CIRES/NOAA ESRL Progress on estimating wet-weather extremes

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Representing work of Kelly Mahoney, Mike Alexander, Dustin Swales, Mike Mueller, Paul Neiman, Cathy Smith, Joe Barsugli, and Jamie Scott.

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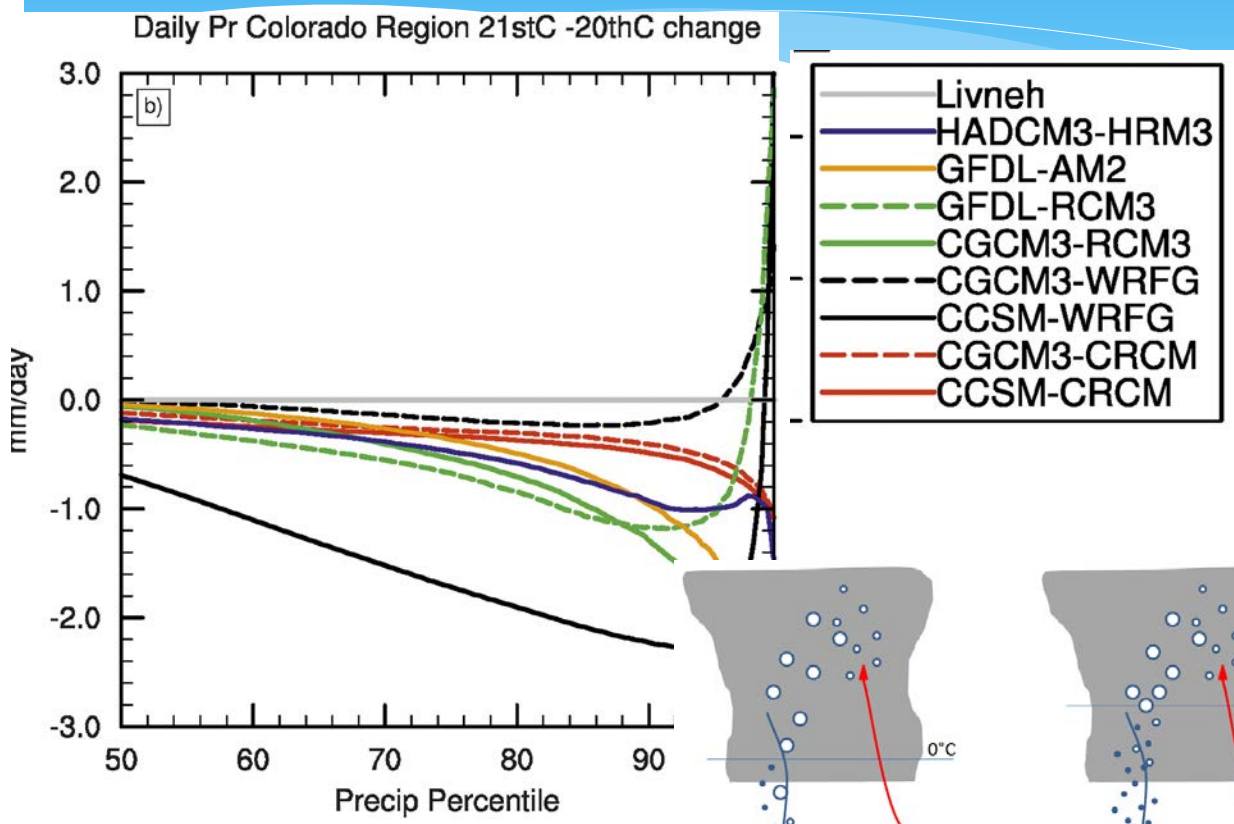
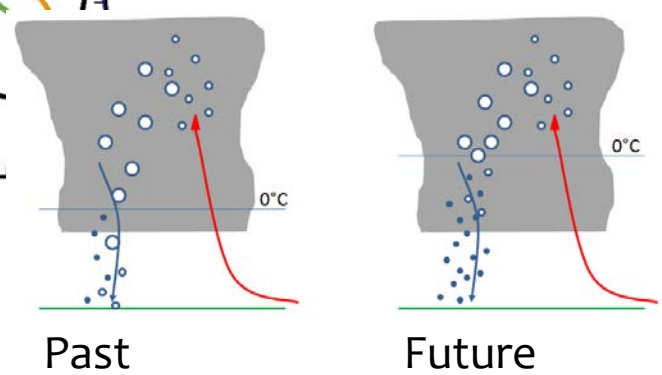
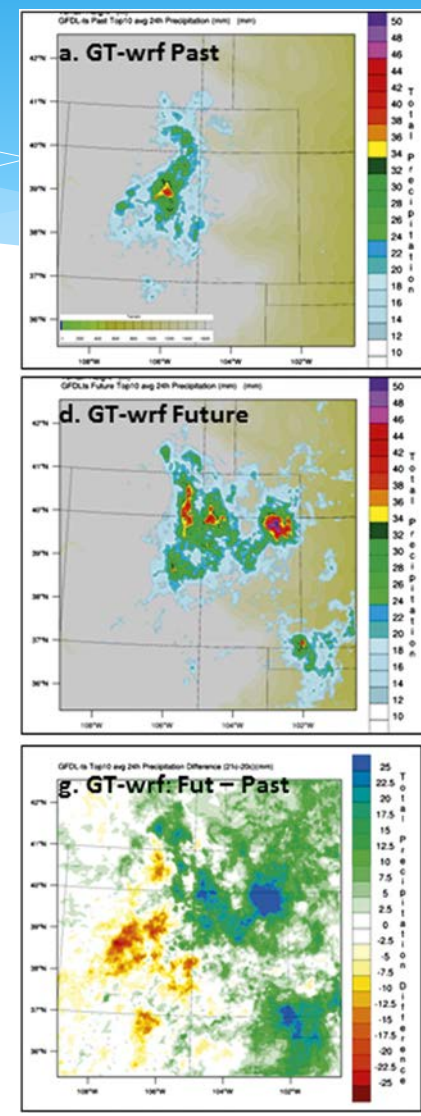
Focus area 1: Improving extreme precipitation estimation and climate change projections using high-resolution model simulations

