Forensic meteorological investigation of hail and high winds in Longwood, FL during Hurricane Irma (9 – 12 September 2017), on 03/20/2018, and during the period 10/01/2019 to 03/12/2020

PREPARED ON: 2 – 3 April 2020
PREPARED FOR: [redacted]
AFFILIATION: [redacted]
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INCIDENT DATES: 9 – 11 September 2017
20 March 2018
10/01/2019 to 03/12/2020
CLAIM: [redacted]
INCIDENT LOCATION: [redacted]

SUMMARY:
Blue Skies Meteorological Services was retained to investigate potentially damaging wind and hail events at [redacted] during Hurricane Irma (9 – 12 September 2017), on 03/20/2018, and during the period 10/01/2019 to 03/12/2020.

Specifically, Blue Skies assessed in-situ wind observations, storm reports, post-storm impact and damage surveys, National Weather Service warnings, and weather radar data to determine whether hail likely impacted the insured property and to estimate the maximum wind speeds likely experienced at the insured property during the period of interest.

CONCLUSIONS:

- ***Hurricane Irma:*** *wind gusts of 75 – 80 mph likely; hail not indicated*
- ***20 March 2018:*** *hail and/or damaging winds not indicated*
- ***10/01/2019 – 03/12/2020:*** *hail up to 0.5" diameter and wind gusts up to 60 mph possible*

DATA

The use of high-quality, reliable data is crucial to ensure the accuracy of forensic meteorological analyses. In the performance of our meteorological investigations and in accordance with industry best practices, Blue Skies Meteorological Services utilizes only quality-controlled data from trusted, official sources that specialize in the collection, quality control, and analysis of meteorological, climatological, and hydrological data for research and operational purposes. Much of the data from the National Oceanic and Atmospheric Administration (NOAA) that was obtained and reviewed for this report can be certified by the Department of Commerce, if necessary.

The following data were reviewed and analyzed during this forensic meteorological investigation. The conclusions drawn in this report are based upon the data that were available at the time of report preparation. Any new, updated, or revised data relevant to these incidents may be incorporated in a later revision of this report.

Storm Event Reports

- Sources:
  1. National Weather Service (NWS) Forecast Office in Jacksonville, FL (JAX)
  2. NWS Forecast Office in Melbourne, FL (MLB)
  3. NWS Forecast Office in Tallahassee, FL (TAE)
  4. The National Oceanic and Atmospheric Administration (NOAA): NWS
- Products:
  1. "Post Tropical Cyclone Report… Hurricane Irma". 22 September 2017.
  2. "Hurricane Irma Post Storm Summary, September 10-11, 2017"
  3. "Detailed Meteorological Summary on Hurricane Irma"
  4. Local Storm Reports for the NWS Forecast Office in Melbourne, FL (KMLB)

In-Situ Wind Observations

- Source: National Oceanic and Atmospheric Administration (NOAA), National Centers for Environmental Information (NCEI)
- Product: Quality Controlled Local Climatological Data (QCLCD) for stations in central Florida, including the Orlando metropolitan area

Radar

- Source: The National Oceanic and Atmospheric Administration (NOAA): National Climatic Data Center (NCDC): Radar Data
- Products:
  1. KMLB (Melbourne, FL): Level II and Level III radar products
  2. NEXRAD National Reflectivity Mosaic

Weather Advisories and Warning Statements

- Source: National Weather Service: Archived NWS Bulletins and Text Products
- Products: Severe weather warnings for NWS Forecast Office KMLB (Melbourne, FL)

ANALYSIS: HURRICANE IRMA

Discussion

The tropical cyclone that was to become Hurricane Irma formed near the Cape Verde Islands on 30 August 2017. Irma intensified rapidly to a category-3 storm (sustained winds of 115 mph) over the next 30 hours. Warm Atlantic ocean waters, a moist atmosphere, and minimal wind sheer allowed Irma to intensify further to a category-5 storms, with maximum sustained winds of 185 mph. Category-5 storms are rare, especially in the open Atlantic, and Irma maintained that strength for 3 days as it passed the northern Leeward Islands, Virgin Islands, and Hispaniola.

As Irma skirted along the northern coast of Cuba, it weakened slightly to category-3 strength; however, as the storm made an expected right-hand turn toward the north over the warm waters of the Florida Straights, it regained category-4 strength before directly impacting the Florida Keys.

As Irma continued its northward track, it began to encounter unfavorable wind shear and dry air, causing the storm to weaken to category-3 strength before making landfall near Marco Island in southwest Florida around 3 pm EDT on September 10th. Sustained winds at the time of landfall were 115 mph, although gusts above 140 mph were reported in the Naples area.

Irma's wind field was quite large, with hurricane force winds extending outward up to 80 miles from the center of the storm and tropical storm force winds extending outward up to 400 miles. Hurricane-force wind gusts were reported throughout much of central Florida, including in the Orlando metropolitan area.

Hurricane Irma also produced heavy rains, especially in those areas impacted by the northern and eastern quadrants of the storm. The east-central Florida coast saw widespread rainfall totals above 8", with several areas experiencing storm-total rainfall of 12" to above 15". The Jacksonville, FL, area was also hard hit, with rainfall exceeding 14" in places and onshore winds that brought flooding to low-lying areas along the St. Johns River.

