MET 3502/5561
Synoptic Meteorology

Lecture 1: Introduction on Synoptic Meteorology

Instructor: Dr. Haiyan Jiang (email: haiyan.jiang@fiu.edu)

Synoptic

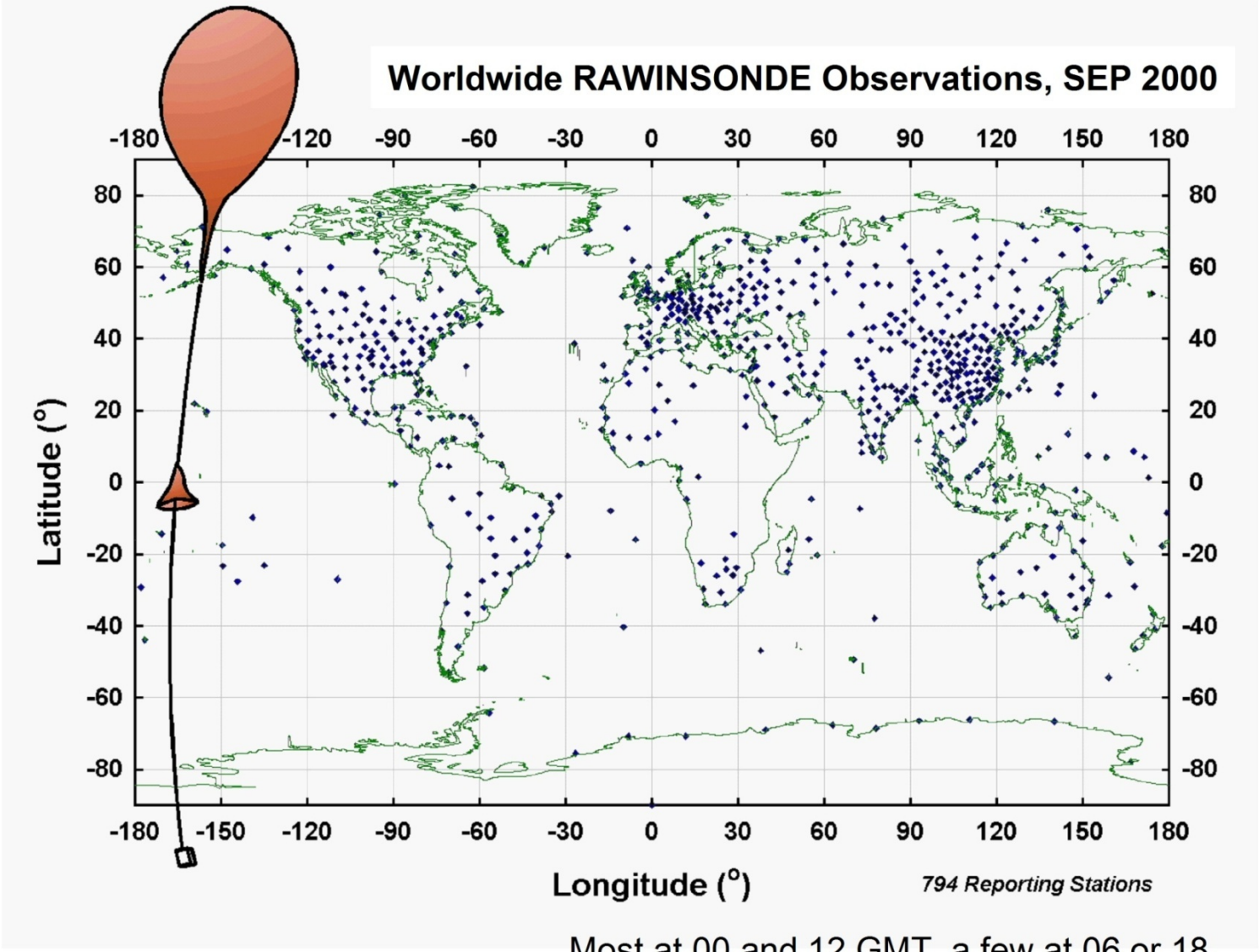
- Synopsis -> overview, not synoptic scale

- Synoptic: from "Synoptikos", a greek word, means "presenting a summary of the principal parts or a general view of the whole." For us, it means that you take everything you learned from physical meteorology, dynamic meteorology, remote sensing, and put them together.

