2. **Tornadoes/Twisters/severe form of Cyclones**

common in portions of the Great Plains in U.S

- Local storm
- Short duration
- Very destructive
- Violent rotating column of air
  - Vortex extends down from a cumulonimbus cloud

- Pressures been estimated as much as 10% lower than immediately outside the storm
  - PG generate max. wind 480 km h\(^{-1}\)
  - Drawn by lower pressure into the center
    - Air near the ground rushes in

Merges with parent T/storm deep in the cumulonimbus cloud

Air spirals upward
• Air sucked in
  o Expands - cooled adiabatically
  o If cooled below dew point T
    ▪ Condensation
    • Pale ominous cloud
  o If NOT cooled below dew pt T
    ▪ Vortex visible
    • See the materials that is sucked from the surface and carried aloft

Funnel shape

Thin rope shape
Development

- In association with severe T/storm that produce:
  - High wind speed
  - Heavy torrential rain
  - Often hail
    - Hail may or may not precede tornado
    - Portion of the T/storm adjacent to large hail are often areas where strong tornadoes occur

- < 1% T/storms produce tornadoes

- Not certain exactly what triggers formation
  - Product of the interaction between strong updrafts in T/storm and winds in troposphere

- Severe T/storms and therefore tornadoes are most often spawned along the CF or squall line of mid-latitude cyclones

Spring - air masses have most contrasting conditions
  - cP - still cold and dry
  - mT - warm, humid and unstable
    - greater the contrast the more intense the storm
Central US

- Location where these two contrasting air masses are likely to meet
- Region generates most tornadoes

Tornado

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter</td>
<td>150 - 600 m</td>
</tr>
<tr>
<td>Speed</td>
<td>250 - 450 km h⁻¹</td>
</tr>
<tr>
<td>Cut path</td>
<td>~ 26 km long</td>
</tr>
<tr>
<td>Typical path</td>
<td>SW to the NE</td>
</tr>
<tr>
<td></td>
<td>Because in front of CF</td>
</tr>
<tr>
<td>Weak: life</td>
<td>&lt; 3 min</td>
</tr>
<tr>
<td>Path</td>
<td>~ 1 km</td>
</tr>
<tr>
<td>Width</td>
<td>~ 100 m</td>
</tr>
<tr>
<td>Speed</td>
<td>&lt; 150 km h⁻¹</td>
</tr>
<tr>
<td>Violent: life</td>
<td>&gt; 3 h, small %</td>
</tr>
<tr>
<td>Path</td>
<td>~ 150 km</td>
</tr>
<tr>
<td>Speed</td>
<td>&lt; 450 - 500 km h⁻¹</td>
</tr>
</tbody>
</table>
Predicting

- Very difficult

Because:

- Severe T/storms & tornadoes are short lived
- "random"
- observation network sparse
  - distance between 1 surface stations ~ 160 km (100 miles)
    - observations - hourly
  - distance between upper air stations ~ 320 km
    - observations - 12 hourly

- radar used – NEXRAD
  - look for characteristic wind pattern & shape – hook
  - rotation of air - wind shear

Supercell structure
Supercell organization

Supercell hook on radar
Tornado evolution

Model of tornado with multiple suction vortices

Suction vortex

Left side boundary

Path of tornado center

Suction swath or band of debris deposit

Right side boundary

Tornado center