Spatiotemporal variations in extreme precipitation in the contiguous USA and the Madden-Julian Oscillation (MJO)

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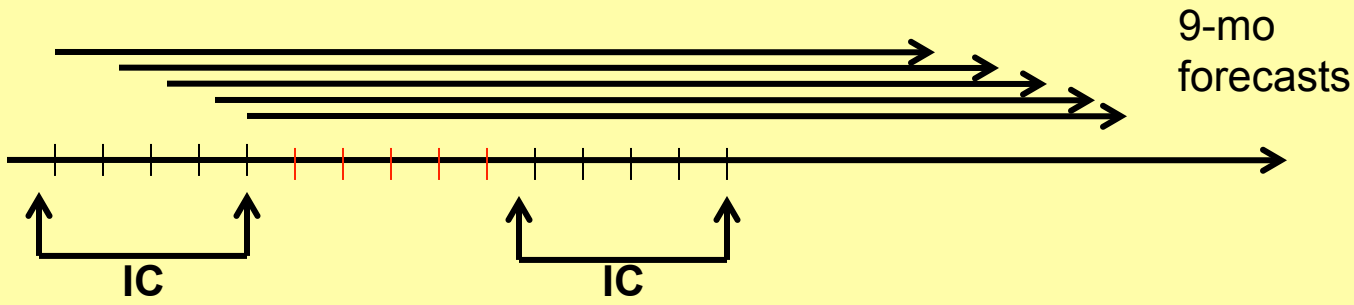
CTB Project: Probabilistic forecasts of extreme events and weather hazards over the United States (Jul 08-Dec 11)

Quick review of previous results

CFS Reforecasts Version 1



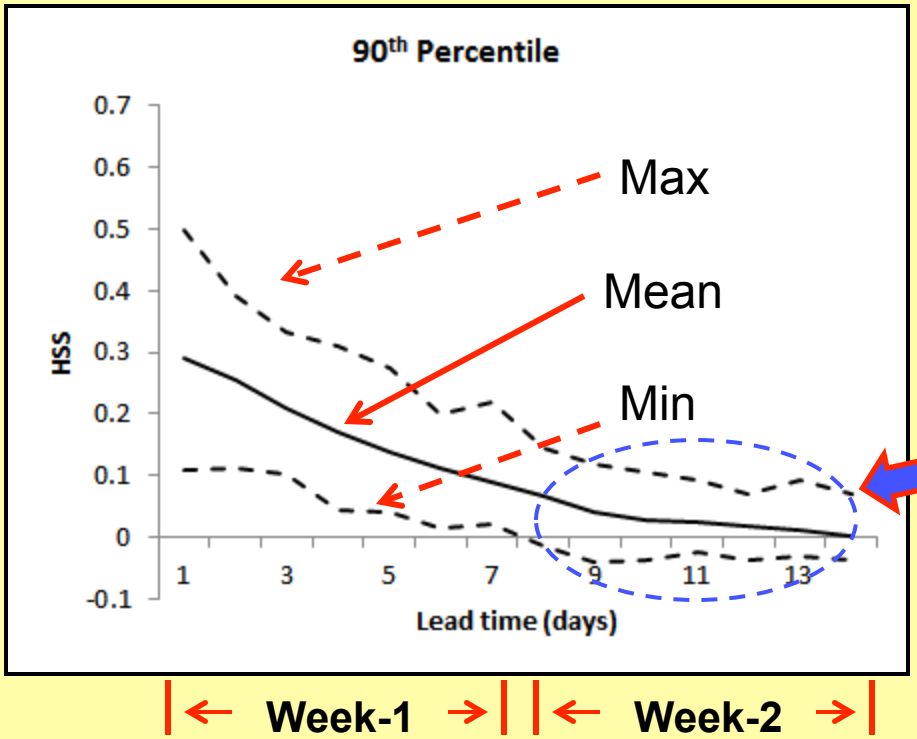
- 15 initial conditions per month
- Forecasts out to 270 days; we analyzed forecasts out to 4 weeks
- Analyzed deterministic and probabilistic forecast skill of extreme P
  - P > 75th percentile P > 90th percentile

→ However, **CFSR.v1** difficult to investigate importance of MJO on **probabilistic forecasts** of extreme P

