

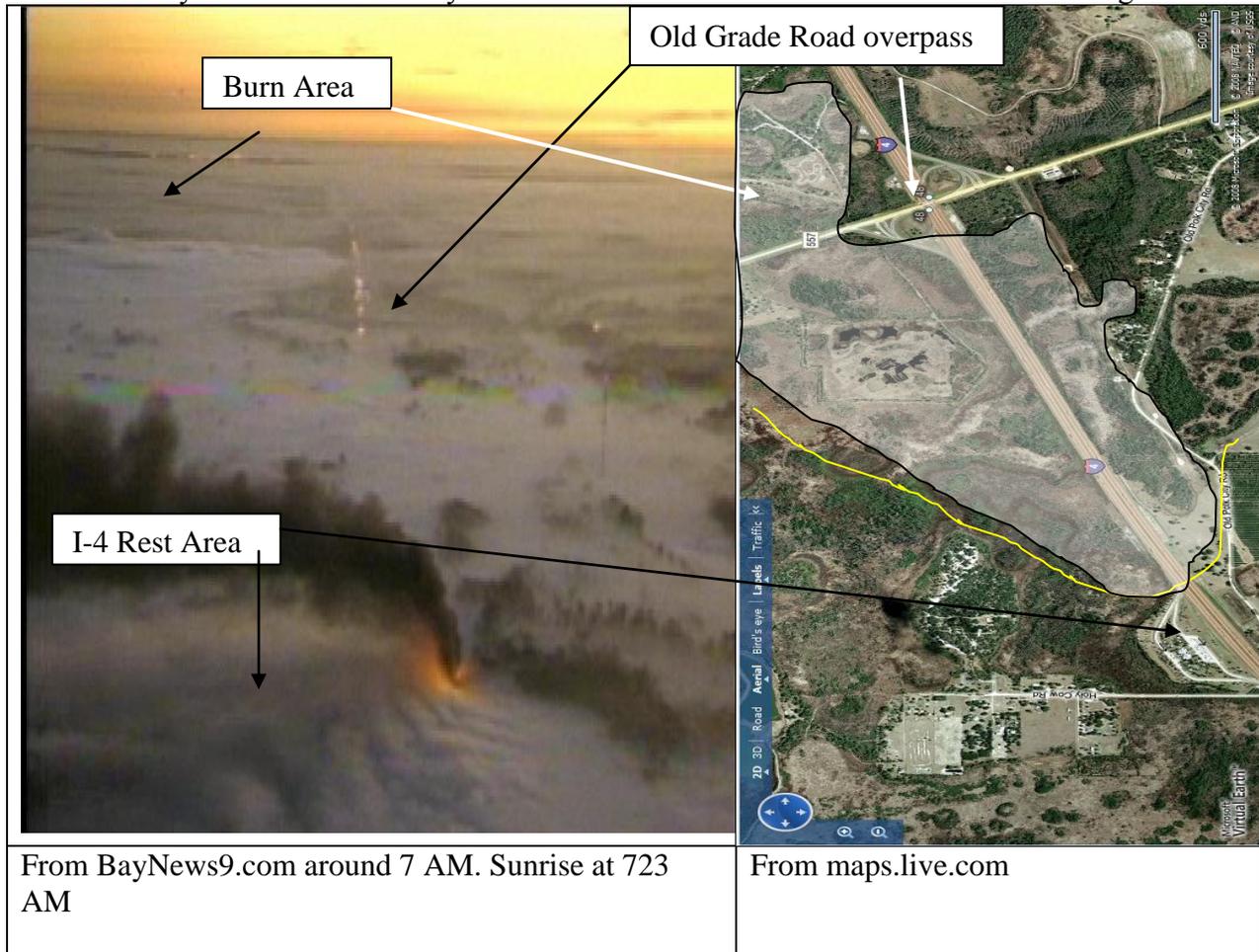
Central Florida Super Fog Carnage on Interstate -4

I. OVERVIEW

A. Summary

Drivers on central Florida’s Interstate 4 in Polk County near mile marker 55 encountered a blinding mixture of smoke and fog crept onto the highway during the early morning hours of 9 January 2008. Seventy cars and trucks collided resulting in 5 deaths and 38 injuries. The dangerous conditions were the result of a prescribed burn by the *insert full name here* (FWC) that went awry. This paper examines the events leading to the deadly pileup and looks at ways to reduce the chances of a future repeat occurrence.

Sheriff Grady Judd of Polk County described the conditions as “a wall of smoke and fog.”



B. What is superfog?

Achtemeier (2003), described superfog as a mixture of smoke, moisture released from damp smoldering organic material, and fog lowering visibilities to less than 3 meters. Under light wind conditions, superfog meanders with drainage flows through low terrain areas.

C. Other similar smoke and fog accidents in Florida (Orlando Sentinel)

A number of other accidents with similar surrounding circumstances have happened in Florida with many more across the country. These cases have distinct similarities including:

- **Time of year was during the winter months when fog is more prevalent.**
- **Time of day was during the early morning hours when fog is more likely.**
- **The roadway was heavily travelled.**
- **Fog was present and smoke limited visibility even more.**

March 8, 2000 -- Three killed, 21 injured during 22-vehicle crash on Interstate 10 near Wellborn (east of Tallahassee). (DEDE SMITH, ASSOCIATED PRESS / March 8, 2000)

June 2, 2000 -- One killed, 12 injured during 14-vehicle pileup on Interstate 95 in Brevard County near State Road 520. (JOE BURBANK, ORLANDO SENTINEL / June 2, 2000)

May 28, 2001 -- One killed, 14 injured in 20-vehicle pileup on Interstate 4 in Polk County near Haines City. (CALVIN KNIGHT, ASSOCIATED PRESS / May 28, 2001)

May 7, 2006 -- Two killed and two injured during five-vehicle crash on Interstate 95 in Brevard County near Port St. John. (BARBARA V. PEREZ, ORLANDO SENTINEL / May 7, 2006)

March 13, 2007 -- Five people killed, three injured during 11-vehicle pileup on Florida's Turnpike in Osceola County near Kenansville. (GARY W GREEN, ORLANDO SENTINEL / March 13, 2007)

Fog induced accident on Alligator Alley, and it was Friday, Jan. 25, 2002, see the synopsis

<http://injuryissues.com/find/article-1216.html>

Dense fog contributed to a major pileup last week outside of Naples, Florida along Alligator Alley, the portion of Interstate 75 that runs across the state. Three people were killed and more than a dozen were injured when a car carrier heading west collided with a pickup truck, sending the pickup into the eastbound lane where another accident occurred. According to the Florida Highway Patrol, nearly 30 [vehicles](#) were involved in the [accident](#). Both the east and westbound lanes of Alligator Alley were immediately shut down. The injured were transported to a [hospital](#) in Naples. -- Article Courtesy of InjuryBoard.com

<http://www.usfa.dhs.gov/downloads/pdf/publications/tr-155-508.pdf>

See also the horrible Mobile Bayway accident [March 20, 1995, 200 car pileup] in an NWA paper <http://www.nwas.org/ej/pdf/2006-EJ3.pdf>

.....
.....
Ellrod and Lindstrom (200?) looked at satellite fog detection techniques with major fog related highway accidents and found rapid changes in visibility from dense patches or narrow bands moving over roadways. They also found current imagery lacking resolution particularly with shallow fog, and visibility assessments require use of surface observations. They suggested, in the absence of highway patrol, environmental roadway sensors to detect low visibilities to quickly inform traffic officials and weather forecasters who in-turn produce weather advisories to the media and to Variable Message Signs (VMS) that reduce speed limits

=====

Info on the fog detection system, Mobile Bayway

Alabama has a 6.2-mile bay way stretch of I-10 near Mobile that is prone to heavy fog. Installation is almost complete on a \$6.2 million system in this area. It consists of 6 forward scatter Scientific Technology brand fog detectors, 11 pan/tilt/zoom closed circuit cameras, 14 fixed closed circuit cameras, 3 Mark 4 dot matrix VMS's with strobes that accentuate the message, 1 portable VMS, streetlights, and fiber optic connections. The fog-mitigation system along I-10 was developed because of a severe 193-car accident in May of 1995. Traffic engineers from Alabama DOT then visited the fog system site in Calhoun, Tennessee.

The Alabama system stretches over the Cochrane Bridge and is located near a tunneled portion of the interstate. The control room for the tunnel has been modified to handle control of the fog system. A variable speed limit system responds to changes in visibility. As the visibility decreases, the speed limit is decreased to a safer level. The original system was installed in the spring of 1999 and used (unsuccessfully) for seven months. It is almost entirely automated; ADOT wanted to eliminate human error in the decision making process. Humans do monitor the system and have a supervisory role. They make the final decision as to accept the systems proposed action or reject it. The fog detectors are spaced roughly 3/4 of a mile to a mile apart. The cameras are about 3/4 of a mile apart. The fog system uses fiber optic cables to route all information to a computer in the tunnel control room. When visibility drops below 900 feet, the fog countermeasures are tripped and that is the initial alert level. VMS's begin warning of fog, but the speed limit stays at 65 mph. When visibility drops to 660 feet, VMS's display "fog, slow, use low beams, trucks keep right." The speed limit is reduced to 55 mph. When fog visibility drops below 450 feet, the speed limit is reduced to 45 and the same VMS display is used. When visibility drops below 280 feet, the speed limit is reduced to 35 mph and the VMS's display "dense fog, slow, use low beams, trucks keep right." When visibility drops below 175 feet, the road is closed and the VMS's divert traffic off the highway.

