NOAA Technical Memorandum EDS ESIC- 7

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Environmental Data Service

An Annotated Bibliography of Studies on Surface and Upper Winds Over India 1941-70

ANNIE E. GRIMES

Environmental
Science
Information
Center

WASHINGTON, D.C.
May 1973

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AN ANNOTATED BIBLIOGRAPHY OF STUDIES ON SURFACE AND UPPER WINDS OVER INDIA 1941—70

Annie E. Grimes
Atmospheric Sciences Library
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WASHINGTON, D.C.
May 1973

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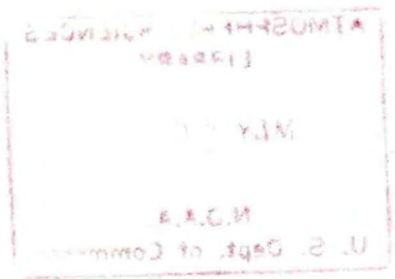
"1941-1970"	1941-1970



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INTRODUCTION

This bibliography of studies on surface and upper winds over India has been compiled from references in three libraries of the Washington Metropolitan Area. Some references may be in more than one of these libraries; however, the call number is recorded in the abstract for only one of them in the preferential order listed below:

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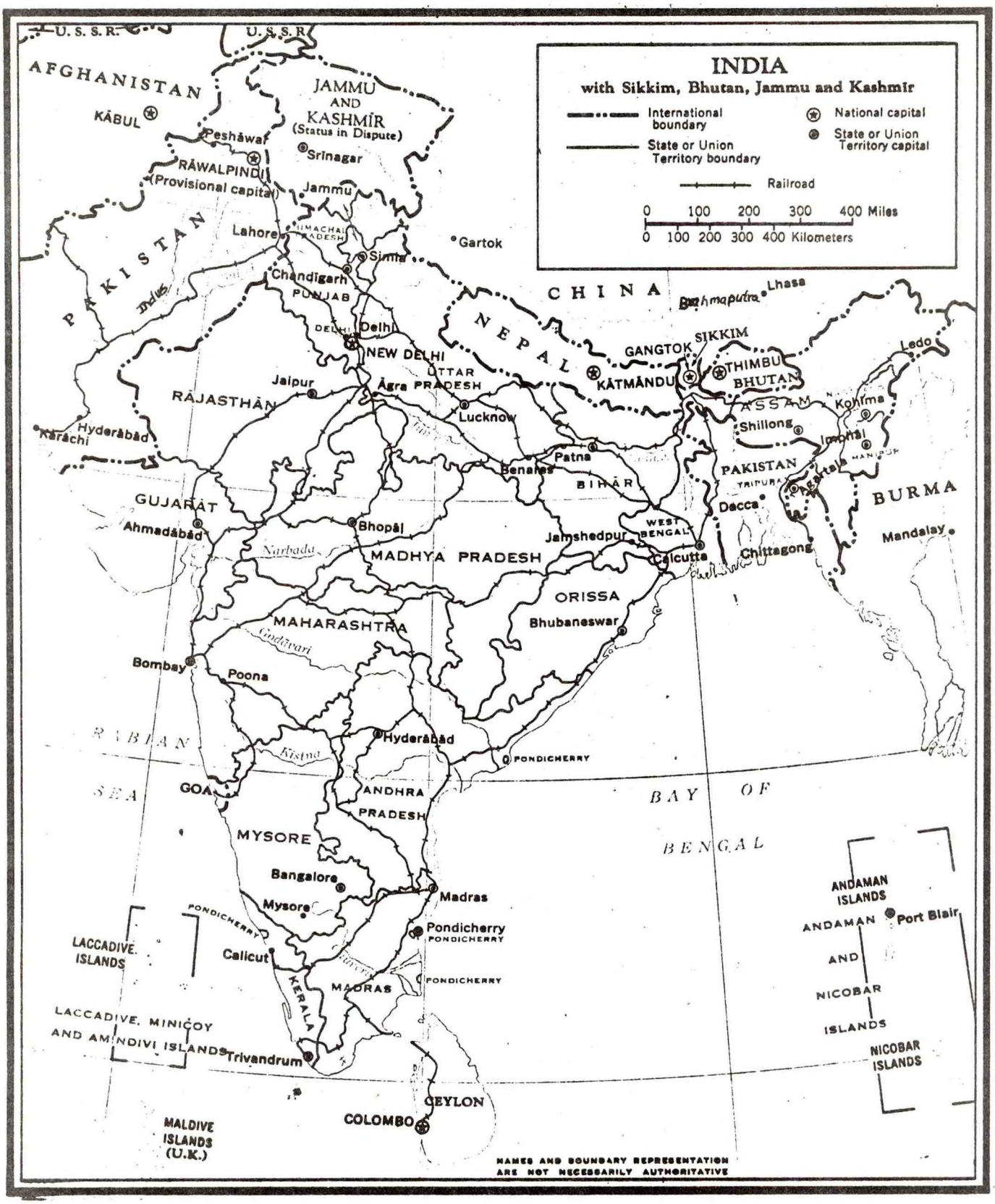
INDIA
with Sikkim, Bhutan, Jammu and Kashmir
International boundary
State or Union Territory boundary
National capital
State or Union Territory capital
Railroad
0 100 200 300 400 Miles
0 100 200 300 400 Kilometers
U. S. S. R.
U. S. S. R.
AFGHANISTAN
KĀBUL
JAMMU AND KASHMĪR (Status in Dispute)
Peshāwar
Srinagar
RĀWALPINDI (Provisional capital)
Jammu
PAKISTAN
Lahore
HIMACHAL PRADESH
Gartok
Simla
Chandigarh
PUNJAB
Indus
CHINA
Brahmaputra
Lhasa
DELHI
Delhi
NEW DELHI
NEPAL
GANGTOK
SIKKIM
Ledo
KĀTMĀNDU
THIMBU
BHUTAN
UTTAR PRADESH
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RĀJASTHĀN
Lucknow
ASSAM
Kohima
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Kistna
PONDICHERRY
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NAMES AND BOUNDARY REPRESENTATION ARE NOT NECESSARILY AUTHORITATIVE

ANNOTATED BIBLIOGRAPHY OF STUDIES ON SURFACE AND UPPER WINDS OVER INDIA

References and Abstracts

1941

1. Roy, A. K. The sea-breeze at Madras. India Meteorological Department, Scientific Notes, 8(97): 139-146. Delhi, 1941. DAS M(055) I39s.

...The paper contains a preliminary study of the sea-breeze at Madras, a station situated on the east coast of the Indian Peninsula. It is found that sea-breeze from the east, which is often very well marked, sets in in the afternoon or evening with some of the characteristics of a cold front during the monsoon months June to September, even though the prevailing gradient wind from the west is itself of oceanic origin but heated by passage over land. Some statistical data relating to the sea-breeze are given in part I of the paper, while part II contains some suggestions regarding the estimated depth of the sea-breeze and the time of its onset, based on the study of the easterly components of the wind at lower levels at dawn and 1400 hrs. - Author's abstract.

1945

2. Malurkar, S. L. Forecasting of surface winds. India Meteorological Department, Technical Note, No. 19, 4pp. Bombay, 1945. DAS M(055) I39te. Also in: Forecasting weather in and near India by S. L. Malurkar. pp. 3-12. 1945? DAS MO9.3 M261f.

...Summarizes the methods used by author in forecasting surface winds in India and Pakistan. The note contains information on the sea breeze, katabatic winds, and surface winds in disturbed weather.

1946

3. John, I. G., and Hare, F. K. Winter circulation over Burma, Thailand and Indo-China. Great Britain, Meteorological Office, Synoptic Divisions Technical Memorandum, No. 120. 10pp. 1946. DAS M(055) G786s.

...Examines the parts of Asia lying between the areas covered by the two main monsoons; describes the Indian monsoon circulation over Burma, Assam, and Thailand; discusses the air masses and fronts; presents details of synoptic charts, which include Burma, Thailand, Indochina, Assam, and Bengal.

1947

4. Malurkar, S. L. Lower level winds along the deltas of the north Madras coast in the monsoon. Current Science, 16(12): 375-376, December 1947. DAS M(05) C976.

...Contains brief notes on the lower level winds along the deltas of the north Madras coast based on data from Madras, Vizagapatam, and Masulipatam. A table presents the mean wind speed and direction for the period (July and August) at heights of 0.5, 1.0, 1.5, and 2.0 km based on data for 1942-1945 at Madras, Vizagapatam, and Masulipatam.

5. Mathur, L. S. A low pressure portable hydrogen generator for pilot balloon observatories. India Meteorological Department, Scientific Notes, IX (114): 161-165. Delhi, 1947. DAS M(055) I39s.

...Describes the design and working of a small portable generator based on silicol-soda process. The construction of this instrument was initiated at the Upper Air Office, New Delhi in February 1942.

6. Sen Gupta, Prabhat Kumar, and Chakravortty, Keron Chandra. Land breeze at Calcutta (Alipore). India Meteorological Department, Scientific Notes, 9 (108): 73-80, Delhi, 1947. DAS M(055) I39s.

...In Calcutta the land breeze sets in during some calm nights of non-monsoon months as light puffs of wind, and is associated generally with a rise of temperature and a fall of relative humidity. 254 cases of land breeze were found during the years 1935 to 1940. The annual and monthly distribution, times of onset, duration, direction, and velocity are given in Tables I and VII. Frequencies of rise of temperature and fall of humidity associated with this breeze are shown in Tables VIII and IX. Tables Xa and Xb give the most favourable condition of wind at 17 hours for the setting in of such a breeze. The probability of occurrence of fog after the onset of land breeze is very small. Comparative data of Dum Dum and Calcutta for a few months in 1941 have been discussed. - Authors' abstract.

1948

7. Pramanik, S. K. Computation of winds in the atmosphere in low latitudes. Part I. Stationary pressure systems. India Meteorological Department, Scientific Notes, X(127): 153-156. Delhi, 1948. DAS M(055) I39s.

...Radiosonde ascents are being taken from a number of stations in India, and the geostrophic wind can be obtained from the isobaric charts. The geostrophic wind, however, differs quite appreciably in Indian latitudes from the gradient wind, which gives a satisfactory approximation to the true wind. The percentage corrections required to be applied to the geostrophic wind to obtain the gradient wind for different velocities of geostrophic wind and radii of curvature of trajectories for cyclonic and anti-cyclonic motions at latitudes 10°, 20° and 30° have been obtained in this note. It is difficult to ob-

Source No. 7 continued

tain the curvatures of trajectories, but in stationary pressure systems they are equal to the curvatures of isobars, which are readily obtainable. The tables in this note can therefore be applied to obtain the corrections from the curvatures of isobars in stationary pressure systems. - Author's abstract.

1949

8. Pramanik, S. K., and Mazumdar, S. Computation of winds in the atmosphere in low latitudes. Part II. Moving pressure systems. India Meteorological Department, Scientific Notes, X(128): 157-176. Delhi, 1949. DAS M(055) I39s.

...In the previous Sc. note, the corrections to be applied to geostrophic wind to obtain the gradient wind from curvature of isobars in stationary pressure systems in Indian latitudes have been given. In this note, percentage corrections have been obtained for cyclonic and anticyclonic pressure systems, moving with different velocities, from curvatures of isobars for different values of geostrophic wind and inclinations of the isobars to the direction of movement of systems at latitudes 10°, 20°, and 30°. - Authors' abstract.

9. Shamshad, Khan M. Katabatic effect over Jodhpur. Current Science, 18(9): 336-337. September 1949. DLC Q1 .C78.

...Describes the location of the airfield at Jodhpur and presents the conditions under which katabatic drainage of air from higher ground is perceptible at the station.

10. Yin, Maung Tun. A synoptic-aerologic study of the onset of the summer monsoon over India and Burma. Journal of Meteorology, Boston, 6(6): 393-400, December 1949. DAS M(05) A512j.

...A comparison of the mean winter and summer flow patterns at 8km in the vicinity of India shows that a trough located to the east of India in winter has shifted westward by summer. A study of the onset of the summer monsoon during 1946 shows that this movement is comparatively rapid and coincides with the "burst of the monsoon" over India. The movement of the trough is explained as being due to changes in the long-wave pattern brought about by the presence of the Himalayan mountain complex combined with seasonal variations in the latitude of the circumpolar jet stream of the northern hemisphere. - Author's abstract.

1950

11. Chaudhury, A. M. On the vertical distribution of wind and temperature over Indo-Pakistan along the meridian 76°E. in winter. Tellus, Stockholm, 2(1): 56-62, February 1950. DAS M(05) T277.

Source No. 11 continued

...A mean cross-section over Indo-Pakistan along the meridian 76° E for January and February 1946 has been computed. Three jet stream centers are obtained along this meridian: one in Siberia, one just south of the plateau, and one in the tropics. The effect of the plateau gives rise to Siberian and Himalayan jets. A numerical comparison of the computed mean profile along 76°E with that of Hess (1948) along 80°W over North America is presented.

Computed wind velocity, wind shear, and absolute vorticity patterns are discussed, particularly with regard to strong anticyclonic shear and very low absolute vorticity found on the south side of the Himalayan jets. The spatial distributions of the isentropic field, the gravitational stability field, the baroclinity field, and the rainfall during the winter months are discussed in regard to the sense of the meridional circulation around the Himalayan and the Equatorial jets. - Author's abstract.

12. Great Britain. Meteorological Office. Equivalent headwinds on some of the principal air routes of the world. Meteorological Reports, No. 7. 19pp. London, 1950. DAS M82 G786m.

...Presents a table with seasonal summaries of mean equivalent headwinds in knots on designated routes (Basra-Bombay, Bombay-Colombo, Bombay-Calcutta, Karachi-Calcutta, Karachi-Delhi, Delhi-Calcutta, Calcutta-Singapore, Calcutta-Rangoon, and Calcutta-Hongkong), mean equivalent headwinds for return flight of these air routes, and variability of the equivalent headwind at specified heights.

13. Pramanik, S. K., and Sreevastava, S. N. Pibals in forecasting. Indian Journal of Meteorology and Geophysics, Delhi, 1 (3): 247-248, July 1950. DAS M(05) 139i.

...Pibal data for Calcutta, Lahore, and Madras were examined in order to determine to what extent their direction and variation with height can help in forecasting improvement or deterioration in local weather as regards occurrence of rain. It is concluded that data on variations of upper wind directions with height up to 10,000 ft over these stations are not useful in forecasting rain. - MAB 2.3-37.

14. Sil, J. M. Relationship between vertical currents and intensity of precipitation. Indian Journal of Meteorology & Geophysics, Delhi, 1(1): 52-58, January 1950. DAS M(05) 139i.

...Using data obtained from radiosonde ascents at Poona, and applying the formulas developed by Fulks and Holmboe, the rate of precipitation has been calculated for various vertical velocities in the saturated layers. From an integration of these rates in the several standard layers (800 mb to 400 mb), a total unit rate is derived which when applied to actual rates of fall for short periods during 211 showers

Source No. 14 continued

(in 35 thunderstorms) permits a table of average and maximum vertical speeds to be compiled. The highest speed was 5.7 m./sec. (12.7 m./h.), June 22, 1945. Precipitation intensities during the showers from 1939 to 1944 are tabulated. (Maximum 5.5 in./hr.) – MAB v.1) 7-82.

15. Venkiteshwaran, S. P. Winds at 10kms. and above over India and its neighbourhood. India Meteorological Department, Memoirs, 28(2): 55-120. Delhi, 1950. DAS M(055) I39m. Also summary in: National Institute of Sciences of India, 16 (1): 19-27, January / February 1950. DAS M(05) N277p.

...The paper contains an analysis of all the upper wind data for the period 1920 - 1941 at 10 km and above over India and neighbourhood. Charts showing the mean air movement in each month at every 2-km level between 10 and 20 km , have been drawn. The chief feature of the upper wind circulation in these levels is the "High" over the South China Seas in winter which moves up to the Himalayas by July and August. The variation of wind with height over different regions of India during the year is discussed. The west-east components of the winds from the ground up to 20 km over approximately 78°E longitude were calculated and charted for the winter and the monsoon seasons and found to be similar to those calculated by Bjerknes from the distribution of pressure and temperature over the northern hemisphere. The paper also shows that the cirrus movements over India approximate most closely with the upper wind circulation at 10 and 12 km , where the temperature is between 240 and 220°A. As observations of high winds with pilot balloons are possible at a station only in clear weather, the conclusions drawn in this paper will be more representative of the conditions prevailing in such weather. - Author's abstract.

1951

16. Agarwala, K. S. On the gustiness of wind and occurrence of gusts at Vishakhapatnam. Indian Journal of Meteorology and Geophysics, Delhi, 2(4): 277-283, October 1951. DAS M(05) I39i.

...Summarizes the results of a study on wind gustiness at Vishakhapatnam based on data for 3 years (1939 - 1941). This article includes a description of the exposure of the anemograph and the method of tabulating the data; discusses the importance of gustiness near the ground, diurnal variation of gustiness, diurnal distribution of gusts, speed and direction of the gusts, duration of gusts, and speed of the highest gust in each year; presents other features of the structure of wind; contains tabular summaries based on 3 years of data. The summaries include monthly and annual mean hourly gustiness; monthly and annual mean, maximum and minimum gustiness based on hourly observations; monthly and annual frequencies of maximum gusts; monthly wind speed frequency of maximum gusts: monthly wind direction frequency of maximum gusts.

17. Venkiteshwaran, S. P., and Yegnanarayanan, S. Radar measurements of upper winds over Poona during the southwest monsoon. Indian Journal of Meteorology and Geophysics, Delhi, 2(3): 228 - 232, July, 1951. DAS M(05) I39i.

...Summarizes the upper winds above the cloud level, up to a height of nearly 10 km during the two monsoon periods in 1949 and 1950. The source contains graphs showing comparative monthly (June - September) mean upper wind speeds based on radar observations (1949 -1950), pilot balloon observations (1949 - 1950), and normal pilot balloon observations from surface up to 14 km; a diagram showing the isopleths of east-west components of radar wind based on the monthly means for the period June 1949 - November 1950.

18. Vittal Sarma, V. Comparison of geostrophic winds on constant pressure surfaces with observed winds in India. Indian Journal of Meteorology and Geophysics, Delhi, 2(1): 41-47, January, 1951. DAS M(05) I39i.

...The paper describes a method of comparing geostrophic winds derived from constant pressure surfaces with observed winds. The differences in heights of the constant pressure surfaces between five pairs of stations in India have been calculated using upper wind data for two levels viz. 850 mb and 700 mb. The differences have also been obtained from the data of radio sonde ascents. These values have been compared, and correlation coefficients have been worked out. Similar computations have been made for some cases in the British Isles. Some plausible explanations for the comparatively lower values of correlation coefficients for the Indian stations have been given. - Author's abstract.

1952

19. Flohn, Hermann. Trade-wind and monsoon circulation according to aerological observations. International Geographical Union, XVIIth International Geographical Congress, Washington, D.C., August 8-15, 1952, Proceedings, Section on Climatology, pp. 24-27. DAS M8 I61p.

...Points out that classical view of meridional trade-wind circulation must be revised based on observational data from more than 150 pilot balloon stations in tropical latitudes. The author concludes that the so-called monsoon rains of India, Indonesia, Northern Australia, and Western Africa are caused by the seasonal shifting of the ITC region with its cyclonic disturbances, travelling chiefly from east to west.

20. Krishna Rao, P. R. Probable regions of jet streams in the upper air over India. Current Science, Bangalore, 21(3): 63-64, March 1952. DAS M(05) C976.

Source No. 20 continued

...Presents a diagram showing the normal distribution of temperature and the mean zonal components of wind in the upper air over India along 78°E in summer and winter. The author presents conclusions based on this diagram.

21. Parthasarathy, S., and Narayanan, J. The diurnal variation of upper winds over Bombay and Poona. Indian Journal of Meteorology and Geophysics, Delhi, 3(3): 197-203, July 1952. DAS M(05) I39i.

...Is a study on the diurnal variation of upper winds over Bombay and Poona based on 5 years of data since 1944. The source presents graphs of mean wind speeds against altitude and hodographs of resultant wind vectors for Poona and Bombay for January, April, July, and October. The table contains mean resultant wind velocity (mps) and mean resultant direction (degrees from north) at surface and heights of 40 and 150 meters above ground level for Poona for each month (October - March).

22. Rahmatullah, M. Synoptic aspects of the monsoon circulation and rainfall over Indo-Pakistan. Journal of Meteorology, Boston, 9(3): 176-179, June 1952. DAS M(05) A512j.

...The circulation and rainfall distribution over India during August 1949 were studied with a view toward determination of the degree of steadiness of monsoonal weather conditions. Not less than five different patterns of flow, each with a characteristic distribution of precipitation, were found to prevail in turn during this month alone. - Author's abstract.

23. Ramaswamy, C. Winds at 40,000 feet and above over Calcutta during the southwest monsoon period. Indian Journal of Meteorology and Geophysics, Delhi, 2(3): 157-158, April 1952. DAS M(05) I39i.

...Is a brief letter on winds at 40,000 feet and above over Calcutta based on data for the first week of September 1951. The easterlies probably extend up to 70,000 feet, and they increase in speed with height up to 65,000 based on information obtained from these observations.

24. Sil, J. M. Windmill power. Indian Journal of Meteorology and Geophysics, Delhi, 3(2): 77-90, April 1952. DAS M(05) I39i.

...Includes monthly summaries over the period (May 1940 - April 1944) of mean hourly wind velocity (mph) and mean wind velocity based on hourly observations at Poona.

25. Sinha, K. L. Strong winds at Allahabad and their forewarnings. Indian Journal of Meteorology and Geophysics, Delhi, 3(2): 101-114, April 1952. DAS M(05) I39i.

Source No. 25 continued

...Analyzes available observational strong wind data at Allahabad (Bamrauli Aerodrome) during the years 1941-1945. The author discusses the situation of aerodrome, general features of winds at Allahabad, winds exceeding 20 mph, classification of strong winds, some characteristics of strong winds, forecasting of strong winds at Allahabad, and some other considerations for short-time warnings of severe dust and thunderstorms of the summer months. The tabular data, summarized over the period (1941-1945) for Allahabad, include monthly and annual frequency of highest wind speed within limits (20 - 29, 30 - 39, 40 - 49 and ≥ 50 mph); monthly and annual frequency of highest wind speed within limits (20 - 29, 30 - 39, 40- 49 and ≥ 50 mph) by direction (16 points); monthly and annual wind direction frequency (16 points); monthly average number of days with strong gusty winds in summer and monsoon ≥ 20 mph; monthly average number of days with winds ≥ 20 mph associated with depressions; monthly average number of days with winds ≥ 20 mph associated with dust or thunderstorms; monthly average number of days with wind ≥ 20 mph.

1953

26. Agarwala, K. S. The diurnal and seasonal variations of the surface wind at Visakhapatnam. Indian Journal of Meteorology and Geophysics, Delhi, 4(1): 76-81, January 1953. DAS M(05) I39i.

