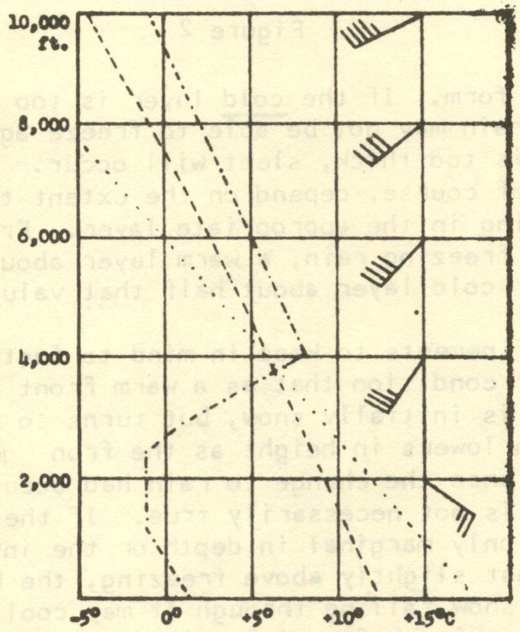
EASTERN REGION TECHNICAL ATTACHMENT
No. 72-1-17
January 17, 1972

The following study was prepared in the Central Region and was originally published as a Technical Attachment to their Staff Notes. It is reprinted here for the information of Eastern Region Forecasters.

FORECASTING FREEZING RAIN

Freezing rain can be a very destructive event, but fortunately it is a rare event. It is rare mainly because it takes a set of circumstances within narrow limits to bring about freezing rain instead of rain, snow, sleet, or snow pellets.

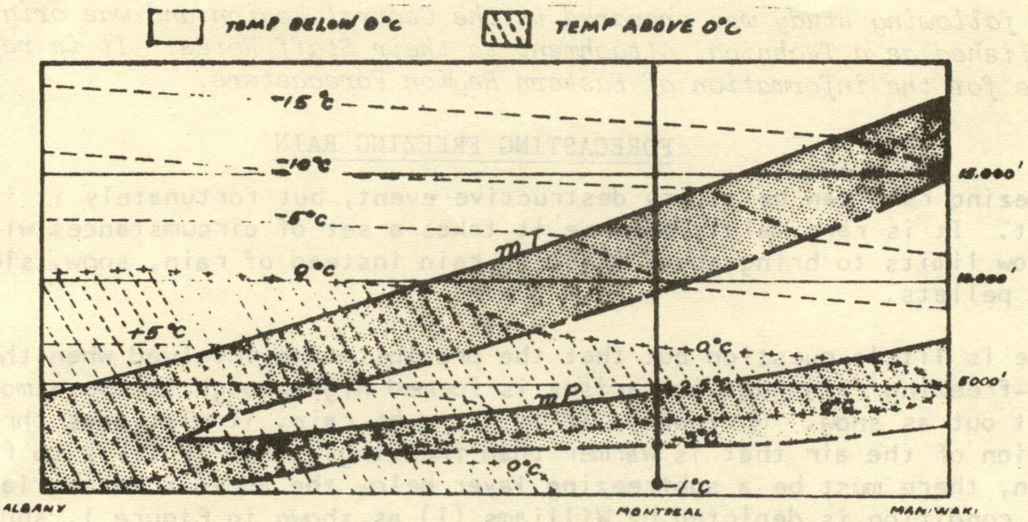
There is little question but that the precipitation involved when the snow-rain-freezing rain question arises is formed high enough in the atmosphere to start out as snow. Obviously, if it is to be rain, it must pass through a portion of the air that is warmer than freezing. Then if it is to freeze again, there must be a subfreezing layer below the above-freezing layer. This condition is depicted by Williams (1) as shown in Figure 1, and similarly by Mahaffy (2) and by Harlin (3).



Wind and temperature in lower levels for Huntsville, Ala., 1300 CST, 2 March 1960. The dash-dotted curve denotes the temperature lapse rate; the dashed curve, the pseudo adiabat; the dotted curve, the dry adiabat.

