


Fog Forecasting

UPS Airlines Conceptual Models and Forecast Methods

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Fog Forecasting

UPS Step Approach to Fog Forecasting

RADIATIONAL FOG: The use of the crossover method.




Fog Forecasting

Six Step approach:

1. Crossover temperature
2. Forecast temperature/low
3. Estimate or knowledge of ground temperature
4. Knowledge of cloudiness
5. Forecast “mixy-ness”
6. Make the forecast

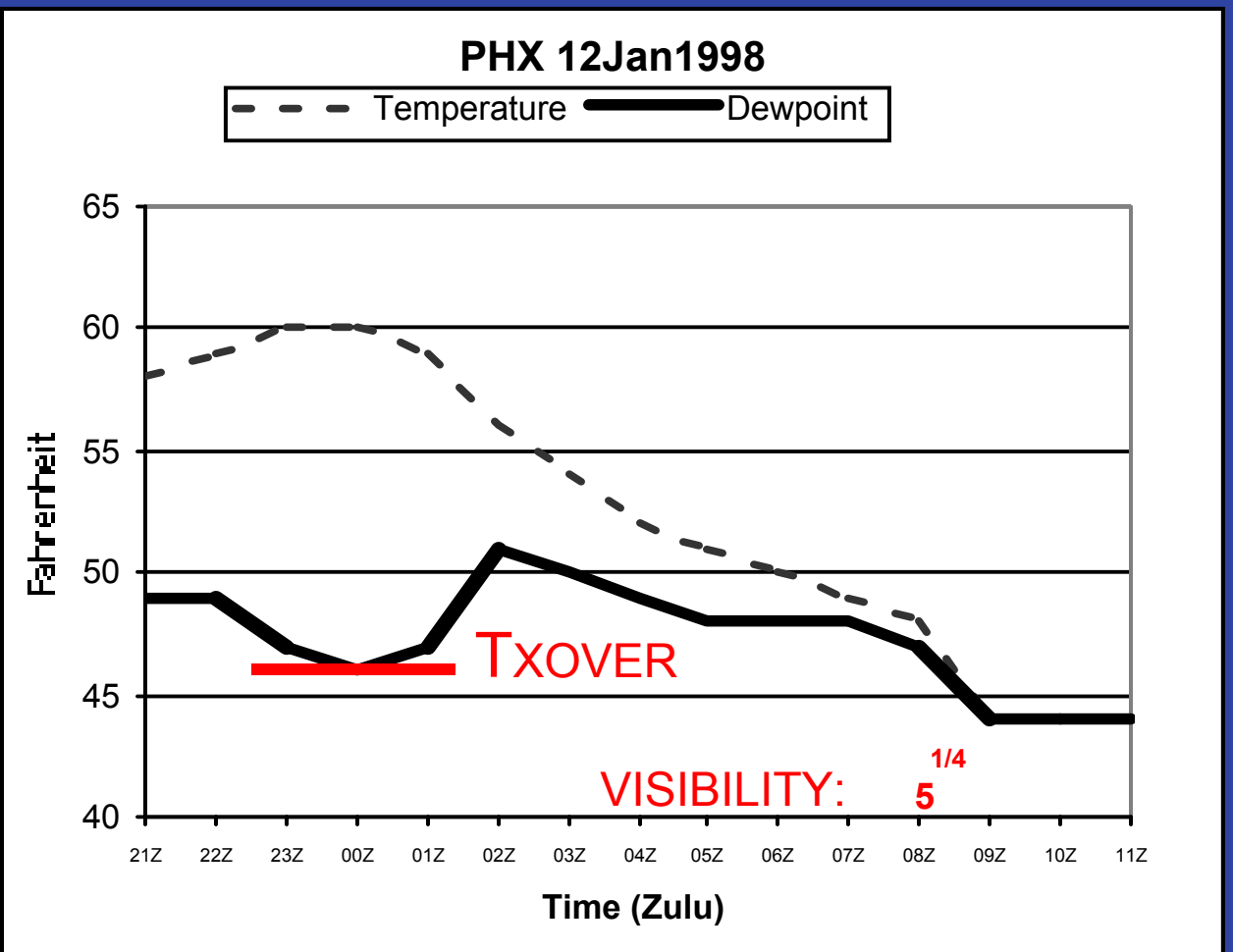



Fog Forecasting

Step 1: Determine an appropriate crossover temperature

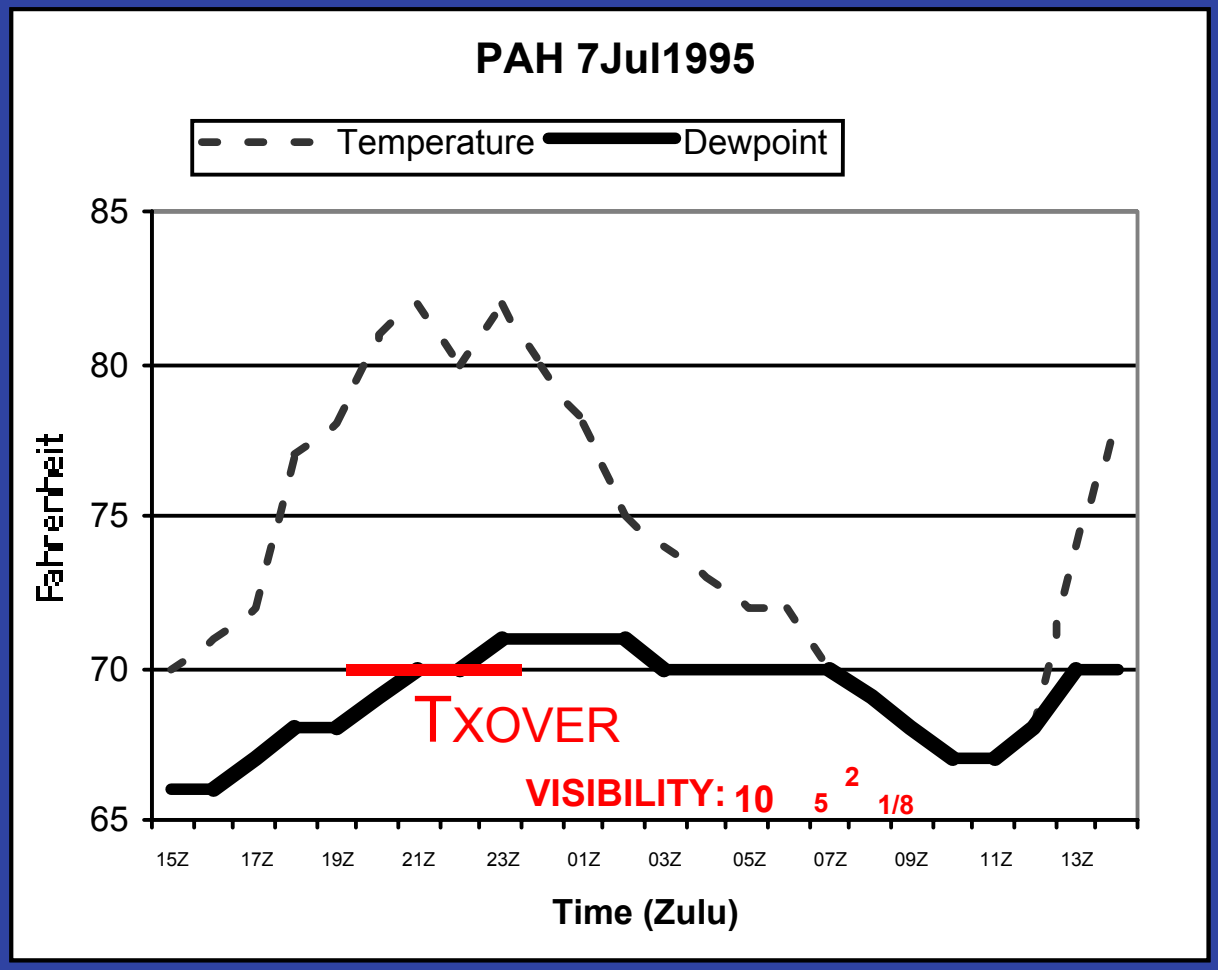
1. Usually the dewpoint temperature at the high temp
2. May use local skew-t data to make adjustments
3. After rain, use dewpoint registered when wind first goes light after sunset
4. Valley locations: use the dewpoint registered about 1 hour after sunset
5. Coastal locations: if the flow shifts to an onshore flow in the evening, use a value you feel represents the new boundary layer

Fog Forecasting



An example of a more typical crossover pattern, where the dew point drops during the warmest part of the day. The crossover temperature would be 46°F. At 0756Z, the visibility was 5 miles with a temperature of 48°F, dew point 47°F. At 0824Z the temperature was 45°F, dew point 45°F, with visibility 1/4 mile.

Fog Forecasting






Fog Forecasting

Step 2. Forecast temperature

1. Use model data of your choice

2. May be the most difficult variable to forecast

Fog Forecasting

Step 3. Ground temperature

1. Use any local sensors

2. Estimate (seasonal)




