

Types of Weather Forecasting and its Importance

JatinderKaur and Gursewak Singh

Punjab Agricultural University, Ludhiana, 141004

Corresponding author: jkbrar7@gmail.com

ARTICLE ID: 021

INTRODUCTION

Weather simply refers to the condition of air on the earth at a given place and time. It is a continuous, data-intensive, multidimensional, dynamic and chaotic process. Knowledge of meteorology forms the basis of scientific weather forecasting, which revolves around predicting the state of the atmosphere for a given location. Weather forecasting as practiced by humans is an example of having to make judgments in the presence of uncertainty.

Weather forecasts provide critical information about future weather. There are various techniques involved in weather forecasting, from relatively simple observation of the sky to highly complex computerized mathematical models. Weather prediction could be one day/one week or a few months ahead. Weather forecasts are based on temperature; wind speed and relative humidity are very important attributes in agriculture sector as well as many industries which largely depend on the weather condition.

DEFINITION

Weather forecasting is the application which combines science and technology to predict the state of atmosphere for future time at a given location. Actually weather forecasting was and is a big arrangement of time, funds, talent and absolute use of technology. It involves computing complex mathematical calculations.

Weather forecasts are made by collecting quantitative data about the current state of the atmosphere at a given place and using scientific understanding of atmospheric processes to project how the atmosphere will change. Weather forecasting entails predicting how the present state of the atmosphere will change.

Prime requirements for weather forecasting

1. A good data set
2. A good method which can be used to forecast.

Weather data used in forecasting

The following weather elements are measured routinely:

1. Pressure, temperature, wind (speed and direction) humidity.
2. Rainfall, cloud (type and amount), visibility pressure change, present and past weather, maximum and minimum temperatures etc.

Types of observations

The main observations used in different weather forecasting types are as follows:

1. Surface observations
2. Upper air observations
3. Aircraft observations
4. Radar observations
5. Satellite observations

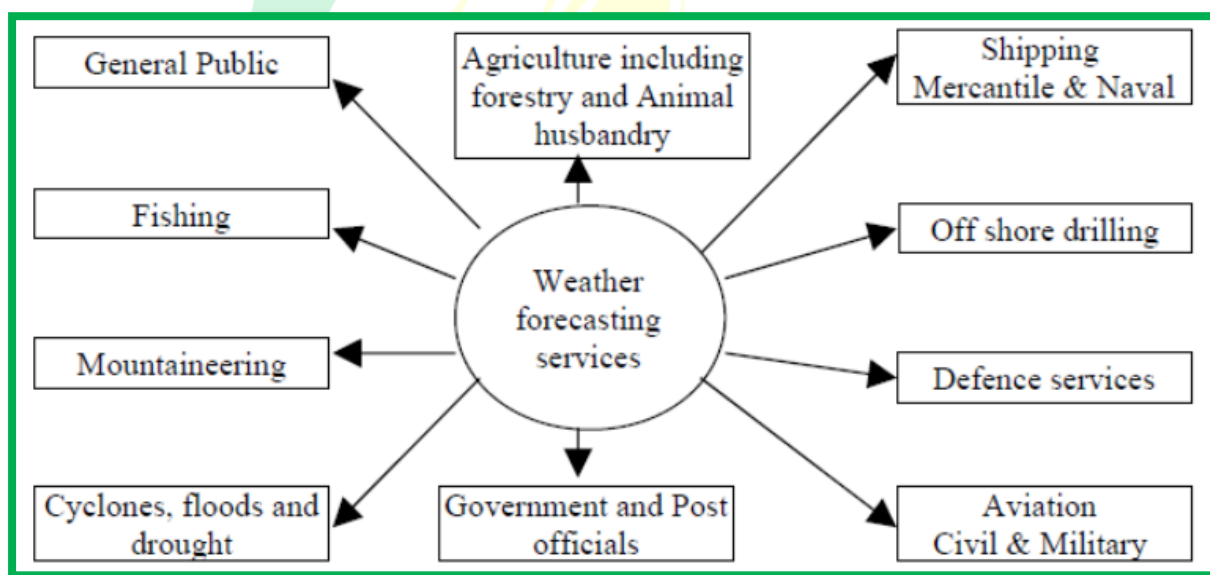
This information is sent to meteorological centers where the data are collected, analyzed and made into a variety of charts, maps and graphs. Modern high-speed computers transfer the many thousands of observations onto surface and upper-air maps.