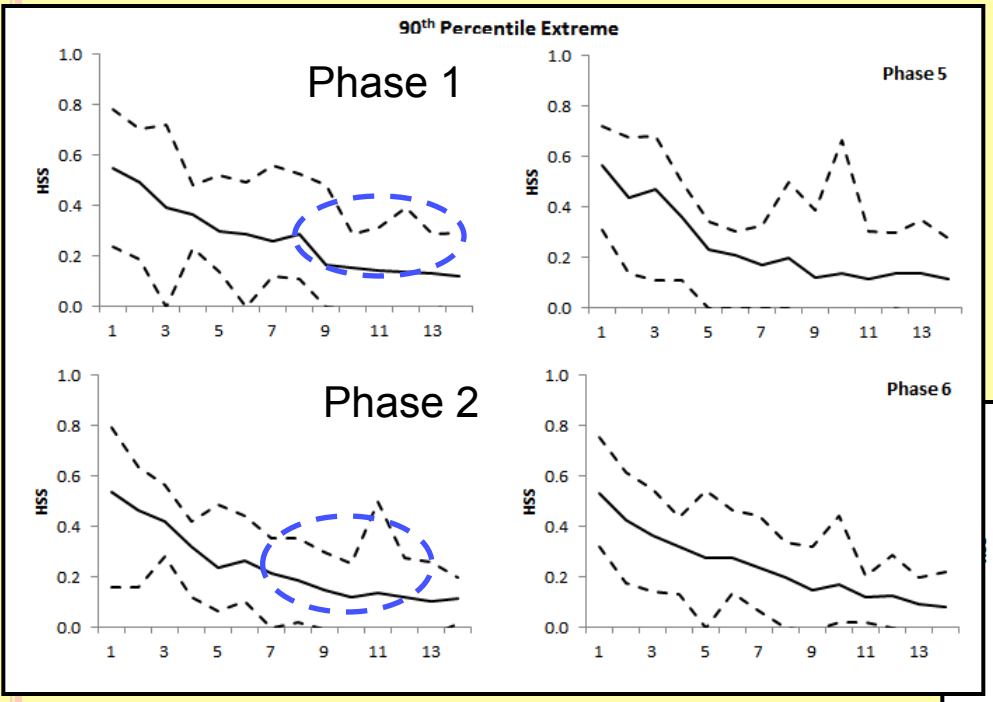
→ **CFSR.v2** offers much higher number of ensemble members

Jones, C., J. Gottschalck, L. M. V. Carvalho, and W. Higgins, 2011: Influence of the Madden-Julian Oscillation on forecasts of extreme precipitation in the contiguous United States. *Monthly Weather Review*, 139, 332-350.

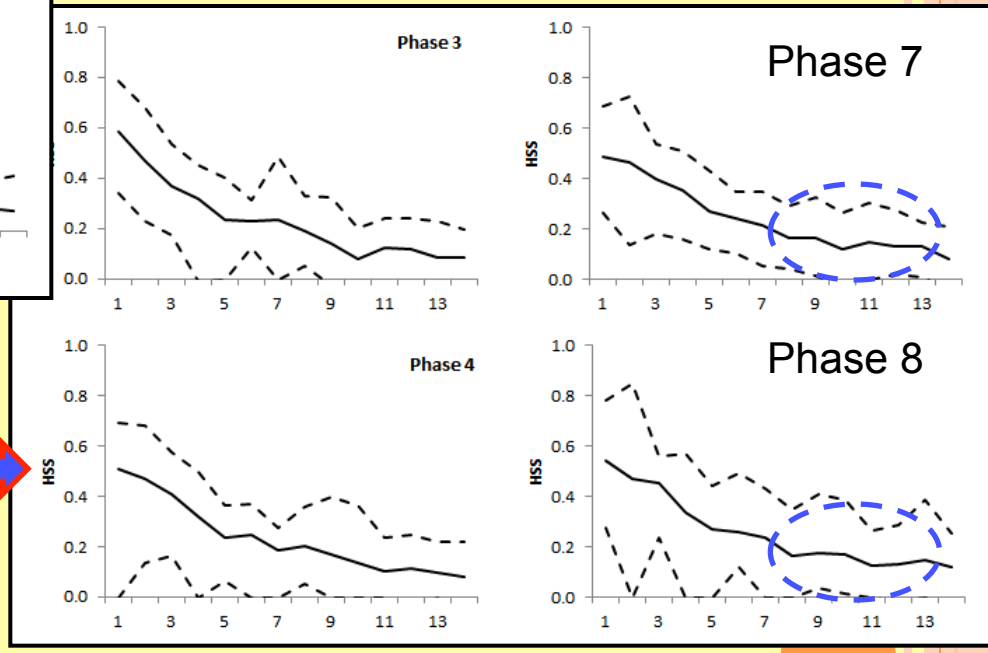
Heidke Skill Score (HSS) 90th percentile extreme Precipitation over the western CONUS



When the MJO is active ….



