PRESENT STATUS OF SURFACE METEOROLOGICAL MEASUREMENTS IN INDIA

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ABSTRACT

After the launch of INSAT-1B, India Meteorological Department installed 100 automatic Weather Stations (AWS) during 1984-85. Status of operational Automatic Weather Stations was above 60 per cent. After ten years, when life span of Automatic Weather Stations was completed, 15 state-of-art Automatic Weather Stations were procured and installed during 1996-1997. The operational status of these Automatic Weather Stations after seven years of operation is above 90 per cent.

India Meteorological Department is shortly procuring 100 state-of-art Automatic Weather Stations and they will be installed in uninhabited, remote, inaccessible areas from where data for weather forecasting, cyclone forecasting are of paramount importance. The AWS data was compared with surface observatory data, standard deviation, deviation, scattered diagrams and correlation coefficient for few stations are plotted and data quality was found within WMO accuracy limits.

Under the augmentation of surface meteorological measurements in India, it is proposed to install 500 Automatic Weather Stations in different parts of India.

Introduction

India Meteorological Department has been operating a network of 100 Automatic Weather Stations in India since 1984. The technology had become obsolete and after ten years of operation the old Data Collection Platforms (DCPs) now renamed as Automatic Weather Stations (AWS) were replaced with state-of-art AWS systems during 1997-98. Various meteorological parameters such as dry bulb temperature, wind speed, wind direction, relative humidity, barometric pressure and rainfall are being measured. AWS Receiving Earth Station is also located in Pune and the quality of data received from the AWS are being evaluated. The quality of data has been found to be very encouraging.

The performance of three such automatic weather stations has been evaluated in this paper by comparing the data with co-located observatory data and the results are discussed here. The overall accuracy of the data received from the AWS is found to be mostly well within the required limits specified by WMO for acceptance of data from an AWS.

INSAT-AWS System

A typical INSAT-AWS system configuration is depicted in Fig.1. INSAT-AWS system consists of field unit, space segment and the ground segment consisting of data receiving, processing and dissemination system. Automatic Weather Station includes sensors, signal conditioning unit, digital system, transmitter and antenna unit. AWS unit is housed in a weather-proof housing.

