WHAT DOES EXTREME PRECIPITATION MEAN TO YOU?

emullens@ufl.edu

Dr. Esther Mullens

Assistant Professor

Department of Geography

APR 7 2021

VanBuskirk, O, P Ćwik; R A. McPherson; H Lazrus; E Martin; C Kuster and E Mullens. 2021. "Listening to Stakeholders: Initiating Research on Sub-seasonal to Seasonal Heavy Precipitation Events by First Understanding What Users Need". ***Accepted*** *with minor revisions, Bulletin of the American Met. Soc*, March 2021.

PRES²iP

ACKNOWLEDGEMENTS– PRES2IP

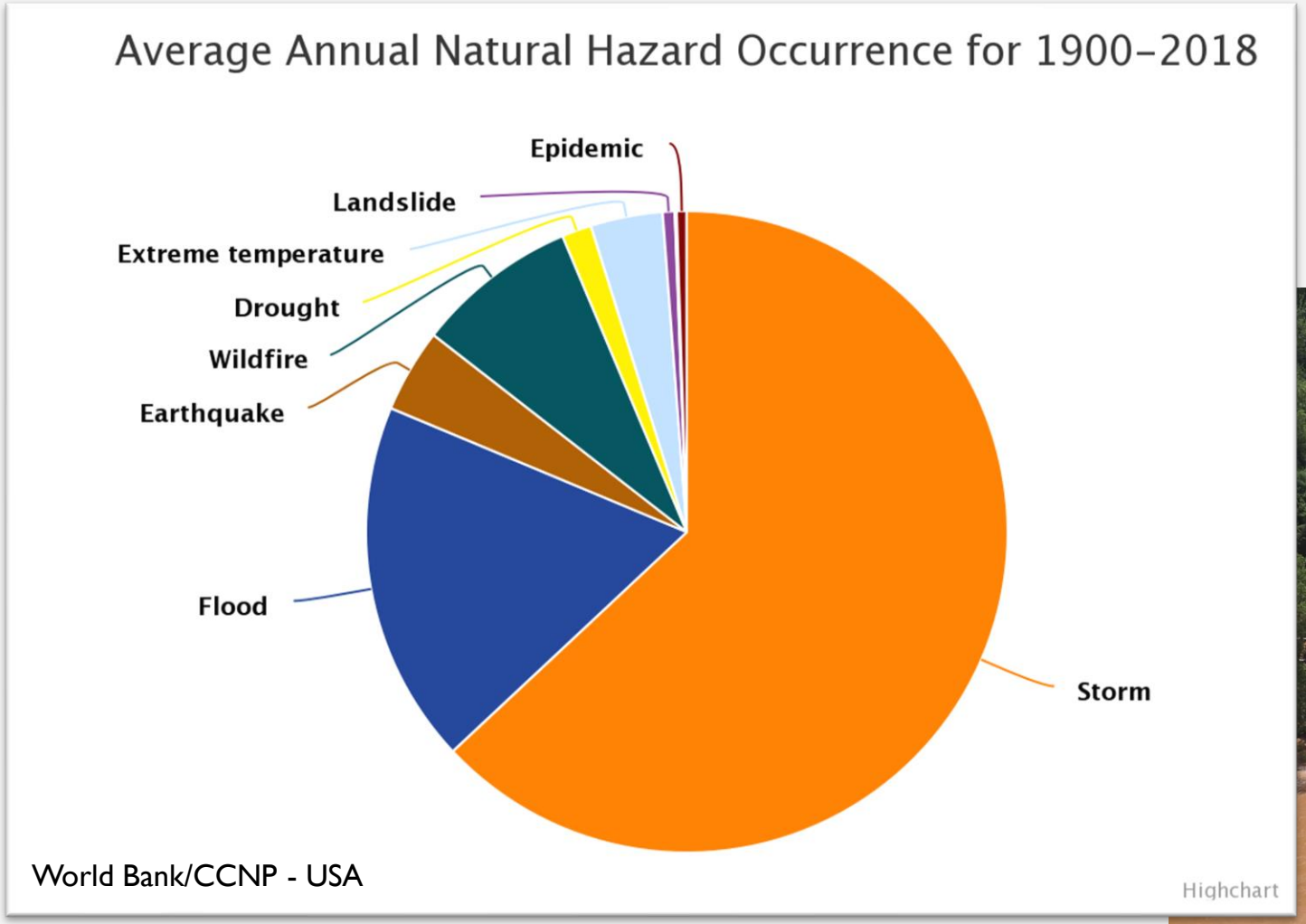
Much of this work is not me!

Thanks to the numerous collaborators at OU and NCAR

- Elinor Martin, Jason Furtado, Mike Richman, Renee McPherson, Jeffrey Basara, Cameron Homeyer, Derek Rosendahl, Ashton Robinson-Cook, Heather Lazrus, Paulina Cwik, Charles Kuster, Olivia VanBuskirk, and numerous talented graduate and undergraduate students!
- University of Oklahoma School of Meteorology, NSSL, SPC, CPC, South Central Climate Adaptation Science Center

