Grand Valley Storm of 8 – 9 December 2009 and Valley Inversions

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Geography: The Grand Valley is located in Western Colorado at an elevation of approximately 4800 feet. To the north, the Roan and Tavaputs Plateau rise to about 8500 feet while to the south the Uncompaghre Plateau rises to between 8500 to 9000 feet. Grand Junction (indicated with the red star below) is the most populous Colorado town west of the Continental Divide and sits in the Grand Valley as indicated below.

Winter Climatology/Weather: During the winter season (November – March), Grand Junction regularly sees high temperatures in the mid-30s and lows in the mid-teens to low 20s. As Grand

Junction is in a valley, snowfall totals are on the light side due to shadowing from the surrounding plateaus. For instance, if a storm moves in from the north or northwest, the Roan/Tavaputs shadow the Valley. On the other hand, if the storm comes in from the south or southwest, the Uncompahgre Plateau shadows the Valley. If a storm approaches from the west, the western end of the Grand Valley will see significant snowfall accumulation while remaining areas will see minimal amounts. Suffice to say, storms that do affect the Grand Valley generally drop 2 to 3 inches of new snow that promptly melts the next day. On some occasions, however, good dynamical lift reflected in deep surface convergence (surface to 700mb) and strong upper level support will cause large amounts of snow (> 6 inches) to fall over the Valley. If enough snow falls and doesn't melt, surface temperatures will stay well below climatological norms as strong valley inversions set up. These inversions can last for weeks causing daytime temperatures to be abnormally low, help in dense night time fog formation, and cause poor air quality conditions.

Set-up: On the evening of December 8th, 2009 a system moved into the Grand Junction area and produced upwards of 9 inches in the Grand Junction city limits with reports of over 12 inches of snow in outlying areas. The NAM12 and GFS40 had been highlighting this possibility over the last few model runs and all forecasters were alert to the possibility for a large snow event in the Valley. However, a storm of this magnitude had only happened twice in the last 14 years so the model output was treated with much skepticism. Finally, the last model run came in indicating almost perfect surface convergence aligned with strong omega and divergence aloft accompanied by ample moisture with 700mb temps hovering around -10C and surface temperatures in the upper 20s. Winter Storm Warnings were issued for almost the entire CWA with most verifying.

Aftermath: Once the storm moved out of the region, widespread snowfall from 8 to 12 inches was reported across the Grand Valley. With such a large amount of snow on the ground, little to no daytime heating was expected which would inhibit any break of the nocturnal inversion. Nightime fog was also anticipated as the boundary layer remained fairly saturated throughout the day and night. Due to the snow, a strong long-level inversion did set up and persisted for over 60 days in the Grand Junction area keeping high temps 12 to 20 degrees below normal. During this event, NWS employees who lived above the inversion reported daily temperatures reaching the mid-40s but as they entered the valley, temperatures would drop considerably. The lack of heating caused the snow to melt much slower which, in turn, caused the inversion to remain over the Grand Valley much longer. This vicious cycle caused abnormally low temperatures until the inversion finally broke in February. As an aside, Grand Junction had measurable precipitation on the ground from 8 December through 11 February (71 days) making it the 4th longest consecutive stretch of measurable snowfall since 1850.

Model Guidance: During this prolonged event, local forecasters realized that the GFS and NAM MOS guidance did not have a handle on the inversion and the effect on temperature. Routinely, MOS would overforecast temps by 10 to 20 degrees. We forecasters realized this bias after a few days and discounted, or modified, what the statistical guidance was forecasting adding quality to the statistical guidance. This storm allowed all of us to see what an important role snowpack and inversions play on forecast guidance and actual, measurable values.