Observation requirements and data assimilation at Météo-France

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Integrated
Forecasting
System

Action de
Recherche
Petite
Echelle
Grande
Echelle

- **A numerical weather prediction system developed and supported by Météo-France and the European Centre (ECMWF)**
- **Includes all contituents needed for global numerical prediction :**
  - A global spectral model (and associated tangent linear and adjoint models)
  - 3D et 4D-VAR global assimilation
  - etc

The ARPEGE global model

Global spectral model

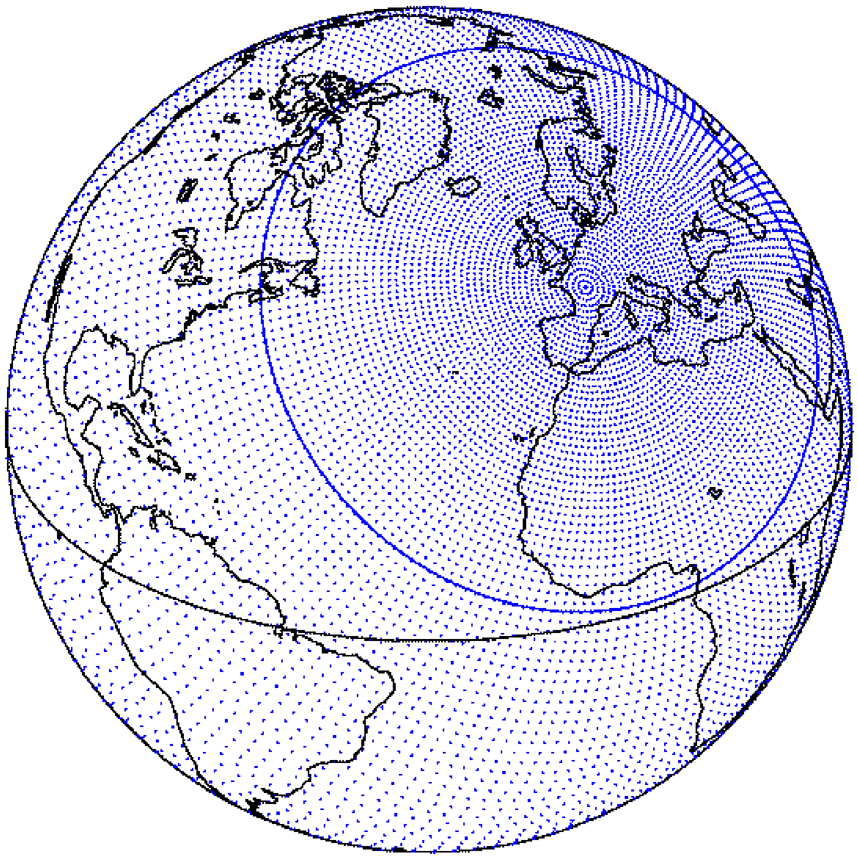
T_L358 C2.4, 41 levels

Associated grid: 23 km (France)
→ 133 km (antipodes)

Representation on the globe with stretching and turning of the pole over the interest zone