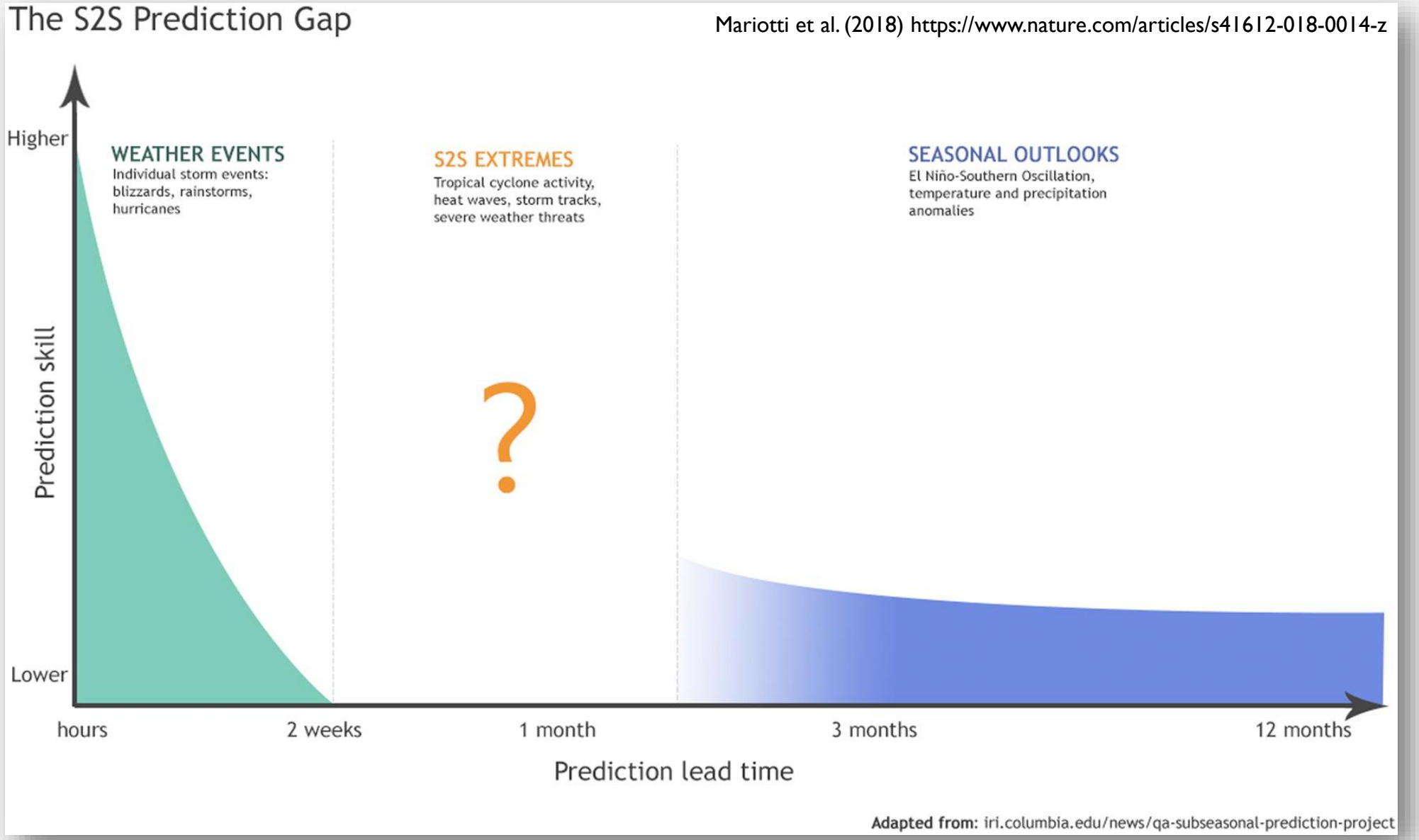
NSF PREEVENTS Track II: PRES2iP project (#1663840) "Developing a Framework for Seamless Prediction of Sub-seasonal to Seasonal precipitation events in the United States (2017-22), PI E. Martin.

WHY HEAVY PRECIPITATION?



World Bank/CCNP - USA

PRES²iP GOALS



PRES²iP GOALS

RQ #1: What are the **synoptic patterns** associated with, and **characteristics of, S2S extreme precipitation events** in the contiguous U.S.?

RQ #2: What role, if any, do **large-scale modes of climate variability** play in modulating these events?

RQ #3: How **predictable** are S2S extreme precipitation events across temporal scales?

RQ #4: How do we create an **informative prediction of S2S extreme precipitation events** for policymaking and planning?

MAKING OUR RESEARCH RELEVANT

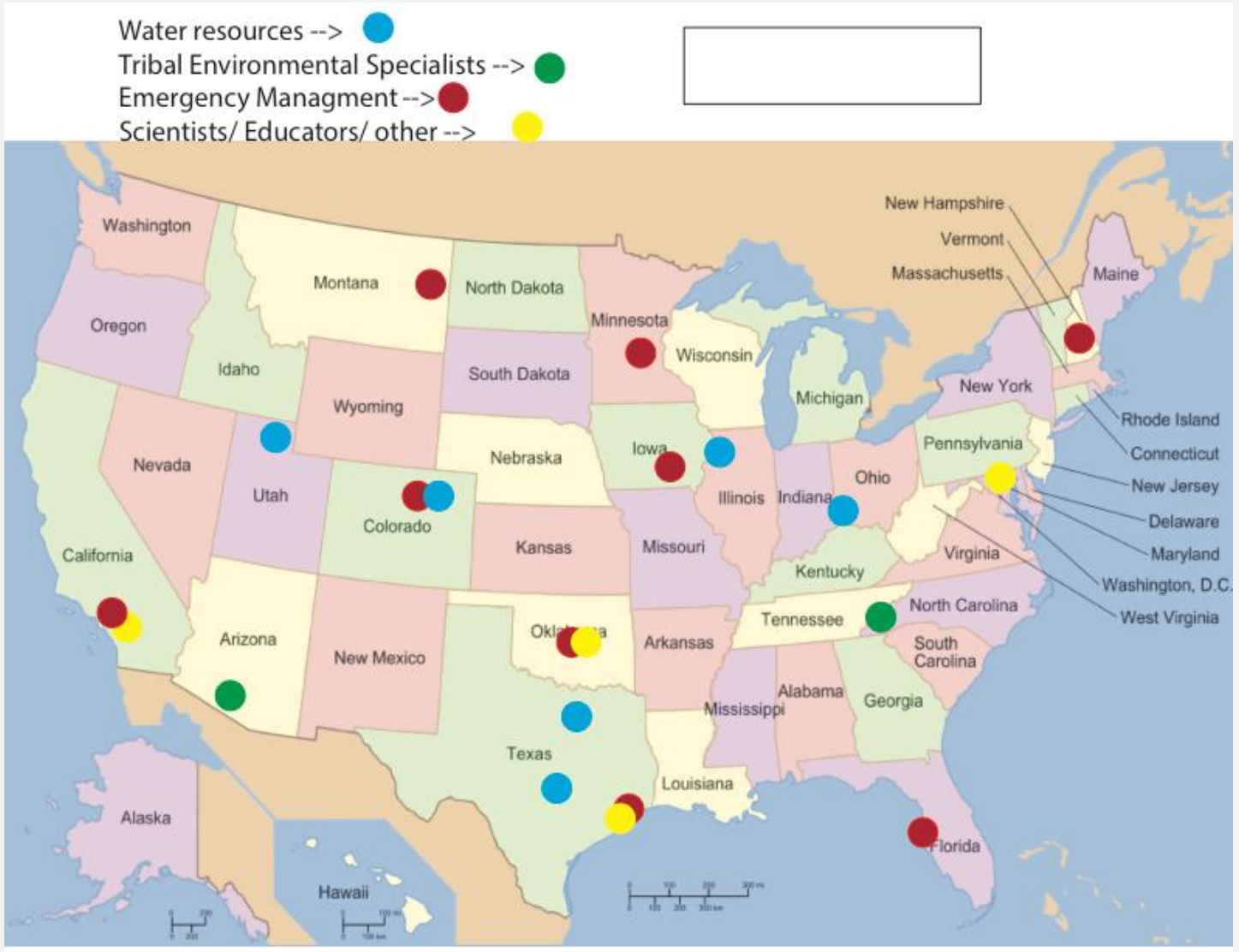
2016 survey & 2018 Stakeholder workshop (Norman, OK) – working together to understand how extreme precipitation affects key sectors, and to gather information on actionable research output.

