

PICTURE OF THE MONTH

GOES Satellite Data Maps Areas of Extreme Cold in Colorado

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ABSTRACT

Geostationary Operational Environmental Satellite (GOES) enhanced infrared (IR) imagery depicted very cold temperatures over Colorado on the morning of 8 December 1978. The situation was unusual because skies were clear and the cold temperatures were not associated with high cloud tops. Instead, satellite data mapped large areas that were experiencing extremely cold surface temperatures. The GOES data were also examined using the Colorado State University interactive data processing system and it was found that the cold IR readings corresponded well with early morning low temperatures over the state. GOES data can be of use in monitoring surface temperatures and can, in certain situations, provide detailed spatial and temporal information over regions experiencing extreme temperatures.

1. Introduction

Satellite data have been used during recent years to monitor surface temperature in several ways. Bartholic and Sutherland (1976) mapped cold surface temperatures over Florida and showed that it was possible to monitor the frost threat to citrus crops. They suggested that satellite infrared data could be used to develop detailed climatologies of where the coldest temperatures should be expected over the peninsula during several characteristic types of frost situations. Carlson *et al.* (1977) performed surface temperature analyses for the Los Angeles area and related morning and evening temperature maxima to types of land use. Urban heat islands over the eastern portion of the country were mapped by Matson *et al.* (1978) using data obtained on an unusually clear summer night. These efforts have used Very High Resolution Radiometer (VHRR) data (resolution ~1 km at the satellite sub-point) from the NOAA polar orbiter satellites. However, on certain occasions coarse-resolution IR data from GOES satellites can be used to monitor surface temperature distributions.

2. Conditions on 8 December 1978

The eastern GOES image (see Fig. 1) for 1200 GMT (0500 LT) on 8 December 1978 apparently indicated patches of high, cold cloud over Colorado

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(IR resolution ~ 8 km over Colorado). However, surface observations indicated that skies over the state were perfectly clear. The dark gray regions indicate IR temperatures in the range -25 to -41°F (-32 to -41°C) and in this unusual instance indicate that large areas of Colorado are experiencing bitterly cold surface temperatures. The temperatures observed are from emitted surface radiation and not shelter height temperatures. Thus one would assume the satellite temperatures would be slightly colder than shelter temperatures. Effects of atmospheric water vapor have not been considered.

As early as 0600 GMT the digitized IR data showed that large areas of Colorado were quite cold. Of special importance (although the GOES image shows only that surface temperatures are in the range -25 to -41°F) is the large area of indicated cold surface conditions in northwestern Colorado. This region is devoid of surface observation sites that operate at night and the operational image might have been used in summarizing state weather conditions, the early morning forecast, and even in providing information on the extent of the extreme cold to the public.

A map showing minimum temperatures recorded in Colorado on the morning of 8 December is presented in Fig. 2. It verifies that the GOES data indeed indicated cold surface conditions. A large number of stations reported low temperatures in the -30 to -50°F (-35 to -46°C) range with the coldest reported being a reading of -50°F at Maybelle in northwestern Colorado.

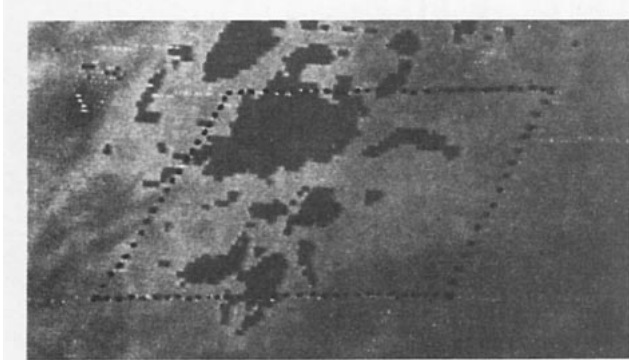


FIG. 1. GOES E digitized IR image for 1200 GMT 8 December 1978, showing Colorado and portions of surrounding states.

3. Analysis on an interactive system

The digital data stream from the GOES E satellite was recorded and archived at the Colorado State University Direct Readout Satellite Ground Station (CSU DRS GS). The sector being saved did not include far western portions of Colorado; however, enough data were recorded to provide an interesting comparison with the GOES laserfax image shown in Fig. 1. These data were processed on the All Digital Video Imaging System for Atmospheric Research (ADVISAR), a man/machine interactive data processing and display system (Smith *et al.*, 1977). Fig. 3 shows a digitized and re-mapped IR image for 1600 GMT (0900 LT) 8 December 1978. State borders are shown as are major interstate highways (I 25, I 70 and I 76 which stretches from Denver (DEN) to the northeast corner of the state along the South Platte River Valley). The Arkansas River is also indicated. The IR temperatures were displayed at