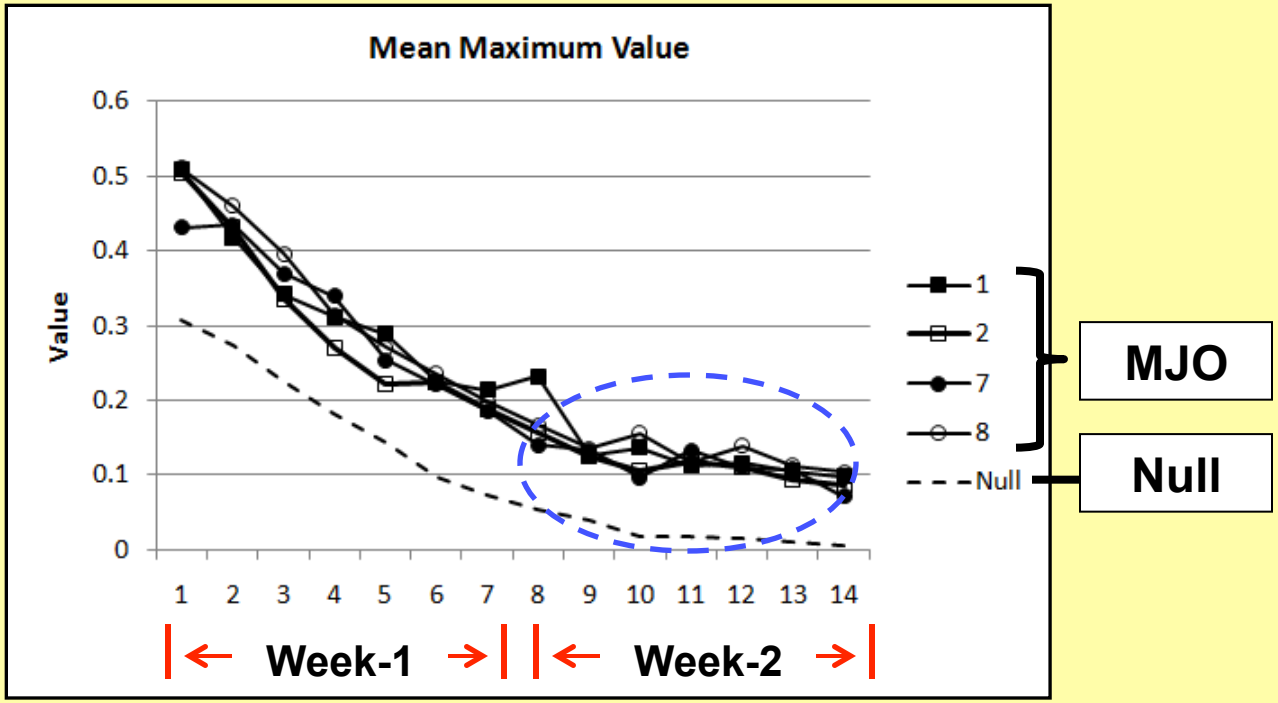
HSS is higher and extends to longer leads (Week-2)



The HSS of extreme precipitation (90th percentile) forecasts during each MJO phase. Solid lines represent the average over grid points that are significant at 5% level. Upper (lower) dashed lines indicate the max (min) HSS values.

Jones, C., L. M. V. Carvalho, J. Gottschalck and W. Higgins, 2011: The Madden-Julian Oscillation and the relative value of deterministic forecasts of extreme precipitation in the contiguous United States. *Journal of Climate,* **24,** 2421-2428.

Application of a simple economic value model to CFSR.v1 forecasts of 90th extreme precipitation

