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THE DEEPENING OF A LOW-LEVEL TROUGH AS INDICATED BY DUST ALOFT IN GOES-1 INFRARED PICTURES

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1. INTRODUCTION

Dust aloft in the plains area of the central United States has been observed on satellite pictures on several occasions.^{1, 2, 3} The occurrence of blowing dust is recognized as a problem to agriculture, aviation and other activities. The occurrence of dust as indicated by satellite pictures can also be used as a forecast aid. On 13 March 1977, a low-level trough was moving slowly eastward out of the Rockies. As it moved over the plains it deepened rapidly. As the low-level winds became more southerly and increased in speed along the eastern side of the trough, quantities of dust were indicated by GOES-1 infrared pictures from eastern Texas and Louisiana to Kansas. The shift in low-level winds as indicated by dust aloft in the GOES-1 pictures provided evidence of the rapid deepening of the trough many hours sooner than provided by constant-pressure charts.

2. DISCUSSION

On 10 March 1977, a rather deep low, with a tight

pressure gradient and strong surface winds moved out of southeastern Colorado into Kansas. The surface low became virtually stationary over Kansas for about thirty-six hours (from 0000 GMT, 11 March 1977 to about 1200 GMT, 12 March 1977). During this thirty-six hour period, the associated cold front moved rapidly eastward across Oklahoma and Texas. During this time strong winds on the west and south sides of the low picked up quantities of dust, resulting in reports of dust and blowing dust over southeastern Colorado, eastern New Mexico, western Kansas, western Oklahoma and most of Texas. After 1200 GMT, 12 March 1977 the low moved rapidly northeastward over Iowa, southeastern Minnesota and Wisconsin, leaving quantities of dust aloft over the plains area.

By 1200 GMT, March 13, 1977, a new surface trough lay from southeastern Wyoming across eastern Colorado and along the Texas-New Mexico border (Figure 1). This trough was reflected at 850 mb as a shallow short wave (Figure 2), while the only indication of the trough that could be

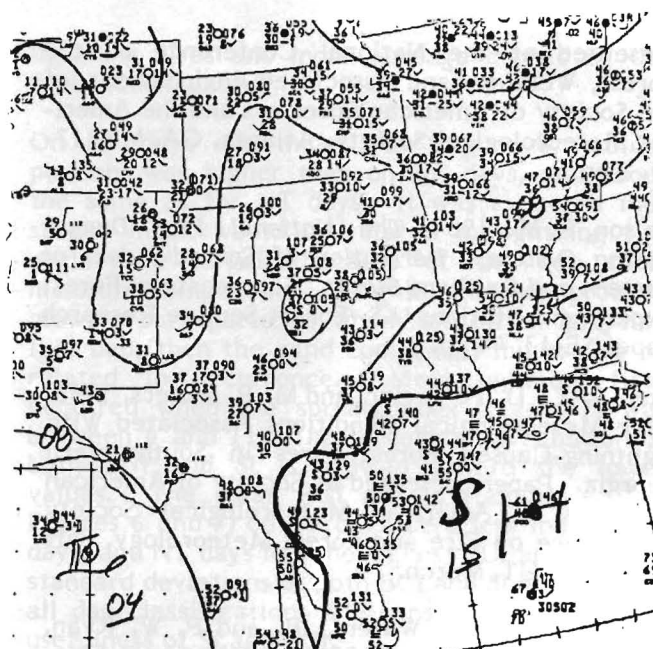


Figure 1. Surface Analysis, 1200 GMT, 13 March 1977.

