

# Weather101: Observations in 3D

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# Observations in 3-D: METARs and U/A Patterns

## What we will cover in this class:

- The ins and outs of METARs
- How are METARs used?
- Upper air patterns
  - Why are some storm systems stronger than others

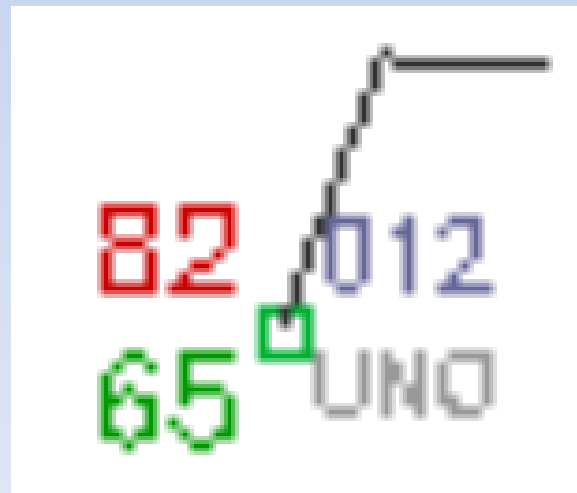
# Observation in 3-D: METARs

METAR: Meteorological Terminal Aviation Routine

## Raw METAR

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KCKV 022052Z AUTO 14006KT 10SM CLR 28/09 A2998 RMK A02 SLP148 T02780089 58023
```

## Plotted METAR



# Raw METARs

KBNA 190153Z 20005KT 10SM OVC095 19/16 A3014 RMK A02 RAE12 SLP202 P0004 T01940156  
KBNA 190101Z VRB06KT 3SM -RA BR BKN035 BKN047 OVC090 19/16 A3012 RMK A02 P0004 T01940161  
KBNA 190053Z 24007G19KT 1 3/4SM R02L/5500VP6000FT +RA BR SCT031 BKN039 OVC050 19/16 A3013 RMK A02 RAB35  
SLP200 P0013 T01940156  
KBNA 190049Z 22010G18KT 200V270 1 3/4SM R02L/5500VP6000FT +RA SCT031 BKN039 OVC050 19/16 A3013 RMK A02  
VIS 1V5 RAB35 P0005  
KBNA 182353Z 20003KT 7SM FEW060 OVC080 19/17 A3008 RMK A02 SLP185 60013 T01890167 10206 20183 55002  
KBNA 182253Z 00000KT 8SM FEW060 BKN090 OVC200 20/17 A3008 RMK A02 RAE06 SLP182 P0000 T02000172  
KBNA 182153Z 17012KT 9SM -RA FEW080 OVC100 19/17 A3006 RMK A02 RAB31 SLP178 P0001 T01940167  
KBNA 182053Z 18007KT 8SM SCT039 OVC080 19/17 A3009 RMK A02 RAE35 SLP186 P0000 60012 T01940172 56018  
KBNA 181953Z 17007KT 4SM -RA BR FEW048 BKN060 OVC080 19/17 A3010 RMK A02 SLP189 P0004 T01890172 \$  
KBNA 181918Z COR 16008KT 4SM -RA BR SCT014 SCT048 OVC060 18/17 A3011 RMK A02 P0002 T01830167 \$  
KBNA 181853Z 27003KT 4SM -RA BR BKN018 BKN050 OVC075 18/17 A3013 RMK A02 SLP201 P0008 T01830167  
KBNA 181753Z 21004KT 3SM RA BR SCT015 BKN021 OVC028 18/17 A3014 RMK A02 SLP205 P0031 60032 T01830167  
10206 20100 55005  
KBNA 181739Z 22005KT 3SM RA BR BKN023 OVC027 18/16 A3015 RMK A02 P0026 T01830161

# Raw METARs

KBNA 181653Z 19009G17KT 7SM -RA FEW038 BKN060 BKN075 OVC130 20/16 A3014 RMK A02 RAB43 SLP202 P0001

# Raw METARs

Station Identifier



KBNA 181653Z 19009G17KT 7SM -RA FEW038 BKN060 BKN075 OVC130 20/16 A3014 RMK A02 RAB43 SLP202 P0001

# Raw METARs

Date/Time Stamp in UTC



KBNA 181653Z 19009G17KT 7SM -RA FEW038 BKN060 BKN075 OVC130 20/16 A3014 RMK A02 RAB43 SLP202 P0001

# Raw METARs

Wind Direction and Speed



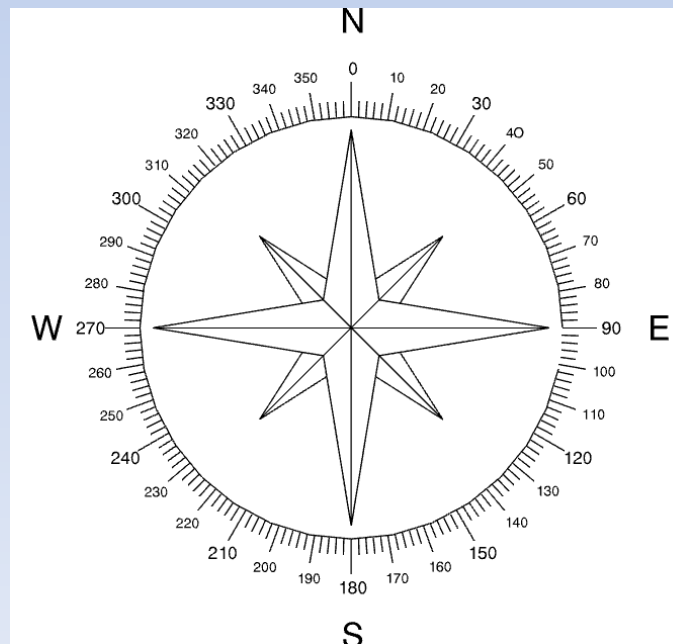
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# Raw METARs

## Wind Direction and Speed



KBNA 181653Z 19009G17KT 7SM -RA FEW038 BKN060 BKN075 OVC130 20/16 A3014 RMK A02 RAB43 SLP202 P0001



# Raw METARs

Visibility



KBNA 181653Z 19009G17KT 7SM -RA FEW038 BKN060 BKN075 OVC130 20/16 A3014 RMK A02 RAB43 SLP202 P0001

# Raw METARs

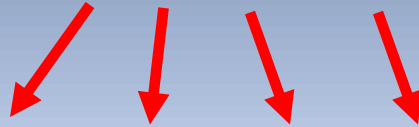
Present Weather



KBNA 181653Z 19009G17KT 7SM -RA FEW038 BKN060 BKN075 OVC130 20/16 A3014 RMK A02 RAB43 SLP202 P0001

# Raw METARs

Ceilings or cloud levels



KBNA 181653Z 19009G17KT 7SM -RA FEW038 BKN060 BKN075 OVC130 20/16 A3014 RMK A02 RAB43 SLP202 P0001

# Raw METARs

Temperature / Dew Point in Celsius



KBNA 181653Z 19009G17KT 7SM -RA FEW038 BKN060 BKN075 OVC130 20/16 A3014 RMK A02 RAB43 SLP202 P0001

# Raw METARs

If it rained, you'll get this group



KBNA 181653Z 19009G17KT 7SM -RA FEW038 BKN060 BKN075 OVC130 20/16 A3014 RMK A02 RAB43 SLP202 P0001

RAB: The time the rain began

RAE: The time the rain ended

# Raw METARs

Amount of rain



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KBNA 181653Z 19009G17KT 7SM -RA FEW038 BKN060 BKN075 OVC130 20/16 A3014 RMK A02 RAB43 SLP202 P0001
```

Starts with P: the amount of rain that hour (in hundredths)

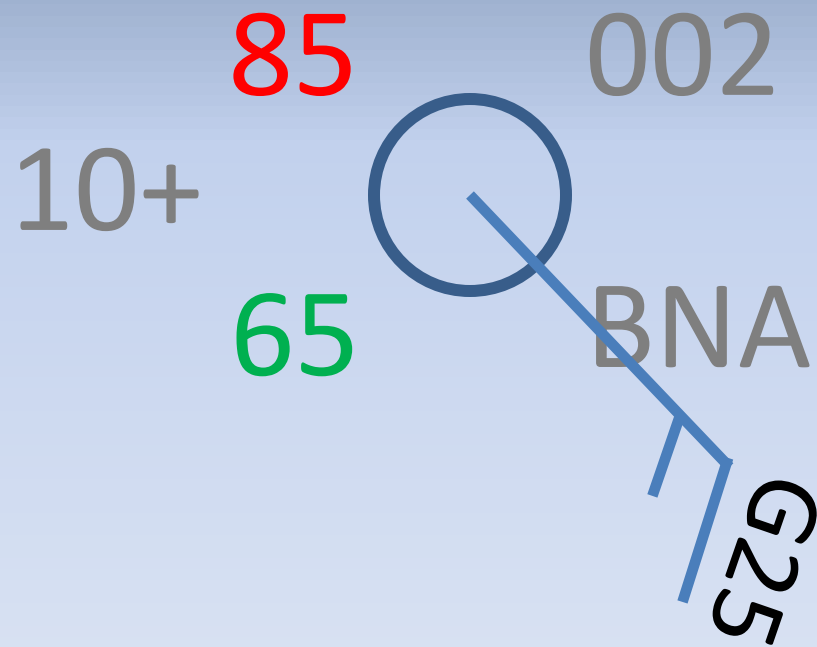
Starts with 6: 6-hour rainfall total (in hundredths)

Note:

