Trend and Variability of Pineapple Express Events Depicted by Seven Global Reanalysis Datasets

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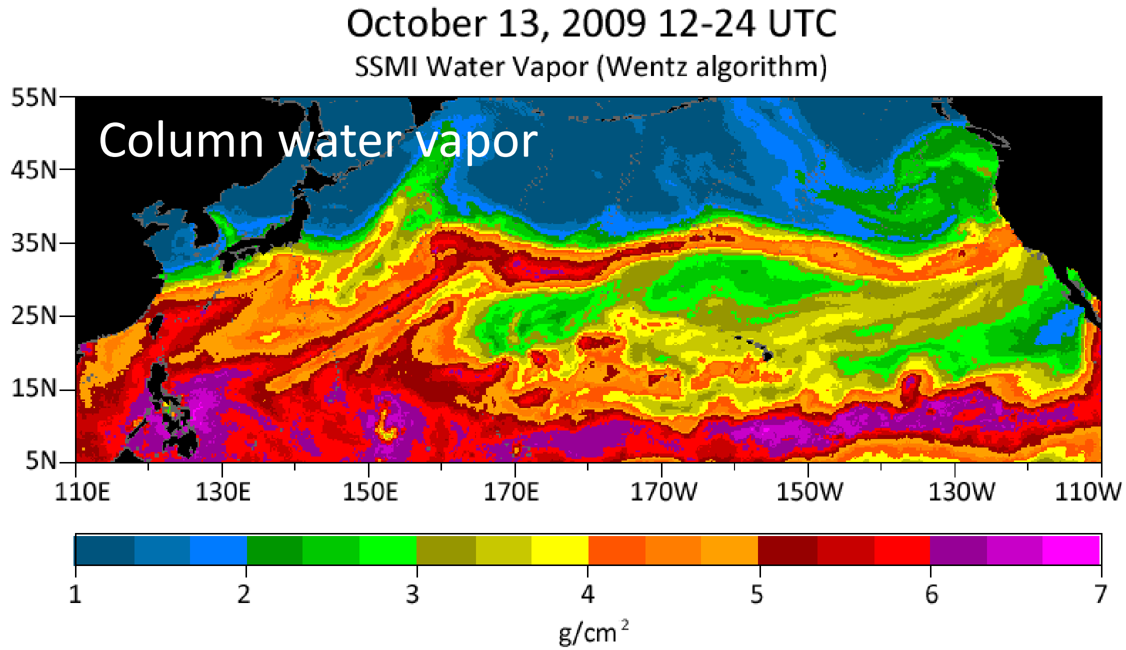
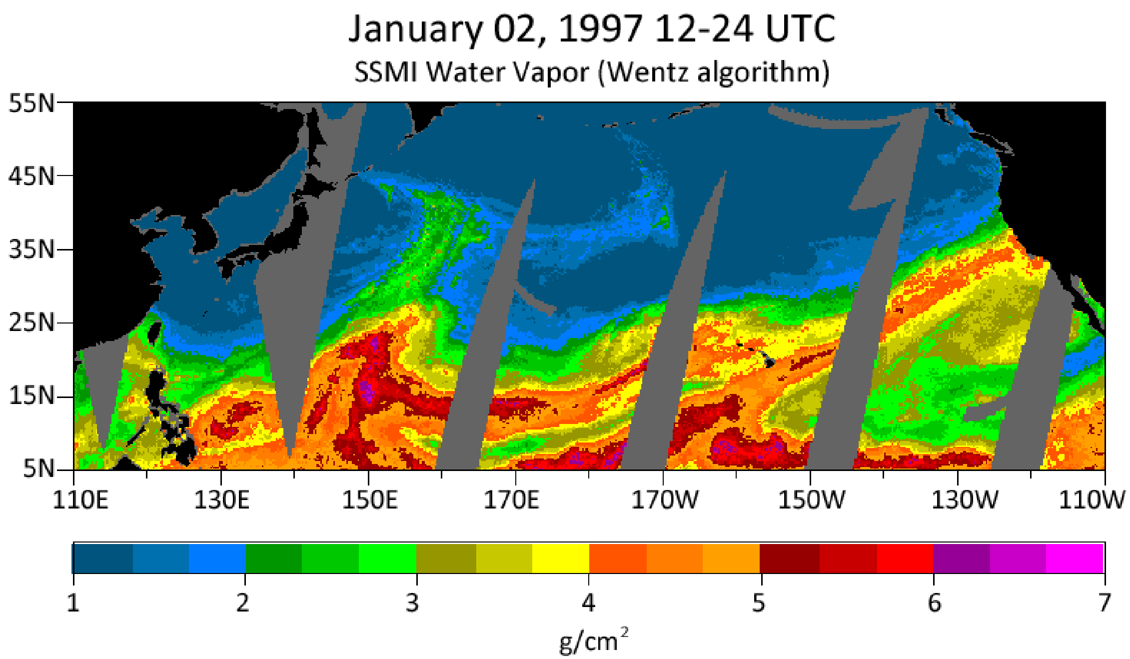
Two types of Atmospheric River:



← Zonal/Midlatitude

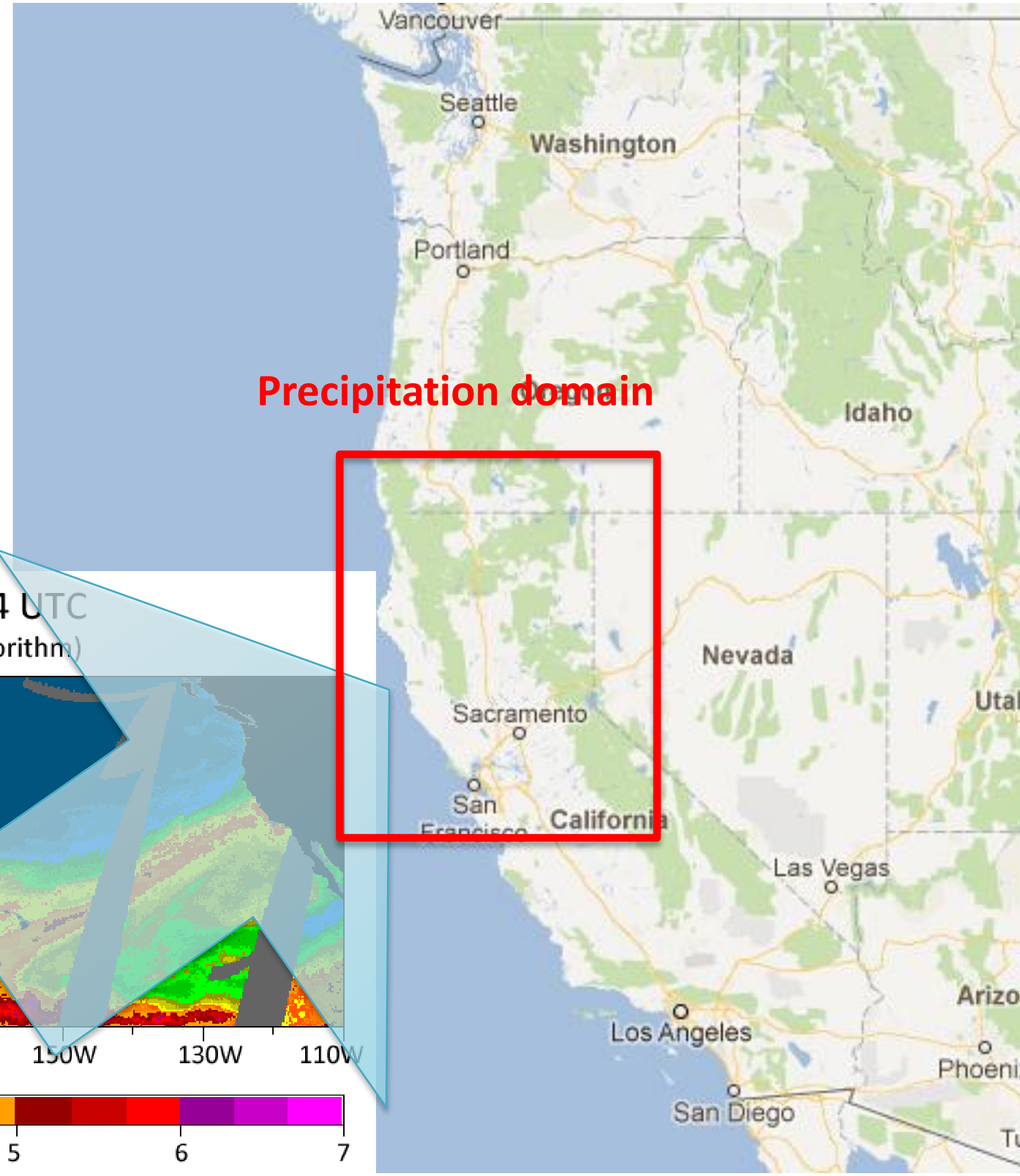