Impacts at the Loss Location

Straight-Line Wind

Wind data included in this analysis are daily, hourly, and sub-hourly observations accessed through the National Centers for Environmental Information (NCEI) Quality Controlled Local Climatological Data (QCLCD) database, maintained by the National Oceanic and Atmospheric Administration (NOAA). Weather stations included in this database adhere to specified standards for data collection. All wind data is collected from an anemometer height of 10 meters (approximately 33 feet), and wind gusts are the maximum wind speed observed over a 5-second period.

During Hurricane Irma's impact, from 9-12 September 2017, the highest recorded wind gusts at the QCLCD weather stations nearest the loss location ranged from 74 mph at

Sanford International Airport to 78 mph at Orlando Executive Airport. Peak wind gusts during Hurricane Irma are displayed in Figure 1, below.

The insured property likely experienced maximum straight-line wind speeds within this range (75 - 80 mph), consistent with the observations at nearby weather reporting stations that experienced a similar intensity of storm impact.

Tornadoes and Hail

No tornadoes were reported within 10 miles of the loss location during Hurricane Irma. Hail is not indicated during Hurricane Irma.

Documentation and Figures

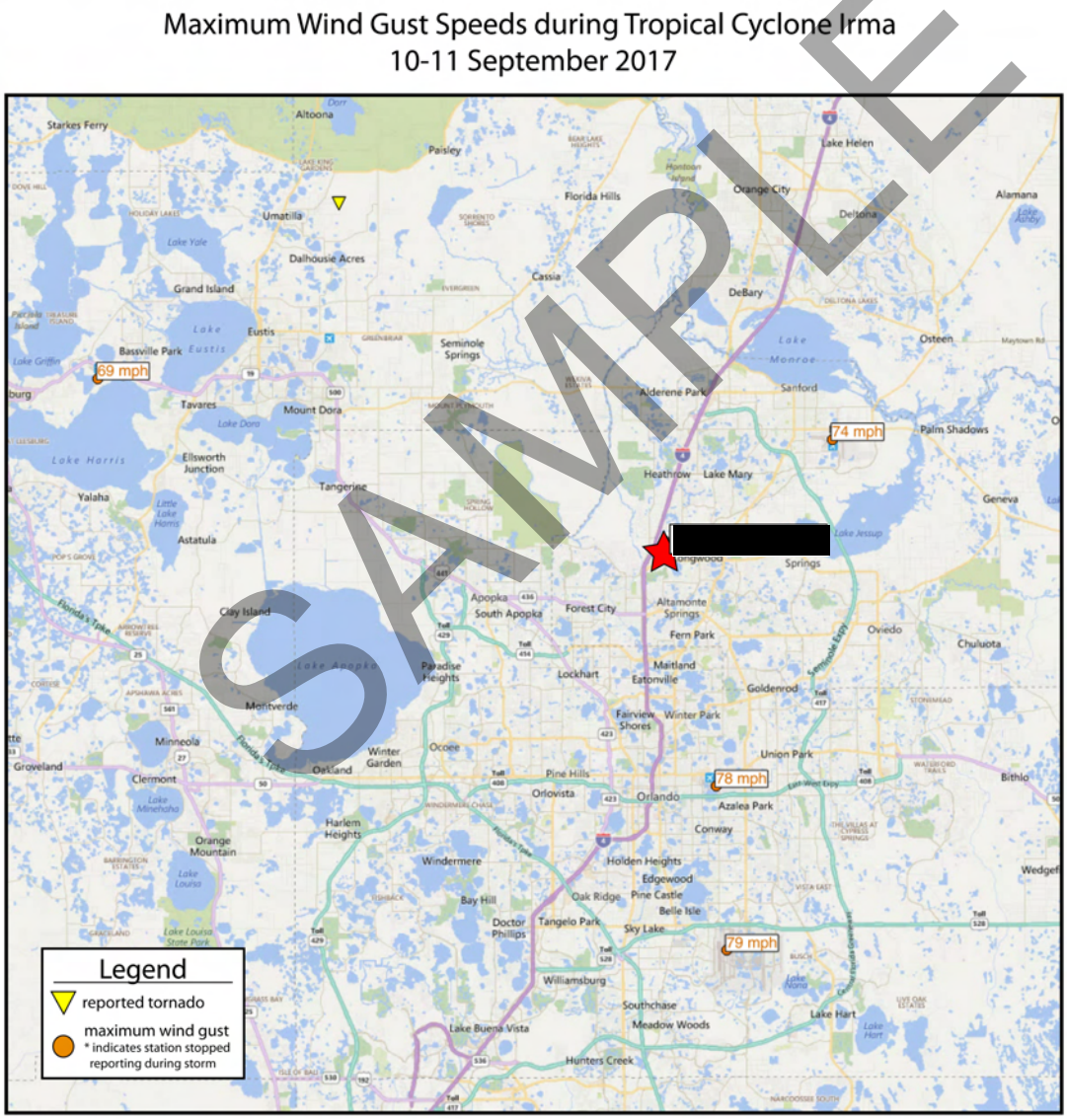

Figure 1: Hurricane Irma peak wind gusts across central Florida. QCLCD weather reporting stations are marked with orange circles, and the maximum wind gust recorded at each station during the storm is labeled in orange text. The loss location is marked with a red star.

