



Characteristics and Origins of Extreme Summertime Precipitation in the Lake Mead Watershed

Mike Sierks, Julie Kalansky, Forest Canon, F.M. Ralph

WSWC S2S 2019

May 24, 2019



Center for Western Weather
and Water Extremes

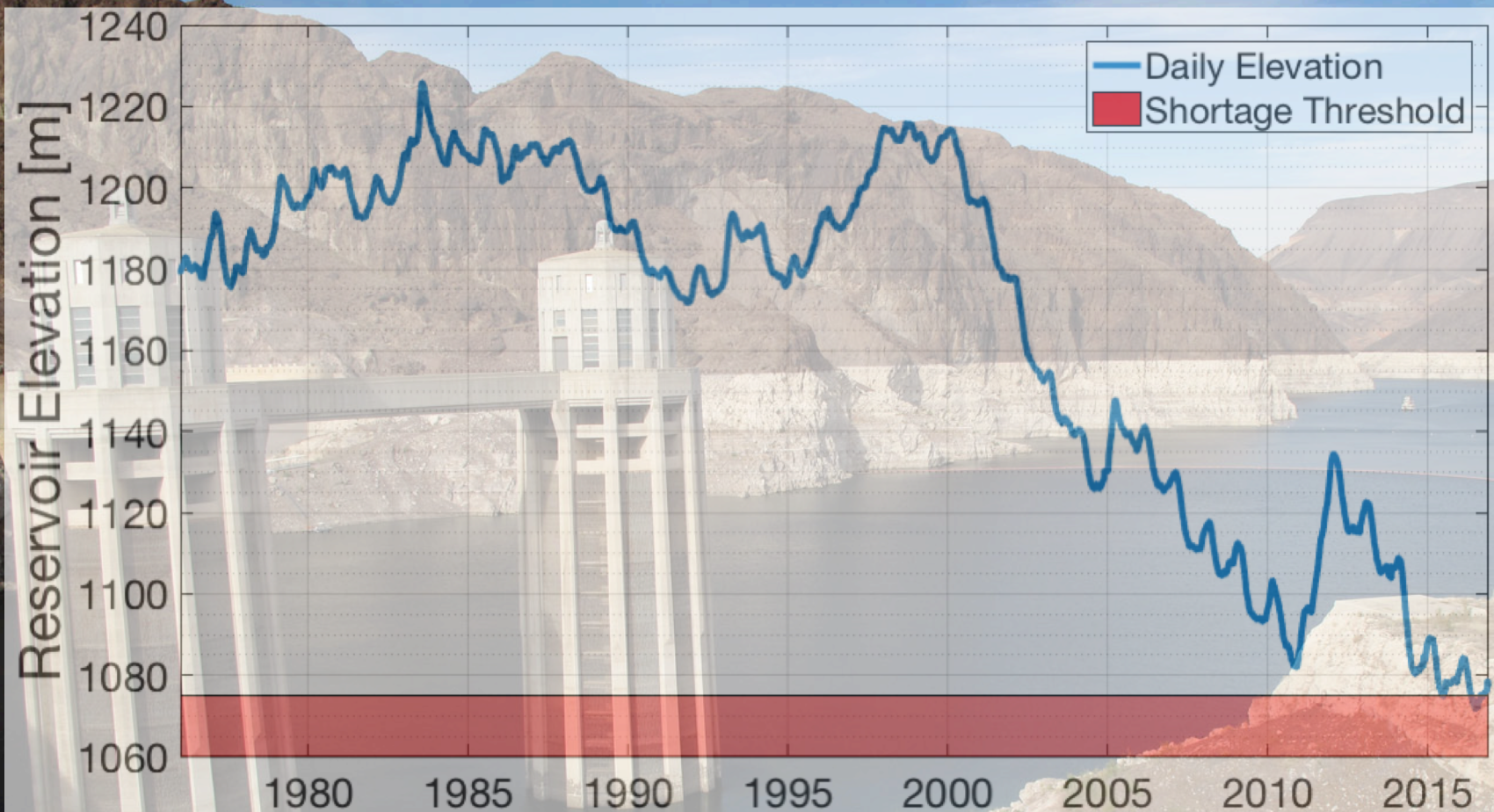
UC San Diego



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OCEANOGRAPHY



Lake Mead

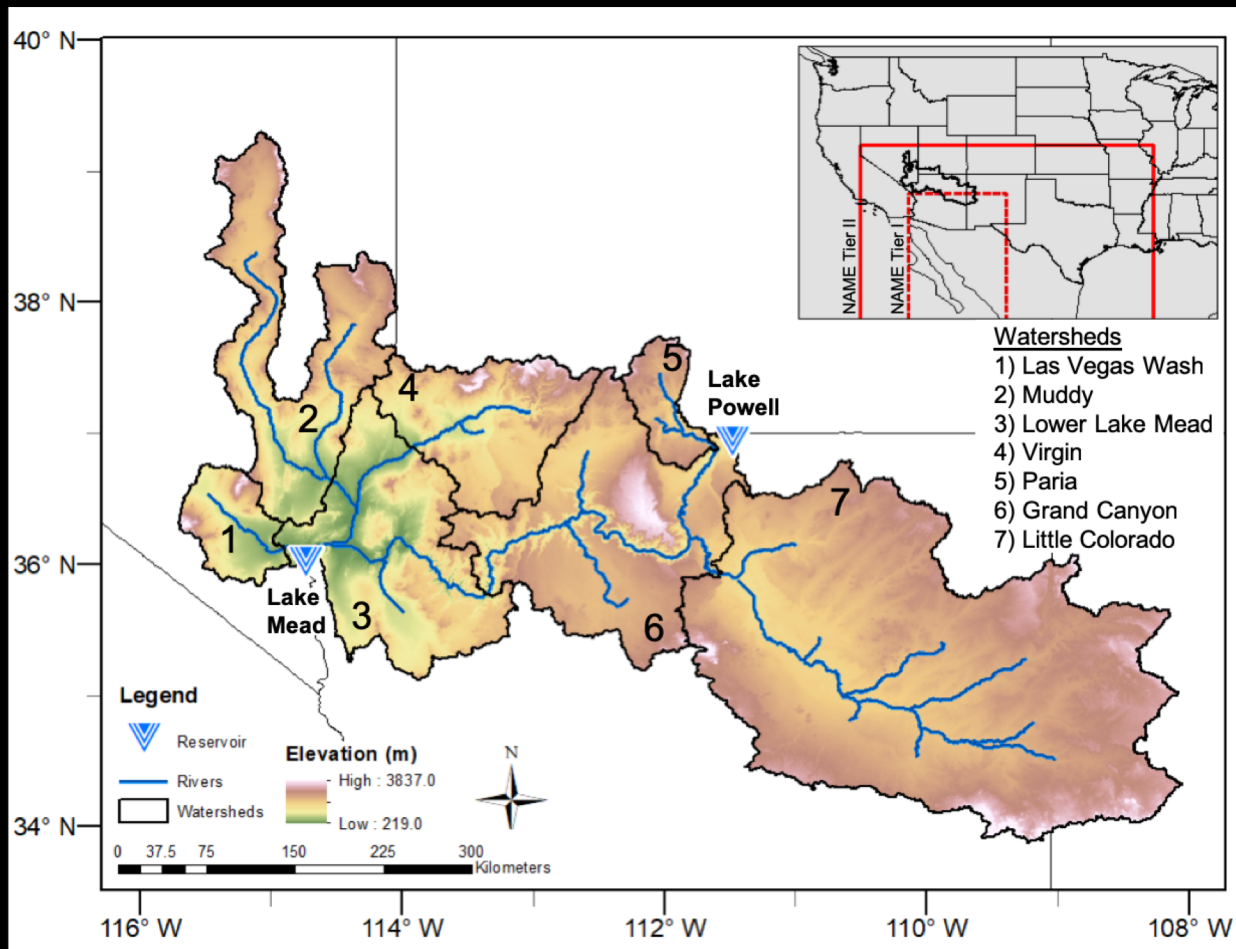


Lake Mead

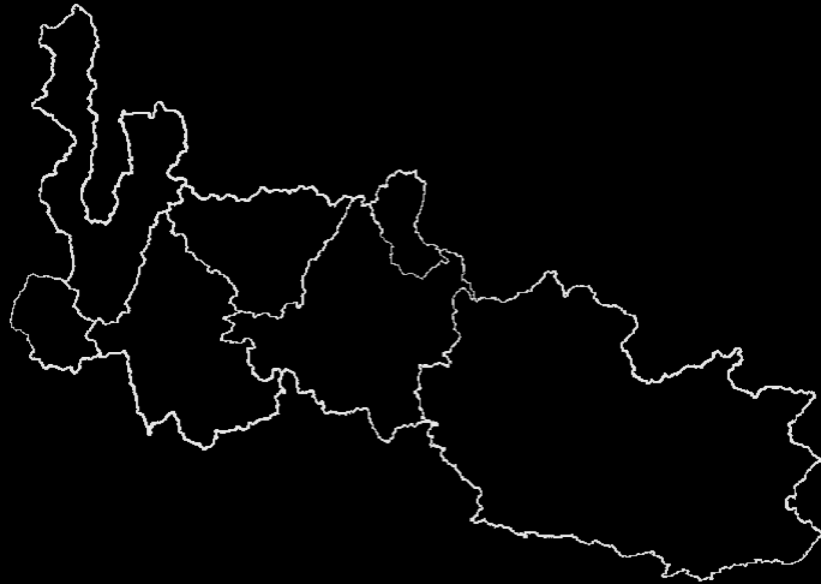
**Near Tucson,
October 2, 1983**



Rod Medvescek
Arizona Daily Star

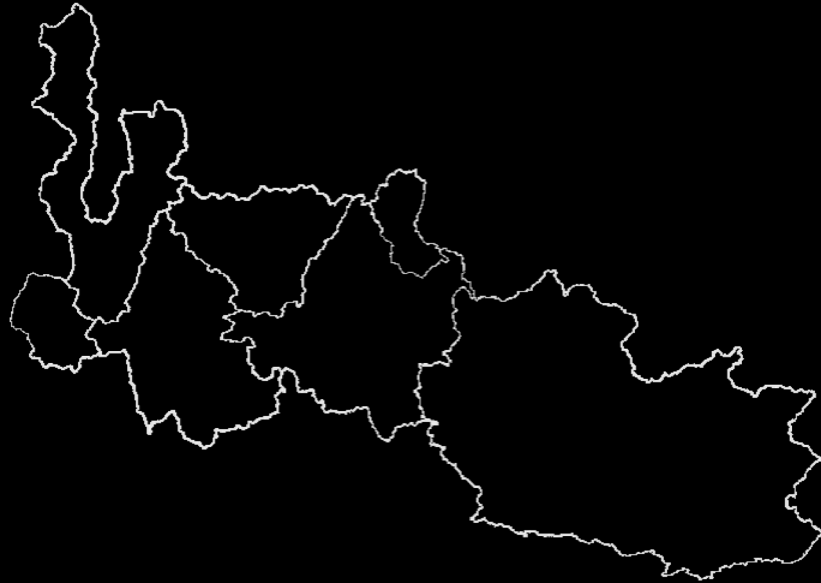


Conclusions



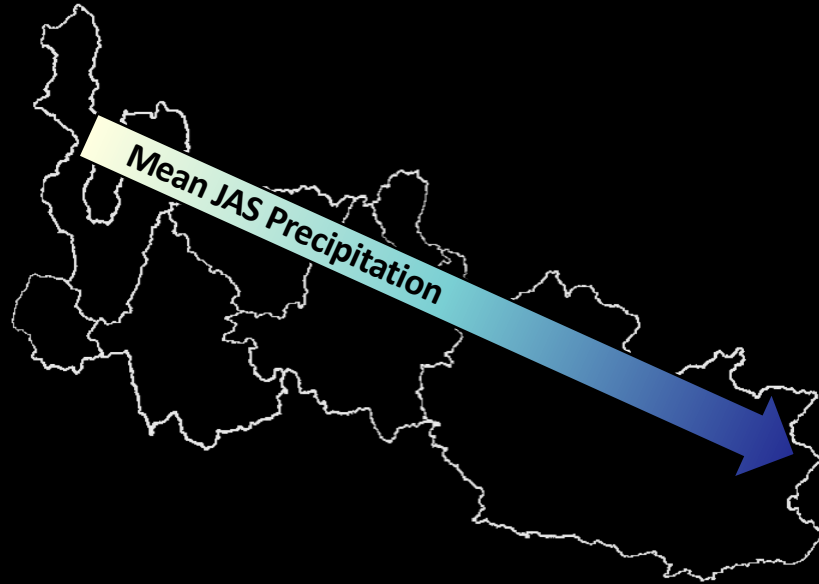
Conclusions

- Stark west-to-east gradient in JAS precipitation characteristics



Conclusions

- Stark west-to-east gradient in JAS precipitation characteristics



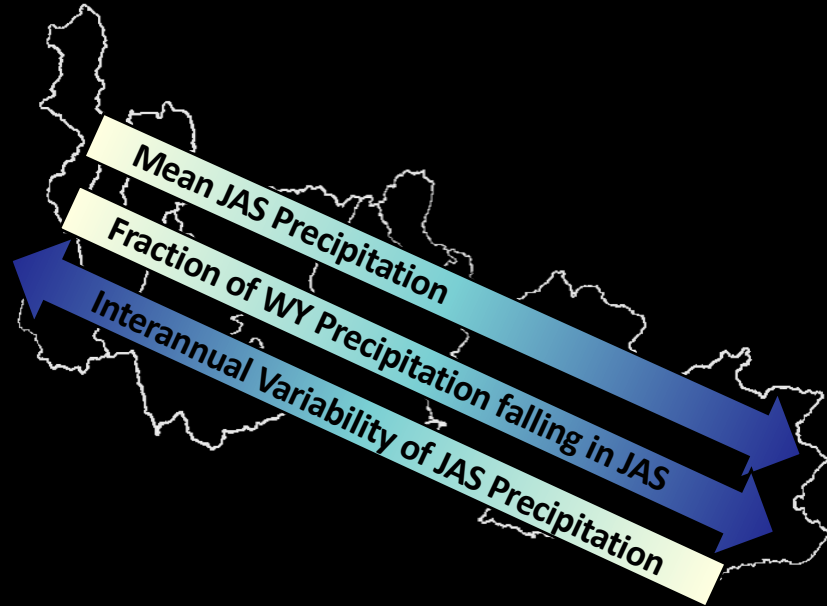
Conclusions

- Stark west-to-east gradient in JAS precipitation characteristics



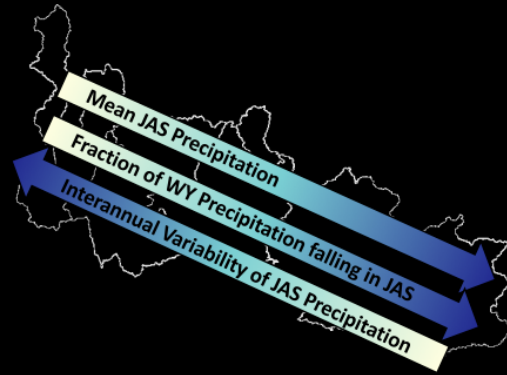
Conclusions

- Stark west-to-east gradient in JAS precipitation characteristics

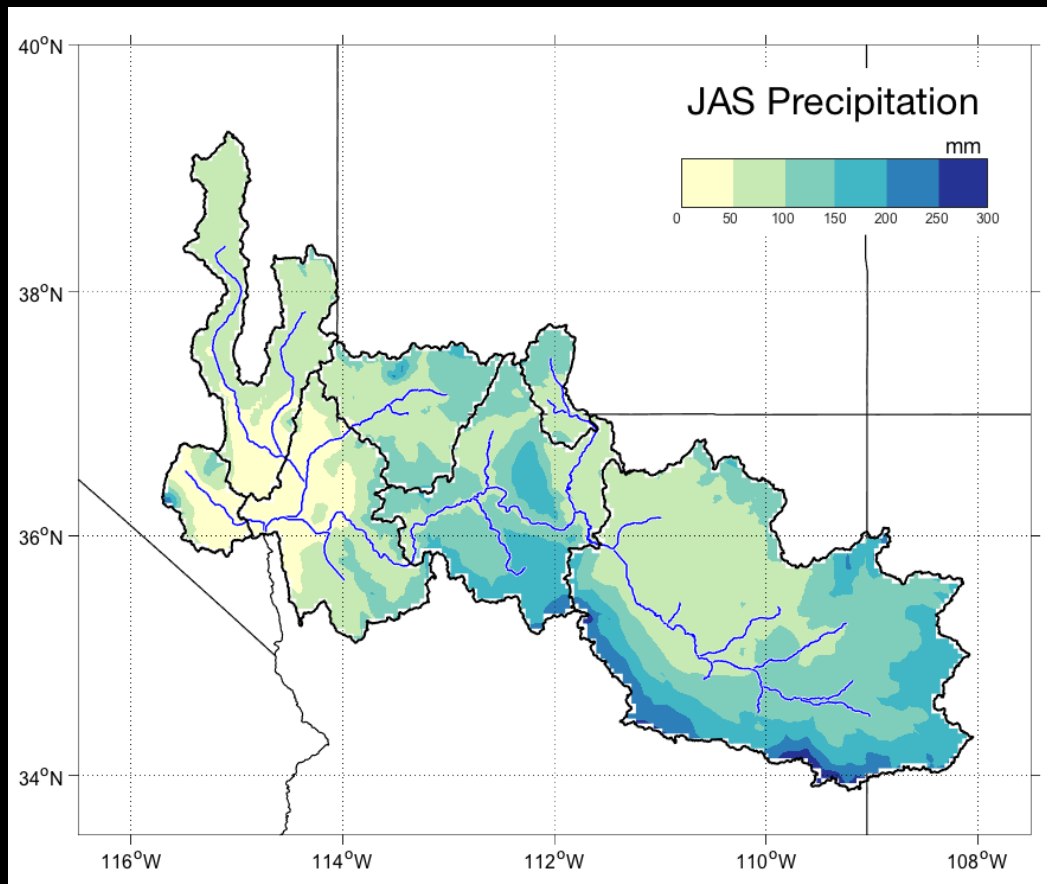


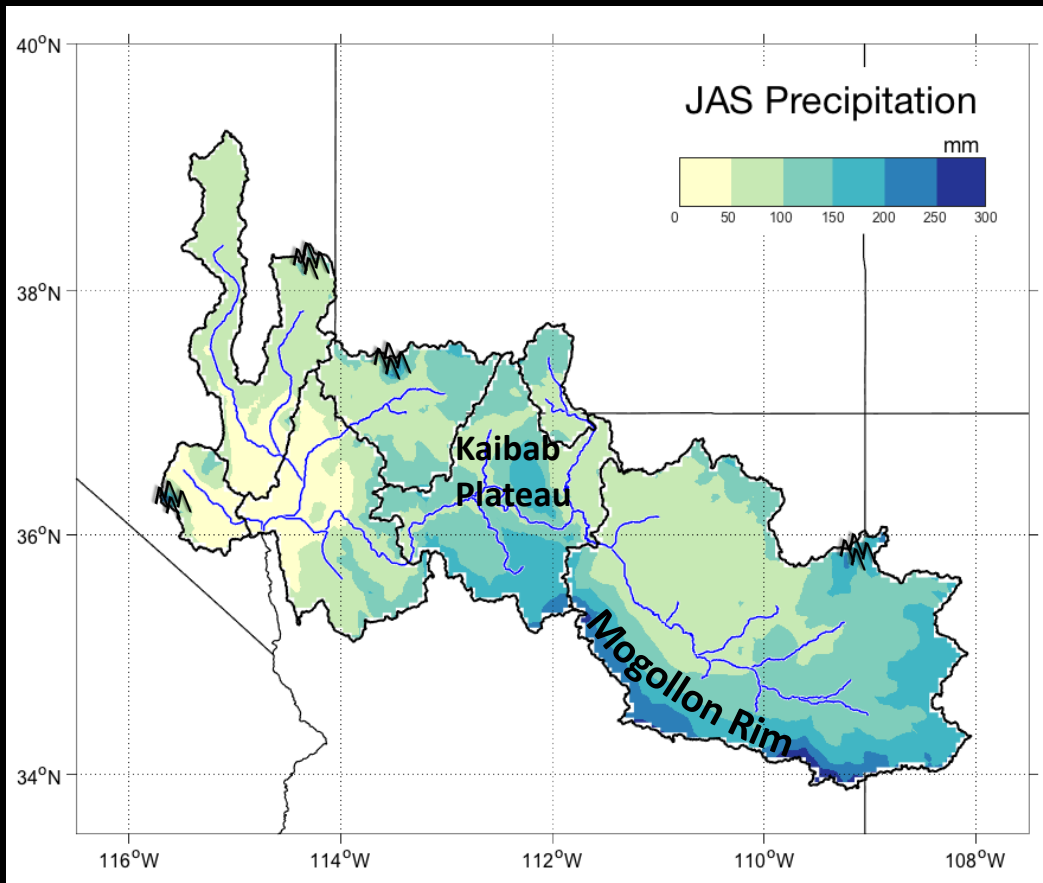
Conclusions

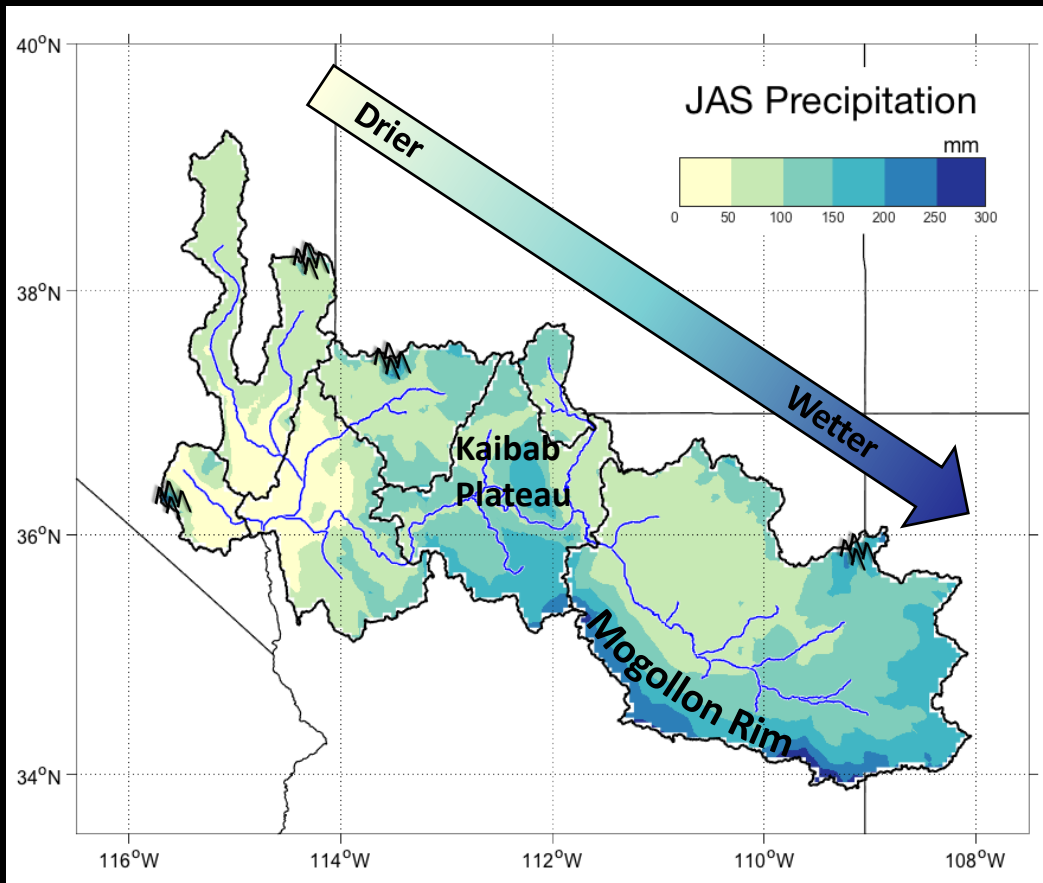
- Stark west-to-east gradient in JAS precipitation characteristics

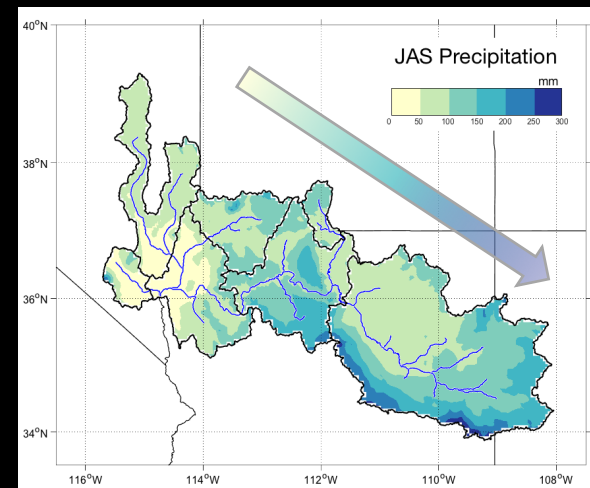
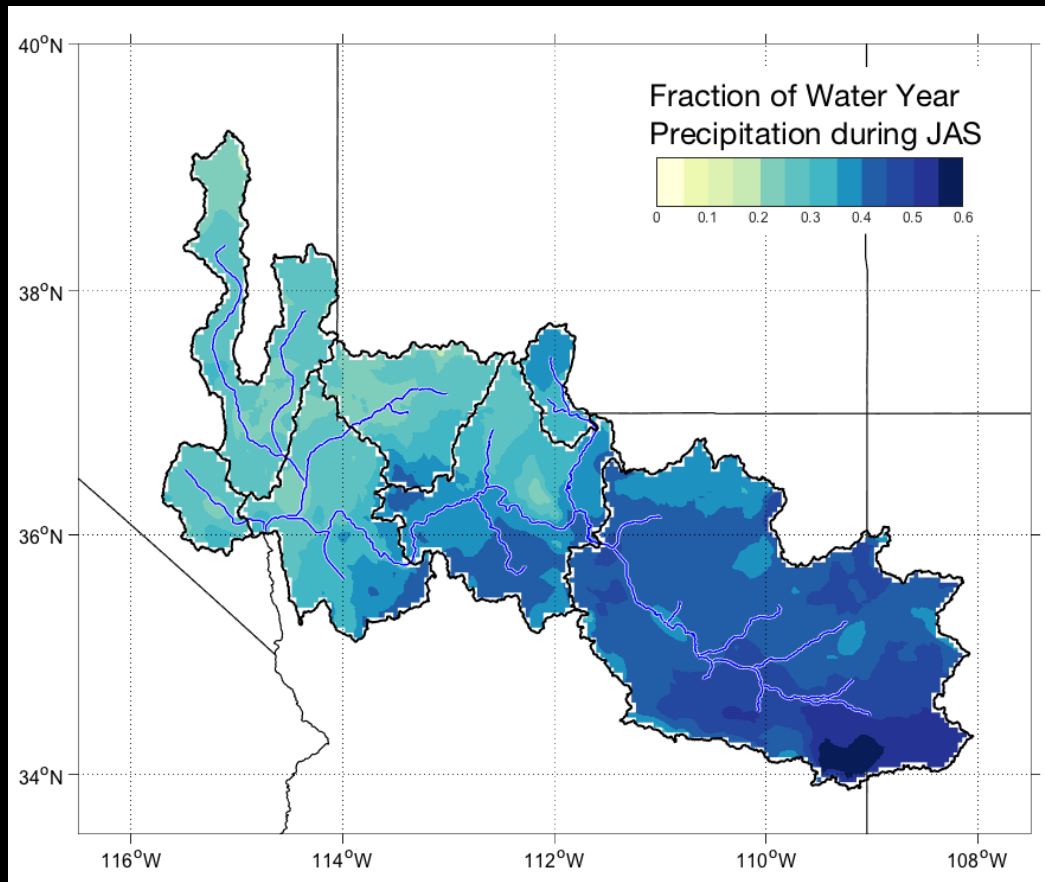


