Weather or Not—Encrypted?

[redacted] (b)(3)-P.L. 86-36

~~Secret Savin~~

This paper describes some of the special security measures introduced in North Vietnamese weather communications which proved to be unique and effectively deceptive.

INTRODUCTION

Practically all weather as we know and experience it occurs in the troposphere, the region of the earth's atmosphere which extends from the surface of the earth to approximately 29,000 feet over the poles and 61,000 feet over the equator. For this reason a weather forecaster must have not only surface data but also data from the other higher levels which will provide the most complete picture possible of the three-dimensional distribution of wind and temperature in the atmosphere up to and including the 100 millibar presure level (approximately 52,493 feet). Only after an accurate and complete analysis of all data, both surface and upper air, can a valid forecast be made.

Surface observations furnish measured data on the various conditions such as wind, temperature, pressure and a visual estimate of sky conditions. However, surface observations yield no quantitative answers to the measurable elements in the layer of air above the earth's surface. The two types of upper-air observations most frequently used to measure most of these data are pilot balloon observations (PIBAL) and rawinsonde observations (RAOB).

A pilot ballon observation is a visual measurement of the direction and speed of the wind above the earth's surface. The direction and speed are computed from successive positions of a free balloon which is assumed to have a fixed ascension rate. The positions are determined from values of the balloon's elevation and azimuth angle read each minute from a theodolite. Information pertaining to the direction and speed of the upper air winds is vital not only to weather forecasters but also to aircraft pilots for selecting a desirable flight altitude and for fuel consumption planning.

A rawinsonde observation is a measurement of the pressure, temperature, relative humidity, and wind direction and force from the surface to the highest point achieved by the instrument carried aloft by a balloon. The rawinsonde consists of meteorological instruments combined with a radio transmitter and assembled in a lightweight box with a

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reflector attached for radar tracking. It is carried aloft by a balloon filled with either helium or hydrogen. Measurements of pressure, temperature, and relative humidity of the air are secured in flight from signals transmitted by the rawinsonde to a ground receiver where they are automatically recorded. When properly received and interpreted, these signals provide an essentially continuous record of the pressure, temperature, and humidity of the atmosphere through which the rawinsonde has passed. Wind direction and force are calculated from tracking data.

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These upper-air observations are made two or more times each day at specified times synoptically throughout the world. Data acquired from these soundings are exchanged with other stations in the shortest amount of time possible without sacrificing the accuracy of usable data. This is accomplished by encoding the data in standard international code forms in accordance with specifications set forth by the World Meteorological Organization (WMO). The data may then be plotted on upper-air charts and diagrams which facilitate analyses. These analyses are related to the surface and other upper-air manifestations to gain a more definitive representation of the existing conditions at different locations and thereby an appreciation for the continuous distribution of atmospheric conditions throughout a given area.

THE PROBLEM

a. Background.

It is clearly evident that weather information such as that described above is essential to those Ground, Naval, and Air Weather Services providing support to the Armed Forces operating in Vietnam. The need is well appreciated by North Vietnam, and though surface weather collectives are broadcast by Hanoi on a regular schedule, efforts have been made to protect the information from all eavesdroppers. For a weather report to serve any useful purpose, the location of the weather station must be determined; it is this portion of the

The surface weather reports were heartily welcomed and gratefully received by the consumers. Precise knowledge of the actual surface weather conditions existing at stations throughout North Vietnam is of utmost importance in the conduct of offensive operations in North Vietnam. However, an important gap existed; a knowledge of the three-dimensional distribution of atmospheric conditions in the tropo-

sphere was practically non-existent since upper-air observations were noted only infrequently in North Vietnamese communications. Thus, the forecaster found himself at a distinct disadvantage in predicting the weather. In September 1965 PIBAL and RAOB reports from Hanoi began to appear on a regular schedule along with the collection of surface weather reports. It was with great delight and much satisfaction that this information was passed to the consumers to fill the void which existed and to permit a more accurate assessment of the weather which was expected to occur.

Much to the consternation of all concerned, the upper-air data soon proved to be suspect. The messages exhibited all the characteristics of valid text; however, when the data were plotted on upper-air charts, the laws and principles governing the nature of the elements measured and the character and behavior of the upper air were violated. There were unreasonable wind shifts, distorted temperature inversions, and impossible temperature/dew-point temperature readings. The problem was a baffling one. At first it was assumed that a combination of factors might have produced the confused soundings, e.g., the intercept was poor, a digit here or there being garbled; the North Vietnamese weather observer was inexperienced or poorly trained and did not always encode the data properly; the equipment was faulty or data were misinterpreted. Consideration was also given to the possibility of the basic international code having been altered in some peculiar way. The possibility of the data being encrypted was considered; however, since all recognition features of the code were clearly in evidence, i.e., limitations expected in clear text were apparent, encryption was temporarily ruled out.

b. Solution.

