OPERATIONAL PRACTICE IN MEDIUM RANGE FORECASTING AT METEOFRANCE. NEW POSSIBLE METHODOLOGY AND PERSPECTIVES.

B.Mornet, T.Lefort
MeteoFrance/SCEM
Toulouse/France

1. INTRODUCTION

For several years, many things have changed in the Medium Range Forecasting approach. The chaotic character of the atmosphere is now taken into account. The sensibility to the initial conditions is a basis for the Ensemble Prediction System (EPS). However EPS is not yet an operational tool and will maybe not solve all formulation and presentation problems. In this paper, we propose a new methodology usable for a part of medium range period. This methodology tries to provide both a forecasting conceptual tool, and a way to present end user forecasts. It has a deterministic aspect but it can also be used in a partly probabilistic approach. An example will illustrate one application of this methodology.

2. FAILURE OF THE SYNOPTIC APPROACH FOR MEDIUM RANGE

For many years, the main conceptual model used for forecasting was the norwegian theory based on fronts (cold front, warm front, occlusion). Each conceptual object gives a specific weather. New conceptual models were formulated (*Browning*, 1985) but are not very used in practice. On the other hand, atmospheric waves, like Rossby waves for example, or baroclinic instability in a 'quasi-geostrophic' atmosphere were also described (*Holton*, 1972). All these studies, theories and conceptual models have given a present way of practice for forecasting that we call the 'synoptic approach'. Very roughly, a forecaster on duty examines numerical weather products at high altitude and at surface. He analyses and forecasts fronts. After that, he elaborates its weather forecasting.

In 1991, the troncation of the ECMWF operational model increased (afterwards we call the present model the 'T213'). After that, in 1992 at MeteoFrance, subjective controls (*Lefort, Mornet*, 1993) have been carried out in the SCEM (Service Central d'Exploitation de la Meteorologie, Toulouse). We can see in fig.1 a diagram presenting the good synoptic schemes frequency evolution. A synoptic scheme, is in fact a frontologic scheme, which allows to directly forecast the weather. It clearly shows that synoptic schemes are most of the time wrong after a specific range, situated between +108 and +120 hour range. It means that forecasts based on a synoptic interpretation will be most of the time wrong after this range. (knowing that a T213 model's run starts at 12 UTC on day 0

(D0) and is usable the following day (D1), it means that this crossover point, between good synoptic schemes and bad ones, is situated on day 5 (D5)).

Then, a new approach for longer range forecasting becomes necessary. The probabilistic approach, using the EPS is a promising solution. However it is not usable yet. We can immediatly address the following problem: what can we do before having a good EPS ? Furthermore, EPS will maybe not respond to all formulation and presentation problems for medium range forecasting. This system will give probabilistic charts. But how to use them ? How to display them for end users ? Shall we keep a deterministic formulation or shall we introduce a probabilistic one ? It seems to be easy to provide local probabilistic forecasts, but how to display the weather on a large area or a country ?

On the other hand, there are information that can be extracted from models for medium range forecasting. Some objective controls show that fact. Moreover, verifications performed for various scales show that only large scales are well predicted in medium range (fig 2, *USER GUIDE to ECMWF products,* 1994). But what has to do a forecaster in order to extract large scale information and how can he present his forecast ?

In France, a working group on Medium Range Forecasting, created in 1993, has to think about such questions. In this paper we will present a part of its works. We will present a new methodology, that can be used for medium range forecasting. However we will only focus on a specific part of medium range, from Day 5 to Day 7 (based on the T213 model for +108 to +180 hour ranges). We will call this period middle (or intermediate) medium range.

3. NEW METHODOLOGY / TOOLS / EXAMPLE.

3.1 As it is possible to identify and forecast, with a high degree of confidence, structures like fronts in short range forecasting, we assume that it is also possible to identify and forecast larger scale structures in medium range forecasting. For this, we started from A.Persson's ideas (*Training Course, ECMWF,* 1993). He suggested that it does exist flow types (or weather regimes) persistants (or slowly variables) over a 3 day period. For each of these flow types, it is possible to associate a characteristic weather.