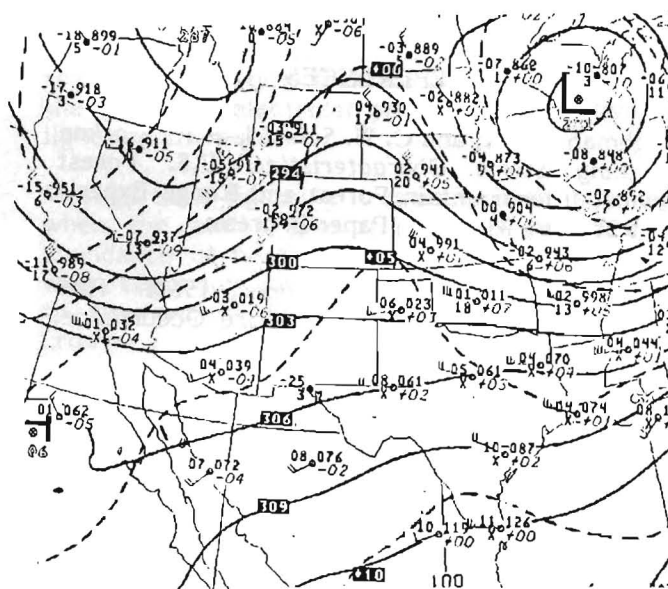


Figure 3. 700-mb Analysis, 1200 GMT, 13 March 1977.

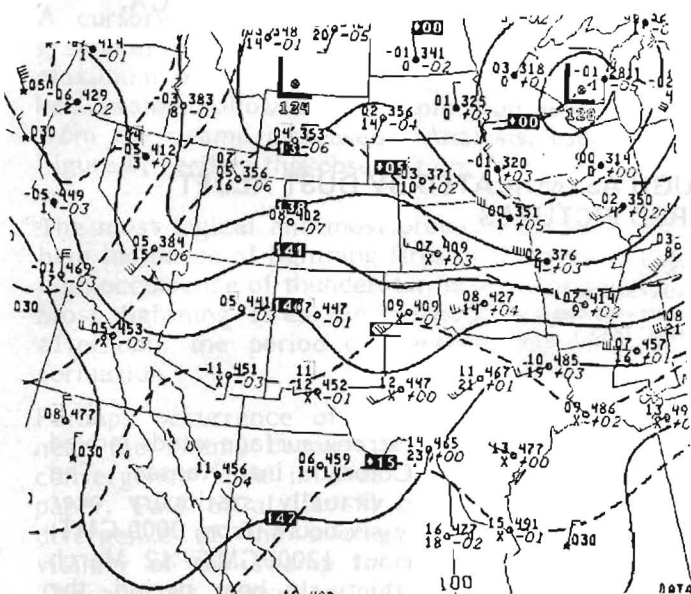


Figure 2. 850-mb Analysis, 1200 GMT, 13 March 1977.

found at 700 mb and 500 mb (Figures 3 and 4) was a thermal ridge at 700 mb.

As the day progressed, the trough at the surface and at 850 mb deepened, and by 0000 GMT, March 14th, became apparent at 700 mb (Figures 5 through 10), but was still not clearly defined at 500 mb (Figure 11).

By 1530 GMT, infrared pictures from GOES-1 indicated dust (A) across central Kansas and the eastern three quarters of Oklahoma (Figure 12). By 1730 GMT, the infrared GOES-1 pictures indicated dust over the eastern half of Texas as well (Figure 13). Dust continued to be shown by

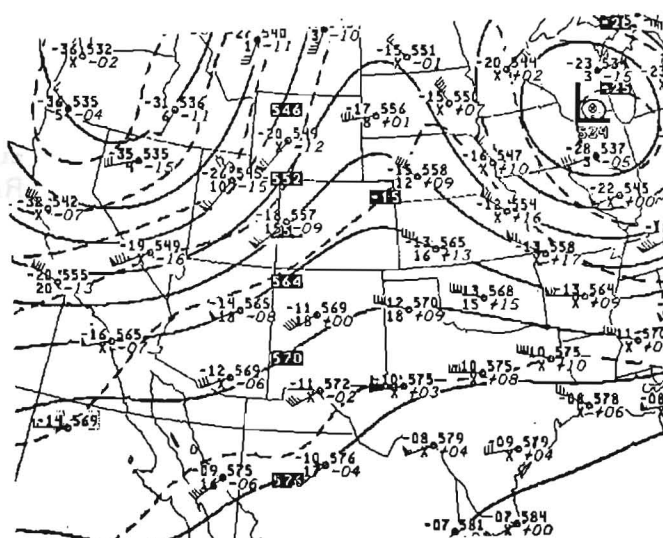


Figure 4. 500-mb Analysis, 1200 GMT, 13 March 1977.