First of three planned workshops

Images taken by C. Kuster, P. Cwik

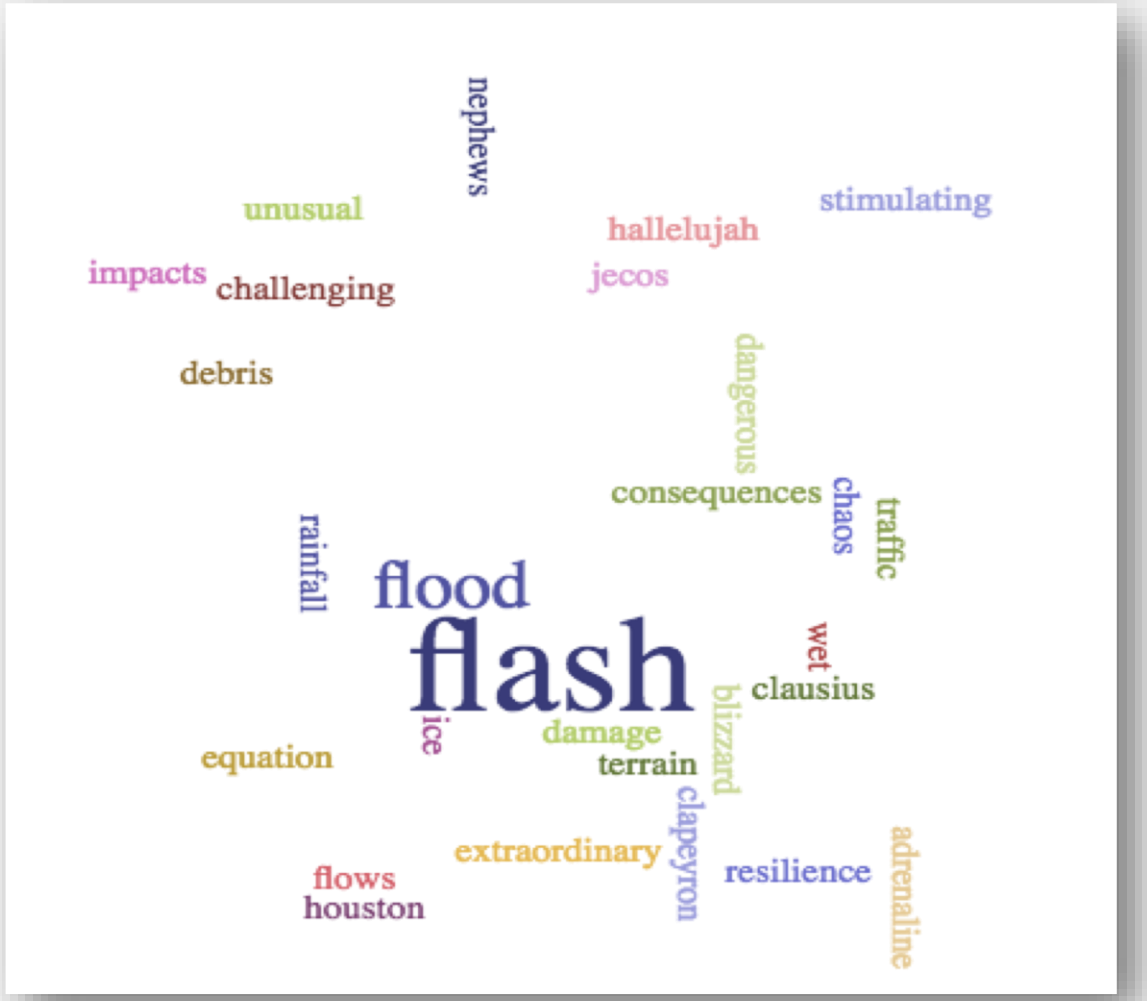
STAKEHOLDER ENGAGEMENT WORKSHOP

21 Stakeholders – non-research
15 Researchers – most as facilitators



(I) WHAT DOES EXTREME PRECIPITATION MEAN TO YOU?

Understanding spatial and temporal scales & magnitudes of extreme precipitation that are of most concern



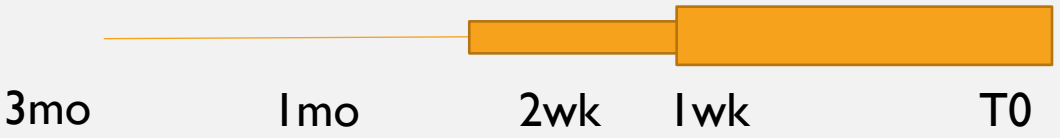
- Easier to respond to this question in terms of impacts, decisions, and stories, versus accumulations and spatial areas.
- Amounts of concern vary by location and context.
- "Extreme rainfall does not necessarily mean an extreme event"

(2) DECISION POINTS

Timelines

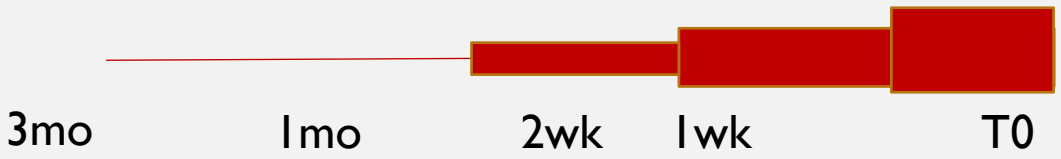
Water Resources (Flood Control)

Public Utilities



Water Resources (River Authority)

Emergency Management



(3) MANAGING UNCERTAINTY

Do you prepare for the most likely event, the most damaging event, or a range of possibilities?

'Worst case' – review potential impacts, plans and decisions must be adaptable at short-notice

Most likely – Take note of potential high end events but plan for where confidence is greatest.

Relationships with forecast offices are important – forecasters are not afraid to express uncertainty. **Probabilistic** better than deterministic.

Worst case – precipitation forecast factors into which specific management plan to implement. When evaluating whether implementation worked, worst case events tend to be the benchmarks.

(3) MANAGING UNCERTAINTY

How reliable would a sub-seasonal extreme precipitation product have to be to be trustworthy?