The idea of our methodology is to classify, on a large geographical area and over 3 days, the forecast flow types. The classification result is represented by only one chart, valuable for the 3 days. The classification domain has to be large, because we deal with large scale phenomena (connected with large waves). At least the domain should be western Europe or, better, eastern Atlantic and the whole Europe. This classification is also directly linked up with weather. For each flow type, a specific and different weather is associated.

Grouping together three days offers one main advantage. For a such period (D5 to D7), front chronology errors are very important (often greater than 12 hours). With our methodology such errors don't appear anymore. The uncertainty, that a forecaster would put in its forecast, doesn't take place anymore.

In his course, A.Persson proposed 3 flow types (straight, undulating, and blocked). We do propose 6 flow types, associated with weather characteristics, as following: (in italics are mentionned the main characters of weather)

Ia) perturbated flow *(rainy, cloudy)*

Ib) straight perturbated flow *(rainy, cloudy, windy)*

IIa) undulating flow *(changeable weather, a rainy period is followed by a sunny one)*

IIb) pseudo-undulating flow *(changeable weather, sun is predominant)*

III) warm blocking *(quiet and dry weather, sunny in summer, dull or foggy in winter)*

IV) cold blocking *(cool or cold weather, often rainy)*

In annex 1, the undulating flow is detailed and illustrated by an example.

Some remarks have to be added. If we focus on weather, it is obvious that for the same class, detailed consequences on sensible weather will be sometimes different and will depend on the season and on the geographical area. For example northwesterly straight flow has not the same effects near the Mediterranean Sea as on the other parts of France. The Mediterranean coast will have short cloudy periods alternating with long sunny and windy ones, because of orography, whereas on France the weather will be most of the time cloudy, windy, rainy and with very scarce and short sunny intervals.

Moreover, the notion of 'weather improvement' or 'degradation' (during three days) is possible. This notion means change of weather type. It corresponds to one of our assumptions, that supposes sometimes flow types are not perfectly persistant but are slowly variable. However, we assume that these areas, where a change of weather type occurs, are in minority, for each classification.

One noticeable interest of this classification is the way we consider the extreme events. We introduce then a probabilistic aspect by just talking about the risk or the lack of risk. For each class we can say which extreme events should be excluded or should not be excluded. For example, in case of westerly straight perturbated flow, there is always a risk of storm, but one can be sure that heavy generalised frost is excluded.

3.2 Practical way of working

The classifying way is still in development at present time. For the moment forecasters integrate in their mind 3 day forecast datas by only looking at classical fields (sea-surface pressure overlaying the 1000-700 thickness, geopotential and temperature at 500 hPa (id ZT500)). They try to disregard synoptic details.

However the use of other products help them to practice. For example the use of spectrally filtered fields can sometimes and at first glance strongly change the idea about the flow pattern (*Persson,* 1984). We can see in fig.3 one example of such filter applied to a ZT500 field, where only waves having a wave number lower than 15 remain.

Maybe, the present EPS can also be usable, at least in a simplistic aspect: the 'ensemble mean' (mean of the 33 different forecasts) or the 'largest cluster mean' are usable because they also give an idea about the flow pattern. Because they provide averaged filtered fields, synoptic details appear also filtered.

3.3 example

Annex 2 shows an example of such classification. ZT500 forecast fields for 3 consecutive days are presented (fig 4a, 4b, 4c), in fig 4d the result of the classification, and in fig 4e one outline possibility for graphic display.

4. VALUE OF THE METHODOLOGY: SUBJECTIVE CONTROLS

From september 94 to september 95 subjective controls were carried out in order to access the value of the methodology presented previously. Every day, the duty forecaster describes over France the predicted weather for days D5 to D7. Forecasts are not exactly made with the methodology described, but following the same guidelines. Forecasters only give the principal characteristic of weather (weather type), disregarding 'synoptic details'. Eight days later the forecaster analyses the observed weather and give a mark to the forecast. Four marks were possible: A very good, B rather good, C rather bad, D completly bad. Marks A and B mean acceptable forecast, marks C and D mean unacceptable forecast.

