

# Transient Atmospheric Flows & Disturbances

## Part II

Sunshine is delicious, rain is refreshing, wind braces us up, snow is exhilarating; there is really no such thing as bad weather, only different kinds of good weather.

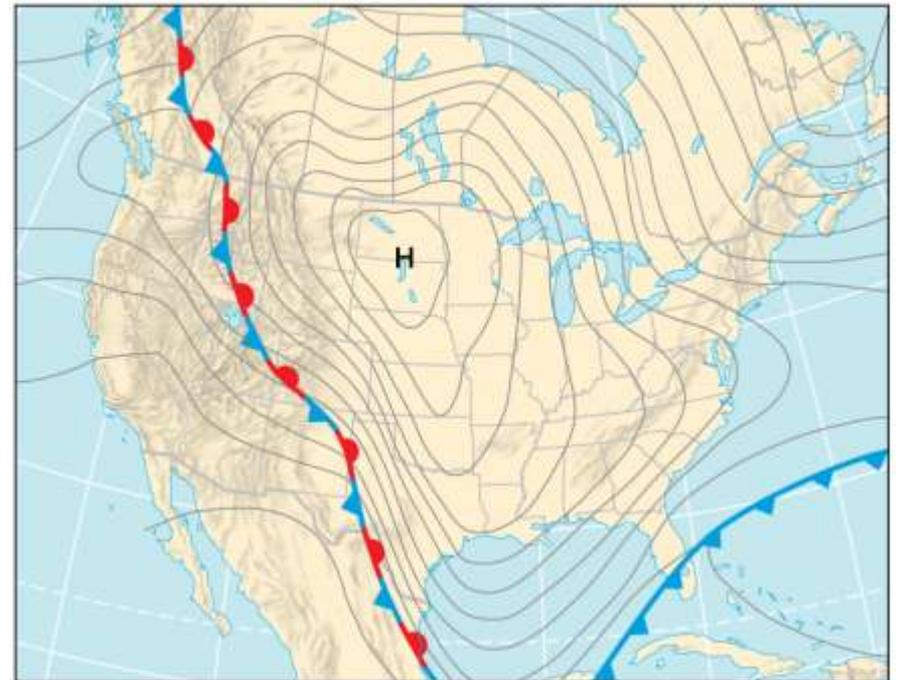
—John Ruskin



# Midlatitude Anticyclones

## Introduction

- Large, migratory high pressure systems
- Path of movement
- Other names





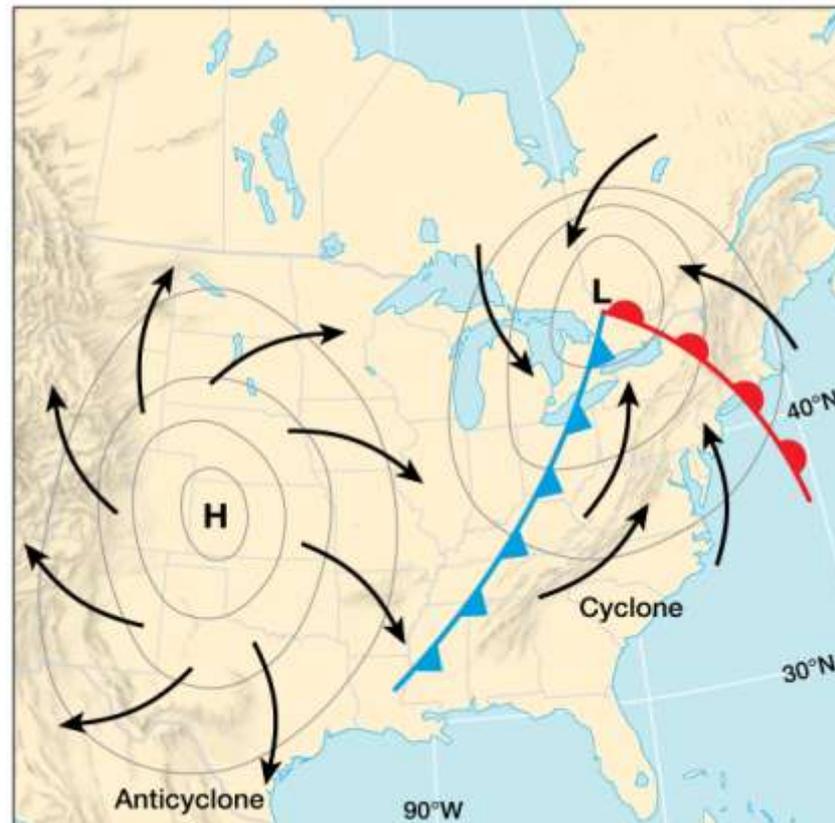
## Characteristics

- Upper air convergence
- Subsidence
- High surface pressure
- Diverging surface winds



## Relations of Cyclones and Anticyclones

- Often occur in next to each other in midlatitudes
- Anticyclone forms a cold front on its leading edge





# Locations of Anticyclones & Cyclones

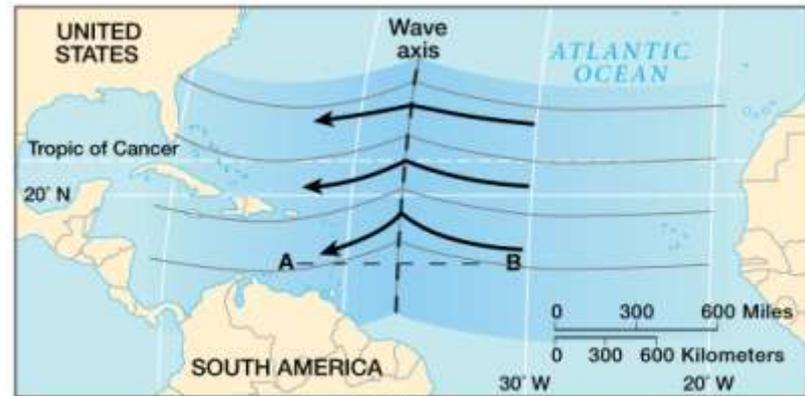
- System of highs and lows,  $35^{\circ}$  to  $70^{\circ}$  of latitude
- East-West migration
- Dominates midlatitudes, especially in winter



