Report prepared by:

[redacted]
Meteorologist Instructor
NOAA/National Weather Service Warning Decision Training Division, Norman, OK
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Introduction

On 13 April 2021 at approximately 2041 UTC the lift boat *Seacor Powe*r capsized off the coast of Port Fourchon, Louisiana. This incident led to multiple fatalities and injuries amongst the crew of the vessel. A line of severe thunderstorms producing very strong winds moved through the area at the time of the incident. As part of the investigation into the accident the National Transportation Safety Board (NTSB) reached out to the National Weather Service (NWS) to provide a subject matter expert to conduct an independent analysis of the meteorological conditions at the time of the incident and in the hours following.

This report is the result of that request and details the synoptic and mesoscale conditions that led up to the severe thunderstorms, a timeline of the event, and an estimate of the wind speeds the vessel experienced to be used in vessel stability analysis/simulation. The event predictability, real-time detection capability, and historical context of the winds that occurred are also provided. I have 11 years of experience as a meteorologist with National Weather Service with most of it spent working with, researching, and teaching on severe convective storms, mesoscale analysis and doppler radar interpretation.

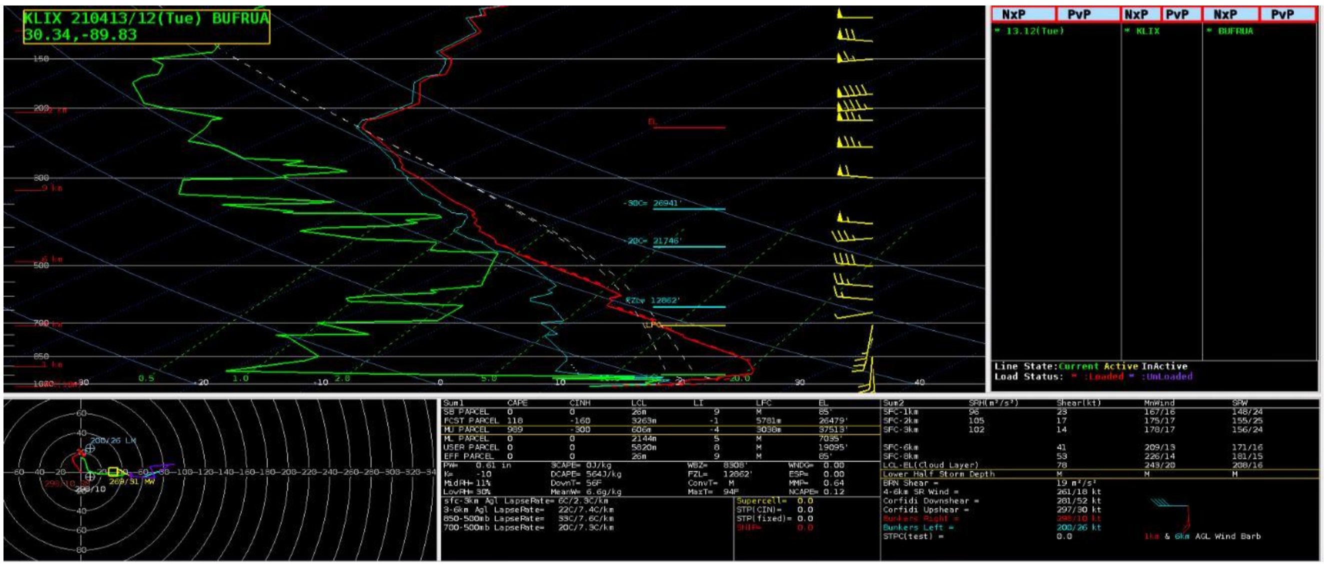
Meteorological Summary

Vigorous convection (in this case and hereafter convection refers to the processes that occur and produce thunderstorm cells) that had formed in an area of rich and deep atmospheric moisture over western Louisiana moved into much drier air over eastern Louisiana and coastal Mississippi on the morning of 13 April. When it encountered the much drier atmospheric conditions the convection rapidly weakened/dissipated. Residual precipitation from these dissipating storms evaporated as it encountered the dry air. This evaporation led to the development of a mesoscale area of high pressure over southern Mississippi and the adjacent coastline. This resulted in a relatively strong surface pressure gradient that produced north to northwest winds across most of eastern Louisiana and coastal Mississippi and formed a gust front that moved south towards the Louisiana coast by around 1800 UTC.

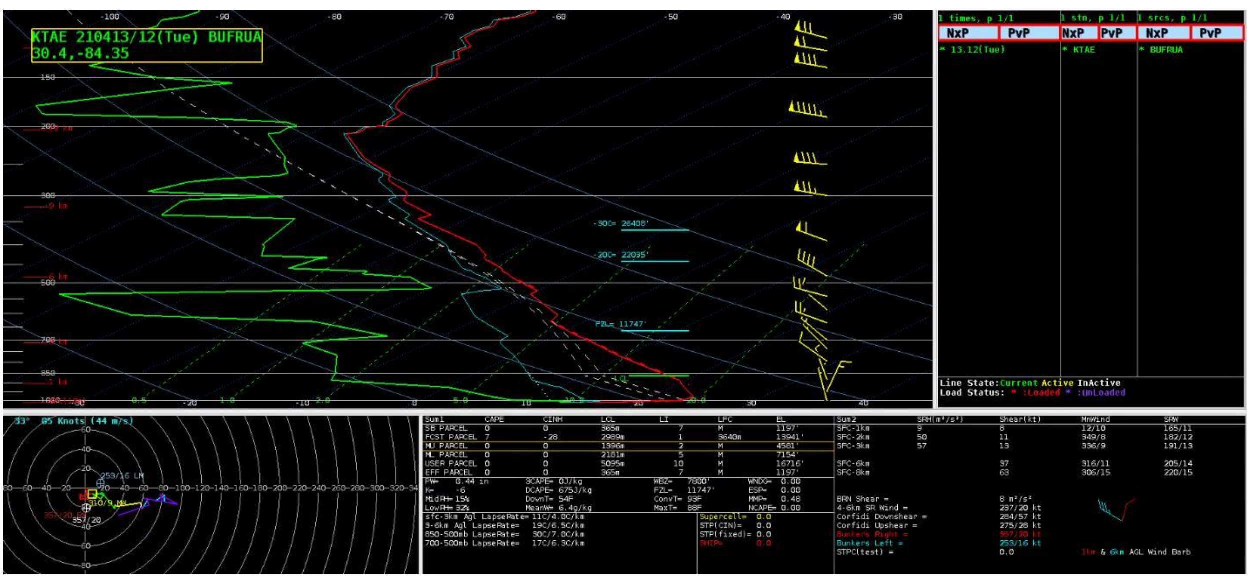
When increased low-level convergence (lift) along this gust front reached richer and deeper atmospheric moisture along the Gulf coast, severe thunderstorms redeveloped in an atmosphere favorable for strong downbursts/downdrafts. The convection also likely locally decreased surface pressure (a phenomenon known as a wake low) which worked with the expanding mesoscale area of high pressure over the Mississippi coast to produce several hours of gale force winds behind the initial line of thunderstorms.

Mesoscale/Antecedent Meteorological Conditions

Vigorous convection moved from western Louisiana into eastern Louisiana/south Mississippi on the morning of 13 April. Observed sounding and GOES-derived satellite radiances showed very dry air in place on the morning of 13 April over southeast Louisiana and coastal Mississippi.

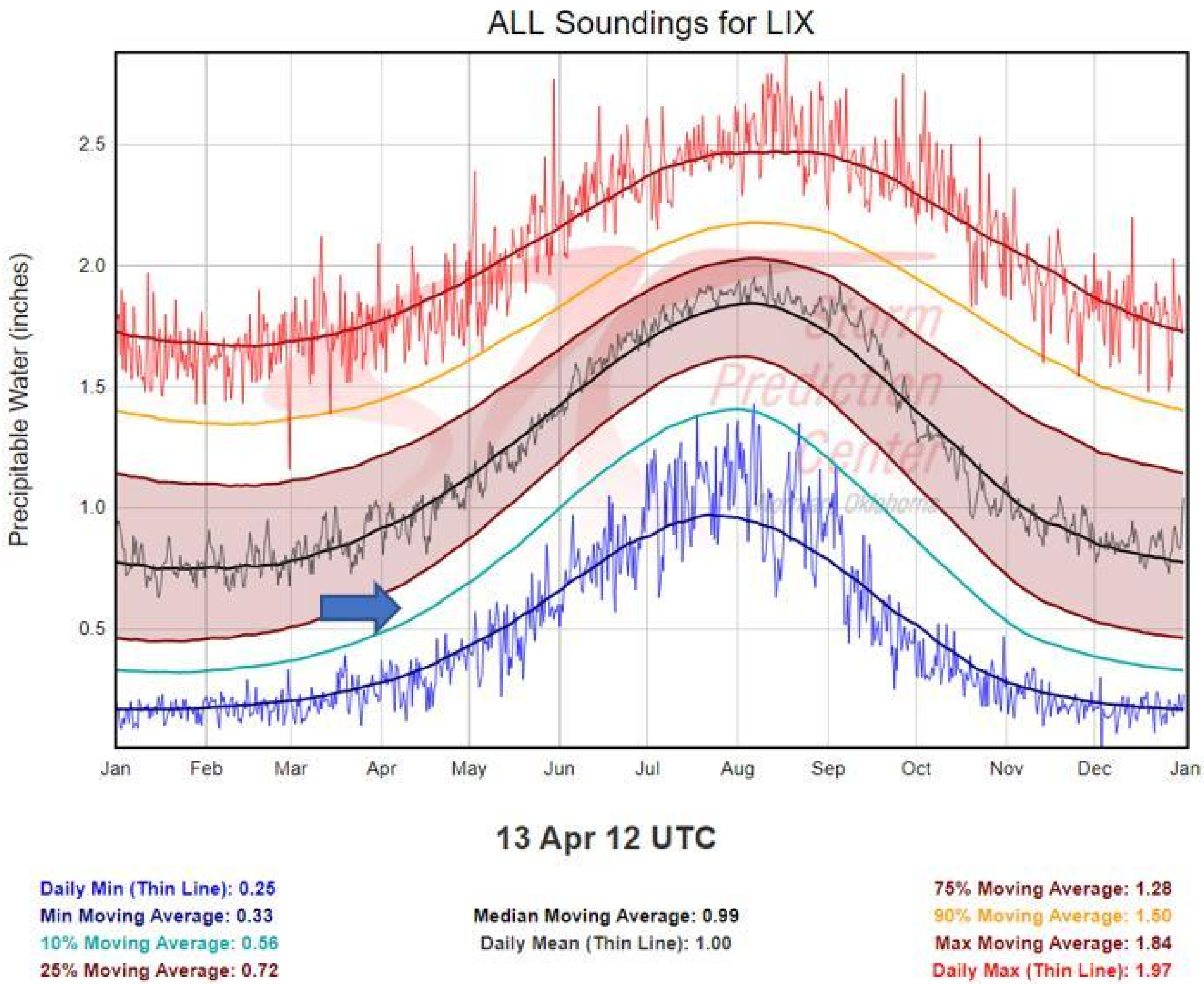


1200 UTC Observed sounding from Slidell, LA (KLIX).



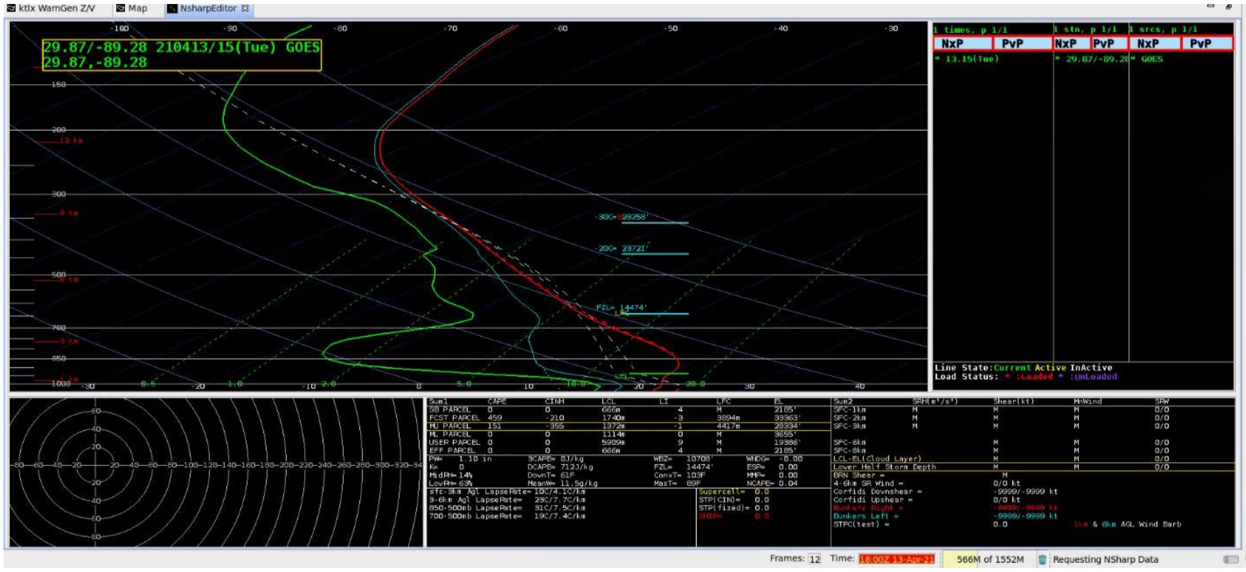
1200 UTC Observed sounding from Tallahassee, FL (KTAE).

