FLASH Product Suite

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Organization

- Total of 39 products in 7 categories

- Mixture of observations, hydrologic models, QPE, QPF, flash flood guidance, and precipitable water

FLASH	
---------Obs---------	
Flood Warnings and Advisories	--.----
Local Storm Reports	--.----
---------Radar---------	
MRMS Quality-Controlled Composite Reflectivity	--.----
MRMS Seamless Hybrid-Scan Reflectivity	25.2005
---------Models---------	
CREST Streamflow	25.2000
CREST Unit Streamflow	25.2000
CREST Soil Moisture	--.----
HRRR-Forced CREST Streamflow	25.2000
HRRR-Forced CREST Unit Streamflow	25.2000
ADSTAT-Forced CREST Streamflow	25.2000
ADSTAT-Forced CREST Unit Streamflow	25.2000
CREST No DA Streamflow	25.2000
CREST No DA Unit Streamflow	25.2000
SAC-SMA Streamflow	25.2000
SAC-SMA Unit Streamflow	25.2000
SAC-SMA Soil Moisture	25.2000
HP Streamflow	25.2000
HP Unit Streamflow	25.2000
---------QPE and QPF---------	
MRMS Radar-Only Instantaneous Rain Rate	--.----
1-hr MRMS Radar-Only QPE	25.2005
3-hr MRMS Radar-Only QPE	25.2005
6-hr MRMS Radar-Only QPE	25.2005
15-min HRRR QPF	--.----
1-hr ADSTAT QPF	--.----
---------Precipitation Return Periods---------	
Maximum Precipitation Return Period of all Accumulations	25.2005
30-min Precipitation Return Period	--.----
1-hr Precipitation Return Period	25.2010
3-hr Precipitation Return Period	25.2005
6-hr Precipitation Return Period	25.2005
12-hr Precipitation Return Period	25.2005
24-hr Precipitation Return Period	25.2005
---------Flash Flood Guidance---------	
Maximum Ratio of all QPE to FFG Accumulations	25.2005
1-hr MRMS Radar-Only QPE to FFG Ratio	25.2010
3-hr MRMS Radar-Only QPE to FFG Ratio	25.2005
6-hr MRMS Radar-Only QPE to FFG Ratio	25.2005
---------Precipitable Water---------	
Precipitable Water Analysis (RAOBs)	25.2010
Precipitable Water Percentile (RAOBs)	25.2005
Precipitable Water Analysis (RAP)	25.2005
Precipitable Water Percentile (RAP)	25.2005

"Observations"

- Multiple sources

  –

    Flash Flood Warnings, Flood Warnings, and Flood Advisories

  – LSRs restricted to the following:
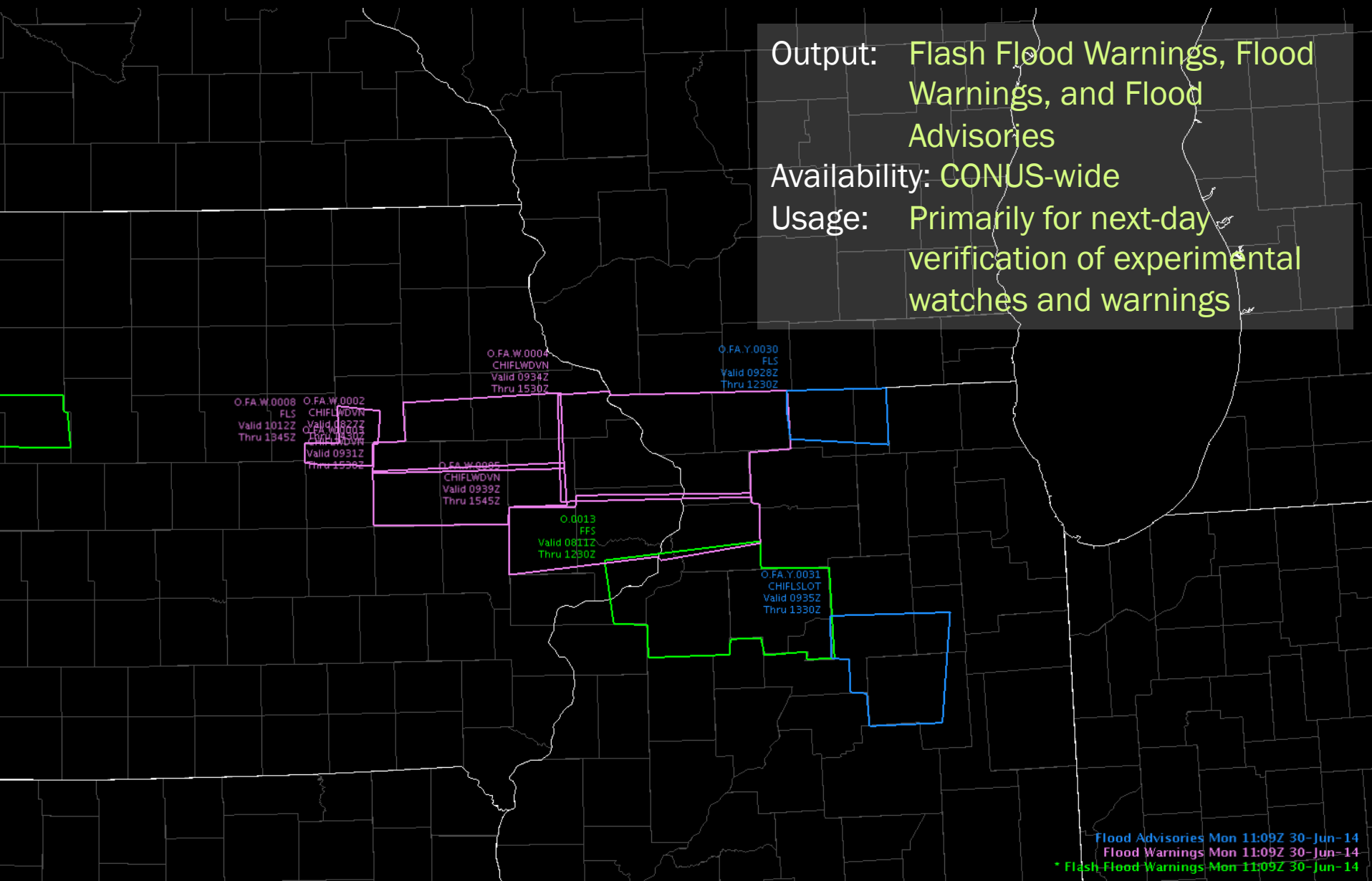
    flood:

    flash flood:

    heavy rain:

  – CAVE will only show *one* LSR at a time

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

O.FA.W.0004
CHIFLWDVN
Valid 0934Z
Thru 1530Z

O.FA.Y.0030
FLS
Valid 0928Z
Thru 1230Z

O.FA.W.0008
FLS
Valid 1012Z
Thru 1345Z

O.FA.W.0002
CHIFLWDVN
Valid 0827Z
Thru 1130Z
CHIFLWDVN
Valid 0931Z
Thru 1530Z

O.FA.W.0005
CHIFLWDVN
Valid 0939Z
Thru 1545Z

O.0013
FFS
Valid 0811Z
Thru 1230Z

O.FA.Y.0031
CHIFLSLOT
Valid 0935Z
Thru 1330Z

Flood Advisories Mon 11:09Z 30-Jun-14
Flood Warnings Mon 11:09Z 30-Jun-14
* Flash Flood Warnings Mon 11:09Z 30-Jun-14

Models

- 14 total products in the models category

- Includes three hydrologic models – CREST, SAC-SMA,

- CREST – Coupled Routing and Excess Storage
  - Developed by OU and NASA

- SAC-SMA – Sacramento Soil Moisture Accounting model

- HP – Hydrophobic Model, all runoff

---------Models---------	
CREST Streamflow	25.2000
CREST Unit Streamflow	25.2000
CREST Soil Moisture	--.----
HRRR-Forced CREST Streamflow	25.2000
HRRR-Forced CREST Unit Streamflow	25.2000
ADSTAT-Forced CREST Streamflow	25.2000
ADSTAT-Forced CREST Unit Streamflow	25.2000
CREST No DA Streamflow	25.2000
CREST No DA Unit Streamflow	25.2000
SAC-SMA Streamflow	25.2000
SAC-SMA Unit Streamflow	25.2000
SAC-SMA Soil Moisture	25.2000
HP Streamflow	25.2000
HP Unit Streamflow	25.2000

Models

- Will have access to three SAC-SMA products
  - Soil Moisture, Streamflow and Unit Streamflow
- Seven CREST products
  - Soil Moisture, Streamflow, and Unit Streamflow
  - HRRR-forced Streamflow, and Unit Streamflow
  - ADSTAT-forced Streamflow, and Unit Streamflow
- Two HP products
  - Streamflow and Unit Streamflow
- All six available every 15 minutes at 1 km resolution (CONUS-wide)

CREST, SAC-SMA, and HP Unit Streamflow
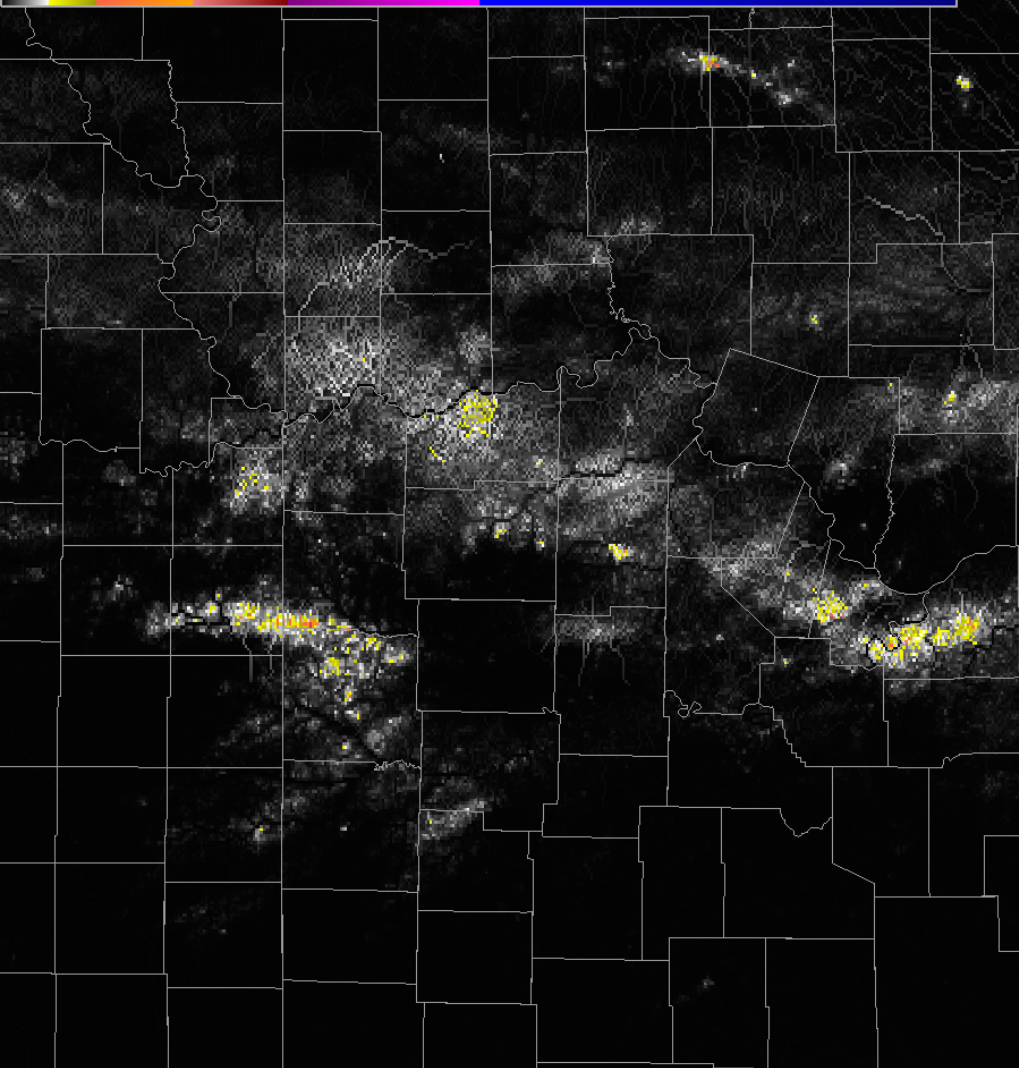
Output: Forecast of maximum unit streamflow from -30 min to +6 hrs, based on modeled stream flows

Scale: $0 - 2000 \text{ ft}^3 \cdot \text{s}^{-1} \cdot \text{mi}^{-2}$

Resolution: 0.01 x 0.01 deg; 15 min

Availability: CONUS

Input: MRMS radar-only QC'ed precipitation rate

Usage: Areas of contiguous pixels with high values (~100 cfs/mi2) are usually a cause for concern; a single pixel or a handful of isolated pixels with large values may not be indicative of a flash flooding threat.

