Factual Report – Attachment 6

Analysis provided by United Airlines.

METEOROLOGY

DCA19MA086

Submitted by: Mike Richards
NTSB, AS-30

UAL 1788 MCO-IAH & UAL 1754 IAH-MSY 23FEB2019

Information provided by United

Flight Numbers	UAL1788/UAL1754
Date	23 FEB 2019
Time	In and around 1235CST (1835z)
Aircraft Types	B737 Max-9
City Pairs	MCO-IAH/IAH-MSY
Location	In the Houston terminal environment
Description	In support of the Atlas Air 767-BCF N1217A, flight 3591-23 FEB, MIA-IAH, Trinity Bay, Texas, NTSB has requested flight data and flight crew statements from United flight 1788 which was operating behind and United flight 1754 which was departing from IAH around the time of the accident. No injuries or damage occurred on either United flight.
Flight Levels	various

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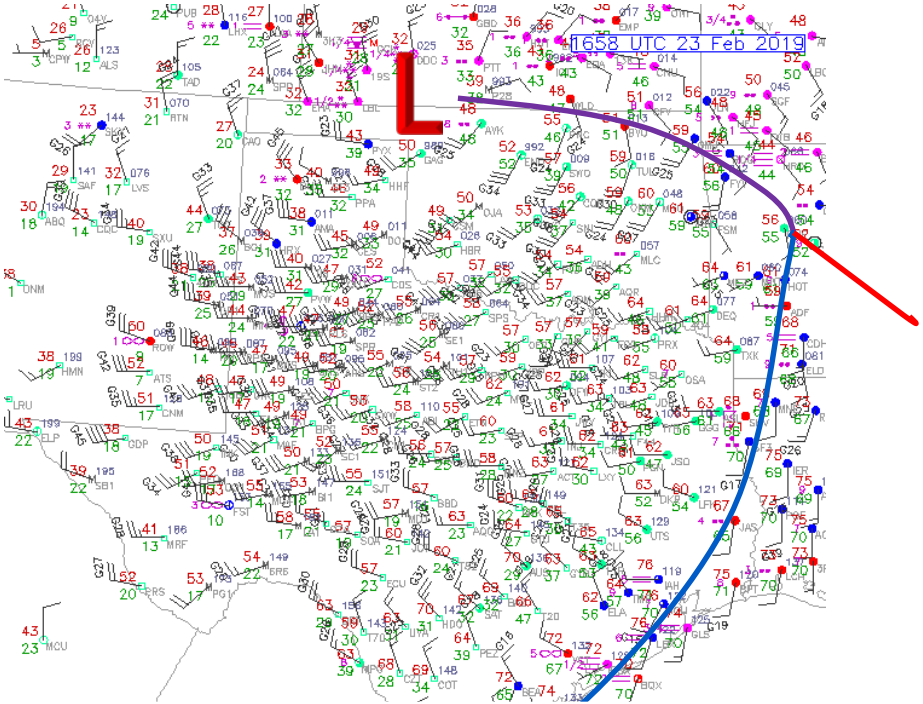

On the morning of February 23, 2019 a strong surface cold front is depicted moving eastward through southeastern Texas. This surface weather analysis is from 1700z or 1100CST. In the METARS below, KIAH reports a peak surface wind gust to 29kts at 1701z and KHOU peaks at 34kts about 40 minutes later. Both also report a brief rain shower.

KIAH 231713Z 32018G24KT 8SM BR SCT016 BKN020 BKN029 19/12 A2991 RMK AO2 PK WND 33029/1701 WSHFT 1653 RAB01E13 VCSH SE-S P0000 T01940122

KHOU 231753Z 31015G25KT 10SM -RA FEW018 BKN025 BKN036 21/15 A2990 RMK AO2 PK WND 28034/1742 WSHFT 1737 RAB23 SLP128 FROPA VCSH NE P0002 60002 T02110150 10256 20211 53009

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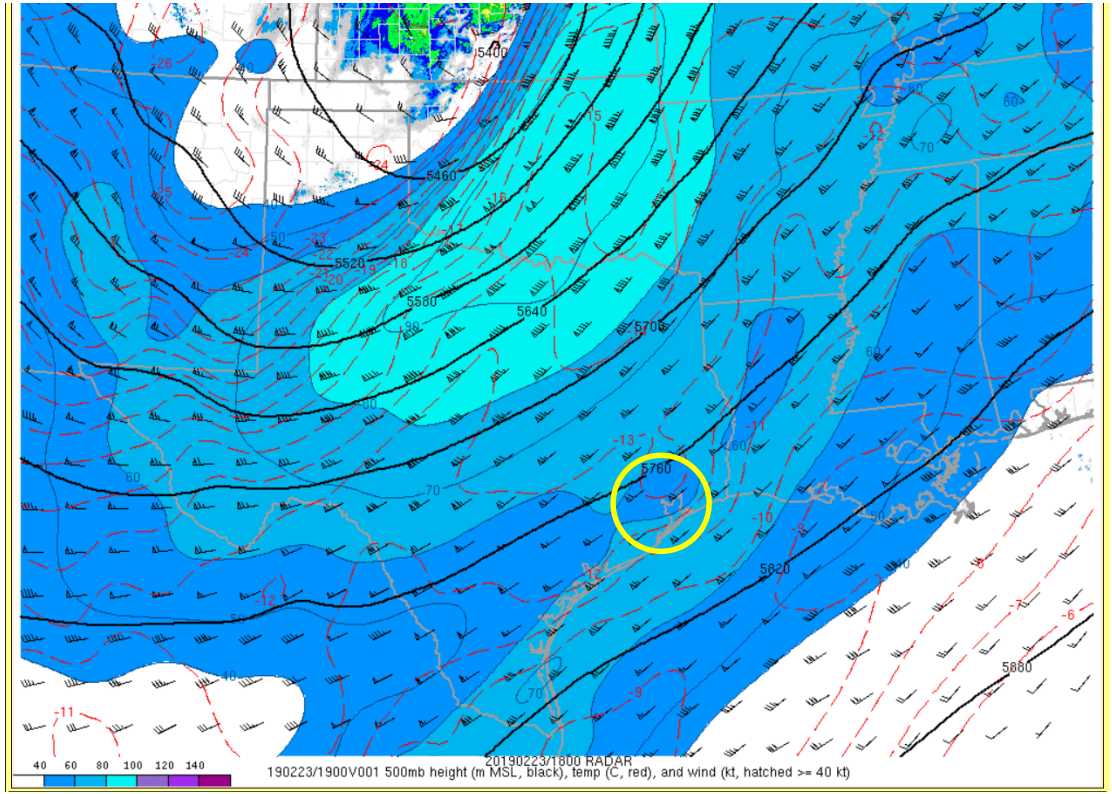

The front is developing eastward as a result of a strong mid level trough translating across the Southern Plains. An analysis of wind at 500mb or about 18,000ft AGL shows southwest winds of about 60kts above the accident location and in the terminal environment (circled in yellow).

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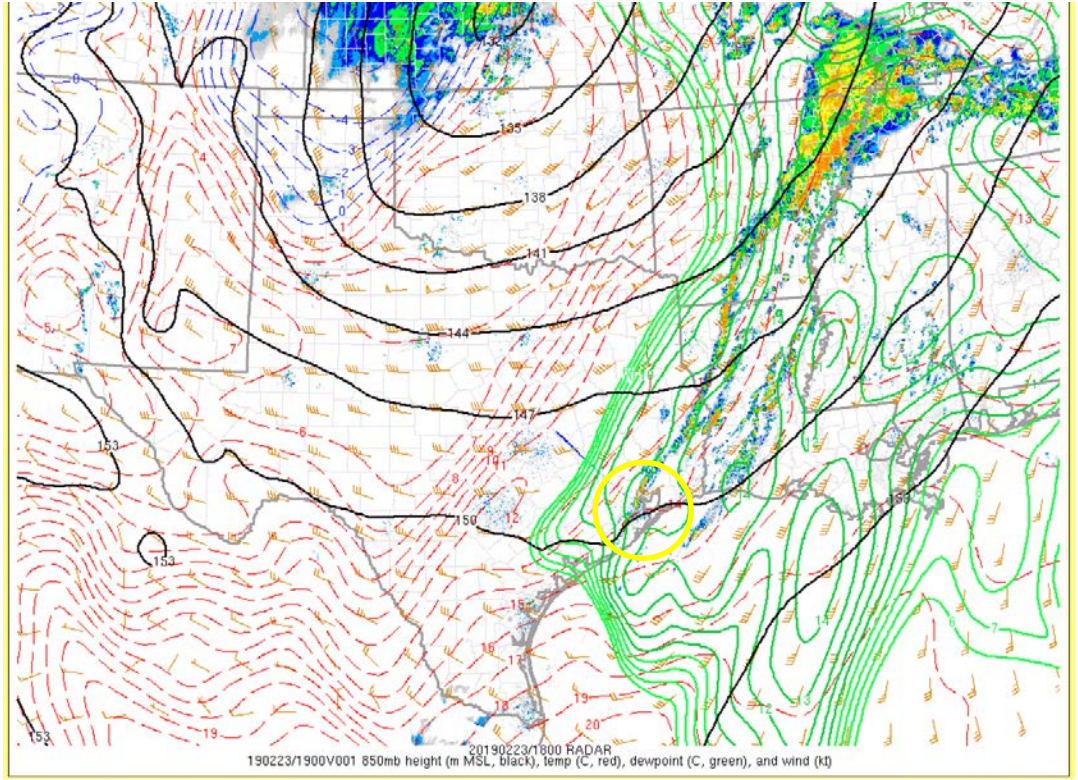

