

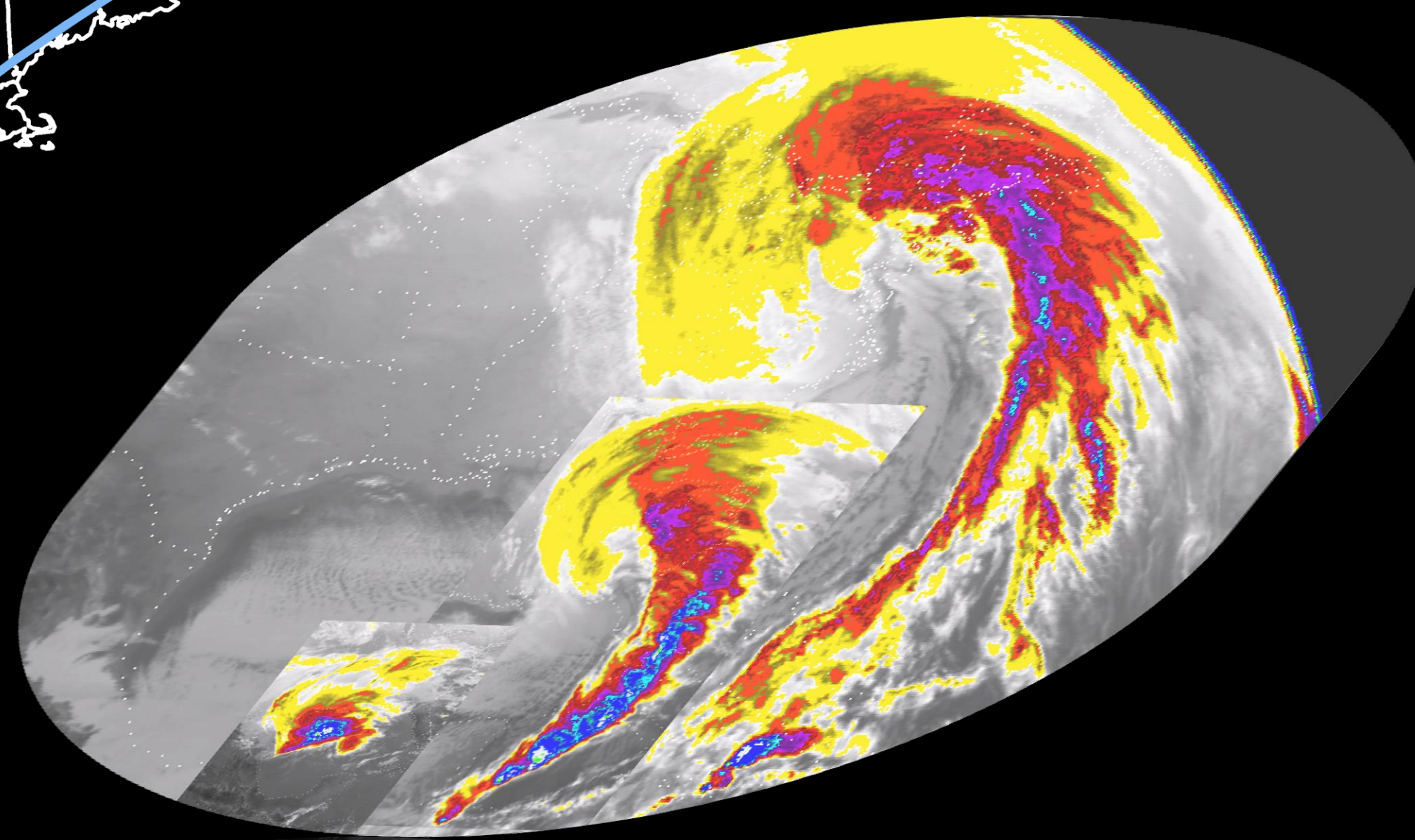