For the first six month (Sept 94 - Feb 95) we obtained the encourageous number of 59% of good forecasts. (*F.Atger, B.Mornet*, 1995). For the six following months the number of good forecasts was 78%. This small increase should be caused by the presence of summer situations in the sample - where weather is generally fine and thus more predictable - and also by the small size of the sample. But this increase is not very important. A meaningful exercise consists in comparing these numbers with those of Fig 1. For same ranges, from +108 to +168 hour ranges, good forecast marks are situated between 54% and 10%. This comparaison shows so an important improvement of weather forecasts. It seems to indicate the good value of the assumptions, which are the basis of our methodology.

5. PERSPECTIVES

5.1 **Links with EPS.**

First, the EPS, with its present performances, can be a tool for practising deterministic forecasts with the methodology we proposed. One more elaborate application is also possible and was presented by F.Atger (1995) (or *F.Atger, B.Mornet* 1995).

Secondly, EPS will improve in the future. Alternatives given by 'clusterisation' (gathering the 33 forecasts into clusters) will be reliable (in a probabilistic sense). Our methodology will also be usable to forecast the weather of each member of the various alternatives given by EPS.

5.2 **Perspectives**

In France we do not produce operational forecasts over Europe, or even France, based on our methodology. The practical way of doing that and the corresponding graphical displays are still in development. However the working group on Medium Range Forecasting has written recommendations for preparing bulletins, both for end users or for other forecasters in the regional centres.

Our methodology focuses only on large scales. So, it forecasts weather types over three days in a deterministic sense, but it also deals with extreme events. One main advantage is to avoid chronology errors for the location of the fronts, by grouping three days together. Some subjective controls seem to show the value and the interest of our methodology. This methodology appears also flexible. As models will improve in the future, such a method could be applied to more extended forecast ranges.

REFERENCES

Holton, 1972: An introduction to dynamic meteorology, Academic Press.

K.A. Browning, 1985: conceptual models on precipitation systems, ESA Journal 1985 Vol 9, Met Office, Bracknell, United Kingdomn.

T.Lefort and B.Mornet, 1993: Synthèse des contrôles subjectifs du modèle T213 du CEPMMT, Bilan final, note SCEM/PREVI/PG, METEOFRANCE.

A. Persson, 1984: The application of filtered fields to synoptic weather prediction, Technical Memorandum n°95, ECMWF.

A. Persson, 1993: The operational medium range forecast, Training course Mod. 4, ECMWF.

F.Atger, 1995: Medium range forecasting with EPS and T213, 3rd meeting on EPS, ECMWF.

F.Atger and B.Mornet, 1995: Operational Medium range weather forecasting, ECAM 95.

USER GUIDE to ECMWF Products (Edition 2.0/ 1994)

ANNEX 1

UNDULATING FLOW: MORE DETAILS.

Description of the meteorological situation:

In altitude : alternatively, moving throughs and ridges. The wave amplitudes are larger than in the perturbated flow.

In low layers : the elements of the norwegian theory, successively fine weather (in a moving anticyclone), perturbation (clouds, rain and front, shower weather). These elements are observed once at least.

The main idea of this class is that the **weather is changeable.** A sunny day with quiet winds is followed by a cloudy and rainy one. The quiet and sunny period lasts almost 18 or 24 hours.

Severe conditions excluded :

- heavy generalised frost (in winter)
- generalised persistant fog (in winter)

Severe conditions not to be excluded :

- very strong winds or storm.
- heavy rain
- snow in plain (if existence of cold air in very low layers of atmosphere)
- strong thunderstorms (in summer)

