A Web of Tele-Connections: Compositing Methods for Isolating Climate-Driver Signals and Understanding Their Societal Impacts

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Advisor: Ángel Muñoz

DiSera et al., *in prep*

International Research Institute for Climate and Society
Earth Institute | Columbia University

Society Based Work

Mosquito Disease Monitoring with CARPHA

ENSO’s Impacts on Farming in Guatemala

What Modes of Variability Can Be Used to Improve Seasonal and Subseasonal Forecasts?

A Model El Niño–Southern Oscillation*

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(Manuscript received 1 December 1986, in final form 23 March 1987)

ABSTRACT

A coupled atmosphere–ocean model is developed and used to study the ENSO (El Niño/Southern Oscillatio
phenomenon. With no anomalous external forcing, the coupled model reproduces certain key features of t
observed phenomenon, including the recurrence of warm events at irregular intervals with a preference for thr
to four years. It is shown that the mean sea surface temperature, wind and ocean current fields determine the
characteristic spatial structure of ENSO anomalies. The tendency for phase-locking of anomalies is expl
in terms of a variation in coupling strength associated with the annual cycle in the mean fields. Sensi
studies reveal that both the amplitude and the time scale of the oscillation are sensitive to several paran
that affect the strength of the atmosphere–ocean coupling. Stronger coupling implies larger oscillations v
longer time scale. A critical element of the model oscillation is the variability in the equatorial heat cont
the upper ocean. Equatorial heat content increases prior to warm events and decreases sharply during the e
A theory for this variability and the associated transitions between non–El Niño and El Niño states is pres
Implications of the model results for the prediction of El Niño events are discussed.

Prediction of the Madden-Julian Oscillation and its impact on the European weather in the ECMWF monthly forecasts

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short to evaluate the amplitude of the impact of the MJO over Europe.

The impact of the MJO on the monthly forecast probabilistic skill scores has been assessed. Results indicate that the MJO simulated by the model has a statistically significant impact on weekly mean probabilistic skill scores in the Northern Extratropics for day 12-18, day 19-25 and 26-32. At the time range day 19-25, the reliability of the probabilistic forecasts over Europe depends strongly on the presence of an MJO event in the initial conditions. This result confirms that the MJO is a major source of predictability in the Extratropics in the sub-seasonal time scale.

The last part of this study investigates the impact of the northern extratropical circulation on the MJO skill scores.

What Modes of Variability Can Be Used to Improve Seasonal and Subseasonal Forecasts?

Geophysical Research Letters

Research Letter | Open Access

Warm Phase of AMV Damps ENSO Through Weakened Thermocline Feedback

Paloma Trascasa-Castro, Yohan Ruprich-Robert, Frederic Castruccio, Amanda C. Maycock

First published: 01 December 2021 | https://doi.org/10.1029/2021GL096149

its impact on
forecasts

Jung

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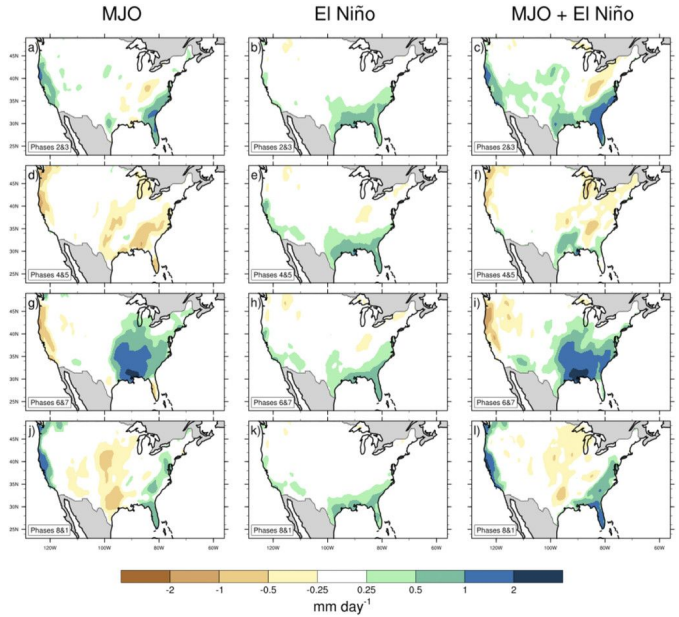
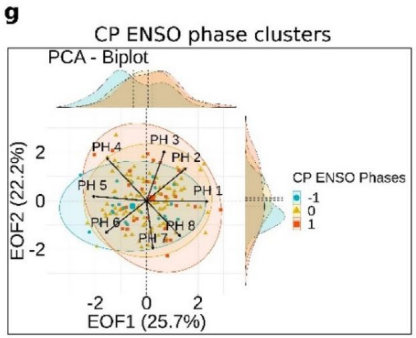
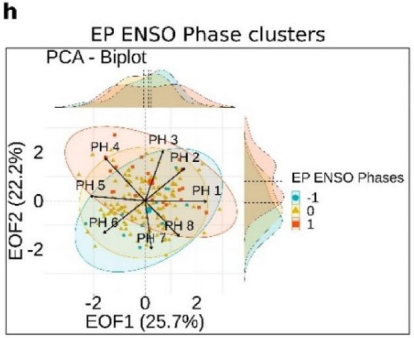
Cross Timescale Interference

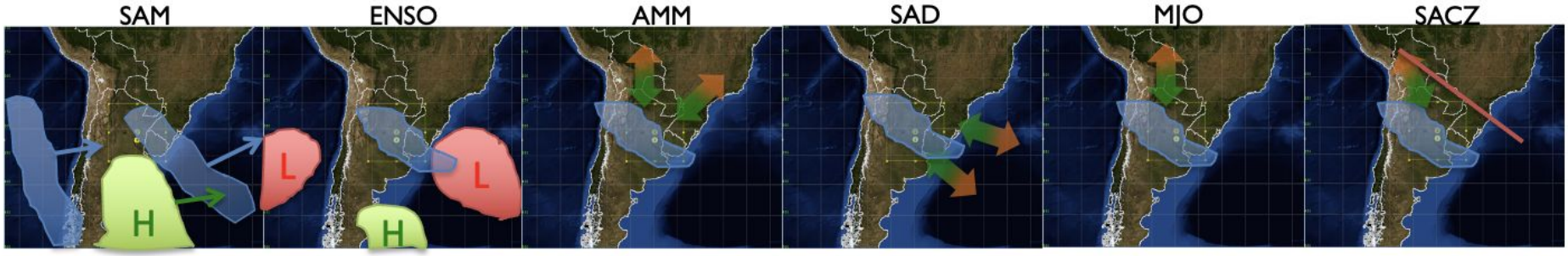
Arcodia et al., 2020







Dasgupta et al., 2021



Muñoz et al., 2015, 2016

Can we identify the individual signatures from the MJO and ENSO from a purely diagnostic approach? If so, can we tease apart their contributions?

Linear superposition:

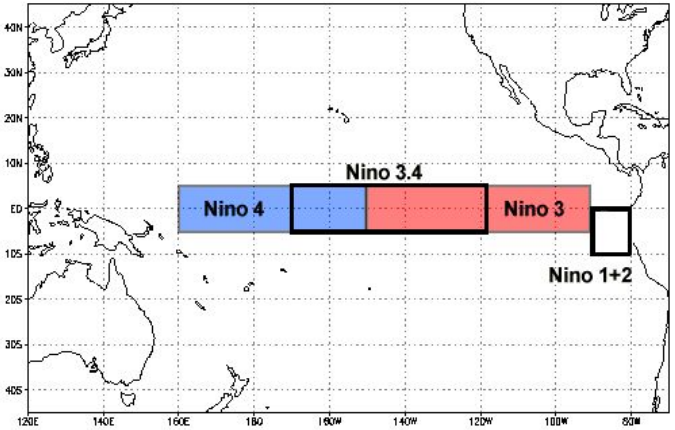
When two or more waves are present simultaneously at the same place, the resultant disturbance is the sum of the disturbance from the individual waves.

