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AIR-MASS WEATHER

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In the following five chapters, information of a mainly descriptive nature is presented which, it is hoped, will help the meteorologist both in the process of analysis and in forecasting. The main emphasis is on the weather accompanying synoptic systems at various stages during their history and, in a qualitative way, on the physical and dynamical processes producing the weather. In analysis the information should aid the forecaster in the identification of synoptic systems and in building a mental 'model' of each system which will be a help in predicting the future development. These ideas will be developed more fully in the chapters on analysis and forecasting.

Having predicted the likely development of the synoptic pattern, the forecaster must then decide what weather is expected over the area of interest. For forecasts up to a few hours ahead it is sometimes possible to rely on continuity or extrapolation, or, if conditions are such that a single process is dominant, as on a calm, clear night when nocturnal radiation plays a major role, it may be possible to allow for that process in a roughly quantitative way. However, for most purposes, and particularly for forecasts for more than a few hours ahead, the forecaster must rely to a large extent on his experience of similar situations in the past. The following chapters cannot provide a substitute for experience, but they are intended as a framework upon which the forecaster can build as he gains knowledge on the bench.

The forecaster should also study any material on local forecasting and features which may have been noted and recorded at his station. The publication 'Aerodrome weather diagrams'[1] contains a wealth of information on local weather features at many stations both at home and abroad.

CHAPTER 4

AIR-MASS WEATHER

4.1 INTRODUCTION

The concept of an air mass implies rather uniform properties of the air over a fairly large area, and it is only when an air mass is over its source region for long enough to reach equilibrium that the actual conditions approach the ideal. As soon as an air mass begins to move away from its source under the influence of the large-scale flow pattern its structure and properties begin to change as a result of many processes - radiation, heat exchange with the surface, evaporation, condensation, vertical motion, wind shear, etc. The British Isles lie a good distance from any of the main air-mass sources and most air masses have undergone considerable changes before arrival, the changes depending largely upon the properties of the original air mass, the trajectory and the properties of the underlying surface along the trajectory. These changes, and more particularly the variability of the changes from occasion to occasion, severely limit the usefulness of the air-mass concept as a forecasting tool. Even elaborate schemes, such as that of Belasco,[2] which attempt to take into account the changes along the trajectory, have proved of little value in day-to-day forecasting.

In addition, although the air mass is nearly homogeneous and barotropic in its source region, the modifications which occur as the air moves away from the area introduce a degree of baroclinicity, generally recognizable from the thickness pattern. When the synoptic conditions combine in such a way to concentrate the baroclinicity into a relatively narrow, elongated band, frontogenesis may occur, and the forecaster should be on the alert for signs that this is happening. When such developments occur, the associated weather is more analogous to that associated with fronts or depressions and many of the remarks in this chapter on air-mass weather will not be applicable.

There have been several classifications of air masses but, as explained earlier, there seems to be little value in attempting to apply these to forecasting in the neighbourhood of the British Isles, and in this chapter only two broad divisions will be made, namely, 'warm' air and 'cold' air. Generally, an air mass will be regarded as 'warm' if it originated in southerly latitudes and is travelling or lying over a cooler surface. On the other hand, air will be regarded as 'cold' if it originated in northerly latitudes and is travelling or lying over a warmer surface. Even this broad generalization is not rigid, however; air classified as warm when passing over a cooler sea may, in summer, move over a heated land surface where it may be regarded as cold air. The converse happens in winter when a cold air mass traversing a warmer sea encounters a colder land surface. Although on physical grounds the classification is primarily based on the direction of heat transfer near the surface (upwards for cold air, downwards for warm air), it seems reasonable to ignore the minor discrepancies mentioned above and treat the two cases as warm and cold air respectively along with the major body of the air mass.

4.2 WARM AIR

The main feature that warm air masses have in common is that they are generally losing heat to the cooler surfaces over which they are travelling. Cooling from below leads to increasing stability in the lowest layers, and the height to which the cooling extends is mainly limited by the depth of the turbulent boundary layer, with radiation generally acting more slowly to spread the cooling through a deeper layer.

