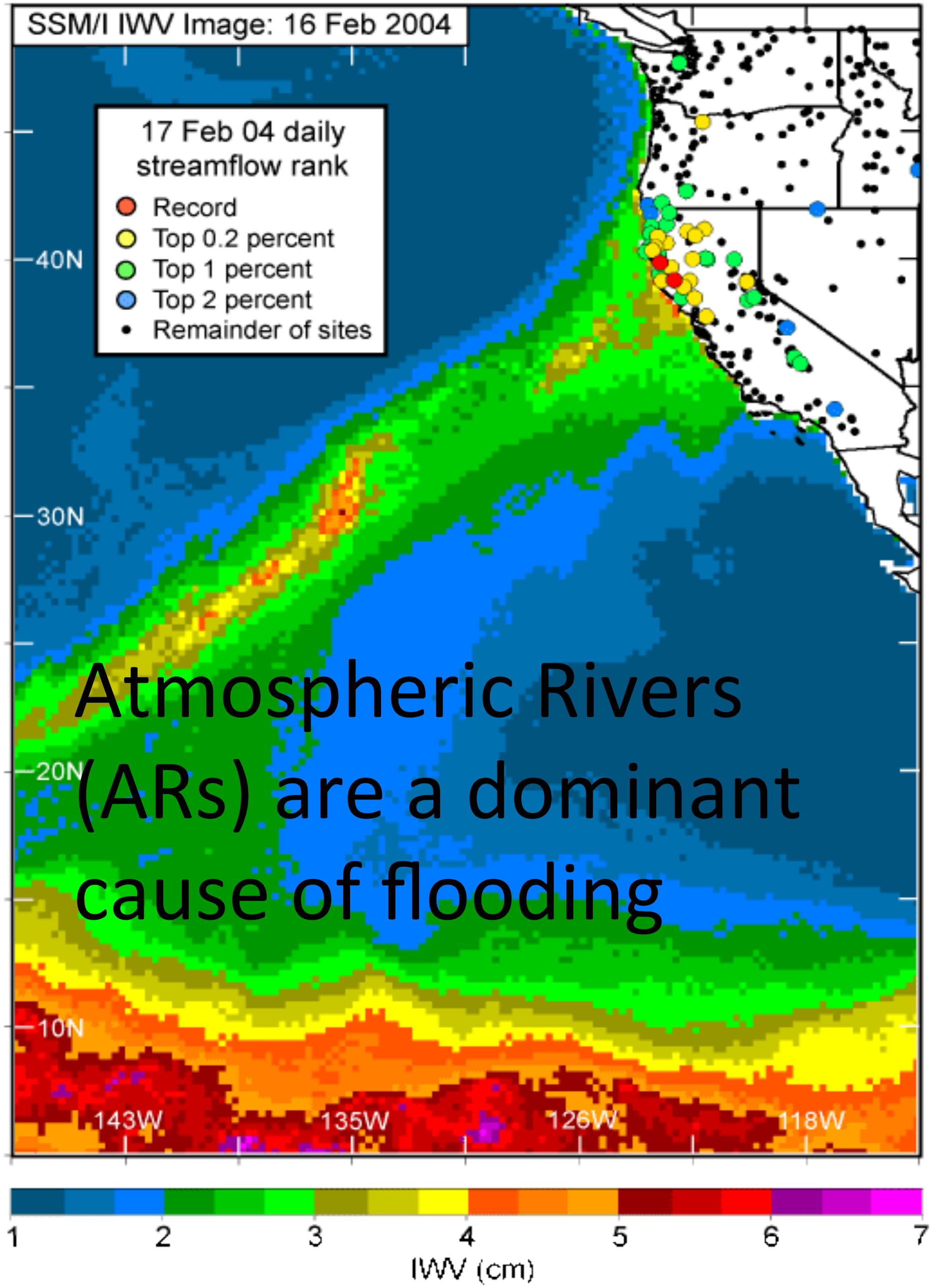
NOAA RESEARCH • ESRL • PHYSICAL SCIENCES DIVISION

Linkages Between Atmospheric Rivers and Orographic Precipitation in the Western U.S.

Mimi Hughes

Science Review
12-14 May 2015
Boulder, Colorado



Atmospheric Rivers (ARs) are a dominant cause of flooding

Flooding on California's Russian River: Role of atmospheric rivers

Ralph, F.M., P. J. Neiman, G. A. Wick, S. I. Gutman, M. D. Dettinger, D. R. Cayan, A. White
Geophys. Res. Lett., 2006

Russian River floods are associated with atmospheric rivers
- all 7 floods over 8 years.

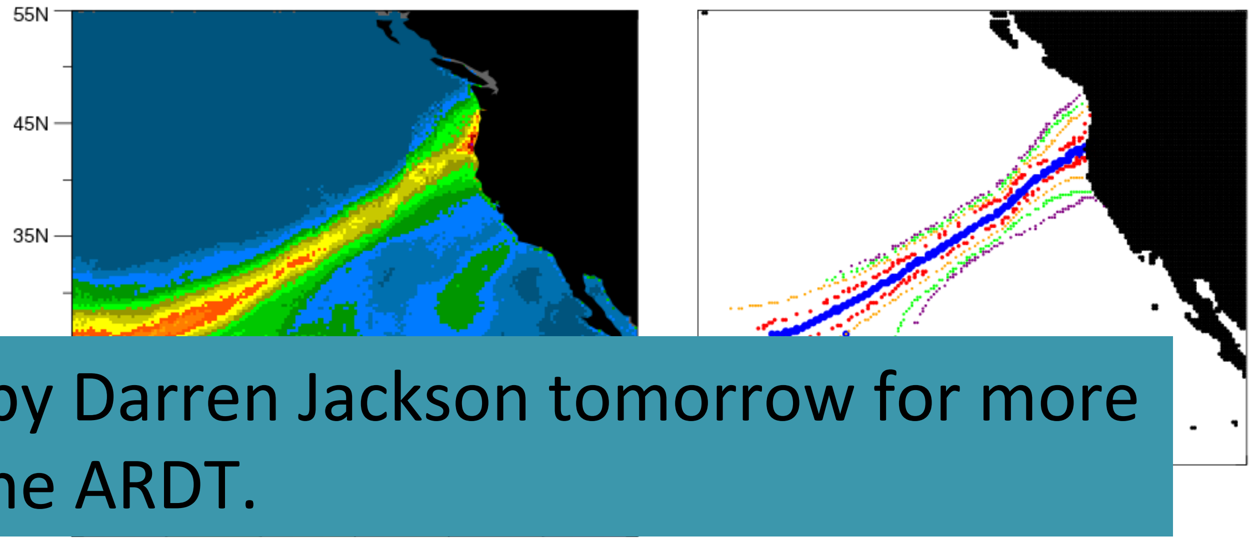
Flooding in Western Washington: The Connection to Atmospheric Rivers
Paul J. Neiman, L. J. Schick, F. M. Ralph, M. Hughes, and G. A. Wick
J. Hydrometeorology (2011)
46 of 48 annual peak daily flows on 4 watersheds were associated with atmospheric rivers.

Slide courtesy F. M. Ralph

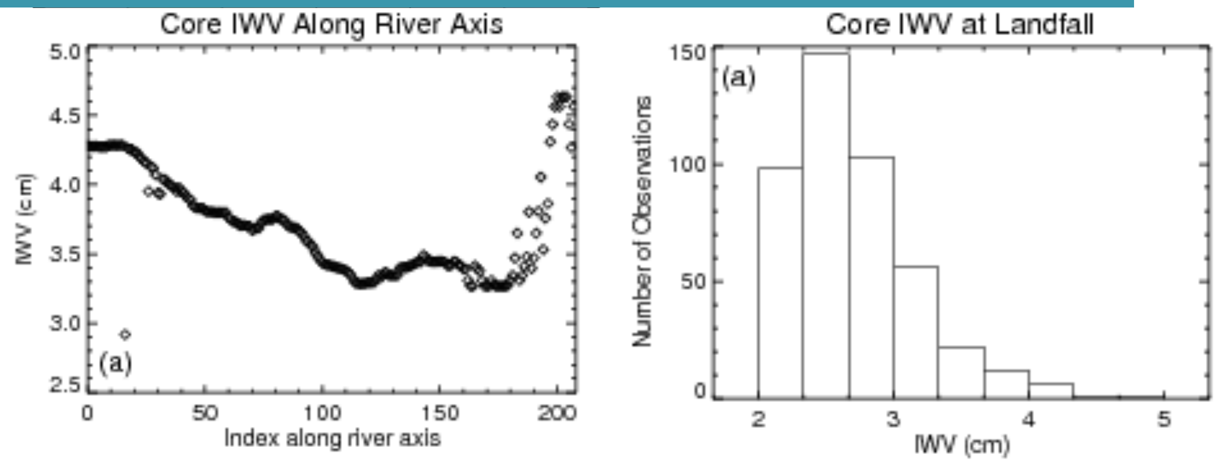
Automated AR Detection Tool (ARDT)

- Automated tool developed for detection of AR events in observed and modeled IWV fields
- Based on thresholds for width, length, and IWV content of ARs
- Validat[…] manua[…] landfall[…] cool seasons
  - 92.8% critical success index
- Procedure returns core IWV, AR width, and orientation along length of AR

Sample application on 7 November 2006



See poster by Darren Jackson tomorrow for more details on the ARDT.



