"The Blue Line" Depicted on Satellite Imagery

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ABSTRACT

Meteorological satellite imageries have shown the "rope cloud" over large bodies of water such as the Gulf of Mexico. Terrain and friction cause this cloud to lose its characteristic pattern as it moves over land. A rare case where a rope cloud is depicted over land is discussed. The passage of this cloud through Cape Canaveral's Air Force Station Weather Information and Display/WIND System shows the rope cloud to have the characteristics of a cold front.

1. Introduction

Frontal cloud bands have been vividly depicted on satellite imageries since our first meteorological satellite was launched. Meteorologists, depending on their individual training and experience, use frontal symbolism (blue lines, red lines and purple lines) in various locations within the depicted frontal cloud bands. Satellite imagery does an excellent job of depicting frontal zones, but it does not indicate the exact location of the surface position of the front. However, there is one possible exception—the rope cloud.

2. Discussion

During the past few years, the rope cloud has been observed quite frequently. Unfortunately, most of the data were over the ocean or areas of sparse synoptic data. Because of this sparsity of conventional data, no confirmation of the rope cloud's coincidence with the surface position of the cold front could be proven. Anderson *et al.* (1966) observed a cloud line resembling a "rope" in the Gulf of Mexico. His opinion was that the rope cloud was most often seen along the less active portions of fronts which extended into subtropical regions. The example accompanying the discussion showed a thin cloud line on the warm edge of the frontal band with radar-measured cumulus tops at 6 km. Wann (1973) published an article on the rope cloud in which he stated that the position of a cold front was apparently "due to the recognizable frontal rope, a hard line of cumulus clouds," but there were no conventional data substantiating this fact.

Defense Meteorological Satellite Program (DMSP) products received in Hawaii often showed this rope cloud over the ocean area. In a Picture of the Month Shaughnessy and Wann (1973) showed rope cloud over the Pacific Ocean. They stated that the "frontal rope is coincident with the leading edge of frontal systems traversing the central Pacific." Their accompanying figure showed the leading edge of a frontal system containing a frontal rope. Their two-year study revealed that cloud tops in the frontal rope would not exceed 4–5 km in the central Pacific. Cloud tops along and in the vicinity of the "frontal rope" were estimated to have maximum heights of not more than 3.3 km with most tops below 3 km.

In 1974, *Aviation Week*[4] published a 0.6 km resolution DMSP photo with a perfect example of rope cloud over the Gulf of Mexico. The accompanying caption stated: "Rope cloud formation, extending from northeastern Mexican coast to a point south of the Mississippi River delta, marks boundary between warm, moist tropical air to the south and cold, dry air to the north." Indeed, a perfect definition of a cold front or the "blue line."

All of the above examples were over the ocean where orographic effects could not disrupt the rope cloud's distinctive characteristics. There were no conventional data to prove or disprove that the rope cloud coincided with the surface position of the cold front. The chance of a rope cloud occurring and maintaining itself over a synoptic network is remote. The narrowness (<40 km) of a rope cloud lends itself to being rapidly torn apart and distorted as it passes over land. Fortunately, however, the terrain of Florida is low and without extensive surface roughness. Therefore, the probability is higher of seeing a rope cloud over this peninsula as it moves onshore from the Gulf of Mexico.

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[4] Issue of 20 May, p. 20.

