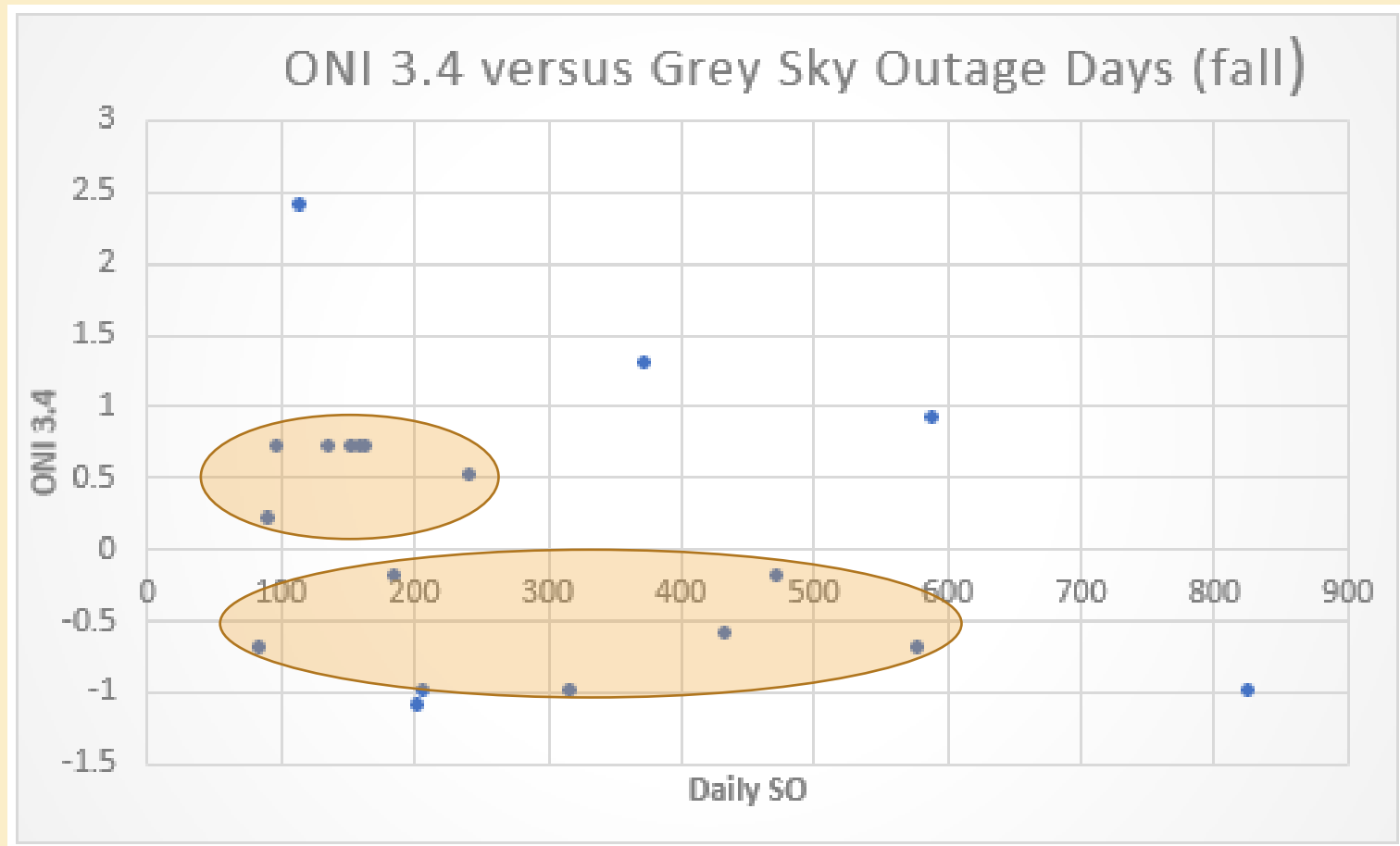




**A quick look at**

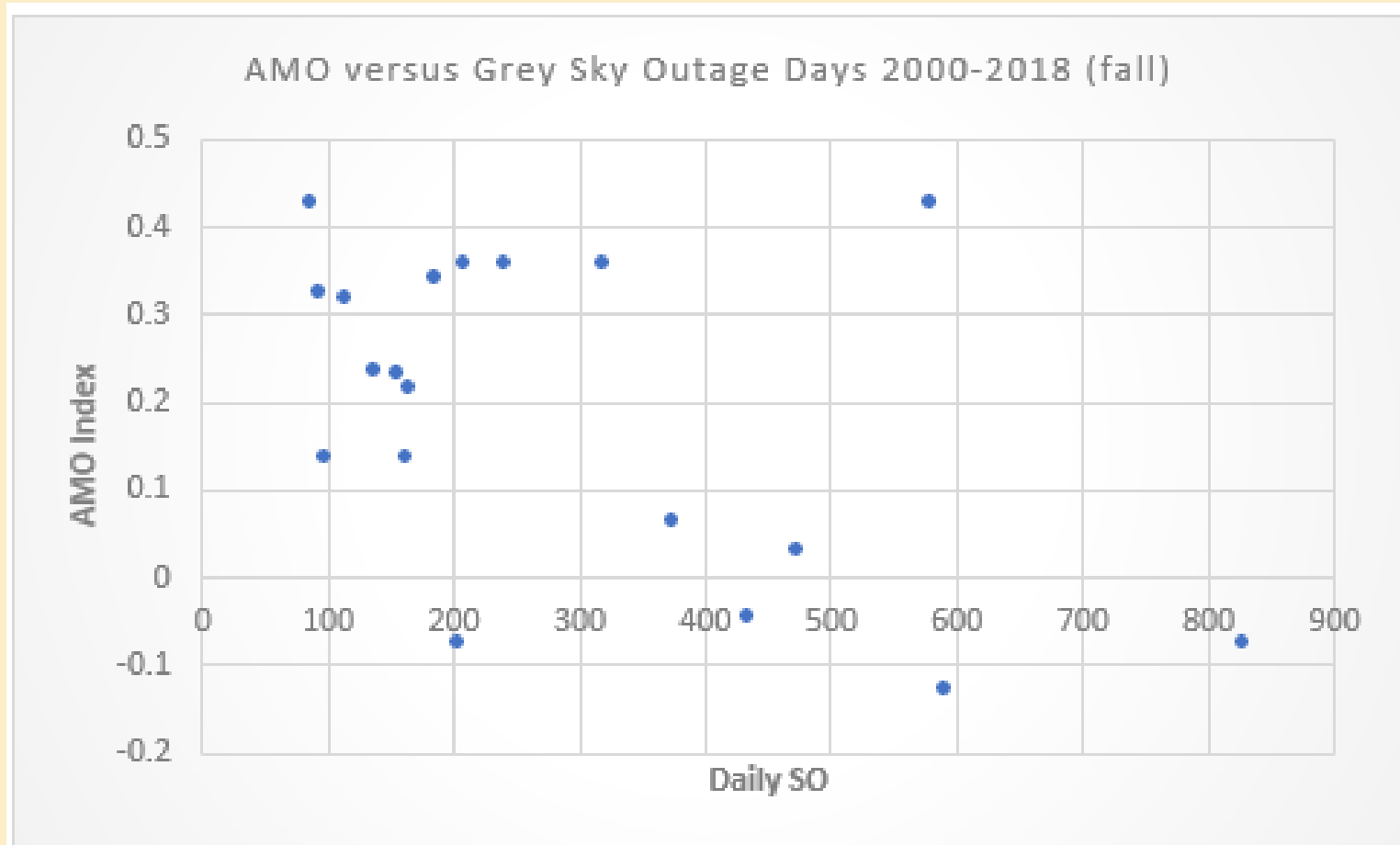
# **Atmospheric Teleconnections And Diablo Winds (2000-2018)**