SYNOPTIC LIMIT

GOOD SYNOPTIC SCHEMES FREQUENCY

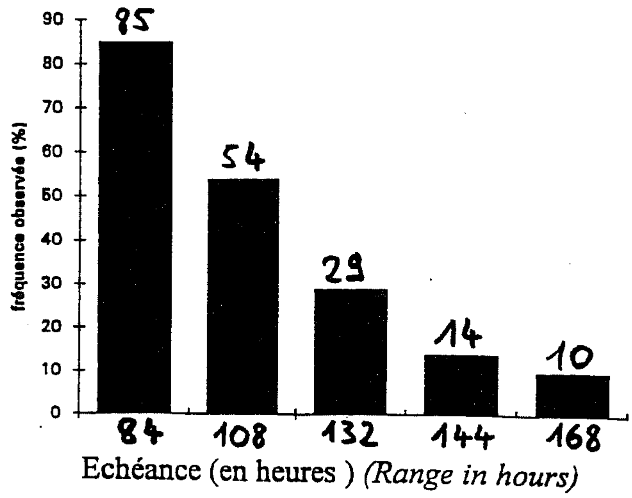
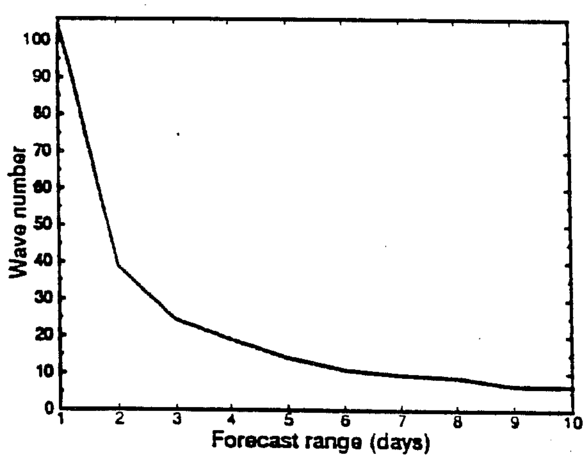


FIG.1

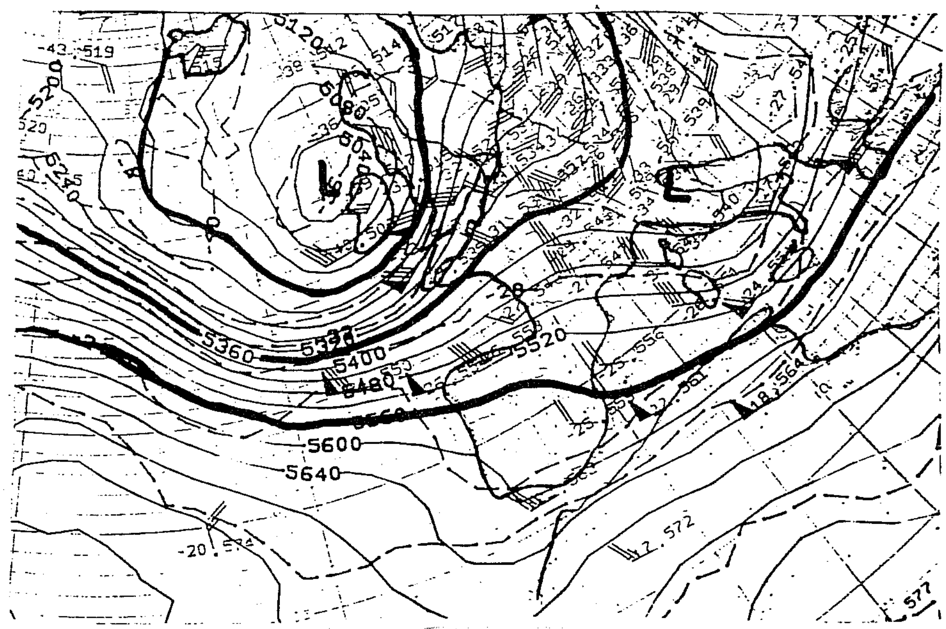


Wave number for which the energy of the forecast error at a given forecast range exceeds the energy of the initialized analysis, deduced from spectra of global fields of Z500 for December 1993. The forecast for higher wave number has little skill in practice.
Ex: USER GUIDE to ECMWF Products (Edition 2.0/ 1994)