* Primarily addresses Long-term gaps **3.06** and **4.03** (Brekke et al. 2011):
  - "Method and basis for estimating extreme **meteorological (3.06)** and **hydrological (4.03)** event possibilities deterministically or probabilistically in a changing climate"
* Three published manuscripts:
  - Alexander et al. 2013: Greenhouse Gas-Induced Changes in Summer Precipitation over Colorado in NARCCAP Regional Climate Models. *J. Clim.*
  - Mahoney et al. 2013: High-Resolution Downscaled Simulations of Warm-Season Extreme Precipitation Events in the Colorado Front Range under Past and Future Climates. *J. Clim.*
  - Mahoney et al. 2012: Changes in hail and flood risk in high-resolution simulations over the Colorado Mountains. *Nat. Clim. Change*
* Work continuing on probabilistic methods

Focus area 1: Improving extreme precipitation estimation and climate change projections using high-resolution model simulations





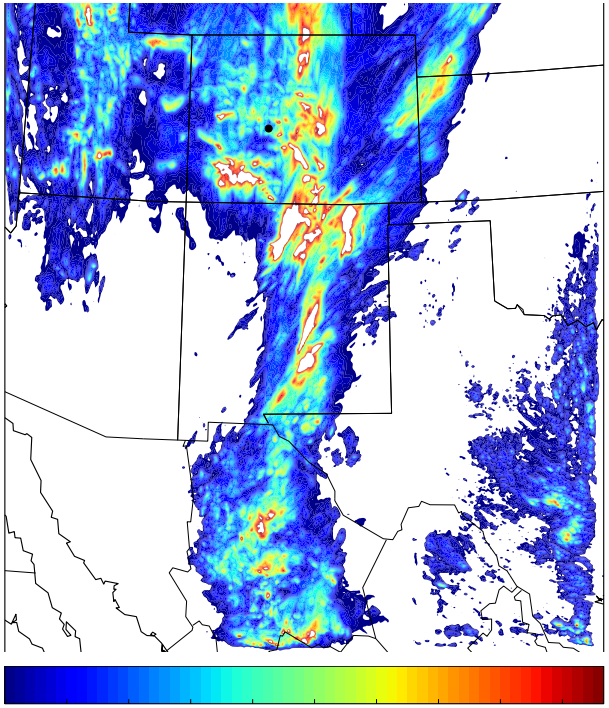


Figures from Alexander et al. 2013 (top left) , Mahoney et al. 2012 (bottom center), and Mahoney et al. 2013 (right)