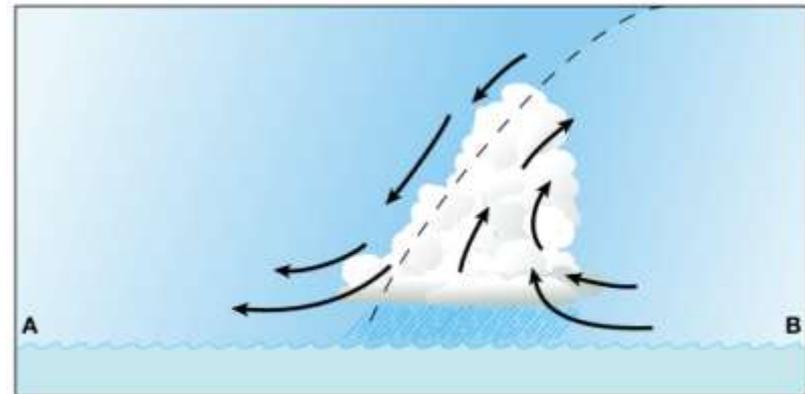
# Minor Tropical Disturbances: Easterly Waves

## Easterly Waves

- Formation
- Path
- Non-cyclonic Convergence
- Relationship to Hurricanes



(a)



(b)



# Major Tropical Disturbances: Hurricanes

Animation  (Hurricanes)

## Introduction

- Intense Tropical Cyclones
- Regional Names
- Tropical Disturbances
  - Tropical depressions
  - Tropical storm
  - Tropical Cyclone (Hurricane)



Hurricane Katrina, August 29, 2005



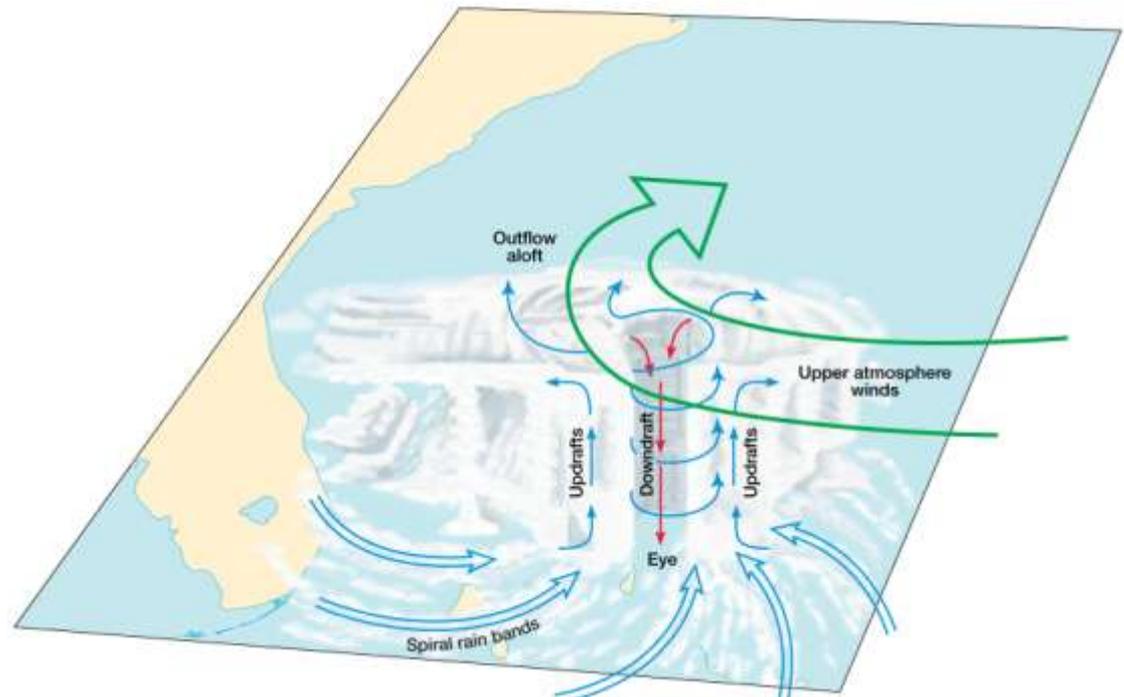
## Characteristics

- Intense low pressure
- Cyclonic convergence
- Minimum wind speed
- Heavy rain
- Energy source and release