...Discusses the seasonal variations of the speed and direction of the surface wind at Visakhapatnam based on data for 3 years (January 1939-December 1941). In this discussion the author presents information on the exposure of the anemograph; method of tabulation of data; diurnal variation of wind speed; co-efficient of eddy diffusion; annual variation of the velocity, direction and steadiness of wind; diurnal variation of the direction of wind; diurnal variation of calms; occurrence of squalls; land and sea breezes. There are also graphs showing the monthly and annual mean hourly wind speed; tabular monthly and annual mean values of day and night maximum wind speeds and their ratios, and mean and minimum wind speeds; tabular monthly and annual resultant wind velocities and wind steadiness; tabular monthly wind direction frequency and frequency of calm at 0300, 0600, 0900, 1200, 1500, 1800, 2100, and 2400.

27. Chaudhury, A. M. A theoretical analysis of upper-air circulation over Indo-Pakistan. Pakistan Journal of Science, Lahore, 5 (2): 83 - 90, April 1953. DGS S(648) P17j.

...Steady flow of air horizontally eastward across the Himalayas and the Tibetan plateau has been studied. A single infinite family of patterns in terms of first and second kind Bessel solutions is possible. Over this non-unique pattern an infinite number of arbitrary free oscillations whose amplitudes are not determined by the boundary conditions may be super-imposed. The plateau can thus introduce a very complicated flow pattern, particularly in its immediate vicinity.

Source No. 27 continued

This complex pattern is quasi-harmonic in the vicinity of the plateau but becomes sinusoidal at a large distance from the plateau. The amplitudes of the wave patterns decrease inversely as the square root of the distance.

Only the position of the first trough of a particular solution coincides almost exactly with the mean observed positions of the Caspian Sea trough upstream and the Asiatic trough downstream off the coast of Indo-China. This particular pattern is on with first order Bessel solution of the second kind. The computed flow pattern over Indo-Pakistan agrees well with that observed, especially for the winter half of the year. The free air circulation over Indo-Pakistan is thus to a large extent the result of the mechanical effect introduced by the Himalayas and the Tibetan Plateau north of Indo-Pakistan.

The effect of the plateau on the east wind has also been studied. A unique solution in terms of modified Bessel function of second kind (first order) has been obtained. The character of the modified solution is hyperbolic and decreases exponentially from the plateau, showing that the east wind in a non-divergent barotropic atmosphere when disturbed cannot execute oscillations but that the disturbance dies down exponentially. - Author's abstract.

28. Chelam, E. V. Synoptic aspects of the monsoon circulation and rainfall over Indo-Pakistan. Indian Journal of Meteorology and Geophysics, Delhi, 4 (3): 264-265, July 1953. DAS M(05) I39i.

...A note refuting the idea expressed by Rahmatullah (J. Met., 9 (3), 1952) that these conclusions regarding the unsteady pattern of precipitation over India and Pakistan were at variance with the conventional ideas of a steady monsoon condition. C. W. B. Normand in "The Weather of India" (1937) expressed the then current recognition of the pulsatory nature of monsoon rains connected with changes in the axis of the North Indian trough. Notes are given regarding 1949 monsoon weather "types" according to Rahmatullah's classification. - MAB 5.9 - 193.

29. Gupta, B. K., and Venkiteshwaran, S. P. A method of using the radar AA No. 3 MK III to track the F-type radio-meteorograph to obtain both radiosonde and upper wind data. Indian Journal of Meteorology and Geophysics, Delhi, 4 (2): 164 - 170, April 1953. DAS M(05) I39i.

...Discusses the specifications of radar equipment (AA No.3 MK III) obtained by the India Meteorological Department for the measurement of upper winds during cloudy weather, adapting the radar to track active targets, signallers for use with F-type radio-meteorographs for following with the radar, modifications in the radar receiver for using it with the radiosonde recorder, and the recording equipment for the radiosonde signals. Radar AA No. 3 MK III has been in use at Poona since 1949.

30. Jagannathan, P. Winds at Tiruchirapalli airfield and neighbourhood. Indian Journal of Meteorology and Geophysics, Delhi, 4(3): 220 - 235, July 1953. DAS M(05) I39i.

...Gives a more detailed picture of the local variation of wind at Tiruchirapalli and its neighborhood than in a previous paper published in 1949 by this same author. The text presents a comparison of the mean wind at the airfield with that at the cantonment and a comparison of mean wind at Tiruchirapalli with those of neighboring observatories; an analysis of variance, diurnal variation, variation of wind direction, predominant winds and sea breezes at Tiruchirapalli; a diagram of predominant monthly ground winds at each hour at Tiruchirapalli airfield; monthly wind roses at 0200, 0500, 0900, 1100, 1400, 1700, and 2200 at Tiruchirapalli airfield. The tables include a monthly harmonic analysis of diurnal variation of wind speed, monthly resultant wind direction and speed at 34 feet above ground for each hour, monthly predominant wind at 34 feet above ground for each hour, and monthly (February - October) frequency of occasions on which there was a definite wind shift from some westerly direction to some easterly direction at Tiruchirapalli.

31. Koteswaram, P. An analysis of the high tropospheric wind circulation over India in winter. Indian Journal of Meteorology and Geophysics, Delhi, 4 (1): 13-21, January 1953. DAS M(05) I39i.

...Discusses the winds and temperature at various heights for two typical days at approximately 80°E during the winter; presents information on the jet stream in the high troposphere over India; includes tabular January sounding balloon normal temperatures over Poona and Agra at specified heights (10, 12, 14, 16, and 18 gkm) and January radiosonde normal temperatures at specified millibar levels (300, 200, 150, and 100) at Poona, Nagpur, Allahabad, and Delhi.

32. Koteswaram, P.; Raman, C. R. V.; Parthasarathy, S. The mean jet stream over India and Burma in winter. Indian Journal of Meteorology and Geophysics, Delhi, 4(2): 111 - 122, April 1953. DAS M(05) I39i.

...Has as its purpose to locate and study the properties of the mean jet stream based on available normal radiosonde and sounding balloon data for stations in India, Pakistan, and Burma. The authors discuss the data used in the analysis, the analysis of the data, the location of the jet stream, distribution of mean absolute vorticity, tropopause and the jet stream, and the thermodynamics of the jet stream. The tables include winter mean temperatures at 700-, 500-, 300-, 200-, 150-, 100-, and 80-mb levels for 14 stations in India, 3 in Pakistan, 3 in Burma, and 1 in Ceylon for specified periods (vary by station); mean heights (gpm) in winter of 300- and 200-mb levels over Poona and Visakhapatnam for each year 1945 - 1951.

33. Koteswaram, P., and Parthasarathy, S. Winds over Mt. Everest. Indian Journal of Meteorology and Geophysics, Delhi, 4 (2): 187 - 189, April 1953. DAS M(05) I39i.

...Using aerological data available for the Himalaya region, the author briefly sums up the principal features of the wind regime over Mount Everest. Seasonal characteristics and day-to-day variations are discussed. The position of the jet stream is indicated. Isotachs are drawn for estimated velocities at 20, 25, and 30 thousand feet for the periods March - May and Sept. - Nov. 1952. - MAB 5.2 - 166.

34. Parthasarathy, S., and Narayanan, J. The diurnal variation of upper winds over the Indian sub-continent. Indian Journal of Meteorology and Geophysics, Delhi, 4 (3): 205 - 219, July 1953. DAS M(05) I39i.

...Has as its purpose to study the broad features of the diurnal variation of winds in the free air at and above 1 km over India and adjacent areas. The textual data include information on testing the significance of the diurnal vectors, theoretical considerations, main features of diurnal variation charts for inland and coastal areas, diurnal variation of winds in different months, diurnal variation in coastal areas, and diurnal variation and climatology. The tables contain actual and calculated diurnal vectors (direction in degrees from north and magnitude in mps) for January, April, July, and October at 14 stations; upper air temperatures at 850-, 700-, and 500-mb levels for morning and evening for April and May for each year at Calcutta (1949 - 1951) and for April and May or May for each year at New Delhi (1950 - 1952).

35. Sinha, K. L., and Sharma, H. R. A study of winds exceeding 20 mph at Delhi. Indian Journal of Meteorology and Geophysics, Delhi, 4 (2): 145 - 163, April 1953. DAS M(05) I39i.

...Is a statistical study of the characteristics of winds of 20 mph or more that are observed at Safdarjung Aerodrome. The authors discuss the location of the aerodrome (also present a map showing the location); the general features of wind at Delhi; the data for winds exceeding 20 mph; winds of 20 mph or more, irrespective of weather; total duration of winds exceeding 20 mph; classification of strong winds; winds exceeding 20 mph, not associated with weather; winds exceeding 20 mph, associated with rain or thundery conditions; winds exceeding 20 mph in association with duststorm or thunderstorm; synoptic situations associated with strong winds. There is also a comparison of winds at Delhi with those of Allahabad. The tables contain for Delhi (1946 - 1950) monthly frequencies (total number of days, total number of occasions not associated with weather, total number of occasions associated with rain or thundery conditions, and total number of occasions associated with duststorms or thunderstorms) of wind speed within limits (20-29, 30-39, 40-49, 50-59, and 60-70 mph) by direction (16 points), wind speed within limits (20-29, 30-39,

Source No. 35 continued

40-49, 50-59, and 60-70 mph) and wind direction when the wind speed is 20 mph or more; monthly and annual total hours of duration of winds ≥ 20 mph by direction (16 points) and total hours of duration of winds ≥ 20 mph; monthly and annual frequencies of winds of 20 mph or more of different durations (< 1/2, 1/2-1, 1-2, 2-3, 3-5, 5-7, 10-15, and 15-20 hours) under specified conditions (not associated with weather, associated with rain or thundery conditions, and associated with duststorms or thunderstorms); monthly and annual frequency of the time of commencement of winds ≥ 20 mph under specified conditions (not associated with weather, associated with rain or thundery conditions, and associated with duststorms or thunderstorms); monthly and annual frequency of maximum wind velocity not associated with weather.

36. Srinivasan, V. Variation of cyclonic circulation with height in September 1951 deep depression. Indian Journal of Meteorology and Geophysics, Delhi, 4 (3); 263-264, July 1953. DAS M(05) I39i.

...Presents notes on the height up to which the circulation in the lower levels round tropical depressions extends. Several instances of the depression center passing close to a station in India have been recorded in September 1951. The contour anomaly of different pressure surface is plotted for Allahabad.

37. Venkateswaran, S. V. The daily variation of wind in the lower atmosphere over Ahmedabad. Indian Journal of Meteorology and Geophysics, Delhi, 4 (1): 82-86, January 1953. DAS M(05) I39i.

...Presents some interesting features of the wind structure over Ahmedabad based on a day-to-day analysis of pilot balloon data for 1950. The tables contain monthly (October-January) number of days on which northeasterly or easterly winds showed marked strengthening in the morning hours and monthly (April-June, October) number of days on which the sea-breeze effect was prominent in Ahmedabad.

1954

38. Koteswaram, P., and Parthasarathy, S. The mean jet stream over India in the pre-monsoon and post monsoon seasons and vertical motions associated with sub-tropical jet stream. Indian Journal of Meteorology and Geophysics, Delhi, 5(2): 138-156, April 1954. DAS M(05) I39i.

...Is a study on the mean horizontal divergence and vertical motion in the troposphere over the country with particular reference to the circulation in the vicinity of the jet streams. The text presents information on the thermal structure of the upper troposphere in the post-monsoon and pre-monsoon periods, mean contour topography at various standard pressure levels, mean meridional cross-sections, monthly variation of the jet stream, the tropopause and the jet stream, general concepts of vertical motion in the vicinity of jet streams, thermodynamical aspects of the jet stream, horizontal di-

Source No. 38 continued

vergence over India, vertical motion over India by kinematic method and by adiabatic method, mechanism of jet streams and clear air turbulence near the sub-tropical jet. The tables present seasonal (post-monsoon and pre-monsoon) mean temperatures at 700-, 500-, 300-, 200-, 150-, and 100-mb levels for 13 stations in India, 4 in Pakistan, and 3 in Burma based on data , wherever possible, for the period 1944-1951.

39. World Meteorological Organization. Energy from the winds. WMO No. 32. TP. 10. 205 pp. Geneva, 1954. DAS M(06) W927p.

...Reports seasonal and annual mean wind speed (mps) for 18 stations in India. These data have been published in "Wind Data for Wind Mills" India Meteorological Department. Scientific Notes, Vol. VI, No. 63 (Second and revised edition 1948).

1955

40. Gilchrist, A. Winds between 300 and 100 mb. in the tropics and subtropics. Great Britain, Meteorological Office, Meteorological Reports, II (16): 1 - 28. London, 1955. DAS M82 G786m.

...Presents an account of the mean atmospheric flow between 300 and 100 mb in the tropics and subtropics for January, April, July and October in 1951 by charts of mean winds at constant pressure levels and mean atmospheric cross-sections at selected longitudes. These charts are based on data during 1951 at individual stations, including 13 in India.

41. Mulky, G. R. Kinematic analysis of upper wind fields. Indian Journal of Meteorology and Geophysics, Delhi, 6(2): 163-170, April 1955. DAS M(05) I39i.

...Explains a method of computing the velocity and direction of movement of troughlines and cyclonic centers which are associated with upper wind fields. Illustrations of this method are presented in the appendix. These illustrations include the Bay of Bengal depression in the first week of August 1953, Masulipatam cyclone of October 1949 and the depression in the last week of July 1951.

42. Raghavan, K. On the strong monsoon winds at Nagercoil. Indian Journal of Meteorology and Geophysics, Delhi, 6(3): 274-276, July 1955. DAS M(05) I39i.

...Analyzes the the morning pilot balloon winds at Nagercoil, Trivandrum and Minicoy for June - September for the period 1947 - 1951 to obtain a quantitative idea of the strength of the upper winds at these places. The tables contain for the southwest monsoon season (June - September) for the period 1947 - 1951 mean wind directions and speeds at heights of 1, 2, 3, 5, 7, 10, 15, and 20 thousands of

feet above sea level for Nagercoil, Minicoy, and Trivandrum; ratios of wind velocities at Nagercoil to those at Minicoy and Trivandrum at heights of 1, 2, 3, 5, 7, 10, 15, and 20 thousands of feet above sea level.

43. Ramamurthi, K. M. A 'jet stream' over northern India as revealed by a 'Comet' debriefing report. Indian Journal of Meteorology and Geophysics, Delhi, 6(3): 277-279, July 1955. DAS M(05) I39i.

...Is a report on severe turbulence and high wind speed experienced by an aircraft on flight from Calcutta to Delhi on December 28, 1952. The author presents a cross-section along Longitude 84°E using radiosonde data for 850-, 700-, 500-, 400-, 300- and 200-mb levels at 1500 GMT on December 28, 1952; a 200-mb contour chart of India at 1500 GMT on December 28, 1952; an extract from the clear air turbulence report from the commander of the aircraft. The conclusion is that the aircraft was apparently flying through the lower portion of the jet stream.

44. Roy, A. K., and Rai Sircar, N. C. On the utility of plotting vectorial changes of upper winds in forecasting developments and progress of important pressure systems. Indian Journal of Meteorology and Geophysics, Delhi, 6(2): 97-118, April 1955. DAS M(05) I39i.

...Discusses the advantages of plotting vectorial changes of winds over using surface pressure tendencies for forecasting formation of depressions in the sea areas, upper wind changes and depressions and cyclonic storms, vectorial changes of winds and western disturbances and upper wind changes and convective showers. The use of the vectorial charts should be of material help in forecasting synoptic conditions, including the development of depressions and cyclonic storms, 24 hours in advance in the tropics. This area includes India and the Indian Seas.

45. Venkateswara Rao, D. The speed and some other features of the sea-breeze front at Madras. Indian Journal of Meteorology and Geophysics, Delhi, 6(3): 233-242, July 1955. DAS M(05) I39i.

...The speed with which the sea breeze advances inland at Madras under various meteorological conditions and its dependence on the time of onset and depth of penetration are discussed in this paper, utilising the records for the years 1945 and 1946 of autographic instruments at three stations located at different distances from the coast. A velocity of 10 - 15 mph, a southsoutheasterly direction of the resultant wind, the months of April to September, and a time of onset during the early afternoon are favoured most by the sea breeze at Madras. The average speed of the sea-breeze front is found to be 3 - 7 mph. It is accelerated with depth of penetration inland independently of the wind speed. It varies with the hour of onset of the sea-breeze, being lowest during the epoch of maximum temperature. The variation of the ratio of the speed inland to that near the coast with

Source No. 45 continued

time of onset and direction of the on-shore wind is investigated. The results are explained on the basis of the temperature gradient and its variation with distance inland. The mean temperature drop and vapor pressure rise caused by the sea-breeze for different times of incidence and magnitudes of wind velocity in the various months have also been studied. The changes are maximum in the proximity of the epoch of maximum temperature and in the month of July in the year. The results of this study would help in anticipating with sufficient accuracy and sufficiently in advance for aviation needs the time of onset of the sea-breeze and the accompanying meteorological changes at the airfield at Meenambakkam, given the time of incidence and the direction of the on-shore wind earlier at a point closer to the coast. - Author's abstract.

1956

46. Chiplonkar, M. W., and Nandgaonkar, M. W. A wind survey of wind power. Journal of the University of Poona, Science and Technology, No. 10. pp. 112 - 124. 1956. DLC AS472 .P6A3.

...A detailed wind survey has been carried out over selected regions covering the western and central parts of India. The analysis has been divided into two parts.

(a) One for the longer period of nearly fifty years and for forty-eight selected stations spread uniformly over this region for which only one average wind speed value per day is available, and -

(b) The second for the shorter period of one year and for the seventeen stations for which five observations per day are available.

It is found that the total wind movement over the whole of the region shows, irrespective of the direction, a regular and stable pattern of an Annual cycle, with a sharp maximum in June, July and flat minimum around December for both the periods. The minimum movement is only about seventy percent and maximum movement about one hundred and sixty-five percent of the long period annual average.

Further the region has been divided vertically and horizontally into groups and subgroups, and wind movement have been studied to bring out the most favourable portion of this large tract.

The time and space diversities represented by the "energy pattern factors" have been calculated for each station or groups of stations, lying in this region. Similarly duration curves have been drawn for each station.

Finally it is concluded that there exist in the Bombay State and the neighbouring districts of Hyderabad sufficiently large areas over which a network of distributed wind power stations can be set up to obtain large and more or less steady wind power. - Authors' abstract.

47. Flohn, Hermann. Der indische Sommermonsun als Glied der planetarischen Zirkulation der Atmosphäre. (The Indian summer monsoon as part of the planetary circulation of the atmosphere). Germany (Federal Republic, 1949 -). Wetterdienst, Berichte, 4(22): 134-139, 1956. DAS M(055) G373ba. Translated from German for Geophysics Research Directorate, AF Cambridge Research Center, Cambridge, Mass., by the American Meteorological Society, Contract number AF 19(604) - 1936, December 1958. DAS M53.21 F628in.

...Summarizes the most important results of this study on the Indian summer monsoon as part of the planetary circulation of the atmosphere based to a great extent on data for 1953 and supplemented by comparisons with data for the years 1949 - 1953. The author also discusses the three planetary wind systems over India and the interaction of the planetary wind belts.

48. Hariharan, P. S. A study of the extension of cold waves at the surface in relation to upper winds at 3000 feet in India. Indian Journal of Meteorology and Geophysics, Delhi, 7(4): 363-370, October 1956. DAS M(05) I39i.

...Is a study connecting the march of minimum temperatures over large areas of the country in the form of cold waves with antecedent upper winds. This includes an analysis of six synoptic situations in which well-marked cold spells appeared over West Pakistan and northwest India and moved eastward.

49. Koteswaram, P. The easterly jet stream in the tropics. Chicago. University. Department of Meteorology. Report on Research prepared under Contract No. N6ori-02036. May 1956. DAS M57.2 C532d. Also revised in: Tellus, Stockholm, 10(1): 43 - 57, February 1958. DAS M(05) T277.

...It is shown that in summer an easterly jet stream overlies southern Asia in the high troposphere with core near 15°N. This current is quasi-geostrophic. Below the level of strongest winds temperatures decrease from right to left across the current looking downstream; above the level of strongest wind (150 - 100 mb) the reverse is true. Distribution of cloudiness and precipitation in the lower monsoon correspond to that noted in association with westerly jet streams in the temperature zone: precipitation downstream from the region with the highest winds to left of the axis, upstream to the right.

The foregoing holds on individual days and climatically during the monsoon season as a whole. Since an easterly jet stream is observed only over southern Asia (and Africa), but not over the Pacific and Atlantic oceans, it is suggested that the current originates in connection with the large-scale arrangement of land masses and oceans, and with the elevated heat source of the Tibetan plateau. - Author's abstract.

50. Mooley, D. A. Zonal wind circulation and vertical temperature distribution along the Indian longitudes during the monsoon and winter seasons. Indian Journal of Meteorology and Geophysics, Delhi 7(2): 113 - 128, April 1956. DAS M(05) I39i.

...The study is based on all the available wind and temperature data for 1944-49. Sections of geostrophic zonal wind and temperature and of observed zonal winds have been prepared. Frequencies of strong winds (speed 70 knots or more) along the section have been worked out for the different latitudes. The chief features of the monsoon sections are - (i) Generally small latitudinal temperature variation upto 300-mb level and an appreciable variation at 200-mb and 150-mb levels in Madras-Nagpur and Nagpur-Jodhpur sectors (ii) Strong easterly winds south of 15°N at 14 km and above. The chief features of the winter sections are - (i) An appreciable latitudinal temperature gradient between Poona and Peshawar upto 400-mb level and reversal of gradient above 200-mb level as observed by others, (ii) Strongest zonal (west) wind near 23°N and a secondary wind maximum apparently near 30°N and (iii) A fairly high frequency of strong winds between 21° and 31°N. From a consideration of the frequency of high winds, a well-marked jet south of 20°N seems unlikely. A comparative study of the various mean sections indicates that during winter, jets in the northern hemisphere are found over a much wider latitudinal belt than in the southern hemisphere and during summer, the westerly jets in northern hemisphere are much weaker than those in the southern hemisphere. - Author's abstract.

51. Nilakantan, P. Utilization of wind power in India. World Meteorological Organization, WMO Bulletin, 5(2): 49 - 51, April 1956. DAS M(05) W927w.

...Gives the results of an examination to determine the possibility of utilizing wind power for pumping installations, etc., in India where most regions have ≤10 mph of wind speed.

52. Pisharoty, P. R., and Kulkarni, S. B. Upper air contour patterns and associated heavy rainfall during the southwest monsoon. Indian Journal of Meteorology and Geophysics, Delhi, 7(2): 103 - 112, April 1956. DAS M(05) I39i.

...The necessity of dealing with the lower troposphere over India as consisting of two separate strata having opposite values of horizontal wind divergence is briefly explained. It may not be sufficient to look for areas of convergence at the lower levels; areas of marked divergence at upper levels of 500 mb and aloft may be equally, if not more, important for the understanding and forecasting of very heavy rains. The principles of deducing areas of marked horizontal divergence on qualitative reasoning based on consideration of non-geostrophic motion as well as air flow down the gradients of vorticity are

then outlined. A few cases of non-orographic phenomenal rainfall of 10" - 24" in 24 hours which fell over certain parts of India during the southwest monsoon of 1954 are shown to have fallen in areas of marked upper air divergence, deducible from such qualitative reasoning applied to flow patterns at 500 mb and aloft. - **Authors' abstract.**

53. Raghavan, K. Influence of orography on the upper winds over Mussooree. Indian Journal of Meteorology and Geophysics, Delhi, 7(3): 289-294, July 1956. DAS M(05) I39i.

