31 Jan 2003
rmm

Problem Set 1 Atmo 445/545 Due Feb 5

You will have to study the links on the class web page

3(4)

1- Answer the following questions for the National Weather Service WSR-88D Weather Radar

a) What is the power output at the klystron 750 KW KW

b) What is the power loss from the klystron to the antenna feed 275 KW KW

2dB dB

Antenna Power = 475 KW

c) If the first side lobe, relative to the antenna power transmitted, is -29 dB then the power in side lobe is .598 KW 598 W

d) Calculate the shortest and longest unambiguous ranges if the radar is operating in short pulse mode

115 Km to 472 Km Km

Note: You'll have to look ahead to pp 105 - 106 in the text

:) If the pulse duration is 2 μs then the pulse length is 600 mm m

:) If the pulse duration is 2 μs and the PRF is 500 Hz, calculate the following - Assume the antenna rotation rate is 1 RPM (revolution per minute) -

The amount of time the antenna is transmitting power during 1 revolution .065 s

The amount of time the antenna is receiving power during 1 revolution 59.945 s

3 orders of magnitude difference!

2- Consider a police traffic radar gun, as typified by the Astroproducts "Phantom" radar

5(6)

a) Power transmitted range is 10 to 20 mW mW

b) Beam width is ~12 degrees

c) Pulse length is Zero m

Continuous Wave

Or "trigger" time X c = length for a single shot or pulse

.) MAXIMUM RANGE AT WHICH THE BEAM DIAMETER IS ≤ THE WIDTH OF AN INTERSTATE TRAFFIC LANE (CONSIDER A TRAFFIC LANE TO BE 3m wide)

~24 m

:) A HIGHWAY PATROL OFFICER "CLOCKS" you speeding at 90mph along I-10 NW of TUCSON. SHE STATES THAT THE READING IS COMPLETELY ACCURATE. DESCRIBE All THE CONDITIONS THAT MUST BE MET FOR HER TO MAKE THIS STATEMENT.

Looking For:

