

## INTRODUCTION

- Atmospheric rivers (ARs) are long narrow corridors of enhanced integrated water vapor (IWV) and water vapor transport (IVT) which often produce high-impact events associated with extreme precipitation and flooding (Fig. 1)
- Middle-tropospheric geopotential height anomalies observed over Western and Eastern North America are characterized by Pacific North American (PNA) pattern whereby a positive phase of PNA describes positive anomalies over Western North America and negative height anomalies over Eastern North America; negative phase is approximately opposite (Examples in Fig. 2)
- Objective is to investigate large-scale regime transitions over North Pacific and North America via PNA and frequency of ARs along North American West Coast (NAWC)

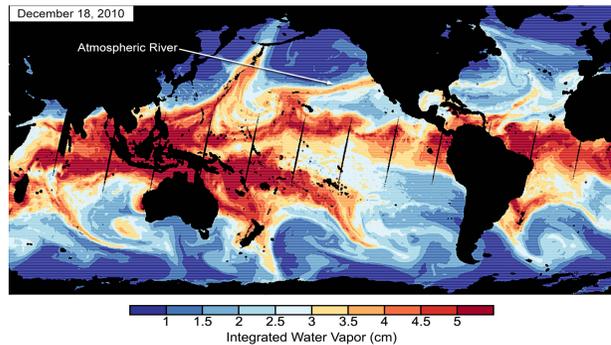


Figure 1: Example of an atmospheric river event occurring in December 2010 and making landfall over the Southern Californian coast

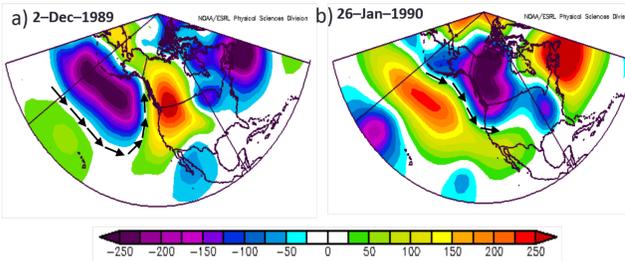


Figure 2: 500hPa geopotential height anomalies representative of a) positive and b) negative PNA regime configurations; approximate mid-tropospheric flow affecting NAWC is denoted by black arrows. Note that a positive PNA phase results in ridging over Northeast Pacific coastal regions while a negative PNA phase results in troughing over a similar area.

## METHODOLOGY

- Choose 22 locations along NAWC
- Cross reference NCEP-NCAR reanalysis-derived sub-daily IVT magnitudes from an AR catalog developed by J. Rutz (NWS WRHQ) and archived daily PNA index values from NOAA Climate Prediction Center (1950–2015)
- Regime transitions over Northeast Pacific defined as a  $\geq 1$  standard deviation change in PNA index value over 7 days that spans +0.5 to -0.5 or vice versa during Dec, Jan, & Feb
- Generate time-lagged composite time series of PNA transition events and determine likelihood of landfalling AR event at each location from 5 days before to 10 days after beginning of a regime transition
- Statistical significance explored using z-score at 95% confidence level (not shown; included in M.S. thesis)

## RESULTS

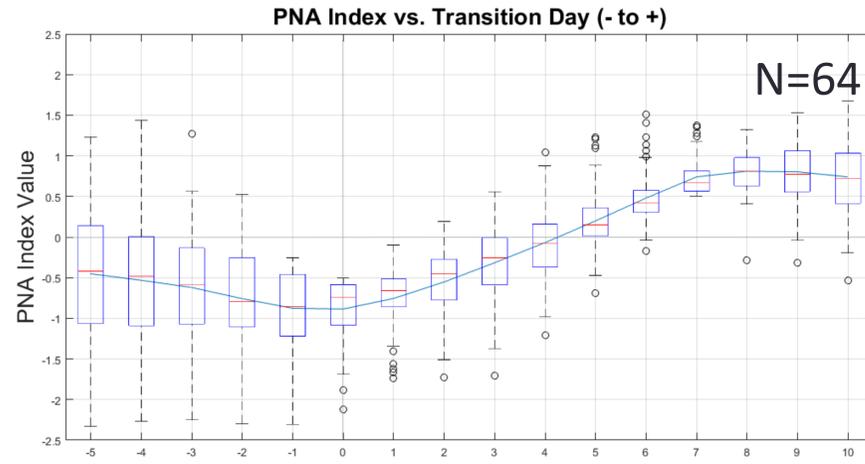
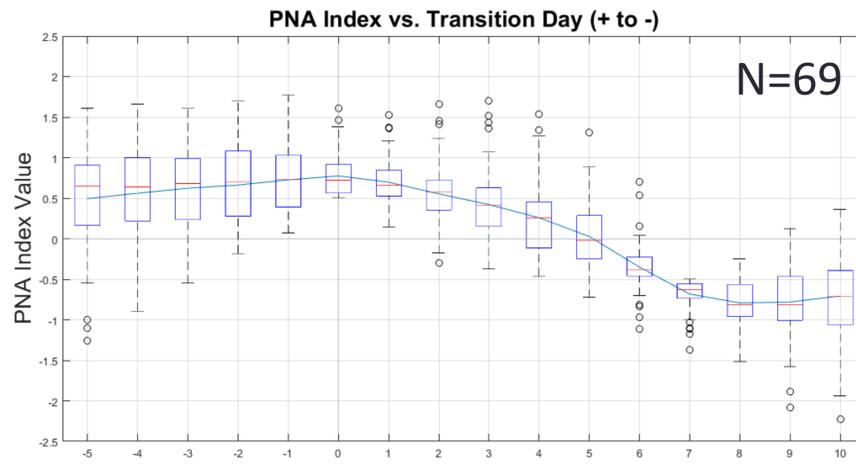