Our goal is to figure out how waves originating from different climate drivers interact with each other, and how they constructively and destructively interfere to affect rainfall.

Composite Maps

Data:

- Oct-Dec season for 2006-2020
- NOAA's CPC UNIFIED global daily precipitation data
- Index data:
  - Niño 3.4 monthly index: NOAA NCEP (KAPLAN)
  - MJO daily Amplitude and Phase: NOAA ROMI



Terclies (e.g. ENSO):

- Positive: $x > 1$
- Negative: $x < -1$
- Neutral: $-1 < x < 1$

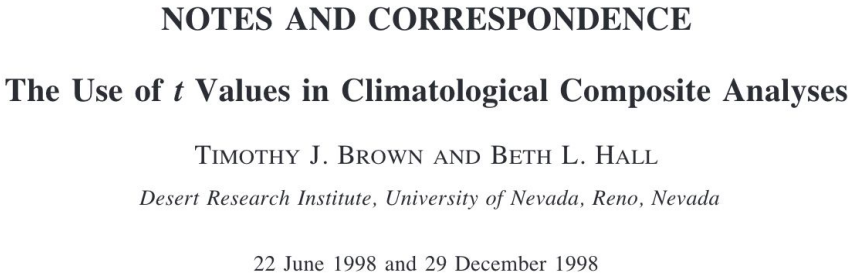
Statistical Significance

Calculated with t-values utilizing medians, rather than means, to accommodate for small sample size (Brown and Hall 1998):

$$t_{value} = \frac{M(1.075)\sqrt{n}}{d_F}$$

Non-significant values are omitted

$p < 0.05$



NOTES AND CORRESPONDENCE

The Use of *t* Values in Climatological Composite Analyses

TIMOTHY J. BROWN AND BETH L. HALL

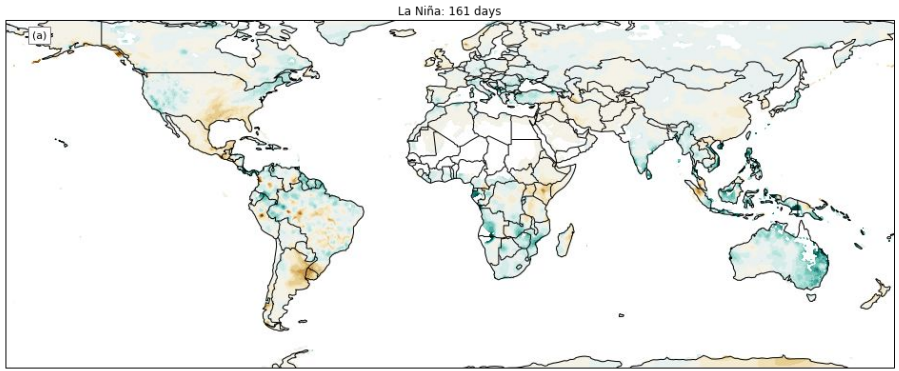
Desert Research Institute, University of Nevada, Reno, Nevada

22 June 1998 and 29 December 1998

[M is the median, n is the number of datapoints, and dF is the “F spread”, similar to the interquartile range of each timeseries.]

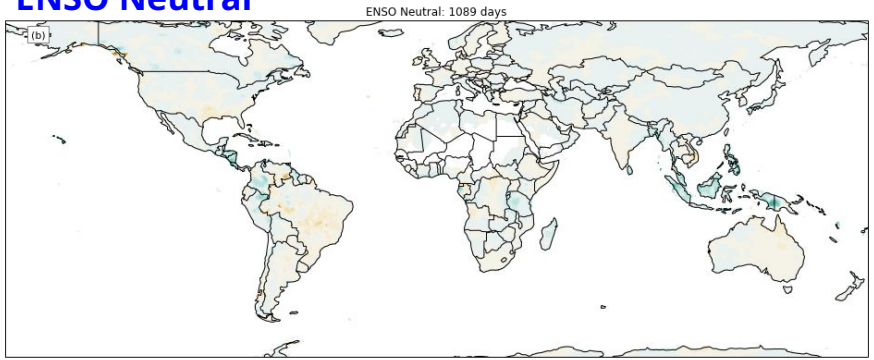
ENSO Composites

Brown (green) represents anomalous below (above) normal precipitation during the October-December 2006-2020 seasons.