An analysis of wind at 850mb or about 5,000ft above ground shows southwest winds of 20-30kts above the accident location and in the terminal environment (approximated by the yellow circle). Dewpoint temperature, contoured in green, indicates sufficient available moisture to support thunderstorm development.

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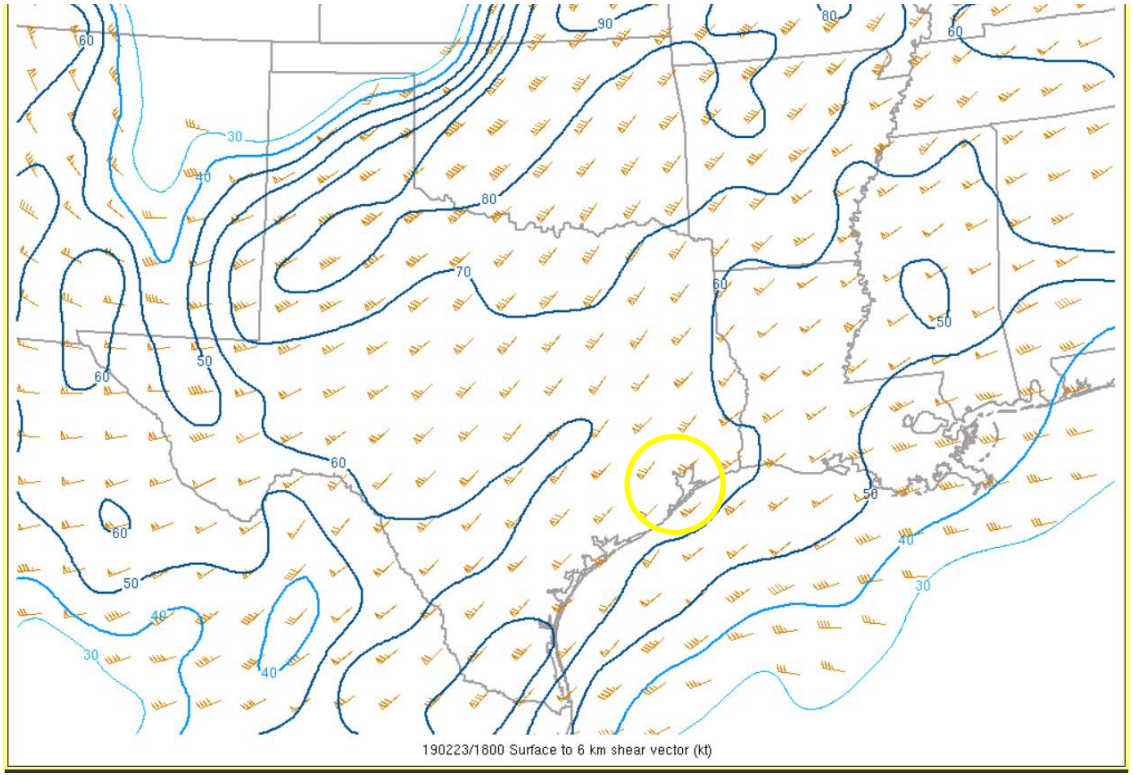

An analysis of wind shear from the surface to about 20,000ft above the accident location and the terminal environment (approximated by the yellow circle) indicates a shear vector of 65-70kts. Wind shear is a key ingredient in thunderstorm development and maintenance.

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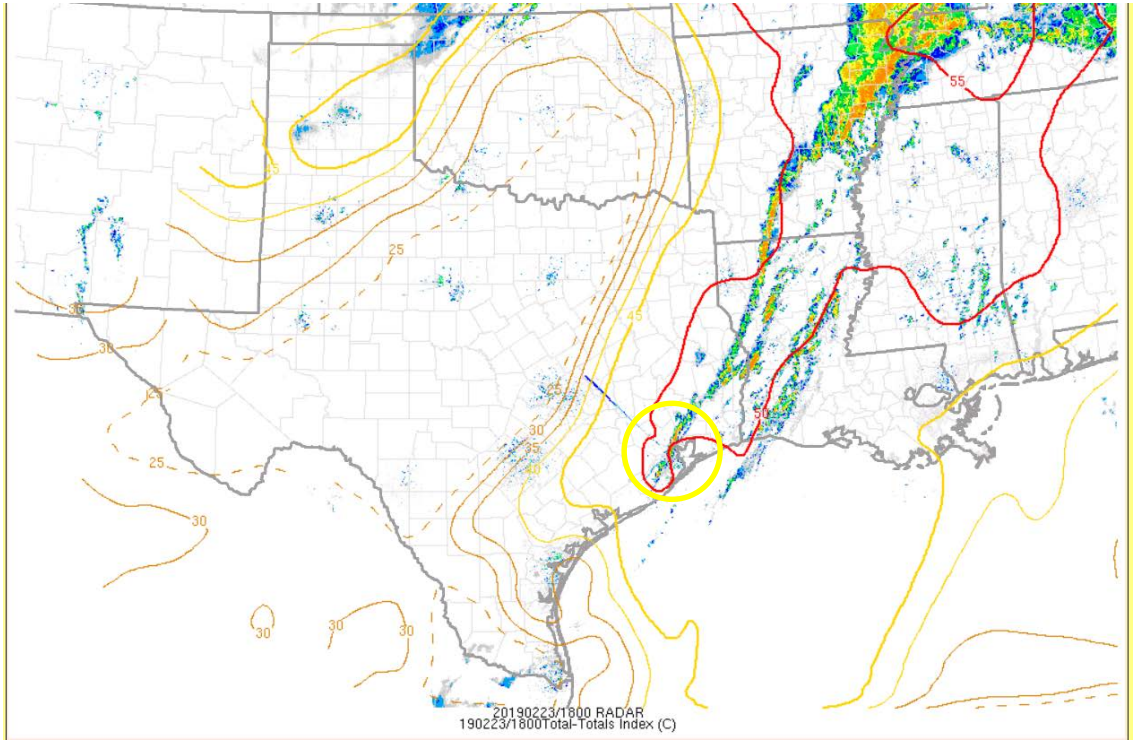

An analysis of the Total-Totals index above the accident location and within the terminal environment (approximated by the yellow circle) indicates a value of 50 or more which is sufficient for thunderstorm activity.