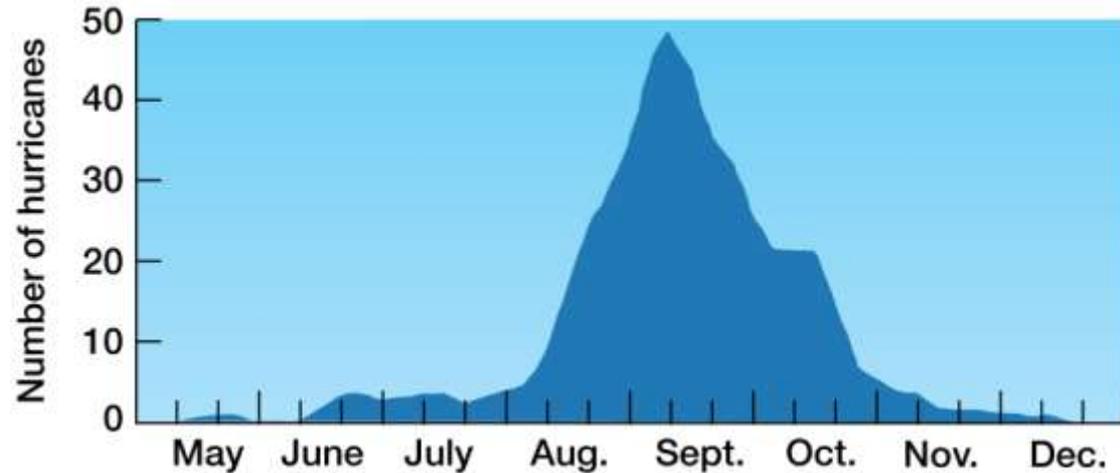
- Towering cumulus and cumulonimbus clouds
- Eye and eye wall of a hurricane





## Origin

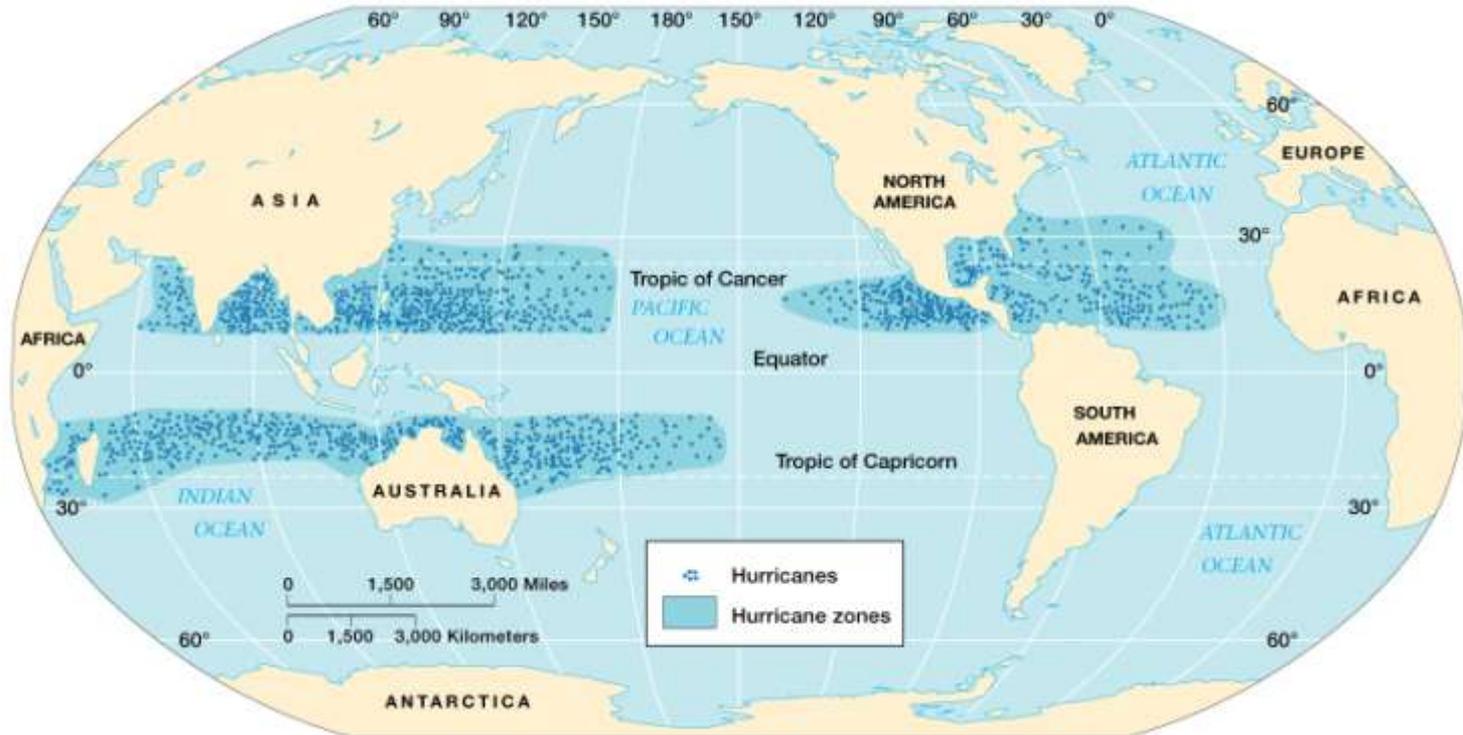
- Seasonality
- Warm tropical waters
- Coriolis effect
- ITC Zone
- Easterly waves
- No wind shear in troposphere
- Upper atmosphere winds (outflow aloft)



Seasonality of North Atlantic Caribbean hurricanes.