IMPORTANCE OF WEATHER FORECASTING

Weather forecasting is used in many situations like severe weather alerts and advisories, predicting the behaviour of the cloud for air transport, prediction of waterways in a sea, agricultural development and avoiding forest fire.

- Weather forecast is very important because it can be used to protect life and property.
- Weather forecasting is important in organizing and planning our daily life programs.
- Its prediction makes our decision well for a particular day and time.
- For a pilot to be known of weather conditions to schedule the flight.
- For a businessman to be informed about the loss and profit in his business for an unexpected and impulsive situation.
- For a farmer to yield a healthy crop. Among different factors that influence crop production, weather plays a decisive role as:
 - ❖ Aberrations in it alone explain up to 50 per cent variations in crop production.
 - ❖ Rainfall is most important among the required forecast, which decides the crop production in a region and ultimately the country's economy.
 - ❖ Planning for moisture conservation under weak monsoon condition and for flood relief under strong monsoon condition is important in a region.

- ❖ A reliable weather forecasting when disseminated appropriately will pave way for the effective sustainability.
- ❖ One can minimize the damage, which may be caused directly or indirectly by unfavourable weather.
- ❖ The recurring crop losses can be minimized if reliable forecast on incidence of pest and diseases is given timely based on weather variables.
- ❖ Help in holding the food grain prices in check through buffer stock operations. This means that in good monsoon years when prices fall, the government may step in and buy and in bad years when price tend to rise, it may unload a part of what it had purchased.
- ❖ Judicious use of water can be planned in a region depending up on the forecast.



❖ **Agricultural development**

Weather plays an important role in agricultural production. It has a profound influence on the growth, development and yields of a crop, incidence of pests and diseases, water needs and fertilizer requirements in terms of differences in nutrient mobilization due to water stresses and timeliness and effectiveness of prophylactic and cultural operations on crops. Weather aberrations may cause:

- (i) Physical damage to crops
- (ii) Soil erosion

The quality of the crop produced during movement from field to storage and transport to market depends on weather. Bad weather may affect the quality of the produce during transport, viability and vigour of seeds and planting material during storage.

❖ **Avoiding Forest fire**

Weather forecasting of wind, precipitations and humidity is essential for preventing and controlling wild fires. Different indices, like the Forest fire weather index and Haines Index, have been developed to predict the areas more at risk to experience fire from natural or human causes.

❖ **Military applications**

Military weather forecasters present weather conditions to the war fighter community. Military weather forecasters provide pre-flight and in-flight weather briefs to pilots and provide real time resource protection services for military installations. Naval forecasters cover the waters and ship weather forecasts. The Navy provides a special service to both themselves and the rest of the federal government by issuing forecasts for tropical cyclone across the Pacific and Indian Oceans through their Joint Typhoon Warning Center.

❖ **Air Force**

Air Force Weather provides weather forecasting for the Air Force and the Army. Air Force forecasters cover air operations in both wartime and peacetime operations and provide Army support. Military and civilian forecasters actively cooperate in analyzing and creating weather forecast products.

SCOPE OF WEATHER FORECASTING

Crops are to be sown at the optimum period for maximum yield; helps to minimize the crop losses due to excess rainfall, cold/heat waves, cyclones etc. It helps in forecasting pests and diseases, choice of crops, irrigation and other intercultural operations through short, medium and long-range forecasts. Some scopes are given below:

- ✚ To study climatic resources of a given area for effective crop planning.
- ✚ To evolve weather based effective farm operations.
- ✚ To study crop weather relationships in all important crops and forecast crop yields based on agro-climatic and spectral indices using remote sensing.
- ✚ To study the relationship between weather factors and incidence of pests and diseases of various crops.

