MÉTÉOROLOGIE

ET

INCENDIES DE FORÊTS

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ملتقى تقني حول علاقة معطيات الرصد الجوي وحرائق الغابات

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METEOROLOGIE

ET

INCENDIES DE FORETS

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Actes de la réunion technique sur l'information météorologique pour l'application des mesures de prévention et de lutte concernant les incendies de forêts qui s'est tenue à Rabat, Maroc, du 25 au 30 novembre 1991, sur l'aimable invitation du Gouvernement du Maroc.
Cette réunion a été organisée par l'OMM et la Météorologie nationale du Maroc, en collaboration technique avec la Division des ressources forestières de la FAO.

TABLE DES MATIERES

A PRELIMINARY STUDY FOR THE DEVELOPMENT OF A METEOROLOGICAL WIND MODEL IN THE AREA OF SIERRA DE GREDOS

E. Hernández, F. Valero, J. Cano, M.T. del Teso, J. Diaz, F. Martin, J.M. Garcia-Miguel, G. Maqueda, A. Garcia, M.L. Martin, Y. Luna, C. Yague, J.F. González, J.M. Cano and R.M. Rodriguez

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Abstract

The results of an experiment in complex mountanuous terrain to determine the conditions favoring the development and spread of forest fires are shown. The thermal and dynamical structures of the synoptic situations which favour the development and spread of fires are analyzed.

These data were used to prepare a model for the mesoscale diagnostics of the different meteorological variables.

INTRODUCTION

Forest fires are one of the scourges which are destroying the environment in most of the Iberian Peninsula. The origin of these fires may be natural or anthropogenic. Natural fires comprise no more than 5% of the total.

The conditions for a fire to develop and spread are described by Alexander and Lanoville (1987), Brotak (1980) and Gonski (1987). In our Peninsula, a classification of the different synoptic situations which favour the development and spreading of a fire is described by Hernández (1991).

The atmospheric variables that characterize each of these situations are synoptic in scale, and so an indepth knowledge of fire development and spread would be filtered in most occasions.

In order to examine thoroughly the development and spreading of a fire in a smaller scale, a mesoscale or microscale, an experiment was conducted to determine the meteorological variables that intervene in a more direct way. This experiment was carried out in the South-East of the Central System, in the zone of the Sierra de Gredos, in the summer of 1991. The information collected in this experiment will be used as initial data and topographic conditions in a diagnostic model for wind speed, wind direction and air temperature.

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A PRELIMINARY STUDY FOR THE DEVELOPMENT OF A METEOROLOGICAL WIND MODEL IN THE AREA OF SIERRA DE GREDOS

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Abstract:

The results of an experiment in a complex orography area to determine the conditions of development and spreading of forest fires are shown. The thermal and dynamical structures of the synoptic situations which favour the development and spreading of fires are analysed.

These data were used to get ready a model for the mesoscale diagnostic of the different meteorological variables, whose first results are shown.

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I INTRODUCTION

Forest fires are one of the scourges which are destroying the environment in most of the Iberian Peninsula. The origin of these fires may be natural or antropogenic. Everybody knows that natural fires suppose no more than 5% of the total.

The conditions for a fire to develope and spread are described in (1,2,3). In our Peninsula a classification of the different synoptic situations which favour the development and spreading of a fire (4).

The atmospheric variables that characterise each of these situations are in a synoptic scale, and so a deep knowledge of the fire development and spreading would be filtered in most occasions.

In order to examine thoroughly the development and spreading of a fire in a smaller scale as could be the mesoscale or even the microscale an experiment has been set to know in depth the meteorological variables that intervene in a more direct way . This experiment has been carried out in the Southeast of the Central System, in the zone of the Sierra de Gredos, in the summer of 1991. Finally this experiment will be used , through the measured variables, as initial data and contour conditions in a diagnostic model for wind speed, wind direction and air temperature.

The aims of this work may sum up as:

1.- Selection of an area to make the experiment.

2.- Installation of five portable meteorological stations to measure the fundamental variables which characterise the state of the atmosphere in the boundary and surface layers so as to determine the micrometeorology in a complex orography terrain.

3.- Carrying out soundings to determine the fine structure of the mesoscale meteorological situations in which forest fires appear and develope.

4.- Selection of the initial conditions for the diagnostic model of the thermal and dynamic variables.

5.- Application of the model to standard meteorological situations.

II EXPERIMENTAL SECTION

The experiment area, as previously explained, was chosen because of its very high frecuency of forest fires (4) and its special orography so as the experimental results may be extended to other areas with similar characteristics.

In order to use the collected data as input to the diagnostic model an area was selected defined by a rectangular grid of 11 x 12.6 km (fig 1) with a spacing of 200 m. Its southwestern corner UTM coordinates are x = 347.0, y = 4456.0. The grid altitudes range from 446 m to 1902 m, what is a proof of its complex orography. As topography input the digitalized data purchased from the Instituto Geográfico Nacional, which provide altitude data every 200 m with an accuracy of 30 m. A representation of the studied topography appears in figure 2, in which the location of each meteorological station is shown with a number.

II.1 Description of the meteorological stations.

A network of meteorological stations was required by the diagnostic model used in this experiment to provide measured data of some atmospheric variables which will be detailed later.

Several factors determine the location of these stations: its location in the grid to provide as uniformly scattered an information as possible and the selection should be representative of the area and should be placed in meteorogically acceptable places.This made us place them at the points shown in figure 2 and table 1, in which their UTM coordinates and altitudes appear.

The variables measured by these portable meteorological stations are wind speed and direction, and air temperature and relative humidity.

Figures (3) and (4) show two of the stations with their sensors of wind speed and direction placed 3 m above the terrain.The data acquisition system scans the sensors every 15 seconds. In order to filter all of the signals with a shorter

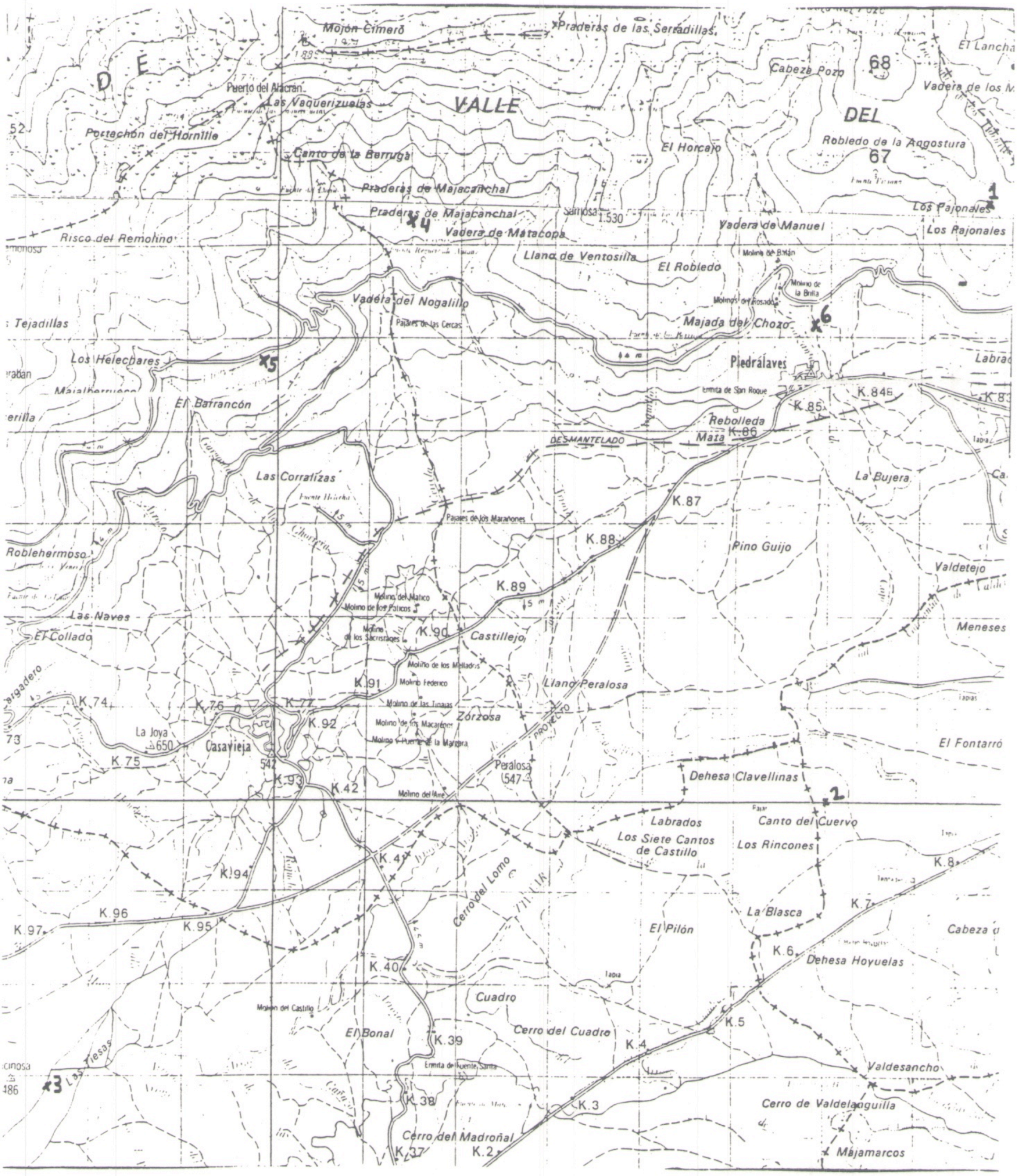

Fig1. Location the meteorological stations.