* RADAR GUN CALIBRATED AND WORKING PROPERLY

* RADAR GUN POINTED DIRECTLY HEAD ON- NO ANGLES

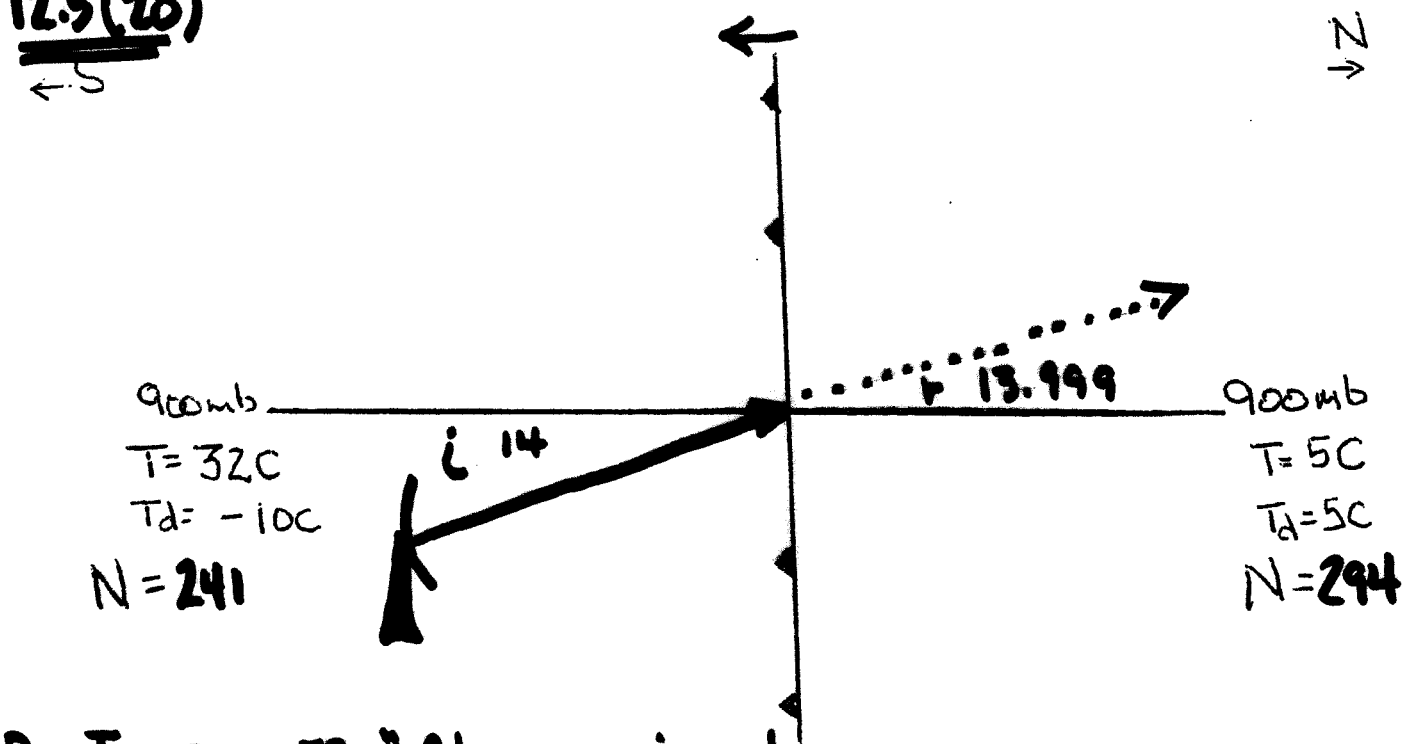
* NO other MOVING TARGETS IN radar beam

* NO UNUSUAL or EXTREME ATMOSPHERIC CONDITIONS

3- BEAM PROPAGATION AND ATMOSPHERIC REFRACTION

a) A VERY STRONG COLD FRONT IS APPROACHING (MOVING AWAY FROM) A WSR88-D RADAR AT 20 m/s. THE RADAR IS OPERATING IN VCP-11. THE CENTER OF ONE OF THE TRANSMITTED BEAMS INTERSECTS THE FRONT AT 900 MB AT ANGLE OF 14 degrees RELATIVE TO HORIZONTAL. WHAT IS THE ANGLE OF REFRACTION FOR THE FRONT APPROACHING ~13.999 degrees AND FOR THE FRONT MOVING AWAY ~14.001 degrees?

12.5(20)



RE: TEXT P. 55 " Changes in refraction are usually much stronger in vertical directions than in horizontal directions."

SKETCH, IN RED, ONE OF YOUR ANSWERS ON THE ABOVE DIAGRAM. CONSIDER THE FRONT TO BE A SINGULAR, VERTICAL DISCONTINUITY WITH THERMODYNAMIC CONDITIONS ON EITHER SIDE AS INDICATED ON DIAGRAM

3b 12.5(20)

b) CONSIDER JOE FLETCHER'S ACCOUNT OF FLYING OVER THE OCEAN "looking" for a RESEARCH RADAR'S BEAM IN HIS PAPER ON THE HISTORY of RADAR. IF THAT RADAR BEAM WERE completely TRAPPED (OR "DUCTED") AT AND BELOW 100m MSL, THE TEMPERATURE AT 100m MUST HAVE BEEN AT LEAST ~10 C.

OTHER CONDITIONS OF IMPORTANCE WERE:

WARM, DRY AIR WAS blowing FROM THE LAND OVER THE OCEAN, WHICH HAD AN SST of 10C.

THE AIR AT THE SEA SURFACE HAD T= 10C AND RH = 100%.