Most commonly, warm air over the British Isles is of maritime origin and is associated with frontal depressions; in air-mass classifications it is usually designated 'maritime tropical'. The remarks in this section refer to the properties of such air well away from the frontal zones of the depression. Originating over the subtropical parts of the Atlantic Ocean, this type of air is generally very moist, particularly in the lowest layers. Cooling as the air passes over colder waters often leads to saturation and the condensation of water vapour to form sea fog or low stratus. The moister the initial state of the air and the greater the cooling, the lower is the expected cloud base and the greater is the probability of fog. The wind speed also has an effect on the height of the cloud base; increasing wind speed leads to an increase in the depth of the turbulent boundary layer, partly as a result of greater surface roughness (larger waves), and drier air from aloft is mixed into the surface layer leading to a higher cloud base or reduced chance of sea fog. Low cloud or sea fog may occur at all times of the year, but they are more common in late winter or spring when cooling is more marked. At times the low cloud may be thick enough and persistent enough to produce drizzle or slight rain.

On reaching land, conditions in warm maritime air depend strongly upon season and topography. With very moist air in the surface layers, particularly in winter, cloud bases over the coast and over hills near the coast can be very low - often below 300 feet (100 metres). As the air moves inland, cloud bases are usually rather higher as a result of the greater intensity of turbulence over land and the entrainment of drier air from aloft as the mixing layer extends upwards. In winter, the cloud layer does not often break up inland, but when it does the result is a mild, sunny day in sheltered areas. At such times the incidence of low stratus inland can be very variable, with topography exerting an important influence on the amounts and heights of low cloud downwind. Gaps in or between ranges of hills sometimes lead to a funnelling effect for some wind directions and enhanced penetration and advection of low cloud, while for other directions the hills may provide shelter for areas to their lee. For example, low stratus in a south-westerly flow can readily be advected through the Severn valley into the Midlands, while the North and South Downs, lying approximately west to east, provide some shelter for the lower Thames valley and estuary when a warm southerly current brings extensive low stratus to the south coast of England.

Although the bases of stratus inland are often higher than near the coast, they are not invariably so. If the ground is exceptionally cold and there is extensive snow cover, the continued cooling of the warm air may be sufficient to cause the cloud base to become lower - even down to the surface, as advection fog, if winds are fairly light. Such occurrences are not very common; they are most likely when a prolonged cold spell, with extensive snowfall, breaks down and the cold air is replaced by a mild, moist current.

In summer, the cloud often clears completely inland during the day, giving warm and sunny, but often rather humid, weather. The cloud may form again at night, or, if the wind becomes light, mist or fog patches may occur late in the night.

Often the warm maritime air is stable throughout the troposphere and, above the lowest levels and well away from the frontal zones, unsaturated and cloudless. These conditions are most likely when the air is barotropic, or nearly so, and, above the friction layer, wind direction varies little with height. If moist layers exist, vertical motion as the air flows over high ground may cause the formation of cloud layers; lee waves may be set up and wave clouds form, at times with spectacular results. There may be precipitation on some occasions, particularly to windward of, and over, high ground. Coastal convergence may at times cause sufficient uplift to produce precipitation.

In contrast to the extensive cloud sheets in moist maritime warm air, dry warm air which has subsided in anticyclonic regions may have but little cloud and what low cloud there is probably has a base near or somewhat above 2000 feet (600 metres). For example, when an anticyclone is situated over continental Europe with its western edge near France, a current of warm air may reach the British Isles as a southerly and relatively dry stream. With such currents the weather is often bright and sunny and sometimes very warm for the time of the year.

While a characteristic feature of many warm air masses near the British Isles is their stable stratification throughout much of the troposphere, some warm air masses do contain layers which are unstable. For example, in the summer half of the year instability in warm air is sometimes present at mid-tropospheric levels - instability in the layer from 700 (or perhaps as low as 800 millibars) to 500 millibars or above might be typical. If this instability can be realized then any cloud or precipitation which is formed will be of typical instability type. When upper instability is present in warm air the lower layers may contain an inversion or exhibit a stable lapse rate. There are two common ways in which the upper instability is sometimes realized. Day-time heating may produce a rise of temperature in the lower layers which is sufficiently large to surmount the stable layer, so that convection currents from the ground can rise until they enter the unstable layer. On the other hand, more general ascent of the air may be brought about dynamically, by convergence within or below the unstable layer. Clouds formed in this way are of convective type and, although they often have a high base (perhaps 5000 feet (1500 metres) or more), they are sometimes of deep vertical extent. With the large amount of moisture sometimes present in the lower levels of these warm air masses, heavy convectional precipitation may be released. Sometimes the storms are very heavy. A typical synoptic situation favourable for this type of weather is one with surface flow from somewhere around south, from France or the Low Countries, towards the British Isles, while the flow aloft is often from a south-westerly direction ahead of a cold trough to the west of the British Isles.

