PICTURE OF THE MONTH

Reliability of Enhanced Infrared (EIR) Geostationary Satellite Data at High Latitudes

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An increasing need for quantitative values from satellite data has led to the development of numerous infrared data enhancement curves (Corbell *et al.*, 1976). Most of these curves have been designed for use on the geostationary (GOES) satellite data and represent temperatures typical of the tropical to mid-latitude regions that lie in the main field of view of these satellites.

The utility of continuous meteorological satellite data for high-latitude areas, such as Alaska, soon became apparent. Early in 1979, the Anchorage Satellite Field Services Station of NOAA's National Earth Satellite Service (NESS) began receiving a full 24 hours per day program of GOES West sectors. Low sun angles for nearly a third of the year require extensive use of infrared (IR) data in Alaska. Thus, new IR enhancement curves that addressed the temperatures observed in this region were developed. After a year of operational use, it was found that realistic quantitative temperature values could be obtained from the geostationary enhanced IR data.

All of Alaska lies north of 50°N, far from the equatorial subpoint of the GOES West satellite and well into the "near-horizon" viewing area of the spacecraft. Data interpretation problems, such as cloud displacement, near the horizon of the GOES data have been addressed by Weiss (1978). Water vapor and other atmospheric constituents absorb outgoing radiation and can result in "cooler" than expected satellite observed temperatures. This effect, discussed by Anderson *et al.* (1974) in regard to polar orbiting satellite data is accentuated in near-horizon areas where the sensor is looking obliquely through a long atmospheric path. This study examines GOES

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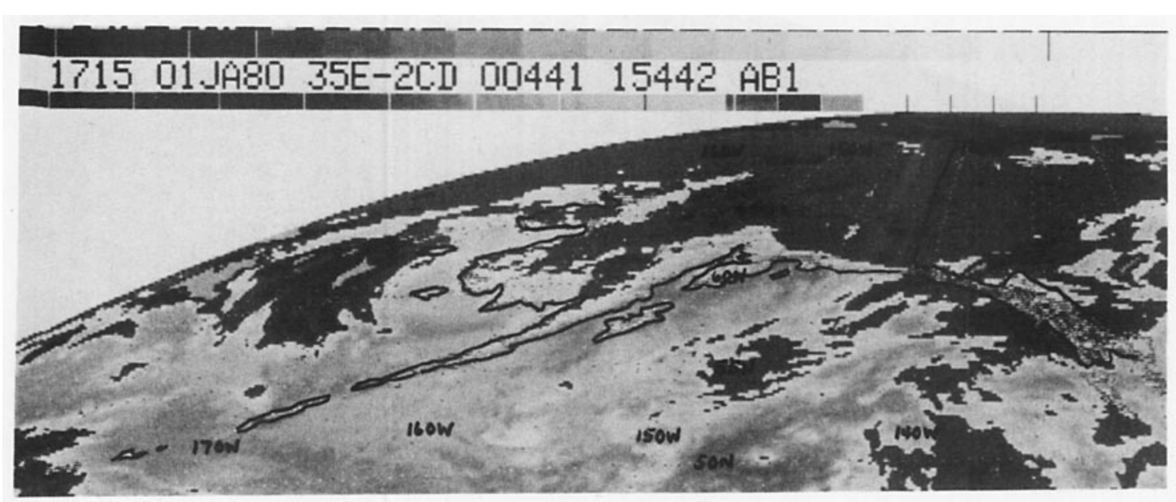

Fig. 1. GOES W, EIR, CD curve 1715 GMT, 1 January 1980.

