Further Comments on "An Approach to Objective Nephanalysis from an Earth-Oriented Satellite"

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The recent discussion (Wood, 1963; Blankenship, 1963) of an interesting paper by Blankenship (1962) has fortunately brought clearly into the public domain the somewhat widely separated views of meteorologists as to whether or not operational use of the radiometer data from meteorological satellites ". . . is still a few years in the future . . . ." These questions have been privately argued, for at least the last three years, by those most directly involved in the meteorological satellite program.

The comments of Mr. Wood are certainly pertinent, and there are still additional problems which were not adequately treated in Blankenship's original paper. One of these is the inability to distinguish positively, from the so called atmospheric window (8–12μ) data alone, the difference between a lower overcast and a higher broken area. But overemphasized problems will continue to relegate the radiometer data to the ". . . few years in the future . . ." category of meteorological tool, especially if one unnecessarily requires that the

tool must be completely perfect in absolute units, and time-tested, before it can be put into operational use. Recent studies at ARACON Geophysics using TIROS II and III radiation data, as well as some of the references cited in the papers under discussion, have shown the immediate value to be gained from the radiometer data if they are viewed primarily as an aid to more accurate conventional analysis; accordingly, it is not essential that the radiometer data, used alone, be sufficient to permit a completely precise and fully comprehensive analysis. The fact that novel data can be usefully applied to practical analysis while many aspects of them still merit significant further investigation was clearly demonstrated by the operational use made of the TIROS cloud pictures within a few days of the TIROS I launch.

The following example illustrates a possible analysis procedure which would allow immediate use to be made of the 8–12 micron atmospheric window data, now being obtained from the TIROS satellites, if real time reduction of the data were available. The data are considerably smoothed by the very nature of this procedure, but the fact that synoptic scale weather systems are apparent and recognizable attest to the value of such data as a tool for the preparation of better analyses.

The procedure followed here was to reduce the radiometer data for each 5°×5° latitude-longitude square from each orbit to a single averaged value. These data, taken from several orbits straddling a standard analysis time (such at 1200 GMT for the case shown), were then plotted and analyzed, generally for each 5° of equivalent black body temperature. The built in smoothing resulting from this gross scale has disadvantages as regards the precise location of cloud systems, but they are compensated by the greater advantage of providing an analysis over a large area at a scale familiar to field forecasters. The specific use of a 5°×5° grid size, as illustrated here, is not necessarily recommended. Perhaps a 2°×2° grid size would still allow sufficient smoothing, so that any errors in the data would be tolerable, while presenting more detail than is available in the 5°×5° grid. Further research on this problem would be required, but for the present example, data on a 5°×5° grid were available and the resulting analysis proved valuable.

An example of such analysis for the continental United States is shown in Fig. 1. The radiometer data contained in this figure were obtained from orbits 057, 058 and 060 of TIROS III on 16 July 1961. The satellite was over the Central United States on these orbits at approximately 0950, 1135 and 1515 GMT, respectively. The data from the 8–12 micron window channel have been converted to equivalent black body temperatures, and isolines in degrees Kelvin are shown as dashes on the figure. The 1200 GMT National Meteorological Center surface pressure pattern and frontal analysis is also shown. Several interesting patterns can be seen, but the example here will be restricted to the tongue

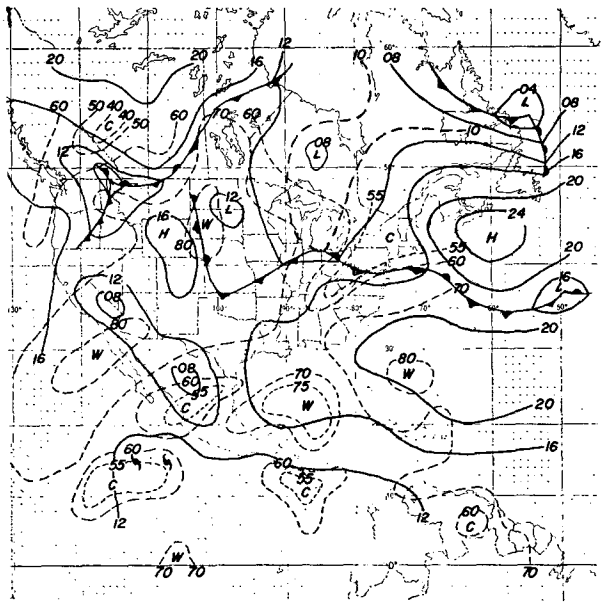

FIG. 1. Map of equivalent temperature analysis (from 8–12 μ window data) and 1200 GMT National Meteorological Center frontal and surface pressure patterns for 16 July 1961.

