GOES Observation of a Rapidly Melting Snowband

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ABSTRACT

GOES observation of rapid dissipation of a 5–10 cm (2–4 inches) depth snowband over the central and upper Mississippi River valley on 15 April 1980 is presented. Differences in the local weather between the stations with and without melting snow are discussed.

1. Introduction

The disappearance of significant snow areas or bands is usually a very gradual process, detectable in satellite imagery as subtle brightness changes from day to day. However, late season snows can melt more rapidly due to higher sun angles and warmer air flows. This note presents GOES visual observations of rapidly melting snow over the central and upper Mississippi River valley on 15 April 1980. In addition, the influence of the melting snow area on local surface weather is examined.

2. Satellite observations

GOES visible images (Fig. 1), displayed on the Man-Computer Interactive Data Access System (McIDAS) and used for the University of Wisconsin's synoptic laboratory course clearly describe the Midwest weather situation during 15 April 1980. A large cloud area centered over Ohio is associated with an occluded, eastward-moving cyclone. The previous day and evening this system brought a late season snow to the central and upper Mississippi River valley. Clear skies dominate the area west of the low due to a strong ridge in Nebraska. The resultant snow band in the wake of the low is depicted clearly in the 1400 GMT image (Fig. 1a) extending from northern Arkansas northeastward through Wisconsin. The GOES image from 2000 GMT (Fig. 1b) illustrates that the snow area is almost completely melted in just 6 h.

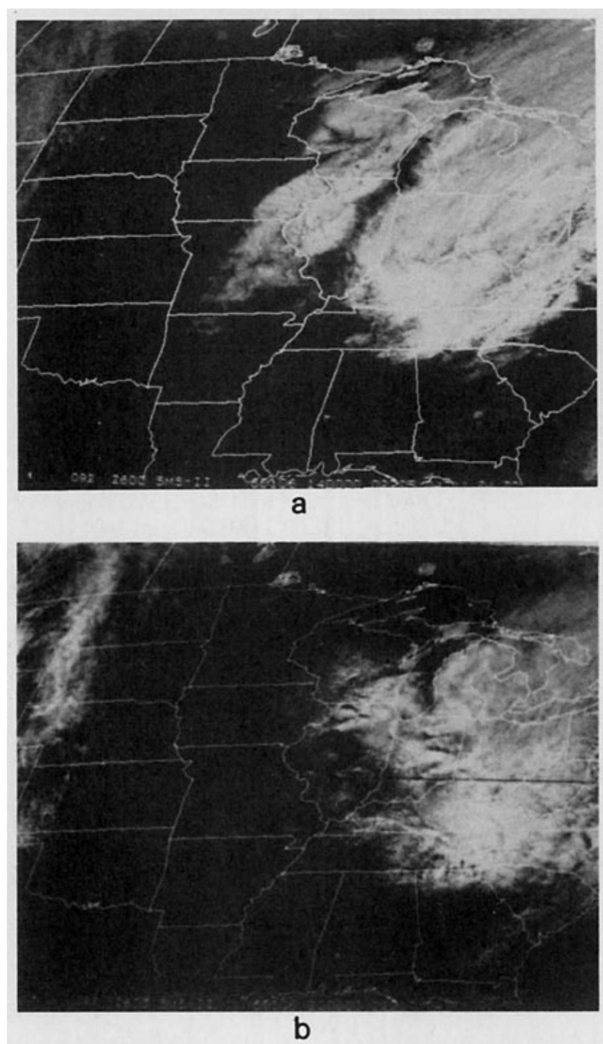

FIG. 1. GOES visual images of the midwest (4 km at subpoint), 15 April 1980: (a) 1400 GMT and (b) 2000 GMT.