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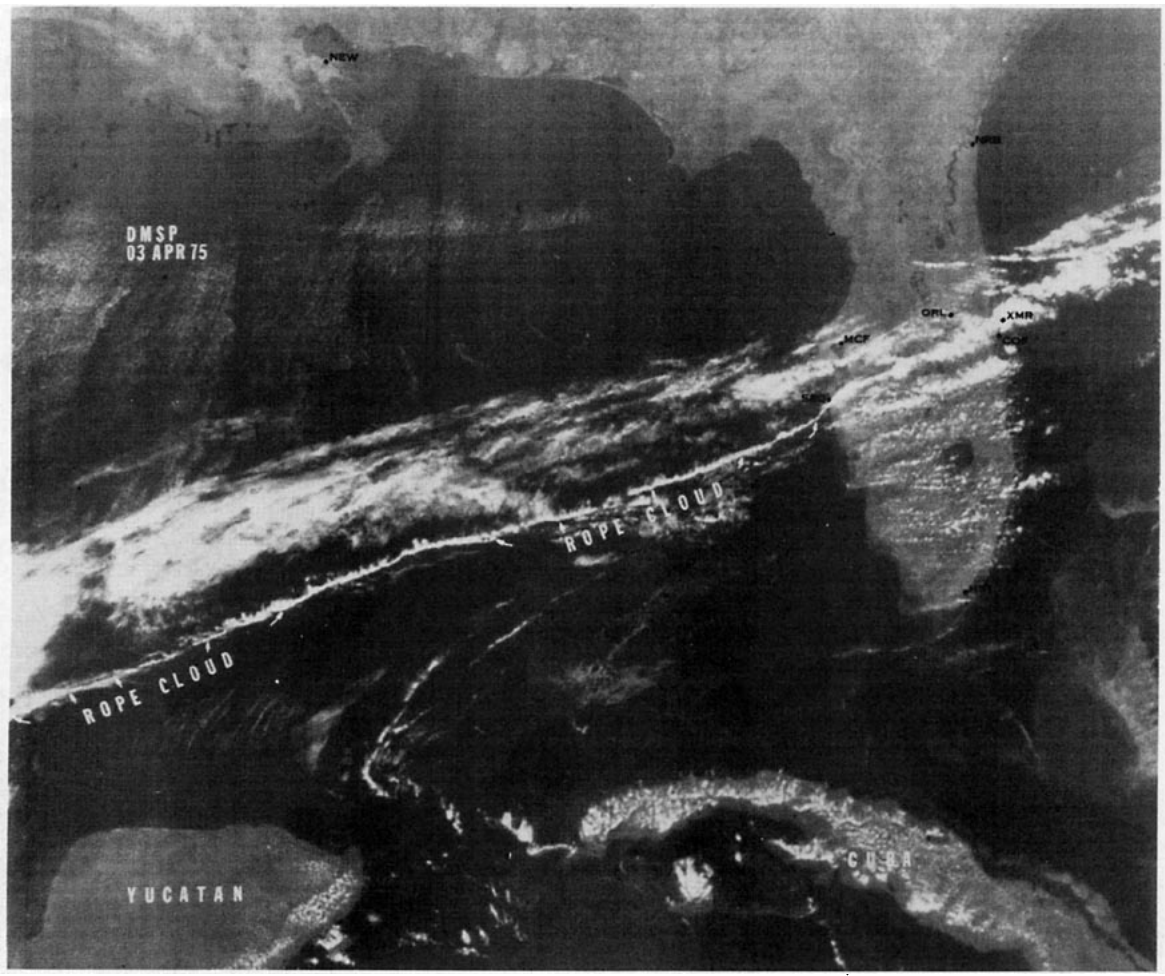

FIG. 1. DMSP visual imagery taken on 3 April 1975 from 1731 to 1733 GMT showing rope cloud in the Gulf of Mexico extending into Florida peninsula. Weather stations lettered in Florida include Orlando (ORL), Cape Canaveral (XMR), Patrick AFB (COF), Tampa (MCF) and Sarasota (SRQ).

