GURME EXPERT WORKSHOP ON AIR QUALITY FORECASTING
24-26 OCTOBER, 2002 CUERNAVACA, MORELOS. MEXICO

AIR QUALITY FORECAST IN MEXICO CITY METROPOLITAN AREA

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Secretaría del Medio Ambiente

AIR QUALITY FORECAST IN MEXICO CITY

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Rationale:

TO PREDICT HIGH OZONE CONCENTRATIONS IN THE METROPOLITAN AREA OF MEXICO CITY
AS A PROTECTIVE MEASURE TO AVOID PEOPLE'S EXPOSURE FOR THE PROTECTION OF THEIR HEALTH.

HIGH OZONE CONCENTRATIONS MAY ACTIVATE THE ATMOSPHERIC CONTINGENCY PROGRAM

ATMOSPHERIC CONTINGENCY PROGRAM

Pre-Contingency

Ozone > 200 IMECA* (232 ppb)

Contingency Phase I

Ozone > 240 IMECA (281 ppb)

Contingency Phase II

Ozone > 300 IMECA (355 ppb)

* IMECA: Metropolitan Air Quality Index

National Ozone Health Standard: 110 ppb 1-hour average = 100 IMECA

AIR QUALITY FORECAST BACKGROUND

1986: Forecasts based on daily local radiosonde (at 6:00 AM)

1988: Incorporation of Synoptic Charts and Satelite Imagery in the forecasts

1990: Incorporation of weather forecasts

1992: Use of a statistical model based on linear regressions and another based on neural networks

1993: Use of an Expert System based on expert meteorologist knowledge rules

1993: Incorporation of the Mixing Layer Height provided by a sodar

1994 to date: Refining the "*traditional*" procedure by the incorporation of real-time Internet data and information.

CURRENT AIR QUALITY FORECAST TRIES TO PREDICT MAXIMUM OZONE CONCENTRATIONS.

FORECAST IS ELABORATED UPON ANALYSES OF THE FOLLOWING INFORMATION:

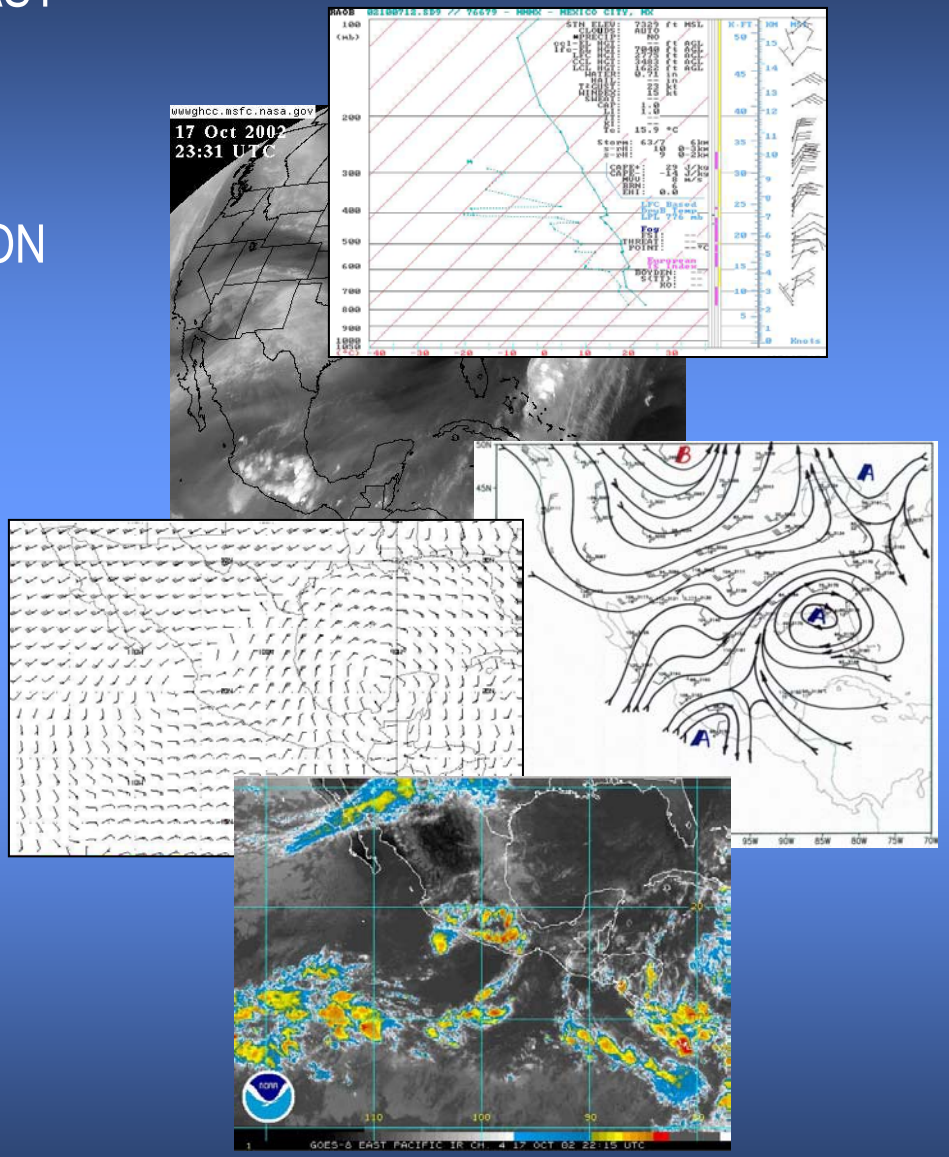
- RADIOSONDE ISOBARIC MAPS
- THERMODYNAMIC DIAGRAM