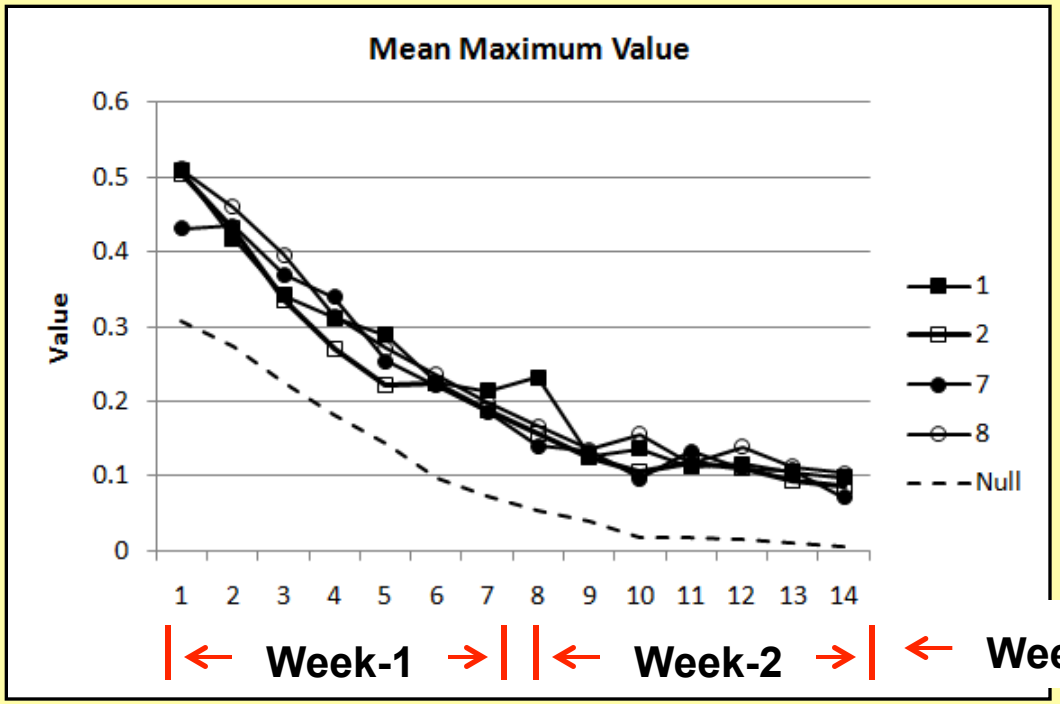


Cost/loss ratio decision model $V = \frac{min(\alpha, s) - F(1-s)\alpha + Hs(1-\alpha) - s}{\min(\alpha, s) - s\alpha}$

Where V is value, α = user's cost/loss ratio (C/L), **s** = climatological base rate of the event (90th extreme), **H** = hit rate, **F** = false alarm rate

When α = **s** ➡ **potential (or maximum) forecast value**

And the challenge is ……..



How to obtain useful forecasts in week-3 and week-4?

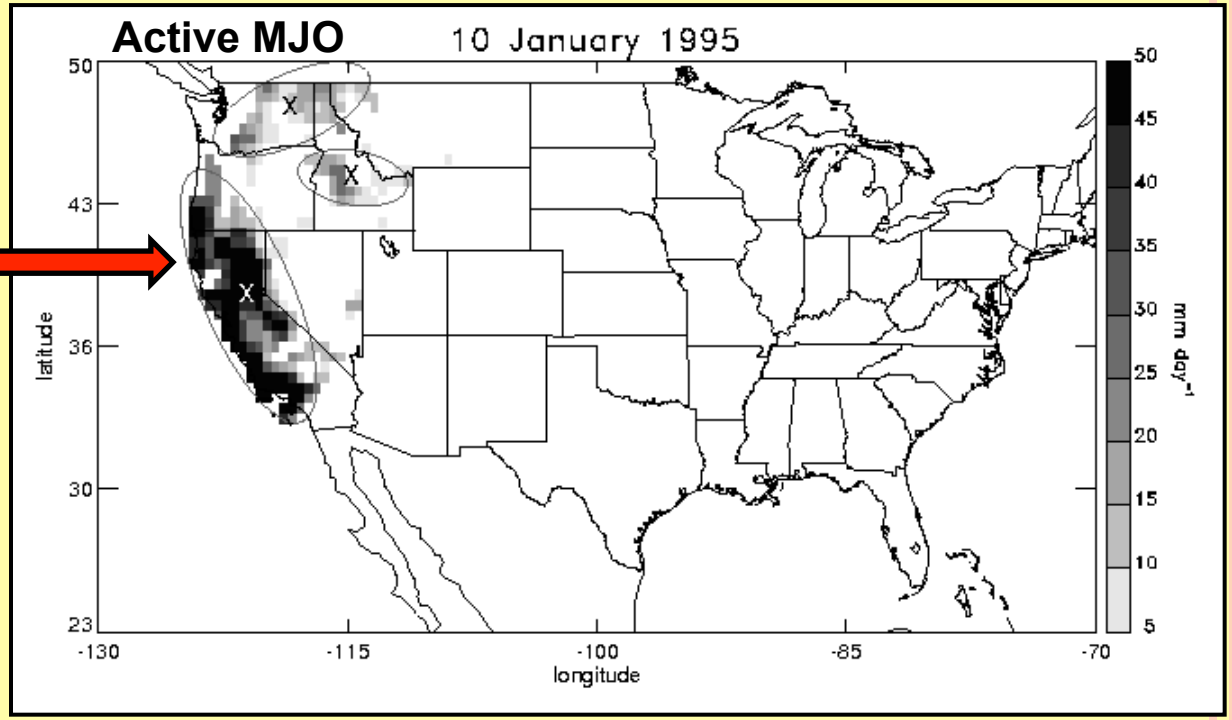
Work in progress

- Investigating how the MJO modulates the spatiotemporal variability of precipitation
- Developing metrics of probabilistic forecasts of precipitation in Weeks 3-4

