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FLASH Product Suite

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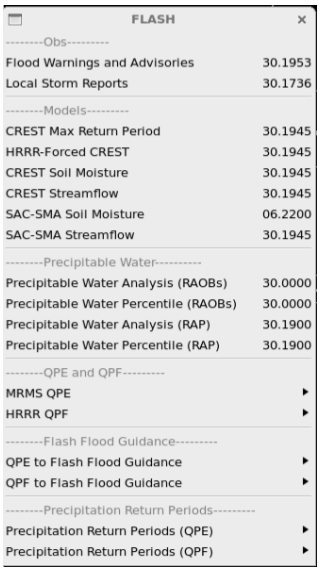
Organization

- Total of 35 products in 6 categories
- Mixture of observations, hydrologic models, QPE, QPF, flash flood guidance, and precipitable water



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"Observations"

- Multiple sources
  - Local Storm Reports and Flash Flood Warnings/ Flood Warnings/Flood Advisories available in AWIPS-II
  - LSRs restricted to the following:
    - flood: 
    - flash flood: 
    - heavy rain: 
  - CAVE will only show *one* LSR at a time

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Flood Warnings and Advisories

Output:	Flash Flood Warnings, Flood Warnings, and Flood Advisories
Availability:	CONUS-wide
Usage:	Primarily for next-day verification of experimental watches and warnings

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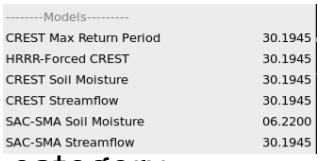
Models



- 6 total products in the models category
- Includes two hydrologic models – CREST and SAC-SMA
- CREST – Coupled Routing and Excess Storage
  - Developed by OU and NASA
- SAC-SMA – Sacramento Soil Moisture Accounting model

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Models

- Will have access to two SAC-SMA products
  - Soil Moisture and Streamflow
- Four CREST products
  - Soil Moisture and Streamflow
  - Maximum Return Period
  - HRRR-forced Maximum Return Period
- All six available every 15 minutes at 1 km resolution (CONUS-wide)

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CREST Max Return Period

Output: Return period
Displays the maximum simulated return period between 30 min before valid time and 6 hr after valid time
Scale: 0 – 200 yr
Resolution: 1 km x 1 km; 15 min
Availability: CONUS-wide excluding WA, ID, and OR. Should be in CAVE approx. 45-50 min after product valid time.
Input: MRMS radar-only QC'ed precipitation rate
Usage: Look for contiguous areas of progressively higher values. Flooding is believed to begin at 2 yr (yellow) and up.

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CREST Max Return Period

Colors: black = <1 yr
green = 1 – 2 yr
yellow = 2 – 10 yr
red = 10 – 50 yr
purple = 50 – 200 yr

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CREST Max Return Period

Technical Notes: This product converts simulated stream flow values from a hydrologic model to an estimated return period. The model is initially run over the entire domain from 2002-2010 using Stage IV precipitation as forcing. Then the maximum yearly stream flow values at each grid cell are stored. In real-time, the same model is forced with MRMS radar-only QC'ed QPE. The stream flow resulting from this second simulation is compared to the maximum yearly values from the Stage IV-forced model run and converted to an estimated return period in years via a Log Pearson III relationship. Note that this process often results in high biased return periods.

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HRRR-Forced CREST

Output: Return period
Displays the maximum simulated return period between 30 min before and 6 hr after valid time
Scale: 0 – 200 yr
Resolution: 1 km x 1 km; 15 min
Availability: CONUS-wide excluding WA, ID, and OR. Should be in CAVE approx. 45 – 50 min after product valid time.
Input: MRMS radar-only QC'ed precipitation rate and HRRR QPF
Usage: Look for contiguous areas of progressively higher values. Flooding is believed to begin at 2 yr (yellow) and up. Values will be higher than in QPE-forced CREST.