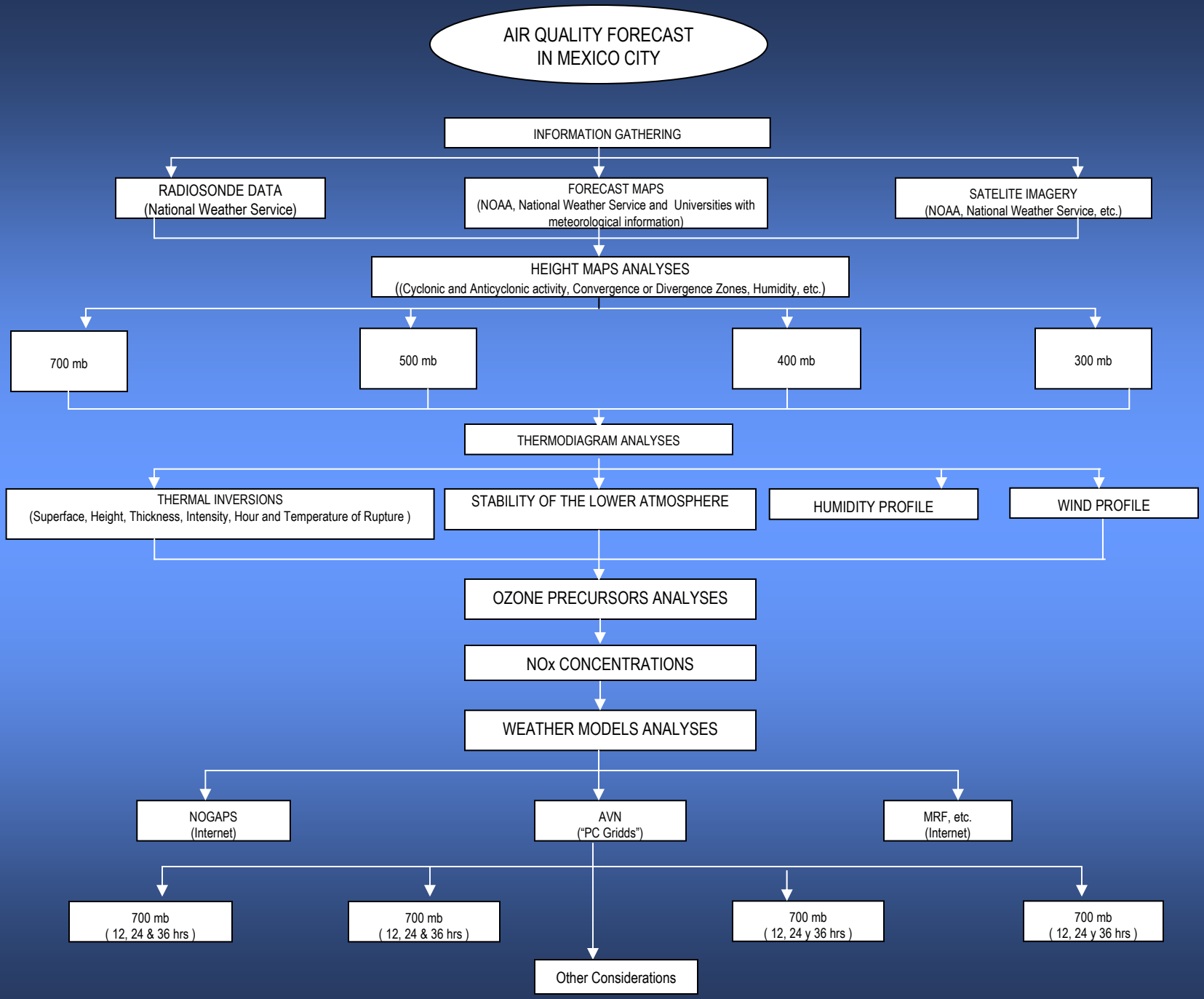
3) SATELLITE IMAGERY

4) EARLY MORNING POLLUTANTS CONCENTRATIONS

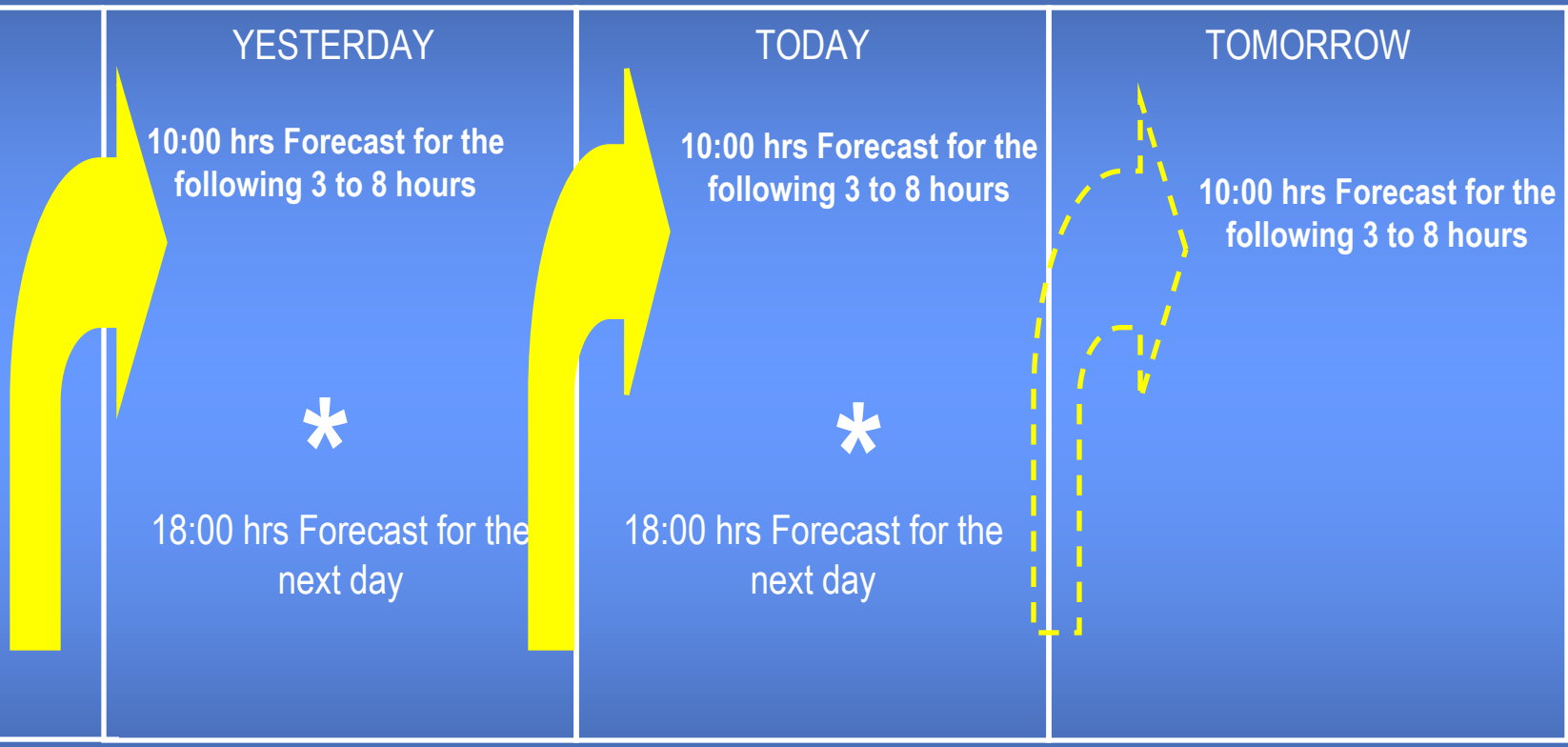
5) WEATHER FORECASTS

6) OTHER CONSIDERATIONS




AIR QUALITY FORECAST
IN MEXICO CITY
INFORMATION GATHERING
RADIOSONDE DATA
(National Weather Service)
FORECAST MAPS
(NOAA, National Weather Service and Universities with meteorological information)
SATELITE IMAGERY
(NOAA, National Weather Service, etc.)
HEIGHT MAPS ANALYSES
((Cyclonic and Anticyclonic activity, Convergence or Divergence Zones, Humidity, etc.)
700 mb
500 mb
400 mb
300 mb
THERMODIAGRAM ANALYSES
THERMAL INVERSIONS
(Superface, Height, Thickness, Intensity, Hour and Temperature of Rupture)
STABILITY OF THE LOWER ATMOSPHERE
HUMIDITY PROFILE
WIND PROFILE
OZONE PRECURSORS ANALYSES
NOx CONCENTRATIONS
WEATHER MODELS ANALYSES
NOGAPS
(Internet)
AVN
("PC Gridds")
MRF, etc.
(Internet)
700 mb
(12, 24 & 36 hrs)
700 mb
(12, 24 & 36 hrs)
700 mb
(12, 24 y 36 hrs)
700 mb
(12, 24 y 36 hrs)
Other Considerations

FORECASTS ELABORATION



* **Intrerim 20 minutes forecasts are elaborated in the presence of high concentrations of ozone**

ANALYSES OF RADIOSONDE ISOBARIC MAPS

700, 500, 400 y 300 mb MAPS **PROVIDED BY THE RADIOSONDE OF THE NATIONAL METEOROLOGICAL SERVICE AT 12:00 UTC**

Responses to the following questions in front of a Cyclone or Anticyclone circulation:

a) What is its intensity ?

b) Will it afect the Valley of Mexico during the current or following day ?

c) Will intensify ?

d) How it behaves in this season of the year ?

e) What mases of air are being transported into the Valley of Mexico at different levels ?

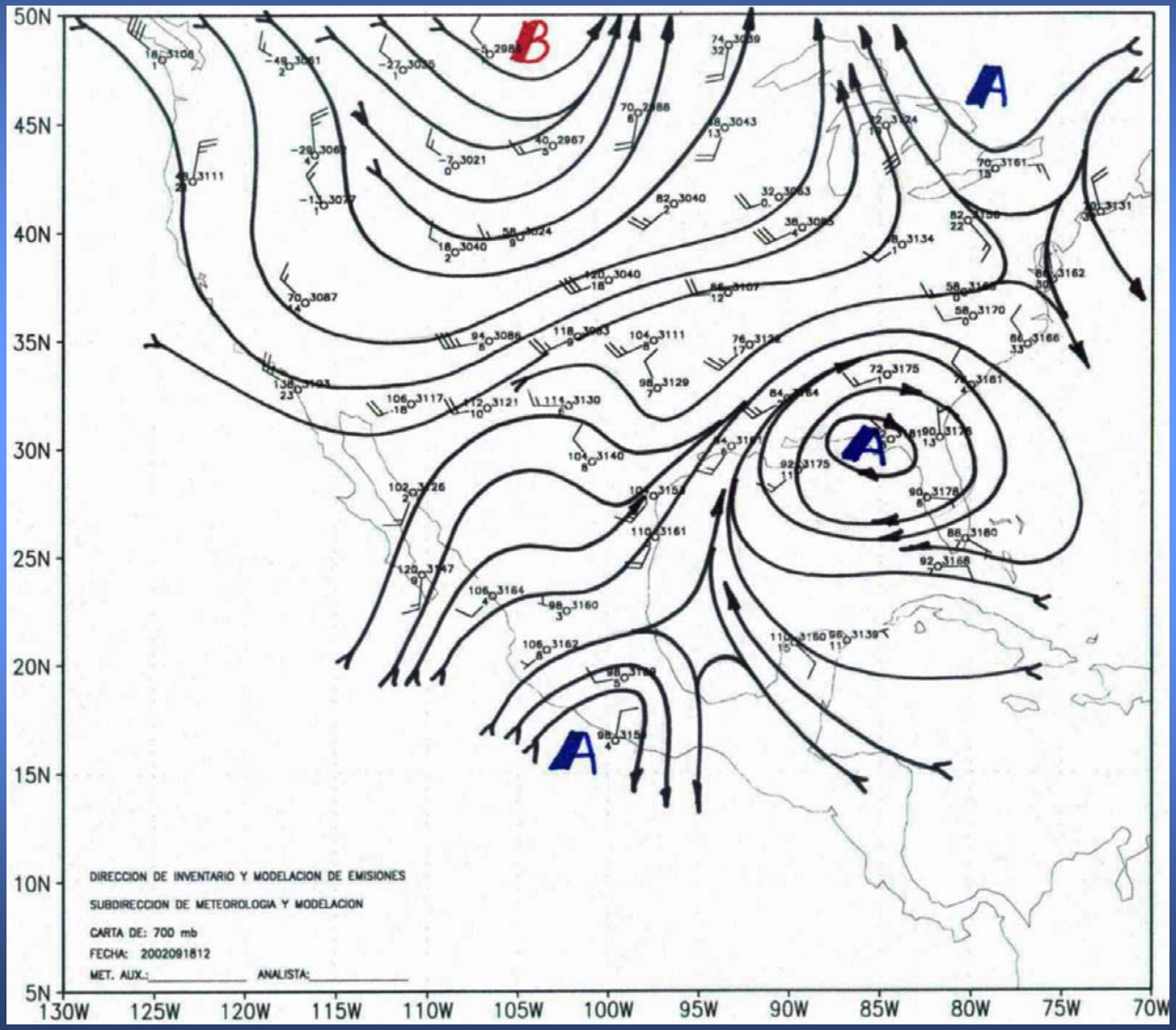
f) How clouds will interact with the incoming solar radiation ?

g) Will it be rain during the day ?

h) What is the interaction among the low and high tropospheric layers?

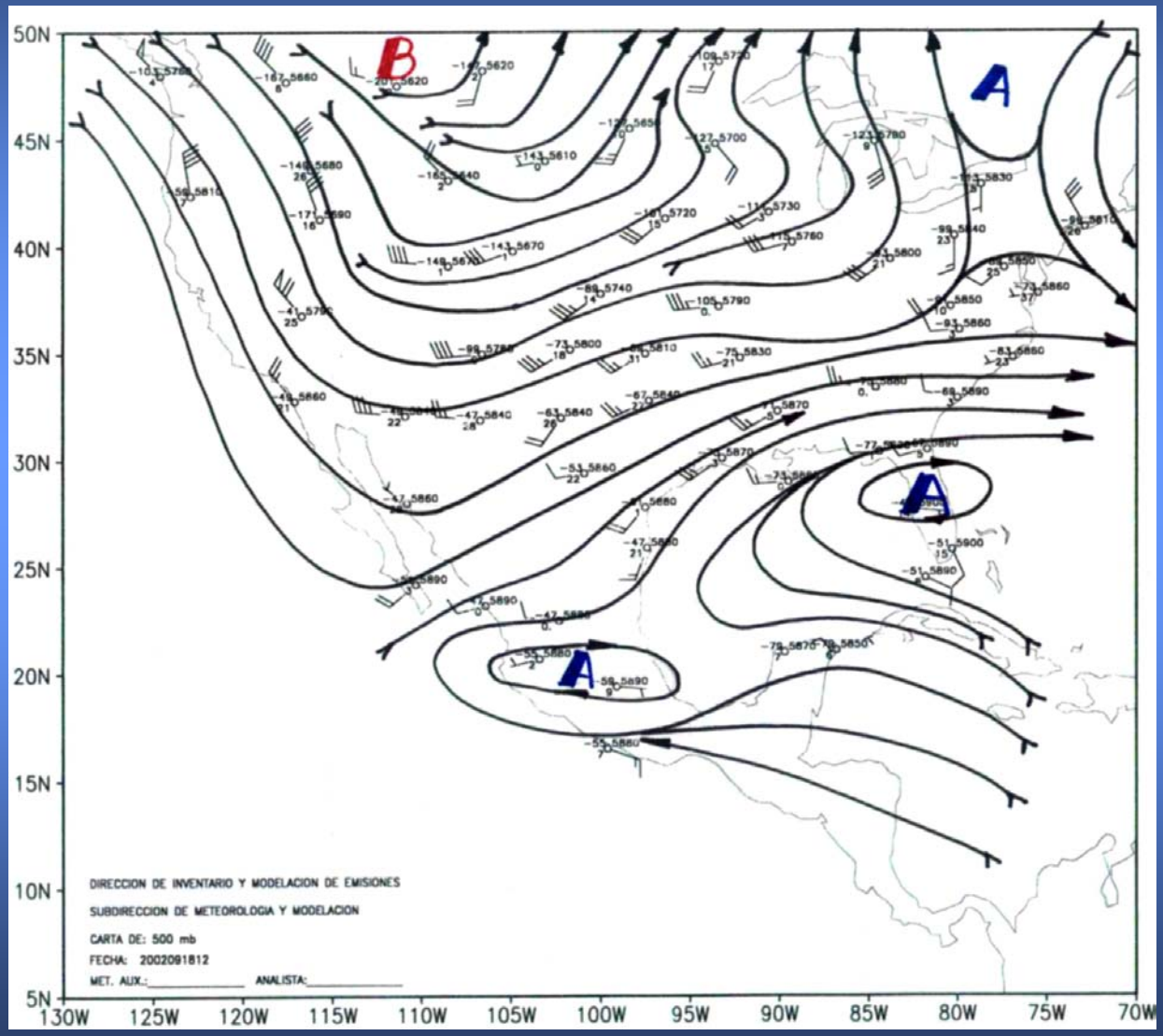
i) Is there a Convergence or Divergence in the high troposphere ?

