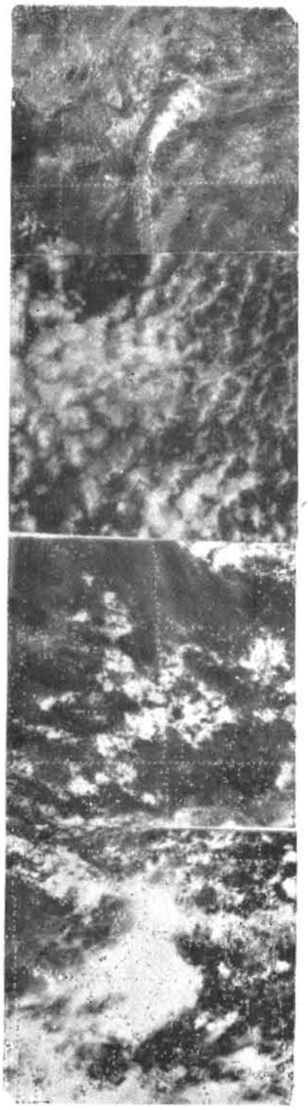
TABLE 2

Clouds	Classification	Description	Classification	Clouds
	1	Clear or open mostly open cumuliform or stratiform or cirriform with definite anticyclonic indication over land		
		Mostly-covered to covered thin cumuliform or stratiform or cirriform with definite anticylonic circulation over land	2	
	3	Open cumuliform with no anticyclonic indications cumulonimbus or cumulus congestus		
		Mostly-open to mostly-covered cumuliform with no anticyclonic indications, isolated cumulonimbus or cumulus congestus may be present	4	
	5	Mostly-covered to covered stratiform without anticyclonic indication or middle or high cloud layer		
		Covered cumuliform with embedded *cb* or *cu* congestus present	6	
	7	Mostly covered with combination of dense *cu/st* or *ci*		
		Clouds associated with moderate to strong frontal zone *cb* and rain showers probable area of deep rain etc	8	

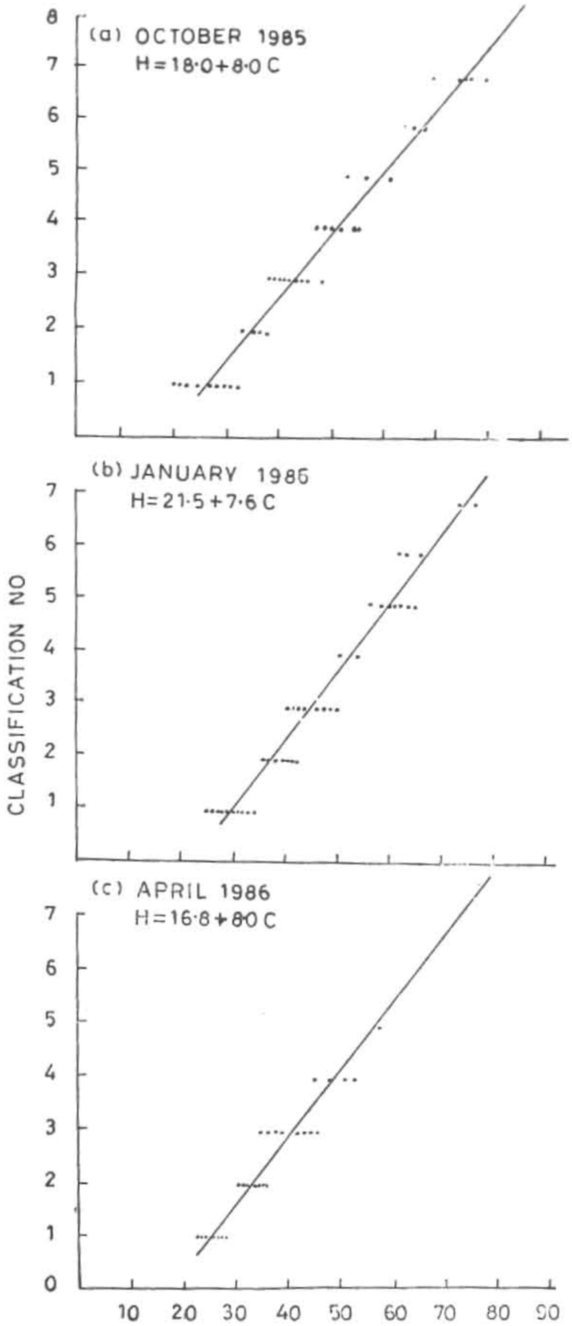


Fig. 1. Average R. H. in lower troposphere for the months of : (a) October 1985, (b) January 1986 and (c) April 1986

