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The spring transition of the North Pacific jet and its relation to deep stratosphere-to-troposphere mass transport over western North America

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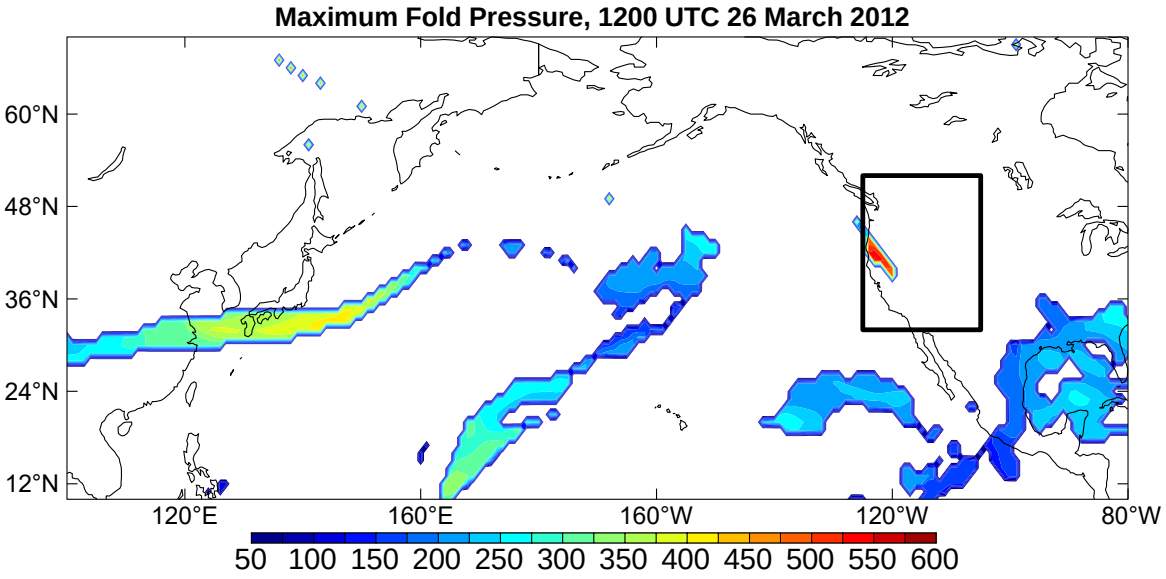
Supplementary Material



Maximum Fold Depth: 560 hPa

 # gridpoints with fold depth pressure greater than 400 hPa in boxed region: 13

 # gridpoints in boxed region: 441

Fold area: 3.0%

Figure S1: The color shading shows the maximum pressure associated with a tropopause fold, defined and tracked by Skerlak et al. (2015). Units are hPa. The black box denotes the region over which tropopause fold characteristics, including their maximum pressure, size, and frequency are considered.

