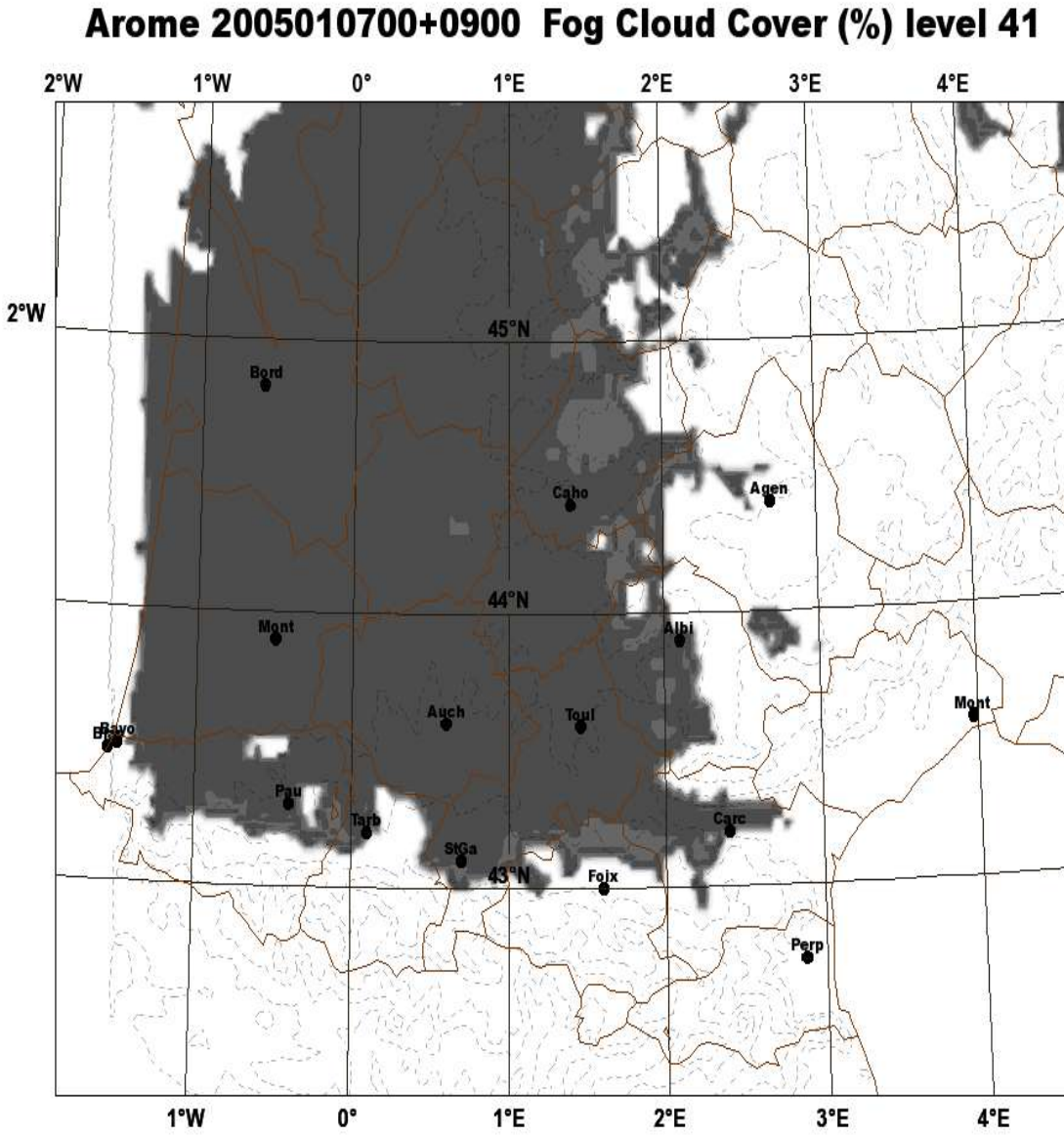
CORINE land covers



Arome-2.5km 9h-range fog dissipation forecast

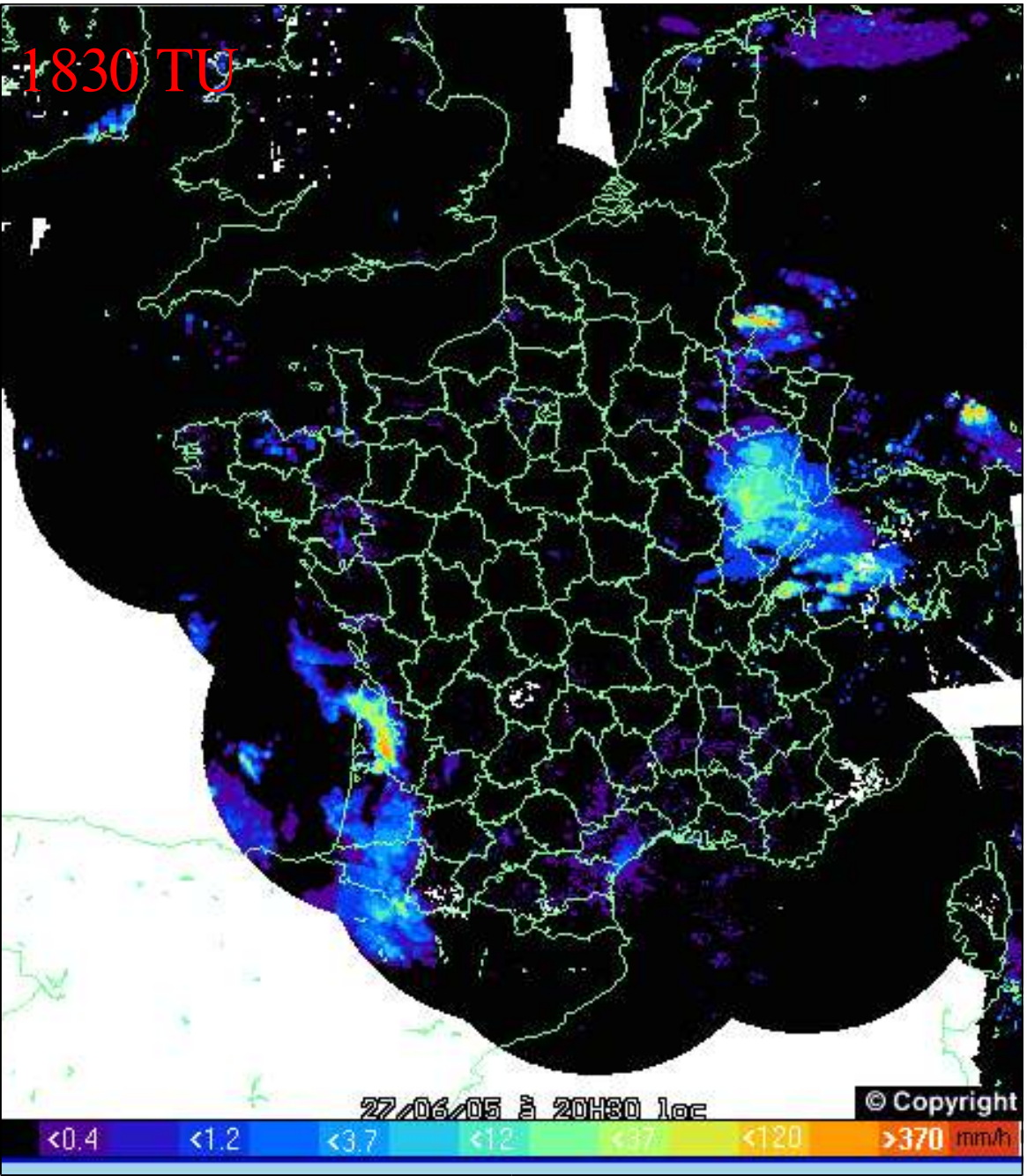
Meteosat visible image

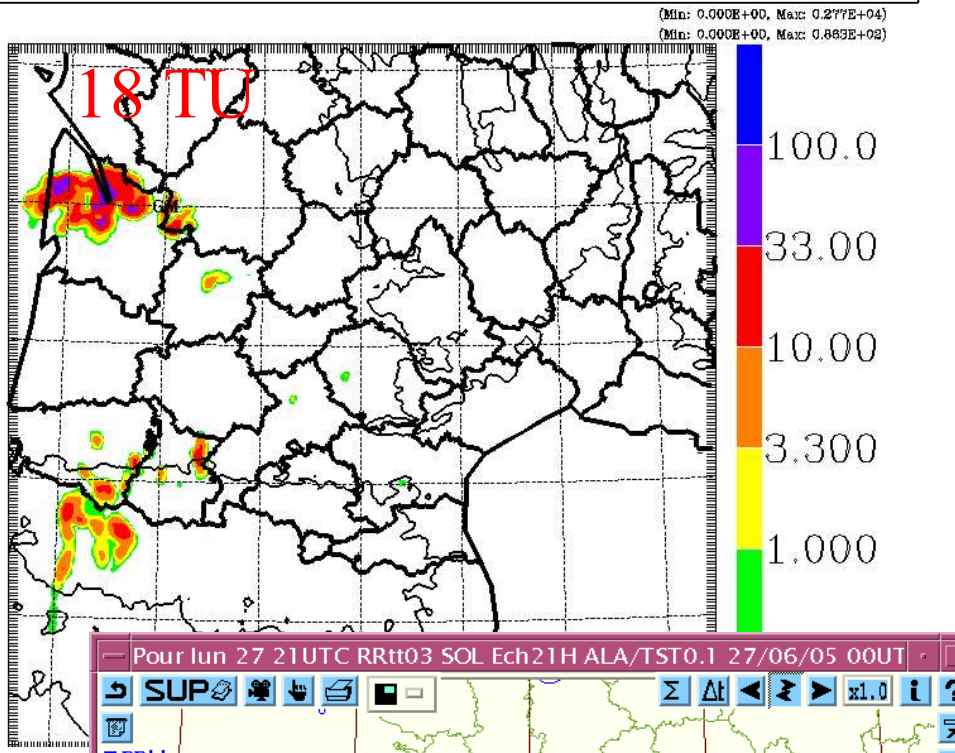