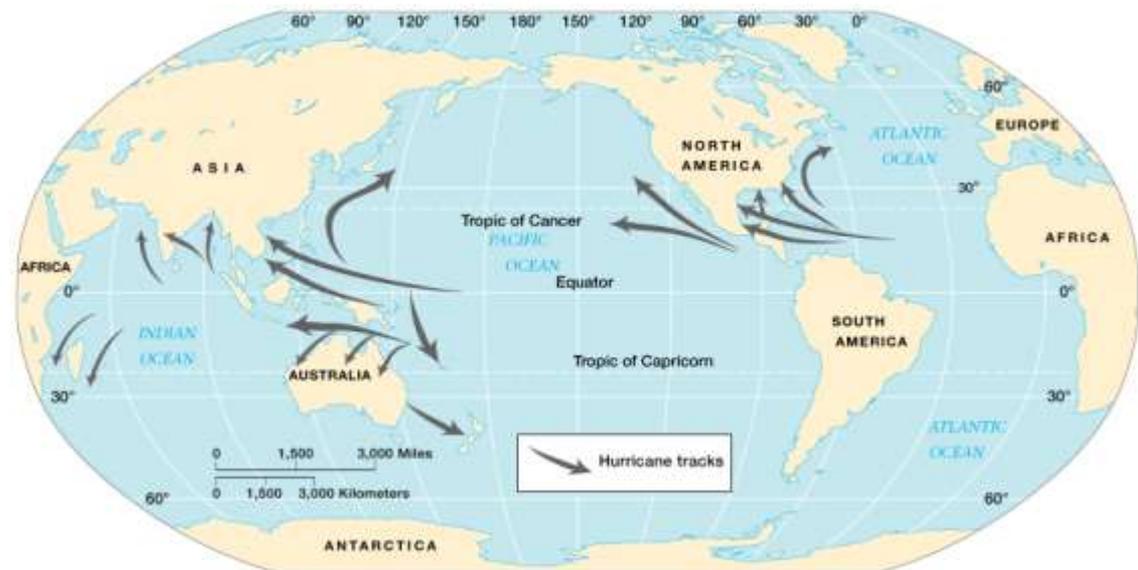
## Source regions





# Movement

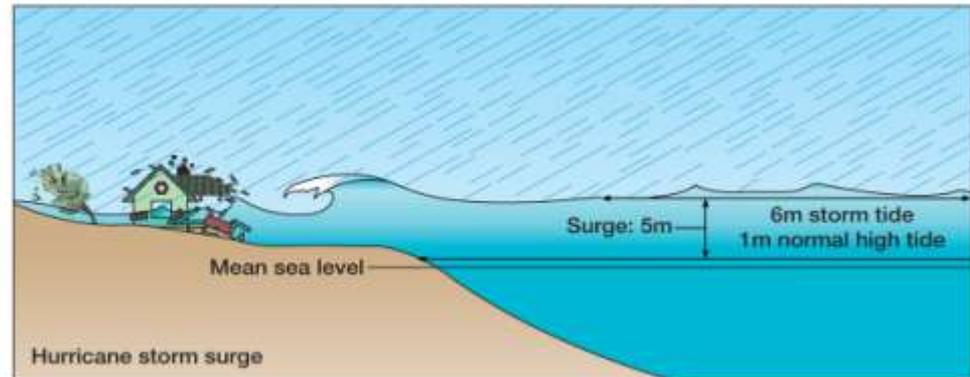
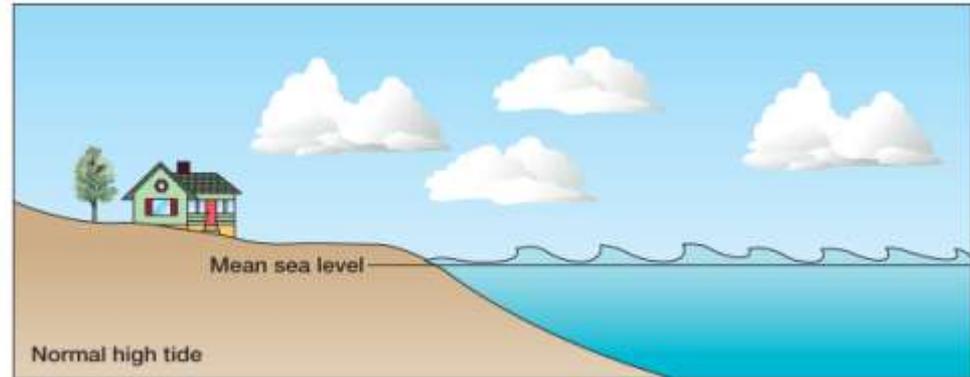
- Specific paths (tracks) difficult to predict
- General tracks
  - Initially, east to west
  - Curve prominently poleward into midlatitudes





# Damage and Destruction

- Causes
- Landfall and storm surge





## Greatest disasters

- Galveston, TX (1900)
- Ganges-Brahmaputra delta
- U.S. Gulf Coast (Katrina, 2005)





# Saffir-Simpson Hurricane Scale

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<i>Category</i>	<i>Central Pressure (millibars)</i>	<i>Wind Speed</i>		<i>Storm Surge (meters)</i>	<i>Damage</i>
		<i>Kilometers per Hour</i>	<i>Miles per Hour</i>		
1	>979	119–153	74–95	1.2–2.5	Minimal
2	965–979	154–177	96–110	1.6–2.4	Moderate
3	945–964	178–209	111–130	2.5–3.6	Extensive
4	920–944	210–250	131–155	3.7–5.4	Extreme
5	<920	>250	>155	>5.4	Catastrophic