Observations

Only gridpoints with P > 90th percentile

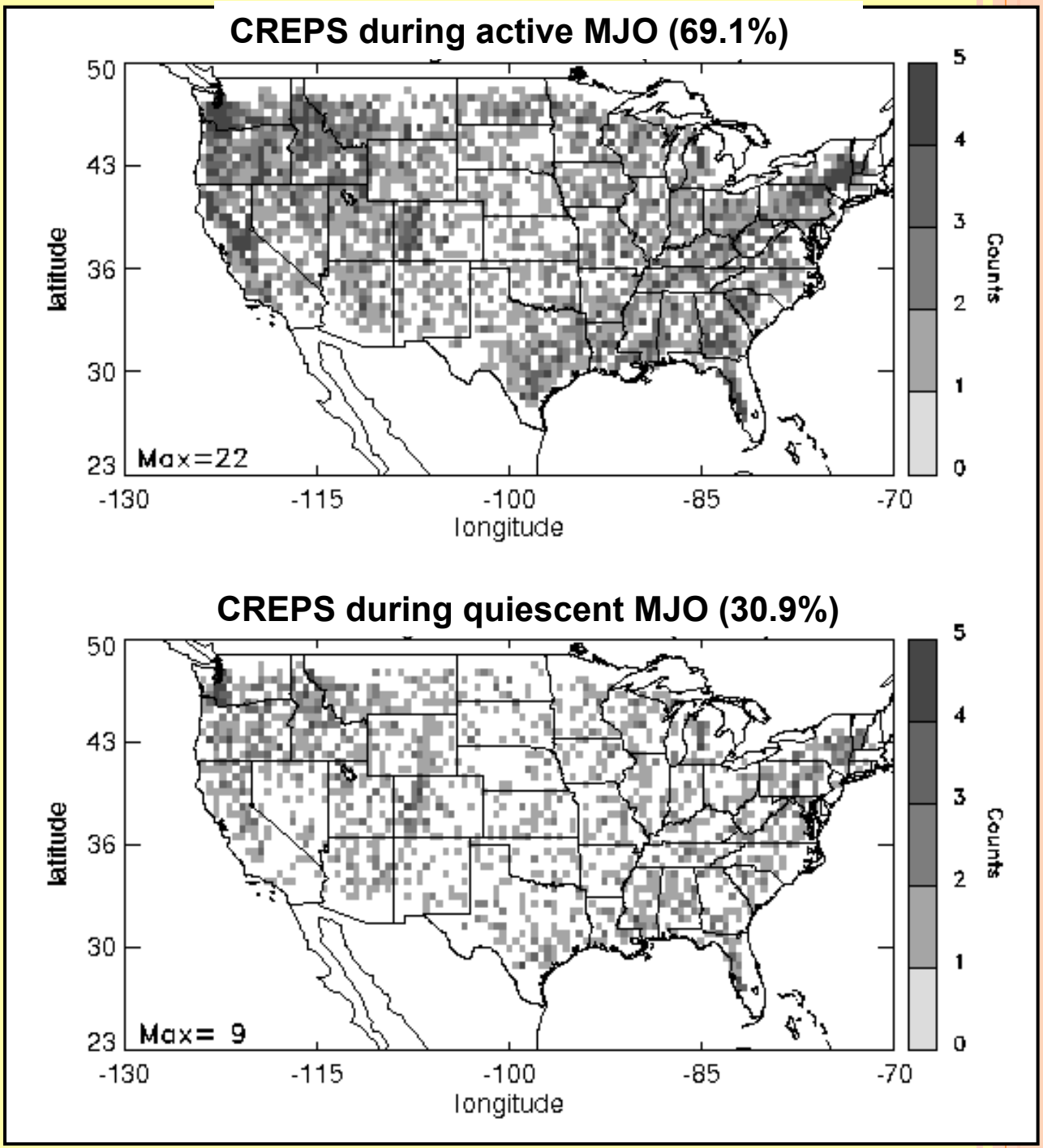
CREP: P in gridpoint > 90th percentile, area of connected gridpoints > 90th percentile of areas of extreme P



For each CREP:

- Day of occurrence
- If MJO was active, in what phase, amplitude
- Mean precipitation, area, center
- Probabilities of CREP with different intensities and areas conditioned on MJO

Counts assigned to center of each CREP (1 November-31 March, 1979-2010). Total: **5600**.