Collaboration with ECMWF

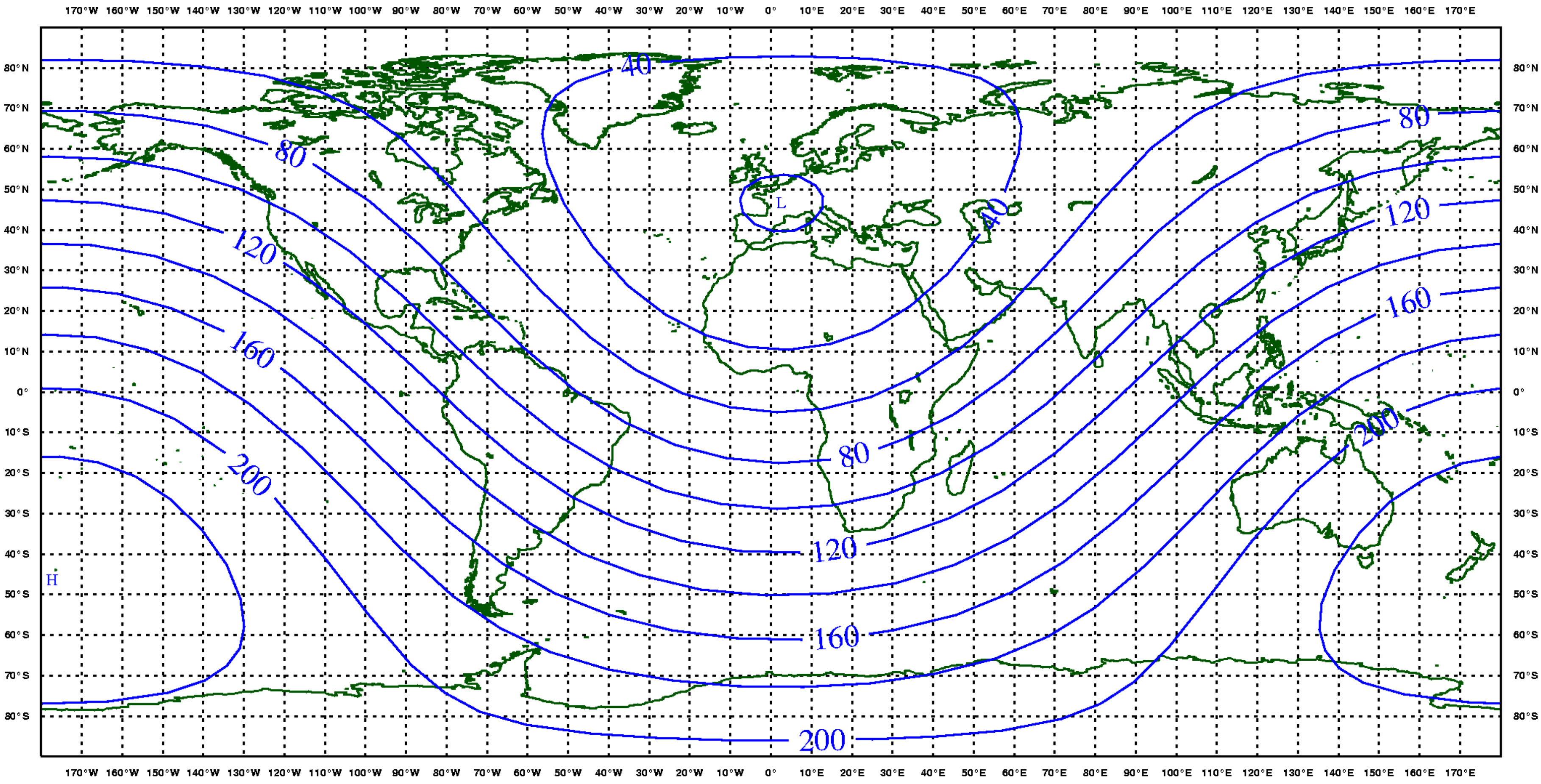
Grid for the ARPEGE model



The ARPEGE global model

T_L 358 C2.4 pole lat. 46.5° lon. 2.6°
Local resolution in km

Vertical resolution: 41 levels

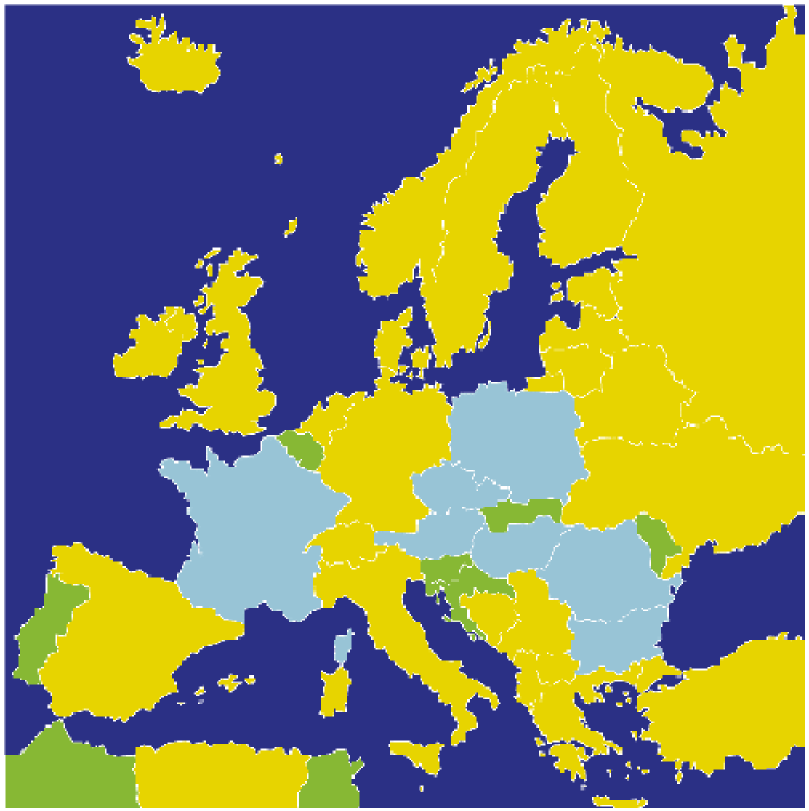


The ALADIN project

Genesis

- Project started by Météo-France in 1990
- A mutually beneficial collaboration with National Meteorological Services of Central and Eastern Europe concerning numerical prediction
- Acronym: <u>A</u>ire <u>L</u>imitée, <u>A</u>daptation dynamique, <u>D</u>éveloppement <u>I</u>nter<u>N</u>ational = <u>L</u>imited <u>A</u>rea, dynamical <u>A</u>daptation, <u>I</u>nter<u>N</u>ational <u>D</u>evelopment

