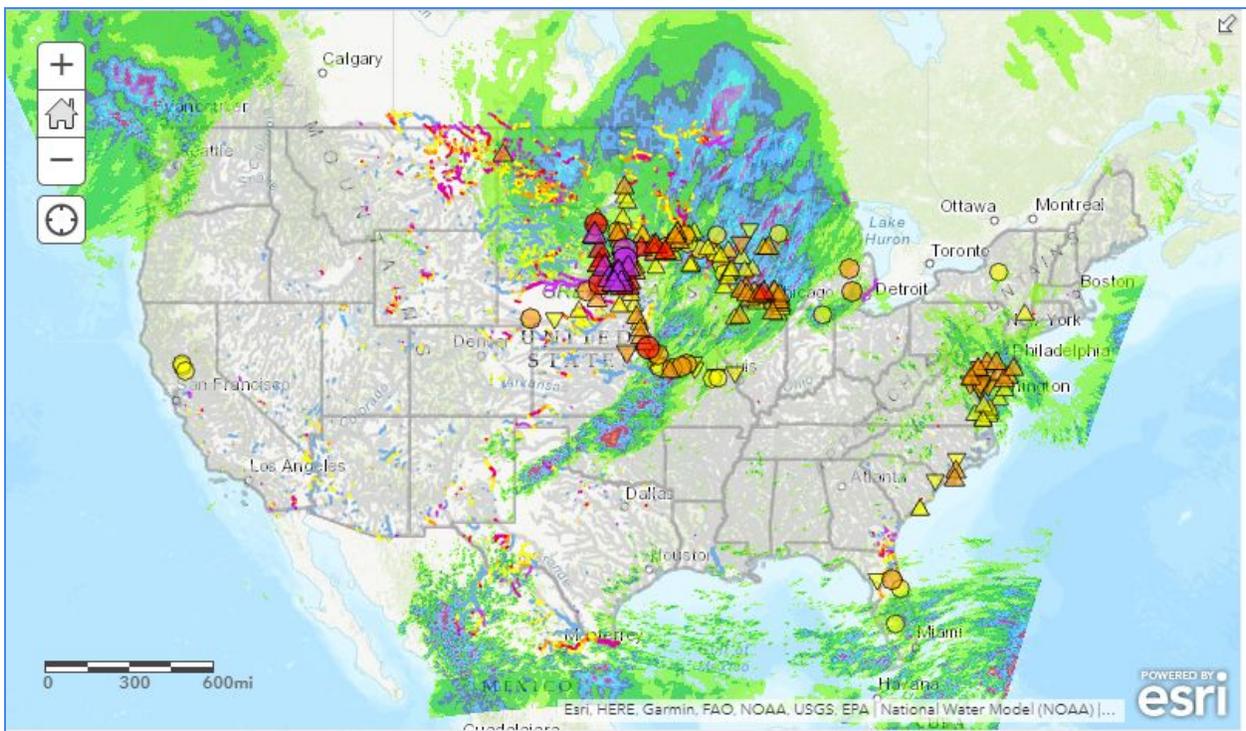


Handbook: NWC Visualization Services

Version 1.4



Updated: September 25, 2020



NWC | National
Water
Center

Preliminary - Subject to Change

Table of Contents

Introduction	3
General Release Updates	4
Reference Services	5
NWS Regions	6
RFC Regions	7
WFO Domains	8
NWM Flowlines	9
NWM Hawaii Flowlines	10
NWM Waterbodies	11
U.S. Cities	12
U.S. County Boundaries	13
U.S. State Boundaries	14
U.S. Urban Areas	15
Replace and Route FIM Catchment Boundaries	16
AHPS and RFC Visualization Services	17
AHPS Maximum Stage Forecast	18
RFC Replace & Route 5-Day Maximum Streamflow Forecast	20
RFC Replace & Route 5-Day Maximum Inundation Extent Forecast	22
NWM Visualization Services	24
Current Conditions: Analysis and Assimilation Configuration	25
NWM Streamflow Analysis - Hawaii	27
NWM High Flow Magnitude Analysis	28
NWM High Flow Magnitude Analysis - Hawaii	29
NWM Inundation Extent Analysis	30
Past 72-Hour Accumulated Precipitation Analysis	32
NWM Snow Depth Analysis	33
NWM Snow Water Equivalent Analysis	34
NWM Past 28-Day Low Flow Analysis	35
NWM Low Soil Moisture Anomaly Analysis	36
NWM Past 24 Hour Snow Melt	37
NWM Past 72 Hour Snow Water Equivalent Change	38
Short-Range Forecast	39
NWM 18-Hour Bankfull Arrival Time Forecast	41
NWM 18-Hour Maximum High Flow Magnitude Forecast	42

NWM 60-Hour Maximum High Flow Magnitude Forecast - Hawaii	43
NWM 18-Hour Maximum Inundation Extent Forecast	45
NWM 18-Hour Streamflow Rate of Change Forecast	47
NWM 18-Hour Peak Flow Arrival Time Forecast	49
NWM 12-Hour Bankfull Probability Forecast	50
18-Hour Accumulated Precipitation Forecast	52
NWM 18-Hour Rapid Onset Flooding	53
NWM 60-Hour Accumulated Precipitation Forecast - Hawaii	55
Medium-Range Forecast	56
NWM 10-Day Bankfull Arrival Time Forecast	58
NWM 10-Day Maximum High Flow Magnitude Forecast	60
NWM 10-Day Maximum Inundation Extent Forecast	62
NWM 10-Day Peak Flow Arrival Time Forecast	64
NWM 5-Day Bankfull Probability Forecast	65
10-Day Accumulated Precipitation Forecast	67
NWM 10-Day Snow Water Equivalent Change	68
Appendix A: HAND and Synthetic Rating Curve References	69

Introduction

This handbook describes a suite of visualization services developed by the NOAA/NWS Office of Water Prediction (OWP) at the National Water Center (NWC). These dynamic services leverage forecasts from the NWS River Forecast Centers (RFCs) and the National Water Model (NWM). Included in the handbook is a brief description of the service and a summary of the methodology used to derive each visualization service; an Appendix is included to further describe methods for estimating inundation extent using the Height Above Nearest Drainage (HAND) method. Updates to existing services are documented in tables at the onset of each section.

Services leverage GIS technology and are made available through the NWC's Enterprise GIS.

General Release Updates

For this release, the following general updates have been implemented:

- None

Specific updates for individual services can be found in the summary tables at the beginning of each configuration section.

Reference Services

Service	Description	Updates
NWS Regions	Depicts the boundaries of the National Weather Service (NWS) Regions.	<ul style="list-style-type: none"> • None
RFC Regions	Depicts the boundaries of the NWS River Forecast Centers (RFC).	<ul style="list-style-type: none"> • None
WFO Domains	Depicts the domains of the NWS Weather Forecast Offices (WFO).	<ul style="list-style-type: none"> • None
NWM Flowlines	Depicts the flowlines in the National Water Model (v2.0).	<ul style="list-style-type: none"> • None
NWM Hawaii Flowlines	Depicts the flowlines in the National Water Model (v2.0) for the state of Hawaii.	<ul style="list-style-type: none"> • None
NWM Waterbodies	Depicts the waterbodies in the National Water Model (v2.0).	<ul style="list-style-type: none"> • None
U.S. Cities	Depicts U.S. cities.	<ul style="list-style-type: none"> • None
U.S. County Boundaries	Depicts the boundaries of U.S. counties.	<ul style="list-style-type: none"> • None
U.S. State Boundaries	Depicts the boundaries of U.S. states and territories.	<ul style="list-style-type: none"> • None
U.S. Urban Areas	Depicts the extent of U.S. urban areas.	<ul style="list-style-type: none"> • None
R&R FIM Catchment Boundaries	Depicts catchment boundaries for FIM v2.X main stem (MS) configuration applied to R&R streamflow forecasts.	<ul style="list-style-type: none"> • New

NWS Regions



Description

Depicts the boundaries of the National Weather Service regions.

Source of data: <https://www.weather.gov/gis/AWIPSShapefiles>

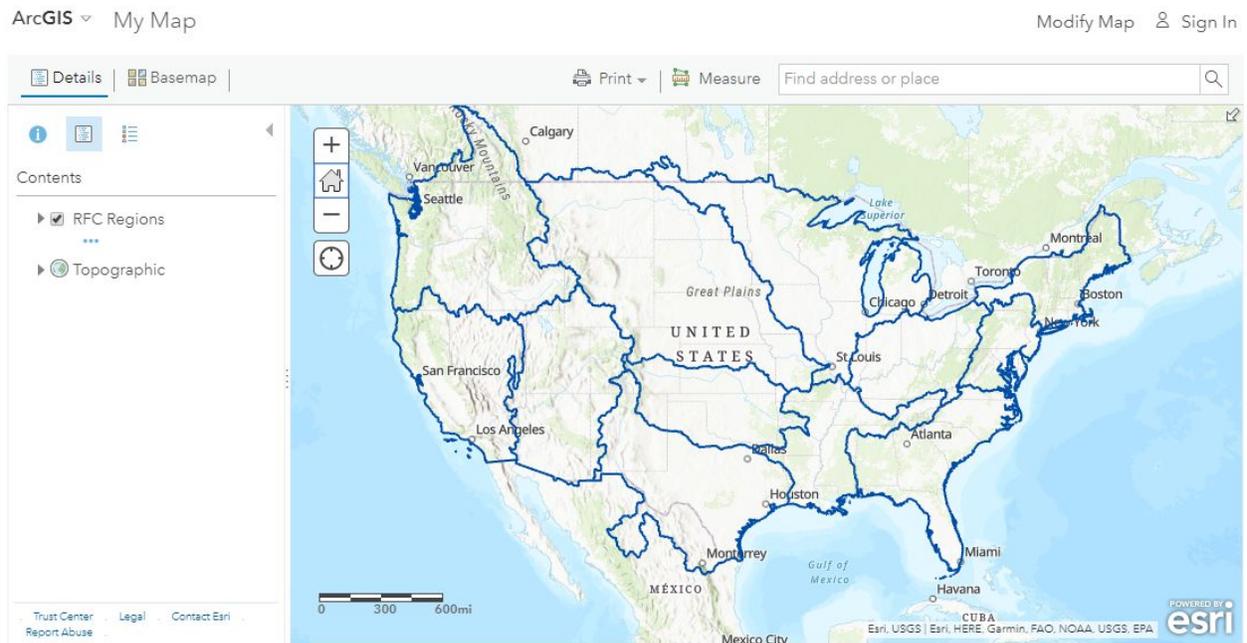
Update Frequency

Static

Methodology

N/A

RFC Regions



Description

Depicts the boundaries of the NWS River Forecast Centers.

Source of data: <https://www.weather.gov/gis/AWIPSShapefiles>

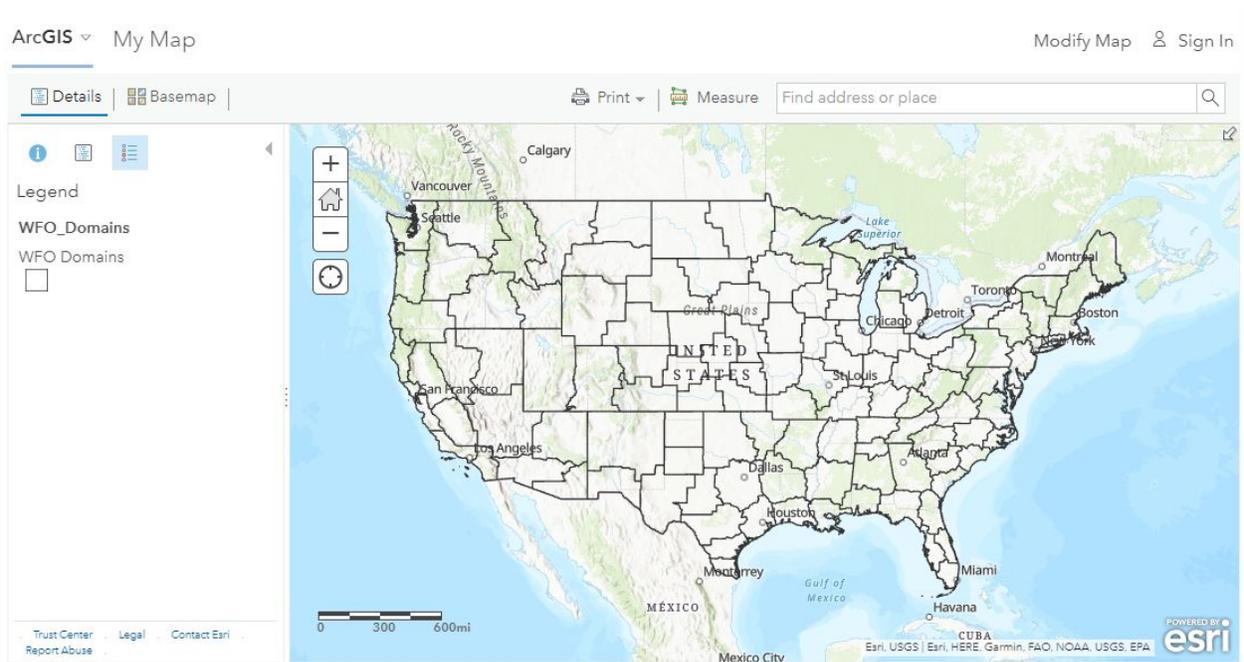
Update Frequency

Static

Methodology

N/A

WFO Domains



Description

Depicts the domains of the NWS Weather Forecast Offices.

Source of data: <https://www.weather.gov/gis/AWIPSShapefiles>

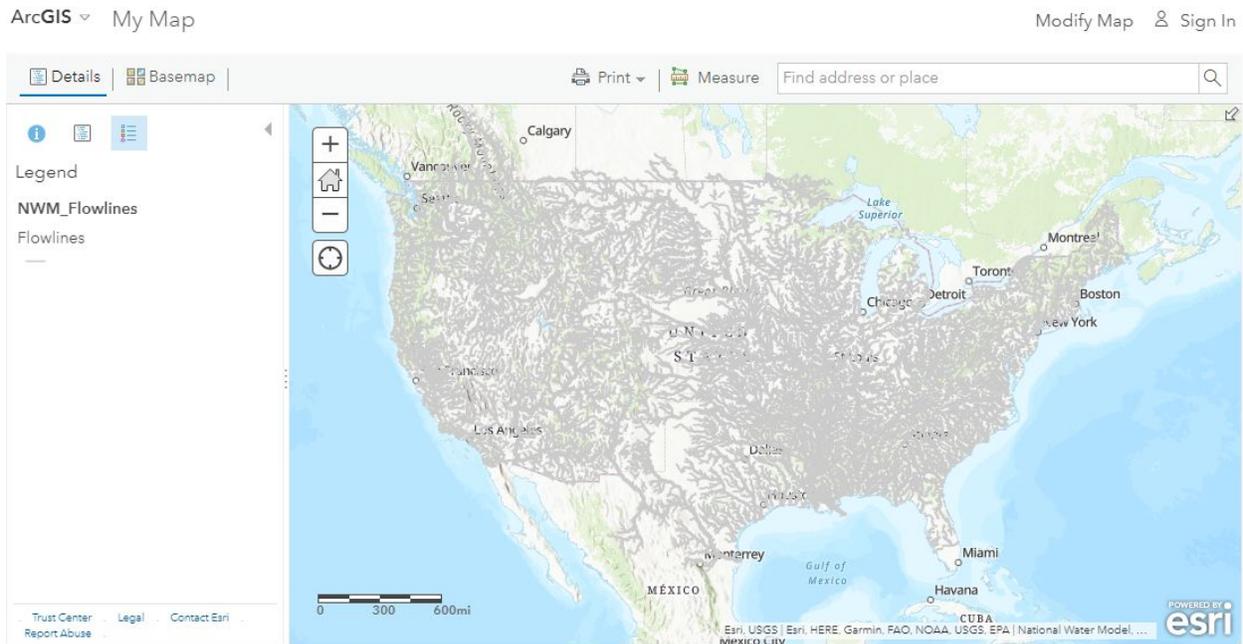
Update Frequency

Static

Methodology

N/A

NWM Flowlines



Description

Depicts the flowlines in the National Water Model (v2.0).

Source of data: <https://water.noaa.gov>

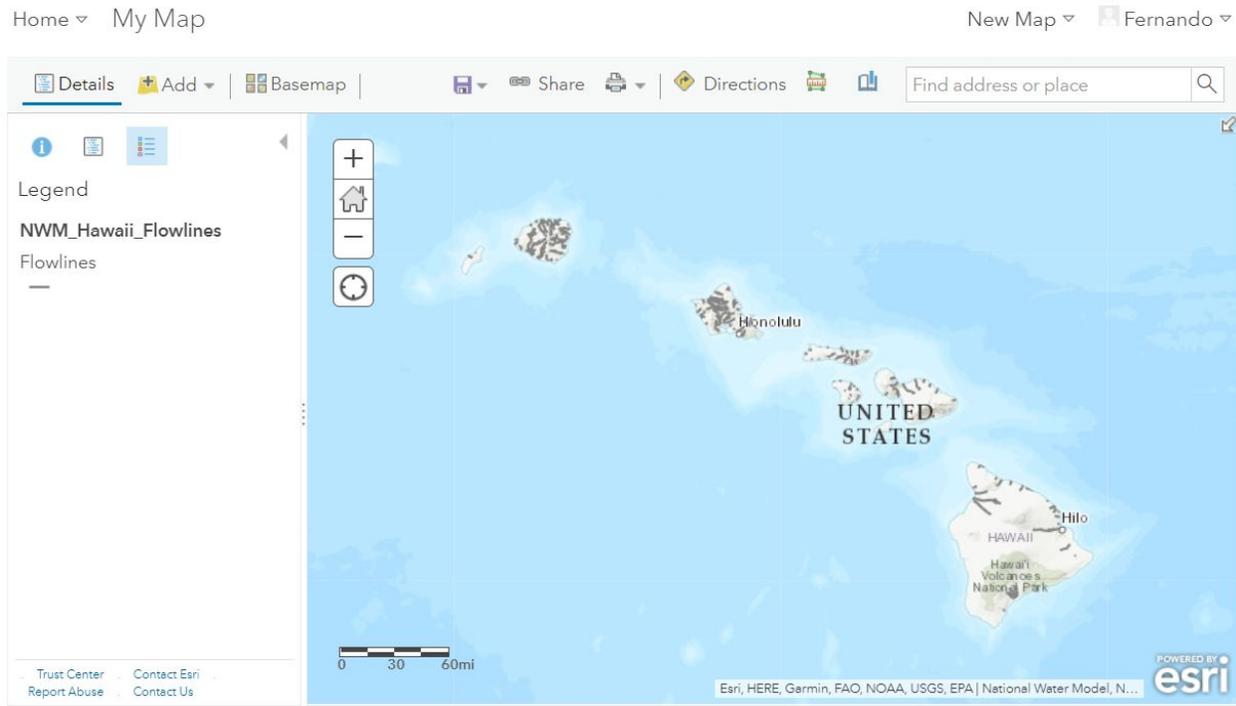
Update Frequency

Static

Methodology

N/A

NWM Hawaii Flowlines



Description

Depicts the flowlines in the National Water Model (v2.0) for the state of Hawaii.

