Old and New Perspectives on Forecasting Rare Snowfall Events in the Lower Rio Grande Valley of Texas

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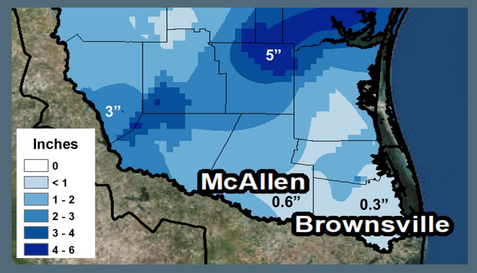
Introduction

Measurable snowfall is very rare in Brownsville, TX, owing to its subtropical latitude (25°55' N) and proximity to the Gulf Coast. However, on 08 Dec 2017, widespread snowfall occurred across the Lower Rio Grande Valley (RGV) of Texas. For Brownsville, this represented the first measurable snowfall since 25 Dec 2004, and only the second recorded since 1895!



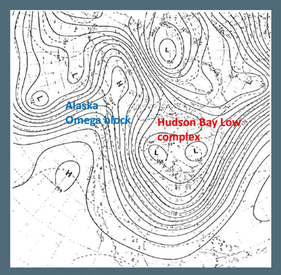
Snowfall map courtesy of NWS/Corpus Christi, TX
Lower left Photo credit: Edinburg, TX Fire Dept.

The "McFarland Signature"

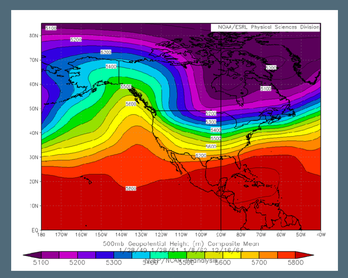
McFarland (1976) identified several correlations between certain 500-hPa features and the occurrence of major freezes in the RGV:

1. A short-wave omega-block superimposed on a long-wave ridge through central Alaska with a deep low between Hudson Bay and Greenland.
2. An east-west oriented trough line over southern Canada/northern United States with zonal flow and a strong jet to the south and northerly flow to the north.
3. A closed low moving southward through the Prairie Provinces of Canada developing into a long-wave trough, without cyclogenesis.
4. Discontinuous retrogression of a full-latitude trough over the western United States involving a closed low or major east-west short-wave moving southward without cyclogenesis.

Such Arctic-air outbreaks are a necessary, but not sufficient, condition for snowfall events in the RGV.



McFarland's (1976) Fig. 5c, showing an example of feature #1.

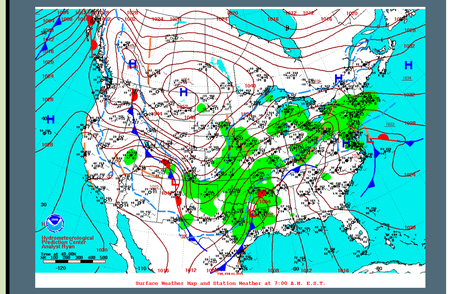


500-hPa composite for four of McFarland's original cases; Image provided by the NOAA-ESRL Physical Sciences Division

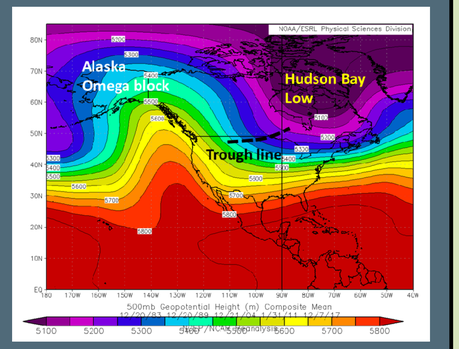
Methodology

Five additional instances of significant freezes or snowfall events occurring in the Lower RGV of Texas since 1976 were identified:

1. 20-25 Dec 1983: One of the most well-known Arctic air outbreaks on record; Harlingen, TX remained below 32°F all on both 25 & 26 Dec.
2. 20-24 Dec 1989: Temperature at Harlingen fell to 15°F night of 23-24 Dec.
3. 22-26 Dec 2004: Christmas Eve-Christmas Day snow in the RGV.
4. 02-05 Feb 2011: Freezing rain; 30-33 hour duration of freezing temperatures.
5. 07-08 Dec 2017: Current study; widespread snowfall over Deep South Texas.