* FLASH Surface CREST Unit Streamflow Img (cfs/smi)   26.12   0HR Fri 12:00Z 26-Jun-15

CREST, SAC-SMA, and HP Unit Streamflow
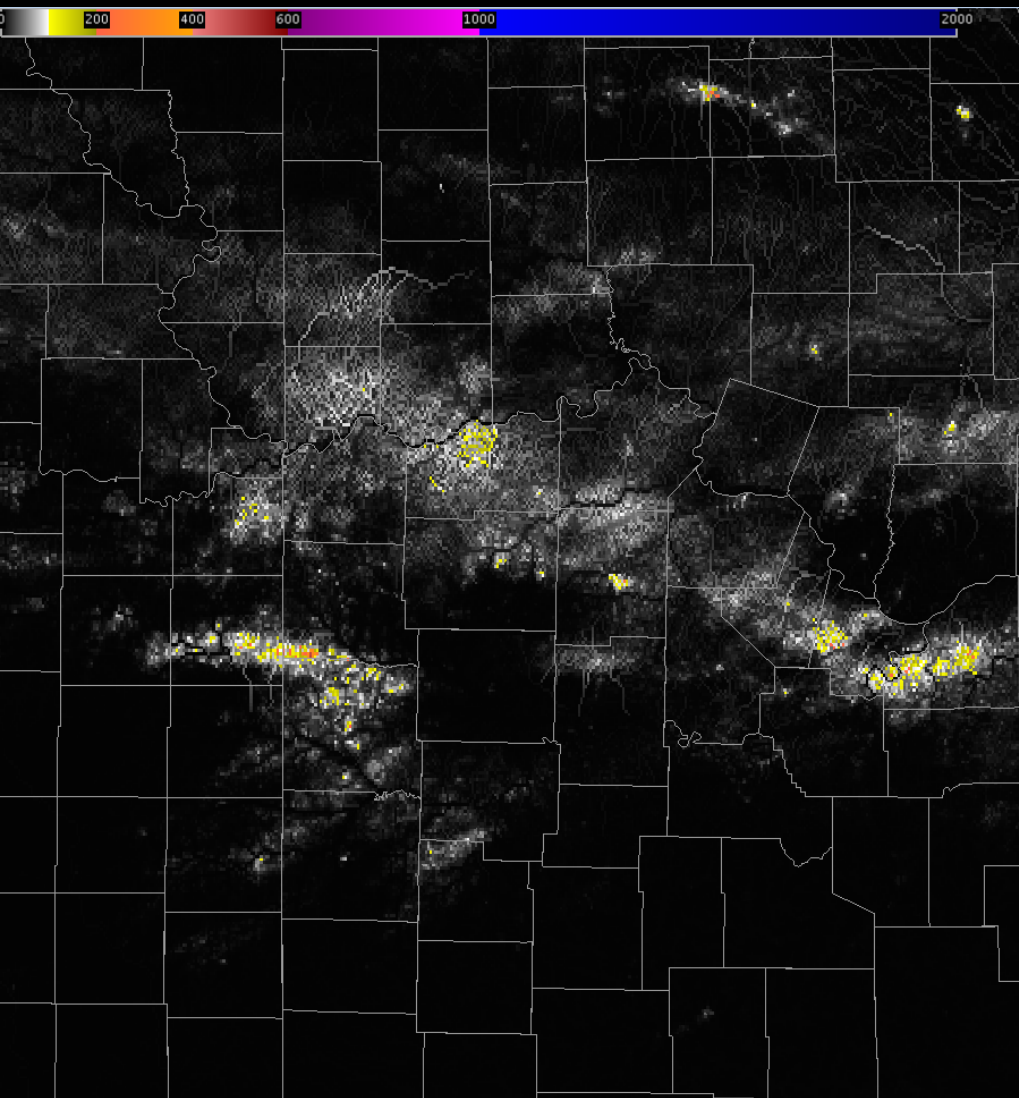
Technical Notes: The forward simulation comes from feeding near real-time precipitation data to the distributed hydrologic model (DHM) and allowing the model to run forward for 6 hours. Currently, the model assumes that all rainfall stops at the model initialization time. Topographical, land cover, land use, and soil type information is used by the model to infiltrate and route precipitation downstream once it reaches the land surface. Thus the output from the DHM is a flow rate/discharge at every grid cell. These time-integrated maximum discharge values are then normalized at each grid cell by the associated drainage area, producing a unit discharge value
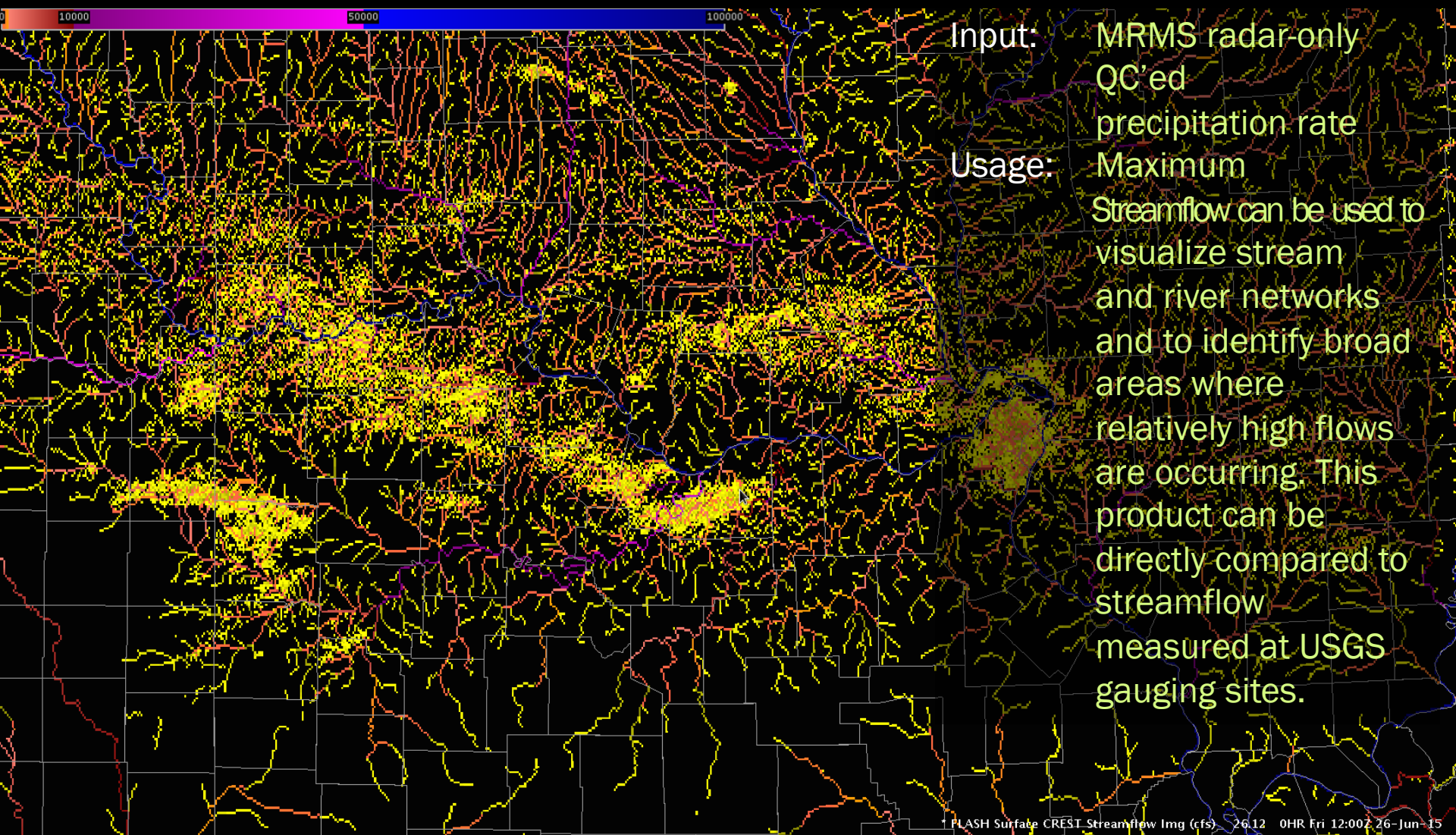
CREST, SAC-SMA, and HP Streamflow
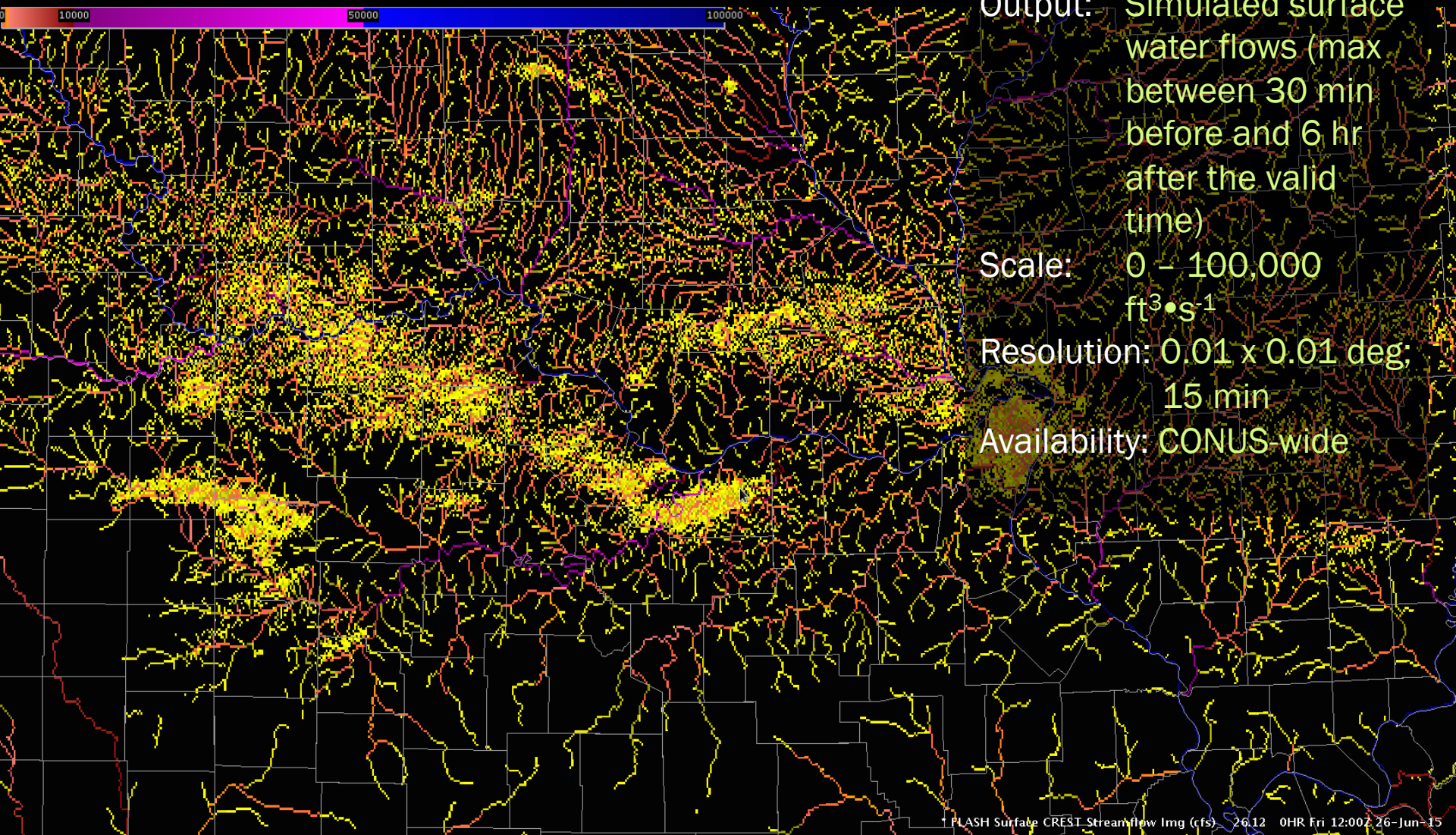
Output: Simulated surface water flows (max between 30 min before and 6 hr after the valid time)

Scale: 0 – 100,000 $ft^3 \cdot s^{-1}$

Resolution: 0.01 x 0.01 deg; 15 min

Availability: CONUS-wide

FLASH Surface CREST Streamflow Img (cfs)   26.12   0HR Fri 12:00Z 26-Jun-15

CREST, SAC-SMA, and HP Streamflow

Input: MRMS radar-only QC'ed precipitation rate

Usage: Maximum Streamflow can be used to visualize stream and river networks and to identify broad areas where relatively high flows are occurring. This product can be directly compared to streamflow measured at USGS gauging sites.

