

Investigating the Representation of Extremes in High-Resolution, Long Period-of-Record Precipitation Products in the Continental US

Janice L. Bytheway NOAA Physical Sciences Laboratory



## **Motivation**

- Multiple US agencies are working to create or update models and datasets that rely on precipitation data, in particular estimates of precipitation extremes:
  - O US Geological Survey: Precipitation induced landslides
  - O Federal Emergency Management Agency: Future of Flood Risk Data (FFRD)
  - O NOAA: Atlas 15, Probable Maximum Precipitation (PMP)
- Each requires precipitation information with
  - O High spatiotemporal resolution
  - O Long period of record
  - O Latency needs vary
  - O Most work is currently CONUS-focused, but some may expand globally



NATIONAL ACADEMIES

Modernizing Probable Maximum Precipitation Estimation



<u>Probable Maximum Precipitation:</u> <sup>1</sup>The greatest depth of precipitation for a given duration meteorologically possible for a design watershed or a given storm area at a particular location at a particular time of year, with no allowance made for long-term climatic trends (WMO, 2009).

<sup>2</sup>Theoretically, the greatest depth of precipitation for a given duration that is physically possible over a given size storm area at a particular geographical location at a certain time of year (AMS, 2022; Hansen et al., 1982).



### What is the best precipitation dataset to use?

## **Candidate Datasets**

Name	Dates of availability	POR	Included data	Spatial Res	Temporal Res	Global?
AORC	1979-present	45	NLDAS-2, StageIV, may include Stage II and CMORPH1	4 km	1h	
Conus404	1979-2022	43	WRF downscaled ERA-5	4 km	1h	
Stage IV	2002-present	22	Radar, gauge	4 km	1h	
MSWEP	1979-present	45	Gauge, satellite, reanalysis	0.1 degree	3 hourly	Х
IMERG v7	2000-present	24	Multi-satellite	0.1 degree	30min	X
PERSIANN-CCS-CDR*	1983-present	41	IR satellite (Gridsat B1, CPC 4km IR) bias corrected monthly with CPCP	4 km	3h	X
CMORPH2*	1990s-present	20-30	Multi-satellite with gauge correction	0.05 degree	30 min	X
NLDAS	1979-present	45	multisensor+reanalysis	0.125 degree	hourly	
ERA-5	1940-present	104	reanalysis	30km	hourly	X
PRISM	1981-present	43	multisensor (incl radar post-2002)	4 km	daily	
Daymet	1980-present	44	gauge-based	1 km	daily	
CHIRPS V2.0	1981-present	43	gauge, satellite, reanalysis	0.05 degree	daily	Х
NARR	1979-present	45	reanalysis	32 km	hourly	
MRMS	2020-present	4	multisensor	1 km	1h (2min)	

\* Dataset of interest but not currently available

## **Study Design**

- 2002-2021
- Accumulate to 3, 6 and 24h rainfall on native grids
- Frequency of ARI exceedances at 2, 10, and 50 year (50%, 10%, and 2% chance of occurrence in a given year)
- Maximum, 90th, 95th, and 99th percentile rainfall at each duration
- Ability to examine CDFs of extreme rainfall at a given location
- Dig into interesting features or events

#### Average Recurrence Interval Thresholds [mm]







### **10 year ARI Exceedances**



AORC and Stage IV similar, less so at shorter accumulation periods.

IMERG has the most ARI exceedances on the west coast.

Impact of gauges visible in MSWEP.

Number of Exceedances

3

4

5

CONUS 404 has highest number of exceedances on the east coast. Apply Sciences Laboratory

## Seasonal 10 year 6 hour ARI Exceedances



## Seasonal 10 year 6 hour ARI Exceedances



## **Maximum Rainfall**

- IMERG-Final, MSWEP, CONUS404 lowest in Mountain West.
- IMERG- Early more similar to AORC and Stage IV, but less contiguous east of Rockies
- CONUS404 higher maxima extending farther north than other datasets.
- MSWEP somewhere between IMERG Early and Final east of the Rockies.



## Upper Quantiles of 6 -h Rainfall



## **CDFs of 6h Rainfall in Select Cities**



## Case Study – Hurricane Ida

#### Total Rainfall August 29-30, 2021





IMERG Early





IMERG Final













#### Total Rainfall September 1-2, 2021





StagelV



CONUS 404



IMERG Final



IMERG Early







## Summary and Ongoing Work

- Understanding the representation of extreme precipitation in high-resolution, longperiod of record datasets has broad interest across a number of US agencies.
- What is the best precipitation dataset to use?
  - o It depends...
  - Satellite datasets tend to miss much of the summertime extreme precipitation in the eastern US, while IMERG (both Early and Final) identifies a large number of ARI exceedances along the west coast during the cool season.
  - The "lower-upper quantiles" of precipitation are fairly similar across the datasets over much of the CONUS the big differences lie in the extreme tails of the distribution.
- Ongoing work will include continued evaluation of case studies and evaluations by storm type (e.g. atmospheric rivers, MCSs, and tropical cyclones)



# Thank you

Janice.Bytheway@noaa.gov



# **Backup Slides**

## Case Study – Hurricane Harvey

Total Rainfall [mm] August 28-31, 2017





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IMERG Early



CONUS 404