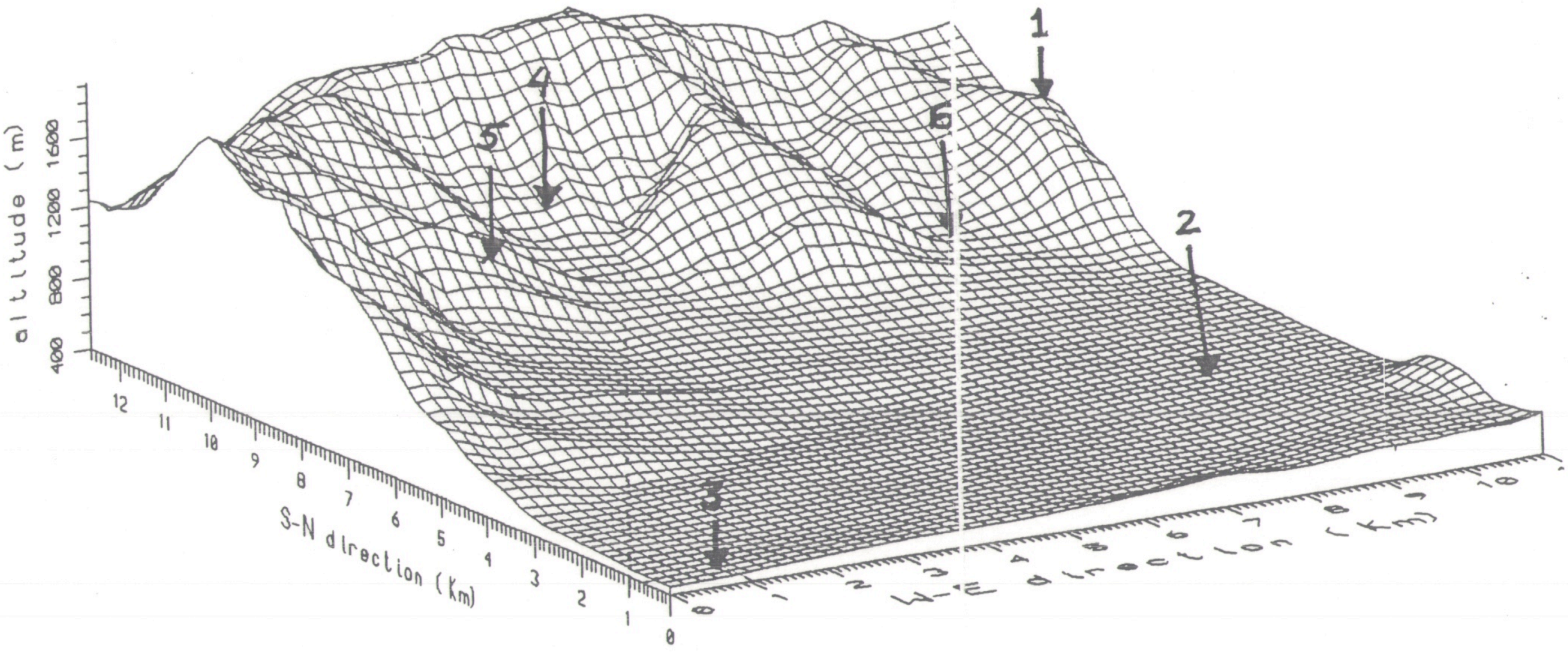

Fig 2. Representation of location the meteorological ::tations.

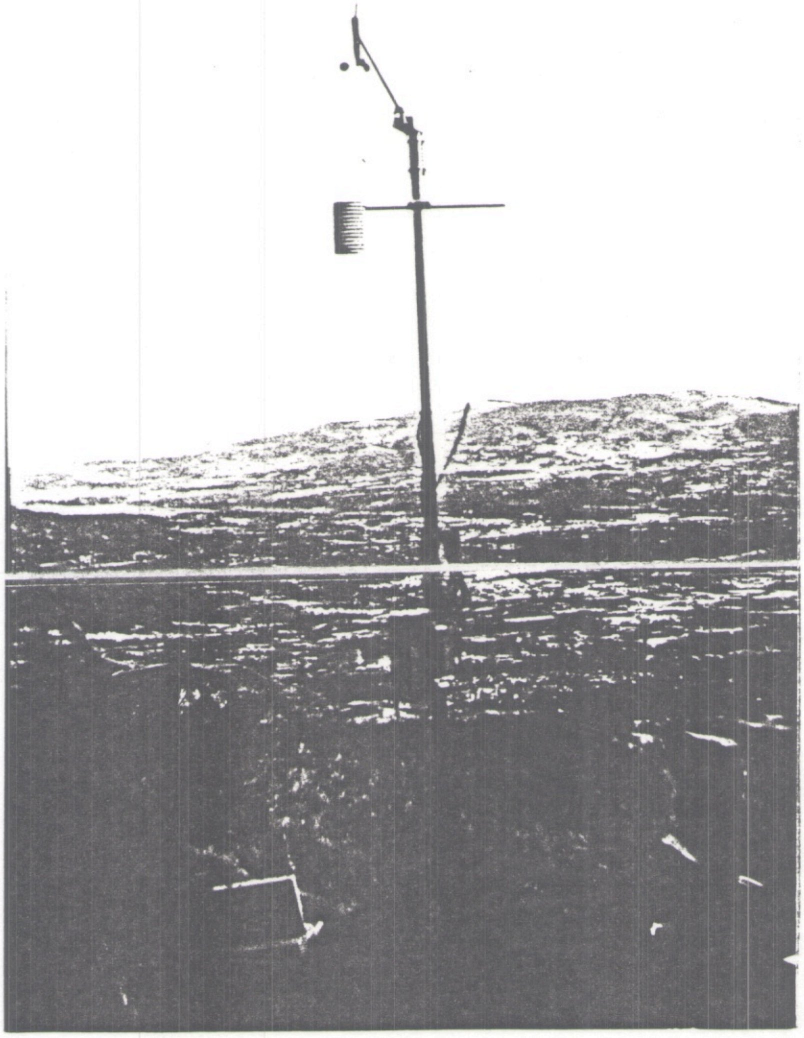

Fig. 3 Station number 5

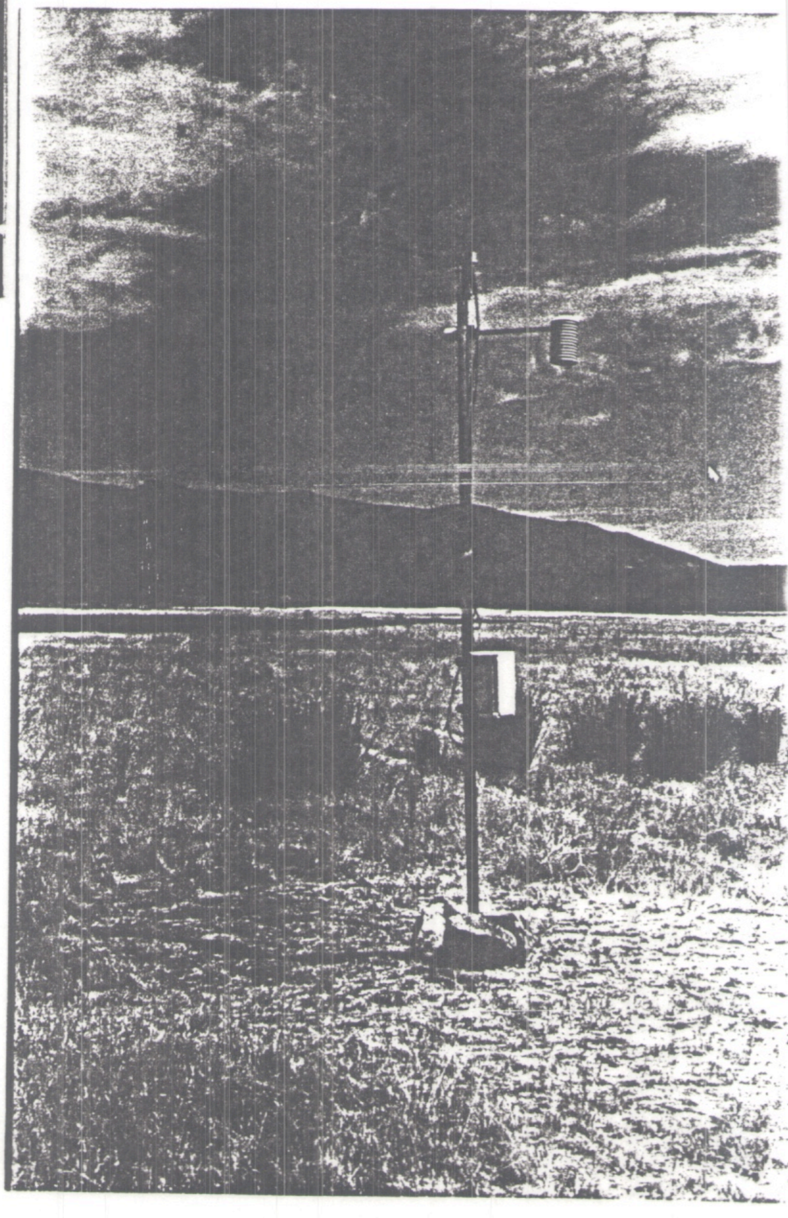

Fig4. Station number 3.

STATIONS	U. T. M. COORDINATES	ALTITUDE (m)	GRID ORIGIN COORDINATES
ONE	x= 357. 6 y= 4466. 4	z= 1294	x= 54.0 y= 53.0
TWO	x= 356. 0 y= 4460. 0	z= 545	x= 46.0 y= 21.0
THREE	x= 347. 5 y= 4456. 8	z= 448	x= 3.5 y= 5.0
FOUR	x= 351. 4 y= 4466. 3	z= 1133	x= 23.0 y= 52.5
FIVE	x= 349. 9 y= 4464. 8	z= 1152	x= 15.5 y= 45.0
SIX	x= 355. 8 y= 4465. 3	z= 828	x= 45.0 y= 47.5

Table I. Location of the meteorological stations period data have been averaged over a 10 minute period. Among the signals filtered are those of the short-lasting turbulence. In a later stage a less drastic filtering of the turbulent effects will be done, because of its great importance in the development and spreading of a fire. These averaged data are saved in a datalogger in order to allow their computation in a later stage.

The accuracy for wind speed is 4% between 0.5 and 40 m s^{-1}; 1% for wind direction; 0.5°C for temperature between 10°C and 60°C; dew-point temperature has the same accuracy as temperature; relative humidity has an accuracy of 5% between 10% and 90%.

There is a meteorological station operated by ICONA at the experiment area which will be used as a reference to characterise the area climatology and will be integrated as another station into the model; its location is shown in figure 2 with number 6 and its coordinates appear in table 1.

II.2 Soundings.

Being the diagnostic model used in this work a tridimensional one, it needs aerological soundings in the planetary boundary layer to be initialized. These have been carried out beside station number 3. This location was chosen because this area is quite plain and open for this region and its altitude is very low, what makes the operation easier and allows for a complete vertical profile of the experiment area, and because of the facilities it has. These soundings provide wind speed and direction, pressure, wet and dry temperature and altitude data through an atmospheric sounding system TS-3A1 Tethersonde. The system consits of an aerosuspended sensor device, an obus-shaped balloon with a 2.25 m^3 capacity, an electric winch and an ADAS. The tethersonde, which broadcasts in a standard frequency of 403.5 MHz, consists of five combined sensors with a sophisticated integrated circuit which conditions and broadcasts the data. Wet and dry temperatures are accurately measured by joint thermistors; wind speed and direction are measured by a three-pan anemometer and a compass, respectively; pressure is obtained from an aneroid compensated-temperature sensor. These devices provide data of the mentioned variables every ten seconds which are saved in a floppy disk to be proccessed in a later stage. On initiating the sounding the base point pressure and altitude must be introduced into the receiving station in order to avoid errors in their absolute values.

During the campaign the soundings were carried out, whenever allowed by the weather conditions, at 8:00, 10:00, 12:00, 14:00 and 17:00 hours, official summer time.

II.3 Intercomparison of the stations.