The problem on the forecast bench is to assess whether the instability at upper levels will be released by convection from below and/or by convergence and ascent in the unstable layer. If the upper instability is not released, the weather over the British Isles is then frequently sunny and very warm. Only relatively small amounts of cumulus cloud, which are often quite shallow, develop and exist for just a few hours after midday. On some occasions, however, there seems to be a combination of intense heating with the consequent release of convection from below over France coupled with an area of upper convergence often in north France or the Low Countries. This convergence causes the formation of an extensive area of medium and upper cloud. Such areas of unstable upper cloud are often orientated approximately east/west and are advected forward with the component of flow at about 700 millibars. These areas of convective activity seem to show a preference to form in the evening over France. Sometimes the weather over the southern British Isles on that same day has been generally hot or very hot, with any small amounts of cloud which formed dispersing about sunset. The disturbed cloudy zone over France moves with a northward component and is often accompanied by an outbreak of thundery rain which is sometimes very heavy. The rain sometimes continues for several hours, but at decreased intensity, after the thunderstorms have moved away northwards. Any thunderstorms which occur are often extensive but within the thundery zone it is sometimes possible to identify areas, perhaps 15 or 25 kilometres in horizontal extent, within which the severity of the thunderstorms is noticeably greater than in surrounding districts. On some occasions a squall line is associated with the thundery precipitation. Such squall lines often move with the speed and direction of the upper wind at about 700 millibars. This relationship is probably due primarily to the fact that the descending chilled air of the squall, originating at upper levels, carries its momentum down to ground level. These thundery outbreaks, spreading northwards from France, tend to reach the Channel coasts or south-eastern regions of England shortly after dark and usually continue to move with a northward component. During the ensuing day most outbreaks gradually lose their intensity but can usually be followed on a sequence of charts as an identifiable and readily recognizable system, often for as long as 12 or 18 hours by which time they have usually progressed up to or beyond the Scottish-English border. After such an outbreak the cold trough to westward usually moves eastwards across the country, but there is then seldom much precipitation associated with the cold front. Indeed it is often almost rainless.

A variant of this type of synoptic situation is one in which the cold trough or pool extends well southward of 45°N - usually to about 40°N and occasionally farther south. The trough is orientated between about south-west and south-south-west and is located between the Azores and Portugal or north-west Spain. Cold pools in this area often show a tendency in summer to persist over the relatively cold water to westward of Portugal and north-west Spain. In this situation there exists a belt of south to south-west thermal winds over Spain and Portugal and north-western France. Any convective activity bred by strong heating over Spain would tend to be carried towards the Bay of Biscay. Although each individual convective cell of any thundery outbreak is usually quite short lived, conglomerate areas of thundery activity sometimes exhibit a tendency to persist for several hours. In this type of situation the early morning sferic reports sometimes indicate areas of activity in the Bay of Biscay to northward of Spain. Presumably these are due to a continuance of activity bred the previous day over Spain, a continuance achieved by a complex of factors not yet fully understood. Whether the activity continues to persist and to move towards and affect south-western districts depends on the thermal structure and other developments. In quite a large number of cases the disturbed weather does not persist and/or move to affect the British Isles but this can seldom be forecast with confidence at the time the early morning sferic reports reveal its existence. If there are concomitant signs of the development of only a slight baroclinic disturbance or pressure trough in close proximity to the outbreak, it would be wise to include in the forecast some mention of the movement (and possible intensification) of the storms from the Bay of Biscay. Subsequent reports in that general area and direction received from all sources (for example, ground and upper air reports, aircraft observations, sferic and radar reports) should be very carefully scrutinized so that the earliest and best-possible positive indication of the development (or lack of it) and movement may be obtained, thereby enabling the forecaster confidently to make the shorter-period forecasts more precise and accurate.

Many of these storm areas in the Bay of Biscay are located fairly near the baroclinic region between the colder air to westward and the warmer air to eastward. In some respects the storms are more a feature of the cold than the warm air mass. However, in view of the broad similarity of this synoptic situation to that in which storms move northwards to the British Isles from northern France it seemed preferable to include the treatment in this section.

