

# ***Severe Winds Due To Mountain Waves Along the Western Foothills of the Southern Appalachian Mountains***

by



**David M. Gaffin:**

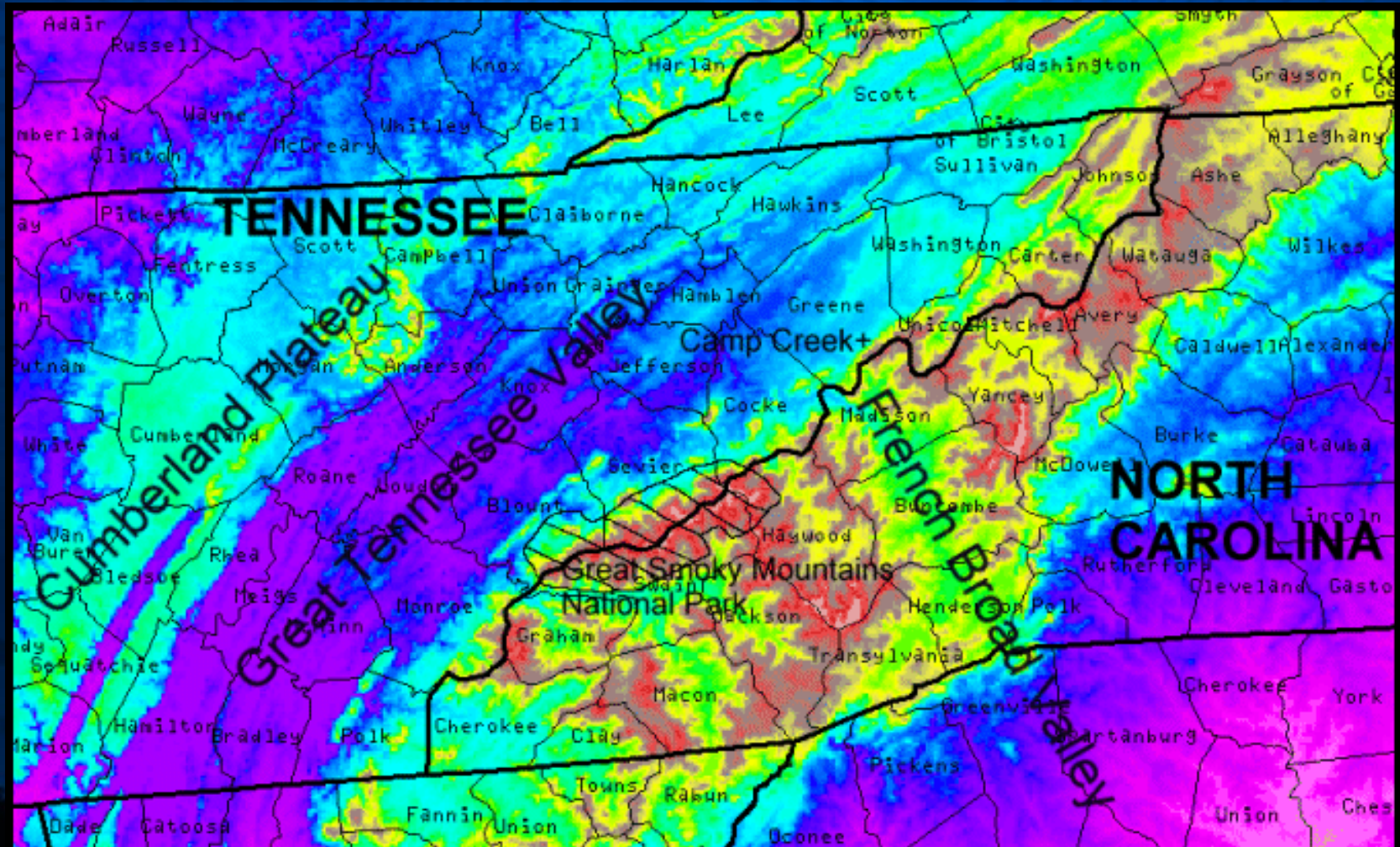
National Weather Service, Morristown, TN