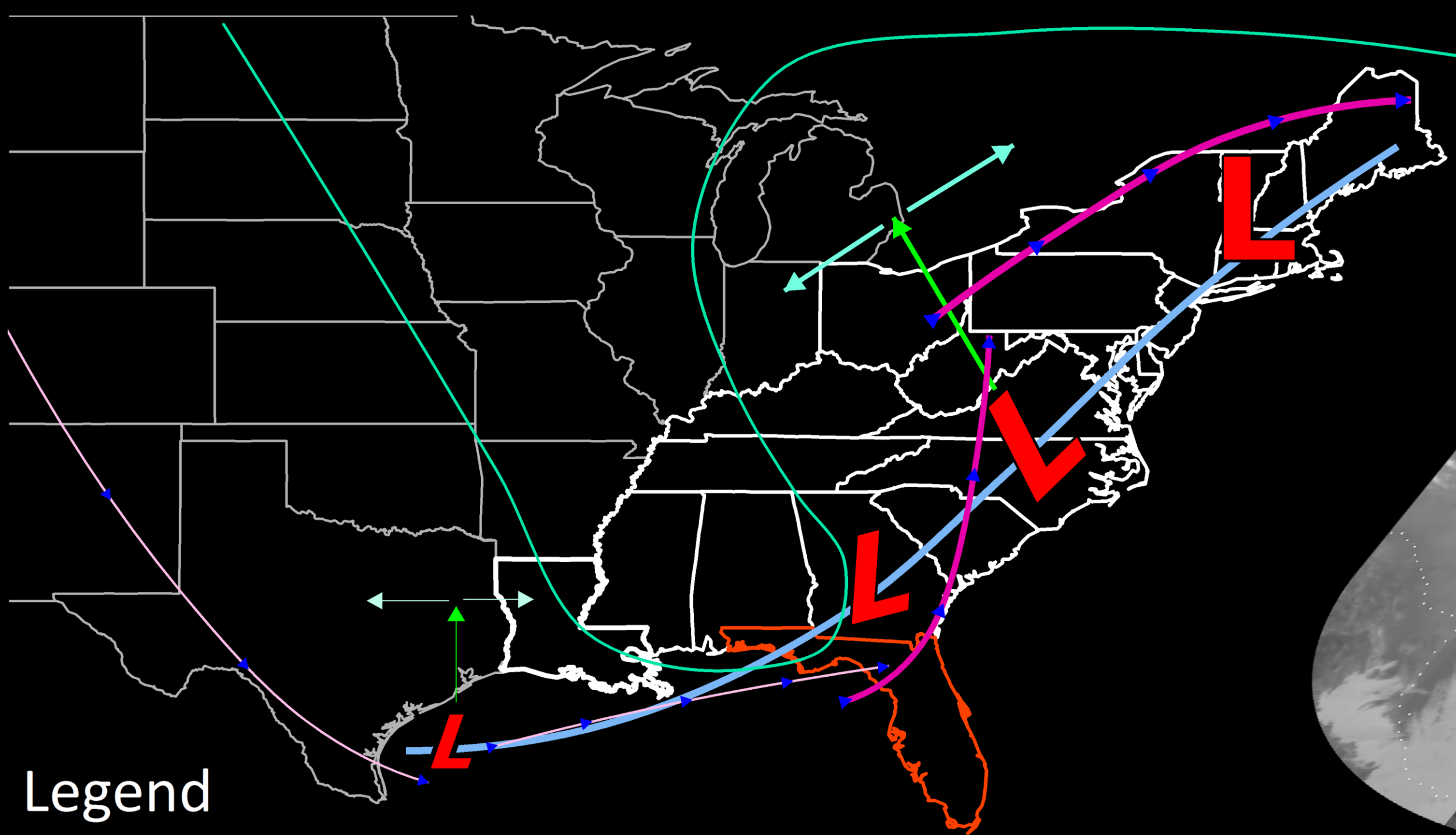