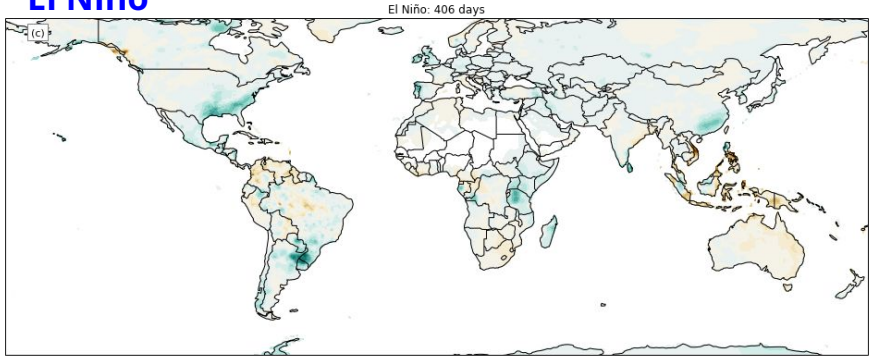


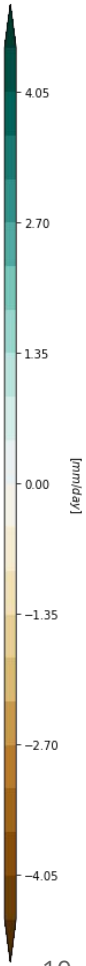
La Niña

ENSO Neutral



El Niño

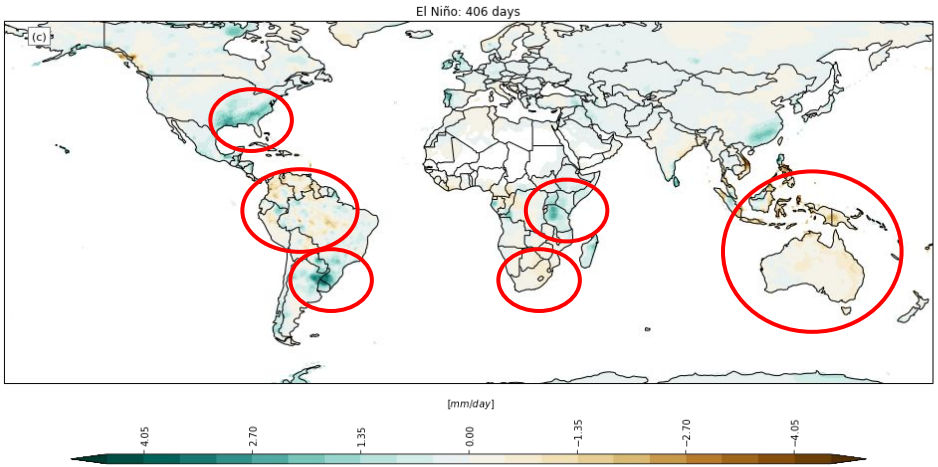


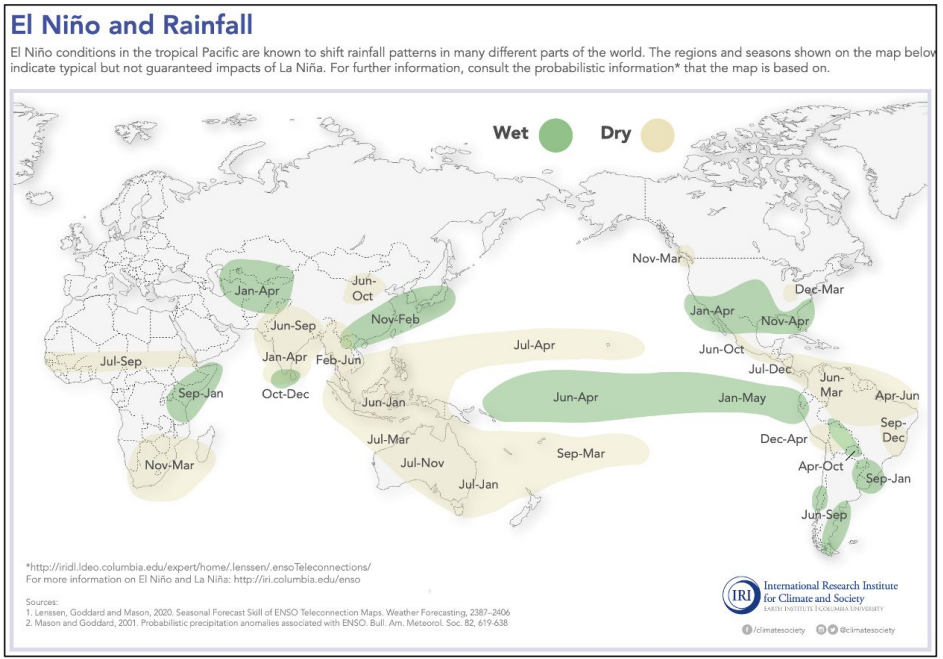


El Niño Phase Composite (OND)

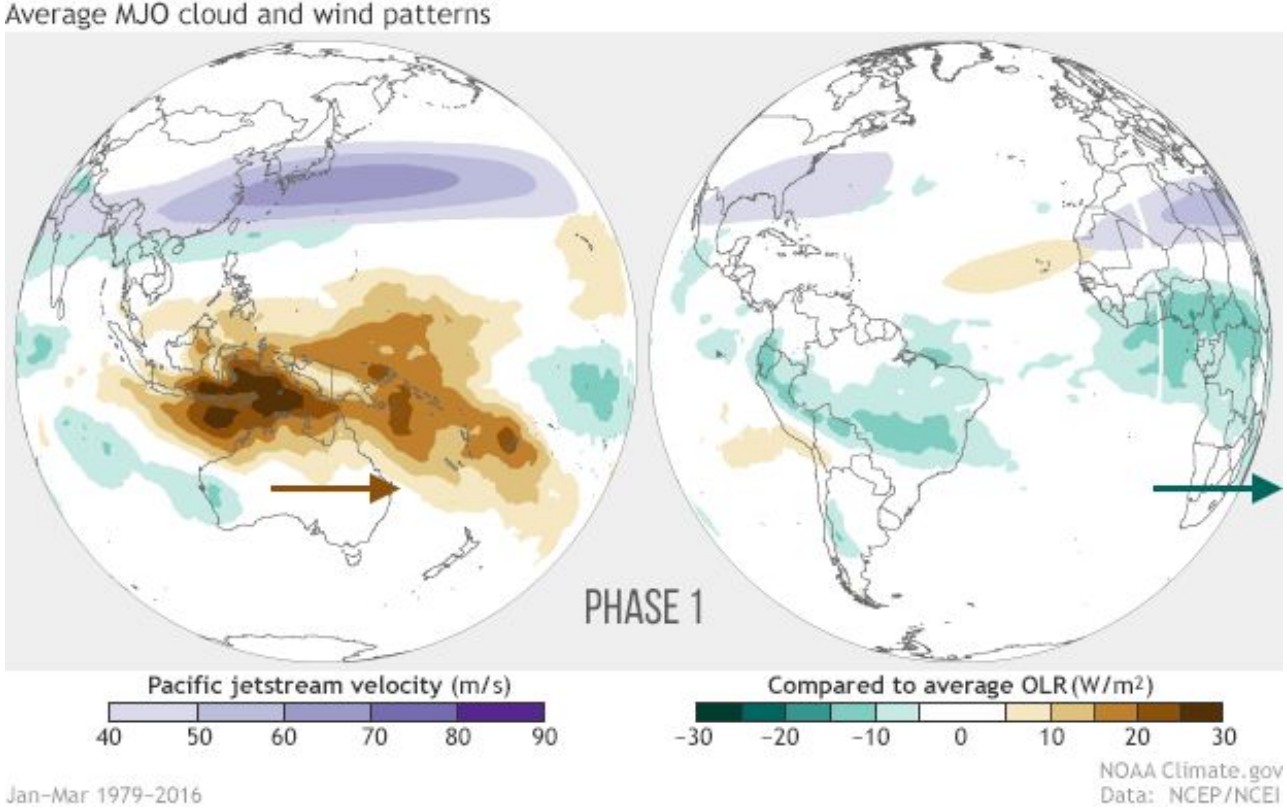
Brown (green) represents anomalous below (above) normal precipitation.