**Matt Hinkin:** 

WATE-TV Chief Meteorologist, Knoxville, TN

# Relief and Geographic Map of the Southern Appalachian Region





# Great Smoky Mountains National Park

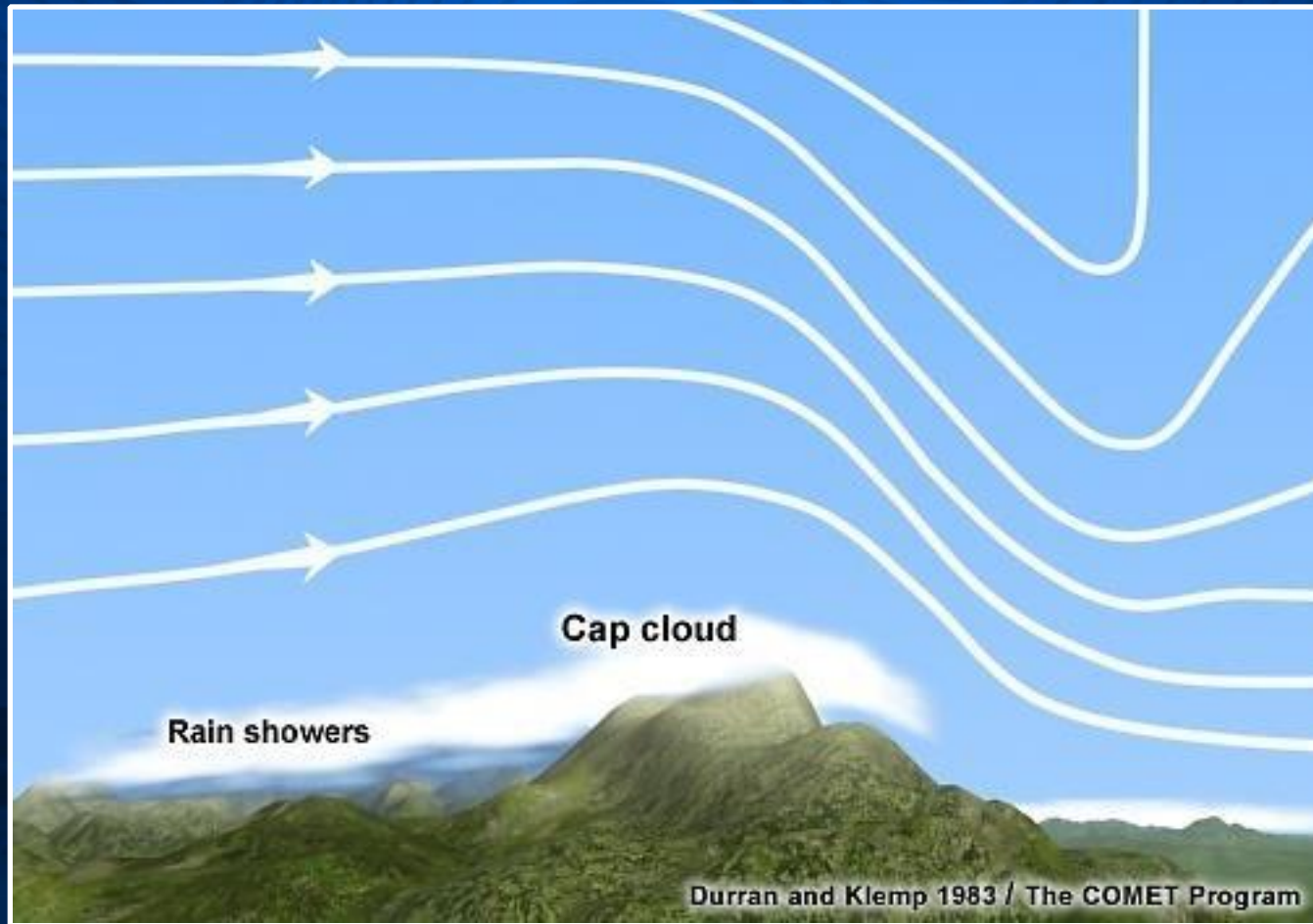


# Mountain Waves Are Similar To Stationary Waves Formed By Boulders In a River





# Conceptual Model of a Large-Amplitude Stationary Mountain Wave



# Mountain Wave Theory

Previous research has found that the following conditions increase the likelihood of mountain waves:

A cross-barrier wind flow exceeding 20 mph that is roughly  $30^\circ$  of perpendicular to the mountain ridges (southeast wind for the western foothills)

A stable layer extending above the mountain ridge (stable air mass causes winds to descend after crossing the main mountain ridge)

A vertical wind profile in which the wind increases with height and a critical level develops where the wind flow becomes parallel to the mountain ridges

# Mountain Wave Theory (continued)

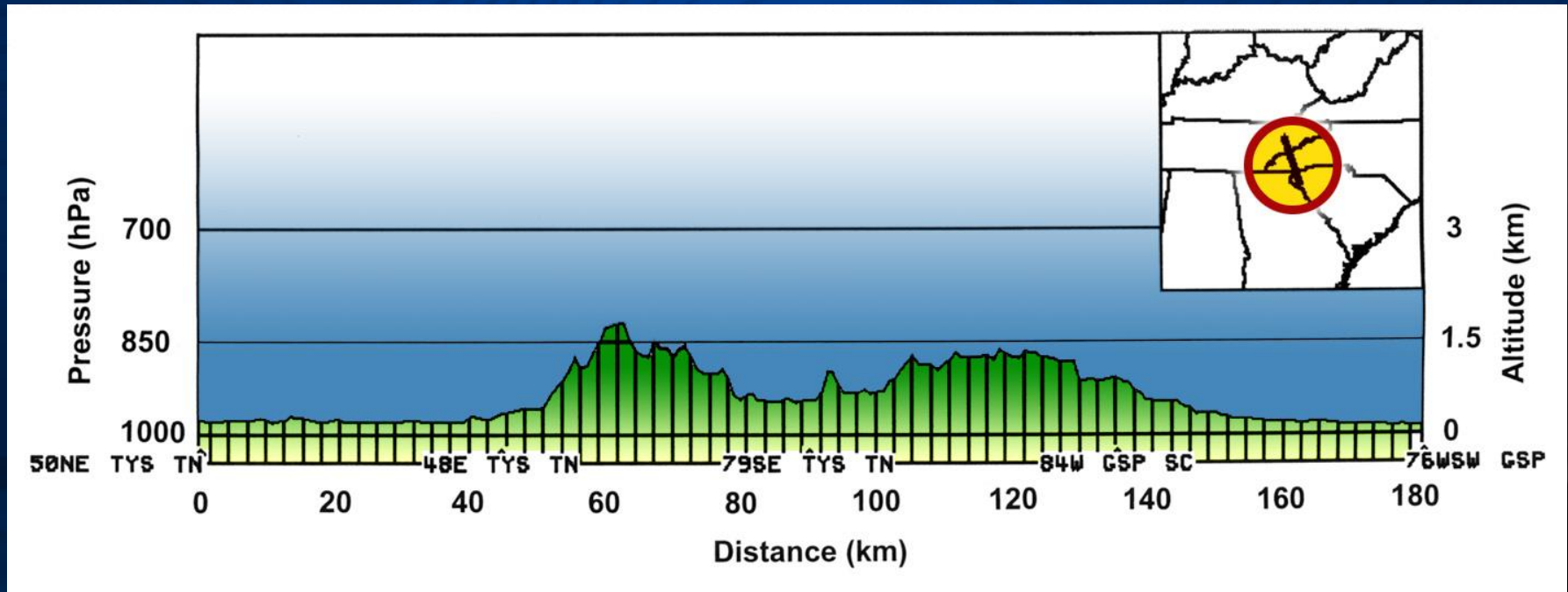
Existence of a mountain barrier with a gentle windward slope and a steep leeward slope.

Cove Mountain has reported higher wind gusts than Clingman's Dome (2,500 feet higher). Cove Mountain is near the foothills and is downwind of the highest and steepest mountain ridges in the National Park.

