UPGRADATION OF INDIAN RADIOSONDE NETWORK: PERFORMANCE & FUTURE PLANS.

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ABSTRACT

India Meteorological Department (IMD) is operating a network of 39 Radiosonde/Radiowind stations on operational basis. IMD is in the process of modernization and has adopted a strategy to replace the obsolete systems. To achieve the standards of data quality required by the Numerical weather Prediction (NWP) centers, various aspects of modernization including upgradation of observing system and transmission of data to central data centre in real time have been planned covering representativeness, accuracy of observations, achieved heights & timeliness. In the first phase of modernization, ten stations have been upgraded with new GPS based Upper air systems in 2009. After the introduction of new systems, data quality has improved substantially at these stations, which has been validated by ECMWF. To further upgrade the network another 14 stations of the network have been planned to be upgraded in 2010. Further GPS radiosonde along with 1680 MHz ground system, acquisition & processing software has also been developed indigenously. It is also being planned to upgrade all the remaining stations of the network in the next phase of modernization to ensure operational performance and data quality. This paper describes the upgradation & future plans of Indian radiosonde network.

1. Introduction

India Meteorological Department (IMD) is operating a network of 39 Radiosonde/Radiowind stations including 2 stations for radiosonde data only, twice a day on operational basis as shown in Fig 1.

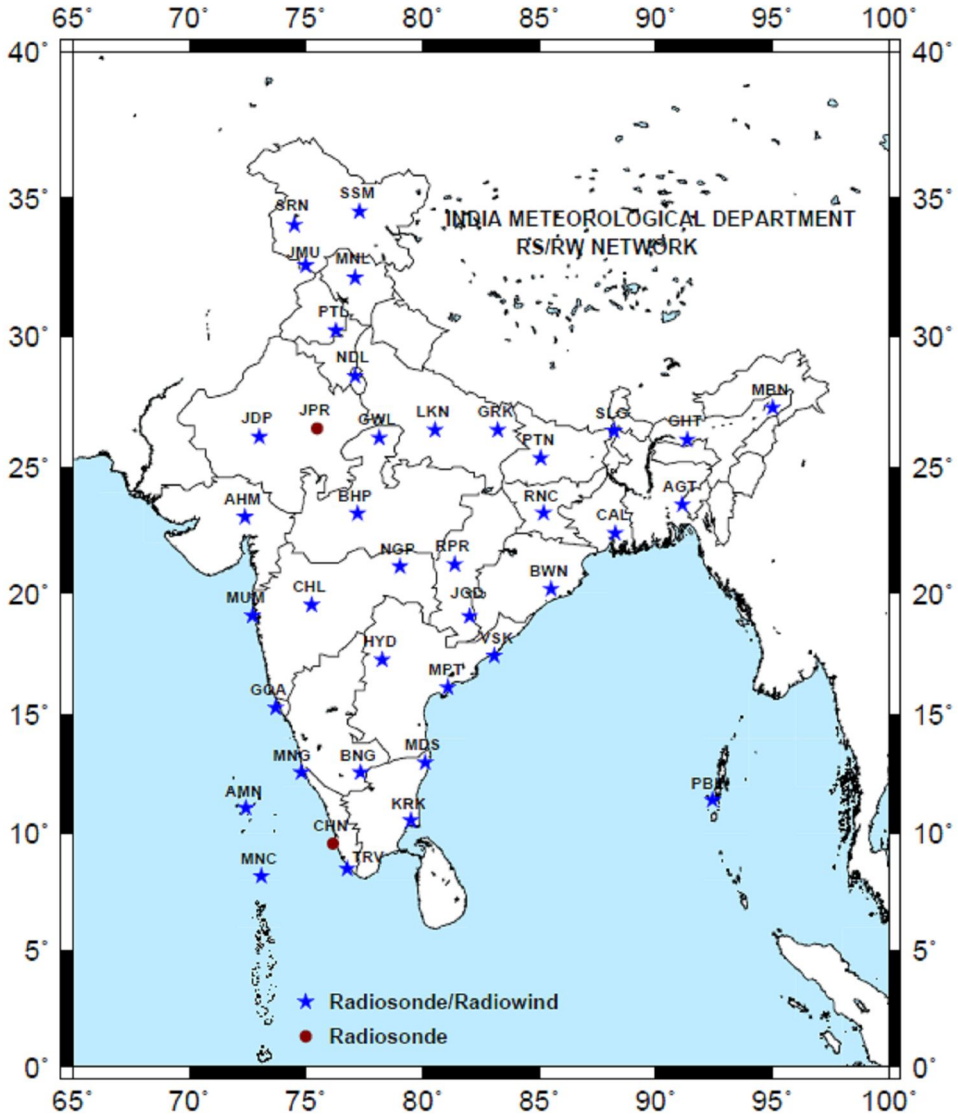


Fig 1: RS/RW Network of India Meteorological Department (IMD)

