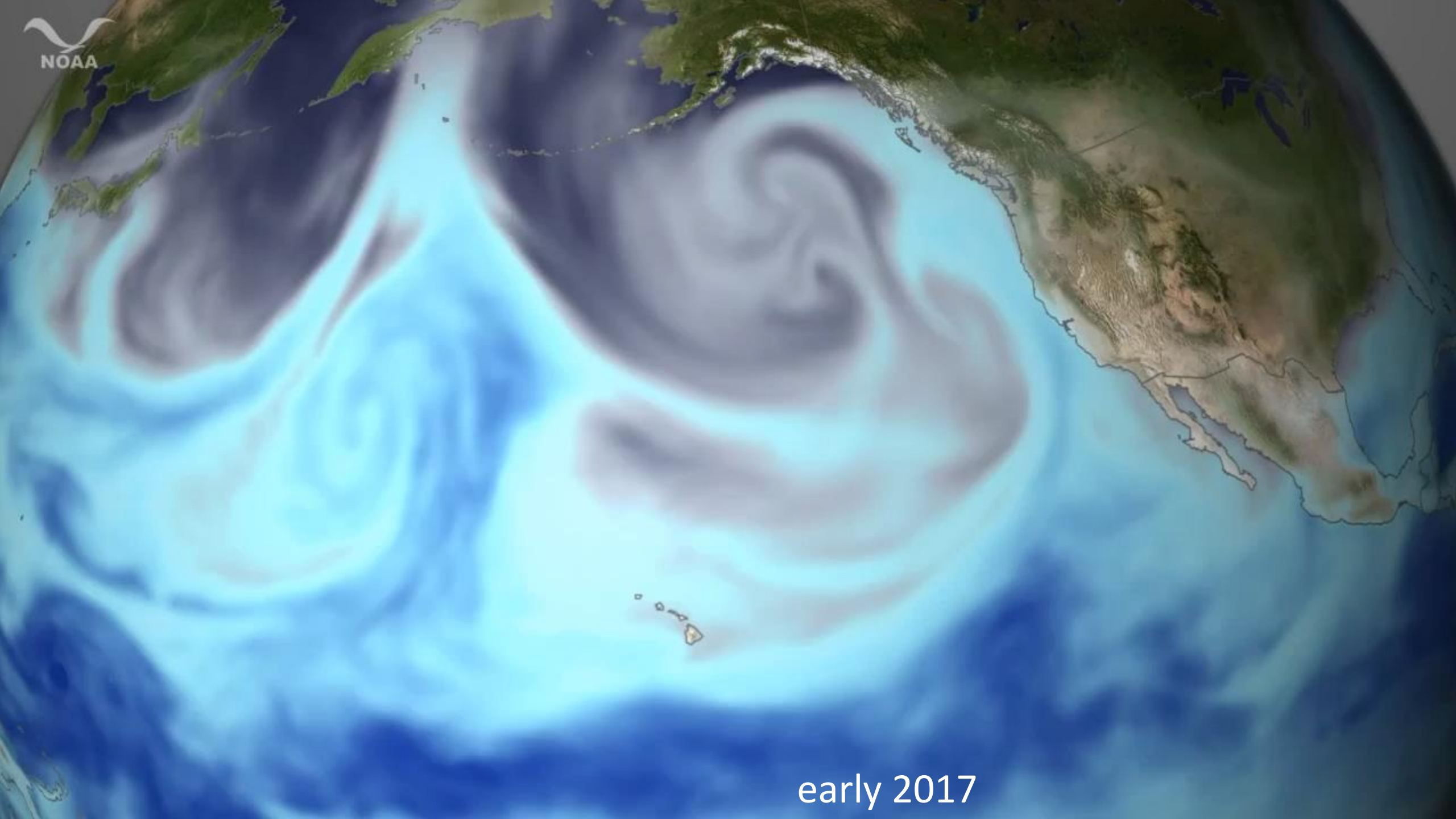
California from drought to deluge

The dramatic switch from drought to flooding

and the accompanying flip from ridge to trough

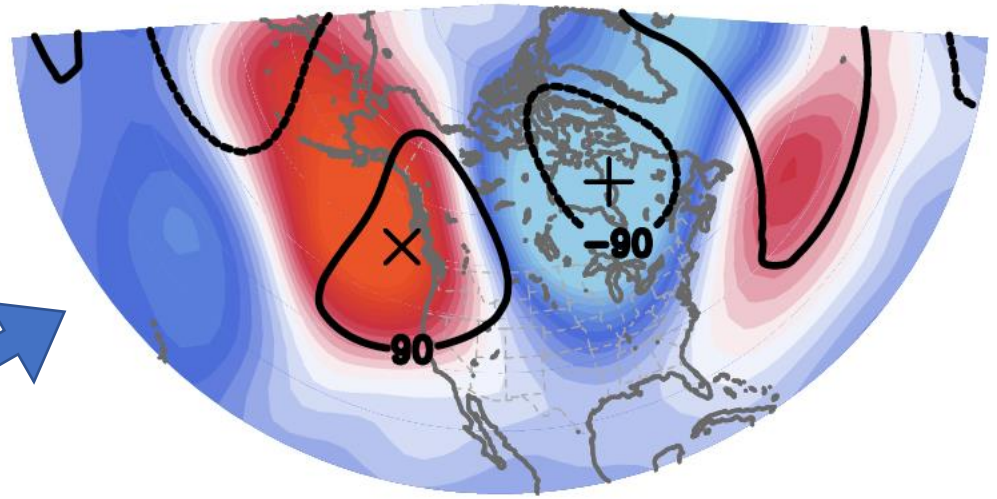
is an exemplification of intensified water cycle.

Utah Climate Center – Simon Wang, Robert Gillies, and collaborators

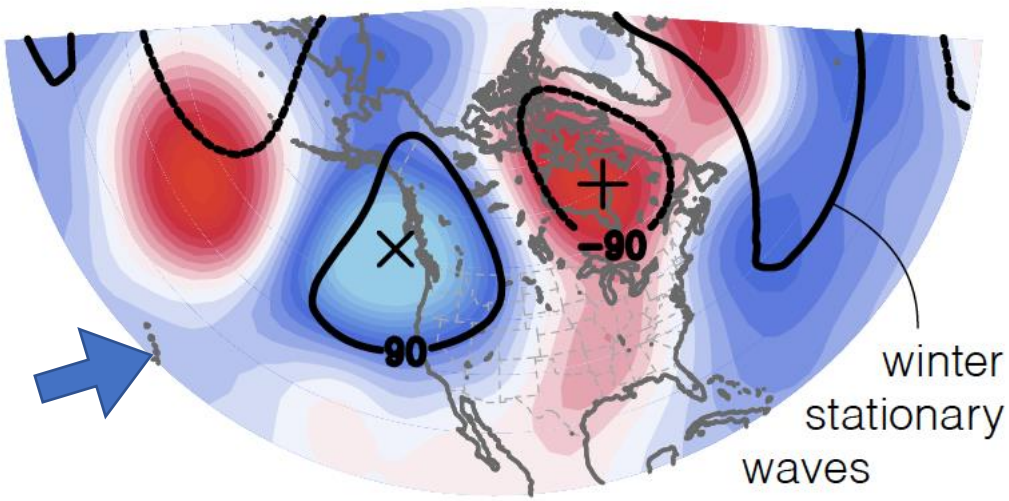

NOAA
early 2017

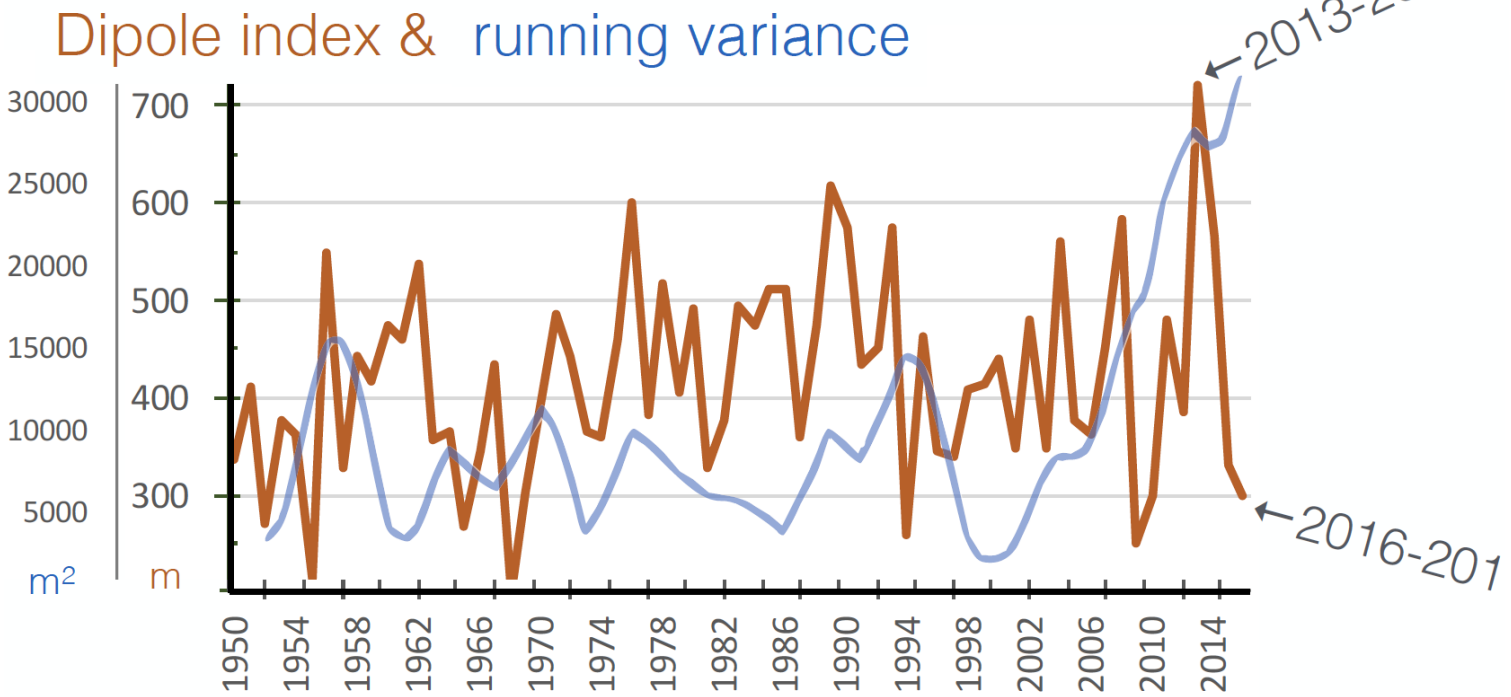
These two winters are nearly opposite!

spatial correlation = **0.8** !