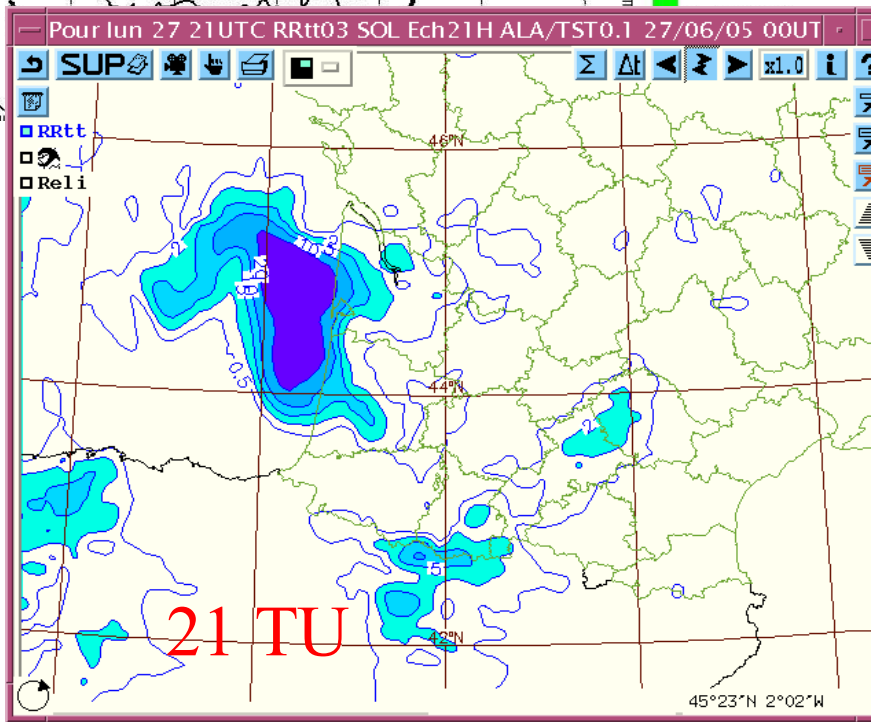


A rather good AROME forecast: 27 Juin 2005

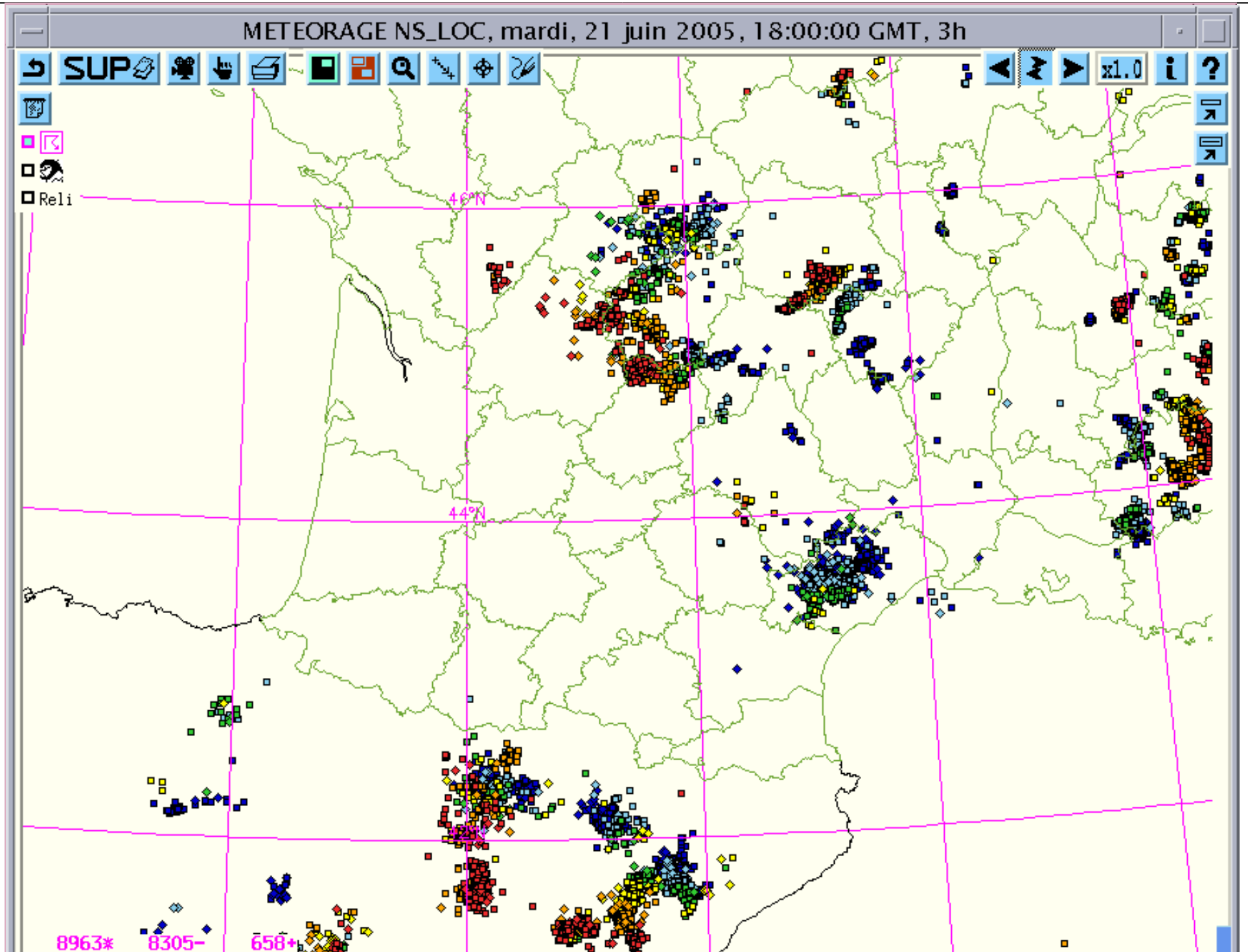
Violent thunderstorms around Bordeaux (1 casualty)





