

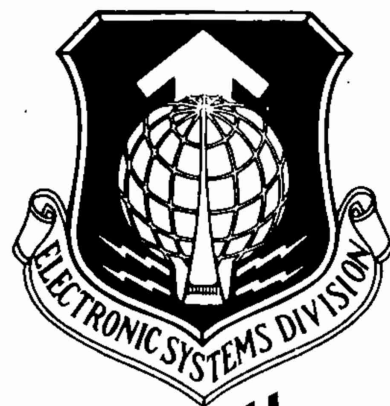
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RADIO REFRACTIVITY AND METEOROLOGICAL
DATA PLOTS FROM RADIOSONDE LAUNCHES
TRADE WINDS - MARCH 1969



L. G. Rowlandson
J. S. Schwarz

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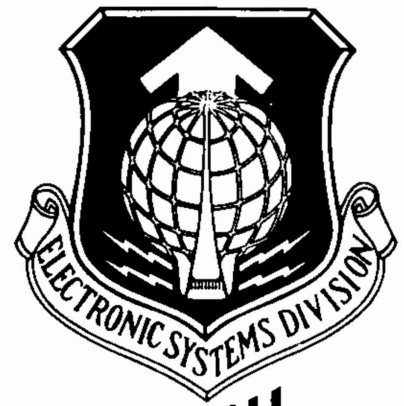
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FOREWORD

This report is prepared for the

Aerospace Instrumentation Program Office
Electronic Systems Division
Air Force Systems Command of the United States Air Force
L. G. Hanscom Field
Bedford, Massachusetts

Air Force Program Monitor - Lt. C. Schafer, FSD/ESSIE
Project Number 6684, Task 6684.08

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1969 March 1 to 1970 January 31.

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This report was reviewed and approved.

C. Schafer, Lieutenant, USAF
Program Manager for FSD/ESSIE/6684.

ABSTRACT

Radiosonde data were collected from the Northern part of the Caribbean Sea, during the period 6 March through 26 March 1969. Stations were selected to encompass the area wherein instrumented aircraft measurements were made of meteorological and radio refractivity parameters.

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SECTION I

INTRODUCTION

An investigation of the characteristics of the Trade Wind Duct was carried out from 6 March through 25 March 1969. Detailed data were collected using a USAF C-131 aircraft which was instrumented to measure free air variables as well as radio refractivity [Reference: Rowlandson, et al, "Measurements of Meteorological Parameters and Radio Refractivity in the Caribbean," ESD-TR-69-374, November 1969]. The aircraft proceeded from Key West, Florida, on a counter-clockwise flight to New Orleans, Merida, Cayman Islands, Puerto Rico, Grand Bahamas, and back to Key West.

Large variations occur in time and space over this area and it was necessary to use radiosonde data to control the experiment. In addition, detailed analysis of the weather conditions along the various paths flown by the aircraft required extensive radiosonde data. The analysis of all data then attempts to show how the characteristics of the Trade Wind Duct change in relation to the controlling weather systems.

The data presented herein show the vertical variation of radio refractivity, N , modified index, M , air temperature, T , water vapor pressure, e , and potential air temperature, θ .

These data will be presented in a chronological order and identified by aircraft mission numbers so they may be related to measurements and data presented in the earlier reports.

Several parameters associated with these measurements should be clearly defined. The first is the radio refractivity, N , and the modified index of refraction, M , both of which play an important role in determining the relationship of the Inversion characteristics to radio wave propagation.

The computer programs used to process and present these data were described earlier [Schwarz, J., "Description of Computer Programs for the Analysis and Presentation of Trade Winds Data," ESD-TR-70-32, December 1969].

The index of refraction, n , for air is related to the refractivity, N , and free air variables by the expression

$$(n - 1) 10^6 = N \quad (1)$$

$$= \frac{77.6 P}{T} + \frac{3.73 \times 10^5 e}{T^2} \quad (2)$$

where P = the air pressure (mb)

T = the air temperature ($^{\circ}$ K)

e = the water vapor pressure in the associated sample of air (mb).

To maintain hydrostatic equilibrium, the pressure, P , decreases almost exponentially with height and has such an overwhelming influence on N , that in general it is found that N also decreases exponentially with height. Variations from this average behavior are primarily due to the water vapor pressure term, e .

When a radio signal is propagated and its travel defined by a single ray, the variations of N along its path produce changes in its velocity and its direction of travel. These considerations are well documented and do not need to be presented herein. In the study of radio ray propagation it is frequently convenient to transform the geometry to a flat earth and treat the problem in Cartesian rather than in polar coordinates. This transformation changes the normal decrease of N with height, over the curved earth, to an apparent increase of N with height over the flat earth.

The new index, M , resulting from this transformation then becomes

$$M(h) = N(h) + h/a \cdot 10^6 \quad (3)$$

where h = the height above the earth's surface

a = the earth radius.

Another parameter, the potential temperature, θ , is of particular importance when studying the Trade Wind Inversion. The potential temperature is given by

$$\theta = T \left(\frac{P}{1000} \right)^{-R_s/C_p} \quad (4)$$

where T = the air temperature ($^{\circ}$ K)

P = the air pressure (mb)

R = the specific gas constant for air

C_p = the specific heat capacity for air at constant pressure

therefore,

$$R/C_p = 0.286 \text{ for dry air.} \quad (5)$$

The potential temperature may be considered to be the temperature a sample of dry air would have if it were compressed (or expanded) adiabatically from a given state P and T to a pressure of 1000 mb. Therefore, θ , is a conservative property of a parcel of air which is invariant during adiabatic processes.

When an inversion occurs, such as in the case of the Trade Wind Inversion, the potential temperature increases very rapidly with height through the layer. This condition indicates that abnormal (non-adiabatic) heating occurs which is produced by the subsidence of the upper air. The vertical stability of the air is then greatly increased in the layer and the vertical transfer of air from the region below the layer is strongly inhibited.

It will be seen that any temperature advection that modifies the air, except for normal adiabatic processes, will have a marked effect on the vertical variation of potential temperature. Greater or lesser stability then occurs depending on the temperature change of the air from adiabatic.

SECTION II

DATA PRESENTATION

Approximately fifteen stations were selected for the analysis. These stations are listed below and their location and number shown on Figure 1.

Since launches were inconsistent, the data for any given day has been assembled in the order of the station number. To show the diurnal effects, an attempt is made to present the 0000 Z launch directly above the 1200 Z launch for any given station. In some cases where launches were not made this procedure is waived in the interest of conserving space in the report.

TABLE I
RADIOSONDE STATIONS USED IN THE ANALYSIS

Station Symbol	Location
72201	Key West, Florida
72202	Miami, Florida
72211	Tampa, Florida
72232	Burwood, Louisiana
76644	Merida, Mexico
78063	Grand Bahama Island
78076	Eleuthera
78118	Grand Turk Island
78367	Guantanamo, Cuba
78384	Grand Cayman Island
78397	Kingston, Jamaica
78486	Sabana de la Mar, Dominican Republic
78501	Swan Island
78526	San Juan, Puerto Rico

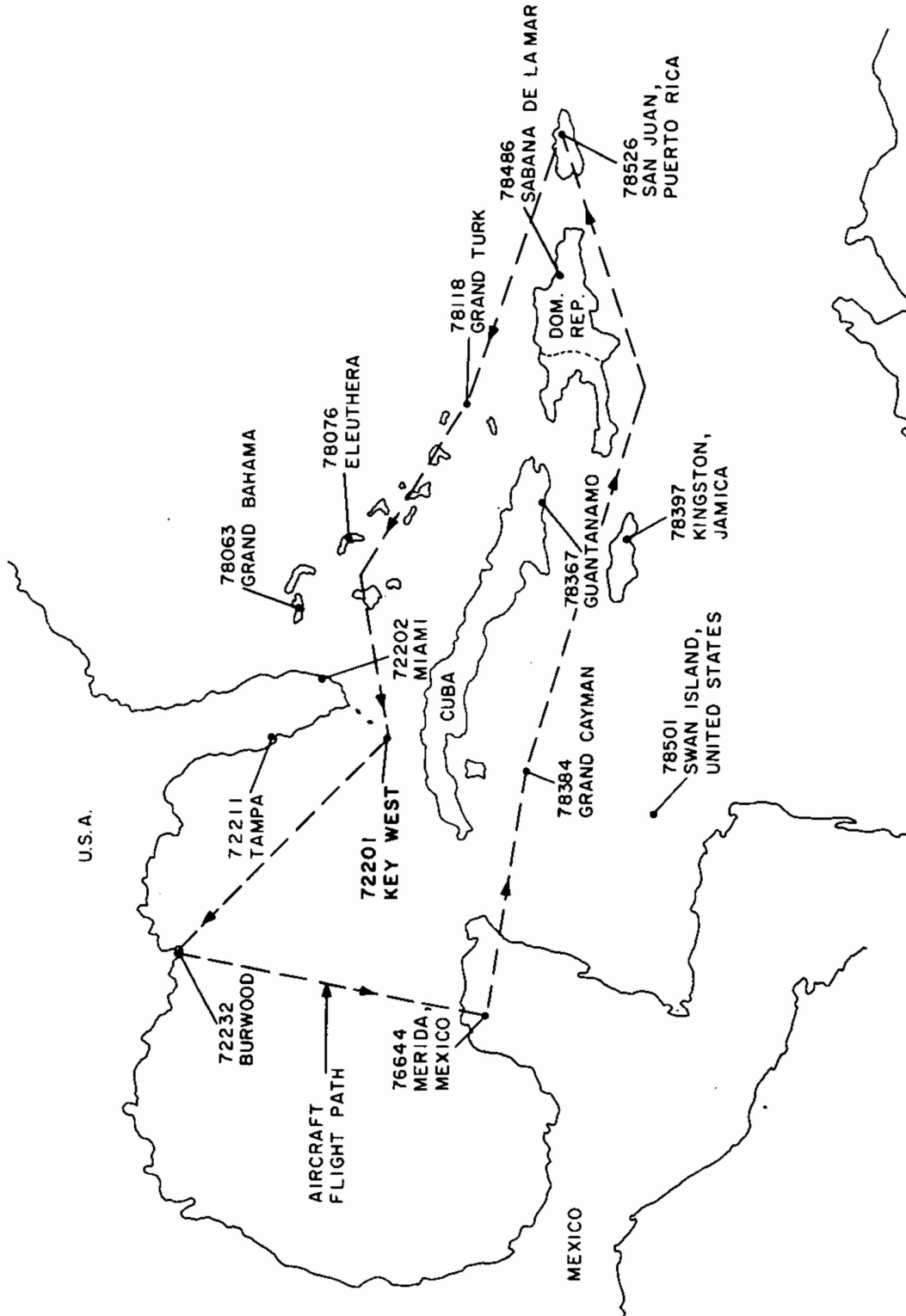
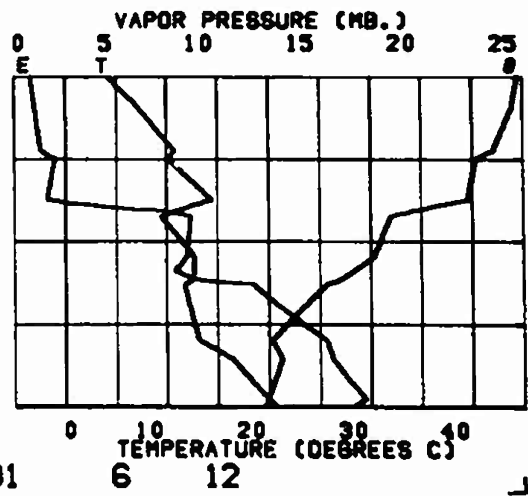
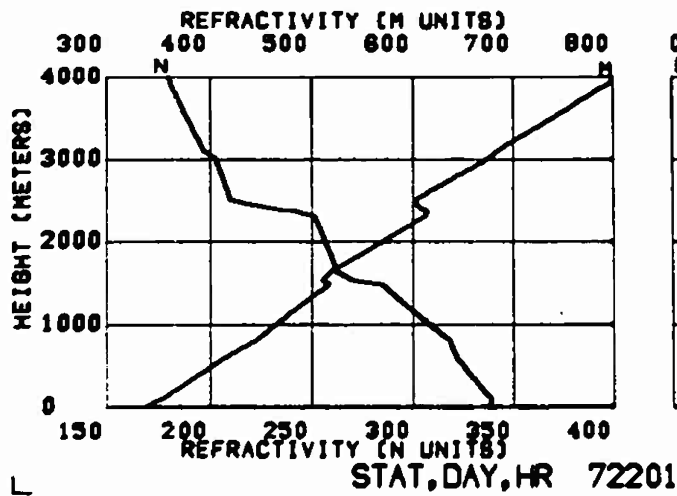
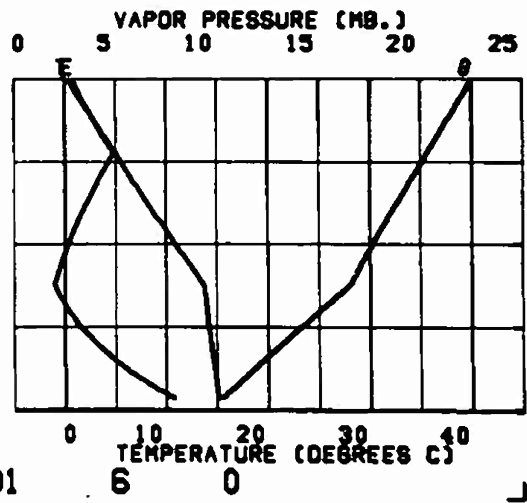
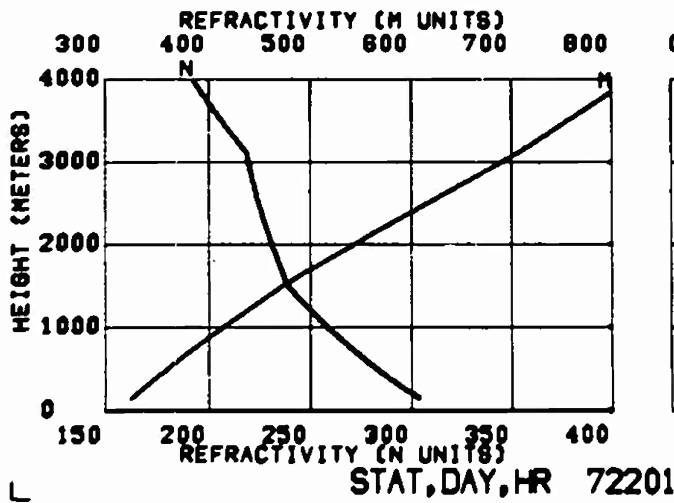
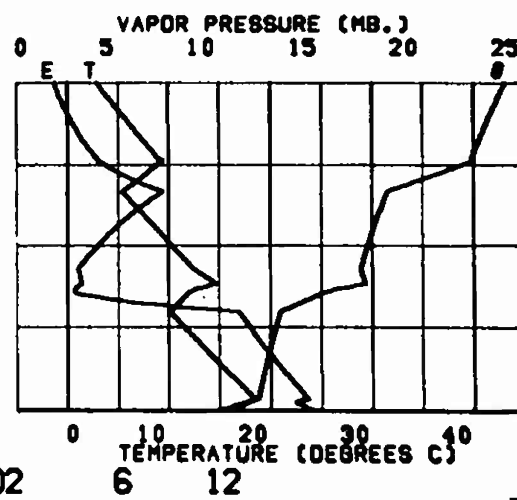
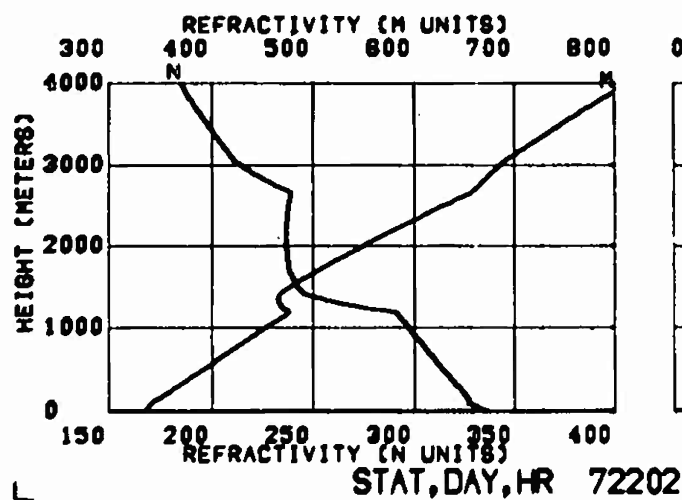
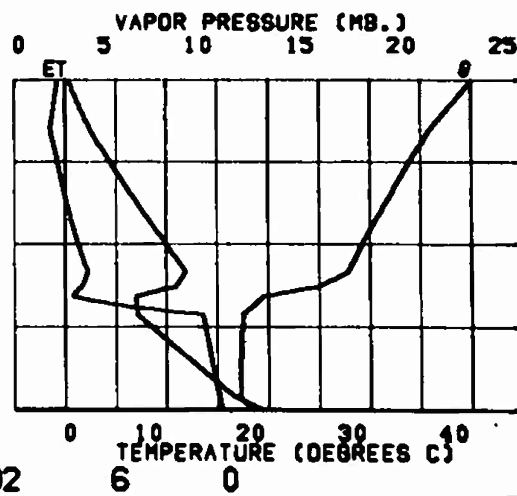
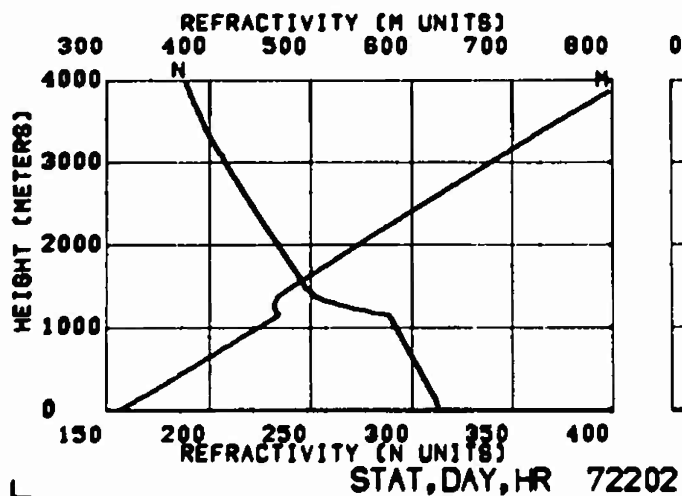
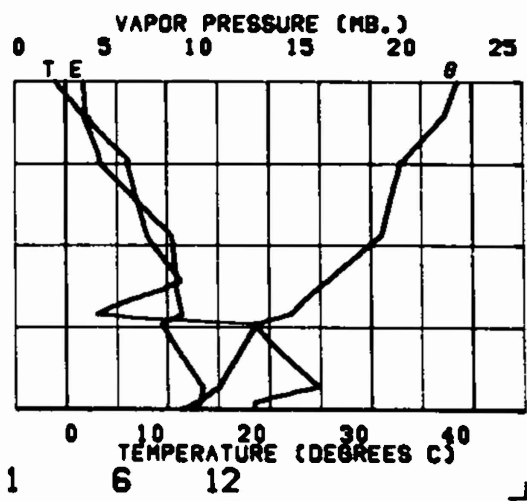
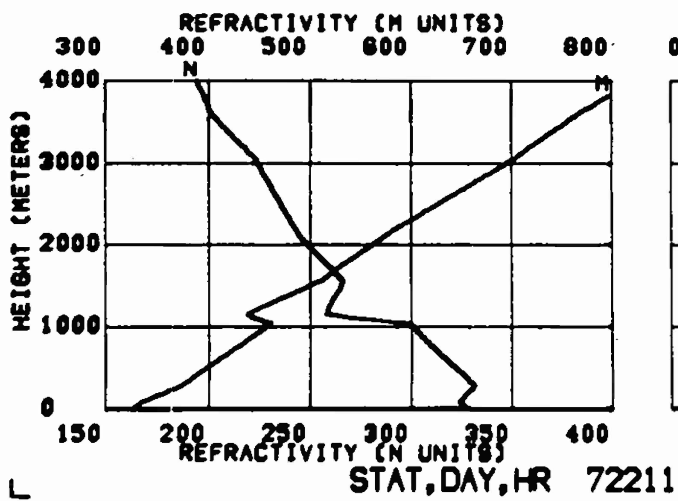
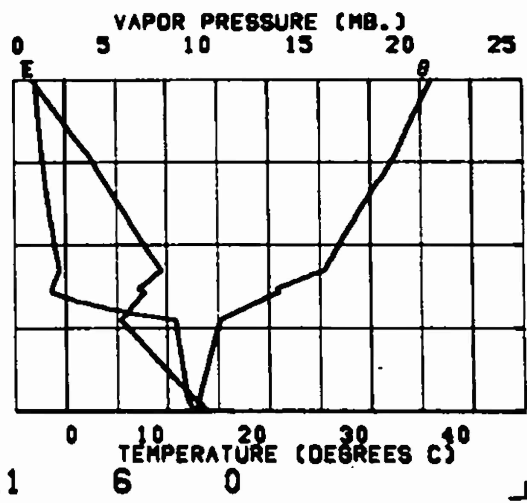
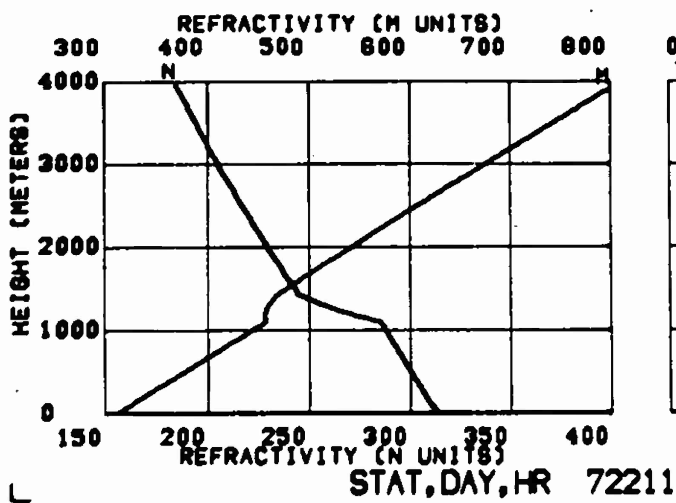
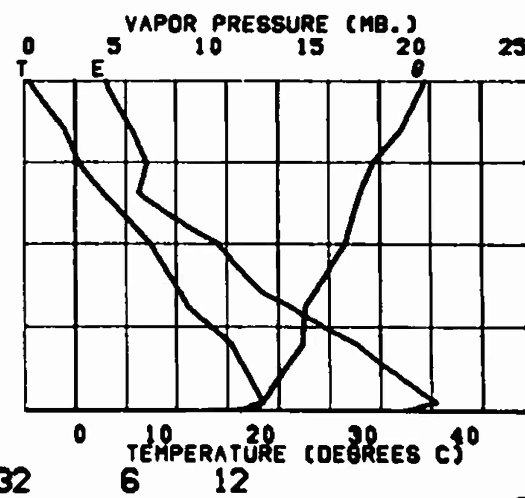
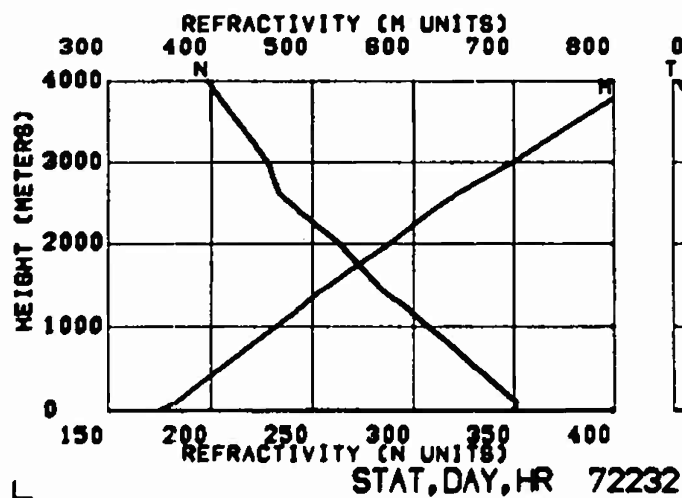
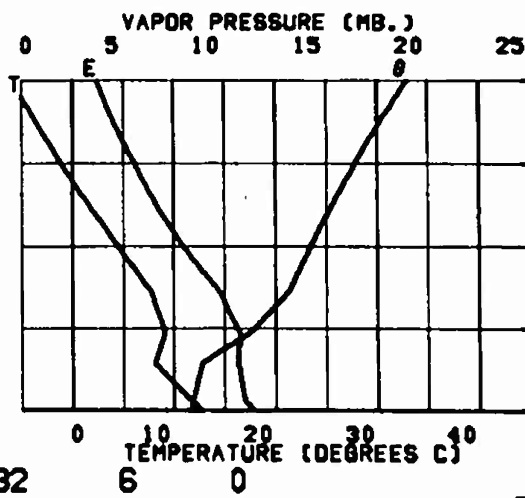
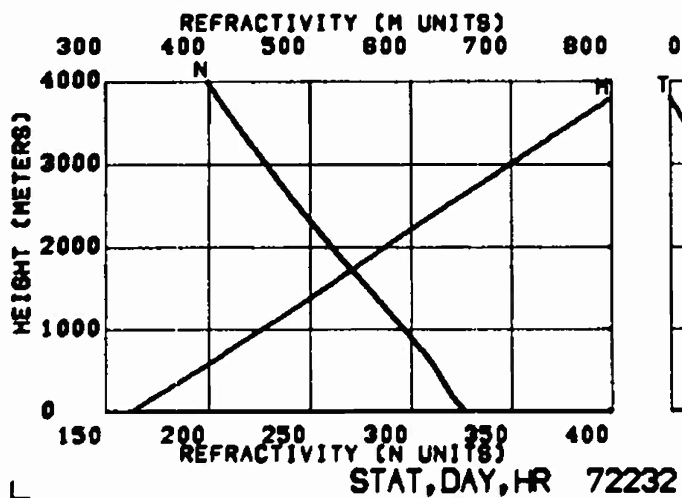


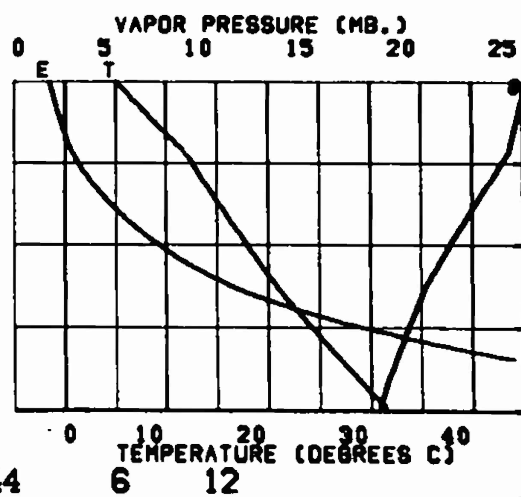
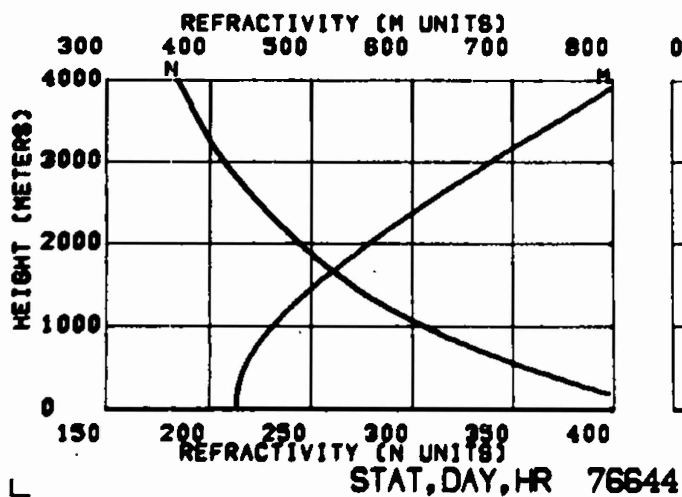
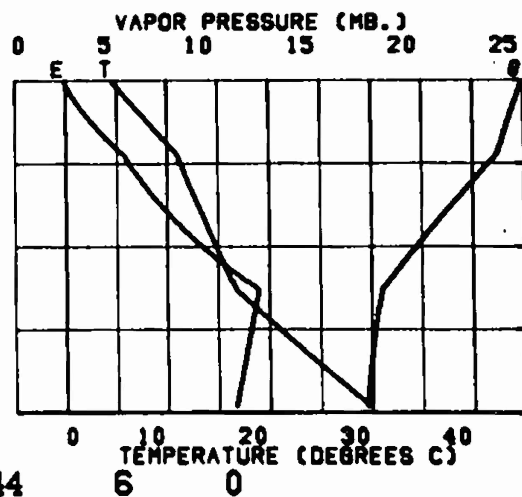
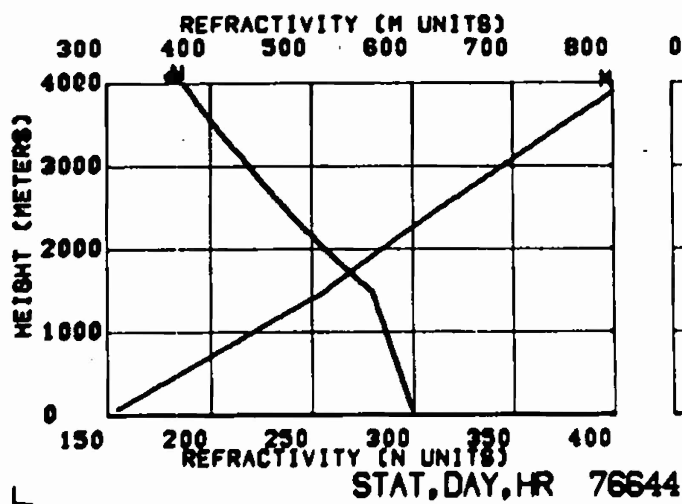
FIGURE 1. RADIOSONDE LAUNCH SITES.

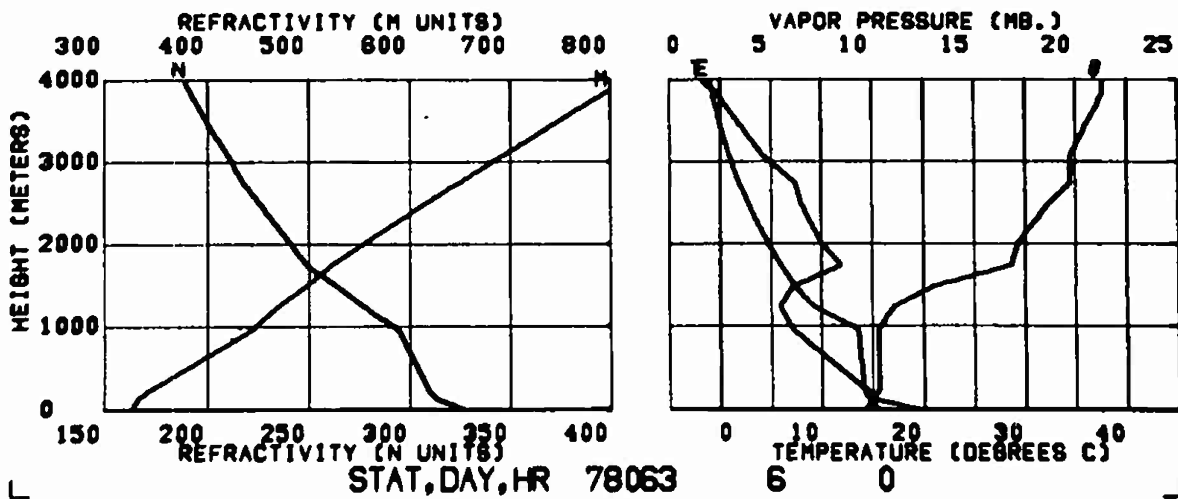




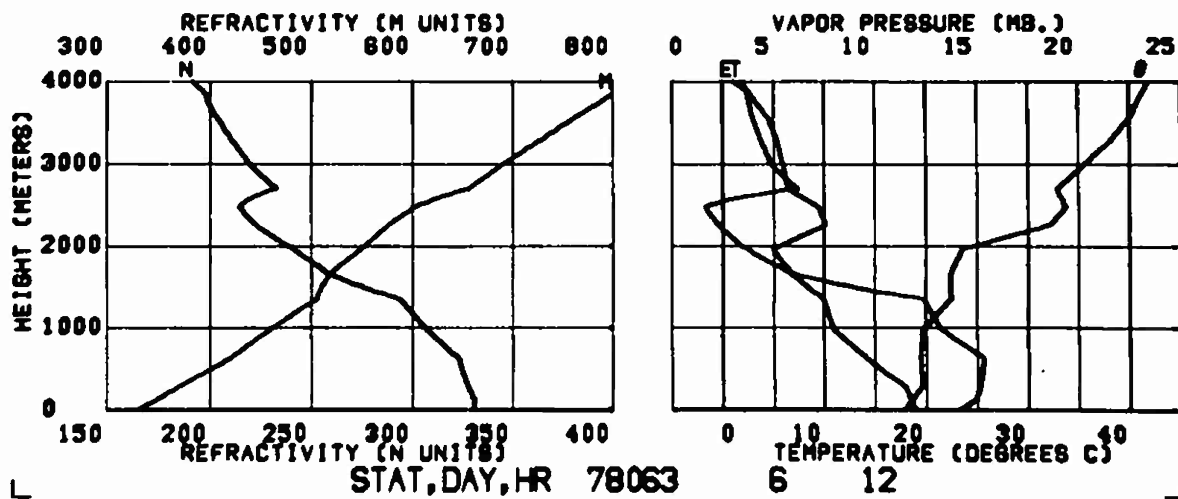


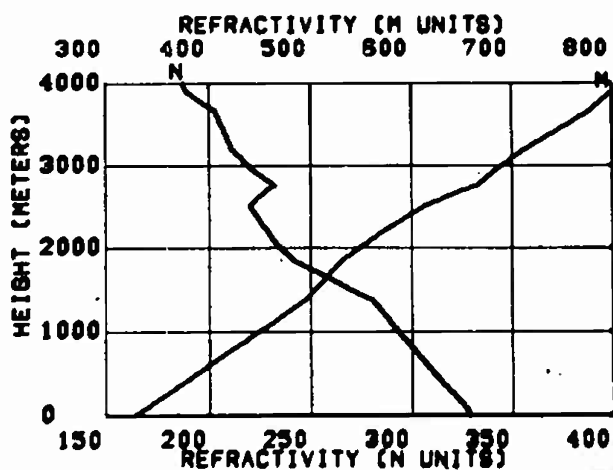




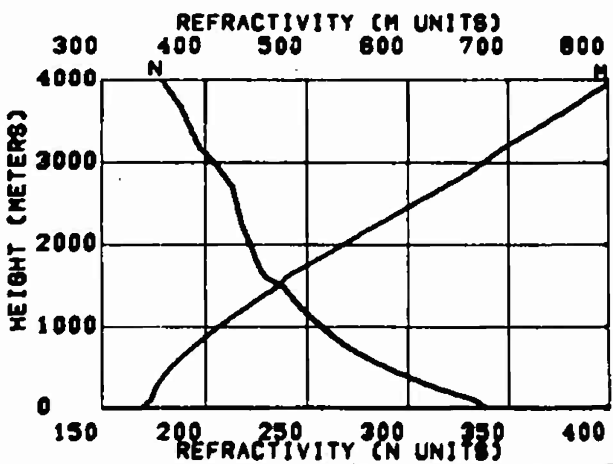
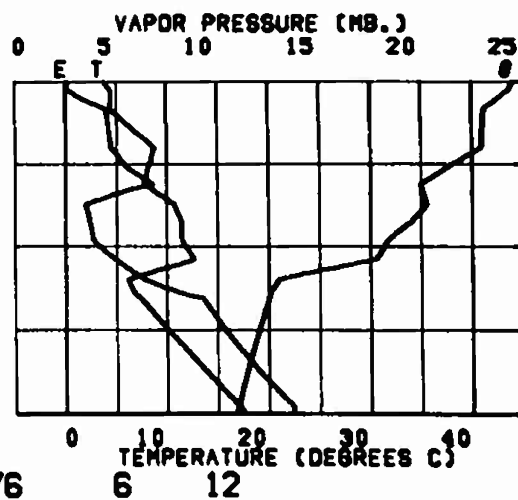


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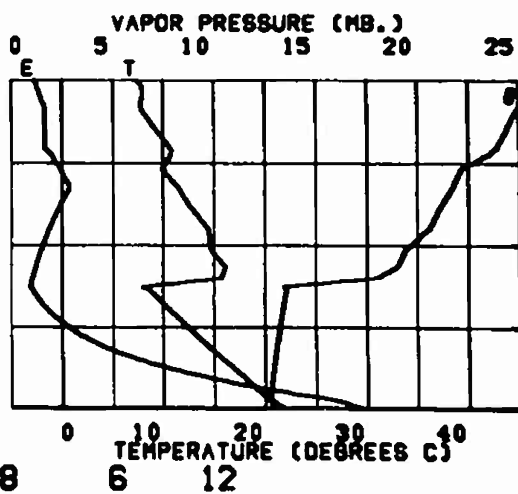


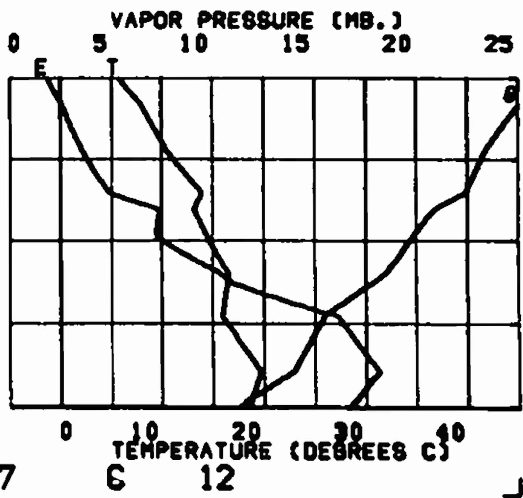
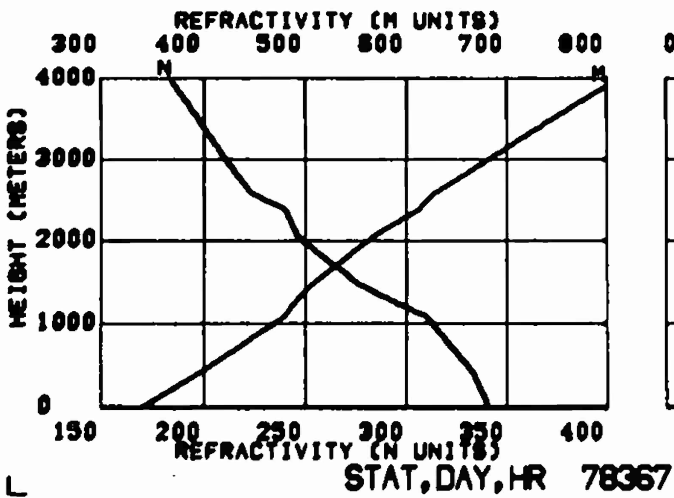
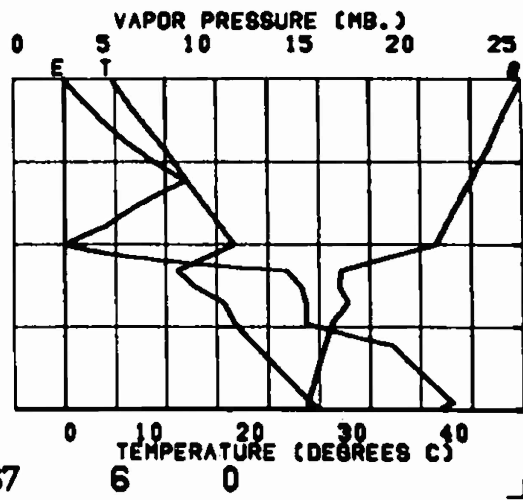
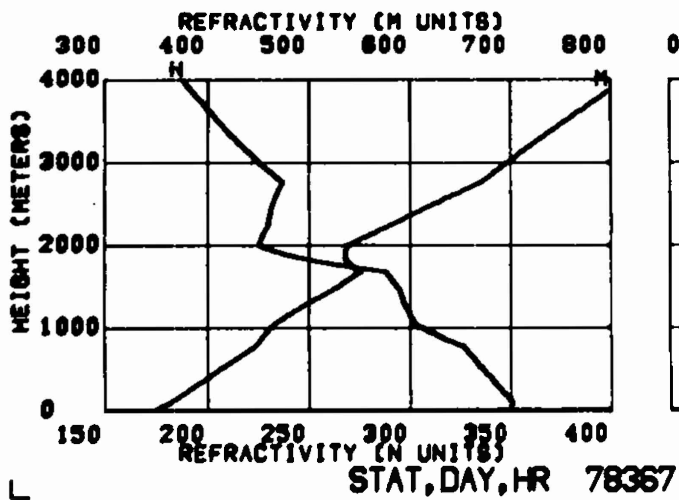


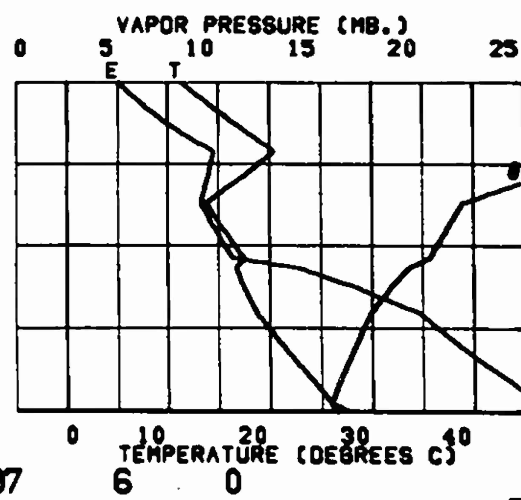
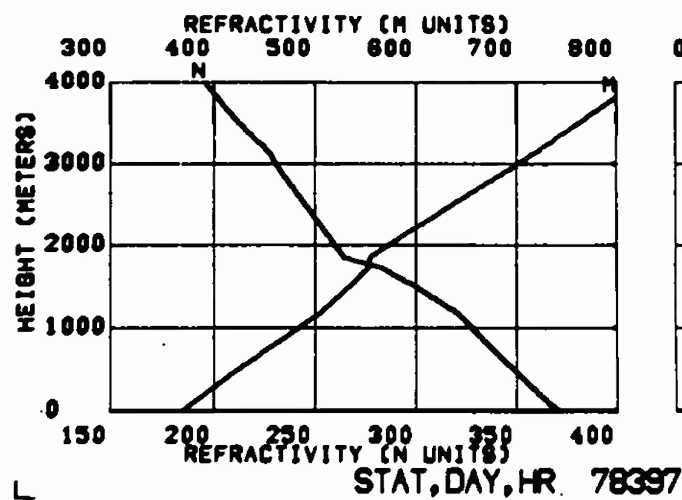
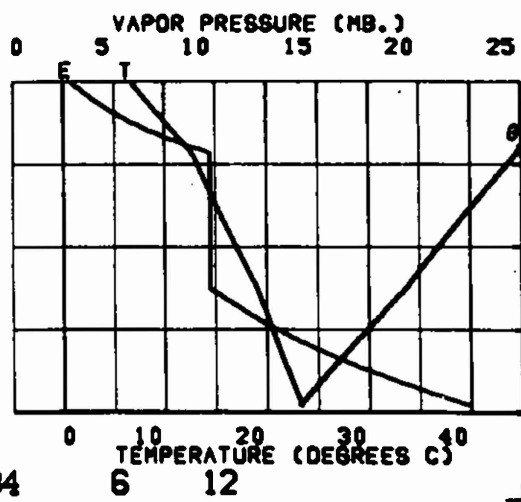
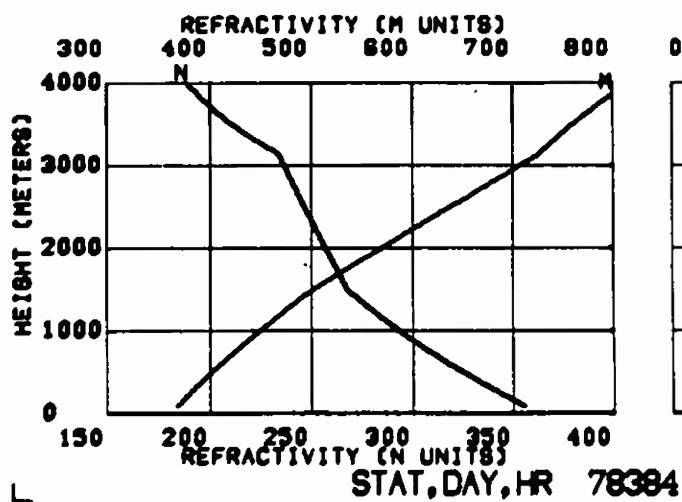
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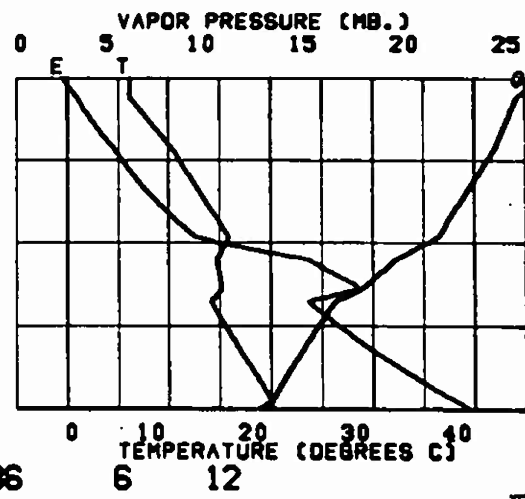
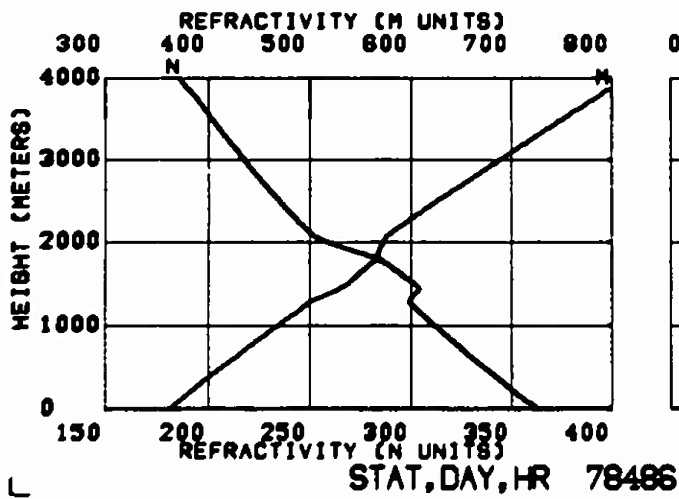
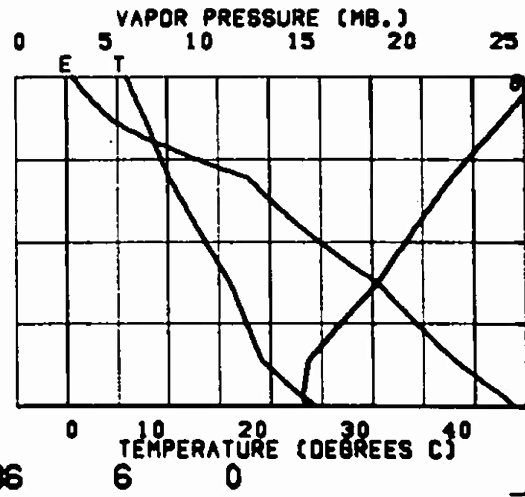
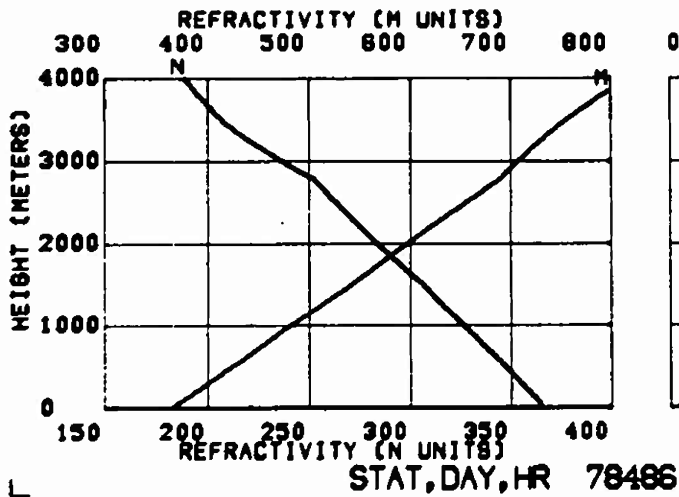


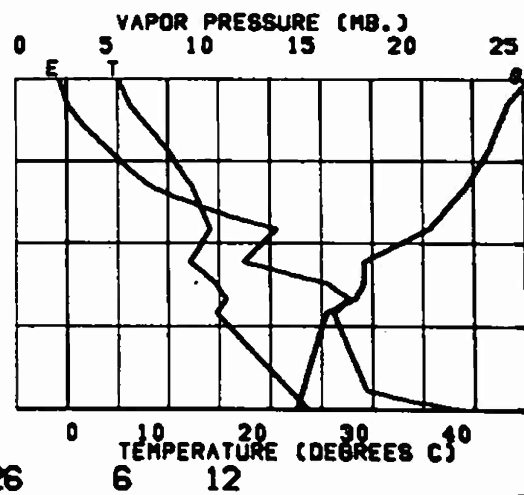
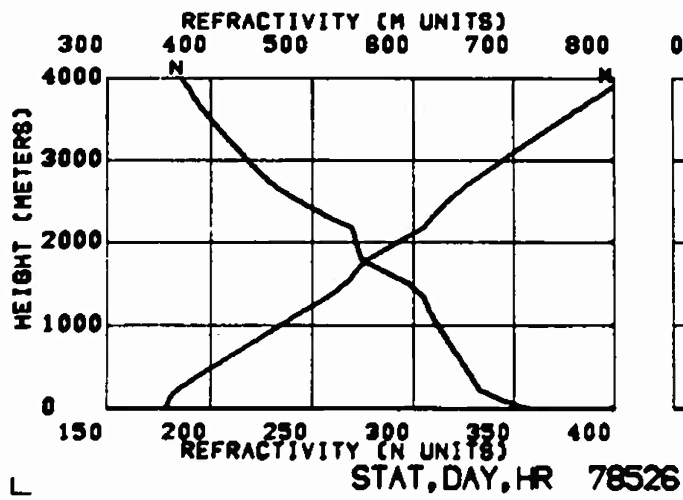
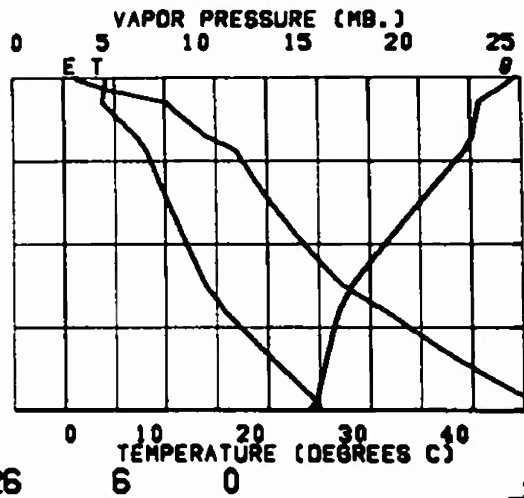
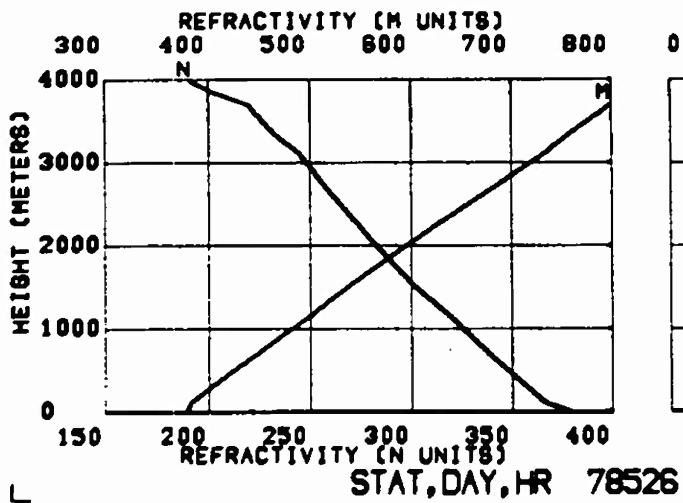
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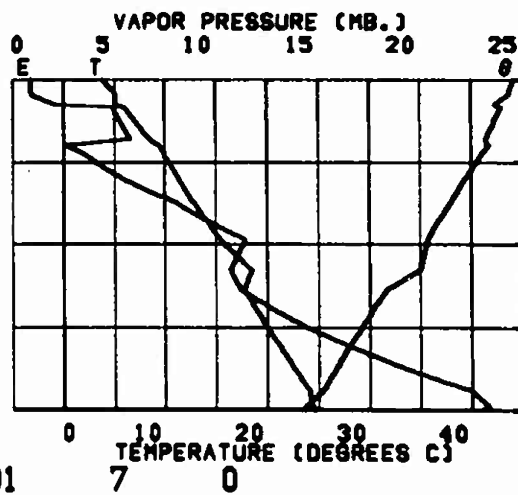
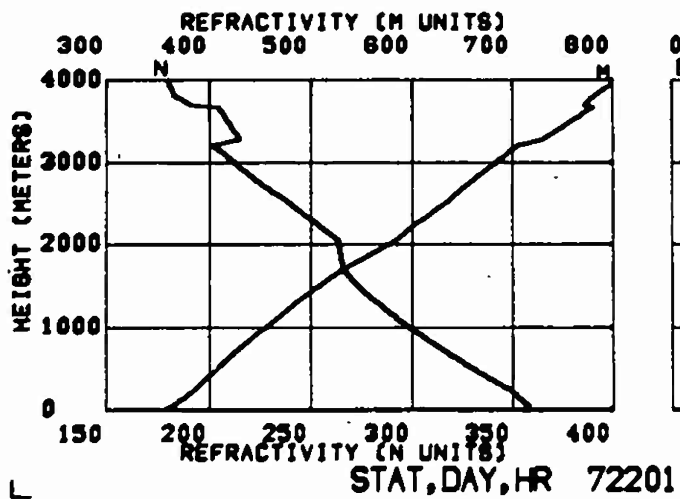


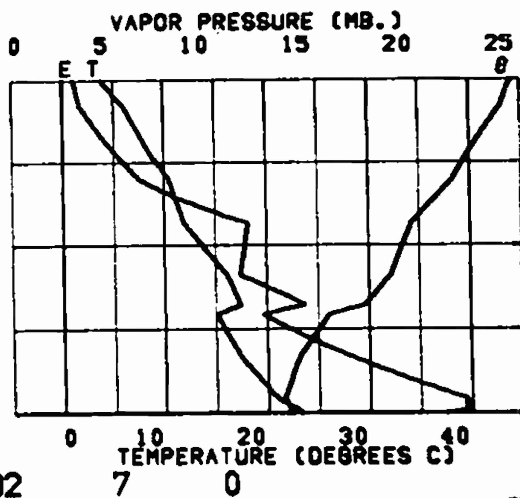
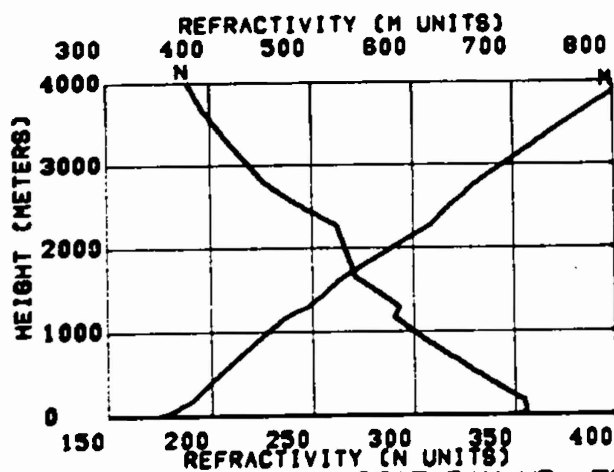




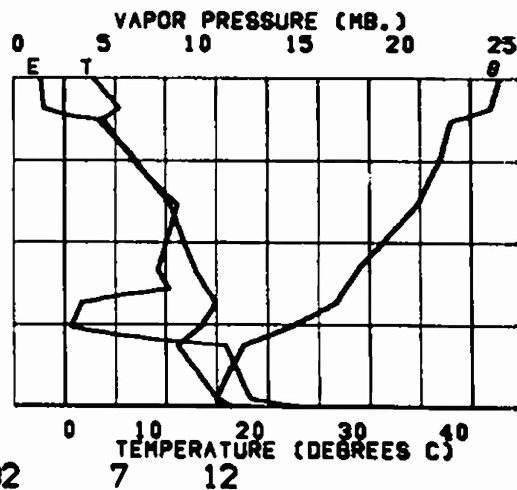
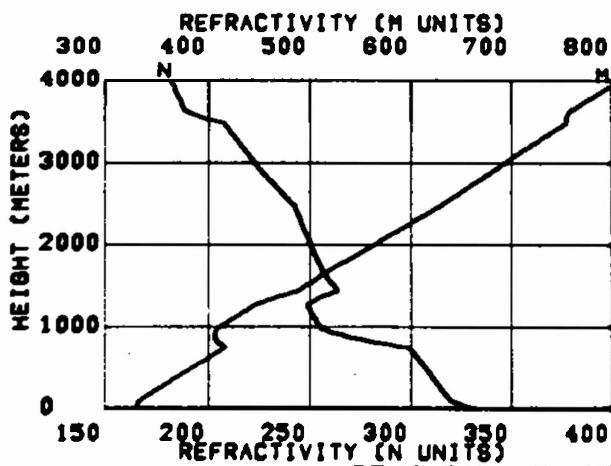




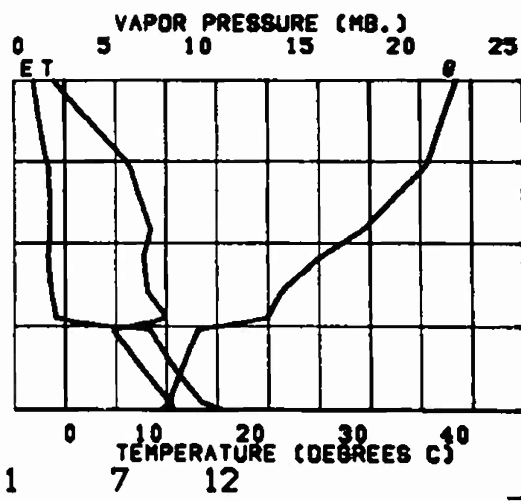
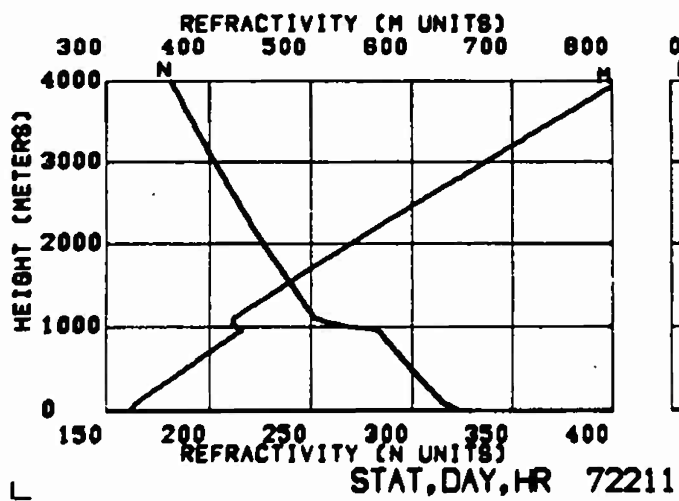


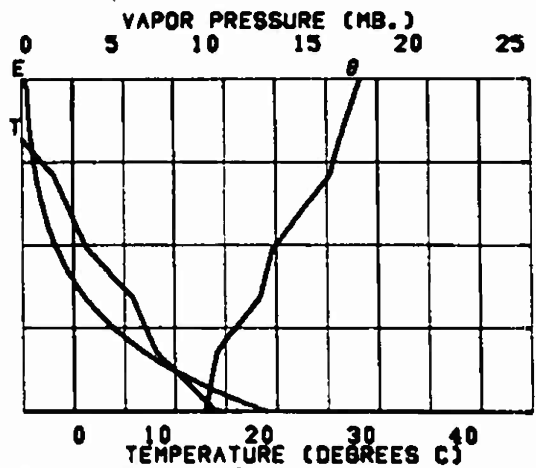
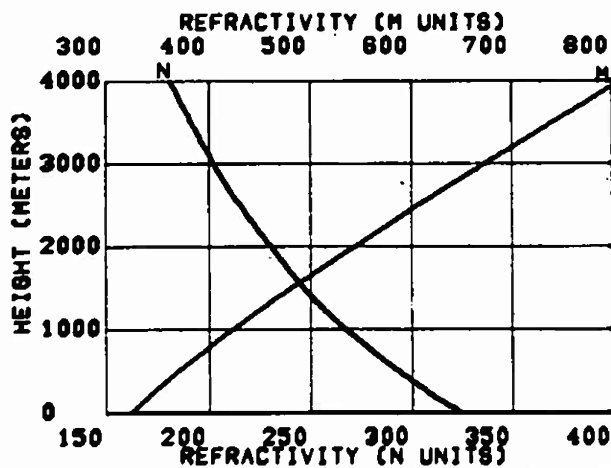


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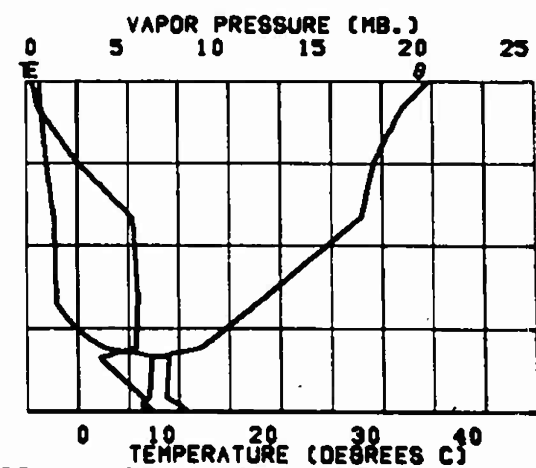
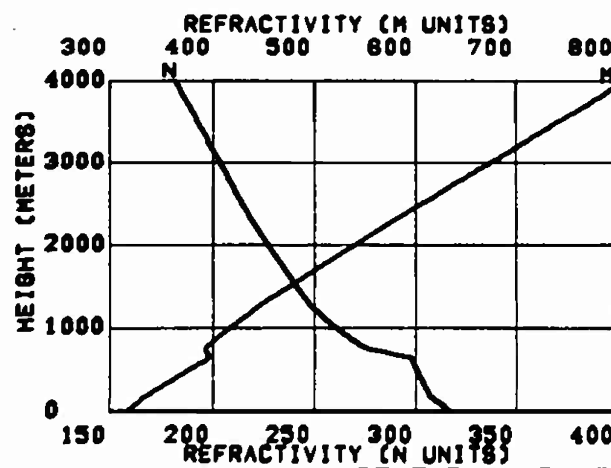


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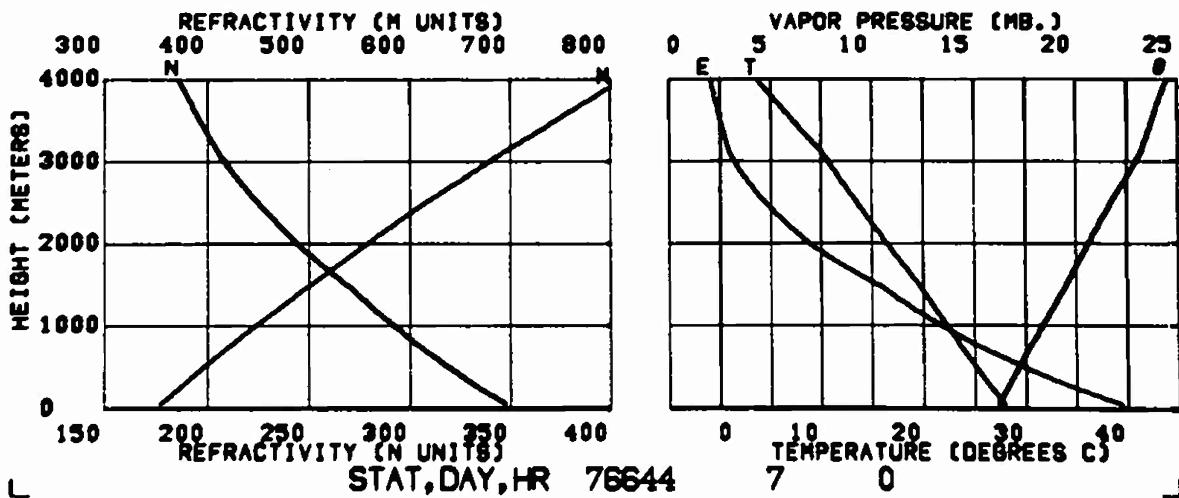


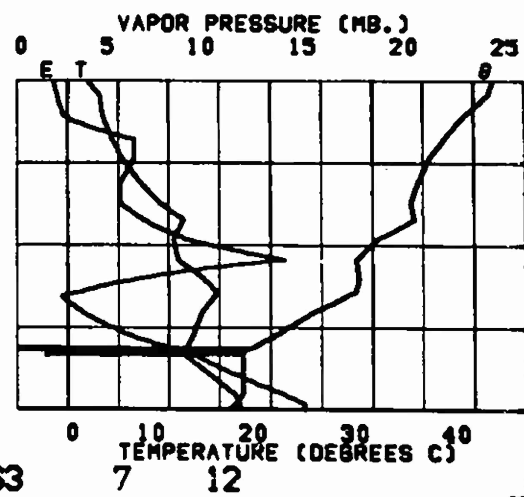
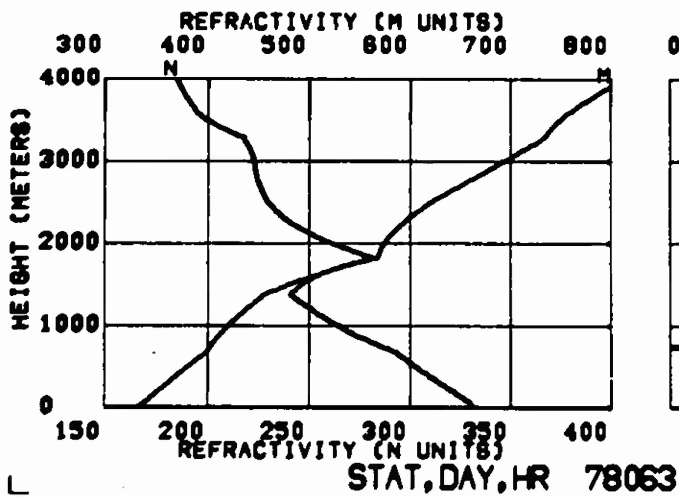
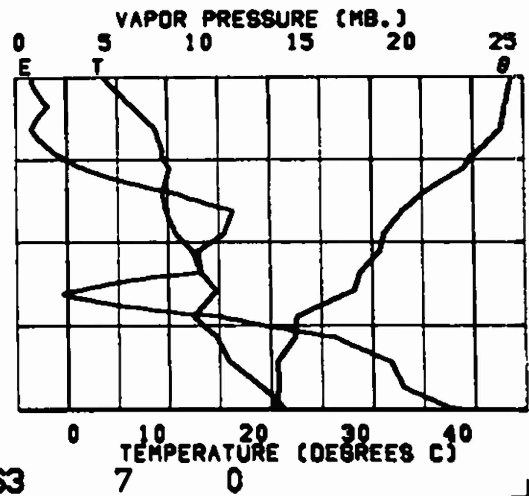
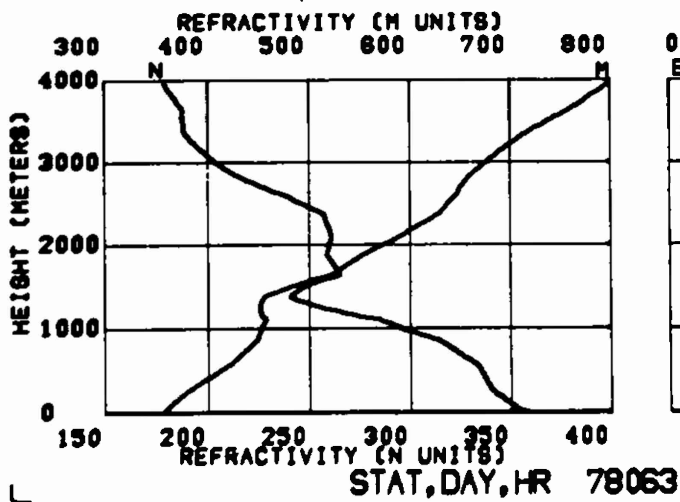


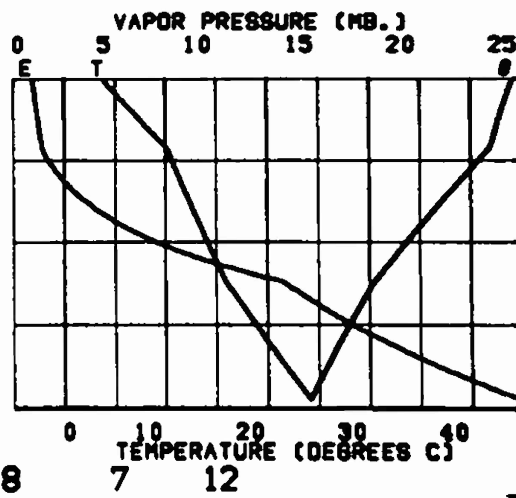
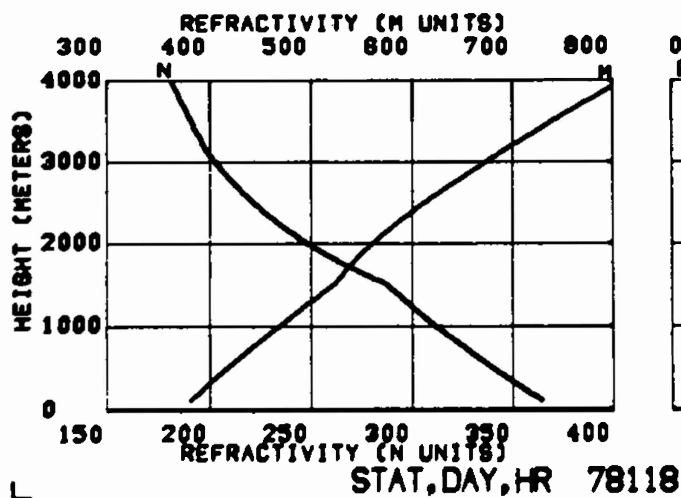
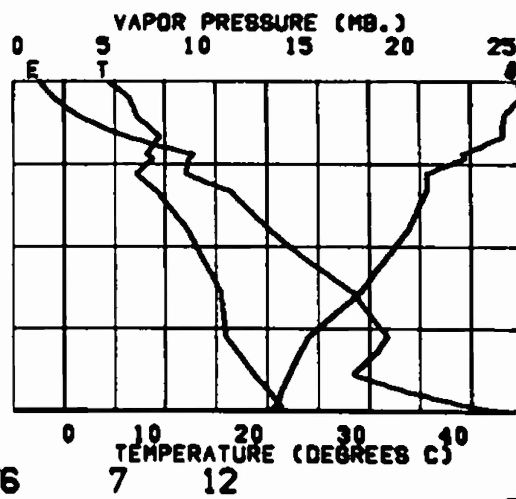
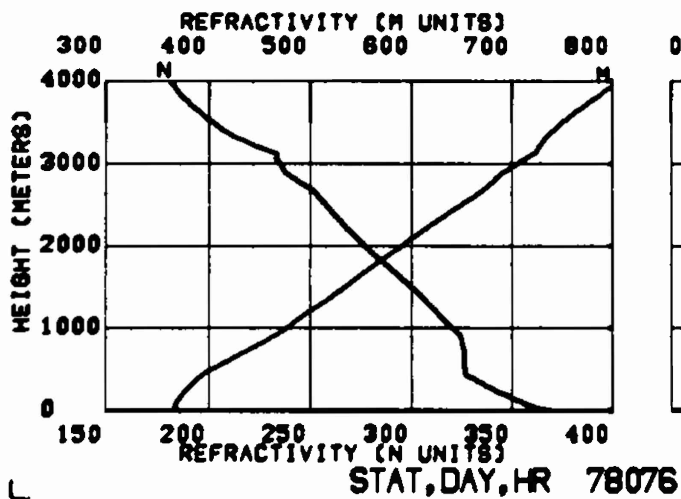
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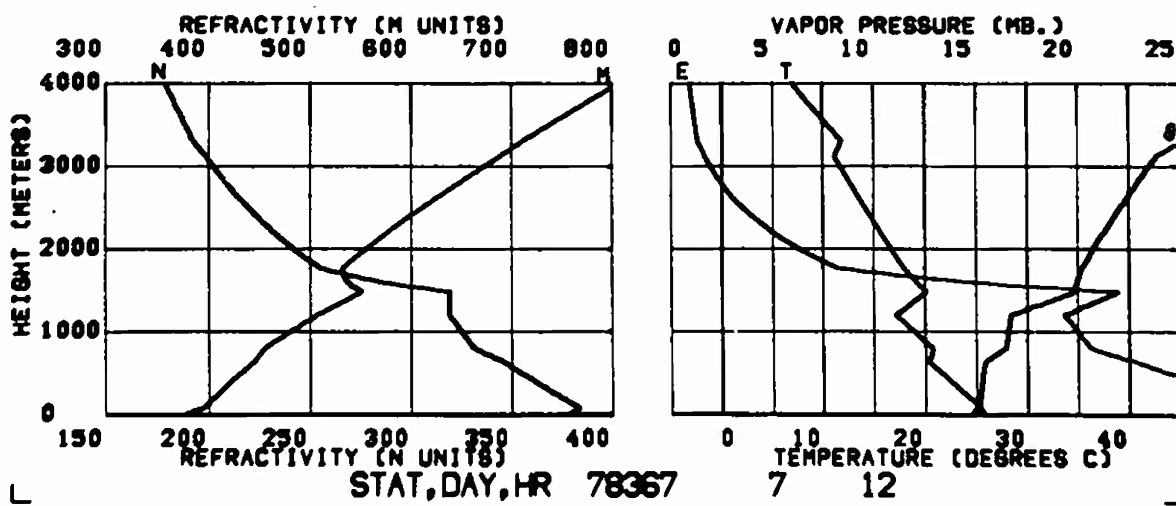


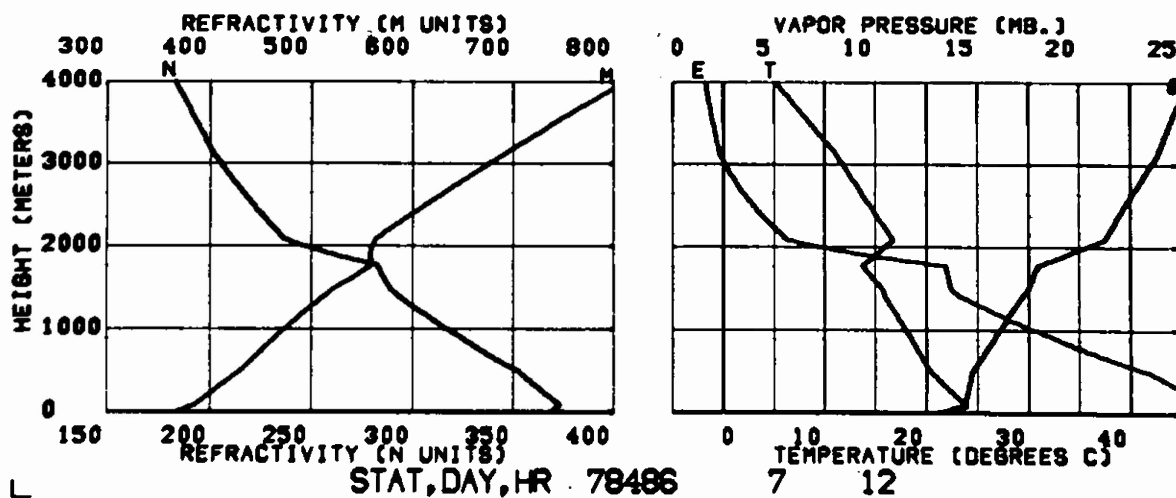
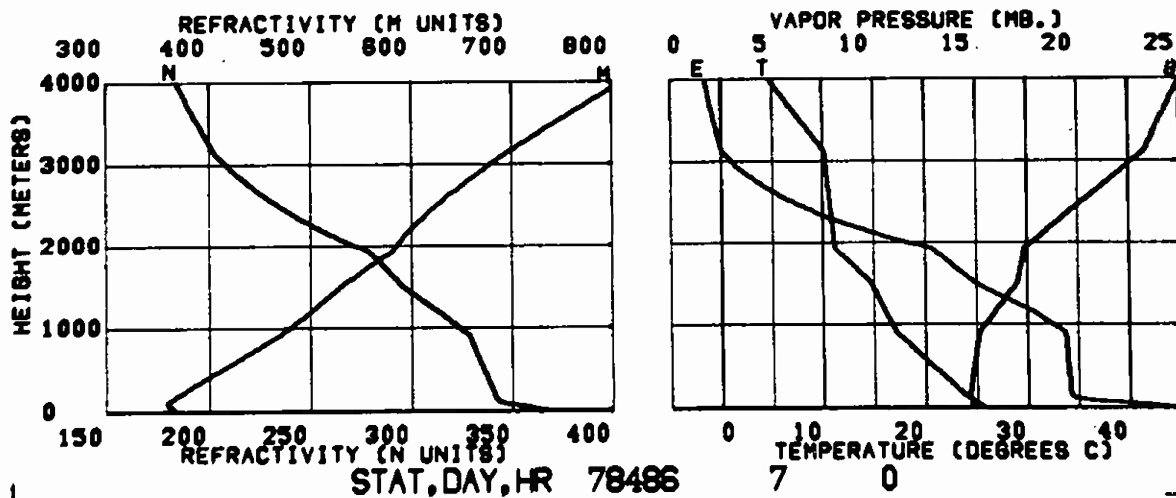
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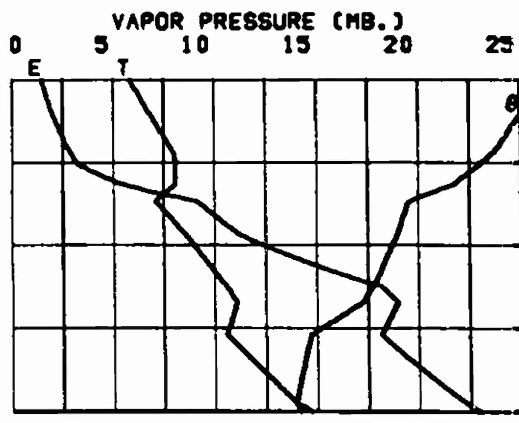
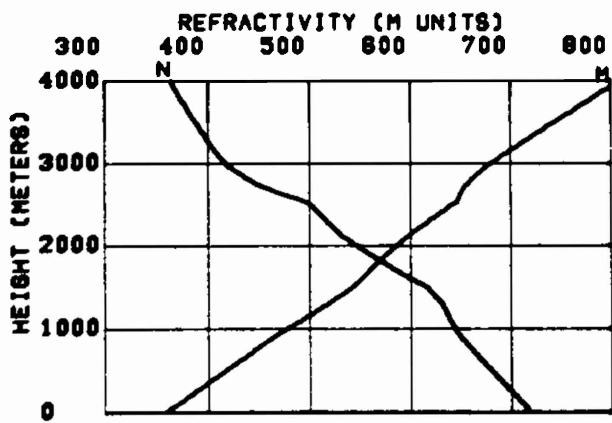




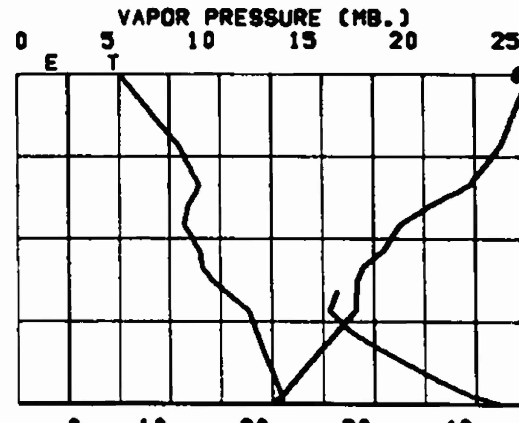
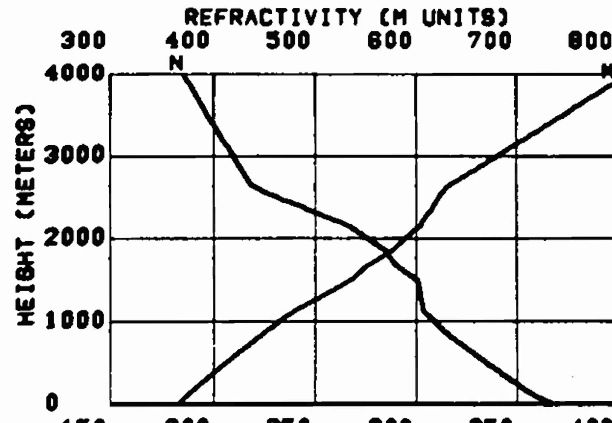




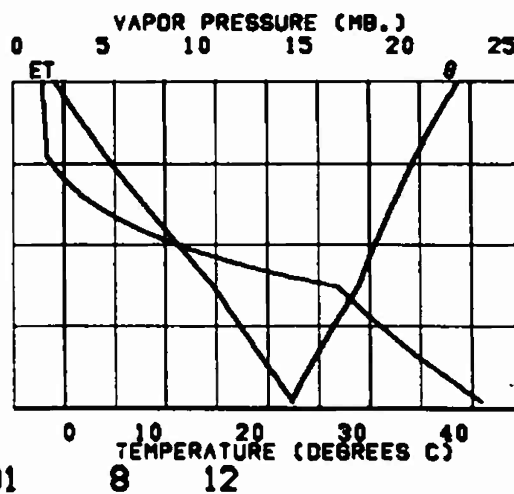
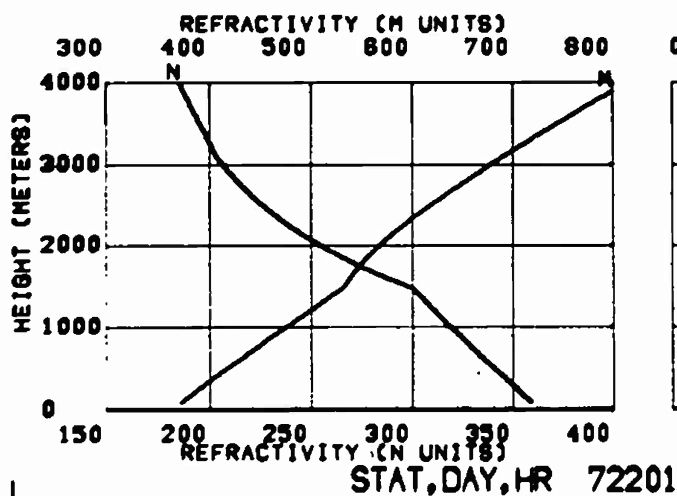
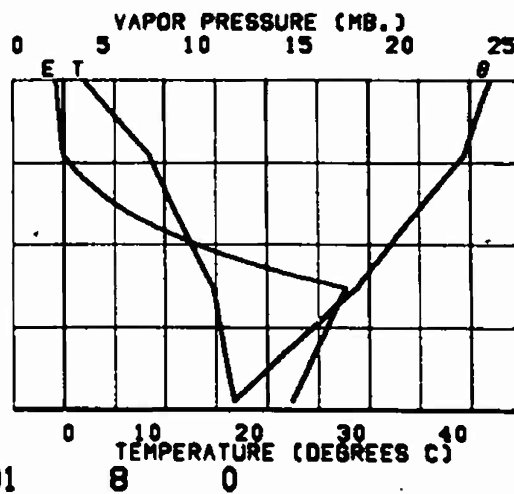
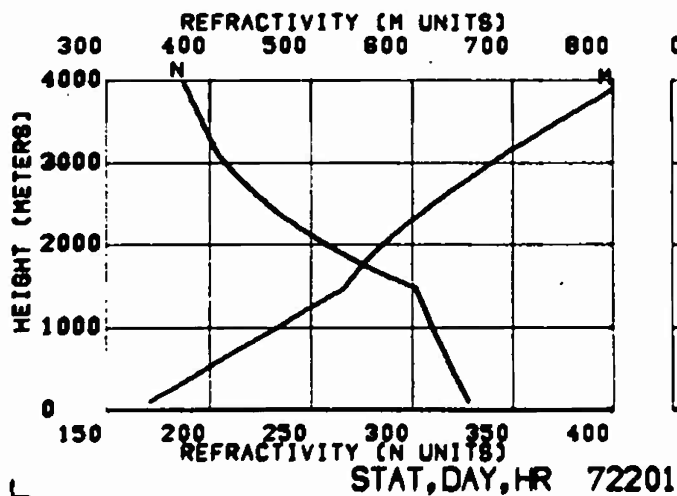


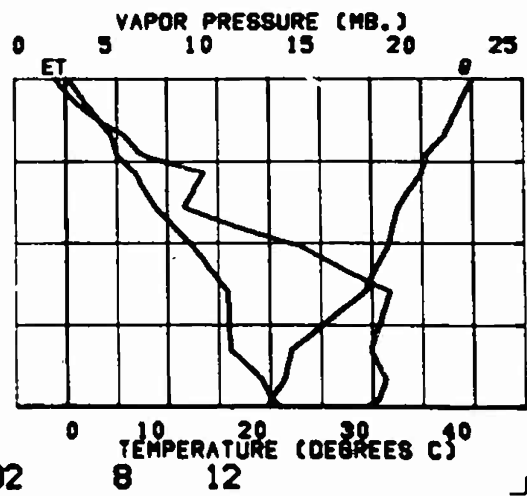
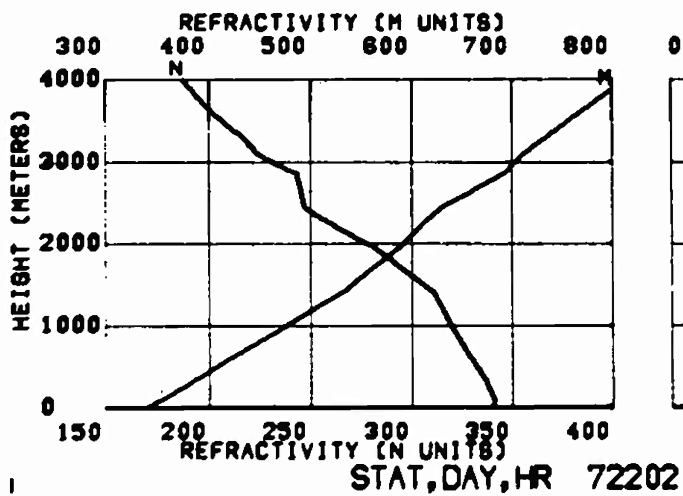
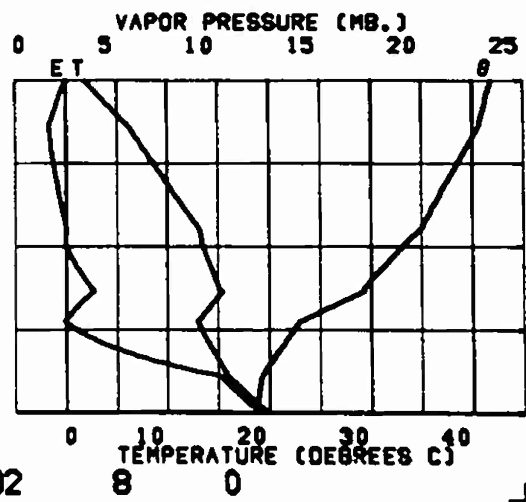
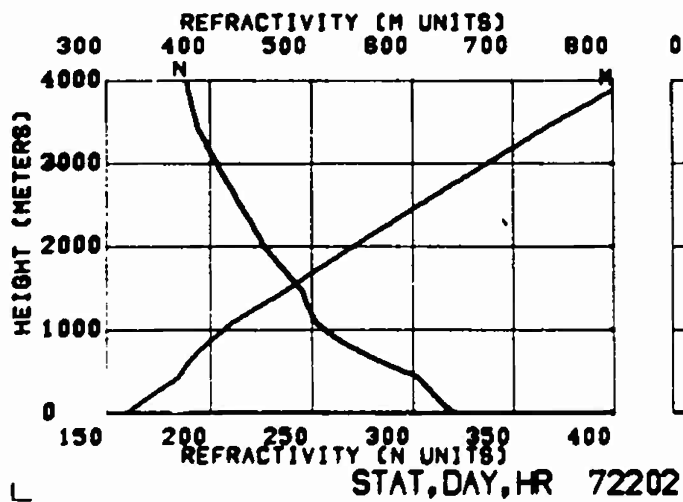


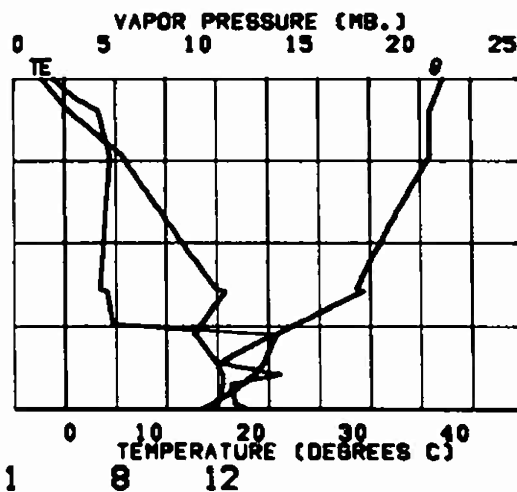
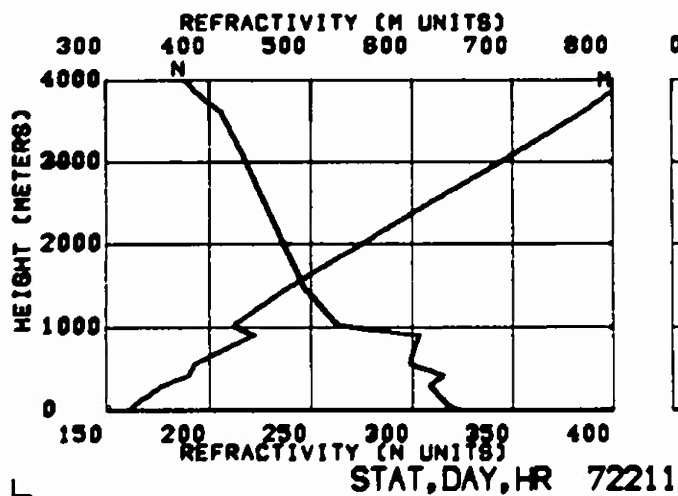
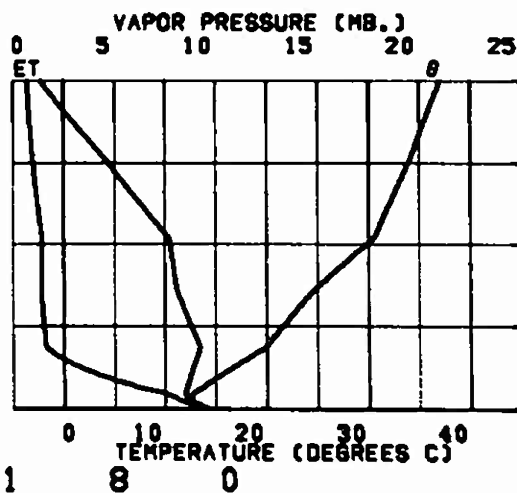
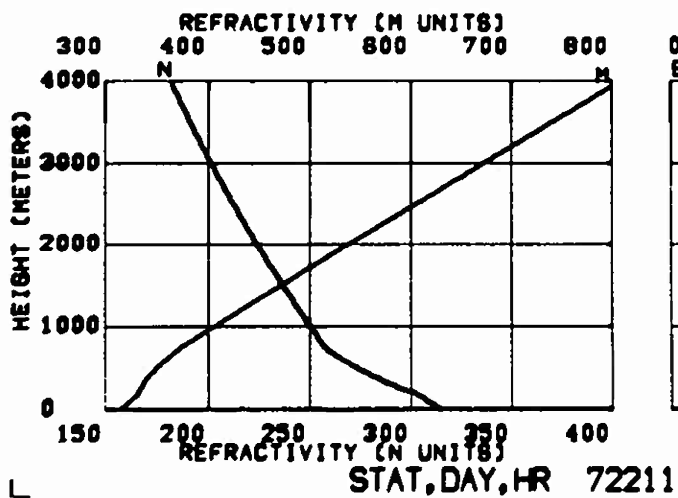
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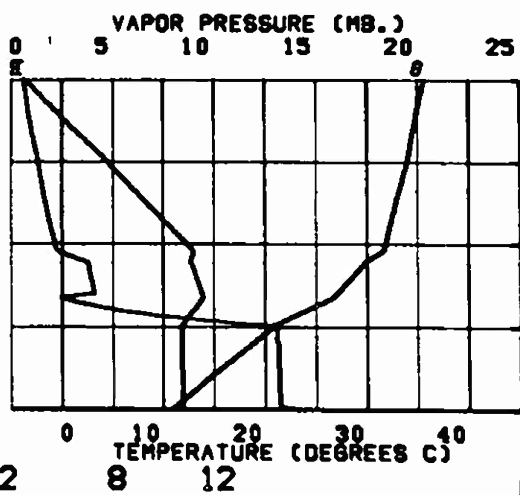
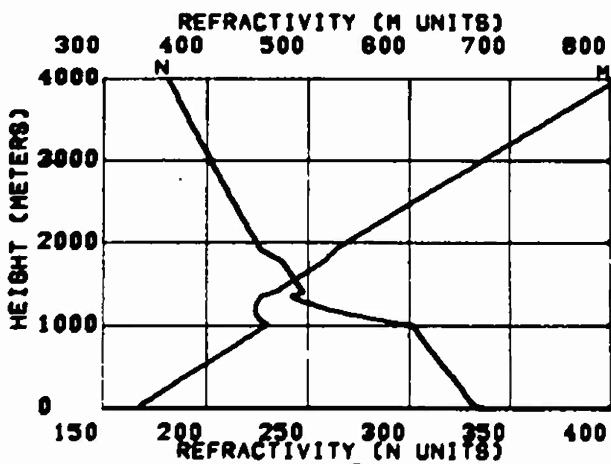
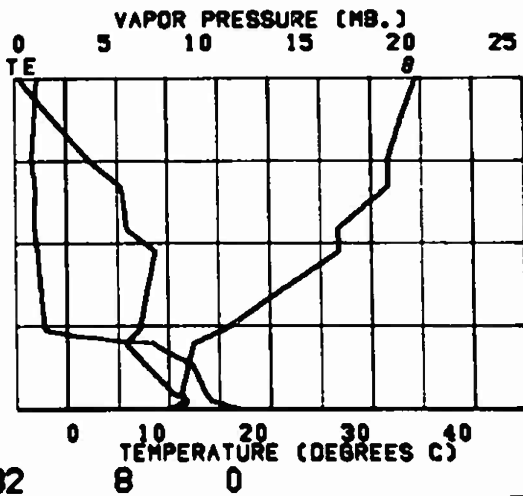
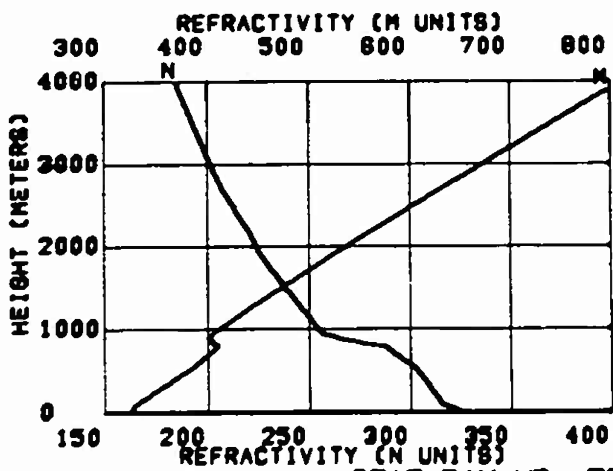


