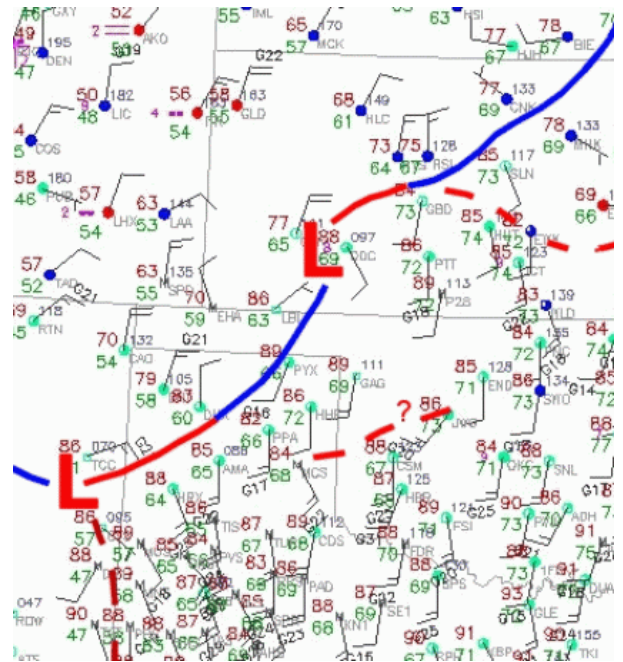
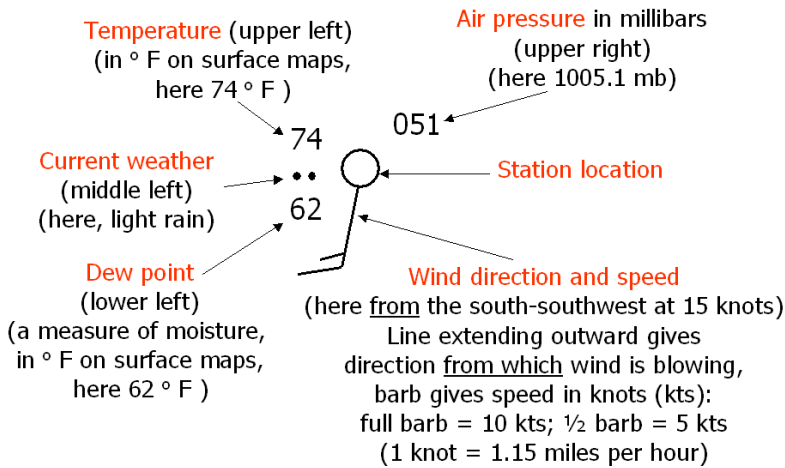


Storm Chasing & Tornado Forecast Class Notes

Jon Davies – Kansas City MO ChaserCon 2011 & 2012

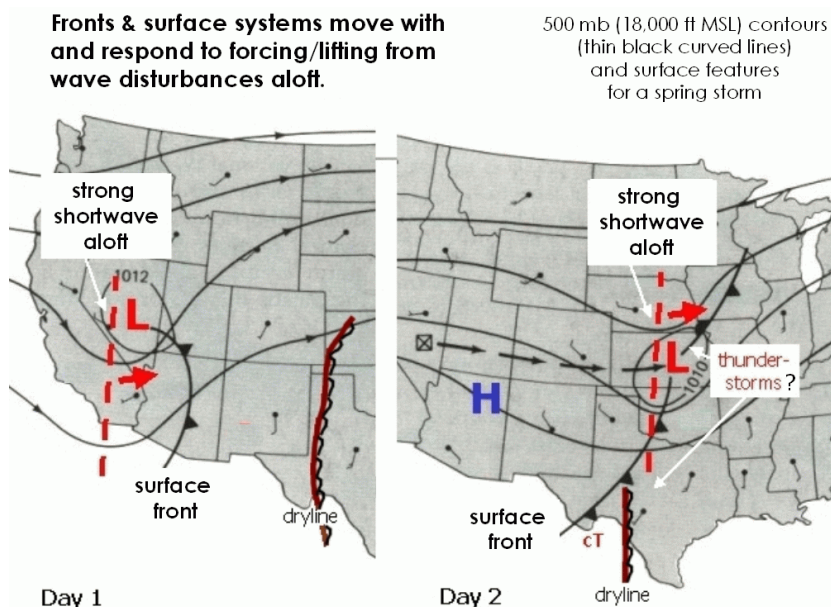
Basic surface station weather observation plot

