Limiting road hazards caused by rain, freezing rain and wet surfaces and the role of weather radar.

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1. Rain and wet roads are the most common hindrances to road traffic and a cause of increased road accidents. According to a recent study road accidents increase by 70 per cent when rain is falling. (Andrey and Yagar, 1992). Comparatively rare but more striking, freezing rain is a severe hazard for drivers and pedestrians, being a cause of that particular form of road icing known as `black ice'. It is contended that weather radar installed in highway offices can be a valuable aid in nowcasting these conditions, supplementing dedicated forecasts.

2. Examples of freezing rain in England and Wales.

2.1. December 1995 was a cold month in the UK and after a few mild days early in the month the frost became general and, in the last week of the month, very severe, with daytime maxima remaining below freezing on several days. During the last two days of the month fronts approaching from the south and southwest threatened to bring blizzard conditions to many areas. In the event there was very little snow over most of southern and central England and South Wales but a period of freezing rain (glazed frost) caused severe icing as rain fell for several hours on surfaces that were well below freezing. Most affected were Wales, the south and west Midlands and southern England from east Devon to west Sussex.

2.2. The December 1995 event was both shorter and less widespread than the glazed frost of January 1940 (Brook and Douglas 1956), which was probably enequalled this century. Widespread freezing rain also occurred on January 20-21, 1966, when road accidents rose by 70 per cent and there were two other notable falls on Christmas Eve 1968, when Wales and the West Midlands were badly hit and during March 17-19 1969, when the eastern slopes of the Pennines suffered most and transport was badly affected.

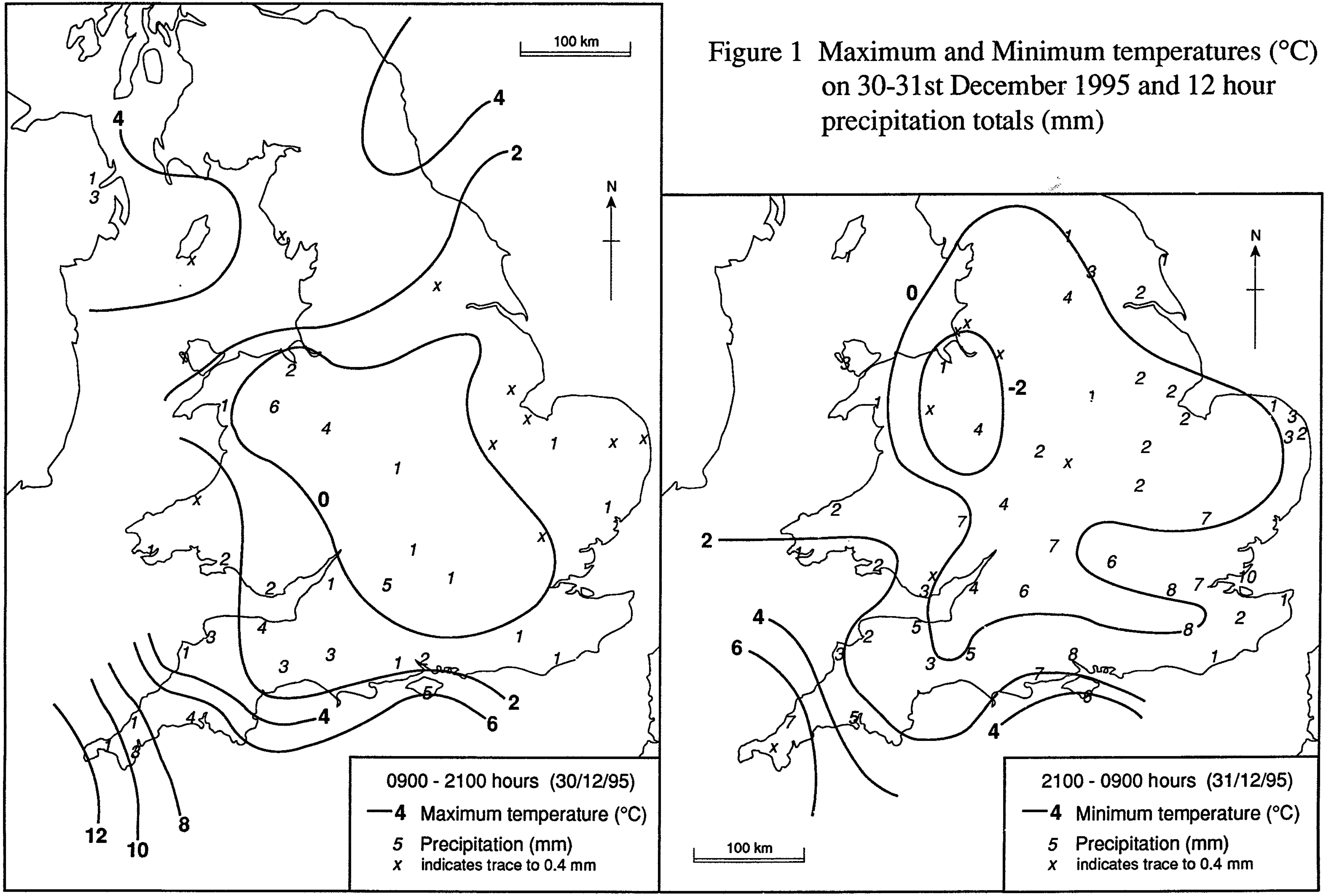
2.3. In the case of December 1995, although road surfaces were treacherous in many places, traffic accidents were fewer than might have been expected because the situation occurred when many people were on leave between the Christmas and New Year period and at a weekend, when many journeys could be postponed. There was, however. a notable rise in insurance claims for minor accidents and many ambulance services were working at full stretch, coping with pedestrian accidents.