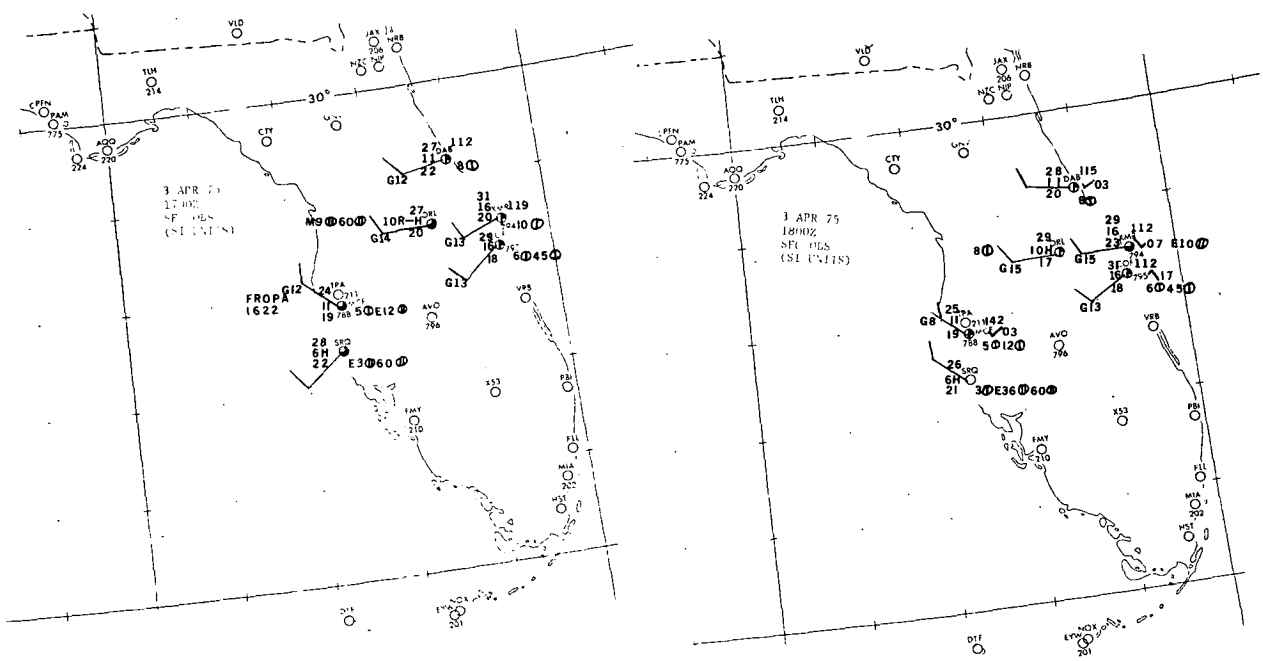

FIG. 2. Sectional surface maps for 1700 and 1810 GMT 3 April 1975 using SI units. In wind symbols, a full barb represents 10 m s^{-1}.

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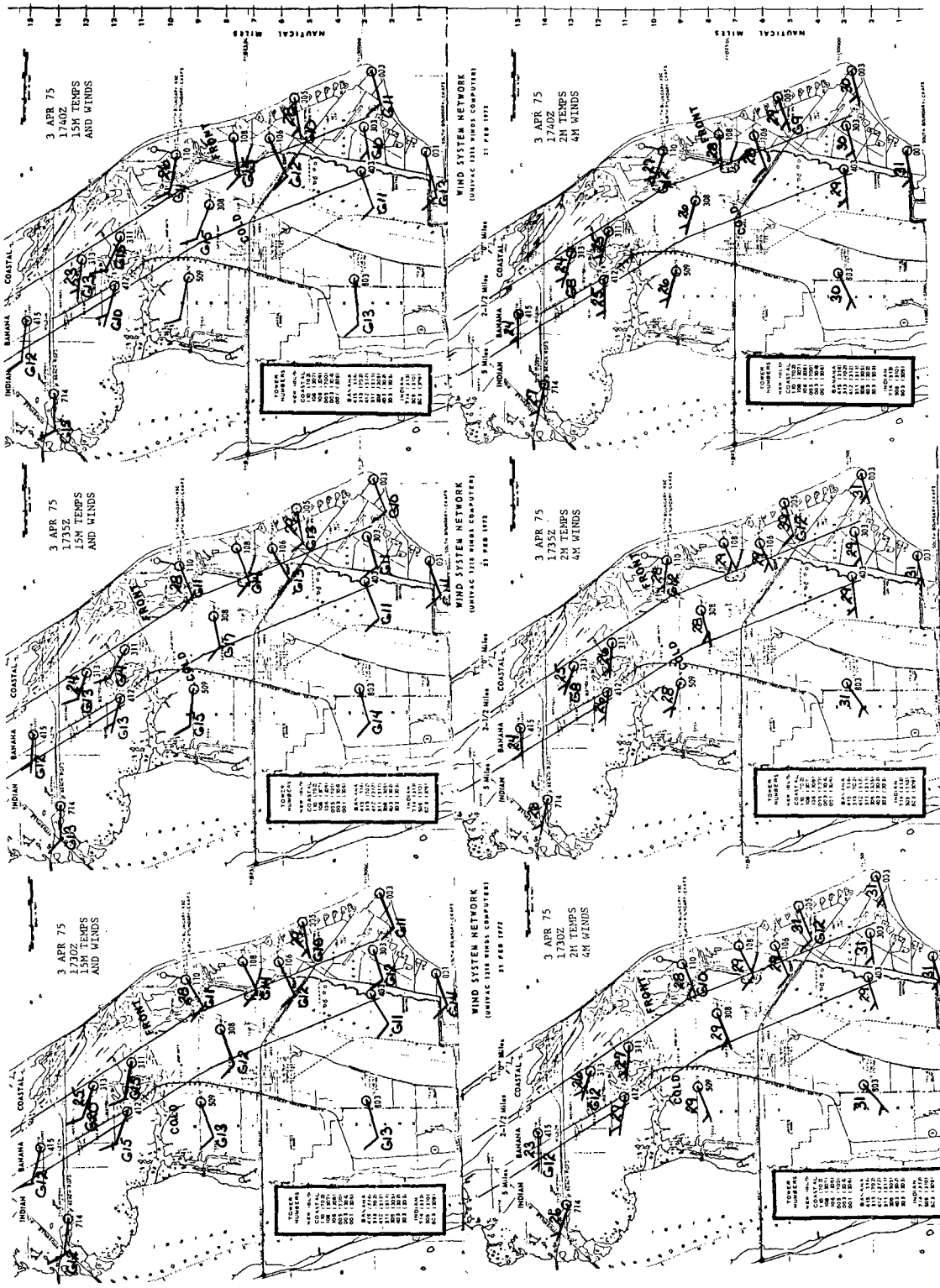