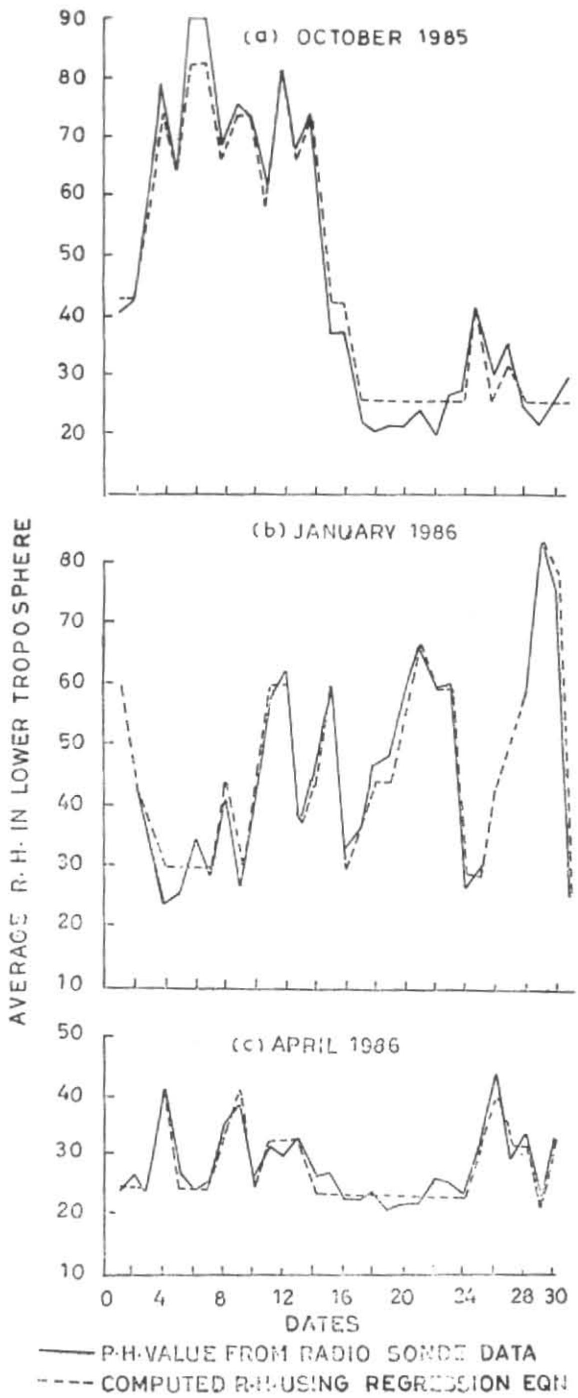


Fig. 2. Plot of R. H. value from radiosonde data for the months of : (a) October 1985, (b) January 1986 and (c) April 1986

TABLE 3

Computed R.H. value (*H* and actual value with standard deviation) and correlation coefficient

Date	Jan 1986			April 1986		
	Class No.	*H* value	Actual value	Class No.	*H* value	Actual value
1	5	59.5	60.0	1	25.2	24.1
2	3	44.3	42.6	1	25.2	27.3
3	—	—	—	1	25.2	24.0
4	1	29.1	24.3	3	41.8	40.8
5	1	29.1	25.8	1	25.2	27.3
6	1	29.1	34.7	1	25.2	24.7
7	1	29.1	28.6	1	25.2	26.1
8	3	44.3	41.8	2	33.5	35.0
9	1	29.1	27.2	3	41.8	39.9
10	—	—	—	1	25.2	26.8
11	5	59.5	58.7	2	33.5	32.6
12	5	59.5	62.2	2	33.5	31.0
13	2	36.7	39.2	2	33.5	33.8
14	3	44.3	46.6	1	25.2	27.4
15	5	59.5	60.5	1	25.2	28.2
16	1	29.1	33.3	1	25.2	24.5
17	2	36.7	37.2	1	25.2	24.3
18	3	44.3	48.0	1	25.2	25.3
19	3	44.3	48.4	1	25.2	23.0
20	5	59.5	60.3	1	25.2	23.7
21	6	67.1	66.1	1	25.2	23.7
22	5	59.5	60.8	1	25.2	27.7
23	5	59.5	61.5	1	25.2	27.3
24	1	29.1	27.5	1	25.2	25.4
25	1	29.1	31.4	2	33.5	32.1
26	3	44.3	43.5	3	41.8	45.6
27	4	51.9	50.3	2	33.5	31.1
28	5	59.5	59.3	2	33.5	35.5
29	8	82.3	85.3	1	25.2	23.9
30	7	74.7	76.7	2	33.5	34.7
31	1	29.1	27.5	—	—	—