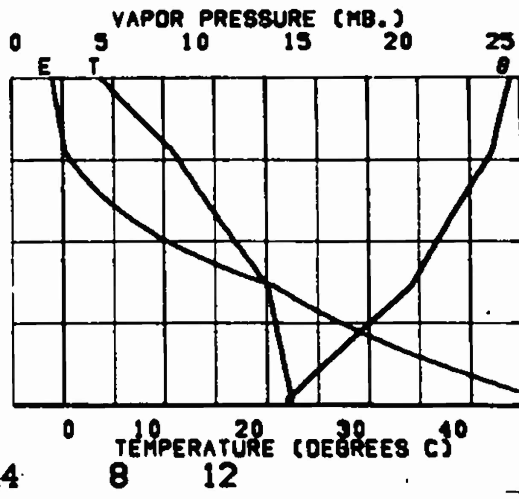
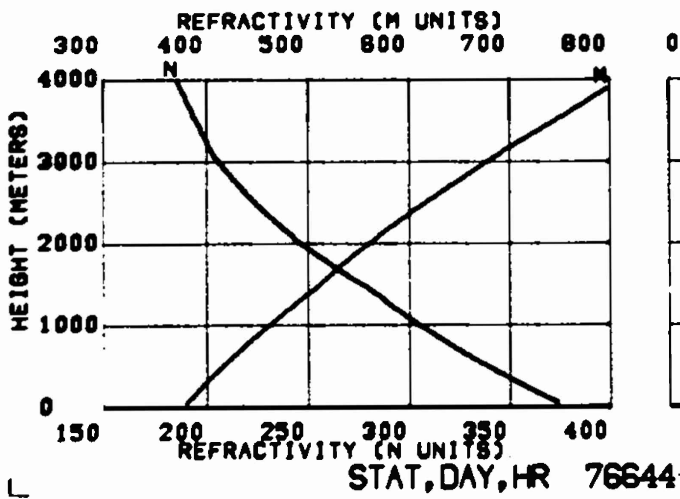
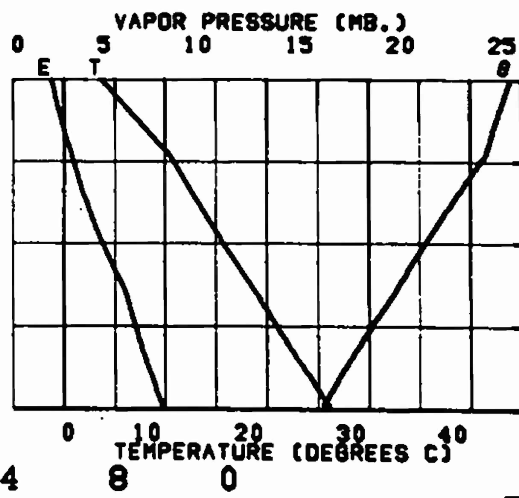
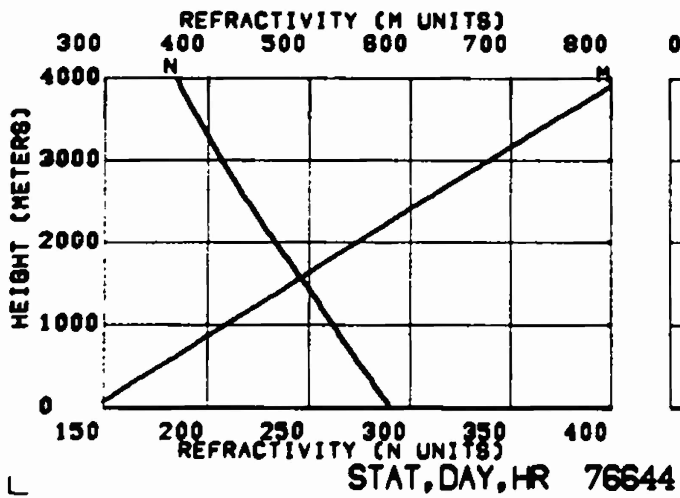
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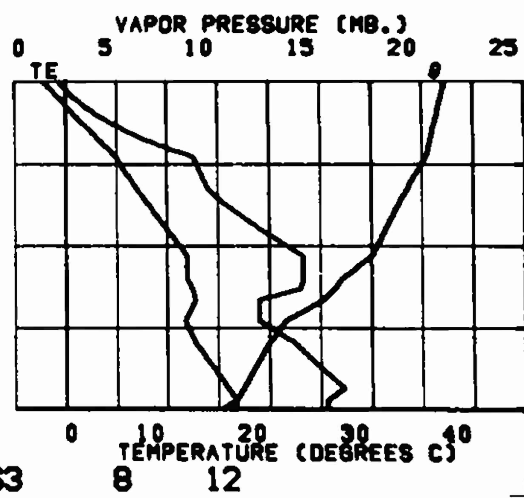
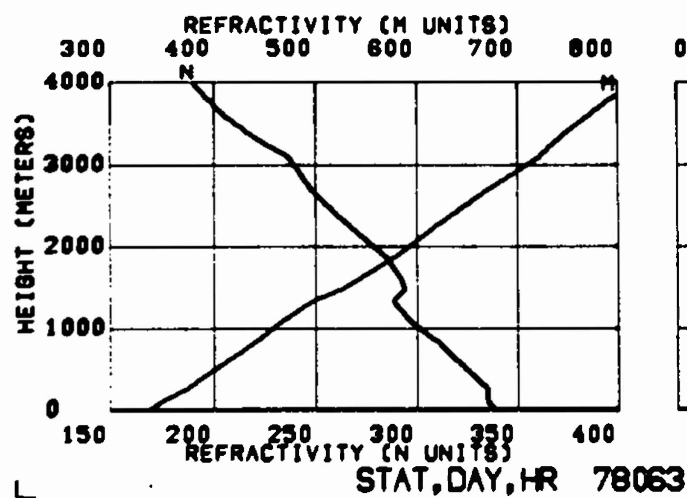
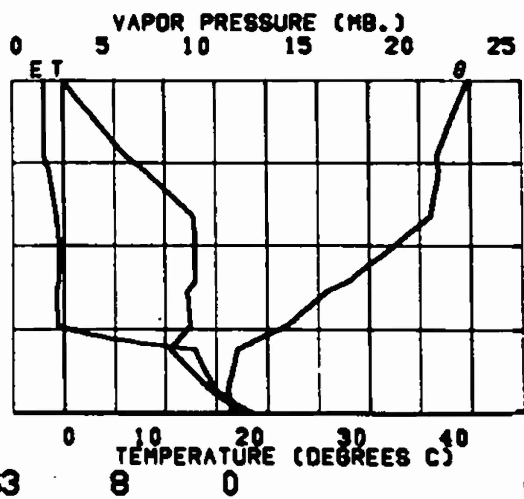
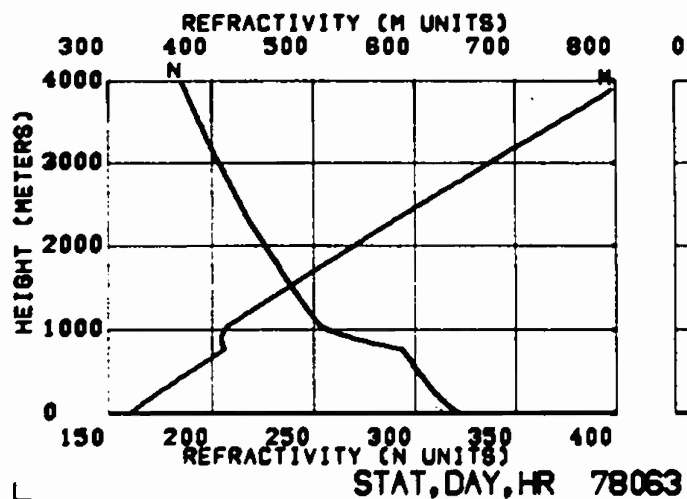


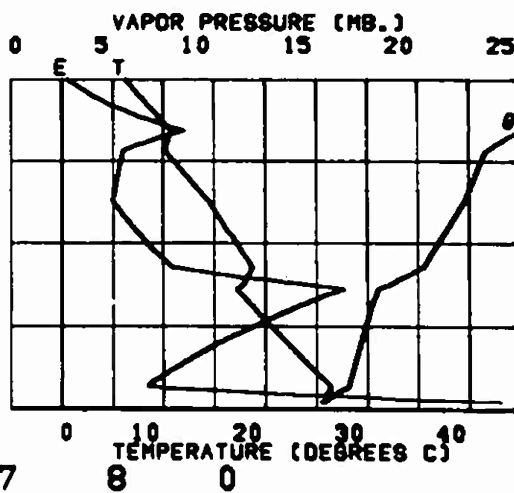
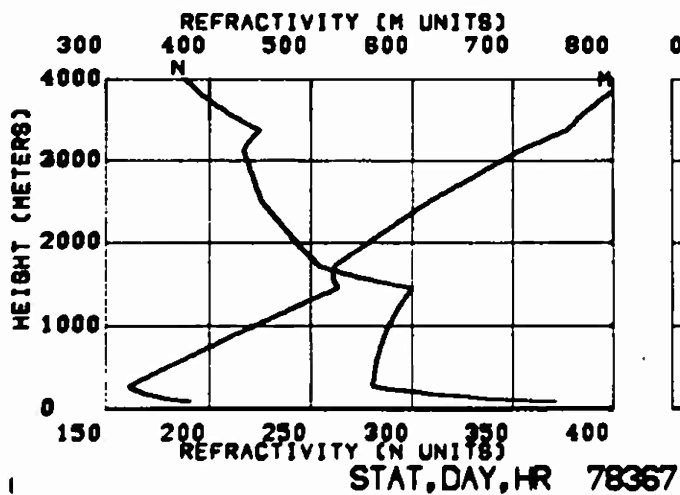
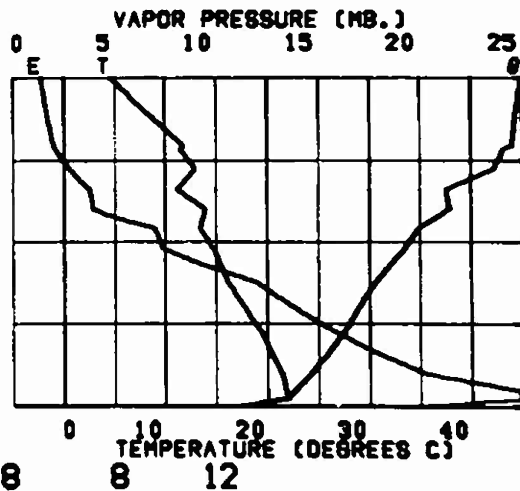
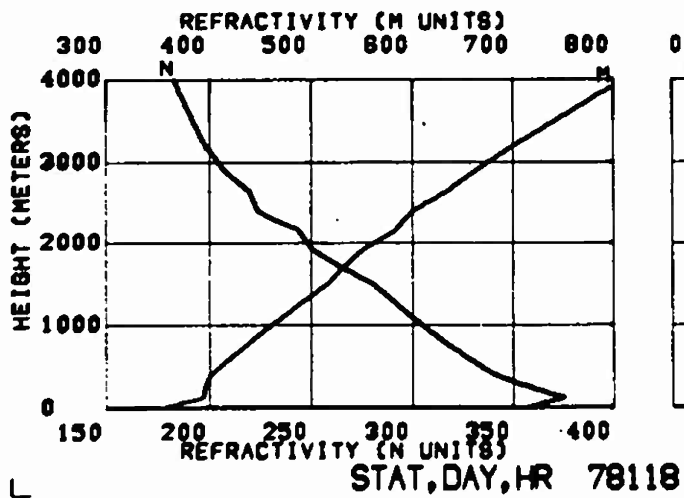


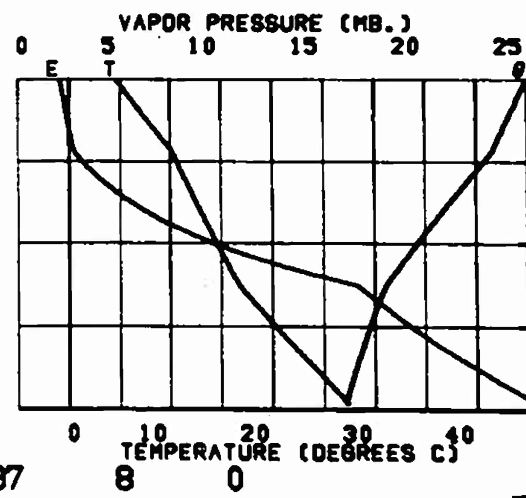
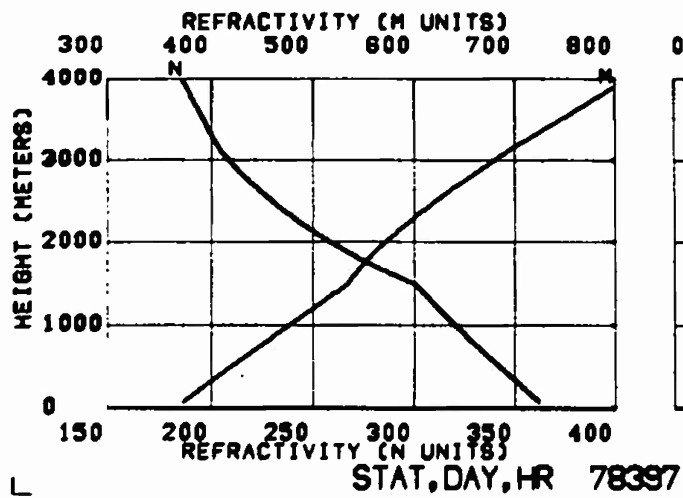
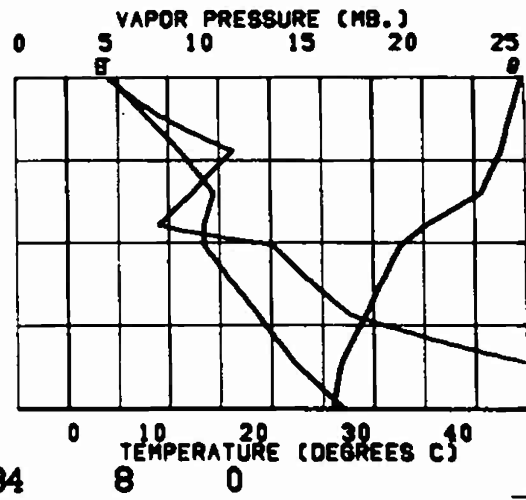
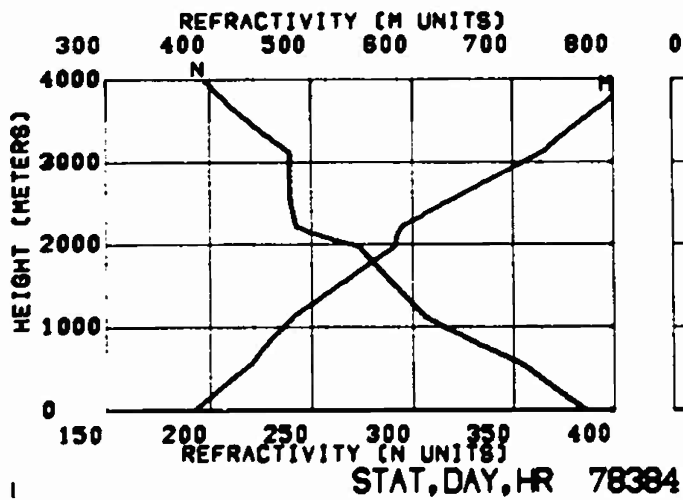


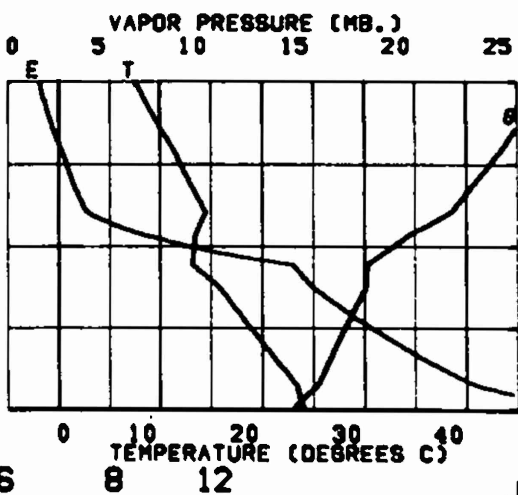
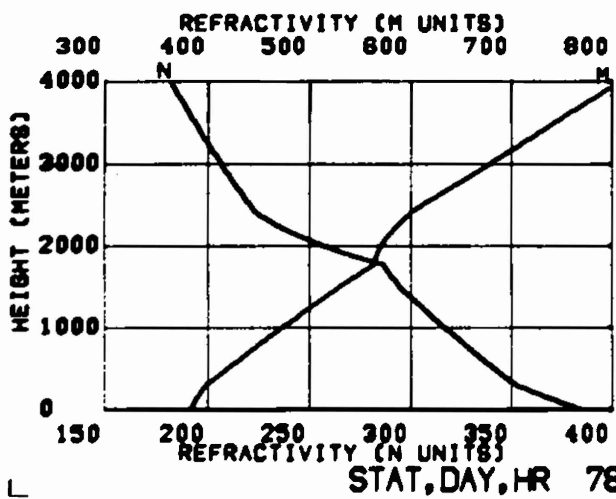
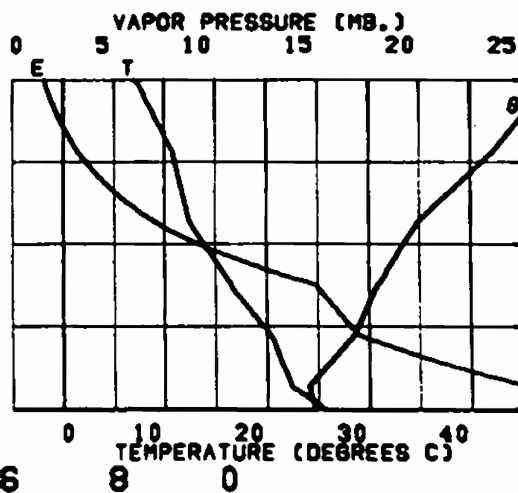
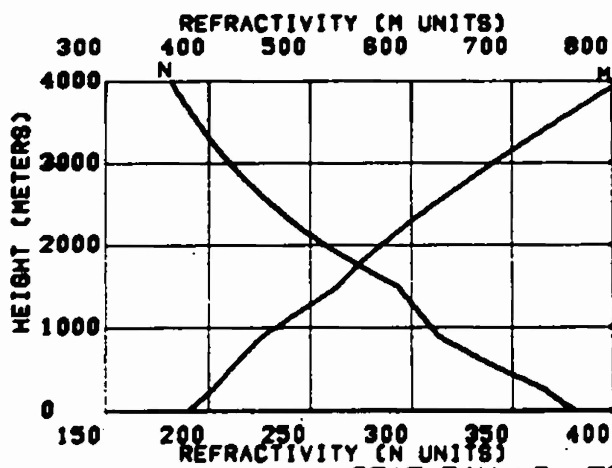


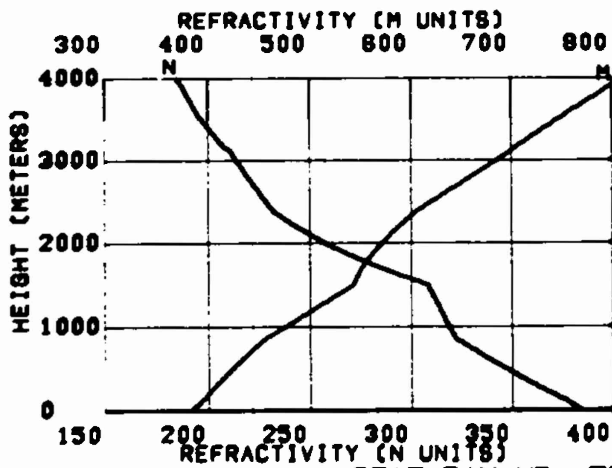




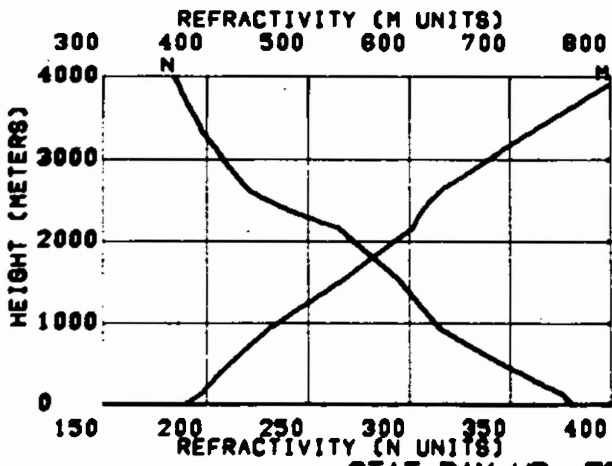
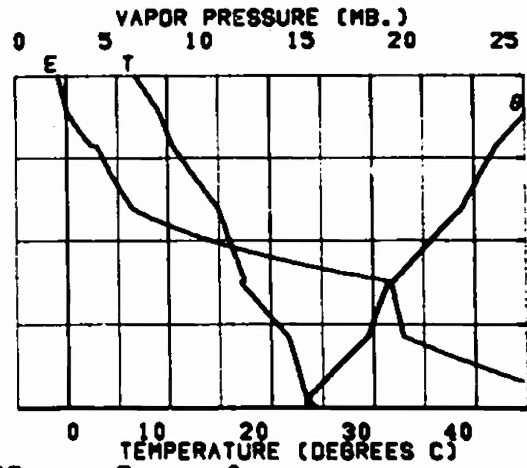




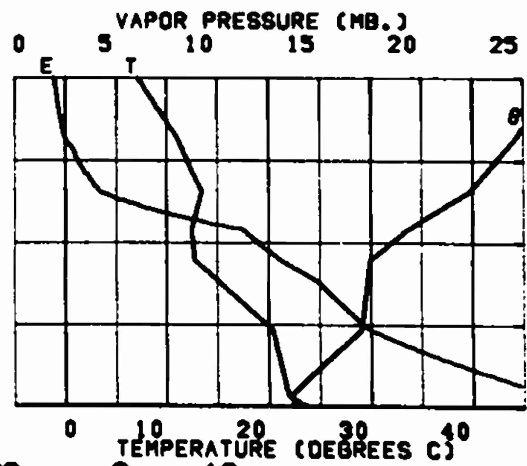


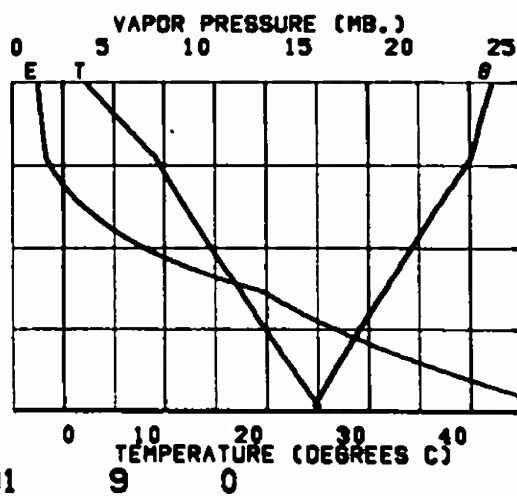
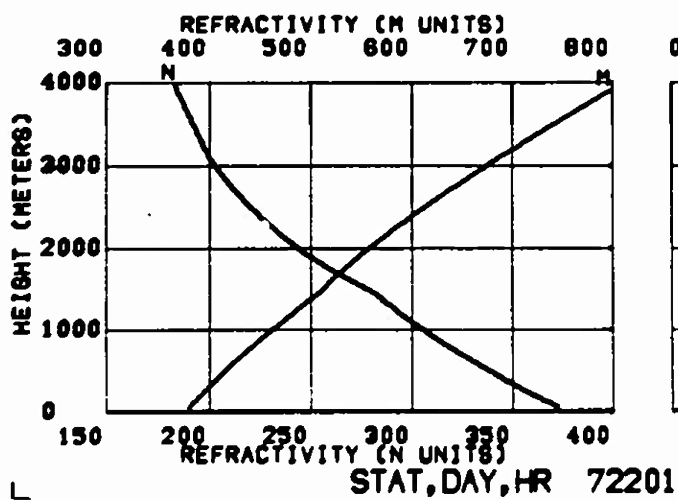


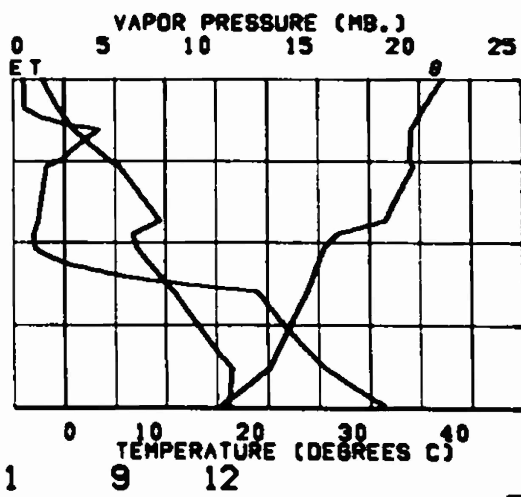
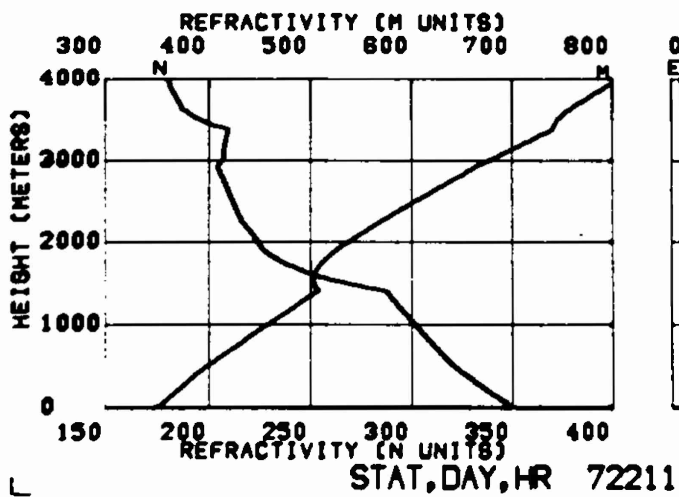
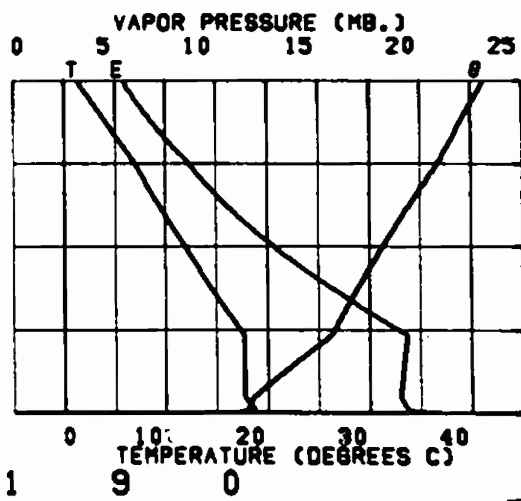
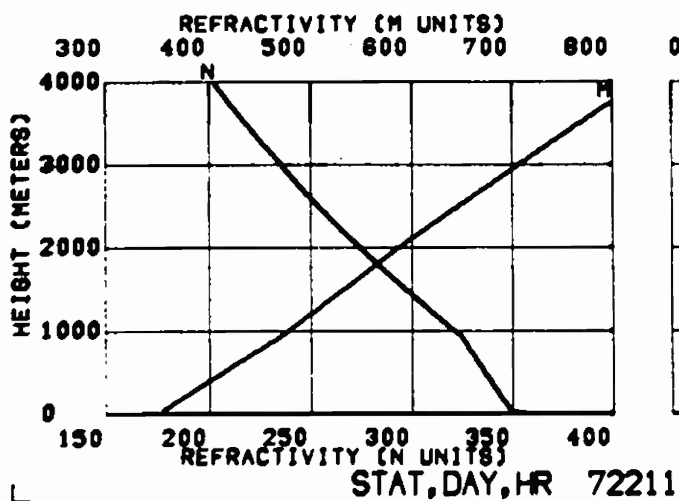
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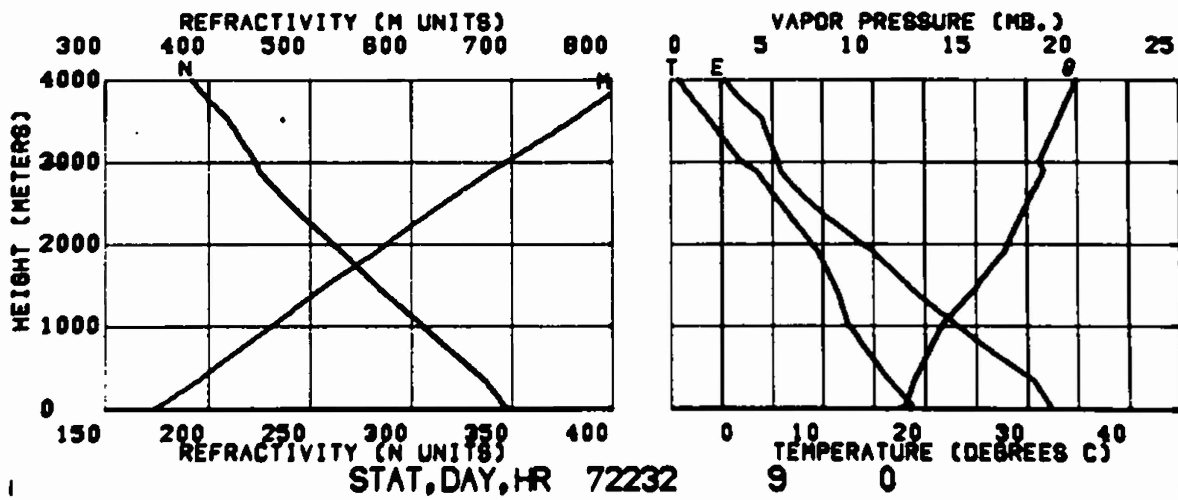


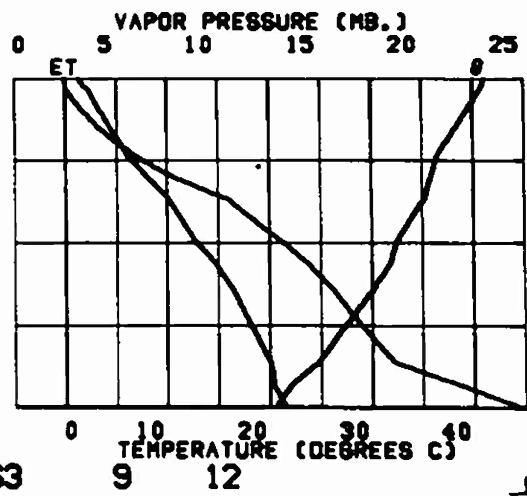
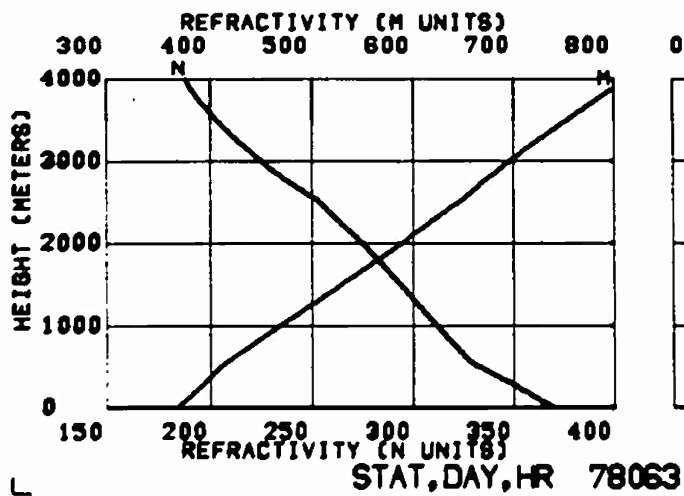
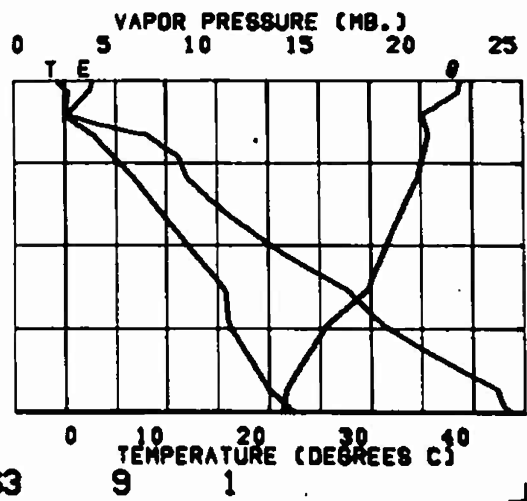
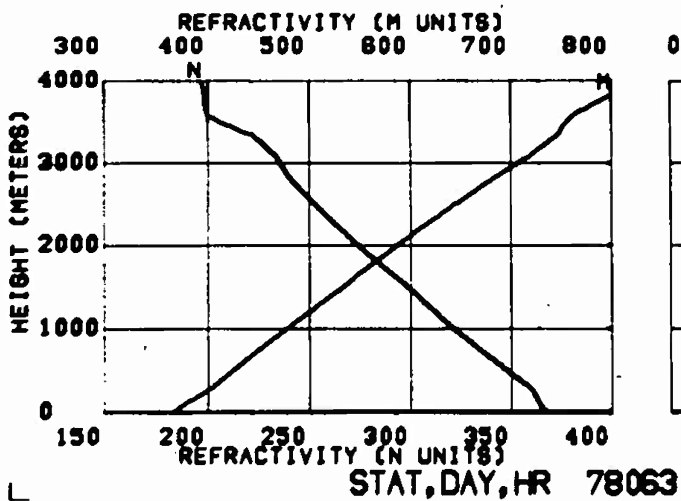
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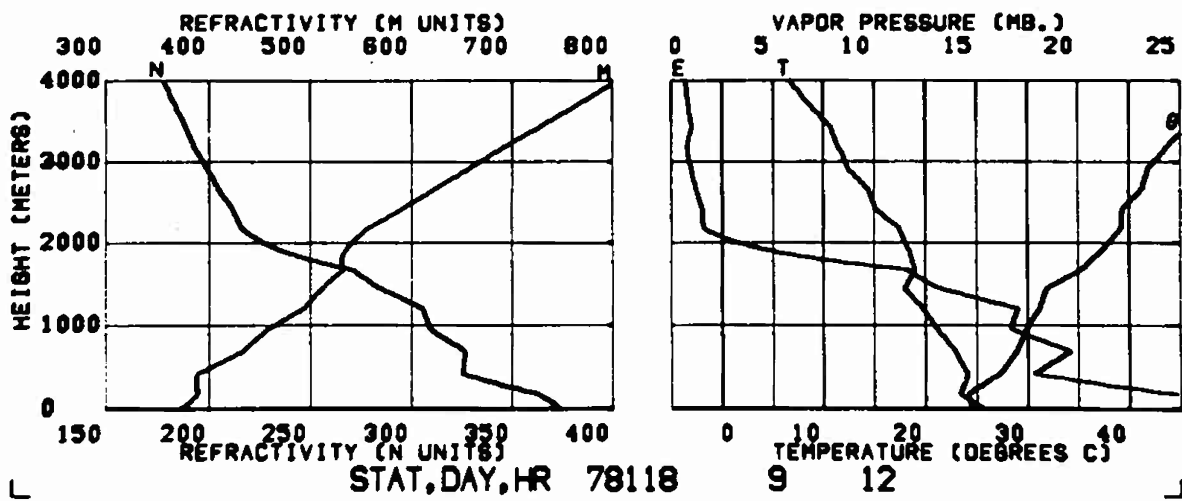


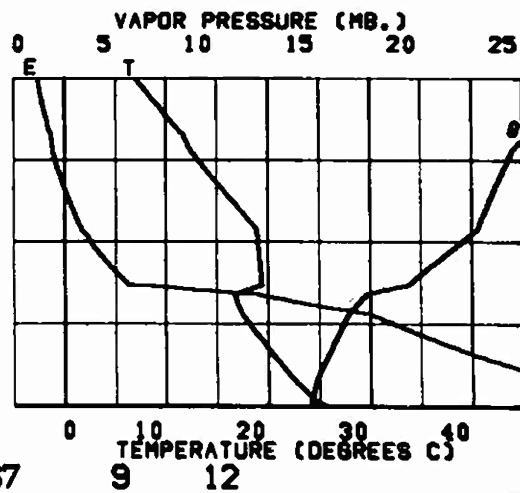
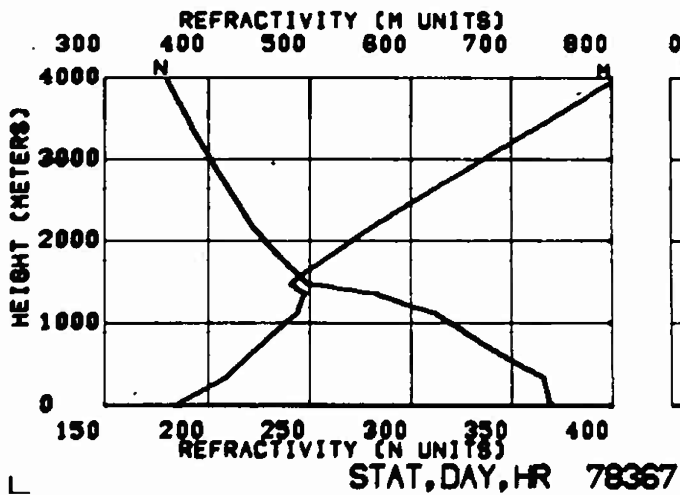
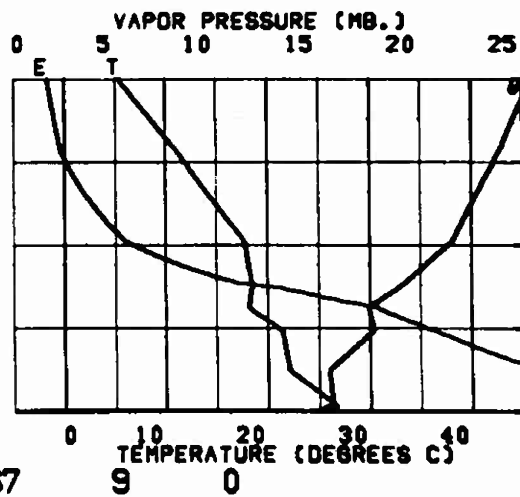
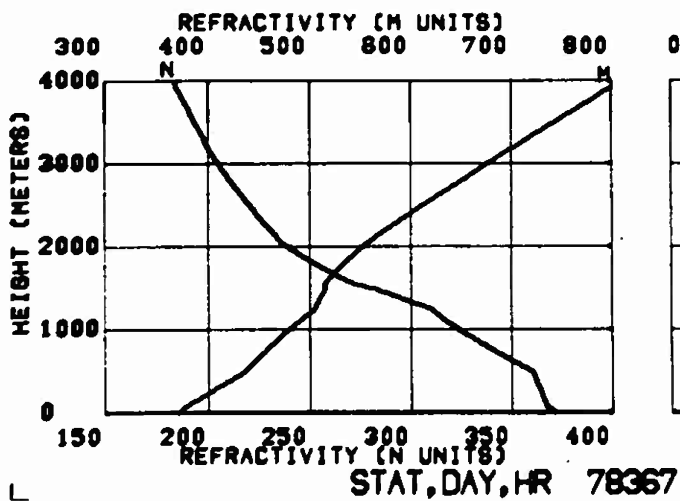


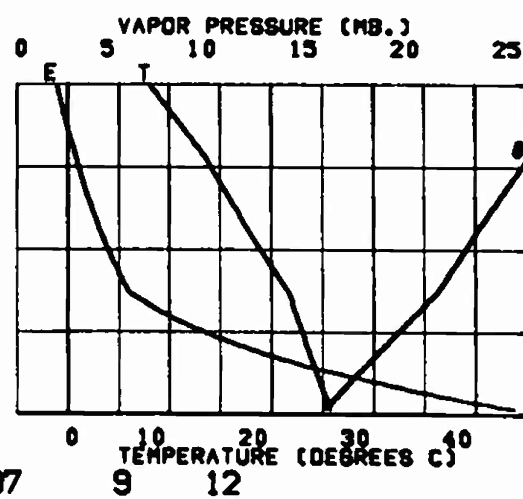
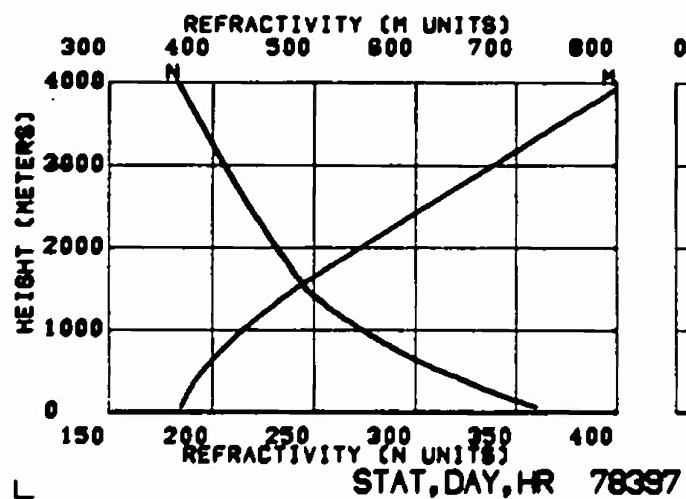
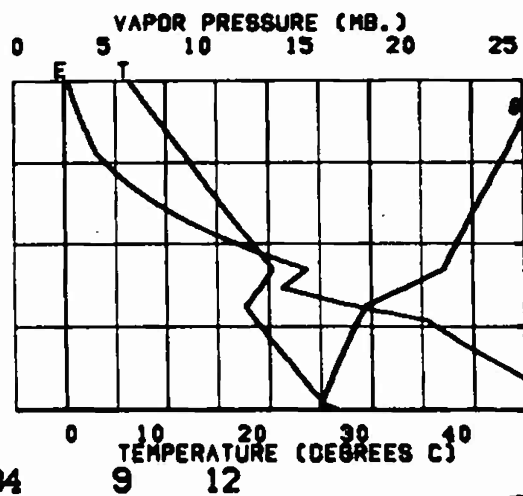
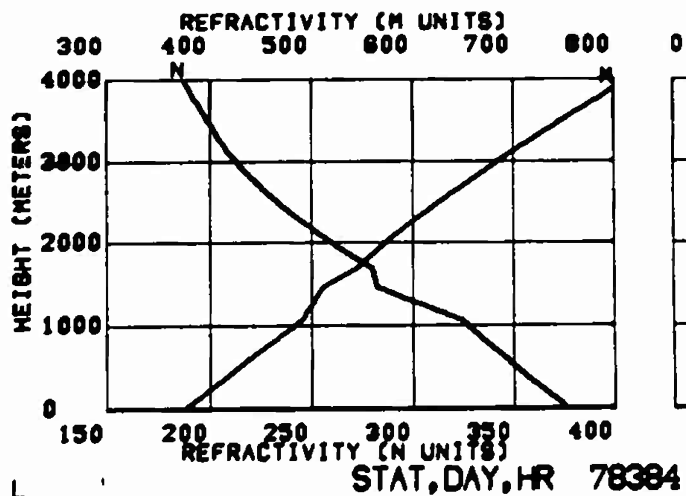


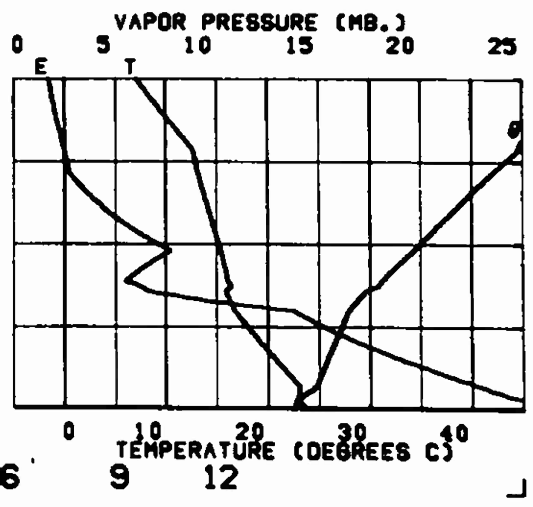
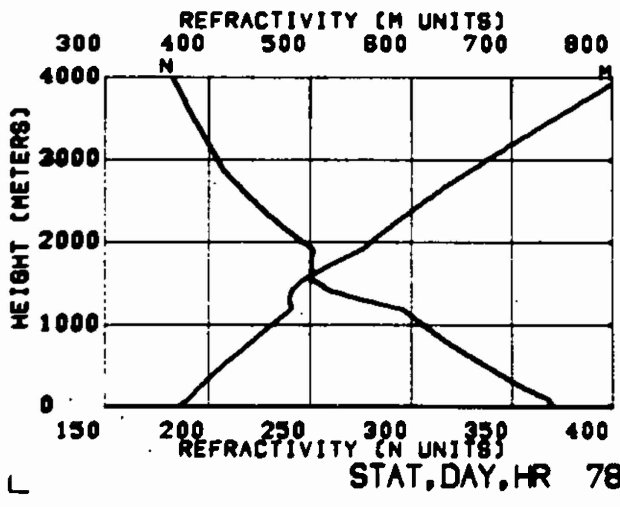
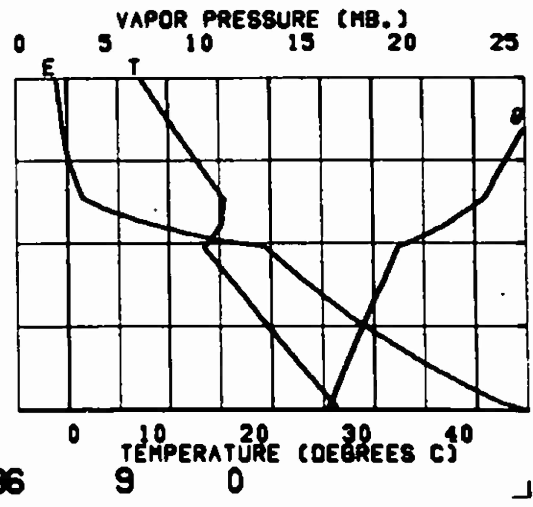
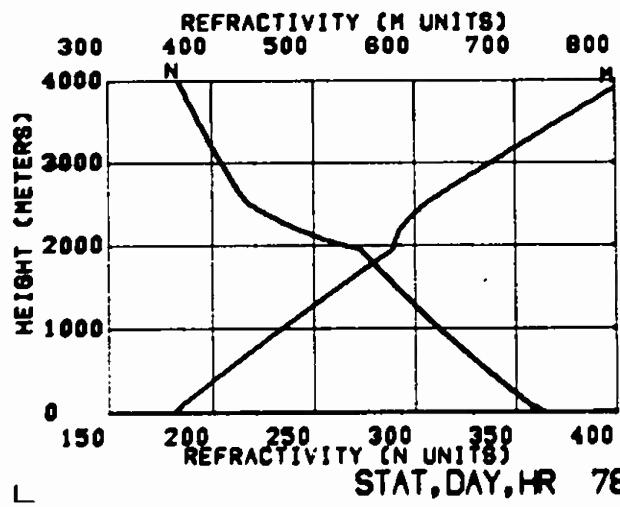


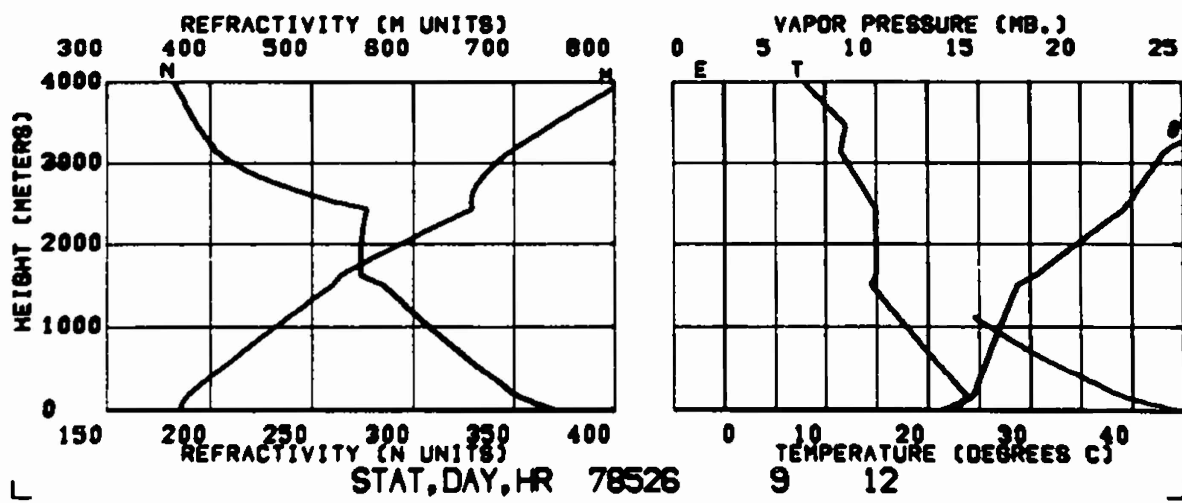


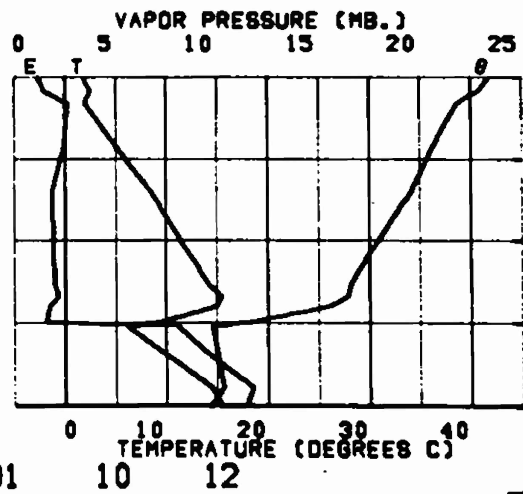
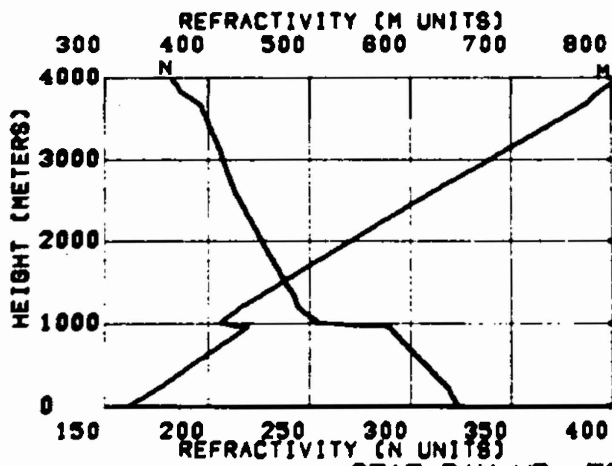




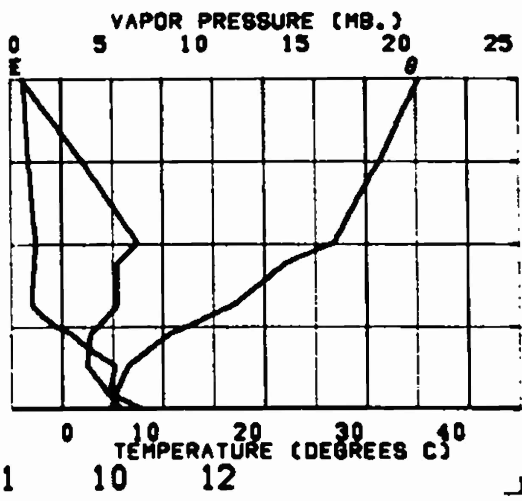
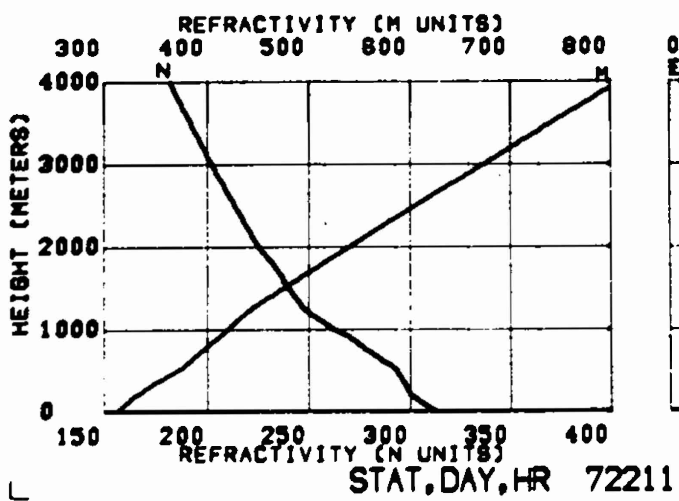
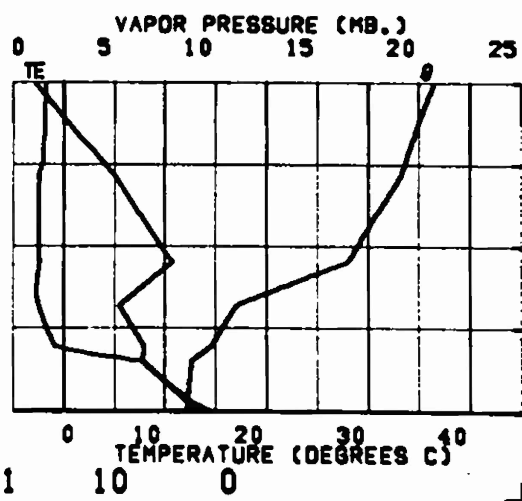
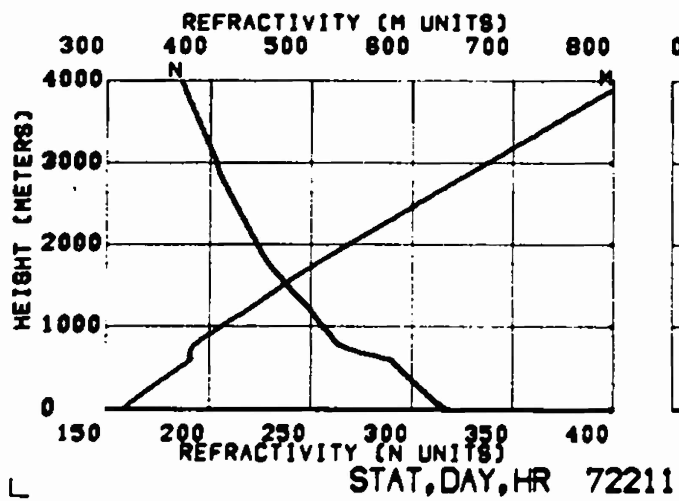


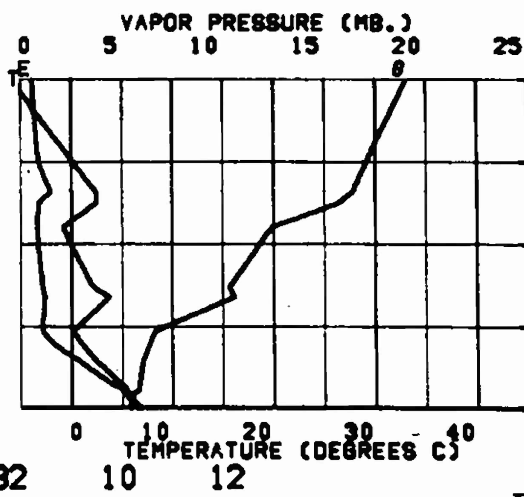
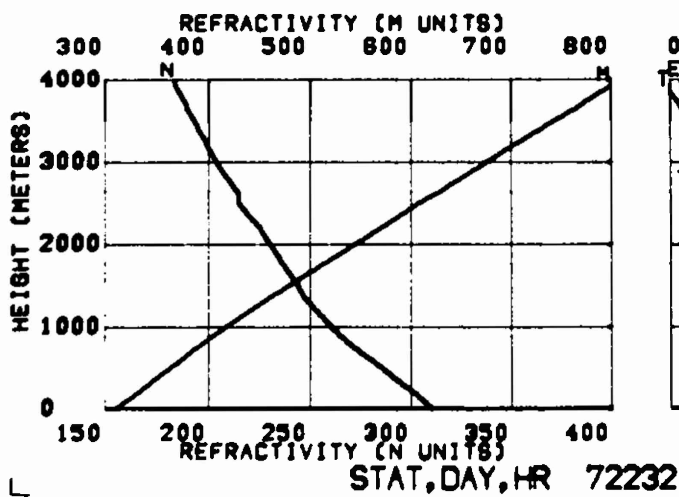
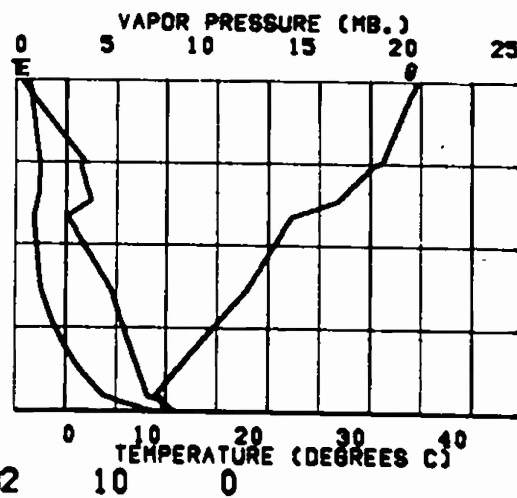
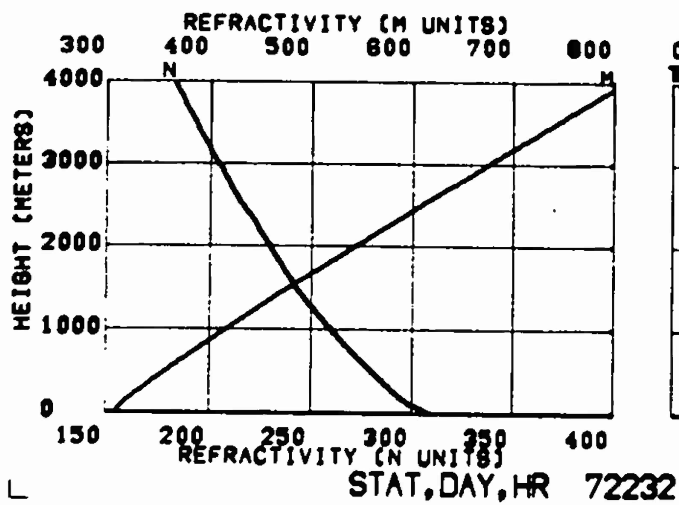


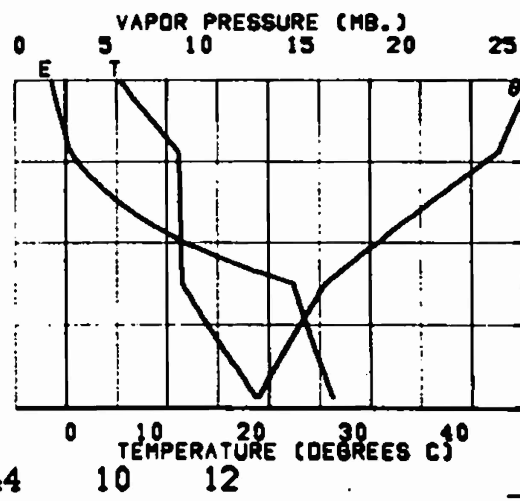
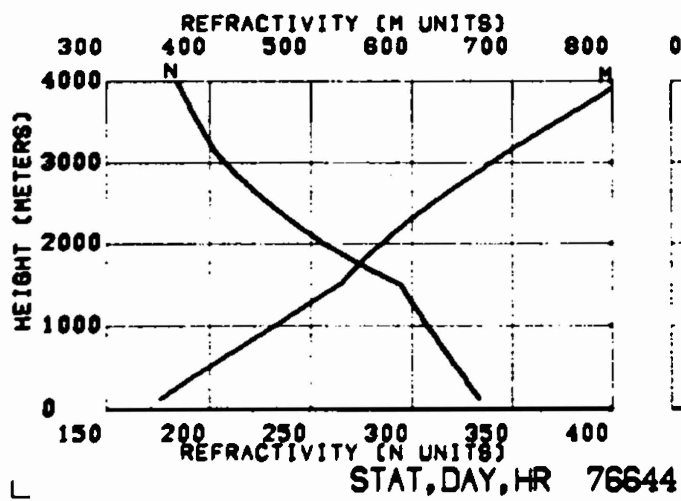


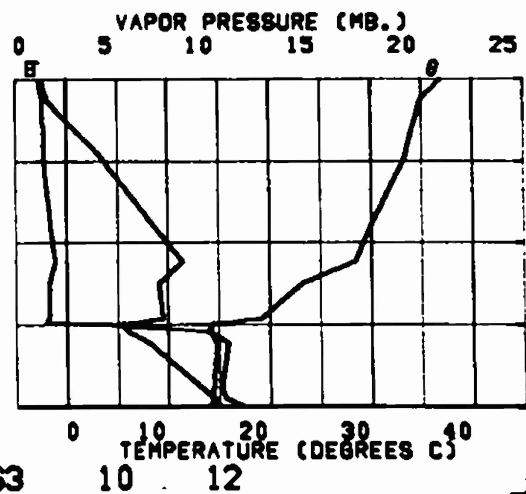
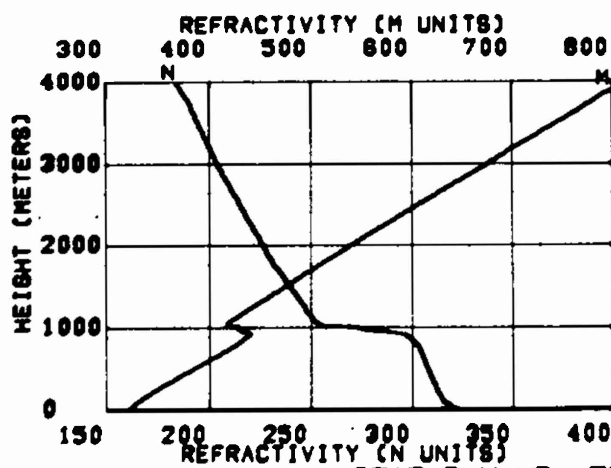
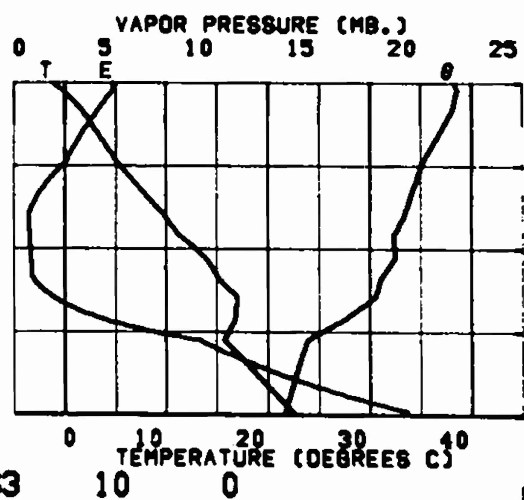
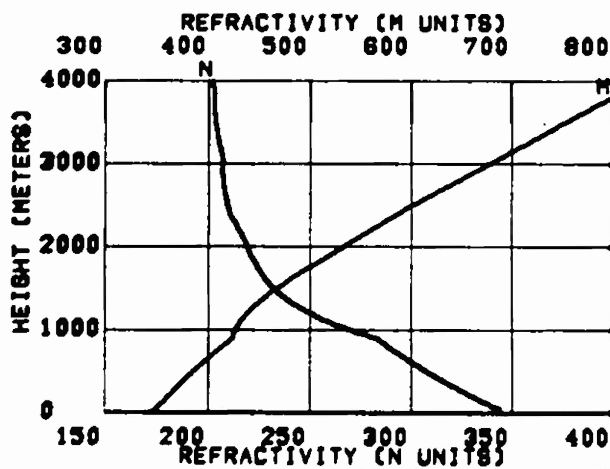


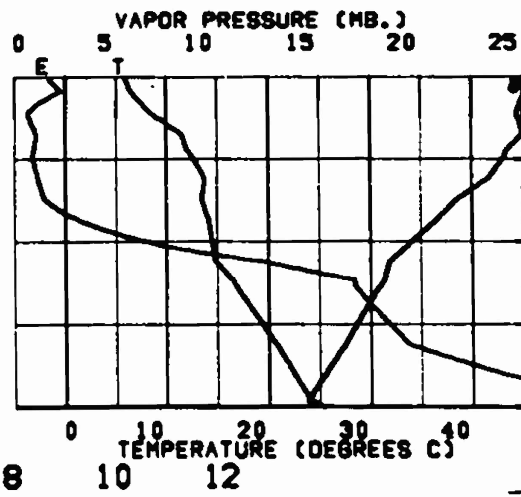
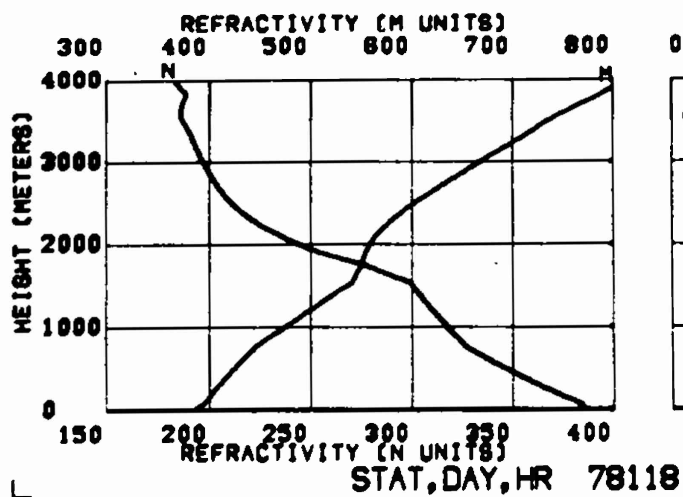
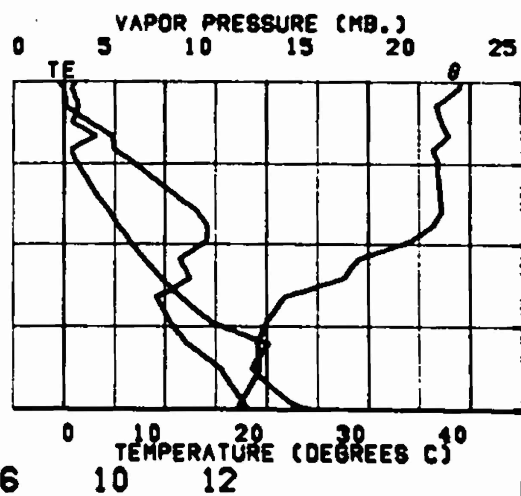
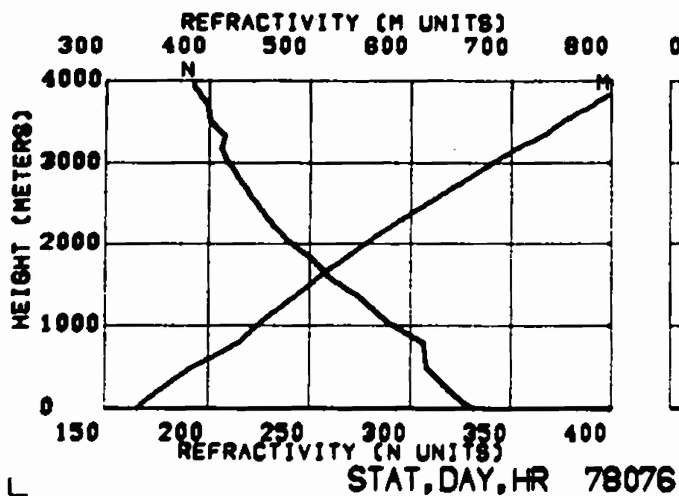
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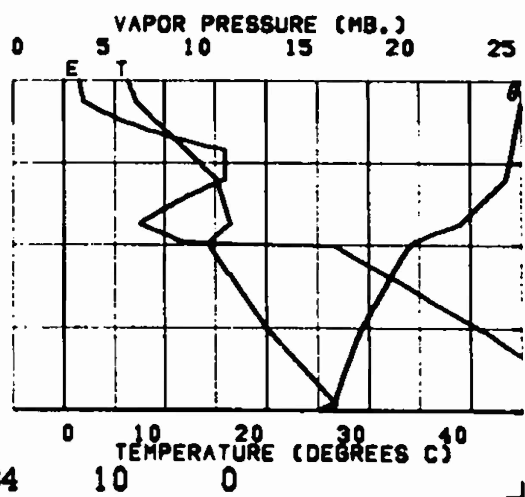
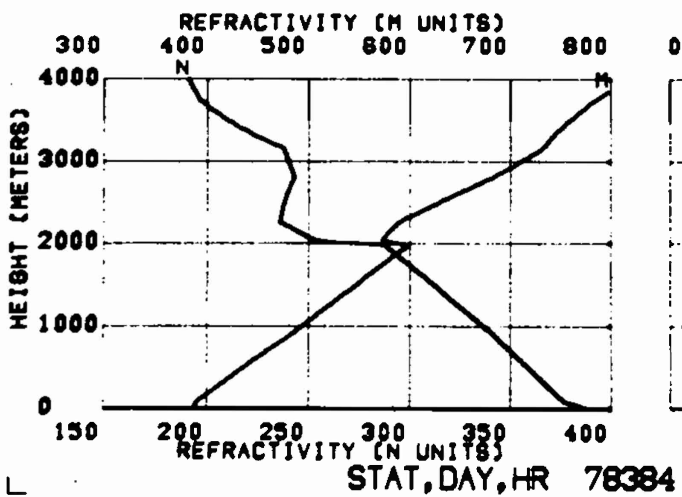
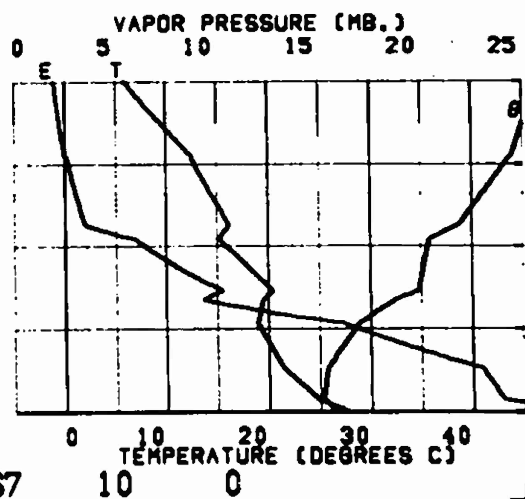
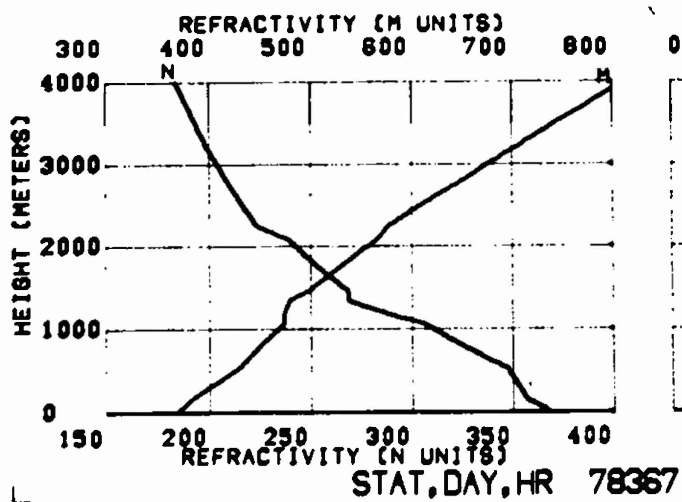


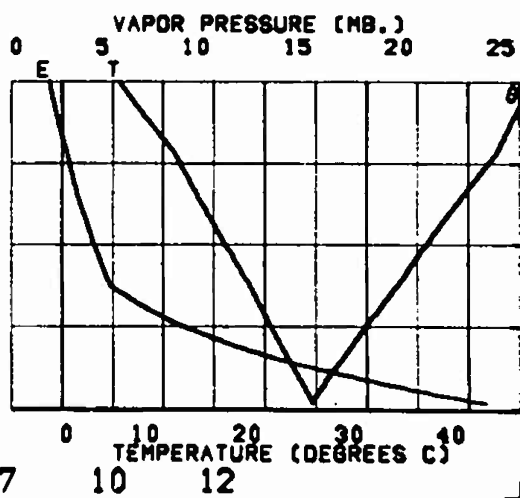
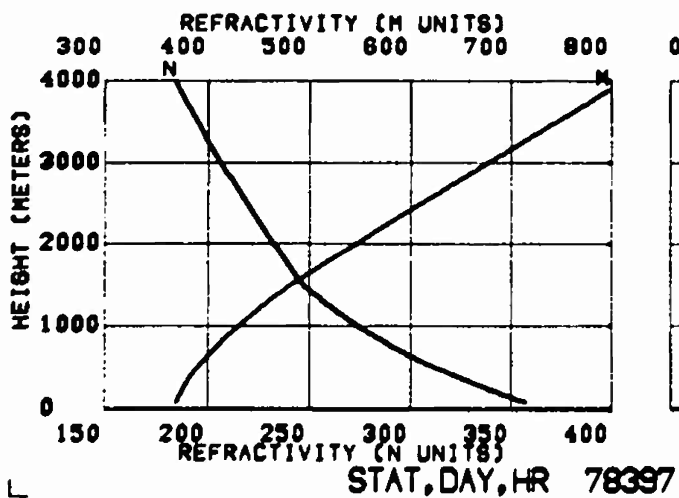
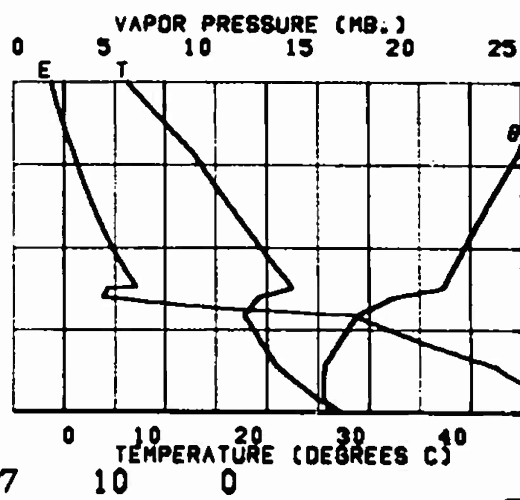
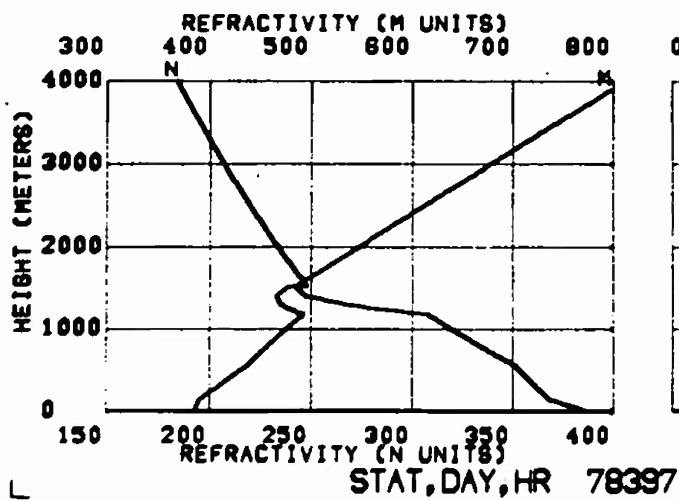


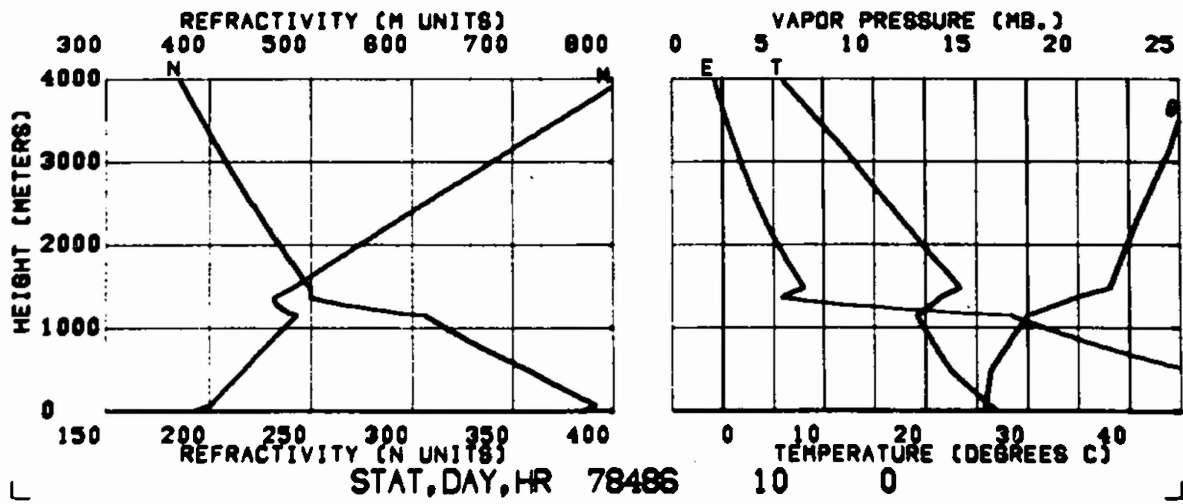


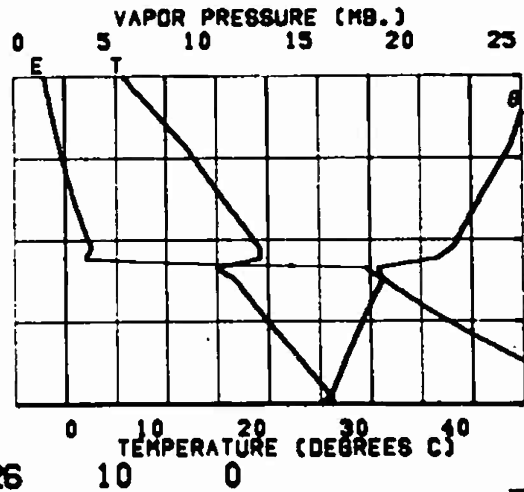
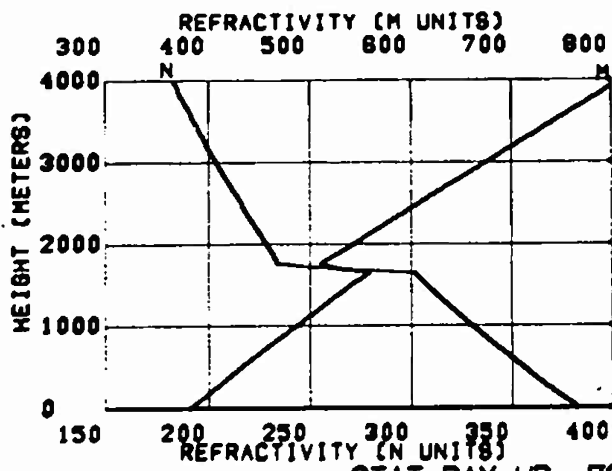






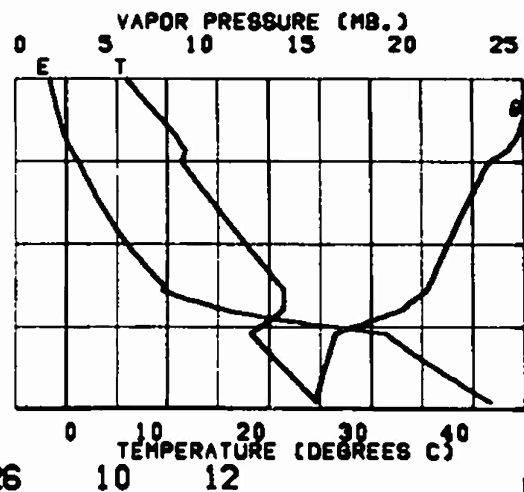
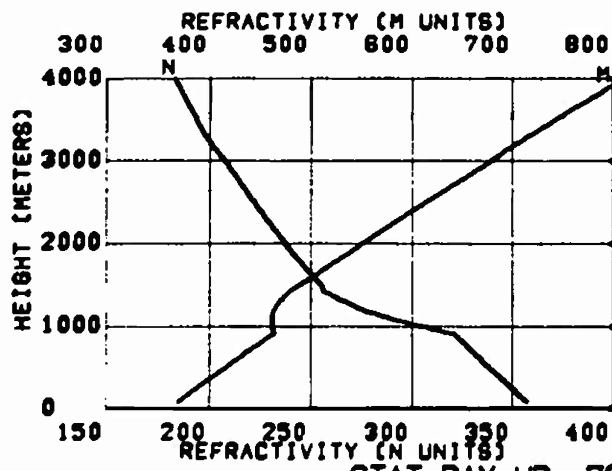






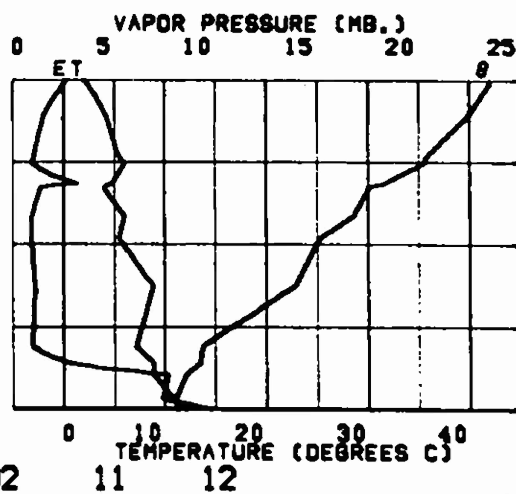
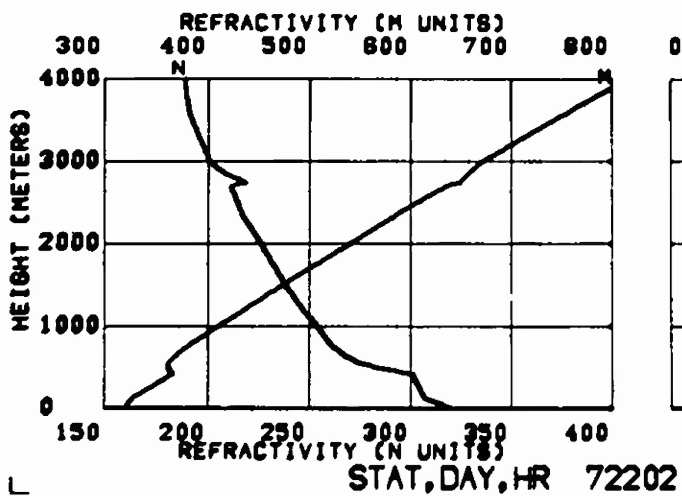
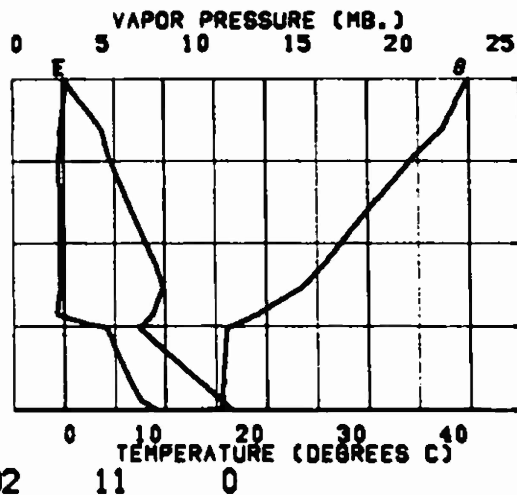
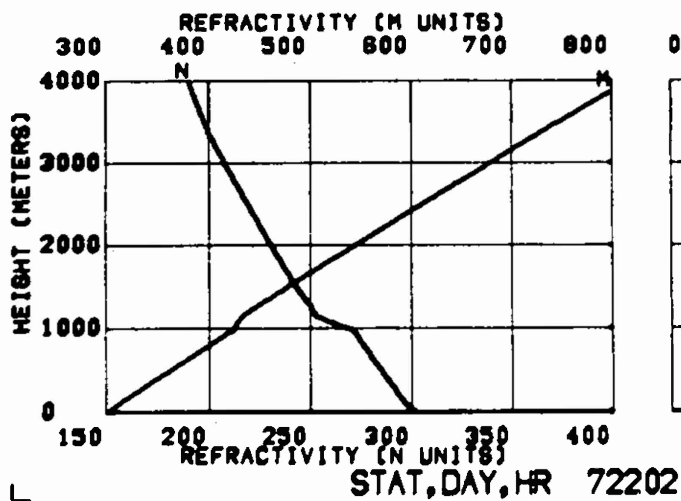
STAT, DAY, HR 78526

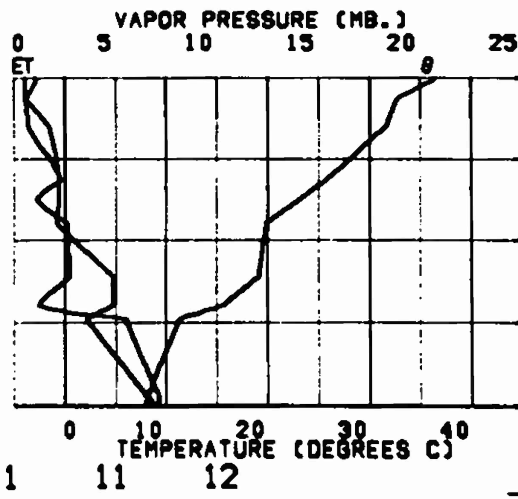
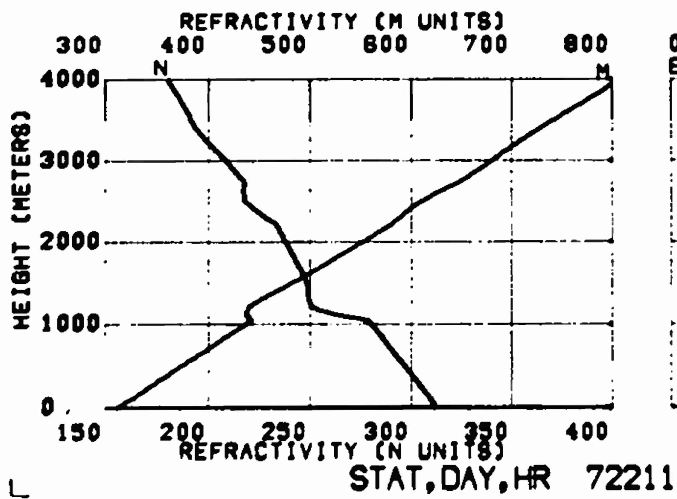
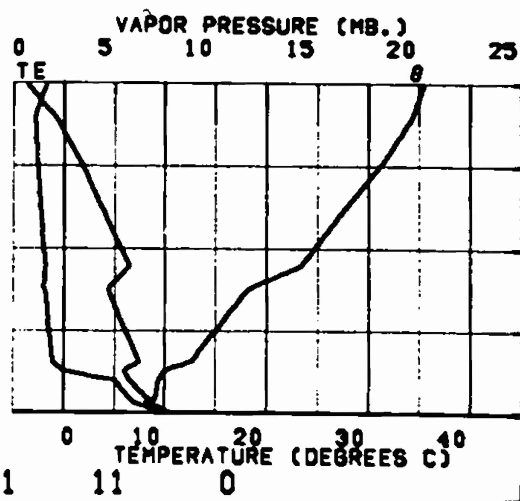
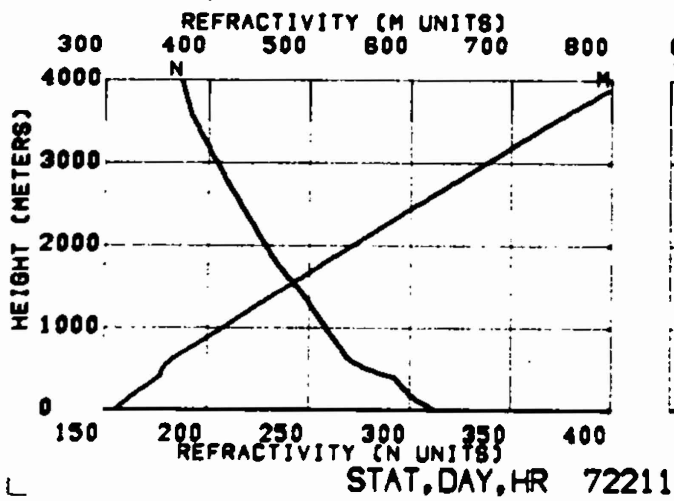
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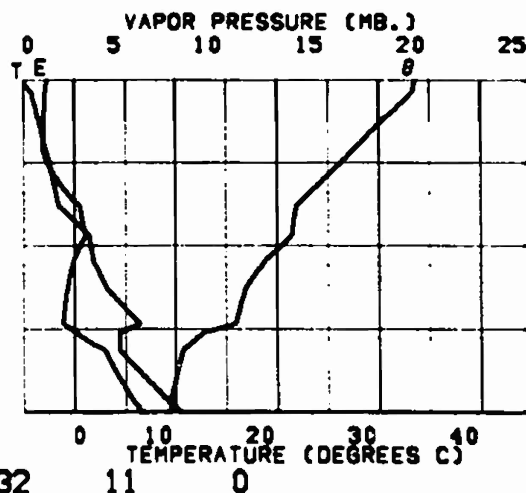
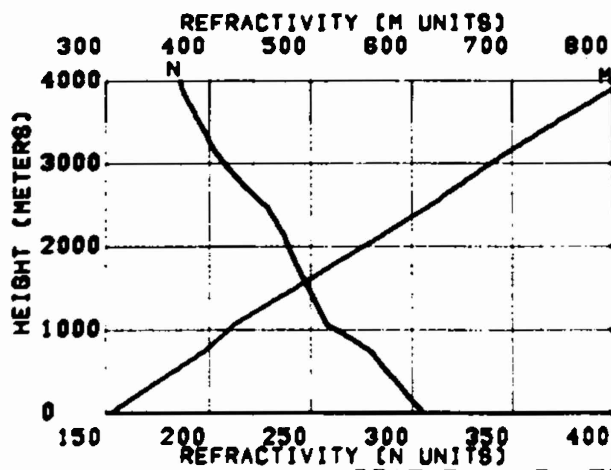


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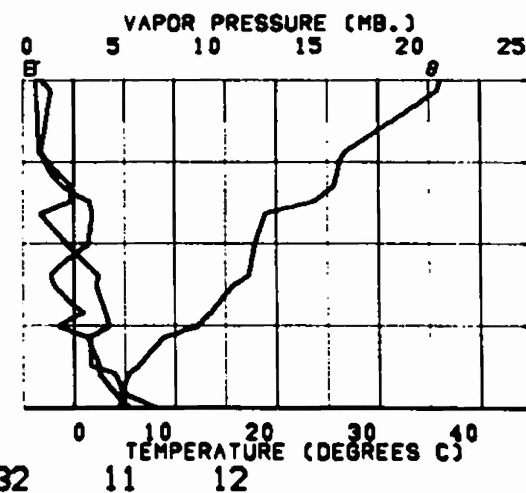
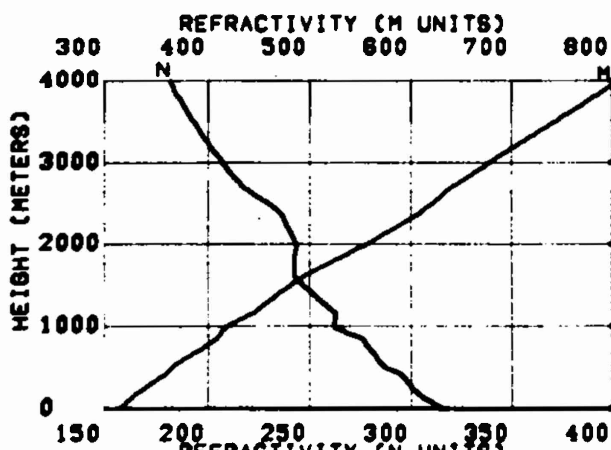
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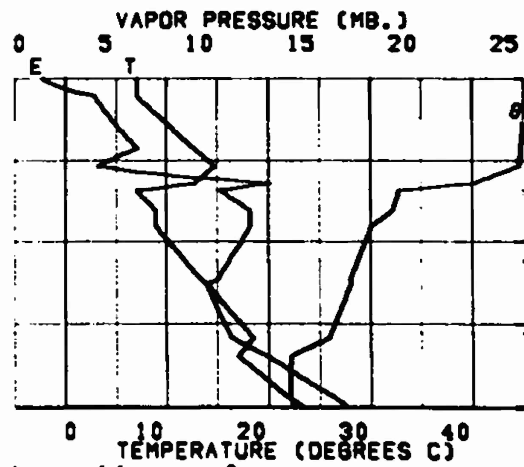
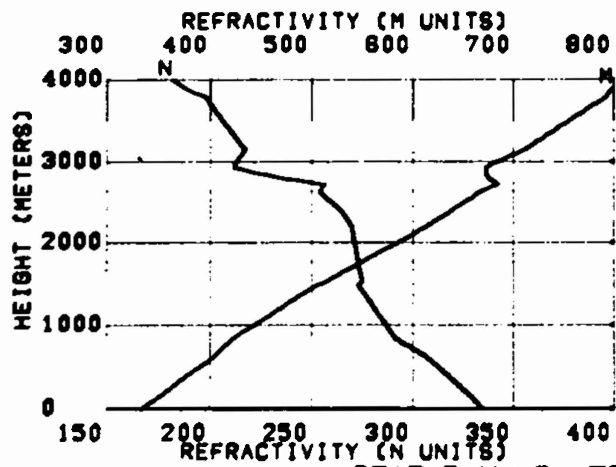




STAT, DAY, HR 72232

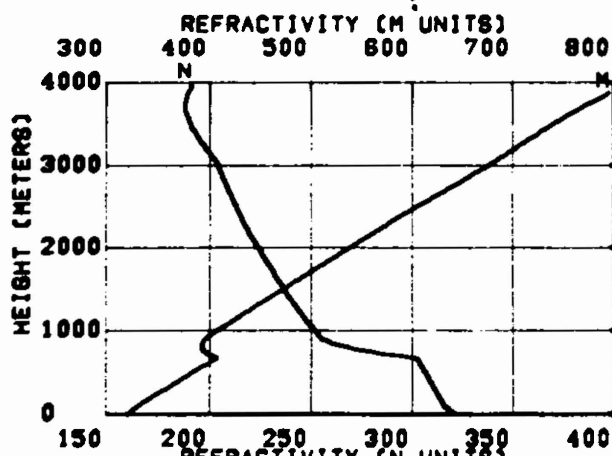


STAT, DAY, HR 72232

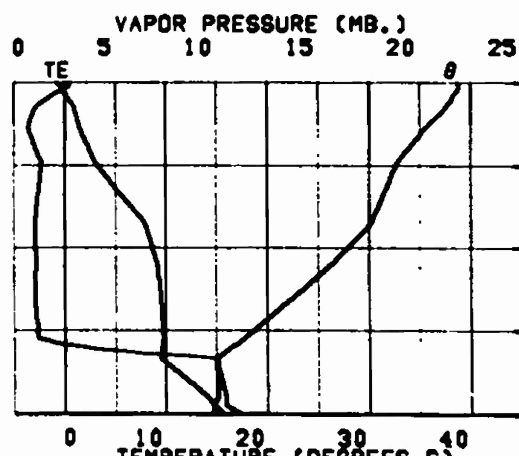


STAT, DAY, HR 76644

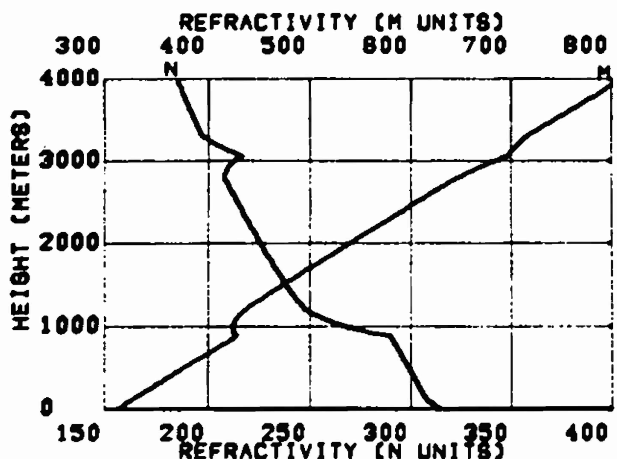
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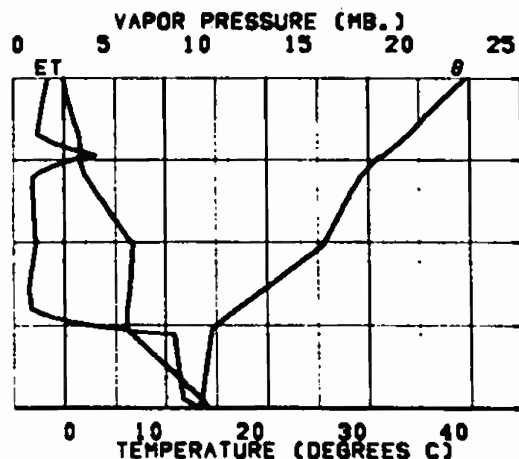
STAT, DAY, HR 78063



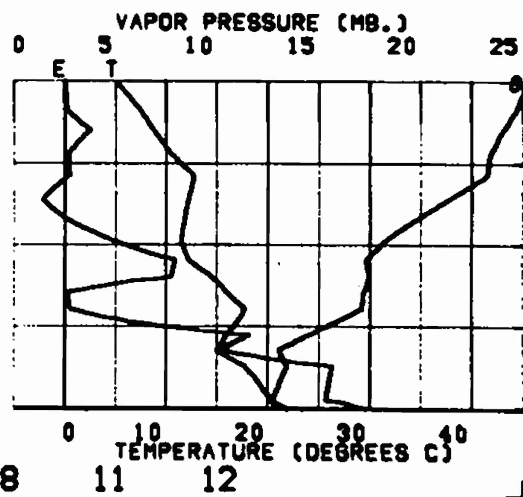
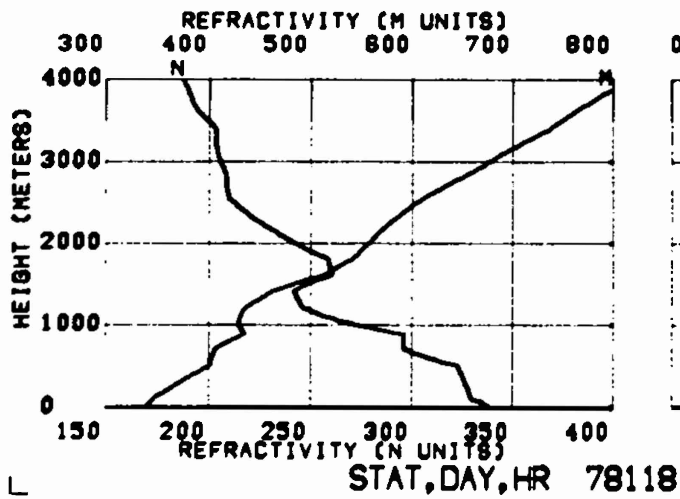
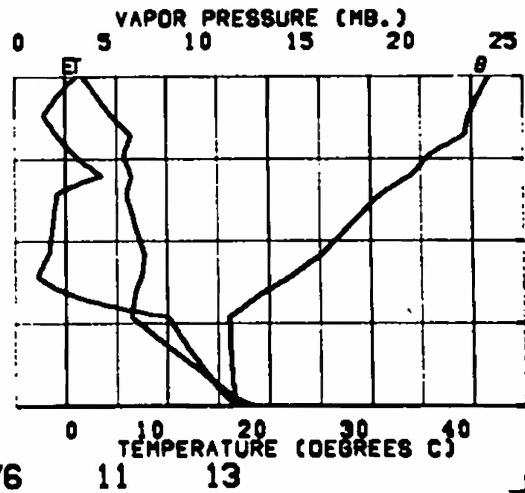
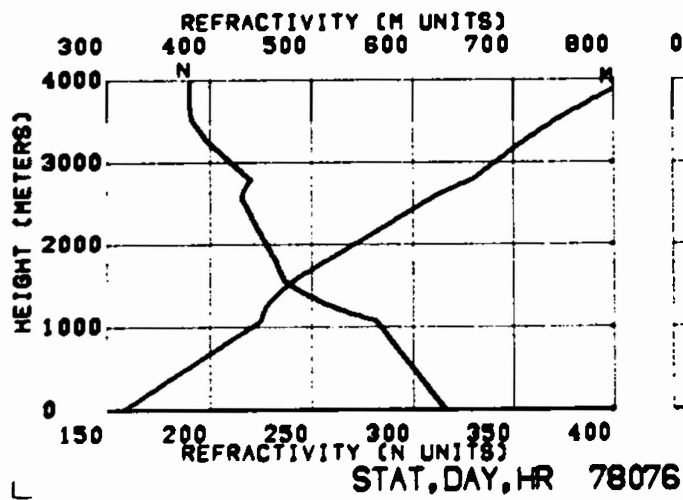
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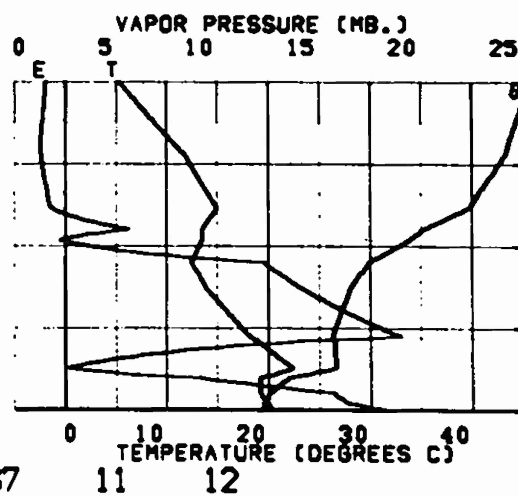
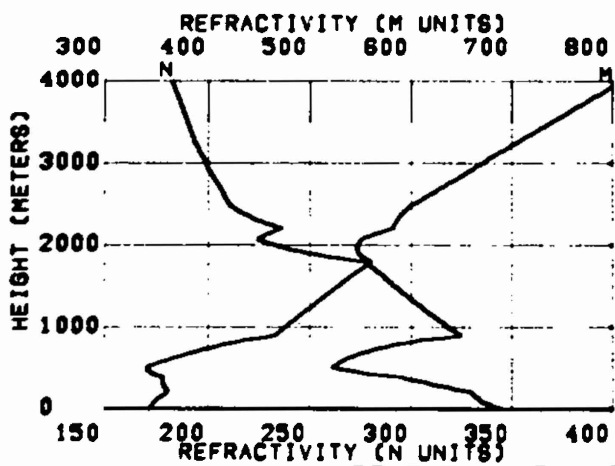
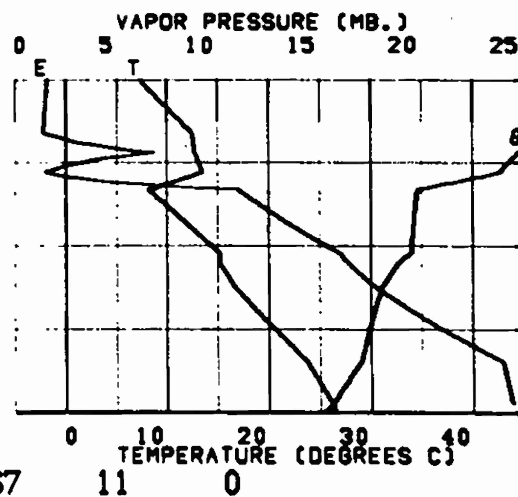
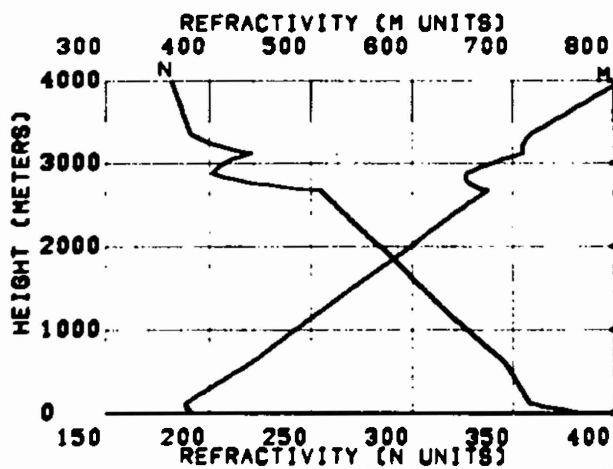


