CORRELATION OF ORIGINS OF ATMOSPHERICS WITH THE VERTICAL INSTABILITY OF ATMOSPHERE

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Practically atmospherics has been considered to originate in the lightning flashes associated with thunderstorm. Thunderstorms develop mainly from violent disturbances in the atmosphere, or we may say meteorologically that the magnitude of the vertical energy of atmosphere is intimately related with thunderstorm, *i.e.* origins of atmospherics and the vertical instability in the atmosphere are correlated closely with each other. In general, if the magnitude of the vertical unstable energy is indicated by the instability, it was pointed out that cumulo-nimbus develops thunderstorm at the time when the instability is over 2,000 joul/kg.

Now, we shall examine whether it is necessary to have instability over 2.000 joul/kg for generation of atmospherics. As origins of atmospherics are not only localized in the region of thunderstorm but also in the region of shower, heavy rain and cumulo-nimbus ; as cumulo-nimbus also develops when energy is less than that order, author suppose that the vertical unstable energy necessary to produce atmospherics is not always indispensable to have the value over 2,000 joul/kg.

To examine how many jouls are necessary to generate atmospherics, the author took following methods:

(1) The records of origins of atmospherics which are accompanyed by Typhoon Kezia were adopted, as these origins fit very well to examine the correlation with the vertical instability of atmosphere.

(2) Using the weather reports of upper atmosphere of CMO, both the aerogram correspond to them and the divergent energy of upward air current were examined.

(3) Then both the corresponding weather changes and origins of atmospherics, which were localized near the observatory of upper atmosphere, were examined.

According to the meteorology, the decrease ratio of temperature which is given for the tangent of the condition curve of aerogram is a measure to indicate the conditional instability of atmosphere. When this ratio (α) takes the value of 1°C/100 m $< \alpha <$ 0.5°C/100 m or $\alpha <$ 1°C/100 m, upper atmosphere is said to be in the conditional instability.

If this conditions are broken for some reasons, the violent upward air currents occur when the accumulated energy in the cloud are changed temporary to the kinetic energy.

When the air mass in this region are rising dh upward, the potential energy changes to the kinetic energy. Then putting the velocity of the unite air mass to v, its temperature to T_2 and the temperature of its vicinity air to T_1, the equation

$$d\left(\frac{v^2}{2}\right)=\left(\frac{T_2-T_1}{T_1}\right)gdh$$

are given, where g is the gravity.

Applying the equation of aerodynamics for the vertical direction to the above equation,

$$d\left(\frac{v^2}{2}\right)=R(T_2-T_1)d\log p$$

are deduced, where R is gas constant and p is atmospheric pressure.

From this equation, it is known that the areas between the condition curve and the curve to indicate the temperature change of this air mass give the divergent energy in this condition.

For an example, the results of adjustments of the observed records of upper atmosphere at Tateno observatory are shown Table 1(*a*) and (*b*). Aerogram which was shown in Fig. 1 is reduced from Table 1(*b*).

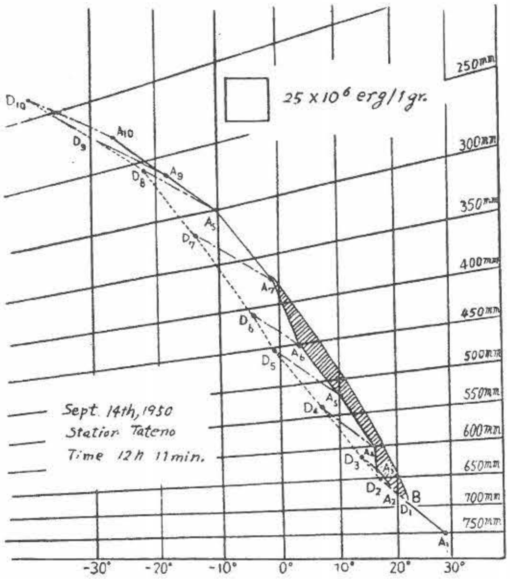

FIG. 1. An example of aerogram.