700 mb ISOBARIC MAP



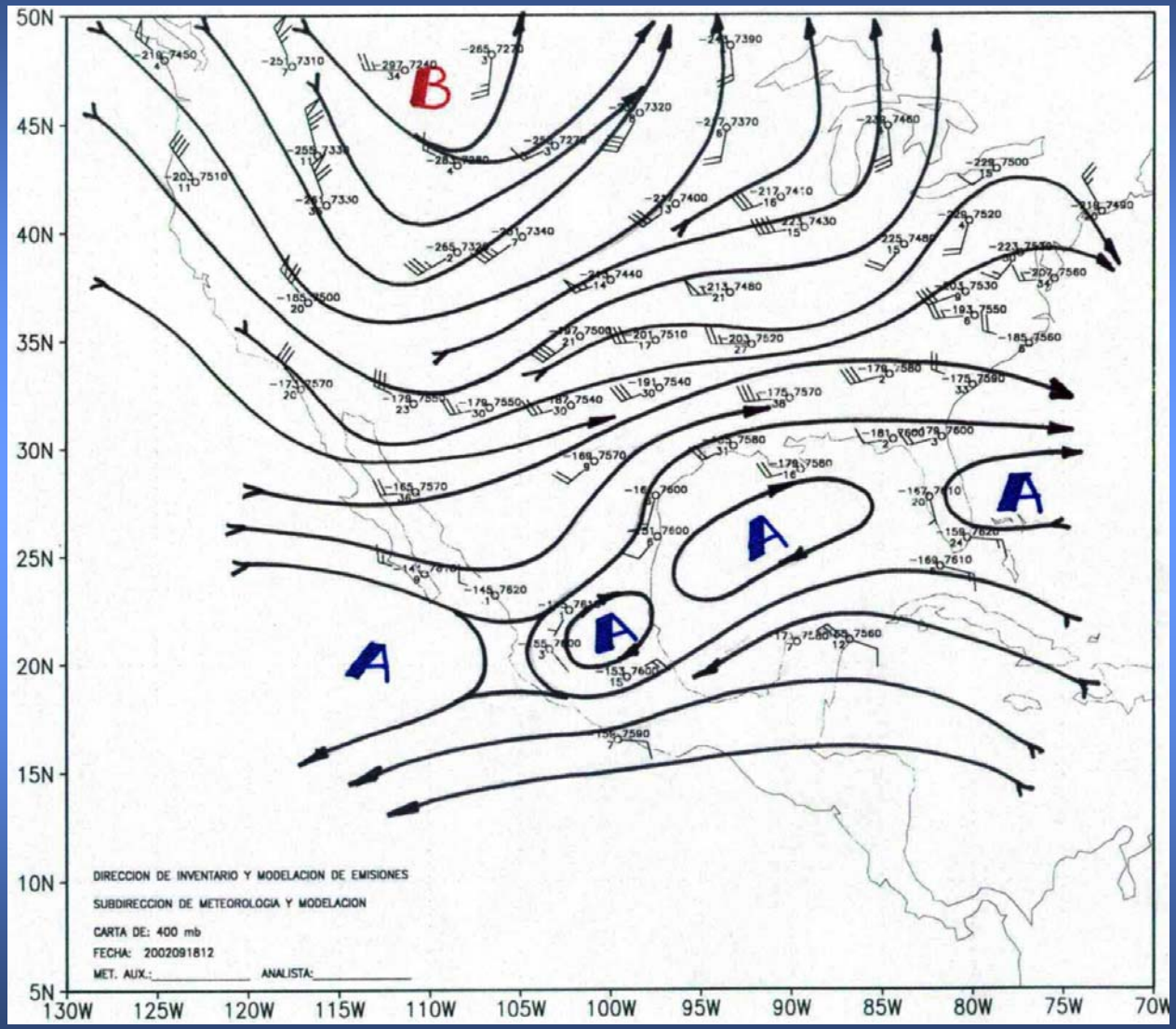
Map shows an anticyclonic vortex over the State of Guerrero, extending its influence over the Valley of Mexico

500 mb ISOBARIC MAP



Map shows an anticyclonic vortex over the Valley of Mexico

400 mb ISOBARIC MAP



Map shows a chain of vortices with anticyclonic circulation

CONDITIONS FOR DISPERSION FROM THE RADIOSONDE
Isobaric Maps

ADVERSE:

i) Anticlyclonic Vortices in different maps.

ii) An anticyclonic vortex at low tropospheric level and a cyclonic one at medium or high level.

iii) A convergence at high tropospheric level.

iv) No humidity transportation into the zone.

FAVORABLE:

i) Cyclonic vortices in different maps, particularly at low tropospheric levels.

ii) A cyclonic vortex at low tropospheric level and an anticyclonic one at medium or high level.

iii) A divergence at high tropospheric level.

iv) Humidity transportation into the zone.

THERMODYNAMIC DIAGRAM

Provides responses to the following questions:

a) What is the humidity in the different tropospheric layers ?

b) Will humidity increase or not during the day ?

c) How is the horizontal wind at different heights ? Strong in one direction or variable ? Weak in one direction or variable ?

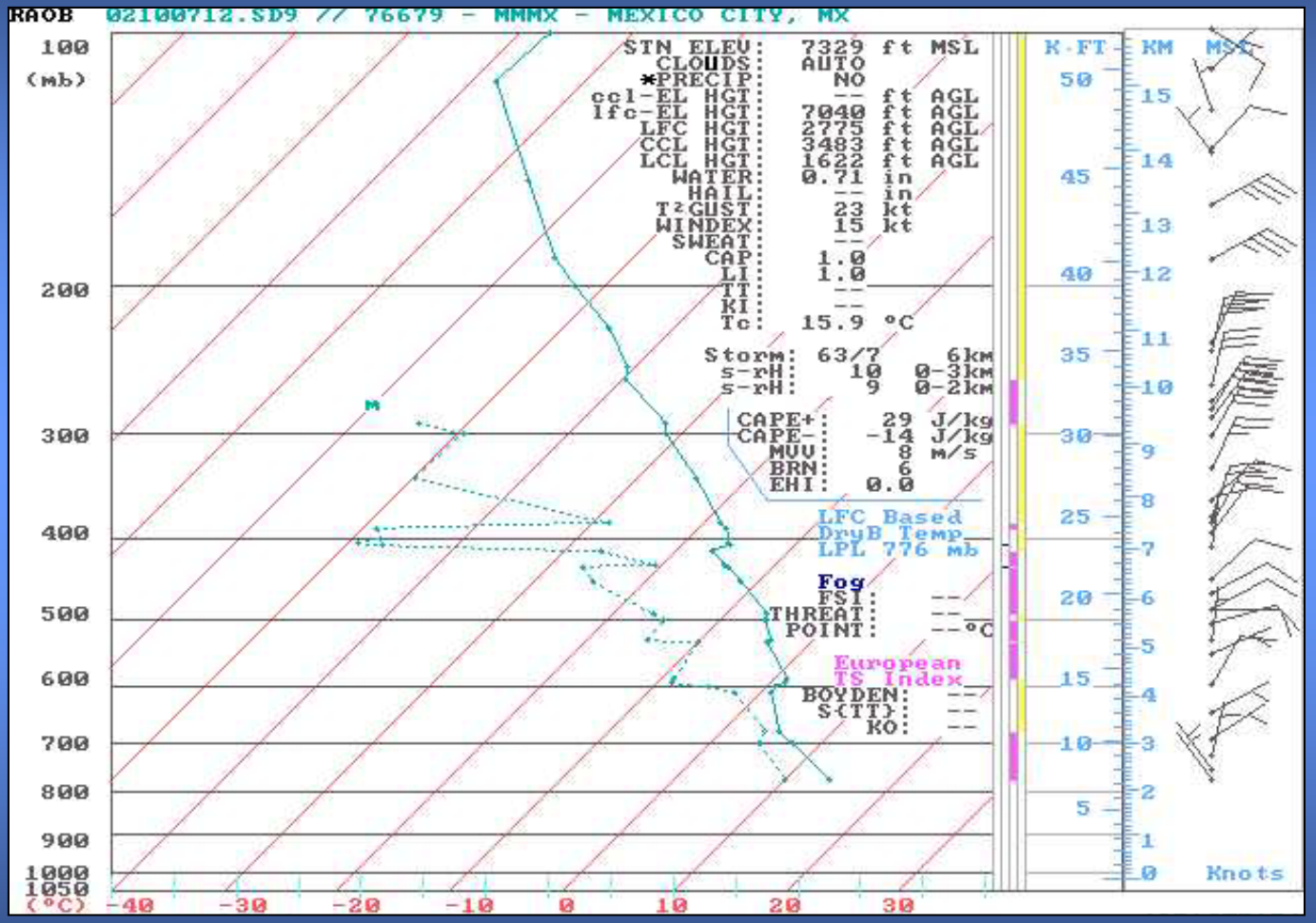
d) Will increase or not during the day ?

e) Are there thermail inversions ? At what height ? What is its intensity ? When will break up ?

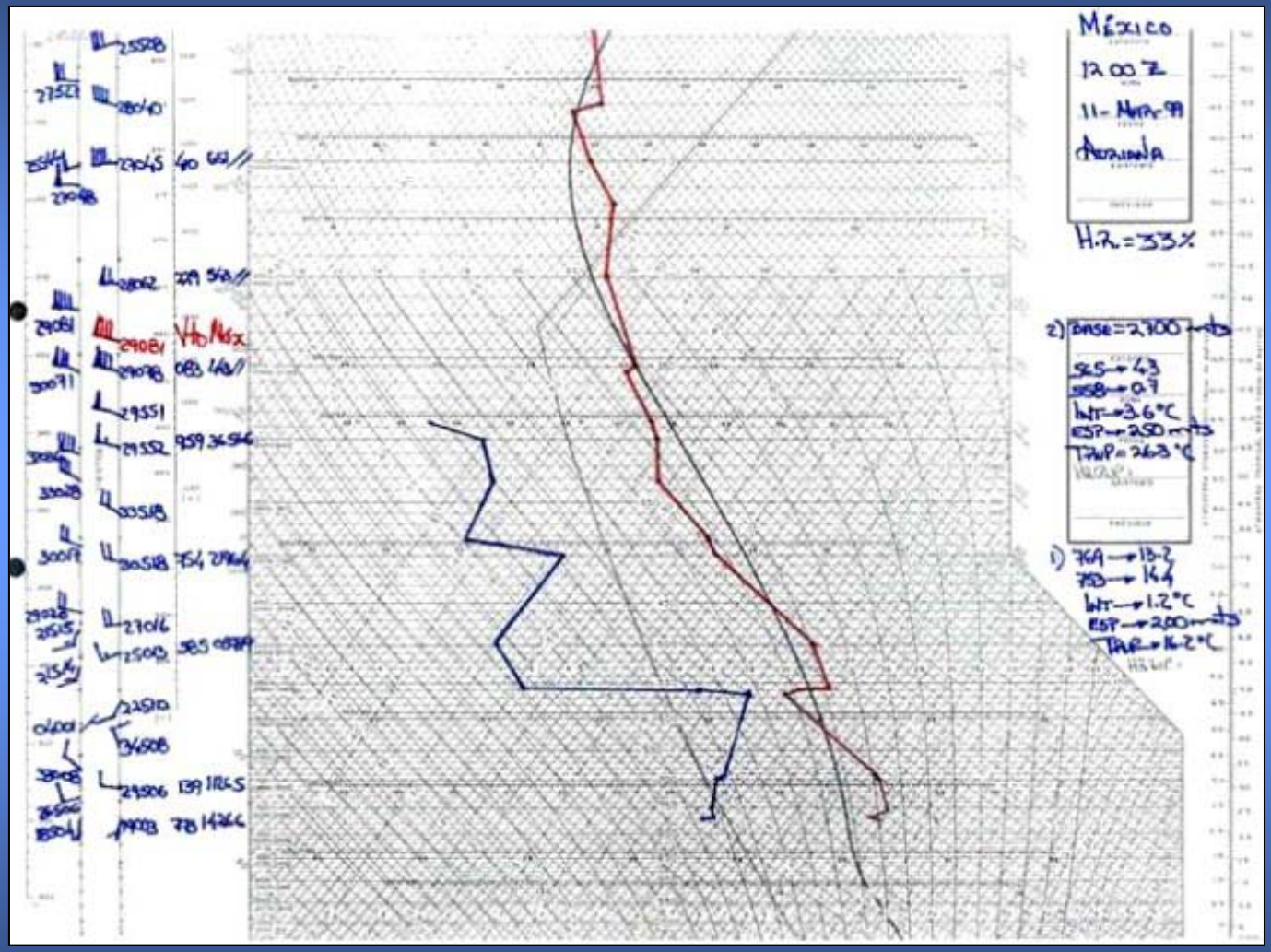
f) Will the thermail inversion dissipate during the day ?

g) How stable or inestable are the tropospheric layers ?

