U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE
NATIONAL METEOROLOGICAL CENTER

OFFICE NOTE 186

Conversion of TIROS-N Data to O.N. 29 Format

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AUGUST 1978

This appendix describes the computations necessary to put the TIROS-N data in Office Note 29 format. In general, the problem is to transform the mean layer temperatures given by the TIROS-N data to mandatory level temperatures and heights. Figure 1a shows the structure of the TIROS-N data and figure 1b is the structure for the Office Note 29 format data.

The first step in the procedure is to compute a mid-layer pressure value for all layers in Figure 1. The exner function, π , at any pressure is defined as

$$\pi = \left(\frac{p}{1000} \right)^{R/c_p} \tag{1}$$

The mid-layer exner function is:

$$\pi = \frac{c_p}{R} \frac{\pi_2 - \pi_1}{\ln p_2 - \ln p_1} \tag{2}$$

where the subscript 1 denotes the lower level and subscript 2 denotes the upper level.

Equations 1 and 2 are solved to yield the pressure, p, at the mid-layer point:

$$p = e^x \tag{3}$$

where,

$$x = \frac{c_p}{R} \left\{ \ln \left[\frac{c_p}{R} \left(\frac{\pi_2 - \pi_1}{\ln p_2 - \ln p_1} \right) \right] + \ln (1000) \right.$$

At this junction we have available the mean layer temperatures for the layers in figure 1a from TIROS-N data. Also, the mid-layer pressures have just been computed for all layers in figures 1a and 1b. Still to be computed are the mean layer temperatures for those layers in figure 1b not prescribed by TIROS-N data. These layers are the 300-250 mb, 250-200 mb, 200-150 mb, 150-100,mb, 30-20 mb, 20-10 mb, 10-7 mb, 7-5 mb, 5-3 mb, and 3-2 mb layers. The key to filling in the missing mean layer temperatures will be the TIROS-N tropopause temperature and pressure. Using the tropopause data as one base point and the nearest TIROS-N mean layer temperature (other than the one in the immediate vicinity of the tropopause) as the other base point, the missing mean layer temperatures will be obtained by interpolation. A convenient formula for interpolation assuming temperature varies linearly with ln (p) is:

$$T = \frac{T_2(\ln p_1 - \ln p) + T_1(\ln p - \ln p_2)}{\ln p_1 - \ln p_2} \quad (4)$$

where subscript 1 denotes the level or layer below p and 2 denotes the level or layer above p.

The procedure for computing the missing mean layer temperatures is illustrated is figure 2. Refering to figure 2 and using equation 4, the mean layer temperature, T_6, becomes:

$$T_6 = \frac{T_4(\ln p_5 - \ln p_6) + T_5(\ln p_6 - \ln p_t)}{\ln p_5 - \ln p_t} \quad (5)$$

After all the mean layer temperatures are computed in a like manner the mandatory level temperatures are calculated following the same procedure. Note, that by constructing the temperature sounding for the mandatory levels by this method the TIROS-N mean layer temperature in the vicinity of the tropopause, T_7, is not used in any of the computations.

In elevated regions the TIROS-N soundings do not include underground temperatures. The program constructs temperature for missing (underground) mandatory level values by extrapolating from the lowest available temperature at a rate of $0.065^{\circ}C$/mb.

For convenience of the user the mid-layer temperature data for the complete sounding are placed the significant level portion of the sounding and assigned the computed mid-layer pressure values.

The heights at the mandatory levels are all relative to zero height for the 1000 mb level; that is, they are in actuality thickness from 1000 mb up to the level in question. The calculation of the thickness, Z_2-Z_1, is:

$$Z_2 - Z_1 = \frac{R}{g}\bar{T}(\ln P_1 - \ln P_2) \quad (6)$$

where $\bar{T}$ is the mean layer temperature between the higher pressure, p_1, and the lower pressure, p_2. The layer thickness are summed to give the mandatory level heights.

