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Analysis of Rapid Interval GOES Data for the 9 July 1982 New Orleans Airliner Crash

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INTRODUCTION

On 9 July 1982 at 1610 CDT, Pan Am Flight 759 crashed shortly after taking off from Moisant Field, New Orleans, Louisiana (MSY). One hundred fifty-three persons died as a result of the crash: 145 in the aircraft and the remainder on the ground. By chance, July 9 had been designated a special "rapid scan" imaging day for the GOES West satellite, and three minute interval visible and infrared data were available for the time of the accident. Analysis of that data, presented in Section 3, shows rapid convective intensification occurring at MSY at the time of the accident. These data further show that rapid convective development was generated where three well defined convective boundaries merged.

2. GENERAL

The synoptic scale setting over southern Louisiana on 9 July was favorable for typical summertime thunderstorm development over that area. Various stability indices showed that the airmass was one that could easily support general thunderstorm activity. At 850 mb (Figure 1) and below, the atmosphere was warm and moist with light southerly flow. At 500 mb (Figure 2), a weak trough was situated over the region. This trough exhibited little movement during the day. By early afternoon, temperatures were in the low 90s in rain free areas, and dew point temperatures were in the upper 60s.

By early afternoon (1500 – 1600 CDT) both satellite imagery and composite radar data showed shower and thunderstorm activity extending from southwestern Louisiana into central Georgia. This activity verified the forecast over those areas. The only severe weather expected during the period was over Iowa. Why then, did such intense convection develop locally over MSY? In the next section we will present our analysis from the special satellite data in an attempt to help answer that question.

3. SATELLITE ANALYSIS

The discussion in this section is based on GOES West, visible and infrared digital data. A three-minute interval imaging (RRSD) day for GOES West was scheduled for 9 July 1982, thus post-processing allowed a more detailed look at this case than would normally be possible (i.e. with the normal 30 minute interval data). Additionally, the Interactive Research Imaging System (IRIS) at Colorado State University (Green and Kruidenier, 1982), was used to make precise cloud top temperature measurements and to

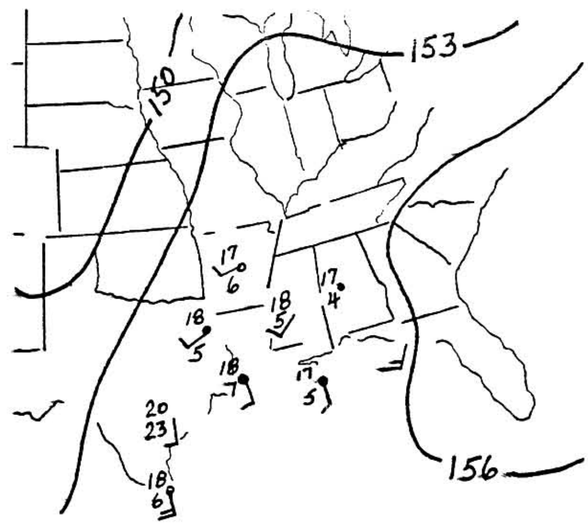

Figure 1. Selected 850mb data and analysis for 9 July 1982 at 1200 GMT.

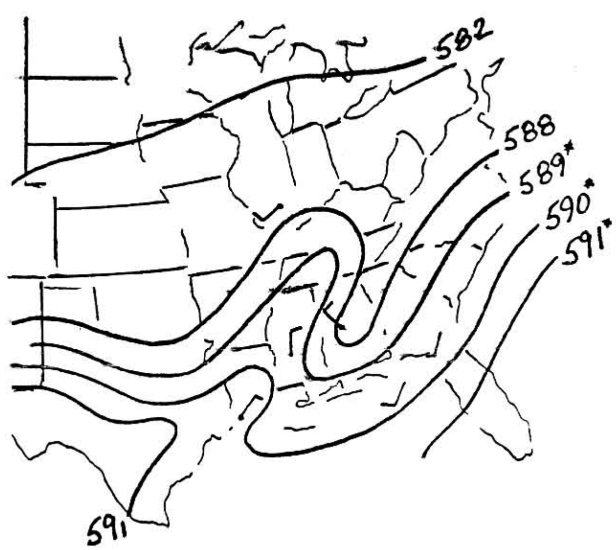

Figure 2. Selected 500mb data and analysis for 9 July 1982 at 1200 GMT.
* indicates value not normally included in synoptic analyses.

