

N.Z.M.O. CIRCULAR NOTE No. 43.MEAN VALUES OF HEIGHTS OF TROPOPAUSE, 300, 500, and 700
MILLIBAR SURFACES AT AUCKLAND, HOKITIKA AND TAIERI.

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Monthly means of the height of the tropopause and of the 300, 500 and 700 millibar surfaces have been computed from the radiosonde data available from Auckland, Hokitika and Taieri.

Radiosonde observations have been made at Auckland almost continuously, one flight a day at 1200 Hours G.M.T. from May, 1943 to date; at Hokitika: from October, 1944 to November, 1945, inclusive, one flight a day at 1200 hours G.M.T., and occasional flights from August, 1946 to date; at Taieri: from February, 1944 to November, 1945, inclusive, one flight a day at 1200 hours G.M.T., and a few training flights since.

The periods used for the computation of the mean values presented in this note were:

Auckland : - May, 1943 to April, 1947.

Hokitika : - October, 1944 to November, 1945

Taieri : - February, 1944 to November, 1945.

The height of the tropopause, H_t , was determined according to the following rules:

- (a) When the stratosphere begins with an inversion, H_c is the height of the first point of Zero temperature gradient.
- (b) When the stratosphere begins with an abrupt transition to a temperature gradient below 2°C per kilometre without inversion H_c is the height of the abrupt transition.
- (c) Where there is no such abrupt change of temperature gradient, the base of the stratosphere is to be taken at the point where the mean fall of temperature for the next kilometre above is 2°C or less, provided that it does not exceed 2° for any subsequent kilometre.

The means are presented in two equivalent sets of tables, the first set giving values in geodynamic metres, the second set in conventional feet (i.e. the unit is 0.98 of one geodynamic foot) and a set of curves showing the annual variation and comparisons between Auckland, Hokitika and Taieri. The curves are smoothed i.e. the values entered on the graphs are obtained from the formula $b' = \frac{1}{2}(a + 2b + c)$, where b is the actual mean for a given month, a and c the actual means for the months preceding and following the given month and b' the smoothed mean for the given month.

The chief purpose of this note is simply to present the mean values but a few observations may be made.

Height of the Tropopause. The means of all observations for each station, 11.0 gkms. for Auckland, 10.4 for Hokitika and 10.3 gkms. for Taieri accord fairly well with, but appear to be slightly lower than, figures quoted for corresponding latitudes in the northern hemisphere. (1). Bureau, Douquet and Wehrle (2), in 1939, obtained a series of atmospheric soundings from Madagascar to Kerguelon and back. In their report they say that all soundings at Kerguelon showed "the base of the stratosphere at once.....much lower and much warmer than..... at Paris" in about the same latitude. It will be interesting to see if Australian soundings also show tropopauses lower than in the northern hemisphere at corresponding latitudes. The downward slope of the mean tropopause towards the pole is illustrated. The amplitude of the annual variation at Auckland, 3 gkms, is in close agreement with Gold's figure for Europe (1910-11) (1), 2.5 gkms.

The fact that the amplitude at higher latitudes (Hokitika and Taieri) is smaller than at Auckland is in agreement with Northern Hemisphere observations and the magnitude of the difference appears to correspond roughly with the difference between the amplitudes at 40°N and 50°N (see diagram due to Ramanathan on P.18 of Brunt's "Physical and Dynamical Meteorology"). Mean values at Taieri and Hokitika higher than at Auckland in July and August are surprising but may be due to abnormalities during these months of the years 1944 and 1945 for which Taieri and Hokitika (1945 only) data are available. The means for the individual months are shown in Table.

