Helicity

While CAPE is a useful variable for assessing severe thunderstorm potential, it does not distinguish between tornadic and non-tornadic situations. This is because there is a preferred storm-relative flow structure for the initiation of tornadic thunderstorms. (Storm relative means the thunderstorm's translation speed has been subtracted from the total wind).

One quantity which does take into account the vertical wind profile is a quantity called "helicity." Helicity is defined as:

$$\vec{H} = \vec{Z} \cdot \vec{V}$$

$\vec{V}$ = 3D wind vector, $\vec{Z}$ = 3D vorticity vector
$\vec{H}$ = Helicity

In practice, we subtract out the storm motion vector $\vec{c}$, and we are only concerned with $\hat{k} \times \partial\vec{V}/\partial z$ (horizontal vorticity) which could be tilted into the vertical by an updraft and develop cyclonic rotation. Special emphasis is placed on the lowest 2 or 3 km, usually below the LFC, which is considered the inflow layer into a convective storm. Therefore, we sum $\vec{H}$ through the inflow

streamwise vorticity $= \hat{k} \times \partial\vec{V}/\partial z$

layer.

Storm relative environmental helicity is given by:

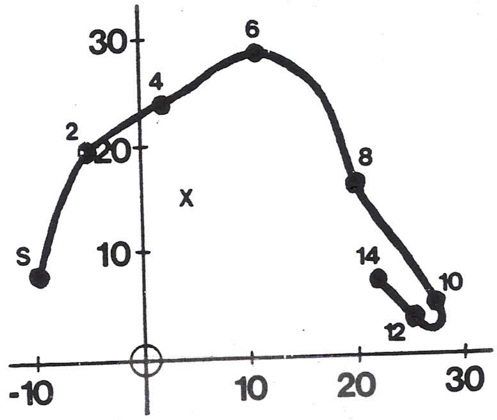
$$H(\vec{c}) = -\int_0^h \hat{k}\cdot(\vec{V}-\vec{c})\times\frac{\partial\vec{V}}{\partial z}\,dz$$

where h is the inflow depth of about 3 km. The following criterion can be applied to tornado forecasting:

Tornadic intensity	$H(\vec{c})$
F0 - F1	150 - 299 $\frac{m^2}{s^2}$
F2 - F3	300 - 449 $\frac{m^2}{s^2}$
F4 - F5	> 450 $\frac{m^2}{s^2}$

However, tornadic intensity can still vary, and this table should be used loosely. A typical hodograph with high helicity may look like:

$\vec{V}-\vec{C}$



$\vec{V}-\vec{C}$

Taken in vicinity of a rotating severe storm in central Oklahoma on 20 May 1977