Synoptic Method

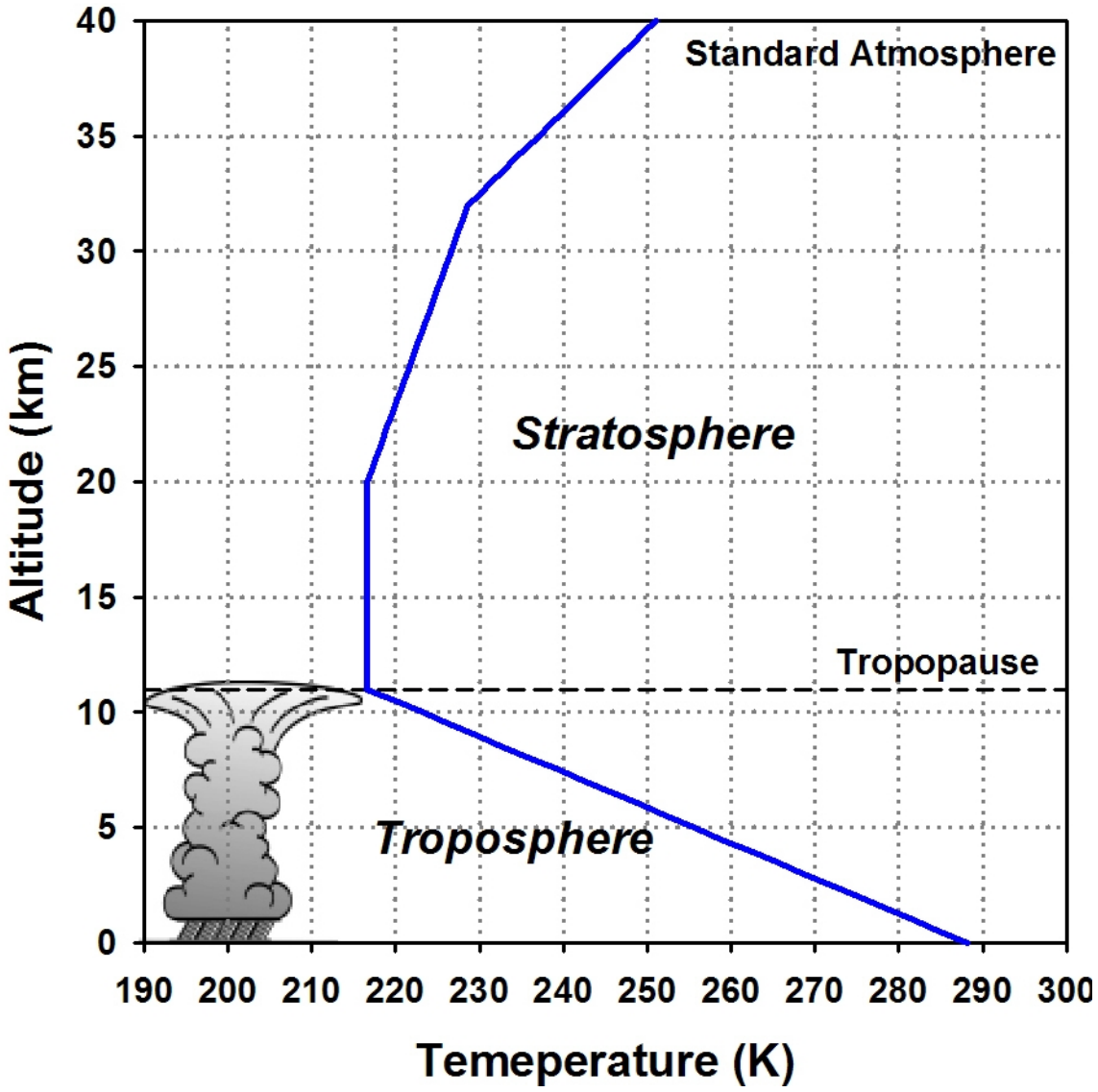
- Simultaneous observations by geographically distributed observers.
- Made possible by:
  - Ben Franklin's observation that many storms move from place to place rather than form in place.
  - Invention of the telegraph so that information could move faster than the weather.
- Main synoptic times 00 and 12 UTC
  - Also 06 and 18Z, or 03, 06, 12…, or hourly…

Rawinsonde Observations



Most at 00 and 12 GMT, a few at 06 or 18

Atmospheric Sounding: temperature profile



Synoptic Scale

- Definition: a scale at which atmospheric phenomena at horizontal dimensions that are much larger than their vertical dimensions.

$$\text{High/Length} << 1$$

Or

$$H/L << 1$$

Table 2.4. Weather systems on or near the ground

Disturbance	Scale	Duration	Max. wind
Extratropical cyclone	500–2000 km	3–15 days	55 m s^{-1}
Cold front	500–2000 km	3–7 days	25 m s^{-1}
Anticyclone	500–2000 km	3–15 days	10 m s^{-1}
Warm front	300–1000 km	1–3 days	15 m s^{-1}
Hurricane	300–2000 km	1–7 days	90 m s^{-1}
Tropical storm	300–1500 km	3–15 days	33 m s^{-1}
Tropical depression	300–1000 km	5–10 days	17 m s^{-1}
Dry front	200–1000 km	1–3 days	20 m s^{-1}
Midget typhoon	50–300 km	2–5 days	50 m s^{-1}
Mesohigh	10–500 km	3–12 h	25 m s^{-1}
Gust front	10–300 km	0.5–6 h	35 m s^{-1}
Mesocyclone	10–100 km	0.5–6 h	60 m s^{-1}
Downslope wind	10–100 km	2–12 h	55 m s^{-1}
Macroburst	4–20 km	10–60 min	40 m s^{-1}
Microburst	1–4 km	2–15 min	70 m s^{-1}
Tornado	30–3000 m	0.5–90 min	100 m s^{-1}
Suction vortex	5–50 m	5–60 s	140 m s^{-1}
Dust devil	1–100 m	0.2–15 min	40 m s^{-1}

Scales of Atmospheric Motion (version 1)