Camp Creek in southeast Greene County frequently reports strong winds – likely due to the location of the French Broad River Valley on the other side of the mountains.



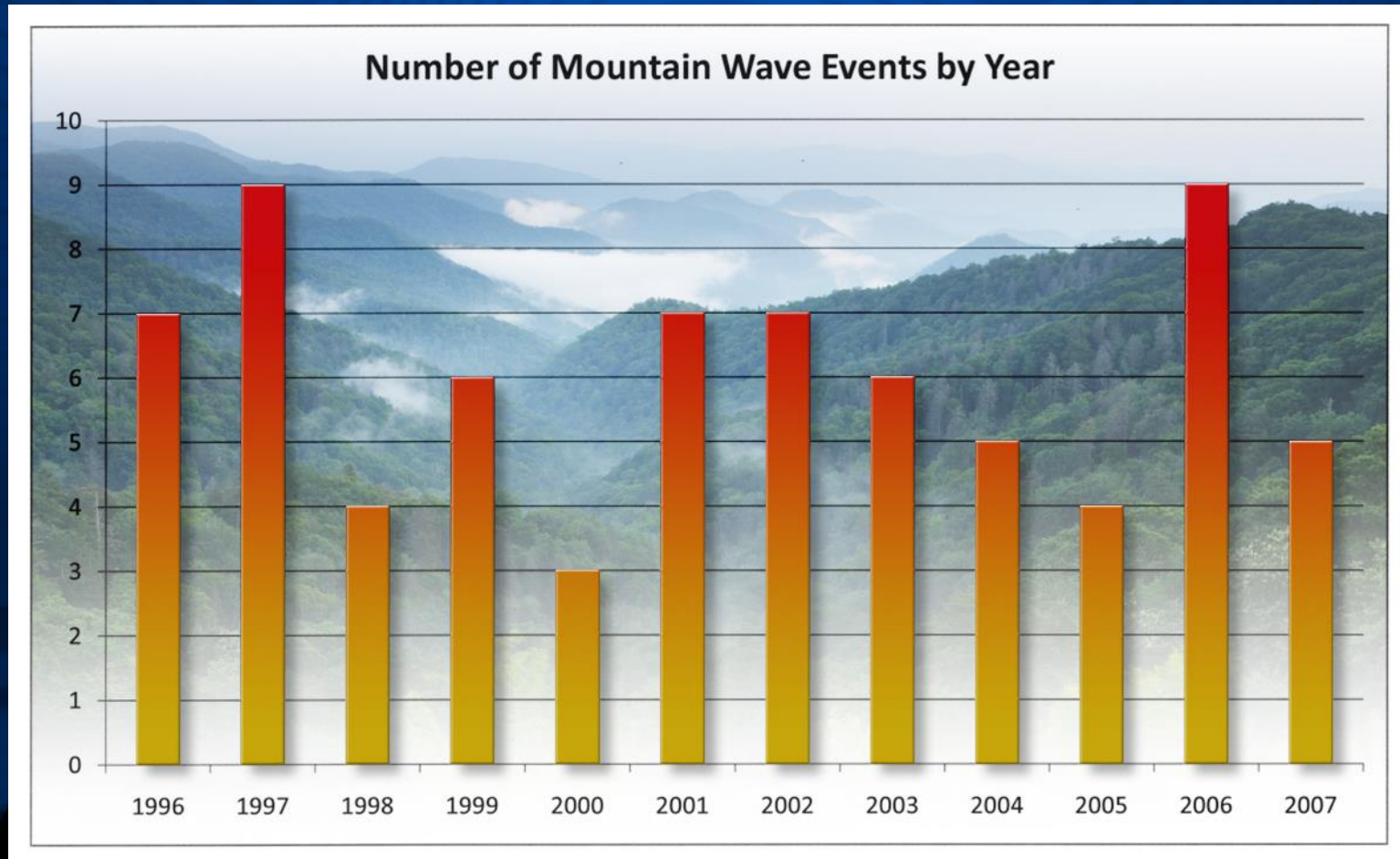
**Cross-section vertical profile of the southern Appalachian Mountains from northwest (left side) to southeast (right side); generally shows a steeper profile along the western slopes**





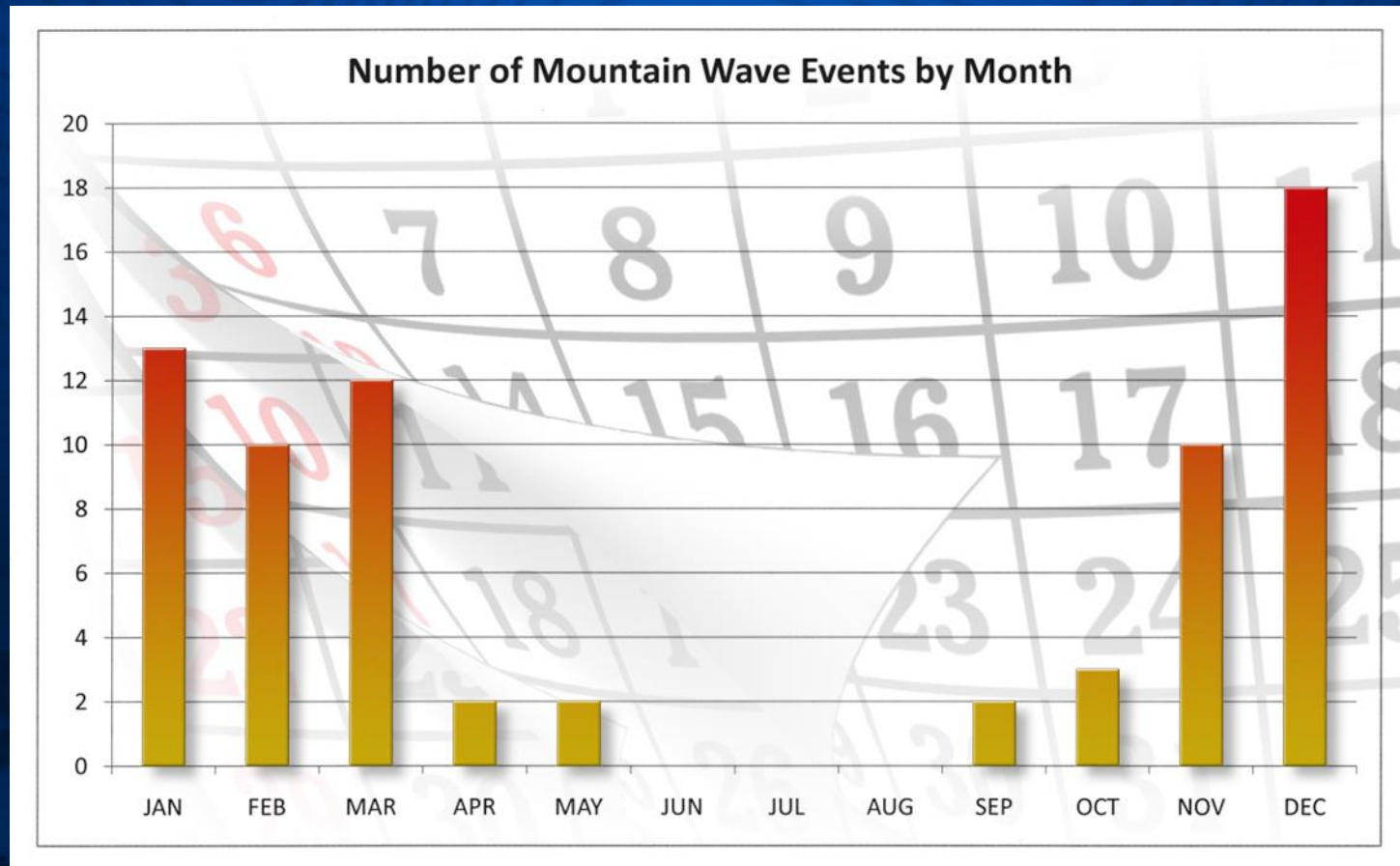
# Climatology of Mountain-Wave-Induced High Winds at Cove Mountain