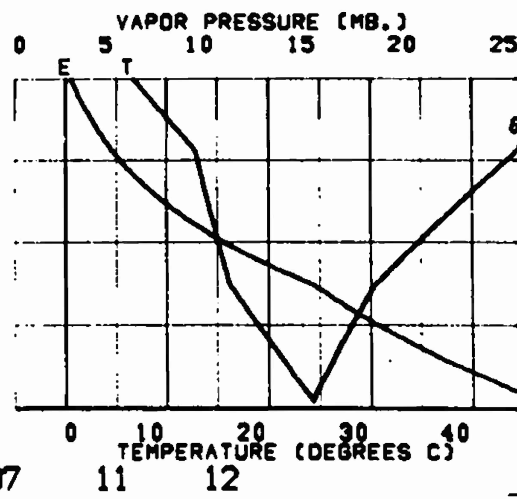
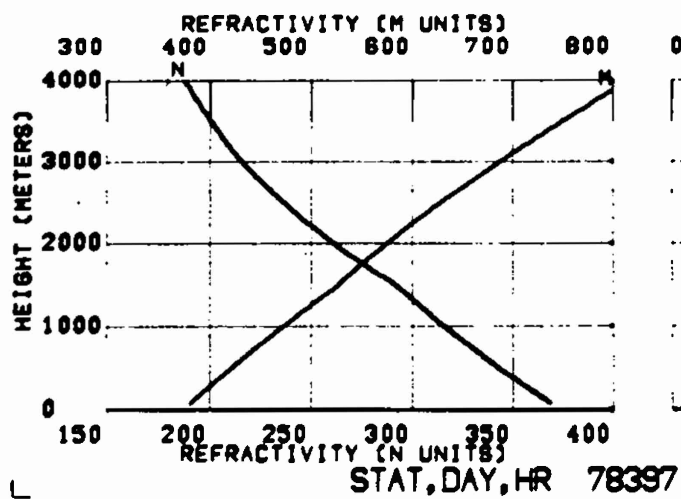
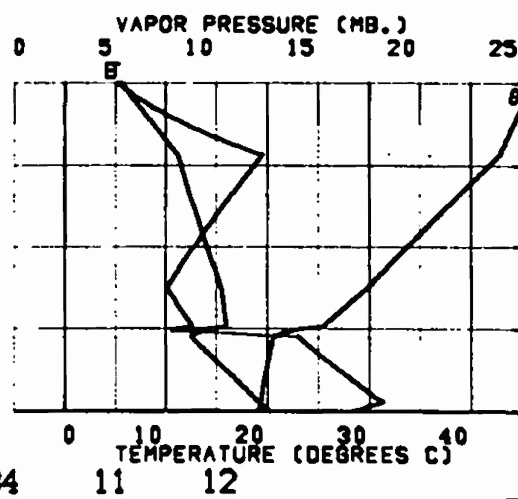
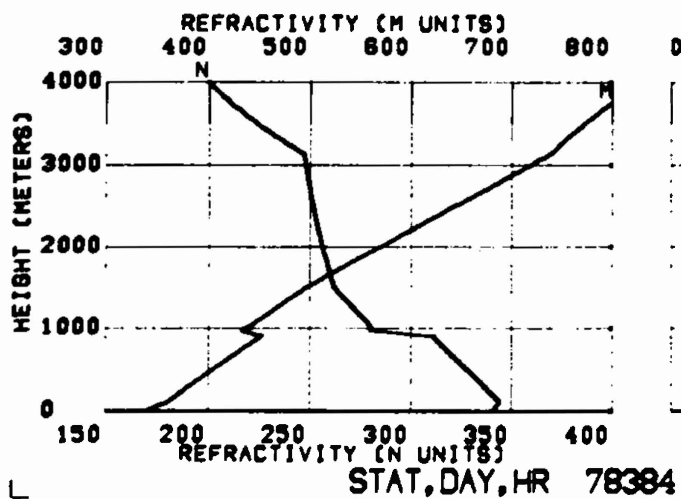
STAT, DAY, HR 78063

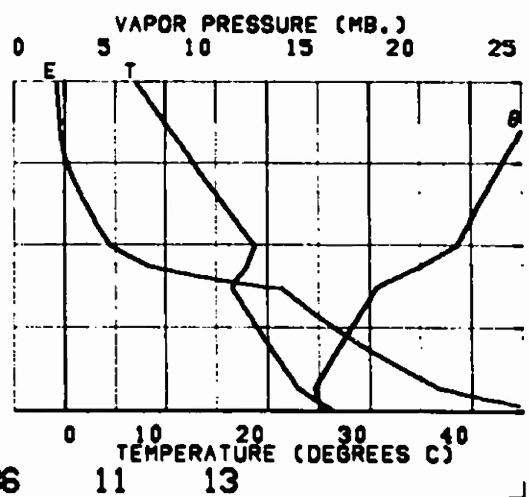
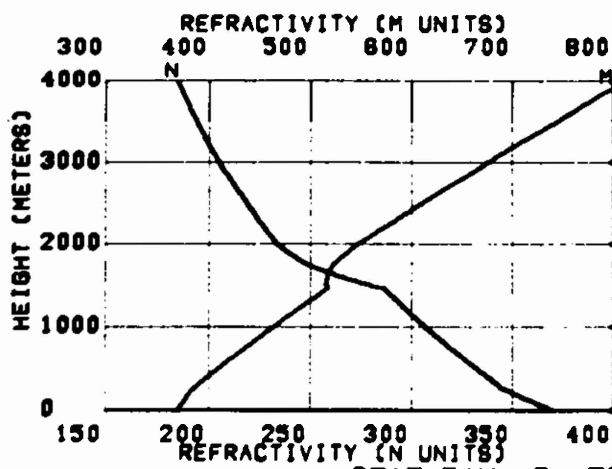
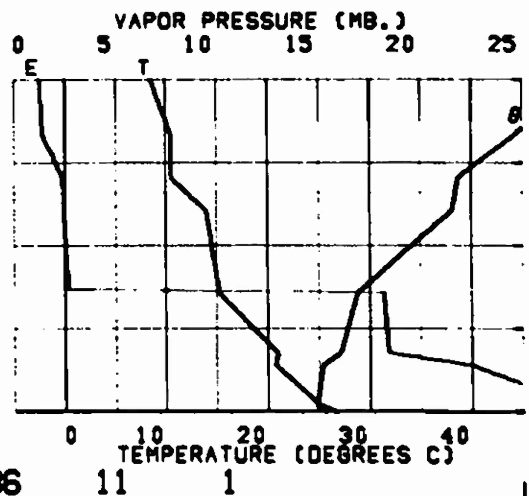
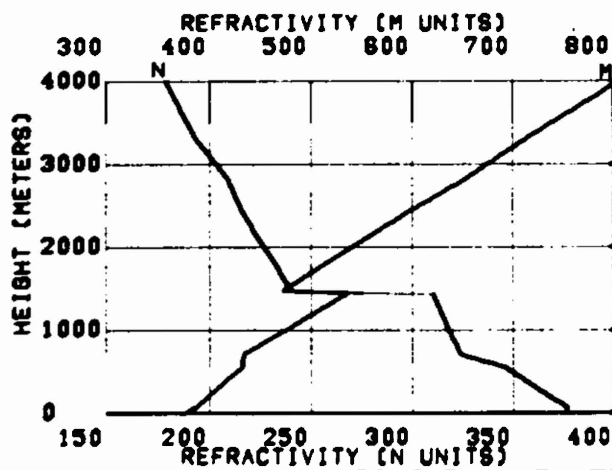


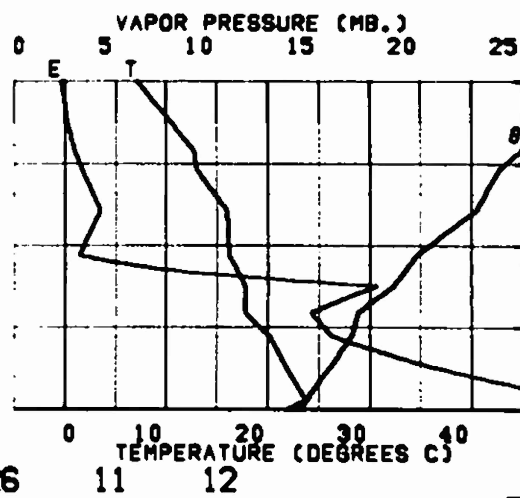
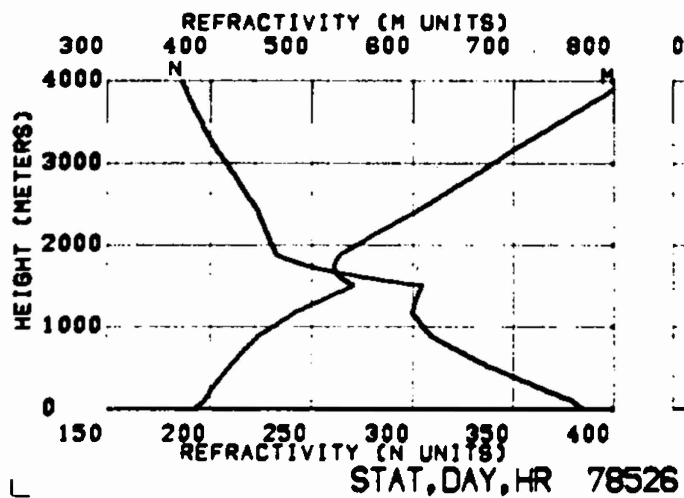
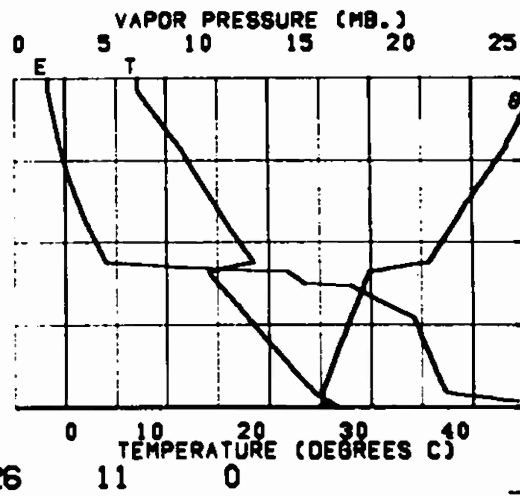
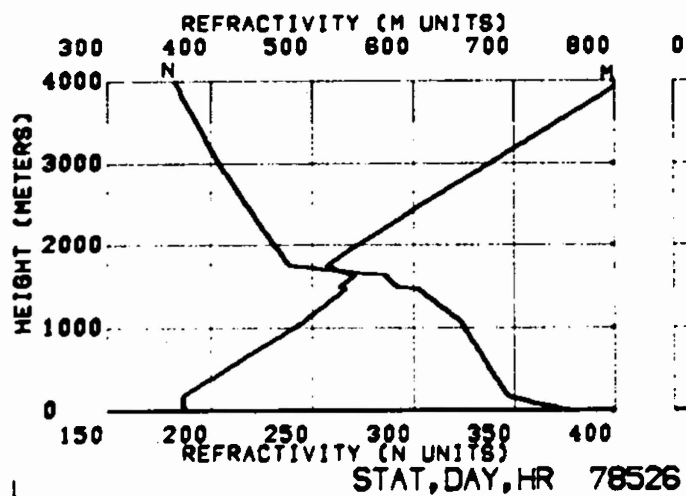
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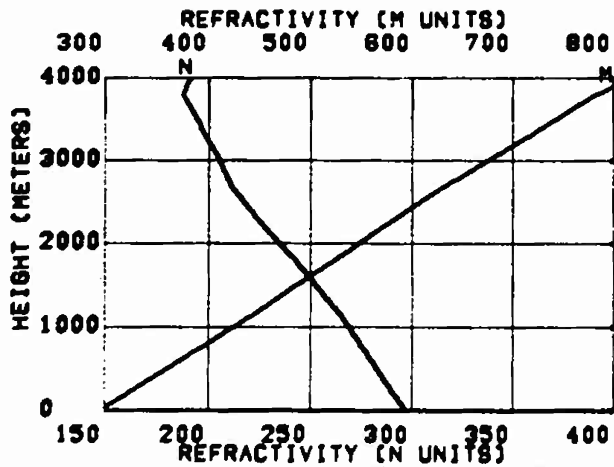




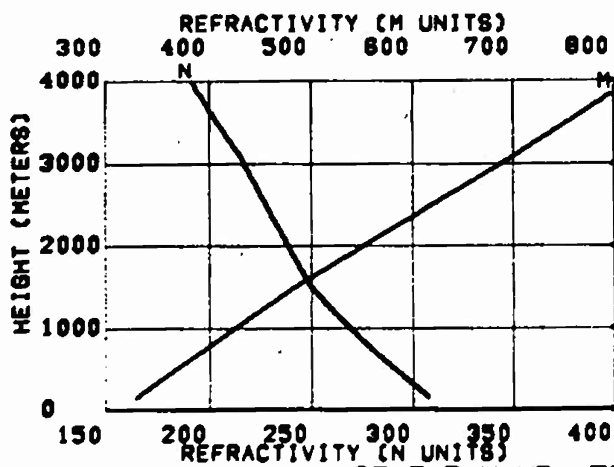
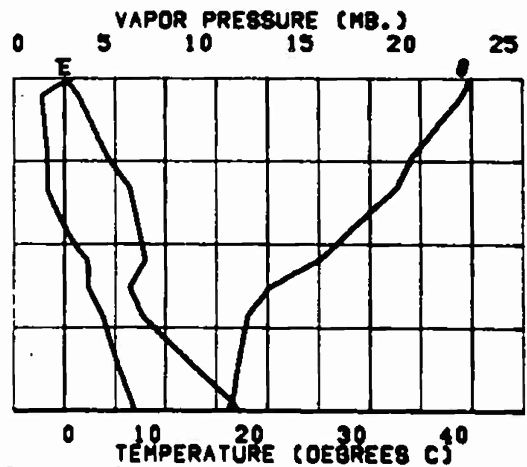




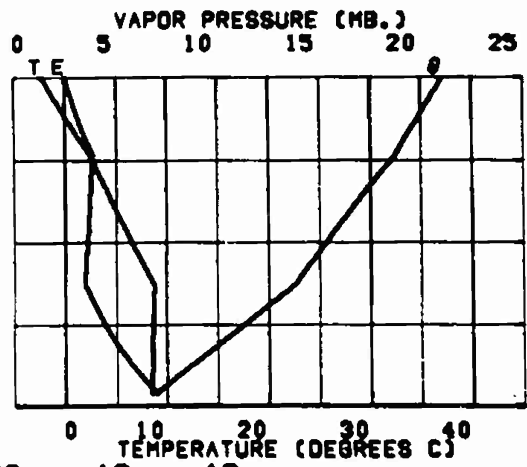


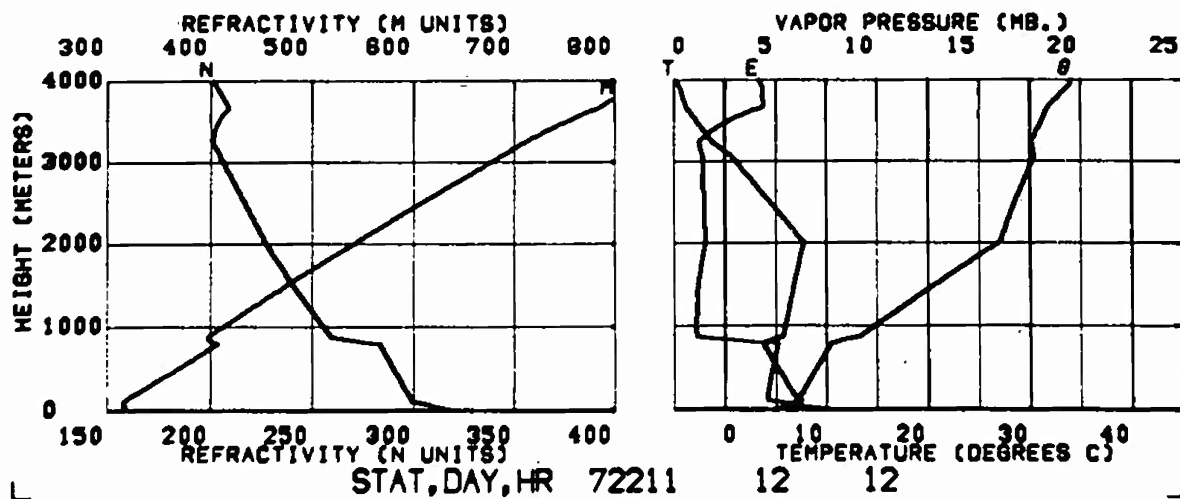
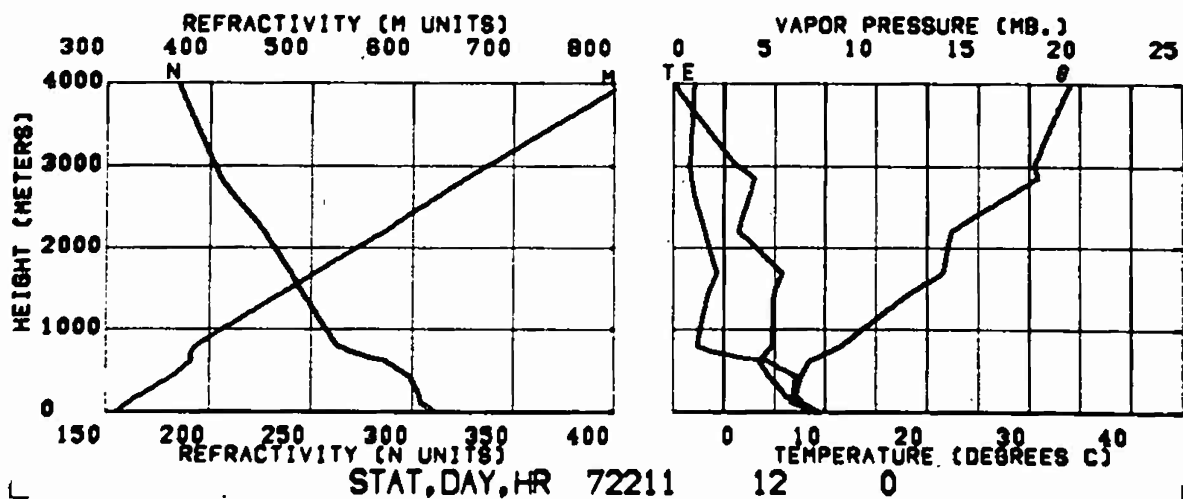


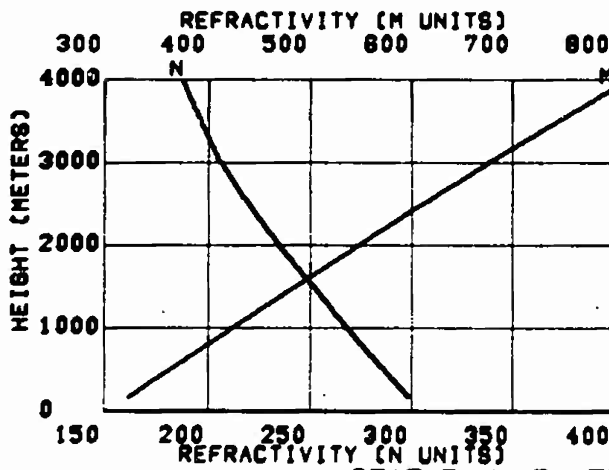
STAT, DAY, HR 72202



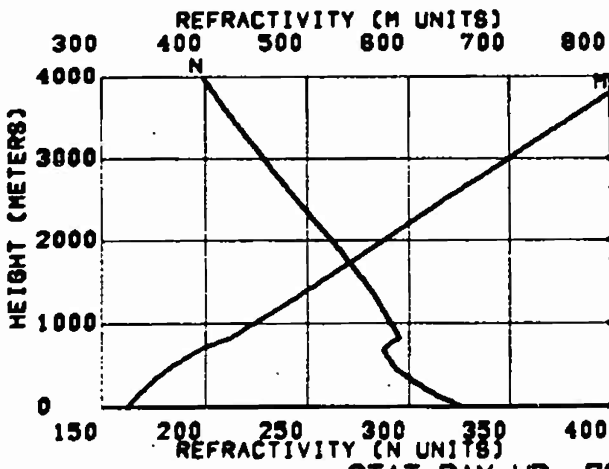
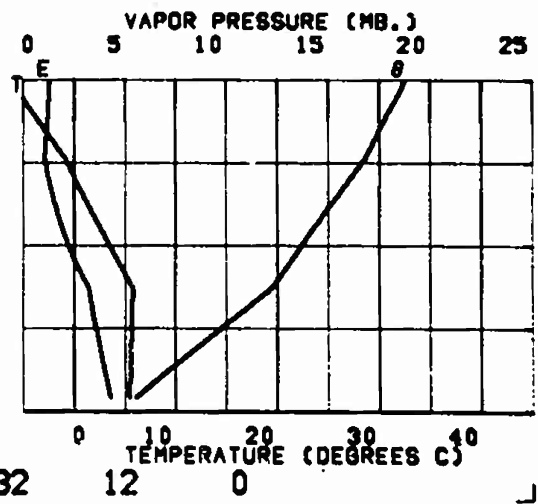
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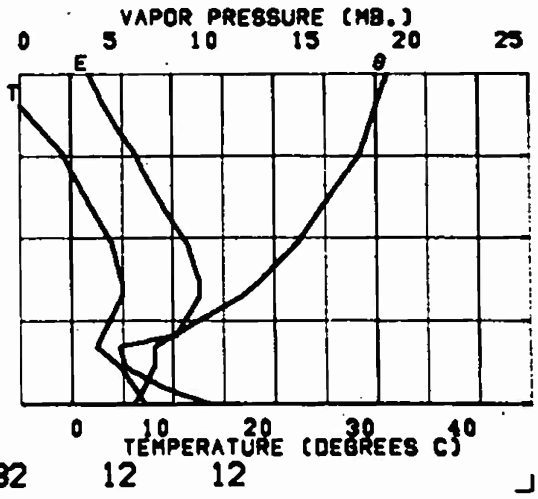


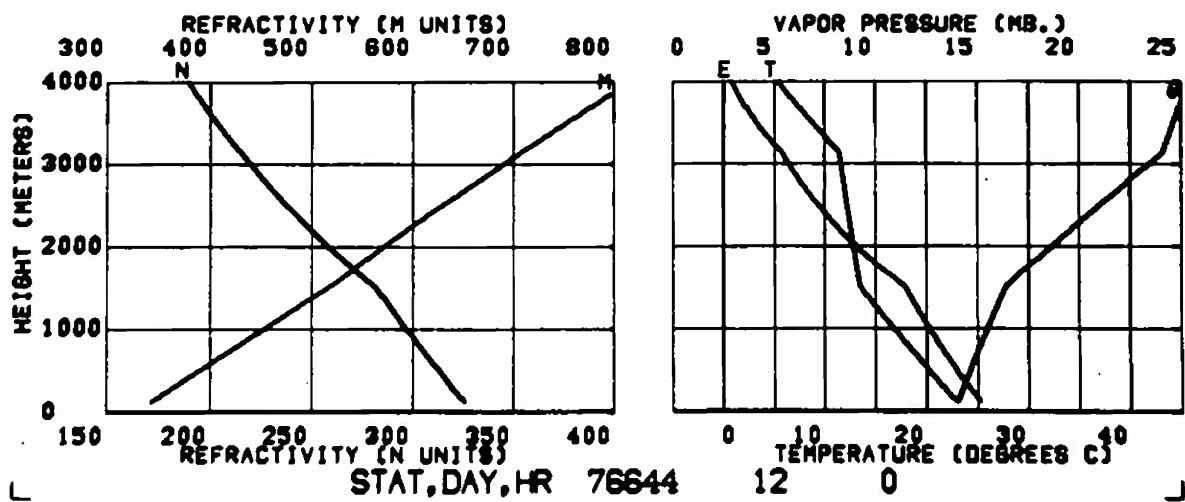


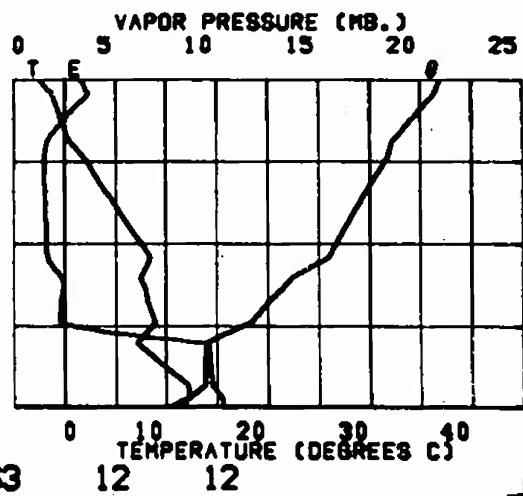
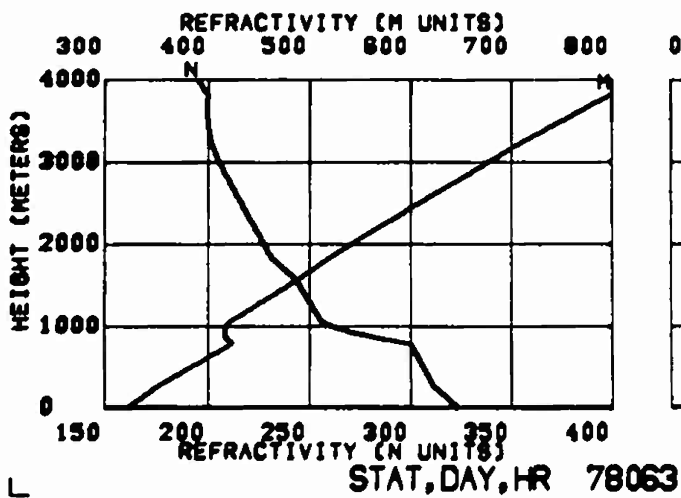
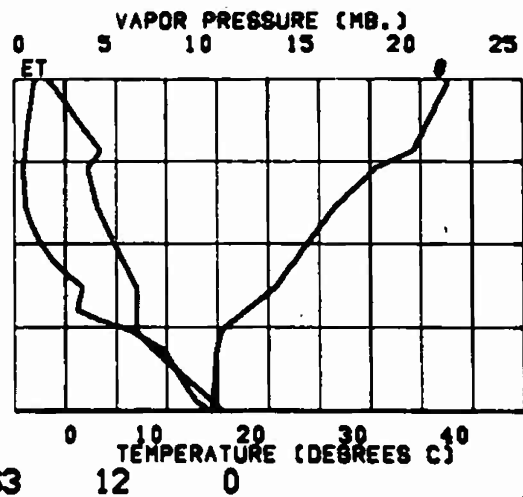
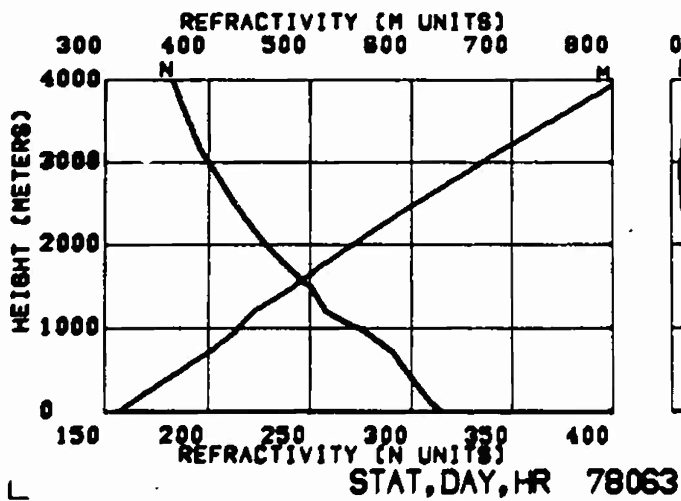
STAT, DAY, HR 72232

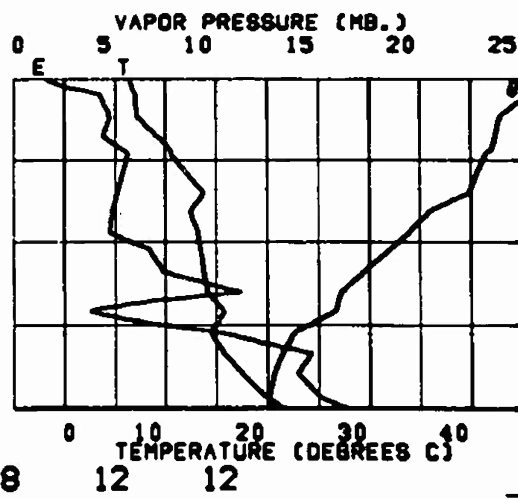
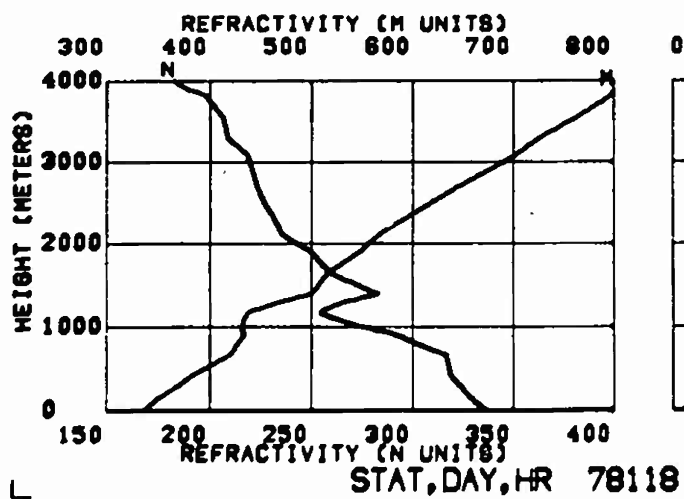
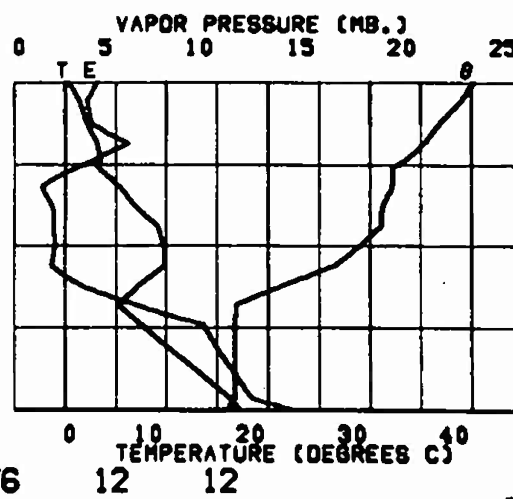
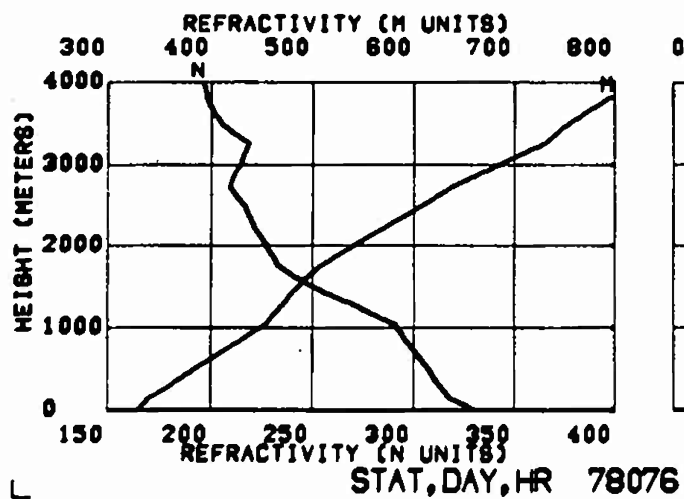


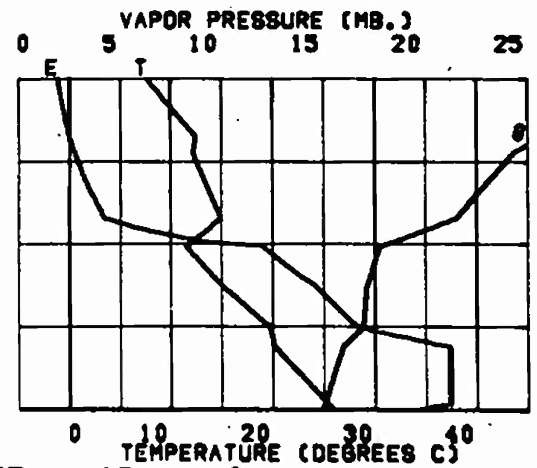
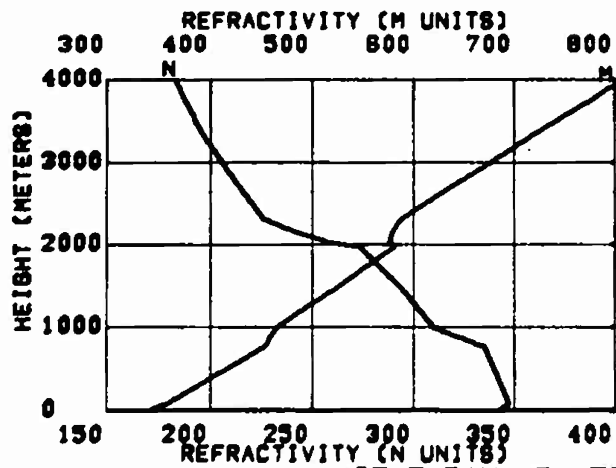
STAT, DAY, HR 72232



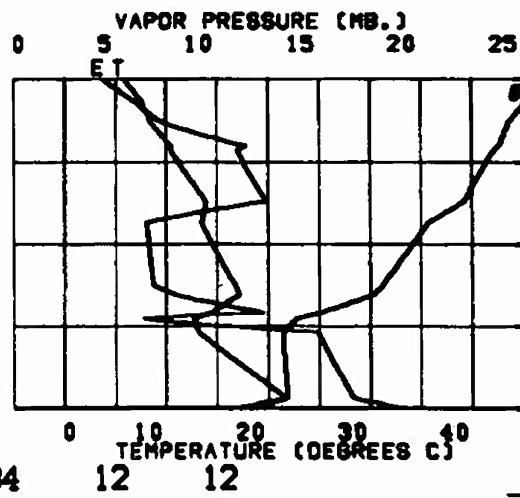
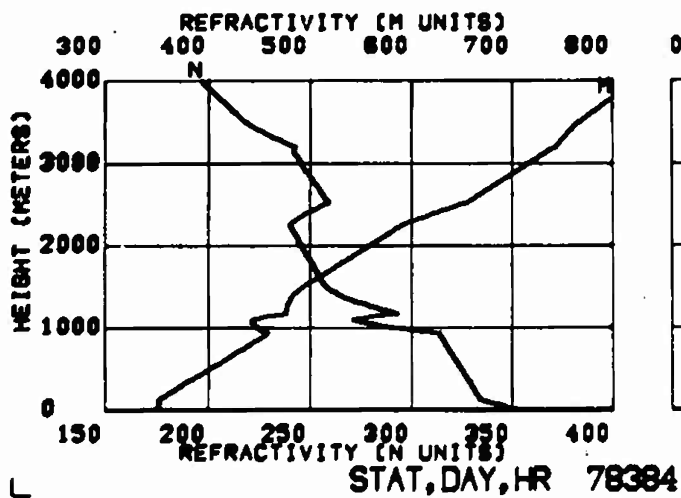
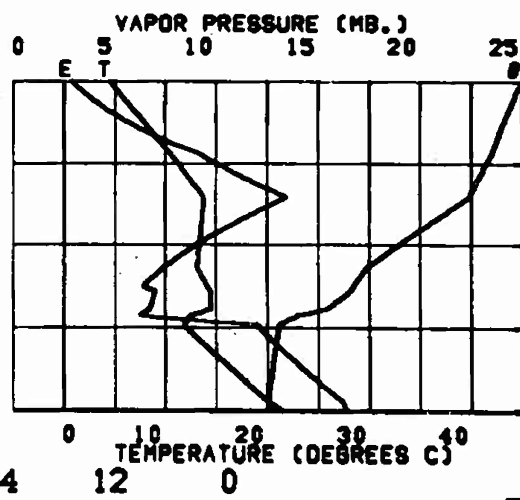
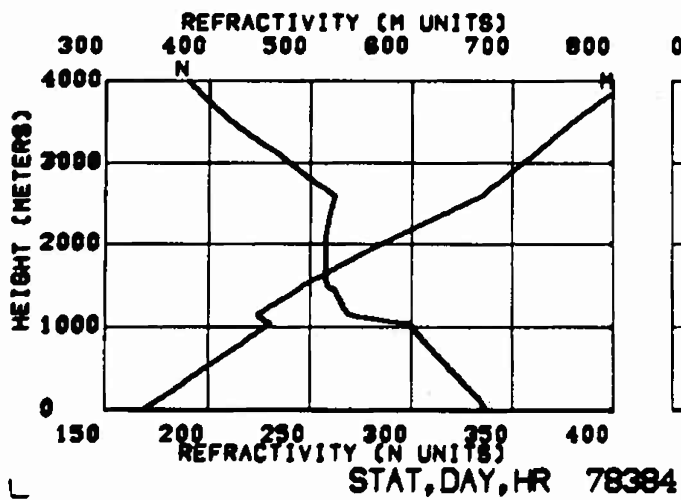


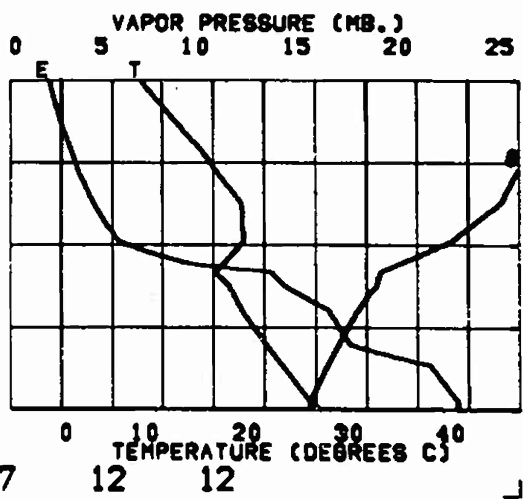
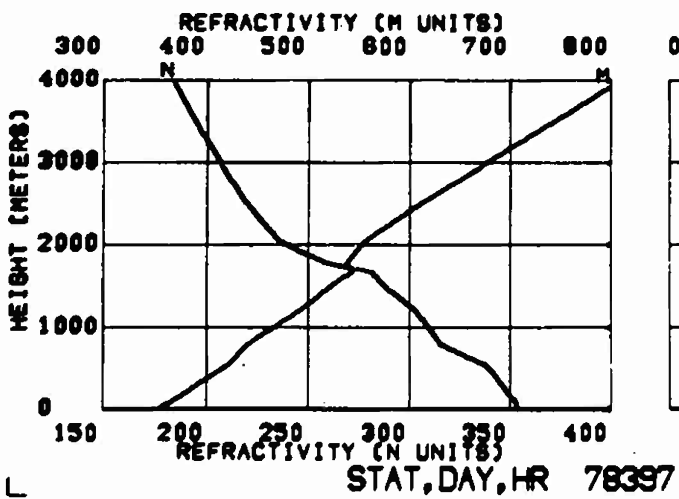
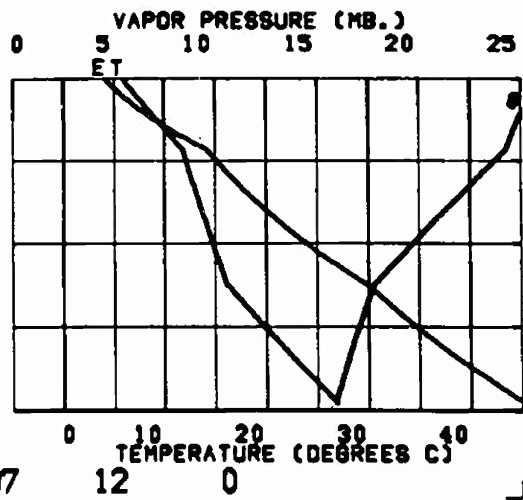
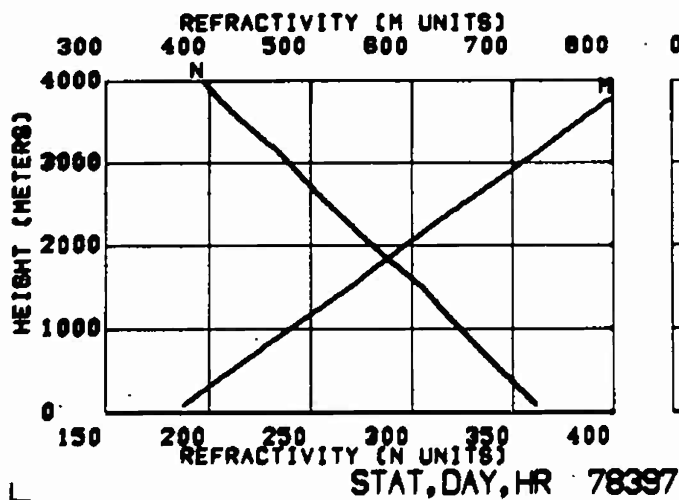


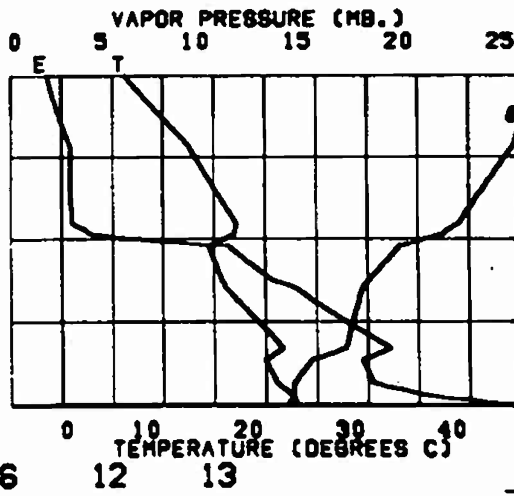
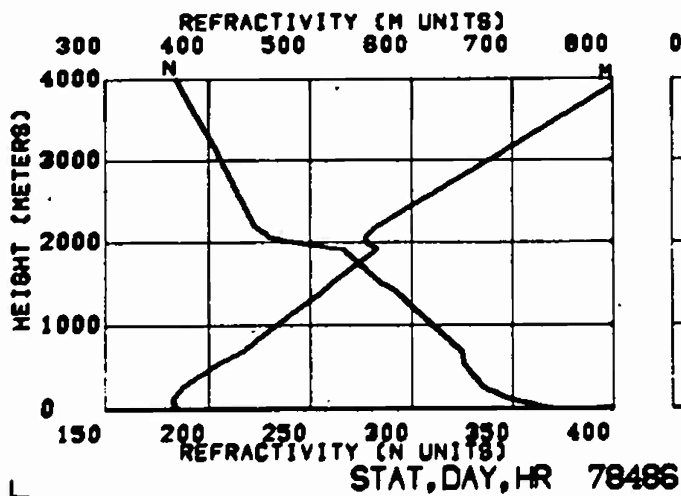
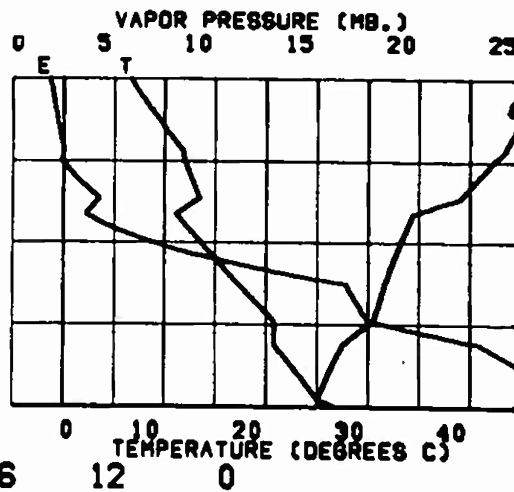
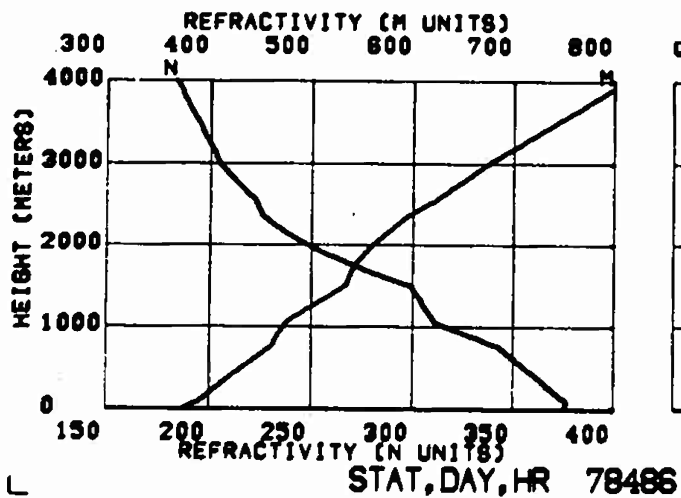


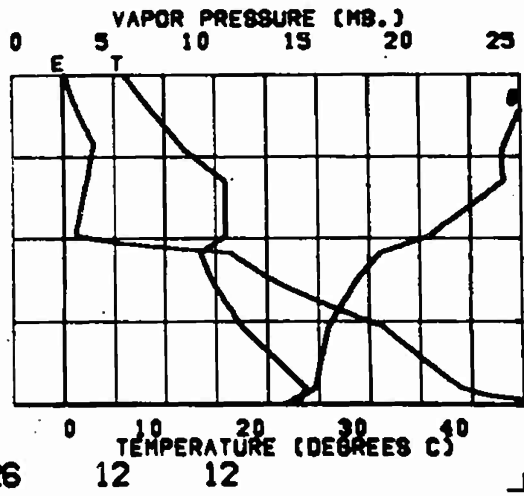
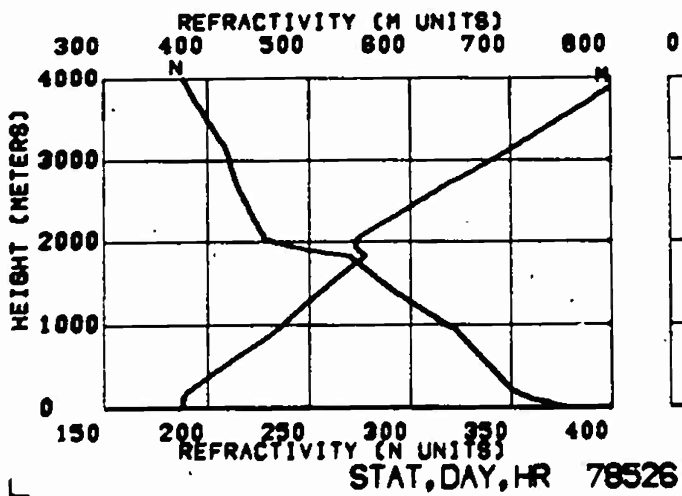
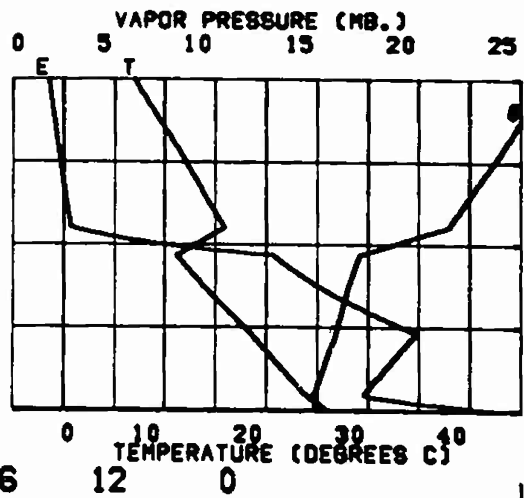
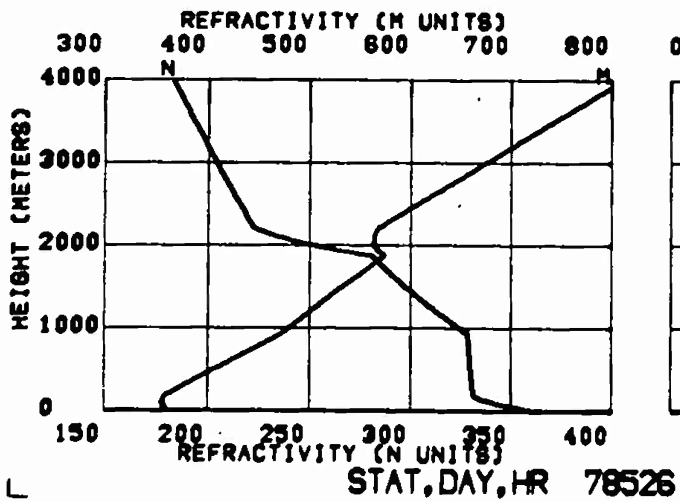


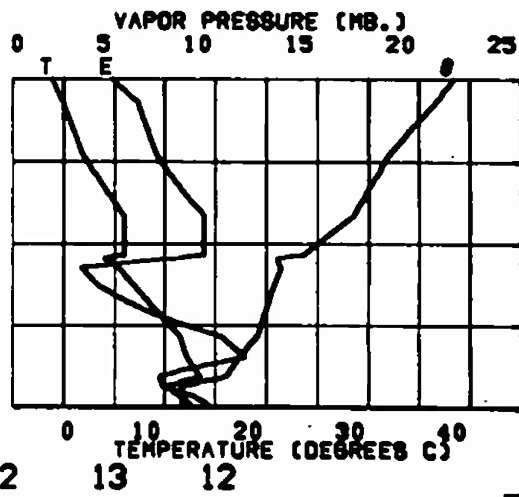
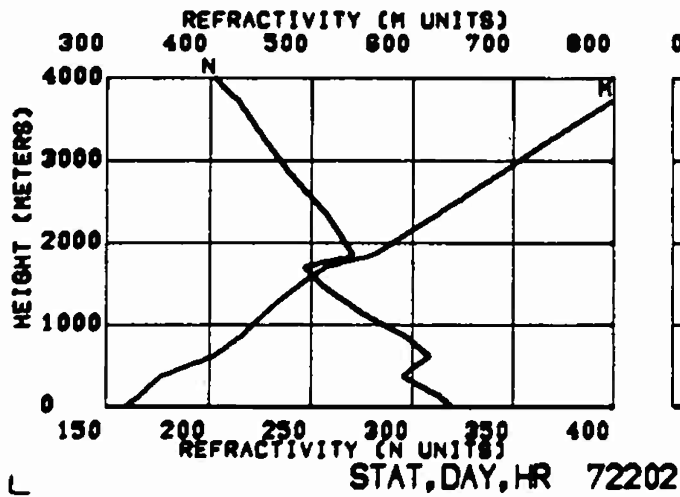
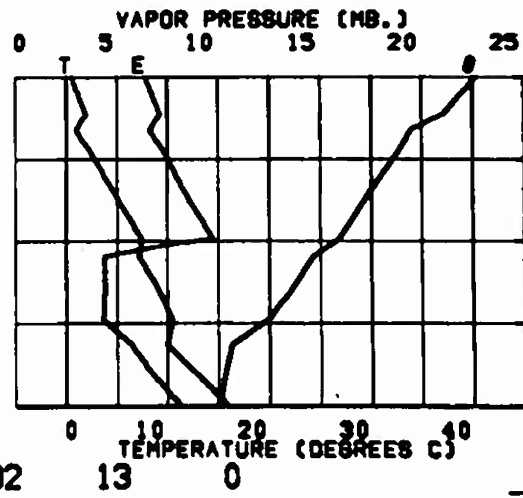
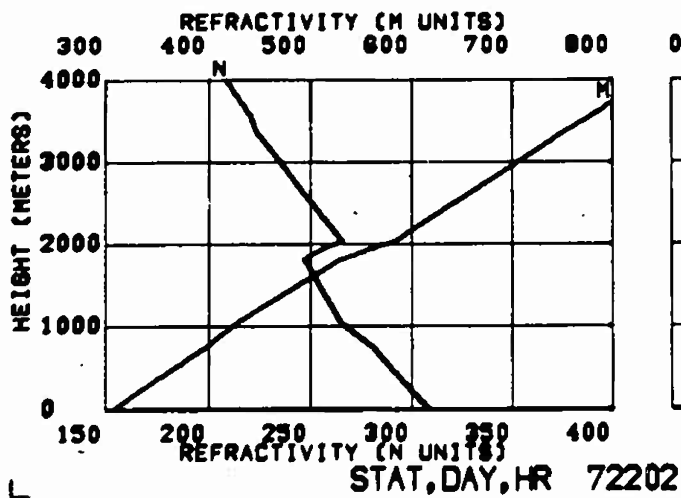
STAT, DAY, HR 78367

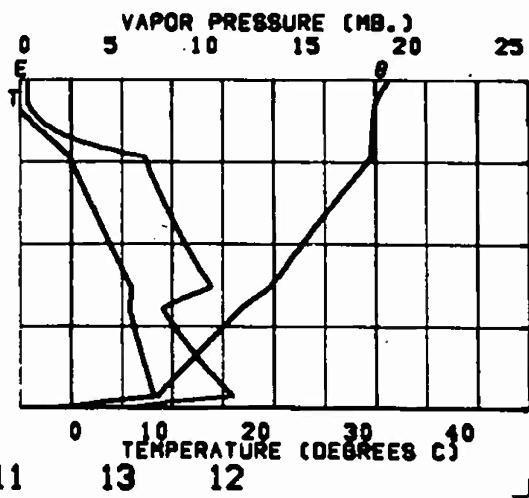
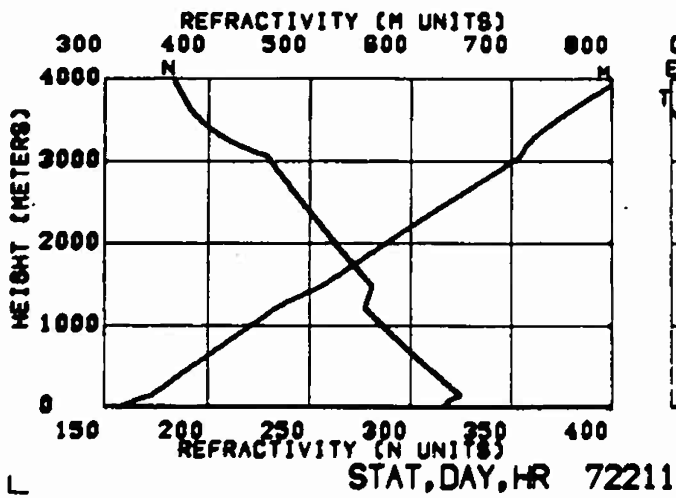
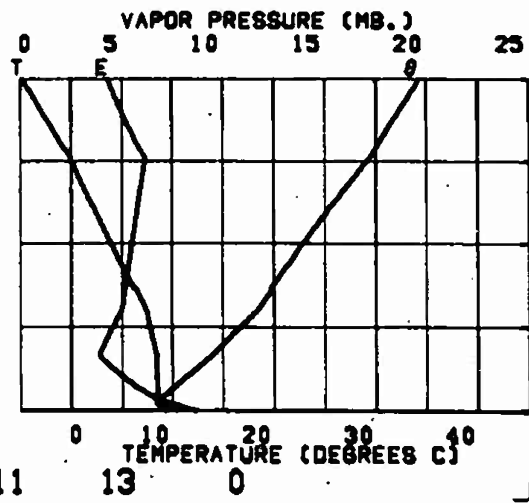
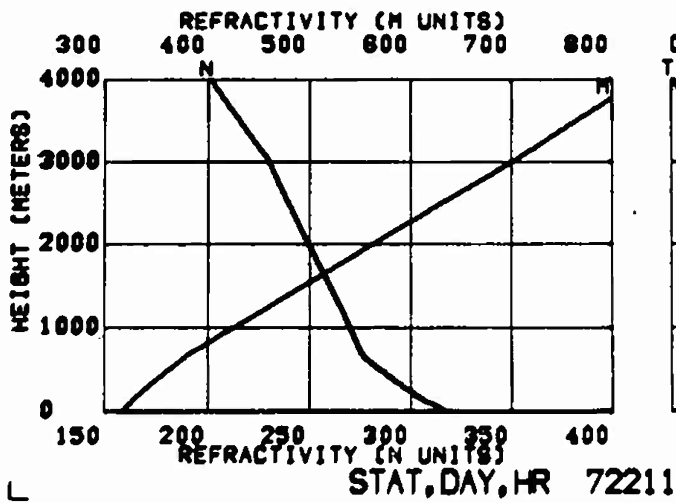


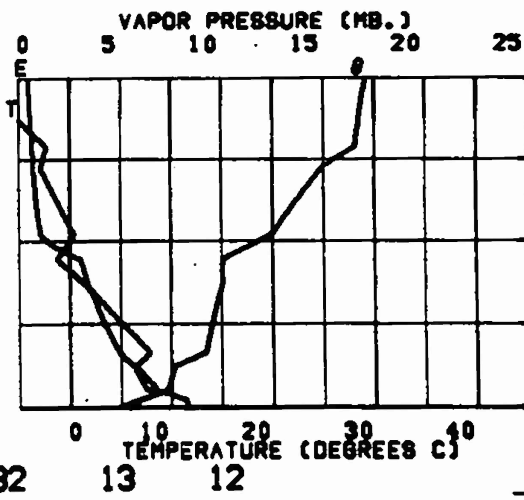
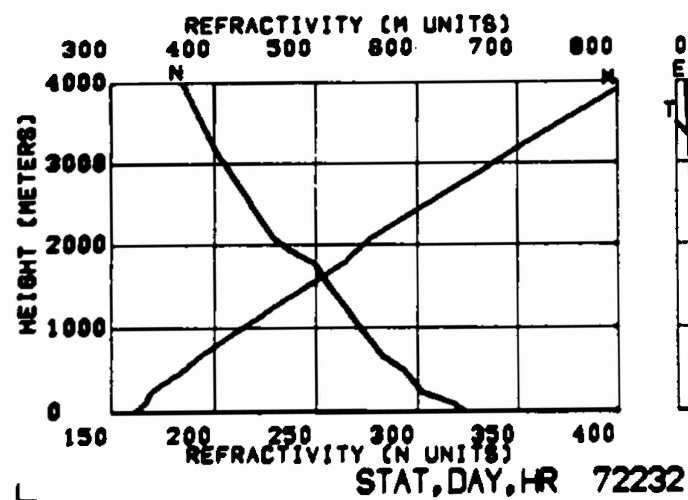
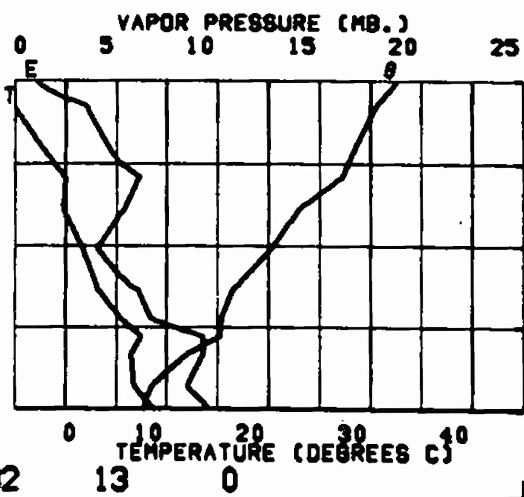
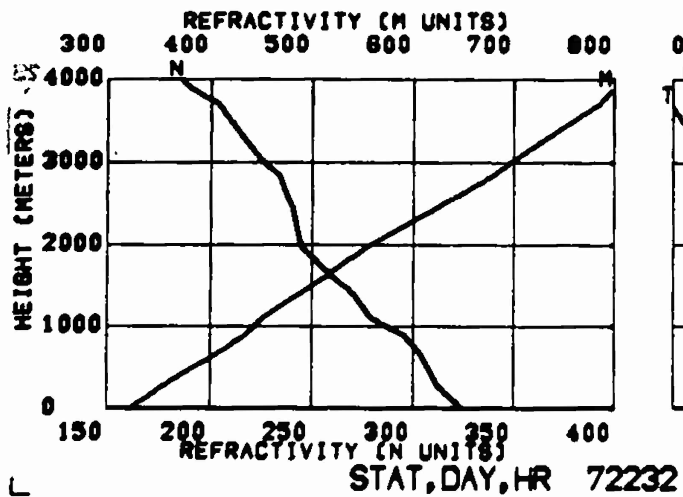


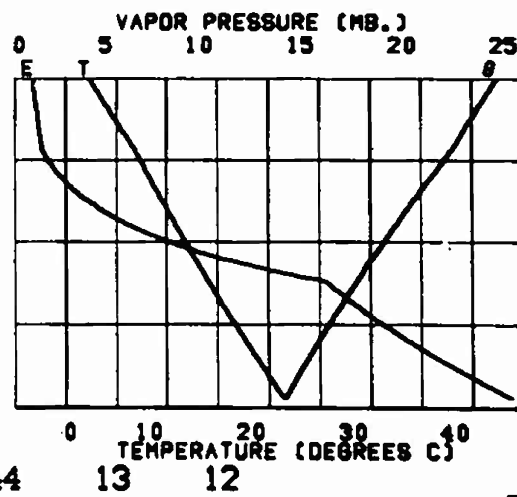
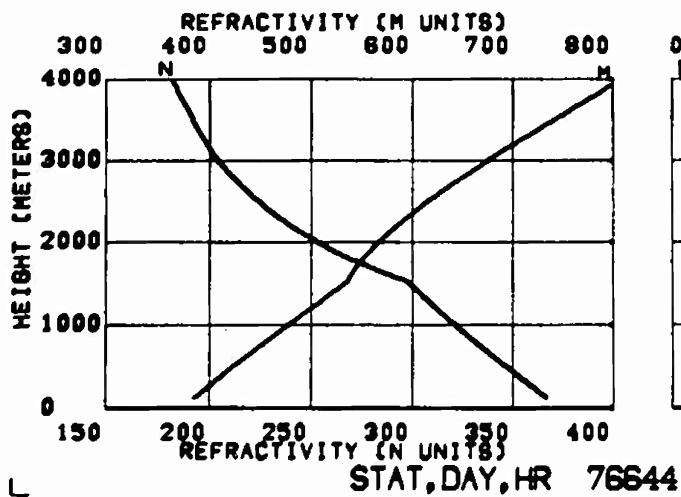
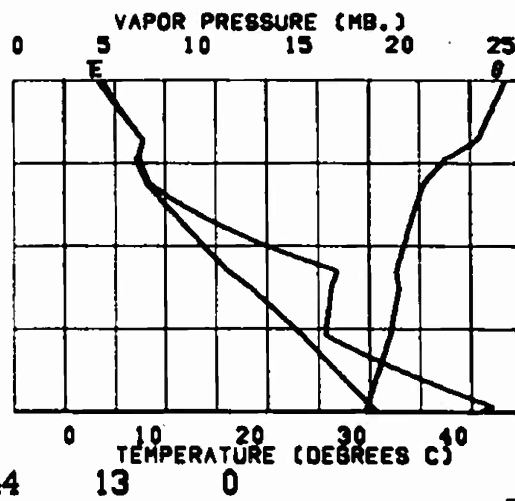
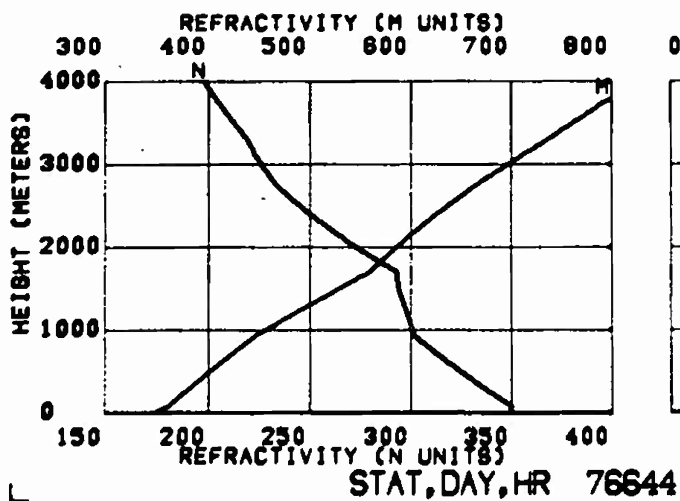


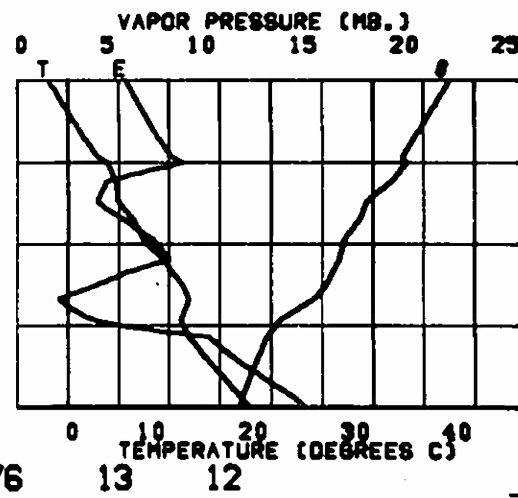
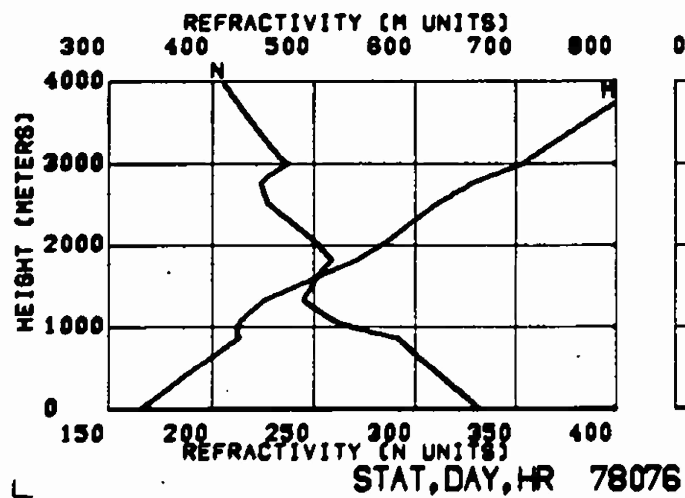
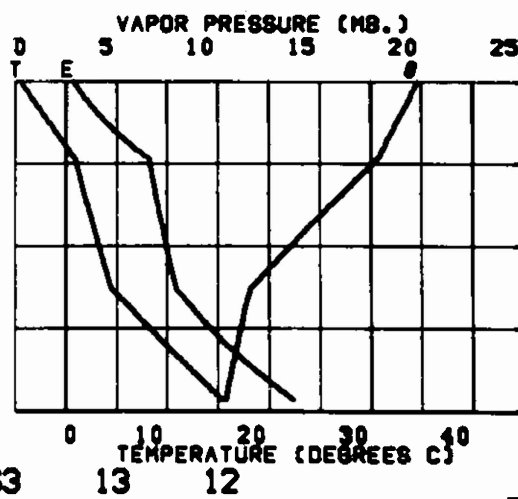
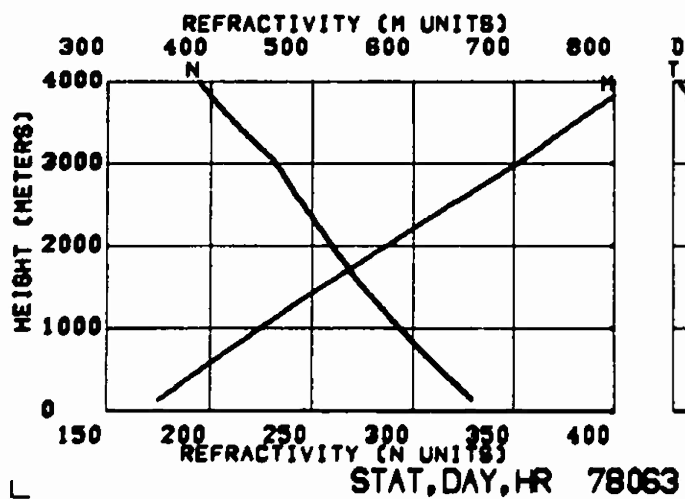


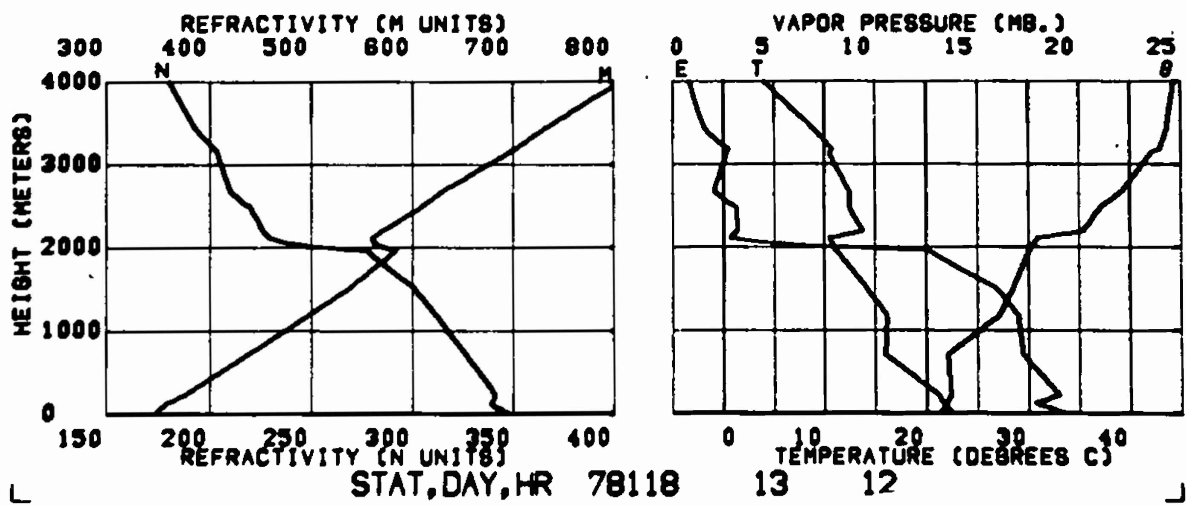


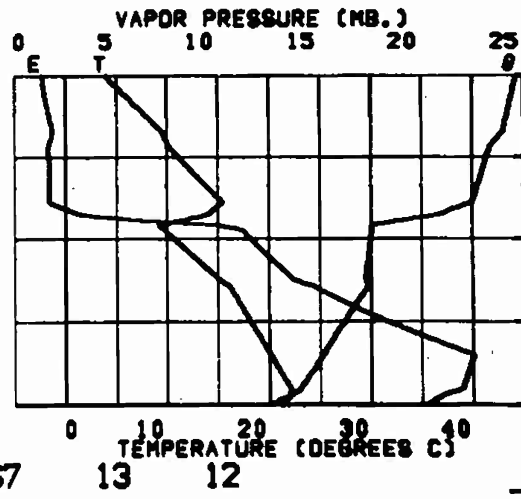
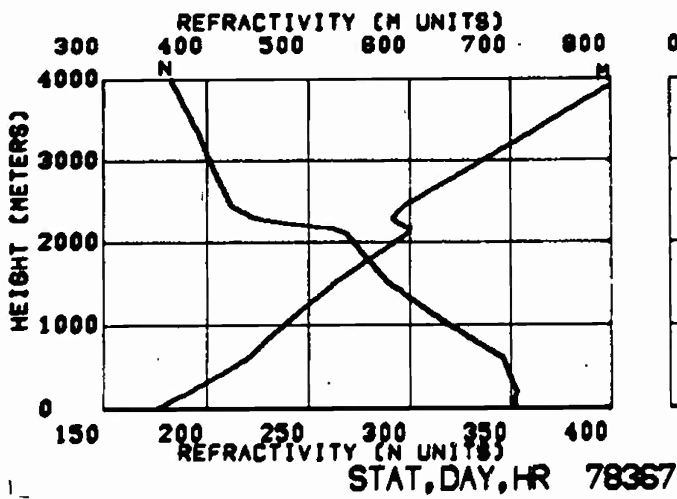
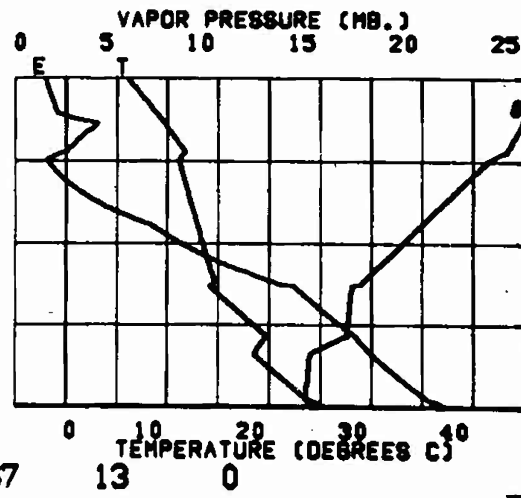
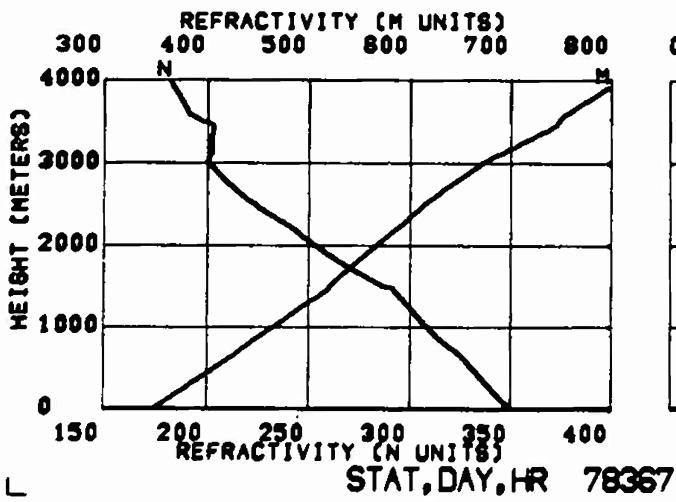


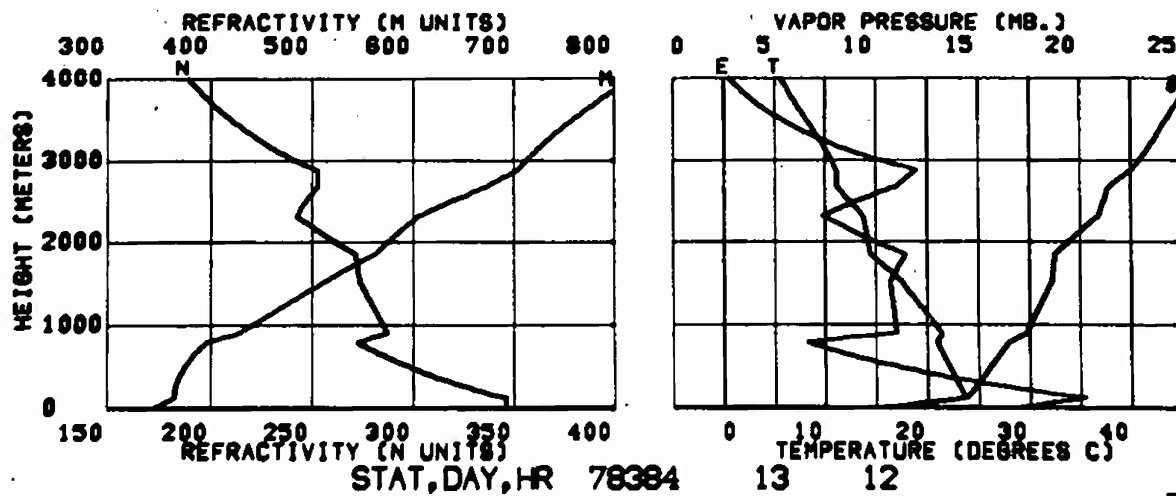
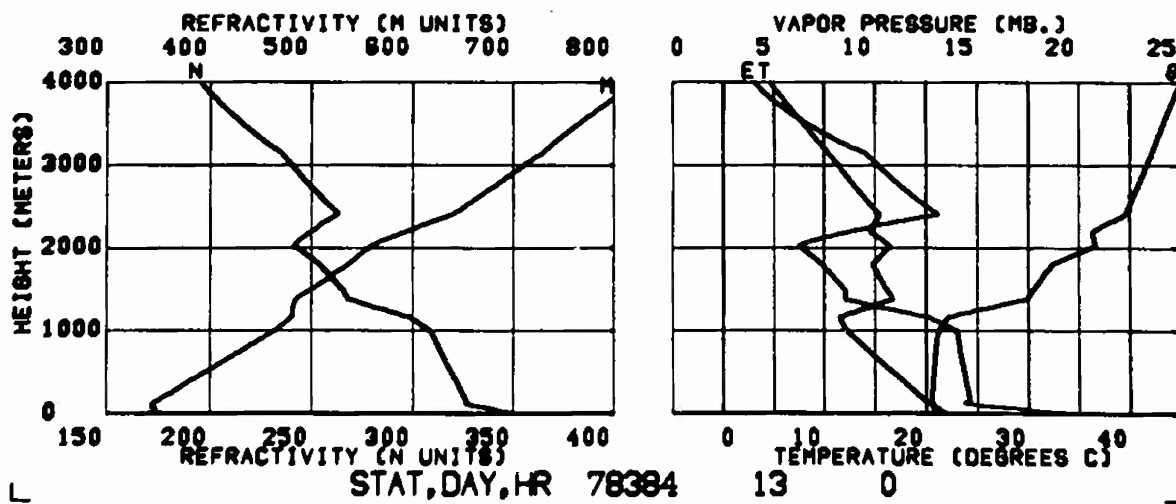


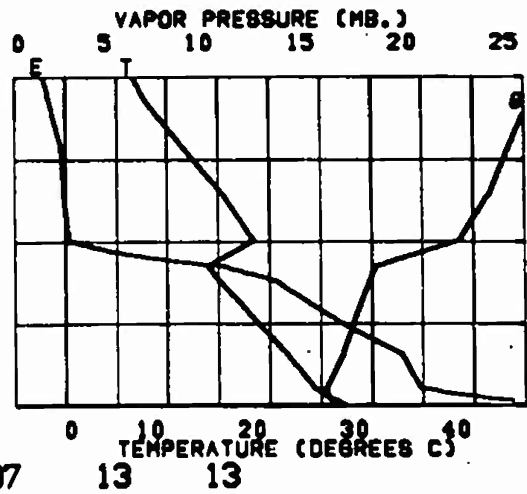
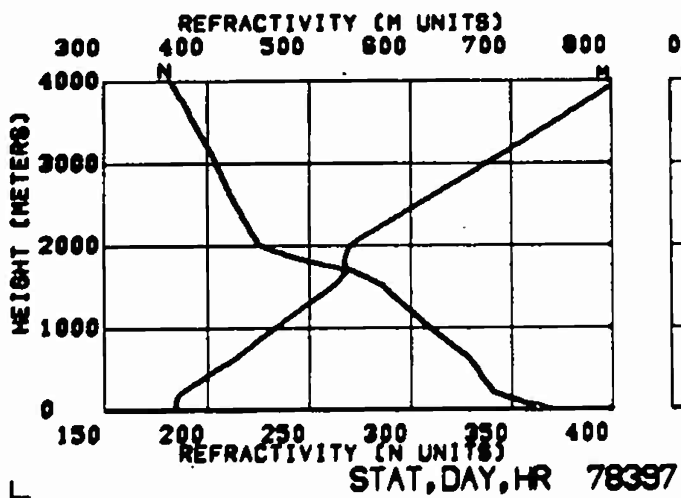
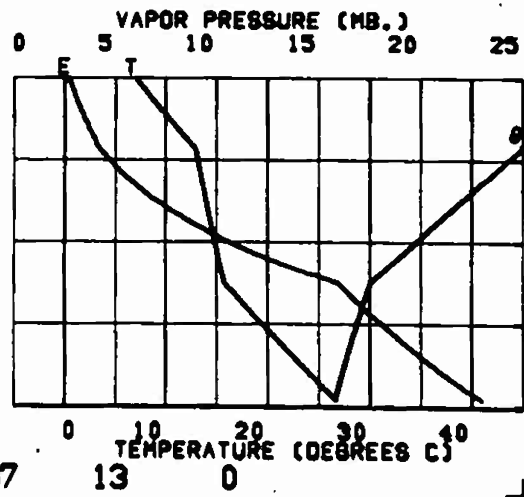
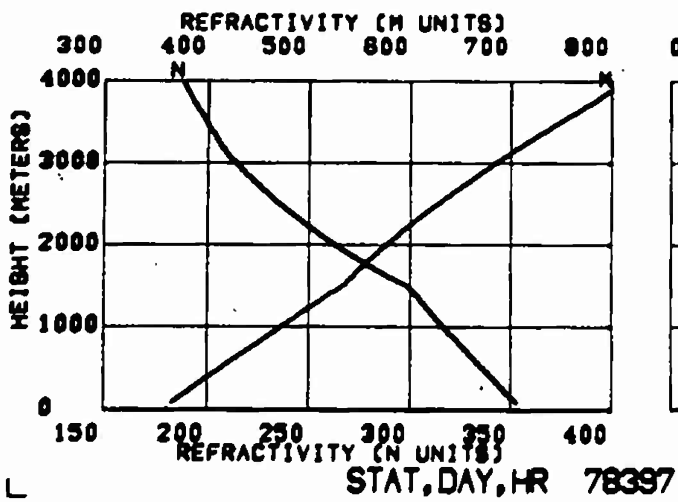


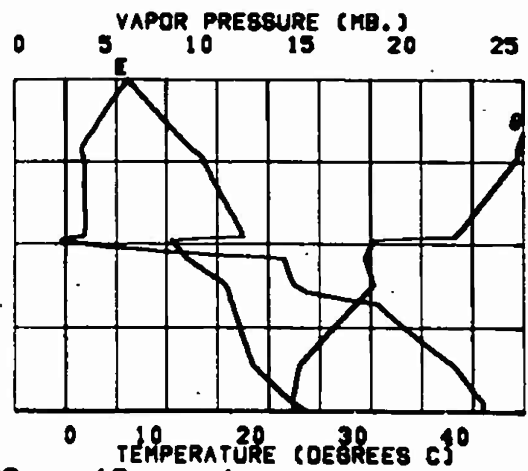
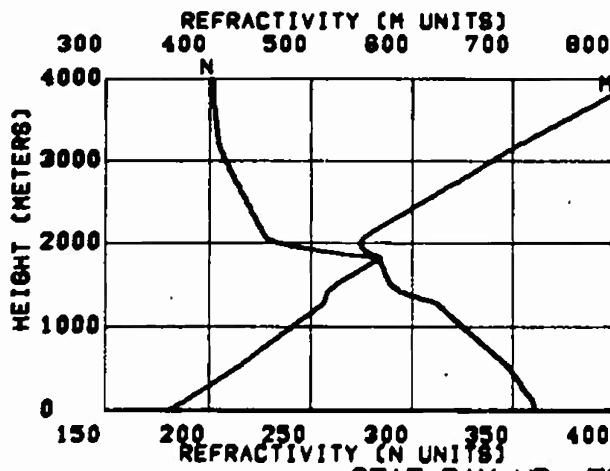






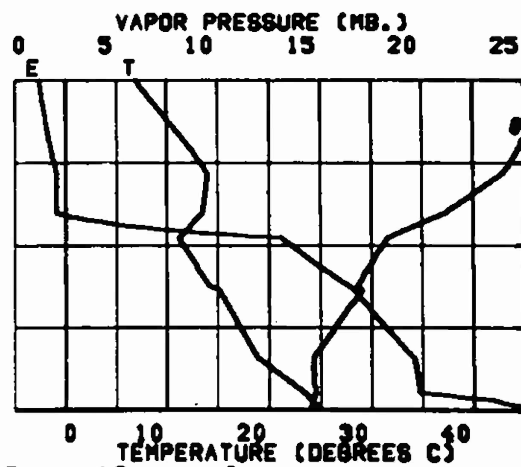
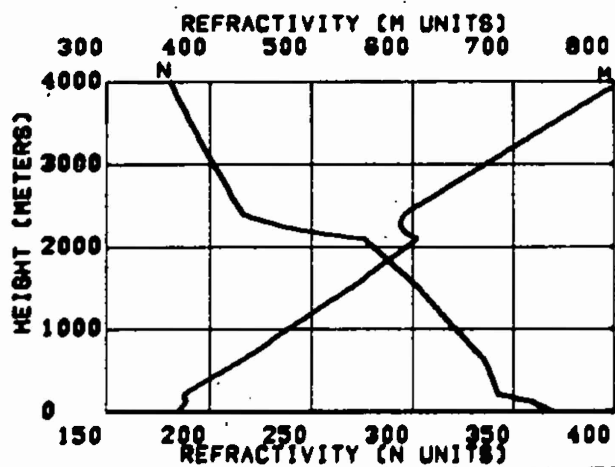






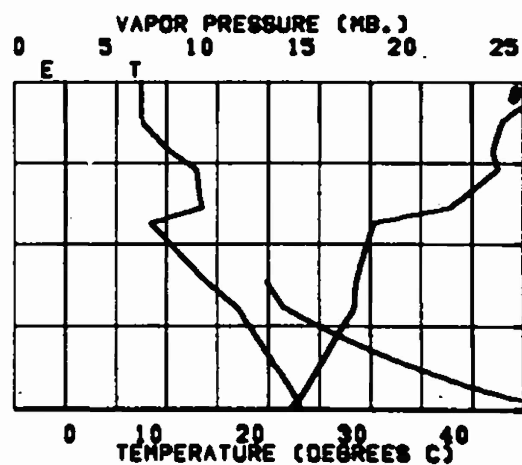
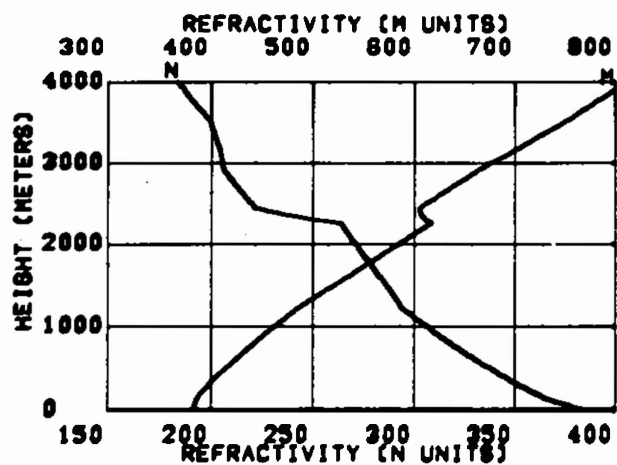
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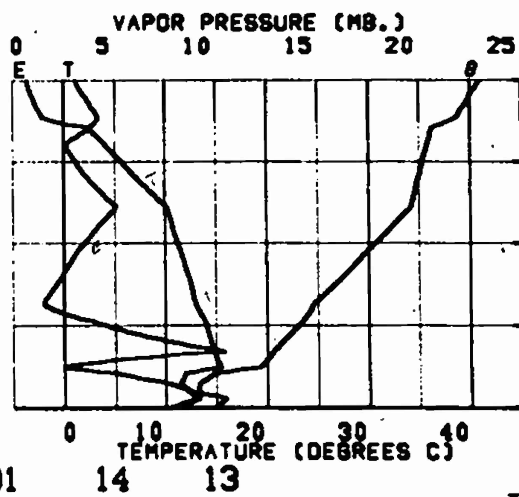
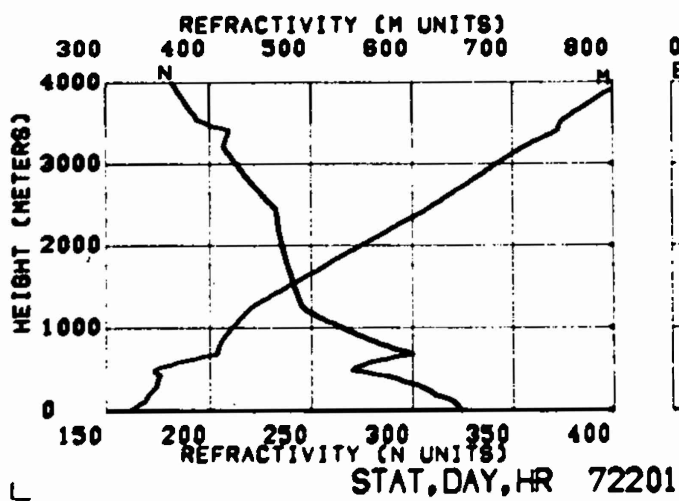
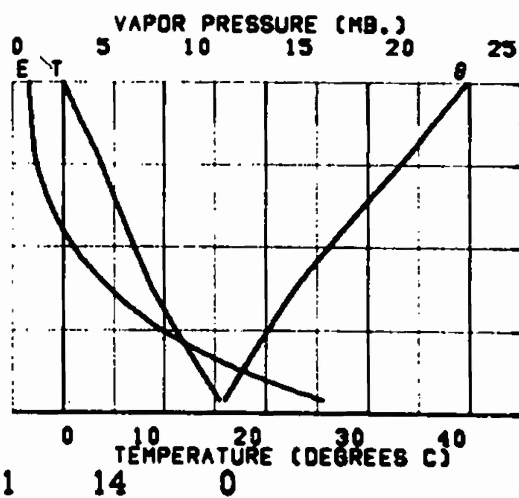
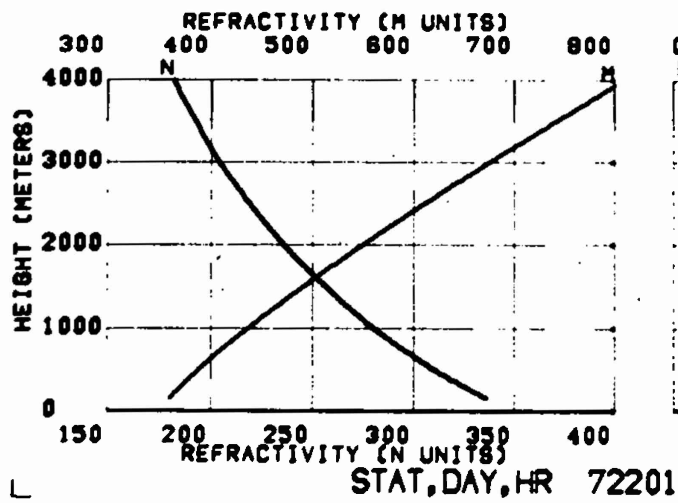
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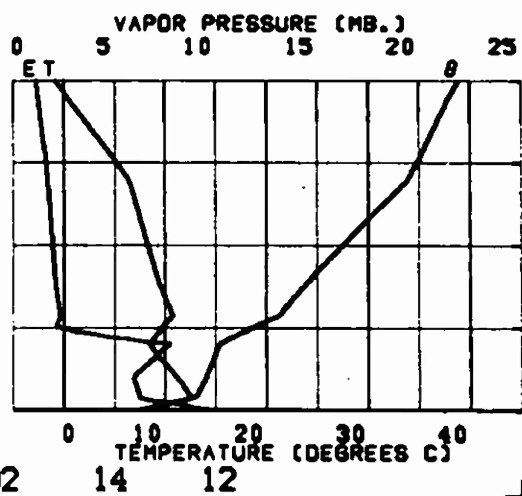
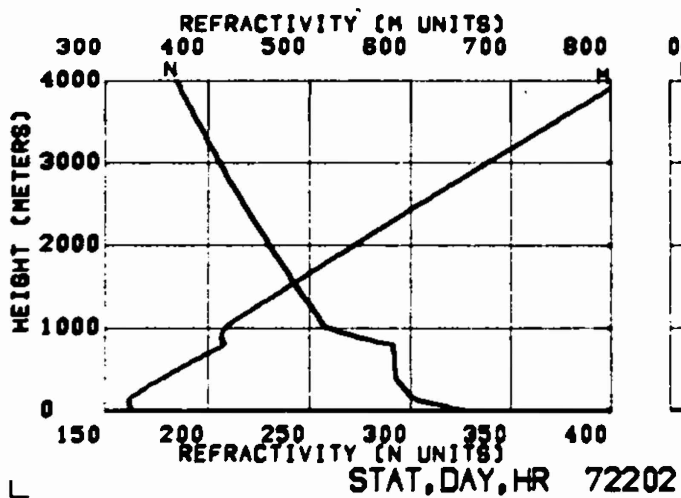
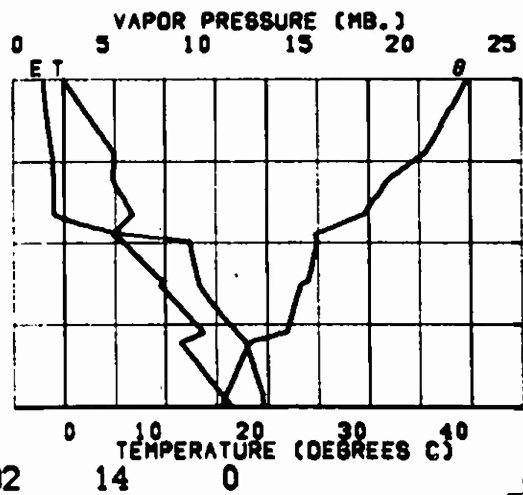
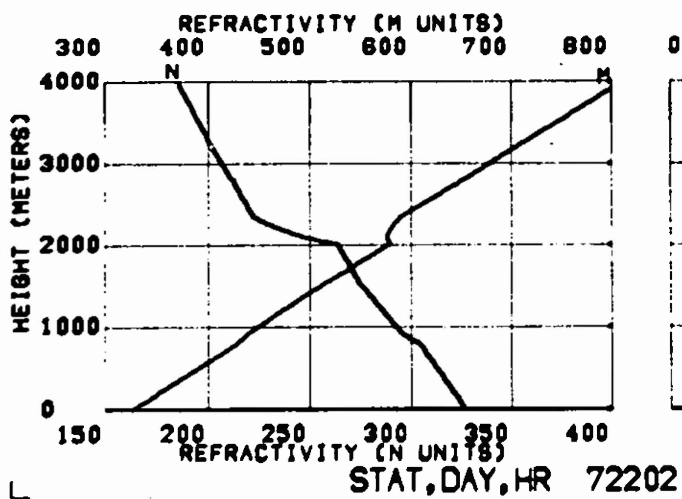
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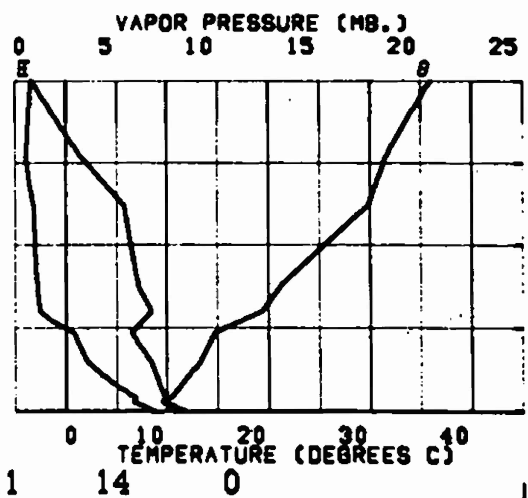
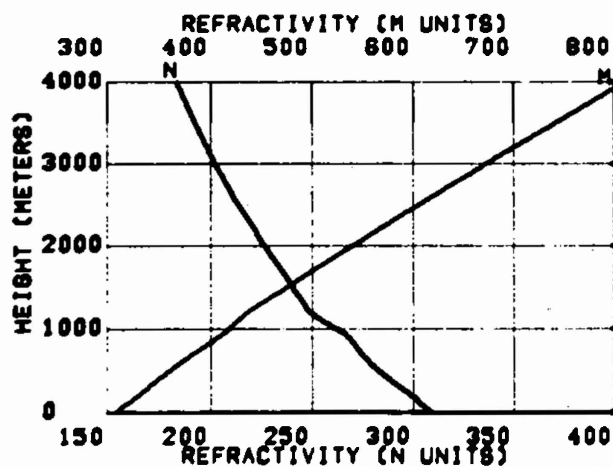