250-hPa geopotential height anomalies





nature COMMUNICATIONS

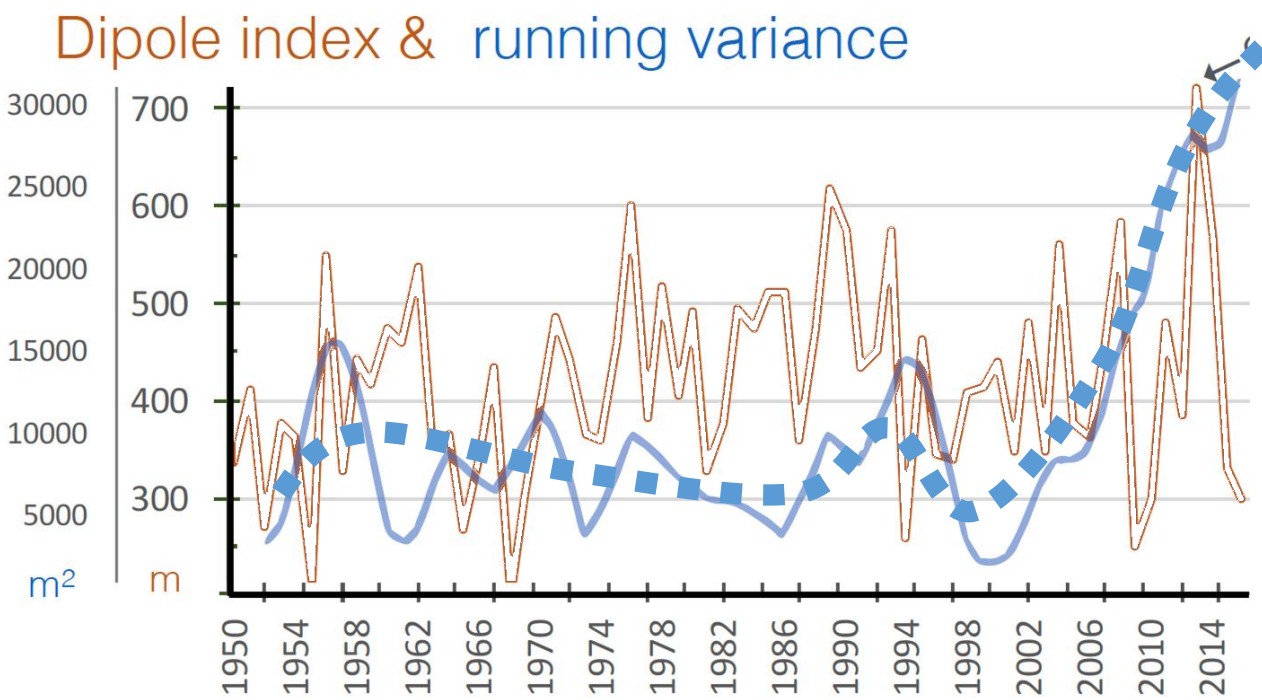
ARTICLE

Received 13 Oct 2014 | Accepted 17 Sep 2015 | Published 21 Oct 2015

DOI: 10.1038/ncomms9657 OPEN

Increasing water cycle extremes in California and in relation to ENSO cycle under global warming

Jin-Ho Yoon[1], S-Y Simon Wang[2], Robert R. Gillies[2], Ben Kravitz[1], Lawrence Hipps[2] & Philip J. Rasch[1]



Future amplification of dipole

due to tropical forcing and Arctic amplification

2040

2080

Geophysical Research Letters

AN AGU JOURNAL

Special collection

The ongoing California Drought of 2012-2015: A testbed for understanding regional climate extremes in a warming world

Does El Niño intensity matter for California precipitation?

Andrew Hoell, Martin Hoerling, Jon Eischeid, Klaus Wolter, Randall Dole, Judith Perlwitz, Taiyi Xu, Linyin Cheng

First Published: 19 January 2016 DOI: 10.1002/2015GL067102

Abstract | Full Text (HTML) | PDF (1.7MB) | References

Journal Highlights

Placing the 2012–2015 California-Nevada drought into a paleoclimatic context: Insights from Walker Lake, California-Nevada, USA

Benjamin J. Hatchett, Douglas P. Boyle, Aaron E. Putnam, Scott D. Bassett

First Published: 28 October 2015 DOI: 10.1002/2015GL065841

Abstract | Full Text (HTML) | PDF (1.2MB) | References

Historic drought puts the brakes on earthflows in Northern California

G. L. Bennett, J. J. Roering, B. H. Mackey, A. L. Handwerger, D. A. Schmidt, B. P. Guillod

First Published: 1 June 2016 DOI: 10.1002/2016GL068378

Abstract | Full Text (HTML) | PDF (2.2MB) | References

Five centuries of U.S. West Coast drought: Occurrence, spatial distribution, and associated atmospheric circulation patterns

Erika K. Wise

First Published: 5 May 2016 DOI: 10.1002/2016GL068487

Abstract | Full Text (HTML) | PDF (1.9MB) | References

Running dry: The U.S. Southwest's drift into a drier climate state

Andreas F. Prein, Gregory J. Holland, Roy M. Rasmussen, Martyn P. Clark, Mari R. Tye

First Published: 4 February 2016 DOI: 10.1002/2015GL066727

Abstract | Full Text (HTML) | PDF (11.9MB) | References

Open Access Journal Highlights

A tale of two California droughts: Lessons amidst record warmth and dryness in a region of complex physical and human geography

Daniel L. Swain

First Published: 19 November 2015 DOI: 10.1002/2015GL066628

Abstract | Full Text (HTML) | PDF (532.5KB) | References

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Research Letters

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Abstract | Full Text (HTML) | PDF (1.1MB) | References

Perspectives on the causes of exceptionally low 2015 snowpack in the western United States

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Journal Highlights

Characterizing the extreme 2015 snowpack deficit in the Sierra Nevada (USA) and the implications for drought recovery

Steven A. Margulis, Gonzalo Cortés, Manuela Girotto, Laurie S. Huning, Dongyue Li, Michael Durand

First Published: 20 June 2016 DOI: 10.1002/2016GL069586

Abstract | Full Text (HTML) | PDF (4.8MB) | References

Probable causes of the abnormal ridge accompanying the 2013–2014 California drought: ENSO precursor and anthropogenic warming footprint

S.-Y. Wang, Lawrence Hipps, Robert R Gillies, Jin-Ho Yoon

First Published: 2 May 2014 DOI: 10.1002/2014GL059748

Abstract | Full Text (HTML) | PDF (1.2MB) | References

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Changes in drought risk over the contiguous United States (1901–2012): The influence of the Pacific and Atlantic Oceans

Jonghun Kam, Justin Sheffield, Eric F. Wood

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Is climate change implicated in the 2013–2014 California drought? A hydrologic perspective

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Abstract | Full Text (HTML) | PDF (771.3KB) | References

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Compounding effects of warm sea surface temperature and reduced sea ice on the extreme circulation over the extratropical North Pacific and North America during the 2013–2014 boreal winter

Ming-Ying Lee, Chi-Cherng Hong, Huang-Hsiung Hsu

First Published: 13 March 2015 DOI: 10.1002/2014GL062956

Abstract | Full Text (HTML) | PDF (1.2MB) | References

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How unusual is the 2012–2014 California drought?

Daniel Griffin, Kevin J. Anchukaitis

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The worst North American drought year of the last millennium: 1934

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Abstract | Full Text (HTML) | PDF (29.9MB) | References

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Global warming and changes in risk of concurrent climate extremes: Insights from the 2014 California drought

Amir AghaKouchak, Linyin Cheng, Omid Mazdiyasni, Alireza Farahmand

Contribution of anthropogenic warming to California drought during 2012–2014

A. Park Williams, Richard Seager, John T. Abatzoglou, Benjamin I. Cook, Jason E. Smerdon, Edward R. Cook

First Published: 28 August 2015 DOI: 10.1002/2015GL064924

Abstract | Full Text (HTML) | PDF (891.3KB) | References

Journal Highlights

Revisiting the recent California drought as an extreme value

Scott M. Robeson

First Published: 22 August 2015 DOI: 10.1002/2015GL064593

Abstract | Full Text (HTML) | PDF (423.8KB) | References

Significant modulation of variability and projected change in California winter precipitation by extratropical cyclone activity

Edmund K. M. Chang, Cheng Zheng, Patrick Lanigan, Albert M. W. Yau, J. David Neelin

First Published: 17 July 2015 DOI: 10.1002/2015GL064424

Abstract | Full Text (HTML) | PDF (3.0MB) | References

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Temperature impacts on the water year 2014 drought in California

Shraddhanand Shukla, Mohammad Safeeq, Amir AghaKouchak, Kaiyu Guan, Chris Funk

First Published: 2 June 2015 DOI: 10.1002/2015GL063666

Abstract | Full Text (HTML) | PDF (2.9MB) | References

Causes and impacts of the 2014 warm anomaly in the NE Pacific

Nicholas A. Bond, Meghan F. Cronin, Howard Freeland, Nathan Mantua

First Published: 5 May 2015 DOI: 10.1002/2015GL063306

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Pacific sea surface temperature and the winter of 2014

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Abstract | Full Text (HTML) | PDF (877.1KB) | References

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Role of ocean evaporation in California droughts and floods