Fog Forecasting

Step 4. Forecast Cloudiness

1. Most clouds will ruin the radiative imbalance you want

2. May be the most difficult variable to forecast




Fog Forecasting

Step 5. Forecast the “mixy-ness”

1. Use the Modified Richardson Number
2. Use model data of your choice




Fog Forecasting

We use a modified version of the Richardson number (MRi) as follows:

$$MRi = (T_b - T_{sfc}) / (u)^2$$

Where:

T_b = T1 or T3 (whichever is warmer) on FOUS60/ETA output.

T_{sfc} = forecast minimum temperature (°c)

u = boundary layer wind speed (FF from ETA/NGM (knots))




Fog Forecasting

```
Modified Richardson Number example
OUTPUT FROM NGM 12Z JAN 11 98
TTPTTR1R2R3 VVVLI PSDDFF HHT1T3T5
PHX//755013 -0603 180206 50100497
06000563935 -1007 180105 53110499
12000433561 01206 172606 54130600
18000492447 -0506 173211 54120501
24000545545 -1006 173404 54110601
```

0000Z MRi = (13-11)/ 6^2 = 0.055 (decoupled).
0600Z MRi = (12-08)/ 11^2 = 0.033 (marginal).
1200Z MRi = (11-07)/ 4^2 = 0.250 (very decoupled).

Fog Forecasting

Through operational forecast use we have found:

- MRi < 0.025 turbulent eddys; expect stratus rather than fog
- MRi 0.025 - 0.04; marginal; expect variable fog
- MRi > 0.04; stagnant air; expect fog development




Fog Forecasting

Step 6. Forecast fog with confidence

1. Visibility at crossover, 1-3 mile
   - o
2. Visibility 3 degrees below the crossover, 1/4-1/2 mile




Stratus Build-down

The presence of stratus is often interpreted as a sign fog will not form since clear sky requirement is not met.