...The influence of the orographic features at Mussooree on the upper winds in the lower levels of the atmosphere has been examined in this paper, analysing the data of 561 pilot balloon ascents during the period May 1950 to June 1955. It has been found that the influence of orography on the upper winds at Mussooree extends to about 30,000 feet a.s.l. resulting in appreciable reduction of the wind speed on a large number of occasions. The frequencies of appreciable velocity reduction at various levels for winds blowing from different directions are presented and discussed. The data studied in this paper support the present theoretical concepts regarding some of the features of "standing waves". - Author's abstract.

54. Ramachandran, S., and Mani, Anna. The F-type Rawinsonde. Indian Journal of Meteorology and Geophysics, 7(2): 161-164. Delhi, April 1956. DAS M(05) I39i.

...Describes the modifications and adaptations of the radar A.A. No. III, Mk.III operating on 204 mcs which has made it possible to get satisfactory F-type radiosonde signals at the Indian stations using this type instrument.

55. Ramanathan, K. R. Problems of tropical meteorology and the relation between the circulations of tropical and extratropical latitudes. Scientific Proceedings of the International Association of Meteorology, Rome, September 1954. pp. 317 - 321. London 1956. DAS M(06) I611g Met. 1954.

...Presents brief notes on the special problems of the meteorologist in the tropics, tropical storms, waves in the upper easterlies, the winter disturbances, and the trade inversion.

56. Ramaswamy, C. On the sub-tropical jet stream and its role in the development of large-scale convection. Tellus, 8(1): 26-60. Stockholm, February 1956. DAS M(05) T277.

...This paper contains mainly the results of a synoptic and climatological study of the large-scale convection in northern India and Pakistan during the three months preceding the onset of the southwest monsoon. It has been shown that the sea-level and lower tropospheric charts give little clue to the development of the large-scale convection and that the latter is overwhelmingly determined by the diver-

gence in the waves in the sub-tropical jet-stream. It has further been shown from detailed synoptic evidence that nor'westers, andhis, and the majority of the thunderstorms without squalls in northern India and Pakistan in the pre-monsoon period are fundamentally the same phenomenon. The role of cold-air advection in the middle and upper troposhere in the development of large-scale convection has also been discussed. This study has further revealed that the regions of upper-divergence and convergence can be qualitatively located by identifying certain typical patterns on the high-level maps more than 12 hours before the usual time of commencement of convection and that, consequently, these maps can be used as effective tools in the issue of area-warnings against thunder in general and nor'westers and andhis in particular.

A general study has also been made of the large-scale convection in southeast Australia, Union of South Africa, Bechuanaland, Southern Rhodesia, northeast Argentina, Uruguay, southeast Brazil, and southeast United States, and the similarities between the large-scale convection in these countries and in Indo-Pakistan have been brought out. On the basis of these studies, it has been suggested that the jet stream plays the very important role of producing large-scale convection in the subtropics all over the world wherever it over-runs on its equatorward side, moist air possessing, a high degree of latent instability.
- Author's abstract.

57. Rao, B. Ramachandra; Rao, M. Srirama; Murthy, D. Satyanarayana. Investigation of winds in the ionosphere by spaced receiver method. Journal of Scientific & Industrial Research, New Delhi, 15A(2): 75 - 81, February 1956. DAS P.

...Deals with the study of wind movements in the ionosphere using the spaced receiver method, describes the equipment used, and presents the results obtained during 1954.

58. Sajnani, P. P. Sea-breeze at Ahmedabad. Indian Journal of Meteorology and Geophysics, Delhi, 7(1): 49 - 54, January 1956. DAS M(05) I39i.

...Gives the results of a detailed analysis of autographic records of Ahmedabad (October 1952 to September 1953) which was made to study further the nature of the sea breeze. The text contains information on the physical features of Ahmedabad, general characteristics of sea breeze at Ahmedabad, frequency of occurrence of sea breeze during different months, sea breeze during monsoon, sea breeze during winter, frequency of setting in of sea breeze at different hours of day, temperature changes associated with sea breeze, relative humidity changes, and typical instances of sea breeze. The tables present summaries over the period (October 1952 - September 1954) of monthly mean number of days with sea breeze, monthly mean number of days when sea breeze set in at different hours (1500 - 1559, 1600 - 1659,..., 2300 - 2359), monthly mean number of days of temperature fall within specified ranges (< 1.0, 1.0 - 1.9, 2.0 - 2.9, 3.0 - 3.9, 4.0 - 4.9, 5.0 - 5.9, 6.0 - 6.9,

Source No. 58 continued

7.0 - 7.9, and ≥ 8.0°F.) and monthly mean number of occasions of rise of relative humidity within specified limits (< 5, 5-9, 10-14, 15-19, 20-24, 25-29, 30-34, 35-39, and ≥ 40%).

59. Sarwal, Shyam S. Harnessing wind energy in the arid zones of Rajasthan. The Journal of the Central Board of Irrigation and Power, Delhi, 13(3): 382 - 388, July 1956. DAS P.

...Includes tabular summaries over the period of annual highest and lowest number of days with zero wind velocity, normal wind velocity and maximum wind velocity for the Jodhpur and Bikaner zones based on 5 years of data; annual frequency of duststorms in the Jodhpur, Bikaner, and Ganganagar areas based on 10 years of data; monthly mean wind speeds (mph) for Ganganagar, Bikaner, Jaisalmer, Jodhpur, Phalodi, Barmer, and Gadra Road based on data for an unspecified period.

60. Sinha, K. L. Abnormally strong gusty winds in West Rajasthan on 15 March 1956. Indian Journal of Meteorology and Geophysics, 7(4): 405, 406. Delhi, October 1956. DAS M(05) I39i.

...Briefly discusses the synoptic situation in west Rajasthan on March 14 and 15, 1956, which gave rise to abnormally gusty winds.

1957

61. Agarwala, K. S. Gustiness of wind in relation to its speed and direction at Visakhapatnam. Indian Journal of Meteorology and Geophysics, Delhi, 8(4): 456-458, October 1957. DAS M(05) I39i.

...Presents the relationship of gustiness to the speed and direction of the wind at Visakhapatnam. The chart shows the direction and speed of the prevailing ground wind at each hour of the day for each month of the year by arrows and feathers and presents isopleths of gustiness.

62. Bedekar, V. C. Mean effective tailwinds along some Indian air-routes. Indian Journal of Meteorology and Geophysics, Delhi, 8(1): 81 - 87, January 1957. DAS M(05) I39i.

...Mean effective tailwinds are computed from data for all years up to 1950 for the Delhi-Allahabad-Calcutta, Bombay-Nagpur-Calcutta, Bombay-Poona-Hyderabad, and Hyderabad-Jagdalpur-Calcutta routes for 2 and 3 km, respectively, for each month. These values when compared with those published by the Air Ministry (London) are considerably higher, especially for the winter months (and March - May on Delhi-Calcutta route). This is said to be due to the greater amount of data used. Theory and method of computing mean effective tailwinds, as well as tabular and graphic presentation of data and discussion of

results, are included. In winter and spring, 3-km winds are stronger than 2-km winds, but the reverse is true, in general, in the summer. Highest effective tailwinds are usually in Feb. (on Bombay-Hyderabad route, maximum winds are at 2 km in July). MAB 8.11-75

63. Dao, Shih-yen, and Chen, Lung-shun. The structure of general circulation over continent of Asia. 75th Anniversary Volume of the Journal of the Meteorological Society of Japan, pp. 215 - 229. November 1957. DAS M(05) M589sjs.

...In this article, an analysis is made on the structure of the mean flow field at 5000-, 10 000-, 20 000-ft level in July over the continent of Asia during the year 1950 - 1955 and the mean contours at 200 mb over Asia for July and August 1956. The vertical cross-sections of the mean flow and temperature fields along 75°E, 90°E, 105°E, and 120°E for July and August 1956 have been constructed. The three-dimensional structure of flow over continent Asia is constituted of the following three basic currents: (1) the westerlies of middle latitudes, (2) the upper level tropical and subtropical easterlies, and (3) the southwesterly monsoon under the upper level tropical and subtropical easterlies.

Moreover, the changes of the general circulation over Asia in the transitional period between spring and summer 1956 is also investigated. It is found that a leaping change of the general circulation over Asia occurs during this period. The upper level subtropical westerly jet-stream to the south of Himalaya retreated northward and a subtropical ridge was established over the latitude of Tibet, and over south Asia (to the south of 12°N) a high level easterly jet-stream was established. At the same time, the southwesterly monsoon of India and the "Meiyu" (plum rain) season of the Yangtze Valley set in. The authors also found that the northward displacement of the rain belt is closely related to the northward retreat and the accompanying weakening in intensity of the westerlies over China main land. - Authors' abstract.

64. Desai, B. N. On sub-tropical jet stream and its role in the development of large scale convection. Reply by C. Ramaswamy. Tellus, Stockholm, 9(1): 135 - 137, February 1957. DAS M(05) T277.

...Desai takes exception to several points in Ramaswamy's paper (see 8.1-202, Aug. 1957, MAB) which attributes widespread thunderstorm and dust squall activity in Northern India and Pakistan during the pre-monsoon season to mass divergence associated with upper tropospheric vorticity patterns at 500- and 300-mb levels, and that these squalls can be predicted 12-24 hours in advance by this method. He claims that local orographic influences, insolation, etc., must be the dominant factors or else the storms would occur throughout the next 24 hours and not be confined to the afternoon and evening (20-24 hours after), and that the inversion is destroyed by insolation and not by sub-

sidence. Ramaswamy replies that he has accounted for all of these factors in his paper, but that mass divergence always occurs during squally weather and convergence during fair weather. Hence these other factors which operate during both fair weather and foul cannot be more than contributory factors. Divergence on the sub-tropical zone jet stream waves, when they come south at high levels over the moist tropical air masses, is considered the invariable factor and hence the only true aid to forecasting these storms. - MAB 9.4-127.

65. Raghavan, K. Vertical currents associated with standing waves over Mussooree. Indian Journal of Meteorology and Geophysics, Delhi, 8(4): 411 - 417. October 1957. DAS M(05) I39i.

...Some observational evidences on the occurrence of vigorous vertical currents associated with standing waves over Mussooree are presented and discussed. Standing waves are found to have sufficient lift for gliders to soar to the stratosphere over Dehra Dun Valley. - Author's abstract.

66. Ramakrishnan, K. P.; Parthasarathi, S.; Aphale, N. C. Some high pilot balloon ascents at Poona. Indian Journal of Meteorology and Geophysics, Delhi, 8(3): 273 - 288, July 1957. DAS M(05) I39i.

...To supplement available observed winds at high levels, about 40 special ascents were made with big balloons at Poona in winter 1952-53. Tails of 200 metres were attached and weighted to reduce slant. 15 of the ascents reached heights above 60,000 feet. The paper gives - (i) height-time curves of the individual ascents, (ii) vertical time-section diagrams for the four months up to 22 km, with isotachs and general wind directions, and (iii) diagrams of departures from normal of temperatures up to 16 km from daily radiosonde ascents. The vertical currents and winds are discussed in relation to the synoptic situations and major temperature changes. - Authors' abstract.

1958

67. Graystone, P. Equivalent headwinds at heights of 30,000 feet and 40,000 feet along air routes. Supplemented and revised. Great Britain Meteorological Office, Meteorological Reports, No. 20. 35 pp. London, 1958. DAS M82 G786m.

...Gives tabular average equivalent headwind in knots on the route from the first named of the terminal airports to the second (Bahrain-Delhi, Cairo-Delhi, Cairo-Bombay, Beirut-Delhi, Basra-Bombay, Karachi-Calcutta, Karachi-Bombay, Calcutta - Madras, Beirut - Calcutta, Cairo-Calcutta, Bahrain - Calcutta, Delhi - Singapore, Delhi - Manila, Karachi - Delhi, Bombay - Rangoon, Bombay - Calcutta, Bombay - Bangkok, Bombay - Beirut, Bombay - Colombo, Delhi - Calcutta, Delhi - Teheran, Calcutta - Hong Kong, Calcutta - Rangoon, Calcutta - Singapore, Calcutta - Allahabad, Calcutta - Gaya, Calcutta - Bangkok, Bangkok - Delhi,

Source No. 67 continued

and Hong Kong - Delhi) and on return flight and the variability of the equivalent headwind from these mean values at each height (30,000 and 40.000 feet) for each mid-season month.

68. Mooley, D. A. Mean zonal wind circulation over India. Indian Journal of Meteorology and Geophysics, Delhi, 9(4): 404 - 407. October 1958. DAS M(05) I39i.

...Presents the author's observation concerning the criticism made by Koteswaram (1957) on an earlier paper by Mooley (1956) on "Zonal wind circulation and vertical temperature distribution along the Indian longitudes during the monsoon and winter seasons". The tables contain radiosonde data for each year and over the period (1950 - 1957) at Jodhpur and mean height of 200-mb surface for each year and over the period (1951 - 1954) at Delhi and Poona.

69. Rai, D. B. Effect of vertical wind shear on rainfall at Poona during southwest monsoon. Indian Journal of Meteorology and Geophysics, Delhi, 9(1): 92 - 94, January 1958. DAS M(05) I39i.

...Suggests an explanation of the results of an objective method of forecasting rain at Poona during the southwest monsoon by Rao in 1955 by the theory of air flow over mountains.

70. Ramakrishnan, K. P., and Jambunathan, R. Sea breeze and maximum temperatures in Madras. Indian Journal of Meteorology and Geophysics, Delhi, 9(4): 349 - 358, October 1958. DAS M(05) I39i.

...Discusses the previous studies made on sea breezes along the Indian and West Pakistan coasts, the sea breeze at Madras and the special observations made, effect of sea breeze on the maximum temperature, and maximum temperatures of Nungambakkam and Meenambakkam.

71. Ramaswamy, C. A preliminary study of the behaviour of the Indian southwest monsoon in relation to the westerly jet-stream. Geophysica, 6(3-4): 455 - 477. Helsinki, 1958. DAS M(055) G345 (Special issue).

...A preliminary study of the Indian southwest monsoon in relation to the westerly jet stream has been made, using charts for sea-level, 1.5 km, and 500-mb level for Asia and East Europe for July 1953, a typical month of active monsoon and for August 1954, a typical month of weak monsoon. The monthly mean 700-mb maps for the northern hemisphere for July 1953 and August 1954 have also been examined in relation to the behaviour of the monsoon.

It has been shown that the atmospheric processes at 500-mb level and perhaps even aloft are more important than the processes in the lower troposphere and at sea level in determining the activity of the monsoon. The striking differences between the middle-latitude patterns

Source No. 71 continued

during active and weak monsoon have been brought out and tentative conclusions have been arrived at regarding the possible associations between the 500-mb level patterns in middle and low latitudes during active and weak monsoon. - Author's abstract.

72. Trewartha, Glenn. Climate as related to the jet stream in the Orient. Erdkunde, XII (3): 205 -214. Bonn, September 1958. DAS P.

...One may doubt whether bona fide monsoon circulations are an adequate explanation of the seasonal climatic phenomena of southern and eastern Asia. The evidence is fairly strong that many of the region's distinctive climatic features result from large-scale changes in atmospheric circulation patterns associated with locational shifts of the jet streams. In these seasonal shifts of the jet the highlands of central Asia, with their excessive altitude but short latitudinal extent, play an important role. The splitting of the zonal westerlies in winter so that a high-velocity and positionally stable jet is anchored along the southern slopes of the Himalayas carries in its train important climatic consequences. Through the jet's regenerating and steering effects upon perturbations it localizes the winter precipitation of northern India-Pakistan and of South China. On the equatorial side of the Himalayan jet strong subsidence acts to create the dry seasons of winter and spring, especially on the subcontinent. The weaker and locationally less stable northern branch of the winter jet, to the north of the Central Highlands, has no such regionalizing effects on winter precipitation as does its more stable southern counterpart. In the Tibetan lee-convergence zone between the two winter jets is a region of strong cyclogenesis, the perturbations which originate there markedly influencing the winter rainfall of South China.

Concurrent with the disappearance in early June of the Himalayan jet from its southern winter position to one north of the Central Highlands, there is a rapid northward surge of equatorial air over southern and eastern Asia, which in turn ushers in the summer rainy season with the "Burst of Monsoon" in India and the beginnings of the Baiu rains in southern China and Japan. - Author's summary and conclusions.

1959

73. Koteswaram, P. Jet streams over South Asia. Proceeding of the Ninth Pacific Science Congress of the Pacific Science Association, 1957, Vol. 13: Meteorology, pp. 251 - 255. Bangkok, Thailand, 1959. DAS M(06) P117p 1957 V. 13.

...Gives a brief account of the two prominent jet streams in the upper troposphere over South Asia and indicates some of their known properties. These jet streams include the westerly during the dry period, October to May, and the easterly during the wet season, June - September.

74. Koteswaram, P. The Asian summer monsoon and the general circulation over the tropics. Symposium on Monsoons of the World, New Delhi, February 19 - 21, 1958. pp. 105-110. Delhi, 1960. DAS M53.21 S989sy.

...An examination of the high tropospheric wind circulation over the tropics in northern summer indicates a broad easterly flow over the Asian and African Summer Monsoon areas with an easterly jet stream over low latitudes. The core of the jet stream is located approximately over 15°N at a pressure level of 150 to 100 mb over South Asia and about 10°N over Africa. The burst of the SW monsoon over India and its fluctuations as well as the formation of the monsoon depressions are seen to be associated with the perturbations in the upper easterly current.

Since the easterly jet stream is found only over South Asia and Africa and not over tropical Atlantic and Pacific Oceans, it has been suggested that the current originates as a result of the large-scale distribution of land masses and ocean and with the elevated heat source of the Tibetan plateau. A vertical circulation cell with the heat sources over this plateau and sink over the equatorial regions is indicated, according to which the SW monsoon is pictured as a poleward return current in the lower troposphere. - Author's abstract.

75. Moghe, D. N. Periodicity of the Indian southwest monsoon current. Symposium on Monsoons of the World, New Delhi, 19 - 21 February 1958, pp. 229-234. Delhi, 1960. DAS M53.21 S989sy.

...In this paper, an examination is made of the possible existence of periodicity in the arrival on the west coast of India of the southwest monsoon current. The upper wind data at a representative station on the west coast, Mangalore in particular, are analysed by the periodogram method. Wind components at 2000 ft a.s.l. for three years, 1948-50, are examined with regard to their deviation from their mean values. An analysis of fluctuations in the easterly components gives, in the first instance, a period of 6.8 days (7 days). It is found from further analysis that a period of 7 days is more favourable. Possibility of other periods is not, however, ruled out. Longer periods like 10 days, for instance, can also be inferred from this analysis. There is, however, a tendency in this method of analysis to raise the period value and, in such cases, further examination of longer periods may be necessary. - Author's abstract.

76. Pisharoty, P. R., and Asnani, G. C. Flow pattern over India and neighbourhood at 500 mb during the monsoon. Symposium on Monsoons of the World, New Delhi, 19-21 February 1958. pp. 112-117. Delhi, 1960. DAS M53.21 S989sy.

...Daily 500-mb charts for the months of July 1954 and 1955 over the

Source No. 76 continued

area equator to Lat. 50°N and Long. 45°E to 145°E confirm the existence of a semi-permanent Tibetan high and of a pronounced trough in the westerlies roughly along the Delhi meridian and extending from Lat. 30°N to 70°N. An idealised flow pattern at 500 mb, i.e., at about 6 km a.s.l., based on these daily charts, is presented. The pattern is broadly similar to one presented by Flöhn for July and differs from it as far as the portions over Burma and over the equatorial area south of Lat. 5°N are concerned. The migratory lows of the middle latitudes have some effect on the position and nature of this westerly trough and the Tibetan high. Prolonged breaks in the Indian monsoon are accompanied by pronounced changes in 500-mb flow pattern. Such periods appear to coincide with marked weather anomalies over Europe and North America. - Authors' abstract.

77. Ramakrishnan, K. P.; Sreenivasaiah, B. N.; Venkiteshwaran, S. P. Upper air climatology of India and neighbourhood in the monsoon seasons. Symposium on Monsoons of the World, New Delhi, February 19-21, 1958. pp. 3-34. Delhi, 1960. DAS M53.21 S989sy.

...Presents information on normal distribution of temperature and winds in the upper air based on pilot balloon and radar/rawin data in India and available data from adjacent areas during the monsoon season. The authors describe the data used, the procedure followed, and the results.

78. Ramanathan. K. R. Monsoons and the general circulation of the atmosphere - a review. Symposium on Monsoons of the World, New Delhi, 19-21 February 1958. pp. 53-64. Delhi, 1960. DAS M53.21 S989sy.

...While monsoons (or seasonal changes of wind and associated weather) occur in many different parts of the world, they are most pronounced over the countries of S. E. Asia, Indonesia, and Australia. Upper Wind Charts in January, April, July, and October were shown to illustrate the large annual movement of inter-tropical convergence zones over the Indian Ocean as contrasted with those over the Pacific and Atlantic Oceans.

In the middle and high troposhere, the maximum S-N swing of the boundary region between the equatorial easterlies and the extra-tropical westerlies occurs over the Indian Ocean and bordering continent of South Asia.

The Asiatic Monsoon with its pattern of extensive seasonal precipitation and associated heating of the middle troposphere should be considered as exercising a very significant influence on the general circulation of the atmosphere. The Indian monsoon is a geographically bound cyclonic system less than 6 km in thickness embedded in the equatorial easterlies. The monsoon strengthens and weakens; strengthens when there is a fresh input of moist air and weakens owing to friction and dispersal of water-vapour. Associated with the monsoon are longitudinally bound strong easterlies at 200- to 100-mb levels at

Source No. 78 continued

about 15°N over South Asia. These strong easterlies form part of the equatorial easterlies but are regionally accentuated.

Important questions such as long travelling waves and jets in easterlies and their role in creating and steering monsoon depressions, prolonged breaks in the monsoon and why they occur, world connections of the monsoon, etc., have been briefly referred to. - Author's abstract.

79. Srinivasan, V. Southwest monsoon rainfall in Gangetic West Bengal and its association with upper air flow patterns. Indian Journal of Meteorology and Geophysics, Delhi, 11(1): 5-18, January 1960. Also: Remarks on 'southwest monsoon rainfall in Gangetic West Bengal and its associations with upper flow patterns' by V. Srinivasan by J. M. Korkhao and Reply by V. Srinivasan. Ibid., 11(4): 418-420, October 1960. DAS M(05) I39i.

...The day-to-day occurrence of rainfall over Gangetic West Bengal during three monsoon seasons was studied in the light of the upper air flow patterns, and it was noticed that the rainfall occurs mostly due to the upper divergence ahead of easterly waves which move across the areas. Details of the structure and other characteristics of these easterly wave troughs are given. A study of the occurrence of fast winds and their relationship to the rainfall over Gangetic West Bengal is also included. - Author's abstract.

1961

80. Das, S. K.; Raju, A. V.; Mull, S. Frequency modulated rawinsonde. Indian Journal of Meteorology and Geophysics, Delhi, 12(4): 623-628, October 1961. DAS M(05) I39i.

...Describes the two transmitters for radiosonde and radio-wind-finding purposes used in the India Meteorological Department, presents the need for combining the two transmitters, discusses the principle of the modified instrument. The table indicates the performance of the rawinsonde at Delhi based on data between June and November 1958.

