Dan Cooley

Graduate Student Researcher: Summer 2003 - October 2005, while a student in CU-Boulder's Department of Applied Mathematics.

Postdoctoral Researcher: October 2005 - Present, joint (50%) appointment with CSU's Department of Statistics.

Projects: Primarily in the field of extreme value theory.

- Model for Paleoclimate reconstruction via lichenometry
- Model of extreme precipitation for Colorado's Front Range
- Madogram: a measure of spatial dependence for extremes
- Modeling precipitation events of different durations (ongoing)
- Spatial prediction for max-stable random fields (ongoing)

Colorado extreme precipitation examples

Big Thompson Flood, 1976

- 145 killed
- $41m damage

Eve Gruntfest, UCCS

Ft Collins Flood, 1997

- 5 killed
- $250m damage

John Weaver

Q: What is a given location's risk for an event like this?

Precipitation Atlases

NWS produces precipitation atlases which give a location's risk in terms of *return levels*.

The r-th year return level, z_r, is the level which one expects the annual maximum to exceed with probability $p = 1/r$.

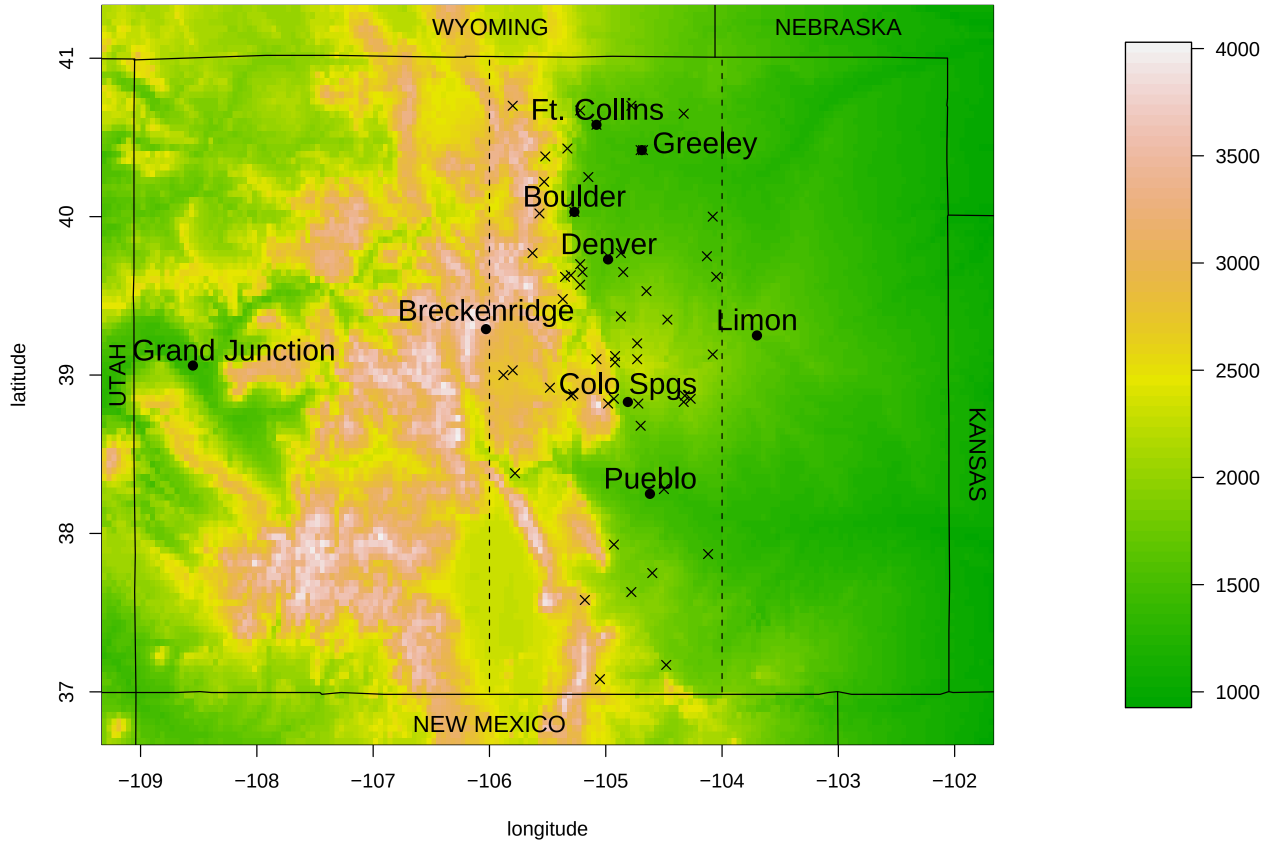
NWS Atlas 2, 1973

- atlas currently used for Colorado
- no uncertainty estimates

NWS Atlas 14, 2003 & 2004

- two maps produced (Southwest US and Mid-Atlantic States)
- using Regional Frequency Analysis (RFA) technique

Study Region and Data



Data: 56 weather stations, 12-53 years of data/station, Apr 1 - Oct 31, First studied 24 hour precipitation measurements

Modeling *Climatological* Extremes:

Model's foundation is the Generalized Pareto Distribution:

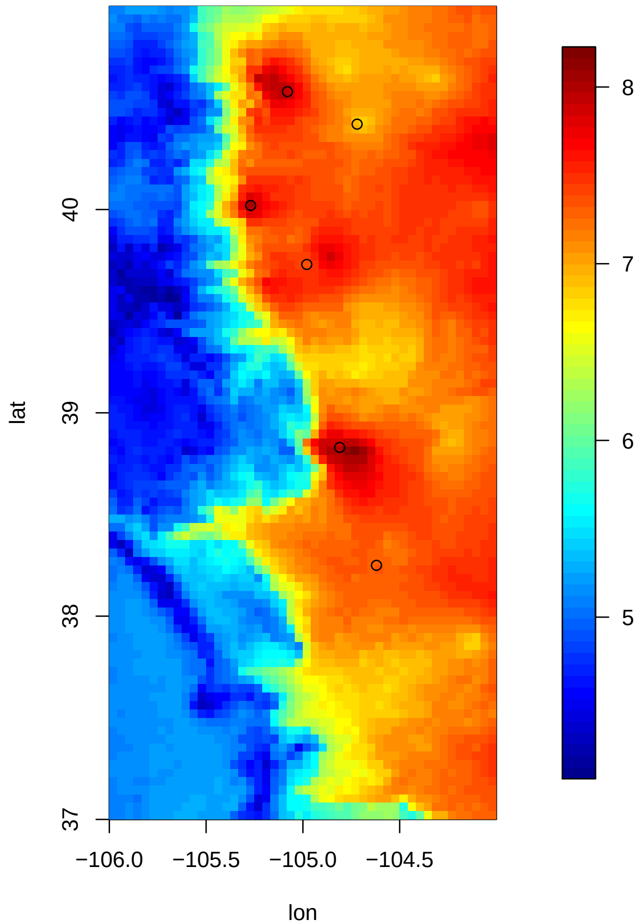
$$P\{Z - u > z | Z > u\} = \left(1 + \frac{\xi z}{\sigma_u}\right)^{-1/\xi}$$

We assume that extreme precipitation is driven by a latent spatial process, which we model in a hierarchy.