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HRRR-Forced CREST

Technical Notes: This product works on the same principles at the "CREST Max Return Period" product (see product notes for more). Here, CREST receives QPF from the HRRR for hydrologic model hours 0 – 6 (in the QPE variation, rainfall in these hours is assumed to be zero). The HRRR QPF is from HRRR model hours 4 – 10. For example, a HRRR-Forced CREST grid valid at 4:00z will consist of MRMS precipitation prior to 4:00z and HRRR QPF from 4:00z to 10:00z (from the 00:00z HRRR model run). This product will, of course, always have higher values than the QPE variation, but the two products can still be compared when the valid times of each match in CAVE.

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CREST Streamflow

Output: Simulated surface water flows (max between 30 min before and 6 hr after the valid time)
Scale: 0 - 1,000 $m^3 \bullet s^{-1}$
Resolution: 1 km x 1 km; 15 min
Availability: CONUS-wide excluding WA, ID, and OR. Should be in CAVE approx. 45 – 50 min after product valid time.

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CREST Streamflow

Input: MRMS radar-only QC'ed precipitation rate

Usage: Use this for model diagnostics. Areas appearing in gray and light green are where rain is currently occurring/ overland flows are being modeled. Channel flows tend to appear in purple and blue.

Colors: black = 0 $m^3 \bullet s^{-1}$
gray = 0.1 – 1.0 $m^3 \bullet s^{-1}$
green = 1 – 10 $m^3 \bullet s^{-1}$
purple & blue = 10 – 1,000 $m^3 \bullet s^{-1}$

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CREST Streamflow

Technical Notes: Taking values from this product literally is not currently recommended. Due to limitations in CAVE, a logarithmic color scale could not be implemented. All large river systems will therefore appear in the same blue shade.

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SAC-SMA Streamflow

Technical Notes: The basic information about this product is identical to its CREST counterpart. However, in general, values for this product are lower. Additionally, at close range, this product will look coarser because some parameter maps used in its development are 4 km x 4 km but the final resolution is still 1 km x 1 km. Taking values from this product literally is not currently recommended. Recent rainfall here will appear solid gray, not gray to light green.

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CREST Soil Moisture

Output: Soil moisture content
Scale: 0 – 100%
Resolution: 1 km x 1 km; 15 minutes
Availability: CONUS-wide. Should be in CAVE approx. 45 – 50 min after product valid time.
Input: MRMS radar-only QC'ed precipitation rate
Usage: Dark blue and dark green areas are nearly saturated. Gray areas are currently experiencing rainfall. It is likely that the same amount of rainfall in two areas will cause greater flooding impacts in the region with more saturated soils.

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SAC-SMA Soil Moisture

Output: Soil moisture content
Scale: 0 – 100%
Resolution: 1 km x 1 km; 15 min
Availability: CONUS-wide. Should be in CAVE approx. 45 – 50 min after product valid time.
Input: MRMS radar-only QC'ed precipitation rate
Usage: Dark blue and dark green areas are nearly saturated. Gray areas are currently experiencing rainfall. It is likely that the same amount of rainfall in two areas will cause greater flooding impacts in the region with more saturated soils.

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SAC-SMA Soil Moisture

Technical Notes: At close range, this product will appear coarser than its CREST counterpart. Despite a final resolution of 1 km x 1 km, coarser 4 km x 4 km maps of the W_{max} parameter are used in generating these maps. The soil moisture percentage is calculated by divided UZTWA (Upper Zone Tension Water Amount) by UZTWC (Upper Zone Tension Water Capacity). In general, soil moisture values are lower for this product than seen in CREST soil moisture.

