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1. INTRODUCTION

The traditional graphic summary of the synoptic meteorological situations is a map showing one field, the sea level pressure, with superimposition of the fronts. These meteorological maps used by forecast services for synoptic analysis and forecast have seldom changed over the years, while our understanding of the atmosphere has improved thanks to satellite images, in parallel with the progress in dynamic meteorology and numerical simulation. Such a presentation of the synoptic situation does not emphasize the importance of upper level forcing, nor reflect the wealth of atmospheric structures. Nowadays, modern dynamic meteorology provides us with a firm framework to build a more complete graphic summary of the synoptic atmosphere than the polar front concept. Moreover, the present guidance prepared at the central forecast office (surface maps and long texts) is not efficient enough to convey the synoptic expertise towards the weather offices. This is the reason why Météo-France decided to introduce a new graphic product named ANASYG-PRESYG (standing for Graphic SYnoptic ANALysis or PREdiction) allowing to summarize as best as possible all the relevant meteorological information at the synoptic scale. In order to promote this new presentation and the associated working method among the forecasters, Météo-France has been undertaking a large training action with the help of a Computed Aided Learning (CAL) software dedicated to synoptic meteorology.

2. WHAT ABOUT THE ANASYG-PRESYG?

The ANASYG-PRESYG is a two-level representation of the atmosphere summarizing with suitable symbols the relevant meteorological information at the synoptic scale. These documents include the crucial upper-level dynamic elements superimposed on the surface phenomena : plotting of upper-level jets and tropopause anomalies (diagnosed at the dynamic tropopause defined as the 1.5 pvu surface) with convenient symbols allow to specify the upper troposphere dynamics; various kinds of fronts and other surface discontinuities are represented by using a wider set of symbols and the activity of the weather systems is specified. Precipitation areas are explicitly represented only when the conceptual models do not allow to

determine their contours with sufficient accuracy. Of course the sea level pressure is also plotted on these new documents as before on the traditional ones.

3. EXAMPLE OF ANASYG-PRESYG

The ANASYG-PRESYG are shown here using examples rather than a formal description (for that see Santurette and Joly, 2001). The case of the 26 December 1999 storm over France (named also *Lothar*) is taken as example. The 06 Z and 12 Z ANASYG as they can be drawn from observations and objective analysis the 25th in the morning are shown fig.1 (respectively (a) and (b)). According to the two level representation of the situation, these maps present superimpositions of symbols identifying the tropopause and the low levels characteristics on the sea level pressure. So, these documents emphasize the risk of cyclogenesis in the near future over East-Atlantic-West of France: a baroclinic interaction between the tropopause anomaly P1, the strong jet and the low level minor low D1 (a so-called mechanism "type B cyclogenesis", also called the "Pettersen scheme") is more and more likely to occur. The ANASYG clearly show the crucial structures leading to cyclogenesis, structures that can be located a long time before the explosive development. Then such a graphic synthesis of the situation helps forecasters to identify and to follow crucial elements on satellite images as well as on model output.