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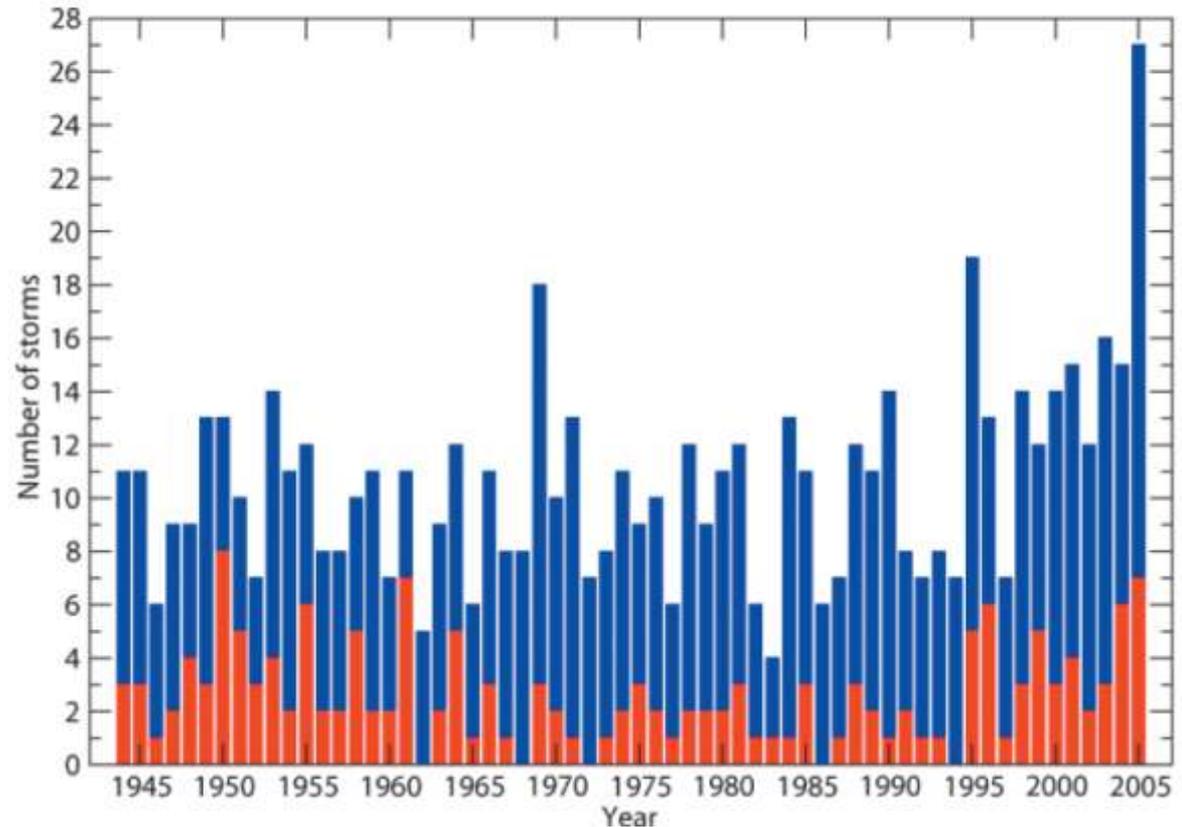


# Hurricanes and Global Warming

- Number of hurricanes increasing

Annual Number of Named Storms and Major Hurricanes

Atlantic, 1944-2005





## Intensity of hurricanes increasing

Hurricane	Year	Minimum Pressure
Hurricane Wilma	2005	882 mb
Hurricane Gilbert	1988	888 mb
The Labor Day Hurricane	1935	892 mb
Hurricane Rita	2005	895 mb
Hurricane Allen	1980	899 mb
Hurricane Katrina	2005	902 mb
Hurricane Camille	1969	905 mb
Hurricane Mitch	1998	905 mb
Hurricane Ivan	2004	910 mb
Hurricane Janet	1955	914 mb

Source: NOAA



## Hurricane Wilma, strongest North Atlantic-Caribbean hurricane on record



Hurricane Wilma (Oct. 20, 2005)