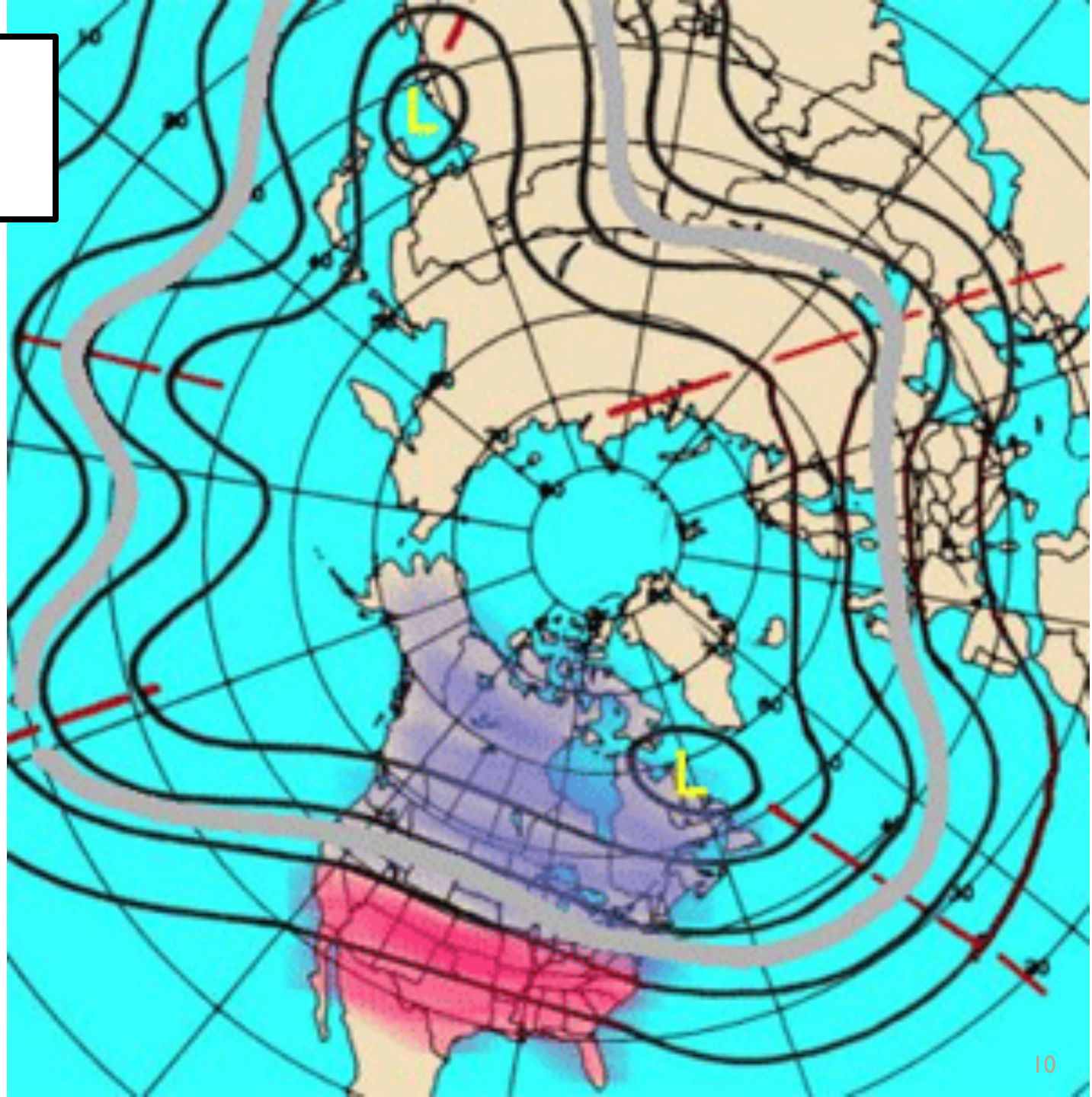
Scale	Length	Time
Planetary	~6000 km (R_e)	Weeks
Synoptic	~ 2000 km	days to a week
Meso-α	2000-200 km	A day or two
Meso-β	200-20 km	A day-hours
Meso-γ	20-2 km	Hours-minutes
Convective	*5 km – 500m*	*Minutes*
Micro	< 2 km	Minutes-seconds

Orlanski, 1975

Scales of Atmospheric Motion (version 2)

- *Planetary scale – These circulations last for weeks or months, and extend* in size from 5000 to 40,000 km (~6000 km).
  - Examples are the Asian monsoon, *El Nino, and La Nina.*
- *Synoptic scale – These circulations last from days to weeks, and range in* size from 100 to 5000 km (~2000 km).
  - Examples are the high- and low-pressure systems we see on weather maps.
- *Mesoscale – These circulations last from minutes to hours, and range in size* from 1 to 2000 km.
  --Examples are thunderstorms, tornadoes, and land-sea breezes.
- *Microscale – These are the smallest circulations, lasting under a few minutes,* and being less than 2 km in size.
  --Examples are wind gusts and dust devils.