The threshold for deactivation of each level of alert is 50 feet of visibility above the activation visibility level. This ensures that the system will not alternate between fog
USfogSysSummary-VaTech.doc

October 2000 Page 2 of 26

levels when visibility hovers around a threshold. Also if the average speed drops below 45 mph, the pan/tilt/zoom cameras activate and can be used to identify problems. The cameras are used primarily to verify accidents on the roadway. A computer screen shows the measurements at all fog detectors and displays a breakdown of the system by zone. The main problem with Alabama's system is that the fog sensors are made for airports and only require a determination of visibility of 2,400 feet. They are not meant to distinguish between finer gradations of fog, so the margin of error is quite large. In 1999, Alabama incorporated backscatter fog detectors in the system, but encountered too many problems. The manufacturer of these fog sensors recommended not using backscatter detectors over water because the reflection from the water's surface can distort readings. ADOT had to use the sensors on the bridge, due to the fog's prevalence there. The manufacturer also recommended that all the detectors face north due to strong sun in southern Alabama, but fog rolls in from all directions so this decreases accuracy in detection. These back scatter detectors were so unsuccessful, ADOT called the

manufacturer to see if there were any detectors that were even operational. They only found one operational in the whole US. They are currently installing more forward scatter fog detectors. ADOT is also experimenting with moving the thresholds up, with the initial threshold beginning at 1500 feet rather than 900, since this interstate handles such large traffic volumes (about 60,000 cars a day). Concerns about fog detectors still remain, as the detectors have a 25% margin of error when it comes to determining visibility distance. This margin of error is too great for ADOT's standards, especially when it comes to lower visibilities. The funding for the system was 80/20 split between FHWA and ADOT. ADOT is in charge of the tunnel, so there was not much cooperation with other agencies for the system. The forward scatter system will be completed by the end of August in 2000. The system is expected to be fully automated by September/October 2000. They will need about two fog seasons to perform tests and gather data before a report comparing the before and after data can be released.
Contacts: Vince Calametti at Alabama DOT (334) 470-8220
John Crosby VP for Operations at (301) 948-6070
Scientific Technology

II. PRESCRIBED BURN OUT OF CONTROL

The area of the prescribed burn was the site of a prior wildfire lasting from February 18-24, 2001. This large wildfire burned over 11,000 acres of mainly grass, scrub trees and shrubs along and north of the Interstate 4 corridor over mainly rural portions of northern Polk County. A ten mile stretch of Interstate 4 was closed between Polk City and Lakeland due to the wildfire for nearly ten days. The variable smoke plume produced by the wildfire occasionally reduced visibility to between one half and two miles as far west as St. Petersburg in Pinellas County. Ash from the smoke plume drifted over 100 miles and was deposited as far away as Ft. Myers in Lee county of Southwest Florida.

A. Original Spot Forecast from the DOF

B. NWS Forecast

FNUS52 KTBW 080909
FWFTBW

FIRE WEATHER PLANNING FORECAST FOR WEST CENTRAL AND SOUTHWEST FLORIDA
NATIONAL WEATHER SERVICE TAMPA BAY AREA - RUSKIN FL
409 AM EST TUE JAN 8 2008

.DISCUSSION...SURFACE HIGH PRESSURE FROM THE WESTERN ATLANTIC
EXTENDING WEST ACROSS THE SOUTHEASTERN U.S. WILL MAINTAIN PLEASANT
DRY WEATHER WITH ABOVE NORMAL TEMPERATURES ACROSS ALL OF WEST
CENTRAL AND SOUTHWEST FLORIDA TODAY THROUGH WEDNESDAY.

...

FLZ050>052-055>057-060-061-082030-
PINELLAS-HILLSBOROUGH-POLK-MANATEE-HARDEE-HIGHLANDS-SARASOTA-
DE SOTO-
409 AM EST TUE JAN 8 2008

TODAY

TONIGHT

WED

CLOUD COVER	PCLDY	MCLEAR	PCLDY
CHANCE PRECIP (%)	0	0	0
WEATHER TYPE	NONE	NONE	NONE
TEMP	82	58	80
RH %	44	100	44
20FT WIND MPH (AM)	E 6		SE 4
20FT WIND MPH (PM)	SE 8	SE 4	W 5
PRECIP DURATION			
PRECIP BEGIN			
PRECIP END			
PRECIP AMOUNT	NONE	NONE	NONE
LAL	1	1	1
MIXING HGT (FT-AGL)	5000	300	5000
TRANSPORT WINDS (MPH)	SE 12	SE 5	NE 5
DISPERSION INDEX	63	2	26
MAX LVORI		10	

REMARKS...LIGHT SURFACE AND TRANSPORT WINDS WILL LEAD TO FAIR DISPERSION INDICES ON WEDNESDAY.

.FORECAST FOR DAYS 3 THROUGH 5...

.THURSDAY...MOSTLY CLOUDY. LOWS IN THE UPPER 50S. HIGHS AROUND 80. SOUTHEAST WINDS 5 TO 10 MPH.

.FRIDAY...PARTLY CLOUDY. A 20 PERCENT CHANCE OF SHOWERS. LOWS IN THE UPPER 50S. HIGHS IN THE UPPER 70S. SOUTHWEST WINDS AROUND 10 MPH.

.SATURDAY...MOSTLY CLOUDY. A 30 PERCENT CHANCE OF SHOWERS. LOWS IN THE UPPER 50S. HIGHS IN THE UPPER 70S. SOUTH WINDS AROUND 5 MPH.

C. Weather changes during the day

D. Florida Division of Forestry steps in

E. NWS Issues Spot forecast

000
 FNUS72 KTBW 082238
 FWSTBW

SPOT FORECAST FOR OLD GRADE RD FIRE...POLK EM
 NATIONAL WEATHER SERVICE TAMPA BAY AREA - RUSKIN FL
 538 PM EST TUE JAN 8 2008

IF CONDITIONS BECOME UNREPRESENTATIVE...CONTACT THE NATIONAL WEATHER SERVICE.

...PATCHY DENSE FOG IS EXPECTED OVERNIGHT INTO EARLY WEDNESDAY MORNING...

.DISCUSSION...SURFACE HIGH PRESSURE WILL CONTINUE TO RIDGE ACROSS FLORIDA

CONTINUING THE EAST TO SOUTHEAST FLOW THROUGH WEDNESDAY NIGHT KEEPING A WARM AND MOIST AIRMASS OVER THE AREA.

.TONIGHT...

TIME (EST)	6 PM	9 PM	MIDNGT	3 AM
SKY.....	PCLDY	PCLDY	PCLDY	MCLEAR
WEATHER TYPE....	NONE	NONE	NONE	FOG
CHC PRECIP (%)..	0	0	0	0
TEMP.....	71	68	64	61
HUMIDITY.....	60	70	82	96
20 FT WIND.....	SE 5G10	SE 4G8	SE 3G6	SE 2G4
MIX HGT (FT)....	3000	2000	1000	500
TRANSPORT WIND..	E 8	E 7	SE 5	SE 3
DISPERSION.....	34	23	10	2
LVORI.....	NA	5	7	9
LAL.....	1	1	1	1

.WEDNESDAY...

TIME (EST)	6 AM	9 AM	NOON	3 PM
SKY.....	MCLEAR	PCLDY	PCLDY	PCLDY
WEATHER TYPE....	FOG	NONE	NONE	NONE
CHC PRECIP (%)..	0	0	0	0
TEMP.....	58	67	78	80
HUMIDITY.....	100	78	50	47
20 FT WIND.....	SE 1G3	SE 2G5	SE 3G6	E 5G10
MIX HGT (FT)....	200	1500	2700	3500
TRANSPORT WIND..	SE 1	SE 2	E 5	E 6
DISPERSION.....	1	8	23	30
LVORI.....	10	8	NA	NA
LAL.....	1	1	1	1

\$\$

FORECASTER...RD

REQUESTED BY...PAUL WOMBLE

TYPE OF REQUEST...WILDFIRE

.TAG 20080108.OLDGR.03/TBW

III. THE OVERNIGHT HOURS

A. Observations

KGIF 091315Z AUTO 0000KT 1 1/4SM BR FEW001 14/14 A3020

KGIF 091253Z AUTO 0000KT 1/4SM FG BKN001 OVC005 12/12 A3019

KGIF 091232Z AUTO 0000KT 1/4SM FG BKN001 BKN007 11/11 A3019

KGIF 091220Z AUTO 0000KT 1/4SM FG SCT001 BKN007 12/12 A3019

KGIF 091153Z AUTO 0000KT 1/2SM FG BKN001 OVC007 13/12 A3019

KGIF 091122Z AUTO 0000KT 1/2SM FG BKN001 OVC007 12/12 A3018

KGIF 091053Z AUTO 0000KT 1/4SM FG FEW001 BKN007 13/12 A3018

KGIF 091009Z AUTO 0000KT 1/4SM FG FEW001 BKN007 13/13 A3018

KGIF 091000Z AUTO 0000KT 1/4SM FG FEW001 SCT007 13/13 A3017

KGIF 090953Z AUTO 0000KT 1/2SM FG VV007 12/12 A3017

KGIF 090946Z AUTO 0000KT 1SM BR FEW001 SCT006 12/12 A3017
KGIF 090918Z AUTO 0000KT 1/4SM FG SCT001 BKN006 12/12 A3018
KGIF 090853Z AUTO 0000KT 1/4SM FG FEW001 SCT006 13/12 A3018
KGIF 090848Z AUTO 0000KT 1/4SM FG FEW001 12/12 A3018
KGIF 090846Z AUTO 0000KT 1/2SM FG VV005 12/12 A3018
KGIF 090842Z AUTO 0000KT 1 1/2SM BR CLR 13/12 A3018

B. Surface obs

C. Satellite obs

D. Firsthand accounts

Rest area, on hill adjacent to accident site, attendant supervisor reported thick smoke and smoke odor from wildfire early on the morning of the accident.

FPH officer reported superfog with 0 vis and smell of wildfire smoke at the accident site.

Truck driver reported smell of smoke less than 1 hour before accident.

E. Superfog formation and migration

IV. THE PILEUP

V. FUTURE PREVENTION

A. Signage

B. DOF spotters

C. FHP Spotters

D. Coordination with NWS

VI. References

Achtemeier, Gary L. 2003. On the origins of "superfog" -a combination of smoke and water vapor that produces zero visibility over roadways In: Second International Wildland Fire Ecology And Fire Management Congress And Fifth Symposium On Fire And Forest Meteorology, November 16-20, Orlando, Florida, p. 1-4.

