Above: *Just a few of the dozens of photographs received at National Weather Service Brownsville this spring. Photos at left and right courtesy of KRGV-TV-5. Center photo courtesy of Mr. John Letney.*

Raising "Hail" in the Rio Grande Valley

Reasons, Theory, and (Mis)Fortune for Spring 2012's Wild Weather

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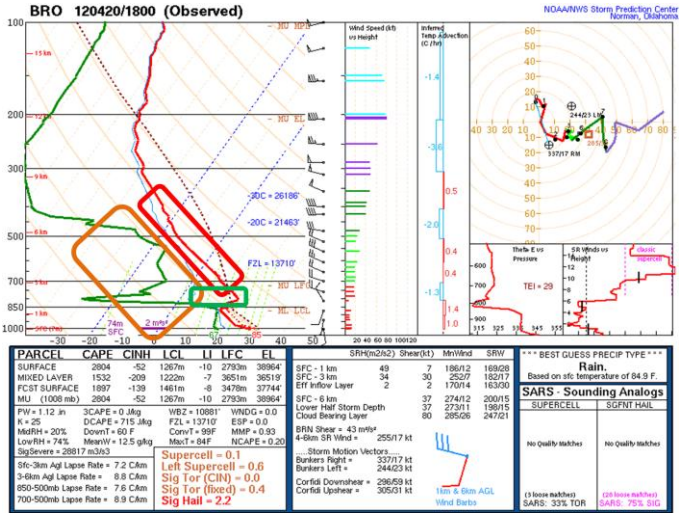
What a season it was. After many years with abbreviated severe weather (defined as hail the size of quarters or larger, winds 58 mph or higher, and tornadoes) seasons that lasted a week or two each May, spring 2012 brought more seven separate episodes and a few more local events, stretching from March 29th through May 15th. Anecdotally, residents did not recall a spring with so many storms that produced *very* large hailstones. Those same residents are asking how and why this happened. We have some, but certainly not all, the answers. Read on!

Meteorological Serendipity…Coincidence…and Science

Serendipity is defined by Merriam-Webster as "the faculty or phenomenon of finding valuable or agreeable things not sought for". This is slightly different from *coincidence,* where the occurrence of events has "some connection". Coincidence best describes the circumstances that define the atmosphere above the Rio Grande Valley to produce several rounds of severe storms in a six week period. Serendipity might explain how some of the same neighborhoods in the City of McAllen had hail the size of baseballs or larger *two times in a three week period* given a probability of *any* very large hail occurrence for the entire region at nearly one in ten *years*.

Consider the state of the atmosphere at any given time a jigsaw puzzle. How the pieces fit together helps determine the "sensible" weather – the situation we experience on earth. How each piece "looks" can explain the simplicity of complexity of a situation. A simple situation – fair weather – might feature the atmospheric equivalent of identical pieces that form a set of interlocking tiles (left side of image), where the tiles include high pressure, dry air, and light winds, embedded within larger scale teleconnections such as the phase of the Arctic Oscillation (AO) combined with the phase of El Niño Southern Oscillation (ENSO). A complex situation – hailstorms – would feature the equivalent of a jigsaw puzzle with multi-sided pieces that need to fit together perfectly (right side of image). This situation might feature sufficient instability (Figure 1), ample low level moisture, an upper level disturbance approaching during

peak afternoon heating (Figure 2), boundaries from nearby storms, and a developing sea breeze. Embedded larger scale teleconnections, such as the phase of the AO and ENSO, would be superimposed over the other puzzle pieces.