Joint probabilities of CREPs during active and inactive MJO days

$P(C_{PX} \cap MJO_{day})$: joint probability of C_{PX} and MJO being active

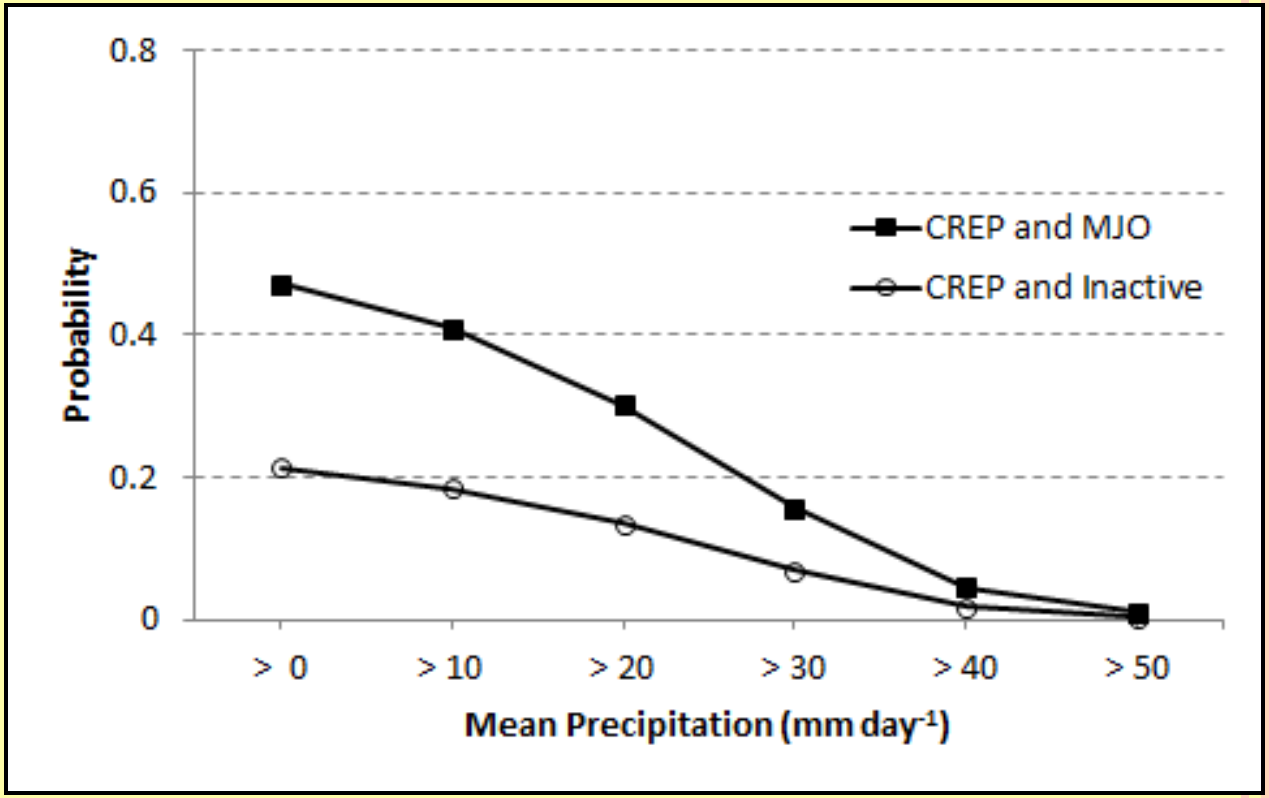
Where:

C_{PX}: one or more CREPs anywhere in the CONUS with mean precipitation exceeding P_x mm day^{-1};

MJO_{day}: an active MJO day (in any phase);

Similarly for:

$P(C_{PX} \cap INA_{day})$: joint probability of C_{PX} and MJO being inactive



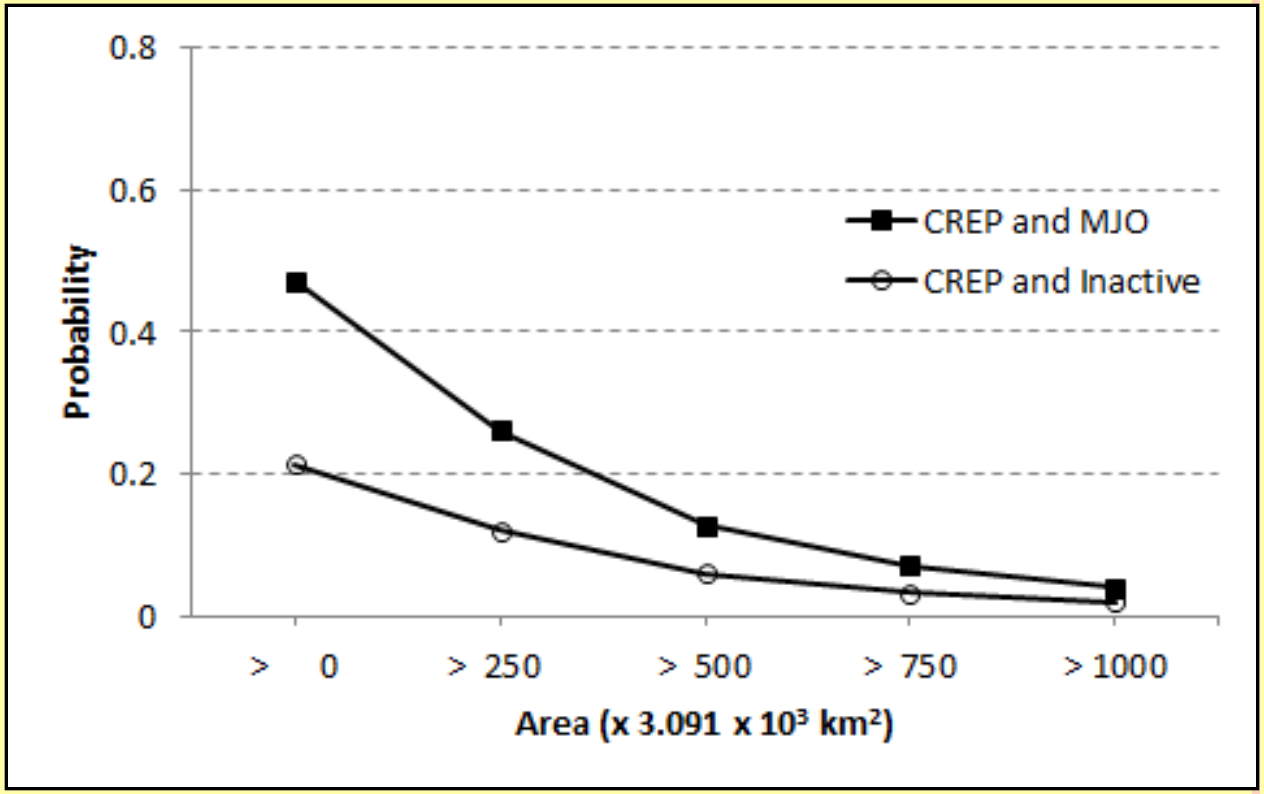
Joint probabilities of CREPs during active and inactive MJO days