P0000 or 60000 = Trace



# Plotted METARs

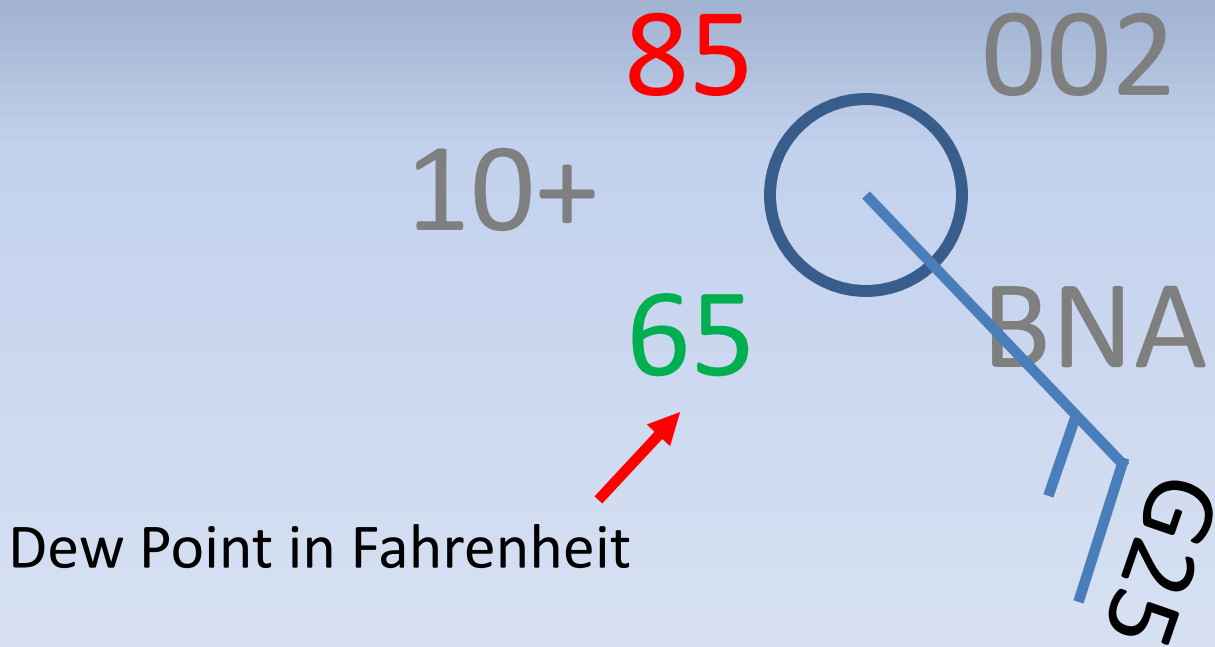


# Plotted METARs

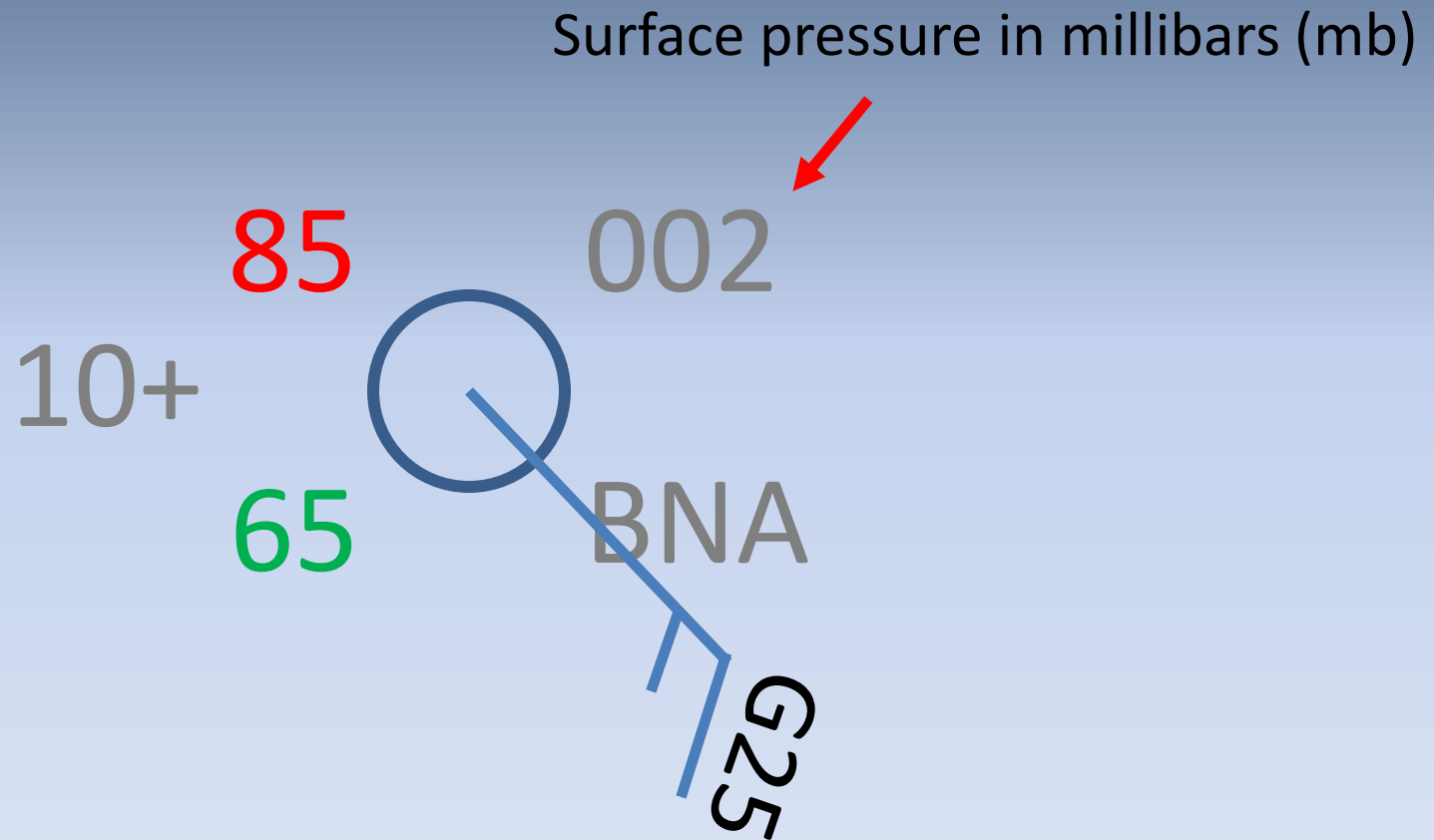
Temperature in Fahrenheit



# Plotted METARs

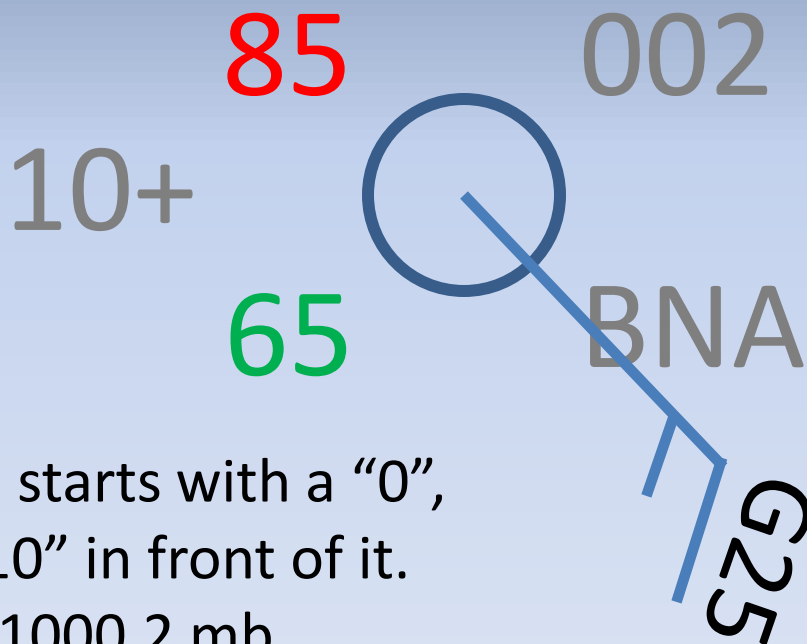


# Plotted METARs



# Plotted METARs

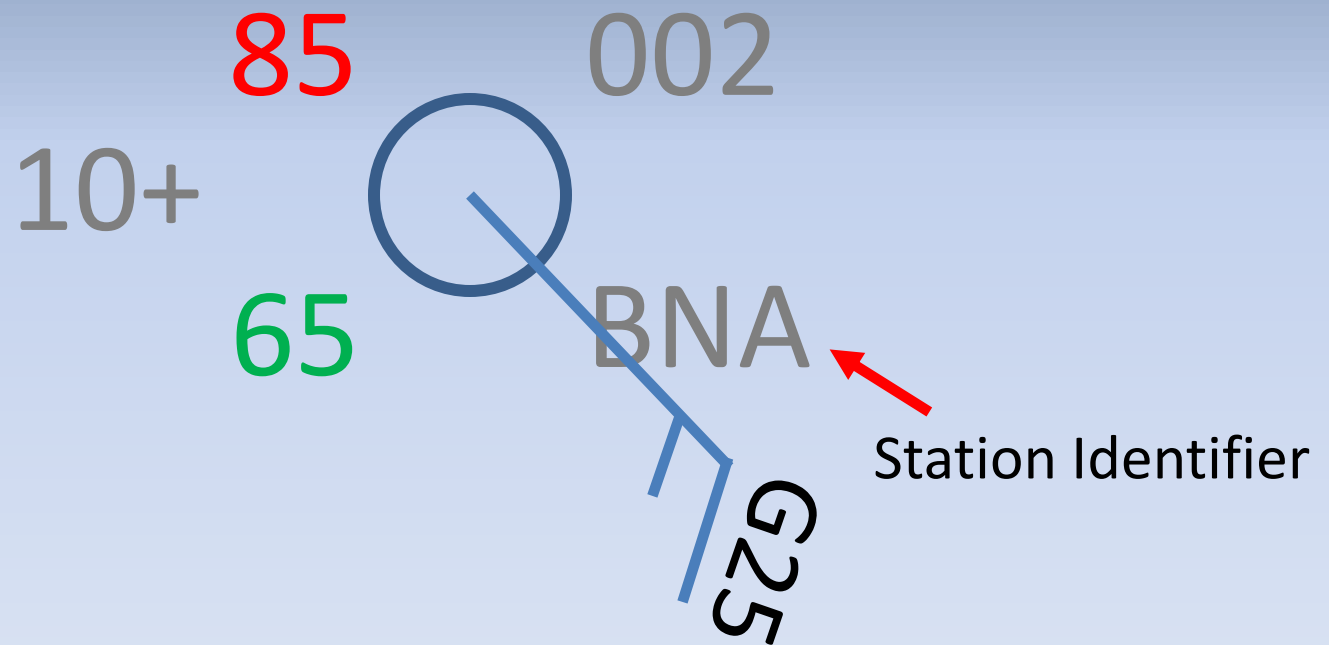
Surface pressure in millibars (mb)



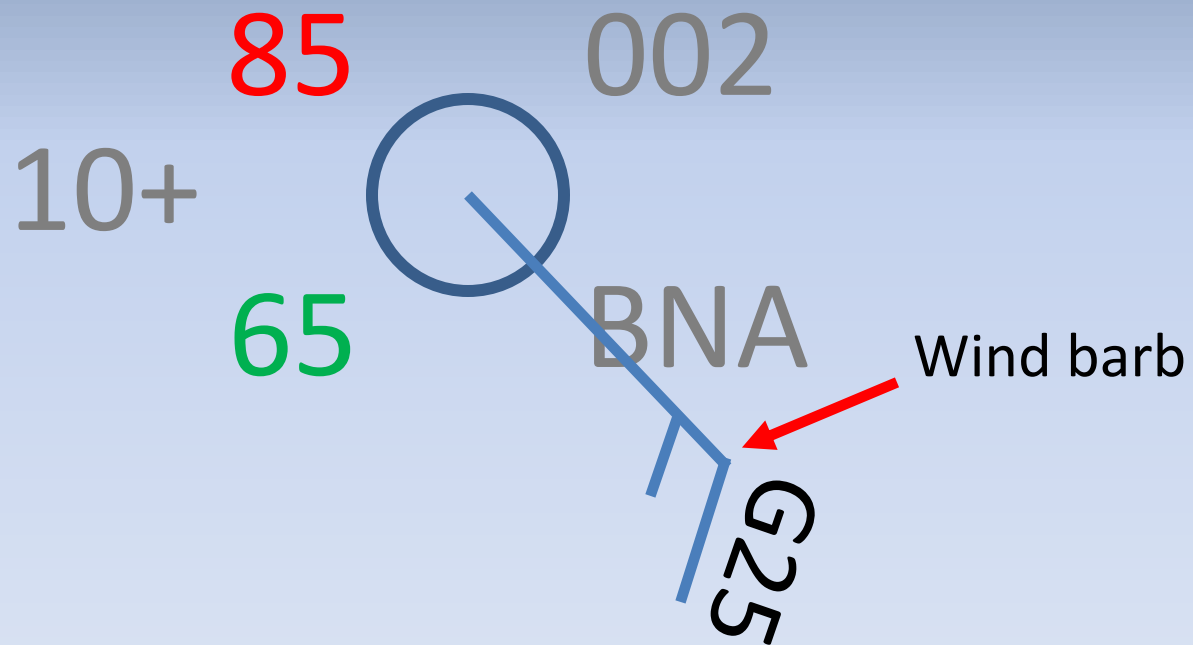
Additional notes:

- If the pressure starts with a “0”, put another “10” in front of it. This example: 1000.2 mb
- If the pressure starts with an 5 through 9, put another “9” in front of it. A display of 823, then becomes 982.3

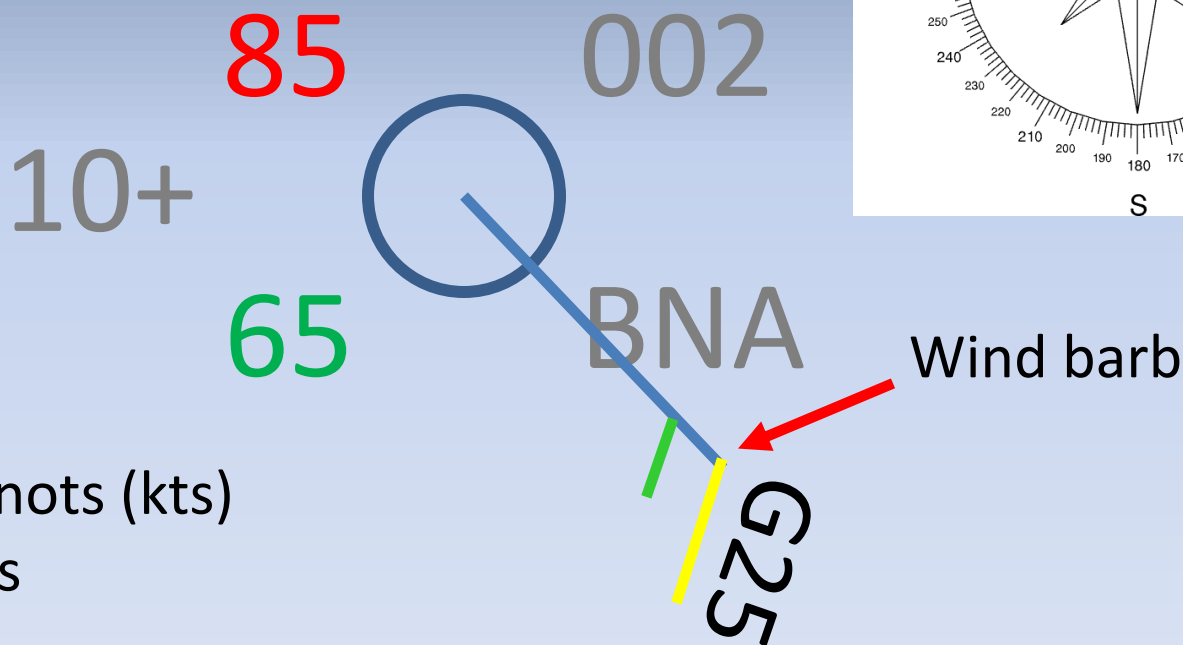
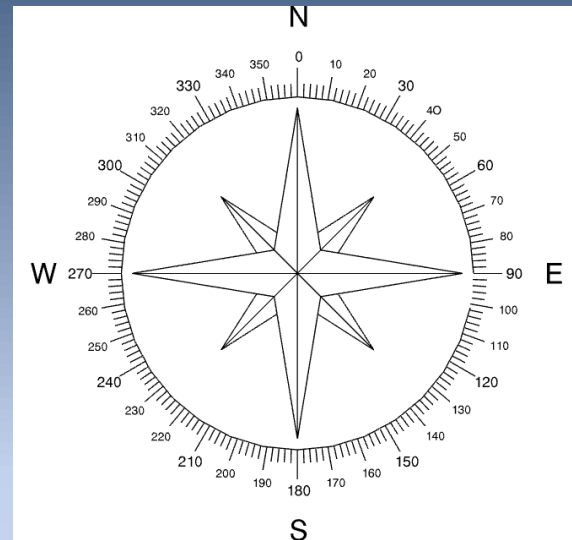
# Plotted METARs



# Plotted METARs



# Plotted METARs



Additional notes:

- Long line = 10 knots (kts)