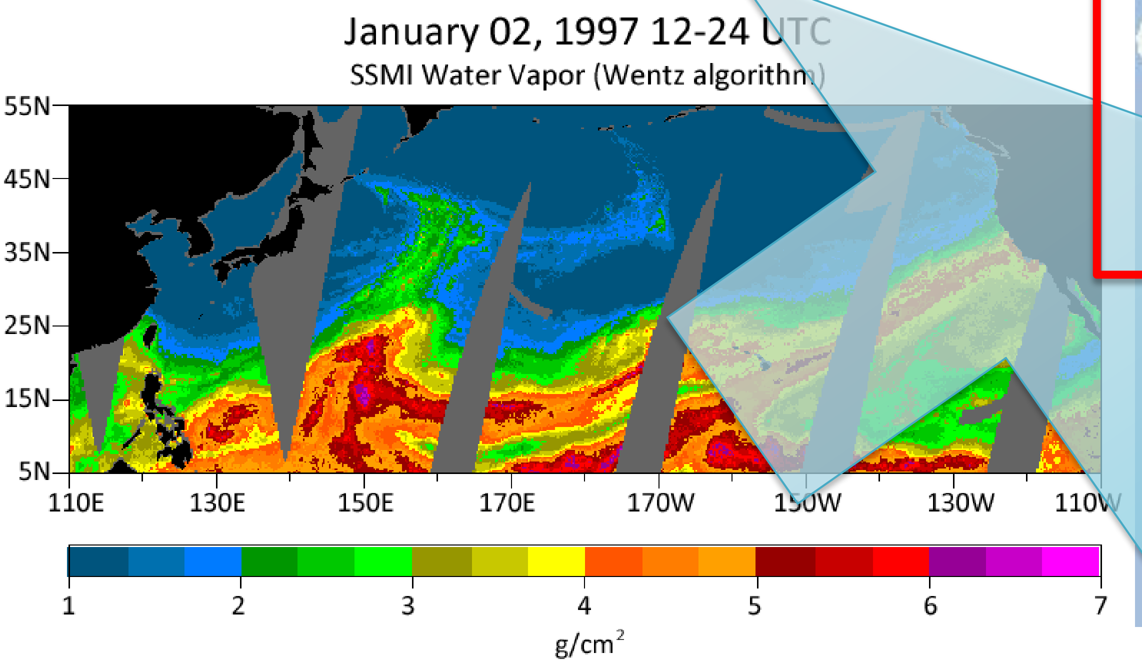
← Pineapple Express

Impact:

In Northern California

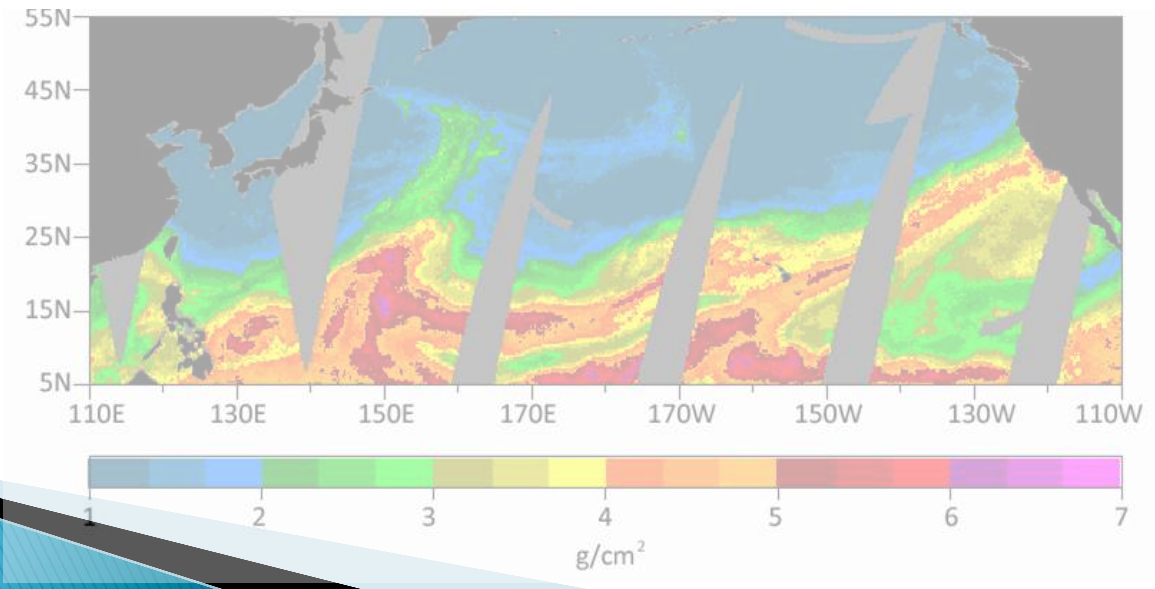
Essentially all major historical floods have been associated with AR events.





Any Change?

- Global warming ➔ tropical belt widening ➔ moisture increase
- → Pineapple Express frequency?



Reanalysis: Pros and Cons

- Uniform / global coverage (✔)

- Changing observations/computer systems (✖)

  → Questionable trend analysis

Thus we need multiple reanalyses

1. NCEP/DOE Reanalysis I

2. NCEP/NCAR Reanalysis II

3. NOAA-CIRES 20th Century Reanalysis V2 (20CR)

4. ECMWF Interim Reanalysis (ERA-Interim)

1. NASA Modern Era Reanalysis for Research and Applications (MERRA)

2. NCEP Climate Forecast System Reanalysis (CFSR)

1. JRA-25 (not there yet)

Northern California High-Impact Cases:

11–24 February, 1986 (Leung and Qian 2009)