Wick et al., TGRS, 2013

CA landfalling ARs as a function of time

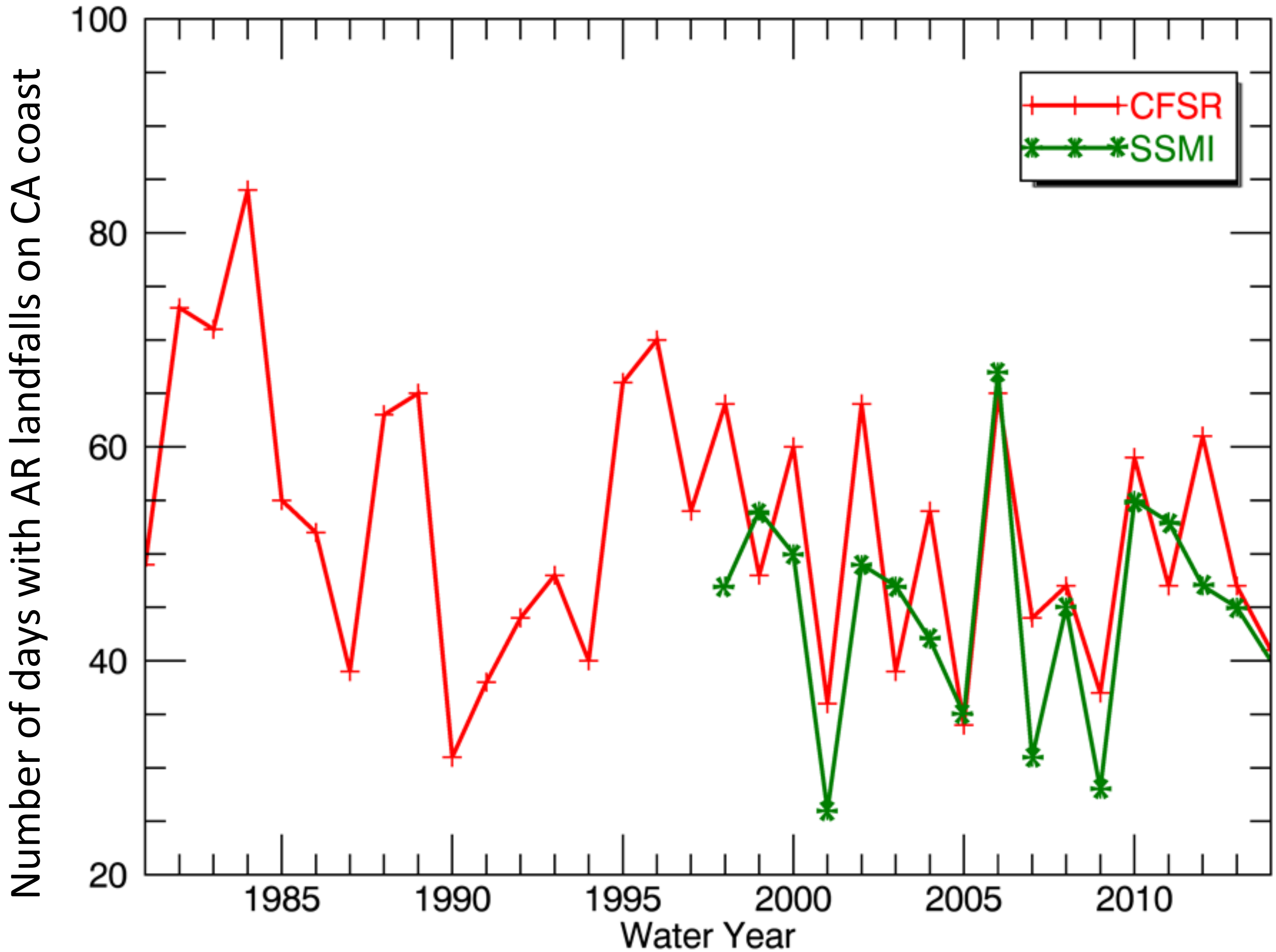
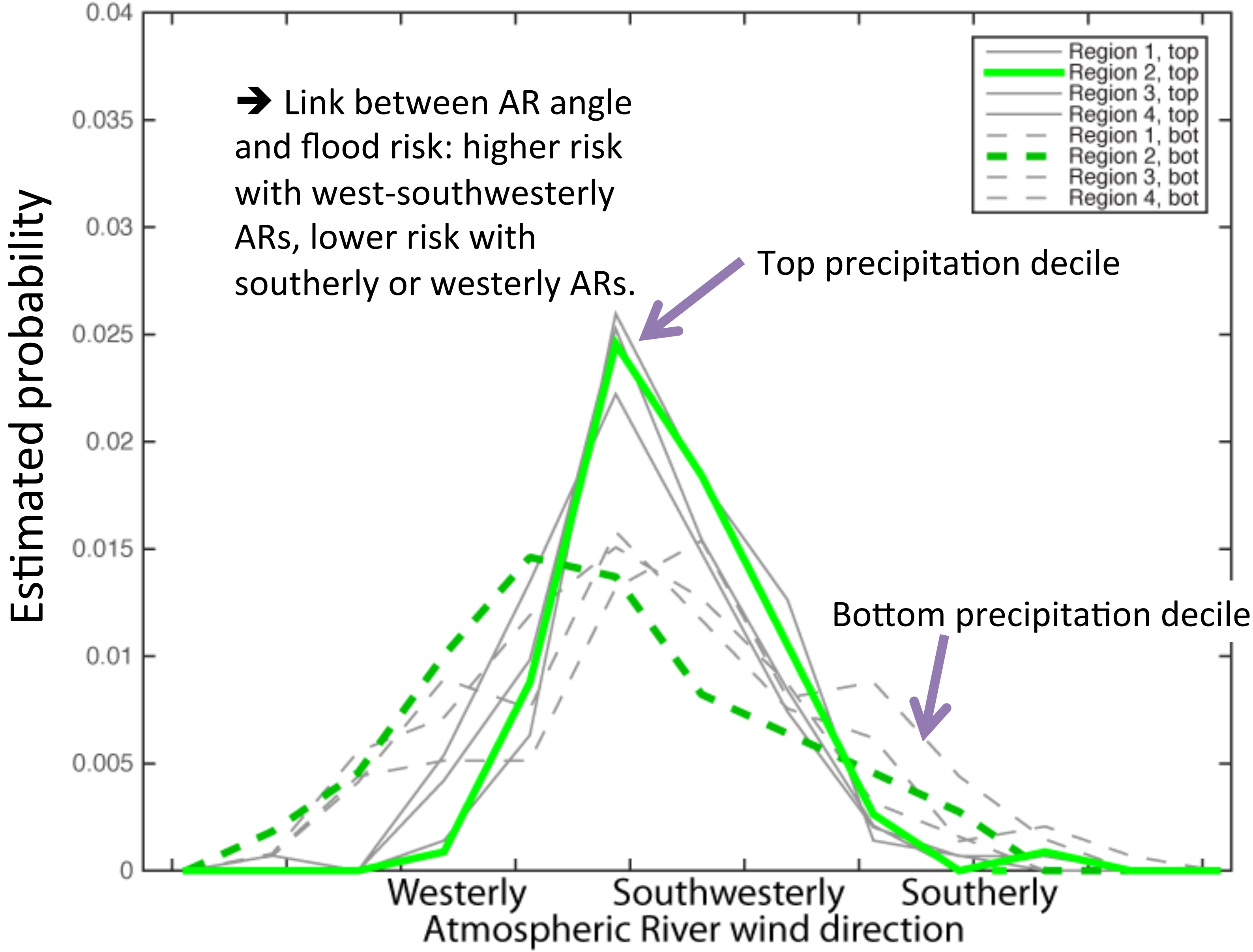


