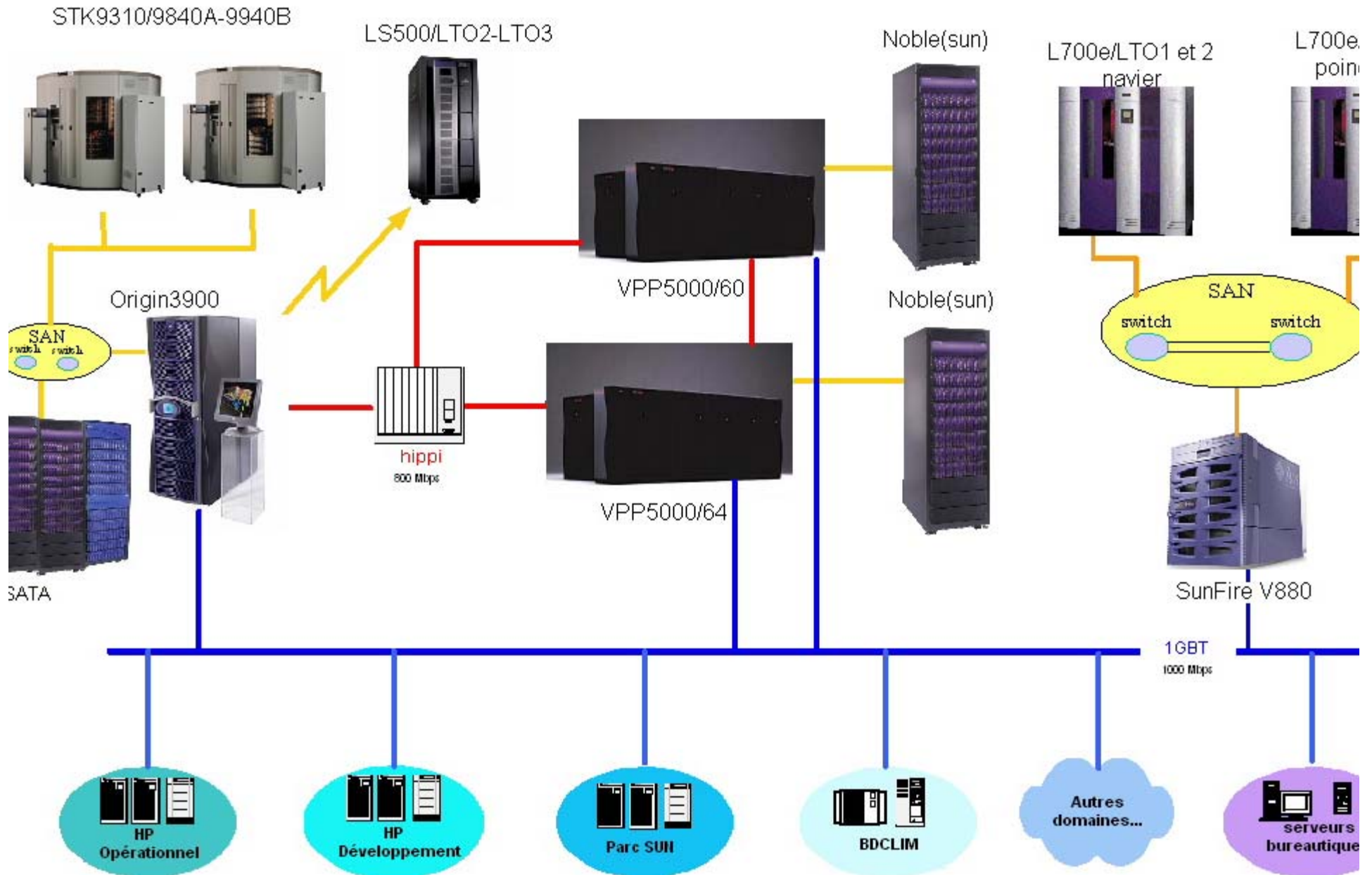


Computing at Meteo-France : a new step to satisfy the operational use of NH model