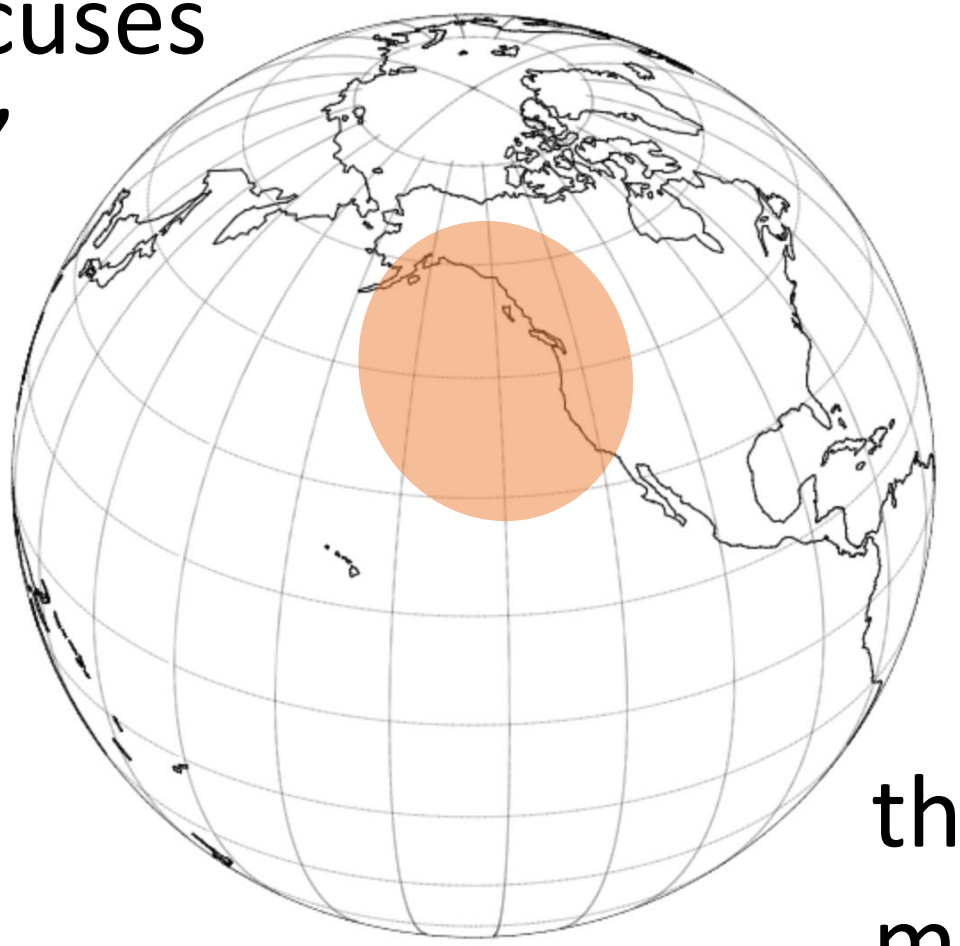
Jiangfeng Wei, Qinjian Jin, Zong-Liang Yang, Paul A. Dirmeyer

First Published: 28 June 2016 DOI: 10.1002/2016GL069586

Abstract | Full Text (HTML) | PDF (4.8MB) | References

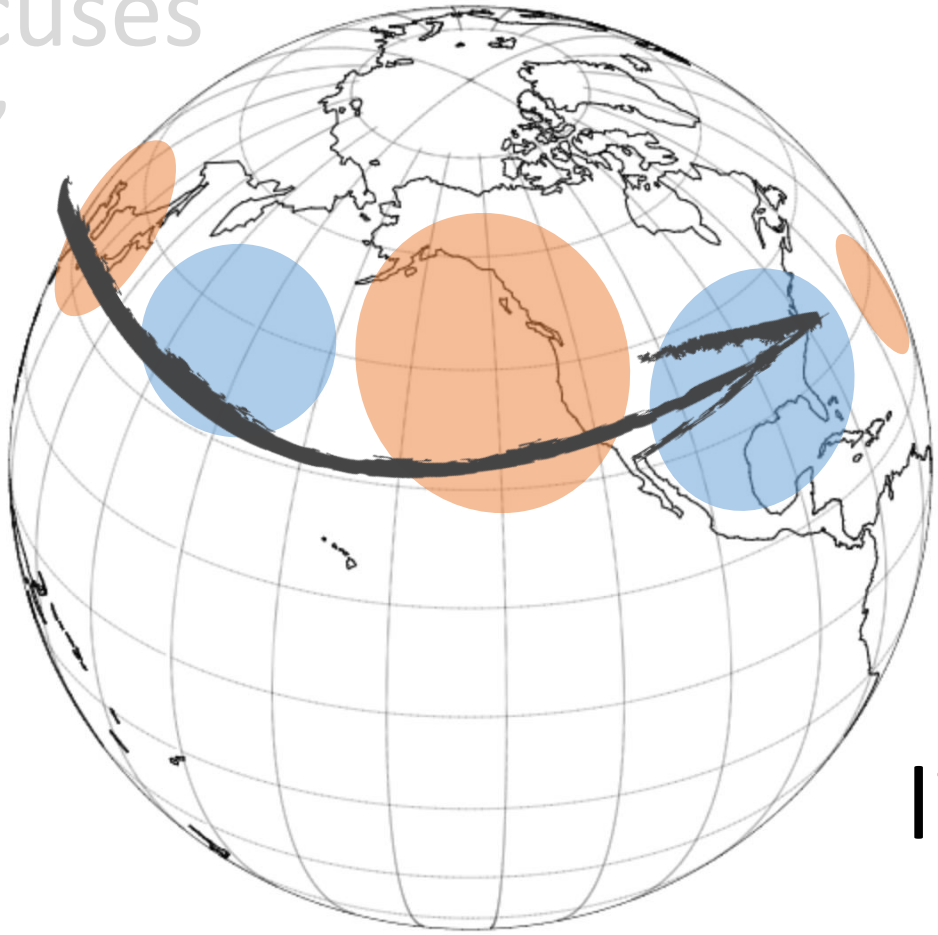
and many more…

If one only focuses on the “ridge” alone,



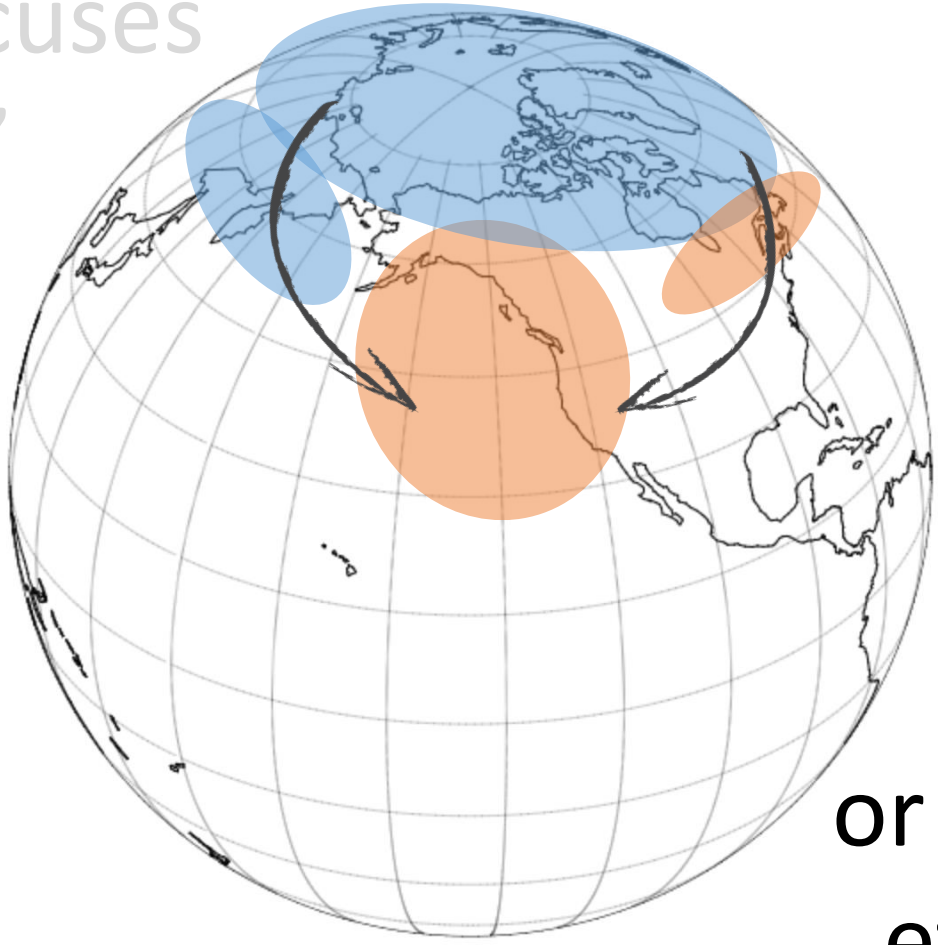
then it involves many ‘forcings’