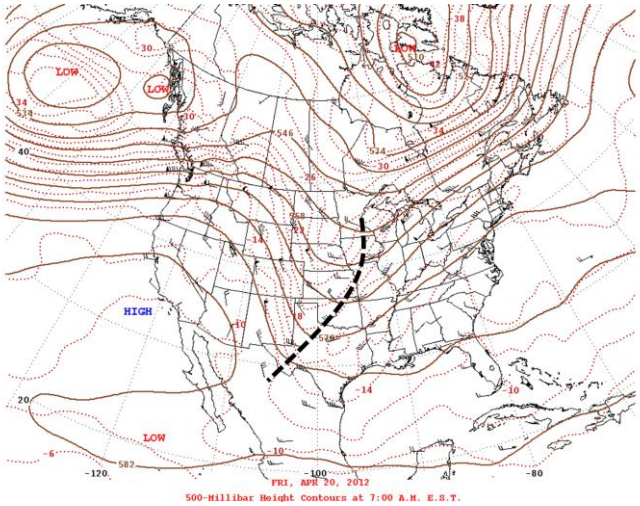


Figure 1 (left). *Atmospheric profile at Brownsville, 1 PM CDT April 20th. Red outline indicates very steep temperature drop with height. Orange outline indicates very dry air in the steep lapse rate region. Green outline indicates inversion layer. Hot humid air below the inversion would be "lifted" by the approaching upper level disturbance, indicated by the dashed black line in* **Figure 2 (right).**

Building the Jigsaw Puzzle: Recipe for Storminess

Future investigation into each of the puzzle pieces will be needed to complete the recipe for the storms. There may never be a perfect recipe; scientists and non-scientists recognize the intangible of (mis)fortune. By mis(fortune), consider the particular set of jigsaw puzzles during spring of 2012: For each episode, and even smaller local events, if the atmosphere could "make" hail, it did! Not only was hail "made", much of it was the size of quarters or larger, on March 29th, April 16th, April 20th, and in at least one location May 8th through 12th. In baseball, hitters often talk about being in the "zone" – when even poorly hit balls somehow fall for base hits. In soccer, a hot "goleador" scores with skill *and* with luck. Does the atmosphere behave in the same way? The question remains to be answered.

It Began in February…

After December 2011's hopeful rain was dashed by a warm, humid, and largely rain-free January 2012, the Valley was preparing for worsening drought. February's weather turned the forecast upside down; a prolonged period of cool and wet weather through mid-month was followed by warming, then more rain, and concluded with one final wetting cold front before rapid warming by leap day (29th). Rainfall, which ranked in the top ten for most Valley locations, combined with end of month warming to bring rapid greenup to a region which saw little green 12 months earlier.