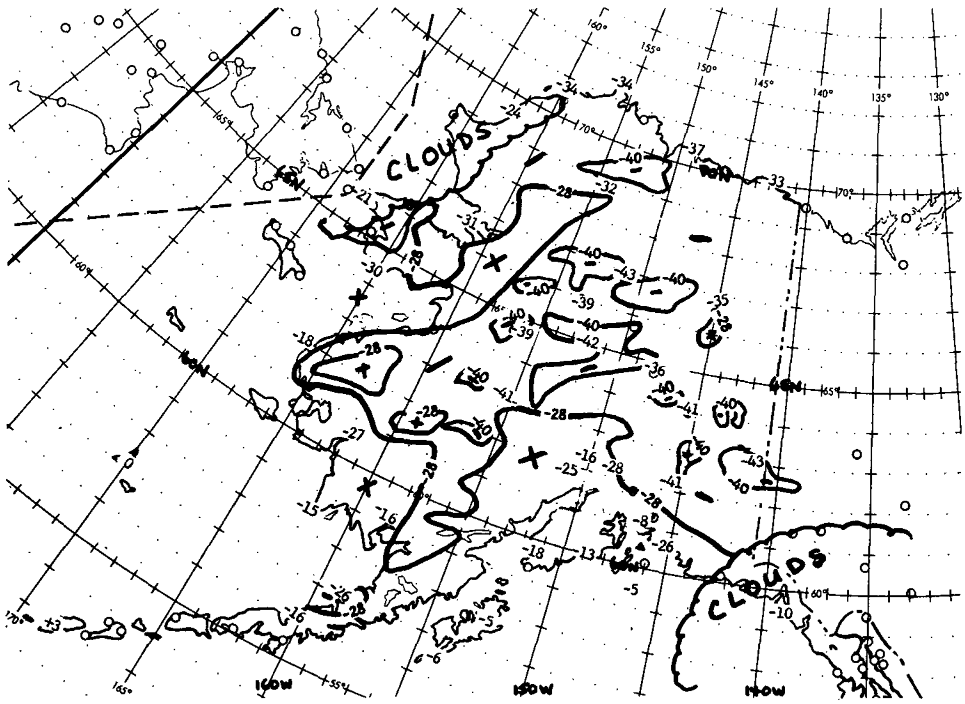

FIG. 2. Satellite-derived isotherms (solid lines) from Fig. 1 and observed surface temperatures.

satellite derived and conventionally observed temperatures for Alaska for two winter cases taken from the operational files.

A large area of high pressure brought clear skies and light winds to much of central Alaska on 1 January 1980. The GOES West enhanced IR (EIR) view of the state appears in Fig. 1. These data are displayed with the CD curve; temperature and gray shade scales for this curve appear below the date/time documentation line. The gray shading in this CD enhancement curve progresses from black, representing the warmest temperatures at the left end, toward light gray until