Both soundings featured very low relative humidity through much of the columns. The total precipitable water at Slidell was 0.61" which was amongst the 10% driest on record for the area dating back to 1948.

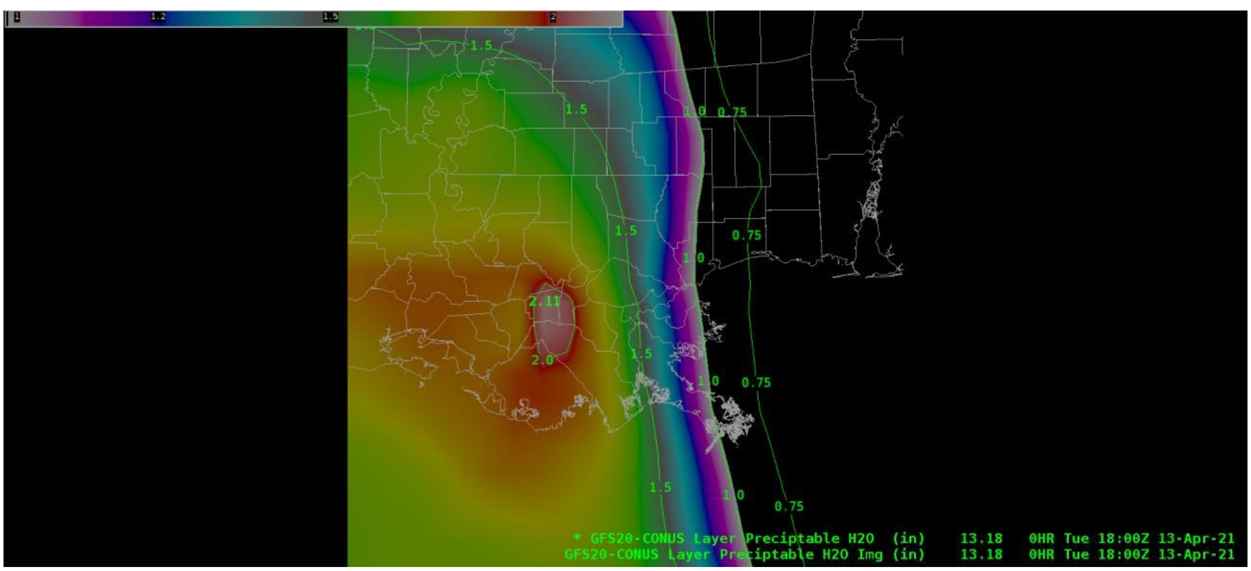


Precipitable water climatology for the New Orleans (LIX) area on the day of the incident. The observed precipitable water value of 0.61" would be along the 10% moving average for 13 April.

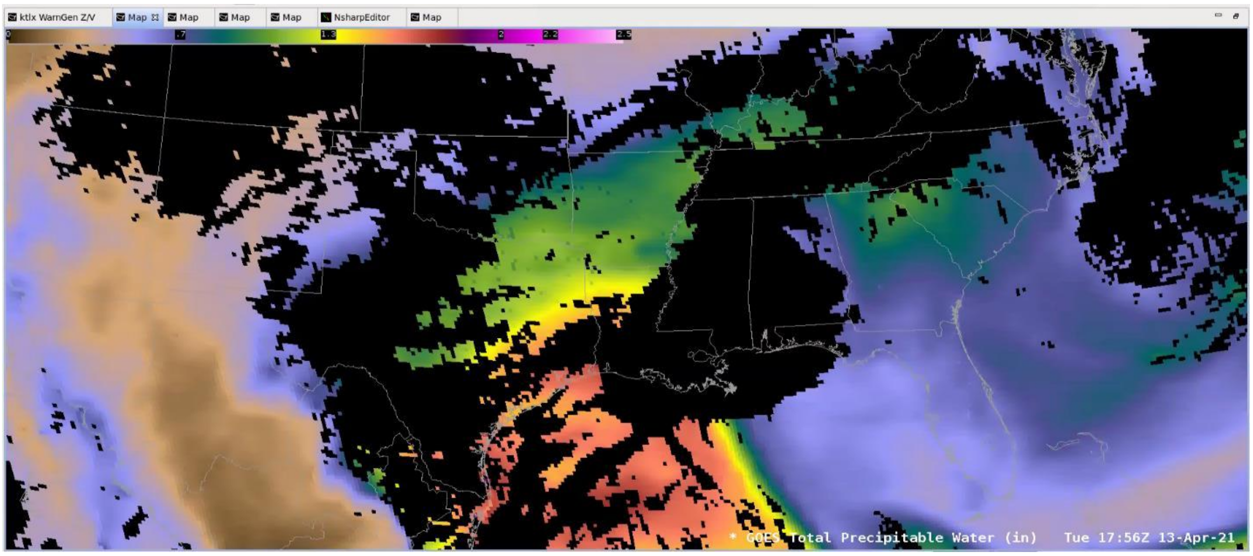
Data from satellite radiances and model analysis show a strong gradient of atmospheric moisture, both at the surface and through the entirety of the atmosphere, with more moist air to the west and much drier air to the east. The sharpest gradient ran along an axis running north to south roughly through the New Orleans metro area at 1800 UTC. These data suggest the gradient extended well-inland to the north and well-offshore to the south.



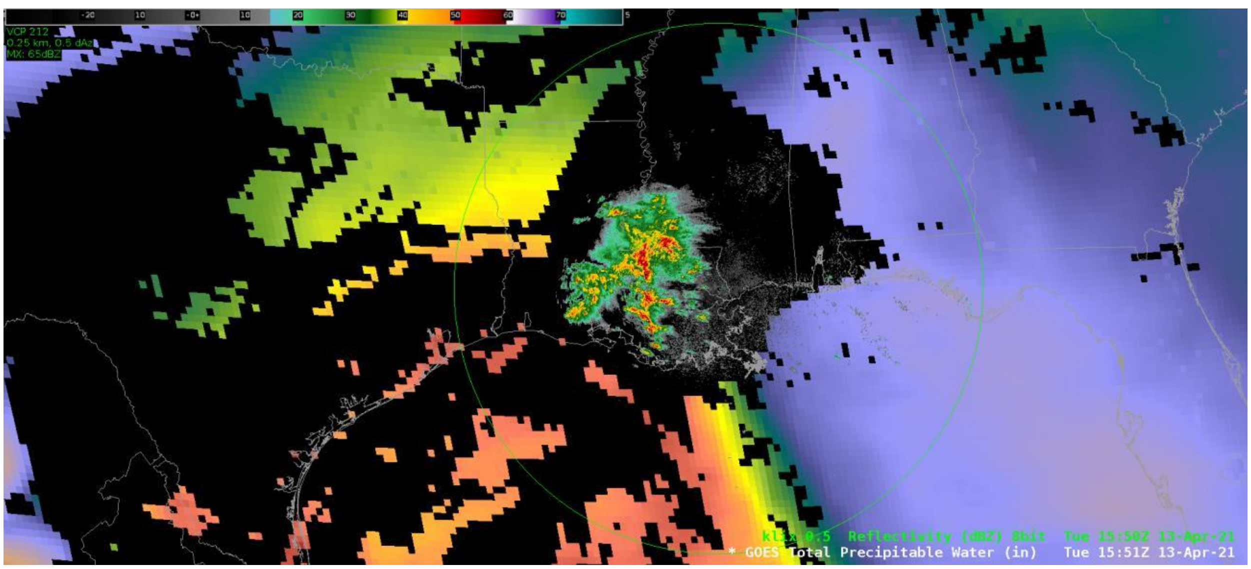
GOES derived sounding from about 60 miles southeast of the accident site showing very dry lower atmospheric conditions. Cloud cover in the region prevent derived sounding availability closer to the accident site.



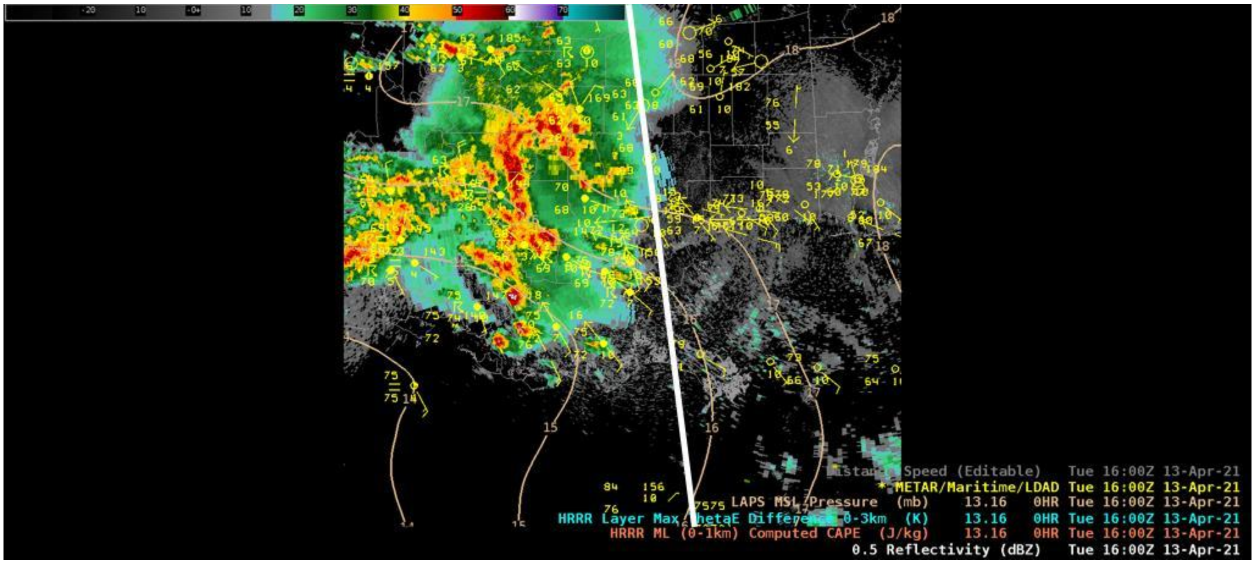
20 kilometer GFS layer precipitable water values analysis valid at 1800 UTC on 13 April. A sharp gradient of very dry air to the east and much higher moisture content air to the west is evident here.

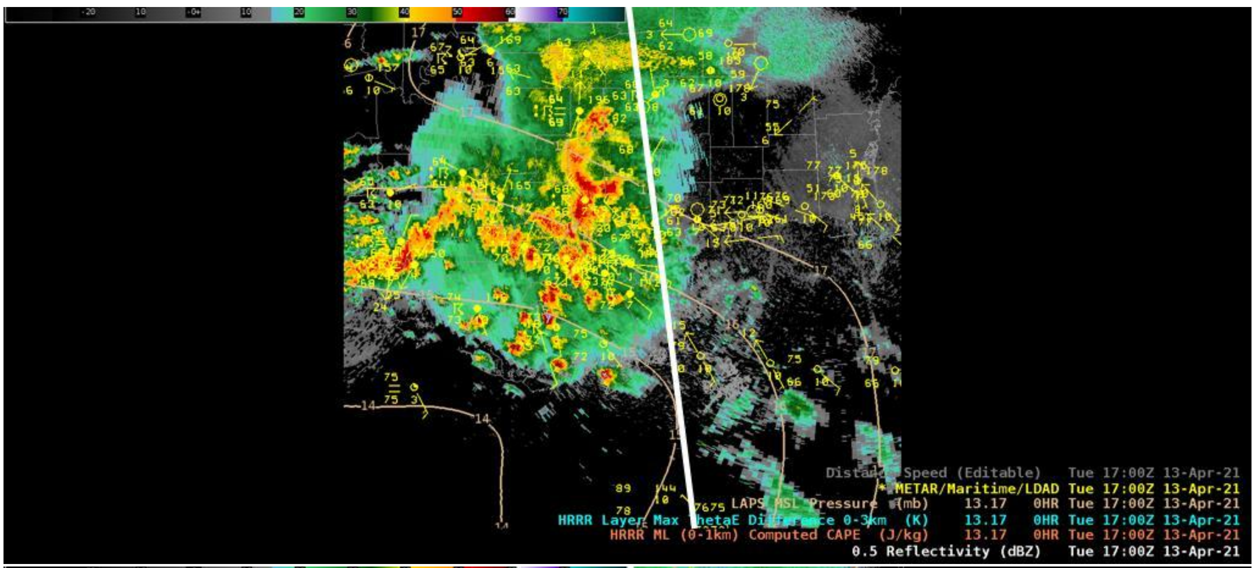


GOES derived total precipitable water values from 1800 UTC on 13 April showing the very dry air (cool colors) to the east of the New Orleans area and more moist air to the west. Cloud cover prevents some values from being produced along the north central Gulf coast, but observations and model data support a continuity of this gradient of drier air.