PLASH Surface CREST Streamflow Img (cfs) 26.12 0HR Fri 12:00Z 26-Jun-15

# CREST and SAC-SMA Soil Moisture

Output: Soil moisture content
Scale: 0 – 100%
Resolution: 0.01 x 0.01 deg; 15 minutes
Availability: CONUS-wide.
Input: MRMS radar-only QC'ed precipitation rate
Usage: Soil Moisture can be used to distinguish between broad areas of wetter or drier soil conditions. This product can help identify areas that have recently received rainfall and are at an increased risk of flash flooding due to moist soil conditions.
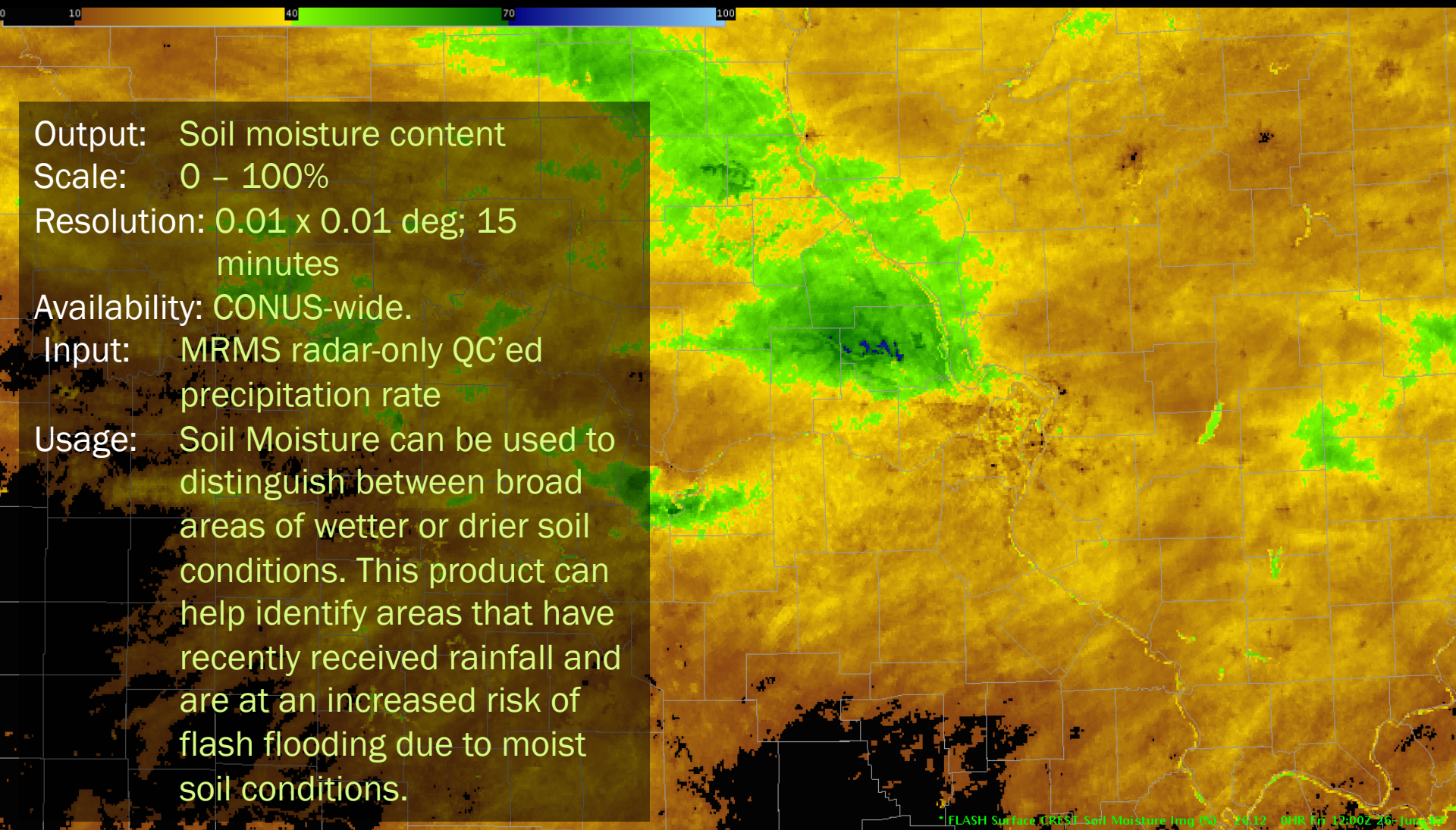
Precipitable Water

- 4 total products
- Observations and model outputs
- Analyses and standard anomalies