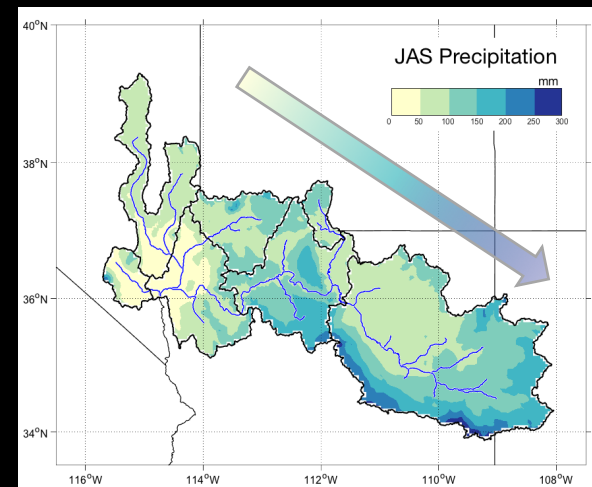
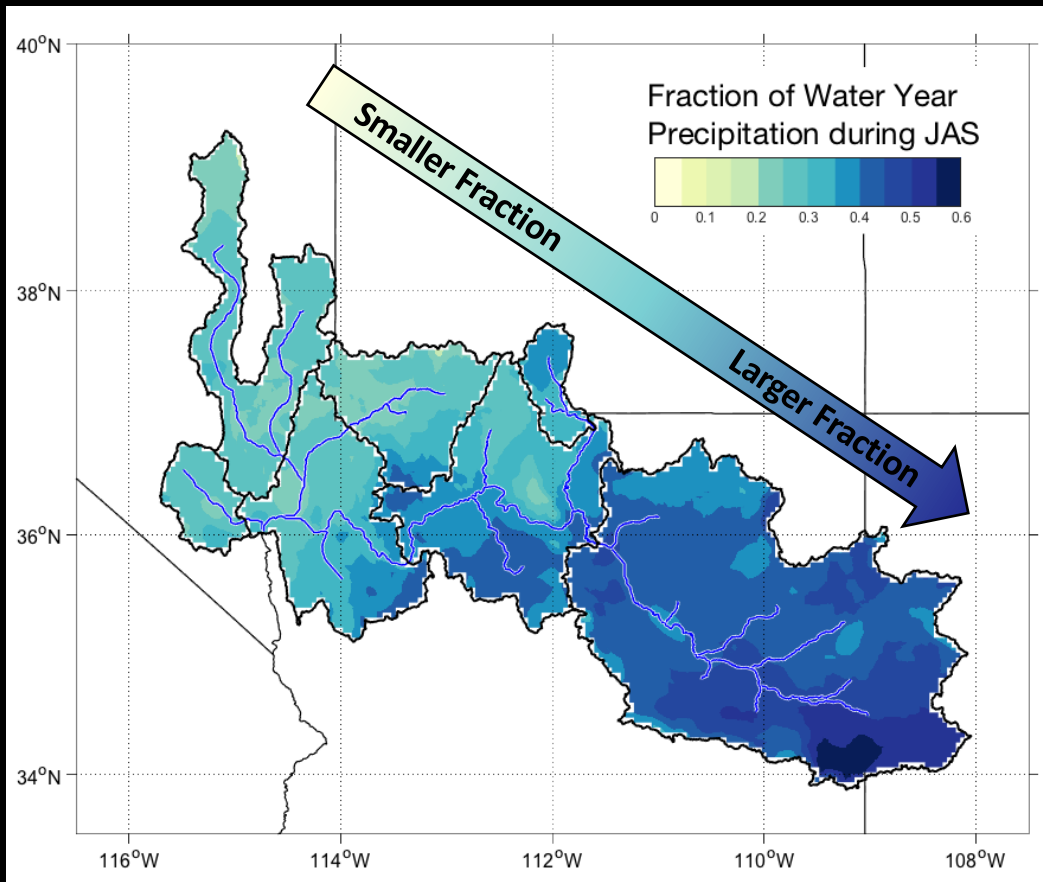
- Anticyclonic Rossby wave breaking in midlatitude westerlies over the US west coast is the dominant synoptic flow regime for extreme precipitation events in the Lake Mead watershed

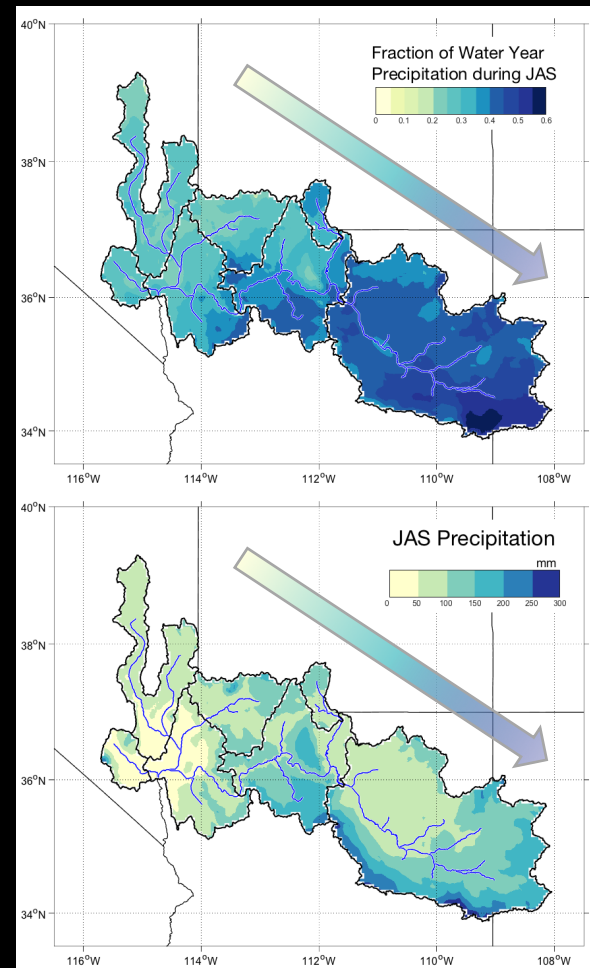
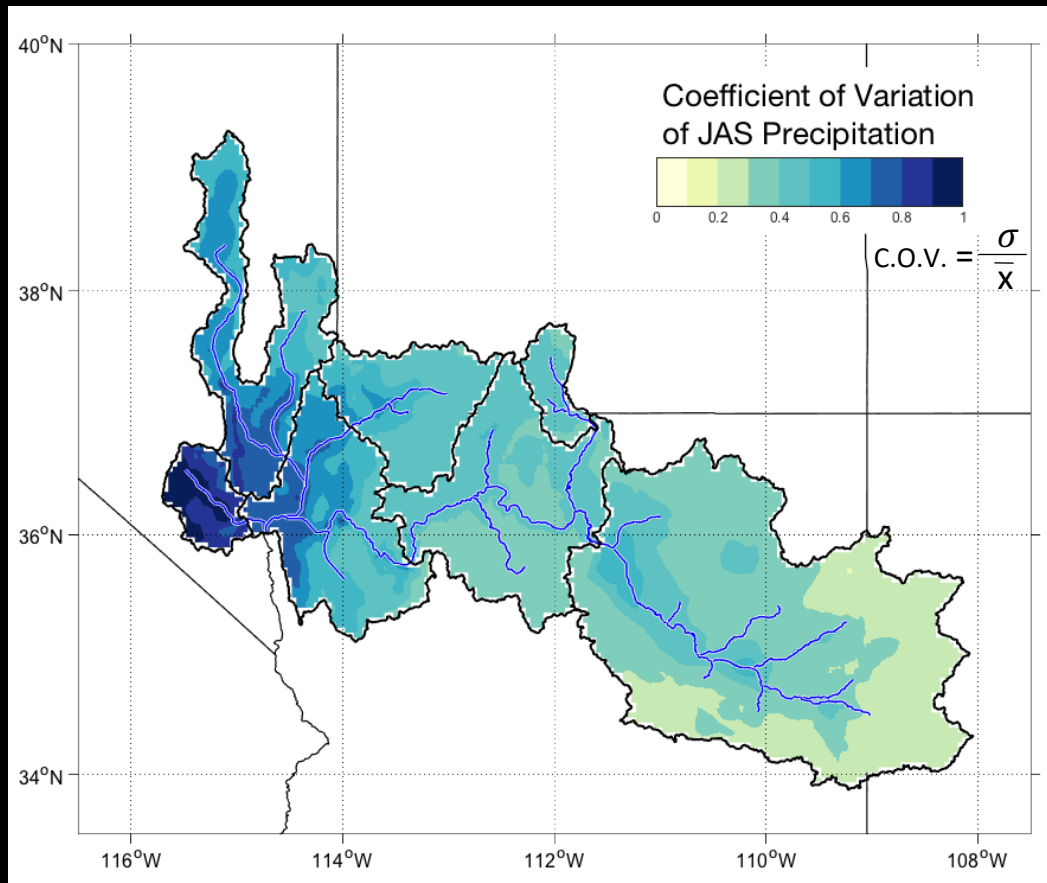


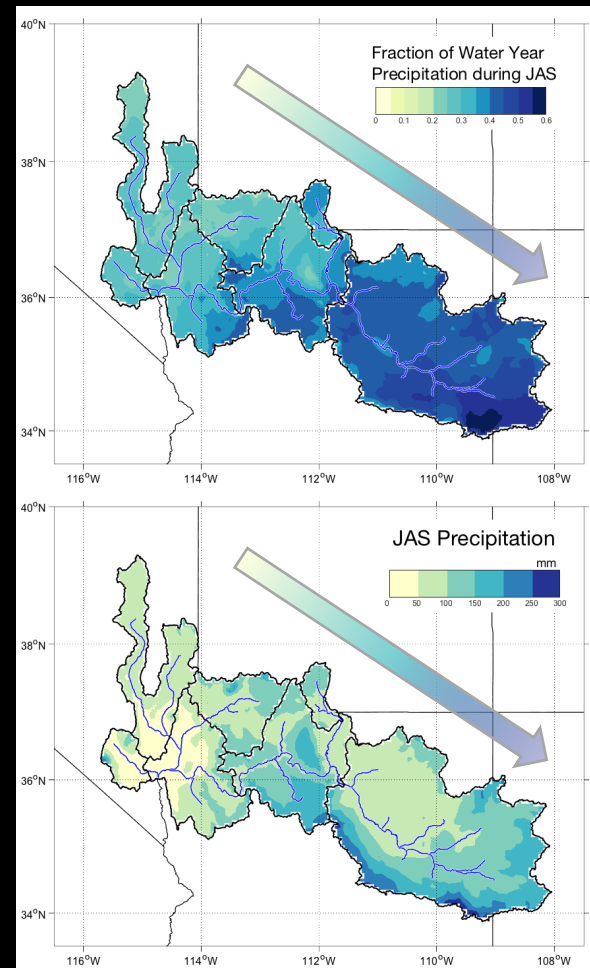
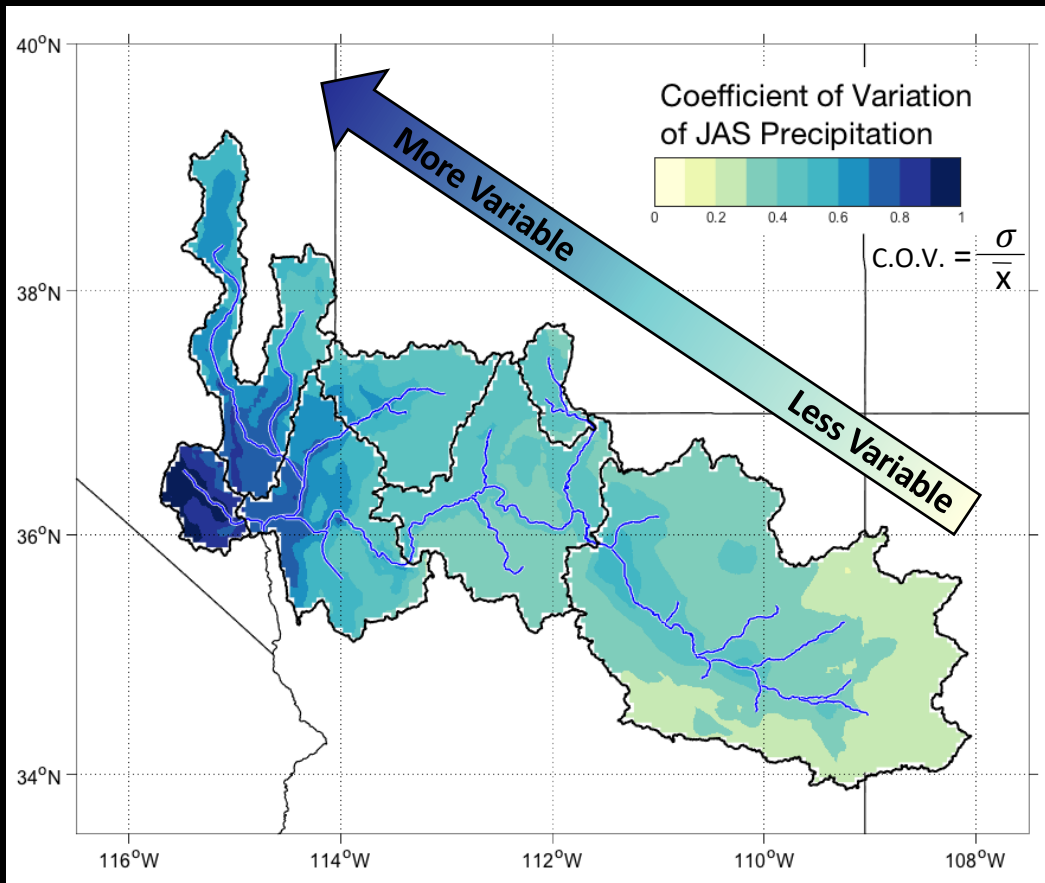