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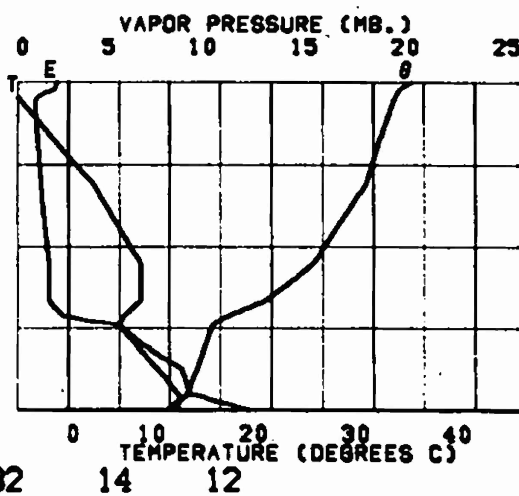
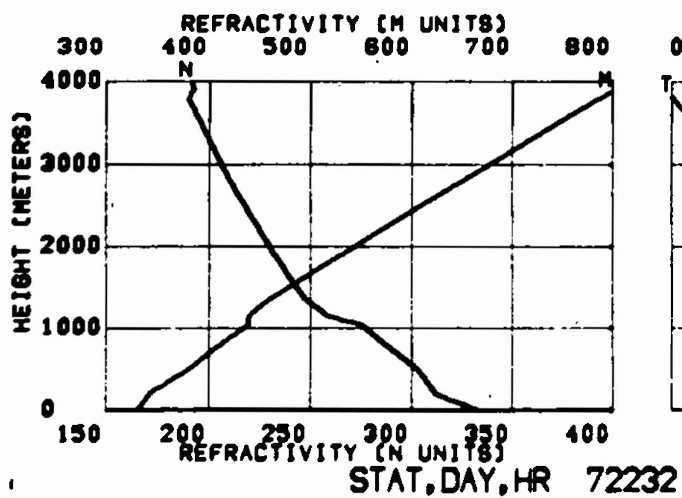
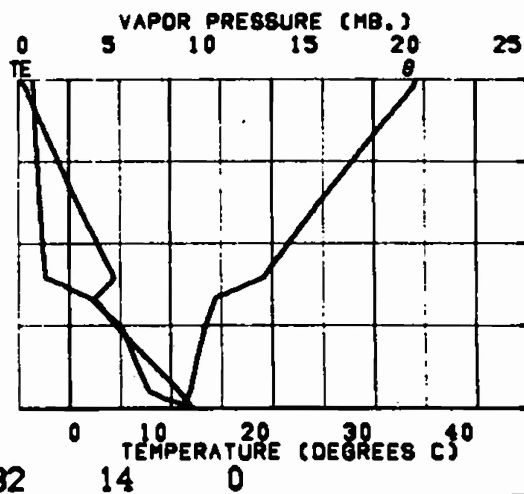
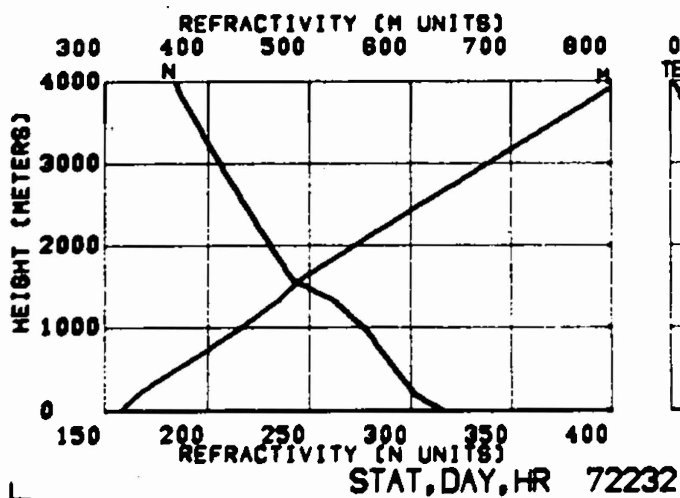
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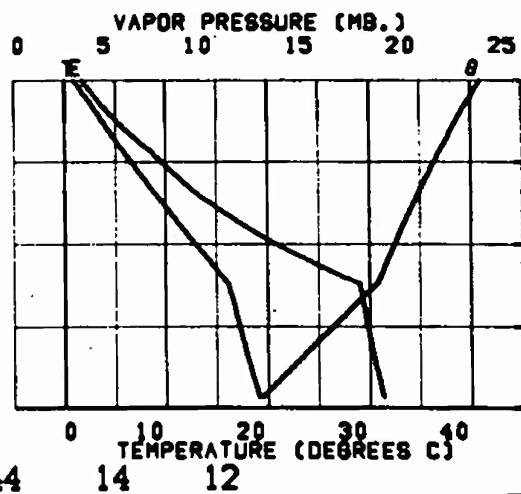
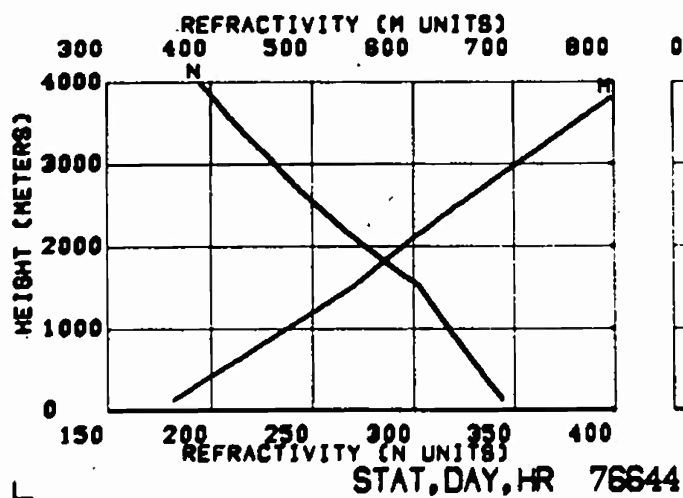
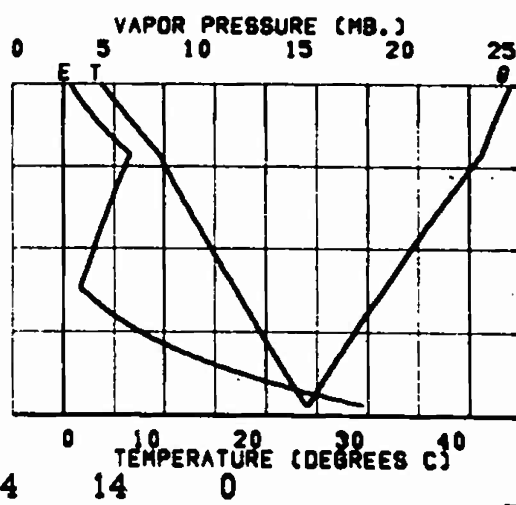
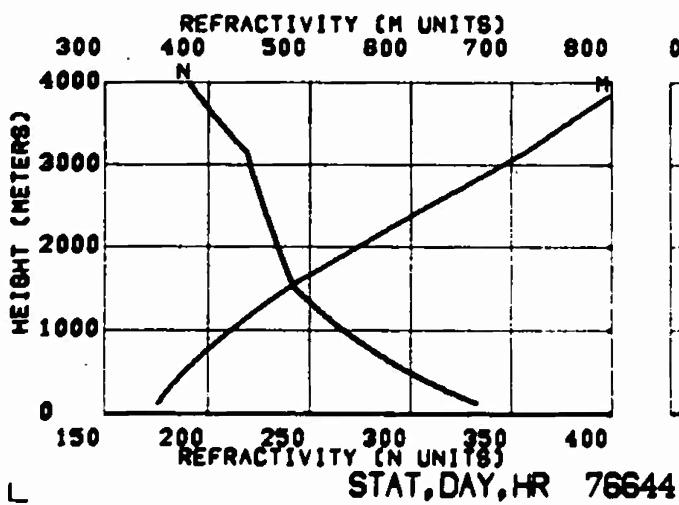


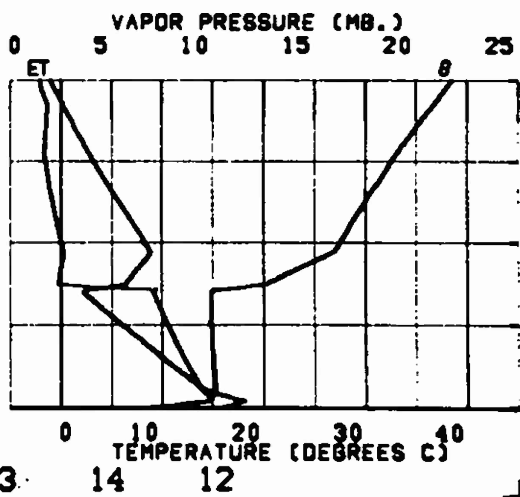
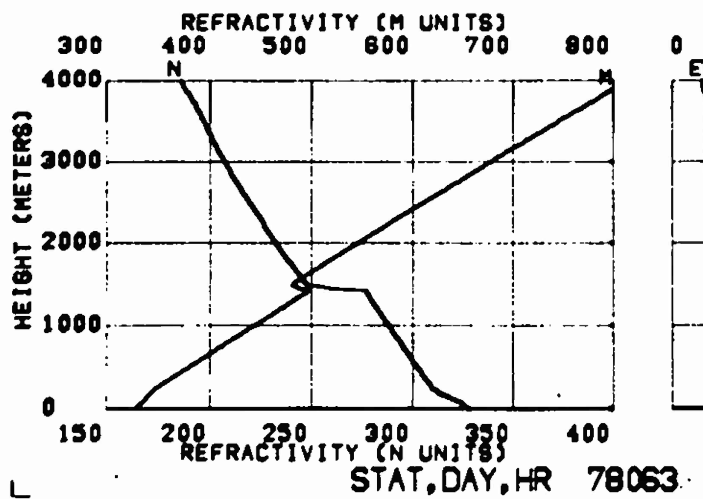
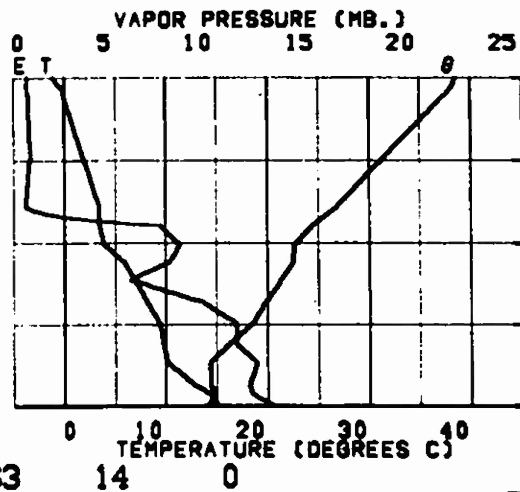
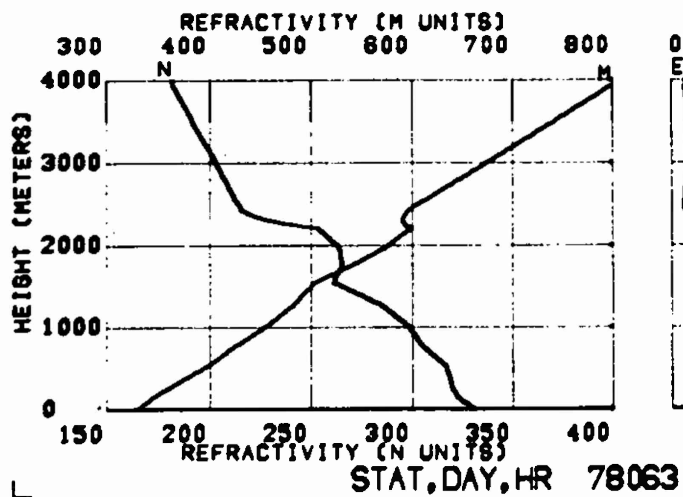


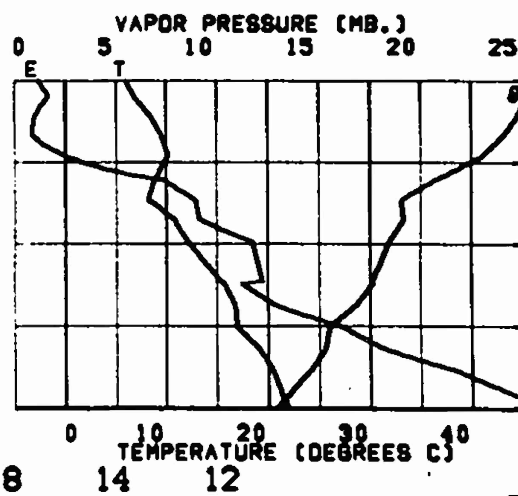
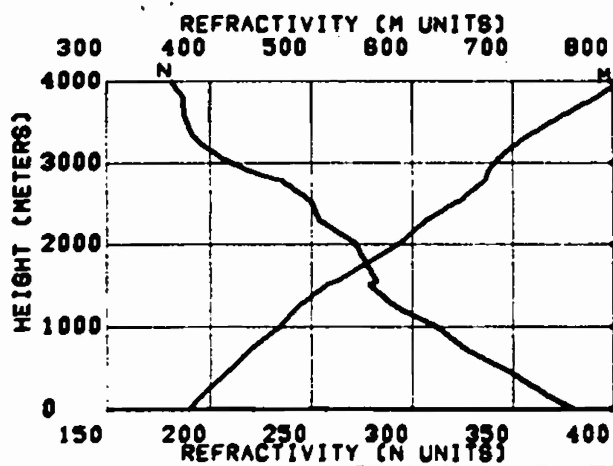
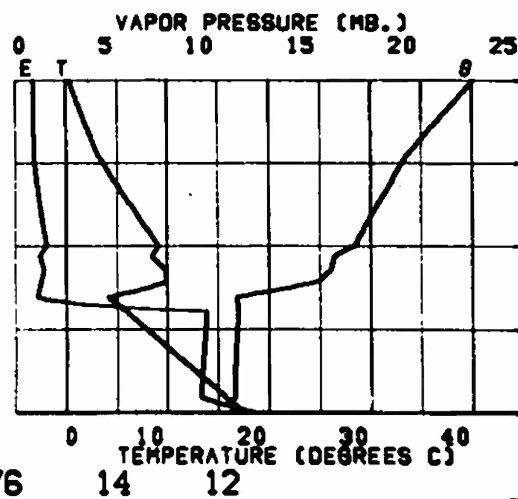
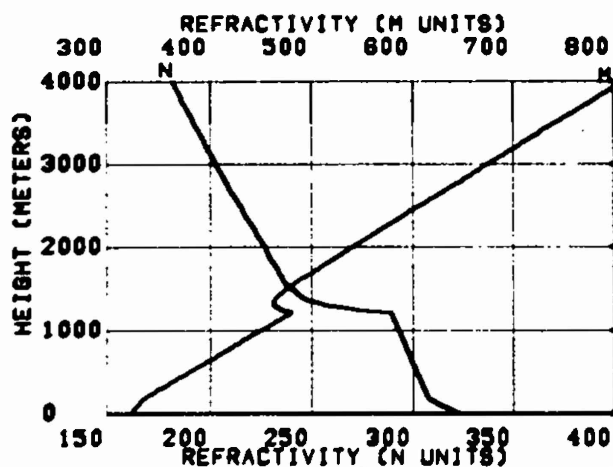


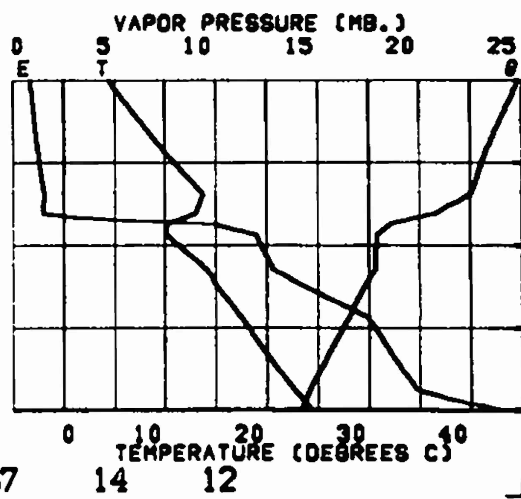
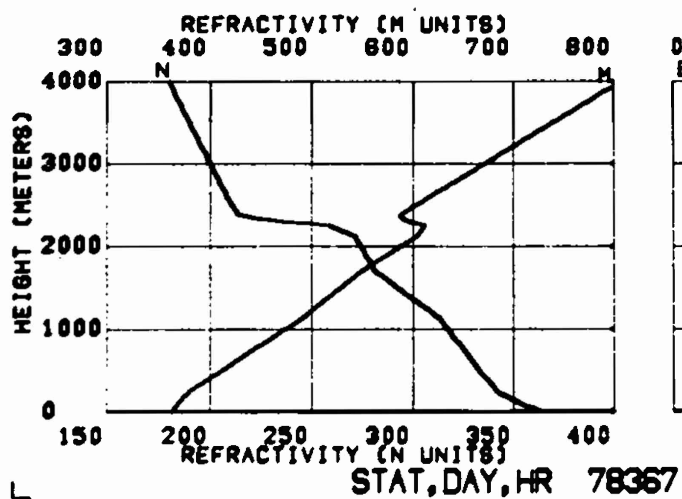
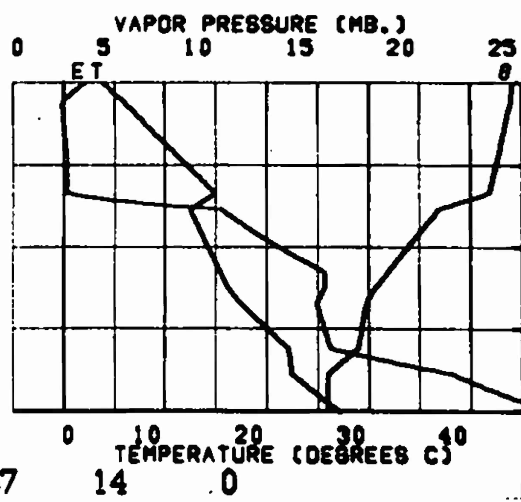
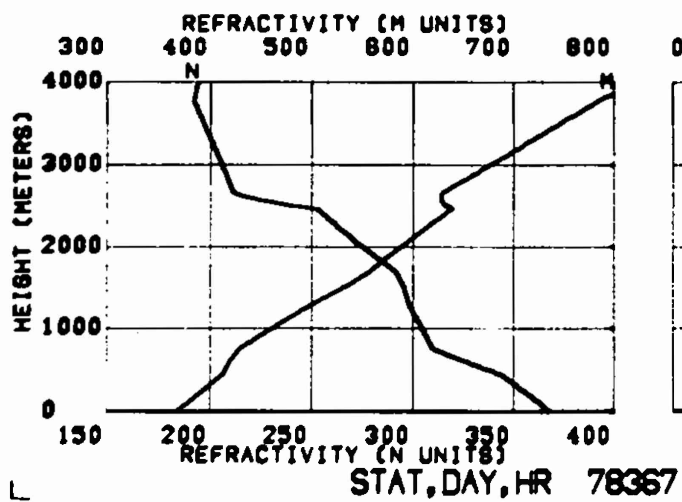
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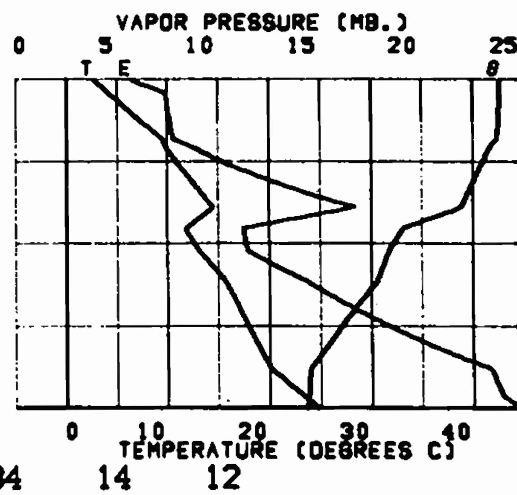
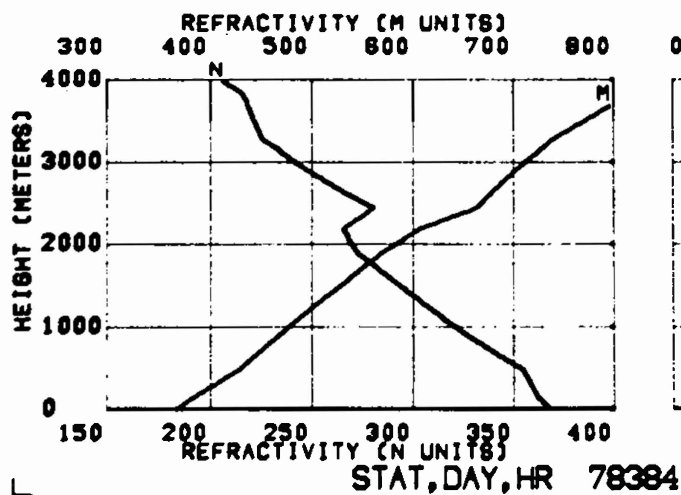
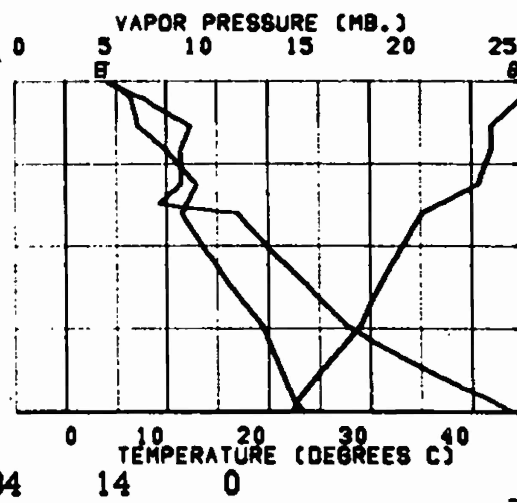
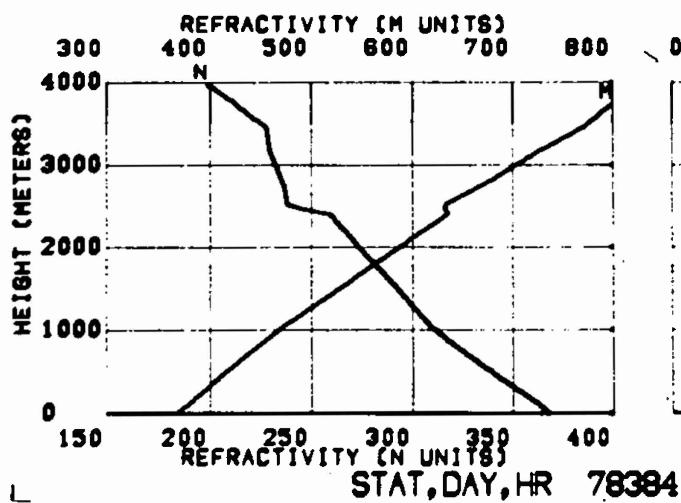


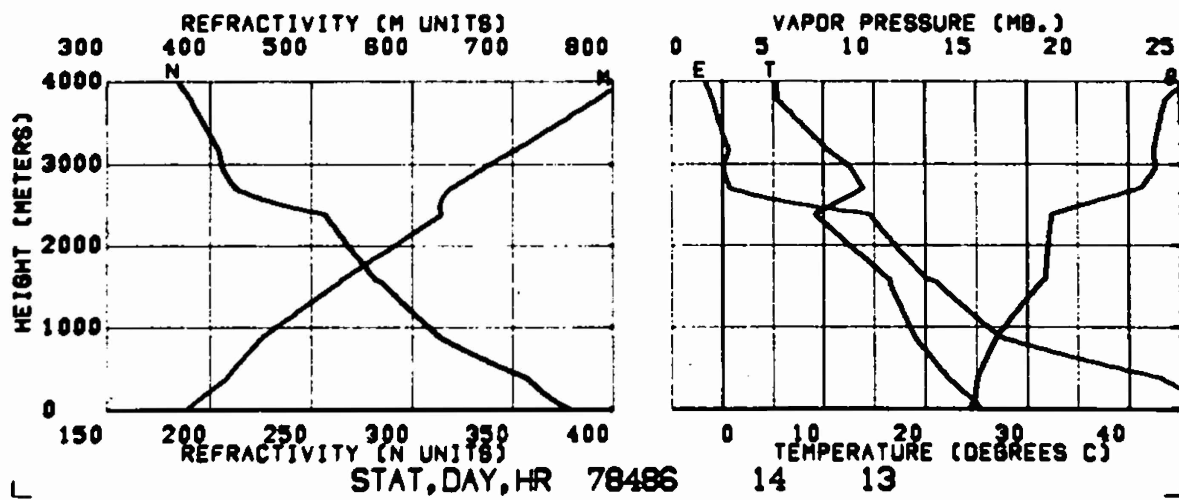


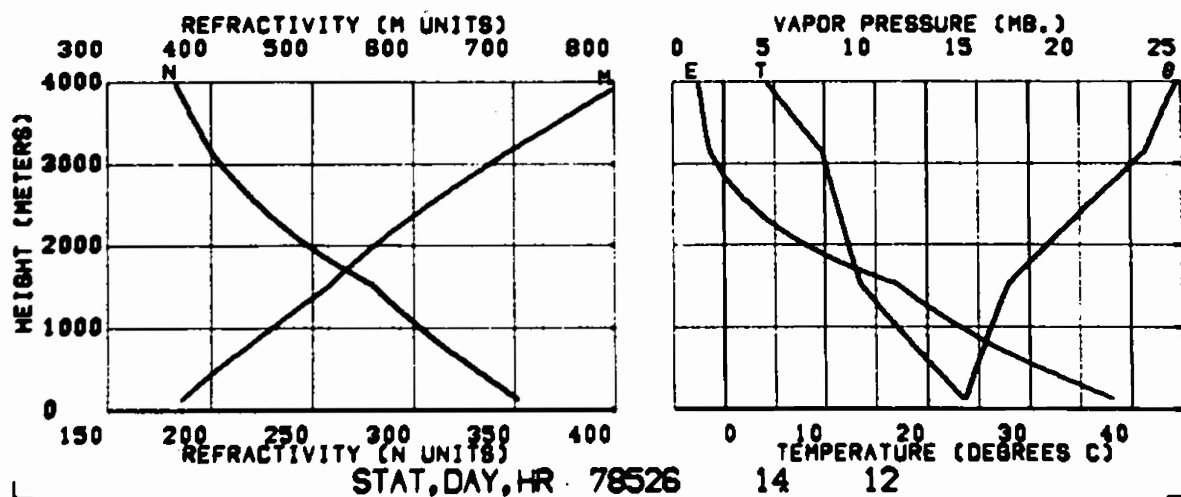
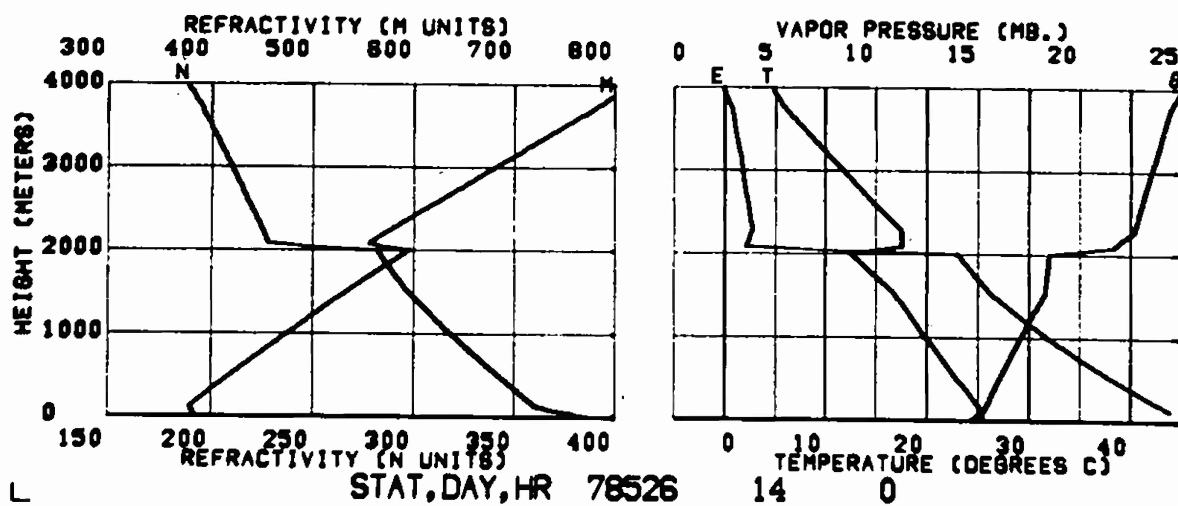


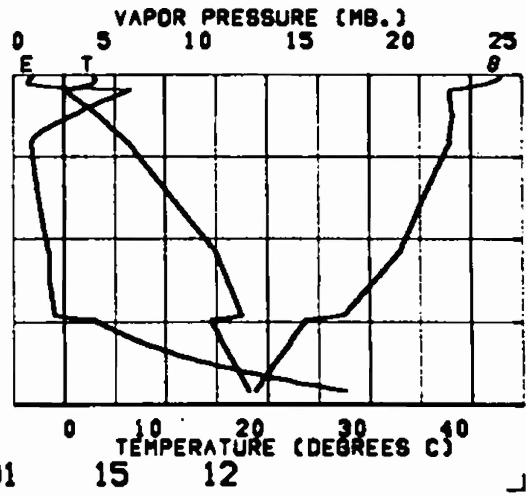
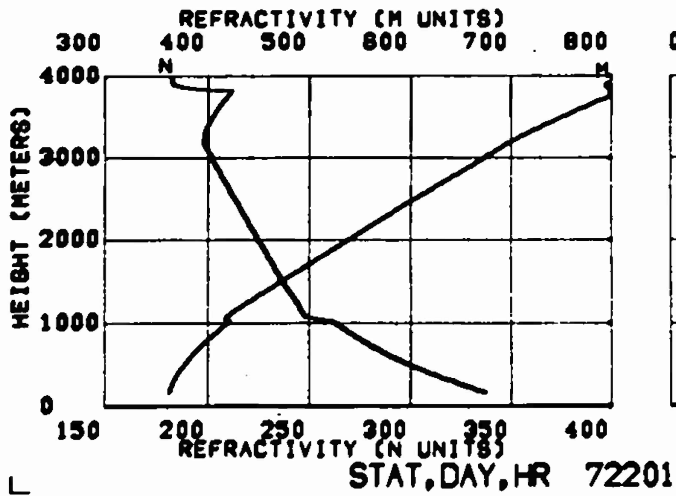
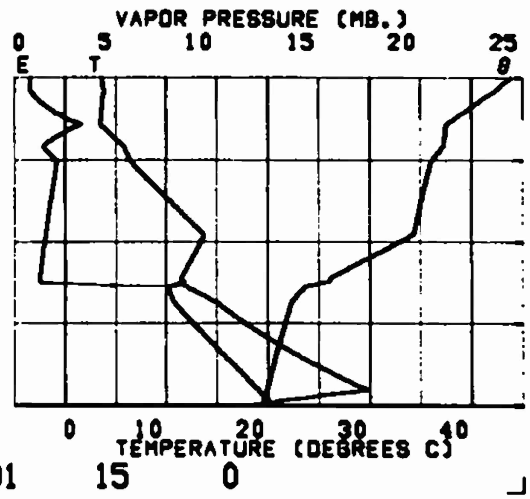
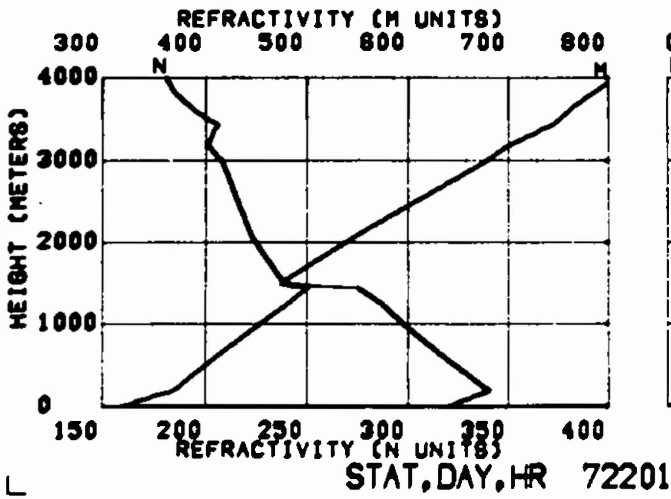


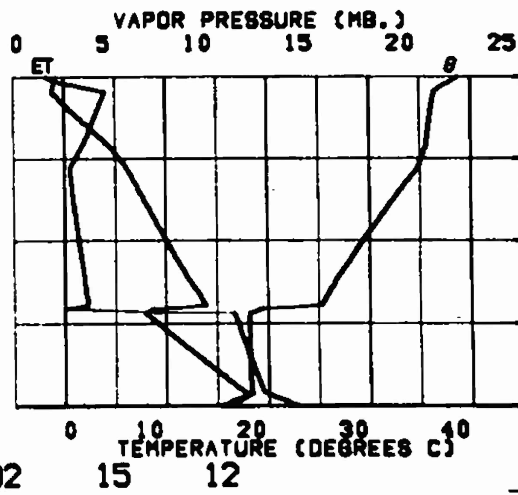
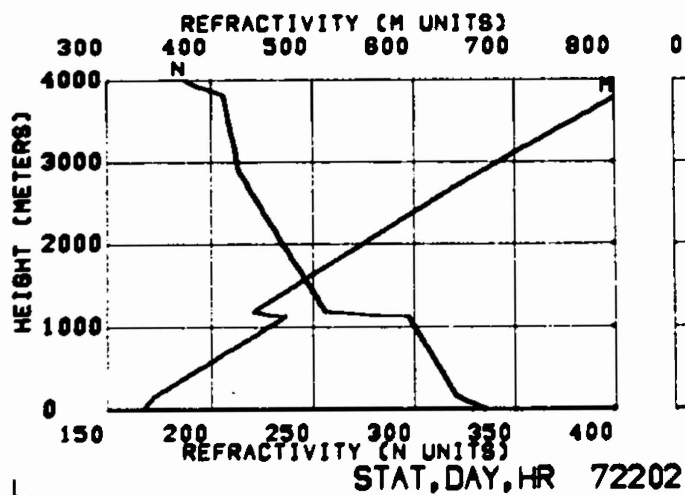
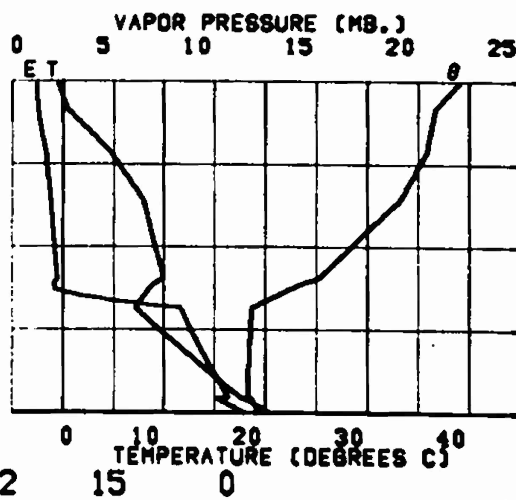
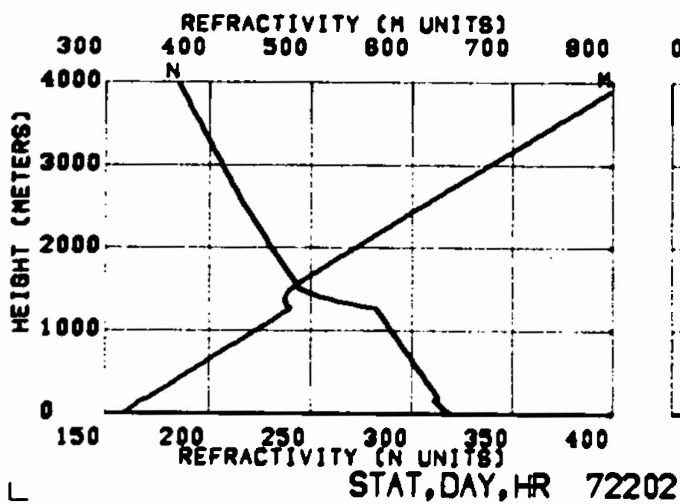


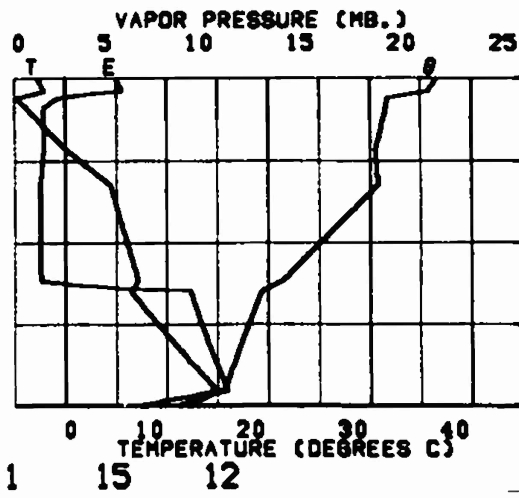
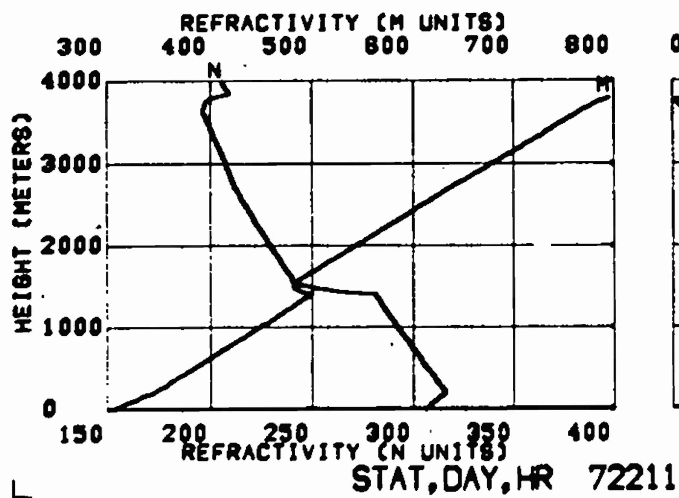
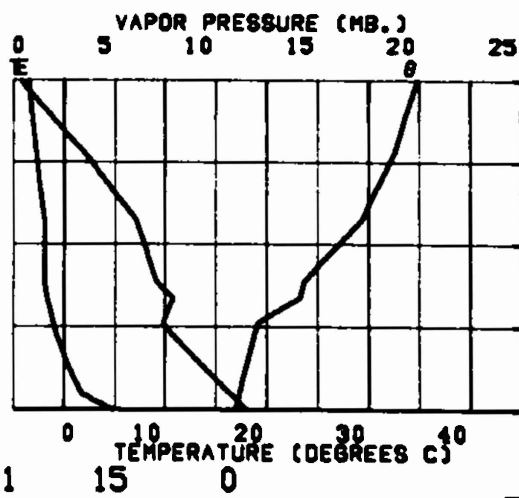
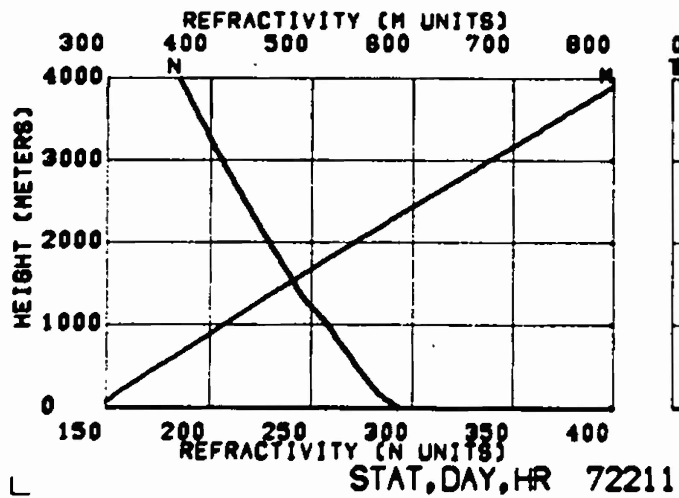


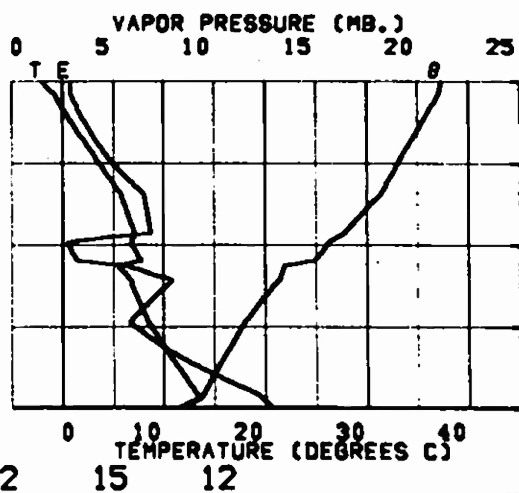
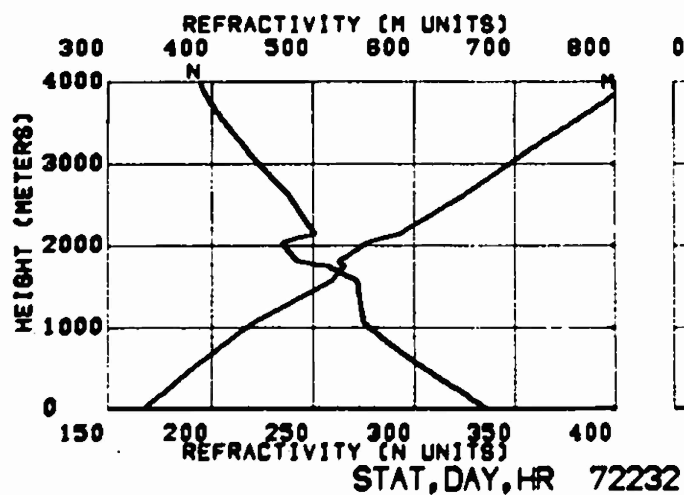
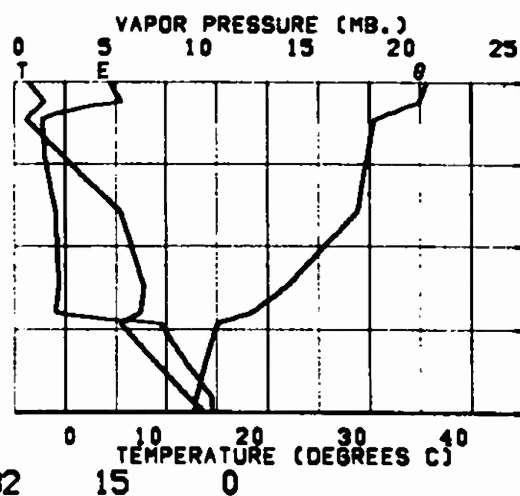
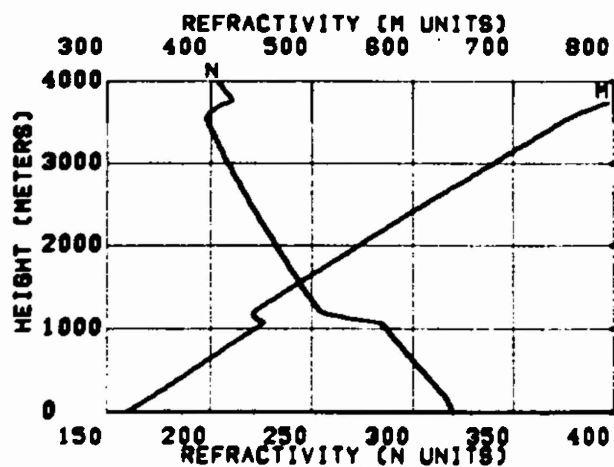


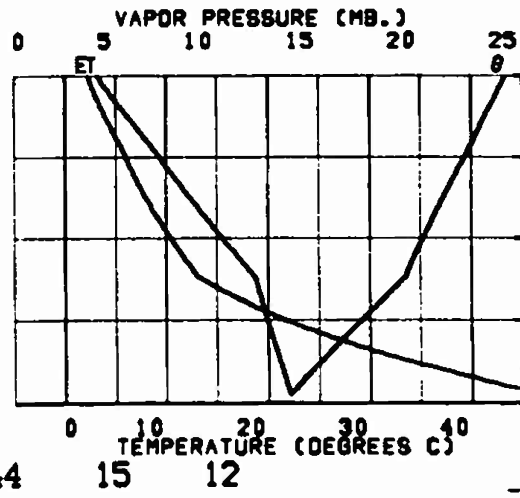
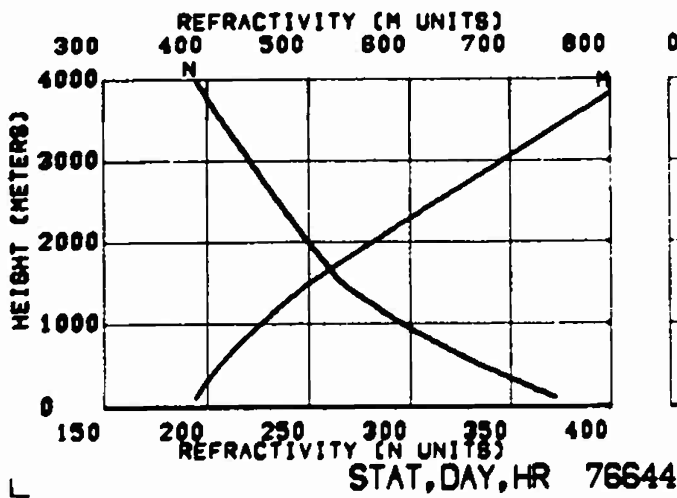
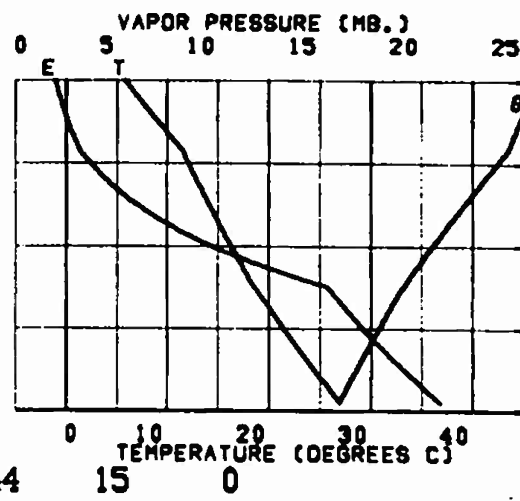
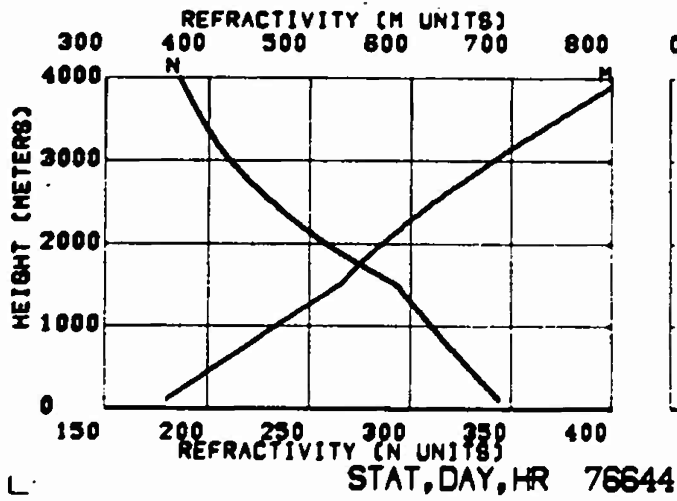


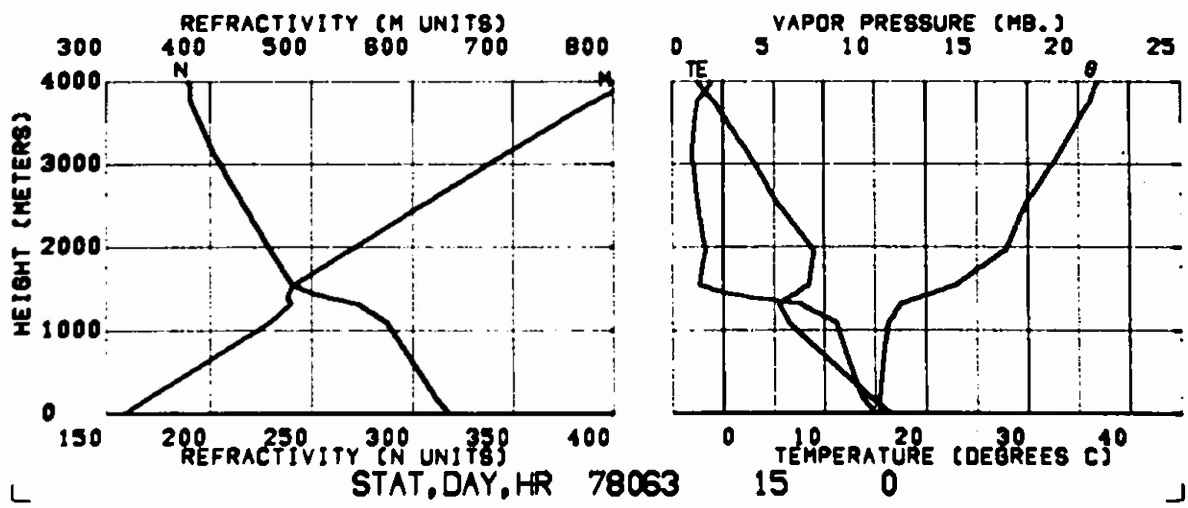


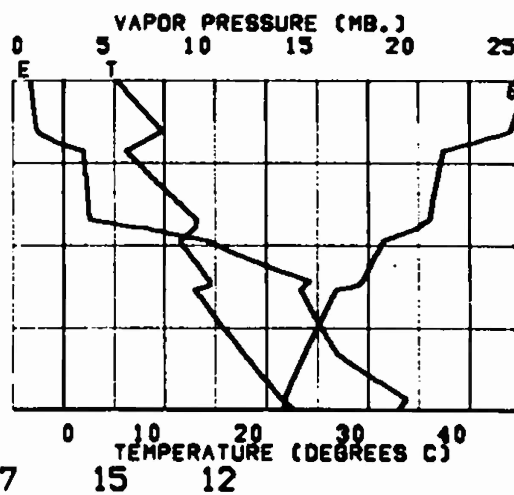
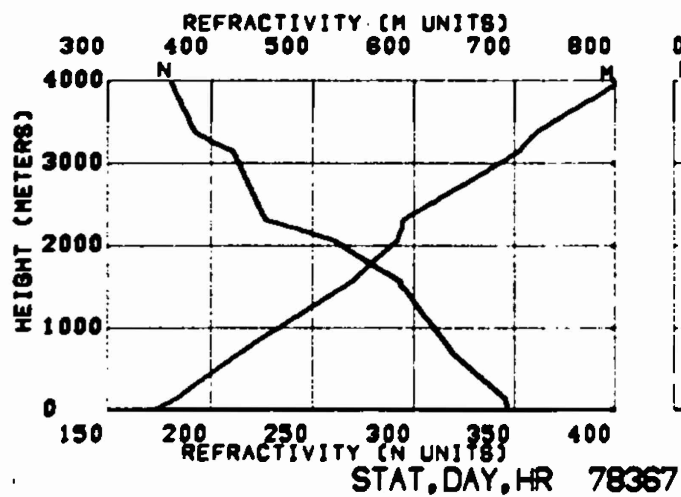
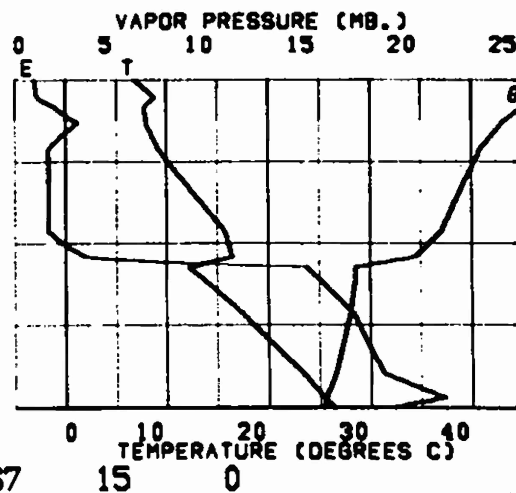
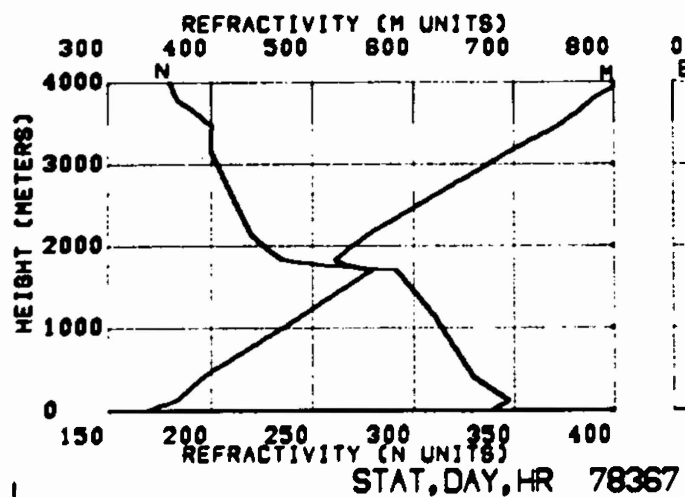


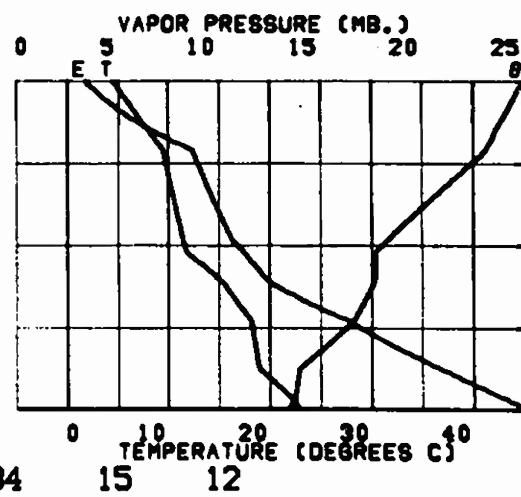
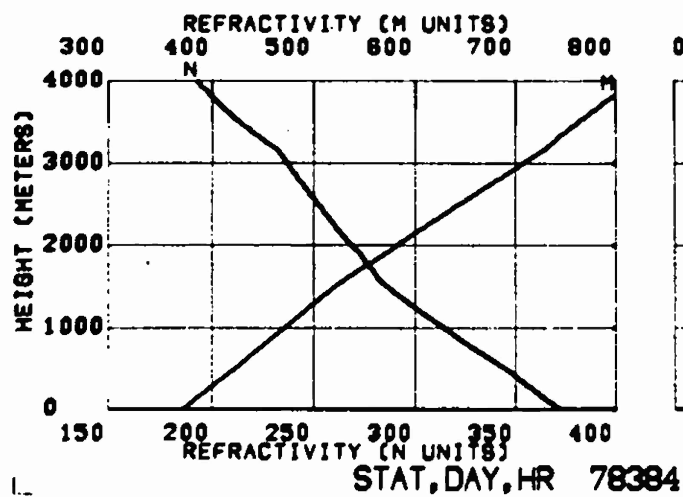
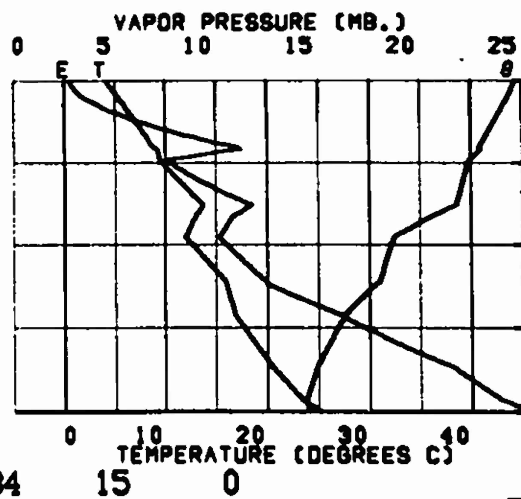
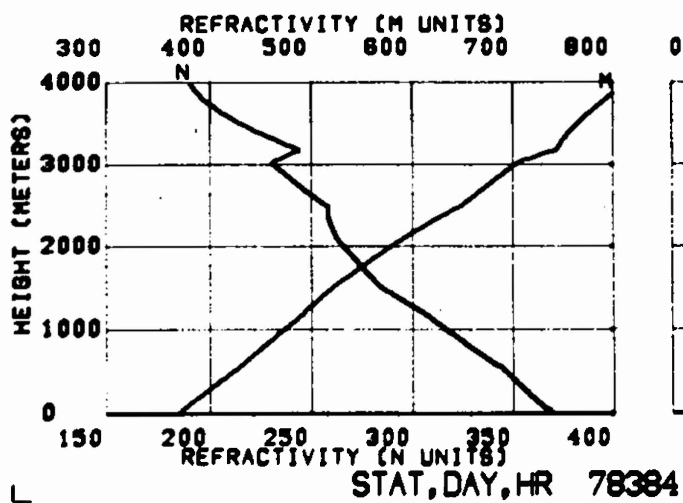


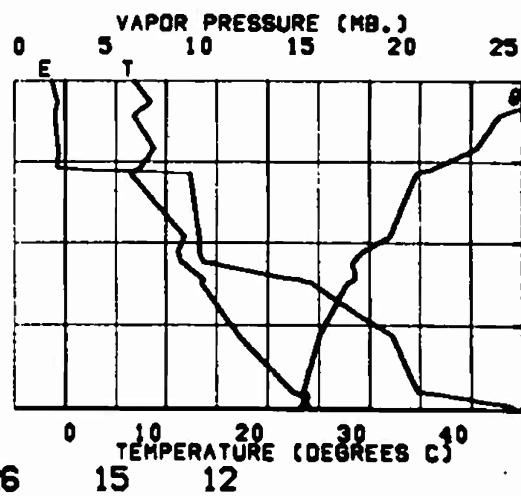
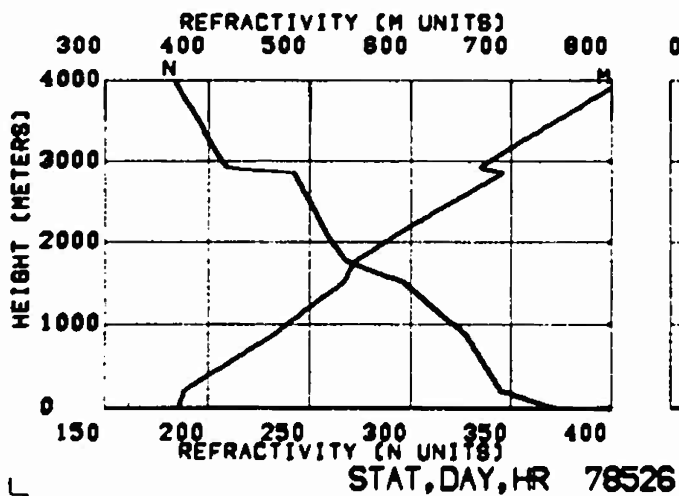
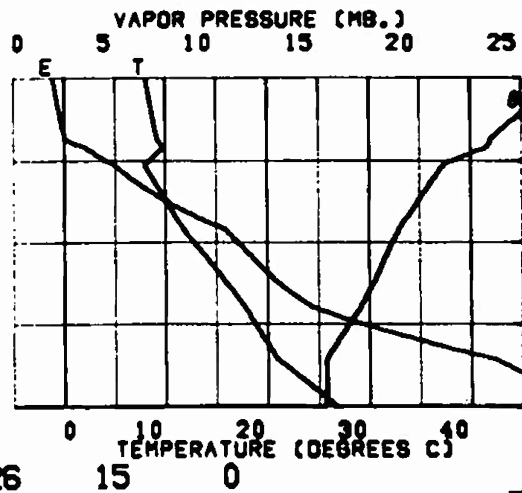
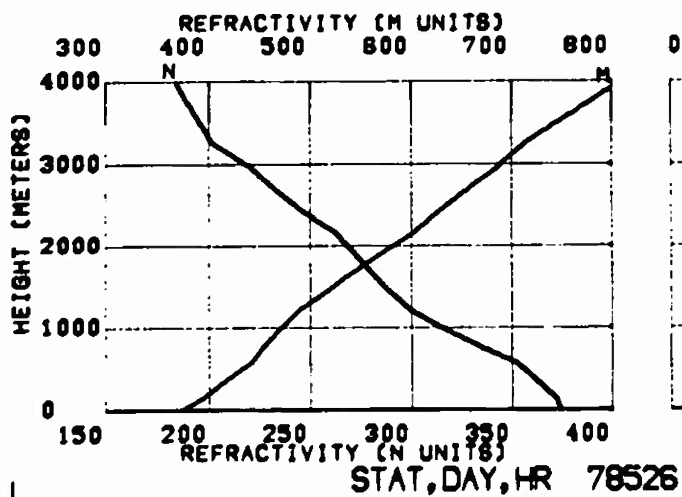


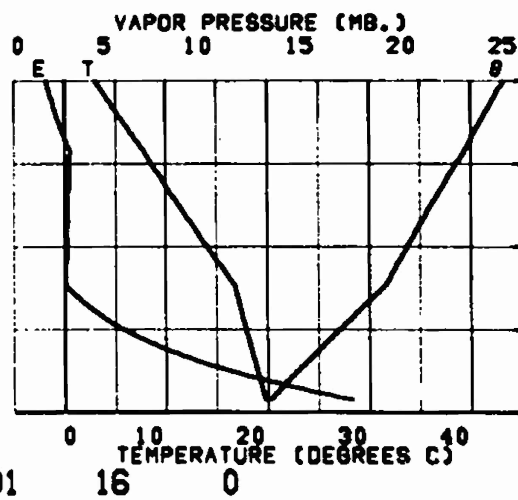
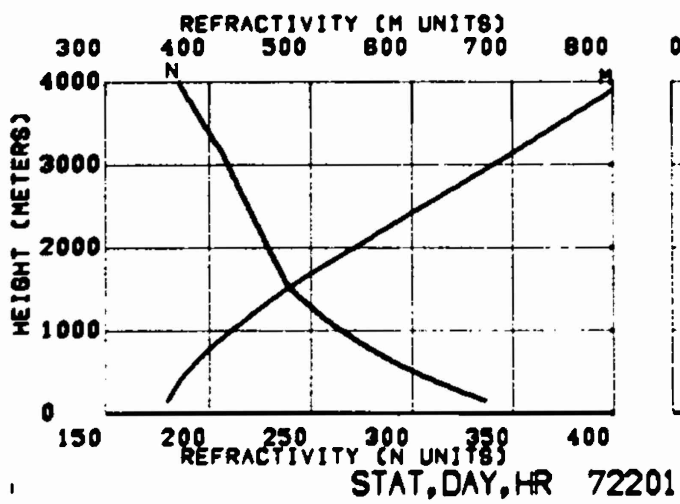


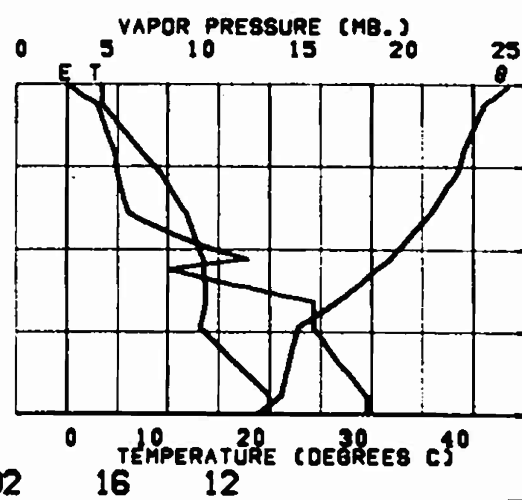
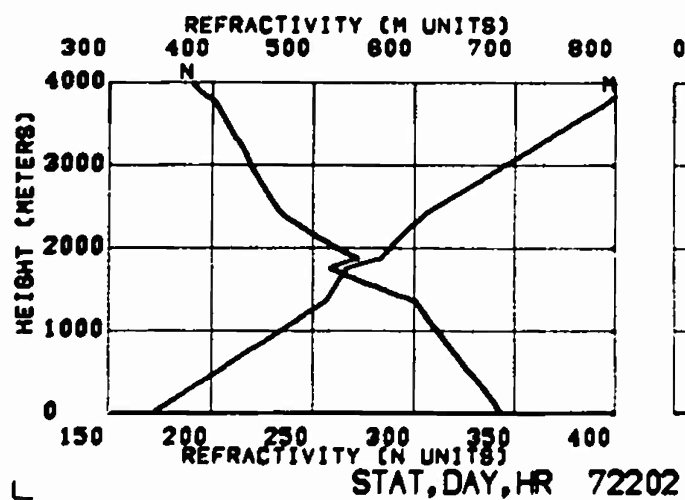
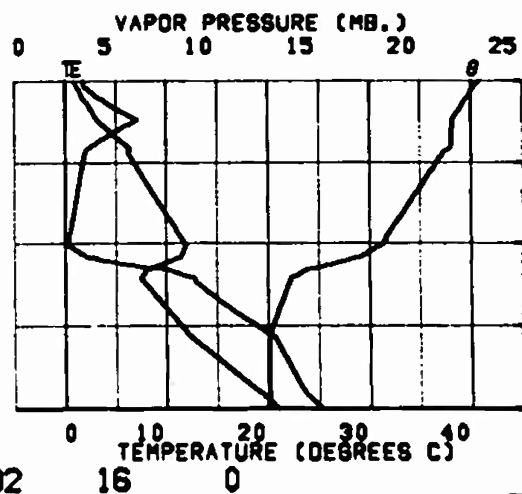
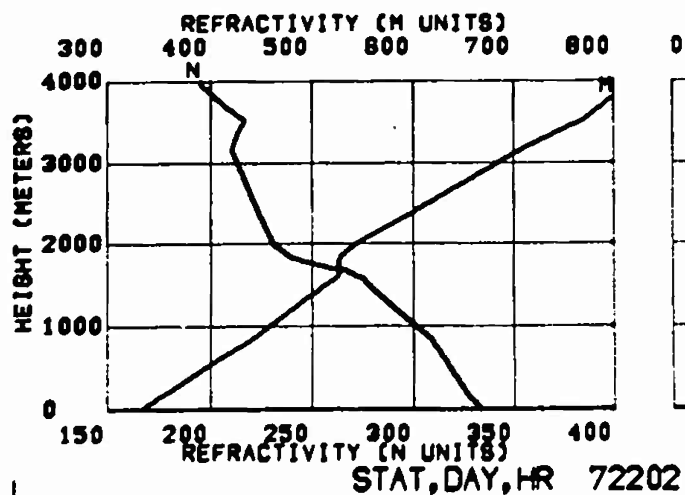


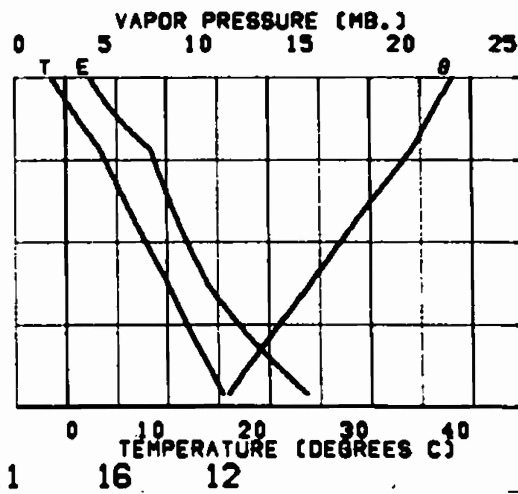
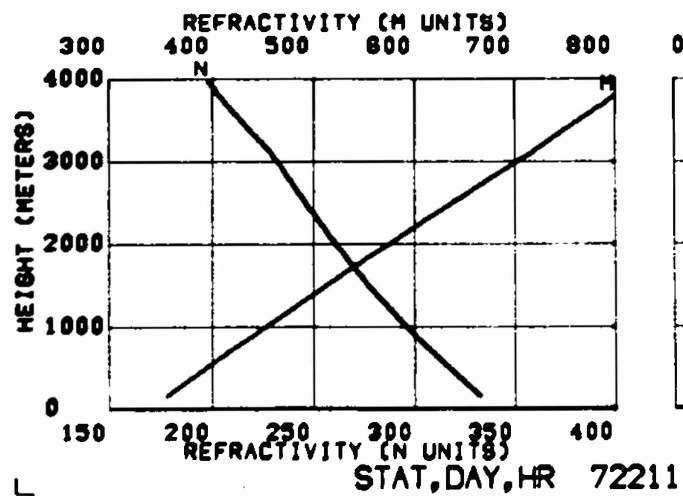
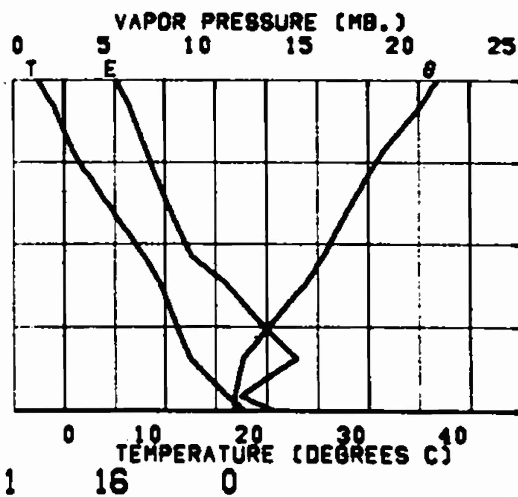
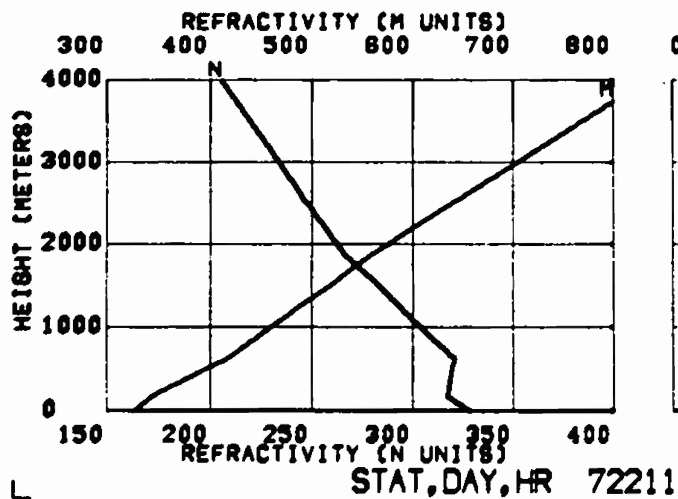


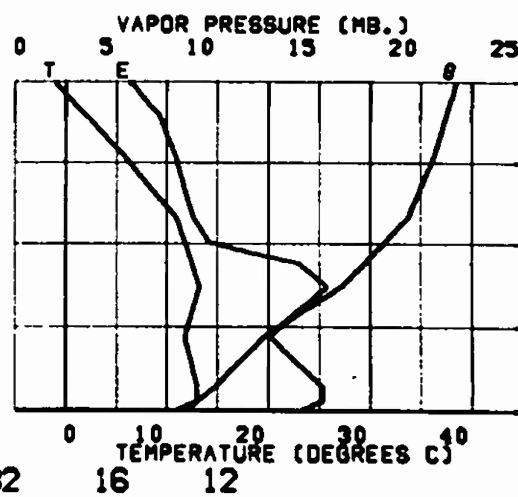
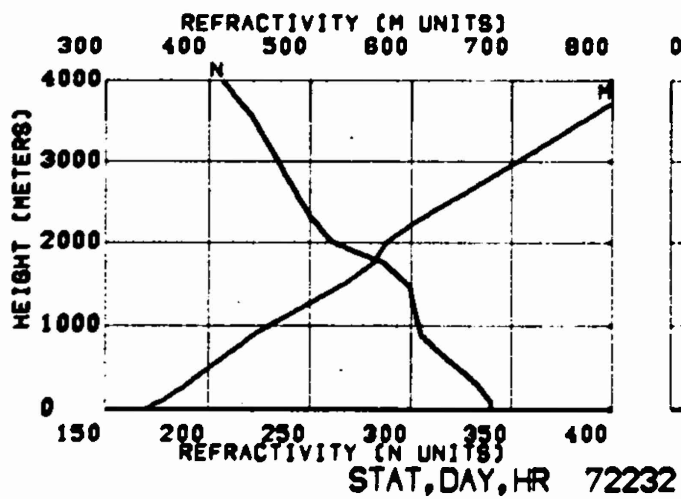
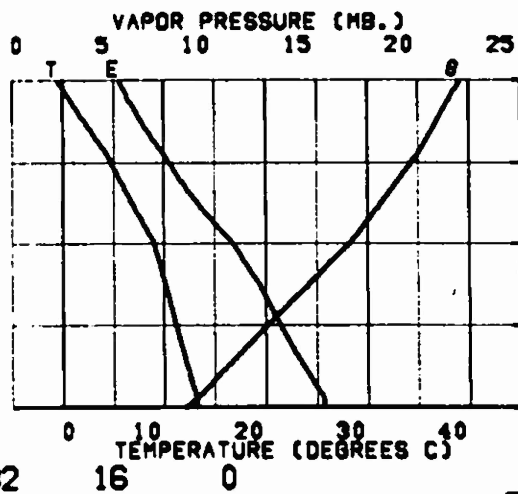
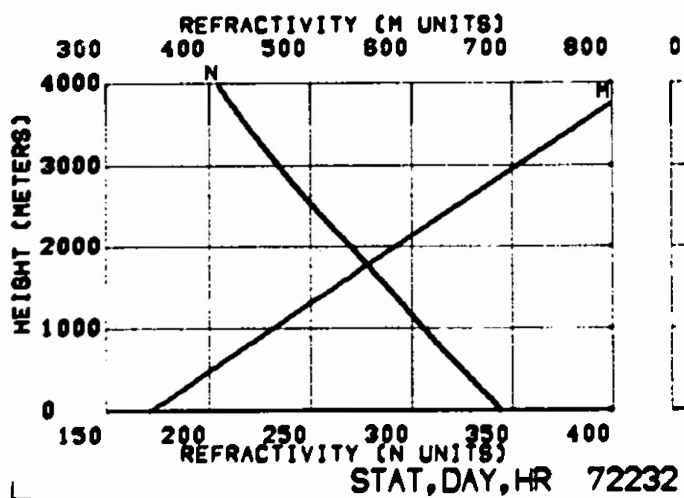


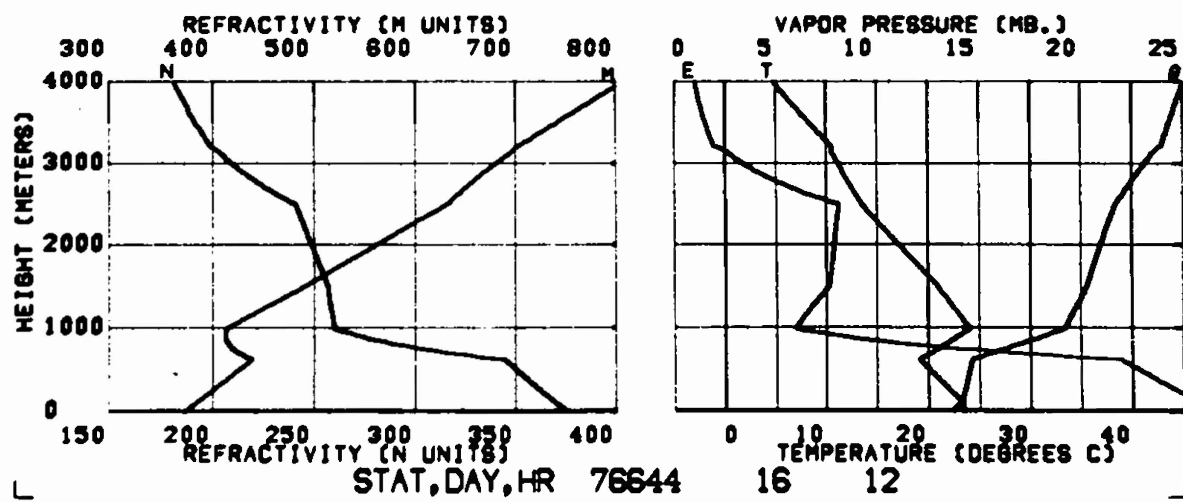


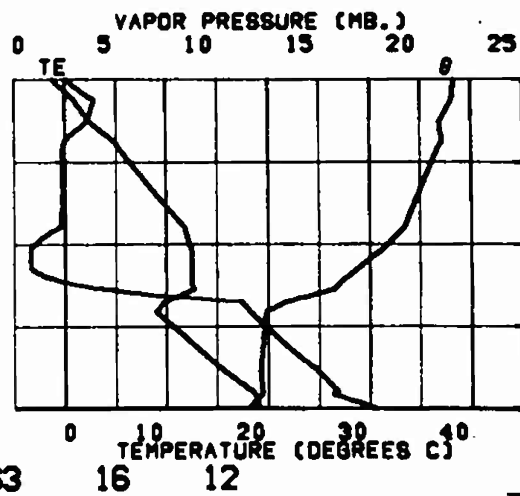
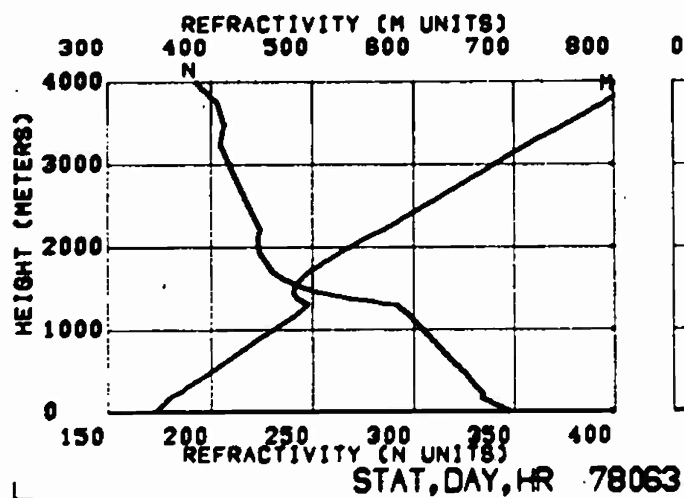
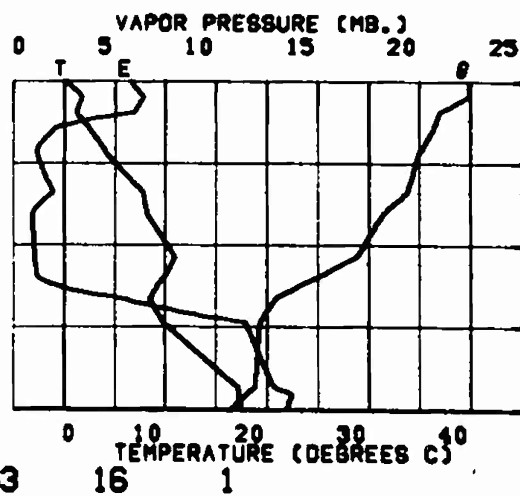
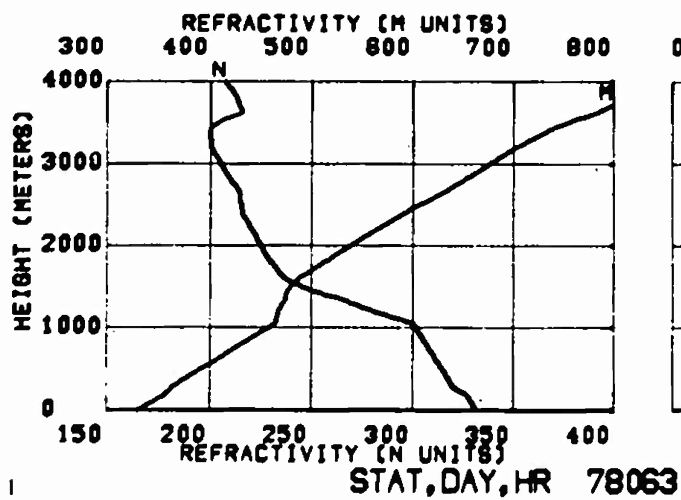


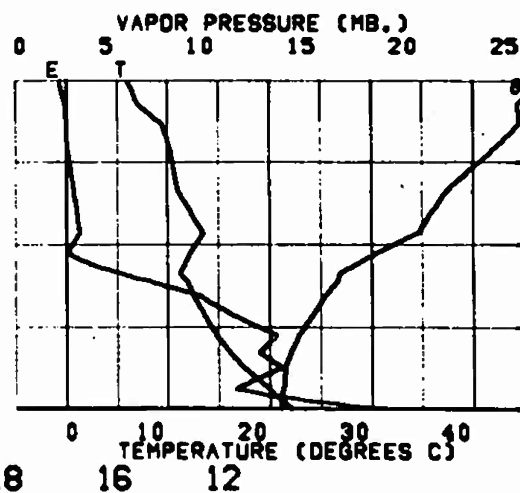
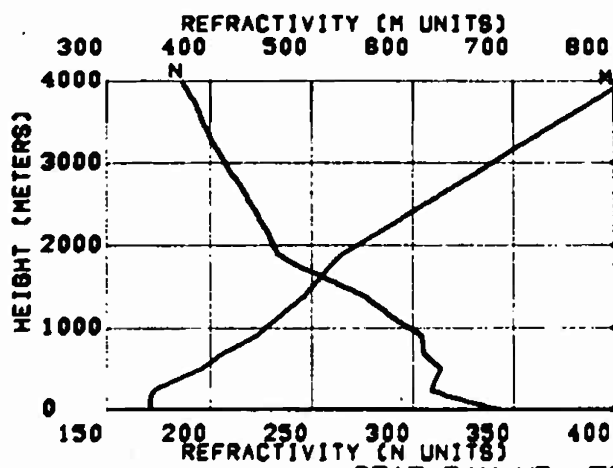


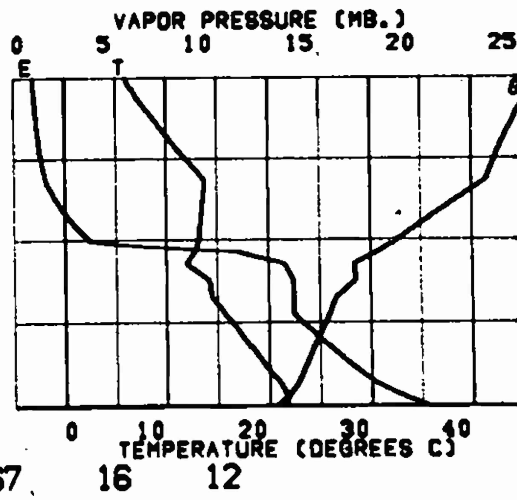
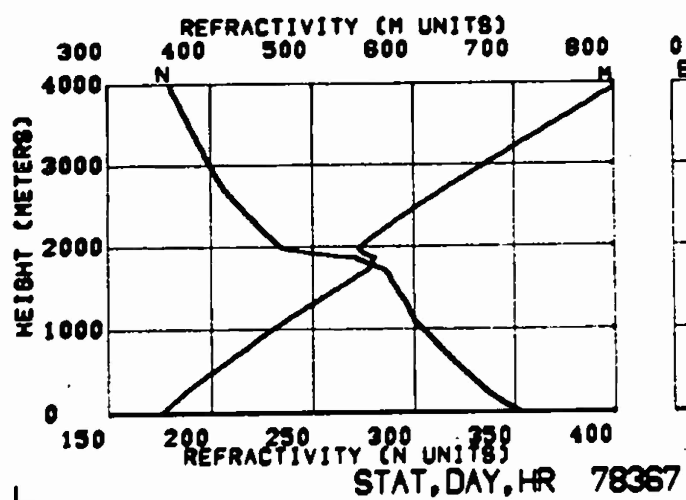
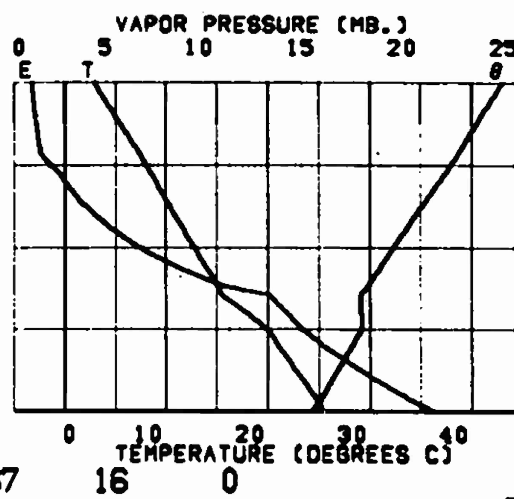
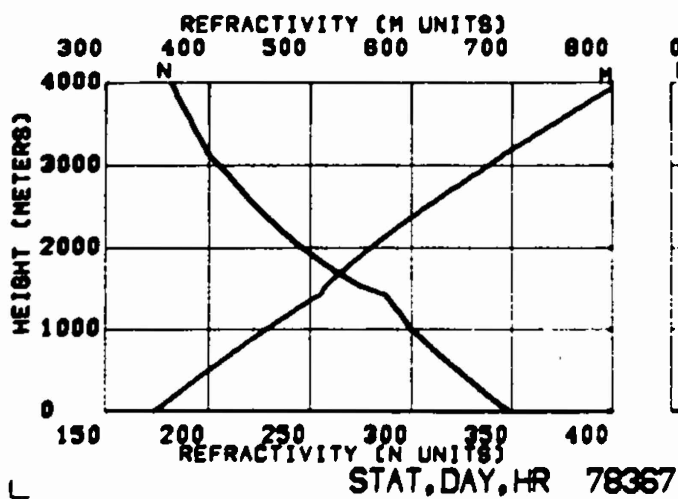


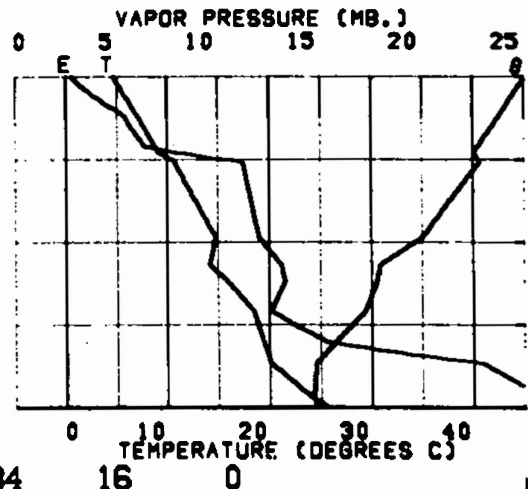
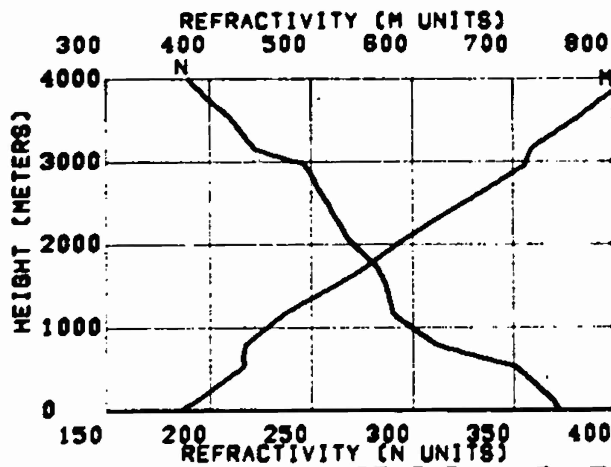




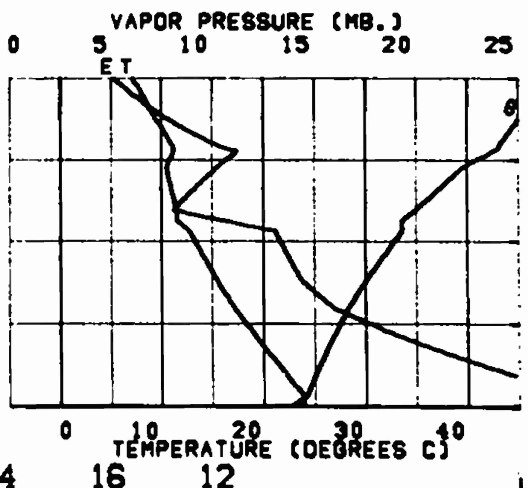
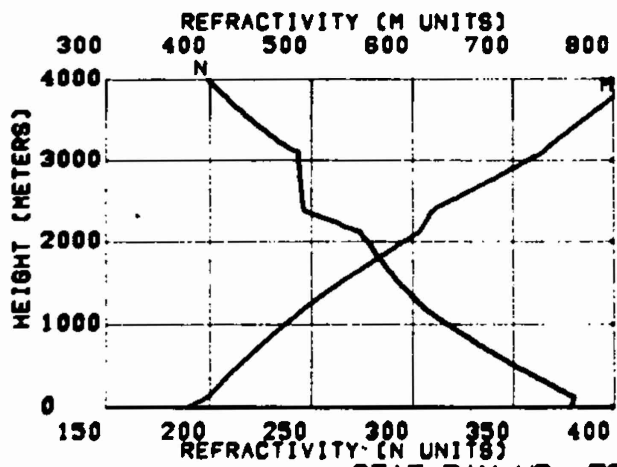




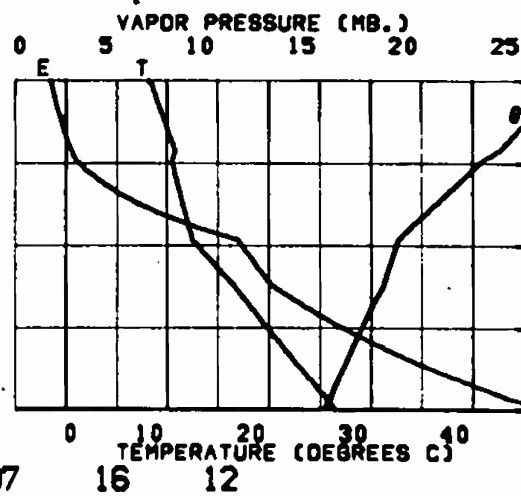
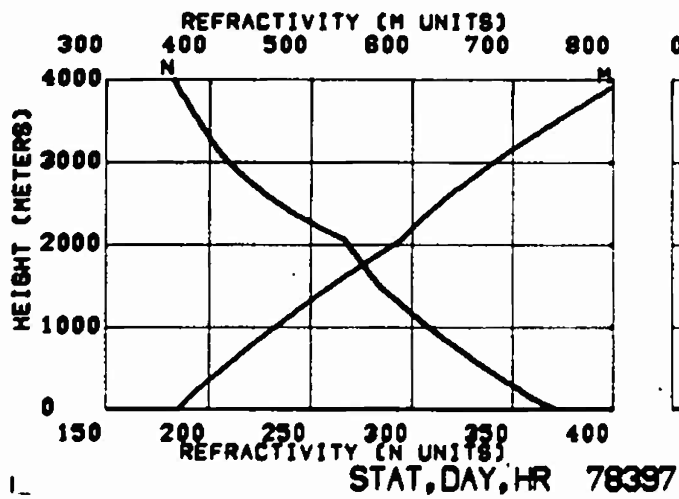
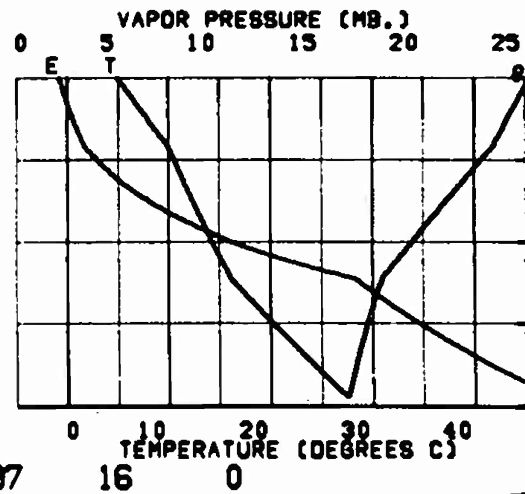
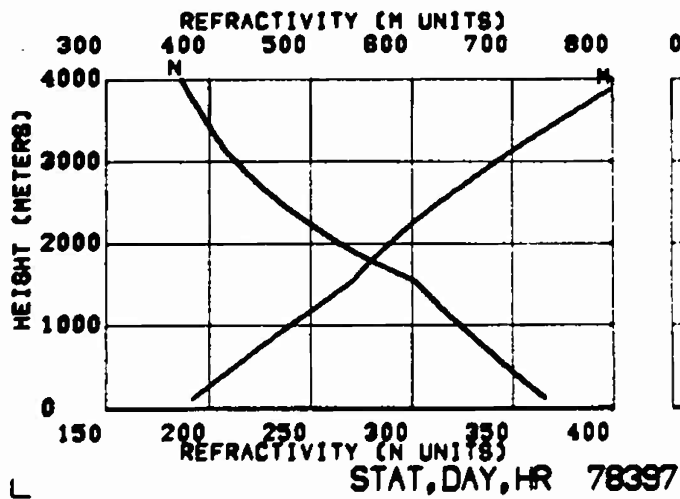


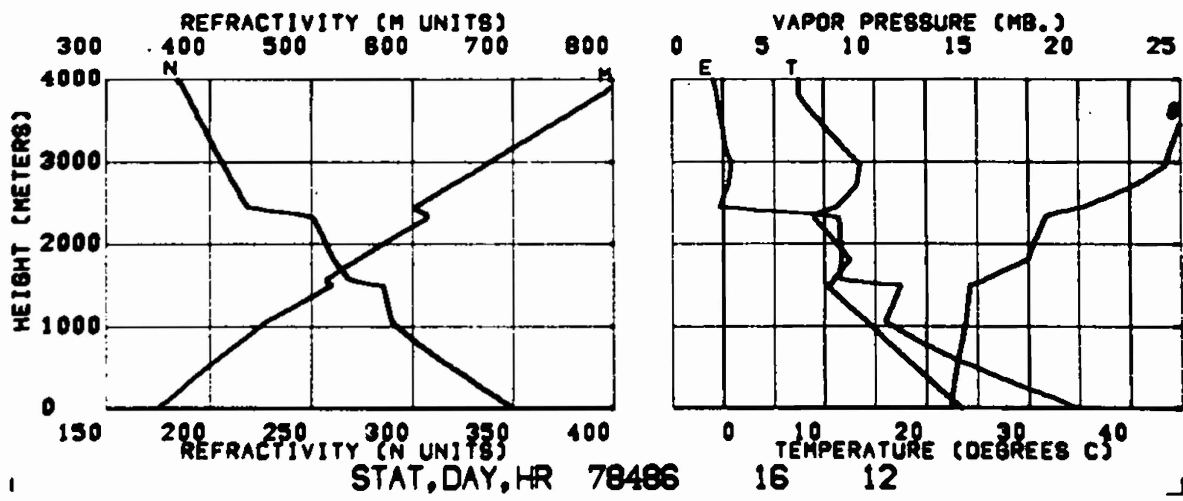


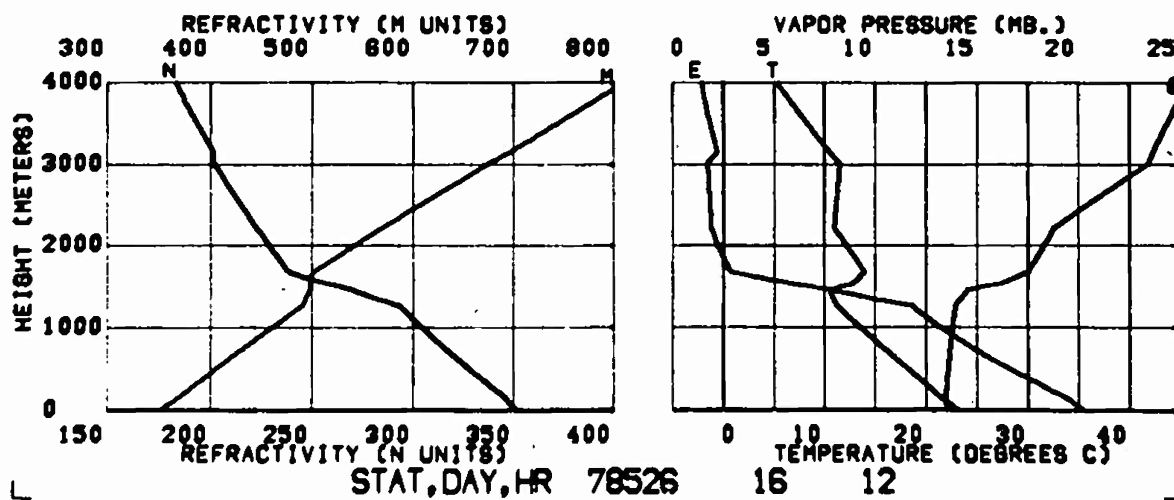
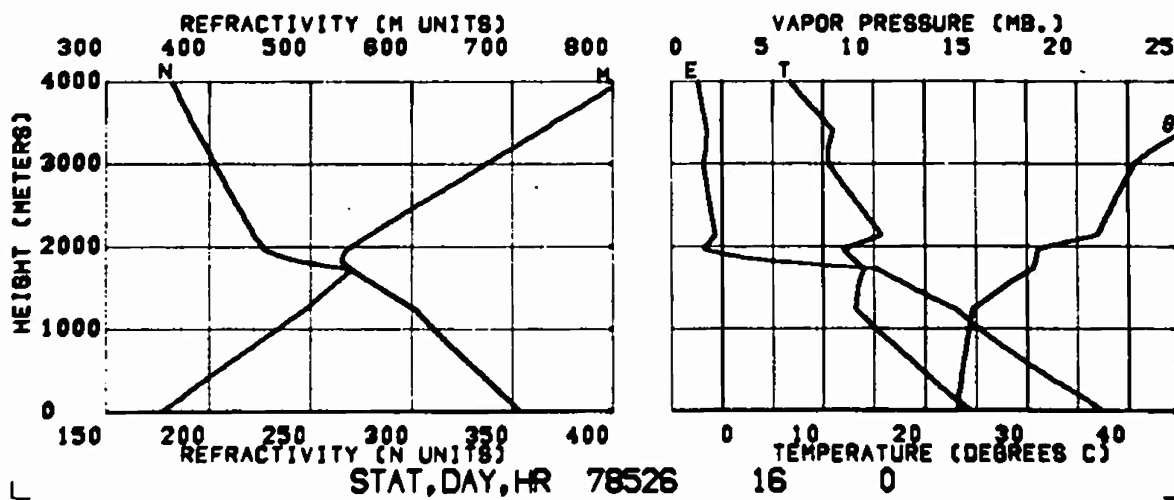
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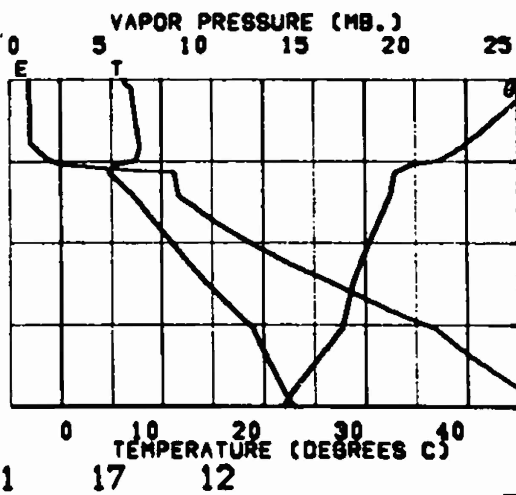
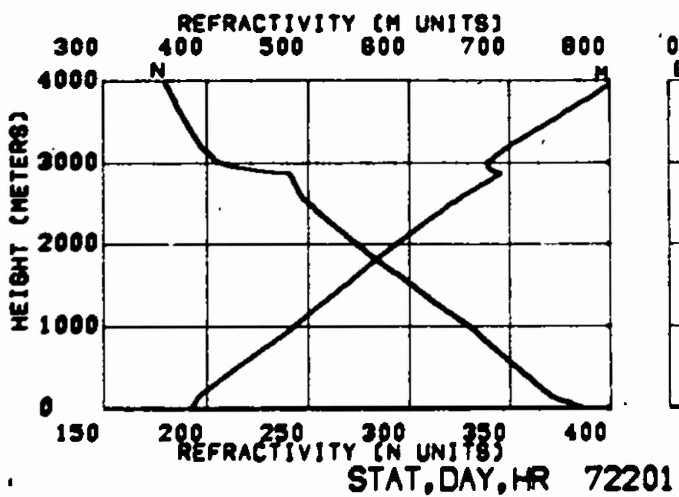
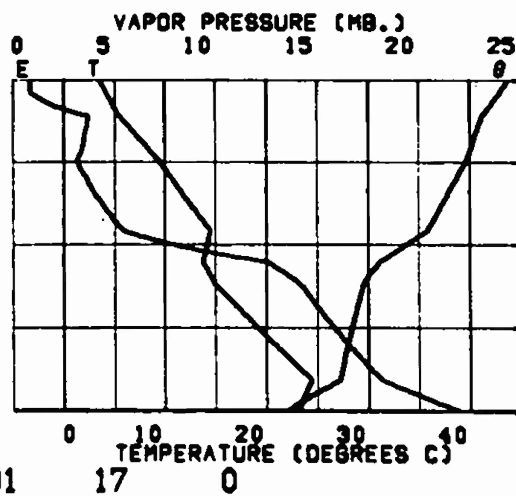
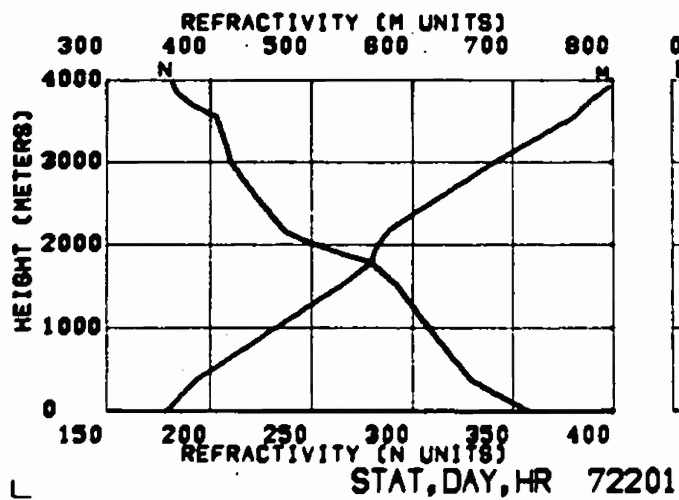


