

## General Circulation of Basic Atmospheric Parameters over a Low Latitude Station (Hyderabad)

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**Abstract:** The wind and temperature data collected from the Radiosonde over Hyderabad (17.2°N, 78.20E) for the years 2010 and 2011 have been consolidated. The results in the form of monthly mean values provide reliable reference wind profiles and temperatures profiles for tropospheric and stratospheric heights up to 40km. The zonal and meridional Wind profiles as well as temperature profiles are calculated and presented in graphical forms. A change in wind direction and velocity has been noticed in zonal wind. Investigation in the dynamics of the lower atmosphere would be helpful in better planning for Aerodynamic Technology.

**Keywords:** Meridional Wind, Radiosonde, Stratosphere, Temperature Troposphere, Zonal Wind.

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### I. Introduction

The atmosphere of the earth is divided in to different layers depending upon temperatures behavior in the atmosphere. The five main layers from lowest to highest altitude are

- (i) Troposphere : 0 to 12km
- (ii) Stratosphere : 12 to 50km
- (iii) Mesosphere : 50 to 80km
- (iv) Thermosphere :80 to 700km
- (v) Exosphere : 700 to 10,000km

The troposphere and stratosphere have been of considerable interest both in understanding the dynamics of lower atmosphere and providing upper wind data for several purposes<sup>1</sup>. The aim of this paper is to study the atmosphere parameters at low latitude station of Hyderabad (17.2°N, 78.2E).

The wind velocity and temperature are significant parameters of the atmosphere. Wind is further divided into three components. They are:

- i. Zonal wind with the horizontal wind component towards east.
- ii. Meridional wind with the horizontal wind component towards north.
- iii. Vertical wind which is typically positive for upward direction.

The temperature in the atmosphere varies with altitude in troposphere. It decreases from 0 to 18km altitude. Where as in stratosphere it increases from 18km to 50km altitude. This turn around of temperature takes place in a region known as tropopause.

### II. Method Of Analysis

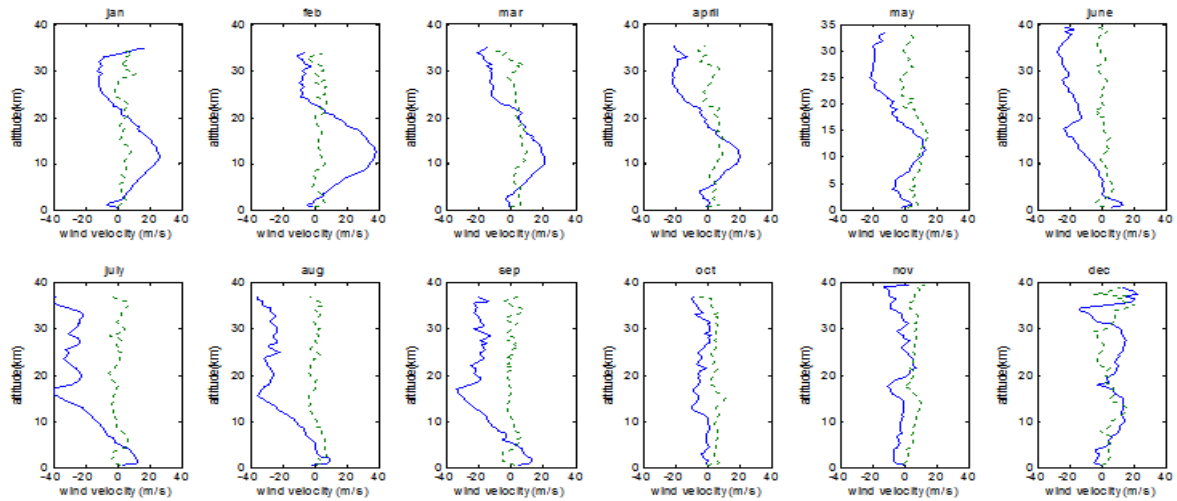
The Radiosonde<sup>4</sup> data consists of the values recorded for range elevation and azimuth of the balloon<sup>2</sup> at 1-min interval of time . These data , from January 2010 to December 2011, is used to study the wind velocity components from 0.5km to 36km altitude. To calculate the model wind profiles, the following method is adopted.

