Assessment of Observational Uncertainty in Extreme Precipitation Events over the Continental United States

Emily A. Slinskey[1], Paul C. Loikith[1], Duane E. Waliser[2], Alexander Goodman[2]

1. Portland State University, Department of Geography, Portland, OR
2. Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA

MOTIVATION

- Our climate is nonstationary and changing, not only in mean conditions but in extremes as well.
- According to the National Climate Assessment (NCA), climate change is projected to alter the frequency, severity, and seasonality of extreme precipitation events across the US (USGCRP 2017).
- Societal Implications: threats to property, agriculture, infrastructure, and human life

Big Sur, 2017; Source: CNN.com

Figure Source: NOAA NCDC based on data updated from Kennedy et al. 2010 and retrieved from the NCA 2014

Research Goal:

improve our ability to monitor and track extreme precipitation events over both space and time

Research Objectives:

1. present a **gridded event-based climate indicator** to capture the regional variability of extreme precipitation events across the U.S.
2. Apply categorization scheme as a basis for a **dataset intercomparison** as an assessment of observational uncertainty

METHODOLOGY

OBJECTIVE 1

EXTREME PRECIPITATION CATEGORIZATION SCHEME

- Precipitation Categories (P-Cats) based on fixed 3-day total accumulated precipitation thresholds

P-Cat 1: $100 < P < 200$mm
P-Cat 2: $200 < P < 300$mm
P-Cat 3: $300 < P < 400$mm
P-Cat 4: $400 < P < 500$mm
P-Cat 5: $P > 500$mm

- Based on methodology similar to the Rainfall Category (R-Cat) scheme introduced in Ralph and Dettinger (2012), *BAMS*

OBJECTIVE 2

DATASET INTERCOMPARISON [1998-2015]

MAGNITUDE

- Annual and seasonal cycle of the maximum P-Cat events

FREQUENCY

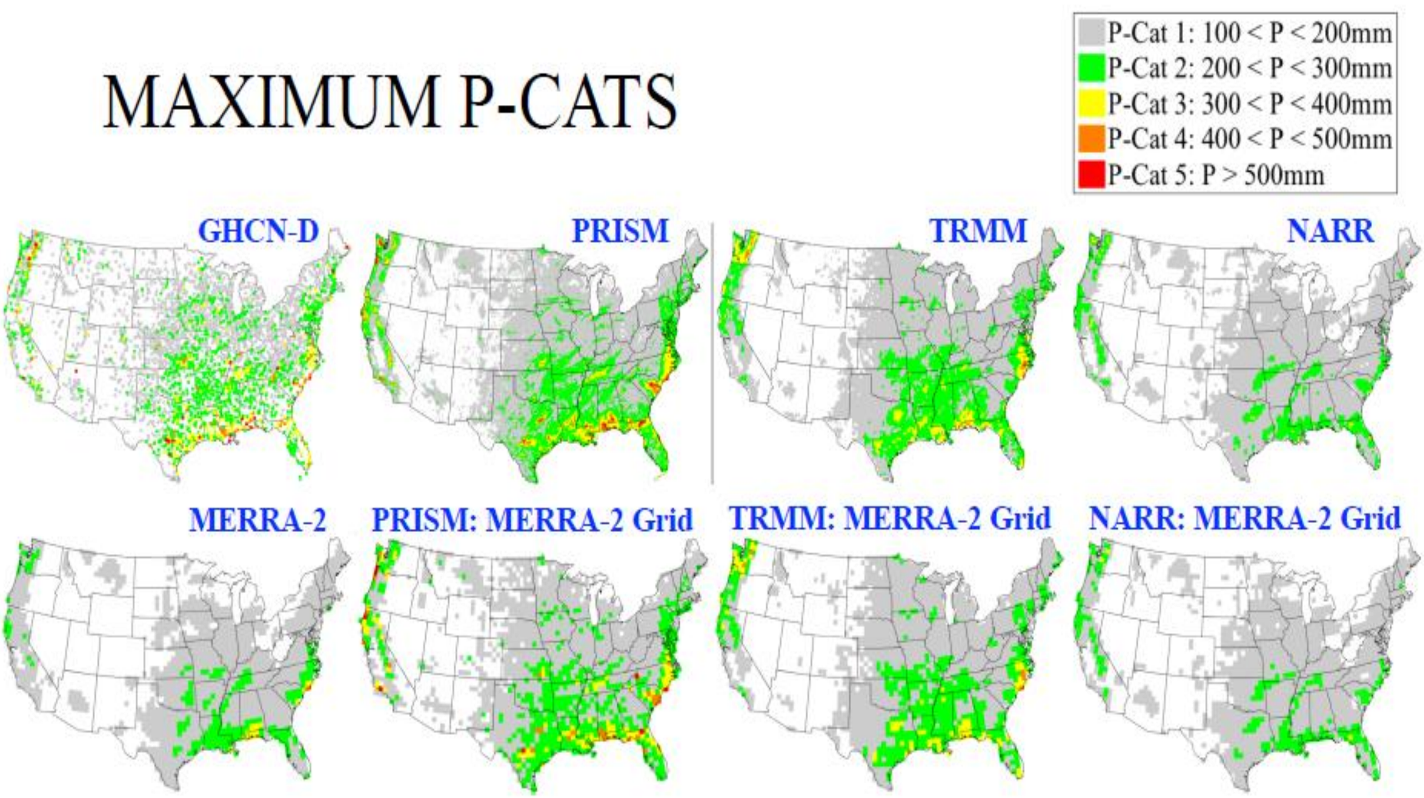
- Frequency of P-Cat occurrence annually, seasonally, and regionally across the CONUS