GOES-1 infrared pictures through 2130 GMT (Figures 14 and 15). The visible GOES-1 pictures during this time showed no evidence of this dust (Figures 16 through 19), indicating that while the dust concentration remained fairly low, it was transported to some height in the atmosphere. If the concentration was great, there would most likely have been some indication on the visible pictures. At low levels it seems unlikely that there would have been enough temperature differences for it to have been distinguishable from the surface on the infrared pictures.

The dust streamlines along the eastern side of the trough indicate that the winds at the level of the

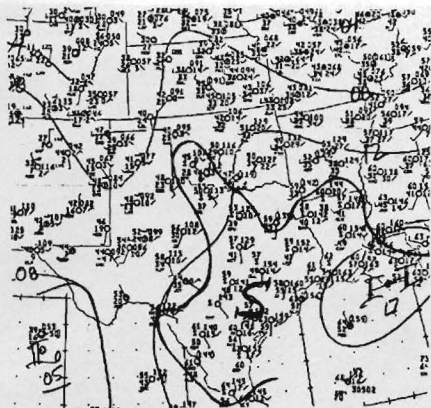


Figure 5. Surface Analysis, 1500 GMT, 13 March 1977.

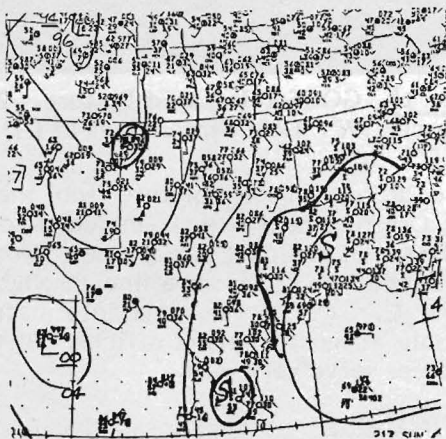


Figure 7. Surface Analysis, 2100 GMT, 13 March 1977.

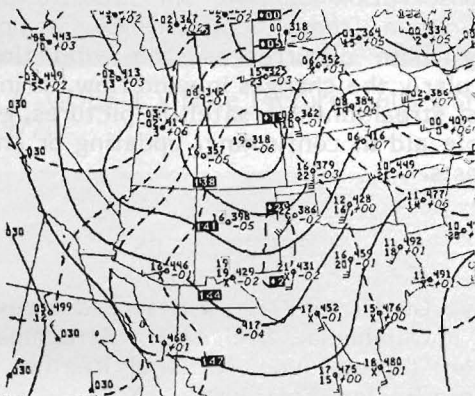


Figure 9. 850-mb Analysis, 0000 GMT, 14 March 1977.

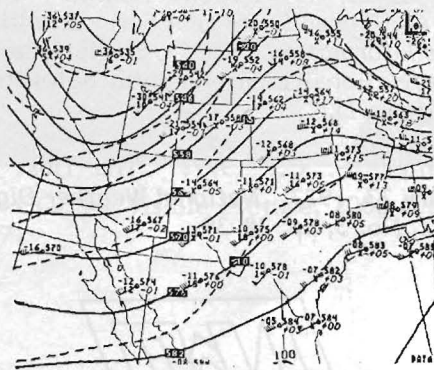


Figure 11. 500-mb Analysis, 0000 GMT, 14 March 1977.

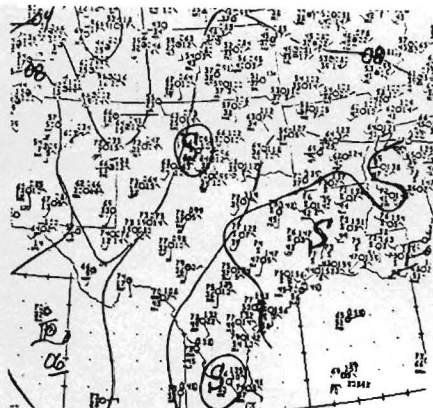


Figure 6. Surface Analysis, 1800 GMT, 13 March 1977.