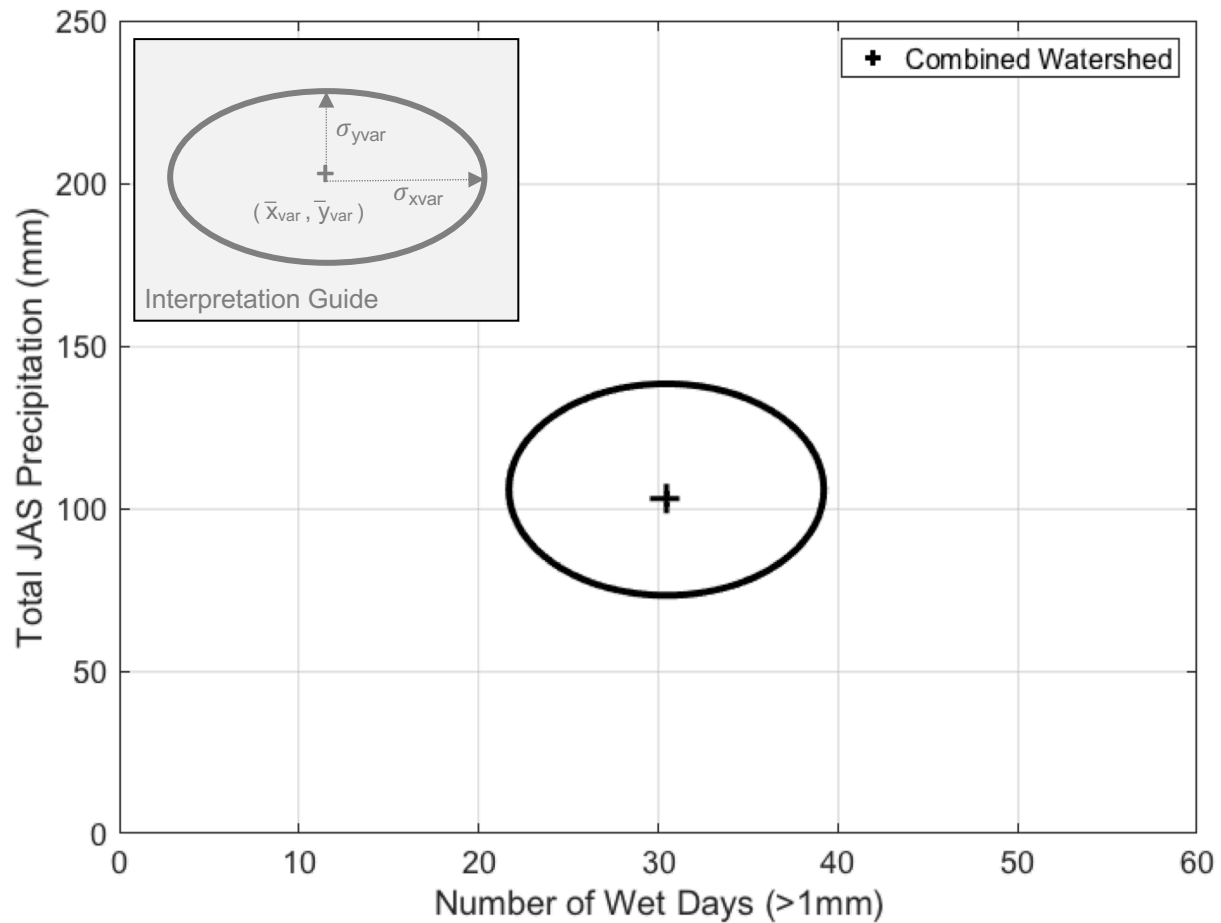


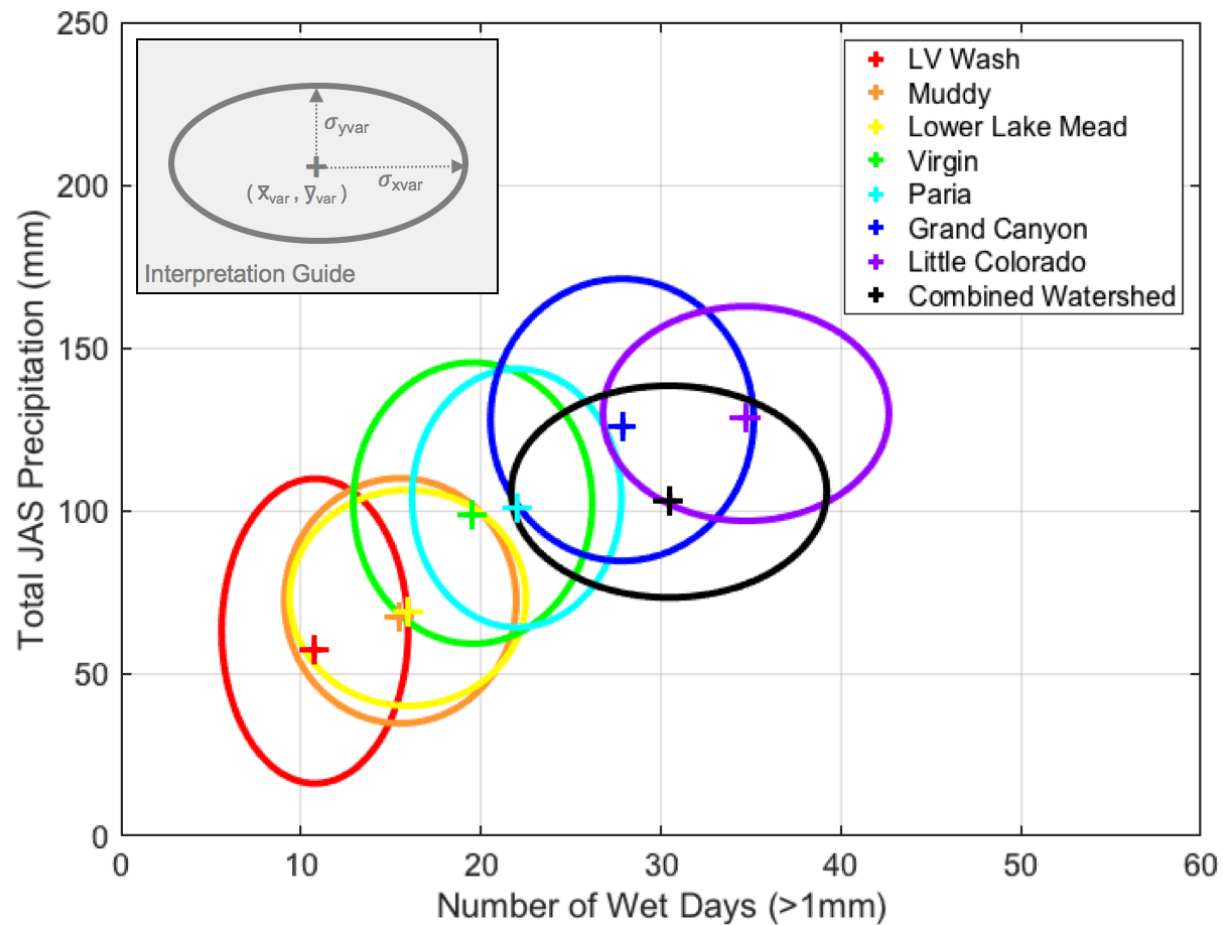


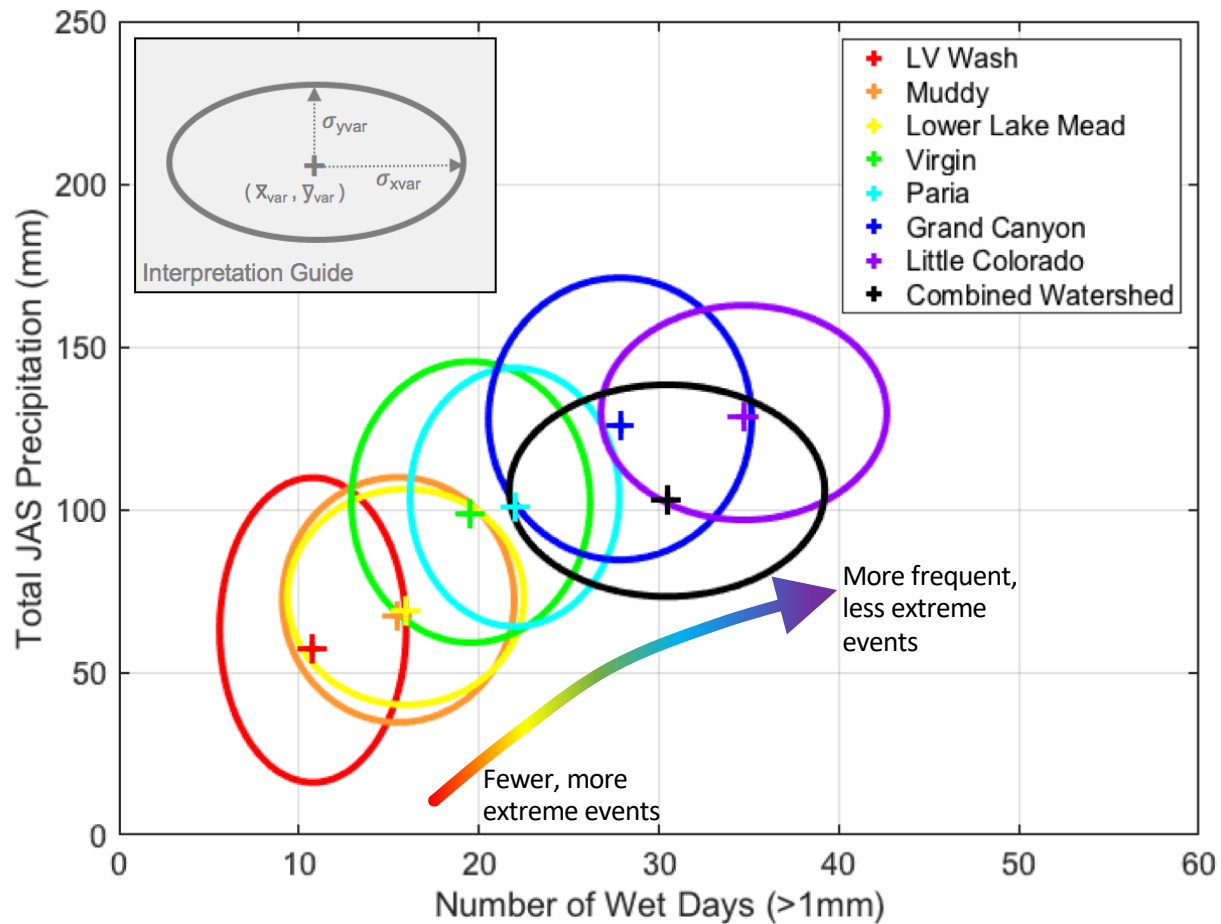


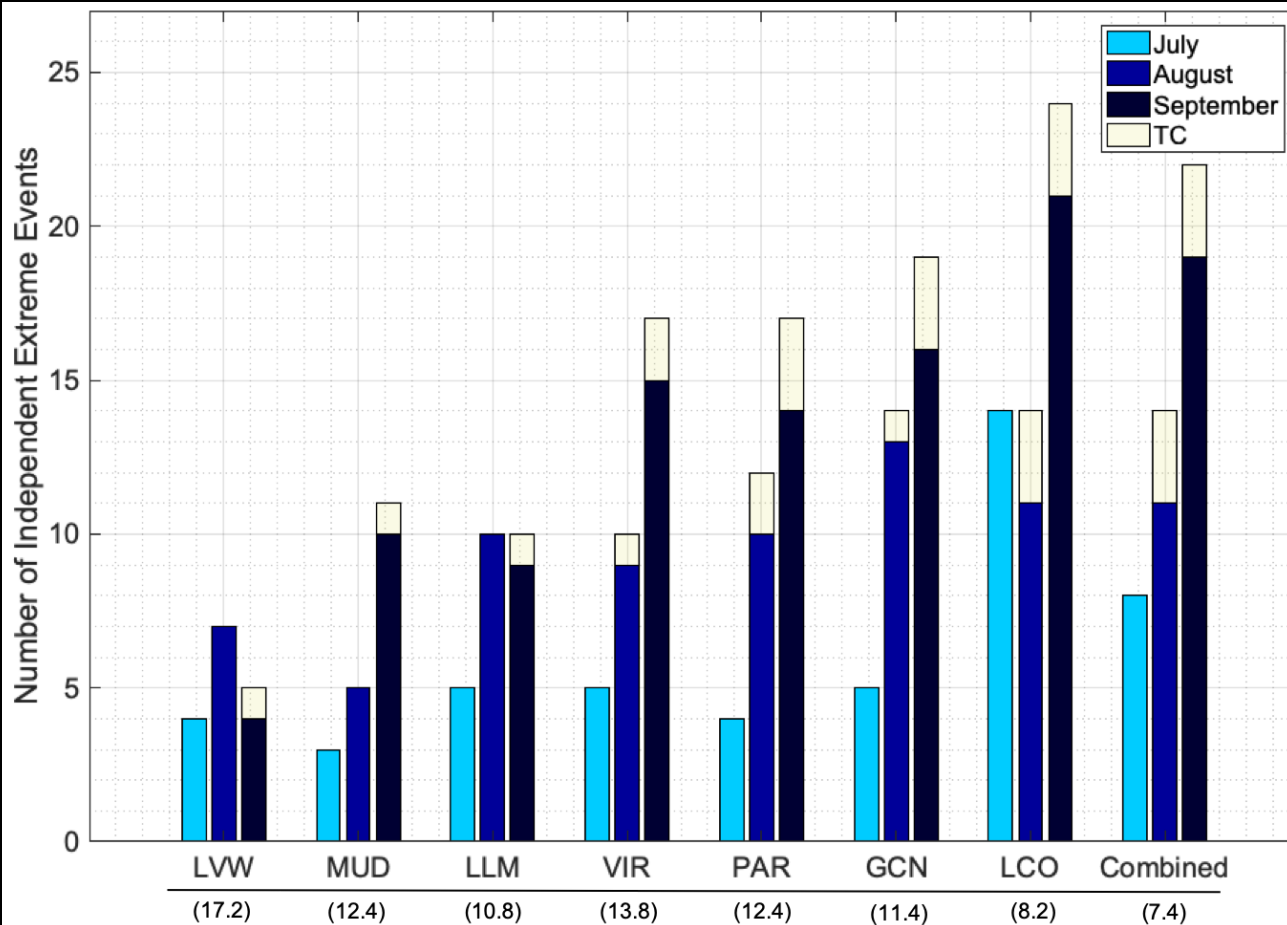




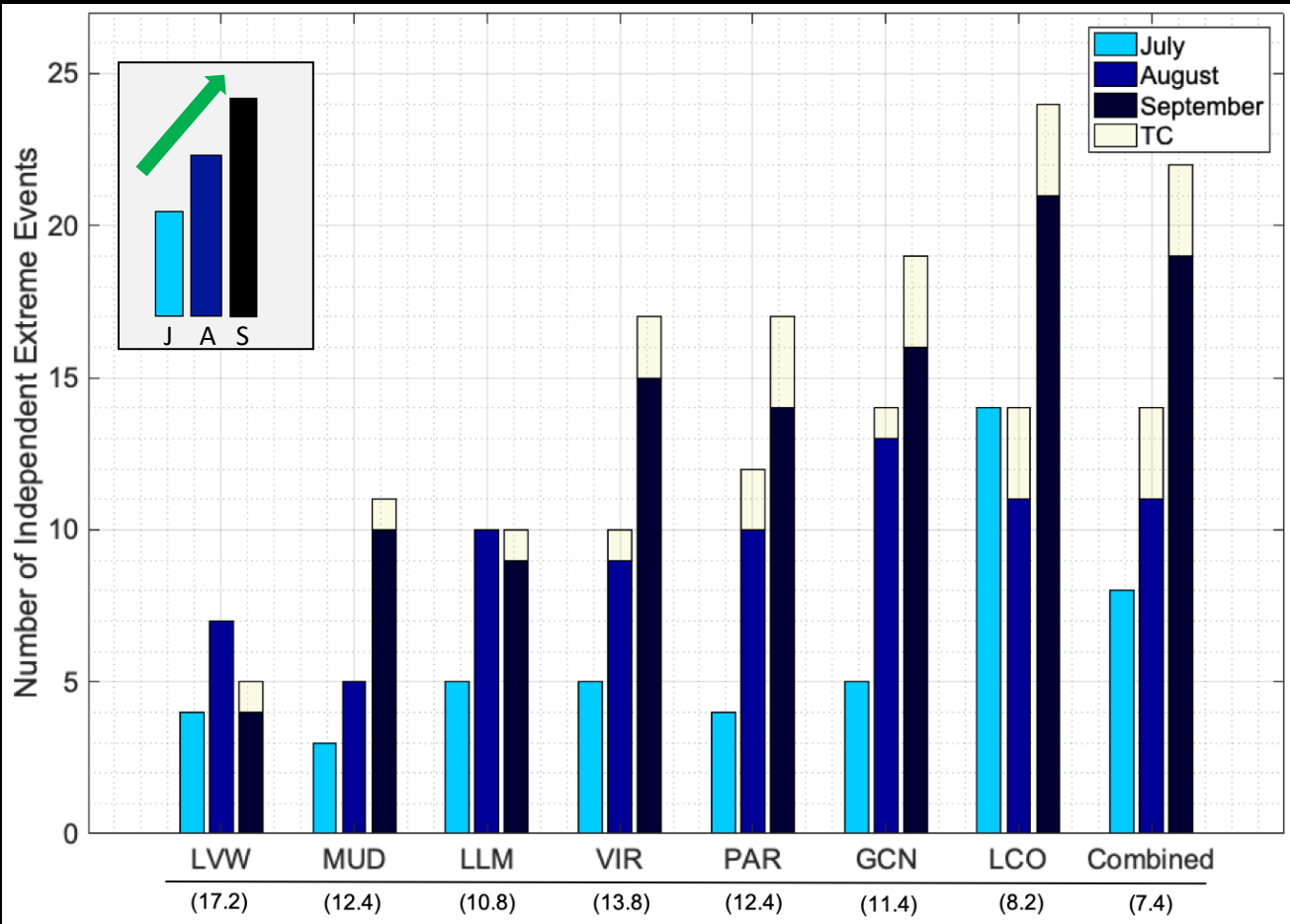


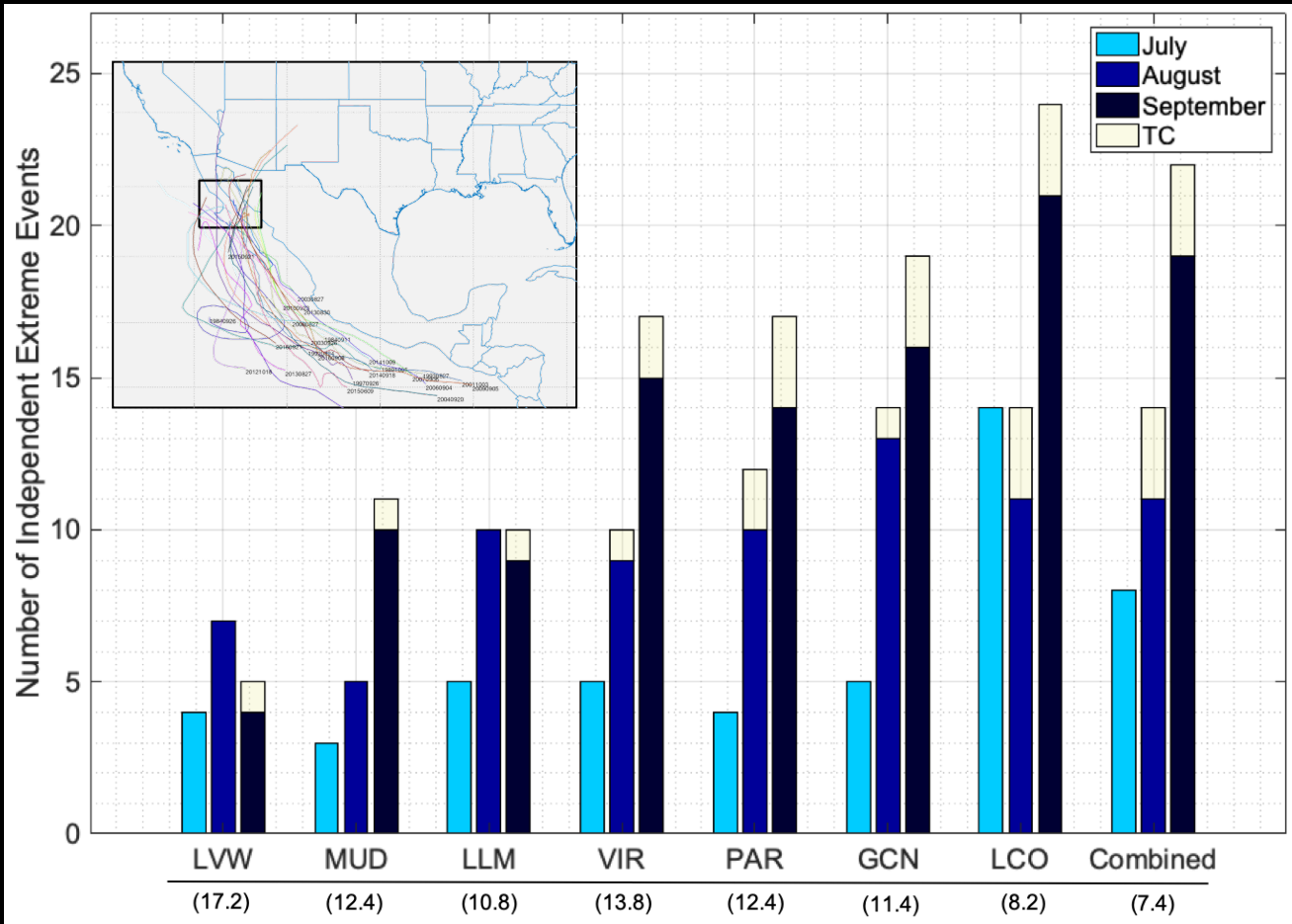




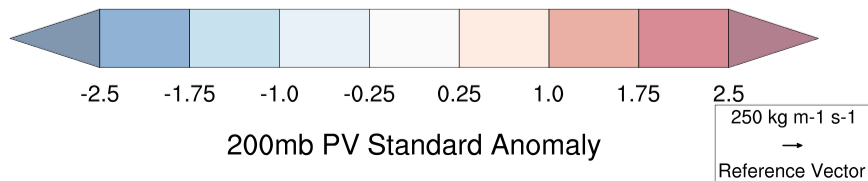
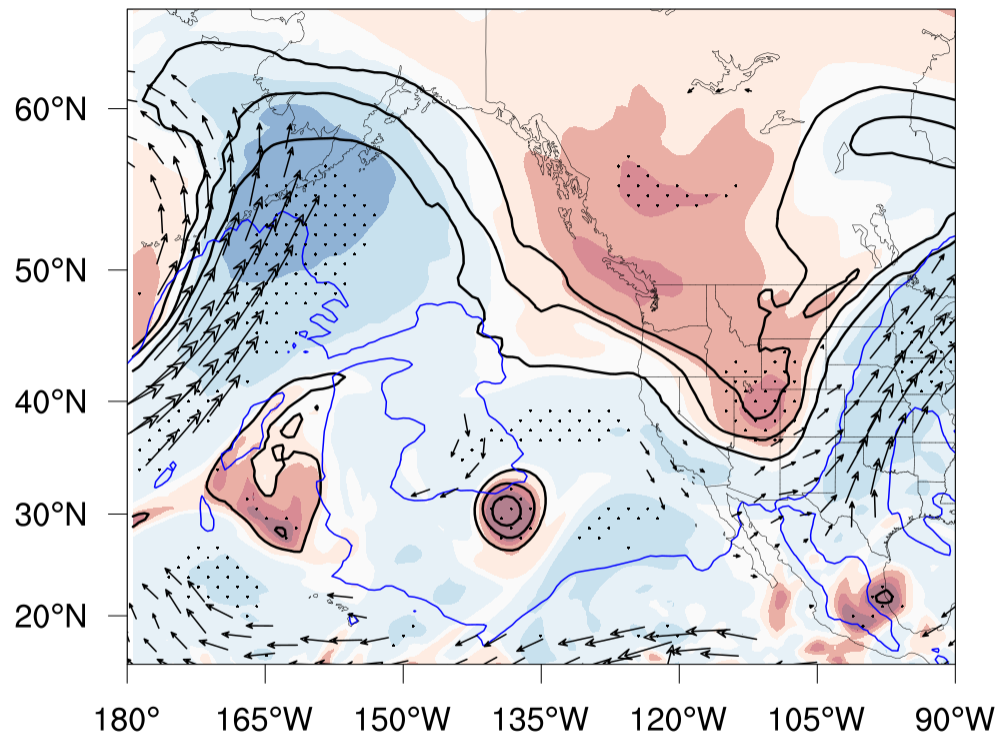


Extreme Event
defined as 95th
percentile of wet
days





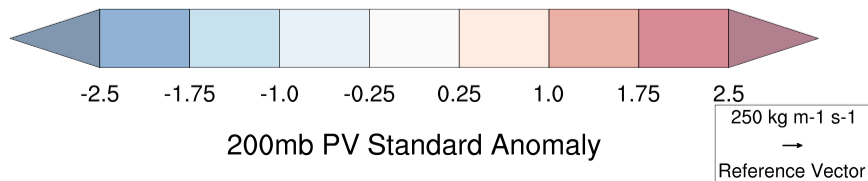
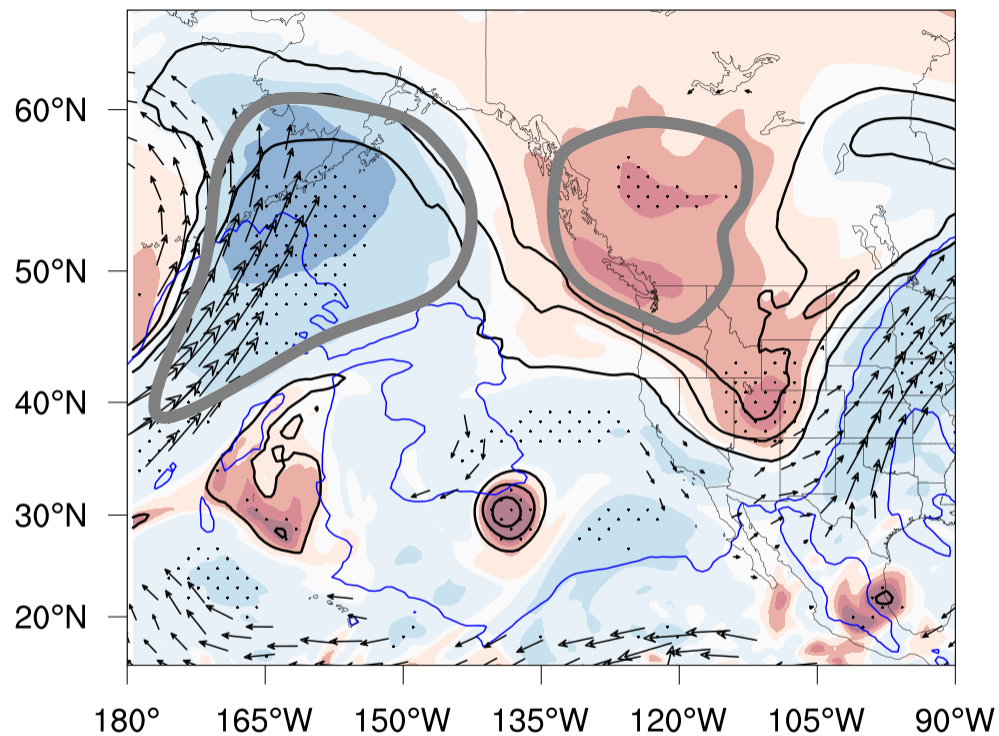
20070918 Event Day -5



2, 4, 6 PVU

33mm IWV

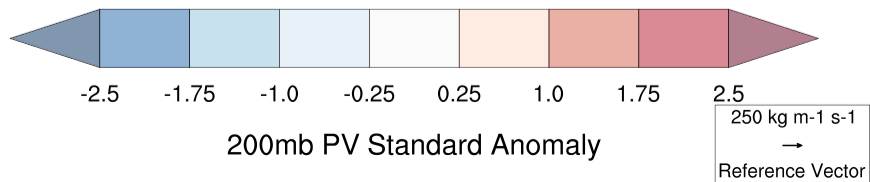
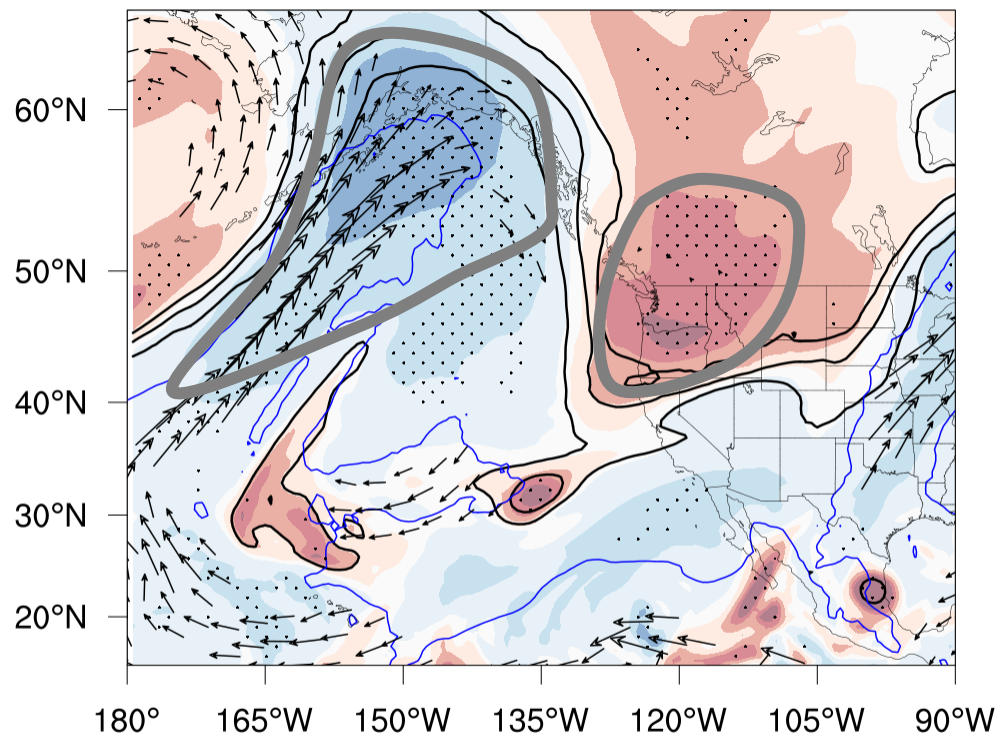
20070918 Event Day -5



2, 4, 6 PVU

33mm IWV

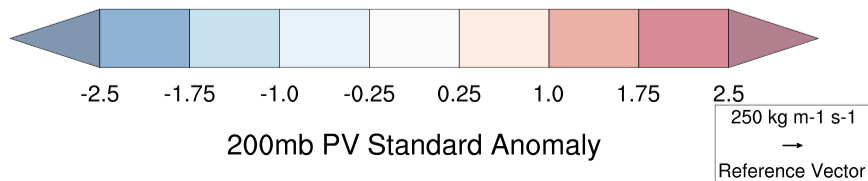
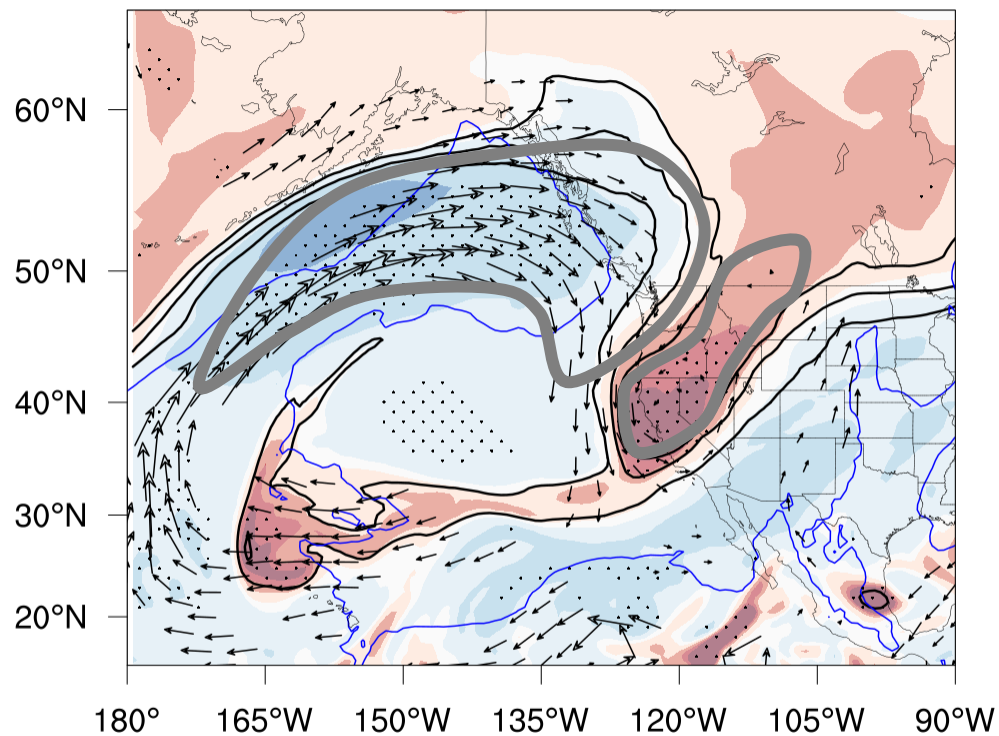
20070919 Event Day -4



~ 2, 4, 6 PVU

~ 33mm IWW

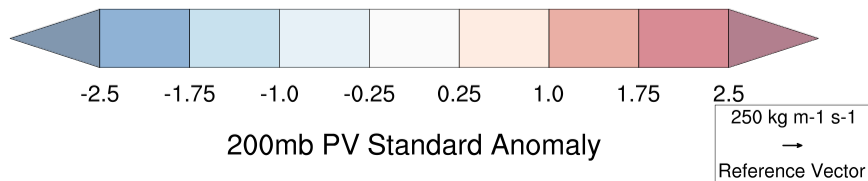
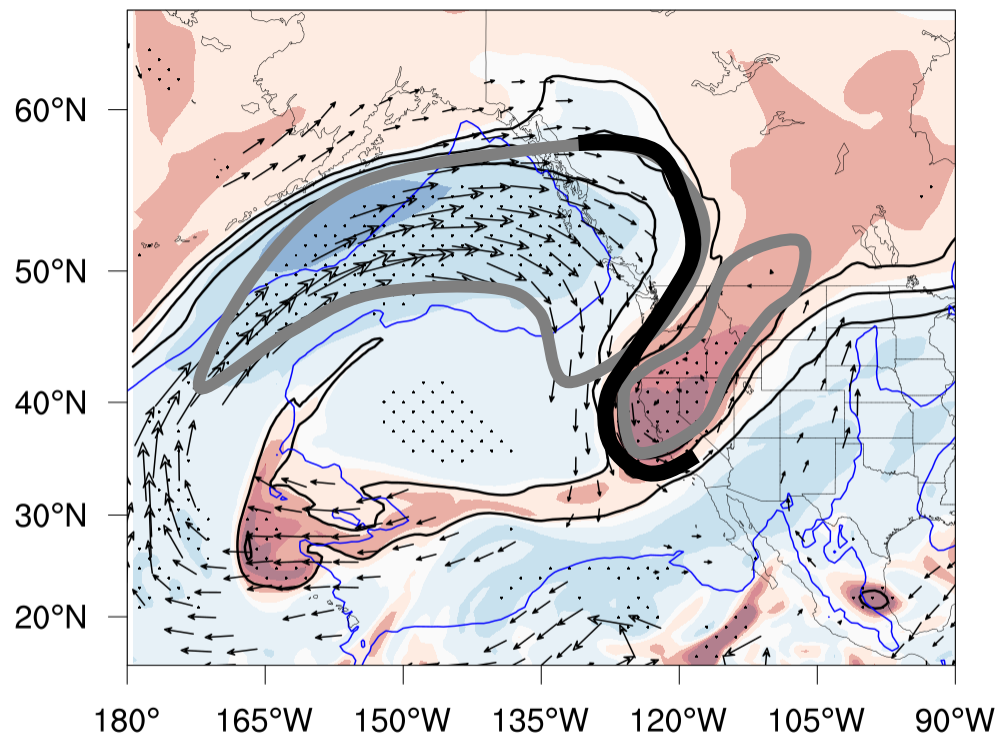
20070920 Event Day -3



~ 2, 4, 6 PVU

~ 33mm IWW

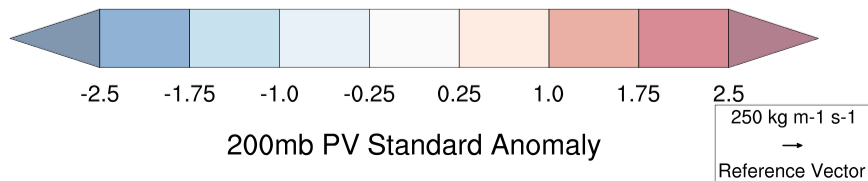
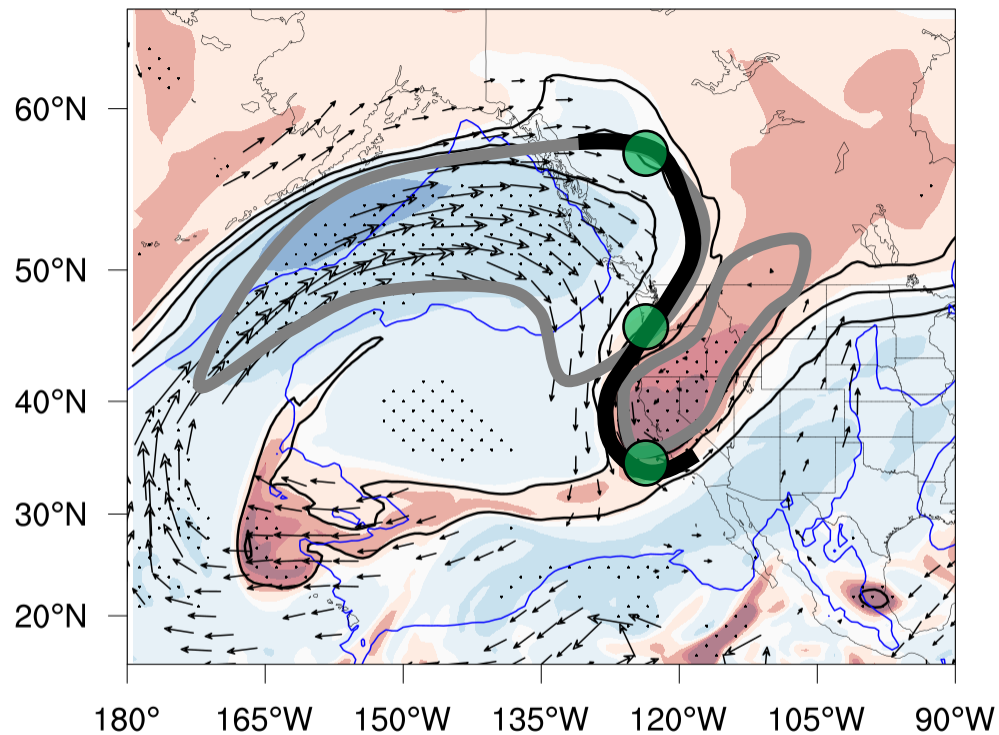
20070920 Event Day -3



~ 2, 4, 6 PVU

~ 33mm IWV

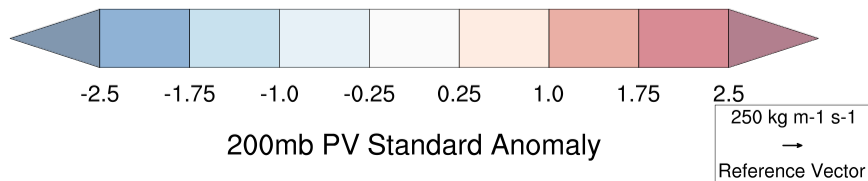
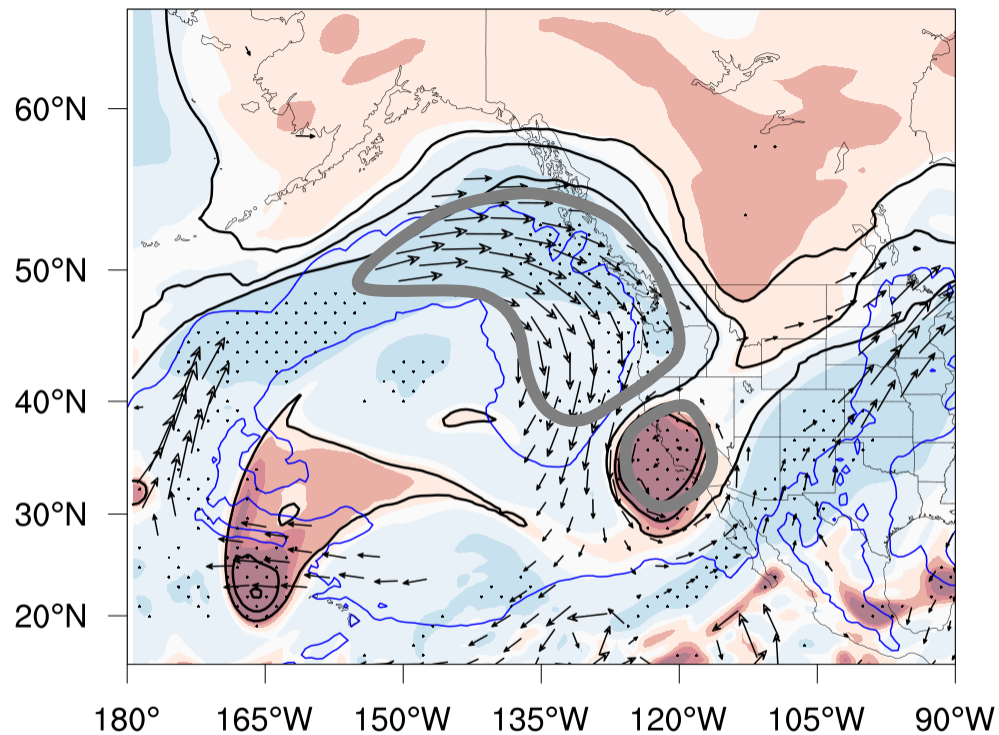
20070920 Event Day -3



~ 2, 4, 6 PVU

~ 33mm IWW

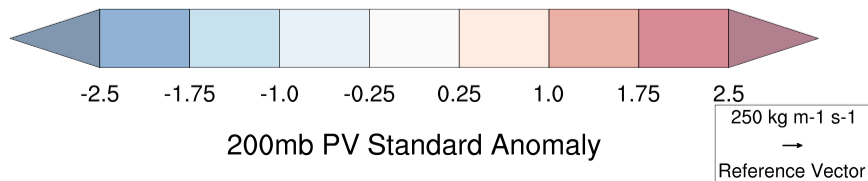
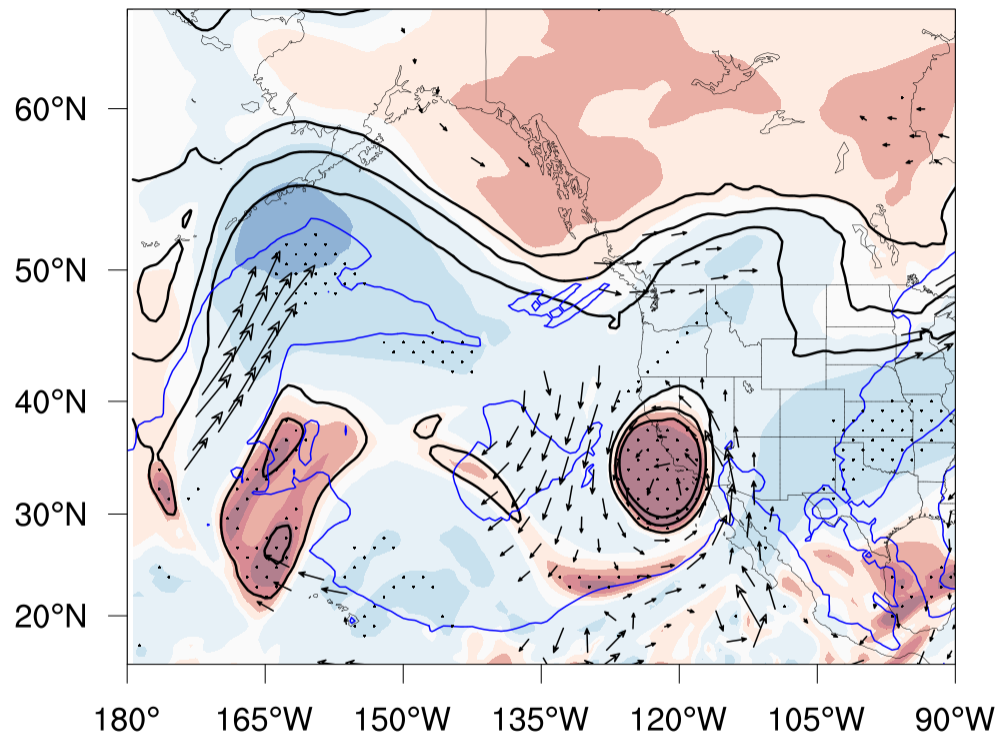
20070921 Event Day -2