AUTOMATED THERMODYNAMIC DIAGRAM



HAND-MADE THERMODYNAMIC DIAGRAM



CONDITIONS FOR DISPERSION FROM THE THERMODYNAMIC DIAGRAM

ADVERSE:

- Wind profile is weak and variable, at least during the first 3,500 meters.
- The humidity is low in the profile as to not produce clouds.
- There is a strong thermail inversion that will dissipate until early afternoon
- There is a thermal inversion under 2,500 meters height.

FAVORABLE:

- Wind profile that keeps a single direction for at least 5000 meters height.
- Humidity is high with height as to produce clouds.
- A thermail inversion that will dissipate before noon.
- A thermal inversion above 2,500 meters.

SATELLITE IMAGERY

Analyses of satellite imagery sequences provide responses to the following questions:

a) How is the shape of the meteorological systems ?

b) How fast these systems move ?

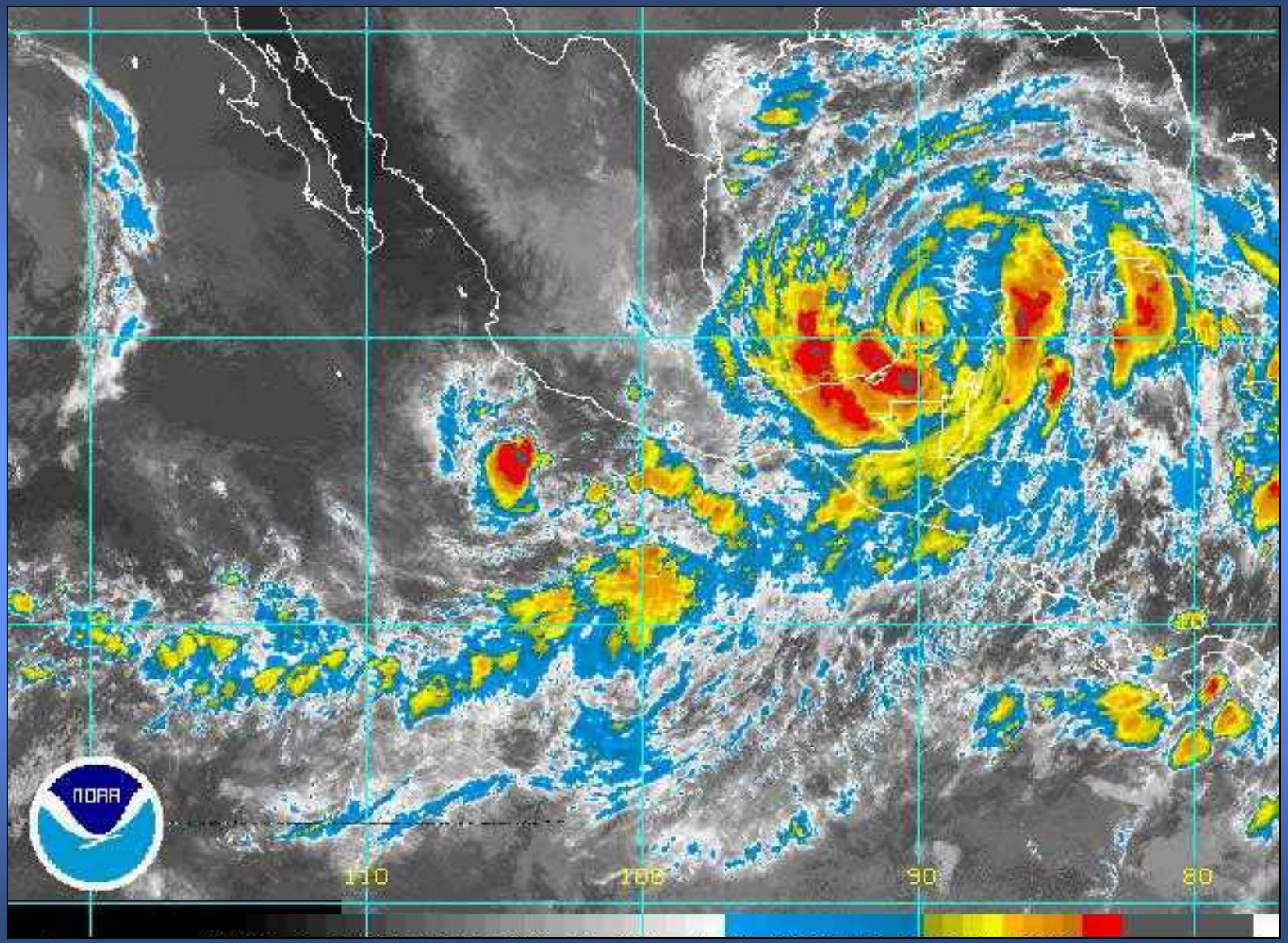
c) Where to are they moving ?

d) Are they gaining intensity or stay unchanged?

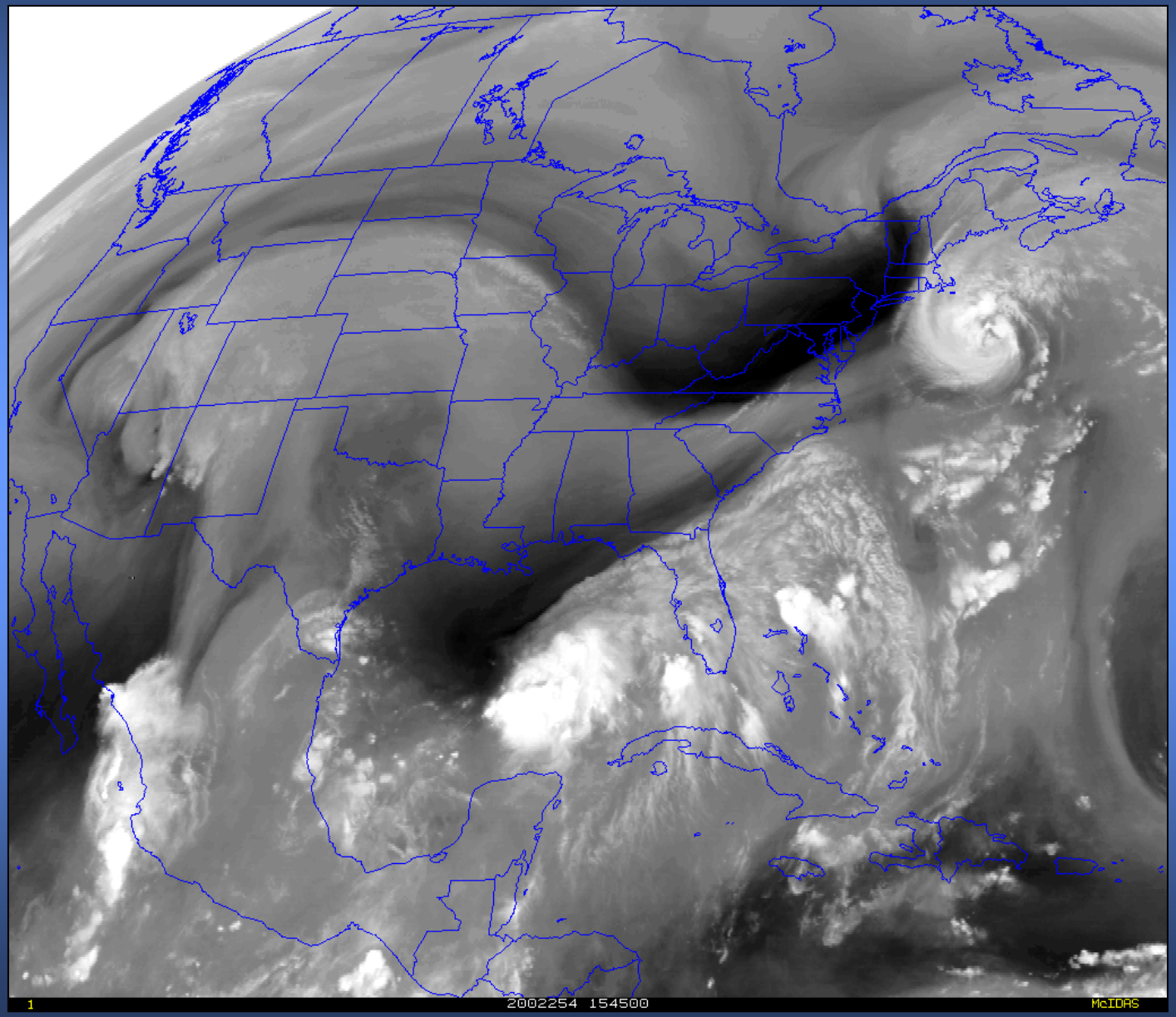
e) What meteorological system can be inferred from the imagery ?

f) How the season of the year influences the analyses of the imagery ?

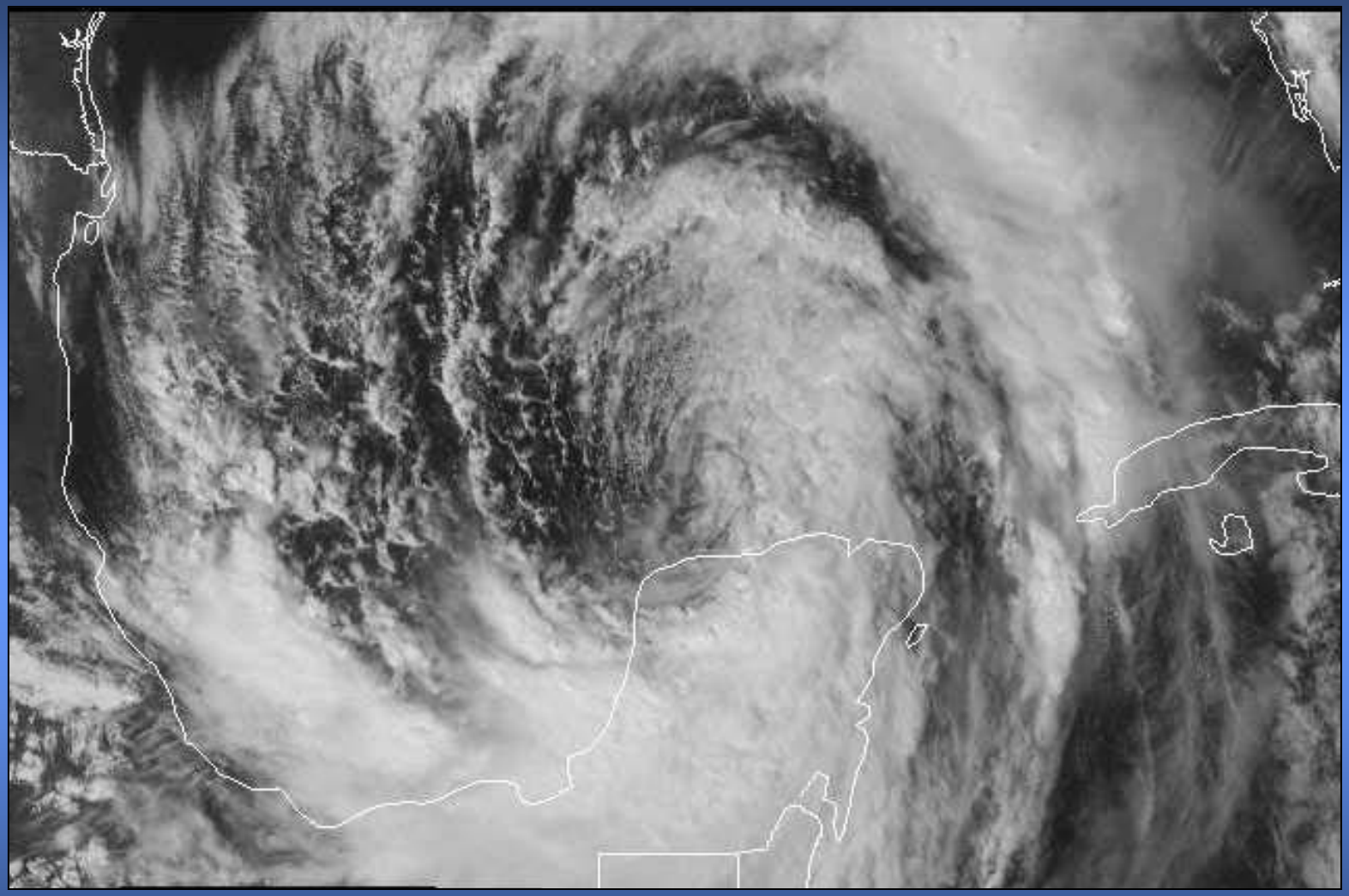
SATELLITE IMAGEN - INFRARED



SATELLITE IMAGEN - WATER VAPOR



SATELLITE IMAGEN - VISIBLE



CONDITIONS FOR DISPERSION FROM THE SATELLITE IMAGERY

ADVERSE:

- Clouds are not present or not moving to the Valley of Mexico.
- Clouds are dissipating.