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Precipitable Water

- 4 total products
- Observations and model outputs
- Analysis and percentiles

--------Precipitable Water----------	
Precipitable Water Analysis (RAOBs)	30.0000
Precipitable Water Percentile (RAOBs)	30.0000
Precipitable Water Analysis (RAP)	30.1900
Precipitable Water Percentile (RAP)	30.1900

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Precipitable Water Analysis (RAOBs)

Output: Precipitable water (PWAT) (sfc – 300 mb)
Scale: 0.0 – 3.0 in
Resolution: 0.1 x 0.1 deg; 12 hr
Availability: Twice daily at 00 and 12z; should appear in CAVE by 01 and 13z
Input: CONUS RAOBs
Usage: Higher PWAT values are associated with a greater probability of heavy rain and thus, flash flooding

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Precipitable Water Analysis (RAOBs)

Colors: black = 0 – 0.1 in
blue = 0.1 – 0.75 in
green = 0.75 – 1.5 in
yellow = 1.5 – 2.0 in
orange and red = 2.0 – 3.0 in

Technical Notes: PWAT values from 0 and 12z rawinsondes over the CONUS are objectively analyzed to the 0.1 deg MRMS grid via a Barnes analysis. Analyzed values are progressively less reliable the farther away from the CONUS you move.

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Precipitable Water Analysis (RAP)

Output: PWAT (sfc – 300 mb)
Scale: 0.0 – 3.0 in
Resolution: 0.1 x 0.1 deg; 1 hr
Availability: Hourly; should appear in CAVE ~1 hr after valid time
Input: RAOBs, integrated retrievals from GPS, other sources (see rapidrefresh.noaa.gov)
Usage: Higher PWAT values are associated with a greater probability of heavy rain and thus, flash flooding

Colors: black = 0 – 0.1 in
blue = 0.1 – 0.75 in
green = 0.75 – 1.5 in
yellow = 1.5 – 2.0 in
orange and red = 2.0 – 3.0 in

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Precipitable Water Analysis (RAP)

Technical Notes: This product consists of the hourly PWAT analysis from NCEP's Rapid Refresh v2 weather model. It is resampled from its 13 km original resolution to the 0.1 deg MRMS grid but is otherwise unaltered from the original. The RAP v2 includes satellite retrievals, RAOBs, and other sources of information.

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Precipitable Water Percentile (RAOBs)

Output: PWAT (sfc – 300 mb) percentile
Scale: 0 – 100%
Resolution: 0.1 x 0.1 deg; 12 hr
Availability: Twice daily at 00 and 12z; should appear in CAVE by 01 and 13z
Input: CONUS RAOBs, PWAT climatology
Usage: Values in the 90th percentile or higher suggest heavy rainfall is possible. Values in the 99th percentile have been associated with major flash flooding events.

Colors: black = 0 – 50%
blue = 50 – 75%
green = 75 – 80%
yellow = 85 – 90%
orange = 90 – 95%
red = 95 – 99%
pink = 99 – 100%

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Precipitable Water Percentile (RAOBs)

Technical Notes: An observed PWAT value for a particular rawinsonde launch is compared to the historical distribution of PWAT values at that launch site and within that month. Then the percentile rank of the observed value is calculated and analyzed to the 0.1 x 0.1 deg MRMS grid via a Barnes analysis. Climatology data generally covers the years 1948 – 2013. PWAT climatology was developed by Matthew Bunkers at NWSFO Rapid City.

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Precipitable Water Percentile (RAP)

Output: PWAT (sfc – 300 mb) percentile
Scale: 0 – 100%
Resolution: 0.1 x 0.1 deg; 1 hr
Availability: Hourly; should appear in CAVE ~1 hr after valid time
Input: RAOBs, integrated retrievals from GPS (see rapidrefresh.noaa.gov), PWAT climatology
Usage: Values in the 90th percentile or higher suggest heavy rainfall is possible. Values in the 99th percentile have been associated with major flash flooding events.

Colors:
black = 0 – 50%
blue = 50 – 75%
green = 75 – 80%
yellow = 85 – 90%
orange = 90 – 95%
red = 95 – 99%
pink = 99 – 100%

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Precipitable Water Percentile (RAP)

Technical Notes: This product consists of the percentile rank of the RAP analysis PWAT value at each grid point. This is obtained by gridding the points that make up the Bunkers PWAT climatology and then comparing the RAP analysis to that grid.