Quantitative Assessment of Observational Uncertainty

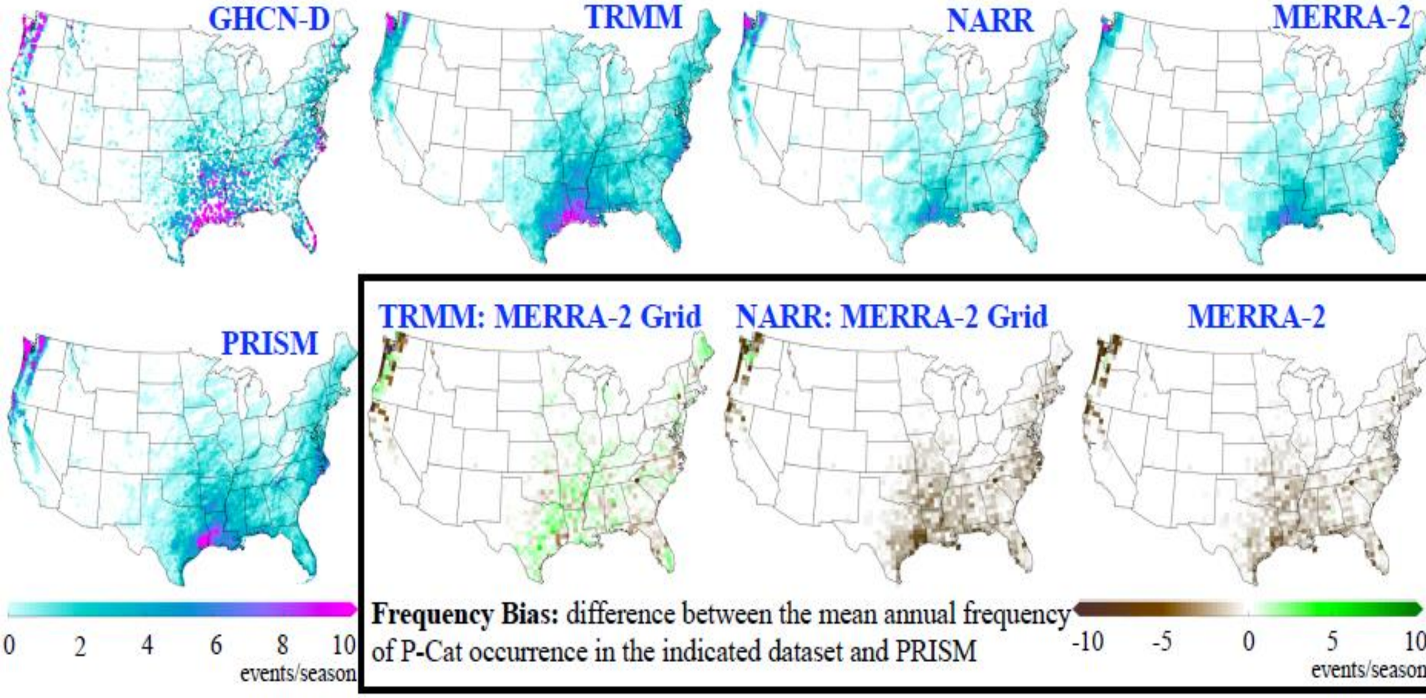
DATA

Agency Source	Dataset		Spatial Resolution	Data Source
NASA	TRMM	Tropical Rainfall Measuring Mission	0.25° x 0.25°	satellite
OSU	PRISM	Parameter-Elevation Regressions on Independent Slopes Model	0.04° x 0.04°	gridded *in-situ* station data
NASA	MERRA-2	Modern Era Retrospective-Analysis Version 2	0.625° x 0.5°	global reanalysis
NCEP	NARR	North American Regional Reanalysis	32 km x 32 km	regional reanalysis with gauge data assimilation
NOAA	GHCN-D	Global Historical Climatology Network		*in-situ* station data