If one only focuses on the “ridge” alone…



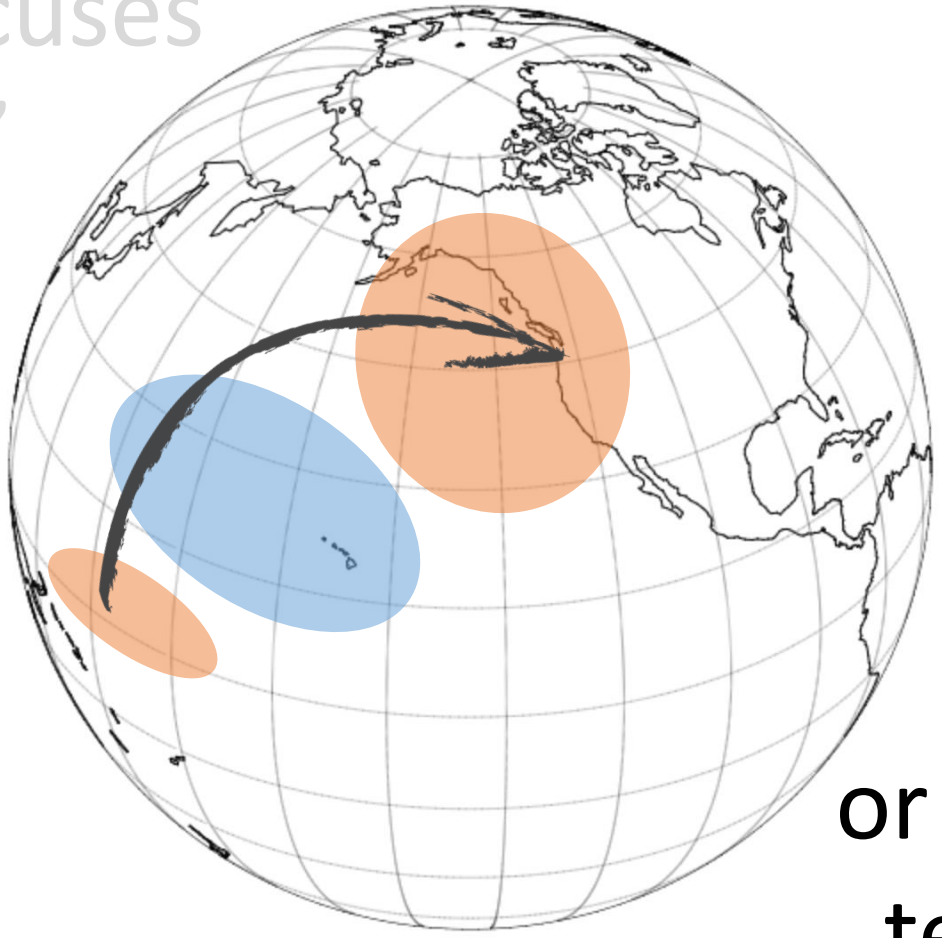
like a jet-stream waveguide,

If one only focuses on the “ridge” alone…



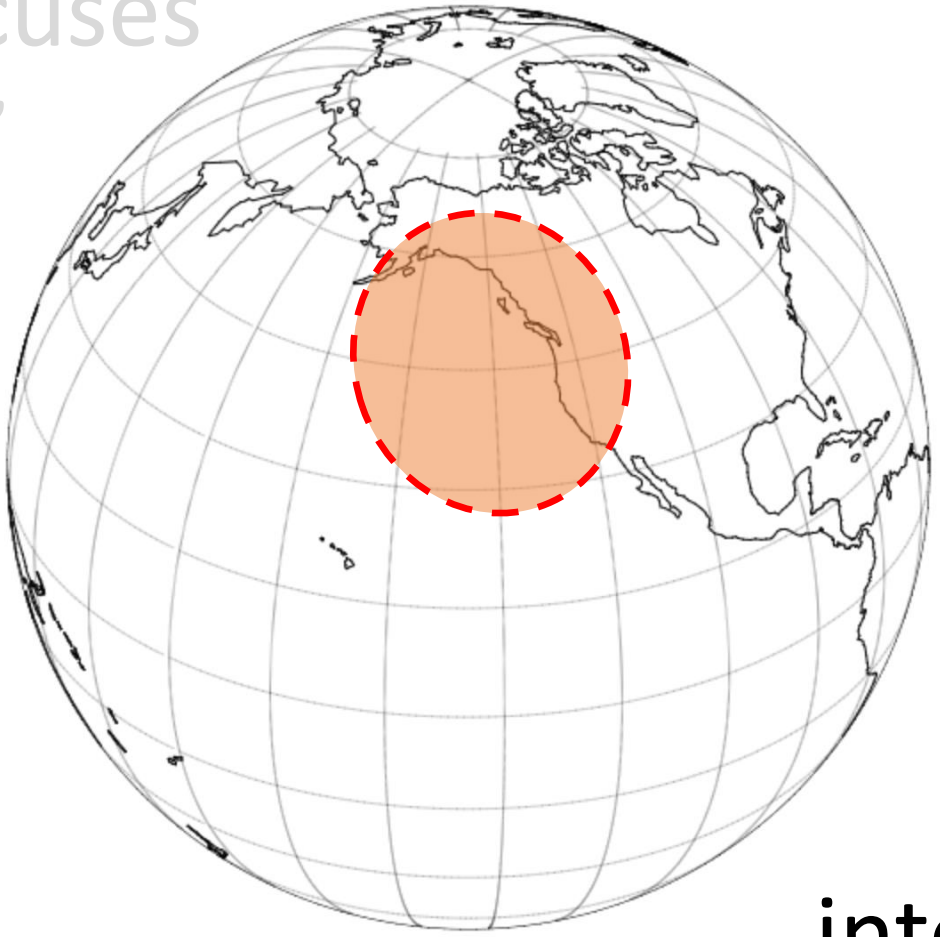
or Arctic warming effect on the jet,

If one only focuses on the “ridge” alone…



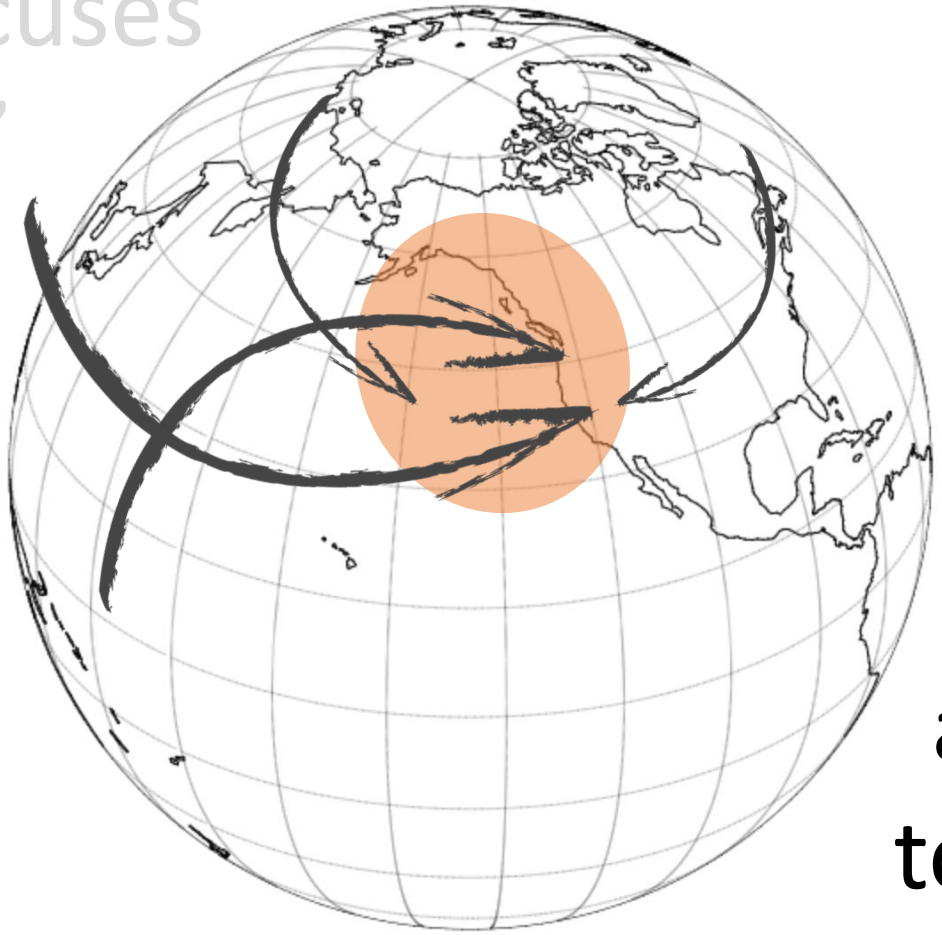
or different tropical teleconnections,

If one only focuses on the “ridge” alone…



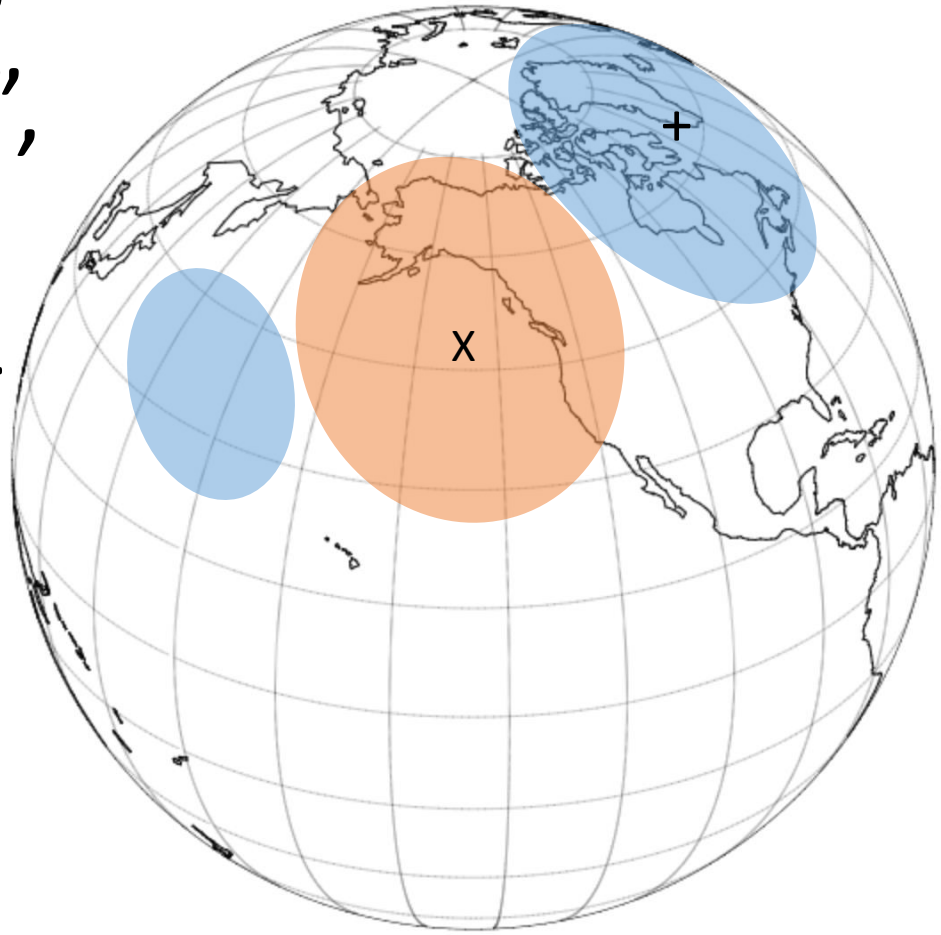
or, just its own internal variability