The meteorological variables measured by the portable stations are, as already mentioned, wind speed and direction and wet and dry temperatures. Although the calibration of their respective sensors has been made in origin by the dealer it has been thought convenient before installing the stations to compare the measures they provide. So, they were located in a site free of obstacles in order to avoid the effects of turbulence which, in spite of its proximity and of averaging the data every ten minutes, might affect them in a different way, specially to wind data.

These measured were registered during a time span long enough to have a set of values which would allow us to compare data from the different stations in different atmospheric situations.

In order to homogeneize the measured values of the different magnitudes the portable station number 3 was chosen as a standard and linear fittings were made between this one and each of the other stations. The results appear in table II, where the number of points, the straight line equation and the percent of residues justified by this linear fitting. These fittings also appear represented in figures numbers 5 to 18.

We must underline that the number of points for the different comparisons is smaller for wind direction than for the other variables because those values which are phisically but not numerically close have been eliminated, because they affect the results of the linear regressions very appreciably.

From the exam of the temperature, wind speed and wind direction graphics of the different stations relative to the standard we may deduce that temperature is the variable that makes

STATIONS		TEMPERATURE	WIND SPEED	WIND DIRECTION
ONE	No. of pts.	600	600	561
	Fitting Eq.	y=1.00x-0.5	y=1.08-0.3	y_1=0.72x+17 y_2=1.18x-52
	Residues explained	99%	97%	97% 98%
TWO	No. of pts.	600	600	
	Fitting Eq.	y=1.00x+0.0	y=1.06x-0.3	
	Residues explained	100%	97%	
FOUR	No. of pts.	600	600	588
	Fitting Eq.	y=1.00x-0.3	y=1.11x-0.4	y=0.99x+1
	Residues explained	100%	97%	98%
FIVE	No. of pts.	600	600	574
	Fitting Eq.	y=0.99x+0.0	y=1.10-0.4	y=1.00x+7
	Residues explained	100%	97%	99%
SIX	No. of pts.	600	600	
	Fitting Eq.	y=1.02x-0.8	y=0.64x-0.4	
	Residues explained	96%	91%	

Table II. Linear fitting of the values of the different variables measured by the stations and those measured by station number three.

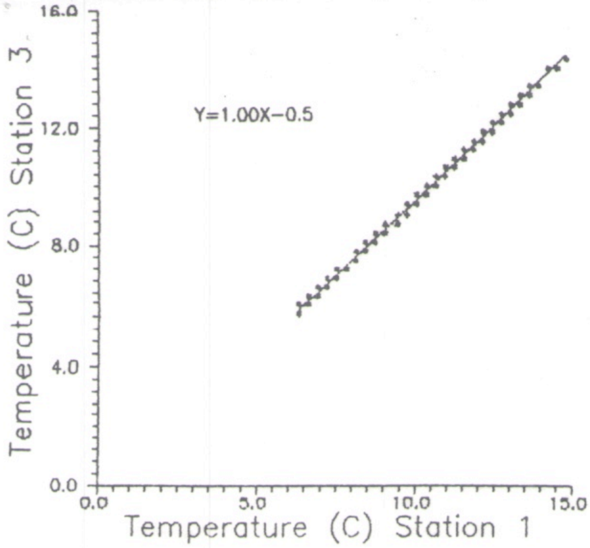

Fig. 5

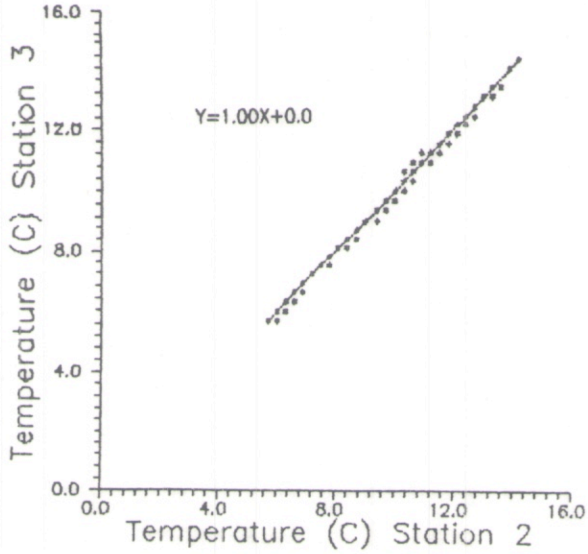

Fig. 6

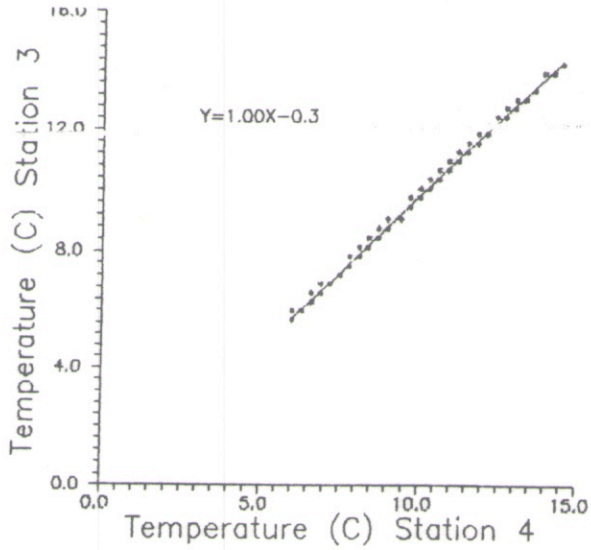

Fig. 7

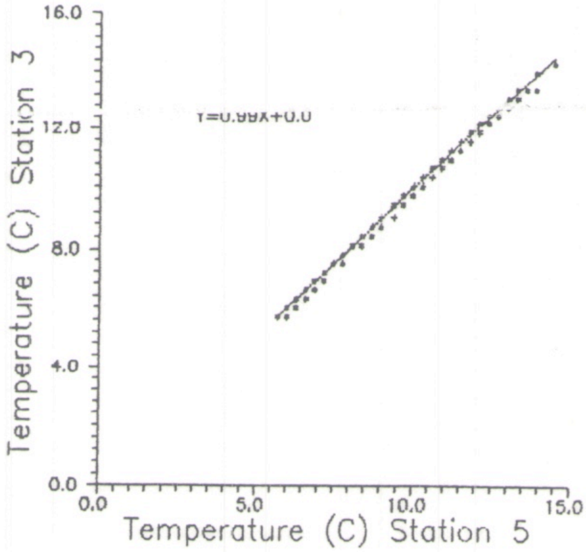

Fig.8

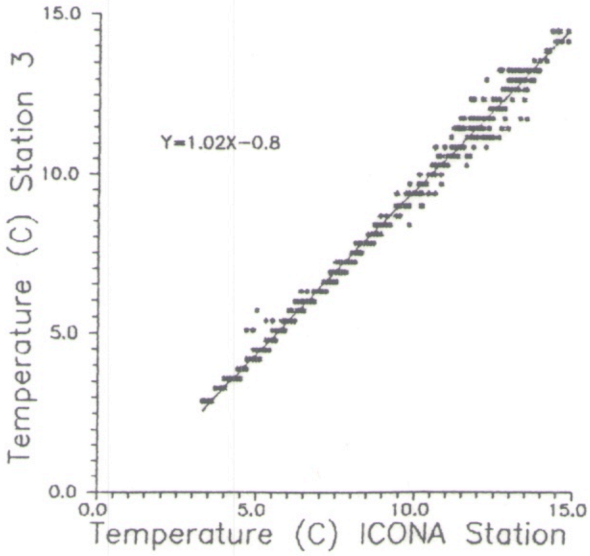

Fig. 9

Lineal fitting of wind direction between each station and station number 3.

