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Research Paper

RELEVANCE OF WEATHER FORECASTING IN MODERN TIMES

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ABSTRACT

The contemporary relevance of weather forecasting is primarily amplified in this article based on qualitative research methodology. Weather forecasting is important for individuals and organizations in the fields of natural disaster management and sustainable development. The scholars have contributed certain observational, theoretical and technological concepts and processes for the development of knowledge of the atmosphere. Weather monitoring had gained a new momentum in 1920s with the invention of the radiosonde. The western scientists developed certain physical laws governing various aspects of the atmosphere on the basis of mathematical equations. Weather forecasting assumed significance during the World War II due to the massive use of military aviation and shipping to conduct the fighting over wide geographical areas. The numerical forecasts had only predicted the evolution of pressure, geo-potential height and vortices patterns. In 1960s, sophisticated computer and weather satellites were used to obtain meteorological data. Several regional and national meteorological organizations were established to monitor weather conditions in 20th century.

The operational weather sounding system was upgraded in the 1990s to improve the status of weather forecasting. The advanced numerical models of the atmosphere have produced forecasts which diverge significantly from reality. The NASA launched the geostationary weather satellites with the GOES-R series in 2015. Weather forecasting can certainly reduces the risk of loss of life and injury on the basis of good evacuation plans, environmental planning and design standards. The modern meteorological institutions play a crucial role in the process of weather forecasting which matters most from sustainable development point of view.

KEYWORDS: weather forecasting, mass media, atmosphere, Weather Prediction



PREAMBLE

Weather forecasting is the application of science and technology to predict the state of the atmosphere in a particular location. Weather forecasts are made by collecting quantitative data about the current state of the atmosphere by using scientific understanding of atmospheric processes to project how the atmosphere will change. The weather forecasting is the single most important practical reason for the existence of meteorology as a science. Weather forecasting offers multi-faceted benefits to government, civil society, defence forces, industrial organizations, agricultural institutions and mass media. Weather forecasting is a specialized activity which is primarily dependent on technological developments and applications. The use of ensembles and model consensus help narrow the error and pick the most likely outcome. The contemporary relevance of weather forecasting is primarily amplified in this article based on qualitative research methodology.

CONCEPT OF WEATHER FORECASTING

Weather forecasting is the application of science and technology to predict the state of the atmosphere in a particular environment. The scientists make weather forecasts by using atmospheric technologies and processes. In the present times, weather forecasting is carried out on the basis of computer-based models, recognition skills, teleconnections and knowledge of model biases. Weather forecasting is a scientific and technological exercise which benefits several end users.

Weather forecasting is primarily based on temperature and precipitation which are important in all walks of life. Weather forecasting is an essentially the task encountered day by day by a weather forecaster (Ryan, 1982:19). Weather forecasting is the attempt by meteorologists to predict the state of the atmosphere at some future time and the weather conditions that may be expected. Weather forecasting is the single most important practical reason for the existence of meteorology as a science (Burrige and Källén, 1983:05). Weather forecasting is important for individuals and organizations in the fields of natural disaster management and sustainable development.

Weather forecasting is primarily carried out by the community of meteorologists who predict the weather a few weeks, a few months, or even a year in advance (Elliot, 1988:09). The civil society and government are responsible for providing opportunities

for people across the country to participate in a range of measures to make their families, their homes and their communities safe from all types of disasters. The national emergency management system is built on shared responsibilities and active participation at all levels.

Weather forecasting is the application of science and technology to predict the state of the atmosphere for a given location. Weather warnings are important forecasts because they are used to protect life and property (Ramsey, 1990:16). Weather forecasting is the process of making predictions of the future based on past and present data and analysis of trends. Trending or predicting a continuation based on the shape of the line generated by plotting past results. Weather forecasting is the use of historic data to determine the direction of future trends. Weather forecasting basically involves the scientific predictions about the present and future states of weather conditions all over the world (Michael, 1999:13).

A typical weather forecasting system is the collection of components, such as sensors, communication, software, and computers. The system helps to capture information of important weather parameters, transmit information, and run forecast models. Main functions of the weather forecasting system include issuing disaster warnings and conducting climate studies.