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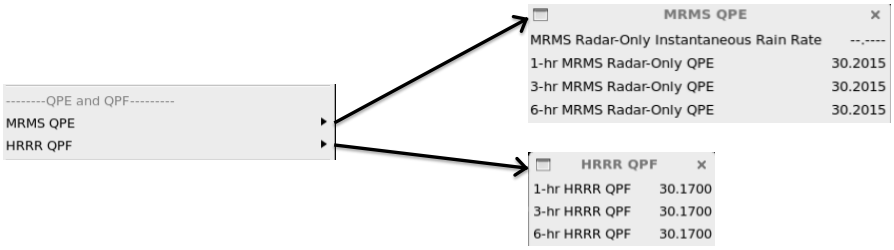
QPE and QPF



- 7 total products
- QPE from the Multi-Radar/Multi-Sensor project
- QPF from the High Resolution Rapid Refresh model

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1-, 3-, 6-hr MRMS Radar-Only QPE

Output: 1–, 3–, or 6–hr radar-derived QPE
Scale: 0.0 – 10.0 in
Resolution: 0.1 x 0.1 deg; 5 min
Availability: CONUS, every 5 min, should appear in CAVE ~10 min after valid time. This lag is due to processing in the FLASH system, not the MRMS system.
Input: Rainfall estimates from WSR-88Ds
Usage: Rainfall accumulations can be used to identify areas experiencing heavy rainfall and thus at risk for flash flooding impacts

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MRMS Radar-Only Instantaneous Rain Rate

Output: Instantaneous rain rate
Scale: 0.0 – 10.0 in/hr
Resolution: 0.1 x 0.1 deg; 5 min
Availability: CONUS, every 5 min, should appear in CAVE ~10 min after valid time. This lag is due to processing in the FLASH system, not the MRMS system.
Input: Rainfall estimates from WSR-88Ds
Usage: High instantaneous rain rates are likely to generate runoff and possibly flash flooding impacts

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1-, 3-, 6-hr HRRR QPF

Output: 1 –, 3 –, or 6 – hr HRRR QPF
Scale: 0.0 – 10.0 in
Resolution: 0.1 x 0.1 deg; 1 hr
Availability: CONUS, every hr, should appear in CAVE ~15-30 minutes after the valid time
Usage: High-resolution short-range rainfall forecasts can be used to identify areas at risk for flash flooding impacts in 1, 3, or 6 hr.

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1-, 3-, 6-hr HRRR QPF

Technical Notes: Like all FLASH products that incorporate HRRR outputs, there is a 3–hr lag between the HRRR initialization time and the product's valid time in CAVE. For example, a 06z 1–hr HRRR QPF in CAVE is actually the 03z 4–hr HRRR QPF. If any hour of a particular HRRR model run is missing, no HRRR-related FLASH products are produced.

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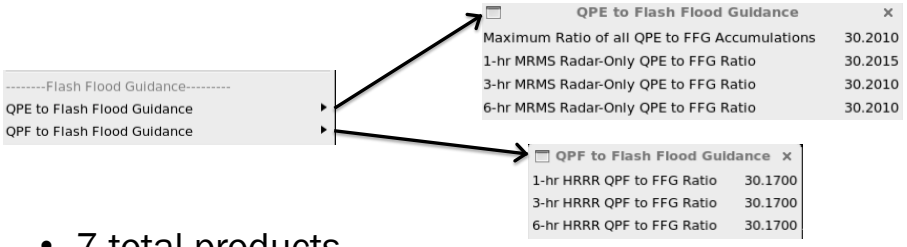
Flash Flood Guidance



- 7 total products
- QPE from the Multi-Radar/Multi-Sensor project
- QPF from the High Resolution Rapid Refresh model
- FFG is mosaicked from individual RFC grids at NCEP WPC and sent to FLASH system

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1-, 3-, 6-hr MRMS Radar-Only QPE to FFG Ratio

Output:	1–, 3–, or 6–hr QPE to FFG ratio
Scale:	0 – 500%
Resolution:	0.1 x 0.1 deg; 5 min
Availability:	CONUS, every 5 min, should appear in CAVE ~10 min after valid time. This lag is due to processing in the FLASH system, not the MRMS system.
Input:	MRMS radar-only QC'ed QPE and RFC FFG grids
Usage:	When QPE exceeds 100% of FFG (yellow), bankfull conditions on small natural stream networks exist.