Figure 3 (left): Time-lagged composite time series of the PNA index for transitions as described by the methodology. Box and whiskers represent inner-quartile range and 5/95%, respectively. Outliers are given by circles.

Probability of AR Landfall vs. Day of PNA Transition (+ to -)

Transition Day / Latitude-Longitude	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	+6	+7	+8	+9	+10
202.5°E 55°N	11	14	17	11	14	14*	17	19	20	26	13	21	11	17	13	11
205°E 55°N	16	21	14	13	16	19	17	19	19	26	19	20	11	19	10	16
207.5°E 55°N	20	19	14	19	10	20	23	19	20	23	14	17	10	17	13	16
210°E 57.5°N	10	24	20	19	10	20	20	21	24	16	10	11	10	9	7	6
212.5°E 57.5°N	13	29	21	16	19	23	21	17	21	13	13	9	6	9	7	7
215°E 57.5°N	13	30	21	17	19	29	23	17	21	13	13	9	6	7	9	6
217.5°E 57.5°N	13	24	26	20	23	21	17	17	21	11	11	6	9	9	6	4
220°E 57.5°N	16	19	21	20	23	17	19	14	17	13	7	7	7	10	4	1
222.5°E 57.5°N	14	16	21	26	20	20	13	9	14	11	3	4	3	4	6	1
225°E 55°N	19	29	27	26	26	30	23	24	23	13	9	6	10	11	7	7
230°E 52.5°N	21	26	31	24	24	21	26	19	21	19	10	9	7	11	11	9
230°E 50°N	24	31	34	26	33	19	39	13	23	16	16	17	11	17	17	17
235°E 47.5°N	33	24	29	17	21	20	20	20	14	24	9	17	9	16	16	24
235°E 45°N	24	27	30	14	19	21	19	21	14	20	14	16	10	19	20	23
235°E 42.5°N	23	20	26	20	16	19	13	19	20	16	14	11	10	20	17	20
235°E 40°N	30	13	19	17	9	16	9	14	17	17	23	14	10	21	19	20
235°E 37.5°N	30	16	17	11	11	10	9	19	9	19	20	13	19	16	13	17
237.5°E 35°N	24	14	13	13	6	9	4	4	16	16	19	17	10	11	14	6
240°E 32.5°N	9	4	11	6	6	3	6	3	13	10	17	13	10	16	11	6
242.5°E 30°N	4	6	1	1	3	7	3	1	7	4	14	20	14	23	16	3
245°E 27.5°N	4	3	1	1	3	1	6	6	7	11	11	17	13	20	14	10
247.5°E 25°N	11	1	3	6	4	3	3	7	9	14	4	16	16	11	13	17

Probability of AR Landfall vs. Day of PNA Transition (- to +)