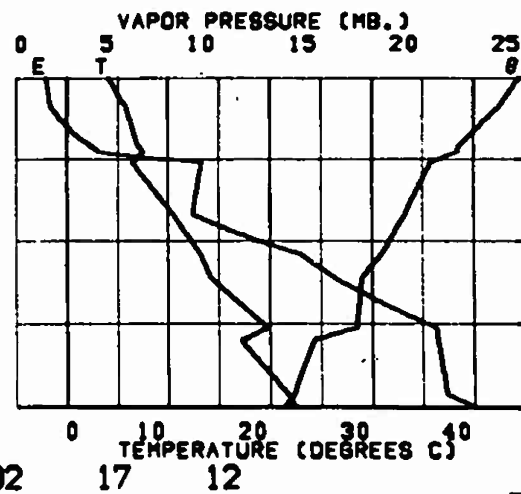
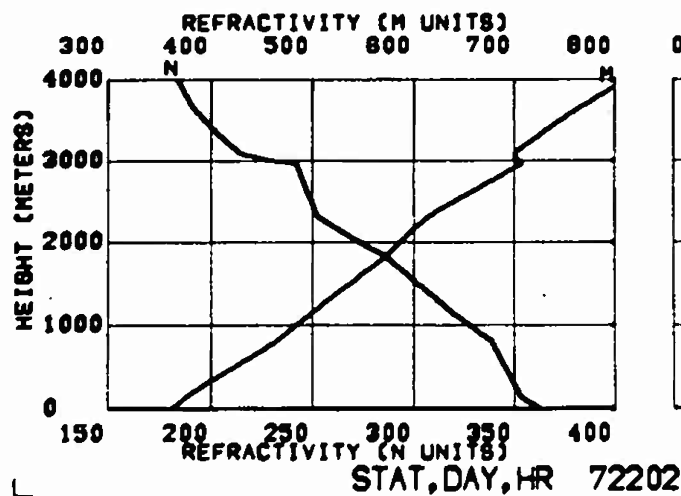
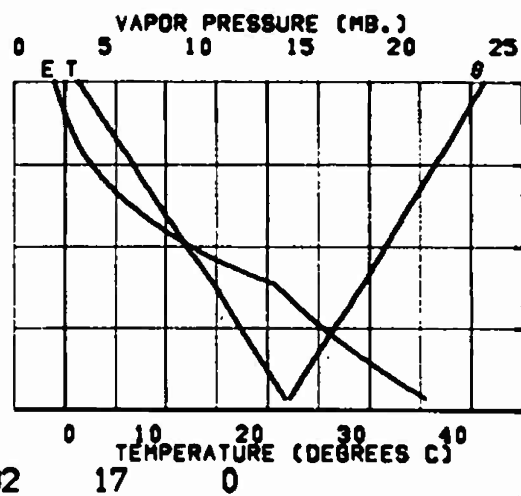
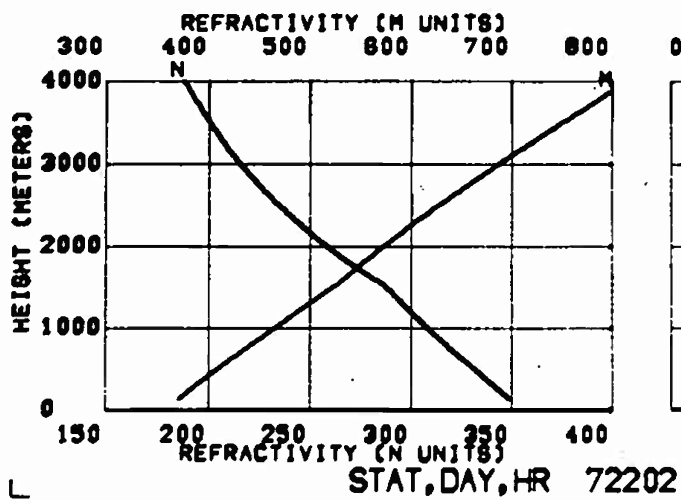
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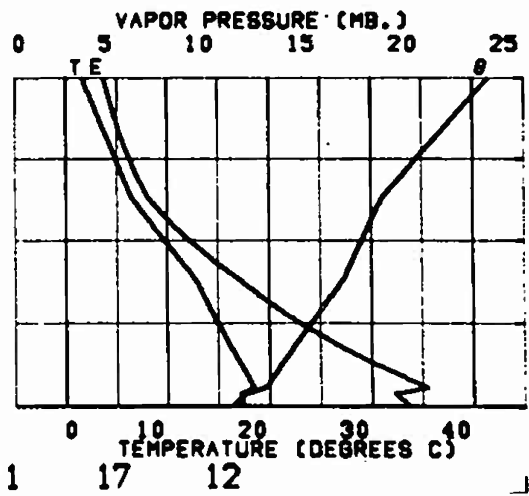
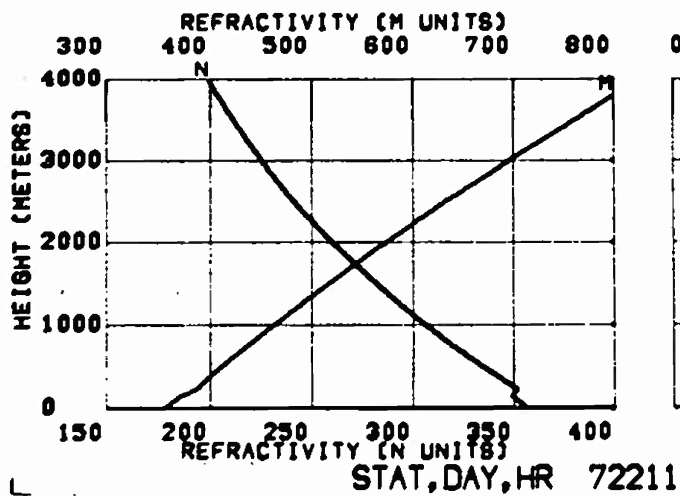
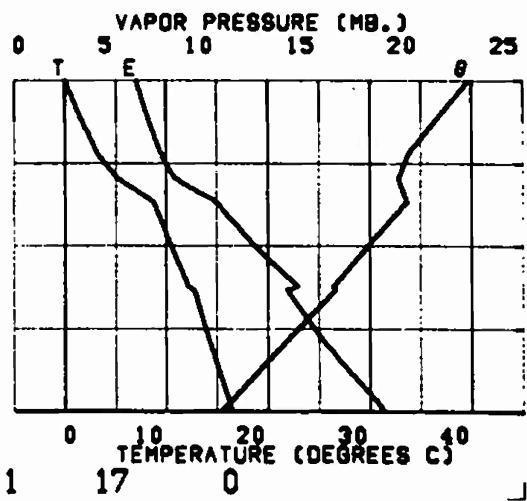
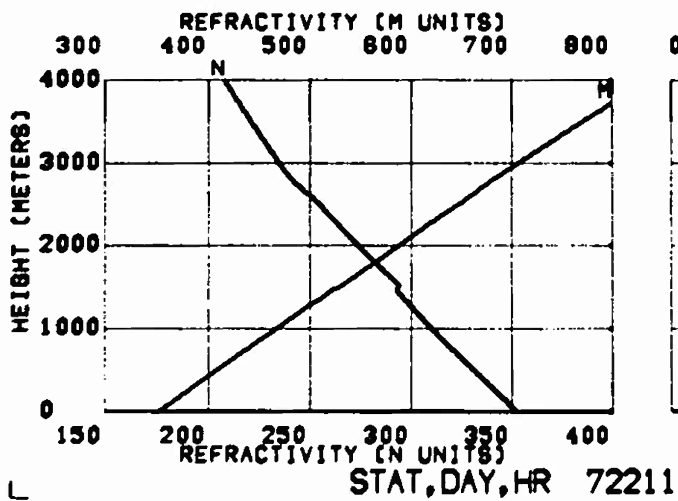


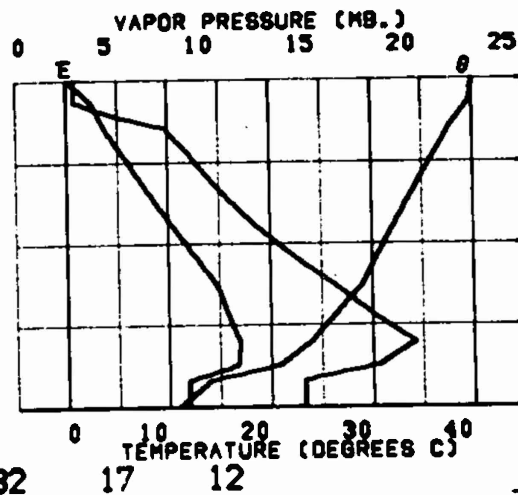
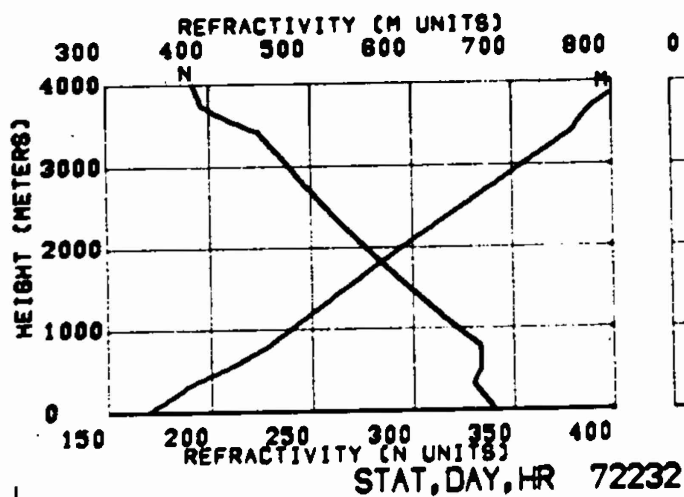
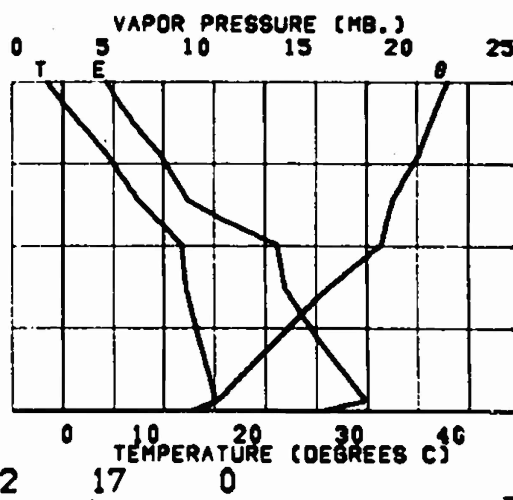
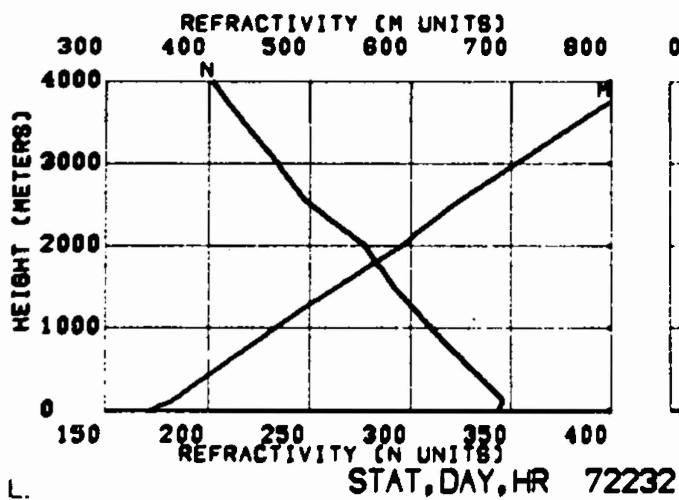


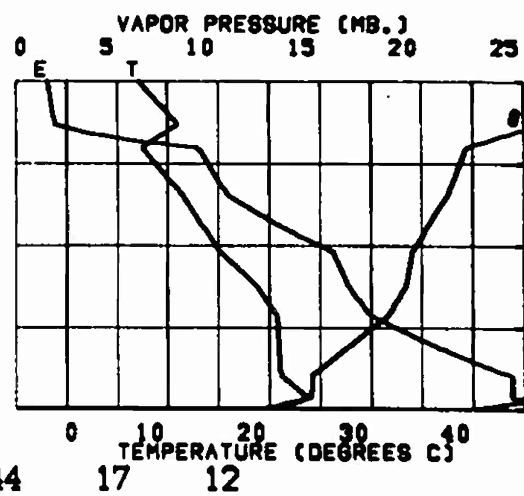
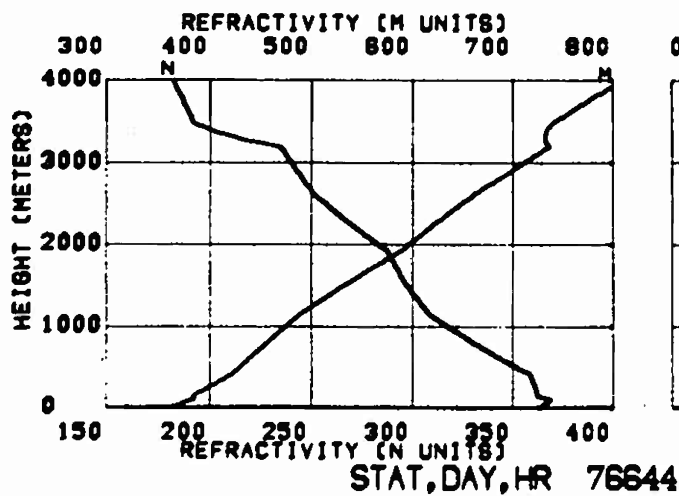
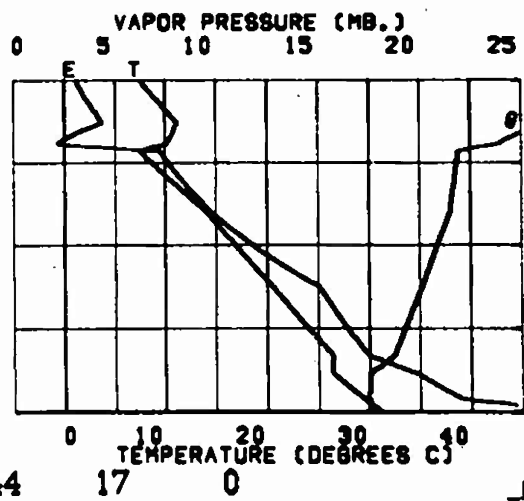
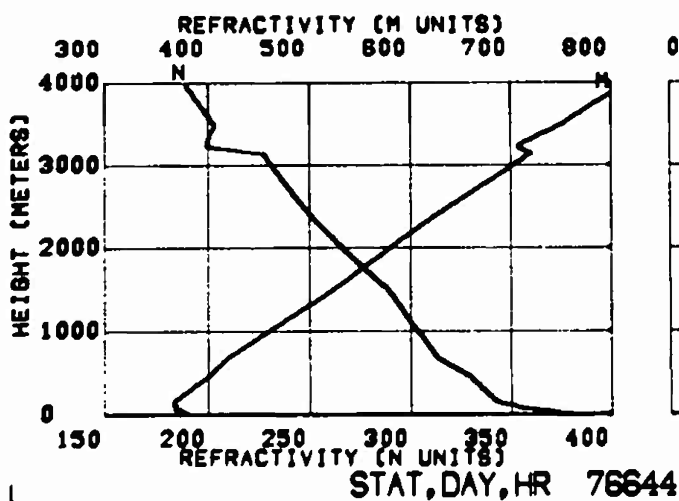


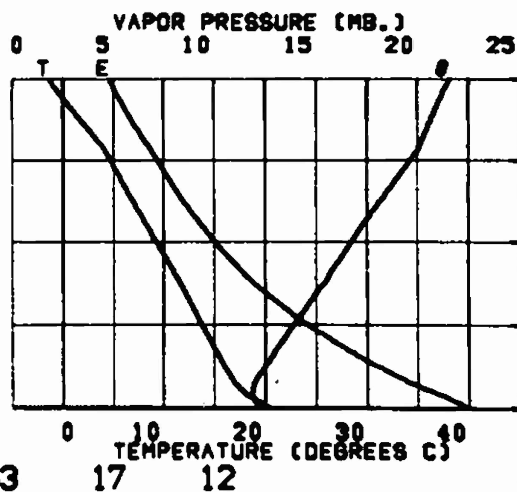
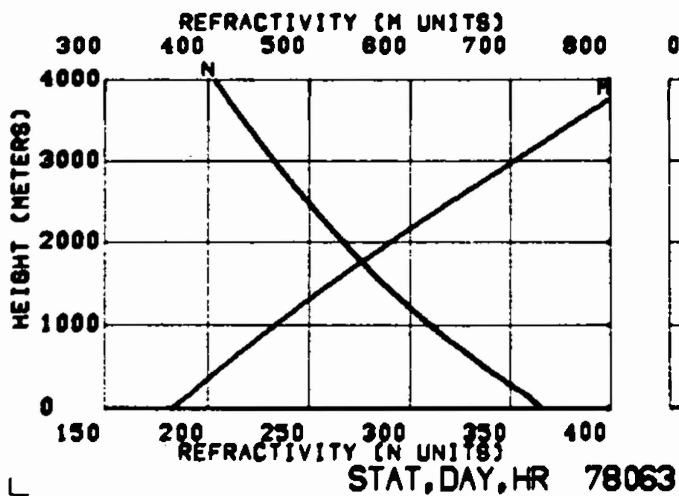
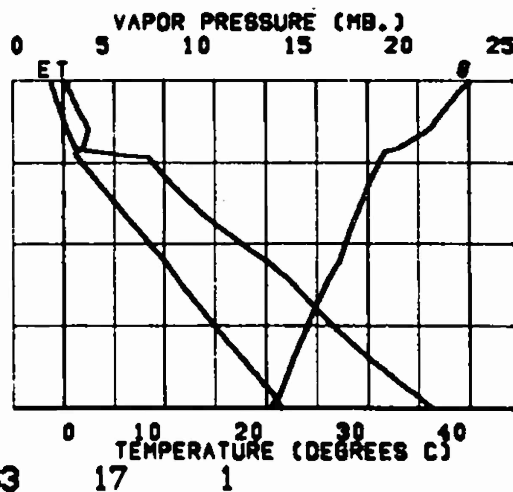
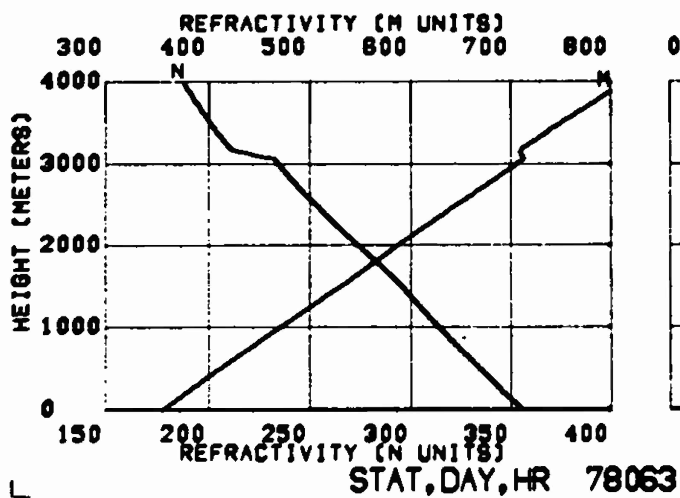


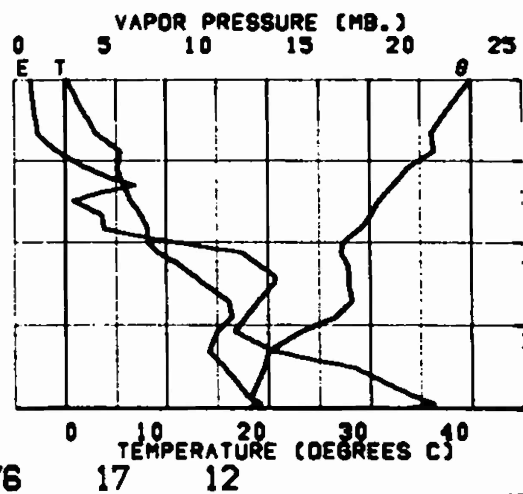
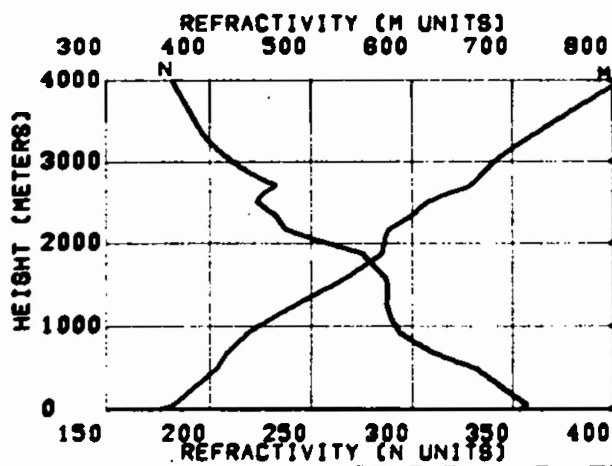






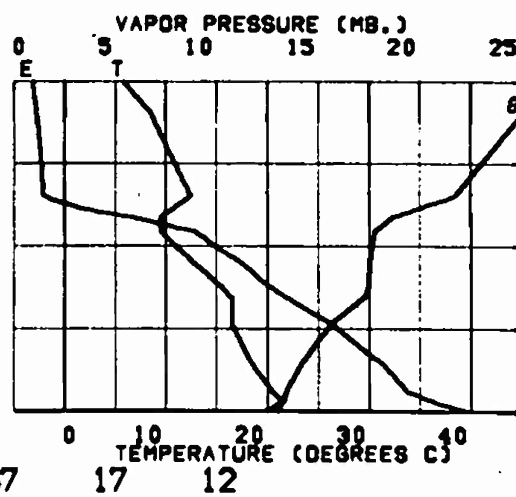
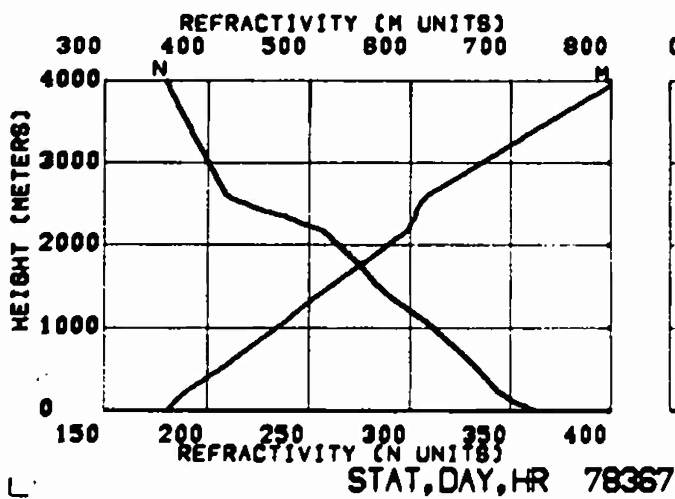
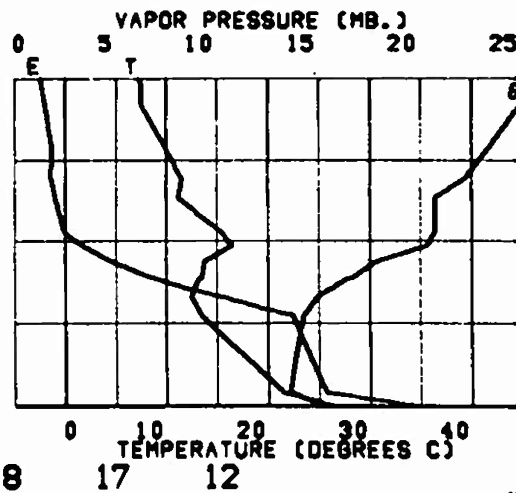
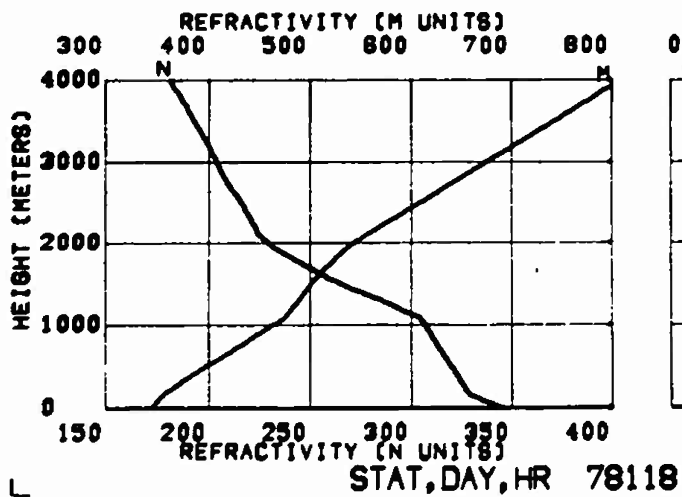


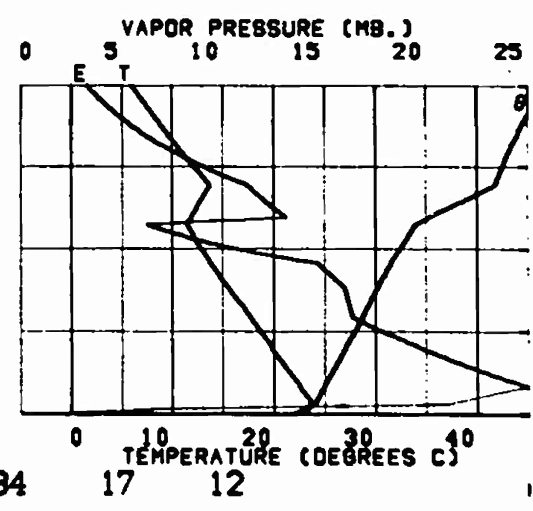
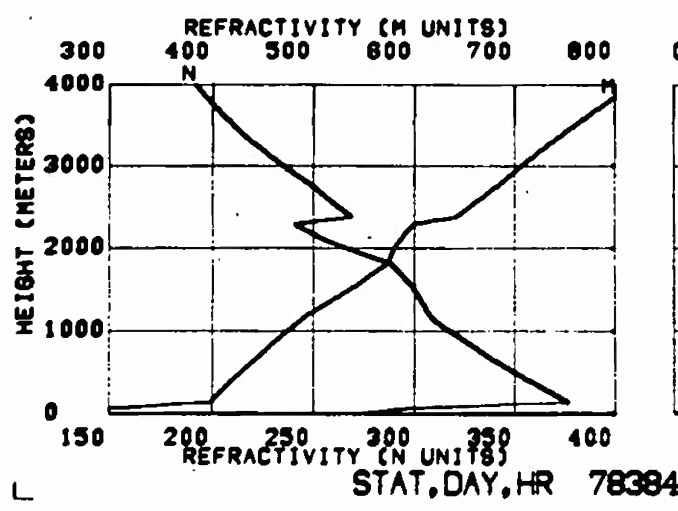
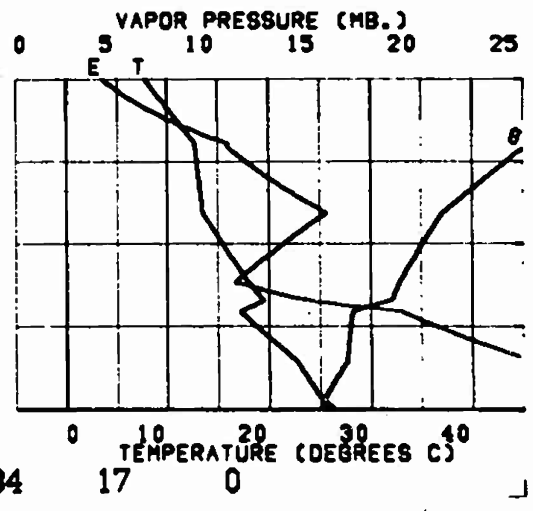
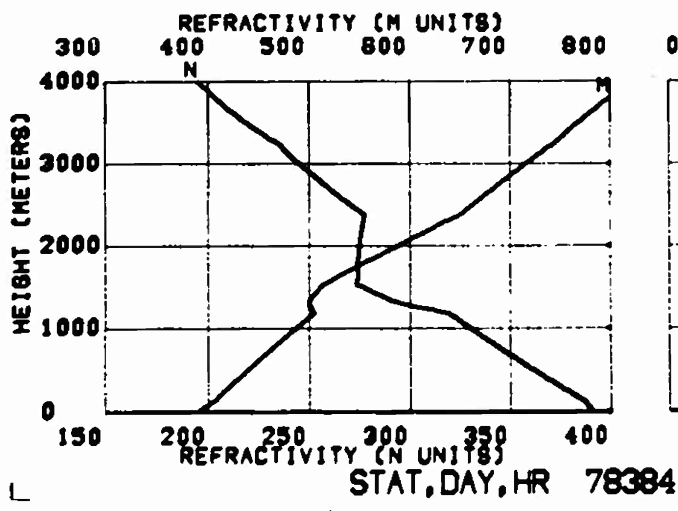


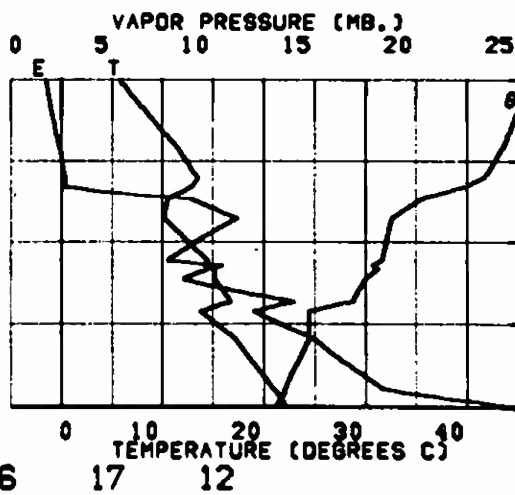
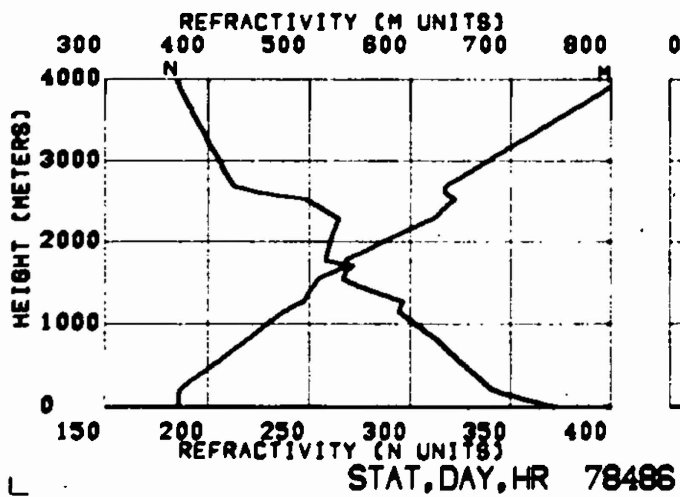
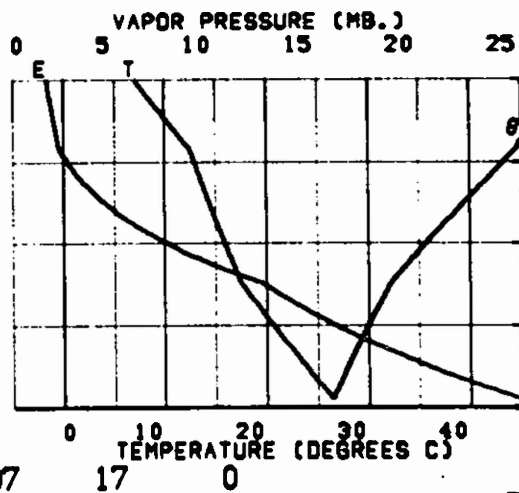
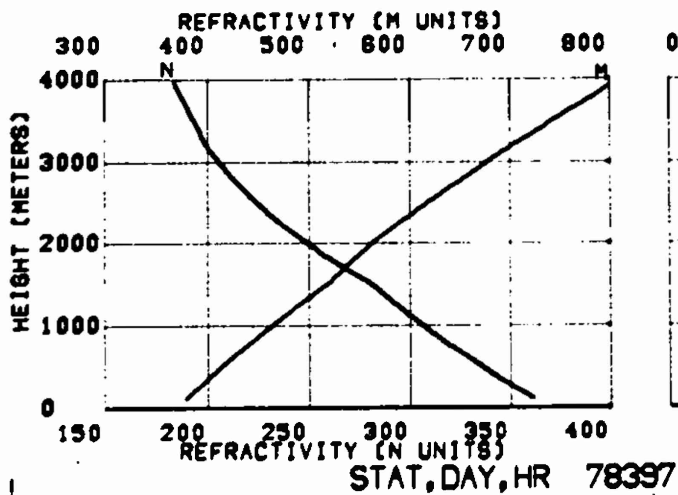


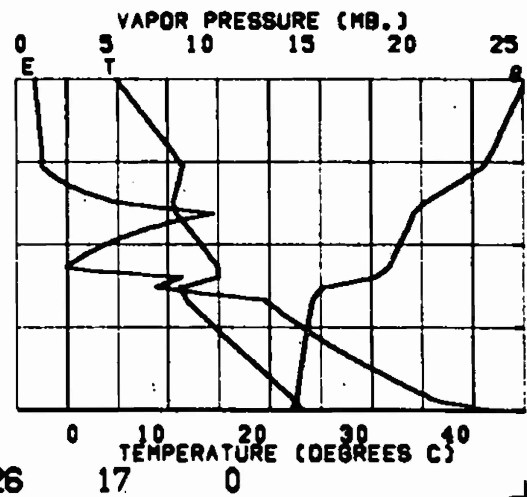
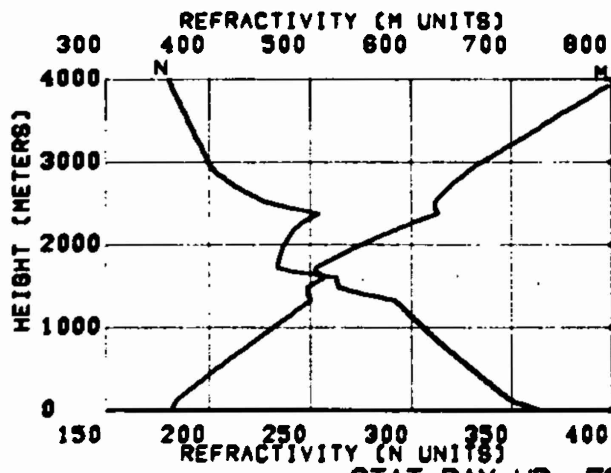
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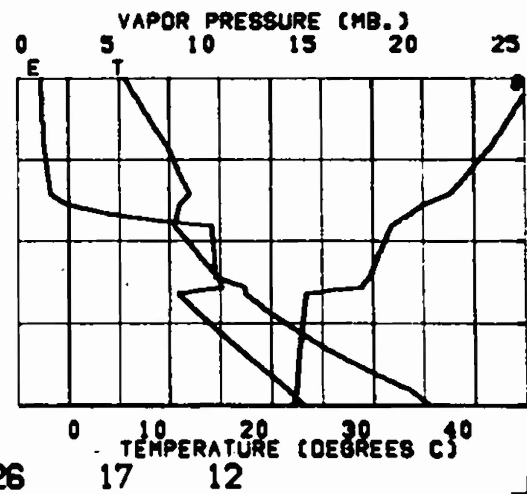
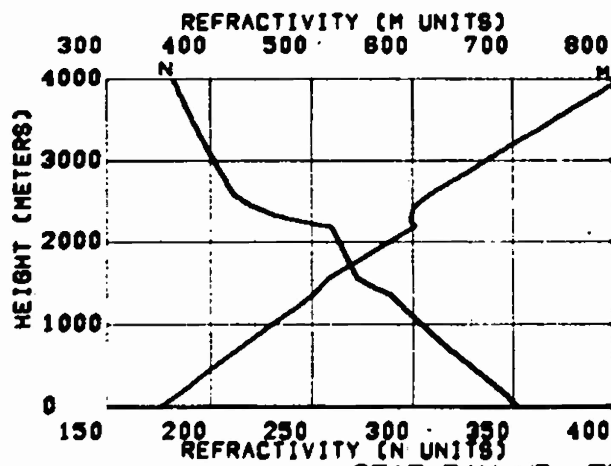




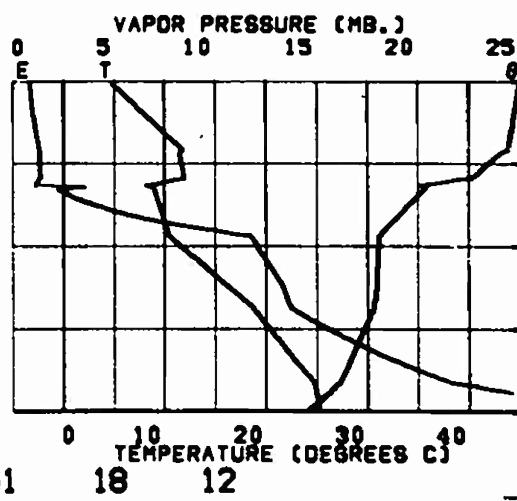
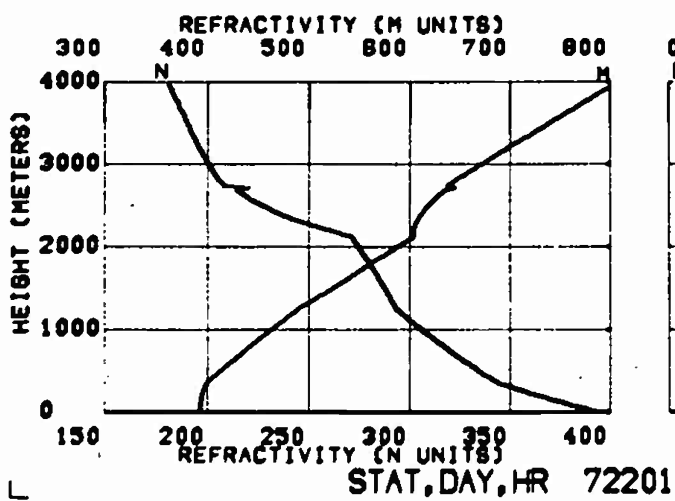


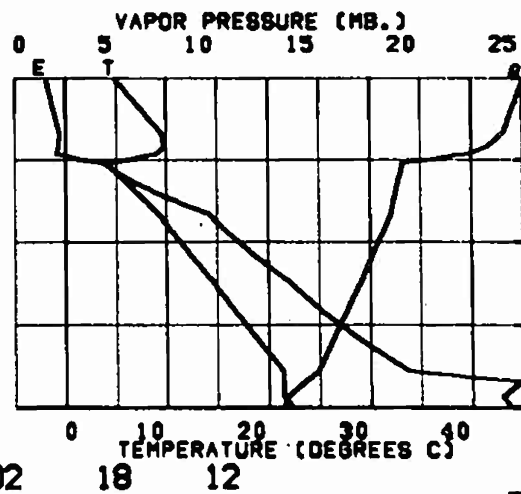
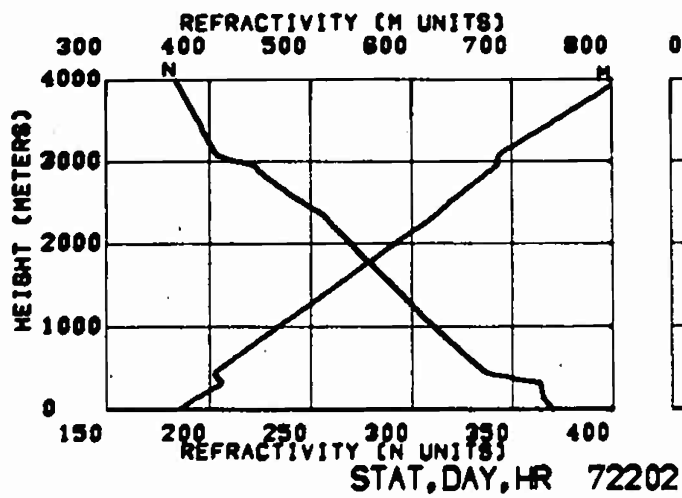
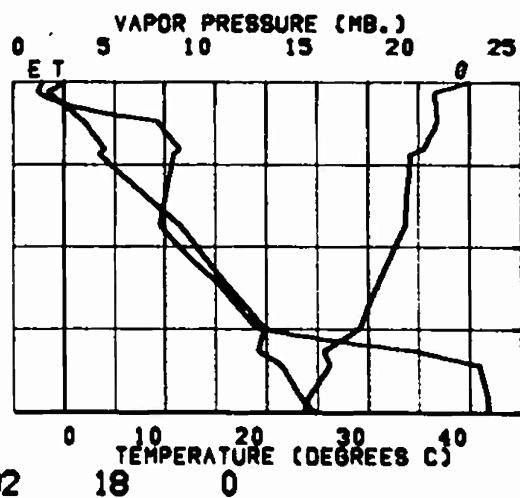
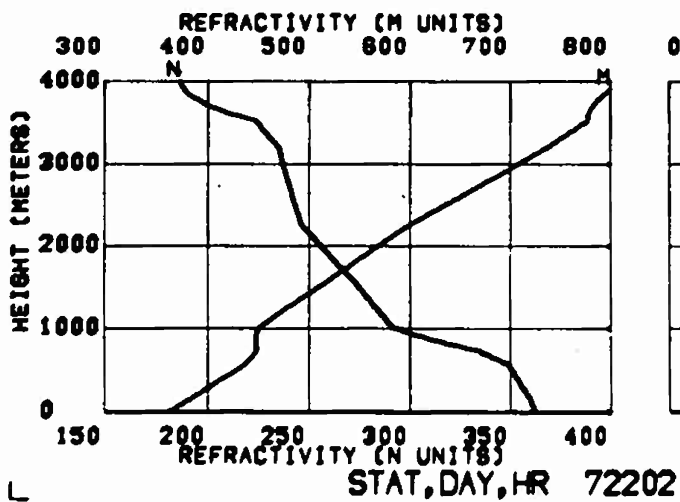


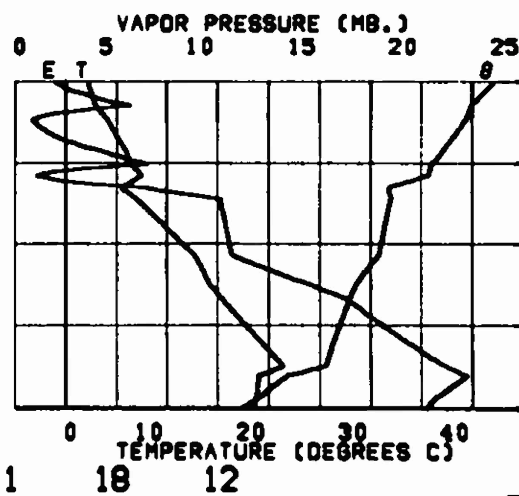
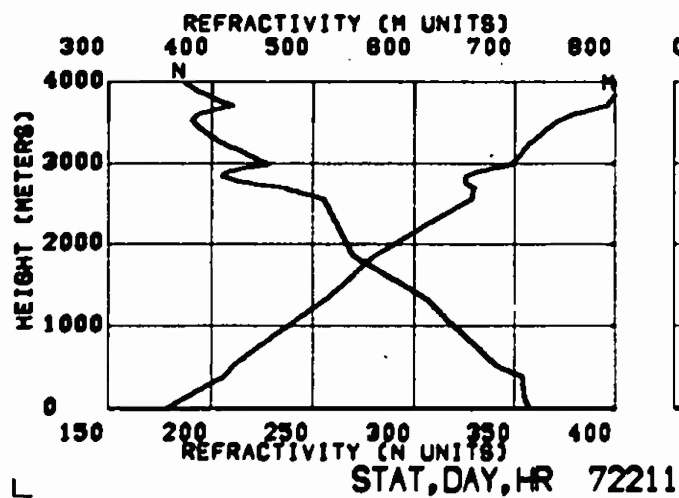
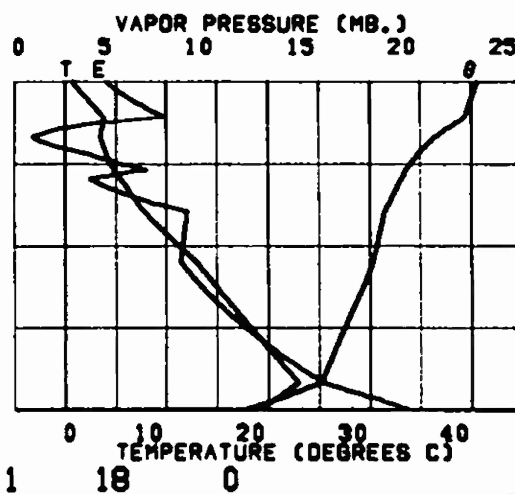
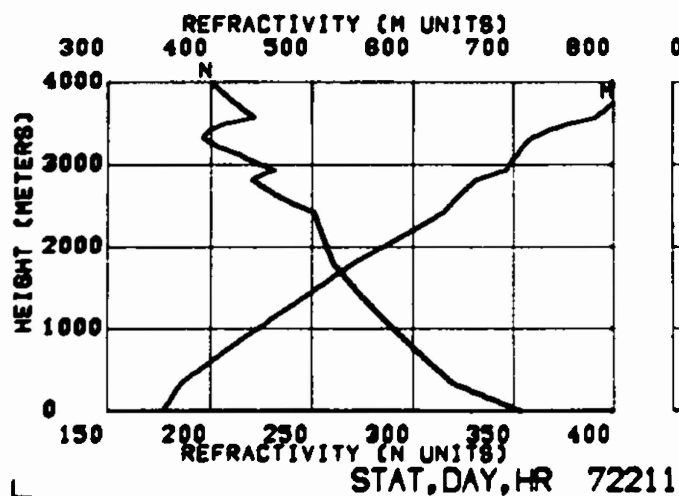
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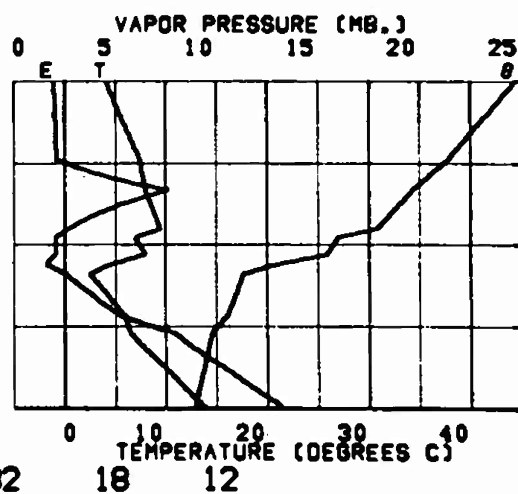
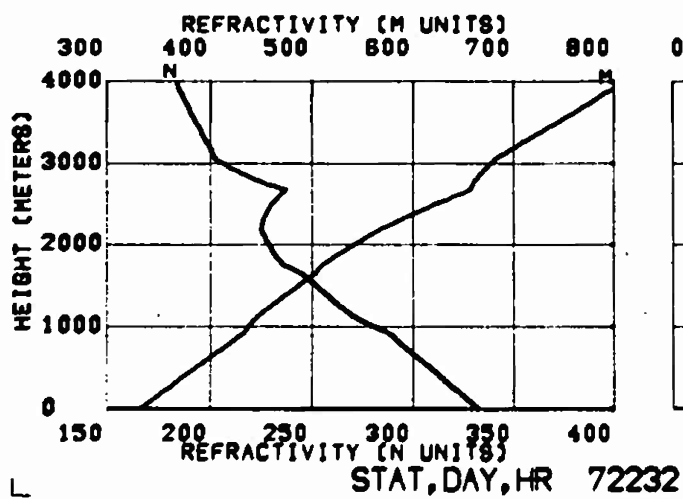
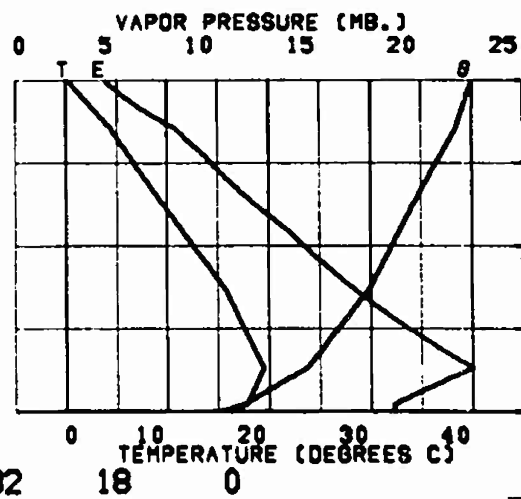
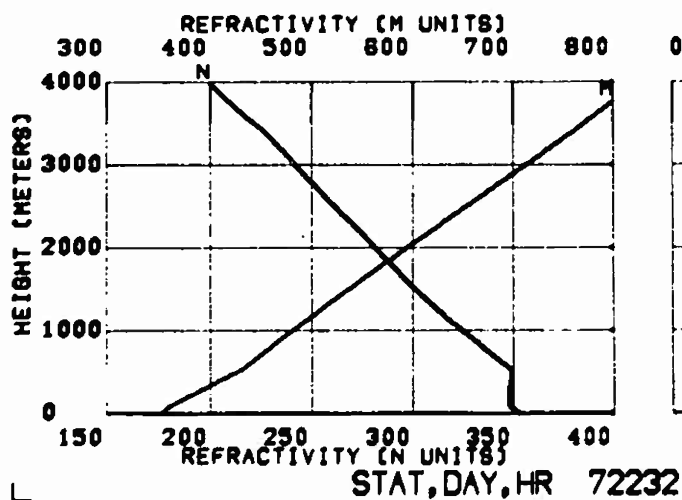


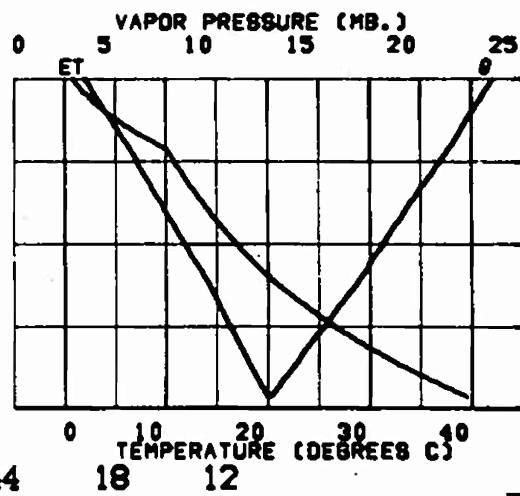
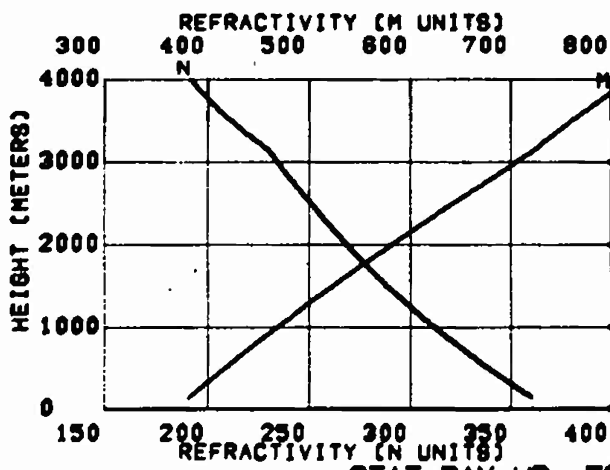
STAT, DAY, HR 78526





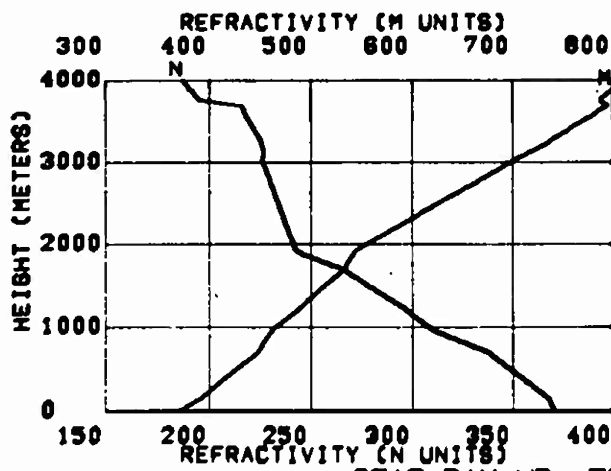




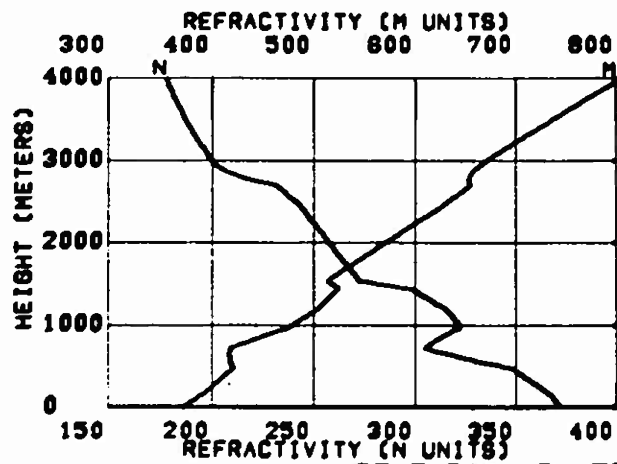
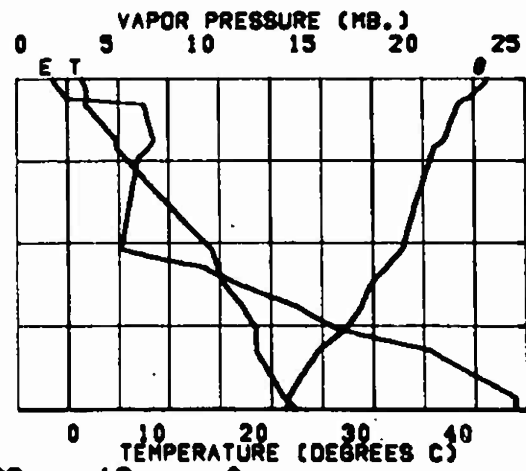


STAT, DAY, HR 76644

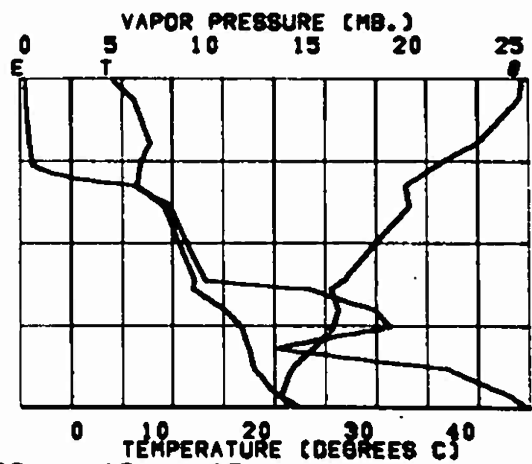
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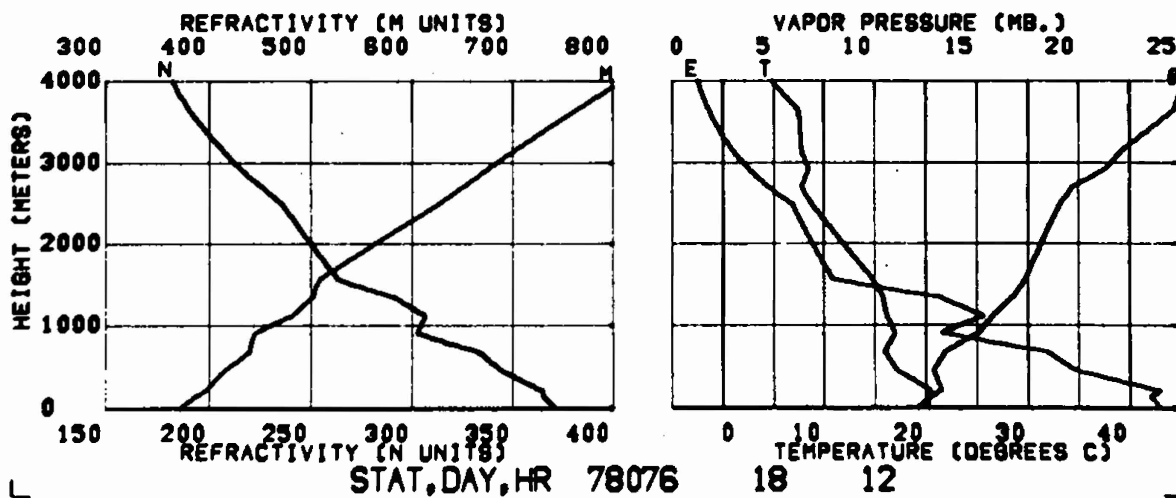


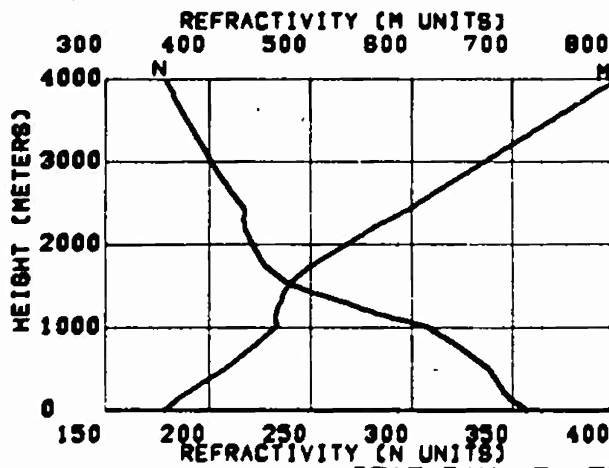
STAT, DAY, HR 78063



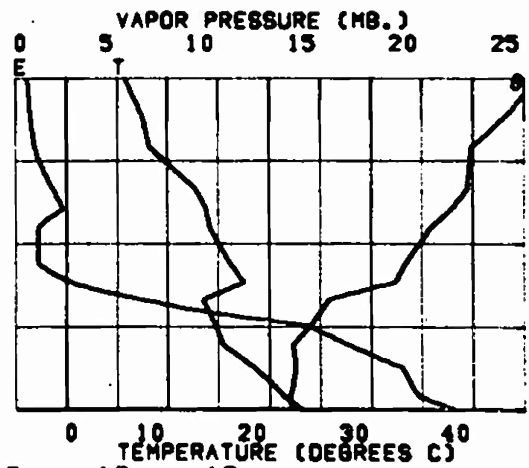
STAT, DAY, HR 78063



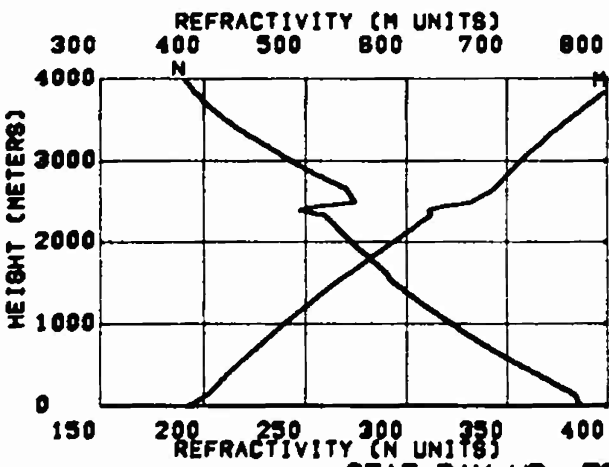




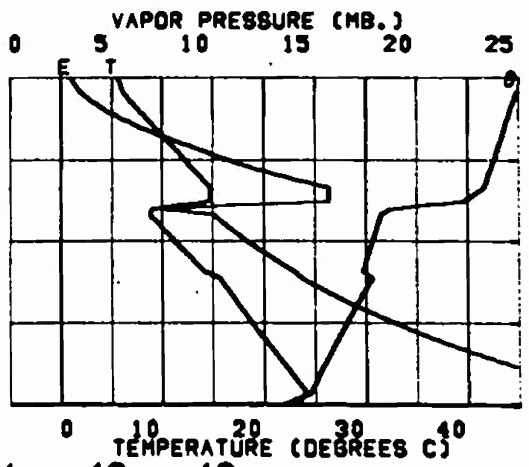
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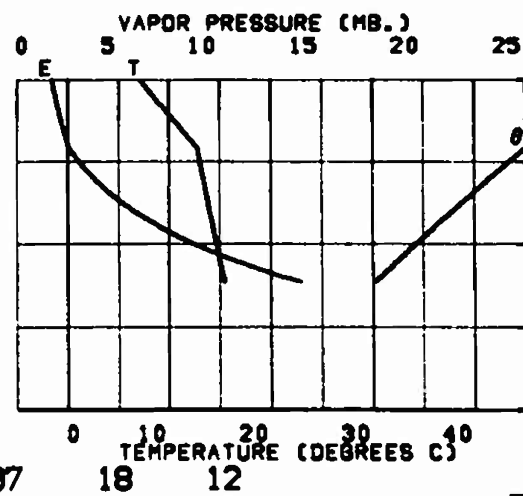
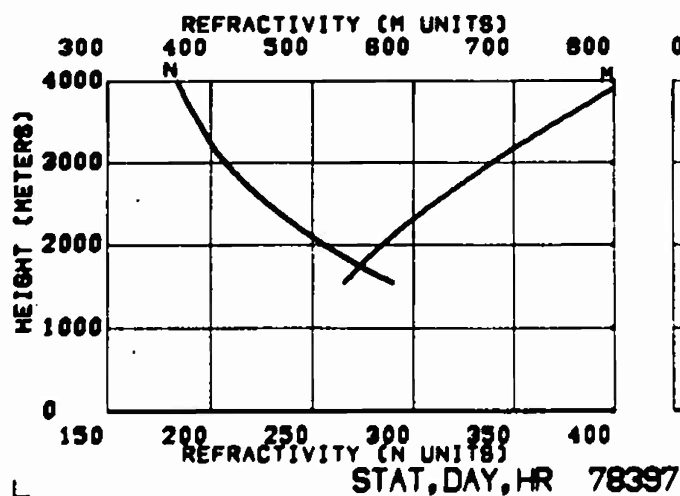
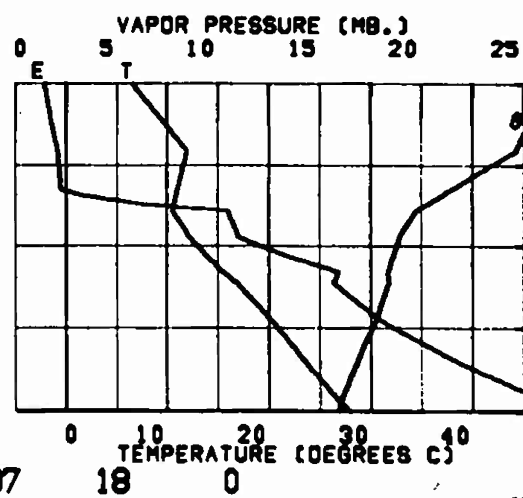
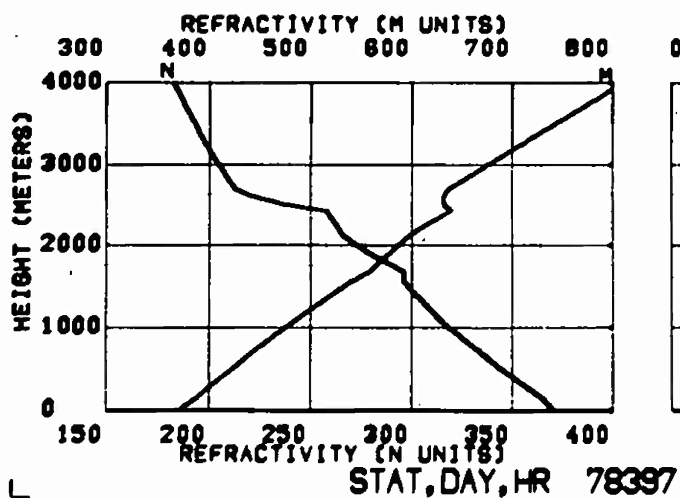
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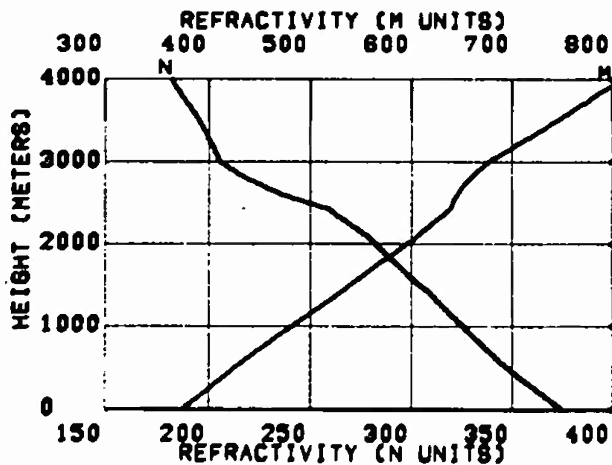


STAT, DAY, HR 78384

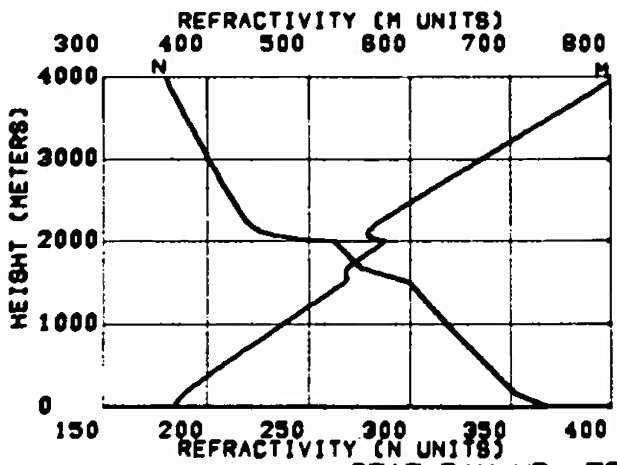
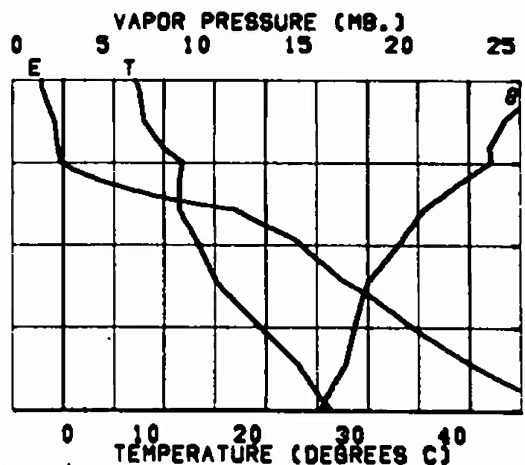


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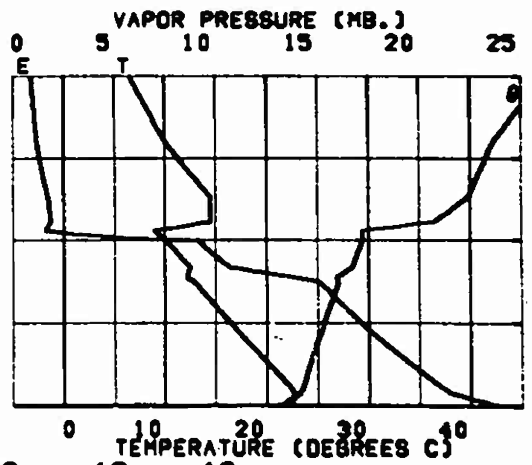


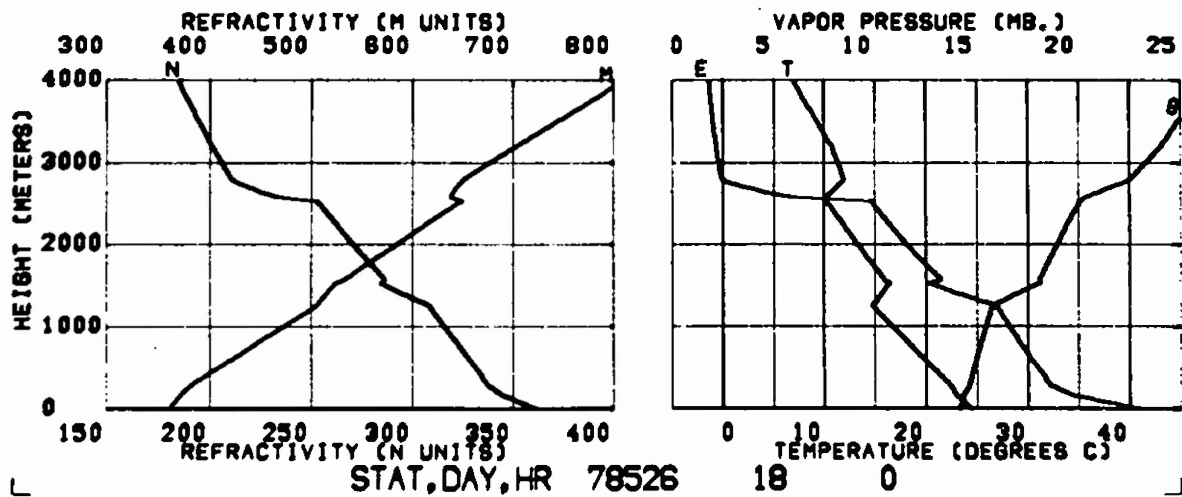


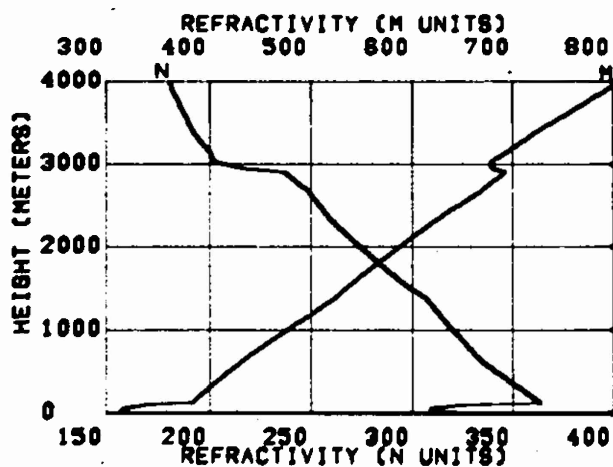
STAT, DAY, HR 78486



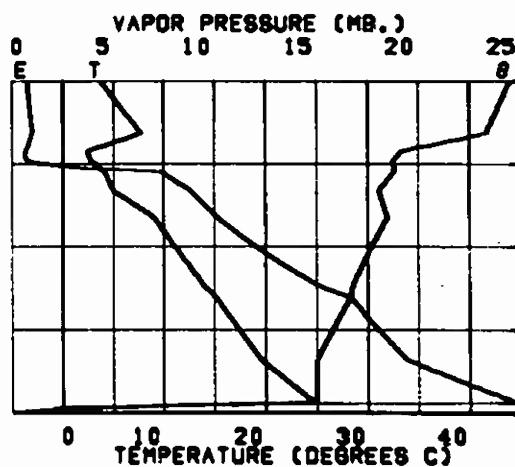
STAT, DAY, HR 78486



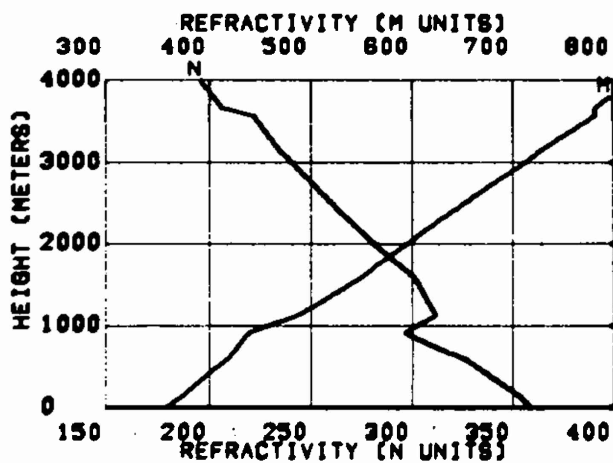




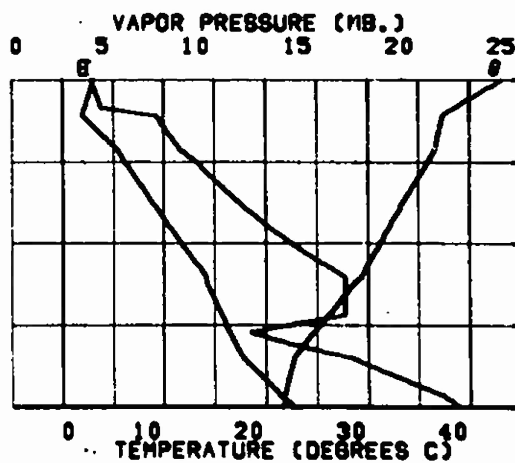
STAT, DAY, HR 72201



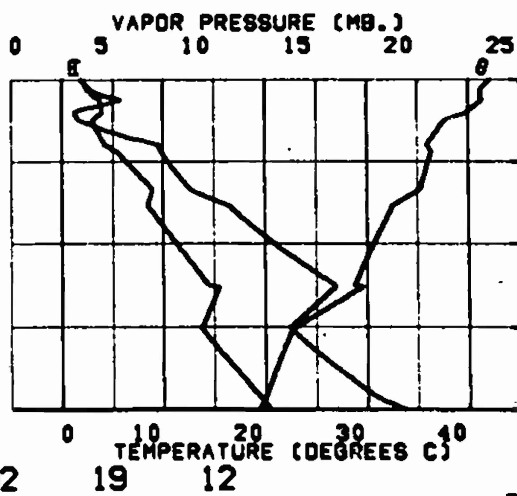
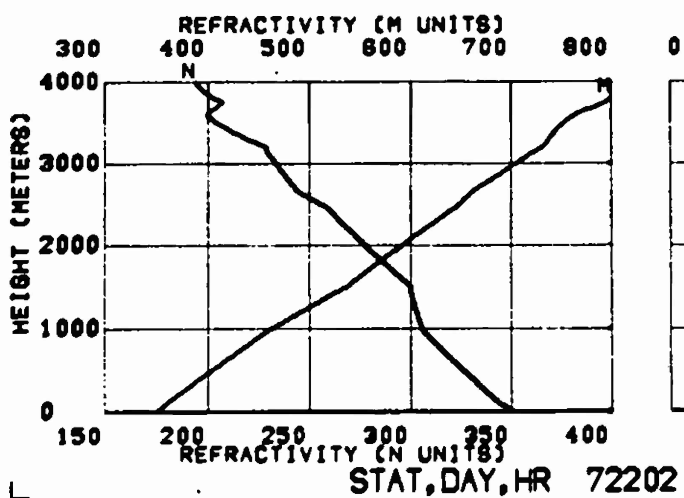
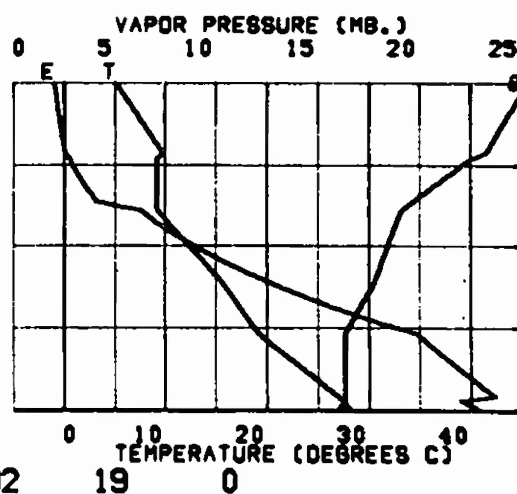
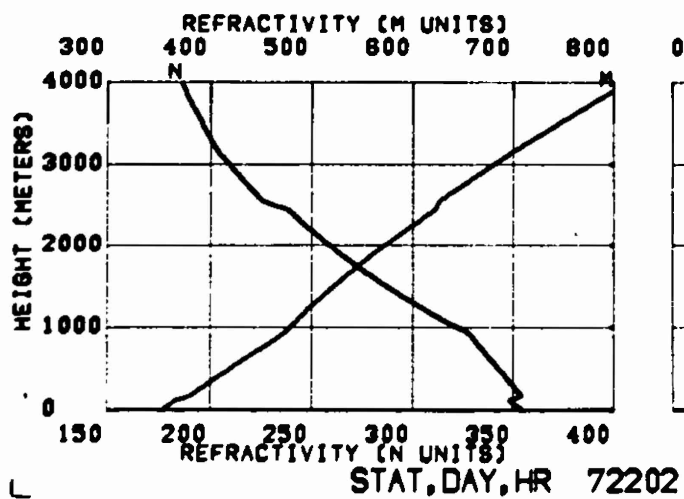
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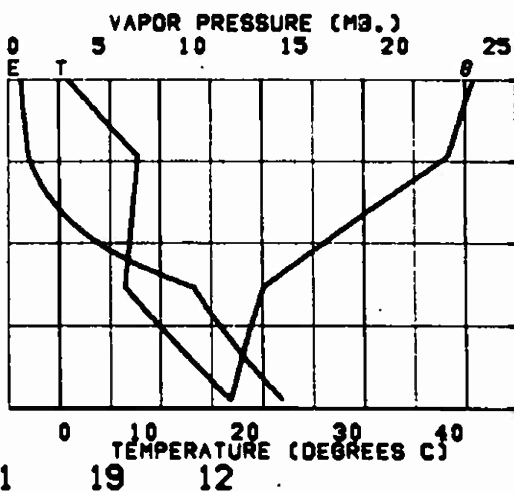
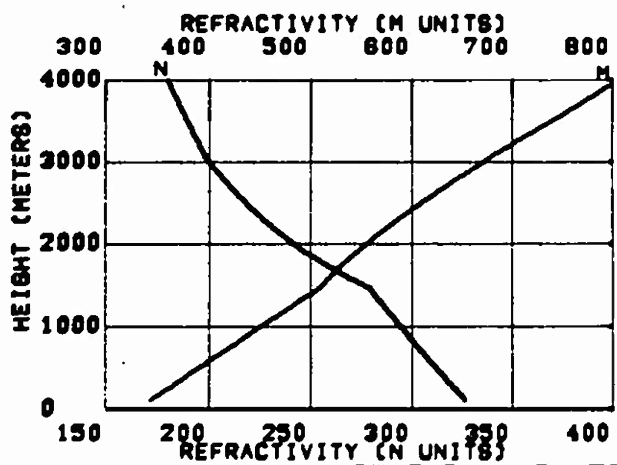
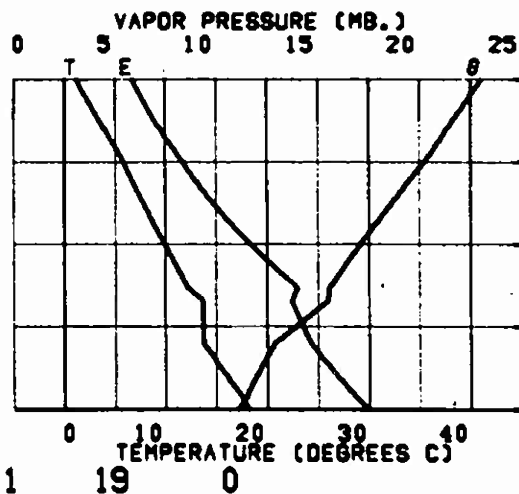
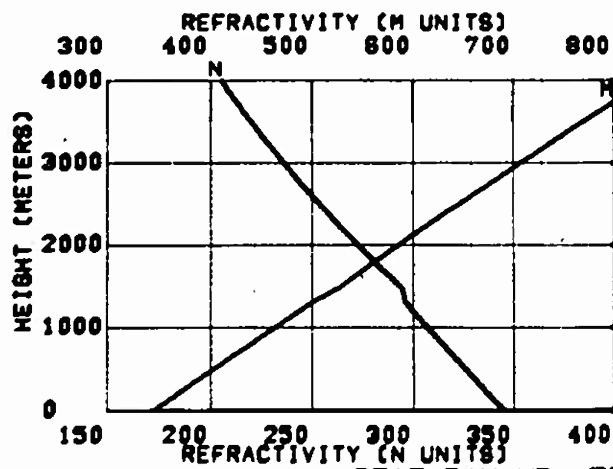


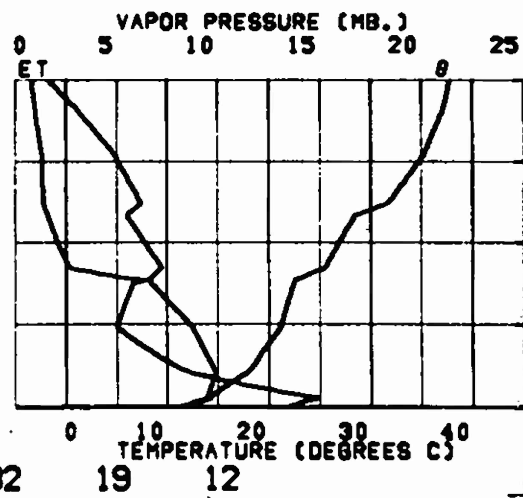
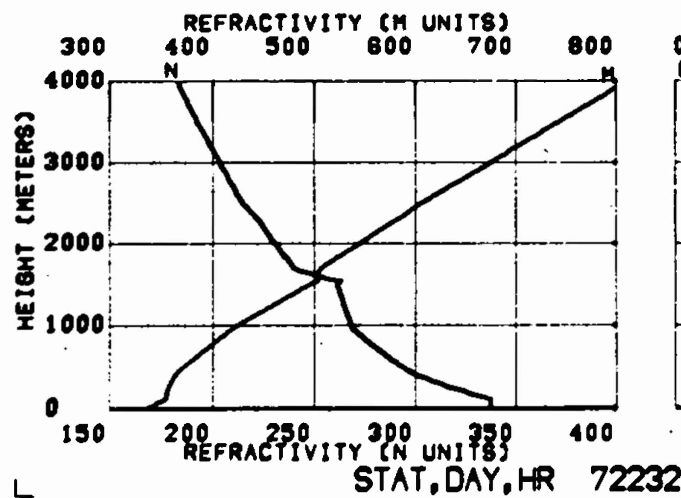
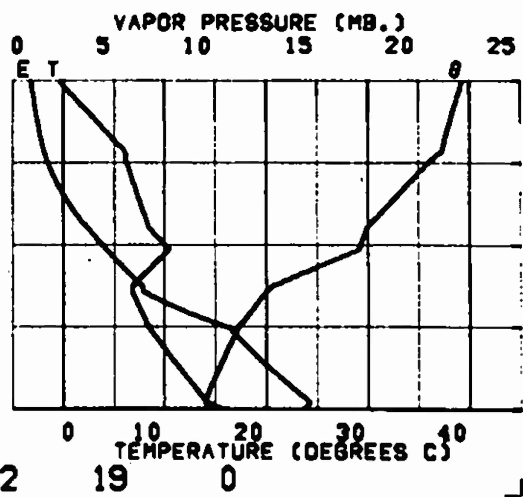
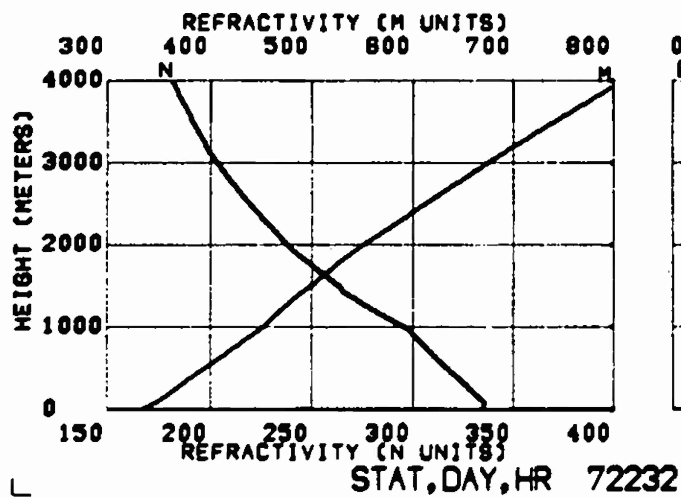
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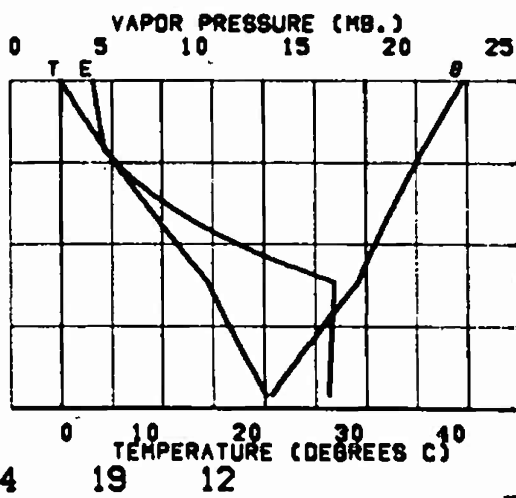
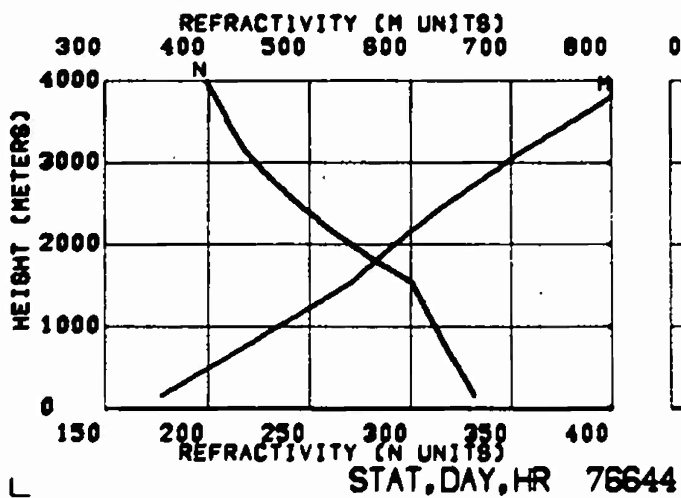
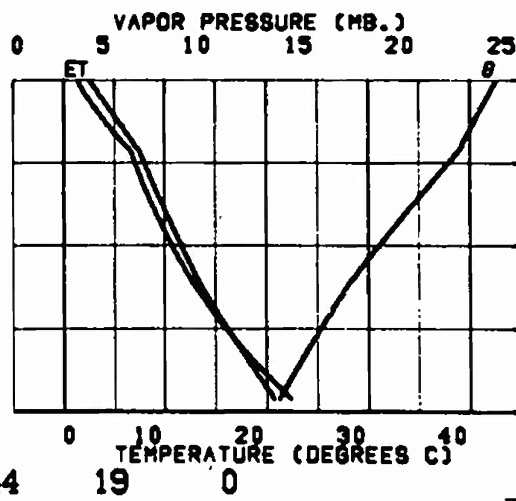
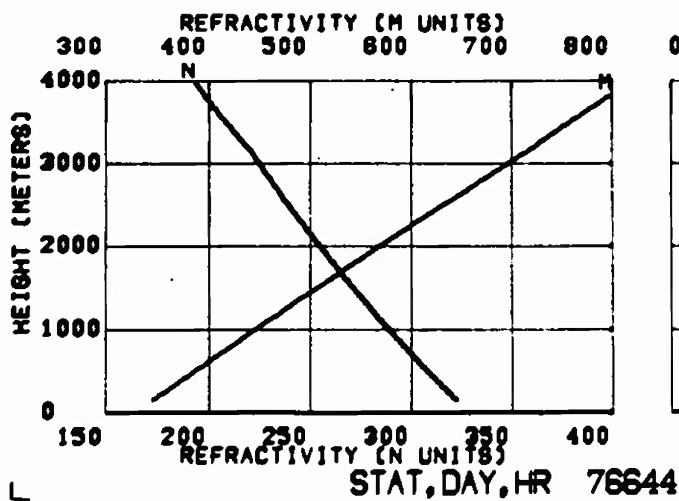


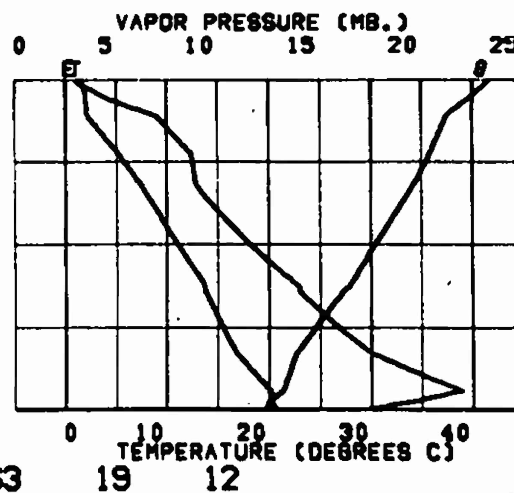
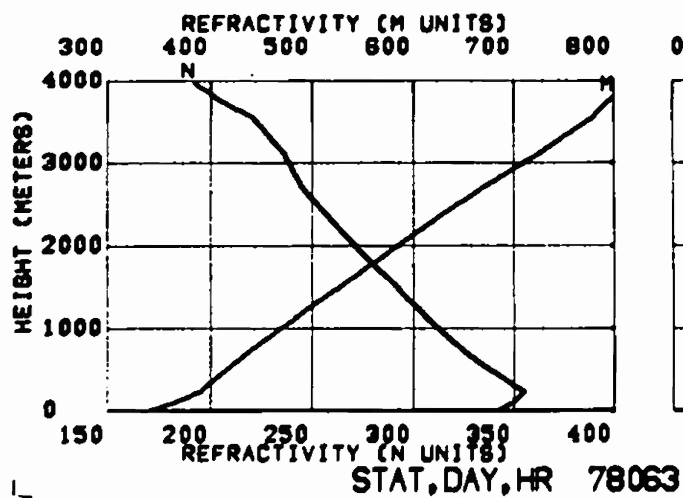
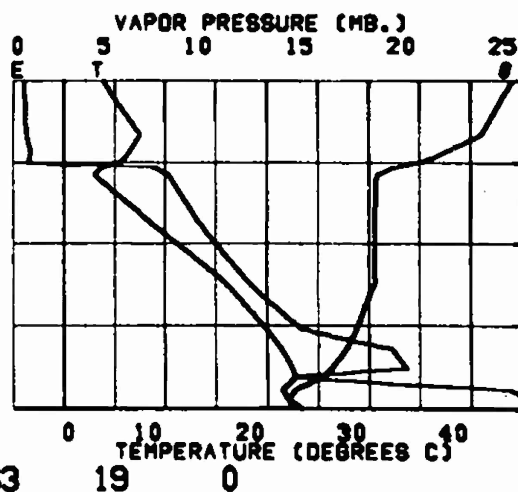
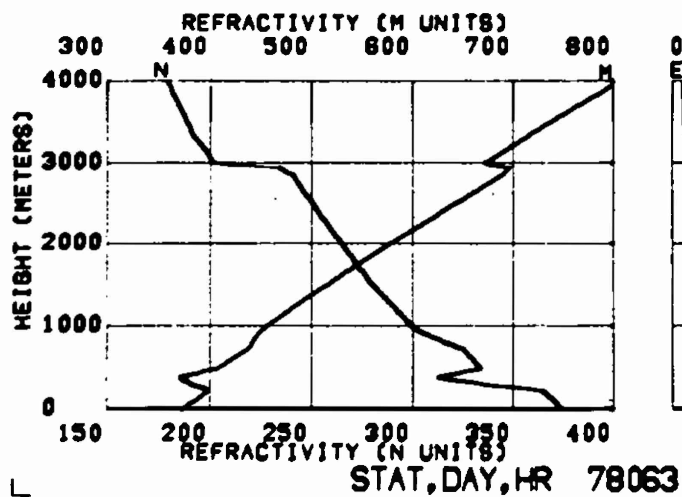
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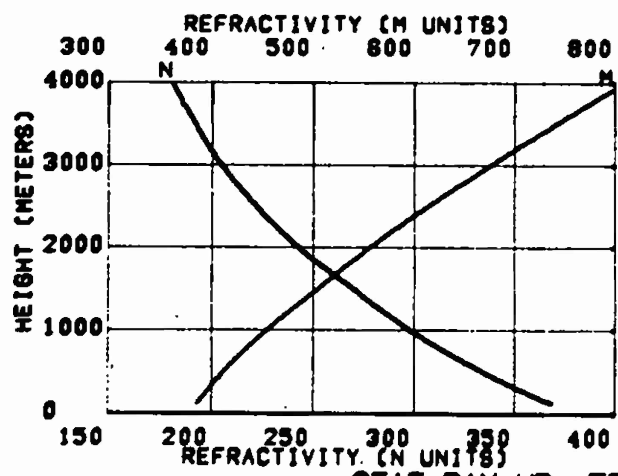