Planetary Waves



Synoptic-Scale Weather in 1863

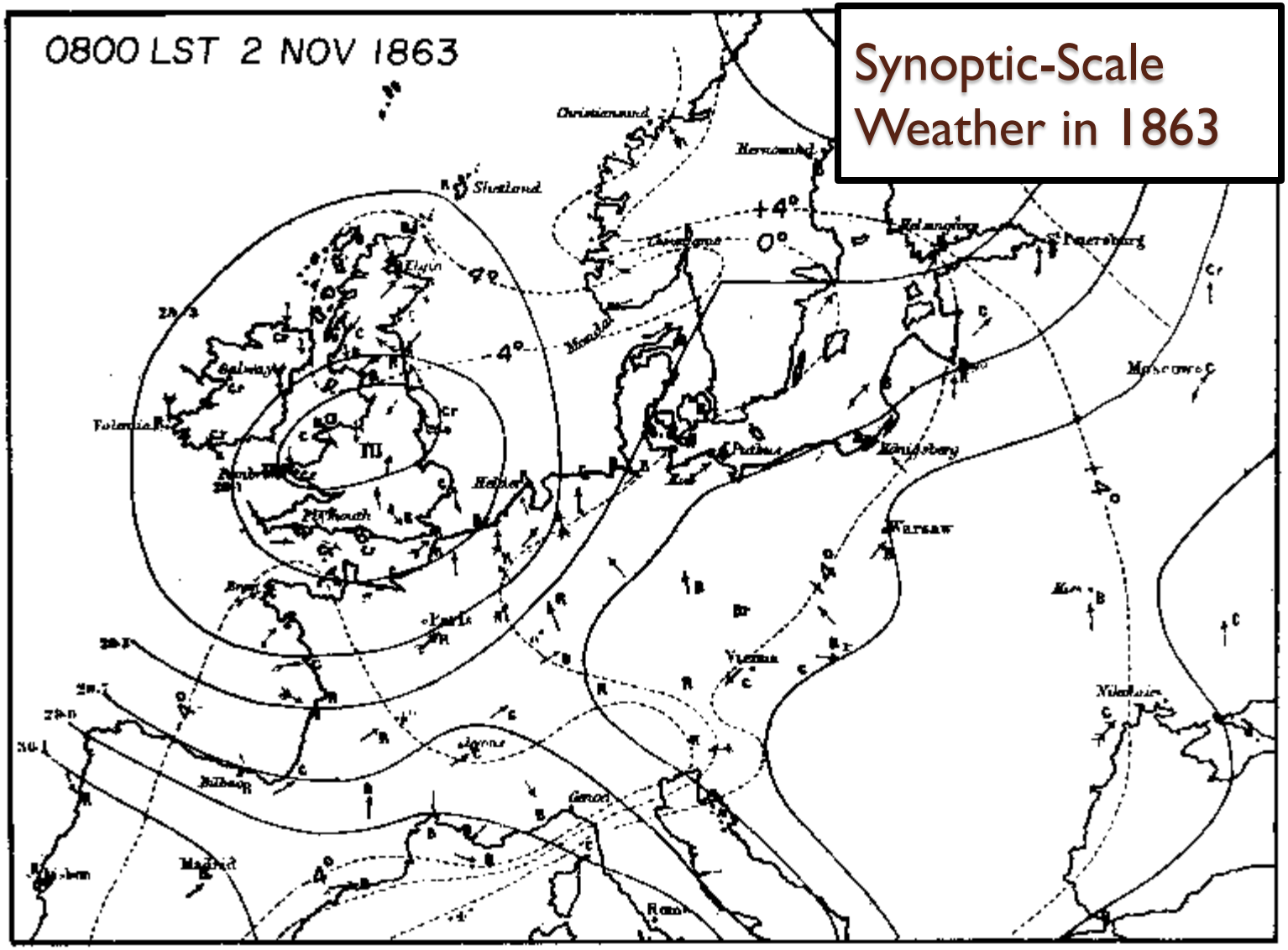


Figure 2.1. Meteorological chart of Europe at 0800 LST, 2 November 1863. (From *Journal of the Scottish Meteorological Society*, October 1868.) Isobars in inches and air temperature in degrees Celsius are drawn with solid and dashed lines, respectively. Symbols of station weather are C, cloudy; B, blue sky and few clouds; R, rain; r, rain during the past 24 hours.

Synoptic-Scale Weather

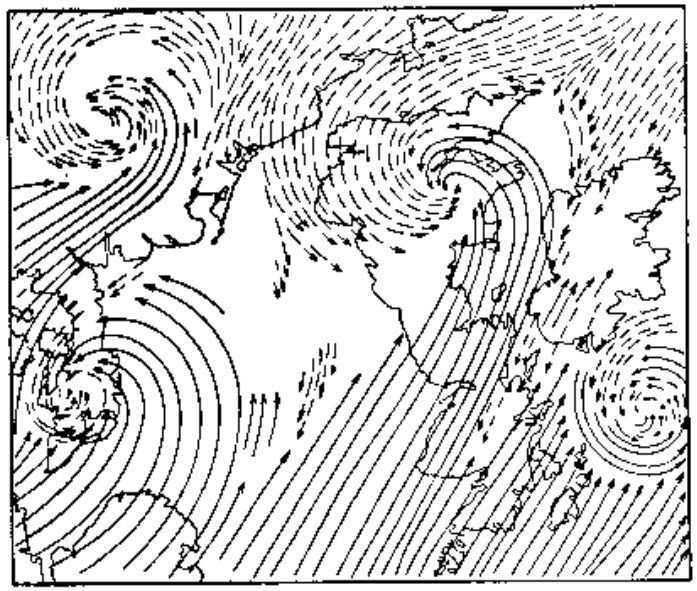


Figure 2.2. Fitz-Roy model of extratropical cyclones introduced by Petterssen (1956). Streamlines of polar air from the north are drawn with full lines, and those of tropical air from the south with dashed lines.

