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FREEZING RAIN VS. ICE PELLETS

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How deep and how cold must the surface-based cold air be to produce ice pellets (sleet) rather than freezing rain? Does the depth of the warm nose affect the type of precipitation? All RAOBs released in or near freezing rain and sleet in the 48 contiguous states during January and February 1974 were examined in an effort to answer these questions. In the process it was found that freezing drizzle occurred with a wide range of sub-freezing temperatures but it also was very limited areawise compared to freezing rain,therefore freezing drizzle was not considered in this report.

Figure 1 is a composite of the freezing rain soundings. Only the temperature curve is shown as most soundings were saturated. Note the shallow layer of below freezing temperatures and the warm nose above. This feature occurs most often in the Southern Region after an Arctic front has moved to the Gulf coast. Then, if a short wave moves across over the cold air, freezing rain or sleet is likely to occur. The 6-level PE progs usually will indicate warm advection (increasing 1000 to 500mb thickness) but this usually occurs aloft without surface warming. There will be almost no diurnal temperature changes as long as a thick stratus cover exists.

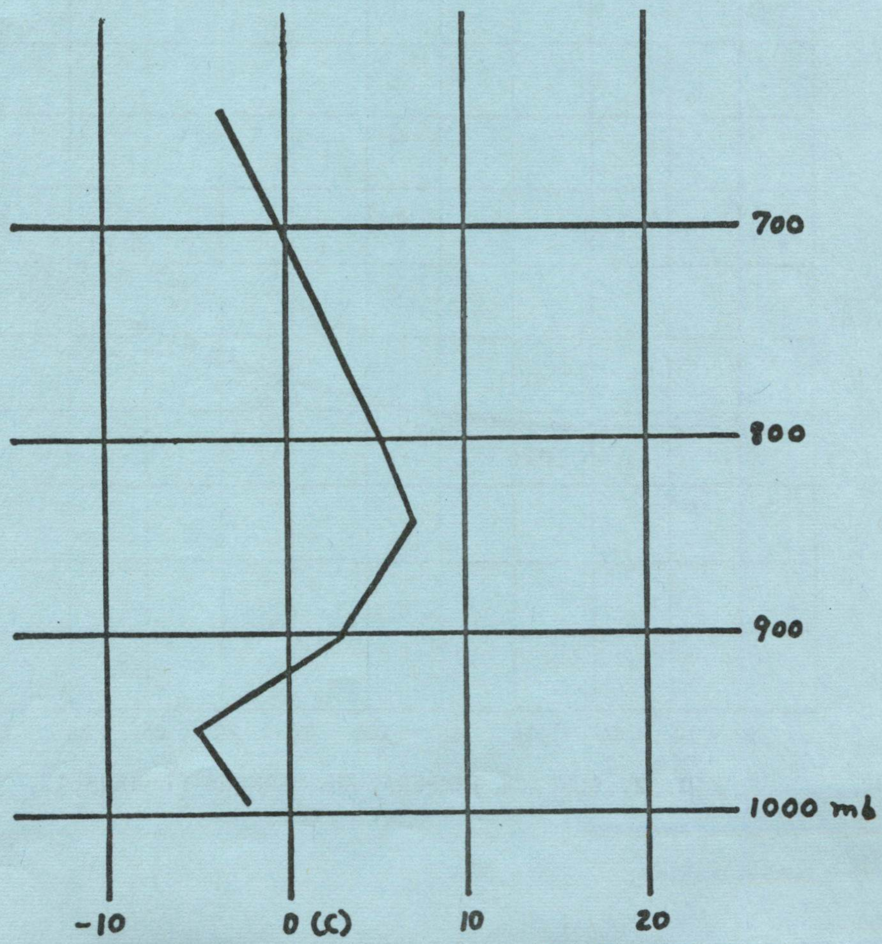

FIG.1. COMPOSITE OF FREEZING RAIN SOUNDINGS WITH TEMP. CURVE

It seems reasonable to assume that the initial temperature of the rain drops, the temperature of the air through which rain is falling and the length of time it is in that air should determine whether the drop would reach the ground in liquid or solid state -- i.e., the depth of the cold air and its temperature should be directly related to the probability of frozen precipitation. In most cases the surface temperature will be a good indicator of the average temperature in the cold surface-based layer. Therefore the surface temperature and the depth of the surface-based cold air was used to forecast whether precipitation would be freezing rain or sleet. The depth of the surface-based cold air is available on the RADAT data at 12Z and 00Z. This is about two hours before the regular RAOB is transmitted.