- i. The height profiles given by balloons launched every day at 00Z and 12Z GMT are averaged to obtain series of monthly mean profiles.
- ii. The average values for data gaps during the period from January 2010 to December 2011, of 24 months, have been obtained by linear interpolation method.
- iii. Model wind profiles for each month are obtained by averaging all profiles in a particular month for the two years. These are called multiannual values of wind for each month.
- iv. The calculated model wind profiles have been compared with CIRA 1980 model for latitude 20° N which is closest available to Hyderabad latitude and it is earlier reported by Gopa Dutta et al<sup>9</sup>.

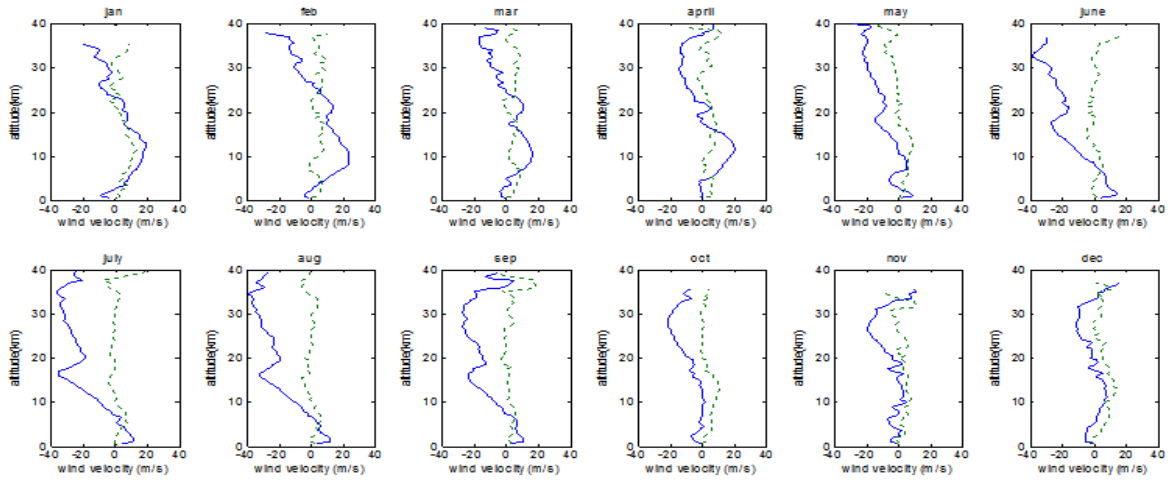
### General features of circulation

The figs.1 and 2 show both zonal and meridional components as solid and dash lines respectively. Fig 3 shows the mean wind profile for years 2010 and 2011. Positive values of the wind denote westerlies whereas

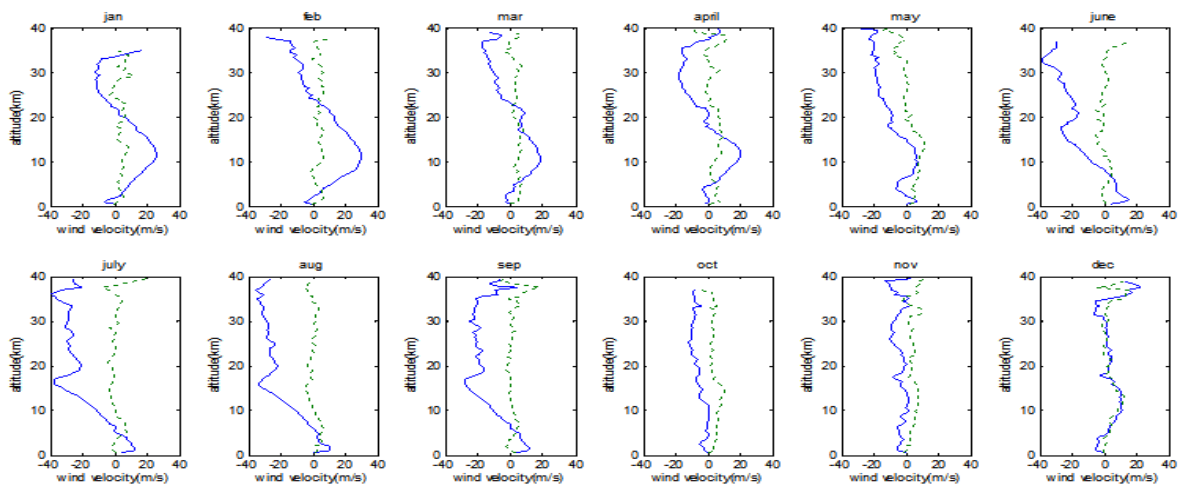
negative values represent easterlies for zonal wind case. Positive and negative values for meridional wind indicate southerly and northerly. The monthly mean magnitude of wind velocity is illustrated in table: 1.