# Oceanic Index 3.4



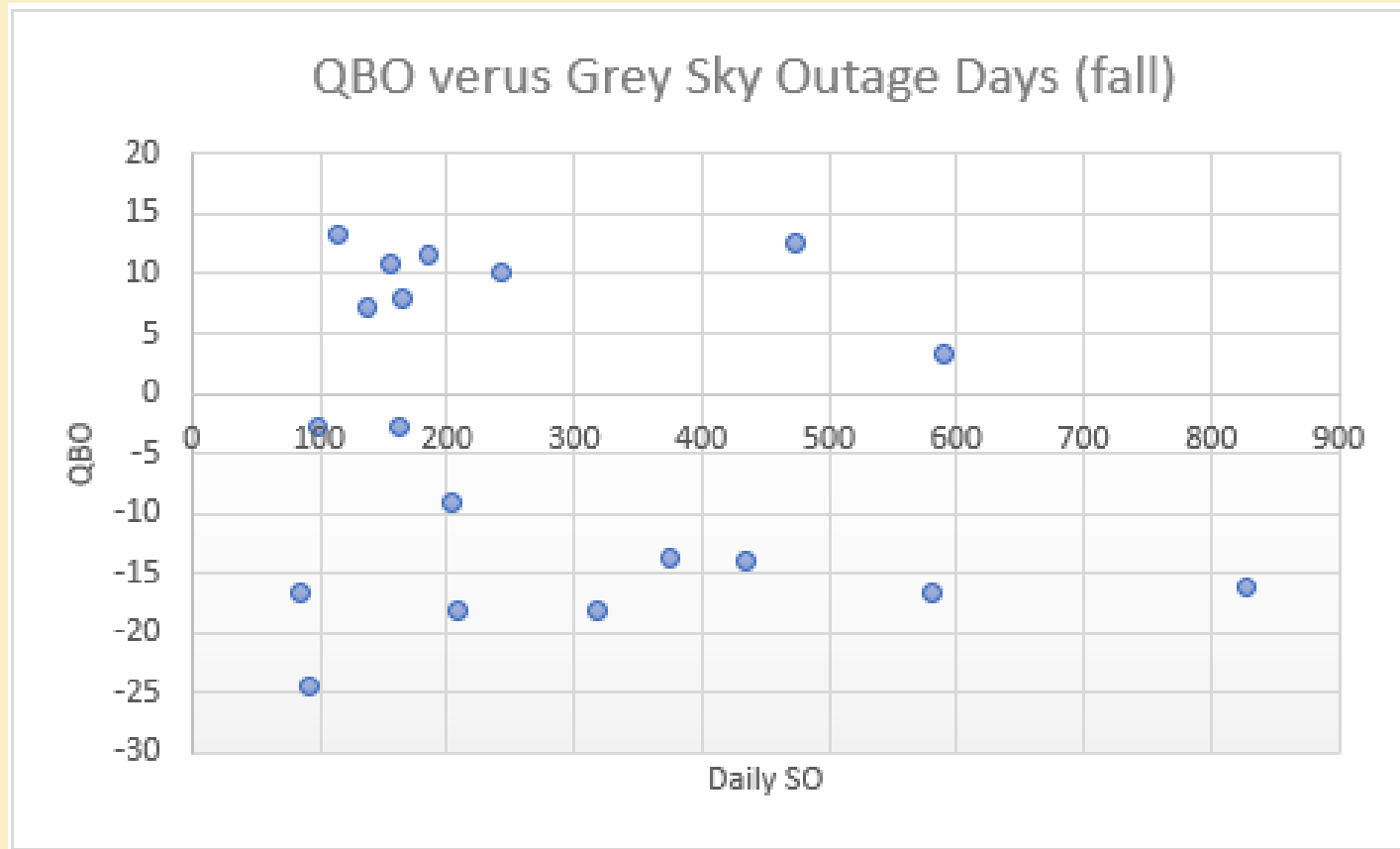
No notable association with ENSO and Diablo wind events. Diablo winds occurred during all phases and varying strengths except strong La Nina (2010). The majority of the cases were when the index was weak (shaded), although that is not significant as the majority of the past 20 ENSO autumns (SON) were in the weak designation with only 5 of 20 years moderate or strong in strength.

# Atlantic Multidecadal Oscillation (AMO)



The vast majority of Diablo wind events occurred during a positive (warm) AMO base state. However, that is not statistically significant as the vast majority of the past 20 years (16 of 20) had a positive AMO during autumn.