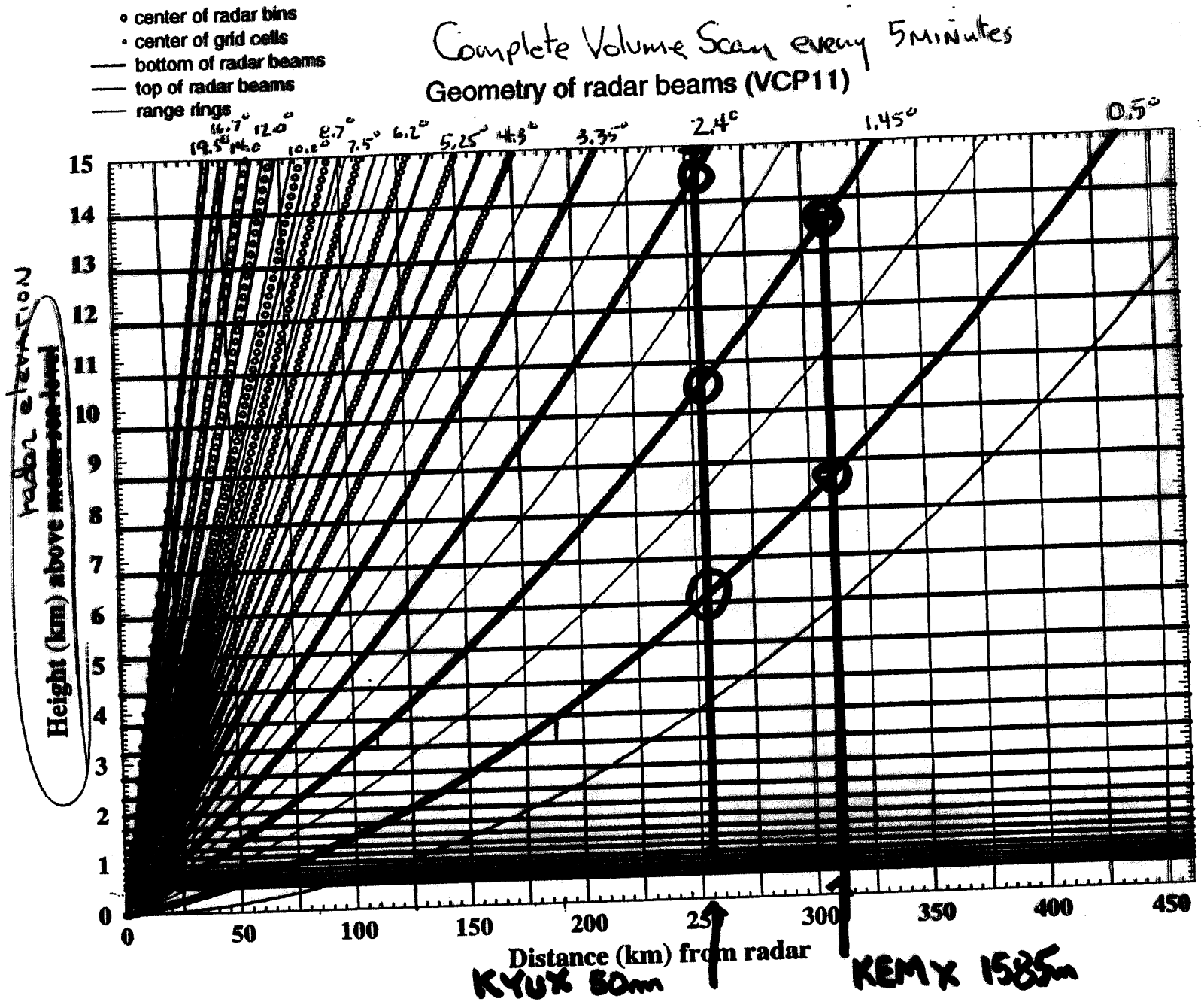
THE AIR AT 100m HAD a MIXING RATIO of 6 g/kg. NOTE this means $T_{900} \geq 6.2\,^{\circ}C$

SEA LEVEL PRESSURE WAS 1000mb AND PRESSURE DECREASED 1mb/10m with HEIGHT.