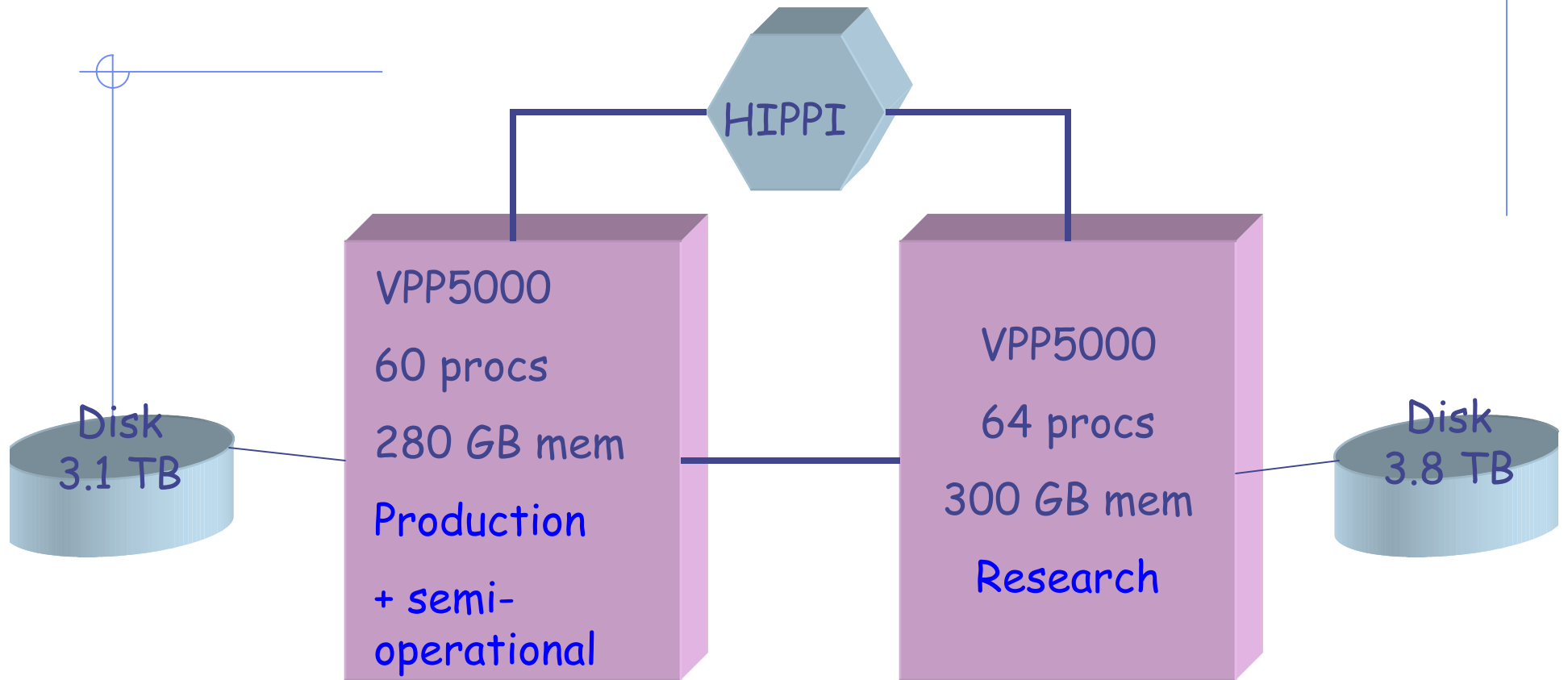
- ◆ Main computer facilities at Météo-France
- ◆ NWP applications
- ◆ Perspective of development on MWP model
- ◆ AROME project
- ◆ Computer costs
- ◆ About the procurement
- ◆ Main issues with new supercomputers

With the collaboration of Jean Pailleux (CNRM – deputy head of research)

Centre de Calcul: 2005



VPP5000 Configuration



Total 1.2 Tflops - 0.4 Tflops sustained
End : August 2007

The Arpege global spectral model (September 2005 specifications)