$P(C_{AX} \cap MJO_{day})$: joint probability of C_{AX} and MJO being active,

Where:

C_{AX}: one or more CREPs anywhere in the CONUS with area exceeding A_X km^2

MJO_{day}: an active MJO day (in any phase)

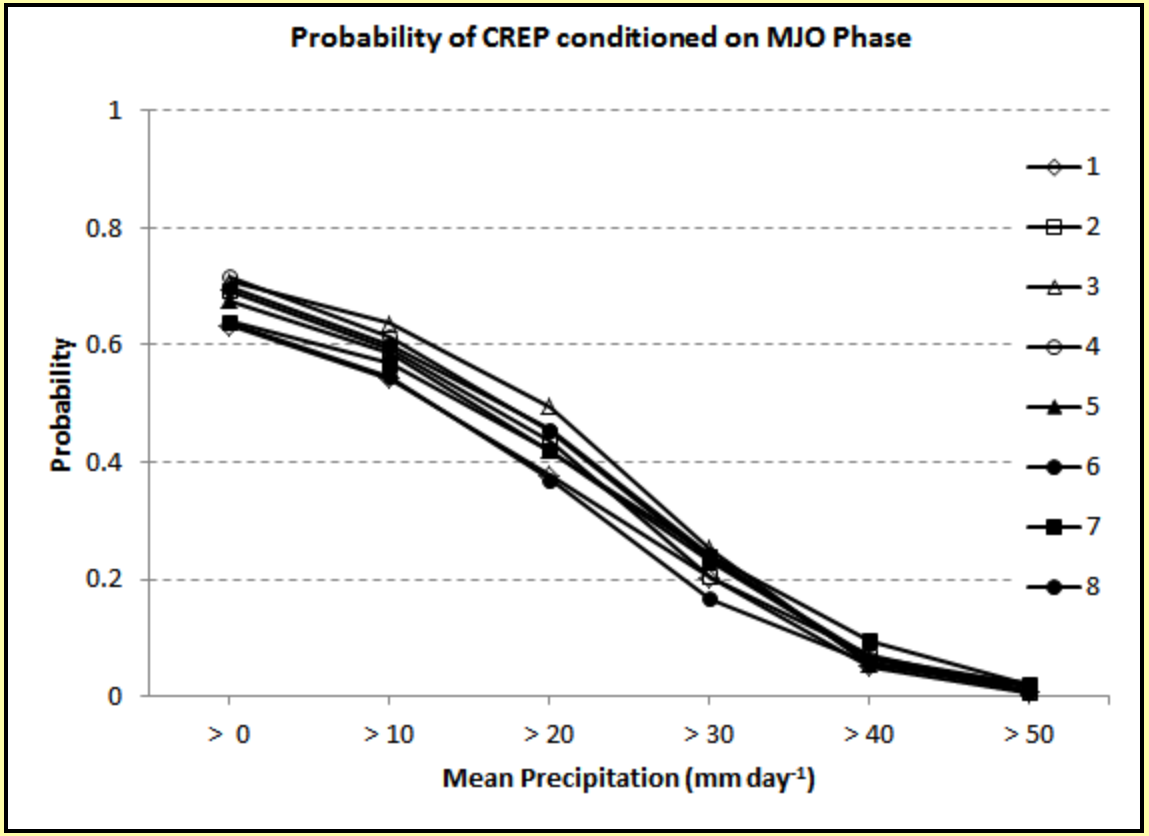


Probabilities of CREPs conditioned on MJO phase

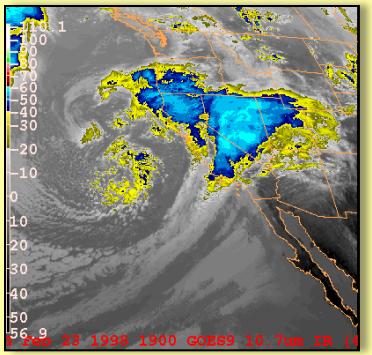
$P(C_{PX} / MJO_{\Phi})$: conditional probability of C_{PX} given that MJO is active and in phase Φ (1-8)