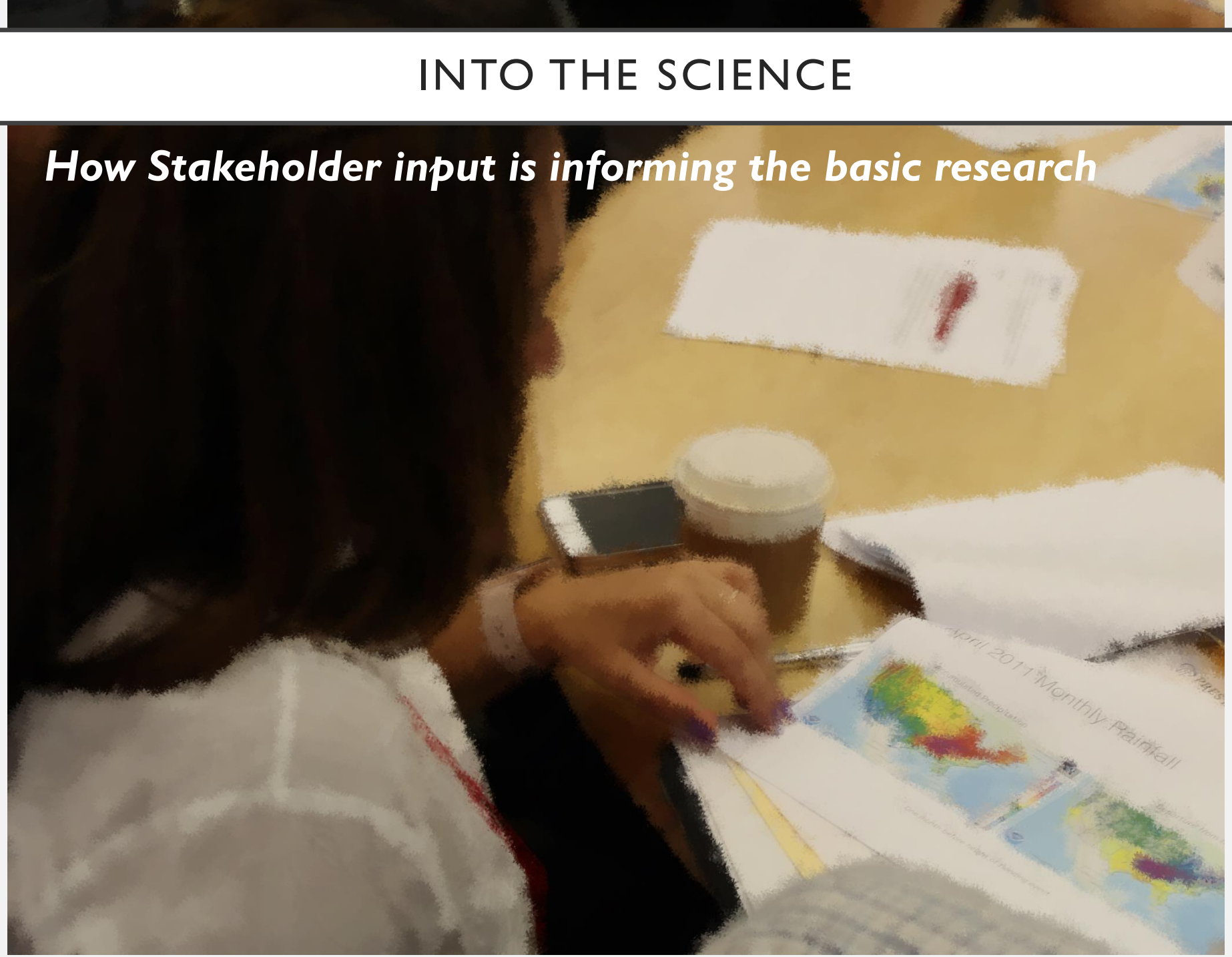
- Most participants would not be able to use forecast products ~50% accurate at 2 weeks-1 month lead time
- Participants were more interested if the forecast could achieve a ~75% or greater accuracy at those same time-scales.
- The importance of good track-record and trust/relationship with product creators was reiterated
- Most in this cohort generally did not see the merit of a 2-3-month lead time

WORKSHOP TAKEAWAYS

- For this cohort – limited utility of >1 month forecast information
  - Should broaden cohort to target those end-users whose decisions encompass longer lead times.
  - Less familiarity with sub-seasonal – seasonal products – how to increase their usability?
- Relationships with product developers and/or NWS as the trusted translator of the information is vital
- Extreme precipitation is highly contextual – little chance to satisfy everyone's definition
- Products should produce a range of scenarios and provide quantitative information rather than probabilities or above/below normal
- Forecast product would need to be quite accurate to be trusted

INTO THE SCIENCE

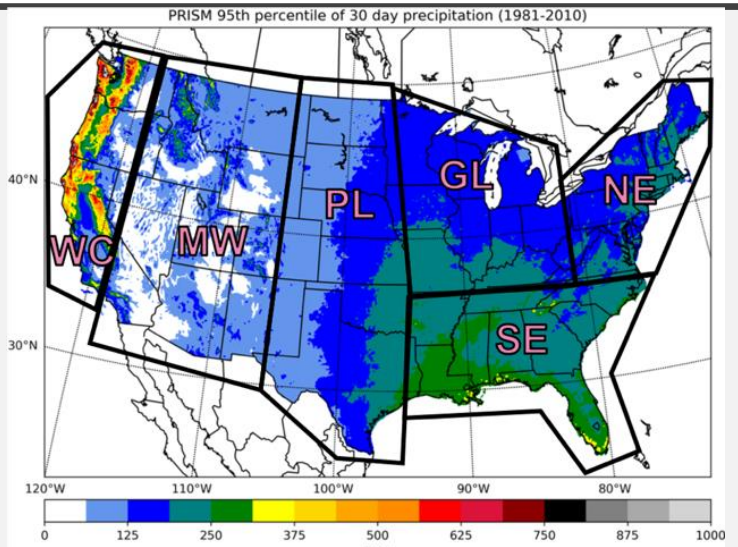
How Stakeholder input is informing the basic research



1. INCLUDE ANALYSIS OF IMPACTS WITHIN IDENTIFIED EXTREME EVENTS

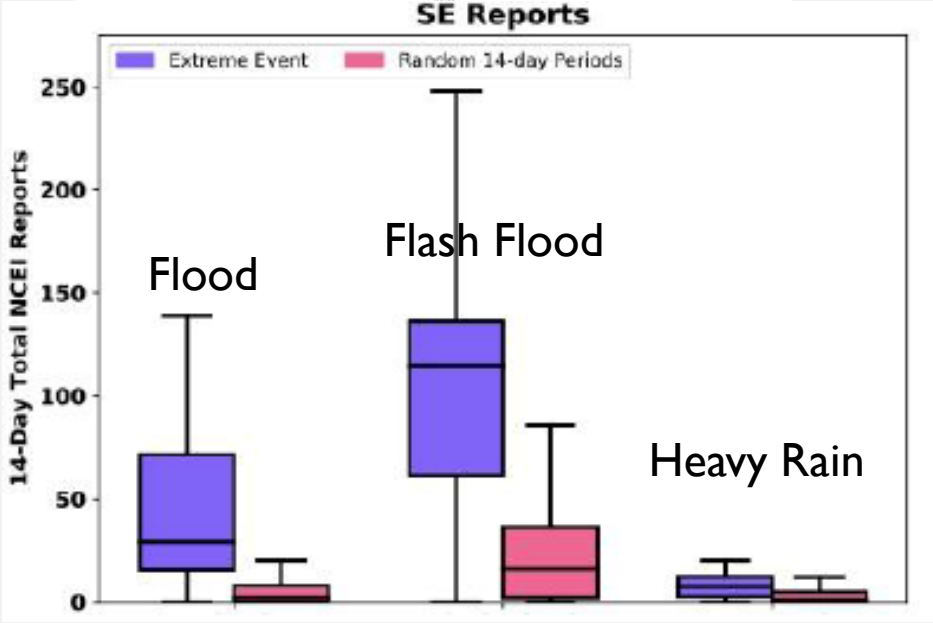
- "Extreme:" > 95th percentile over 14 day period (moving window)
- Spatial extent estimated via Kernel Density, and must exceed 200,000 km^2.