Spectral computation

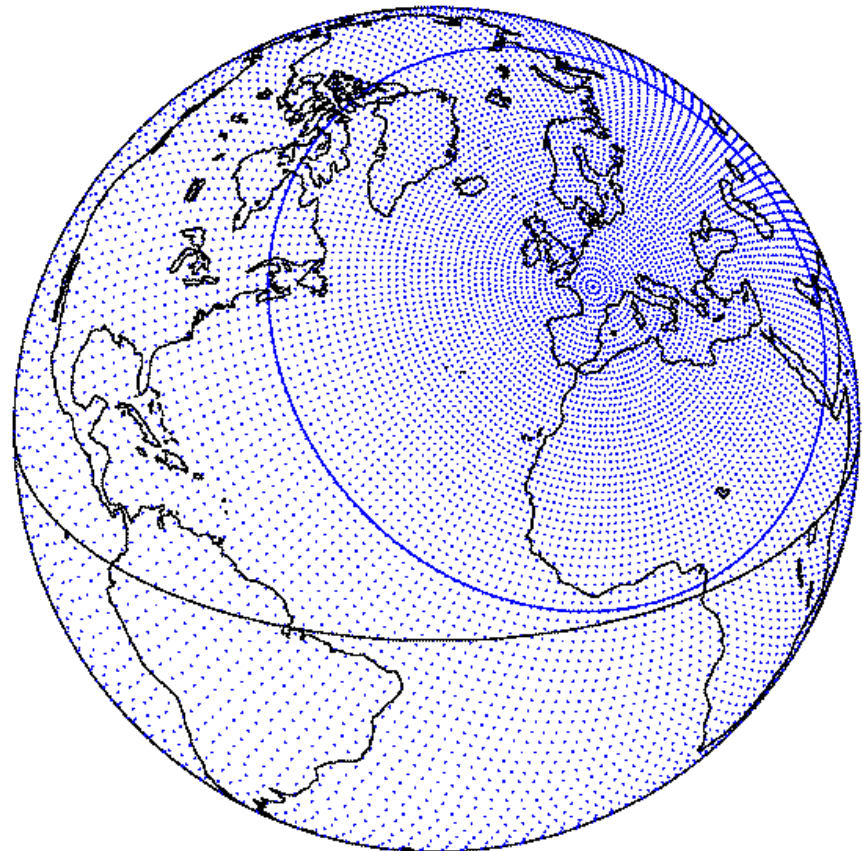
T_L358L41 (grid
720x360x41 - soon will
move from 41 to 46 levels)

Variable resolution C2,4
with pole of interest over
France

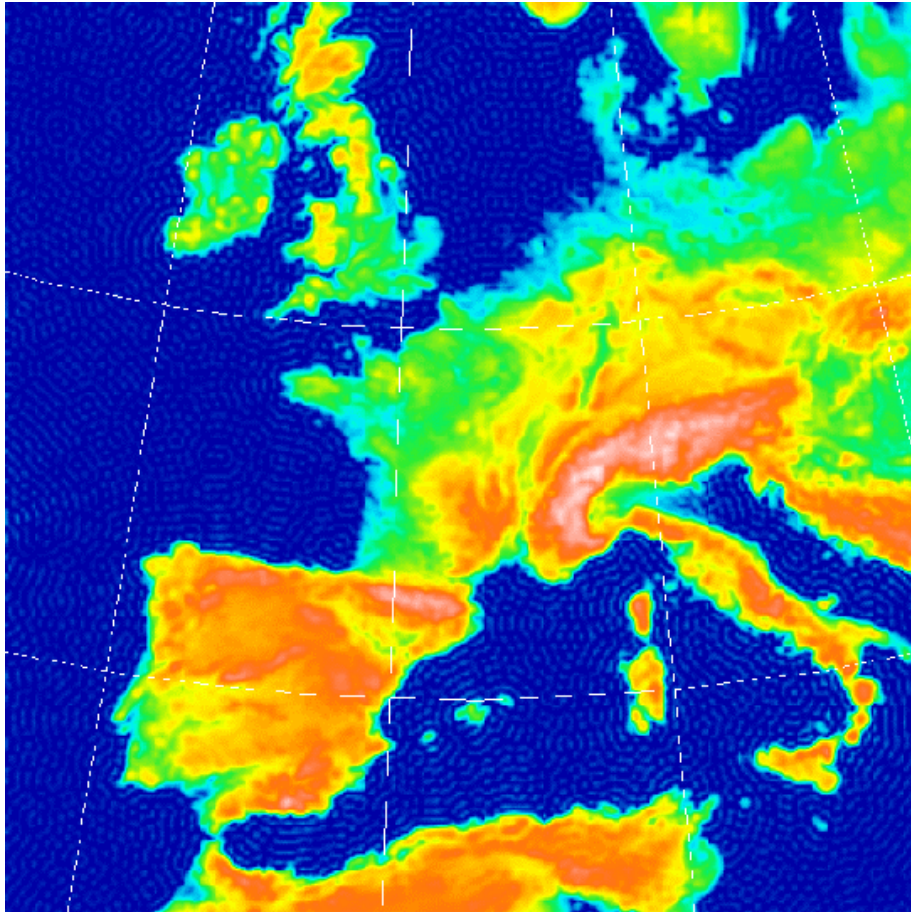
(dx=23km over France,
133km over antipode)