The ALADIN project



Meteorological services taking part in the ALADIN project

in blue,

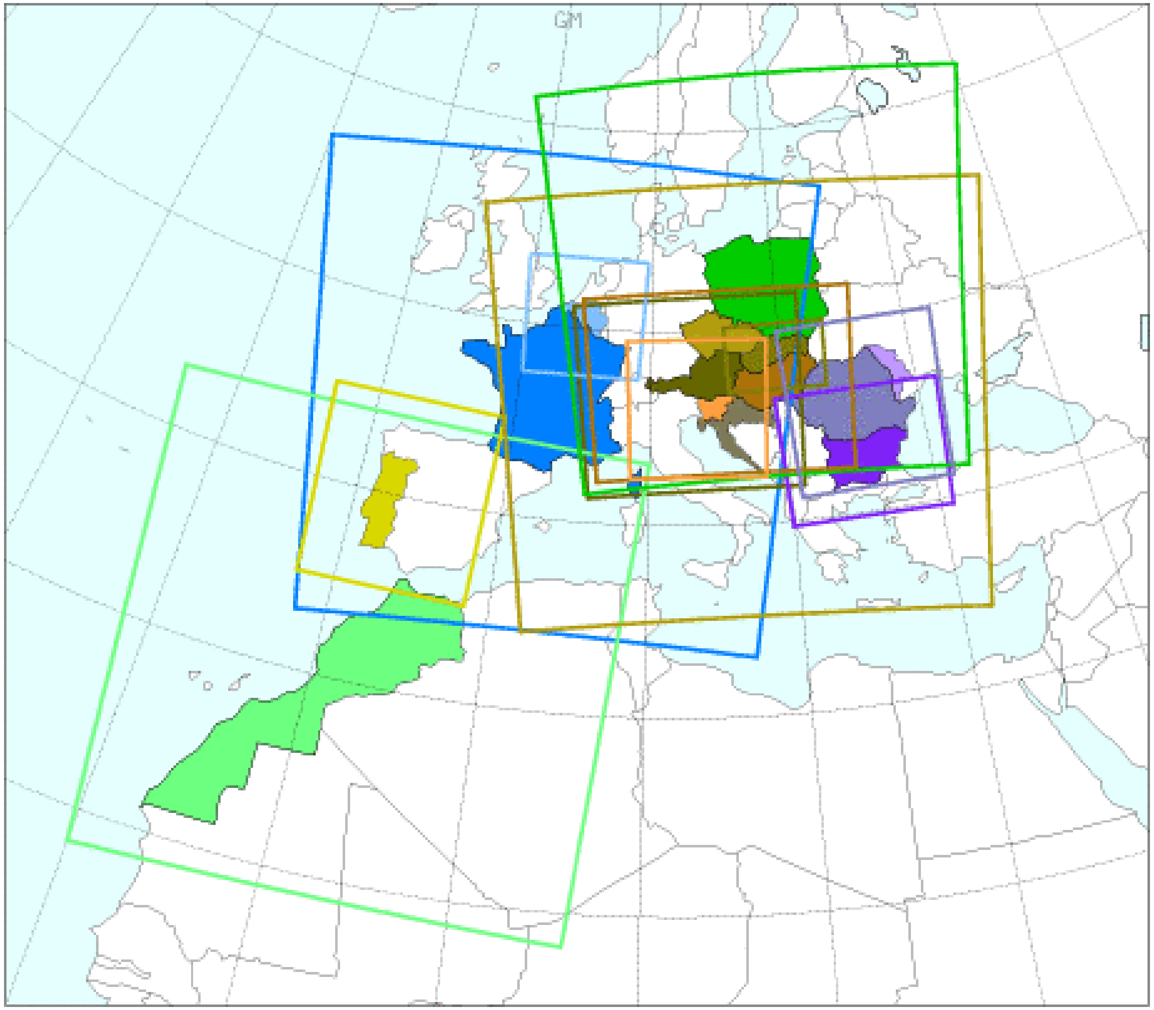
the first seven countries

in green,

the eight countries that joined the group later

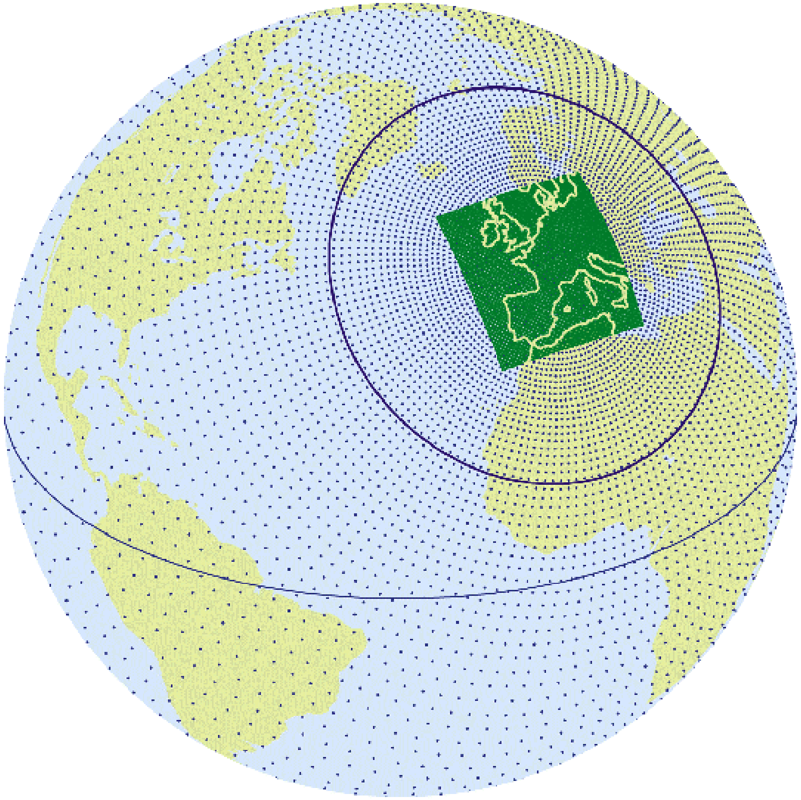
The ALADIN project :

Different operational domains

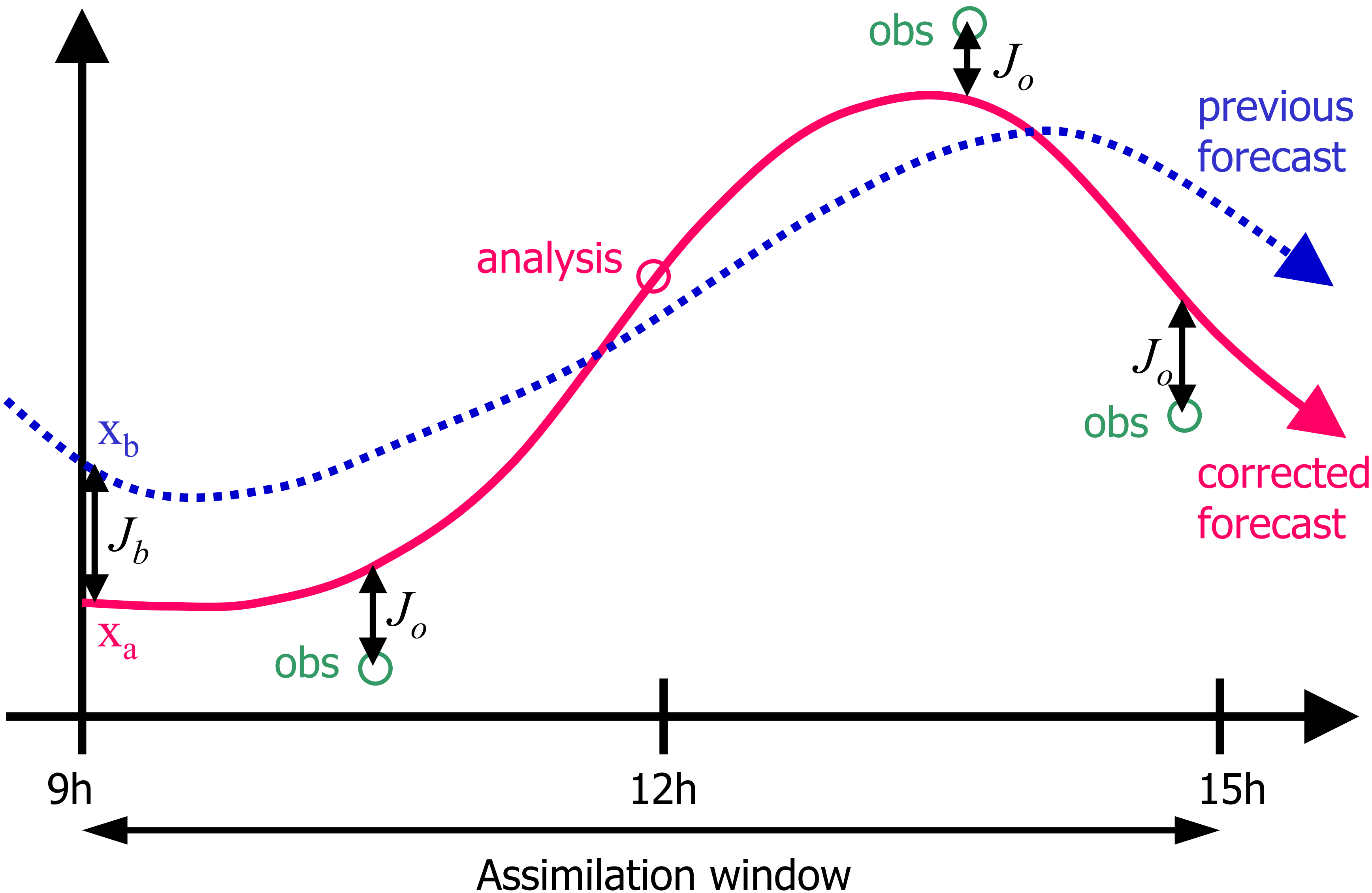


The Aladin-France limited area model

- *A spectral model*
- *Domain:* a square 2740 km in side, centered on the point of maximal resolution of Arpège
- *Vertical levels:* same as Arpège (41)
- *Horizontal resolution* (9 km) ~ 2.5 × max resolution in Arpège
- *Coupling:* applied every three hours to the global model Arpège



Principles of 4D-VAR assimilation



Operational use of models at Météo-France

- **ARPEGE model** (variable mesh), routine run 4 times a day :

- starting 00h UTC, until 102h with a **1h50** and **8h10** cut-offs

- starting 06h UTC, until 48h with a **3h00** and **6h50** cut-offs

- starting 12h UTC, until 72h with a **1h50** and **8h10** cut-offs

- starting 18h UTC, until 36h with a **3h00** and **6h50** cut-offs

- **ALADIN/France model,** routine run 4 times a day, coupled to the corresponding ARPEGE model that gives boundary conditions and initial conditions, until the same forecast ranges
- **Initial conditions** are given by a 4D-VAR assimilation run on 6h long time windows, centered on each of 00, 06, 12 and 18h UTC. Digital Filter Initialisation (DFI) is used for ARPEGE and ALADIN.