Storm Data



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I-4 PILEUP

JAN. 9, 2008 • POLK COUNTY

PREVIOUS

TUESDAY, JANUARY 8

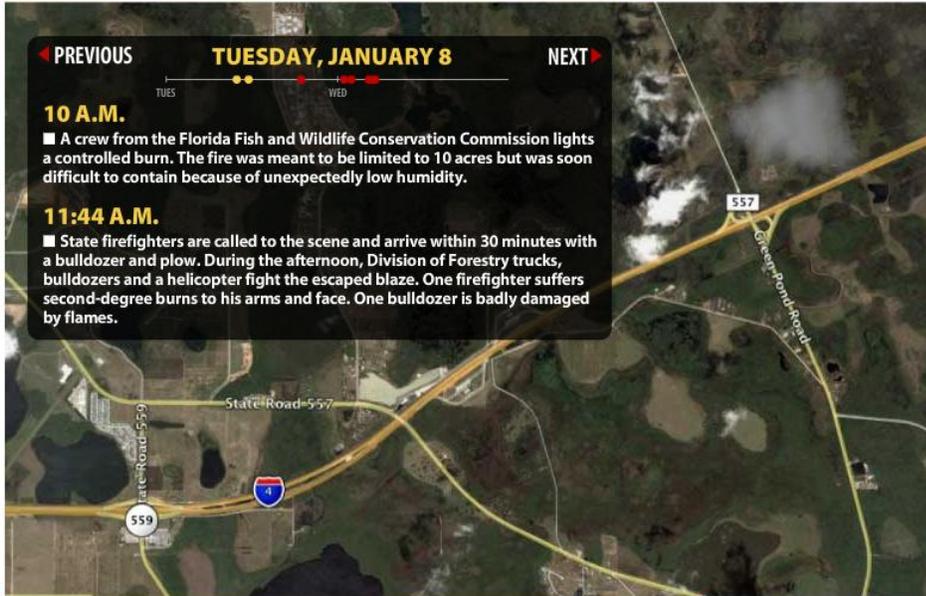
NEXT

10 A.M.

A crew from the Florida Fish and Wildlife Conservation Commission lights a controlled burn. The fire was meant to be limited to 10 acres but was soon difficult to contain because of unexpectedly low humidity.

11:44 A.M.

State firefighters are called to the scene and arrive within 30 minutes with a bulldozer and plow. During the afternoon, Division of Forestry trucks, bulldozers and a helicopter fight the escaped blaze. One firefighter suffers second-degree burns to his arms and face. One bulldozer is badly damaged by flames.



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I-4 PILEUP

JAN. 9, 2008 • POLK COUNTY

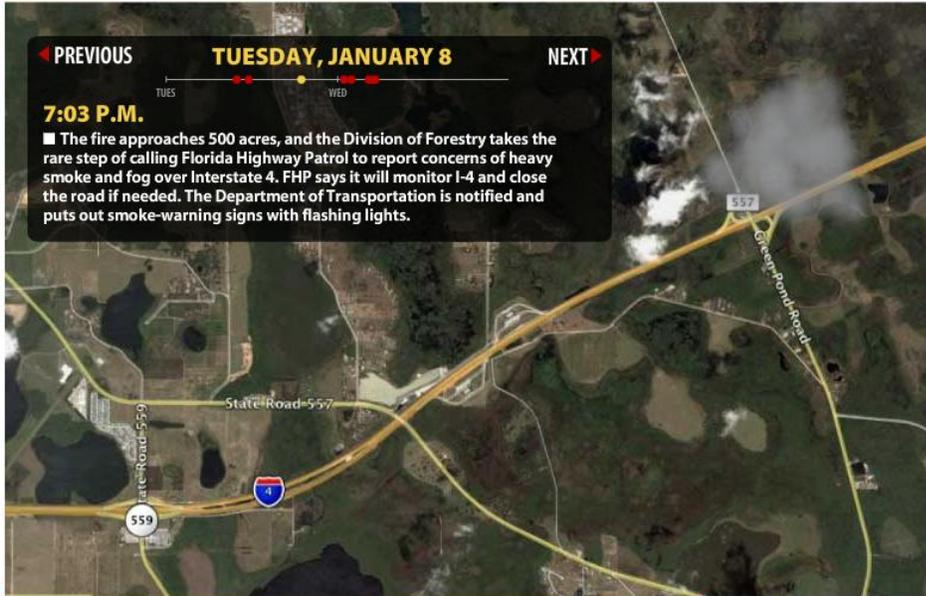
PREVIOUS

TUESDAY, JANUARY 8

NEXT

7:03 P.M.

The fire approaches 500 acres, and the Division of Forestry takes the rare step of calling Florida Highway Patrol to report concerns of heavy smoke and fog over Interstate 4. FHP says it will monitor I-4 and close the road if needed. The Department of Transportation is notified and puts out smoke-warning signs with flashing lights.



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I-4 PILEUP

JAN. 9, 2008 • POLK COUNTY

PREVIOUS WEDNESDAY, JANUARY 8 NEXT

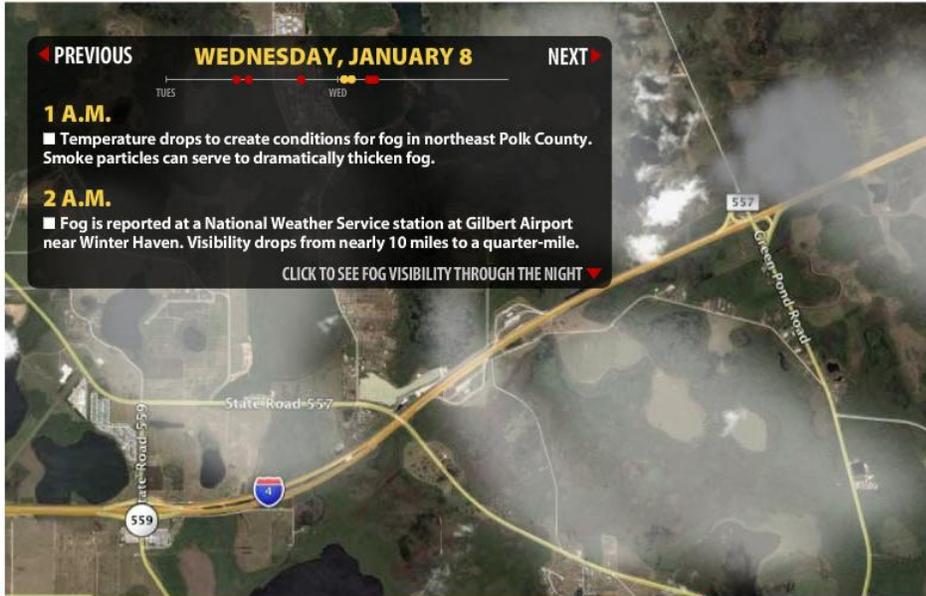
1 A.M.

Temperature drops to create conditions for fog in northeast Polk County. Smoke particles can serve to dramatically thicken fog.

2 A.M.

Fog is reported at a National Weather Service station at Gilbert Airport near Winter Haven. Visibility drops from nearly 10 miles to a quarter-mile.

CLICK TO SEE FOG VISIBILITY THROUGH THE NIGHT



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CREDITS SHARE FEEDBACK



charlie.paxton@noaa.gov has 1 new message

Re: Schedule for May 9 - 10 Cena Paxton

It did not get changed. This is the 2nd practice the first practice is still on Wednes

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May 5, 2008

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I-4 PILEUP

JAN. 9, 2008 • POLK COUNTY

PREVIOUS

WEDNESDAY, JANUARY 8

NEXT

4:30 A.M.

The Polk County Sheriff's Office receives the first call of a major accident on I-4. Numerous calls followed to the sheriff's office and other law enforcement.

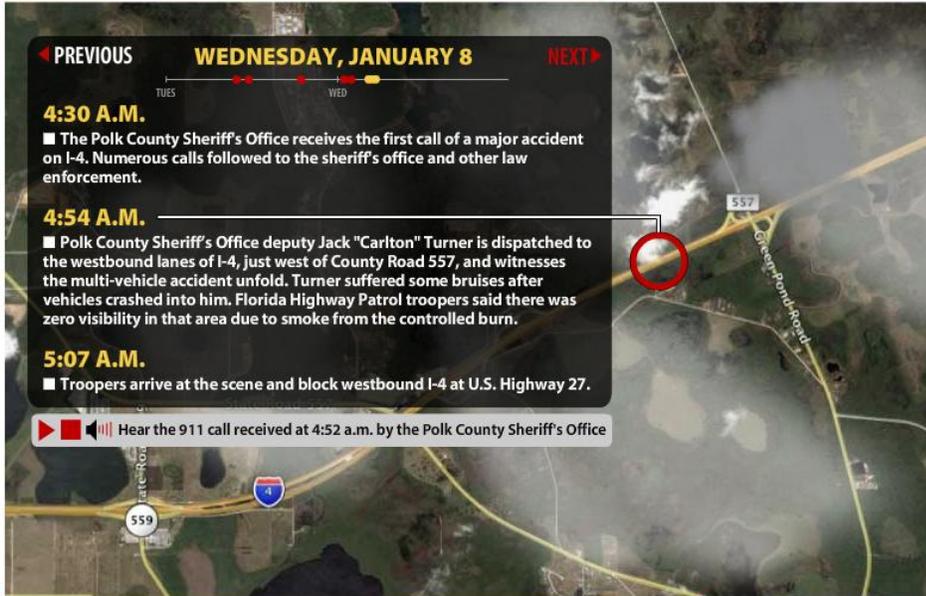
4:54 A.M.

Polk County Sheriff's Office deputy Jack "Carlton" Turner is dispatched to the westbound lanes of I-4, just west of County Road 557, and witnesses the multi-vehicle accident unfold. Turner suffered some bruises after vehicles crashed into him. Florida Highway Patrol troopers said there was zero visibility in that area due to smoke from the controlled burn.

5:07 A.M.