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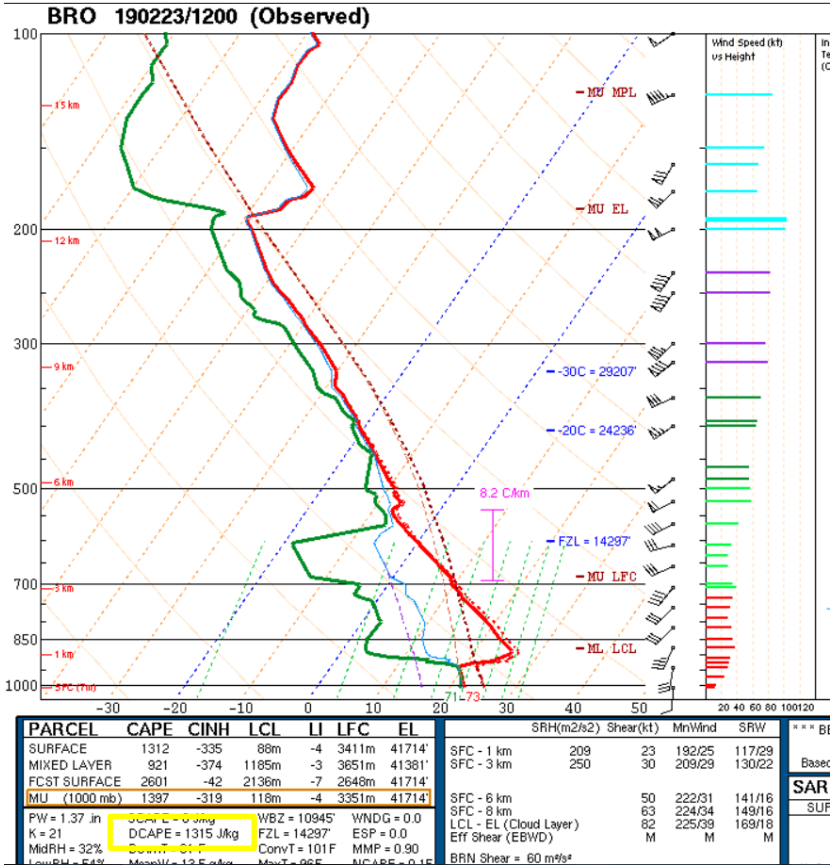

Of particular interest, this upstream weather balloon launched over Brownsville, TX the morning of the accident indicates a very dry lower atmosphere supportive of convective downbursts as evidenced by the calculated DCAPE of 1315 (highlighted in yellow) in the table below. DCAPE can be used to measure the potential strength of rain cooled downdrafts. Larger DCAPE values are associated with stronger downdrafts and values greater than 1000 are significant.

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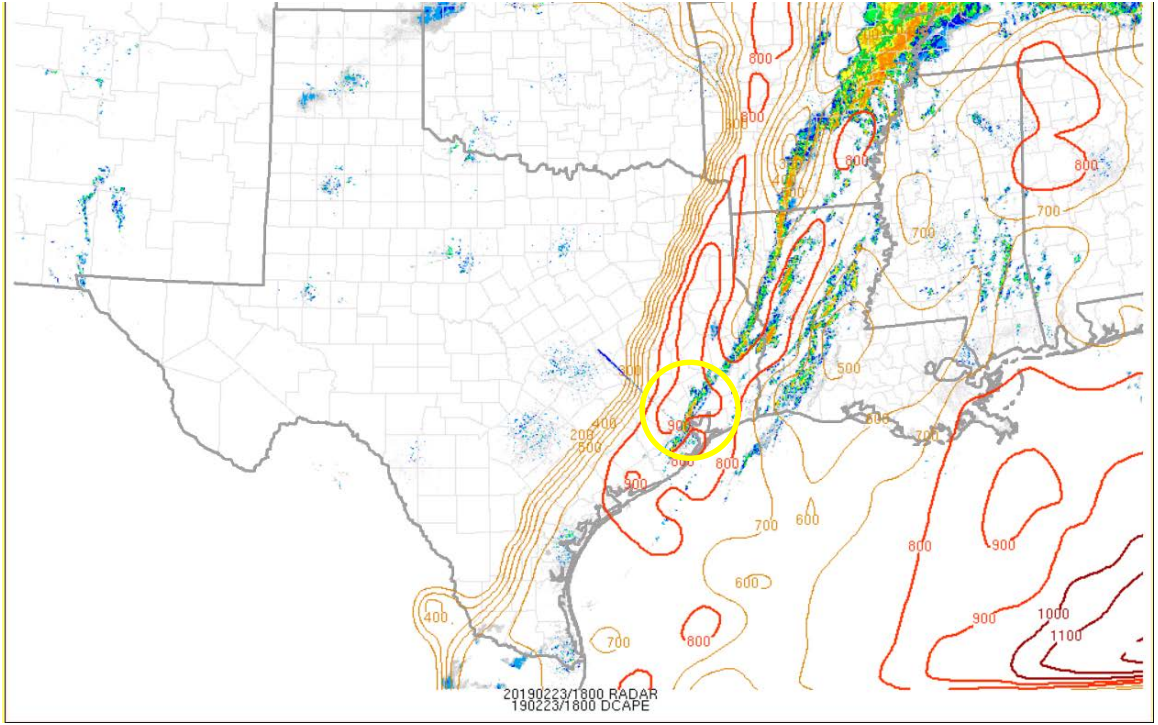

This analysis of DCAPE over the IAH terminal area and the accident location (circled in yellow) at 1800z indicate a DCAPE value near 900. Not as large a value as measured in the BRO sounding earlier in the morning however still capable of stronger downdraft winds.

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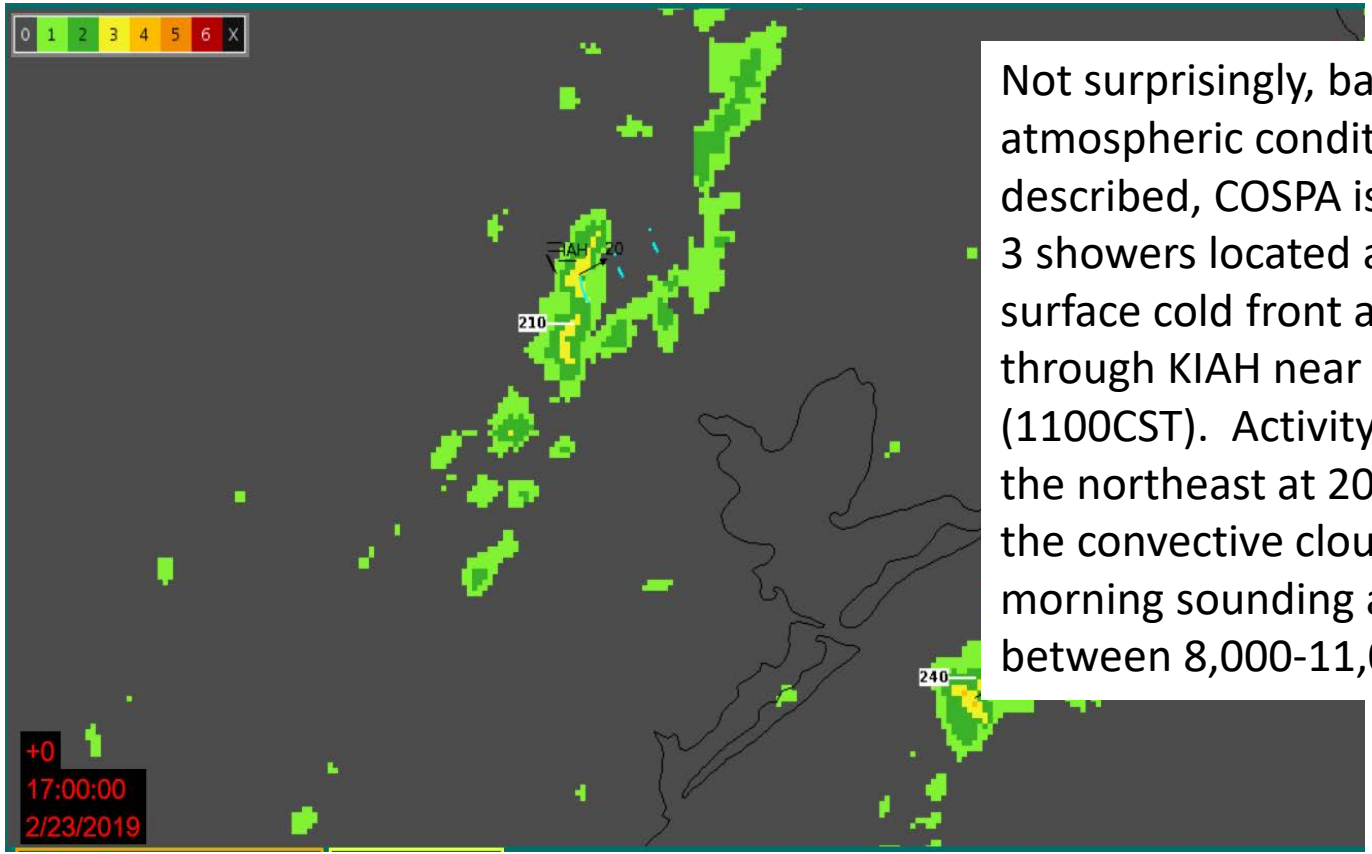

Not surprisingly, based on the atmospheric conditions just described, COSPA is depicting level 3 showers located along the surface cold front as it moves through KIAH near 1700z (1100CST). Activity is developing to the northeast at 20-30kts. Bases of the convective clouds from the morning sounding are estimated between 8,000-11,000 feet.