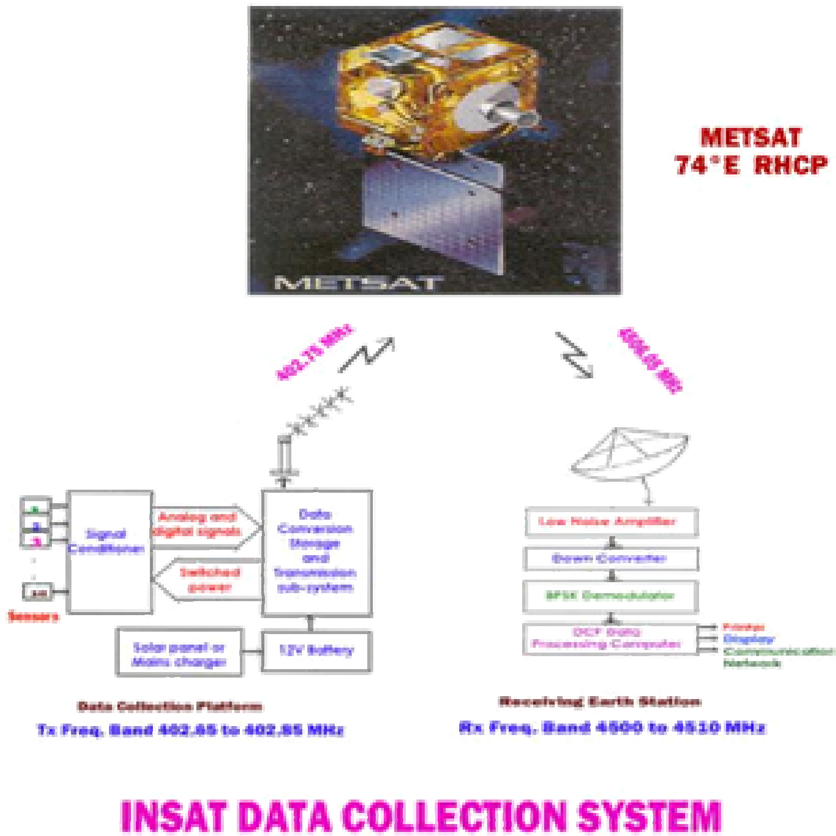

Fig.1 INSAT AWS System Configuration

The space segment METSAT(Kalpana-1) consists of UHF receiving antenna for 402.75 MHz, down converter (402.75 MHz to 28 MHz), filter, upconverter, amplifier and transmitting antenna. The receiving earth station at Pune consists of 3.8 meter parabolic dish antenna, low noise amplifier, down converter, Digital Direct Read Out Ground Station (DDRGS) and data processing computer.

AWS field stations automatically take environmental observations and transmit weather data at every full hour UTC at an uplink frequency of 402.75 MHz which is received by METSAT(Kalpana-1). The received signals are downconverted to 28 MHz at the satellite and then amplified and upconverted and transmitted back to Pune receiving earth station at down link frequency of 4506.05 MHz. The dish antenna of the receiving earth station receives the signal transmitted by METSAT and is amplified by low noise amplifier and downconverted to 140.95 MHz by downconverter and fed to DDRGS demodulator. The raw data is processed by the computer and hourly data of the meteorological parameters are made available and archived for further use for climatological purpose. It is also used for data validation. The weather parameters measured are air temperature, wind speed, wind direction, atmospheric pressure, relative humidity and rainfall. The data is made available to the forecasters and other users in real time through GTS network of IMD in WMO format.

Data and methodology

AWS and surface data for 03 UTC and 12 UTC observations for two stations Dwarka and Ratnagiri along the west coast of India for the period Jan-Nov 2004 has been taken for analysis. The meteorological parameters dry bulb temperature, station level pressure and relative humidity have been taken for preparation of scatter diagrams and calculation of correlation coefficient and standard deviation. The monthly standard deviations for the dry bulb temperature and station level pressure for the same period Jan-Nov 2004 for 03 and 12 UTC have also been compared for the stations Dwarka and Ratnagiri. AWS and Surface data for the station Chennai on the east coast of India has been compared for dry bulb temperature and station level pressure for Jan-Nov 2004 for both 03 and 12 UTC The results have been analysed and discussed.

Results and discussions

a) Dwarka

Fig.2 shows the scatter diagram in respect of Dwarka for 03 and 12 UTC for dry bulb temperature, station level pressure and relative humidity for the period Jan-Nov 2004. Figs. 2(a) & (b) show the existence of a high degree of correlation between AWS Dry bulb data and surface observatory data for 03 and 12 UTC. The correlation coefficient (CC) for 03 UTC is 0.98 with a standard deviation of 0.59 °C. The CC for 12 UTC is 0.98 with a standard deviation of 0.44 °C.

Scatter diagrams for 03 UTC and 12 UTC Station Level Pressure (SLP) of Dwarka AWS site shown in Fig.2(c) & (d) also show a correlation coefficient equal to nearly 1 (0.99). Standard deviation between AWS data series and surface data series for Dwarka (Jan-Nov 2004) for 3 UTC & 12 UTC is 0.20 hPa which depict the higher dependability of pressure sensor measurements. Figs. 2(e) & (f) show the relative humidity scatter between AWS Dwarka and surface observatory data of 03 & 12 UTC for the same period. The CC for 03 UTC is 0.96 with a standard deviation of 2.59% and CC for 12 UTC is 0.98 with a standard deviation of 2.77%. The standard deviations are well within WMO accuracy limits.

b) Ratnagiri

Fig. 3 shows the scatter diagrams of 03 UTC and 12 UTC of Ratnagiri AWS data and surface observatory data for period Jan-Nov 2004. The Correlation Coefficient for 03 UTC dry bulb temperature data is 0.96 with a standard deviation of 0.66 °C and CC for 12 UTC is 0.97 with a standard deviation of 0.36 °C which has been shown in Figs.3(a) & (b).