Radar image from KLIX overlaid on the precipitable water gradient as thunderstorms begin to approach the drier air and dissipate over southern Mississippi.


Speed (Editable) Tue 16:00Z 13-Apr-21
* METAR/Maritime/LDAD Tue 16:00Z 13-Apr-21
LAPS MSL Pressure (mb) 13.16 0HR Tue 16:00Z 13-Apr-21
HRRR Layer Max ThetaE Difference 0-3km (K) 13.16 0HR Tue 16:00Z 13-Apr-21
HRRR ML (0-1km) Computed CAPE (J/kg) 13.16 0HR Tue 16:00Z 13-Apr-21
0.5 Reflectivity (dBZ) Tue 16:00Z 13-Apr-21


Speed (Editable) Tue 17:00Z 13-Apr-21
* METAR/Maritime/LDAD Tue 17:00Z 13-Apr-21
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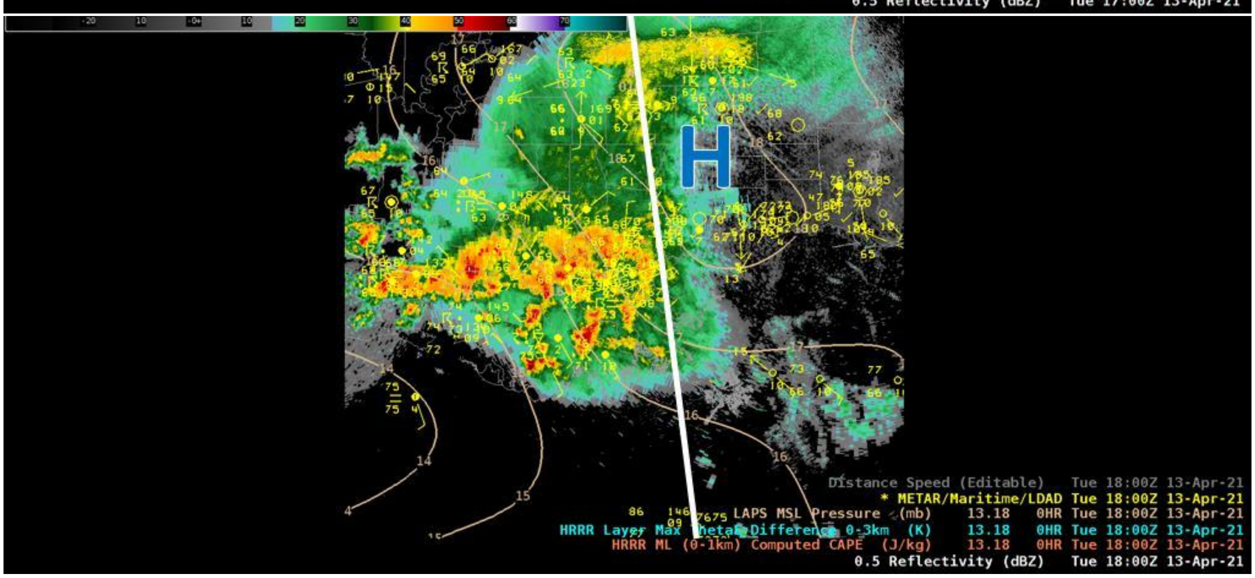
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Distance Speed (Editable) Tue 18:00Z 13-Apr-21
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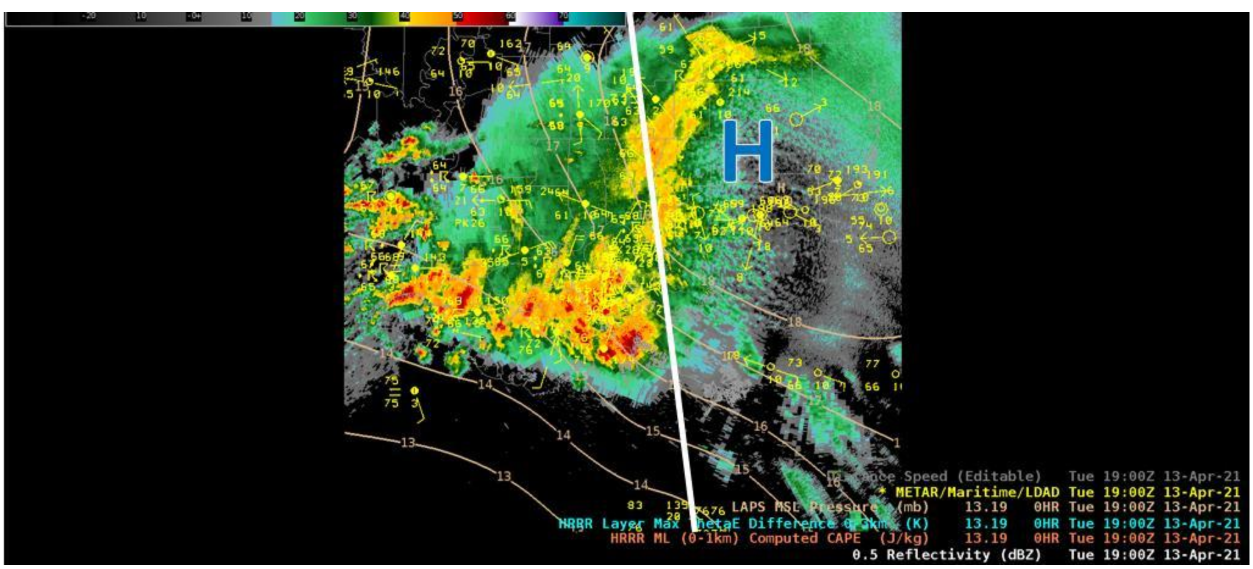
LAPS MSL Pressure (mb) 13.18 0HR Tue 18:00Z 13-Apr-21
HRRR Layer Max ThetaE Difference 0-3km (K) 13.18 0HR Tue 18:00Z 13-Apr-21
HRRR ML (0-1km) Computed CAPE (J/kg) 13.18 0HR Tue 18:00Z 13-Apr-21
0.5 Reflectivity (dBZ) Tue 18:00Z 13-Apr-21

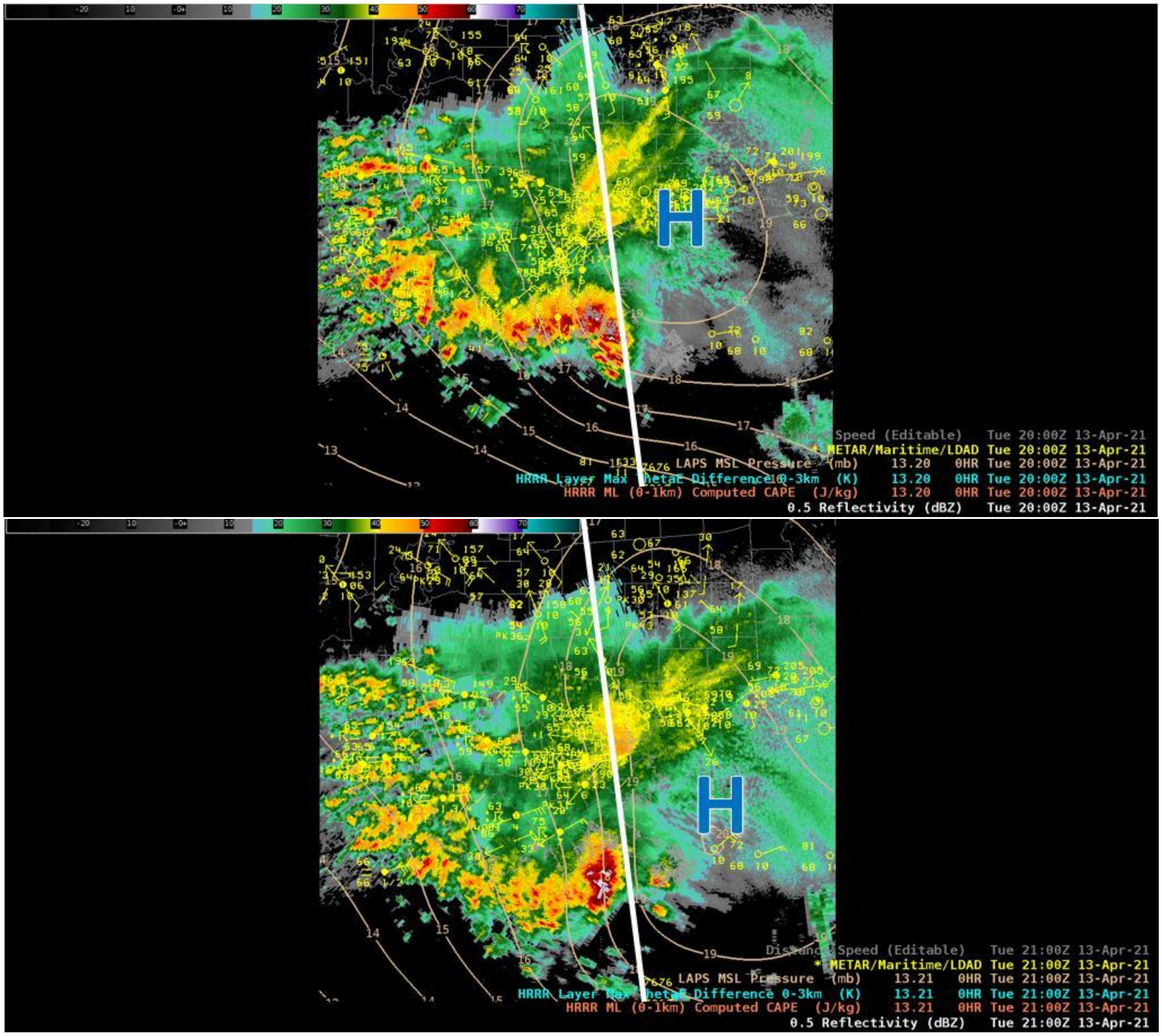
Sequence of hourly observations (yellow) model derived sea level pressure (brown) and radar reflectivity (scale in the upper corner of each image) from 1600 UTC to 2345 UTC on 13 April. The white line running roughly north to south denotes where deeper and richer column moisture gives way to very dry air below 400 millibars. Precipitation enters the area of drier air from the west and dissipates. Significant evaporation of the residual precipitation lowers temperatures about 10 degrees Fahrenheit across southern Mississippi and increases surface pressure by 4-5 millibars as a cold pool/mesohigh establishes over the area. This cold pool is further reinforced by additional convection through the early afternoon.