$N_{1000} \cong 332$ Nunits

if $\Delta N/\Delta H \leq -157$ Nunits/km

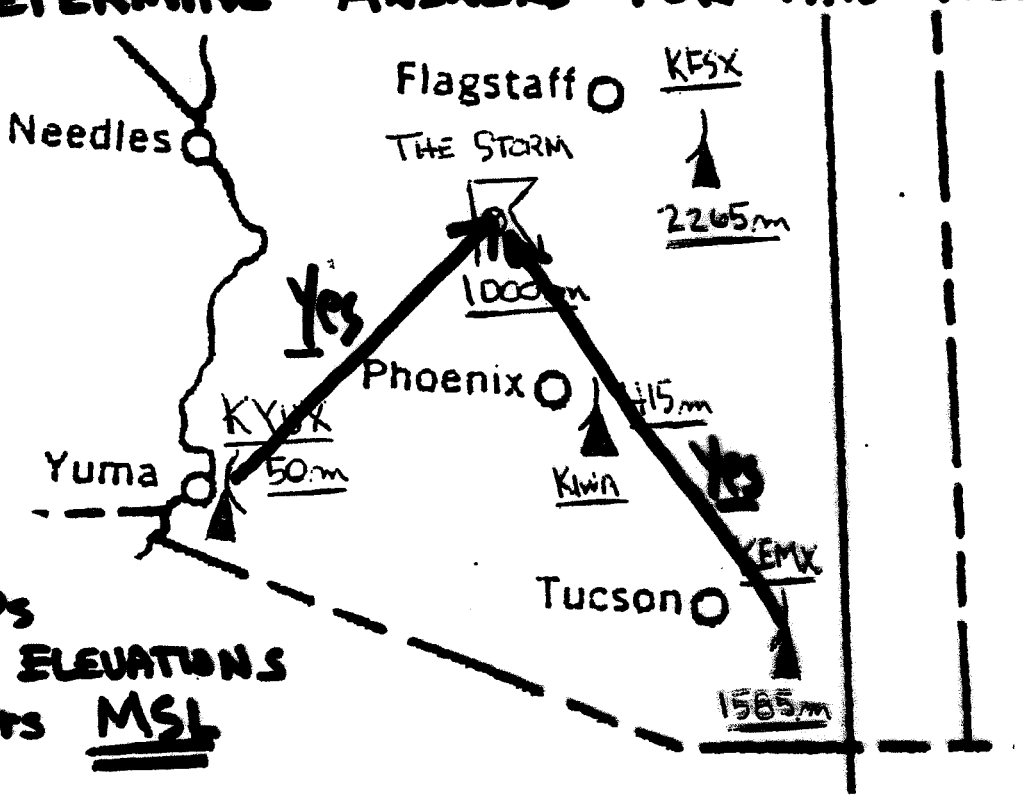
THEN $N_{990} \leq 316$ Nunits


center of radar bins
center of grid cells
bottom of radar beams
top of radar beams
range rings
Complete Volume Scan every 5 Minutes
Geometry of radar beams (VCP11)
19.5° 16.7° 14.0° 12.0° 10.2° 8.7° 7.5° 6.2° 5.25° 4.3° 3.35° 2.4° 1.45° 0.5°
Height (km) above mean sea level
radar elevation
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
0 50 100 150 200 250 300 350 400 450
Distance (km) from radar
KYUX 80nm
KEMX 155nm