ANALYSIS: 20 March 2018

Discussion

Numerous reports of large hail were received across the Orlando metropolitan area in association with two separate severe thunderstorms on 03/20/2018. Both of these severe thunderstorms remained well south of and did not directly impact the loss location on [redacted] in Longwood.

Figure 2, below, shows the progression of these severe thunderstorms across the greater Orlando metropolitan area, with storm motion toward the east-northeast indicated by the red arrows. The top row shows radar base reflectivity (left panel) and digital vertically integrated liquid (right panel) at 1339 EST as the first severe thunderstorm was producing large hail in northeastern Orlando, south of the insured property.

Base reflectivity is a measure of the amount of radar energy reflected back to the radar by precipitation particles; high reflectivity values are associated with heavy rain and/or hail. In Figure 2, base reflectivity data are shown from the lowest available radar elevation angle, which samples the atmosphere at a height of 4,700 ft AGL over Longwood. Vertically integrated liquid (VIL) is a measure of the amount of precipitation within an entire column of air (from near the surface to near the top of the thunderstorm), with higher VIL associated with more intense precipitation; the presence of hail increases VIL. VIL is also useful for locating the vertical cores of thunderstorms.

The middle row shows the same two radar products 20 minutes later, at 1359 EST, as the first severe thunderstorm was impacting the Oviedo area northeast of Orlando while the second severe thunderstorm intensified over southwestern Orlando. This second thunderstorm moved east-northeastward and by 1413 (bottom row), was due south of the insured property.

Impacts at the Loss Location

None of the severe thunderstorm warnings issued by the National Weather Service (NWS) forecast office in Melbourne, FL on 03/20/2018 included the property on [redacted] in Longwood, suggesting the NWS meteorologists monitoring this storm event did not expect damaging weather to impact the insured property.

Further, radar data do not indicate hail near the insured property. No wind-related damage or strong wind gusts (greater than 40 mph) were reported in the Orlando metropolitan area on this date, nor do radar data indicate potentially damaging winds at the insured property on this date.

Damaging winds and hail are not indicated at the insured property on 03/20/2018.

