

Reply

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Colorado State University Atmospheric Science Paper No. 200 by David Novlan (1973) gives more details on the data reduction procedures of our hurricane tornado study. Our source for the number of tornadoes in Beulah as referenced in this report is a study by G. Grice, J. R. Scoggins, and R. A. Clark (1967) titled "An Investigation of the Tornadoes Associated with Hurricane Beulah." On page 2 of this study the authors note the discrepancies in the number of tornadoes reported with Beulah (47, 85, 115, 141) and again assert

on page 5 that their sources were teletype reports and the survey of the State Climatologist. Furthermore, on page 6 of this study the number of tornadoes is broken down by day as follows:

September 19	---08
20	---62
21	---33
22	---33
23	---05
Total	-----141

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Figure 5 of this study shows the positions of these tornadoes by day in the state of Texas.

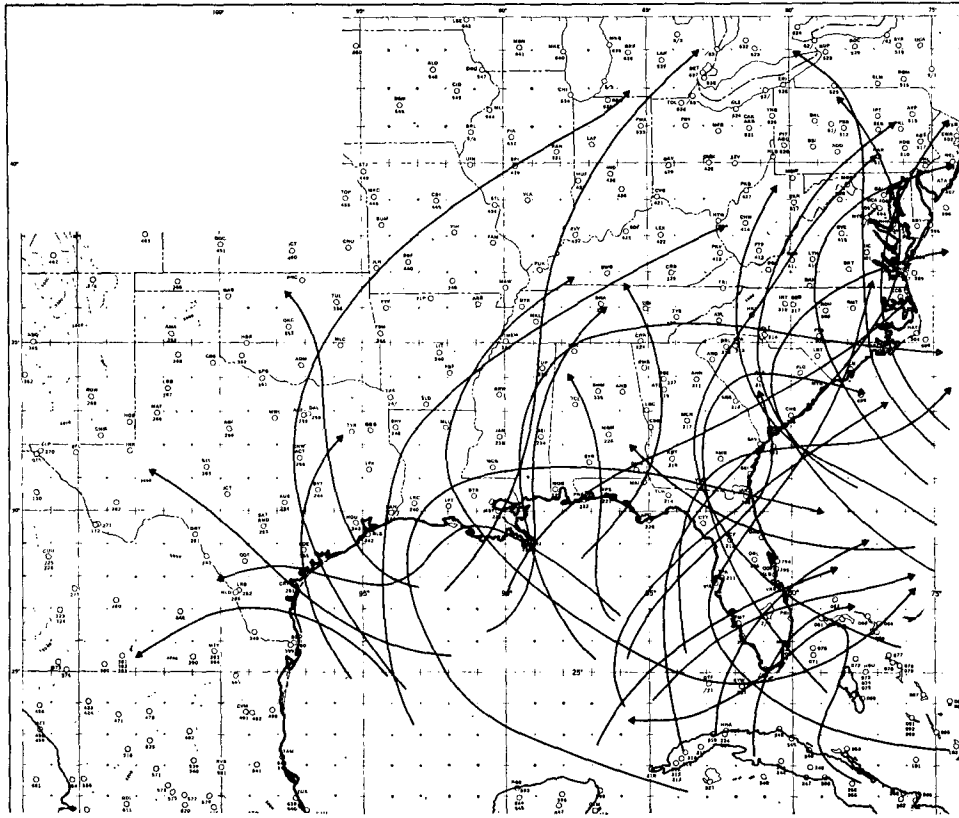


FIG. 1. Tracks of tropical cyclones which spawned tornadoes.