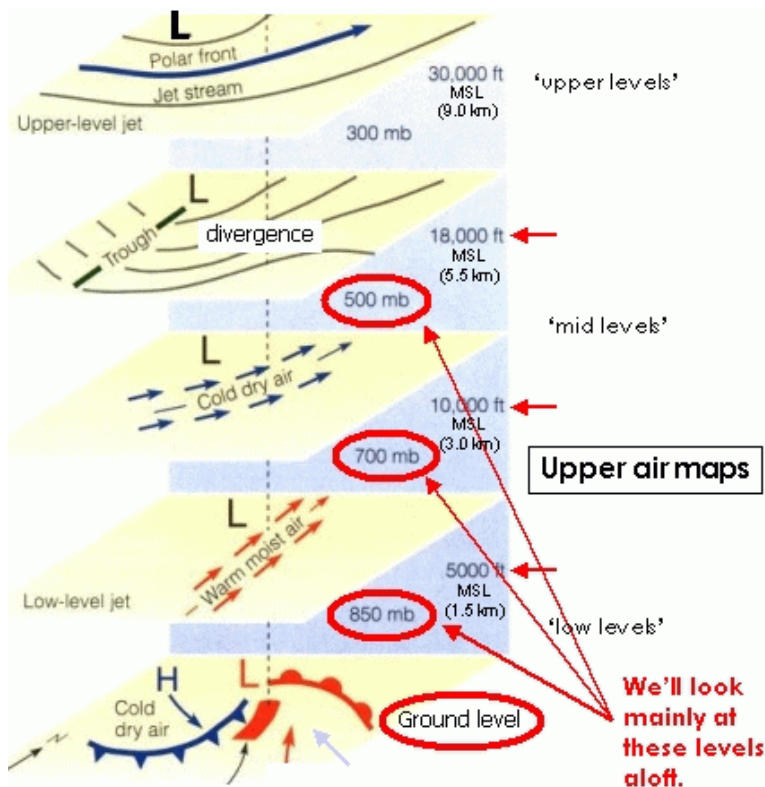


Boundaries can be located on surface weather maps by looking for any one or a combination of the following organized along a line or curve:

- Sharp temperature changes over a short distance
- Changes in moisture content (dew point)
- Changes in wind direction

Weather maps above ground (upper air maps) are important because they tell us a lot about what will be going on with our weather at the ground:





Upper air maps on computer model forecasts:

500 mb map (approx. 18,000 ft MSL):

- use this level to check for troughs & waves in the flow that produce lift
- also stronger wind speeds (deep shear) & jet stream branch locations – look for divergence (jet branches and winds “spreading apart”)

700 mb map (approx. 10,000 ft MSL):

- use this level to check for 70%+ RH (green areas) that suggest precip/storms
- also look at temperatures regarding capping issues (see table later)

850 mb map (approx. 5,000 ft MSL):

- use this level to check for stronger winds and location of low-level jet (contributes to low-level shear and storm-relative helicity or SRH).