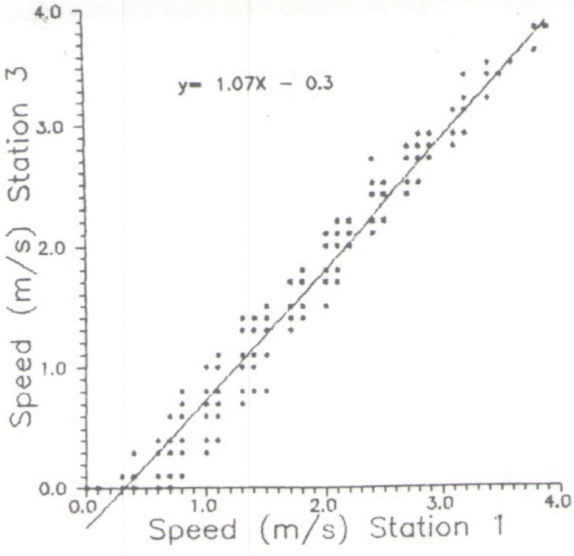

Fig. 10

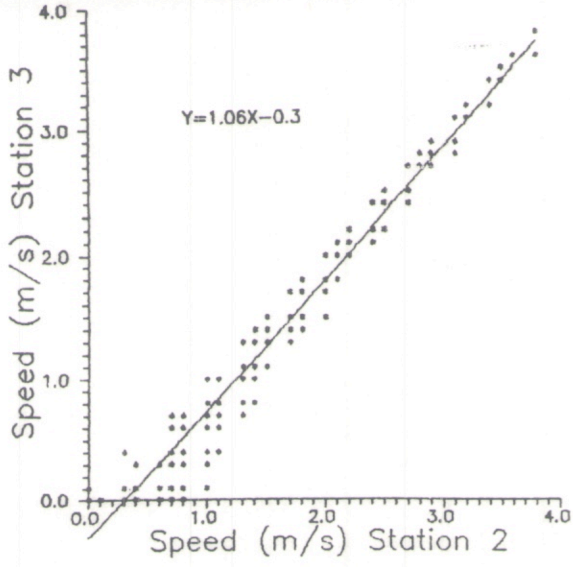

Fig. 11

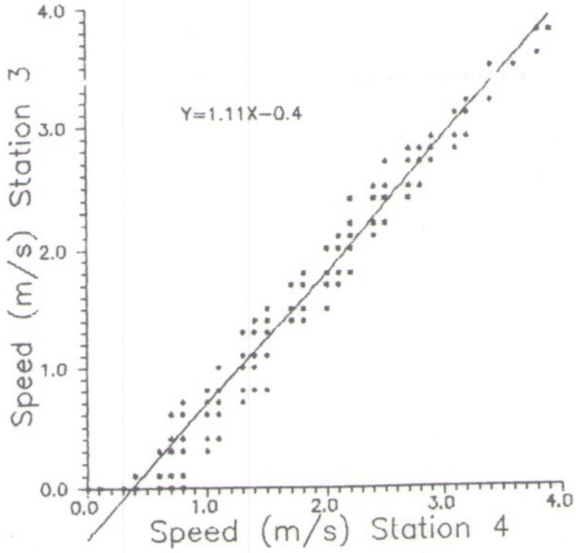

Fig. 12

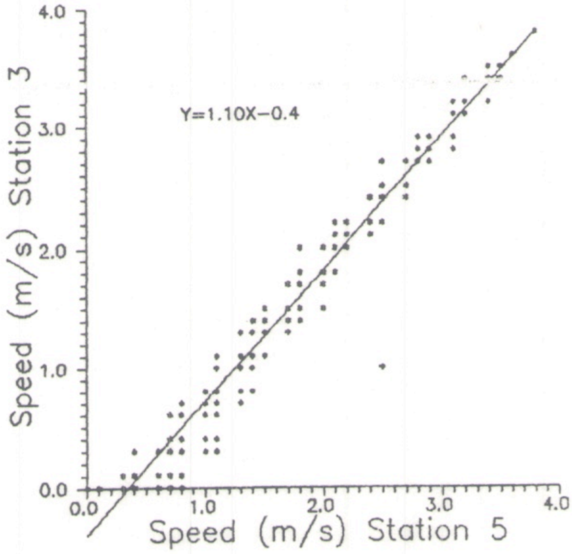

Fig. 13

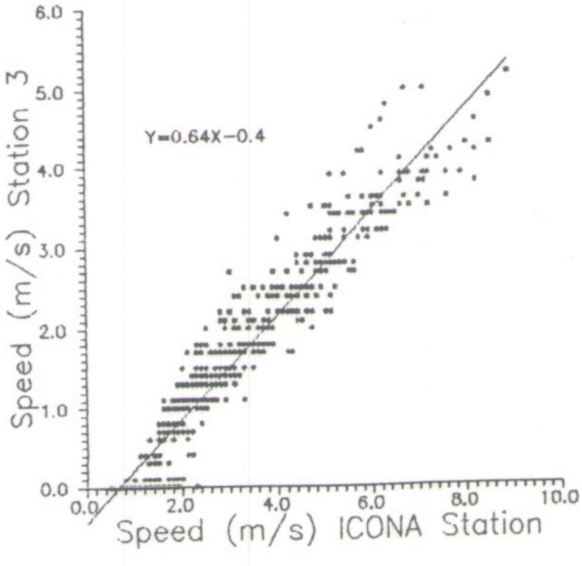

Fig. 14

Lineal fitting of wind speed between each station and station number 3.

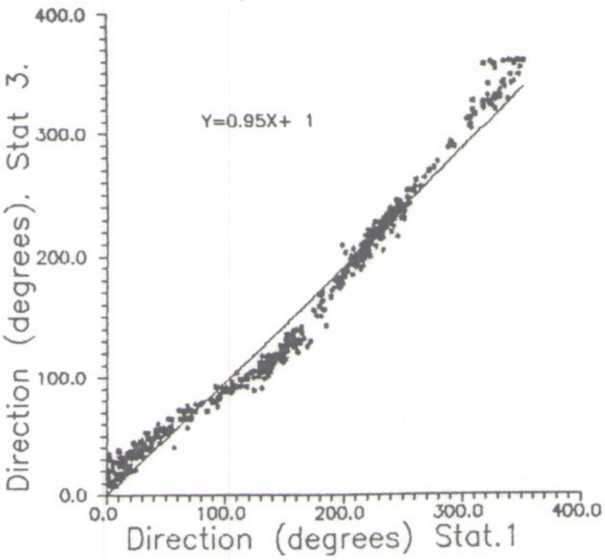

Fig. 15

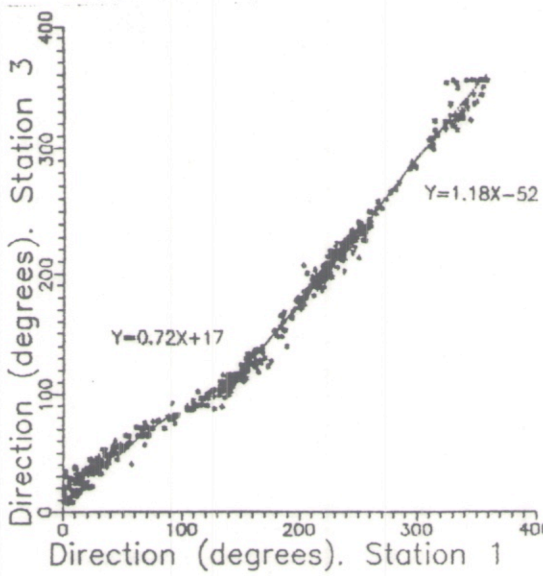

Fig. 16

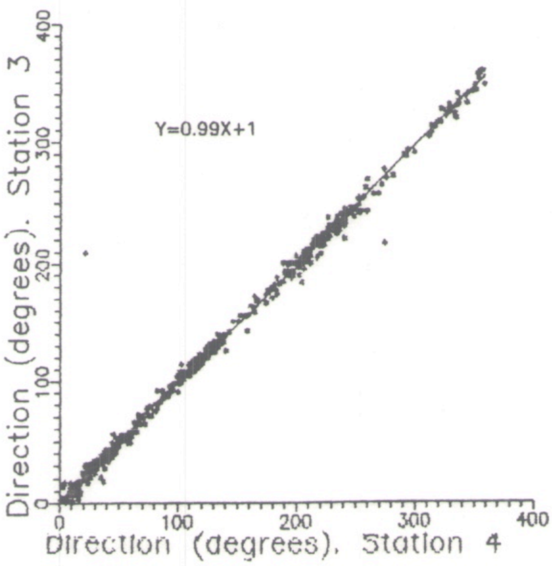

Fig.17

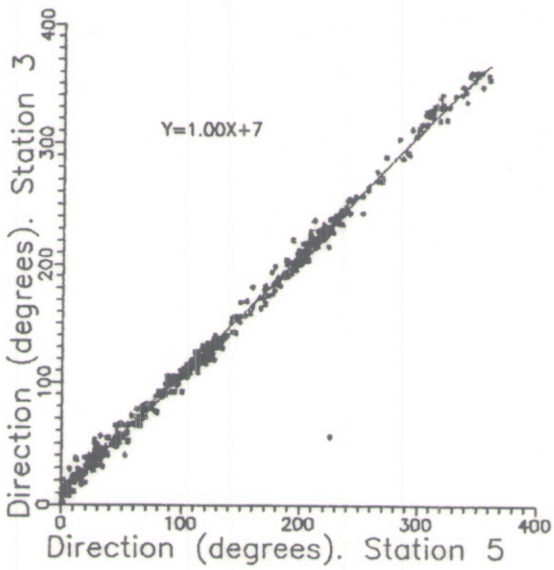

Fig. 18

Lineal fitting of wind direction between each station and station number 3.

the best fitting, justifying up to the totality of the residues, except for station number 1, which only justifies 99%. As for wind direction, the level of justification is of 98% for station 4 and of 99% for station 5.

Station 1 showed a different behaviour. Although the linear fitting justified 97% of the residues, the observation of the graphics showed that a fitting to two different straight lines, one up to 145° and a second one from there to 360° made both lines pass through most points and minimized the fitting error. The first fitting, up to 145°, justified 98% of the residues and the second one, from 145° to 360°, justified 99%.

As we might have expected, because to the different heights of the sensors in the ICONA fixed station - 10 m - and in the portable stations - 3 m -, the correlation coefficient for their respective measures is smaller than the coefficient for the portable stations. However, both temperature and wind speed may be fitted to a first grade polynomial, with a justification of residues of 96% for temperature and 91% for wind speed. Relative to the homogeneization of wind directions, because of the greater height of the ICONA station the terrain roughness perturbates less its measures and its measures will be used without correction.

In the same way, the data provided by the Tethersonde were compared through dynamic and static tests with other Tethersondes belonging to the Instituto Nacional de Meteorología and the results showed no correction was neccessary.

III THERMAL AND DYNAMIC STRUCTURES OF MESOSCALE METEOROLOGICAL SITUATIONS

The importance of the synoptic situations for the development and spreading of forest fires was proved in previous works -(3), (4)-. As this classification has been done from a macroscopic point of view, we must penetrate into the fine structure of each synoptic situation and analize the behaviour of the variables that give rise to these situations. A network of surface stations was set up from July to September, both included, in order to know this structure.

By the way, a series of aerologic soundings with a captive

CAMPAIGNS	DATES	CLASS I	CLASS II	UNCLASSIFIED
ONE	July 11th		X	
	July 12th		X	
TWO	July 22nd		X	
	July 23rd	X		
	July 24th	X		
	July 25th			X
	July 26th	X		
	July 27th	X		
THREE	August 26th	X		
	August 27th	X		
	August 28th	X		
	August 29th			X
	August 30th		X	
FOUR	Sept. 17th	X		
	Sept. 18th		X	
	Sept. 19th	X		
	Sept. 20th		X	

Table III. Synoptic situations classified in the days in which aerological soundings with a captive balloon were carried out.

balloon was made during this period distributed in such a way as to be representative of the period with a greater probability of forest fires. These soundings provide the thermal and dynamic structures of the atmosphere in the planetary boundary layer. We can classify the atmospheric stratification with them and deduce whether the convective flows which are fundamental in the development and spreading of forest fires are developing. The sounding campaigns were four: 11-12 and 22-27 July, 26-30 August and 17-20 September.

The synoptic situation (4), according to the mentioned classification, appears in table III. As shown, the days in which the soundings were done the prevailing situation was the denominated Class I, seven days for five with situation Class II, what agrees with the results obtained in previous works (4).

Next, we have selected the situations corresponding to August 27 for Class I and September 18 for Class II- whose surface analyses and 500 HPa topographies corresponding to 12:00 GMT appear in figures (19),(20),(21) and (22) -to determinate the thermal and dynamic structures for standard situations.

III.1 Thermal and dynamic structures of the atmosphere in the August 27 10:00 and 12:00 h soundings.

As for the thermal structure we must underline that at 10:00 a little thermal inversion persists in the lower layers in spite of the early morning heating, but where the strong subsidence inversion that prevents vertical flows lies is between 800 and 1000 meters.(Fig 23).

Figure 24 shows relative humidity and altitude. The whole profile is very far from saturation as could be expected for this season. At the ground of the layer corresponding to the thermal inversion a maximum of relative humidity can be observed, while it falls abruptly because of the lid effect of the subsidence inversion and reaches a minimum at its top. From that point the relative humidity keeps growing to the sounding top, what is logical as temperature also decreases and, therefore, the capacity of the atmosphere to keep water vapour.