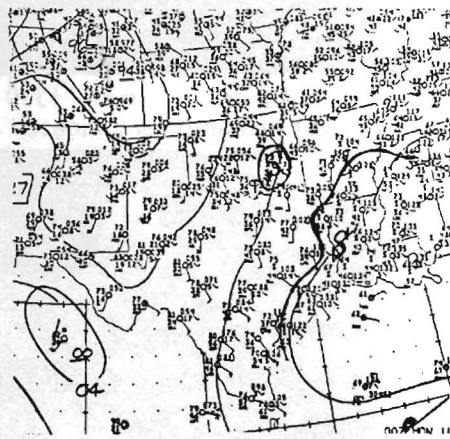


Figure 8. Surface Analysis, 0000 GMT, 14 March 1977.

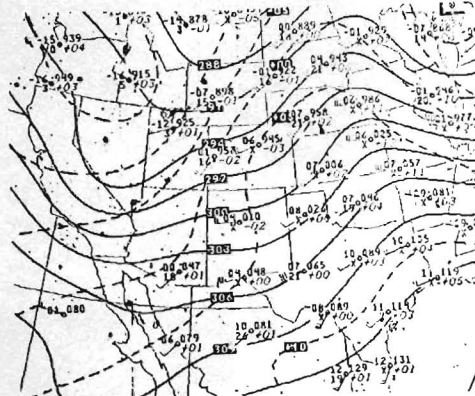


Figure 10. 700-mb Analysis, 0000 GMT, 14 March 1977.

dust were from 210° to 220° as early as 1530 GMT and maintained approximately that direction through 2130 GMT (Figures 12 through 15). This is much more southerly than indicated by the 1200 GMT 850 mb chart (Figure 2). This evidence of the deepening of the trough was available in forecast offices, via laser-fax printout, approximately eleven hours sooner than the constant pressure charts would be available. (The 0000 GMT 700 mb chart is currently scheduled at 0258 GMT and the 0000 GMT 850 mb chart at 0308 GMT.)



Figure 12. GOES-1 Infrared Picture, 1530 GMT, 13 March 1977. Dust Streamlines indicated at (A).

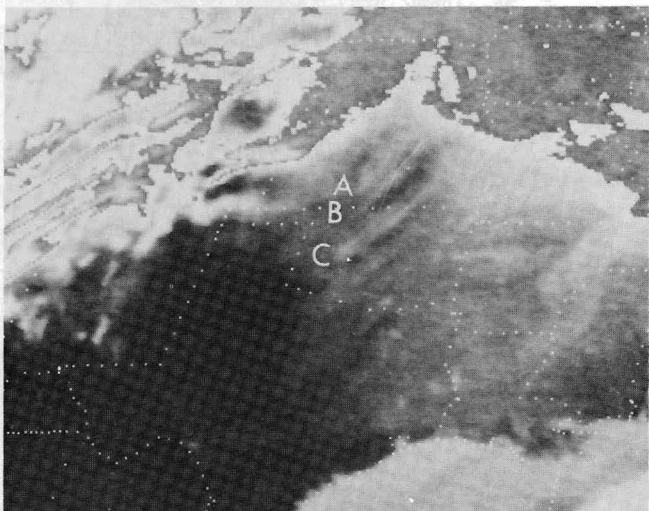


Figure 13. GOES-1 Infrared Picture, 1730 GMT, 13 March 1977. Dust Streamlines indicated at (A, B, C). General area of dust across East Texas, Louisiana, and Arkansas.

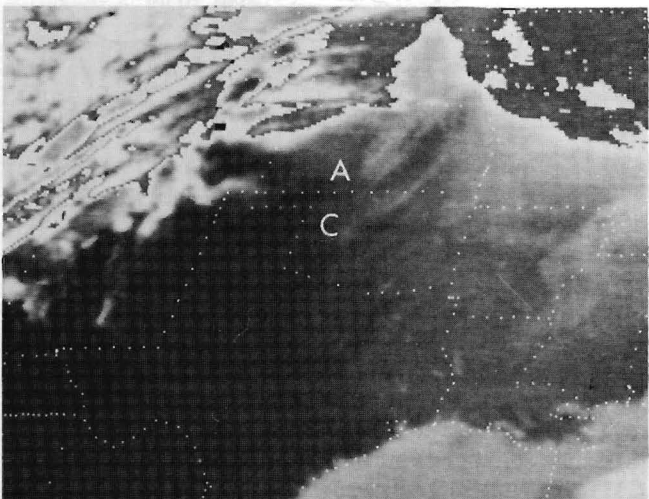


Figure 14. GOES-1 Infrared Picture, 2030 GMT, 13 March 1977. Dust Streamlines indicated at (A, C).