~ 2, 4, 6 PVU

~ 33mm IWW

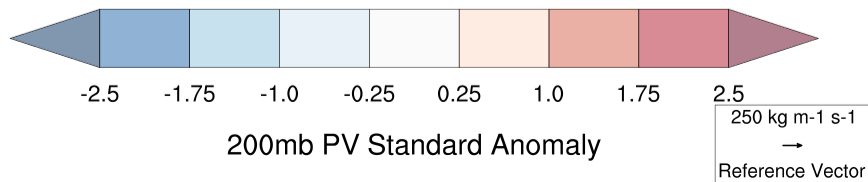
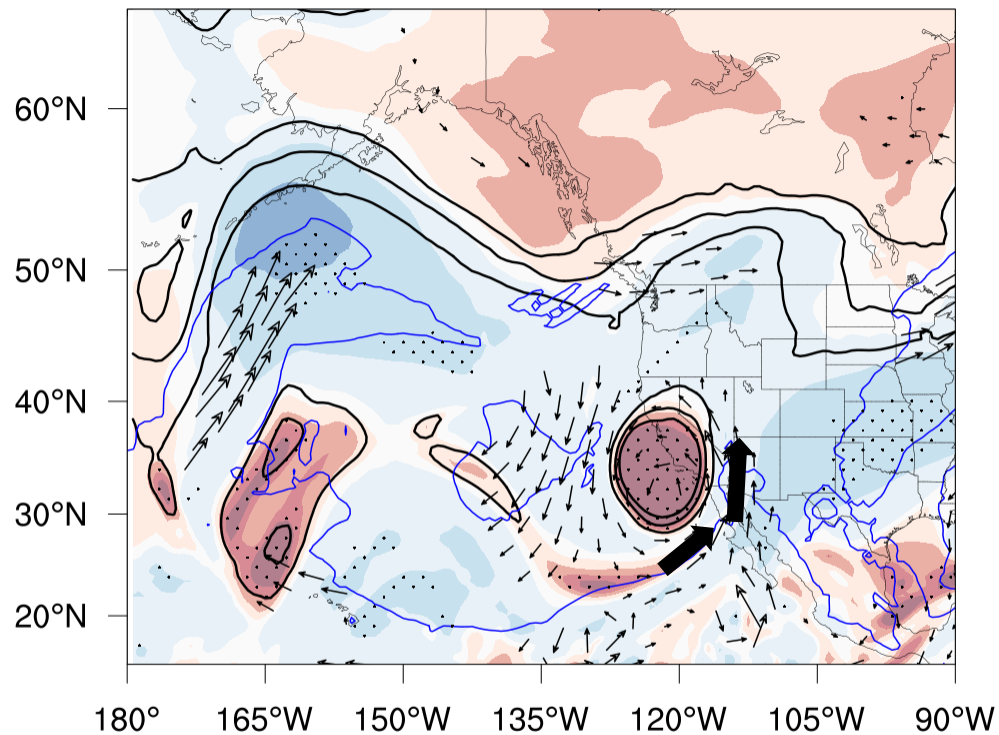
20070922 Event Day -1



~ 2, 4, 6 PVU

~ 33mm IWW

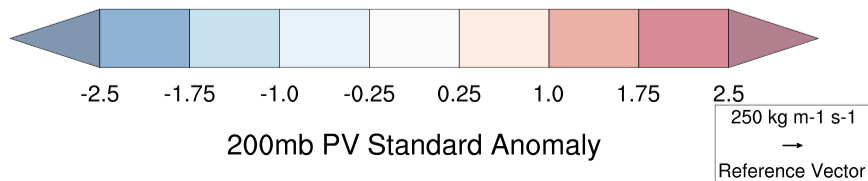
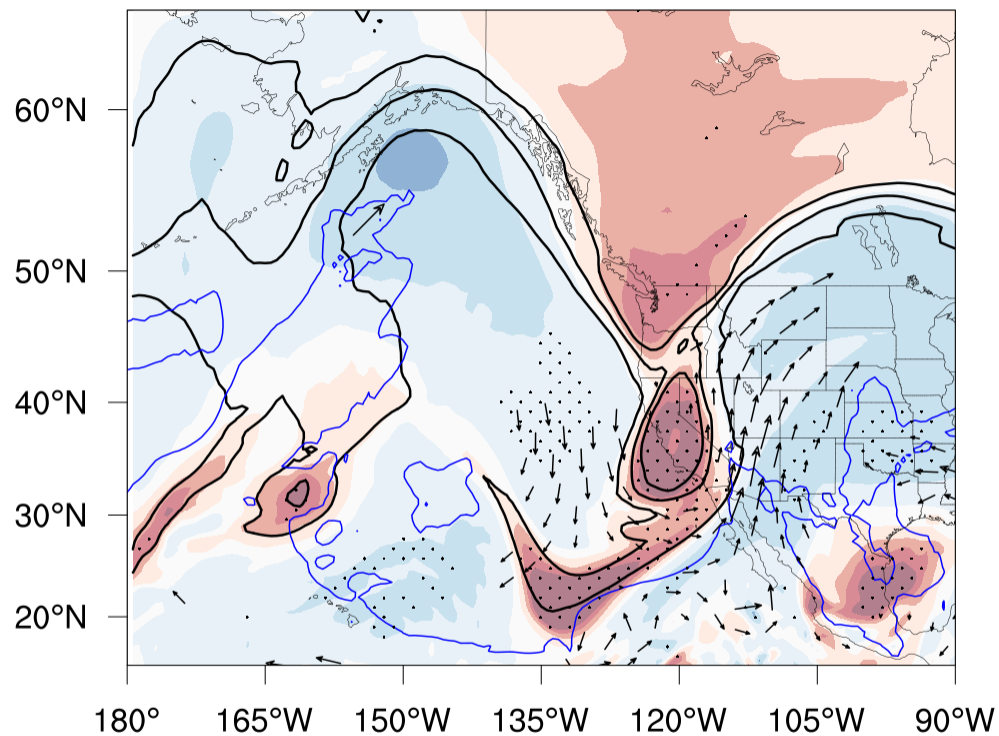
20070922 Event Day -1



~ 2, 4, 6 PVU

~ 33mm IWW

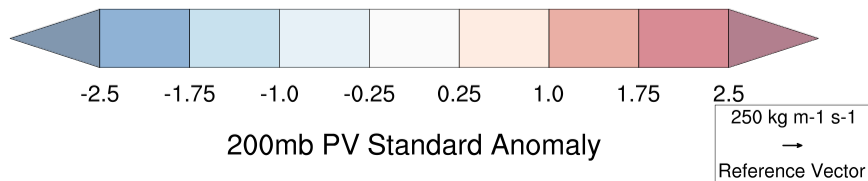
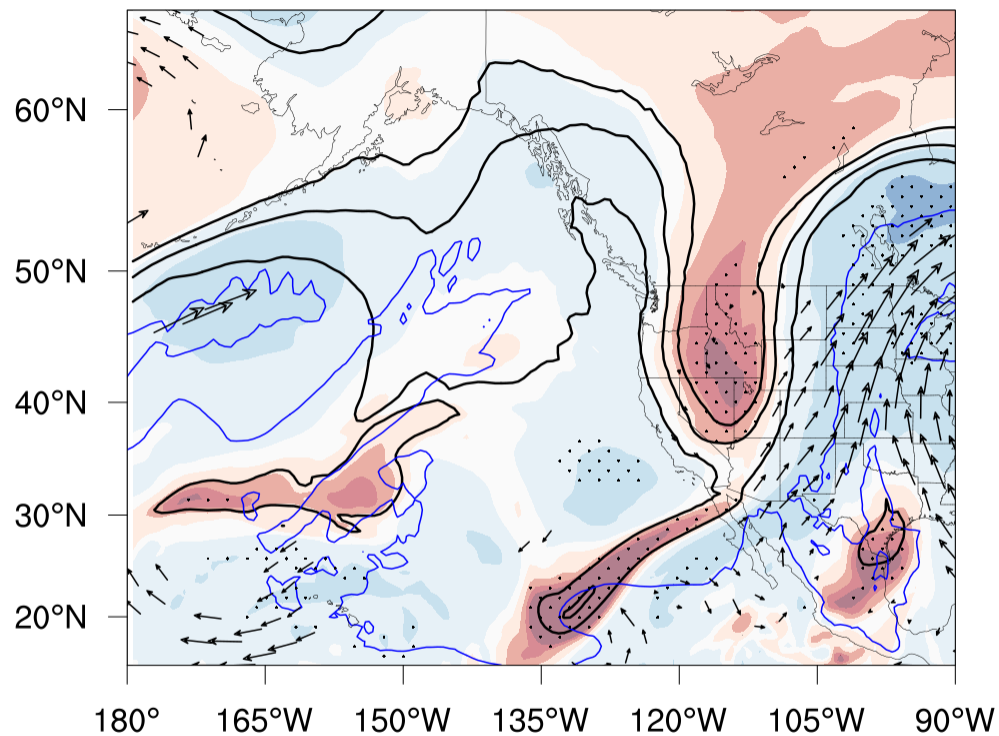
20070923 Event Day +0