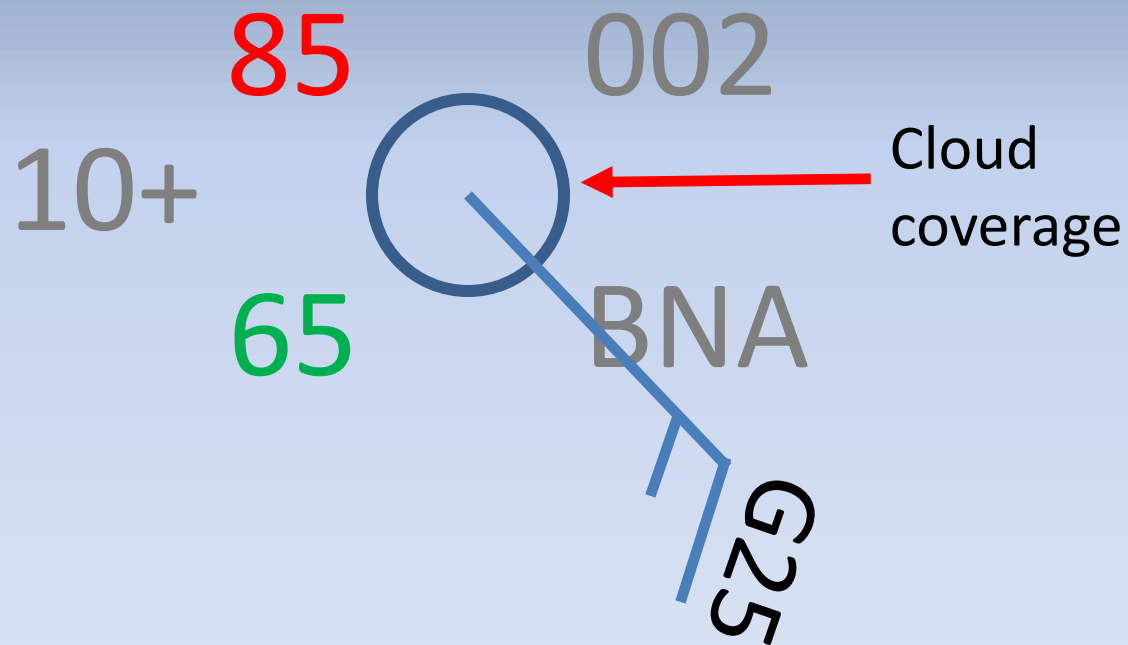
- Short line = 5 kts

- Flag = 50 kts

- "G" indicates Gusts. In this example,





the wind is **out of** the southeast at 15 kts, gusting to 25 kts

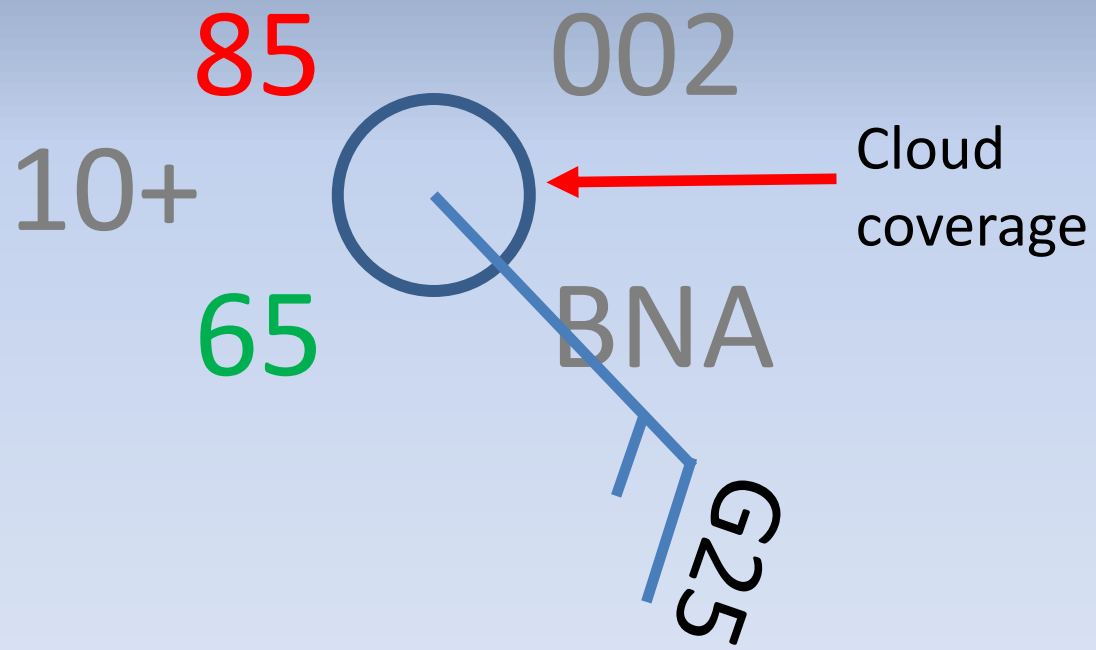
# Plotted METARs



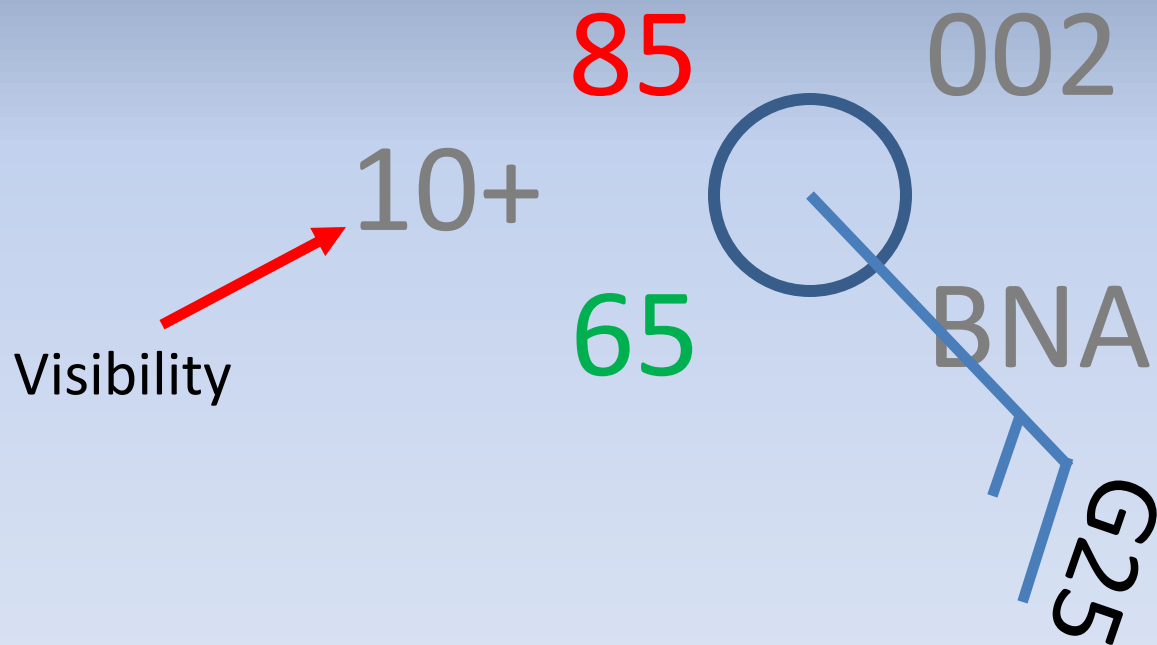
# Plotted METARs

Additional notes:

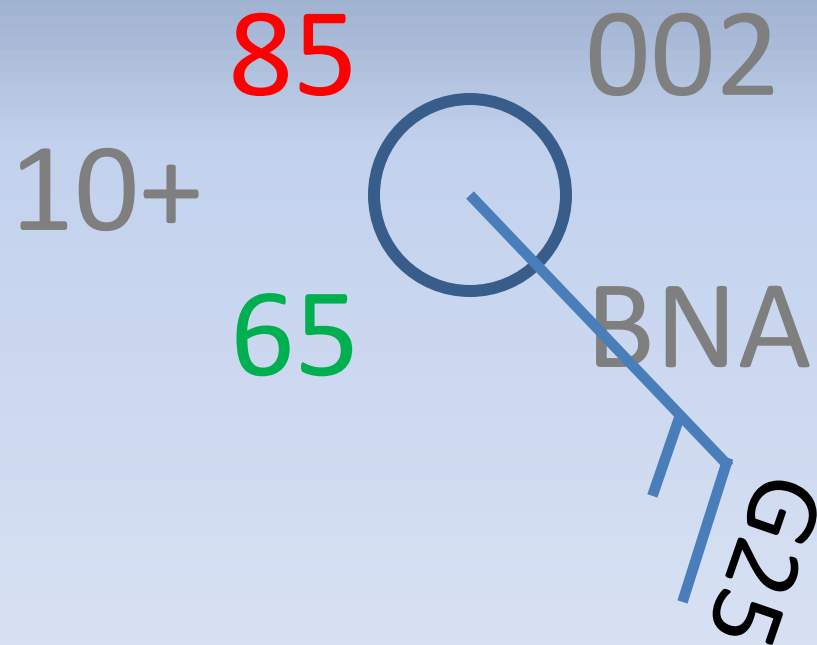
-  Clear/Few (SKC or FEW)
-  Scattered Clouds (SCT)
-  Broken Clouds (BKN)
-  Overcast (OVC)



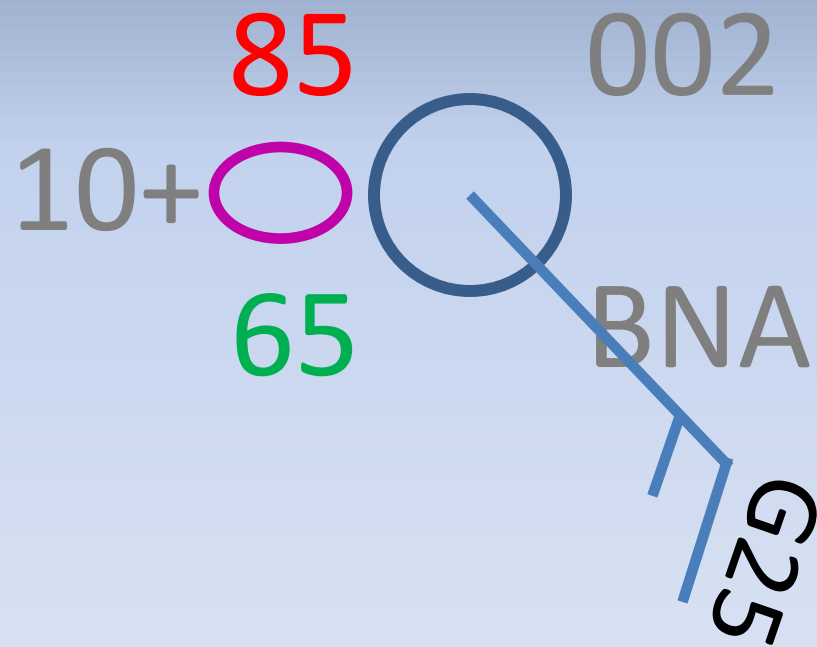
# Plotted METARs



# Plotted METARs







































































































# Plotted METARs



# WEATHER SYMBOLS

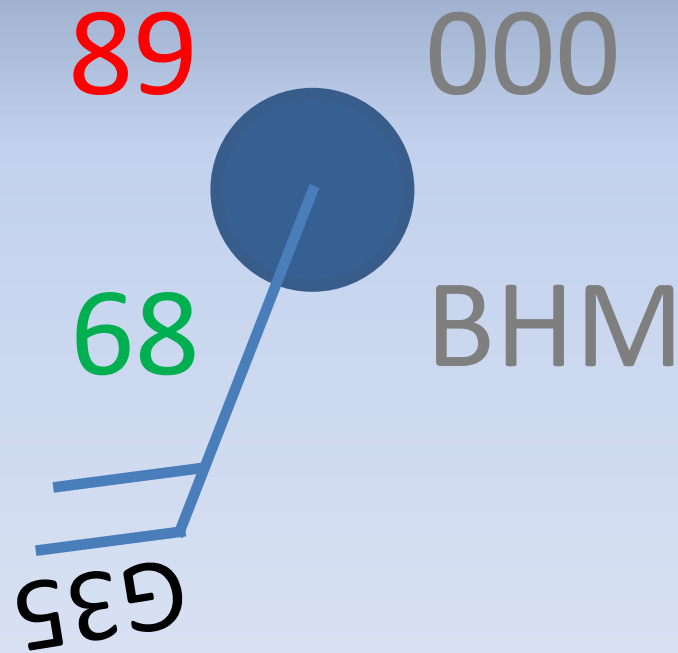
Numbers indicate the weather code as used in synoptic weather reports (ww, present weather reported from a manned weather station, as defined in WMO Pub. No. 306-A).

00  Cloud development not observed/observable during past hour.	01  Clouds generally dissolving during past hour.	02  State of sky unchanged during past hour.	03  Clouds generally forming or developing during past hour.	04  Visibility reduced by smoke.	05  Haze.	06  Dust suspended in the air, but not raised by wind.	07  Dust or sand raised by wind.	08  Dust devils now or within past hour.	09  Duststorm or sandstorm not at station but within sight.
10  Mist.	11  Patches of shallow fog at station, not deeper than 2 m (10 m at sea).	12  Continuous shallow fog at station, not deeper than 2 m (10 m at sea).	13  Lightning visible, but no thunder heard.	14  Precipitation visible but not reaching ground at station.	15  Precipitation reaching the ground not at or near the station but at a distance.	16  Precipitation reaching the ground not at the station but nearby.	17  Thunder heard but no precipitation at the station.	18  Wind squall now or during the past hour.	19  Tornado, waterspout, or funnel cloud observed now or during past hour.
20  Recent drizzle (not freezing, not showers) during past hour.	21  Recent rain (not freezing, not showers) during past hour.	22  Recent snow (not showers) during past hour.	23  Recent rain and snow (not showers) during past hour.	24  Freezing drizzle or rain (not showers), not now but during past hour.	25  Rain showers, not now but during past hour.	26  Snow showers, not now but during past hour.	27  Hail or hail and rain, not now but during past hour.	28  Fog, not now but during past hour.	29  Thunderstorm, with or without precipitation, not now but during past hour.
30  Slight/moderate duststorm or sandstorm, decreased during hour.	31  Slight/moderate duststorm or sandstorm, no change during hour.	32  Slight/moderate duststorm or sandstorm, increased during hour.	33  Severe duststorm or sandstorm, which has decreased during hour.	34  Severe duststorm or sandstorm, no change during past hour.	35  Duststorm or sandstorm, severe, has increased during past hour.	36  Drifting snow, slight or moderate.	37  Drifting snow, heavy.	38  Blowing snow, slight or moderate.	39  Blowing snow, heavy.
40  Fog at a distance but not at station during past hour.	41  Patchy fog.	42  Fog, sky discernible, and has become thinner during past hour.	43  Fog, sky not discernible, and has become thinner during past hour.	44  Fog, sky discernible, no change during past hour.	45  Fog, sky not visible, no change during past hour.	46  Fog, sky visible, has begun or become thicker during past hour.	47  Fog, sky not visible, has begun or become thicker during past hour.	48  Freezing fog, sky visible.	49  Freezing fog, sky not visible.
50  Drizzle, light, intermittent, not freezing.	51  Drizzle, light, continuous, not freezing.	52  Drizzle, moderate, intermittent, not freezing.	53  Drizzle, moderate, continuous, not freezing.	54  Drizzle, heavy, intermittent, not freezing.	55  Drizzle, heavy, continuous, not freezing.	56  Freezing drizzle, light.	57  Freezing drizzle, moderate or heavy.	58  Drizzle and rain mixed, light.	59  Drizzle and rain mixed, moderate or heavy.
60  Rain, light, intermittent, not freezing.	61  Rain, light, continuous, not freezing.	62  Rain, moderate, intermittent, not freezing.	63  Rain, moderate, continuous, not freezing.	64  Rain, heavy, intermittent, not freezing.	65  Rain, heavy, continuous, not freezing.	66  Freezing rain, light.	67  Freezing rain, moderate or heavy.	68  Rain and snow mixed, light.	69  Rain and snow mixed, moderate or heavy.
70  Snow, light, intermittent.	71  Snow, light, continuous.	72  Snow, moderate, intermittent.	73  Snow, moderate, continuous.	74  Snow, heavy, intermittent.	75  Snow, heavy, continuous.	76  Ice needles, with or without fog.	77  Snow grains, with or without fog.	78  Snow crystals, with or without fog.	79  Ice pellets (sleet).
80  Rain showers, light.	81  Rain showers, moderate or heavy.	82  Rain showers, torrential.	83  Rain/snow showers mixed, light.	84  Rain/snow showers mixed, moderate or heavy.	85  Snow showers, light.	86  Snow showers, moderate or heavy.	87  Ice pellet showers, light.	88  Ice pellet showers, moderate or heavy.	89  Hail, light, not associated with thunder.
90  Hail, moderate or heavy, not associated with thunder.	91  Rain, light. Thunder heard during past hour but not now.	92  Rain, moderate or heavy. Thunder heard during past hour but not now.	93  Light snow or rain/snow mixed with hail. Thunder heard during past hour.	94  Moderate or heavy snow or rain/snow with hail. Thunder in past hour.	95  Thunderstorm, light or moderate. Rain or snow, but no hail.	96  Thunderstorm, light or moderate, with hail.	97  Thunderstorm, severe. Rain or snow, but no hail.	98  Thunderstorm, with duststorm or sandstorm.	99  Thunderstorm, severe, with hail.

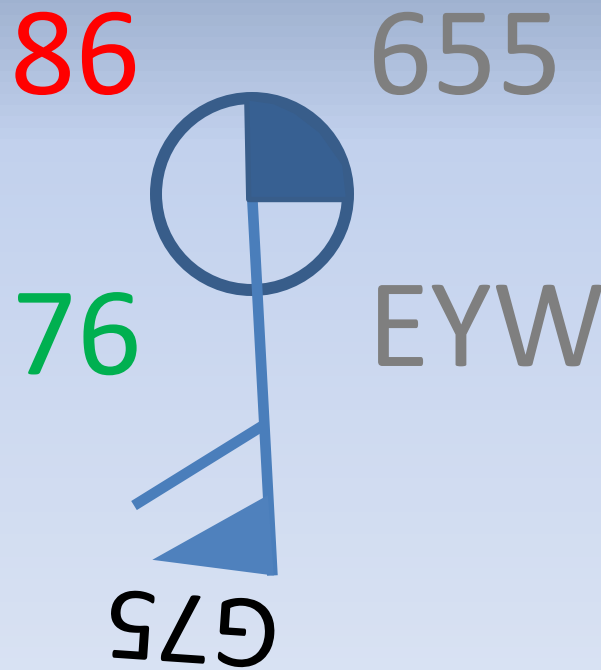
# Participation Time

KMEM 292310Z 06015KT 2 1/2SM +TSRA BR BKN013 OVC035CB 25/25 A3008 RMK A02 WSHFT 2255 LTG DSNT ALQDS OCNL  
LTGICCG ALQDS TS ALQDS MOV E P0019 T02500250 \$