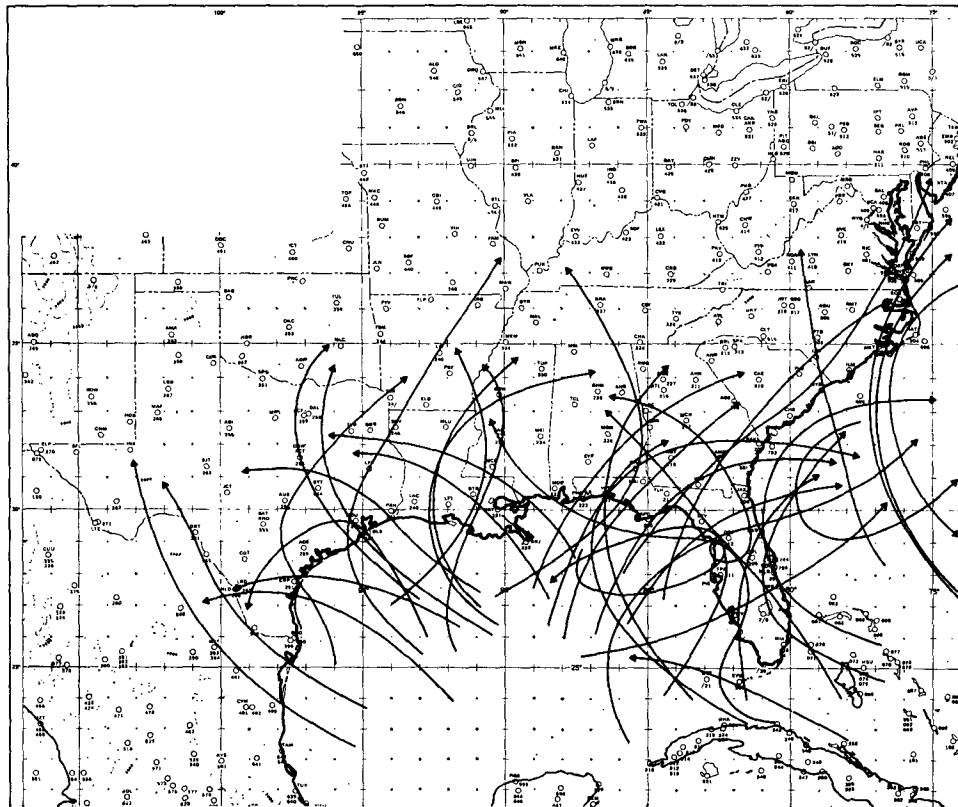


FIG. 2. Tracks of tropical cyclones which did not spawn tornadoes.

Likewise, the source for the number of tornadoes in Carla was also referenced in Colorado State University Report 200. The source is "The Hurricane Tornado," by J. S. Smith (1965). All 26 tornadoes are listed with respect to date, time of occurrence, and location. Different sources will often quote slightly different numbers but this is, in our opinion, a minor point. There are always problems in specifying the exact number of tornadoes for these types of storms. How about those hurricanes which spawned tornadoes which weren't detected because they occur in remote areas of the storm which prevented detection?

With regard to the quadrant question of there being no available soundings to the rear of the hurricane center, this is dependent on the direction of hurricane motion and the character of the surrounding land features. Figures 1-2 show how variable these directions and land features are and how it is very possible to have soundings in the rear quadrants. Fig. 1 portrays the tracks of tropical cyclones which spawned tornadoes, Fig. 2 the tracks of cyclones which did not spawn tornadoes. There were 75 U. S. soundings within 100 n mi and 3 h of tornado occurrence. These are *all* available documented data. There were also 75 null soundings chosen from closely similar hurricane tracks which reported no tornadoes. The similar pairs of matched hurricanes *with* and *without* tornadoes were very carefully chosen with regard to trajectory, distance from the center, intensity, etc. The number of observations

per quadrant percentage-wise was:

Right front	78%
Left front	8%
Right rear	10%
Left rear	4%

Very few observations came from the southern quadrants. They were made possible by such cases as Carla which, on 13 September 1961, still spawned tornadoes when her decaying center was northwest of Dallas. In addition, many east coast storms went inland, then recurved and spawned or did not spawn tornadoes, permitting proximity soundings in their left rear quadrants. Also, many Gulf-coast storms passed west of Florida and entered Georgia. This permitted proximity soundings in distant right-rear quadrants over Florida. As most tornadoes occur in the right-front quadrant, it is fortunate that the majority of our soundings are in this location.

REFERENCES

- Grice, G. K., J. R. Scoggins, and R. A. Clark, 1967: An investigation of the tornadoes associated with hurricane Beulah. Texas A & M University Report, 26 pp.
- Novlan, D. J., 1973: Hurricane spawned tornadoes. Dept. of Atmos. Sci. Report No. 200, Colorado State Univ., 57 pp.
- Novlan, D. J. and W. M. Gray, 1974: Hurricane-spawned tornadoes. *Mon. Wea. Rev.*, **102**, 476-488.
- Smith, J. S., 1965: The hurricane-tornado. *Mon. Wea. Rev.*, **93**, 453-459.