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An Ensemble Concept that May Reduce the Inherent Dry Bias in Complex Terrain

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Forecast Challenges in the West:

- Mountains Receive Most of the Precipitation
- Population Centers Tend to be in Drier Valleys
- Significant Precipitation in the Populated Drier Valleys (how do dynamics interact with complex terrain?)
  → ***Potential High Impact Events*** ←

Goals

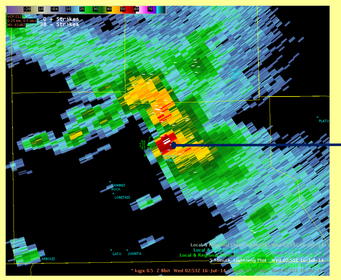
- Introduce a New Forecast Concept Addressing QPF
- Increase Situational Awareness
- Boost Forecaster Confidence on Significant Precipitation Events for Populated Drier Valleys
- Improved Decision Support Services

Case Example to Demonstrate Forecast Concept

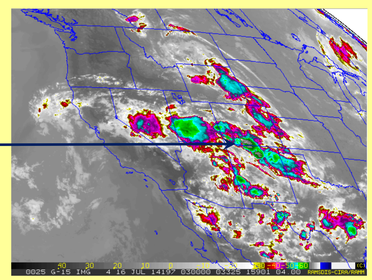
Pagosa Springs, Colorado Flooding – July 15, 2014

- Highway 160 – Water was up to 18" deep. Nearby camping/RV facilities was evacuated (no flash flooding occurred at these facilities).
- Downtown Pagosa Springs – Water up to 12" deep flowed across a local street. Water flowed across a neighborhood of homes and businesses (6" – 8" deep).
- West side of Pagosa Springs – Local businesses experienced flooding with one store manager reported water inside was 12" deep. No structural damage to infrastructure or buildings were reported.

Can This Event be Forecast in Advance?



KGJX 0252Z 16 July 2014 Radar Image with Storm over Pagosa Springs, Colorado



4KM IR – 0300Z 16 July 2014

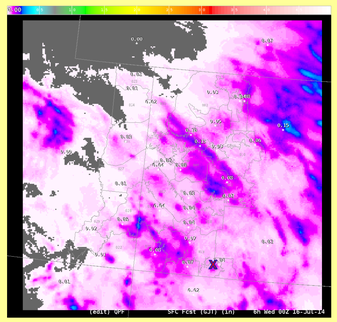
"Situational Awareness" Data for Pagosa Springs at 00Z 16 July 2014
(From RAP Model)

Temperature: 24C
Precipitable Water: 0.90
Elevation: 2172 m MSL (7126 feet)

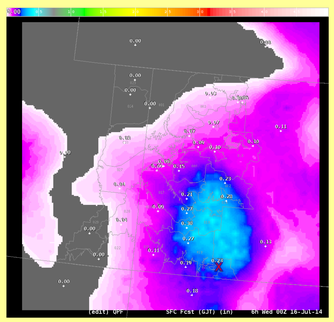
Dew Point Temperature: 9C
Freezing Level Height: 4980m MSL
Population: 1727 (2010 Census)

Short Term Outlook: Warm Moist Conditions Exist – Precipitation Efficiency Above Normal

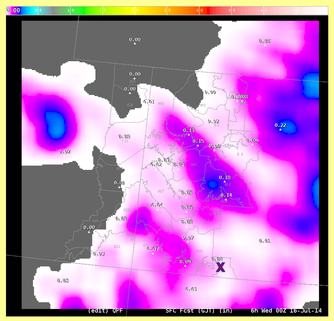
Various QPF 6 Hour Forecast – Which Is Best?
X Marks Pagosa Springs, Colorado



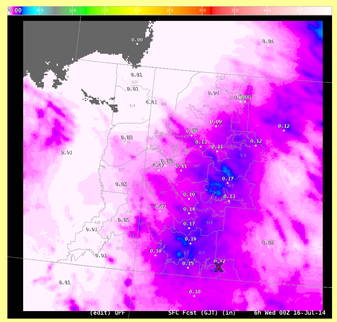
Blend of Several Models with Various Resolutions
"Poor Man's" Ensemble



Weather Prediction Center (WPC)



Smoothed High Resolution Models
[NamDNG5, RAP13, WRF(ARW + NMM)]



50% "Poor Man's Ensemble"/50% WPC

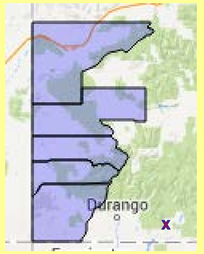
Python Scripts within the Graphical Forecast Editor (GFE) Created the Images in this Box

	PROS	CONS
"Poor Man's" Ensemble	Combines Several Models and Guidance	QPF Maxima
WPC Guidance	"Big Picture" Overview	Lacks Detail for Complex Terrain
Smoothed High Resolution Models	Convective "Bulls-eye"	More Prone to Error
50% WPC/50% CONSAll Blend	Maintains the "Big Picture" With Convective "Bull's-eye"	Maxima QPF may be too smoothed

Methodology

1. Start with WPC Guidance as the baseline with a good depiction of the "Big Picture". (WPC outperforms all individual models – results from Novak et al. (2014).
2. Smooth Blended Higher Resolution Models to target potential convective bull's-eye. The Forecaster role is essential since models have limited ability to predict locally heavy rainfall. Forecaster can "accept" the solution, or toss it. If higher resolution models are not accepted, use a lower resolution model ensemble blended approach. This is a good first-guess.

   Reason for Smoothing (averaging of grid points) – Interactions of Mesoscale weather phenomena and orographic enhancement of precipitation are not fully understood (Tardy 2005). The result means higher QPF values for drier locations.
3. Combine the WPC Guidance with the detailed solution described in Step. 2.
   Caveat: Smoothing allows for forecast uncertainty and may help remove wet or dry bias.



Deterministic Forecasting

Image on the left is an example of Deterministic Forecasting. Flash Flood Watch was issued for the shaded southwest Colorado areas from 3 PM to Midnight on 15 July 2014.

No reports of Flash Flooding occurred in the shaded areas.

Flashing Flooding occurs at location X, Pagosa Springs.

Summary:

- WPC Provided Good Guidance on QPF "Bulls-eye"
- "Poor Man's Ensemble" Missed the Heavy Rain Potential over Pagosa Springs
- Better Idea 1: Use WPC Guidance as a "Base" to Handle the "Big Picture"
- Better Idea 2: Use Higher Resolution Models (HRRR, WRF, etc…) to refine the "Bigger Picture".
- Will Continue to Work on this Methodology for Different Cases and Environments
- Use Applications (e.g. GFE Smart Tools) as Part of the Forecast Decision-Making Process
- Methodology Combine Strengths of the National Centers and Local WFO Forecasters
- Result: ***Improved Forecast and Decision Support Services***

References

Novak, David R., et. al. 2014: Precipitation and Temperature Forecast Performance at the Weather Prediction Center. Wea. Forecasting, 29, pp 489-504.

Tardy, Alexander O., M. Jackson and E. Szoke 2005: Evaluation of high resolution QPF performance in the complex terrain of the Great Basin as part of the DTC Winter Forecast Experiment. 21st Conference on Weather Analysis and Forecasting/17th Conference on Numerical Weather Prediction

Pagosa Springs Image Credit: Wikipedia