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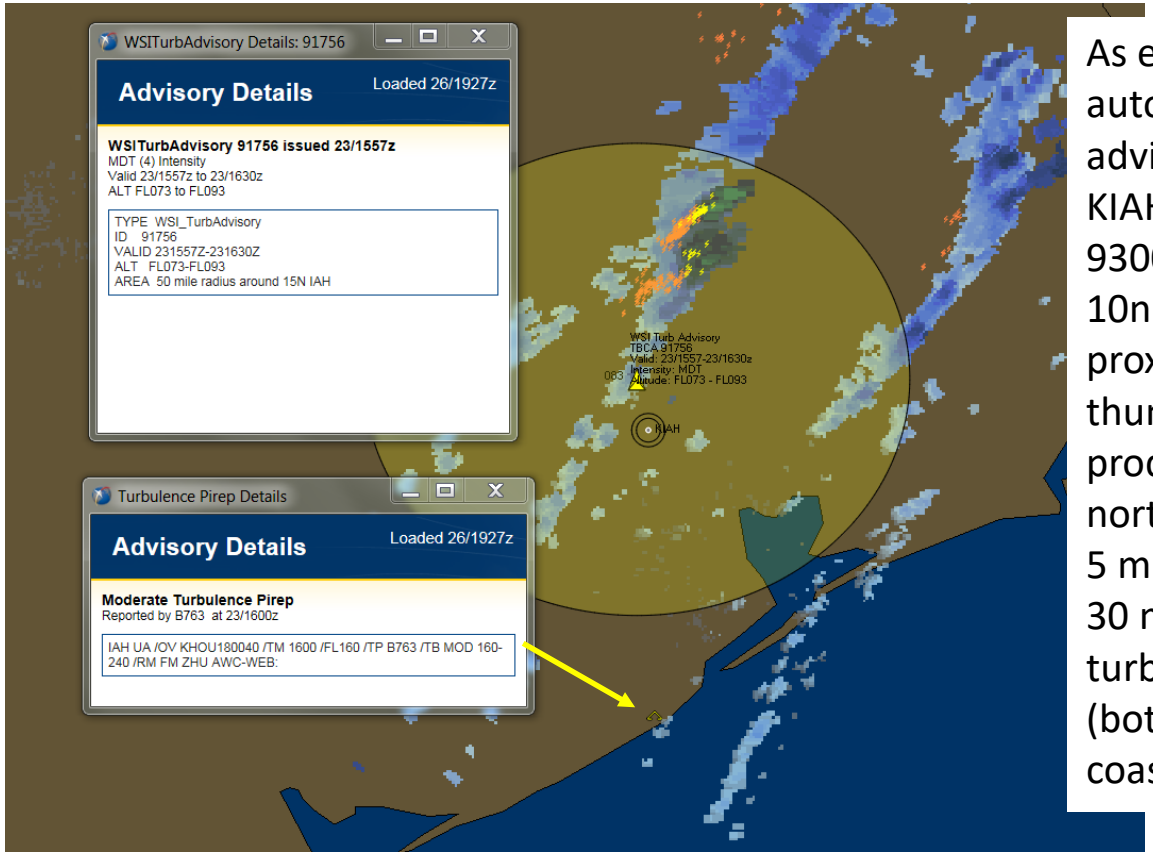

As early as 1600z (1000CST), an automated TWC moderate turbulence advisory (yellow ring) encompassing KIAH is triggered for flight levels 7300-9300ft as a result of a TAPS report about 10nm to the north of IAH. This is in close proximity to the showers and isolated thunderstorms shown in this echo tops product. Lightning is also evident to the north (yellow strikes are within the past 5 min. while orange are within the past 30 min.) There also is a moderate turbulence report from FL160-240 (bottom) from a B767 along the Texas coast

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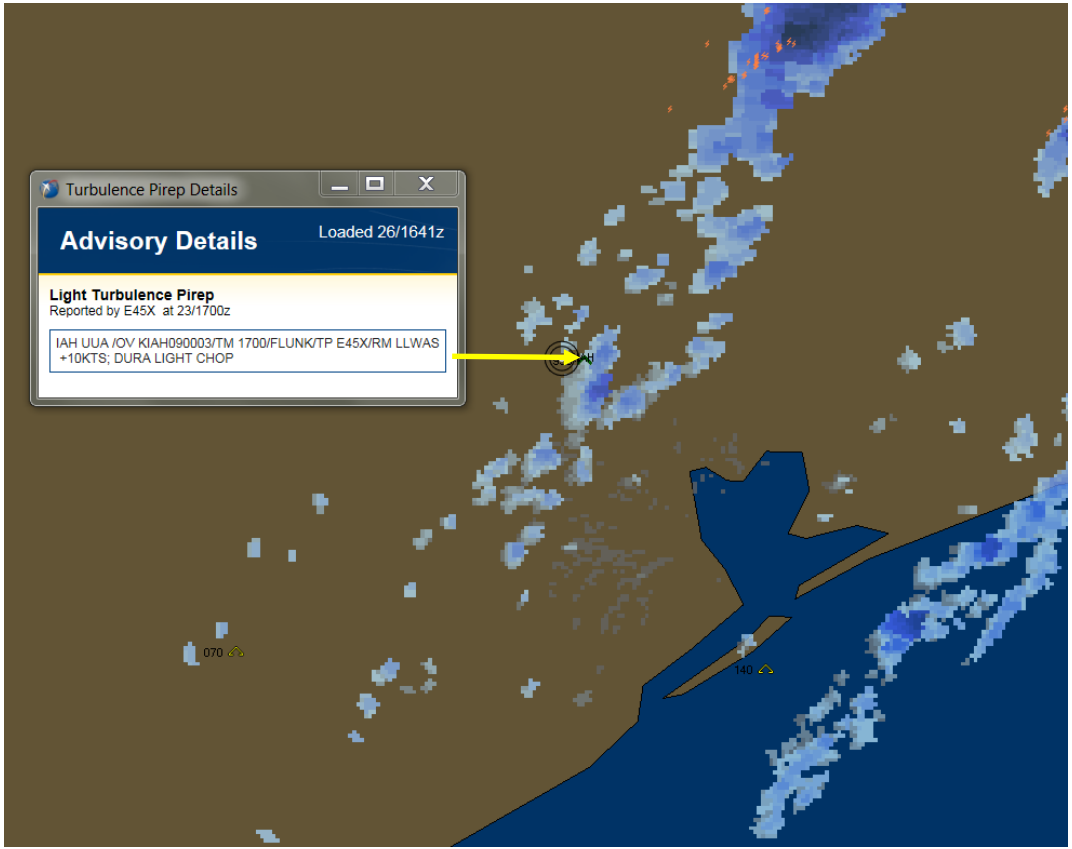

At 1700z (1100CST), an E45X reports light chop and low level wind shear of + 10 knots on approach into KIAH. Lightning is diminishing and moving further northeast of the terminal (yellow strikes are past 5 min. while orange are past 30 min.)

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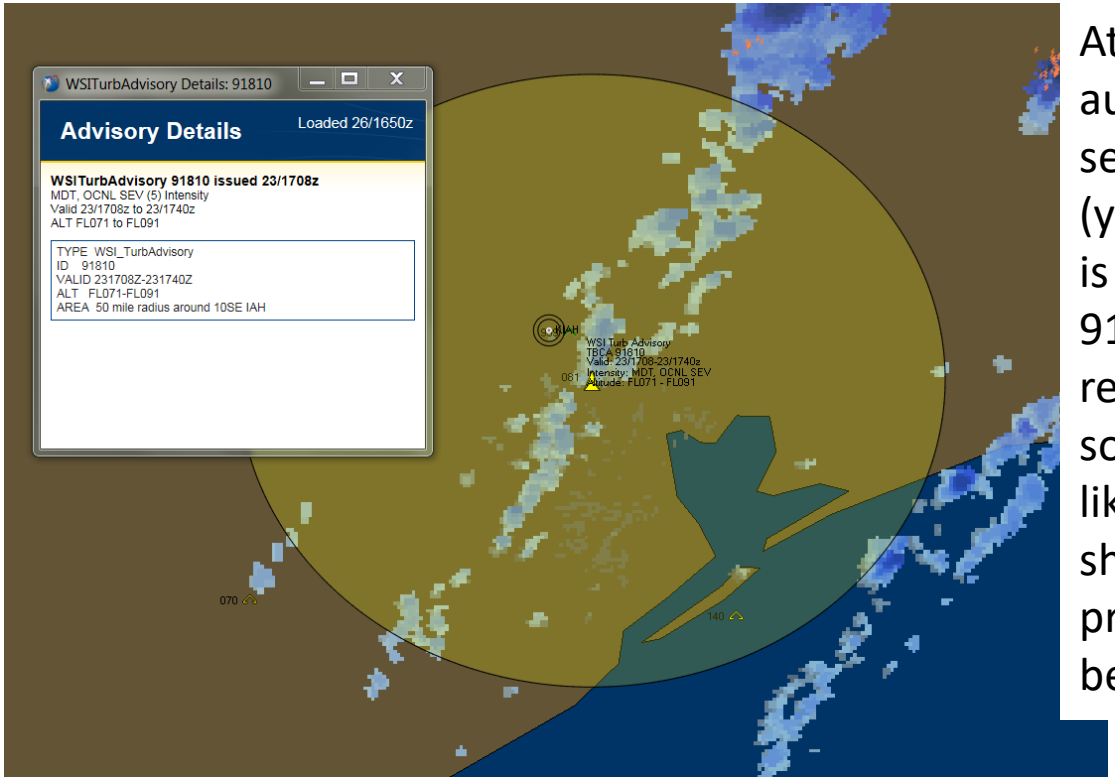