# Participation Time



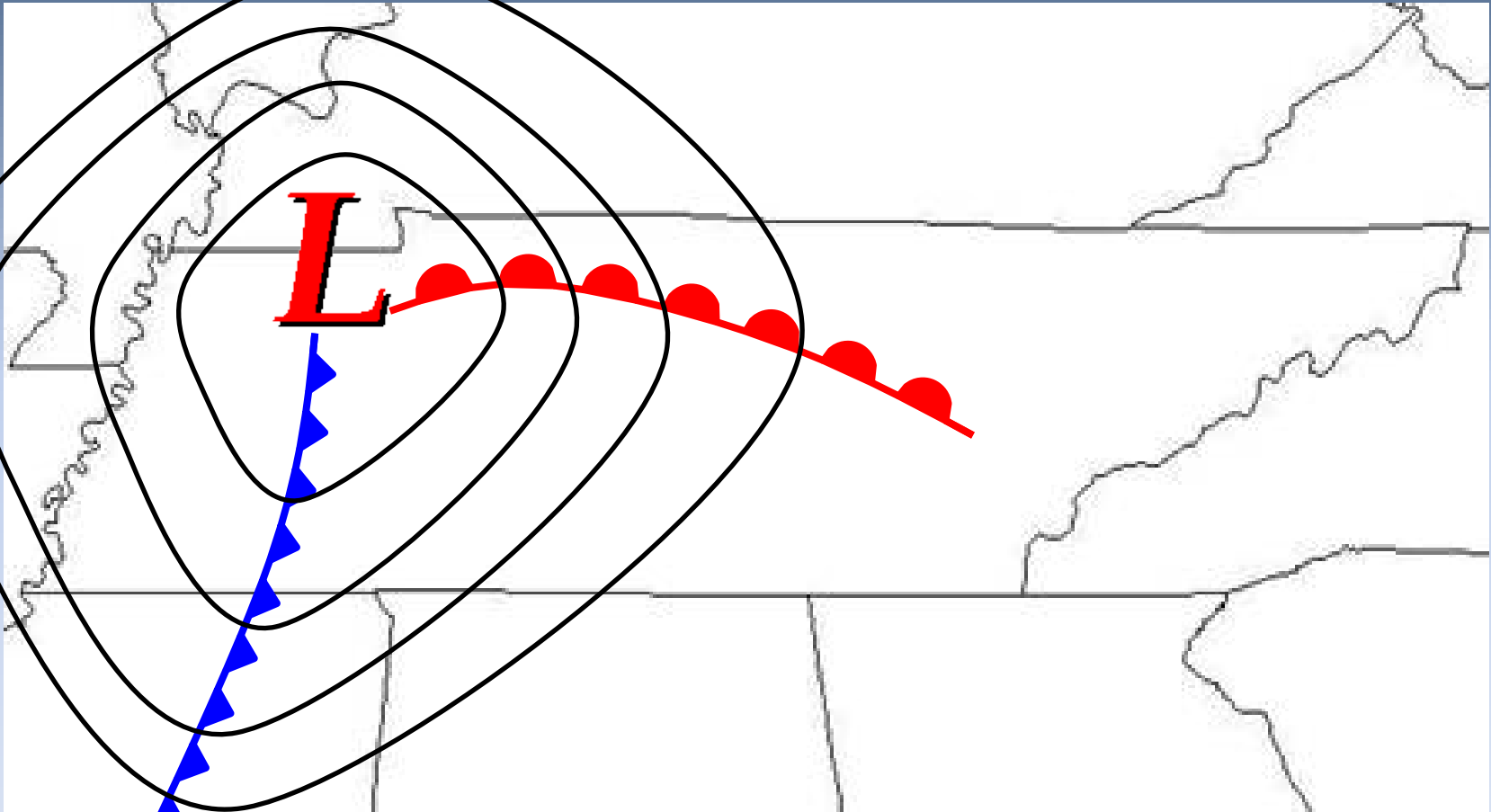
# Participation Time



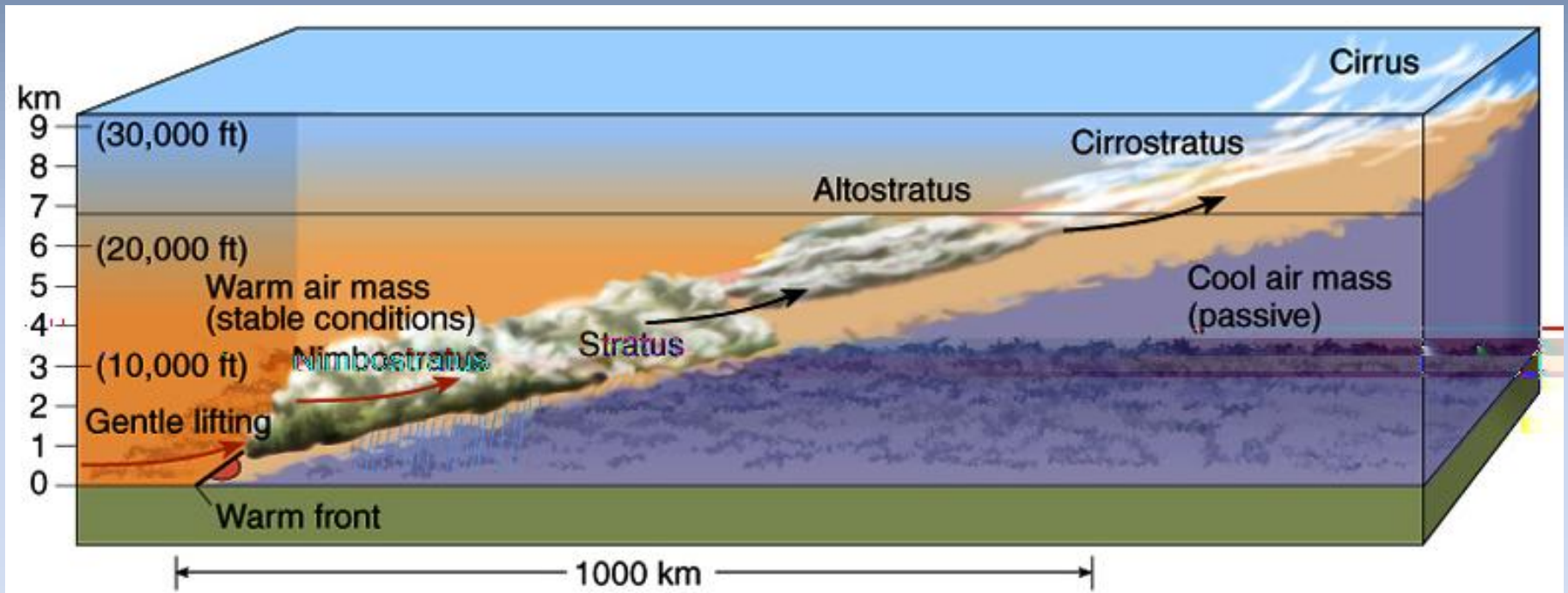
# Observations in 3-D: METARs and U/A Patterns

How do we use these METARs?

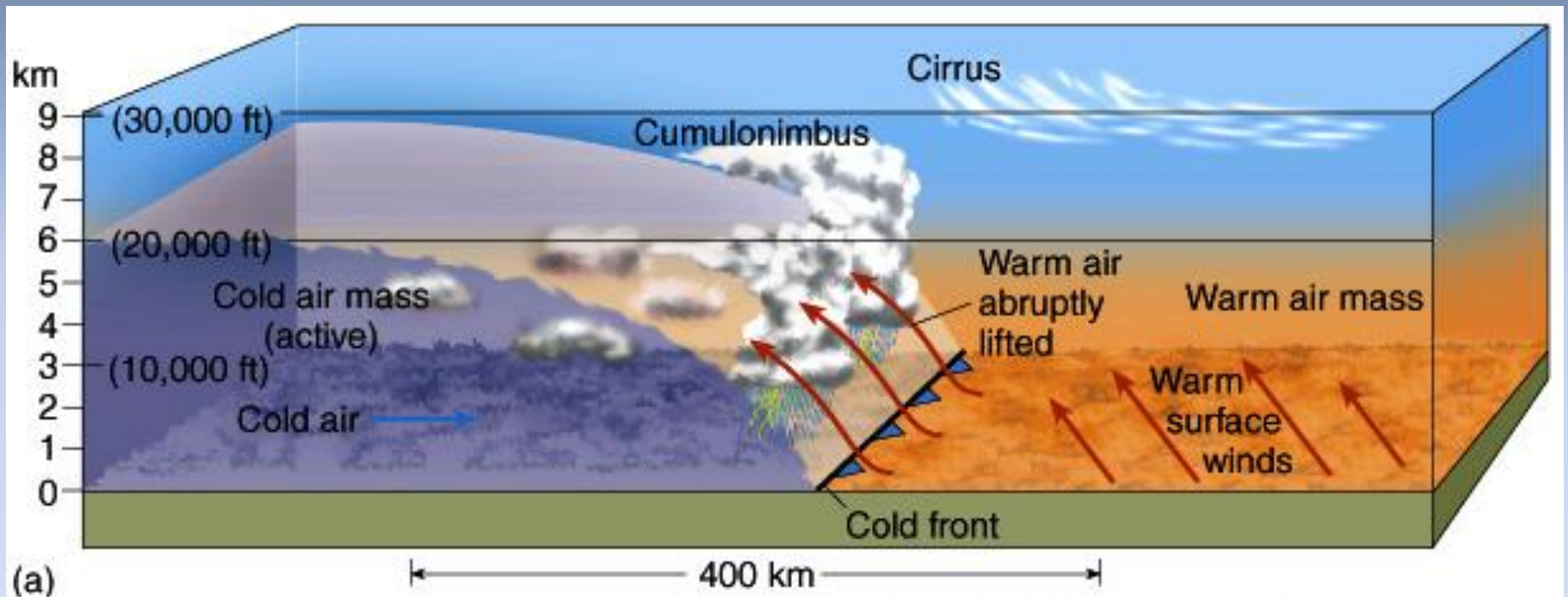
# Observation in 3-D: Low Pressure Systems



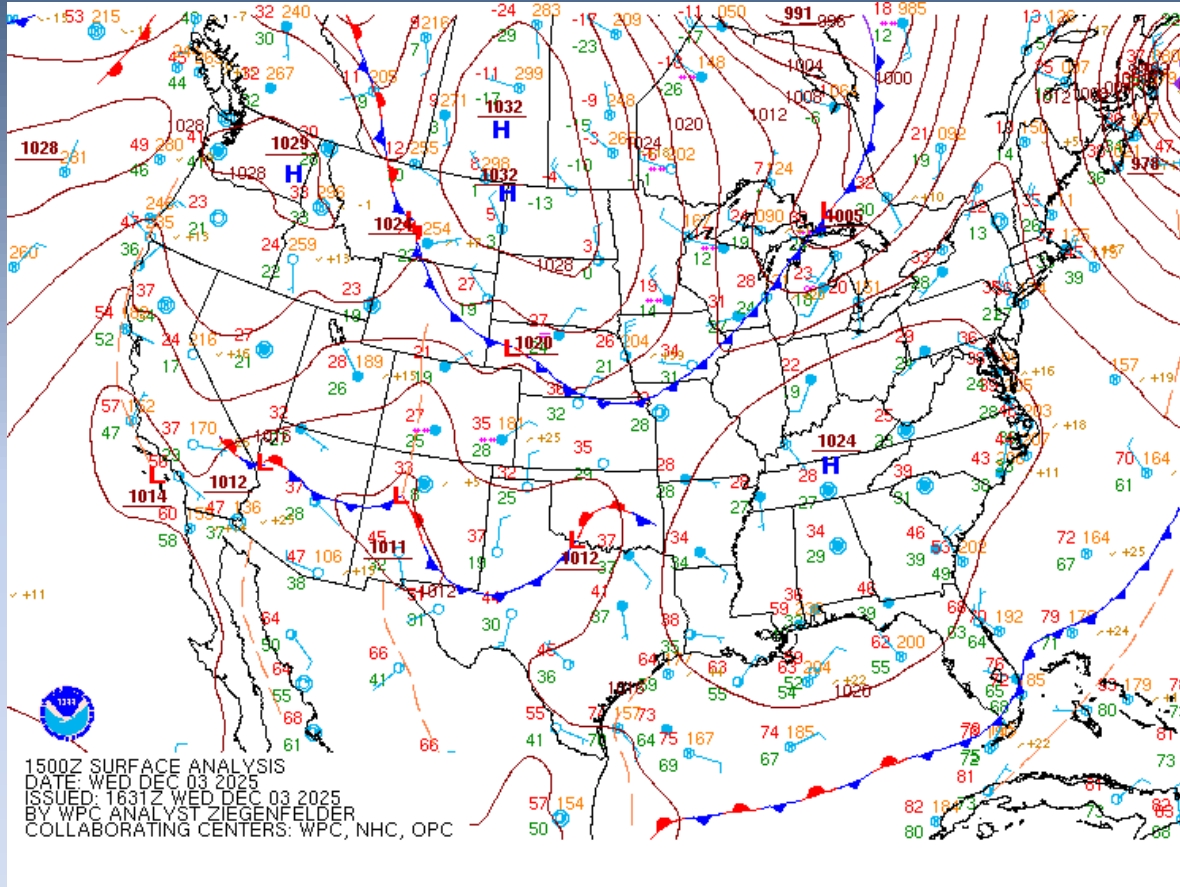
# Observations in 3-D: Warm Front



# Observations in 3-D: Cold Front



# Live examples

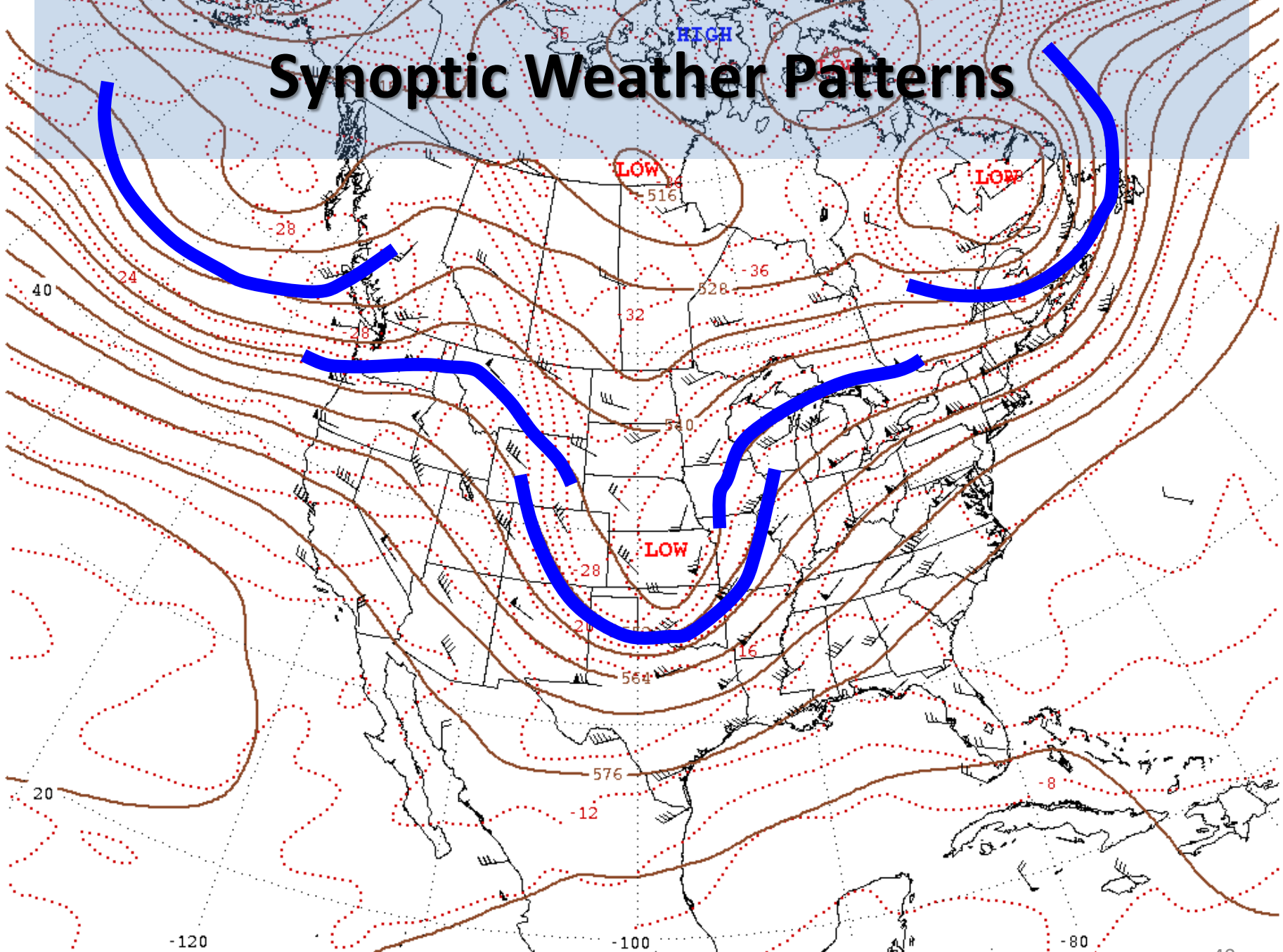


<https://www.wpc.ncep.noaa.gov/html/sfc2.shtml>

# Observations in 3-D: U/A Patterns

Why are some systems stronger than others?