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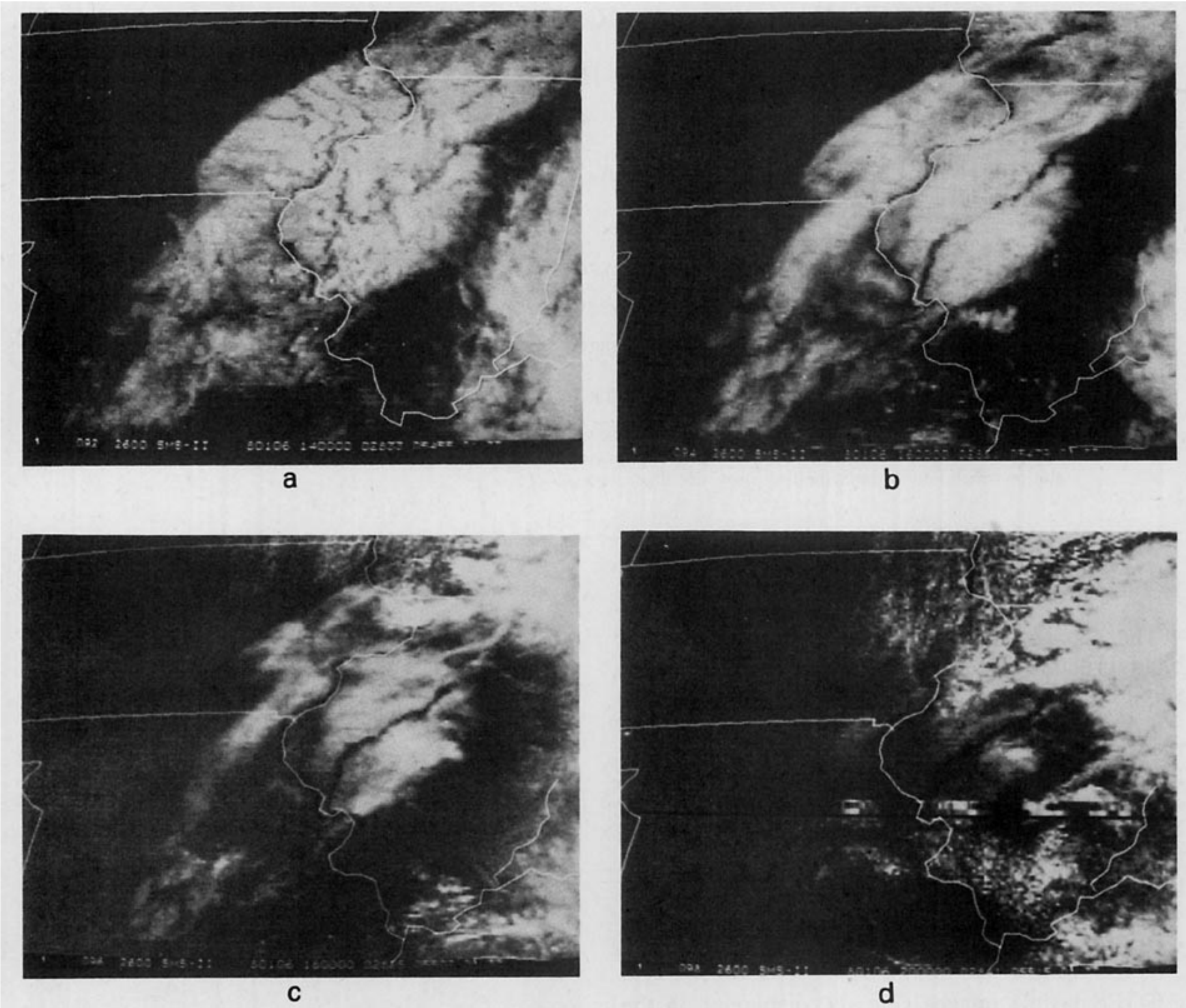

FIG. 2. Full resolution GOES visual images (1 km at subpoint) over snow area, 15 April 1980: (a) 1400 GMT, (b) 1600 GMT, (c) 1800 GMT, and (d) 2000 GMT.

Full resolution visible images (1 km at subpoint)[3] centered on the snow area every 2 h record the details of the rapid melt (Fig. 2). The snow depths at 1200 and 1800 GMT synoptic observation times are presented for comparison in Fig. 3. The morning snow depths ranged from 5–10 cm (2–4 inches), with the heaviest amounts in west central Illinois and eastern Iowa. The sequence of GOES images shows the rapid albedo changes as the snow melted. The Mississippi and Illinois River valleys, losing snow cover first, become distinct as dark sinuous lines against the still snow-covered higher terrain. By 1800 GMT only Springfield, Illinois, reported a measurable snow depth [2 cm, (1 inch)]. However, the 1800 GMT satellite data (Fig. 3c) indicates bright areas away from river valleys and cities, suggesting measurable snowcover still present in rural areas. By 2000 GMT even those areas have melted with only a small remaining snow area southeast of Springfield. Some scattered low clouds and fog were present over Illinois at 1400 GMT. This cloudiness dissipates before 1600 GMT; however, scattered afternoon cloudiness reappears over the region by 2000 GMT with a nearly overcast area over northeastern Illinois associated with a weak secondary front west of the occluded low. Cloudiness associated with this front is seen near Lake Superior at 1400 GMT (Fig. 1a).