In the course of a study of the reports undertaken by one of the consumers, all sources of upper-air data, COMINT and non-COMINT, in the areas bordering on North Vietnam were collected and much to everyone's amazement, RAOB reports originated by Hanoi were found in the weather exchange between Moscow and Washington. [redacted]

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much as 18° in temperature and dew-point temperature values (from −9° to +9° Celsius); (b) to cause the winds to veer by as much as 90°; and (c) to increase the wind speed by as much as 9 meters per second. The temperature and dew-point temperature distortions for the standard millibar pressure levels in the above example are examined both horizontally and vertically herewith:

Temperature and dew-point temperature differences for each standard pressure level:	1000 mbs.	[redacted]
	850 mbs.	
	700 mbs.	
	500 mbs.	
	400 mbs.	
	300 mbs.	

[redacted]

Temperature and dew-point temperature change between standard pressure levels:	1000–850 mbs.	[redacted]
	850–700 mbs.	
	700–500 mbs.	
	500–400 mbs.	
	400–300 mbs.	

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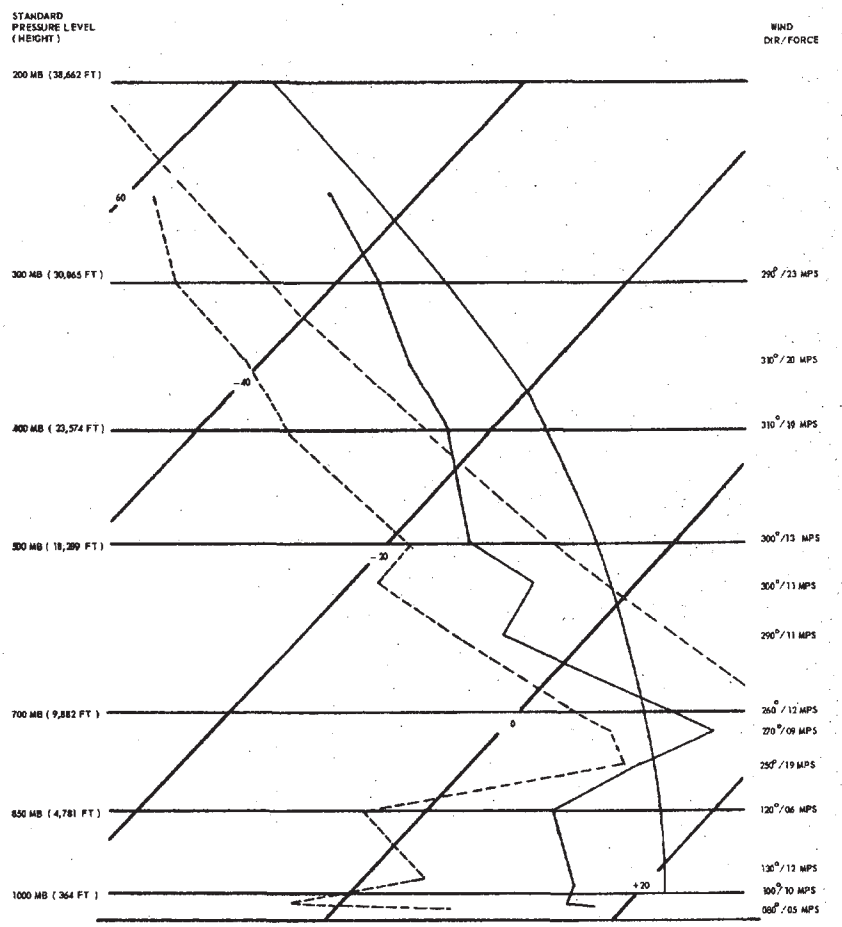
Notice the marked differences in temperature gradients between the 850 and 500 millibar levels in the two reports.

Temperature and dew-point temperatures are extremely important in describing the character of a parcel of air at a specific height; when data are accurately plotted on a chart, much is revealed about the stability or instability of the air. Information of this type is essential in determining the likelihood of fair or foul weather occurring. Figures 1 and 2 are representations of the plotted reports; the chart used is a USAF SKEW T, log p Diagram.

Remarks Pertaining to Figs. 1 and 2.