Here are the main computer models that are run and maintained by the National Weather Service (National Centers for Environmental Prediction, or NCEP) and used by most forecasters: the GFS is for long range (2.3 week), NAM & RAP are shorter range (3.5 & 2 days), & HRRR has most detail for 1 or 2 days out):

- **GFS (Global Forecast System):** goes out to 16 days & is run 4 times per day (12z am & 00z pm runs most accurate as they use new sounding obs).
- **NAM (North American Mesoscale):** goes out to 3.5 days (84 hours), run 4 times per day.
- **RAP (Rapid Refresh):** goes out to 18 hours (out to 48 hours at 15z/21z/03z/09z), run hourly.
- **HRRR (High Resolution Rapid Refresh):** goes out to 18 hours (out to 48 hours at 12z/18z/00z/06z) run hourly. Has highest resolution detail, best for 1-2 day convective/thunderstorm forecasting.

The GFS is used to look farther ahead (out to 2 weeks), but it is very unreliable beyond 5-7 days. The early panels can also be used as a comparison to the NAM.

The NAM is used to look out to 3 days or so, and is more detailed than the GFS. The panels out to 12 hours can also be used as a comparison to the RAP.

The RAP and HRRR are short-range models used mostly within 1-2 days of an impending event. The HRRR is updated frequently with available current observations for even more detail.

Some brief comments/impressions about how computer models handle some things:

- The GFS can be compared with the European model (ECMWF, available on some sites), for longer range forecasting.
- I tend to use the RAP out to 48 hours more than the NAM, as my experience suggests it is better.
- The HRRR is best for thunderstorm forecasting with its greater detail, and shows “rotation” tracks on its radar forecast panels, suggesting where supercell storms may form and evolve. Be careful not to read these too literally, as they suggest storm mode in a general area, and can vary on the specifics from hour to hour runs.

Some sites with computer model forecast output:

College of DuPage (CoD):

weather.cod.edu/forecast (GFS, NAM, RAP, & HRRR – also ECMWF)

Pivotal Weather:

www.pivotalweather.com/model.php (same models as CoD above)

TwisterData:

www.twisterdata.com (GFS, NAM, & RAP)

UCAR site (has been around for a long time):

weather.rap.ucar.edu/model (GFS, NAM, & RAP)

Computer models, at best, are only an approximation and estimation of the atmosphere. They make assumptions that may not apply well, and data initialization over oceans is sparse.

- As models go farther out in time, errors amplify to make large inaccuracies.
- Use computer models only as "opinion" to be considered and compared.

Reading UTC time (computer models and most weather maps use "UTC" or "Z" time stamps - they are the same): Using a 24-hour/military time system, subtract the proper number of hours for your time zone from the given UTC time to get your local time in "military hours".

TIME	24-HR SYSTEM TIME	TIME	24-HR SYSTEM TIME	TIME	24-HR SYSTEM TIME	TIME	24-HR SYSTEM TIME
A.M.		A.M.		P.M.		P.M.	
12:00 (midnight)	0000	6:00	0600	12:00 (noon)	1200	6:00	1800
1:00	0100	7:00	0700	1:00	1300	7:00	1900
2:00	0200	8:00	0800	2:00	1400	8:00	2000
3:00	0300	9:00	0900	3:00	1500	9:00	2100
4:00	0400	10:00	1000	4:00	1600	10:00	2200
5:00	0500	11:00	1100	5:00	1700	11:00	2300

Pacific Time Zone Mountain Time Zone Central Time Zone Eastern Time Zone

Subtract 8 hours from the UTC time to get PST time. Subtract 7 hours from the UTC time to get MST time. Subtract 6 hours from the UTC time to get CST time. Subtract 5 hours from the UTC time to get EST time.

Subtract 7 hours from the UTC time to get PDT time. Subtract 6 hours from the UTC time to get MDT time. Subtract 5 hours from the UTC time to get CDT time. Subtract 4 hours from the UTC time to get EDT time.