In many cases, base of stratus builds downward into fog. (Pettersen)




Stratus Build-down

UPS Step Approach to Fog Forecasting

STRATUS BUILD-DOWN FOG




Stratus Build-down

7 Step approach:

1. Estimate or knowledge of the surface temperature
2. Understanding of moisture profile in boundary layer
3. Knowledge of inversion height
4. Forecast of “mixy-ness”
5. Forecast the build-down rate
6. Knowledge of the cloudiness
7. Make the forecast




Stratus Build-down

Step 1: Surface Temperature (soil or water)

1. Use local sensors (soil or buoy)
2. Estimate (seasonal)

Stratus Build-down

Step 2: Understand the moisture profile of BL

1. Use local skew-t data
2. Use forecast skew-t data
3. Use model data of your choice

Stratus Build-down

Step 3: Understand or estimate the inversion height

1. Use local skew-t data
2. Use forecast skew-t data
3. Use local observations
4. Use the model data of your choice

Stratus Build-down

Step 4: Forecast the “mixy-ness”

1. Use the MRi
2. Use the model data of your choice




Stratus Build-down

Step 5: Forecast the build-down rate

1. Boundary layer moisture versus surface temperature

2. How mixy are you?




Stratus Build-down

- $T_{GROUND} \geq 5^{o}$ F warmer than dew point, stratus build-down (SBD) not expected.

- T_{GROUND} within 5^{o} F of dew point, SBD rates of 100-200 ft/hour

- $T_{GROUND} \geq 5^{o}$ F colder than dew point, SBD fog risk elevated, rates of 300-400 ft/hour.




Stratus Build-down

Step 6: Forecast clouds

1. Most clouds will ruin the radiative imbalance you want for build-down

2. May be the most difficult variable to forecast




Stratus Build-down

Step 7: Forecast stratus build-down fog with confidence




Fog Forecasting

Step 1: Estimate the surface temperature.

SOIL TEMPERATURES AT 4 INCH DEPTH

:LOCATION		DATE/TIME	MAX	MIN
CBGI2:	BOTANIC GARDENS	: DD /	/	
PRUI2:	PERU	: DD170700/	50	/ 42
RFDI2:	ROCKFORD	: DD170700/	52	/ 50
SNWI2:	STREAMWOOD	: DD170700/	47	/ 47
WANI3:	WANATAH IN	: DD170700/	56	/ 51
WATI2:	WATSEKA	: DD /	/	