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--------Precipitable Water----------
Precipitable Water Analysis (RAOBs)          25.2010
Precipitable Water Percentile (RAOBs)        25.2005
Precipitable Water Analysis (RAP)            25.2005
Precipitable Water Percentile (RAP)          25.2005
```

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

* FLASH Surface Precipitable Water Analysis (RAOBs) Img (in)   29.12   0HR Sun 12:00Z 29-Jun-14

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.

* FLASH Surface Precipitable Water Analysis (RAOBs) Img (in)   29.12   0HR Sun 12:00Z 29-Jun-14

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

* FLASH Surface Precipitable Water Analysis (RAP) Img (in)   30.17   0HR Mon 17:00Z 30-Jun-14
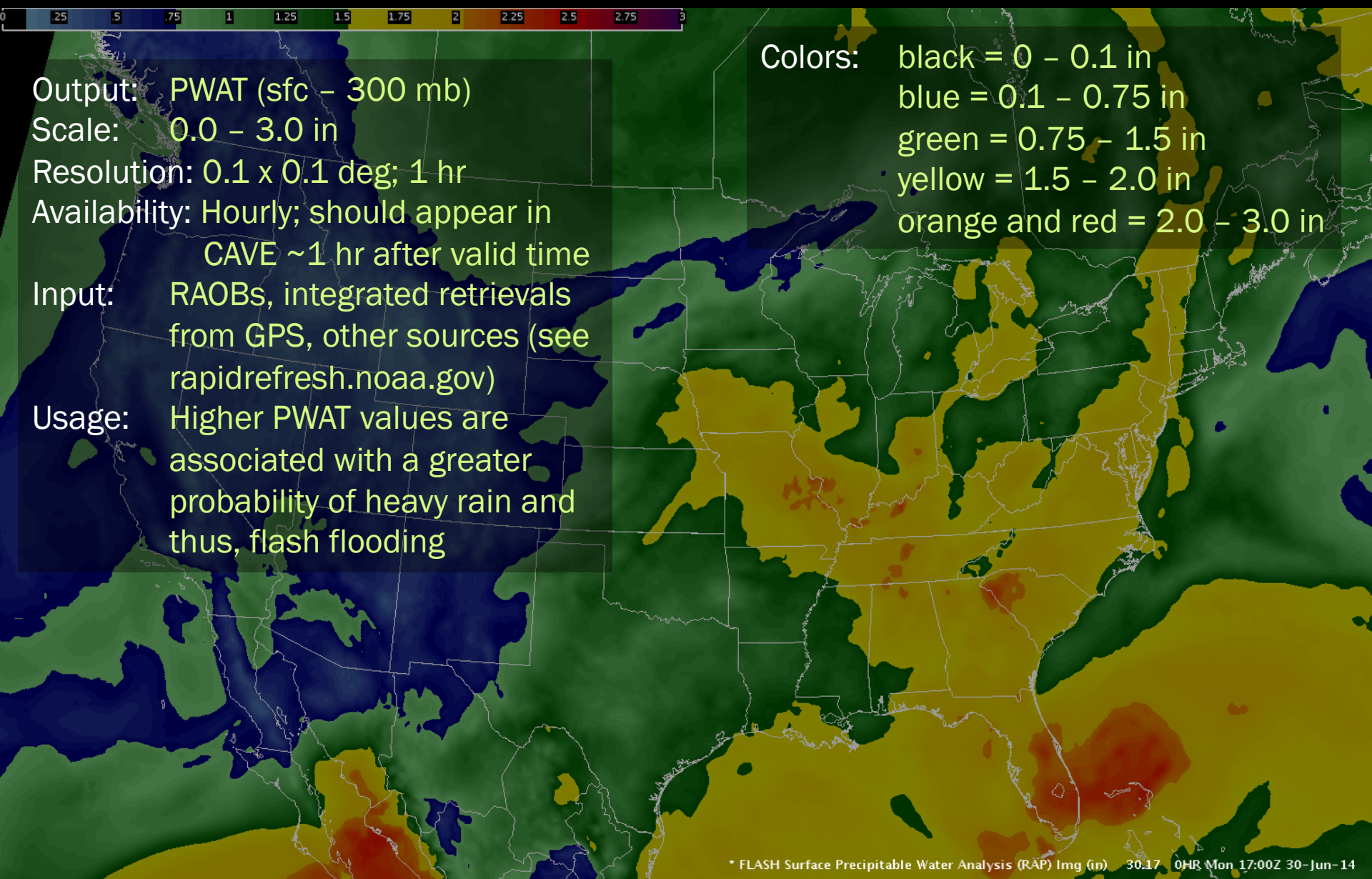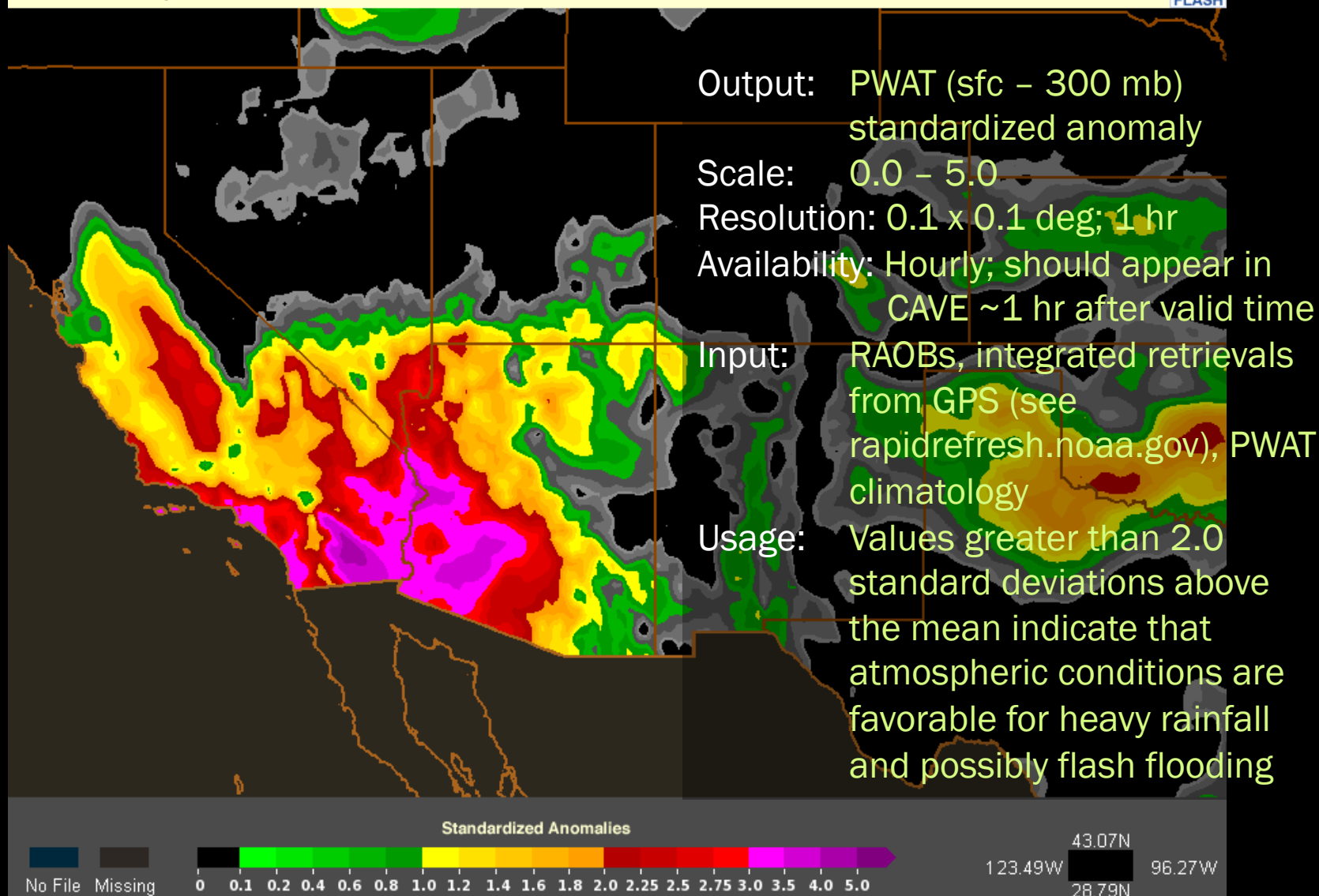
Precipitable Water Analysis (RAP)

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.
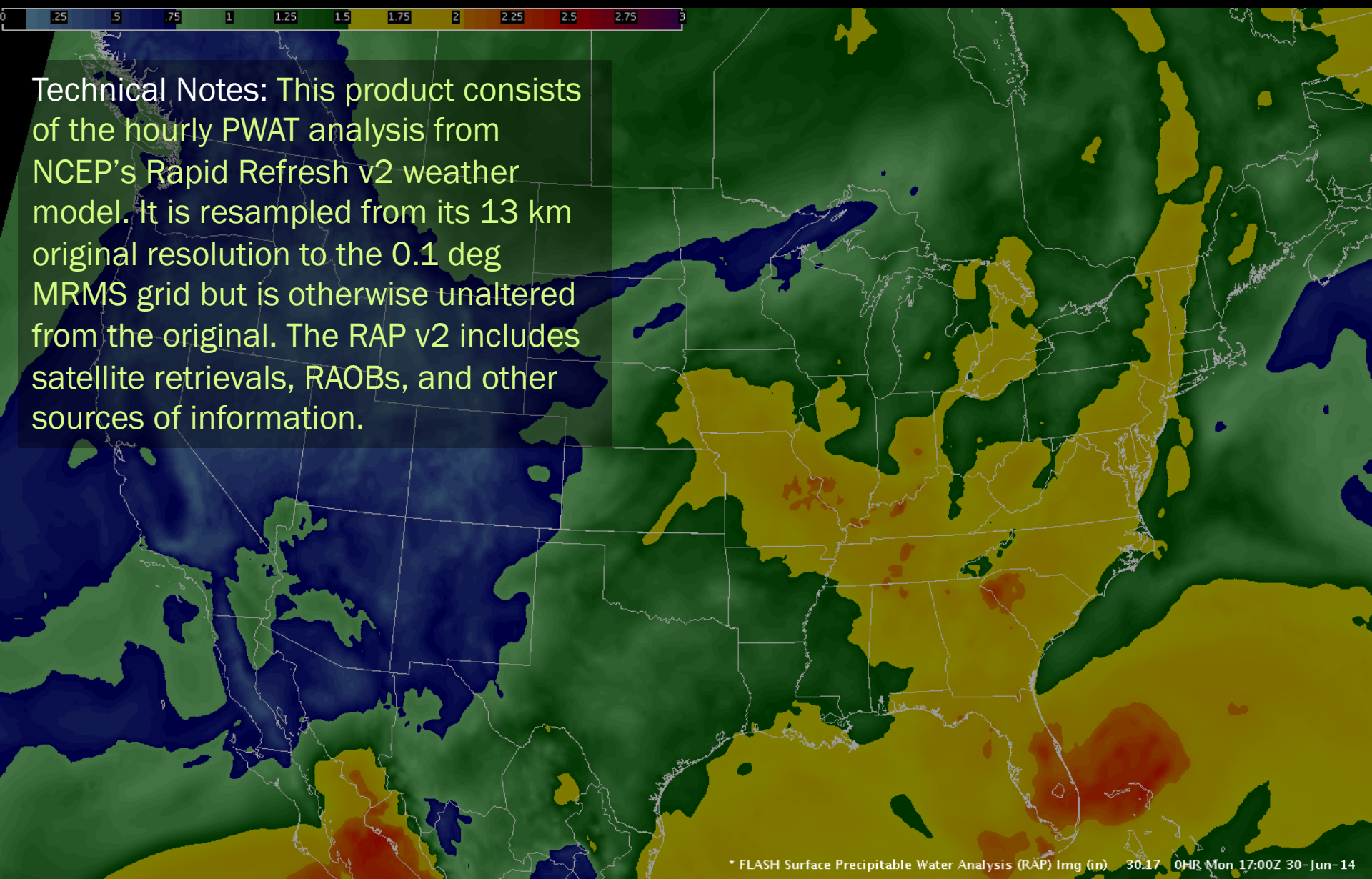
* FLASH Surface Precipitable Water Analysis (RAP) Img (in)   30.17   0HR Mon 17:00Z 30-Jun-14

Precipitable Water Std Anomaly (RAP)

Precipitable Water Std Anom
RAP Analysis

Valid: 07/14/2014 16:00:00 UTC

FLASH

Output: PWAT (sfc – 300 mb) standardized anomaly

Scale: 0.0 – 5.0

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 greater than 2.0 standard deviations above the mean indicate that atmospheric conditions are favorable for heavy rainfall and possibly flash flooding

Standardized Anomalies

No File   Missing   0 0.1 0.2 0.4 0.6 0.8 1.0 1.2 1.4 1.6 1.8 2.0 2.25 2.5 2.75 3.0 3.5 4.0 5.0

43.07N
123.49W   96.27W
28.79N

Precipitable Water Std Anomaly (RAP)

Precipitable Water Std Anom
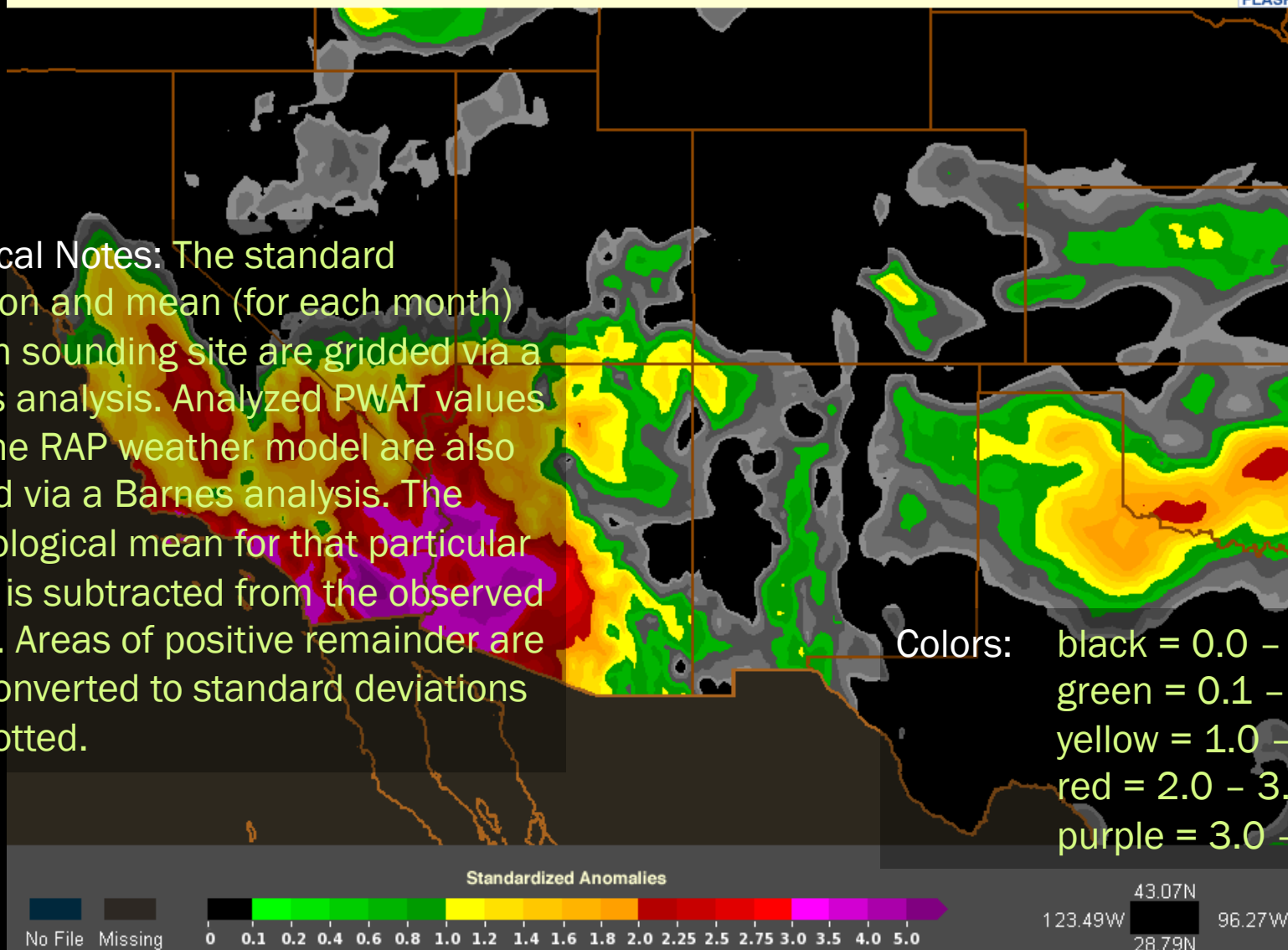**RAP Analysis**

Valid: 07/14/2014 16:00:00 UTC

FLASH

Technical Notes: The standard deviation and mean (for each month) at each sounding site are gridded via a Barnes analysis. Analyzed PWAT values from the RAP weather model are also gridded via a Barnes analysis. The climatological mean for that particular month is subtracted from the observed values. Areas of positive remainder are then converted to standard deviations and plotted.

Colors:
black = 0.0 – 0.1
green = 0.1 – 1.0
yellow = 1.0 – 2.0
red = 2.0 – 3.0
purple = 3.0 – 5.0

Standardized Anomalies

No File   Missing   0   0.1 0.2 0.4 0.6 0.8 1.0 1.2 1.4 1.6 1.8 2.0 2.25 2.5 2.75 3.0 3.5 4.0 5.0

43.07N
123.49W   96.27W
28.79N

Precipitable Water Std Anomaly (RAOBs)

Precipitable Water Std Anom
Observed Soundings

Valid: 07/14/2014 12:00:00 UTC

FLASH

Output: PWAT (sfc – 300 mb) standardized anomaly

Scale: 0.0 – 5.0
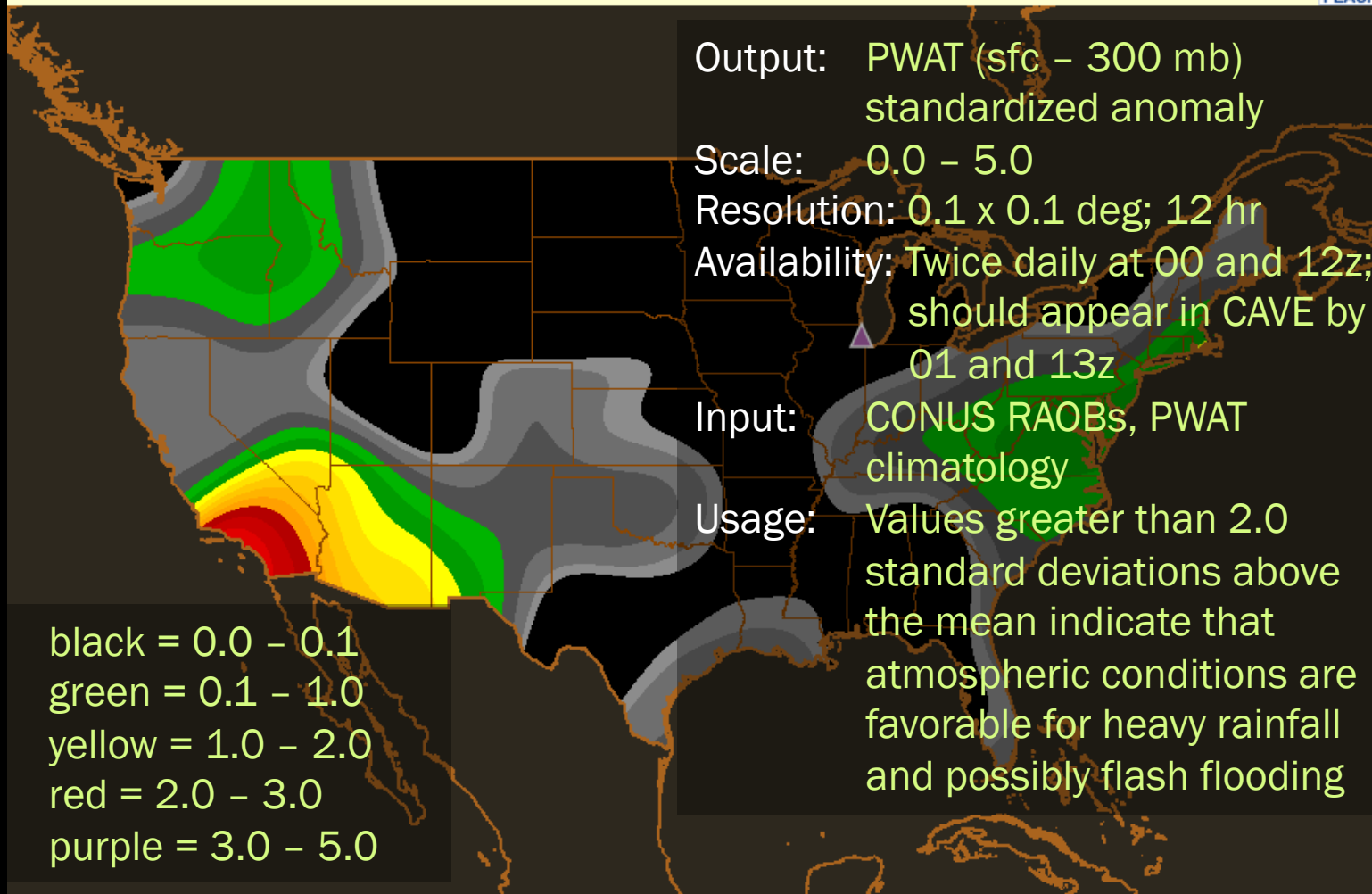
Resolution: 0.1 x 0.1 deg; 12 hr

Availability: Twice daily at 00 and 12z; should appear in CAVE by 01 and 13z

Input: CONUS RAOBs, PWAT climatology

Usage: Values greater than 2.0 standard deviations above the mean indicate that atmospheric conditions are favorable for heavy rainfall and possibly flash flooding

Colors:
black = 0.0 – 0.1
green = 0.1 – 1.0
yellow = 1.0 – 2.0
red = 2.0 – 3.0
purple = 3.0 – 5.0

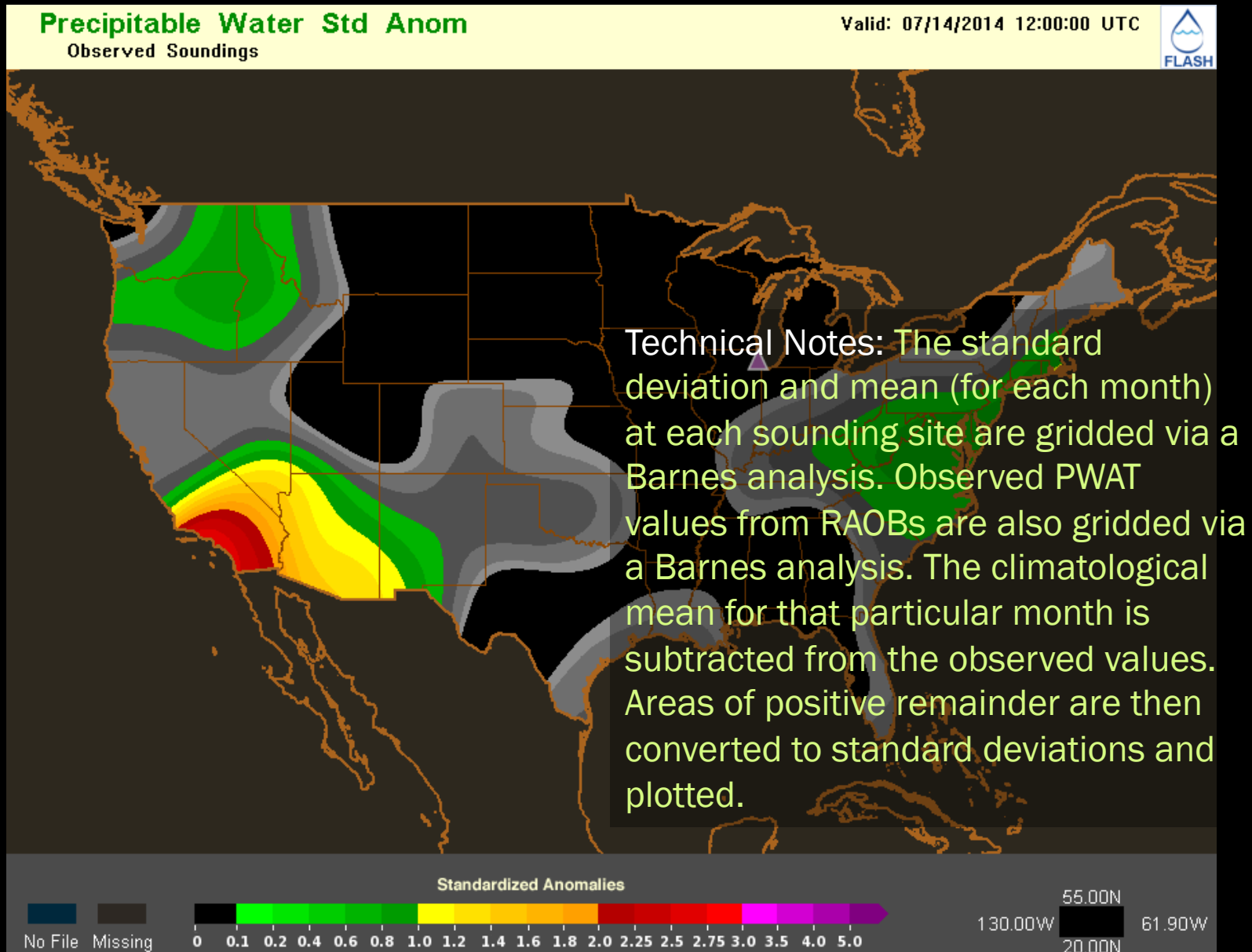**Standardized Anomalies**

No File   Missing

0   0.1 0.2 0.4 0.6 0.8 1.0 1.2 1.4 1.6 1.8 2.0 2.25 2.5 2.75 3.0 3.5 4.0 5.0

55.00N
130.00W   61.90W
20.00N

Precipitable Water Std Anomaly (RAOBs)

Precipitable Water Std Anom
Observed Soundings

Valid: 07/14/2014 12:00:00 UTC

FLASH

Technical Notes: The standard deviation and mean (for each month) at each sounding site are gridded via a Barnes analysis. Observed PWAT values from RAOBs are also gridded via a Barnes analysis. The climatological mean for that particular month is subtracted from the observed values. Areas of positive remainder are then converted to standard deviations and plotted.

Standardized Anomalies

No File   Missing

0 0.1 0.2 0.4 0.6 0.8 1.0 1.2 1.4 1.6 1.8 2.0 2.25 2.5 2.75 3.0 3.5 4.0 5.0

55.00N
130.00W
20.00N
61.90W

QPE and QPF