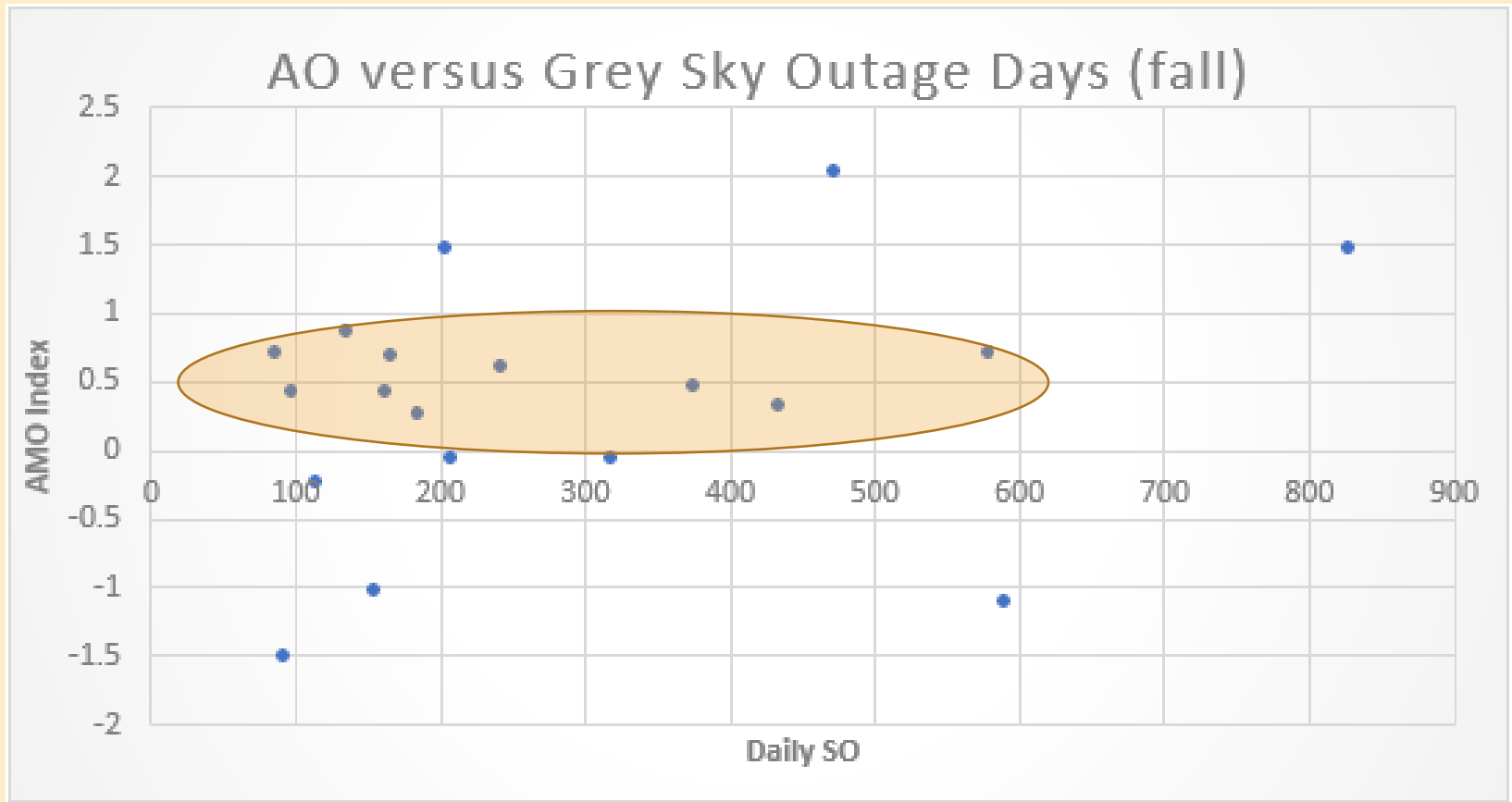
# Quasi-biennial Oscillation (QBO)



No notable association with QBO and Diablo wind events on a seasonal scale. Strong Diablo wind events occurred in both positive and negative phases of varying strengths.

\* The Quasi-biennial Oscillation (**QBO**) is a tropical, lower stratospheric, downward propagating zonal wind variation

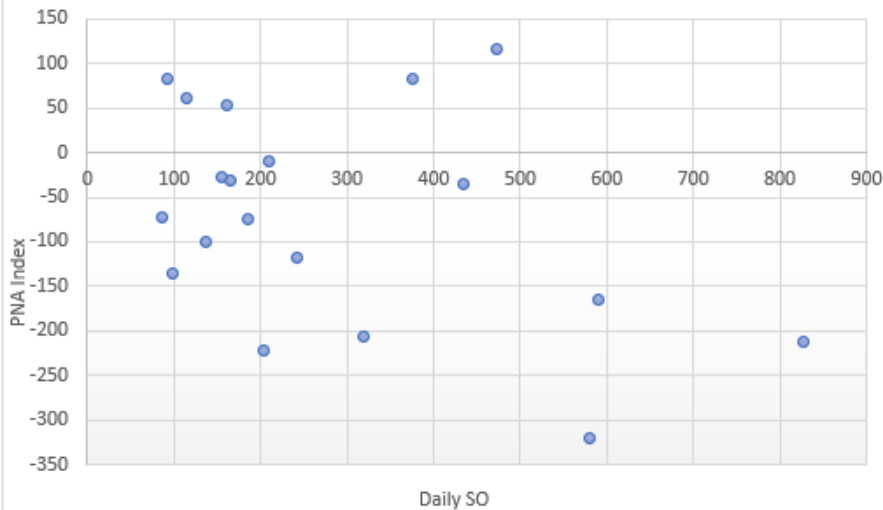
# Arctic Oscillation (AO)