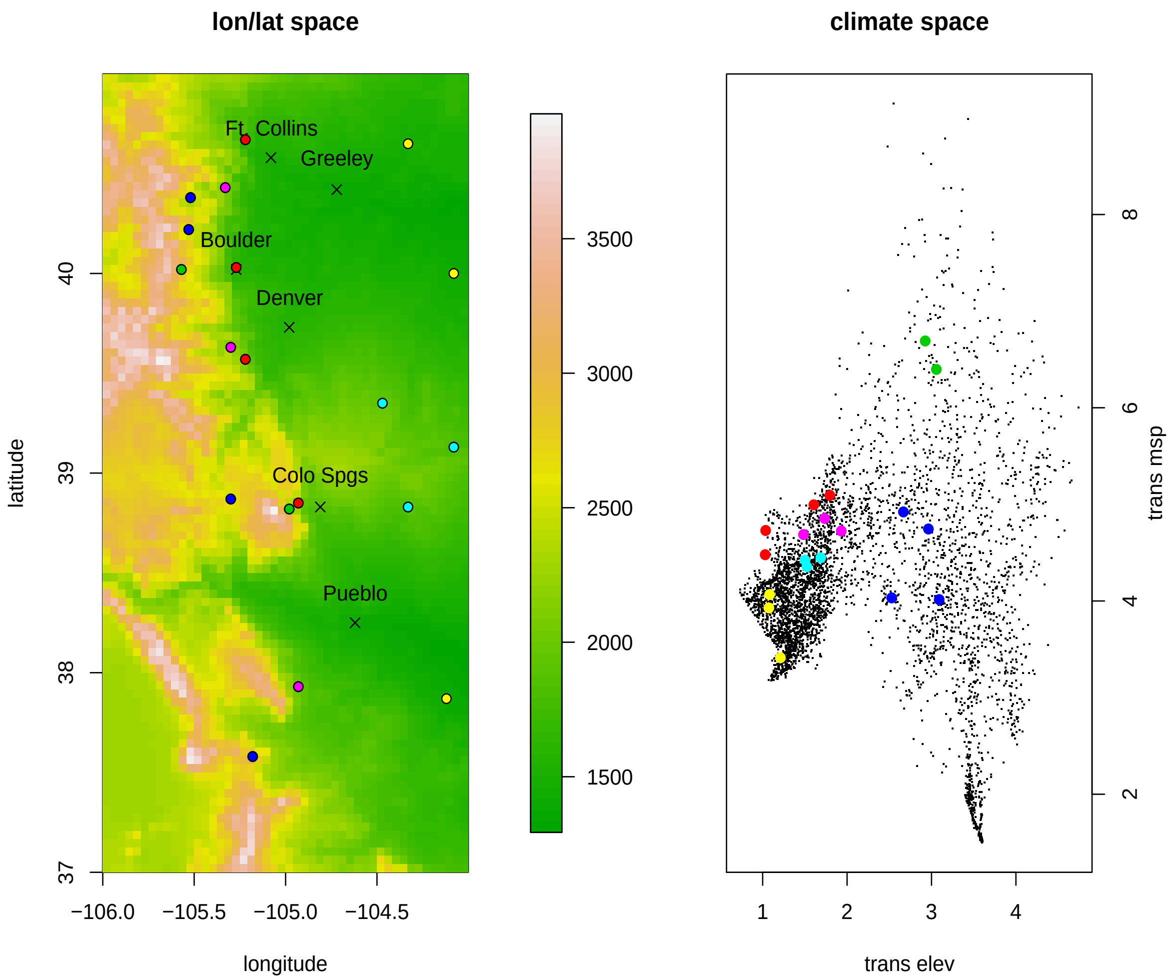
data level:	$[Z(\boldsymbol{x}) > u \mid \sigma(\boldsymbol{x}), \xi(\boldsymbol{x})]$
process level:	$[\phi(\boldsymbol{x}) \mid \boldsymbol{x}, \boldsymbol{\alpha}_\phi, \boldsymbol{\beta}_\phi]$ $[\xi(\boldsymbol{x}) \mid \boldsymbol{x}, \boldsymbol{\alpha}_\xi, \boldsymbol{\beta}_\xi]$
prior level:	$[\alpha_\phi, \beta_\phi, \alpha_\xi, \beta_\xi]$

