Upper Air Observation at Syowa Base (I)

Zenbei SEINO*

昭和基地に於ける高層気象観測 (第1報)

清野善兵衛*

第3次越冬期間中 (1959 年2月-1960 年1月) に約100回のラジオゾンデ観測を行い，一応各高度気温の年変化を観測することが出来た．夏の状態曲線は 300 mb 附近に極めてシャープなトロポポーズが現れ，成層圏では高度と共に気温は上昇する．トロポポーズの気温は比較的高温で -50°C に達しない時もある．一方冬の状態曲線は一般に地上附近に顕著な気温逆転が現われ，トロポポーズはあまり明瞭でなくなり，成層圏でも高度と共に気温は下降を続ける．気温の年変化は 300 mb 以下では地上の Kernlose 型の変化と似た変化を示すが (振幅は少ない) 300 mb 以上では単純な年変化となり，振幅も高度が高い程大きくなる．トロポポーズの平均高度は冬に高くなり，夏よりも 2000 m 以上も高い．850～700 mb 附近に第2の逆転層が見られ，この層は強固なものでブリザードがあっても却々解消せず，時間と共に次第に高い方に移動して行くことが認められた．

1. Introduction

Radiosonde observations were made at Syowa base about 100 times for the period of February 1959-December 1959. Observing apparatus for the upper air observation which were carried to the base by air transportation are as follows:

Radiosonde (JMA-SIII-56)	120
800 g Balloon	120
Canned Calcium Hydride	about 400
(One can contains about 800 g CaH and these can in all be capable to inflate about 100 time's portion of ballon)	
Hydrogen Generator	1 complete set
Vacume chamber and Pump	
Standard Aneroid Barometer	
Radio Receiver	
Optical Theodolite	

Since we had chemicals of only 100 time's portion of observation for generating Hydrogen Gas we had to consider in what way these should be apportioned for one year. As it was our first trial to make upper air observations at Syowa Base, considering the importance of the annual variation of meteorological elements in the upper air,

* Japan Meteorological Agency. Member of the Japanese Antarctic Research Expeditions, 1956-57 and 1957-58. Member of the Wintering Party, the Japanese Antarctic Research Expedition, 1958-59.

we apportioned them so as to be equal throughout the year. Thus, we made it a general rule to take 2 observations a week as a routine basis (Monday & Thursday) and for WMI (World Meteorological Interval), 10 day's continuous observation if weather permitted.

Stimultaneously with radiosonde observations, visual observations of wind aloft by theodolite were made only in clear sky.

In summer time, some pilot ballon observations were also carried out.

The observation and computation of observed values were in charge of the meteorological group (SEINO & KAWAGUCHI) but inflation and tracking of ballon by theodolite were performed in cooperation with all members in Syowa Base.

2. Radiosonde used

The meteorological unit is the same one with JMA's specification which is now applied for stations in Japan. The frequency of Transmitter was set at 27 Mc as we could use an ordinary short-wave receiver. A covered copper wire, length of $\lambda/2$ was, used as an antenna and utilized simultaneously as part of suspention string. The train regulator used in launching balloon proved also to be very useful in the strong winds. Details of radiosonde used will be shown in Table 1.

Table 1. JMA-SIII-56 Radiosonde.

1. Meteorological units:

Element	Method	Range	Accuracy	Number of Morse Code
Temperature	Bimetal	+40°C～−85°C	±0.2°C	about 120 Codes
Pressure	Aneroid	1040 mb～5 mb		about 90 Codes
Humidity	Hair	100%～0%	±5%	over 40 Codes

2. Transmitter:
   - Frequency 27.12 MC.
   - Input power 4.8 V 500 mA.
   - Output power about 0.3 Watts
   - Antenna $\lambda/2$ (4.7 m)
   - Battery water activated battery (Cupreus chloride, Magnesium)
     Capacity 4.8 V, 600 mA 80minutes, Weight 150 grm.
3. Weight: 692 grm. (except battery and antemna).