Jennrich et al. (2020)

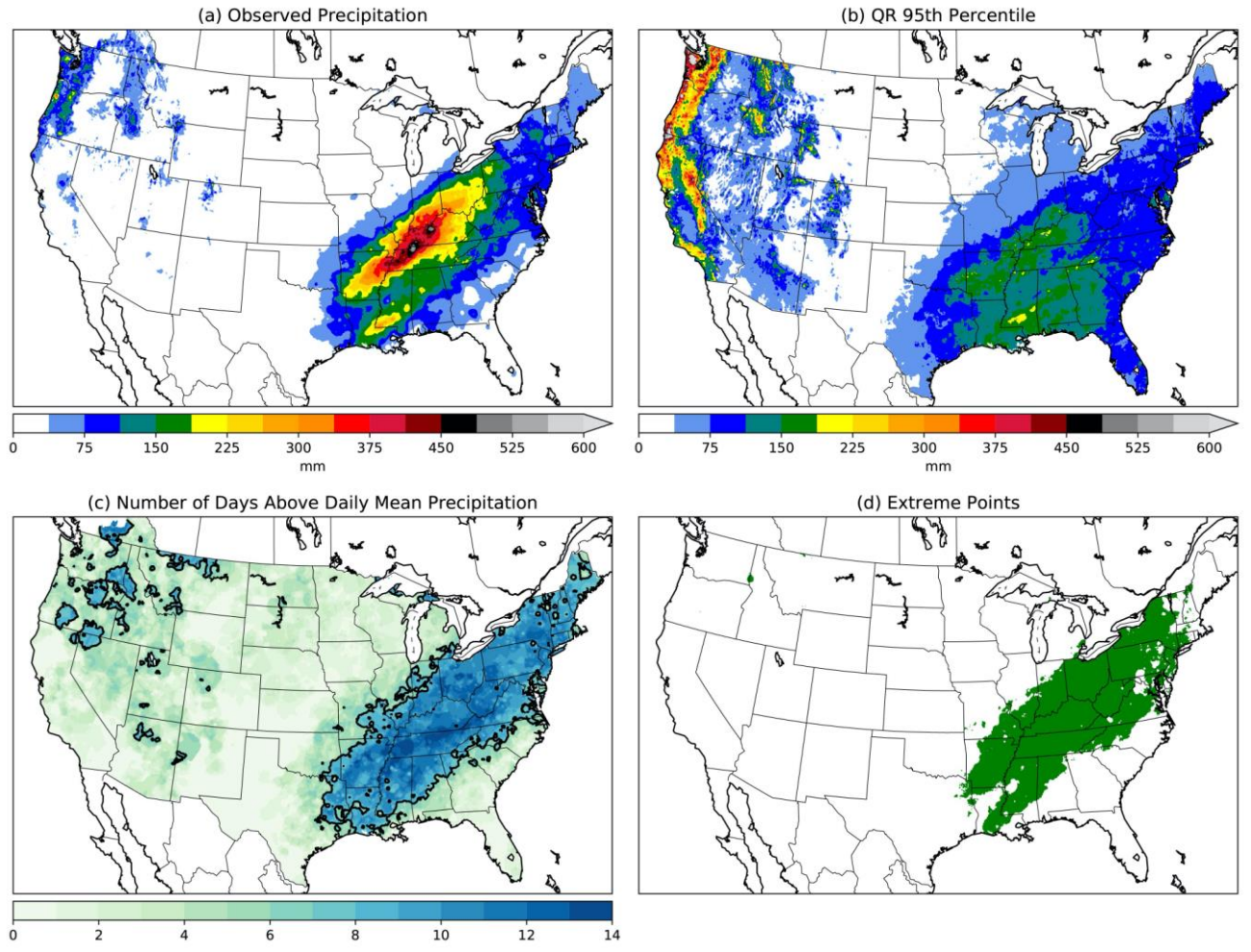


- Characteristics (example for SE):
  - Extreme events are associated with *significantly more flood reports* than random 14-day periods

Melanie Schroers, E. Martin, Greg Jennrich, J. Furtado (prep.)