Fig.3(c) & (d) are the scatter diagrams for Ratnagiri station level pressure(SLP) which depict a near perfect correlation with a CC of 0.99 at both 03 UTC and 12 UTC. The standard deviations are 0.38 hPa and 0.25 hPa respectively for 03 & 12 UTC. Figs.3(e) & (f) for relative humidity values show a CC of 0.97 for 03 UTC & 0.98 for 12 UTC with standard deviations of 3.28% and 2.61% respectively for 03 & 12 UTC.

c) Chennai

The scatter diagrams for 03 & 12 UTC station level pressure (SLP) and dry bulb temperature values have been shown in Figure 4. CC for dry bulb temperature is 0.98 and 0.99 for 03 & 12 UTC with standard deviations of 0.55 ˚C & 0.43 ˚C respectively as shown in fig 4(a) & (b). Correlation coefficient(CC) R=0.99 for both 03 & 12 UTC SLP values with standard deviations of 0.44 hPa and 0.61 hPa respectively as seen in Fig. 4(c) & (d).

The effect of diurnal variation can be seen from the monthwise standard deviations calculated from the deviation between AWS values and surface observatory values for 03 and 12 UTC. This analysis has been done for Dwarka and Ratnagiri for the period Jan-Nov 04 and is shown in Fig.5. It is seen from fig.5(a) & (c) that 03 UTC dry bulb temperature deviations for Ratnagiri are more than 12 UTC for the entire period. In the case of Dwarka 03 UTC similar trend is observed except in the months of May-Aug where the deviations are less than 12 UTC. In the case of station level pressure the trend is shown in fig.5(b) & (d).