Documentation and Figures

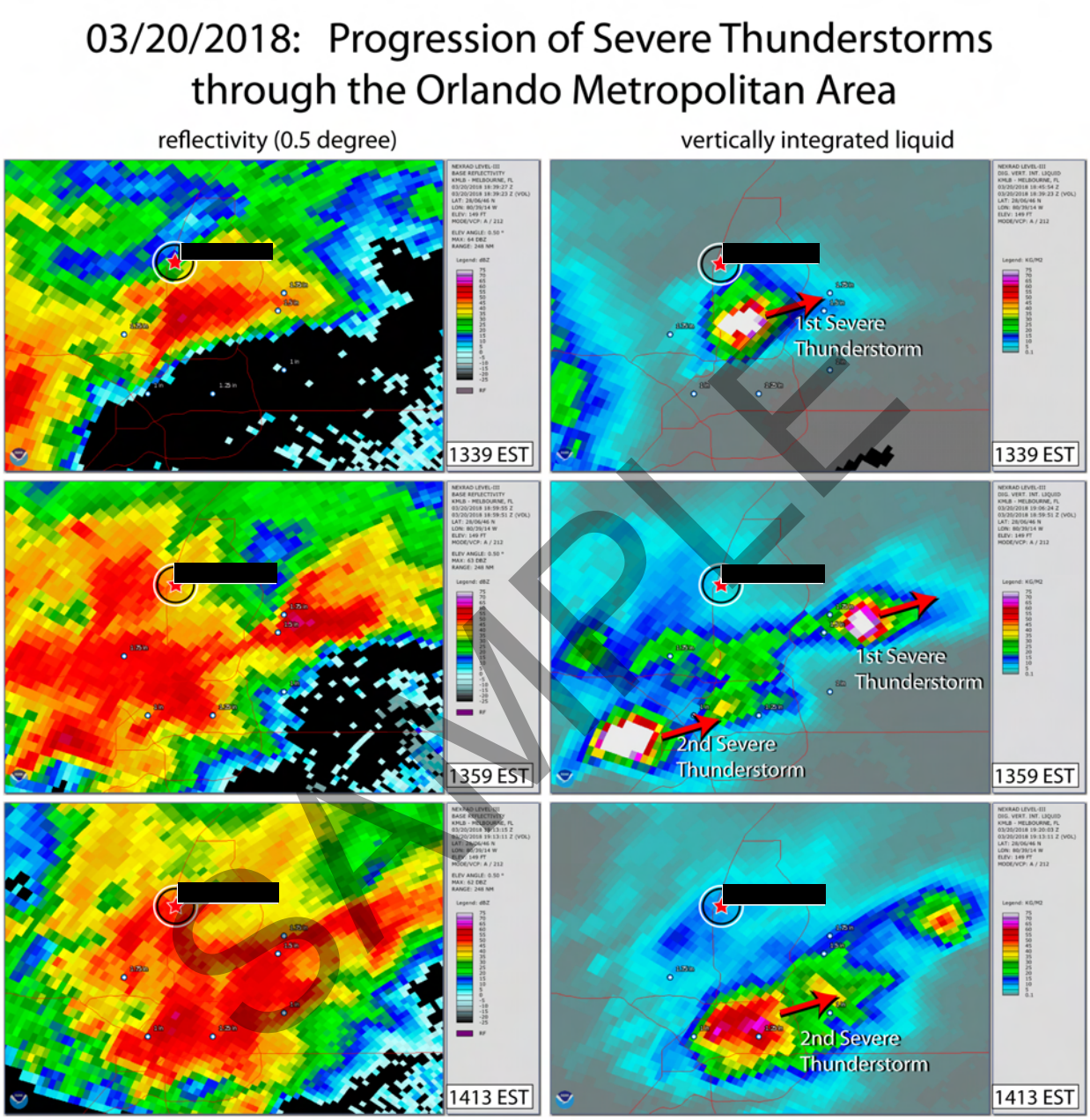

Figure 2: Progression of the two severe thunderstorms that impacted the Orlando metropolitan area on 03/20/2018. Top row: 1339 EST (1839 UTC) volume scan. Middle row: 1359 EST volume scan. Bottom row: 1413 EST volume scan. In all rows, base reflectivity is displayed on the left and digital vertically integrated liquid is displayed on the right on the right. Locations of hail and strong wind reports on this date are marked with white dots and labeled with the reported magnitude. The loss location is marked with a red star within a black and white circle. The two severe thunderstorms that impacted the Orlando metropolitan area on 03/20/2018 remained well south of the insured property in Kissimmee. Source: NWS KMLB WSR-88D level 3 data.

ANALYSIS: 10/01/2019 – 03/20/2020

Methodology

An initial inventory of potential hail events was performed via survey of the NEXRAD Hail Index derived radar product, centered over the loss location.

The hail index (HI) product estimates the likelihood that a storm is producing hail aloft as well as estimates the maximum size of that hail via evaluation of storm structure and intensity from radar reflectivity data. It does not incorporate dual-polarization variables or other derived level III radar products that have been shown to correlate well with the presence of hail, and HI is therefore used only as a first-pass to identify *potential* hailstorms that impacted the loss location.

To refine the list of potential hail events, the dates on which HI suggested hail aloft were compared with official National Weather Service (NWS) hail reports in Seminole and surrounding counties as well as with NWS warnings for severe thunderstorms or tornadoes and NEXRAD reflectivity data. The NWS issues severe thunderstorm and tornado warnings when damaging weather is occurring or is indicated by radar to be immanent.

Potential high-wind events were identified and assessed using a similar methodology that included evaluation of wind gust reports, wind damage reports, and NWS severe weather warnings.

A date was assessed for hail potential if it met any of the following criteria:

- The hail index (HI) radar product indicated a moderate to high probability of hail 1.0" or greater diameter aloft in proximity to the insured property (~5 mi radius)
- A NWS severe thunderstorm warning for hail or tornado warning was in effect for the insured property
- Hail was reported within 10 miles of the insured property

A date was assessed for damaging wind potential if it met any of the following criteria:

- A National Weather Service severe weather warning was in effect for the loss location
- A strong wind gust (greater than 50 mph) was reported within 15 miles of the loss location
- Wind damage was reported within 15 miles of the loss location

In total, two dates met one or more of the above criteria and comprise the Dates of Interest described in Table 1, below. Those dates are also described in detail below.

On neither of these dates did the weather data indicate severe hail (hail 1" diameter or greater) or wind gusts over 60 mph in the immediate vicinity of the insured property.

The findings of this initial analysis are detailed in Table 1: Dates of Interest, while National Weather Service reports of hail, strong wind gusts, and wind damage are listed in Table 2. Due to the size of both tables, they are also provided digitally in a format more easily read. Figure 3 shows the locations of hail, strong wind gusts, and wind damage reports nearest the insured property during this time period.

12/17/2019: *Sub-severe hail up to 0.5" diameter possible*

A severe thunderstorm intensified over Lake Apopka and moved northeastward. 0.5" - 0.7" hail was reported near Apopka (see Figure 4). The storm weakened as it approached Longwood, and the hail threat was downgraded to penny size (0.75") prior to the storm impacting the loss location. The core of this storm passed near and south of the insured property.

The radar presentation of the storm suggests it was not capable of producing large hail as it impacted the loss location, and no additional hail was reported. However, small, sub-severe hail cannot be completely ruled out, as dual-polarization data indicate a slight reduction in correlation coefficient values within the core of the storm as it passed near and south of the insured property (see Figure 5). Sub-severe hail of this size is not typically associated with substantial property damage.

02/06/2020: *Wind gusts up to 40 - 50 mph likely; wind gusts up to 60 mph possible*

A squall line of strong-to-severe thunderstorms moved rapidly eastward across the entire Florida peninsula, impacting the Orlando metropolitan area beginning just before midnight on 02/06/2020. This squall line directly impacted the insured property. Wind gusts of 40 - 48 mph were reported in the Orlando metropolitan area during passage of this line of storms; scattered tree and sign damage was also reported. Radar data suggest winds near the loss location were likely similar to those reported elsewhere in the vicinity. The extent and nature of the damage reported (i.e. tree but no structural damage) suggests that winds likely remained below 60 mph during this event. Figure 6 shows this squall line as it approached (top row), impacted (center row), and moved away from (bottom row) the loss location.