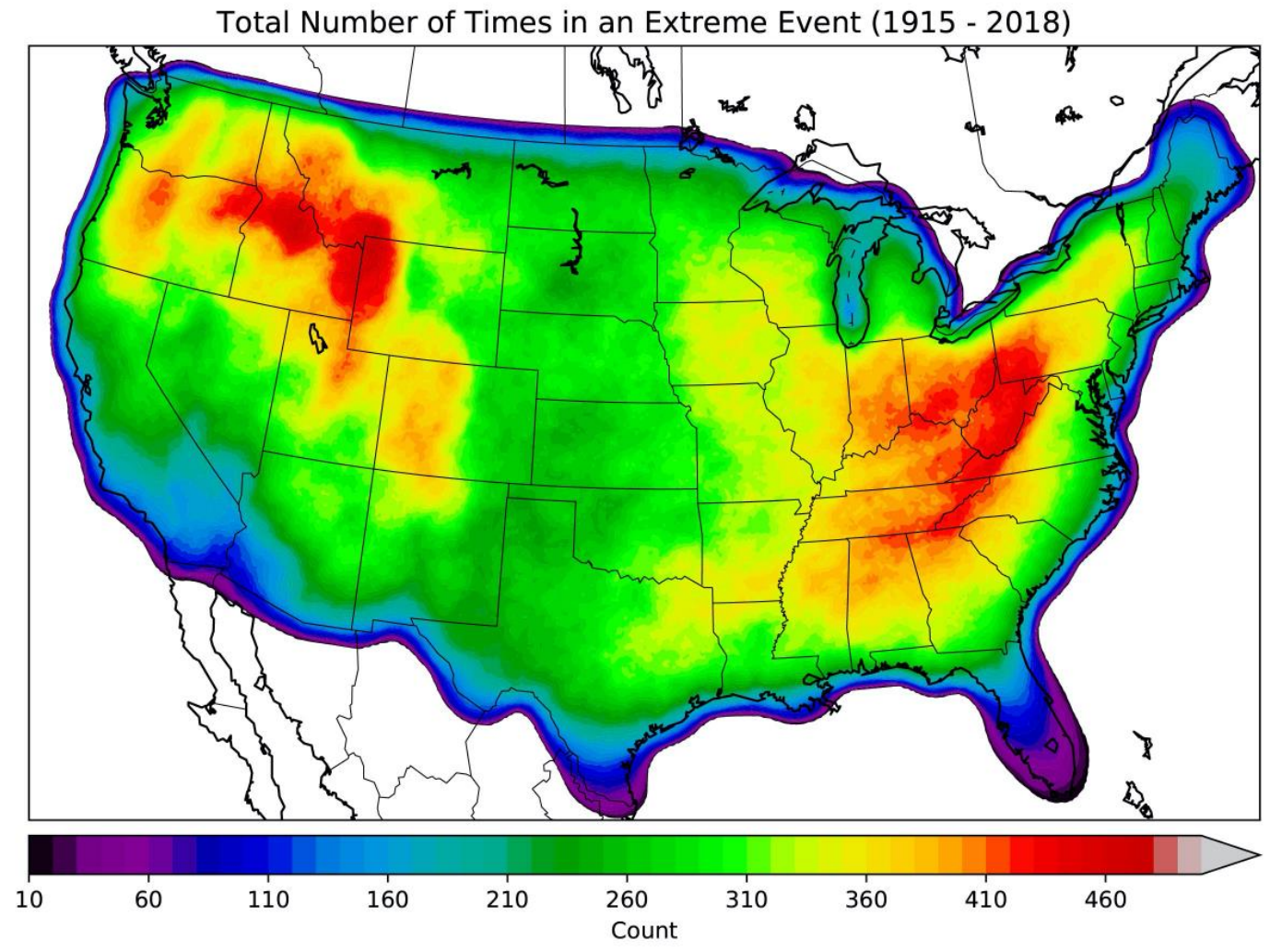
11. FLEXIBLE DEFINITION FOR 'EXTREME'



A point must experience above normal daily precipitation on at least 7 days of the window.

Credit: E. Martin

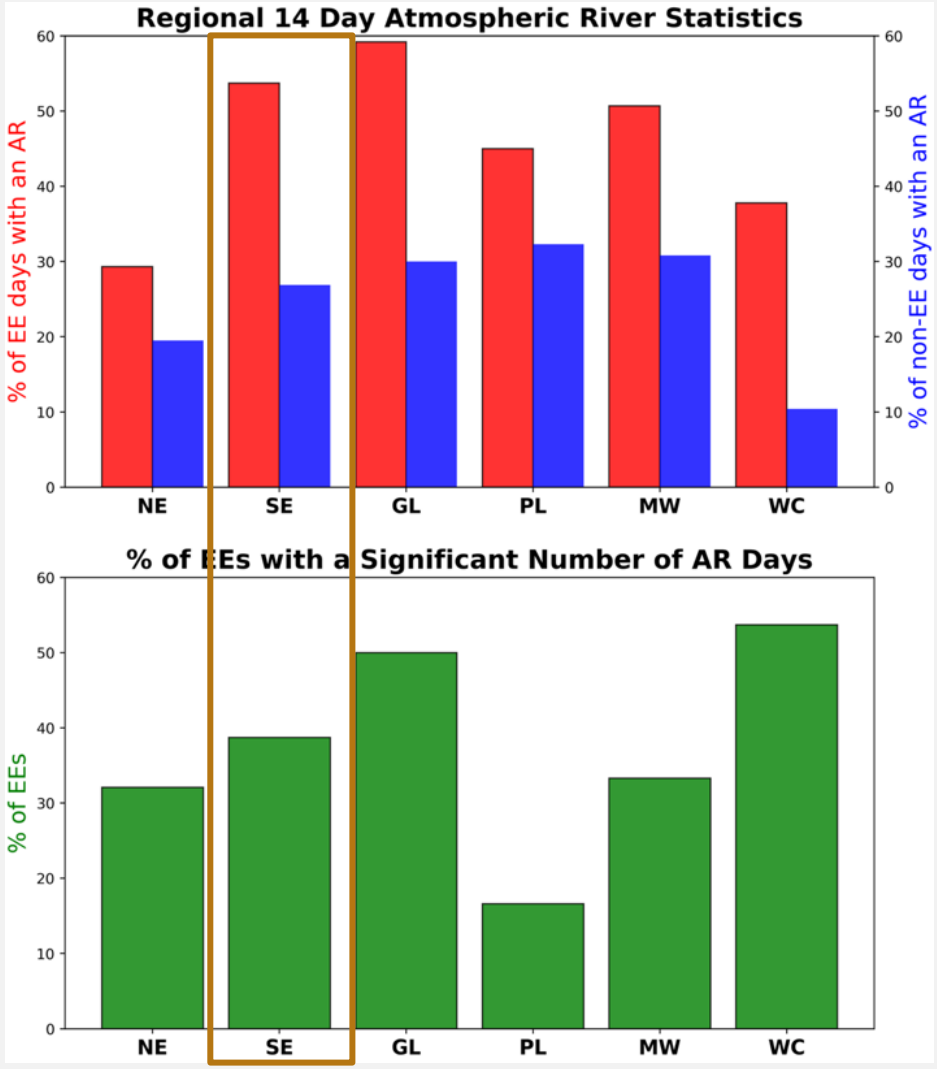
II. FLEXIBLE DEFINITION FOR 'EXTREME'



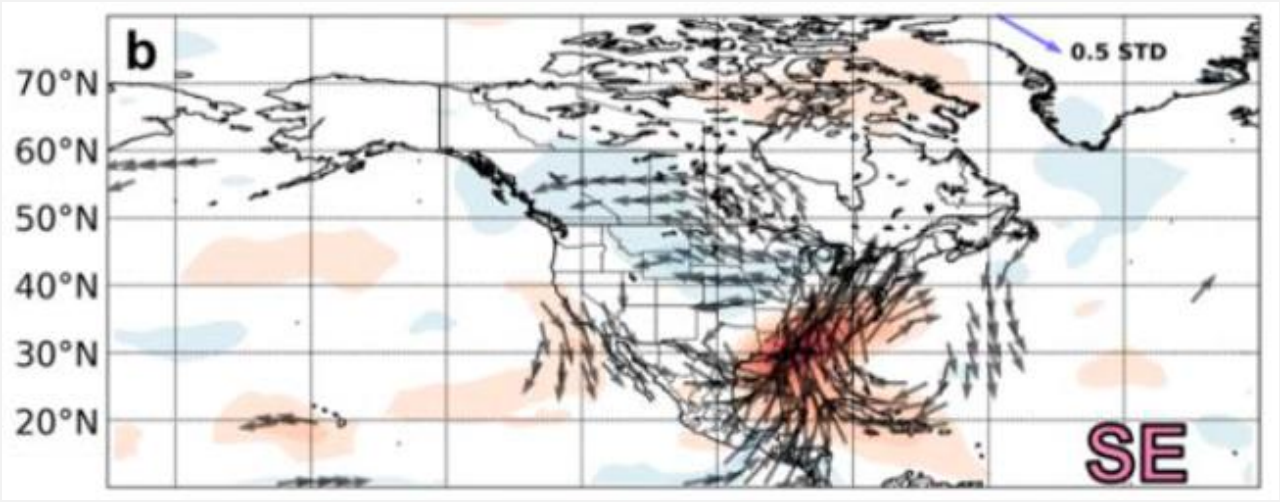
Credit: E. Martin

III. EXAMINE CHARACTERISTIC METEOROLOGY*

- Example (for SE):
  - Extreme events are associated with *Atmospheric Rivers* & active southward-displaced storm track