Satellite detection and mapping of snowcover have been studied by Barnes and Bowley (1968)[4], Mc-

[3] Pixel size over Illinois (40°N, 90°W) is approximately 1.5 km by 1 km.

[4] Barnes, J. C., and C. J. Bowley, 1968: *Operational Guide for Mapping Snow Cover from Satellite Photography*, Contract Report No. E-162-67(N), Allied Research Associates, Concord, MA.

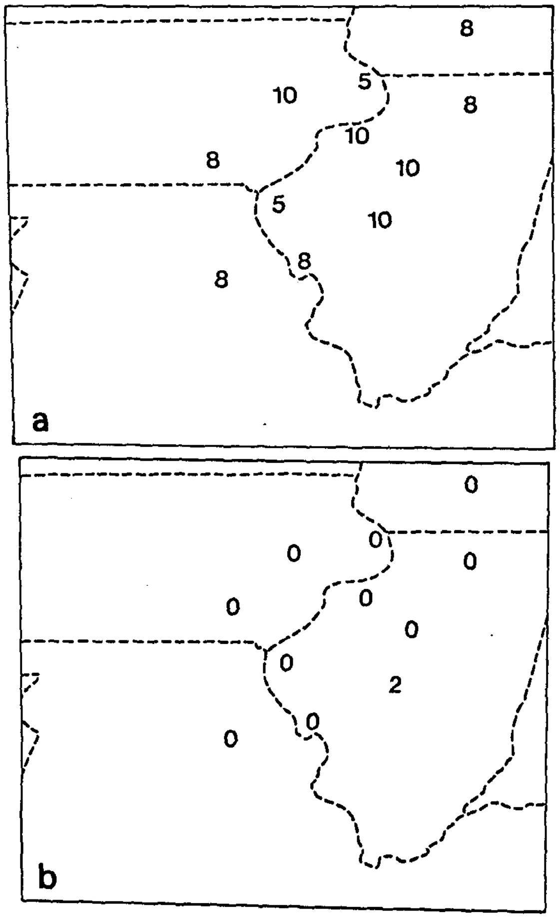

FIG. 3. Snow depth (cm) for 15 April 1980: (a) 1200 GMT and (b) 1800 GMT.

Ginnis *et al.* (1975), McGinnis and Schneider (1978), Wiesnet and Matson (1979), and others. Barnes and Bowley found that in non-forested areas, brightness can be qualitatively related to snow depths up to four inches (10 cm). For accumulation > 4 inches no further brightness change is normally detectable. This relation holds well in this example as the 10 cm reports in eastern Iowa and western Illinois are areas of maximum brightness (Fig. 2a). McGinnis and Schneider noted that even very light snowfalls (1–2 cm) are detectable in satellite imagery, given favorable terrain conditions. This is verified by the discrepancy between the 1800 GMT satellite image (Fig. 3c) and the reported snow cover. The small amounts of remaining snow at 1800 GMT are easily detectable by the satellite over the relatively flat, dormant landscape.