construct animated sequences of images from the three-minute interval visible and infrared data. Animation is particularly helpful in identifying mesoscale weather features that may not be notable on individual photographs. This is because the development of mesoscale weather features is often associated with organized cloud patterns. These are readily detectable in an animated sequence of images, in which the rest of the cloud field forms, moves and dissipates in a less organized fashion.

Often the air in one portion of a mesoscale region has different characteristics than that in another. These different characteristics are evident in satellite imagery as a cloud pattern evolves since the clouds and cloud patterns observed in a satellite image or sequence of images represent the integrateed effect of ongoing dynamic and thermodynamic processes in the atmosphere (Purdom 1979, 1982). These differences are important factors in mesoscale weather development since intense convective development often occurs at boundaries separating air masses. One common example is a cold front. Other examples, all readily detectable in satellite imagery, include:

1) sea breezes - formed due to differential heating between land and adjacent water (Haurwitz, 1947);
2) lake breezes - as in sea breezes (Chandik and Lyons, 1971);
3) cloud breeze fronts - generated due to differential heating between early morning cloudy and adjacent clear regions (Purdom, 1973, 1982; Purdom and Gurka, 1974);
4) thunderstorm outflows - formed by rain-cooled air as it spreads out and away from thunderstorms (Fujita, 1963; Purdom, 1976).

Such boundaries are commonly identifiable in satellite imagery as organized cloud lines. Not only do such boundaries often mark the location of subsequent intense storm development (Purdom, 1976), but many times the most intense activity becomes fixed to those boundaries (Weaver, 1979; Zehr, 1982).

3.1 Visible imagery analysis

Detailed analysis of RRSD satellite imagery from the 9 July case revealed several low-level boundaries in the vicinity of MSY during the period of interest (Figures 3 and 4). Those features were:

1) a sea breeze front that moved northward from the Gulf Coast at around 12 kts - feature A in Figures 3 and 4;
2) a lake breeze front which remained nearly stationary throughout most of the afternoon - feature B in Figures 3 and 4;
3) a convective line that formed along a boundary separating what had earlier in the day been a stratus and fog region from an adjacent clear region - feature C in Figure 3;
4) a thunderstorm outflow boundary (feature D in Figure 4) associated with the storm labeled D*.

Our analysis of the satellite data places the intersection of the lake breeze front with the cloud breeze induced boundary over Moisant Field, Figure 3. This intersection region remained nearly stationary during the afternoon. The evolution of cloud features between the times of Figures 3 and 4 shows that the sea breeze is moving into the region from the south, and that the thunderstorm D* along the sea breeze front has produced an outflow boundary (D in Figure 4) that is moving rapidly northward toward MSY. As the three boundaries (lake breeze front, cloud breeze front, and thunderstorm outflow boundary) merged in the vicinity of MSY, rapid convective intensification occurred, as described in Section 3.2 below.

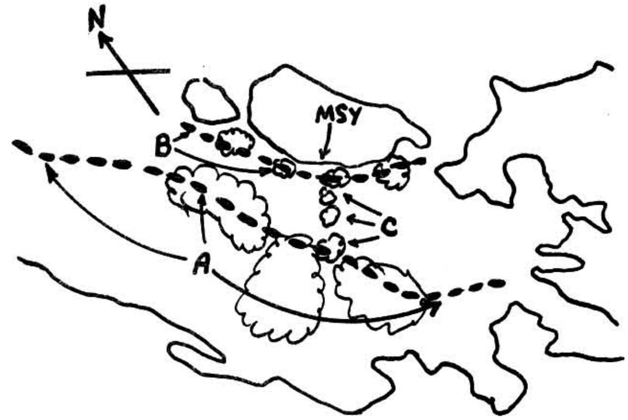

Figure 3. Nephanalysis annotated with various mesoscale features discussed in text. From GOES West 1 km resolution visible imagery taken at 2005 GMT, 1505 CDT, 9 July 1982.