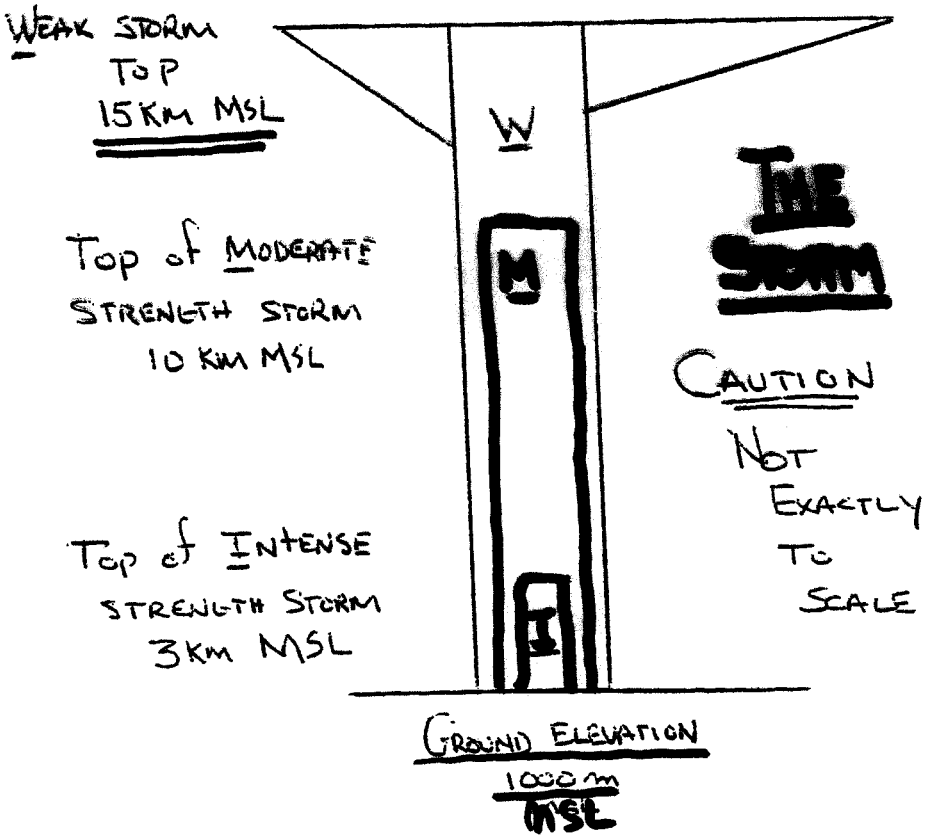
Prob Set 1 5