In summary the data available in Office Note 29 format is stored in IBUF29 as follows:

Category 1: mandatory temperature, and heights
Category 2: mean layer temperatures at the assigned mid-layer pressure.
Category 5: tropopause data from TIROS-N
Category 7: Cloud cover data from TIROS-N
Category 8*: precipitable water data from TIROS-N (see Table 101 Office Note 29 for specification)

*May be deleted in final version

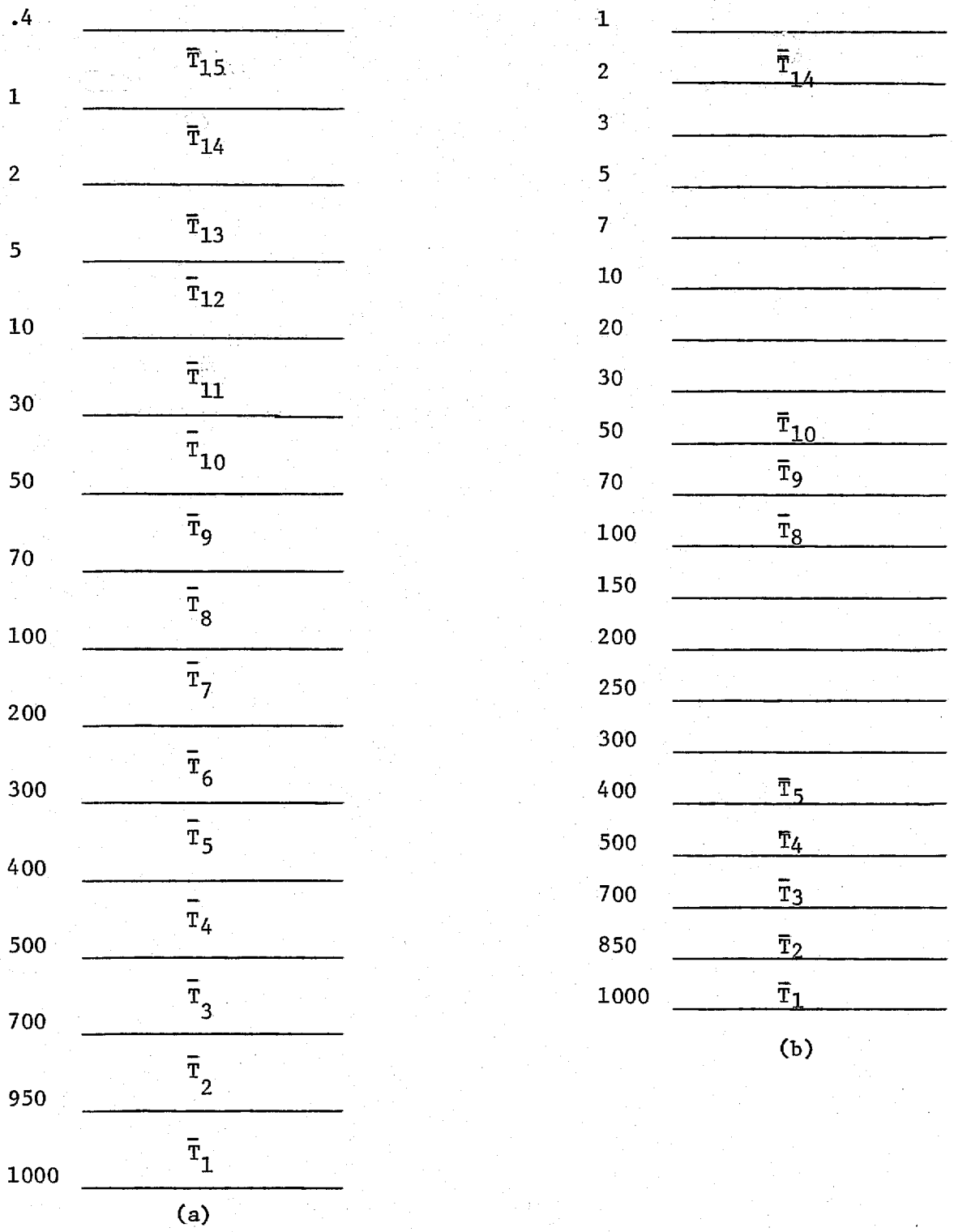

Figure 1. Tiros-N data structure (a) and mandatory level structure (b). Tiros-N mean layer temperatures, $\bar{T}$, are given for layers in (a) and equivalent layers in (b)