At 1708z (1108CST), a second automated TWC moderate to severe turbulence advisory (yellow ring) encompassing KIAH is triggered for flight levels 7100-9100ft as a result of a TAPS report about 13nm to the southeast of IAH. This is most likely a result of proximity to the showers shown in this echo tops product. No recent lightning has been observed.

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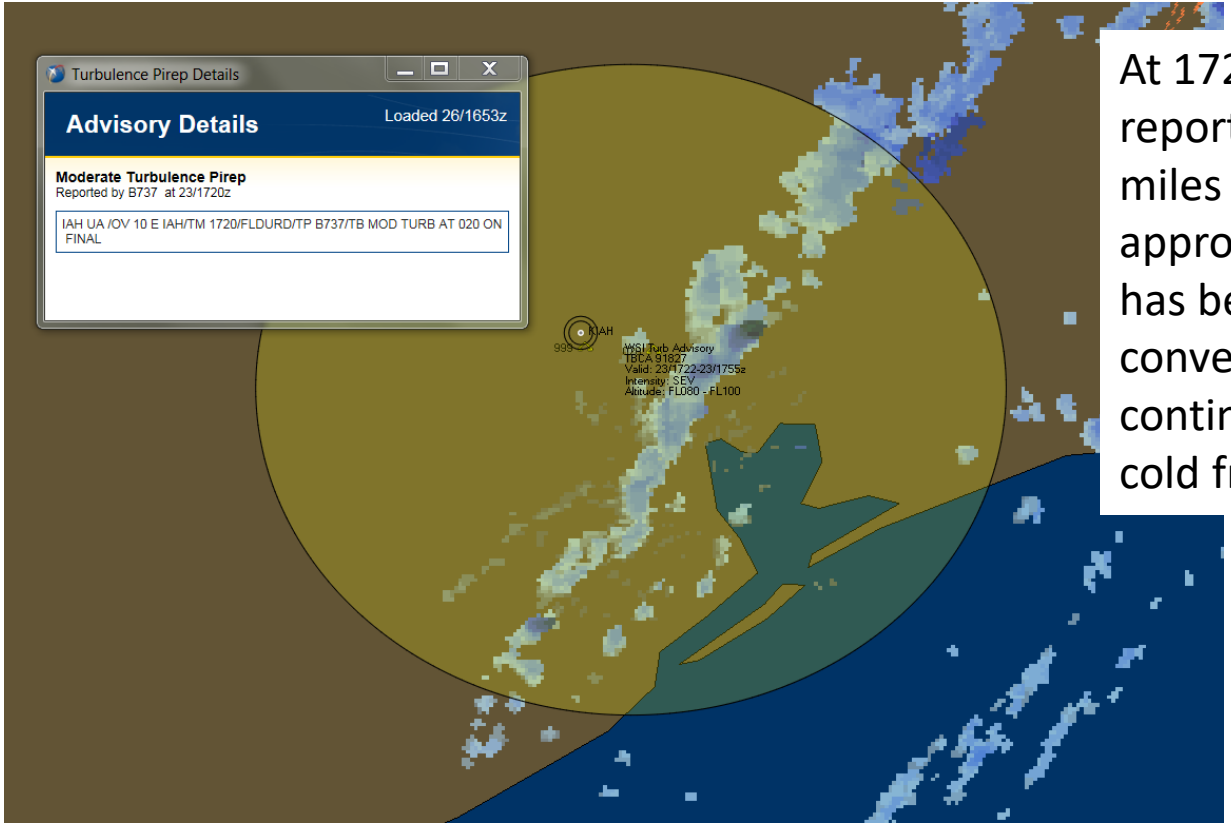

At 1720z (1120CST), a B737 reports moderate turbulence 10 miles east of KIAH at FL020 on approach. No recent lightning has been observed, however convective rain shower activity continues eastward along the cold front.

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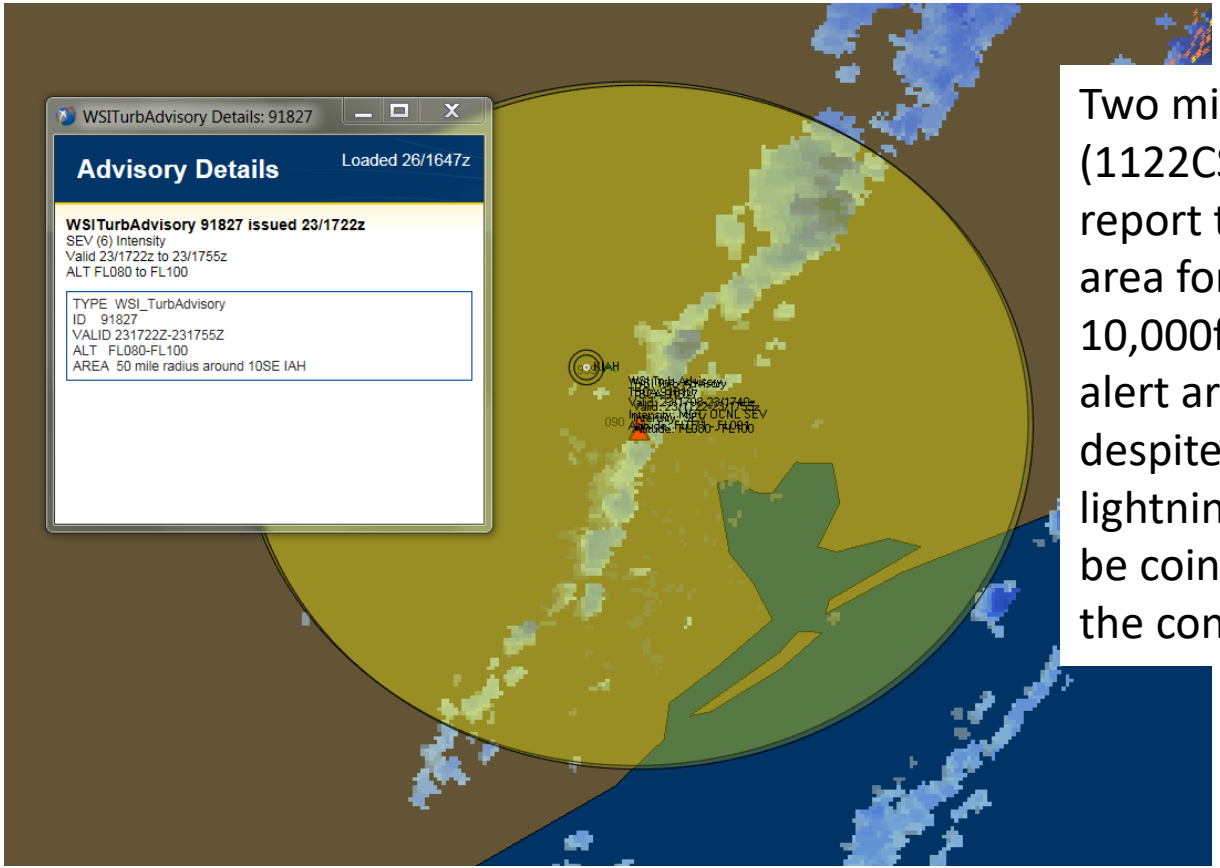

Two minutes later, at 1722z (1122CST), a third TWC TAPS report triggers a severe alert area for flight levels 8,000-10,000ft valid until 1755z. The alert area includes KIAH and despite the continued lack of lightning, the reports appear to be coincident with and beneath the convective cloud bases.