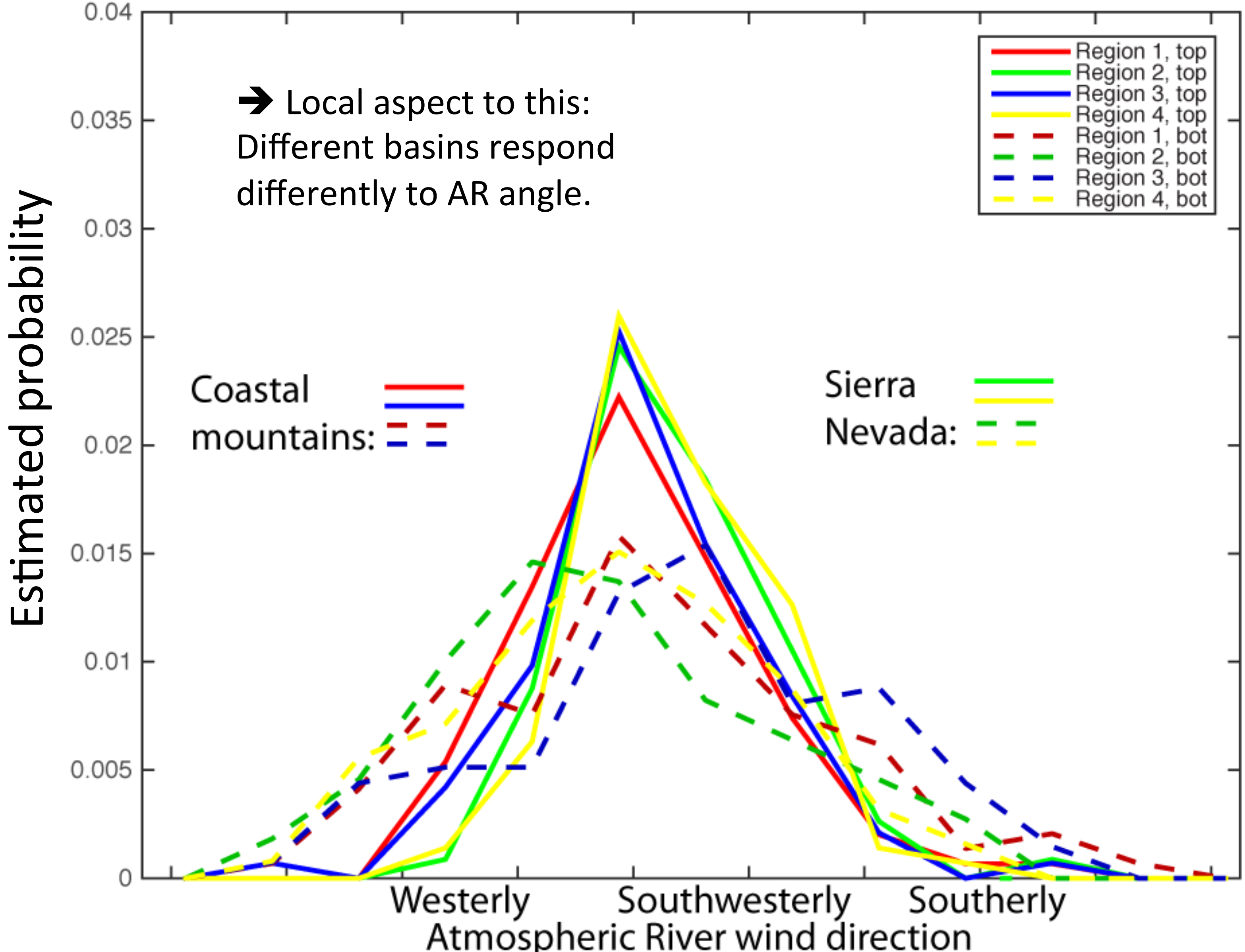
Figure courtesy D. Jackson

Floods vs. duds: AR orientation

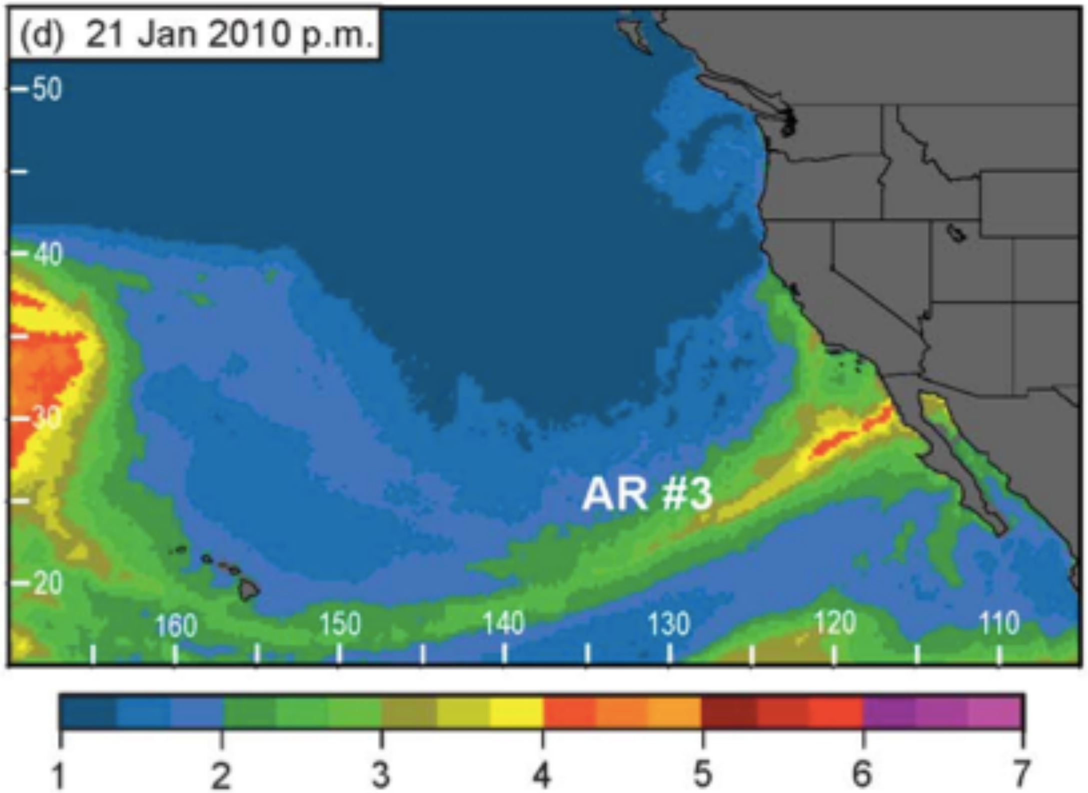
➔ Link between AR angle and flood risk: higher risk with west-southwesterly ARs, lower risk with southerly or westerly ARs.



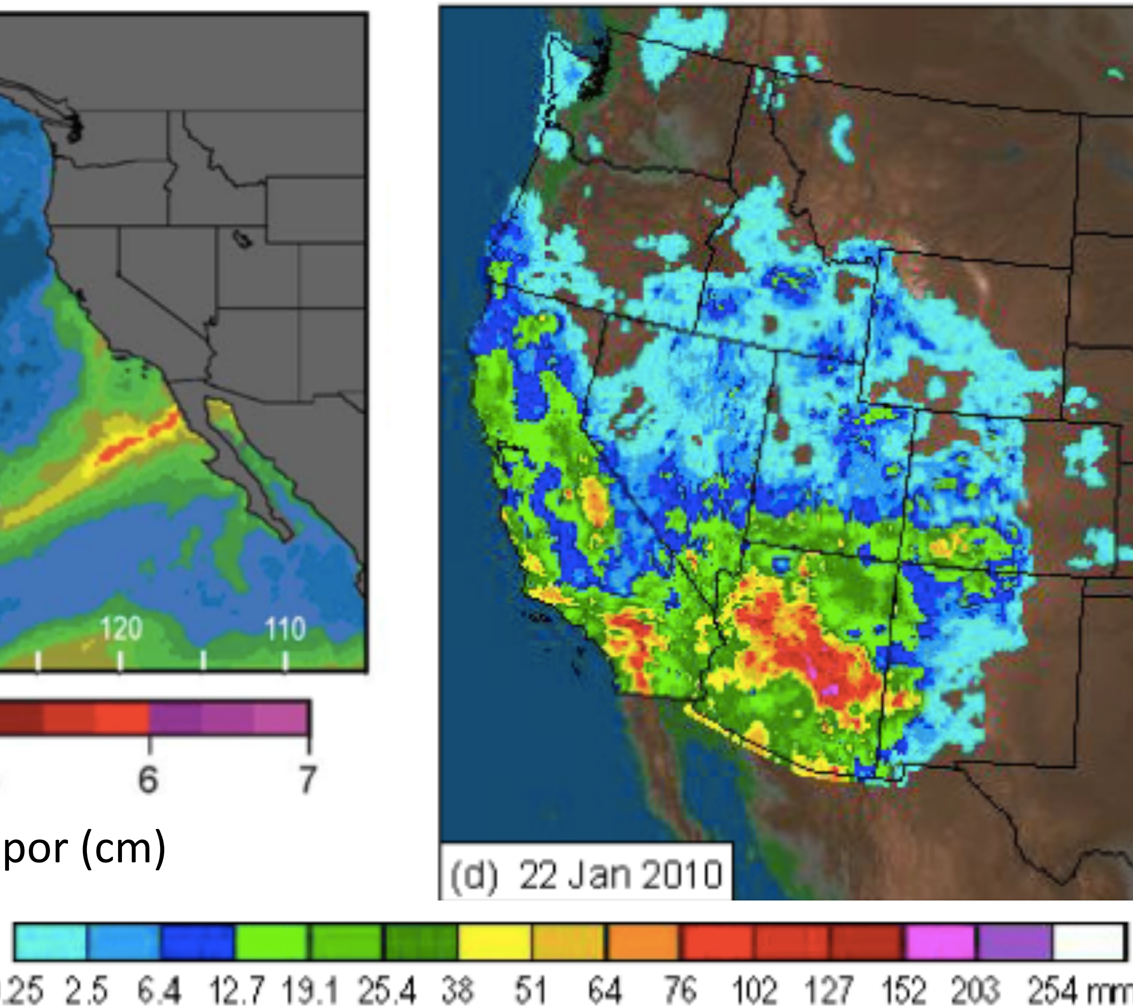
Floods vs. duds: AR orientation



Landfalling Atmospheric River (AR) -> Extreme Precipitation amounts in Arizona



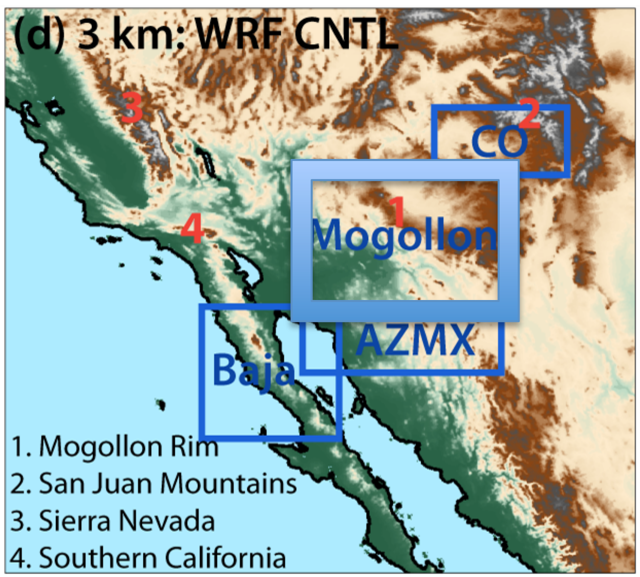
Integrated Water Vapor (cm)