FIG.2

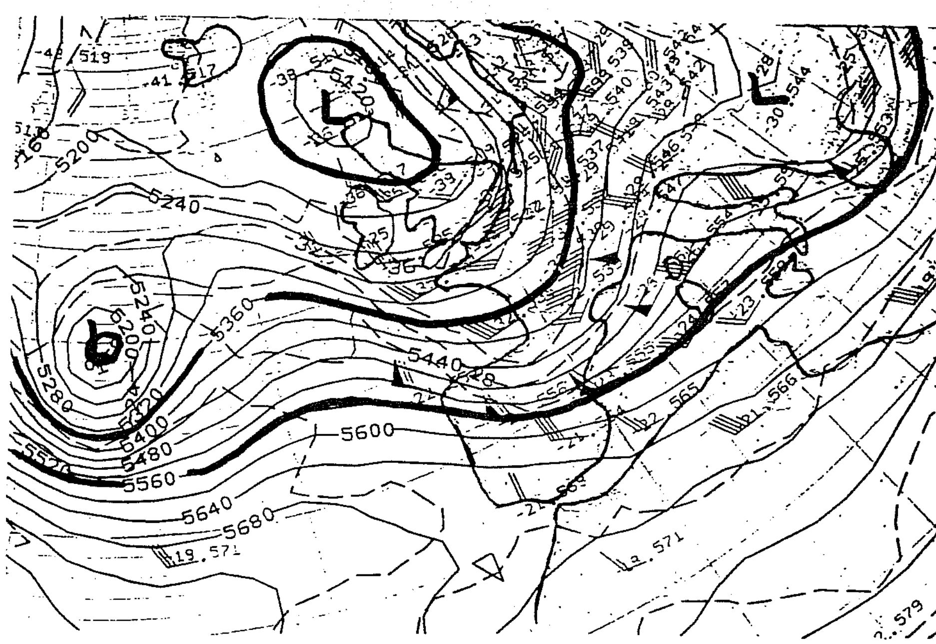
95/03/07

12 UTC



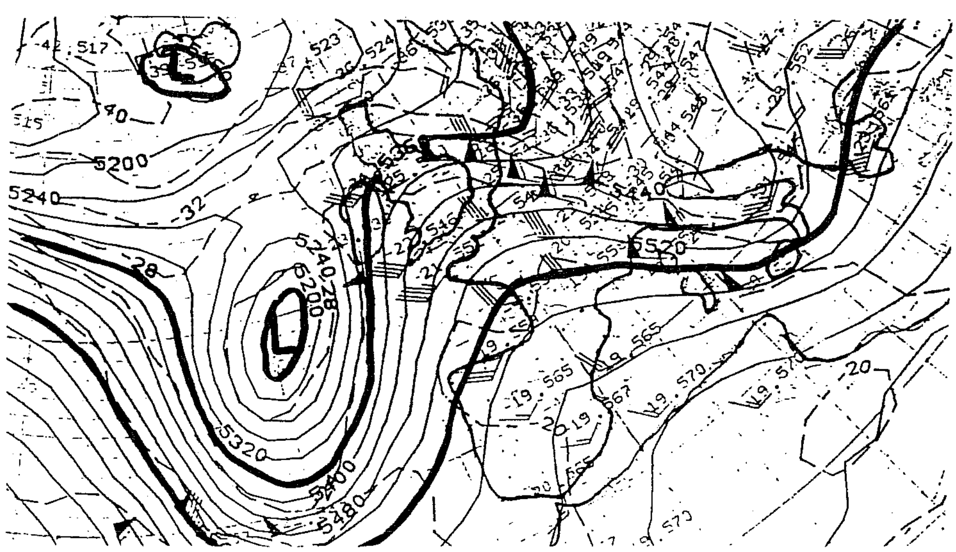
95/03/08

12 UTC