Maritime warm air is stable at low levels until it has been strongly heated at the surface and usually more than one day's heating over land is required to release instability. With some summer cold fronts, especially in the south, there is a tendency for troughs or small lows to develop ahead of them (these nearly always seem to form when summer cold fronts approach north Spain and western France and their formation and behaviour have already been discussed). Another type of pre-frontal outbreak of precipitation sometimes occurs ahead of these cold fronts. The relatively narrow band of precipitation is aligned with the front but the rear edge is clearly in advance of the surface front. Sometimes a well-marked squall occurs in the rain belt. These pre-frontal outbreaks seem to be particularly well marked in the United States of America where sometimes the squall line may be 150 kilometres ahead of the cold front. Pre-frontal squall lines occasionally occur in the neighbourhood of the British Isles. It is generally difficult to forecast confidently a pre-frontal belt of precipitation or squall line in advance of its occurrence but, once formed, there is a tendency for the system to be self-maintaining so that the movement of the weather can be reasonably extrapolated from a series of recent observations and from the forecast movement of the cold front. In some actual cases it may seem preferable on later chart analyses to jump the cold front forward and locate it with the belt of precipitation and any squall - even though this is incorrect historically. Whether this should be done or not is largely a matter of personal preference.

Although no detailed classification of air masses has been attempted in this handbook it may be useful to describe a few typical situations in which warm air reaches the British Isles. A common and widely recognized type is that in which warm air reaches windward shores as a broad relatively straight current - often from a direction lying between about 200° and 260°. If this maritime warm air has recently travelled from regions well to south of the latitude of the Azores, dew-points are likely to be very high. When the Azores anticyclone extends to northward of its usual location warm air may reach the British Isles from directions to north of west. From the point of view of general synoptic weather it is important to determine the earlier history of the warm air. If it has travelled mainly across the cooler waters of the North Atlantic, perhaps as a south-westerly or westerly current before veering to north of west near the British Isles, the air is unlikely to have a very high dew-point. If, however, in the western Atlantic the air had travelled as a southerly current from quite low latitudes prior to veering to west in mid Atlantic and later to west of north near the British Isles then dew-points are often very high. In such cases low stratus and sea fog may be extensive. When an anticyclone in warm air is situated near the western regions of the British Isles, warm air may travel well to northward before turning and approaching the British Isles from the north. When the anticyclone is large and stationary the arrival of warm air from the north is unlikely to catch the forecaster unawares. At times, however, when a surface anticyclone of relatively small dimensions is centred near or somewhat to westward of Scotland, warm air in the low levels may circulate from the Atlantic Ocean, around the north of Scotland and enter the North Sea between Scotland and Norway. It may then reach the eastern shores of England and Scotland as a relatively moist easterly current, often laden with low stratus or fog. The increased humidity in this air mass is sometimes a factor which causes a persistent north-easterly current, previously virtually free from cloud, to become laden with low stratus or fog.

When warm maritime air reaches the British Isles on a trajectory from between 200° eastward to about 160°, its traverse across Portugal, Spain or France introduces some modifications. It is not possible to indicate in general terms the extent of modification, but it is reasonable to expect an increasing degree of continental influence on maritime air with decrease in azimuth of the wind direction. Air which is primarily of continental origin may also reach the British Isles from these or more easterly directions. In summer, when warm continental or Mediterranean air leaves the European mainland and has a substantial fetch across the relatively cold North Sea before reaching the eastern shores of Britain, it is often difficult for forecasters to decide when and where low stratus will occur in the airstream. It is not possible to give general and reliable guidance and each such synoptic situation must be assessed individually from the available data. The modifications to the low-level distributions of temperature and humidity of warm airstreams when crossing cold water surfaces are discussed in section 17.7.8.2 of Chapter 17 - Temperature, and section 18.5.1.1 of Chapter 18 - Humidity. Some remarks on low stratus clouds are contained in section 19.6 of Chapter 19 - Clouds and precipitation.

4.3 COLD AIR

As with warm air the types of weather associated with cold air range between wide extremes. On the one hand there may be a particularly fine day, with brilliant sunshine, light winds and excellent visibility. Towards the other extreme, there may be a good deal of cloud, with strong winds and frequent squally showers or longer periods of rain and temperatures well below the normal for the time of year.