El Niño

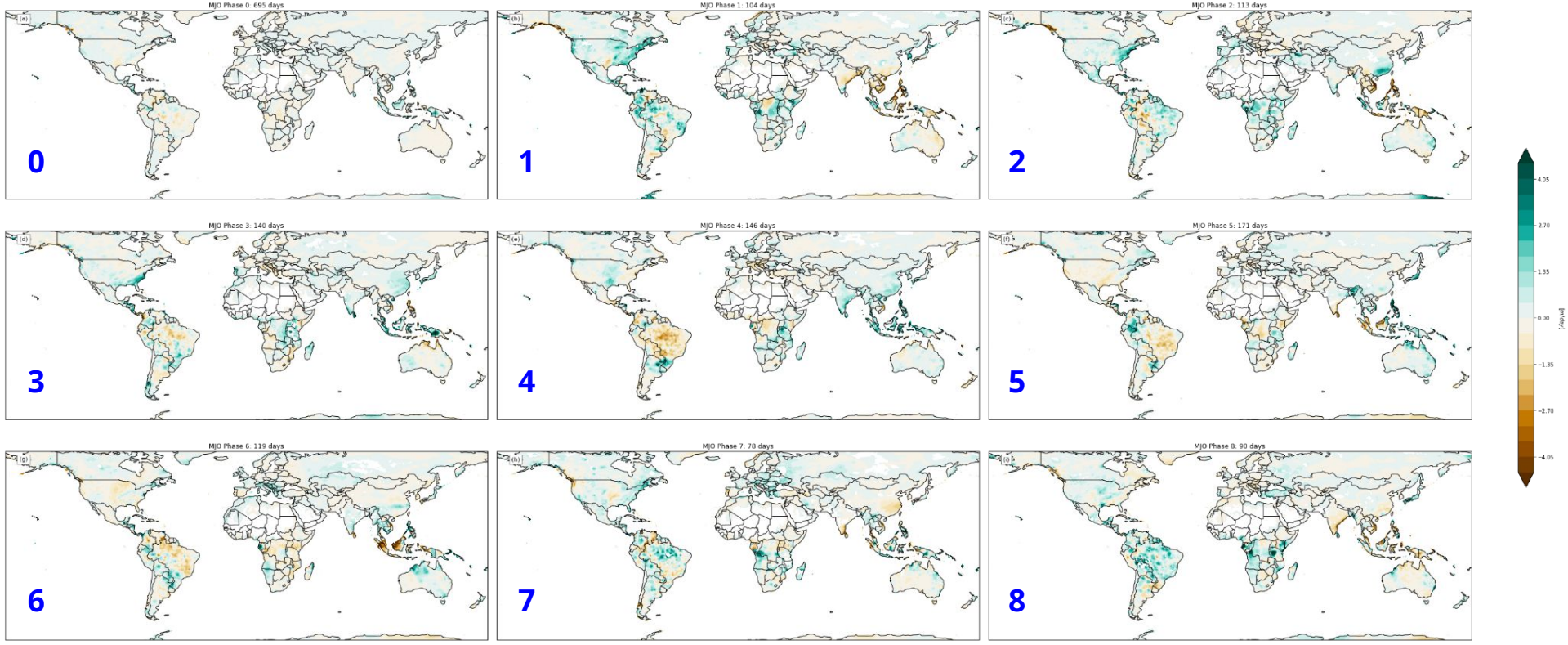




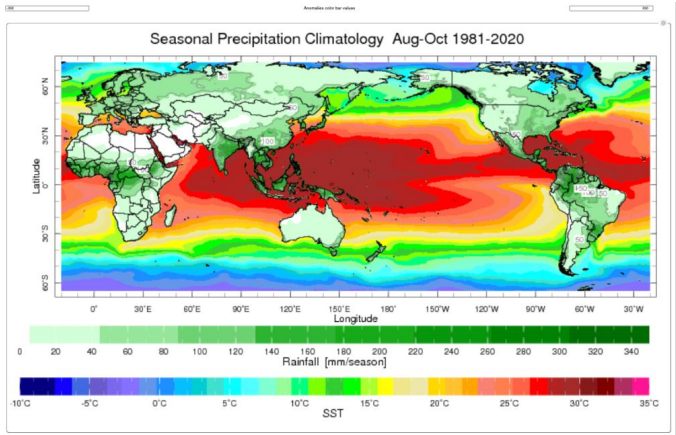
Madden Julian Oscillation

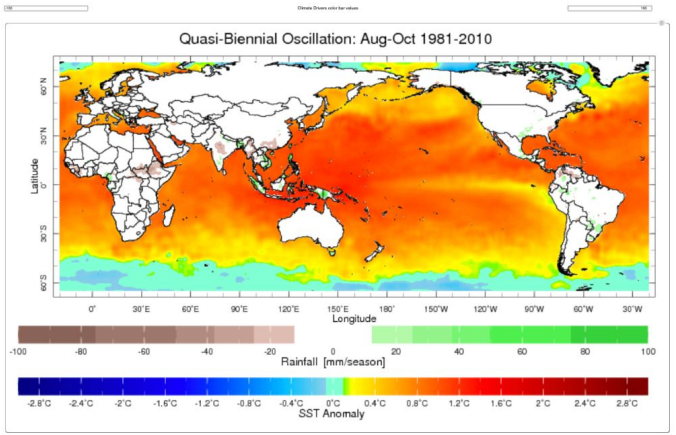


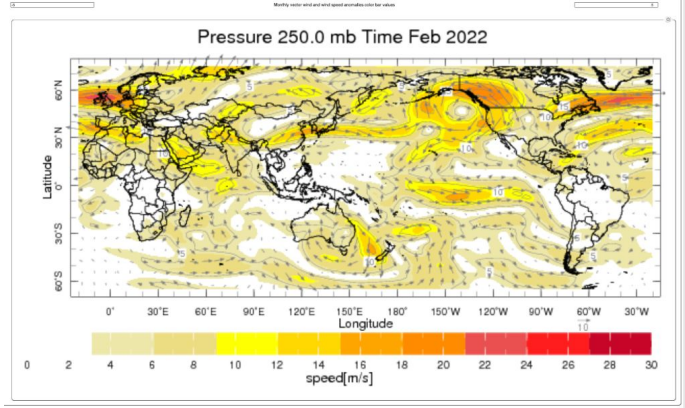
MJO Phase Composites (OND)

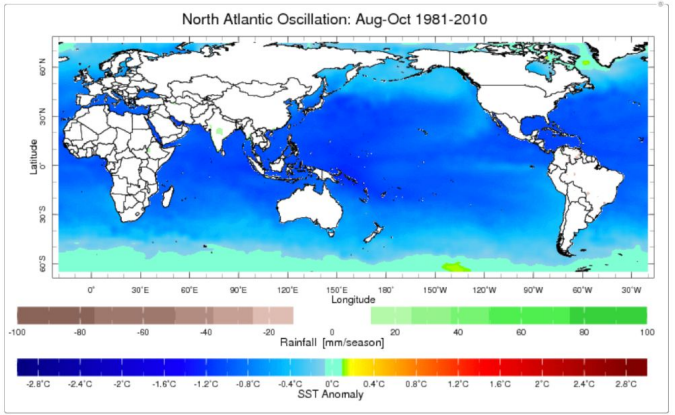


IRI Cross Timescale Interactive Maproom







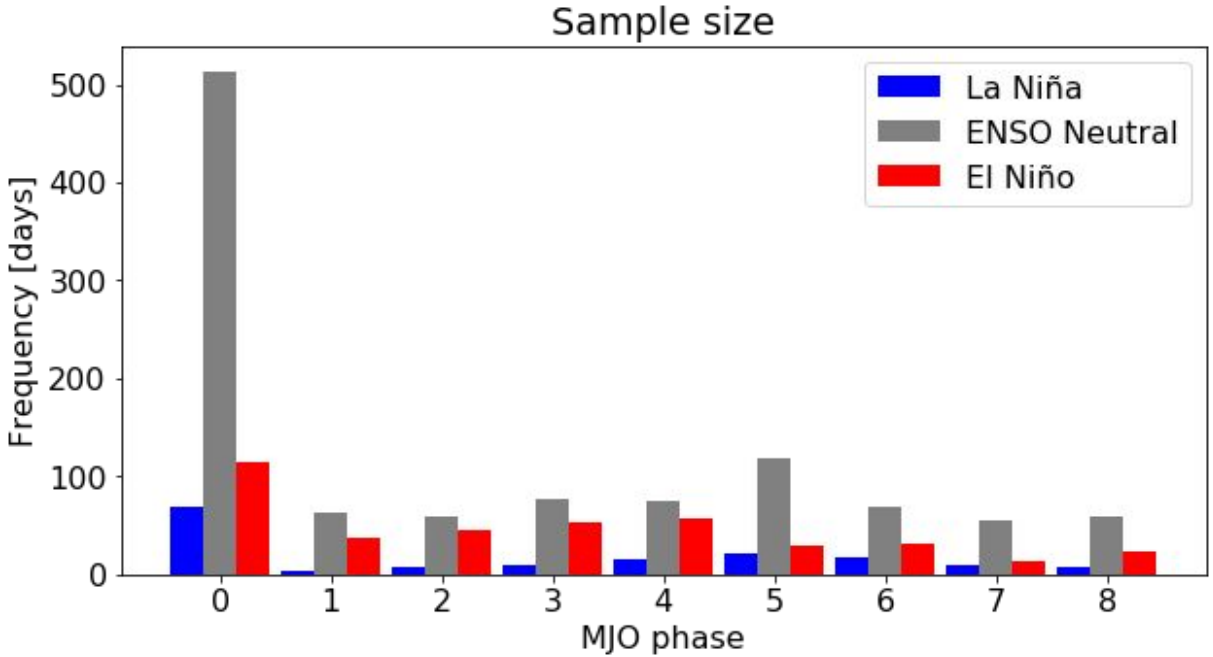


Can we see the contributions of rainfall from a nonlinear analysis?