Documentation and Figures

Dates of Interest - Longwood, FL - 10/01/2019 - 03/12/2020

Date (EST)	Hail Index (HI)			Hail Reports					Wind Reports					NWS Bulletins		Radar Notes - National Reflectivity Mosaic	Impacts at the Loss Location
	max size	time (EST)	notes	county	time (EST)	size	nearest hail report to loss location	possibly same event as HI?	county	time (EST)	size	nearest wind report to loss location	warning	hazards	Composite Reflectivity (CR) and Base Reflectivity (BR, when available)	Impacts based on in-situ observations, storm reports, NWS bulletins, radar reflectivity, dual-polarization radar (if explicitly noted)
12/17/19	1.5"	1530 - 1545 EST	Hail signatures in W-to-E line 2 - 3 mi SW of the loss location, with additional signatures scattered to the E of the insured property.	Orange	1526 EST	0.70"	8.2 mi (0.7")	yes	Seminole	1540 EST	wind gust: none wind dmg: stop signs & tree limbs down	wind gust: N/A wind dmg: 4.0 mi (stop signs & tree limbs down)	1456 EST - svr tstorm	60 mph wind gusts & quarter size hail; downgraded to penny size hail at 1547 EST	A severe thunderstorm intensified over Lake Apopka and moved northeastward. 0.5" - 0.7" hail was reported near Apopka. The storm weakened as it approached Longwood, and the hail threat was downgraded to penny size (0.75") prior to the storm impacting the loss location. The core of this storm passed near and south of the insured property. No additional hail was reported.	Sub-severe hail up to 0.5" diameter possible
2/6/20			none	none				N/A	Orange, Seminole, Lake	1430 - 0031 EST	wind gust: 40 - 48 mph wind dmg: trees & power lines down	wind gust: 5.1 mi (48 mph) wind dmg: 11.4 mi (tree & power lines down)	1118 EST - svr tstorm	70 mph wind gusts	A squall line of severe thunderstorms moved rapidly eastward across nearly the entire Florida peninsula. This line impacted the Orlando metropolitan area, including Longwood, around midnight on 02/06/2020 - 02/07/2020. Wind gusts of 40 - 50 mph were reported in the Orlando metro area during passage of this line of storms. No structural wind damage was reported, suggesting that wind gusts across the area were likely similar to the sub-severe 40 - 50 mph gusts reported by ASOS/AWOS stations.	Wind gusts up to 40-50 mph likely; wind gusts up to 60 mph possible

Table 1: Dates of Interest for the property at [redacted] during the period 10/01/2019 – 03/12/2020. Note: this table has also been provided as a digital supplement to the report, which is more easily read than the above version that has been sized to fit on a standard printed page.

Table 2 provided digitally only - table is too large to fit on a standard printed page

Table 2: National Weather Service (NWS) Local Storm Reports of hail, wind damage, and strong wind gusts from the Melbourne, FL (KMLB) weather forecasting office within 30 miles of the loss location during the period of interest (10/01/2019 – 03/12/2020).