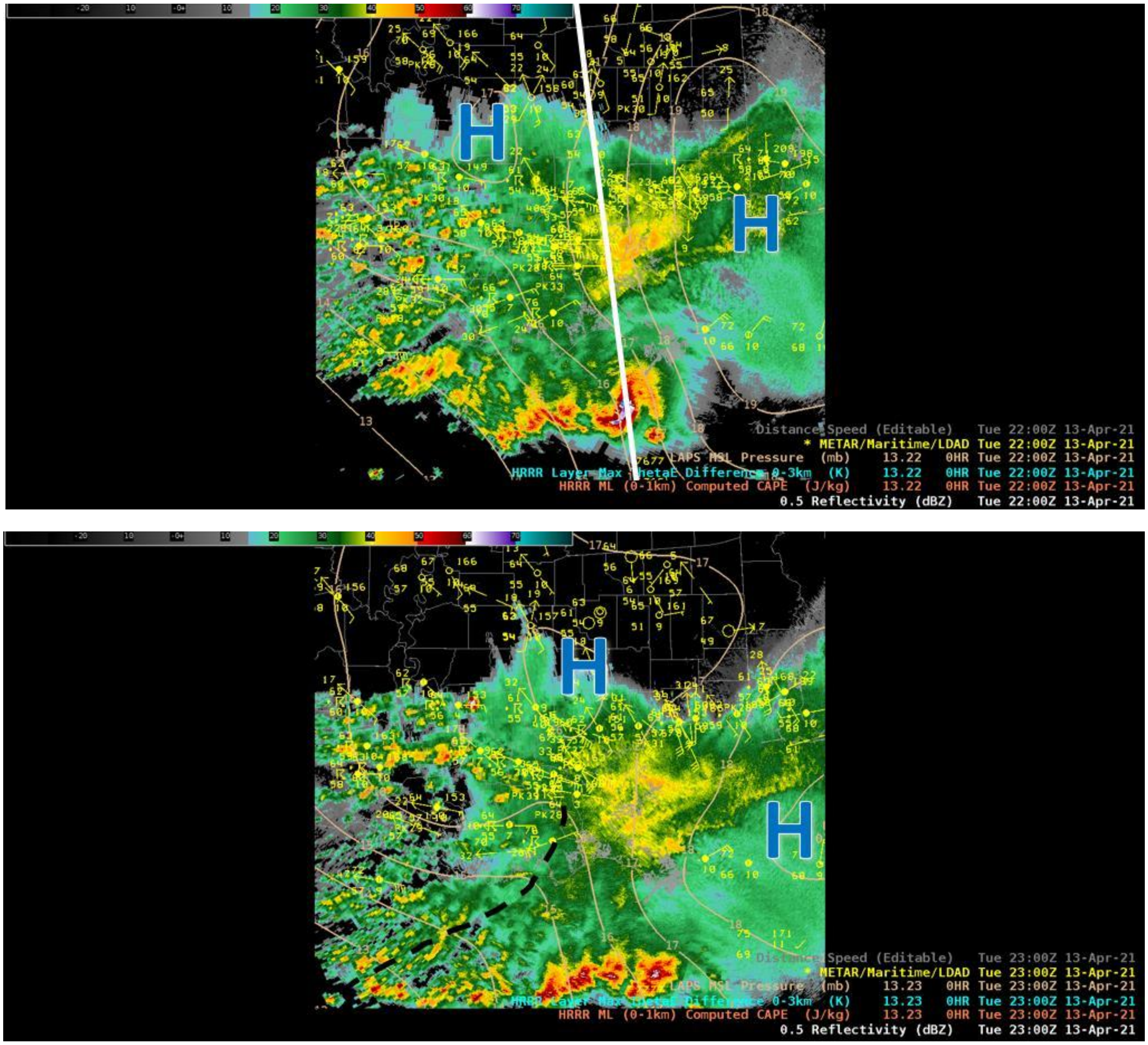
Surface pressure readings at KLIX increased from 1016.2 millibars at 1700 UTC to 1020.0 millibars at 1800 UTC. This was part of the reflection of this area of higher pressure centered from roughly Slidell to Hattiesburg, LA (denoted with the blue H). At 1900 UTC a +5.8 millibar pressure gradient existed between KLIX and KNBG (NAS New Orleans Joint Reserve Base), which were separated by 59.2 kilometers. This pressure gradient resulted in a surge of northwesterly winds west of an eddy (or mesolow) centered roughly over Lake Borgne. These northwest winds were evident on the KLIX NEXRAD and TMSY (New Orleans) Terminal Doppler Weather Radar (TDWR) and widespread returns of 40-60 knots were evident in the 1,000 to 3,000 ft above ground level (AGL) layer. The KMSY (Louis Armstrong Int'l Airport) METAR reported sustained winds of 23 to 28 knots from 1837 UTC to 1953 UTC, with a peak gust measured at 47 knots.

The remaining sequence of images show the developing cold pool and evaporating precipitation to the north, which led to a surge of northerly winds. This surge manifested as a gust front that would have significantly increased low-level convergence along its leading edge. In this region atmospheric moisture remained much richer and deeper with much stronger convective available potential energy. Archived data suggests around 2,500 J/kg of 100 millibar Mixed Layer Convective Available Potential Energy (CAPE) was available to these storms, with deep layer shear values around 50 to 60 knots. These values would be sufficient to support organized severe thunderstorms. Thunderstorms quickly developed and increased in intensity along the leading edge of the southward advancing gust front.



By 1900-2000 UTC, along the edge of this cold pool convergence is increased and thunderstorms develop and begin moving south, into an area of deeper and richer atmospheric moisture. The airmass was much *more unstable here allowing vigorous thunderstorms to form and develop into a mesoscale convective system that advances to the southeast.*

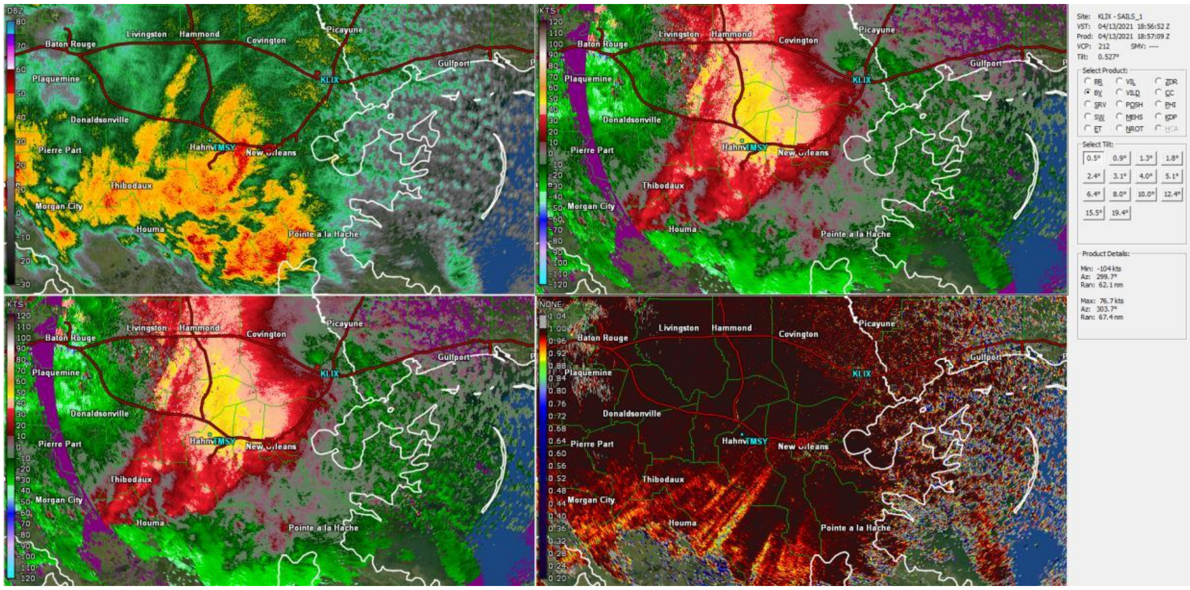




By 2300 UTC surface pressure troughing behind the line is significant enough to be picked up by model analysis (highlighted by black dotted line).

Storm Scale Analysis

Between 1600-1800 UTC as stronger winds began in the New Orleans metro area convection appeared relatively weak, with 50 dBZ values only extending to around 16,000 feet on the LIX NEXRAD in the New Orleans area. This activity seemed to be fed by convergence from the developing northwest winds driven by the cold pool-forced increases in the surface pressure. Presumably, the dry air remained in place aloft over the New Orleans area, allowing evaporation and negative buoyancy effects to lead to the convective wind gusts. Gradient wind balance of selected pressure gradients in the area support winds of 20 to 26 knots, although locally tighter gradients likely existed than what was observed within the available data.

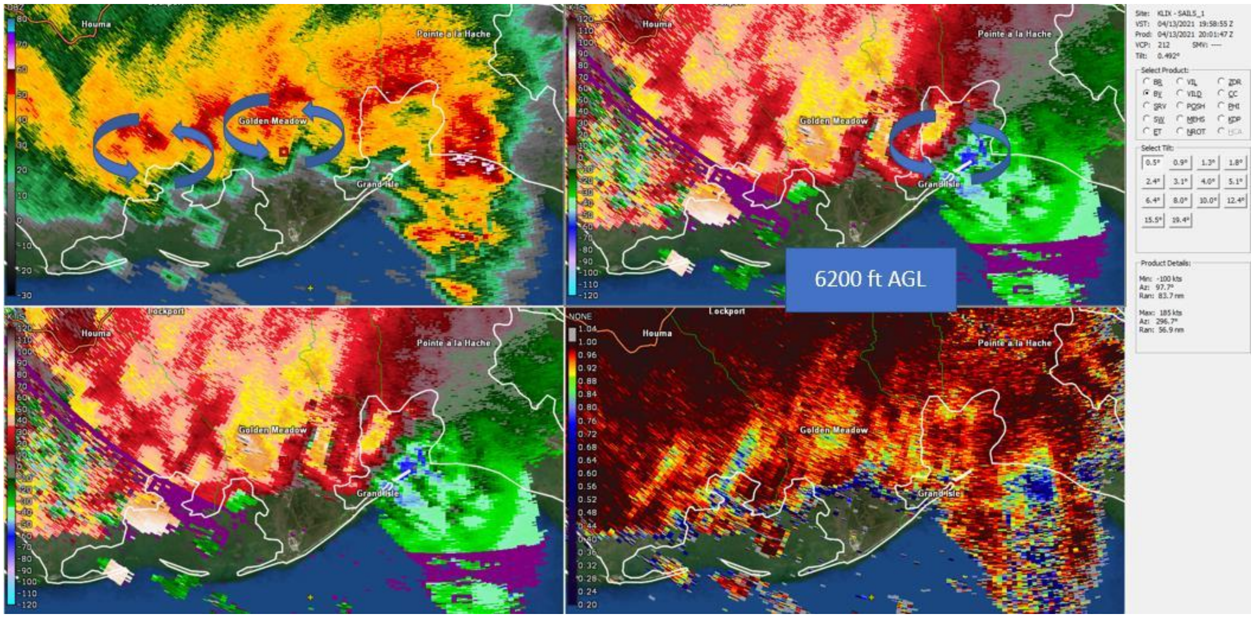


0.5° elevation angle KLIX NEXRAD imagery from 1856 UTC with reflectivity (upper left), base velocity (upper right), storm relative velocity (lower left) and correlation coefficient (lower right).

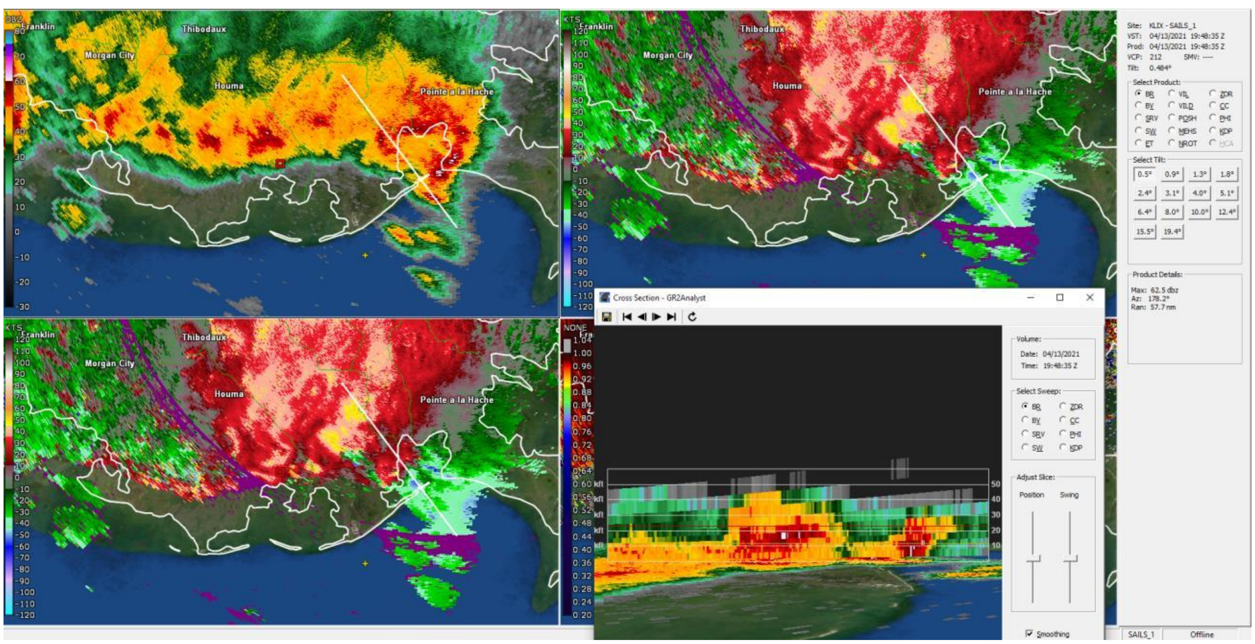
Southwest of New Orleans, in a more moist and unstable airmass, increasing thunderstorm activity formed into a line of multiple convective cells known as a mesoscale convective system (MCS) and swept southward towards the coast. Individual thunderstorm clusters developed southeast of the MCS along the coast. At 1902 UTC the KLIX NEXRAD showed one of these rapidly developing thunderstorms producing roughly 100 knots of storm top divergence (this is a proxy for the intensity of a thunderstorm based on how strongly winds are separating at the top of the atmosphere, the threshold for a severe thunderstorm is roughly 60 knots) with 50 dBZ reflectivity values up to 21,000 to 26,000 feet – about 15 miles northwest of Grand Isle, LA. By 1917 UTC a moderate strength mesocyclone formed in one of the convective cells near Grand Isle stretching from around 5,000 to 10,000 feet AGL.

This area of convection persisted and grew more intense while moving little through 1953 UTC (while the MCS continued to move south towards the area). By 1948 UTC 50 dBZ reflectivity values had extended to around 41,000 ft and storm top divergence had increased to around 160 knots, which was indicative of a very severe updraft. Broad and deep rotation was evident over Caminada Bay, and the combination of reflectivity and velocity information suggested the presence of a mesoscale convective vortex (MCV), which may have produced even lower surface pressures locally. From the storm over Caminada Bay to about 35 miles west of the bay several other severe updrafts were evident with 65 dBZ cores over 28,000 feet and storm top divergence signatures over 110 knots. The complex appeared to be producing three separate mesocyclones by 1958 UTC. At this point the leading edge of the cold pool surge was about 10 miles north of the Louisiana coast, and the surface convergence along this edge clearly aided in the recent rapid intensification of the thunderstorms.