Other UTC conversion information:

- If the UTC time is given as 4 digits, put a decimal at 2 places: 0045 UTC = 00.45
 - If the UTC time is given as 2 digits, it is a whole number: 03 UTC = 03.00 or 11 UTC = 11.00
 - If the UTC time is less than the number of hours you're subtracting for your time zone, add 24 to the UTC time: 0243 UTC (02.43) is less than any of the hours one would subtract in any U.S. time zone, so add 24: 2.43 + 24 = 26.43 when doing the conversion (0243 UTC = 9:43 pm CDT, or 8:43 pm CST).
- Also, remember that dates change backwards a day when doing evening & most nighttime UTC time conversions: 0000 UTC 5 May 2007 is actually 7:00 pm CDT 4 May 2007
 04 UTC 21 February 2011 is actually 10:00 pm CST 20 February 2011

If this all seems too complicated, memorize a table of time conversions for your time zone, such as:

**Table converting Universal Time (UTC)
to Central Time (CST or CDT):**

0000 UTC =	6:00 p.m. CST	= 7:00 p.m. CDT
0300 UTC =	9:00 p.m. CST	= 10:00 p.m. CDT
0600 UTC =	midnight CST	= 1:00 a.m. CDT
0900 UTC =	3:00 a.m. CST	= 4:00 a.m. CDT
1200 UTC =	6:00 a.m. CST	= 7:00 a.m. CDT
1500 UTC =	9:00 a.m. CST	= 10:00 a.m. CDT
1800 UTC =	noon CST	= 1:00 p.m. CDT
2100 UTC =	3:00 p.m. CST	= 4:00 p.m. CDT

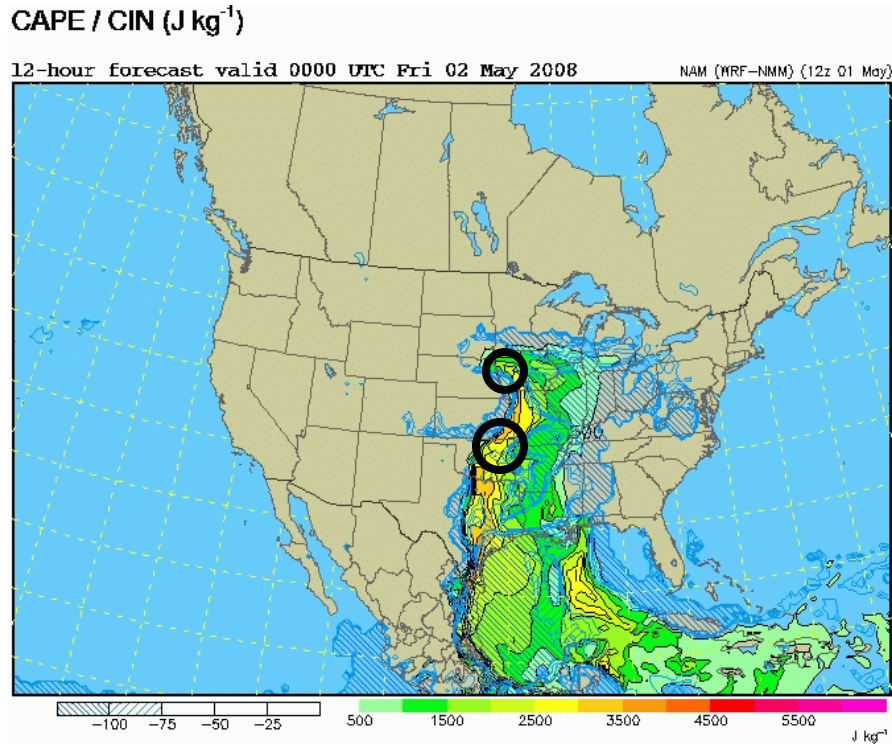
Basic Requirements for Severe Thunderstorms (strong convection):

- ✓ **Moisture and instability**
 - seasonably large dew points
 - moisture and warmth for CAPE (instability)

- ✓ **Significant wind shear**
 - strong winds aloft for supercells
 - winds veering and increasing with height
in lower-levels for possible tornadoes

- ✓ **Forcing and upward motion**
 - waves of energy aloft (divergence)
 - surface boundaries for convergence and lift
 - daytime heating can help
 - absence of an inhibiting capping inversion