**Figure1: Zonal and meridional wind velocity for year 2010 (solid line: zonal; dashed line:meridional)**



**Figure2: Zonal and meridional wind velocity for year 2011 (solid line: zonal; dashed line:meridional)**



**Figure 3: Zonal and meridional mean wind velocity for the years 2010 and 2011 (solid line: zonal; dashed line:meridional)**

**Table1: Maximum zonal and meridional wind velocity with respective to height**

Month	Maximum zonal velocity(ms <sup>-1</sup> )	Altitude(km)	Maximum meridional velocity(ms <sup>-1</sup> )	Altitude(km)
January	26.08	11.5	9.04	13
February	30.06	11	6	16.5
March	18.6	11	7.85	17
April	20.28	11.5	9.16	15.5
May	-11.05	18.5	10	12
June	-26.57	17	3.09	11
July	-37.84	16.5	6.87	5
August	-33.08	15.5	6.50	6
September	-28.06	16	5.48	7
October	-11.93	20.5	10.25	14.5
November	-8.22	17.5	7.81	13
December	11.17	10	12.49	12.5

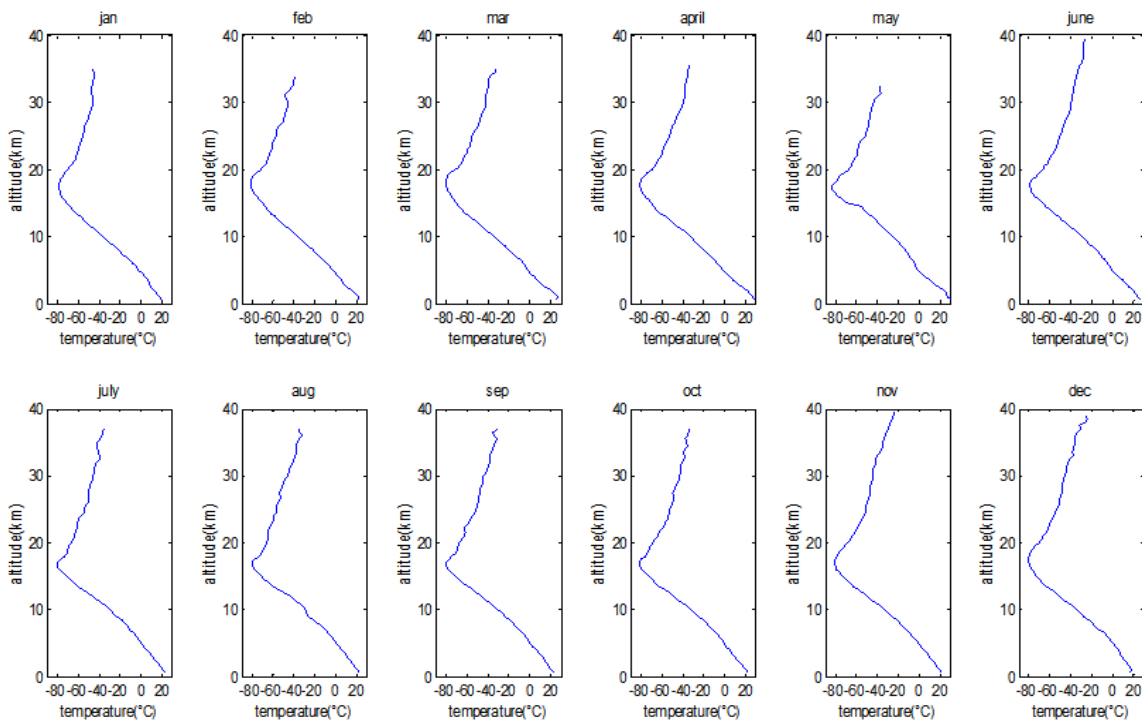
From the above table, it is observed that zonal wind circulation in troposphere over Hyderabad has an annual cycle. Westerlies prevail for seven months i.e from May to November and easterlies dominate the remaining period during both the years.