$$\phi = \log(\sigma)$$

Results at last year's panel meeting



Spatial Modeling

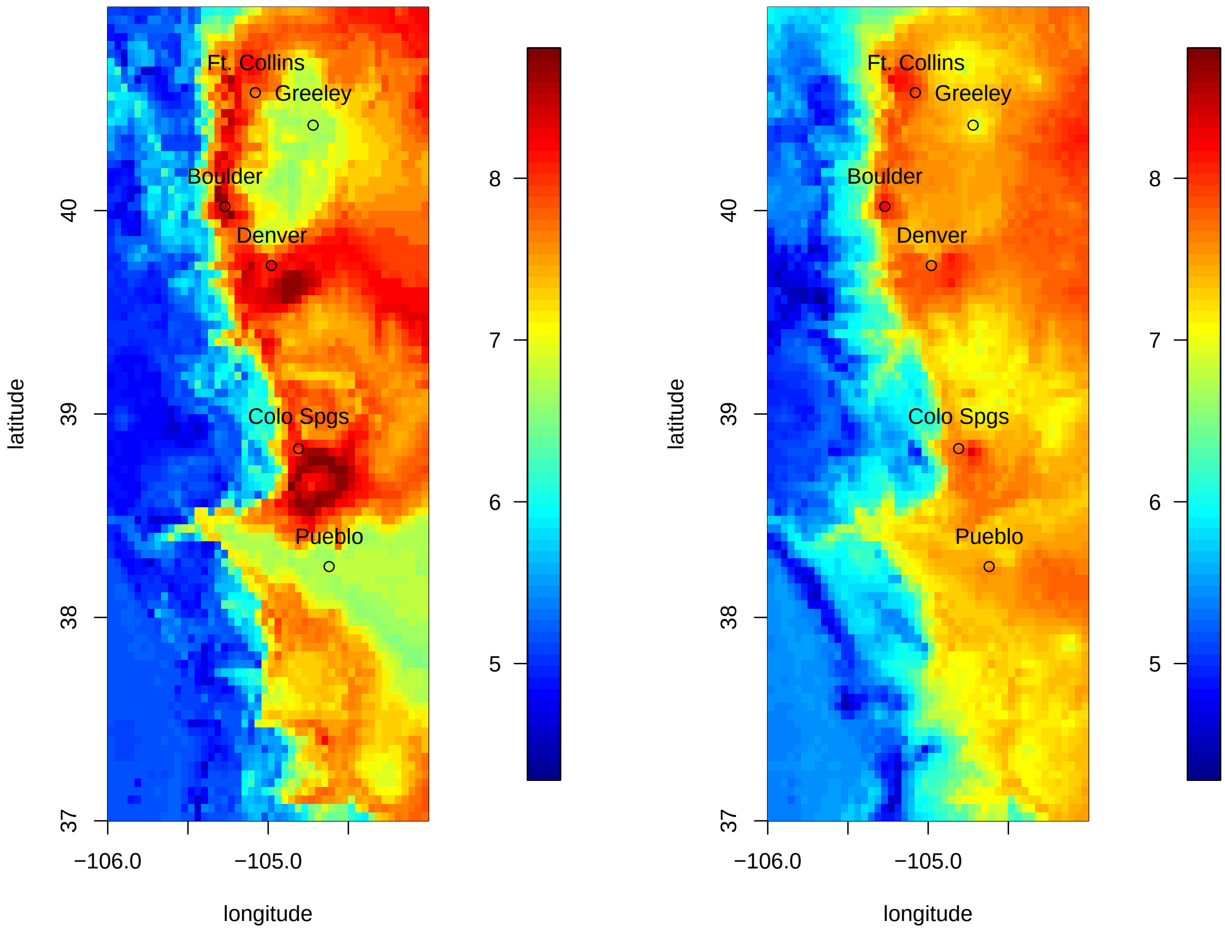


Exceedance Models Tested

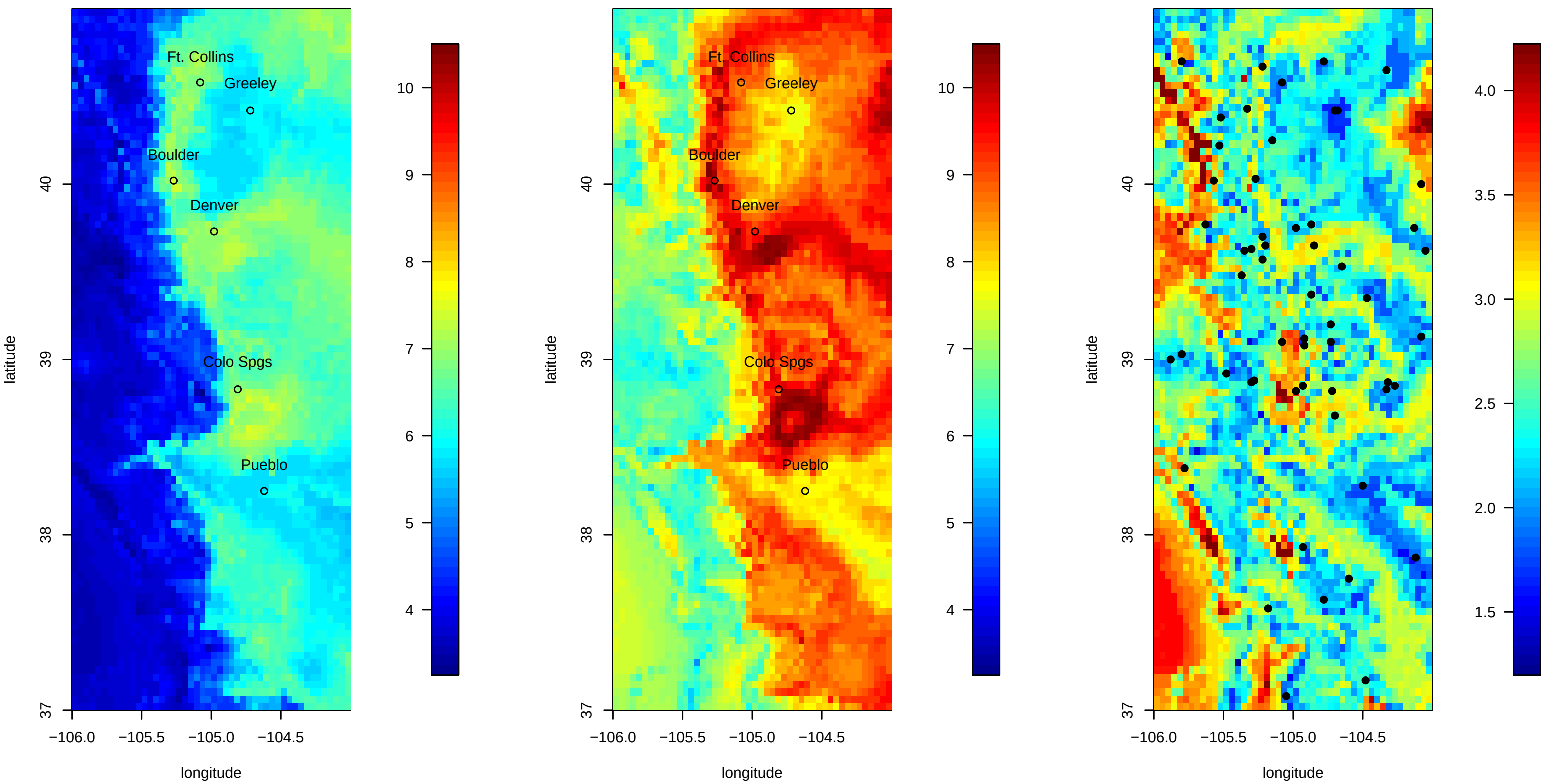
Models in Latitude/Longitude Space			$\bar{D}$	p_D	DIC
Model 1:	$\phi =$	$\alpha_0 + \epsilon_\phi$	73442.0	40.9	73482.9
	$\xi =$	ξ			
Model 2:	$\phi =$	$\alpha_0 + \alpha_1(\text{msp}) + \epsilon_\phi$	73441.6	40.8	73482.4
	$\xi =$	ξ			
Model 3:	$\phi =$	$\alpha_0 + \alpha_1(\text{elev}) + \epsilon_\phi$	73443.0	35.5	73478.5
	$\xi =$	ξ			
Model 4:	$\phi =$	$\alpha_0 + \alpha_1(\text{elev}) + \alpha_2(\text{msp}) + \epsilon_\phi$	73443.7	35.0	73478.6
	$\xi =$	ξ			
Models in Climate Space			$\bar{D}$	p_D	DIC
Model 5:	$\phi =$	$\alpha_0 + \epsilon_\phi$	73437.1	30.4	73467.5
	$\xi =$	ξ			
Model 6:	$\phi =$	$\alpha_0 + \alpha_1(\text{elev}) + \epsilon_\phi$	73438.8	28.3	73467.1
	$\xi =$	ξ			
Model 7:	$\phi =$	$\alpha_0 + \epsilon_\phi$	**73437.5**	**28.8**	**73466.3**
	$\xi =$	$\xi_{mtn},\ \xi_{plains}$			
Model 8:	$\phi =$	$\alpha_0 + \alpha_1(\text{elev}) + \epsilon_\phi$	73436.7	30.3	73467.0
	$\xi =$	$\xi_{mtn},\ \xi_{plains}$			
Model 9:	$\phi =$	$\alpha_0 + \epsilon_\phi$	73433.9	54.6	73488.5
	$\xi =$	$\xi + \epsilon_\xi$			