81. Keshavan, R. S. Shear wind calculator. Indian Journal of Meteorology and Geophysics, Delhi, 12(3): 535-536, July 1961. DAS M(05) I39i.

...Presents the method of working out the shear wind vector used in most offices in medium range forecasting.

82. Krishnan, A.; Pant, P. S.; Ananthakrishnan, R. Variability of upper winds over India. Indian Journal of Meteorology and Geophysics, Delhi, 12(3): 431-438, July 1961. DAS M(05) I39i.

...Information about the normal upper winds as well as their variability with respect to direction and speed are useful factors for aviators.

Source No. 82 continued

Based on normal upper winds at pibal stations in India and neighbourhood, the steadiness factor and the standard vector deviation have been computed at selected levels for four typical months, January, April, July and October. Charts depicting these parameters have been prepared and the results discussed. - Authors' abstract.

83. Kulshrestha, S. M. and Gupta, R. G. Some interesting observations of high level wind maxima in the atmosphere. Indian Journal of Meteorology and Geophysics, Delhi, 12(4): 678-681, October 1961. DAS M(05) I39i.

...Analyzes the wind data of six high-level cosmic ray balloon flights conducted at Hyderabad during March 1960. Each of these flights revealed the presence of two wind maxima.

84. Nilakantan, P; Ramakrishnan, K. P.; Venkiteshwaran, S. P. Windmill types considered suitable for large scale use in India. India (Republic), National Aeronautical Laboratory, Technical Note No. TN-WP-3-61. 30 pp. Bangalore, April 1961. DAS M(055) I39tec.

...Considers the various aspects involved in the utilization of wind power; the monsoon, nature's provision of water; windmills for water supply; windmill types suitable for Indian conditions; performance of the WP-2 type windmill; future developments in windmill design to suit Indian conditions; some special problems of windmill design; future program of research and development. The table contains normal seasonal (winter, summer, monsoon and post-monsoon) and annual rainfall amount for Kashmir and 25 subdivisions of India.

85. Ramakrishnan, K. P. and Venkiteshwaran, S. P. Wind power resources of India with particular reference to wind distribution. India (Republic), National Aeronautical Laboratory, Technical Note No. TN-WP-1-61. 15pp. Bangalore, June 1961. DAS M(055) I39tec.

...Includes information on wind data from non-recording anemometers and from recording anemographs at meteorological observatories and stations, spells of low wind at individual stations, and highest gust speed at different stations in India. The summaries include tabular annual mean number of spells of low wind (< 8 kph) of durations of 5-hour intervals from 1 to >50 hours and annual duration of longest spell of low wind in hours at 12 stations in India based on data for 3 -4 years; tabular annual maximum gust speed at 9 stations based on data up to the end of 1952; annual velocity-duration curves of 8 selected stations based on data for 3 years.

86. Rao, Y. P. Some characteristics of the southwest monsoon circulation. Indian Journal of Meteorology and Geophysics, Delhi, 12(3): 413-418, July 1961. DAS M(05) I39i. Also abstract issued in: Symposium on Monsoons of the World Held at Meteorological Office, New Delhi, 19 - 21 February 1958. New Delhi, 1960. DAS M53.21 S989sy.

Source No. 86 continued

...The southwest monsoon is probably the largest local perturbation on the general circulation of the atmosphere. Meridional transport of mass, heat energy and angular momentum associated with the southwest monsoon circulation have been computed from the upper air data of Singapore, Nairobi, Madras, Bombay, Nagpur and New Delhi for July and August 1955. In view of the large airflow in lower levels across the equator in this period, mass exchange between the hemispheres is important. At Singapore and Nairobi, both near the equator, compensating southward flow exists at 200- and 600-mb levels respectively. There is still significant net flow northwards at Singapore and southwards at Nairobi, probably representative of the eastern and western sections of the monsoon circulation. In the southwest monsoon area due to the large cloudiness, the solar energy absorbed by the ground and the lower atmosphere decreases appreciably and is in a portion slightly less than the outgoing radiation. There is advective flux of heat from the north into this 'sink'. Necessity and evidence for transport of heat from summer to winter hemisphere is discussed. Angular momentum flows into the monsoon area from the north and more so northwards across the equator at Singapore. - Author's abstract.

87. Subbaramayya, Indugula. Studies on the Indian southwest monsoon. Thesis submitted to the Andhra University for the award of the degree of Doctor of Philosophy. 147pp. December 1961. DAS MF2369.

...Part I on the study of the southwest monsoon circulation describes the general winds in the tropics from the surface to the stratosphere; explains the meaning of monsoons; reviews the monsoon theories; contains the methods of analyses followed for the study of the circulation in the lower troposphere during the monsoon period, presents the findings, and discusses the results; deals with the study of the circulation in the upper troposphere, the changes during the premonsoon period and the relations between the changes and the onset and advance of the monsoon in India; gives a general picture of the proposed meridional circulation in the South Asian regions; presents the merit of this proposed meridional circulation over the theory of Koteswaram. Part II deals with the Bay cyclones.

88. Venkiteshwaran, S. P. Operation of Allgaier Type(6-8 KW) Wind Electric Generator at Porbandar. India (Republic), National Aeronautical Laboratory, Technical Note No. TN-WP-2-61. 9pp. Bangalore, June 1961. DAS M(055) I39tec.

...In the section on "Meteorological conditions at site selected for the erection of the Wind Electric Generator" there are tables with monthly and annual mean wind speeds in kph during different periods of the day (0830-1730, 1730-0830 and 0830-0830IST) at Porbandar during 1960; annual number of occasions when wind speeds at Porbandar Airport lay in specified ranges (intervals of 5 kph from 0-40 kph) from 0830-1730, 1730-0830 and 0830-0830 during 1960; monthly and annual mean total rainfall amount and number of rainy days for Porbandar.

89. Bose, B. L. Occurrence of low tropopause in northwest India in association with western disturbances and the jet stream. Symposium on Meteorology in Relation to High-level Aviation over India and Surrounding Areas Held at Meteorological Office, New Delhi, 7 December 1957, pp. 127-142. Delhi, 1962. DAS M:629.13 S989sy.

...With the increased flying activities in the upper tropopause and lower stratosphere, it has become essential for meteorologists to pay greater attention to these layers. Two of the outstanding features of this region of the atmosphere are the jet stream and the tropopause. In this note, a study has been made in regard to instances of the low tropopause observed in northwest India, and its association with the jet stream has been discussed. The usefulness of the study of tropopause level as a guide for prognosticating weather developments has also been discussed with reference to a few selected examples.
- Author's abstract.

90. Das, P. K.; Bose, B. L.; Banerji, S. Some aspects of forecasting clear air turbulence and high level winds. Symposium on Meteorology in Relation to High-Level Aviation over India and Surrounding Areas Held at Meteorological Office, New Delhi, 7 December 1957, pp. 47-54. Delhi, 1962. DAS M:629.13 S989sy.

...To examine the possibility of forecasting upper winds and clear air turbulence in the mid- and upper troposphere, the following aspects were examined as applicable to conditions prevailing in India - (a) Richardson's number, and (b) The ageostrophic component at high levels.

Upper winds corresponding to 300, 250 and 200-mb levels were used to compute Richardson's number for the layers 300-250 mb and 250-200 mb. Upper wind data for the winter months of 1957 and 1953 were used, and it was found that the mean values of the ratio K_h and K_m coefficients

for eddy transfer of heat and momentum were 0.48 and 0.25 for the above layers. On only a few occasions the theoretically predicted value for increase in turbulence was exceeded. The theoretical considerations of this number have also been discussed.

The ageostrophic component was computed for 15 cases during the winter months of 1953, 1956, and 1957. Only cases with negligible curvature of the 500-mb contours along the Delhi-Calcutta and Delhi-Jodhpur routes were considered in the present study. The ageostrophic component was computed as a percentage departure in the form

$$(V_{\text{Actual}} - V_{\text{Geostrophic}}) / V_{\text{Actual}}$$

and it was observed that the root mean square of the geostrophic departure was 13 per cent for the Delhi-Calcutta route, and 25 per cent for the Delhi-Jodhpur route. The correlation coefficient between ob-

Source No. 90 continued

served wind and the geostrophic wind varied from 0.3 to 0.8. Theoretical aspects of these results have been discussed in the paper.
- Authors' abstract.

91. Janardhan, S., and Viswanathan, R. A study of the hourly wind speeds at Bangalore (HAL) from the point of view of wind power utilisation. India(Republic), National Aeronautical Laboratory, Technical Note No. TN-WP-14-62. 14pp. Bangalore, November 1962. DAS M(055) I39tec.

...The hourly wind speeds of Bangalore (HAL), Mysore State, for the three years 1958-60 have been examined from the point of view of wind power utilisation. Frequencies and cumulative frequencies of different wind speeds during the different months and the year have been worked out and used to estimate the amount of energy that can be extracted. Durations of spells of low wind (less than 8 km p.h.) have also been examined since they have a bearing on energy storage problems. The mean diurnal variation of wind during each month has been worked out to indicate at what hours during the day energy will be available.

The annual mean wind speed (1958-60) at the site works out to 13 km p.h., the highest value being 50 km p.h. with a frequency of two a year. The annual output works out to 2,360 kWh for a wind machine with an overall power coefficient of 12 per cent (swept area, 30 square metres) and amount of water that can be pumped out by a windmill of swept area 23.6 square metres and overall power coefficient of 12 per cent to 64,000 kilolitres a year. - Authors' abstract.

92. Koteswaram, P. Jet streams over India and neighbourhood. Symposium on Meteorology in Relation to High-level Aviation over India and Surrounding Areas Held at Meteorological Office, New Delhi, 7 December 1957, pp. 101-108. Delhi, 1962. DAS M:629.13 S989sy.

...India is traversed by a westerly jet stream in the dry months (October - May) and an easterly jet stream during the southwest monsoon season (June - September). The mean location of these jet streams, their spatial extent, thermal and dynamical properties are indicated. The role of jet streams in the formation of local disturbances over the Indian area and weather associated are briefly discussed.
- Author's abstract.

93. Nedungadi, T. M. K. Weather and circulation over India, February to April 1961. Chagnon, C. W. (ed.), Joint Indo-United States balloon flight program, 1961, pp. 105-117. December 1962. DAS M07.321.2 C433jo.

...Briefly describes the climatic conditions over the Indian subcontinent with special reference to the area south of Latitude 25°N and the actual prevailing meteorological conditions during the period of these flights. Seasonal trends in weather, progress of weather during the

Source No. 93 continued

period February - April 1961, normal circulation, flow features in February - April 1961, and subtropical jet stream are discussed.

94. Pisharoty, P. R.; Asnani, G. C.; Pacheco, J. H. Horizontal wind shear and consequent instability associated with jet streams over India. Symposium on Meteorology in Relation to High-level Aviation over India and Surrounding Areas Held at Meteorological Office, New Delhi, 7 December 1957. pp. 117-126. Delhi, 1962. DAS M:629.13 S989sy.

...Analyzes the characteristics of wind maxima observed over India with the aid of actual winds on some consecutive days. The examination of the observed winds from the point of horizontal and vertical shears include information on the source of data, the selection of the area, selection of the dates, times of observations, horizontal velocity, more detailed analysis for four days in each season, wind shear along the vertical, and geostrophic velocity. The authors also present the results of the study and the limitations of these results.

95. Prakasa Rao, M. S., and Radhakrishnan, S. P. A study of the hourly wind speeds at Hyderabad from the point of view of wind power utilization. India (Republic), National Aeronautical Laboratory, Technical Note No. TN WP-13-62. 14pp. Bangalore, October 1962. DAS M(055) I39tec.

...The hourly wind speeds at Hyderabad for the three years 1958-60 have been analysed. Frequencies and cummulative frequencies of wind speeds have been worked out and used to estimate the amount of energy that can be extracted from the wind at Hyderabad under certain assumptions. Durations of spells of low wind (less than 8 km p.h.) and the diurnal variation of wind have also been examined since they have bearing on energy storage problems.

The annual energy output is estimated at 1,250 kWh for a generator with an overall power coefficient of 12 per cent. The water-pumping capacity of a WP-2 windmill is estimated at 37,300 kilolitres a year. - Authors' abstract.

96. Rai Sircar, N. C., and Patil, C. D. A study of high level wind tendency during premonsoon months in relation to time of onset of southwest monsoon in India. Indian Journal of Meteorology and Geophysics, Delhi, 13(4): 468-471, October 1962. DAS M(05) I39i.

...Instances of unusually early or late arrival of the southwest monsoon over the whole country or a large part thereof during the 15-year period 1943-57 have been studied with reference to the high-level wind changes during the corresponding premonsoon months. The rapid weakening of the mean westerly components of the prevailing winds during April appear to be associated with early monsoon while their strengthening with late monsoon. Some typical cases are illustrated and discussed in the note. These may be of interest to a forecaster who has

Source No. 96 continued

to make a long-range forecast regarding the probable time of arrival of the monsoon in a particular year. - Authors' abstract.

97. Ramakrishnan, K. P., and Sivaraman, K. R. The contribution from wind power to the energy requirements of India. India (Republic), National Aeronautical Laboratory, Technical Memorandum No. TM-WP-1-62. 23 pp. Bangalore, September 1962. DAS M(055) I39tm.

...Includes annual wind velocity duration curves for Verval, Poona, Bombay, and Madras and annual frequency of hourly wind speed on graphs.

98. Ramakrishnan, K. P., and Janardhan, S. A study of the hourly wind speeds of Verval (Gujarat) from the point of view of wind power utilisation. India (Republic), National Aeronautical Laboratory, Technical Note No. TN-WP-5-62. 25 pp. Bangalore, June 1962. DAS M(055) I39tec.

...The hourly values of wind speed obtained by a Dines' Pressure Tube Anemograph maintained by the India Meteorological Department of Veraval in Gujarat are analysed in this paper from the point of view of extraction of power from the wind. Frequencies of occurrence of different values of wind speed in each month and the whole year are given, and the annual velocity and power duration curves are presented. Average numbers of hours when wind speed was too low to work a windmill or wind electric generator and frequencies of occurrence of such spells of low winds of different durations are given. Estimates of the average electrical energies that can be derived from a wind electric generator installed at Veraval have been made on certain simplifying assumptions. The quantities of water that can be pumped have also been estimated under certain assumptions for all the days of a typical year. The diurnal variation of wind speed in different months is discussed. - Authors' abstract.

99. Raman, C. R. V. A study of the easterly jet stream over India in July 1957. Symposium on Meteorology in Relation to High-level Aviation over India and Surrounding Areas Held at Meteorological Office, New Delhi, 7 December 1957, pp. 109-116. Delhi, 1962. DAS M:629.13 S989sy.

...This paper embodies the result of an analysis of all available upper tropospheric wind data of Indian stations for July 1957 with a view to locating the easterly jet stream and studying its behaviour. The time and meridional sections constructed with the available data reveal the existence of a wind maximum at or slightly above the 150-mb level in the latitudinal belt between 10° and 15°N. In this belt, the core passes over the Madras latitude. The vertical shear below the jet increases from a minimum at Delhi to a maximum at Madras and decreases again towards Colombo. Evidence has been adduced for a lateral oscillation of the axis of the jet north and south of its mean position. It was found that the speed of the easterly jet stream underwent a phase of organisation and a phase of dissipation, the two together ranging from about five to nine days. A typical instance of

Source No. 99 continued

an easterly jet stream displaying the requisite vertical and horizontal wind shear which occurred in this month is also discussed. - Author's abstract.

100. Ramanathan, R., and Viswanath, S. Estimated annual energy output of two types of wind electric generators at selected stations in India. India (Republic), National Aeronautical Laboratory, Technical Note No. TN-WP-4-62. 20 pp. Bangalore, May 1962. DAS M(055) I39tec.

...Estimates of monthly and annual energy output of the Allgaier 7.5-kW and the Dowsett Holdings 25-kW wind machines have been worked out for 12 stations in India, based on hourly wind speeds of the stations and the overall power coefficients of the machines at different wind speeds. The output per kW. of installed capacity and the cost per kWh at selected stations have also been computed for each of the two generators. The suitability of the mean wind speed as a criterion for comparing the wind-power potentialities of different places has been examined.

At Veraval, the windiest station considered, the Allgaier machine will yield about 14,700 kWh. in a year whereas the Dowsett Holdings machine will give about 18,500 kWh At 9 of the 12 places the former has a larger output than the latter. The output per kW of installed capacity of the Dowsett Holdings plant is only 20 to 40 percent of the corresponding value for the Allgaier plant.

Assuming the capital costs of both machines to be about Rs 2,000 per kW of installed capacity, the cost per kWh for the Allgaier generator works out to 12 nP. for Veraval and 24 to 27 nP. for Bhopal, Gopalpur and Madras. For the Dowsett Holdings generator, the cost per kWh ranges from 33 nP. for Veraval to Re.1 for Madras. At other stations the cost estimates for both generators are higher. - Authors' abstract.

101. Ramanathan, R. and Narasimhaswamy, K. N. A study of hourly wind speeds at Bombay (Colaba) from the point of view of wind power utilization. India (Republic), National Aeronautical Laboratory, Technical Note No. TN-WP-6-62. 15pp. Bangalore, July 1962. DAS M(055) I39tec.

...Data of hourly mean wind speeds at Bombay (Colaba) obtained from the India Meteorological Department have been analyzed, and the frequencies of occurrence of different wind speeds calculated. These have been used for the estimation of the energy output and the quantity of water pumped out by a windmill and for the analysis of spells of low wind, diurnal variation, etc.

The annual average wind speed at Bombay (Colaba) works out to 10.6 km p.h. The energy that can be extracted at Bombay by a generator of swept area 30 square metres, cut-in speed 8 km p.h., and overall power coefficient 12 per cent has been estimated as about 1150 kWh per annum. The average number of hours per day with wind speed less than

Source No. 101 continued

8 km p.h. is 9, and the average duration of a low wind spell works out to 6 hours. The quantity of water that can be pumped by a windmill of the WP-2 type works out to about 29,000 kilolitres per annum. - Authors' abstract.

102. Ramanathan, R., and Narasimhaswamy, K. N. A study of the hourly wind speeds at Bombay (Santa Cruz) from the point of view of wind power utilisation. India (Republic), National Aeronautical Laboratory, Technical Note No. TN-WP-19-62. 15pp., Bangalore, December 1962. DAS M(055) I39tec.

...The data of hourly mean wind speeds at Bombay (Santa Cruz) for 1958-60 have been analysed from the point of view of wind power utilisation. The frequencies of different wind speeds have been determined and used for the estimation of the energy extractable from wind and the quantity of water pumped. The spells of low wind and diurnal variation of wind speed have also been examined.

At Bombay (Santa Cruz) the annual mean wind speed is 12 km p.h. The energy output of a generator of cut-in speed 8 km p.h., swept area 30 sq. metres, and overall power coefficient 12 per cent works out to about 1,920 kWh per annum. The quantity of water that can be pumped annually by a windmill of the WP-2 type works out to 56,500 kilolitres. A comparison of the wind power potentialities of this station with that of Bombay (Colaba) indicates that the potential output at Santa Cruz is higher due to better exposure to wind, which constitutes an important criterion in choosing between sites. - Authors' abstract.

103. Ramanathan, R., and Viswanath, S. A study of hourly wind speeds of Madras (Meenambakkam) from the point of view of wind power utilization. India (Republic), National Aeronautical Laboratory, Technical Note No. TN-WP-12-62. 15pp. Bangalore, August 1962. DAS M(055) I39tec.

...The data of the hourly wind speeds at Madras obtained from the India Meteorological Department have been used to study the frequency distribution of wind speeds, estimate the energy extractable from wind and the quantity of water that can be pumped by a windmill and also to examine the spells of low wind and diurnal variation of wind speed.

At Madras the annual mean wind speed is 13 km p.h. The annual energy output of a generator of cut-in speed 8 km p.h., swept area 30 square metres, and an overall power coefficient of 12 percent works out to about 1,900 kWh. Taking the year as a whole, the average number of hours in a day when the wind speed was below 8 km p.h. comes to about 6 hours, and the average duration of a spell of low wind (of speed less than 8 km p.h.) about 4 hours. The quantity of water that can be pumped in a year by a windmill of the WP-2 type has been estimated as approximately 54,000 kilolitres. - Authors' abstract.

104. Ramanathan, R., and Narasimhaswamy, K. N. A study of the hourly wind speeds at Poona from the point of view of wind power utilisation. India (Republic), National Aeronautical Laboratory, Technical Note No. TN-WP-16-62. 13pp. Bangalore, December 1962. DAS M(055) I39tec.

...The hourly wind speeds at Poona for the three years 1958-60 have been used for computing the frequencies and cumulative frequencies of different wind speeds during the different months and the year and estimating the amount of energy that can be extracted from the wind. Duration of spells of low wind (less than 8 km p. h.) have also been analysed since they have a bearing on energy storage problems. The mean diurnal variation of wind during each month has been worked out, as it indicates at what hours during the day energy will be available.

The annual energy output is estimated at 1,390 kWh for a wind-driven machine of cut-in speed 8 km p. h., swept area 30 sq. metres, and an overall power coefficient of 12 per cent. The quantity of water that can be pumped annually by the WP-2 type of windmill has been estimated as 38,000 kilolitres. - Authors' abstract.

105. Rama Rao, M. Jet streams and ozone. Symposium on Meteorology in Relation to High-level Aviation over India and Surrounding Areas Held at Meteorological Office, New Delhi, 7 December 1957. pp. 143-150. Delhi, 1962. DAS M:629.13 S989sy.

...Discusses the observations made regarding jet streams and ozone with special reference to the work in the tropics on the jet stream.

106. Ramaswamy, C. Breaks in the Indian summer monsoon as a phenomenon of interaction between the easterly and the sub-tropical westerly jet streams. Tellus, Uppsala, 14(3): 337-349, August 1962. DAS M(05) T277.

...The present paper contains the results of the study of a synoptic situation over India during a period of 8 days in which normal monsoon conditions were followed by a break and were further followed by a return to normal monsoon. This study has shown that during breaks in the monsoon, a trough in the middle latitude westerlies with a jet embedded in it increases considerably in its amplitude and gets retarded as it moves into the Tibetan Plateau on account of its entering a region of weaker basic current. The large-amplitude trough weakens or destroys completely the Tibetan high at the 500-mb level and appreciably weakens the easterlies at the higher levels to the south of the Himalayas. Protruding into India and Pakistan, the large amplitude trough contributes to the development of heavy rainfall along and near the foot of the Himalayas, which is characteristic of the break conditions. The southward protrusion of the trough and its subsequent movement eastward is also indirectly responsible for a corresponding shift of the high over Iran and Arabia, which in its turn, seems to lead to the formation of a secondary jet core in the easterlies west of 80° E between 20° N and 25° N. Consequent on the above developments, the

Source No. 106 continued

westerly jet which had retreated to the north of the Himalayas at the time of the onset of the monsoon reenters the Indo-Pakistan sub-continent during the breaks. Thus we see during break conditions the remarkable spectacle of two jets of entirely different types - the easterly and the subtropical westerly - within a short latitudinal distance of each other and dynamically interacting with each other.

The above detailed study, supplemented by a general examination of the monthly mean 700 mb charts for the northern hemisphere for a period of 10 years, suggests that active monsoon over India is closely associated with high index circulation in middle latitudes over Asia and neighbourhood, while weak monsoon is closely associated with low index circulation over the same region. - Author's abstract.