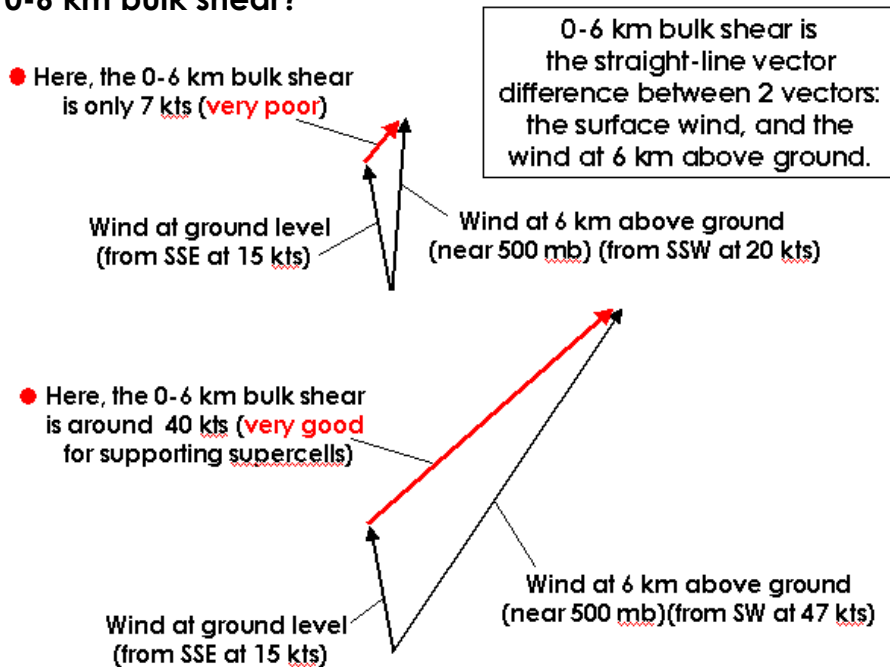
Moisture and instability – look for CAPE (forecast from NAM model below):



Significant wind shear for supercells (deep layer shear required, along with CAPE):

- look for strong winds aloft at 500 mb, 30-35 kts, prefer 40-50 kts or more
- look for 0-6 km bulk wind shear at least 30-35 kts, prefer 40-50 kts or more

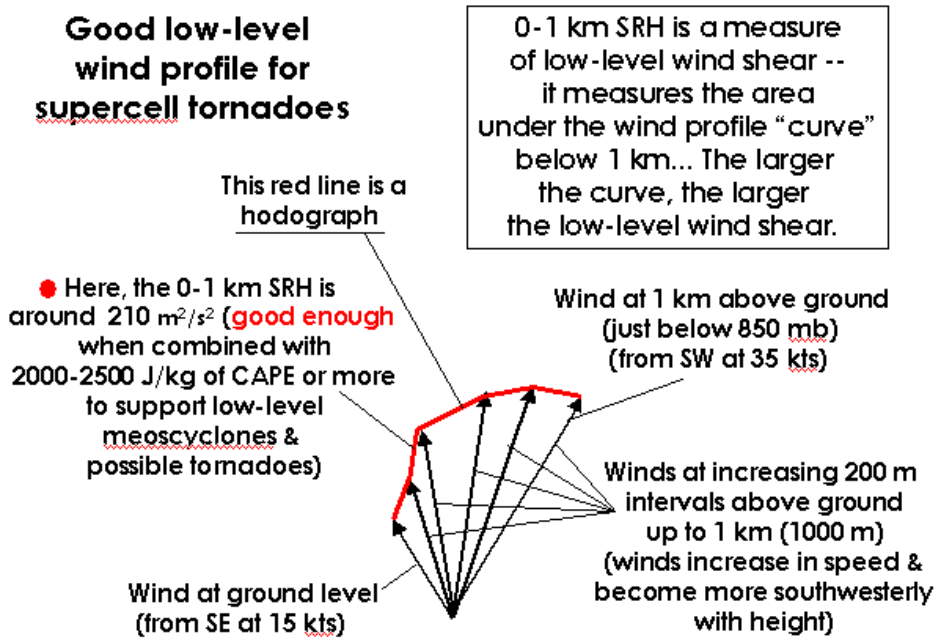
What is 0-6 km bulk shear?