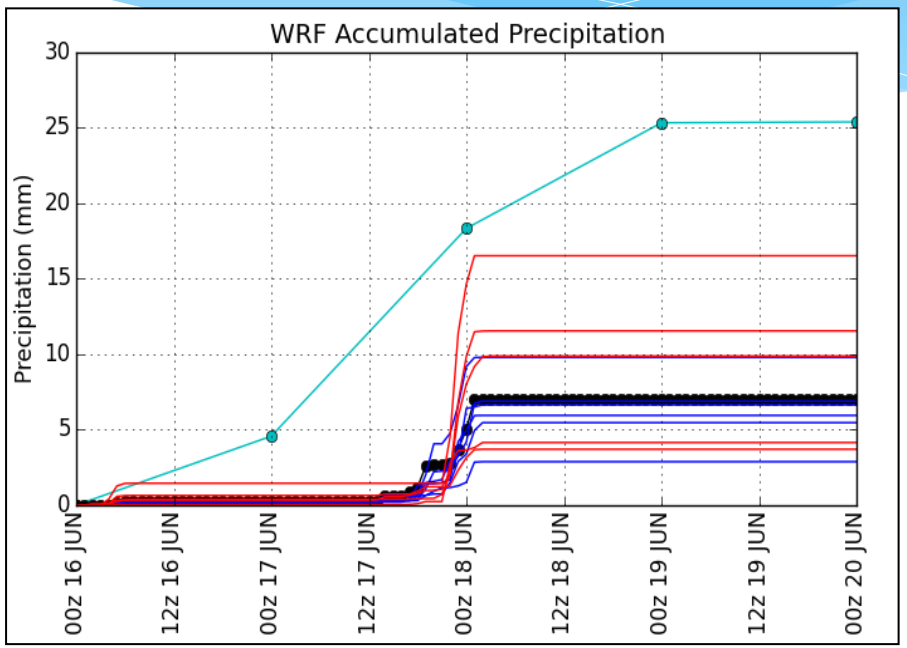
2015

Focus area 1: Improving extreme precipitation estimation and climate change projections using high-resolution model simulations

Ensemble precipitation maximum



Precipitation (mm)



Exploring ensemble methods: What are the best paths forward for characterizing and interpreting precipitation uncertainties?

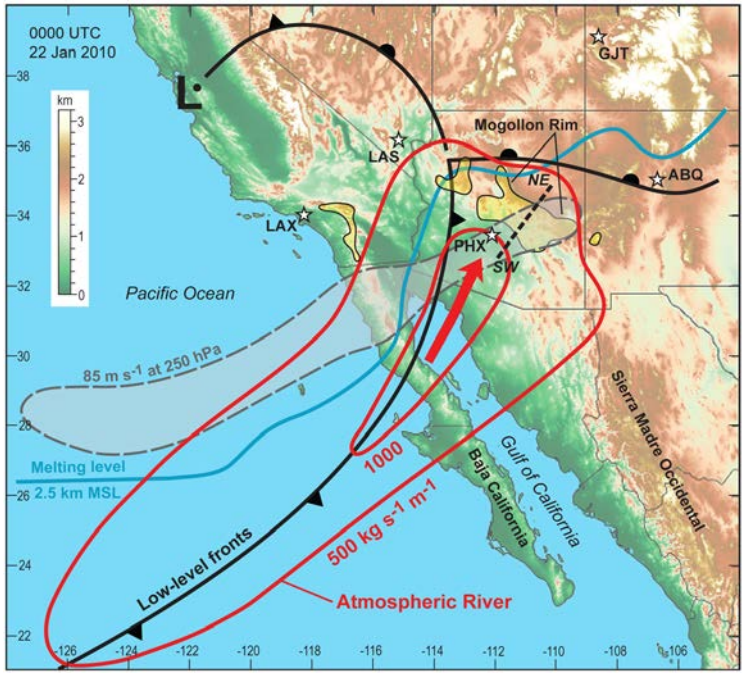
Figures from Mueller et al. (work in progress)