Nonlinear Composite Maps

Terclies (e.g. ENSO):

- Positive: x>1
  - MJO Phases 0-8
- Negative: x<-1
  - MJO Phases 0-8
- Neutral: -1<x<1
  - MJO Phases 0-8



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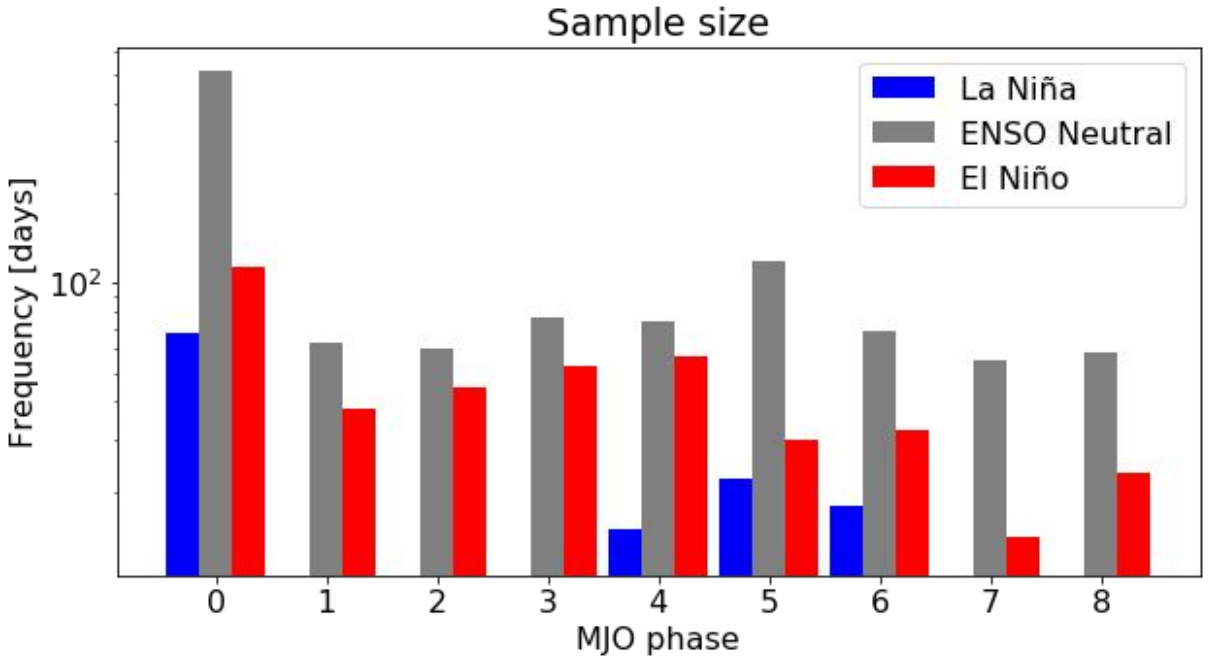
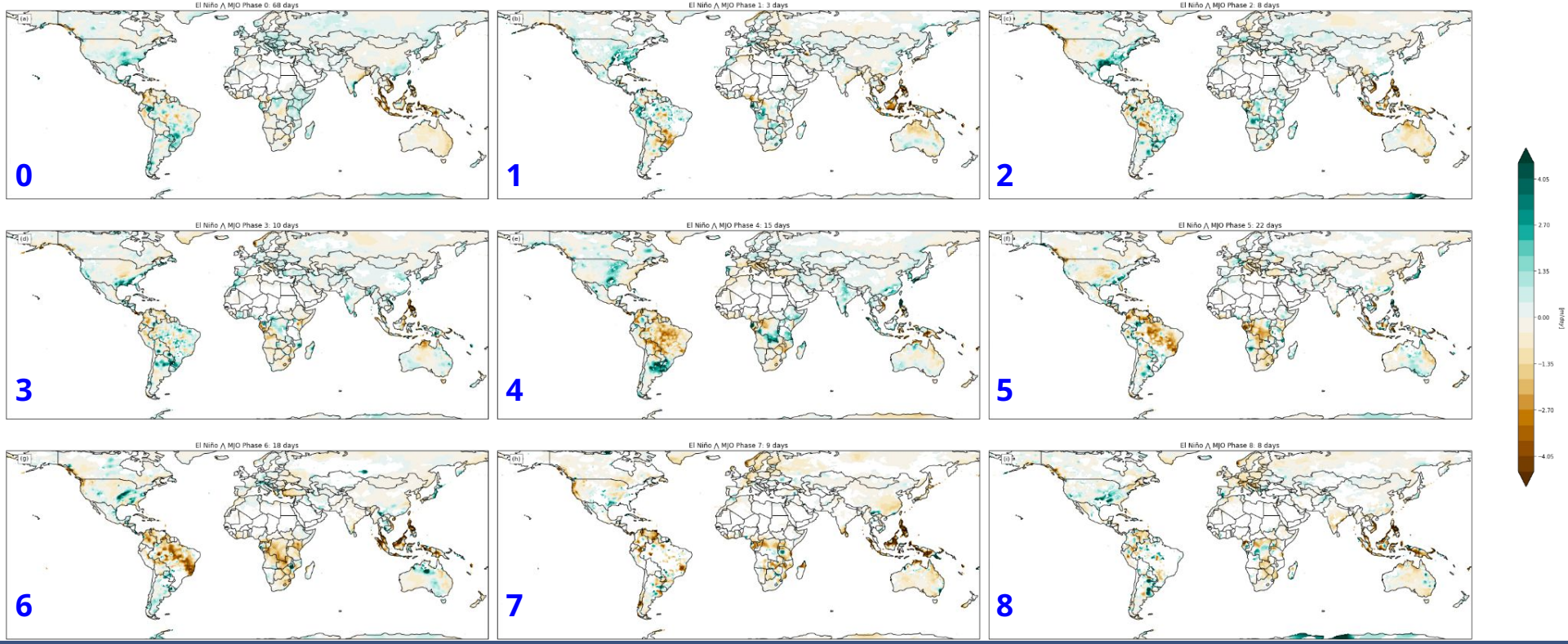
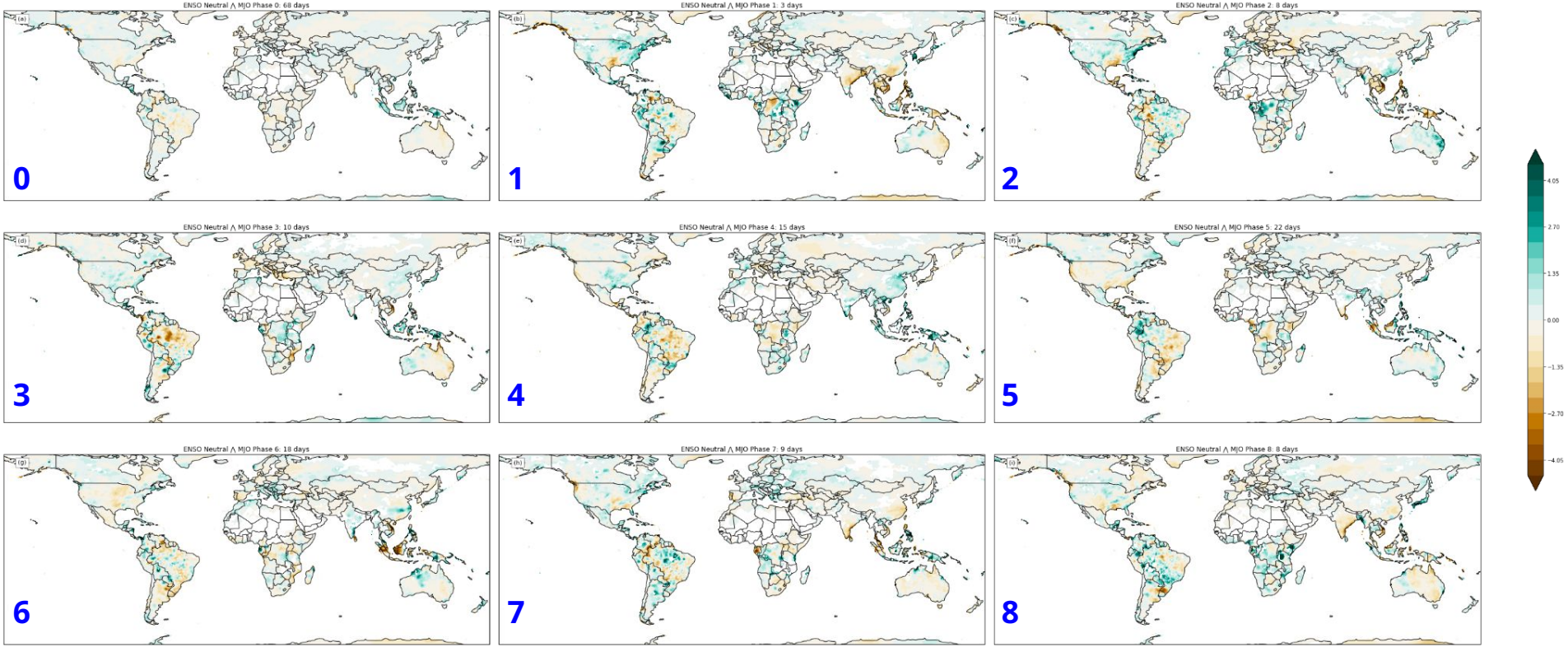