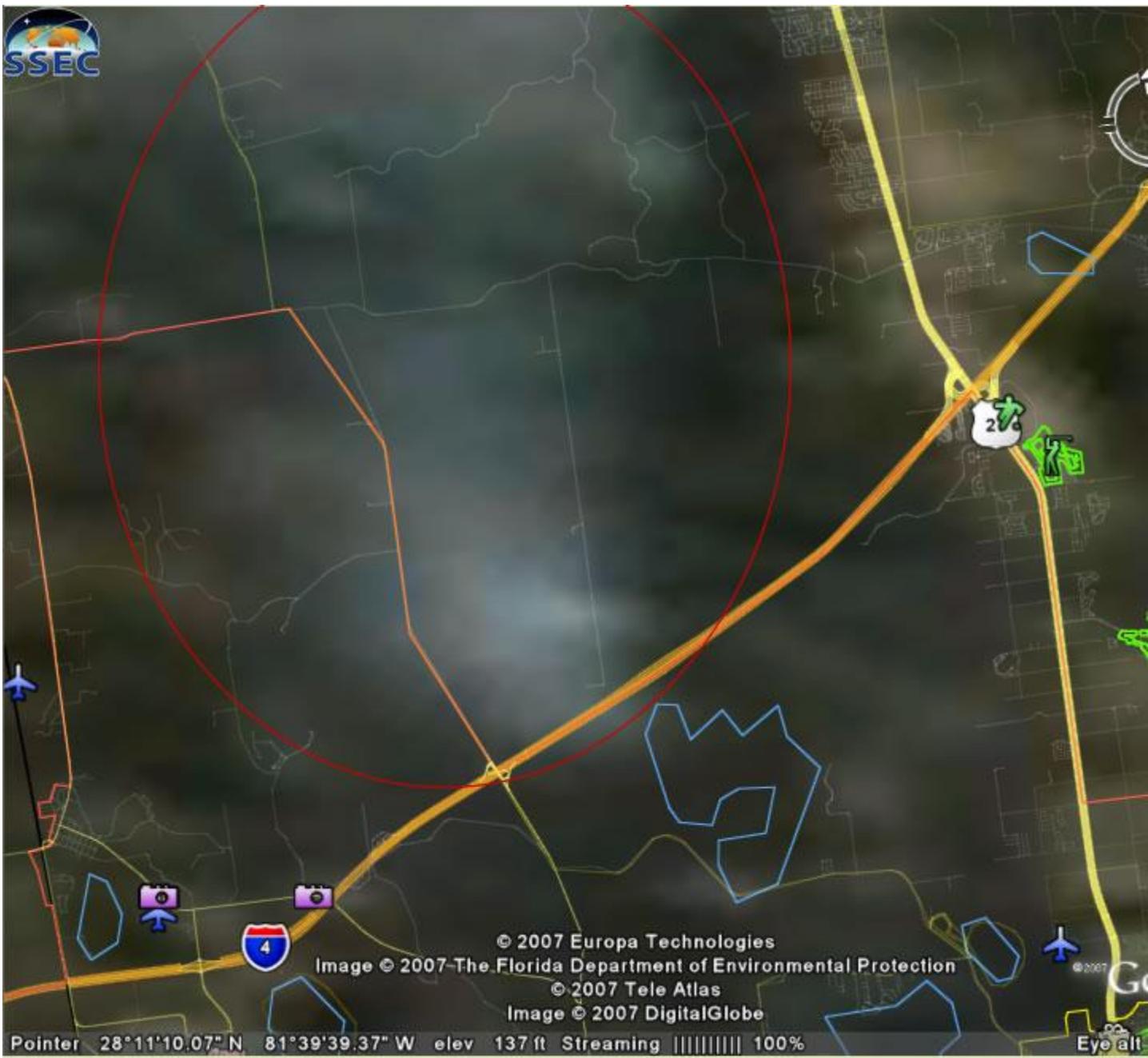
Troopers arrive at the scene and block westbound I-4 at U.S. Highway 27.

Hear the 911 call received at 4:52 a.m. by the Polk County Sheriff's Office



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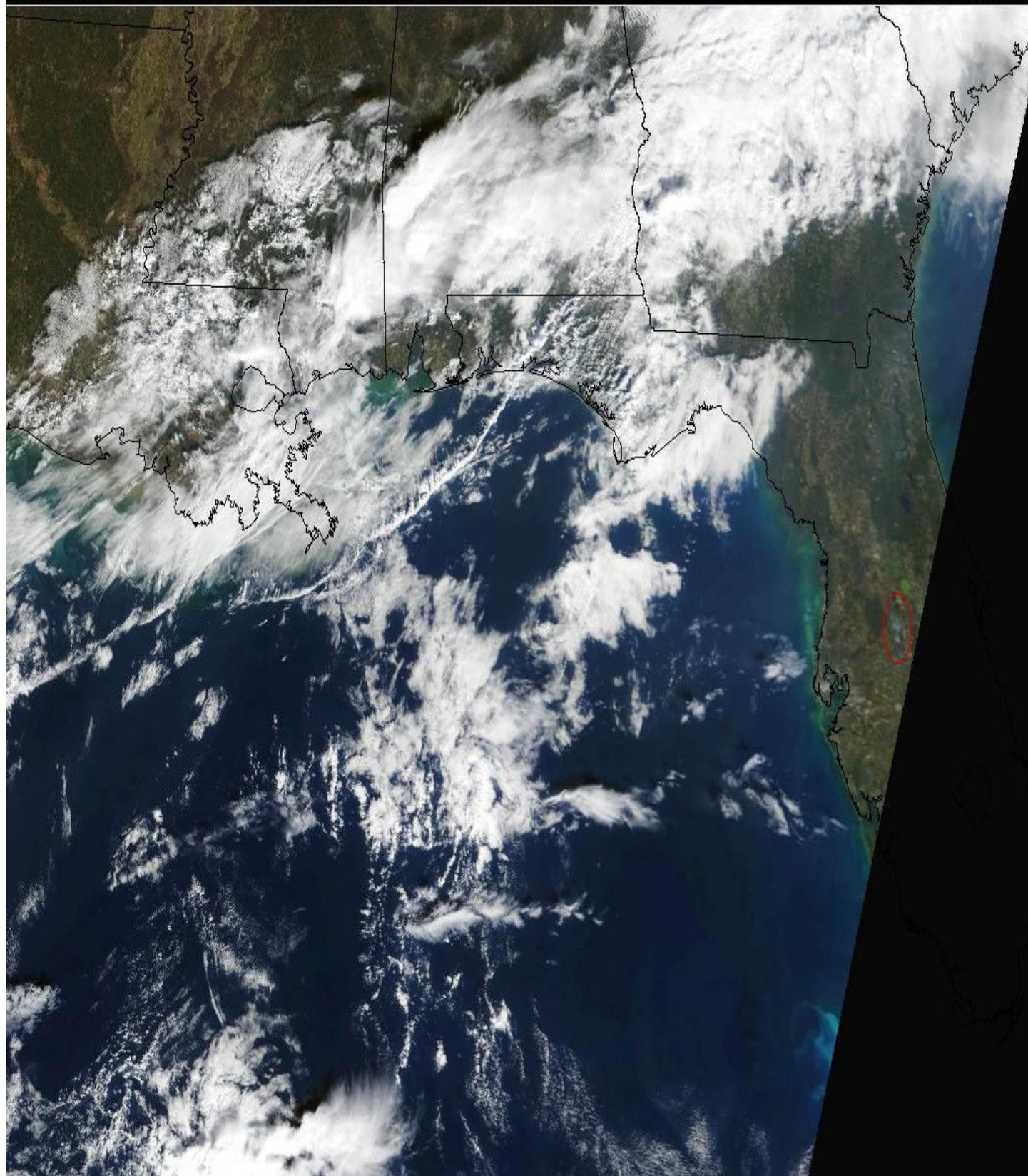
© 2007 Europa Technologies
Image © 2007 The Florida Department of Environmental Protection
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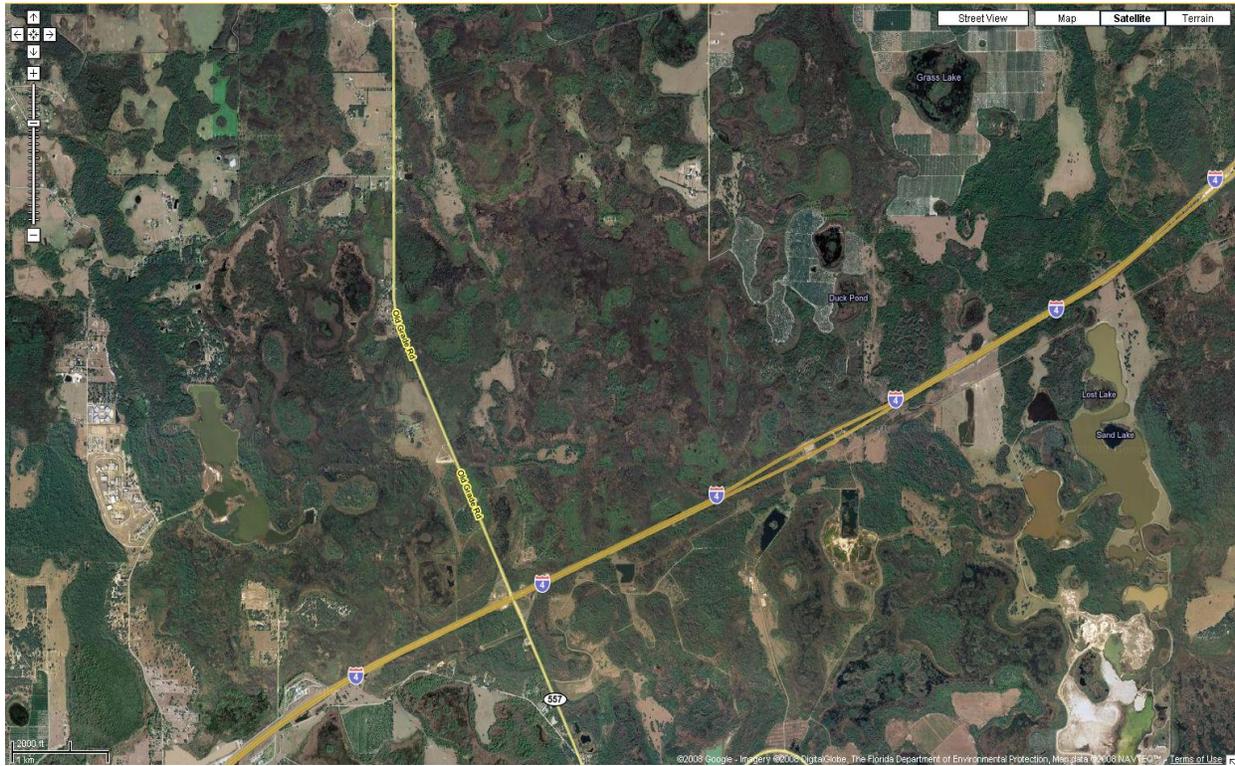
Pointer 28°11'10.07" N 81°39'39.37" W elev 137 ft Streaming ||||| 100%

Eye alt



Lakeland Ledger







SUPPLEMENTAL INFORMATION#####

The circumstances surrounding the wild fire occurring on January 8, 2008 in Polk County has been investigated by the Office of Agricultural Law Enforcement and an independent multi-agency review team empanelled by the Division of Forestry. The following is summary of information developed during the investigation.