Code shared with ECMWF

Arpege grid



The Aladin-France limited area model



Representation of orography as it is taken into account in the Aladin-France model (Hor. Resol = 9km)

SOME ASPECTS OF THE OPERATIONAL 4D-VAR AT METEO-FRANCE (Toulouse)

Version September 2005

- ◆ **6h (max) minimisation** window: going to a higher time window (ECMWF:12h) would require much more computer resources (not planned)
- ◆ **INCREMENTAL technique**: increments evaluated through 2 minimisations at T107 and T149 ($c=1$) about a T358/ $c2.4$ main model trajectory. Rough target for 2010: T800 instead of T358; T250 instead of T149.
- ◆ **OBS USED**: conventional, satellite winds, ATOVS radiances, scatterometer data. AIRS not used:
future use of such infra-red instruments will be very demanding in computer resources

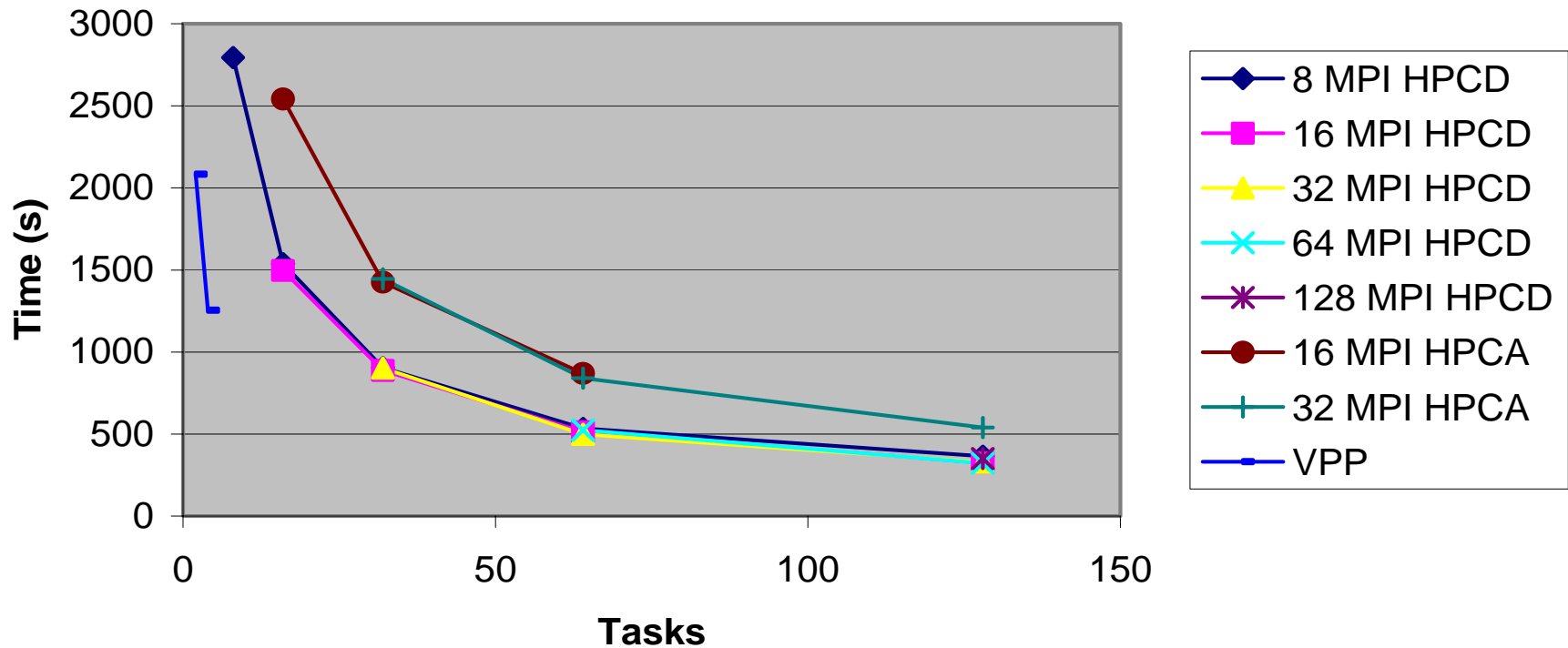
Tested platforms (before procurement)