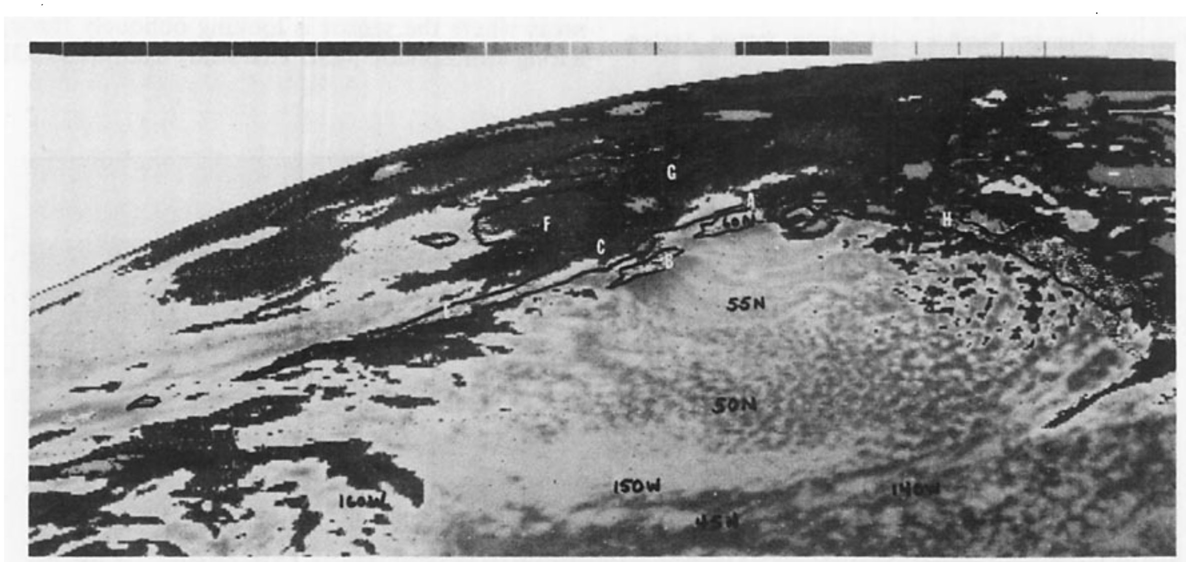

FIG. 3. GOES W, EIR, CD curve 1215 GMT, 16 January 1980, with radiosonde stations marked.

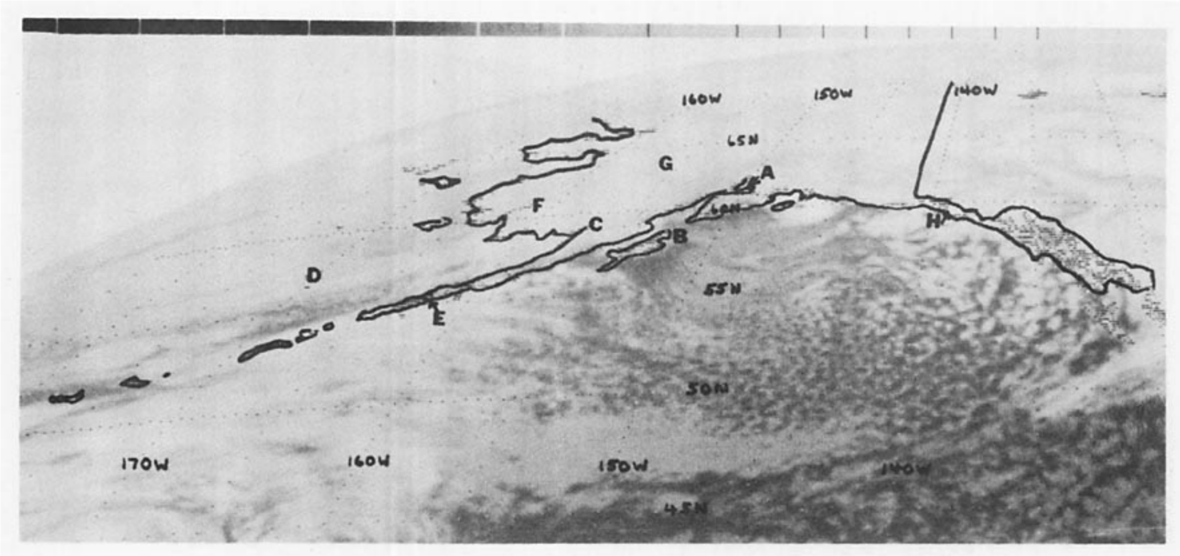

FIG. 4. GOES W, IR, 1245 GMT, 16 January 1980, with radiosonde stations marked.