Troposphere jets are seen between 10km and 20km with zonal wind velocity reaching up to 35ms<sup>-1</sup>. Between 1 to 7kms easterlies are observed<sup>4</sup> more frequently. Whereas in stratosphere region which is between 20 to 40km the zonal wind circulation over low latitude is predominately of easterlies throughout the year. This has been earlier reported by Gopa Dutta et al<sup>5</sup>, up to altitude of 36km using data from 1984 to 1994 and Gohale et al<sup>3</sup>, up to the altitude 30km using the data from 1956 to 1964. Kumar and Nagpal<sup>2</sup> also reported similar features using data for the period 1977-1983. The magnitude of the wind velocity is found to decrease by a factor of two-thirds during winter months as compared to monsoon months.

Meridional wind velocity in the upper troposphere i.e from 5km to 17km appears to be predominantly southerly with an average maximum speed of 8ms<sup>-1</sup> near troposphere jet region. Above 17km, the circulation turns into northerly from 20km to 40km altitude. But in the troposphere, below 5km, meridional wind velocity appears to be mostly northerly.

**Temperature features**

In troposphere, temperature decreases gradually with a lapse rate of 6.4 °c/km from surface of the earth to tropopause. The minimum temperature is found to be ~ -81°C between 17km to 18km altitude. Above 18km in the stratosphere, temperature increases gradually up to 40km. The altitude for minimum temperature is same for all months as illustrated in the figs.4, 5 and 6.