- ✚ To delineate climatic/agro-ecological/agro-climatic zones for defining agro climatic analogues so as to make effective and fast transfer of technology for improving crop yields.
- ✚ To prepare crop weather diagrams and crop weather calendars.
- ✚ To develop crop growth simulation models for assessing/obtaining potential yields in different agro-climatic zones.
- ✚ To monitor agricultural droughts on crop-wise for effective drought management.
- ✚ To develop weather based agro-advisories to sustain crop production utilizing various types of weather forecast and seasonal climate forecast.
- ✚ To investigate microclimatic aspects of crop canopy in order to modify them for increased crop growth.
- ✚ To study the influence of weather on soil environment on which the crop is grown.
- ✚ To investigate the influence of weather in protected environment (e.g. Glass houses) for improving their design aiming at increasing crop production.

TYPE OF WEATHER FORECASTING

Weather forecasting now has a wide range of operational products that traditionally are classified under the following groups:

Types of forecast	Validity period	Main users	Predictions
1. Short range a) Now casting	Up to 72 hours 0-2 hours	Farmers marine Agencies, general public	Rainfall distribution, heavy rainfall, heat and cold wave conditions, thunder storms etc.
b) Very short range	0-12 hours		
2. Medium range	Beyond 3 days and upto 10 days	Farmers	Occurrence of rainfall, temperature.
3. Long range	Beyond 10 days upto a month and a season.	Planners	This forecasting is provided for Indian monsoon rainfall. The outlooks are usually expressed in the form of expected deviation from normal condition.

Each weather forecast can be defined on the basis of the following criteria:

- ✚ Dominant technology
- ✚ Temporal range of validity after emission
- ✚ Characteristics of input and output time and space resolution
- ✚ Broadcasting needs
- ✚ Accuracy

METHODS USED IN WEATHER PREDICTION

1. SYNOPTIC METHOD

This is a subjective technique. In this method weather charts are analysed and the analogous situation happened in the past are matched with present situation. This method is useful for present situation. This method is useful also for short range forecast. The success of the forecast depends on the skill and experience of the forecaster.

2. STATISTICAL METHODS

In this method correlations and regressions are calculated using weather elements. This method is useful for long range weather forecast. Records of average temperatures, average rainfall and average snowfall over the years give forecasters an idea of what the weather is "supposed to be like" at a certain time of the year.

3. NUMERICAL METHODS

This is basically an objective technique. Several equations are solved numerically using high speed and large memory computers. This method is useful for short and medium range forecasts.

TRADITIONAL WEATHER FORECASTING

In ancient times, forecasting was mostly based on weather pattern observation. Over the years, the study of weather patterns has resulted in various techniques for rainfall forecasting. Present rainfall forecasting embodies a combination of computer models, interpretation, and an acquaintance of weather patterns. The following technique was used for existing weather prediction.

❖ Persistence

The simplest method of forecasting the weather was persistence relies upon today's conditions to forecast the conditions tomorrow. This can be a valid way of forecasting the weather when it is in a steady state, such as during the summer season in the tropics. This

method of forecasting strongly depends upon the presence of a stagnant weather pattern. Therefore, when in a fluctuating weather pattern, this method of forecasting becomes inaccurate. It can be useful in both short range forecasts and long range forecasts.

❖ **Use of a barometer**

Measurements of barometric pressure and the pressure tendency (the change of pressure over time) have been used in forecasting since the late 19th century. The larger the change in pressure, especially if more than 3.5 hPa (2.6 mmHg), the larger the change in weather can be expected. If the pressure drop is rapid, a low pressure system is approaching, and there is a greater chance of rain. Rapid pressure rises are associated with improving weather conditions, such as clearing skies.

❖ **Looking at the sky**

Along with pressure tendency, the condition of the sky is one of the most important parameters used to forecast weather in mountainous areas. Thickening of cloud cover or the invasion of a higher cloud deck is indicative of rain in the near future. At night, high thin cirrostratus clouds can lead to halos around the moon, which indicates an approach of a warm front and its associated rain. Morning fog portends fair conditions, as rainy conditions are preceded by wind or clouds which prevent fog formation. The approach of a line of thunderstorms could indicate the approach of a cold front. Cloud-free skies are indicative of fair weather for the near future. A bar can indicate a coming tropical cyclone.