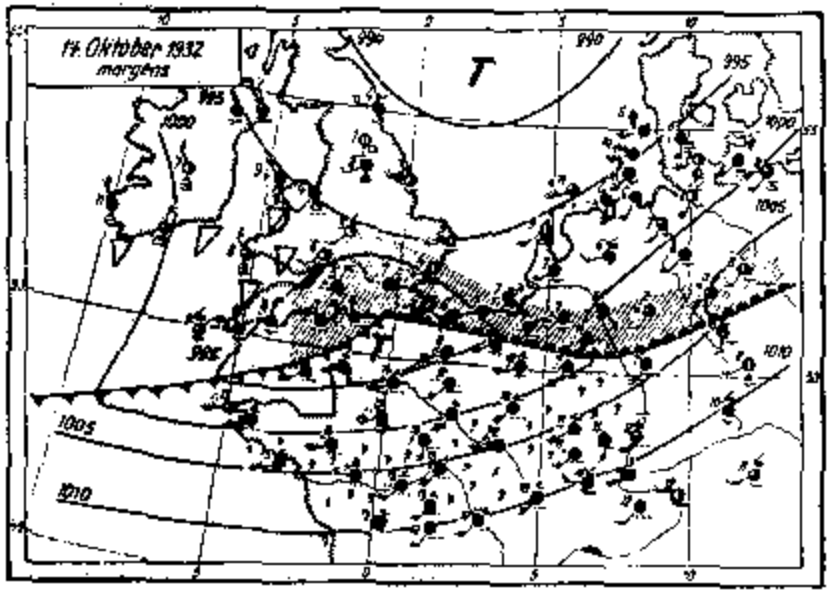
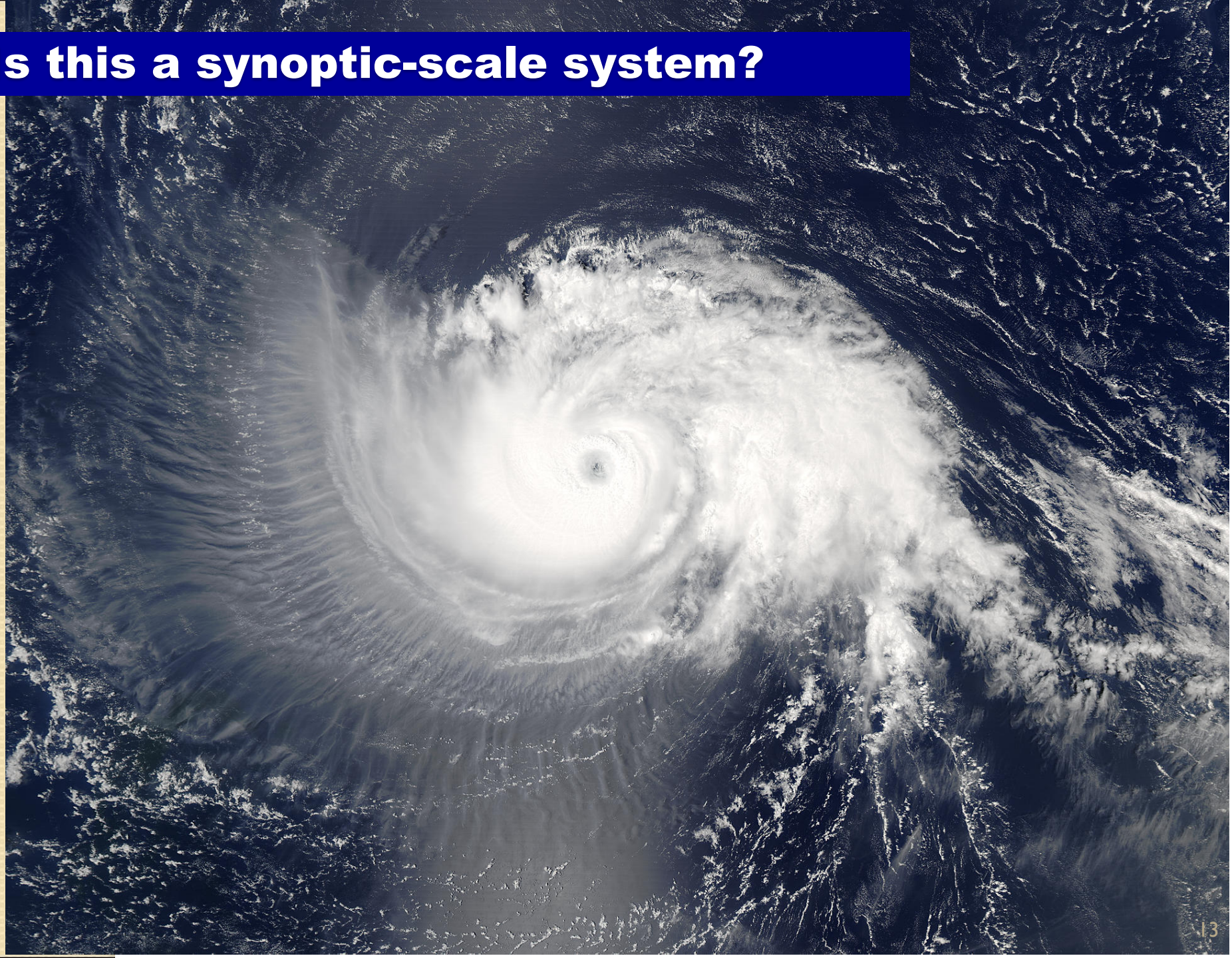
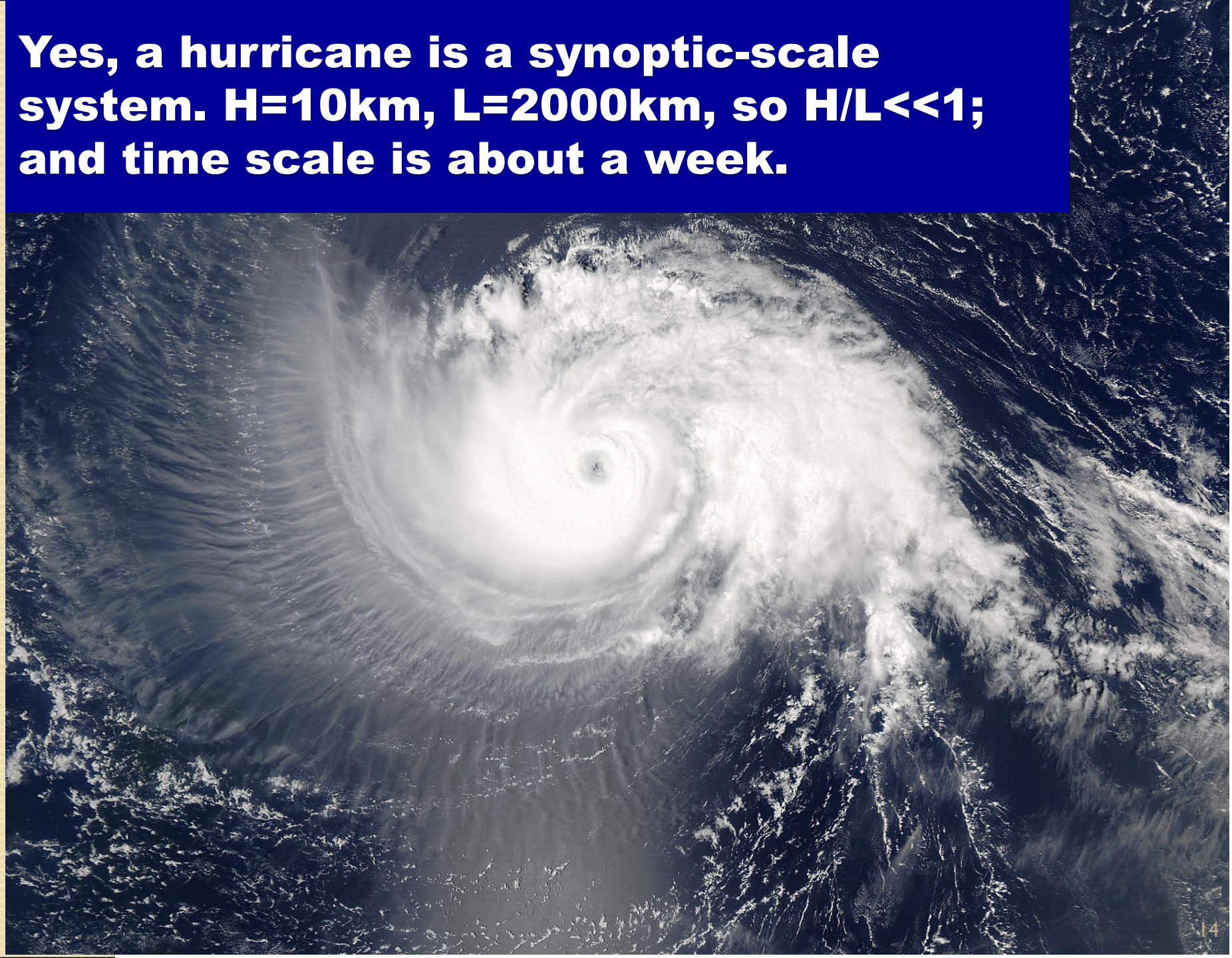


