Forecast Average Recurrence Interval (ARI) Precipitation Maps for the U.S. A New Way of Communicating the Location and Magnitude of High Impact Precipitation Events

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### Overview

- The ARI Concept
  - Method
  - Examples of Observed ARI
- Motivation for Forecast Mode ARI
- WDT Operational WRF System
- Forecast ARI Example
- Products and Applications





# The ARI Concept

- Precipitation frequency (PF) estimates are depths of precipitation that are expected at different recurrence intervals (i.e. "return periods").
- PF estimates are statistically calculated based on <u>historical</u> precipitation data.
  - Provided as gridded GIS files by the National Weather Service (NWS)
- The ARI represents a <u>current</u> precipitation event (amount per unit time) as the average number of years
  between equivalent events for a specific location.

## The ARI Concept

- The ARI of precipitation is an objective means of conveying the rareness or commonness of precipitation, even without knowledge of the precipitation regime of a location.
- The ARI of precipitation is useful as a "Potential Flood Index", communicating the likelihood that flooding may have or might occur. Note, however, that it does not imply the same ARI of flood
  - 100 year rain  $\neq$  100 year flood



# The ARI Concept – Method



10-year

NWS 24-hour **Precipitation Frequency** Estimates

#### 24-hour Average Recurrence Interval (ARI)





**Tropical Storm** Hermine – Texas September 7, 2010







**Radar-estimated** Precipitation or QPF

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## The ARI Concept – Real-Time Example

# April 15, 2011 12:54 PM CDT



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Map Sate Dry METSTAT 1-yr 2-yr 6-hour ARI 3-yr 4-yr 5-yr 10-yr 20-vr 40-yr 60-yr 80-yr 100-yr 200-vr 300-yr 500-yr 1000-yr >1000-vr



# **Motivation for Forecast ARI**

- Mesoscale Numerical Weather Prediction (NWP) models provide state-of-the-science quantitative precipitation forecasts (QPF) out to a few days.
- WDT provides operational mesoscale NWP services based on the community WRF modeling system for a variety of applications, including QPF for hydromet application
- Can we convert these gridded QPF values into ARI values?
- If so, do they provide a meaningful and/or more effective means of communicating precipitation forecasts?



# **Operational CONUS WRF Domain**

- Advanced Research WRF Version 3.3
- Precipitation Physics Selections
  - Kain-Fritsch Conv. Parameterization
  - WSM6 Microphysics
- Unique LAPS+FDDA Data Assimilation
  - WDT 3D Quality-Controlled Radar Mosaics
  - GOES IR Image Channels and CDW
  - Wind Profilers
  - Conventional Observations

- 11.8-km grid cells
- 120-h forecast with 1-h output steps
- Updated every 6 hours (03, 09, 15, 21Z)
- Custom Post-Processing
  - GRIB2 produced concurrent with model execution
  - Selectable precipitation time accumulation
  - WDT algorithms for derived products



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## WDT WRF QPF Application Example





WDT has been providing high-resolution WRF forecasts for quantitative precipitation forecasts. GIS post-processing remaps the gridded QPF values to basin averages. These forecasts are used to plan cloud seeding operations. WRF performs particularly well in forecasting onset and duration of precipitation events.

GIS processing converts gridded values to basin averages





### Forecast ARI Example

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### • Hurricane Irene – August 27-29, 2011



45h Forecast, Initialized 26 Aug 2011/1500Z, Valid 28 Aug 2011/1200Z



### Forecast ARI Example (Cont.)

### • Hurricane Irene – August 27-29, 2011



69h Forecast, Initialized 26 Aug 2011/1500Z, Valid 29 Aug 2011/1200Z



26<sup>th</sup> HYDRO (92<sup>nd</sup> AMS, 2012)

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### Initial Forecast ARI Products & Applications

#### **Initial Product Offerings**

- Every CONUS WRF Forecast
  - Updated 4 times each day
- Converted to 0.1° Lat/Lon Grid
- 6-h ARI
  - 6-120 hours, 3-h time steps
- 24-h ARI
  - 24-120 h, 12-h time steps
- 5-day Maximum 6-h and 24-h ARI
- Flexible Delivery Mechanism
  - Interactive and Static Maps
  - Data Files (ArcASCII, NetCDF, etc.)
  - GIS Services (WMS and REST)
  - Image Tile Web Service

#### **Application Examples**

- Media Outlets
- Emergency Managers
- Flood Control Districts
- Water Resource Managers
- Business Continuity
- Smart Grids (Hydroelectric Generation)
- Risk Management
- Insurance/Re-insurance
- DOTs

Additionally, real-time ARI *analysis* products for 1, 3, 6, and 24-h periods are available

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### Summary

- ARI is a revolutionary way to communicate precipitation information
  - Adds local context via climatology
  - Amenable to visual presentation
- Forecast ARI enhances value of mesoscale NWPbased QPF
  - Readily summarizes many "frames" of information
  - Provides situational awareness for upcoming events