2.4. Rain reached the far south west of England in the early hours of 30 December and spread slowly northward and eastward during the day. Except over high ground like Dartmoor there were few problems in the southwest, where milder air quickly arrived, but further east temperatures remained at or near freezing point all day. During daylight hours on the 30th the worst icing occurred on the high ground of the Cotswolds where 5mm of rain fell and in neighbouring parts of Avon and Oxfordshire and in South Wales where, quite exceptionally, sections of the M4 between Swansea and Newport were closed for the greater part of two days. Overnight the rain extended northward into the Midlands (Fig 1), where minimum temperatures were 0 to -1, and into West Sussex and Hampshire, where up to 8mm of rain was recorded in the 12 hours up to 0900 on 31st December. It was not until later on the 31st that the ice thawed over all of southern and central England as temperatures gradually rose.

2.5. The event will be remembered most for the series of accidents on the M4 in South Wales early on the 31st when traffic was still light and which led to the closure of the road. It also revealed the lack of preparations for such a problem in the service station areas on the English side of the Severn Bridge. These areas were dangerous to both cars and their occupants when wishing to gain the havens of the service facilities. Some had no warnings to drivers arriving and in at least one case the service area was closed to traffic and in another the managers resorted to placing a vehicle with its lights on partially blocking the turnoff from the motorway, hardly a welcoming gesture!

2.6. On Saturday 27 January 1996 another very hazardous situation involving black ice developed suddenly in the middle of the morning in parts of South Wales, when, after a dry start, a light shower of snow fell on ungritted urban roads. Motorists and pedestrians found even the roads in the middle of shopping areas dangerous in the extreme and a number of casualties resulted.

Figure 1 Maximum and Minimum temperatures (°C) on 30-31st December 1995 and 12 hour precipitation totals (mm)