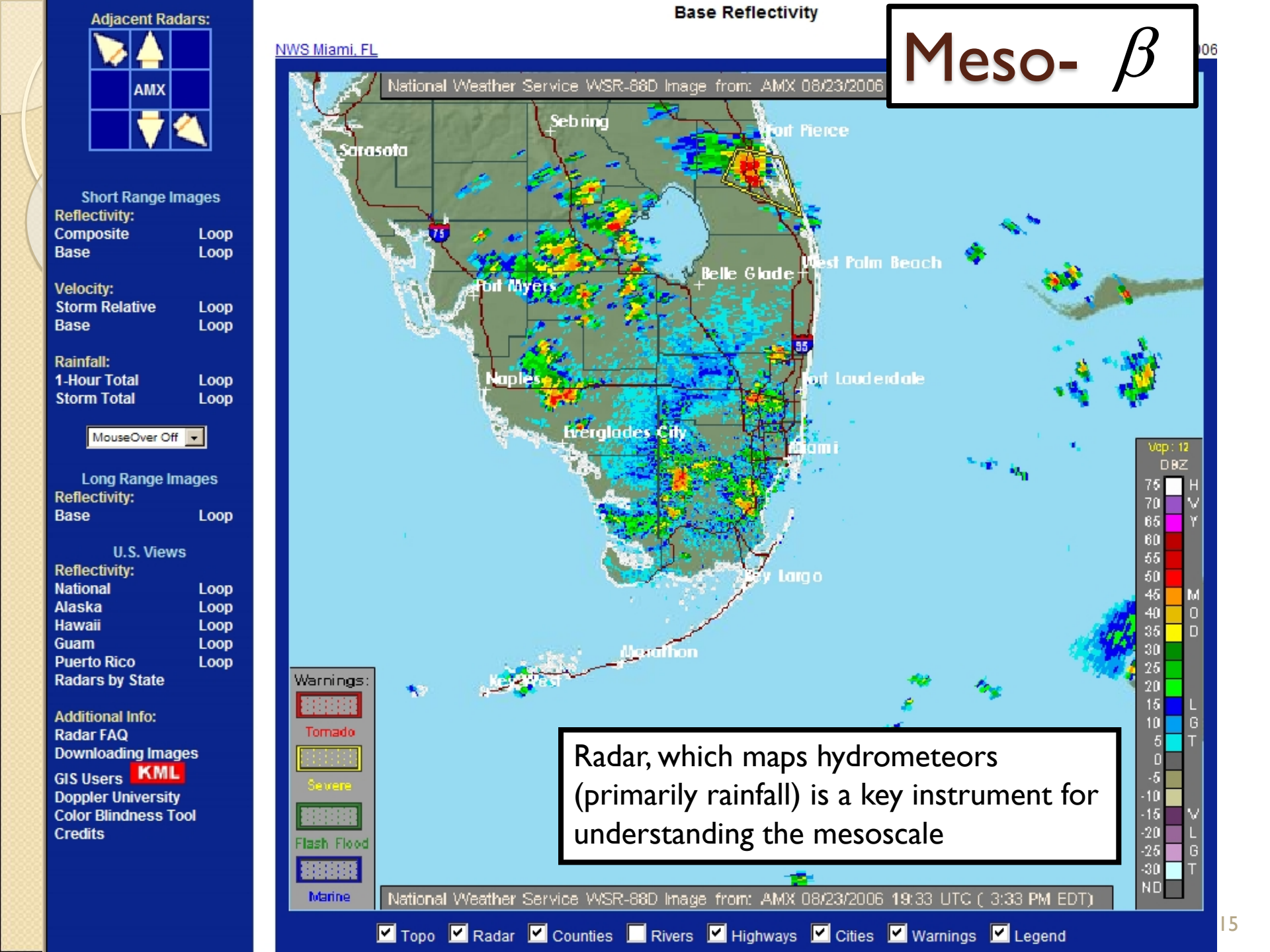
Figure 2.4. A wave cyclone analyzed by Van Mieghem, introduced by Chromow (1942); warm and cold fronts are shown. Isobars are in millibars; plotted temperatures are in degrees Celsius.

Is this a synoptic-scale system?