Figure 4. Same as figure 3 above, except for 2045 GMT, 1545 CDT, 9 July 1982.

3.2 Infrared data analysis

Infrared cloud top temperature can be related to height in the atmosphere, and temperature changes can be related to vertical growth of convection (Adler and Fenn, 1979). Vertical growth rates of storms over MSY and others near by are shown in Table 1. However, before inspection of that information one should be aware of certain facts. The infrared sensor on GOES has a resolution of 4 x 8 km at satellite subpoint (versus 1 x 1 km for visible data). With GOES West being located over 135 W at the equator, this resolution has degraded by a factor of two when viewing the region near MSY. This means that each infrared data point represents the average temperature from an area approximately 14 x 8 km, considerably larger than the size of the entire airport. Analysis of radar data and precipitation patterns (Caracena, et al, 1983) shows that the activity within a single infrared data point over the airport was actually composed of a number of individual cells. However, one can reach certain conclusions concerning storm intensity by looking at the growth rates of the convective activity over the airport versus growth rates of other convective regions nearby.

Table 1 makes such a comparison. In Table 1, the "nearby area" represents several small storm areas over southern Louisiana. Comparison of the data in Table 1 shows that at the time of the accident the storm area over the airport was growing at roughly twice the rate of other storms in the same "mesoscale" region.

4. CONCLUSIONS

Post analysis of rapid scan satellite data has shown that at the time of the aircraft accident that the most rapid convective development was occurring in the vicinity of Moisant Field. This rapid intensification occurred where three well defined boundaries, readily identifiable using animated rapid scan visible imagery, merged. It should be noted, that the activity on 9 July would most likely have gone unnoticed if the intersection had not occurred directly over a high traffic air facility, and been the site of an aircraft accident. In the case of 9 July 1982, the routine detection of such intersections would require: 1) rapid scan (RRSD) satellite data; 2) real time availability to that data; 3) equipment for analyzing the data (animation, ability to extract temperatures, etc.); and 4) forecasters trained in using satellite and other data sources for mesoscale analysis and very short range forecasting (nowcasting).

Will we ever have the ability to make such very short range forecasts (nowcasts)? Currently, equipment and analysis techniques capable of providing information on this scale are not available. However, the design of such a system is one integral part of the PROFS program (Beran and MacDonald, 1982). Also, NEXRAD promises to provide Doppler radar information to forecasters. Finally, routine five-minute interval imaging, with an improvement in infrared resolution by a factor of two, is planned for the next generation GOES satellites (around 1988).

Table 1. Comparison of growth rates over MSY and nearby region as computed using 3 minute interval GOES West infrared data.

	Storms over MSY			Nearby region storms		
Time GMT	Temp. deg C	Height Kft	Growth ft/min	Temp. deg C	Height K ft	Growth ft/min
2101	-11.7	21.3		-26.2	28.0	
			966			667
2104	-17.2	24.2		-30.7	30.0	
			1600			500
2107	-28.0	29.0		-34.2	31.5	
			1033			667
2110	-36.2	32.1		-39.2	33.5	
			700			333
2113	-41.2	34.2		-42.2	34.5	

However, understanding is sorely lacking concerning the causes of mesoscale weather development. And it is through improved understanding - in conjunction with these improved data sources and analyses - that truly good, accurate mesoscale analyses and forecasts (nowcasts) will be possible. Thus, the answer to the above question is: "Yes, provided the proper research and training takes place along with the development of new data analysis and observational systems."

5. ACKNOWLEDGEMENTS

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