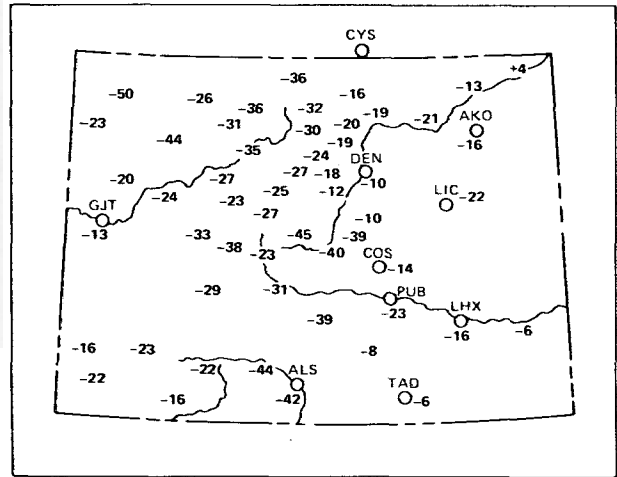


FIG. 2. Minimum temperatures recorded in Colorado on 8 December 1978.

1°C intervals for the temperature range -18°C (black) to -40°C (white). The corresponding GOES E visible image is shown in Fig. 4 for comparison. The skies were perfectly clear and the mountain ranges west of I 25 are visible. The three high mountain valleys (N. Park, S. Park, and the San Luis Valley—not marked but directly south of S. Park) remained extremely cold at this time with the digitally derived satellite surface temperatures in the range -34 to -37°C. The Fig. 3 digital display shows that mountainous terrain is relatively warm with the coldest air trapped in valleys and the major river basins. Such a display allows precise monitoring (both in space and time) of the surface temperature over a large region. This type of remote temperature mon-

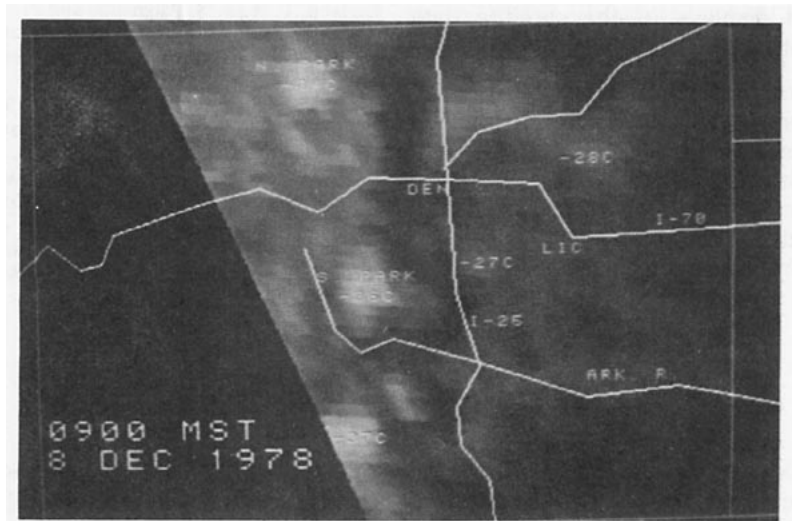


FIG. 3. Digitized IR image produced on the CSU ADVISAR for 1600 GMT December 8, 1978. Contour interval is 1°C with black = -18°C and white = -40°C. Some of the colder IR temperatures are indicated.

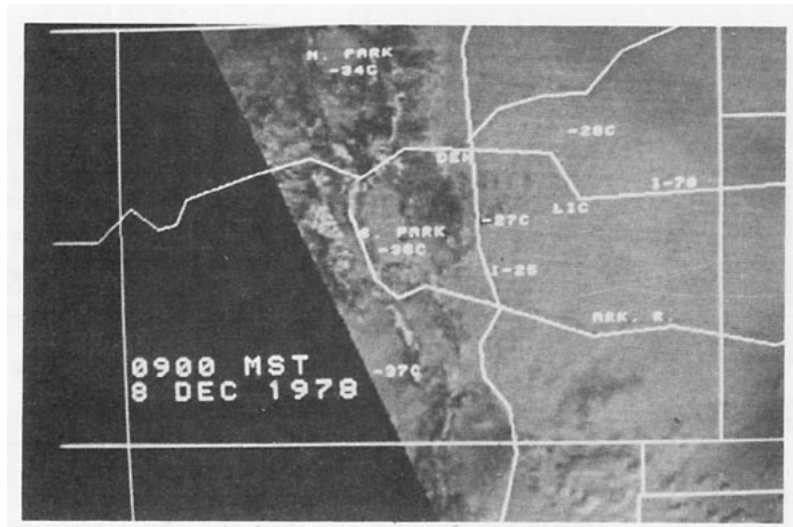


FIG. 4. GOES E visible image produced on the CSU ADVISAR for 1600 GMT 8 December 1978 with colder IR temperatures indicated.

itoring could be especially valuable over regions devoid of conventional observation sites.

4. Conclusions

Satellite imagery from 8 December 1978 have been used to show that, under certain conditions, coarse resolution GOES IR data can be of use in monitoring the extent and evolution of extreme surface temperatures. Such information could possibly provide valuable inputs to state weather summaries and forecasts, and fairly specific temperature information for energy related activities (e.g., public service companies and agribusiness). An interactive data processing system allows quantitative manipulations, interpretations and displays of the satellite data greatly increasing its usefulness.

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