If one only focuses on the “ridge” alone…

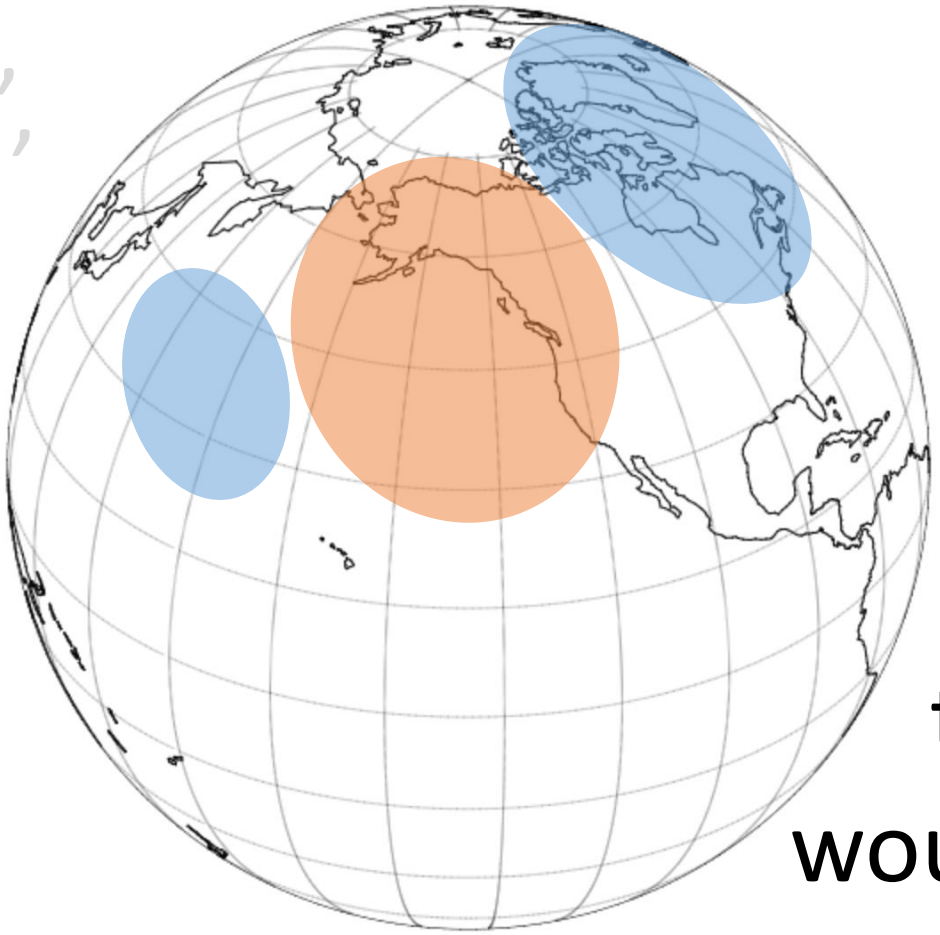


…all of them acting together to modulate the ridge/trough

But if we focus on the ”dipole”, which links to the stationary-waves,

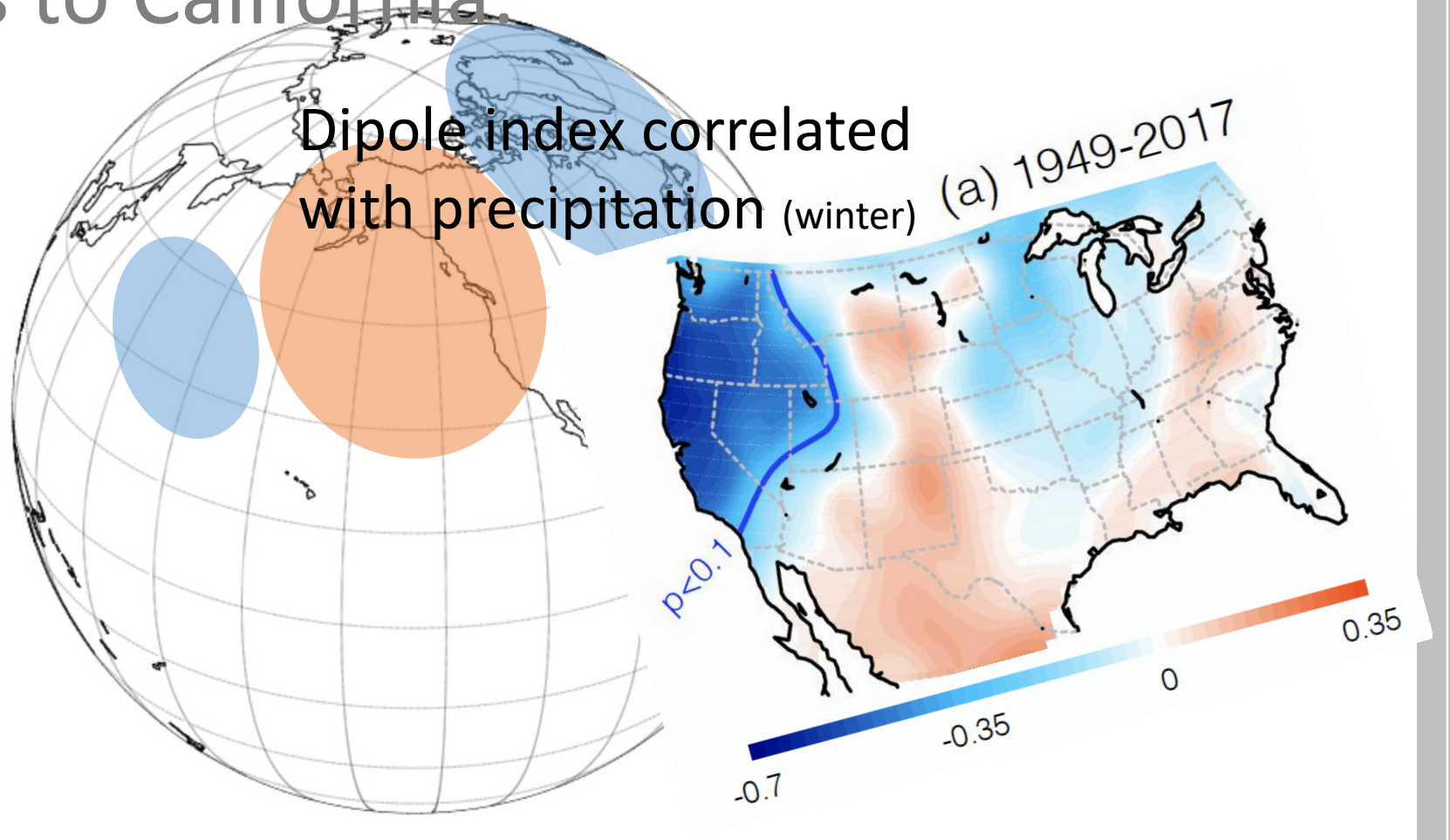


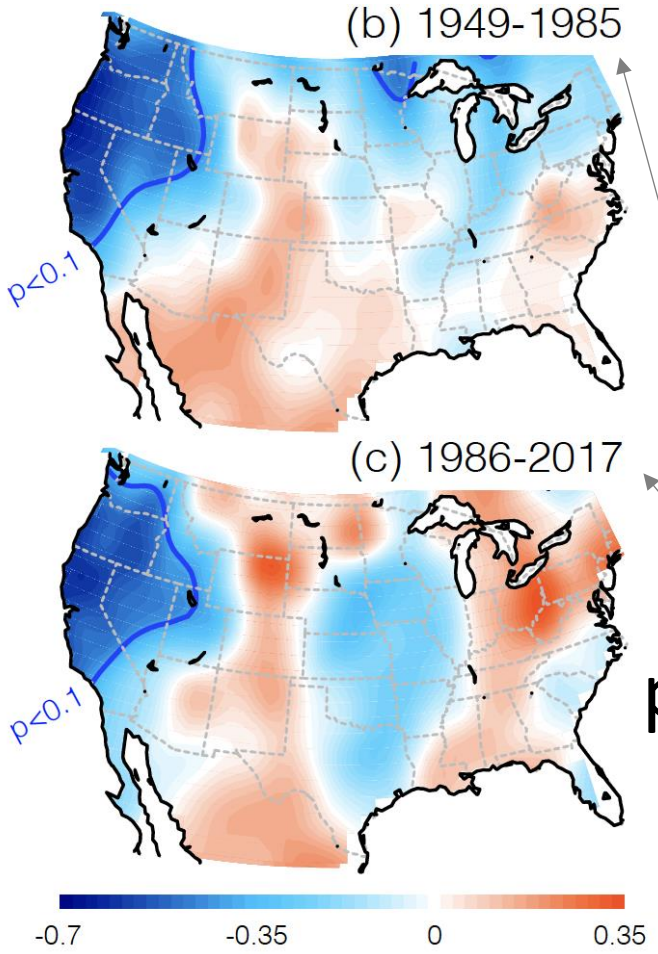
But if we focus on the ”dipole”, which links to the stationary-waves,



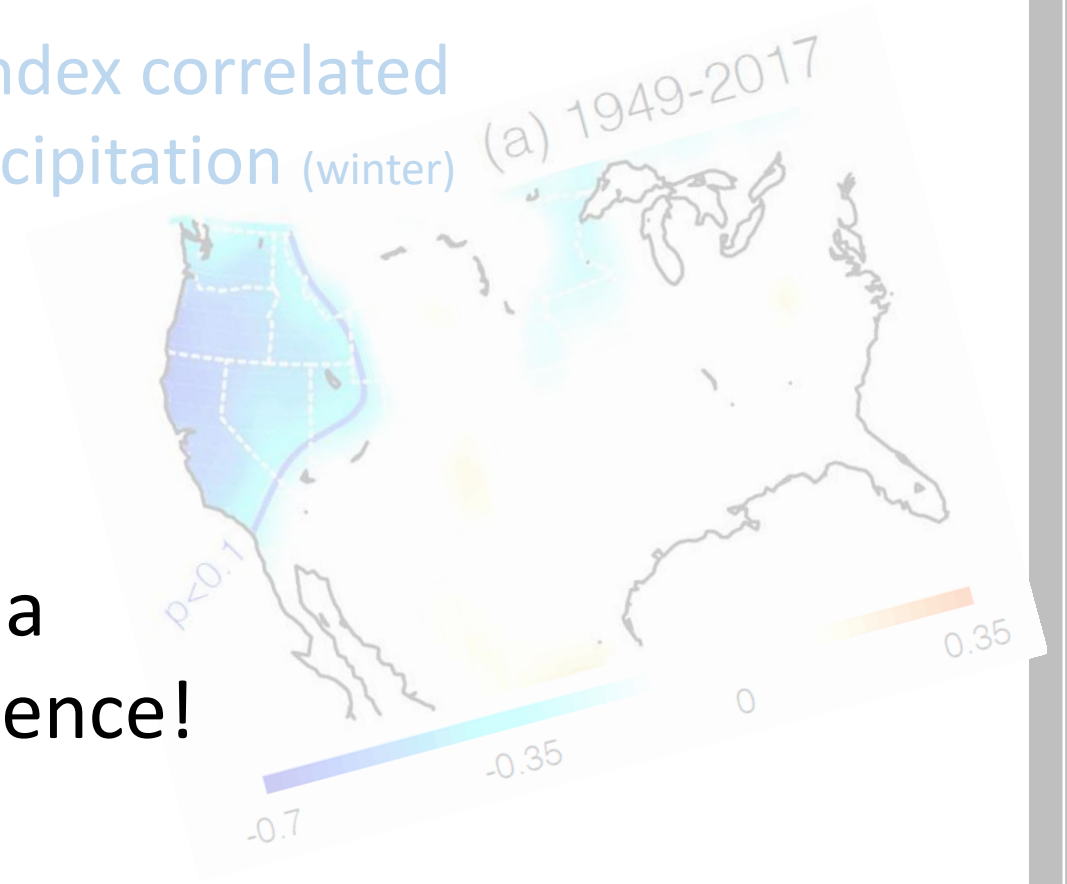
then its forcing would be stronger and is traceable

And it matters to California:



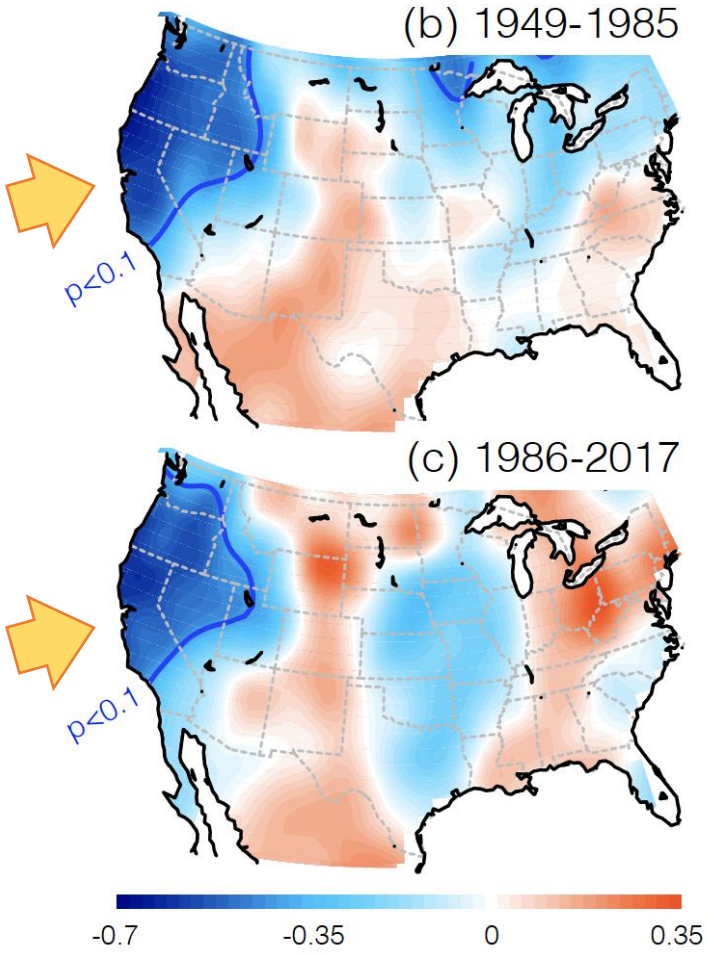


Dipole index correlated with precipitation (winter)

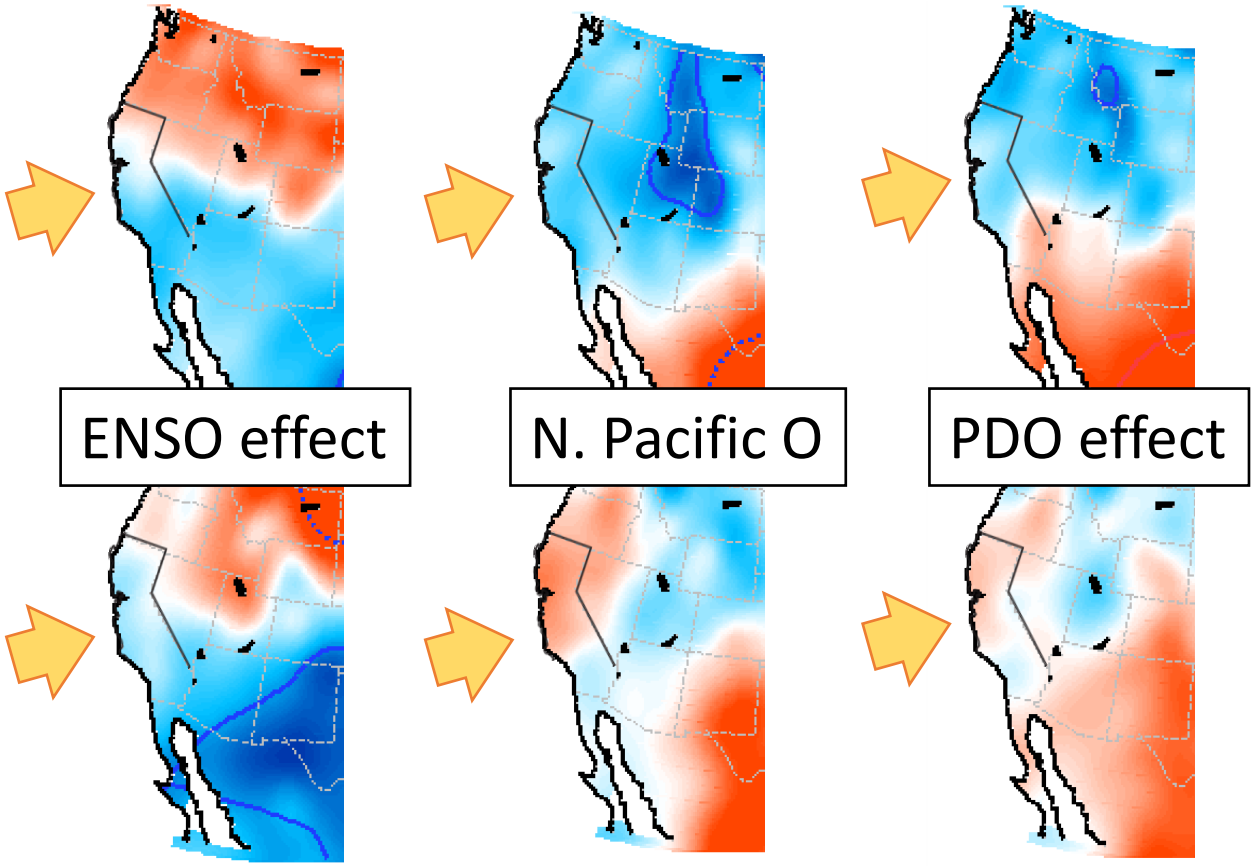


with quite a persistent influence!

better than any other oscillations, anyway 😉



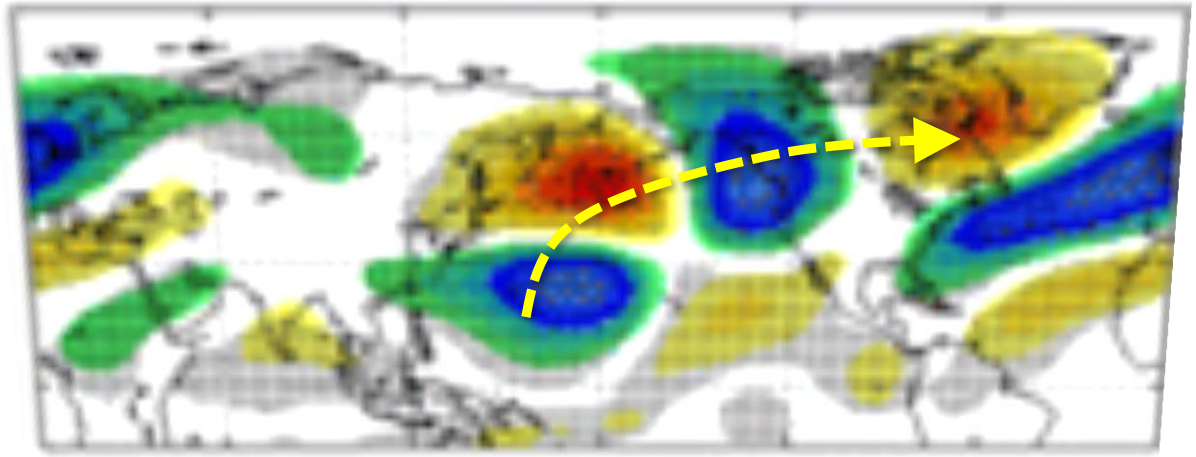
vs.



on S2S prediction

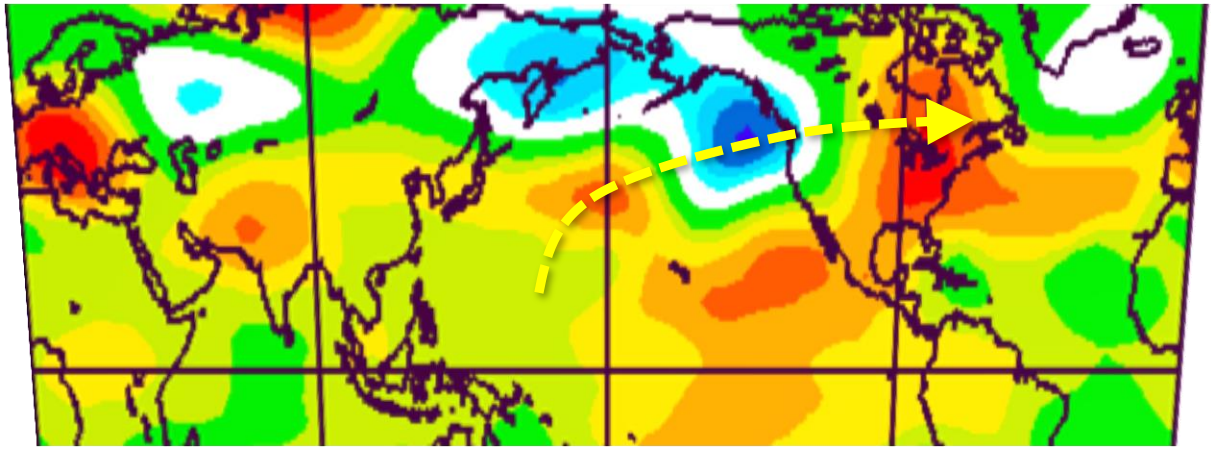
current challenge:

streamfunction composite

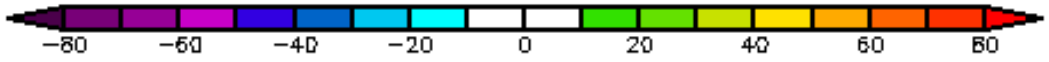


← Goss et al. (2016, JCLI) defined a *stationary wave index* and this is the peak phase

