Figure 14.7. Profiles of radar reflectivity and tangential winds in Hurricane Alicia. The data were recorded from 0109 to 0128 GMT, 18 August 1983. The radar reflectivity cross section was obtained by compositing vertical rays from the tail radar at four samples per minute. The horizontal arrow indicates the altitude of the aircraft.
Tropical Cyclone Formation Regions

- Form over water of temperature 26°C or above, at 5-25 degrees from equator

![Diagram of tropical cyclone formation regions](image1)

**Figure 10.1** Locations of tropical cyclone formation over a 20-year period. (From Gray, 1979. Reprinted with permission from the Royal Meteorological Society.)

![Diagram of tropical cyclone tracks](image2)

**Figure 10.2** Tracks of tropical cyclones in relation to mean sea-surface temperature (°C). September temperatures are taken for the Northern Hemisphere. March temperatures are taken for the Southern Hemisphere. (From Bergeron, 1954. Reprinted with permission from the Royal Meteorological Society.)

(Houze, *Cloud Dynamics*, 1994)
Comparison of Tropical, ET Cyclones

(TWB p. 132)

**Tropical Cyclone**
- Warm at center
- Forms over tropical oceans
- Energy source: latent heat from water evaporated off warm ocean
- Strong winds at surface
- No fronts
- 500 km diameter

**ET Cyclone**
- Cold at center
- Forms at boundary between warm, cold midlatitude airmasses
- Energy source: horizontal temperature contrasts
- Strong jet stream aloft
- Cold and warm fronts
- 1500 km diameter
Hurricane lifecycle

Easterly waves form in subtropics.
- In a few strong easterly waves, a tropical depression with 20-40 mph circulating winds develops.
- May amplify to tropical storm (gets a name), then hurricane in a couple of days.
- Hurricane moves with the average winds in troposphere, typically lasting up to a week.
- Most hurricanes die after ‘recurring’ into midlatitude westerlies, or dissipate over land (flooding).

Figure 11.1  (EOM)
An easterly wave as shown by the bending of streamlines. (The heavy dashed line is the axis of the trough.) The wave moves slowly westward, bringing fair weather on its western side and showers on its eastern side.
Hurricane Tracks

URL: weather.unisys.com under Hurricane Data
Green  tropical depression
Yellow  tropical storm (named)
Red  Category 1 hurricane
Light Red  2
Magenta  3
Lt. Magenta  4
White  5

...also E and W Pacific, Indian Ocean maps.
Hurricane Intensification Feedback

- Requires a *preexisting* surface cyclone with 10-30 mph winds.
- Circulations, pressure variations are weaker aloft, so low surface pressure overlying warm air.

**Diagram:**
- Low Central Surface Pressure
- Strong surface winds over constant-temperature ocean
- Inflow moistened, kept warm
- Core updraft condenses, latent heating begins at lower height than in surrounding convection
- Warm core updraft
Hurricane storm surge

How hurricanes pile up water

1. Hurricane winds push water toward the center, creating a mound of water.
2. Instead of piling up, the water spreads out.
3. Water flows away, creating underwater currents.

In the open ocean...

The mound of water is only a few feet high.

In shallow water near land...

...the effects of low pressure and water being pushed into the center combine, creating monster surges.

What happens when the surge comes ashore...

Ultimate height of the "storm tide" is a combination of the astronomical tide and the storm surge. The surge normally does not rise as a "wall of water" but more like quick rise in the tide to extremely high levels.

What a super storm's surge would do to New Orleans...

The map below was created by National Weather Service's C. Hassan. It shows water depths of the surge from a Category 4 hurricane following the path shown. If the Category 4 Hurricane Camille had just a little to the left in 1969, it could have followed a path. The storm shown would leave water more than 25 feet above normal in downtown New Orleans. Mississippi River levees would break, and the surge from the west side of the river.
Wind Damage

- Facing in direction of hurricane motion (5-10 m/s), strongest winds are in the right eyewall, where rotational and translational winds add together.
- Damage increases rapidly with wind speed

Hurricane Damage vs. intensity

<table>
<thead>
<tr>
<th>Category</th>
<th>Damage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (74-95)</td>
<td>Limb damage to trees</td>
</tr>
<tr>
<td>2 (96-110)</td>
<td>Some trees blown over, major damage to mobile homes</td>
</tr>
<tr>
<td>3 (111-130)</td>
<td>Large trees blown over, mobile homes destroyed, bldg damage</td>
</tr>
<tr>
<td>4 (131-155)</td>
<td>Considerable building, roof damage, flooding to 15 ft ASL</td>
</tr>
<tr>
<td>5 (156+)</td>
<td>Roofs removed, small bldgs collapsed, flooding to 25 ft ASL</td>
</tr>
</tbody>
</table>
Hurricane Prediction

- Lots of decadal variability, less hurricanes with Sahel drought, El Nino