# An Approach to Objective Nephanalysis from an Earth-Oriented Satellite

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There will be several important differences between the satellites to be used by the National Operational Meteorological Satellite (NOMS) System and those being used in the present TIROS R&D System. The advanced meteorological satellites to be used by NOMS will be earth-oriented and will carry new and more advanced sensory systems. One new sensor will be a high resolution radiometer (4 to 5 n mi per scan spot) which will utilize the 3.7- to 4.2-micron atmospheric window. Scanning will be produced by a rotating mirror which scans space, earth disk, and housing to provide two references (one at zero-radiation level, and one radiating at a known temperature) and a measure of emitted radiation in the 3.7- to 4.2-micron window. This atmospheric window is relatively free of absorption by water vapor; for example, about 89 per cent of the energy in the wavelength range of 3.7 to 4.2 microns is transmitted through 100 mm of precipitable water vapor according to Howard (1960).

This note describes one possible means of processing the data available from the NOMS high resolution radiometer system to obtain an operationally significant end product for use by the aviation meteorologist. The technique will yield objective nephanalyses of cloud cover, in tenths, for layers in the middle and upper troposphere.

Four major assumptions upon which this technique is based are: (a) the NOMS data can be provided on a square-grid spacing of 5×5 n mi; (b) the radiation values can be converted, in real time, to an effective black-body radiation temperature; (c) the effective black-body radiation temperature can be related to the ambient temperature of the upper portion of moderately thick cloud decks; and (d) the temperature fields for the 700-, 500-, and 300-mb surfaces are available (either observed, forecast, or climatic) for the areas covered by the NOMS data.

A square area 60×60 n mi will be considered in classifying the amount of cloud cover existing over a given location. This area would contain 144 NOMS data points. However, at the edge of the scan, the number of data points in the 60×60 n mi area would probably be reduced to less than 50 data points when the rotating mirror shifts the field of view near the horizon. For this reason, it would appear advisable to use only that portion of the scan where the number of scan spots per 60×60 n mi data square equals or exceeds 70 data points. The procedure used to estimate the amount of cloud cover existing in this area would be as follows. First, the effective black-body radiation temperature ($T_e$) for each NOMS data point in the area is computed. Next, the number of data points at which $T_e$ is equal or less than the ambient temperature ($T_R$) is determined. $T_R$ is the temperature at a preselected reference altitude ($R$). Clouds are considered to exist at those NOMS data points where $T_e \leqslant T_R$. Then the ratio (in tenths) of the number of points indicating clouds to the total number of points in the area considered (70 to 144 points) is computed. This ratio is taken as the amount of cloud cover existing from the reference altitude $R$ to the top of the atmospheric cloud layer. The cloud cover amount computed in this way is assigned to the center of the particular 60×60 n mi data block. This process would be repeated for adjacent data blocks until the complete NOMS-data swath was considered. The end product would be a 60×60 n mi grid of cloud amount in tenths.

The first reference level to be used would be the 300-mb surface. $T_R$ would then be the 300-mb temperature over the area considered. This would yield a measure of the total amount of thick or dense cirrus located above 300 mb. However, it should not be expected to indicate the presence of thin cirrus. Fritz and Winston (1962) found that thin cirrus was not revealed by the TIROS II infrared measurements. The second reference level would be the 500-mb surface. The resulting nephanalysis should depict most of the clouds existing above 500 mb. The final reference level would be the 700-mb surface which should yield a nephanalysis of the total middle- and upper-cloud coverage A comparison of these nephanalyses (300 mb and above, 500 mb and above, and 700 mb and above) would provide a measure of the vertical distribution of the cloud cover as seen by the satellite.

The temperature fields employed in such a method may be derived from the NWP thickness field using climatological lapse rates. In areas of little or no upper-air data, the monthly mean temperature fields may be used if they are modified according to the indicated synoptic systems; i.e., anomalies associated with large storm centers. The location of these storm centers can be obtained from an analysis of the low-resolution satellite infrared data, as shown by Weinstein and Suomi (1961).

The possibility of obtaining a nephanalysis of the total cloud cover from the surface to the top of the cloud layers also exists. However, very accurate knowledge of surface temperature and of the temperature structure in the lowest layers would be required. Over mountains and in polar areas where the surface temperature would be colder than the ambient temperature at 700 mb, the cloud data would be unreliable. However, these areas can be identified on a geographical and climatological basis. Over ocean areas, mean sea-surface temperatures could be used to obtain a nephanalysis of all clouds.

In conclusion, it appears that a data-processing technique of the type described would yield a nephanalysis of the total middle- and upper-cloud cover. Such an analysis would be of value to meteorologists supporting aircraft operations in the middle and upper troposphere.

## REFERENCES

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