

INDIA

The five IMD stations recording total ozone since 1957 with Dobson spectrometers/Brewer Ozone Spectrophotometers are spread out in a latitudinal belt ranging from 10° N to 35°N. The mean total ozone amounts over these stations range from about 300 DU at the northern most stations to about 250 DU at the southern extreme. All the stations show marked seasonal variations in total ozone amounts. The amplitudes of the seasonal variations are higher over Srinagar (34°N), with 40 DU and are low over stations in the tropical belt where the amplitudes are about 20-25DU. A clear phase-shift in the occurrence of ozone maxima and minima is also observed as we move from higher to lower latitude tropics. The maxima and minima occur during spring (Feb-Apr) and autumn (Sept-Oct), respectively in Srinagar. This progressively shifts to summer (Jun-Aug) and winter (Dec-Jan) at Kodaikanal (10°N). Although one could be due to sun driven photochemistry and lower stratospheric dynamics. Analysis of long-term total ozone data from the Indian stations has not shown any trends, however, there are inter-annual variations. Such variations are of scientific interest and not of any public concern at the present age. Measurements by different techniques and investigations also vary nominally, mostly within the limits of statistical fluctuations of the data.

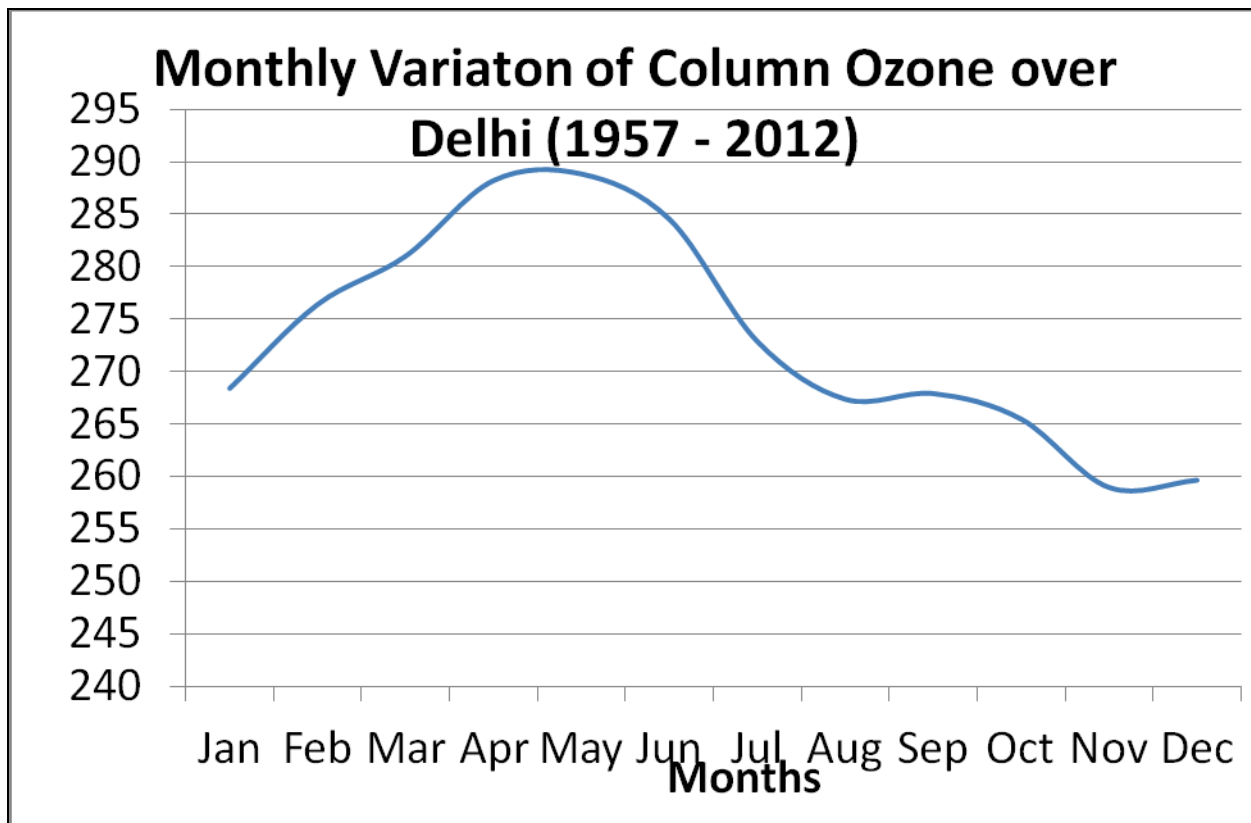
The vertical distribution of ozone in the equatorial atmosphere has been shown to be generally same although small changes occur in both the lower stratosphere and the troposphere. One particularly interesting feature is smallest concentration of ozone found consistently, just below the Tropopause, in all seasons and at all places where sounding have been made in India. Over Delhi the maximum occurs at about 23-24 km with secondary maxima in the lower stratosphere particularly during winter and spring. The maximum ozone concentration of the order of 150 μ mb occurs at a height of 26-27 km over Thiruvananthapuram (8°N) and 25-26 km over Pune (8°N). During the summer monsoon months, the vertical distribution of ozone throughout India is very similar.