107. Rao, Y. P. Meridional circulation associated with the monsoons of India. Indian Journal of Meteorology and Geophysics, Delhi, 13(2): 157-166, April 1962. DAS M(05) I39i.

...Meridional components in January and July at twelve Indian Rawin stations and Colombo, Nairobi, Aden, Bahrein, and Tashkent based on three years' data are presented. The centres of direct and indirect cells are located at higher elevations, probably to overcome the obstruction to meridional exchange from high mountain ranges running east to west. At Bahrein and Aden the upper southerlies of the direct cell are absent in winter. The direct cell retreats northward to near 30°N in July, and a 'monsoon cell' with lower southerlies and upper northerlies occupies the Indian area from 26 to 13° N. Northerlies at Colombo and Trivandrum in the lower troposphere in July suggest that the feed across the equator into the Arabian Sea branch of the monsoon may be extremely limited. - Author's abstract.

108. Viswanathan, R., and Janardhan, S. A study of the hourly wind speeds at Ahmadabad from the point of view of wind power utilisation. India (Republic), National Aeronautical Laboratory, Technical Note No. TN-WP-18-62. 13pp. Bangalore, December 1962. DAS M(055) I39tec.

...The hourly wind speeds at Ahmadabad for the three years 1958-60 have been used to compute frequencies and cumulative frequencies of different wind speeds during the different months and the year and estimate the amount of energy that can be extracted from the wind. Durations of spells of low wind and mean diurnal variation of wind have been worked out.

The energy that can be extracted from the wind with a machine of overall power coefficient 12 per cent is estimated at 1330 kWh per year. The quantity of water that can be pumped by a windmill of the same power coefficient is estimated at 39,500 kilolitres per year or 24,000 gal per day. - Authors' abstract.

109. Viswanathan, R., and Janardhan, S. A study of the hourly wind speeds at Bangalore (Central Observatory) from the point of view of wind power utilisation. India (Republic), National Aeronautical Laboratory, Technical Note No. TN-WP-15-62. 11pp. Bangalore, December 1962. DAS M(055) I39tec.

...The hourly wind speeds at Bangalore (Central Observatory) have been analysed. Frequencies and cumulative frequencies of different wind speeds during the different months and the year have been worked out and used to estimate the amount of energy that can be extracted at the site under certain assumptions. The estimated annual energy output at Bangalore (Central Observatory) is 713 kWh for a wind electric generator of overall power coefficient 12 per cent and swept area 30 sq. m and the quantity of water that can be pumped by a windmill of the same power coefficient and swept area of 23.6 sq.m (corresponding to a rotor diameter of 5.5 m) works out to 12,200 kilolitres (2,684,000 gal) per year. These estimates are less compared to those for H.A.L. at Bangalore reported earlier, due to more obstructions, where the anemograph is located.

Spells of low wind and diurnal variation of wind speed have also been discussed. - Authors' abstract.

110. Radiosonde-Rawin Observatory at Srinagar. Indian Journal of Meteorology and Geophysics, Delhi, 13(3): 406-407, July 1962. DAS M(05) I39i.

...Announces the establishment of a new Radiosonde-Radiowind Observatory at Srinagar in Kashmir on July 19, 1962, describes the installation of the instruments, and presents photographs of the observatory and the radio-theodolite.

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111. Anjaneyulu, T. S. S., and Sikka, D. R. Equatorward extension of troughs in the upper westerlies and the relation of upper tropospheric flow to onset of monsoon rains over India. U. S. National Science Foundation, India Meteorological Department and U. S. Information Service, Preliminary Results and Future Plans of the International Indian Ocean Expedition Meteorology Programme, Proceedings of a Seminar Held in Bombay on 1 August 1963. pp. 68-79. October 1963. DAS M:551.46 U585pre.

...Daily 200-mb streamline charts for the months of March through May occasionally show large equatorward extension of troughs in upper westerlies. The possible effects of the troughs on surface weather during their eastward passage are briefly discussed.

The differences between mean circulation over India and neighbourhood during April and May 1963 and the normal April and May circulation are discussed. Mean 200-mb level winds during May 1963 have been studied

Source No. 111 continued

more critically to show the suddenness of changes in upper tropospheric circulation pattern during the second half of the month. Mean zonal and meridional components of winds at 200 mb over India and neighbourhood have been studied to determine possible relationships between the perturbations in the westerlies at that level in the transition season and the onset of the summer monsoon over India. - Authors' abstract.

112. Deshpande, D. V. **Utility of 850-mb charts for estimation of upper winds over India.** Indian Journal of Meteorology and Geophysics, Delhi, 14(3): 353-354, July 1963. DAS M(05) I39i.

...Presents the preliminary results of an analysis of 850 - mb charts for India based on data for January - June 1947, January 1949 - December 1950.

113. Dixit, C. M., and Nicholson, J. R. The sea breeze at and near Bombay. U. S. National Science Foundation, Preliminary Results and Future Plans of the International Indian Ocean Expedition Meteorology Programme, Proceedings of a Seminar Held at Bombay on 1 August 1963. Bombay? 1963. pp. 82-93. DAS M:551.46 U585pre. Also slightly revised in: Indian Journal of Meteorology & Geophysics, Delhi, 15(4): 603-608, October 1964. DAS M(05) I39i.

...The first portion of this paper deals with the theory of the sea breeze and also describes the work of Estoque.

The observational material collected by the sea breeze traverses of the U. S. Weather Bureau Research Flight Facility aircraft at Bombay is presented in the latter section of this paper. - Authors' abstract.

114. Janardhan, S., and Viswanath, S. A study of the hourly wind speeds at Gopalpur from the point of view of wind power utilisation. India (Republic), National Aeronautical Laboratory, Technical Note No. TN-WP-27-63. 16pp. Bangalore, May 1963. DAS M(055) I39tec.

...The hourly wind speeds at Gopalpur, recorded by a Dines' Pressure-Tube Anemograph, were used to study their frequency distribution, estimate the energy extractable from wind by a windmill under certain assumptions, and also examine such characteristics of the wind as diurnal variation and spells of low wind.

The annual mean wind speed at Gopalpur works out to 13 km p.h. The annual energy output of a wind electric generator of rotor area 30 sq.m and a uniform overall power coefficient of 12 per cent works out to about 3,640 kWh. The average quantity of water that can be pumped in a year by a WP-2 type windmill has been estimated at about 1,06,600 kilolitres (2,34,52,000 gal approximately), i.e., 290 kl (63,800 gal.) per day. - Authors' abstract.

115. Lockwood, J. G. Winds at the 200 mb level over the tropics and subtropics during the seasons of monsoon change. Meteorological Magazine, London, 92(1088): 75-84, March 1963. DAS M(05) G786m.

...Over the tropics and subtropics from Africa to the western Pacific, the 200-mb flow patterns can be divided on a climatological scale into two general types. One flow pattern dominates from November to April, and the other from June to September. The average wind charts for January and July in Geophysical Memoirs No. 103 show the basic flow patterns at their respective greatest developments. The changes in the 200-mb flow pattern in May and June appear to take place in a definite sequence. The October transition is less distinct, but it is still possible to find some order in the sequence of events. The main 200-mb easterly current leaves Khartoum in North Africa before the south-west monsoon retreats from northern India. The south-west monsoon normally retreats from northern India before winds of jet-stream strength (above 60 knots) appear at New Delhi. This would appear to be the reverse of the sequence of events occurring in May and June. - Author's conclusions.

116. Pant, P. S. Upper tropospheric circulation over India. Proceedings of IGY Symposium, February 13-16, 1961, New Delhi, 2: 7-19. New Delhi, 1963. DAS 551 I61pro.

...Meridional sections along 80°E depicting the month-to-month variation during 1958 of winds and temperatures have been prepared for the levels 9, 10.5, 12, 14, and 16 km. Charts showing streamlines and isotachs for the same levels and for the months January, April, July, and October (representative of the four seasons) have been drawn. Corresponding sections and charts based on normal upper winds and temperatures have also been prepared.

On the basis of these charts the upper tropospheric circulation has been discussed with special reference to the onset and withdrawal of strong westerly and easterly winds of jet magnitude. The position of region of strongest winds, the horizontal and vertical shears associated with these winds, and the characteristics of the tropopause have been examined. A few case studies during IGY period have also been presented. -Author's abstract.

117. Prakasa Rao, M. S., and Radhakrishnan, S. R. A study of the hourly wind speeds at Allahabad from the point of view of wind power utilisation. India (Republic), National Aeronautical Laboratory, Technical Note No. TN-WP-22-63. 13pp. Bangalore, January 1963. DAS M(055) I39tec.

...The hourly wind speeds at Allahabad for 1958- 60 have been analysed. Frequencies and cumulative frequencies of wind speeds with different values during each month and the year have been computed and used to estimate the amount of energy extractable. Durations of spells of low wind have also been examined since they have a bearing

Source No. 117 continued

on energy storage problems. The mean diurnal variation of wind during each month has been worked out, as it indicates at what hours during the day energy will be available.

The annual mean wind speed works out to 6 km p. h. the maximum wind speed was 40 km p. h. and occurred only once in a year. The annual output of a wind electric generator with an overall power coefficient of 12 per cent and swept area 30 sq. m works out to 353 kWh. The quantity of water that can be pumped in a year by a direct-acting windmill with a swept area of 23.6 sq. m and overall power coefficient of 12 per cent is about 6,500 kl (1,430,000 gal.). - Authors' abstract.

118. Prakasa Rao, M. S. A study of hourly wind speeds at Bhopal from the point of view of wind power utilization. India (Republic), National Aeronautical Laboratory, Technical Note No. TN-WP-23-63. 14pp. Bangalore, April 1963. DAS M(055) I39tec.

...The hourly wind speeds at Bhopal for the three years 1958 to 1960 have been analysed. Frequencies and cumulative frequencies have been worked out and used to estimate the amount of energy extractable from the wind under certain assumptions. Durations of spells of low wind (less than 8 km p. h.) and the diurnal variation of wind have also been discussed.

The yearly average wind speed at Bhopal is 11 km p. h. The annual energy output works out to 1,370 kWh for a wind electric generator with an overall power coefficient of 12 per cent. The annual water pumping capacity of a WP-2 type windmill is estimated at about 42,000 kilolitres (9,240,000 gallons). - Author's abstract.

119. Prakasa Rao, M. S., and Radhakrishnan, S. R. A study of the hourly wind speeds at Calcutta (Dum Dum) from the point of view of wind power utilisation. India (Republic), National Aeronautical Laboratory, Technical Note No. TN-WP-28-63. 14pp. Bangalore, June 1963. DAS M(055) I39tec.

...The hourly wind speed data of Calcutta (Dum Dum) for the years 1958 to 1960 have been analysed. The frequency distribution, and the cumulative frequencies of the hourly wind speeds were computed and used to work out the energy extractable from wind. The number of hours of low wind, the spells of such low winds, and the diurnal variation were discussed.

The annual mean wind speed works out to 9 km p. h. The annual energy output of a wind electric generator with 30 sq. m swept area, and 12 per cent overall power coefficient is 1,009 kWh. The water pumping capacity of a WP-2 type windmill is 30,500 kl (6,710,000 gal) per annum or 18,400 gal per day. - Authors' abstract.

120. Prakasa Rao, M. S., and Radhakrishnan, S. R. A study of the hourly wind speeds at Jaipur from the point of view of wind power utilization. India (Republic), National Aeronautical Laboratory, Technical Note No. TN-WP-25-63. 14pp. Bangalore, April 1963. DAS M(055) I39tec.

...The hourly wind speeds at Jaipur (Rajasthan) obtained from the India Meteorological Department for the years 1958-1960 have been analysed in this study to assess the wind power potentiality of the place. Certain characteristics of wind such as frequency distribution, spells of low winds, and the diurnal variation are discussed.

The annual energy output of an aerogenerator of 30 sq. metres swept area and an overall power coefficient of 12 per cent is estimated at 561 kWh. The annual water pumping capacity of a direct-acting windmill with the same overall power coefficient, but with a swept area of 23.6 sq. metres (WP-2 type windmill) is estimated at about 17,550 kilolitres (3,861,000 gallons), i. e., 10,580 gal per day. The annual mean wind speed works out to 7 km p. h. -Authors' abstract.

121. Prakasa Rao, M. S., and Radhakrishnan, S. R. A study of hourly wind speeds at Vishakhapatnam from the point of view of wind power utilisation. India (Republic), National Aeronautical Laboratory, Technical Note. No. TN-WP-21-63. 12pp. Bangalore, January 1963. DAS M(055) I39tec.

...The hourly wind speeds at Visakhapatnam for the period 1958-60 have been analysed from the point of view of extracting power from the wind. Frequencies and cumulative frequencies of different wind speeds during the different months and the year have been worked out and used to estimate the amount of energy that can be extracted by a wind electric generator under certain assumptions. Durations of spells of low wind and the mean diurnal variation of wind during each month have been discussed.

The annual mean wind speed at Visakhapatnam works out to 8 km p. h., the highest value being 40 km p. h. with a corresponding frequency value of 2. The annual output of a wind electric generator of swept area 30 sq. m and 12 per cent overall power coefficient is 992 kWh. The amount of water that can be pumped in a year by a direct-acting windmill with 23.6 sq. m swept area and 12 per cent overall power coefficient works out to 33,460 kl (7,361,200 gal) - Authors' abstract.

122. Raman, C. R. V. Upper air climatology. U. S. National Science Foundation, India Meteorological Department, and U. S. Information Service, Preliminary Results and Future Plans of the International Indian Ocean Expedition Meteorology Programme, Proceedings of a Seminar Held in Bombay on 1 August 1963. pp. 13-28. October 1963. DAS M:551.46 U585pre.

...To facilitate daily analysis at the IMC and to serve as a reference

Source No. 122 continued

background for research, a set of mean resultant upper wind charts for the mid-season months January, April, July, and October for the standard isobaric levels 850 mb through 200 mb is presented. Salient features of circulation patterns have been discussed with reference to subtropical anticyclones, low latitude and equatorial configurations, the trades and the westerlies. Reference is made to the significantly large displacement of the subtropical ridge line over the Indian subcontinent during summer. The existence of near equatorial circulations in the lower troposphere and their influence on the Indian summer monsoon have been mentioned. - Author's abstract.

123. Ramanadham, R., and Subbaramiah, I. Wind structure of the easterly jet stream. Indian Journal of Pure and Applied Physics, New Delhi, 1(4): 157-159, April 1963. DAS P.

...Is a brief study on the wind structure of the easterly jet stream. It contains a table with summaries for each year (1957-1959) and over the period of mean velocities in knots of the easterlies at Verval, Bombay, Nagpur, Madras, and Trivandrum.

124. Ramanathan, R., and Viswanath, S. A study of the hourly wind speeds at Jodhpur from the point of view of wind power utilization. India (Republic), National Aeronautical Laboratory, Technical Note No. TN-WP-29-63. 15pp. Bangalore, September 1963. DAS M(055) I39tec.

...The hourly average wind speeds for 1958-1960 at Jodhpur in Rajasthan have been analysed to assess the wind power potentiality of Jodhpur. The frequency distribution of wind speeds, the average electrical energy extractable from wind by a generator of assumed characteristics, and the quantity of water that can be pumped by a WP-2 type windmill have been determined. The frequencies and duration of spells of low winds and the diurnal behaviour of wind speed have also been discussed.

The annual mean wind speed at Jodhpur is 9 km p. h. The estimated annual energy output of a wind driven machine having a cut-in speed of 8 km p. h., a swept area 30 sq.m, and an overall coefficient of 12 per cent is 789 kWh. The average quantity of water that the WP-2 type windmill with an overall power coefficient of 12 per cent and swept area 23.6 sq.m can pump is about 23,000 kilolitres a year or about 14,000 gal per day. - Authors' abstract.

125. Ramanathan, R., and Viswanath, S. A study of the hourly wind speeds at Lucknow from the point of view of wind power utilization. India (Republic), National Aeronautical Laboratory, Technical Note No. TN-WP-26-63. 14pp. Bangalore, April 1963. DAS M(055) I39tec.

...The data of the hourly average wind speeds at Lucknow for the years 1958- 60 have been obtained from the India Meteorological Department. Based on these, the frequency distribution of wind speeds, estimated amount of energy extractable from wind, and the estimated quantity of

Source No. 125 continued

water that can be pumped by a windmill have been determined. The frequencies and duration of spells of low winds and the diurnal variation of wind speed have been examined.

The annual mean wind speed at Lucknow is 9 km p.h. The estimated annual energy output of a wind driven machine having a cut-in speed of 8 km p.h., swept area 30 sq.m , and an overall power coefficient of 12 per cent is 1,320 kWh. The average amount of water that the WP-2 type windmill with an overall power coefficient of 12 per cent and swept area 23.6 sq.m can pump in a year is about 40,000 kilolitres which works out to about 23,800 gal per day. - Authors' abstract.

126. Ramanathan, R., and Viswanath, S. A study of the hourly wind speeds at New Delhi from the point of view of wind power utilisation. India (Republic), National Aeronautical Laboratory, Technical Note No. TN-WP-31-63. 14pp. Bangalore, November 1963. DAS M(055) I39tec.

...Hourly mean wind speed data for the period 1958-60 have been used to estimate the energy and water output of wind-driven plants. The distribution of wind speed, the diurnal variation of wind speed and spells of low wind have also been studied.

The annual mean wind speed at New Delhi is 10 km p.h. The estimated annual energy output of a wind-driven plant of cut-in speed 8 km p.h., swept area 30 sq.m and overall power coefficient 12 per cent is 1361 kWh. The estimated annual water output of a windmill of the WP-2 type is 39,940 kilolitres.

These estimated values of water output have been compared with the actual output of a WP-2 windmill installed at the Technical Centre of the Civil Aviation Department, New Delhi, and with the estimates made from the wind data recorded by a cup-contact anemometer with impulse recorder installed near the windmill. - Authors' abstract.

127. Rao, D. V. L. N., and Venkiteshwaran, S. P. Performance of the 6-8KW Allgaier Wind Electric Generator at Porbandar. India (Republic), National Aeronautical Laboratory, Technical Note No. TN-WP-33-63. Bangalore, December 1963. DAS M(055) I39tec.

...Includes monthly (April 1961-March 1962) summaries of mean number of hours when wind blew with specified speeds at Porbandar and diurnal variation of wind speed at Khapat Agricultural Farm, Porbandar.

128. Rao, D. V. L. N., and Narasimhaswamy, K. N. A study of the hourly wind speeds at Amritsar from the point of view of wind power utilization. India (Republic), National Aeronautical Laboratory, Technical Note No. TN-WP-24-63. 17pp. Bangalore, April 1963. DAS M(055) I39tec.

...The hourly wind speeds at Amritsar have been analysed from the point

Source No. 128 continued

of view of wind power utilization.

Frequencies of different wind speeds and cumulative frequencies were computed to determine the energy extractable from the wind by a machine with an overall power coefficient of 12 per cent and 30 sq.m swept area. The annual energy works out to 984 kWh.

The quantity of water that can be pumped on each day of a typical year was computed; the annual quantity works out to 31,000 kilolitres (68, 20,000 gallons) of water pumped by a windmill of overall power coefficient of 12 per cent and swept area of 23.6 sq.m. - Authors' abstract.

129. Rao, D. V. L. N., and Narasimhaswamy, K. N. A study of the hourly wind speeds at Gaya from the point of view of wind power utilization. India (Republic), National Aeronautical Laboratory, Technical Note No. TN-WP-32-63. 14pp. Bangalore, December 1963. DAS M(055) I39tec.

...Analysis of the hourly wind speeds at Gaya for the period 1958-1960 shows that the electrical energy extractable in a year using a wind machine of 30 sq.m swept area and of 12% overall power coefficient is 1320 kWh. The average annual quantity of water that could be pumped by a windmill of 23.6 sq.m swept area (WP-2 type) and of 12% overall power coefficient works out to 39610 kl (8,714,200 gal) or 23,870 gal per day. The number of hours of low wind (speed below 8 km p.h.) in a day have been completed. The diurnal variation of wind speed is also discussed. - Authors' abstract.

130. Singh, M. S. Upper air circulation associated with a western disturbance. Indian Journal of Meteorology and Geophysics, Delhi, 14(2): 156-172, April 1963. DAS M(05) I39i.

...Upper tropospheric circulation associated with the development of a western disturbance which was active over India and Pakistan from 28 to 31 December 1960 has been studied with the help of the Asian charts. It was observed that between 26th and 28th a meridional type circulation developed at 300-mb level in the Middle-East and the South-Russian Region. As a result, the upper air trough in the westerlies extended deep into the north Arabian Sea and a strong northwesterly jet developed upstream of this trough by the 28th. It was on this day that a feeble western disturbance along Makran coast intensified. On the 29th the meridional circulation at 300-mb level was destroyed. Probable causes of these developments in the upper air as well as at the surface have been discussed. - Author's abstract.

131. Sivaraman, K. R., and Venkiteshwaran, S. P. Utilisation of wind power for irrigation of crops in India with special reference to the distribution of wind and rainfall. India (Republic), National Aeronautical Laboratory, Technical Note No. TN-WP-30-63. 9pp. Bangalore, November 1963. DAS M(055) I39tec.

Source No. 131 continued

...The need for increasing food production in India, through an increase in area under irrigation cannot be overemphasised. Utilisation of wind power for minor irrigation using windmills would be very helpful, particularly in areas under irrigation from wells. Two types of direct water-pumping windmills, viz., the WP-1 and WP-2, have been developed in the National Aeronautical Laboratory, Bangalore. The monthly quantities of water that can be pumped by a WP-2 windmill at 16 places in India have been computed, based on the mean hourly wind speeds at these places. Comparison of the water pumped against the monthly rainfall at these places shows that at most of the places under study, the water pumped is a maximum when the rainfall is minimum.

The trials with a 6 kW, 220 volts D.C., Allgaier wind electric generator, at an agricultural farm at Porbandar for pumping water for irrigation show that the cost of pumping water is less than half that by a 10 H.P. Diesel Engine. -Authors' abstract.

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132. Ananthakrishnan, R., and Rao. K. V. Diurnal variation of low level circulation over India. Symposium on Tropical Meteorology, Rotorua, New Zealand, 5-13 November 1963, Proceedings. pp. 89-95. Wellington, 1964. DAS M15.5 S89pr.

...Discusses the seasonal changes in circulation, diurnal changes in circulation, and sea level pressure and wind patterns over India.

133. Ananthakrishnan, R., and Ramakrishnan, A. R. Perturbations of the general circulation over India and neighbourhood. Symposium on Tropical Meteorology, Rotorua, New Zealand, 5-13 November 1963, Proceedings. pp. 144-159. Wellington, 1964. DAS M15.5 S89pr.

...The general upper air circulation over India and neighbourhood consists of a summer circulation from end of May to the beginning of October and a winter circulation during the period from October to May. The transition from the winter to summer circulation which takes place rather abruptly in the second half of May ushers in the south-west monsoon over the country; the onset of the winter circulation brings about the withdrawal of the monsoon from North India and the central parts of the country. Large-scale perturbations in the normal flow patterns occur in both the winter and summer months. The nature of these perturbations and the dynamical and thermodynamical features associated with them are discussed on the basis of case studies. - Authors' abstract.