As for the stratification stability we must underline the

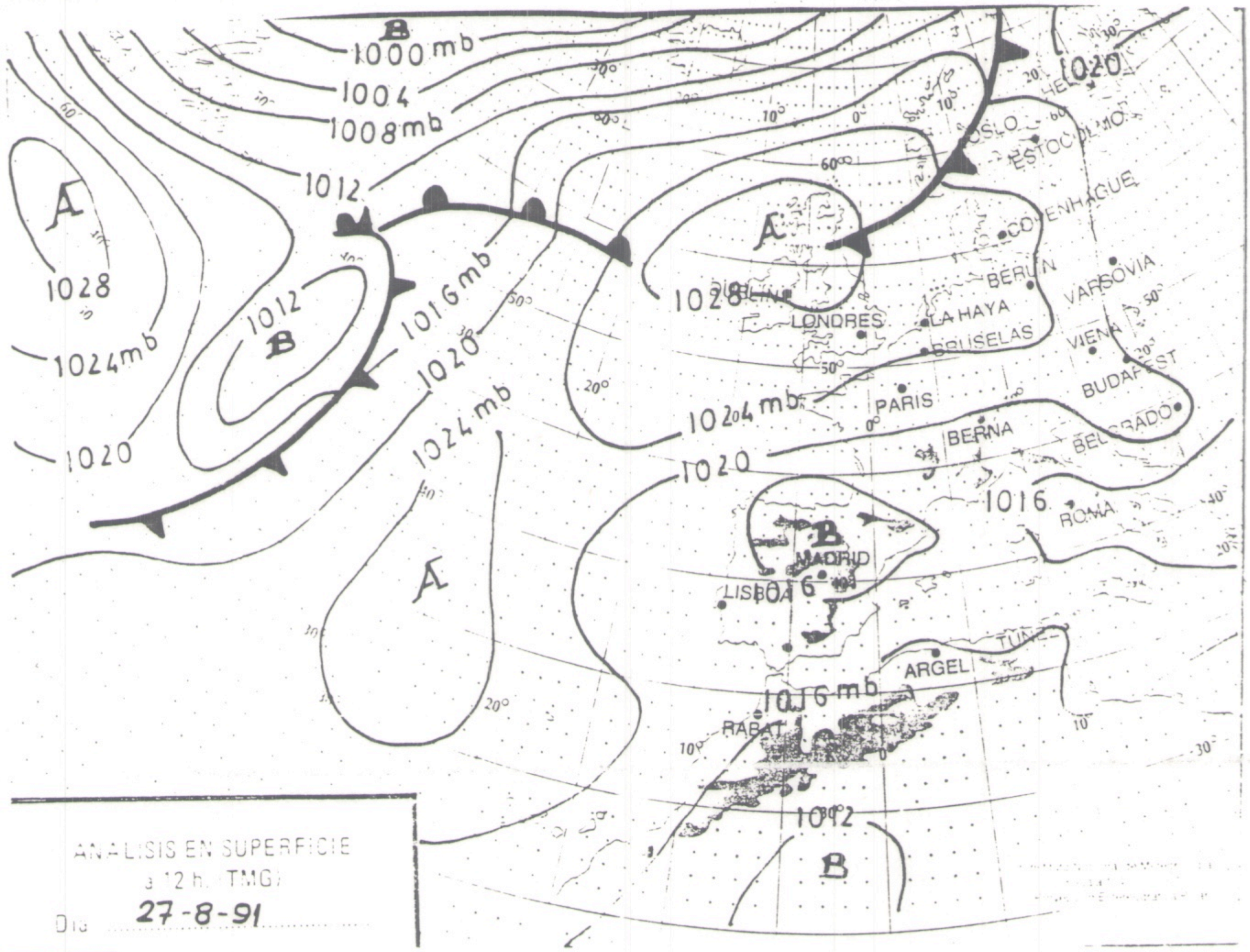

Fig 19. Surface analysis corresponding to class I situation.

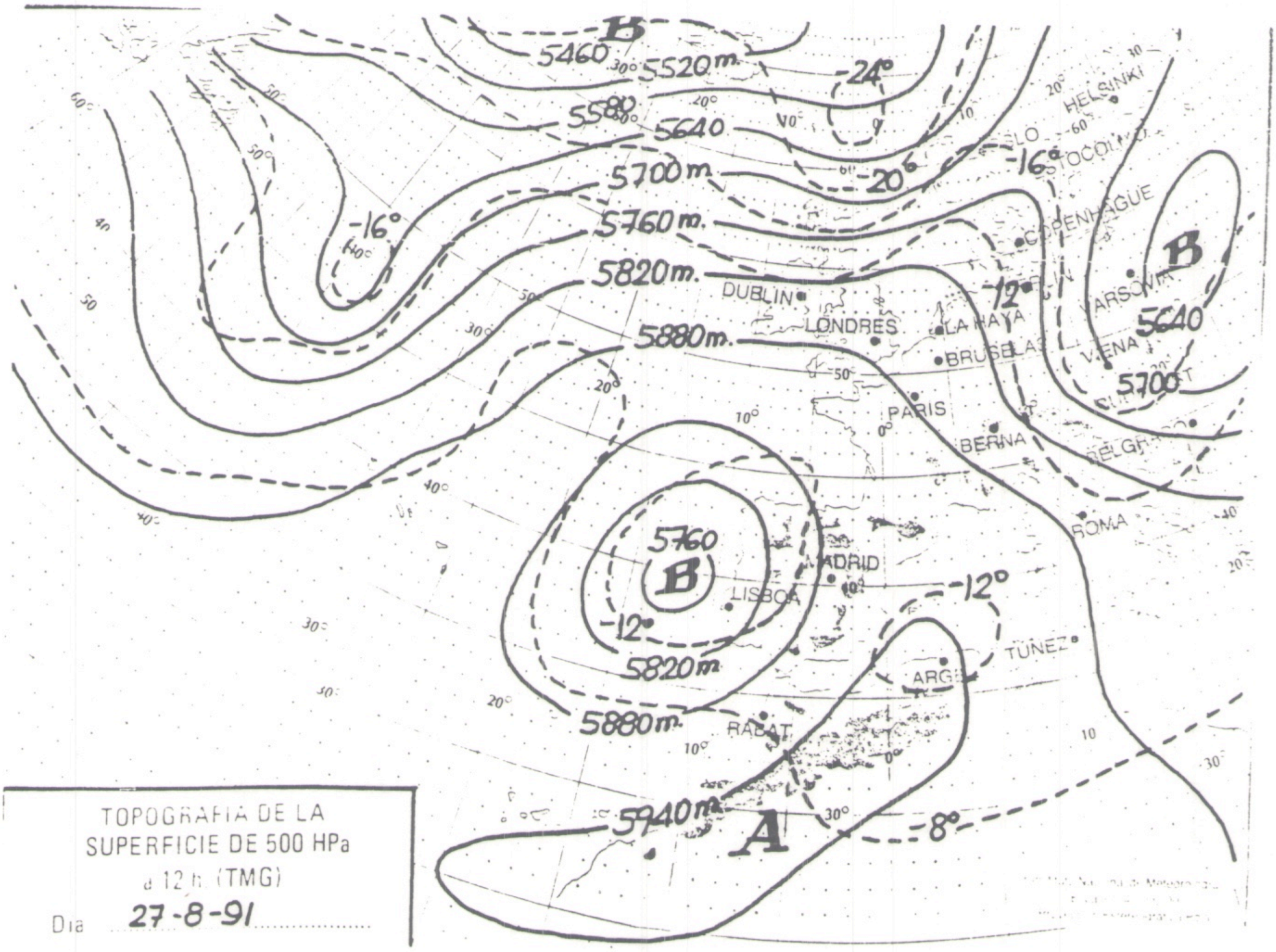

Fig 20. 500 HPa corresponding to class I situation.

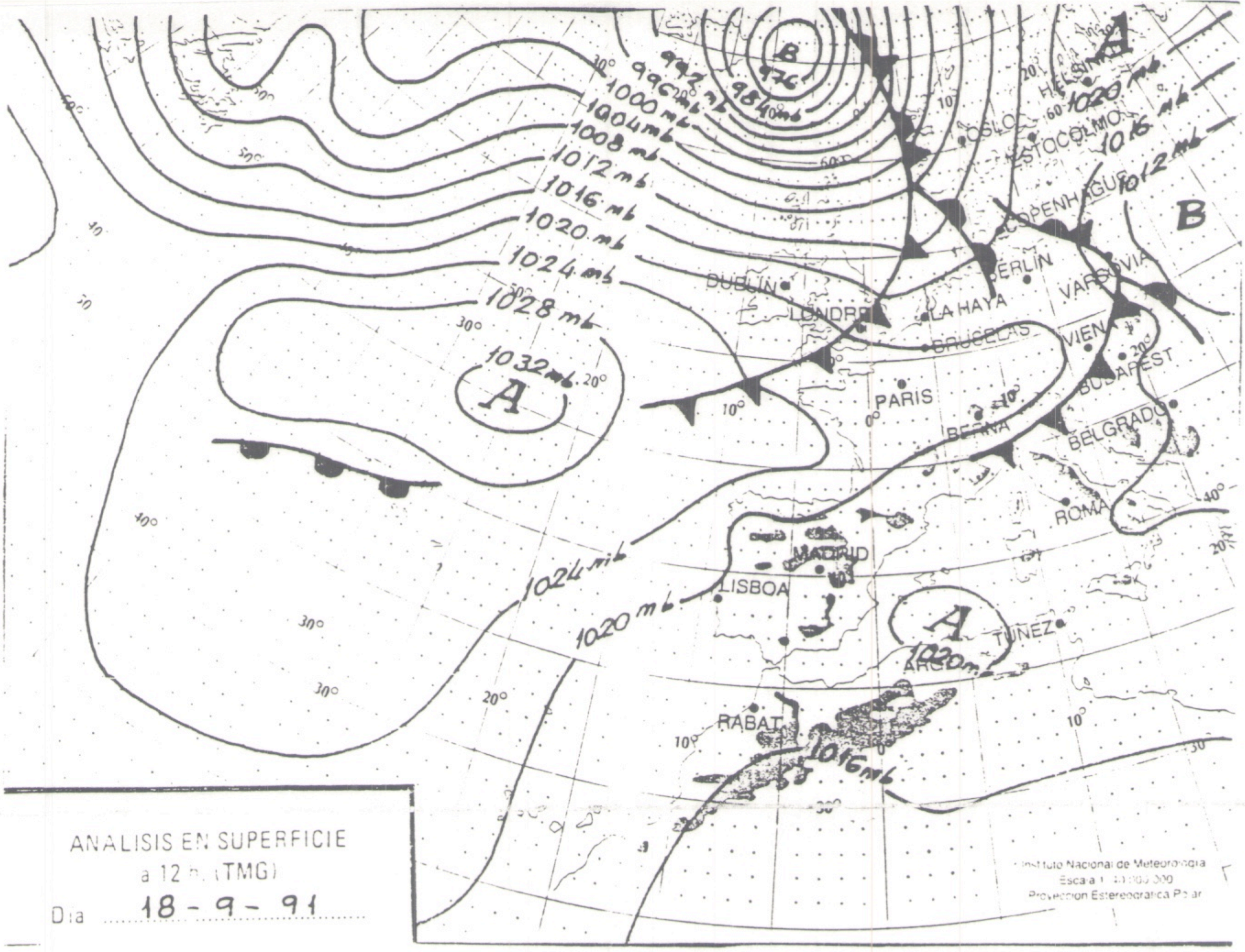

Fig. 21. Surface analysis corresponding to class II situation.