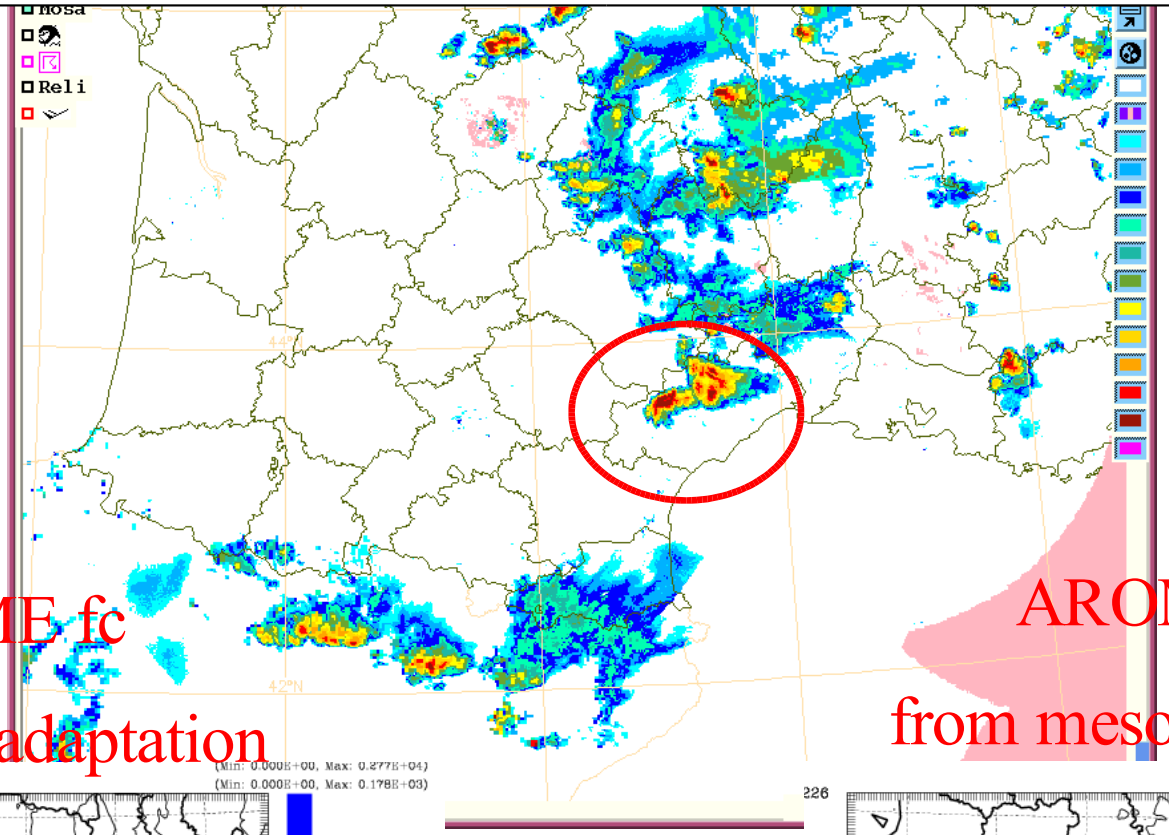


AROME real-time forecast on 21 June 2005



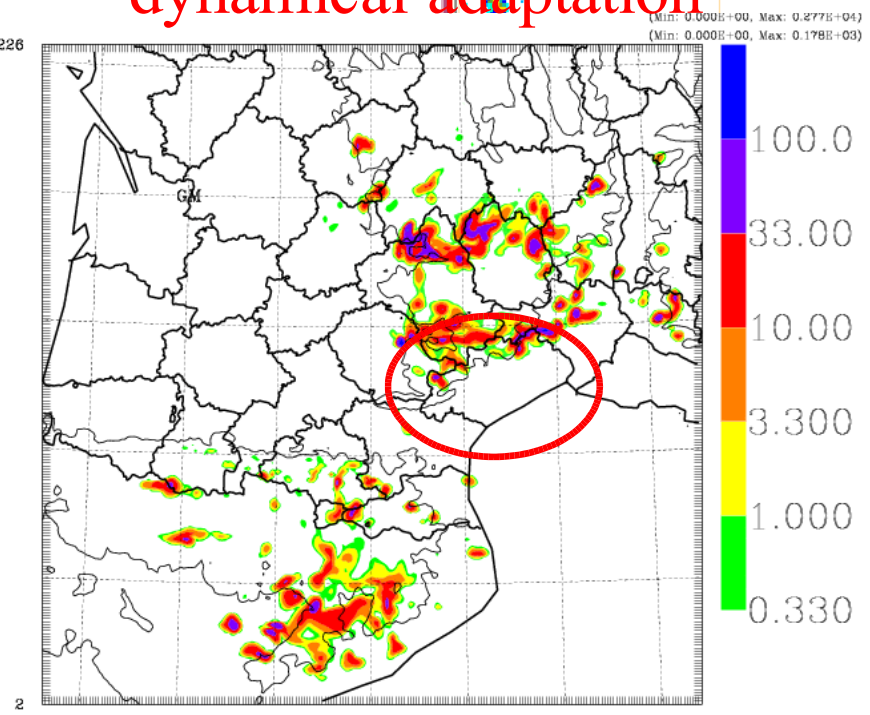
radar composite

15 TU



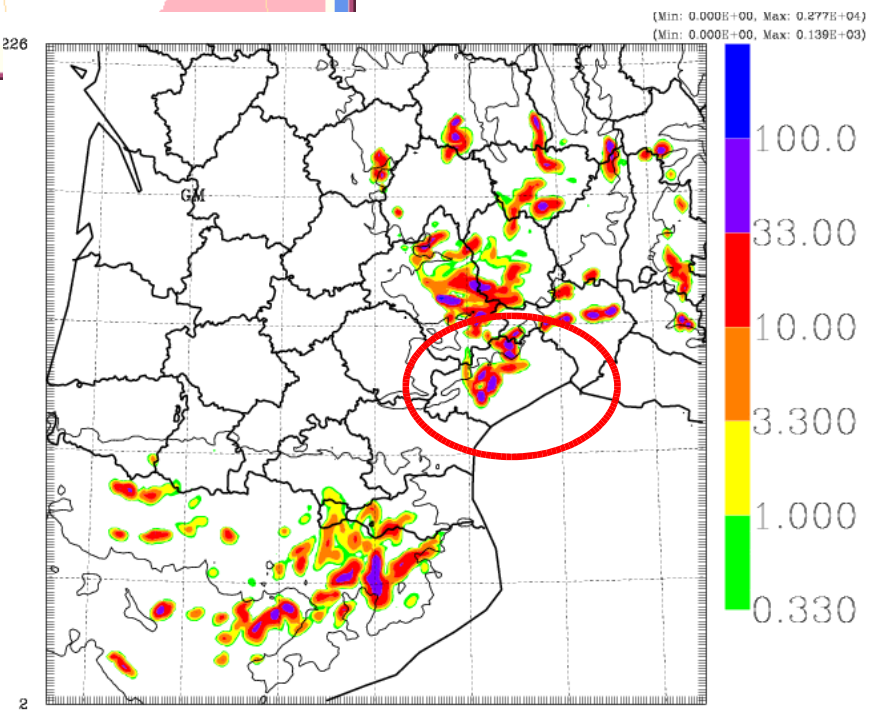
AROME fc

dynamical adaptation



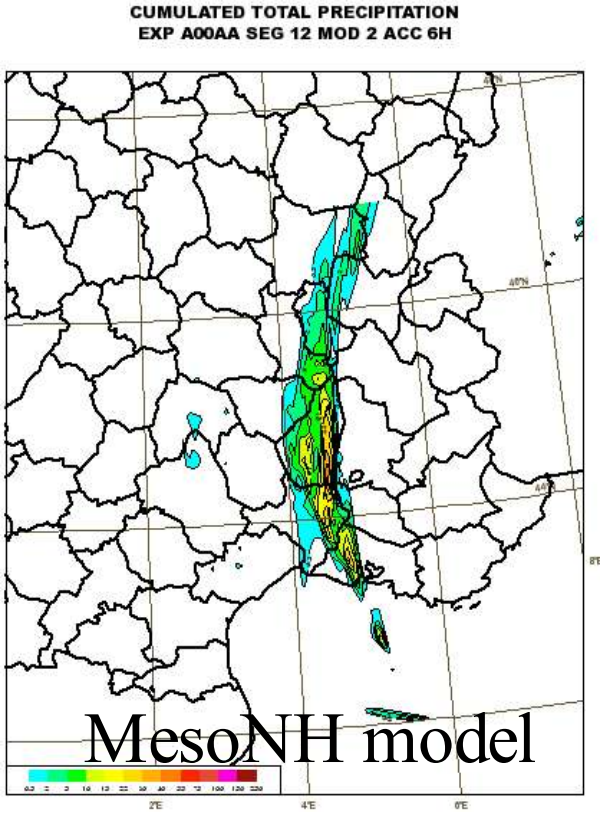
AROME fc started

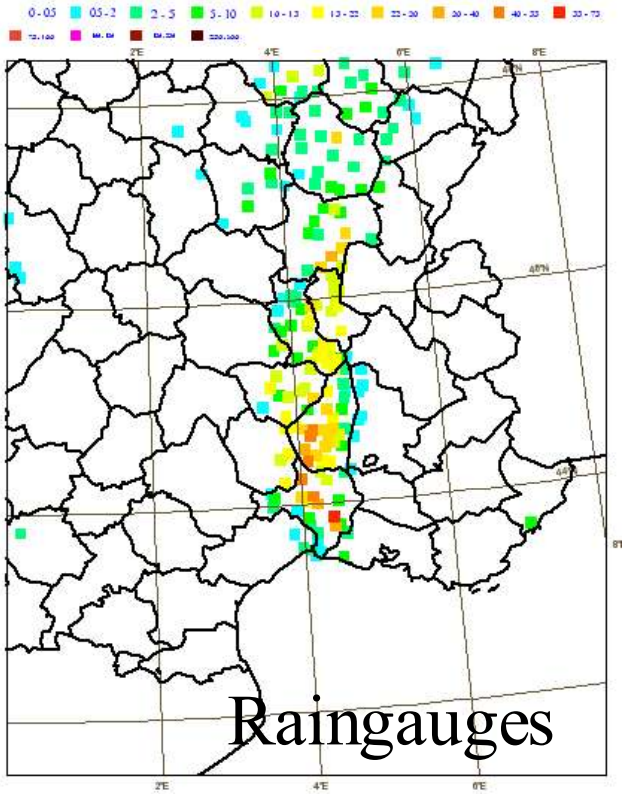
from mesoscale assimilation



AROME status & plans

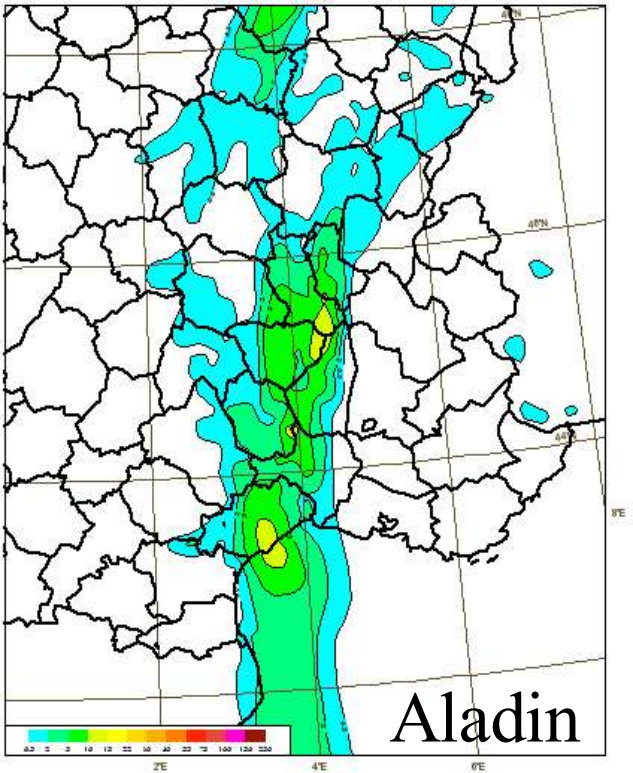
- 2.5km forecast model runs daily since May 2005 on 500km domain with **1-minute timestep**