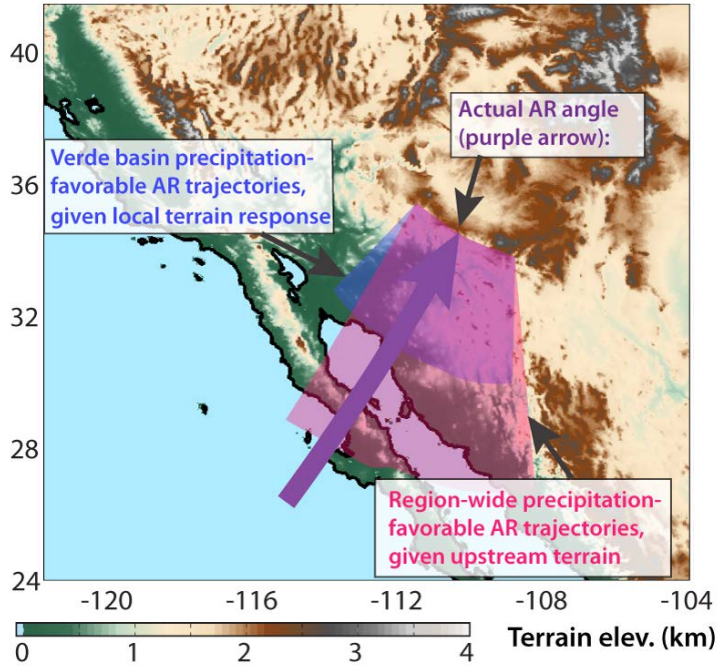
Focus area 2: Moisture sources for extreme precipitation events in the Intermountain West

* Primarily addresses Long-term gap **3.01** (Brekke et al. 2011):
  - "Understanding on observed climate variability from daily to multidecadal time scales, which underpins interpretation of future variability in climate projections and its relation to planning assumptions"
* Three published manuscripts, one manuscript in preparation:
  - Swales et al. 2015 (in prep): Examining Moisture Pathways and Extreme Precipitation in the U.S. Intermountain West using Self Organizing Maps
  - Alexander et al. 2015: Moisture Pathways into the U.S. Intermountain West Associated with Heavy Winter Precipitation Events. *J. Hydrometeor*
  - Neiman et al. 2013, Hughes et al. 2014: The landfall and inland penetration of a flood-producing atmospheric river in Arizona, Parts 1 and 2, *J. Hydrometeor*
* Work continuing on climate change impacts

Focus area 2: Moisture sources for extreme precipitation events in the Intermountain West