FAVORABLE:

- Clouds are present or moving to the Valley of Mexico.
- Clouds will stay over the Valley of Mexico.

EARLY MORNING POLLUTANTS CONCENTRATIONS

Data analyses are conducted between 06:00 and 09:30 hours every morning focused on last day's NOx and ozone concentrations and actual NOx concentrations as ozone precursor. NOx concentrations and adverse dispersion conditions can provoke undesirable ozone concentrations later in the day.

a) Take into consideration last day NOx and ozone concentrations.

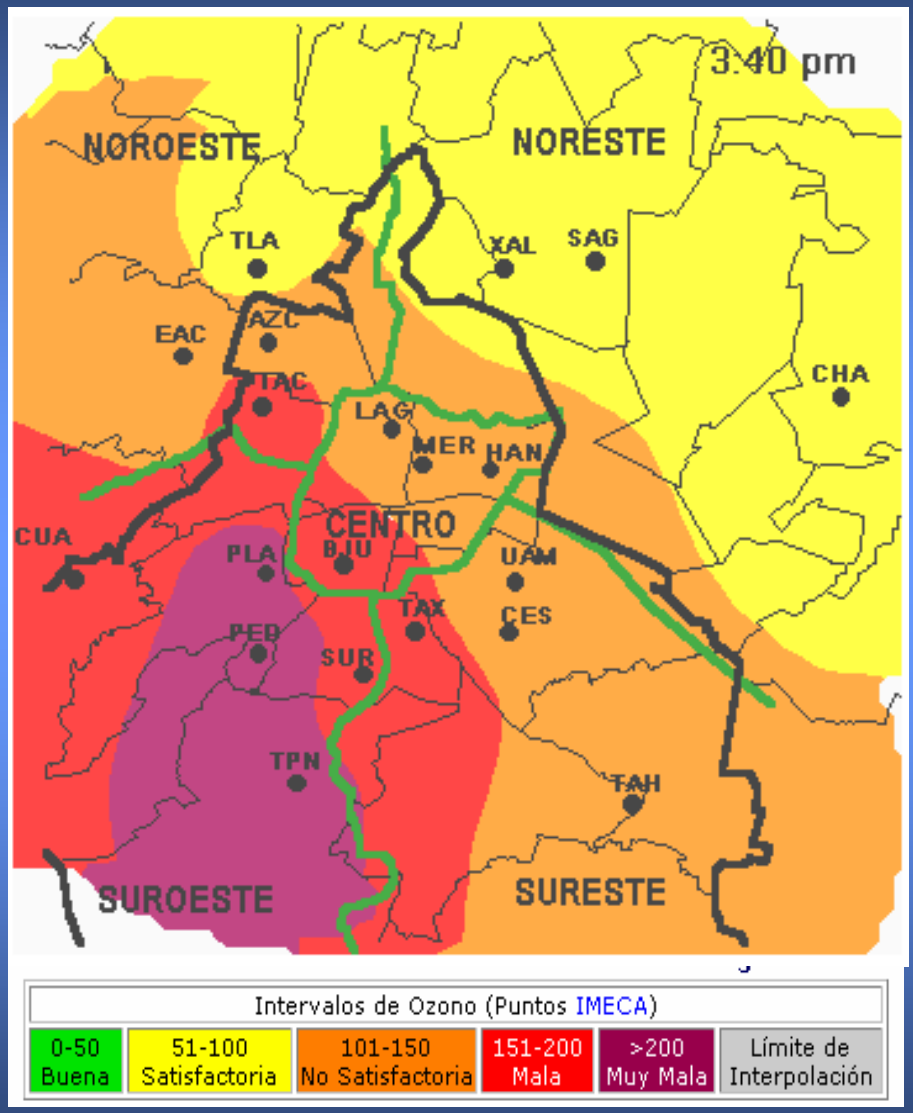
b) An actual NOx concentration is considered low if it is less than 150 ppb.

c) An actual NOx concentration is considered moderate if it lies between 150 and 250 ppb.

d) An actual NOx concentration is considered high if it is above 250 ppb.

OZONE MAP

NOx data is taken from the Ambient Air Monitoring Network ...



… as ozone data is taken for making the ozone map.

www.sma.df.gob.mx

CONDITIONS FOR DISPERSION FROM THE ANALYSES OF EARLY MORNING POLLUTANTS CONCENTRATIONS

ADVERSE:

- Yesterday ozone concentrations > 196 ppb
- Early morning NOx concentrations range 150 - 250 ppb

FAVORABLE:

- Yesterday ozone concentrations < 160 ppb
- Early morning NOx concentrations <150 ppb

WEATHER FORECASTS

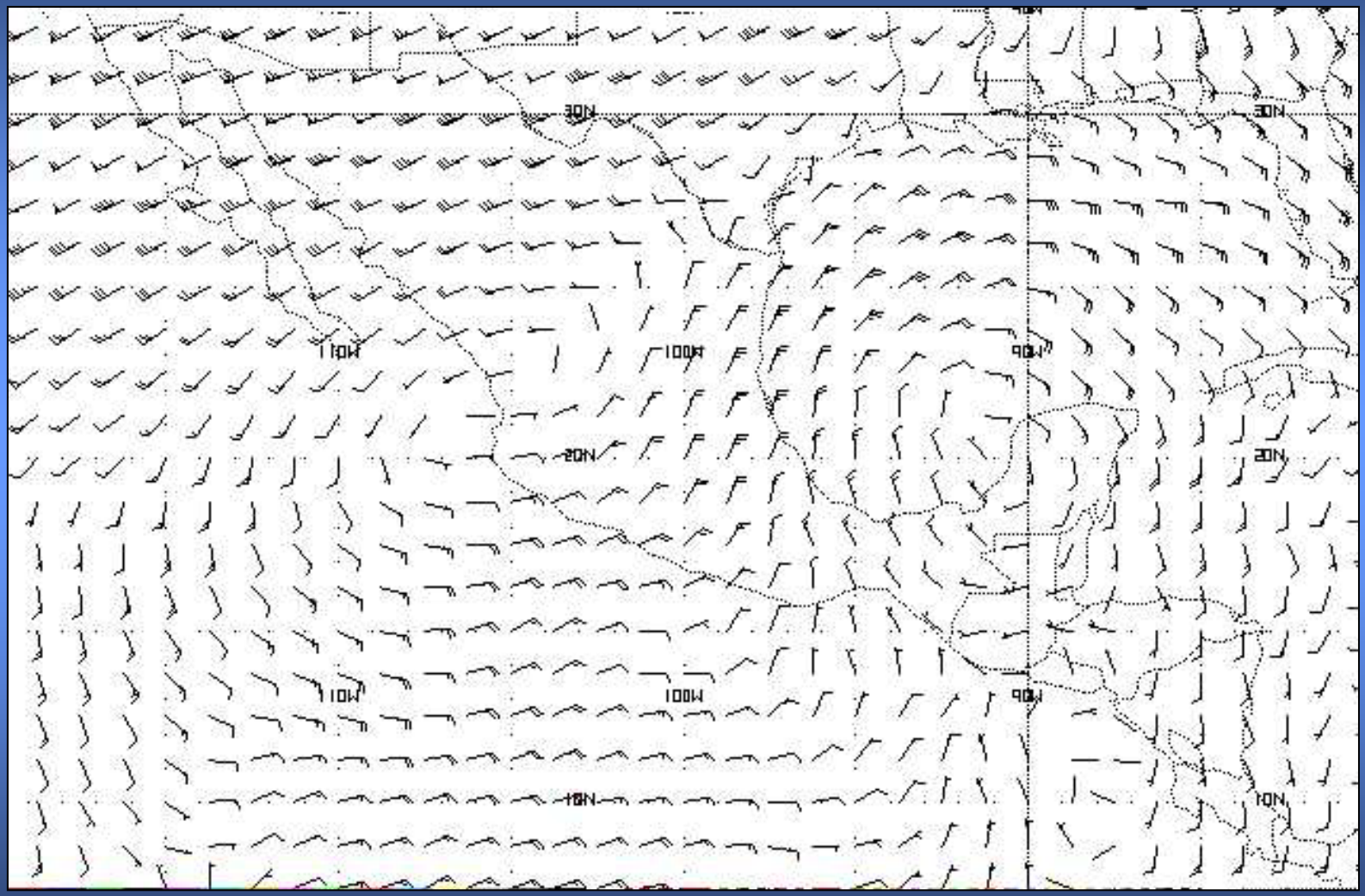
- Used forecasts derive from models such as NOGAPS, AVN (Aviation), MRF, etc.

- Most forecasts are observed through the Internet, with some exceptions as AVN.

- Meteorological parameters of interest are wind vertical velocity, relative humidity, convergence and divergence of air mases and wind speed and direction.

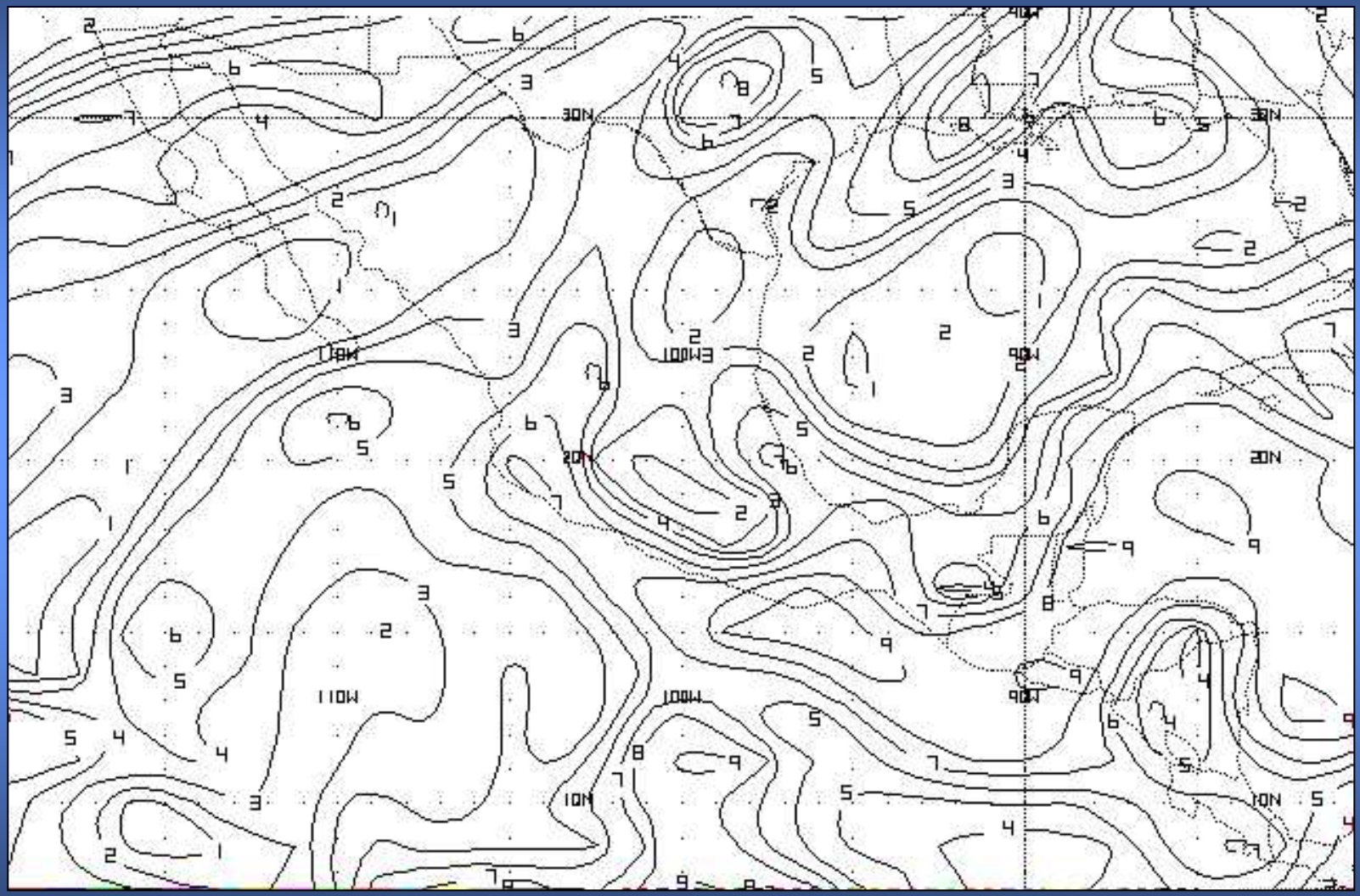
- Forecasts are presented as maps or tables.