TABLE 1(*a*). Weather Report at Tateno

Date	14th Sept.
Time	12 h. 11 m.
Cloud and weather	$10\ C_uC_iC_c$ ◎ $L_2M_0H_2$
Surface wind	SSE 6.5

TABLE 1(*b*). Weather Report of Upper Atmosphere at Tateno (14 Sept. 1950)

PP. (mp)	TT. (°C)	U. (%)	$\frac{622}{p-e}\cdot e$ (g)	θ (°C)	Θ (°C)
1,000	28.6	75	17.625	28.5	78.0
900	19.7	88	13.904	28.7	67.0
850	16.5	85	11.56	30.5	62.5
800	15.8	62	8.68	35.0	59.9
700	10.2	52	5.772	40.9	57.0
600	2.9	62	4.898	46.4	60.9
500	− 1.3	44	3.036	58.0	67.5
400	−10.8	45	1.89	69.7	74.5
350	−18.3	42	1.071	70.5	74.2
300	−26.8	39	0.546	73.5	75.0

From Table 1 and Fig. 1, the atmosphere of this region will be considered to be in the conditional instability. This unstable condition, judging from the equi-temperature graph shown in Fig. 2, are broken as the cold air currents flow into that region from Pacific Ocean. When the air mass of point A in Fig. 1 are rising to the point B of the condition curve, cumulo-nimbus are developed. In fact, cumulo-nimbus are observed here. At the same time, origins of atmospherics are also densely localized. The divergent energy of this case measureing from Fig. 1 was about 407 joul/kg. By the same method, the instability at various observatory shown in Table 2 are measured. Table 3 are shown on origins of atmospherics within 100 km at the same observatory.

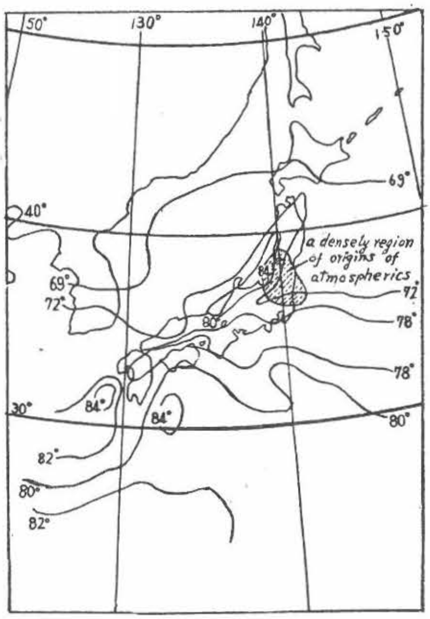

FIG. 2. Equi-temperature chart.

Because of the time deviation between Table 2 and Table 3, the unstable energy was not found whether it is proportional to the numbers of localized origins. But, considering from both the weather change and the situation of the distribution of origins, it may be assumed roughly that the developments of cumulo-nimbus in which origins of atmospherics are observed occur when the unstable energy is over 400 joul/kg. It must also be noted that this analysis was only to give some hints to

TABLE 2. Instability at Some Station

Date	13th Sept.		14th Sept.	
Time	0 h	12 h	0 h	12 h
Station ↓	(joul/kg)	(joul/kg)	(joul/kg)	(joul/kg)
Kagoshima		450.6	Stable	Stable
Shionomisaki		1048	228.5	512.7
Yonago	Stable	77.3		
Tateno				407.3

TABLE 3. The Number of Origins Near Various Station

Date	13th Sept.				14th Sept.				
Time	17 h	18 h	19 h	23 h	8 h	12 h	18 h	19 h	23 h
Station ↓	The number of origins of atmospherics								
Kagoshima	1	5	2	0	1	0	0	0	1
Shionomisaki	7	5	5	7	2	0	0	0	0
Yonago	0	0	0	0	0	0	0	1	0
Tateno	0	0	0	0	0	0	10	12	1

find out the quantitative correlation of origins of atmospherics with the vertical instability of atmosphere. Author will intend to study more for this problem.

References

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