- Excellent performance on wind, low-level temperature and convective weather
- Quality is situation-dependent: long routine verification is needed
- Assimilation runs at lower 10km resolution so far with very positive impact on 0-12h forecast ranges wrt. dynamical adaptation
- **main target:** 6-hourly 36-h NWP forecasts over France (1000kmx1000km) in less than 30 minutes, in 2008 + hourly very short-range forecasts
- priority on relocatable **nowcasting applications** in 2009-2010

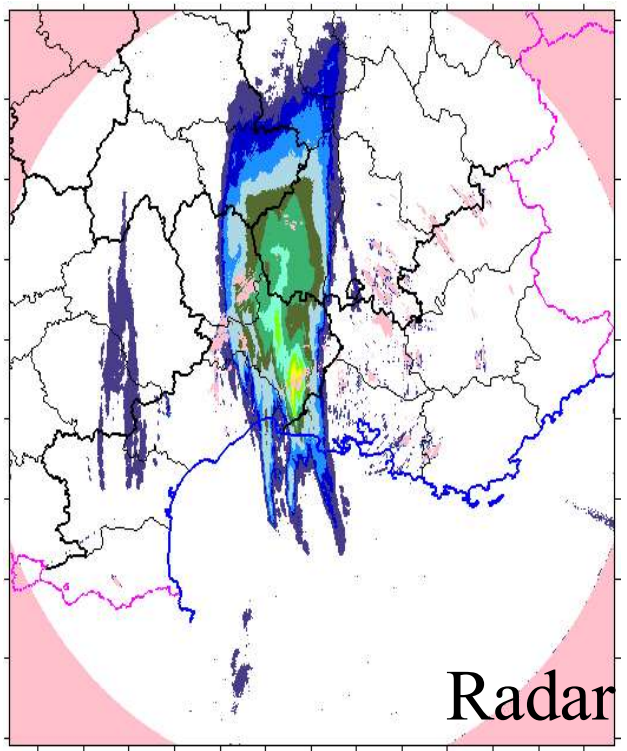




The difficulty of validating rainfall:

here, cumulated over 6h
(6-12h forecast range)





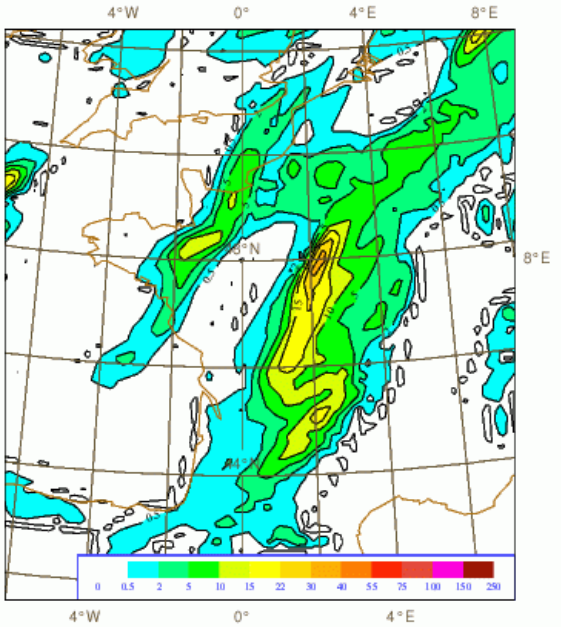
prévisions à partir
d'analyses
(2.5km pour Méso-NH,
10km pour Aladin)

Impact study :
Precipitation forecast

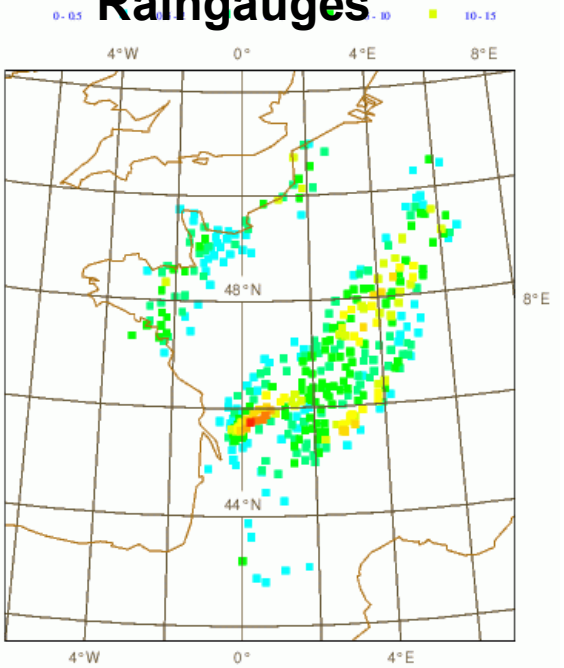
2004/07/18 12UTC

RR P12 – P6

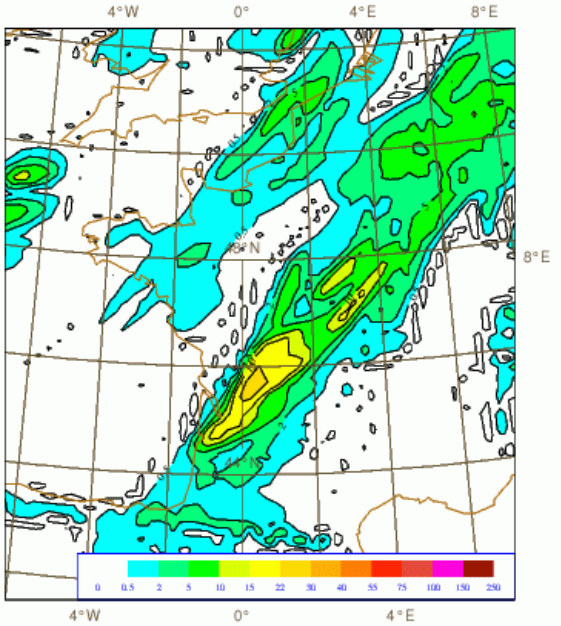
Dyn. Adapt.