Source of data: <https://water.noaa.gov>

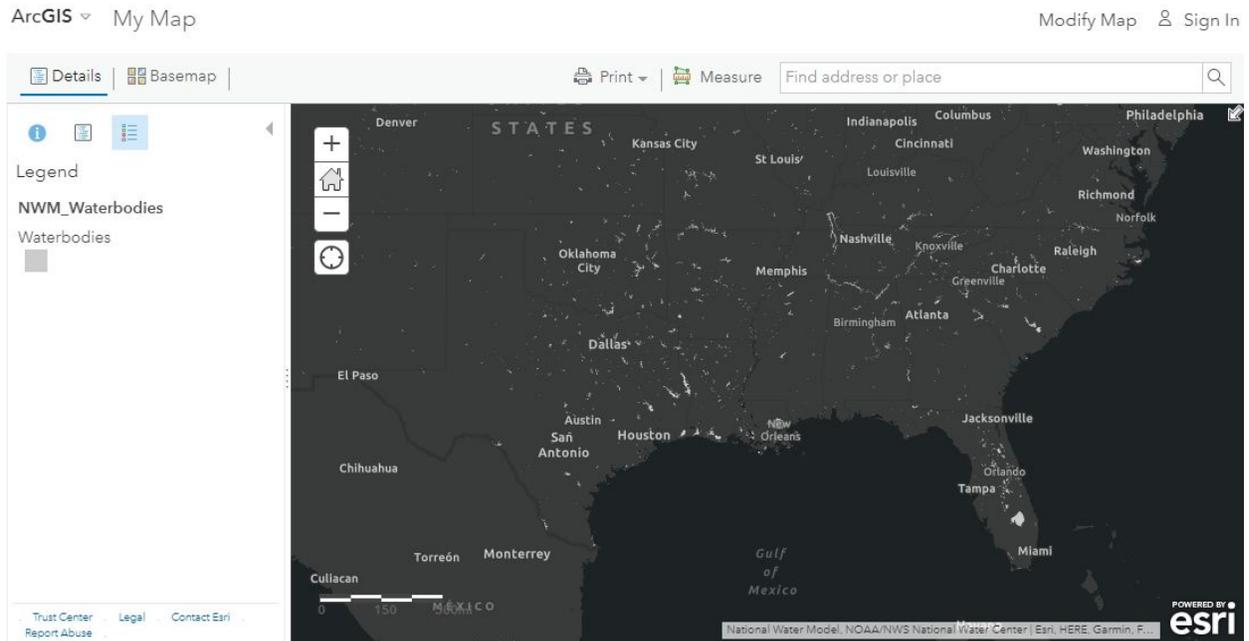
Update Frequency

Static

Methodology

N/A

NWM Waterbodies



Description

Depicts the waterbodies in the National Water Model (v2.0).

Source of data: <https://water.noaa.gov>

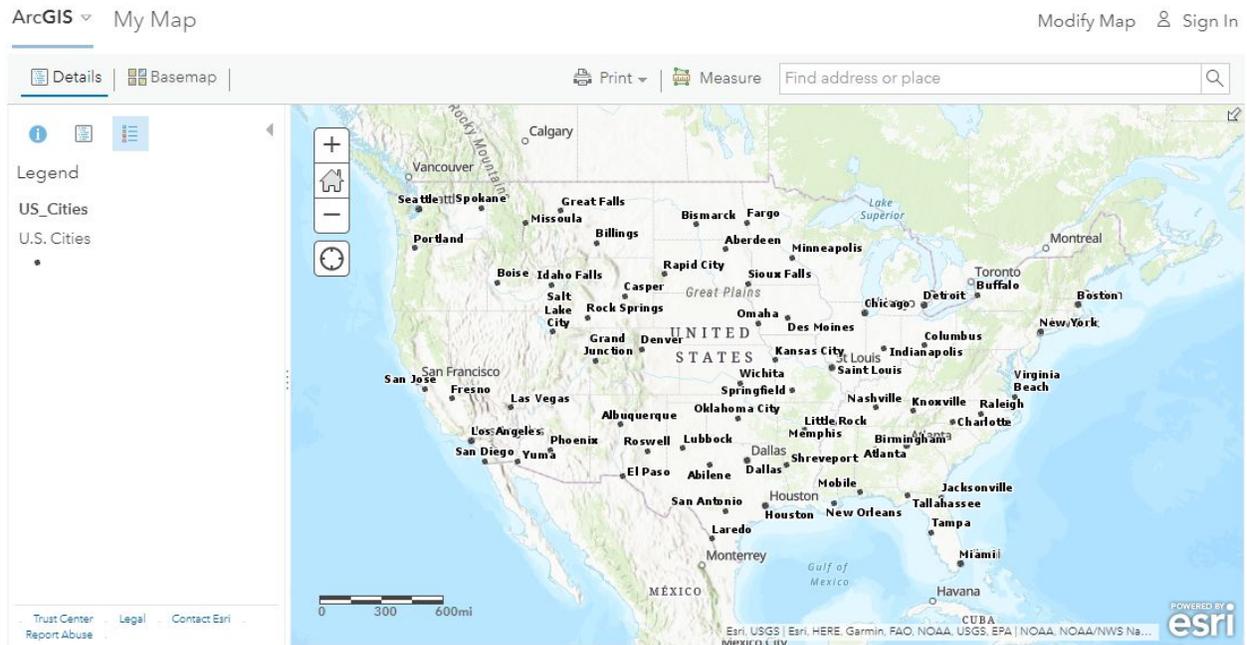
Update Frequency

Static

Methodology

N/A

U.S. Cities



Description

Depicts U.S. cities.

Source of data:

https://tigerweb.geo.census.gov/tigerwebmain/TIGERweb_restmapservice.html

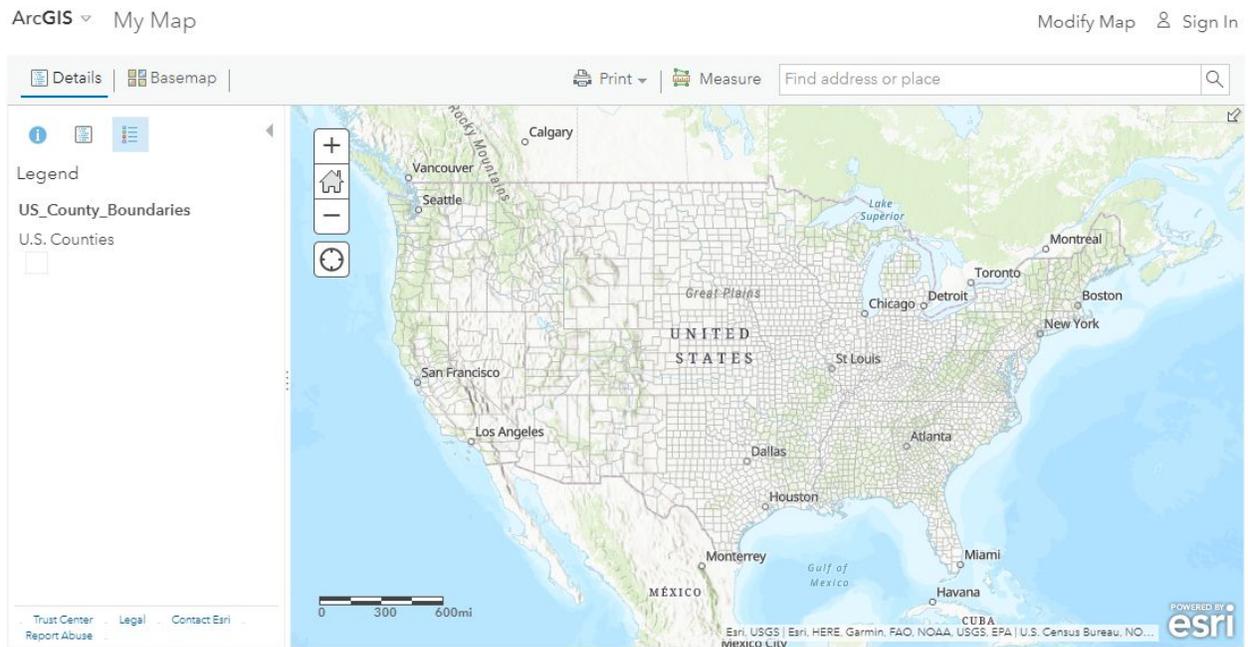
Update Frequency

Static

Methodology

N/A

U.S. County Boundaries



Description

Depicts the boundaries of U.S. counties.

Source of data:

https://tigerweb.geo.census.gov/tigerwebmain/TIGERweb_restmapservice.html

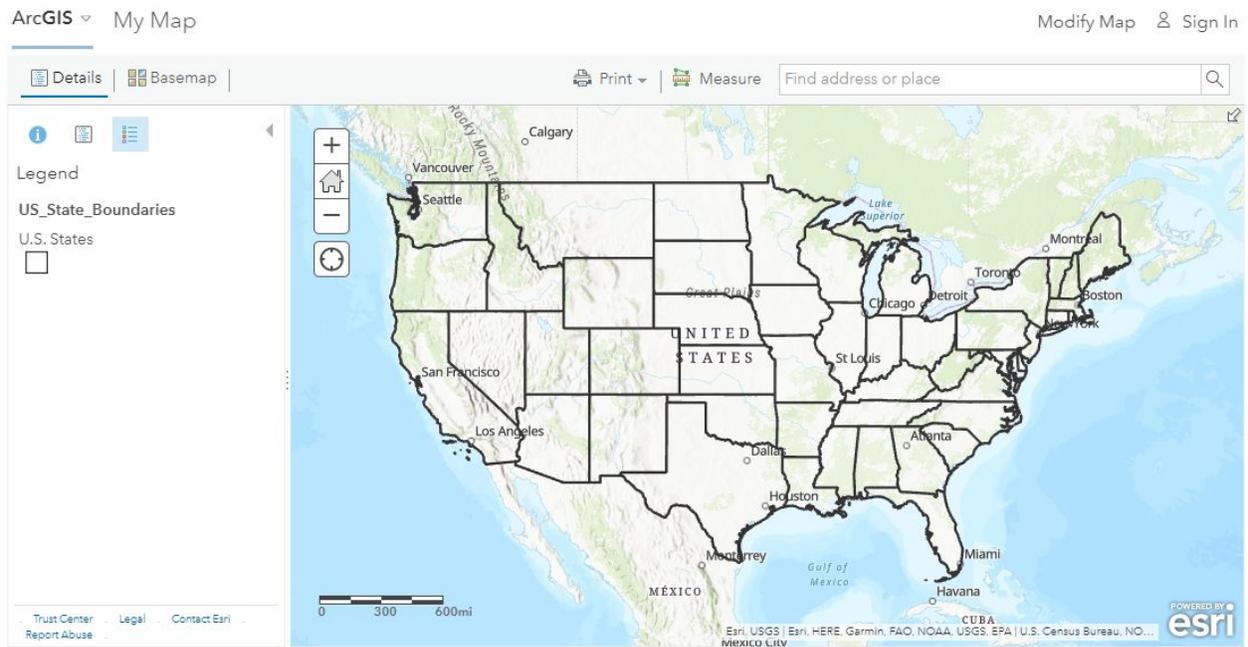
Update Frequency

Static

Methodology

N/A

U.S. State Boundaries



Description

Depicts the boundaries of U.S. states and territories.

Source of data:

https://tigerweb.geo.census.gov/tigerwebmain/TIGERweb_restmapservice.html

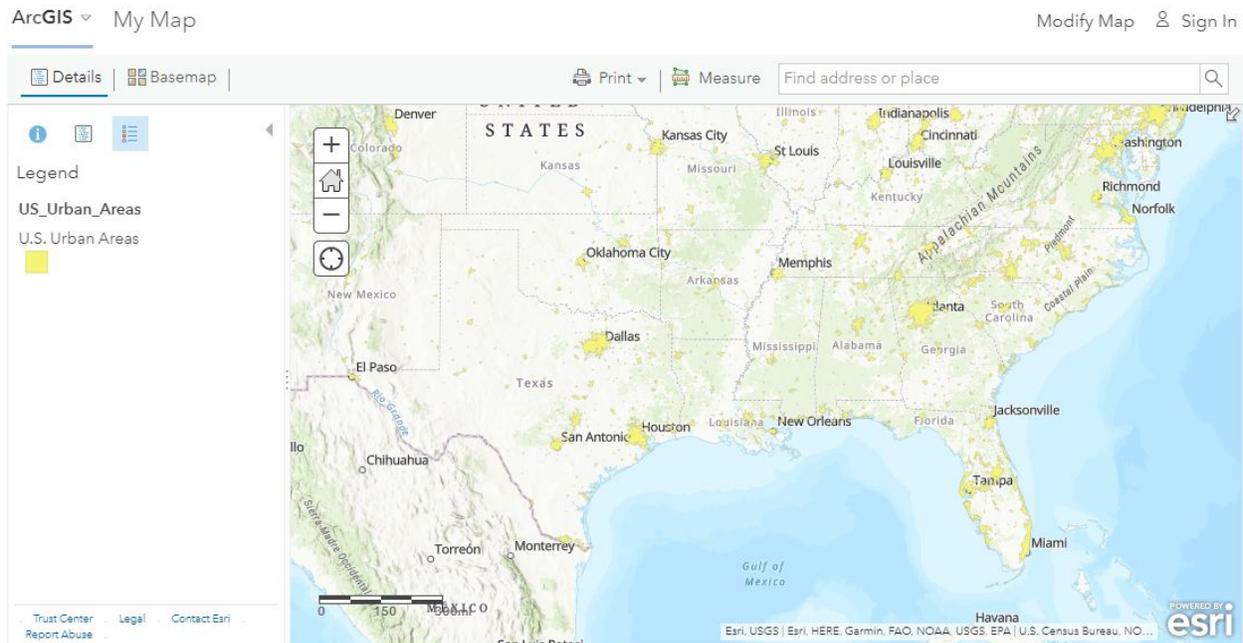
Update Frequency

Static

Methodology

N/A

U.S. Urban Areas



Description

Depicts the extent of U.S. urban areas.

Source of data:

https://tigerweb.geo.census.gov/tigerwebmain/TIGERweb_restmapservice.html

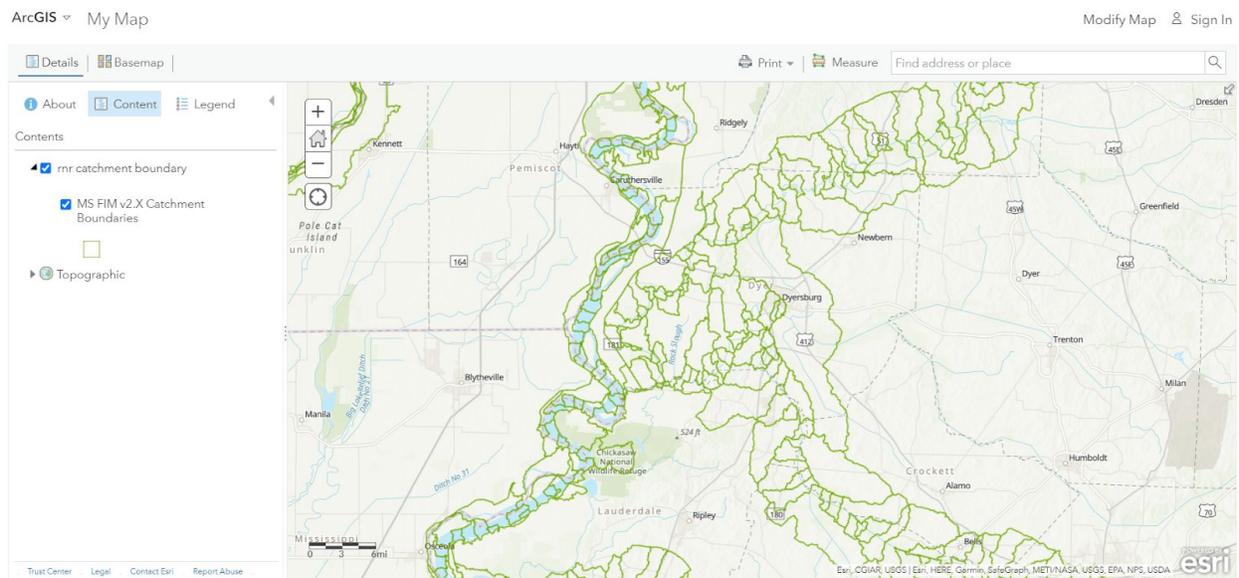
Update Frequency

Static

Methodology

N/A

Replace and Route FIM Catchment Boundaries



Description

Catchments for the main stem FIM v2.X based on v1.3 Height Above the Nearest Drainage (HAND) grids.