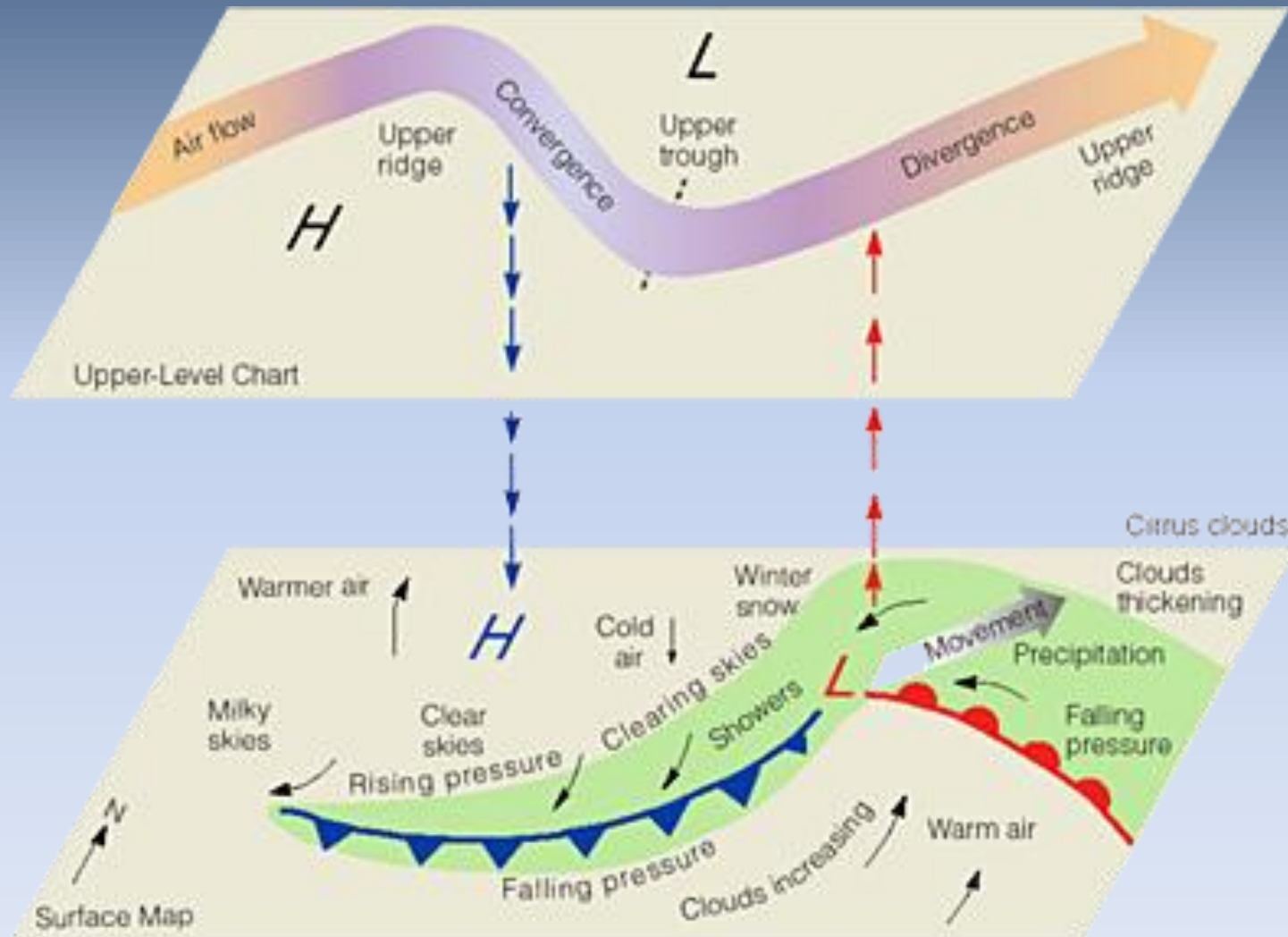
# Synoptic Weather Patterns

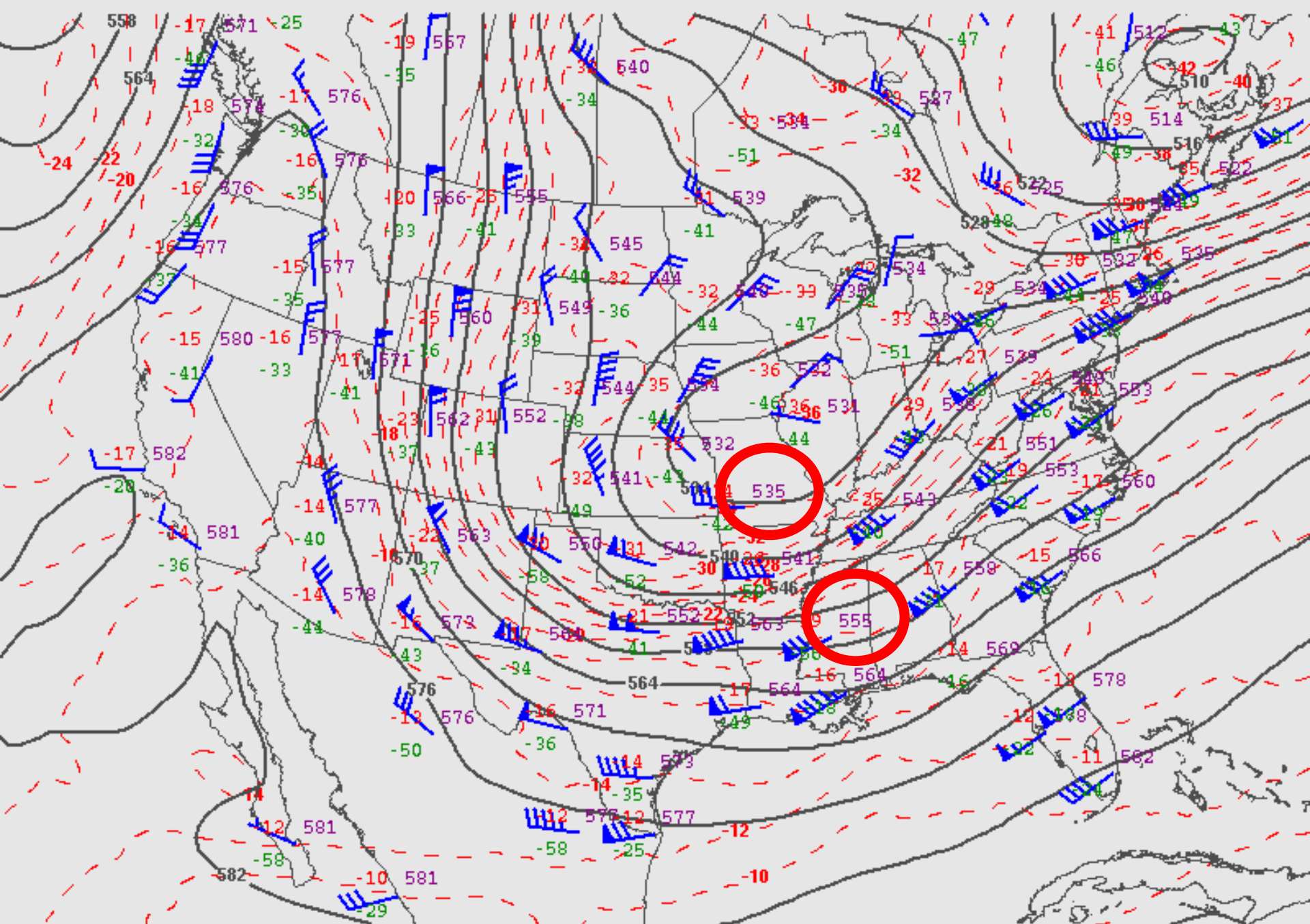


THU, JAN 10, 2008

500-Millibar Height Contours at 7:00 A.M. E.S.T.