Upper air data of IMD network was doubted for many years by leading Numerical weather Prediction (NWP) centers of the world and observations were rejected by data assimilation systems. IMD is undergoing modernization and has adopted a strategy to replace the obsolete systems. To achieve the standards of data quality required by the Numerical weather Prediction (NWP) centers, various aspects of modernization including upgradation of observing system and transmission of data to central data centre in real time have been planned covering representativeness, accuracy of observations, achieved heights & timeliness.

2. Recent Developments

In recent years, the Upper Air Radiosounding System based on Global Positioning System (GPS) is used as an effective method resulting to improved

observation accuracy and allowing simplification of ground equipment. Accordingly, in the first phase of modernization, ten stations have been upgraded with new GPS based Upper air systems in 2009. After the introduction of new systems, data quality has improved substantially at these stations, which has been validated by ECMWF. Recently another GPS system has been installed at New Delhi to facilitate the nowcasting during Commonwealth Games in October'2010.

At present the network comprised of GPS system at 11 places, 10 IMS-1500 Radiotheodolites installed in 2002 & at remaining stations Ground System of indigenous make installed in 1992-93. Details of Ground systems used in IMD upper air network are shown in Fig 2.

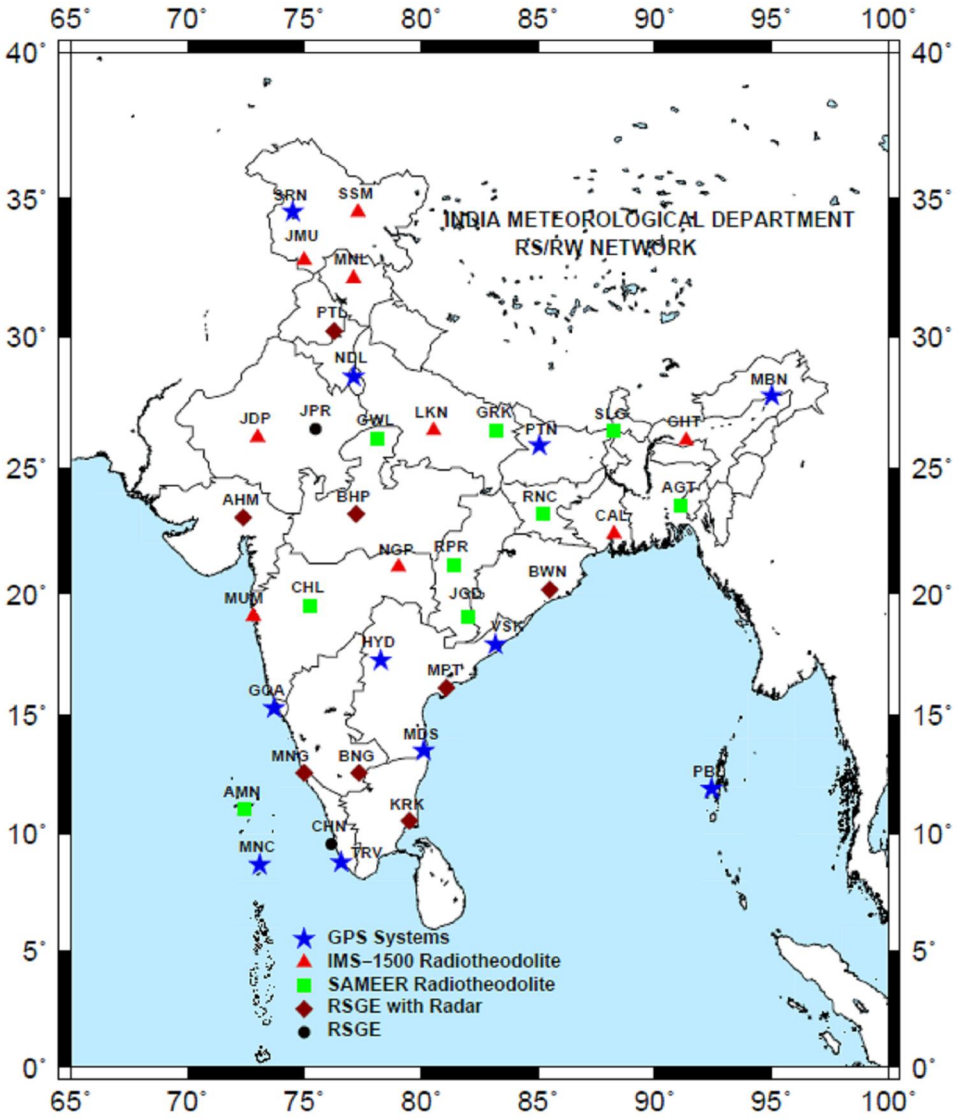


Fig 2: Ground System under RS/RW Network.

3. Performance Analysis

Performance evaluation of the RS/RW observation is a multidimensional concept covering various aspects of the operation quality, accuracy of observations, achieved heights, completeness, timeliness, proper reporting, archiving etc (Kats et al. 2008). But First Guess field is used as the primary reference

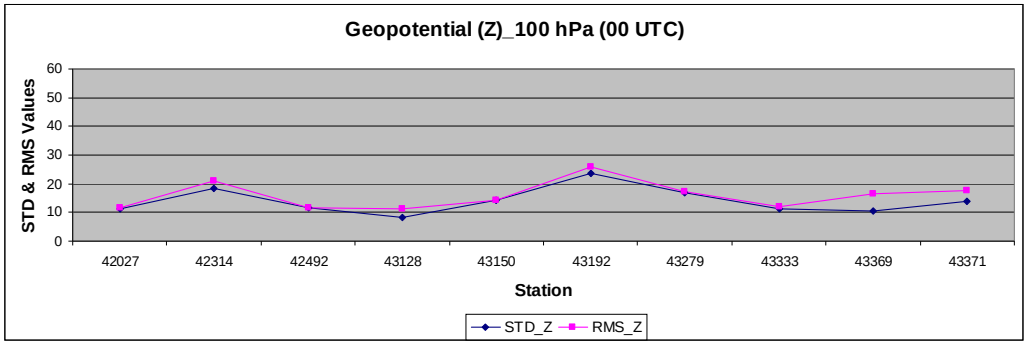
(Hollingsworth et al. 1986) and it is necessary to compare monitoring results with ECMWF and other NWP centers. After the installation of GPS systems, data was monitored with the ECMWF global data monitoring reports to get the overview of the quality of observations. Data of these stations is not reported as suspect stations under any category since June'2009 in ECMWF's Monthly Monitoring Reports.

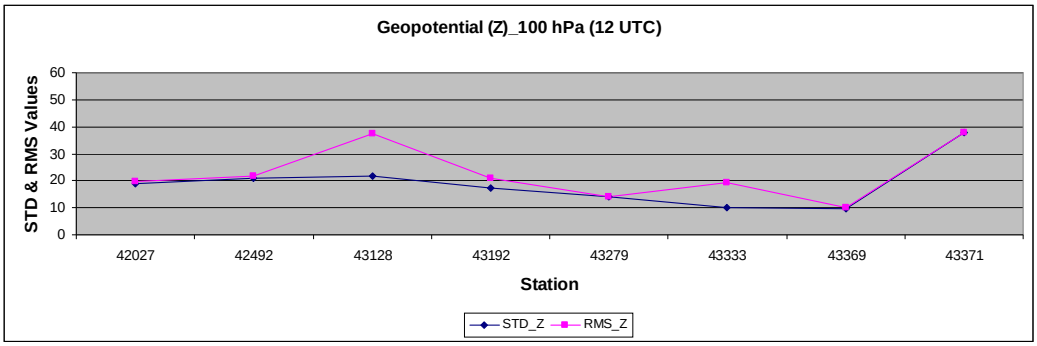
One of the known problems of Indian RS/RW temperature observation was its random large fluctuation on daily scale (Das Gupta et al. 2005). National Centre for Medium range Weather Forecasting (NCMRWF), India also evaluated the performance of upper air observations from these stations by comparing with their T254L64 Global Data Assimilation System (GDAS) first guess (6hr- forecast from T254L64 model). It has been observed that after the introduction of GPS radiosonde, these types of large fluctuation were not seen for guess temperature field. Various reports indicate an improvement in quality as mentioned below:

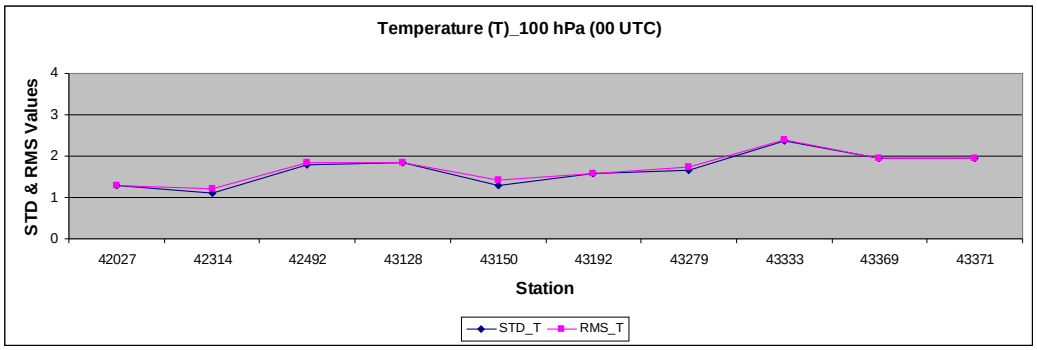
1. Random large fluctuations have reduced on daily scale.
2. Root Mean Square Errors (RMSE) and bias of temperature observations from respective guess for different levels have reduced considerably.
3. Difference (O-B) between observations (O) and first guess (B) have reduced at all levels.
4. Observations are accepted by global/regional models.
5. Rejections of specific humidity observations have reduced substantially.
6. Maximum height reported has increased significantly.

Apart from the data quality, regularity of observations, completeness and timeliness of the collection of observational data at the center concerned, is very important. To enable this, all TEMP data generated from GPS stations has been broadcasted to GTS through SOCKET transmission. Web based portal for on line monitoring of Upper air network has also been started. Performance of the ascents, achieved heights, message dissemination time, Total number of ascents taken, MISDA reported, comparative performance of the all stations, stock statement etc can be monitored.

Graphs of Standard Deviation (STD) & Root Mean Square (RMS) Errors at 100 hPa of Geopotential (Z), Temperature (T), Wind Speed (F) & Wind Direction (D) of one month data of the period August' 2009 are shown in Fig. 3 & 4 which indicates that random deviations largely reduced leading to significant improvement in data quality. The information presented on data quality is based on differences between observations and the values of the most recent forecast ("first guess") of the same parameter. Station performance in terms of mean and maximum height achieved by the stations and number of ascents reached beyond 20 hPa & 100 hPa of 10 stations from the date of installation to April 2010 are shown in Fig 5, 6 & 7.