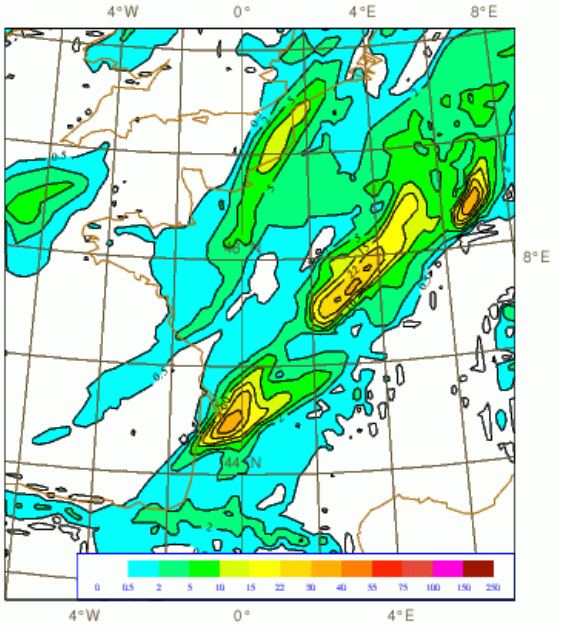
Raingauges



3DVar



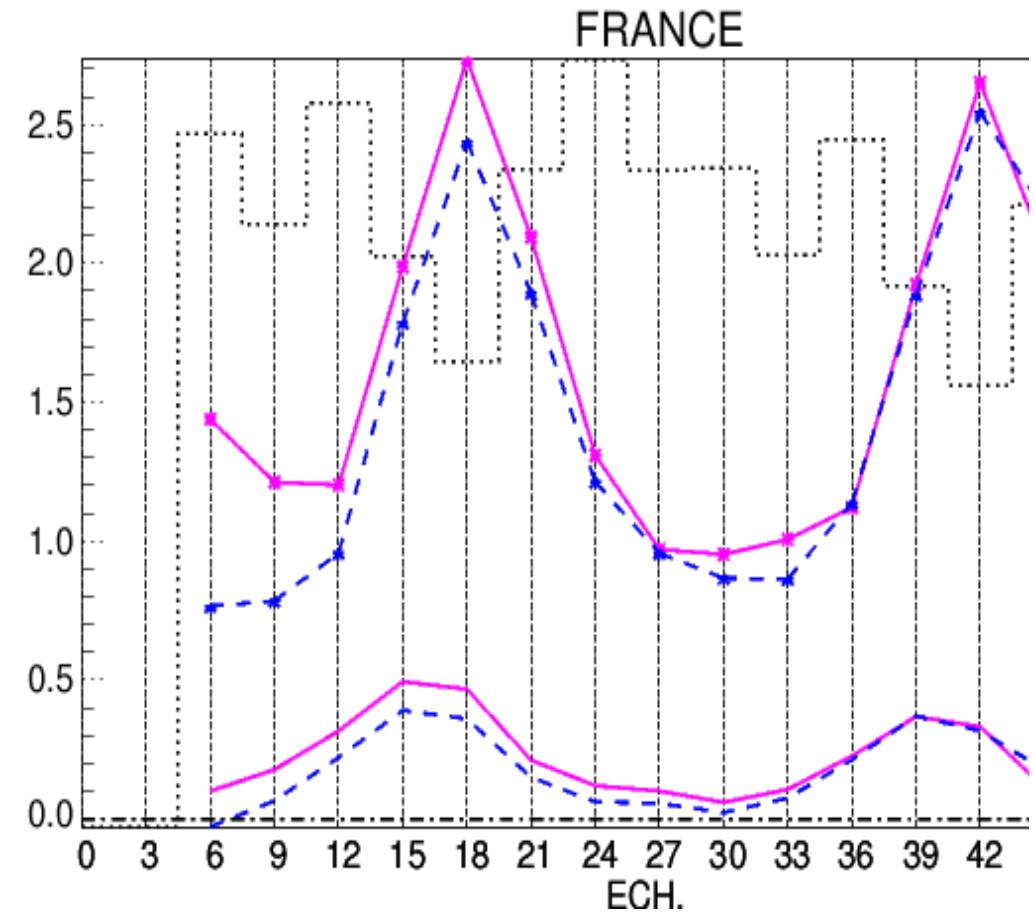
3DVar with SEVIRI



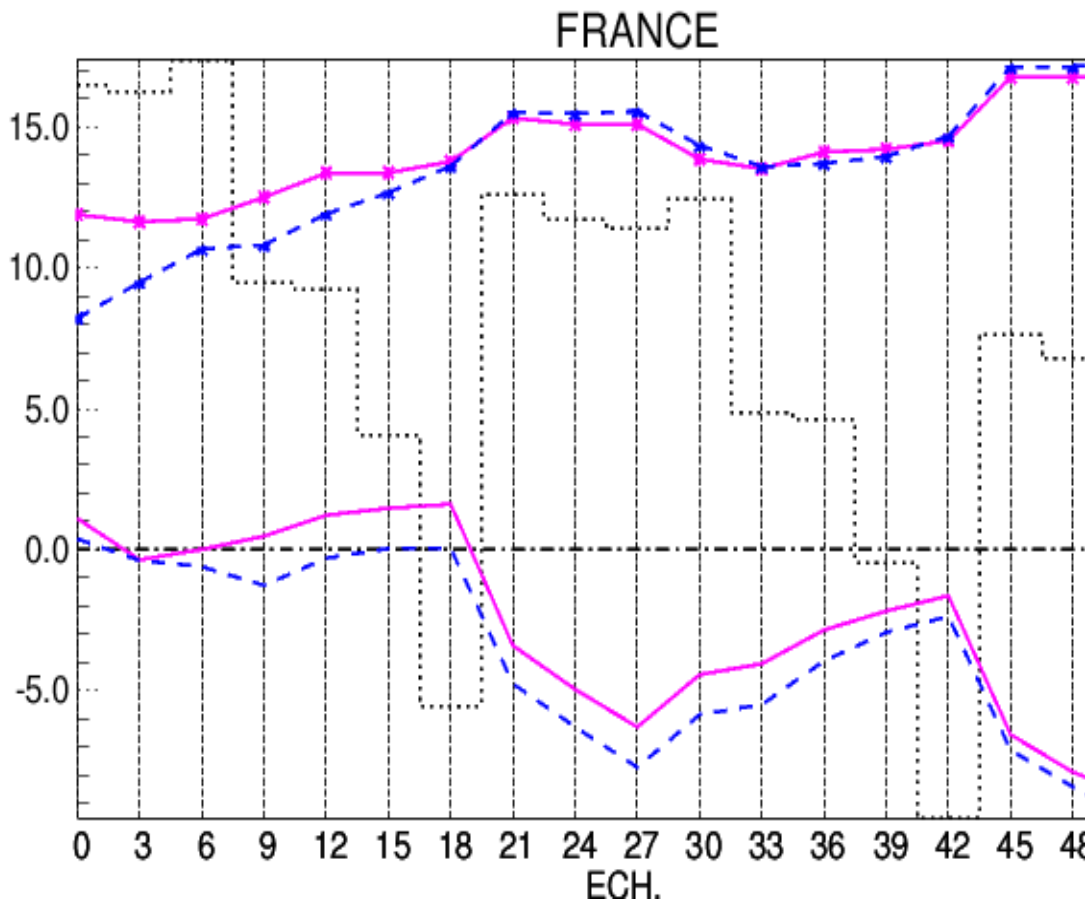
Objective score impact of 10km assimilation vs. range (rmse and bias)