(no significant correlation to El Nino or La Nina)



# Climatology of Mountain-Wave-Induced High Winds at Cove Mountain

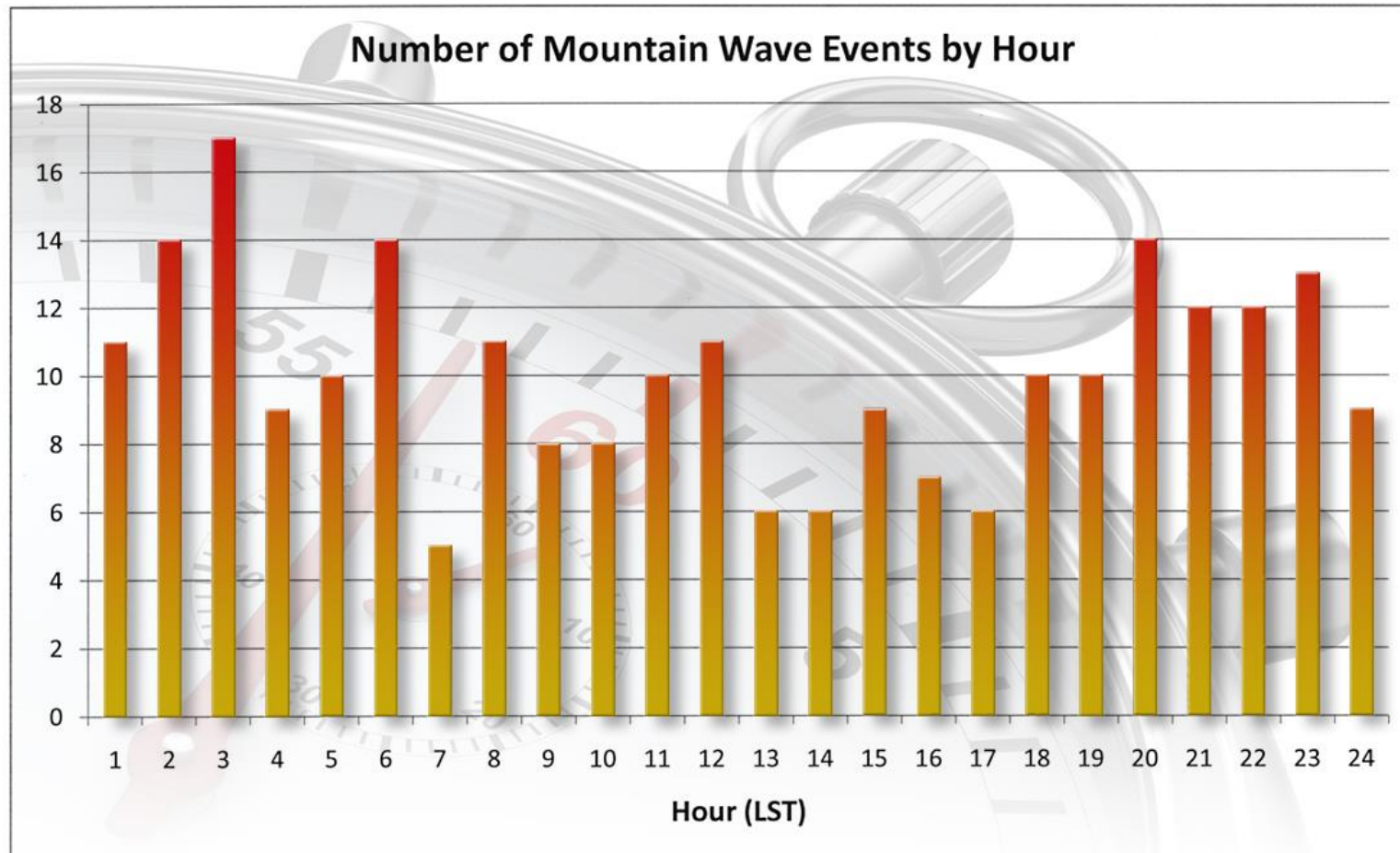
(most events occur between November and March)





# Climatology of Mountain-Wave-Induced High Winds at Cove Mountain

(most events occur at night when stable layers are more prevalent)





# Headline on October 18, 2006 from the Knoxville News Sentinel Newspaper



Today: Sunny  
and warm  
High: 84  
Low: 53  
Details: B2

50 cents  
★★★★  
October 18, 2006

## Wednesday NEWS SENTINEL Knoxville

KnoxNews.com

### MOUTHWATERING MERGER

The J.M. Smucker Co. has purchased K White Lily brand of baking products. C

### 'GROSS-OUT CAKES'

Make brains  
and eyeballs for  
Halloween. E1



# Wind batters Smokies

Downed trees,  
power lines make  
mess; few injuries

BY ROBERT WILSON  
rwilson2594@msn.com

**GATLINBURG** — Weldon Sanders appeared mostly unconcerned about the hissy fit that Mother Nature threw in the Great Smoky Mountains National Park late Monday.