134. Ananthakrishnan, R., and Ramakrishnan, A. R. Vertical variation of the constancy of upper winds over India. Indian Journal of Meteorology & Geophysics, Delhi, 15(3):359-374, July 1964. DAS M(05) I39i.

Source No. 134 continued

...Examines the variability of upper winds at 12 rawin stations in India, describes the features of individual stations in the order of increasing latitude, and presents tabular summaries of resultant wind speed (knots), resultant wind direction in degrees, and the wind constancy (%) at levels of 6.0, 7.2, 9.0, 10.5, 12.0, 14.1, 16.2, and 18.0 km for January and July at the 12 rawin stations based on data for 4-10 years during the period 1951-1960.

135. Asnani, G. C., and Umamaheswara Rao, A. Seasonal changes in the circulation pattern over India and neighbourhood. Symposium on Tropical Meteorology, Rotorua, New Zealand, 5-13 November 1963, Proceedings. pp. 207-215. Wellington, N.Z., 1964. DAS M15.5 S89pr.

...Based on monthly means of observations during the IGY year 1958, time-sections are presented for the four meridians 20°E, 80°E, 180° and 80°W extending from latitude 60°S to 60°N. Important differences in these sections, apparently due to land and sea contrasts, are highlighted. The Indian radiosonde data, averaged for two different months January and July, are used to calculate various measures of vertical stability. The Indian pibal and rawin data for January are used to evaluate horizontal and vertical wind shears. It is found that the ratio of the relative vorticity to the coriolis parameter is constant for a given level on the anticyclonic side of the westerly wind maximum. Brief reference is made to the applicability of geostrophic assumption to the mean January flow over India south of 20°N. - Authors' abstract.

136. Bhattacharyya, J. C., and Prakash, Surya. A mean windspeed indicator. Indian Journal of Meteorology & Geophysics, Delhi, 15(2): 277-280, April 1964. DAS M(05) I39i.

...Describes a simple instrument which would indicate directly at a distance the mean wind speed over any desired interval of time. This instrument was tested at Weather Central, Poona, with the anemometer on the tower of the Meteorological Office.

137. Flohn, Hermann. Investigations on the tropical easterly wave (Untersuchengen über die tropische Ost-Strahlströmung). Bonner Meteorologische Abhandlungen, Heft 4 (1964). 83 pp. Bonn. DAS M(055) B716bon Heft 4.

...Discusses the upper wind climatology of south Asia, meridional temperature cross sections, dynamics of the tropical easterly jet, the role of the tropical easterly jet in the general atmospheric circulation, and the synoptic behavior of the tropical easterly jet above India. The tables contain for 1-12 stations in India summaries for specified periods of July - August average temperatures at levels of 850, 700, 500, 300, 200, and 100 mb; July - August resultant winds at levels of 200, 150, and 100 mb; July - August zonal temperature cross-sections along 25°N at 850-, 700-, 500-, 300- and 200-mb. levels;

Source No. 137 continued

July - August temperature distribution along the thermal equator at 850-, 700-, 500-, 300-, 200-, and 100-mb. levels; July and August statistical wind parameters (direction and velocity of resultant wind).

138. Frost, R., and Stephenson, P. M. Mean stream lines for standard pressure levels over the Indian Ocean and adjacent land areas. Proceedings of the Symposium on Tropical Meteorology, Rotorua, New Zealand, 5-13 November 1963. pp. 96-106. Wellington, 1964. DAS M15.5 S89pr.

...Mean stream line charts for standard pressure levels (700, 500, 300, and 200 mb) over the Indian Ocean and adjacent land areas for Jan., April, July, and Oct. are presented. The principal features shown by these charts are: (1) the large poleward displacement of the subtropical ridge axis over the Indian sub-continent from winter to summer, (2) the existence of a large cyclonic circulation at 500 mb, (3) the existence at all seasons of equatorial westerlies between Jan and Sumatra from the surface to 700 mb (in July to 500 mb) which fall off and become light variable at 500 mb (except in July) and at higher levels become easterlies which increase with height, and (4) the marked cross equatorial flow in July at 300 mb between long. 70°E and 140°E. - MGA 17.2 - 259.

139. Hutchings, J. W. Large scale perturbations of the tropical circulation. Proceedings of the Symposium on Tropical Meteorology, Rotorua, New Zealand, 5-13 November 1963, pp. 123-143. Wellington, N. Z., 1964. DAS M15.5 S89pr.

...This study is based on two points of view. The first one regards the perturbation due to large-scale heating and cooling of the continents relative to the surrounding oceanic areas with the flow at higher levels playing only a minor part. The second view has a tendency to treat the large-scale perturbation as arising mainly from a thermally induced seasonal oscillation in the planetary wind field at upper levels. In discussing the second point of view, studies by several authors on monsoons and circulation over India have been reviewed.

140. Jagannathan, P.; Das, U. S.; Datar, V. V. On winds at Poona. Indian Journal of Meteorology & Geophysics, Delhi, 15(1): 3-26, January 1964. DAS M(05) I39i.

...Discusses the variation of wind and the graduation of periodic variation of wind at Poona based on data for the period January 1949 to December 1958. The tables include the monthly standard deviation of the hourly values of wind speed, mean hourly wind speed (mph), mean hourly range of gust (mph), mean hourly gustiness, and vector mean winds (direction in degrees and speed in mph) for each hour at Poona. There are also hourly wind roses for Poona for each month.

141. Prakasa Rao, M. S., and Radhakrishnan, S. R. A study of the hourly

Source No. 141 continued

wind speeds at Kodaikanal from the point of view of wind power utilisation. India (Republic), National Aeronautical Laboratory, Technical Note No. TN-WP-17-62. Revised. 11 pp. December 1964. DAS M(055) I39tec.

...The hourly wind speeds at Kodaikanal have been used to estimate the energy extractable from the wind. The number of hours of low winds, the spells of such low winds with different durations, and the diurnal variation of the wind are discussed.

The annual mean wind speed works out to 11 km p.h. The annual output of a wind electric generator of 30 sq.m swept area and an overall power coefficient of 12 per cent works out to 1,553 kWh. The water pumping capacity of a WP-2 type windmill is 55,850 kl (12,310,000 gallons) per annum or 36,500 gallons per day. - Authors' abstract.

142. Rai Sircar, N. C., and Sikdar, D. N. Pre-monsoon jet streams over the Indian sub-continent and the associated vertical motions. Indian Journal of Meteorology and Geophysics, Delhi, 15(1): 95-98, January 1964. DAS M(05) I39i.

...Examines a few cases of premonsoon jet streams to study how far the conclusions of Koteswaram (1954) can be applied to day-to-day situations. According to Koteswaram, the confluence of two currents, (1) the southwesterlies to westerlies over the Bay of Bengal and the Peninsula and (2) the continental westerlies to northwesterlies from higher latitudes, causes the premonsoon jet stream and the jet stream during the dry months. He also shows by his charts that there is a southward transport of air across the jet stream both above and below it. Diagrams and text seem to disprove Koteswaram's conclusions.

143. Raman, C. R. V., and Dixit, C. M. Analyses of monthly mean resultant winds for standard pressure levels over the Indian Ocean and adjoining continental areas. Proceedings of the Symposium on Tropical Meteorology, Rotorua, New Zealand, 5-13 November 1963. pp. 107-118. Wellington, N. Z., 1964. DAS M15.5 S89pr.

...Presents and discusses a series of mean resultant wind charts for standard pressure surfaces over the Indian Ocean and adjacent land areas.

144. Rangarajan, S. Ozone variations associated with the equatorial stratospheric wind oscillations. Indian Journal of Meteorology & Geophysics, Delhi, 15(4): 565-578, October 1964. DAS M(05) I39i.

...Discusses the discovery of the equatorial stratospheric oscillation, possible relationship of the 26-month oscillation with long period ozone changes, the stratospheric wind oscillation over the southern parts of India, and some features of ozone in low latitudes; analyses total ozone data; compares the wind and ozone oscillations.

145. Rao, D. V. L. N.; Narasimhaswamy, K. N.; Radhakrishnan, S. R. A study of the hourly wind speeds at Jagdalpur and Jamshedpur from the point of view of wind power utilization. India (Republic), National Aeronautical Laboratory, Technical Note TN-WP-34-64. 14 pp. Bangalore, January 1964. DAS M(055) I39tec.

...The analysis of hourly wind speeds for Jagdalpur and Jamshedpur revealed certain features from the point of view of wind power utilization, which called for a combined study of these two stations. One of these factors is the low value of annual energy at each of these stations compared to the other stations.

Jagdalpur has an annual mean wind speed as low as 3 km p.h. The annual output of energy from a windmill of 30 sq.m swept area, cut-in speed of 8 km p.h., and constant overall power coefficient of 12 per cent works out to 89 kWh. The quantity of water that can be pumped in a year by a WP-2 type windmill of 23.6 sq.m swept area and overall power coefficient of 12 per cent has been estimated at 2,600 kl.

Jamshedpur has an annual mean wind speed of 5 km p.h. The annual output of energy here works out to 236 kWh. The quantity of water that can be pumped by a WP-2 type windmill at Jamshedpur has been estimated at 6,580 kl per year. - Authors' abstract.

146. Singh, M. S. Structural characteristics of the subtropical jet stream. Indian Journal of Meteorology and Geophysics, Delhi, 15(3): 417-424, July 1964. DAS M(05) I39i.

...Characteristics of the subtropical jet-structure over India and Pakistan were studied with the help of longitudinal cross-sections. It was observed that the subtropical jet is a broad band of great latitudinal span located in the break between the middle and the tropical tropopauses. Generally the jet-core has two Layers of Maximum Wind (LMW) attached to it. But it is replaced by separate cores with no LMWs when the branching of the jet stream takes place. Connected to each core and located beneath it is found a layer of frontal type discontinuity which may be called the "Subtropical Front". The present knowledge about the westerly jet streams over India and Pakistan has been discussed in the light of above findings. _ Author's abstract.

147. Sreeramamurthy, D. Subtropical jet-streams and thunderstorms. India (Republic), Institute of Tropical Meteorology, Technical Paper No. TP-3-64. 9 pp. March 1964. DAS M(055) I391te.

...The main features of the subtropical jet-streams encountered in the atmosphere are summarised. The occurrence of the thunderstorms in the vicinity of jet-streams is explained and illustrated. A few measurements indicate the existence of a positive space charge in the vicinity of jet-streams even when there is no active thunderstorm directly below. Consequently the potential gradients in the thunderstorms associated with jet-streams are likely to be larger than in those unconnected with jet-streams. - Author's abstract.

148. Swaminathan, D. R. Convective activity associated with jet stream, Indian Journal of Meteorology & Geophysics, Delhi, 15(2), 247-250, April 1964. DAS M(05) I39i.

...Synoptic situations and weather associated with the passage of a jet stream over the central and northern parts of the country between 8 and 14 March 1962 were examined. Thunderstorm activity was pronounced in the right entrance and in the left exit sectors of the jet stream where superposition of high-level divergence over lower level convergent areas could be assumed. - Author's abstract.

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149. Ananthakrishnan, R., and Thiruvengadathan, A. Comparison between the observed and geostrophic winds over the Indian tropics during the summer and winter monsoons. Proceedings of the Symposium on Meteorological Results of the International Indian Ocean Expedition, Bombay, India, 22-26 July 1965. pp. 384-394. DAS M:551.46 S989pr. Abstract also in: Symposium on Meteorological Results of the International Indian Ocean Expedition, Bombay, India, 22-26 July 1965, Abstracts. Comparison between actual and geostrophic winds over the Indian tropics during the summer and winter monsoon months by R. Ananthakrishnan and A. Thiruvengadathan, p.21. DAS M:551.46 S989a.

...The results of a study of the relationship between the observed zonal winds and the corresponding geostrophic winds, using the daily values of the surface pressure and the Radiosonde/Rawin data of selected Indian stations are presented. Marked deviations from geostrophic flow is noticed. The nature and magnitude of these deviations are discussed. - Authors' abstract.

150. Ananthakrishnan, R. General circulation of the atmosphere over the Indian Ocean and adjoining areas. Proceedings of the Symposium on Meteorological Results of the International Indian Ocean Expedition, Bombay, India, 22-26 July 1965. pp. 105-114. DAS M:551.46 S989pr.

...The discussion presents information on the Asiatic summer monsoon, seasonal march of solar insolation, summer and winter circulation, seasonal transitions, departure from geostrophic flow at low latitudes, and zonal and meridional winds. Illustrative maps, diagrams, and graphs are included.

151. Ananthakrishnan, R.; Ramakrishnan, A. R.; Thiruvengadathan, A. Interrelation between the lower tropospheric westerlies and the upper tropospheric easterlies during the southwest monsoon. Proceedings of the Symposium on Meteorological Results of the International Indian Ocean Expedition, Bombay, India, 22-26 July 1965. pp. 141-143. DAS M:551.46 S989pr.

...Examination of the rawin data of stations over peninsular India

during the monsoon months for a period of 8 years shows that there is no significant correlation between the periodical strengthening and weakening of the lower tropospheric westerlies with the corresponding changes in the upper tropospheric easterlies. - Authors' abstract.

152. Ananthakrishnan, R., and Ramakrishnan, A. R. Upper tropospheric zonal circulation over India and neighbourhood in relation to the south west monsoon. Symposium on Meteorological Results of the Indian Ocean Expedition, Bombay, India, 22-26 July 1965, Proceedings. pp. 415-422. DAS M:551.46 S989pr.

...A study has been made of the zonal wind changes at the 200-mb level at the rawin stations in India and at the Middle-East stations of Aden and Bahrein, accompanying the onset and withdrawal of the southwest monsoon. The changes in question are the reversal of the westerly circulation to the easterly at the time of onset and the opposite change at the time of withdrawal. Although these changes at some of the stations give prior indication of the onset and withdrawal, they have little forecasting value. - Authors' abstract.

153. Gokhale, G. S.; Menon, M. G. K.; Redkar, R. T. Zonal winds in the 10-35 km region of the subtropical atmosphere over India. Journal of the Atmospheric Sciences, Boston, 22 (2): 116-119, March 1965. DAS M(05) A512j.

...High-altitude balloon ascents made from Bombay (19N, 73E) and Hyderabad (17.6N, 78.5E) indicate that during the period from September to May through December, in the subtropical atmosphere over India, the stratospheric winds above 22 km are mostly easterlies. These are found to build up in strength with increasing altitude. Also, with the advent of summer the stratospheric easterly stream strengthens at all altitudes whilst the westerlies characteristic of the upper troposphere weaken. Between April 1957 and May 1964, there were two periods, 1959 (March - May) and 1961 (February - April), when at the highest altitudes attained by the balloons, at or above 30 km, stratospheric westerlies were observed; during 1963 (October - December) some flights showed westerlies and others easterlies at these altitudes. These westerlies could be an extension to lower altitudes of the winter westerly regime observed by rocket-sondes in the Northern Hemisphere. The easterly to westerly change-over observed by us at high altitudes is also discussed in terms of the quasi-biennial wind cycle in the tropical stratosphere. - Authors' abstract.

154. Mukherjee, A. K. and Ghosh, S. K. Orographical influence on the air flow over Brahmaputra valley. Indian Journal of Meteorology and Geophysics, Delhi, 16(3): 429-436, July 1965. DAS M(05) I39i.

...Airflow over Assam during different seasons has been examined. It has been shown that except during the monsoon, easterly air at the lower levels originates from the Himalayas. These are more marked during winter. Similarly it has been shown that there is a tendency

Source No. 154 continued

for air to flow towards Himalayas during monsoon. Basing on this tendency the distribution of fog in winter over the whole valley has been explained. The effect of this air on the formation of thunderstorm activity over Brahmaputra valley has also been indicated. - Authors' abstract.

155. Nataraja Pillai, N., and Surya Rao, V. Heavy rainfall in Kerala during the Indian south west monsoon in relation to upper winds over Trivandrum and Minicoy. Proceedings of the Symposium on Meteorological Results of the International Indian Ocean Expedition, Bombay, India, 22-26 July 1965. pp. 367-373. DAS M:551.46 S989pr.

...The wind profiles of Minicoy and Trivandrum on the eve of occurrence of heavy and light rainfall in Kerala show that, while the low level westerlies are much stronger during the heavy rainfall spells than during the light rainfall spells, the upper level easterlies do not show any significant change. The winds at low levels in association with both heavy and light rainfall situations increase downstream from Minicoy to Trivandrum, indicating low-level divergence. A plausible explanation of this is offered. Monthly means of the vertical extent of westerlies over Trivandrum and Madras for the monsoon months are presented. Lastly, the relationship between the vertical extent of the westerlies over Trivandrum with the maximun speed of the low-level westerlies on the one hand and the maximum speed and the level of maximum speed of the high-level easterlies on the other is discussed. - Authors' abstract.

156. Nicholson, J. R. On the character of the Bombay sea breeze. Proceedings of the Symposium on Meteorological Results of the International Indian Ocean Expedition, Bombay, India, 22-26 July 1965, pp. 86-96. DAS M:551.46 S989pr.

...This paper deals with some of the aspects of the sea breeze based on aircraft, surface, and upper air observations in the vicinity of Bombay in March 1964. The sea breeze is an intense manifestation of a set of complex circulations. The conclusions of this study are that (1) further evidence show that the circulation begins offshore, then moves onto land, (2) an opposing circulation may be set at some distance at sea, (3) opposing circulations are induced in the upper layers, (4) the primary sea breeze circulation persists, and even intensifies for a short period at sea and on land after sundown, and (5) the need to extend the numerical models to include more complicated conditions as vertical shear in the large scale flow and integrations over a period longer than 24 hours.

157. Ramamurthi, K. M.; Keshavamurty, R. N.; Jambunathan, R. Some distinguishing features of strong and weak monsoon regimes over India and neighbourhood. Proceedings of the Symposium on the Meteorological Results of the International Indian Ocean Expedition, Bombay, India, 22-26 July 1965, pp. 350-361. DAS M:551.46 S989pr.

Source No. 157 continued

...Two periods, each of two week's duration, one of strong monsoon and the other weak monsoon (during 1963) were chosen, and the mean resultant winds were computed for each period. Streamline-isotach analyses for the standard levels were made. Thickness charts between standard levels were analysed. Mean meridional sections of vorticity and of zonal and meridonal components of wind were prepared for longitudes 75°E and 85°E.

The wind fields at 700 mb show the greatest contrast between the two regimes. It is found that rainfall distribution associated with the two epochs can be explained on the basis of vertical circulations caused by advection discontinuities. The thickness charts show that the main monsoon trough over the Gangetic plains is warm-cored but the midtropospheric vortex during strong monsoon over Gujarat is cold-cored at 700 mb. The charts show the presence of an upper tropospheric westerly trough over West Pakistan and also the more southward position of the upper tropospheric subtropical ridgeline during weak monsoon. The upper tropospheric easterlies build up more between 200 and 100 mb during strong monsoon and between 300 and 200 mb during weak monsoon. The sections of meridional component of wind show that the monsoon or reverse cell is more prominent during strong monsoon and the Hadley cell is more prominent during weak monsoon. - Authors' abstract.

158. Raman, C. R. V.; Keshavamurty, R. N.: Jambunathan, R.; Ramanathan, Y. Some aspects of the meridional circulation over the Indian monsoon area. Proceedings of the Symposium on Meteorological Results of the International Indian Ocean Expedition, Bombay, India, 22-26 July 1965. pp. 401-412. DAS M:551.46 S989pr.

...Careful analyses are made at standard isobaric levels, of wind, height, temperature, and moisture fields for mean July, active monsoon (7 July 1963), and weak monsoon (19 July 1963). Based on 5-degree grid point values derived therefrom, internal, potential, and latent heat energies are computed and also the meridional fluxes of these energies and of relative angular momentum. Significant differences are noticed in the meridional circulation and fluxes. For mean July, a direct energy-producing monsoon cell operates along 90°E and an indirect energy consuming Hadley cell operates along 55°E. The change-over takes place around 75°E. During strong monsoon the monsoon cell extends westwards to 75°E. There is net meridional inflow of total energy over Arabian Sea over Bay of Bengal increases during strong monsoon. - Authors' abstract.

159. Ramanadham, R., and Subbaramayya, I. The sea breeze at Visakhapatnam. Indian Journal of Meteorology & Geophysics, Delhi, 16(2): 241-248, April 1965. DAS M(05) I39i.

...The development of sea breeze and its vertical structure at Visakhapatnam are studied during the premonsoon period. A number of observed characteristics of the sea breeze are described and discussed.

Source No. 159 continued

The winds at an inland station 10 km distant from the coast are also examined to study the variations, as the sea breeze spreads inland. - Authors' abstract.

160. Ranganathan, C., and Soundarajan, K. A study of a typical case of interaction of an easterly wave with a westerly trough during the post monsoon period. Indian Journal of Meteorology & Geophysics, Delhi, 16(4): 607-616, October 1965. DAS M(05) I39i.

...A spell of heavy rain which first occurred over south India and later gradually spread northwards in the course of about three days during the first week of December 1962 has been studied. An easterly wave which had been affecting south India on 1 December moved out into the Arabian Sea and interacted with a trough in the westerlies which was moving across Rajasthan and northern plains of India in association with a western disturbance. The result of the interaction on 2 December and on subsequent days, which was facilitated by the presence of an induced low in between them, was the formation of an extended trough in the low-level easterlies. The northern part of the extended trough in which was embedded the induced low then move eastward and got fractured. The fracture of the waves was accompanied by the weakening of the trough systems, as well as the induced low. Unprecedented heavy rains for the month occurred in Madhya Pradesh and Vidarbha and broke the all-time record for the month at a number of stations during and after the formation of the extended trough. - Authors' abstract.

161. Rao, M. S. V., and Sikdar, D. N. Methods of measuring winds and temperature in the upper atmosphere with small rockets. Indian Journal of Meteorology & Geophysics, Delhi, 16(4): 661-670, October 1965. DAS M(05) I39i.

...The Indian Meteorological Rocket Launching Programme was initiated at Thumba on 14 July 1964. During the following six months seven Judi-Dart rockets and eleven test rockets were fired. The chaff payload released from the Judi-Dart rockets were tracked by an MPS-19 radar system. The data thus collected were reduced following a method which is a simple adaptation of the India Meteorological Department graphical technique.

This paper includes a description of the Judi-Dart and test rockets as well as the radar system. The method of data reduction employed at Thumba is explained with an actual example. A comparison is drawn between this method and the one employed in the U.S.A. (Wallops station).

A few remarks are added on the present International ROCOB Code in the light of the experience gained at Thumba.

A brief survey is also included of techniques of measuring winds and temperatures with small meteorological rockets which are currently in use in other countries and some of which may be adopted at Thumba in future. - Authors' abstract.

162. Rao, M. S. V., and Chandrasekharan, C. K. Stratospheric and mesospheric winds in July - August over an equatorial station. Indian Journal of Meteorology & Geophysics, Delhi, 16(3): 361-370, July 1965. DAS M(05) I39i.

...Examines the results of three successful rocket firings made from Thumba Equatorial Rocket Launching Station during July and August 1964 and gives the results. This study also presents the results of RAWIN observations at Trivandrum, Minicoy, Madras, Port Blair, Bangkok, and Saigon.

163. Rao, M. S. V.; Sikdar, D. N.; Chandrasekharan, C. K. Vertical wind shear in the lowest layers of the atmosphere over Thumba during winter months - A preliminary study. Indian Journal of Meteorology & Geophysics, Delhi, 16(2): 221-228, April 1965. DAS M(05) I39i.