EARLY HISTORY OF WEATHER FORECASTING

The Chinese astronomers had developed a calendar that divided the year into 24 festivals in 300 B.C. The Greek philosopher Aristotle wrote Meteorological, a philosophical treatise that included theories about the formation of rain, clouds, hail, wind, thunder, lightning and hurricanes in 340 B.C. Aristotle had also made some remarkably acute observations concerning the weather, along with some significant errors. The Babylonians had monitored seasonal changes in the weather around 650 B.C. The art of weather forecasting had begun with early civilizations using reoccurring astronomical and meteorological events to assess seasonal changes in the weather.

Leonardo da Vinci built the first basic hygrometer to measure the humidity of air in 1400 B.C. Galileo Galilei was the first to notice that the density of a liquid changes in proportion to its temperature in 1593 B.C. He invented a thermo scope to display a change in temperature. It was from Galileo's work that the thermometer was later invented. Evangelista Torricelli

invented the barometer to measure atmospheric pressure 1643 B.C. Ole Christensen Rømer transformed the thermometer into a thermometer by adding a temperature scale in 1701 B.C. He invented the Rømer scale which was initially used 0 as the freezing point of brine and 60 degrees as the boiling point of water. Francis Beaufort introduced the Beaufort wind scale, which ranged from 0 (calm) to 12 hurricane forces in 1806 B.C (Richards et. al. 2004:17).

During the period of Renaissance, the speculations of the natural philosophers were found inadequate by the scholars. They also felt that it was necessary to further the understanding of the atmosphere. They had also developed certain instruments to measure the properties of the atmosphere, such as moisture, temperature and pressure. These meteorological instruments were refined during the 17-19 centuries (Campbell and Diebold, 2005:06). The scholars also contributed certain observational, theoretical and technological concepts and processes for the development of knowledge of the atmosphere.

The invention of the telegraph and the emergence of telegraph networks in the mid-nineteenth century had enabled the routine transmission of weather observations to and from observers and compilers. The state of weather forecasting was stated quite bluntly by French scientist in 1846. The Meteorological Department of the Board of Trade was established in 1854. The marine weather forecasting was undertaken in 1859 for forecasting purposes and to help with transoceanic plane navigation. The satellite images on cloud cover and various parameters such as winds, rainfall, sea surface temperature etc., have become an integral part of weather forecasting. About 15 land stations were established around the UK and transmitted daily weather reports.

The weather-observing stations were also established in the world and paved the way for the birth of synoptic weather forecasting on the basis of compilation and analysis of many observations taken simultaneously over a wide area, in the 1860s. In the mid-1800's, weather observation networks had began to grow and expand across the United States (Gneiting and Raftery, 2005:11). Scientists also developed a large body of literature on weather forecasting in the world. Several regional and global meteorological observation networks were also developed in the nineteenth and twentieth century's across the globe. The scientists had also obtained data on the basis of observation-based weather forecasting.

Weather monitoring had gained a new momentum in 1920s with the invention of the radiosonde. It was a small lightweight box equipped with weather instruments and a radio transmitter. This machine was carried high into the atmosphere by a hydrogen or helium-filled balloon that ascends to an altitude of about 30 kilometers before bursting. During the ascent, these instruments transmit temperature, moisture, and pressure data (called soundings) back to a ground station (Terri and Moran, 2005:20). Thus, the data were made available for constructing weather maps or insertion into computer models for weather prediction. In the present times, radiosondes are launched every 12 hours from hundreds of ground stations all over the world.

MODERN WEATHER PREDICTION

The western scientists developed certain physical laws governing various aspects of the atmosphere on the basis of mathematical equations. Vilhelm Bjerknes carried out pioneering research in the field of numerical weather forecasting in 1904. The first daily weather forecast was published in The Times in 1860 in UK. The first weather maps were also produced this year in The Times. The Weather Book was published by Fitzroy which advanced the scientific opinion of meteorology in 1863. The United States established a national weather service within the Signal Service in 1870. The civilian-based U.S. Weather Bureau was established in 1890. Vilhelm Bjerknes worked toward a physically-based way to forecast the weather in 1904.

Richardson also produced a wildly inaccurate six-hour forecast for an area near Munich, Germany subsequently. But, the changes predicted in Richardson's forecast could never occur under any known terrestrial conditions due to certain limitations. He published a well known book entitled 'Weather Prediction' in 1922 which explained a scheme for predicting the weather before it actually happens (Belousov and Berkovich, 2006:04). The scheme had involved a roomful of people, each computing separate sections of the equations, and a system for transmitting the results as needed from one part of the room to another. His works primarily highlighted the obvious fact that a large number of calculations had to be made very rapidly in order to produce a timely forecast.