3. Local weather observations

Some influences of this snowband on the local weather are now discussed. Fig. 4 compares the 1200 GMT and 1800 GMT surface temperatures over

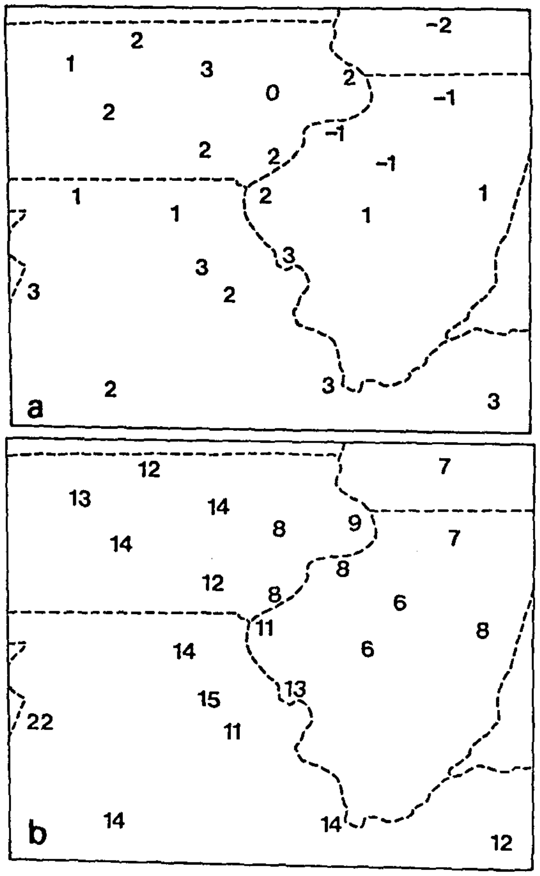

FIG. 4. Surface temperatures (°C) for snowband area, 15 April 1980: (a) 1200 GMT and (b) 1800 GMT.

the region. The early morning temperatures were near freezing, with a slight tendency for lower readings over the snow area. At midday (Fig. 4b) a defi-

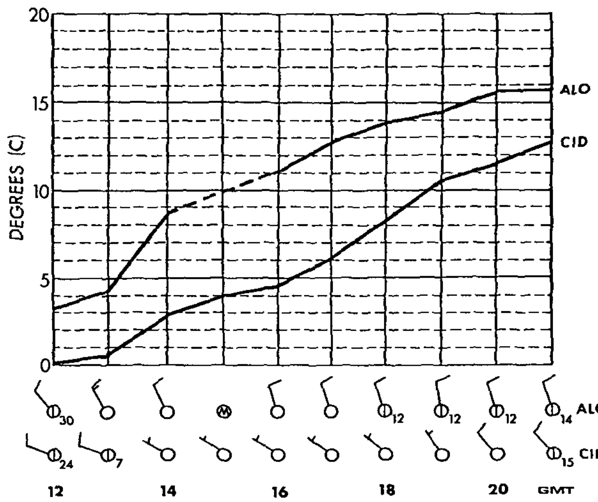

FIG. 5. Profiles of temperature (°C) and plot of cloud cover and surface wind (m s^{-1}) for Cedar Rapids (CID) and Waterloo, Iowa (ALO) during the period 1200 to 2100 GMT 15 April 1980.

nite region of lower temperatures is found over the snow area. Stations in the area of maximum snow depth (Cedar Rapids, Iowa; Springfield and Peoria, Illinois) are considerably cooler (6–8°C) than the surrounding areas (14–15°C). This cool area is advected eastward during the day.

The difference in local weather between the snow free and snowband areas is illustrated in Fig. 5 by a comparison of hourly temperatures, wind and cloud cover for Cedar Rapids (CID) and Waterloo, Iowa (ALO). These stations are only 50 nm (~90 km) apart; however, while CID reported a 10 cm snow depth at 1200 GMT, ALO reported none. Distinct weather differences are observed between the two stations. CID is approximately 6°C (11°F) cooler during the middle of the day, its wind speed of 5 m s^{-1} is half that of ALO, and scattered afternoon cumulus develop three hours later. The snow area temperatures are depressed during the day due to its higher albedo and the energy required to melt the 10 cm snow cover. The lower surface temperatures resulted in a more stable boundary layer and reduced mixing layer depth, hence the reduced wind speeds and later onset of afternoon cumulus.

4. Summary

This note presented GOES and surface observations of a rapidly melting 5–10 cm (2–4 inches) snowband over the central and upper Mississippi River valley on 15 April 1980. A sequence of visual images illustrates large albedo changes as the snow dissipated over a 6 h period. An analysis of surface reports during the day revealed the melting snow area was characterized by lower surface temperatures, reduced surface winds and later development of afternoon cumulus. These data illustrate the distinct mesoscale influence of the snowband and its melt on the 15 April local weather of this region.

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