...Vertical wind shear in the lowest layers of the atmosphere over Thumba - an equatorial station - has been studied. Wind data from the surface up to 200 ft were collected at different altitudes (8, 31, 56, 134, and 200 ft) during the months December 1963 and January 1964, for the above study. Analysis reveals that appreciable wind shear exists very close to the surface, i.e., in the layer up to 31 ft. On the other hand, in the layer 31-200ft , the shear values are not considerable. It is further observed that the shear magnitude reaches maximum in the afternoon. The frequency of occurrence of shear magnitudes more than 10 kts/30m (which, as indicated by ICAO, is important for supersonic transport operation) is high in the lowest layer round about 1430 IST during the winter months. - Authors' abstract.

164. Sallee, Ralph W. Use of the monthly mean resultant wind charts prepared by the International Meteorological Centre, Bombay, for day to day forecasting analysis of tropical streamline charts. Proceedings of the Symposium on Meteorological Results of the International Indian Ocean Expedition, Bombay, India, 22-26 July 1965. pp. 115-116. DAS M:551.46 S989pr.

...A technique for the use of the Monthly Mean Resultant Wind Charts prepared by Raman and Dixit at the International Meteorological Centre, IIOE, Bombay, is discussed. The principal utilization of the mean charts, in addition to encouraging an understanding of the tropics, is to provide a basis for analysis in areas of sparse data and a means of encouraging a day-to-day continuity in chart analysis. - Author's abstract.

165. Sikka, D. R. On some aspects of the fluctuations of the sub-tropical westerly jet stream over India during winter. Proceedings of the Symposium on Meteorological Results of the International Indian Ocean Expedition, Bombay, India, 22-26 July 1965. pp. 178-189. DAS M551.46 S989pr.

...The analysis of the 200-mb charts shows that there are local variations in the intensity of the jet, but, on many occasions, it is very

Source No. 165 continued

difficult to trace any regular west to east propagation of the jet maxima and minima; although on some occasions, it may be possible to trace west to east propagations in association with well-marked troughs and ridges moving across NW India.

It is suggested that many of these variations in the intensity of the jet occur under the influence of perturbations in the lower tropospheric equatorial chart and of the extra-tropical middle and upper tropospheric westerly belt. Possibility of variations in the meridional circulation along longitudinal belt 70-75°E and its effect on the intensity of the jet stream over that region for short periods averaging about 5 days is also examined. - Author's abstract.

166. Srivastava, G. P.; Ramachandran, S.; Wagholikar, R. R.; Narayana Iyer, N. An electrical anemograph. Indian Journal of Meteorology & Geophysics, Delhi, 16(1): 123-126, January 1965. DAS M(05) I39i.

...Describes an electrical anemograph designed and constructed at the Instruments Division of the Meteorological Office at Poona to meet the requirements recommended by ICAO. The units installed at Santacruz, Dum Dum, and Poona are working satisfactorily.

167. Subramanian, D. V. A note on wind-finding with weather radar. Indian Journal of Meteorology & Geophysics, Delhi, 16(3): 453-458, July 1965. DAS M(05) I39i.

...A method of estimating upper winds under adverse weather conditions, by radar observations on the movement of clouds containing precipitable water content, is described. The utility and limitations of the method are discussed. - Author's abstract.

168. Thiruvengadathan, A. Mean upper air flow patterns associated with spells of strong and weak northeast monsoon conditions over the Madras State in the month of November. Indian Journal of Meteorology & Geophysics, Delhi, 16(1): 61-68, January 1965. DAS M(05) I39i.

...Mean upper air flow patterns have been worked out for spells of strong and weak northeast monsoon conditions over the Madras State in the month of November and compared with the normal patterns for the month. It is noticed that the winds at 1.5 and 3.0 km a.s.l. over the Peninsula are mainly easterlies when the monsoon is strong, but becomes northerlies, when the monsoon is weak. At 6.0 and 9.0 km a.s.l. anticyclonic cell over the Bay of Bengal is prominent during strong monsoon conditions but becomes diffuse during weak monsoon conditions, when the high-pressure cell over the Arabian Sea becomes dominant. - Author's abstract.

169. Thiruvengadathan, A., and Ananthakrishnan, R. Vertical structure of the high level easterlies over Trivandrum and Minicoy during the southwest monsoon season of 1963. Indian Journal of Meteorology &

Source No. 169 continued

Geophysics, Delhi, 16(1): 137-140, January 1965. DAS M(05) I39i.

...From rawin ascents at Trivandrum and Minicoy Island in 1963 some interesting features of the upper tropospheric - lower stratospheric zonal winds over the extreme southern part of the Peninsula during the southwest monsoon months have been revealed. These features are discussed briefly in this note.

1966

170. Bhargava, B., and Jauhari, N. P. A simple system for continuous measurement of average wind speed and its digital display. Indian Journal of Meteorology & Geophysics, Delhi, 17(1): 57-66, January 1966. DAS M(05) I39i.

...The paper describes a simple system for measurement of average wind speed at a remote place. The average wind speed is computed as frequently as desired by transistor binaries from the pulses received from a photo-transistor anemometer during each ten-minute interval and is registered on transistor decade units. Diode decoders transfer this figure to digital display tubes. The display on the indicating tubes is held through relays. The average wind speed is thus continuously displayed. - Authors' abstract.

171. Bhavsar, P. D.; Ramanujarao, K.; Verenkar, K. G. Study of the neutral upper atmosphere winds near the equator. Space Research, VI: 401-409. Washington, 1966. DAS A/QC801.S88.

...Preliminary results from the first three sodium vapour rocket launchings from TERLS, India, during 1963-64 are presented. Results of these three shots indicate that the wind profiles at the equator above 100 km are not different from profiles found at the middle latitudes and resemble winds in the Southern Hemisphere. - Authors' abstract.

172. Gupta, R. G. A study of winds up to 32 km over Hyderabad Deccan. Indian Journal of Meteorology & Geophysics, Delhi, 17(2): 199-206. April 1966. DAS M(05) I39i.

...Rawin observations of eleven high-altitude ascents at Hyderabad Deccan (India) during the months of February 1960 and April to May 1959 have been analysed. An abrupt change in direction of winds at an altitude of about 19 km during summer months, depth of westerlies and easterlies, and the occurrence of two maxima and at least one minima of velocities and the relationship between their altitudes have been described. Also, vector average winds throughout the observed channel of atmosphere (0-32 km) and their relationship with the maxima have been determined and described. It was also found that the upper winds were quite steady. The steadiness factor has been calculated for each altitude for the month of March 1960. - Author's abstract.

173. Joseph, P. V., and Raman, P. L. Existence of low level westerly jet stream over peninsular India during July. Indian Journal of Meteorology & Geophysics, Delhi, 17(3): 407-410, July 1966. DAS M(05) I39i.

...From an analysis of July rawin and pilot data over peninsular India it is shown that a low-level jet stream (as defined by Reiter) exists over peninsular India on a large number of days, with level of wind speed maximum near 1.5 km asl and with core speeds ranging from 40 to 60 kts. High vertical wind shear is observed below the jet core. - Authors' abstract.

174. Murakami, Takio. Final report of mission in tropical weather analysis and numerical weather prediction for tropics. 16 pp. Poona, India, 1966? DAS MO9.313 M972fi.

...Discusses the numerical experiment of the monsoon, observational studies of the monsoon circulation, the Palghat Gap observation, and the instability theory in the tropics. The report also includes notes on the numerical monsoon experiment by M. Sankar Rao, V. Brahmananda Rao, and J. Subbarayudu; a case study of energetics of a monsoon low by K. V. Rao and S. Rajamani; the Palghat Gap project by G. Ramachandran; instability of tropical zonal currents by Sreeramamurthy Daggupaty.

175. Rai Sircar, N. C., and Jayaraman, S. A study of upper winds, temperature and humidity over Madras in relation to precipitation occurrences there during the monsoon season. Indian Journal of Meteorology & Geophysics, Delhi, 17(4): 649-651, October 1966. DAS M(05) I39i.

...Is a study to determine whether the strengthening or weakening of the zonal or meridional components of winds aloft over Madras has any bearing on the development of weather at this station and its vicinity during the next 24 hours. The authors also make an examination to find out if there is any significant variation in the vertical distribution of temperature and humidity associated with dry days and wet days over the same region.

176. Ramage, C. S. The summer atmospheric circulation over the Arabian Sea. Proceedings of Symposium on Meteorological Results of the International Indian Ocean Expedition, Bombay, India, 22-26 July 1965. pp. 197-207. DAS M:551.46 S989pr. Also published in: Journal of the Atmospheric Sciences, Boston, 23(2): 144-150, March 1966. DAS M(05) A512j.

...The summer heat low system extending from Somalia across southeast Arabia to northwest India is the most extensive and intense on earth. Although it develops in the normal way over desert regions in response to the sun's zenithal march, it is maintained and intensified through the summer by subsidence of air originally lifted and warmed by the release of latent heat in monsoon rain systems to the east and south. The subsidence not only dominates West Pakistan, Arabia, and Somalia but severely restricts low cloud formation over the central and western Arabian Sea.

Source No. 176 continued

The heat low exports cyclonic vorticity in the middle and upper troposphere to the northern Arabian Sea. When a deep layer of moist air is present over the eastern part of this area, subtropical cyclogenesis occurs, producing a burst of west Indian monsoon rains. This in turn, by increasing subsidence above the heat low, intensifies it and its associated low-level monsoon circulation. When supply of moist air is cut off, the subtropical cyclone fills, the heat low weakens, and a break takes place in the monsoon rains. With renewal of the moisture supply, the sequence is repeated. - Author's abstract.

177. Rangarajan, S., and Mokashi, R. Y. Some aspects of the statistical distribution of upper winds over India. Indian Journal of Meteorology & Geophysics, Delhi, 17 (1): 25-38, January 1966. DAS M(05) I39i.

...For a quantitative evaluation of the probabilities of occurrence of upper wind speed and directions, a number of standard statistical parameters like standard deviations of the zonal and meridional components of the wind and the correlation coefficients between them are required. Utilising all radio-wind observations of the 5-year period, 1959-1963, these statistical parameters have been computed for the standard geometrical heights 1.5, 3.0, 6.0, 9.0, 12.0, 14.1, and 16.2 km a.s.l. for all the twelve months of the year for three representative stations in India, viz., New Delhi, Nagpur, and Trivandrum. The brief theory underlying the use of statistical parameters and the method of constructing the distribution ellipses are outlined. The verification of the procedure has been illustrated by four actual cases of wind distribution. The main features of the distribution of winds in the different seasons have been discussed. In general, there is a tendency for the upper wind distribution to be elliptical rather than circular. - Authors' abstract.

178. Rao, M. S. V. Results of meteorological rocket soundings at an equatorial station. Space Research, VI: 410-424. Washington, 1966. DAS A/QC801.S88.

...A series of meteorological rocket experiments was conducted at Thumba Equatorial Rocket Launching Station during the current IQSY period. The series included three successful rocket soundings in the monsoon months and six in the winter.

During the monsoon, eastnortheasterly winds of speeds 60 - 90 knots were observed in the stratosphere. Further upwards in the mesosphere, the data revealed a region of unusually strong winds with high shears. Radar observations of the rate of dispersion of chaff confirm the existence of this complex pattern of high shears and pronounced turbulence, in this season. The winter data indicate up to 50 km generally moderate easterly flow, instead of the cyclonic circumpolar vortex of middle latitudes. Even above 50 km, westerlies appear to establish themselves rather late in the winter period.

Source No. 178 continued

From an attempt to study eddy diffusivity from chaff dispersion, it is inferred that the diffusion coefficient has an order of magnitude $10^5 cm^2/sec$ just below the stratopause and $10^6 cm^2/sec$ in the equatorial mesosphere. - Authors' abstract.

179. Sen Roy, N., and Prakash, S. A wide band local oscillator for 403 MC/S Rawin receiver. Indian Journal of Meteorology & Geophysics, Delhi, 17(3): 477-479, July 1966. DAS M(05) I39i.

...Describes the characteristics of a wide-band tunable oscillator that has been built to eliminate difficulties previously encountered and will be suitable for the future requirements of the India Meteorological Department.

180. Seshadri, N. Radar upper wind measurements at New Delhi using Decca wind finding radar - type WF2. Indian Journal of Meteorology & Geophysics, Delhi, 17(2): 225-232, April 1966. DAS M(05) I39i.

...This note gives a brief description of the Decca wind-finding type WF2 acquired by the India Meteorological Department. An analysis of the series of upper wind measurements taken with this radar at New Delhi during the monsoon months, July to September 1960 and the winter months, December 1960 to February 1961, is given. The structure of the upper winds over New Delhi during these months, as revealed by the composite wind velocity profiles, is also indicated. The ratios of the maximum wind speed to the mean wind speed between the ground level and level of maximum wind were computed for all these ascents, and the mean ratio was found to be 2.78. The comparison of the radar upper winds with the Rawin winds indicate close agreement at lower levels and when the winds are light. However, at higher levels in winter the radar winds are stronger than the Rawin winds. - Author's abstract.

181. Tangri, A. C. Computation of streamlines associated with a low latitude cyclone. Indian Journal of Meteorology & Geophysics, Delhi, 17 (3): 401-406, July 1966. DAS M(05) I39i.

...From available wind data at 500 mb, computations were made of the vorticity field associated with a cyclone, which struck the southern half of peninsular India in December 1964. By defining a stream function Ψ, such that the Laplacian of Ψ is the vorticity, we solved a Poisson equation for Ψ by relaxation. It was assumed that Ψ vanishes along the boundary of the region chosen for study. Comparisons were then made between (i) wind components computed from the gradient of Ψ and (ii) the actual wind. Applying statistical tests, we find that there is good agreement between the computed and the observed wind, suggesting that at 500 mb, the non-divergent part of the wind vector provides a good approximation to the actual wind. - Author's abstract.

182. Venkiteshwaran, S. P., and Huddar, B. B. A method of estimating the vertical component of gusts in turbulence in the upper air. Indian Journal of Meteorology & Geophysics, Delhi, 17(4): 563-566, October 1966. DAS M(05) I39i.

...It has been shown how the rate of rotation of the fan in the F-type radiosonde can be used to locate regions of turbulence in the upper air. A method of estimating the vertical component of the gusts from the radiosonde records is described in this paper. The mean rate of rotation of the fan at different heights has been obtained from a number of flights when no turbulence is present. This decreases uniformly with height due to the decrease in density of the air. Tests conducted in a wind tunnel give the rate of rotation of the fan for different speeds of wind in the direction of the axis of the fan. From these values, it has been shown how the vertical component of the gust in regions of turbulence can be estimated. - Authors' abstract.

183. Venkiteshwaran, S. P. A simple method of estimating the vertical component of the gusts in the upper air from the F-type radio-sonde records. The Journal of the Aeronautical Society of India, New Delhi, 18(4): 113-114, November 1966. DAS P.

...Describes a method of estimating the value of the gusts from the F-type radiosonde records at Poona.

184. Yegnanarayanan, Sumathi. Vector mean wind and standard vector deviations for selected Rawin stations in India. Indian Journal of Meteorology & Geophysics, Delhi, 17(2): 179-186, April 1966. DAS M(05) I39i.

...A statistical investigation of all available Rawin data at 3.0, 6.0, 9.0, 12.0, 14.1, and 16.2 km above sea level, for five Indian stations, covering the years 1961 and 1962 is reported in this paper. The stations are Bombay, Calcutta, Madras, New Delhi, and Trivandrum. The tables showing the mean meridional and zonal components together with the standard vector deviations for the two seasons December-February and July-August are included. The vector mean winds and the standard vector deviations for each station are given. The distribution of winds at the different levels mentioned above are tested for circularity and found to be mostly noncircular for the stations south of Lat. 20°N and mostly circular for stations north of it. - Author's abstract.

1967

185. Bhaskara Rao, N. S., and Dekate, M. V. Effect of vertical wind shear on the growth of convective clouds. Royal Meteorological Society, Quarterly Journal, 93(397): 363-367, July 1967. DAS M(055) R888q.

...The relationship between vertical wind shear and the vertical

Source No. 185 continued

extent of convective clouds is examined. In order to take into consideration the movement of a cloud, a 'Relative Top Shear' (RTS) is defined. Radar data and upper winds at some Indian stations in different seasons have been studied and a comparison made between RTS at different levels and the maximum tops of convective clouds. The results show that deep convective cloud was confined to layers in which RTS did not exceed 10 kt/km. - Authors' abstract.

186. Desai, B. N. Circulation over India and neighbourhood during the southwest monsoon season. Indian Journal of Meteorology & Geophysics, Delhi, 18(4): 459-464, October 1967. DAS M(05) I39i.

...A survey has been made of circulation over India and neighbourhood as represented by streamline analysis by different authors for July and of the theories put forward by different workers about the southwest monsoon taking into consideration the IIOE observations over the Arabian Sea and facts of weather, climatology, and orographic features of the country. It is shown that the claims of the exponents of streamlines analysis regarding its utility in day-to-day forecasting have to be treated with considerable reserve as the same does not give adequate importance to topographical features which play a vital role in the (a) production of rainfall besides convergence and upglide action, (b) modification of the properties of the air masses involved, and (c) deflection of the air streams which contribute significantly in making the Indian southwest monsoon a selfsustaining system in the lower levels of the atmosphere. The significant layers would appear to be from the surface up to about 500 mb; the position of the partition at 9 and 12 km between the middle latitude westerlies and the easterlies to their south remains about the same in the July "mean" and in "active" and "break" monsoon conditions. - Author's abstract.

187. Desai, B. N. The summer atmospheric circulation over the Arabian Sea. Journal of the Atmospheric Sciences, Boston, 24(2): 216-220, March 1967. DAS M(05) A512j.

...Ramage's model for the summer atmospheric circulation over the Arabian sea is discussed, and it is shown that the inversion there as well as over the West Pakistan heat low area is due to air masses and not to subsidence. The role of the Western Ghats in 1) breaking up the inversion, 2) causing precipitation and the consequent development of cyclonic circulation above 2 km over the Bombay area at the western end of the trough axis, and 3) producing a moist air current about 5 km deep over the Peninsula is emphasized. The causes responsible for the development of the trough over the Gangetic Valley as well as for rainfall between 18 and 27N in western India are indicated. Ramage's model and his various interpretations cannot be accepted by experienced Indian meteorologists.

His model of the Bay of Bengal monsoon referred to in his concluding remarks also cannot be accepted. - Author's abstract.

188. Gokhale, G. S.; Menon, M. G. K.; Redkar, R. T. Atmospheric circulation at altitudes up to 37 km over India in the latitude belt 17° - 19° N. Indian Journal of Meteorology and Geophysics, Delhi, 18 (1): 5-12, January 1967. DAS M(05) I39i.

...Mean monthly winds in the 7-37 km range for the months of September to May through December, based on 155 balloon ascents made over the period 1957-66 in the latitude belt 17° - 19°N in India, are reported. It is shown that except for few short periods during winter and spring, when weak westerlies prevailed, the stratospheric circulation was predominantly zonal with winds generally increasing with altitude. - Authors' abstract.

189. Huddar, B. B. An improved automatic signalling anemometer. Indian Journal of Meteorology and Geophysics, Delhi, 18(1): 137-138, January 1967. DAS M(05) I39i.

...Describes an improved automatic signalling anemometer designed for the use of the Indian Railway, for automatic traffic control over long bridges. This new signalling anemometer is modified to trigger the cautionary signals at wind speeds which exceed 26 knots.

190. Joseph, P. V. A case of very low latitude occurrence of the subtropical jet stream over the Indian region. Indian Journal of Meteorology & Geophysics, Delhi, 18(2): 217-226, April 1967. DAS M(05) I39i.

...This paper is a case study of an unusual excursion of the subtropical jet stream into very low latitudes. From 18 December 1963, the subtropical jet stream began moving south from its normal position, roughly Bahrain to Delhi, consequent to the formation of a deep trough in the upper tropospheric westerlies, near Bahrain longitude. At 0000 GMT on 24 December 1963, the subtropical jet is located along Aden-Visakhapatnam, with Aden recording a maximum of 120 kts. westerly, which is quite unusual. The vertical cross-section along 80°E for 0000 GMT of 24 December 1963 shows clearly two jet streams, the subtropical jet stream core near Visakhapatnam, below the tropical tropopause and close to a break in the tropopause and another jet stream core, over Delhi, in the angle formed by the tropopause and an inclined front which does not extend below 500 mb. - Author's abstract.

191. Joseph, P. V. A study of maximum wind surface in the easterly jet stream over India during July 1966. Indian Journal of Meteorology & Geophysics, Delhi, 18(2): 213-216, April 1967. DAS M(05) I39i.

...In this paper a study is made of the level of maximum wind of the easterly jet stream over India using July 1966 upper wind data. It is found that, in general during the month, the level of maximum wind increases in height from about 13-15 km near Trivandrum latitude to about 16-18 km at about 15-20 degrees North latitude and towards further north decreases to at times as low a height as 12-13 km near Allahabad-Delhi latitudes. Many of the 200-mb charts of July 1966

Source No. 191 continued

show two distinct jet axes 10-15 degrees latitude apart, the northern jet axis being of very limited longitudinal extent. The author finds that double jets occur on 200-mb charts due to the inverted V-shaped nature of the north-south vertical profile of the level of maximum wind. A tentative schematic diagram of a typical north-south vertical section of the easterly wind field of July 1966 is presented in the paper. - Author's abstract.

192. Murakami, T.; Godbole, R. V.; Kelkar, R. R. Numerical experiment of the monsoon along 80°E Longitude (Preamble). 45 pp. Poona, India, 1967. DAS M53.21 M977n.

...Carries out a theoretical and numerical experiment of the monsoon. The purpose of the experiment is to clarify the basic mechanism responsible for maintaining the monsoon circulation and the climatology of the monsoon condition and to simulate the essential features of the monsoon circulation with a minimum of parametric constraints.

193. Narayanan, V. An observational study of the sea breeze at an equatorial coastal station. Indian Journal of Meteorology & Geophysics, Delhi, 18(4): 497-504, October 1967. DAS M(05) I39i.

...The paper contains a preliminary study of the sea breeze at Thumba (08° 32' N, 76° 52' E) based on observations on 392 days, spread over a period of three years (1963-1966).

Analysis on hourly wind observation reveals that the northeasterly or northerly land breeze is replaced by westerly or southwesterly sea breeze before mid-day during October to May. It is also seen that November to April are favoured most by the sea breeze at Thumba. Southerly setting, late onset as well as early cessation of the sea breeze have been noticed on a few occasions. The wind is always above 5 kt after the incidence of the sea breeze and it may vary to a maximum speed of 22 kt and oscillates between 180° - 300° depending on the prevailing synoptic situation. The vertical extent of the sea breeze is about 1 km and 0.8 km in summer and winter, respectively.

The frontal characteristics of the sea breeze are not very marked at Thumba. There is no significant temperature fall associated with the sudden onset of the sea breeze, but slight rise in relative humidity is 5-10 per cent recorded on a few occasions. The reversal of land and sea breeze is illustrated by an example giving hourly tower wind and pilot balloon wind data. - Author's abstract.