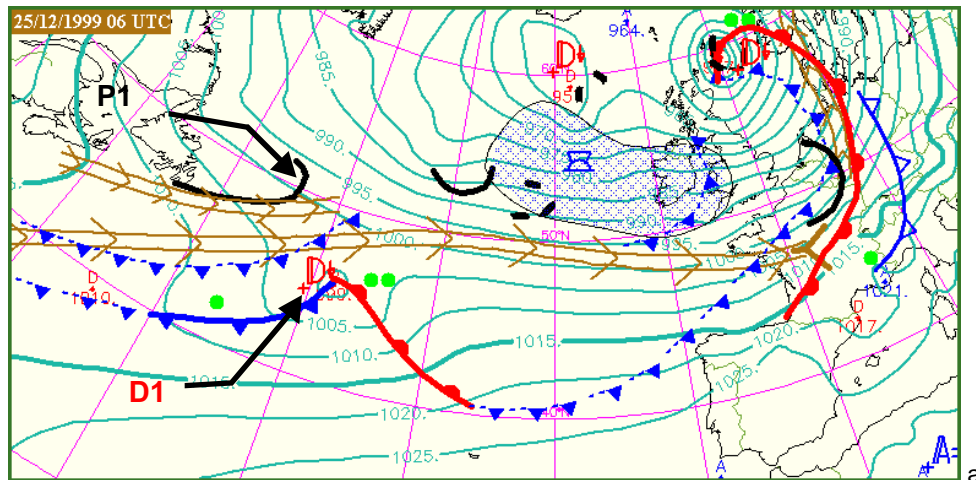
Figure 1 (c) presents the 24 h PRESYG valid on 26 December 1999 at 00 UTC, based on the ARPEGE* model run from 25 December 1999 at 00 UTC. This PRESYG synthesizes the 24 h forecast and then points up the beginning of a baroclinic development close to the west of France. This document shows the crucial elements of the dynamics : the leading edge of the tropopause anomaly is marked by a thick black line *P1* and the jet-stream (with eventually a strong diffluent zone) is also mentioned; in addition to the sea level pressure this PRESYG also points up the relevant low level elements such as the frontal systems or the low level baroclinic zone (maximum of temperature gradient with no wind forcing, marked as non active front). Then the baroclinic interaction between the low D1 and the dynamic upper level flow is clearly suggested on the PRESYG.

These examples of ANASYG and PRESYG show how such graphic documents highlight the relevant

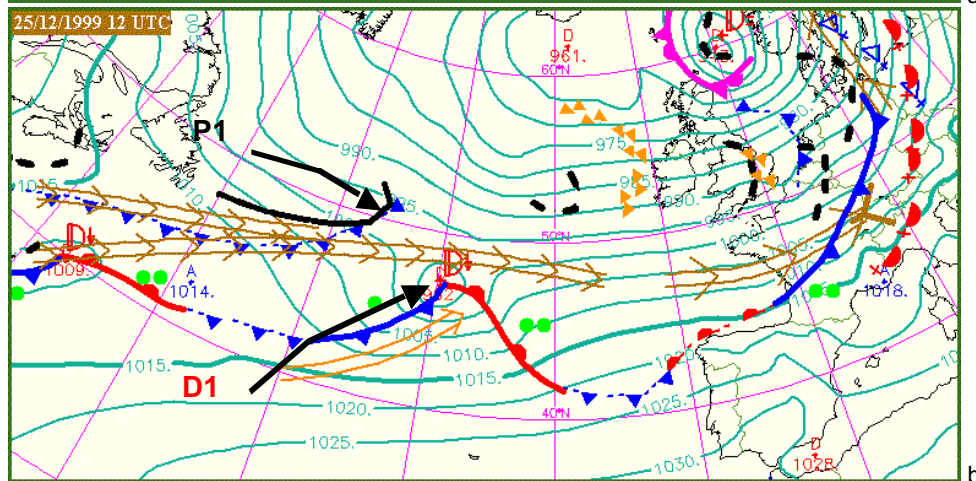
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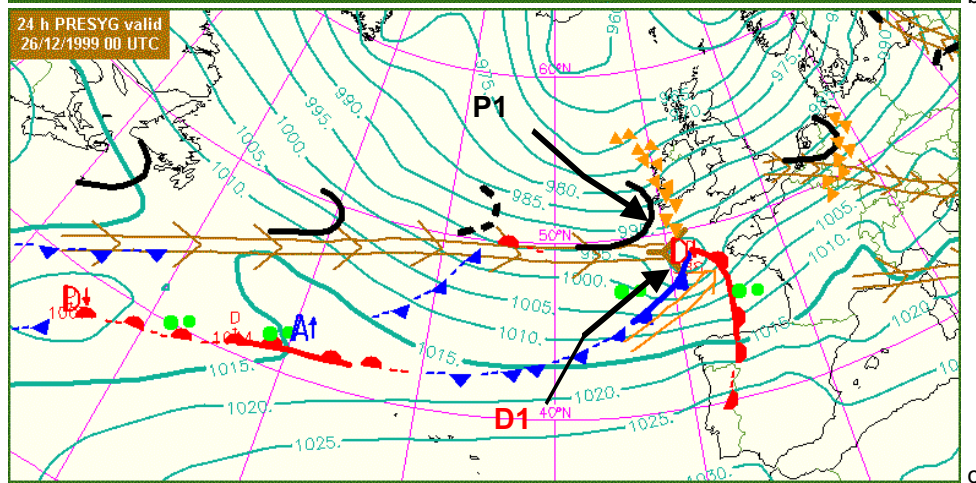
* ARPEGE : the French global numerical model.