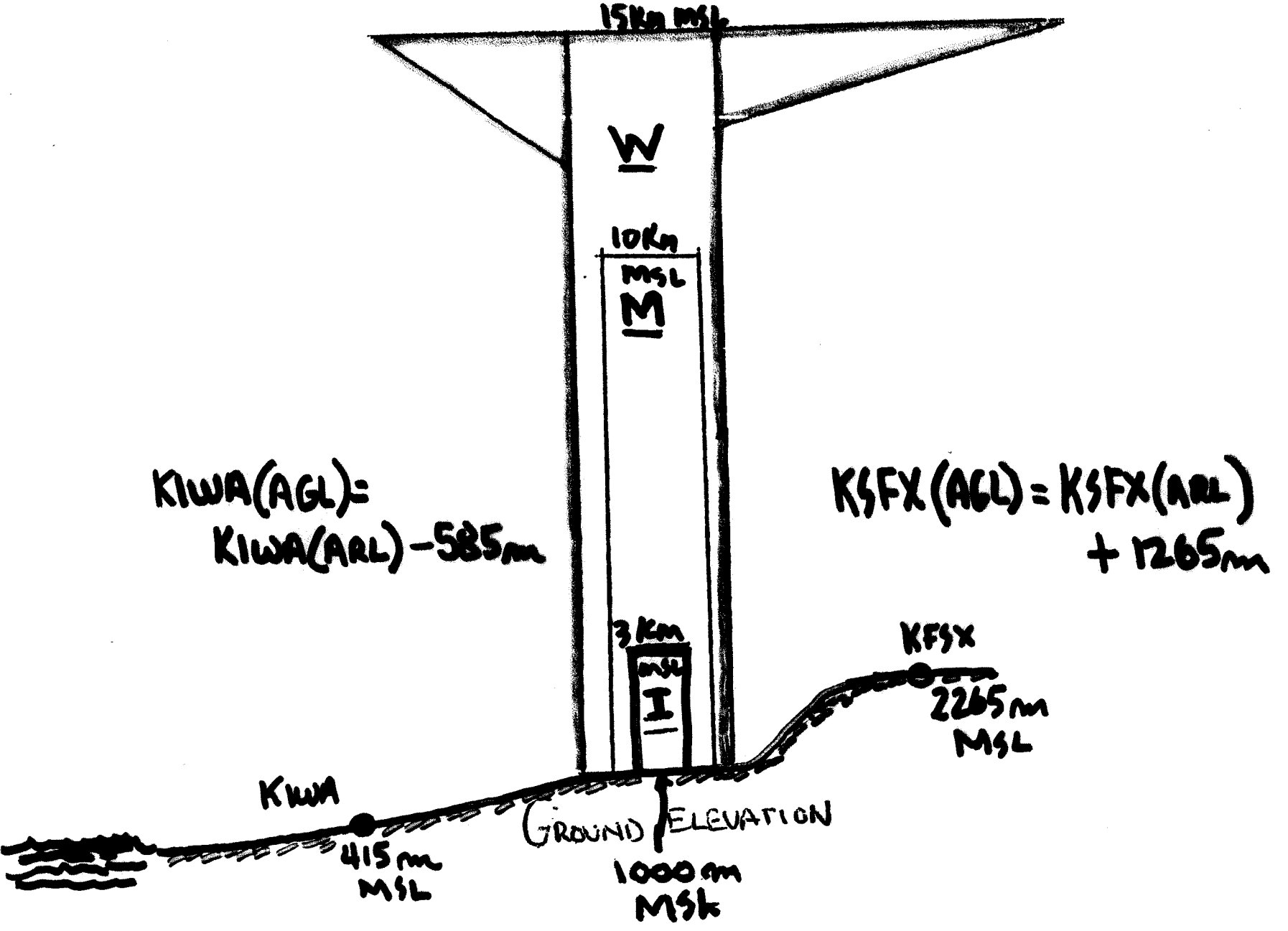
25 (40)