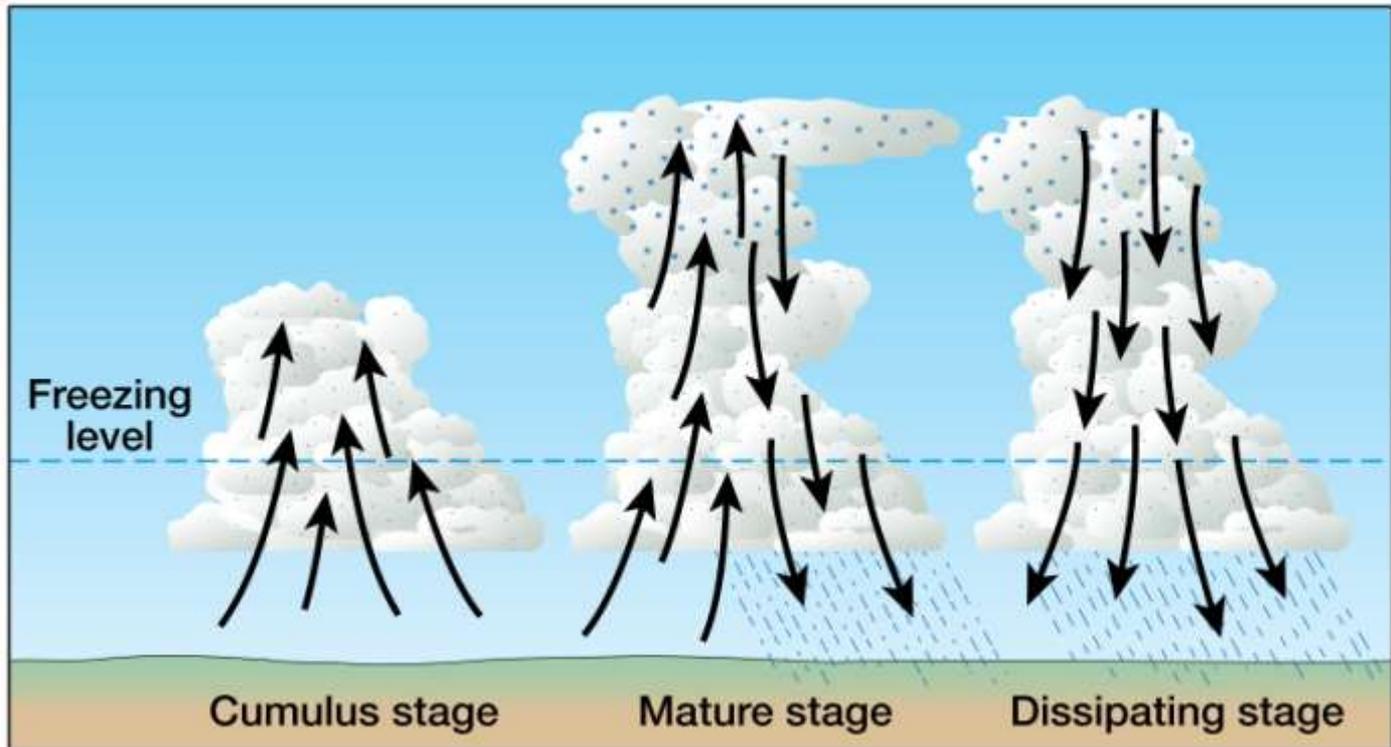
# Localized Severe Weather

- Thunderstorms and Tornadoes
  - Small storms of local significance
  - Associated with larger storms, too
- Thunderstorms
  - Nature
    - Violent convective storm
    - Thunder and lightning
    - Hail
    - Strong updrafts and downdrafts