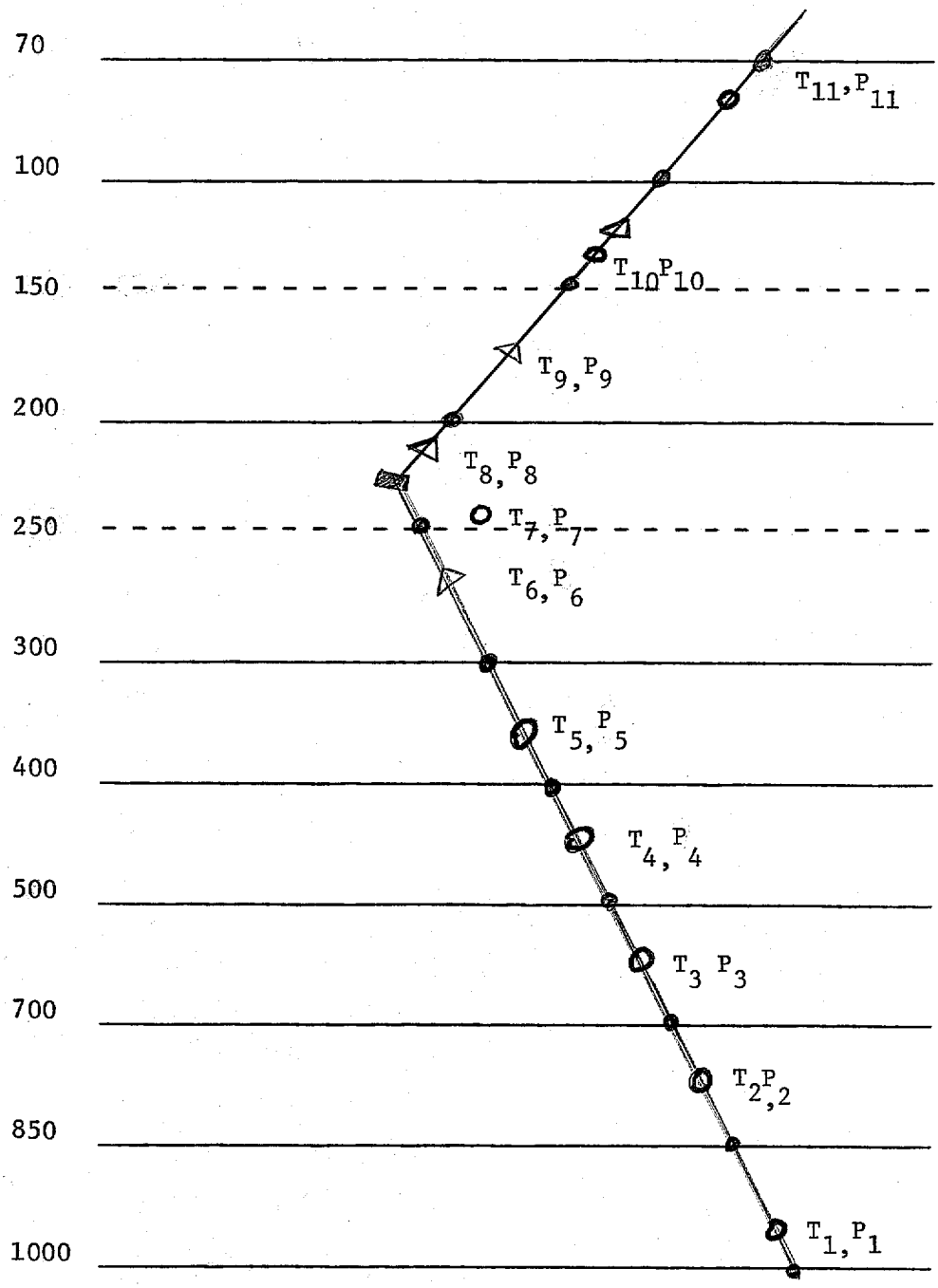
70
100
150
200
250
300
400
500
700
850
1000
T_{11}, P_{11}
$T_{10} P_{10}$
T_9, P_9
T_8, P_8
T_7, P_7
T_6, P_6
T_5, P_5
T_4, P_4
$T_3 P_3$
$T_2 P_2$
T_1, P_1
o Tiros-N mean layer temperatures
Tiros-N tropopause temperature and pressure
Δ Mean layer temperatures to be computed
● Mandatory level temperatures to be computed

Figure 2