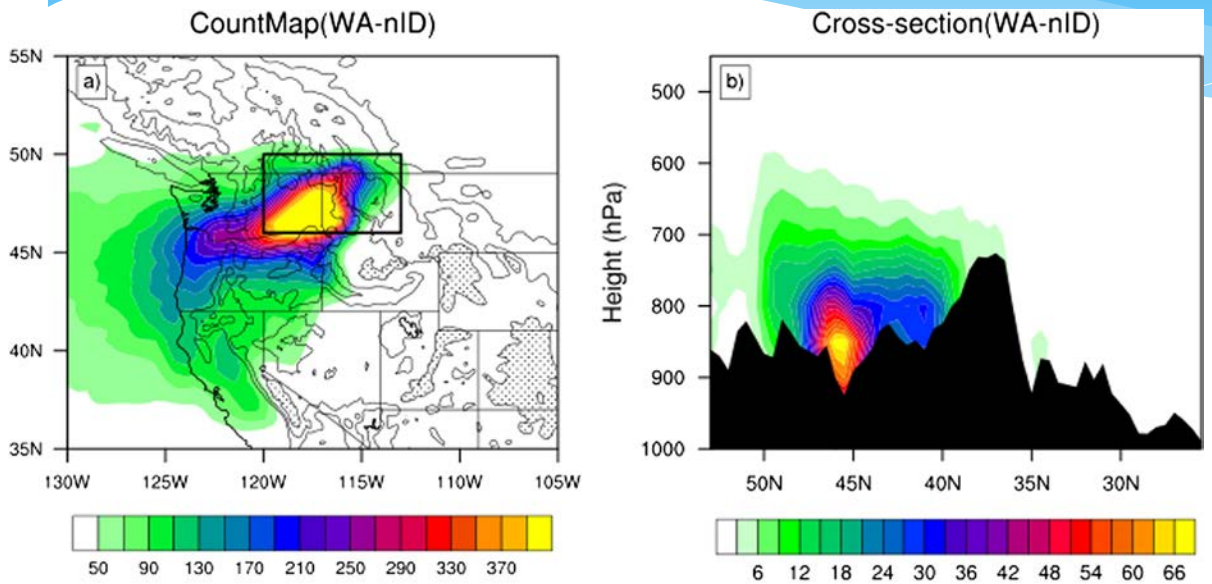
- Atmospheric rivers are one mechanism for moisture to penetrate the Intermountain West.
- The terrain storms cross as they move inland impacts total available moisture and thus their region-wide precipitation impact.
- Their landfall angle impacts basin-wide precipitation impact.

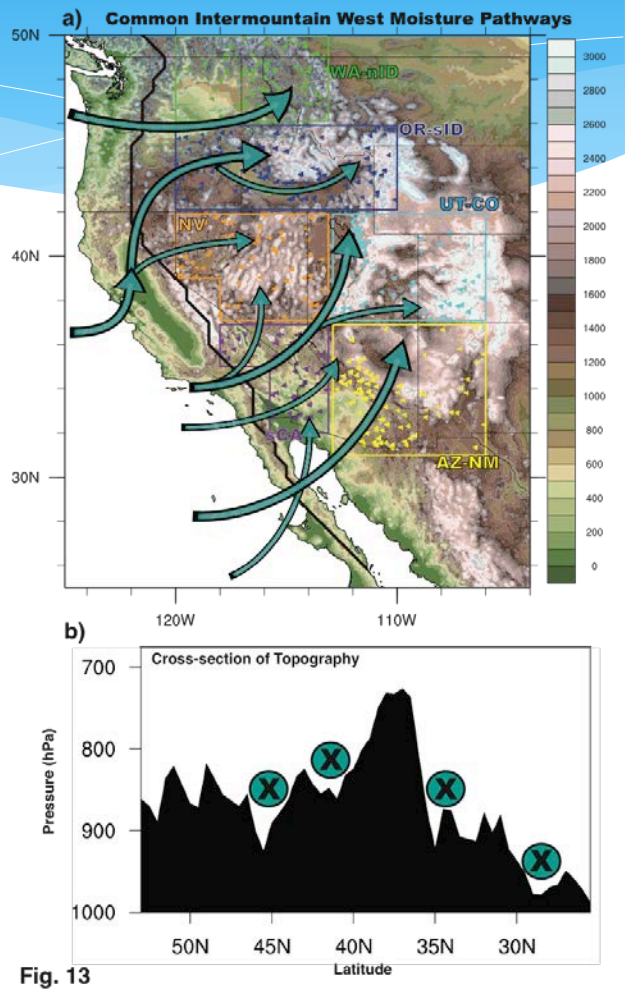




Figures from Neiman et al. 2013 (left) and Hughes et al. 2014 (right)

Focus area 2: Moisture sources for extreme precipitation events in the Intermountain West