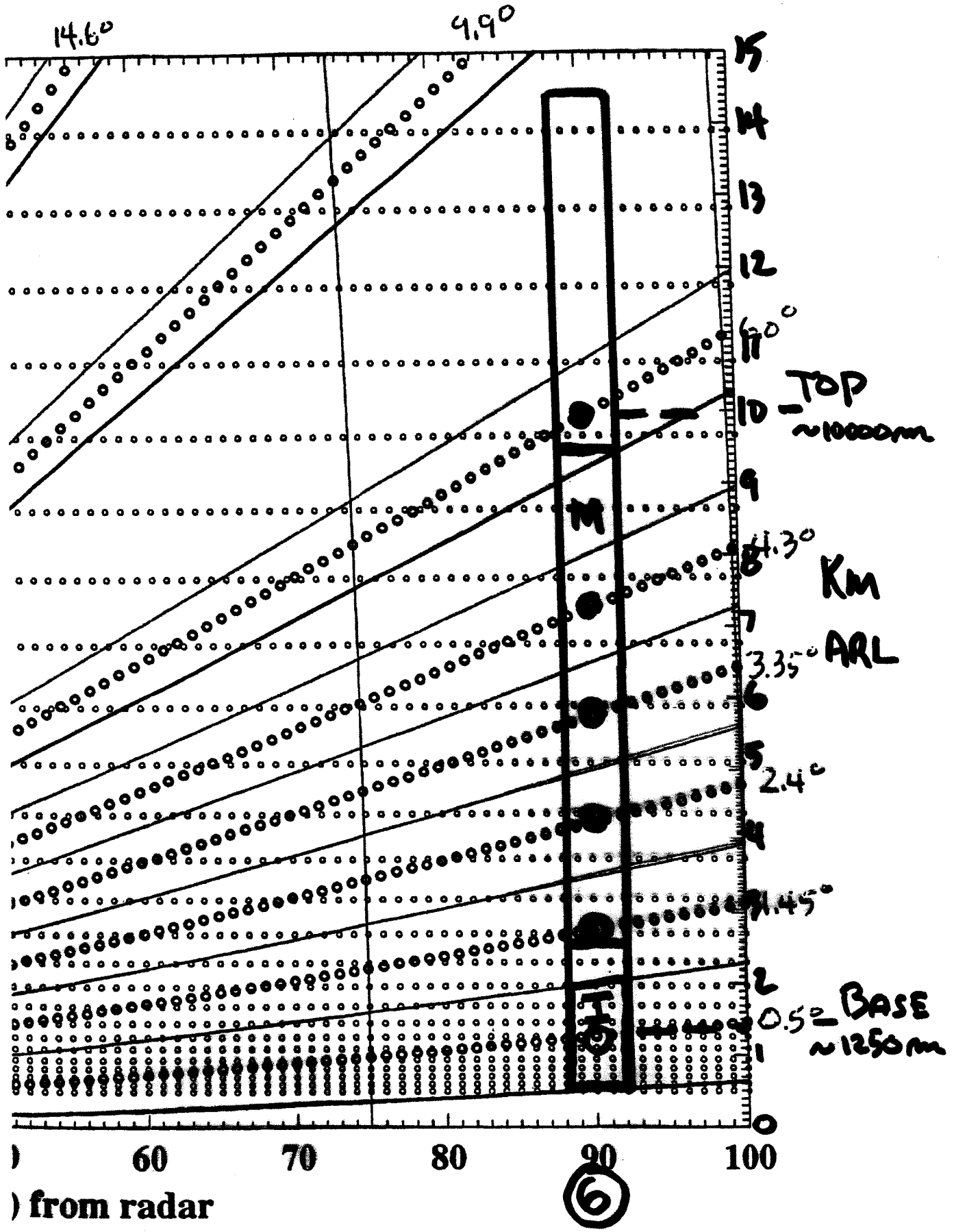
USE THIS MAP AND THE STORM DRAWING TO DETERMINE ANSWERS FOR THIS QUESTION.