By 1958 UTC the larger MCS system began to catch up with the leading individual storm clusters. Subsequent volume scans showed curvature in the reflectivity products, and patterns in velocity products supported the existence of moderate strength mesocyclones that were 12,000-15,000 feet deep. This suggested good storm-scale organization and a persistent and strong updraft. There were no obvious signatures that suggested the presence of a tornado, and low-level environmental shear strength and geometry did not appear favorable for tornadoes.



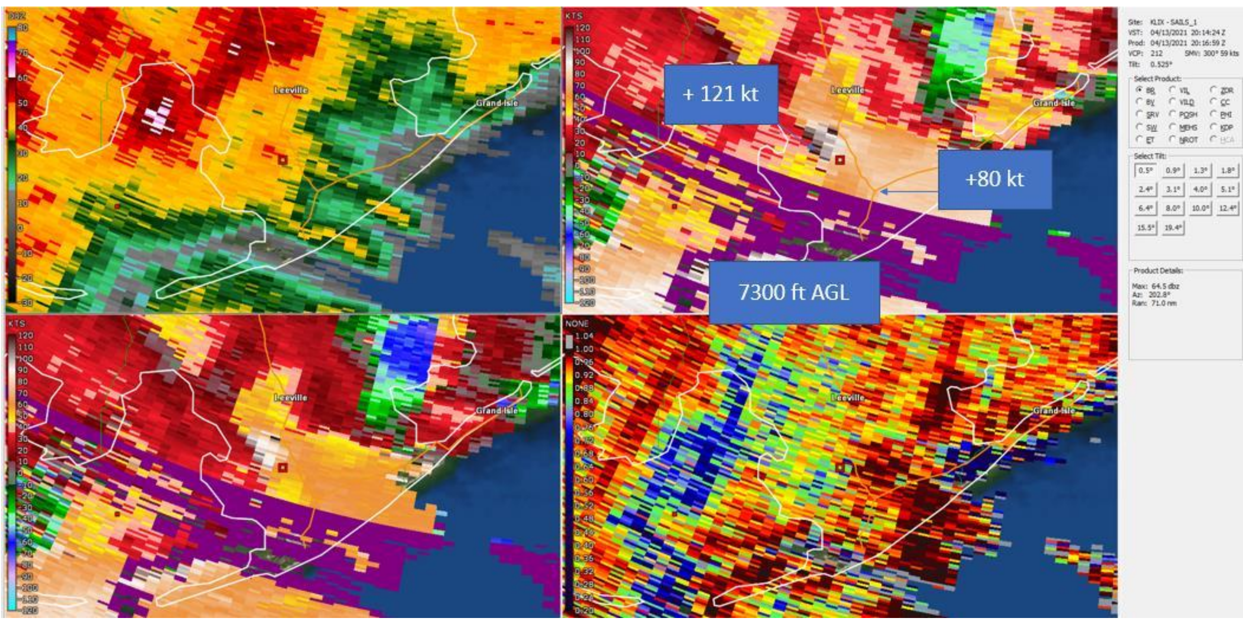
1958 UTC 0.5° 4-panel from KLIX. The blue arrows show areas of curvature in reflectivity and rotation in velocity indicative of mesocylcones.



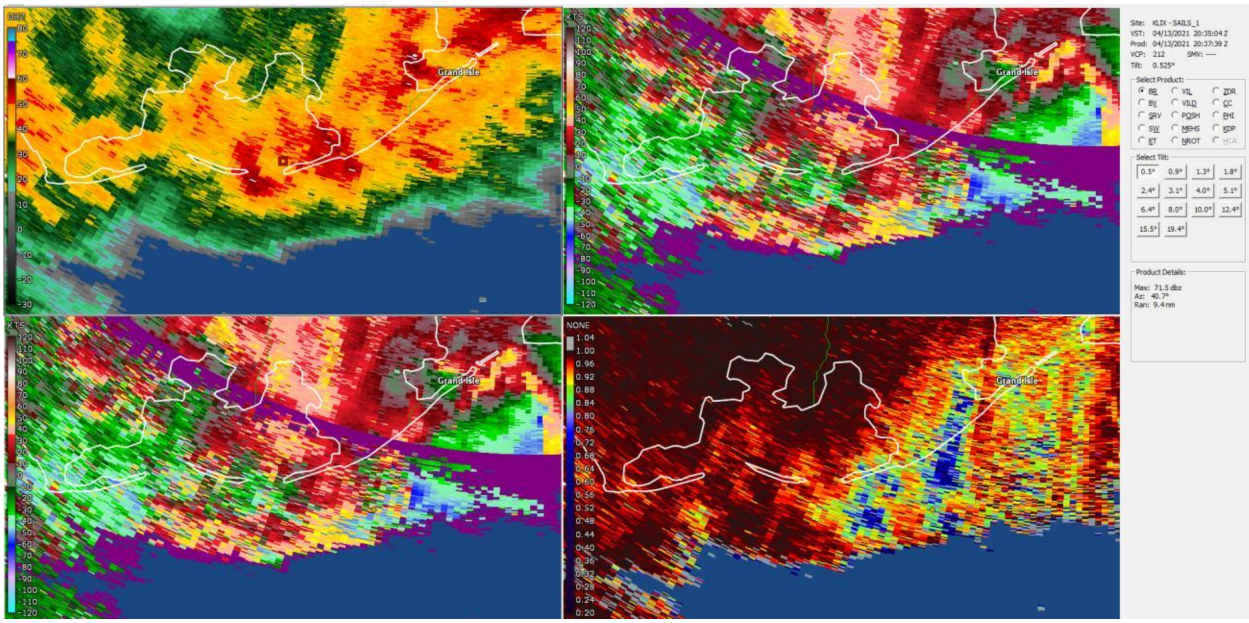
1948 UTC 0.5° elevation angle from KLIX, with a cross section cut through the area highlighted by the white line. Suspended reflectivity cores are evident in this cross section, which often precede downburst/microbursts.

By 2000 UTC most of the convection had become distant enough from the radar that the standard 0.5° beam elevation put the center of the beam around 5,000-6,000 ft AGL. This was likely above the top of the boundary layer given the strong subsidence inversion present on the 1200 UTC (13 April) and 0000 UTC (14 April) rawinsonde observations from Slidell. However, such a strong inversion could also lead to radar beam super refraction, which would cause the beam to be sampling elevations lower than typical. Uniform areas of 70 to 80 knot outbounds along the leading edge of convection suggested that at least some of these values were from within the boundary layer (sub ~4,500 ft) and would thereby be somewhat representative of surface wind speed.

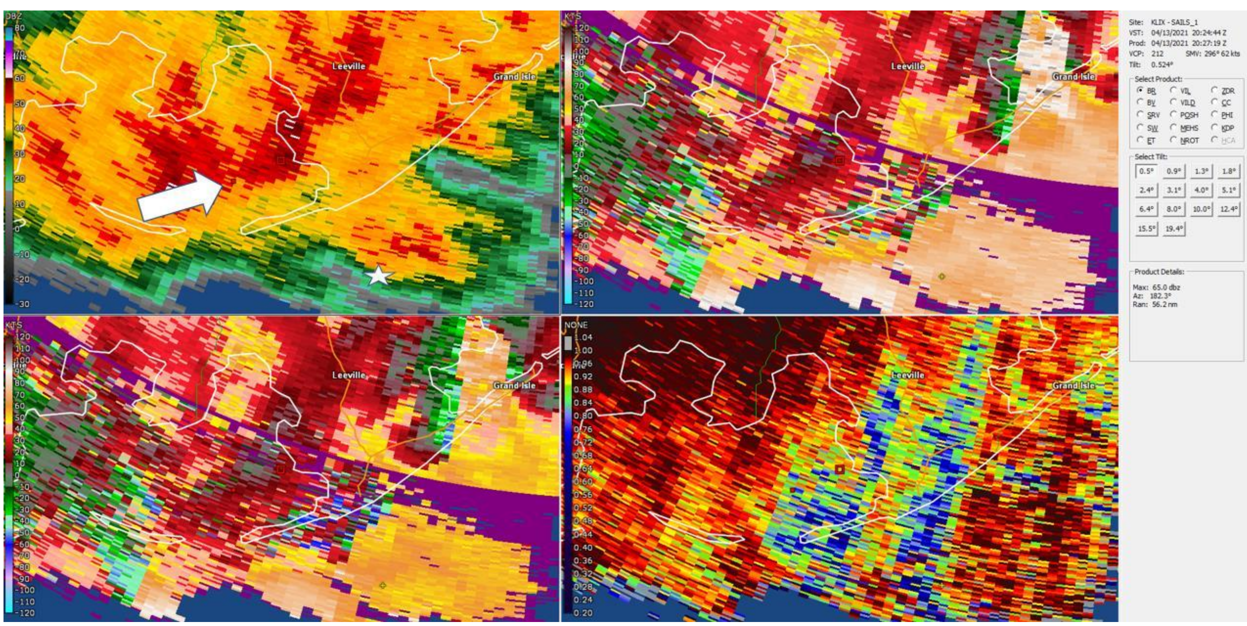
Of the data collected, the 2014 UTC volume scan presents some of the strongest observed doppler winds of the event with an area of returns of +121 knots just south of Leeville. Subjective assessment of these returns present jagged transitions and dealiasing failures, as well as range folding that would be expected in a super refraction situation. This is because the returned power is coming from varying heights and the radar dealiasing algorithms assume it is being sampled along a smooth plane. I have low confidence in this +121 knot value. More reliable looking and widespread returns of approximately +80 knots are visible across much of coastal Lafourche Parish. This section of velocity returns are more uniform in appearance and may be representative of the winds in the top of the boundary layer.

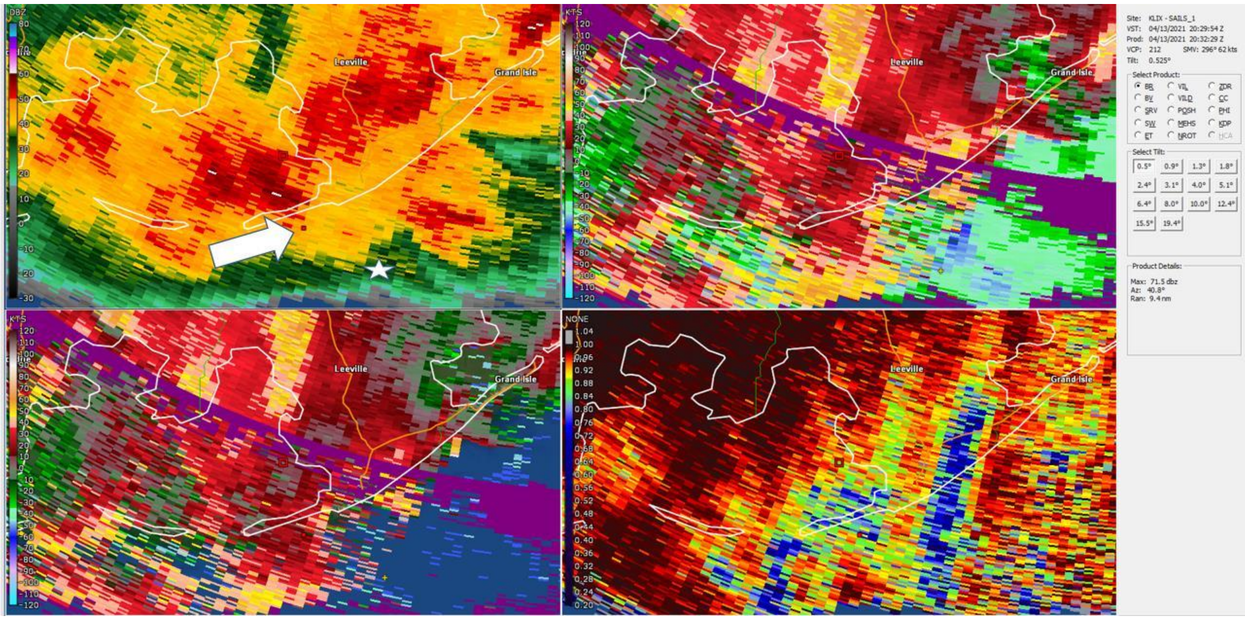


2014 UTC 0.5° elevation angle from KLIX with areas of enhanced velocity highlighted and the approximate typical beam centerline elevation at that location for 0.5° data.