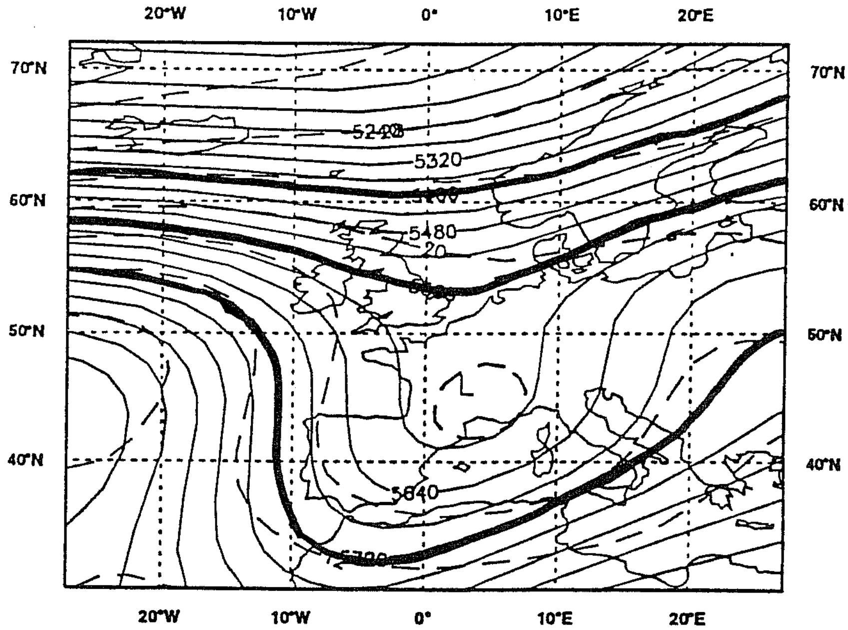


95/03/09

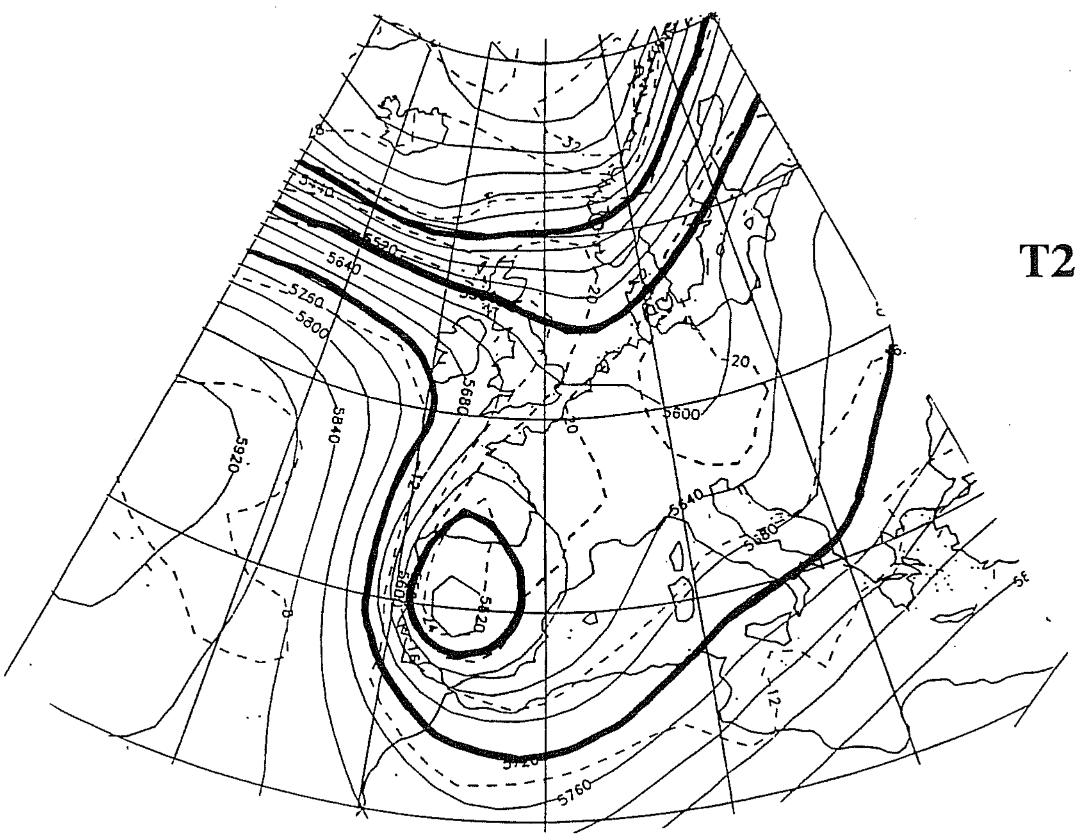
12 UTC



Ech. 120 - Valid 25/09/95: 12 - Modele CEP a T15



T15