3. Balloon used

800 g balloon (Latex) was used. The balloon was put into a paper bag and still more, a pack of every 10 pieces was put into the tin can which had been placed in the corridor of the base for preservation. Since temperature of the corridor was almost nearly to that of outdoor, this state of preservation could not be said better. Accordingly for a week or so prior to the use, the balloon had been kept in the warm room (temperature +10°C−+15°C) and just before the time of observation it was soften by warming up in the generator hut (+40°C−+50°C), then used for filling. As the

bursting height of balloon became lower in winter season (described later), we used the ballon immersing in diesel oil several seconds and obtained a satisfactory result.

4. Inflation and generating of hydrogen gas

In inflating one 800 g balloon, about 3.2 kg calcium hydride and about 30 l water were consumed. Free lift was obtained in the range of 2000 g–2300 g. Calcium Hyride is canned 800 g apiece and sealed hermetically. In using this, we make about 10 small holes in the top of can and connect the can with a tin cylinder about 50cm in length and putting them into water to react chemically, then take out gas from the top of the cylinder by a rubber-tube.

In actual inflation, 4 tins were used simultaneously and the required time to complete inflation was 15–20 minutes. On account of water tempesature being considerably high upon the reactional heat, the balloons were inflated without any difficulty even for the intense cold. However, a large quantity of steam gets into the ballon along with Hydrogen gas, and part of which becomes ice crystals on the inner walls of the balloon, being 'Dead Weight' namely, it is consequently expected to have deteriously influenced to the intensity of balloon.

The inflating site of balloon was made by digging a snow hole adjacent to the gateway south of the generator hut. Dimensions are about 2 m×2.5 m in floor space with 2.5 m in height and canvas cover was used for the roof. In case of launching, this was removed.

5. Calibration and correction

Radiosonde observations and computations of data were carried out in accordance with the observation manual being used in the home country. Calibrations were done only for pressure because of no calibration equipments for temperature and humidity. Therefore, for the calibration of these two elements, immediately before launching, comparing with temperature and humidity at the surface, only those of which the error is within the prescribed limits (±0.2°C for temperature, ±5% for humidity) were used in the observation. Those of being beyond limits of error were scarcely found but for the hygrometers, most of them had been over the prescribed limits of error, so that, they were used after adjusting the original point and modifying the calibration curve.

6. Bursting height of balloon

Fig. 1 shows monthly mean bursting heights of balloon. The annual variation, similar to the temperature on the whole, indicates to be higher in summer and lower in winter. Mark ⊙ in the figure shows that balloons used are immersed in diesel oil before the inflation, and comparing with those of not being immersed, a considerable rise can be found.