Operational use of observations at Météo-France

- Synop stations over land, ships and buoys over sea (pressure and V10m over sea)
- Radiosondes (wind, temperature and humidity) and pilots (wind)
- Wind profilers
- Aircraft observation (wind and temperature)
- Geostationary satellites winds (cloud winds, water vapour winds)
- ATOVS raw radiances from the NOAA satellites (NOAA 15, 16 and 17) transmitted from US to Europe, but locally-received ATOVS data are currently experimented.

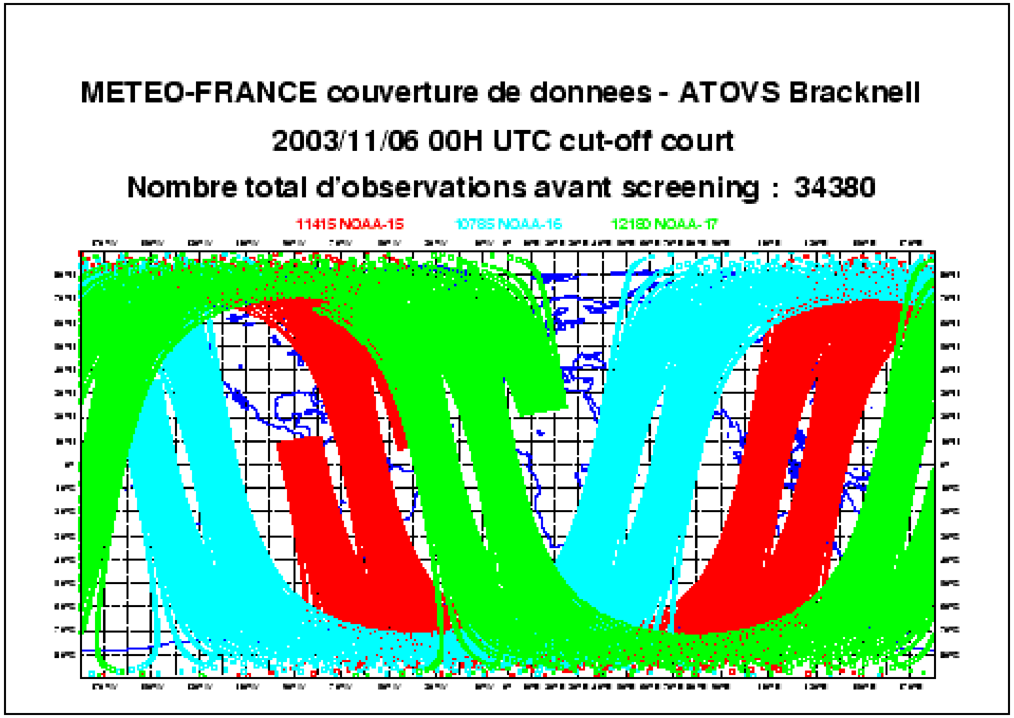
- Scatterometer, SSM/I data and MODIS winds are planned to be used in the french data assimilation

Specific observation requirements for ARPEGE and ALADIN

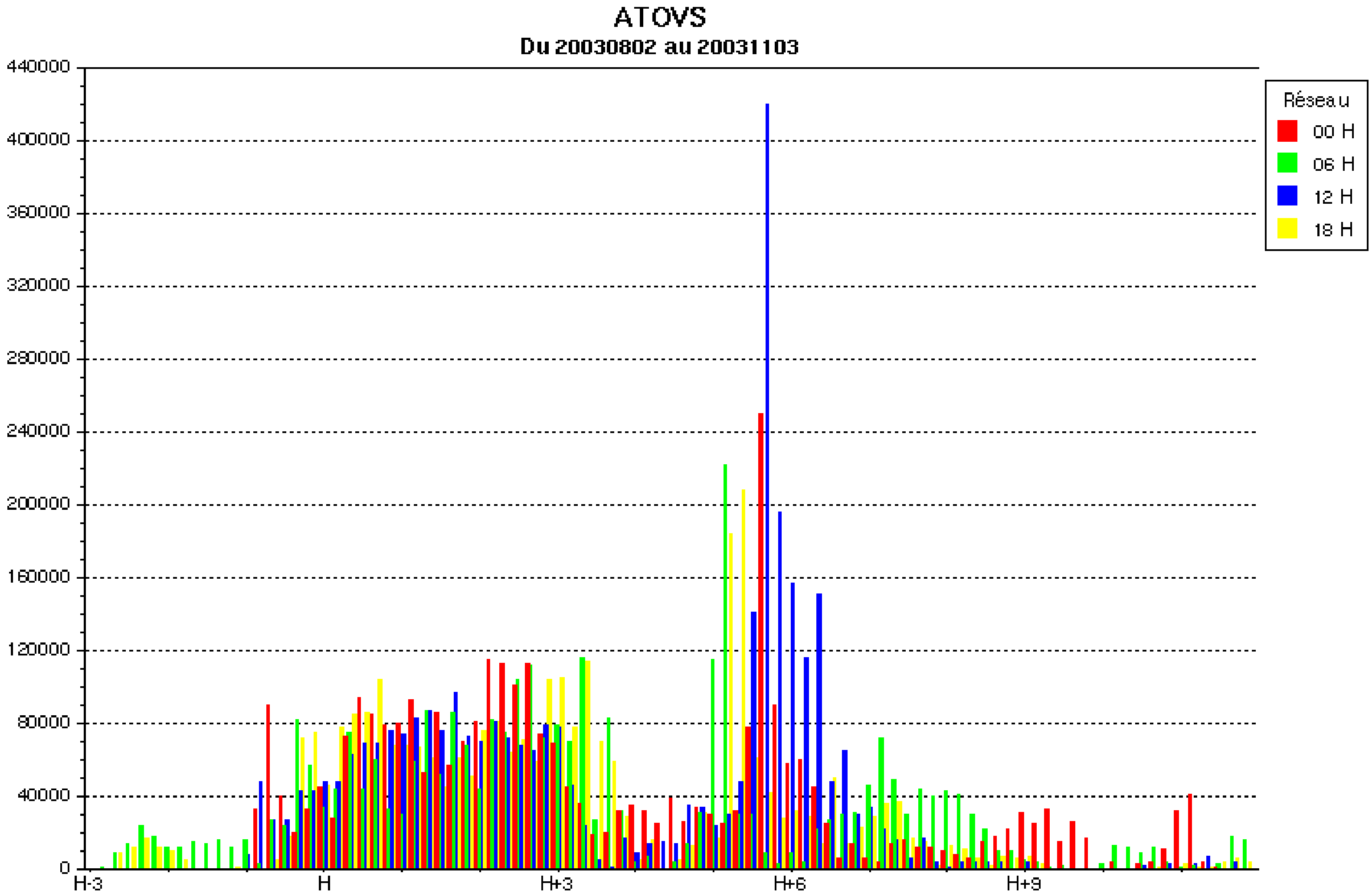
- Since the operational implementation of 4D-VAR in June 2000, observations are assimilated with a 1h time-step ⇨ improvement expected by an increase of the frequency of synoptic-time observations (radiosondes, surface synops…)
- Important specific requirement ⇨ A faster availability of radiosonde data, since the short cut-off at Météo-France (1h50 for the 00 UTC or the 12 UTC run) is chosen in order to have both a reasonable % of radiosondes over the North Atlantic and the European areas and an optimal organisation of the forecasting work at meteo-France.
- Other challenge : fast availability of ATOVS data, also required by the short cut-off. The time needed to get the data from the satellite, to encode and transmit them is currently too long for an efficient use of these data (this is the reason of the actual studies at Météo-France with locally-received ATOVS data).