Update Frequency

Static

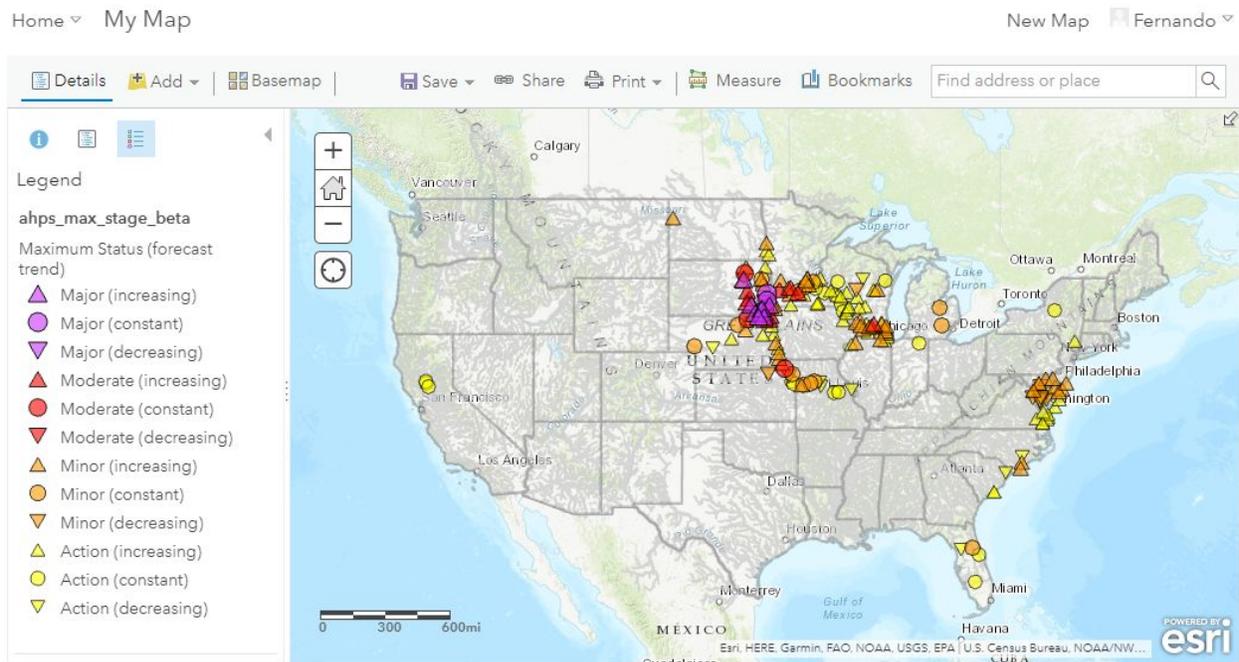
Methodology

N/A

AHPS and RFC Visualization Services

Service	Description	Updates
AHPS Maximum Stage Forecast	Depicts AHPS gauges with forecasts at or above "action" stage. Circles represent gauges where stages are changing by less than +/- 5% over the entire forecast period. Upward-pointing triangles represent gauges where a greater than 5% increase in stage is expected sometime during the forecast. If stage increases greater than 5% are not expected, downward-pointing triangles represent gauges where a greater than 5% decrease in stage is expected sometime during the forecast. Gauges are colored by their maximum forecast flood category.	<ul style="list-style-type: none"> • Updated Description • New Trend Algorithm (see description) • New Fields <ul style="list-style-type: none"> ○ Altitude ○ Altitude Datum
RFC Replace & Route 5-Day Maximum Streamflow Forecast	Depicts maximum streamflow over the next 5 days derived from the official RFC forecasts routed through the National Water Model (v2.0) stream network downstream of AHPS gauges (Replace & Route). Maximum streamflows are available downstream of AHPS gauges whose forecasts reach action status or greater.	<ul style="list-style-type: none"> • None
RFC Replace & Route 5-Day Maximum Inundation Extent Forecast	<p>Depicts expected maximum inundation extent derived from the official RFC forecasts routed through the National Water Model (v2.0) stream network downstream of AHPS gauges (Replace & Route). Shown are areas expected to be inundated at some point over the next 5 days.</p> <p><i>Note: Inundation extent is only viewable to users in the NWC FIM Services group on the NWC Portal.</i></p>	<ul style="list-style-type: none"> • None

AHPS Maximum Stage Forecast



Description

Depicts AHPS gauges with forecasts at or above "action" stage. Circles represent gauges where stages are changing by less than +/- 5% over the entire forecast period. Upward-pointing triangles represent gauges where a greater than 5% increase in stage is expected sometime during the forecast. If stage increases greater than 5% are not expected, downward-pointing triangles represent gauges where a greater than 5% decrease in stage is expected sometime during the forecast. Gauges are colored by their maximum forecast flood category.

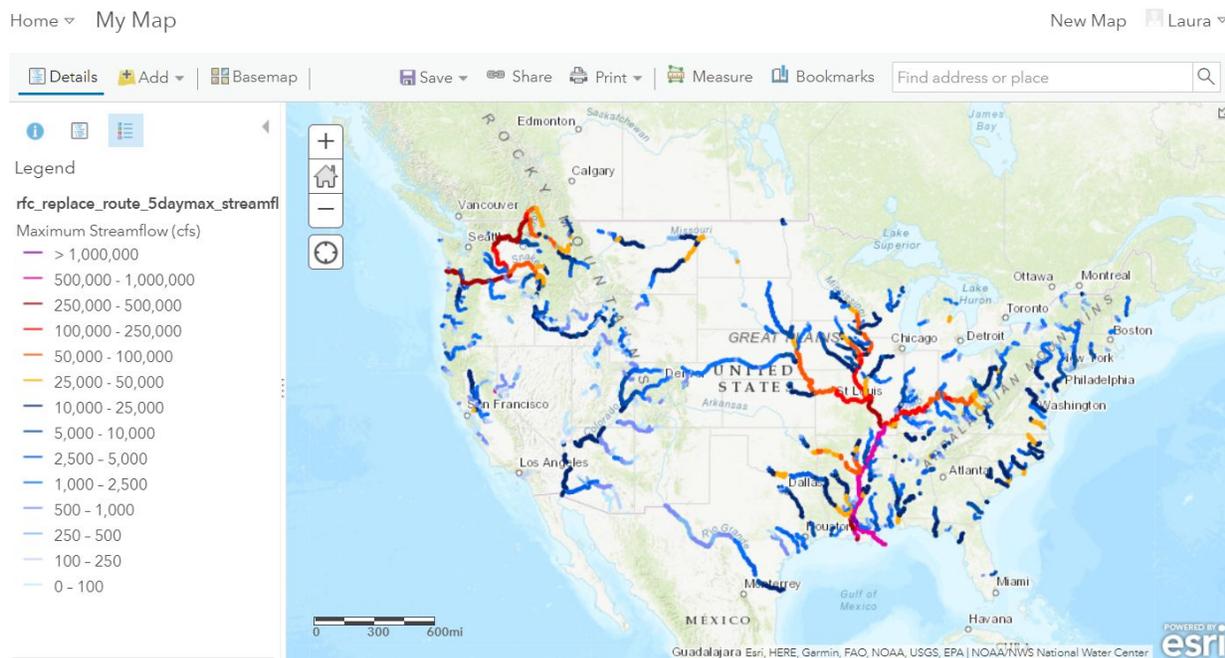
Update Frequency

Once every 15 minutes.

Methodology

HML products transmitted through the SBN are ingested into a database and then queried through an API. Forecast time series are then analyzed to detect changes in flood stage.

RFC Replace & Route 5-Day Maximum Streamflow Forecast



Description

Depicts maximum streamflow over the next 5 days derived from the official RFC forecasts routed through the National Water Model (NWM) (v2.0) stream network downstream of AHPS gauges (Replace & Route). Maximum streamflows are available downstream of AHPS gauges whose forecasts reach action status or greater.

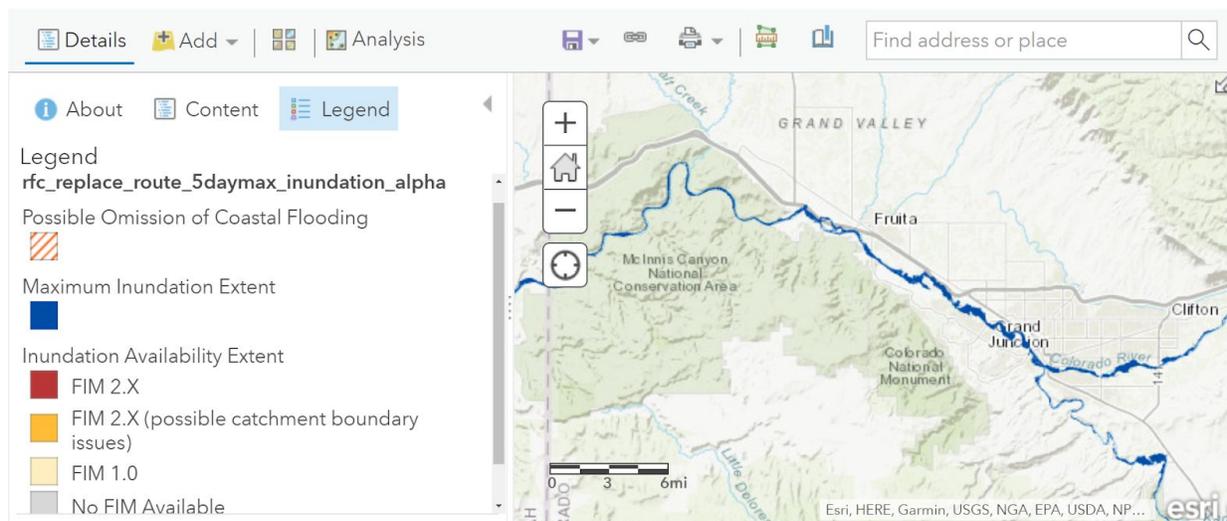
Update Frequency

Once per hour.

Methodology

HML products transmitted through the SBN are ingested into a database and then queried. Forecast streamflow time series are assimilated into the NWM (v2.0) channel routing module and then routed through river segments downstream (Replace & Route). The NWM Analysis and Assimilation configuration provides the initial streamflow conditions for Replace & Route.

RFC Replace & Route 5-Day Maximum Inundation Extent Forecast



Description

Depicts expected maximum inundation extent derived from the official RFC forecasts routed through the National Water Model (NWM) (v2.0) stream network downstream of AHPS gauges (Replace & Route). Shown are areas expected to be inundated at some point over the next 5 days. Inundation extents are derived using the Height Above the Nearest Drainage (HAND) method; stage heights are interpolated from routed discharges using synthetic rating curves, interpolated stage heights are rounded up to the nearest foot, and corresponding pre-computed inundation extent polygons are displayed.

Note: Inundation extent is only viewable to users in the NWC FIM Services group on the NWC Portal.

Update Frequency

Once per hour.

Methodology

HML products transmitted through the SBN are ingested into a database and then queried. Forecast streamflow time series are assimilated into the NWM (v2.0) channel routing module and then routed through river segments

downstream (Replace & Route). The NWM (v2.0) Analysis and Assimilation configuration provides the initial streamflow conditions for Replace & Route.

Forecast streamflows from Replace & Route are converted to forecast stages using synthetic rating curves derived from reach-averaged channel properties. Reach-averaged channel properties are derived from 10-meter elevation data. Forecast stages are then converted to forecast inundation extents using a 10-meter relative elevation grid derived using the HAND method.

NWM Visualization Services

This section outlines the suite of visualization services driven by the National Water Model (NWM). The NWM provides estimates of current and forecast hydrologic conditions (including streamflow) across the U.S. via several model configurations: Analysis and Assimilation (current conditions), Short-Range Forecast (18-hours), Medium-Range Forecast (10-days) and Long-Range Forecast (30-days); see **Figure 1** below. For more information about the NWM, visit <https://water.noaa.gov>.

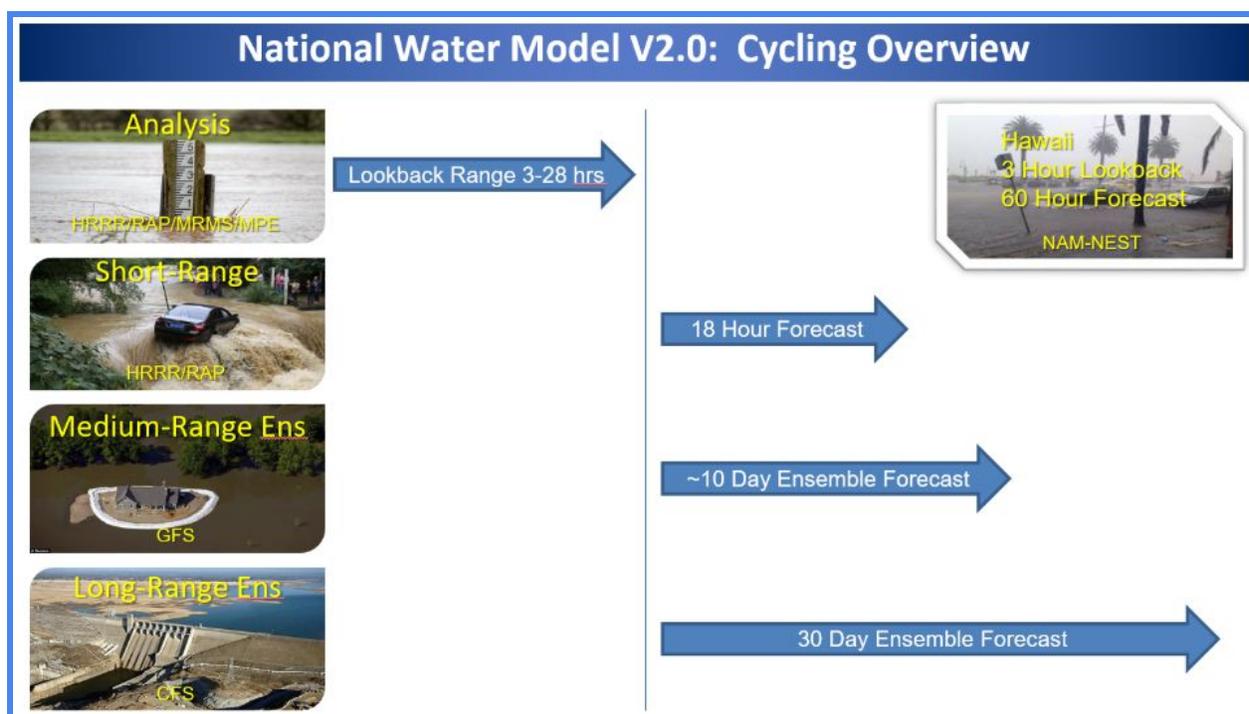


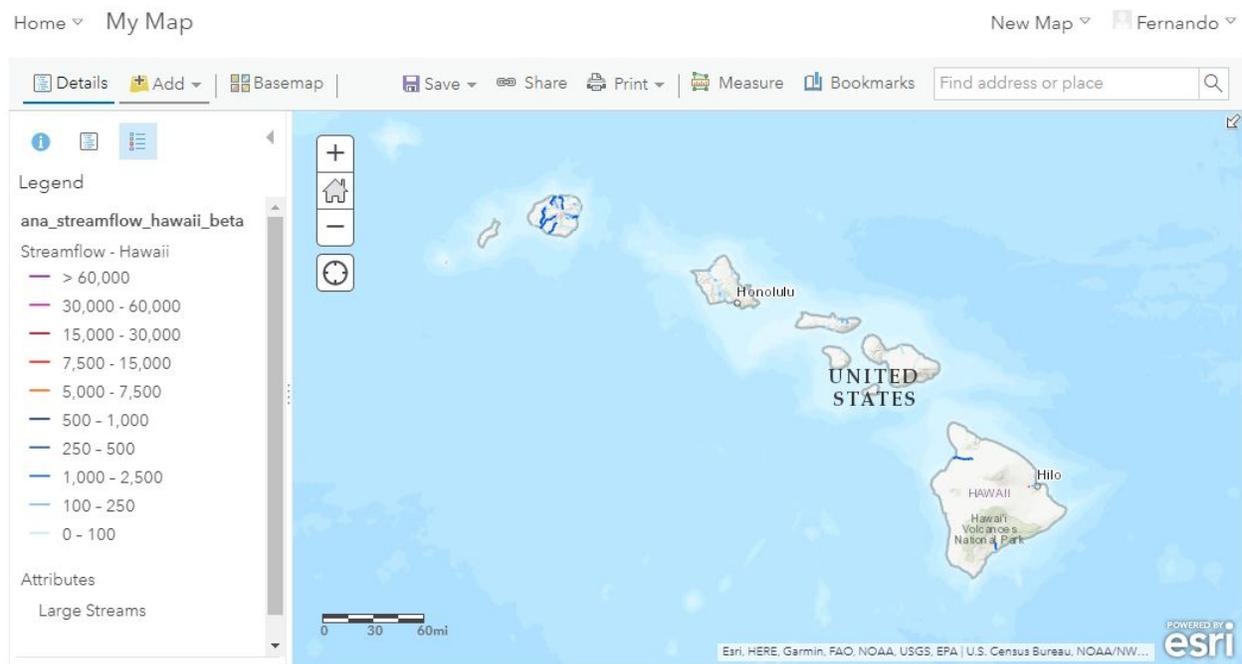
Figure 1: NWM configurations.

Current Conditions: Analysis and Assimilation Configuration

Service	Description	Updates
NWM Streamflow Analysis - Hawaii	Depicts the streamflow output from the operational National Water Model (v2.0) analysis and assimilation for the state of Hawaii.	<ul style="list-style-type: none"> • None
NWM High Flow Magnitude Analysis	Depicts high flow magnitudes derived from the operational National Water Model (v2.0) analysis and assimilation. Shown are reaches with flow at or above bankfull. Reaches are colored by the annual exceedance probability of their current flow.	<ul style="list-style-type: none"> • None
NWM High Flow Magnitude Analysis - Hawaii	Depicts high flow magnitudes derived from the operational National Water Model (v2.0) analysis and assimilation configuration for the state of Hawaii. Shown are reaches with flow at or above bankfull. Reaches are colored by the annual exceedance probability of their current flow.	<ul style="list-style-type: none"> • Scale Dependent Rendering • Updated Field Alias <ul style="list-style-type: none"> ○ Max Annual Exceed Prob (%) -> Annual Exceed Prob (%) • Updated Legend Category <ul style="list-style-type: none"> ○ Not Available -> Insufficient Data
NWM Inundation Extent Analysis	Depicts inundation extent derived from the operational National Water Model (v2.0) analysis and assimilation. <i>Note: Inundation extent is only viewable to users in the NWC FIM Services group on the NWC Portal, and only available over the Texas/WGRFC, SERFC, MARFC and NERFC domains.</i>	<ul style="list-style-type: none"> • None
Past 72-Hour Accumulated Precipitation Analysis	Depicts accumulated precipitation totals over the past 72 hours derived from the MRMS forcing for the operational National Water Model (v2.0) analysis and assimilation.	<ul style="list-style-type: none"> • None
NWM Snow Depth Analysis	Depicts the snow depth output from the operational National Water Model (v2.0) analysis and assimilation.	<ul style="list-style-type: none"> • None
NWM Snow Water Equivalent Analysis	Depicts the snow water equivalent output from the operational National Water Model (v2.0) analysis and assimilation.	<ul style="list-style-type: none"> • None

<p>NWM Past 28-Day Low Flow Analysis</p>	<p>Depicts low flow anomalies derived from the operational National Water Model (v2.0) analysis and assimilation. Anomalies are based on 28-day average streamflow percentiles for each reach for the current calendar day.</p>	<ul style="list-style-type: none"> • None
<p>NWM Low Soil Moisture Anomaly Analysis</p>	<p>Depicts low soil moisture anomalies derived from the latest operational National Water Model (v2.0) output. Values represent soil saturation anomaly categories for the averaged 0 - 100 cm soil layer. Anomalies are based on the current operational forecast compared against the 15-day average low soil moisture percentiles centered around the current calendar day.</p>	<ul style="list-style-type: none"> • None
<p>NWM Past 24 Hour Snow Melt</p>	<p>Depicts snow melt over the past 24 hours derived from the operational National Water Model (v2.0) analysis and assimilation.</p>	<ul style="list-style-type: none"> • None
<p>NWM Past 72 Hour Snow Water Equivalent Change</p>	<p>Depicts snow water equivalent changes over the past 24, 48, and 72 hours derived from the operational National Water Model (v2.0) analysis and assimilation.</p>	<ul style="list-style-type: none"> • None

NWM Streamflow Analysis - Hawaii



Description

Depicts the streamflow output from the operational National Water Model (NWM) (v2.0) analysis and assimilation for the state of Hawaii.