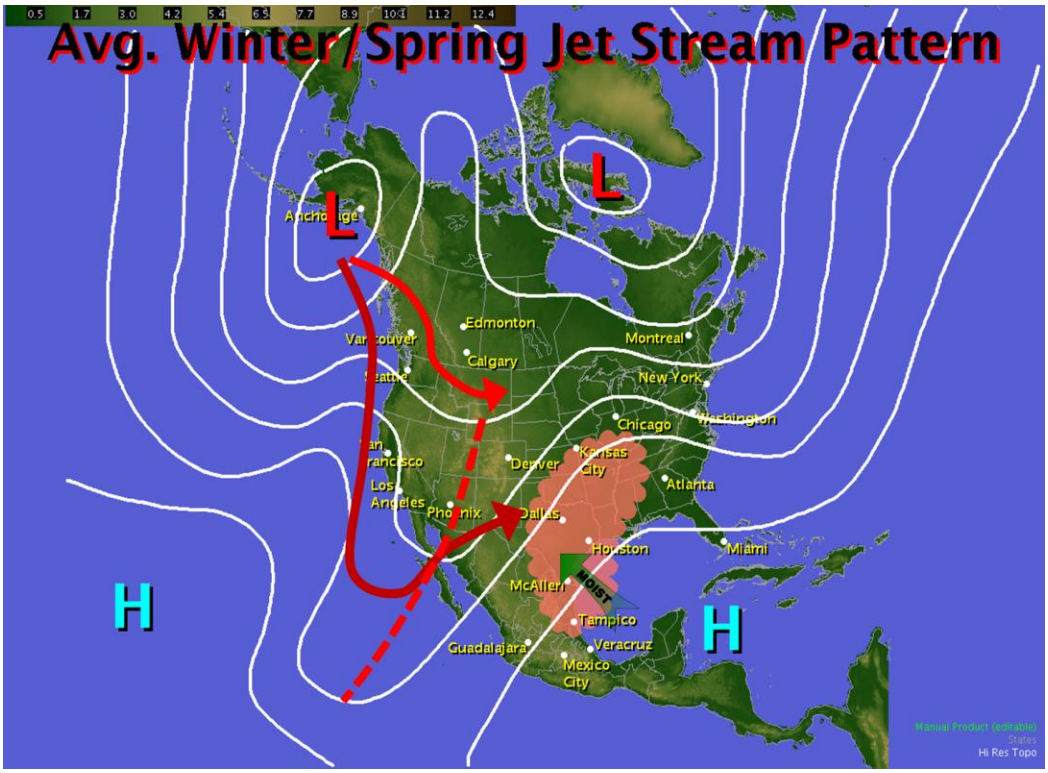
…Setting the Table in March

Rainfall reverted to below average in March, but ample top soil moisture and plant growth combined with persistent warm winds from the south kept many nights balmy. Between March 13th and 19th, overnight temperatures failed to drop below 70 in Harlingen, which allowed full growth and blossoming of grasses, trees, and plants. The increased moisture provided through evapotranspiration may have contributed to the amount of realized convective (rising) energy when acted on by a significant lifting mechanism, such as an upper level disturbance.

Parade of Disturbances

From December through May, the pattern of the "jet stream" across North America often showed a persistent area of low pressure in the Gulf of Alaska and a recurring area of low pressure across the southwest U.S. and northwest Mexico. This recurring area of low pressure formed two ways: 1) A "piece" of the Gulf of Alaska low pressure area would dive southward toward California and the southwest U.S., or 2) A "piece" of the Gulf of Alaska low would cut through the Pacific Northwest/south British Columbia and move through the Rockies –

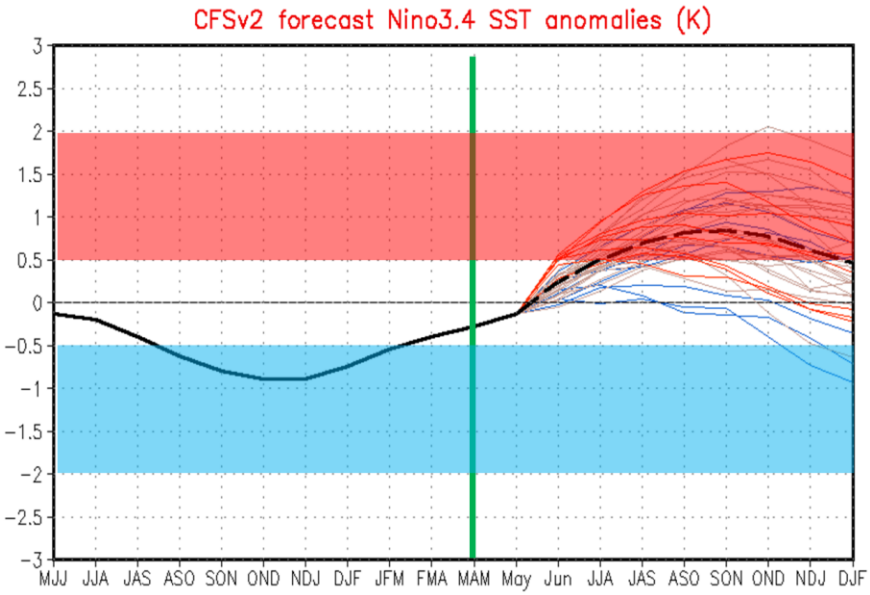
but leave a remnant trough which extended from the Rockies into northwest Mexico (Figure 3, right). As the southwest U.S./northwest Mexico disturbances organized, low level flow from the south transported additional moisture across south Texas and into the Lower Mississippi Valley (peach colored area on map), which was in place when either individual waves ejected from the disturbance or the entire disturbance moved east toward Texas. Each wave destabilized the mid and upper levels of the atmosphere, moving drier and cooler air aloft toward the Valley and giving a "push" to the very warm and humid in place near the surface.



The combination of these pieces completed each atmospheric jigsaw puzzle, with energy released as clusters, complexes, and lines of damaging thunderstorms. No county in the Rio Grande Valley or South Texas Ranchland was spared; at least one instance of damaging wind, large hail, tornadoes, or lightning-started fires occurred between March 29th and May 15th.

What's L(a Niña) Got To Do With It?