VPP5000 : 9.6 Gflops/Pes 60 Pes

IBM SP4 : P690 (HPCA)
colony switch
960 Pes – 1.3 GHz

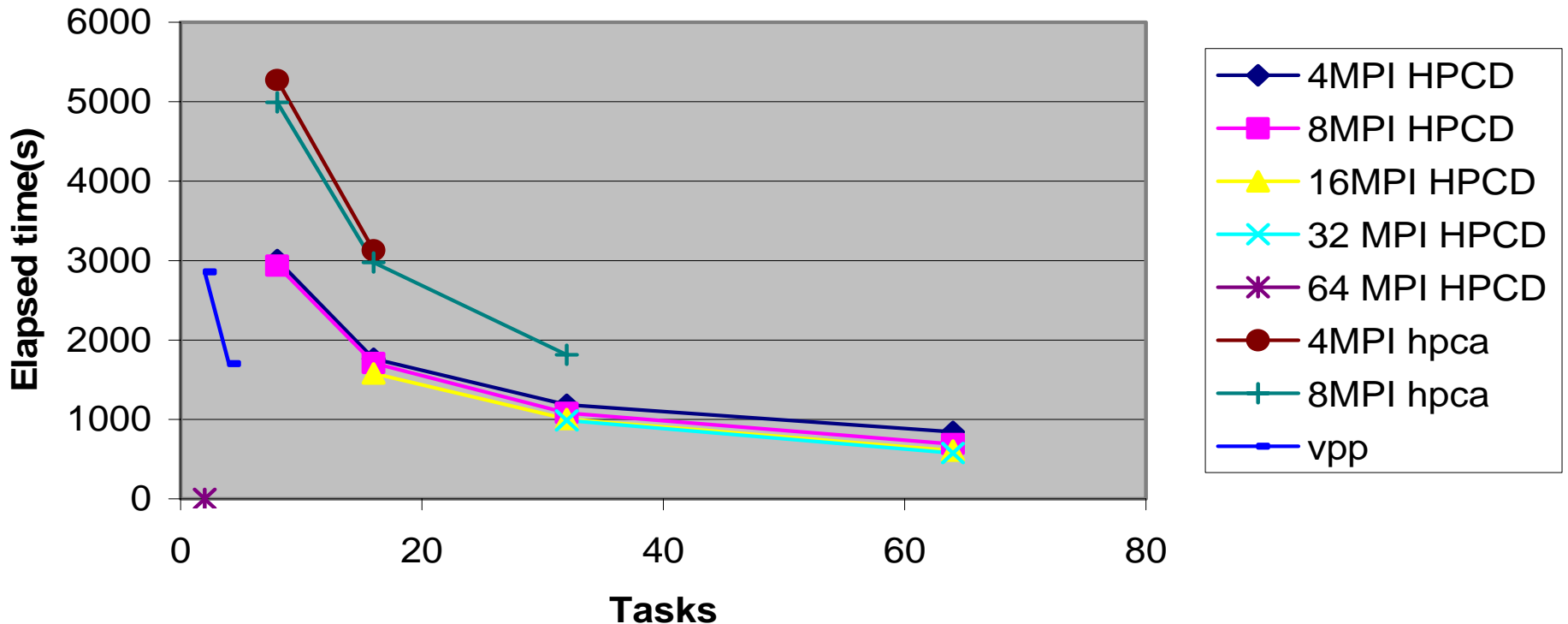
IBM SP4 : P690+ (HPCD)
Federation switch
2176 Pes – 1.9 GHz

ARPEGE 48 H T358c24



- For each curb : MPI constant, threads change
- Scalability decrease after 64 MPI
- Good scalability MPI/threads
- Ratio P690+/P690 between 1.6 and 1.7
- Ratio VPP/P690+ between 4.5 and 5

ALADIN FR 48H



- For each curb : MPI constant and threads change
- Less scalability with more than 32 Pes
- Good scalability MPI/Threads
- Ratio IBM P690+/P690 between 1.7 and 1.8
- Ratio VPP /P690+ between 3 and 3.5

Perspectives of development on NWP models

- ◆ **More details in the forecast** : resolution increase and relaxation of the hydrostatic assumption (2 to 3 km on the horizontal over France by 2008-2010?)
- ◆ **More physical ingredients in the models** : liquid/ice water, ozone, more realistic couplings with surface (ocean or land)
- ◆ **Development of a probabilistic approach for forecasting** (Ensemble Prediction System based on 11 ARPEGE members now run daily at Meteo-France)
- ◆ **Improvements of assimilation algorithms** with more efforts on the small scales
- ◆ **Development and use of new observing systems** : satellite missions (AIRS...), radar...