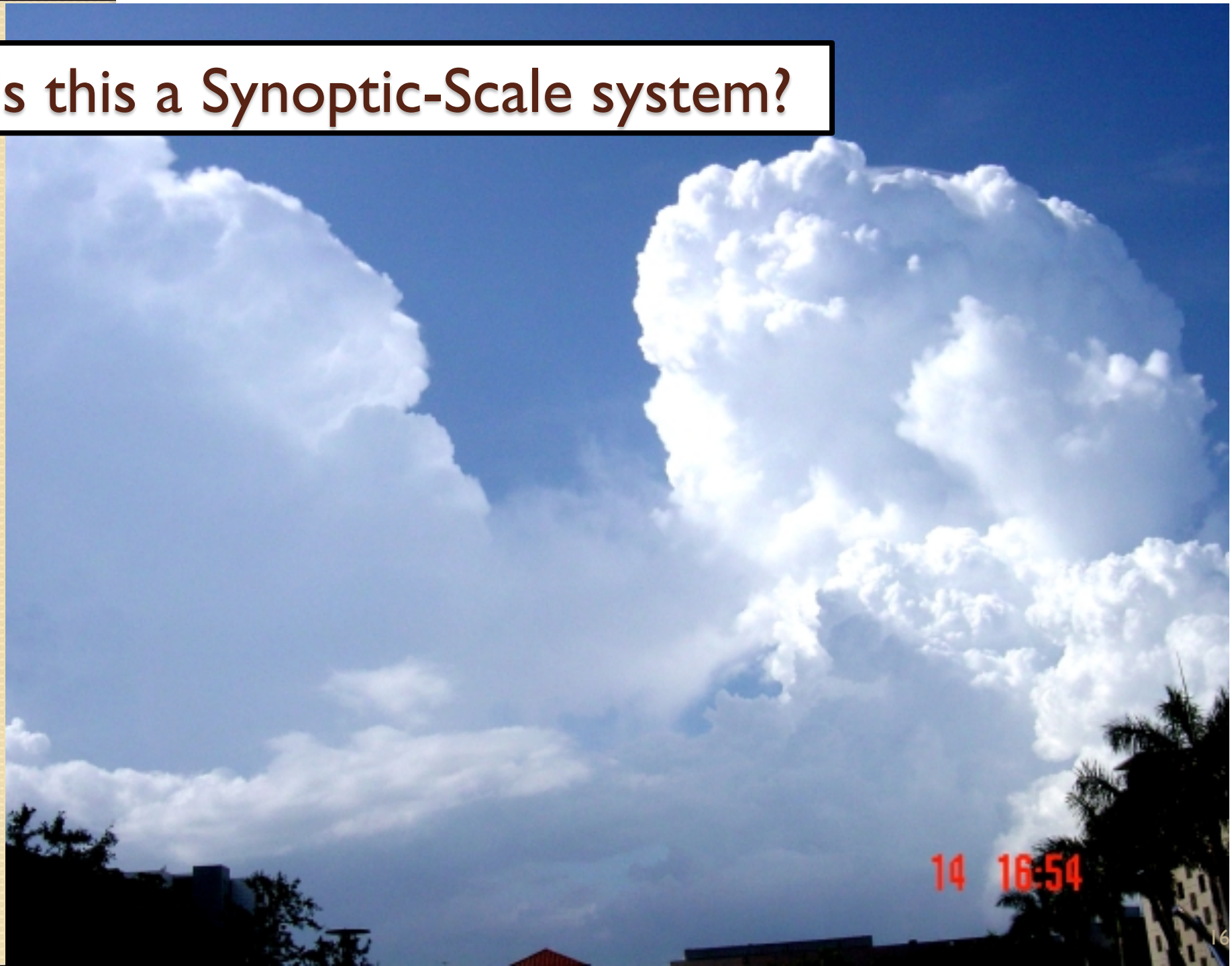


Yes, a hurricane is a synoptic-scale system. H=10km, L=2000km, so H/L<<1; and time scale is about a week.