Sanders, of Seagoville, Texas, near Dallas, was camping alone in his tent at the Elk-

mont Campground when a rainstorm, accompanied by record-breaking winds, swept through the park and parts of Blount and Sevier counties. It uprooted or broke hundreds of trees, blocked roads, cut power and made a mess of the campground.

Sanders said he intended to stay another night at Elkmont.

It seemed likely Tuesday, however, that he might have the campground pretty much to himself. Most of the other campers were leaving on the

advice of the National Park Service.

Bob Miller, public affairs officer for the park, said 90-mph winds and a record 106-mph gust were recorded at Cove Mountain near Laurel Falls early Tuesday during the peak of the storm, which slashed through the forest with a hurricane-like ferocity.

A 65-mph wind, also a record, was registered at Cades Cove. Clingmans

See **SMOKIES** on A10

### PARK ROADS OPEN

- Part of Little River Road from Newfound Gap Road to Elkmont Campground

### PARK ROADS CLOSED

- Newfound Gap Road from Gatlinburg to Cherokee, N.C.
- Laurel Creek Road from Townsend entrance to Cades Cove
- Cades Cove Loop Road

- Gatlinburg bypass
- Greenbrier Road
- Cosby entrance road

- Foothills Parkway East and West
- Cherokee Orchard Road
- Roaring Fork Motor Nature Trail



ROBERT WILSON/SPECIAL TO THE NEWS SENTINEL

Source: National Park Service



# Observations on October 17, 2006

Most roads in the Great Smoky Mountains National Park were closed due to fallen trees.

Greene County schools were closed due to numerous trees down around the Camp Creek area.

Wind gusts up to 106 mph at Cove Mountain

72 mph at Clingman's Dome (only available from May-October)

