

STRATOSPHERIC WIND CIRCULATION IN THE LATITUDE BELT OF 16-18° N OVER INDIA DURING OCTOBER TO MAY

TIFR Balloon Facility, Hyderabad had been taking high altitude ascents with special plastic and rubber balloons since 1959 for their experiments in the stratospheric studies for balloon performance evaluation, cosmic-ray studies, X-ray astronomy, gamma-ray astronomy, stratospheric water vapour measurements, infrared astronomy, stratospheric wind data and other miscellaneous flights. These flights were tracked with the India Met. Dep. radar at Hyderabad Airport and with optical theodolites based at two or more stations for determining the floating altitude wind structure and for the speedy recovery of the cosmic-ray payload. For the convenience of launching of these huge balloons nearly calm surface wind with clear sky periods were chosen and hence, there were no ascents during monsoon period. The number of ascents are not uniformly spaced in time and they differ from month to month. Upper wind data being sparse in those high altitudes (above 30 km), consequently the above data is very useful for probing the structure of wind circulation in those altitudes.

2. Data and analysis

In the present study the upper wind data computed at the interval of every kilometre altitude for the period 1970 to 1982 has been taken. The data comprises of about 300 flights taken during the months October to May through December with a few flights in June and July. Meridional velocity components were found to be small throughout and hence only zonal velocity components have been analysed. The data is, however, discontinuous both in time and space. Actual zonal components (not averages) for all the flights have been plotted chronologically and isotachs are drawn at the interval of 10 mps. A line has been drawn to show the discontinuity. The isotach analysis are shown in Figs. 1-2. A frequency table of height *versus* zonal component velocity (in mps) has been prepared for the periods December-January, February-March, April-May, June-July, October-November and which is presented in Tables 1(a & b).

3. General characteristic features of the wind circulation

The general features of the stratospheric wind circulation during October to May is given below :

(i) The wind flow is predominantly westerly between 15 & 20 km altitude levels. Zonal components of strong

TABLE 1 (a)

Frequency analysis of zonal components of upper winds of TIFR high altitude ascents for the period 1970-1982

Altitude (km)	Dec-Jan						Feb-Mar					
	E			W			E			W		
	0-10	11-20	21-30	0-10	11-20	21-30	0-10	11-20	21-30	0-10	11-20	21-30
Velocity (mps)												
Above 35 km (36-40)	17	13	12	2	1	—	21	10	3	8	6	—
31-35	89	70	22	38	18	—	96	41	16	40	7	—
26-30	136	76	6	49	9	—	100	73	6	42	21	—
21-25	141	29	2	81	4	—	136	30	3	80	2	—
18-20	53	2	—	87	10	—	23	6	—	113	11	—
15-17	7	—	—	54	60	27	14	—	—	48	75	16

TABLE 1 (b)

Altitude (km)	Apr-May						Jun-Jul					Oct-Nov							
	E			W			E			W	E			W					
	0-10	11-20	21-30	0-10	11-20	21-30	0-10	11-20	21-30	31-35	0-10	11-20	21-30	0-10	11-20	21-30			
(Velocity (mps))																			
Above 35 km (36-40)	17	37	4	24	1	—	—	—	—	—	—	—	—	12	8	—	36	22	—
31-35	84	115	55	13	—	—	—	21	3	10	—	—	—	103	62	12	64	13	—
26-30	104	176	36	9	—	—	1	14	40	—	—	—	—	111	145	50	—	2	—
21-25	163	107	10	27	—	—	—	22	38	—	—	—	—	169	126	14	14	2	—
18-20	108	31	—	55	1	—	—	15	21	—	—	—	—	129	31	3	21	7	—
15-17	39	16	1	87	43	6	3	5	22	6	—	—	—	102	15	1	59	15	—

August-September data not available

westerlies (20-30 m/s) are observed below 17 km altitude during December, March and April.

(ii) The wind flow is predominantly easterly between 20-30 km altitude levels. Zonal components of strong easterlies (20-30 m/s) are observed at 25-28 km altitude during October & November.

(iii) Both easterlies and westerlies are observed above 30 km upto 40 km altitudes with easterlies in the lower levels and westerlies in the higher levels. Further it is observed that the easterlies weakening with increased height and westerlies strengthening with increased height.

4. Characteristic features of wind circulation in different seasons

(A) During post-monsoon (October-November) period

(i) In 15-18 km altitude level — Light westerlies or light easterlies. Strengthening of westerlies by November observed.

(ii) In 18-30 km altitude level — Mainly easterlies with a maximum speed of 25-30 m/s observed between 26 & 30 km altitude level.

(iii) In 30-40 km altitude level — Easterlies decreasing in speed with increase in height and above

it westerlies which tend to strengthen in speed with increase in height. Strong easterlies speed 25-30 m/s observed below 35 km. Moderate westerlies speed 10-15 m/s observed above 37 km.

(B) *During winter (December-March) period*

(i) *In 18-15 km altitude level* — Strong westerlies decreasing in speed with increase in height observed with a maximum speed of 25-35 m/s below 16 km.

(ii) *In 18-30 km altitude level* — Mostly westerlies below 21 km and mostly easterlies above it. Generally westerlies observed to be decreasing in speed with increase in height while easterlies speed increasing with increase in height with a maximum speed of 10-15 m/s.

(iii) *In 30-40 km altitude level* — In general easterlies prominent compared to westerlies. There appears to be a diffused cyclic order of direction of wind shift annually. Prominent easterlies decreasing in speed with increase in height and above it westerlies are observed to be changing to prominent westerlies decreasing in speed with increased height and easterlies above it. However, this cyclic order of directional wind shift annually is not strictly confirmed because of paucity of data in some years.

(C) *During pre-monsoon (April-May/June) period*

(i) *In 15-18 km altitude level* — Predominantly westerlies. It is also observed that westerlies becoming easterlies in May. Subsequent to the change of season,

i.e., in June-July easterlies strengthen to 35-40 m/s below 17 km.

(ii) *In 18-30 km altitude level* — Predominantly easterlies. Speed observed to be increasing with increase in height with a maximum of 20-25 m/s above 25 km. Subsequent to the change of season, *i.e.*, in June-July easterlies strengthen to 25-30 m/s above 25 km.

(iii) *In 30-40 km altitude level* — Mainly easterlies with a maximum speed of 25-30 m/s between 33 & 36 km altitude level. Occasionally light westerlies observed above 36 km in April.

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References

- Gokhale, G. S., Menon, M. G. K. and Redkar, R. T., 1967, *Indian J. Met. Geophys.*, **18**, 1, pp. 5-6.
- Rajaram, K. S., & Joseph, K. T., 1969, *Indian J. Met. Geophys.*, **20**, 3, pp. 213-220.

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