	July 1944	August, 1944	July, 1945	August, 1945.
Auckland	10.0	9.4	9.7	10.2
Hokitika	-	-	10.1	10.2
Taieri	10.3	10.4	10.3	10.4

There are however two facts which point to the possibility that this reversal of the slope of the Tropopause in winter is genuine. The first is that the reversal is complete i.e. Taieri tropopause is higher than Hokitika's which in turn is higher than Auckland's. The other is that it has been shown (N.Z.H.O. Circular Note No.25) that the passage of depressions over the North Island is common and most frequent in winter. This is also interesting in view of the Little America III observations (3) which indicate a disappearance of the tropopause over the Antarctic in winter and temperature at high levels much colder in winter than in summer.

The December means for Hokitika and Taieri are based on only one month's observations in 1944 when the Auckland mean was 10.7 gkms, which is 0.7 gkms. lower than the Auckland December mean for four years.

Heights of 300, 500 and 700 Millibar Surfaces. The main features of the curves of Figures 1 b to 1 d are much the same as those of Figure 1a but of course the amplitude of the annual variation decreases with increasing pressure. The heights of the surfaces lower polewards and in all months the Auckland mean heights are higher than Hokitika's and Taieri's. All surfaces are at a maximum height at all stations in February (smoothed values). Over Taieri however there are signs of a double minimum in the 300 millibar curve in June and September. This is more marked at the 500 millibar level and at this level Hokitika exhibits the same tendency. At the 700 millibar level the minima at Hokitika and Taieri occur in May and November. (Note: the smoothing process results in the exceptionally low December, 1944 values of the 700 mb. height for Hokitika and Taieri being reflected in the November values; the true minima would appear from the tables of unsmoothed values to be in October). The Auckland smoothed curve of 700 millibar heights exhibits no double minimum but there is a distinct flattening of the curve between May and September. The un-smoothed Auckland 700 mb values in Table I show two minima, in May and August. The period during which radiosonde observations have been taken at Hokitika and Taieri is however too short to show conclusively whether or not the double minimum is real.

References.

- (1) "The International Kite and Balloon Ascents". E. Gold.M.O. Geophysical Memoirs, Vol.1, No.5, 1942.
- (2) "Radiosondages dans les mers australes" R.Bureau, & Ph.Wehrte. C.R. Acad.Sci.Paris, Vol.208, 1939, pp 1419-20 (abstract in Bulletin Amer.Met.Soc. Vol.20, 1939, P.359).
- (3) "Tropopause Disappearance During the Antarctic Winter" Arnold Court, Bulletin Amer. Met. Soc. Vol.23, 1942 pp.220-238.

MONTHLY MEAN HEIGHTS OF TROPOPAUSE, 300 mbs., 500 mbs. and 700 mb.
SURFACES AT AUCKLAND, HOKITIKA AND TAIERI.

TABLE Ia - Tropopause (in Geodynamic Kilometres)

	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sept	Oct.	Nov.	Dec.	Year
Auckland.	12.2	12.8	12.4	11.7	10.5	10.5	9.5	9.5	9.7	10.2	11.0	11.4	11.0
No.	(66)	(70)	(63)	(44)	(69)	(67)	(75)	(67)	(81)	(67)	(74)	(64)	
Hokitika	11.4	11.0	10.8	11.1	10.1	10.3	9.9	9.8	9.6	10.1	10.4	10.3	10.4
No.	(20)	(19)	(22)	(12)	(28)	(29)	(28)	(26)	(22)	(43)	(42)	(16)	
Taiari	12.0	10.9	10.5	10.4	10.3	10.1	10.1	10.2	9.8	9.7	10.2	9.8	10.3
No.	(18)	(44)	(49)	(33)	(44)	(47)	(55)	(56)	(48)	(54)	(49)	(28)	

TABLE Ib - 300 mbs. Surface (in Geodynamic Metres.)