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1-, 3-, 6-hr MRMS Radar-Only QPE to FFG Ratio

Technical Notes: Flash Flood Guidance is produced at 12 River Forecast Centers between 1 and 4 times per day. Here, it appears in 1-, 3-, and 6-hr flavors. FFG is defined as the amount of rainfall required in that time to cause bankfull conditions on small natural stream networks. FFG is produced differently from RFC to RFC, so use caution in interpreting the product along these domain boundaries. Unlike FFMP, we cannot "zero out" antecedent precipitation when an FFG grid is updated. Therefore, be aware that spuriously high ratios may appear immediately after a new FFG grid is ingested.

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Maximum QPE to FFG Ratio of All Accumulations

Output: Maximum QPE to FFG ratio
Scale: 0 – 500%
Resolution: 0.1 x 0.1 deg; 5 min
Availability: CONUS, every 5 min, should appear in CAVE ~10 min after valid time. This lag is due to processing in the FLASH system, not the MRMS system.
Input: MRMS radar-only QC'ed QPE and RFC FFG grids
Usage: Used to quickly determine if any FFG product is being exceeded by QPE

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1-, 3-, 6-hr HRRR QPF to FFG Ratio

Output: 1-, 3-, or 6-hr QPF to FFG ratio
Scale: 0 – 500%
Resolution: 0.1 x 0.1 deg; 1 hr
Availability: CONUS, every hr, should appear in CAVE 15-30 min after the hour.
Input: MRMS radar-only QC'ed QPE, HRRR QPF, and RFC FFG grids
Usage: When QPE + QPF exceeds 100% of FFG, bankfull conditions on small natural stream networks exist.

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1-, 3-, 6-hr HRRR QPF to FFG Ratio

Technical Notes: This product uses a combination of MRMS QPE and HRRR QPF to forecast FFG ratios forward 1, 3, or 6 hrs into the future. For example, assume you view the 6-hr product at 1930z. The first frame will be valid at 20z and it will contain 1 hr of HRRR QPF (19 –20z) and 5 hr of MRMS QPE (14 – 19z). Keep in mind that the HRRR QPF is not a 1-hr forecast from the 19z initialization but a 4-hr forecast from the 15z initialization.

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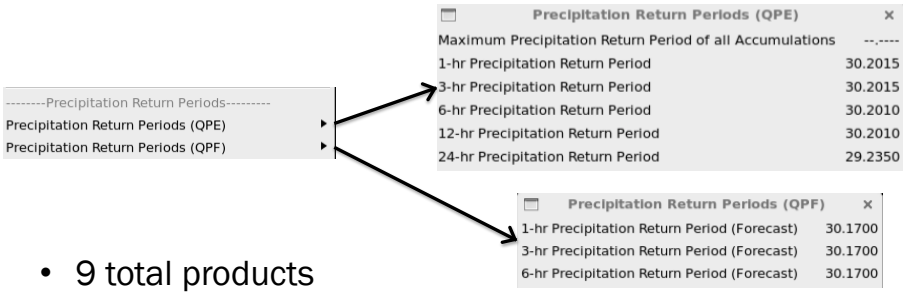
Precipitation Return Periods



- 9 total products
- QPE from the Multi-Radar/Multi-Sensor project
- QPF from the High Resolution Rapid Refresh model
- Precipitation is compared to NOAA Atlas 14 or the Cornell NY/NE Extreme Precipitation dataset