The thermodynamic factor which most influences the behaviour of cold air masses is that the air is usually moving over increasingly warm surfaces. Heat is being supplied to the air from below, setting up an unstable lapse rate; the resulting convection spreads the heat throughout much of the depth of cold air, together with any water vapour entering the lowest layers by evaporation from the surface. Cold air masses are thus usually typified by convection cloud, often with showery precipitation and, occasionally, thunderstorms.

Temperature contrasts within a cold air mass are usually greater than in warm air. In addition, the upper-air flow is often more favourable for development, and this may lead to the intensification of zones of temperature contrast, with the formation of secondary fronts (see Chapter 5 - Fronts and frontal weather) or troughs in which the precipitation, although still mainly convective in origin, is more intense and prolonged than in the main body of the air mass.

Considerations of potential vorticity suggest that an airstream moving equatorwards has a tendency to subside and spread out laterally if the relative vorticity does not change. On the western flank of an extensive cold airstream moving towards the equator, anticyclones are likely to form, often becoming important features of the mid-latitude circulation and giving a quiet interlude between families of depressions. On the eastern side, however, the strong temperature contrast between the cold air and poleward-moving warm air leads to marked development fields and cyclonic activity; the cold air remains deep generally, often with a good deal of convective activity and at times with areas of more widespread ascent of the cold air. Even here, however, there are locations where anticyclogenesis may occur to produce mobile ridges or highs between the individual members of a family of depressions.

The contrast between the areas of subsiding air and the deep, unstable cold air is often well seen on satellite photographs. Over the sea, the subsiding air is marked by the presence of closed cells of clouds, 10-100 kilometres across, almost hexagonal in shape with narrow cloud-free bands between the cells, and consisting mainly of stratocumulus. The deep cold air is marked by the presence of open cells, particularly over the sea but at times over the land - lines of cumuliform cloud forming the edges of the almost hexagonal cells with clear spaces in the centre. Typical cloud patterns in a cold air mass are shown in Figure 1.[3] Open cells in the deep cold air are shown at A, while the closed cells, at B, are associated with air subsiding in the developing ridge. The clouds at C do not have the characteristics of either type of cell, and probably show an area of enhanced convection and cumulonimbus development.

In the major portion of the cold airstream, heating from below is usually sufficient to produce convection and showers, except over land in the colder months of the year when the land may often be colder than the air. Showers may occur well inland in winter, but usually some other factor, such as convergence, is required in addition to diurnal heating. Over the seas surrounding the British Isles, convection is likely to occur at any time of the year, although there are probably maxima of frequency and intensity during the winter months. Over land, during the period from late spring to mid autumn, diurnal heating alone is often sufficient to give rise to convection, usually deeper and more widespread than that over the sea, and leading at times to thunderstorms. Cold air masses sometimes become stagnant or slow moving over the British Isles, in cols, in weakly cyclonic areas or in filling depressions; there is often deep convection in the afternoon, with heavy showers, perhaps accompanied by thunder, but usually separated by areas of drier, clearer weather.

By far the greater majority of showers and thunderstorms in cold air masses in winter are bred over the relatively warm seas. When the cold air is fairly deep and convection from the sea surface can penetrate easily up to 600 or 400 millibars showers will be frequent and often heavy, particularly near windward coasts, and there may be a few thunderstorms. However, the majority of deep cold outbreaks occur near the centres of cold pools or pronounced cold troughs and the low temperatures of the upper air restrict the maximum total water content to a fairly low limit which will tend usually to place a curb on the severity of thunderstorms. Once the