Daily Weather Map, valid 12Z on 01 Feb 2011

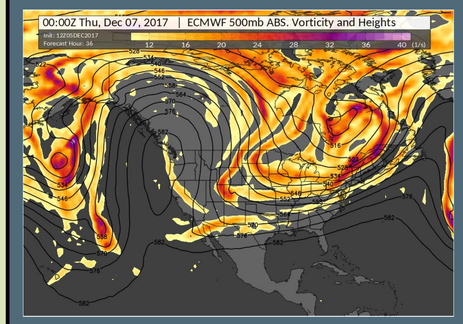


500-hPa composite of the five "new" McFarland cases since 1976; Image provided by the NOAA-ESRL Physical Sciences Division

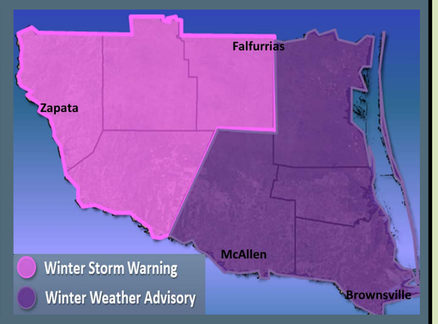
NOAA *Daily Weather Maps* and surface observations were analyzed to determine the timing of the initial Arctic frontal passage (FROPA) through the RGV for both the "old" and "new" cases (nine in total). It was found that the McFarland signature was generally most pronounced 36-48h prior to FROPA. 500-hPa geopotential height fields from NCEP/NCAR Reanalysis data (Kalnay, et al. 1996) were composited for the original and more recent cases for comparison.

The Forecast

A pattern favoring possible snowfall in the RGV was noted by several experienced forecasters by the afternoon of Tue, 05 Dec. Other deterministic model guidance (not shown) was similar. After collaborating with the Weather Prediction Center's Winter Weather Desk, confidence in accumulating snow was high enough to add it to Winter Weather headlines early in the afternoon of the 7th. A rapid changeover from rain to snow (i. e., no sleet) was expected as an upper-level trough was forecast to quickly cool the atmospheric column below freezing.



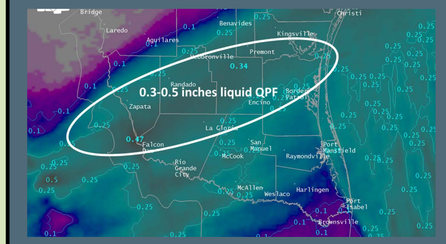
ECWMF 500-hPa height/vorticity forecast from 12Z cycle on 05 Dec 2017, valid 00Z Thu, 07 Dec 2017 (~36 hours prior to RGV FROPA). Note that several elements of the McFarland Signature are present.



Winter Storm Warnings and Advisories issued 1917Z on 07 Dec 2017.

National Blend of Models (NBM)

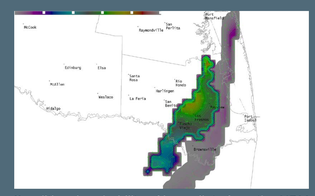
The 07 Dec 12Z cycle of the NBM 3.0 (Tew, et al. 2016), placed the axis of highest precipitation amounts accurately; compare with snowfall map in Introduction.



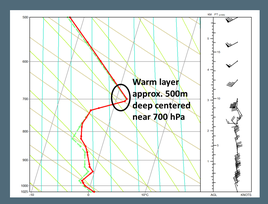
6h accumulated precip from the NBM 12Z 07Dec cycle, valid 06-12Z 08Dec.

The NBM forecast probability of snow was 100% in this area. Assuming a 10:1 snow-to-liquid ratio, it also produced reasonably *accurate snow accumulation totals* across the swath 24 hours in advance.

In addition, the NBM forecast a high probability (60-70%) of sleet to fall over eastern Cameron County during the early morning hours of 08 Dec, an element not included in National Digital Forecast Database (NDFD) grids. Sleet was observed around 08-09Z, by both the author and ASOS at KPIL. This is consistent with the shallow warm layer on the 12Z KBRO sounding.



Conditional probability of ice pellets from the NBM 12Z 07Dec cycle, valid 10Z 08Dec.



KBRO rawinsonde observation from 12Z 08Dec 2017.

Conclusions

- Recognition of the McFarland Signature continues to be a useful forecast tool, even more than 40 years after it was first identified.
- The NBM qualitatively performed well in capturing both spatial placement and snowfall amounts 24 hours prior to this rare snow event for Deep South Texas.
- Even for rare cases such as this, synoptic pattern recognition can add skill and confidence to forecasts.
- The NBM 3.0 correctly forecast a period of transitional sleet with 24h lead-time, which was not included in official NWS forecasts.
- An AWIPS tool such as ForecastBuilder, had it been available, may have assisted in including a period of forecast sleet in the NDFD grids.

References

Kalnay, E. and Coauthors, 1996: The NCEP/NCAR Reanalysis 40-year Project. *Bull. Amer. Meteor. Soc.*, **77**, 437-471.

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