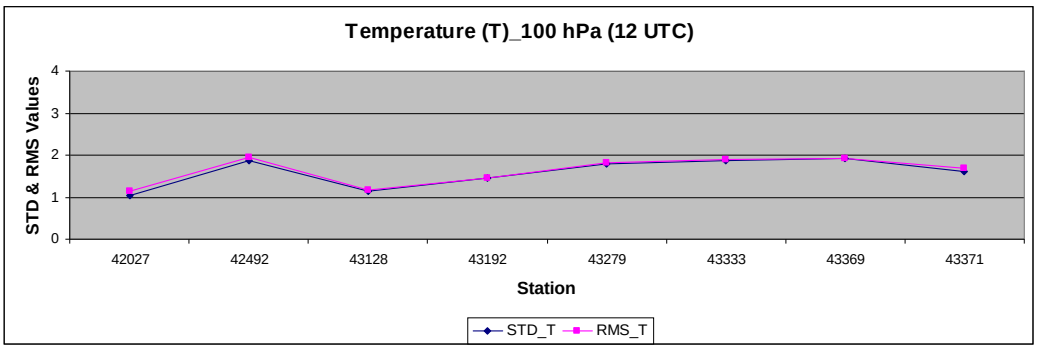
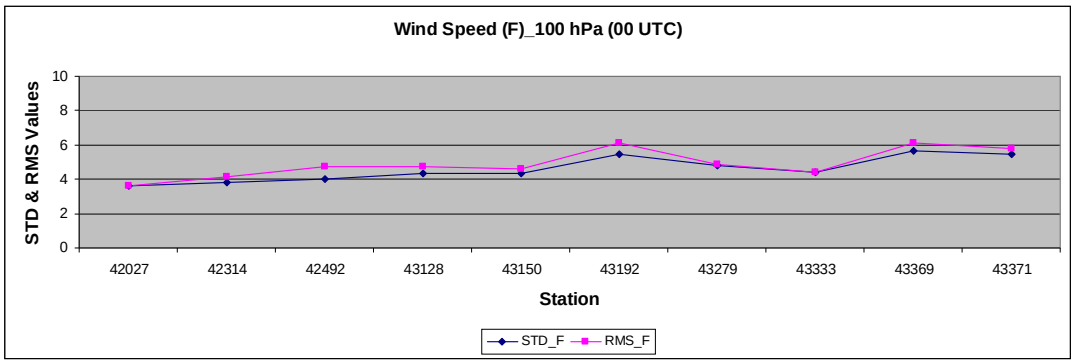
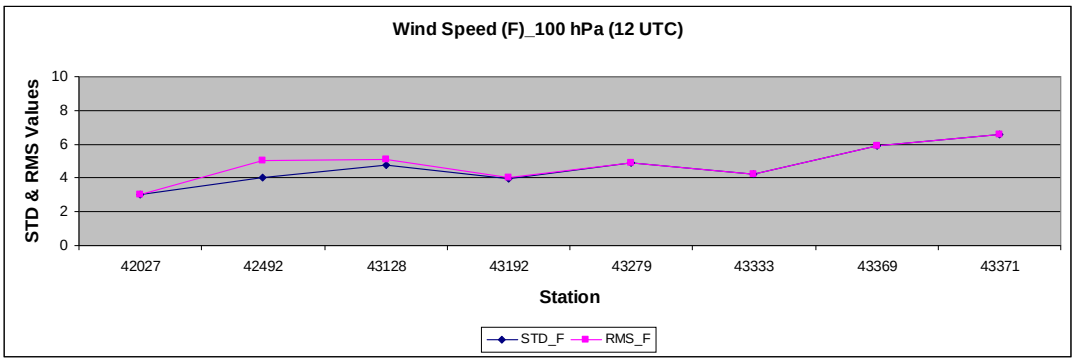
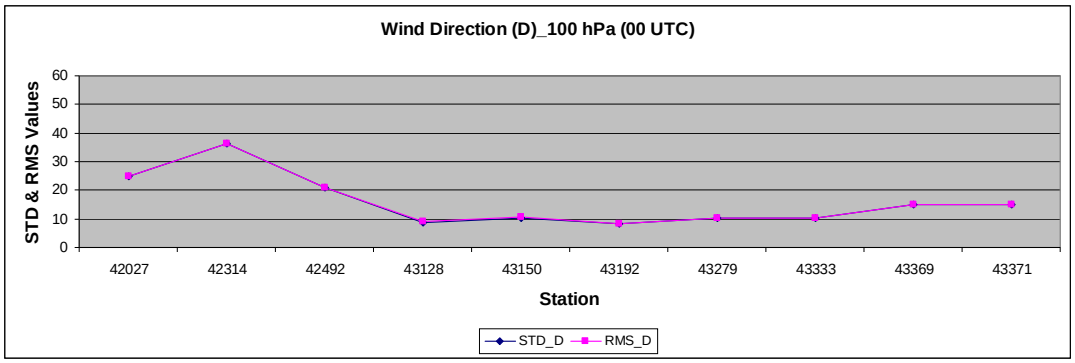