~ 2, 4, 6 PVU

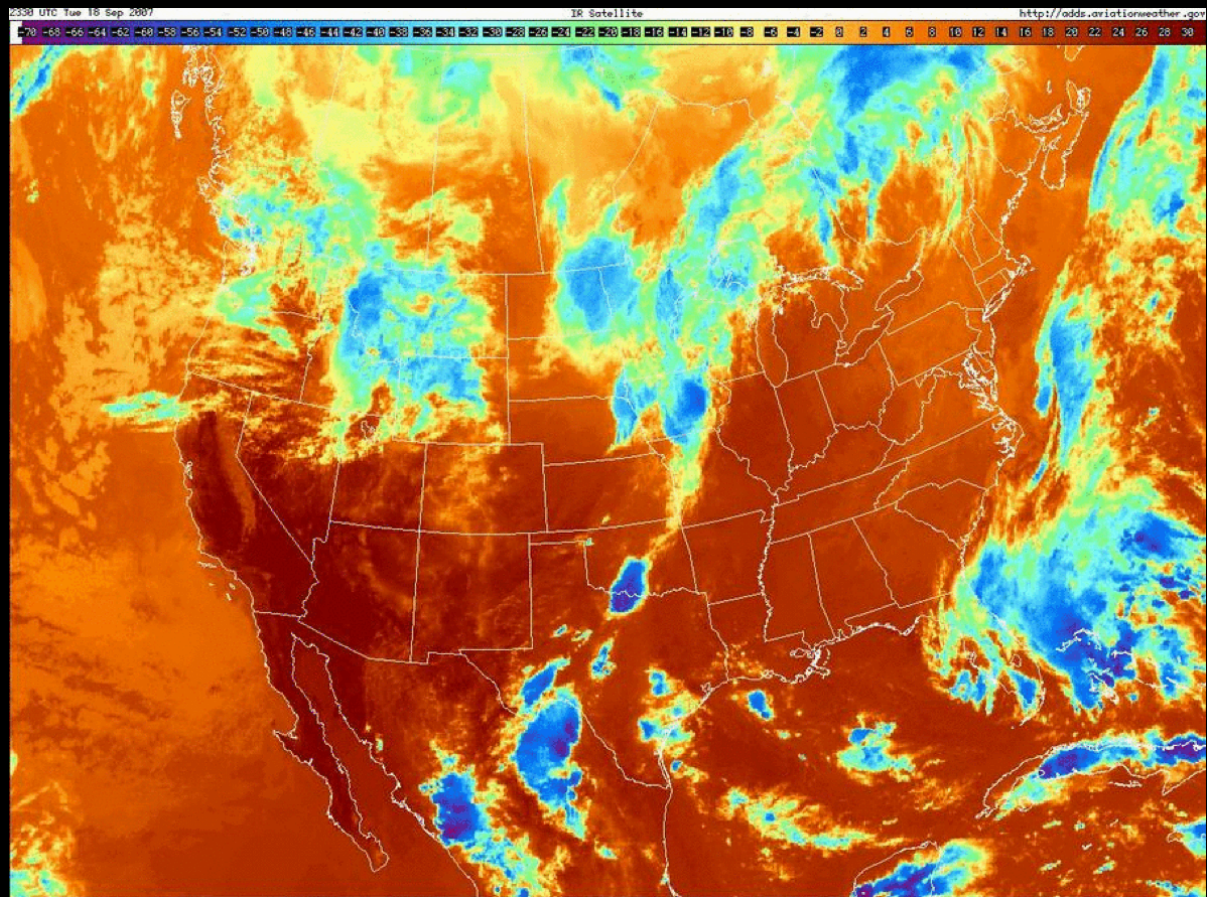
~ 33mm IWW

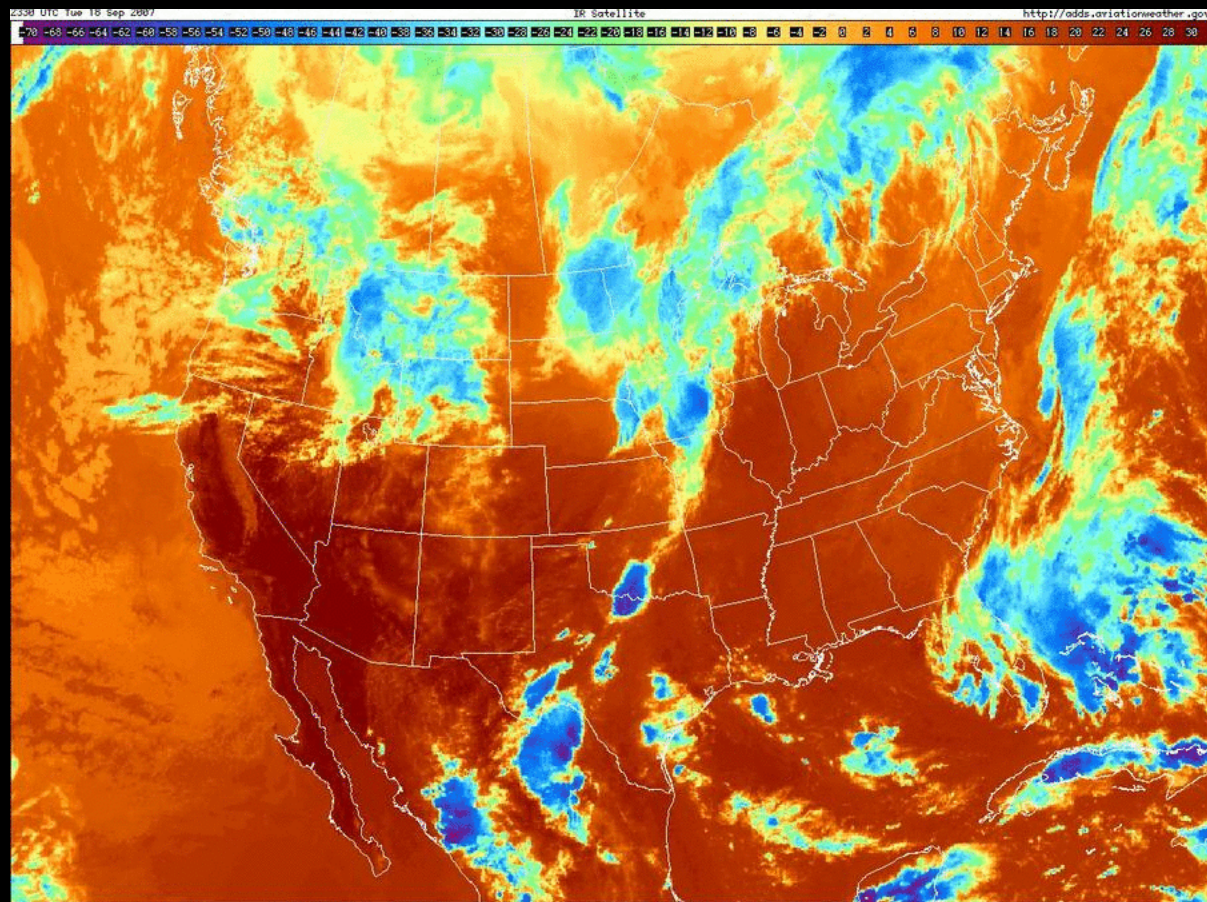
20070924 Event Day +1

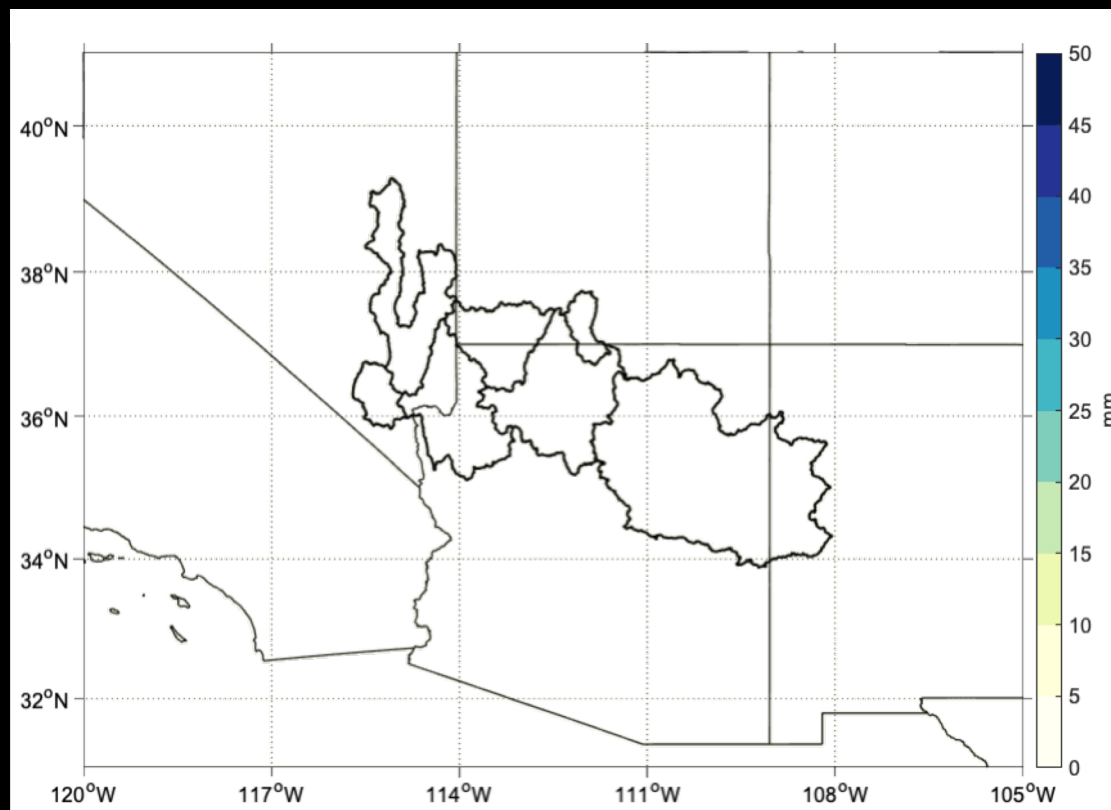


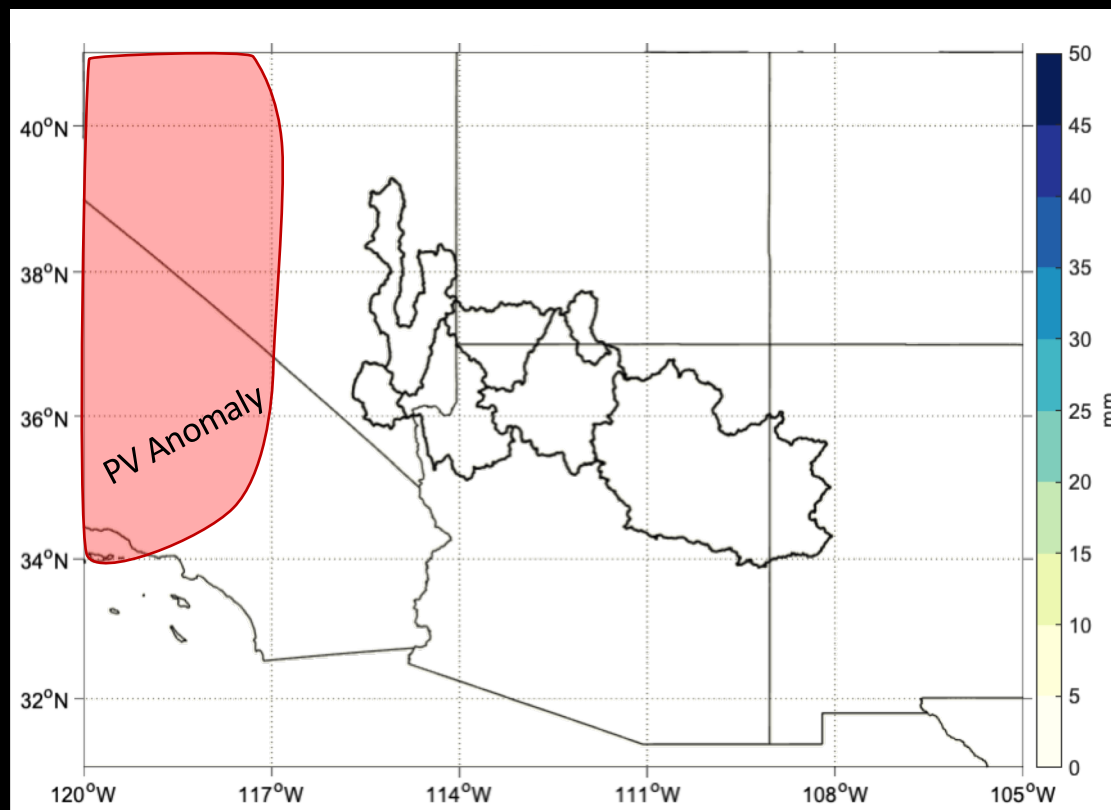
~ 2, 4, 6 PVU

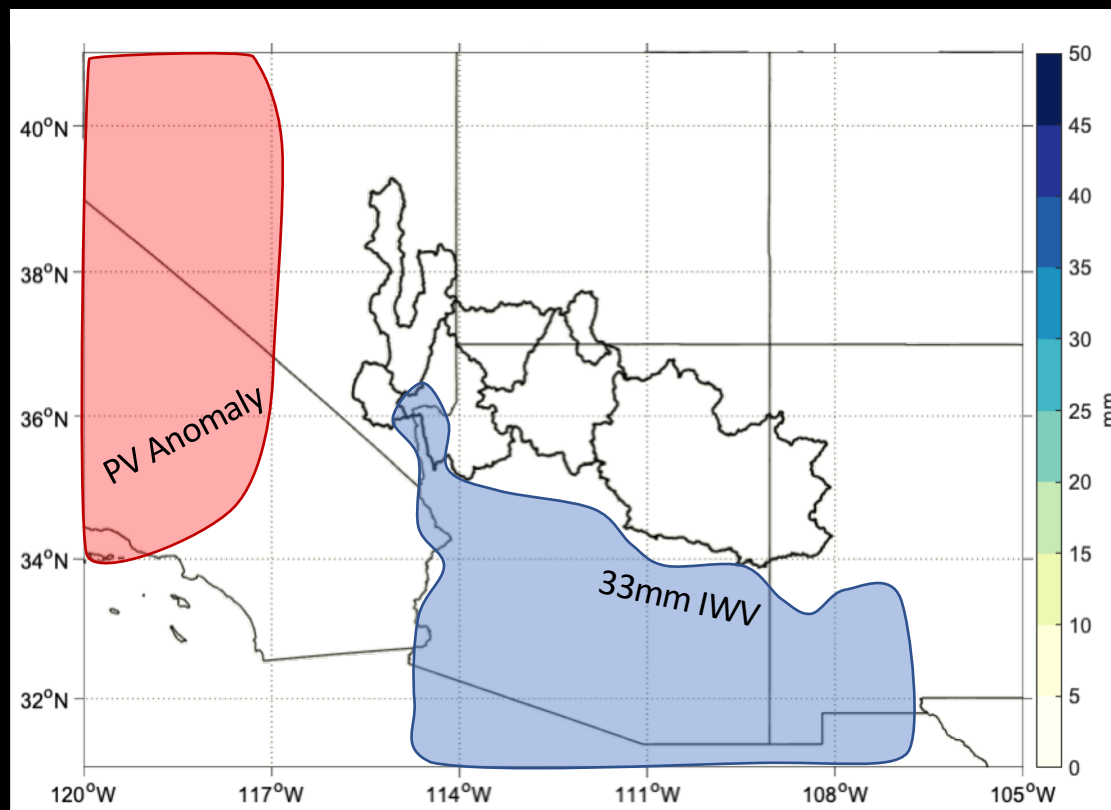
~ 33mm IWV

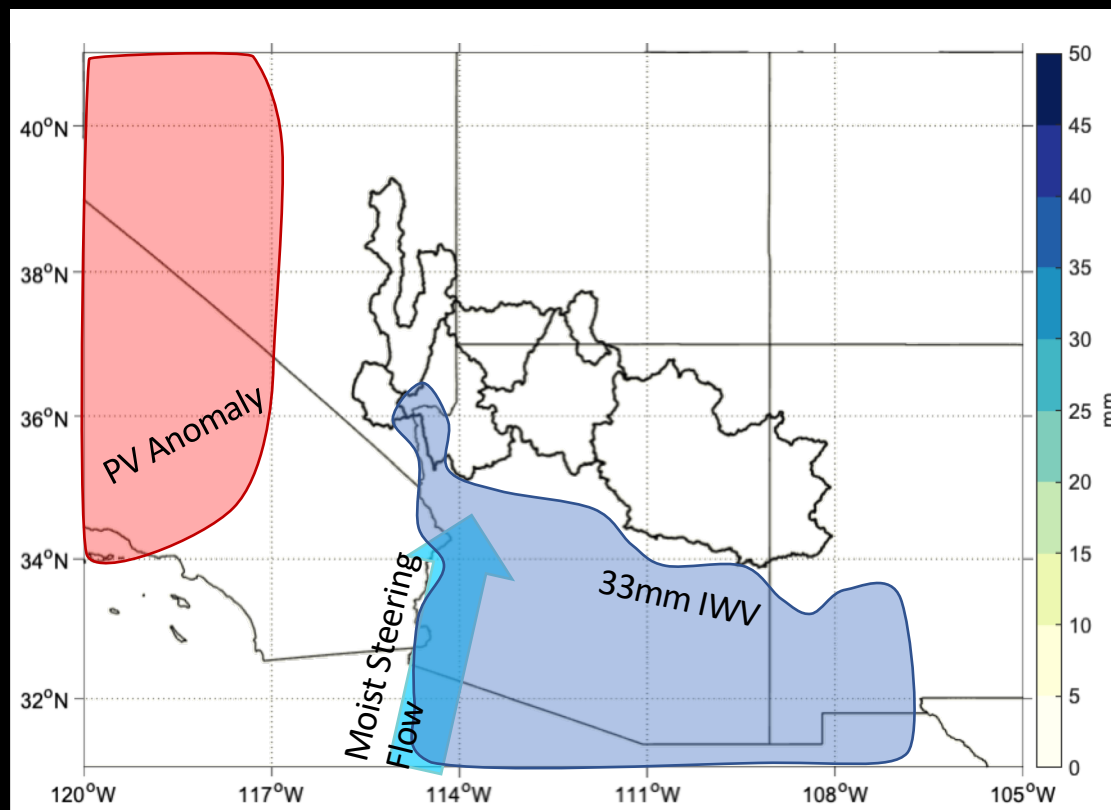


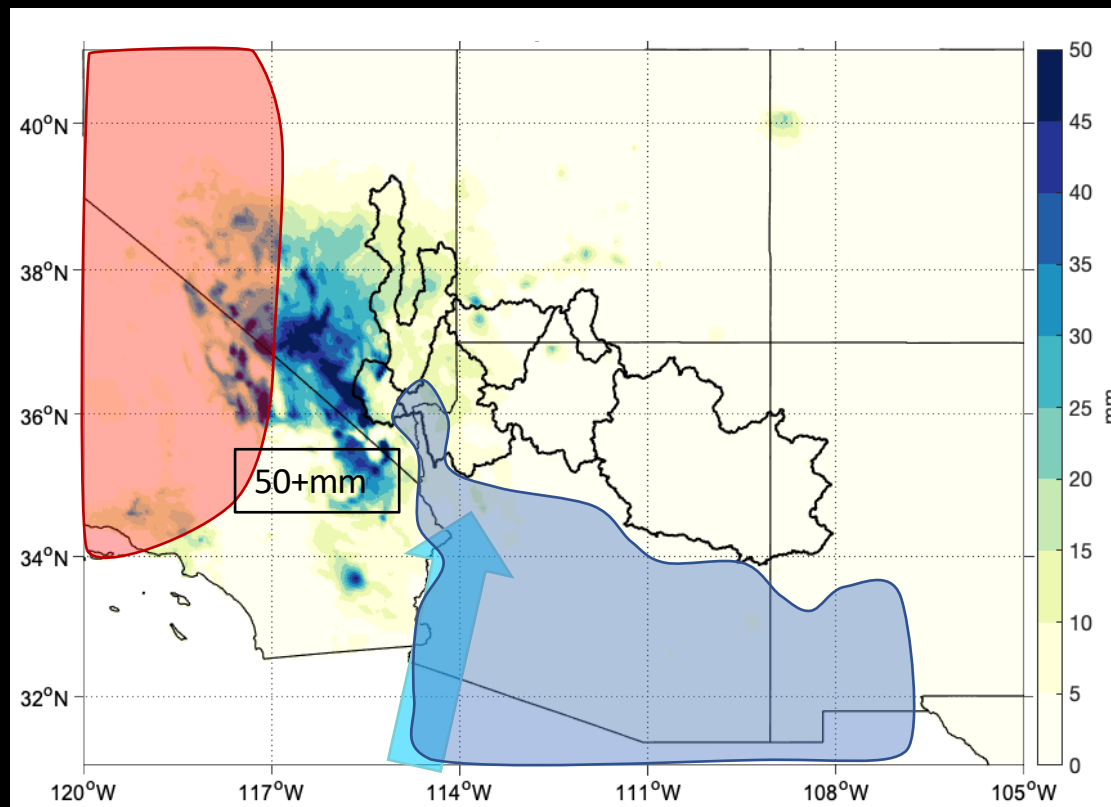




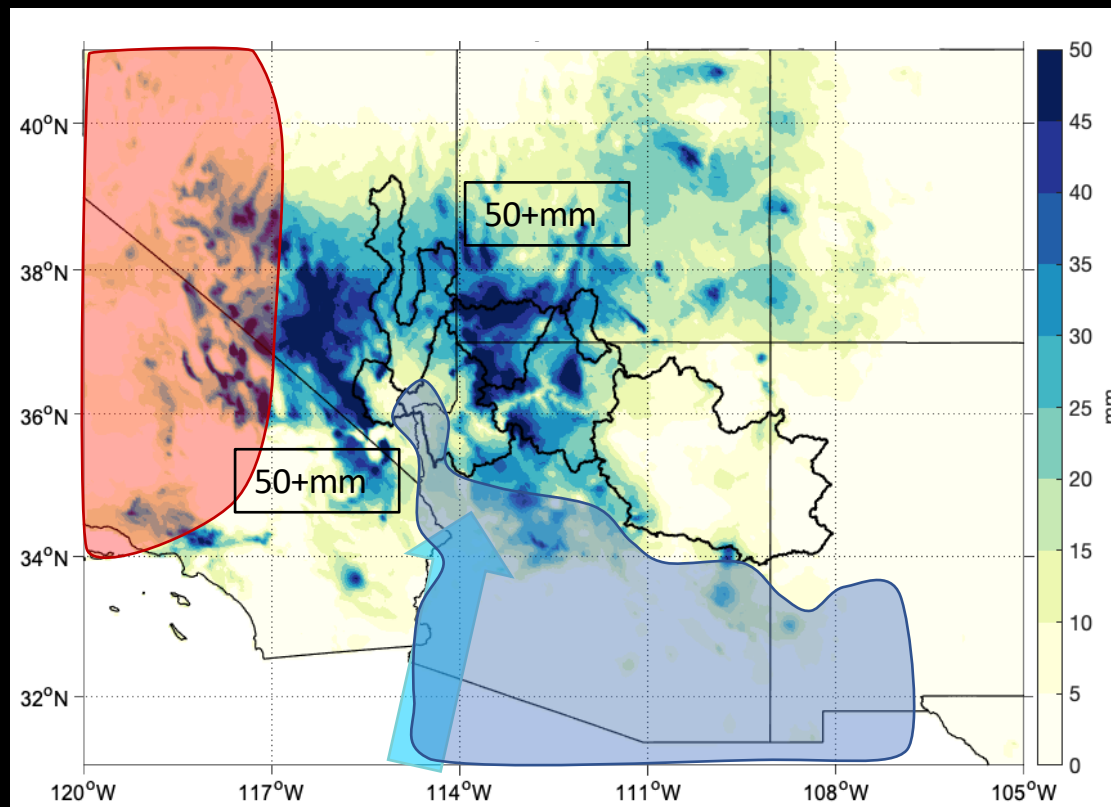




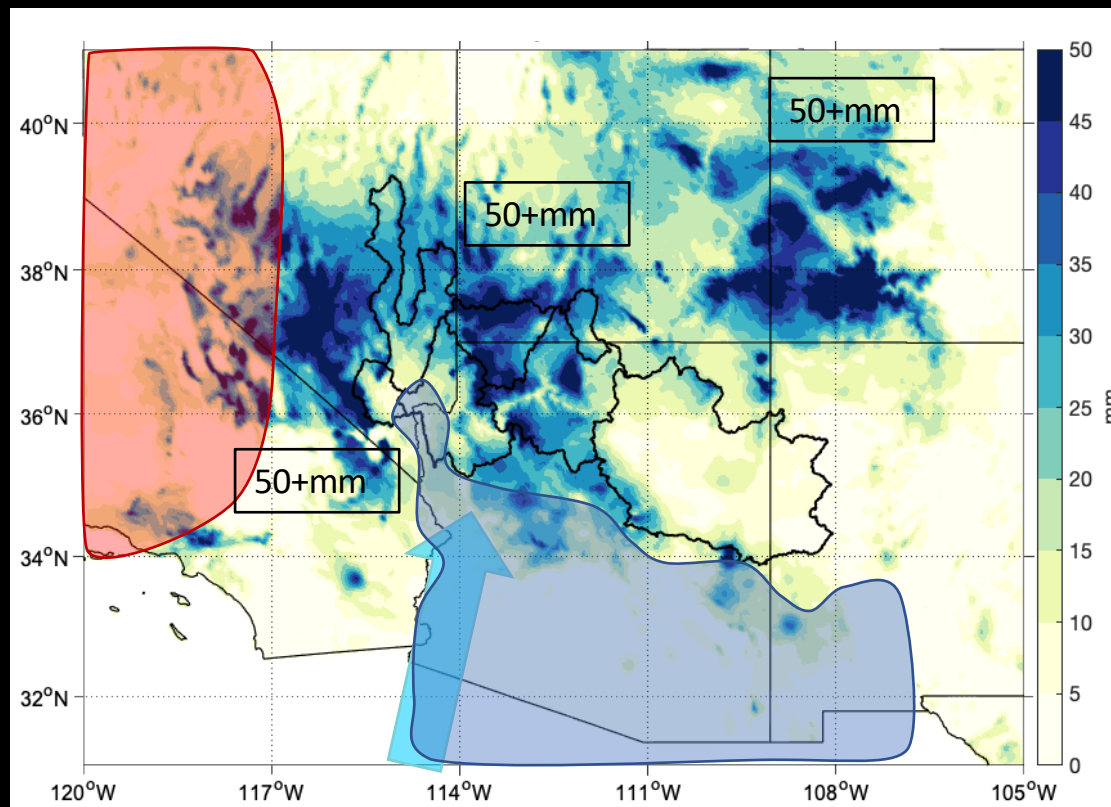




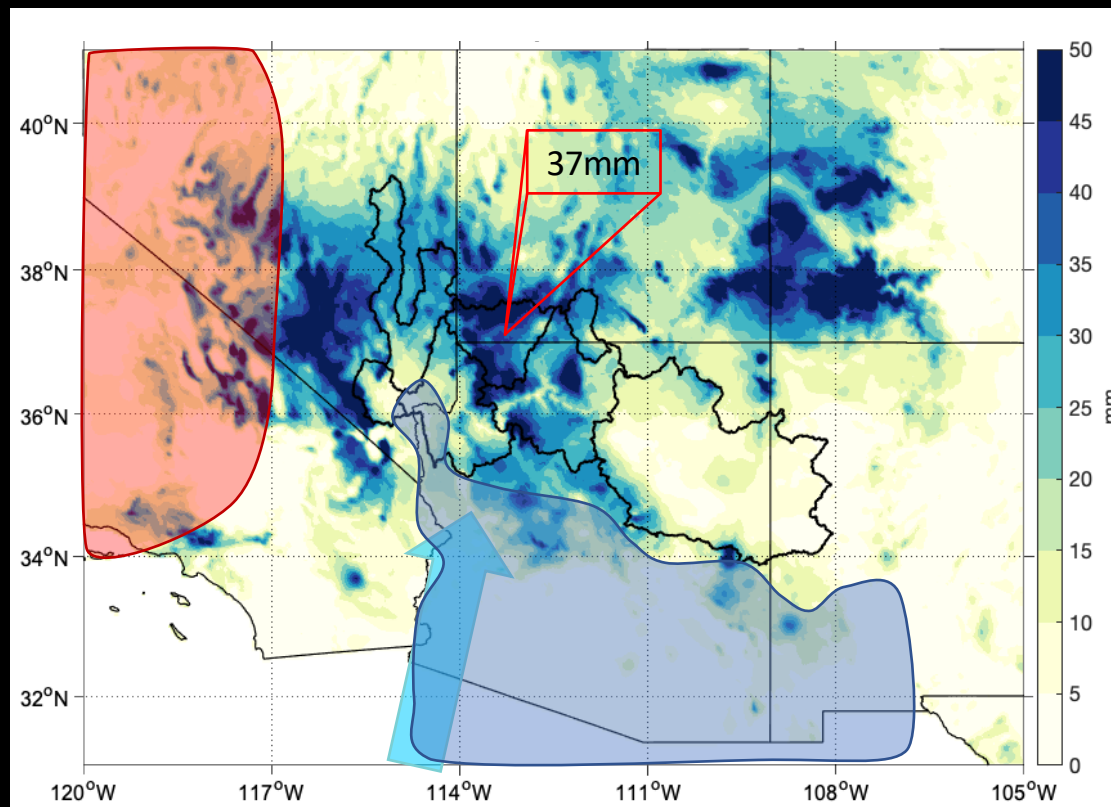
24hr Precipitation Ending on 20070922



48hr Precipitation Ending on 20070923

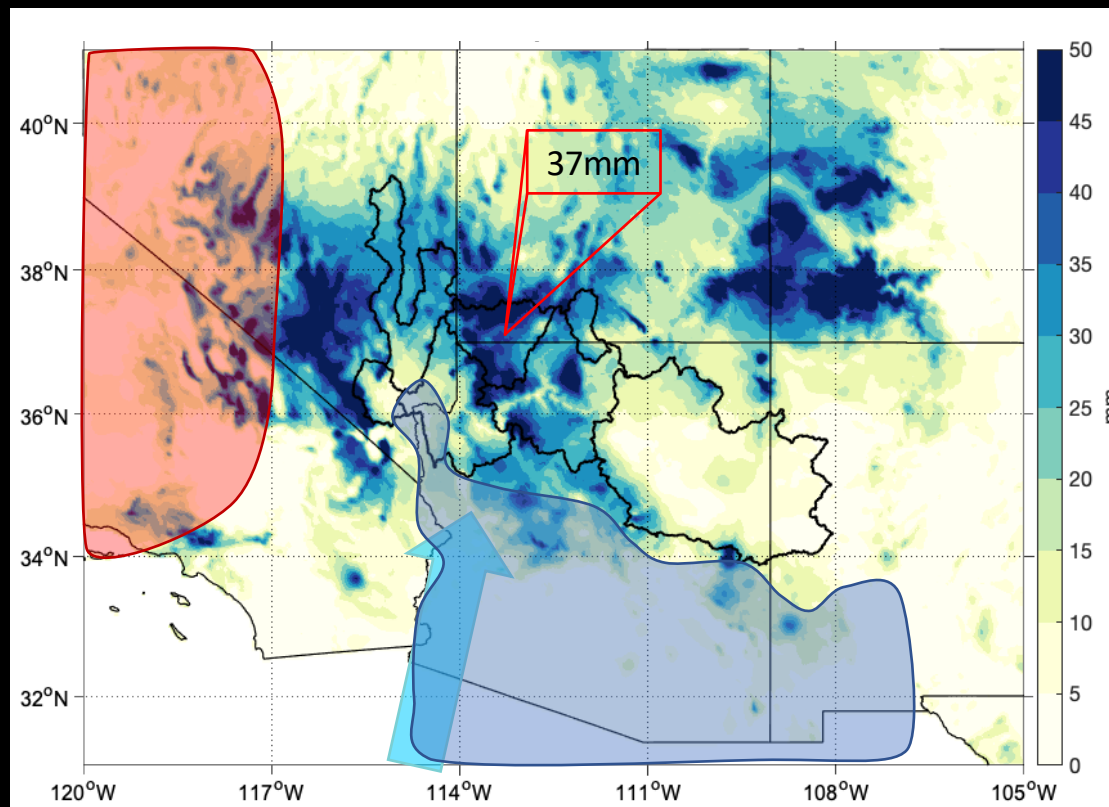


72hr Precipitation Ending on 20070924



Precipitation Highlights
- 37mm in 24hr in VIR

72hr Precipitation Ending on 20070924

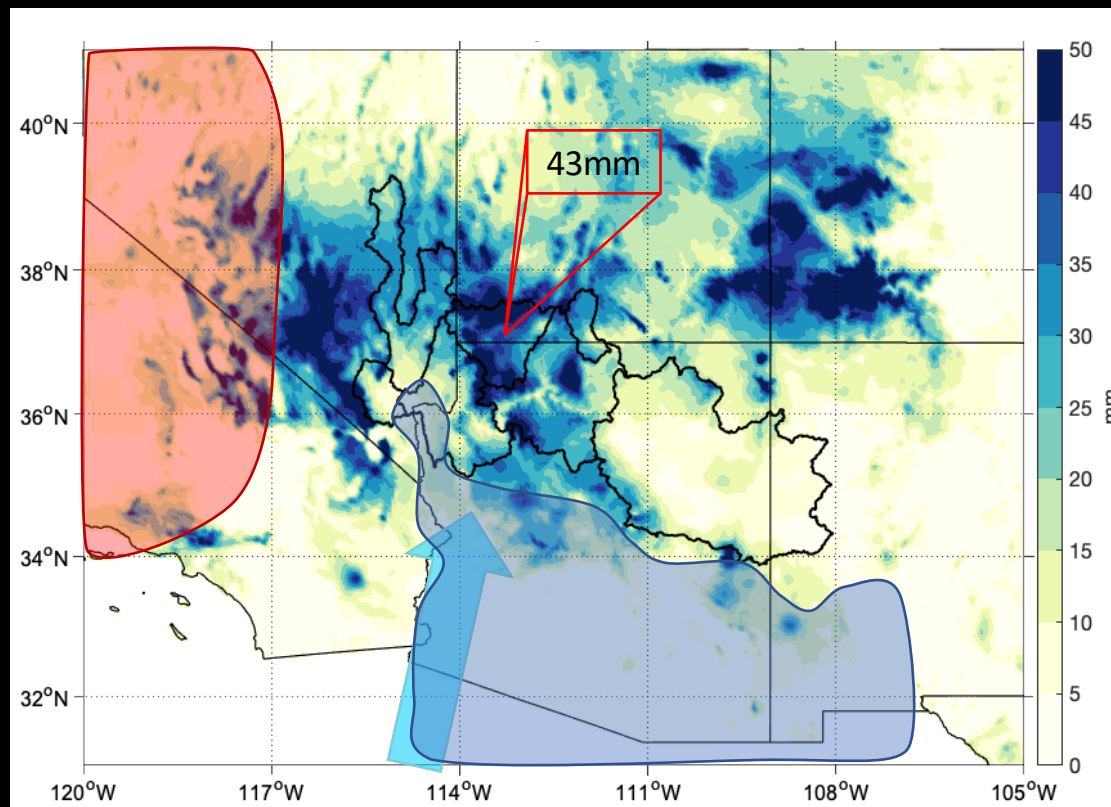


Precipitation Highlights

- 37mm in 24hr in VIR

- 31% of JAS precipitation during 24hr for VIR

72hr Precipitation Ending on 20070924



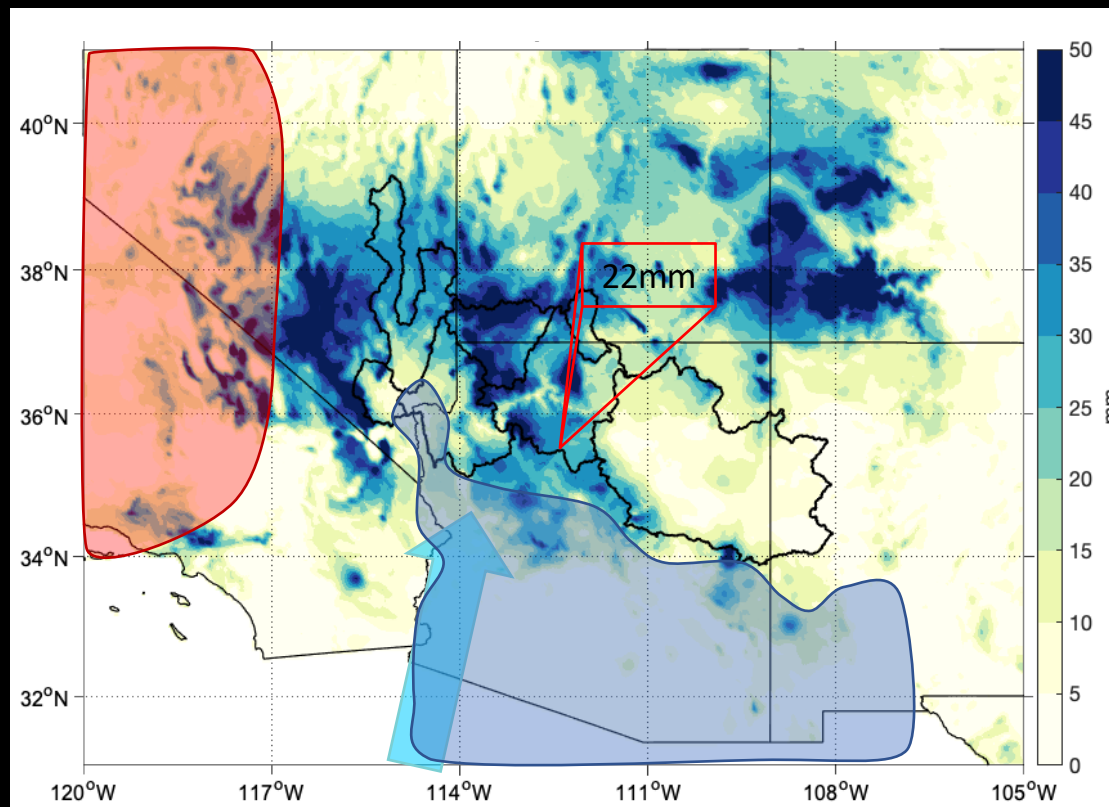
Precipitation Highlights

- 37mm in 24hr in VIR

- 31% of JAS precipitation during 24hr

- 43mm in 72hr in VIR
(43% of JAS mean)

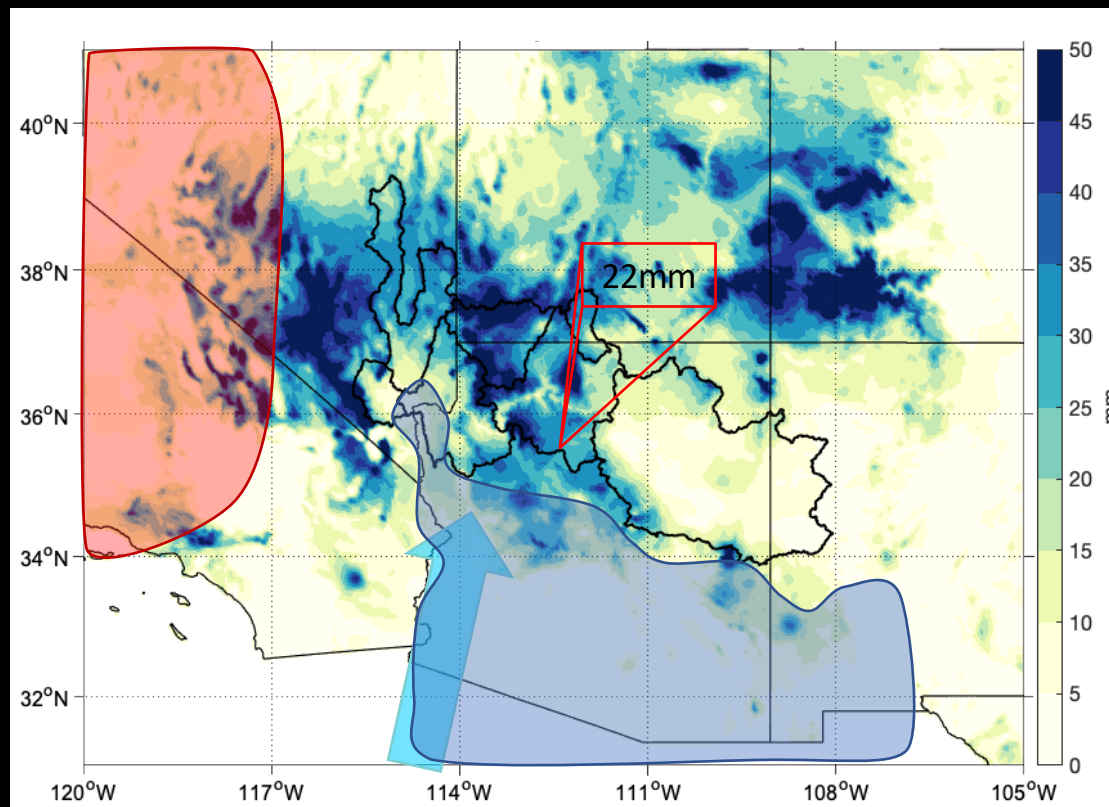
72hr Precipitation Ending on 20070924



Precipitation Highlights

- 37mm in 24hr in VIR
- 31% of JAS precipitation during 24hr
- 43mm in 72hr in VIR (43% of JAS mean)
- 22mm over entire Lake Mead basin in 72hrs