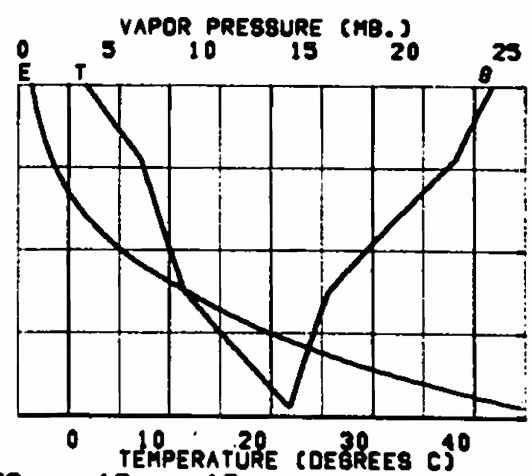




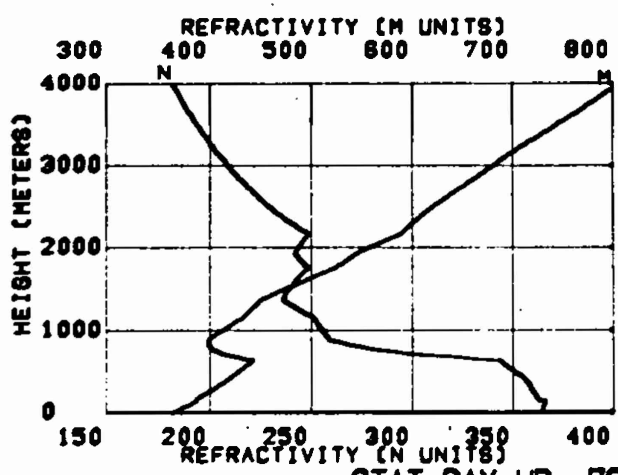




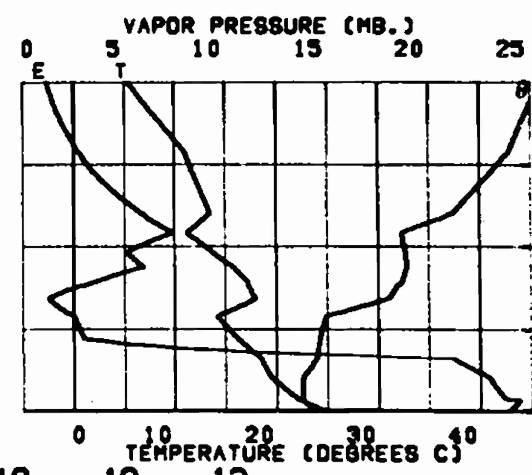
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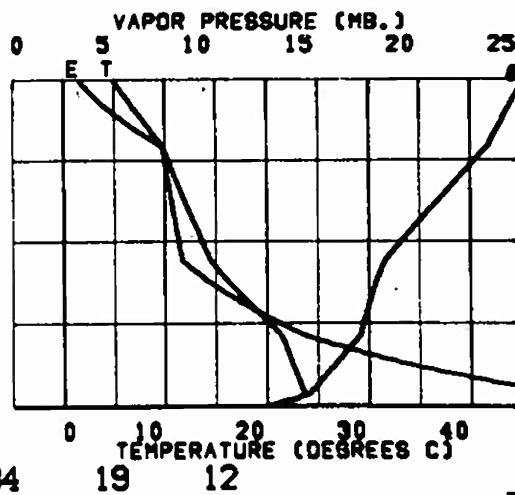
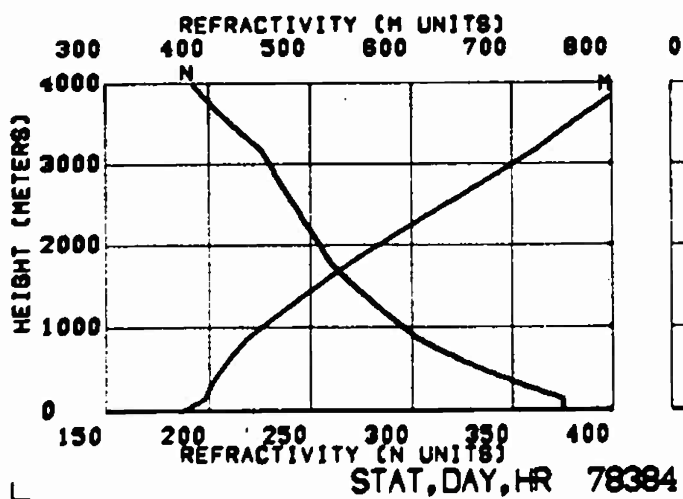
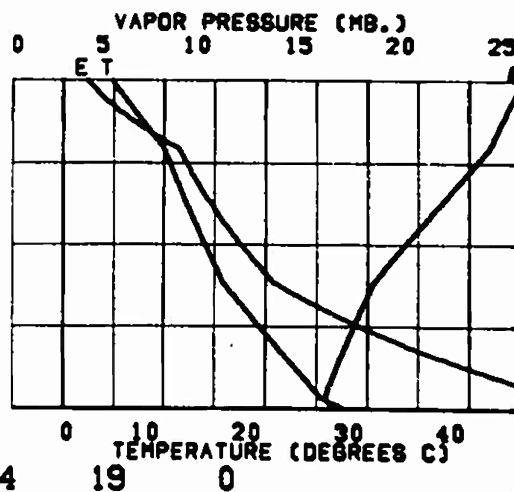
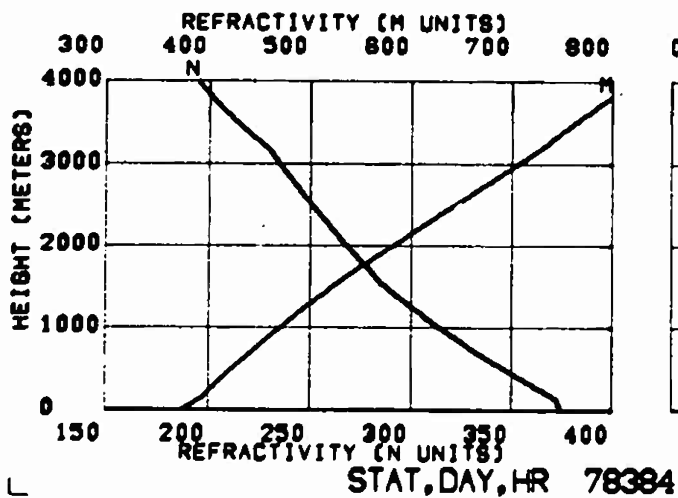
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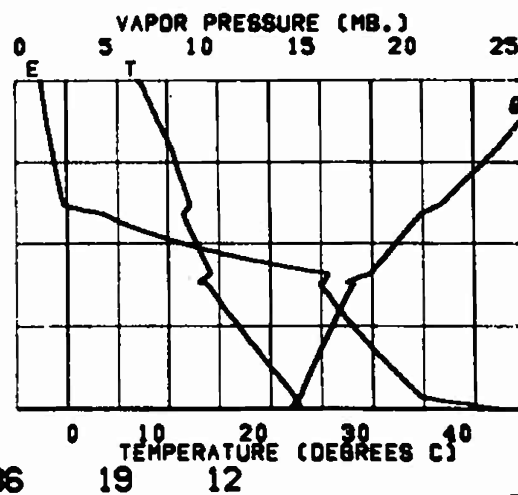
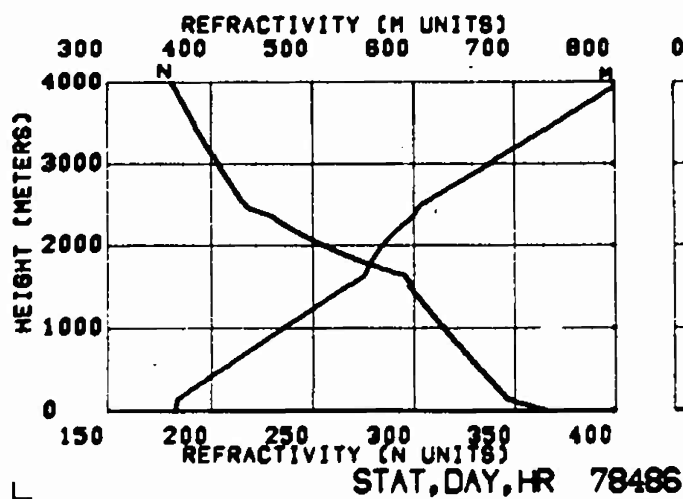
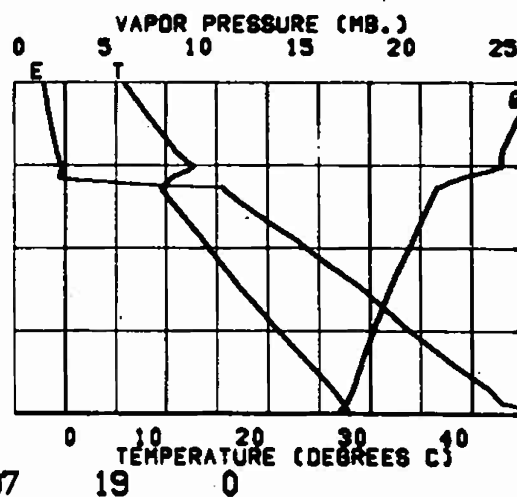
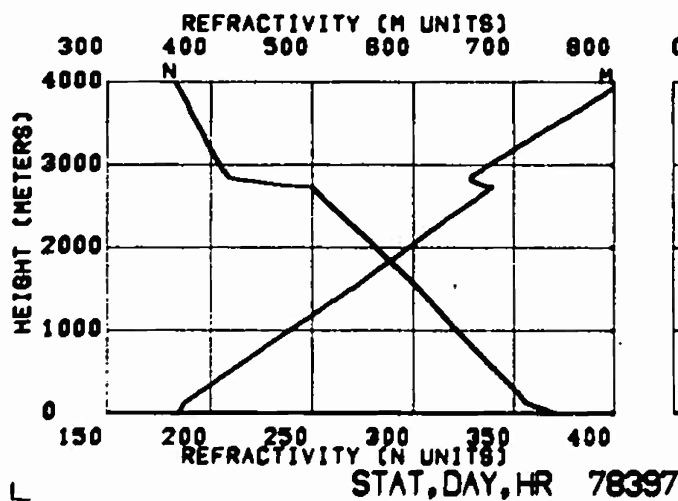


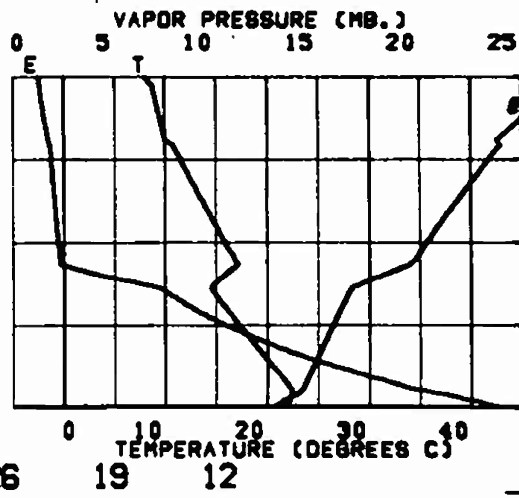
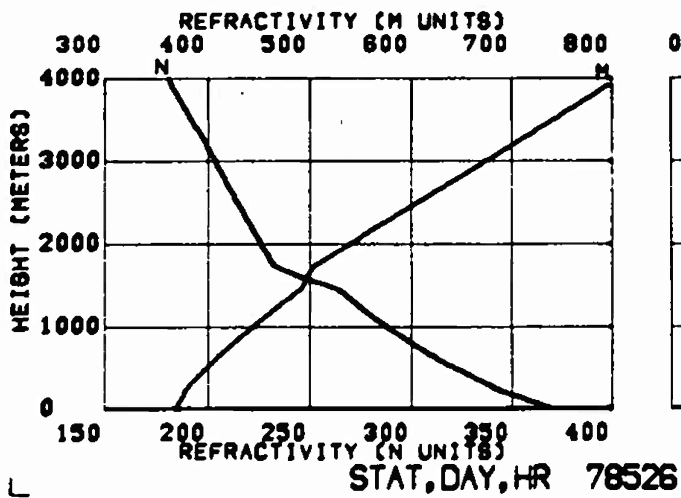
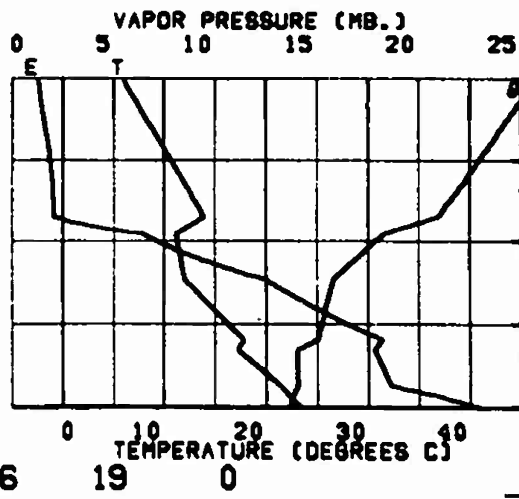
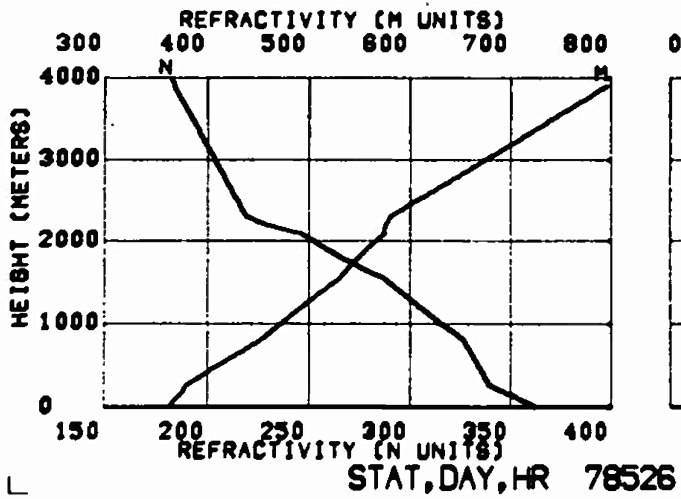
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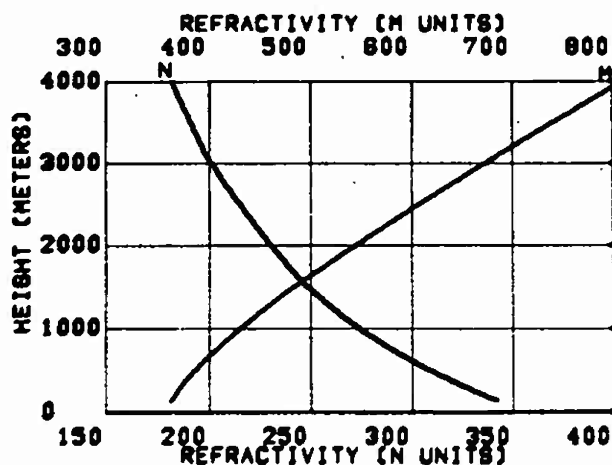


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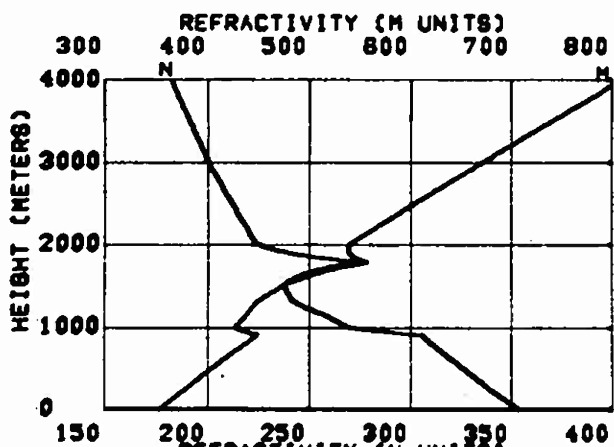
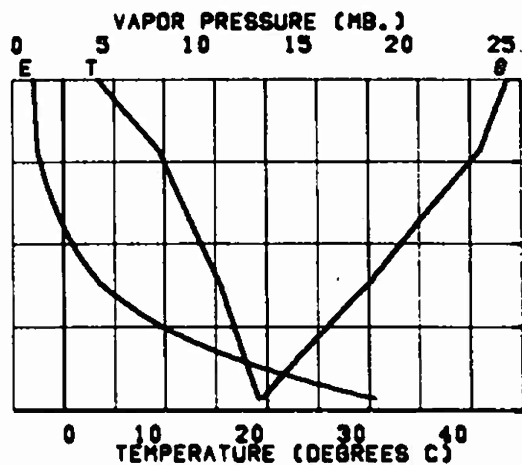




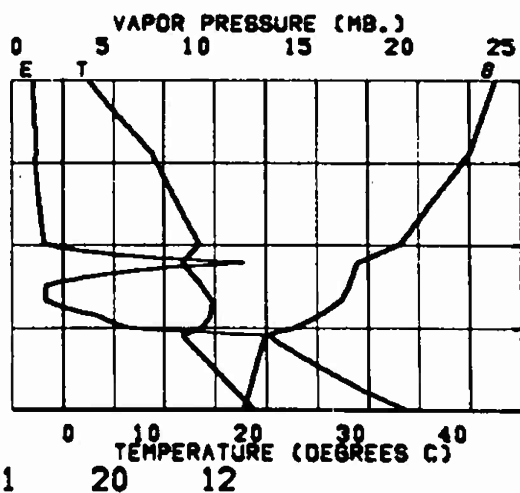


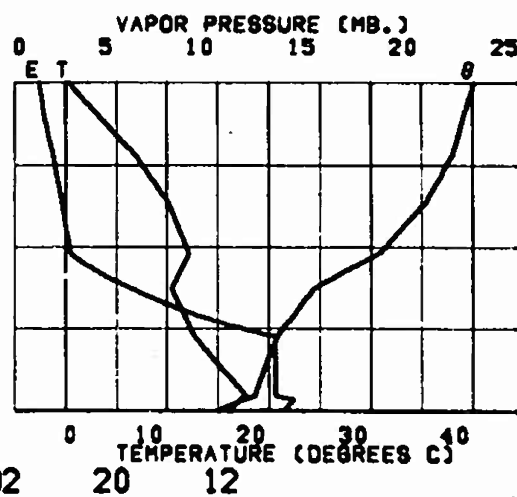
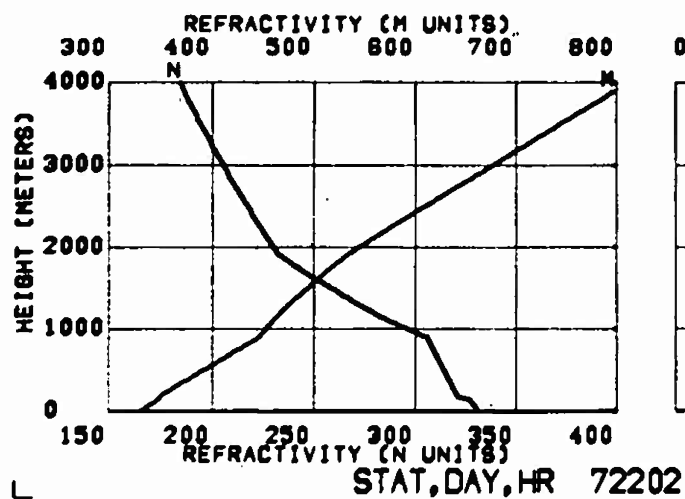
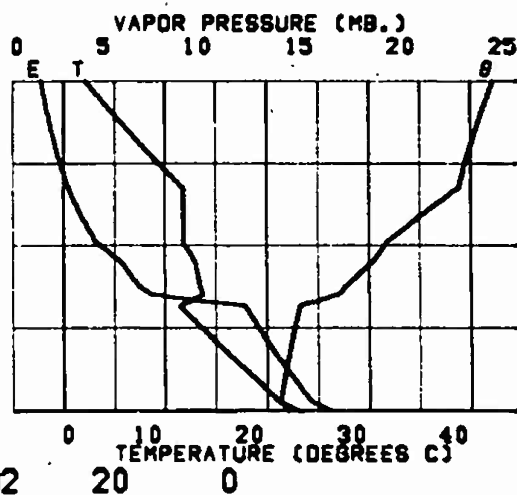
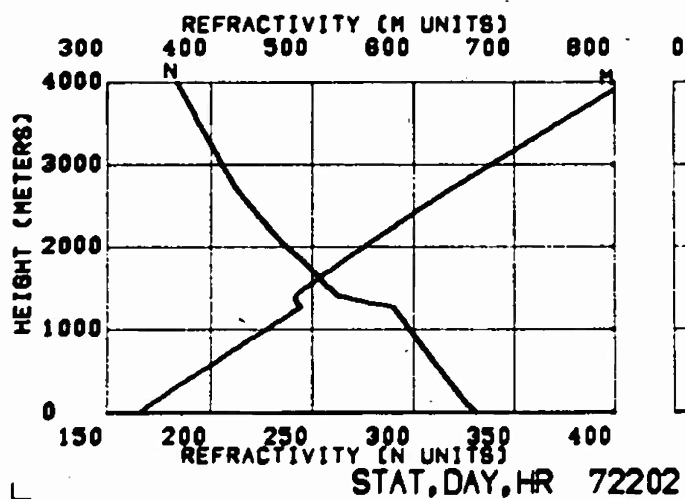


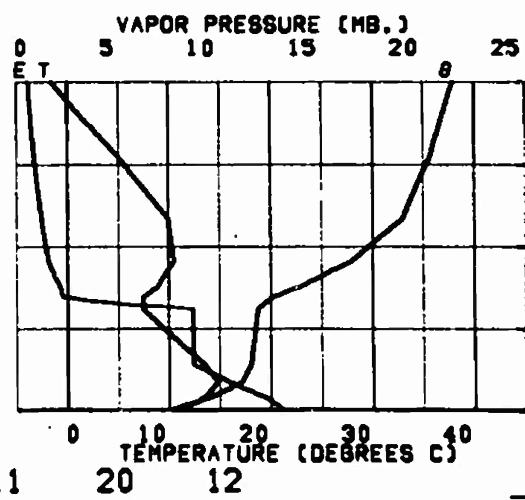
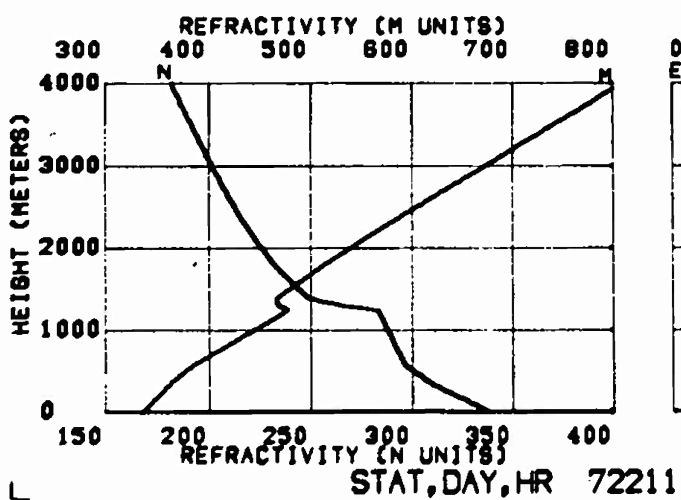
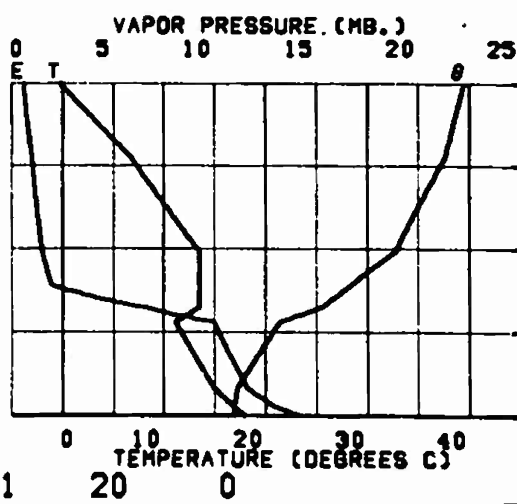
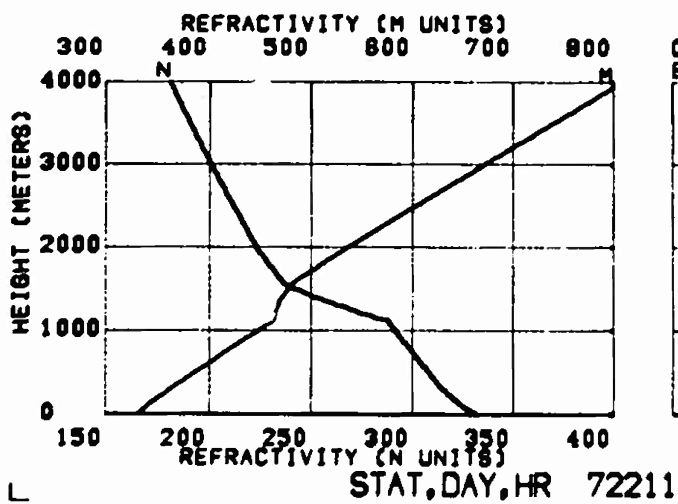
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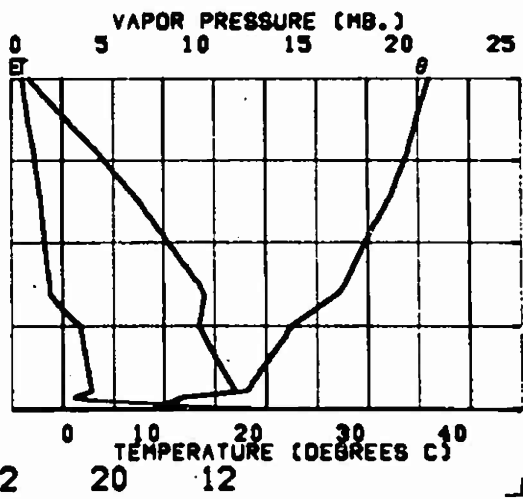
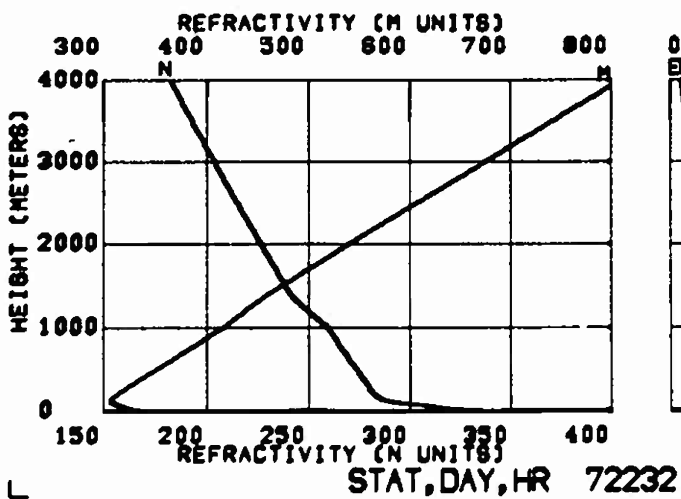
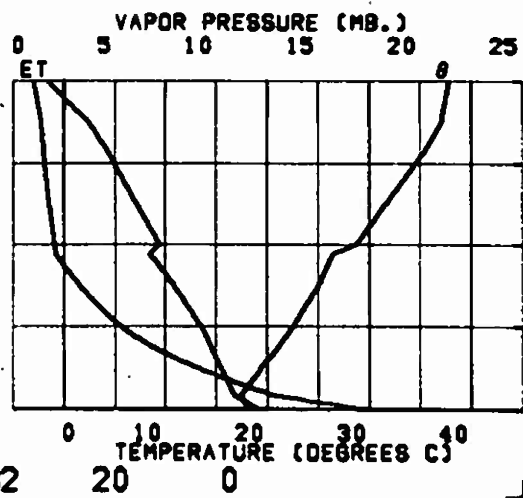
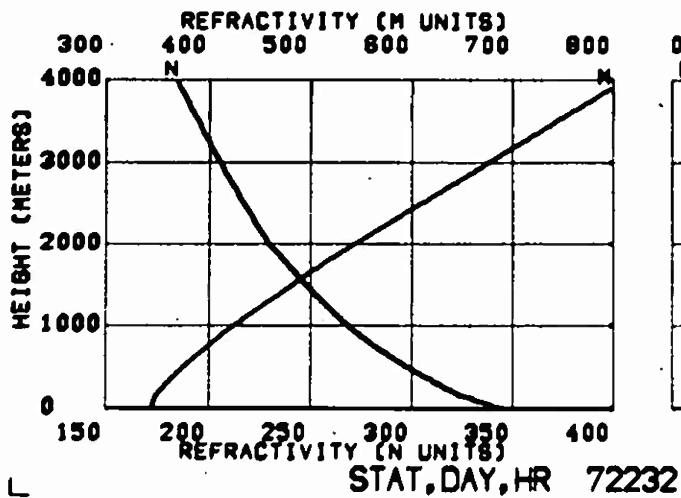


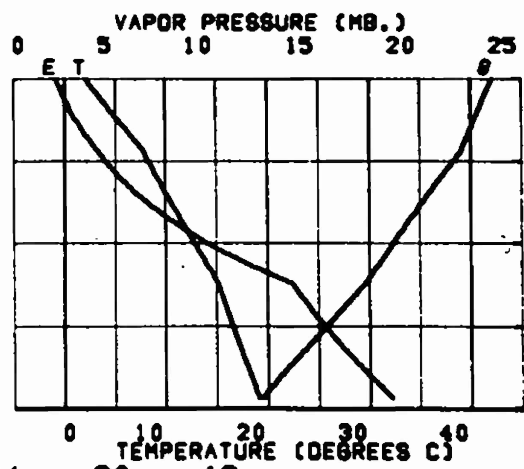
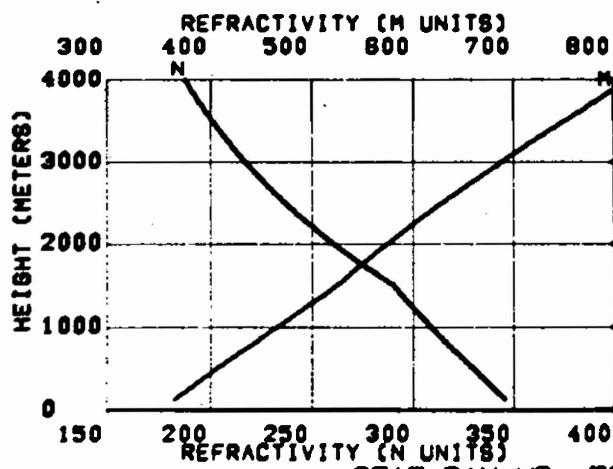
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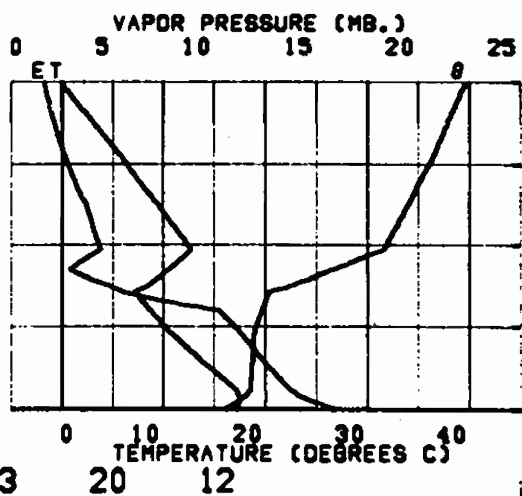
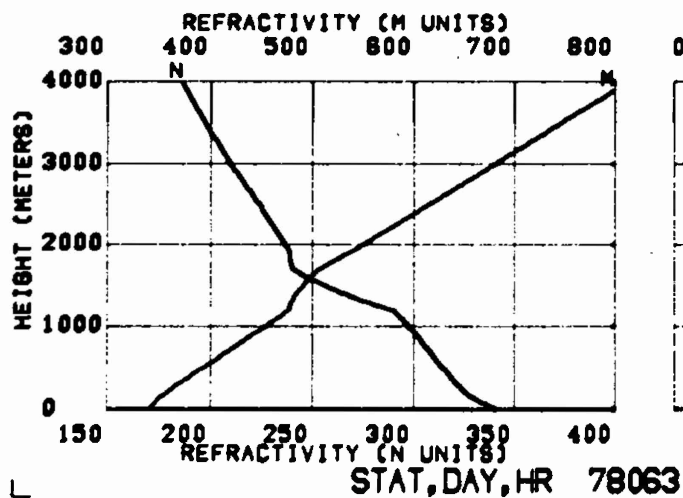
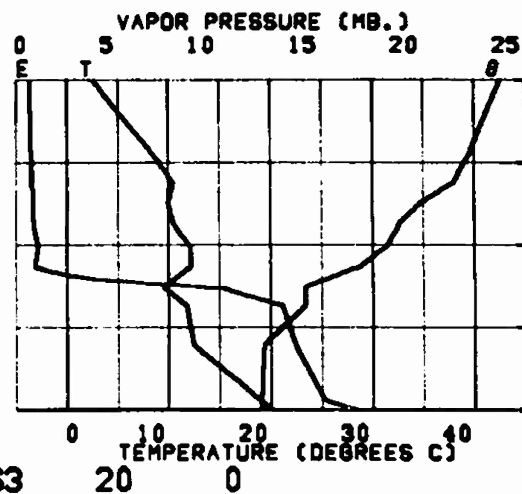
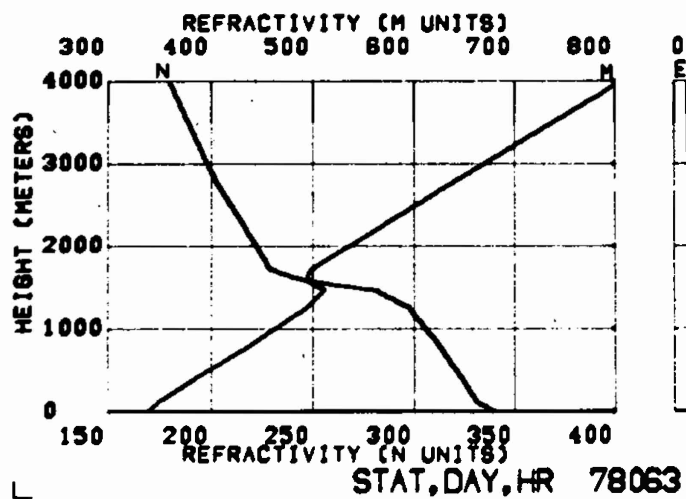


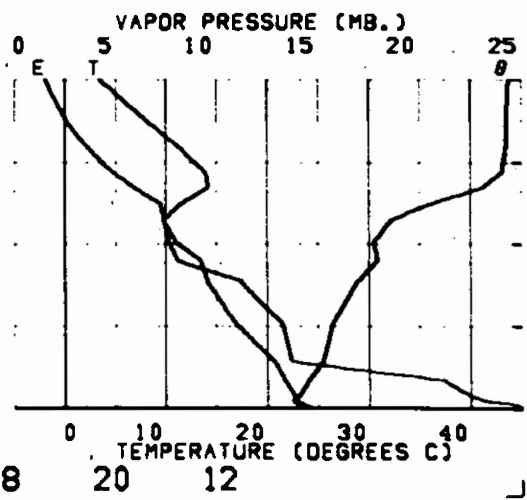
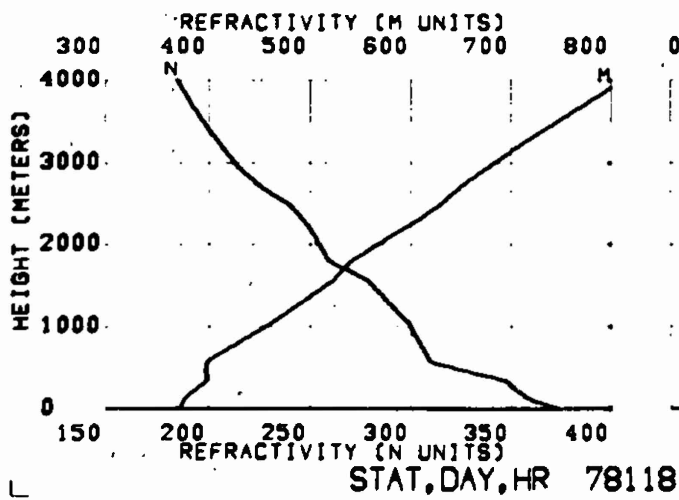
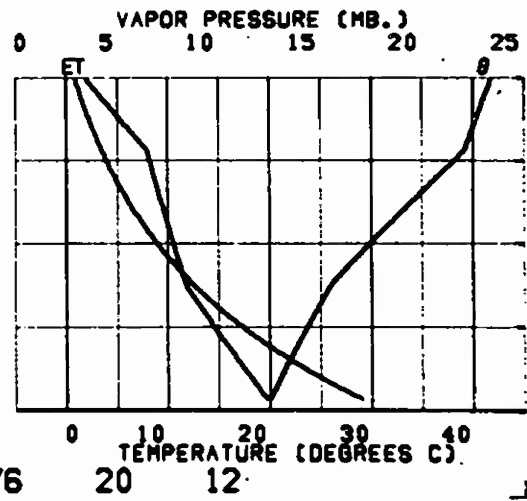
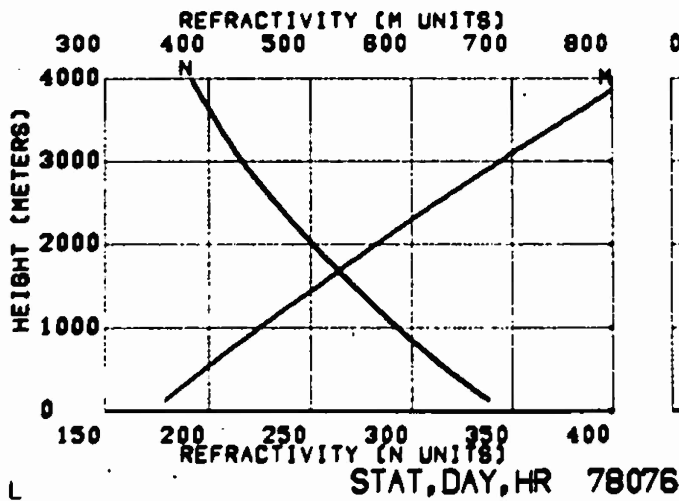


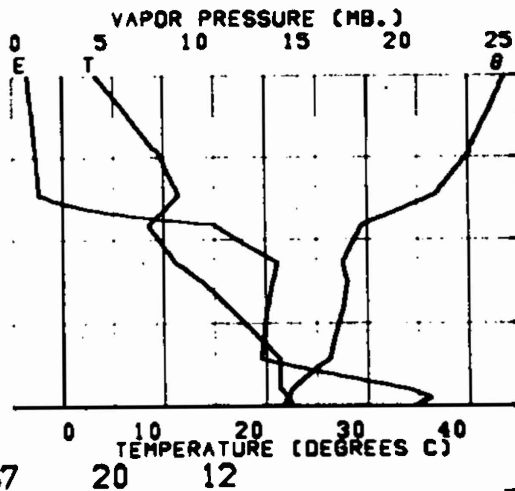
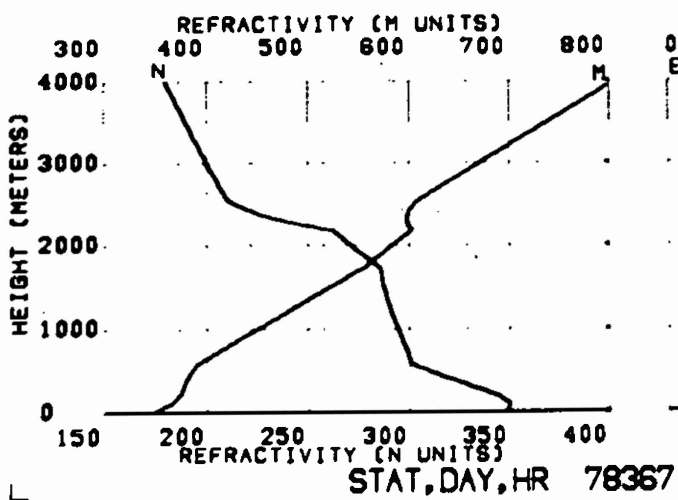
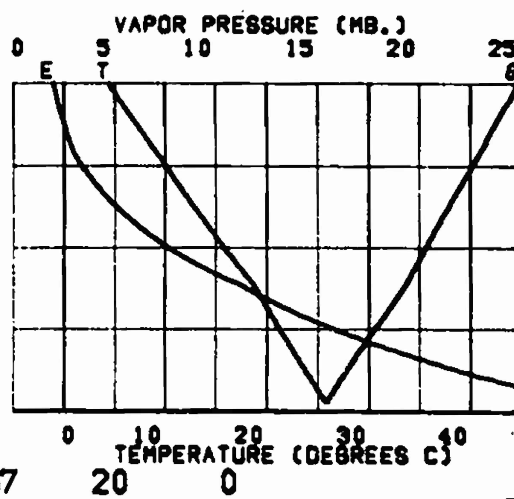
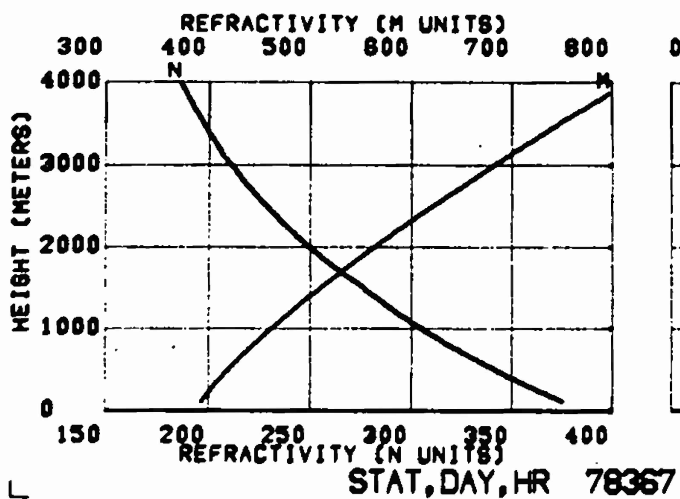


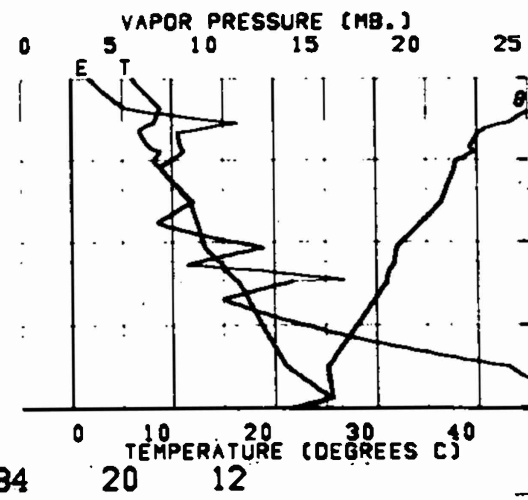
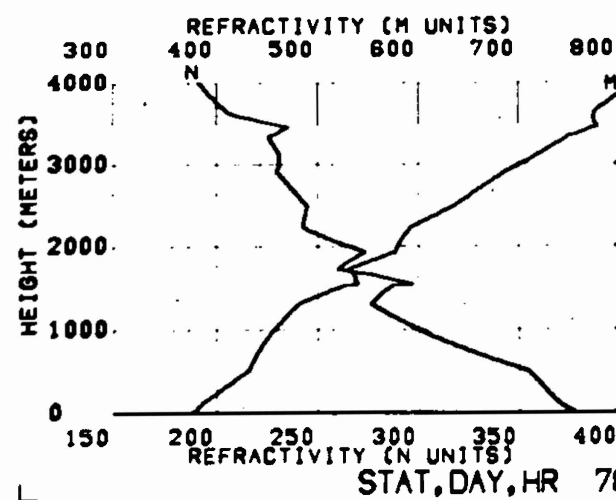
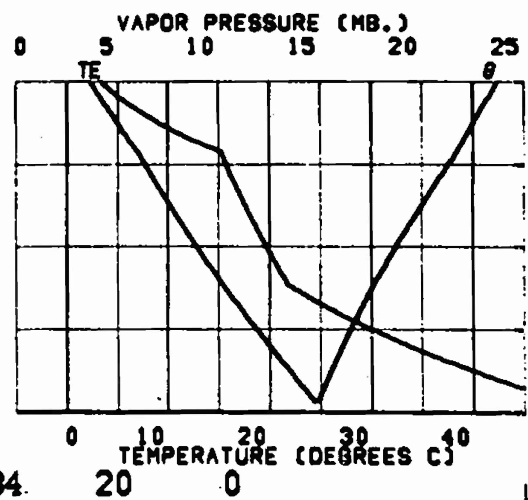
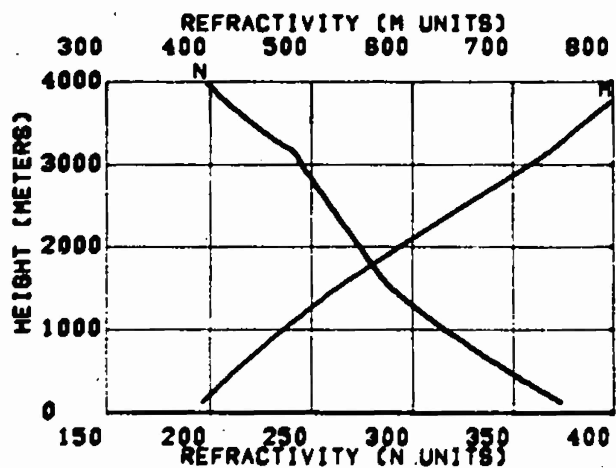
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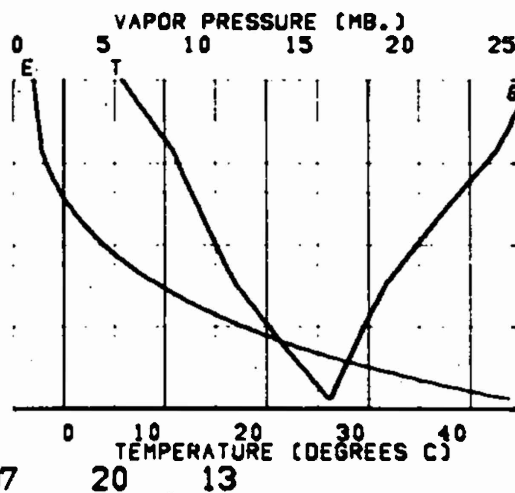
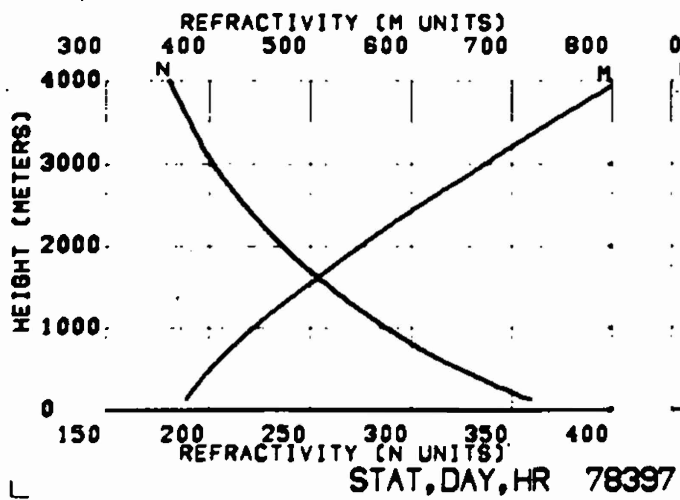
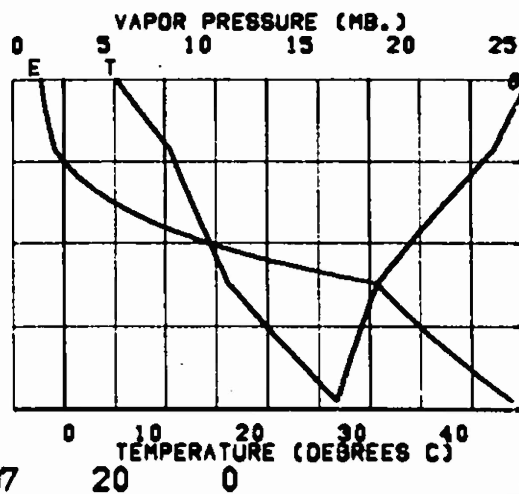
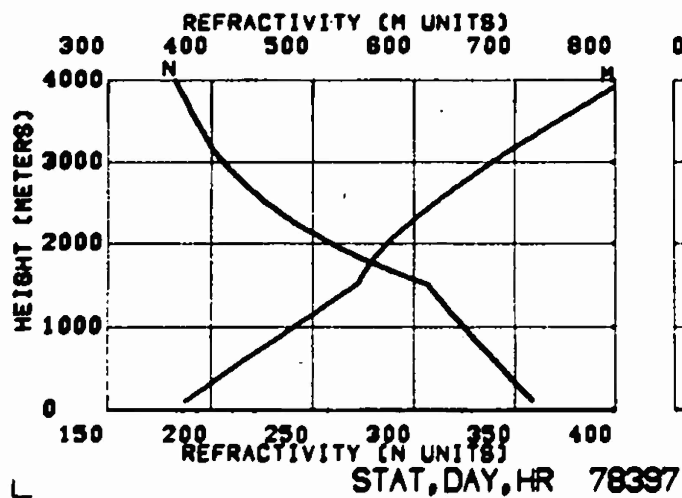
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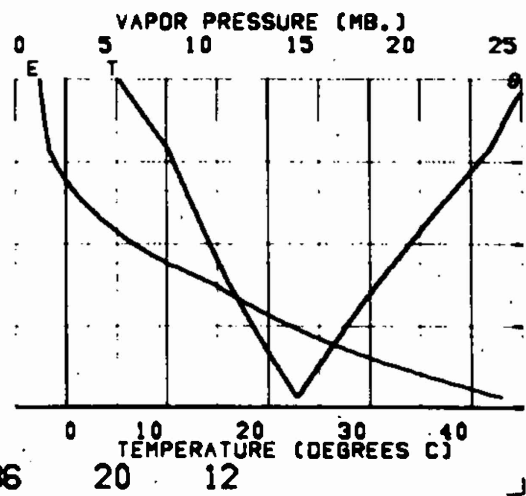
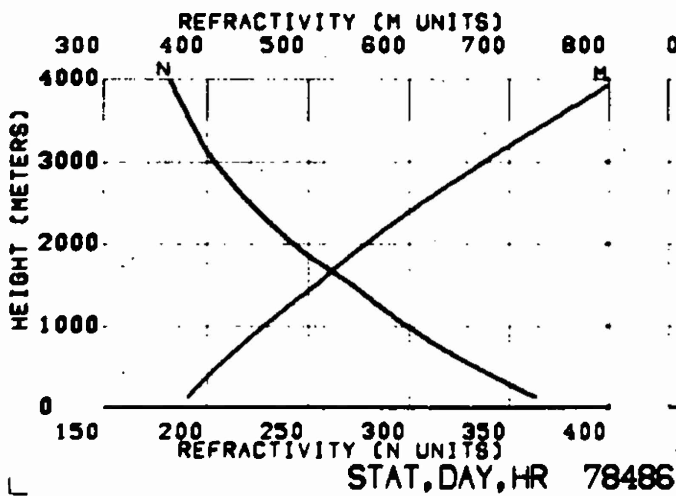
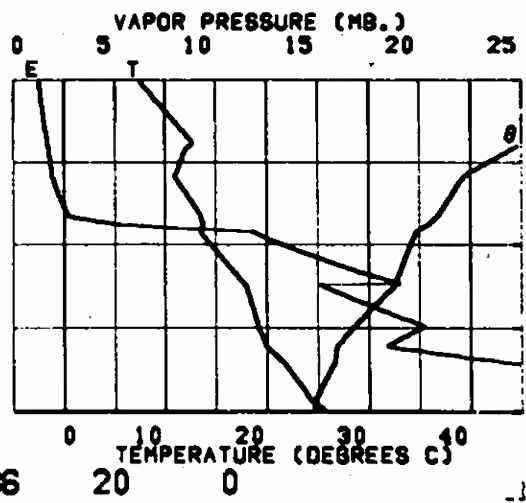
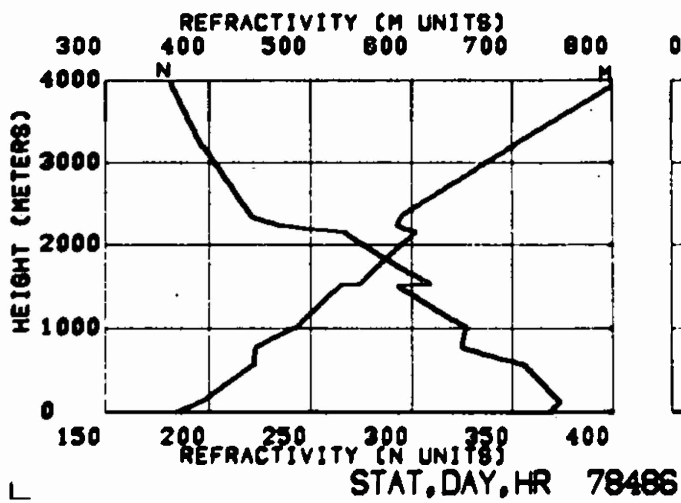


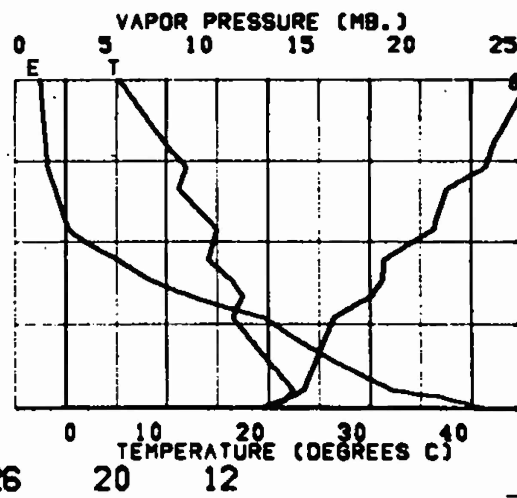
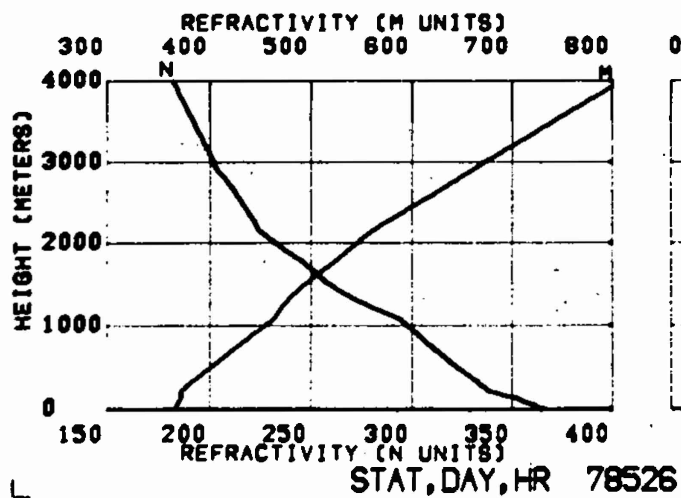
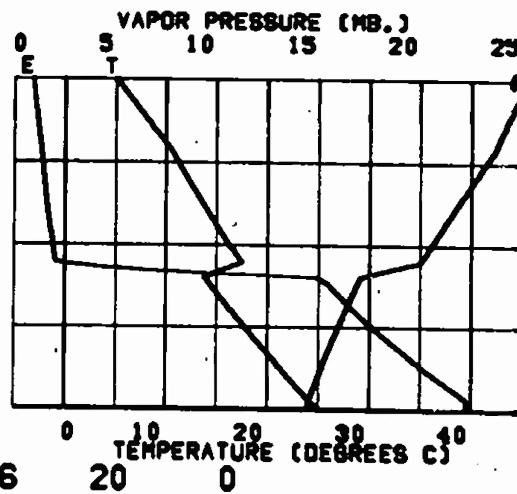
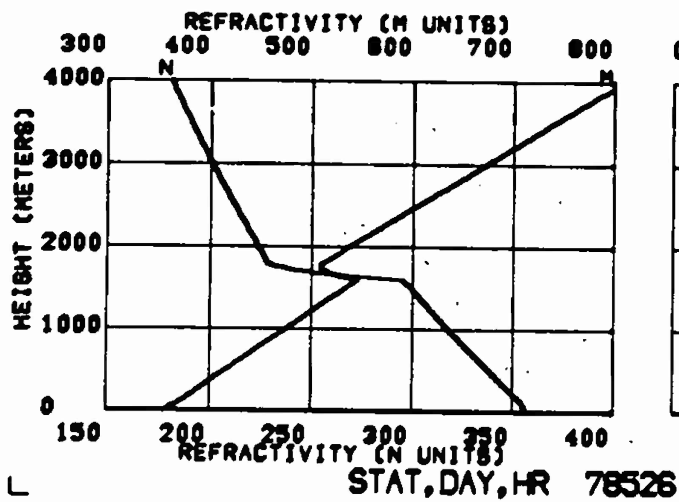


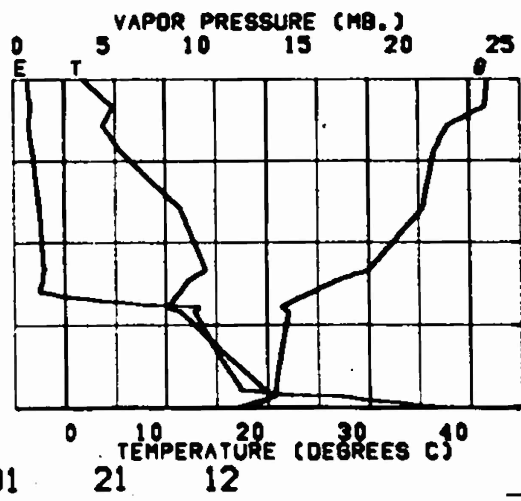
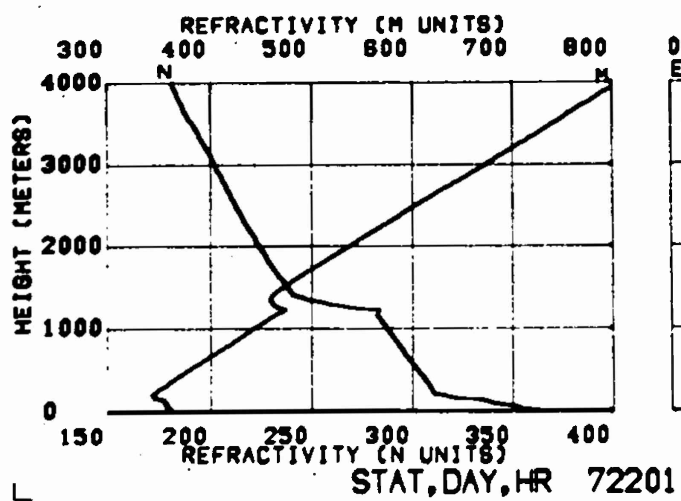
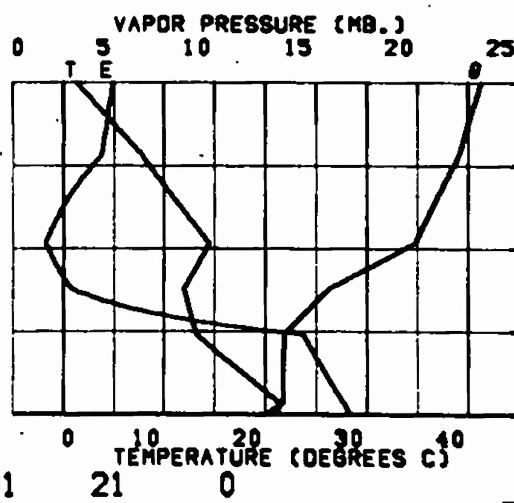
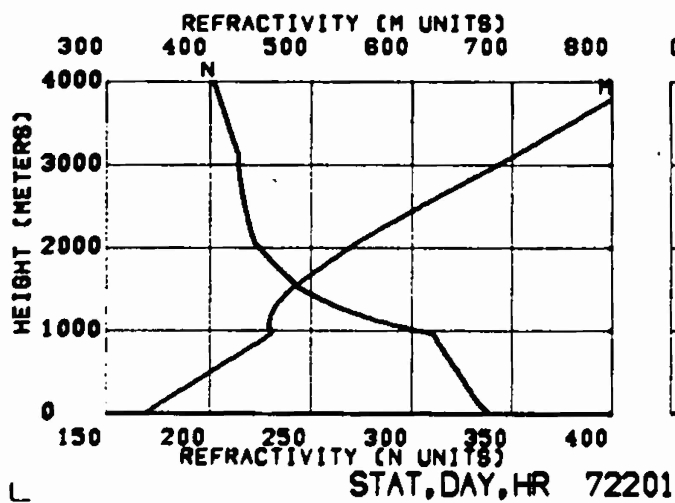


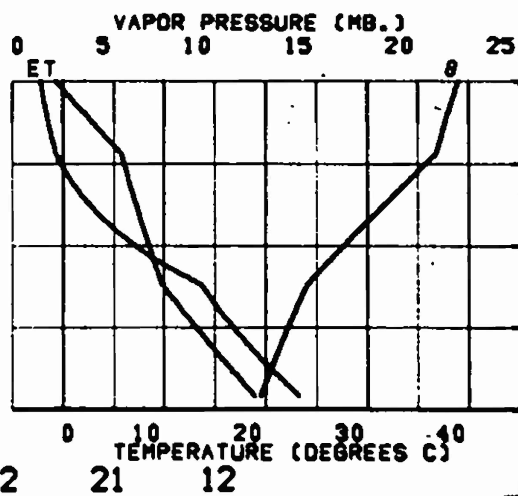
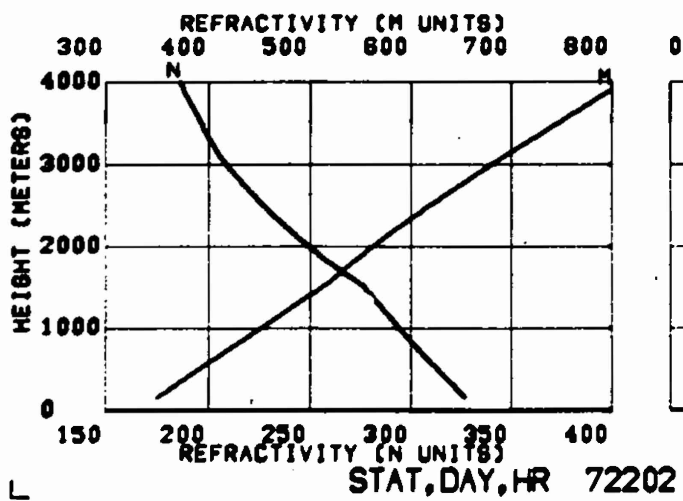
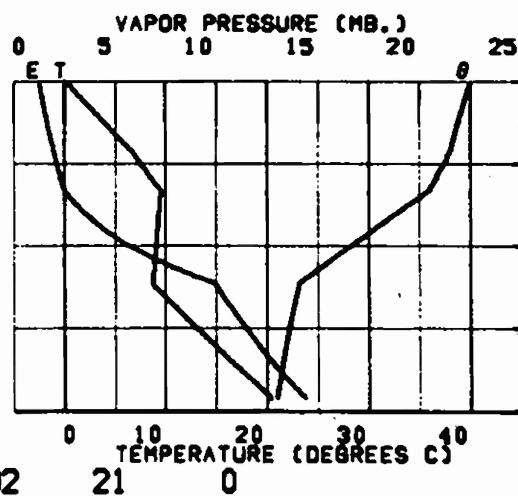
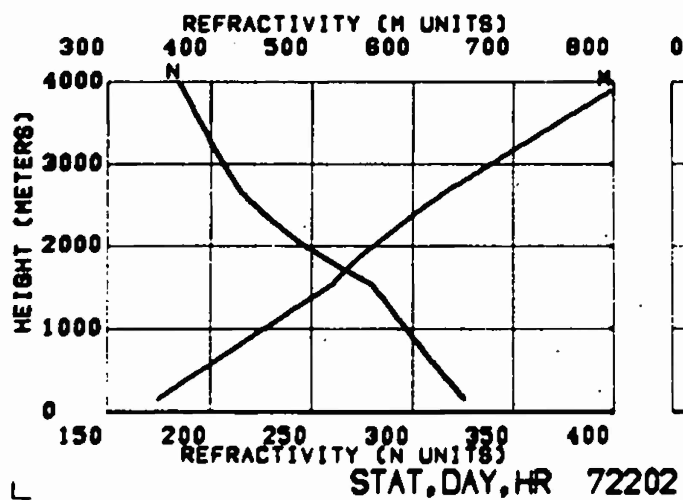


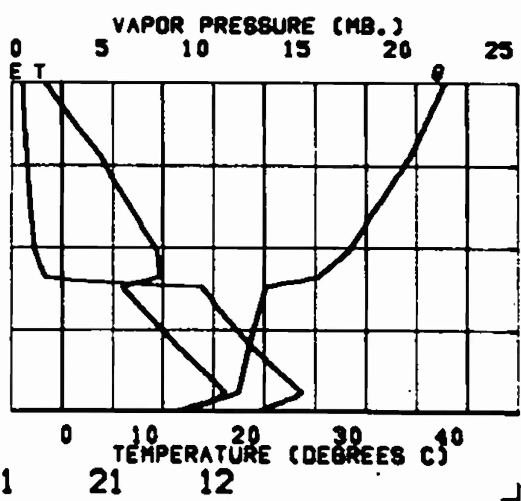
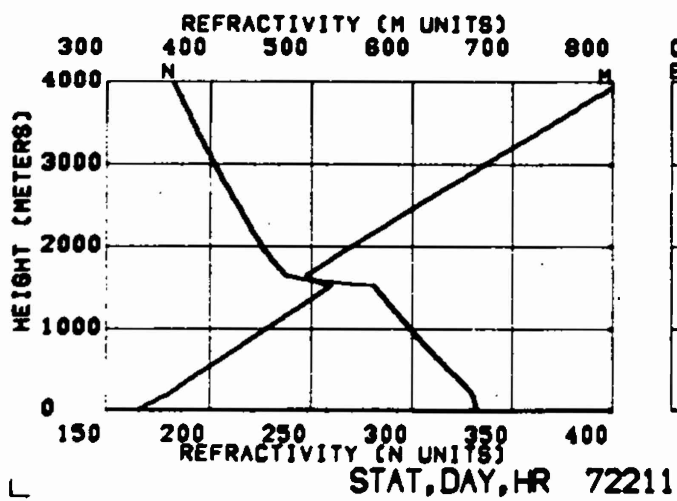
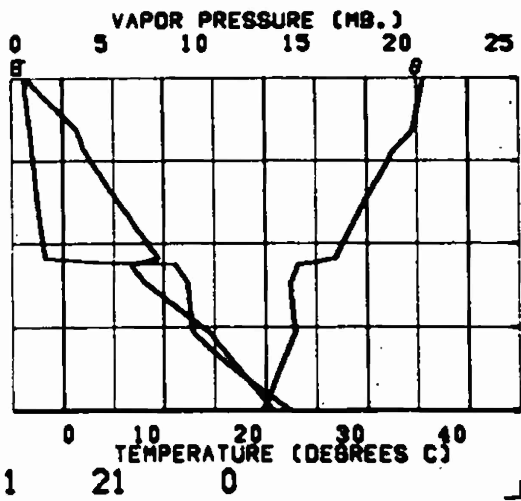
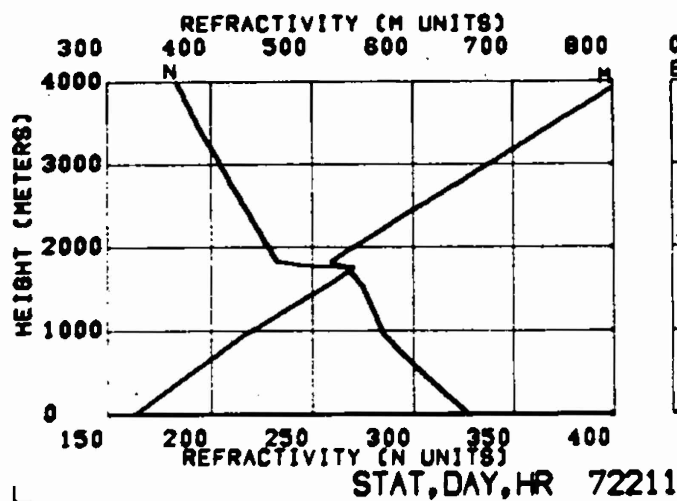


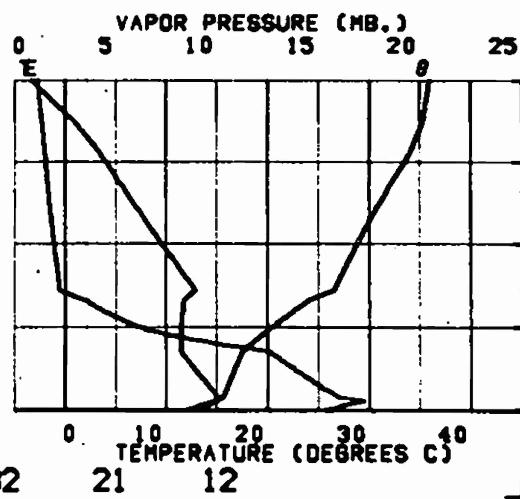
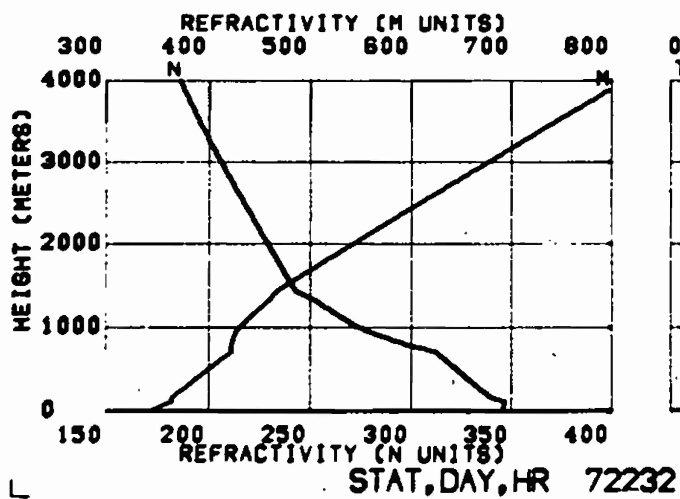
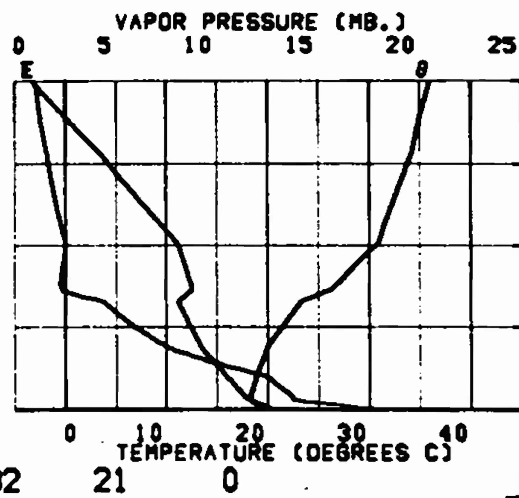
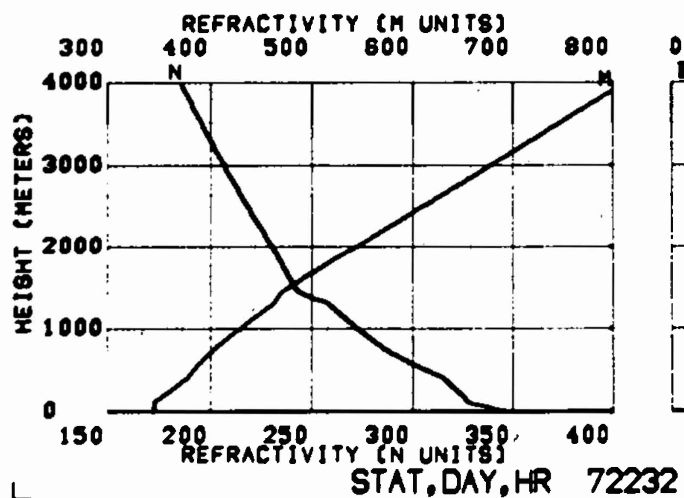


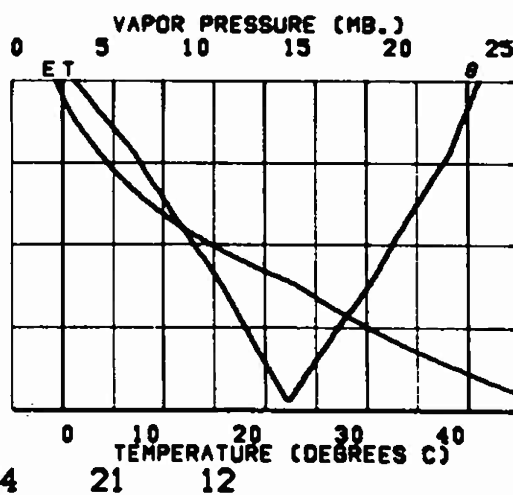
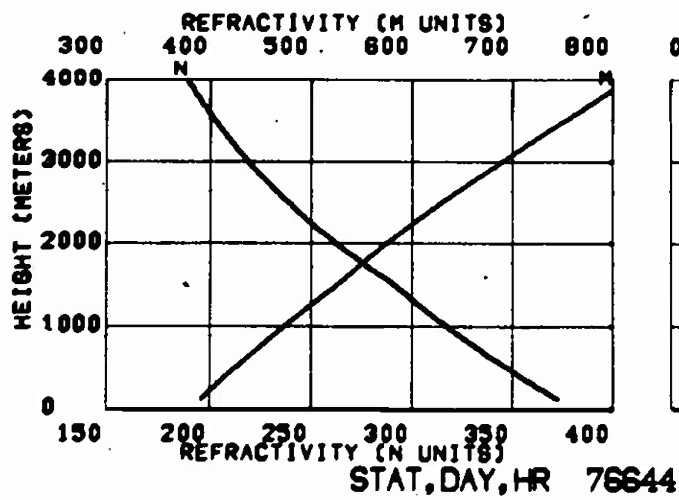
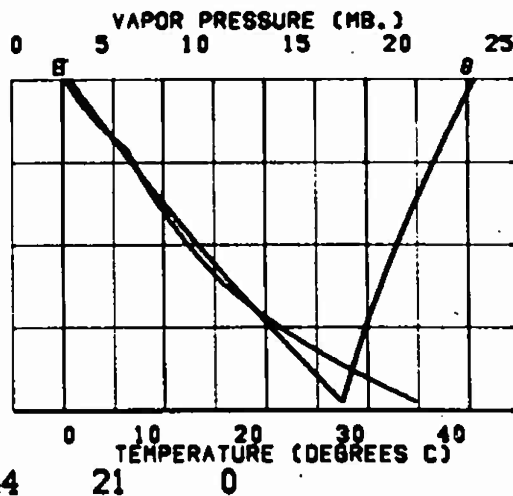
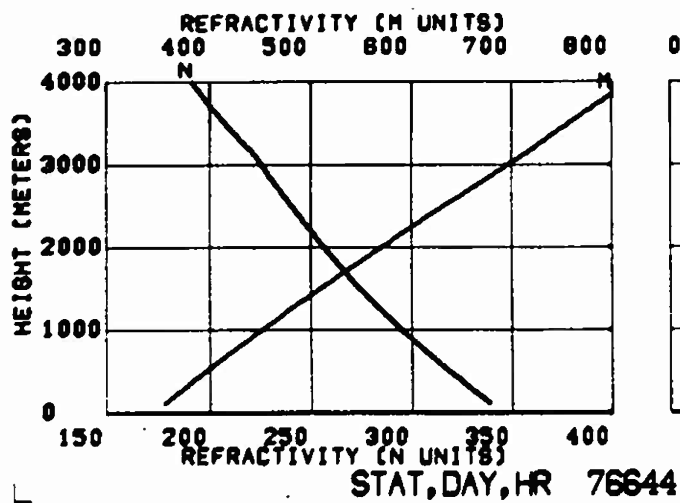


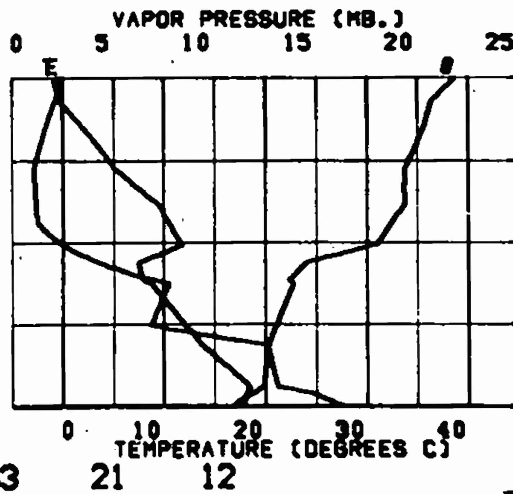
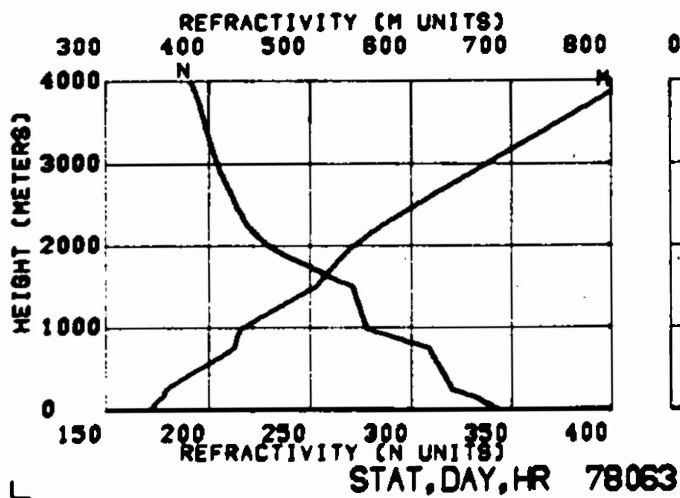
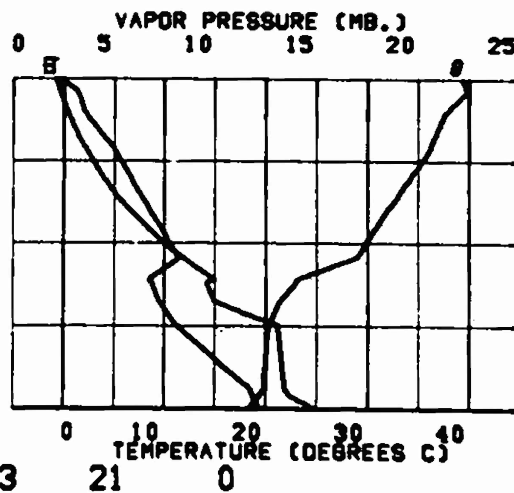
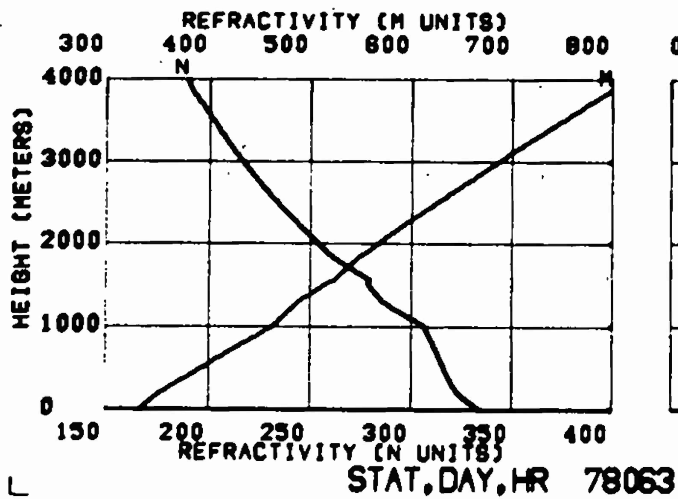


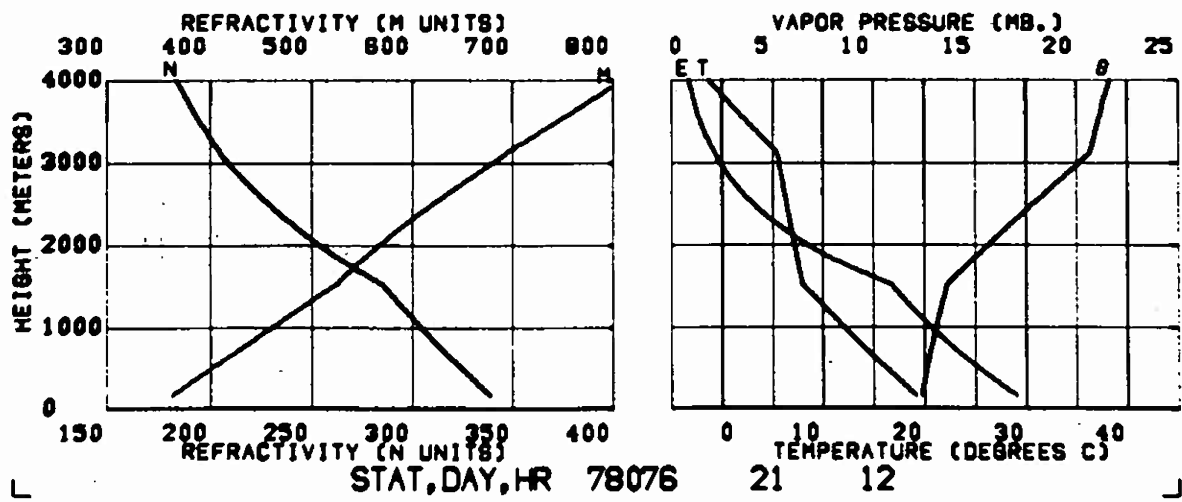


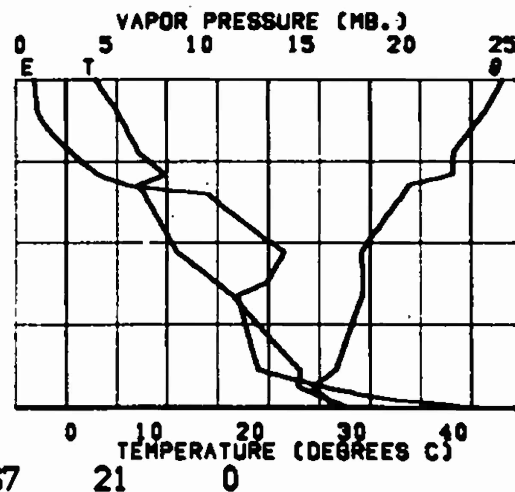
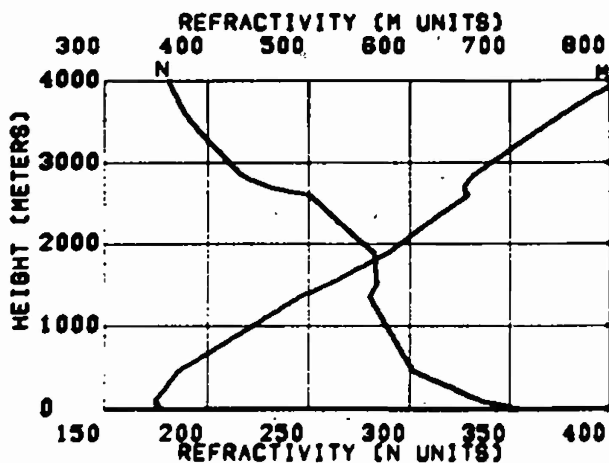
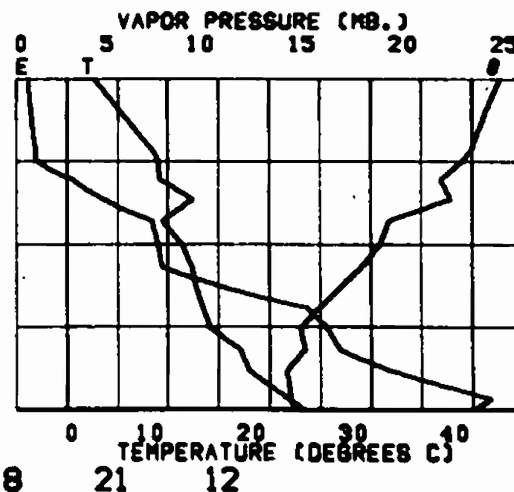
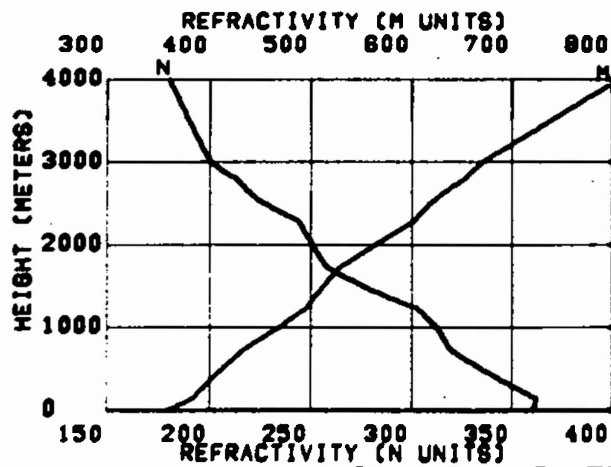


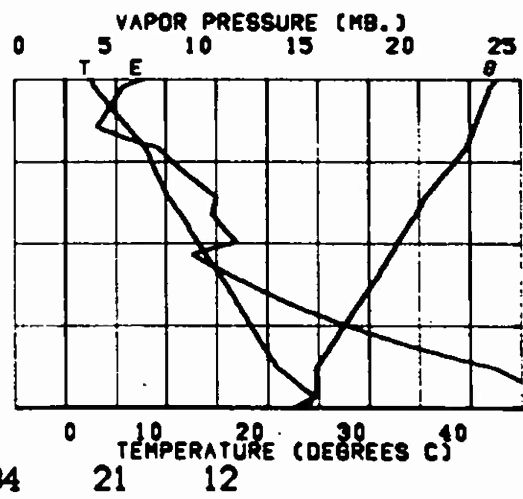
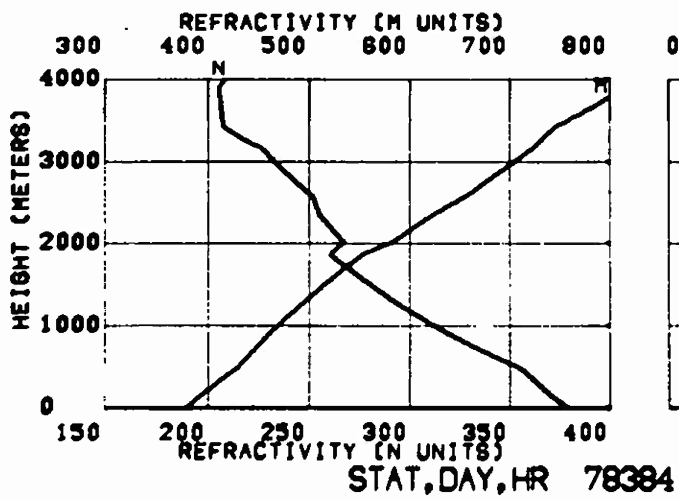
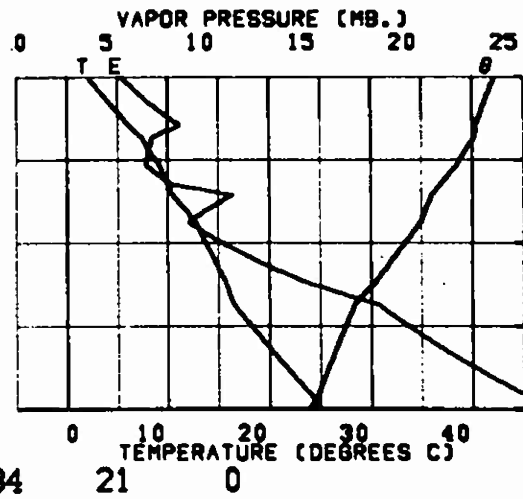
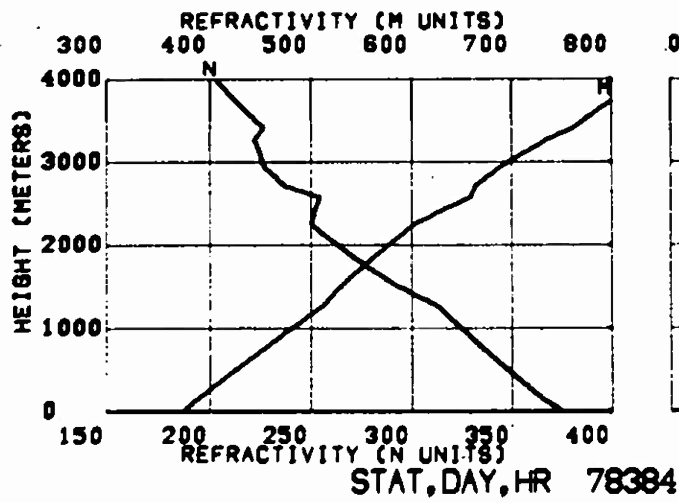


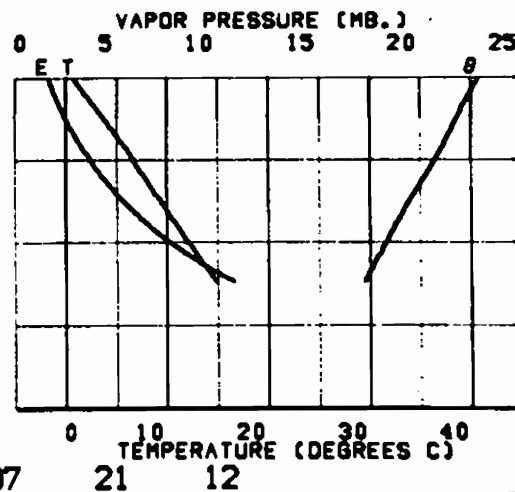
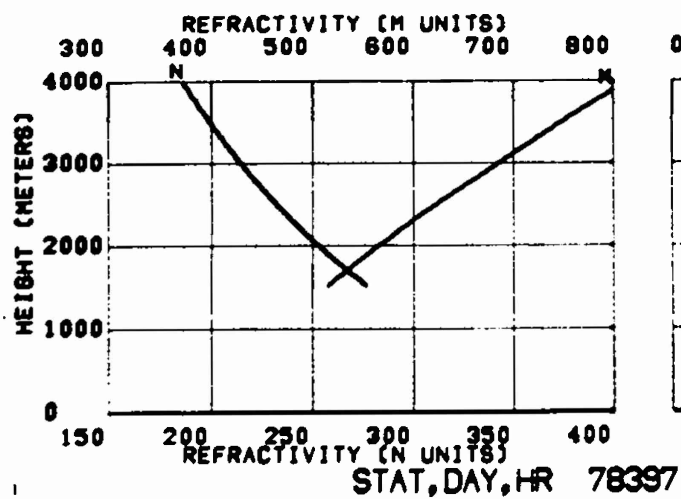
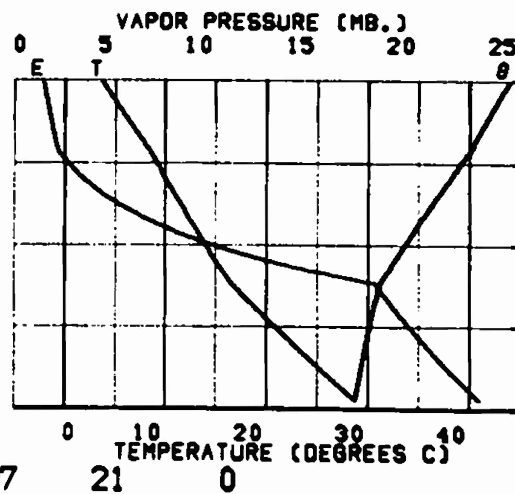
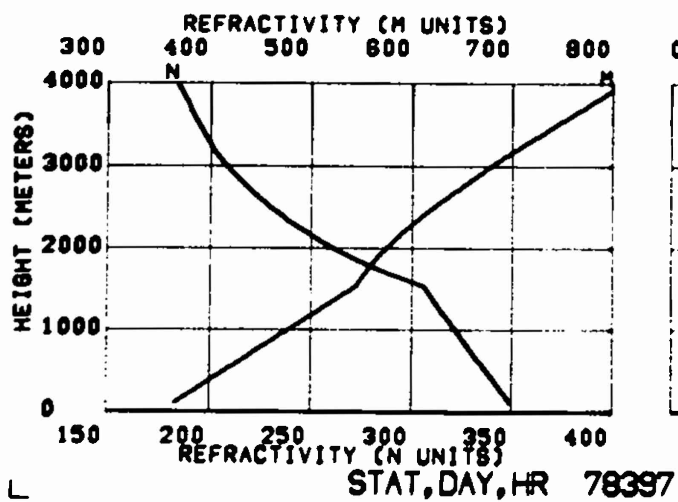


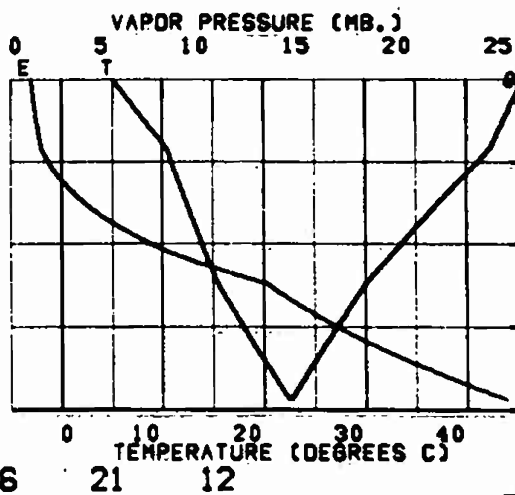
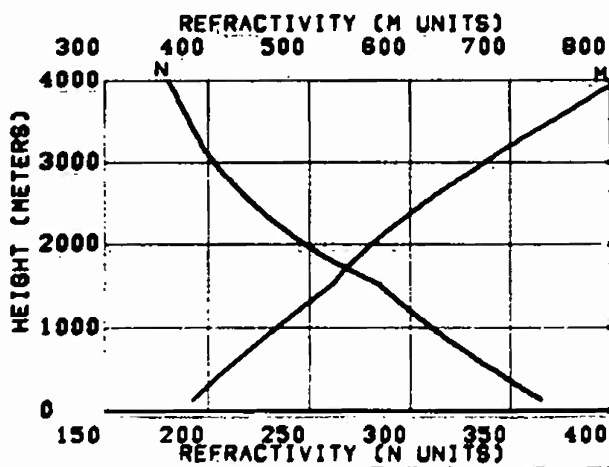
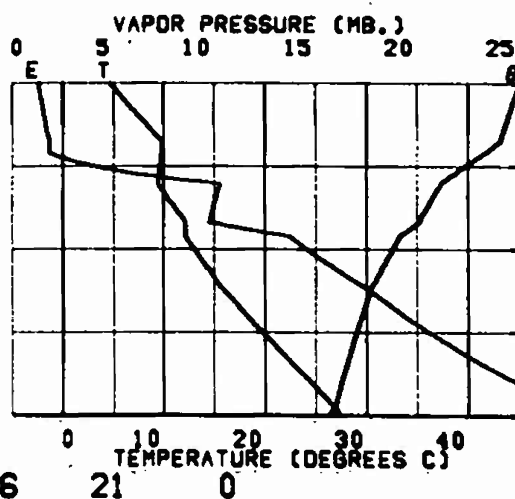
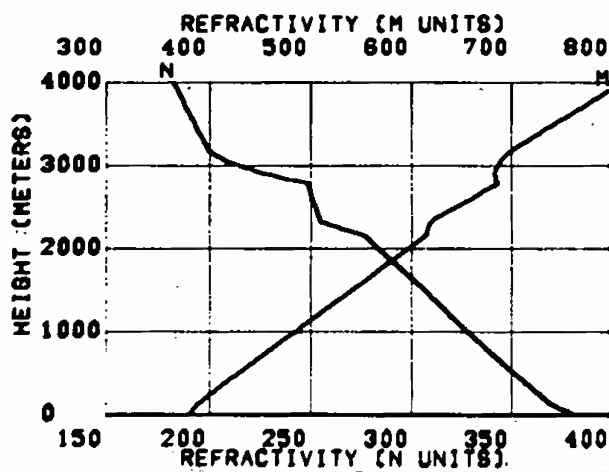


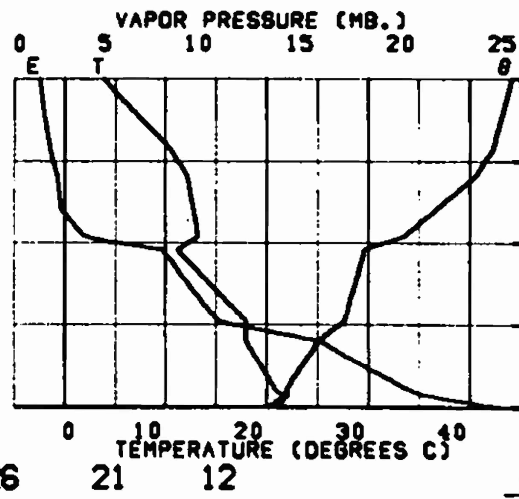
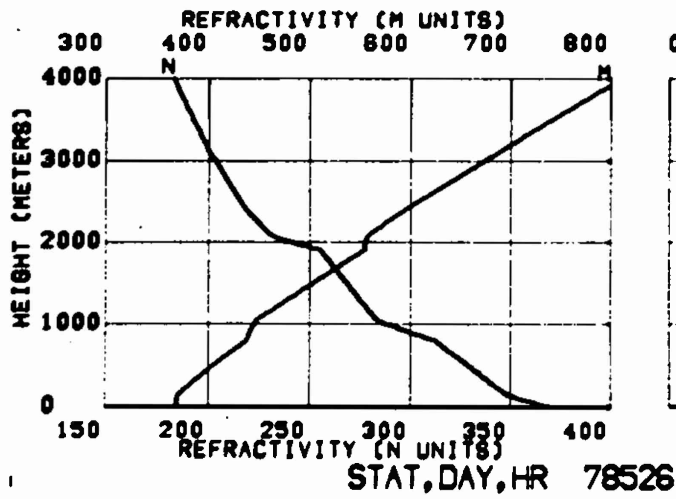
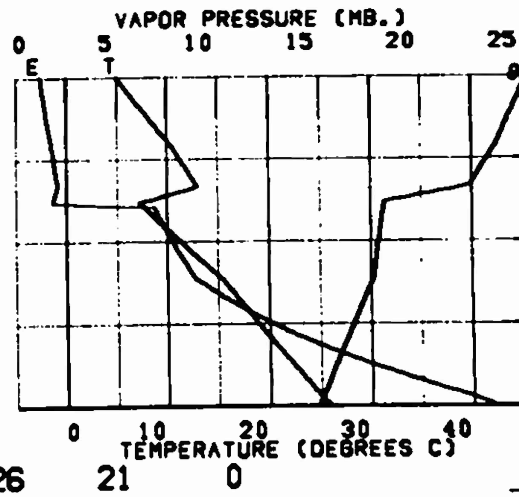
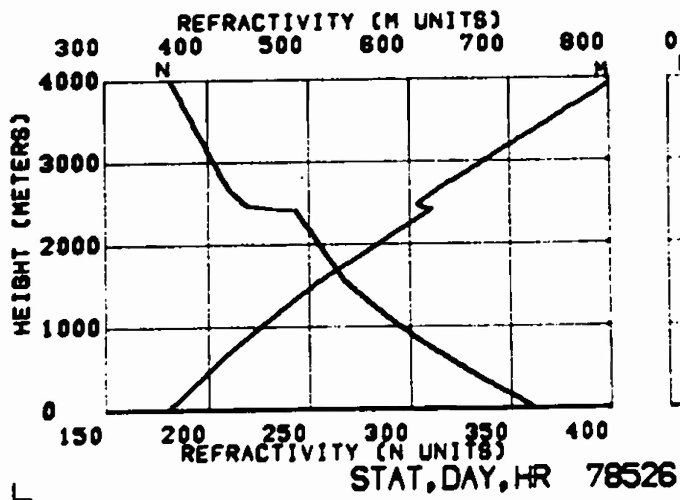


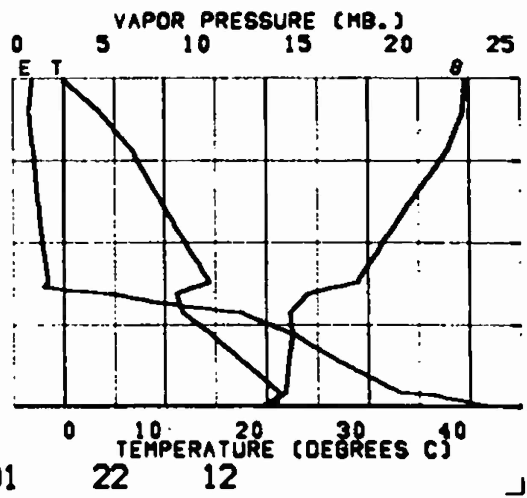
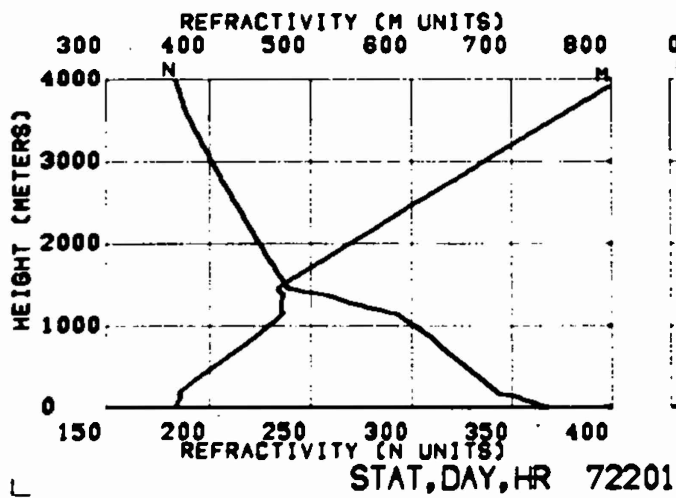


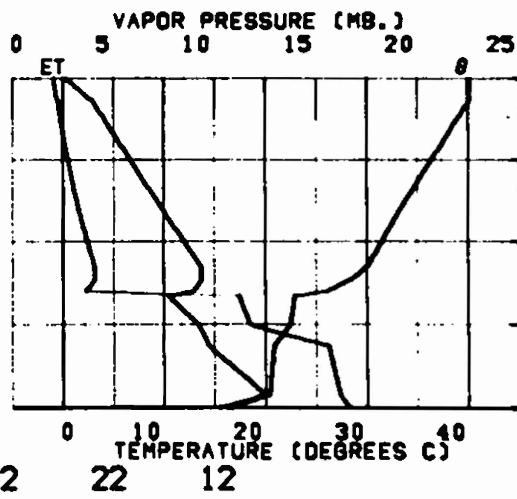
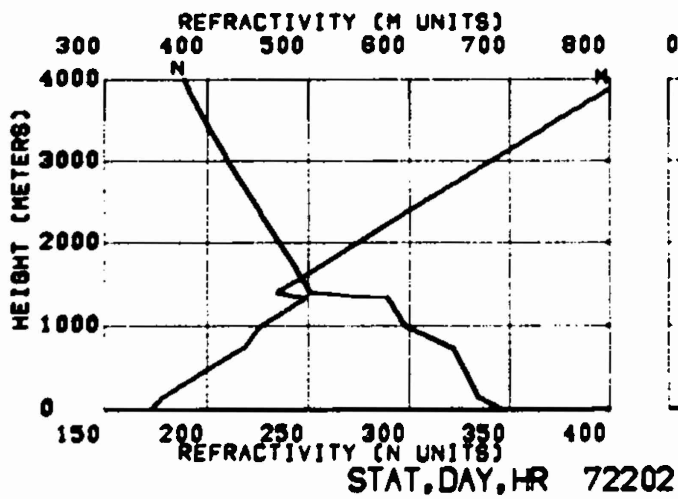
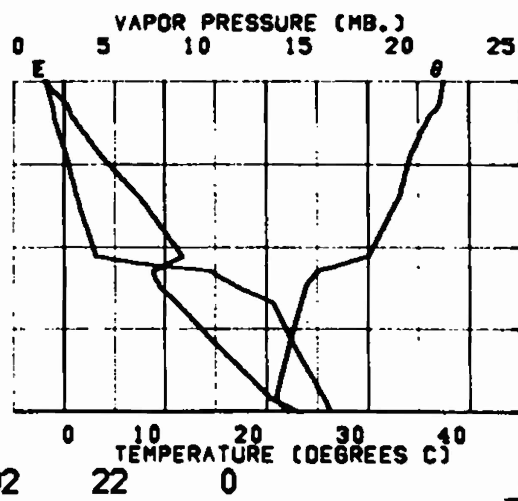
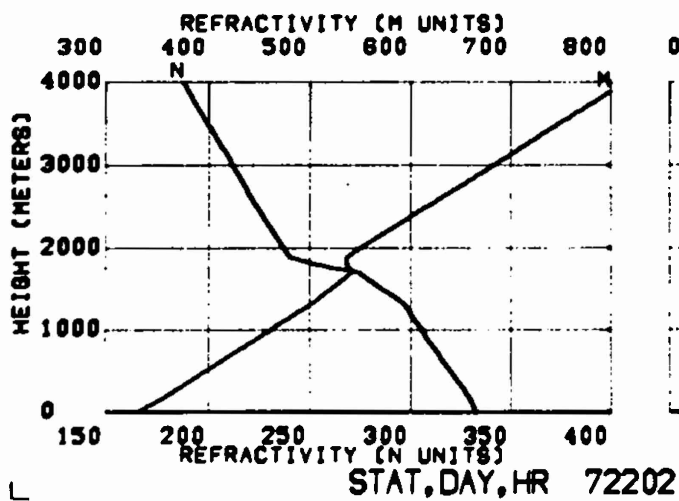