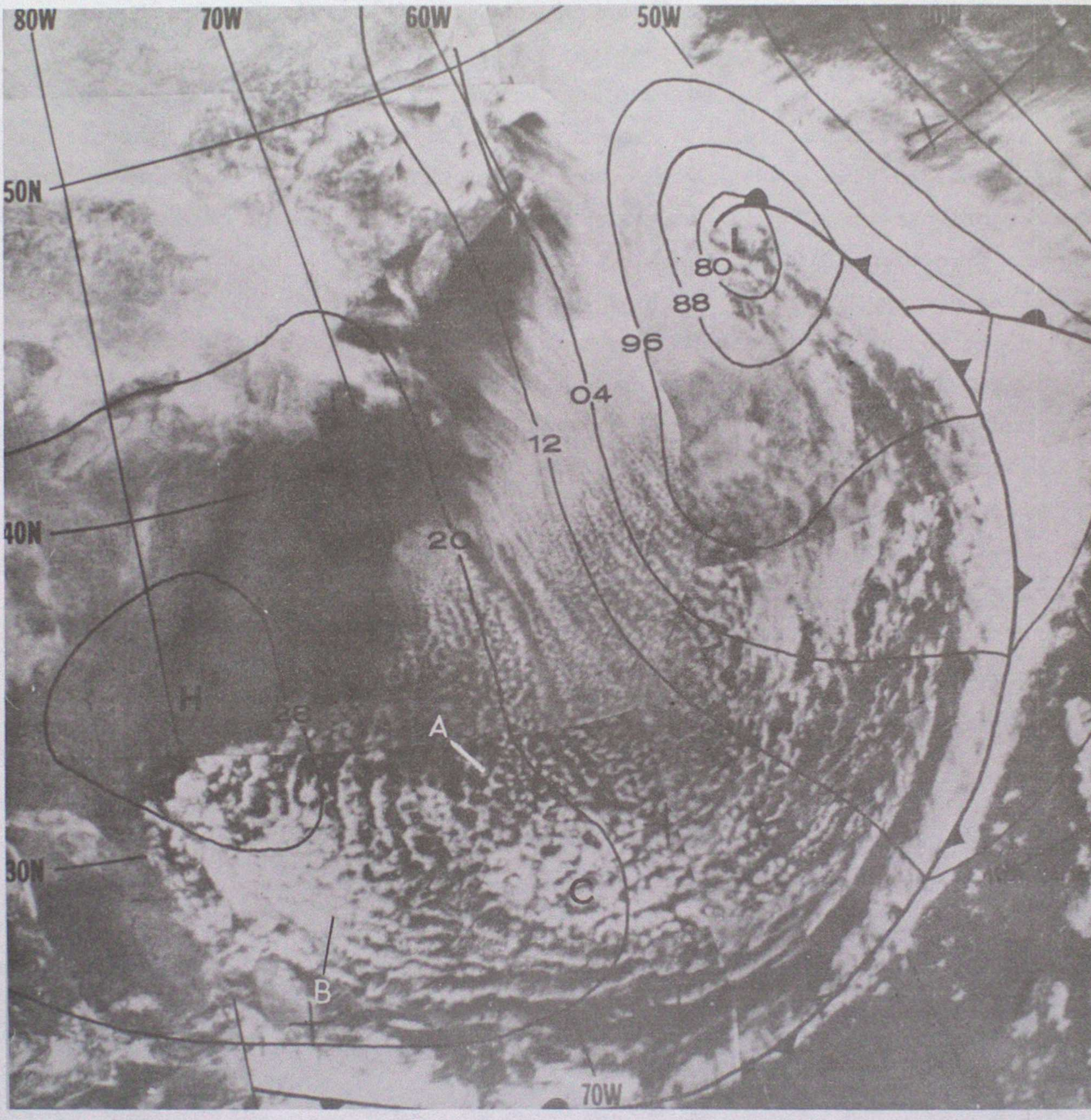

FIGURE 1. Photograph from US satellite ESSA 6 at 1400 GMT on 8 March 1968 over the east coast of North America

Typical post-cold-front convective cloud patterns in a cold air mass which is being heated from below.

winter type of shower moves inland over relatively low-lying ground it usually tends to decrease in activity but it may penetrate some tens of kilometres before decaying completely. For example, showers bred over the Irish Sea in a north-westerly current may penetrate through the Cheshire gap and survive long enough, by day or by night, to reach the Midlands. By night they would seldom survive long enough to reach London but, by day, diurnal convection from the land might maintain the shower (or generate another) so that showers would occur in south-eastern parts of the country. The orientation of hills sometimes has an important effect on the extent and direction of the penetration inland of showers. When the wind blows along a range of hills, the high ground does not impede the penetration inland to any substantial degree and some configurations of quite small ranges of hills appear at times to assist penetration. However, when the wind blows across the longer horizontal dimension of the hills many of the showers which reach the hills, or are triggered off by forced ascent when air ascends the windward slopes, deposit much of their precipitation over the hills, on the lee slope or on adjacent lee ground. Consequently, many areas well to the lee are effectively in a 'shadow' which is characterized by an almost complete absence of showers and, possibly, by quite small amounts of cloud if there is a well-marked föhn.