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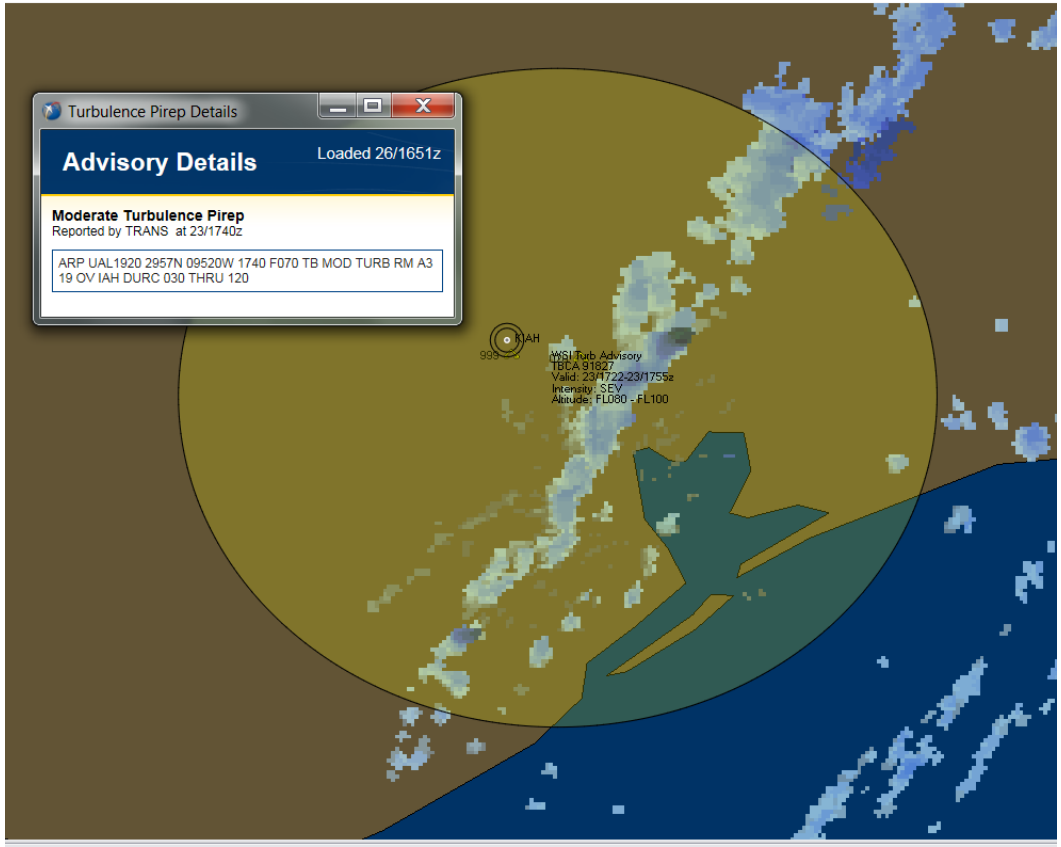

At 1740z (1140CST), UAL 1920 reports moderate turbulence from flight levels 3000-12,000 feet during climb out from KIAH.

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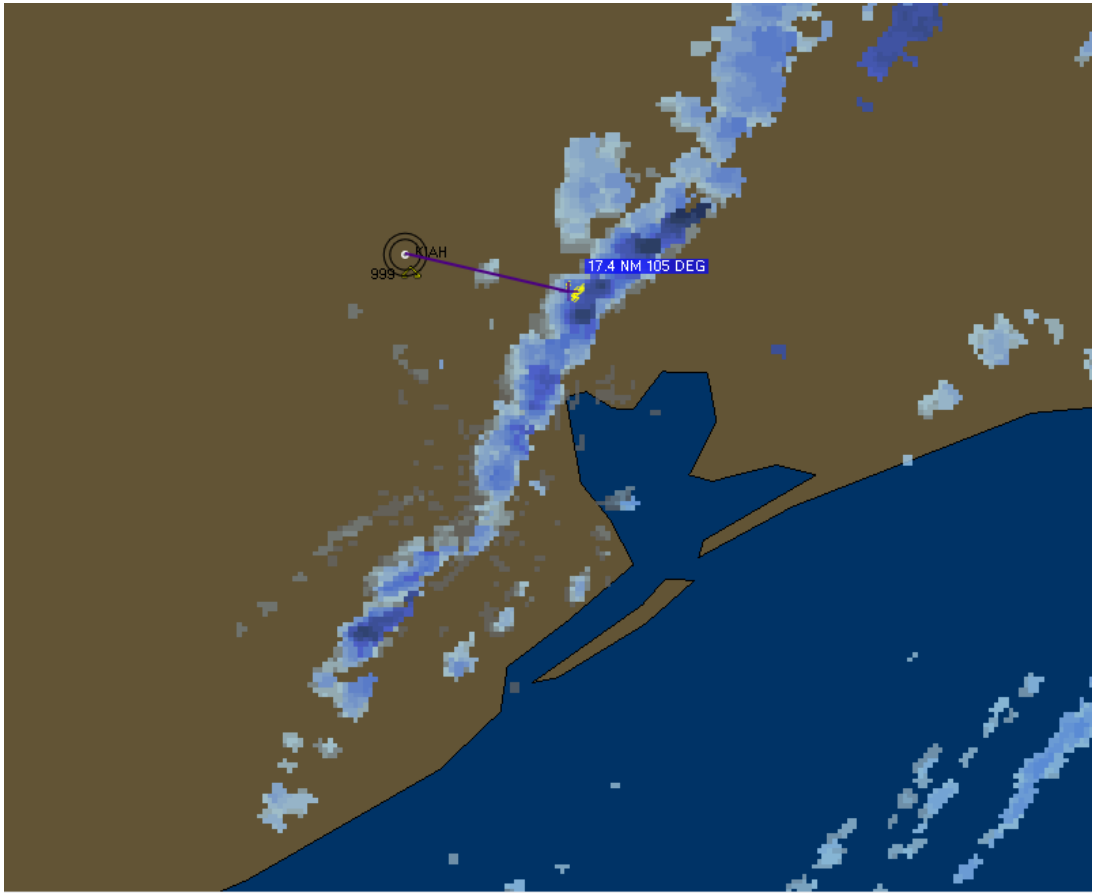

Between 1750-1755z isolated lightning strikes are once again being observed in the taller echo tops about 17nm to the east–southeast of KIAH. Overall, the tops have the appearance of strengthening and organizing into a short linear feature across southeast Texas.

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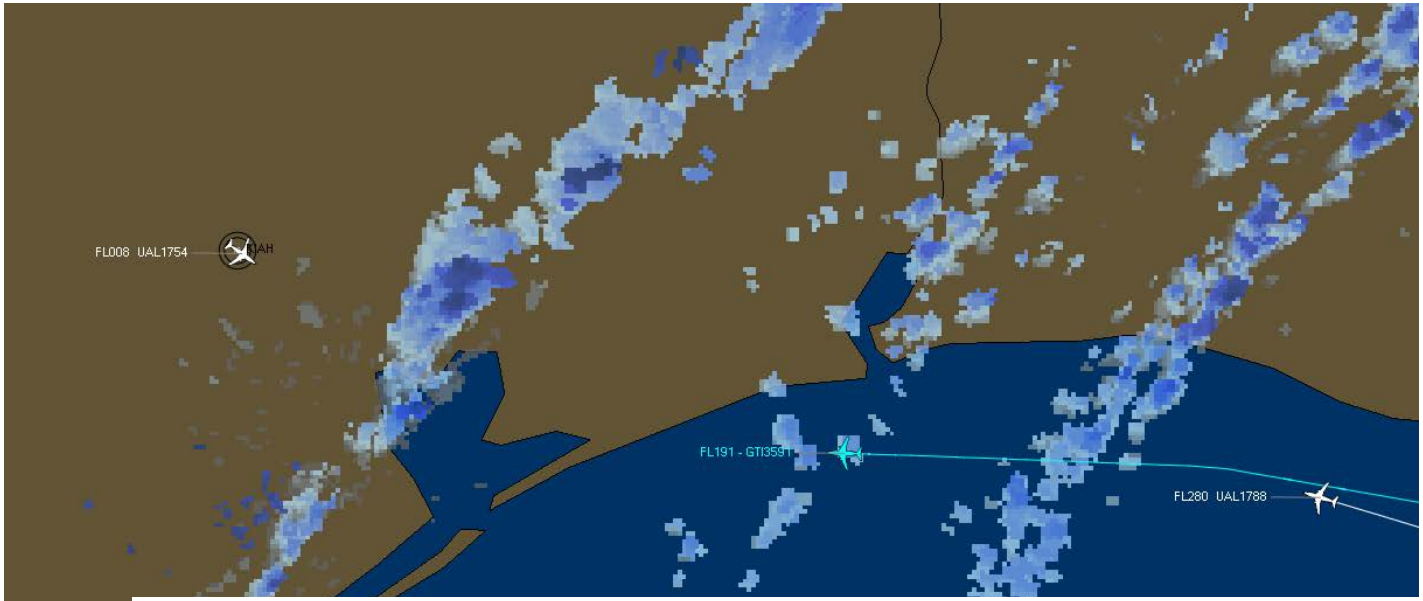

At about 1830z (1230CST) UAL 1754 departs KIAH (left). GTI3591 is descending through 19,000ft (middle) and UAL 1788 (right) is located behind at 28,000ft. Lightning is no longer being observed in the showers and no adverse pilot reports have recently been received.