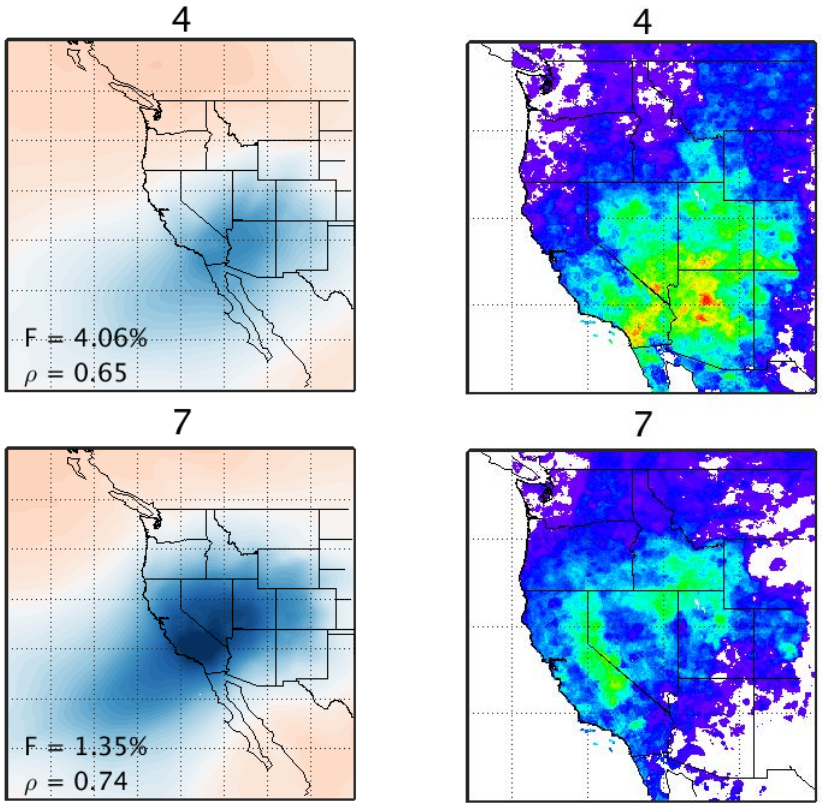


Trajectory analysis of parcels during extreme precipitation cases reveals specific pathways for moisture to penetrate the intermountain west, often through low-elevation gaps in the coastal ranges and Cascades/Sierra Nevada.

Figures from Alexander et al. 2015.

Focus area 2: Moisture sources for extreme precipitation events in the Intermountain West