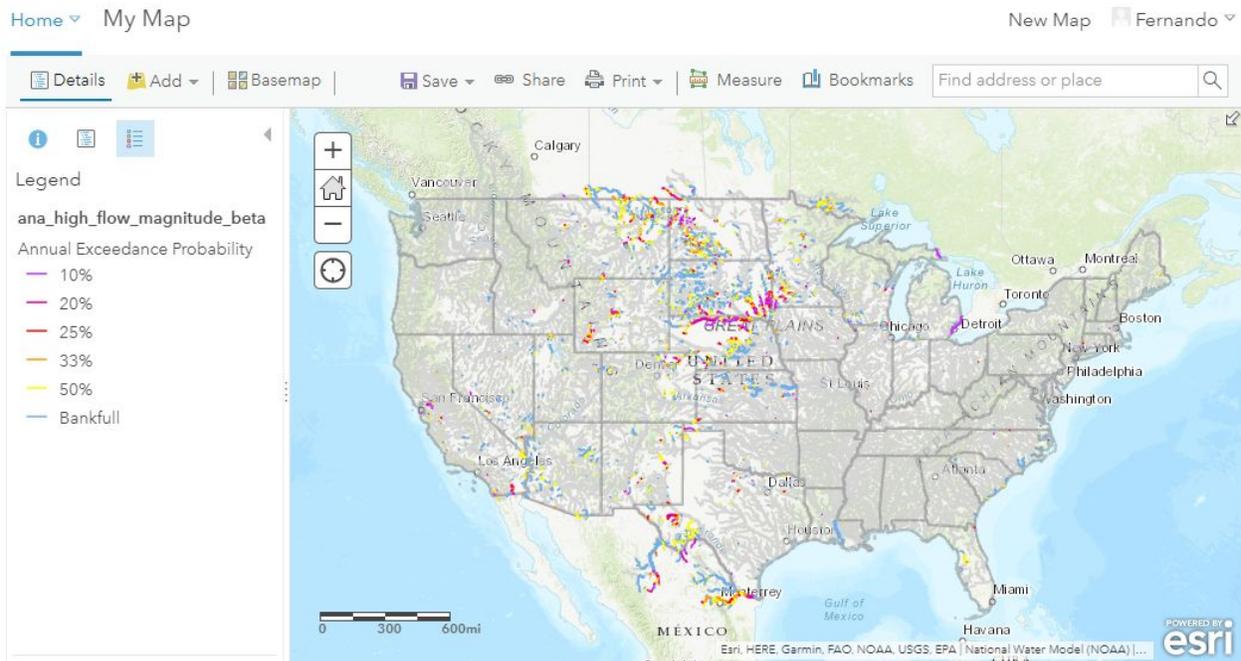
Update Frequency

Once per hour.

Methodology

Raw NWM (v2.0) output is displayed.

NWM High Flow Magnitude Analysis



Description

Depicts high flow magnitudes derived from the operational National Water Model (NWM) (v2.0) analysis and assimilation. Shown are reaches reached with flow at or above bankfull. Reaches are colored by the annual exceedance probability (AEP) of their current flow. Bankfull flows and AEPs were derived using a 25-year retrospective analysis of the NWM (v2.0).

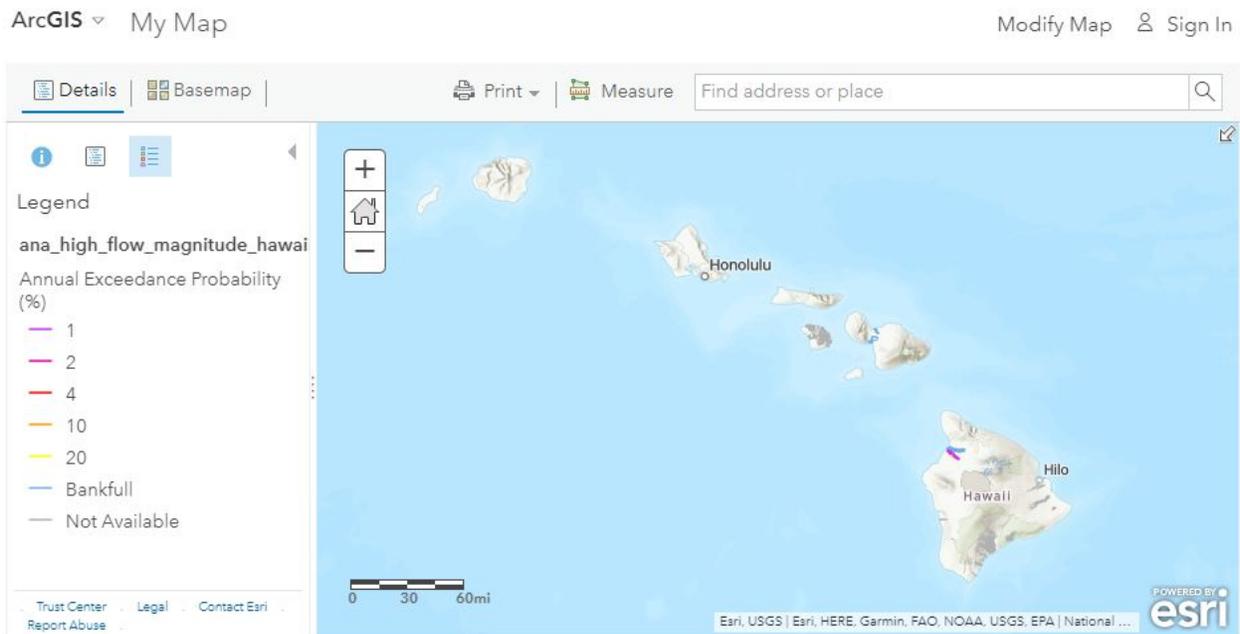
Update Frequency

Once per hour.

Methodology

AEPs were derived from a multi-decade reanalysis of the NWM (v2.0). NWM streamflow values are compared to these AEPs and classified accordingly. "Bankfull" conditions are approximated by the 67% AEP.

NWM High Flow Magnitude Analysis - Hawaii



Description

Depicts high flow magnitudes derived from the operational National Water Model (NWM) (v2.0) analysis and assimilation configuration for the state of Hawaii. Shown are reaches with flow at or above bankfull. Reaches are colored by the annual exceedance probability (AEP) of their current flow. Bankfull flows and AEPs were derived from USGS regression equations found at https://pubs.usgs.gov/sir/2010/5035/sir2010-5035_text.pdf.

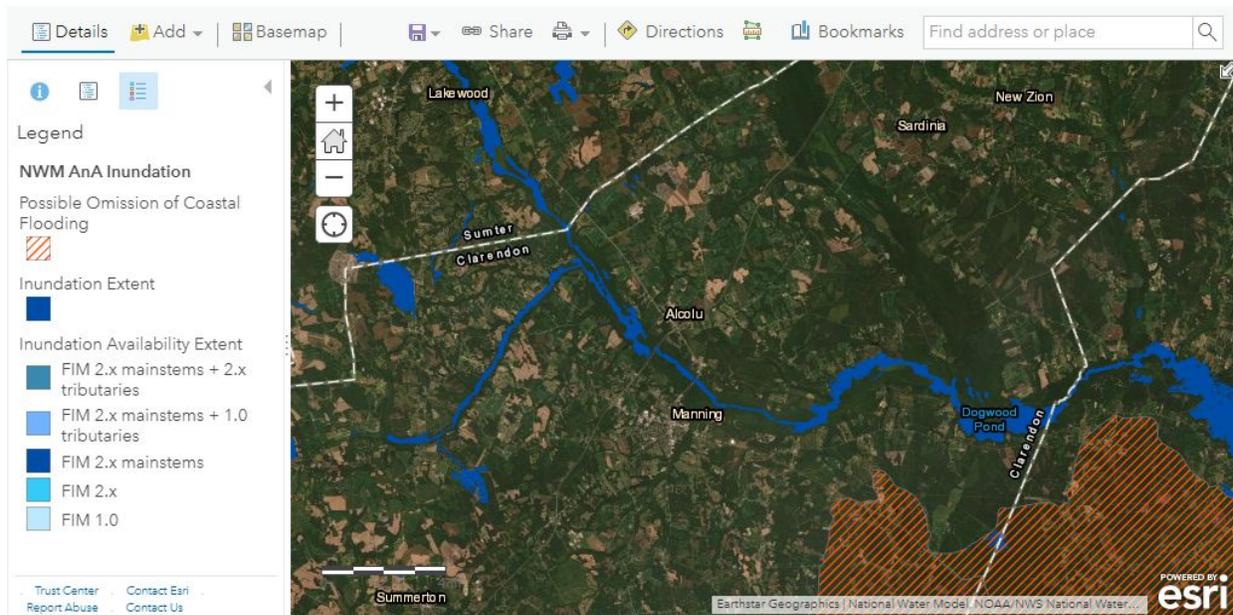
Update Frequency

Once per hour.

Methodology

Bankfull flows and AEPs were derived from USGS regression equations found at https://pubs.usgs.gov/sir/2010/5035/sir2010-5035_text.pdf. Streamflow values are then compared to AEPs and classified accordingly. "Bankfull" conditions are approximated by the 67% AEP.

NWM Inundation Extent Analysis



Description

Depicts inundation extent derived from the operational National Water Model (NWM) (v2.0) analysis and assimilation. Inundation extents are derived using the Height Above the Nearest Drainage (HAND) method; stage heights are interpolated from NWM (v2.0) discharges using synthetic rating curves, interpolated stage heights are rounded up to the nearest foot, and corresponding pre-computed inundation extent polygons are displayed.

Note: Inundation extent is only viewable to users in the NWC FIM Services group on NWC Portal, and only available over the Texas/WGRFC, SERFC, MARFC and NERFC domains.

Update Frequency

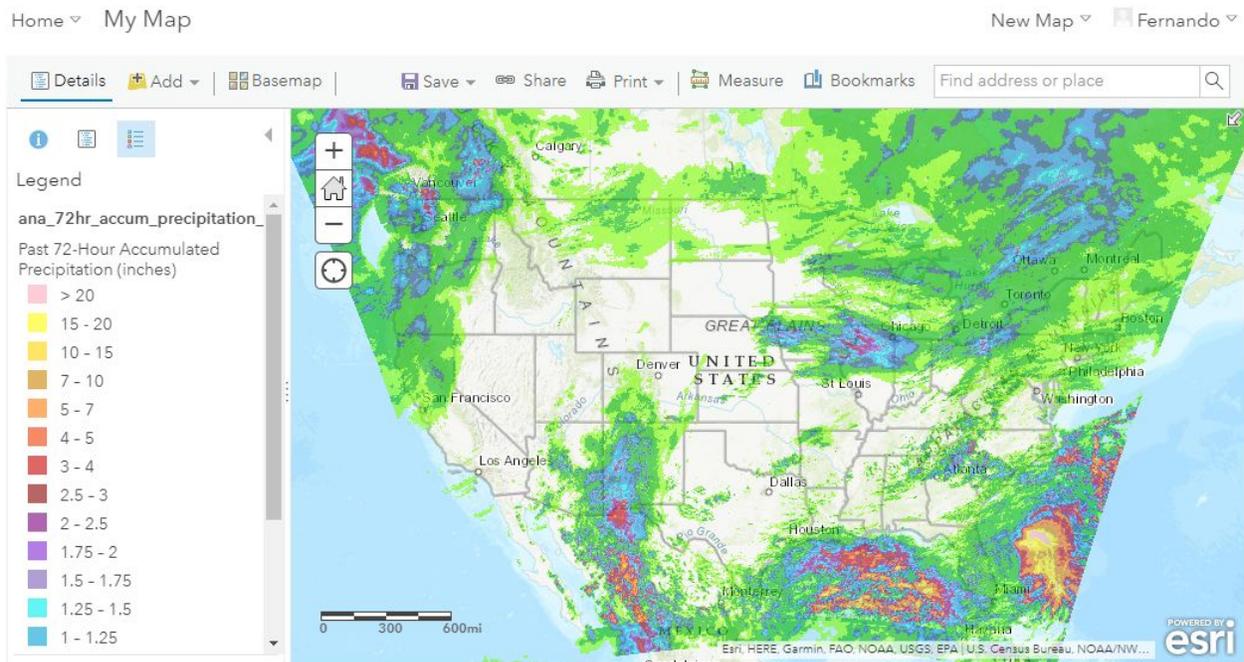
Once per hour.

Methodology

NWM streamflows are converted to stages using synthetic rating curves derived from reach-averaged channel properties. Reach-averaged channel properties are derived from 10-meter elevation data. Stages are then

converted to inundation extents using a 10-meter relative elevation grid derived using the HAND method. “Bankfull” conditions are approximated by the 67% AEP. AEPs were derived from a multi-decade reanalysis of the NWM (v2.0). For more information on HAND and synthetic rating curves, see the references listed in **Appendix A**.

Past 72-Hour Accumulated Precipitation Analysis



Description

Depicts accumulated precipitation totals over the past 72 hours derived from the MRMS forcing for the operational National Water Model (NWM) (v2.0) analysis and assimilation. Data for each interval can be seen by using a filter to select the name of the desired layer.

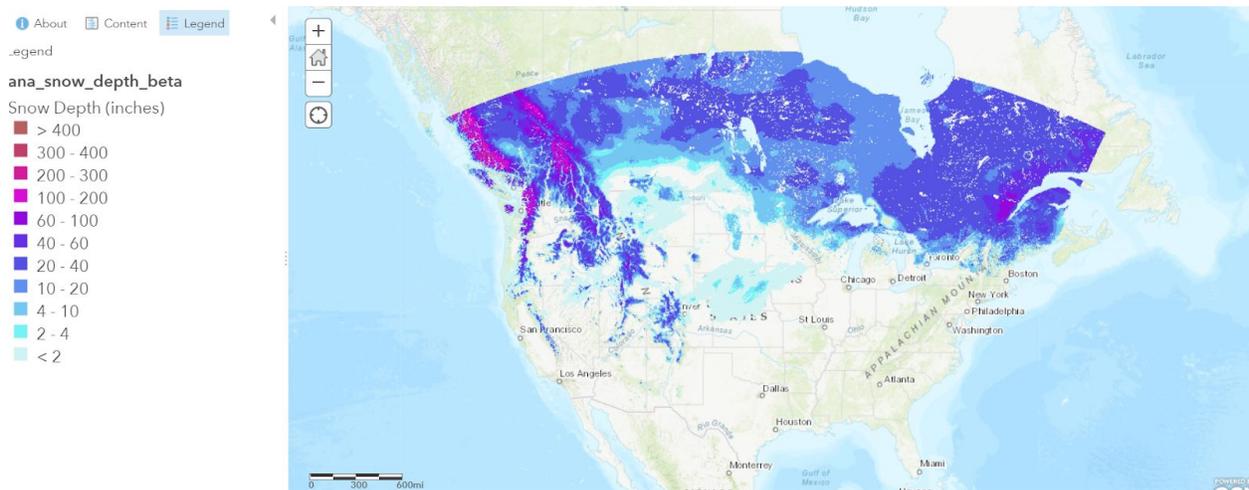
Update Frequency

Once per hour.

Methodology

Hourly precipitation from the NWM (v2.0) analysis and assimilation configuration is accumulated over past intervals: 1 hour, 3 hours, 6 hours, 12 hours, 24 hours, 48 hours, and 72 hours. NWM (v2.0) analysis and assimilation precipitation is derived from a HRRR/RAP/MRMS/MPE blend.

NWM Snow Depth Analysis



Description

Depicts the snow depth output from the operational National Water Model (NWM) (v2.0) analysis and assimilation.

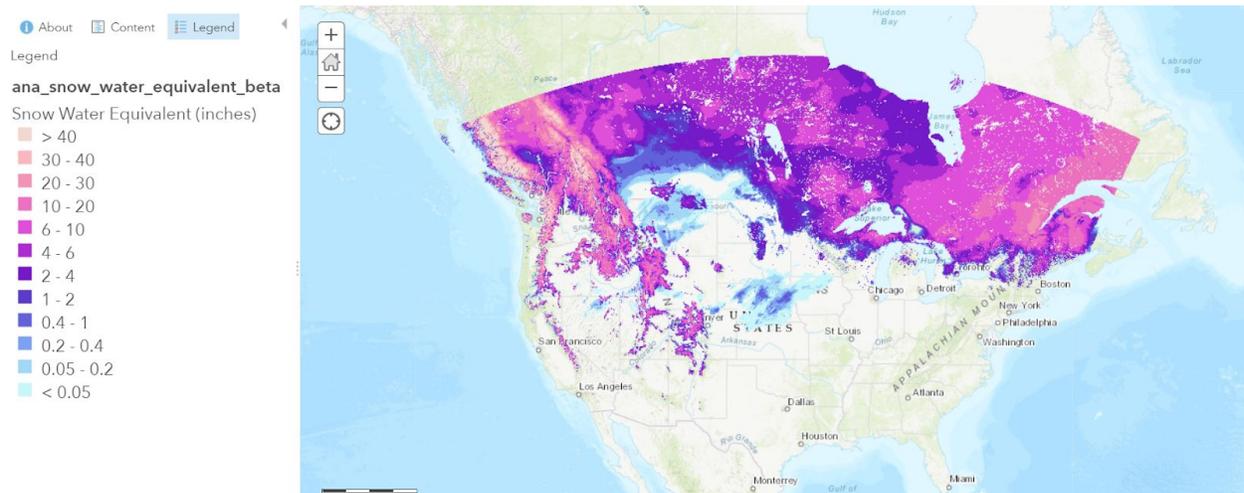
Update Frequency

Once per hour.