(pink=ARPEGE 4DVar dynamical adpation, blue=ALADIN LAM 3DVar)

RR



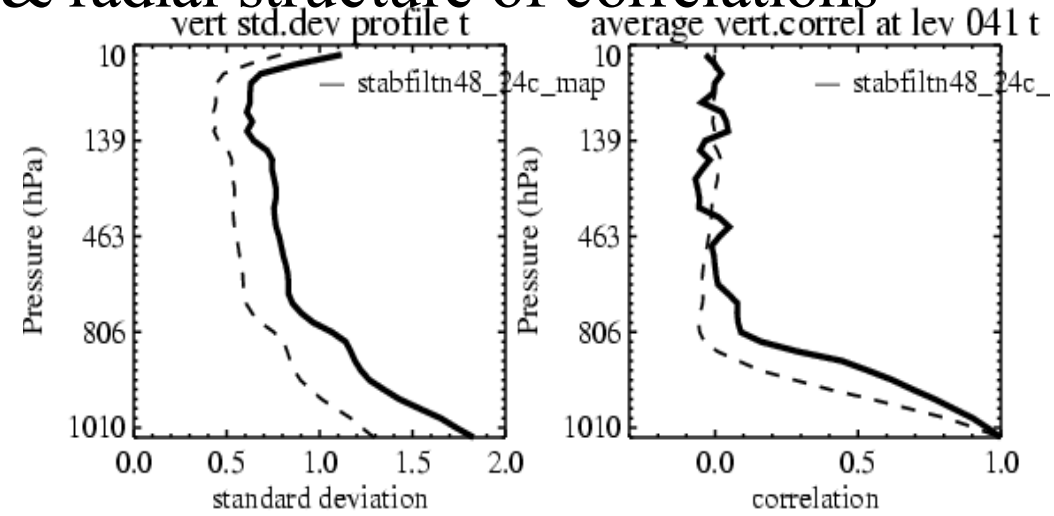
RH2m

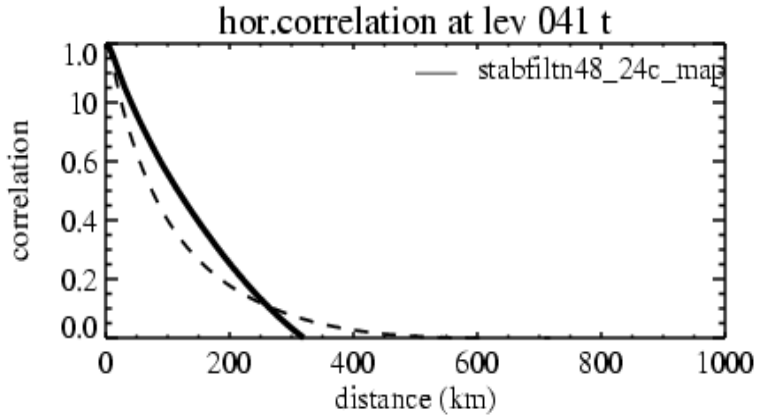


Mesoscale background errors:

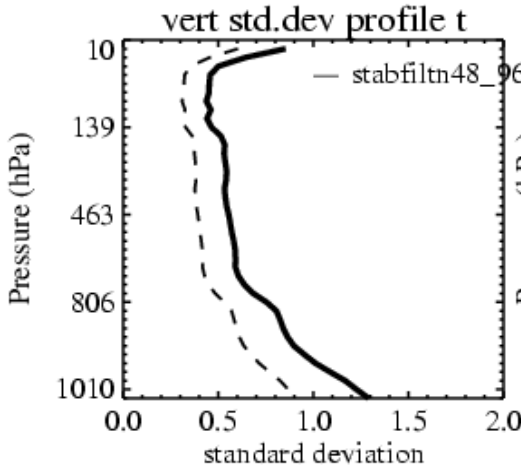
vertical profiles of standard errors

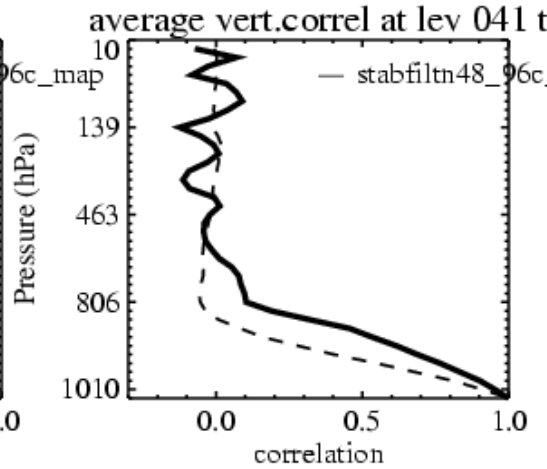
& radial structure of correlations

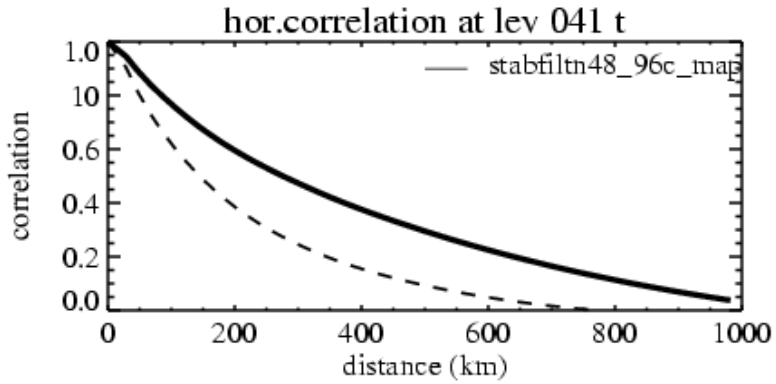




Jbc à 2,4 km

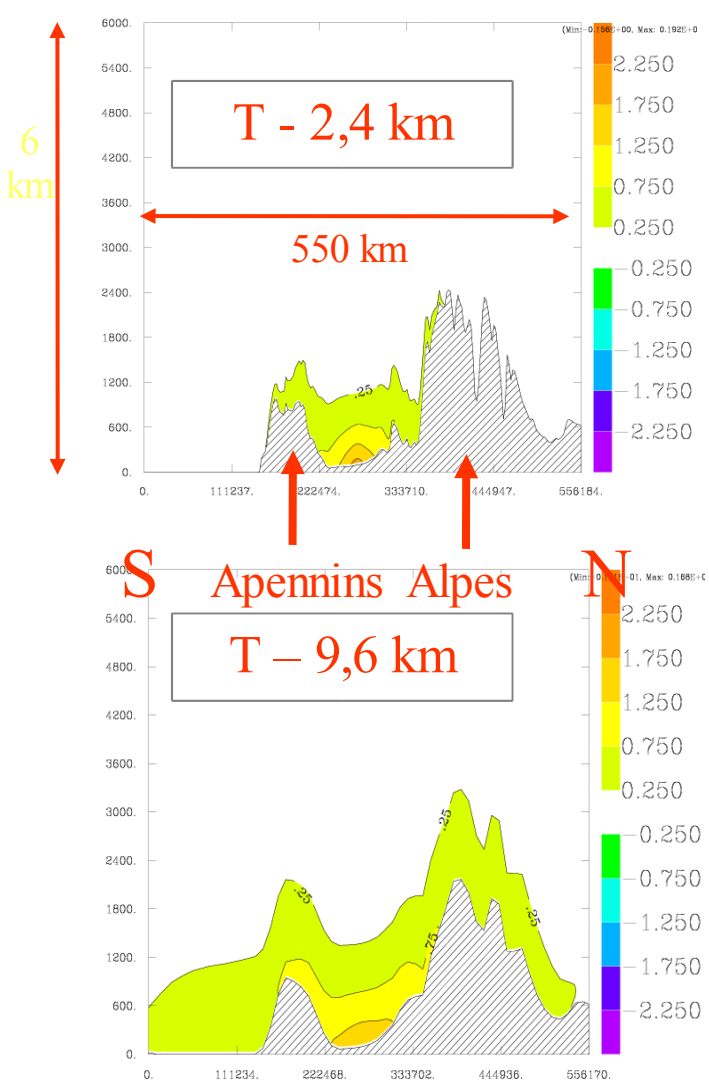


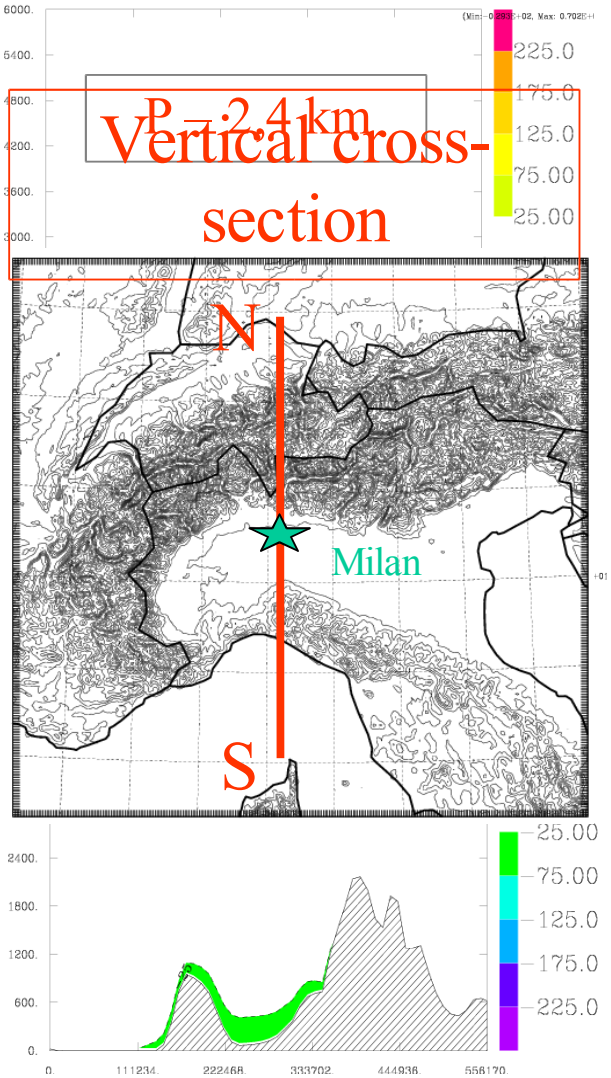


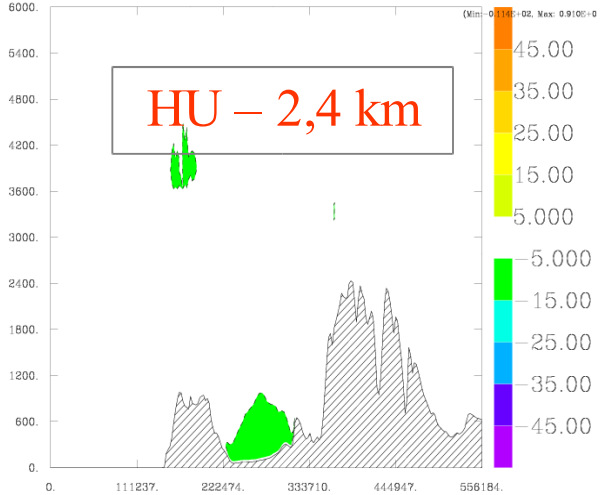


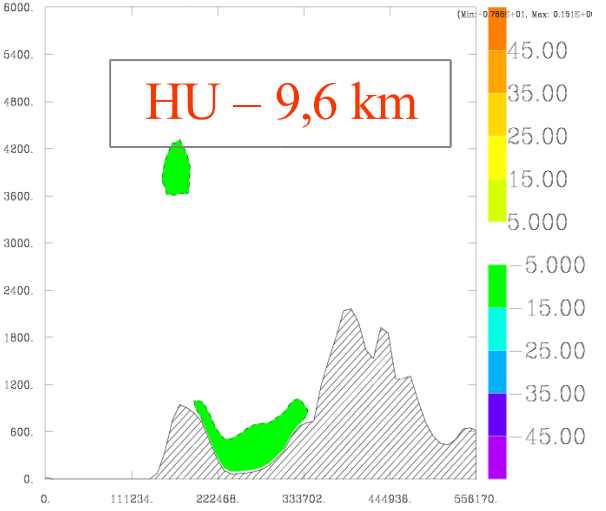
Jb à 9,6 km

3DVar impact of analysing 1 T obs in 2 different models (dx=2.4km & 9.6km) on Milan, T=background+2C near the ground









Analysing 1 obs: T=+2C at 700hPa

(a radiance obs would have a similar, deeper impact)

9 km