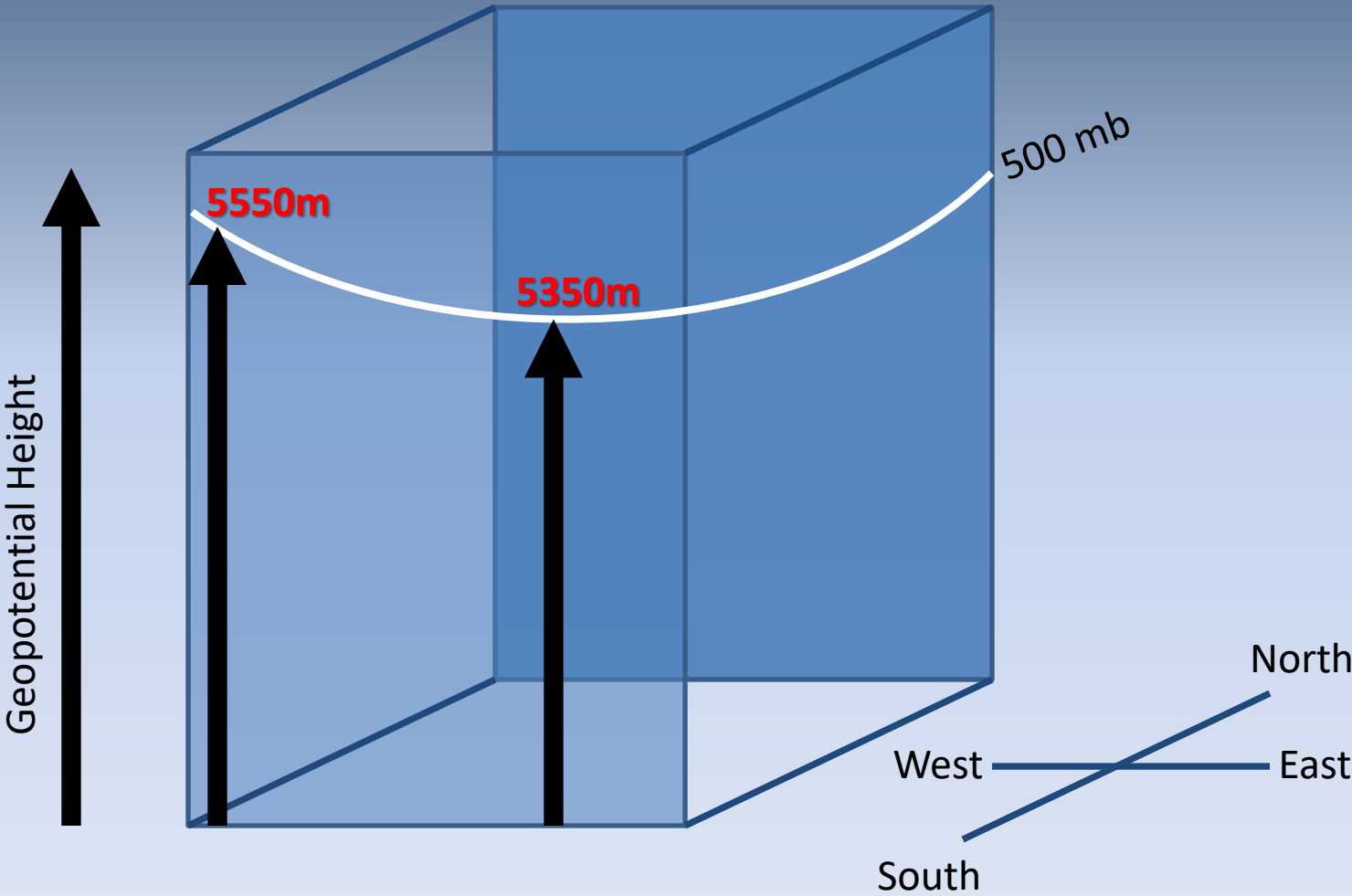
# Observations in 3-D: U/A Patterns

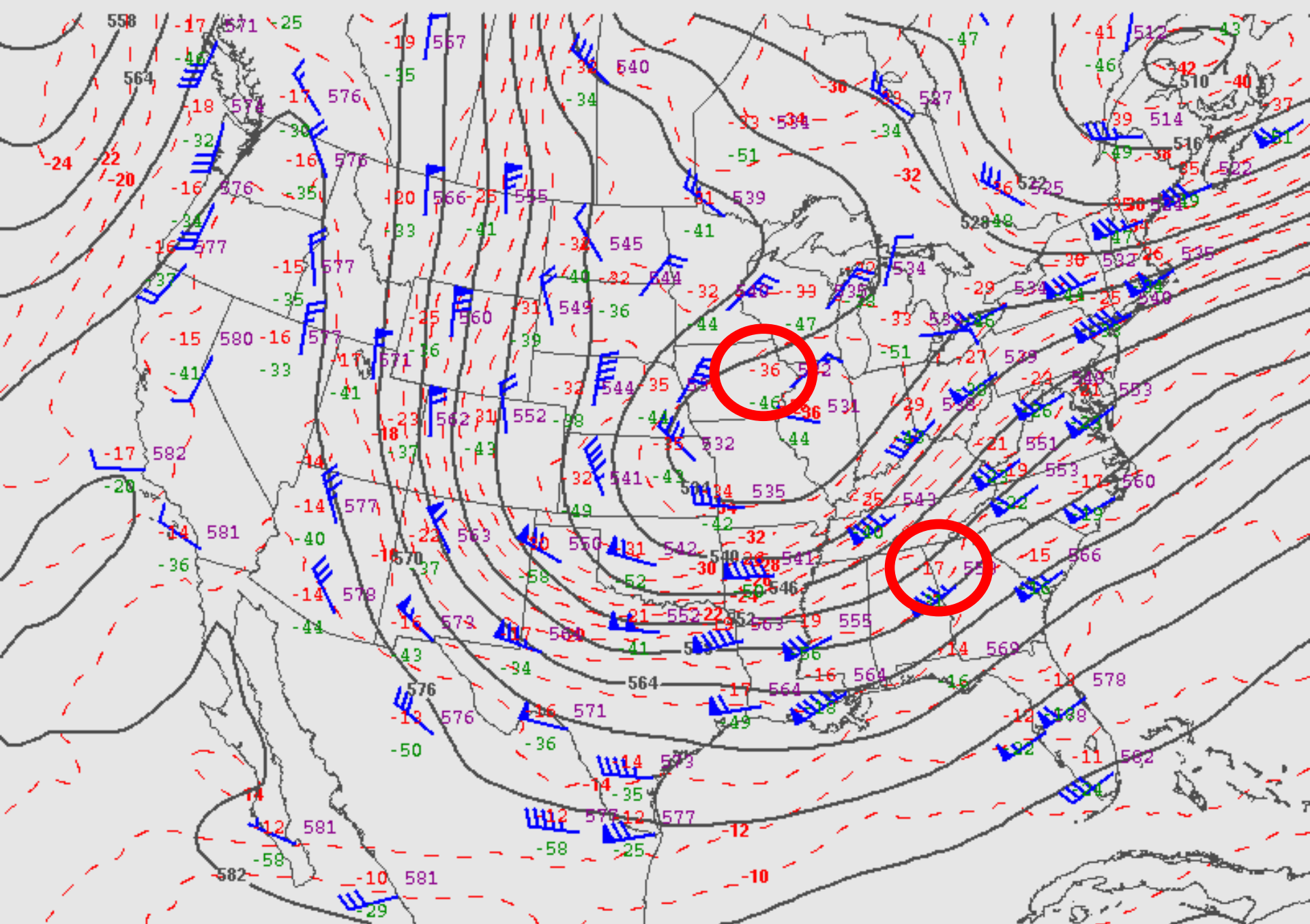




060211/1200 500 MB UA OBS, HGHTS, and TEMPS

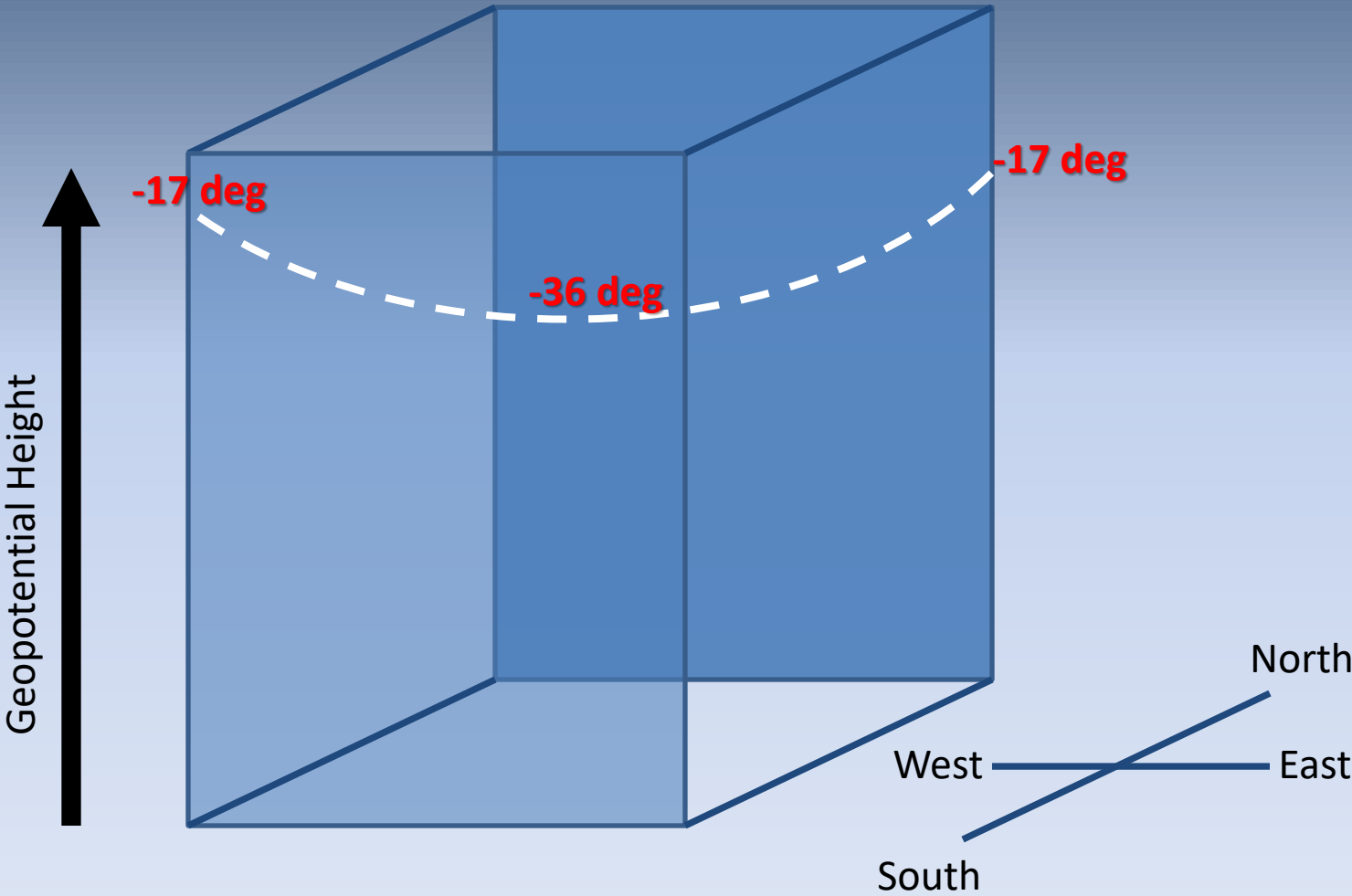
# Observations in 3-D: Cross Section of Upper Low

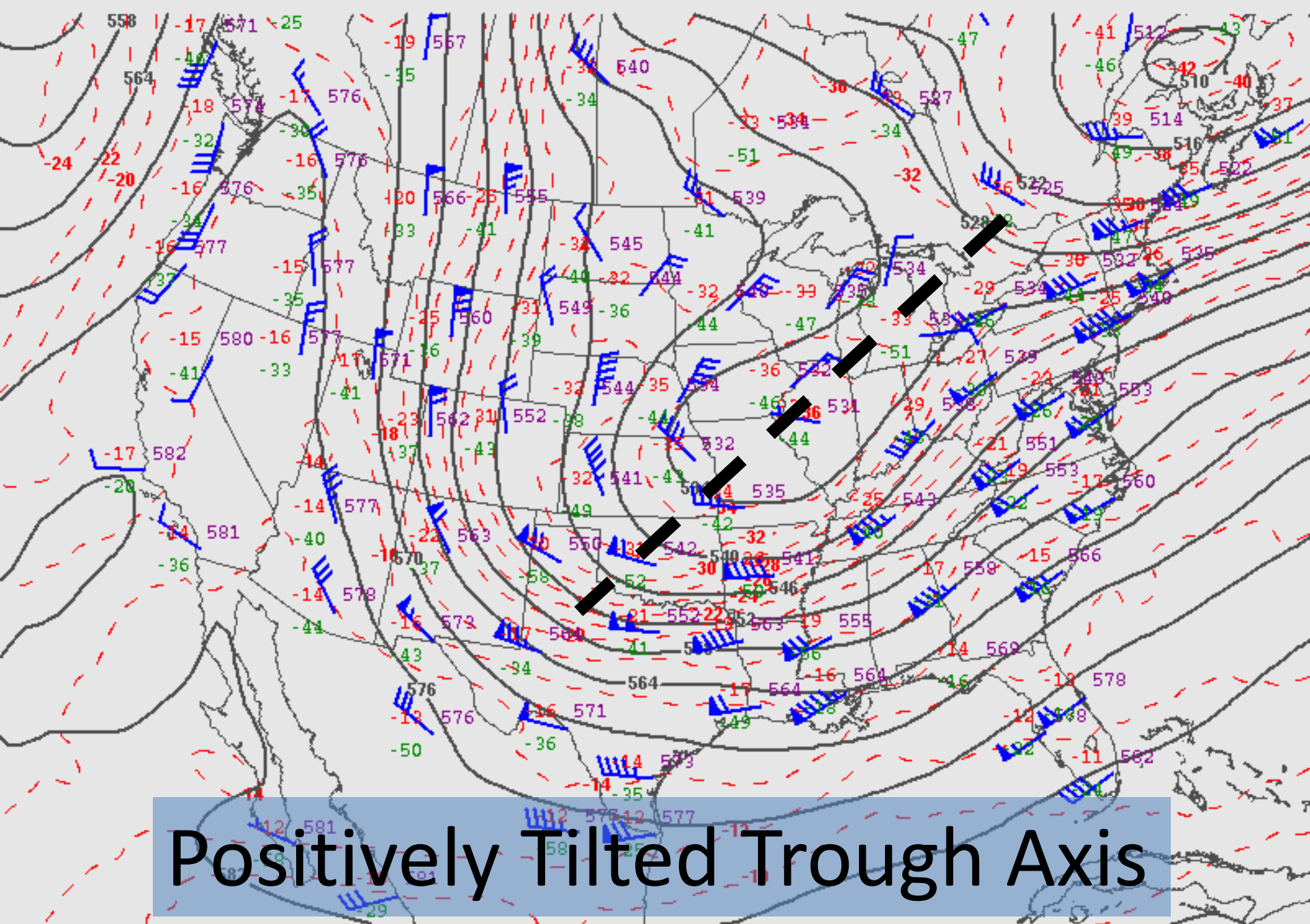




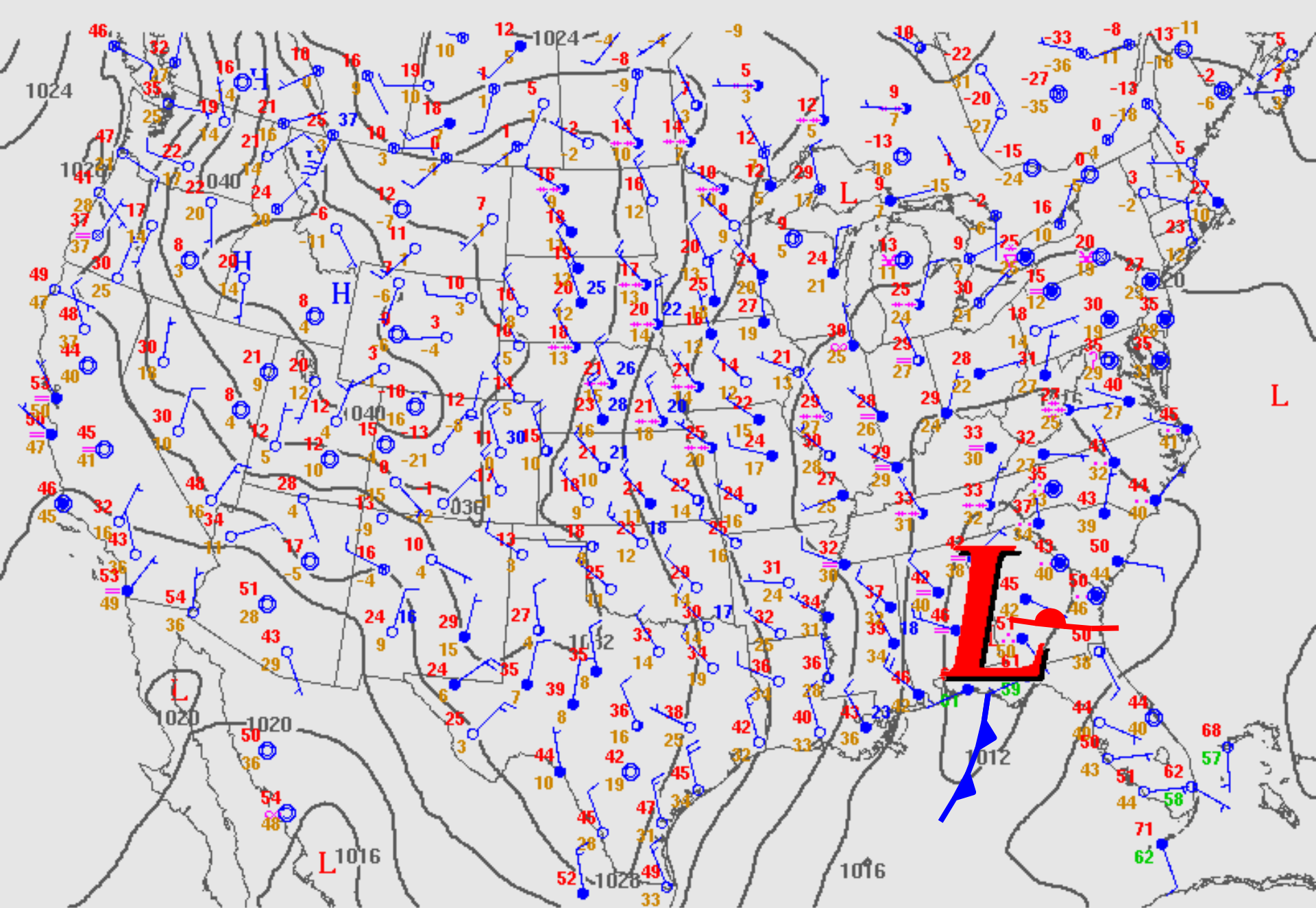
060211/1200 500 MB UA OBS, HGHTS, and TEMPS