FORECAST MAP OF WINDS AT ABOUT 1,000 m HEIGHT



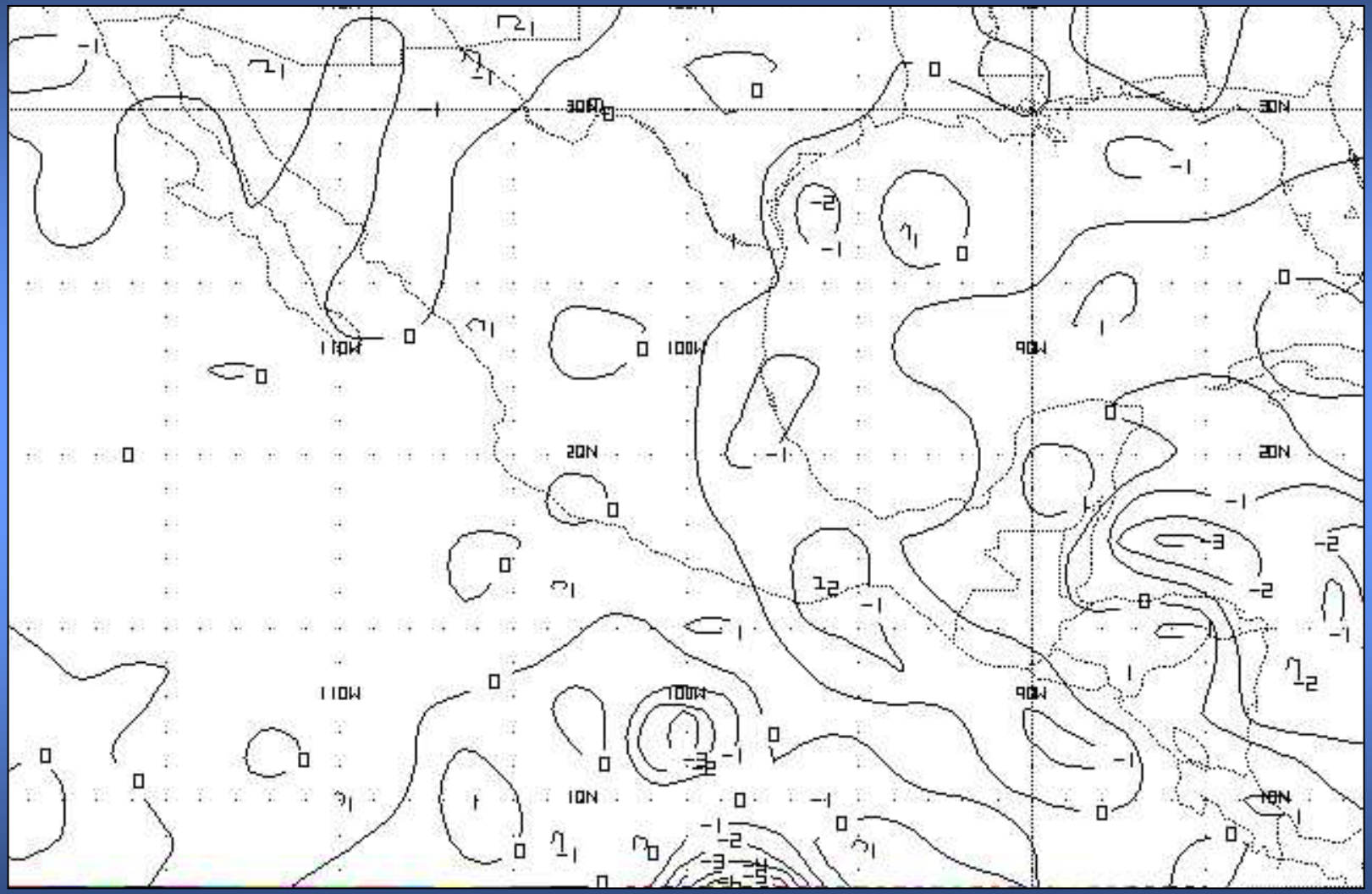
300 mb 12:00Z 24 hrs 5/Oct/2002 *AVN*

ISOPLETHS WITH RELATIVE HUMIDITY PERCENTAGE AT 10,000 m APPROX.



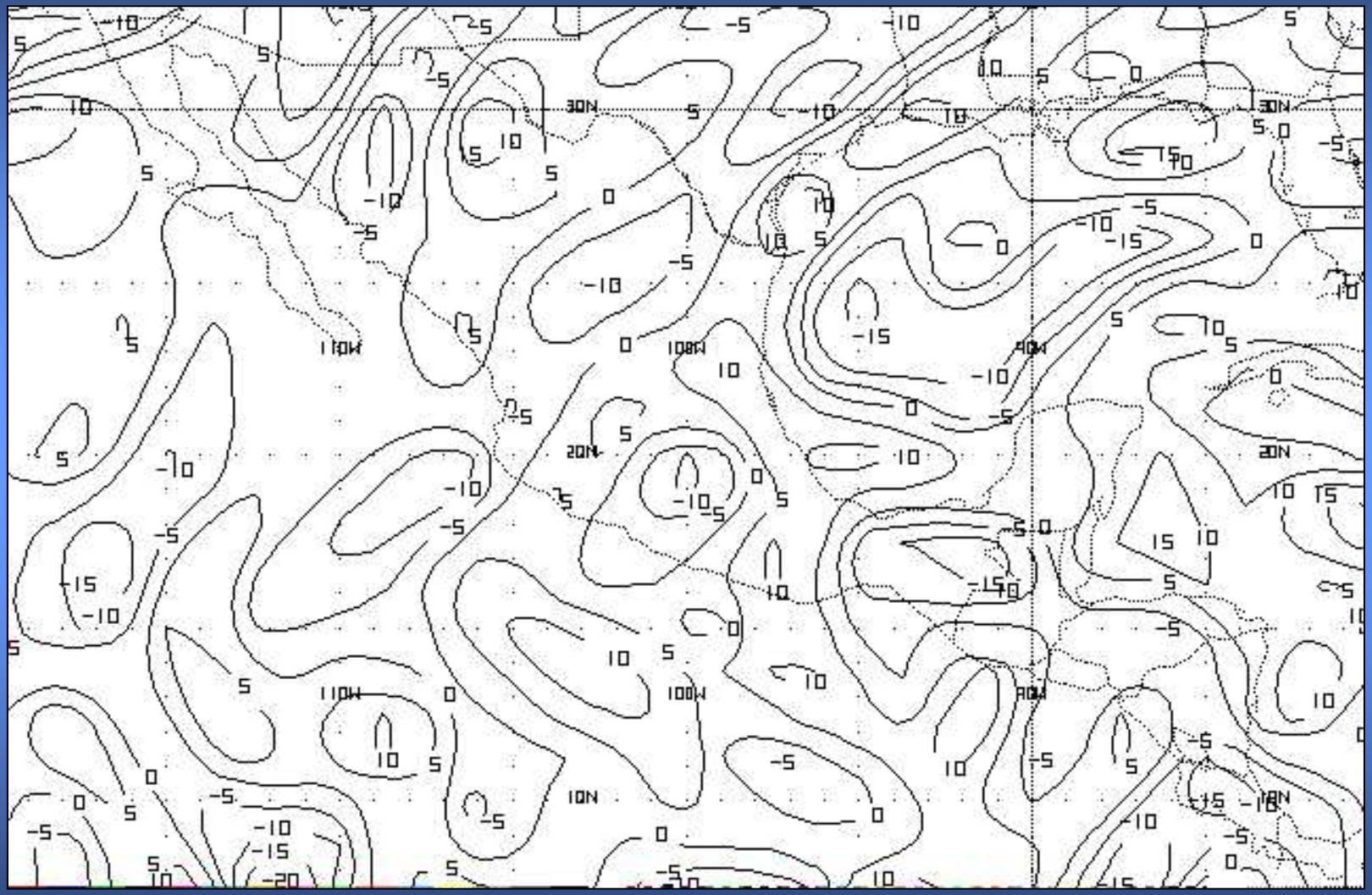
300 mb 12:00Z 24 hrs 5/Oct/2002 *AVN*

ISOPLETHS OF VERTICAL WIND SPEED AT 10,000 m APPROX.