The Burn Plan, Authorization and Site Preparation:

The FWC burn was authorized to be conducted in accordance with Chapter 590.125(3)(b). The statute has 7 elements which must be met to be deemed in accordance with the statute. Investigation determined requirements set forth in subsections 1, 2, 3, 4, 6 and 7 were met. The only element in question is subsection 5 which requires adequate firebreaks at the burn site and sufficient personnel and firefighting equipment for the control of a fire. While the burn authorization issued by the Division of Forestry was for a total of 50 acres, the actual burn plan

called for two (2) ten acre plots to be burned. Only one of the two plots was ignited before the problems started to occur which resulted in the wildfire.

The burn plan called for control lines around the perimeter of each burn plot to be mineral soil 12 feet wide. It was substantiated by visual observation that such control lines did exist prior to the burn.

The burn plan identified a total number of six personnel to be onsite, including the Burn Manager. All six were identified and interviewed. All six were on site for the duration of the burn.

The burn plan identified equipment to be used to include: (1) 500 gallon brush truck, (1) 220 gallon truck, (1) tractor and disc, (3) ATV's, (1) 1000 gallon water tender with high pressure pump, and assorted hand tools. It was verified that this equipment was onsite at time of the burn.

The Burn Manger is an FWC employee and has been Certified by the Division of Forestry since 1990. Records show he has conducted 27 control burns prior to the burn occurring January 8, 2008. There are no infractions identified for any previous burn. The Burn Manager actually began planning for this burn on November 27, 2007.

On January 8, 2008, at 5:25 AM, the burn manager obtained a spot weather forecast through a web based computer program offered by the Division of Forestry. The purpose of the spot forecast is to give a projection of weather for the day in a specific location. The spot forecast showed the lowest predicted humidity for the day to be 60 percent, with winds to be from the East-Southeast and East. Wind speed was predicted to be between 5 and 12 mph.

Also obtained was a weather forecast issued by the National Weather Service at 4:09 AM January 8, 2008. This forecast covered a six county area including Polk County. The forecast called for Partly Cloudy skies with a minimum RH of 44 percent for that afternoon. Winds were predicted to be East at 6 MPH in the morning, and Southeast at 8 mph in the afternoon. Both forecasts showed the winds should carry smoke away from Interstate 4.

At approximately 07:30 AM, The Burn Manager called the Division of Forestry for a Burn Authorization. Because the burn was to be conducted in a Smoke Sensitive Area, the Authorization required approval from the local area supervisor for DOF.

Between 07:30 AM and 08:00 AM, The Burn Manager contacted the Forest Area Supervisor to discuss the proposed burn. During that conversation the FAS discussed line preparation, number of personnel, equipment and predicted weather for the proposed burn. As a result of that conversation, the Forest Area Supervisor gave his approval to allow the authorization to be issued.

The Burn and Wildfire:

At approximately 10:00 AM, prior to the burn commencing, a field weather test was conducted by the Burn Manager at the burn site. The burn plan records a Relative Humidity to be 63

percent with a South-Southeast wind at 2 to 7 mph. Prior to commencing the actual burn, a test burn was conducted as required.

At approximately 10:15 AM the burn was started. FWC personnel stated the fire burned as expected against the wind. It was estimated that the fire had burned an estimated 40 to 45 minutes when problems started to occur. FWC personnel stated the fire had backed an estimated 15 feet to 30 yards before problems start to occur.

FWC personnel stated that at approximately 11:00 AM the weather began to change, with the winds picking up and changing direction and the humidity rapidly dropped. The fire began to burn erratically and a spot over occurred. FWC Personnel took suppression action on this spot over, when another spot over occurred about 50 yards away. Despite suppression efforts, they were unable to suppress the fire outside of the control lines.

At approximately 11:30 AM the Burn Manager requested DOF to respond.

Rangers arriving on scene reported the fire to be 15 to 20 acres in overall size. From this point the fire grew.

At 1:00 PM the Burn Manager recorded another onsite field weather test conducted at the scene. The relative humidity was recorded at 29 percent, with winds SSE at 3 to 5 mph, gusting to 7 mph.

On January 8, 2008, The Division of Forestry notified FHP and DOT of the fire and the potential for Smoke on the highway. This is a normal practice so these agencies can take whatever actions are deemed necessary to alert the public of a potential problem, and close roads if necessary. Information obtained shows that warning signs were being put out at 5:40 PM by DOT.

On January 8, 2008 at 5:38 PM the National Weather Service issued an updated spot forecast for Polk County. The forecast stated that patchy dense fog was expected in the area. The forecast also increased the LVORI to a 10 and lowered the mixing height from 300 feet to 200 feet. This information showed the fog was expected to be at its worst in Polk County on the evening of January 8, 2008 and morning of January 9, 2008.

Weather Data:

The National Weather Service was consulted during the investigation regarding weather predictions made prior to the fire and reported weather occurrences during the fire. The Meteorologist in charge of the Ruskin, Florida office was the primary point of contact.

A National Weather Service advisory predicted patchy dense fog and an air mixing height of 300 feet for the period from 1/7/2008 through 1/9/2008 for Polk County in the morning hours. The Low Visibility Occurrence Risk Index (LVORI) was predicted at 9, 10 being the most severe condition. The NWS stated that actual weather readings collected by the National Weather Service from observation stations confirmed these predictions to be correct.

Investigators discussed the Fire Weather Forecasts issued by the NWS for the area including Polk County for 1/8/2008. The forecast showed that the relative humidity was expected to drop to 44% in the afternoon hours with an East Southeast wind of 6 mph in the morning and 8 mph in the afternoon.

Investigators had obtained Weather observations from area weather stations closest to the burn. They included Davenport, Lake Alfred, and Polk City. These locations were closest to the burn and gave a triangulation view of the actual weather around the fire before and during the prescribed burn. Observations show that between 10 AM and 11:00 AM humidity's dropped from an average of 90 percent to about 53 percent. Weather data also shows that wind speeds increased to 10 mph with gusts as high as 16 mph, and were erratic. By 1:00 PM, Davenport recorded the relative humidity at 37 percent, and it dropped as low as 31 percent by 3:19 PM.

The meteorologist was told of the fire behavior described by personnel on the burn. He stated that as the fire burned it would have dried the air allowing the upper level air to drop down at that location. The sudden drop in humidity caused by the air dropping down could have created the erratic fire behavior as described by FWC Personnel on scene. He also explained the 29 percent humidity recorded on scene at 1:00 PM was due to the fire causing more of a drying effect on the air at that location, which was not detected at the weather stations.

Based upon eye witness information and weather data collected, evidence shows that weather elements not forecast by the National Weather Service or DOF Spot Weather Forecast is the primary cause of the spot over's that were exacerbated by gusty winds, which lead to the containment problems.

Investigative Findings:

1. The wildfire that occurred on January 8, 2008 was a result of a controlled burn that was being conducted FWC on their property.
2. The burn was authorized and conducted in accordance with Chapter 590.125(3)(b), as a Certified Burn.
3. Based upon all available facts and information the cause of the wildfire appears to be an unpredictable change in weather that caused the prescribed fire to burn erratically which resulted in spot fires outside of the established boundary lines of the prescribed burn.
4. Based upon all available facts and information there does not appear to be any evidence of criminal violations or gross negligence on behalf of the FWC Personnel involved in the burn.

he Florida Highway Patrol continues to investigate the multiple vehicle crashes that occurred on January 9, 2008, on I-4 in Polk County, FL.

At this time, the Florida Highway Patrol is releasing the following information concerning the multiple crashes that occurred on the west bound side of I-4.

Press release 1 - westbound

There were eight separate crashes on the westbound side of I-4 that occurred shortly after 6 a.m. These crashes were minor in nature and the information is as follows regarding the vehicles and their occupants:

Vehicle Driver Age City State Injuries

2006 Chevrolet. Rhonda Sher, 47, Davenport, FL. Minor injuries
1993 Mack Truck. Otis Benton Jr, 29, Haines City, FL. None
2004 Ford. Young Jung, 46, Altamonte Spgs, FL. None
2002 Chevrolet. Wilfredo Reveron, 49, Orlando, FL. None
1999 Acura. Luis Morales, 31, Apopka, FL. Minor injuries
2007 Volvo. Truck John Reddington, 55, Orlando, FL. None
1987 International Truck. Jose Hernandez, 54, Orlando, FL. None
1994 Chevrolet. Mark Gioni, 69, St Augustine, FL. Minor Injuries
2006 Mack Truck. David Howell, 53, Plant City, FL. None
2000 Mazda. Eric Rannebarger, 43, Davenport, FL. Minor
1995 Geo. Javiero Soto, 42, Kissimmee, FL. Minor
2000 Chevrolet. Julio Simon, 21, Benton, MI. None
2006 Chevrolet. Benjamin Schaub, 31, Altamonte Spgs, FL. None
2006 International Truck. Steve Williams, 46, Orlando, FL. None
2007 Freightliner Truck. Lawrence Vancour, 43, Shawsville, VA. None
2006 Mack Truck. Richard Westphal, 72, Hudson, FL. None
Unknown vehicle struck and left after being hit

Please note that the above vehicles and drivers were involved in eight separate crashes, some of which were involved in a secondary crash after their initial collision.

The investigation continues involving the other crashes.

Press release 2 - eastbound

There were two separate crashes on the eastbound side of I-4 that occurred shortly before 5:00am. Listed below is the information for one of the two crashes. This is not the major crash as that one is still being investigated.