The importance of rapid availability of satellite data

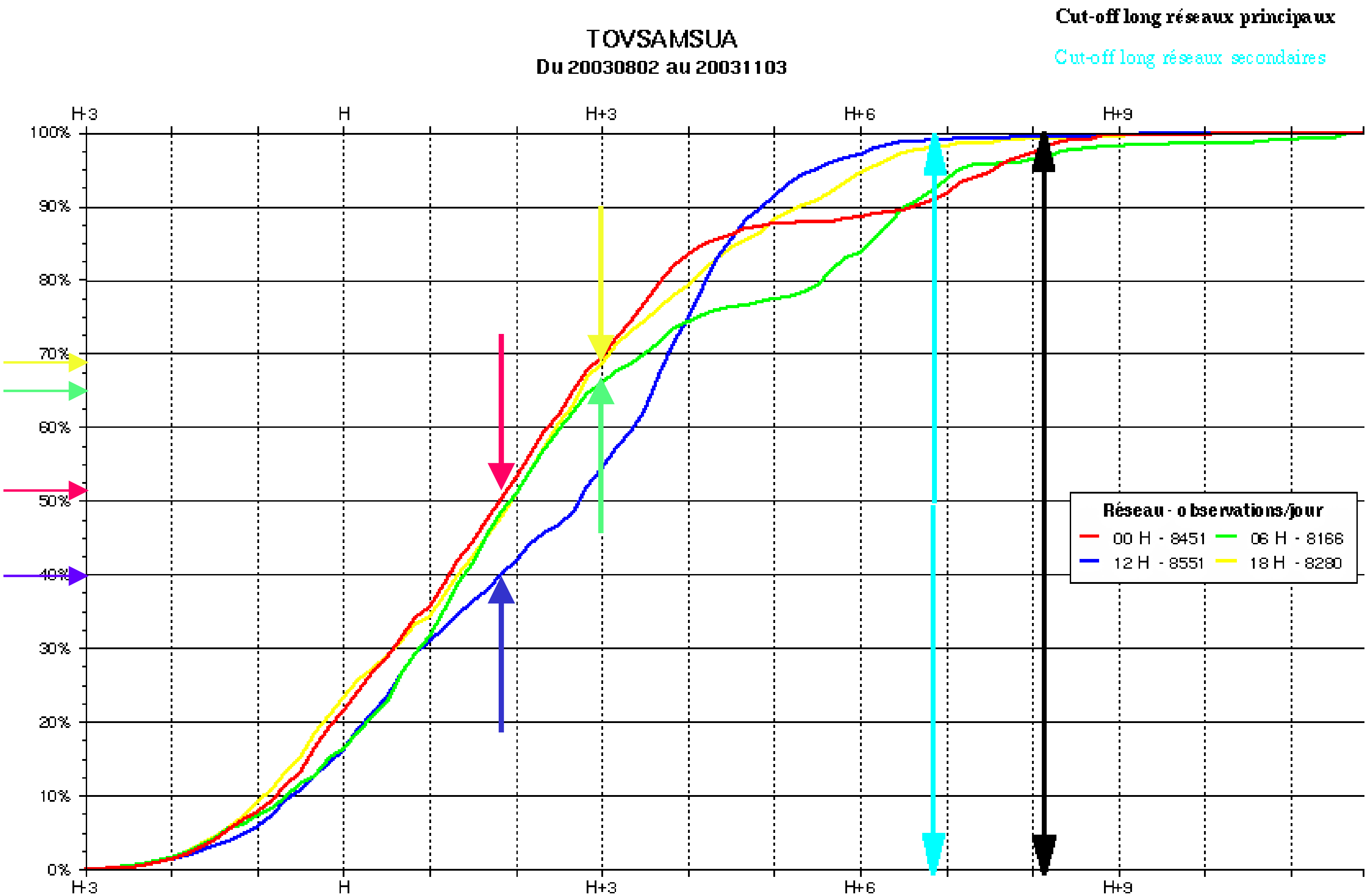
We have done recent experiments on the impact of the AMSU-A data in our assimilation scheme, and on the importance of the length of the cut-off. It has shown an improvement of the scores, significant at some ranges and some domains (for example, we have a 0.6m improvement when the forecast is launched from a long cut-off analysis, for Z500, 72H range in the SH).