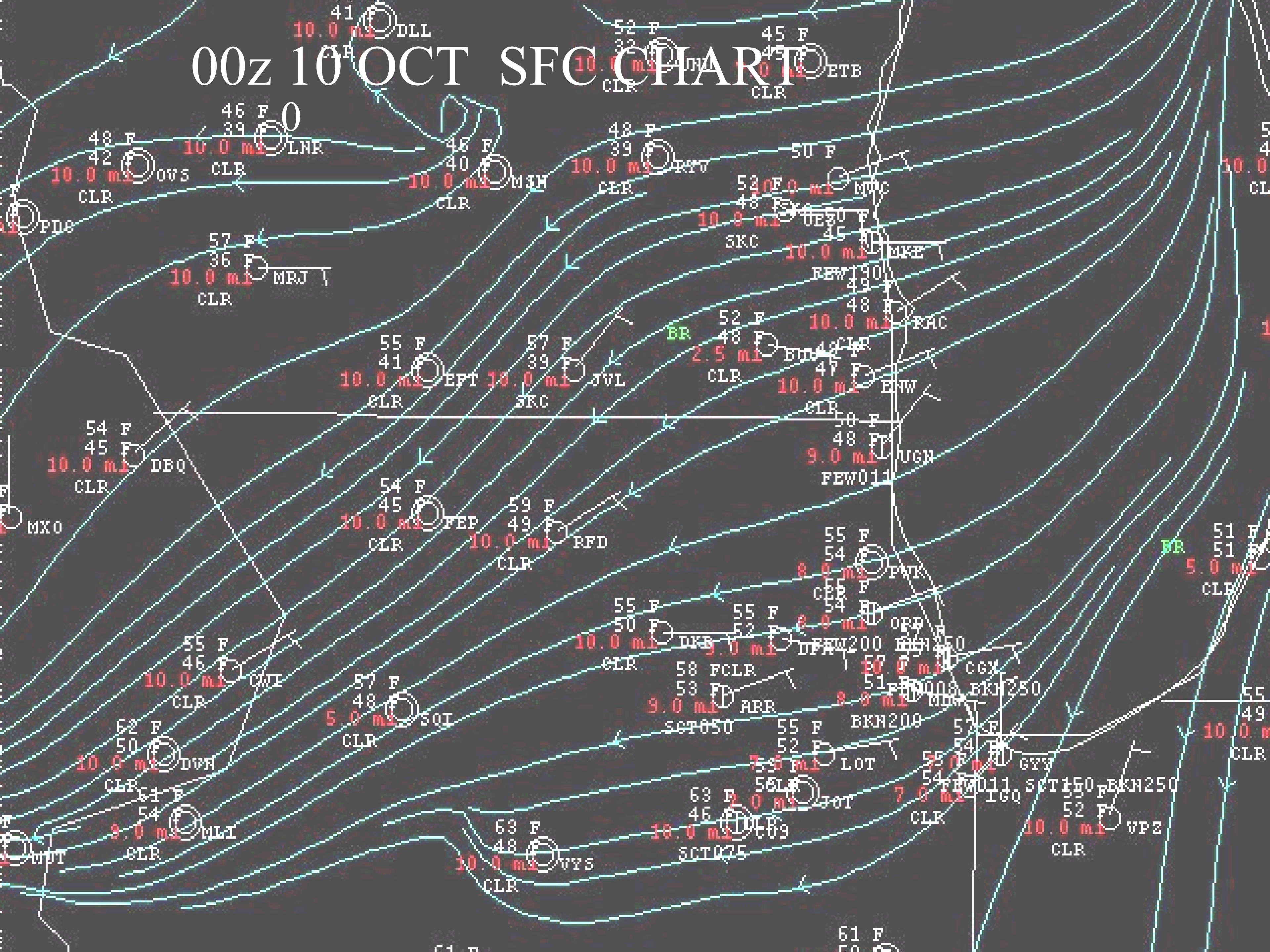

Stratus Build-down

Step 2: Knowledge of the moisture profile.

```
RFD SA 1954 AO2A 250 SCT 10+ 205/65/47/0000/013/ WND LGT
AND VRB /=
RFD SA 2054 AO2A 250 SCT 10+ 205/66/47/0000/013/
RFD SA 2154 AO2A 250 SCT 10+ 204/67/48/0000/013/=
RFD SA 2254 AO2A CLR BLO 120 10+ 05/65/47/3603/013/=
RFD SA 2354 AO2A CLR BLO 120 10+ 206/59/49/0603/014/ 059=
```

CROSS-OVER 47

00z 10 OCT SFC CHART






Stratus Build-down

Step 3 and 4: Inversion height and mixy-ness.

```
OUTPUT FROM ETA 12Z OCT 09 02
TTPTTR1R2R3 VVVLI PSDDFF HHT1T3T5
ORD//736338 -1706 202713 54111204
06000596122 -1604 181002 55171104
12000764315 -0904 190710 57151205
18000864814 00305 211012 57141205
24000745815 -1304 211412 57141305
30000445419 -1403 201607 59211305
36000454917 -0503 191112 60201407
42000494223 -1405 201414 60191407
48000573112 -2206 201411 60161407
54000432420 -1506 181211 62211408
60000462232 -0906 160913 65201509
```




Stratus Build-down

```
RFD  C    NGM MOS GUIDANCE  10/09/02  1200 UTC
     DAY /OCT   9 /OCT  10                 /OCT  11                 /
     HOUR   18 21 00 03 06 09 12 15 18 21 00 03 06 09 12 15 18 21 00
     MN/MX                    48          73          50          74
     TEMP   63 66 60 54 51 50 50 61 70 72 66 58 54 53 52 62 71 73 66
     DEWPT  46 47 48 48 48 48 48 52 51 51 52 51 50 49 49 54 54 55 55
     CLDS   SC SC SC SC SC OV OV OV BK BK BK CL CL CL CL CL SC SC BK
     WDIR   01 32 06 09 10 10 10 14 14 15 11 12 12 14 15 17 17 16 15
     WSPD   07 04 02 02 01 01 01 05 07 07 03 03 01 02 01 08 10 10 05
     POP06         0     1    23    15     4     1     0     6     9
     POP12                    18          14          5           11
     QPF         0/    0/    0/0   0/    0/0   0/    0/0   0/    0/0
     TSV06      4/ 0  4/ 0  5/ 0  7/ 0 14/ 0  5/ 0  5/ 1  3/ 1  0/ 2
     TSV12            6/ 0       10/ 0       16/ 0       8/ 1
     PTYPE   R  R  R  R  R  R  R  R  R  R  R     R     R     R     R
     POZP    0  0  1  0  1  0  1  0  0  0  1     0     0     0     0
     POSN    1  0  0  0  0  0  0  0  0  0  0     0     0     0     0
     SNOW        0/    0/    0/0   0/    0/0   0/    0/0   0/    0/0
     CIG     7  7  7  7  7  7  6  6  7  7  7     7     7
     VIS     5  5  5  5  5  5  5  4  5  5  5     5     4
     OBVIS   N  N  N  N  N  N  F  F  N  N  N     N     F
```




Stratus Build-down

Calculate the Richardson number (MRi):