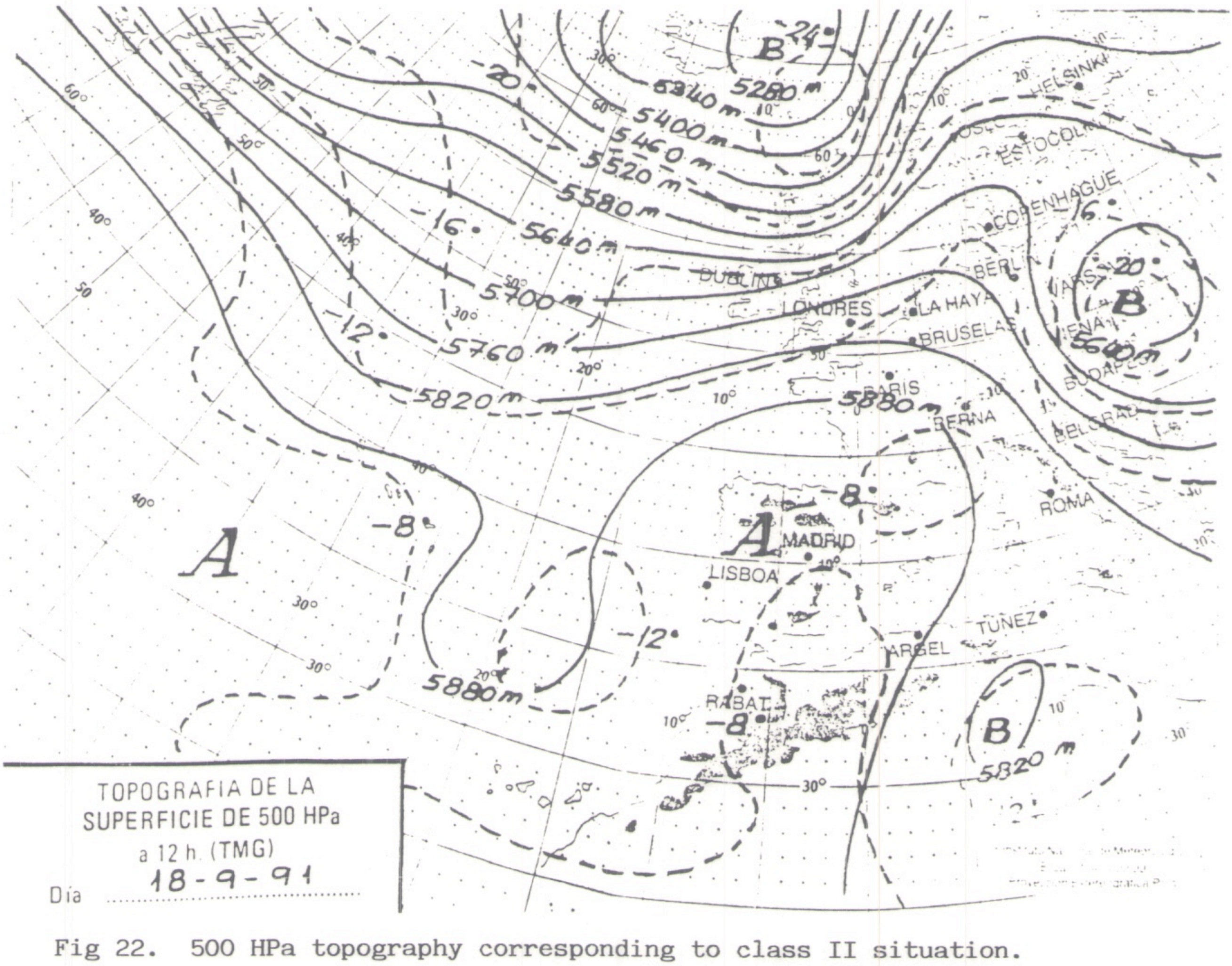

Fig 22. 500 HPa topography corresponding to class II situation.

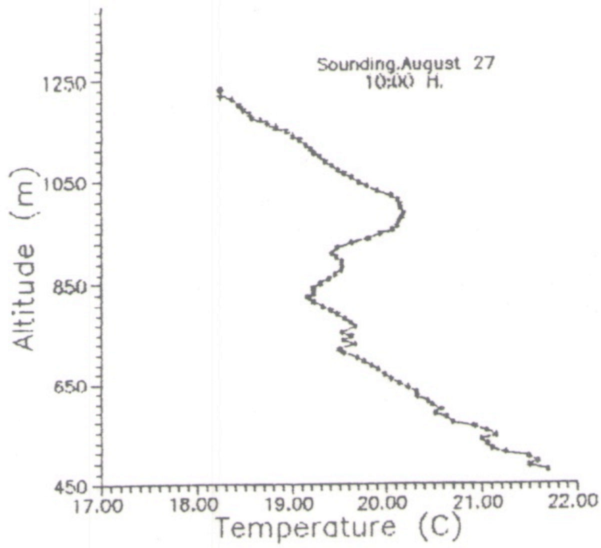

Fig. 23

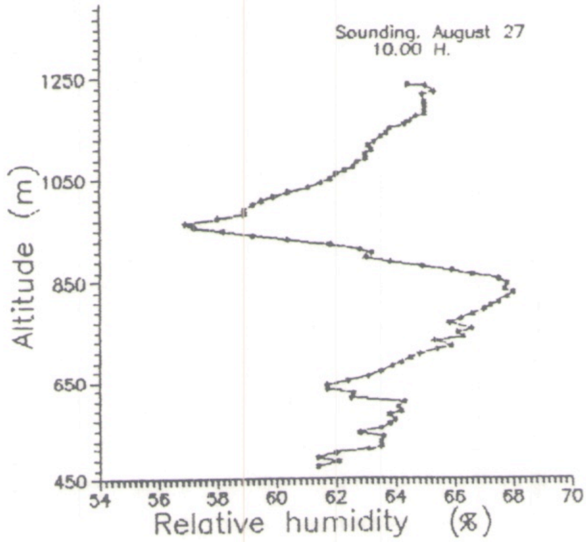

Fig. 24

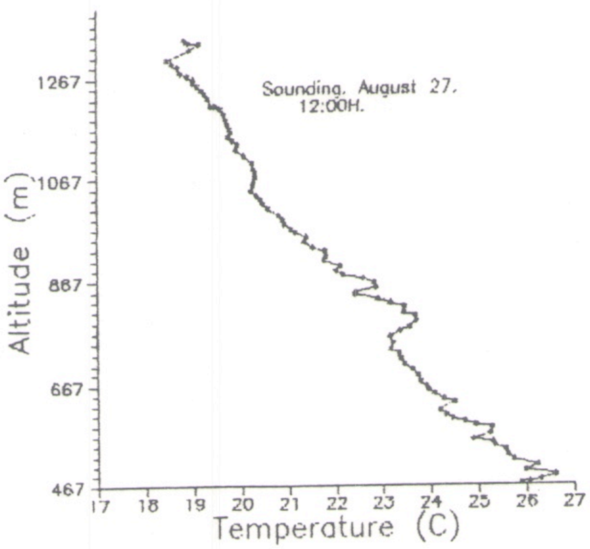

Fig. 25

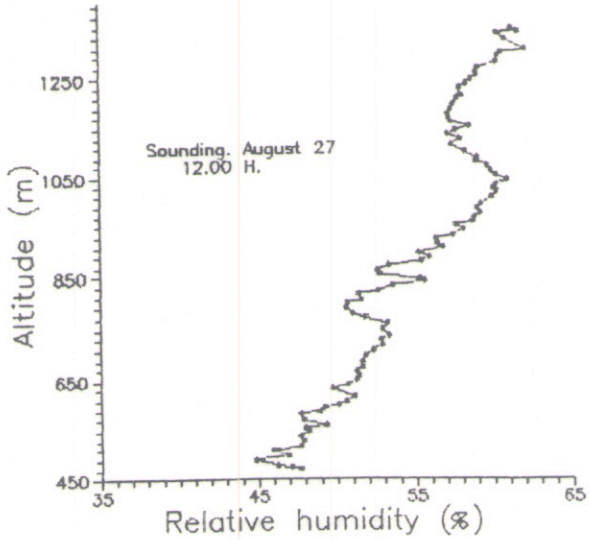

Fig. 26

slight instability, with a thermal gradient of 1.4°C/100m, from the top of the lower inversion to the ground of the upper one which allows for the development of convective flows. These will give rise in the central hours of the day to the development of the thermal low that characterises this type of situation on a synoptic scale. The thermal inversion area presents a great stratification stability, preventing vertical flows. Over the inversion layer an slightly stable layer appears.

Global stability appears in the 12:00 h sounding (fig 25) -0.9°C/100m- but a thermal inversion persists in those layers where it existed at 10:00, although its thickness has been considerably reduced in the subsidence inversion due to the convective turbulent mixing forced by the vertical flows due to the solar heating, while the floor inversion practically remains the same due to the air trapping leeward of a near hill.

This sounding relative humidity profile (fig 26) shows a drop of this variable, what is logical due to the higher temperature of the atmosphere, what makes the thermal structure of the lower atmosphere even more suitable to the development and spreading of fires.

As for the dynamic structure of the atmosphere at 10:00 we must underline that the wind-speed profile (fig 27) is very fluctuating up to 950 m - height of the inversion top - with speeds ranging from 0.3 to 2.5 m/s. As shown in figure 27, the inversion ground coincides with a marked speed minimum, while the top marks a maximum. From that level upwards speed grows with a slight fluctuation, but from 2.3 to 3 m/s. Logically, on ascending we move away from the geostrophic flow perturbating elements, what justifies the decrease of fluctuations and the progresive increase of wind. Wind direction (fig 28) also shows a slight fluctuation in the WNE sector, what indicates a change in the air-mass advections into the layer, whether hot or cold, according to the sector from which wind comes in each case and level. From the inversion top upwards wind is clearly from SW with a strong persistence coinciding with the mentioned growth in speed.