upheaval of '93

During March 1993, a historic, widespread, and extremely hazardous weather event occurred. An extraordinary extratropical cyclone affected about 40 percent of the United States and took the lives of approximately 300 human beings. The enormous storm had two major components: a severe weather outbreak that devastated Florida and a winter blizzard that pummeled Mississippi to Maine.

Synopsis: An energetic northern jet streak dove southeast from the Pacific Northwest toward the Gulf of Mexico. Meanwhile, a strong baroclinic zone (frontal boundary) was draped across the Gulf Coast. A second jet streak moved northeast from the Gulf over the eastern U.S. The positioning and interaction of these two energetic pieces of the jet stream were crucial to extremely dynamic storm development. The left-exit region of the northern jet streak and right-entrance region of the eastern jet overlapped one another in the western Gulf of Mexico. This produced intense upper-level divergence and rapid surface low development along the baroclinic zone near the western Gulf Coast. Strong diabatic release of latent heat from warm Gulf waters added to explosive intensification. The deepening surface low and tightening pressure gradient promoted strong low-level jet (LLJ, i.e., wind maximum) development. The LLJ imported warm, unstable air northward from the Gulf as the cold conveyor belt pulled cold air south and west to the north of the storm in low and mid levels. This facilitated intense frontogenesis, intense lift, and instability aloft in the storm, which resulted in blizzard conditions from parts of the Deep South to New England as the low moved northeast along the East Coast. Very heavy convective snows (i.e., thundersnow) and strong surface winds combined to create much havoc. Meanwhile, south and east of the low, a powerful line of thunderstorms (squall line) caused extreme wind gusts, widespread wind damage, and tornadoes across Florida.

Strong Upper-Level Divergence



Enhanced infrared satellite imagery at left is a composite containing 3 images at various stages of storm development. *Left:* March 12, 11 am EST. *Middle:* March 13, 5 am EST. *Right:* March 13, 6 pm EST.

Legend

- Blizzard
- Severe Weather
- Little or No Impact
- Upper-Level Trough
- Jet Streak
- Storm Track
- Divergence Arrow

Base from geodatabase: Graphic generated from resource data of AMS Journal Vol. 76, No. 2, Feb 1995.

More people died from drowning during this storm than from Hurricane Hugo and Hurricane Andrew combined.

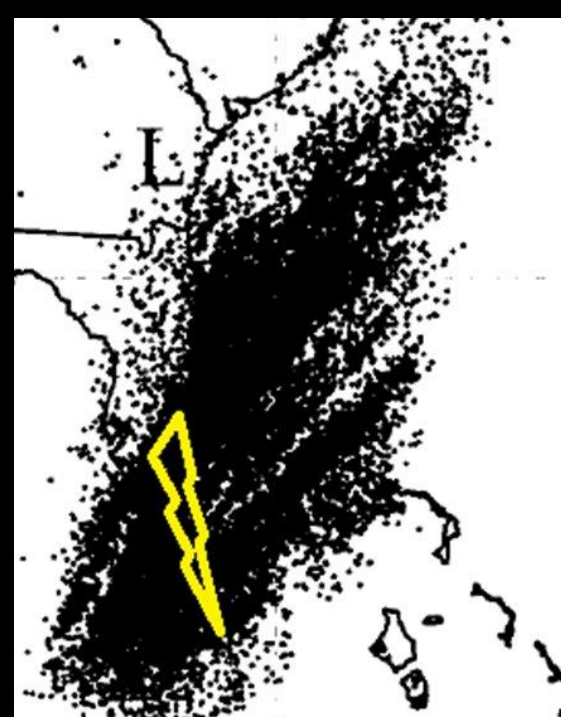
Severe Weather Impacts

- Florida was hit by hurricane-like severe weather, especially from the central Panhandle to Tampa Bay.
- Storm surge in Florida was up to 12 feet in places, higher than some hurricanes, and produced widespread coastal flooding.
- Storm was responsible for almost 50 deaths in Florida, including at least 11 drownings from the storm surge.
- 18,000 homes were damaged or destroyed in Florida. Total property damage in Florida alone was estimated at \$1.6 billion.
- Non-tornadic wind gusts were recorded around 100 mph in the Florida Keys.
- Myrtle Beach, SC recorded a wind gust of 90 mph.
- Beach erosion was common all along the East Coast.
- Hundreds of homes along the East Coast were damaged or washed away.