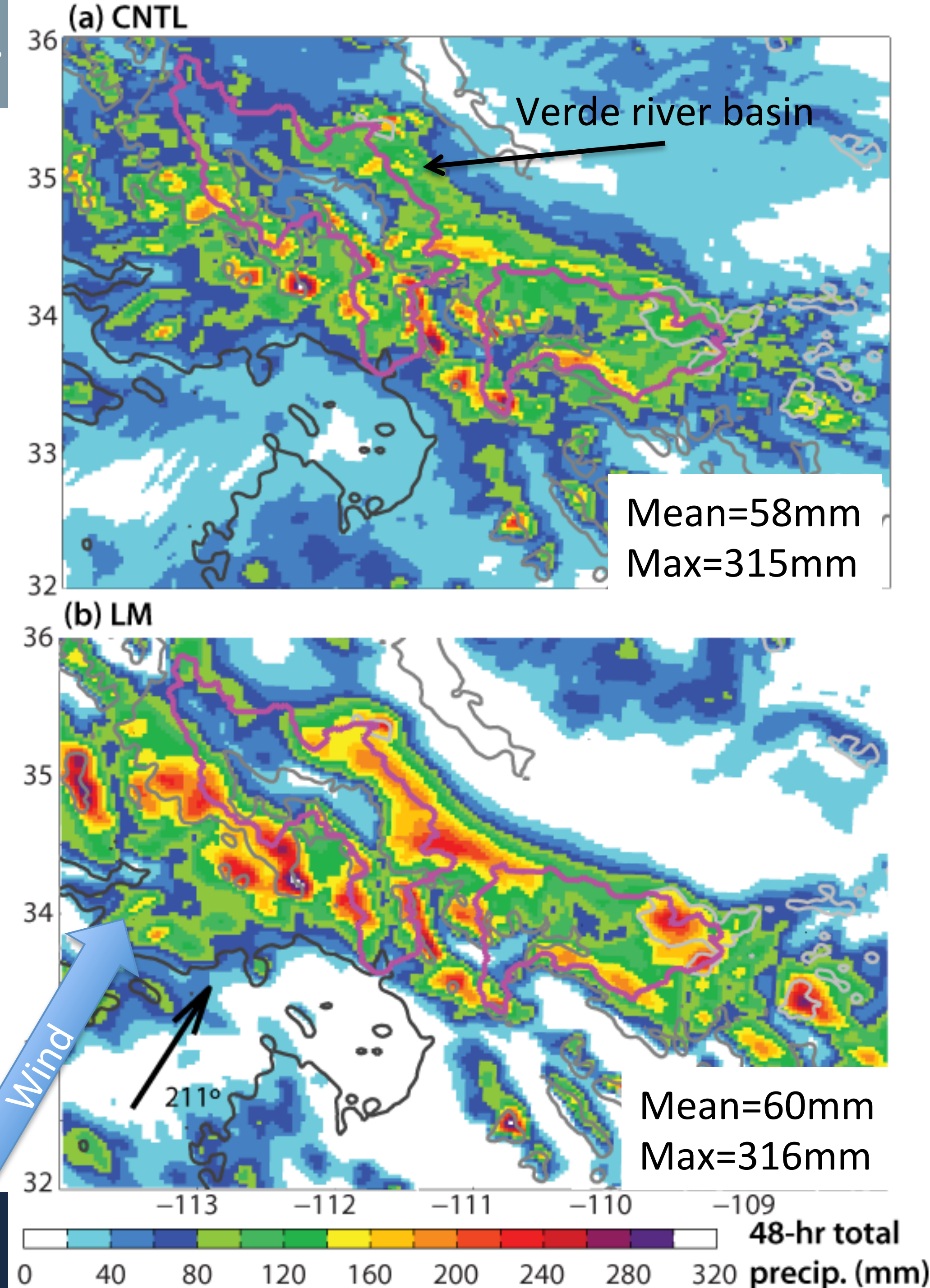
Quantitative precipitation estimation (mm)

From Neiman et al. 2013

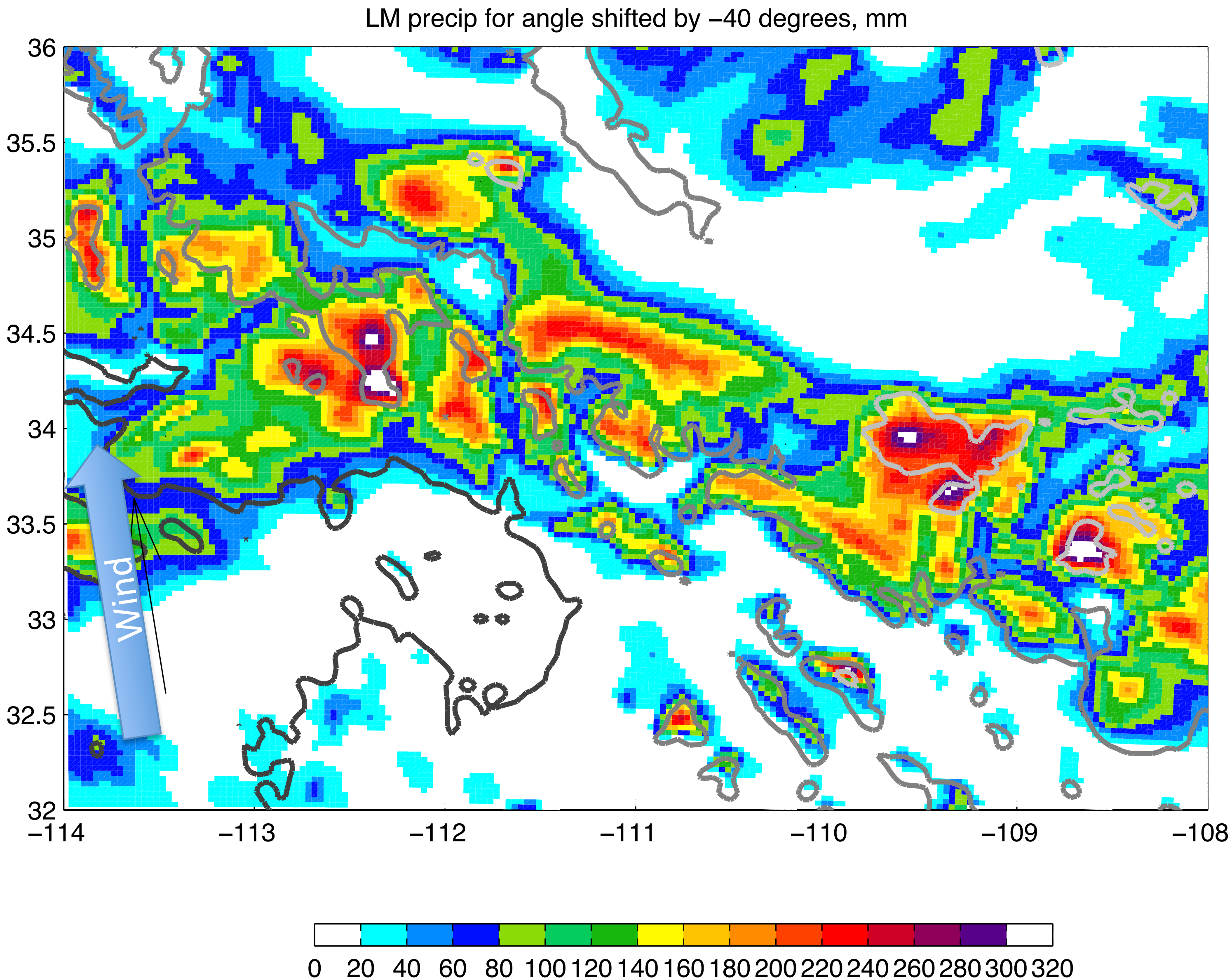
Smith and Evans (2007) Linear model (LM) of orographic precipitation



