IMPLEMENTATION OF A REAL-TIME NOWCASTING AND VERY SHORT-RANGE FORECASTING SYSTEM IN INDIA – CHALLENGES FACED AND THE ROADMAP AHEAD

S.K.Roy Bhowmik, Soma Sen Roy and Kuldeep Srivastava
India Meteorological Department, Lodi Road, New Delhi-110003, India.

1. INTRODUCTION:

The improved network of observations under the modernization program of India Meteorological Department (IMD), has thrown up a challenge to provide accurate, location and user specific real-time forecasts for the Indian region. The recent demand for location specific short range forecasts of weather for major sport events like the Commonwealth Games 2010 in Delhi has further set India on a path of improvement of the quality of its nowcasts and short range forecasts of weather and its dissemination. This paper briefly describes the challenges faced in the implementation of a real-time nowcasting and short-range weather prediction system in India. We also discuss the future potential of this field in India and also the roadmap ahead for its implementation.

2. DATA SOURCES:

Under a major modernization program of the weather services of the India Meteorological Department (IMD), a network of 55 Doppler weather radars is currently being installed all over India. In the first phase, 12 S-Band Doppler radars, and 2 C-Band Dual Polarization Doppler radars have so far been put in place to monitor the main weather systems over India. In another initiative, IMD has established 550 Automatic Weather Stations (AWS), of which about 125 have extra agricultural sensors like solar radiation, soil moisture and soil temperature, 1350 Automatic Rain Gauge (ARG) stations and 10 GPS in 2009 and will shortly increase these to 1300, 4000 and 40, respectively. For the purpose of the Commonwealth Games, a meso-network of 42 AWS (including 11 Air Quality-cum-weather stations) was set up around Delhi, to enable better monitoring and short-range weather prediction over the region. For the purposes of nowcasting, the latter two observation resources, namely the radar data and the data from the AWS has proved to be most beneficial.

The data from the observation network is transmitted in real-time to a central node in IMD headquarters -TRANSMET, for onward transmission nationally and internationally. A 256 /512 Kbps Virtual Private Network (VPN) line connects the radar stations to the central location. The data from the radars is uploaded in real-time every 10 minutes to a central server, from where the data is transmitted globally through the GTS.

3. SETTING UP A REAL-TIME SHORT-RANGE FORECASTING SYSTEM:

A High Power Computing (HPC) System with 300 terabyte storage and 14 Teraflop computing power has been installed at NWP Centre at IMD New Delhi, to deal with the huge data-flow from these observation platforms. The radar reflectivity data received through the GTS is quality controlled, and the radar velocity data is de-aliased following internationally recognized algorithms (Sen Roy et al, 2010). The AWS data is also quality controlled according to WMO specifications, before input into numerical models.

The Short-range forecasting (less than 24 hours) issue is addressed in the Indian context, by a multitude of interdependent models, providing a cascade of forecasts valid for T=0 to T=36 hours. Currently two nowcasting softwares are operational, namely, Warning Decision Support System

(WDSS-II: technology from National Severe Storms Laboratory) and Short-range Warning of Intense Rainstorms in Localized Systems (SWIRLS: technology from Hong Kong Meteorological Office). The quality controlled radar data is also assimilated into the Advanced Regional Prediction System (ARPS: technology from Oklahoma University), which is implemented for real-time very short range forecasting for a period of 1-9 hours at 9 km resolution and updated every hour. For location specific forecasts for upto 36 hours, WRF (ARW) model is run at 3km resolution (Double nested at 27 and 9 km and nestdown at 3 km).The twice daily run (00 and 12 UTC) includes assimilation of radar data from multiple radars and AWS data. These models were all tested for the optimal assimilation and parameterization schemes in the run-up to the Commonwealth Games (RoyBhowmik et al, 2011, Srivastava et al, 2010, 2011 and 2012). All the models performed seamlessly to generate nowcasts and short-range forecasts for the Delhi and adjoining National Capital Region for the duration of the Commonwealth Games, 2010 and have since been brought into the operational regime of IMD. The location specific values of weather parameters for displayed on an interactive GIS based platform.

4. IMPLICATIONS OF REAL-TIME NOWCASTING AND THE CHALLENGES AHEAD:

Having implemented the real-time nowcasting and short-range forecasting system for the Commonwealth Games, the objective now, is to implement the same technology for all metropolitan cities of India under a "Megacity Forecasting Project". Further, there is need to develop heuristic guidelines for effective nowcasting. The current challenges for implementation of a nationwide effective nowcasting platform may be summarized as follows:

(i) ***Communication network*** – Nowcasting softwares are highly dependent on the timely throughput of input data as well as effective and timely dissemination of output data. The 256/512 kBps link appears to be insufficient for the data flow. There is a proposal to increase the link speed to 1/10 MBps.

(ii) ***Heuristic information of tropical weather systems*** – Due to the recent availability of Doppler radar data, information about the structure of weather systems over this region, has only recently become available to users. This information is very necessary for the development of a customized nowcasting and short-range forecasting software for the Indian region.

(iii) ***Regular feedback sessions with users***- Since the concept of nowcasting is very new to India, the public awareness needs to be increased so that the output is made proper use of and improved.

(iv) ***Nowcasting with multiple radar data*** -For operational nowcasting with a longer forecast lead-time, India is shifting to multiple radar algorithms that will take advantage of the network of radars and the improvements in the communication network.

5. REFERENCES:

a. Roy Bhowmik S.K., S. Sen Roy, K. Srivastava, B. Mukhopadhay, S. B. Thampi ,Y. K. Reddy, Hari Singh, S. Venkateswarlu, Sourav Adhikary, **2011**: Processing of Indian Doppler Weather Radar Observations for mesoscale applications, ***Meteorology and Atmospheric Physics* , 111,** 133-147

b. Sen Roy Soma, V Lakshmanan, S K Roy Bhowmik and S B Thampi, **2010**: Doppler Weather Radar based nowcasting of Cyclone Ogni, ***J. Earth Syst Sci***, **119**, 183-200

c. Kuldeep Srivastava, Bhardwaj Rashmi and Roy Bhowmik SK, **2011,** Assimilation of Indian Doppler Weather Radar observation for simulation of measo-scale features of a land-falling cyclone, **Natural Hazards, 59,** 1339-1355.

d. Srivastava, K.,Jidong Gao, Keith Brewster, S. K. Roy Bhowmik, Ming Xue and Ranu Gadi,**2010**: Assimilation of Indian radar data with ADAS and 3DVAR techniques for simulation of a small-scale tropical cyclone using ARPS model, **Natural Hazards, 58**, **15-29.**

e. Srivastava K., S.Y. Lau, H.Y. Yeung, T.L. Cheng, R. Hardwaj, B.A.M. Kannan, S.K.Roy Bhowmik & H. Singh, **2012**: Use of *SWIRLS* nowcasting system for quantitative precipitation forecast using Indian DWR data. ***MAUSAM*, 63(1),** 1-16pp..