$MRi = (14-10) / (12)^2$

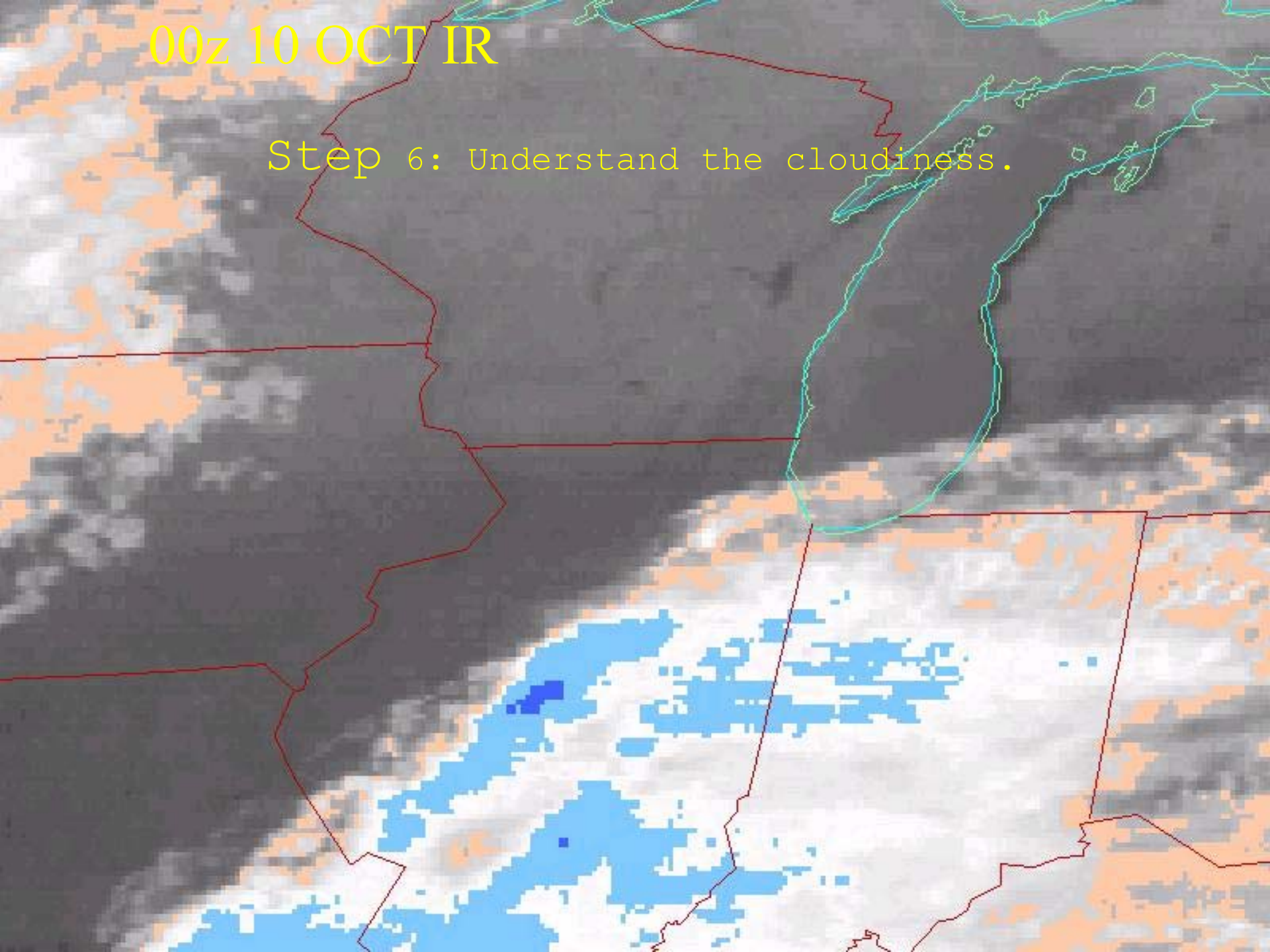
MRi = 0.027




Stratus Build-down

Step 5: Build-down rate.

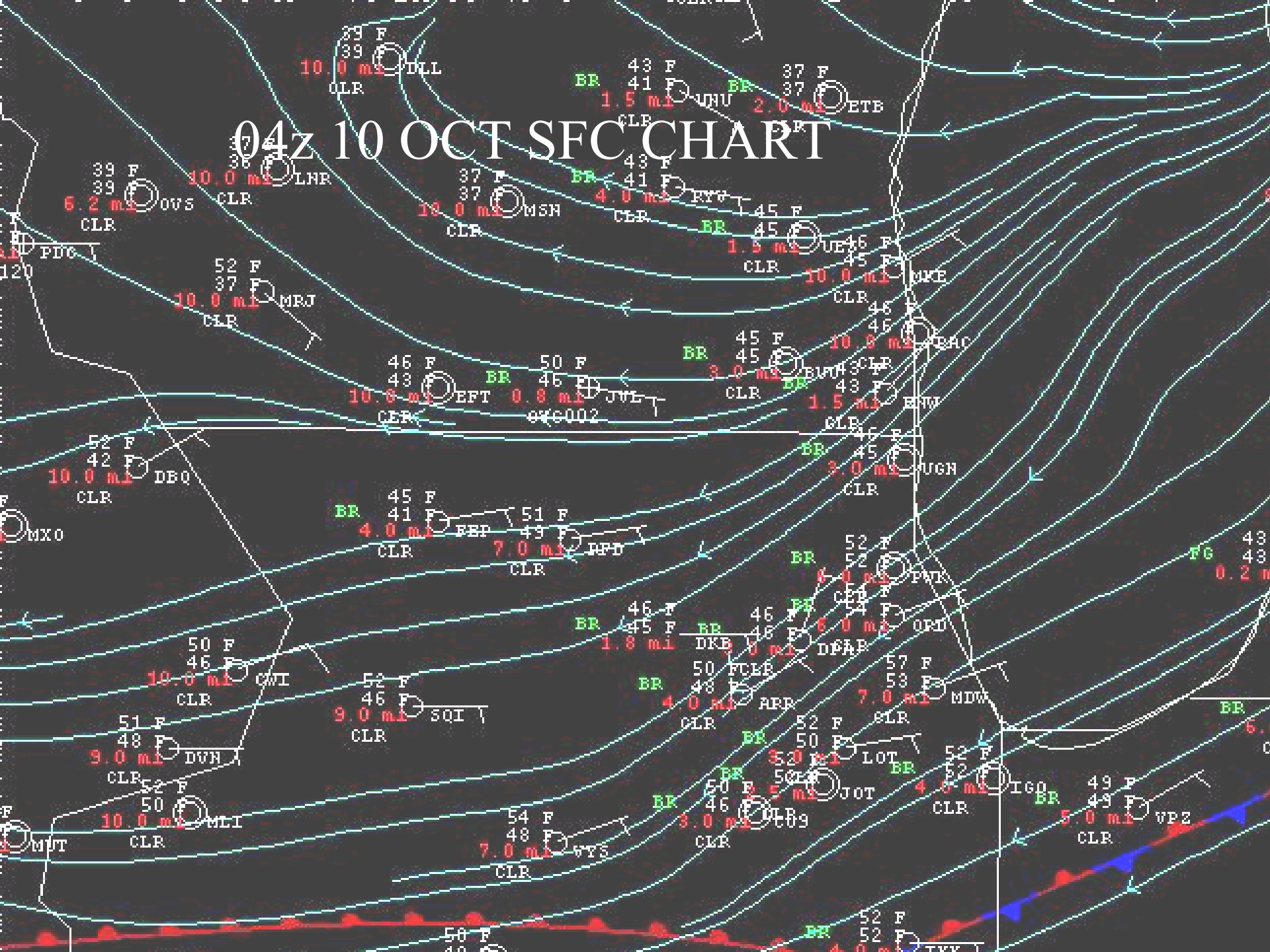
- TGROUND > 5° F warmer than dew point, stratus build-down (SBD) not expected.
- TGROUND within 5° F of dew point, SBD rates of 100-200 ft/hour
- TGROUND > 5° F colder than dew point, SBD fog risk elevated, rates of 300-400 ft/hour.