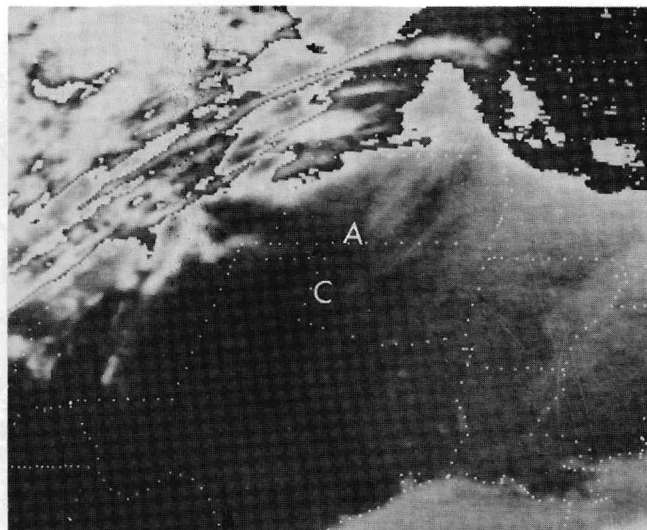


Figure 15. GOES-1 Infrared Picture, 2130 GMT, 13 March 1977. Dust Streamlines at (A, C).

Figure 20, a composite picture from the NOAA-5, Polar Orbiting Satellite, is included to show the full extent of the dust streamlines. Note streamlines northeastward from a line through points A, B, and C. Of course, this information is not available at most forecast offices, but the GOES-1 pictures serve very well.

3. SUMMARY

The observation of dust via satellite pictures, while not a frequent occurrence, is not rare. During those occurrences, the wind flow, and particularly the changes in wind flow, as indicated by dust streamlines on satellite pictures, can be a valuable aid in confirming, updating or amending forecasts.

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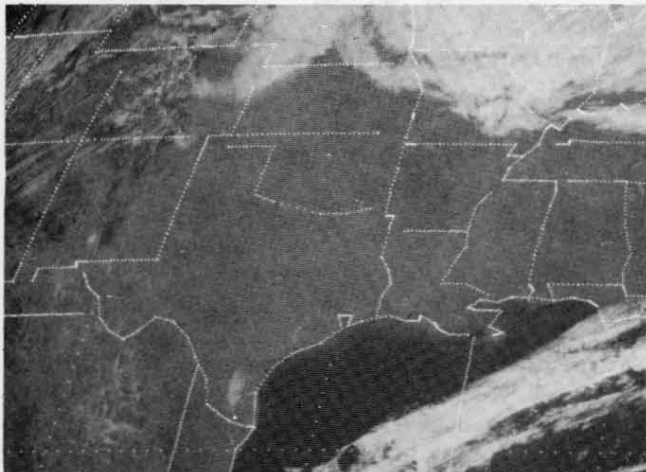


Figure 16. GOES-1 Visible Picture. 1530 GMT, 13 March 1977.

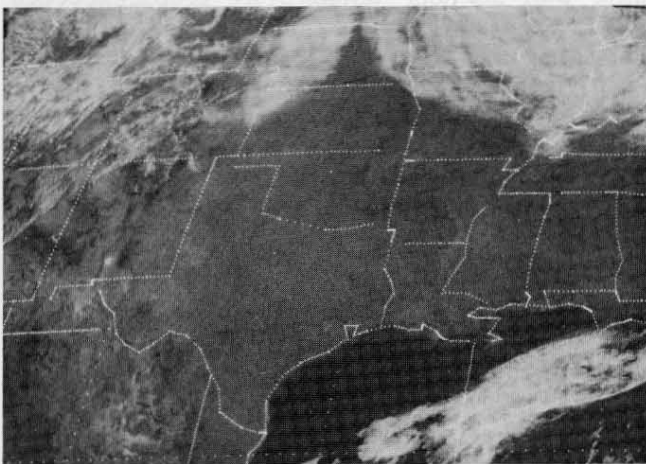


Figure 17. GOES-1 Visible Picture, 1600 GMT, 13 March 1977.