Vehicle Driver Age City State Injuries

1999 Jeep. Robert Bell, 24, Wesley Chapel, FL. None
1991 Ford. Jeronimo Gomez, 29, Lakeland, FL. Serious
1994 Plymouth. Marco Moran, 51, Lakeland, FL. Serious
Passenger Adrian Moran, 30, Lakeland, FL. Serious
2006 Toyota. Donna Groves, 42, Lakeland, FL. None

2007 Sterling. Truck Franklin Conyers, 40, Tampa, FL. None
1999 Volvo. Truck Chris Rhodes, 40, Polk City, FL. None
2005 Dodge. Trevor Tilton, 29, Lakeland, FL. None
2006 Ford. Pamela Smith, 48, Winter Haven, FL. None
2007 Nissan. Rydell Mathieu, 28, Lakeland, FL. Minor

Please note that the above vehicles and drivers/passenger were involved in one crash. The investigation continues involving the other crashes.

Press release 3 -More vehicles involved

Due to the damage on some vehicles, their year and model have not been confirmed.

Year Make Model Damage Other

Tractor Trailer. Burned. Bealls Clothing
Tractor Trailer. Heavy Damage. Bealls Clothing
Tractor Trailer. Burned
Tractor Trailer. Burned
Tractor Trailer. Burned
Straight/Box Truck. Burned
Straight/Box Truck. Burned. Tire Company
2004 Freightliner Straight/Box Truck. Heavy Damage. Kanes Furniture
2006 Freightliner Straight/Box Truck. Heavy Damage. Ashe Industries
Tractor Trailer. Heavy Damage. Soil Tech
International Tractor Trailer. Minor Burn
Tractor. Burned
Ford F-750. Heavy Damage. Neff Rentals
2006 Hino Straight/Box Truck. Heavy Damage
Ken Worth Straight/Dump Truck. Heavy Damage
Ford Mustang. Burned
1991 Lincoln. Burned
2005 Chevrolet Straight/Heavy Truck. Heavy Damage
Toyota Car. Heavy Damage
GMC Crew Cab Pickup. Heavy Damage
2000 Toyota. Full size Pickup. Heavy Damage
1994 Ford Taurus. Minor Damage
2005 Dodge Ram Pickup. Moderate Damage
2003 Chevrolet S-10 Pickup. Heavy Damage
1995 Geo Prism. Heavy Damage
Chevrolet Crew Cab Pickup. Heavy Damage
2005 GMC Pickup. Heavy Damage. All American Roofing
2005 Chevrolet Malibu. Heavy Damage
Chevrolet Suburban. Burned
2001 Ford Ranger Pickup. Moderate Damage

1999 Subaru Station Wagon. Heavy Damage
2001 Pontiac Grand Prix. Moderate Damage
2003 Ford Taurus. Heavy Damage
Chevrolet Cavalier Coupe. Burned
2002 International Straight Truck. Heavy Damage On Time Services
2005 Toyota SUV. Moderate Damage
2004 Chevrolet Avalanche. Moderate Damage
2008 Honda Civic Sedan. Heavy Damage
Mini Van. Burned
2002 Ford Focus. Moderate Damage
2000 Ford F-150 Pickup. Moderate Damage

POLK COUNTY (Bay News 9) -- Interstate 4 in Polk County remains closed after the Wednesday morning accidents that killed at least four people.

Smoky conditions from Tuesday's [controlled burn](#) that grew out of control, as well as morning fog, led to the crashes.

The accidents took place in a 14 mile stretch of I-4 near Polk City. The interstate will likely be closed all of Wednesday and perhaps into Thursday.

The accidents began about 5 a.m. Wednesday. There were two large pileups, one involving 41 vehicles and one involving 19 vehicles.

Witnesses said visibility was less than five feet.

People involved in the crashes said they couldn't see what was happening; they could only hear the screeching of metal as multiple vehicles plowed into each other.

"It was just crash after crash after crash," one eyewitness said.

Steve Webb of Webb's Towing had 20 vehicles working the crash site picking up mangled, burned out semis.

"Everytime we go to pick something up it falls to pieces," Webb said later in the evening.

The latests figures are:

- Four fatalities
- 38 people transported to hospitals
- Five life-threatening injuries
- 20 tractor trailers involved
- Six trailers destroyed
- Five cars on fire

- 70 total vehicles involved

The Interstate is closed between the Polk Parkway and U.S. Highway 27.

A spokesperson with the Florida Department of Transportation (FDOT) said a 650 foot stretch of road that was burned and melted under many of the semi trucks in the accident will be resurfaced starting about midnight after all the burned vehicles are removed.

After FDOT workers finish scraping off the burned roadway and putting down new asphalt they have to put new lane stripes on the road. But they still don't know when I-4 will be opened.

Sheriff: A 'major disaster'

At a press conference late Wednesday morning, Polk County Sheriff Grady Judd described the scene as a "major disaster" on I-4.

"We have a very intense situation here," Judd said. "Our firefighters and certainly our EMT's went into a situation where you could see absolutely nothing in front of you. It was as if you hit a wall of smoke and fog."

More Information

- [Accident aftermath](#) 
- [Who's responsible](#)
- [I-4 closed indefinitely](#) 
- [Fires getting contained](#) 
- [Smoke conditions](#) 
- [Multi-car pile up](#) 
- [Semi on fire](#) 
- [Deputy involved in accident](#) 
- [911 calls](#) 
- [Sky 9 video from the fire](#) 
- [Firefighter response](#) 
- [Map of affected area](#)
- [The weather's role](#)

Judd said one of his deputies, Carlton Turner, was involved in one of the first accidents and tried to help afterwards.

"He said to me 'I did all that I could but I watched a man burn to death today and I heard others screaming and crying,'" Judd said.

Victims with the most serious injuries were taken to Lakeland Regional Medical Center, which is the closest trauma center from the accident scene.

Earlier Wednesday, the hospital activated their emergency preparedness plan for mass casualties. That has since been deactivated.

Less seriously injured victims were taken to Winter Haven Hospital.

Controlled burn contributes to crashes

After a [controlled burn](#) escaped the perimeter on Tuesday afternoon, the blaze quickly grew near I-4 and Old Grade Road, near mile marker 55.

Complicating matters was a previous hot spot that flared up on Tuesday and merged with the controlled burn fire.

Officials started another controlled burn Wednesday morning, which added to the already smoky conditions.

Firefighters had to deal with car fires throughout the morning as well as monitor the brush fire that consumed more than 600 acres of rural land near mile marker 55.

[Begin SlideShow](#)

OLK COUNTY (Bay News 9) -- A controlled burn involving two fires in a rural area of Polk County escaped its perimeter on Tuesday afternoon.

The blaze quickly grew near I-4 and Old Grade Road, near mile marker 55.

The fires were reported about 11:45 a.m. No homes or structures were threatened, but the road was closed from the entrance of I-4 north to Fussell Road.

The Polk County Fire Department reported late Tuesday 85-90 of the fire was under control. Authorities had not anticipated closing any portion of I-4.

The Department of Forestry lost a brush truck to the flames.

Comcast

At Least 3 Dead in Fla. 50-Car Pileup

7 hours ago
LAKELAND, Fla. — About 50 cars

crashed on a highway blanketed by fog and smoke from a brush fire Wednesday, and authorities said at least three people were killed.

A stretch of nearly 15 miles of Interstate 4 between Tampa and Orlando was closed by several accidents, including the 50-car pileup.

Aerial footage showed the soupy mix of fog and smoke covering the landscape for miles and giving the sky an eerie golden color.

The poor visibility forced rescuers to walk along the closed interstate checking individual vehicles for injured motorists, Florida Highway Patrol Trooper Larry Coggins said. The conditions cleared in late morning, showing mangled, charred trucks and cars pinned underneath some tractor trailers.

Workers were still trying to rescue one man pinned beneath an overturned truck.

Polk County Sheriff Grady Judd did not say how many people were injured.

Numerous tractor trailers overturned on the roadway, including a tanker. At least six of them burned completely.

"Everything came to a halt," Robert Ellison, who was driving east on the highway about 6 a.m., told The T

and WFLA-TV. "You can't see your hand in front of your face."

One of the first accident victims was a sheriff's deputy, Judd said. The deputy told Judd that conditions on

worsened suddenly. "It was clear, it was a little foggy, then it was total darkness," Judd recounted the de

The sheriff said the deputy was shaken up, but helped move people to safety as vehicles continued to cra

sounds of metal grinding and gnashing in the darkness.

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Comcast.net News - At Least 3 Dead in Fla. 50-Car Pileup Page 1 of 3

<http://www6.comcast.net/news/articles/general/2008/01/09/Brush.Fire.Crash/> 1/9/2008

The Florida Highway Patrol is investigating the crash and the role of smoke from the fire that started as a

and grew out of control.

Judd said he was "exceptionally concerned" about the decision to start a fire during dry conditions and da freeze likely added more tinder. State officials are still investigating how the fire got out of control. Since Tuesday, the fire has charred 400 acres. It is burning roughly half a mile from the highway and is 90 contained, Division of Forestry spokeswoman Chris Kintner said. She said forestry workers notified the highway patrol that smoke from the blaze could mix with fog. Warni also placed on the interstate, but Kintner said she didn't know if the signs were lit.
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[Long Drive to Orlando](#)

Posted by Ledger Staff on **January 10, 2008 10:16:29 AM**

Lakeland residents had a lengthy commute to Orlando this morning.

During the week, Craig Horan, of North Lakeland, commutes on Interstate 4 to exit 75 from his home in North Lakeland. It normally takes him about 45 minutes.

Horan spent about 1 1/2 hours in the car this morning. He took State Road 33 through Polk City where traffic nearly stopped until he reached Fussell Road. Horan said visibility was poor because of fog and smoke and cars drove about 5 to 20 mph.

After Fussell Road, Horan said it was a breeze. He drove north to Clermont then headed east.

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[Three Bealls Trucks Were Damaged](#)

Posted by Ledger Staff on **January 10, 2008 6:24:50 AM**

Three delivery trucks from Bradenton-based department store chain Bealls Inc. were involved in the accident as they were traveling from the main warehouse in Bradenton to stores around the state, said Dan Doyle, a company spokesman.

"We're happy to report all the drivers were able to walk away from the accident," he said.

Two of the trucks and their contents were destroyed in a fire, Doyle said, and the third truck had minor damage. The company expects to salvage some merchandise from that truck.

Bealls uses I-4 regularly, he said, and "this was a substantial accident for us."