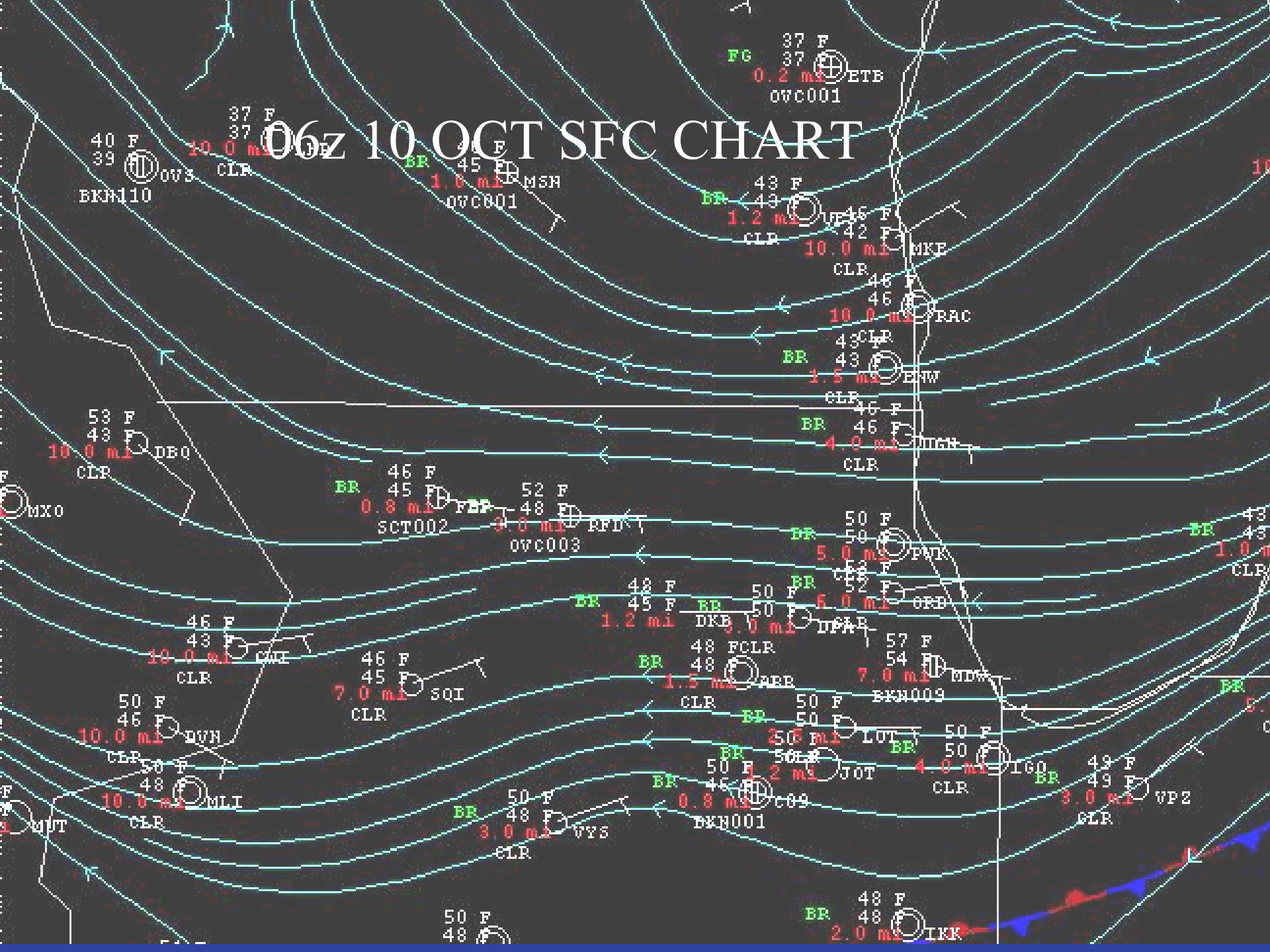

00z 10 OCT IR
Step 6: Understand the cloudiness.