Météo-France Plans (2000-2010) in NWP

- ◆ **Optimise the ARPEGE-ALADIN system**, mainly for the physics, the use of observations and the assimilation algorithms
- ◆ **AROME Project** (Application de la Recherche à l'Opérationnel à Méso-Échelle) : NWP system with 2-3 km horizontal resolution over France by 2008-2010
- ◆ **Objectives** : more efforts on the forecast of dangerous phenomena at short range (ex.: precipitations), together with a better coordination with other organisations using the forecasts (ex.: hydrology)

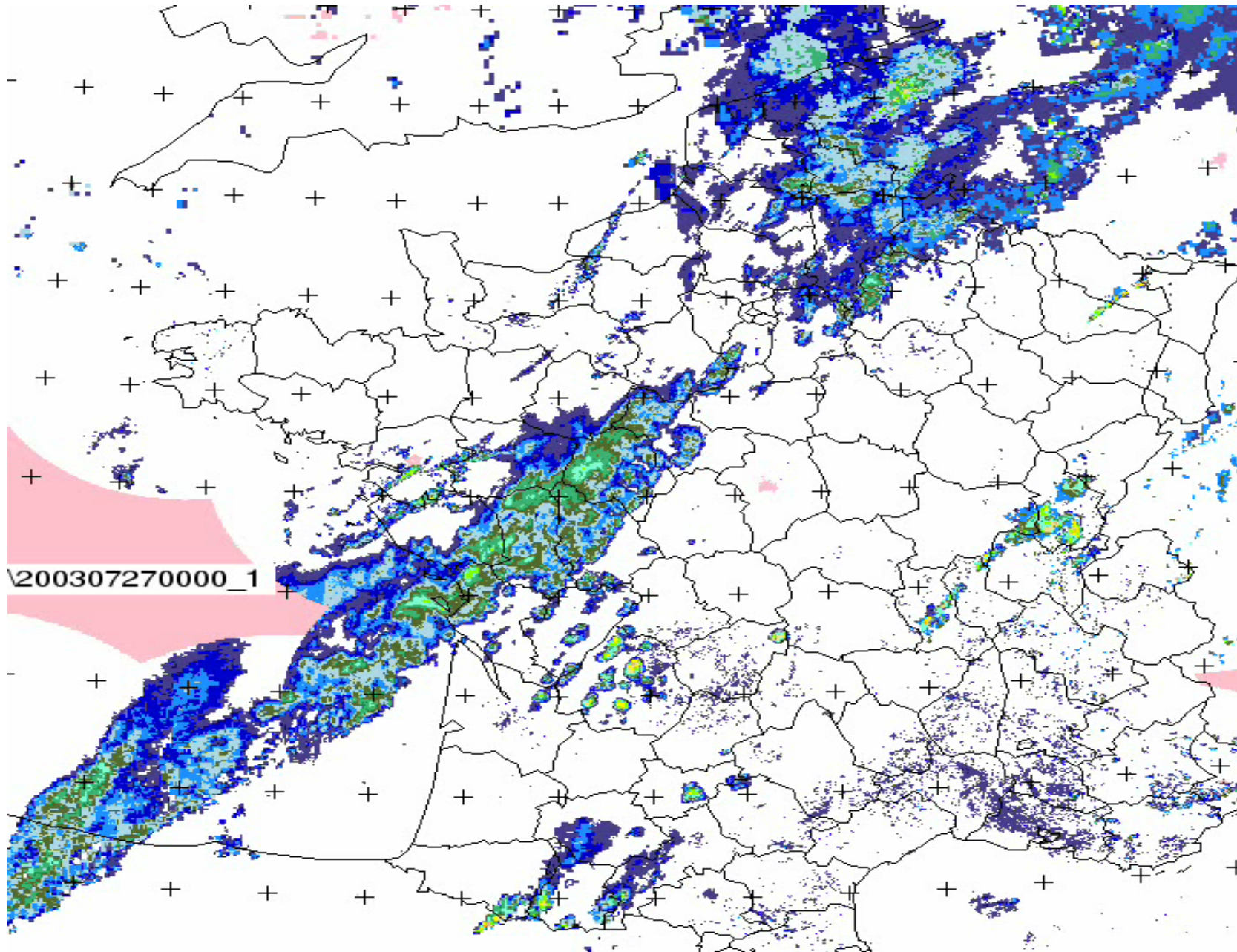
AROME PROJECT

- ◆ Non-Hydrostatic model (NH) based on the ALADIN dynamics.
- ◆ Largely derived from Meso-NH (research) for the physical parameterizations.