```
---------QPE and QPF---------
MRMS Radar-Only Instantaneous Rain Rate          --.----
1-hr MRMS Radar-Only QPE                       25.2005
3-hr MRMS Radar-Only QPE                       25.2005
6-hr MRMS Radar-Only QPE                       25.2005
15-min HRRR QPF                                  --.----
1-hr ADSTAT QPF                                  --.----
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- 6 total products

- QPE from the Multi-Radar/Multi-Sensor project

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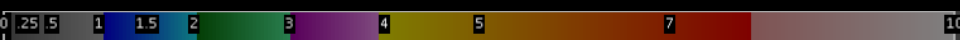
1-, 3-, 6-hr MRMS Radar-Only QPE
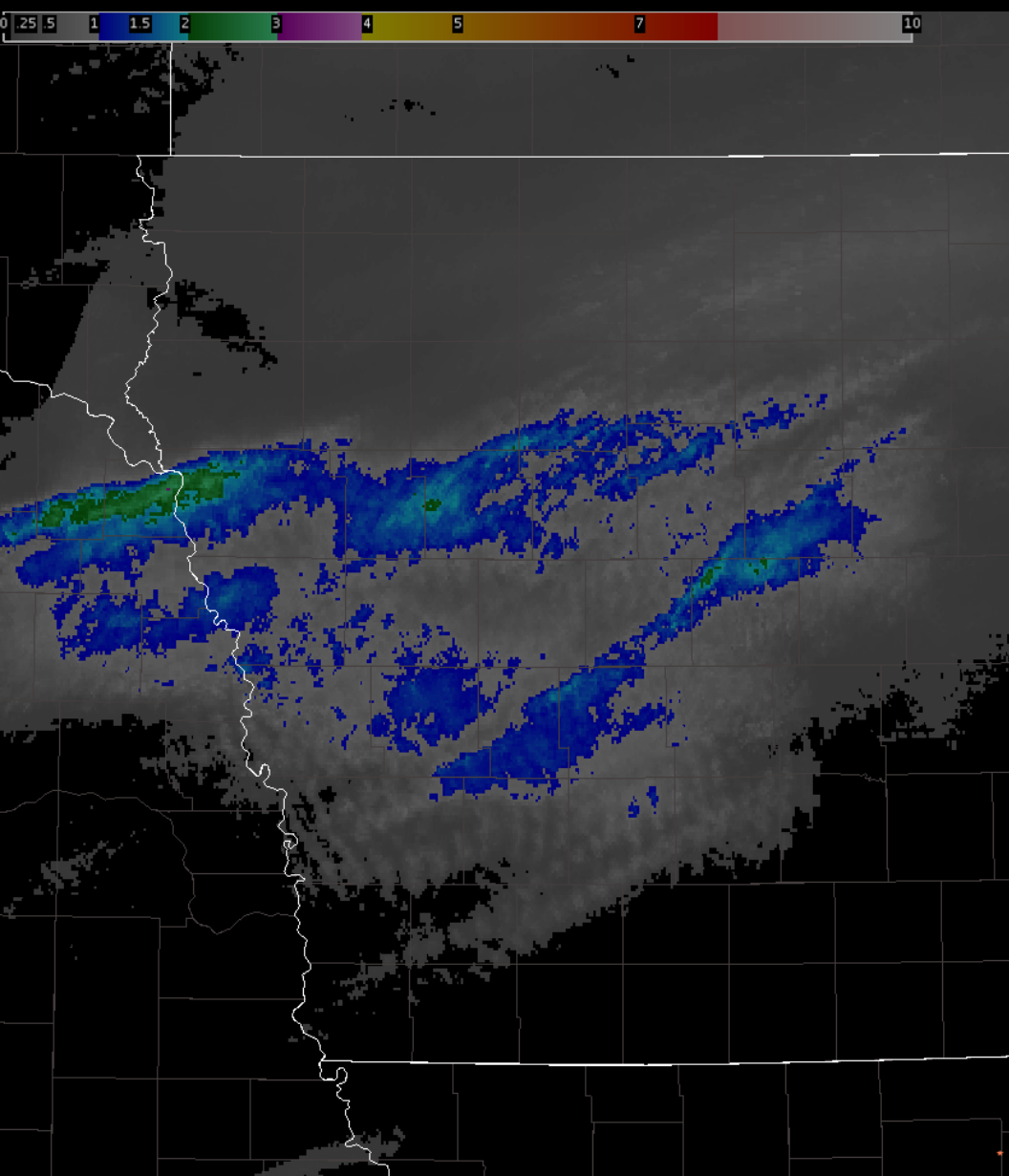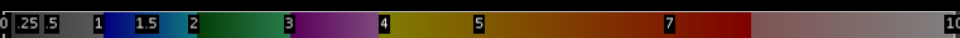
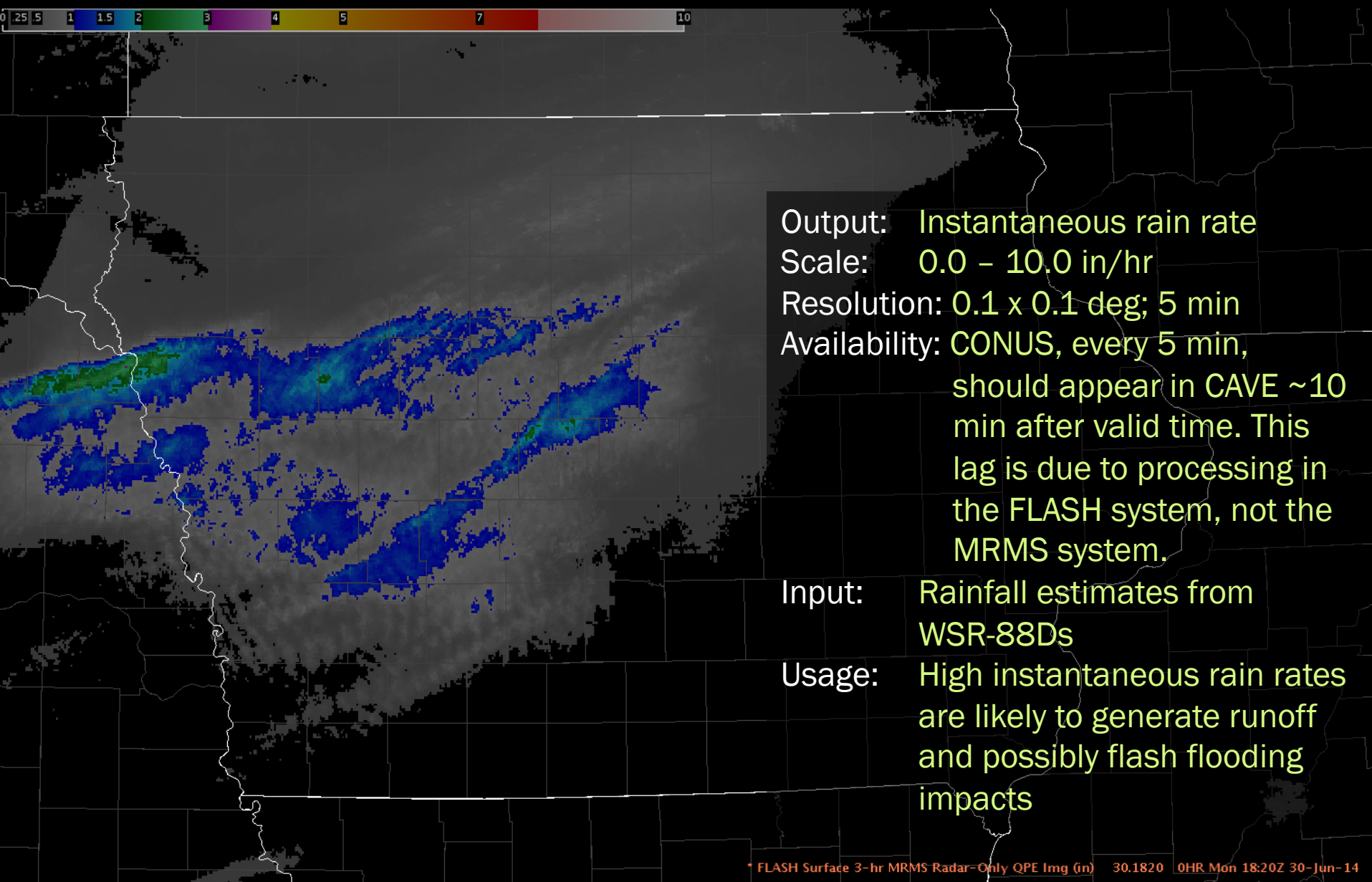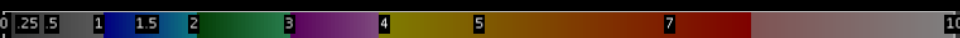|	
Output:	1–, 3–, or 6–hr radar-derived QPE
Scale:	0.0 – 10.0 in
Resolution:	0.1 x 0.1 deg; 5 min
Availability:	CONUS, every 5 min, should appear in CAVE ~10 min after valid time. This lag is due to processing in the FLASH system, not the MRMS system.
Input:	Rainfall estimates from WSR-88Ds
Usage:	Rainfall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