The drivers reported visibility was "very bad," said Doyle, who declined to elaborate until officials complete the accident investigation. The company did not release names.

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School Buses Used to Evacuate Motorists

Posted by Ledger Staff on **January 10, 2008 6:22:01 AM**

A Polk school official said some buses were late to school Wednesday morning and at least 40 teachers were late because of traffic on alternate roads.

Polk County school buses were used to evacuate people with minor injuries, said Fred Murphy, assistant superintendent of transportation services. Those buses will not be used in transporting students home today.

None of the district's school buses were involved in the crash, Murphy said.

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I-4 to Remain Closed

Posted by Ledger Staff on **January 9, 2008 9:09:02 PM**

Count on having to find another way to go to work Thursday. Portions of Interstate 4 will remain closed until further notice, the Florida Highway Patrol said.

"Don't plan any road trips on the interstate in the near future," said Polk County Sheriff Grady Judd.

[More...](#)

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Injured Sent to Polk Hospitals

Posted by Ledger Staff on **January 9, 2008 7:11:10 PM**

Nearly 30 patients were taken to Polk County hospitals Wednesday to be treated for injuries suffered in the multi-car accidents that closed Interstate-4 between Polk City and Haines City.

Others among the 38 who were injured went to hospitals outside the county.

The largest number seen locally, 16, were treated at Winter Haven Hospital. All had been released that afternoon, according to Joel Thomas, hospital spokesman.

Two came early in the morning. Another 14 were brought by school bus and returned to the Northeast Polk Sheriff's Substation, he said.

Four went to Heart of Florida Regional Medical Center in Haines City.

Many of the most seriously injured were at Lakeland Regional Medical Center, Polk County's biggest hospital, which has the county's only trauma center.

[More...](#)

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Truck Companies Assess Damage

Posted by Ledger Staff on **January 9, 2008 4:46:20 PM**

Three delivery trucks from Bradenton-based department store chain Bealls Inc. were involved in the accident as they were traveling from the main warehouse in Bradenton to stores around the state, said Dan Doyle, a company spokesman.

"We're happy to report all the drivers were able to walk away from the accident," he said.

Two of the trucks and their contents were destroyed in a fire, Doyle said, and the third truck had minor damage. The company expects to salvage some merchandise from that truck.

Bealls uses I-4 regularly, he said, and "this was a substantial accident for us."

The drivers reported visibility was "very bad," said Doyle, who declined to elaborate until officials complete the accident investigation. The company did not release names.

A driver and helper in a Kane's Furniture truck received significant but not life-threatening injuries, said Lisa Brock, a spokeswoman for the Pinellas Park furniture chain.

Both people, whose names were not released, were taken to a hospital, she said. The driver will require surgery for his unspecified injuries.

The truck had left from the company's Pinellas Park warehouse to deliver orders in the Cocoa area, Brock said. She had no information on the extent of damages to the truck or its contents.

The drivers were still in shock on Wednesday and provided no accident details, she said.

A truck from SYSCO Corp., a Houston-based distributor of food and supplies to the food service industry, also got caught in the accident but sustained minor damages, said Walt Anderson, the director of safety at the company's Palmetto office. The driver was not injured.

"The angels were on his shoulder," Anderson said.

The truck was on the way from the Palmetto warehouse to Orlando, he said.

"One of the Worst Crashes"

The area where today's pileup on I-4 occurred is ripe for such accidents, but officials say they can't remember a more massive accident there or anywhere else in Polk County.

Chris Kintner, a spokeswoman for the Florida Division of Forestry, said she certainly does not recall a worse fire-related accident in the 26 years she's worked for the agency.

"I think it's safe to say this is one of the worst crashes in Polk County history," said Florida Highway Patrol spokesman Larry Coggins.

But Kintner said the area along Interstate 4 "is a bad area" where smoke from wildfires can mix with fog on still nights to cut visibility to zero.

That happened in 2001 when a wildfire charred 10,119 acres near Polk City.

Interstate 4 was closed for a week because of heavy smoke and fire in the median and along the edge of the road.

That was in February, with the highway periodically closed because of smoke from that and other fires in the area throughout the spring.

In May 2001, one person was killed and 10 injured in an 18-vehicle pileup that was attributed to smoke and fog.

With Major, Fog- related Highway Accidents

Gary P. Ellrod
Office of Research and Applications (NOAA/NESDIS)
Camp Springs, Maryland
Scott Lindstrom
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Abstract

Five multi - vehicular highway accidents caused by low visibilities in fog were examined as to the ability of Geostationary Operational Environmental Satellite (GOES) techniques to detect the fog in advance. All of the accidents occurred near or shortly after sunrise on major U. S. or Canadian highways and resulted in numerous injuries and some fatalities. Multi- spectral infrared and visible channel data were used in the evaluation. In most cases, fog was detectable from GOES products but the lead time was usually short (1- 3 hours). All were mesoscale events that would have required use of all available forms of observational data from satellites and surface mesonets to properly diagnose. Benefits and shortcomings of satellite- based techniques are described, along with technology improvements planned for future spacecraft.

1. Introduction

There are approximately 700 highway fatalities per year in the United States caused by driving in areas of dense fog (visibilities $\frac{1}{4}$ mile or less), and around 50 fog- related highway fatalities per year in Canada (Whiffen et al. 2004). While these do not seem like large numbers, fog- related highway fatalities are nevertheless ten times the number of deaths due to tornadoes. Within the past ten years, the number of fog- related accidents resulting in injury or death has stayed about the same, whereas the total number of weather - related highway accidents has declined (Figure 1) (Goodwin, 2002). A similar trend has been observed in Canada (Whiffen 2004).

Among many possible reasons for the continued high accident rate in foggy conditions are the following: (1) Despite steady improvements in automobile safety equipment, traffic volumes continue to rise, along with average speeds. (2) Drivers are commuting longer distances to their jobs, introducing the fatigue factor, especially in the early morning hours when fog is most often found. (3) Finally, the occurrence of very dense fog (that reduces visibility to a few car lengths) is relatively rare; so many drivers do not have the experience of driving in conditions of very low visibilities. The purpose of this paper is to examine the ability of meteorological satellites to detect fog and provide useful information to weather forecasters or transportation officials for the purpose of local warnings and advisories. Specifically, do satellite image products from Geostationary Operational Environmental Satellites (GOES) detect fog in the vicinity of major accidents and provide sufficient lead time for warnings? If not, what are the deficiencies of the satellite detection techniques? Five major fog related accident events were evaluated with these questions in mind. While smaller, less dramatic events are no less important, information on the larger accidents was easier to obtain via media reports, and most likely represent the worst possible driving conditions.

2. Data and Analysis

GOES products used in this analysis include single band Infrared (IR) in the 11 μm and 3.9 μm wavelength channels (IR4 and IR2 respectively), 0.6 μm Visible images during daytime periods, and the derived "fog product" at night (based on the 11 μm - 3.9 μm brightness temperature difference (BTD)) (Ellrod 1995). There is also a special fog depth color enhancement that can be applied directly to the fog product that helps determine where fog or low clouds are particularly thick and will likely persist for several hours after sunrise. The fog product is available to National Weather Service forecasters on the Advanced Weather Interactive Processing System (AWIPS), and can also be viewed on the Web at several sites (see appendix). It should be stressed that the nighttime fog product highlights all stratiform clouds consisting of water droplets, regardless of altitude, so careful interpretation and use of supplemental data from METeorological Aviation Reports (METAR) or aircraft pilot reports (PIREPs) is critical. Single band GOES images as well as animations were evaluated to determine if fog was detectable prior to the time of the accidents. Detection of fog using the GOES two- band IR fog product usually requires a BTD value of at least 2K. This threshold can be lower in areas of marine stratus due to the micro- physical effects of larger droplet sizes found with those types of clouds systems (Lee et al. 1997). Thresholds can also be lower in situations where dense fog with small droplets is present, but is geometrically very shallow, resulting in smaller observed BTD. Generally, the synoptic conditions leading to those two scenarios are quite different; allowing a forecaster to determine which of the two is most likely. The value of animated GOES imagery is to show trends in area coverage and thickness. GOES data were obtained at 15 to 30 min intervals. In this study, several major fog- related highway accident events were analyzed using archived GOES data. The accidents all involved at least dozens of vehicles, numerous injuries, and in many cases, fatalities. All occurred in the early morning hours, shortly after sunrise. The cases are summarized in Table 1.

TABLE 1.

Summary of Accident Cases Analyzed

Location	Highway	Date	# of Vehicles	Injuries	Fatalities
Mobile, AL	I- 10	20 Mar '95	193	91	1
Windsor, Ont.	401	2 Sep '99	145	150	8
Cedar Grove, WI	I- 43	11 Oct '02	38	38	10
Caliente, CA	CA58	3 Jan '02	77	15	1
Long Beach, CA	I- 710	3 Nov '02	194	40	0

3. Results

a. Mobile Bay Alabama, 20 March 1995

The Mobile, Alabama "Bayway" accident that occurred early on 20 March 1995 is considered the largest in U. S. history, involving around 200 vehicles, and resulting in more than 90 injuries. The meteorological aspects of this crash were first described by Croft et al. 1997. Interstate highway 10 (I- 10) crosses the extreme north side of Mobile Bay in an east - west direction (Figure 2). In the early spring, bay and offshore water temperatures are quite cool along the Gulf Coast, fed by cold water from southward flowing rivers such as the Alabama River that flows into Mobile

Bay. When warm moist air flows northward from the Gulf of Mexico in a stable environment, fog often results. Animated GOES imagery and surface wind data showed that on the morning of 20 March 1995, the flow of air in the central Gulf Coast was

from the warm Gulf of Mexico northward toward the coast. A single band IR4 image at 1032 UTC (4:32 AM CST) (Figure 3) showed several dark gray regions, including one in the vicinity of Mobile. The dark areas can indicate the presence of either warm, moist cloud-free air, or fog or low stratus (e.g. Gurka 1995), so the use of IR4 imagery alone can be ambiguous. Animated GOES fog product imagery (Figure 4) clearly showed however, that low clouds or fog (shown by the whiter areas) covered Mobile Bay and then extended well inland. The fog increased in area coverage with time as the clouds were spread inland by the southwesterly flow (image navigation, and thus the map overlay, was offset slightly to the east on this morning).