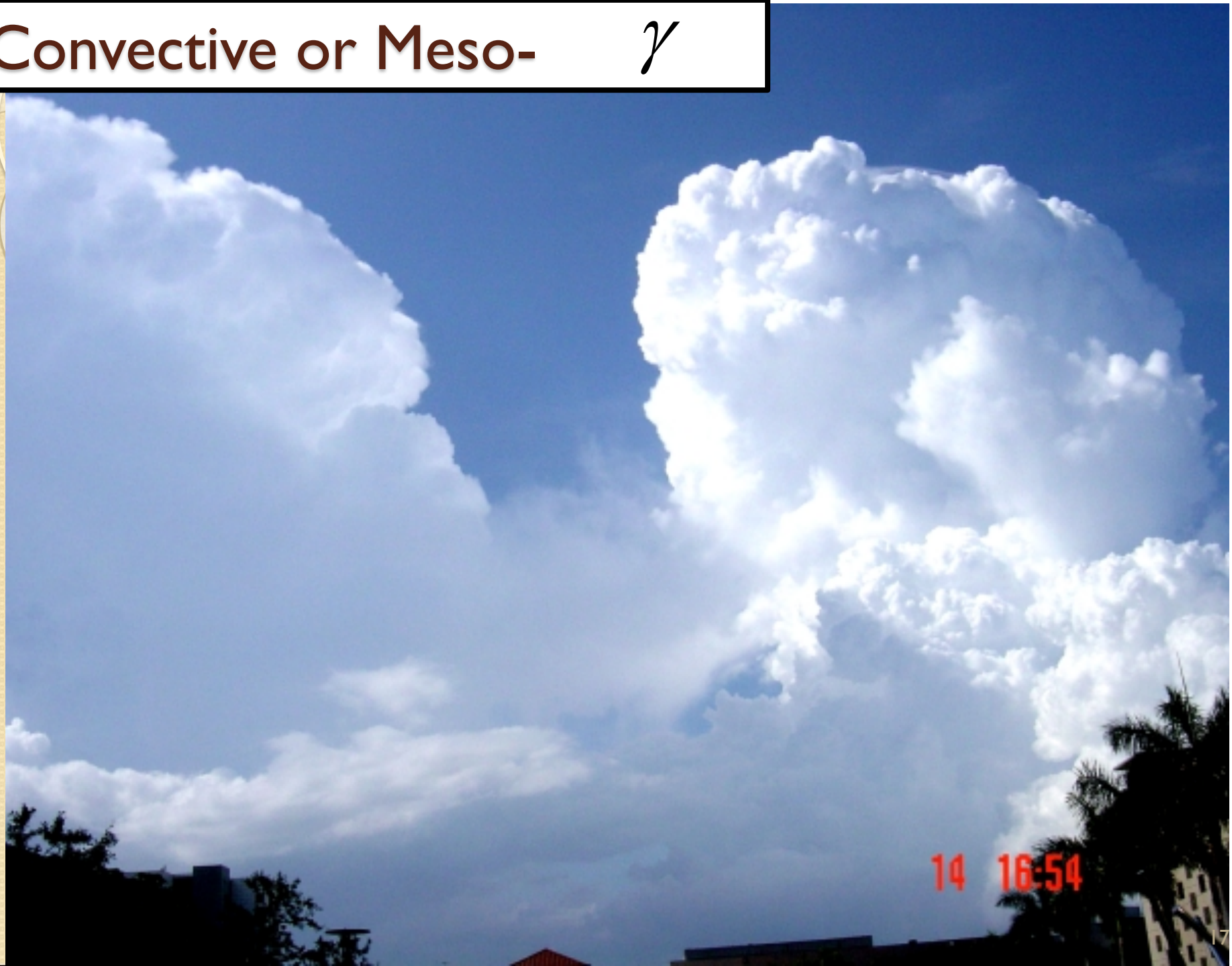



Adjacent Radars:
AMX
Short Range Images
Reflectivity:
Composite Loop
Base Loop
Velocity:
Storm Relative Loop
Base Loop
Rainfall:
1-Hour Total Loop
Storm Total Loop
MouseOver Off
Long Range Images
Reflectivity:
Base Loop
U.S. Views
Reflectivity:
National Loop
Alaska Loop
Hawaii Loop
Guam Loop
Puerto Rico Loop
Radars by State
Additional Info:
Radar FAQ
Downloading Images
GIS Users KML
Doppler University
Color Blindness Tool
Credits
Base Reflectivity
NWS Miami, FL
National Weather Service WSR-88D Image from: AMX 08/23/2006
Sebring
Fort Pierce
Sarasota
West Palm Beach
Belle Glade
Fort Myers
Naples
Fort Lauderdale
Everglades City
Miami
Key Largo
Marathon
Key West
Warnings:
Tornado
Severe
Flash Flood
Marine
Vcp: 12
DBZ
75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 -5 -10 -15 -20 -25 -30 ND
HVY MOD LGT VLG T
National Weather Service WSR-88D Image from: AMX 08/23/2006 19:33 UTC (3:33 PM EDT)
Topo Radar Counties Rivers Highways Cities Warnings Legend
Meso- β
Radar, which maps hydrometeors (primarily rainfall) is a key instrument for understanding the mesoscale

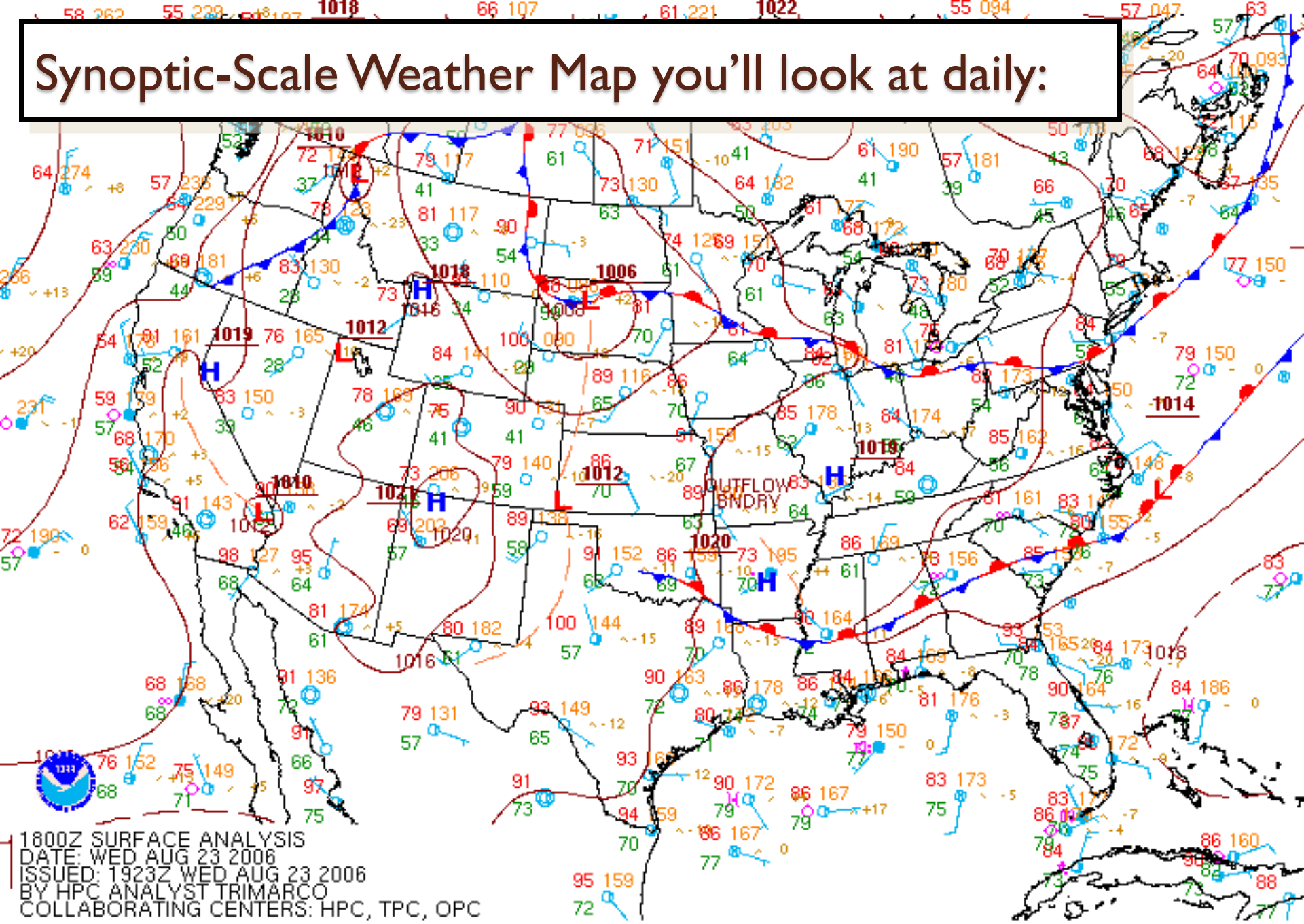
Is this a Synoptic-Scale system?



Convective or Meso- γ



Synoptic-Scale Weather Map you'll look at daily:



Synoptic Meteorology

- A sub-discipline of meteorology that synopsizes theory, dynamics, observational analysis, numerical analysis across all scales to understand and predict the weather.

Synoptic-Scale Flows

- Fill the depth of the Troposphere (10-20 km)
- Winds are close to Geostrophic Balance
  - Large horizontal scale (> 1000 km)
  - Change slowly (days)
- Vertical motions (cm s^{-1}) much weaker than horizontal motions (10s of m s^{-1})
- Pressure is hydrostatic
- Move heat horizontally (poleward) rather than vertically
- Big enough to appear in observations from many stations
- Lasting long enough to appear on several weather maps.