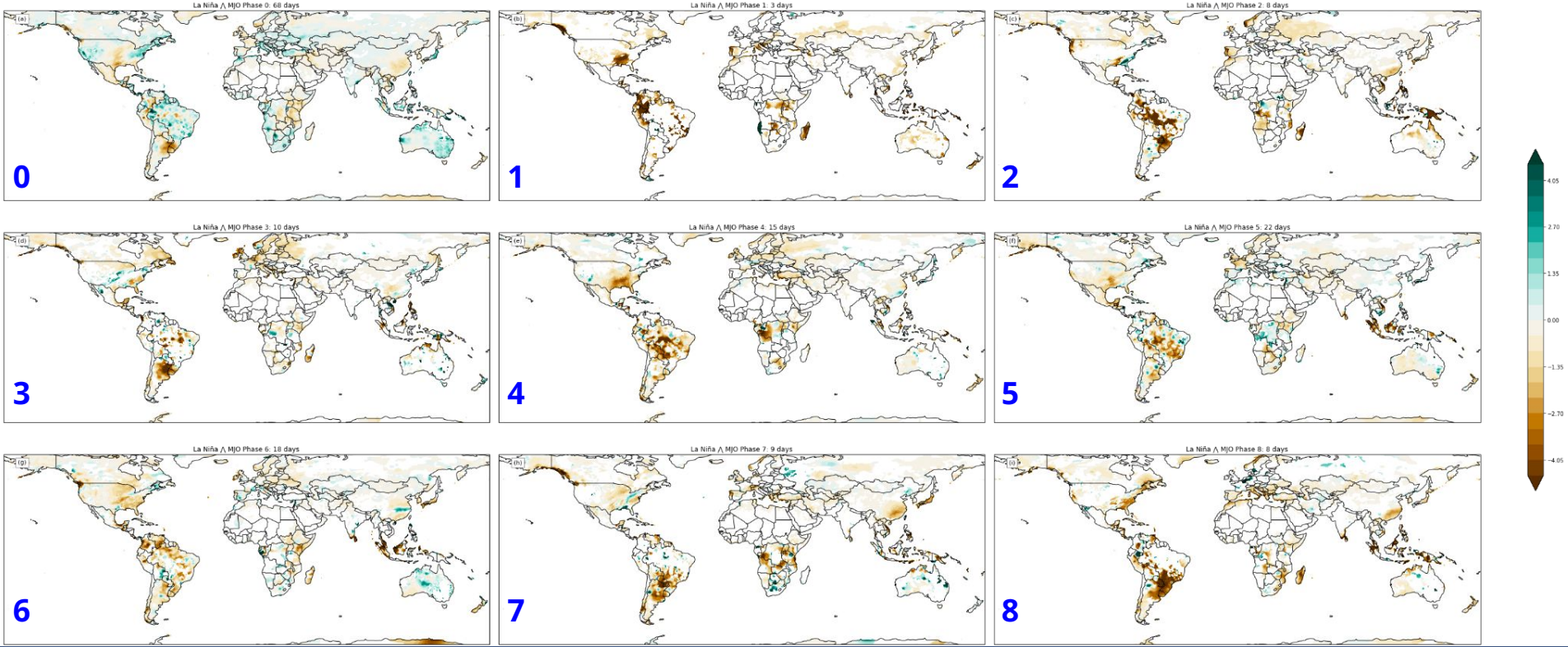
MJO Conditioned on El Niño



MJO Conditioned on Neutral



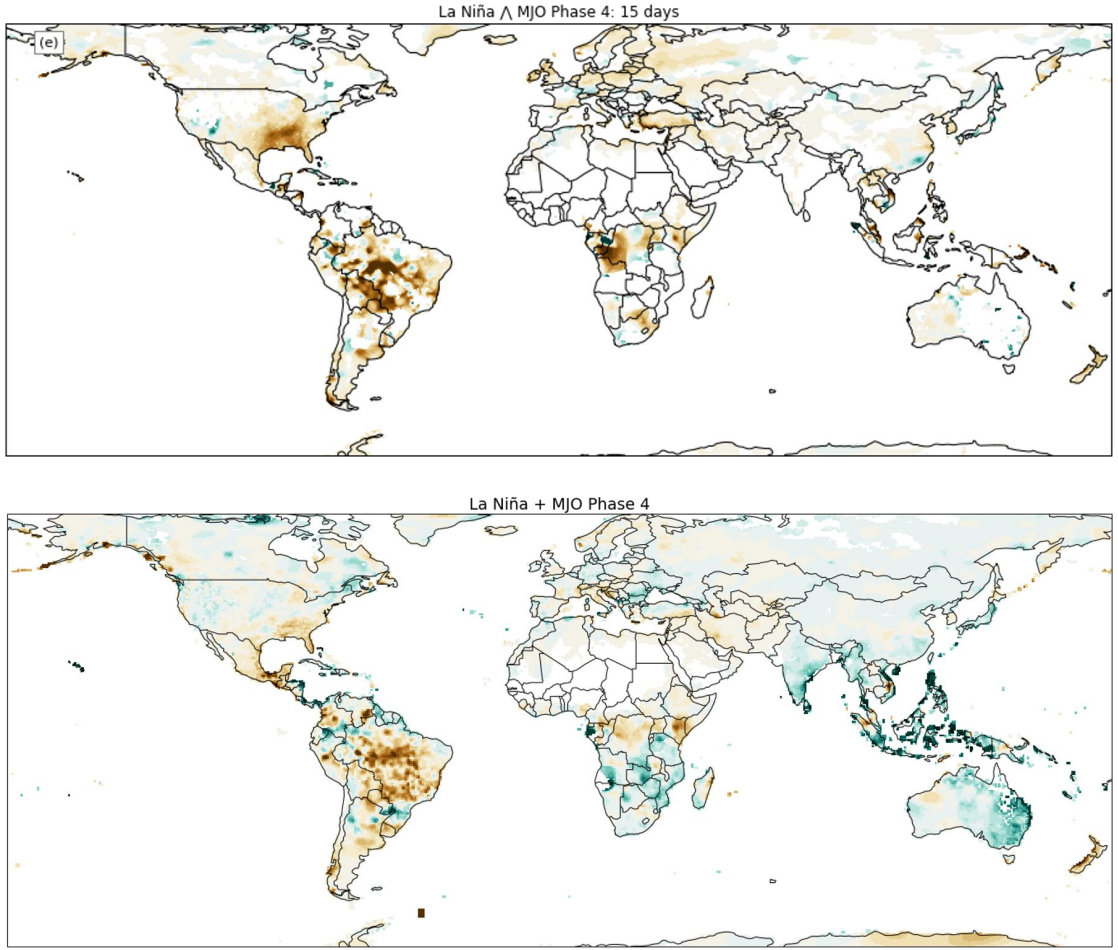
MJO Conditioned on La Niña



How do they amplify or attenuate one another spatially and temporally? (constructive vs destructive interference)

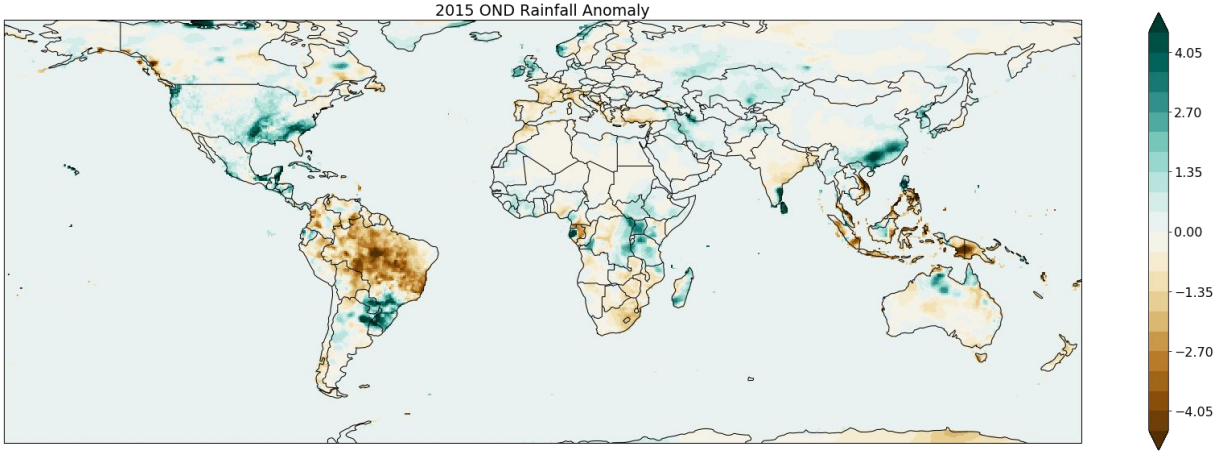
MJO Phase 4 Conditioned on La Niña

MJO Phase 4 + La Niña

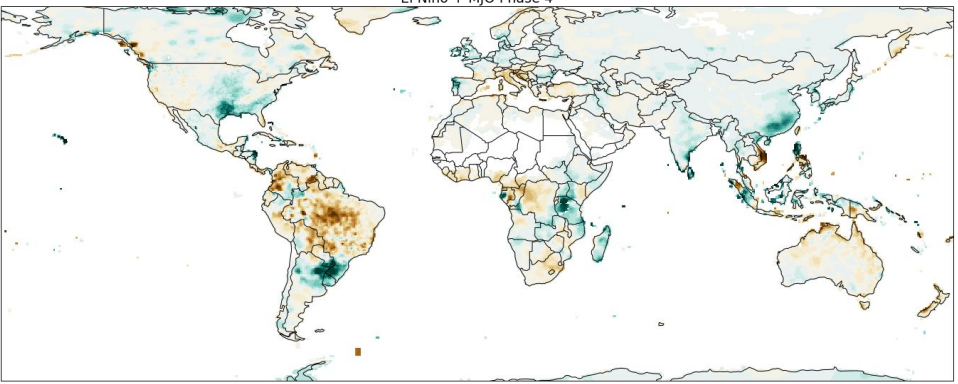


We can take this a step further...