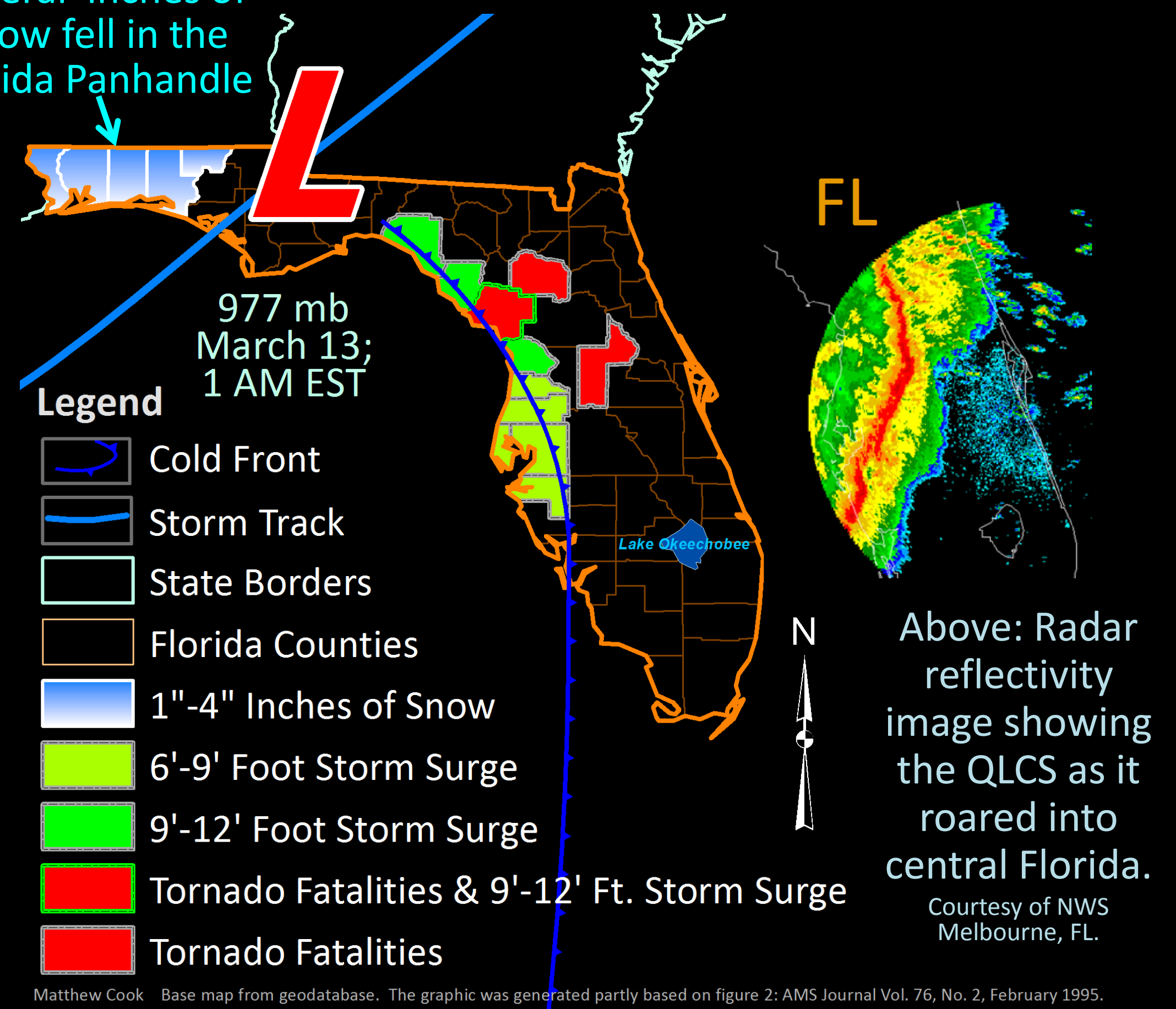
Florida: Severe Weather and Snow

- An intense quasi-linear convective system (QLCS) along the storm's trailing cold front brought many wind gusts of 60-100 mph, widespread wind damage, tornadoes, and a strong storm surge. Widespread coastal flooding ensued from strong onshore winds that forced Gulf waters to swell along the western coast. To worsen things, westerly gales developed behind the cold front which prolonged the impact and flooding.
- Northwest of the storm (i.e., in the Florida Panhandle), several inches of snow fell, a rarity for Florida.

