

A large proportion of our weather changes can be accounted for in this way, but clearly not all. A long front such as that mentioned has been shown by the Norwegian school on both theoretical and observational grounds to be unstable. Consequently, instead of running in a straight or gently and uniformly curved line, it tends to break up into waves. Some of these waves become very strongly developed and form what have always been recognized here as cyclones. But the difference between them and smaller waves, which were in many cases not recognized at all, is a matter of degree only. The smaller waves account for many of the irregularities in wind, rain, &c., which occur in our normal westerly depression. The waves move rapidly along the main cold front in a poleward direction. The cold air spreads out into the warm air on the northern side of the wave, while in the middle, the warm air forms a bay in the cold. On the southern side of this warm sector is what is called the "warm front" where the warm air is climbing up over the cold. Owing, however, to the almost constant eastward advance of the low-pressure trough, carrying the waves along with it, warm front phenomena are seldom easily recognizable in New Zealand. There is no doubt that the introduction of frontal methods will explain many phenomena in New Zealand weather which have hitherto been obscure.

It is interesting to note that the Norwegian methods were officially adopted for all work a year or two ago in Great Britain and a recent Commission of inquiry in America recommended their gradual adoption by the United States Weather Bureau as officers were able to become versed in them. It is very difficult for a single worker to become expert in frontal meteorology merely by reading published papers. In Norway the method has been developed by a coterie of brilliant researchers and is continually being improved and expanded. In 1931, the writer was able to get a good preliminary appreciation of the method in the course of a week's visit to Bergen. Thereafter, gradual progress was being made in the application of the method to local conditions, which differ very considerably from those of Europe. Fortunately for this Branch, however, an experienced Norwegian forecaster, in the person of Mr. J  rgen Holmboe, was attached to the Lincoln Ellsworth Antarctic Expedition. Mr. Holmboe has spent a considerable time at the Meteorological Office, Wellington, partly before the departure of the Expedition and partly since its return. While here, he has, in such time as was available, thrown himself enthusiastically into the study of local weather conditions, and, with the assistance of his special knowledge, it has been possible to gain a much clearer insight into the methods used by his countrymen. Owing to New Zealand's isolation, this is not likely to lead to any revolutionary improvement in the weather forecast, but it will add greatly to the interest and understanding of weather processes. This is bound to produce a gradual increase of accuracy in forecasting, especially when it comes to the detailed work required for aviation purposes. For the method to be used successfully, however, we need, in addition to the Australian reports already mentioned, additional staff in order that reports may be charted as expeditiously as possible and the forecasting officer have time to consider the position fully and give proper attention to all aspects of the various forecasts required. At present the officer has to plot his reports hurriedly and without further consideration proceed immediately to the preparation of the various reports and forecasts. In no other service is the forecaster so pressed for time. In the greater majority of cases a forecast has to be issued without any information from west of New Zealand, which for our purposes is the most important region.

The special forecasts asked for during the year indicate that very much increased attention is being paid by farmers to the weather forecasts in planning the day's work. Special mention may be made of warnings of approaching frost.

#### UPPER-AIR OBSERVATIONS.

The programme of pilot balloon observations as described last year has been continued.

Reference was made previously to the presence at Wellington of Mr. J. Holmboe, of the Lincoln Ellsworth Antarctic Expedition. Mr. Holmboe had been provided by the International Polar Year Commission with a number of "radio-sondes." A radio-sonde is a piece of apparatus which is sent up into the air attached to a hydrogen-filled balloon in order to explore conditions in the upper levels. If the temperature and pressure at all levels be known, it is possible to deduce most of the remaining characteristics of the atmosphere. The instrument, therefore, has means of recording the temperature and pressure of the air through which it rises. Connected with the recording parts is a wireless transmitter which, by means of appropriate signals, is able to indicate the progressive changes. The signals are picked up in a receiver and an account of the structure of the atmosphere is thus obtained. The type of "sonde" previously used merely carried its record with it. When the balloon burst this fell to the ground, and if fortune were favourable it was picked up and sent to the institution which made the ascent. But the chances of the record being picked up in polar regions are very slight indeed, and in New Zealand it would almost invariably be carried so far by the winds that it would fall into the sea. The advantages of the radio-sonde are, therefore, obvious. But, since it has to be extremely light, it is a very delicate piece of apparatus. Also, it is of a new type, and much remains to be learned regarding the best method of construction. It, therefore, requires very skilled use, and is easily put out of order by rough handling. Owing to the damage to its aeroplane, the stay of the Ellsworth Expedition in the Antarctic was very brief. Mr. Holmboe had no time to launch his radio-sondes, and so brought them back to New Zealand. But they suffered considerably owing to the rolling of the expedition's vessel and the jarring resulting from the ramming of pack ice. The large rubber balloons used, also, deteriorate with age. It was decided, therefore, to send up most of the sondes at Wellington after overhaul, repair, and calibration. A certain number of ascents have already been made, and although the heights reached, chiefly through the failure of the balloons, have not been as great as was hoped for, some very interesting information has been obtained. The complete discussion will, of course, take some time. Very little data are available from the high levels of the atmosphere in the Southern Hemisphere, so that Mr. Holmboe's results will be especially valuable.

He has been assisted in his work by Mr. R. G. Simmers, of the Meteorological Office staff.