Fig. 2 shows, in abscissa, monthly mean values of minimum temperature of the

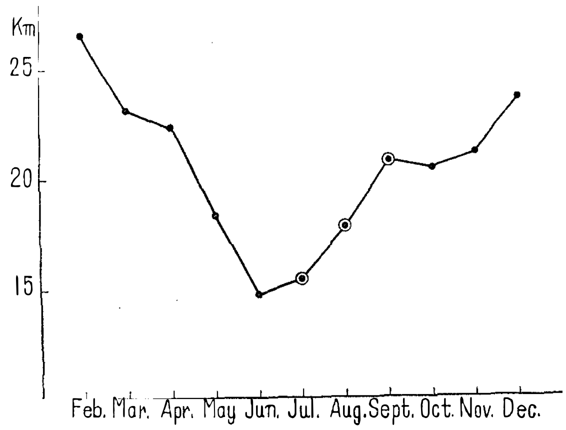

Fig. 1

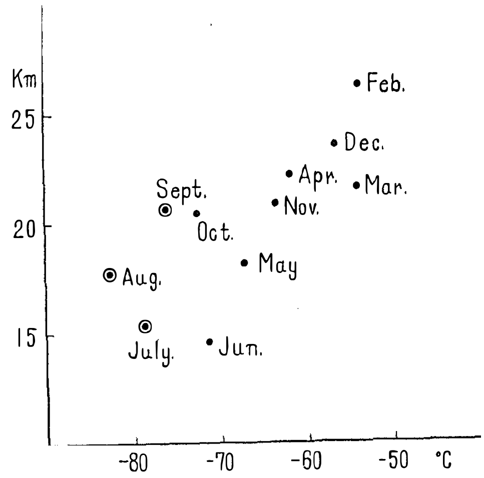

Fig. 2

Table 2

	5 | 10 k	10 | 15 k	15 | 20 k	20 | 25 k	25 | 30 k	30 | 35 k	mean volue of gpm
Feb.			1	1	2	2	26485
Mar.		1	3	2	3		23123
Apr.			3	9	2	1	22373
May			6				18306
Jun.		4	3				14655
Jul.		7	6				15434
Aug.		1	6	1			17887
Sept.		1	2	3	1		20855
Oct.		2	3	7	2		20633
Nov.			2	3			21140
Dec.				2			23829
Total		16	35	28	10	3	

layer through which the ballon ascended and in ordinate, monthly mean heights of balloon bursted. Mark ⊙ in the figure indicates that the balloon used are immersed and mark ·, those of not immersed. This figure shows that the bursting heights of balloon which are not immersed in diesel oil decreases linearly with temperature but those of oiled balloon are higher than this. From this figure we can see definitely the effect of immersion in diesel oil.

Table 2 shows the frequency by heights and mean bursting height in each.

7. Seasonal variations of temperature

Fig. 3 shows a representative ascension curve in summer and winter. Curve 1 is for summer type observed at 1200 GMT, 22 December 1959. Temperature inversion near the surface layer is scarcely found. Tropopause appears sharply near 300 mb and temperature in the stratosphere increases with height. At the height of tropopause comparatively high temperature is predominant for summer time and it is likely that temperature does not reach even -50°C. Curve 2 is forwinter type observed at 1200 GMT 24 August 1959. Near the earth's surface, magnificent temperature inversion appears frequently during winter season, and may dissipate after a