Figure 1

The condition depicted fits the usual warm frontal situation, as seen by Figure 2 (from Mahaffy). However, the lower subfreezing layer under an above-freezing layer restricts the number of occasions considerably, but this restriction is not enough, for, in addition, precipitation has to ba falling, and the thickness of the two lower layers has to be within reasonable limits. If the <u>warm</u> layer is too thin, complete melting of the snow will not occur,



Cross-section of the lower atmosphere from Albany, N. Y. to Maniwaki, P. Q, at 1900, 25 February 1961.

Figure 2

and snow pellets may form. If the cold layer is too shallow or too little below freezing, the rain may not be able to freeze again before hitting the ground, while if it is too thick, sleet will occur. The proper thickness of these layers would, of course, depend on the extent the temperature reaches above or below freezing in the appropriate layer. From the references given it appears that, for freezing rain, a warm layer about 5000 feet thick is proper, while a lower cold layer about half that value is reasonable.

There are several refinements to keep in mind to further help in the decision. It is a common winter condition that as a warm front approaches, the precipitation at the ground is initially snow, but turns to rain or freezing rain as the frontal inversion lowers in height as the fron gets closer. One would generally think that once the change to rain had occurred that the threat of snow was over. This is not necessarily true. If the warm layer is not close to saturation and is only marginal in depth or the inversion nose is blunt so the temperature is just slightly above freezing, the heat given up by the air in melting the first snow falling through it may cool the layer to below the freezing point so the rain or freezing rain turns back to snow again. This is especially likely to happen if the warm frontal advance is associated with a small wave passing through and the wave crest is just passing, so the warm frontal advance upon the station has just stopped.

Another refinement is due to the heat island of the larger cities. At critical times this added heat is sufficient to have an advancing snow situation turn to rain over and/or downwind of the city, or to have freezing rain in the suburbs and just rain in and downwind of the city.

Also to be considered is the recent temperature condition. If there had been quite cold conditions which have quickly warmed quite a bit as the possible freezing-rain condition moves in, the coldness of the ground, trees, and telephone wires, and other objects, means that an icing condition can be more severe than had the ground and objects been at a temperature much closer to freezing.

A final point involves a small area with at least a few hundred feet difference in elevation within it. The sounding by Williams shown above (Figure 1) was for just such a situation, as it was in the Appalachian Mountain area. The sounding resulted in only rain at the location of the sounding, but, as noted by Williams, "light rain and sleet began at Huntsville Airport at 2216/1st. The sleet ended in fifteen minutes, but the rain continued throughout the following day with three and one-half inches accumulating."

"During the day on March 2nd, one could look at the surrounding hills and see a clear demarcation where ice was accumulating on higher elevations." Evidently, the warmer layer nearest the ground saved the city from an ice storm that at 1000 feet higher was serious.

Forecasting temperature conditions horizontally and vertically with the detail and accuracy necessary to make such sounding forecasts is probably not possible at this time. Instead, the problem takes on the character of "now-casting" in that one should examine the nearby soundings as soon as they are available, and if precipitation is expected to occur soon and the above diagrammed conditions exist in the vertical initially, a short-term weather forecast becomes reasonable on the assumption the sounding changes little. The sounding taken in support of air pollution work could be of considerable benefit for such a weather forecast.

References

(1) Williams, B. B., 1960: The 1960 Ice Storm In Northern Alabama. Weatherwise V. 13, No. 4, 196-199.

(2) Mahaffy, F. J., 1961: The Ice Storm of 25-26 February 1969 at Montreal. Weatherwise, V. 14, No. 6, 241-244.

(3) Harlin, B. W., 1952: The Great Southern Glaze Storm of 1951. Weatherwise, V. 5, No. 1, 10-13.

SCIENTIFIC SERVICES DIVISION, ERH
January 17, 1972