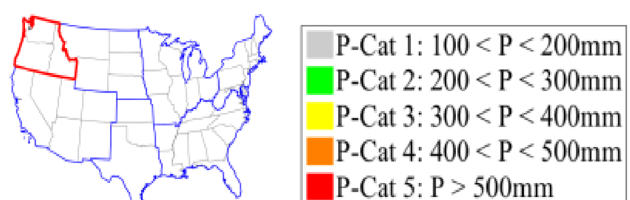
MAXIMUM P-CATS

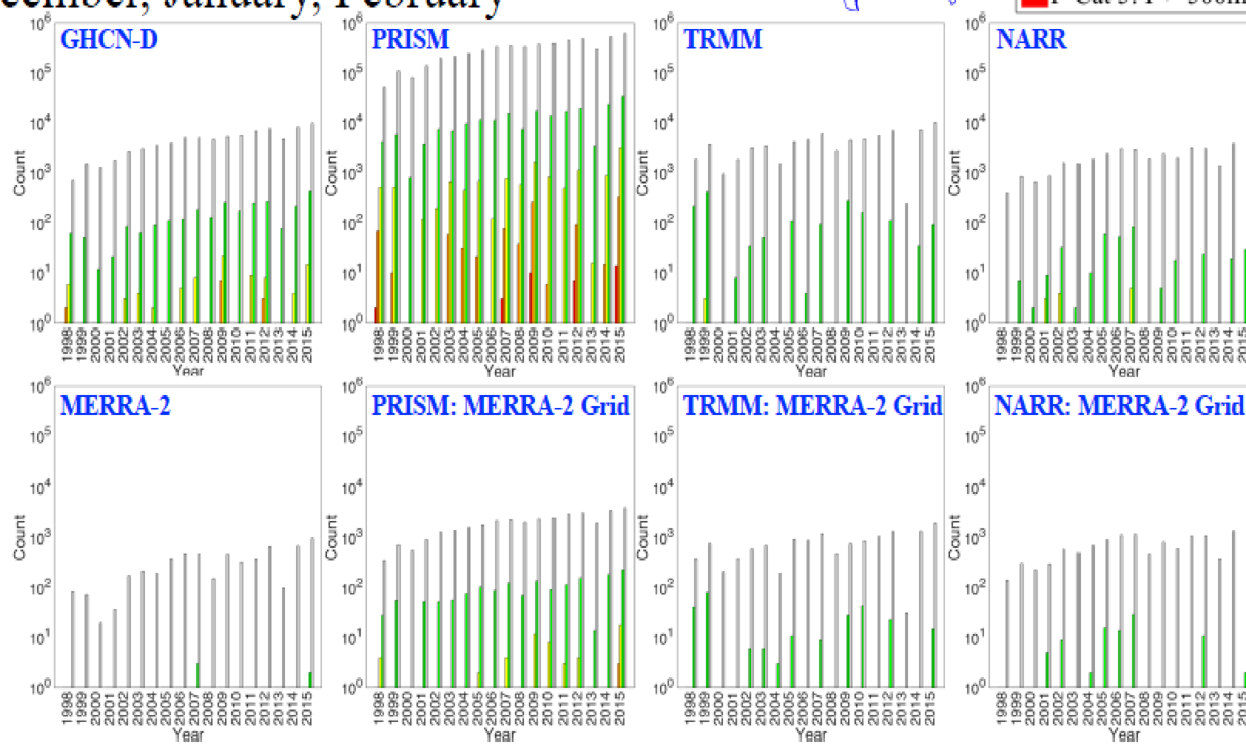


MEAN ANNUAL P-CAT FREQUENCY
September, October, November



ANNUAL P-CAT OCCURENCE: NORTHWEST
December, January, February

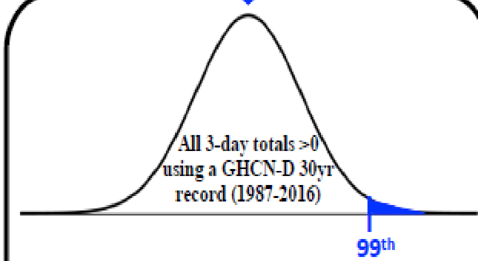




PERCENTILE-BASED P-CAT METHODOLOGY

- P-Cat 1: 100 < P < 200mm
- P-Cat 2: 200 < P < 300mm
- P-Cat 3: 300 < P < 400mm
- P-Cat 4: 400 < P < 500mm
- P-Cat 5: P > 500mm

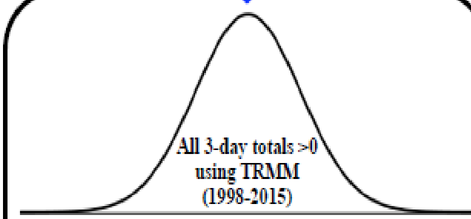
fixed P-Cat thresholds



compute percentile range for each fixed threshold over CONUS

Precipitation Category	Percentile Threshold	CONUS Return Period
P-Cat 1	99.2850 - 99.9521	1/140
P-Cat 2	99.9521 - 99.9937	1/2,090
P-Cat 3	99.9937 - 99.9986	1/15,940
P-Cat 4	99.9986 - 99.9996	1/69,030
P-Cat 5	> 99.9996	1/250,140

percentile thresholds (>99th percentile)

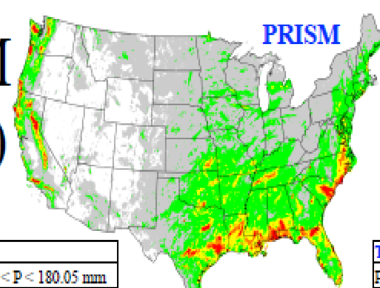


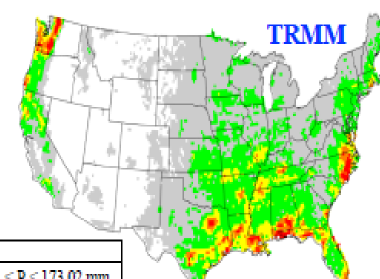
calculate value associated with each percentile

