Index values for tornadoes

General guidance only, literature and opinion varies

Use with caution, and false alarms possible

Assembled by Pat Fitzpatrick

Showalter Index	SI<-6	
Lifted Index	LI<-4	
Total Totals Index	$50 \leq TT \leq 51$ Isolated tornadoes	
	$52 \leq TT \leq 55$ A few tornadoes	
	$TT \geq 56$ Scattered tornadoes	
Convective Available Potential Energy (units J kg^{-1})	CAPE > 2500	
Severe WEAther Threat Index	$400 \leq SWEAT \leq 499$ Tornadoes possible	
	$500 \leq SWEAT \leq 599$ Tornadoes likely	
	$SWEAT \geq 600$ Tornado outbreak likely	
0-1 km or "effective" storm-relative helicity (units m^2 s^{-2}) For 0-3 km, add 150 Only meaningful if convection already exists	$150 \leq SRH \leq 299$ Storm rotation possible	Some suggests this also indicates EF0 and EF1 tornadoes are possible
	$300 \leq SRH \leq 399$ Supercell rotation possible	Some suggests this also indicates EF2 and EF3 tornadoes are possible
	$SRH \geq 400$ Tornadic storm possible	Some suggests this also indicates EF4 and EF5 tornadoes are possible
Bulk Richardson Number (Only use if $1500 \leq CAPE \leq 3500$)	$BRN \geq 45$ Formation of multicell thunderstorms likely	This suggests weak shear, which is conducive to vertical updrafts
	$10 \leq BRN \leq 45$ Supercell formation possible	Indicates there is the proper balance between low-level wind shear and instability, promotes the quasi-steady circulation of the supercell
	$BRN \leq 10$ Squall line development still possible	Represents severely sheared environment, prevents sustained updrafts

Energy Helicity Index (use only if convection exists)	$1 \leq EHI < 2$ Potential for supercells	
	$EHI \geq 2$ Favorable for tornadoes	Remember that large CAPE is not necessary if SRH large. But the premise is that storm rotation should be maximized if CAPE and SRH is large.
Supercell Composite Parameter	$STP < 2.5$ Associated with non-supercells	
	$STP \geq 2.5$ Associated with supercells	
Significant Tornado Parameter	$STP < 1$ Associated with non-tornadic supercells	
	$STP \geq 1$ Associated with EF2 or better	
Bulk layer shear, 0-1 km (units knots)	0-1 BL=15 to 20 Favorable for tornadoes	
Bulk layer shear, 0-6 km (units knots)	0-6 BL=25 to 40 Favorable for supercells	Storm tends to get more organized as increases from 0 to 25
“Effective” bulk layer shear the maximum bulk shear from the "most unstable" lifted parcel level upward to 40-60% of the equilibrium level height. This parameter is similar to the 0-6 km bulk shear, though it accounts for storm depth and is designed to identify both surface-based and "elevated" supercell environments	Effective BL=25 to 40 Favorable for supercells	
Lifting Condensation Level Only use if model soundings favor tornadic conditions later that day	LCL < 1 km	
Convective Inhibition (units J kg^{-1}) Also sometimes written as CINH The opposite of CAPE, area between the LCL and LFC	$-49 \leq CIN \leq 0$ Favorable for tornado formation	Weak cap

Only use if model soundings favor tornadic conditions later that day		
	$-199 \le CIN \le -50$ Favorable for tornado formation, if lift strong enough	Moderate cap
	$CIN \le -200$ “Lid” may be too strong	Strong cap

Index name Formula

Bulk Richardson number	$\mathrm{BRN} = \dfrac{\mathrm{CAPE}}{\frac{1}{2}(\overline{U} - U_0)^2}$
Storm-relative helicity	$\mathrm{SRH} = -\int_{z_0}^{z} \mathbf{k} \bullet \left[(\mathbf{V}_h - \mathbf{C}) \times \dfrac{\partial \mathbf{V}_h}{\partial z} \right] dz$
Energy-helicity index	$\mathrm{EHI} = \dfrac{(\mathrm{CAPE})(\mathrm{SRH})}{160{,}000}$
Supercell composite parameter	$\mathrm{SCP} = \left(\dfrac{\mathrm{MUCAPE}}{1000\ \mathrm{J\,kg^{-1}}}\right)\left(\dfrac{\mathrm{SRH}_{0-3\,\mathrm{km}}}{100\ \mathrm{m^2\,s^{-2}}}\right)\left(\dfrac{\overline{U} - U_0}{40\ \mathrm{m s^{-1}}}\right)$
Significant tornado parameter	$\mathrm{STP} = \left(\dfrac{\mathrm{MLCAPE}}{1000\ \mathrm{J\,kg^{-1}}}\right)\left(\dfrac{\mathrm{SHR}_{0-6\,\mathrm{km}}}{20\ \mathrm{m s^{-1}}}\right)\left(\dfrac{\mathrm{SRH}_{0-1\,\mathrm{km}}}{100\ \mathrm{m^2\,s^{-2}}}\right)\left(\dfrac{(2000\,\mathrm{m} - \mathrm{MLLCL})}{1500\ \mathrm{m}}\right)$