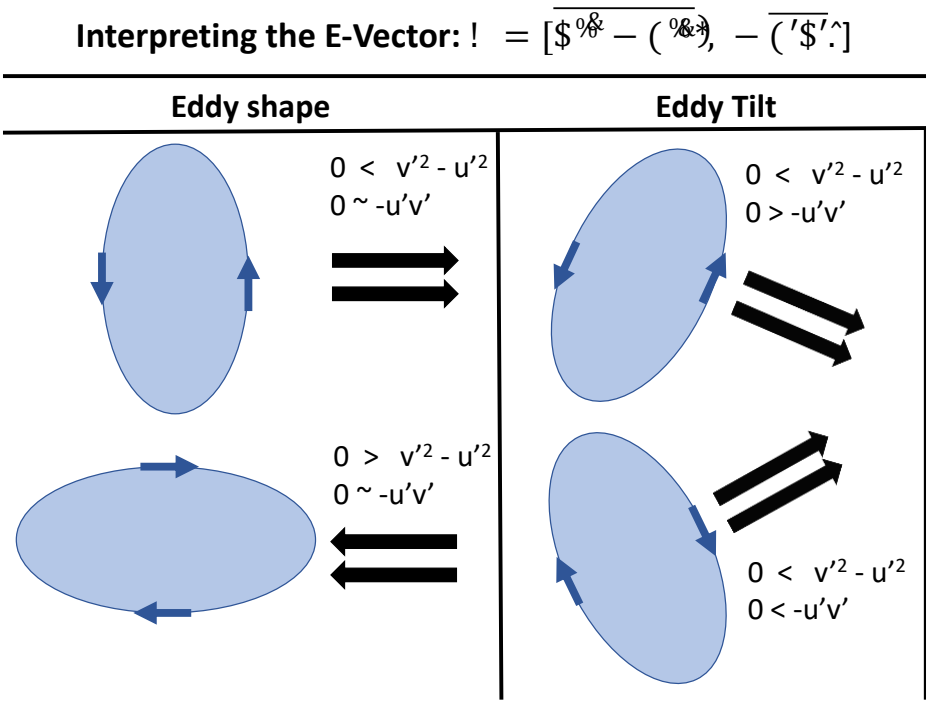


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Figure S2: Schematic for interpreting the horizontal components of E.

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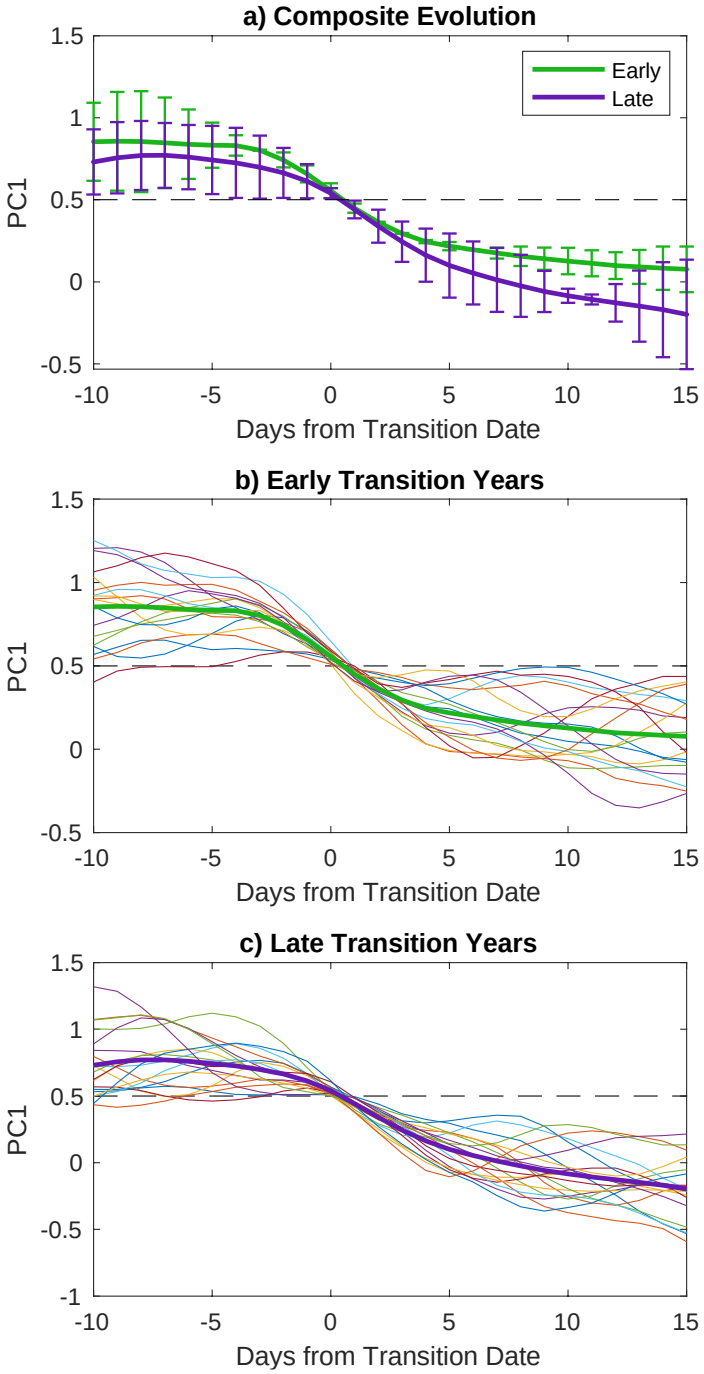