Integrated Vapor Transport (IVT) Greg Jennrich, J. Furtado

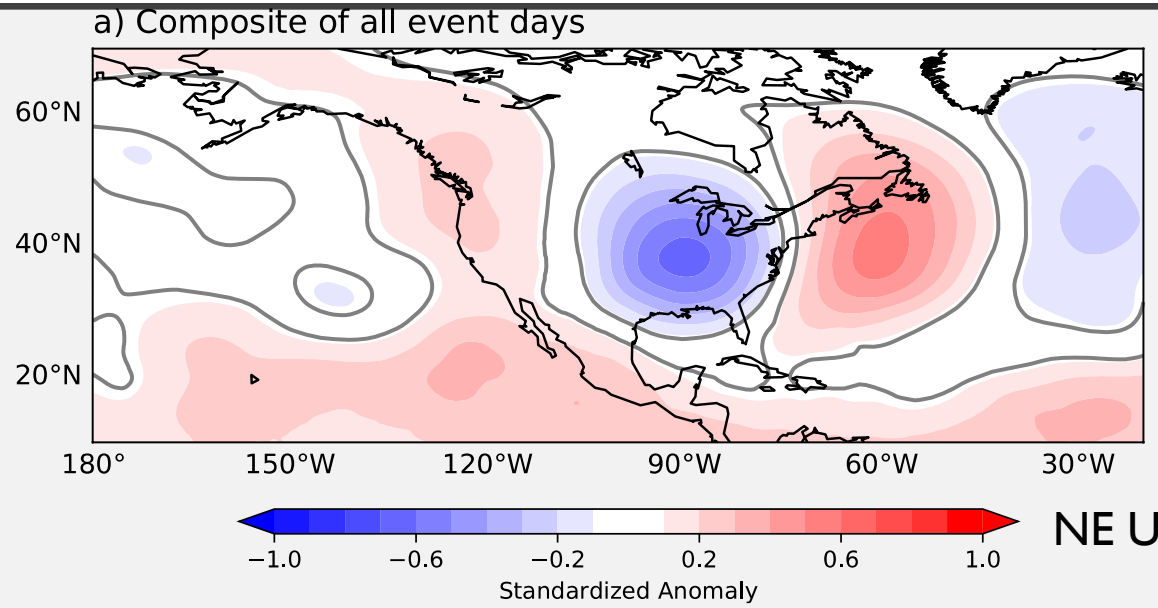


*focusing on mid-latitude processes (i.e., non-tropical systems)

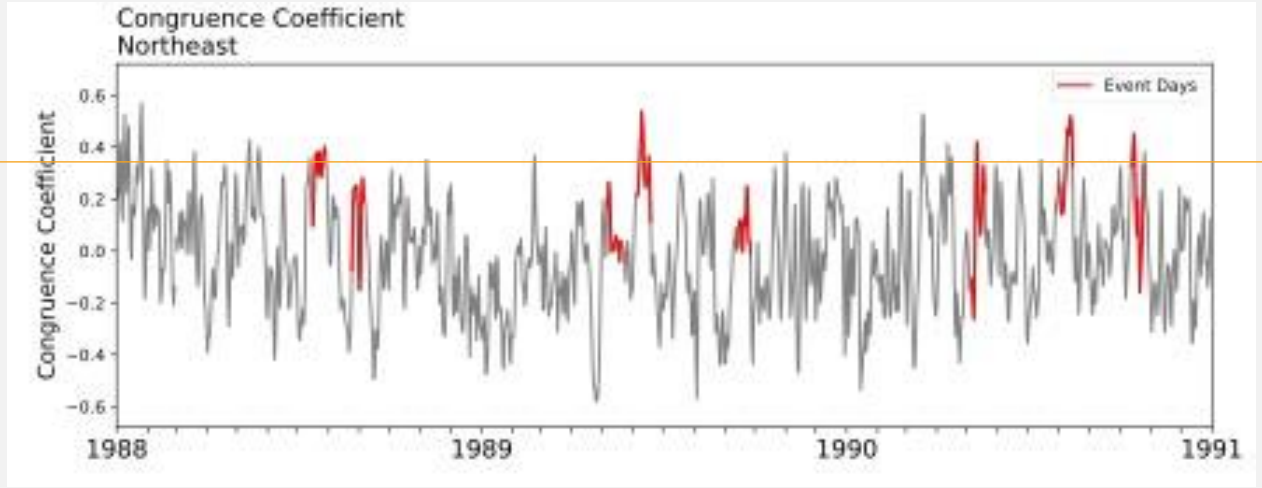
WE HAVE A PREDICTABILITY PROBLEM!