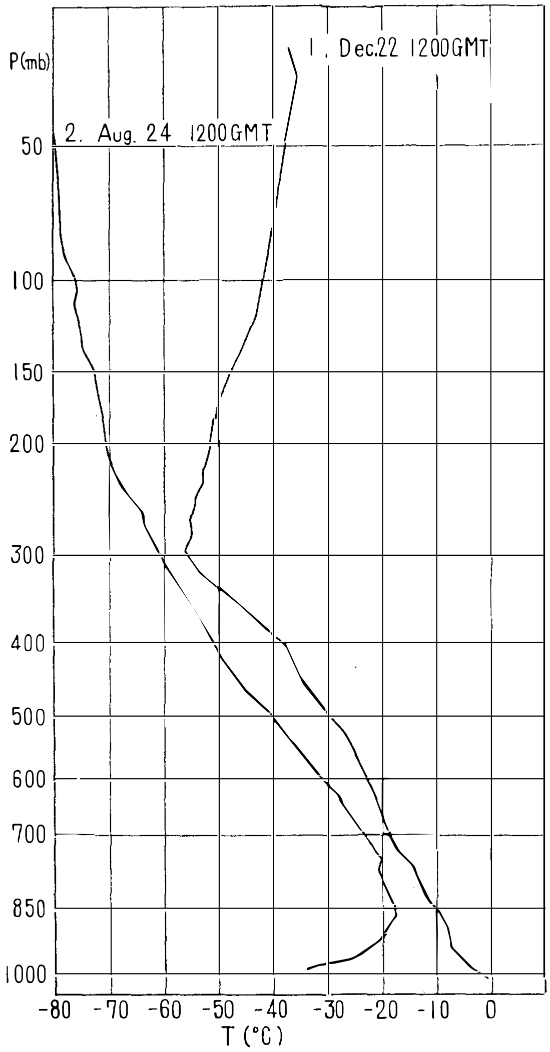

Fig. 3

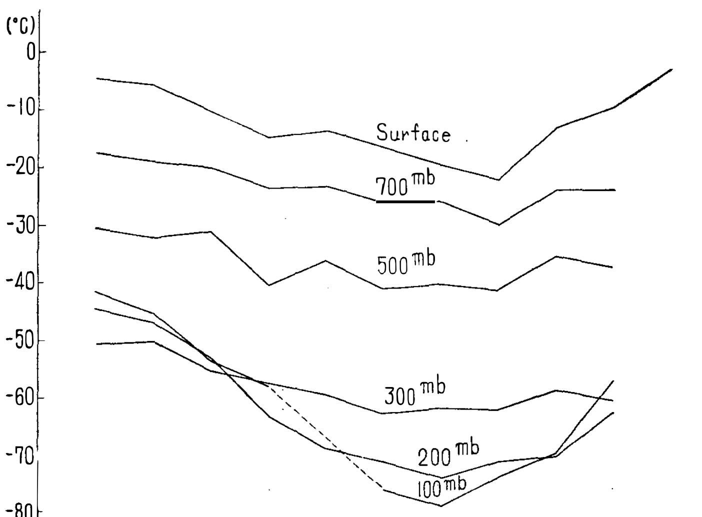

Fig. 4

spell of strong cyclonic winds. The upper ilmit of the inversion (or isothermal layer) which can be found near 850 mb remains its traces for the occurrence of strong mixing, and has a tendency to move gradually into the higher level. (described later). Winter tropopause is, in general, not so obvious but is also unlikely to dissipate completely. The height of tropopause is more or less higher in winter than in summer. Temperature in the stratosphere continues to decrease with increasing height and records the minimum temperature at about the bursting height of balloon. The minimum temperature observed is -86.2°C at 65 mb on 20 August 1959.

So far the typical example of summer and winter are described, it is therefore natural that spring and autumn shall be located between them.

8. Annual variation of upper air temperature

Fig. 4 shows the variation of monthly mean temperature of mandately levels (700, 500, 300, 200, 100 mb). At 700 mb and 500 mb the variations resemble that of the surface, the so-called "Kernlose Type", but their amplitude is smaller than that of the surface. At 300 mb, this character vanishes. At 200 mb, being already included in the stratosphere, the changes are simple with a large amplitude.

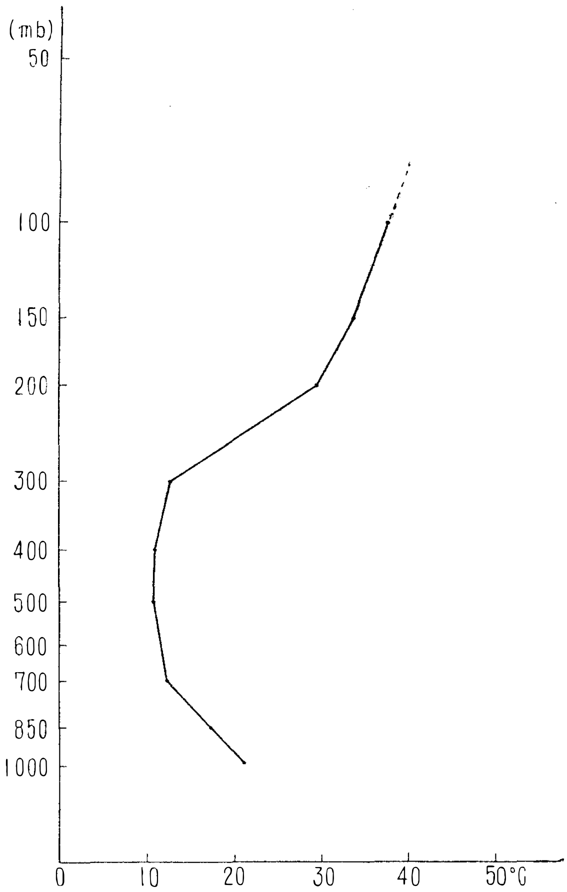

Fig. 5

At 100 mb, though being almost the same with 200 mb changes, the amplitude is much larger.