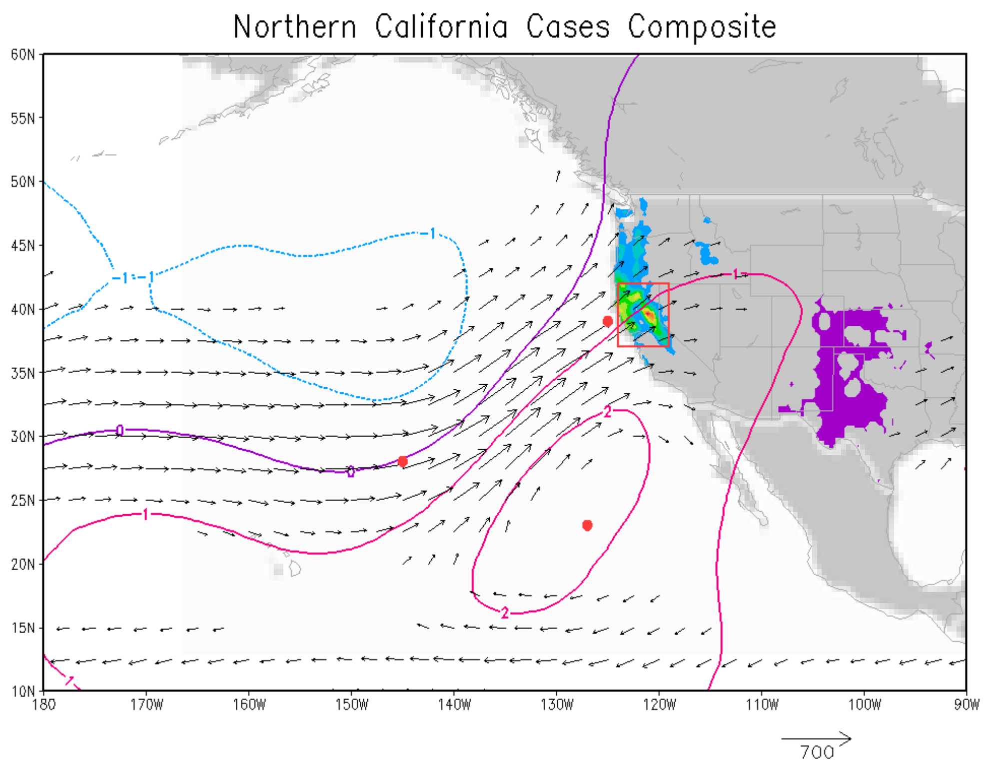
29 December, 1996 – 4 January,1997 (Galewsky, J., A. Sobel, 2005)

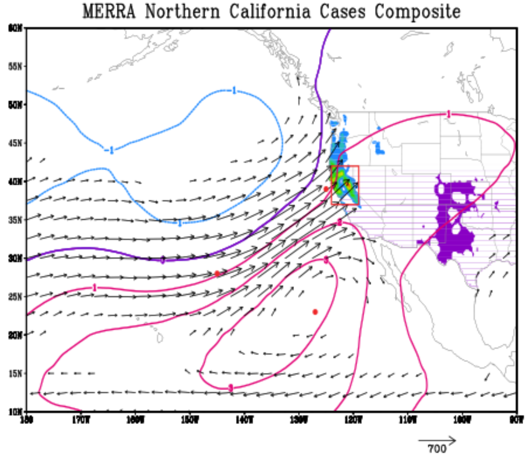
16–18 February, 2004 (Ralph, F. M., P. J. Neiman, G. A. Wick, S. I. Gutman, M. D. Dettinger, D. R. Cayan, and A. B. White, 2006)

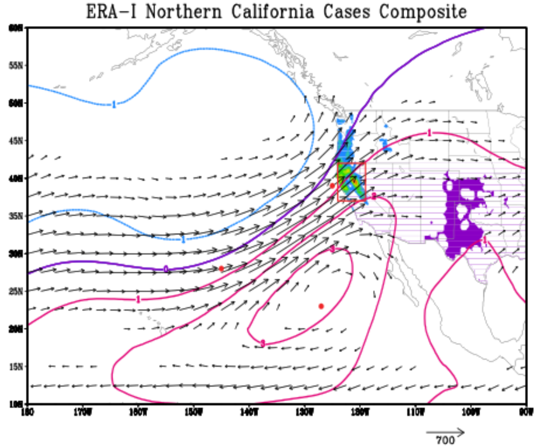
29 December, 2005 – 2 January, 2006 (Smith, B.L., S.E. Yuter, P.J. Neiman, and D.E. Kingsmill, 2010)