FLASH Surface 3-hr MRMS Radar-Only QPE Img (in)   30.1820   0HR Mon 18:20Z 30-Jun-14

1-, 3-, 6-hr MRMS Radar-Only QPE
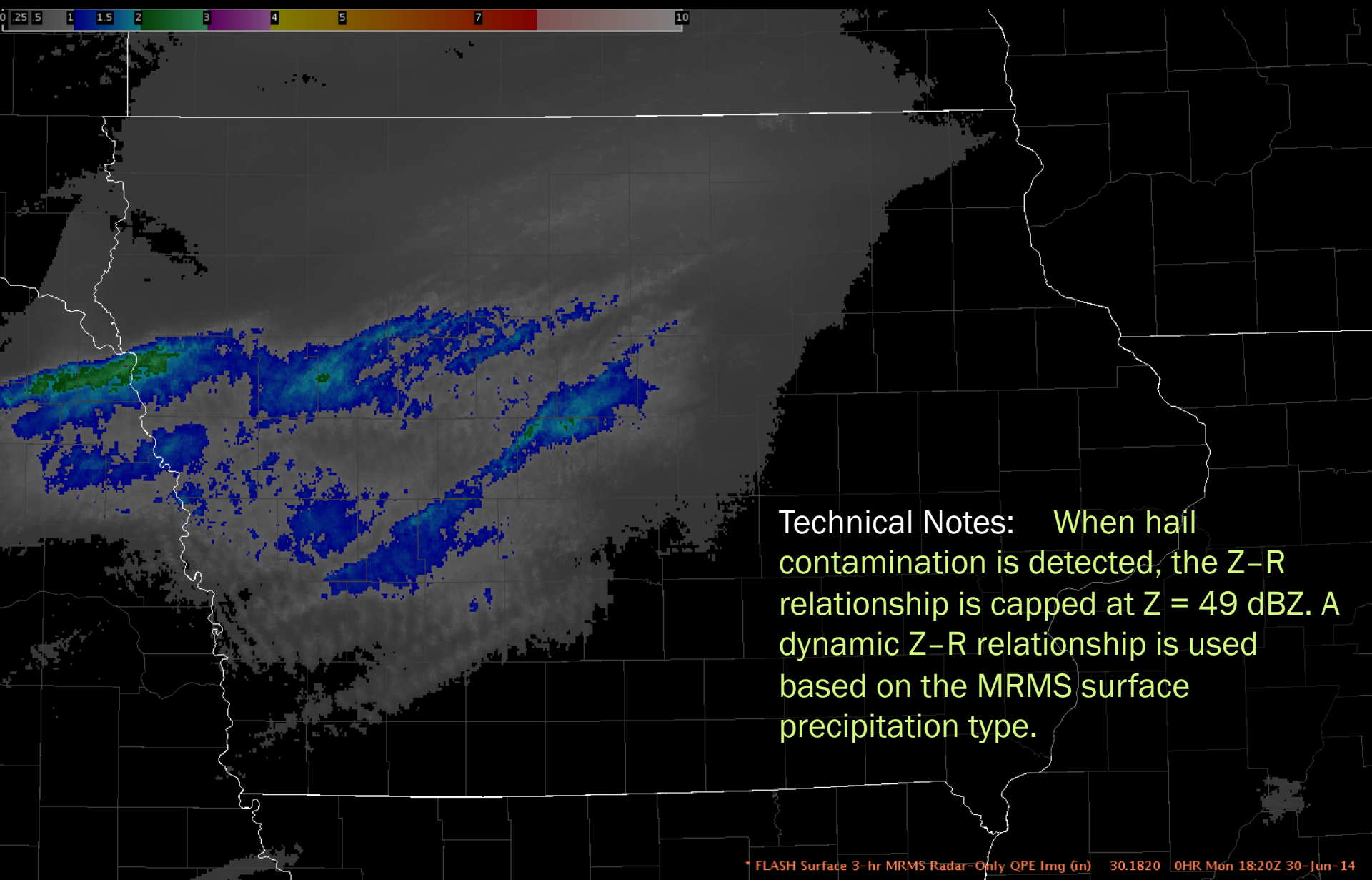
Technical Notes: When hail contamination is detected, the Z–R relationship is capped at Z = 49 dBZ. A dynamic Z–R relationship is used based on the MRMS surface precipitation type.

* FLASH Surface 3-hr MRMS Radar-Only QPE Img (in)   30.1820 0HR Mon 18:20Z 30-Jun-14

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

FLASH Surface 3-hr MRMS Radar-Only QPE Img (in)   30.1820   0HR Mon 18:20Z 30-Jun-14

Flash Flood Guidance

--------Flash Flood Guidance---------	
Maximum Ratio of all QPE to FFG Accumulations	25.2005
1-hr MRMS Radar-Only QPE to FFG Ratio	25.2010
3-hr MRMS Radar-Only QPE to FFG Ratio	25.2005
6-hr MRMS Radar-Only QPE to FFG Ratio	25.2005

- 4 total products
- QPE from the Multi-Radar/Multi-Sensor project
- FFG is mosaicked from individual RFC grids at NCEP WPC and sent to FLASH system

1-, 3-, 6-hr MRMS Radar-Only QPE to FFG Ratio
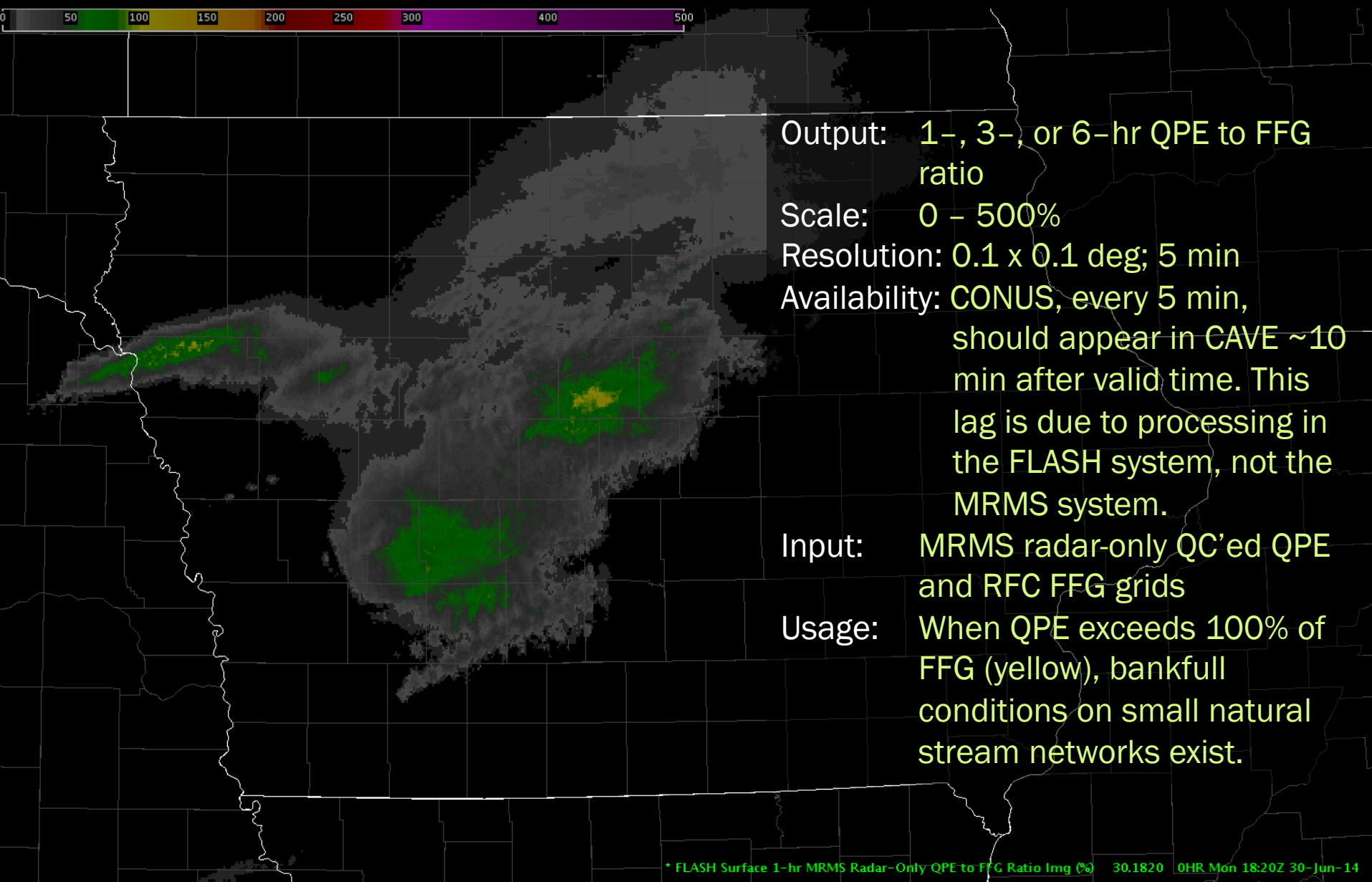
Output: 1-, 3-, or 6-hr QPE to FFG ratio

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.
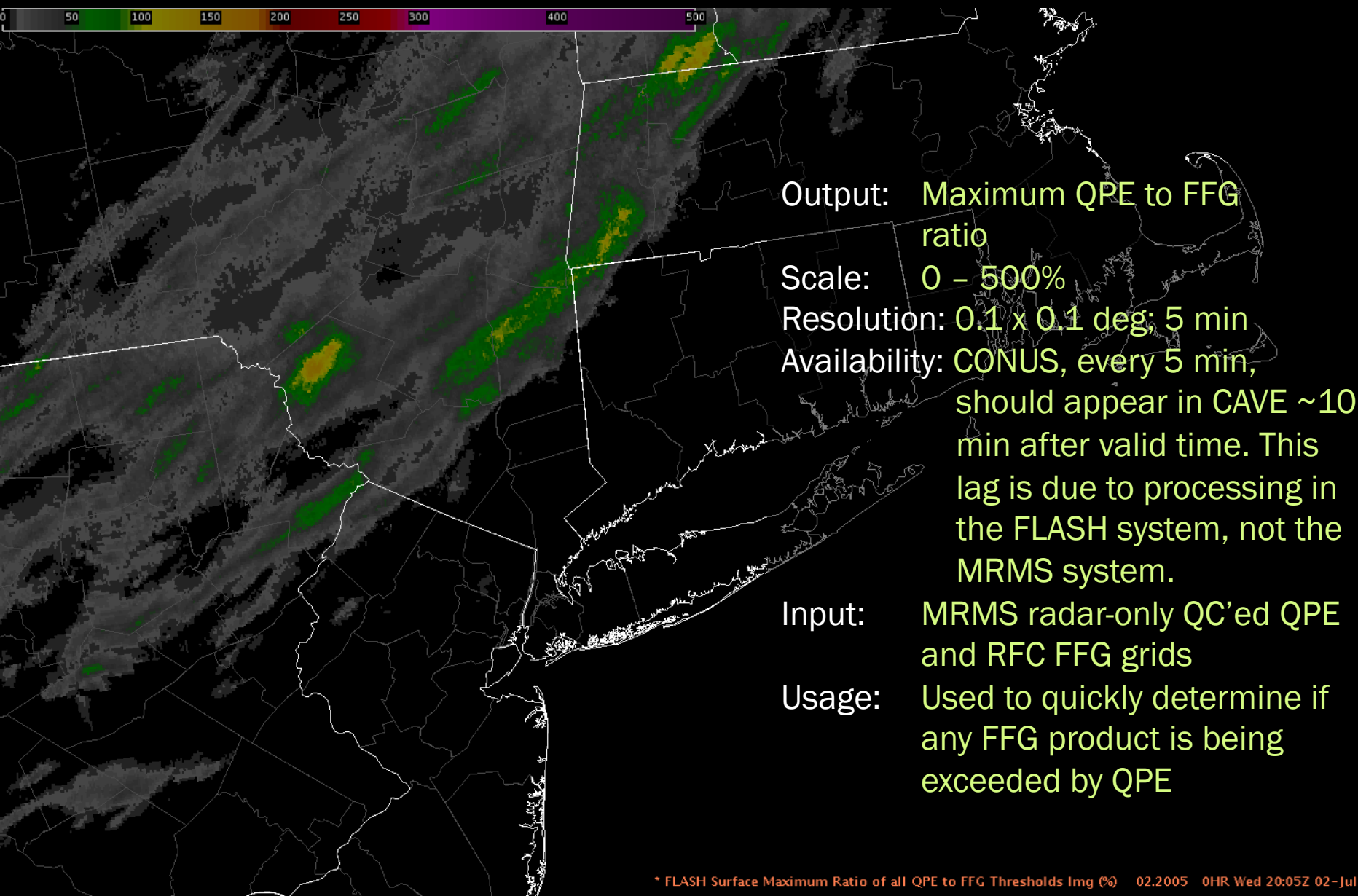
Input: MRMS radar-only QC'ed QPE and RFC FFG grids

Usage: When QPE exceeds 100% of FFG (yellow), bankfull conditions on small natural stream networks exist.