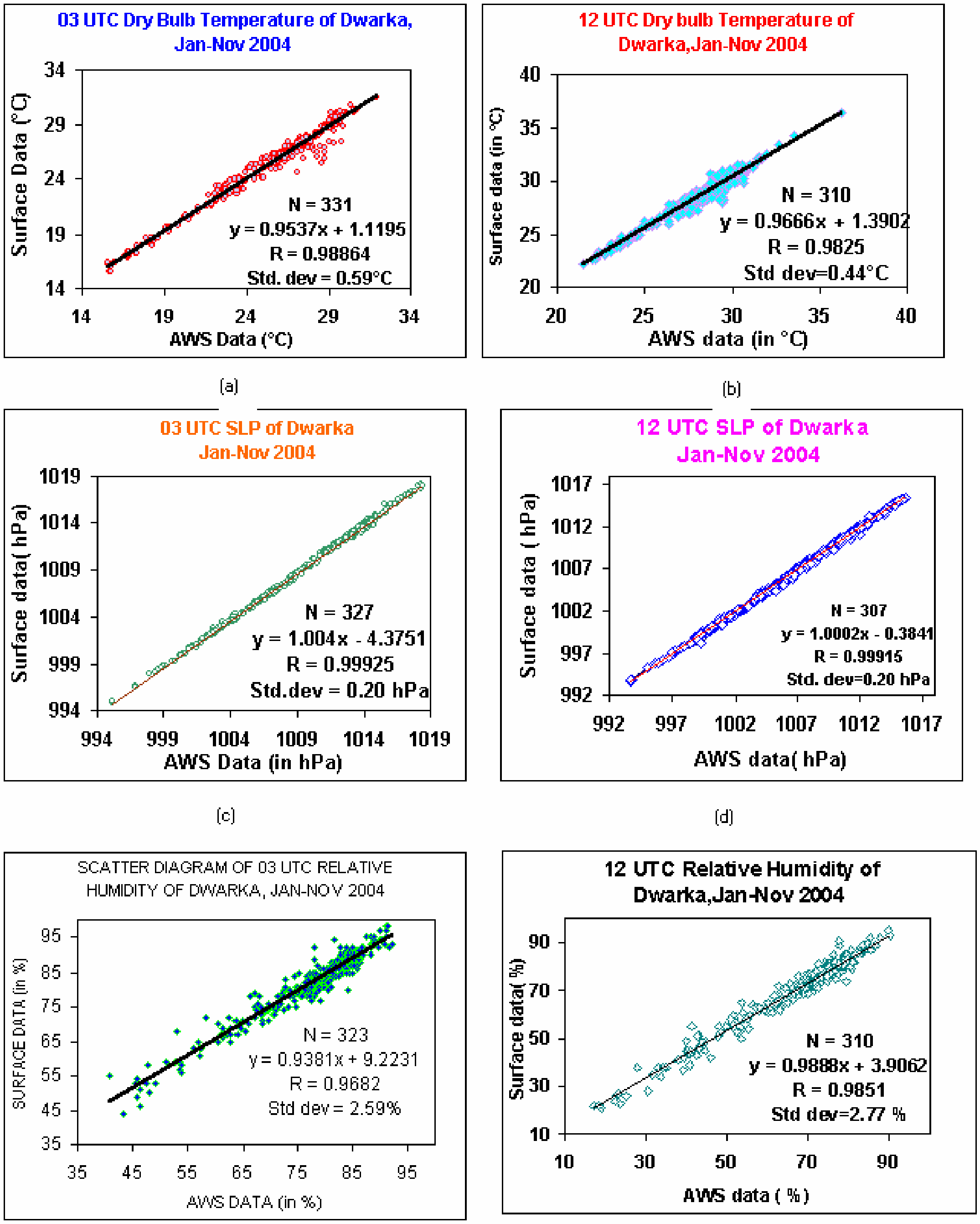

Fig.2 Scatter diagrams of Dwarka, 03 & 12 UTC for Jan-Nov 2004

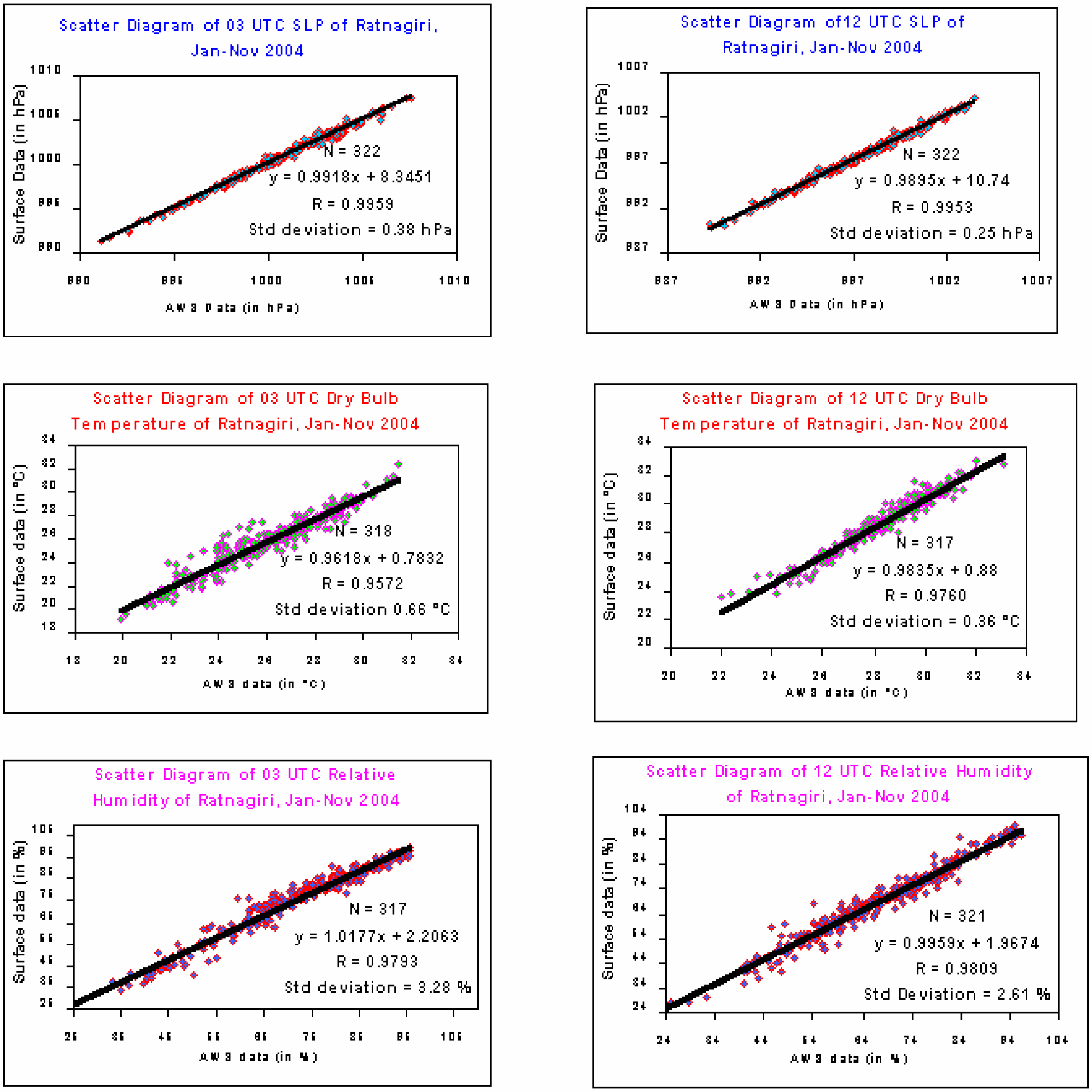

Fig.3 Scatter diagrams of Ratnagiri for 03 & 12 UTC, Jan-Nov 2004

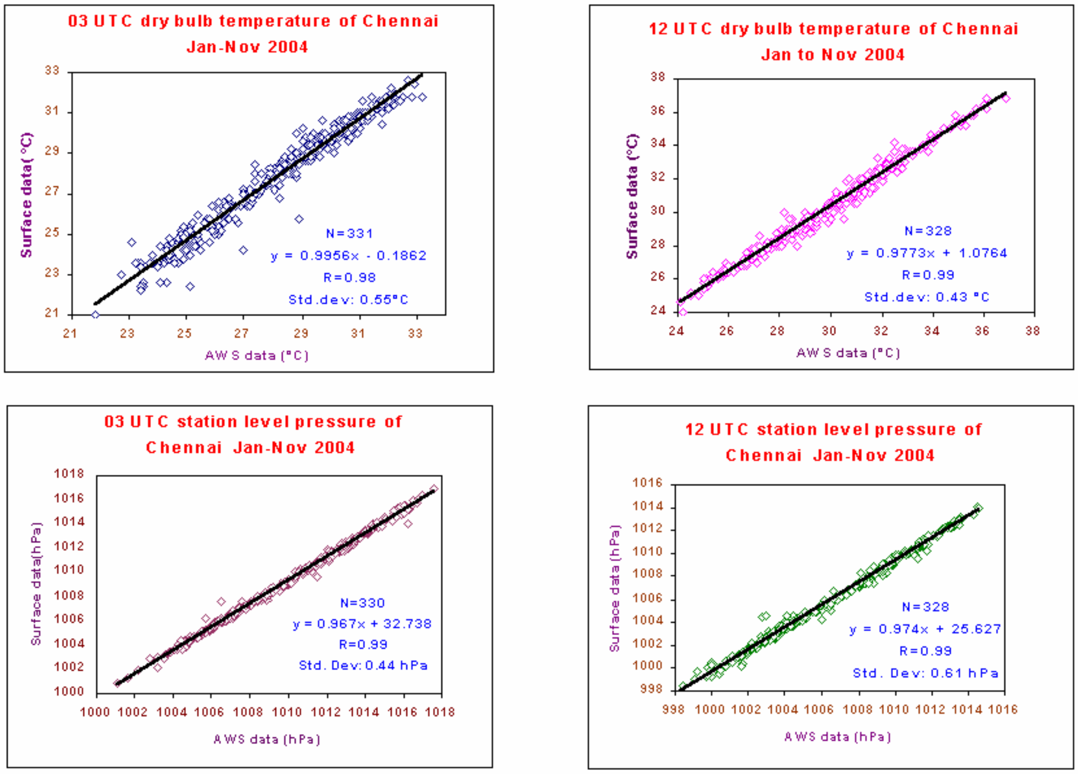

Fig.4 Scatter diagrams for Chennai 03 & 12 UTC, Jan-Nov 2004

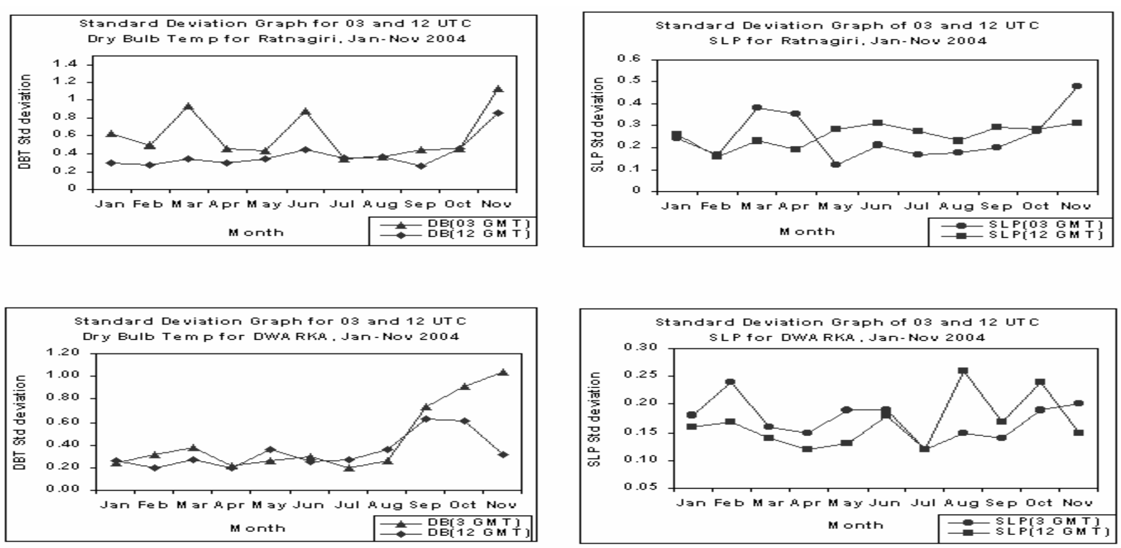

Fig.5 Monthwise standard deviation graphs for Dwarka & Ratnagiri 03 & 12 UTC

Conclusion

The values of statistical parameters for series of differences are within WMO accuracy limits for automatic weather stations. Rigorous checking of data for quality control and preventive maintenance of the automatic weather stations have ensured that the data received from the AWS are of highly comparable and dependable quality. Monitoring of the data is required because of the probability of instrumental uncertainty. Corrective maintenance is required for sensor failures. The presence of a satellite based AWS data receiving earth station which monitors data from AWS at real time plays a very important role in monitoring the network of AWS and undertaking preventive measures in the case of non-functioning of a station.

It has been also noticed that the differences in the values of meteorological parameters is due to the difference in the time of observation between a manual observation and an automatic measurement. The time of observation in a surface observatory for the entire network could never be set exactly at full hour UTC against an automatic sampling which records the values automatically at that hour without any human intervention.

All these factors have been taken into consideration and from the experience gained it is strongly felt that, AWS systems will provide accurate and timely surface meteorological data because of the full range of sophisticated sensors available, data communications options and remote maintenance monitoring capabilities. Hence it is planned to establish a wider network of automatic weather stations and automatic raingauge stations to get data from unrepresented areas of the country. This will aid in better forecasting of weather occurrences.

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