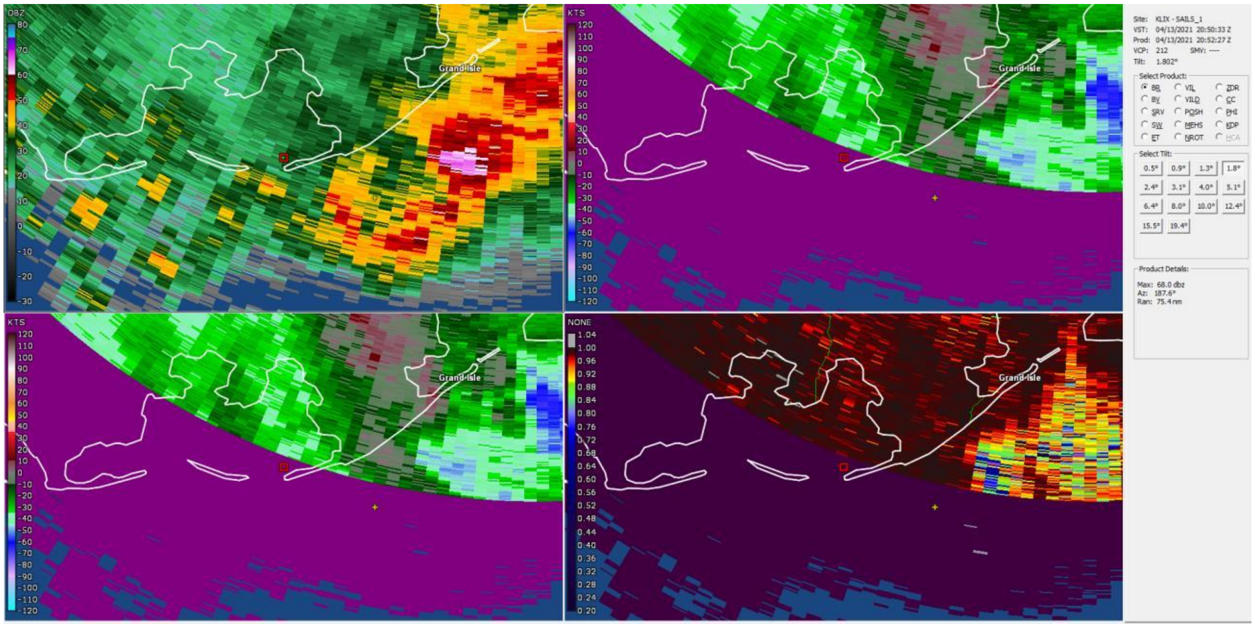
The location of the vessel was just outside the KLIX maximum unambiguous range at 2035 UTC (marked by the purple range folded data in a semicircle) and there are significant range folding and radar dealiasing errors present in the velocity data beyond that range.





KLIX 0.5° elevation angle from 2024 and 2029 UTC. The leading edge of the 50 dBZ reflectivity returns can be tracked between volume scans and a forward speed derived (55 to 60 knots). The white arrow highlights the approximate leading edge of 50 dBZ reflectivity approaching the accident site, marked by a white star.

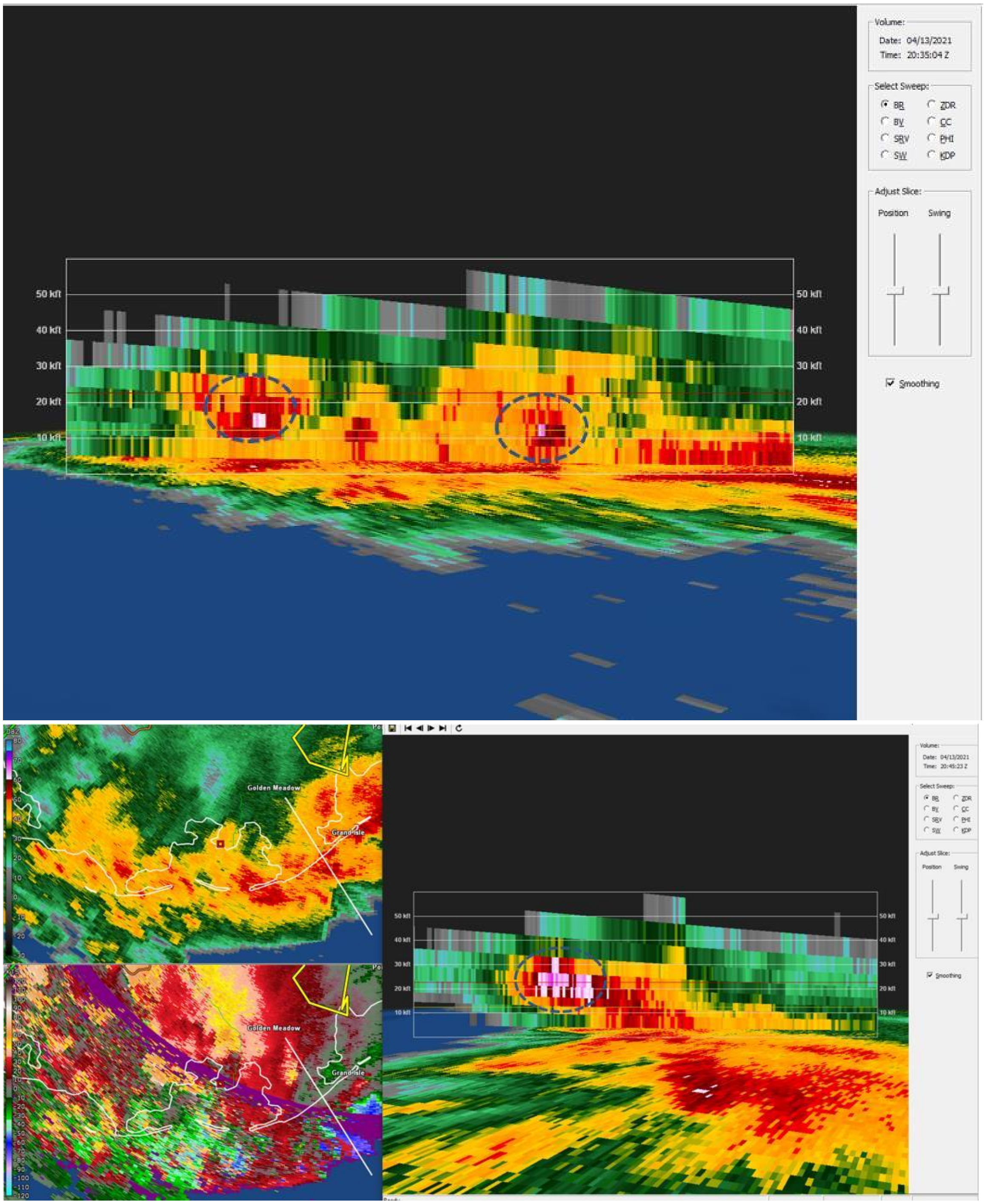
The leading edge of convection as it approached the accident site translated southeast between 55 and 60 knots. Principles of momentum transfer make it possible to use such translation to set a rough lower bound on surface wind speeds. Strong downbursts likely occurred below this convection that would have further enhanced wind speeds. A leading individual cell that formed just ahead of the main surge merged with the main line just east of the vessel at 2032 UTC and a significant increase in convective intensity occurred through 2052 UTC. This series of activity was likely the most responsible for the wind conditions at the accident site.



KLIX 1.8° elevation data from the 2050 UTC volume scan. This data would be at roughly 18,000 feet AGL.

At 2050 UTC, a large area of 60-70 dBZ reflectivity can be seen just northeast of the accident site. This would be at roughly 18,000 feet AGL, and 60+ dBZ reflectivity extended further to 37,000 ft in this volume scan. This would be indicative of a very intense updraft, which would also be strongly supportive of very strong downburst winds.

Numerous volume scans showed evidence of "elevated reflectivity cores," which are areas of strong reflectivity overlaying areas of weaker reflectivity. These are often associated with downburst/microbursts as the heavier and more reflective hydrometeors fall through a layer of lighter precipitation. The water loading/gravity effects often work in concert with entrainment of drier air/evaporation to produce a downburst.



Volumetric data from the 2035 and 2045 UTC KLIX scans showing strong suspended cores in the vicinity of the accident site.

At the vessel, synoptic scale flow of around 20 knots (10-meter, 2-minute average) from the southeast likely shifted around 2020 UTC to a more variable, but predominantly south-southwesterly direction at about 15 to 25 knots as air was pulled into the approaching thunderstorms. At around 2035 UTC the wind abruptly shifted to the north-northwest at 25 to 35 knots as the leading edge of the cold pool and thunderstorm gust front reached the site. This was followed up within a matter of minutes by intense thunderstorm downburst and downdraft winds that lasted approximately 20 minutes. 10-meter 2-minute average winds were approximately 40 knots, with bursts of stronger wind producing 10-meter 5-second gusts to around 80 knots. Winds were likely significantly stronger at the higher elevations of many of the platforms and vessels in the region. A logarithmic wind relationship extrapolation of 80 knots at 10-meters would result in 80-meter winds (260 feet) of 115 knots. This estimate is based on direct meteorological observations in the region of the accident, recorded video feeds, and observed radar and environmental characteristics.

Winds of this magnitude are not unheard of for the Gulf coast but would be somewhat rare outside of a tropical cyclone. For example, the National Oceanic and Atmospheric Administration (NOAA) National Ocean Service station GISL1 (located about 20 miles northeast of the vessel) gusted to 74.9 miles-per-hour at 2030 UTC. In the station's record going back 10 years no gusts over 65 miles-per-hour had been recorded outside of Hurricanes (Delta 2020, Isaac 2012). In adjacent Lafourche and Terrebone Parish only two equivalent thunderstorm gusts were recorded in NWS StormData going back to 1961 (in 1982 and 1987). These three instances over a 60-year period give us a rough estimate that thunderstorm winds of this magnitude would have about a 1 in 20-year recurrence interval in the area.

Behind the main line of storms weak pressure fluctuations from Automated Surface Observing System (ASOS) sites along the coast suggest the more organized convection in a warm moist airmass may have led to local pressure decreases or a "wake low." The strong mesohigh centered along the Mississippi coast, which was continually being reinforced by convection moving into extremely dry air led to a strong pressure gradient behind the storms. This led to a persistent pressure gradient that produced 25 to 35 knot (10-meter, 2-minute average) winds with 5-second 10-meter gusts to 45 knots through at least 0000 UTC on 14 April.

A rough calculation of significant wave height given the fetch and duration would produce significant wave heights increasing to 4-6 ft. If the wind component was more easterly than estimated (longer fetch) the system could have produced heights up to 8 ft. These strong winds and steepening seas would have extended well into the initial search and rescue timeframe.

Summary of wind conditions at the accident site on 13 April 2021

Until around 2020 UTC (background conditions):
Southeast wind around 20 knots (10-meter, 2-minute average) from synoptic/large scale flow (Pre-event background conditions).

2020 to 2035 UTC:
Southwest winds 15-25 knots (10-meter, 2-minunte average) from inflow into approaching thunderstorms.

2035 pm to 2100 UTC
Intense thunderstorm downburst and downdraft winds predominantly north-northwest at 30 to 50 knots (10-meter, 2-minute average) with peak gusts up to 80 knots (5-second gust).

Estimated Maximum Wind Speed in knots by height and duration.

	Height	5-second	10-second	30-second	60-second
Upper Bound	10-m	80	77	74	71
	150 ft	89	86	83	80
	300 ft	95	92	89	86
Lower Bound	10-m	65	62	59	56
	150 ft	74	71	68	65
	300 ft	80	77	74	71

Based on video/meteorological reports and radar, gusts between these upper and lower bounds likely persisted to around 2100 UTC.

2100 UTC to 0200 UTC on 14 April
Winds north-northeast gradually becoming more easterly at 25 to 35 knots gusting to 45 knots (gradient from mesohigh).

0200 UTC 14 April to 1100 UTC 14 April
Winds east-northeast at 15 to 20 knots.

Wind Speed Approximation Limitations and Methods

Several vessels in the general area of the accident vessel provided wind observations. The *Deepwater Asgard*, *Discoverer Inspiration*, and *Louisiana* provided the raw data from high frequency observations from multiple non-standard elevations. The Louisiana Offshore Oil Port (LOOP), also provided high frequency observations. The *Vanessa, Rockfish,* and *Christian Chouset* provided verbal accounts and pictures from meteorological observing equipment onboard the vessel. The NOAA National Ocean Service site GISL1 provided standard observations about 20 miles northeast of the accident site.

Videos were also available from near the accident site (see the NTSB's public docket for this accident), and the following videos were especially helpful:
08-FOURCHON MAIN TOWER SOUTH.wmv
CPORT DRYDOCK WEST_0_4.wmv
CPORT DRYDOCK NORTH_0_4.wmv
11 – Tower PTZ – GENERIC_camera_2021-04-13 14h 00m11s_000.wmv
These videos showed clear pulses of very strong wind, characteristic of strong microbursts and downbursts. In one of the videos a large crane was shifted nearly 180-degrees, and in another large vessels were moved a considerable distance. These videos matched well with the recorded meteorological observations from the area.