In most freezing rain situations low stratus is present several hours prior to the beginning of precipitation. This is a clue that the lower portion of the sounding is saturated and the only changes will be through advection. Usually the advection terms are small but such that they continue to support the freezing rain. If low stratus is not present then it becomes important to allow for changes in the sounding due to evaporation. These changes are usually much larger than advectional changes if the layer is initially dry when precipitation begins to fall. It was noted in two

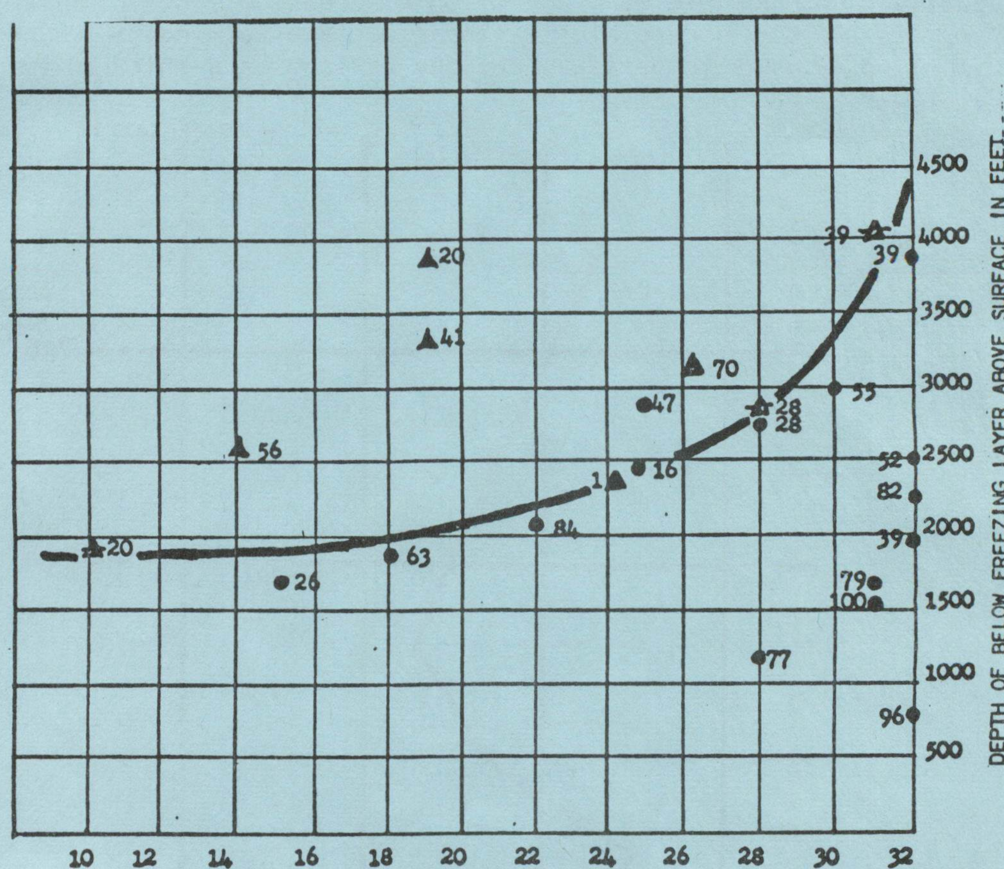

FIG. 2. SURFACE TEMPERATURE DEGREES FAHRENHEIT

cases that .10 inch of precipitation will cool the dry bulb temperature and reduce the wet bulb depression by 75 percent. Thus the wet bulb curve should approximate the sounding after about a quarter-inch of liquid precipitation has fallen. If the wet bulb curve does not have the warm nose with a layer above freezing, precipitation is likely to be mostly snow. A half dozen cases have been noted in which precipitation began as rain and changed to snow when the wet bulb curve was below freezing within 2500 feet of the surface and remained below freezing above that height.

Figure 2 is a plot of the freezing rain and sleet cases found during January and February 1974. The abscissa is the surface temperature in degrees fahrenheit while the ordinate is the depth of the sub-freezing layer in feet above the ground. The triangle with a bar represents a mixture of sleet and freezing rain. The numbers near these symbols show the depth of the warm nose in hundreds of feet. The warm nose was greater than 3000 feet in 87 percent of the freezing rain cases but was about equally divided in the sleet cases. As the warm nose becomes more shallow sleet should occur more often, other parameters remaining constant. If freezing rain were forecast for all combinations of temperatures and depths of cold air below the curve and sleet were forecast for all combinations above the curve, the percentage correct would have been 96%. The sample is small and additional data would surely change this percentage. Figure 2 shows that the depth of the cold air must be more shallow as the surface temperature decreases for freezing rain to occur - - just the reverse of what normally takes place.

Freezing rain was treated as rain in the development of the PEATMOS equations used to forecast the conditional probability of frozen precipitation on FAX N39 and N109. Therefore most freezing rain should fall in areas with less than 50 percent probability of frozen precipitation. This has been true in the few cases investigated.

In summary, freezing rain occurs most frequently in the Southern Region under the following conditions:

1. Surface based sub-freezing temperatures less than 3000 feet deep. As surface temperature decreases the layer must be more shallow.

2. A warm nose above. This warm nose must be deep enough to melt snow as it falls through. Also it should be warm enough so that it cannot be cooled below freezing by precipitation falling through it.

3. Precipitation-producing mechanism expected. Usually a short wave or overrunning with indicated warm advection on the numerical progs.

4. Little or no warming occurs at the surface.

The RADAT combined with the surface data can provide useful and early answers to 1 and 2 above for short range forecasts.