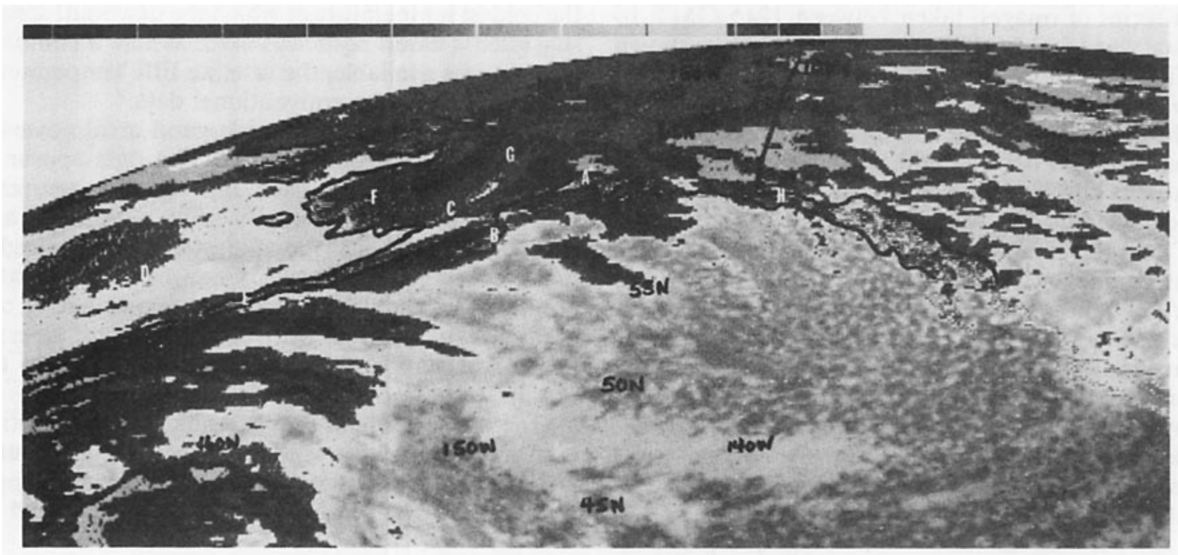

FIG. 5. As in Fig. 3, but for 0115 GMT, 17 January 1980.

temperatures reach −28°C.[2] Then alternating darker tones are used: dark gray depicts −28 to −40°C; black −40 to −50°C; medium gray −50 to −60°C; white, colder than −60°C. The −28 and −40°C isotherms, analyzed directly from this EIR image (Fig. 1), appear as solid lines in Fig. 2. (Plus and minus signs indicate whether the area enclosed is warmer or colder, respectively.) Although the CD curve temperature intervals are large, the satellite-derived isotherms are in good agreement with the observed 1800 GMT surface temperatures also appearing in Fig. 2. This is true even at 70°N, along the north coast of the state.

[2] Each vertical tick mark represents 10°C. The −28°C gray shade begins just to the left of the AB1 label in the documentation in Fig. 1.

TABLE 1. Eight radiosonde locations.

A	Anchorage (273)
B	Kodiak (350)
C	King Salmon (326)
D	Saint Paul Island (308)
E	Cold Bay (316)
F	Bethel (219)
G	McGrath (231)
H	Yakutat (361)

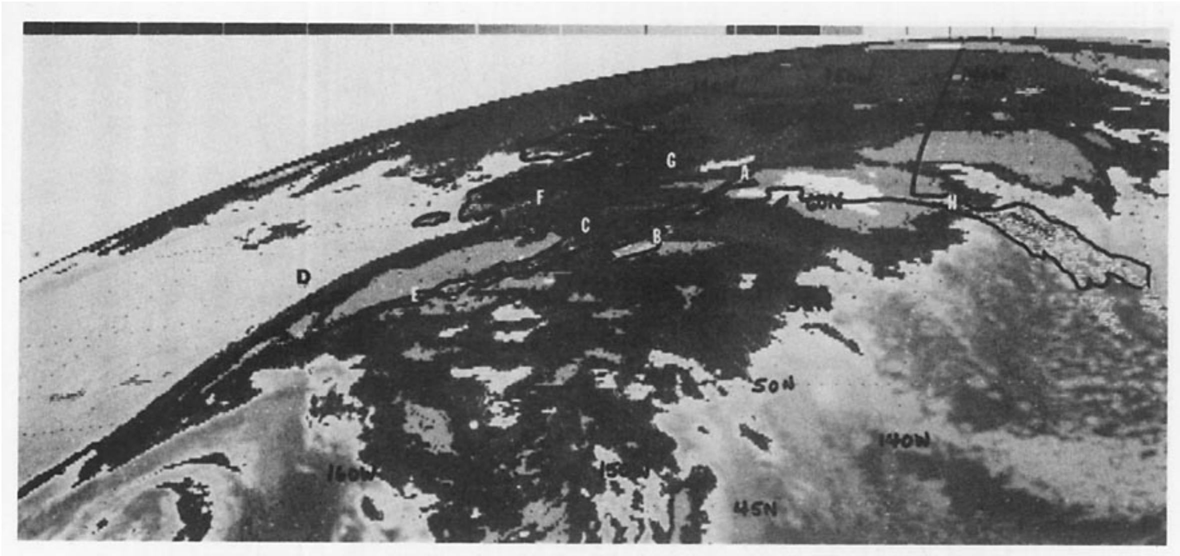

FIG. 6. As in Fig. 3, but for 1215 GMT, 17 January 1980.