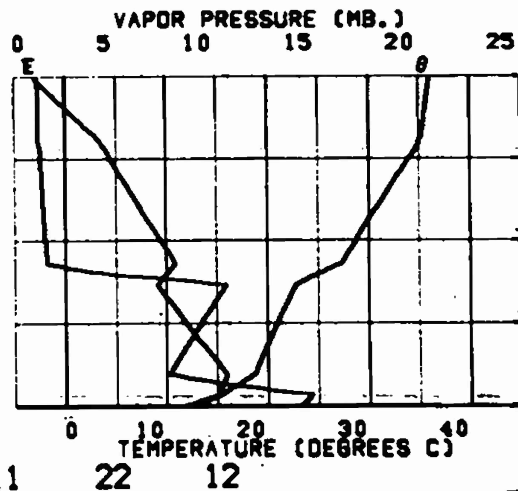
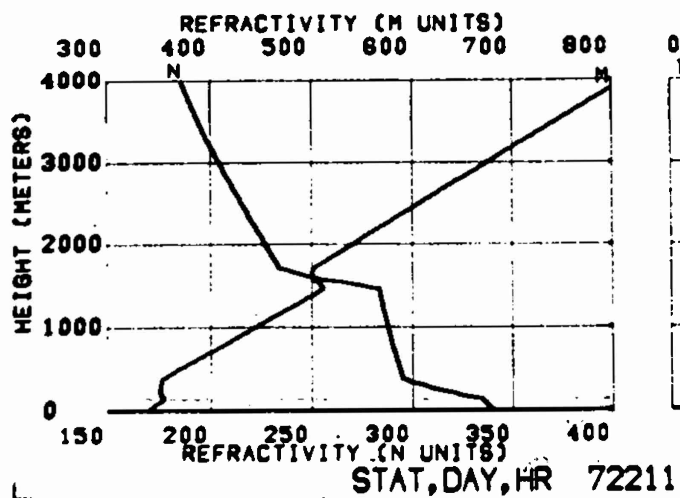
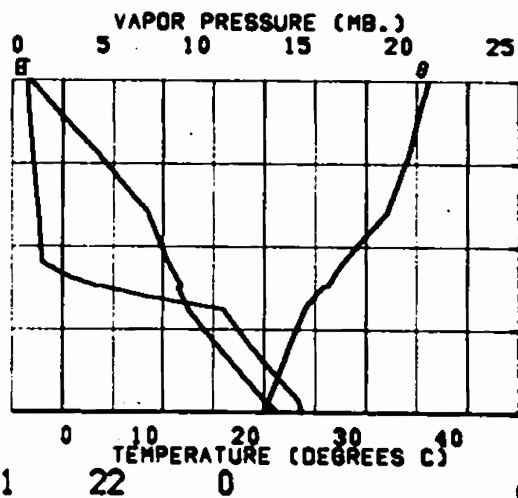
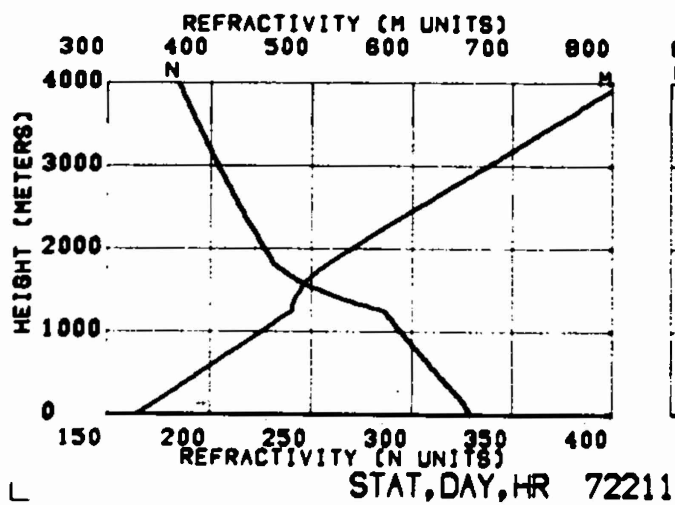


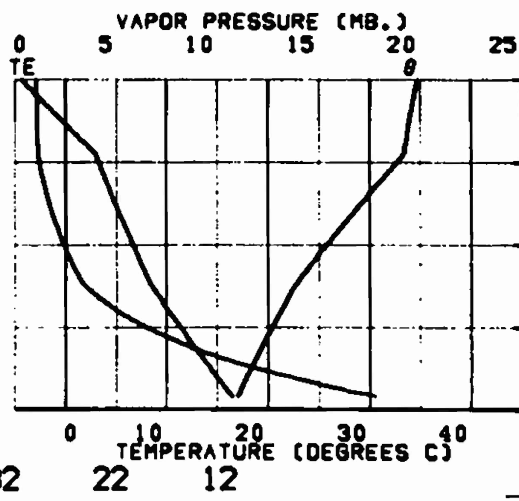
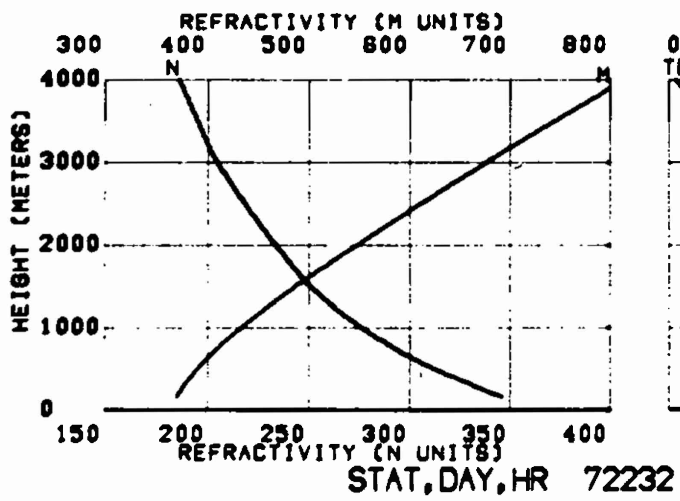
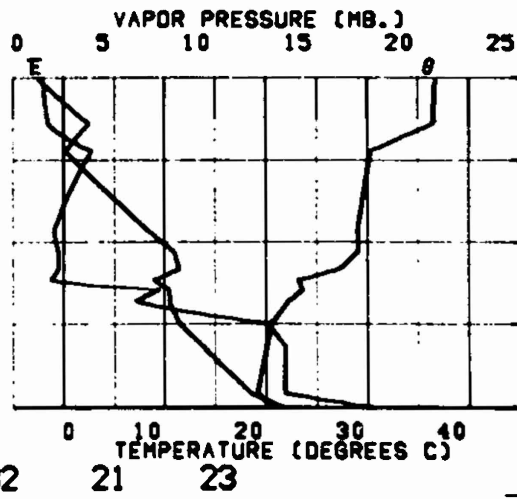
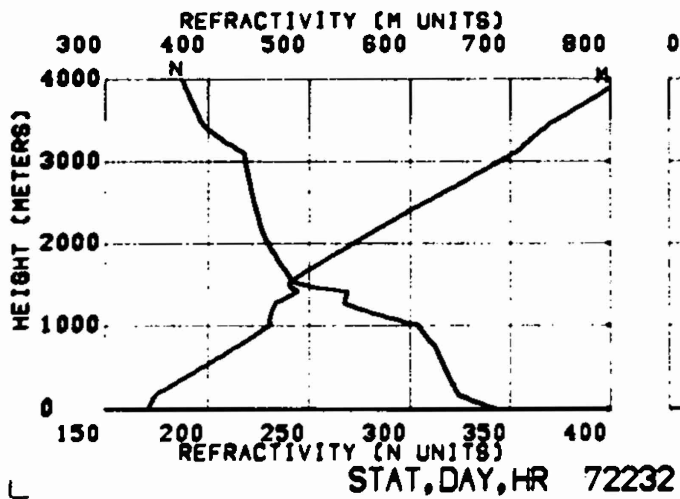


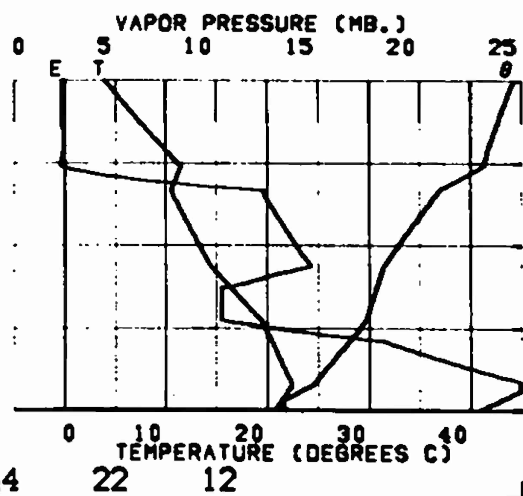
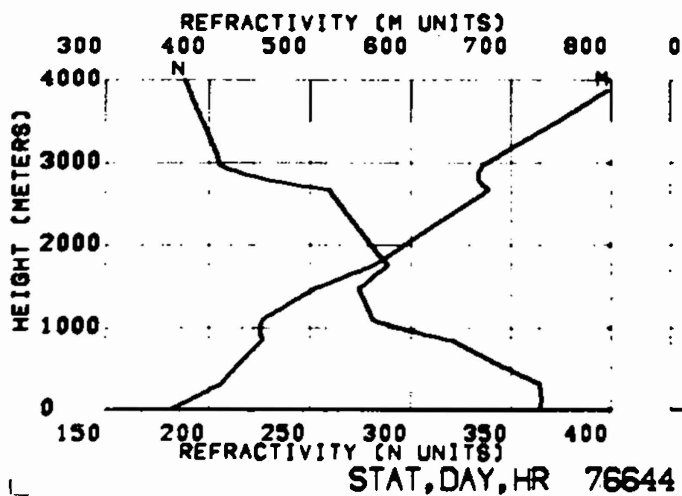
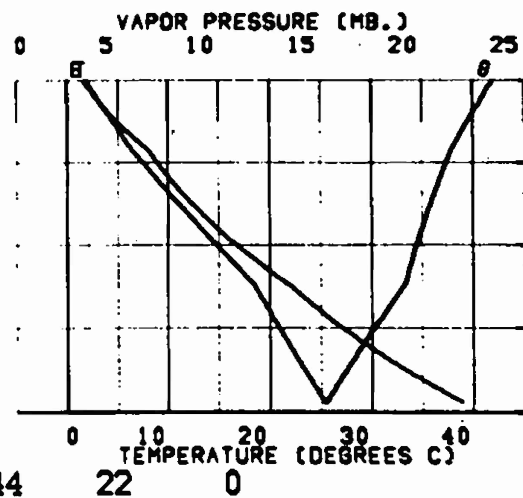
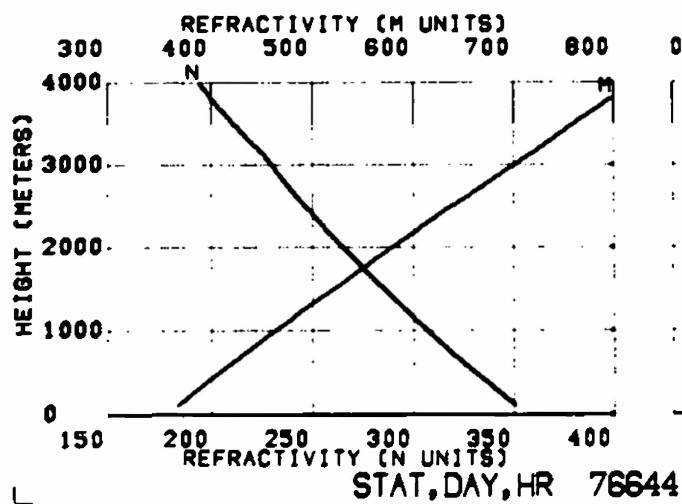


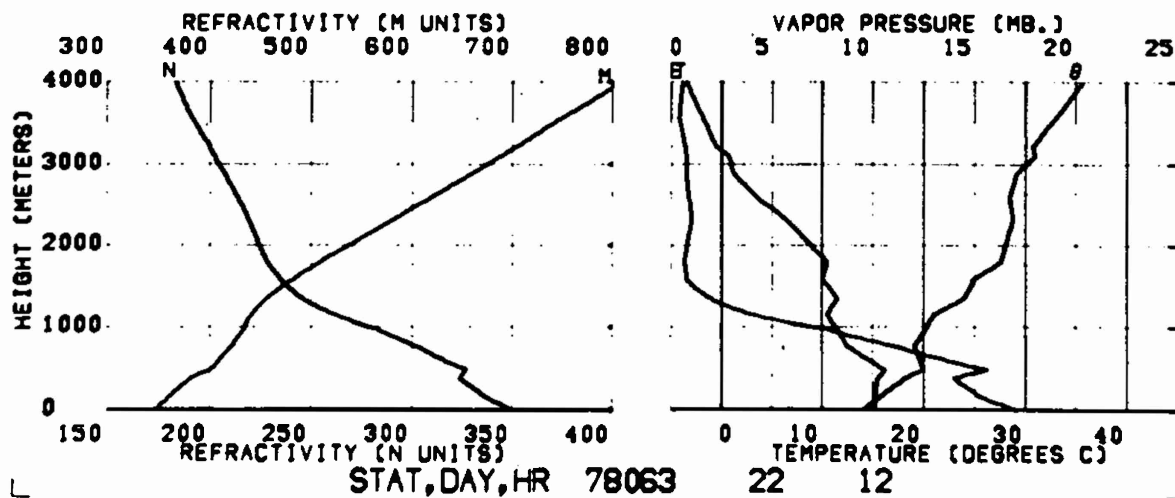
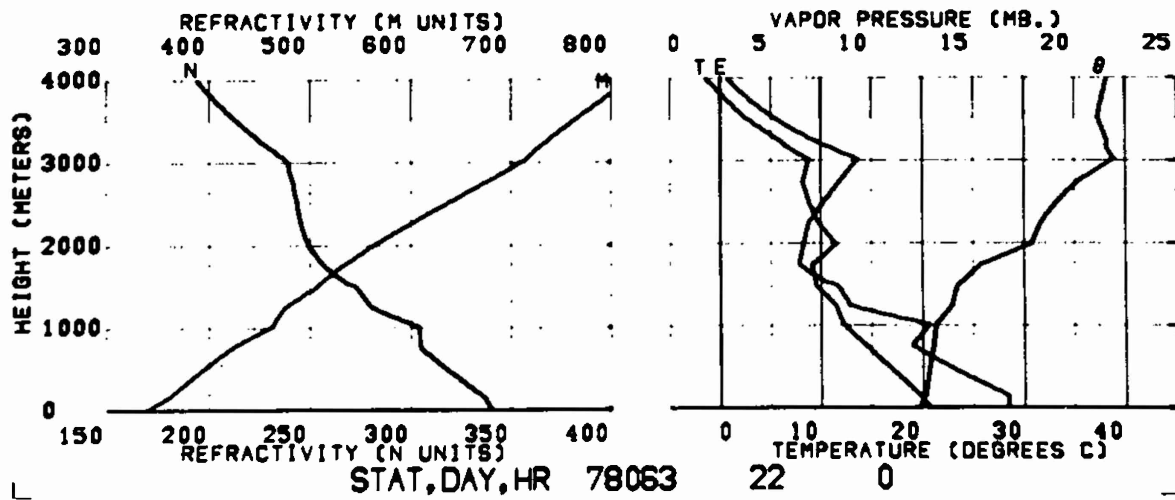


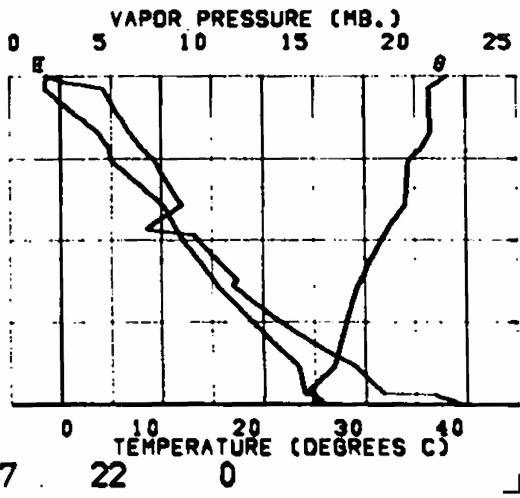
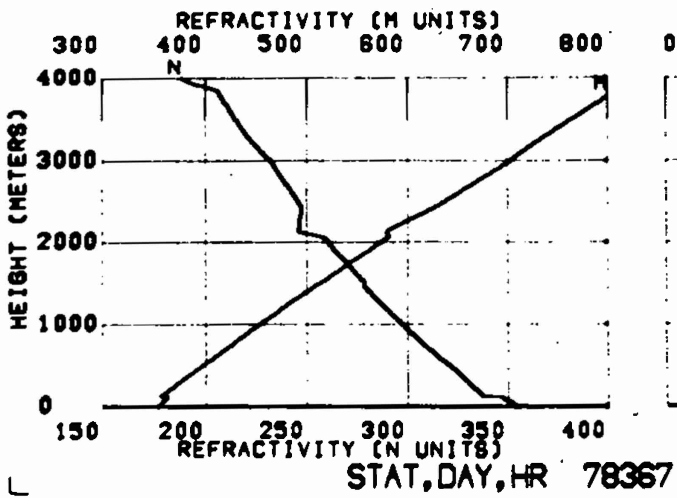
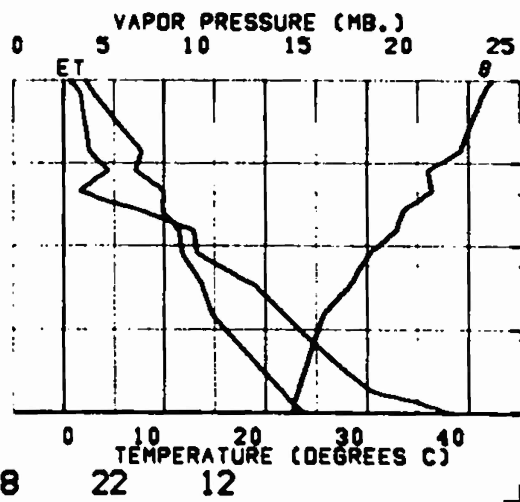
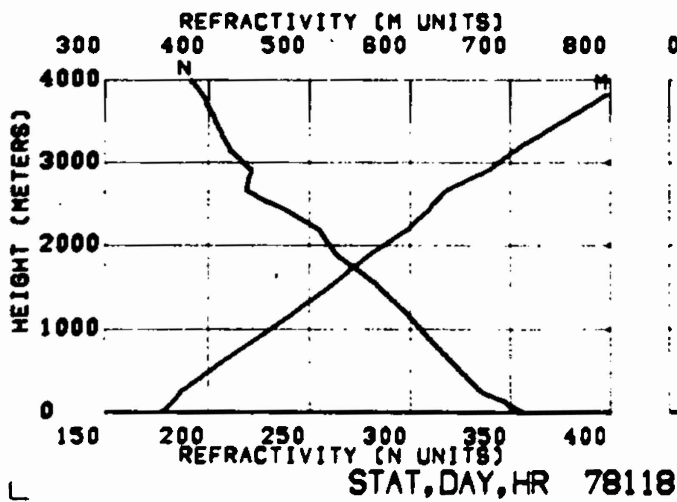


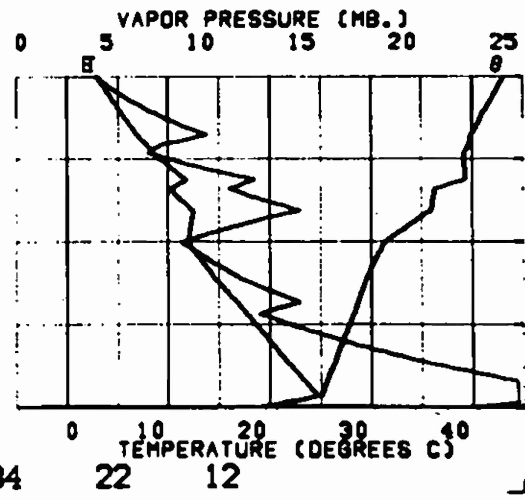
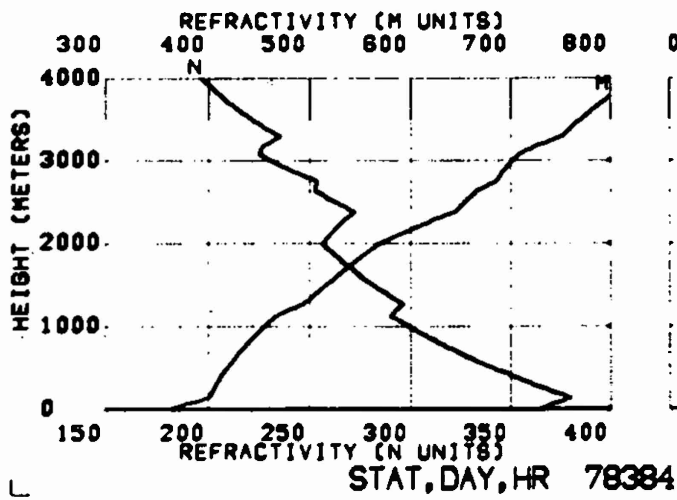
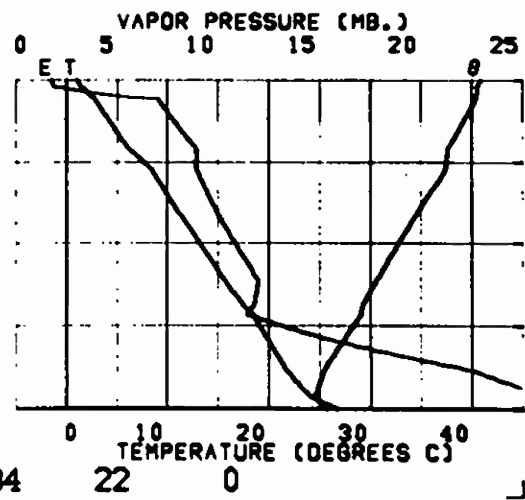
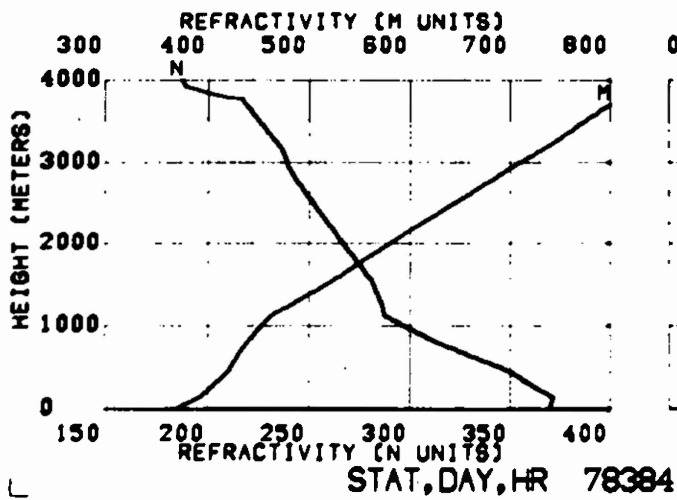


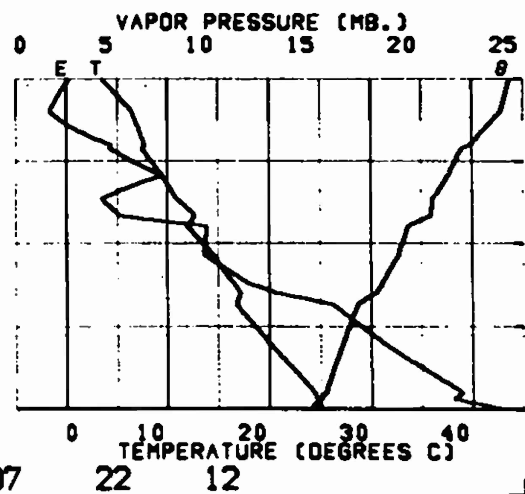
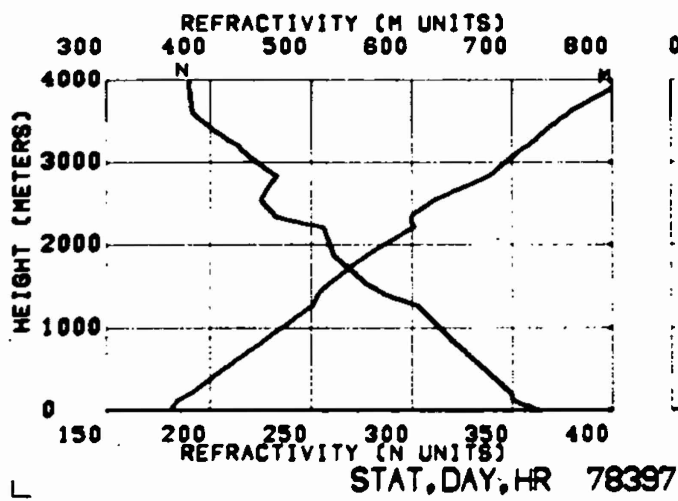


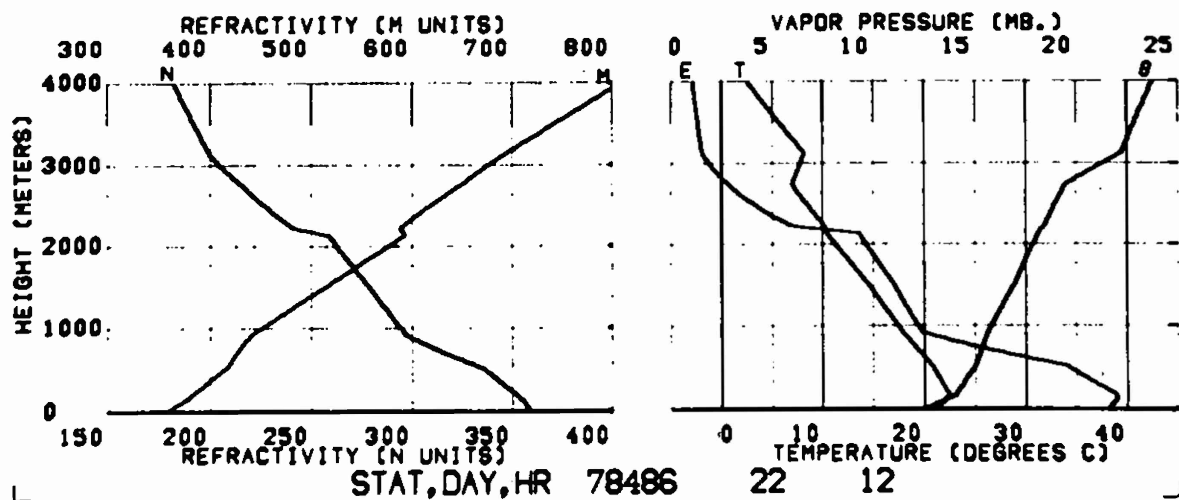
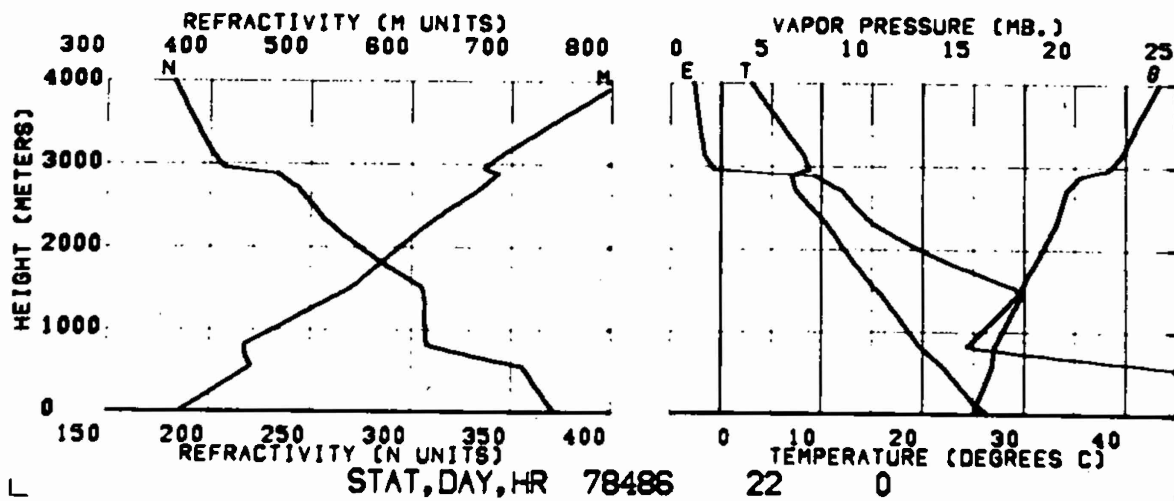


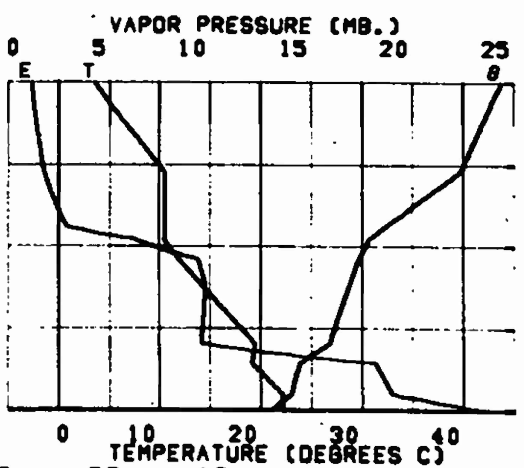
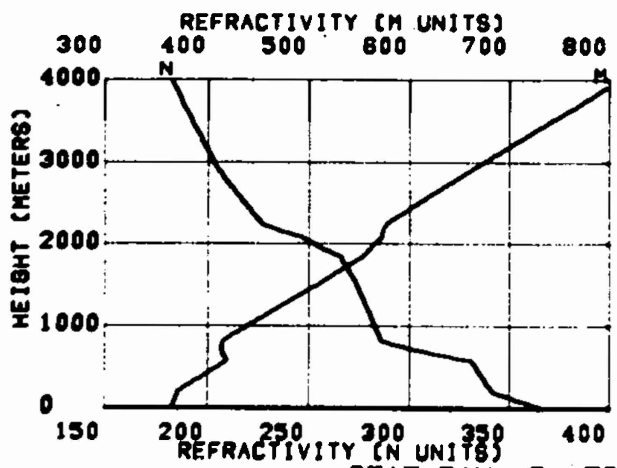
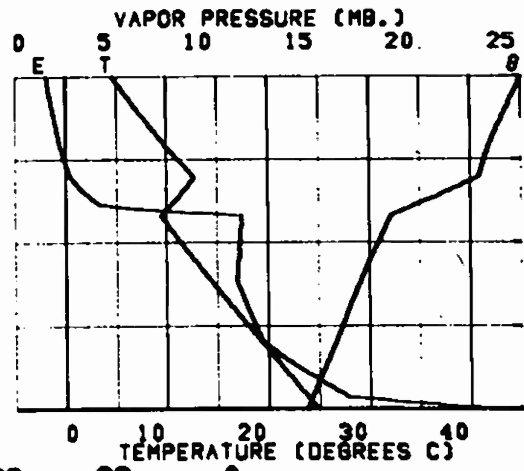
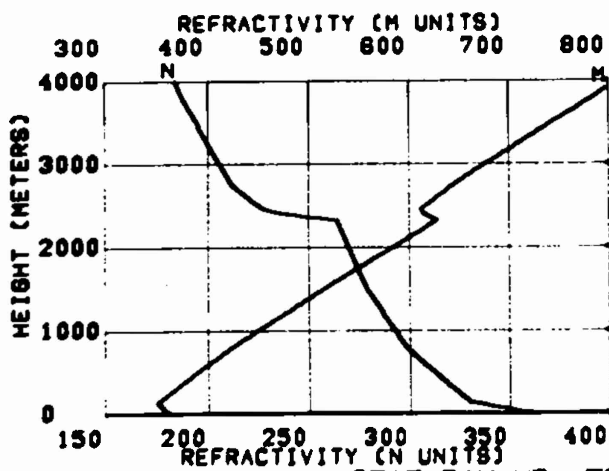


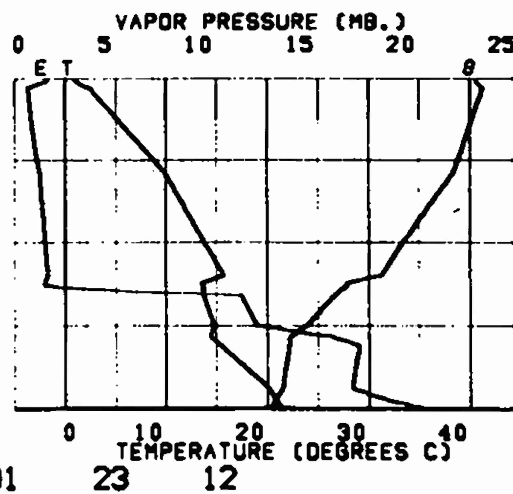
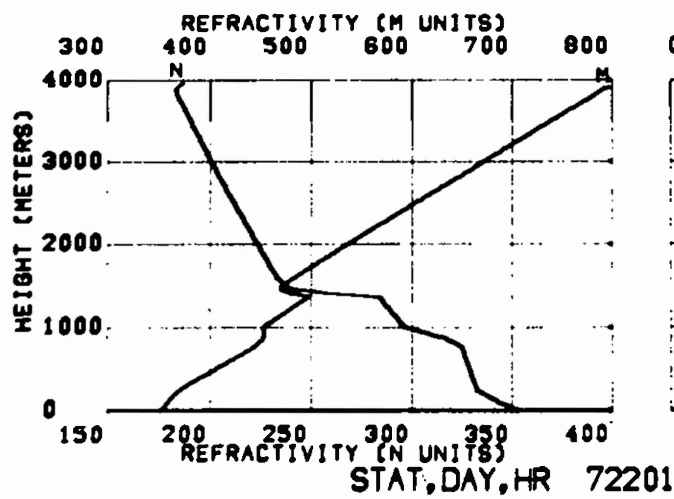
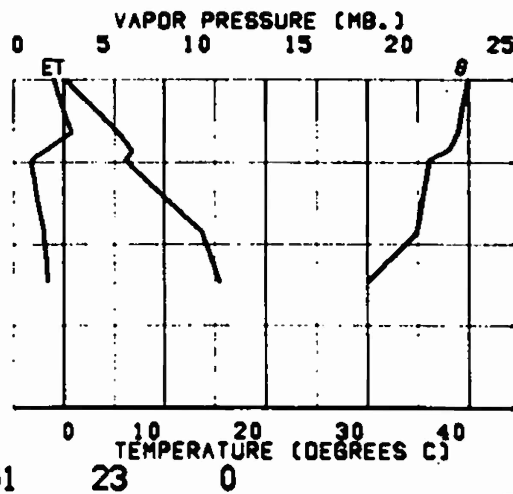
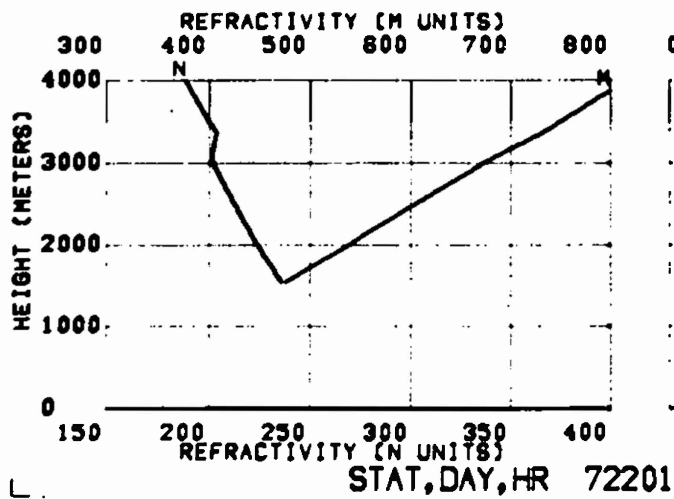


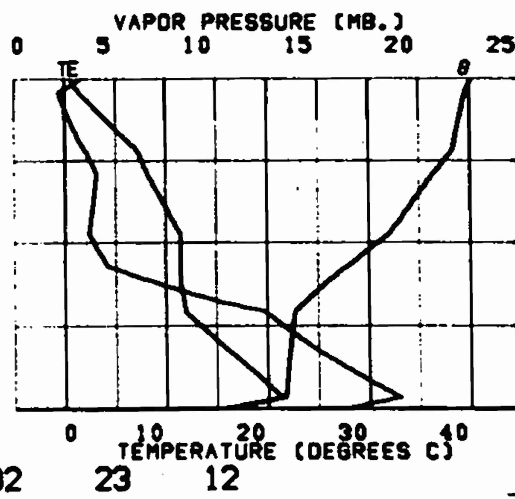
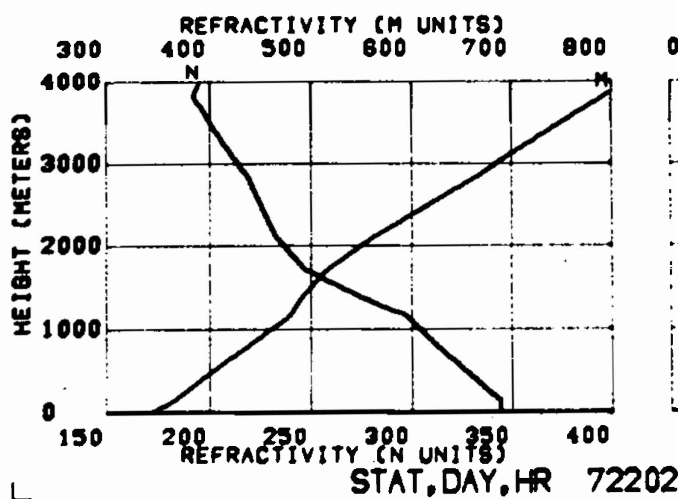
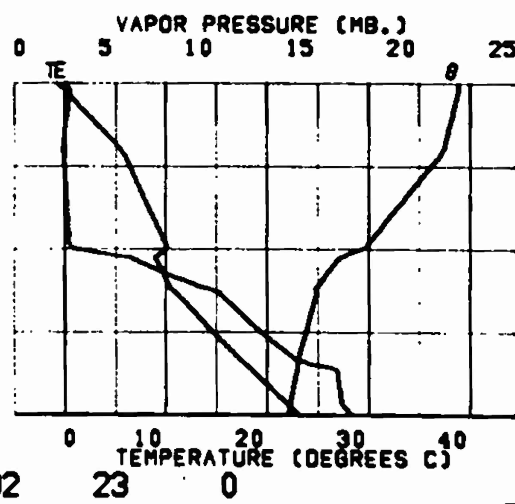
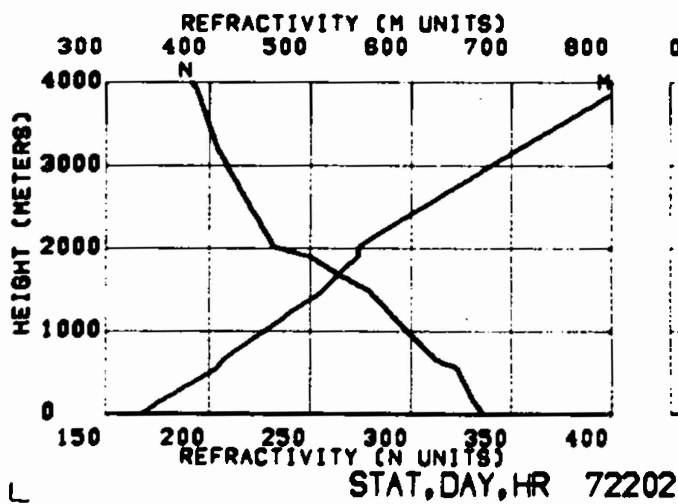


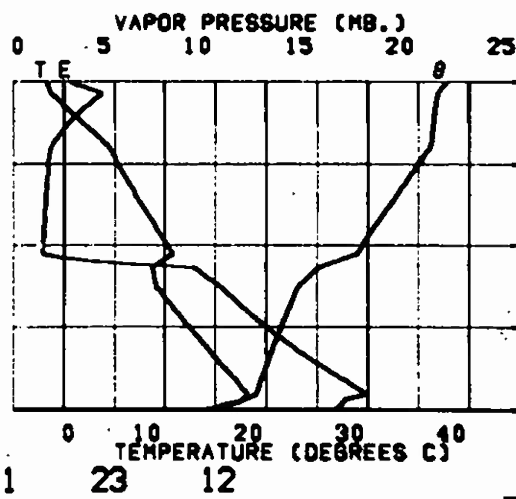
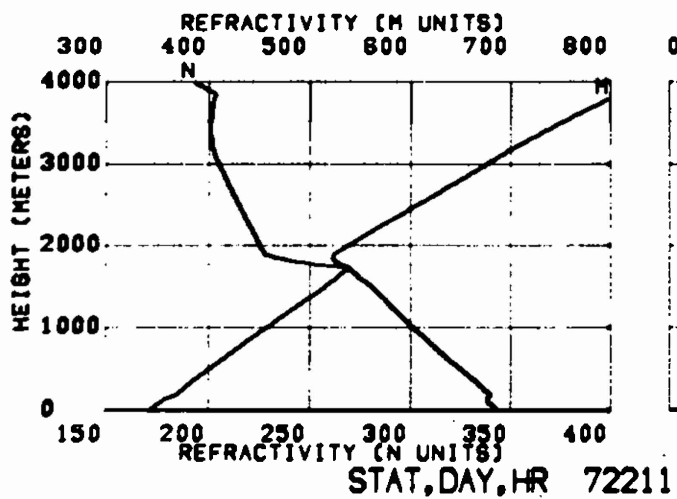
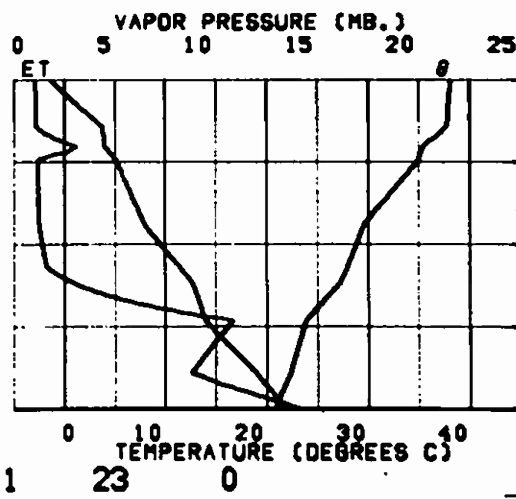
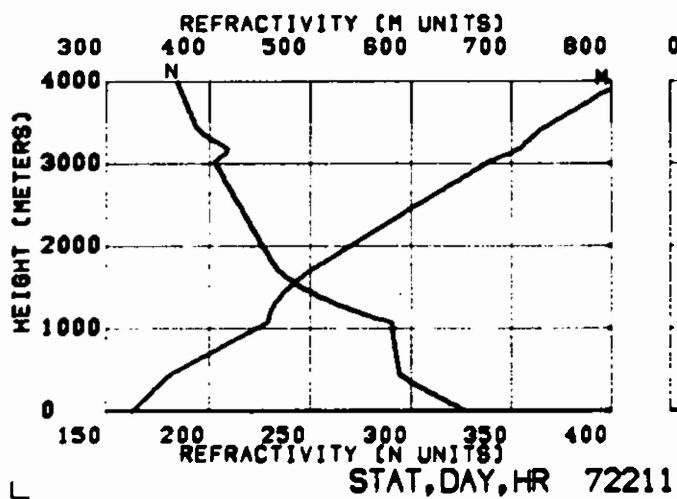


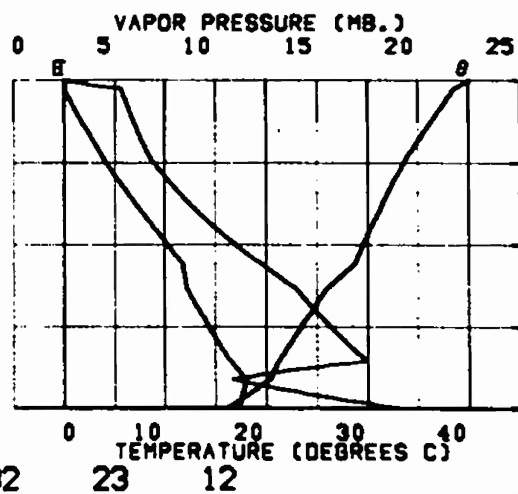
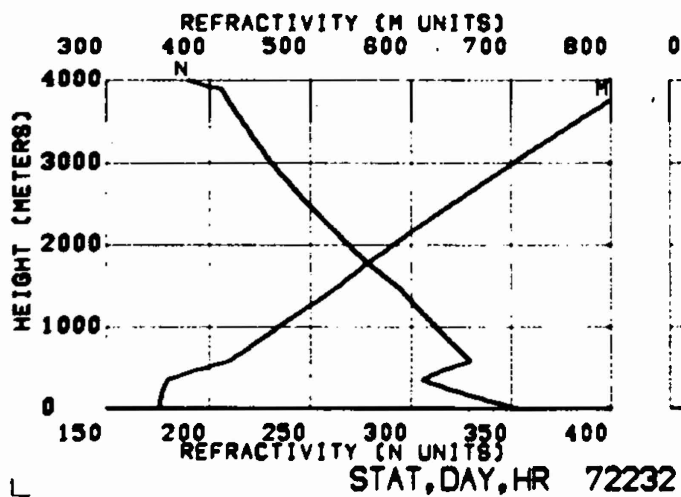
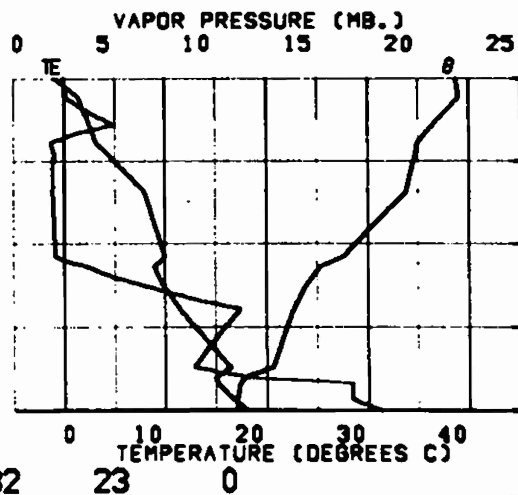
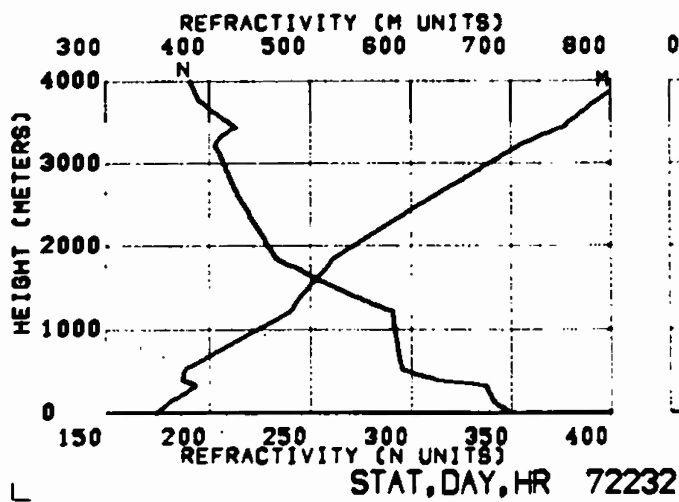


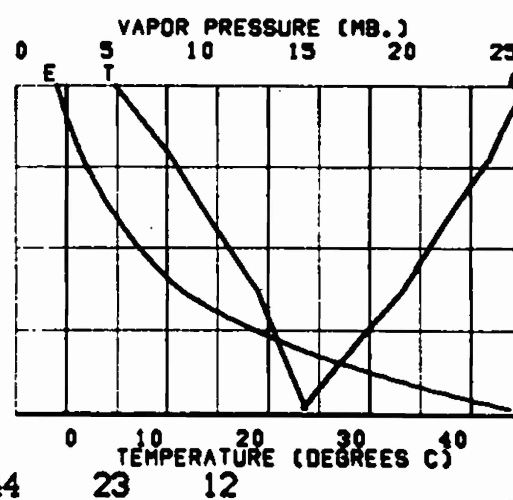
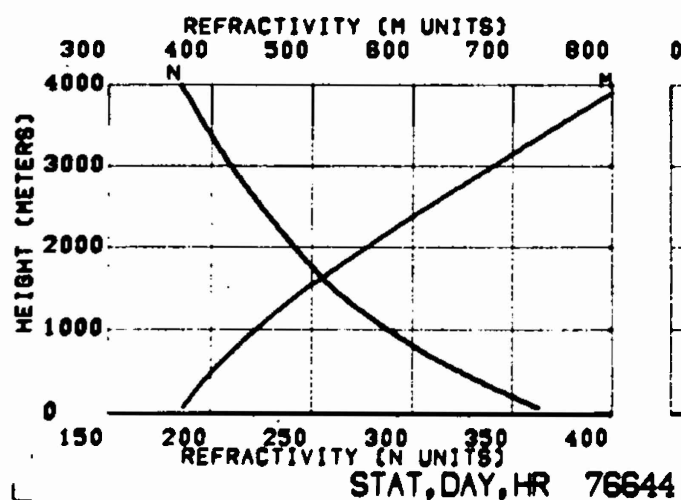
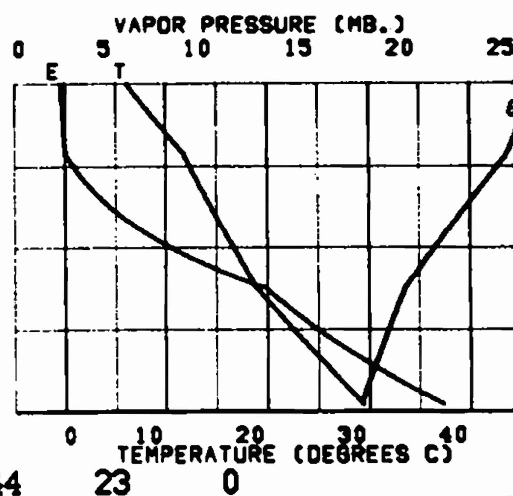
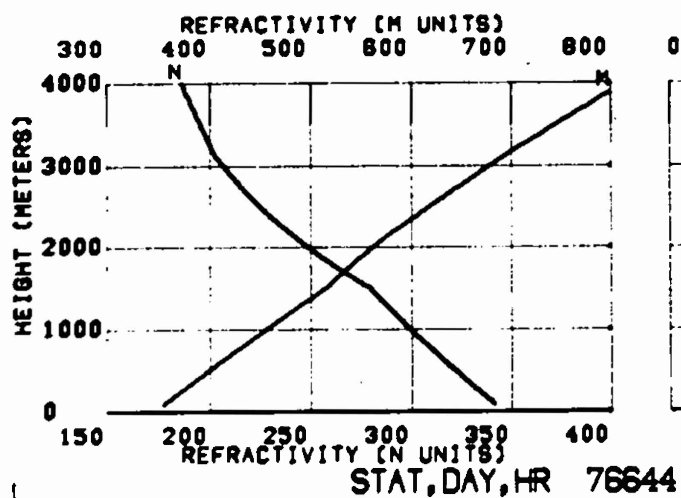


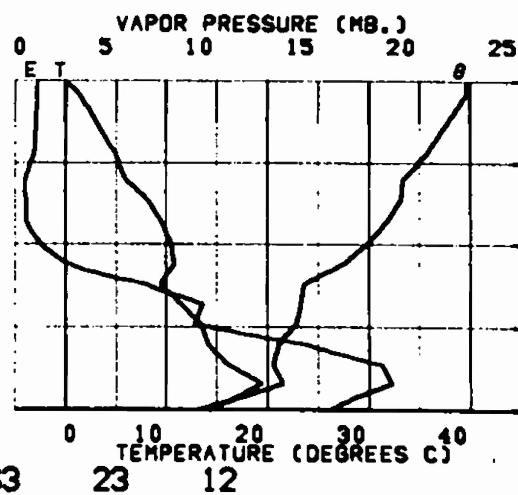
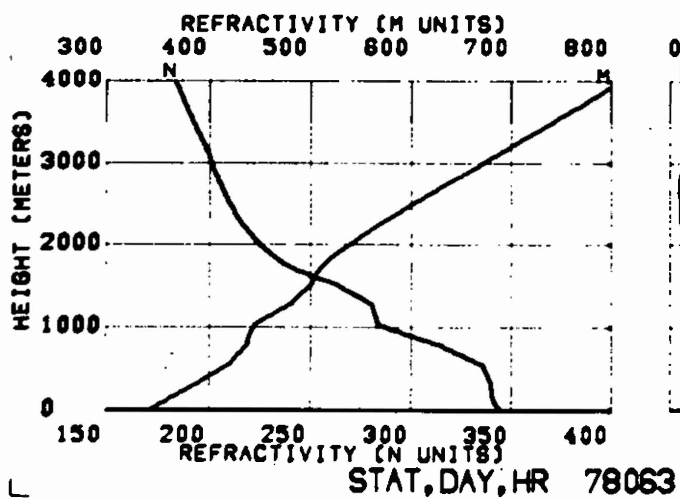
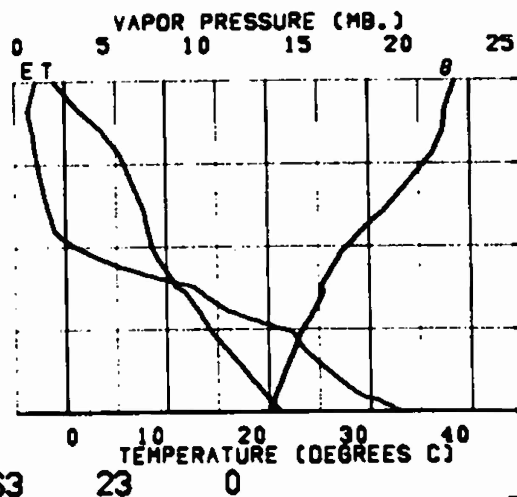
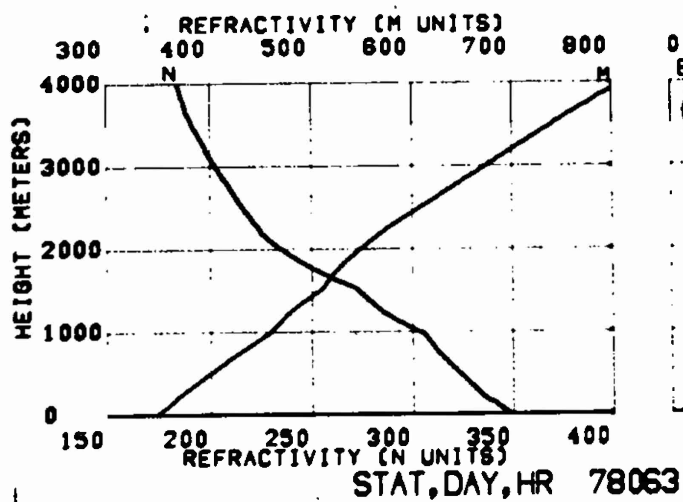


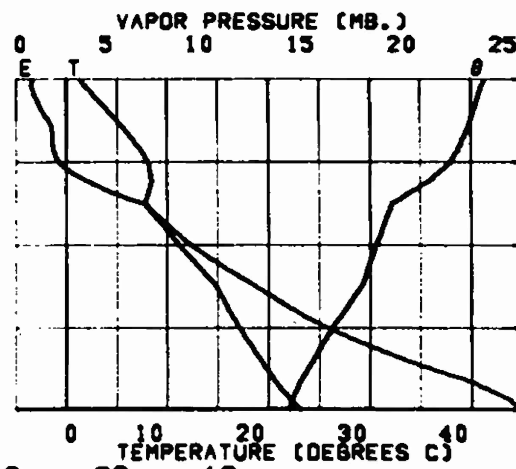
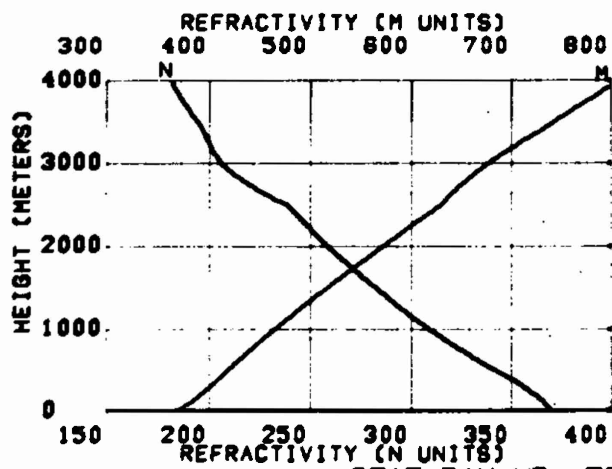






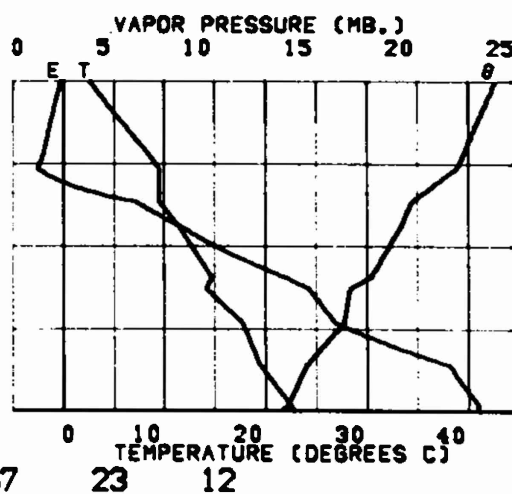
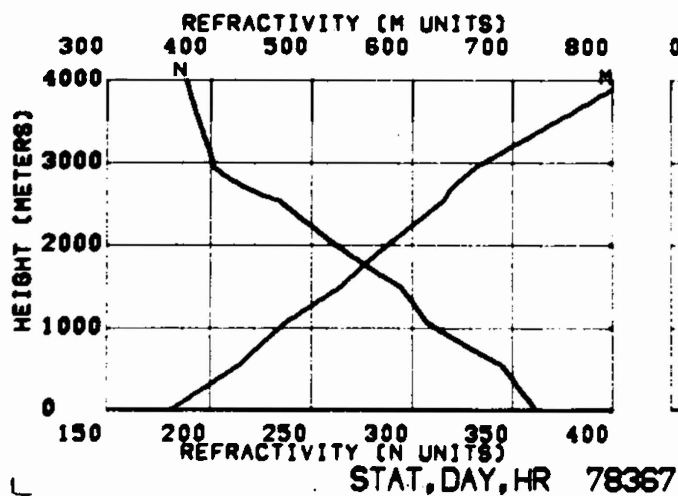
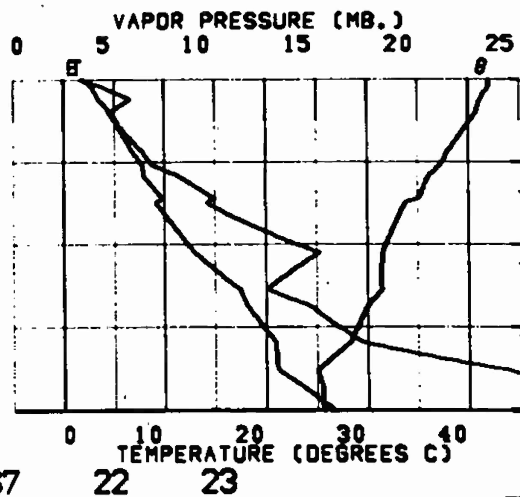
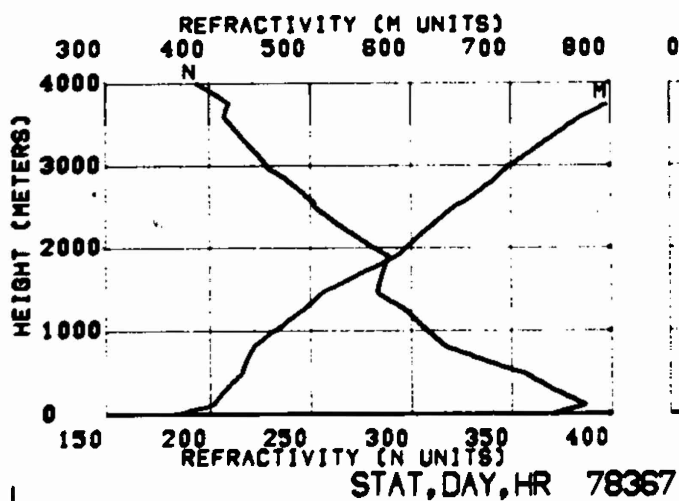


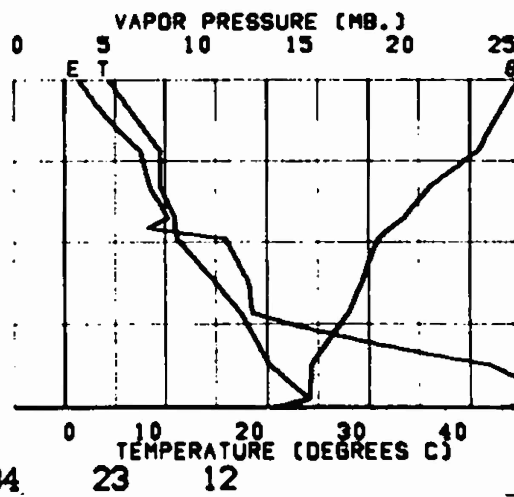
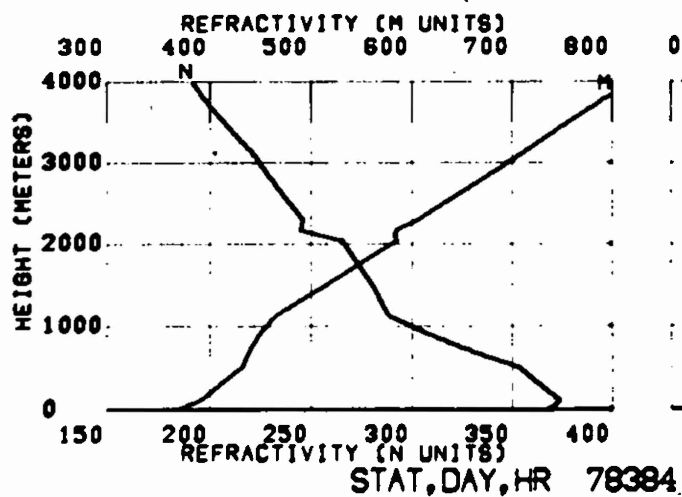
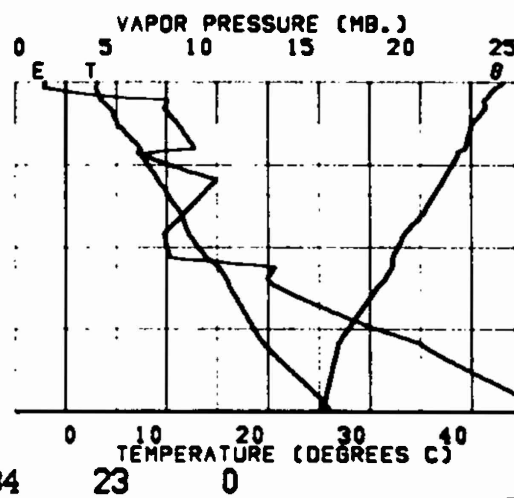
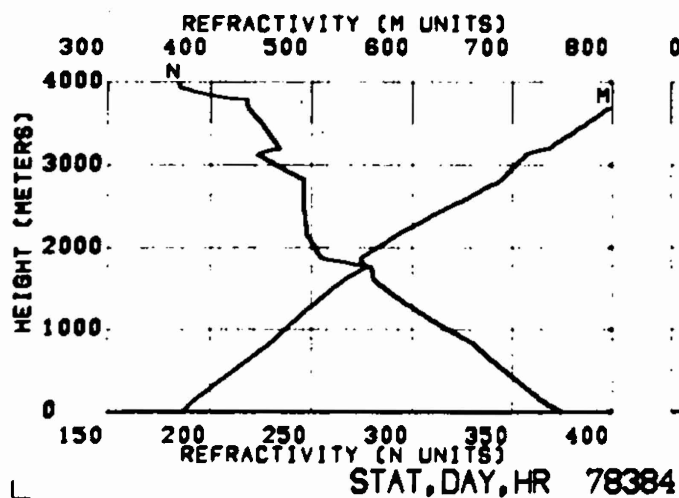


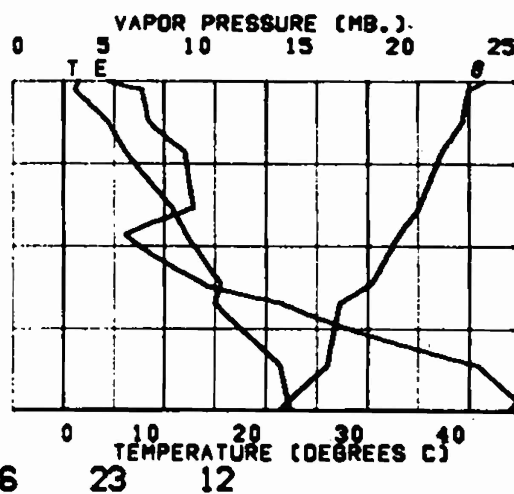
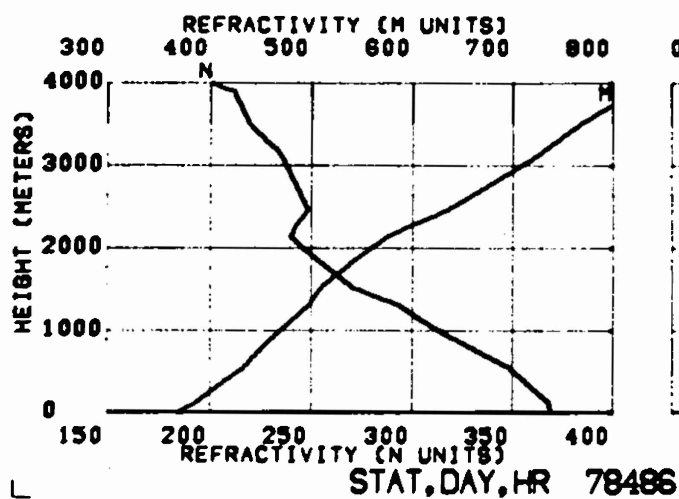
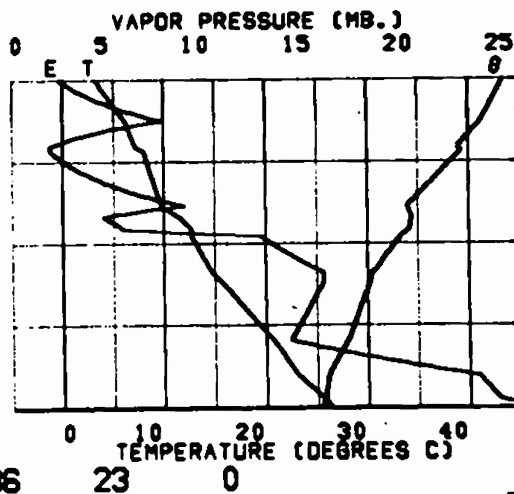
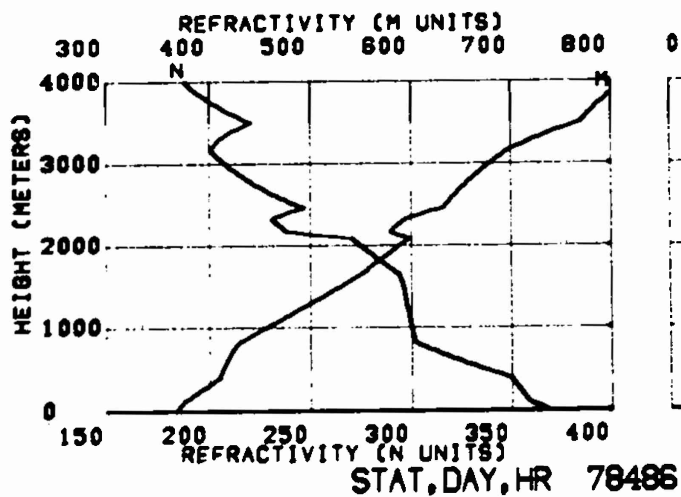


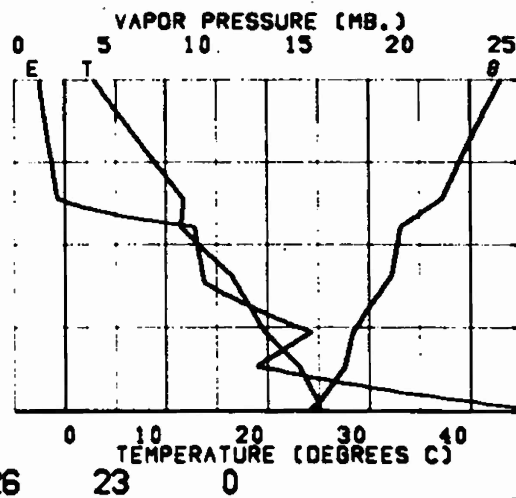
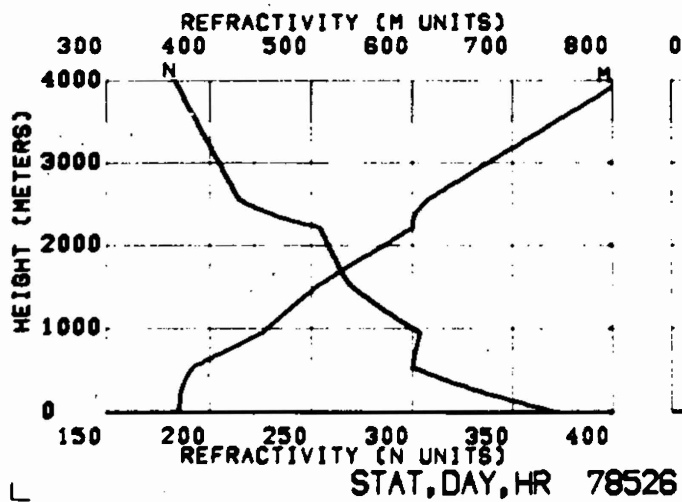
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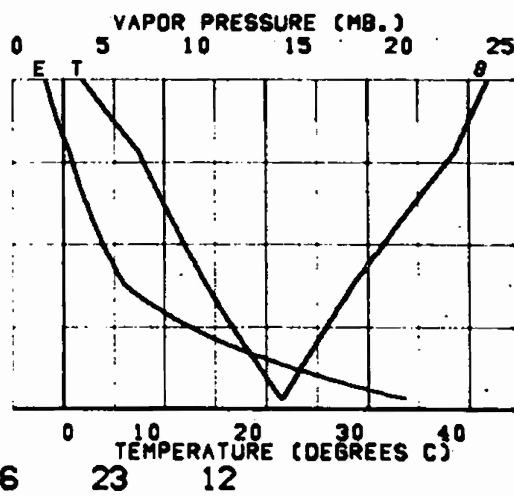
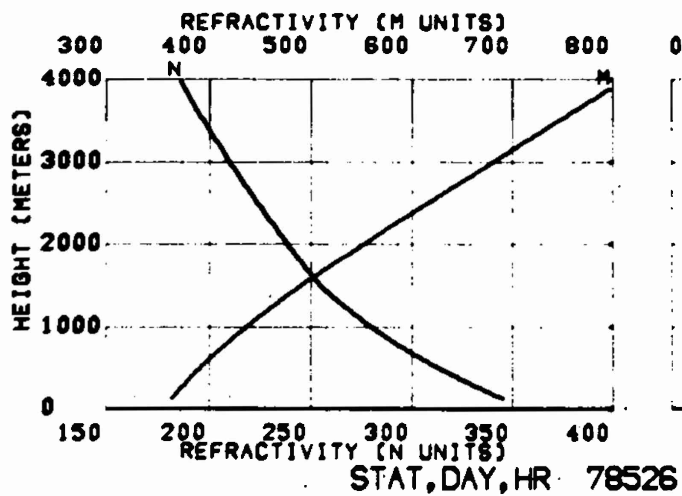


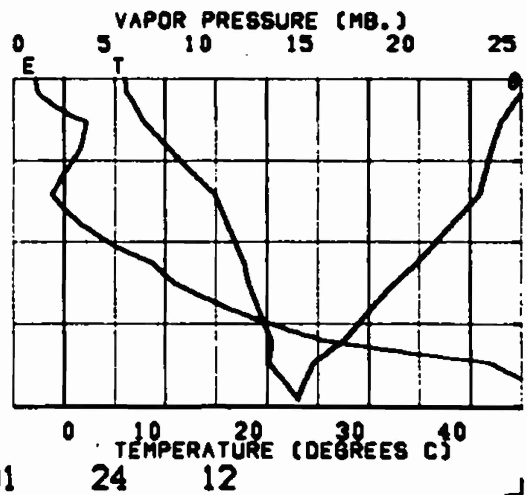
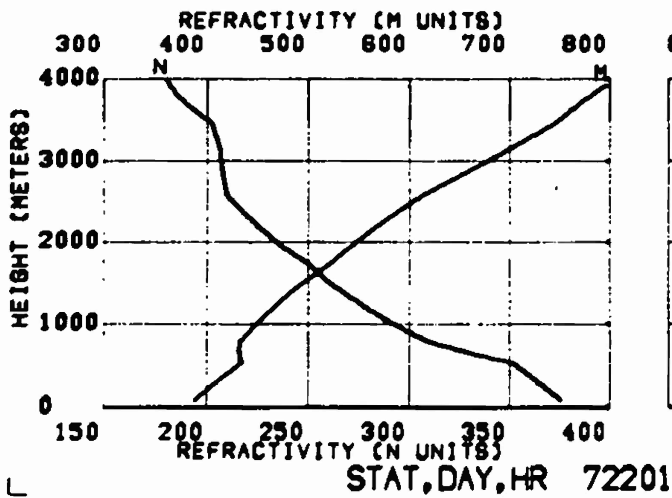
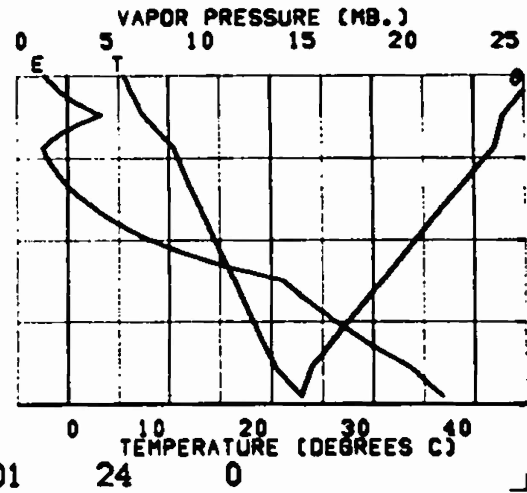
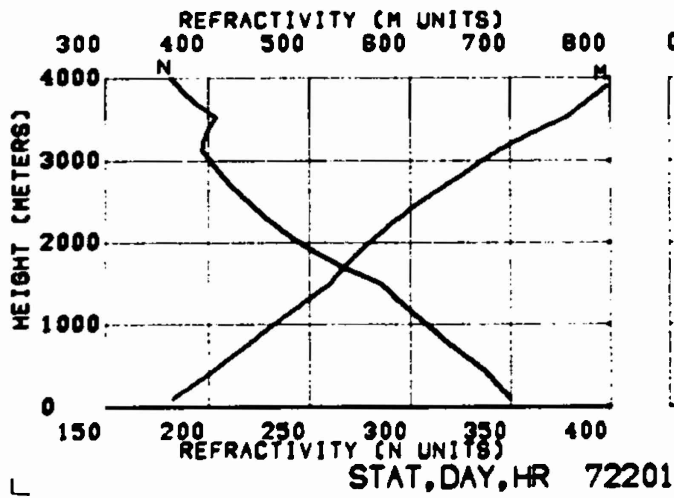


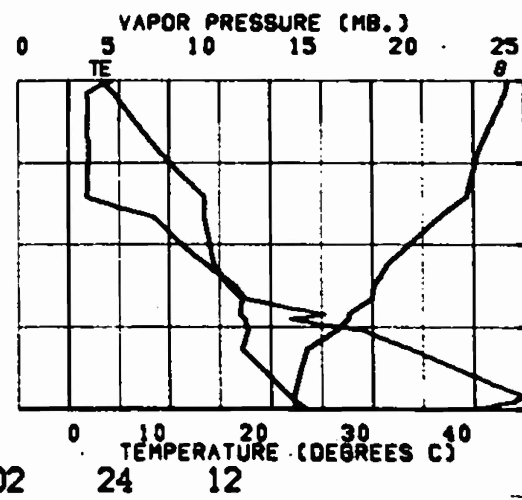
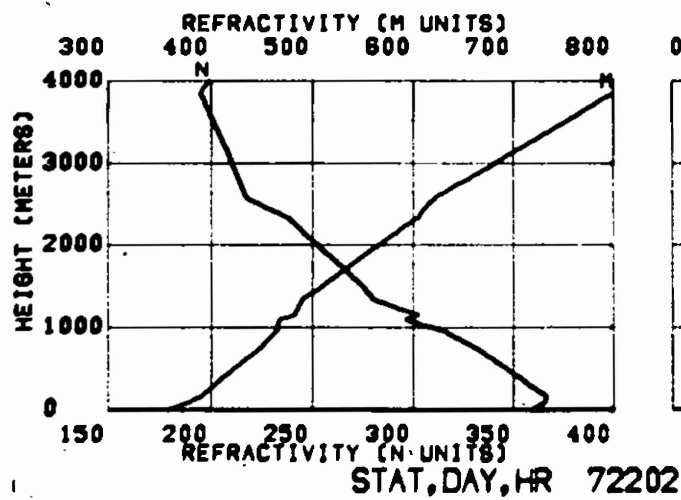
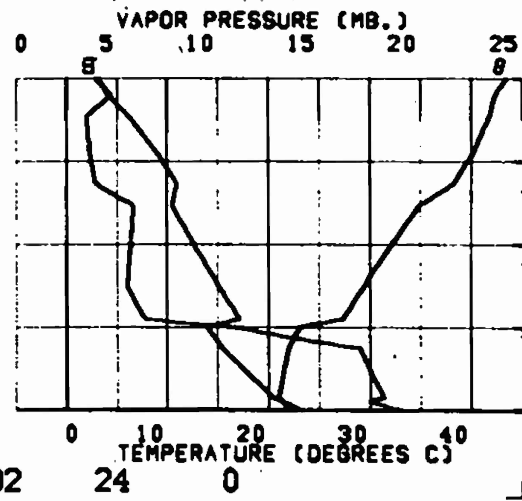
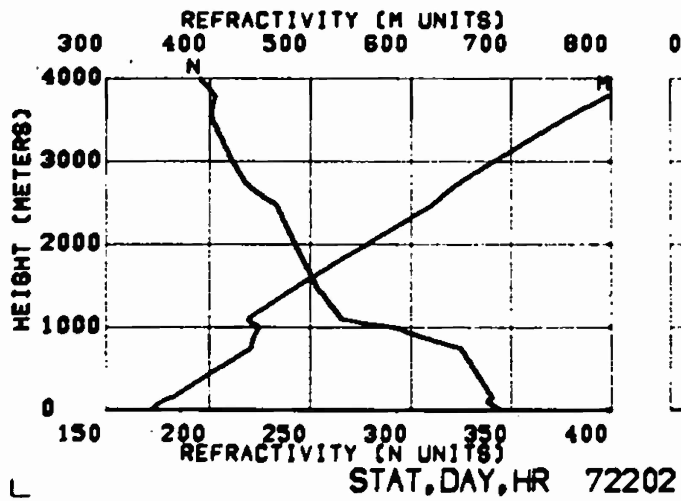


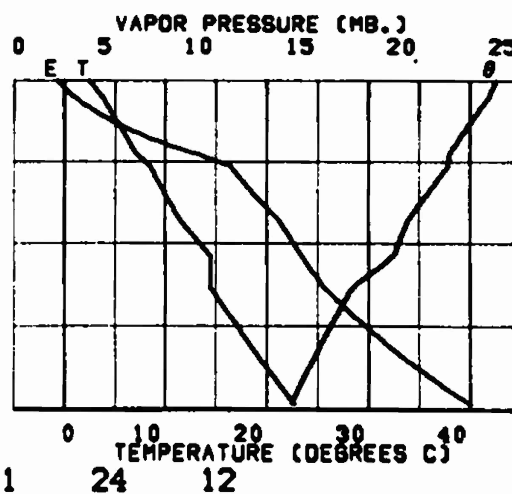
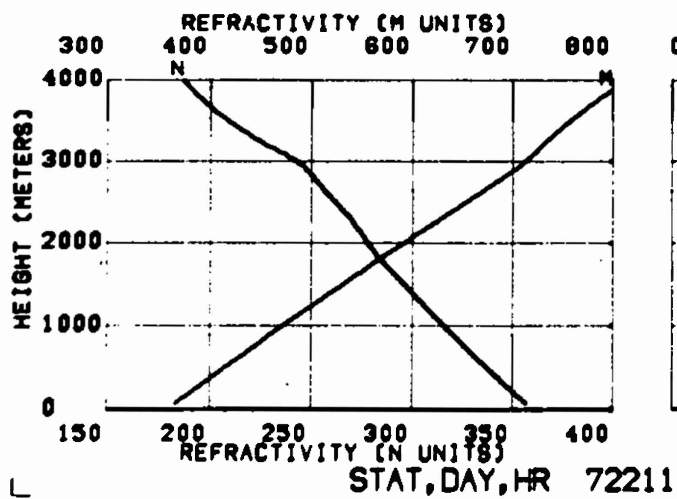
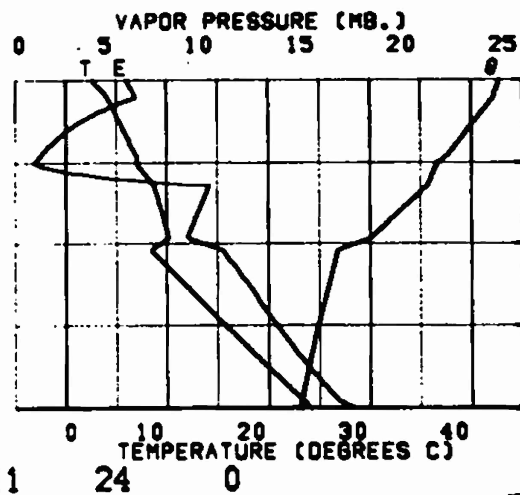
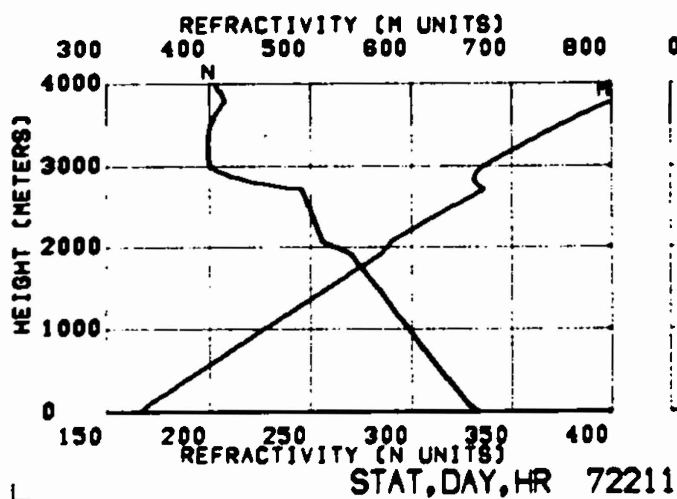


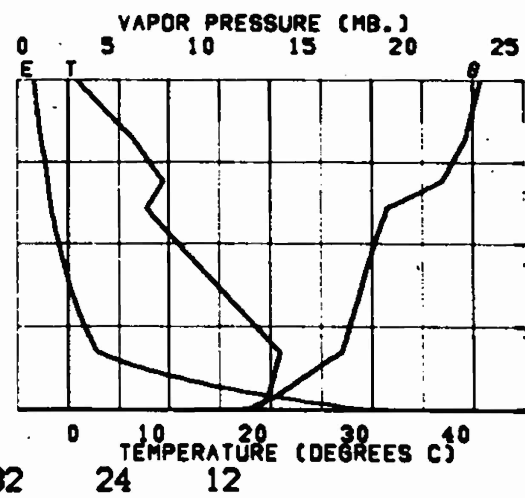
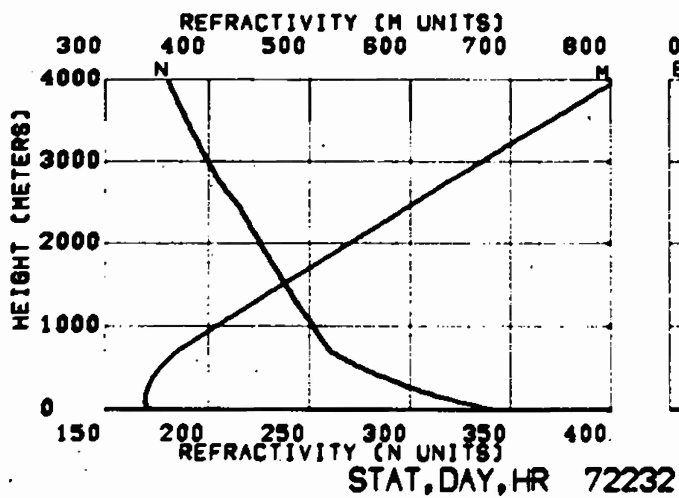
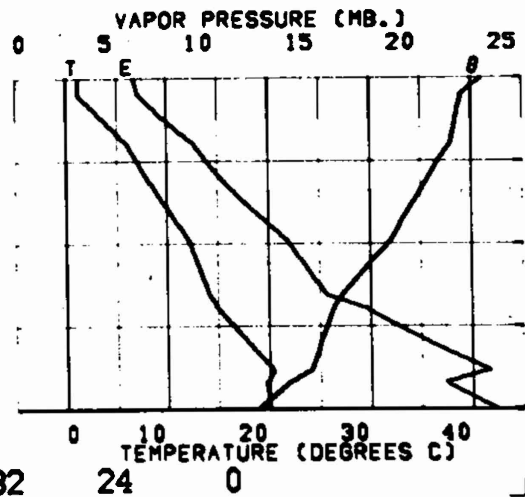
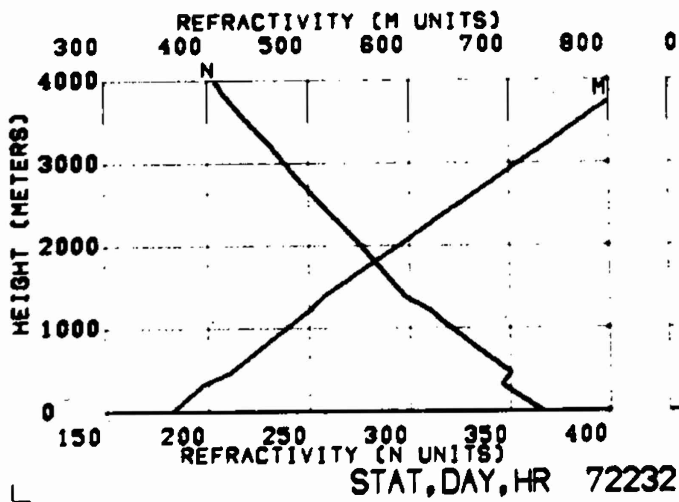
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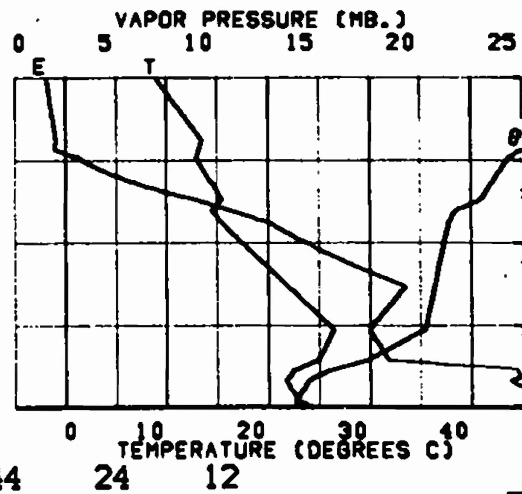
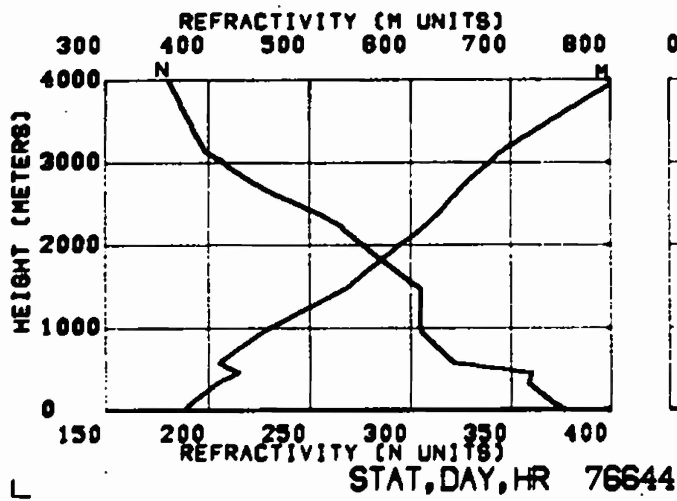
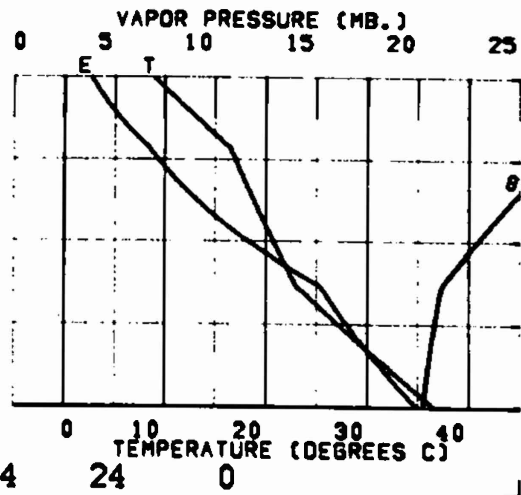
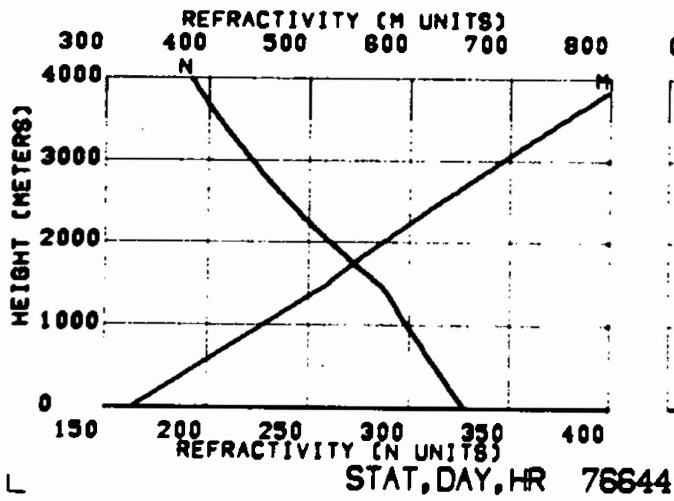


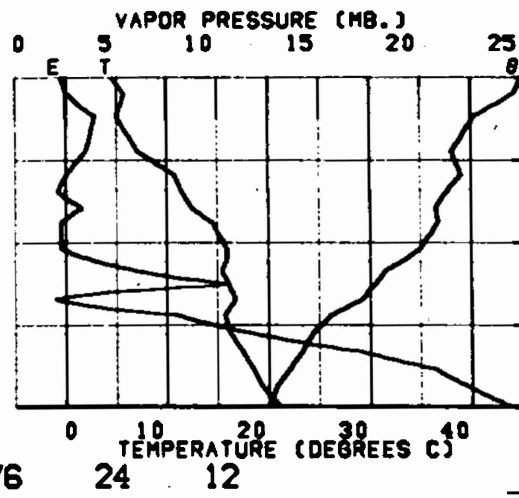
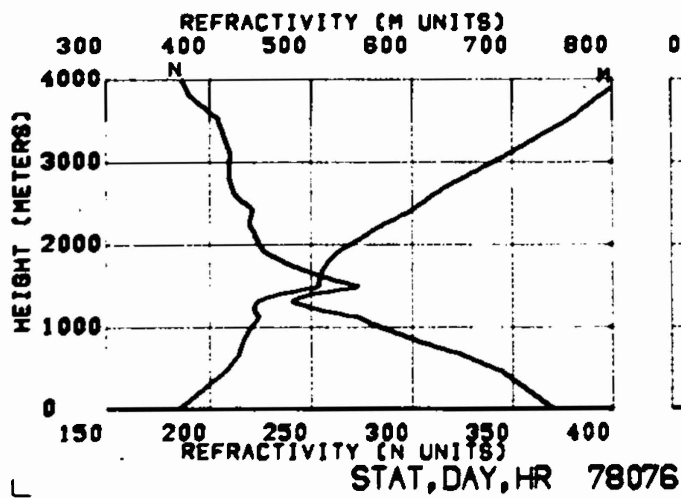
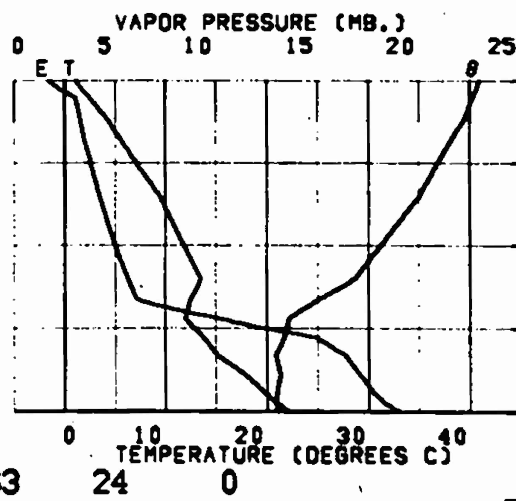
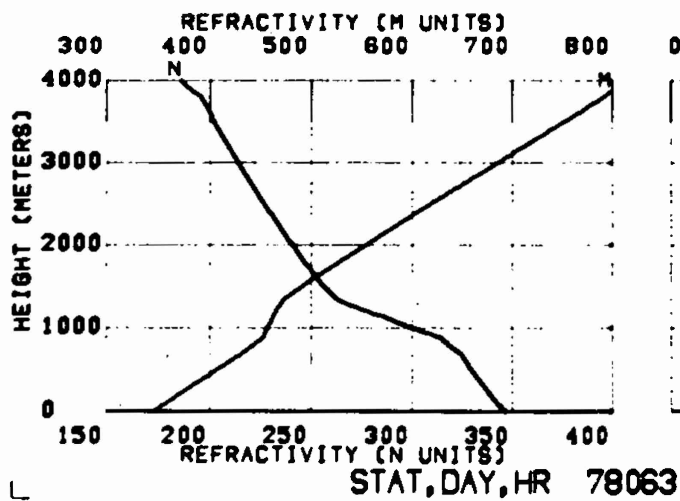