Stratus Build-down

Step 7: Make the forecast for 6z.

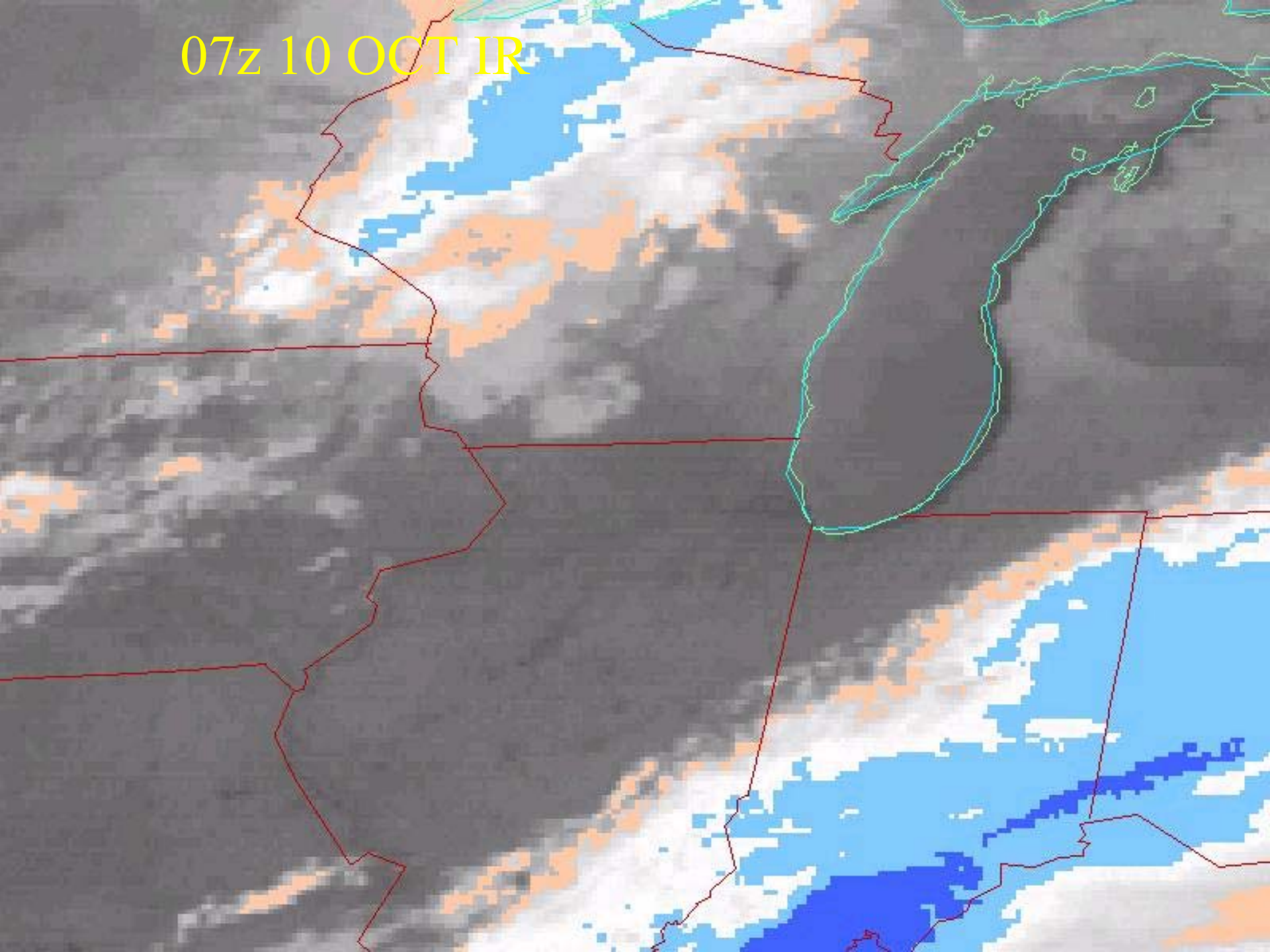

04z 10 OCT SFC CHART


06z 10 OCT SFC CHART




Stratus Build-down

Step 7: Make the forecast for 9z.