Figure S3: a) The green (purple) lines show the composite PC1 evolution for the early (late) transition groups, centered on the transition date (Day 0) each year. In panels b) and c), the thin lines show the evolution of PC1 each year for early and late years, respectively.

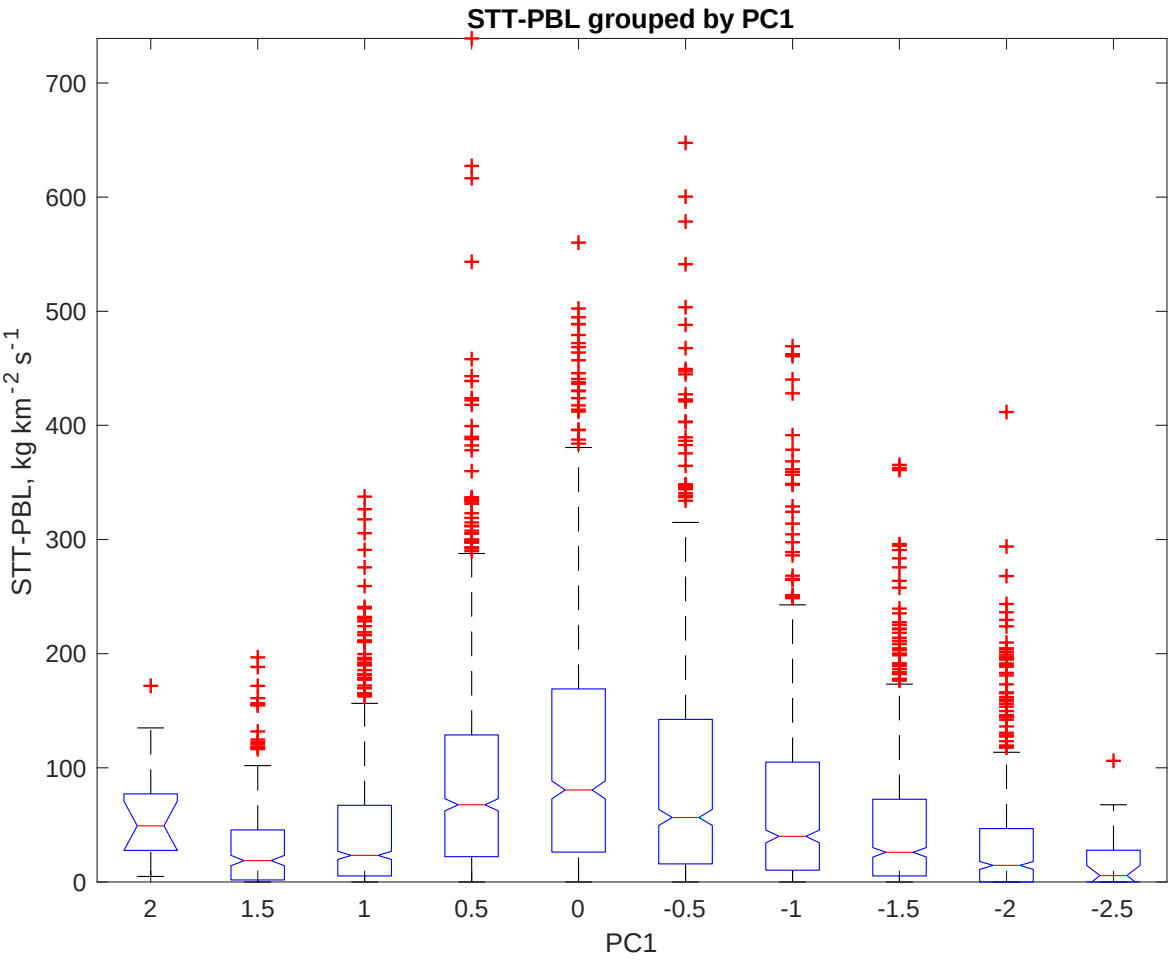

Figure S4: Distribution of STT-PBL over western North America binned by PC1 of 200-hPa zonal wind. The median STT-PBL for each bin is shown in the red line with confidence interval of the median indicated by the notches. The 25th and 75th percentile ranges are shown by the blue boxes. The red crosses denote outliers.

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Early Years Mean Transition Date: March 17	On Time Transition Years Mean Transition Date: April 4	Late Years Mean Transition Date: April 18
1981 (March 29)	1979 (April 3)	1983 (April 11)
1982 (March 25)	1980 (April 3)	1987 (April 13)
1985 (March 3)	1984 (April 3)	1990 (April 20)
1989 (March 28)	1986 (April 4)	1992 (April 22)
1991 (March 25)	1988 (March 31)	1993 (April 26)
1999 (March 9)	1994 (April 8)	1995 (April 16)
2000 (March 23)	1998 (April 5)	1996 (April 18)
2002 (March 27)	2001 (April 4)	1997 (April 25)
2008 (March 16)	2003 (April 2)	2004 (April 14)
2009 (February 24)	2006 (March 31)	2005 (April 30)
2010 (March 26)	2011 (April 5)	2007 (April 19)
2012 (February 26)	2015 (April 2)	2013 (April 18)
	2017 (April 8)	2014 (April 15)
		2016 (April 10)

Table S1: Early, on time and late transition dates determined using PC1 from the ERA-Interim dataset. La Niña (El Niño) conditions are marked by blue (red) text.