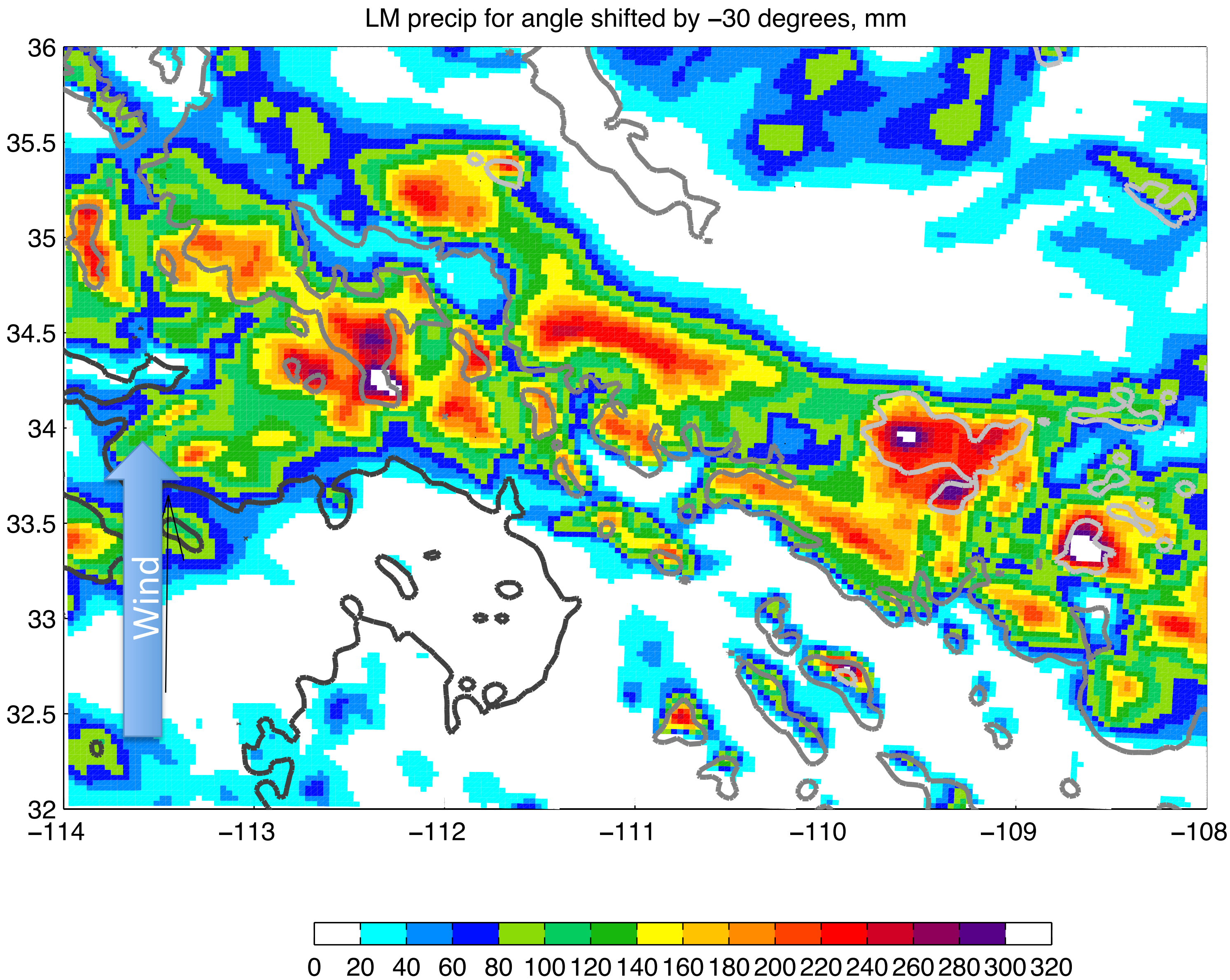
Spatial correlation coefficient = 0.83



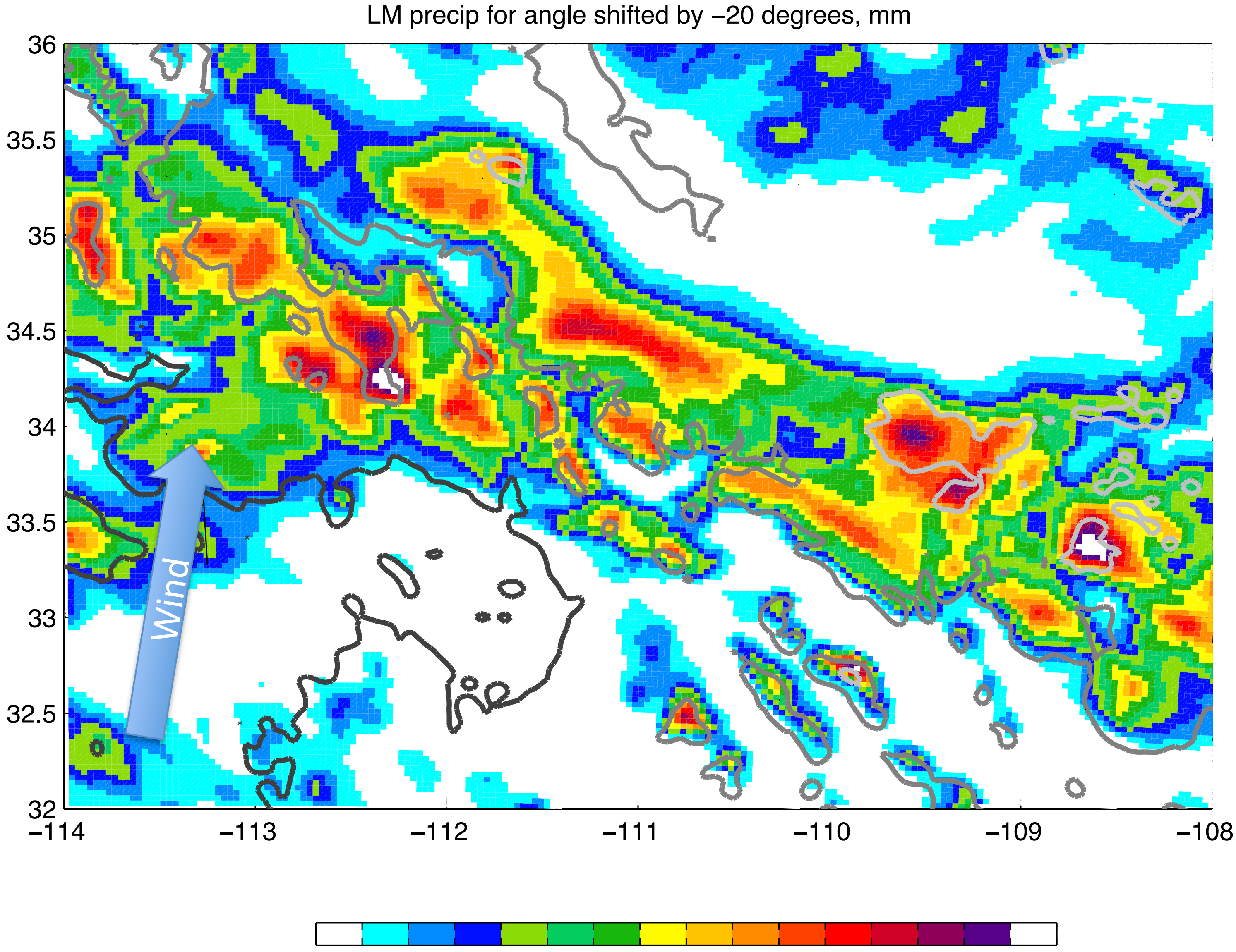
Linear Model applied



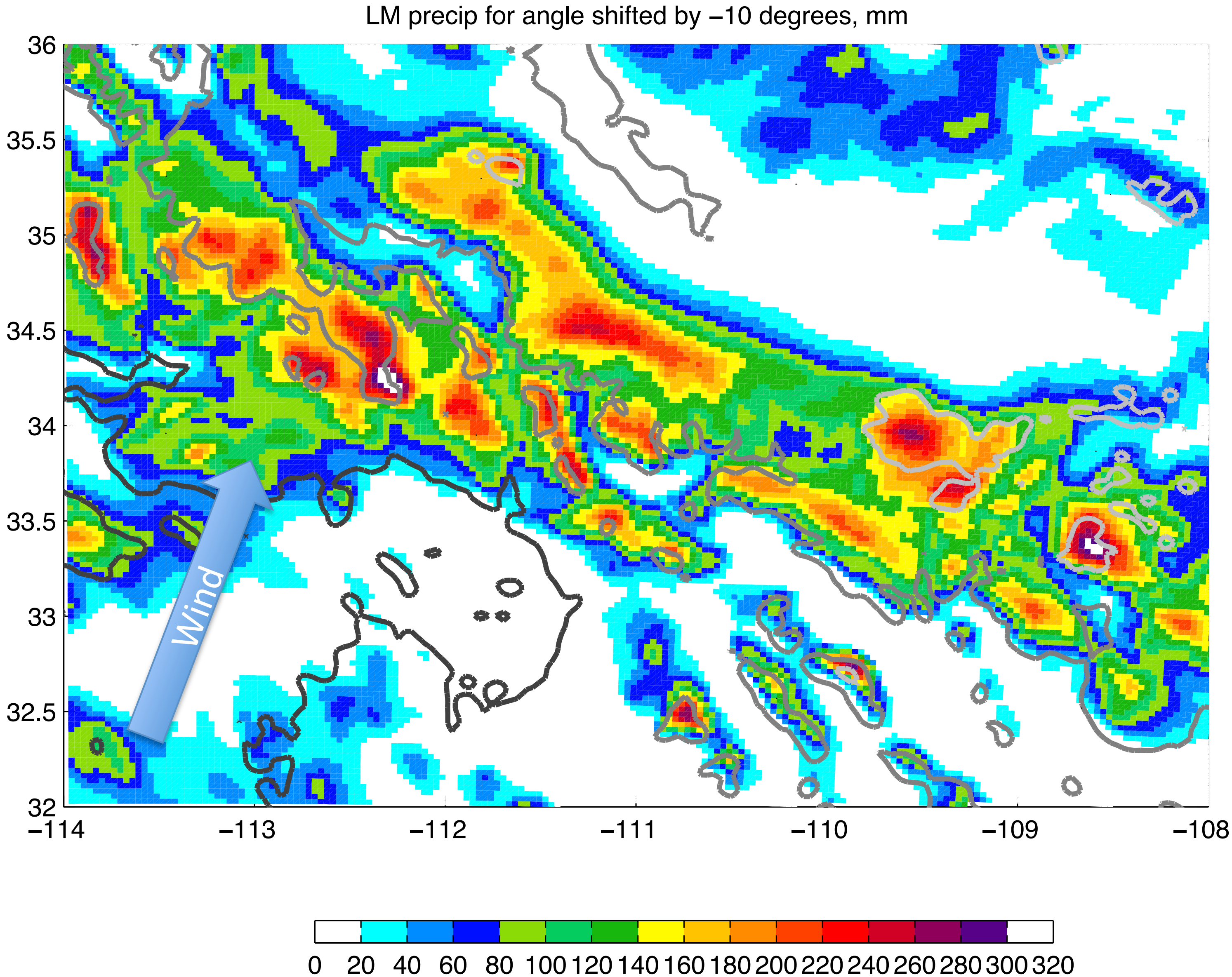
Linear Model applied



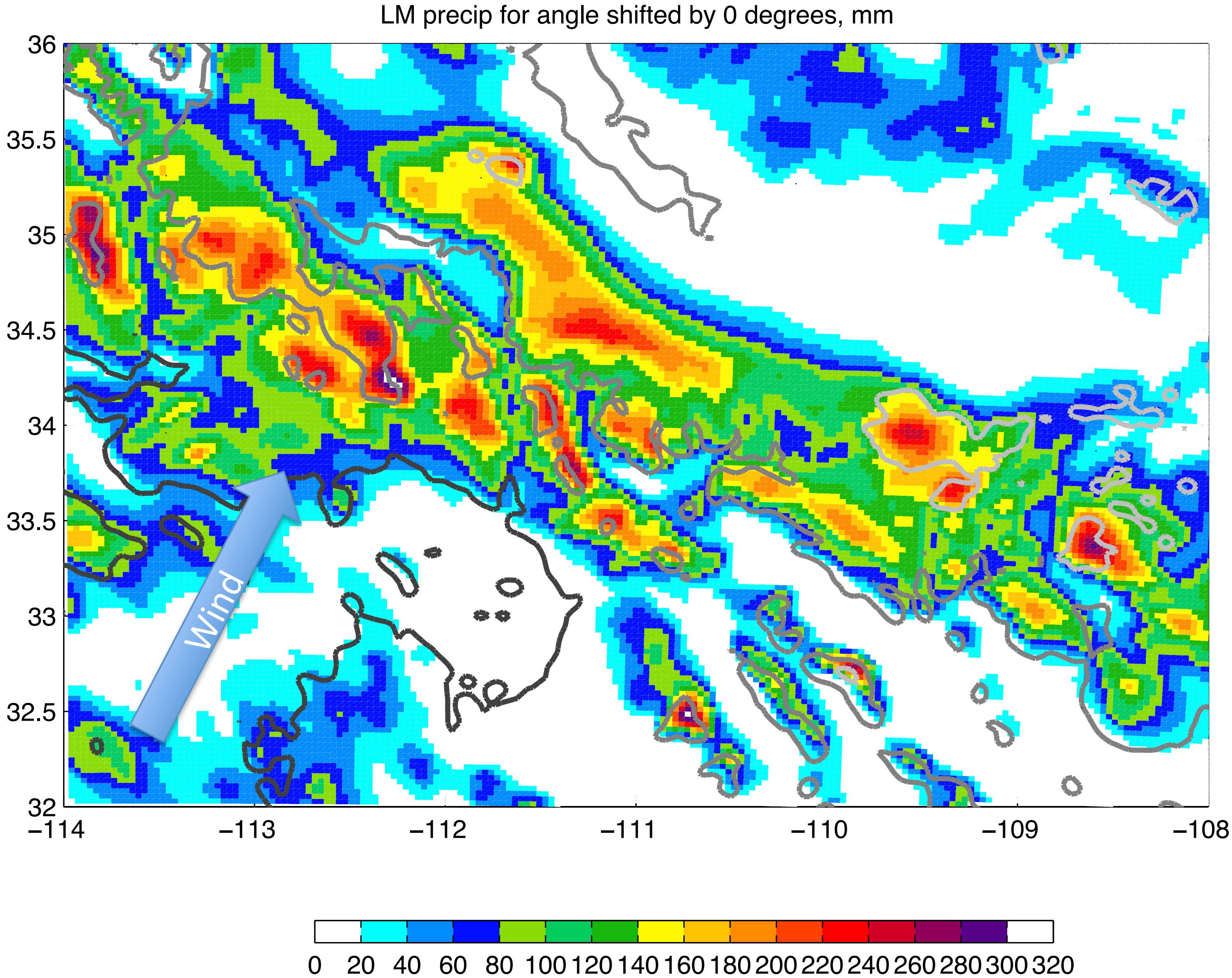
Linear Model applied



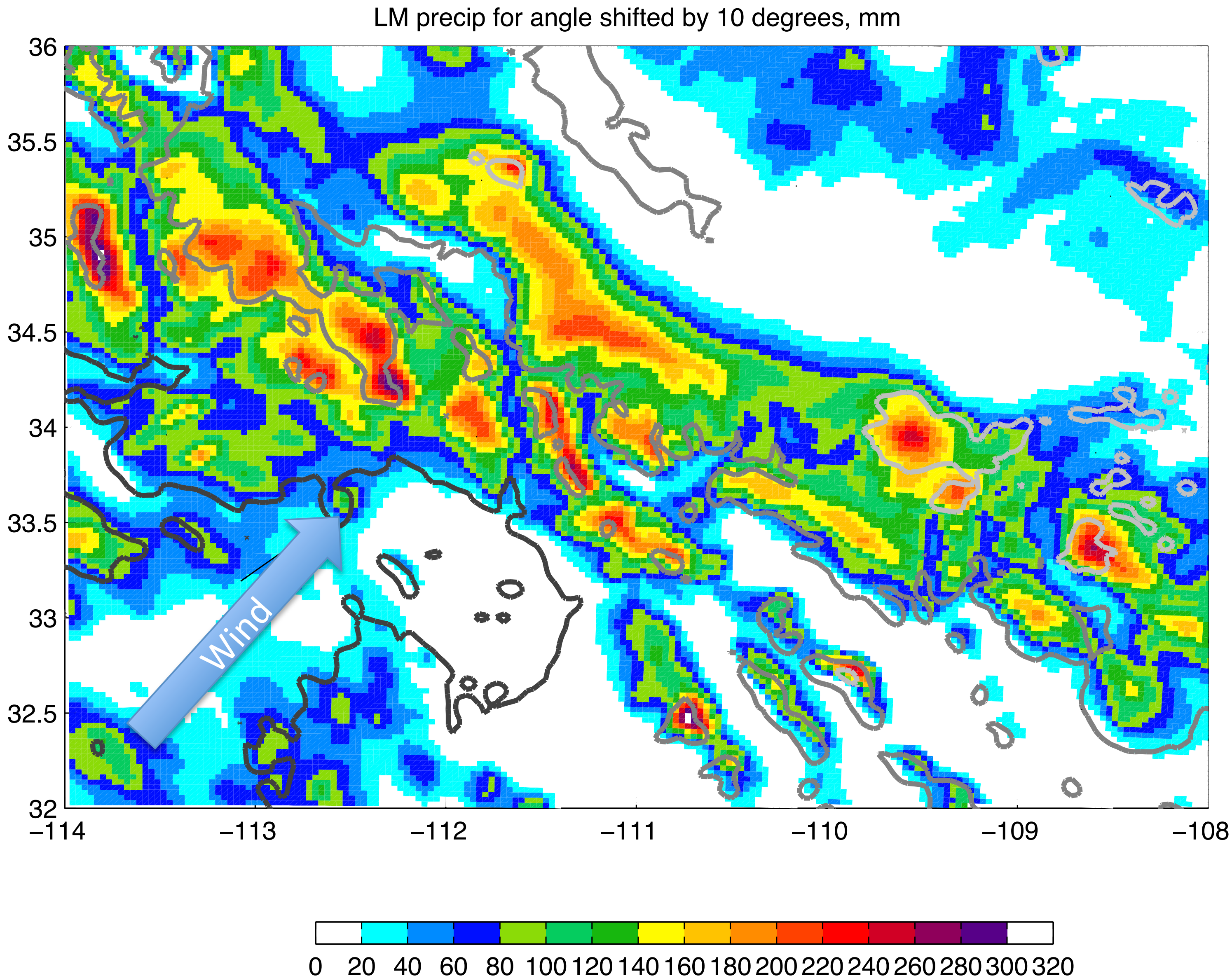
Linear Model applied