Fig. 5 shows the amplitude of annual variation of monthly mean temperature at each level (December is excepted due to a few observations). Maximum amplitude appears in the stratosphere and becomes larger with height. At the surface, the amplitude is of secondary magnitude. The smallest one lies in the troposphere between 700 mb and 300 mb. It may therefore be regarded that an active advection of warm air from north and the consequent mixing takes place frequently in the troposphere. In the stratosphere, there is a little chance in alternating mixing of north-south air masses, accordingly, an intense heating by the sun may arise in summer and a radiation cooling in the polar winter night may be strengthened.

Fig. 6 shows isopleth diagram in which continuous line is for isothermal line and

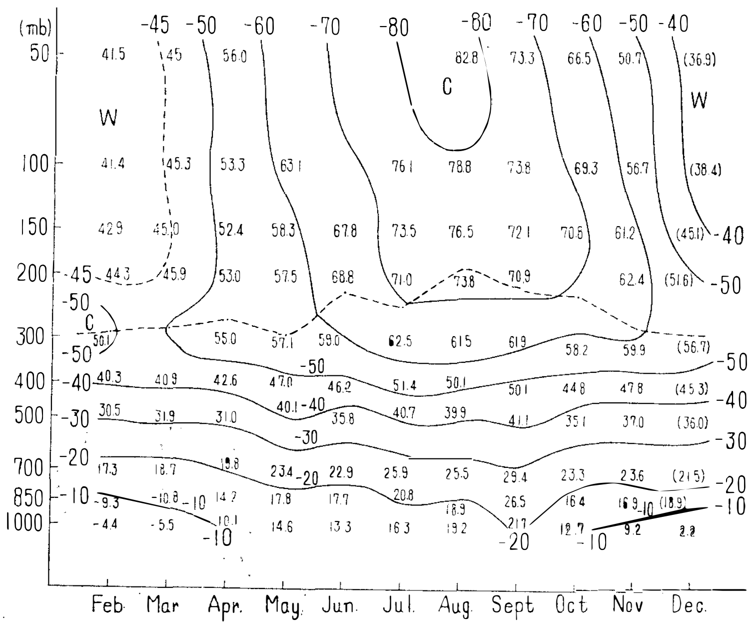

Fig. 6

dash line for tropopause. Minimum temperature in the stratosphere appears in August but in the troposphere it appears one month later. Height of tropopause may be the highest in August in which the temperature of stratosphere becomes the lowest and conversely, it may be the lowest in winter. The difference in height between summer and winter may amount to over 2000 m.

9. Temperature inversion in lower level

There are many occasions in which isothermal layer or inversion layer can be seen near from 850 mb to 700 mb throughout the year. In winter season, furthermore, teh inversion layer may appear nearly at the earth's surface. Surface inversion layer may be build up magnificently after it is successive clear days with weak wind, but it may be soon dissipated by mixing when blizzard begins. However, inversion layer (or isothermal layer) in the level around 850–700 mb is much stable and does not dissipate completely even in the blizzard, keeping its traces and tends to go up gradually with time. Fig. 7 shows of this examples in which part of ascension curves represents only 1200 GMT respectively for 15–21 July. Weak wind continued for the period of 15–18 July, and surface inversion was becoming remarkable. Blizzard began on 19 July and in the state of 20 July, complete dissipation of inversion could be seen. (No observation on 19 July.) Continued storming by 21 July second inversion existed near 800 mb did not dissipate even in the blizzard and moved into the higher level gradually and its trace remained near 650 mb on 21 July.