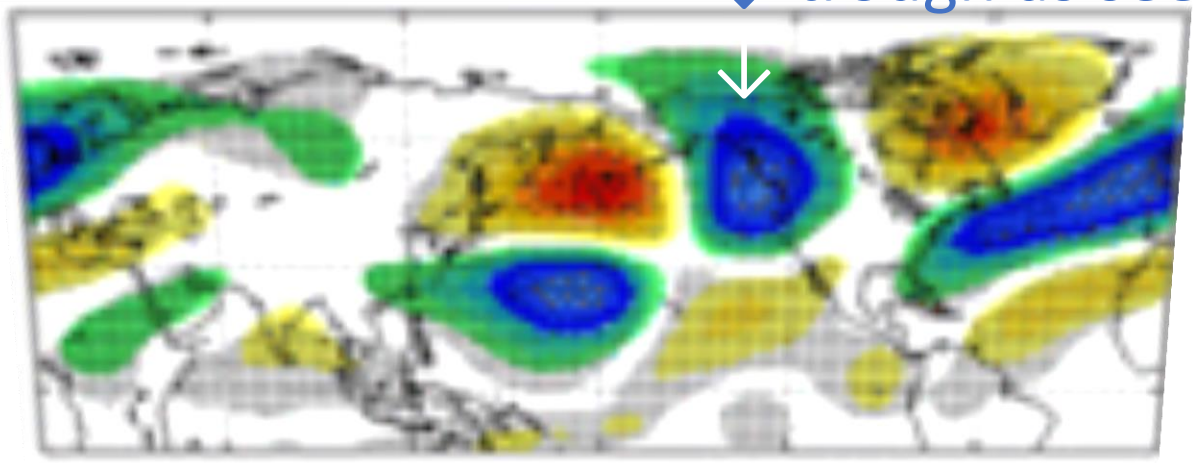
HGT 2017 DJF



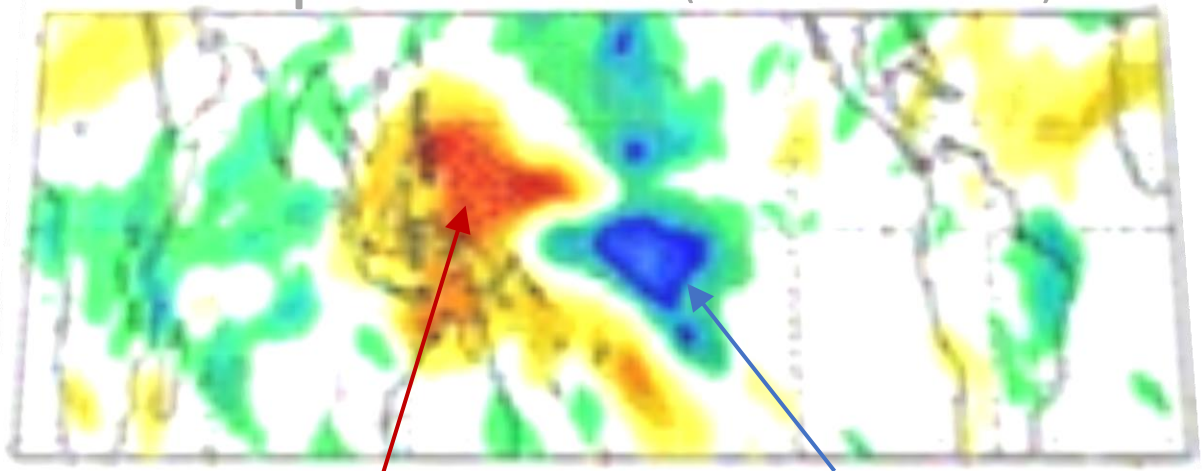
← the 2017 condition is similar!



↓ trough as seen in 2017



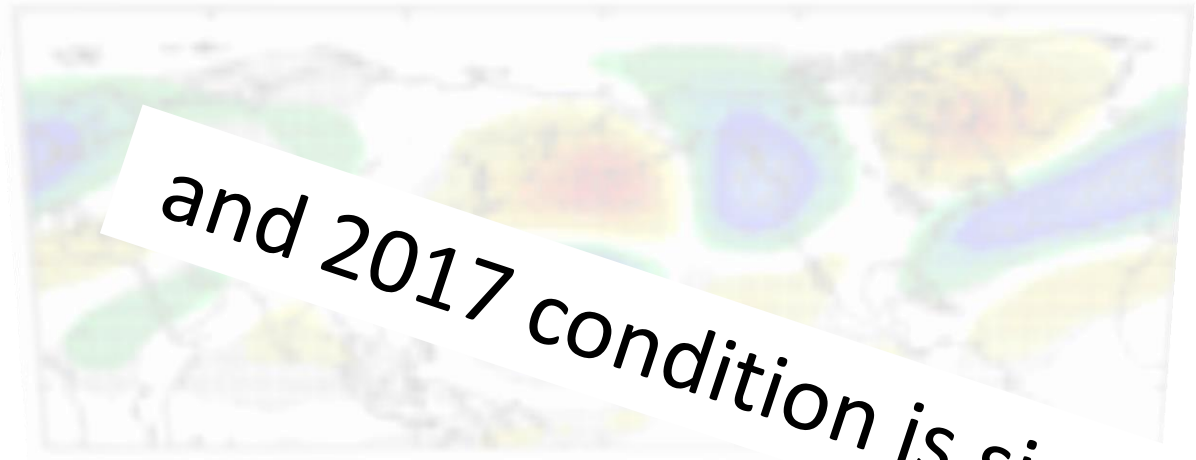
composite OLR (Goss et al. 2016)



← They found a signature pattern of tropical forcing to alter the stationary waves

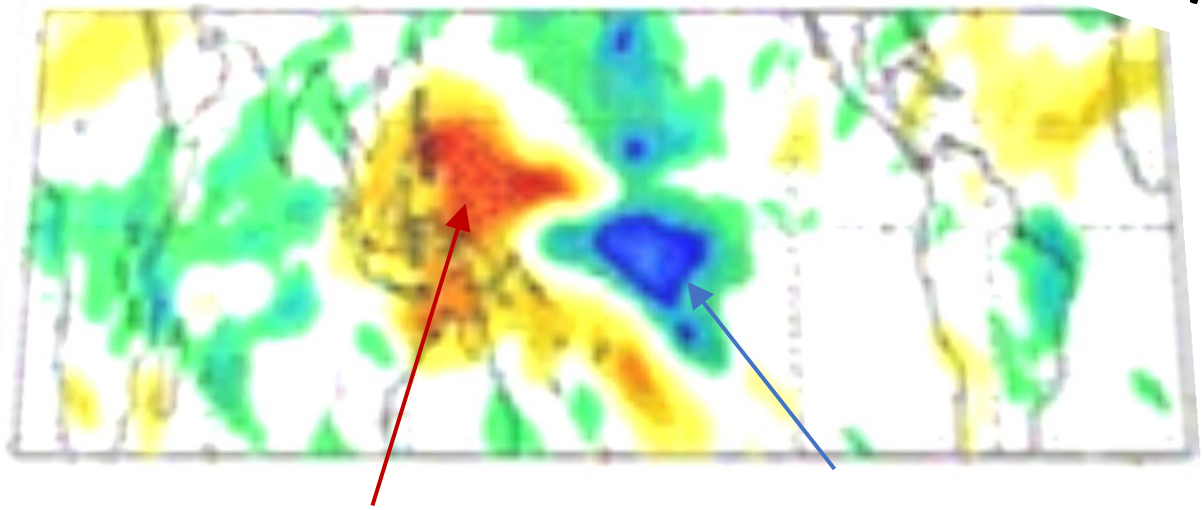
enhanced convection

suppressed convection

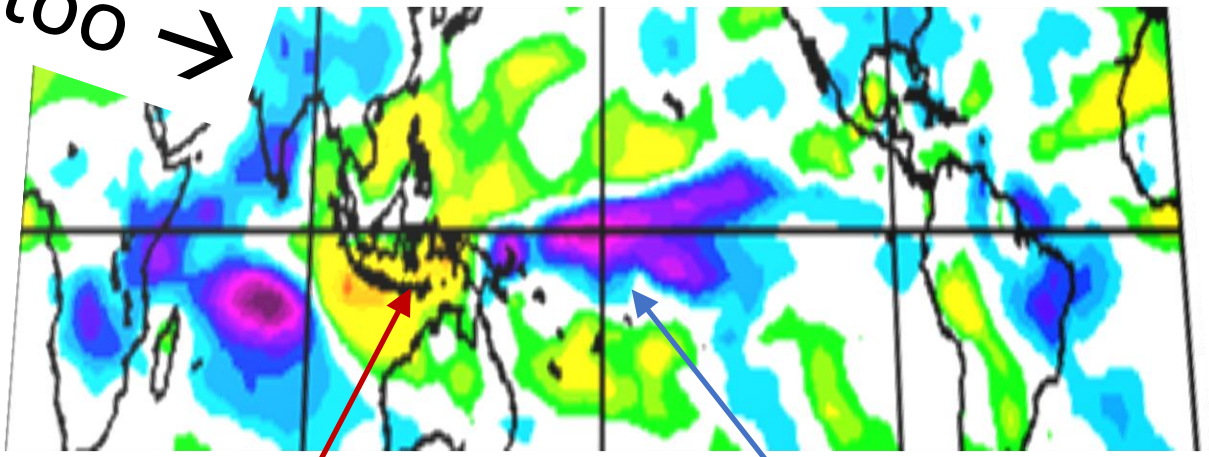


winter

and 2017 condition is similar, too →



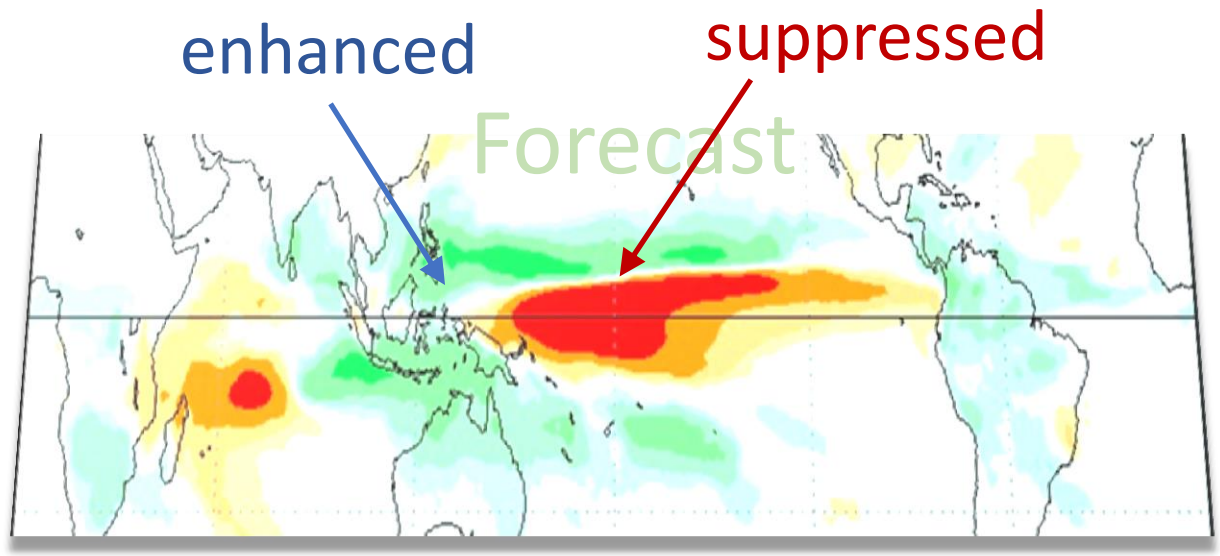
Observed tropical convection anomalies (DJF OLR 2016-17)