T213

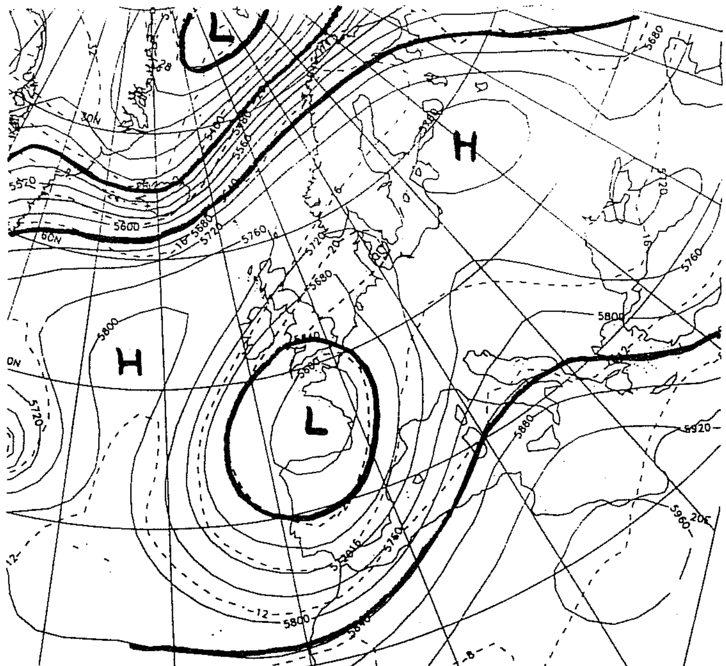
FIG.3

ANNEX 2

13/9/95

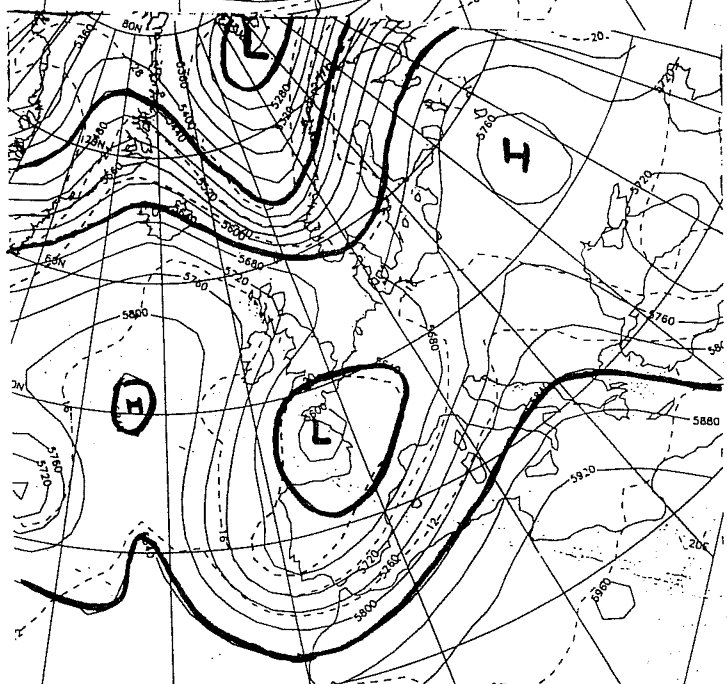
MODEL T213

ZT500 hPa