Methodology

Raw NWM (v2.0) output is displayed.

NWM Snow Water Equivalent Analysis



Description

Depicts the snow water equivalent output from the operational National Water Model (NWM) (v2.0) analysis and assimilation.

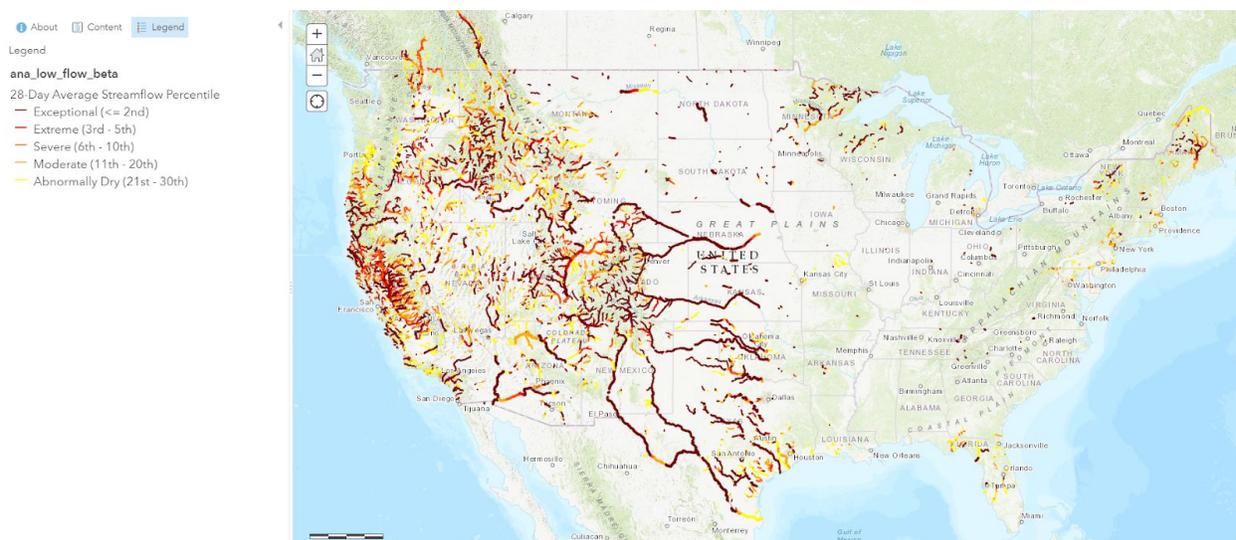
Update Frequency

Once per hour.

Methodology

Raw NWM (v2.0) output is displayed.

NWM Past 28-Day Low Flow Analysis



Description

Depicts low flow anomalies derived from the operational National Water Model (NWM) (v2.0) analysis and assimilation. Anomalies are based on 28-day average streamflow percentiles for each reach for the current calendar day. Streamflow percentiles were derived from 28-day streamflow averages for each reach for each calendar day using a 25-year retrospective analysis of the NWM (v2.0).

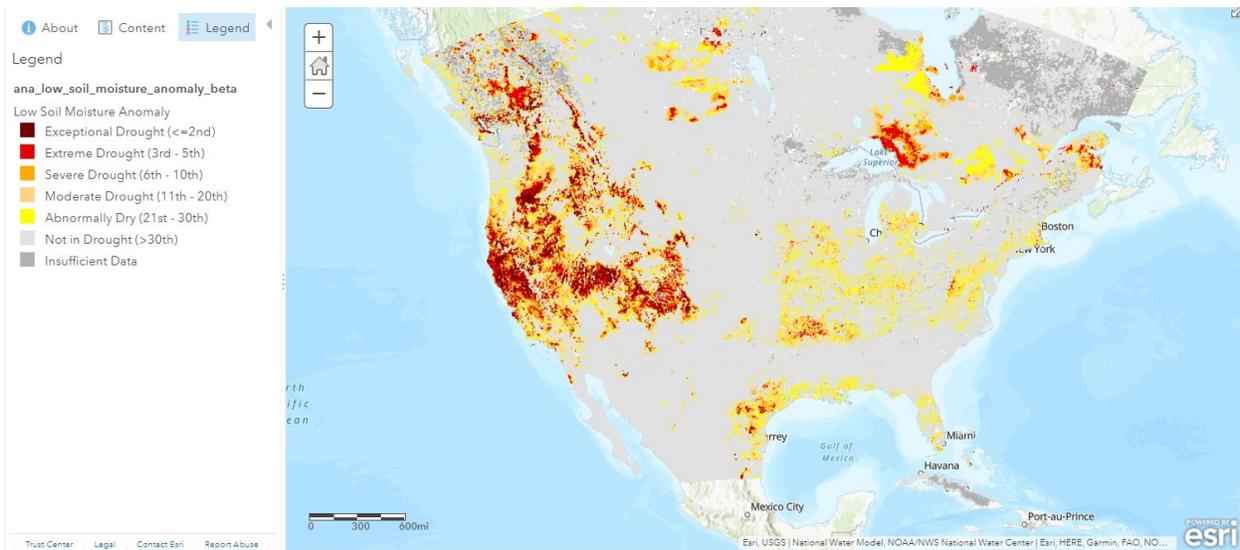
Update Frequency

Once per day.

Methodology

Low flows are based on 28-day average streamflow percentiles for each reach for the current calendar day. For example, reaches shown in red, the Drought (< 2 nd) category, have a 28-day streamflow average below their 2nd streamflow percentile for this time of year. Streamflow percentiles were derived from 28-day streamflow averages for each reach for each calendar day using a 25-year retrospective analysis of the NWM (v2.0).

NWM Low Soil Moisture Anomaly Analysis



Description

Depicts low soil moisture anomalies derived from the operational National Water Model (NWM) (v2.0) analysis and assimilation. Values represent soil saturation anomalies for the 0 - 100cm soil layer. Anomalies are based on 15-day average soil saturation percentiles for each reach centered around the current calendar day. Percentiles were derived from 15-day soil saturation averages for each reach for each calendar day using a 25-year retrospective analysis of the NWM (v2.0).

Update Frequency

Once per day.

Methodology

Soil moisture percentiles were created at a 1km-resolution from a 15-day average centered around the day of the year using a 25-year retrospective analysis of the NWM (v2.0).

NWM Past 24 Hour Snow Melt



Description

Depicts snow melt over the past 24 hours derived from the operational National Water Model (v2.0) analysis and assimilation.

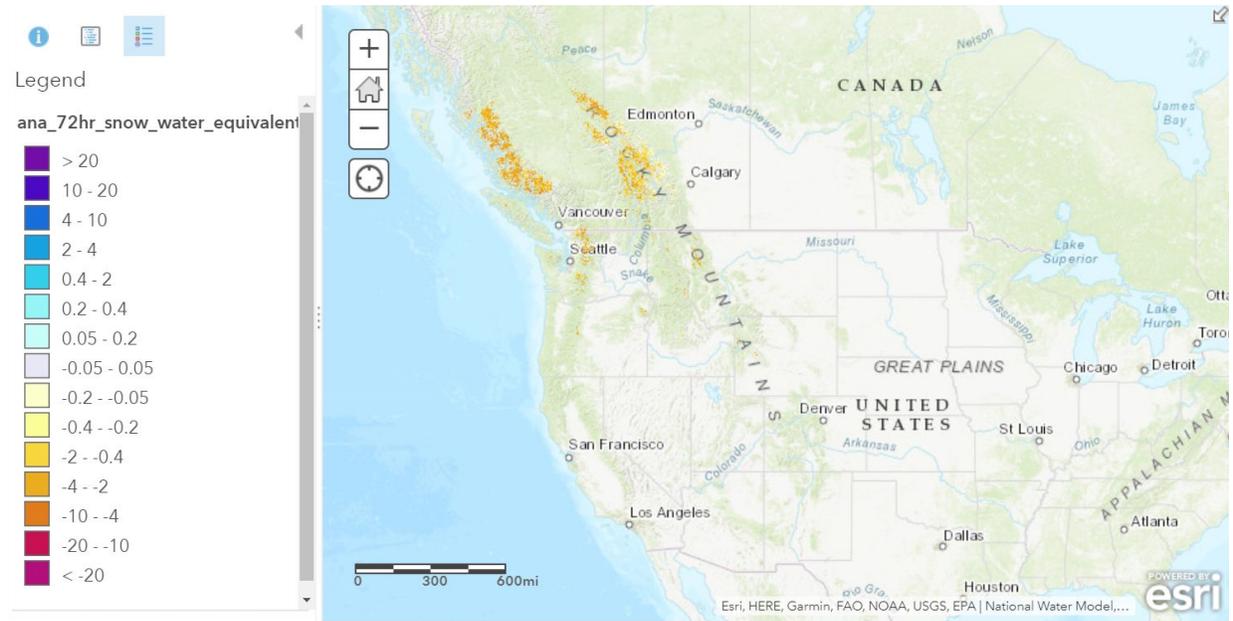
Update Frequency

Once per day.

Methodology

Compares snow water equivalent values from 24 hours in the past to current conditions. A decrease in snow water equivalent directly corresponds to an equal amount of snow melt in the past 24 hours.

NWM Past 72 Hour Snow Water Equivalent Change



Description

Depicts snow water equivalent changes over the past 24, 48, and 72 hours derived from the operational National Water Model (v2.0) analysis and assimilation. Data for each interval can be seen by using a filter to select the name of the desired layer.

Update Frequency

Once per hour.

Methodology

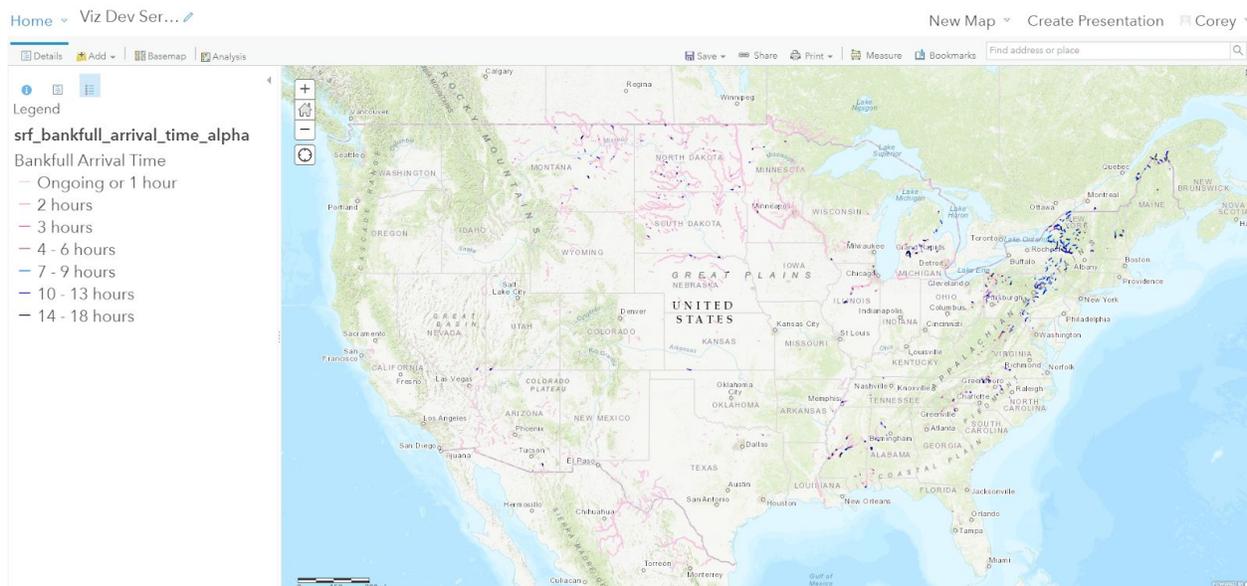
Compares current snow water equivalent values to snow water equivalent values from 24, 48, and 72 hours in the past.

Short-Range Forecast

Service	Description	Updates
NWM 18-Hour Bankfull Arrival Time Forecast	Depicts expected bankfull arrival times derived from the operational National Water Model (NWM) (v2.0) short-range forecast. Shown are reaches that are expected to have flow at or above bankfull within the next 18 hours. Reaches are colored by the time at which they are expected to be at bankfull.	<ul style="list-style-type: none"> • None
NWM 18-Hour High Flow Magnitude Forecast	Depicts expected high flow magnitudes derived from the operational National Water Model (NWM) (v2.0) medium-range forecast. Shown are reaches that are expected to have flow at or above bankfull over the next 3, 5, and 10 days. Reaches are colored by the annual exceedance probability of their maximum forecast flow over the next 3, 5, and 10 days.	<ul style="list-style-type: none"> • None
NWM 60-Hour High Flow Magnitude Forecast - Hawaii	Depicts expected high flow magnitudes derived from the operational National Water Model (NWM) (v2.0) short-range forecast for the state of Hawaii. Shown are reaches that are expected to have flow at or above bankfull over the next 60 hours. Reaches are colored by the annual exceedance probability of their maximum forecast flow over the next 60 hours.	<ul style="list-style-type: none"> • Scale Dependent Rendering • Updated Legend Category <ul style="list-style-type: none"> ○ Not Available -> Insufficient Data
NWM 18-Hour Maximum Inundation Extent Forecast	Depicts expected maximum inundation extent derived from the operational National Water Model (NWM) (v2.0) short-range forecast. <i>Note: Inundation extent is only viewable to users in the NWC FIM Services group on the NWC Portal, and only available over the Texas/WGRFC, SERFC, MARFC and NERFC domains.</i>	<ul style="list-style-type: none"> • None
NWM 18-Hour Streamflow Rate of Change Forecast	Depicts expected change in discharge derived from the operational National Water Model (NWM) (v2.0) short-range forecast. Change is computed between the current streamflow and that expected over the next 18 hours at 3-hourly intervals, and is only displayed for reaches that are expected to have flow at or above bankfull over the next 18 hours.	<ul style="list-style-type: none"> • None
NWM 18-Hour Peak Flow	Depicts expected peak flow arrival times derived from the operational National Water Model (NWM)	<ul style="list-style-type: none"> • None

Arrival Time Forecast	(v2.0) short-range forecast. Shown are reaches that are expected to have flow at or above bankfull over the next 18 hours. Reaches are colored by the time at which they are expected to be at their maximum flow within the forecast period.	
NWM 12-Hour Bankfull Probability Forecast	Depicts above-bankfull probabilities derived from a time-lag of the operational National Water Model (NWM) (v2.0) short-range forecast. Shown are reaches that are expected to have flow at or above bankfull within the next 12 hours, using the last 7 NWM (v2.0) short-range forecasts. Reaches are colored by the probability that they will meet or exceed bankfull within the next 12 hours.	<ul style="list-style-type: none"> • None
18-Hour Accumulated Precipitation Forecast	Depicts expected accumulated precipitation totals over the next 18 hours derived from the HRRR forcing for the operational National Water Model (v2.0) short-range forecast.	<ul style="list-style-type: none"> • None
NWM 18-Hour Rapid Onset Flooding	Depicts the potential for rapid onset flooding derived from the operational National Water Model (NWM) (v2.0) short-range forecast. Shown are reaches with a forecast flow increase of 100% or greater in an hour, and which are expected to be at above bankfull within 6 hours of that increase. Also shown are HUC10 polygons symbolized by the percentage of NWM features in each that are expected to meet previously mentioned criteria.	<ul style="list-style-type: none"> • New
NWM 60-Hour Accumulated Precipitation Forecast - Hawaii	Depicts expected accumulated precipitation totals over the next 60 hours derived from the NAM-Nest forcing for the operational National Water Model (v2.0) short-range forecast for Hawaii. Data for each interval can be seen by using a filter to select the name of the desired layer.	<ul style="list-style-type: none"> • New

NWM 18-Hour Bankfull Arrival Time Forecast



Description

Depicts expected bankfull arrival times derived from the operational National Water Model (NWM) (v2.0) short-range forecast. Shown are reaches that are expected to have flow at or above bankfull within the next 18 hours. Reaches are colored by the time at which they are expected to be at bankfull. Bankfull flows were derived using a 25-year retrospective analysis of the NWM (v2.0).

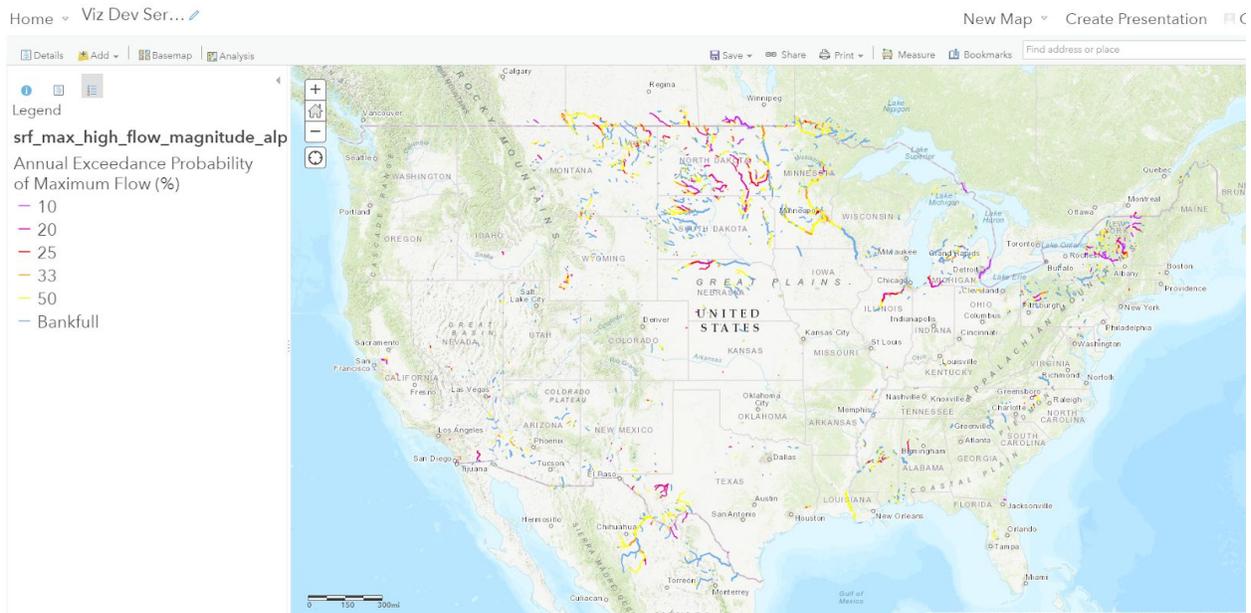
Update Frequency

Once every hour.