Fig 3: Standard Deviation & RMS Errors for Geopotential & Temperature







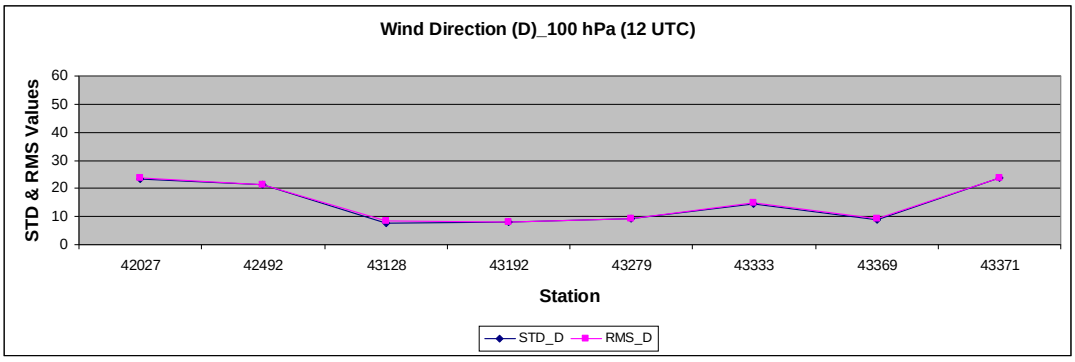
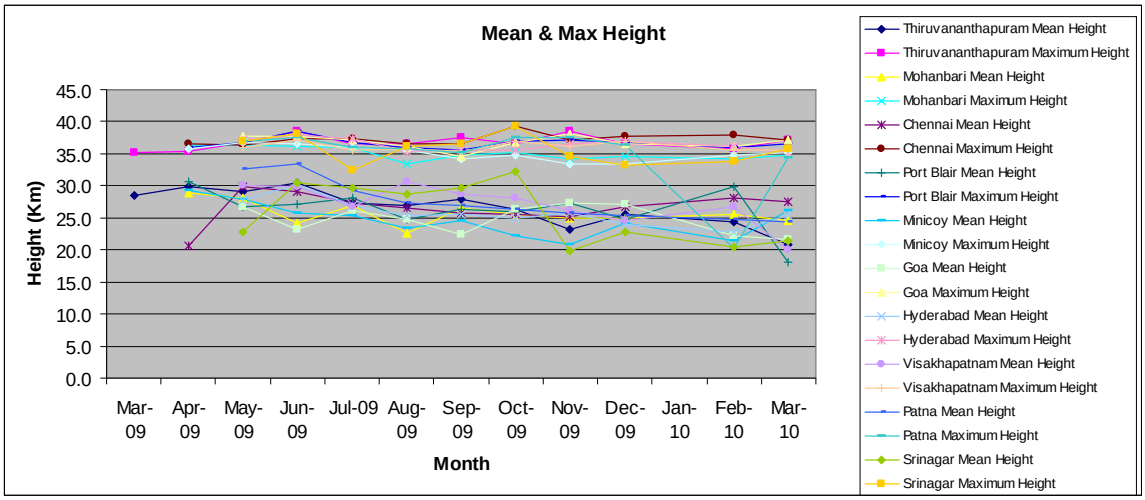
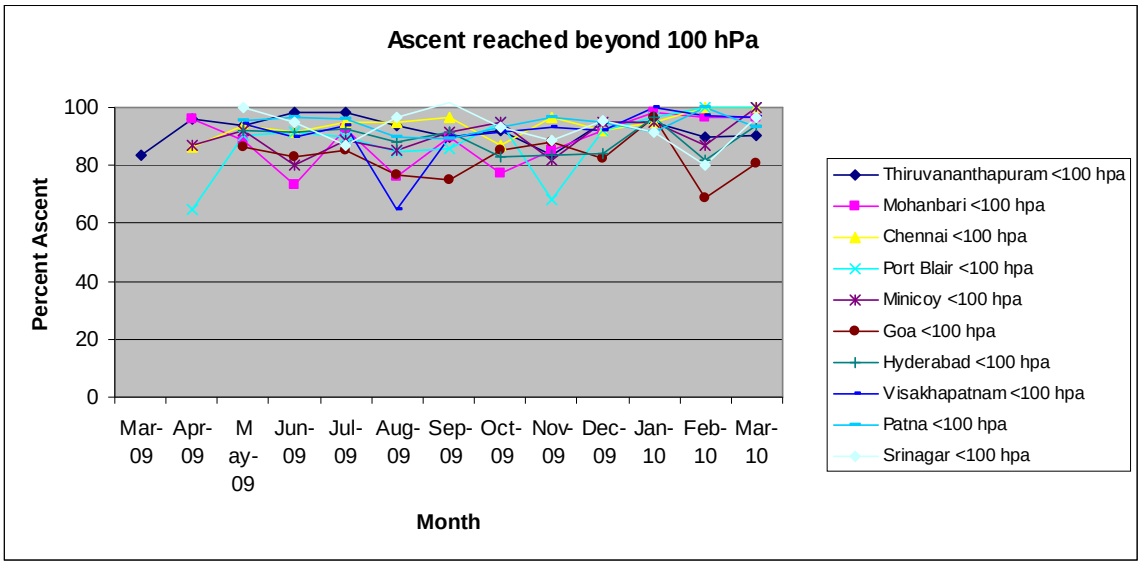