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By 1835z (1235CST) UAL 1754 is climbing through 11,500ft and heading toward the weather (left). GTI3591 has moved onshore and continues to descend through 12,800ft (middle) and UAL 1788 (right) is located behind at maintains 28,000ft. Lightning is not being observed and no recent pilot reports have been received.

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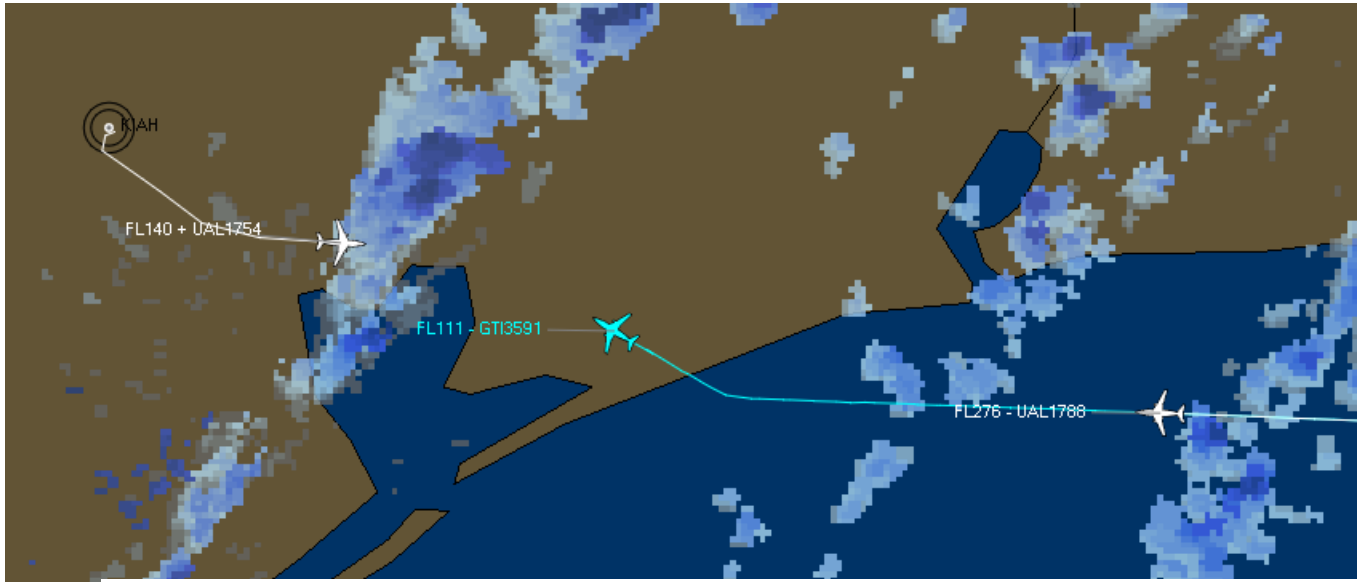

By 1836z (1236CST) UAL 1754 is climbing through 14,000ft and is in close proximity to the weather (left). GTI3591 continues to descend through 11,100ft (middle) and UAL 1788 (right) has descended to 27,600ft. Lightning is not being observed and no recent pilot reports have been received.

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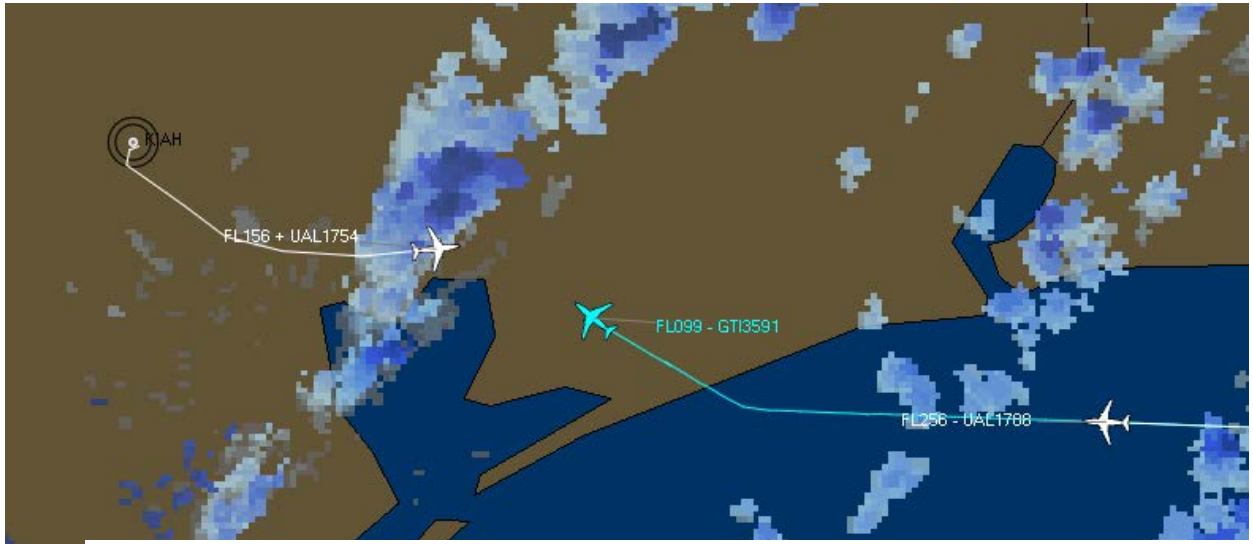

At 1837z (1237CST) UAL 1754 is climbing through 15,600ft and close to moving east of the weather (left). GTI3591 has now descended below 10,000ft (middle) and UAL 1788 (right) has descended to 25,600ft. Lightning is not being observed and no recent pilot reports have been received.

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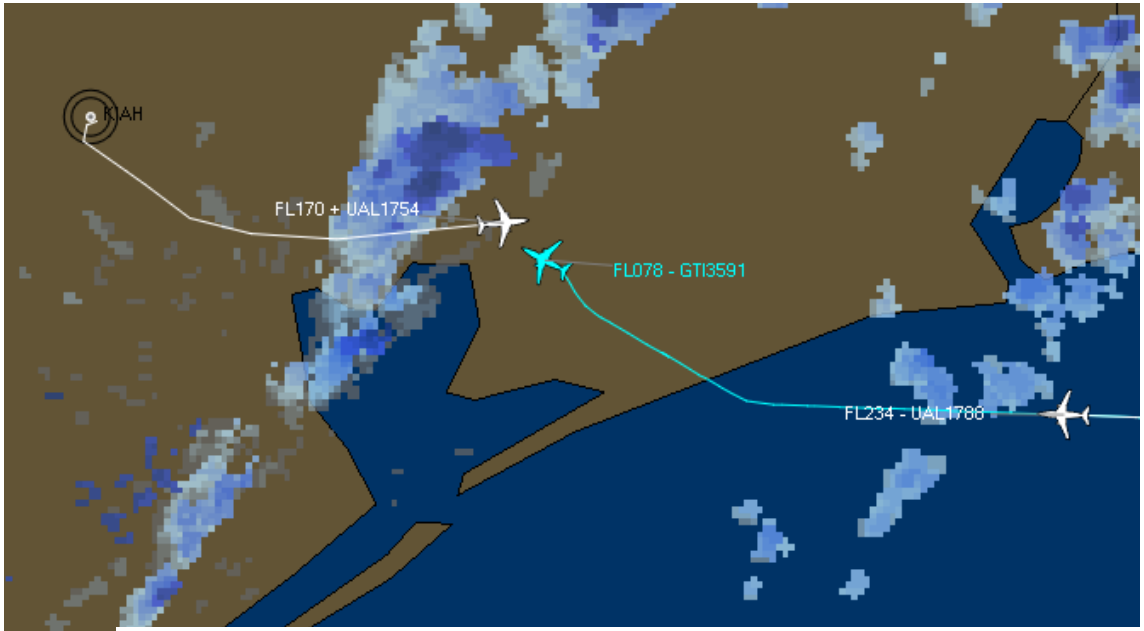

At 1838z (1238CST) UAL 1754 is climbing through 17,000ft and now clear of the weather (left). GTI3591 has now descended to 7,800ft (middle) and UAL 1788 (right) has descended to 23,400ft. Lightning is not being observed and no recent pilot reports have been received.