* FLASH Surface 1-hr MRMS Radar-Only QPE to FFG Ratio Img (%)   30.1820   0HR Mon 18:20Z 30-Jun-14

1-, 3-, 6-hr MRMS Radar-Only QPE to FFG Ratio
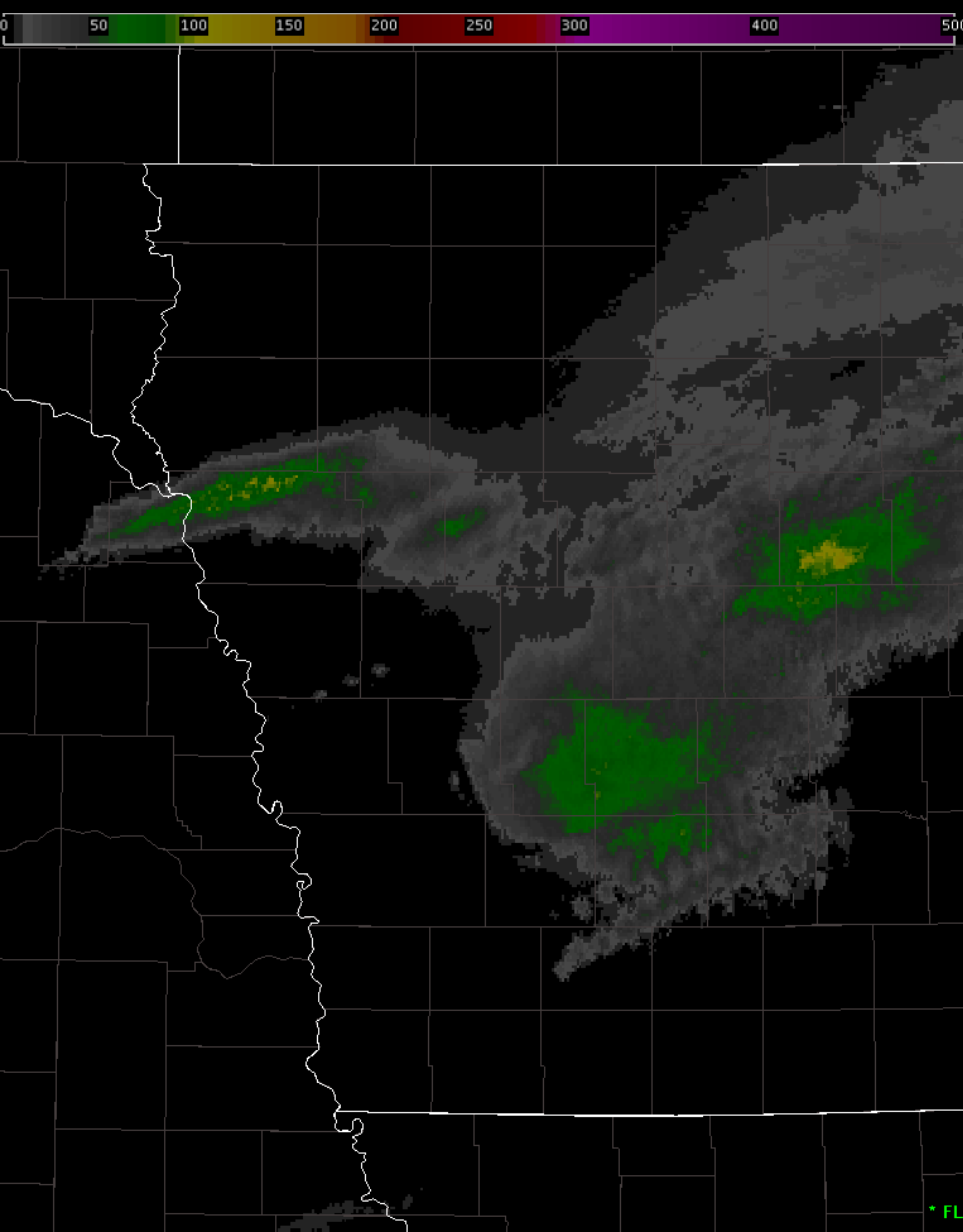
Technical Notes: Flash Flood Guidance is produced at 12 River Forecast Centers between 1 and 4 times per day. Here, it appears in 1-, 3-, and 6-hr flavors. FFG is defined as the amount of rainfall required in that time to cause bankfull conditions on small natural stream networks. FFG is produced differently 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.

* FLASH Surface 1-hr MRMS Radar-Only QPE to FFG Ratio Img (%)   30.1820   0HR Mon 18:20Z 30-Jun-14

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

Precipitation Return Periods

--------Precipitation Return Periods--------	
Maximum Precipitation Return Period of all Accumulations	25.2005
30-min Precipitation Return Period	--.----
1-hr Precipitation Return Period	25.2010
3-hr Precipitation Return Period	25.2005
6-hr Precipitation Return Period	25.2005
12-hr Precipitation Return Period	25.2005
24-hr Precipitation Return Period	25.2005

- 7 total products
- QPE from the Multi-Radar/Multi-Sensor project
- Precipitation is compared to NOAA Atlas 14 or the Cornell NY/NE Extreme Precipitation dataset

Precipitation Return Periods
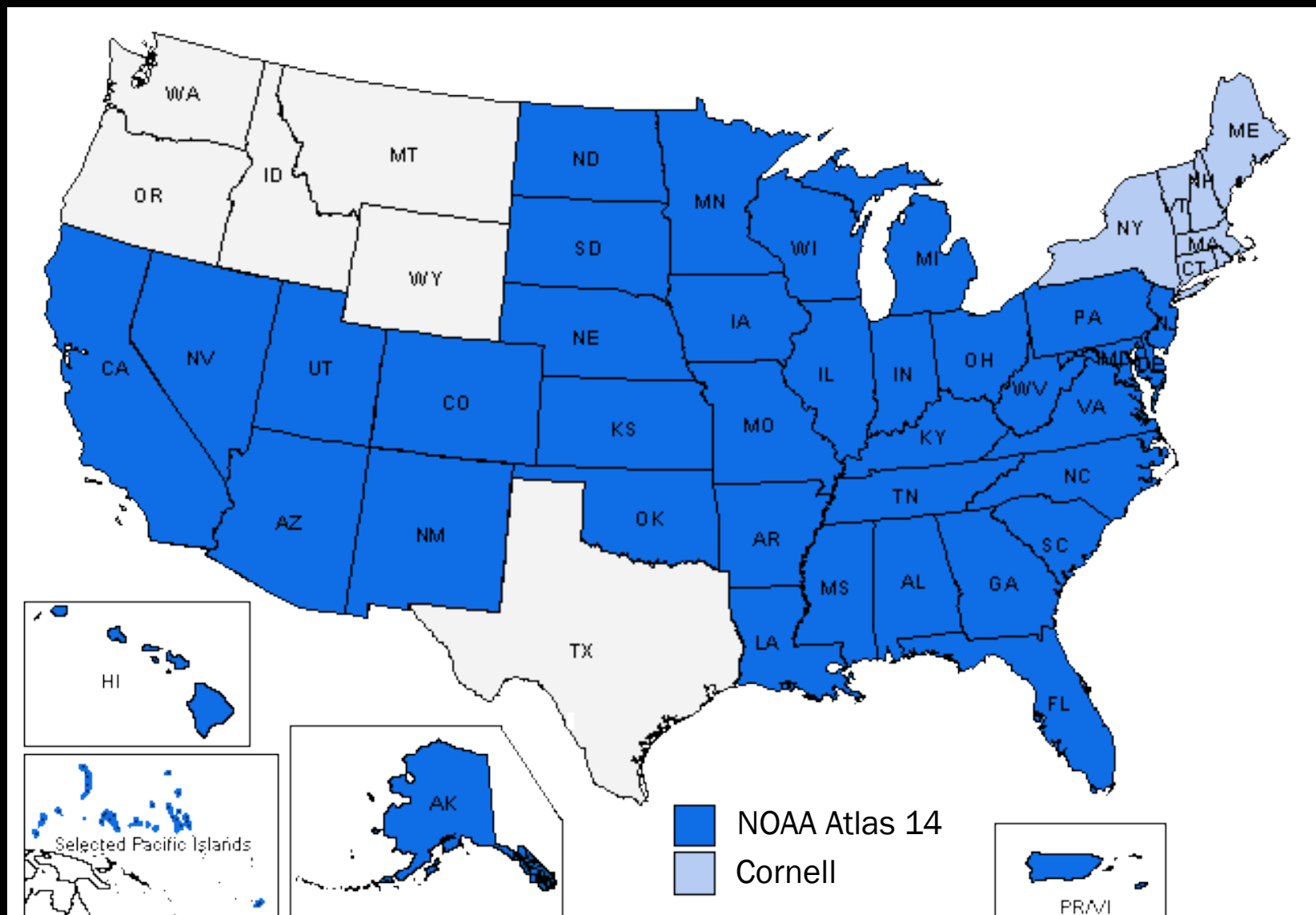
1-, 3- , 6-, 12-, and 24-hr Precipitation Return Period
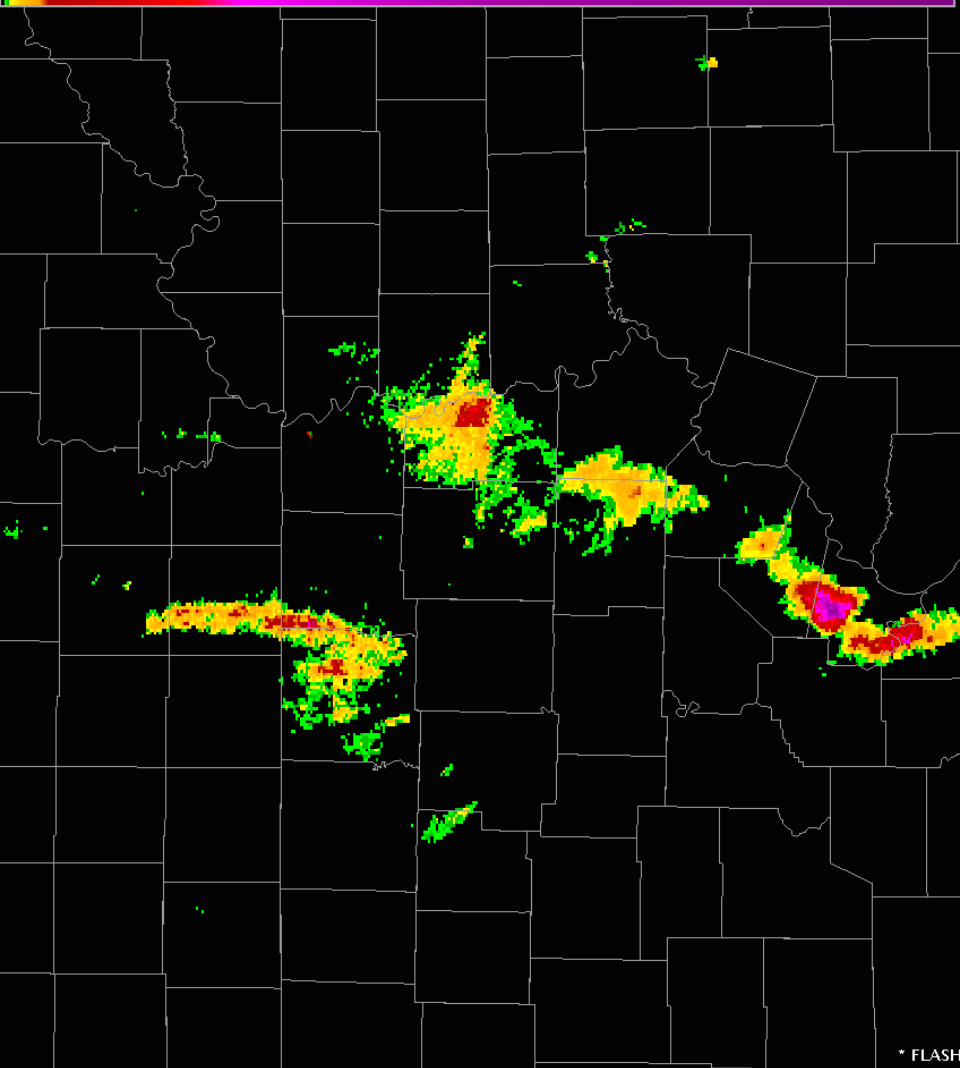
Output: 1-, 3-, 6-, 12-, or 24-hr precipitation return period