Weather forecasting assumed significance during the World War II due to the massive use of military aviation and shipping to conduct the fighting over wide geographical areas. Weather observing and forecasting practices had improved rapidly through this

period, with forecasters for the first time starting to pay attention to the development of the middle and upper troposphere in order to determine what might happen to the weather (Chassignet and Verron, 2006:07). The use of weather balloons carrying instrumented packages to observe the upper troposphere became more widespread as a result. Adequate research activities were conducted after the war to refine weather forecasting models and methods.

Scientists achieved significant progress in the field of numerical weather forecasting in 1940s by using the earliest modern computers. A team of dedicated meteorologists and mathematicians succeeded in computer application for weather forecasting in the Institute for Advanced Study in Princeton, New Jersey, USA. John von Neumann, Jule Charney and others played a crucial role in revising a set of equations, filtering out sound and gravity waves in order to simplify the calculations (Vasquez, 2006:21). The scientists had focused on the phenomena of most importance to predicting the evolution of continent-scale weather systems by the mid-1950s

The first operational numerical weather forecasts were made by the Swedish Military Weather Service in 1954 under the leadership of Carl-Gustav Rossby. He founded the Swedish Institute of Meteorology and continued to develop numerical forecasting methods in 1950s. During the 1950s and early 1960s the UK Met Office had to do its research into NWP on borrowed computers. In 1965 the UK Met Office started Operational Weather Forecasting to routinely produce numerical weather forecasts. It succeeded remarkably in producing the first numerical prediction of precipitation in 1967. The numerical forecasts had only predicted the evolution of pressure, geo-potential height and vortices patterns.

ADVANCED TOOLS OF WEATHER FORECASTING

In 1960s, sophisticated computer and weather satellites were used to obtain meteorological data. The satellites were used to obtain data from the remote areas of the globe. The Television and Infrared Observation Satellites were launched in 1960s. The satellite sensor technology was refined to provide database for systematic calculation of atmospheric temperature, moisture profiles and other environmental variables. The data retrieved from sounder measurements taken from a satellite was made similar to radiosonde observations (Alan, 2008:01). The National Oceanic and Atmospheric Administration, European Centre for Medium-Range

Weather Forecasts and other institutions played an important role in the development of operational numerical weather prediction models. There were substantial improvements in the accuracy of mid- and long-range weather forecasts in the world.

INTERNATIONAL METEOROLOGICAL NETWORKS

In the nineteenth and twentieth centuries, several regional and national meteorological organizations were established to monitor weather conditions. The computer models were developed to match the 20th century temperature rise by adjusting many input parameters and using strong positive feedbacks. The number and the lengths in time of sunspots were correlated very closely with average temperatures on earth (Dunlop, 2009:08). Modern meteorological organizations provide weather forecasts ranging from 24 hours to several days on the basis of technological advancements and computer applications.

The European Centre for Medium-range Weather Forecasts was established in 1970s to develop operational NWP forecasts for the medium range by utilizing the funds given by major European meteorological services. The center was considered as the best in the world by the meteorologists. The US National Center for Environmental Prediction was established to develop ensemble methods and advanced computing facilities (Fukuoka, 2009:10).

Countries like England, Sweden, Australia, China, Japan, Korea, France, Brazil and Canada also established the meteorological centers in 1970s. During this period, most of the major meteorological agencies around the world were well established (Klein, et. al. 2009:12). These organizations had used NWP methods as the basis of their operational forecasts.

The National Aeronautics and Space Administration (NASA) is an independent agency of the executive branch of the United States federal government. This organization is responsible for the civilian space program as well as aeronautics and aerospace research. The weather forecasters can improve their predictions for gale force winds, storm surges and coastal flooding. The NASA also has the Rover Environmental Monitoring Station (REMS) which measures and provides daily and seasonal reports on atmospheric pressure, humidity, ultraviolet radiation at the Martian surface, wind speed and direction, air temperature, and ground temperature around the rover.