Where:

C_{PX}: one or more CREPs anywhere in the CONUS with mean precipitation exceeding P_x mm day^{-1}



MJO and extreme precipitation

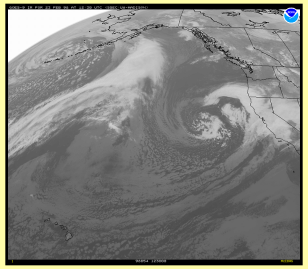


- Forecast skill of extreme precipitation is usually higher when the MJO is active and has enhanced convection occurring over the western hemisphere, Africa, and/or the western Indian Ocean than in quiescent periods.
- HSS greater than 0.1 extends to lead times of up to two weeks in these situations.
- Occurrences of CREPS over the CONUS are significantly higher when the MJO is active (69.1%) than during inactive days (30.9%).
- The probability of occurring one or more CREPs over the CONUS is nearly twice as large when the MJO is active than in quiescent days.


Daily Nexus

Clinton Declares State of Emergency

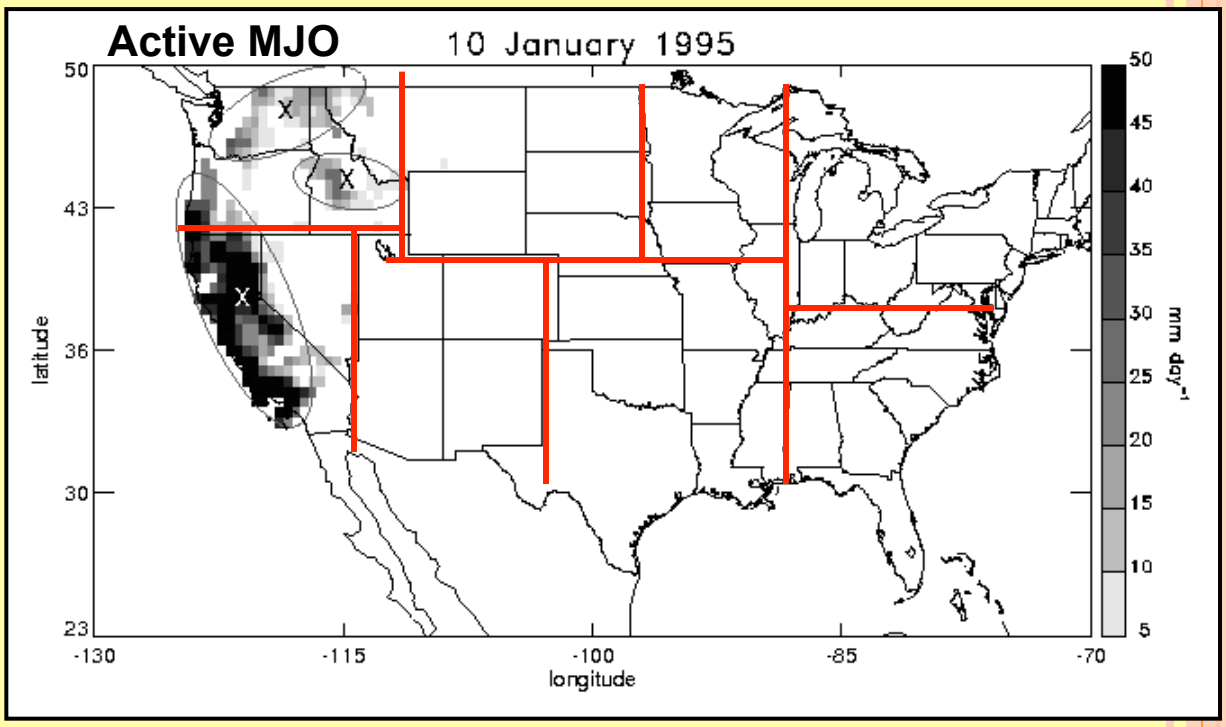
Santa Barbara Wiped Out by Record Inches



Work in progress

- Evaluating skill of probabilistic forecasts of precipitation in Weeks 3-4

Predictand:
S_J is percentage of CONUS sector with average precipitation in Week-K > Threshold (50^{th}, 75^{th}, 90^{th} percentiles)



Identification of MJO

- NCEP/NCAR reanalysis: U200, U850 intraseasonal anomalies
- combined EOF
- Phase diagram from PC1/PC2
- MJO event has amplitude > 0.9
- Phase rotates anti-clockwise
- 81 MJO events during 1 Nov-31 Mar, 1979-2010

(phases ~Wheeler and Hendon 2004)

Enhanced convection