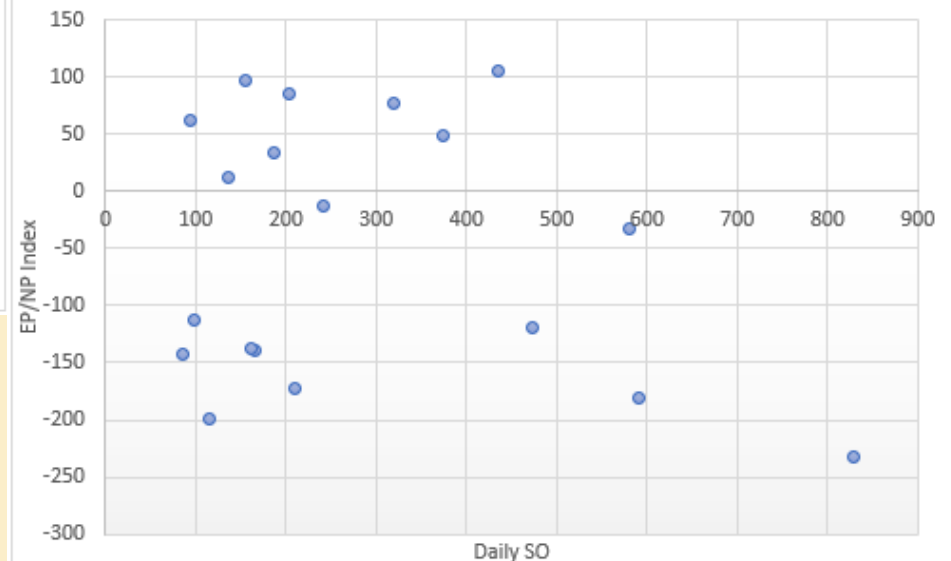
No strong association with AO and Diablo wind events as they have occurred under varying strengths and sign. However, more than half of the cases (10 of 19) were when the index was weak positive (shaded).

# PNA and EP/NP

PNA versus Grey Sky Outage Days (fall)

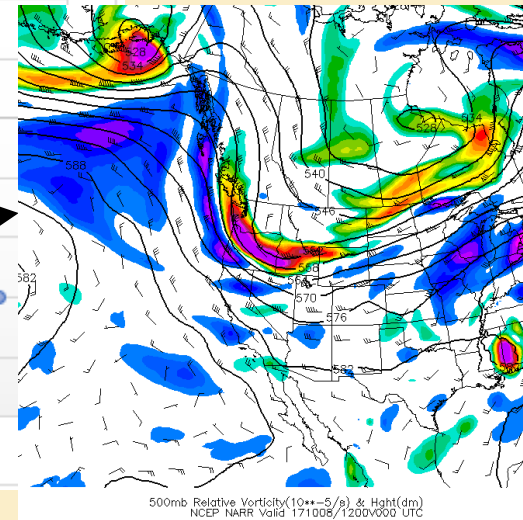
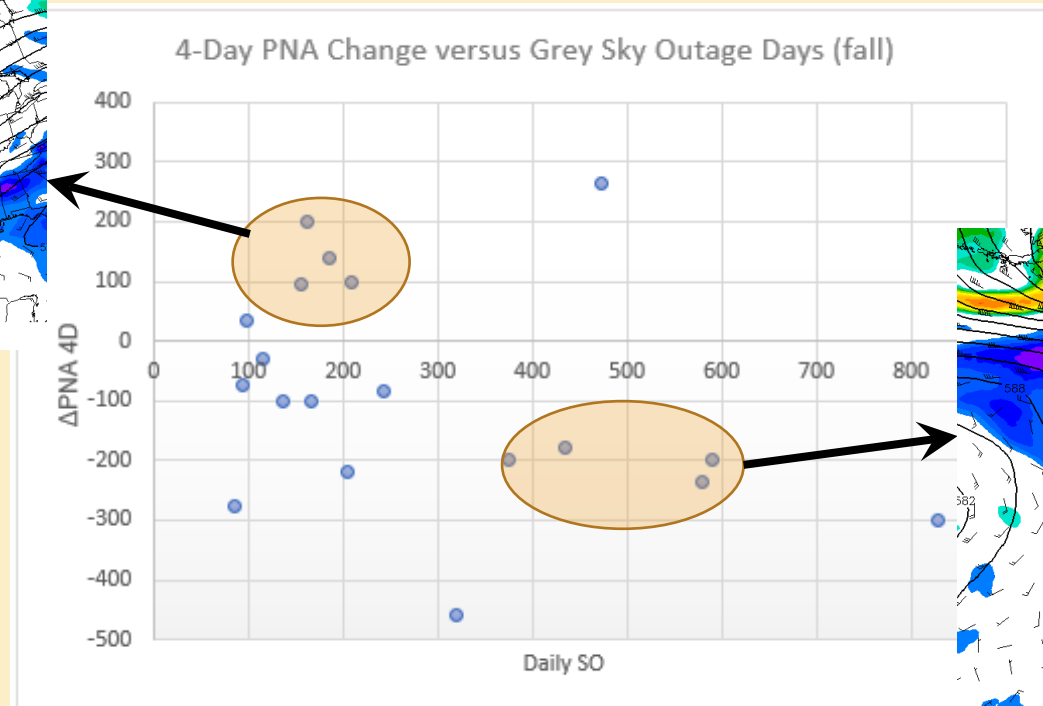
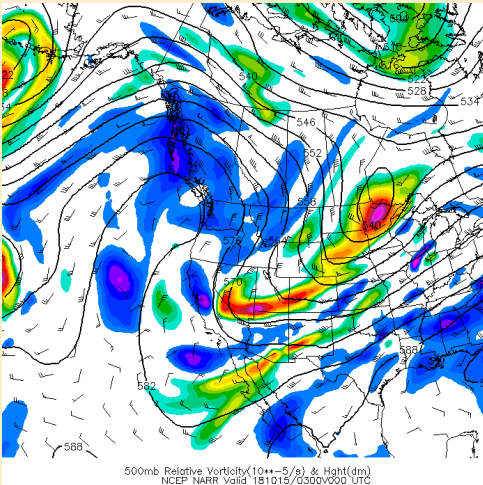


EP/NP versus Grey Sky Outage Days (fall)