An incredible number of lightning strikes occurred from 1-7 am EST on March 13 from the QLCS. *Courtesy Monthly Weather Review, Dec 1997.*



Several inches of snow fell in the Florida Panhandle



Above: Radar reflectivity image showing the QLCS as it roared into central Florida. *Courtesy of NWS Melbourne, FL.*



Saint Petersburg, Florida: Waves crashed onshore as a truck sat in a flooded street caught by the long-lived flooding. *Image courtesy of NOAA.*



Crystal River, Florida: A boat was washed inside a house from the strong storm surge and flooding. *Image courtesy of Tampa Bay Times photo library.*



Tampa Bay, Florida: In the wake of the storm, gale force winds developed which worsened the flooding impact. *Image courtesy of Bay News 9.*

Matthew Cook

University of Louisville



Superstorm of '93

Eastern U.S. Blizzard

- Intense jet streak dynamics, rapid surface cyclogenesis, strong deep-layered frontogenesis, abundant cold moist air, and instability aloft combined to produce a blizzard from parts of the Deep South to the northeastern United States.
- Heavy wind-driven convective snow produced **snowfall rates of 2-3 inches an hour along with thunder and lightning** at times.
- Every county in the state of Alabama reported measurable snowfall.
- In Dalton, Georgia, roof tops of businesses collapsed under the weight of the heavy snow.
- A large deployment of the National Guard assisted many people in many states sustaining life after the storm had passed.
- In the wake of the storm, record cold and numerous deaths were reported. Deaths primarily occurred from overexertion/cardiac arrest from trying to remove vast amounts of heavy snow from their property.



Abundant and anomalous lightning strikes occurred from 1-7 am EST on March 13 within the area of heavy snow (thundersnow) over Alabama into Georgia.

Courtesy Monthly Weather Review, Dec 1997.



Newspaper courtesy of Chattanooga New-Free Press.

*"..people were calling the station with the question; **"IS JESUS COMING BACK?!"** ..because for a vast majority of our viewers it was their first time witnessing a phenomenon such as thundersnow."*

Meteorologist: Paul Barys
WRCB TV 3 Chattanooga, Tennessee

Extreme Winter Weather Record/Highlights

- A surface low that deepens very rapidly is referred to as a "bomb cyclone" or simply a "bomb" when its pressure falls at least 19 mb in 24 hours at 45° latitude or 24 mb in 24 hours at 60° latitude.
- The March 1993 superstorm surface low occurred between 30-45° latitude and deepened a whopping 29 mb in 24 hours. This denoted very impressive, explosive development.
- Sea-level pressure records were set along the East Coast.
- Two major records were broken in Birmingham, Alabama: record low temperature of 2°F and snowfall of 13 inches (with some reports as high as 17 inches). On average, Birmingham receives 1.7 inches of snow a year.
- **Record-low sea level pressure:** White Plains, NY: 961.1 mb.
- **Highest recorded wind gust:** Mount Washington, NH: 144mph.
- **Highest snow total:** Mount LeConte, TN: 60 inches (5 feet!)



Syracuse, New York:

Cars were buried by a record breaking 43 inches of snow.

Image courtesy of NOAA.



Birmingham, Alabama:

This looks more like the Arctic than Dixie. Birmingham broke their official all-time snowfall record with 13 inches.