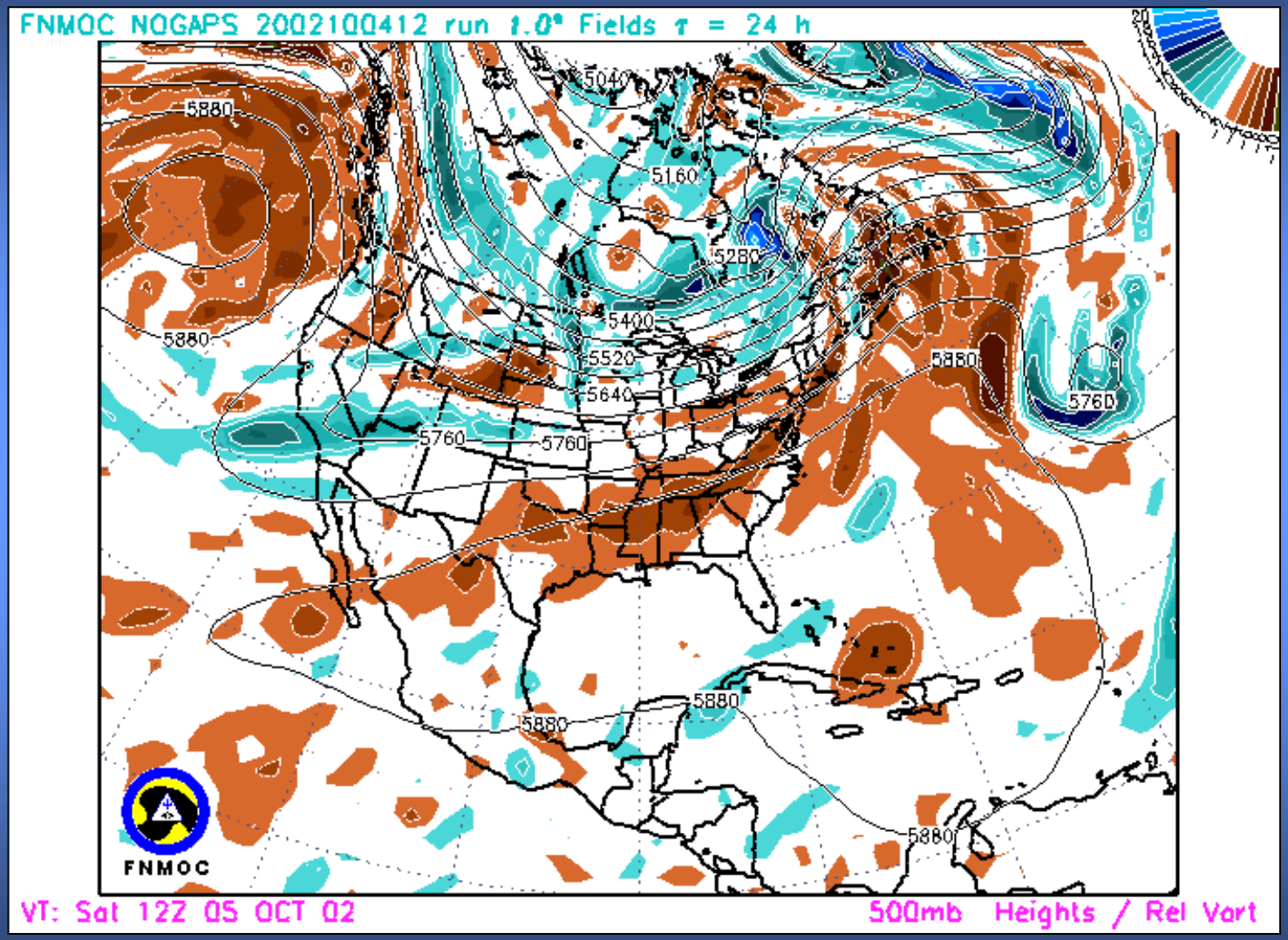
300 mb 12:00Z 24hrs 5/Oct/2002 *AVN*

ISOPLETHS OF CONVERGENCE AND DIVERGENCE AT 10,000 m APPROX.



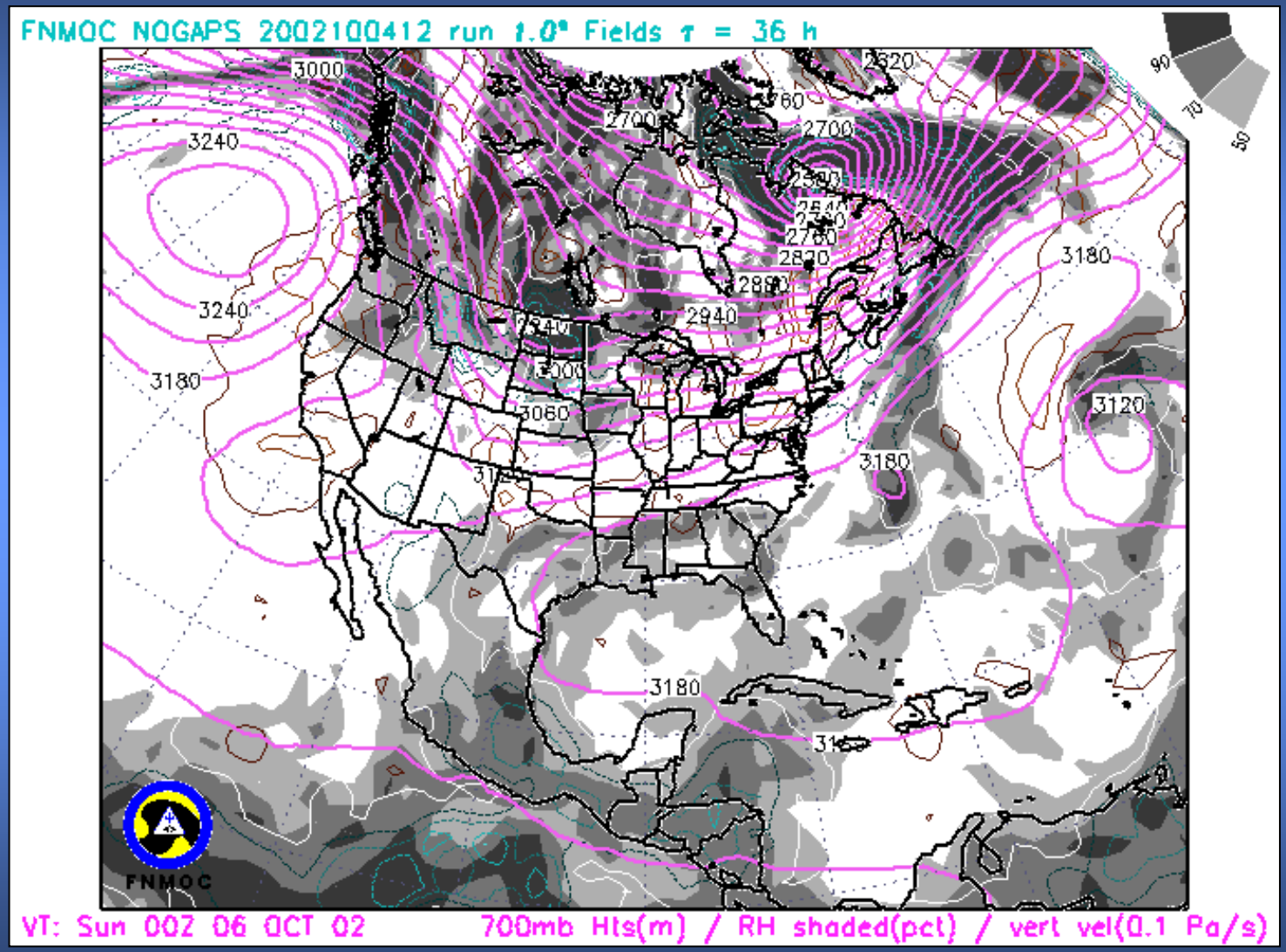
300 mb 12:00Z 24hrs 5/Oct/2002 *AVN*

METEOROLOGICAL SYSTEMS AT 5,500 m, APPROX.



500 mb. 12:00Z 24 hours 05/Oct/2002 *NOGAPS*

METEOROLOGICAL SYSTEMS AT 3,000 m, APPROX.



700 mb. 12:00Z 36 hours 06/Oct/2002 *NOGAPS*

ADDITIONAL CONSIDERATIONS FOR THE ELABORATION OF THE AIR QUALITY FORECAST IN MEXICO CITY

Air Quality Forecast is done twice a day (10:00 and 17:00 hours), 7 days a week, and considers:

1. Whether or not is Friday.
2. Whether or not is pay-day.
3. Whether or not there will be public demonstrations in the streets, pilgrimage.
4. Whether or not is daylight saving season or Christmas time.

Forecast is done on weekends and holidays as well, for which additional considerations are:

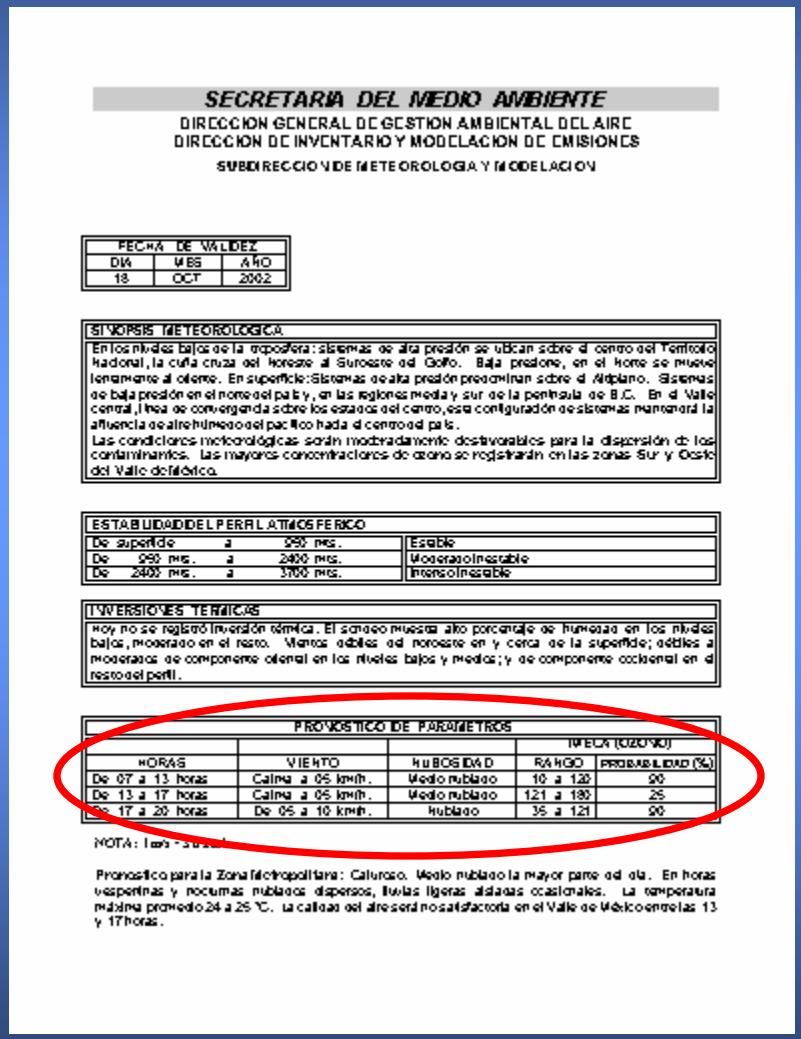
1. During weekends all vehicles are not restricted to the "*No Driving Day*" scheme, as well as holidays when it is not in force. On these days morning traffic appears a few hours after than normal days.

2. Traffic is always low on Sundays and Easter.

OZONE FORECAST

Based on analyses of the information presented before, an empirycal 24-hour ozone forecast, in terms of the Air Quality Index (IMECA) is elaborated.

Due to the nature of the meteorological phenomena a maximum percentage of probability of sucess of 90% is established.



SECRETARIA DEL MEDIO AMBIENTE

DIRECCION GENERAL DE GESTION AMBIENTAL DEL AIRE
DIRECCION DE INVENTARIO Y MODELACION DE EMISIONES
SUBDIRECCION DE METEOROLOGIA Y MODELACION

FECHA DE VALIDEZ		
DIA	MES	AÑO
18	OCT	2002

SINOPSIS METEOROLOGICA

En los niveles bajos de la troposfera: sistemas de alta presión se ubican sobre el centro del Territorio Nacional, la cuña cruza del noreste al Suroeste del Golfo. Baja presión, en el norte se mueve lentamente al oriente. En superficie: Sistemas de alta presión predominan sobre el Altiplano. Sistemas de baja presión en el norte del país, en las regiones media y sur de la península de B.C. En el Valle central, línea de convergencia sobre los estados del centro, esta configuración de sistemas mantendrá la afluencia de aire húmedo del pacífico hacia el centro del país.
Las condiciones meteorológicas serán moderadamente desfavorables para la dispersión de los contaminantes. Las mayores concentraciones de ozono se registrarán en las zonas Sur y Oeste del Valle de México.

ESTABILIDAD DEL PERFIL ATMOSFERICO

De superficie	a	990 mts.	Estable
De 990 mts.	a	2400 mts.	Moderado inestable
De 2400 mts.	a	3700 mts.	Intenso inestable

INVERSIONES TERMICAS

Hoy no se registró inversión térmica. El sondeo muestra alto porcentaje de humedad en los niveles bajos, moderado en el resto. Vientos débiles del noroeste en y cerca de la superficie; débiles a moderados de componente oriental en los niveles bajos y medios; y de componente occidental en el resto del perfil.