We wish we knew. Following a winter with weak to nearly moderate La Niña conditions, the estimated March to May index was neutral (Figure 4, right, green line). The March to May value in 2012 will end up a little higher than that of 2011, which was just a couple points into weak La Niña (-0.5 and lower, blue shading). The similarity in values requires a deeper look into other medium to long range forecast tools, such as teleconnections. One of those teleconnections, the Arctic Oscillation, differed markedly from the winter of 2011 to the winter of 2012. In 2010/2011, the index was highly *negative* from December until early February; in 2011/2012, the index was highly positive from December until near the end of January (Figure 5). Did the prolonged wintertime positive phase play role in the ability of the atmosphere to create the wave energy across the southwest U.S., which aided rainfall production and moisture influx across the Rio Grande Valley from late February through March? Does the neutral phase of both ENSO and the AO tell us anything about the jet stream and surface pattern that led to the wild spring 2012 weather in South Texas?



No matter what future research tells us about the 2012 spring weather across the Rio Grande Valley, few will forget the harrowing experiences with large hail, damaging wind, and lightning, particularly in McAllen. Combined damage from all the storms will likely exceed $100 million when insurance and other data are collected. If there's a silver lining to all the storm clouds, we hope that awareness of these storms is it. Spring 2012 reminds the Rio Grande Valley there's more to our weather than hurricanes and floods.

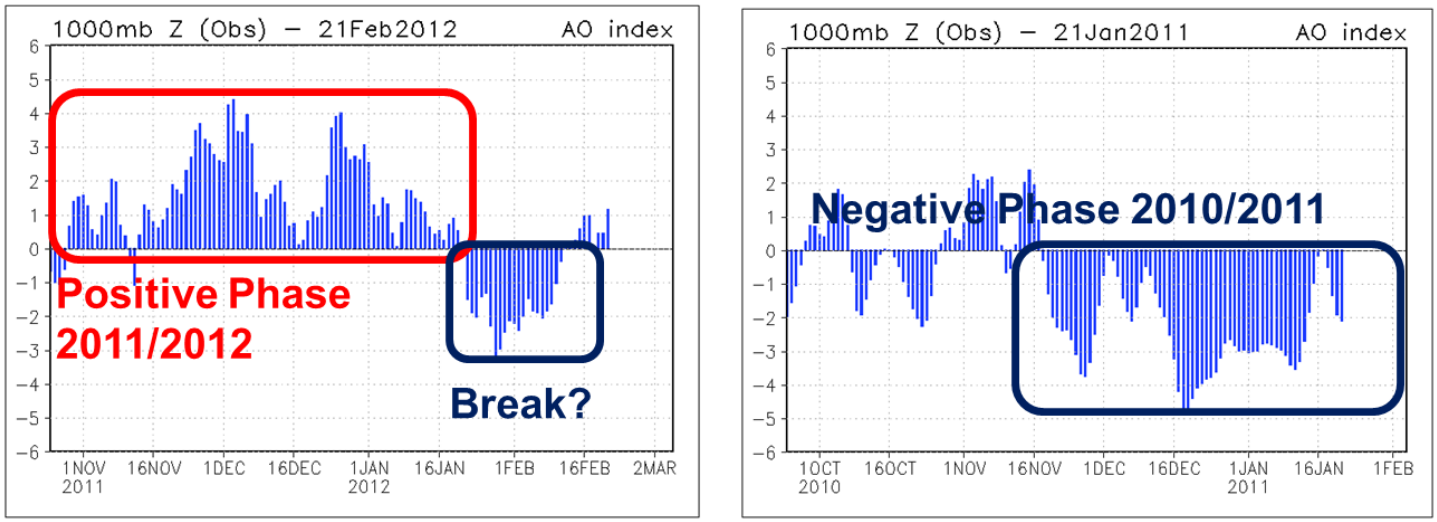


Figure 5. *Comparison of Phase of the Arctic Oscillation (AO) during the winter of 2011/2012 (left) and 2010/2011 (right).*

News Article Links

- **February: Dented, not Ended – Rainfall helps reduce Drought Impacts**
- **March 29th McAllen Hailstorm**
- **April 16th Rio Grande Valley Wind, Rain, and Hail**
- **April 20th : More Supersized Hail for Mid Valley**
- **May 8th: Downbursts Rake Rural Rio Grande Valley**
- **May 9th: Another Day, Another Damaging Wind/Hail Storm for the RGV**
- **May 11th: Overnight Squall Line Sweeps Valley with Rain, Hail, and Tornadoes**
- **May 12th: Pulse thunderstorms fire up more hail in Lower Valley**
- **Week of May 8th through 15th: Welcome Rain Dents the Drought…Again**