**Figure 4 Temperature for the year 2010**

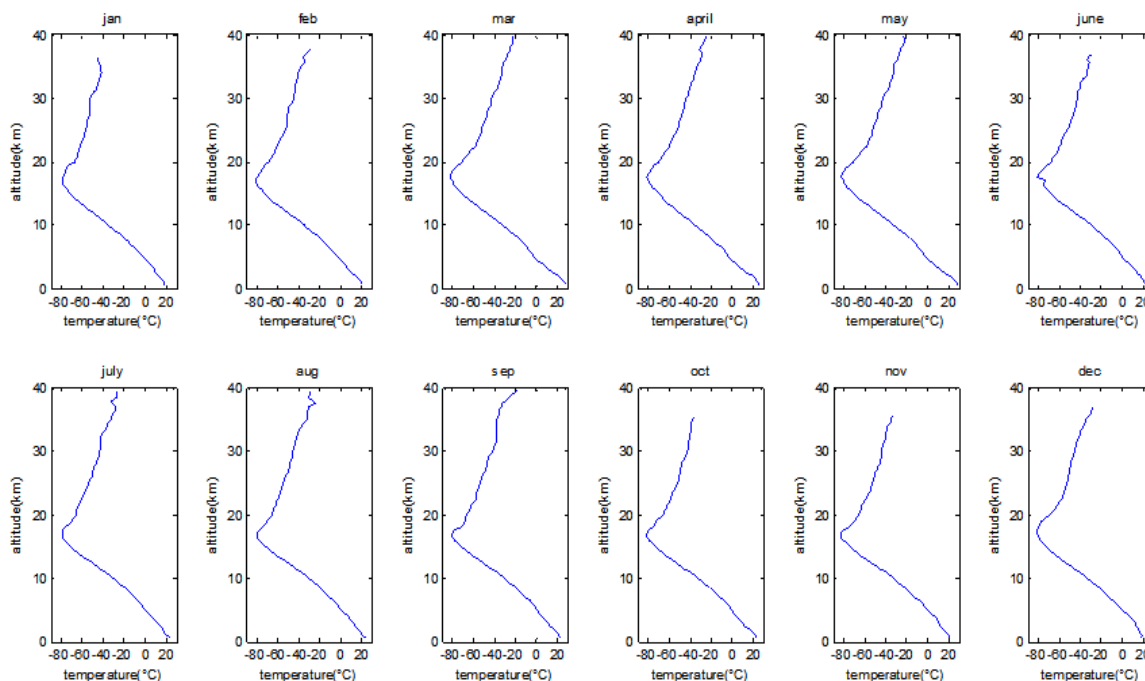


Figure 5 Temperature for the year 2011

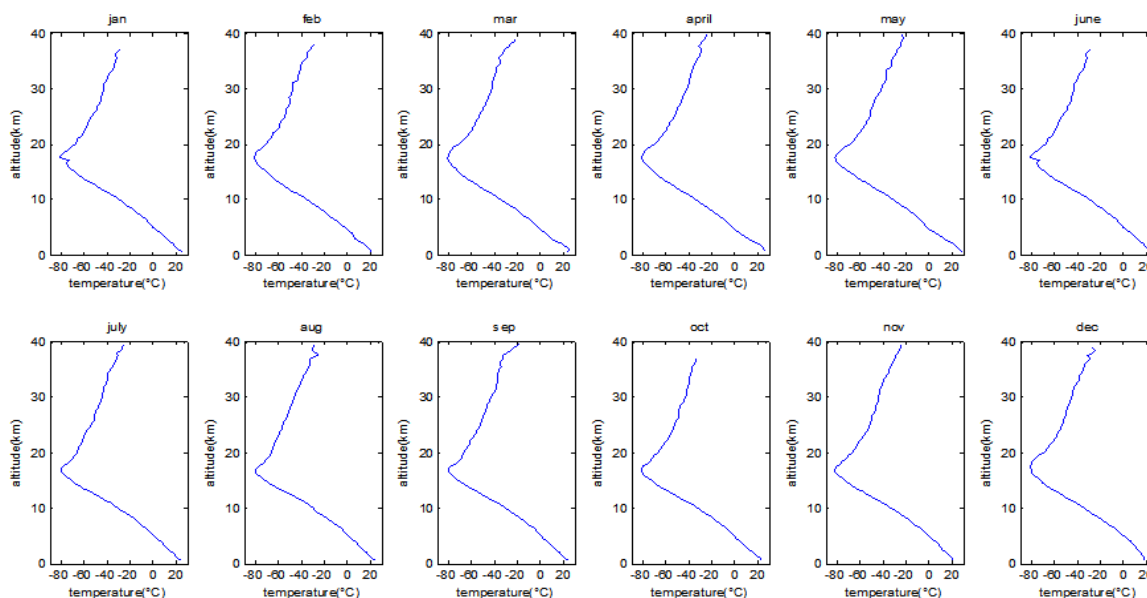


Figure 6 Mean Temperature for years 2010 and 2011

### III. Summary And Conclusion

The main features of wind and temperature characteristics, brought out in this study, are as follows

- i. **Atmospheric circulation in troposphere:** The zonal components below 20km are found to be westerlies from May to November each year and turns into easterlies for the remaining months at all times. The jets velocities as high as  $35 \text{ ms}^{-1}$  are observed between 12km and 18km altitude. The meridonal components between 10km to 20km altitude are found to be southerly with jet velocity of  $8\text{ms}^{-1}$  near the tropopause level.
- ii. **Atmospheric circulation in stratosphere:** The study has found that the zonal wind remains easterlies throughout the year. It is also observed that the meridonal wind remains northerly throughout the year.
- iii. **Temperature in troposphere and stratosphere:** The minimum temperature is found to be  $\sim -81^{\circ}\text{C}$  between 17km to 18km altitude. This means that troposphere, at low latitude, is extended up to 18km altitude. Above 18km, the temperature starts increasing in stratosphere up to 40km altitude.

It is thus inferred that this study of wind and temperature profiles would form the basis of further investigation in the dynamics of lower atmosphere and would also be helpful in further developing Aerodynamics Technology.

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