Transition Day / Latitude-Longitude	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	+6	+7	+8	+9	+10
202.5°E 55°N	14	5	14	12	11	8	5	9	11	9	11	14	12*	14	9	9
205°E 55°N	14	5	14	12	9	8	3	11	11	8	14	18	12	14	14	11
207.5°E 55°N	12	15	8	8	14	9	6	9	8	9	14	14	17	20	14	14
210°E 57.5°N	6	11	3	9	8	6	6	3	8	8	14	15	20	17	14	17
212.5°E 57.5°N	9	6	3	6	6	5	6	11	9	17	21	18	15	21	18	15
215°E 57.5°N	9	5	2	6	8	3	6	6	6	9	14	17	20	12	24	24
217.5°E 57.5°N	14	5	0	6	3	3	5	6	3	9	11	14	24	15	15	23
220°E 57.5°N	8	6	2	5	2	6	5	5	6	5	12	15	23	14	21	18
222.5°E 57.5°N	8	8	0	2	2	8	3	5	3	5	8	21	27	15	20	12
225°E 55°N	14	9	6	12	6	5	6	8	12	12	21	33	23	30	32	20
230°E 52.5°N	18	9	11	8	9	6	8	15	18	14	24	30	27	20	24	27
230°E 50°N	20	15	15	9	9	6	11	18	21	21	18	33	29	21	30	24
235°E 47.5°N	14	12	20	11	17	14	18	14	27	18	33	24	27	23	26	15
235°E 45°N	15	15	21	18	24	12	20	15	26	18	23	29	27	24	23	20
235°E 42.5°N	15	21	24	18	21	12	17	14	26	20	23	17	20	23	18	12
235°E 40°N	12	30	29	18	21	15	15	18	35	24	18	23	21	11	24	8
235°E 37.5°N	18	23	24	18	20	21	11	20	23	30	11	26	9	11	20	8
237.5°E 35°N	15	17	11	17	23	17	15	18	15	15	14	15	11	8	6	17
240°E 32.5°N	11	12	15	15	14	15	17	14	8	6	11	5	8	3	8	9
242.5°E 30°N	15	14	8	12	18	15	14	9	6	9	11	2	3	5	5	9
245°E 27.5°N	12	14	5	9	11	9	8	11	9	2	8	8	3	5	5	6
247.5°E 25°N	18	14	14	11	12	14	8	9	5	2	5	6	3	3	5	9

Figure 4 (below): AR onset probability for locations along NAWC during PNA transition events (top) and composite PNA index value time series during sampled regime transitions (bottom). Color shading of individual cells denotes deviation from mean, hence blue shading represents below average probabilities and red shading represents above average probabilities.

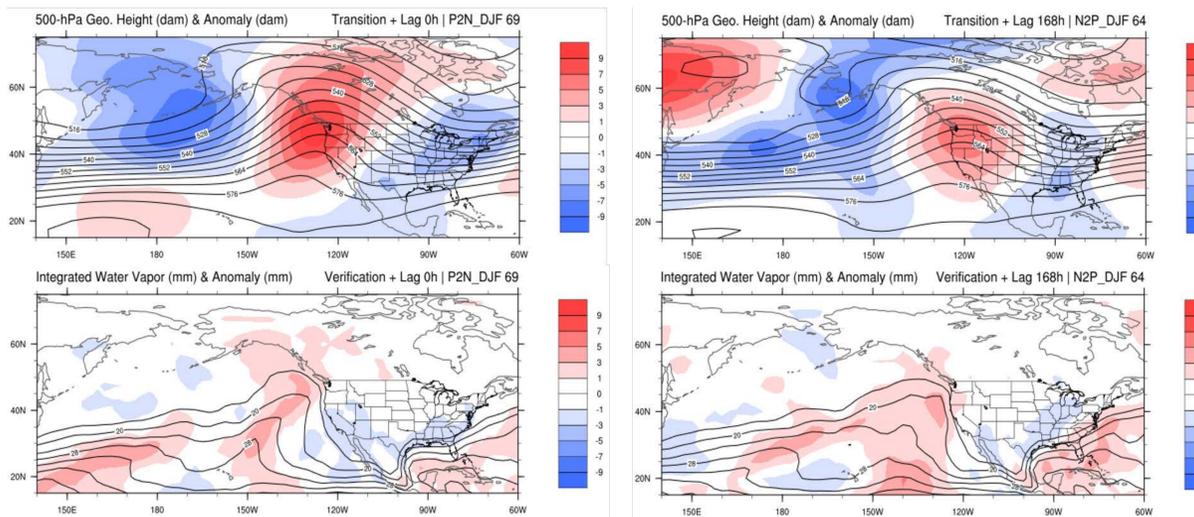


Figure 5: Composite 500hPa geo. heights (top row) and IWV (bottom row) on day 0 of positive to negative transitions (left) and day +6 of negative to positive transitions (right).

## DISCUSSION

### Positive-to-negative transitions:

- Increased likelihood of ARs along AK/BC between day -4 and day 0
- Decreased likelihood of ARs along BC between day +5 and day +10
- Decreased likelihood of ARs along So. CA and Mexico between day -4 and day +2

### For negative-to-positive transitions:

- Decreased likelihood of ARs along AK/BC between day -3 and day 0
- Increased likelihood of ARs along southern BC between day +6 and day +9

### Overall preliminary findings

- AR probabilities during transitions max out between 30–40%; additional research will investigate transitions that support landfalling ARs and those that don't
- Future work will investigate relationship between landfalling ARs and tropical phenomenon (such as QBO, MJO and ENSO) in conjunction with PNA transitions