07z 10 OCT IR

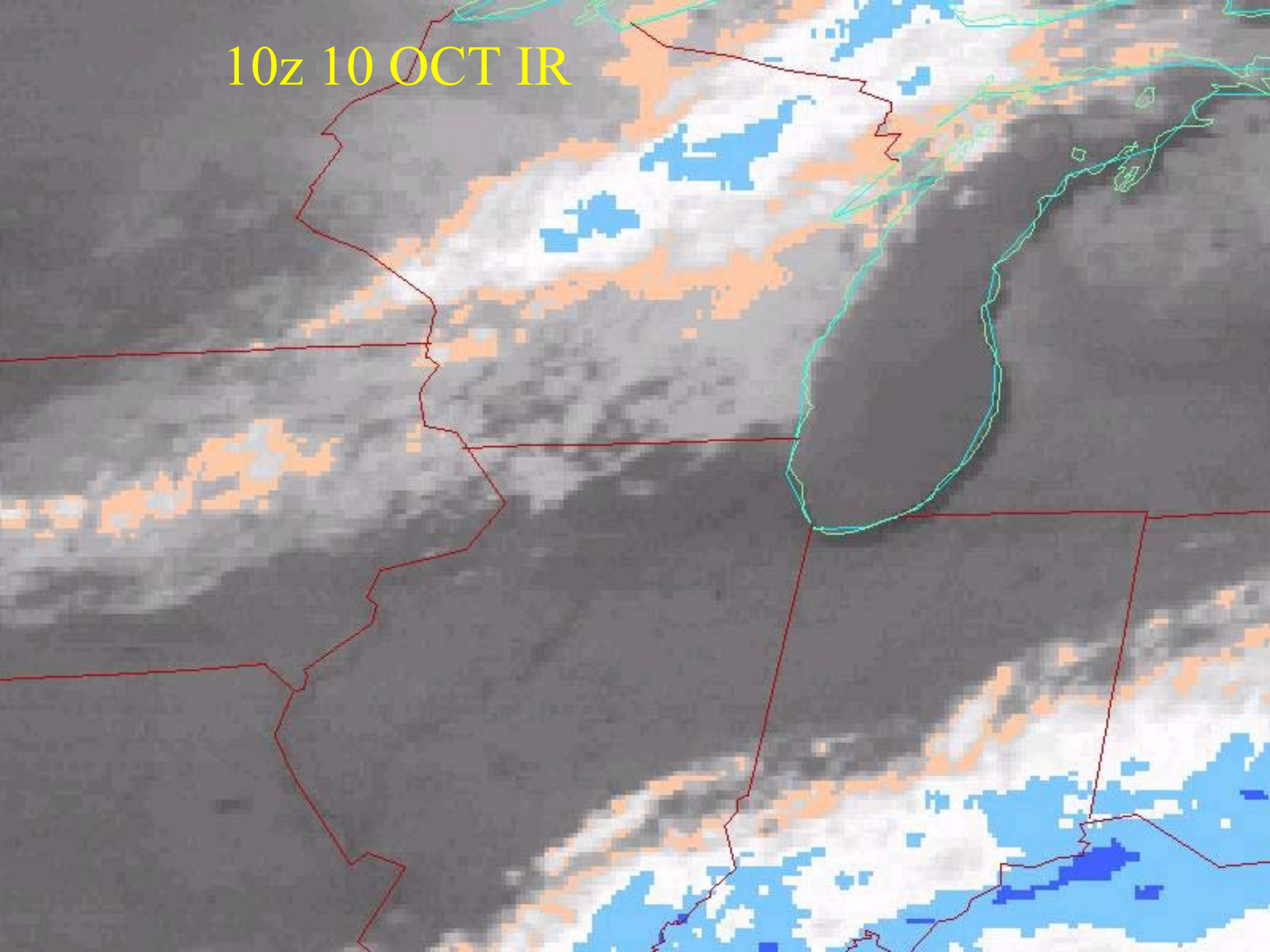



Stratus Build-down

```
RFD SA 0054 AO2A CLR BLO 120 10+ 212/56/48/0000/015
RFD SA 0154 AO2A CLR BLO 120 10+ 214/55/51/1005/016
RFD SA 0254 AO2A CLR BLO 120 10+ 217/53/50/0905/017/ 51011=
RFD SA 0354 AO2A CLR BLO 120 7 218/51/49/0804/017/=
RFD SA 0354 AO2A CLR BLO 120 7 218/51/49/0804/017/=
RFD SA 0454 AO2A CLR BLO 120 4F 214/50/49/1005/016/=
RFD SA 0554 AO2A E3 OVC 3F 214/51/49/1004/016/ 58003 10059 20050
RFD SA 0654 AO2A E3 OVC 13/4F 215/51/50/1106/017/=
RFD SA 0754 AO2A E1 OVC 3/4F 214/51/50/0000/016/=
RFD SA 0854 AO2A W1X 1/2F 211/52/51/1205/015/ 58002
```

Stratus Build-down

Step 7: Make the forecast for 12z.


10z 10 OCT IR




Stratus Build-down

```
RFD SA 0054 AO2A CLR BLO 120 10+ 212/56/48/0000/015
RFD SA 0154 AO2A CLR BLO 120 10+ 214/55/51/1005/016
RFD SA 0254 AO2A CLR BLO 120 10+ 217/53/50/0905/017/ 51011=
RFD SA 0354 AO2A CLR BLO 120 7 218/51/49/0804/017/=
RFD SA 0354 AO2A CLR BLO 120 7 218/51/49/0804/017/=
RFD SA 0454 AO2A CLR BLO 120 4F 214/50/49/1005/016/=
RFD SA 0554 AO2A E3 OVC 3F 214/51/49/1004/016/ 58003 10059 20050
RFD SA 0654 AO2A E3 OVC 13/4F 215/51/50/1106/017/=
RFD SA 0754 AO2A E1 OVC 3/4F 214/51/50/0000/016/=
RFD SA 0854 AO2A W1X 1/2F 211/52/51/1205/015/ 58002
RFD SA 0954 AO2A W1X 1/2F 212/52/51/1306/016/=
RFD SA 1054 AO2A E1 OVC 11/4F 211/52/51/1306/015/=
RFD SA 1154 AO2A E3 OVC 21/2F 219/52/51/1305/017/ 53006 10052 50=
RFD SA 1254 AO2A E3 OVC 13/4F 219/52/51/1106/018/=
```