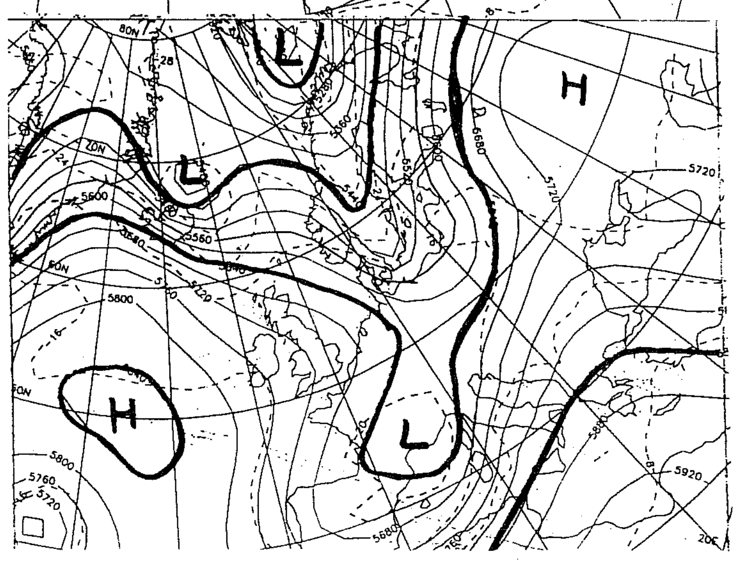
+120

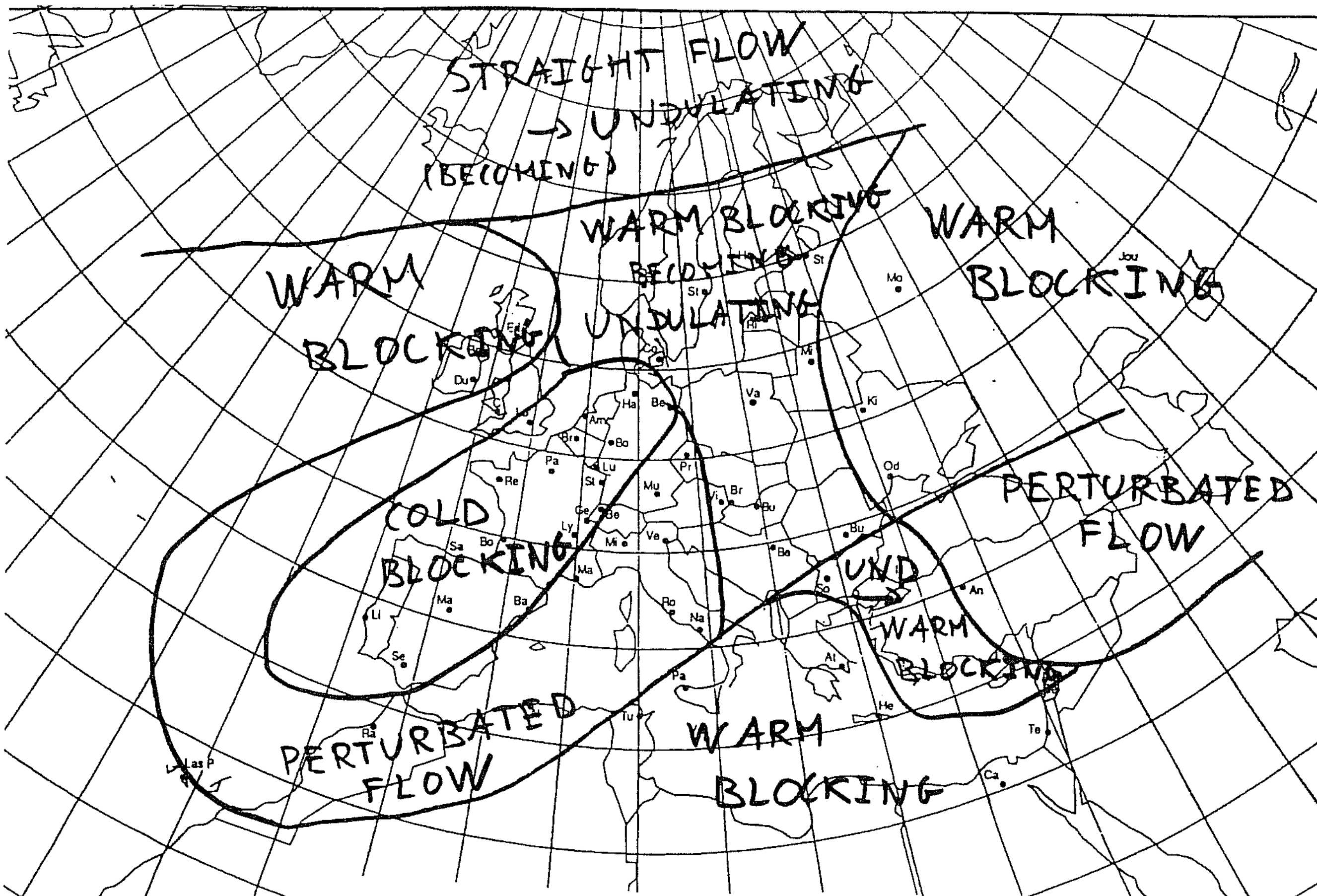
FIG.4a



+144

FIG.4b





ANNEX 2 FIG.4d

MODEL T213 13/9/95