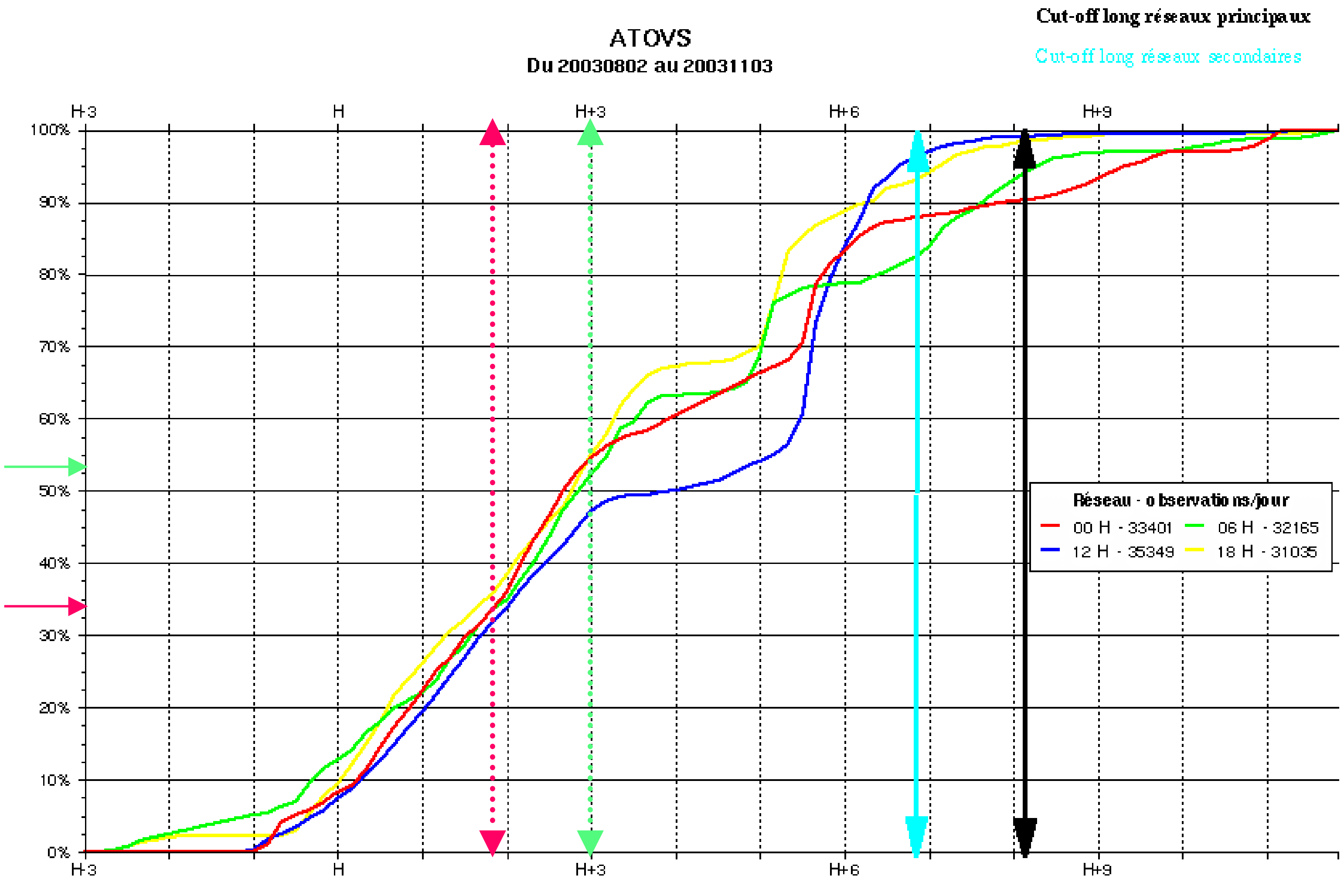
Arrival time of the ATOVS data in the obs data base (repartition)



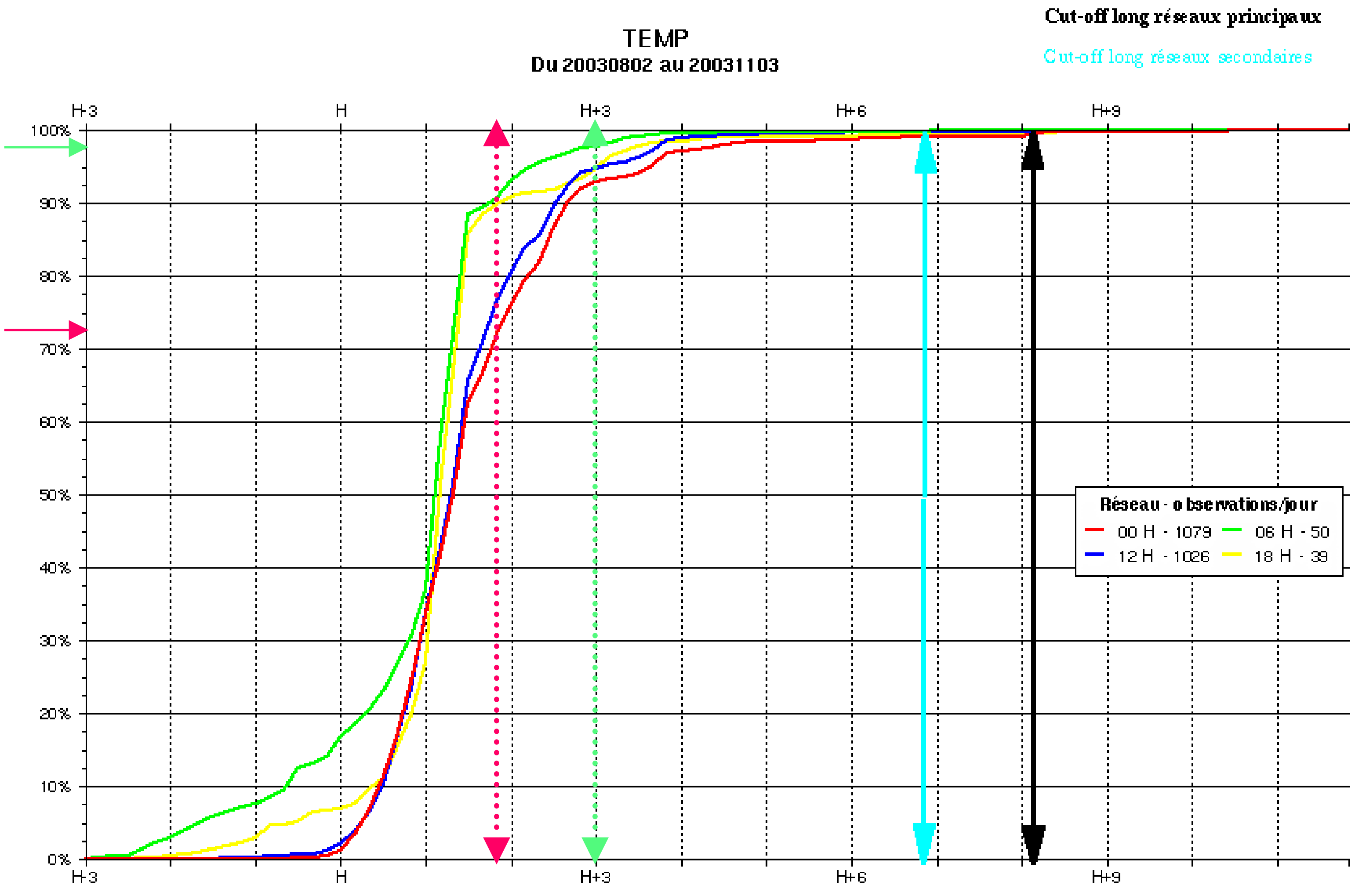
Arrival time of the AMSUA data in the obs data base (cumulated)