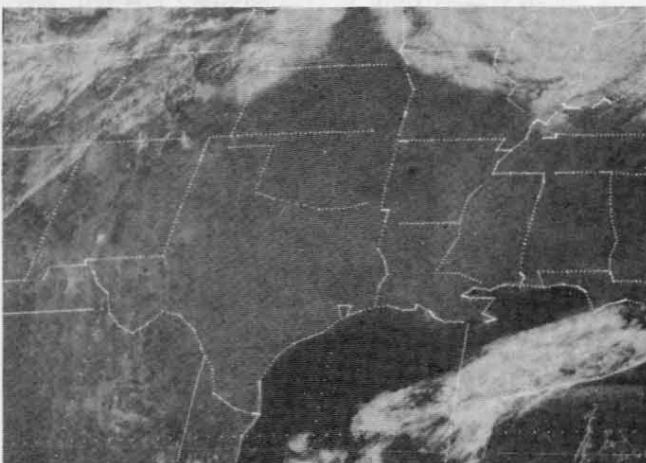


Figure 18. GOES-1 Visible Picture, 2000 GMT, 13 March 1977.

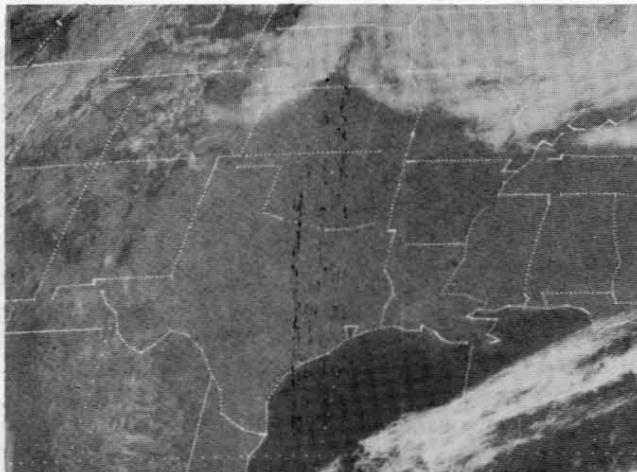


Figure 19. GOES-1 Visible Picture, 2100 GMT, 13 March 1977.

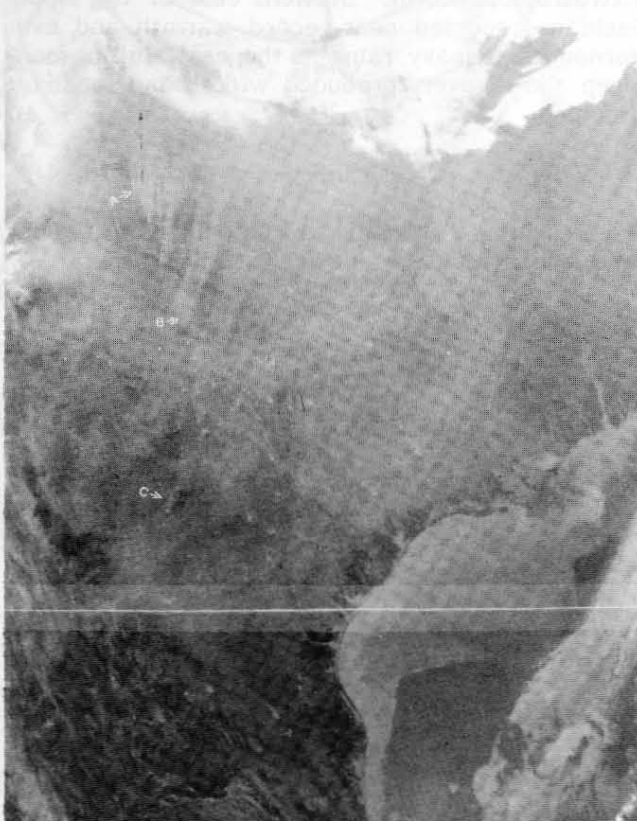


Figure 20. NOAA-5 Infrared Composite Picture at 15:37:46 GMT and 15:33:21 GMT, 13 March 1977.

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