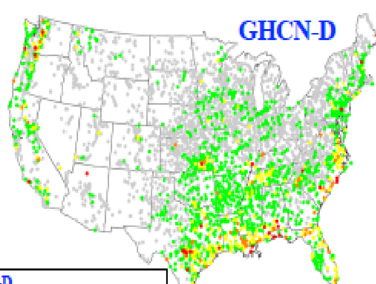
P-Cat 1	93.41 < P < 173.02 mm
P-Cat 2	173.02 < P < 245.71 mm
P-Cat 3	245.71 < P < 302.20 mm
P-Cat 4	302.20 < P < 349.24 mm
P-Cat 5	P > 349.24 mm

newly defined P-Cat thresholds

PERCENTILE-BASED MAXIMUM P-CATS (1998-2015)

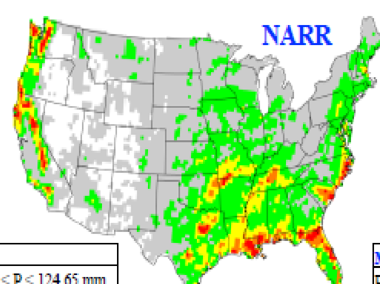


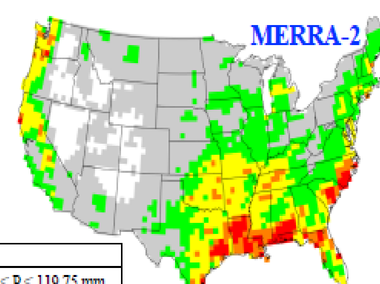




PRISM	
P-Cat 1	87.51 < P < 180.05 mm
P-Cat 2	180.05 < P < 271.68 mm
P-Cat 3	271.68 < P < 354.50 mm
P-Cat 4	354.50 < P < 425.87 mm
P-Cat 5	P > 425.87 mm

TRMM	
P-Cat 1	93.41 < P < 173.02 mm
P-Cat 2	173.02 < P < 245.71 mm
P-Cat 3	245.71 < P < 302.20 mm
P-Cat 4	302.20 < P < 349.24 mm
P-Cat 5	P > 349.24 mm





GHCN-D	
P-Cat 1	100.90 < P < 200.70 mm
P-Cat 2	200.70 < P < 300.67 mm
P-Cat 3	300.67 < P < 398.92 mm
P-Cat 4	398.92 < P < 483.49 mm
P-Cat 5	P > 483.49 mm

NARR	
P-Cat 1	62.95 < P < 124.65 mm
P-Cat 2	124.65 < P < 180.96 mm
P-Cat 3	180.96 < P < 224.94 mm
P-Cat 4	224.94 < P < 260.56 mm
P-Cat 5	P > 260.56 mm

MERRA-2	
P-Cat 1	59.02< P < 119.75 mm
P-Cat 2	119.75 < P < 176.98 mm
P-Cat 3	176.98 < P < 221.49 mm
P-Cat 4	221.49 < P < 263.33 mm
P-Cat 5	P > 263.33 mm

CONCLUSIONS & FUTURE DIRECTION

Objective 1: Event-based Indicator of Change in Extreme Precipitation

- The most extreme precipitation events occur in the West due to landfalling atmospheric rivers and in the Southeast due to tropical systems

Objective 2: Dataset Intercomparison

- All datasets capture the principle patterns of P-Cat climatology
- Higher resolution datasets most closely resemble gauge data, even after regridding
- Variability persists across the five-dataset suite in the frequency, spatial extent, and magnitude of events

Preliminary Results: Percentile-based P-Cat Definitions

- Some differences persist when extreme event definition is based on percentiles

Results of this analysis provide both a complete and intuitive way to interpret and visualize extreme precipitation climatology across the CONUS and a clear intercomparison between various precipitation estimation products.

Future Direction:

- Employ this indicator as a climate model evaluation target
- Investigate the meteorological mechanisms driving P-Cat events across the CONUS

THANK YOU!
QUESTIONS?

Support for this work was provided by the NASA Indicators for the NCA Program

Contact: Emily Slinskey, slinskey@pdx.edu