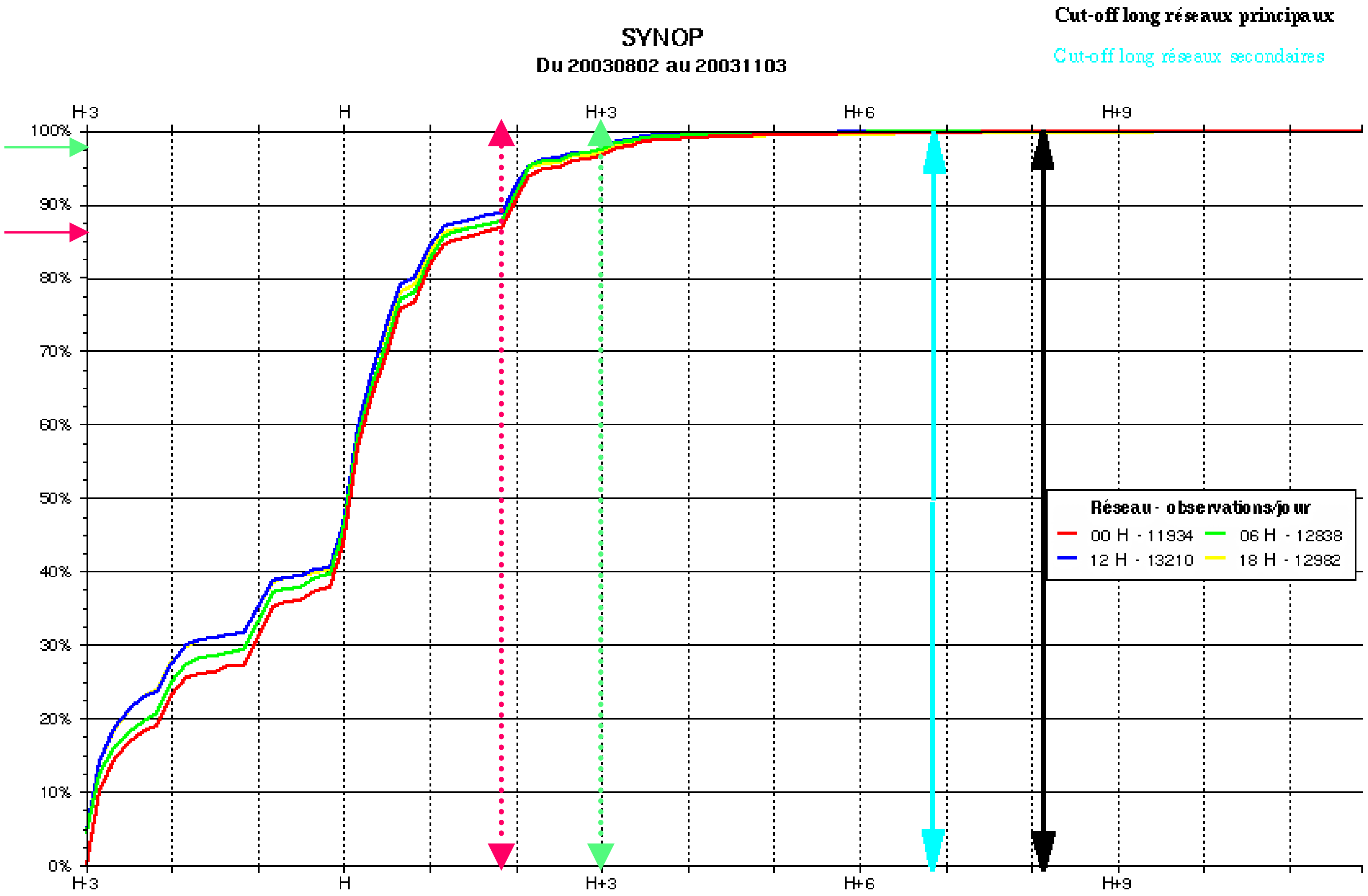
Arrival time of the pre-processed ATOVS data in the obs data base (cumulated)



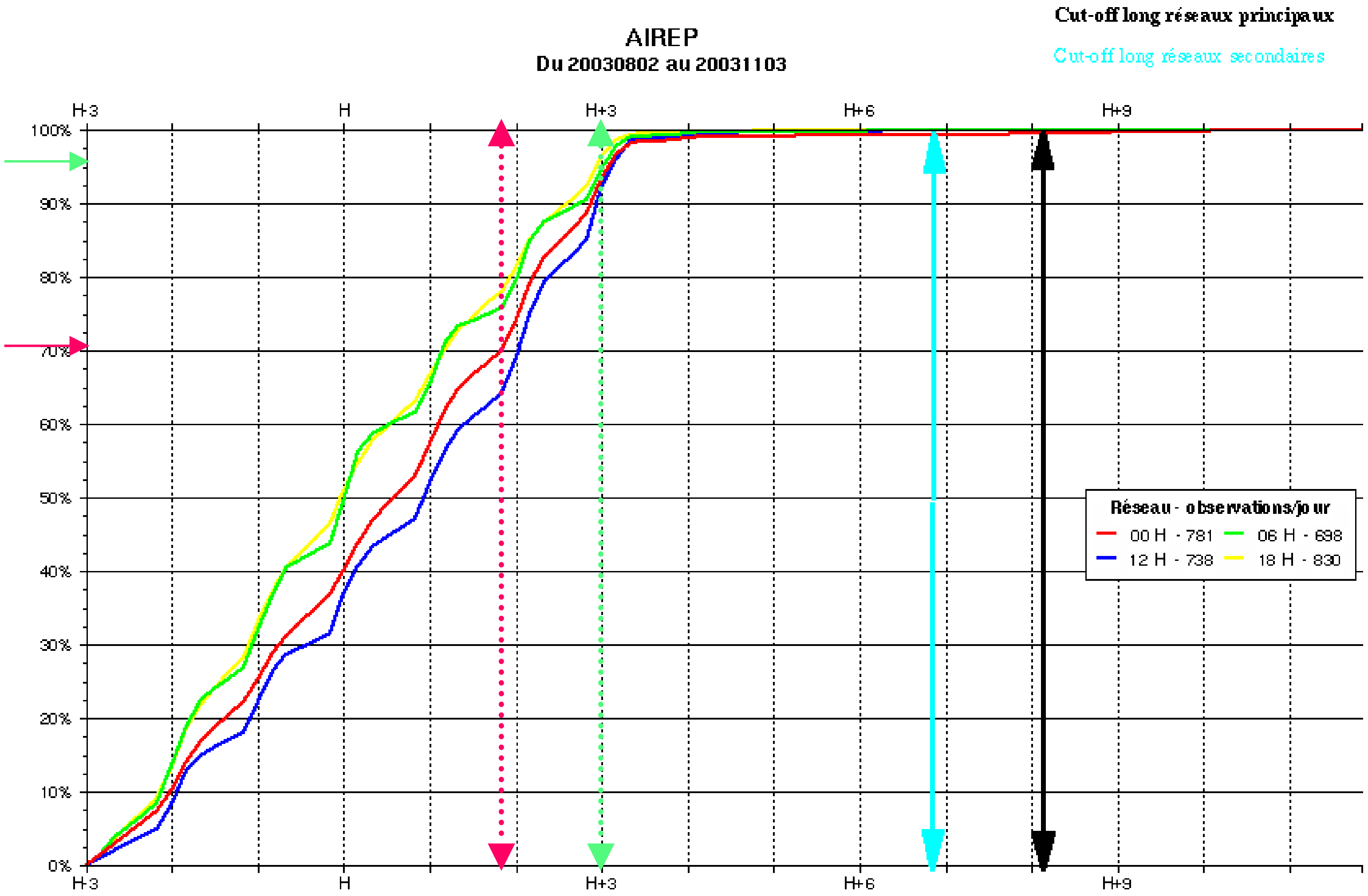
Arrival time of the Radiosonde data in the obs data base (cumulated)