3. The role of weather radar

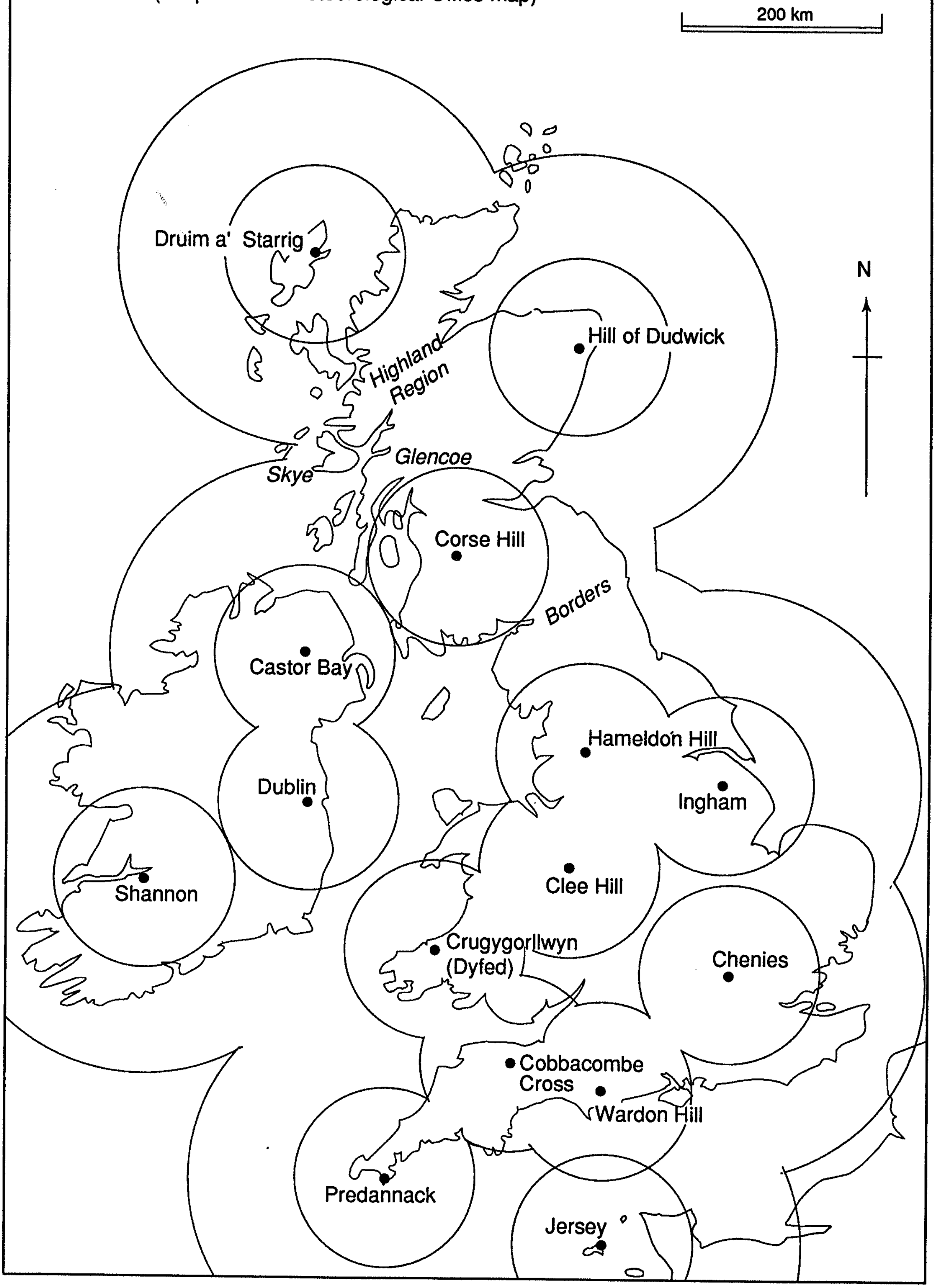
3.1 These events indicate the need for a quick response to the approach of a shower of freezing rain or another form of shower precipitation, such as hail, sleet or wet snow, which in freezing temperatures will instantly produce extreme conditions of slipperiness on roads and pavements. Such conditions cannot be forecast in detail since many areas may remain entirely dry. Short of blanket gritting the only way to meet such hazards is by nowcasting for local conditions using weather radar in the highways office or central control, interpreted in conjunction with the readings from ice sensors in the roads.

3.2. Between 1986 and 1989 work at Swansea University on behalf of the Welsh Office added to the evidence on the value of weather radar being made available to observers on almost a real-time basis. (Perry and Symons, 1991, 29-32). This followed the pioneer investment in co-operation with the Meteorological Office in the foundations of the weather radar network and adoption of regular monitoring by Devon CC. It was our view that installations to make the imagery available to Welsh highway authorities would be advantageous but no progress was made because the Meteorological Office could only offer the service at a charge that the authorities considered they could not justify.

