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A STUDY OF ANNUAL OSCILLATIONS OF TROPOPAUSE OVER INDIA

1. Seasonal variations of pressure, height and temperature elements at the level of upper tropopause also known as tropical type of tropopause (it is characterised by inversion at the base of the stratosphere) existing around 16-17 km over India, throughout the year, have been studied. It may be mentioned that another lower type or extra tropical type of tropopause also exists around 10-12·5 km in higher latitudes over India (about 25°N) in the months November to April (this lower type of tropopause is characterised by a nearly isothermal layer above it).

This study is based on the data of 13 radiosonde stations in India, collected during the years 1958 to 1962. There were, on the average, 25 ascents in every month distinctly defining the upper tropopause. The minimum number of ascents in a month at one station was 3 and highest 103.

The data were subjected to Fourier analysis. Only the first harmonic or the annual oscillations of pressure, height and temperature have been presented. Higher harmonics or smaller period oscillations have not been presented in this note because the amplitudes of these oscillations are small as compared to the annual oscillation.

2. *Annual variations*

2.1. *Pressure*—In the height column of Table 1, the annual pressure variations and corresponding phase angles are given.

Annual pressure oscillations are maximum at the northern and southern ends of India (about 7 mb) and in the central part, there is minimum (about 2·5 mb) in the maximum amplitude variations.

The time of maxima in the extreme south of India is around middle of August and towards the northern latitudes in middle of December.

2.2. *Temperature*—Annual temperature variations are given in the temperature column of Table 1. These also follow the same patterns as that of the pressure fluctuations. In the north of the continent, the fluctuations are the greatest, being of the order of 5·0°C and there is a minimum in central part of India (being only 0·5°C). The amplitudes again increase further down south, being 1·5°C.

The time of maximum is mid-February in the north and middle of July in the southern region.

2.3. *Height*—The annual fluctuations of the height of the upper tropopause are maximum in the northern and southern latitudes of India, being of the order of 500 to 600 gpm (see Table 1—height column) and least in the central regions, about 250 gpm.

These occur sometimes in the middle of March in the southern parts and round middle of June

TABLE 1

Characteristics at Tropopause level

	Pressure			Height (tens of gpm)			Temperature		
	A_0 (mb)	A_1 (mb)	ϕ_1 (°)	A_0 (gpm×10)	A_1 (gpm×10)	ϕ_1 (°)	A_0 (°A)	A_1 (°C)	ϕ_1 (°)
Allahabad	103·7	4·4	330	1664	47	164	202·1	3·3	20
Amritsar	107·2	7·7	299	1644	65	151	206·8	3·9	359
Calcutta	103·7	2·7	273	1664	25	185	199·3	0·8	95
Gauhati	105·4	4·8	348	1653	58	169	202·1	2·5	45
Madras	107·0	7·1	213	1630	53	46	196·6	0·9	65
Jodhpur	105·0	5·9	207	1659	57	167	203·2	3·1	22
Nagpur	104·6	3·8	273	1647	28	96	197·1	0·9	61
New Delhi	103·8	7·7	339	1655	65	167	202·4	5·1	25
Trivandrum	109·4	7·8	224	1620	53	17	196·9	1·5	230
Port Blair	111·0	6·5	246	1617	32	66	196·7	1·7	149
Veraval	106·3	8·4	274	1642	44	112	198·6	1·0	23
Santacruz	102·3	2·0	298	1678	25	161	200·7	0·5	307
Visakhapatnam	105·0	5·4	240	1637	32	73	195·7	0·8	73

A_0 — Annual mean amplitude

A_1 — Amplitude of first harmonic or annual oscillation

ϕ_1 — Phase angle indicating the date of occurrence when annual variation is at its maximum

The conversion of phase angles to dates is given below —

Phase angles	0°	30°	60°	90°	120°	150°	180°	210°	240°	270°	300°	330°
Dates corresponding to phase angles given above	Apr 15	Mar 15	Feb 15	Jan 15	Dec 15	Nov 15	Oct 15	Sep 15	Aug 15	Jul 15	Jun 15	May 15

in the north (fluctuations towards minimum occur after six months in the above regions).

3. From this study, it is seen that at the tropopause level over India, the annual pressure, temperature and height fluctuations have maxima in the northern and southern latitudes with minimum fluctuations over the central region of India.

K. K. SHARMA

Regional Meteorological Centre,
Nagpur
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