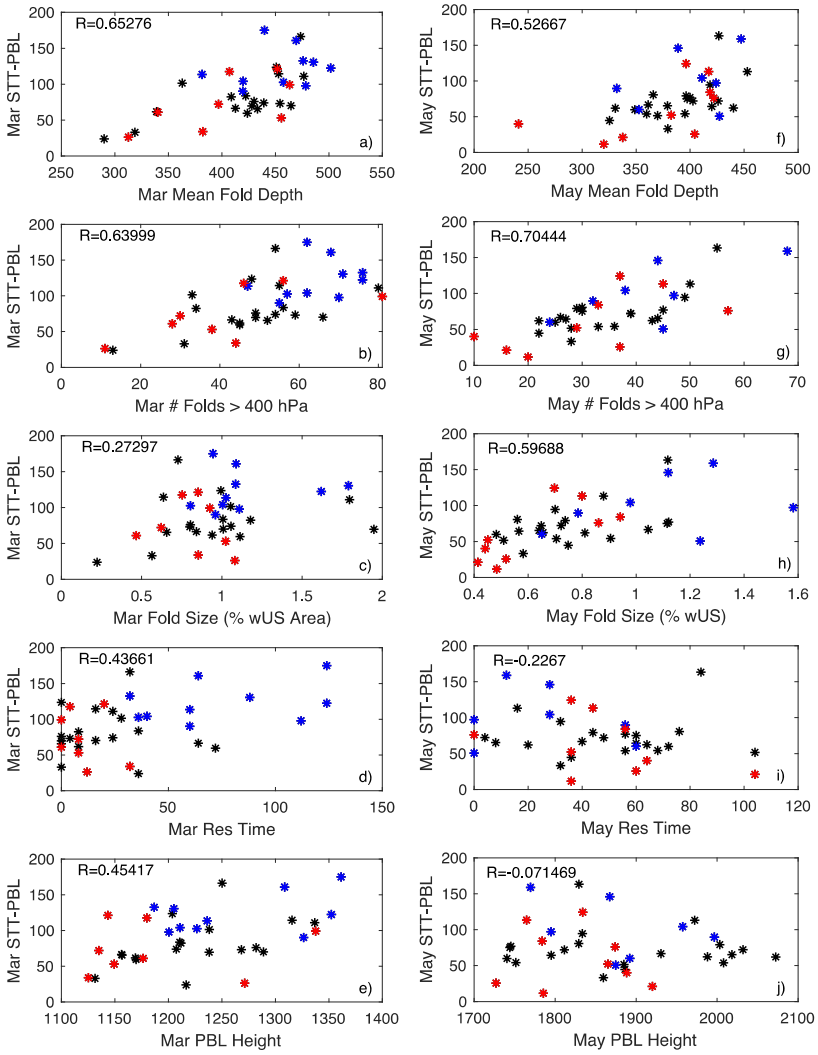

Figure S5: Relationship between monthly mean STT-PBL and mean fold depth, fold frequency, mean fold area, residence time of PC1 +/- .5, and mean boundary layer height. Values for March are shown in panels a) – e), and values for May are shown in panels f)-j). Each star represents one monthly mean value, and is colored by ENSO phase, with La Niña months in blue, El Niño in red and ENSO neutral