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LIMITATION OF OPERATIONALLY AVAILABLE INFRARED SMS-1  
SATELLITE IMAGERY IN THUNDERSTORM DETECTION

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Satellite pictures, especially when used together with radar information and surface observations, have been very useful in identifying areas of thunderstorm activity.<sup>1</sup> There are, however, times that thunderstorms occur and yet are not detected by radar or even suspected from information in infrared (IR) satellite pictures. This paper illustrates one such case. In this case the thunderstorms had low tops and occurred in cold unstable polar air behind a cold front and ahead of an upper level trough.

The thunderstorms were reported on February 25, 1975, in surface observations from New York and Pennsylvania at the location and times shown in Table 1. Pilot observations (Table 2) also indicated thunderstorm activity over parts of Pennsylvania and New York between 1000Z and 1130Z. Radar observations from Pittsburgh and Buffalo indicated precipitation with tops to 14,000 feet, but no thunderstorms (Table 3). Radar observations from other adjacent stations did not report thunderstorm activity.

Table 1. Location and Time of Thunderstorm Reports, February 25, 1975

Williamsport, Pa.	1011 - 1030Z
Harrisburg, Pa.	1023 - 1045Z (FQT LTGCG)
Elmira, N.Y.	1035 - 1055Z
Syracuse, N.Y.	1128 - 1148Z

Table 2. Pilot Reports Indicating Thunderstorms, February 25, 1975

DEL ILG UA 1006 OVR ILG PILOT RPTS LTGIC DSNT NW C310

NY UCA UA 1120 SYR-DNY (46E BGM) TOPS 150 BLDUPS TO 170-180  
HI CIRRUS E LGT MDT CHOP VCNTY BLDUPS ON CLIMBOUT BA 11

Table 3. Buffalo and Pittsburgh Radar Reports, February 25, 1975

BUF 1033 AREA 7SW 48/112 101/107 166/104 252/41 321/55 2720  
MT 120 UNIFORM

PIT 1035 AREA 6SW 338/100 45/126 97/137 206/88 264/110  
C2625 MT 140 AT 70/88

PIT 1135 AREA 6SW 339/37 198/80 110W C2725 MT 140 AT 254/66

BUF 1133 AREA 6SW 33/126 79/124 150/104 194/70 291/84 2730 MT  
120 UNIFORM

<sup>1</sup>A Field Use of GOES Pictures in Maintaining a Weather Watch, Russell A. Dorr, Jr., Eastern Region Staff Notes Technical Attachment #74-9-3, 9/3/74.

SMS-1 four-mile resolution\* IR pictures received at WSFO Boston did not reveal any clues of thunderstorms embedded in the clouds over the area and times described in Tables 1-3. Visible pictures were not available because it was dark. What the IR pictures do show is a rather uniform grey appearing cloud pattern over the area in question, Central New York extending southward through Central Pennsylvania, with a much brighter cloud pattern just to the east, associated with a frontal system (Figure 1).

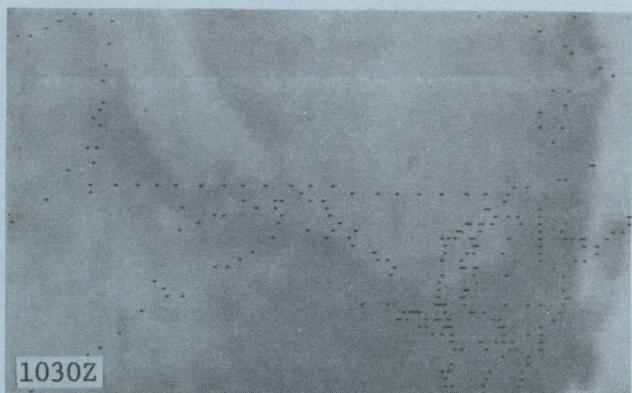
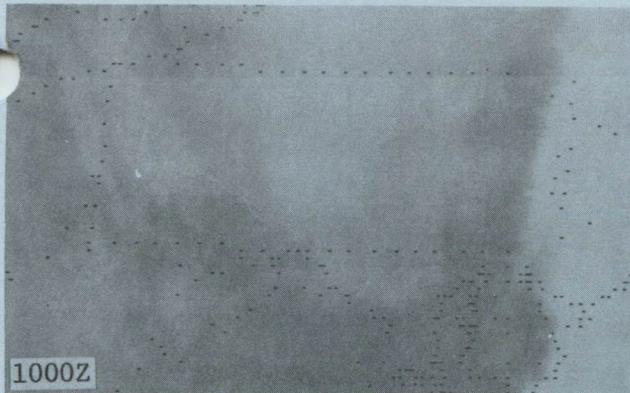
The thunderstorms are not suspected in these IR pictures because either the satellite was not capable of sensing revealing information that would distinguish the thunderstorm activity, or information sensed by the SMS-1 satellite could not be recognized in the operational photographs received at the WSFO.