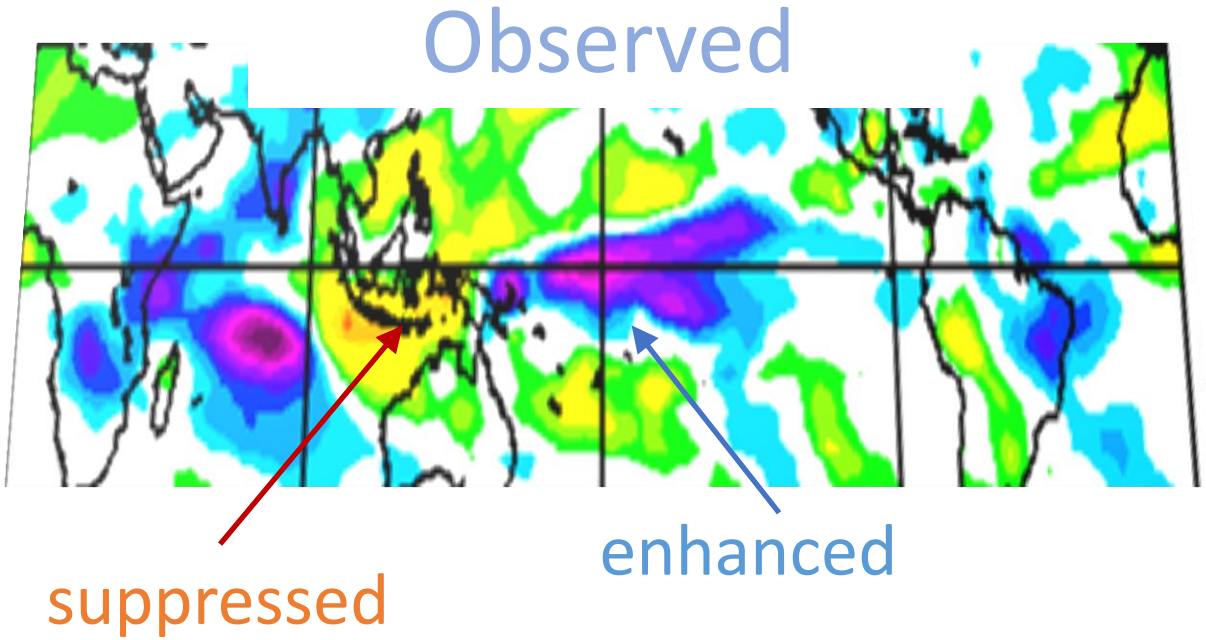
suppressed convection

enhanced convection

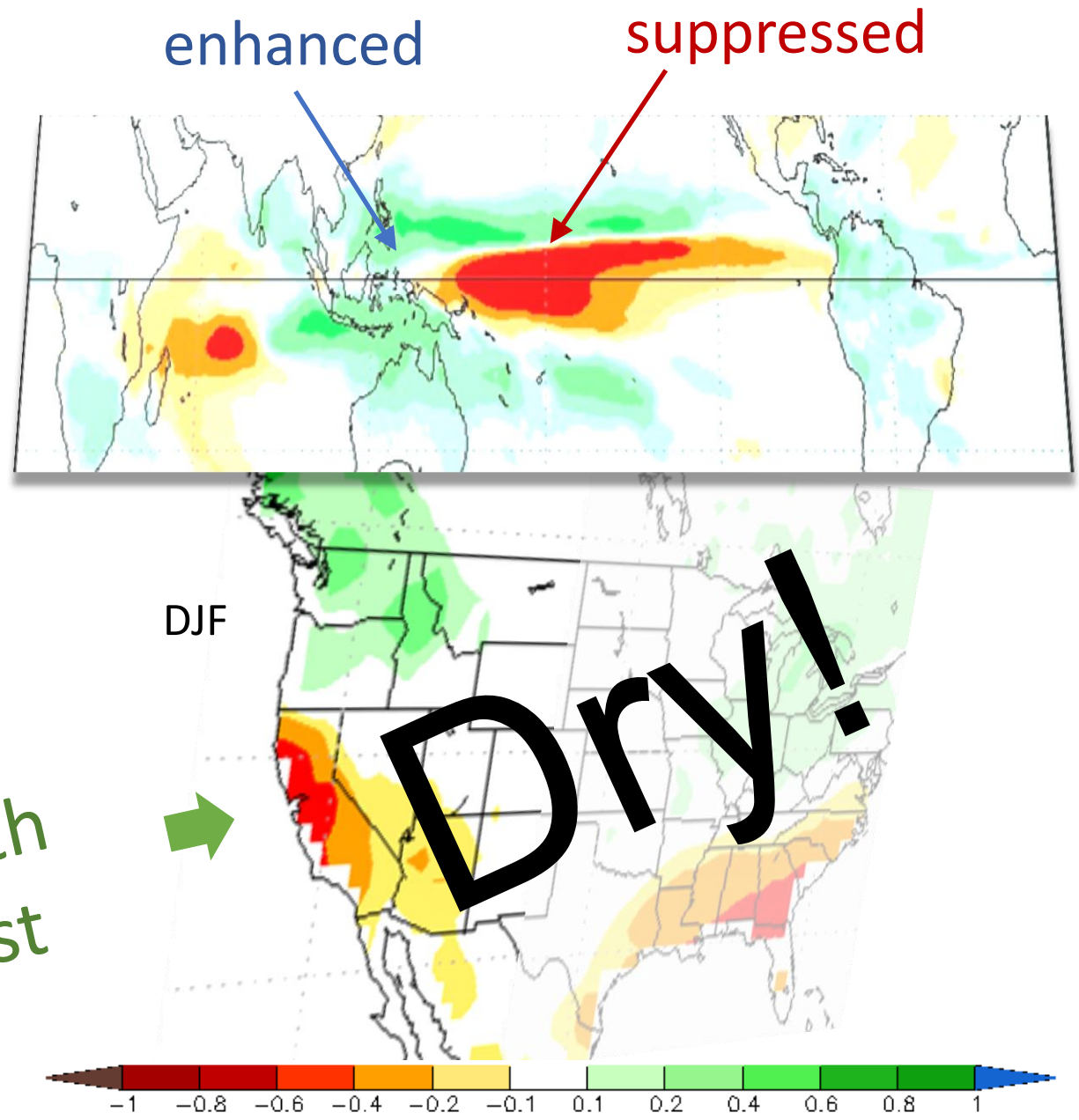
NMME 1-month precip forecast



but forecast was opposite



NMME 1-month precip forecast

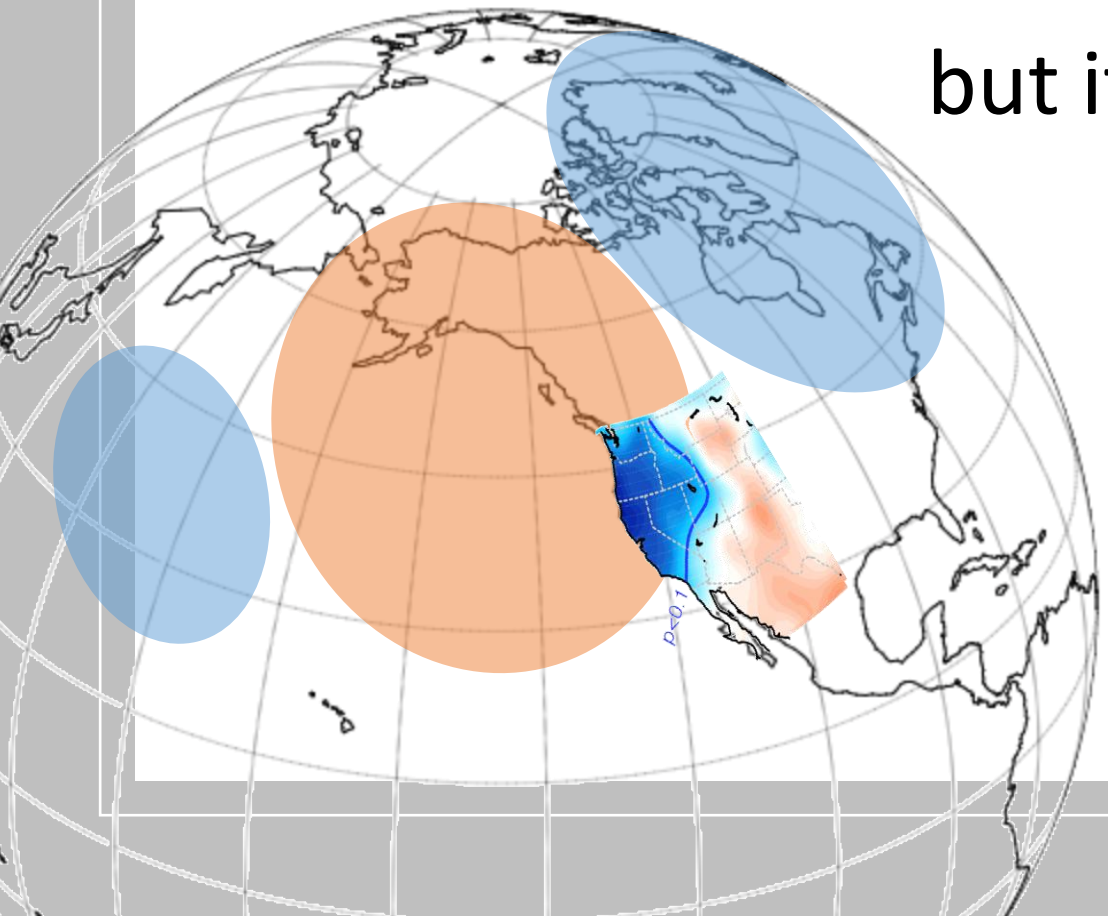


and the

teleconnection seems reversed

NMME 1-month precip forecast

Summary



- The dipole doesn’t explain everything, but it is an important mode
  - S2S forecast on tropical intra-seasonal variability is crucial
    - But S2S forecast of tele-connection is lacking

California from drought to deluge

Nature Climate Change (in review)

- Wang et al., 2017: The California Drought: Trends and Impacts. In *Climate Extremes: Patterns and Mechanisms*, AGU Monograph, Wang et al. (Ed.), in press.
- Yoon et al., 2015: Increasing Water Cycle Extremes in California and in Relation to ENSO Cycle Under Global Warming. *Nature Communications*.
- Yoon et al., 2015: Extreme Fire Season in California: A Glimpse into the Future?. *Bulletin of the American Meteorological Society*.
- Wang et al., 2015: The North American winter 'dipole' and extremes activity: A CMIP5 assessment. *Atmospheric Science Letters*.
- Wang et al., 2014: Probable causes of the abnormal ridge accompanying the 2013-14 California drought: ENSO precursor and anthropogenic warming footprint. *Geophysical Research Letters*.

Utah Climate Center – Simon Wang, Robert Gillies, and collaborators