Methodology

The arrival time is calculated by comparing the forecast streamflow for each lead time to the estimated “bankfull” condition. The time at which forecast streamflow first exceeds the “bankfull” condition is considered the arrival time. “Bankfull” conditions are approximated by the 67% annual exceedance probability (AEP). AEPs were derived from a multi-decade reanalysis of the NWM (v2.0).

NWM 18-Hour Maximum High Flow Magnitude Forecast



Description

Depicts expected high flow magnitudes derived from the operational National Water Model (NWM) (v2.0) medium-range forecast. Shown are reaches that are expected to have flow at or above bankfull over the next 3, 5, and 10 days. Reaches are colored by the annual exceedance probability (AEP) of their maximum forecast flow over the next 3, 5, and 10 days. Bankfull flows and AEPs were derived using a 25-year retrospective analysis of the NWM (v2.0).

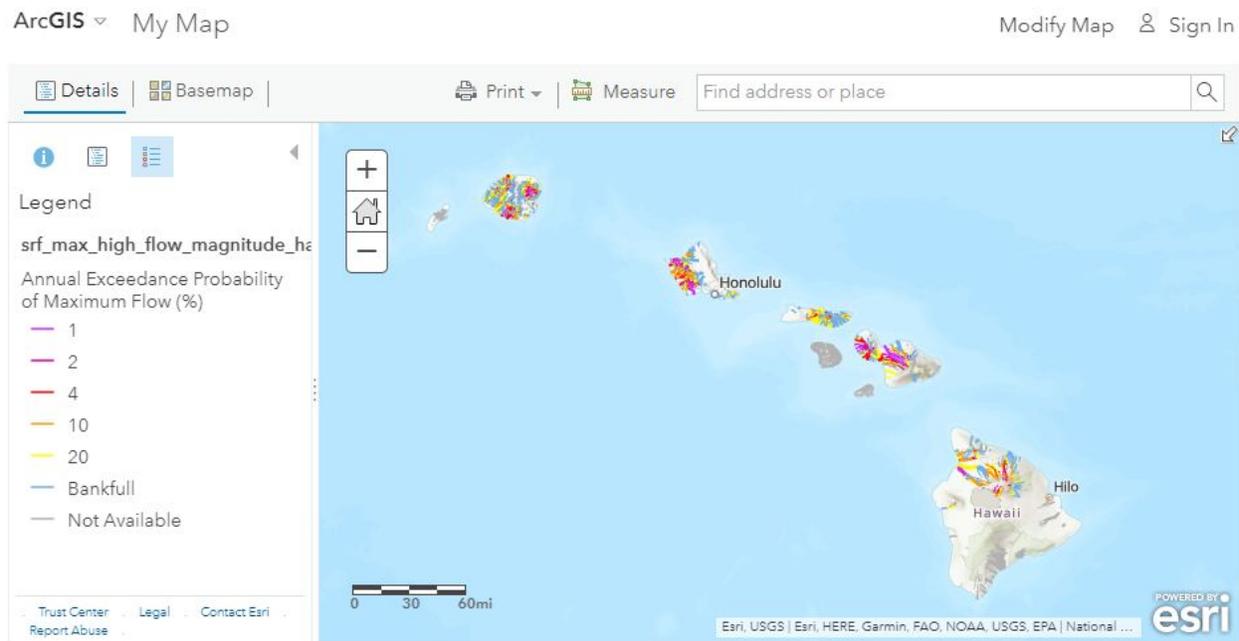
Update Frequency

Once per hour.

Methodology

AEPs were derived from a multi-decade reanalysis of the NWM (v2.0). Maximum streamflow values are compared to these AEPs and classified accordingly. "Bankfull" conditions are approximated by the 67% AEP.

NWM 60-Hour Maximum High Flow Magnitude Forecast - Hawaii



Description

Depicts expected high flow magnitudes derived from the operational National Water Model (NWM) (v2.0) short-range forecast for the state of Hawaii. Shown are reaches that are expected to have flow at or above bankfull over the next 60 hours. Reaches are colored by the annual exceedance probability (AEP) of their maximum forecast flow over the next 60 hours. Bankfull flows and AEPs were derived from USGS regression equations found at https://pubs.usgs.gov/sir/2010/5035/sir2010-5035_text.pdf.

Update Frequency

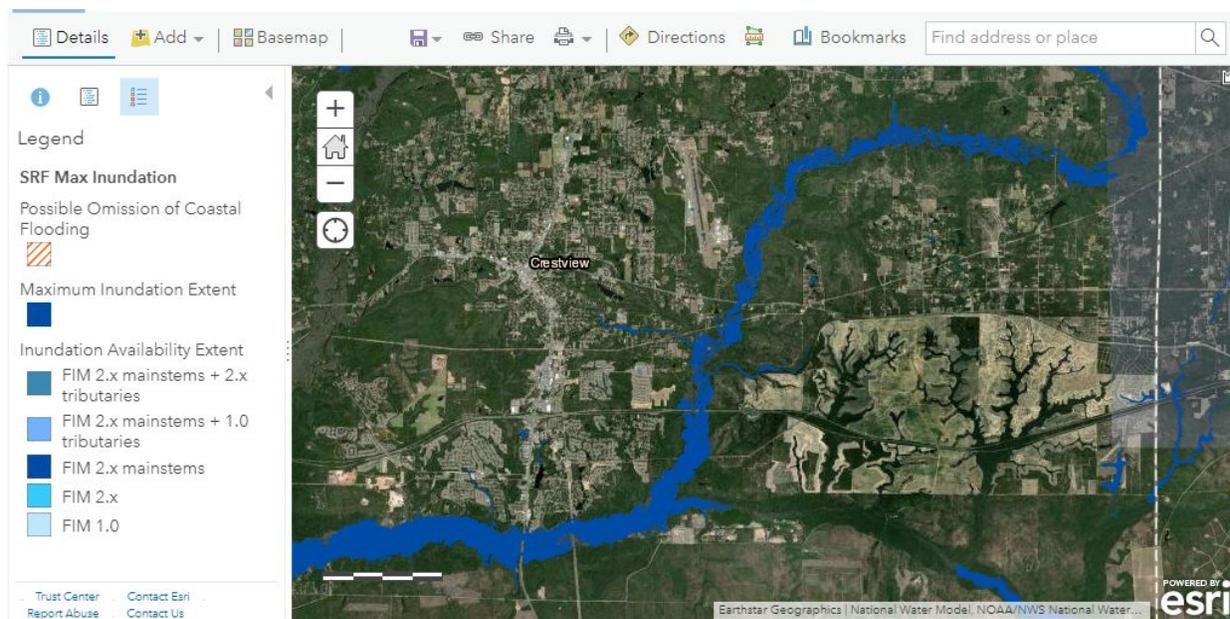
Once every 6 hours.

Methodology

Bankfull flows and AEPs were derived from USGS regression equations found at https://pubs.usgs.gov/sir/2010/5035/sir2010-5035_text.pdf. Streamflow

values are compared to these AEPs and classified accordingly. "Bankfull" conditions are approximated by the 67% AEP.

NWM 18-Hour Maximum Inundation Extent Forecast



Description

Depicts expected maximum inundation extent derived from the operational National Water Model (NWM) (v2.0) short-range forecast. Inundation extents are derived using the Height Above the Nearest Drainage (HAND) method; stage heights are interpolated from NWM (v2.0) discharges using synthetic rating curves, interpolated stage heights are rounded to the nearest foot, and corresponding pre-computed inundation extent polygons are displayed.

Note: Inundation extent is only viewable to users in the NWC FIM Services group on NWC Portal, and only available over the Texas/WGRFC, SERFC, MARFC and NERFC domains.

Update Frequency

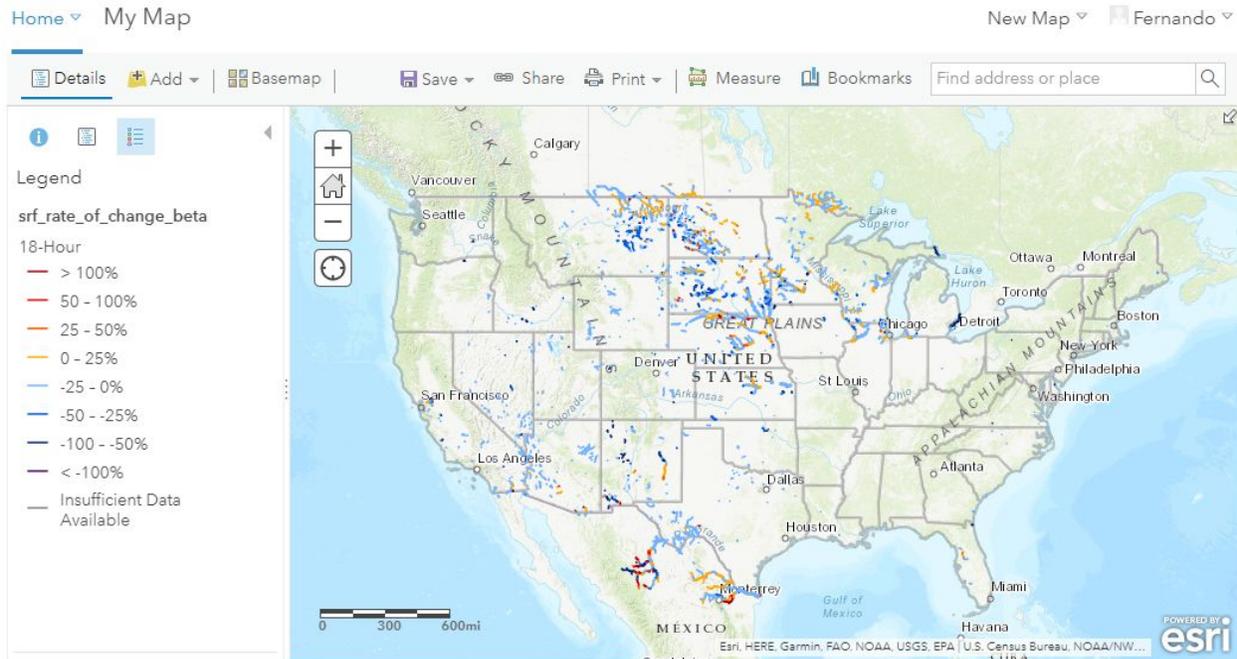
Once per hour.

Methodology

NWM streamflows are converted to stages using synthetic rating curves derived from reach-averaged channel properties. Reach-averaged channel properties are derived from 10-meter elevation data. Stages are then

converted to inundation extents using a 10-meter relative elevation grid derived using the HAND method. “Bankfull” conditions are approximated by the 67% annual excess probability (AEP). AEPs were derived from a multi-decade reanalysis of the NWM (v2.0). For more information on HAND and synthetic rating curves, see the references listed in **Appendix A**.

NWM 18-Hour Streamflow Rate of Change Forecast



Description

Depicts expected change in discharge derived from the operational National Water Model (NWM) (v2.0) short-range forecast. Change is computed between the current streamflow and that expected over the next 18 hours at 3-hourly intervals, and is only displayed for reaches that are expected to have flow at or above bankfull over the next 18 hours. Bankfull flows were derived using a 25-year retrospective analysis of the NWM (v2.0).

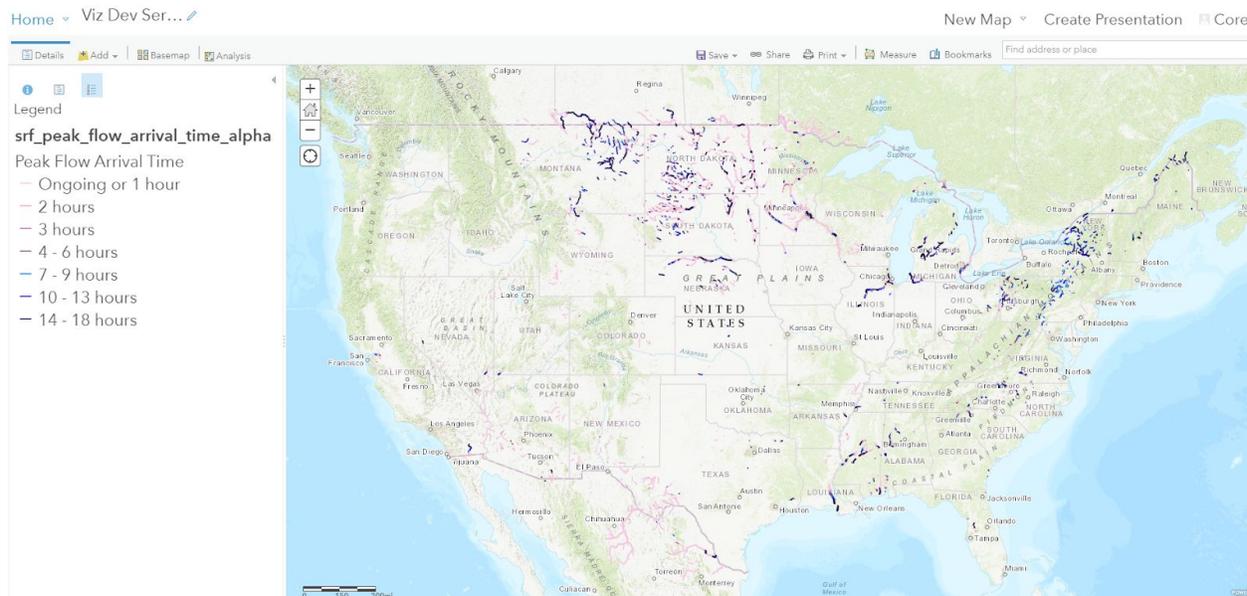
Update Frequency

Once per hour.

Methodology

Change is computed between the current streamflow and that expected in 3, 6, 9, 12, 15, and 18 hours, and is only displayed for reaches that are expected to have flow at or above “bankfull” at any time within the next 18 hours. “Bankfull” conditions are approximated by the 67% annual excess probability. AEPs were derived from a multi-decade reanalysis of the NWM (v2.0).

NWM 18-Hour Peak Flow Arrival Time Forecast



Description

Depicts expected peak flow arrival times derived from the operational National Water Model (NWM) (v2.0) short-range forecast. Shown are reaches that are expected to have flow at or above bankfull over the next 18 hours. Reaches are colored by the time at which they are expected to be at their maximum flow within the forecast period. Bankfull flows were derived using a 25-year retrospective analysis of the NWM (v2.0). Updated hourly.

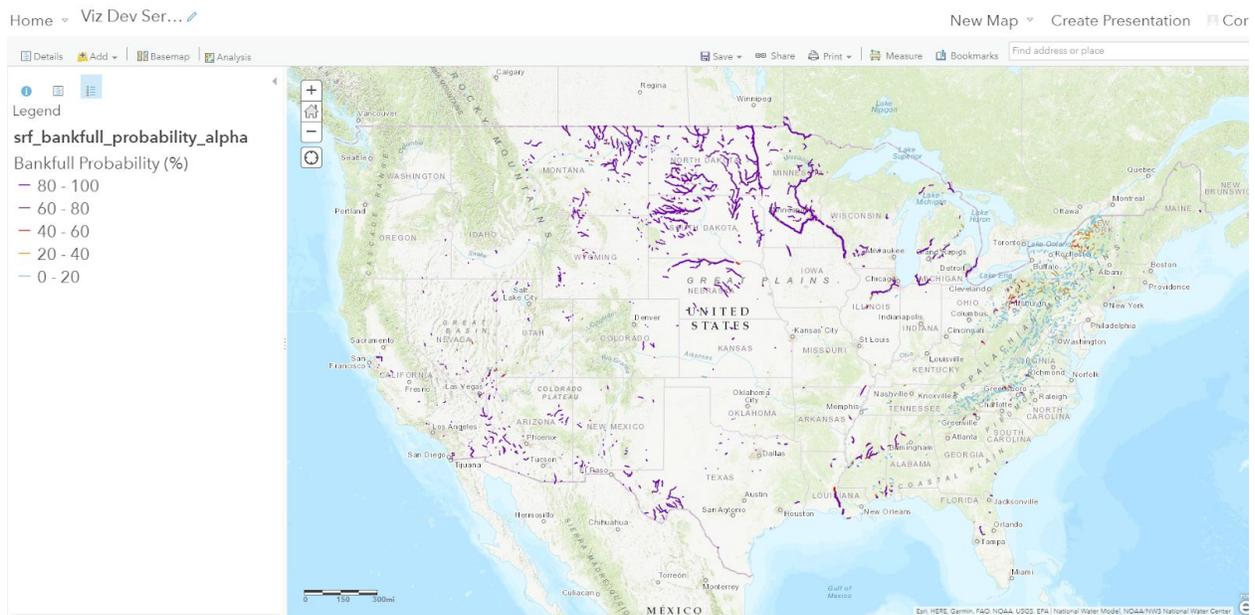
Update Frequency

Once every hour.

Methodology

Shown are reaches that are expected to have forecast streamflow at or above "bankfull" conditions within the next 18 hours. "Bankfull" conditions are approximated by the 67% annual excess probability (AEP). AEPs were derived from a multi-decade reanalysis of the NWM (v2.0). Reaches are colored by the time at which they are expected to be at their maximum streamflow within the forecast period, even if it is not the first peak to occur.

NWM 12-Hour Bankfull Probability Forecast



Description

Depicts above-bankfull probabilities derived from a time-lag of the operational National Water Model (NWM) (v2.0) short-range forecast. Shown are reaches that are expected to have flow at or above bankfull within the next 12 hours, using the last 7 NWM (v2.0) short-range forecasts. Reaches are colored by the probability that they will meet or exceed bankfull within the next 12 hours. Probabilities are derived from the streamflow values for each reach over the past 7 NWM (v2.0) short-range forecasts, equally weighted. Bankfull flows were derived using a 25-year retrospective analysis of the NWM (v2.0).

