# Topic Page: Weather forecasting

Definition: **weather forecast** from *The Macquarie Dictionary*

## 1.

a description of the prevailing weather conditions and a forecast of those of the immediate future, based on meteorological observation.

weather forecasts

Summary Article: **weather forecast**
From *The Hutchinson Unabridged Encyclopedia with Atlas and Weather Guide*

Prediction of changes in the weather. The forecast is based on several different types of information from several sources. Weather stations are situated around the world, on land, in the air (on aircraft and air balloons), and in the sea (on ships, buoys, and oilrigs). Forecasters also use satellite photographs which show cloud patterns, and information from the Meteorological Office, such as a synoptic chart which shows atmospheric pressure and changes in air masses (known as a weather front). The information is used to predict the weather over a 24-hour period, and to suggest likely changes over a period of three or four days.

Forecasts may be short-range (covering a period of one or two days), medium-range (five to seven days), or long-range (a month or so). Weather observations are made on an hourly basis at meteorological recording stations – there are more than 3,500 of these around the world. Numerous nations participate in the exchange of weather data through the World Weather Watch programme, which is sponsored by the World Meteorological Organization (WMO), and information is distributed among the member nations by means of a worldwide communications network. Incoming data is collated at weather centres in individual countries and plotted on weather maps, or charts. The weather map uses internationally standardized symbols to indicate barometric pressure, cloud cover, wind speed and direction, precipitation, and other details reported by each recording station at a specific time. Points of equal atmospheric pressure are joined by lines called isobars and from these the position and movement of weather fronts and centres of high and low pressure can be extrapolated. The charts are normally compiled on a three-hourly or six-hourly basis – the main synoptic hours are midnight, 0600, 1200 and 1800 – and predictions for future weather are drawn up on the basis of comparisons between current charts and previous charts. Additional data received from weather balloons and satellites help to complete and corroborate the picture obtained from the weather map.

**Early forecasts** In the early days of weather forecasting, when few recording stations were available, the features that stood out most clearly on weather maps were the patterns made by isobars, forming regions of low pressure (depressions or cyclones), regions of high pressure (anticyclones), and the connecting patterns: ridges, troughs, cols, and secondary depressions.

One of the founders of meteorology as a science was the Dutch mathematician, physicist, and meteorologist Christoph Hendrik Diederik Buys Ballot, who was a professor at the University of Utrecht. He advocated international cooperation in the field of meteorology and in 1854 founded the Royal Netherlands Meteorological Institute. The invention of the telegraph made the collation of simultaneous weather observations possible, and enabled Buys Ballot to set up a wide network for the exchange of weather data. Nowadays, he is best known for his observation made in 1857, known as Buys Ballot's Law, that if one stands with one's back to the wind in the northern hemisphere, atmospheric pressure will be lower on the left than on the right, and the converse in the southern hemisphere. In fact, unknown to Buys Ballot, a theory to this effect had already been put forward by a US meteorologist, William Ferrel, who expanded on this with a theory on the deflection of air currents on the rotating Earth.

**Gradient and geostrophic winds** Ferrel's law was confirmed by the formula that gave a theoretical speed and direction to the wind in the free atmosphere known as the gradient wind. This wind blows along the isobars with a speed proportional to the pressure gradient between the isobars (the closer together the isobars, the stronger the wind). It is increased by a smaller quantity for anticyclonic curvature, and decreased similarly for cyclonic curvature of the isobars. The effect of the curved isobars is normally small enough to neglect; this wind is known theoretically as the geostrophic wind.

However, both the gradient and geostrophic winds neglect to take into account the effect of change of pressure with time and vertical motion, as well as frictional forces. These values are all generally small and the wind speed at about 600 m/1,970 ft above the surface may be read off the synoptic chart by placing a scale appropriate to the latitude across the isobars. Surface wind is affected considerably by friction and the configuration of the land, especially in hilly regions where it tends to blow along the valleys; the speed is usually less than the gradient wind, and the direction at an angle (often 20–30°) across the isobars from high pressure to low. The effects neglected by the gradient–wind equation are important, for it is these that lead to inflow of surface air to regions of low or falling pressure and, conversely, of outflow from regions of high and rising pressure. If the surface air is flowing into a region then the air must escape by rising and spreading out aloft; this leads to adiabatic cooling and instability, cloud, and unsettled weather. Conversely, diverging air leads to subsidence, adiabatic warming, stability, clear skies, and settled weather. These theories are, in general, confirmed by the observation of unsettled weather in depressions and settled weather in anticyclones.

**Orographic rain** When air blows over hills and mountains it is forced to rise and, if it contains enough moisture, cloud is formed; if the process continues long enough, or the air is very moist or unstable, rain falls. This type of rain is called orographic rain, and tends to be prevalent on coasts exposed to frequent winds from the sea. Even if the humidity of the air is not sufficient to produce rain, drizzle often occurs, and even very low hills may be shrouded in cloud; these are the conditions that produce a mist in the Western Isles of Scotland or the *crachin* of South China. Areas on the leeside of the hills are likely to experience finer and drier weather as the air will have lost most of its moisture before reaching them and many of the clouds will have dispersed.

**Weather fronts** During World War I, Norwegian meteorologists Vilhelm Bjerknes and his son Jacob, using a very close network of reporting stations, noticed that the change from one relatively homogenous type of air mass to another was often very rapid with clear demarcations which they termed fronts. They found that these frontal zones are regions of widespread cloud development and precipitation, and that the air masses exhibit specific changes in weather characteristics as they move from colder to warmer regions and vice versa. As an air mass moves to a warmer region, the lower atmosphere becomes warm and the air becomes unstable, leading to convective cumulus cloud and showers; on the other hand, when an air mass moves over colder regions the lower air becomes colder, resulting in condensation and the development of fog or a very low layered cloud known as stratus.

From these observations Jacob Bjerknes produced the theory that the atmosphere consists of warm (tropical) and cold (polar) air masses separated by distinct boundaries (fronts) and that it is wave disturbances in these fronts that give rise to cyclones or depressions. This theory greatly aided the accuracy of weather forecasting. In 1939 Bjerknes emigrated to the USA where he contributed significantly to the war effort by training meteorologists for the US aviation services.

**Modern forecasting** Meteorologists, aided by communications and computer technology, are increasingly able to refine the accuracy of forecasts, but however sophisticated the techniques become there will always be an element of the unknown in any forecast which, as shown by the chaos theory, is unlikely to be eliminated. This is often referred to as the 'butterfly effect' – the flapping of a butterfly's wings, or a small gust of wind, on one side of the Earth will have an ongoing effect that will eventually be felt on the opposite side of the globe.

The effects of changes in the weather are wide-ranging. On a personal level, a weather forecast helps individuals to make plans for activities that depend on certain types of weather. Weather predictions allow emergency services to prepare for severe weather conditions. Global forecast services are provided to help aviation and shipping around the world; this information is necessary both for world travel and for world defence systems.

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