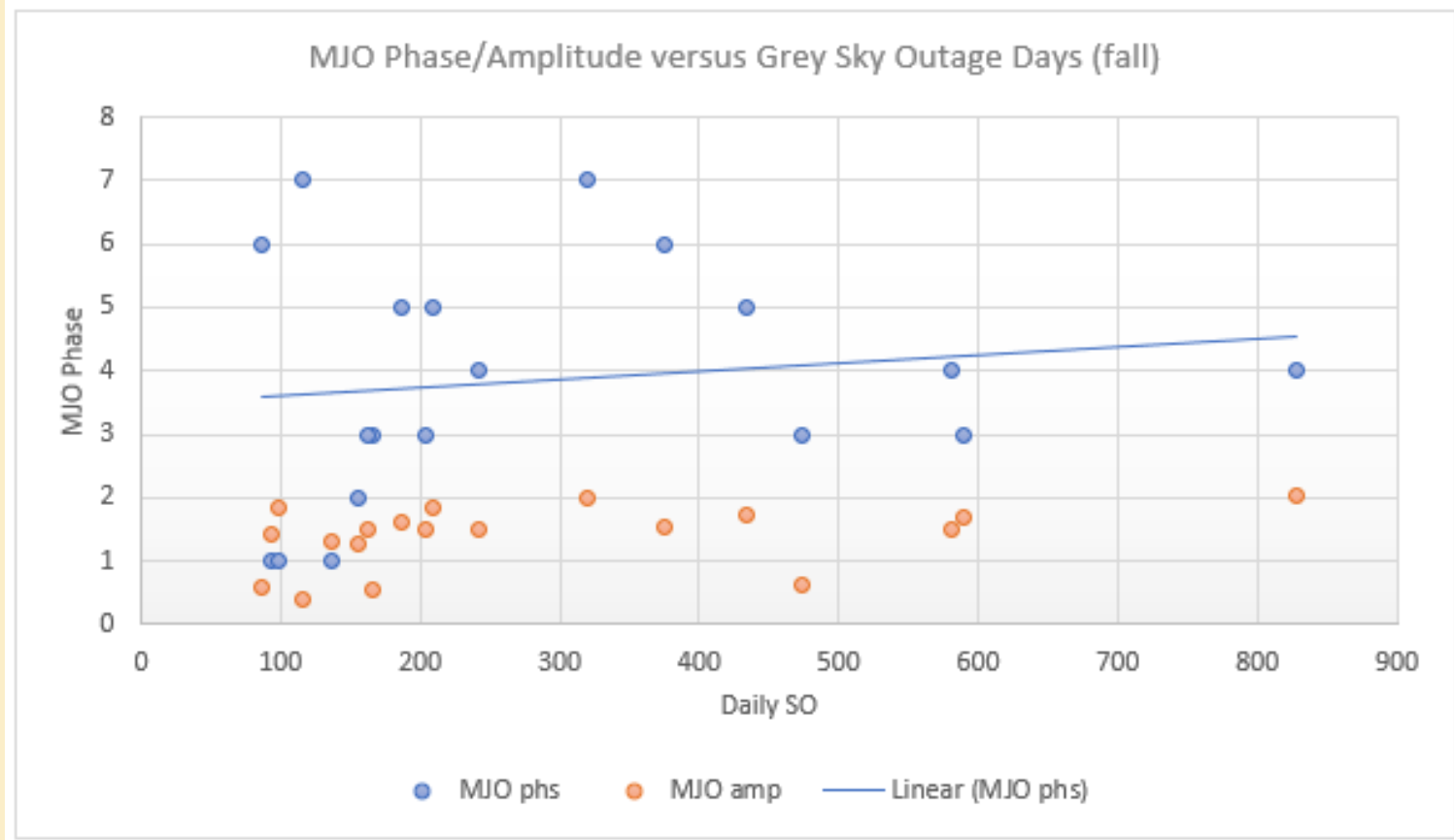
There is no notable relationship between PNA and EP/NP and Diablo wind events as they have occurred in both the positive and negative phases for both indexes, although there is a slight lean toward negative indexes, primarily PNA. Also, there were more stronger negative events versus stronger positive events.

# PNA 4-day Change



The 4-day change in the PNA index leading up to an event showed a negative decrease in most events, especially the stronger events. This makes sense since there is usually a high pressure ridge in place in the Interior West prior to an event (positive PNA) before a trough develops in the Western US (negative PNA) associated with that first inside slider (image on right). The positive PNA trend events are associated with the “multiple” event scenario where the trough is already in place across the western US (and possibly already an event) and a high pressure ridge builds into CA after the passage of the final inside-slider (upper-left image).

