



**MET 4300**

**Lecture 23**  
**Tornadoes II (CH19)**

# Outline

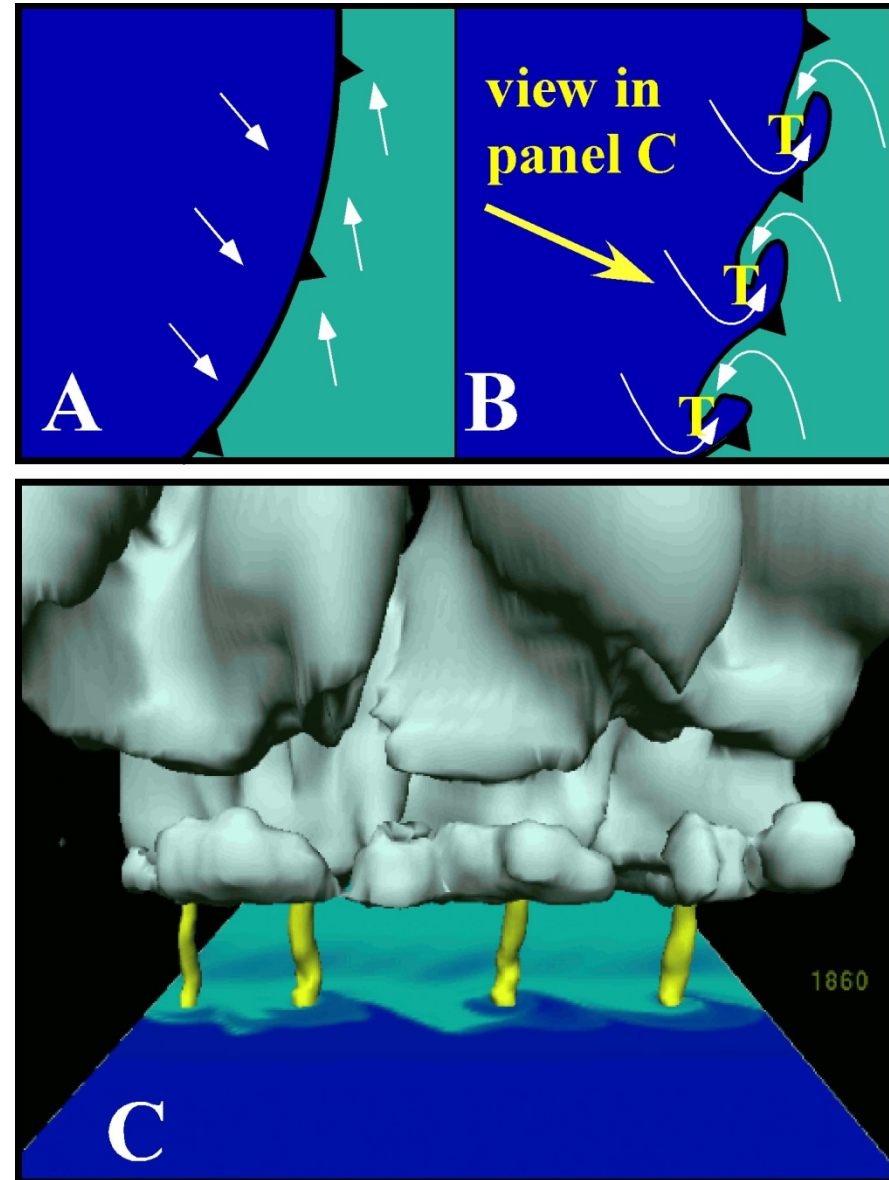
- Definition, life cycle, & climatology of tornadoes
- Tornado formation within supercells
- **Tornado formation within non-supercell thunderstorms**
- Fujita scale
- Tornado statistics
- Historic cases
- Tornado detection, forecasting, and safety

# Tornado Formation within Non-Supercell Thunderstorms: Landspouts

- Within squall line thunderstorms or along outflows from MCSs, or even in Florida sea-breeze airmass T-storms.
- Terms: non-supercell tornadoes, landspout tornadoes, mesovortices, or gustnadoes (collectively called **landspout tornadoes**)
- Short-lived and not as intense as supercell tornadoes (but still dangerous)
- The non-supercell thunderstorms are triggered by lifting associated with an advancing front or gust front and are located along the frontal boundary.