- ◆ Specific data assimilation system (inspired from the existing ALADIN 3D-VAR system, not operational).

Use of observations in the AROME assimilation (A 3D-VAR to start with)

- ◆ Priority on the use of radar observations and of some satellite data (mainly imagery and infra-red radiances).
- ◆ Maximum use of conventional observation networks
- ◆ Use of other satellite data: micro-waves, GPS (especially the ground GPS), lidar winds.

Typical convective structures AROME will try to forecast



Real Case

GARD flood 8-09-2002

Simulation parameters:

Size 192x192 points

Full Physique

Radiation called every 15'

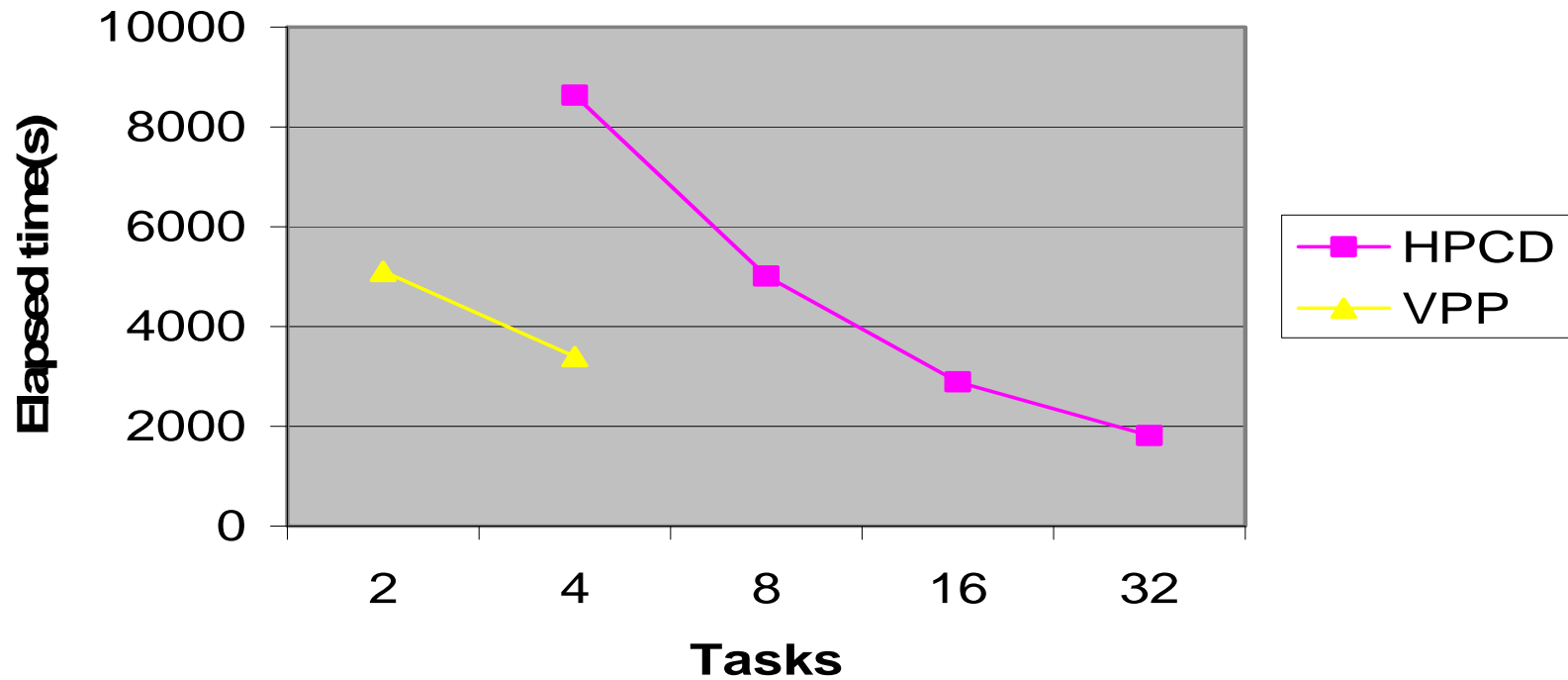
Coupling every 3h with Aladin France

Begin at 12TU 8 September, end 00TU 9 Sept.