- Compare all days to event height composite
- Congruence Coefficient

$$r_c = \frac{\sum XY}{\sqrt{\sum X^2 \sum Y^2}}$$



NE U.S example



rc exceedance threshold

Credit: E. Martin

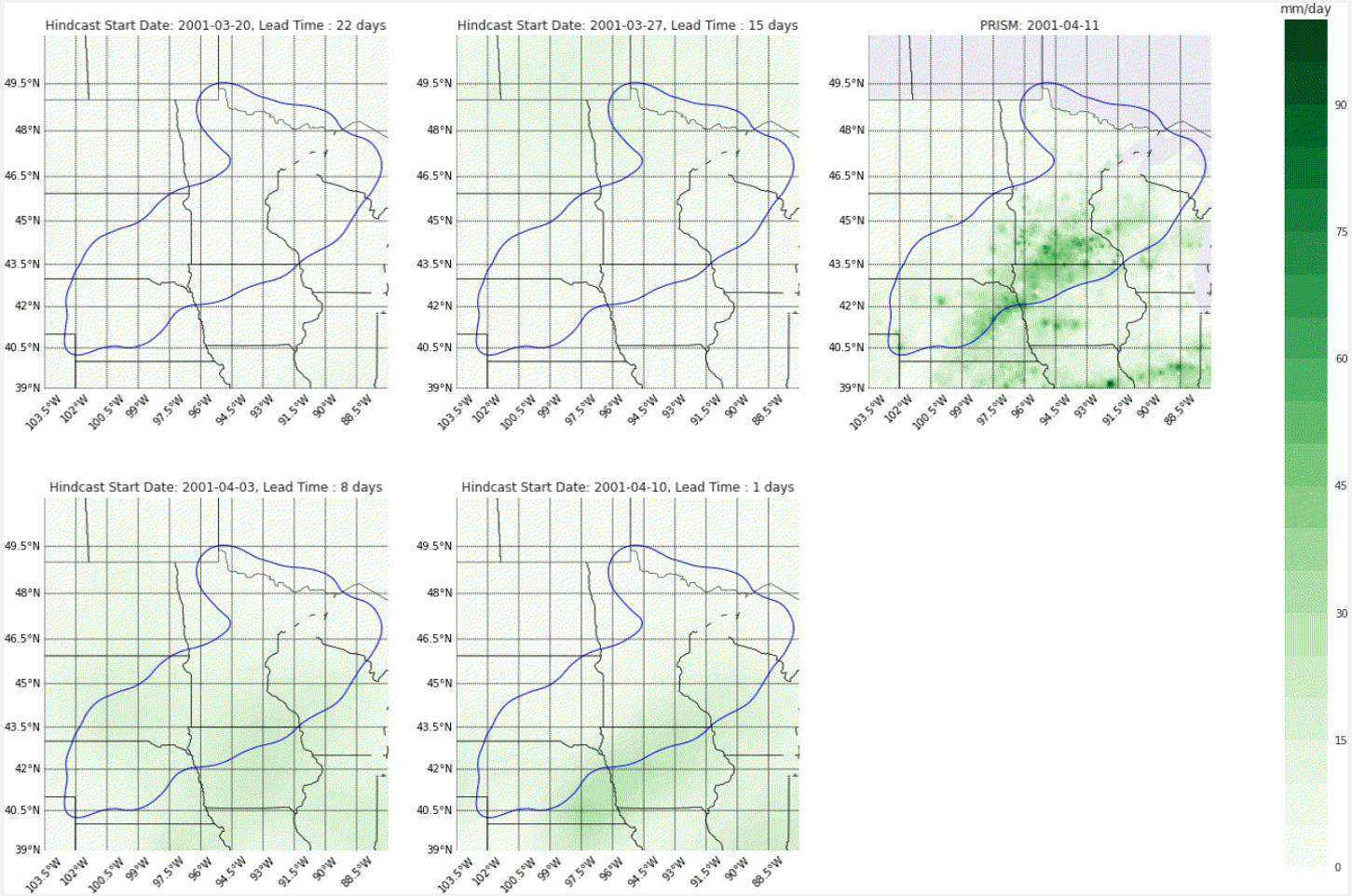
WE HAVE A PREDICTABILITY PROBLEM!

	Heights Alone		Heights and Precipitable Water	
	POD	FAR	POD	FAR
NE	20%	89%	12.6%	87.6%
SE	19%	85%	16%	83%
GL	30%	84%	22%	78%
NP	34%	92%	19.7%	91%
SP	20%	89%	12%	82%
MW	19%	84%	9.6%	77%
WC	30%	77%	21%	70%

Credit: E. Martin

POD = Probability of detection
FAR = false alarm rate

WE HAVE A PREDICTABILITY PROBLEM!



Credit: E. Martin

"No convincing regional or seasonal model skill for 14-day extreme events in the S2S forecast range…" (McAfee at al. 2021) – BUT study limited (only 14 cases, and one NCEP hindcast model). More models, events need to be evaluated.

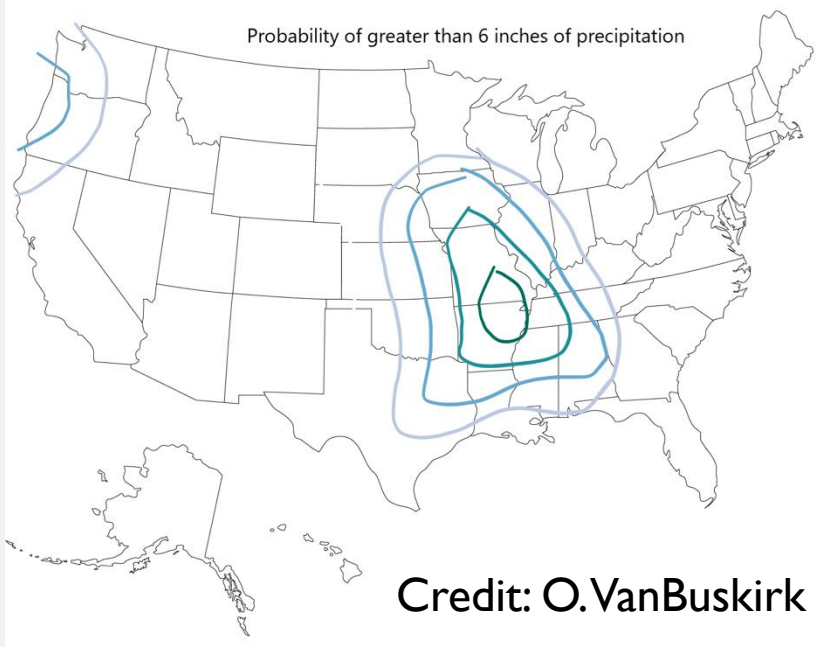
NEXT STEPS: RESEARCH

- Multi-scale assessment of S2S predictability across the suite of Seasonal forecast (NMME) models.
- Evaluation of statistical predictability, based on known linkages with synoptic-planetary natural variability using machine learning/AI techniques.
- Subsequent testing and model evaluation for both statistical and dynamical models.

NEXT STEPS: STAKEHOLDER ENGAGEMENT

- Engagement now picking up again, *as well as hopefully recruiting more stakeholders in relevant professions*.
- Regular newsletter disseminated to participants providing science updates
- Aim to begin some online seminars and discussions
- Workshop #2 has been delayed due to COVID, intention is to have it take place this coming fall (remote option likely).
- Theme is product development

- Interested in joining? Email me!



KEY TAKEAWAYS

- Goal is to develop sub-seasonal forecasts of extreme precipitation – mainly focusing on long-duration (~14 day) events.
- Engaging stakeholders early and often builds trust and stands a better chance of sustained collaboration.
- Ongoing challenges:
  - Creating a resource that benefits a wide variety of stakeholders
  - S2S models are currently lacking skill in their prediction of 14-day heavy precip events
  - Establishing/investigating relationships with natural variability to evaluate the potential for an effective statistical model

THANK YOU!

PRES²iP

http://Pres2ip.com