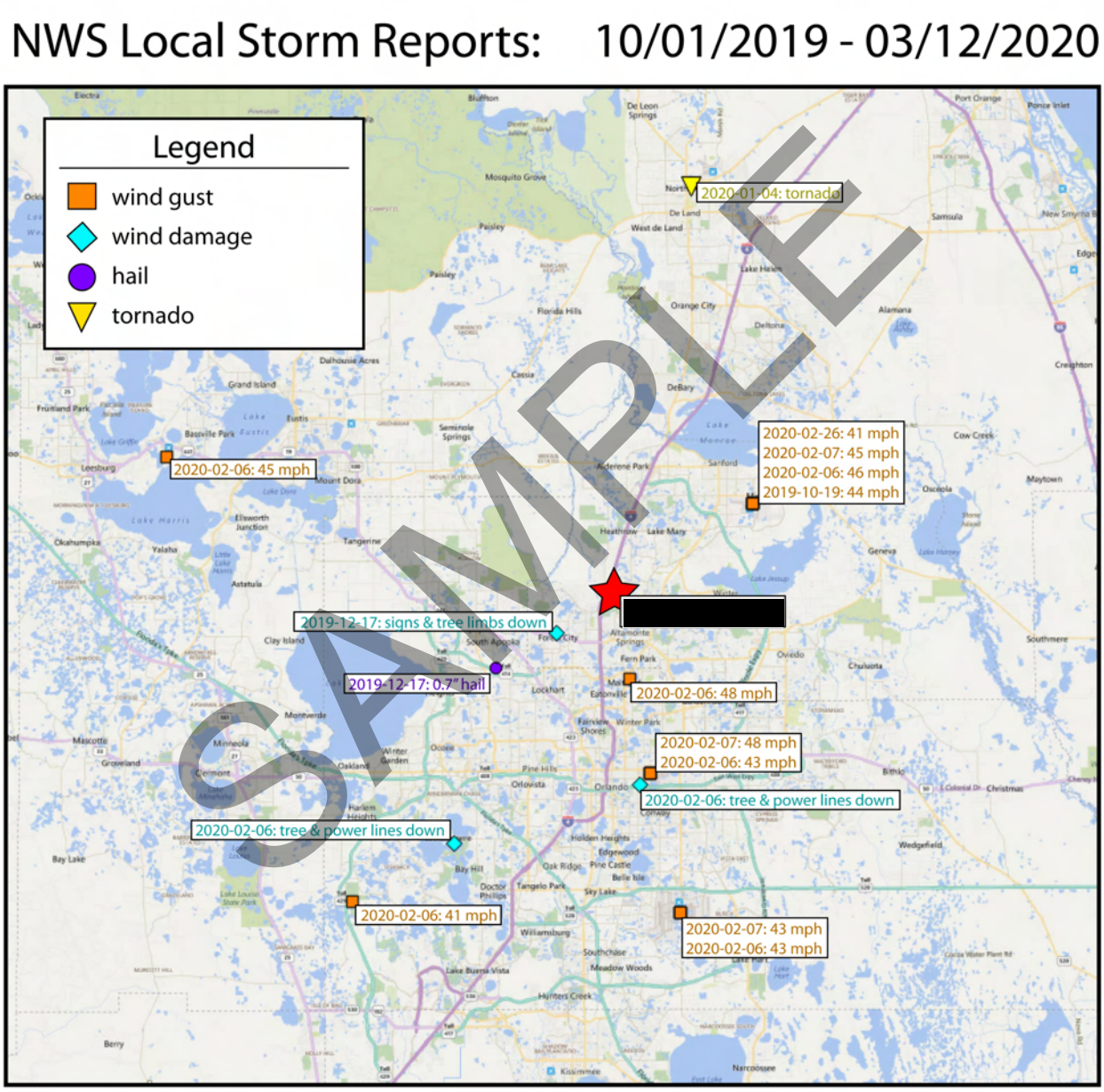

Figure 3: National Weather Service (NWS) Local Storm Reports of hail, strong wind gusts, wind damage, and tornadoes from the Melbourne, FL (KMLB) weather forecasting office during the period of interest (10/01/2019 – 03/12/2020). Additional details about the storm reports nearest the loss location are provided in Table 2.