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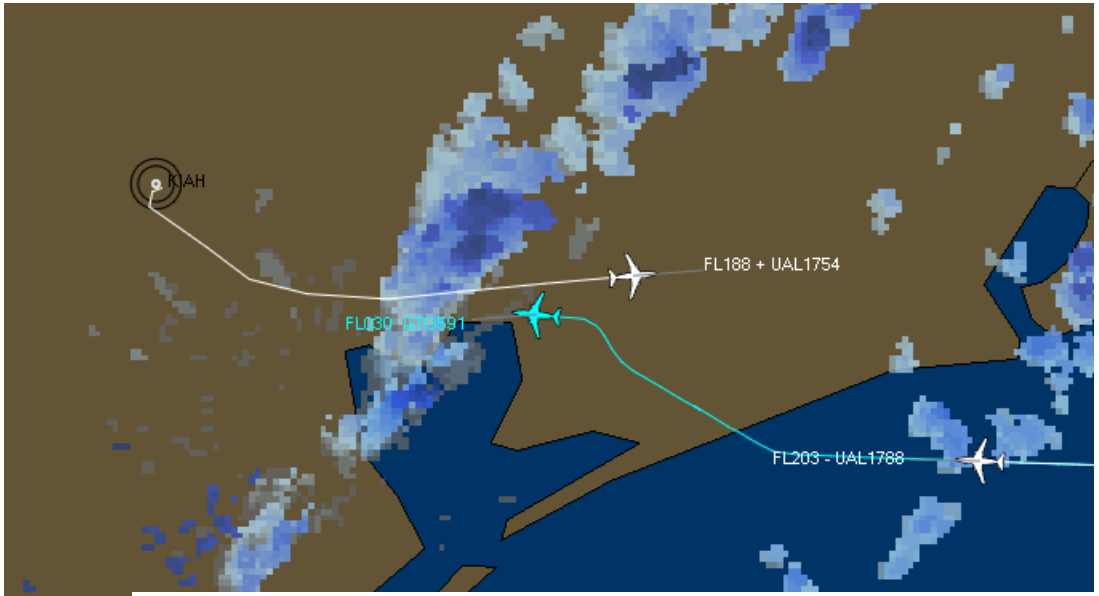

By 1839z (1239CST) UAL 1754 is climbing through 18,800ft and continues eastbound (top/middle). GTI3591 has now descended to 3000ft just ahead of the weather (left). UAL 1788 (right) continues it's descent to 20,300ft. Still no lightning is not being observed and no further pilot reports have been received.

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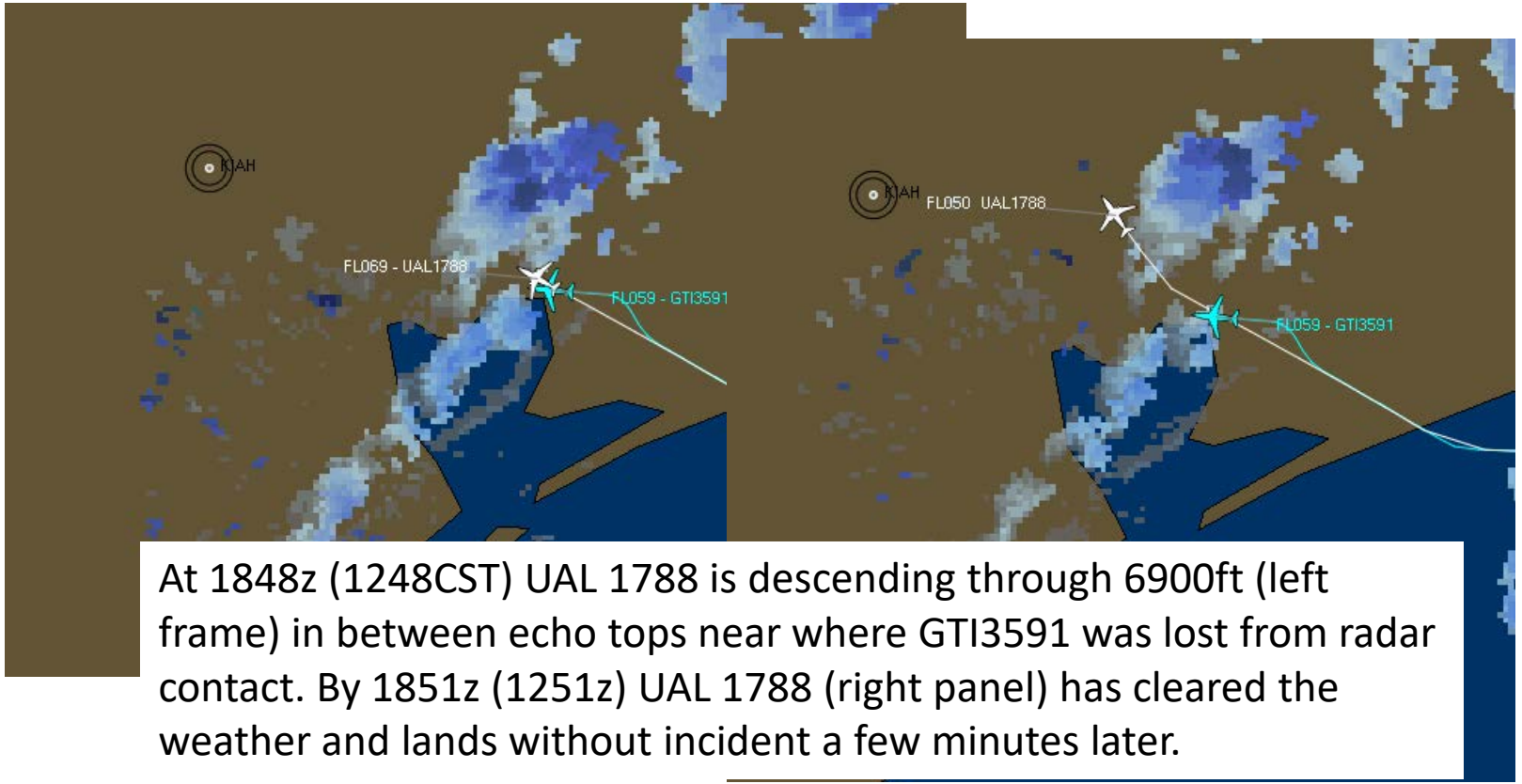

At 1848z (1248CST) UAL 1788 is descending through 6900ft (left frame) in between echo tops near where GTI3591 was lost from radar contact. By 1851z (1251z) UAL 1788 (right panel) has cleared the weather and lands without incident a few minutes later.

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SUMMARY PAGE 1

- A strong cold front moved across southeast Texas during the late morning and early afternoon on February 23, 2019 (slide 2)
- Atmospheric parameters were conducive for showers and thunderstorms along and ahead of the cold front. (slides 3-6). Furthermore, a layer of very dry air observed below the convective cloud base was sufficient to generate localized strong convective downbursts (slides 7-8)
- Eastward moving showers and embedded thunderstorms were observed across southeastern Texas prior to, during and after the departure or UAL1754 and arrival of UAL 1788 (slides 9-23)
- Three separate automated low level TWC turbulence advisories were triggered from TAPS reports prior to the departure of UAL 1754 and arrival of UAL 1788. Intensity ranged from moderate to severe and from flight level 7100-10,000ft (slides 10, 12 and 14)
- In addition there were at least three moderate low level turbulence reports and a low level wind shear report in the vicinity of the convection in the TRACON airspace (slides 10-11, 13 and 15)

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SUMMARY PAGE 2

- UAL 1754 climbed through an area of echo tops from FL140-FL170 (slides 19-21) without reported incident. GTI3591 descended below 8000ft and was lost from radar contact just ahead of the approaching convective cloud base (slide 22). UAL 1788 followed a similar approach path and crossed the weather (slide 23) and landed at IAH without reported incident.
- Downbursts below shower and isolated thunderstorm cloud bases along with mechanical mixing along the cold frontal zone likely caused the TAPS reports received and also may have contributed to the PIREPS of turbulence and low level wind shear. Also, the possibility exits that a downburst event may have been a contributing factor in the crash of GTI3591 - weather cannot be ruled out at this point

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