Some winter thunderstorms in cold air may be regarded as purely barotropic storms. The storms are usually short lived and quite isolated - but the shower activity may be very widespread. With very deep cold air masses any thunderstorms near windward coasts may be rather more extensive. However, surface observations plotted on synoptic charts will generally indicate that isolated storms appear here and there at one synoptic hour. At the next hour it is often impossible to identify with any certainty any storms existing at the previous hour. In marginal cases some storms appear to give only one or, at most, a few claps of thunder. It is clearly impossible to forecast the location of any particular short-lived storm in advance of its initial occurrence. Radar observations of any existing storms are very valuable for very short-period forecasting but, in view of the short life of this type of storm, any tendency to extrapolate forward beyond one hour would be unwise in general. The majority of isolated winter thunderstorms occur near windward coasts, perhaps within a few tens of kilometres, and there is a maximum frequency in the early morning. The extent of penetration inland is a difficult problem. Although winter insolation is weak, convection from day-time heating over land must be a factor at times in maintaining an existing thunderstorm.

In a number of cases, particularly in strong flows from between about west and north, some winter thunderstorms are associated with weak baroclinic features. These thunderstorms tend to be more widespread and severe than the air-mass storms. They also persist for longer periods and move farther inland before decaying completely. In some cases a line of storms develop local circulations which exert a self-maintaining effect on the storms. Once the baroclinic type of storm areas have been identified on detailed synoptic charts, their movements can be determined and extrapolated with reasonable accuracy. However, when they are upwind to seaward, their presence is often difficult to detect with much accuracy.

When cold air leaves a source region near Greenland or over the North American continent and travels across almost the whole of the North Atlantic Ocean before reaching the British Isles, the air-mass characteristics are considerably modified by the sea passage. The air has usually lost some of its intense low-level instability although it is generally still unstable. The water content of the air has increased considerably, particularly when the air penetrates well south over the warmer regions of the Atlantic Ocean before approaching the British Isles from an approximately south-westerly direction. In such cold airstreams there are often local outbreaks of heavy rain. These outbreaks tend to occur in belts, often more or less parallel to the thermal wind. The rain is usually continuous, but of the instability type, and persists for several hours. The duration of the heavier rain is usually limited to a few hours. In some cases the precipitation is intermittent rather than continuous.

Cold air which reaches this country in winter, in easterly situations which are sometimes persistent, deserves some special mention. In the persistent situation the airstream originates from continental eastern Europe or even farther east. In January or February, if the north German plains are frozen hard, the cold airstream is fairly dry and sometimes cloudless on reaching the continental shore abutting the North Sea. During its passage across the North Sea towards the shores of the British Isles the air is modified by the sea to an extent depending partly on sea temperatures, on the characteristics of the air on leaving the European continent and on the length of sea track. These cold easterly airstreams in winter are predominantly either cloudy or cloudless when they reach the eastern seaboard of the British Isles. The cloudless type usually produces very cold nights but the sunny days may be quite invigorating. The cloudy type produces less extreme temperatures but there are often frequent falls of snow - particularly in eastern coastal districts. When the airstream is cloudy and the low-level relative humidity is high the weather feels particularly raw and colder to the body than the temperature alone would imply.

In some situations there may be extensive low cloud already present in the easterly flow when it leaves the European continental coast and enters the North Sea. The effect of transit over the North Sea will, in general, maintain or even thicken the cloud sheet. Except for the infrequent occurrence of dispersal of cloud due to the dynamic causes, most of these cloudy airstreams will still be cloudy when they reach eastern coastal districts of the British Isles. Some comments on forecasting with such easterly situations are given in section 17.7.8.1 of Chapter 17 - Temperature, and section 19.6 of Chapter 19 - Clouds and precipitation.

BIBLIOGRAPHY

1. London, Meteorological Office. Aerodrome weather diagrams and characteristics. HMSO, London, 1960.

2. BELASCO, J.E.; Characteristics of air masses over the British Isles. Geophys Mem, London, 11, No. 87, 1952.

3. Geneva, World Meteorological Organization. The use of satellite pictures in weather analysis. Tech Notes, Wld Met Org, Geneva, No. 124, 1973.