Update Frequency

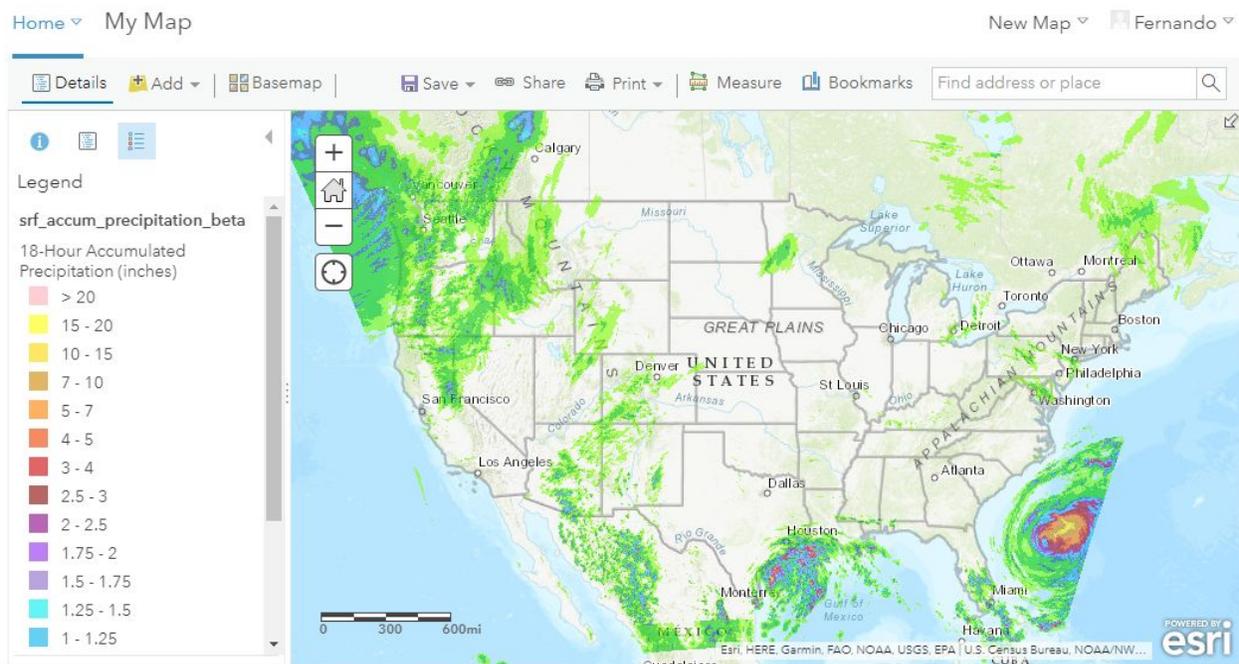
Once every other hour.

Methodology

Shown are reaches that are expected to have forecast streamflow at or above "bankfull" conditions within the next 12 hours. "Bankfull" conditions are approximated by the 67% annual excess probability (AEP). AEPs were derived from a multi-decade reanalysis of the NWM (v2.0). Probabilities are computed for a 12-hour valid time range from the latest NWM (v2.0) short-range forecast reference time. For a particular reach, all forecast streamflow values from the past 7 NWM (v2.0) short-range forecasts for the

valid time range of interest are obtained and considered of equal weight. From these values, the number of times a reach was forecast to be at or above "bankfull" is used to compute bankfull probability over the 12-hour valid time range.

18-Hour Accumulated Precipitation Forecast



Description

Depicts expected accumulated precipitation totals over the next 18 hours derived from the HRRR forcing for the operational National Water Model (v2.0) short-range forecast. Data for each interval can be seen by using a filter to select the name of the desired layer.

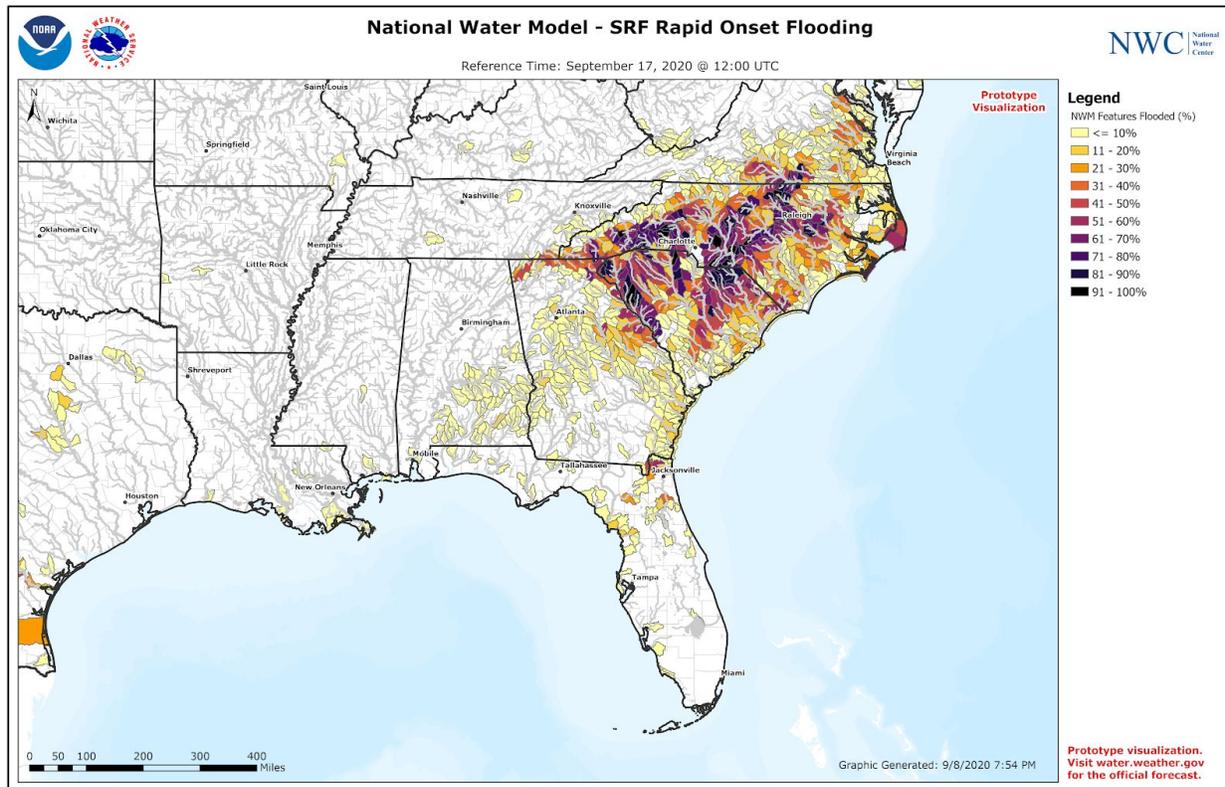
Update Frequency

Once per hour.

Methodology

Hourly forecast precipitation from the NWM (v2.0) short-range forecast configuration is accumulated over future intervals: hour 1, hour 2, hour 3, hours 4-6, hours 7-9, hours 10-12, hours 13-15, hours 16-18 and hours 1-18. NWM (v2.0) short-range forecast precipitation is derived from a HRRR/RAP blend.

NWM 18-Hour Rapid Onset Flooding



Description

Depicts the potential for rapid onset flooding derived from the operational National Water Model (NWM) (v2.0) short-range forecast. Shown are reaches that are expected to be reached with a forecast flow increase of 100% or greater in an hour, and which are expected to be at above bankfull within 6 hours of that increase. Also shown are HUC10 polygons symbolized by the percentage of NWM features in each that are expected to meet previously mentioned criteria. Bankfull flows were derived using a 25-year retrospective analysis of the NWM (v2.0).

Update Frequency

Once per hour.

Methodology

Shown are reaches that are expected to have a forecast flow increase of 100% or greater in an hour, and which are expected to be at above bankfull

within 6 hours of that increase. "Bankfull" conditions are approximated by the 67% annual excess probability (AEP). AEPs were derived from a multi-decade reanalysis of the NWM (v2.0). Reaches are colored in two ways. One sublayer colors reaches by the time at which they are expected to reach "Bankfull" conditions. Another sublayer colors reaches by the length of time between when the streamflow increases above bankfull and the streamflow decreases below bankfull. If the streamflow never decreases below bankfull within the forecast period, the length will be "ongoing". HUC10s are also shown and colored based on the percentage of NWM features within that HUC that reach rapid onset flooding criteria.

NWM 60-Hour Accumulated Precipitation Forecast - Hawaii



Description

Depicts expected accumulated precipitation totals over the next 60 hours derived from the NAM-Nest forcing for the operational National Water Model (v2.0) short-range forecast for Hawaii. Data for each interval can be seen by using a filter to select the name of the desired layer.

Update Frequency

Once per hour.

Methodology

Hourly forecast precipitation from the NWM (v2.0) short-range forecast configuration is accumulated over future intervals: hours 1-3, hours 3-6, hours 6-9, hours 9-12, hours 12-24, hours 24-48, and hours 48-60. NWM (v2.0) short-range forecast precipitation is derived from a HRRR/RAP blend.

Medium-Range Forecast

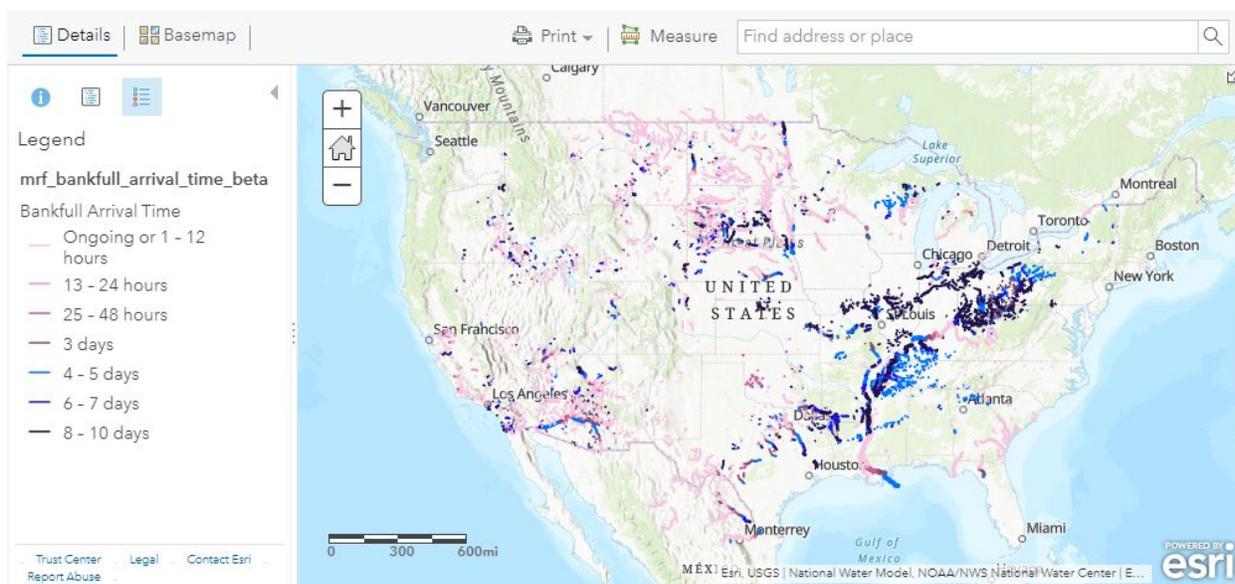
Service	Description	Updates
NWM 10-Day Bankfull Arrival Time Forecast	Depicts expected bankfull arrival times derived from the operational National Water Model (NWM) (v2.0) medium-range forecast. Shown are reaches that are expected to have flow at or above bankfull over the next 10 days. Reaches are colored by the time at which they are expected to reach bankfull.	<ul style="list-style-type: none"> • None
NWM 10-Day High Flow Magnitude Forecast	Depicts expected high flow magnitudes derived from the operational National Water Model (NWM) (v2.0) medium-range forecast. Shown are reaches that are expected to have flow at or above bankfull over the next 3, 5, and 10 days. Reaches are colored by the annual exceedance probability of their maximum forecast flow over the next 3, 5, and 10 days.	<ul style="list-style-type: none"> • None
NWM 10-Day Maximum Inundation Extent Forecast	<p>Depicts expected maximum inundation extent derived from the operational National Water Model (NWM) (v2.0) medium-range forecast. Shown are areas that are expected to be inundated sometime over the next 3, 5, and 10 days.</p> <p><i>Note: Inundation extent is only available to users in the NWC FIM Services group on NWC Portal, and only available over the Texas/WGRFC, SERFC, MARFC and NERFC domains.</i></p>	<ul style="list-style-type: none"> • None
NWM 10-Day Peak Flow Arrival Time Forecast	Depicts expected peak flow arrival times derived from the operational National Water Model (NWM) (v2.0) medium-range forecast. Shown are reaches that are expected to have flow at or above bankfull over the next 10 days. Reaches are colored by the time at which they are expected to be at their maximum flow within the forecast period.	<ul style="list-style-type: none"> • None
NWM 5-Day Bankfull Probability Forecast	Depicts bankfull probabilities derived from the operational National Water Model (NWM) (v2.0) medium-range forecast. Shown are reaches that are expected to have flow at or above bankfull on Day 1, Day 2, Day 3, and Days 4-5, using the 7 members of the NWM (v2.0) medium-range forecast. Reaches are colored by the percentage of ensemble members that forecast that the reach will meet or	<ul style="list-style-type: none"> • Layer rename <ul style="list-style-type: none"> ○ Day 4 - 5 to Days 4-5 • Updated underlying algorithm to reflect probability of ensemble member agreement instead of percentage of time forecasted to be above bankfull

	exceed bankfull on Day 1, Day 2, Day 3, and Days 4-5.	
10-Day Accumulated Precipitation Forecast	Depicts expected accumulated precipitation totals over the next 10 days derived from the GFS forcing for the operational National Water Model (v2.0) medium-range forecast.	<ul style="list-style-type: none"> • None
NWM 10-Day Snow Water Equivalent Change	Depicts expected snow water equivalent changes over the next 1, 3, 5, 7, and 10 days derived from the operational National Water Model (v2.0) medium-range forecast.	<ul style="list-style-type: none"> • None

NWM 10-Day Bankfull Arrival Time Forecast

ArcGIS ▾ My Map

Modify Map ⓘ Sign In



Description

Depicts expected bankfull arrival times derived from the operational National Water Model (NWM) (v2.0) medium-range forecast. Shown are reaches that are expected to have flow at or above bankfull over the next 10 days. Reaches are colored by the time at which they are expected to reach bankfull. Bankfull flows were derived using a 25-year retrospective analysis of the NWM (v2.0).

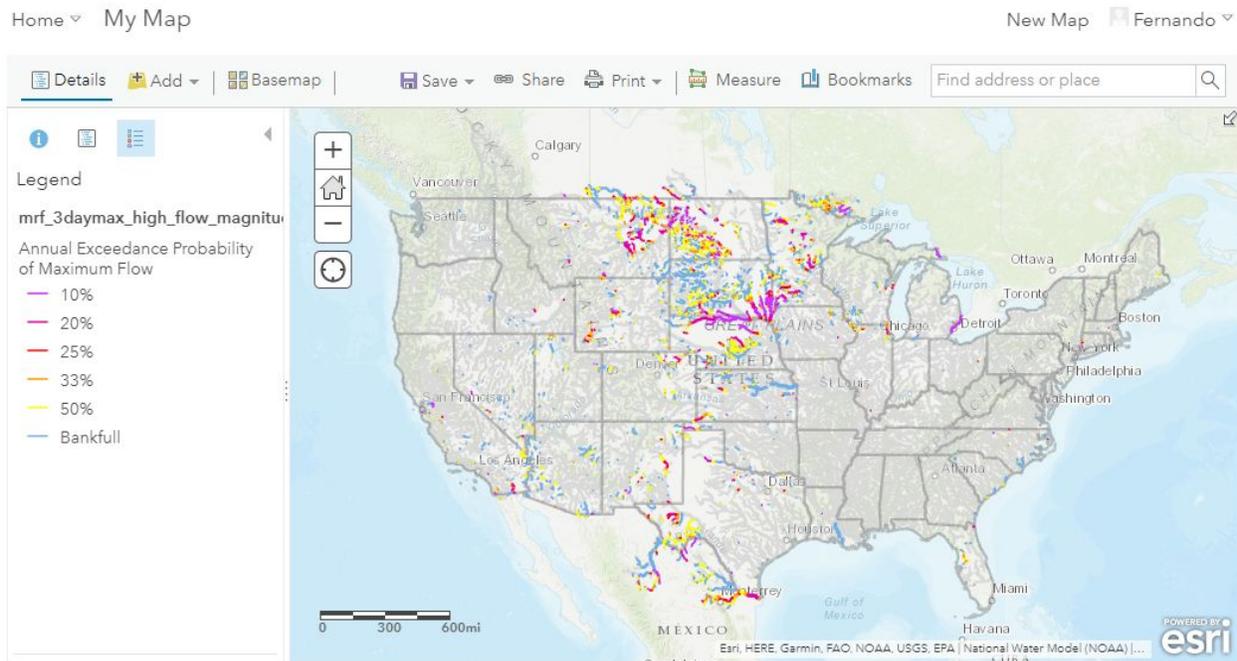
Update Frequency

Once every 6 hours.

Methodology

The arrival time is calculated by comparing the forecast streamflow for each lead time to the estimated “bankfull” condition. The time at which forecast streamflow first exceeds the “bankfull” condition is considered the arrival time. “Bankfull” conditions are approximated by the 67% annual exceedance probability (AEP). AEPs were derived from a multi-decade reanalysis of the NWM (v2.0).

NWM 10-Day Maximum High Flow Magnitude Forecast



Description

Depicts expected high flow magnitudes derived from the operational National Water Model (NWM) (v2.0) medium-range forecast. Shown are reaches that are expected to have flow at or above bankfull over the next 3, 5, and 10 days. Reaches are colored by the annual exceedance probability (AEP) of their maximum forecast flow over the next 3, 5, and 10 days. Bankfull flows and AEPs were derived using a 25-year retrospective analysis of the NWM (v2.0).