Based on Umkehr data, Ozone concentration in the lower troposphere has been observed to be slightly increasing over Delhi. Also the stratosphere shows a decreasing trend, especially after 1982.

From the study of Peshin et al 2003,2008,2011 , Chakrabraty and Peshin 1995,1998,2011,Sreedharan, C.R., et.al. 1989; Mani, A., 1993; Subbaraya,B.H., 1993; Rao, K. Nagbhusan, 1993; Sreedharan, C.R., et. al. 1993a; Sreedharan, C.R., et. al. 1993b; Koppa, A.L. and S.C. Nagraath, 1991; Kane, R.P., 1994 and Tiwari, V.S., 1992; the following conclusions may be drawn:

1. Analysis of the data available so far does not establish any clear trend in the variation of total ozone over India. However, stratospheric ozone shows little decreasing trend since the last few years over stations situated North of Lat.24-25°N. Tropospheric ozone shows an increasing trend but not statistically significant.
2. From the equator to about 20°N, the tropospheric ozone concentration remains practically the same throughout the year.
3. Significant changes occur in the vertical distribution of ozone associated with passing weather systems occur at New Delhi during the non-monsoon months.
4. Depletion of ozone over Antarctica is observed, confirming occurrence of Antarctic hole. The ozone hole phenomenon has also been observed over the Indian Antarctic Station at Maitri (70°S, 11°E) where IMD monitors ozone amounts throughout the year.

5. Surface ozone data over the Indian stations have not indicated any systematic variation. Presently ozone concentrations at surface level are within safe limits. Ambient surface concentrations prevailing over Indian cities are not more than 40 ppbv which is well within the prescribed limits of 50 ppbv as given by the MoES (SAFAR).



TOTAL OZONE:

S.No	Name of station	Lat.	Long.	Instrument Type & S.No	Frequency of obsn.	Since when
1	Srinagar	34° 05' N	74° 50' E	Dobson 10	6/day	Nov.1955
2	New Delhi	28° 35' N	77° 12' E	Dobson 36	6/day	Jan. 1955
3	New Delhi	28° 35' N	77° 12' E	Brewer 089/164	Cont.	Aug.1994
4	Varanasi	25° 18' N	83° 01' E	Dobson 55	6/day	Dec.1963
5	Pune Pune	18° 32' N	73° 51' E	Dobson 39 Brewer 170	6/day Cont.	Mar.1973 Oct. 2005
6	Kodaikanal	10° 14' N	77° 28' E	Dobson 45	6/day	July 1957
7	Kodaikanal	10° 14' N	77° 28' E	Brewer 094	Cont.	May 1994
8	Maitri (Antarctica)	70° 48' S	11° 42' E	Brewer 153	Cont.	July 1999
9	New Delhi	STANDARD	Dobson 112		Aprl.1969	