This dynamic structure agrees quite well with the

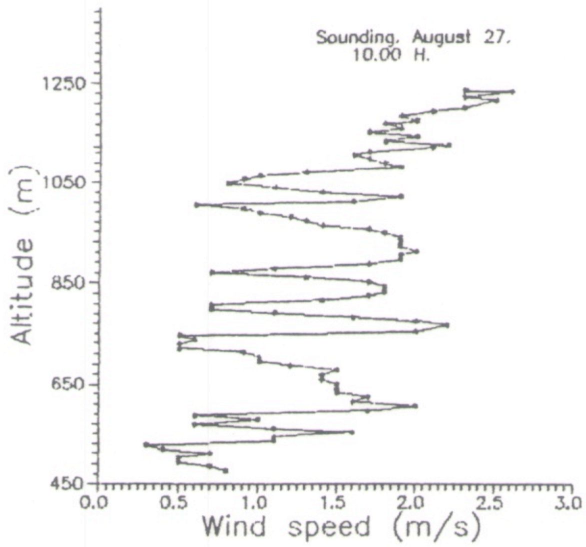

Fig. 27

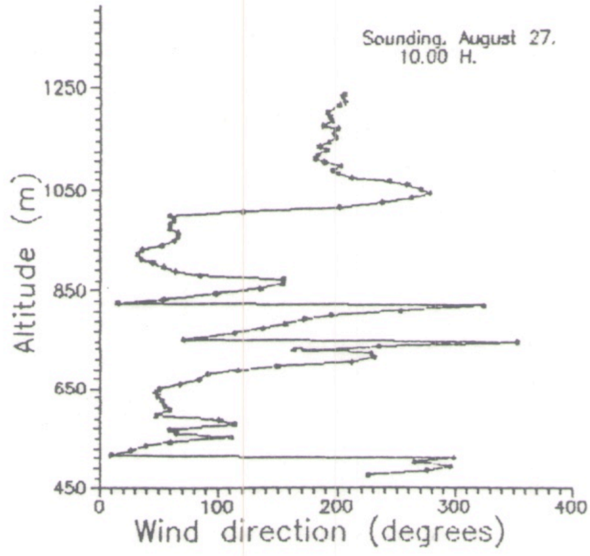

Fig. 28

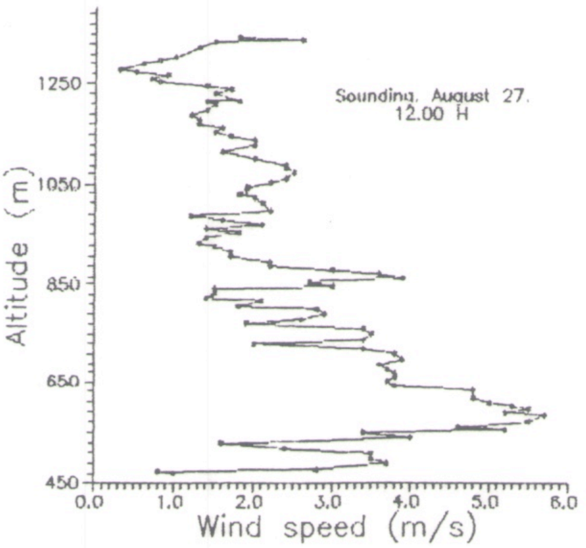

Fig. 29

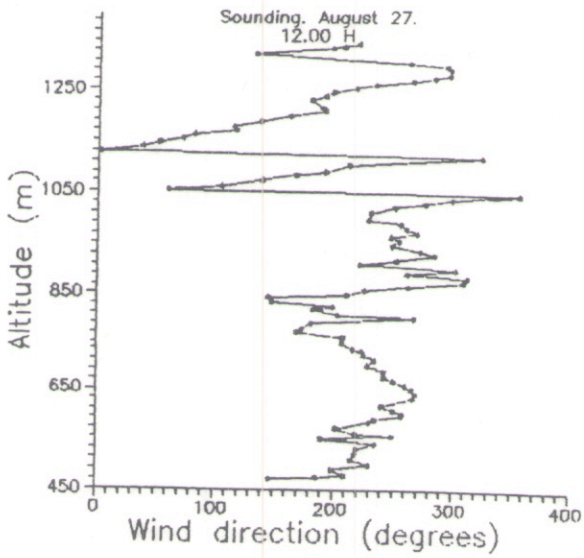

Fig. 30

traditional scheme of a deepening low, as there is a convergence at the ground produced by low wind speeds and there is a divergence at the top produced by greater wind speeds. This dynamic structure has the same effect as a chimney draught with its resulting favouring effect on the developing and spreading of fires.

In the 12:00 h sounding (fig 29, 30) the same dynamic structure holds,but we can see that the top of the low is not reached because the registered speeds are not the maximum horizontal speed which would produce as a consequence the maximum divergence.

III.2 Thermal and dynamic structures in the September 18 10:00- and 12:00-hours soundings

We have selected September 18, 1991 in order to characterise Class II synoptic situations. Although this day belongs to the mentioned type, there is a little difference due to the persistence for most of the summer of the Azores anticyclone, of a great thickness. Fronts that are usually associated with this type of situations are cold fronts, and sweep the NW of the Peninsula, but in this situation the front does not penetrate the Peninsula but approaches the Bay of Biscay.

In order to know more thoroughly the thermal structure of the atmosphere in this day we will refer first to the 10:00 h sounding. It is shown in figure 31 and we can appreciate a strong inversion from surface to about 600 meters. The temperature gradient is, up to this altitude, of 1.5°C/100m. From 600 to 700 meters an isothermal zone appears. From here to 900 meters there is a slight inversion. From that point upwards the atmosphere is slightly stable to the sounding top. As for the humidity curve (fig 32) we must underline that it is very far away from saturation, decreasing up to the inversion top. From that point upwards it remains practically constant to the sounding top.

In the 12:00 sounding (fig 33) the characteristics of the stratification globally are of a slight stability, although there is an overheated layer beside the ground. This fact can be appreciated in a lot of thermal evolution curves in different days