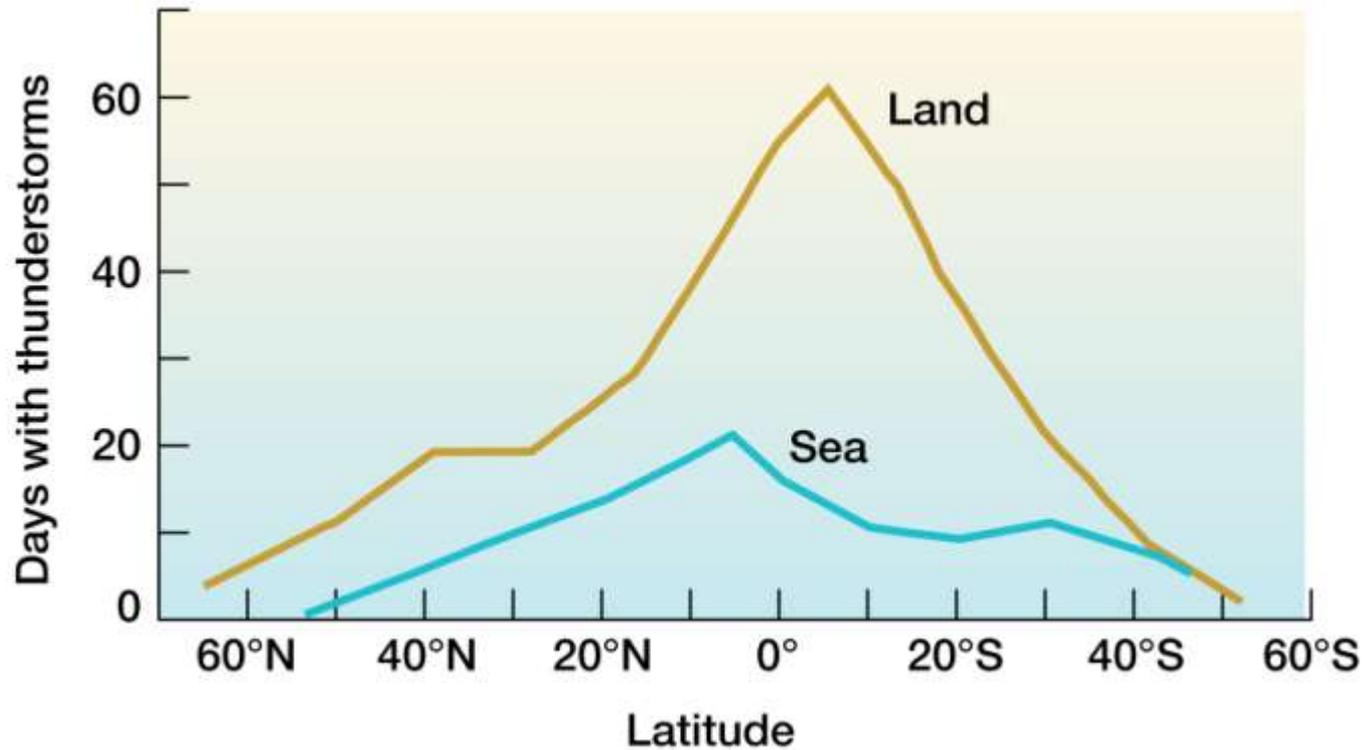


# Sequential Development



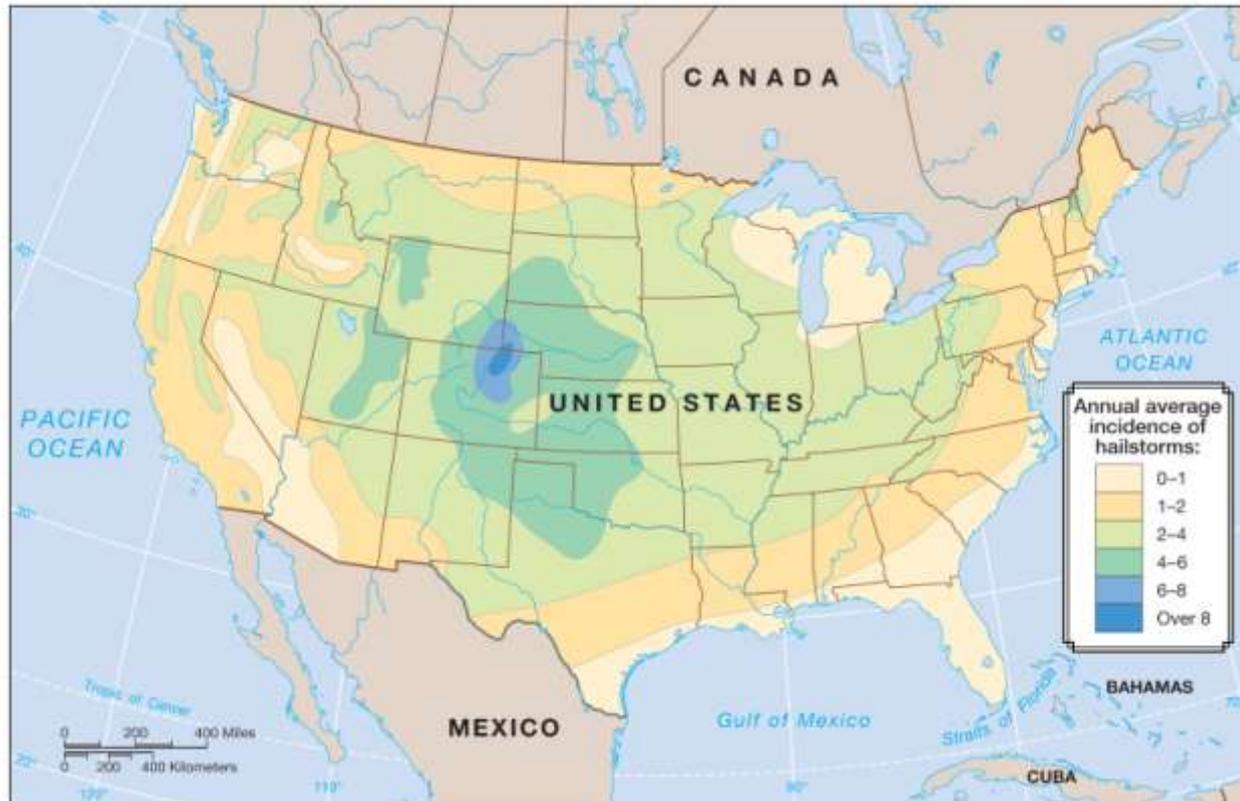


## Frequency by latitude (per year)





# Frequency of hailstorms in the US (per year)





# Tornadoes

## Animation (Tornadoes)

### – Nature

- Size
- Funnel
- Pressure & wind
- Damage paths





# Classification

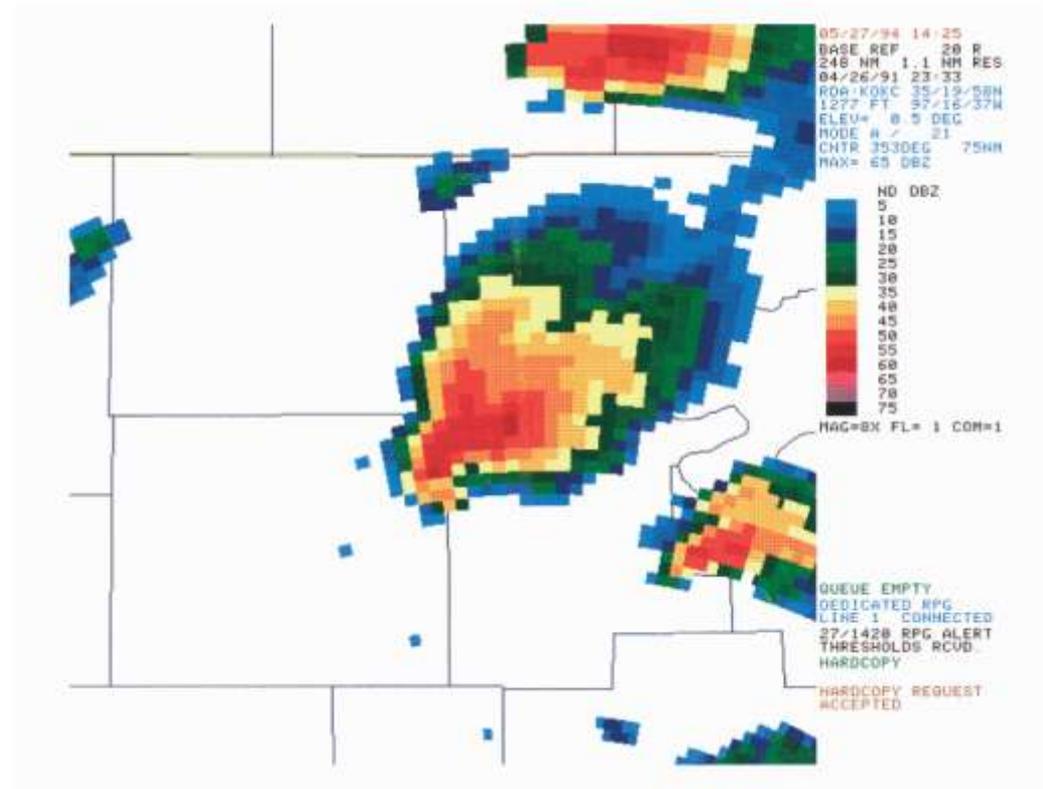
## Fujita Tornado Intensity Scale

<i>F Number</i>	<i>Fujita Scale</i>		<i>Enhanced F Scale</i>			<i>Expected Level of Damage</i>
	<i>kph</i>	<i>mph</i>	<i>EF Scale</i>	<i>3-second gust kph</i>	<i>3-second gust mph</i>	
F0	<116	<72	0	105–137	65–85	Light: Broken tree branches; uprooted small trees; billboards and chimneys damaged.
F1	116–180	72–112	1	138–177	86–110	Moderate: Roof surfaces peeled off; mobile homes overturned or pushed off their foundations.
F2	181–253	113–157	2	178–217	111–135	Considerable: Mobile homes destroyed; roofs blown off wooden-frame houses; uprooted large trees; light objects become “missiles.”
F3	254–332	158–206	3	218–266	136–165	Severe: Trains derailed or overturned; walls and roofs torn off from well-constructed houses; heavy cars thrown off ground.
F4	333–419	207–260	4	267–322	166–200	Devastating: Structures with weak foundations blown for some distance; well-built houses destroyed; large objects become missiles.