A series of images, taken between 1215 GMT 16 January and 1215 GMT 17 January 1980 are shown in Figs. 3–6. During this time, a weak low was moving into southeast Alaska and cloudiness was increasing in the south central and southwestern portions of the state. Data in Figs. 3, 5 and 6 are displayed with the same CD curve used in Fig. 1. A regular IR display appears in Fig. 4.

Cloud-top temperatures at eight radiosonde locations (Table 1) were derived from the satellite imagery. These temperatures appear in Table 2; their locations are noted on Figs. 3–6. [No viewing angle corrections (Weiss, 1978) were used to relocate the cloud areas.] Table 2 also summarizes the cloud-top temperatures determined from the radiosonde observations. Dewpoint data, necessary to define cloud tops, often terminated before the top of a cloud layer could be determined. For these cases (with asterisks), the coldest temperature at which the dewpoint spread suggested a cloud layer was used. Where a complete data set was available, the satellite EIR temperatures compared well with conventional data.

GOES satellite data provide good areal coverage of central and southern Alaska. EIR data appear to reliably depict both surface and cloudtop temperatures throughout the year. By using radiosonde and satellite observations, the analyst can assign heights to the observed cloud cover. Changes in cloud cover and cloud height, particularly thunderstorm tops, can easily be monitored from the half-hour interval GOES imagery and are regularly included in the products of the Anchorage SFSS.

One of the users of these products is the aviation community. Aviation is the primary means of transportation in Alaska; vital medical, postal and supply services to many locations can only be provided by

TABLE 2. Cloud-top temperatures (°C) derived from satellite imagery at eight radiosonde stations.

	1200 GMT, 16 January 1980		0000 GMT, 17 January 1980		1200 GMT, 17 January 1980	
Station	Radiosonde	Satellite	Radiosonde	Satellite	Radiosonde	Satellite
A	−31*	−28 to −40	−30	−28 to −40	−40*	−50 to −60
B	−10.5**	−10 to −15	−9, −37	−28 to −40	−40*	−50 to −60
C	−28.9	−28 to −40	−40	−28 to −40	Missing	−50 to −60
D	−38	−28 to −40	Missing dewpoint	−20 to −28	−28** 2° Inversion	−20 to −28
E	−35	−28 to −40	−39	−28 to −40	−38*	−40 to −60
F	−40	−28 to −40	Missing	−28 to −40	−37.9**	−40 to −50
G	−40*	−40 to −50	−40*	−40 to −50	−30*	−40 to −60
H	−8, −45*	−40 to −50	Missing	−10 to −28 −40 to −50	−41*	−40 to −50

* Temperature of last saturated condition observed before dewpoint reading was lost.
** Clear, temperature at surface.

air. Most observations are made during the day, and little weather information is available through the night until pilots are airborne. Thus, the quantitative information on cloud cover, cloud height and system movement available from the GOES satellite data is particularly useful to the aviation forecaster and the pilot.

REFERENCES

Anderson, Ralph K., *et al.*, 1974: Applications of meteorological satellite data in analysis and forecasting. ESSA Tech. Rep. NESC 51, National Earth Satellite Service, Washington, DC 20233, pp. 6c 1–18.

Corbell, Ralph P., J. Cornelius Callahan and William J. Kotsch, 1976: *The GOES/SMS User's Guide*. National Oceanic and Atmospheric Administration/National Earth Satellite Service and National Aeronautics and Space Administration, Washington, DC 20233, 80 pp.

Weiss, Carl E., 1978: Cloud-location corrections near the horizon of an SMS image. Satellite Applications Interpretation Note 78/8, National Earth Satellite Service, Washington, DC 20233, 8 pp.