a



b



c



Figure 1 : Example of the ANASYG on 25/12/1999 at 06 UTC (a) and 12 UTC (b), and of a 24 h PRESYG valid 26/12/1999 at 00 UTC (c). Mean sea level pressure (green, contour interval 5 hPa). Non active fronts are dashed; Key for other main dynamic symbols are explained at the bottom.

structures of the atmosphere that (can) develop bad weather. With the help of the available successive ANASYG and the 24 h PRESYG, the regional and local forecasters having to cope with a similar storm situation can get very good information to catch the crucial elements they have to follow on satellite images and other observations. In that way they could be aware of the cyclogenesis risk and they could understand the actual evolution of the situation better than nowadays with the present guidance that is less efficient to convey this kind of information.

4. WHERE ARE THE ANASYG-PRESYG COMING FROM?

At the end of the eighties, French forecasters were meeting the limitations of the traditional Norwegian approach almost every day. They began to talk about it and discuss possible solutions. The work started from these concerns and of a preliminary proposal discussing what could be the impact of current knowledge in dynamic meteorology on the graphic depiction of mid-latitude weather (Joly, 1993).

4.1. Theoretical framework, guidelines and constraints for a revised synoptic graphic document

Key ideas about dynamic meteorology on the synoptic scale arising from the continuing research effort since the twenties allow to place a revised synoptic graphic summary on a firm dynamic framework:

- upper level dynamics is crucial for the development of bad weather at mid-latitudes, particularly for cyclogenesis that remain the primary source of very bad weather on the synoptic scale; so a precise depiction of these process and information about potential risks of future development are necessary;
- the modern dynamic meteorology tell us that the best upper level to supplement the surface map is the tropopause (more exactly the “dynamic tropopause”, i.e. the 1.5 pvu or 2 pvu surface);
- the existence of a balanced state of the atmosphere at the synoptic scale and the use of the properties of the potential vorticity justify a *two-level representation* of the atmosphere on the synoptic scale: the top of the boundary layer and the tropopause.

Finally the best characteristics of the state of the synoptic atmosphere can be found near the surface and at the tropopause. All the significant sources of bad weather can be represented by symbols located at least at one of these two levels.

4.2. A scientists-forecasters cooperation

The final ideas underlying this new way of analyzing meteorological situations have resulted from fruitful discussions and experiments between scientists and forecasters.

The first results led to an internal definition of a new kind of documents (Santurette et al., 1997) and then to developments and tests. The FASTEX^{*} experiment offered the opportunity for French forecasters to test and discuss with scientists these ANASYG-PRESYG concepts. The new symbols were integrated in the drawing facilities available on the forecaster’s workstation named SYNERGIE and tested in Shannon (Ireland) by the French team of experts preparing forecasts in the framework of FASTEX. The successful use of these documents within a quasi-operational context led Météo-France to promote this new presentation and the associated working method among the forecasters.

5. THE NEED FOR A LARGE TRAINING ACTION

This new form of synoptic guidance compelled Météo-France to undertake a large training action to promote these new documents and the associated working methods among the people involved in forecasting (about 900 people).

5.1. A decentralized training action

This action consists in the training of trainers that have to train the forecasters spread over the regional and local weather offices. The training of the trainers began in April 1999. From 1999 to 2000, 60 forecasters coming from different forecast offices acquired the new concepts of synoptic meteorology. These forecasters were divided in four groups of trainers. During a week each group took a synoptic meteorology course divided in lessons and practical exercises of realization and interpreting ANASYG and PRESYG. The decentralized mass-training has begun this year and will extend up to 2003.