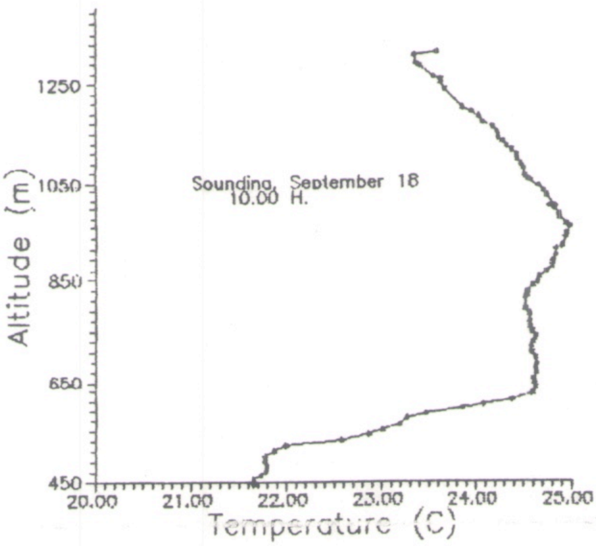

Fig. 31

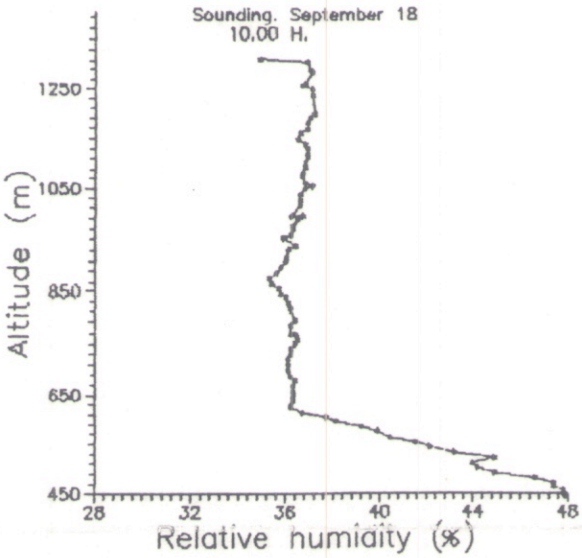

Fig. 32

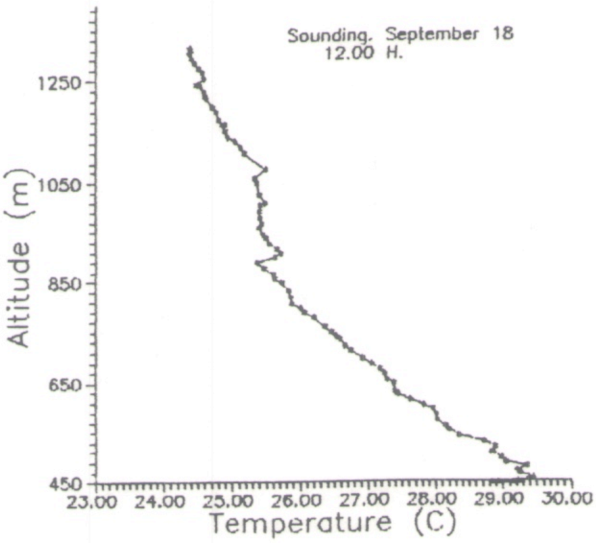

Fig.33

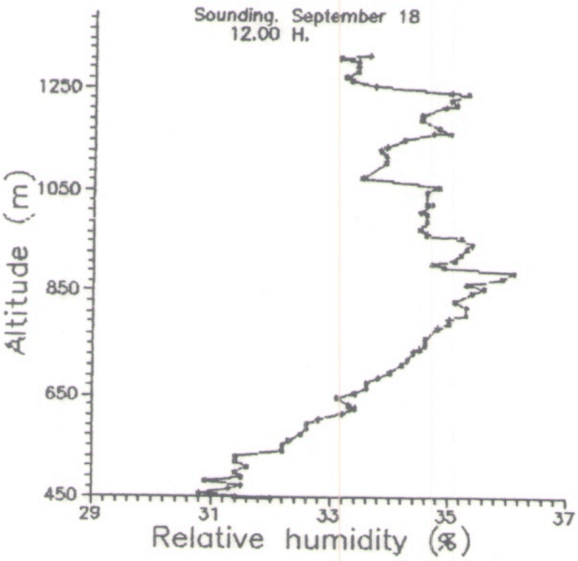

Fig. 34

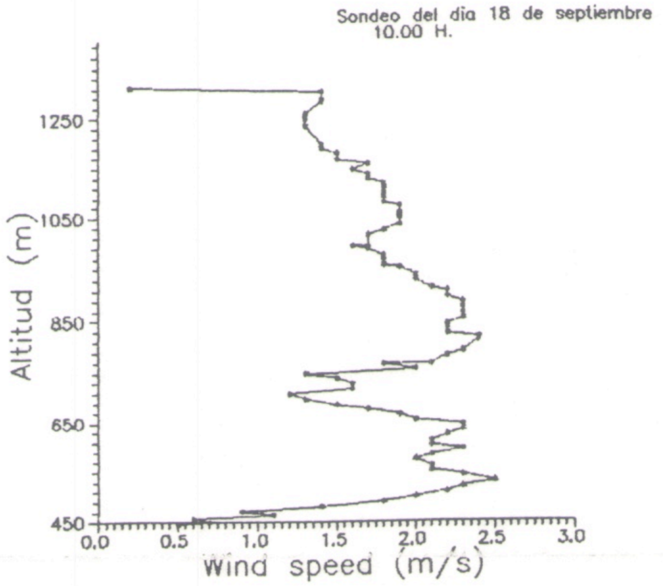

Fig. 35

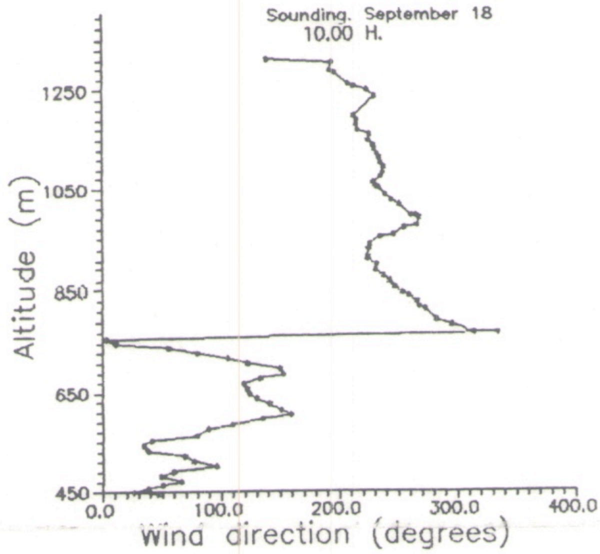

Fig. 36

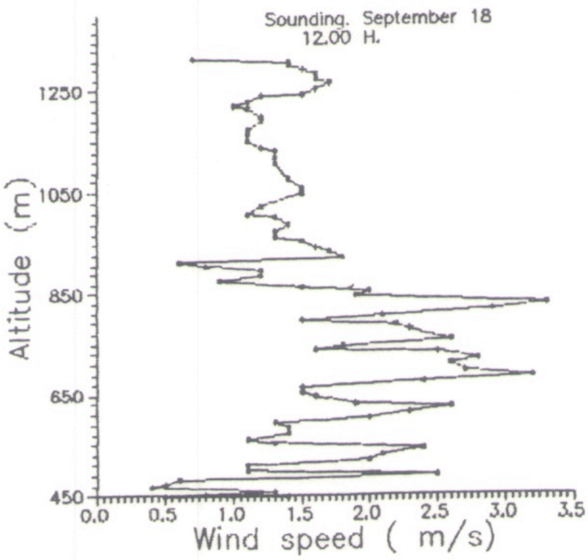

Fig.37

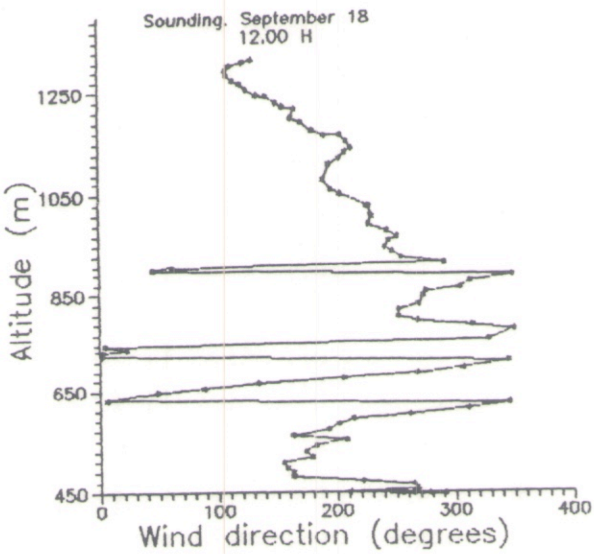

Fig.38

and hours. A detailed research of this phenomenum has taken us to connect it with a small orographic obstacle, the La Encinosa hill - 480 m - (fig 1), already mentioned, located closed to the sounding area, which in favourable wind conditions might be responsible for a hot air advection at that altitude, with the resulting heating effect on that layer, favoured by the air trapping leeward of the hill due to the flux separation and the stagnation whirlwinds.

As for the dynamic structure of the atmosphere, shown in the curves of change of wind speed and wind direction with altitude (fig 35-36), we can see that wind speed grows in the first 100 meters, point where the sounding maximum is reached, being the averaged wind direction in the first quadrant. This increase in speed may be the result of the development of turbulence by orographic obstacles and of the contribution to these flows by the catabatic winds originated at the NE slopes of the test zone. However, it was observed that wind decreases and changes direction when height increases. This effect would become the opposite phenomenum with regards to the development and spreading of a fire. It was shown in previous works (4) that the frequency of this kind of situations in the development and spreading of forest fires was 20% less than Class I in that period, from 1974 to 1987.

As for the 12:00 sounding (fig 37-38) we must underline the 180-degree turn in wind direction, originated close to the ground by the mountain breeze, giving rise to a cold advection. It can also be seen that a relative maximum in wind speed caused by the mentioned hill persists. As foreseen, speed varies from 0 to 3.5 m/s in the layer below 850 m, and from 1 to 1.8 m/s in upper layers, what severely decreases the descending vertical flows, a residue of the catabatic winds. In these conditions we can conclude that the developing and spreading of a fire are less favourable under Class II than under Class I situations.

IV DIAGNOSTIC MODEL

Several numerical models have been developed for wind prediction and diagnostic with complex orography (Klemp and Lilly,1978 (5); Mahrer and Pielke, 1977 (6); Yamada, 1978 (7)).

All of them are based on the principles of momentum, mass and energy conservation. Imposing different restrictions simpler models may be obtained, such as the that we are trying to round off in this work. The selected model is that developed by Fosberg and Sestak - Krissy model -, a tridimensional wind diagnostic model.

The equations that govern this model were developed by Fosberg (8). Basically, the improvements over the σ-corrdinate models by Sherman (9) and Goodin (10) are:

1. Compressibility is introduced through dependence of density on space in the steady-state equation of continuity.

2. Although Creesman's $1/R^2$ interpolation method - 1959 (11) is upheld for surface wind, vertical profiles are used to calculate the vertical derivatives, which are then interpolated with the $1/R^2$ method.

3. Momentum transport is considered to calculate w according to Onishi, 1969 (12).

The grid width for this model may vary from 200 meters to several kilometers.

The required data to initialize the model are the surface observations by the described stations and the soundings carried out near station number 3, more precisely, horizontal wind speed and direction and air temperature. To these data altitude of every grid point must be added. The grid width used is 200 meters, for a grid dimension of 11 x 12.6 kilometers, what renders a total of 55 x 63 points, as previously indicated. The exact location of the stations in UTM coordinates as well as its altitude must be introduced.

In this first stage of the experiment the KRISSY model was run to obtain a surface wind diagnostic. As data input we have used those of the previously mentioned surface variables as well as the vertical profile provided by the sounding of days considered as representative of each standard situation, August 27 10:00 and September 18 12:00. These hours have been chosen because, in spite of belonging to different synoptic situations, its thermal structure may be considered as similar in order to

		STATIONS					
		ONE	TWO	THREE	FOUR	FIVE	SIX
PREDICTED VALUES	Direc. (deg)	146	148	154	156	134	147
	Speed (m/s)	0.4	0.4	0.5	0.5	0.6	0.3
OBSERVED VLUES	Direc. (deg)	169	160	156	133	160	146
	Speed (m/s)	0.1	0.1	0.5	0.6	0.6	0.4
ERROR IN DIRECTION (degrees)		-23	-12	-2	23	-26	1
ERROR IN SPEED (m/s)		0.3	0.3	0.0	-0.1	0.0	-0.1

Table IV. Results of the model for each station with data belonging to August 27th 10:00 h

STATIONS						
		ONE	THREE	FOUR	FIVE	SIX
PREDICTED VALUES	Direc. (deg)	154	174	177	123	148
	Vel. (m/s)	0.7	0.7	0.7	1.0	0.4
OBSERVED VALUES	Direc. (deg)	215	129	120	195	154
	Speed (m/s)	0.3	1.0	1.0	0.8	0.7
ERROR IN DIRECTION (degrees)		-61	45	57	-72	-6
ERROR IN SPEED (m/s)		0.4	0.3	0.3	0.2	-0.3

Table V. Results of the model for each station with data belonging to September 18th 12:00 h.

make comparisons between its results.

The model output for every grid point is horizontal wind speed and direction and potential temperature.

To validate results the KRISSY program has the option to ignore input data from previously selected stations. The program runs without those data and provides an estimation of horizontal wind speed and direction and potential temperature for those stations, just as for every other grid point. Later, it compares these results with the input data and calculates error as difference between observed and predicted. This way, and ignoring one station at a time we have obtained the results that appear in Table IV for August 27 10:00.

From this table we establish that the average absolute error for the previously mentioned input data is 15° for wind direction and 0.1 m/s for wind speed with a standard direction of 154° and speed of 0.8 m/s.

The results corresponding to September 18 12:00 appear in Table V, being the average absolute error 48° and 0.3 m/s.

As for the August 27 10:00 sounding, its errors may be considere acceptable fom a meteorological point of view. The September 18 12:00 errors, representative of Class II, are greater but also acceptable. Anyway, the finality of this experiment was the acquisition of field data of the wind field to be used as input to a model of developing and spreading of forest fires, and, if we accept Pickford's idea - 1987 (13) - that a difference of 45° in the estimation of wind direction and 2.2 m/s in wind speed does not generally change the direction of fire movement, we can assume that even in this first stage of model developing it is providing satisfactory results.

V RESUME AND CONCLUSIONS

1. The area selected for the development of this experiment is located SE of the Central System, more precisely at Sierra de Gredos. The test area is a 11 x 12.6 km grid with a grid width of 200 meters.

2. The placement of the stations was chosen under the conditions of being representative of the test area, being placed

in meteorologically acceptable places and uniformly scattered.

3. Station number 3 is considered the reference station and all the other are compared with it. The fittings obtained through regresion rect lines for the different variables and stations relative to the data of station 3 are higly significative, as shown by their respective correlation indices (Table II). The ICONA station will serve as areference to establish a climatology of the area.

4. The tethersonde was calibrated through static and dynamic tests by comparison with others belonging to the Instituto Nacional de Meteorología.

5. The soundings were carried out in relatively plain and open zone in this environment and from a low altitude, what allows an easier operation and a complete vertical profile of the selected area.

6. According to the patterns set by other works (4), the different synoptic situations of the days in which soundings were carried out were classified .

7. August 27 and September 18 1991 were chosen as representative of each class of situation for the experimentation period.

8. The dynamic and thermal structures for each standard situation appeared well differenced. In Class I both the thermal and the dynamic structure are those of a developing thermal low, with a behaviour similar to that of a chimney draught, what once again shows it is the most suitable for the developing and spreading of forest fires. Class II has the structure of a very thick antyciclone with vertical descending flows, what, if fires develope, does not favour its spreading as long as thermal turbulence does not appear, which would produce convective flows.

9. A diagnostic method has been developed to calculate the wind field that provides in a first approach good results in order to be used as input to models of development and spreading of forest fires.

10.All this work must be considered as a first approach to the problem of the development and spreading of forest fires. With the accomplished campaigns we will continue to deepen into the mesoscalar knowledge of the meteorological situations from both points of view, dynamic and thermal, which will be the immediate subject of future works.

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