# Formation of A Landspout Tornado

- A. Sharp change in wind speed and direction along the front → **horizontal wind shear**.
- B. Periodically along the front, the horizontal wind shear is strong enough to cause the flow to **break down to small vortices**.
- C. When these vortices develops under updraft, **the updraft stretches the vortex** to form a tornado. Vortices sometimes develop every few kolimeters along a front.



# Landspouts

- Nearly all tornadoes in California in winter develop along cold fronts are landspout tornadoes.
- Landspouts also form within squall lines in the central & eastern US.
- In the radar reflectivity field: no hook echo, but breaks in the line of higher dBZ may appear (breaks are due to reduction of rain under strong updrafts).
- Doppler radial velocity field is the best means to detect landspouts: rotation appears as a tight couplet of inbound & outbound velocities.

# Waterspouts

- A class of weak tornadoes; observed off coastlines (FL coast & Gulf of Mexico)
- **Mechanism (similar to landspouts):** a spin-up of circulations created by breakdown of the flow in regions of low-level horizontal wind shear, which could be generated along sea breeze front or outflow boundaries by previous thunderstorms



A Waterspout off the Florida coast.

# Hurricane Tornadoes

- Generated in thunderstorms within landfalling hurricanes.
- Often embedded in very heavy rain and are difficult to see approaching.
- Most of hurricane tornadoes occur in the NE quadrant of hurricanes.
- Mechanism not fully understood. Some are believed to be spawned by mini-supercells that form within spiral bands.

# Other Tornado-like Vortices



# Cold Air Funnel

- Vortices that emerge from the base of elevated convective clouds that develop over cool surface air
- Often emerge from cumulus clouds within large-scale, upper-level **cutoff low** pressure centers (associated with unusually cold air in the upper troposphere)
- Formation mechanism similar to landspouts, but much weaker, short-lived, rarely touching down, and causing very little damage when they do.



# Dust Devils

- Dust devils are associated with **dry convection**
- Develop over **hot surfaces**, and common in **deserts**
- Can extend over a km in depth
- Can reach wind speeds similar to a weak tornado



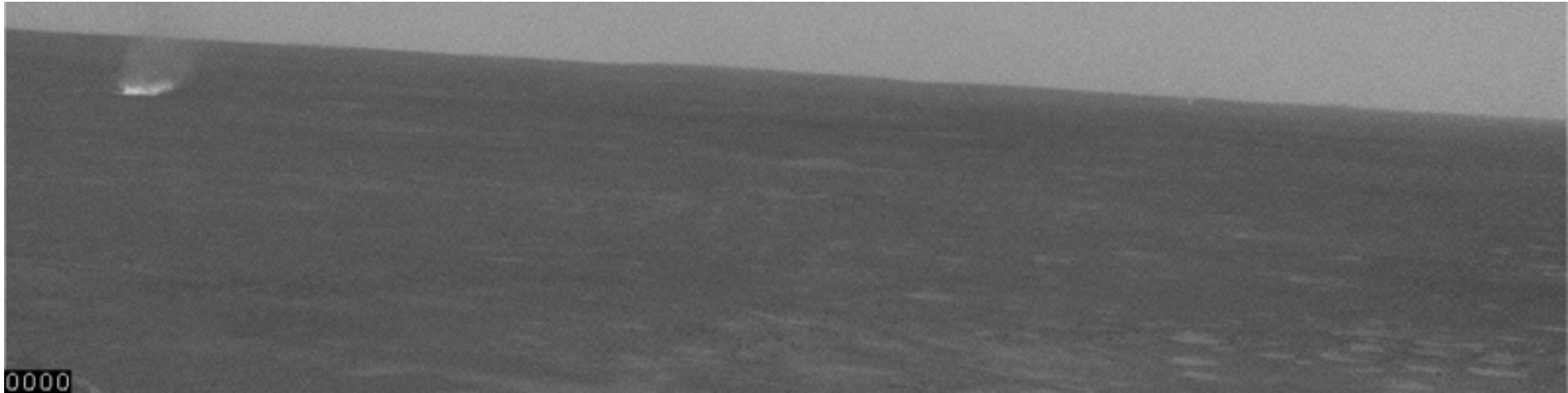
# Fire Whirls

- Tornado-like vortices that develop in association with fires
- Develop in the heated air that is rising above a raging fire



# Dust Devils & Waterspouts





**Dust Devils generally require absolute instability in a dry environment, they are shallow 100s of meters to a few kilometers**



Water Spout off Bolivar Peninsula 6-16-2003