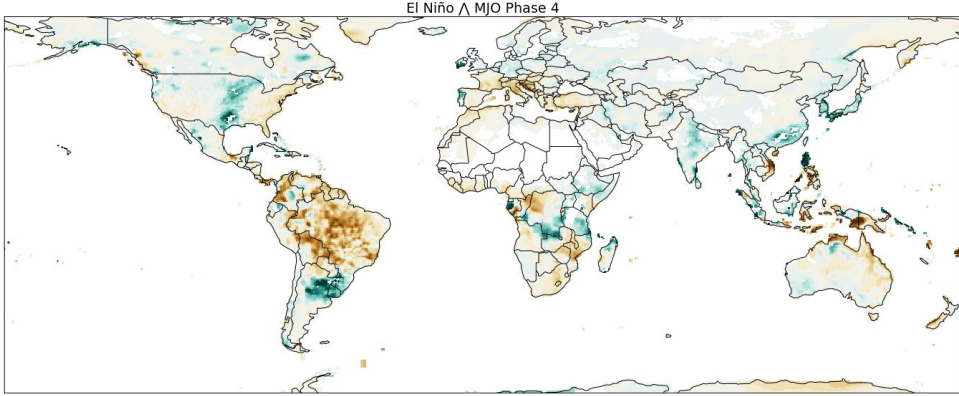
Observed Rainfall OND 2015



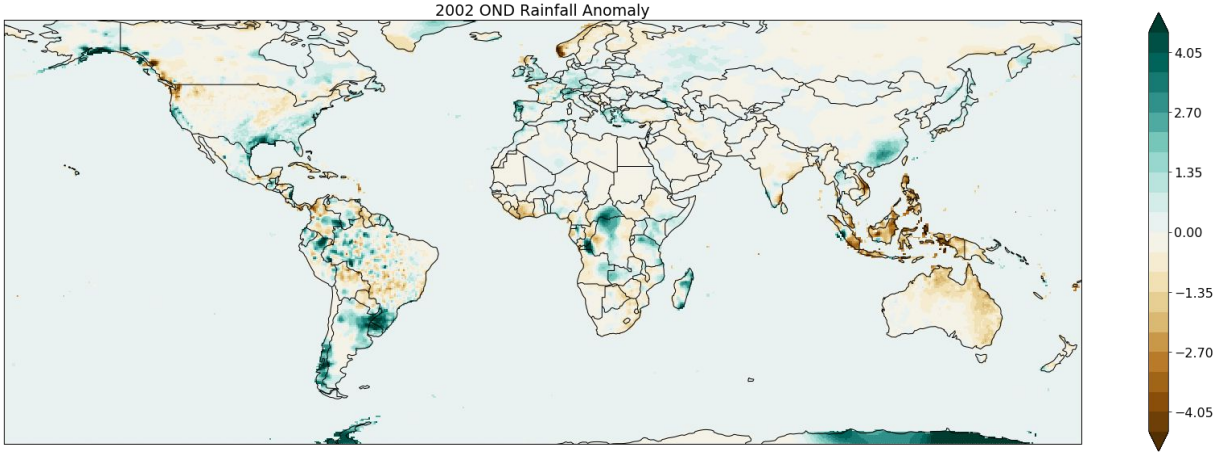
Linear Superposition



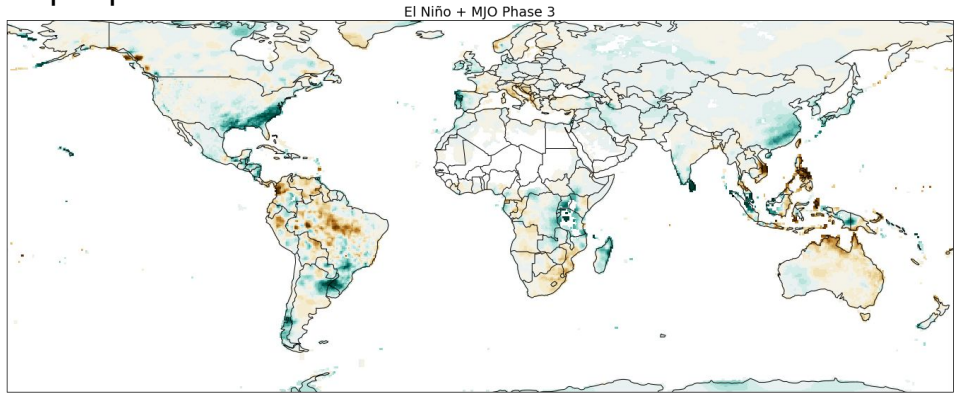
General Superposition



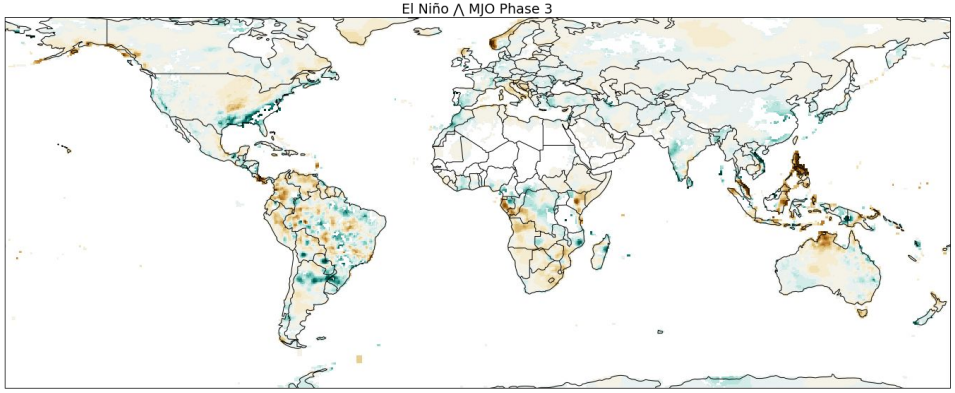
Observed Rainfall OND 2002



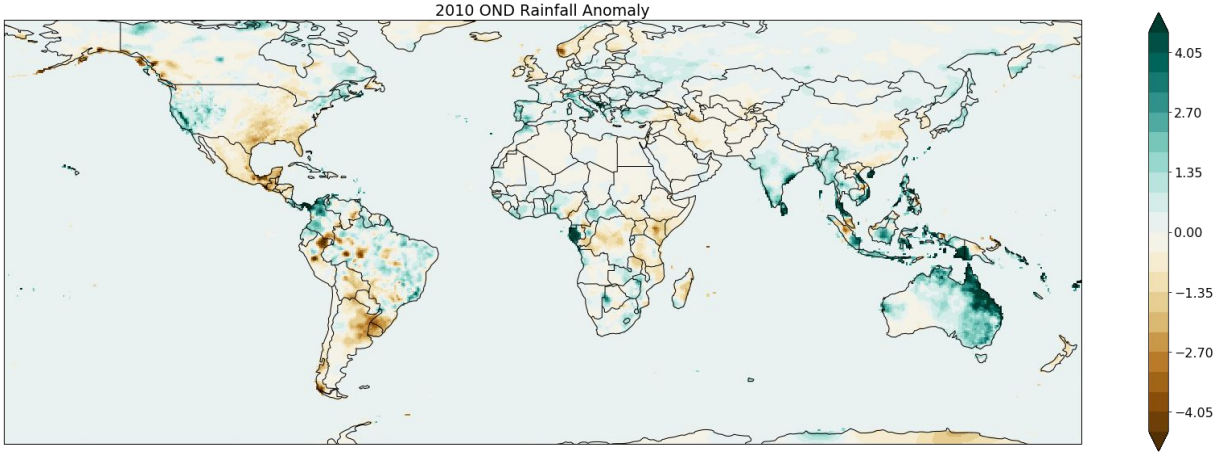
Linear Superposition