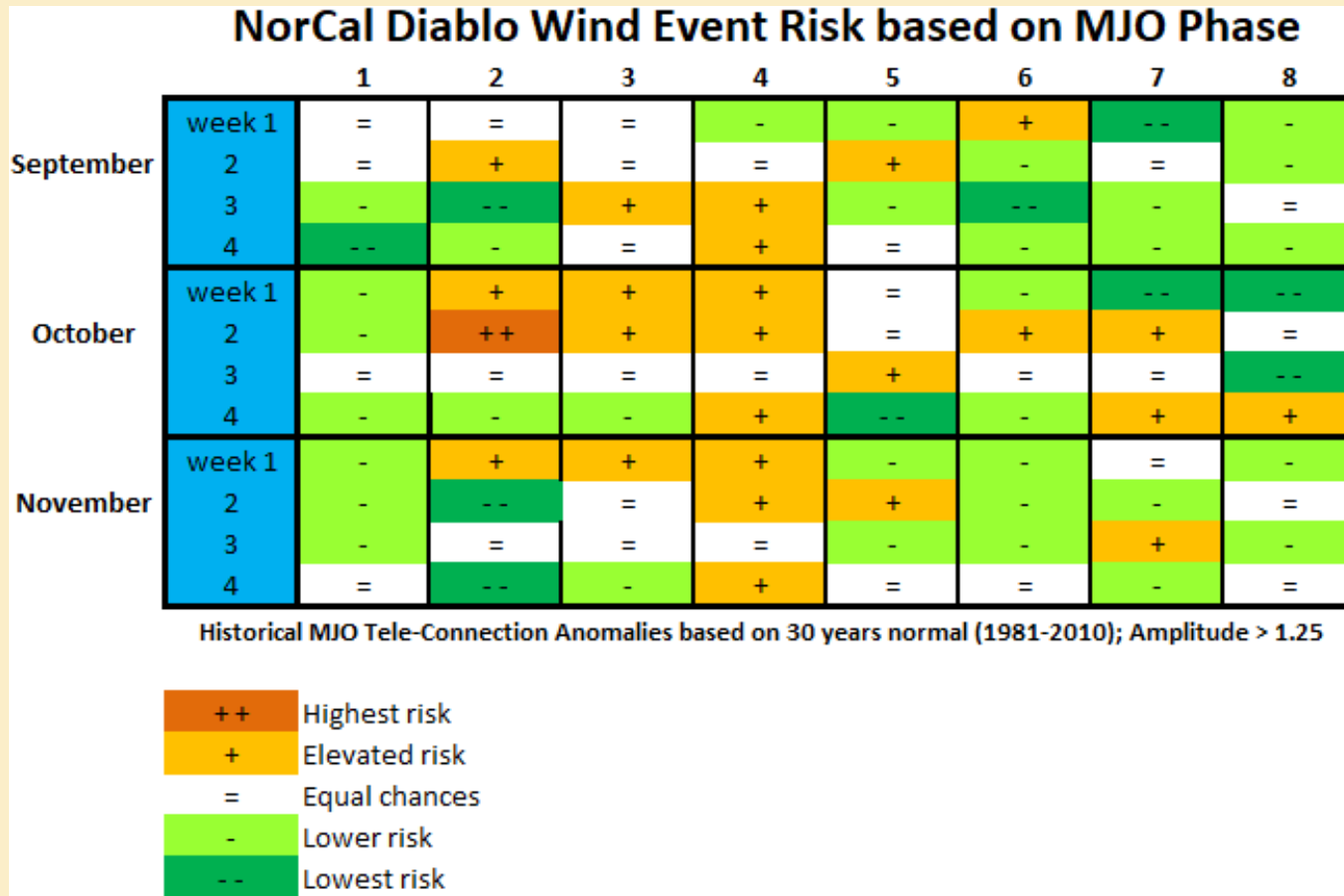
# Madden-Julian Oscillation



The MJO may be our best tool for forecasting DWEs in the weeks 2-4. Looking at the chart above for fall/autumn, there is a slight trend with higher incidences in phases 3-5, but there were cases in all phases except 8. The mid-latitude loading pattern associated with the effects of the MJO is seasonal, hence why the CPC breaks up the temperature/precipitation composites into 12 separate 3-month bins



# Madden-Julian Oscillation

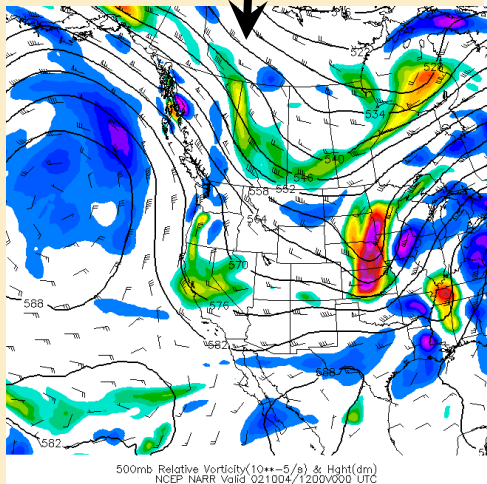


Atmospheric circulations that would support Diablo winds in Northern California show varying levels of predictability in the historical MJO analog database (a tool provided by Maxar, Inc). Each week was assigned a risk based on the inferred loading pattern using 5 levels of risk—highest, higher, equal chances, lower, and lowest. \*\*statistical significance is not included in the tool

# Madden-Julian Oscillation

Phases 3 and 4

Date	Result
10/3-10/7-2000	False Alarm
10/1-10/6-2001	Weak Match
10/1-10/6-2002	Match
10/1-10/3-2004	Weak Match
10/9-10/16-2005	Match
10/10-10/16-2008	Match
10/1-10/6-2009	Match
10/3-10/7-2012	Match
10/6-10/11-2017	Match
10/8-10/16-2018	Match



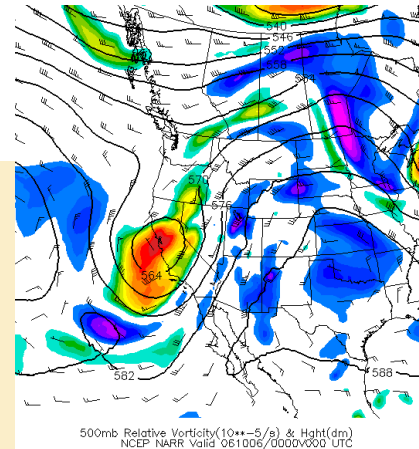
10/4/2002 Phase 3

NorCal Diablo Wind Event Risk based on MJO Phase

		1	2	3	4	5	6	7	8
September	week 1	=	=	=	-	-	+	-	-
	2	=	+	=	=	+	-	=	-
	3	-	-	+	+	-	-	-	=
	4	-	-	=	+	=	-	-	-
October	week 1	-	+	+	+	=	-	-	-
	2	-	++	+	+	=	+	+	=
	3	=	=	=	=	+	=	=	-
	4	-	-	-	+	-	-	+	+
November	week 1	-	+	+	+	-	-	=	-
	2	-	-	=	=	+	-	+	-
	3	-	=	=	=	-	-	+	-
	4	=	-	-	+	=	=	-	=

Historical MJO Tele-Connection Anomalies based on 30 years normal (1981-2010); Amplitude &gt; 1.25

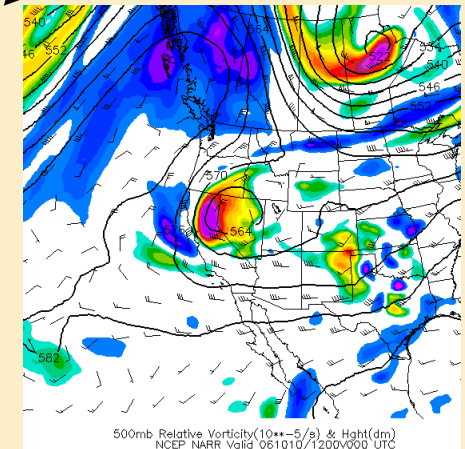
++ Highest risk  
+ Elevated risk  
= Equal chances  
- Lower risk  
-- Lowest risk