3.3. A different approach to financial relationships within the public service sector led to Switzerland becoming the first country to make weather radar available to highway authorities on a nationwide basis. It was accepted that road safety and efficiency were equally matters for the public domain and that these required weather radar to be installed in roadmasters' offices.

3.4. The problem has more recently been overcome in Scotland. The solution resembles the Devon approach on a larger scale. The Scottish Office Development Department made a contribution to the establishment of weather radar stations in Scotland and the imagery is now available to all regional authorities to install in highway offices as they think fit. A modest licence fee is payable but this is no barrier to the service being available wherever needed and at all times.

Figure 2 The UK Radar Rainfall Network
(adapted from Meteorological Office map)



4. Summer use of weather radar.

4.1. It is by no means only in winter that the weather radar is useful. The experience of some highway engineers is that its greatest use is in relation to summer surface dressing. The application of polyurethane and epoxy resins used in anti-skid surfaces has added to the importance of correctly forecasting the approach of showers which would negative the value of the work and result in expensive losses. Also by monitoring the radar the highway engineer can know where showers are occurring so that the road will be wet and unsuitable for dressing for some time even if no further showers occur. This will act as a guide, especially in the early morning when decisions on what orders are to be given to contractors have to be made.

4.2. Some authorities prefer to continue to depend on continued contact between the engineer and the forecast office, mobile phones assisting this procedure. The choice may be guided by consideration of the type of area involved. Working in limited areas, perhaps with very close contact with the forecaster, may produce better results than could reasonably be expected in a large and mountainous area bounded by an intricate coast such as in highland Scotland.

4.3. This comment reflects particularly the view held in the Highland Region, covering west and north Scotland. After two years' use there is conviction that the weather radar reduces problems and financial losses. This is particularly true of the western areas, especially Skye, where fast-moving fronts come in from the Atlantic ocean. Traffic is relatively heavy and will increase with the bridge to the mainland open. Almost the whole Highland Region enjoys radar coverage, except for Glencoe, (Fig.2) though the quality of the imagery is inevitably somewhat variable.

4.4. Southern Scotland is less well covered by the existing weather radar stations (Fig 2). One or more additional radars are needed in the Borders or northern England. Nevertheless, most areas are reasonably well catered for.

4.5. Another use for weather radar at all times of the year is in connection with warnings of hazardous driving conditions when extremely heavy rain produces conditions of bad visibility either from the rain itself or spray from heavy goods vehicles and coaches. Although this is a field mainly for forecasting and dissemination of information through the normal channels there is also scope here for local interpretation of the approach of a storm and local warnings through on-road signalling or local radio.

4.6. Not for the highway engineer's use but of interest as an indication of a more esoteric application of weather radar is an attempt at point forecasting of the thickness of a film of water on the road and consequent liability to aquaplaning on vulnerable roads. (Terpstra, 1992) Depths of water of around 2mm derived from extrapolations of radar plots are considered as adequate to explain an incident in the Netherlands in June 1991.

5. Wider availability of weather radar.

5.1. A breakthrough which makes weather radar available at low initial cost has been made through the Meteorological Office's MIST system. This provides an image about thirty minutes after it is available to the real-time observers and this is close enough to be of considerable value. Furthermore, there are prospects that this time-lag could be reduced to about 10 minutes.

5.2. Through MIST the imagery is available at low cost but there is still a licence fee and a small charge for each image accessed. These charges have been described by one highway engineer as 'not insignificant'and a reason for limiting the number of MIST outlets. The charges are, of course, minute compared with the cost of a winter night's salting so should be acceptable even if only one or two dressings are delayed until after the threat of showers has passed, but this will not necessarily permit them to be incurred in a restricted budget situation. This has also been given as a reason for not using the radar in connection with summer surface dressing.

5.3. The MIST equipment is readily portable so can be taken home and plugged in to a domestic VDU for continuing observations, as was done by some engineers to meet the bad weather situations of last Christmas. A comment here from one Welsh area is that there were twice forecasts of heavy snow but salting was minimized as the radar images showed the storms affecting neighbouring counties to be obligingly missing the one being monitored.

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