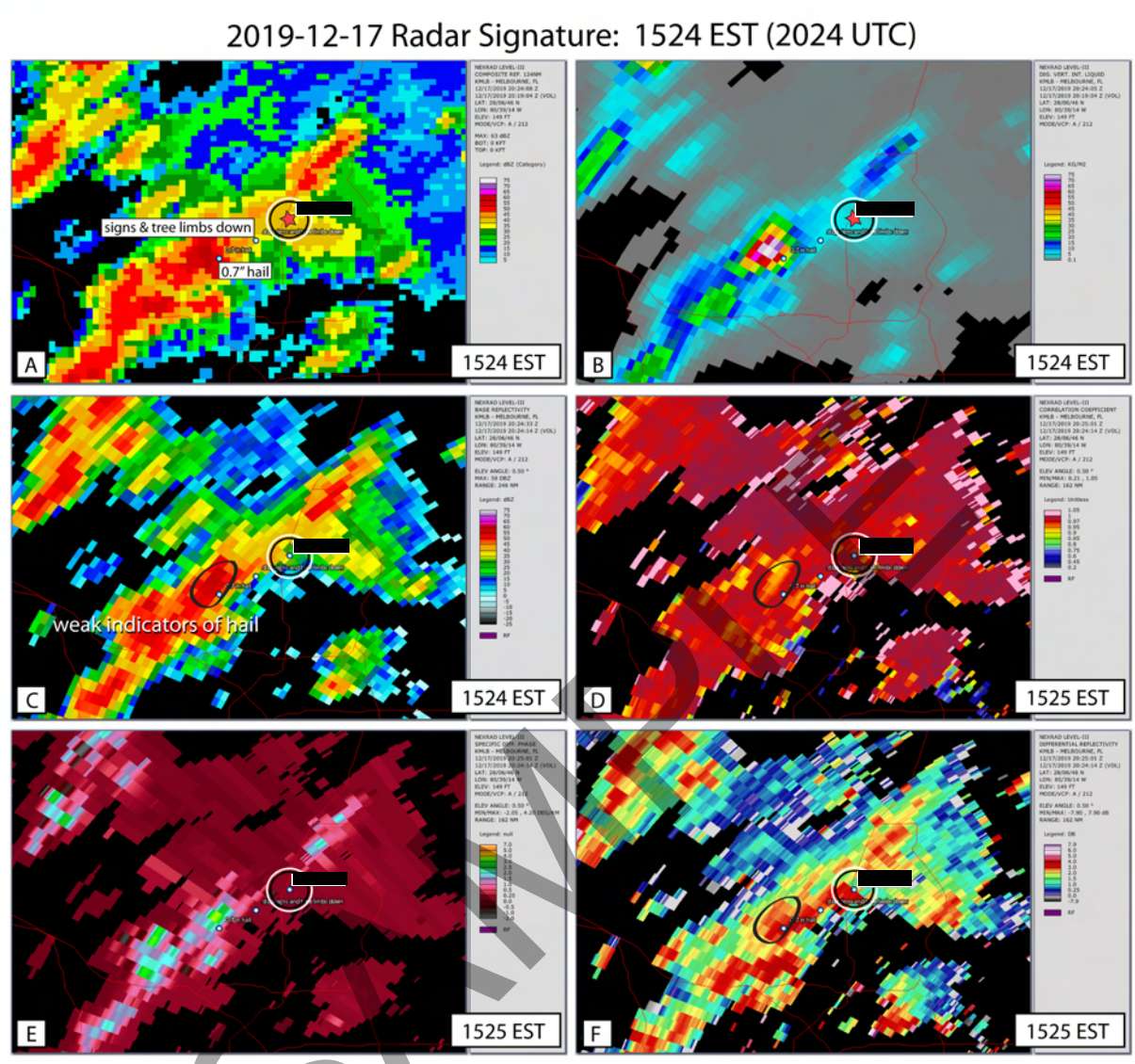

Figure 4: 6-panel radar hail signature for 2019-12-17 at 1524 EST as the severe thunderstorm was moving northeastward and impacting an area southwest of the insured property. The loss location is indicated by a white dot within a black and white circle. Storm reports associated with passage of this storm are marked by white dots and labeled with the reported magnitude. The region in which dual-polarization radar data suggest hail aloft is circled in black. A) composite reflectivity – shows the highest reflectivity from all available elevation angles and thereby indicates regions of intense precipitation within a storm. B) digital vertically integrated liquid – a measure of the amount of precipitation within a column of air, with higher VIL associated with more intense precipitation; the presence of hail increases VIL. C) base reflectivity – a measure of the power returned to the radar, with higher reflectivity values associated with more intense precipitation; the presence of hail typically increases reflectivity. D) correlation coefficient – a dual-polarization radar variable; lowered correlation coefficient values coincident with lowered differential reflectivity (F) and high reflectivity (C) are associated with the presence of hail. E) specific differential phase – a dual-polarization variable that indicates the amount of liquid water present within a sampled volume. F) differential reflectivity – a dual-polarization variable that indicates how symmetrical sampled hydrometeors are about the horizontal and vertical axes; lowered differential reflectivity values in the presence of lowered correlation coefficient (D) and high reflectivity (C) are associated with the presence of hail. Source: KMLB level 3 dual-polarization data.

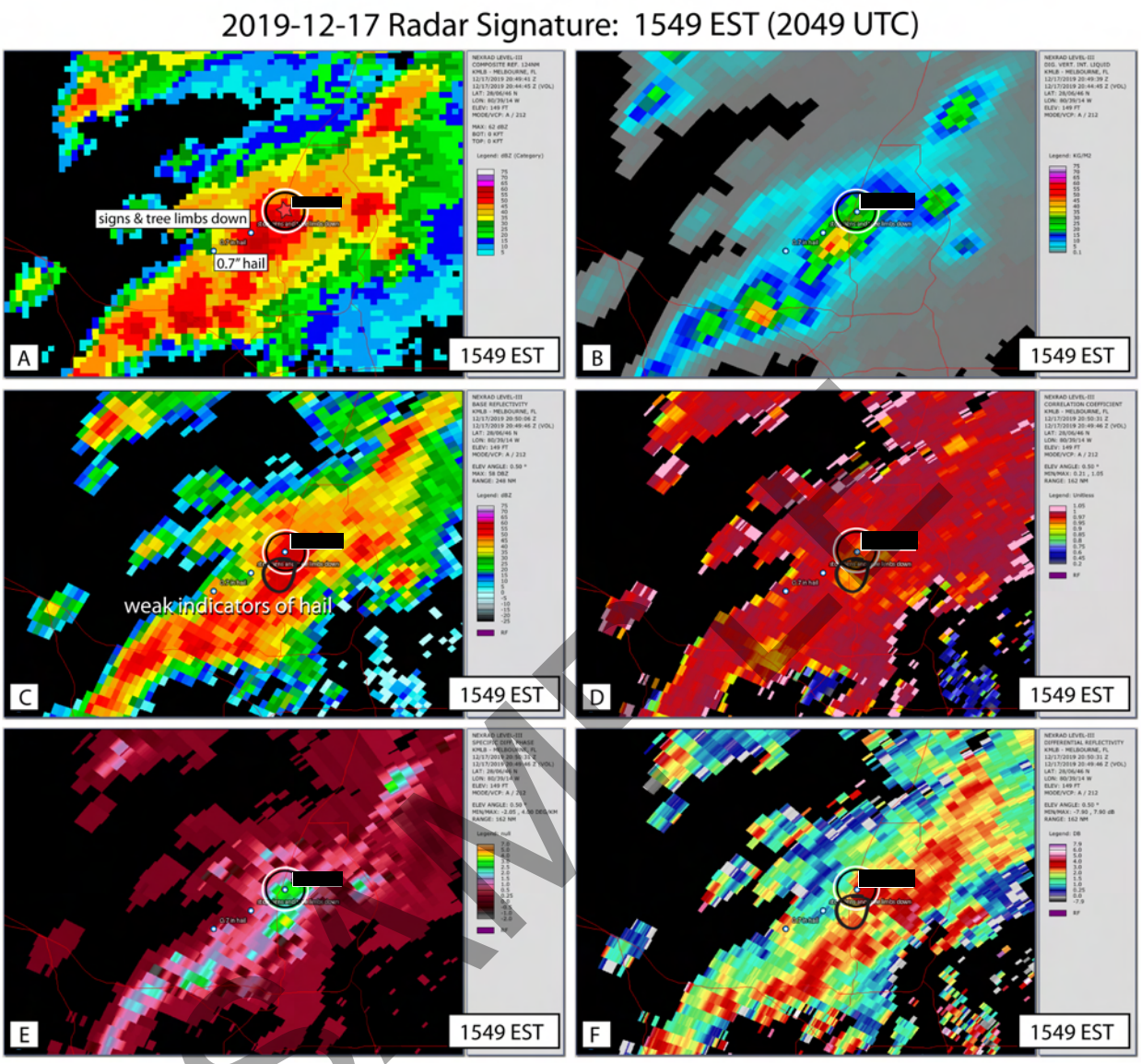

Figure 5: Figure 3: 6-panel radar hail signature for 2019-12-17 at 1549 EST as the severe thunderstorm was impacting the insured property. The loss location is indicated by a white dot within a black and white circle. Storm reports associated with passage of this storm are marked by white dots and labeled with the reported magnitude. Panels the same as in Figure 4. Source: KMLB level 3 dual-polarization data.