Time step 60s

Goal : As good as referenced mesoNH simulation

AROME Gard case 12H



- Small problem of scalability
- Ratio VPP / P690+ between 2.5 and 3

COMPUTER COSTS

- ◆ AROME IS THE DIMENSIONING PROJECT FOR THE FUTURE METEO-France COMPUTER (OP. BY 2008)
- ◆ THE ARPEGE 4D-VAR (OP. SINCE 2000) IS CURRENTLY THE MOST EXPENSIVE OPERATIONAL TASK

NON-NWP CP CONSUMING RESEARCH ACTIVITIES (METEO-France)

- ◆ Runs of climate scenarios (e.g. 1% CO₂ increase per year until multiplied by 4)
more informations <http://www.cnrm.meteo.fr/dods/>
- ◆ Large-scale chemistry models
- ◆ Air-pollution models (chemistry at meso-scale)
- ◆ Oceanography (MERCATOR and coupling model – use of MPI2 – spawn)
- ◆ Marine (wave model 3D generation under development)

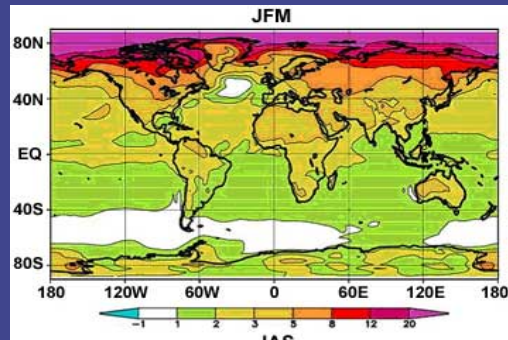
GMGEC

« Global meteorology and climate dynamics » Group

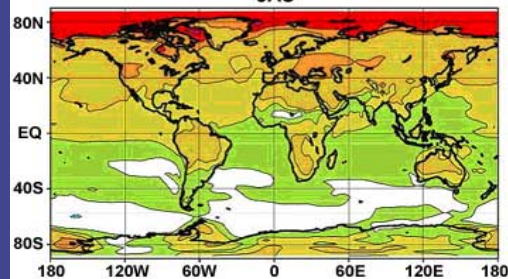
Global climate
change modeling

Seasonal forecast
of precipitation

Winter

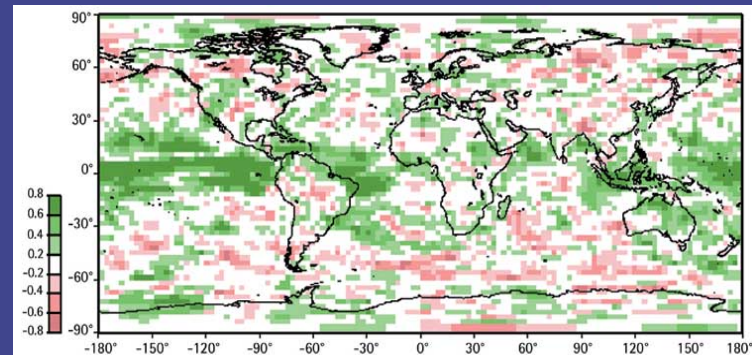


Summer



Temperature anomalies between

2070-2099 and 1961-1990



Correlation of spring Rainfall
between modeling and
analysis 1979-1993

Green = good correlation

Procurement schedule

Call to tender : 18/12/04 (new regulation)

Benchmark tests : beginning February 2005

First set of results : mid-May 2005

Second set of results : mid-September 2005

Last offer : End of December 2005

Choice : End of March 2006

First installation : 4 T 2006

Operational acceptance : June 2007

Main issues about supercomputers

From the system :

User support greatly appreciate

System administration quite complex!

Job scheduling – swap => adapt for operational use!

Infrastructure :

Need big computer room!

Important Cooling necessary (air or water)

Important consumption of electricity!

From an application point of view :

Easy portable code with a rather good efficiency!

= Market completely OPEN!