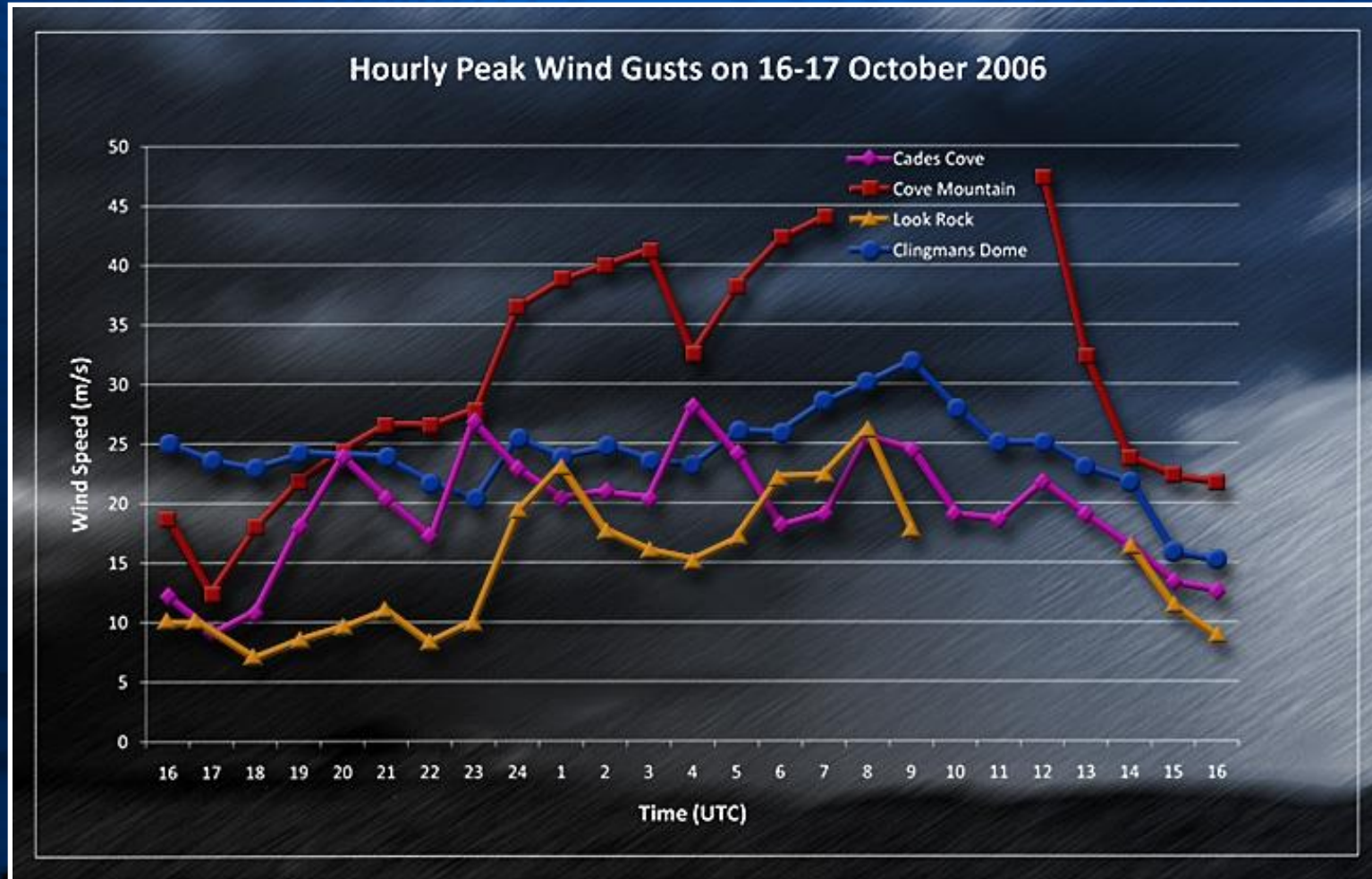
63 mph at Cades Cove

59 mph at Look Rock

Only 5 to 15 mph in the Great Tennessee Valley

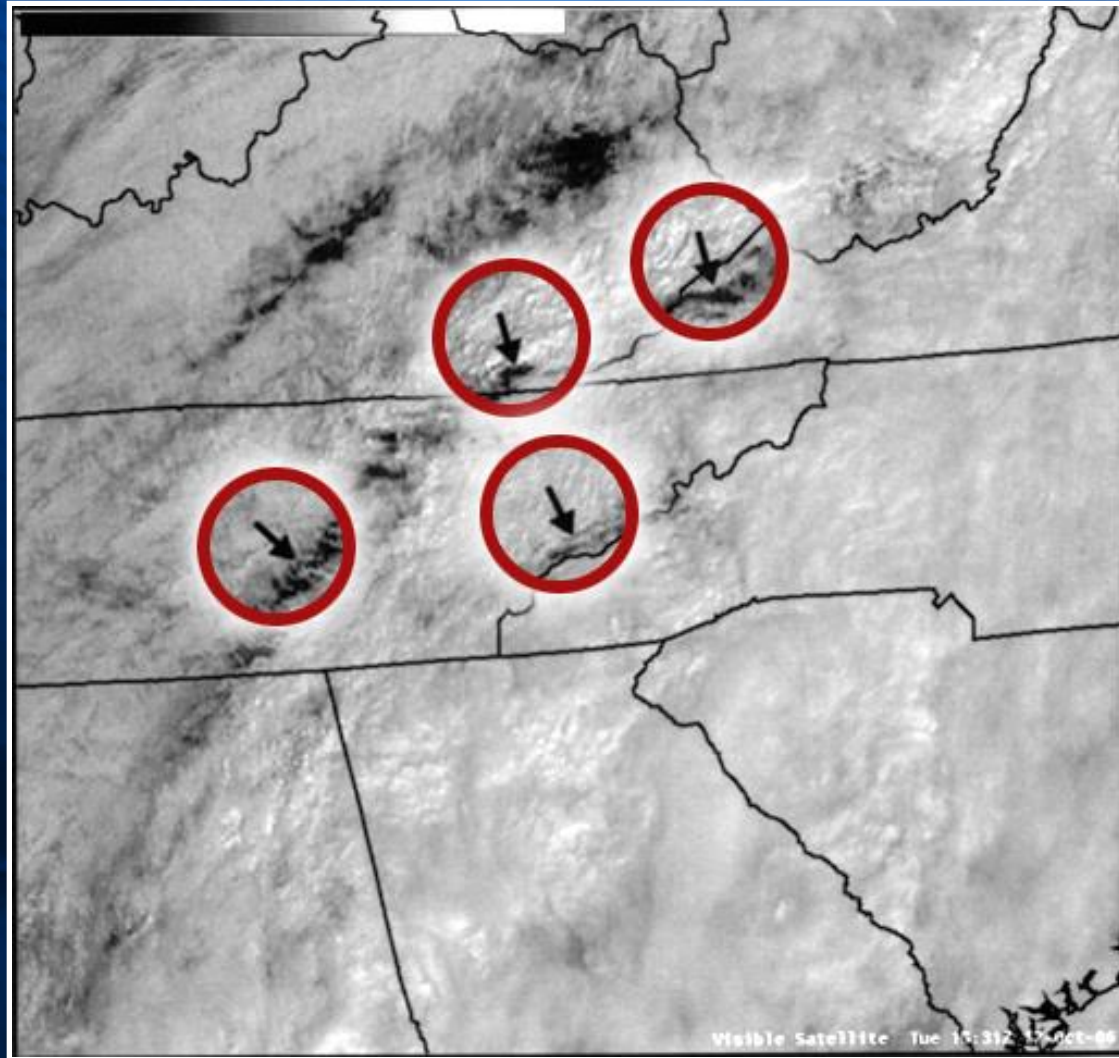
# Wind Gusts on October 16-17, 2006

(1 m/s = 2.24 mph; 47 m/s = 105 mph)