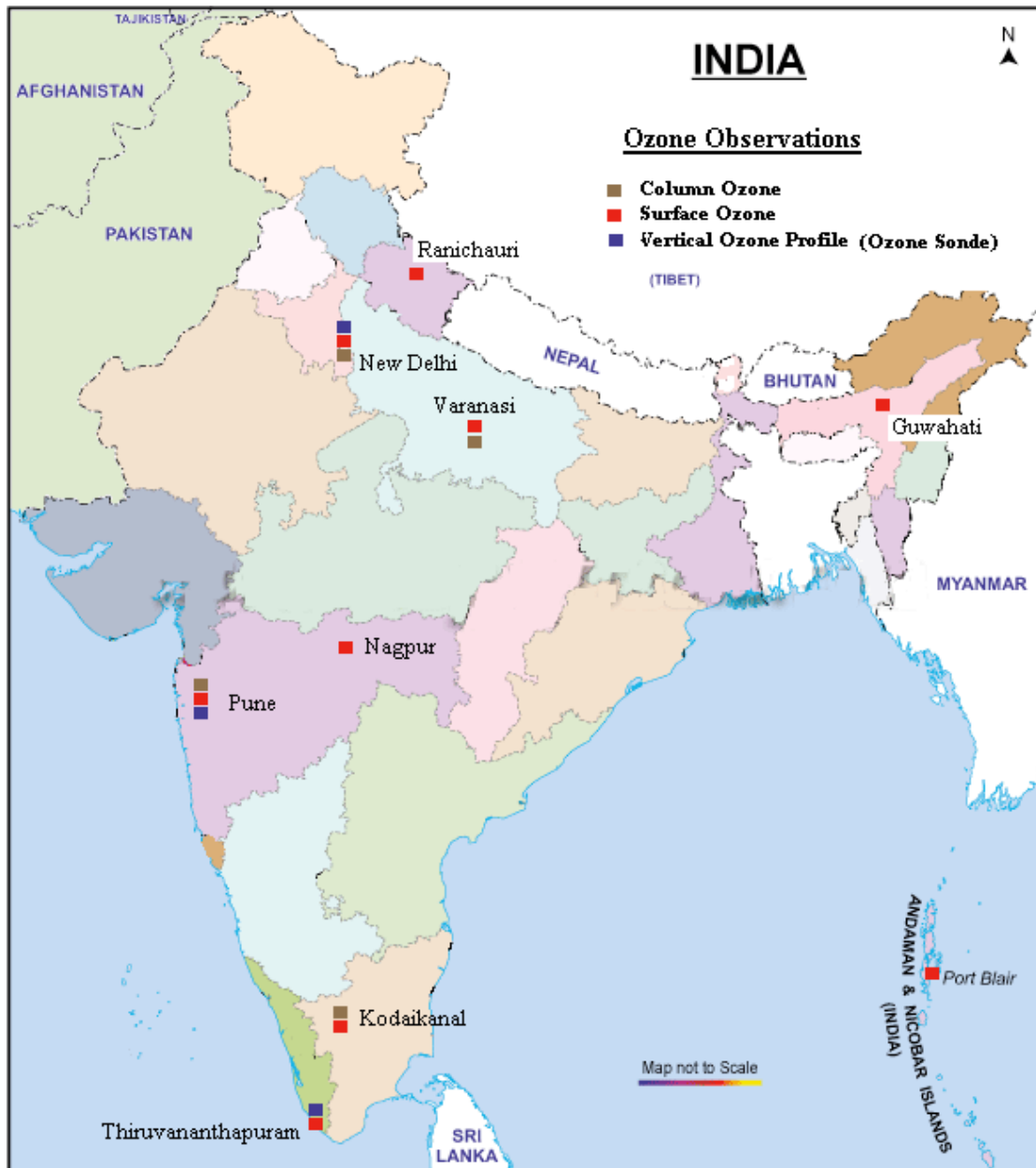
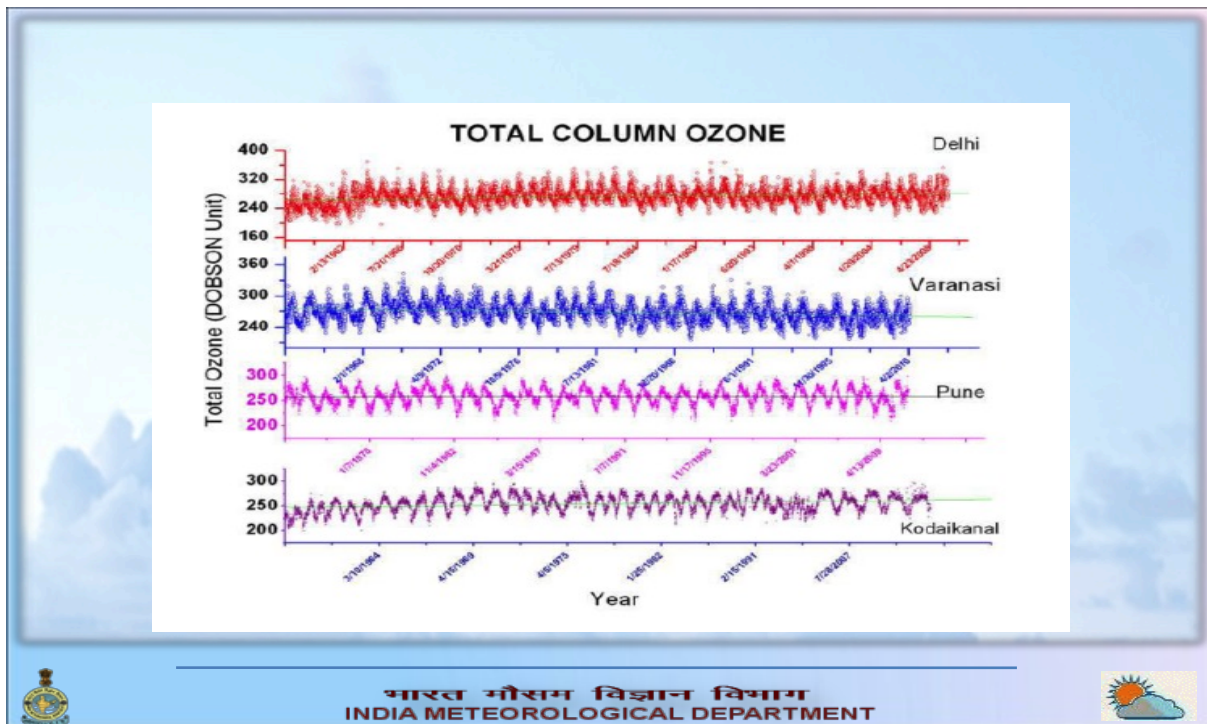


Figure : IMD's Network of Ozone Monitoring Stations in India

Vertical distribution of ozone

S.No	Name of station	Lat.	Long.	Frequency of observation	Since when
1	New Delhi	28° 35' N	77° 12' E	Fortnightly	1971
2	Pune	18° 32' N	73°51' E	Fortnightly	1971
3	Thiruvananthapuram	08° 29' N	76° 57' E	Fortnightly	1971
4	Dakshin Gangotri	70° 03' S	12°E	Weekly	1986-89
5	Maitri (Antarctica)	70° 48' S	11° 42' E	Weekly	1990

Indian ozonesonde was intercompared in West Germany in 1970 and 1980, Canada in May 1991 and in Germany February 1996.



Calibration

- Network instruments standardized against the National Standard at regular intervals.
- National Standard, in turn intercompared with world standard in international intercomparisons/RA-II held in Japan .
- IMD participated in such comparisons held at Belsk (1974), Boulder (1977), Melbourne (1984) and Japan (1996,2006).

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NEEDS AND RECOMMENDATIONS

The WMO support is required for technical inspection of the Brewer spectrophotometers in Delhi, Kodaokanal and Pune, and calibration of all the 3 ones operating in India, and also Calibration of Dobson Spectrophotometer.