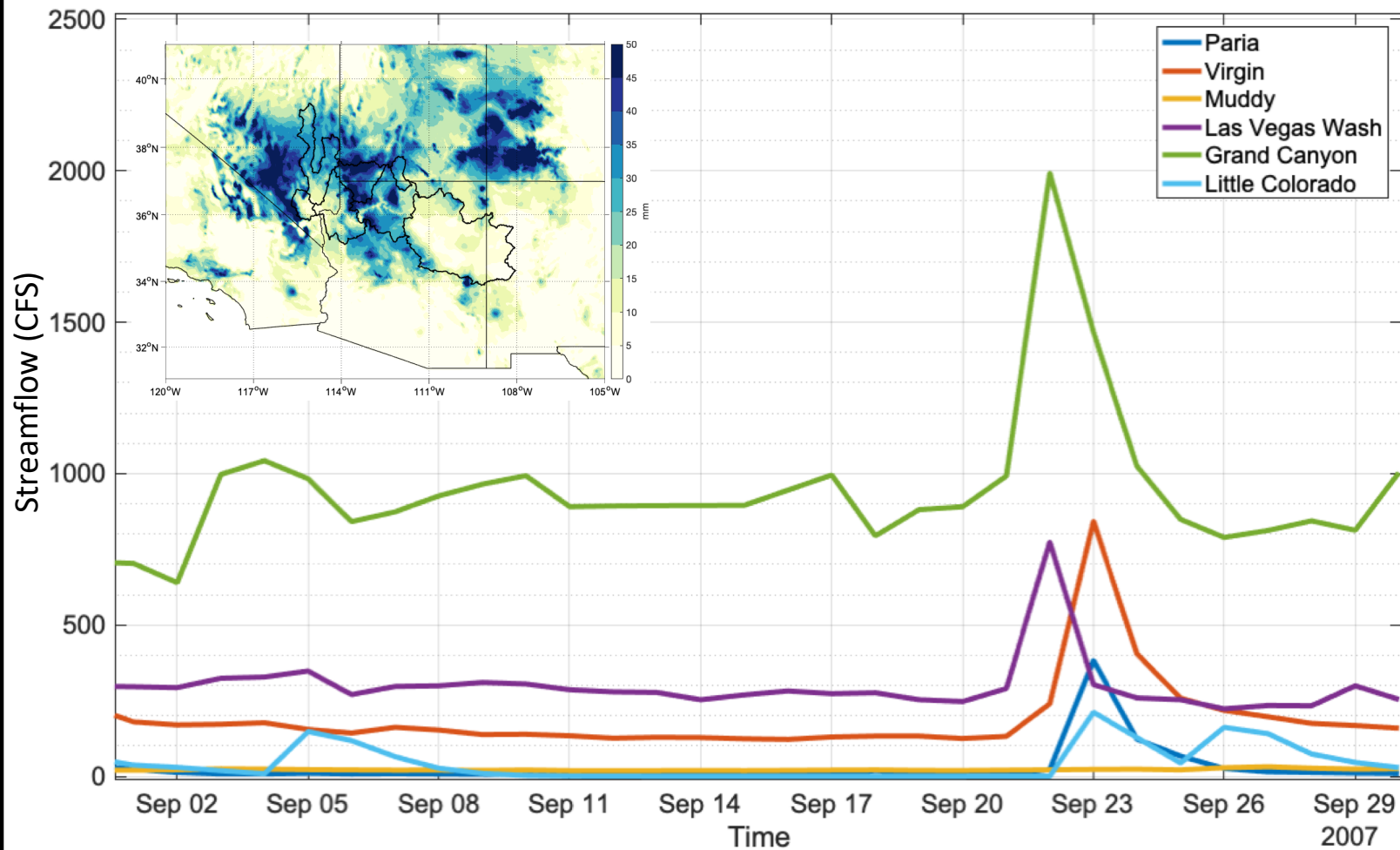
72hr Precipitation Ending on 20070924

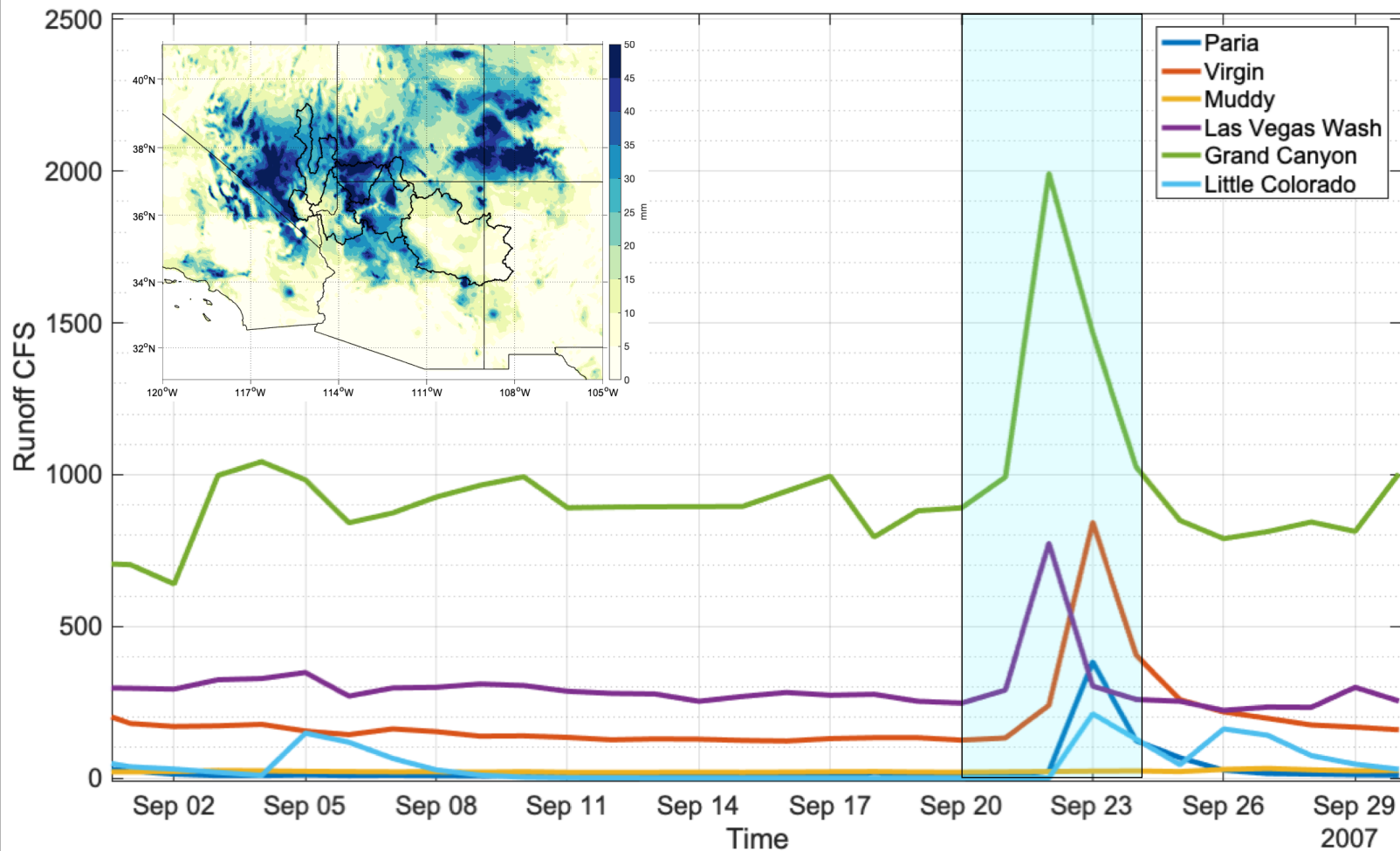


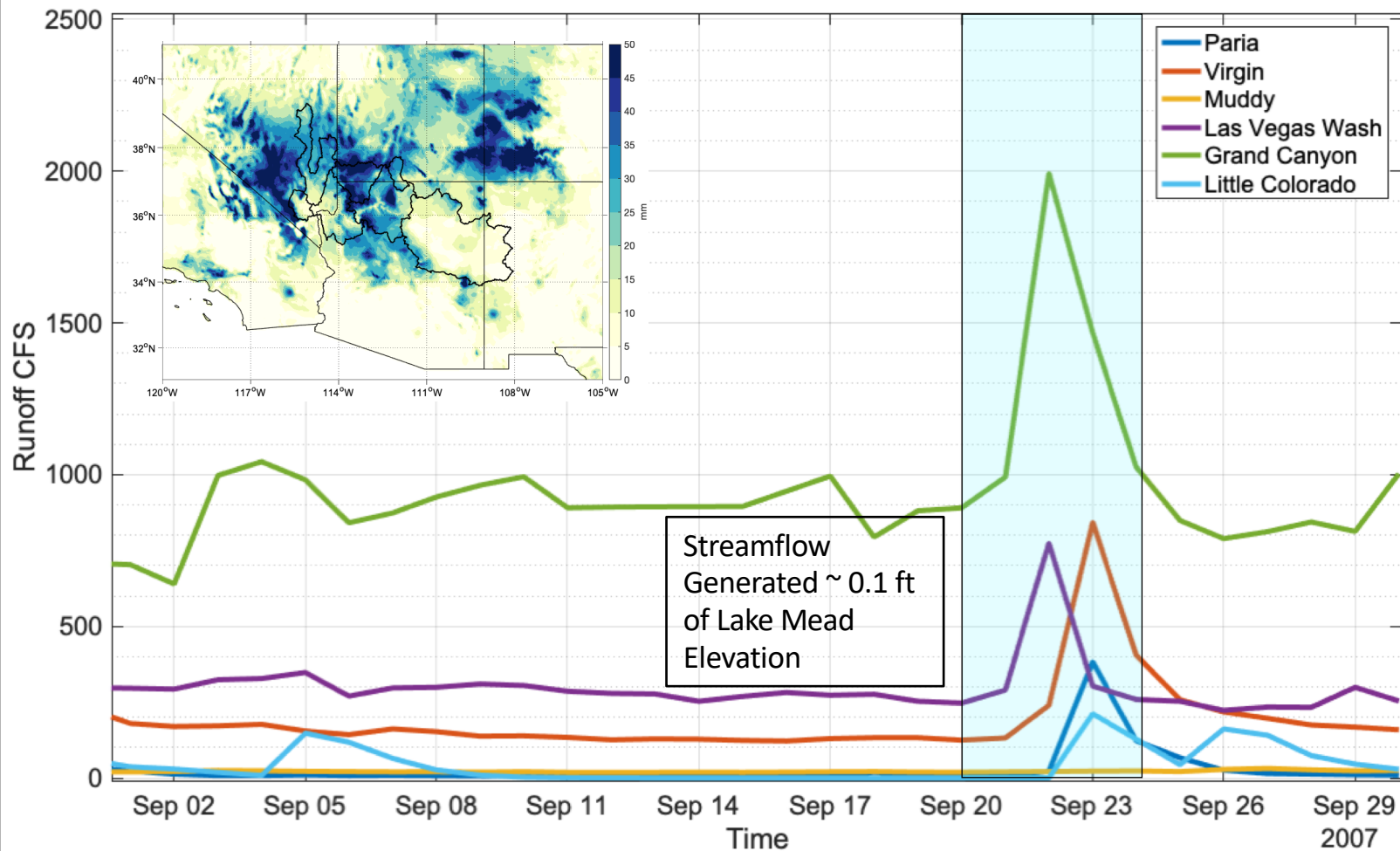
72hr Precipitation Ending on 20070924

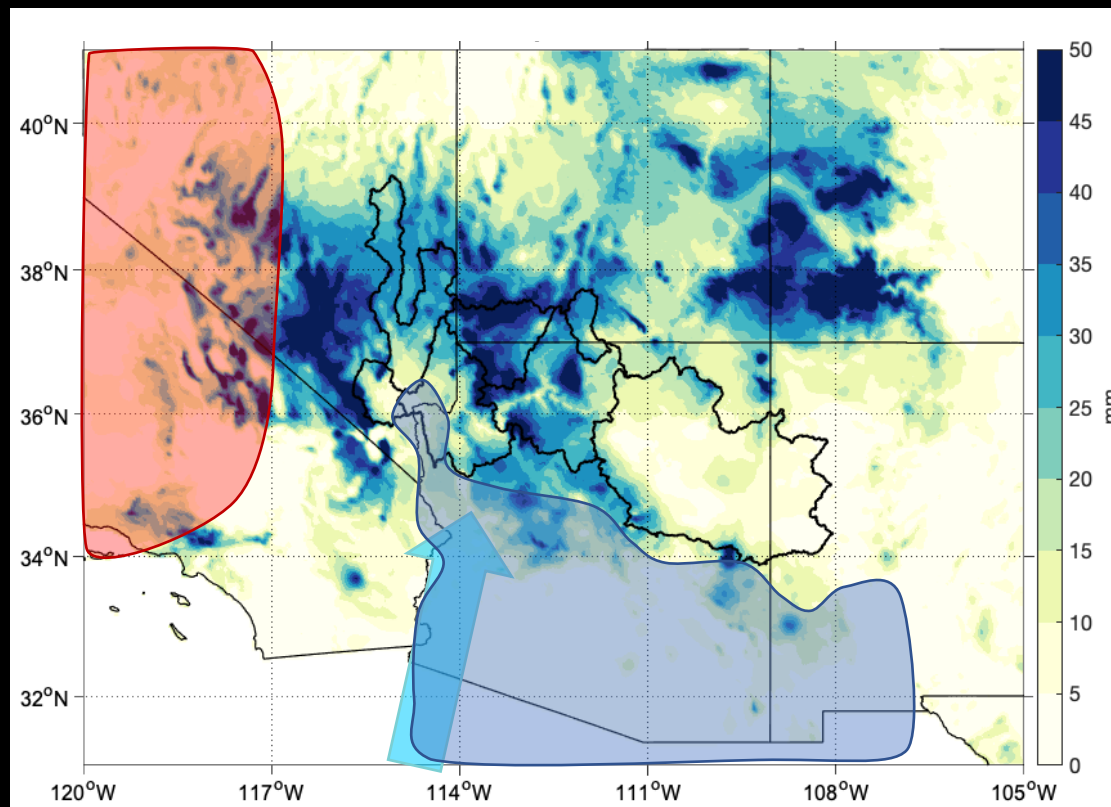
Precipitation Highlights

- 37mm in 24hr in VIR
- 31% of JAS precipitation during 24hr
- 43mm in 72hr in VIR (43% of JAS mean)
- 22mm over entire Lake Mead basin in 72hrs
- 19% of JAS precipitation during event for entire Lake Mead basin

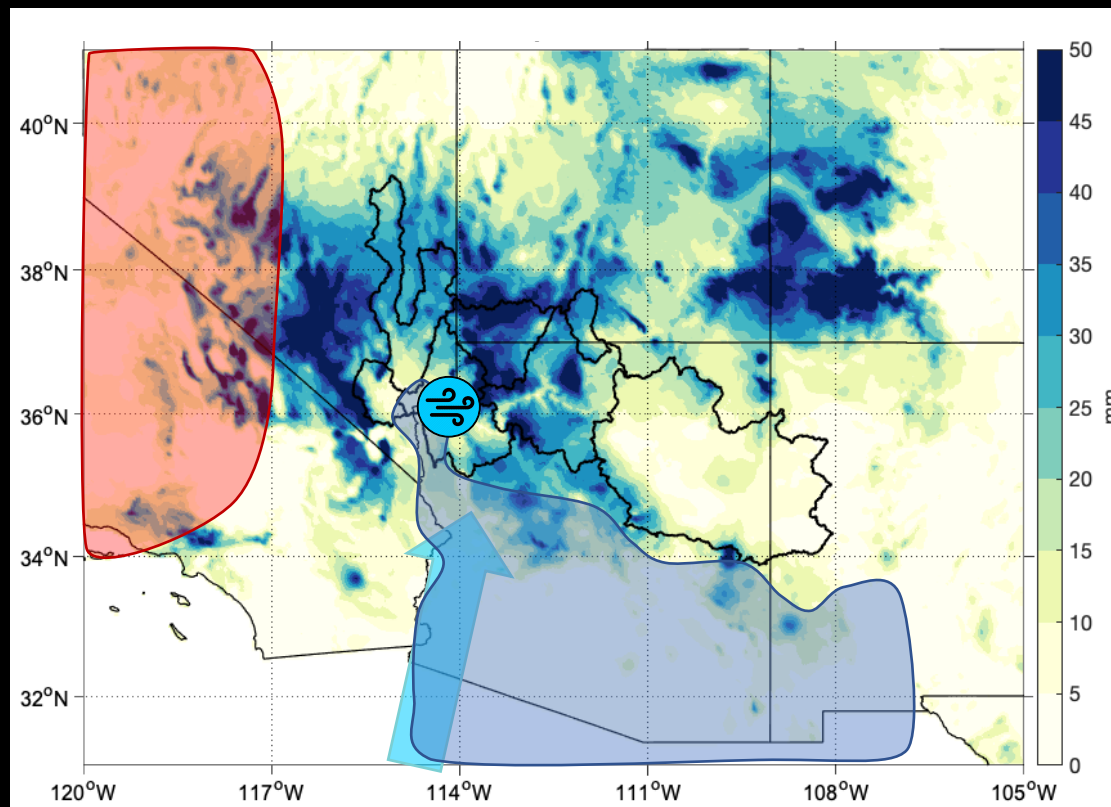






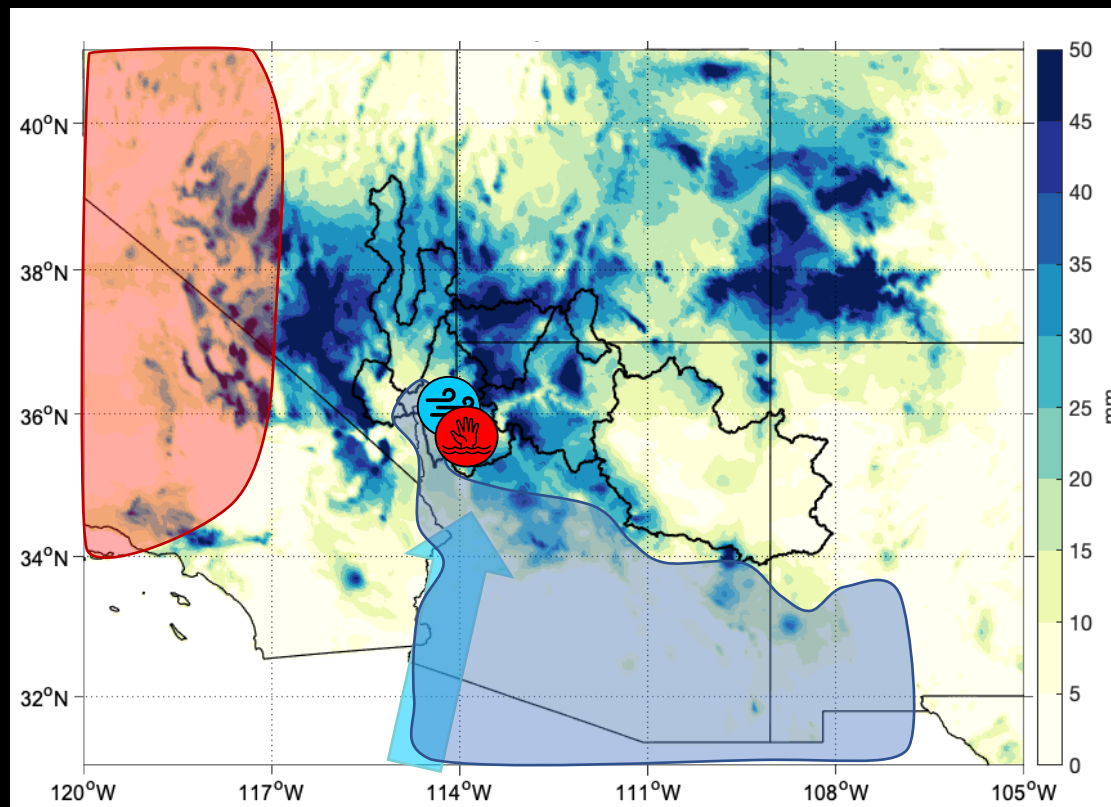


NOAA Storm Events associated with 20070923



wind

NOAA Storm Events associated with 20070923

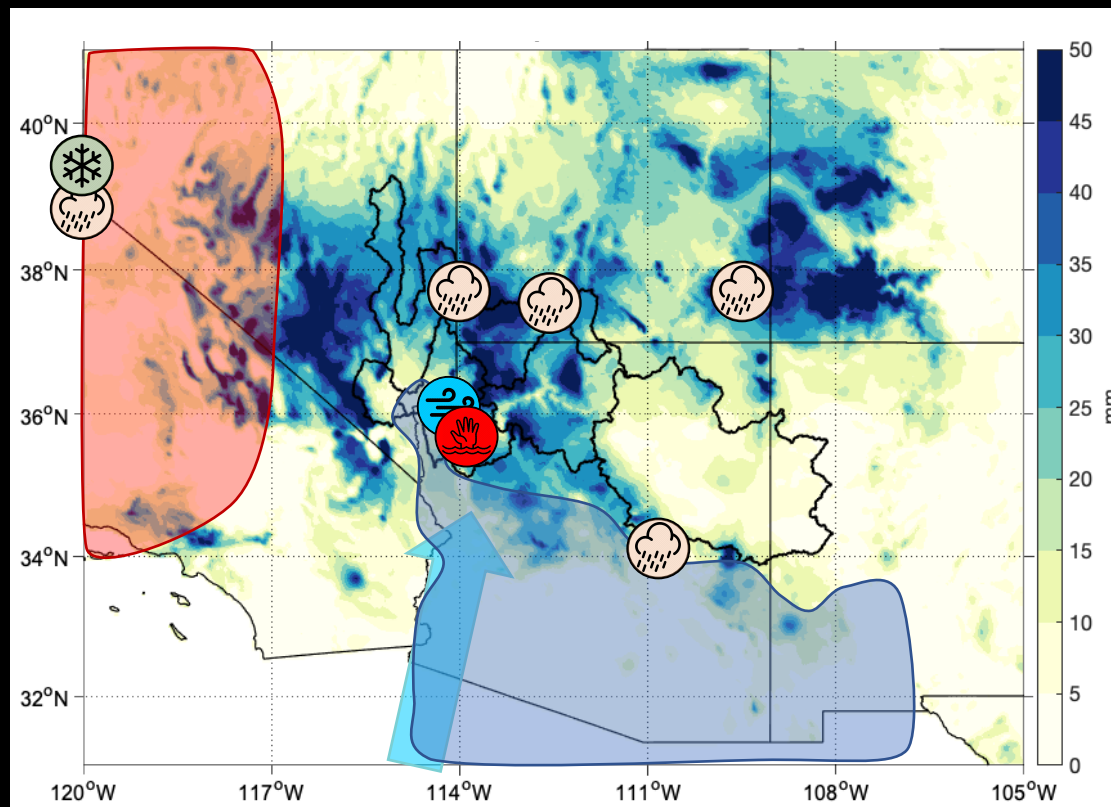


wind



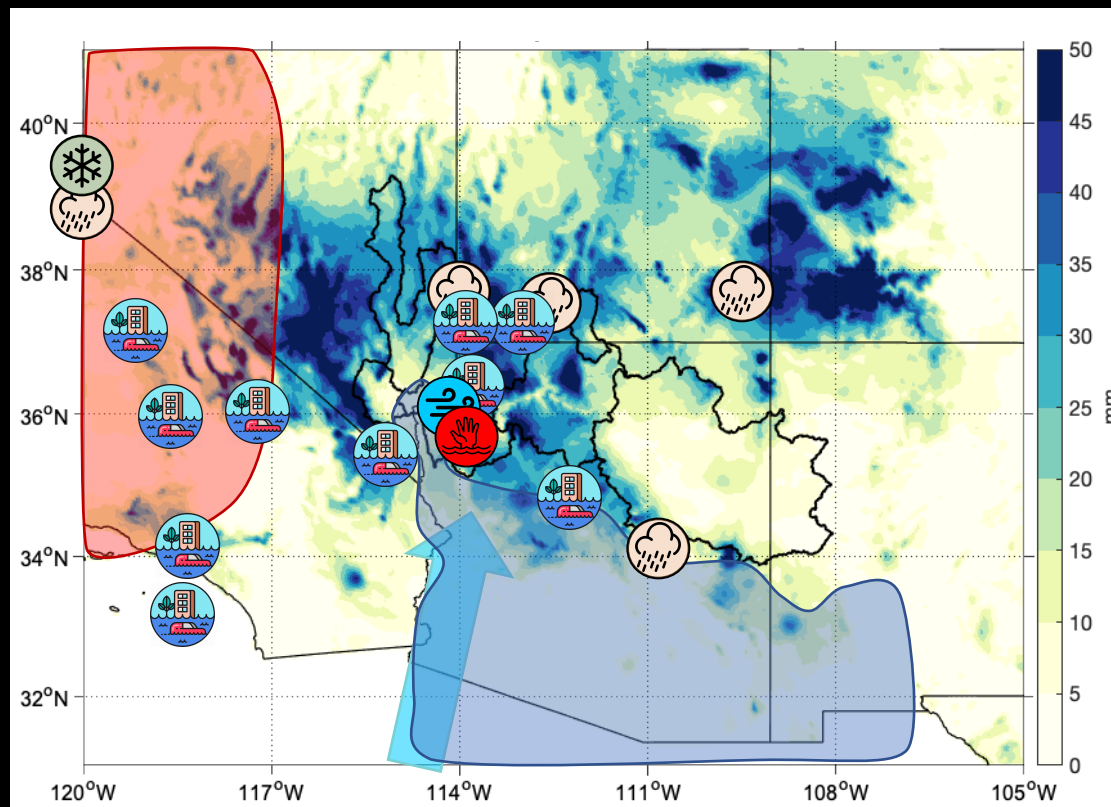
drowning

NOAA Storm Events associated with 20070923



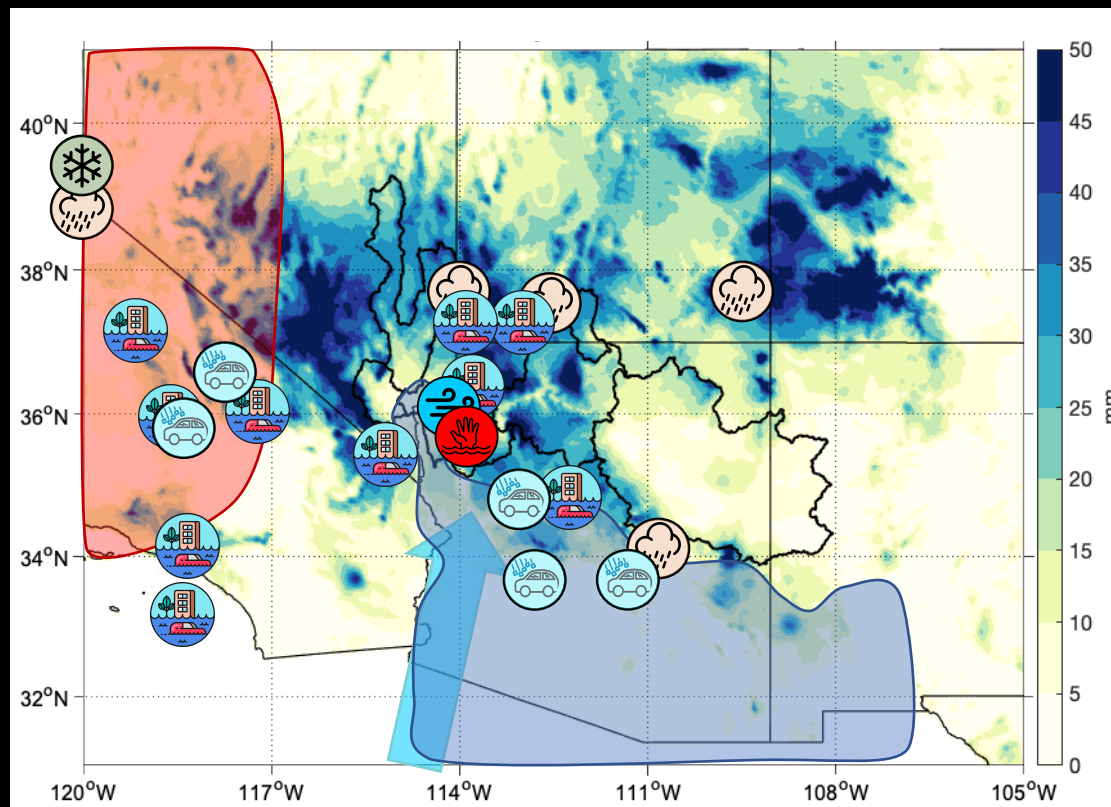
-  wind
-  drowning
-  heavy precip

NOAA Storm Events associated with 20070923



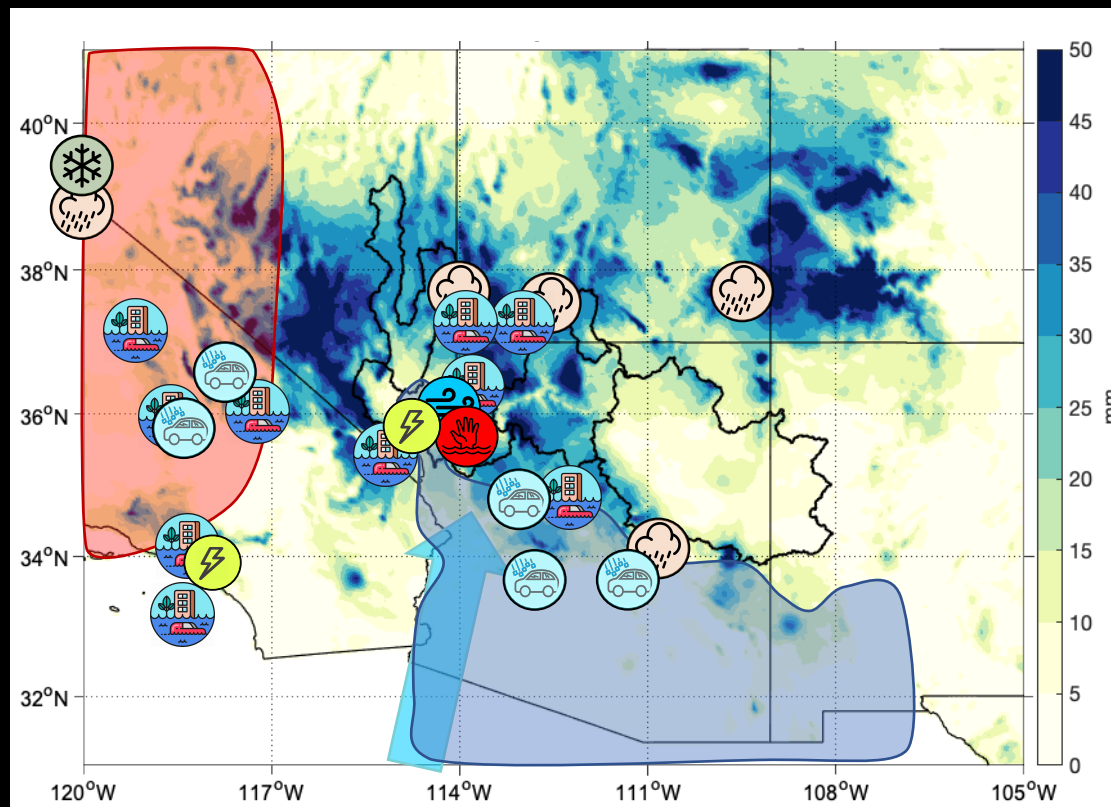
-  wind
-  drowning
-  heavy precip
-  flash flooding

NOAA Storm Events associated with 20070923



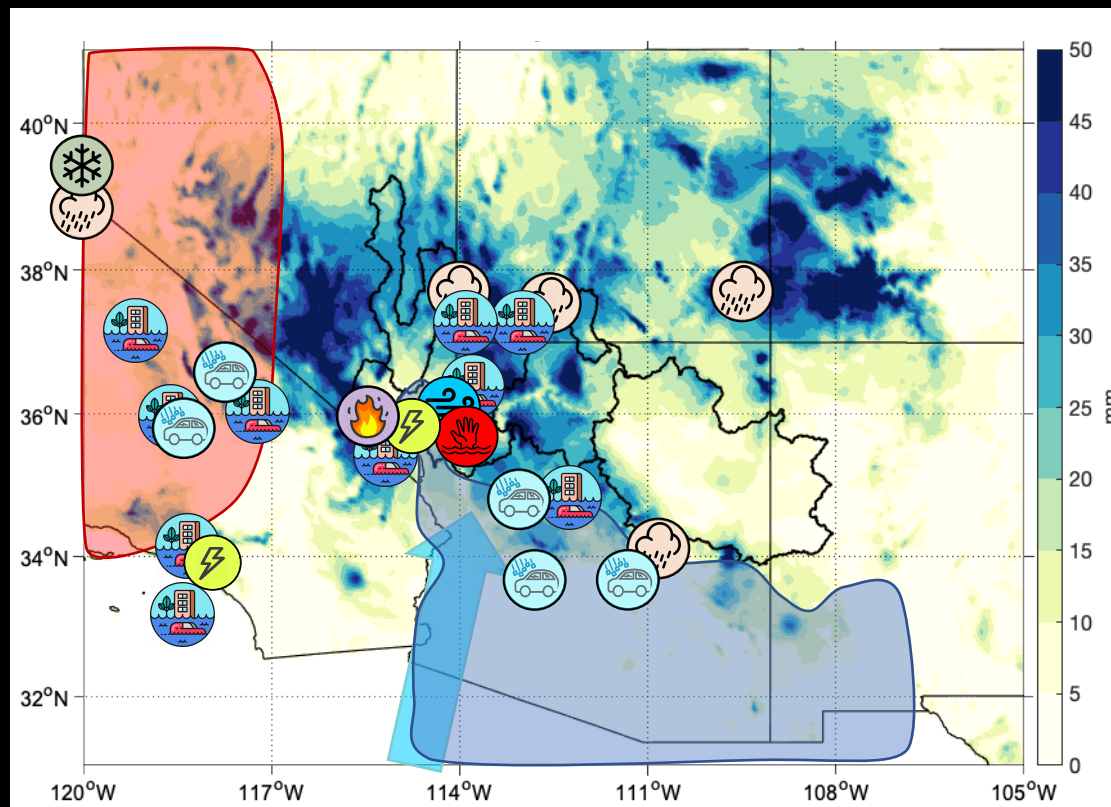
-  wind
-  drowning
-  heavy precip
-  flash flooding
-  hail

NOAA Storm Events associated with 20070923



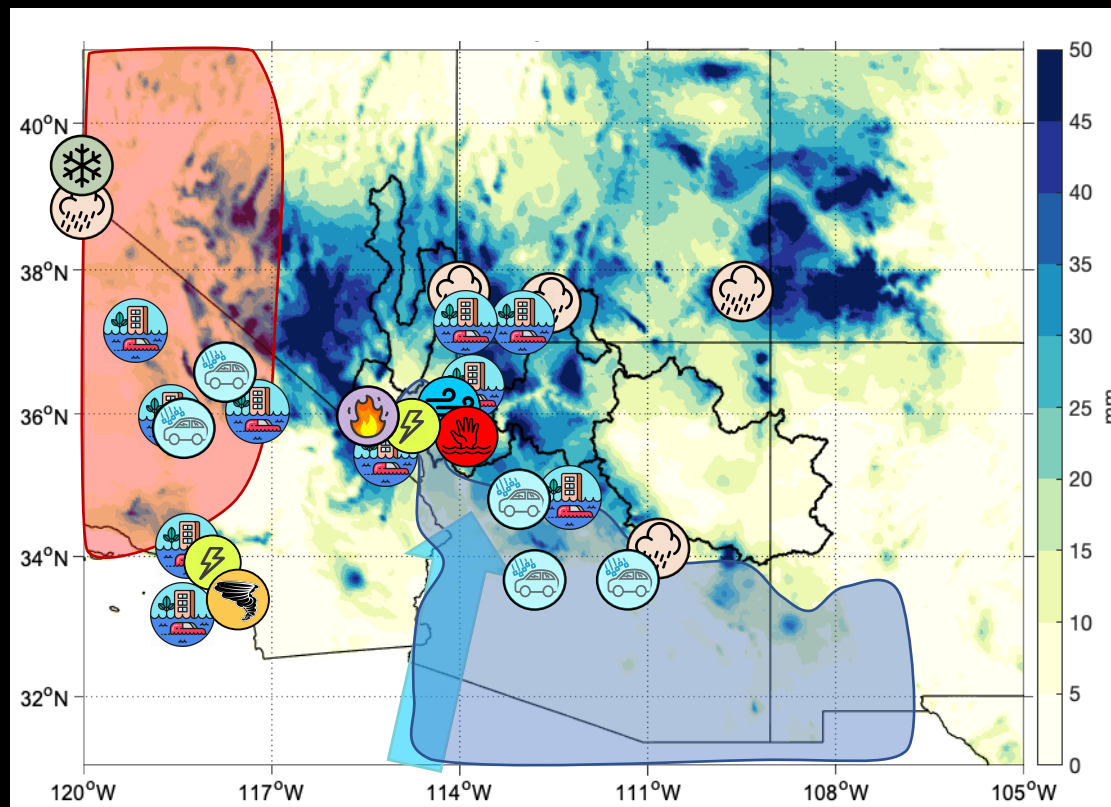
-  wind
-  drowning
-  heavy precip
-  flash flooding
-  hail
-  lightning