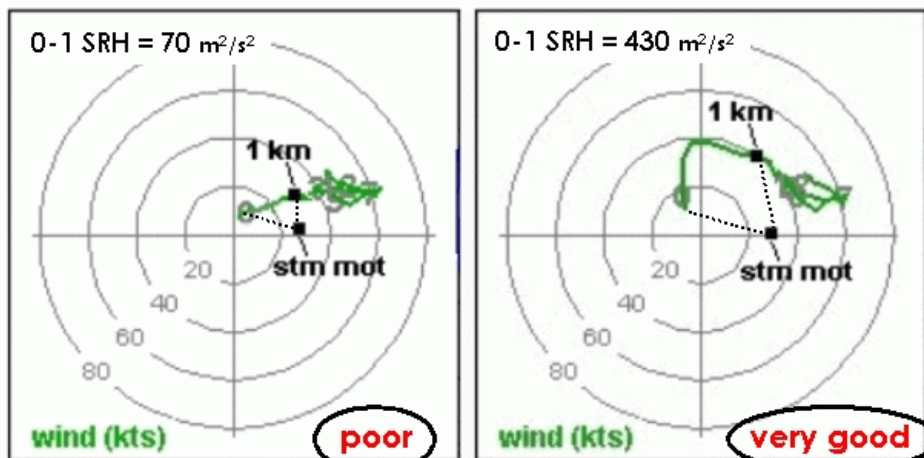
Significant wind shear in low-levels needs to be added to support tornadoes:

- winds veering and increasing with height in low-levels to induce rotation
- strong low-level jet at 850 mb
- sizable 0-1 km storm-relative helicity (SRH), with low-level winds as above - desired values will vary (100-300+ m^2/s^2), depending on amount of CAPE

Note: when 0-1 km SRH < 100 m^2/s^2 , this is not very supportive of tornadoes EXCEPT in the high plains west of 100 deg west longitude where warmer temps at higher surface elevations (resulting in steep low-level lapse rates) can help storms "stretch" to at times produce tornadoes with smaller SRH shear at these higher plains elevations.