IR pictures can be enhanced to make certain features stand out. For example, clouds usually associated with thunderstorm activity have higher, and therefore colder, tops than surrounding clouds. These colder cloud tops can be enhanced to make them appear brighter in the picture than the surrounding clouds within which they may be embedded. Enhanced IR pictures were produced for this case to help determine if the satellite did detect information useful in identifying the thunderstorms (Figure 2). Examining these pictures carefully, one can see a bright north to south oriented cloud pattern extending downward from point A on the top center of the pictures. This cloud pattern was enhanced to appear brighter while the surrounding clouds, in which this brighter pattern was embedded, appear dark. Even with this enhancement, there would be no reason to expect the presence of thunderstorms had there not been surface and pilot reports. However, once it is known that there are indeed thunderstorms present, then the enhanced pictures are of value in describing the extent and subsequent movement of the thunderstorm related cloud pattern. In Figure 2, the brightest and therefore highest clouds, on the far right of the pictures, are associated with the front to the east.

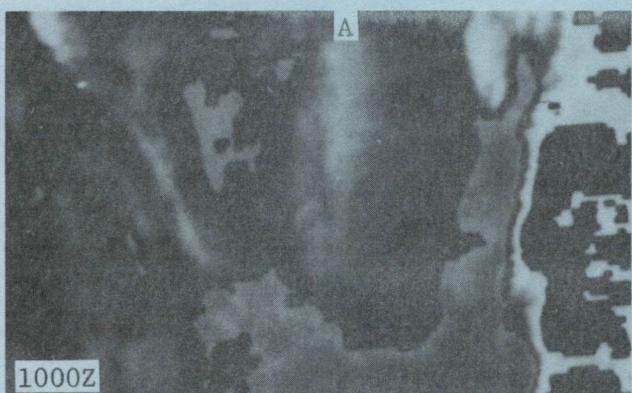
This case study presents what may be a typical limitation of satellites--the detection of thunderstorms with tops not much different in height or appearance than the tops of clouds in which the thunderstorms are embedded.

The significance of this example is it illustrates that if we are to maintain a high quality weather watch, we must use all information available, including radar, satellite, surface observations and pilot reports. Information from any one source should not be considered as redundant or misleading, but rather as an opportunity to enhance the information available from other sources.

\*The pictures were received enlarged to an equivalent of half-mile and two-mile resolution.



**Figure 1.** February 25, 1975 SMS-1 four-mile resolution infrared pictures as received at WSFO Boston. The upper pictures were received enlarged to an equivalent half-mile resolution in an attempt to see finer cloud details that may reveal reported thunderstorm activity over New York and Pennsylvania. The lower pictures are enlarged less, to an equivalent two-mile resolution, but show the clouds for a bigger area. Thunderstorm activity could not be recognized in the cloud detail shown over Central New York and Central Pennsylvania.



**Figure 2.** February 25, 1975 SMS-1 four-mile resolution enhanced IR pictures. The areal coverage in these pictures is slightly greater than the coverage shown in the top row of Figure 1. Thunderstorms were associated with the north-south bright area extending toward the bottom of the pictures from point A in the top center of the pictures. (Enhanced pictures provided by James Gurka, NESS Applications Group).