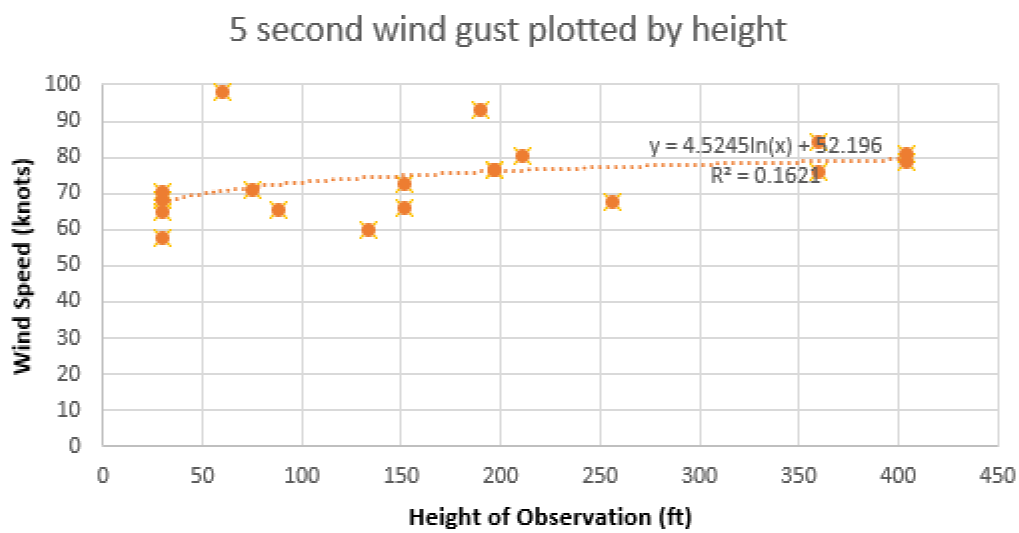
What is clear from the weather radar and the observations data is that severe thunderstorms occurred across the entire area that these observations were collected from, so generally similar conditions were likely experienced across the coastal areas and waters within about 25 miles of the accident site.

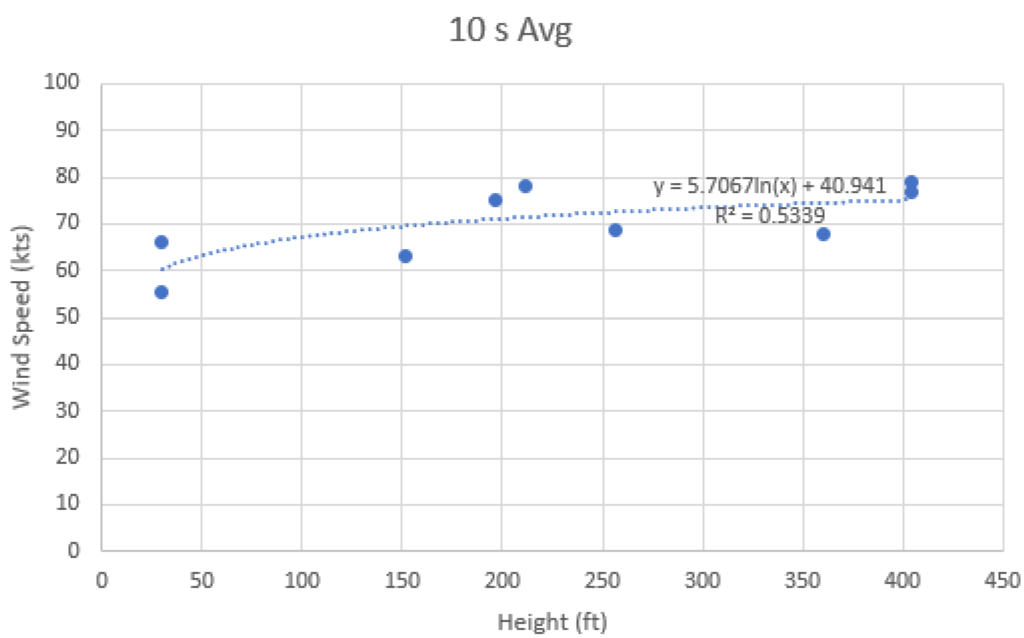
Hurricane dropsonde observations routinely collect a vertical profile of available wind speeds, and a specific relationship of wind speeds at x height correlating to wind speeds of y at 10-meters, or any desired elevation. As a result the relationship between wind speed with height in hurricanes is well established. Hurricanes however are in meso/synoptic scale gradient balance, and the wind speeds are driven by more evenly distributed pressure and density gradients. In severe thunderstorms these balances are much smaller scale and variable and no established library of observations or published studies of thunderstorm wind height variability is available.

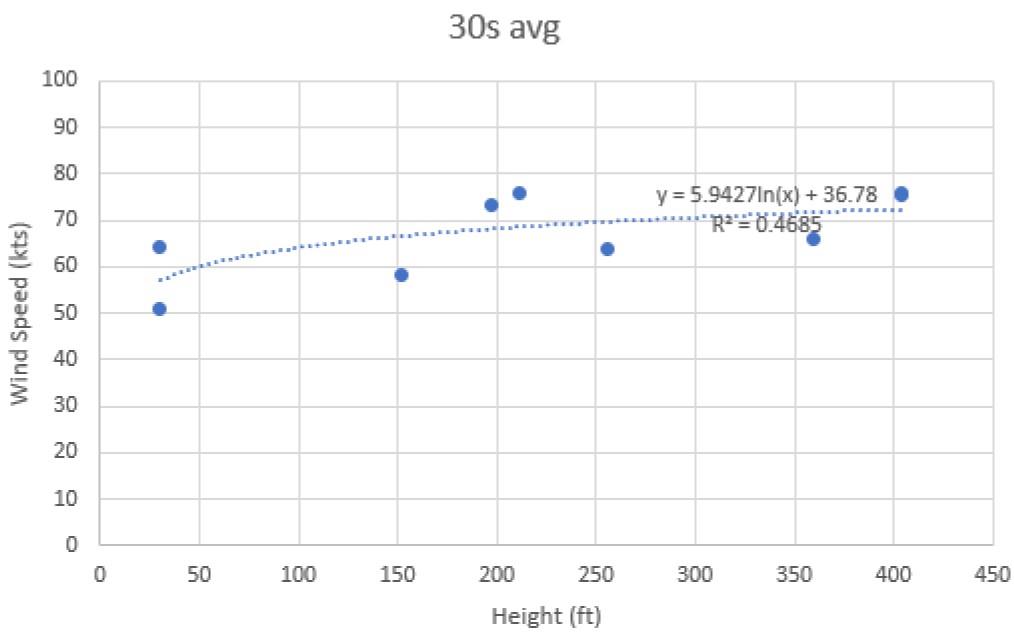
In practice to make a surface wind speed estimate from elevated doppler radar observations, NWS warning forecasters take the ground-relative velocity data from doppler radar and weigh thermodynamic and shear conditions that roughly guide how efficiently wind processes would translate to the surface. They then take the height of the radar observation, and make some, typically downward, adjustment in their surface wind estimate. The greater the height above ground level of the lowest available data, the less certain the estimate and a greater probability of minima or maxima going unnoticed. For example, 75 knot velocities assessed at 1,000 feet above ground level would yield a higher confidence of 70-80 mile-per-hour surface winds than 75 knot winds at 9,000 feet.

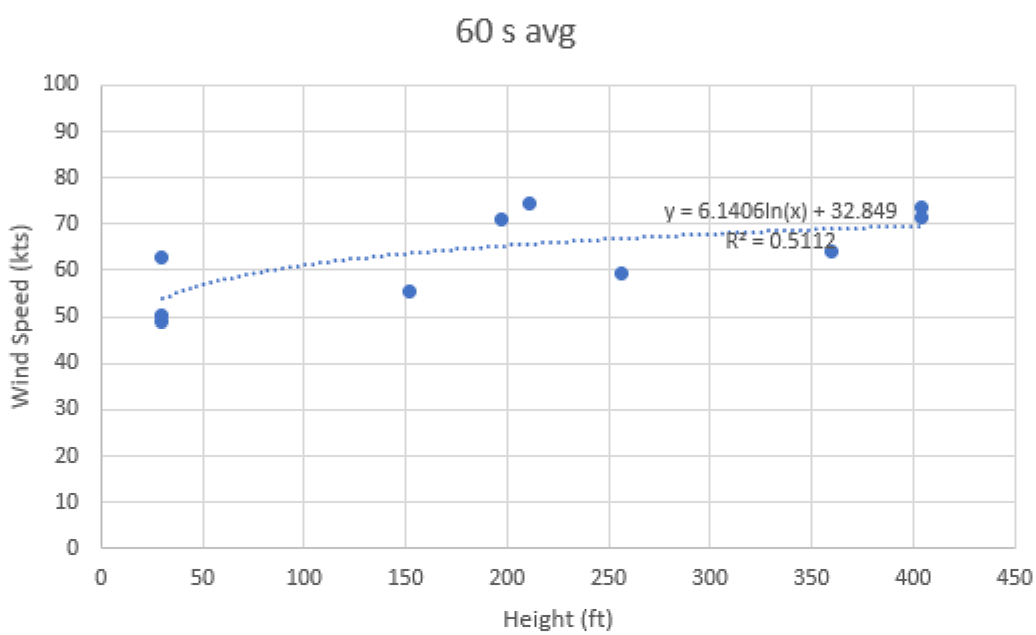
For this case, the 0.5° elevation angle from the Slidell, LA NEXRAD was typically approximately 8,500 ft AGL at the accident site. A strong subsidence inversion likely capped the top of the boundary layer at no more than 4,000 feet over the Gulf of Mexico. Super-refraction of the radar beam may have shifted the 0.5° elevation angle enough to have at least partially sampled from the top of the boundary layer, but there would have been no way for the forecaster to verify this in real time. These range and elevation issues would create considerable uncertainty in the representativeness of the observation to a ground-level wind.

Traditionally, any vertical wind profile approximation is displayed using a logarithmic relationship, with the winds reducing in magnitude most sharply closest to the surface due to friction. Over the ocean this reduction would be expected to be less than over land. The number of observations that were provided in the vicinity of this accident provides an opportunity to attempt a logarithmic fit to the data. The following plots of wind speeds, with longer averages calculated form instantaneous wind data, are the result.


5 second wind gust plotted by height
Wind Speed (knots)
Height of Observation (ft)
y = 4.5245ln(x) + 52.196
R² = 0.1621
0
10
20
30
40
50
60
70
80
90
100
0
50
100
150
200
250
300
350
400
450


10 s Avg
Wind Speed (kts)
Height (ft)
y = 5.7067ln(x) + 40.941
R² = 0.5339
0
10
20
30
40
50
60
70
80
90
100
0
50
100
150
200
250
300
350
400
450



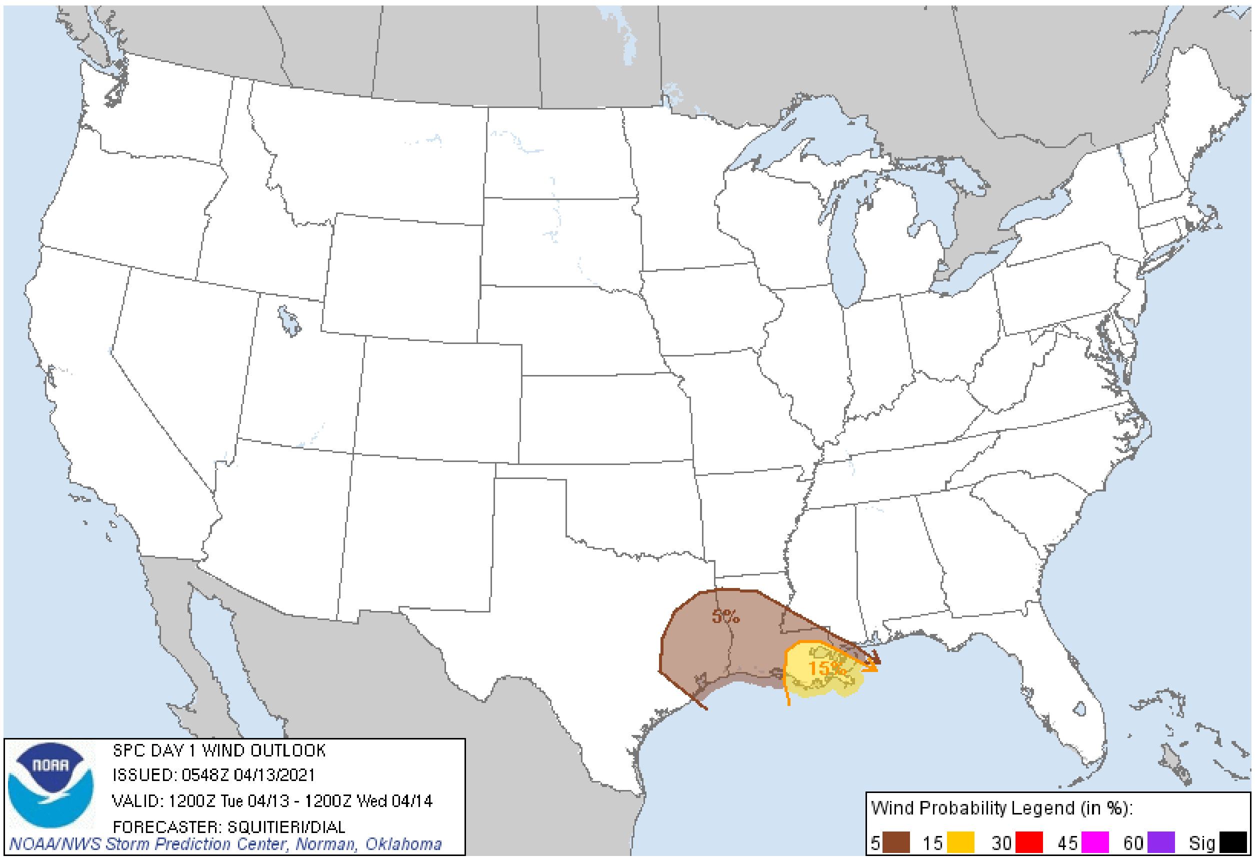


Plots of wind speed by height based averaged by duration.