NOAA Storm Events associated with 20070923

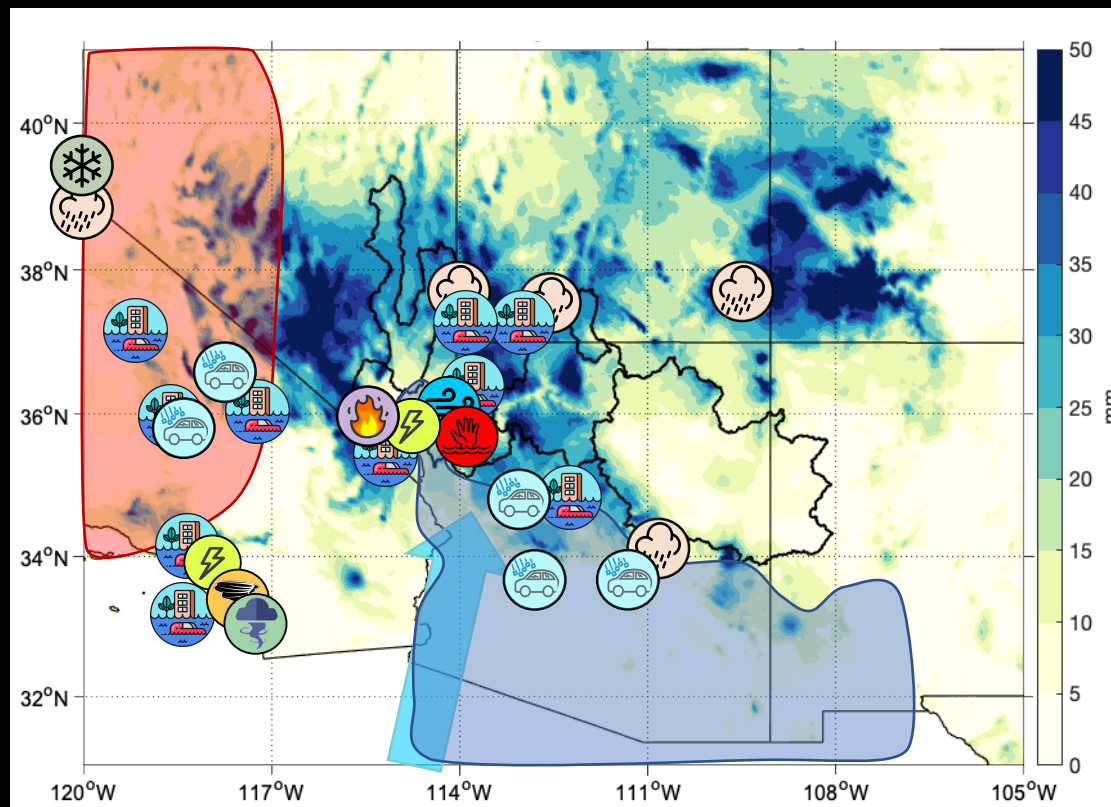


-  wind
-  drowning
-  heavy precip
-  flash flooding
-  hail
-  lightning
-  fire

NOAA Storm Events associated with 20070923

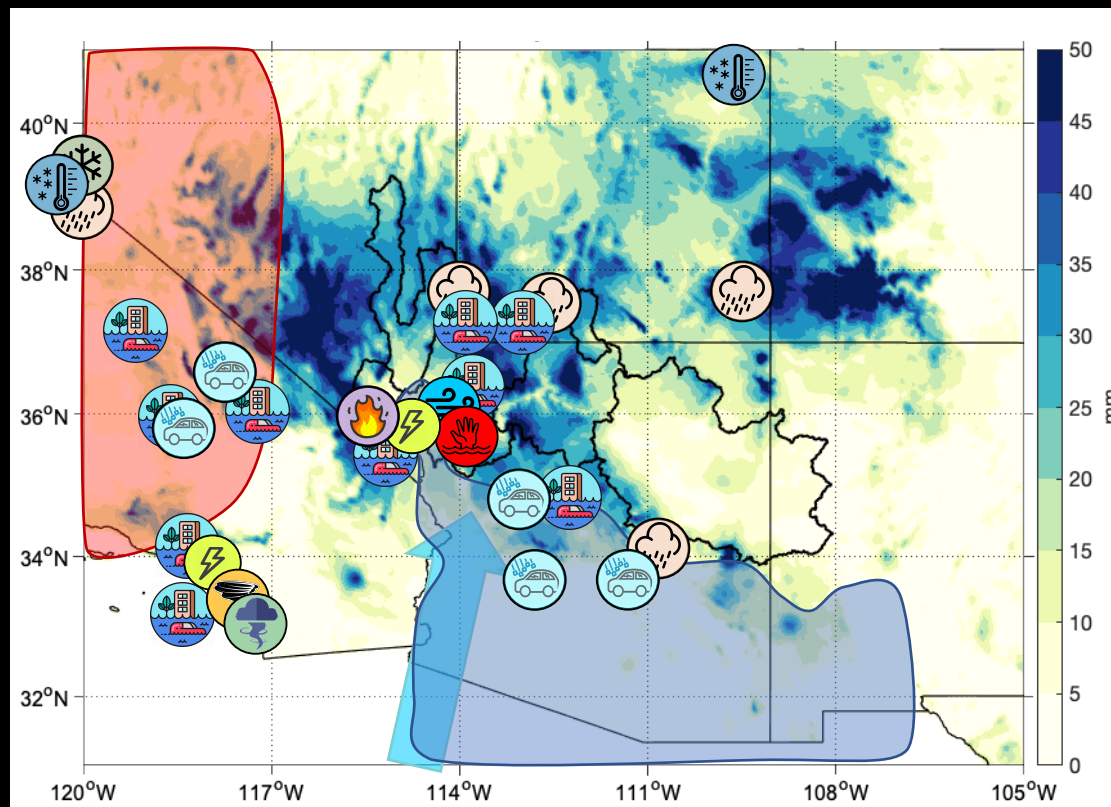


NOAA Storm Events associated with 20070923



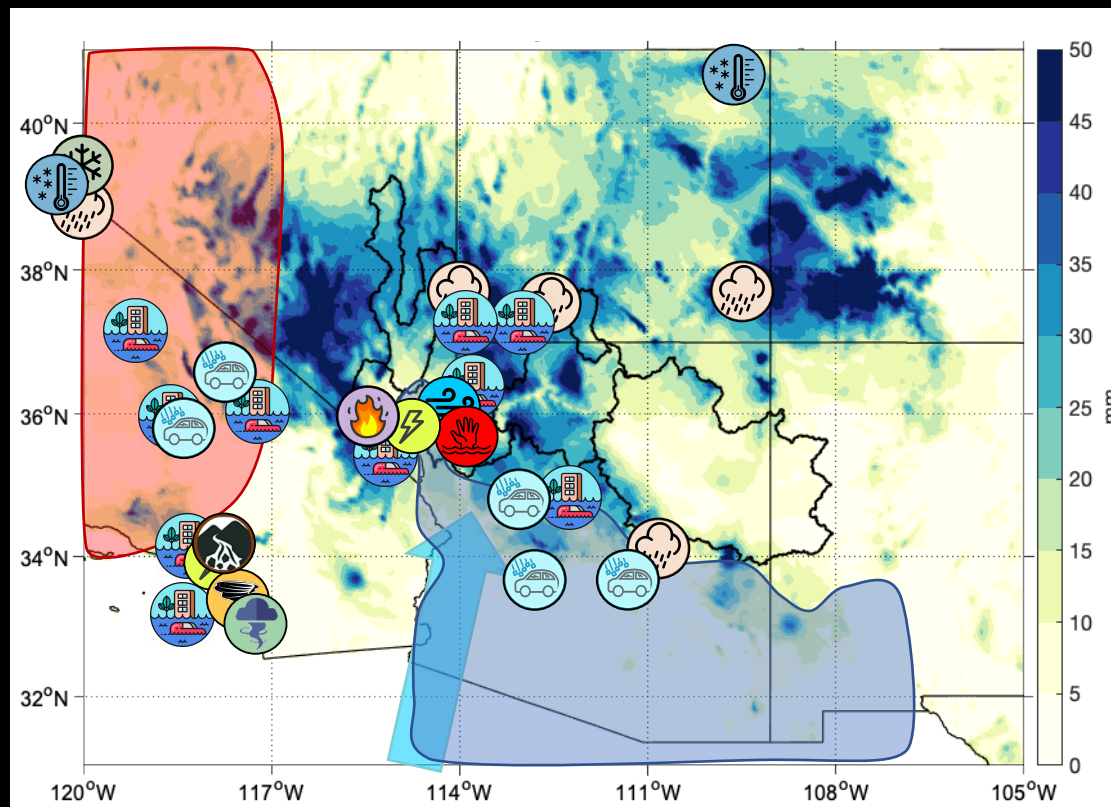
- wind
- drowning
- heavy precip
- flash flooding
- hail
- lightning
- fire
- tornado
- water spout

NOAA Storm Events associated with 20070923



- wind
- drowning
- heavy precip
- flash flooding
- hail
- lightning
- fire
- tornado
- water spout
- freeze

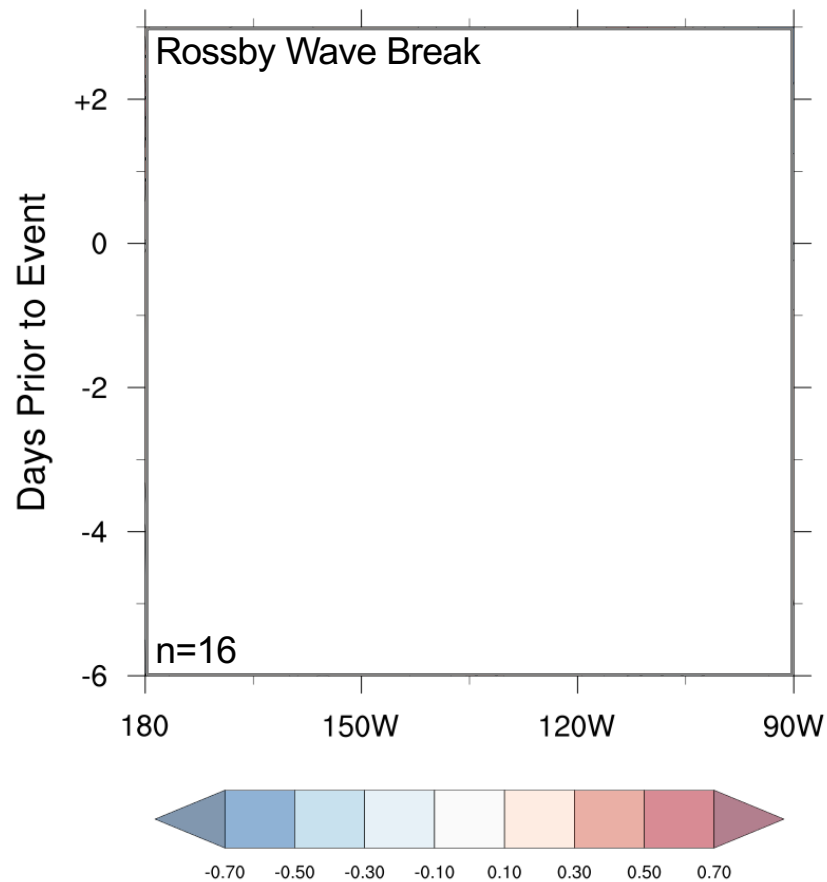
NOAA Storm Events associated with 20070923



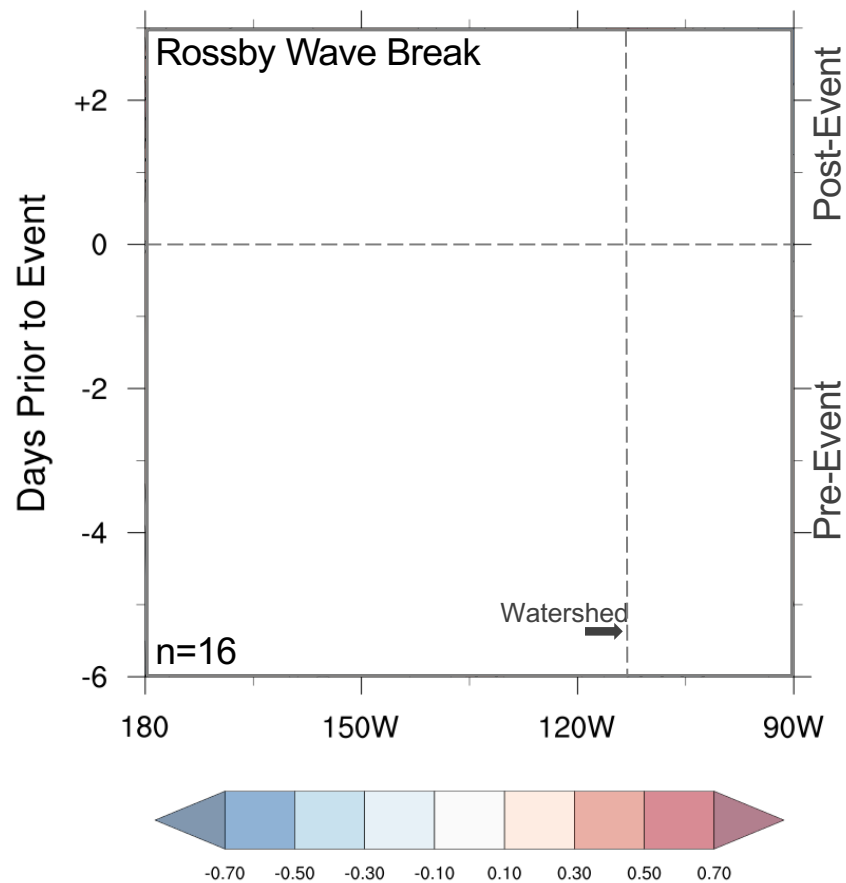
-  wind (2)
-  drowning (1)
-  heavy precip (6)
-  flash flooding (16)
-  hail (5)
-  lightning (2)
-  fire (1)
-  tornado (1)
-  water spout (3)
-  freeze (2)
-  debris flow (1)