FIG. 3. Plotted data (SI units) from the Weather Information and Display (WIND) System at Cape Canaveral Air Force Station. Charts are for 1730, 1735 and 1740 GMT. Plotted using SI units. See text.

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A narrow, fast-moving cold front passed over central Florida between 1700 and 1800 GMT on 3 April 1975. The visual DMSP imagery with 0.6 km resolution is shown in Fig. 1. A rope cloud is clearly seen and labelled in the Gulf of Mexico. The rope cloud retains its identity as it intersects the west coast of Florida, where it is slowed down by surface friction. The rope cloud widens as it extends across the state through Cape Canaveral Air Force Station. Fortunately, a multitude of meteorological observations were available for this time period including data at 5 min intervals. Fig. 2 contains sectional surface charts for 1700 and 1800 GMT.

A close comparison of the satellite imagery and the plotted charts reveals the fact that, in this case, the rope cloud is, indeed, the "blue line." The 1731–1733 GMT DMSP picture indicates the major cloud mass to the north of Cape Canaveral AFS and the rope cloud directly over Sarasota (SRQ).

Looking at Fig. 2, one finds little difference in Tampa's two observations following a reported 1622 GMT frontal passage (FROPA), but Sarasota's (92 km south of Tampa) observations indicate a frontal passage between 1700 and 1800 GMT. Orlando's (ORL) observation indicates post-frontal clearing and drying, and Cape Canaveral AFS (XMR) on the east coast indicates that the frontal zone had passed through between 1700 and 1800 GMT. Patrick AFB (COF) is still south of the front at 1800 GMT.

Further creditability is added to the rope cloud by the data from the Cape Canaveral AFS Weather Information Network and Display (WIND) system. The WIND system consists of meteorological towers located throughout the NASA and Cape Canaveral complexes. Each tower measures parameters such as wind direction, speed, temperature and humidity at 2, 4 and 15 m at 5 min intervals. Data from these towers are plotted as two sets of charts in Fig. 3. The first set (lower half of the figure) contains the temperature at 2 m and the wind at 4 m; the second set (top half of the figure) contains winds and temperature at 15 m. An analysis of these data reveal the following pattern.

BASED ON LOWER LEVEL TOWER DATA

1) At 1730 GMT, based on the charts for the lower levels, the front is between Towers 311 and 509, based on wind direction and temperature.

2) At 1735 the front has passed Tower 509 (wind veered and temperature cooled 1°C) and is upon Tower 110 (wind starting to veer, speed increased and gusting to 12 m s^{-1}).

3) At 1740 the front is south of Towers 308 and 110 and appears to be in the immediate vicinity of Tower 108 (wind beginning to veer).

BASED ON 15 m DATA

4) At 1730 the front is between Towers 311 and 509 (wind direction).

5) At 1735 the front has passed Tower 509 (wind veered, gusts increased from 13 to 15 m s^{-1}). It appears to be in the immediate vicinity of Tower 308 (wind gust increased 12 to 17 m s^{-1}). But, the front is still north of Tower 110.

6) At 1740 the front is past Tower 110 and in the vicinity of Tower 108.

The meteorological information from these towers indicates that the rope cloud or frontal zone is very narrow and moving rapidly.

3. Conclusion

This note covers the analysis of a rope cloud moving over land. Shown are a satellite picture of the rope cloud, plotted maps indicating passages of the rapidly moving front, and data from a complex net of meteorological towers. The extensive ground truth data verifies that for this case, the rope cloud is the cold front.

REFERENCES

Anderson, R. K., E. W. Ferguson and V. J. Oliver, 1966: The use of satellite pictures in weather analysis and forecasting. World Meteorological Organization, Tech. Note No. 75, pp. 22, 23 and 111.

Shaughnessy, J. E., and T. C. Wann,, 1973: Picture of the Month: Frontal rope in the North Pacific. *Mon. Wea. Rev.*, **101**, 774–776.

Wann, T. G., 1973: The use of DAPP data in map analysis (surface streamlines). *Aerospace Sci. Rev.*, Air Weather Service, August, 18–21.

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