Arrival time of the Synop data in the obs data base (cumulated)



Arrival time of the Airep data in the obs data base (cumulated)



Research experiments with locally received AMSUA data

Data available for the operational production, 1h50 cut-off time

Nesdis/Bracknell data

EARS data

Eumetsat ATOVS Retransmission Service

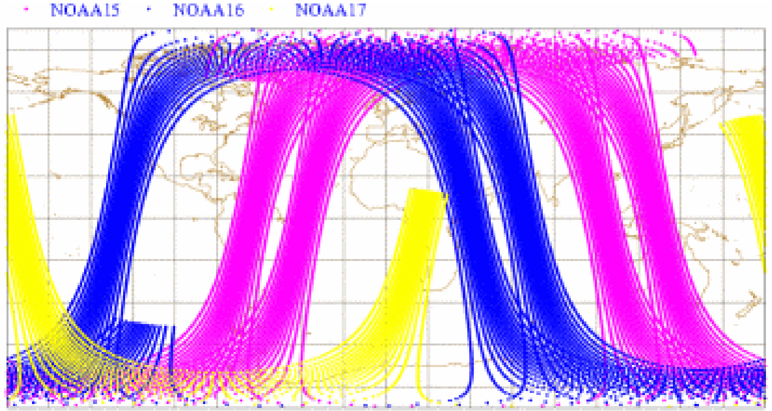
- Data rapidly available
- No blind orbit for NOAA17

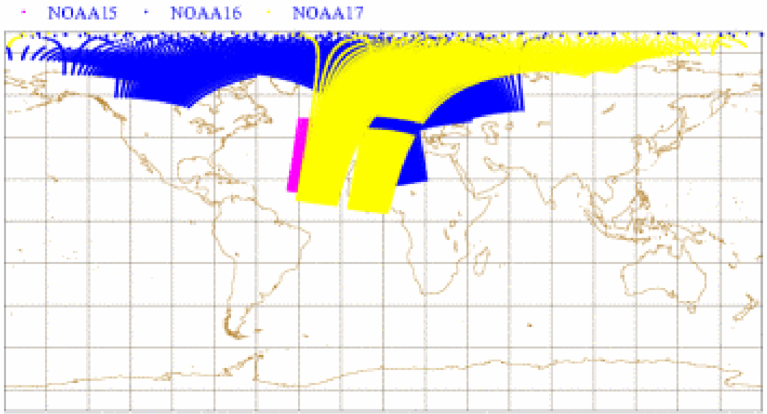
(reception centres: Greenland, Norway, Canary Islands)

Lannion data 45W/40E/70N/30N

- Even more rapidly available, but smaller area & only NOAA16/NOAA17

13 March 2003 12 UTC



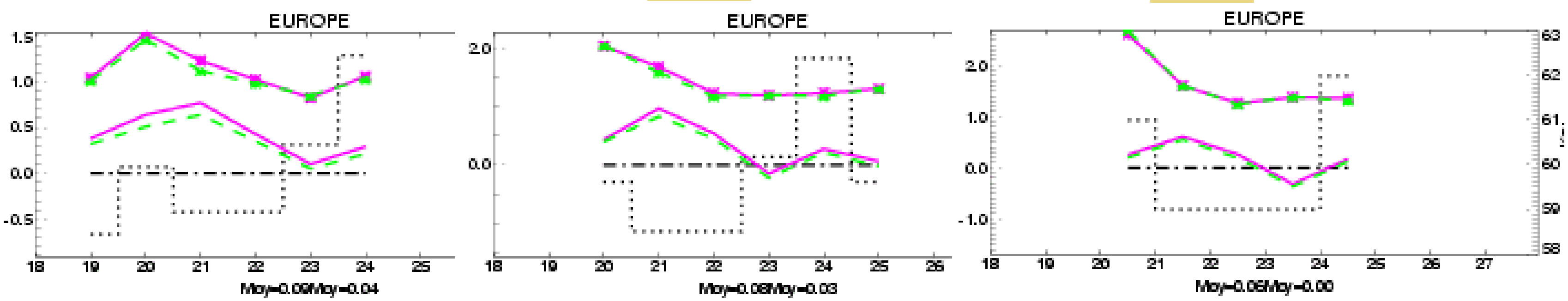


Impact of EARS and Lannion data in addition to Bracknell data (rms/bias wrt radiosondes)

Temperature @ 250 hPa

forecast range (hour)

12 36 48



Bracknell Bracknell+EARS+Lannion

First step: assimilation in operational model ARPEGE

Next step: assimilation in regional model ALADIN (... AROME) in research mode

AMSUA, HIRS, AMSUB (observation density, bias correction, ...)

The AROME project and the future observation requirements

- The close future at Météo-France will consist in improving the existing models ARPEGE and ALADIN (physical parametrisations, assimilation algorithms and observations use)
- The main project for 2003-2010 is called AROME (Application de la Recherche à l'Opérationnel à Méso-Echelle). The aim is an operational NWP system over France with a horizontal resolution around 2 or 3 km, and coupled to a large-scale NWP system. The specific goal of Arome is the short-range prediction of dangerous phenomena (heavy precipitations, floods…) with a greater coordination with other organizations using such predictions (eg. hydrologues)
- In addition to the observed data already or to be used by the large scale assimilation, Arome will use radar and all conventional surface regional and national network. Arome will also use satellite data, with a priority on infra-red radiances and imagery, and also micro-wave, GPS and Lidar wind data. The availability and the frequency requirements for these data will be stronger than the current operational one.

Conclusion

- The current global observation requirements are very similar to the ECMWF ones, except the huge time constraint. The necessity to run frequent forecasts with a short cut-off (1h50 and maybe less in the future) stresses the need of a quick exchange of polar orbiting satellite data (at least in the area of interest of Arpege and Aladin). There is also a strong interest for getting all the surface observations produced with a 1h frequency.

- Arome will strongly increase the observation requirements towards new observing systems, rapid and frequent availability of almost all the meso-scale observing systems. The assimilation time period of Arome will probably be 1h, the long cut-off 2h and the short cut-off 1/2h !