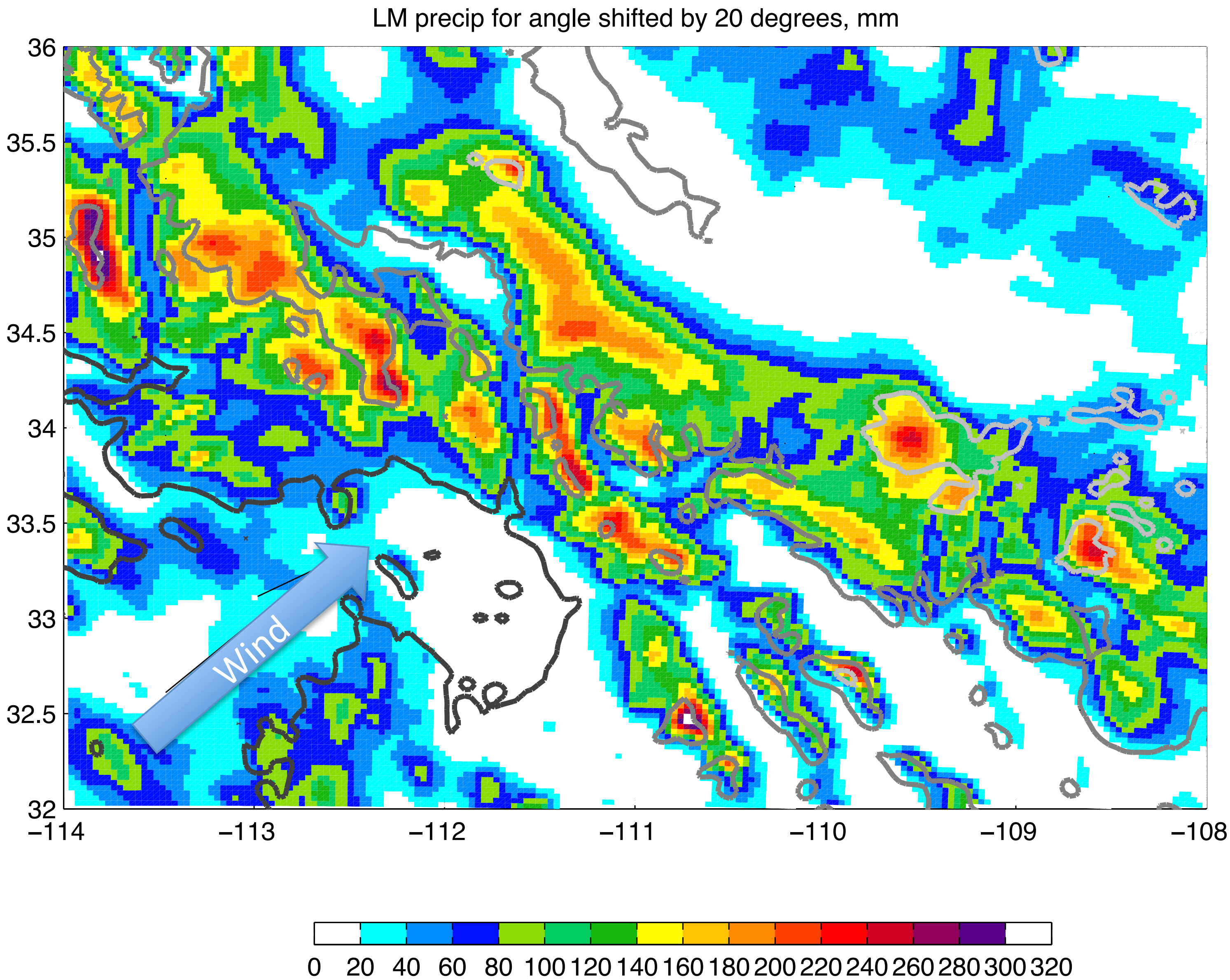
Linear Model applied



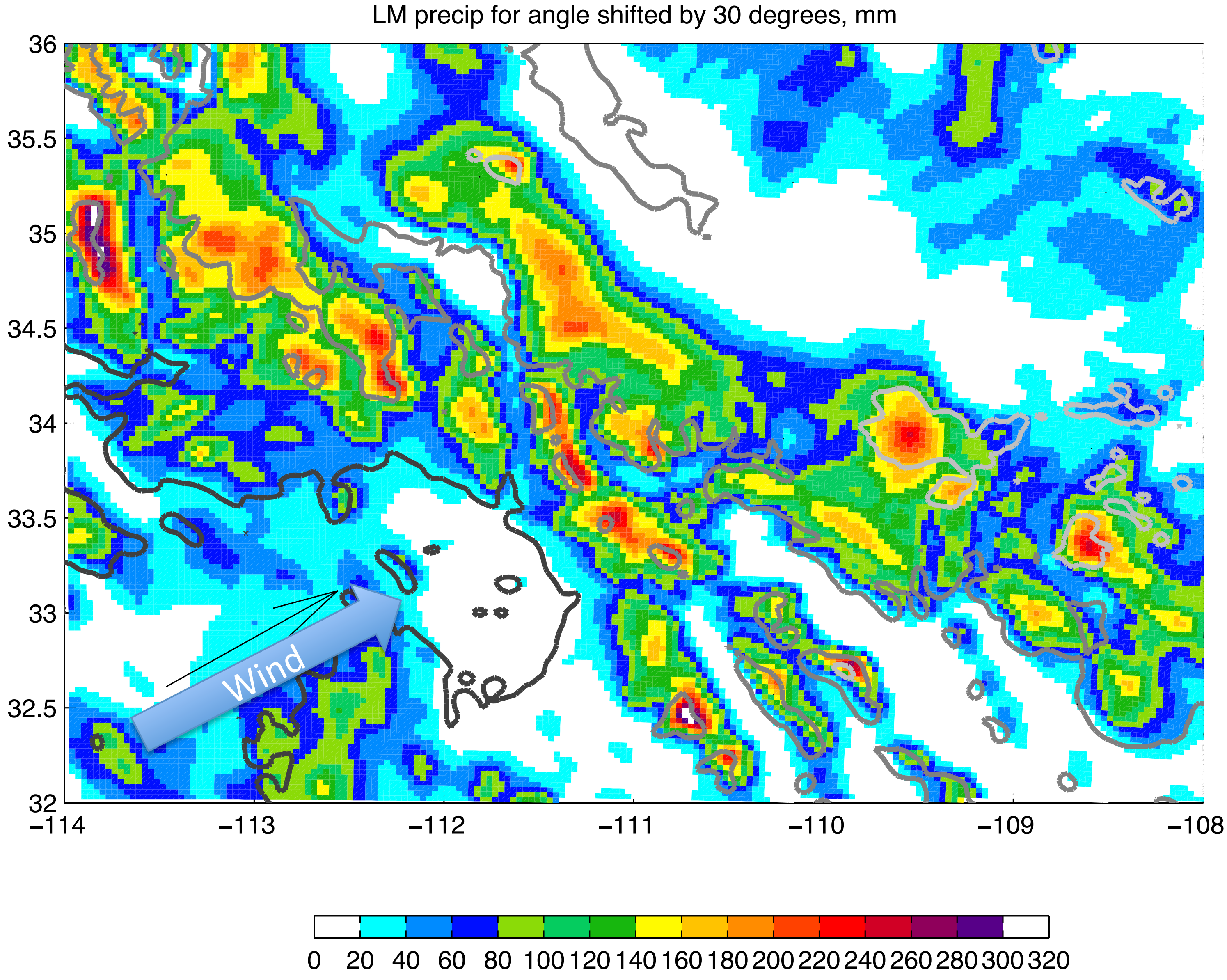
Linear Model applied



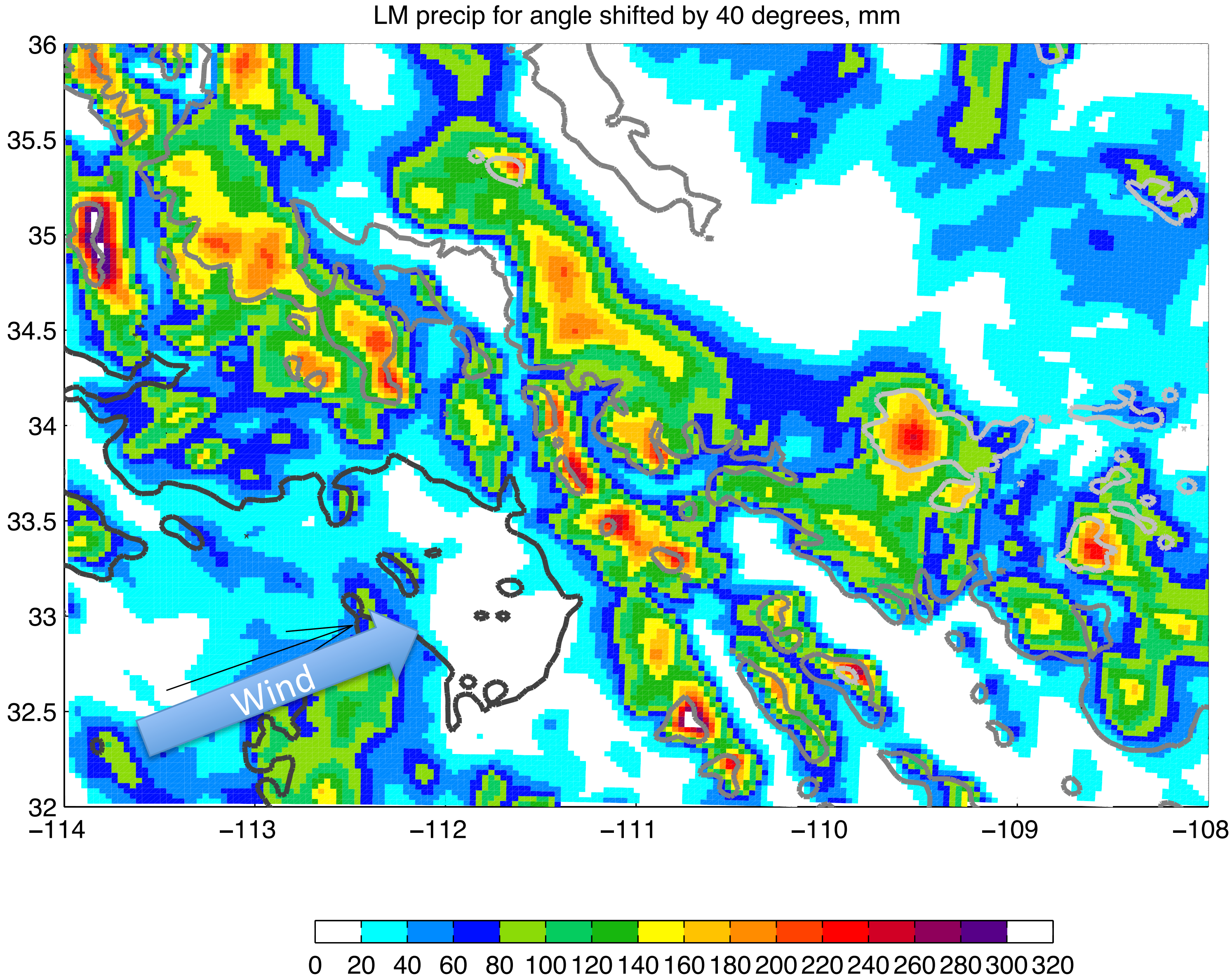
Linear Model applied



Linear Model applied

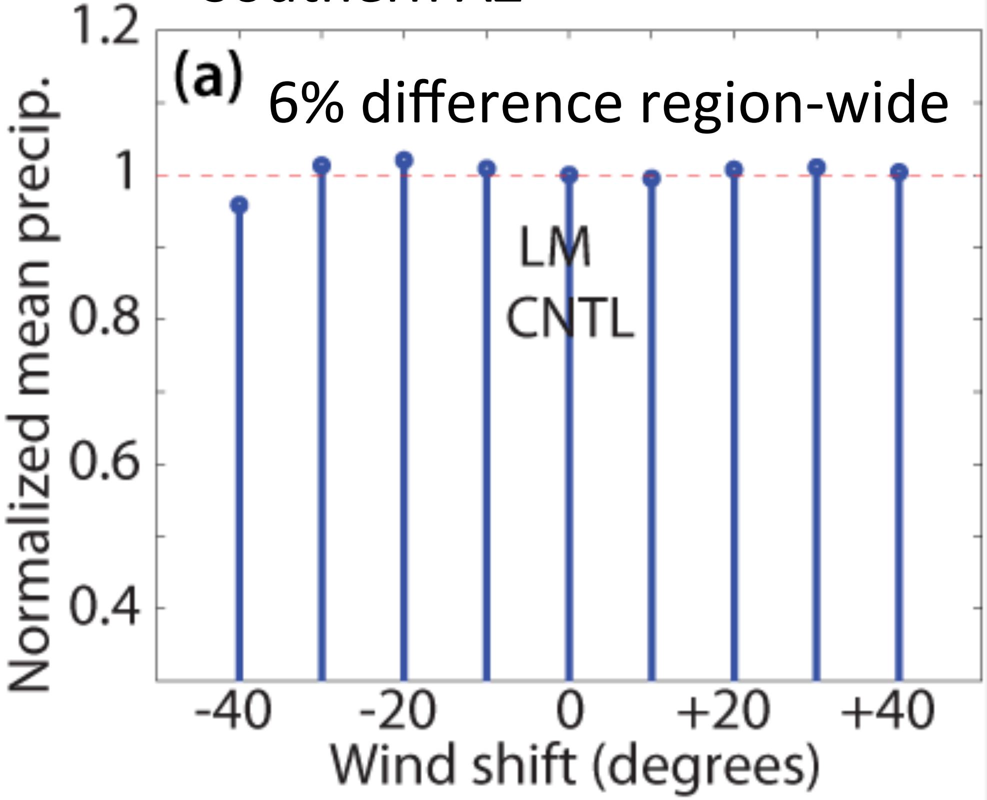


Linear Model applied



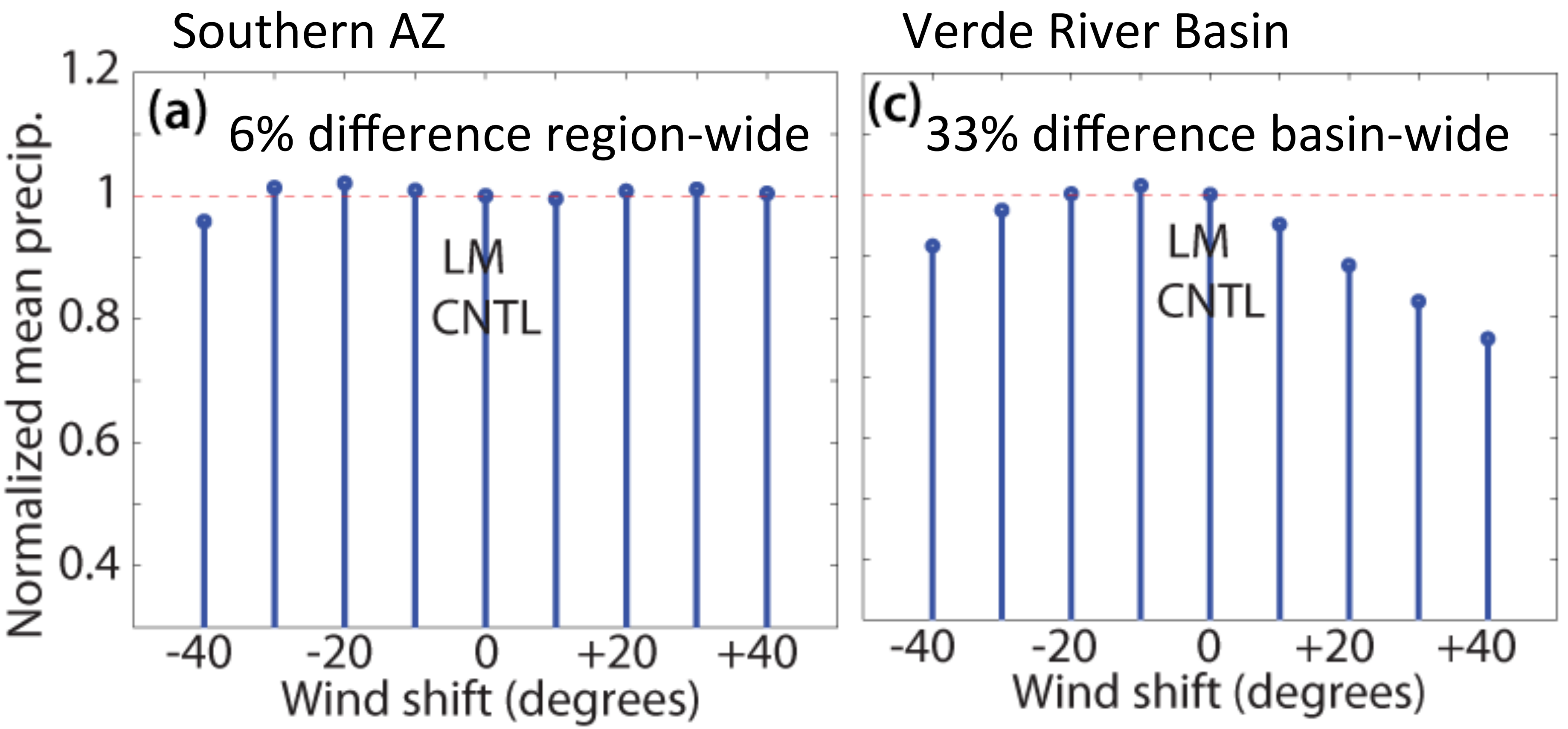
Mesoscale precipitation response to ARs

Southern AZ



Water vapor flux **angle**

Mesoscale precipitation response to ARs



Water vapor flux **angle**

From Hughes et al. 2014

Summary and Conclusions

- ARs are a **dominant cause of, but not a sufficient condition for, extreme precipitation** – and often flooding – events on the US west coast.
- While ARs are themselves synoptic-scale features, **mesoscale orographic processes** control where and how much precipitation falls as a result of their landfall.
- Continued work in this area will help understand the **processes that control extreme precipitation at the basin scale** – fundamental for deducing flood risk.