The fog was detected in GOES imagery well before sunrise, although it was somewhat difficult to see over Mobile Bay due to the geographic map overlay. Along I- 10, the thickest fog near Mobile was confined to the Bay northward, so motorists driving at high speeds on I- 10 would have encountered the fog rather suddenly as they crossed the causeway. Some fog was also present over the Florida panhandle to the east, but based on IR fog depth images (visible was not available for this case), this fog was most likely shallower, although quite extensive (Figure 5).

b. Windsor , Ontario, 3 September 1999

The Windsor, Ontario accident occurred around 8 AM EDT on 3 September 1999 on Highway 401, a busy corridor connecting the major cities of southwest Ontario with Detroit and other cities in the northern Midwest (Figure 6). This was a very serious vehicle pileup that resulted in 8 fatalities and 150 injuries. A detailed analysis of this case is provided in Pagowski et al. 2004. A weak high pressure area centered over southwest Ontario resulted in light east to northeast winds across Lake St. Clair, just to the north of route 401.

Animated GOES IR fog product imagery (Figure 7) showed that a patch of fog of low clouds developed over the western part of Lake St. Clair and drifted southward toward the Ontario peninsula (the crash site location is annotated on the images). Reports of extremely low visibilities from Mt. Clement, Michigan, at the northern tip of this cloud bank, suggested that this was likely dense fog. The last image in the loop (at 1200 UTC, close to the accident time) was shortly after sunrise, and exhibited a BTDR reversal which resulted in the fog patch turning a dark gray shade (Figure 7). An animation of close-up GOES visible images (Figure 8, courtesy of Patrick King, Meteorological Service of Canada) beginning at 1200 UTC revealed that the fog patch grazed the north side of the peninsula (and Highway 401), then continued drifting southwest, dissipating by 1400 UTC except for a small area over Lake St. Clair. The fog patch appeared to be slightly larger in visible images than was revealed by the IR fog product prior to sunrise.

In this case, GOES images detected the fog prior to the accident, but only careful analysis of animated GOES IR images could have led to the expectation that the fog would impact Highway 401. An encouraging aspect of this case is that the Penn State University/National Center for Atmospheric Research MM5 mesoscale model (Grell et al. 1995) was able to simulate the fog formation and development reasonably well (Pagowski et al. 2004), providing some hope of the future ability to forecast such events using high resolution models.

c. Cedar Grove, Wisconsin, 11 October 2002

Highway I- 43 runs north- south along the western shore of Lake Michigan and connects small to medium sized cities such as Green Bay and Manitowoc in northeastern Wisconsin with Milwaukee and Chicago to the south (Figure 9). On the morning of 11 October 2002, motorists encountered dense fog near the town of Cedar Grove that resulted in a multi - vehicle accident that killed 10 persons and injured 38. A previous study was completed on the satellite detection capabilities for this case by Lindstrom (2004). Inspection of animated GOES fog product images (Figure 10) showed some hint of fog development prior to the accident, which occurred just after sunrise. Based on the movement of the fog, there appeared to be a light onshore breeze along the west side of Lake Michigan. However, the BTDR threshold for the bi- spectral images was 1- 2K, which is slightly lower than is normally observed for significant fog or

low clouds using this technique. Even the visible image (Figure 11) barely showed the fog due to its shallowness (Lindstrom 2004). For this case, it is doubtful that a warning could have been issued based on GOES satellite data alone.

d. Caliente , California, 3 January 2002

The fourth case is the Caliente , California accident on state highway CA58 on the morning of Monday, 3 January 2002. CA58 connects the lower San Joaquin Valley and Bakersfield metropolitan area with the Mojave Desert to the southeast (Figure 12). Seventy- seven vehicles were involved in this accident, resulting in 15 injuries and 1 fatality. A multi - layered, frontal cloud system with some precipitation had just passed through the region, as shown in the IR image (Figure 13) . Much of the valley to the north of Caliente was seen covered by a dark gray region in the unenhanced IR image, suggesting either warm moist air or low clouds, but most likely the latter given the synoptic situation. An animation of the two- band IR fog product showed that low stratus was forming and moving down the valley toward Caliente in the northwesterly flow following the front (Figure 14) . The final image of the sequence is at 1400 UTC, about 1 hour prior to the accident, so it is likely that fog enveloped the accident scene just before sunrise.

e. Long Beach, California, 3 November 2002

The fifth and final case occurred on I- 710, a north- south freeway near Long Beach, California (Figure 15) shortly after sunrise (1500 UTC) on the morning of Sunday, 3 November 2002. The accident involved 194 vehicles, and resulted in 40 injuries, 9 of which were critical.

Animated GOES fog product images observed the fog develop in the pre- dawn hours in the area near Long Beach, and the southern portions of Los Angeles (Figure 16). However, the fog was quite patchy, and tended to form rapidly in some locations, while dissipating in others. The area of fog that caused the accident formed in a northwest to southeast band to the north of Long Beach by around 1200 UTC, and then drifted southwestward over I- 710, expanding in area coverage as it moved. Since the fog was not widespread, motorists would likely have encountered the fog suddenly while en route to or from Long Beach. A close up view of the area provided by a GOES visible image after sunrise (1530 UTC) (Figure 17) showed that the IR fog product provided reliable information about the location of the fog during the pre- dawn hours.

4. Satellite Analysis Summary

Analysis of the five major accident cases showed that GOES satellite image products were able to observe fog or low clouds at or near the accident location in most cases. The one possible exception is the I- 43 event, where fog was difficult to detect because it was too shallow . The fog was observed in GOES images typically 1 to 3 hours in advance of the accidents, allowing a short period of time to provide some warnings or advisories. The sudden onset of fog was no doubt a factor in the severity of most of these accidents. The resulting rapid decrease in visibility was caused by the limited extent of the fog (which was in patches or narrow bands), along with either movement or development. In other words, these were truly mesoscale events, which require high resolution, high frequency data to resolve, predict, and provide warnings.

A mitigating factor in all cases was that the events occurred shortly after sunrise, at a time when GOES IR products used in fog detection become less useful due to contamination by solar reflectance, and visible imagery is still somewhat limited by low sunlight conditions. Thus, some extra effort is required to observe and analyze both types of image products during the transition period from night to day.

Lastly, there is the nagging uncertainty caused by the inability of GOES products to detect low visibility conditions at the surface. While some progress has been made in determining the likelihood of a low cloud base using GOES and surface temperature data (e.g. Ellrod 2002), low cloud bases do not necessarily correlate well with low visibilities at the surface. Thus, GOES data must be supplemented with surface visibility reports such as those from Road Weather Information Systems. Demonstration of the complementary use of satellite and surface data in fog detection and analysis was shown by Fischer et al. 2003. The existing METAR system

provides weather and visibility observations from airports but is not adequate for highway fog warnings. In the cases described in this report, there were often METAR observations that showed fog in the region, but not in the immediate vicinity of the accident (e.g. Mt. Clement, Michigan for the Ontario crash).

5. Upcoming Technological Improvements to GOES

Some technological improvements are scheduled to be implemented on GOES that should help with fog detection and advisories. Some near-term improvements will come about starting with the GOES-N (GOES-13) spacecraft due to be launched early 2006. An increased power supply will allow the Imager to operate throughout the satellite eclipse periods in fall and spring, eliminating nighttime blackout periods during severe storms, hurricanes, and fog formation. A star tracker navigation system will be deployed, allowing an increase in mapping accuracy from 6 km to 2 km at night.

Even greater improvements will come with the launch of GOES-R (circa 2012) and the modernized Advanced Baseline Imager (Schmit et al. 2005). The most notable improvements will be: (1) the faster scanning capabilities, allowing routine 5-minute interval observations of the Continental United States and southern Canada, (2) higher spatial resolution, with 2 km IR and 0.5 km visible imagery, (3) improved signal to noise ratio (SNR) in the shortwave IR channels, that will allow better discrimination of fog from background surfaces at night, especially with colder surface temperatures.

The latter two upgrades have been simulated using high resolution polar satellite data from the NOAA Advanced Very High Resolution Radiometer (AVHRR) and NASA Moderate-resolution Imaging Spectroradiometer (MODIS) instruments. Figure 18 approximates the improved resolution that will be attainable from the ABI during fog episodes using AVHRR 1 km fog imagery reduced to 2 km resolution. It can be seen that the precise coverage of valley fog in the Central Appalachian Mountains is much more easily determined with the 2 km data. Figure 19 compares MODIS fog product imagery (with a fog depth color enhancement) with GOES for a case of extensive fog and stratus in the Great Plains of the U. S. The MODIS image has a better definition of the fog edges, especially for the fog filament in eastern South Dakota. The GOES-R ABI will have an SNR value that is better than current GOES, but slightly worse than shown by the MODIS example.

6. What's needed To Improve Highway Fog Warnings?

In addition to the technological improvements to GOES previously noted, there are a number of steps that are needed to provide a better system to warn motorists about hazardous fog situations. Many of these recommendations were outlined in a recent forum on Weather and Highways (American Meteorological Society 2003). More environmental sensors are needed along roadways to detect low visibilities and quickly provide the information to Road Weather Information Systems for use by traffic officials and weather forecasters. National Weather Service (NWS) offices need to have direct access to this data to help with the timely issuance of Hazardous Weather Advisories similar to those for snow or ice, excessive heat, high winds, etc. Unfortunately, some states have very few (or no) RWIS, and must rely on on-site reports from motorists or highway patrolmen. Although RWIS' are somewhat expensive to install and maintain, their benefits can more than outweigh costs, especially on roadways with high traffic volume.

Once a dense fog event has been observed, the use of Variable Message Signs (VMS) and dynamic speed limits can then be used to help reduce the large variation of travel speeds that can occur, decreasing the risk of collisions. Finally, better driver education courses and public safety messages on radio and television would increase driver awareness of the dangers of dense fog and offer helpful advice on how to reduce the risk of accidents, such as adherence to VMS posted speed limits, use of emergency flashers, etc. The incorporation of GOES (and other types of) satellite data into highway warnings while feasible, appears to be a long way off due to shortcomings previously described. GOES image products nevertheless can contribute to the situational awareness of traffic officials and weather

forecasters by providing information on the extent, movement, and possible duration of dense fog.

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