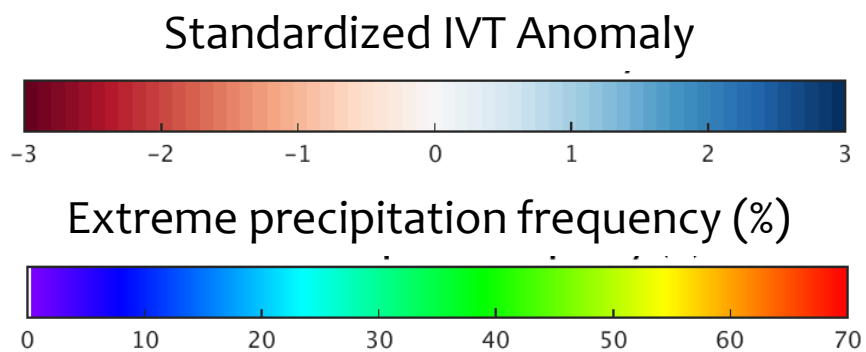
Self-organized map nodes 4 and 7



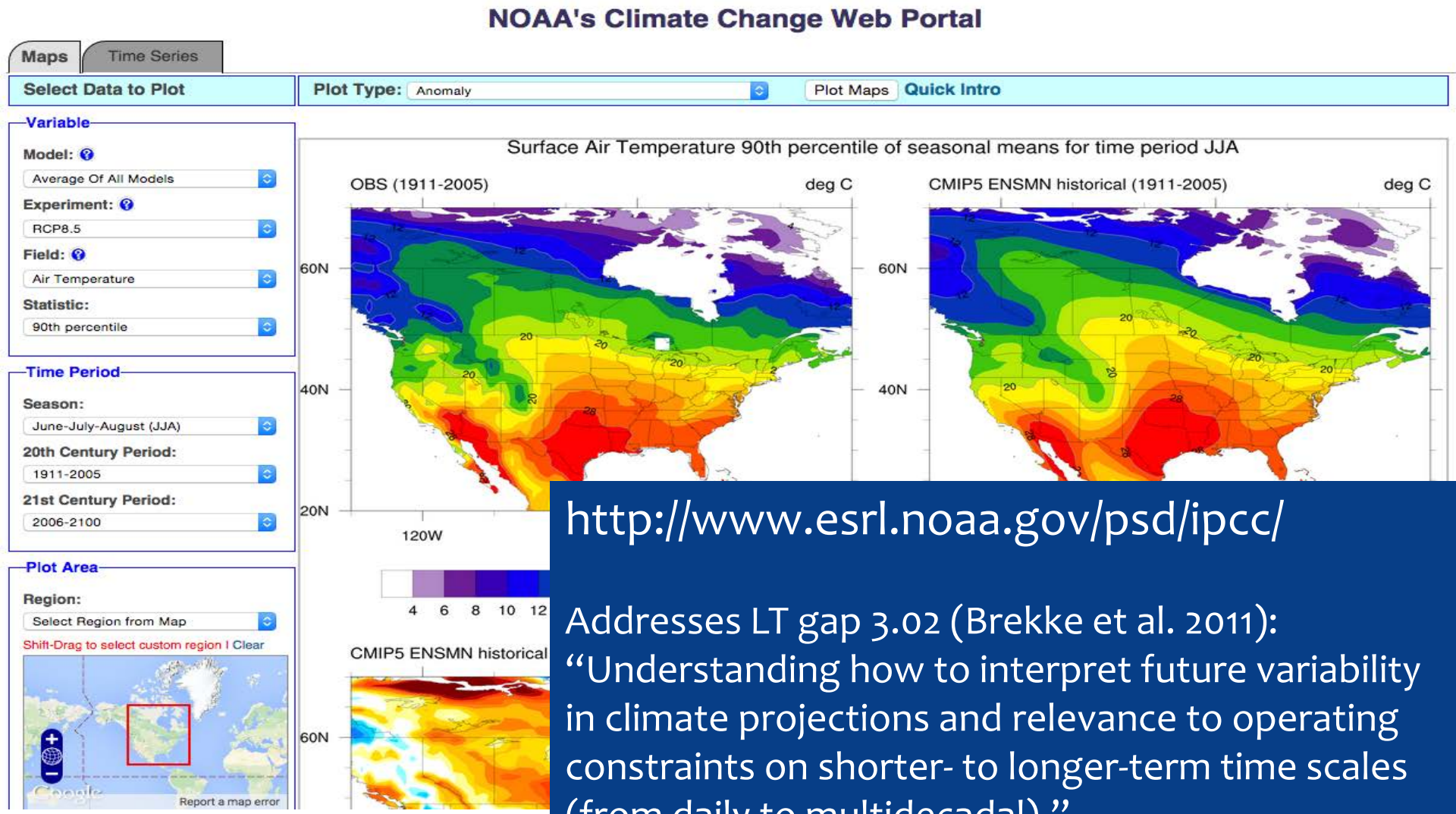
Standardized IVT Extreme precip %

Figures from Swales et al. 2015 (in prep).

- A substantial number of extreme precipitation events in the IMW are associated with infrequently occurring synoptic patterns
- Moisture pathways noted in Alexander et al. (2015) also evident with this method.



Focus area 3: NOAA's Climate change web portal



http://www.esrl.noaa.gov/psd/ipcc/

Addresses LT gap 3.02 (Brekke et al. 2011): "Understanding how to interpret future variability in climate projections and relevance to operating constraints on shorter- to longer-term time scales (from daily to multidecadal)."

Paths forward

* Continued exploration of ensemble characterization of extreme events, including both meteorological and hydrological sensitivity studies
  - Where do system sensitivities lie and which structural uncertainties matter?
* Using our knowledge of current intermountain west moisture sources to interpret projections of climate change
  - Will the frequency of moisture penetrations for each region change?