or trough of cold temperatures extending along the western edge of the Applachian Mountains. Many of the other significant features noted on this map, along with a discussion of them as related to surface and 500-mb synoptic features for the three day sequence from 15 July to 17 July, have been studied by Wexler and Sherr.[1]

Frontal analyses over continents in mid-July are often misleading, or depict boundaries between air masses whose characteristics are not substantially different. The front shown in Fig. 1, lying generally east-west along 40N, is such a case; and skies along the front are generally clear or scattered west of the Mississippi. The only significant weather east of the Rockies is occurring within the area enclosed by the isoline labeled 60° (260K), where cumulus congestus clouds are reported, and in two small areas of cumulonimbus activity over northern Florida. The shape of the cold temperature trough and its orientation suggest a developing squall line, which is supported by conventional reports of convective development and by the television pictures. Fig. 2 is a mosaic of TIROS III pictures (taken on orbit 061 R/O 062 at about 1645 GMT) of the southern part of the area enclosed by the 260K isoline. By 1645 GMT the cloud line shown in Fig. 2 has lengthened and extends across western Tennessee to northern Mississippi.

Clouds with tops having equivalent temperatures colder than 255K are indicated by the radiometer data.

[1] Wexler, Raymond, and Paul E. Sherr, 1964: Synoptic analysis of TIROS III radiation measurements. Final Report under Contract No. AF 19(628)-429, ARACON Geophysics Company, 33 pp.

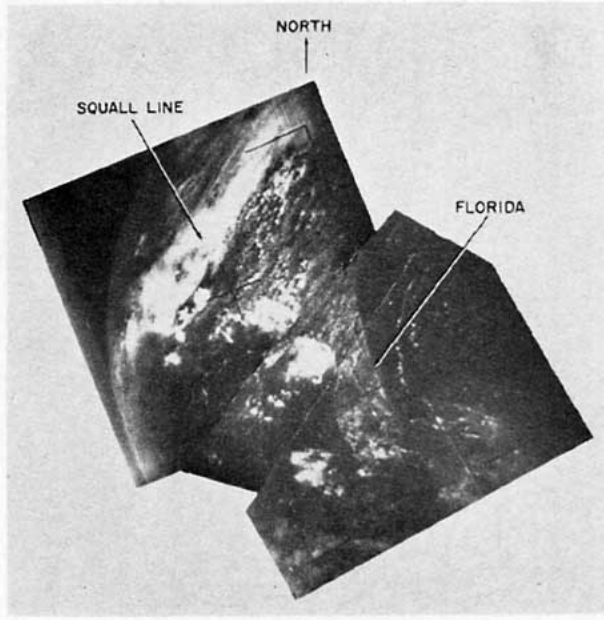

FIG. 2. Mosaic of pictures from Orbit 061 R/O 062, TIROS III, 1645 GMT showing squall line and area of active cumulonimbus over northern Florida and Southern Alabama.

Since the actual height of the 255K isotherm was at about 22,000 ft, and since the highest cloud tops undoubtedly cover only a small portion of the 5° squares, it is probable that some of these clouds extended above 30,000 ft.

By 1800 GMT thunderstorms had begun over western Tennessee and northeastward along the center line of the tongue of cold temperatures shown in Fig. 1. This squall line moved slowly eastward and was located along a line from approximately 250 miles east of New York southwest to Florida by 0600 GMT July 17th. The similar map of equivalent temperatures for 17 July (not shown) also indicated the presence of this squall line by a trough of cold temperatures just off the east coast of the United States, thus depicting very well this area of significant weather. Precipitation amounts of greater than 0.6 inch were associated with many portions of this squall line.

The example clearly shows a case where immediate practical use could be made of 8–12 micron atmospheric window data if they were available in real time. Much of the earth between 58S and 58N is now observed by TIROS radiation sensors twice per day. The comparatively simple scheme of data presentation used here, with all its drawbacks of relatively low time and space resolution, could be a valuable tool in synoptic analysis. The frame of mind for achieving these benefits must be that the radiometer data need not necessarily stand by themselves, but should primarily be another tool available to the forecaster. Therefore, we concur with Captain Blankenship that ". . . these data are usable operationally since the limitations are known and can be dealt with effectively in the design of an operational plan."

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