in black. Correlation between each x-axis variable and STT-PBL is shown in the top left corner of each panel.

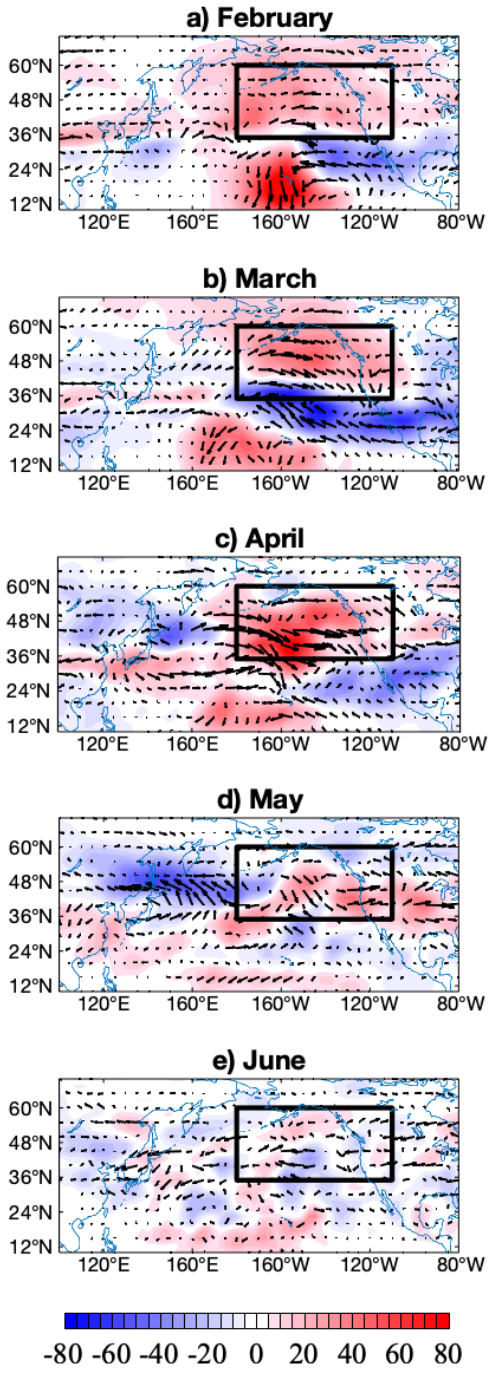

Figure S6: Difference in EKE (color shading, units $m^2 s^{-2}$) and E (black arrows), La Niña – El Niño, during the ERA-Interim period 1979-2017, during a) February through e) June. The black box marks the region over which EKE is averaged for bootstrapping (Figs. 6f,l; 10f,l).