10/5/2006 Phase 6

Phases 6 and 7

Date	Result
10/4-10/11-2006	Match
10/1-10/9-2011	Match
10/1-10/10-2012	Weak Match
10/5-10/12-2013	Match

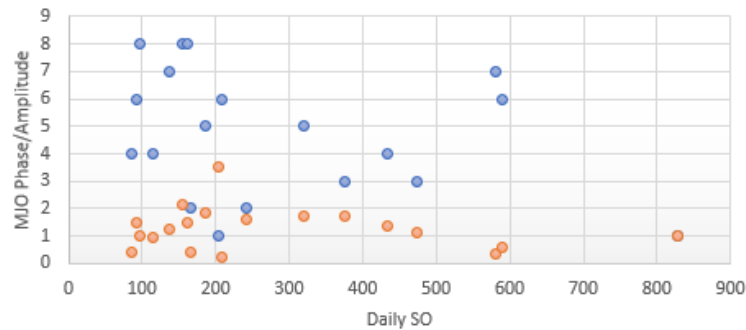


10/10/2006 Phase 7

Hindcast verification of the risk tool showed some skill at predicting Diablo wind events. Four time periods that were examined showed a 60-75% success rate. Two of those hindcast periods during the highest climatological risk period October 1 – 15 are shown in this slide.

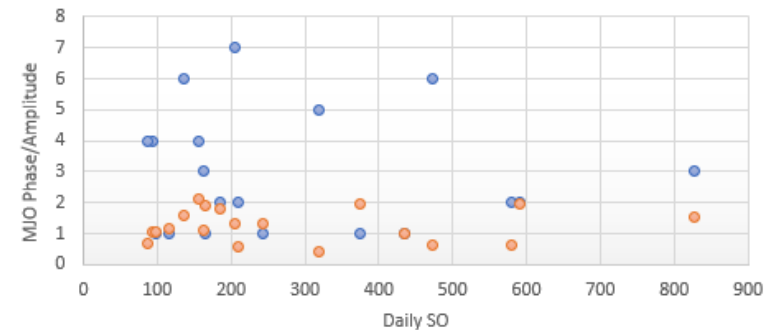
# MJO Lag 2 - 4

MJO Lag 2 versus Grey Sky Events



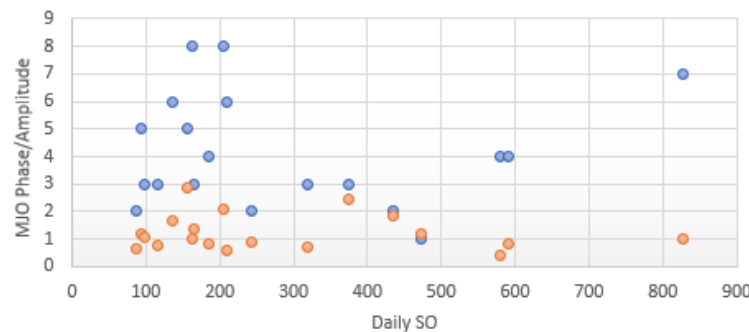
● wk 2 lag ph ● wk 2 lag amp

MJO Lag 4 versus Grey Sky Events



● wk 4 lag ph ● wk 4 lag amp

MJO Lag 3 versus Grey Sky Events

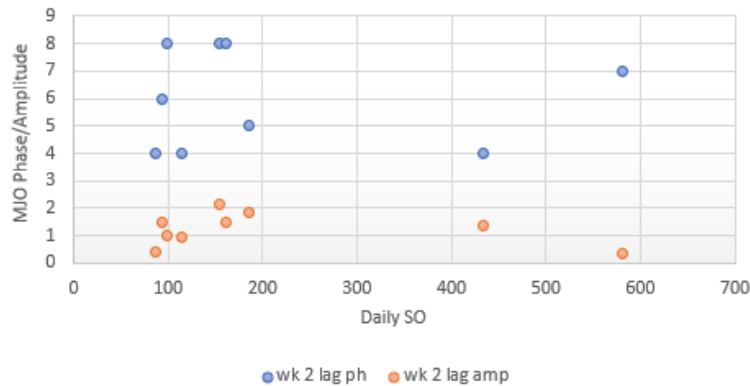


● wk 3 lag ph ● wk 3 lag amp

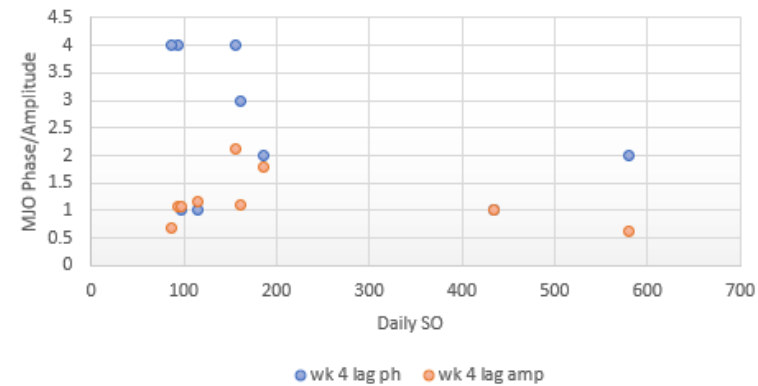
The MJO composites at the CPC also include lagged composites based on the Wheeler and Hendon Diagram phase and sorted by 3 month bins. They also present masked composites significant at the 95% level. Looking at just the raw days for Grey sky events show no notable associations between lag and Diablo wind events

# MJO Lag 2 – 4 (October)

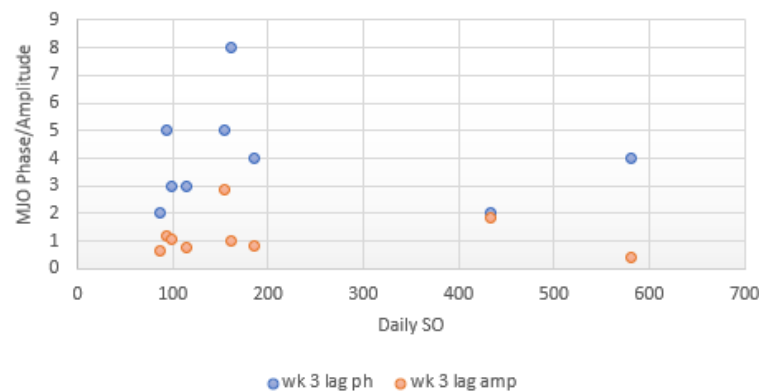
MJO Lag 2 versus Grey Sky Events (October)