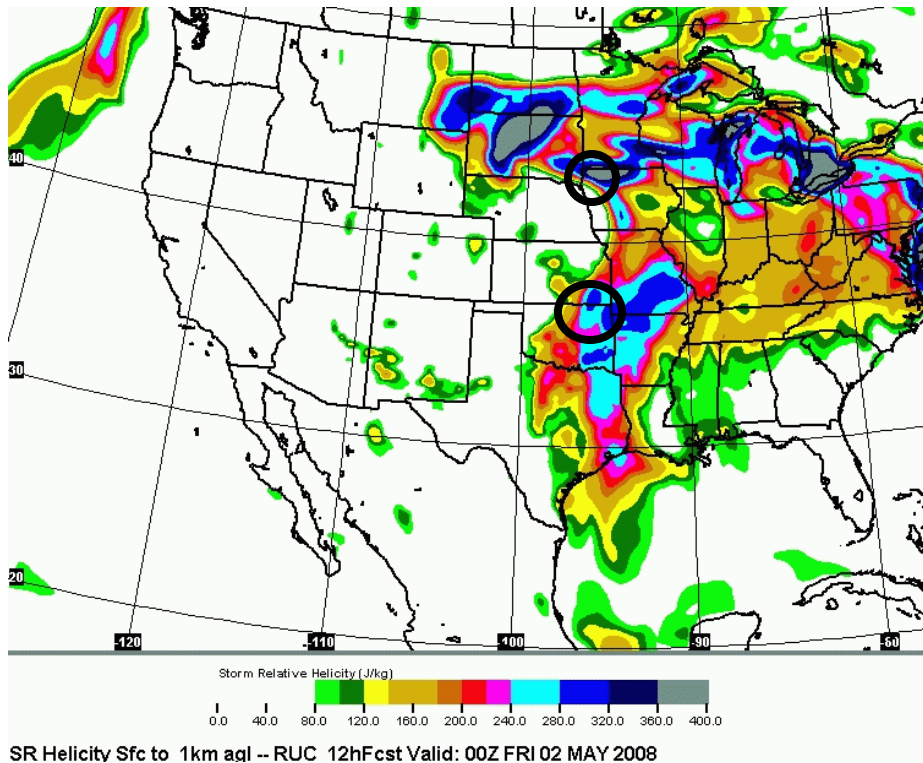
0-1 km SRH from contrasting hodographs



5/13/09 NW Missouri (non-tornadic supercell)

5/13/09 NC Missouri (EF2 tornadic supercell)

The SPC mesoanalysis page shows regional hodographs on maps at: www.spc.noaa.gov/exper/mesoanalysis (click on 'Hodograph Map' at bottom of 'Wind Shear' drop down menu)

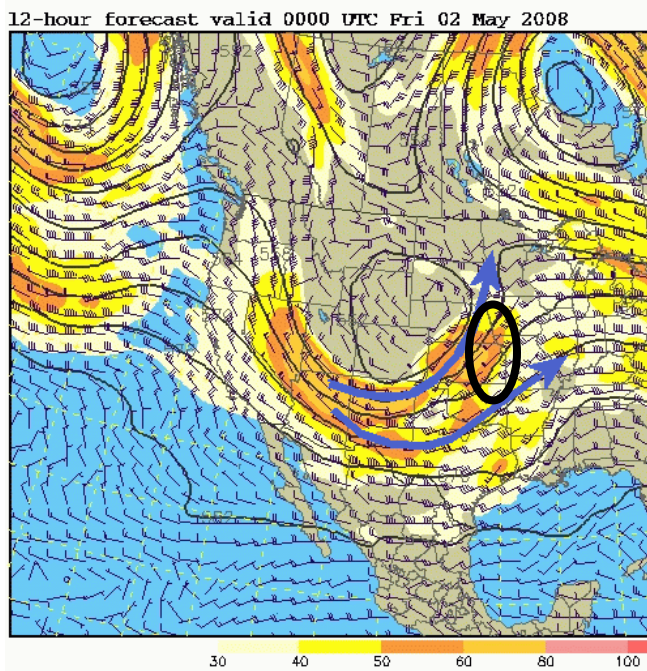


Note large 0-1 km SRH (circled areas) on RAP/RUC model forecast above, suggesting better potential for tornadoes in those specific areas along moisture axis (compare with CAPE forecast earlier).

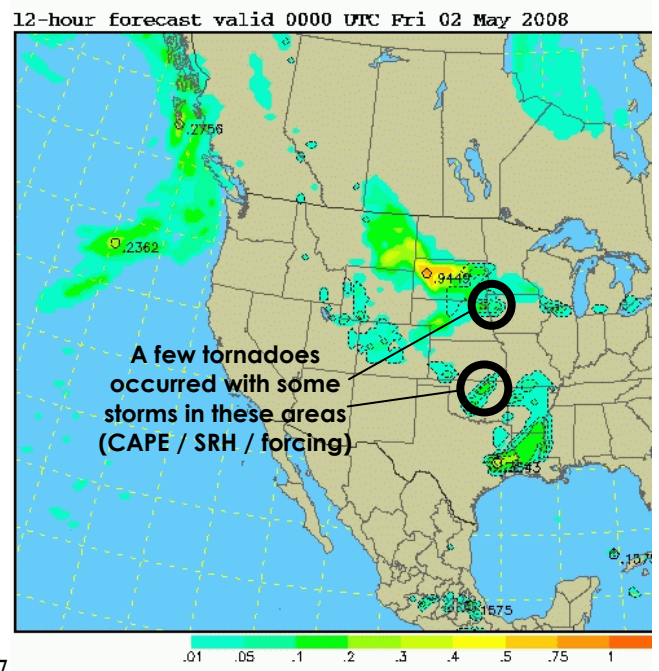
Forcing and upward motion (needed to initiate thunderstorms)