The National Oceanic and Atmospheric Administration (NOAA) is a systematic

study of the structure and behavior of the ocean, atmosphere and related ecosystems. It also includes discoveries and ever new understanding of the oceans and atmosphere. The science basically provides the foundation and future promise of the service and stewardship. The NOAA services include climate predictions and projections; weather and water reports, forecasts and warnings; nautical charts and navigational information; and the continuous delivery of a range of earth observations and scientific data sets for use by public, private, and academic sectors. The foundation of NOAA's long-standing record of scientific, technical, and organizational excellence is its people. The diverse functions require an equally diverse set of skills and constantly evolving abilities in its workforce.

CONTEMPORARY WEATHER FORECASTING

The operational weather sounding system was upgraded in the 1990s to improve the status of weather forecasting. The Atmospheric Infrared Sounder (AIRS), the Advanced Microwave Sounding Unit (AMSU) and the Humidity Sounder for Brazil (HSB) were developed in the early 21st century (Yorke, 2010). These developments also enabled the meteorologists to improve and extend their predictions and reduce the number of significant prediction mistakes.

Weather forecasting offers several benefits to various stakeholders in the world in the present times (Watts, 2011:22). The weather forecasting has been enriched by advances in satellite technology, a sweeping acceleration in worldwide communications and overwhelming increases in computing power.

The meteorological services became more accurate in 1980s. The advent of high bandwidth communication networks in the 1990's facilitated a wide range of guidance from numerical models. The communication networks also played a vital part in operational meteorology (Risiro, et. al. 2012:18). The recent advancements in operational forecasting have enhanced the computing power to meteorological agencies. There is still a fundamental place in the weather forecasting process for human experts. The advanced numerical models of the atmosphere have produced forecasts which diverge significantly from reality even at quite short time ranges (Neméghaire, 2013:15). Television, Internet and other channels are used to present weather forecasts all over the world.

WEATHER MONITORING SATELLITES

The NASA began its satellite development programme in 1960. It basically develops weather satellites for the benefit of mankind. The organization had launched 10 TIROS satellites in 1965. The weather satellites have proven key to helping saving lives during natural disasters. The NASA launched the first Geostationary Operational Environmental Satellite in 1975. In combination with polar-orbiting satellites, these spacecraft gave weather forecasters a powerful toolkit to monitor the planet. The satellites enable the scientists to monitor and forecast space weather across the globe. The NASA also launched the geostationary weather satellites with the GOES-R series in 2015.

The instruments of NASA enable the researchers to observe cloud and surface changes more rapidly for correct prediction of weather conditions. The services facilitate the mapping of lightning flashes for early warnings of storm intensification. The monitoring of solar radiation also facilitates better forecasting of space weather and early warnings of possible impacts to the earth environment. The BBC has secured the commercial contract to provide daily forecasts for various international broadcasting organizations. The institution has been recognize as the prominent source of world weather service. A separate weather center has been established with a view to provide tailored weather reports every 24 hours across the globe.

Weather forecasting is based on the efforts made by the meteorologists who depend on advanced models, technologies and applications. The users of weather forecasts have substantial experience with forecasts and subsequent weather conditions (Andrews, 2015:03). The weather forecasts also have certain practical limitations despite the recent advances in ensemble forecasting, growing understanding of potential pitfalls of deterministic forecasting, and evolving user needs (Alfred, 2016:02). The meteorologists often find it challenging to communicate uncertainty effectively.

The latest satellites have also carried Data Relay Transponders (DRT) to facilitate reception and dissemination of meteorological data from in-situ instruments located across vast and inaccessible areas (Milham, 2017:14). The Indian Space Research Organizations has developed ground based observation systems such as, Automatic Weather Station (AWS), Agro-meteorological (AGROMET) Tower and Doppler

Weather Radar (DWR) as well as Vertical Atmospheric Observations System such as GPS Sonde and Boundary Layer LIDAR (BLL). These ground based system would augment the space based observations and validating the outcomes pertaining to various earth system processes. Weather forecasting has become an important instrument of natural disaster management. Weather forecasting can certainly reduces the risk of loss of life and injury on the basis of good evacuation plans, environmental planning and design standards.

CONCLUSION

The subject of weather forecasting has gained significance in the wake of climate change. Weather communication enables the people in all walks of life to adapt themselves to the changing weather conditions. The media have a great social responsibility of educating the people about climate change and weather conditions. The goal of sustainable development cannot be achieved in the absence of systematic climate change centered and weather forecasting oriented communication in modern times. The modern meteorological institutions play a crucial role in the process of weather forecasting which matters most from sustainable development point of view.

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