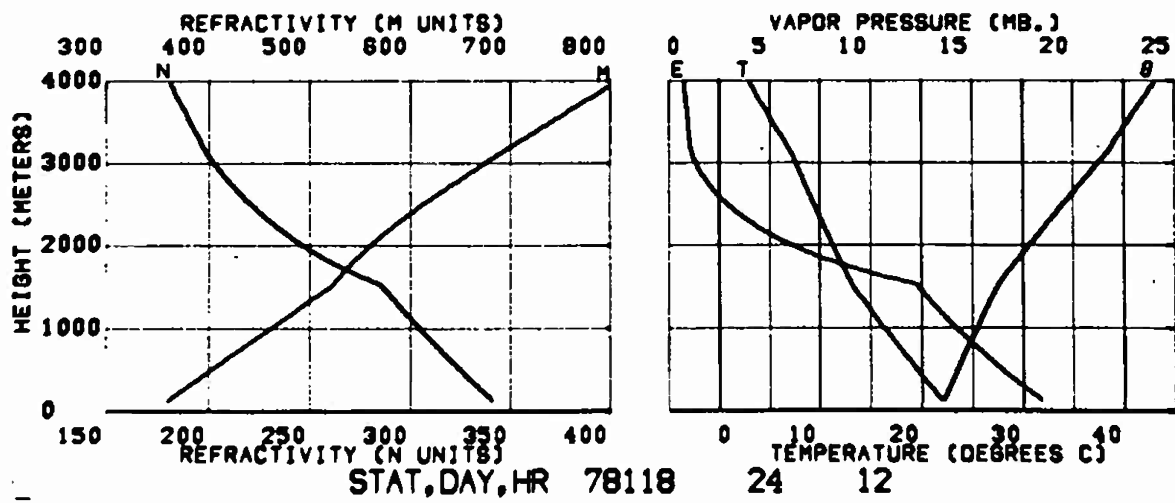


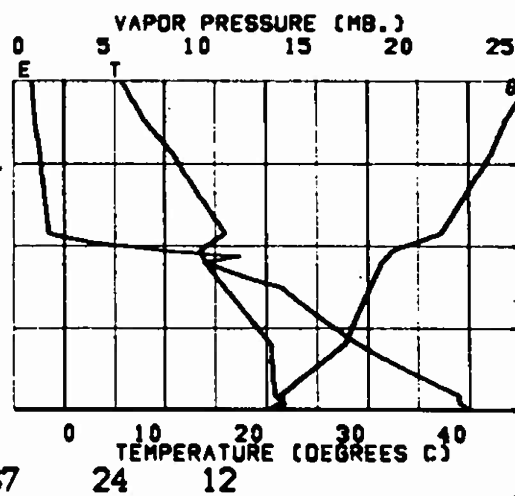
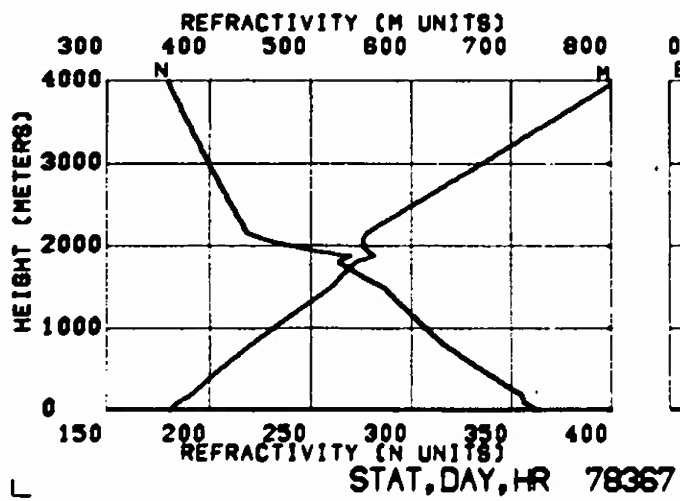
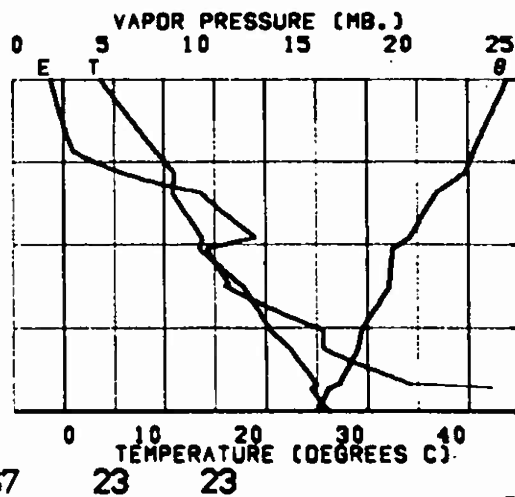
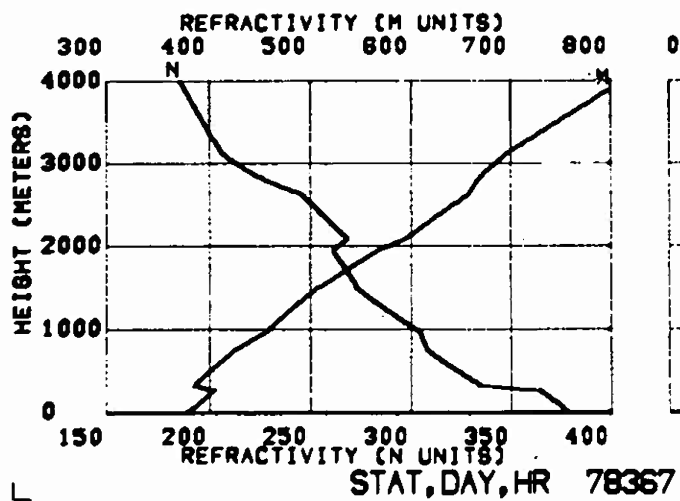


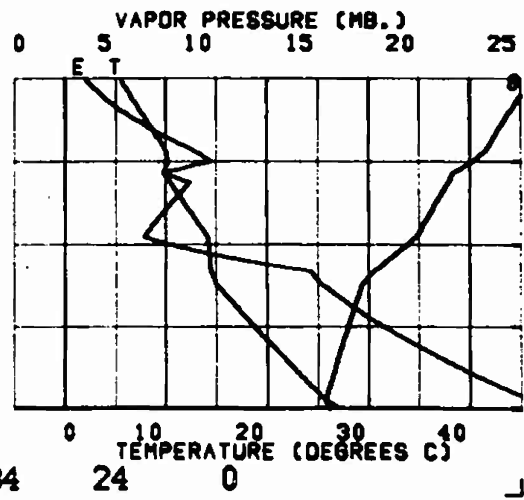
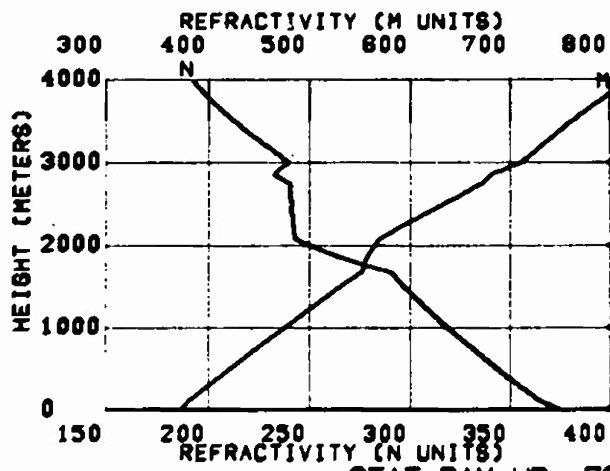




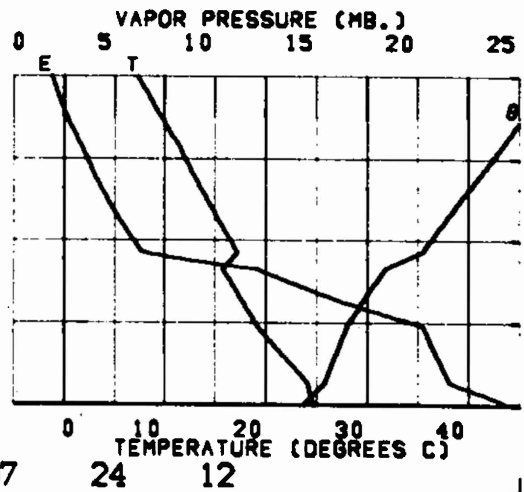
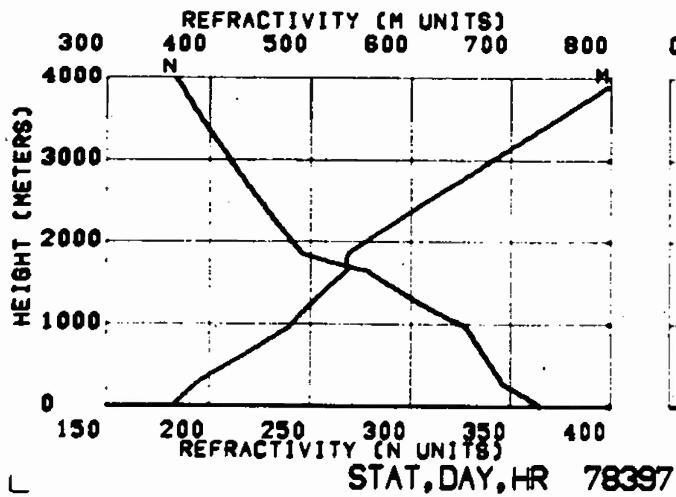
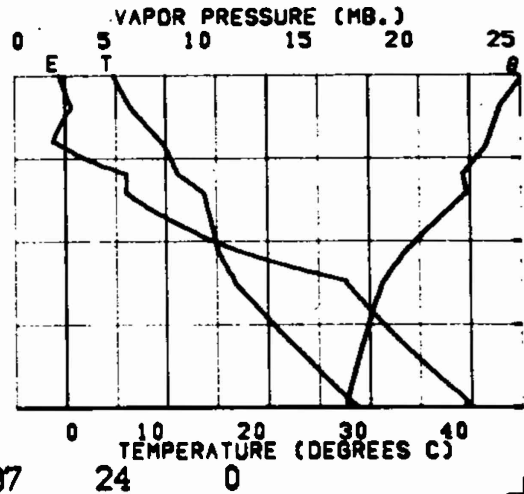
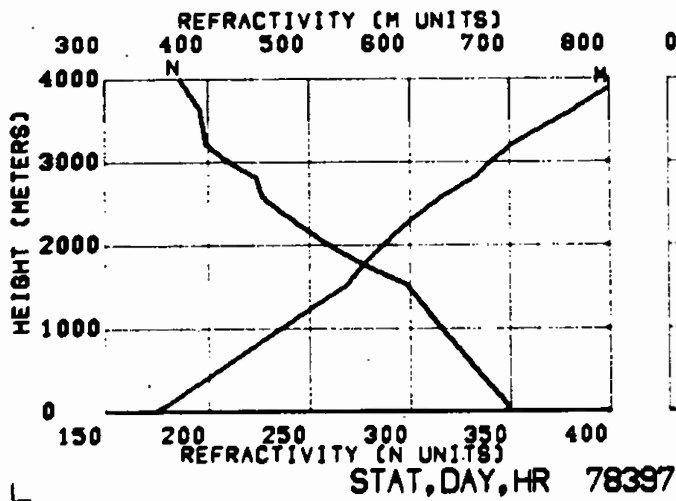


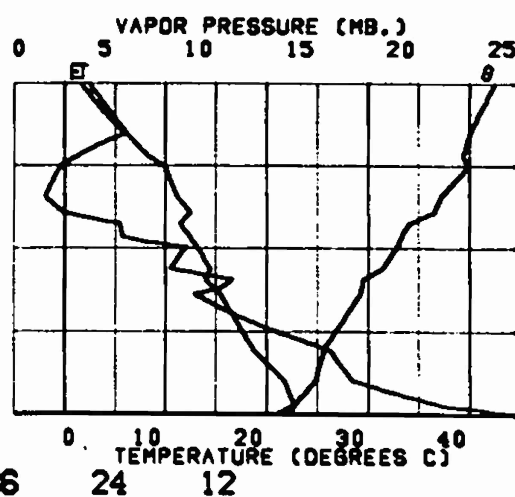
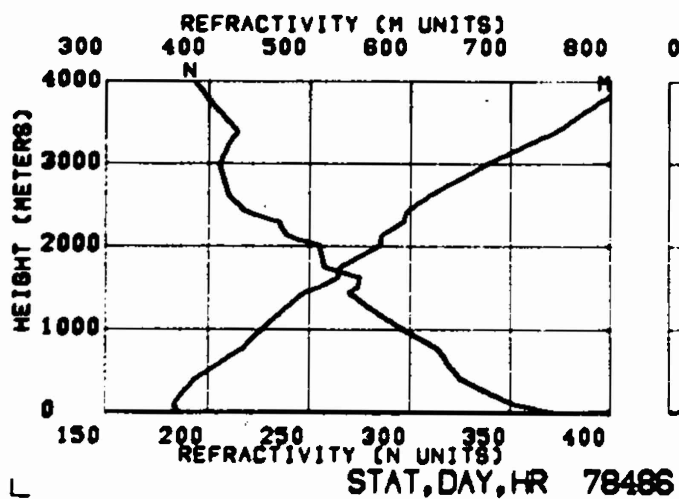
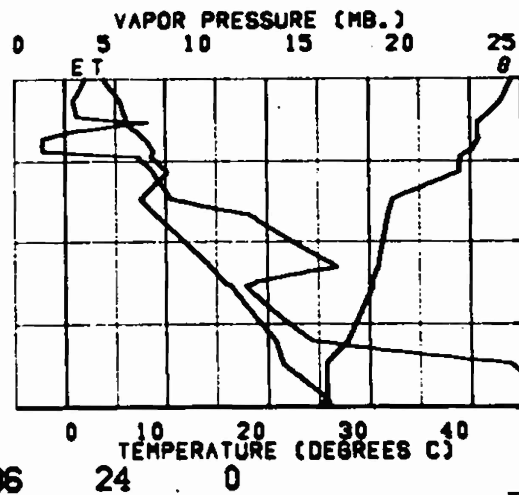
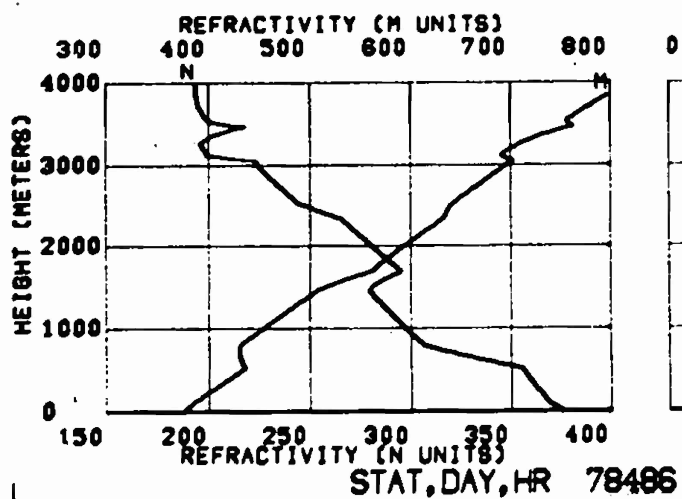


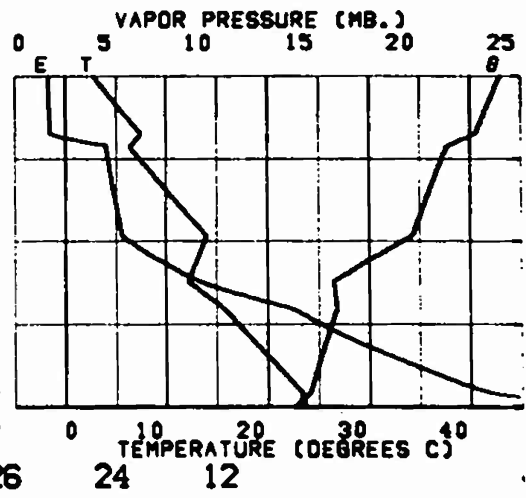
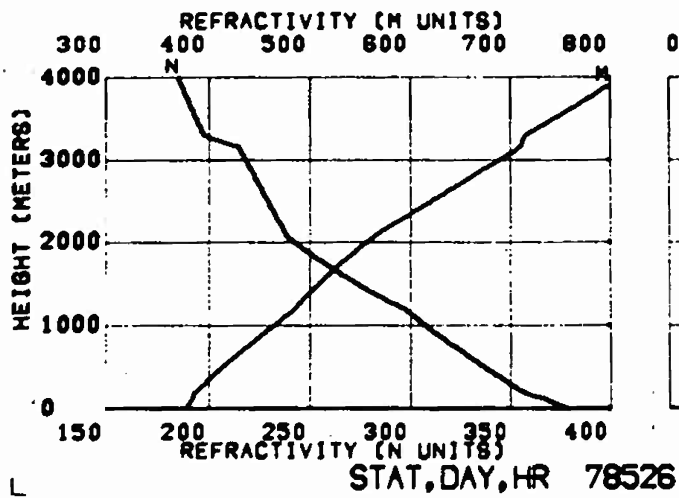
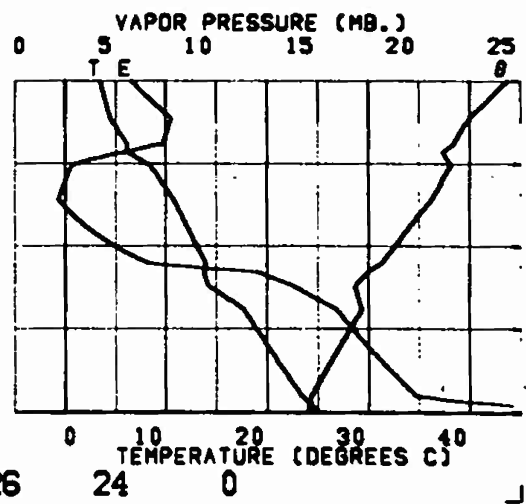
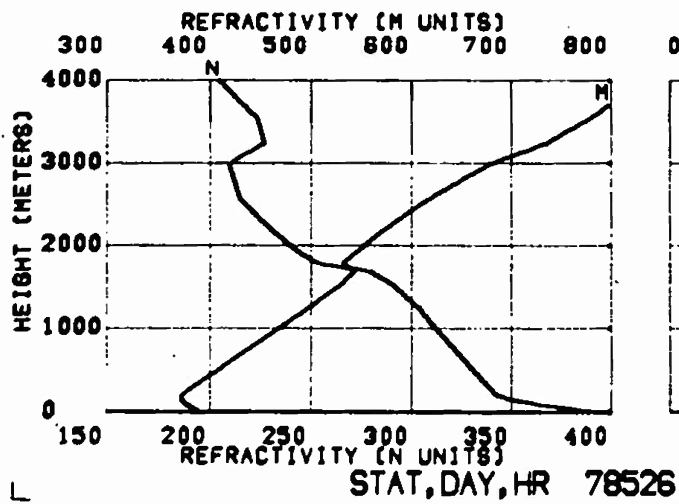


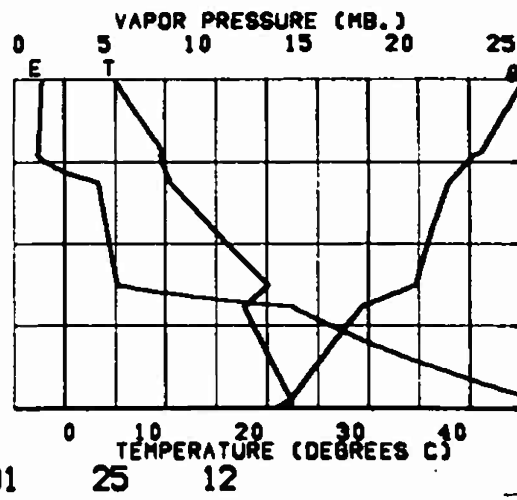
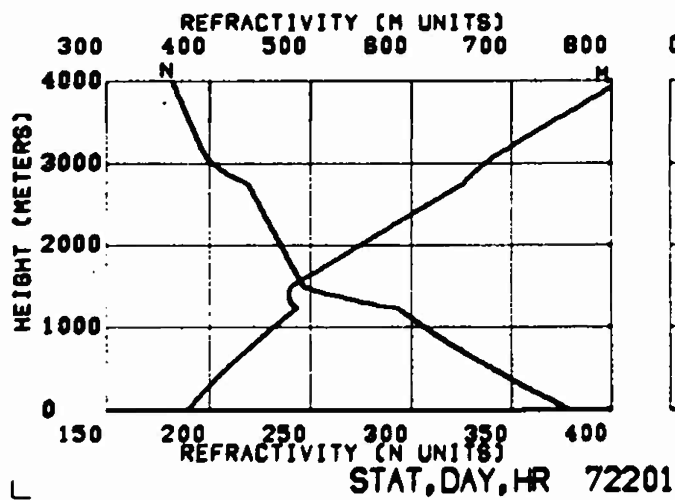
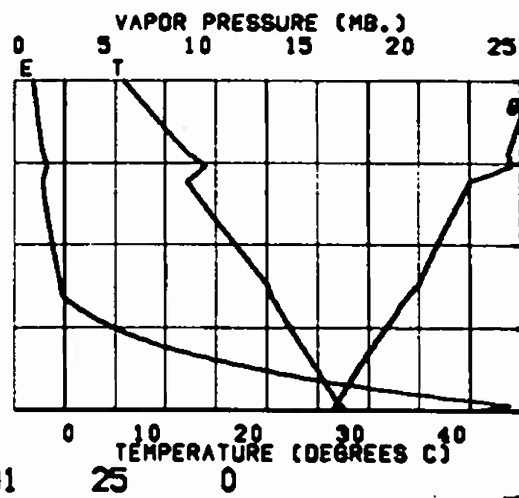
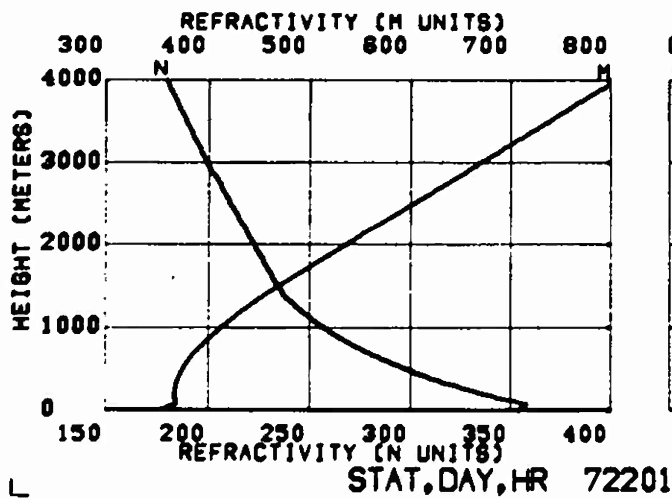


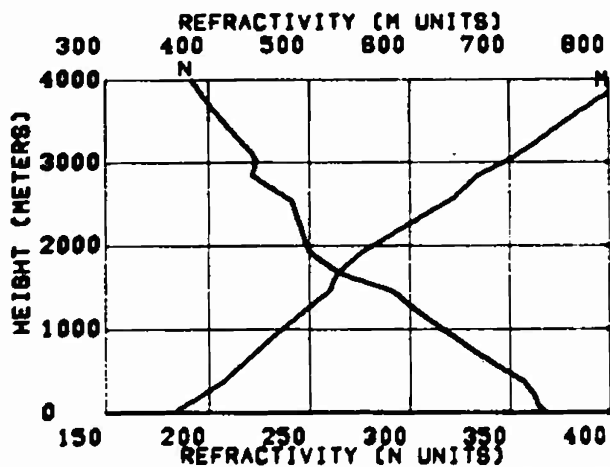
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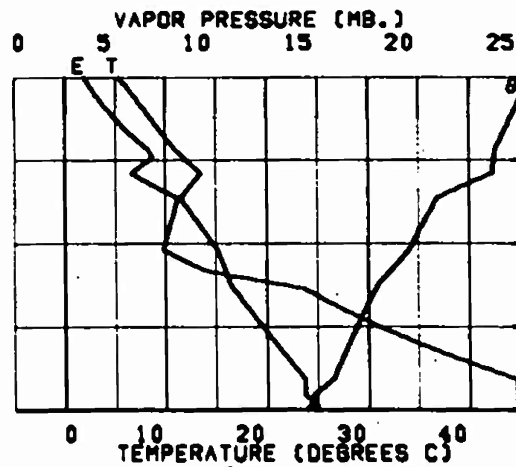




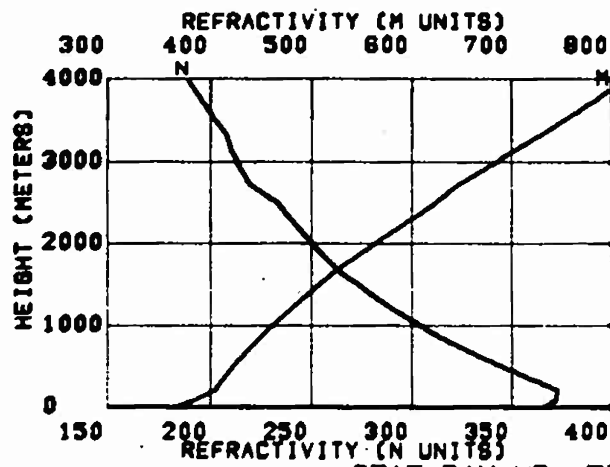




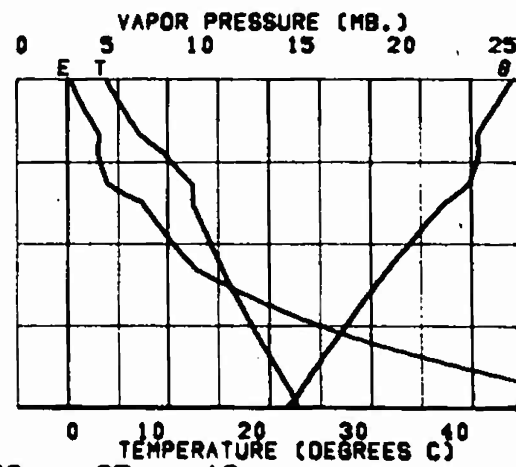
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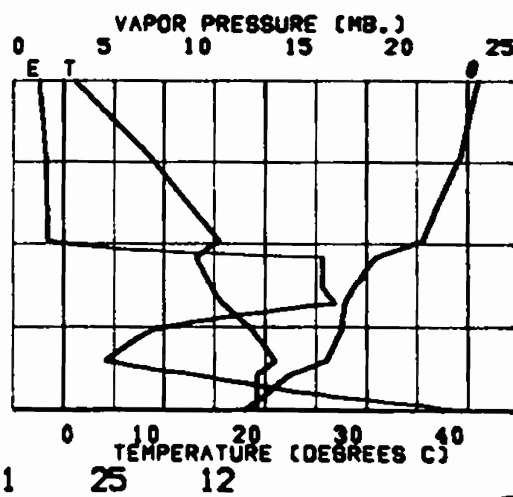
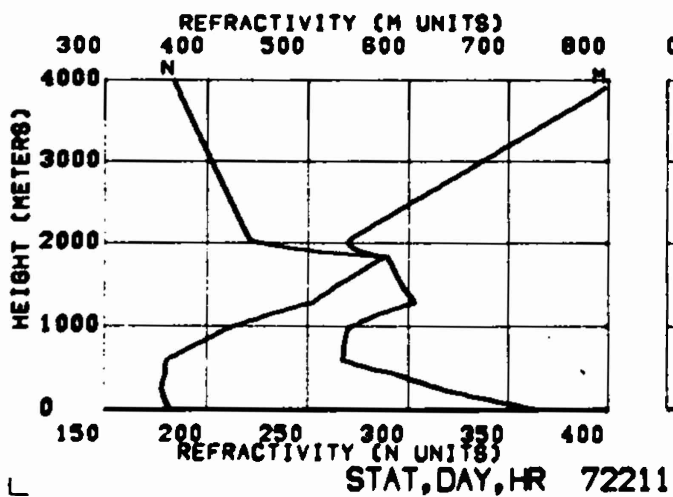
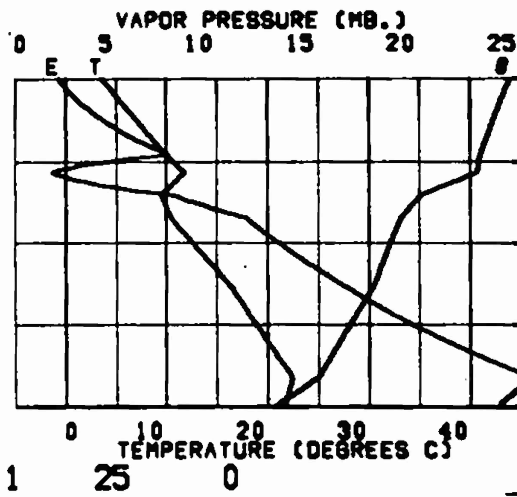
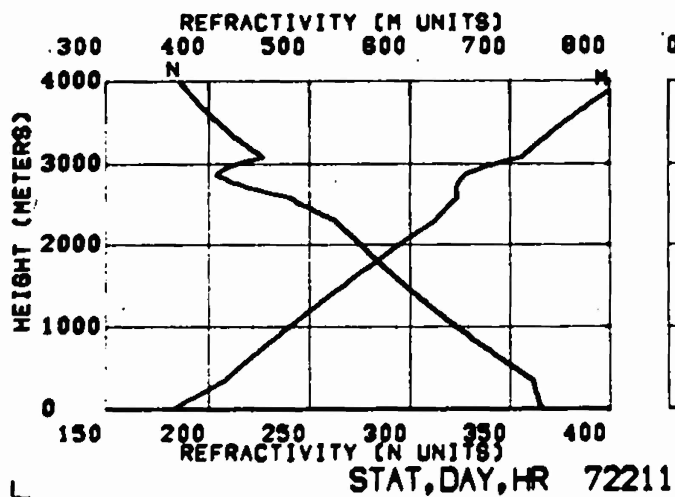
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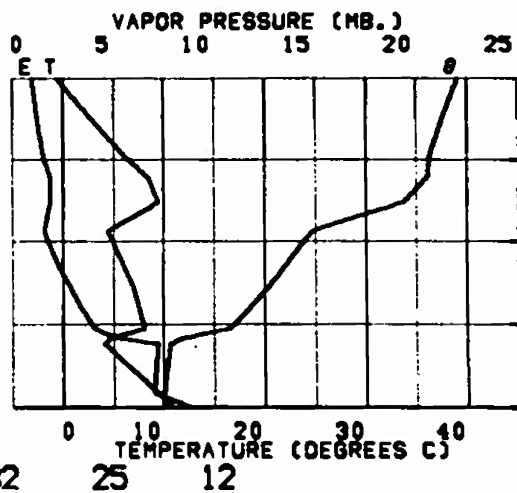
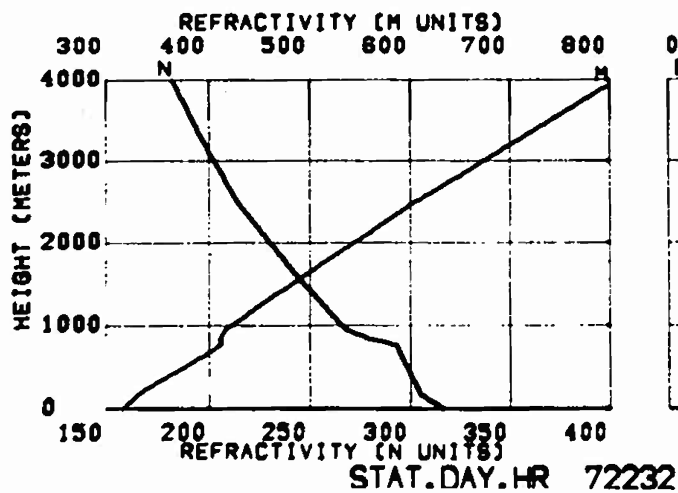
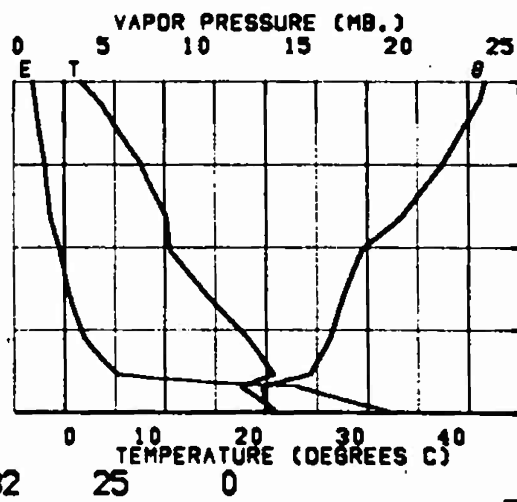
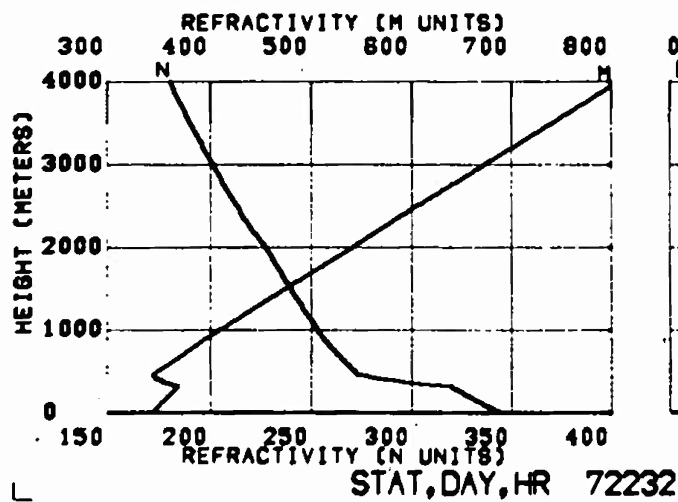


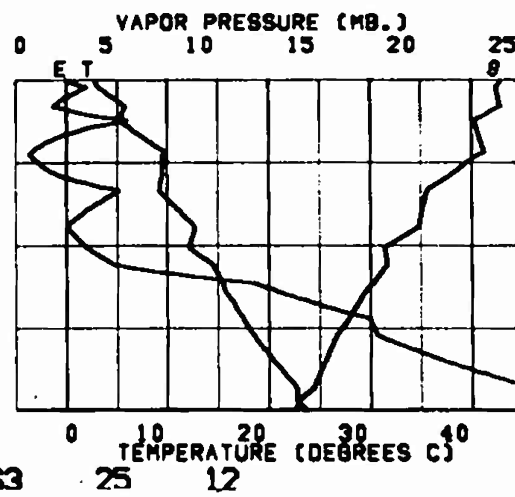
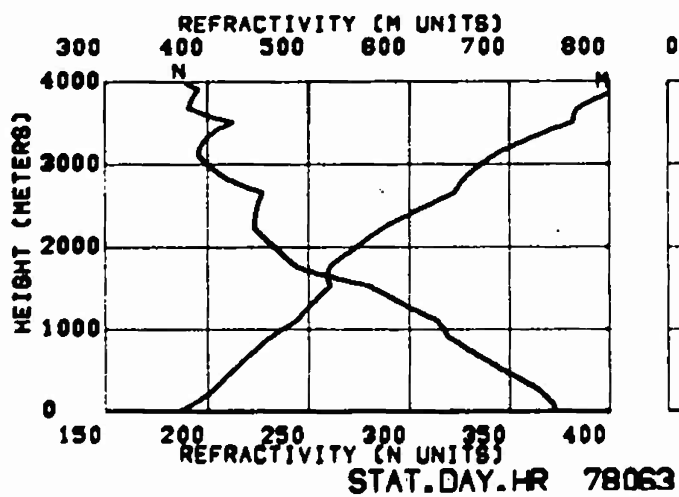
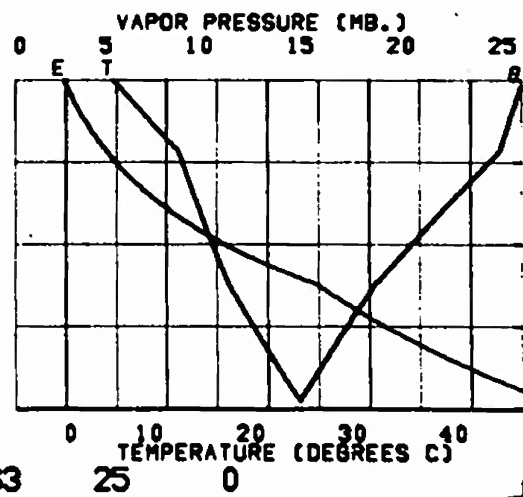
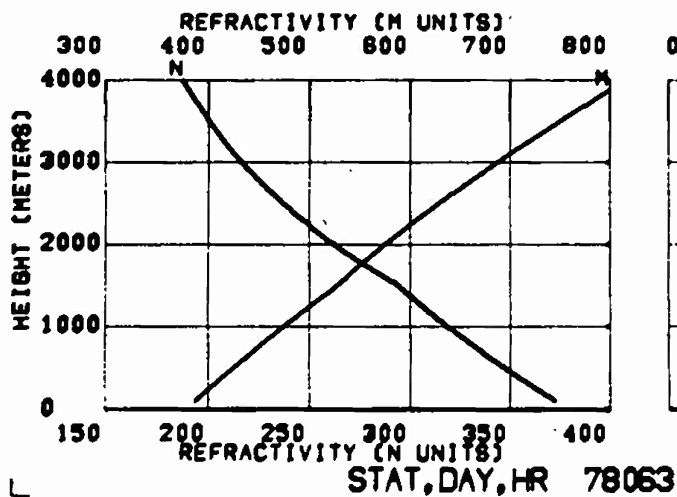
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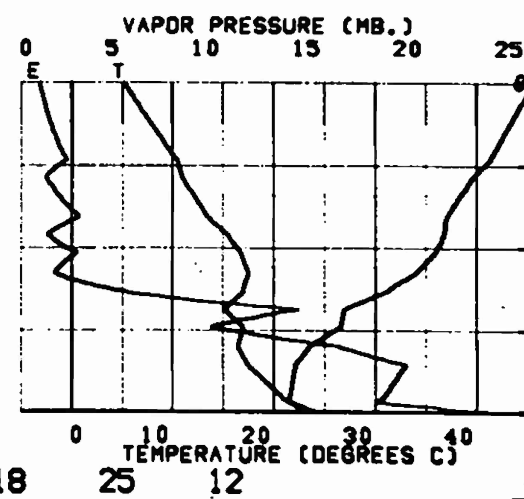
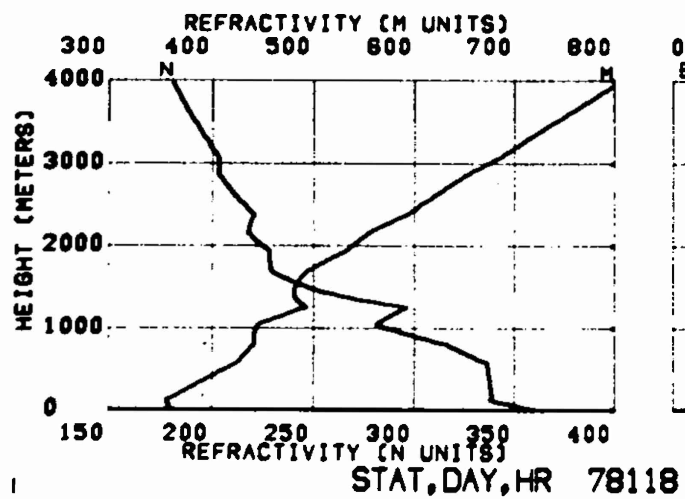
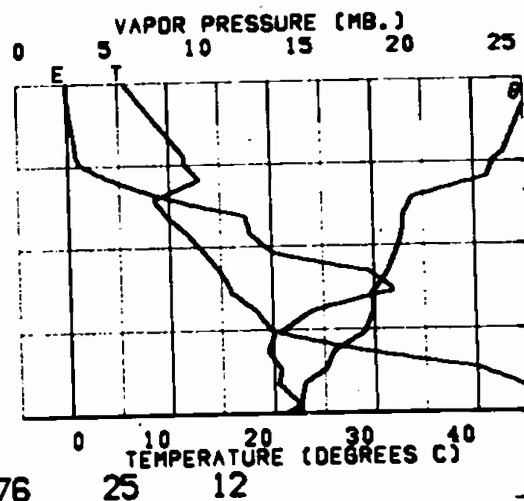
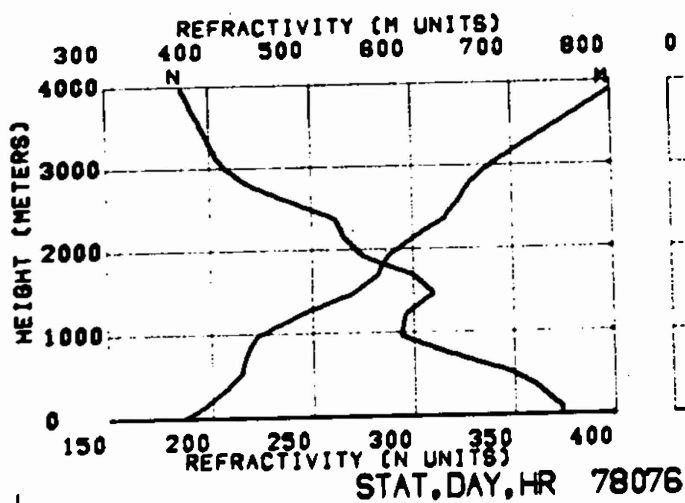


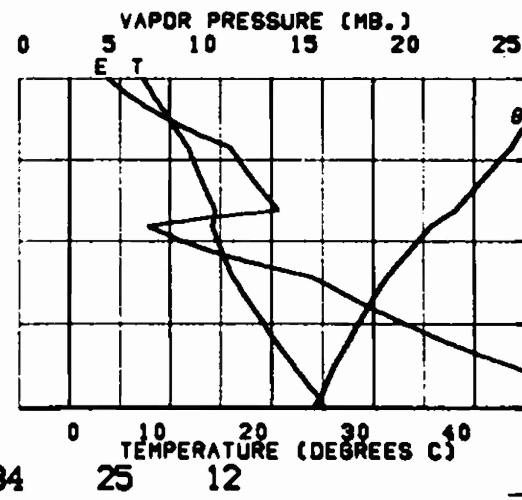
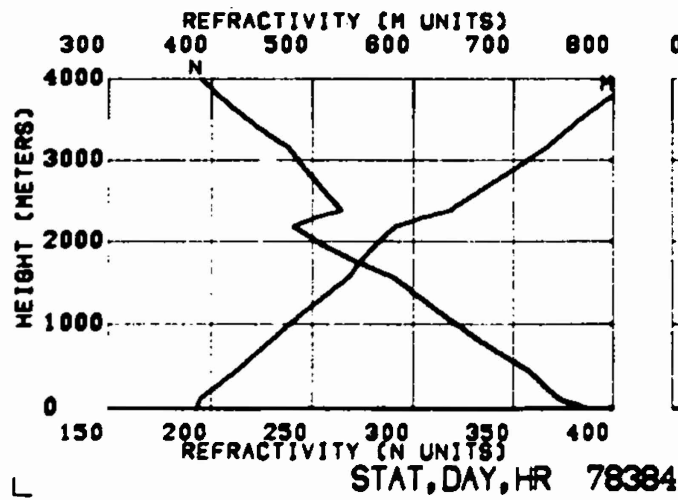
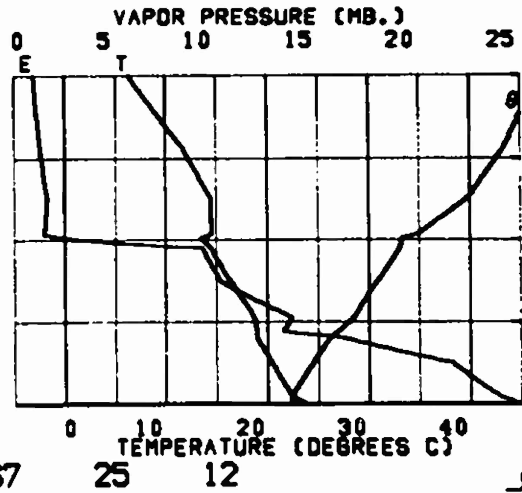
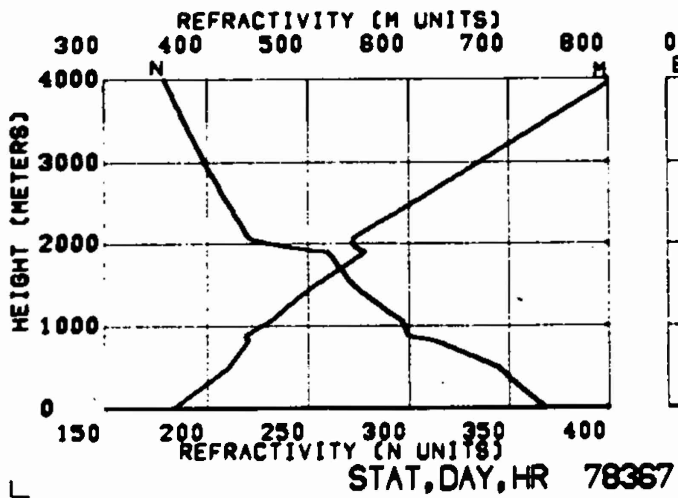
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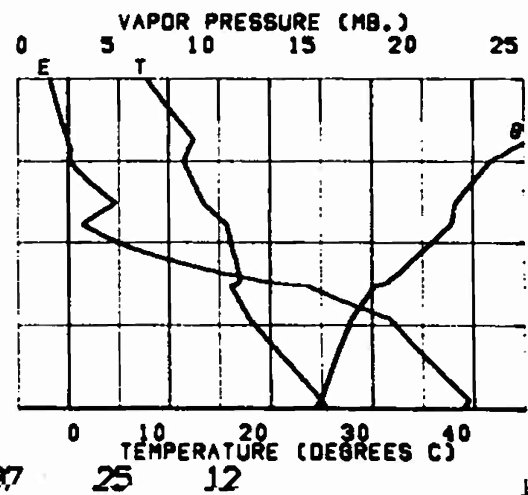
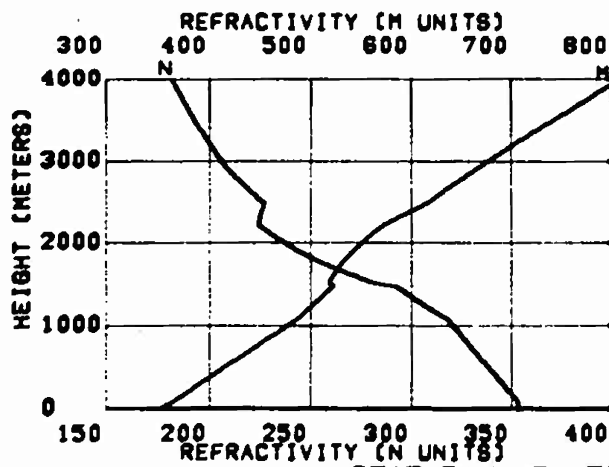
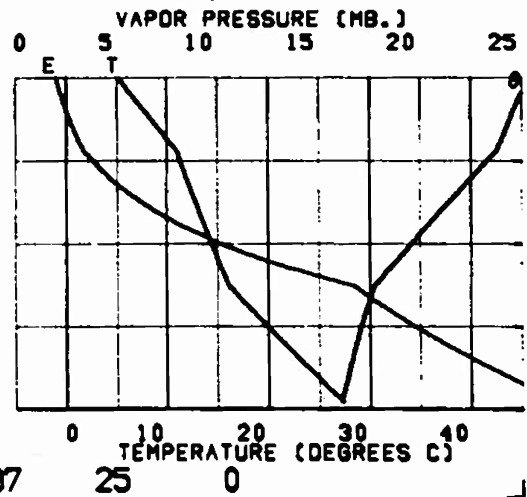
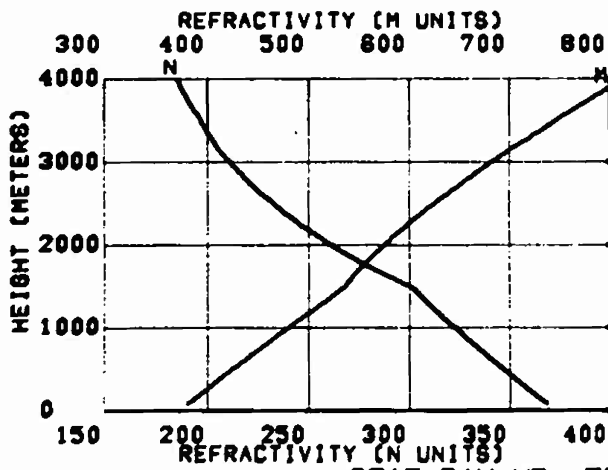


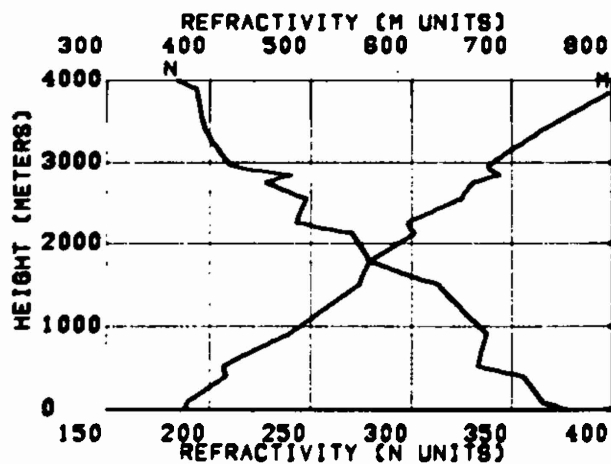




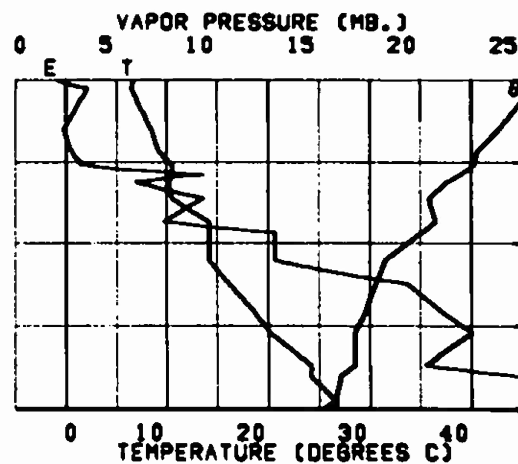




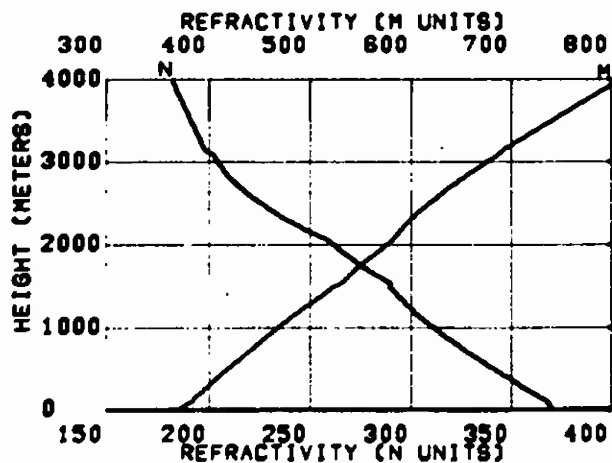




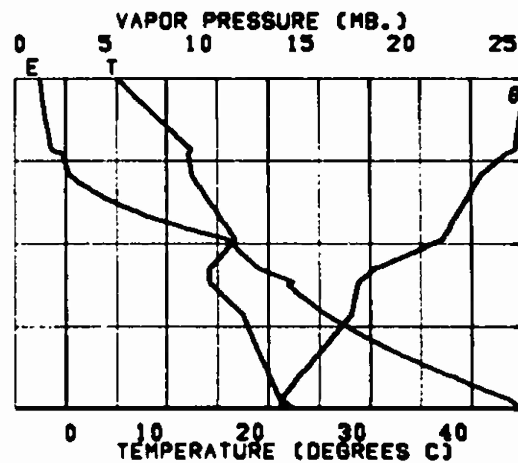
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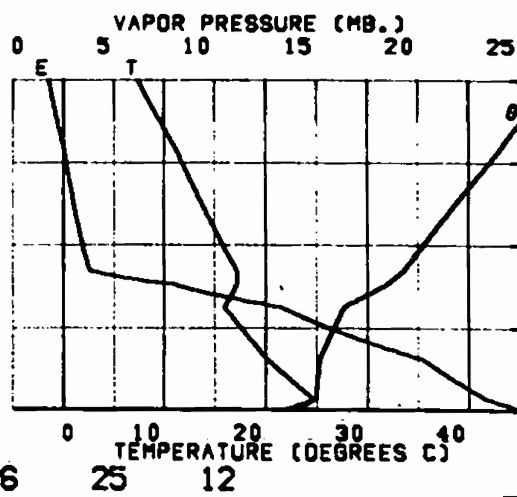
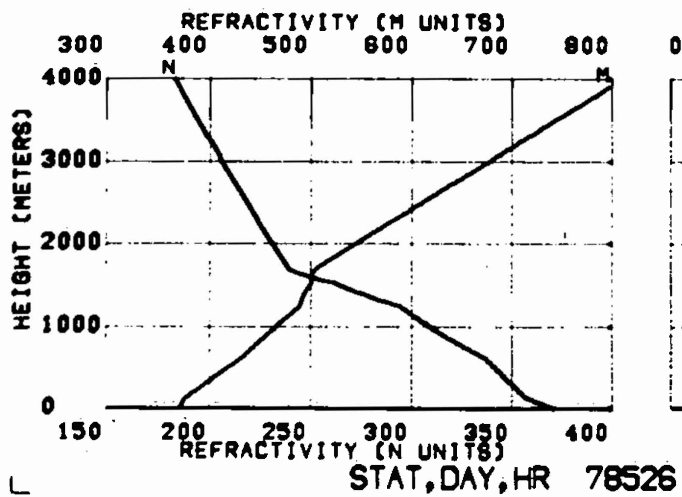
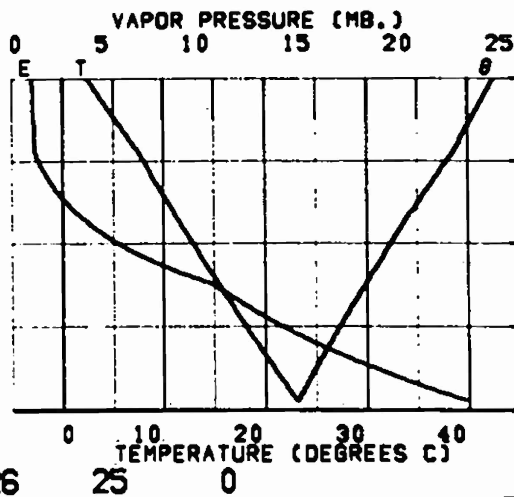
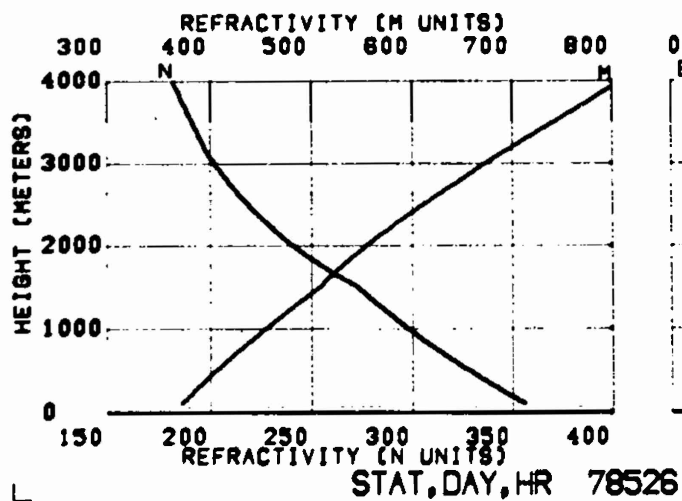
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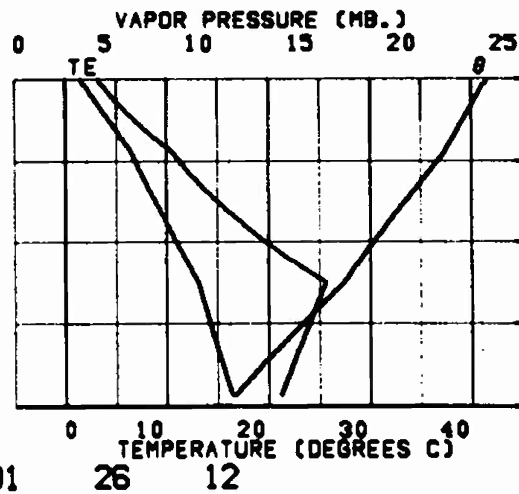
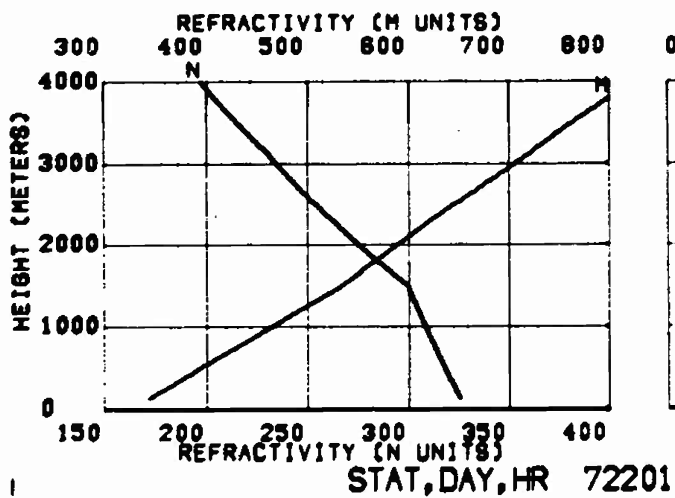
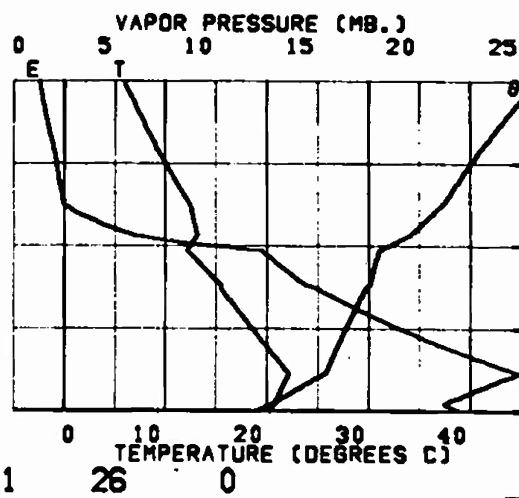
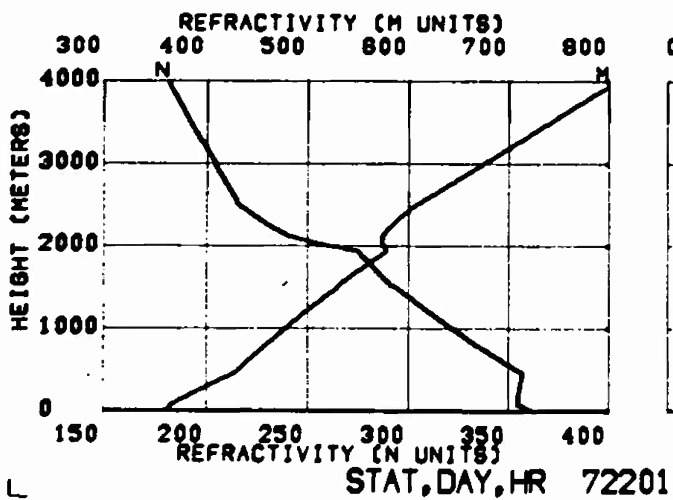


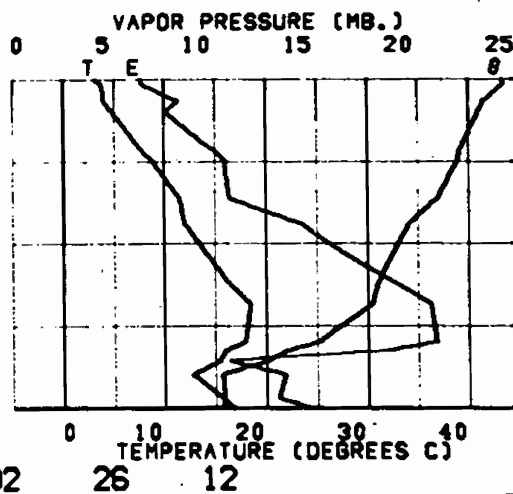
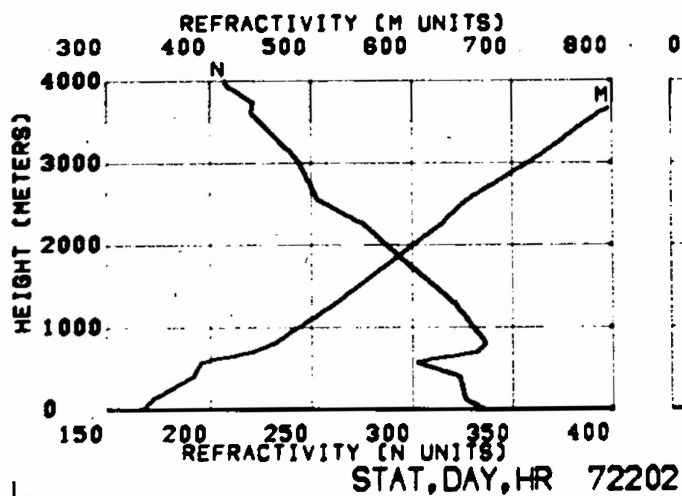
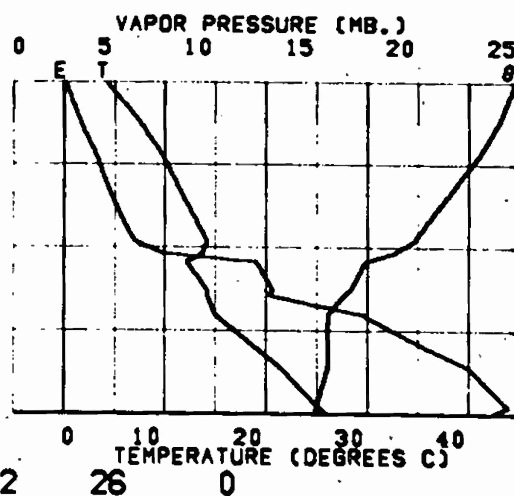
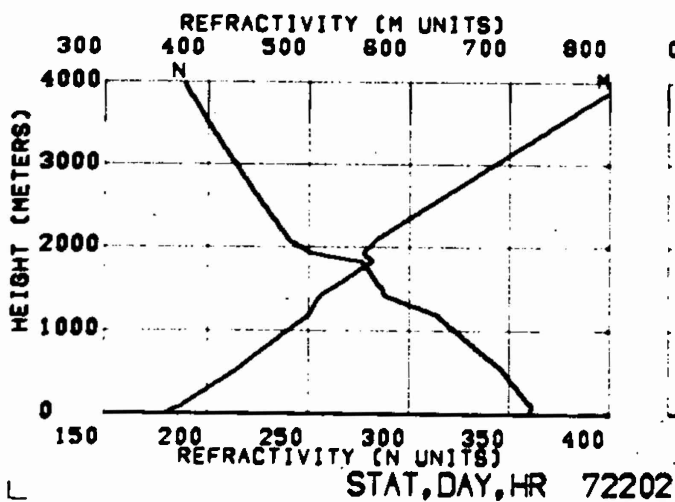
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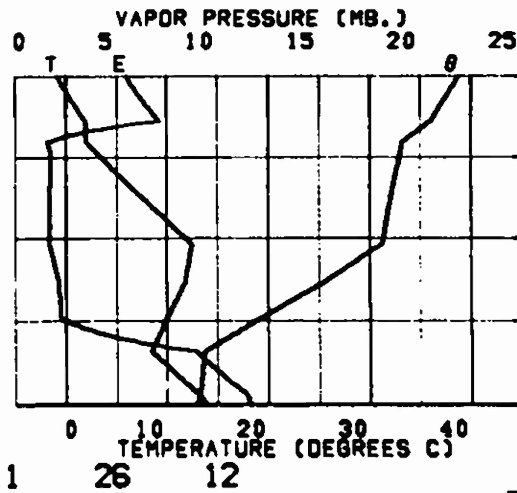
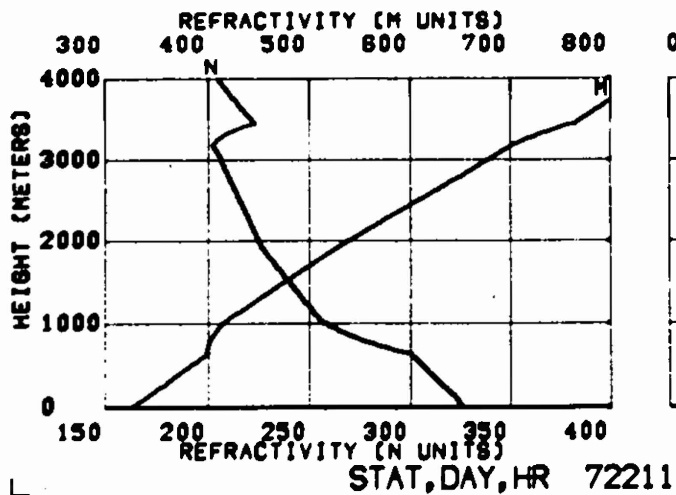
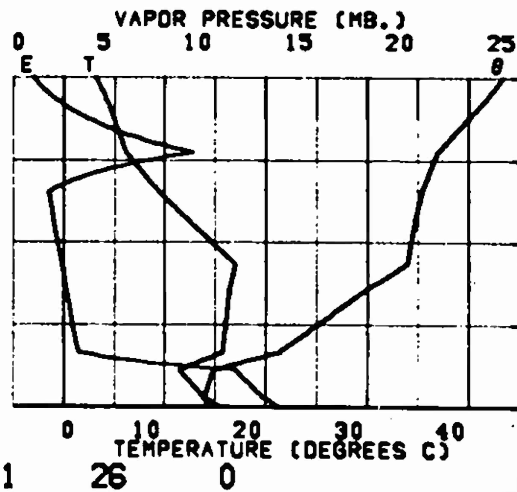
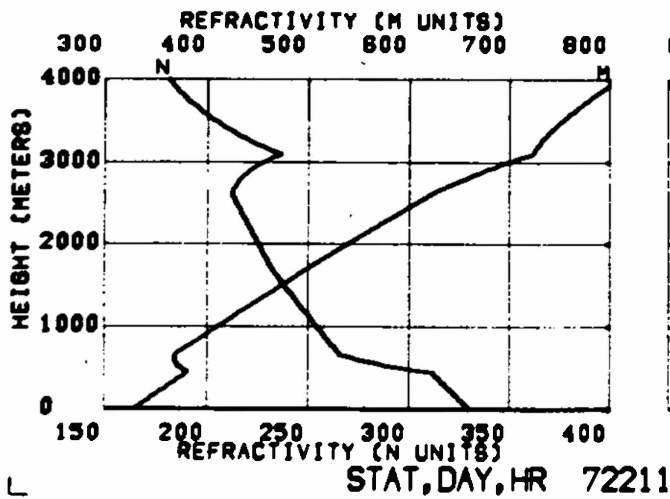


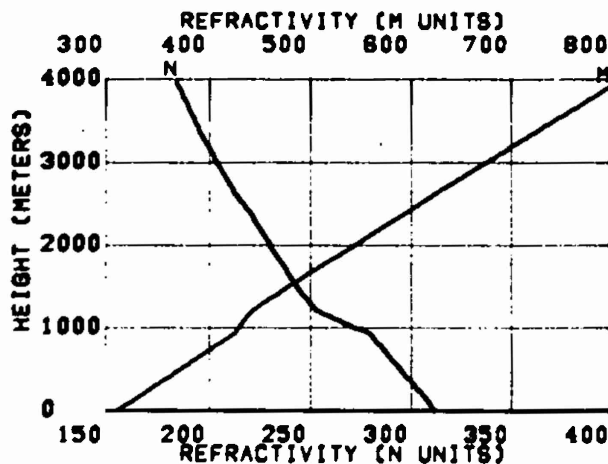
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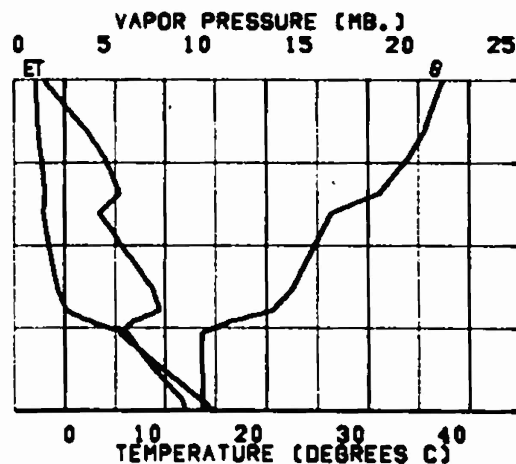




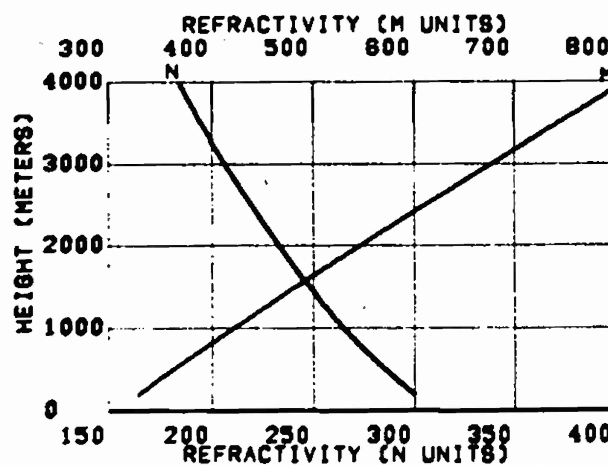




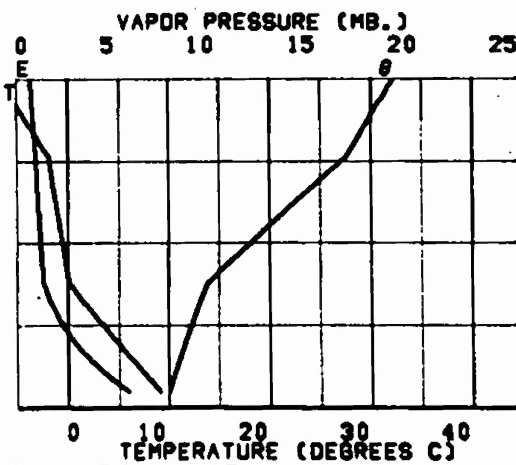
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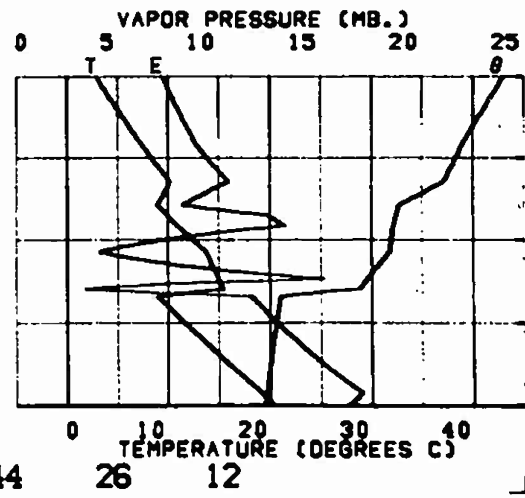
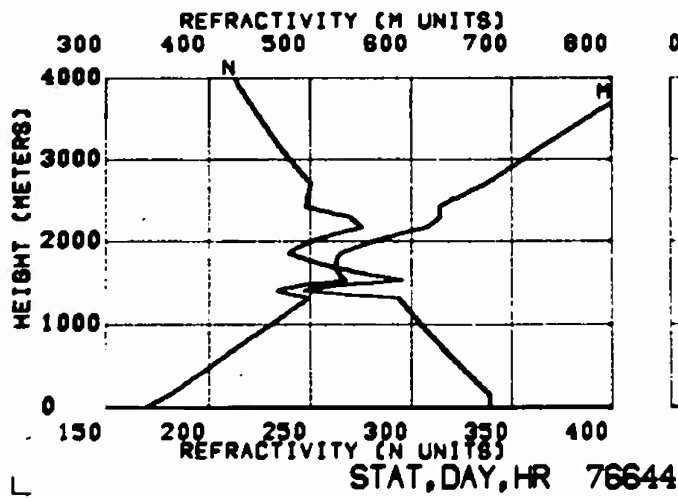
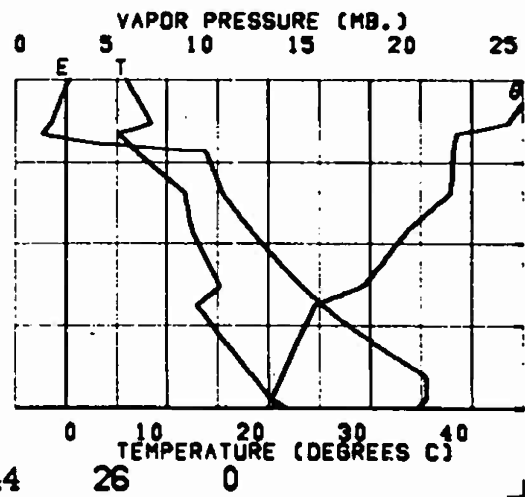
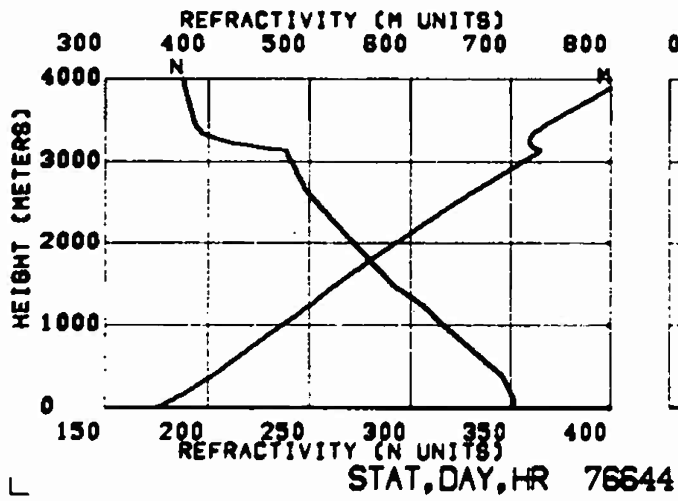
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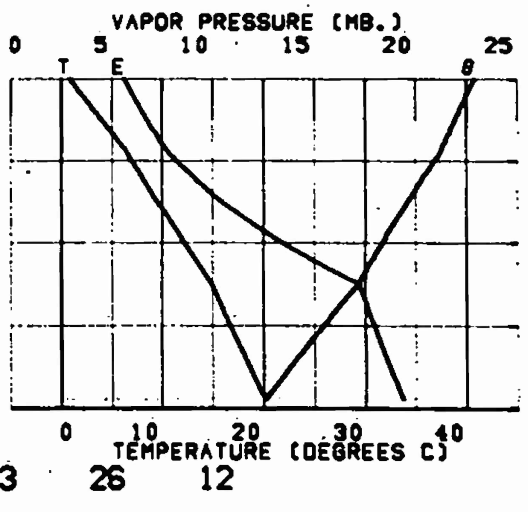
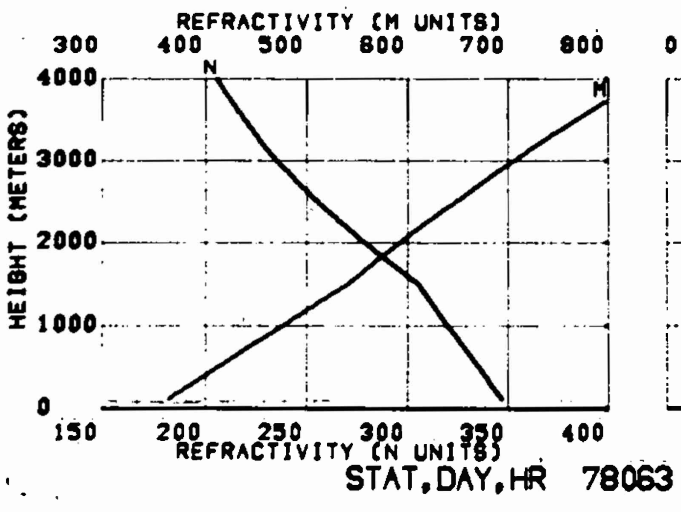
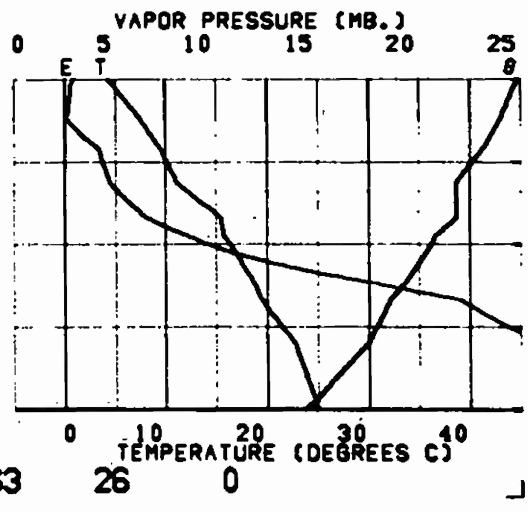
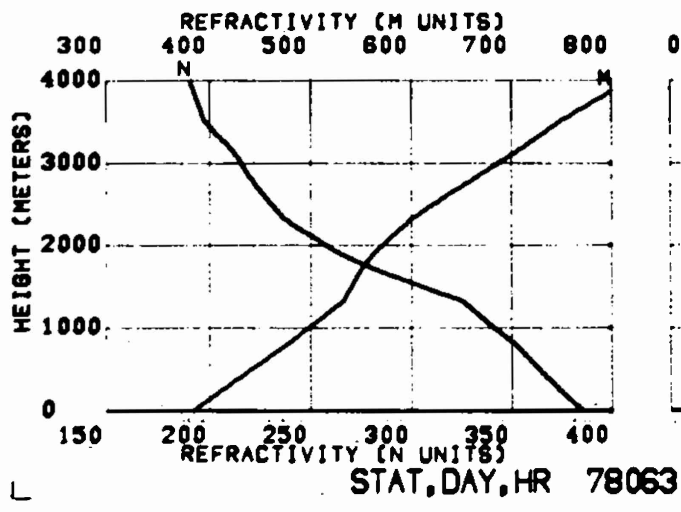


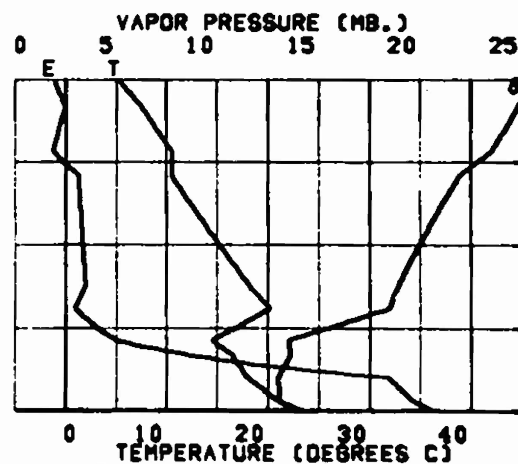
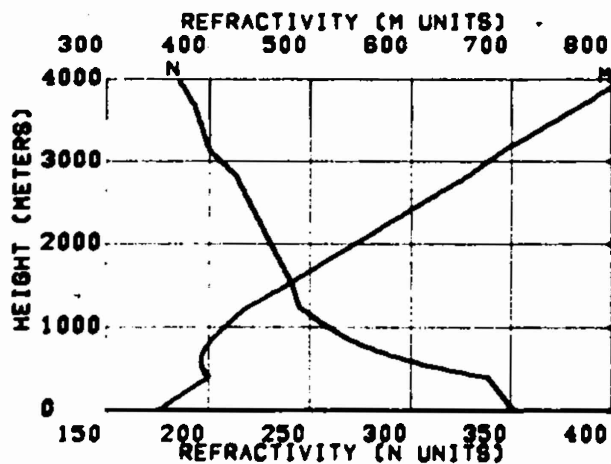
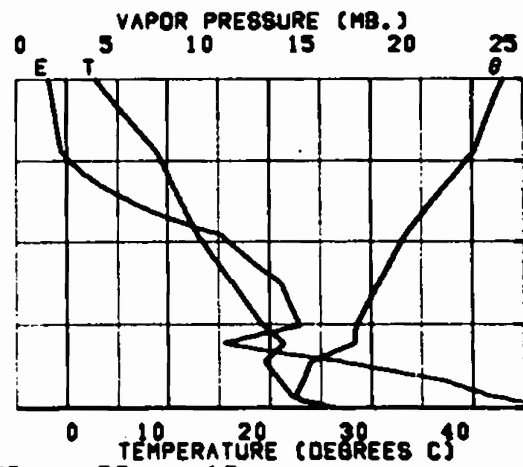
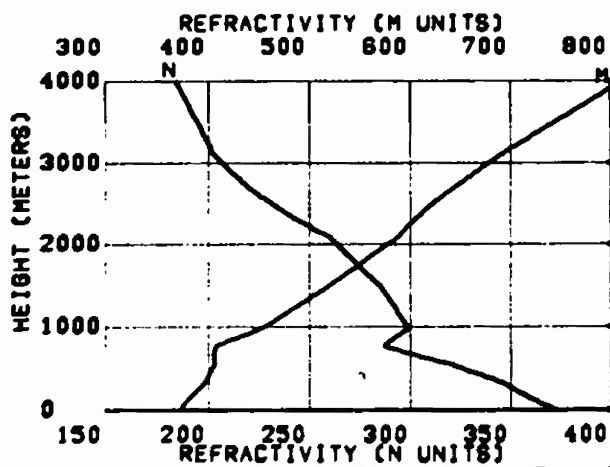
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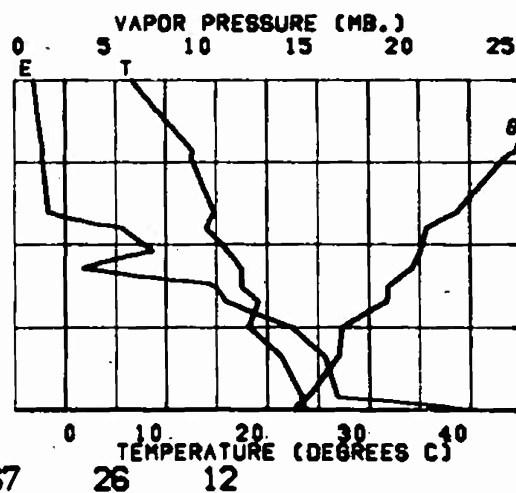
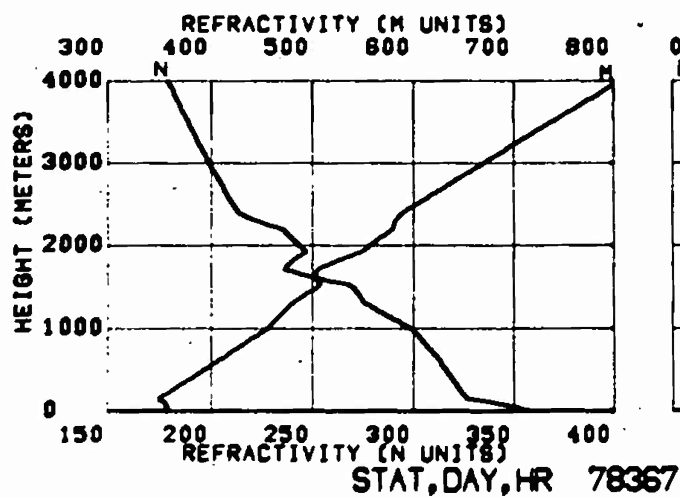
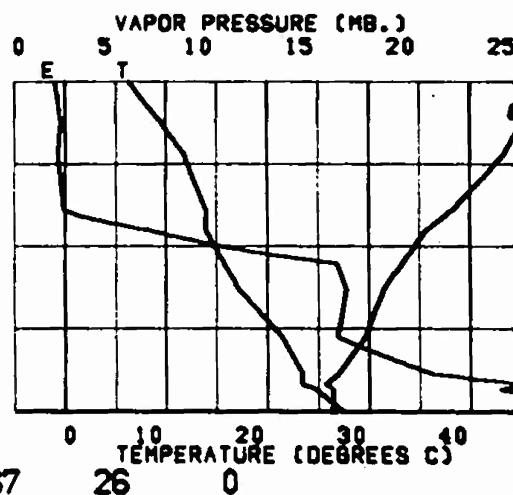
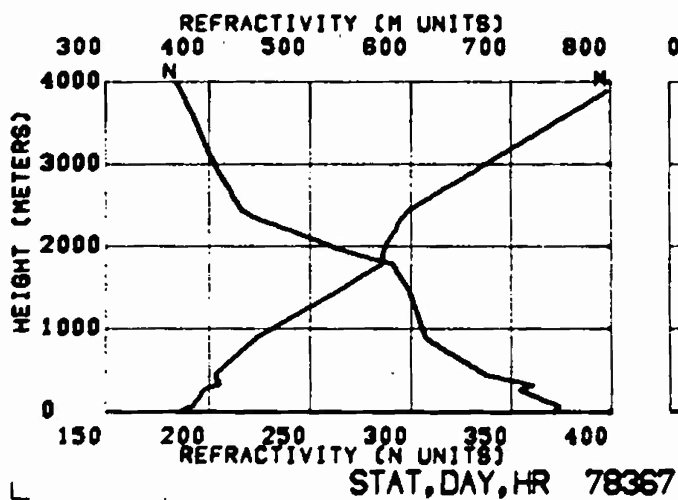


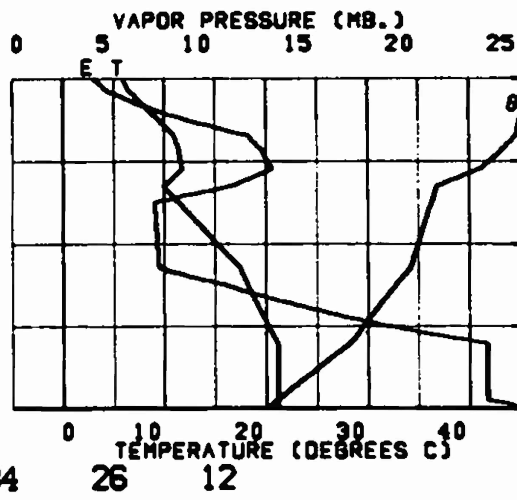
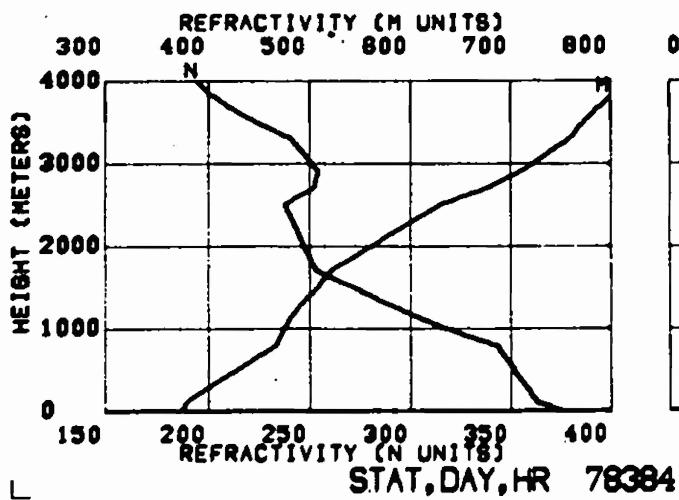
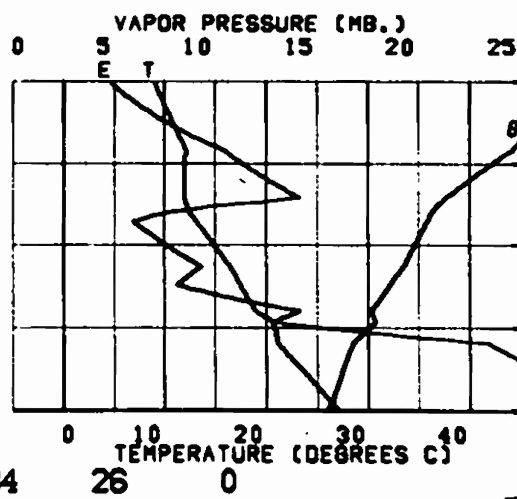
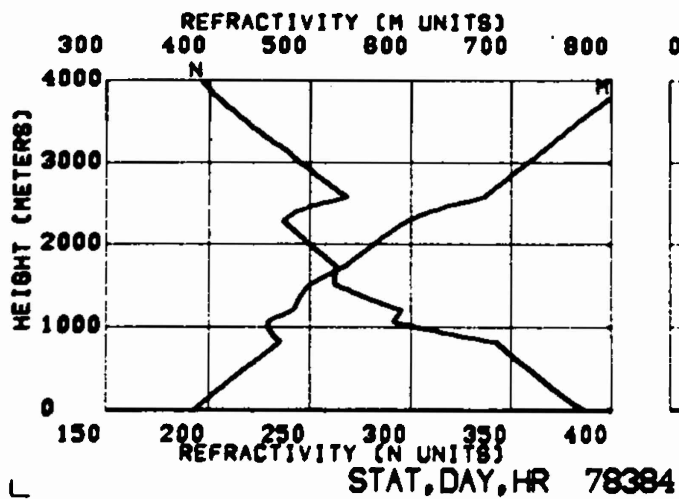
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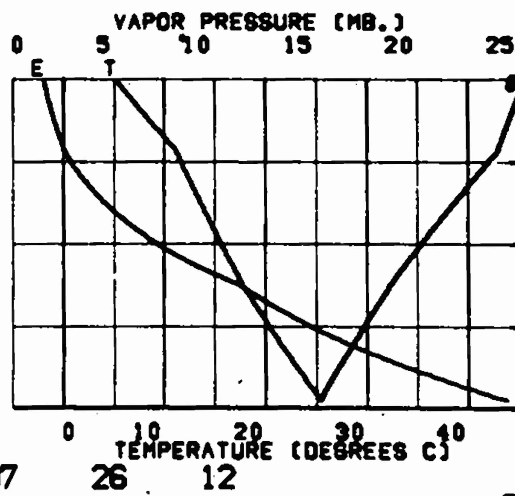
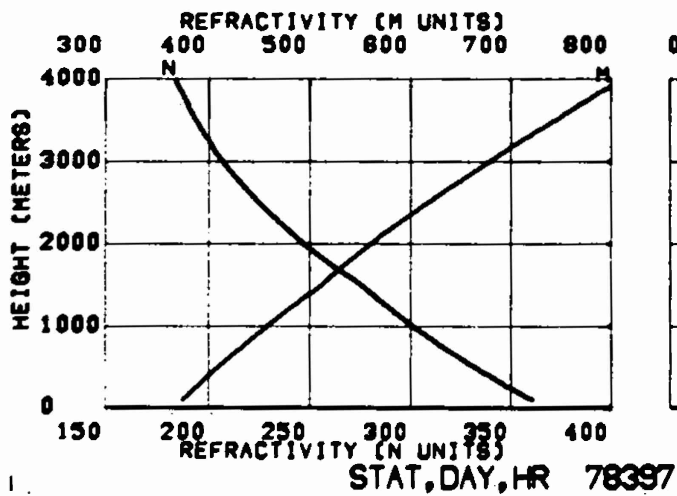
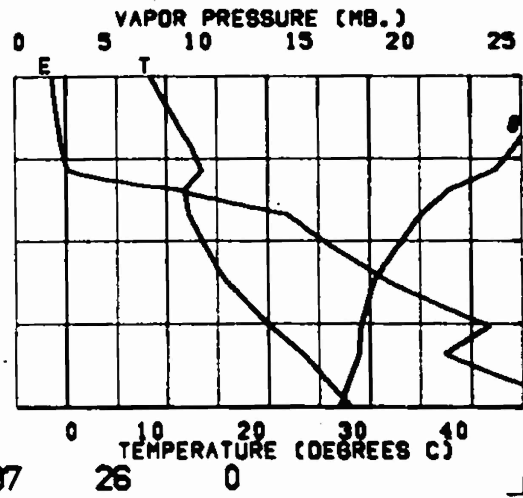
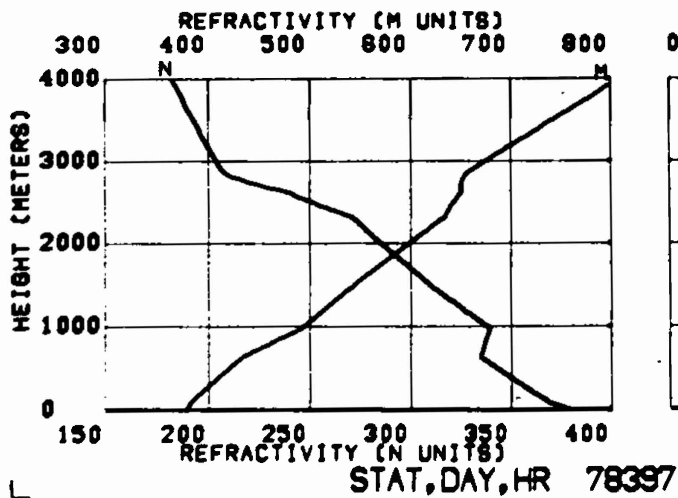


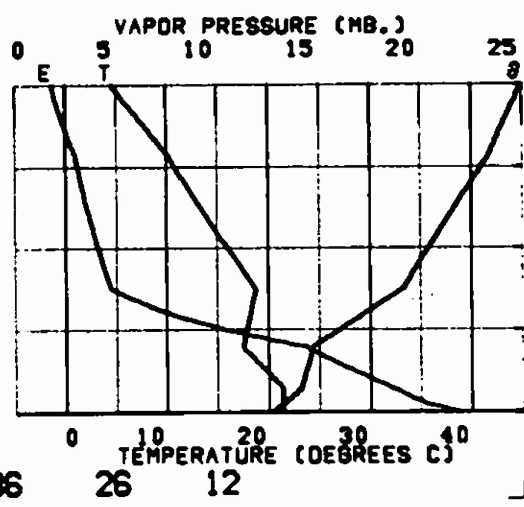
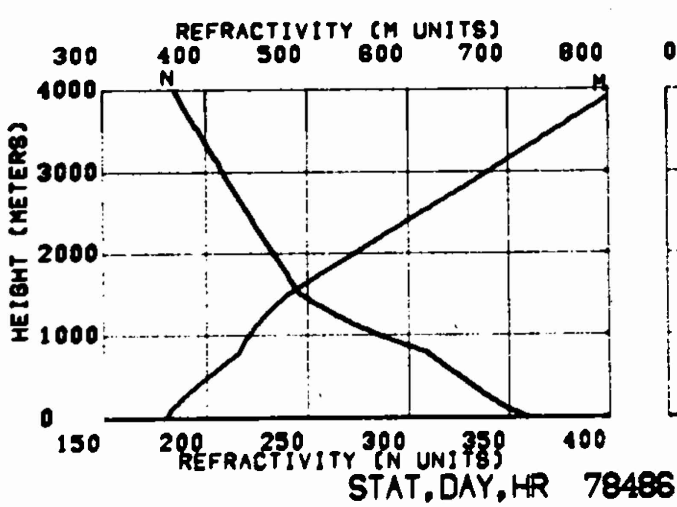
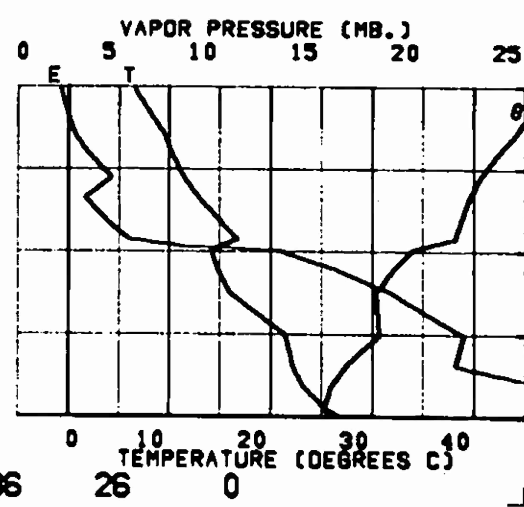
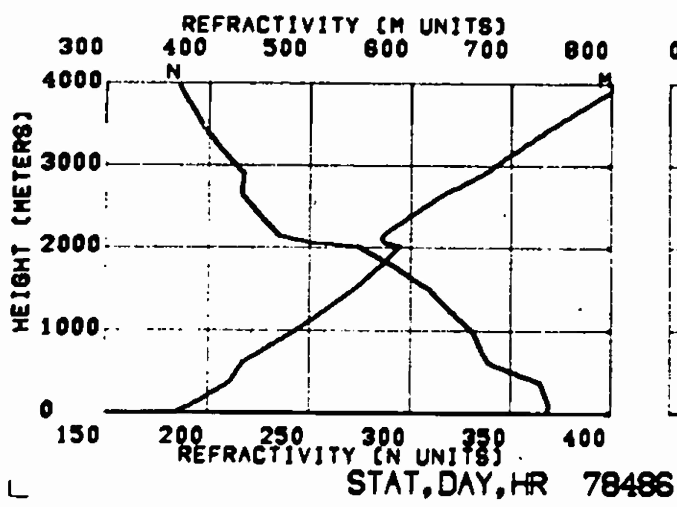


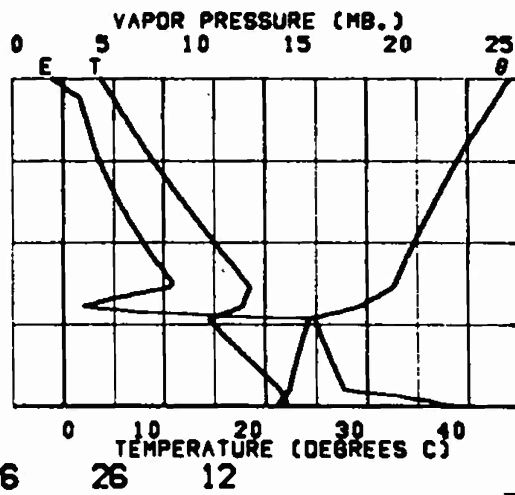
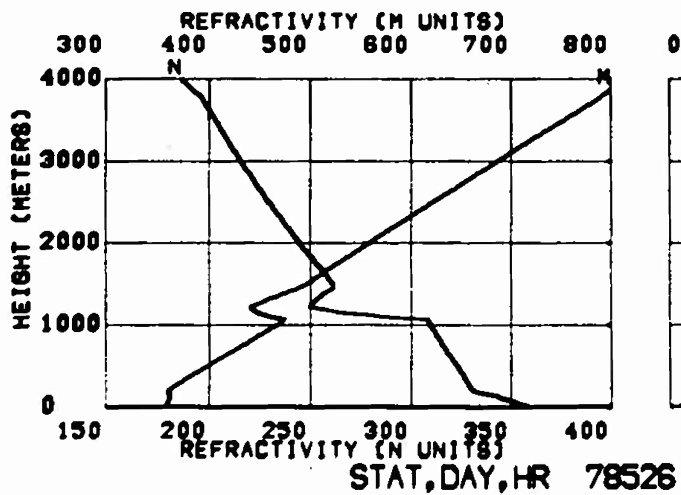
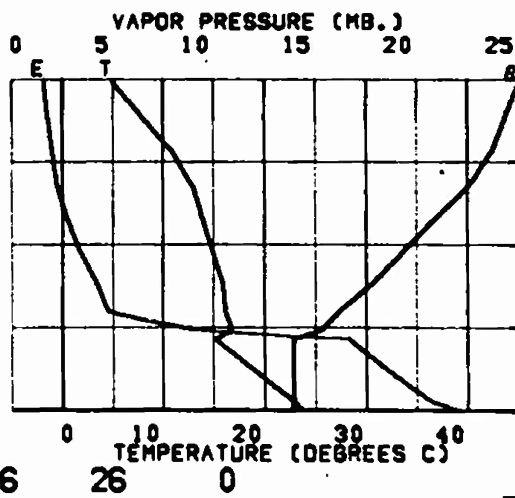
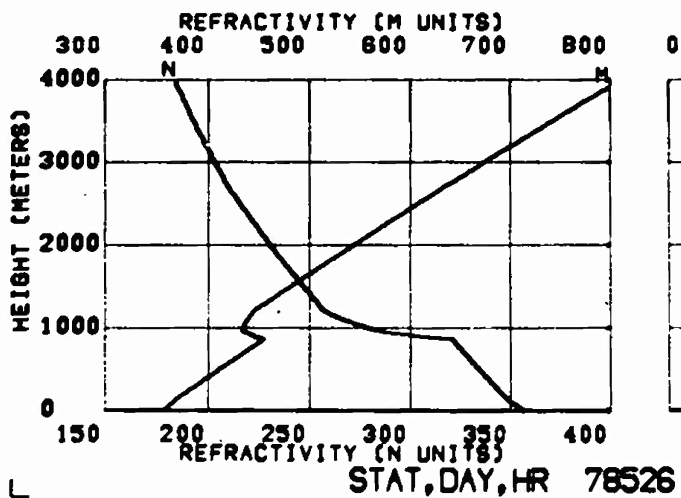












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LAUNCHES TRADE WINDS - MARCH 1969

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13. ABSTRACT

Radiosonde data were collected from the Northern part of the Caribbean Sea, during the period 6 March through 26 March 1969. Stations were selected to encompass the area wherein instrumented aircraft measurements were made of meteorological and radio refractivity parameters.

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