F5	>419	>260	5	Over 322	Over 200	Incredible: Well-built houses lifted off foundations and carried considerable distance before complete destruction; tree bark removed; automobile-sized missiles carried more than 100 meters.



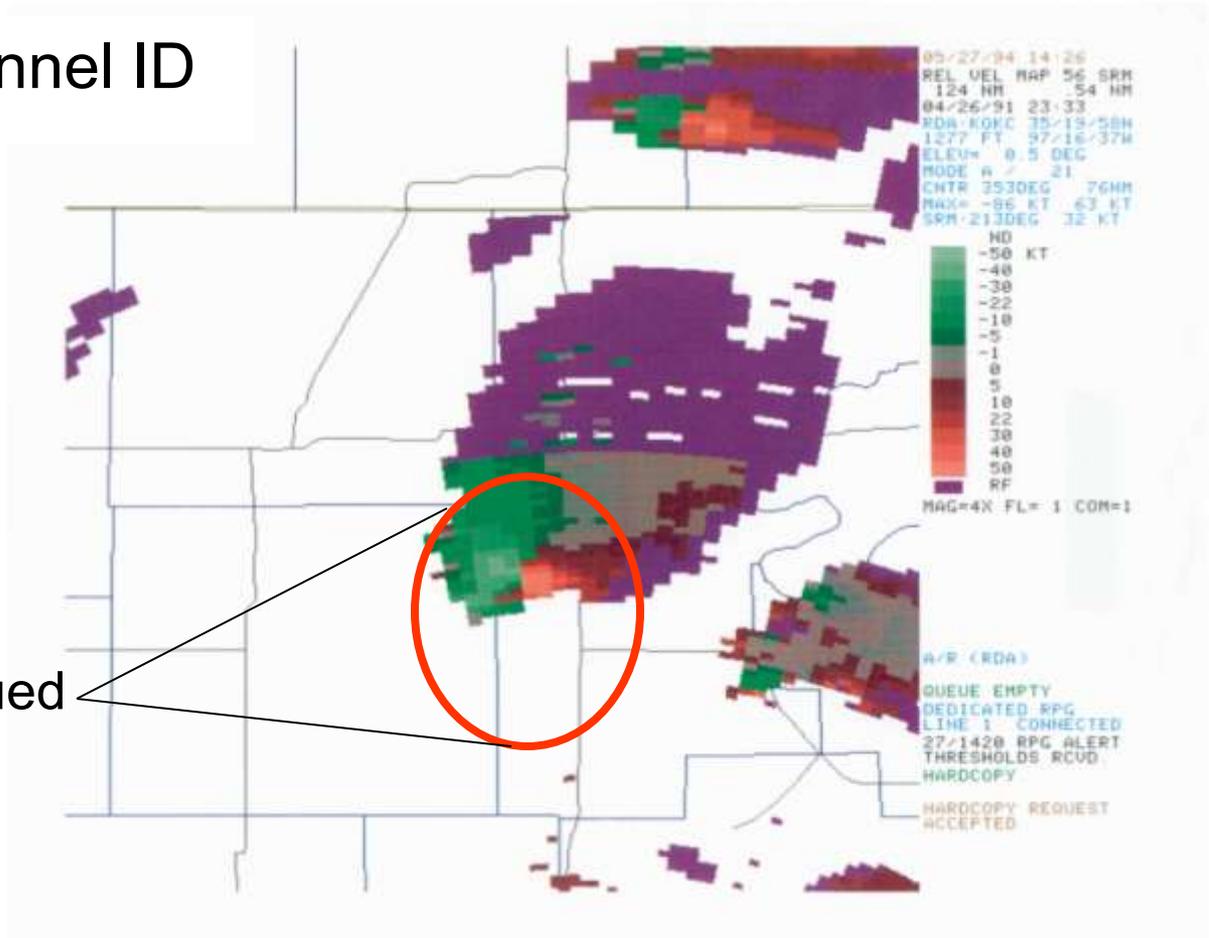
# Forecasting Severe Storms with NEXRAD Doppler radar

Reflectivity = Storm intensity





Motion detection = Funnel ID



Tornado warning issued



## Summary

- Air masses are large bodies of air in the troposphere that have relatively uniform horizontal physical characteristics.
- When air masses move away from the source regions, they bring significant weather changes as they go.
- A front is a zone of unsettled and sometimes stormy weather that forms when unlike air masses meet.
- Air masses and fronts are prominent parts of major migratory pressure systems called midlatitude cyclones and midlatitude anticyclones.



- These systems dominate the weather of middle latitudes, especially in the winter.
- Minor tropical disturbances include Easterly Waves, a few such storms develop into hurricanes.
- Hurricanes are low latitude storms characterized by high winds and heavy rainfall.
- Other kinds of storms, such as thunderstorms and tornadoes are much more localized.
- NEXRAD forecasts an early warning of severe local storms.