5.2. A computed Aided Learning dedicated to synoptic meteorology

This large training action is mainly supported by a Computed Aided Learning (CAL) software dedicated to synoptic meteorology. This CAL displaying interactively HTML pages can be browsed remotely thanks to the Météo-France’s internal network and a CD-ROM allows to use it on a stand-alone personal computer. The new approach is described in three parts:

- the first one explains the relevant principles of recent dynamic meteorology. Nine modules compose this dynamic meteorology part. The main modules deal with the baroclinity, the benefit of the so-called “PV-thinking”, the main equilibria and their consequences, the vertical motion, the cyclogenesis mechanism, the frontogenesis and fronts;
- the second part dedicated to the synoptic meteorology practice describes the various conceptual models of the synoptic mid-latitudes phenomena and their appropriate symbols used by the

* FASTEX : Front and Atlantic Storm Track EXperiment

ANASYG-PRESYG. Concrete examples illustrate these conceptual models and show the way to recognize them by means of observations, satellite images and model output available operationally. This part includes 13 modules about the jet-stream and jet-streaks, the practical use of the dynamic tropopause, the cyclogenesis, the various kinds of fronts, the deep convection and its synoptic context, the symbols used in the ANASYG-PRESYG.

- the third part explains the methodology allowing to rationally build an ANASYG and a PRESYG and provides the forecaster with the way of using this document to understand the 3D structure of the atmosphere and its expected evolution.

Regarding the analysis, the modules show how to combine satellite images and numerical analysis to interpret the recent past of the atmosphere (and eventually how to detect models' failures). In particular the ANASYG modules explain how to use water vapour images and the dynamic tropopause fields (geopotential, wind) to detect and to mark the upper level anomalies.

The PRESYG modules are based on models fields criticized by the forecaster. They set out how to combine relevant model fields to synthesize on one hand the upper level dynamics, on the other hand the low levels characteristics and finally the possible interactions between these levels.

The interpretation ANASYG and PRESYG modules show how the various symbols summarize the crucial atmospheric structures the forecasters have to follow on observations or model output and then make easier the appropriation of the synoptic context by the forecasters.

Each module of the 2nd and 3rd parts are illustrated by concrete examples allowing manipulations and practical work near the forecaster's workplace with the help of workstation facilities (animation, superimposition, interactive exercises...).

5.3. A special training for central forecasters

The ANASYG-PRESYG are built by the central forecasters on the workstation SYNERGIE. An additional formation took place for them : each forecaster of the Central Forecast Office could practice producing ANASYG and PRESYG on the day situation in quasi operational environment at the Forecast Laboratory. Moreover, at the time of the first operational production of PRESYG, the Forecast Laboratory goes on advising the duty forecaster.

All the forecasters of the Central Forecast Office have experimented these new methods and tools by such an on-the-job training so that Météo-France has been producing three PRESYG a day since April 2001.

6. CONCLUSION

The Météo-France forecast production is, particularly for short range forecast, the result of a man-machine synergy in which three forecast levels are involved: the Central Forecast Office, the Regional and the Local Offices. It is essential that the synoptic guidance as expertised by the Central Forecast Office be understood quickly by the other weather office. Moreover, the forecasters have nowadays to be well-trained in order to be able to practise an efficient expertise on the amount of available data. For these reasons Météo-France is undertaking a large training action for all the forecasters in parallel with the improvement of the forecast tools.

The ANASYG-PRESYG CAL is the master element of this training action. It can be a permanent guide available on forecaster's workstation. Some representative examples of the modules that make up this CAL will be presented to illustrate the efficiency of such a tool for the wide-spreading training action going to take place in the Météo-France forecasting services.

The generalization for the whole production of the ANASYG-PRESYG should be completed by the middle of 2002. At the same time the CAL well adapted for self-learning will continue to be intensively used by all the forecasters to improve their knowledge about the new concepts. Moreover, an English version of this CAL is now available; it can be consulted at <http://euromet.meteo.fr/~labo/anasyg-presyg/>

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