- Check 500 mb forecasts for waves, jet stream branches, & divergence (below).
- Check surface map forecasts and evolving surface maps for areas of wind and moisture convergence, also for heat/thermal axes.
- Check model precipitation/radar forecasts for initiation of convection (below).
- Check 700 mb forecasts for temperature pattern (locate any "capping" issues, next page).

500 mb Heights (dm) / Isotachs (knots)

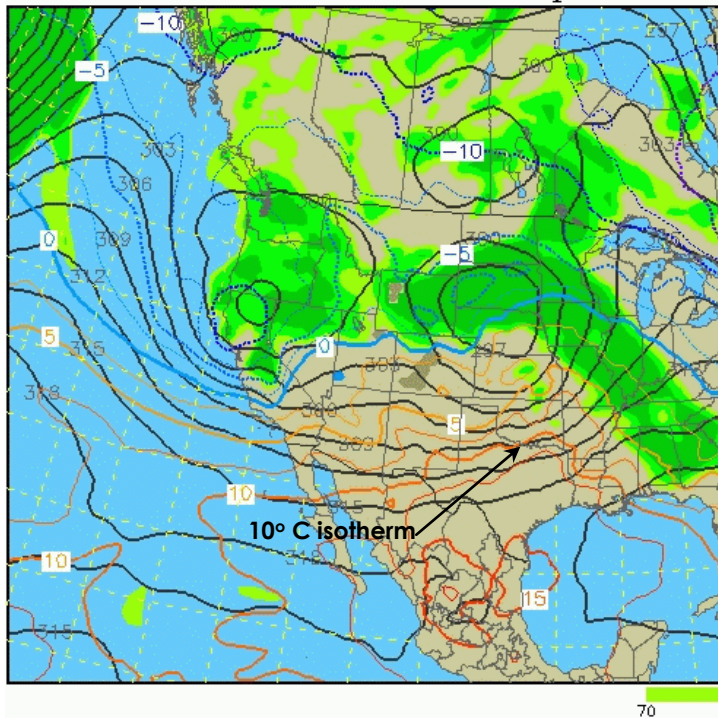


12-h accum precip (total-shaded; convect-dashed)



700 mb Heights (dm) / Temperature (°C) / Humidity (%)

12-hour forecast valid 0000 UTC Tue 11 May 2010



The 700mb map in the separate case shown above shows the 10° C isotherm near the border between TX and OK. The rough chart below suggests that the area south of the Red River is “capped”, with temperatures near 10,000 ft MSL too warm for thunderstorm initiation.

A chart like this can help avoid some “cap bust” forecasts by estimating the southern extent of thunderstorm development.

700 mb temperature estimations of areas that are “capped” (too warm aloft for thunderstorms):

	Spring	Fall	
March	approx $\geq 5-6^{\circ}$ C	August	approx $\geq 12^{\circ}$ C
April	approx $\geq 7-8^{\circ}$ C	September	approx $\geq 9-11^{\circ}$ C
May	approx $\geq 9-11^{\circ}$ C	October	approx $\geq 7-8^{\circ}$ C
June	approx $\geq 12-13^{\circ}$ C	November	approx $\geq 5-6^{\circ}$ C

*This chart doesn't work well in the western High Plains due to elevation (e.g., eastern NM, eastern CO, far western NE, etc.).

Have fun forecasting!
- Jon Davies 2012

davieswx.blogspot.com

www.jondavies.net