

Composite Parameters

1) Significant Tornado Parameter (effective layer): “SigTor Effective” on weathernerds.org refers to the Significant Tornado Parameter computed using the effective layer shear and helicity fields along with mixed-layer thermodynamic quantities. The methodology matches that used by NOAA’s Storm Prediction Center (SPC) and is defined in Thompson et al. 2012. Taken directly from the SPC help page:

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

The index is formulated as follows:

$$STP = (mCAPE/1500 \text{ J kg}^{-1}) * ((2000-mLCL)/1000 \text{ m}) * (ESRH/150 \text{ m}^2 \text{ s}^{-2}) * (EBWD/20 \text{ m s}^{-1}) * ((200+mCIN)/150 \text{ J kg}^{-1})$$

The mLCL term is set to 1.0 when mLCL < 1000 m, and set to 0.0 when mLCL > 2000 m; the mCIN term is set to 1.0 when mCIN > -50 J kg⁻¹, and set to 0.0 when mCIN < -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.

A majority of significant tornadoes (F2 or greater damage) have been associated with STP values greater than 1 within an hour of tornado occurrence, while most non-tornadic supercells have been associated with values less than 1 in a large sample of RAP analysis proximity soundings.

2) Significant Tornado Parameter (fixed layer): “SigTor Fixed” on weathernerds.org refers to the Significant Tornado Parameter computed using 0 – 6 km shear and 0 – 1 km storm-relative helicity (fixed levels) along with surface based thermodynamic fields. The methodology matches that used by SPC and is defined in Thompson et al. 2003. Taken directly from the SPC help page:

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 formulation presented by Thompson et al. (2012) 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:

$$STP = (sbCAPE/1500 \text{ J kg}^{-1}) * ((2000-sbLCL)/1000 \text{ m}) * (SRH1/150 \text{ m}^2 \text{ s}^{-2}) * (6BWD/20 \text{ m s}^{-1}) * ((200+sbCIN)/150 \text{ J kg}^{-1})$$

The sbLCL term is set to 1.0 when sbLCL < 1000 m, and set to 0.0 when sbLCL > 2000 m; the sbCIN term is set to 1.0 when sbCIN > -50 J kg⁻¹, and set to 0.0 when sbCIN < -200; 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.

A majority of significant tornadoes (F2 or greater damage) have been associated with STP values greater than 1, while most non-tornadic supercells have been associated with values less than 1 in a large sample of RAP analysis proximity soundings.

3) Supercell Composite Parameter (effective layer): “Sup-Comp-Par” on weathernerds.org refers to the Supercell Composite Parameter computed using effective shear and effective storm relative helicity along with most-unstable CAPE (most-unstable CAPE in lowest 300 mb above ground). The methodology follows that used by SPC and is defined in Thompson et al 2004b. Taken directly from the SPC help page:

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:

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

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.

References:

- Thompson, R. L., R. Edwards, J. A. Hart, K. L. Elmore, and P. Markowski, 2003: Close proximity soundings within supercell environments obtained from the Rapid Update Cycle. *Wea. Forecasting*, **18**, 1243-1261.
- Thompson, R. L., R. Edwards, and C. M. Mead, 2004b: An update to the Supercell Composite and Significant Tornado Parameters. Preprints, 22nd Conf. on Severe Local Storms, Hyannis, MA, Amer. Meteor. Soc.
- Thompson, R.L., B.T. Smith, J.S. Grams, A.R. Dean, and C. Broyles, 2012: Convective Modes for Significant Severe Thunderstorms in the Contiguous United States. Part II: Supercell and QLCS Tornado Environments. *Wea. Forecasting*, **27**, 1136–1154.