Supercell Composite Parameter (newer version)

A multiple ingredient, composite index that includes effective storm-relative helicity (ESRH, based on Bunkers right supercell motion), most unstable parcel CAPE (muCAPE), and effective bulk wind difference (EBWD). Each ingredient is normalized to supercell "threshold" values, and larger values of SCP denote greater "overlap" in the three supercell ingredients. Only positive values of SCP are displayed, which correspond to environments favoring right-moving (cyclonic) supercells.

This index is formulated as follows:

SCP = (muCAPE / 1000 J kg^{-1}) * (ESRH / 50 m^2 s^{-2}) * (EBWD / 20 m s^{-1})

EBWD is divided by 20 m s^{-1} in the range of 10-20 m s^{-1}. EBWD less than 10 m s^{-1} is set to zero, and EBWD greater than 20 m s^{-1} is set to one.

Left Supercell Composite Parameter

A multiple ingredient, composite index that includes effective storm-relative helicity (ESRH, based on Bunkers left supercell motion), most unstable parcel CAPE (muCAPE), and effective bulk wind difference (EBWD). Each ingredient is normalized to supercell "threshold" values, and larger values of SCP denote greater "overlap" in the three supercell ingredients. Only negative values of LSCP are displayed, which correspond to environments favoring left-moving (anticyclonic) supercells.

This index is formulated as follows:

LSCP = (muCAPE / 1000 J kg^{-1}) * (ESRH / 50 m^2 s^{-2}) * (EBWD / 20 m s^{-1})

EBWD is divided by 20 m s^{-1} in the range of 10-20 m s^{-1}. EBWD less than 10 m s^{-1} is set to zero, and EBWD greater than 20 m s^{-1} is set to one.

Significant Tornado Parameter fixed layer (newer version)

A multiple ingredient, composite index that includes 0-6 km bulk wind difference (6BWD), 0-1 km storm-relative helicity (SRH1), surface parcel CAPE (sbCAPE), and surface parcel LCL height (sbLCL). This version of STP mimics the original formulation presented by Thompson et al. (2003) by using fixed-layer calculations of vertical shear, and substitutes the surface lifted parcels as an alternative to the ML parcels in the "effective layer" version of STP.

The index is formulated as follows:

STP = (sbCAPE/1500 J kg^{-1}) * ((2000-sbLCL)/1000 m) * (SRH1/150 m^2 s^{-2}) * (6BWD/20 m s^{-1})

The sbLCL term is set to 1.0 when sbLCL < 1000 m, and set to 0.0 when sbLCL > 2000 m; the 6BWD term is capped at a value of 1.5 for 6BWD > 30 m s^{-1}, and set to 0.0 when 6BWD < 12.5 m s^{-1}.

Significant Tornado Parameter, effective layer (newer version)

A multiple ingredient, composite index that includes effective bulk wind difference (EBWD), effective storm-relative helicity (ESRH), 100-mb mean parcel CAPE (mlCAPE), 100-mb mean parcel CIN (mlCIN), and 100-mb mean parcel LCL height (mlLCL).

The index is formulated as follows:

STP = (mlCAPE/1500 J kg^{-1}) * ((2000-mlLCL)/1000 m) * (ESRH/150 m^2 s^{-2}) * (EBWD/20 m s^{-1}) * ((200+mlCIN)/150 J kg^{-1})

The mlLCL term is set to 1.0 when mlLCL < 1000 m, and set to 0.0 when mlLCL > 2000 m; the mlCIN term is set to 1.0 when mlCIN > -50 J kg^{-1}, and set to 0.0 when mlCIN < -200; the EBWD term is capped at a value of 1.5 for EBWD > 30 m s^{-1}, and set to 0.0 when EBWD < 12.5 m s^{-1}. Lastly, the entire index is set to 0.0 when the effective inflow base is above the ground.