# Observations in 3-D: Cross Section of Upper Low

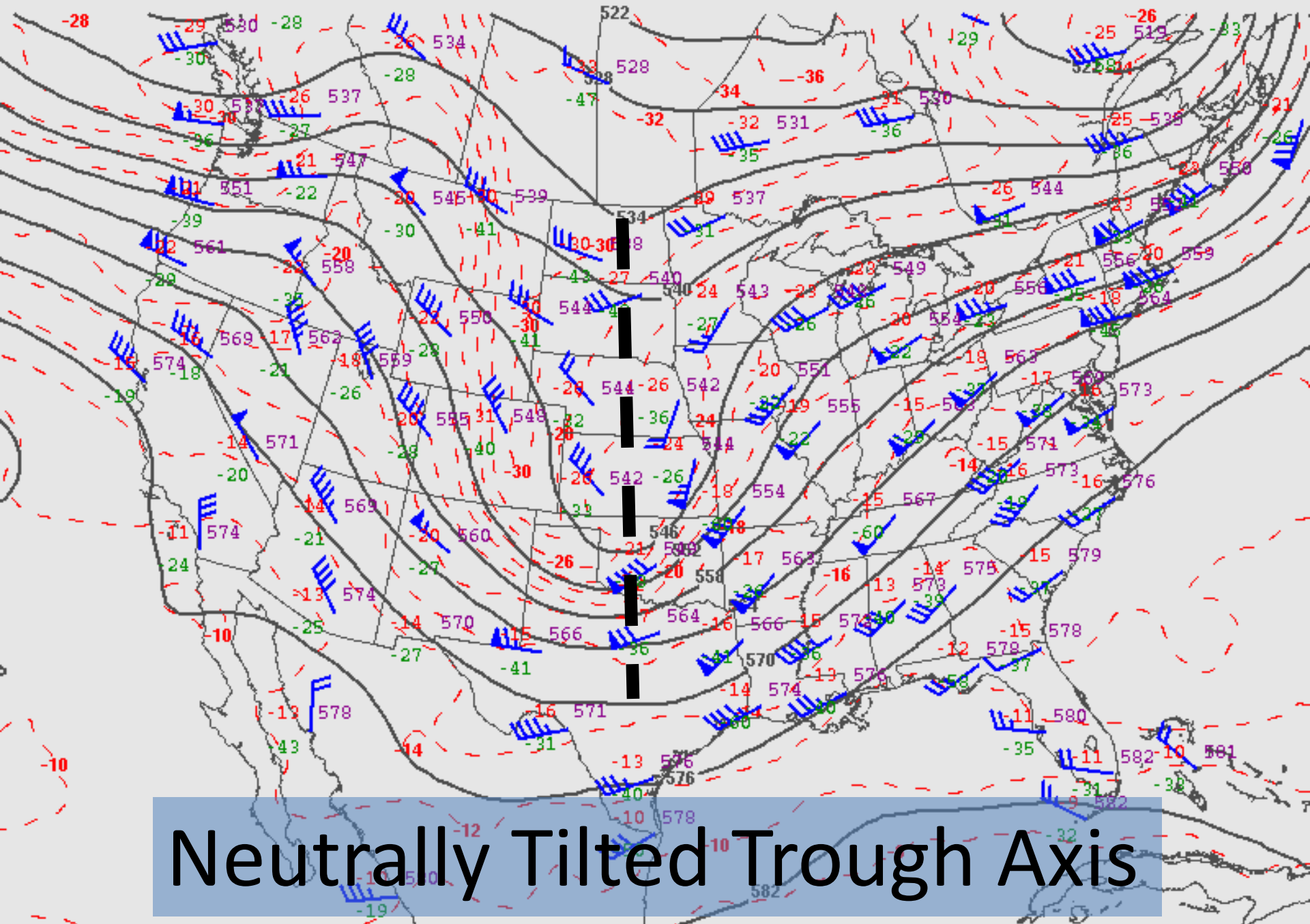




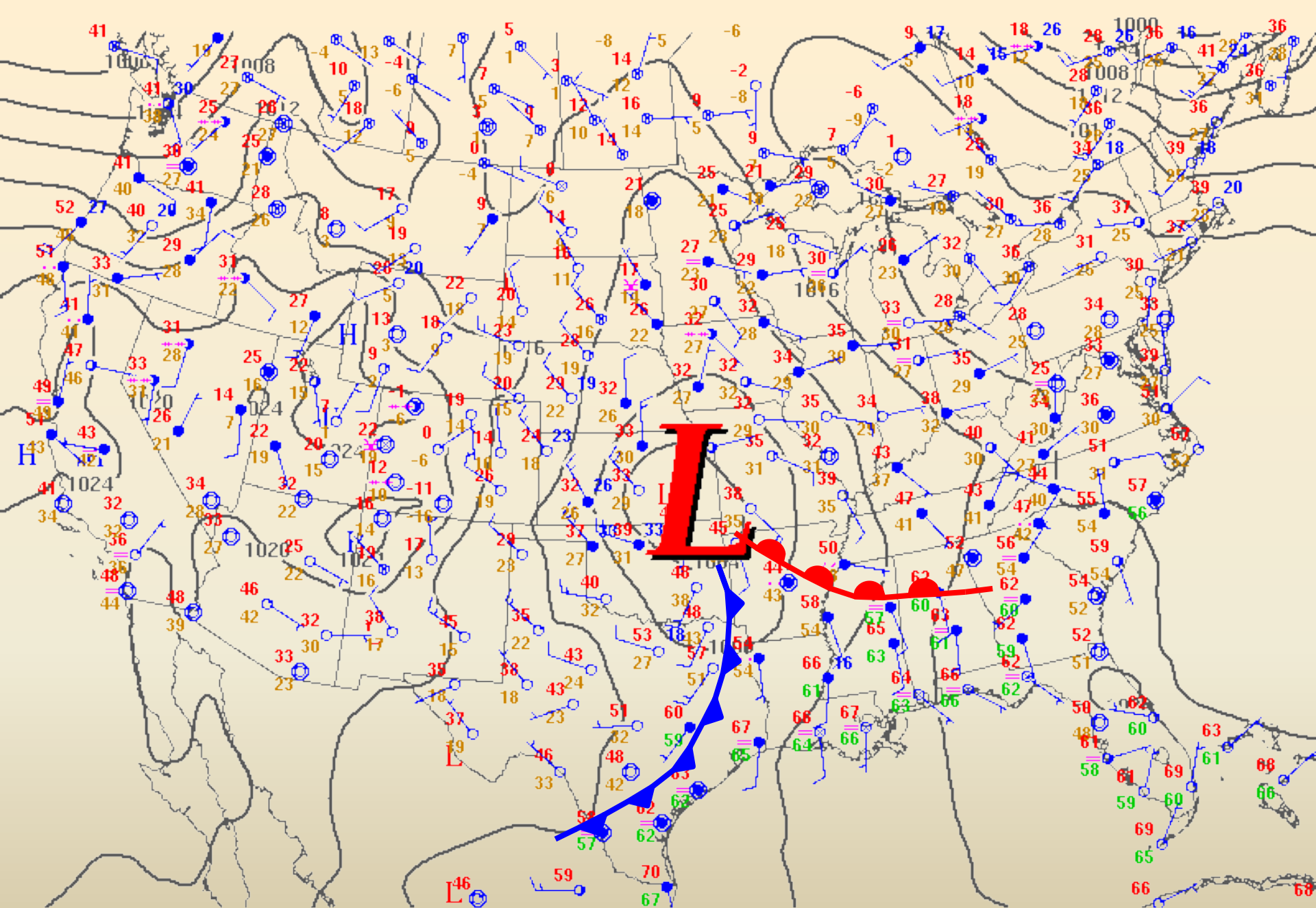
# Positively Tilted Trough Axis



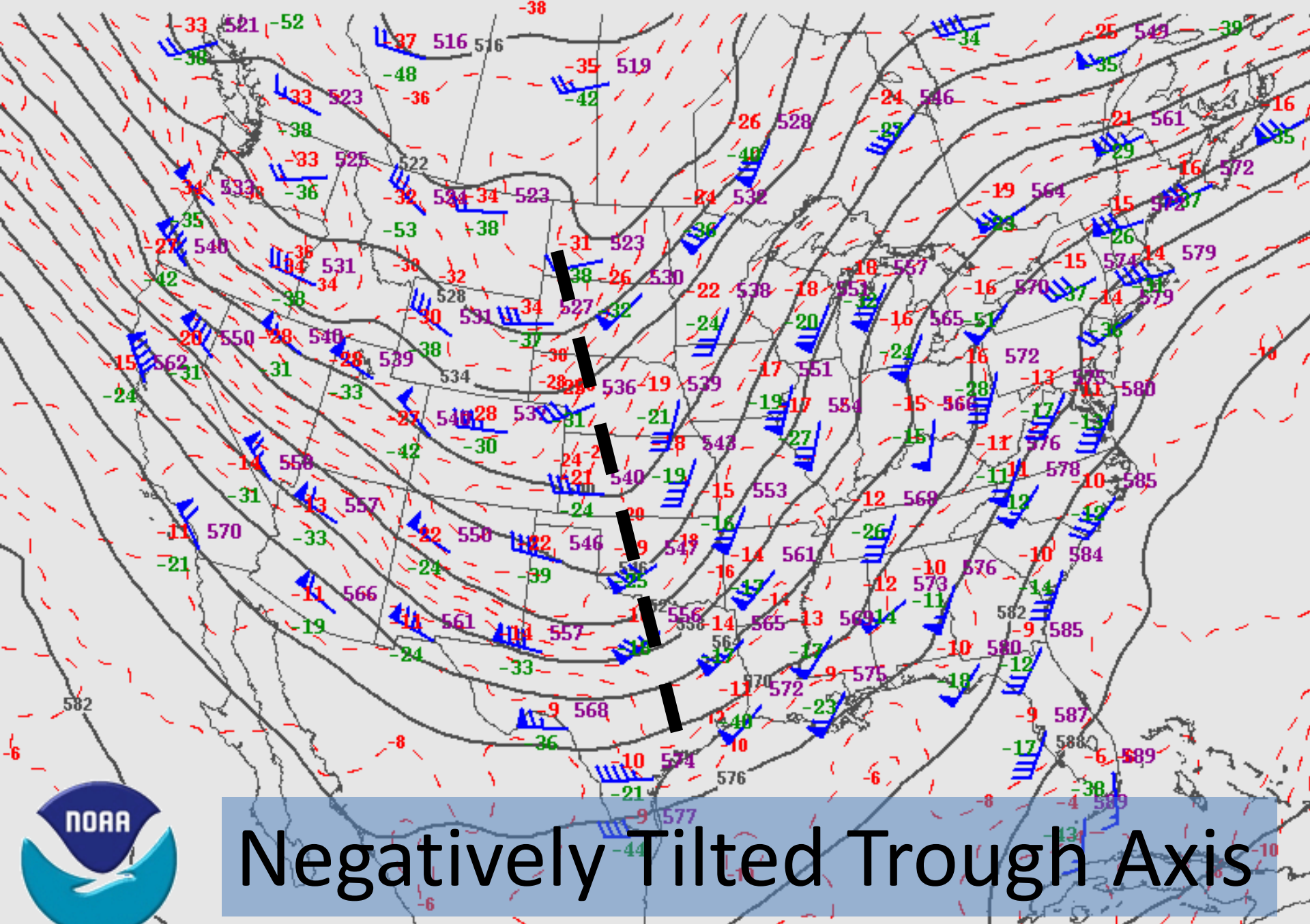
060211/1200 Surface OA Pressure and Obs  
Weather, Temp, Dwp, Gusts