194. Rao, M. S. V. Further results of meteorological rocket soundings at Thumba. Space Research VII, Proceedings of the Seventh International Space Science Symposium, Vienna, 10-18 May 1966, Volume 2, p. 961. Amsterdam, 1967. DAS A/QC801.S88.

...A total of twenty-two successful meteorological rocket experiments

Source No. 194 continued

were conducted at Thumba Equatorial Rocket Launching Station between July 1964 and April 1966.

An analysis of the data collected shows the following pattern of winds in the equatorial upper atmosphere. In the stratosphere, the wind flow is predominantly easterly. However, westerlies are observed above 25-30 km in April, November, and December. In the mesosphere, westerlies become more frequent and are noticeable, not only in the above months, but in February and March also. The transition to this pattern from the middle latitude wind regime seems to take place gradually in the sub-tropics.

From a study of the wind shears over Thumba as well as from the radar observations of the spread of chaff, it is noticed that during certain periods a region of high shears and pronounced turbulence manifests itself above 50 km.

Further, from chaff dispersion studies, it has been possible to make a preliminary estimate of the diffusion coefficient in the stratosphere and mesosphere. - Author's abstract.

195. Rao, M. S. V. Results of meteorological rocket experiments at Thumba. Journal of Applied Meteorology, 6(2): 401-407, April 1967. DAS M(05) J86joa.

...A series of 23 successful meteorological rocket experiments were conducted at Thumba Equatorial Rocket Launching Station from July 1964 through July 1966.

An analysis of the data collected shows the following pattern of winds in the equatorial upper atmosphere. In the stratosphere, the wind flow is predominantly easterly. However, westerlies are observed above 25-30 km in April and October-November. In the mesosphere westerlies become more frequent and are noticeable not only in the above months but also in February through April. The transition to this pattern from the middle latitude wind regime seems to take place gradually in the subtropics.

From a study of the wind shears over Thumba, as well as from radar observations of the spread of chaff, it is noticed that during certain periods a region of high shears and pronounced turbulence manifests itself above 50 km.

Further, from chaff dispersion studies, it has been possible to make a preliminary estimate of the diffusion coefficient in the stratosphere and mesosphere. - Author's abstract.

196. Saxena, S. P., and Seshadri, V. R. Strong surface winds at Ahmedabad airfield. Indian Journal of Meteorology & Geophysics, Delhi, 18(1): 136-137, January 1967. DAS M(05) I39i.

Source No. 196 continued

...Discusses the statistical features of strong winds ($\geq$ 38 kph) at Ahmedabad airport based on data for the period 1957-1961. The discussion includes information on monthly frequency, direction and maximum speed, and time of occurrence of strong winds.

197. Sharma, K. K. Gustiness and temperature at Nagpur. Indian Journal of Meteorology & Geophysics, 18(1): 79-90. Delhi, January 1967. DAS M(05) I39i.

...Ten years autographic records of wind and temperature have been utilised for the present study. The seasonal and diurnal variations of mean wind speed, average range of gusts and gustiness along with the temperature variations have been worked out.

The influence of diurnal ground temperature variations on gustiness has also been brought out. - Author's abstract.

198. Srinivasan, T. R., and Narayanan, S. Rainfall in relation to lower and upper tropospheric winds and temperatures over Madras during southwest monsoon season. Indian Journal of Meteorology & Geophysics, Delhi, 18(1). 130-133, January 1967. DAS M(05) I39i.

...Is a study on the relation between the upper winds and temperature over Madras at different standard isobaric levels and the rainfall during the subsequent 24-hour period over the same place during the southwest monsoon period.

199. Walker, J. M. Some ideas on winter atmospheric processes over south-west Asia. Meteorological Magazine, 96(1139): 161-167, June 1967. DAS M(05) G786m.

...This paper discusses the weather and climate of south-west Asia in relation to the subtropical jet stream and polar front jet streams over the region.

It is found that the mean position of the axis of, and the circulations associated with, the subtropical jet stream are consistent with the observed precipitation and trade cumulus distributions.

A case study has suggested that cumulonimbus clouds were released by orographic lifting of potentially unstable south-westerly airflows along the coasts of Persia and Pakistan and at the foothills of the Himalayas, and that the cumulonimbus clouds were accompanied by jet streams near the 300-mb level. The jet streams over Pakistan and India contained air which has ascended undiluted from the trade-wind layer over the Arabian Sea whilst the jet over the Persian coast probably also contained trade-wind air which had however been modified by rather deep small-scale convection over southern Arabia. - Author's abstract.

200. Wright, P. B. Changes in 200 mb circulation patterns related to the development of the Indian south-west monsoon. Meteorological magazine, London, 96(1143): 302-315, October 1967. DAS M(05) G786m.

...The upper tropospheric circulation pattern over India from April to June is discussed, and it shown that sudden changes occur. The advance of the south-west monsoon up to the west coast of India is shown to be closely related to these changes, and also to the strength of the lower tropospheric westerly flow over the Indian Ocean.

A mechanism is suggested to explain the observed changes in the upper flow, and how they influence the progress of the south-west monsoon. - Author's abstract.

1968

201. Dekate, M. V. Climatological study of sea and land breezes over Bombay. Indian Journal of Meteorology and Geophysics, Delhi, 19(4): 421-426, October 1968. DAS M(05) I39i.

...In the present study, the various aspects of the local winds at Santacruz - sea and land breezes - their frequency, times of onset, accompanying temperature drop, and changes in relative humidity have been statistically analysed. The mean monthly surface and upper winds up to 2.1 km have also been studied, and the results are discussed. - Author's abstract.

202. Gupta, M. G. A case study of the westerly jet over Trivandrum. Indian Journal of Meteorology and Geophysics, Delhi, 19(1): 65-72, January 1968. DAS M(05) I39i.

...A study has been of the formation of a cut-off low in a westerly trough at 500 mb near Trivandrum, with an associated westerly jet over it, during the period 11 to 13 December 1958. In addition to this localised jet over Trivandrum, there were also two other jets over the country. - Author's abstract.

203. Keshava Murty, R. N. On the maintenance of the mean zonal motion in the Indian summer monsoon. Monthly Weather Review, 96(1): 23-31, January 1968. DAS M(05) U587m.

...The maintenance of the westerlies in the lower troposphere and the easterlies in the upper troposphere in the Indian southwest monsoon is studied by considering the angular momentum balance in the region. The main source term for the zonal angular momentum is the Coriolis or the $\bar{\Omega}$-transport term. This term contributes enough to maintain the lower tropospheric westerlies against friction. The zonal pressure gradient term and the mountain torque are of a smaller magnitude. The flux divergence at the boundaries is small in the lower troposphere; it is large in the upper troposphere and serves to export the easterly momentum produced in the region.

Source No. 203 continued

Thus, it is concluded that the mean meridional circulation (which is direct) mainly contributes to the maintenance of the mean zonal motion. Actually there is divergence of eddy flux of momentum from the region of maximum zonal winds. The mean meridional circulation releases kinetic energy of the same order of magnitude as the release by the winter meridional cell over an equal area. - Author's abstract.

204. Ramamurthi, K. M. On the role of the perturbations of the southwest monsoon in relation to high level east wind maxima over India. Indian Journal of Meteorology and Geophysics, Delhi, 19(3): 347-349, July 1968. DAS M(05) I39i.

...The perturbations of the strong monsoon extending their effects to great heights can be viewed as the cause of (1) the higher topography of the east wind maximum around 18° - 19°N and its sloping down both to the north and the south and (2) the occurrence of two maxima in easterlies 10-15 degrees latitude apart at the 200-mb level.

205. Sajnani, P. P. Divergence, vorticity and vertical motion in the fields of winter and monsoon circulations over India. Indian Journal of Meteorology & Geophysics, Delhi, 19(4): 391-394, October 1968. DAS M(05) I39i.

...Using upper wind data of 69 pilot balloon and rawin stations in India, Pakistan, Burma, and Ceylon, multi-level fields of divergence, vorticity, and vertical motion have been computed on five consecutive days in the months of January and July 1958 to study the winter and monsoon circulations over the Indian region. Computations have been made at 37 grid points 2.5 degrees apart, with the help of a digital computer. A filtering technique was used to smooth the observed winds so as to filter out noise.

The study provides a convenient method of computing divergence directly from observed winds instead of doing so indirectly through the vorticity equation. The computed values of divergence and vorticity show that the two are of comparable magnitude. Examination of the divergence fields does not reveal narrow bands of convergence, characteristic of well-defined frontal systems. The distribution of vertical velocities in the monsoon field indicates the existence of a source region over the eastern half of India and a sink over the western half. - Author's abstract.

206. Sharma, B. L., and Sehgal, U. N. Study of extreme winds over North India. Indian Journal of Meteorology and Geophysics, Delhi, 19(3): 319-322, July 1968. DAS M(05) I39i.

...Attempt has been made to develop maps for estimation of extreme wind and maximum mean hourly wind speed for different return periods north of 20°N over India. The procedure for obtaining information about extreme winds has been made simple for the convenience of design

Source No. 206 continued

engineers engaged in designing buildings and other engineering structures on which calculation of wind pressure, offered by extreme winds, is needed. - Authors' abstract.

1969

207. Ananthakrishnan, R., and Ramakrishnan, A. R. Fluctuations in the upper tropospheric easterlies over India during the southwest monsoon season. Poona, India, Institute of Tropical Meteorology, Scientific Report, No. 102, 1969. 27 pp.

...On the basis of climatological and synoptic evidence, Raman and Ramanathan claim that a pronounced strengthening of the upper tropospheric zonal easterlies over the Indian Peninsula occurs immediately to the south of an area with significant rainfall. Miller and Kesavamurthy support this and have stated that they found large rises of temperature in the upper troposphere over Bombay and Ahmedabad in association with heavy rainfall over these stations. These findings are reexamined critically on the basis of climatological data relating to rainfall and upper winds as well as utilizing the daily synoptic rainfall and upper air data for the monsoon months of July and Aug. for the years 1961-1967. The subjective nature of the synoptic study of Raman and Ramanathan is emphasized, and an objective method was adopted to examine their claim. Positive and negative changes in the wind field of comparative magnitudes occur with and without rainfall. Therefore, the claim of Raman and Ramanathan cannot be substantiated and no significant correlation exists between rainfall and strengthening of the upper tropospheric zonal easterlies on the next day. A critical study was made on the basis of daily radiosonde data of Bombay-Ahmedabad for July 1963, and Bombay for July-Aug. 1968, to see whether any significant rise in temperature occurs in the upper troposphere in association with rainfall. Positive and negative changes in temperature of comparable magnitudes occur with and without rainfall. Therefore, the observational data do not lend any support to the claim of Miller and Kesamurthy. - MGA 22.7-335.

208. Dekate, M. V. A note on an objective study of sea-breeze over Bombay. Indian Journal of Meteorology and Geophysics, Delhi, 20(3): 297-299, July 1969. DAS M(05) I38i.

...This study, based on data for the period 1961-1964, was made to find the correlation between the phenomena of sea breeze with various meteorological parameters before and after the occurrence of sea breeze for the purpose of developing objective methods of forecasting the occurrence of sea breeze and resultant changes in the surface parameters.

209. Mokashi, R. Y. A study of vertical wind profile of the westerly jet stream over Delhi, using radar wind data. Indian Journal of Meteorology and Geophysics, Delhi, 20(4): 361-368, October 1969. DAS M(05) I39i.

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...Radar wind observations for the months December to February (winter season) during three consecutive years (1963-1966) have been utilised to study the vertical wind profile of the sub-tropical westerly jet stream over Delhi and the observed features have been discussed. The main finding is that the stronger the sub-tropical westerly jet stream, the lower is the altitude of maximum wind. - Author's abstract.

210. Narayanan, V., and Krishnamurthy, G. A note on post sunset sea breeze and associated angel echoes at Bombay airport. Indian Journal of Meteorology and Geophysics, Delhi, 20(4): 401-403, October 1969. DAS M(05) I39i.

...Instances of post sunset sea breeze at Santacruz during the winter season based on data from autographic charts for the period 1960-1965 are caused primarily by the opposing gradient flow which has a strong tendency to drive against the sea breeze.

211. Rai Sircar, N. C.; Jayaraman, S.; Srinivasan, T. R. A study of wind distribution and associated dry or wet weather probability over Madras during monsoon and post-monsoon months. Indian Journal of Meteorology and Geophysics, Delhi, 20(3): 267-270, July 1969. DAS M(05) I39i.

...In this paper, a detailed analysis has been made of the frequency of wind vectors at surface, 850-, and 300-mb levels over Madras (Meenambakkam) for the monsoon and post-monsoon months during the eight-year period 1956-63. The relationship between the various wind vectors and the impending dry or wet weather spells for the next 12 hours has also been examined. The results are presented in the form of 'roses' which may be of some use to a forecaster in connection with prediction of dry or wet weather during the next 12 hours on the basis of the prevailing winds. - Authors' abstract.

212. Raja Rao, K. S., and Joseph, K. T. Stratospheric and lower mesospheric wind systems in the equatorial region. Indian Journal of Meteorology and Geophysics, Delhi, 20(3): 213-220, July 1969. DAS M(05) I39i.

...Rocket wind data from 25 firings over Thumba (India) have been used in conjunction with similar data from other low-latitude stations like Ascension Island, Colon (Panama), Natal (Brazil), Barking Sands (Hawaii), and Sonmiani (Pakistan). Behaviour of the stratospheric and mesospheric winds seasonally, in the equatorial region and outside it, has been studied. A strong easterly jet is detected over the equatorial stations in January, with core winds varying from 35 to 60 mps and heights varying from 42 to 50 km. From a synoptic study of the rocket wind data pertaining to 17 March 1965 over Thumba, Ascension Island, U. S. Navy ship Croatan at 13°S, 78°W, Barking Sands, and Sonmiani, it is inferred that in the equinoctial month of March, the stratospheric wind speed increases with proximity to the equator, with the region of maximum wind speed to the south of the equator; but in the mesosphere the region of maximum wind is to the north of the equator. Jet stream

in the troposphere (both easterly and westerly) in the Indian region, has been studied in relation to the stratospheric winds over Thumba and Sonmiani and found that there is no obvious relation between the tropospheric jets and the stratospheric wind system. Lack of correlation between the zonal(and also meridional) wind speeds in the stratosphere and the ozone content above the station indicates that ozone mixing may be taking place mainly in the vertical. Vertical wind shears have been computed for rocket flights over Thumba and Sonmiani, and their plots against height reveal that turbulence is larger over Thumba than over Sonmiani. In the equatorial region, there is considerable wind shear in the equinoctial months, which decrease in winter when there is a peak shear in the mesosphere near 52 km. Outside the equatorial region, there is very little seasonal variation in the wind shear, either in the stratosphere or in the mesosphere. The rocket wind data of Thumba do not indicate oppositely directed winds at each level from one year to the next, as is shown by the data of Kwajalein. It is, therefore, inferred that the amplitude of the quasi-biennial wave is greater over Kwajalein than over Thumba, contrary to expectation. - Authors' abstract.

213. Sadler, James C. Mean circulation and cloudiness during the development of the southwest monsoon over India and southeast Asia. Conference on the **Summer Monsoon of Southeast Asia conducted 7-9 April** 1969 at Department of Geosciences, University of Hawaii, Proceedings. Edited by Colin S. Ramage. U. S. Navy Weather Research Facility, Norfolk, Virginia, September 1969. pp. 13-19. DAS M53.21 C7h8pr.

...For the months of April, May, June, and July, updated long-term monthly mean wind climatology at standard pressure levels is discussed in relation to detailed cloud climatology prepared from 3 years of satellite data. A deep tropical southwesterly current flows into southern Burma in May and brings the monsoon rains to Rangoon a month earlier than at the same **latitude** on the west coast of India, which in May is still dominated by a strong anticyclonic cell in the subtropical ridge. The rains over southern South Vietnam, which are persistent from the first of May, occur within a mean May southeasterly flow such that the onset of the southwesterly monsoon over Saigon cannot be determined from a rainfall analysis alone. - Author's abstract.

214. Swaminathan, D. R. Large scale convection over central parts of India in relation to 'sub tropical jet stream wave'. Indian Journal of Meteorology and Geophysics, Delhi, 20(3): 247-252, July 1969. DAS M(05) I39i.

...Large-scale convection over central parts of India during 17-19 February 1962 was found to be associated with strong upper tropospheric divergence in a sinusoidal type of 'Sub-Tropical Jet Stream Wave', augmented by the southeastward movement of 'Jet Maximum' from central India to coastal Andhra Pradesh. Mean sea-level situations or lower

tropospheric flow patterns alone did not give conclusive or significant clue to subsequent large-scale convective developments. - Author's abstract.

1970

215. **Ananthakrishnan, R., and Keshavamurthy, R. N.** On some aspects of the fluctuations in the pressure and wind fields over India during the winter and monsoon season. Symposium on Tropical Meteorology, June 2 - 11, 1970, University of Hawaii, Honolulu, Hawaii, Proceedings. pp. L III-1 to L III-5. August 1970. DAS M S989pr.

...The method of power spectrum analysis has been used in recent years to study periodicities in the fluctuations of wind and pressure fields over the tropics. In this paper the results of the application of power spectrum analysis to wind, pressure and rainfall at New Delhi, Nagpur, and Trivandrum for the years 1965 and 1967 are presented.

216. Ananthakrishnan, R. Reversal of pressure gradients and wind circulation across India and the southwest monsoon. Royal Meteorological Society, Quarterly Journal, 96(409): 539-542, July 1970. DAS M(05) R888q.

...This paper describes some features of the climatology of the free atmosphere over India which are related to the onset and withdrawal of the monsoon. - Author's abstract.

217. Banerji, S.; Rao, D. V. L. N.; Kundra, M. D. On objective assessment of convergence and precipitation by dynamic trajectory method. Indian Journal of Meteorology and Geophysics, Delhi, 21(1): 59-64, January 1970. DAS M(05) I39i.

...Dynamic trajectories are drawn for intervals of three hours by means of arc-strike technique developed by Good-year and later by Peterson and others. The wind field required for this purpose is obtained on the basis of streamline analysis at 0.6-km level, while the geostrophic winds have been evaluated from the sea-level charts. **A fairly accurate idea of areas of low-level convergence can be had** with the help of these trajectories.

An estimation of moisture inflow into the convergence area is made by the use of an empirical relation involving the computation of precipitable water and average wind-speed normal to the line of maximum curvature. In order to reduce time on computations, they were done on polar coordinates, and a nomogram was also prepared for different latitudes for direct application on the polar diagram.

The results obtained in a few cases are presented here, which show that some improvements is obtainable by using the streamline analysis,

particularly in view of the sparse aerological network. - Authors' abstract.

218. George, C. A. Interaction between lower and upper tropical tropospheres during the southwest monsoon over India. Indian Journal of Meteorology and Geophysics, Delhi, 21(3): 401-414, July 1970. DAS M(05) I39i.

...Raman and Ramanathan's suggestion that latent heat released by "excessive cloudiness and copious precipitation" speeds up upper tropospheric winds over the west coast of India during the southwest monsoon is not borne out by observational evidence. Their proposition is shown to support rather than contradict Koteswaram's hypothesis regarding upper tropospheric easterlies and the southwest monsoon activity along the west coast of India. The influence of these easterlies on the onset of monsoon over Kerala is illustrated for the year 1961-68. - Author's abstract.

219. Mokashi, R. Y. A study of vertical wind profile of the tropical easterly jet stream over Madras. Indian Journal of Meteorology and Geophysics, Delhi, 21(3): 415-420, July 1970. DAS M(05) I39i.

...Rawin observations for the months June to September during five consecutive years (1961-65) have been analysed to study the vertical wind profile of the tropical easterly jet stream over Madras, Visakhapatnam, and Trivandrum. The main finding is that the stronger the tropical easterly jet stream, the higher is the altitude of maximum wind. This is just the opposite of the author's earlier finding in the case of sub-tropical westerly jet stream where the stronger the jet maximum the lower is its level of occurrence. It is also seen that the tropical easterly jet strengthens as one moves towards south from Visakhapatnam to Trivandrum while level of occurrence lowers. - Author's abstract.

220. Ramachandran, S. Analogue simulation of anemometers. Indian Journal of Meteorology and Geophysics, Delhi, 21(1): 53-58, January 1970. DAS M(05) I39i.

...The differential equation for cup and vane anemometers was set up on analogue computers and the responses of the instruments studied for sinusoidal and random types of wind speed variation. The effects of both static and dynamic friction have been taken into account. The results show a large exaggeration of mean indicated wind speeds, a large attenuation in the gust amplitudes, and a distortion in gust shapes. - Author's abstract.

221. Rao, Y. P., and Desai, B. N. The Indian summer monsoon. Symposium on Tropical Meteorology, June 2-11, 1970, University of Hawaii, Honolulu, Proceedings. pp. J V-1 to J V-6. Editorial Branch of the Hawaii Institute of Geophysics, August 1970. DAS M S989p.

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...Discusses the important aspects of the Indian monsoon circulation and considers the causes responsible for its performance over the subcontinent from the rainfall point of view. The climatology of the summer monsoon season, the burst of the monsoon, the monsoon rains, the monsoon depression, Thar Desert, variability of monsoon rainfall, origin of the southwesterly to westerly moist current over the Arabian Sea, and the monsoon circulation cell are the topics discussed in this paper.

222. Rao, Y. P., and Desai, B. N. Remarks on the nature and origin of the low-level jet off Somalia and over the Indian Peninsula during the southwest monsoon. Indian Journal of Meteorology and Geophysics, Delhi, 21(4): 651-653, October 1970. DAS M(05) I39i.

...The low-level jet off Somalia and over the Indian Peninsula which is associated with good rainfall on the west coast does not appear to be due to thermal causes. The low-level jet current is a continuation of the southerly jet current which originates in the southern hemisphere.

223. Sikka, D. R., and Ramanathan, Y. Some experiments in the objective analysis of the wind-field over India and neighbourhood. Indian Journal of Meteorology and Geophysics, Delhi, 21(2): 237-244, April 1970. DAS M(05) I39i.

...As a first step towards preparing input of wind observations for numerical weather prediction work in the Indian region, objective analysis of the wind-field has been made on a number of maps using a variation of Cressman's Scheme. The programme was executed on the CDC 3600 computer adopting a (53 X 17) grid in the region between 20° to 150°E and the equator to 40°N. The stream line patterns obtained by objective analysis for three maps are compared against conventional analyses. Vorticity patterns using the wind obtained from the objective analysis are presented. Root mean square error of the analysed winds, with reference to the station observations, is found to be about 8 kt. The stream function patterns, as well as 500-mb 24-hour forecast based on non-divergent barotropic model with the objective and the subjective wind analysis as inputs, do not show any synoptically significant differences. - Authors' abstract.

224. Vittal Sarma, V. A simple method of evaluating vertical velocity over small areas for forecasting heavy rainfall. Indian Journal of Meteorology and Geophysics, Delhi, 21(1): 87-92, January 1970. DAS M(05) I39i.

...Vertical motion is an important parameter in any study of the atmospheric process. Evaluation of this parameter from derived values of divergence and vorticity involve elaborate calculations. A simple and quick method by adapting the vorticity equation in a

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simplified form has been attempted in the present study. The method has been applied to a small area formed by four pibal stations in Gujarat. Vertical velocity for six layers between surface and 700 mb were calculated. With these values, rainfall over the area was also computed and compared with the actual observed rainfall. The results are compared and discussed. - Author's abstract.

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