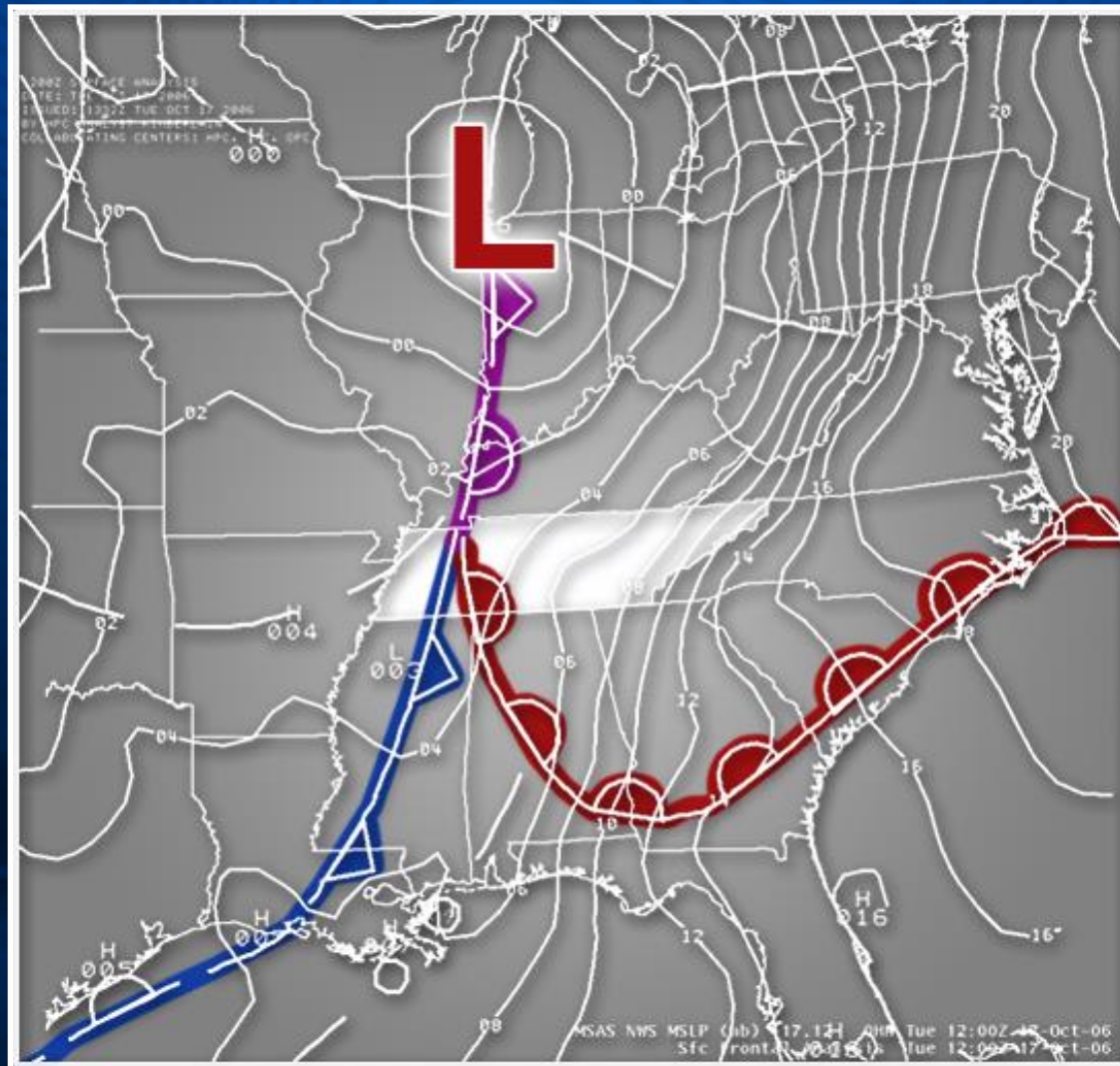




# Visible Satellite Imagery on October 17, 2006 at 11:31 am EDT

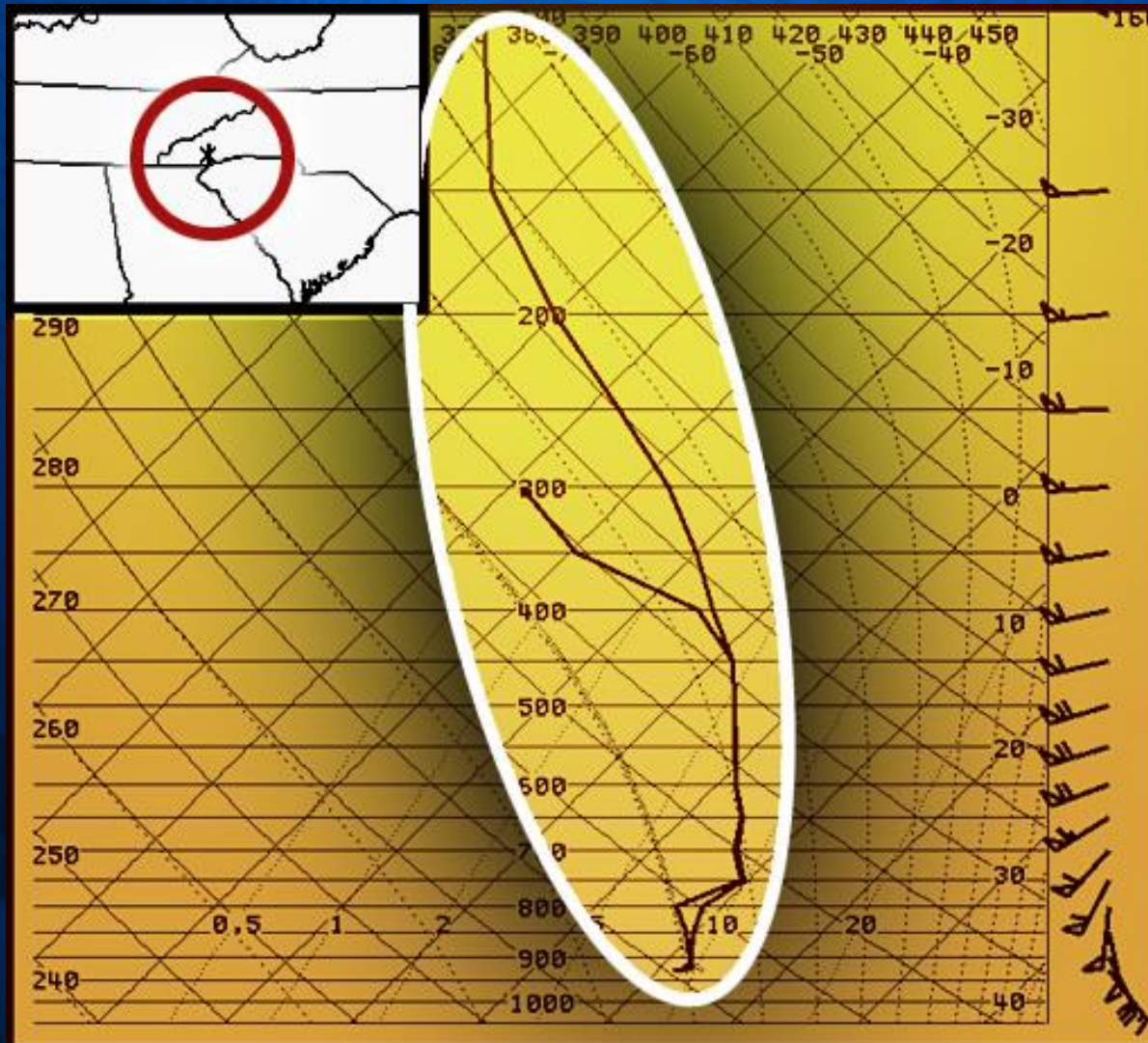


# Surface Fronts and Isobars at 8 am EDT on October 17, 2006



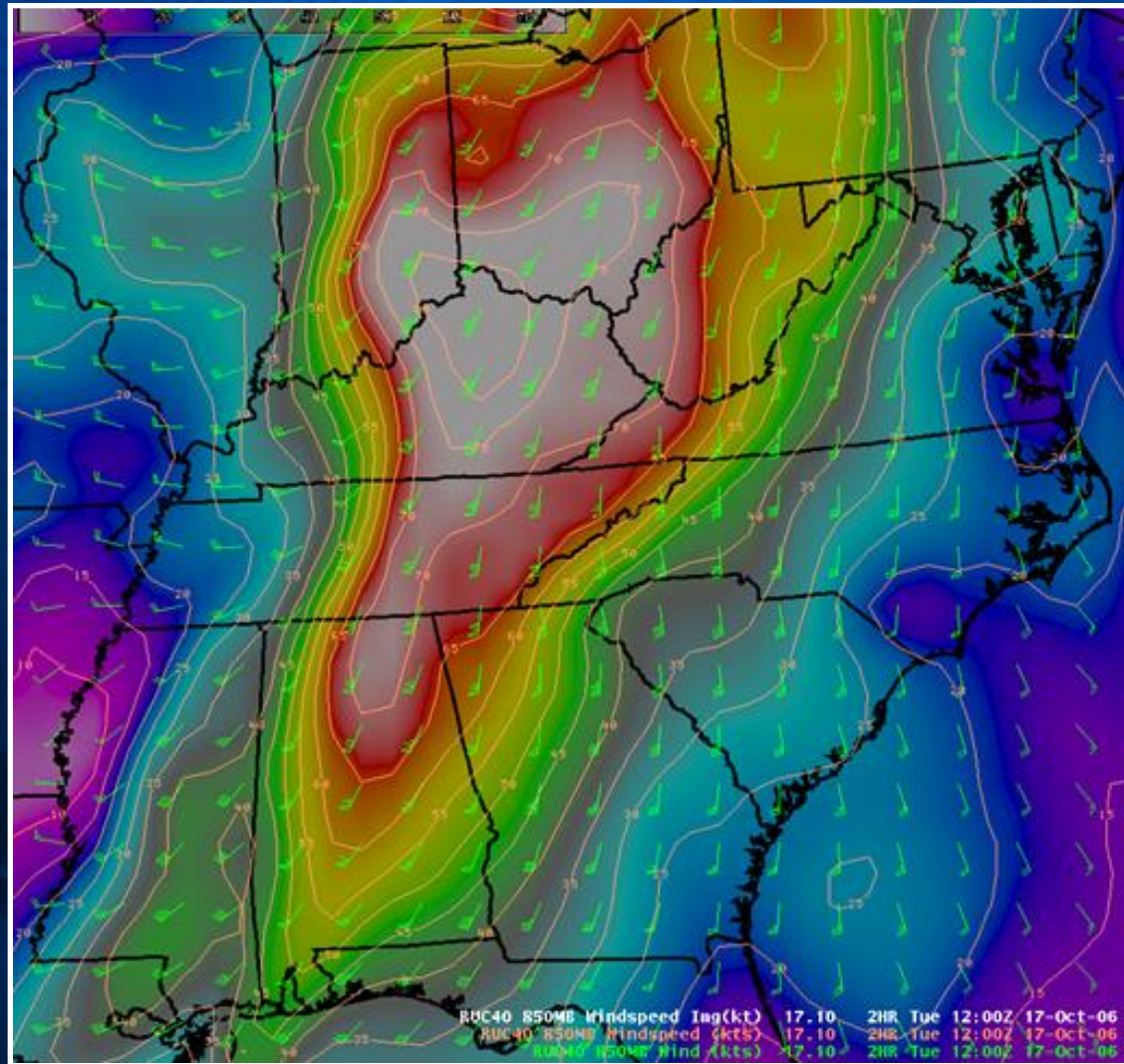


# Sounding (upstream of the mountains) at 8 am EDT on October 17, 2006





# Winds at 850 mb (~5,000 feet MSL) at 8 am EDT on October 17, 2006





# Recent Mountain Wave Events That Produced Strong Winds in the Foothills

Four examples of high wind events due to mountain waves along the western slopes of the southern Appalachians:

**17 October 2006** (winds measured up to 106 mph at Cove Mountain in the foothills of the Smokies)

**9 March 2011** (winds measured to 83 mph at Camp Creek)

**24-25 December 2009** (winds measured up to 94 mph at Cove Mountain in the foothills of the Smokies)

**20 December 2012** (winds measured up to 90 mph at Cove Mountain in the foothills of the Smokies)

# **Video from October 17, 2006**

**(winds measured up to 106 mph at Cove Mountain in the  
foothills of the Smokies)**





# Video from March 9, 2011 Event

(winds measured to 83 mph at Camp Creek)



# Historic Coughran Barn in Cades Cove of the Great Smoky Mountains National Park





# **Historic Coughran Barn After the 24-25 December 2009 Event**

**(winds measured up to 94 mph at Cove Mountain in the  
foothills of the Smokies)**



# **Overturned 18-Wheel Truck at Camp Creek on December 20, 2012**

**(winds measured up to 90 mph at Cove Mountain in the  
foothills of the Smokies)**



Photo: Mark Reynolds, WJHL-TV



# Roof Damage at Camp Creek on December 20, 2012



Photo: Mark Reynolds, WJHL-TV



# Siding Damage at Camp Creek on December 20, 2012



Photo: Mark Reynolds, WJHL-TV



# More Information

(wind speeds are in meters per second)

- Data from the NOAA observation site at Camp Creek can be found at <http://dataviewer.atdd.noaa.gov/campcreek/>
- Data from the Cove Mountain observation site can be found at <http://www.nature.nps.gov/air/data/current/index.cfm>
- Several research papers concerning mountain waves along the western foothills of the southern Appalachian Mountains can be found on the NWS Morristown website at <http://www.srh.noaa.gov/mrx/?n=research>