The 5-second gust plot considered data inputs from the *Deepwater Asgard*, *Discoverer Inspiration*, *Louisiana*, *Vanessa*, *Rockfish* and *Christian Chouset* vessels. Land based observations from NOAA NOS Site GISL1 and the LOOP were also included. For the 10, 30 and 60-second averages, data from the *Deepwater Asgard*, *Discoverer Inspritation*, LOOP and *Louisiana* were included as they provided 1-second observations that could be averaged over that time period. The 5-second average has a lower R^2 (i.e., the data fit the linear regression more poorly) but this may be due to differences in the duration that the wind speeds were measured. They are presumed to be essentially instantaneous or 5 second obs, but the eyewitness reports were of unknown actual duration (may have been 1-second, 3-second, 5-second etc). The other durations have a reasonably good R^2 so this logarithmic relationship was accepted and applied to establish a wind/height/duration relationship for the wind speed that were provided in this assessment.

Forecast Products and Event Forecastability

The region was outlined in a slight risk of severe thunderstorms in the severe weather outlook from the Storm Prediction Center issued at 0548 UTC 13 April 2021 that identfied 15% probabilities for hail and wind.



SPC Day 1 Convective Wind Outlook for April 13, 2021.

A Severe Thunderstorm Watch was issued at 1705 UTC highlighting the risk of 1.5 inch diameter hail and scattered damaging wind gusts to 70 mph.

URGENT - IMMEDIATE BROADCAST REQUESTED
Severe Thunderstorm Watch Number 94
NWS Storm Prediction Center Norman OK
1205 PM CDT Tue Apr 13 2021

The NWS Storm Prediction Center has issued a

* Severe Thunderstorm Watch for portions of
  Southeast Louisiana
  Coastal Waters

* Effective this Tuesday afternoon and evening from 1205 PM until 600 PM CDT.

* Primary threats include...
  Scattered damaging wind gusts to 70 mph possible
  Scattered large hail events to 1.5 inches in diameter possible

SUMMARY...Clusters of elevated storms from this morning will begin to evolve into more surface-based storms this afternoon while moving southeastward with an increasing threat for occasional damaging winds across southeast Louisiana, including the New Orleans area. Otherwise, large hail will continue to be a threat with the strongest storms through the afternoon.

The severe thunderstorm watch area is approximately along and 75 statute miles east and west of a line from 40 miles northwest of New Orleans LA to 55 miles southwest of Boothville LA. For a complete depiction of the watch see the associated watch outline update (WOUS64 KWNS WOU4).

PRECAUTIONARY/PREPAREDNESS ACTIONS...

REMEMBER...A Severe Thunderstorm Watch means conditions are favorable for severe thunderstorms in and close to the watch area. Persons in these areas should be on the lookout for threatening weather conditions and listen for later statements and possible warnings. Severe thunderstorms can and occasionally do produce tornadoes.

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A Severe Thunderstorm Warning was issued for areas about 30 miles north of the accident site at 1922 UTC and highlighted the risk for two-inch diameter hail.

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BULLETIN - EAS ACTIVATION REQUESTED
Severe Thunderstorm Warning
National Weather Service New Orleans LA
222 PM CDT Tue Apr 13 2021

The National Weather Service in New Orleans has issued a

* Severe Thunderstorm Warning for...
  East central Lafourche Parish in southeastern Louisiana...
  Central Jefferson Parish in southeastern Louisiana...

* Until 300 PM CDT.

* At 222 PM CDT, a severe thunderstorm was located over Larose,
  moving east at 40 mph.

  HAZARD...Two inch hail.

  SOURCE...Radar indicated.

  IMPACT...People and animals outdoors will be injured. Expect
           damage to roofs, siding, windows, and vehicles.

* Locations impacted include...
  Larose, Cut Off, Jean Lafitte, Lafitte and Barataria.

PRECAUTIONARY/PREPAREDNESS ACTIONS...

Prepare immediately for large hail and deadly cloud to ground
lightning. Seek shelter inside a well-built structure. Stay away from
windows.

To report severe weather, contact your nearest law enforcement
agency. They will send your report to the National Weather Service
office in New Orleans.

Torrential rainfall is occurring with this storm, and may lead to
flash flooding. Do not drive your vehicle through flooded roadways.

&&

LAT...LON 2949 9042 2960 9046 2975 9009 2952 9000
      2952 9001
TIME...MOT...LOC 1922Z 254DEG 35KT 2956 9037

HAIL...2.00IN
WIND...<50MPH

$$
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Ahead of this storm, a Special Marine Warning was issued for areas about 20 miles northeast of the accident site at 1927 UTC.

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BULLETIN - IMMEDIATE BROADCAST REQUESTED
Special Marine Warning
National Weather Service New Orleans LA
227 PM CDT Tue Apr 13 2021

The National Weather Service in New Orleans has issued a

* Special Marine Warning for...
  Breton Sound...
  Coastal waters from the Southwest Pass of the Mississippi River to
  Port Fourchon Louisiana out 20 NM...

* Until 330 PM CDT.

* At 226 PM CDT, a severe thunderstorm was located 9 nm northwest of
  Barataria Bay, moving east at 15 knots.

  HAZARD...Wind gusts 34 knots or greater and large hail.

  SOURCE...Radar.

  IMPACT...Expect wind gusts in excess of 34 knots and suddenly
           higher waves. Boats could sustain damage or capsize. Make
           sure all on board are wearing life jackets. Return to
           safe harbor if possible. Large hail could result in
           injury and damage to boats...vessels and oil rigs.

* Locations impacted include...
  Barataria Bay.

PRECAUTIONARY/PREPAREDNESS ACTIONS...

Boaters should seek safe harbor immediately until this storm passes.
Wind gusts 34 knots or greater, large hail, high waves, dangerous
lightning, and heavy rain are possible with this storm.

Report severe weather to the Coast Guard or the National Weather
Service.

&&

LAT...LON 2956 8965 2934 8984 2933 8984 2937 8975
      2942 8974 2936 8975 2930 8967 2935 9010
      2936 9010 2936 9004 2944 8998 2953 9000
      2954 8998 2952 8998 2954 8997 2946 8998
      2951 8992 2945 8987
TIME...MOT...LOC 1926Z 274DEG 16KT 2945 9008

HAIL...>.75IN
WIND...>34KTS

$$
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As the storms formed into a robust line a larger Special Marine Warning that included the accident site was issued at 1957 UTC.

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701
WHUS54 KLIX 131957
SMWLIX
GMZ550-552-572-132100-
/O.NEW.KLIX.MA.W.0094.210413T1957Z-210413T2100Z/

BULLETIN - IMMEDIATE BROADCAST REQUESTED
Special Marine Warning
National Weather Service New Orleans LA
257 PM CDT Tue Apr 13 2021

The National Weather Service in New Orleans has issued a

* Special Marine Warning for...
  Coastal Waters from Port Fourchon LA to Lower Atchafalaya River LA
  out 20 nm...
  Coastal waters from Southwest Pass of the Mississippi River to Port
  Fourchon Louisiana from 20 to 60 NM...
  Coastal waters from the Southwest Pass of the Mississippi River to
  Port Fourchon Louisiana out 20 NM...

* Until 400 PM CDT.

* At 256 PM CDT, severe thunderstorms were located along a line
  extending from 10 nm east of Barataria Bay to near Point Au Fer
  Island, moving southeast at 25 knots.

  HAZARD...Wind gusts 34 knots or greater and large hail.

  SOURCE...Radar.

  IMPACT...Expect wind gusts in excess of 34 knots and suddenly
           higher waves. Boats could sustain damage or capsize. Make
           sure all on board are wearing life jackets. Return to
           safe harbor if possible. Large hail could result in
           injury and damage to boats...vessels and oil rigs.

* Locations impacted include...
  Caillou Bay, Terrebonne Bay, Grand Isle, Timbalier Island,
  Timbalier Bay, Barataria Bay, Isle Derniers and Louisiana Offshore
  Oil Port.

PRECAUTIONARY/PREPAREDNESS ACTIONS...

Boaters should seek safe harbor immediately until these storms pass.
Wind gusts 34 knots or greater, large hail, high waves, dangerous
lightning, and heavy rain are possible with these storms.

Report severe weather to the Coast Guard or the National Weather
Service.

&&
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Both Special Marine Warnings highlighted “severe thunderstorms” capable of producing wind gusts of 34 knots or greater and large hail. The Houma, LA airport (KHUM) reported a gust to 45 knots (10 meter, 5-second gust) at 1903 UTC. The south Lafourche Leonard Miller Jr. Airport (KGAO) reported a wind gust of 40 knots (10 meter, 5-second gust) at 1955 UTC. Thunderstorm intensity along the developing line increased very rapidly and the warning provided may have been about as timely as possible. Through 2012 UTC the intensity further increased markedly.

There were significant data quality issues in the velocity data from KLIX, and the TMSY terminal radar was at the very edge of its range when the thunderstorms became more intense and wind speeds presumably began increasing markedly. It would have been difficult, if not outright impossible to have accurately assessed the true peak wind threat of 80 knot (10 meter, 5-second gusts) that the vessel would have ultimately experienced given the radar data quality and height and range limitations. It is possible that manipulation of the 88D pulse repetition frequency (PRF) may have mitigated this some, but the center of the 0.5° beam at the accident site was 8,800 feet AGL so there was still going to be significant uncertainty towards ground level conditions.

Close mesoanalysis may have revealed the strong pressure gradient that had developed across the region, but a lack of sea level pressure observations, particularly right along the Gulf coast, would have made understanding the intensity (over gale force) and duration (at least 3-4 hours) nearly impossible to recognize in real time, let alone forecast prior to the event. This type of convectively driven pressure perturbation/gravity event occurs with some regularity along the Gulf coast, and more dense pressure sensors might have made it possible to detect/react more quickly when they occur. Currently, forecasters may only see an increase in wind speed that is difficult to explain without the resulting sea level pressure data.

From the perspective of mariners this storm would presumably have felt more like the second half of a strong tropical storm – with the initial core/eye conditions of the thunderstorm complex followed by persistent near-tropical storm force winds for several hours. The meteorological situation was anomalous and complex. Even assuming some degree of clairvoyance to the situation there is no NWS product that was designed to prepare users for sudden 70-80 knot wind gusts followed by hours of gale force winds. The Special Marine Warning product is the correct product for this situation, but its issuance threshold (34 knot, 10 meter, 5-second gust) means that several hundred are issued by coastal offices each year which could lead to a degree of complacency amongst mariners, particularly of larger vessels that would not be negatively impacted by lower wind speeds and might not seek the text of the warning where enhanced wording of 50+ knot wind speeds would appear Special Marine Warnings are also issued for 10-meter 5-second gust thresholds, and the height of rigs and vessels off the Louisiana coast might present vulnerabilities not accounted for by this threshold.

Recommendations/Takeaways

From the observational and historic data, this was an unusually intense thunderstorm wind event for the region, outside of tropical cyclones, which typically come with much longer lead-time and preparation/evacuation. Winds of these intensities appear to at least be around a 1 in 20-year recurrence interval. An unusual combination of meteorological conditions combined in complex ways to result in the final intensities observed. Real-time detection of the true magnitude of this event would have been made essentially impossible by a lack of real-time observations that were applicable to the situation.

Here are the items that I find worthy of consideration to improved outcomes in the future:

1) Lower minimum elevation angle to the Slidell, LA NEXRAD, which is coming as part of a move of the radar to Hammond, LA would give better low-level velocity assessments over this portion of the Gulf that is heavily populated by offshore oil platforms.

2) Special Marine Warnings are currently for 34 knot (10-meter, 5-second wind gusts). This region and much of the northern Gulf of Mexico has unique vulnerability of vessels that reach much higher than 10 meters. Documentation of important wind thresholds for large vessels and Gulf structures, and the incorporation of that into Special Marine Warning templates may prove useful. Additional forecaster training on assessing high winds over marine areas and responding within Special Marine Warnings may also be helpful.

3) Thunderstorm wind differences with height and the relationship of doppler winds at higher elevations are not well established in the literature, and an effort to do so would likely prove beneficial for multiple applications of the NWS warning program.