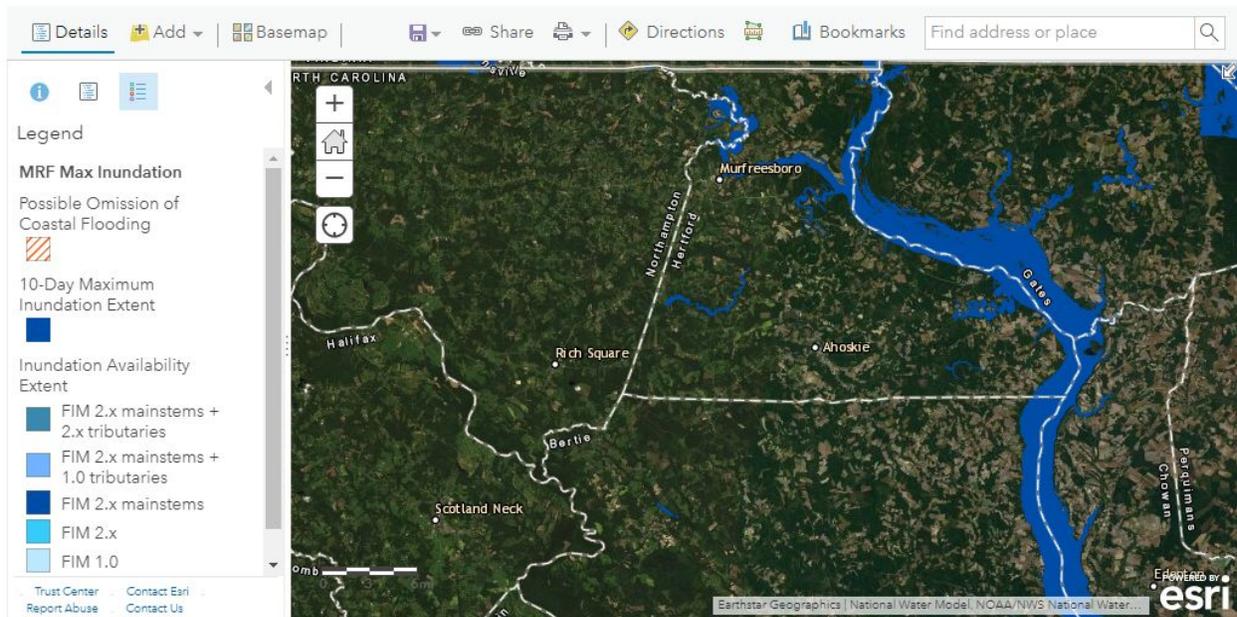
Update Frequency

Once every 6 hours.

Methodology

AEPs were derived from a multi-decade reanalysis of the NWM (v2.0). Maximum streamflow values over the forecast period are compared to these AEPs and classified accordingly. "Bankfull" conditions are approximated by the 67% AEP.

NWM 10-Day Maximum Inundation Extent Forecast



Description

Depicts expected maximum inundation extent derived from the operational National Water Model (NWM) (v2.0) medium-range forecast. Shown are areas that are expected to be inundated sometime over the next 3, 5, and 10 days. Inundation extents are derived using the Height Above the Nearest Drainage (HAND) method; stage heights are interpolated from NWM (v2.0) discharges using synthetic rating curves, interpolated stage heights are rounded up to the nearest foot, and corresponding pre-computed inundation extent polygons are displayed.

Note: Inundation extent is only viewable to users in the NWC FIM Services group on NWC Portal, and only available over the Texas/WGRFC, SERFC, MARFC and NERFC domains.

Update Frequency

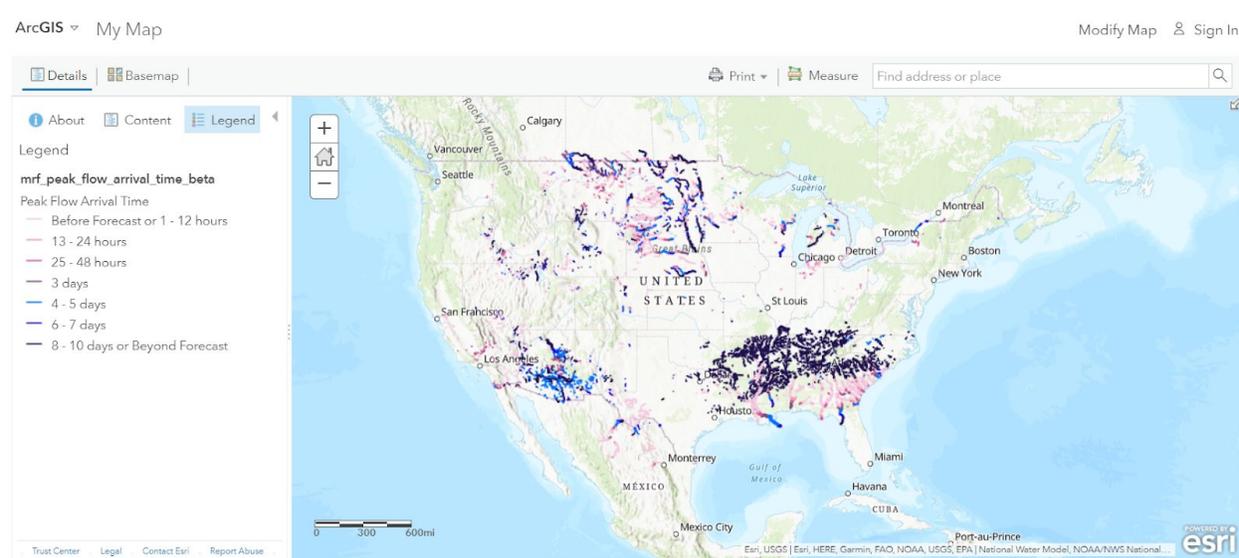
Once every 6 hours.

Methodology

NWM streamflows are converted to stages using synthetic rating curves derived from reach-averaged channel properties. Reach-averaged channel

properties are derived from 10-meter elevation data. Stages are then converted to inundation extents using a 10-meter relative elevation grid derived using the HAND method. "Bankfull" conditions are approximated by the 67% annual exceedance probability (AEP). AEPs were derived from a multi-decade reanalysis of the NWM (v2.0). For more information on HAND and synthetic rating curves, see the references listed in **Appendix A**.

NWM 10-Day Peak Flow Arrival Time Forecast



Description

Depicts expected peak flow arrival times derived from the operational National Water Model (NWM) (v2.0) medium-range forecast. Shown are reaches that are expected to have flow at or above bankfull over the next 10 days. Reaches are colored by the time at which they are expected to be at their maximum flow within the forecast period. Bankfull flows were derived using a 25-year retrospective analysis of the NWM (v2.0).

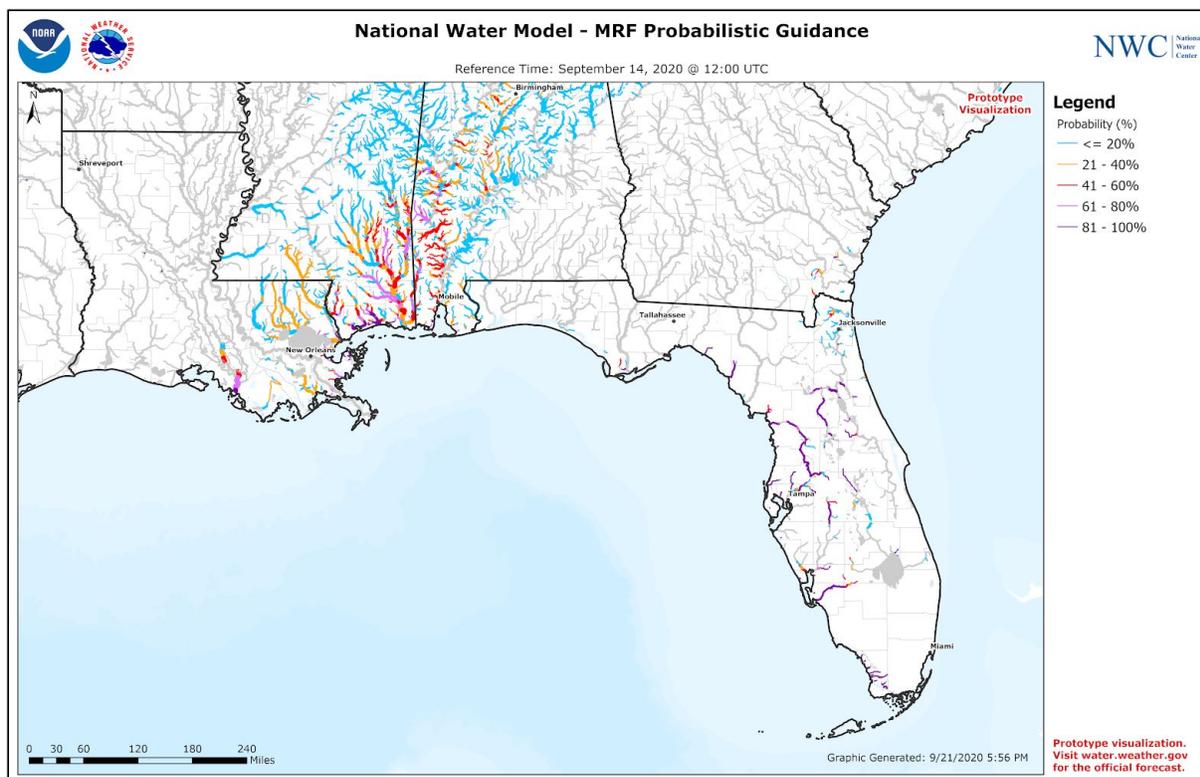
Update Frequency

Once every 6 hours.

Methodology

Shown are reaches that are expected to have forecast streamflow at or above “bankfull” conditions within the next 10 days. “Bankfull” conditions are approximated by the 67% annual exceedance probability (AEP). AEPs were derived from a multi-decade reanalysis of the NWM (v2.0). Reaches are colored by the time at which they are expected to be at their maximum streamflow within the forecast period, even if it is not the first peak to occur.

NWM 5-Day Bankfull Probability Forecast



Description

Depicts bankfull probabilities derived from the operational National Water Model (NWM) (v2.0) medium-range forecast. Shown are reaches that are expected to have flow at or above bankfull on Day 1, Day 2, Day 3, and Days 4-5, using the 7 members of the NWM (v2.0) medium-range forecast. Reaches are colored by the probability that they will meet or exceed bankfull on Day 1, Day 2, Day 3, and Days 4-5. Probabilities are computed as the % agreement across the 7 ensemble members that a given reach will be at or above bankfull at some point during the time period of interest, based on the NWM (v2.0) medium-range forecast. Bankfull flows were derived using a 25-year retrospective analysis of the NWM (v2.0).

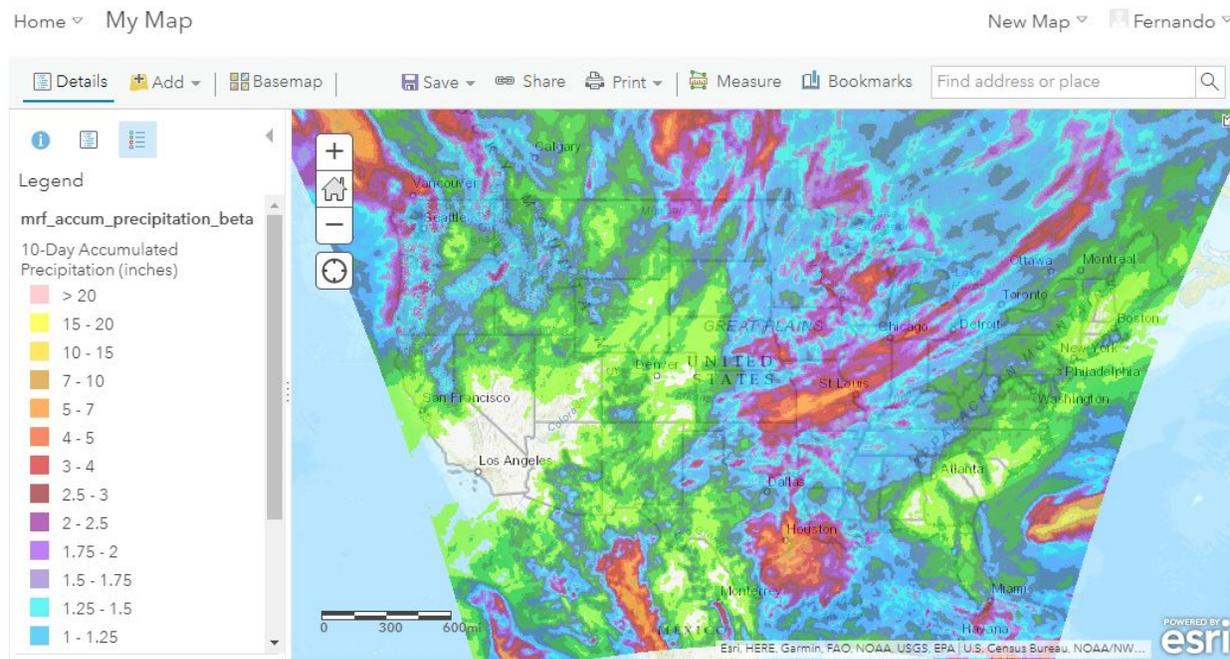
Update Frequency

Once every 6 hours.

Methodology

Shown are reaches that are expected to have forecast streamflow at or above "bankfull" conditions on Day 1, Day 2, Day 3, and Days 4-5. "Bankfull" conditions are approximated by the 67% annual exceedance probability (AEP). AEPs were derived from a multi-decade reanalysis of the NWM (v2.0). Probabilities are computed for Day 1, Day 2, Day 3, and Days 4-5 valid time ranges from the latest NWM (v2.0) medium-range forecast reference time. For a particular reach, all forecast streamflow values from the 7 members of the latest NWM (v2.0) medium-range forecast for the valid time ranges of interest are obtained and considered of equal weight. From these values, the number of times a reach was forecast to be at or above "bankfull" during each of the valid time ranges is used to compute bankfull probabilities.

10-Day Accumulated Precipitation Forecast



Description

Depicts expected accumulated precipitation totals over the next 10 days derived from the GFS forcing for the operational National Water Model (v2.0) medium-range forecast. Data for each interval can be seen by using a filter to select the name of the desired layer.

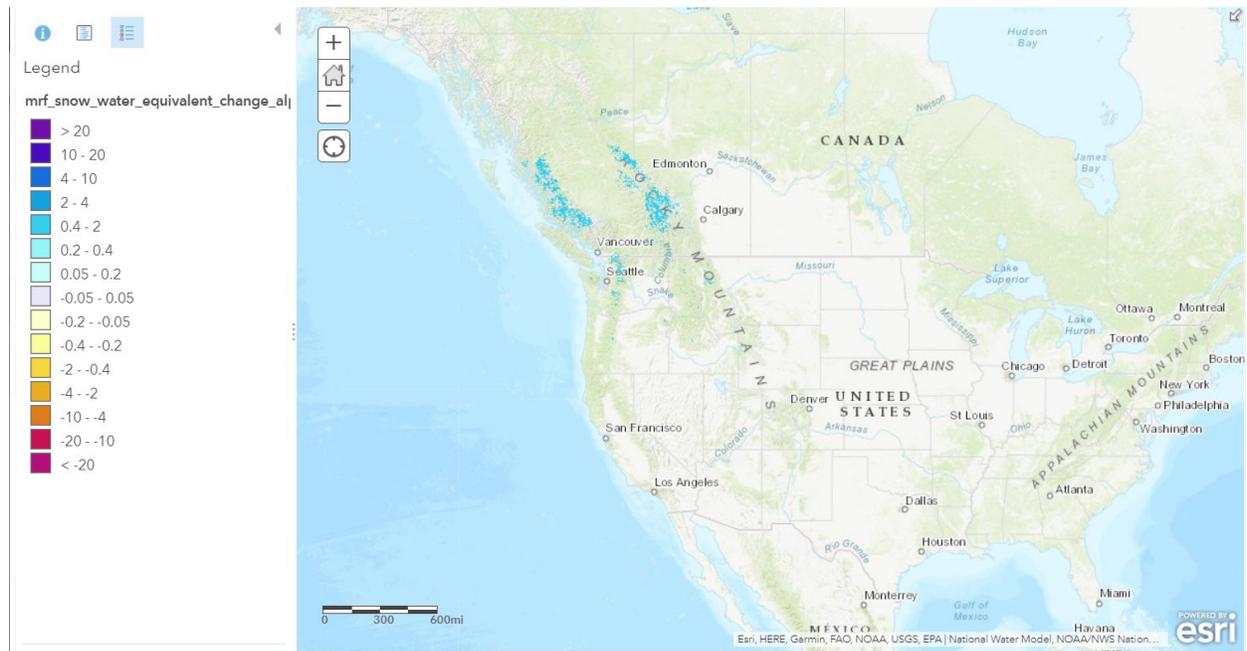
Update Frequency

Once every 6 hours.

Methodology

Hourly forecast precipitation from the NWM (v2.0) medium-range forecast configuration is accumulated over future intervals: Hours 1-6, Hours 7-12, Hours 13-18, Hours 19-24, Day 1, Day 2, Day 3, Days 4-5, Days 6-7, Days 8-10, and Days 1-10. NWM (v2.0) medium-range forecast precipitation is derived from the GFS.

NWM 10-Day Snow Water Equivalent Change



Description

Depicts expected snow water equivalent changes over the next 1, 3, 5, 7, and 10 days derived from the operational National Water Model (v2.0) medium-range forecast. Data for each interval can be seen by using a filter to select the name of the desired layer.

Update Frequency

Once every 6 hours.

Methodology

Compares current snow water equivalent values to snow water equivalent values from the 1, 3, 5, 7, and 10 day lead times of the medium-range forecast.

Appendix A: HAND and Synthetic Rating Curve

References

For more information on the Height Above the Nearest Drainage (HAND) method of inundation mapping and derivation of synthetic rating curves, please refer to the following publications:

- Liu, Y. Y., D. R. Maidment, D. G. Tarboton, X. Zheng and S. Wang, (2018), "A CyberGIS Integration and Computation Framework for High-Resolution Continental-Scale Flood Inundation Mapping," JAWRA Journal of the American Water Resources Association, 54(4): 770-784, <https://doi.org/10.1111/1752-1688.12660>.
- Zheng, X., D. G. Tarboton, D. R. Maidment, Y. Y. Liu and P. Passalacqua, (2018), "River Channel Geometry and Rating Curve Estimation Using Height above the Nearest Drainage," JAWRA Journal of the American Water Resources Association, 54(4): 785-806, <http://doi.org/10.1111/1752-1688.12661>.