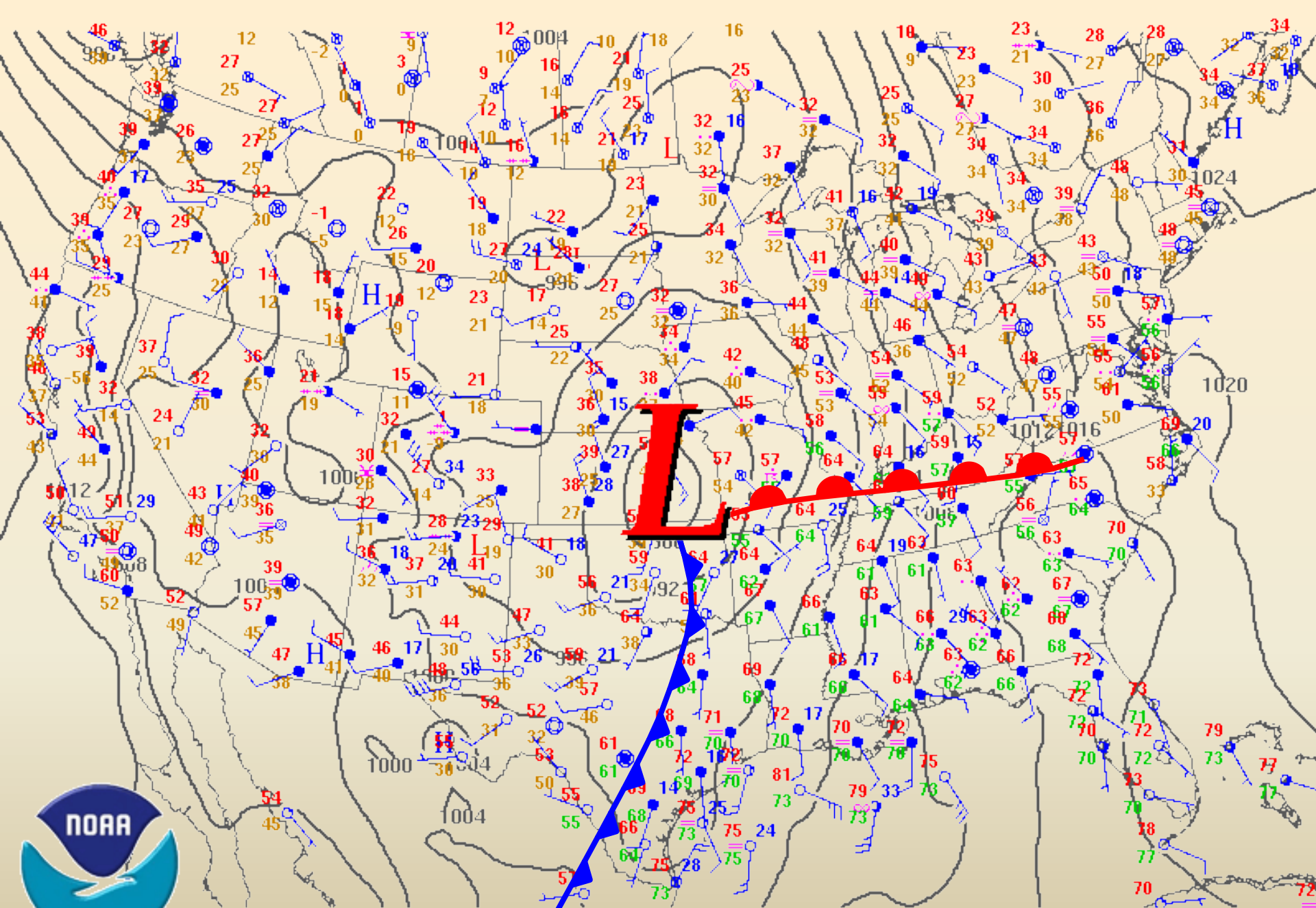
Neutrally Tilted Trough Axis



080110/1200 Surface OA Pressure and Obs  
Weather, Temp, Dwpt, Gusts



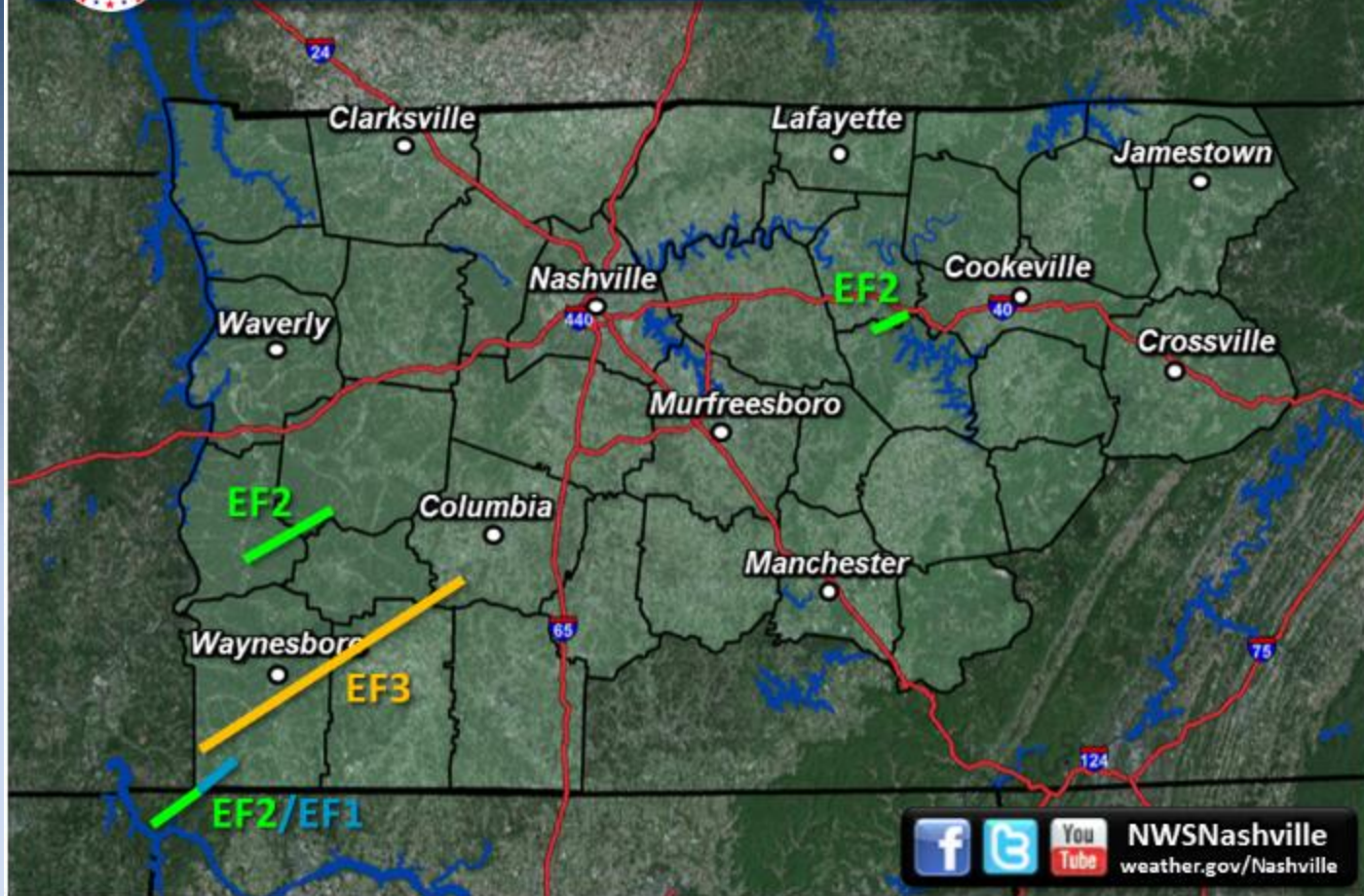
# Negatively Tilted Trough Axis



151223/1200 Surface OA Pressure and Obs  
 weather, Temp, Dwp, Gusts

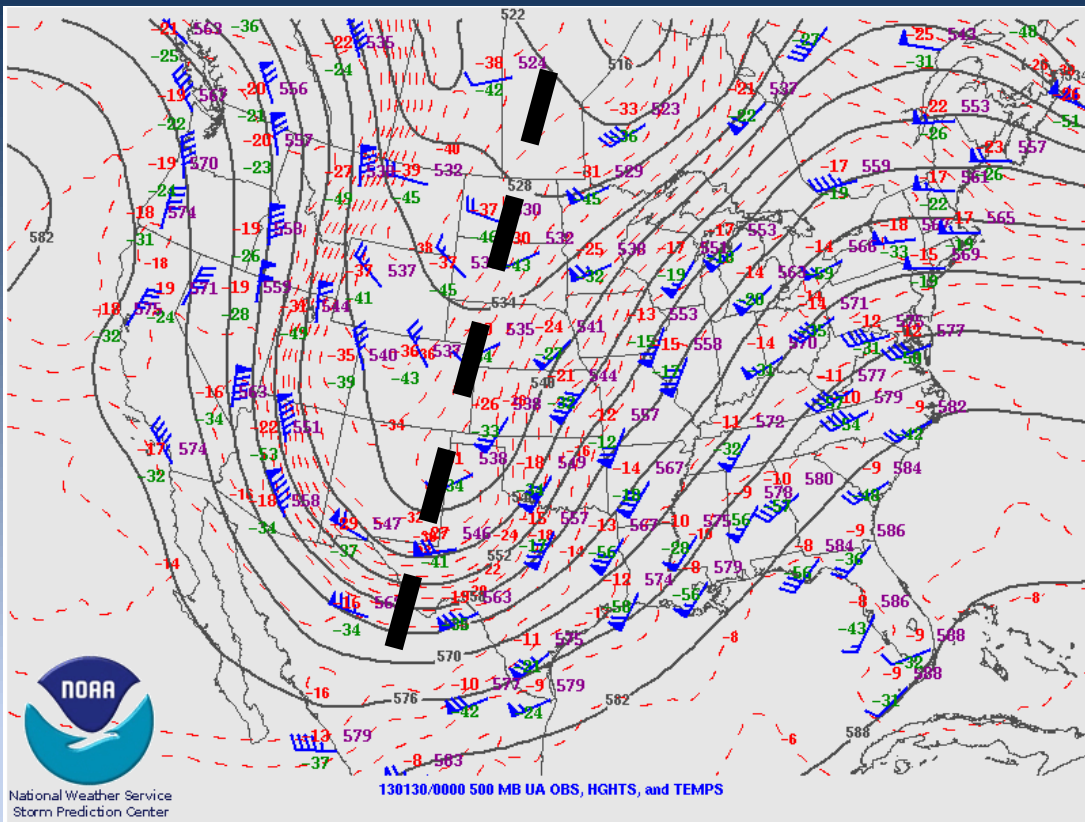


## December 23, 2015 Tornado Outbreak

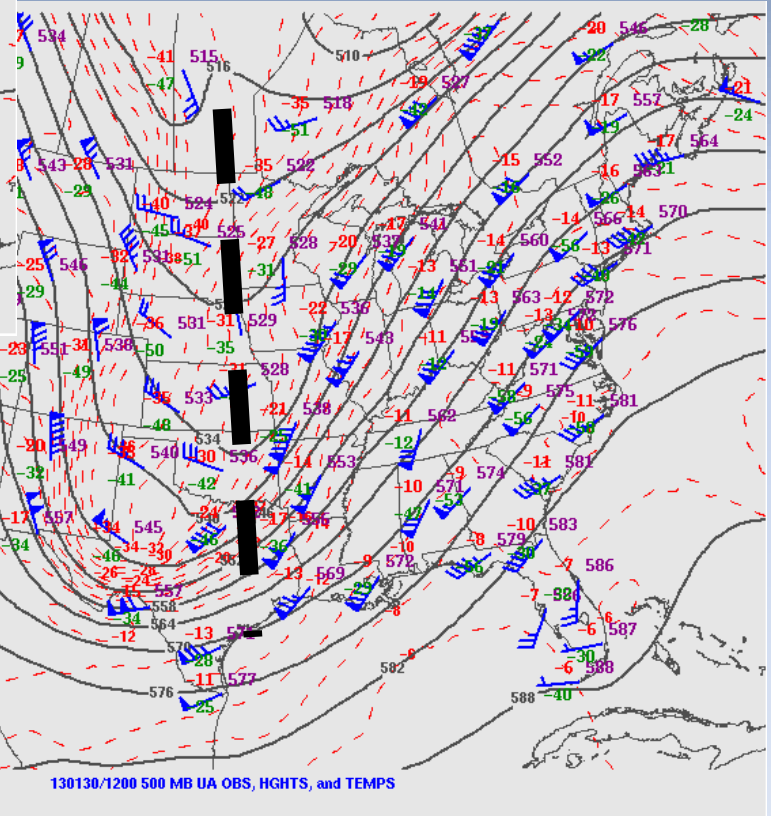


### Tornado Statistics

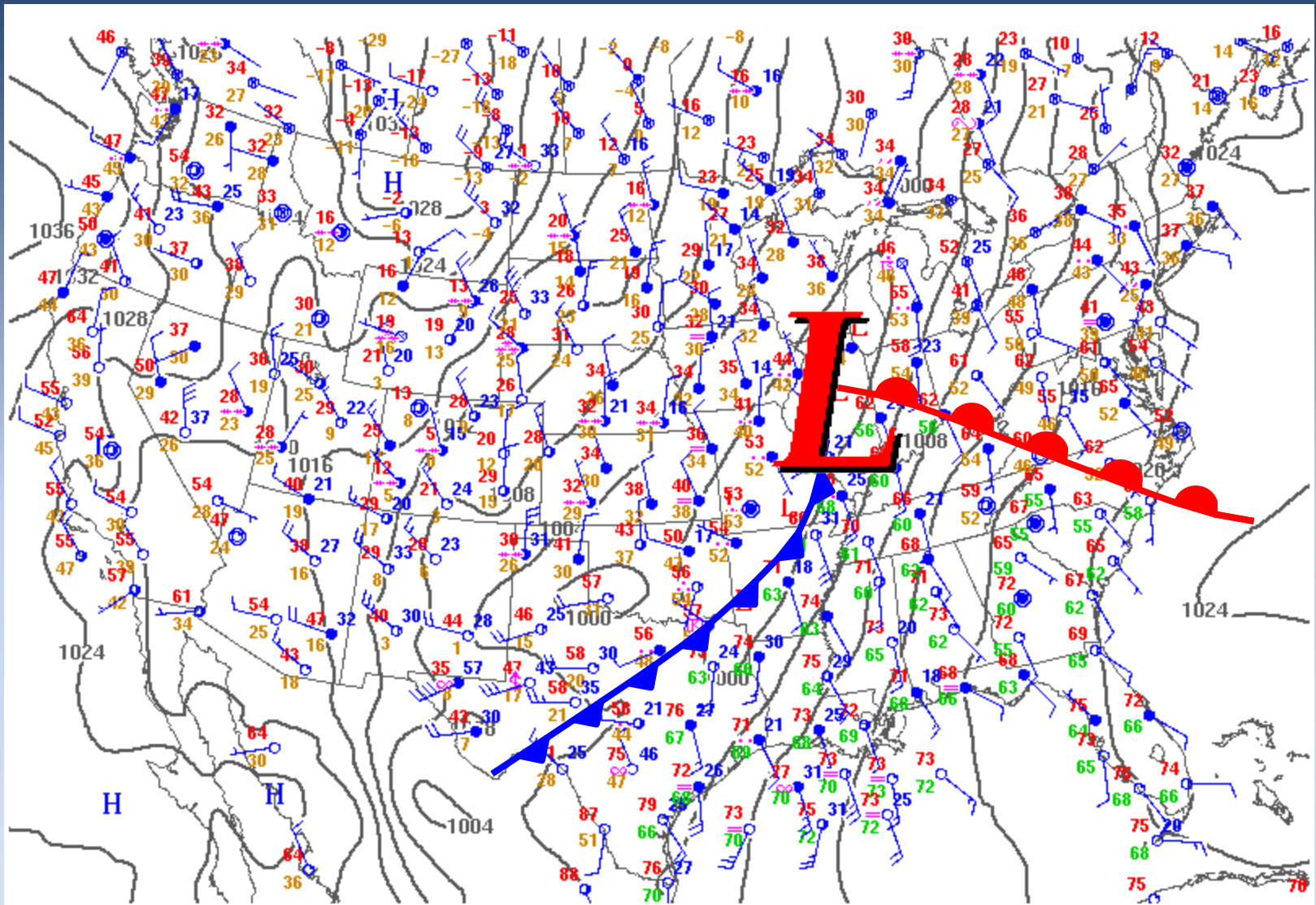
# Counties	Rating	Time (CST)	Length (miles)	Width (yards)	Fatalities	Injuries
1 Perry/Hickman	EF2	1818	13.95	500	2	0
2 Wayne/Lawrence/Lewis/Maury	EF3	1855	48.51	800	0	7
3 Lauderdale AL/Wayne	EF2/EF1	1900	11.0	400	0	0
4 DeKalb/Smith	EF2	2214	8.43	250	0	0



January 30<sup>th</sup>, 2013  
7 am



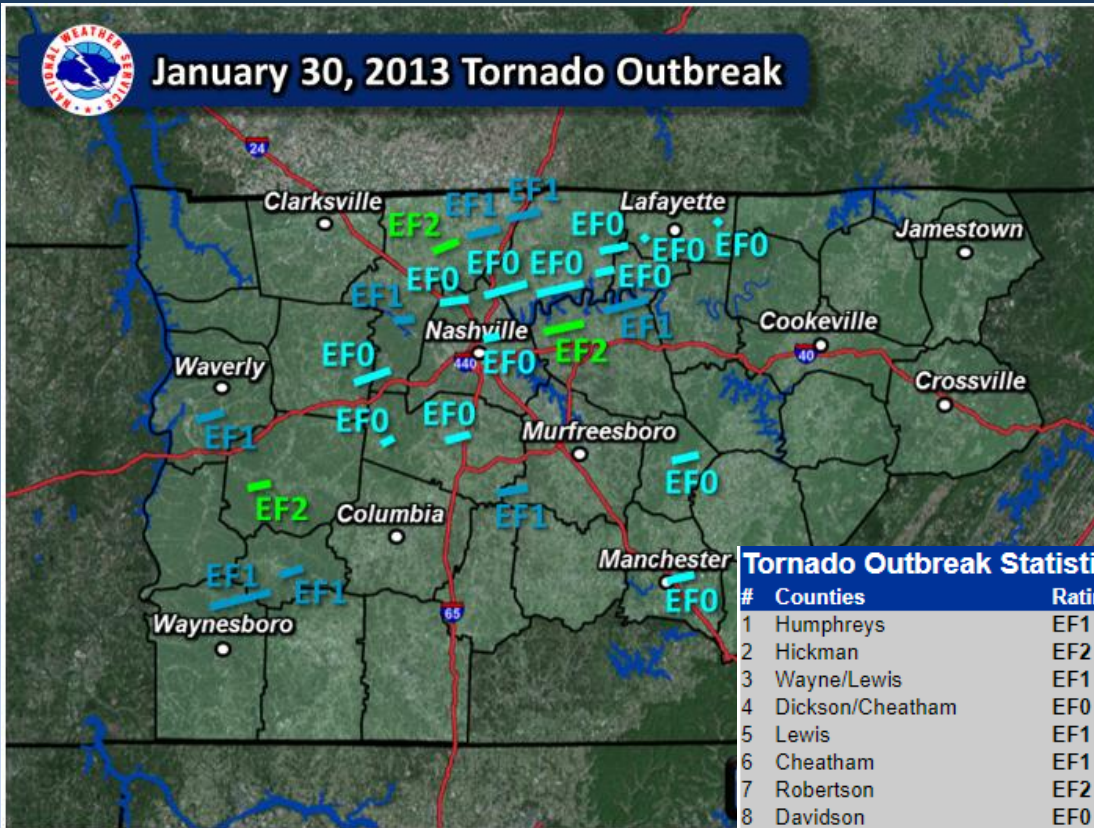
January 29<sup>th</sup>, 2013  
7 pm



130130/0000 Surface OA Pressure and Obs  
 Weather, Temp, Dwpt, Gusts



# January 30, 2013 Tornado Outbreak



## Tornado Outbreak Statistics

#	Counties	Rating	Time (CST)	Length (miles)	Width (yards)	Fatalities	Injuries
1	Humphreys	EF1	0211	5.22	150	0	0
2	Hickman	EF2	0226	4.55	500	0	0
3	Wayne/Lewis	EF1	0232	9.17	100	0	0
4	Dickson/Cheatham	EF0	0245	7.10	10	0	0
5	Lewis	EF1	0246	3.74	200	0	0
6	Cheatham	EF1	0251	3.23	125	0	1
7	Robertson	EF2	0259	4.97	200	0	0
8	Davidson	EF0	0300	5.55	50	0	0
9	Williamson	EF0	0301	1.00	75	0	0
10	Robertson	EF1	0305	5.75	150	0	0
11	Davidson/Sumner	EF0	0310	13.00	75	0	0
12	Robertson/Sumner	EF1	0312	4.90	100	0	0
13	Davidson	EF0	0312	3.20	75	0	1
14	Williamson	EF0	0318	2.30	75	0	0
15	Sumner	EF0	0323	10.61	125	0	0
16	Wilson	EF2	0325	5.51	150	0	0
17	Sumner	EF0	0334	3.63	100	0	0
18	Sumner/Trousdale	EF0	0337	6.10	50	0	0
19	Wilson/Trousdale	EF1	0340	9.91	150	0	0
20	Williamson/Rutherford	EF1	0341	4.78	150	0	0
21	Macon	EF0	0347	0.97	50	0	0
22	Macon	EF0	0401	1.53	75	0	0
23	Cannon	EF0	0429	6.65	200	0	0
24	Coffee	EF0	0525	5.24	75	0	0

# Upcoming classes

- Weather101
  - [www.weather.gov/ohx/weather101](http://www.weather.gov/ohx/weather101)
- Basic and Advanced SKYWARN Spotter Classes
  - [www.weather.gov/ohx/skywarn](http://www.weather.gov/ohx/skywarn)
- All classes held each spring and fall
- Spring: March to May
- Fall: October through mid-December



The National Weather Service Presents

# Weather101

## Upcoming Classes (times are CT):

TOMORROW	10 am	Monsoons
Mon, Dec 8	10 am	The Radar
Mon, Dec 8	7 pm	AI in Convective Outlooks
Tue, Dec 9	7 pm	Upper Air Soundings
Wed, Dec 10	10 am	Satellites
Thu, Dec 11	10 am	Rip Currents

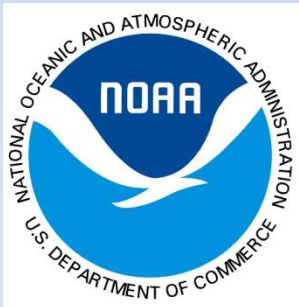
To register and for a full list of classes, visit to [weather.gov/ohx/weather101](http://weather.gov/ohx/weather101)

**These ONLINE classes are FREE and open to people of all ages**  
**Each class is hosted by a NWS meteorologist**  
**Classes run 1 hour or less including a Q&A session**

# Questions or Comments?

- Email: [scott.unger@noaa.gov](mailto:scott.unger@noaa.gov)
- If more than one, please send me an email with the number of people in attendance at your computer
- To download this presentation:

<https://www.weather.gov/ohx/weather101presentations>



U.S. Department of Commerce  
National Oceanic and Atmospheric Administration  
National Weather Service – Nashville, TN