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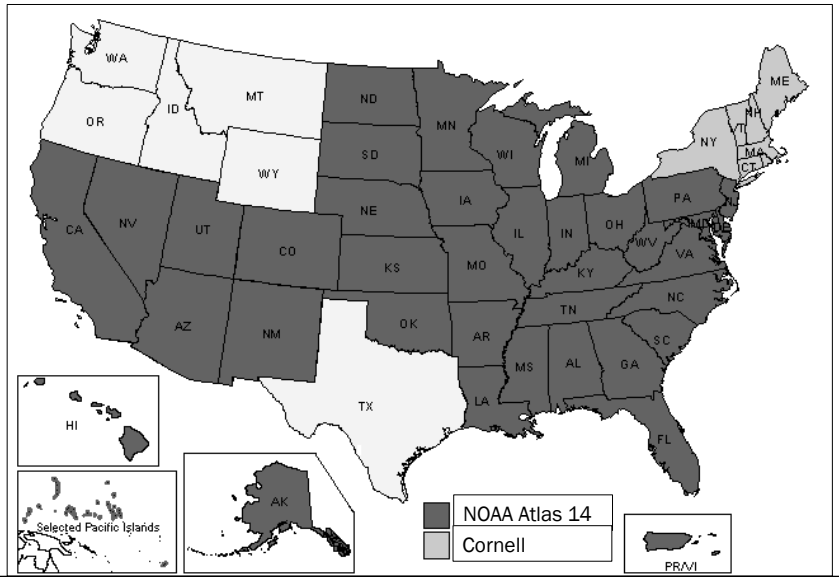
Precipitation Return Periods



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1-, 3- , 6-, 12-, and 24-hr Precipitation Return Period

Output: 1-, 3-, 6-, 12-, or 24-hr precipitation return period
Scale: 0 – 500 yrs
Resolution: 0.1 x 0.1 deg; 5 min
Availability: CONUS except TX, ID, MT, WY, WA, and OR; every 5 min; should appear in CAVE ~10 min after valid time. This lag is due to processing in the FLASH system, not the MRMS system.
Input: MRMS radar-only QC'ed QPE, NOAA Atlas 14 Precipitation Return Periods, and Cornell New York & New England Extreme Precipitation dataset
Usage: Extreme precipitation return periods are likely to overwhelm small streams and infrastructure

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1-, 3- , 6-, 12-, and 24-hr Precipitation Return Period

Technical Notes: Precipitation estimates from MRMS are compared to gridded to estimates of precipitation return periods from NOAA Atlas 14 (most of CONUS) or the Cornell dataset (in the northeast).

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1-, 3- , and 6-hr Precipitation Return Period (Forecast)

Output: 1-, 3-, or 6-hr forecast precipitation return period
Scale: 0 – 500 yrs
Resolution: 0.1 x 0.1 deg; 1 hr
Availability: CONUS except TX, ID, MT, WY, WA, and OR; every hr; should appear in CAVE 15-30 min after the hour.
Input: MRMS radar-only QC'ed QPE, NOAA Atlas 14 Precipitation Return Periods, Cornell New York & New England Extreme Precipitation dataset, and HRRR QPF
Usage: Extreme precipitation return periods are likely to overwhelm small streams and infrastructure

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1-, 3- , and 6-hr Precipitation Return Period (Forecast)

Technical Notes: This product uses a combination of MRMS QPE and HRRR QPF to forecast precipitation return periods forward 1, 3, or 6 hrs into the future. For example, assume you view the 6-hr product at 1930z. The first frame will be valid at 20z and it will contain 1 hr of HRRR QPF (19 –20z) and 5 hr of MRMS QPE (14 – 19z). Keep in mind that the HRRR QPF is not a 1-hr forecast from the 19z initialization but a 4-hr forecast from the 15z initialization.

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Maximum Precipitation Return Period of All Accumulations

Output: 1-, 3-, 6-, 12-, or 24-hr precipitation return period
Scale: 0 – 500 yrs
Resolution: 0.1 x 0.1 deg; 5 min
Availability: CONUS except TX, the NW, New England, and NY; every 5 min; should appear in CAVE ~10 min after valid time. This lag is due to processing in the FLASH system, not the MRMS system.
Input: MRMS radar-only QC'ed QPE, NOAA Atlas 14 Precipitation Return Periods, and Cornell New York & New England Extreme Precipitation dataset
Usage: Used to quickly diagnose the highest precipitation return period regardless of accumulation time period