$\epsilon_. \sim MVN(0, \Sigma)$ where $[\sigma]_{i,j} = \beta_{.,0} \exp(-\beta_{.,1} ||\boldsymbol{x}_i - \boldsymbol{x}_j||)$

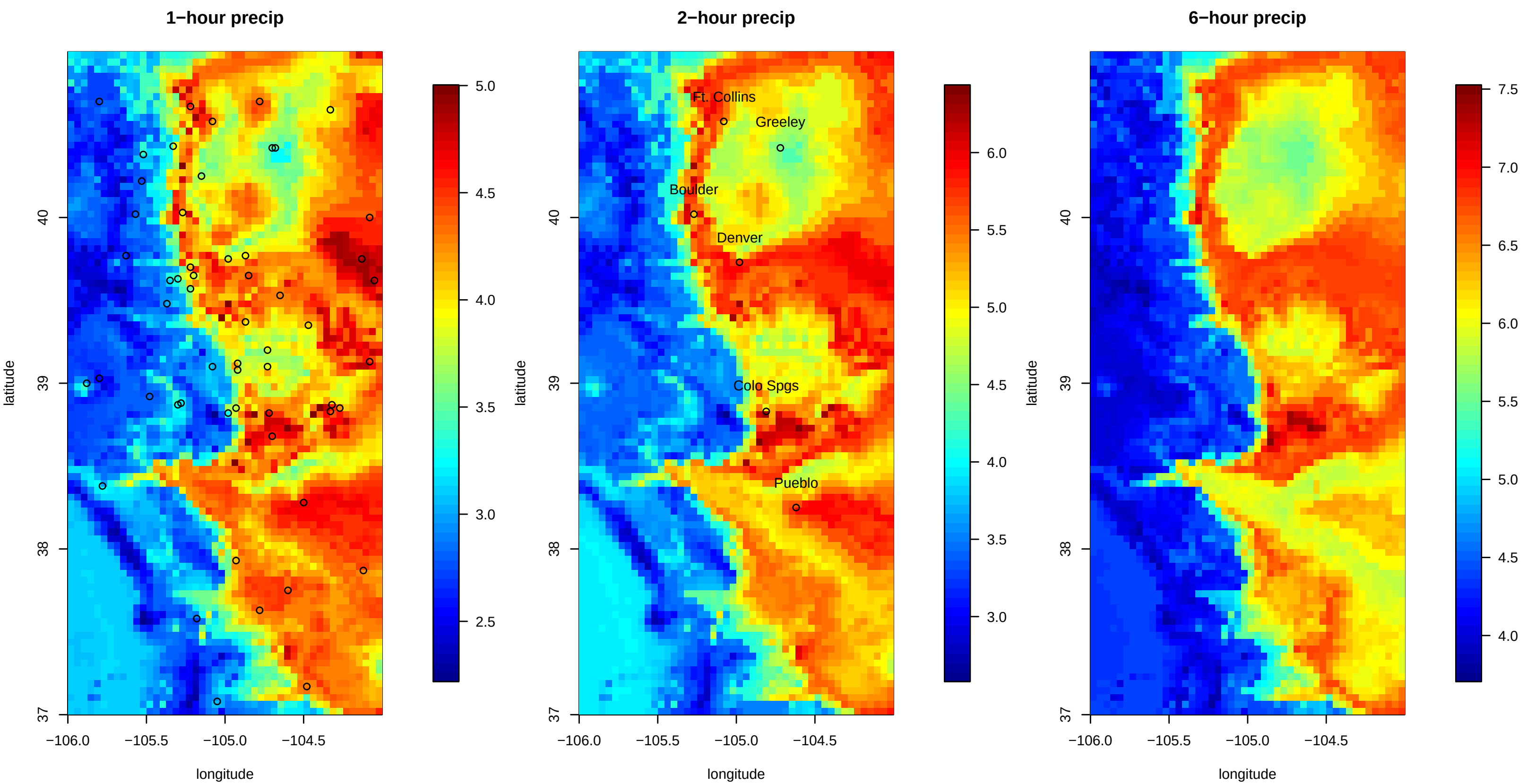
25-year Return Level Point Estimate



Return Level Uncertainty



Modeling Other Duration Periods

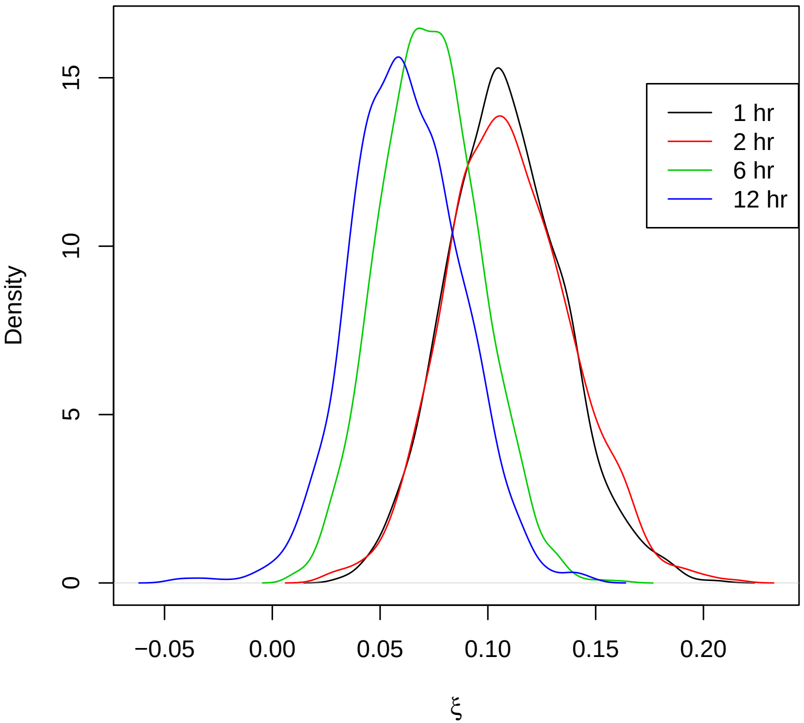


Time series for durations greater than one hour "artificially" created from 1 hour time series, models run separately.

Problem with separate approach

100-year return level

	6-hour	12-hour
Hartsel	7.82 cm	7.76 cm



Current Work

Can we model all duration periods at once and obtain consistent estimators?

- Combine the different durations' time series?
- Time series approach?

Can we explain the decreasing tail weight?