Fig 4: Standard Deviation & RMS Errors for Wind Speed & Wind Direction

Fig 5: No. of ascents reached beyond 100 hPa & 20 hPa

Fig 6: Mean & Maximum Height achieved by stations





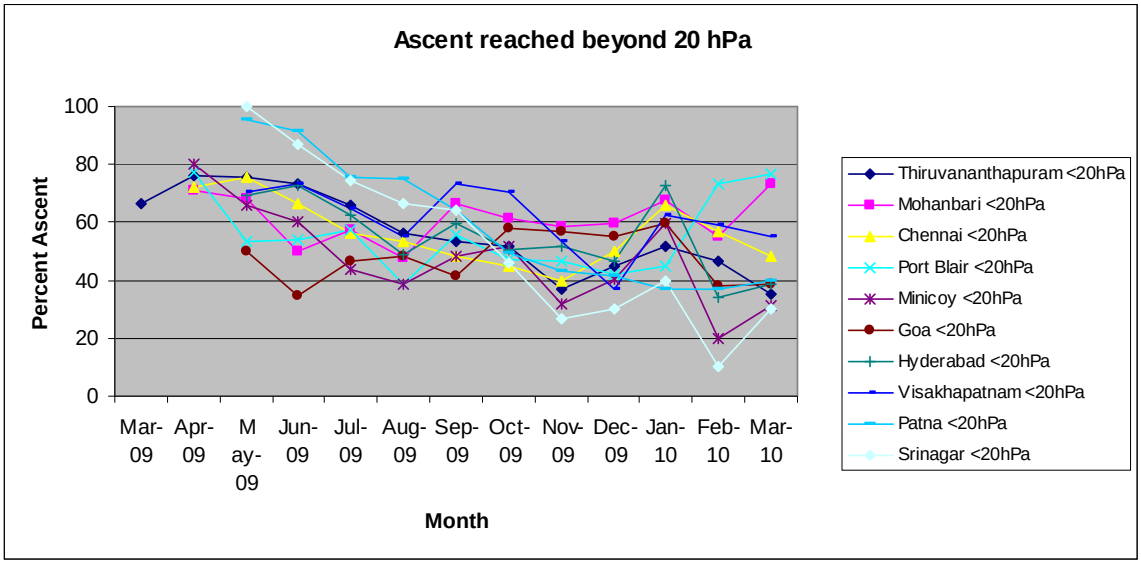


Fig 7: Comparative performance of all GPS stations

4. Future Plans

To further upgrade the network another 13 stations of the network have been planned to be upgraded in 2010. Locations of the stations have been identified as per the NWP requirements and representativeness of the network. After the installation at these locations upgradation at 24 stations will be completed. It is also being planned to upgrade all the remaining stations of the network in the next phase of modernization to ensure operational performance and data quality. Proposed network with the upgradation under modernization phase-1 is shown in Fig 8.