S.D. =15.9 S.D. =5.71

Corr. Coeff. =0.99 Corr. Coeff.=0.95

4. Discussion

In the study of three-year cloud classification it was observed that in general classification up to type 4 were very much common. In more than 82% of the cases, cloud classifications were of type 4. Higher type of classification (No. 5, 6, 7, 8) were very rare. In the months of April and October, higher types than type 5 were not observed at all.

In the month of January, cloud classifications higher than type 5 were also observed, but the frequency was not more than 2 to 3 per month which was due to the passage of western disturbances around Delhi. Table 1 shows cloud classification as estimated from INSAT-1B cloud picture during the different months. Based on the cloud classification for various months and using the proposed regression equation we estimated that in general, the average relative humidity (*H*) around Delhi in the lower troposphere was of the order of 45% in January and about 42% in the month of April and October, in about 82% of the cases.

During this study vertical distribution of relative humidity was also tracked level by level and case by case both at 00 and 12 GMT observations. From the study of 3 years data for January, April and October it was observed that in the month of January on 50% occasions humidity has been observed up to 700 mb level and only 15% of the cases humidity has been observed up to 600 mb level. During April and October in 59% of the cases moisture was traced up to 700 mb level, and out of which in 21% cases moisture extended up to 600 mb level. Above 600 mb level moisture could not be traced out. In general, we can say that during April and October moisture distribution confined to the lower atmosphere only.

Using proposed regression equation average relative humidity (*H*) was computed for January 1986 and April 1986 as shown in Table 3. The computed relative humidity values have been plotted along with the radiosonde data as shown in Fig 2. In Fig. 2(b) radiosonde relative humidity values are drawn by continuous lines whereas the computed values have been plotted by dotted curves. The study of these curves shows that computed values curve resemble very close with radiosonde data value curves except with slight difference, which may be due to sudden increase in moisture due to passage of western disturbances in the month of January. The correlation coefficient of computed relative humidity with radiosonde data for Fig. 2 data sets worked out to be 0.99. Fig. 2(c) shows plot between RS data and computed R.H. value using regression equation for the month of April. The study of this figure shows that computed R.H. value curve coincides with RS data curve in general except with slight mis-match which is due to the limitation in estimating cloud classification which cannot be in fractional number. With this limitation the estimated R.H. value may differ by 7-8% from RS data value. The computed R.H. value shows a very good correlation coefficient (0.95) with the RS data. Fig. 2(a) provides similar comparison for October 1985 data sets.

5. Conclusion

In this paper authors have based the study over Delhi as ground truth was available in order to arrive at regression equation for inland station, outside mountainous region, oceans and coastal stations. This regression equation will provide a method to estimate average value of vertically distributed relative humidity in the lower troposphere using INSAT-1B cloud pictures. This technique may fill the data gap for moisture estimation over data sparse region over land outside mountainous, oceanic and coastal areas from where conventional radiosonde data are not possible due to inaccessibility reasons. Estimation of relative humidity using proposed regression equations and satellite picture may provide additional support to quantitative precipitation forecasting and developing new prognosis models.

6. Results

(*i*) In general, moisture distribution confines up to 700 mb level in January, April and October.

(*ii*) The average relative humidity of 45% have been observed in January and 42% in April and October.

(*iii*) In general, cloud classification of type 3-4 have been observed during these months.

(*iv*) These regression equations can provide fairly good estimation of relative humidity values in the lower troposphere over inland station during January, April and October months.

References

Essenwanger, O., and Haygard, G., 1960, 'Project report on cloud cover and relative humidity, National Weather Records Center, U.S. Weath. Bur., 73 pp.

Meclain, E.P., 1966, *Mon. Weath. Rev.*, **94**, 8, pp. 509-514.

Smagorinsky J., 1960, 'Physics of precipitation', Geophysical Monograph; No. 5, Amer. Geophys. Un. Wash. D.C., pp. 71-78.

Thompson, Aylmer H. and Philip, W. West, 1961, *Mon. Weath. Rev.*, **95**, pp. 791-798.