	Jan.	Feb.	Mar.	Apr.	May.	June.	Jul.	Aug.	Sept	Oct.	Nov.	Dec.	Year
Auckland	9197	9219	9169	9094	8973	8927	8868	8854	8894	8975	9055	9091	9025
No.	(100)	(89)	(88)	(76)	(83)	(79)	(88)	(86)	(96)	(81)	(97)	(98)	
Hokitika	9138	9094	8913	8997	8798	8814	8765	8806	8820	8847	8942	8903	8903
No.	(25)	(21)	(26)	(13)	(29)	(29)	(29)	(27)	(25)	(44)	(47)	(16)	
Taiari	9099	9061	8967	8906	8817	8751	8775	8816	8770	8809	8873	8800	8870
No.	(23)	(50)	(56)	(45)	(46)	(50)	(58)	(59)	(50)	(57)	(52)	(30)	

TABLE Ic - 500 Mbs. Surface (in Geodynamic Metres.)

Auckland	5602	5620	5598	5564	5468	5453	5431	5412	5440	5462	5517	5544	5509
No.	(105)	(97)	(101)	(90)	(98)	(92)	(97)	(93)	(105)	(96)	(104)	(107)	
Hokitika	5570	5550	5443	5479	5352	5396	5378	5391	5396	5378	5432	5599	5430
No.	(25)	(21)	(27)	(13)	(29)	(30)	(30)	(27)	(26)	(45)	(50)	(17)	
Taiari	5530	5431	5436	5412	5370	5336	5376	5370	5350	5351	5388	5326	5390
No.	(29)	(51)	(62)	(48)	(54)	(55)	(60)	(61)	(52)	(58)	(54)	(31)	

TABLE Id - 700 mbs. Surface (in Geodynamic Metres)

	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Auckland	3017	3036	3023	2998	2934	2952	2945	2930	2938	2949	2970	2973	2972
No.	(107)	(97)	(105)	(92)	(102)	(92)	(101)	(99)	(108)	(102)	(107)	(108)	
Hokitika	3002	3004	2924	2960	2863	2924	2916	2923	2917	2887	2922	2880	2927
No.	(25)	(21)	(28)	(13)	(29)	(30)	(37)	(27)	(26)	(48)	(54)	(17)	
Taiari	2967	2930	2915	2901	2883	2869	2921	2902	2876	2868	2886	2831	2896
No.	(50)	(53)	(62)	(49)	(58)	(56)	(60)	(60)	(53)	(58)	(55)	(31)	

MONTHLY MEAN HEIGHTS OF TROPOPAUSE, 300 mb., 500mb. and 700 mb.

Surfaces At Auckland, Hokitika and Taieri in conventional feet. (Unit = 0.98 geodynamic foot)

TABLE IIa - Tropopause.

	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
Auckland.	40680	42980	41340	39040	35100	35100	31820	31820	32480	34120	36740	38060	35660
Hokitika	38060	36740	36090	37070	33790	34450	33140	32810	32150	33790	34780	34450	34780
Taieri.	40030	36420	35100	34780	34450	33790	33790	34120	32810	32480	34120	32810	34560

TABLE IIb - 300 mbs. Surface.

Auckland	30790	30860	30700	30450	30040	29890	29690	29640	29780	30050	30310	30430	30210
Hokitika	30590	30450	29840	30120	29450	29510	29340	29480	29530	29620	29930	29810	29810
Taieri	30460	30340	30020	29820	29520	29300	29380	29510	29360	29490	29690	29460	29690

TABLE IIc - 500 mb. Surface.

Auckland	18750	18820	18740	18630	18310	18260	18180	18120	18210	18290	18470	18560	18440
Hokitika	18650	18580	18220	18340	17920	18060	18010	18050	18060	18010	18190	18070	18100
Taieri	18510	18180	18200	18120	17980	17860	18000	17980	17910	17910	18040	17830	18050

TABLE IId - 700 mb. Surface.

Auckland	10100	10160	10120	10040	9820	9880	9860	9810	9840	9870	9940	9950	9950
Hokitika	10050	10060	9790	9910	9580	9790	9760	9790	9760	9670	9790	9640	9800
Taieri	9930	9810	9760	9710	9650	9600	9780	9740	9630	9600	9660	9480	9700

Fig. I. Annual Variation of Heights
of Tropopause, 300, 500 and 700mb. Surfaces