NOAA Storm Events associated with 20070923

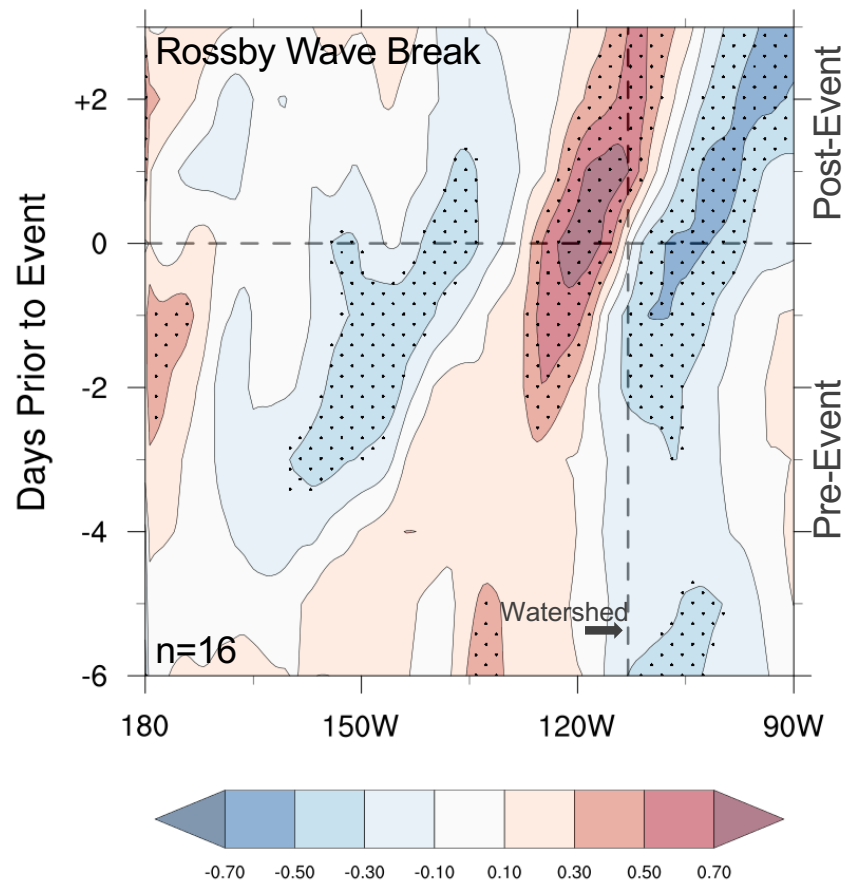
32N-45N Mean 200mb PV Standard Anomaly



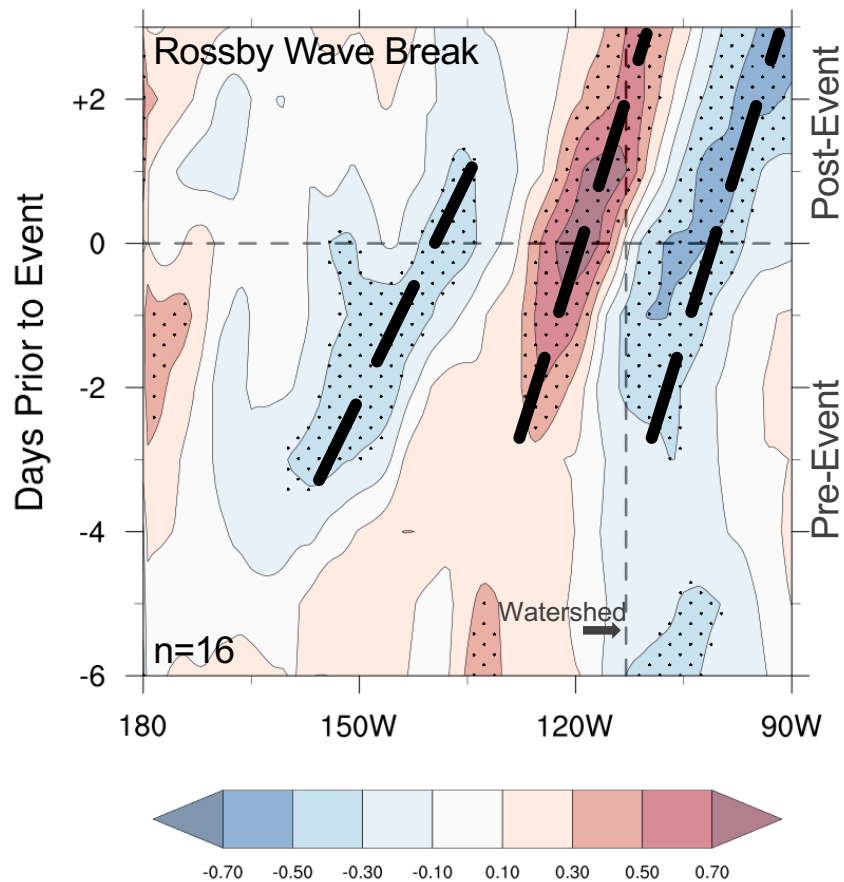
32N-45N Mean 200mb PV Standard Anomaly



32N-45N Mean 200mb PV Standard Anomaly

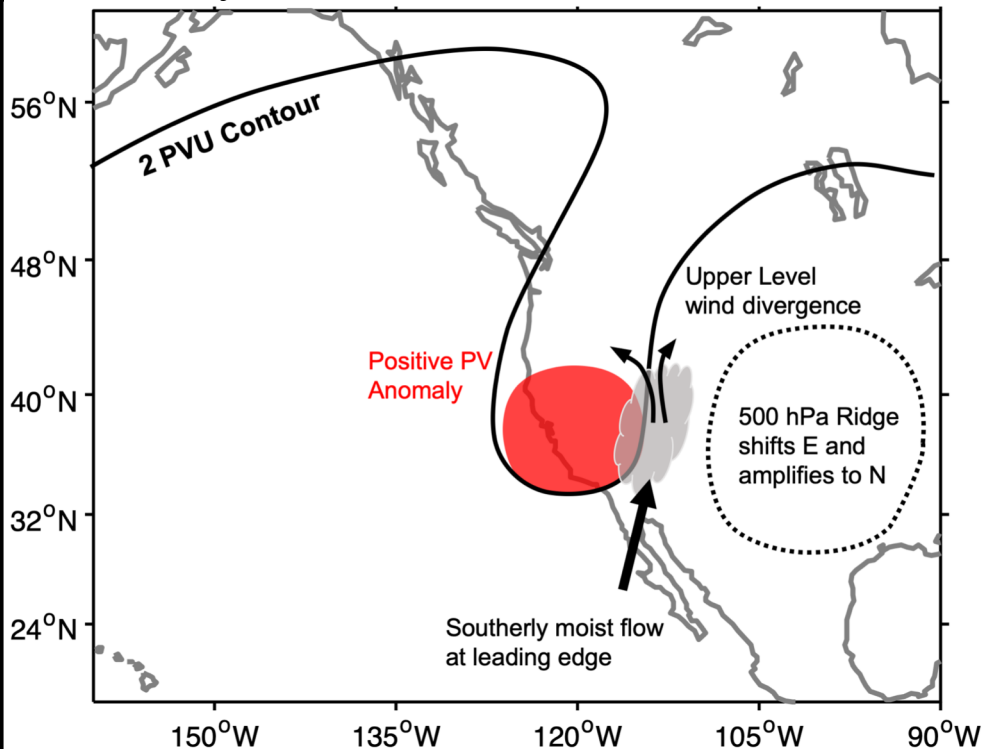


32N-45N Mean 200mb PV Standard Anomaly



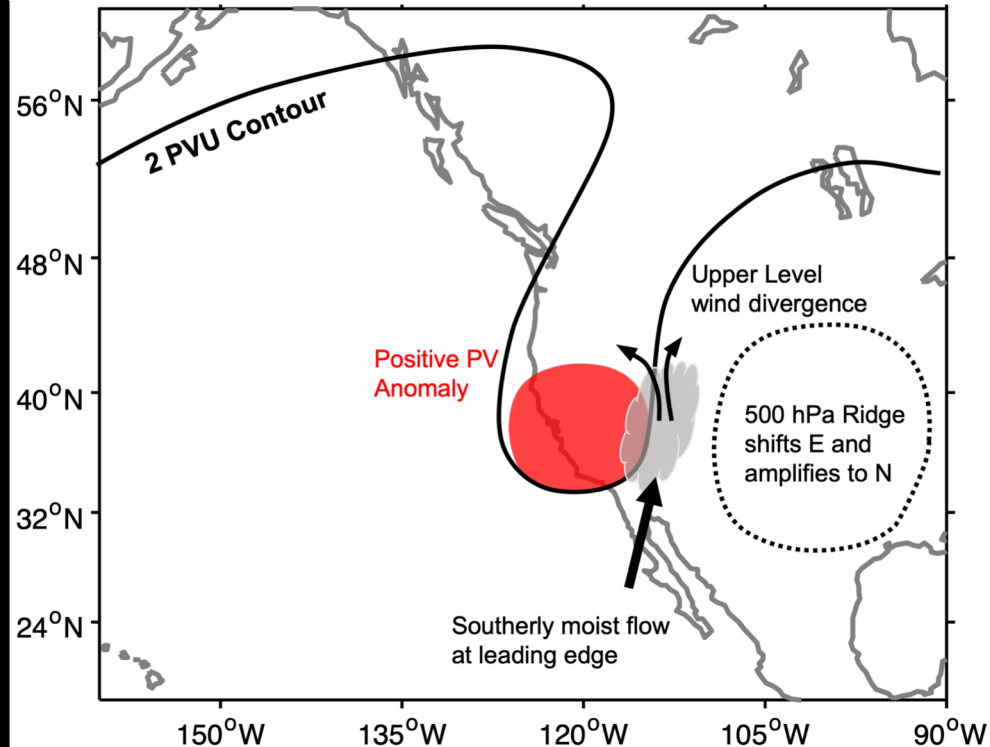
Rossby Wave Break

71%



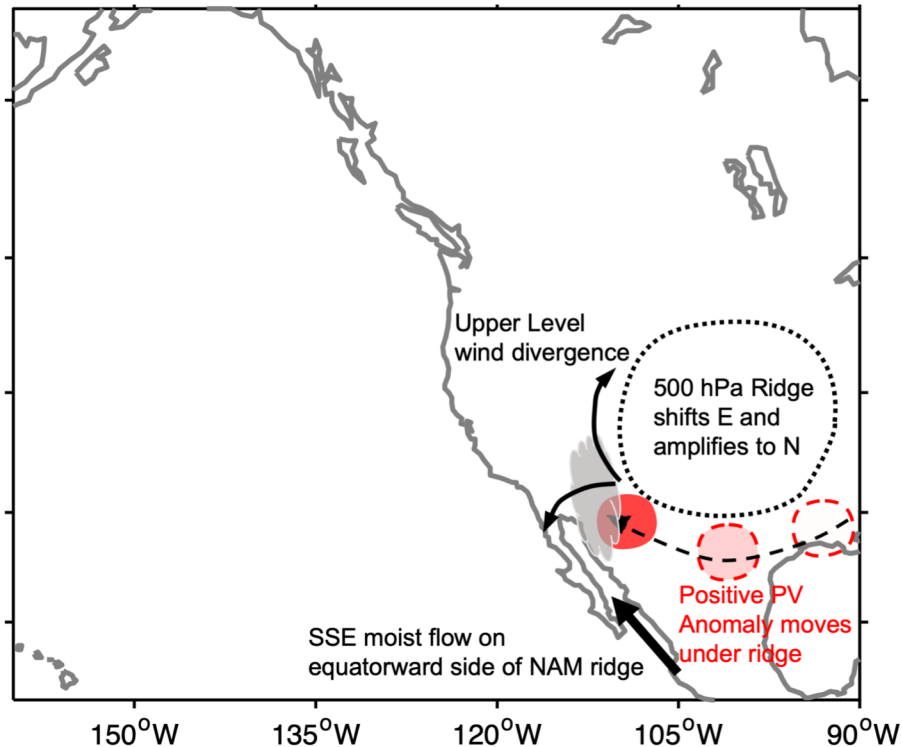
Rossby Wave Break

71%



Inverted Trough

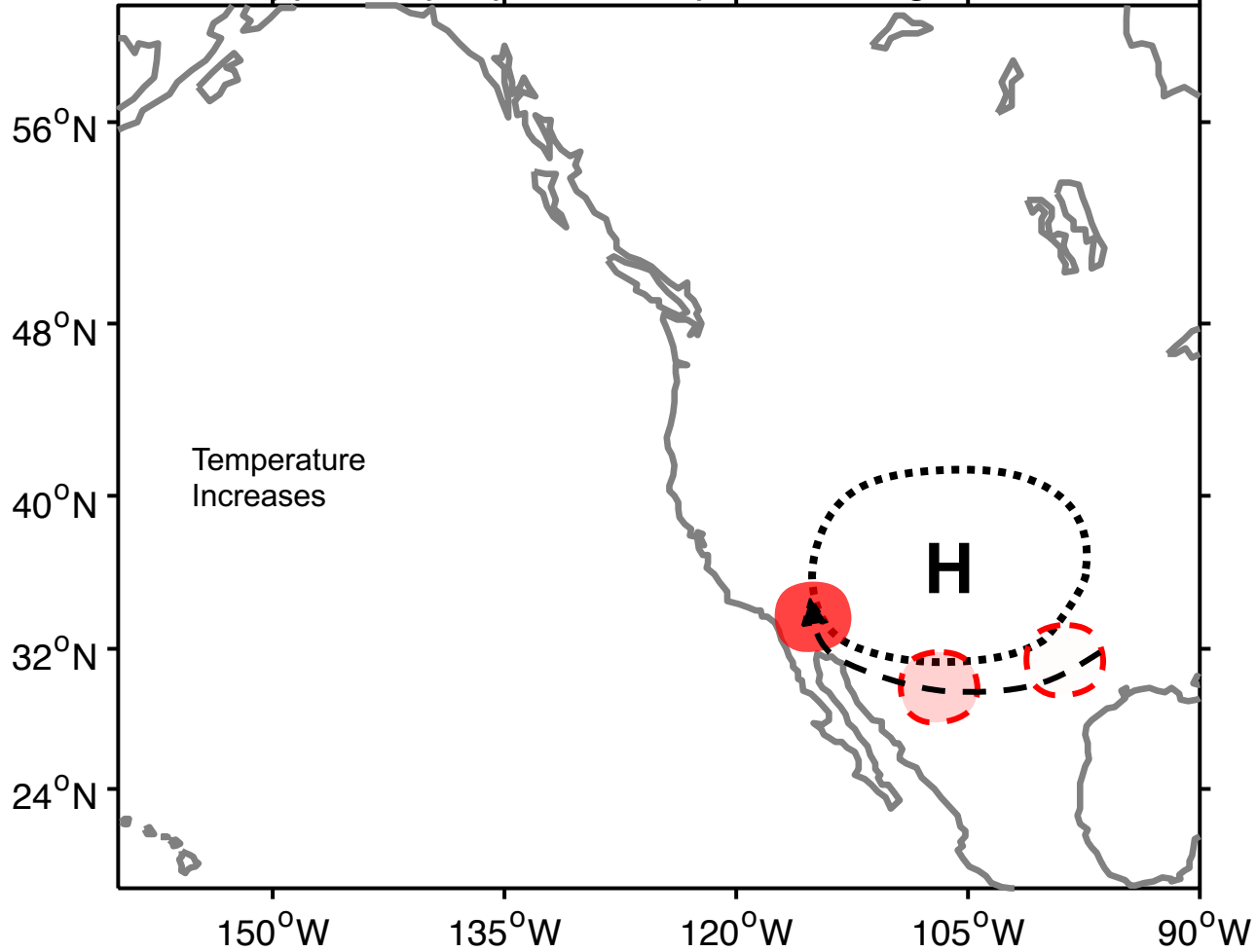
17%



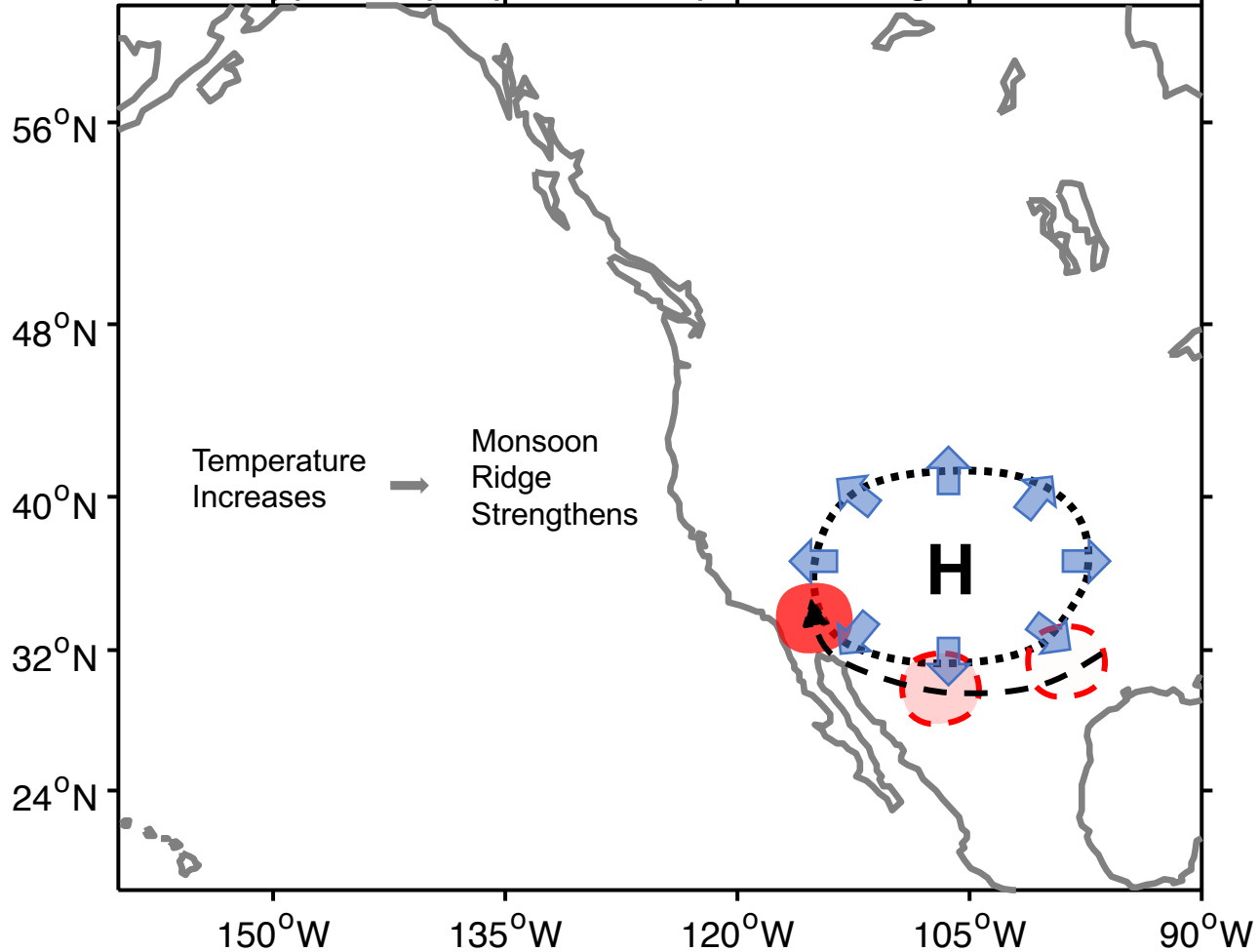
Future Climate

- Lahmers et al. 2016
 - Long-term changes in Inverted Trough using downscaled WRF
- Pascale et al. 2018
 - Influence of increased CO₂ on NAM moisture surges

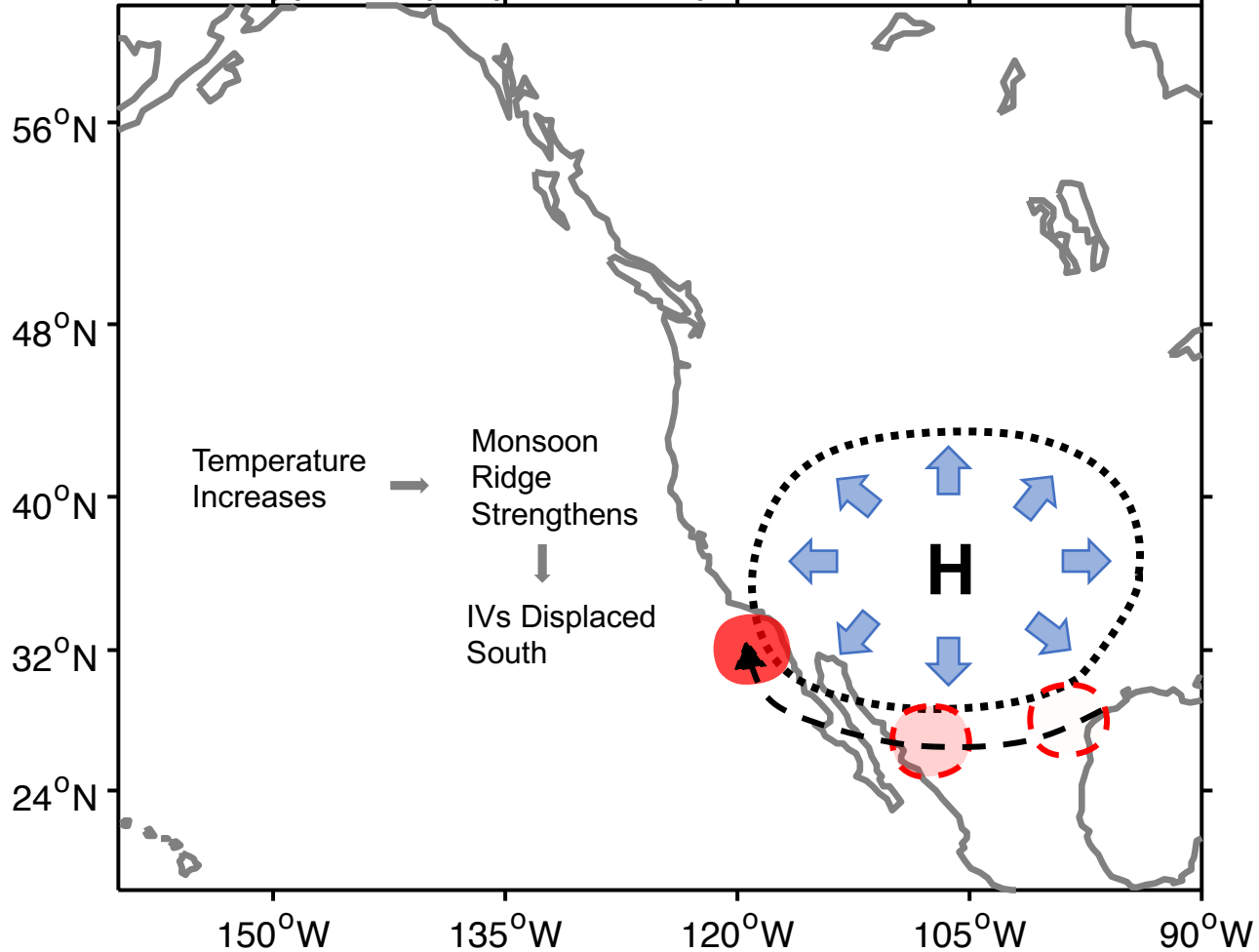
Upper Troposphere Setup – Warming Climate



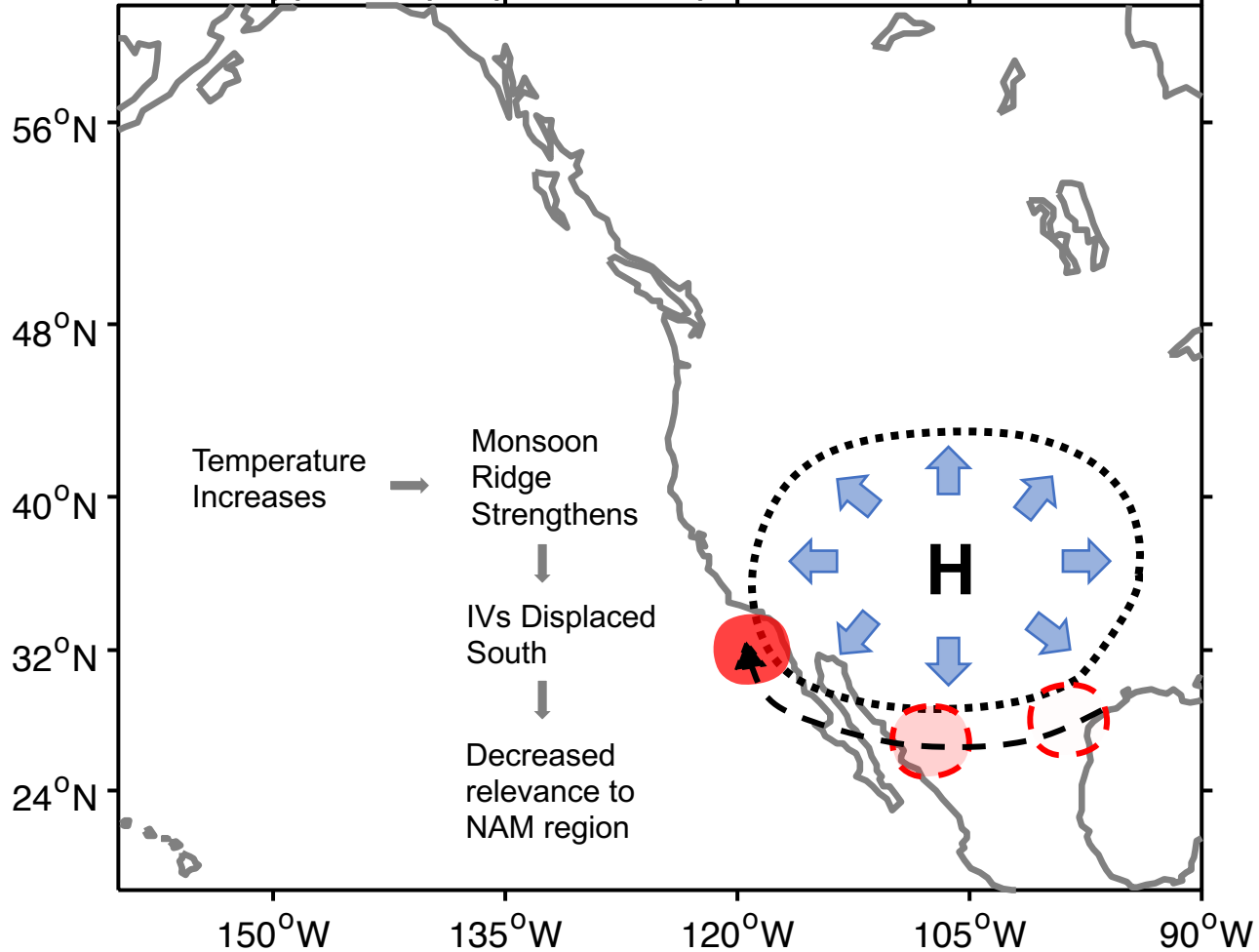
Upper Troposphere Setup – Warming Climate



Upper Troposphere Setup – Future Climate



Upper Troposphere Setup – Future Climate



Future Climate

- Decreased relevance of IVs to the NAM region

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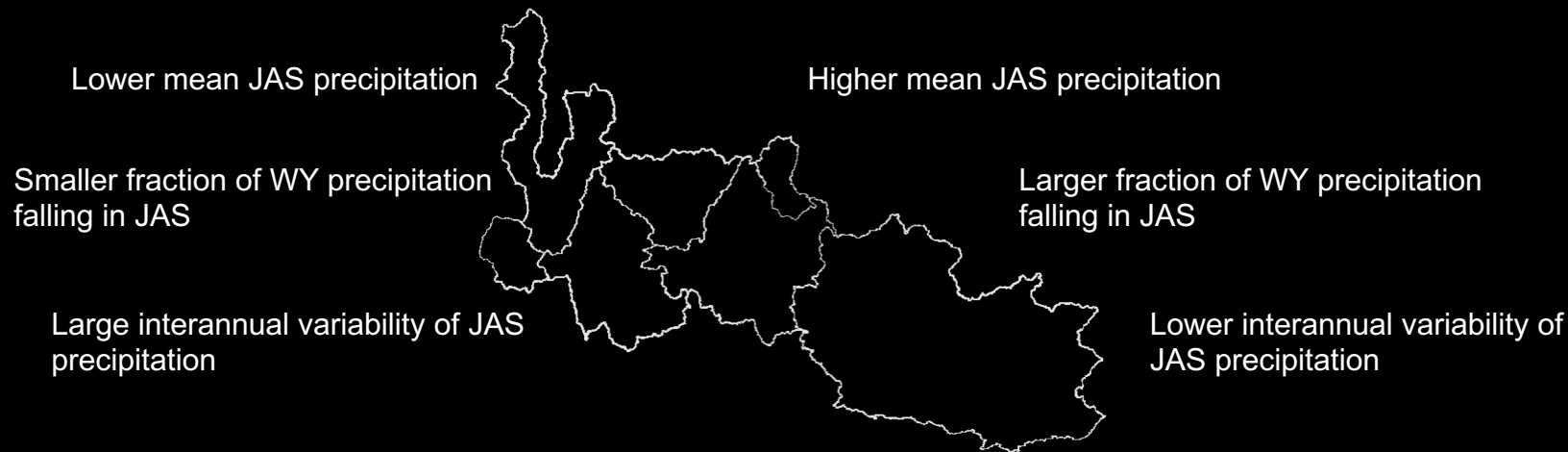
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- How will the relationship between RWB and NAM ridge be affected by a warming climate? (TCs too)

Future Climate

- Decreased relevance of IVs to the NAM region
 - Storms phase locked to high terrain
- Increased IWV doesn't correspond to increased precipitation*
 - Decrease (increase) in non-extreme (extreme) events
- How will the relationship between RWB and NAM ridge be affected by a warming climate? (TCs too)
- Forecast challenges associated with cut-off lows

Conclusions

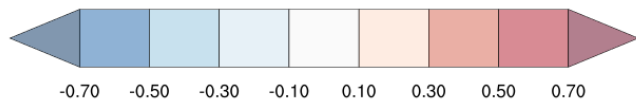
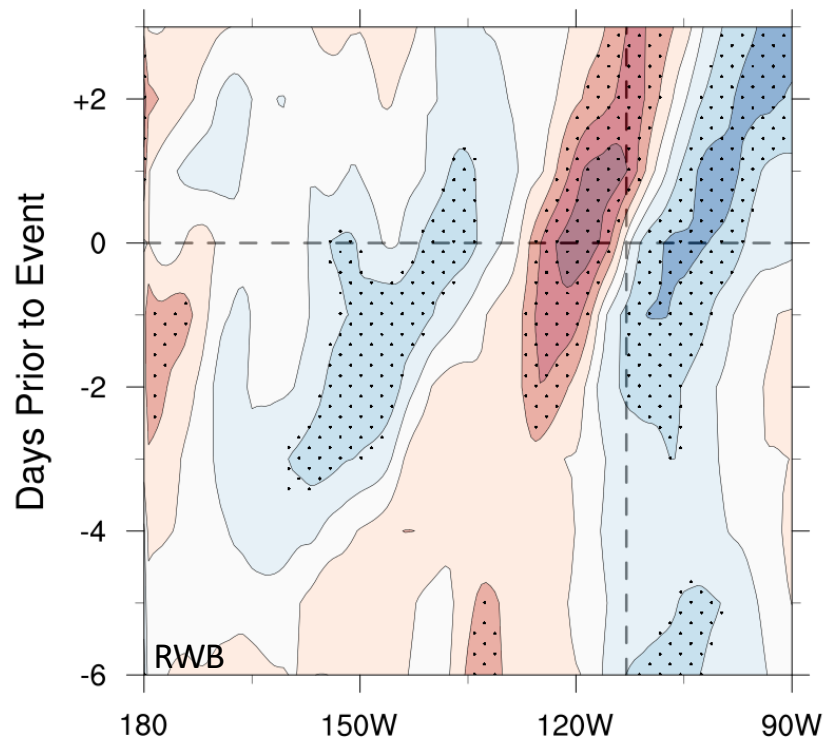
- Stark west-to-east gradient in JAS precipitation characteristics



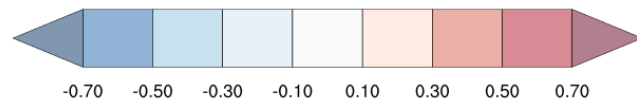
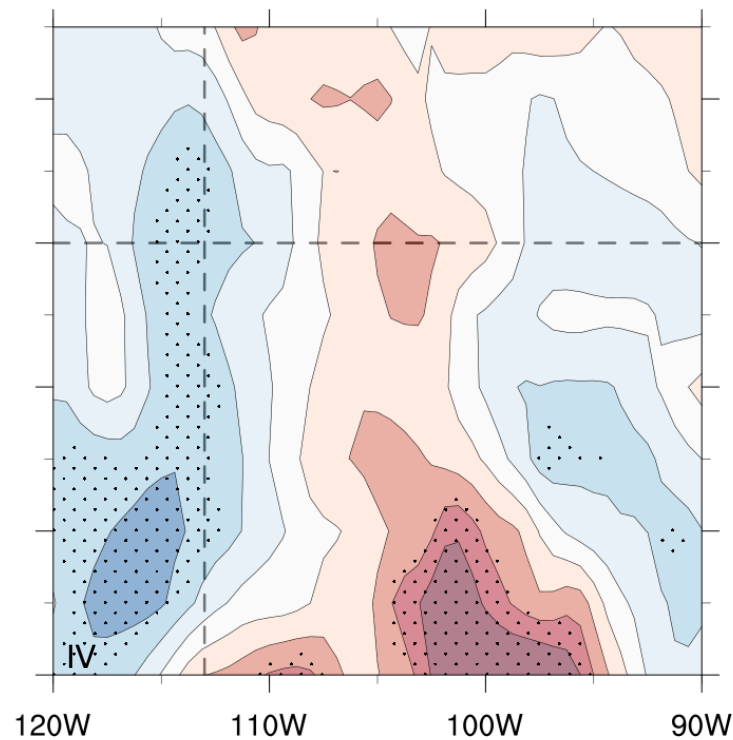
- Anticyclonic Rossby wave breaking in midlatitude westerlies over the US west coast is the dominant synoptic flow regime for extreme precipitation events in the Lake Mead watershed

Extra Slides

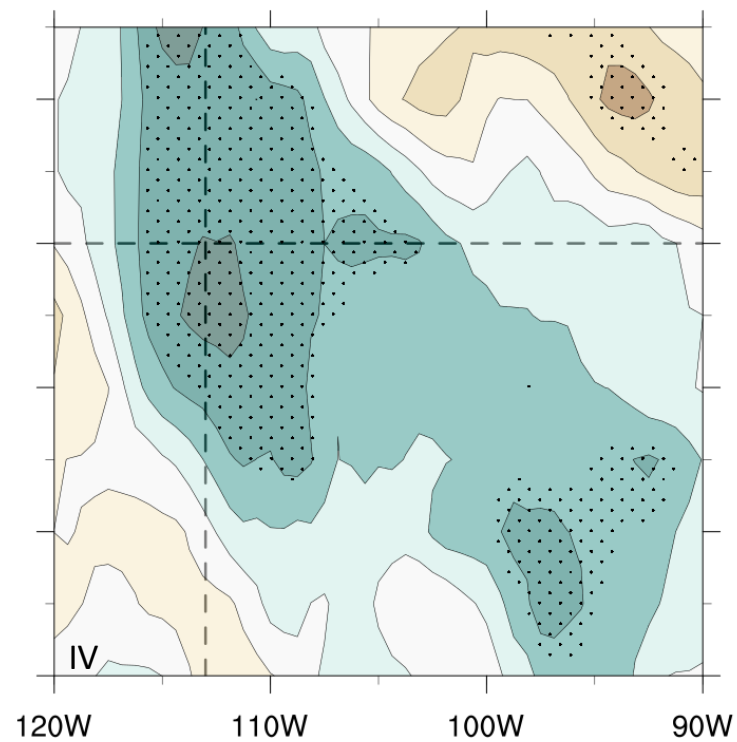
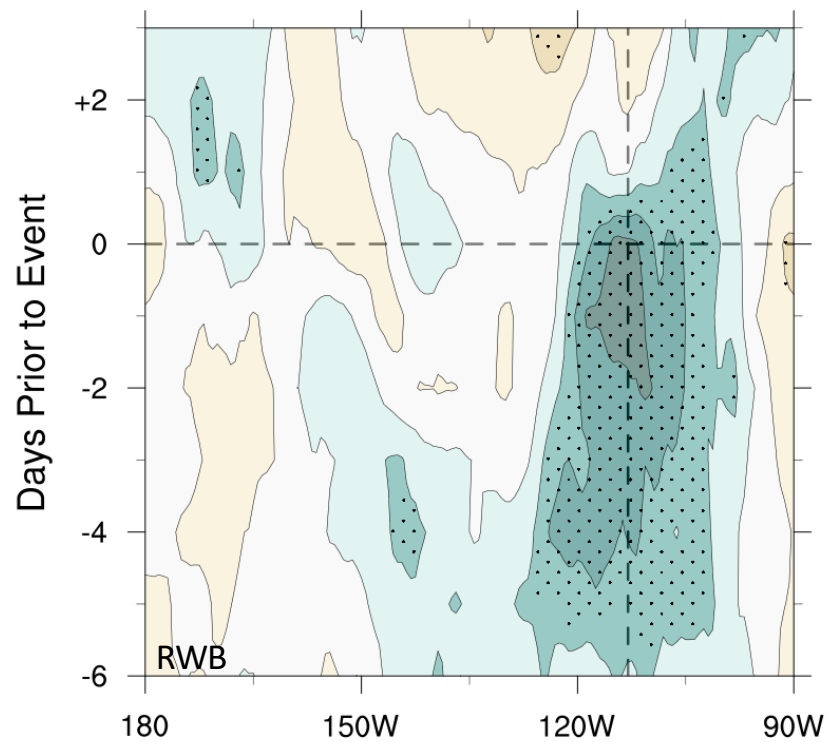
32N-45N Mean 200mb PV Standard Anomaly



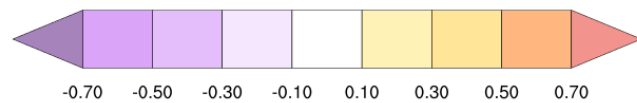
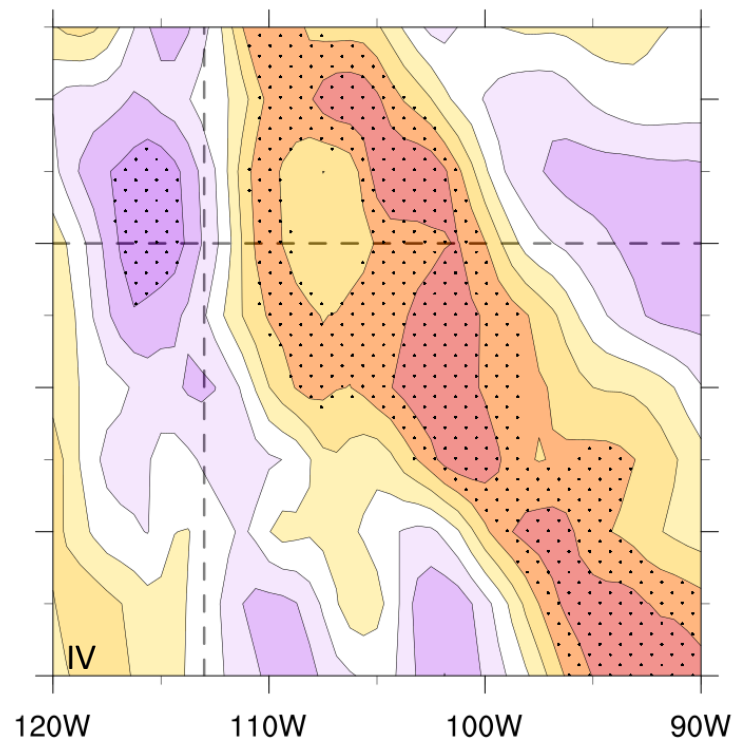
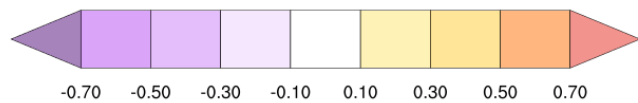
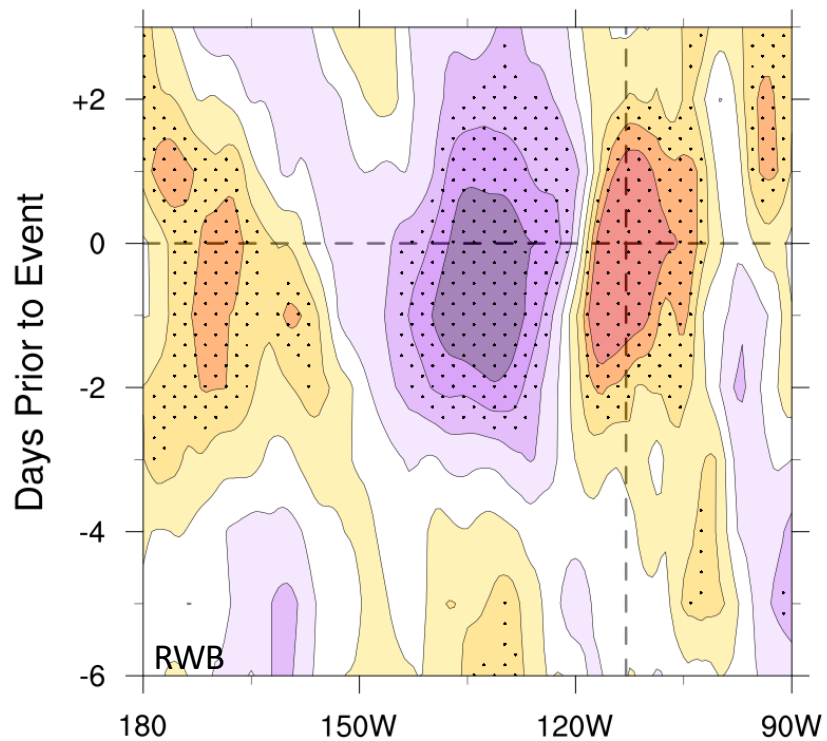
25N-35N Mean 200mb PV Standard Anomaly



25N-35N Mean IWV Standard Anomaly



25N-35N Mean V700hPa Standard Anomaly



Distribution of Events by Basin - 10mm