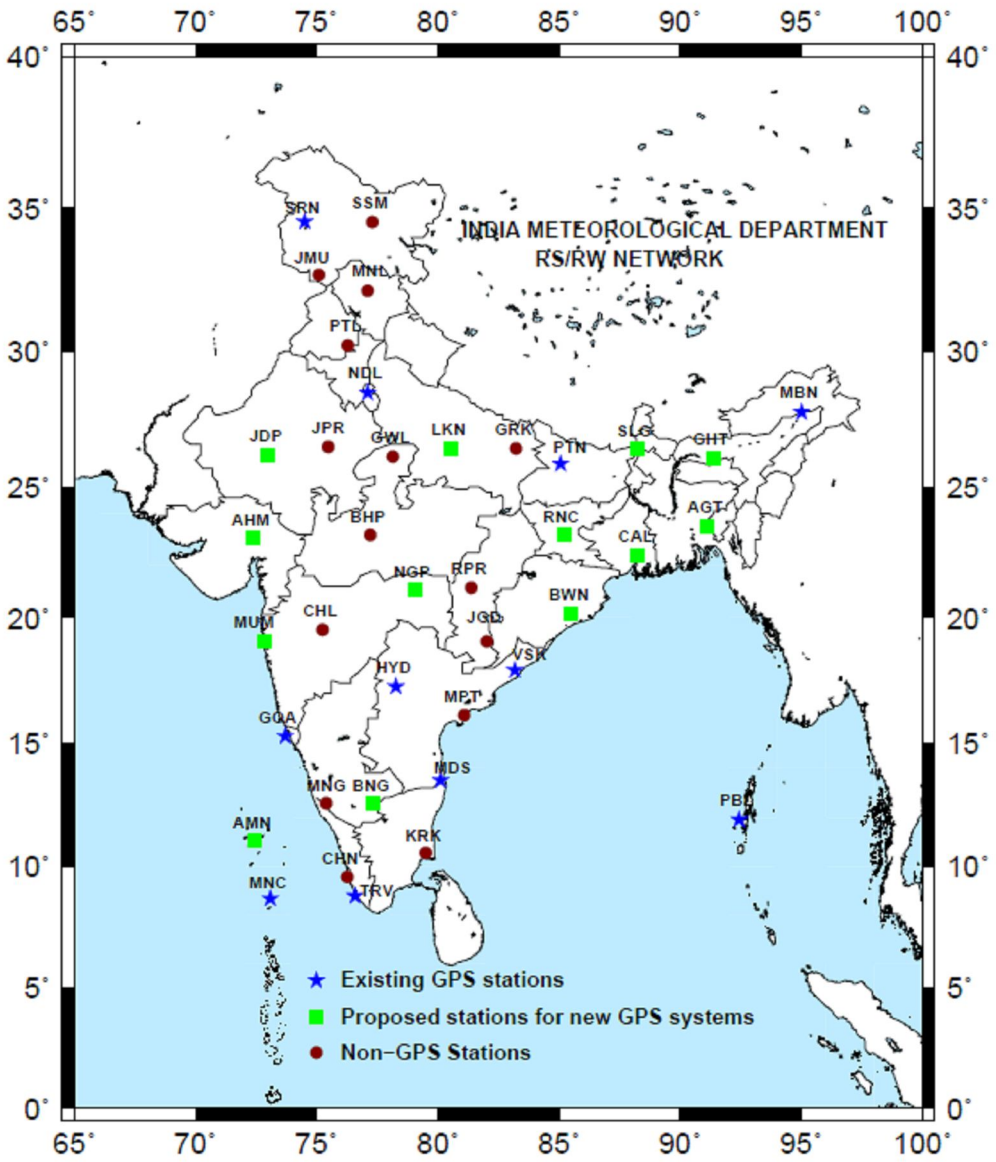


Fig 8: Proposed upgradation of RS/RW Network of IMD.

At present none of the Indian stations are the member of Global Upper Air Network (GUAN). To establish national commitments for the preservation of a minimum set of upper-air stations and to build a collection of validated data from these stations in standardized formats, 5 stations namely New Delhi, Kolkata, Mumbai, Chennai & Nagpur have been proposed to be part of GUAN.

Further GPS radiosonde along with 1680 MHz ground system, acquisition & processing software has also been developed indigenously to make the IMD Self reliance in latest state of the art upper air sounding systems. Data from the indigenous GPS radiosonde has been analyzed and results were encouraging. The sonde will be inducted into the operational network after evaluation.

5. Conclusion:

- **I.** IMD is undergoing modernization to upgrade its observational network with state of art technology. New system has been installed at 11 stations. Another 13 stations of the network are in the process of upgradation.
- **II.** Standards of data quality required by the Numerical weather Prediction (NWP) centers have been achieved at upgraded 11 stations, which will be extended to 24 stations including 5 GUAN stations after ensuring operational performance and data quality.
- **III.** GPS radiosonde along with 1680 MHz ground system, acquisition & processing software has also been developed indigenously to make the IMD Self reliance in latest state of the art upper air sounding systems in future.
- **IV.** Remaining stations of the network have also been planned for upgradation in the next phase of modernization to ensure operational performance and data quality at all 39 stations.

Reference:

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