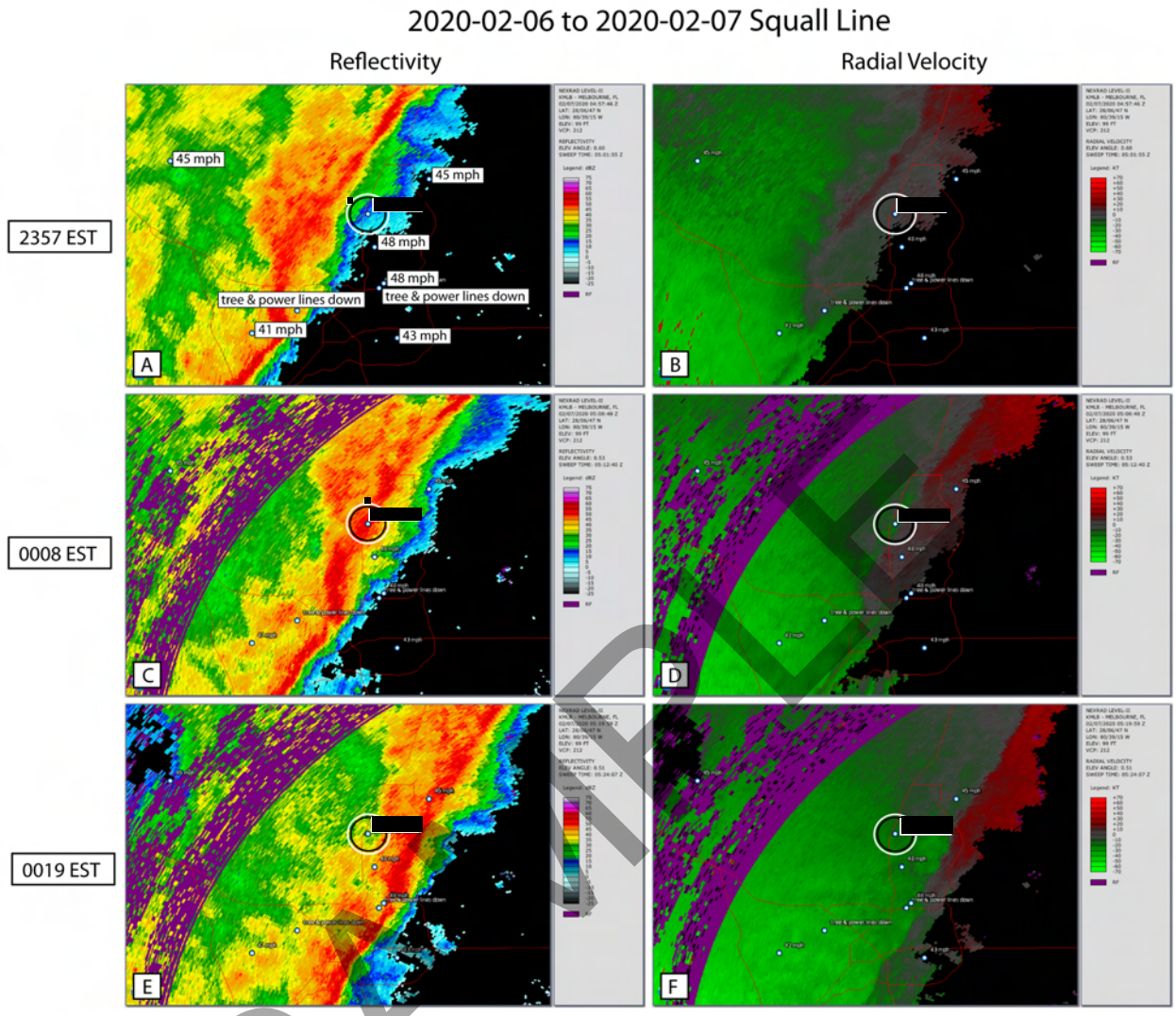

Figure 6: Time-evolution of the squall line as it approached (top row), impacted (middle row), and moved away from (bottom row) the insured property. The loss location is indicated by a white dot within a black and white circle. Storm reports associated with passage of this storm are marked by white dots and labeled with the reported magnitude. The left-hand column shows radar reflectivity data while the right-hand column shows radial velocity data for the same volume scans. In the radial velocity data, wind blowing toward the radar is indicated in green, while wind blowing away from the radar is indicated in red. The speed of the wind is denoted by the intensity of the color, as indicated in the scale bar to the right in each panel, with brighter colors indicating stronger winds.