MODERN WEATHER FORECASTING

❖ **Use of forecast models**

In the past, the human forecaster was responsible for generating the entire weather forecast based upon available observations. Today, human input is generally confined to

choosing a model based on various parameters, such as model biases and performance. Using a consensus of forecast models, as well as ensemble members of the various models, can help reduce forecast error. Humans are required to interpret the model data into weather forecasts.

❖ **Analog technique**

The analog technique is a complex way of making a forecast, requiring the forecaster to remember a previous weather event which is expected to be mimicked by an upcoming event. It remains a useful method of observing rainfall in places such as oceans, as well as the forecasting of precipitation amounts and distribution in the future. A similar technique is used in medium range forecasting, which is known as tele-connections, when systems in other locations are used to help pin down the location of another system within the surrounding regime.

❖ **Numerical Forecasting**

A number of weather forecasting agencies operate modeling centers where supercomputers are used to run NWP models that span the entire globe. These include

- ✚ National Center for Environmental Prediction (NCEP) in the United States
- ✚ United Kingdom Meteorological Office (UKMO)
- ✚ European Centre for Medium-range Weather Forecasts (ECMWF)

❖ **Ensemble Forecasting**

To predict the weather forecast meteorologists have developed atmospheric models that approximate the atmosphere by using ensemble forecasting to describe how atmospheric temperature, pressure and moisture will change over time. The equations are programmed into a computer and the data on the present atmospheric conditions are fed into the computer. The computer solves the equations to determine how the different atmospheric variables will change over the next few minutes.

The computer repeats this procedure again and again using the output from one cycle as the input for the next cycle. For some desired time in the future, the computer prints its calculated information. It then analyzes the data, drawing the lines for the projected position of the various pressure systems. Weather forecasts made for 12 and 24 hours are typically accurate. Forecasts made for two or three days are usually good. Beyond above five days, forecast accuracy falls off rapidly. Weather information can also come from remote sensing, particularly radar and satellites.

❖ Radar

Radar stands for **Radio Detection and Ranging**. In radar, a transmitter sends out radio waves. The radio waves bounce off the nearest object and then return to a receiver. Weather radar can sense many characteristics of precipitation, its location, motion, intensity, and the likelihood of future precipitation. Most weather radar is Doppler radar, which can also track how fast the precipitation falls. Radar can outline the structure of a storm and in doing so estimates the possibility that it will produce severe weather condition.

❖ Weather satellites

Weather satellites have been increasingly important sources of weather data since the first one was launched in 1952 (Sputnik I). Weather satellites are the best way to monitor large scale systems like storms. Satellites can also monitor the spread of ash from a volcanic eruption, smoke from fires, and pollution. They are able to record long-term changes. Figure given below shows one of the geostationary satellites that monitors conditions over the world. Weather satellites may observe all energy from all wavelengths in the electromagnetic spectrum. Most important are the visible light and infrared (heat) frequencies.



Figure: Geo-stationary satellites

❖ Weather maps

Weather maps simply and graphically depict meteorological conditions in the atmosphere. Weather maps may display only one feature of the atmosphere or multiple features. They can depict information from computer models or from human observations. Weather maps are found in newspapers, on television, and on the Internet. On a weather map, each weather station will have important meteorological conditions plotted. These conditions may include temperature, current weather, dew point, cloud cover, sea level air pressure, wind speed and direction. On a weather map, meteorologists use many different symbols. These symbols give them a quick and easy way to put information onto the map.

Conclusion

- ✚ Over the last 2,000 years, the prediction horizon of state of the art weather forecasts has advanced significantly from seeing one day ahead based on the color of the sky to almost a two-week outlook.
- ✚ The risk management community moved more quickly, as in only a few years, the very concept of a weather forecast has changed from a single best guess of the future to a distribution of likely future weather scenarios.
- ✚ The ultimate aim of accurate probability forecasts of commercially relevant variables is being pursued on time scales from a few hours to several months.