ARIZONA WSR-88Ds ANTENNA ELEVATIONS IN meters MSL

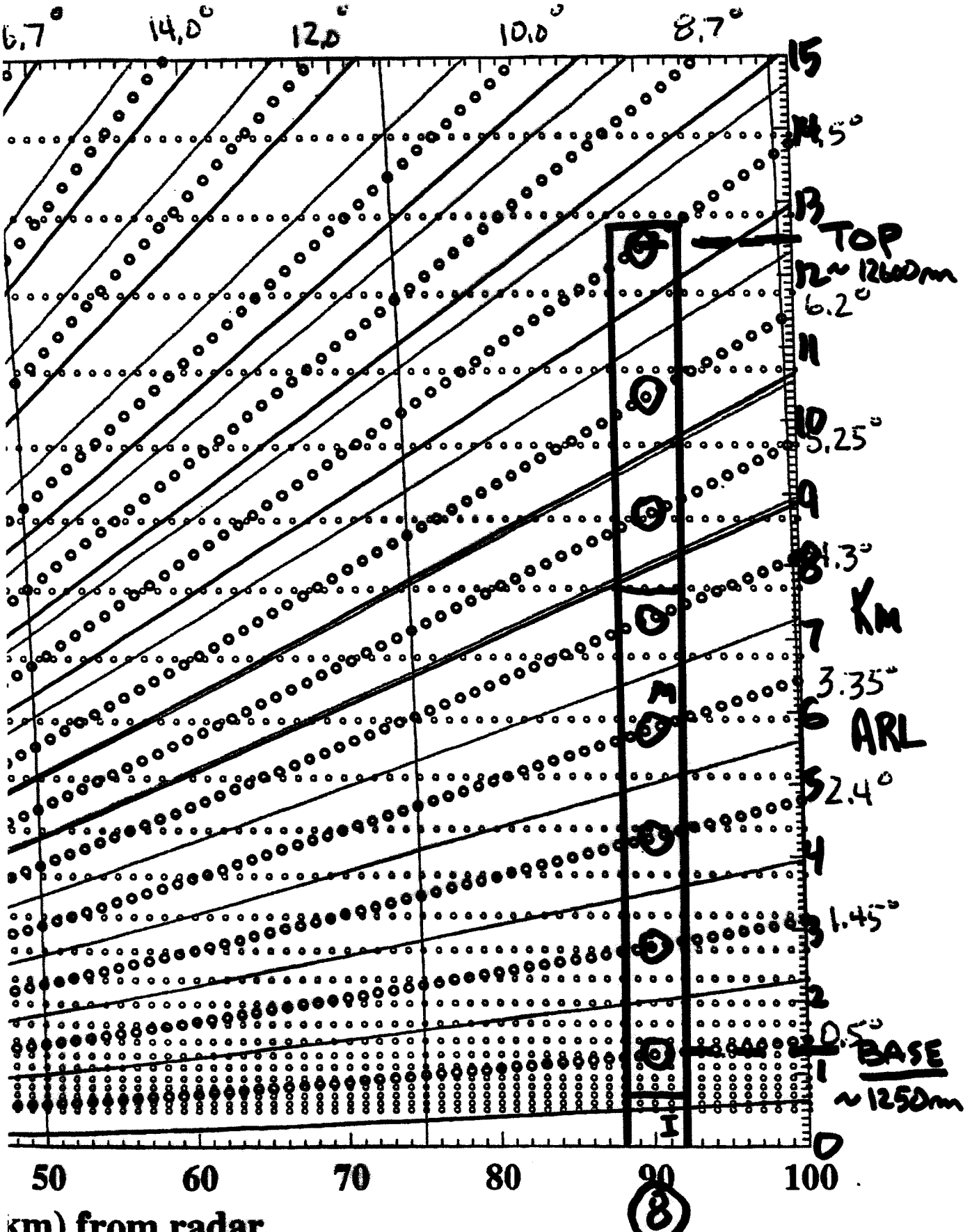



15Km MSL
W
10Km
MSL
M
3Km
MSL
I
KIWA(AGL)=
KIWA(ARL) - 585m
KSFX(AGL) = KSFX(ARL)
+ 1265m
KFSX
2265m
MSL
KIWA
415m
MSL
GROUND ELEVATION
1000m
MSL



KIWA
VCP-21

KIWA(AGL) = KIWA(ARL) − 585m


6.7°
14.0°
12.0°
10.0°
8.7°
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
14.5°
TOP
~12600m
6.2°
5.25°
4.3°
KM
3.35°
ARL
2.4°
1.45°
0.5°
BASE
~1250m
50
60
70
80
90
100
km) from radar
KFSX
VCP-11
KBX(AGL) = KSFX(ARL)
+1265m

#4

OTHER DETAILS

THE STORM IS LOCATED FROM EACH RADAR AT RANGE OF: KFSX 90 Km KIWA 90 Km KYUX 255 Km

KEMX 310 Km KFSX IS OPERATING IN VCP11

KIWA IS OPERATING IN VCP21

RADARS CAN "DETECT" STORM ECHO IF AT LEAST HALF THE BEAM IS FILLED BY STORM. RADARS DETECT INTENSITY LEVELS ONLY IF ENTIRE BEAM FILLED BY THAT INTENSITY OF STORM. "HEIGHTS" of ALL STORM FEATURES DETERMINE BY HEIGHTS OF RADAR BEAM CENTERS. ASSUME "STANDARD" REFRACTION. ARL = HEIGHT ABOVE RADAR ANTENNA ELEVATION AGL = HEIGHT ABOVE ground surface AT STORM LOCATION.

DETERMINE THE FOLLOWING

	KIWA		KFSX	
STORM BASE	~1250 mARL	~665 mAGL	~1850 mARL	~2515 mAGL
STORM TOP	~10000 mARL	~9415 mAGL	~12600 mARL	13865 mAGL
MAX STORM STRENGTH	I		M	

BONUS KYUX Yes KEMX Yes

Note: STORM "BASE" is lowest height of radar detected Storm Echo

STORM "TOP" is highest height of radar detected Storm Echo