Scale: 0 – 500 yrs
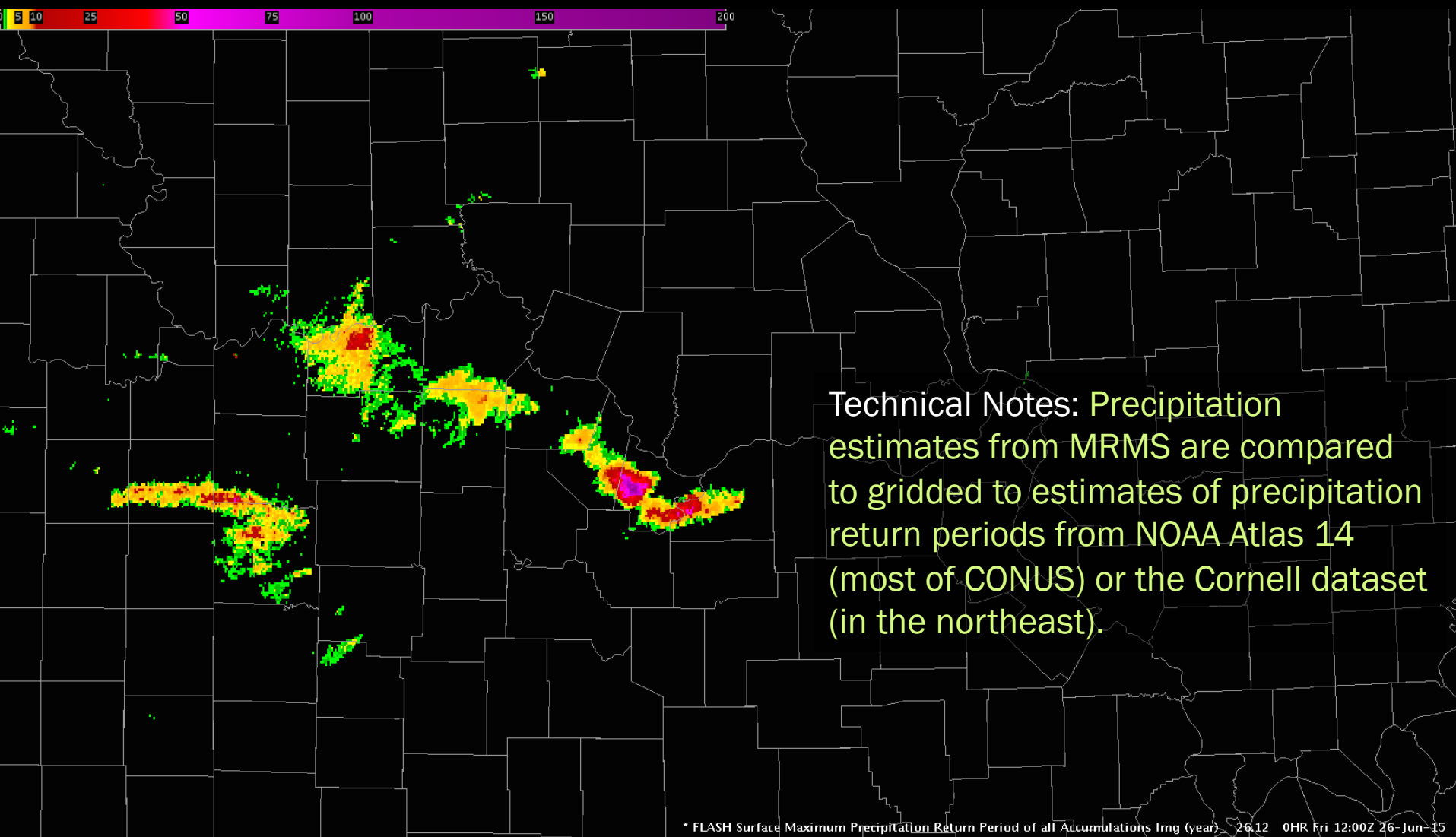
Resolution: 0.1 x 0.1 deg; 5 min

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

* FLASH Surface Maximum Precipitation Return Period of all Accumulations Img (year) 26.12 0HR Fri 12:00Z 26-Jun-15

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).

* FLASH Surface Maximum Precipitation Return Period of all Accumulations Img (year)   26.12   0HR Fri 12:00Z 26-Jun-15

Maximum Precipitation Return Period of All Accumulations

Output: 1-, 3-, or 6-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

* FLASH Surface Maximum Precipitation Return Period of all Accumulations Img (year) 26.12 0HR Fri 12:00Z 26-Jun-15

Radar Products

- 2 MRMS radar products
  - Quality-controlled composite reflectivity
  - Seamless hybrid-scan reflectivity

```
---------Radar----------
MRMS Quality-Controlled Composite Reflectivity     14.1755
MRMS Seamless Hybrid-Scan Reflectivity             14.1755
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MRMS Quality-Controlled Composite Reflectivity

Output: Mosaicked composite radar reflectivity

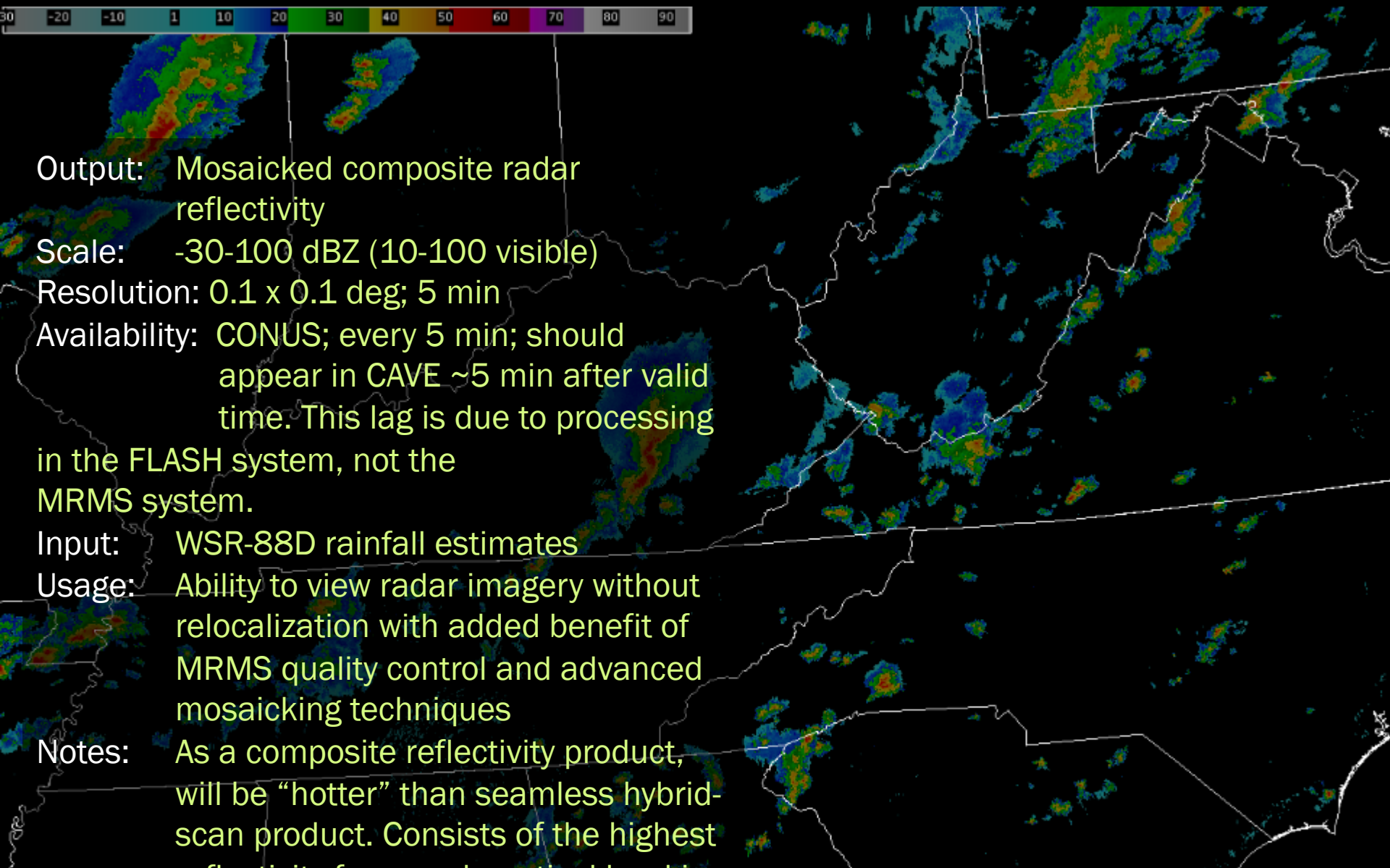Scale: -30-100 dBZ (10-100 visible)

Resolution: 0.1 x 0.1 deg; 5 min

Availability: CONUS; every 5 min; should appear in CAVE ~5 min after valid time. This lag is due to processing in the FLASH system, not the MRMS system.
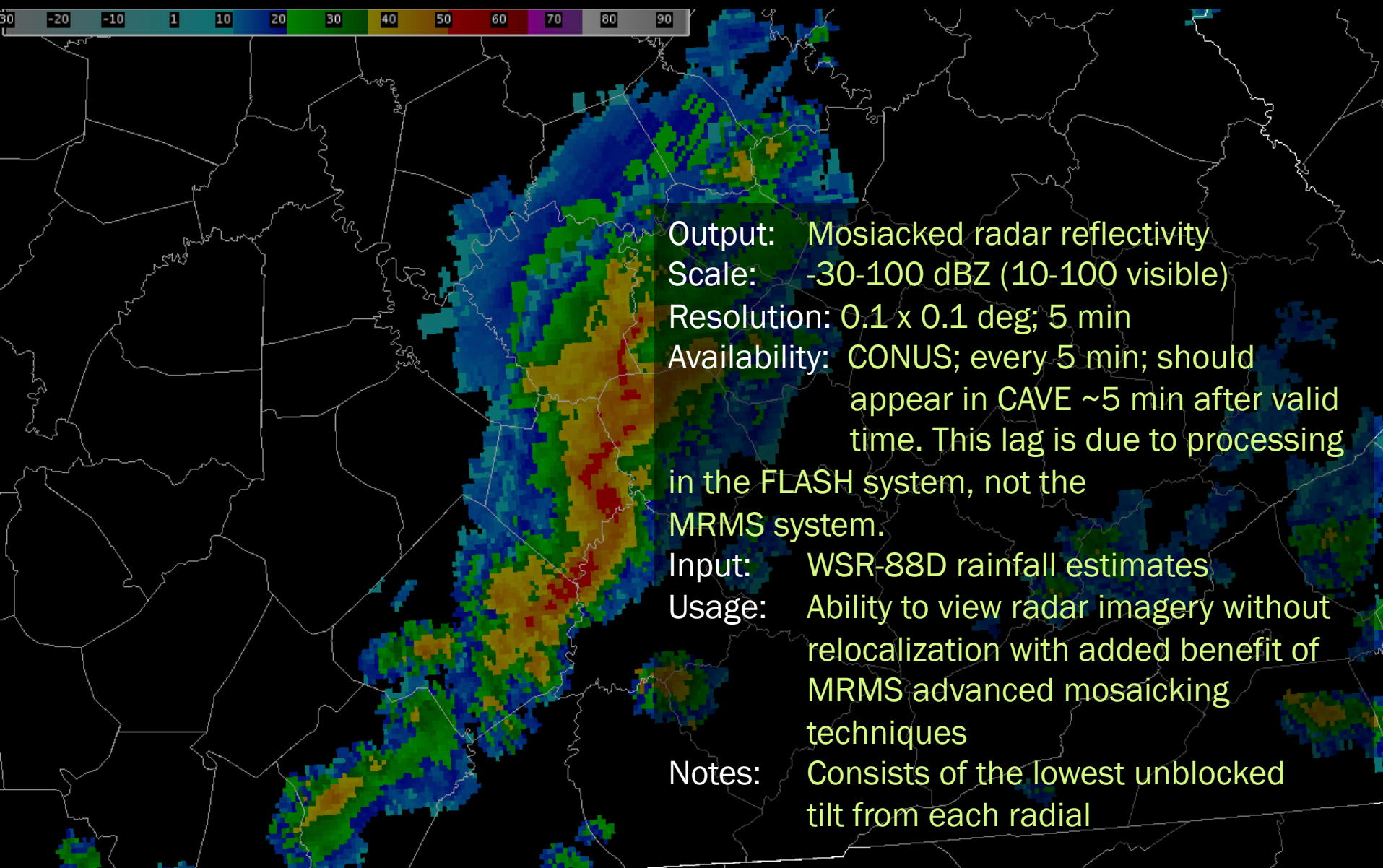
Input: WSR-88D rainfall estimates

Usage: Ability to view radar imagery without relocalization with added benefit of MRMS quality control and advanced mosaicking techniques

Notes: As a composite reflectivity product, will be "hotter" than seamless hybrid-scan product. Consists of the highest

MRMS Seamless Hybrid-Scan Reflectivity

Output: Mosiacked radar reflectivity
Scale: -30-100 dBZ (10-100 visible)
Resolution: 0.1 x 0.1 deg; 5 min
Availability: CONUS; every 5 min; should appear in CAVE ~5 min after valid time. This lag is due to processing in the FLASH system, not the MRMS system.
Input: WSR-88D rainfall estimates
Usage: Ability to view radar imagery without relocalization with added benefit of MRMS advanced mosaicking techniques
Notes: Consists of the lowest unblocked tilt from each radial