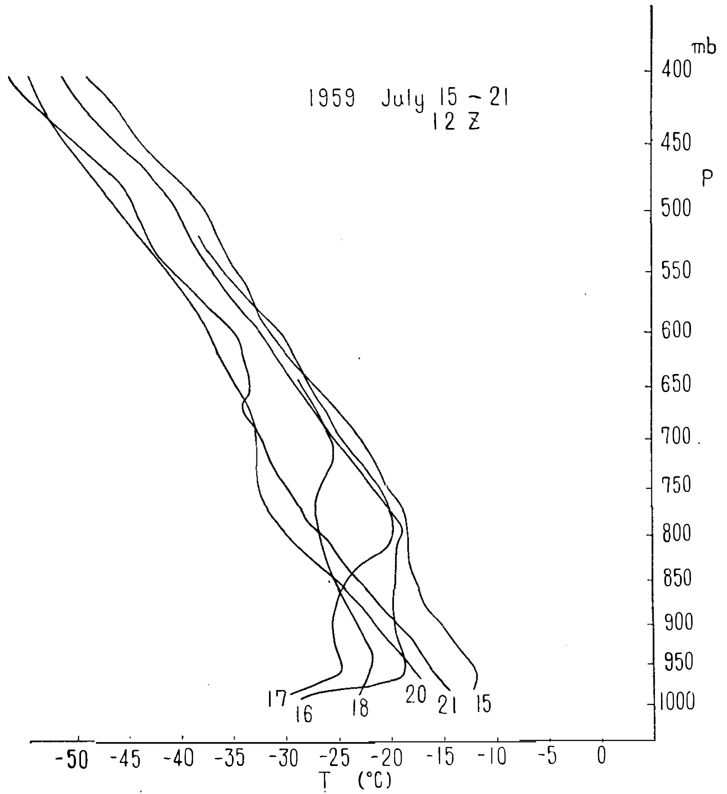

Fig. 7

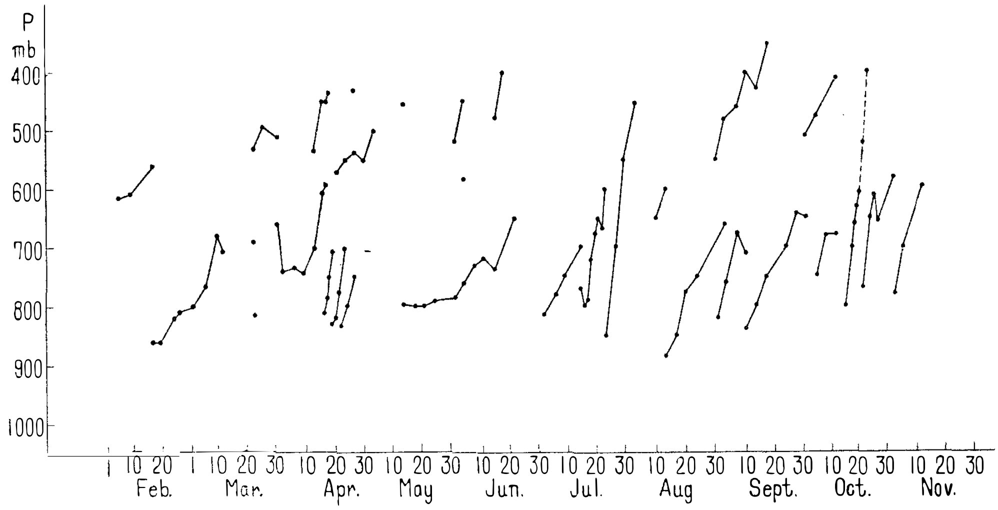

Fig. 8

Generally speaking, the second inversion at around 850 mb is of persistence, not to be destructive by blizzard and tends to go higher with time. When it reaches at about 600–650 mb in height new inversion may be formed at about 850 mb. Fig. 8 shows signs of this.