After a cursory examination of the two plotted soundings which provide a graphic representation of the cross-section of the troposphere at Hanoi, a trained weather analyst would consider Fig. 1 suspect. This is indicated by the unexpected and comparatively severe irregularities in the temperature curve of Fig. 1 as compared with Fig. 2. With increasing height the temperature of the air generally decreases,



LEGEND

BROKEN CURVED LINE - DRY ADIABAT (TEMPERATURE LAPSE RATE)
SOLID CURVED LINE - SATURATION ADIABAT (TEMPERATURE LAPSE RATE)
SOLID DIAGONAL LINES - STANDARD TEMPERATURE, DEGREES CELSIUS
SOLID HORIZONAL LINES - HEIGHT OF STANDARD PRESSURE LEVELS
IRREGULAR SOLID LINE - CURVE OF REPORTED TEMPERATURES
IRREGULAR BROKEN LINE CURVE OF REPORTED DEW-POINT TEMPERATURES

Fig. 1

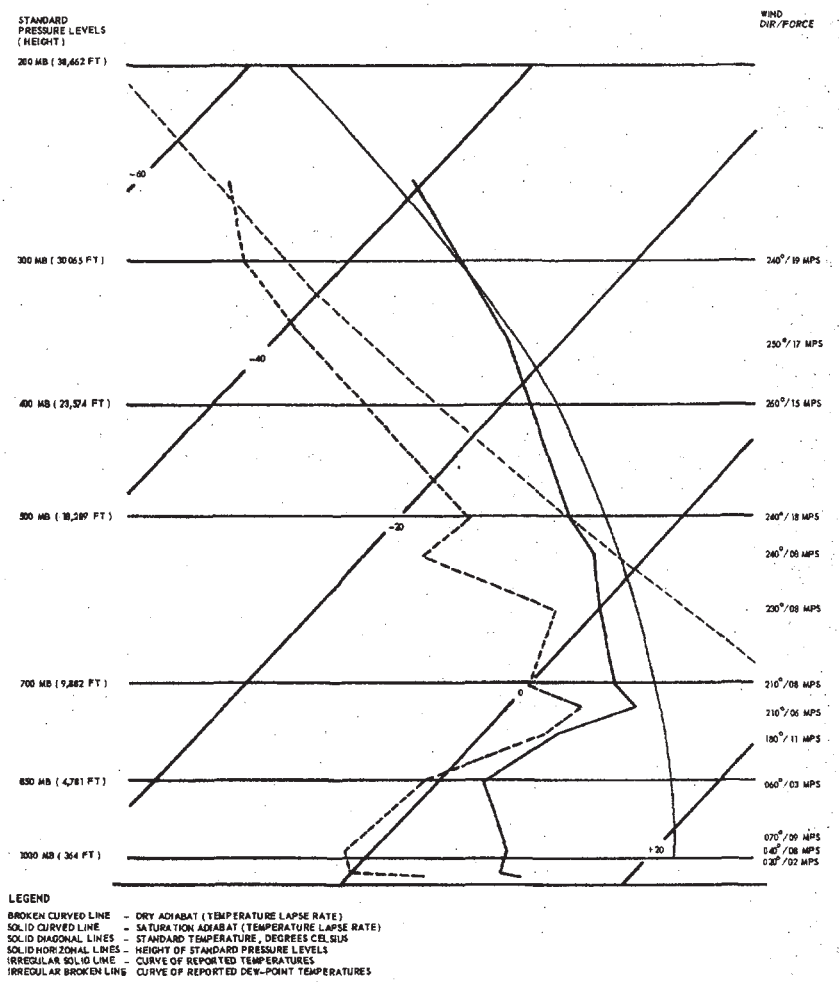

STANDARD PRESSURE LEVELS (HEIGHT)
WIND DIR/FORCE
200 MB (38,662 FT)
300 MB (30 065 FT)
400 MB (23,524 FT)
500 MB (18,289 FT)
700 MB (9,882 FT)
850 MB (4,781 FT)
1000 MB (364 FT)
-60
-40
-20
0
+20
240°/19 MPS
250°/17 MPS
260°/15 MPS
240°/18 MPS
240°/08 MPS
230°/08 MPS
210°/08 MPS
210°/06 MPS
180°/11 MPS
060°/03 MPS
070°/09 MPS
040°/08 MPS
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Fig. 2

but occasionally the reverse is true; when the temperature increases with height there is said to be an inversion. Notice the intensity of the inversion occurring near 9,000 feet in Fig. 1 is greater than that of Fig. 2. An even more striking feature of Fig. 1 is the super-adiabatic temperature lapse rate between approximately 9,000 and 14,000 feet. A super-adiabat is readily identified as that portion of the sounding where the slope of the temperature curve is less than the slope of the dry adiabat; i.e., the rate of change in temperature (decrease) is greater than 3° Celsius per 1,000 feet. An abnormal condition, super-adiabatic lapse rates actually occur only through thin layers in contrast to the 5,000 foot thickness noted in Fig. 1. At a lesser magnitude, a super-adiabatic condition also prevails between 16,000 and 18,000 feet. A realistic super-adiabatic condition is presented in both figures for a shallow layer near the surface.

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CONCLUSION

Never before has a system such as that described been observed in weather traffic from any country. It is considered an ingenious method of providing security in weather communications; until the system was detected, the weather analysts and forecasters were effectively and unwittingly misled. [redacted]