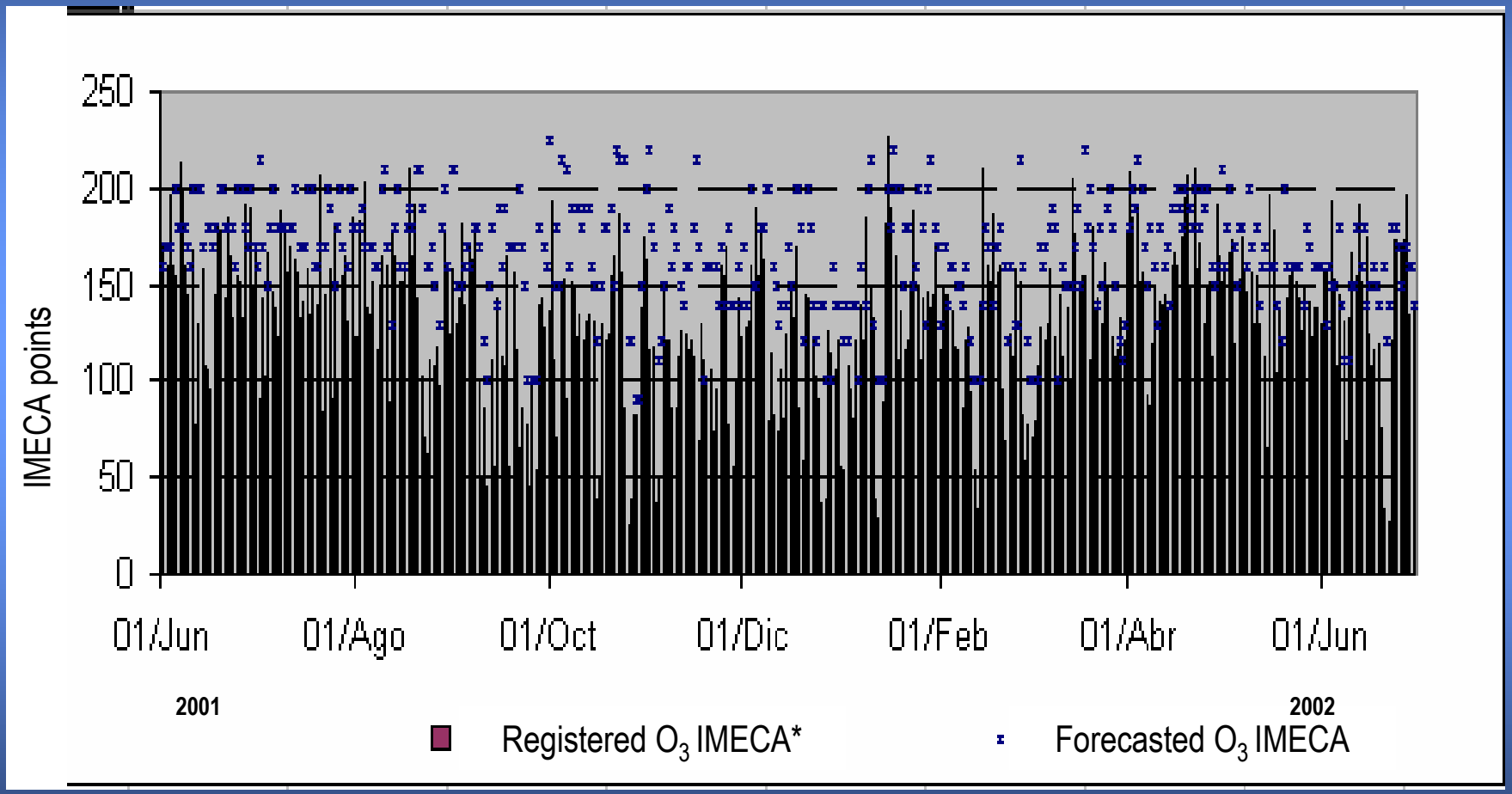
PRONOSTICO DE PARAMETROS

			IMECA (OZONO)	
HORAS	VIENTO	NUBOSIDAD	RANGO	PROBABILIDAD (%)
De 07 a 13 horas	Calma a 05 km/h.	Medio nublado	10 a 120	90
De 13 a 17 horas	Calma a 05 km/h.	Medio nublado	121 a 180	25
De 17 a 20 horas	De 05 a 10 km/h.	Nublado	35 a 121	90

NOTA: [illegible]

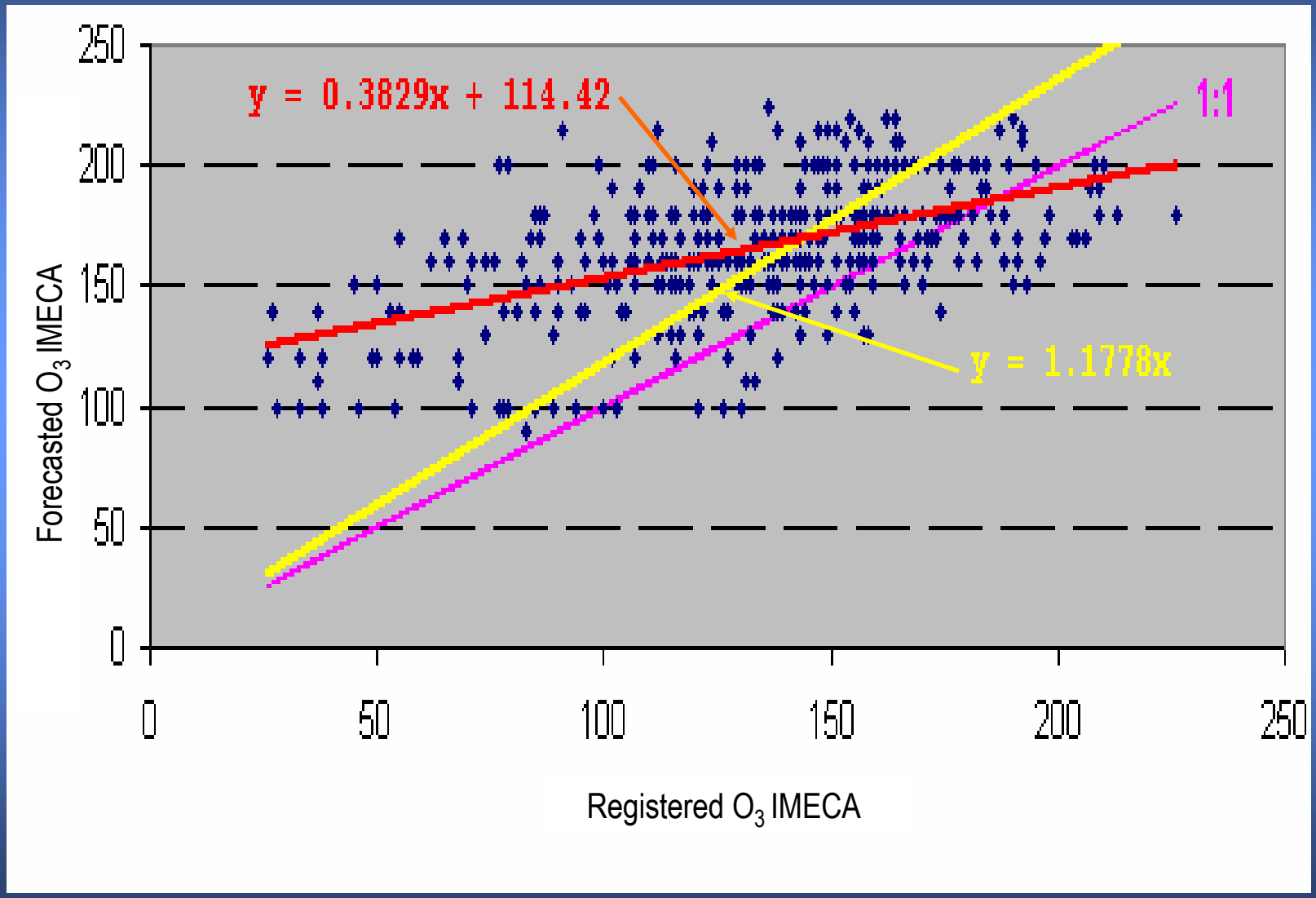
Pronostico para la Zona Metropolitana: Caluroso. Medio nublado la mayor parte del dia. En horas vespertinas y nocturnas nublados dispersos, lluvias ligeras aisladas ocasionales. La temperatura maxima promedio 24 a 26 °C. La calidad del aire será insatisfactoria en el Valle de México entre las 13 y 17 horas.

OZONE FORECAST

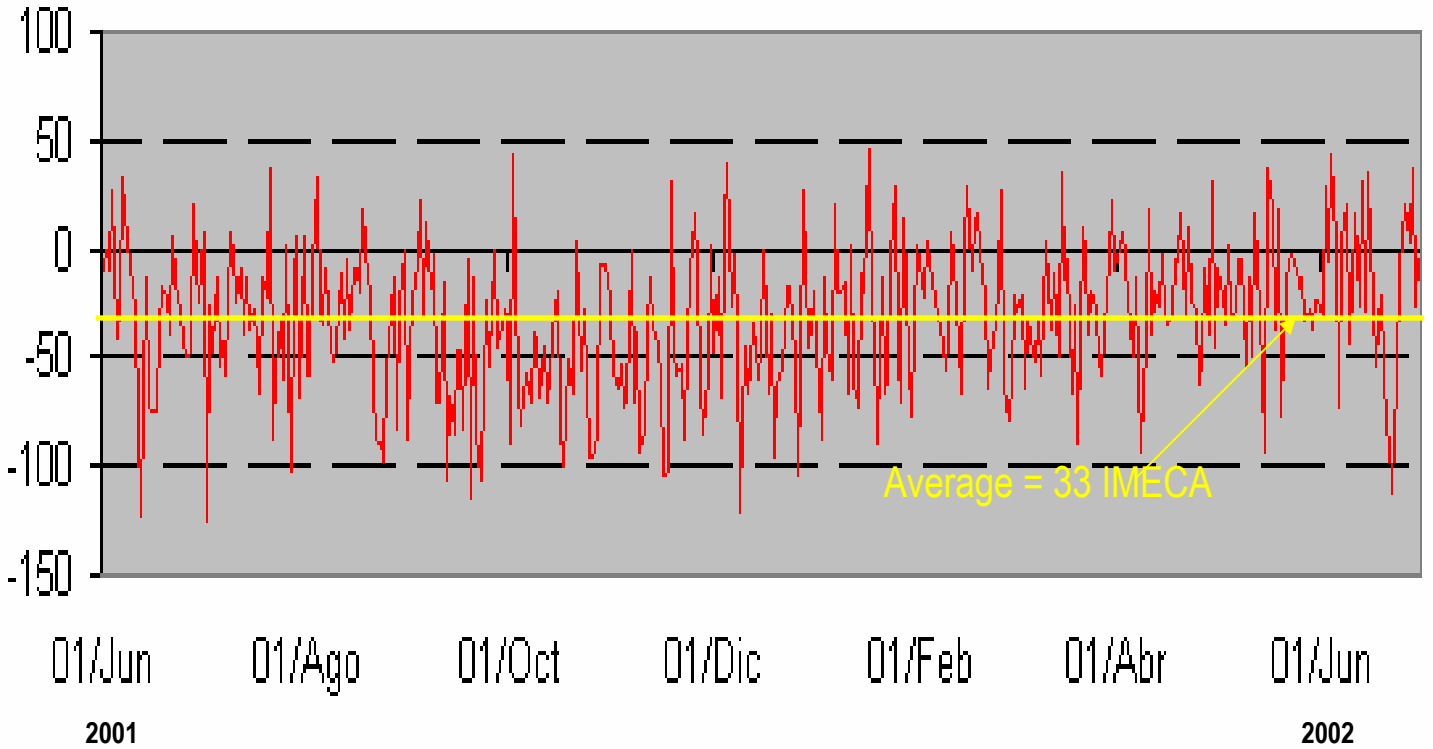


* By the Ambient Air Monitoring Network (RAMA)

OZONE FORECAST



OZONE FORECAST



Thank You For Your Attention

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