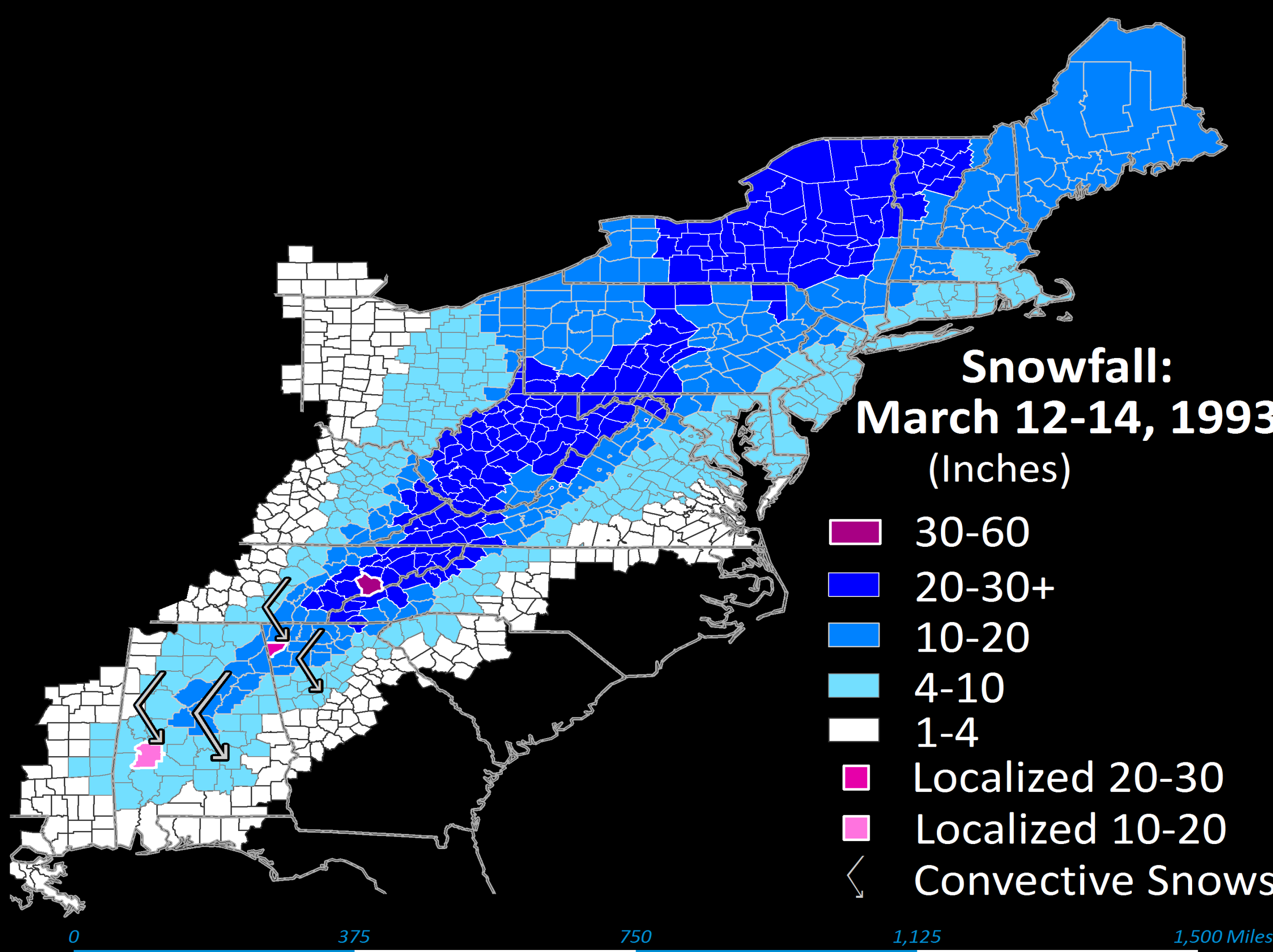
Image courtesy of Jim Westland, NWS Birmingham.



Asheville, North Carolina:

A common sight in the blizzard: fallen trees knocked over by extreme winds and heavy snow, and cars buried by snow.

Image courtesy of NOAA.



Base from geodatabase. Graphic generated partly based on noaa.gov snowfall graphic for March 12-14, 1993.

March 1993 Superstorm Net Effects

- Caused severe weather, tornadoes, and a blizzard.
- 40% of U.S. population affected (26 states).
- Approximately 300 people died from direct or indirect causes of the storm.
- Total damage estimated at \$9 billion.
- 60,000 lightning strikes occurred during a 72-hour period.
- Every major airport on the East Coast was closed at one point during the storm.
- 10 million customers lost power during the storm. Some people were without power for weeks.

Matthew Cook

University of Louisville