MJO Lag 4 versus Grey Sky Events (October)

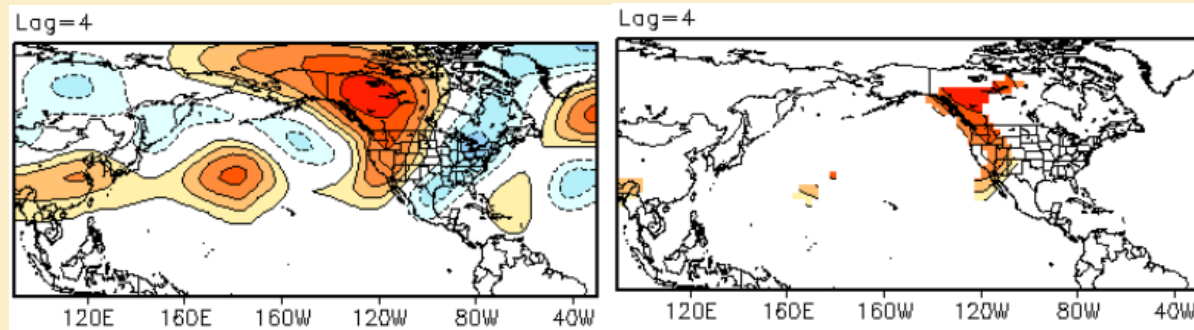
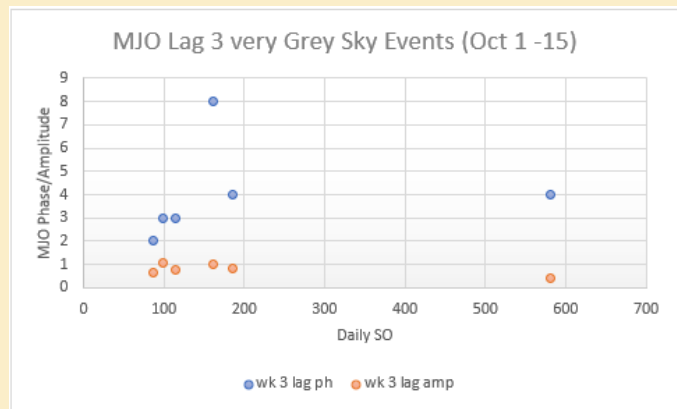
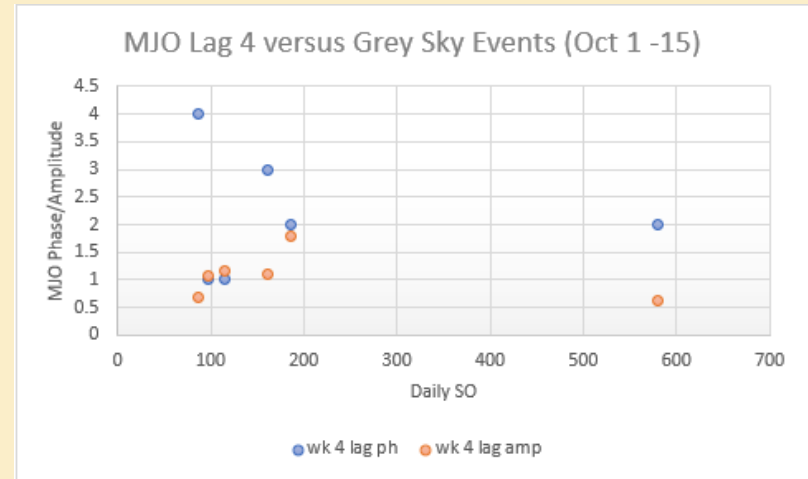
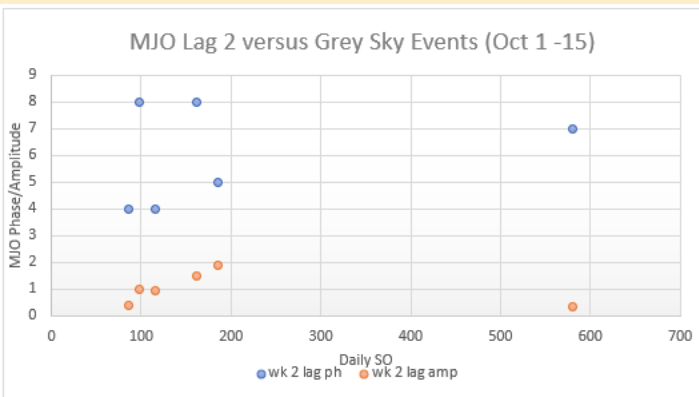


MJO Lag 3 versus Grey Sky Events (October)



Since MJO is seasonal, cases were reduced to just October and it still shows no notable associations between lag and Diablo wind events

# MJO Lag 2 – 4 (October 1 -15)



Reducing cases to just the first half of October, there is still no notable associations between lag and Diablo wind events except a weak link for lag 4 where all cases were phases 1-4, although the number of case is small. This makes sense when looking at the CPC [masked composites](#) that show very few areas with statistical significance at the 95% level and one case that does is phase 4 lag 4 SON that supports ridging in the interior West (images above)

# Key Points

- No strong associations between oceanic forcing (ENSO, AMO) and Diablo Wind Events on a seasonal scale
- No correlation between QBO and Diablo winds on a seasonal scale
- A weak association with the Arctic Index and Diablo winds as more than half have of cases occurred when the index was weak positive and only three were negative
- No notable associations between PNA/EP and Diablo wind events; a weak association was noted with 4-day change in the PNA index
- MJO showed some skill at predicting Diablo wind events based on phase and a stronger amplitude ( $>1.25$ )
- No notable skill was shown using lagged MJO composites except for a handful of potential scenarios (e.g. ph 4, lag 4 SON)

\*Daily SO = Total number of daily Sustained Outages

\*\*Grey Sky = Any day where the number of weather related outages is impactful