COMMENTS ON "HEAVY SNOWFALL DURING AN ARCTIC OUTBREAK ALONG THE COLORADO FRONT RANGE"

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A recent article by Wesley, Weaver and Pielke (1990) [hereinafter WWP] investigates an interesting heavy snowfall episode associated with the arctic outbreak of February 1989. As a veteran observer of winter snowstorms in the Rockies (University of Wyoming Professor for 22 years), it is my opinion that this article does offer some clues to an unusual weather situation; however, there are several salient points overlooked by the WWP that need to be reconciled for a more comprehensive explanation for the heavy snowfall.

Heavy snowfall episodes, of the type described by WWP, caused by the overrunning of warm, humid air over the thermal barrier of a cold dome are not uncommon across the High Plains of Colorado & Wyoming. Such snow situations here in New Zealand, referred to as warm advection type snowfalls, are well known in causing catastrophic stock losses on the Canterbury and Otago Plains. In my experience, such snowfall on the High Plains can be expected at a given location with a recurrence interval of about 8 years. The most common situation occurs when an arctic front stalls over the rugged terrain near the Colorado-Wyoming border. With the prevailing terrain averaging 6000 ft msl, the top of the arctic air may build to the 10000 ft msl (700-mb) level. Thus the cold air provides an effective barrier and lifting mechanism for warm, humid southwesterlies whose trajectories originate from central and western Colorado where temperature/dewpoint values range near 40°F/30°F. The resultant clouds, growing in the released convective instability along the deepening southwestern edge of the cold air, reach their maximum depth with appropriate thermodynamic constraints for dendritic ice crystal growth (as reviewed in the opening paragraphs of WWP. Reporting stations in southern Wyoming and northeastern Colorado typically receive 12-hr snowfall episodes of 8–15″ while shivering in sub-zero temperatures.

It is in this scenario that the 1–5 February 89 storm needs to be reviewed. WWP have presented most adequate documentation of the strength, timing and movement of the arctic airmass. But, due to a probable oversight, there is no evidence cited of any quantitative thermodynamic data of the westerly airflow supposedly spawning the cloud and snow. While the importance of short wave disturbances and vorticity maxima in the disturbed westerly flow can not be overlooked, it is the thermodynamic signature of the upstream air that needs to be reconciled with in-cloud temperature for dendritic ice crystal production, satellite CTT's, snowfall location, etc. The authors are encouraged to inspect the GJT and SLC raobs, along with central and western CO stations not affected by the arctic air, for the source and trajectory of the overrunning air and the accompanying cloud bases (LFC or CCL) atop the cold air.

From the soundings shown in the article (Fig. 5), I would venture an estimate that the source air be characterized by $\theta_w \approx$ 14°C. This value agrees well with the authors' assessment of CCT (−25°C to −30°C) at the times of moderate snowfall, and places the dendritic growth regime (−13°C to −15°C) ideally within the 520–560-mb layer for a buoyant parcel.

In summary, I again commend the authors for calling attention to a difficult forecasting scenario. My comments are not meant as faultfinding criticisms; rather they are intended to add further annotation directed at the thermodynamics and microphysics of a heavy snow-producing situation.

References

Wesley, D. A., J. F. Weaver, and R. A. Pielke, 1990: "Heavy snowfall during an arctic outbreak along the Colorado Front Range", *Nat. Wea. Dig.*, 15(3), 2–19.