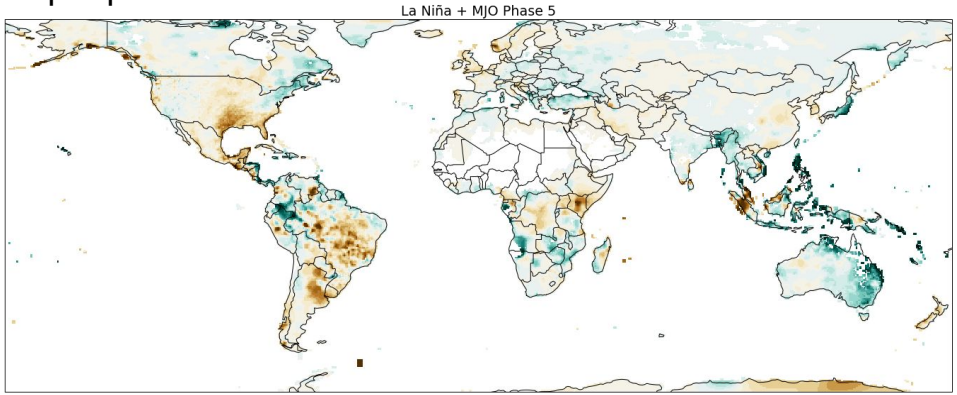
General Superposition



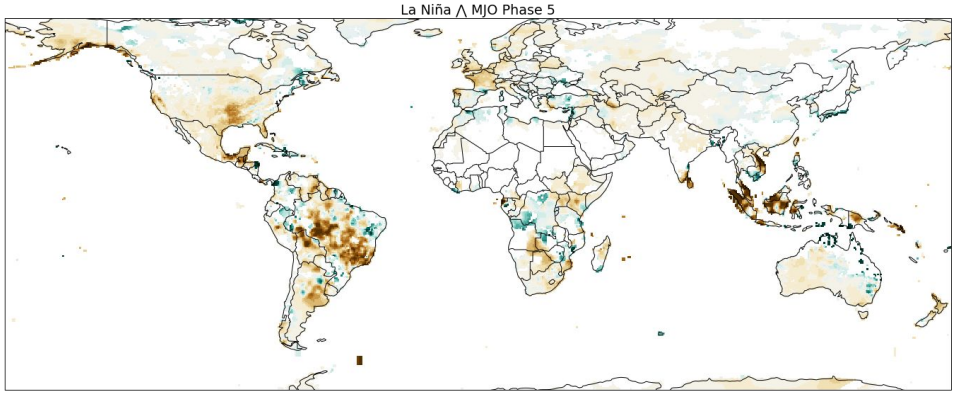
Observed Rainfall OND 2010



Linear Superposition



General Superposition



NENSIC (New Era Network For Societally Integrated Climatology)

Nensic.org | Slack |Mailing List | Calendar

Thanks!

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