Column water vapor flux & its streamfunction ➔

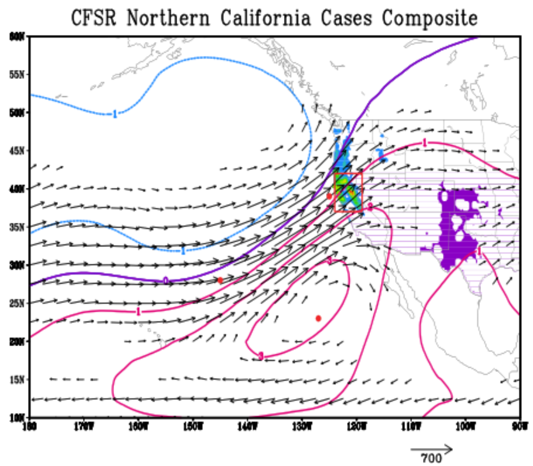
Precipitation (USMEX) ➔

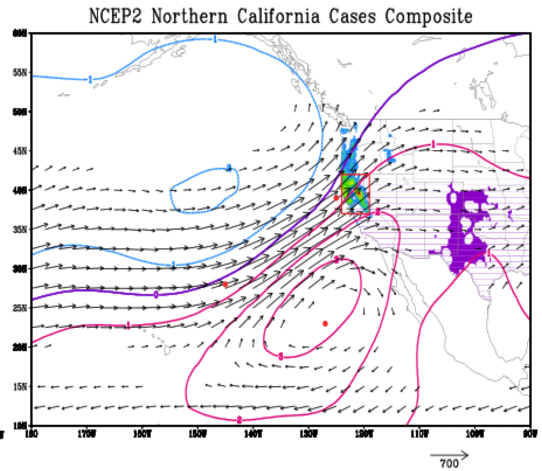


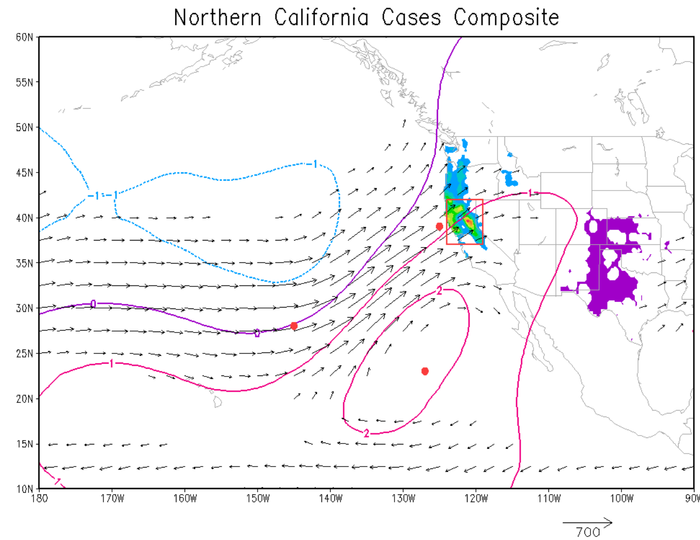


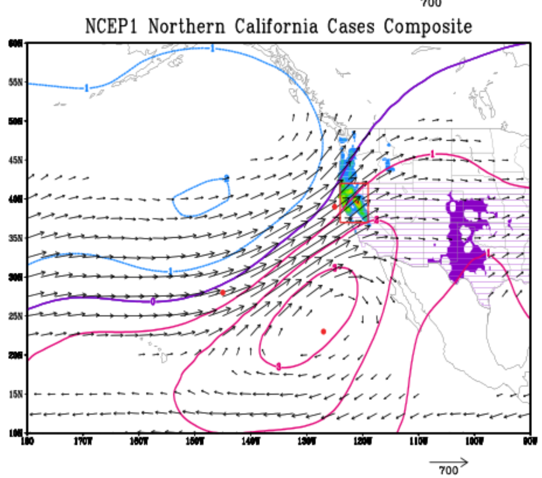


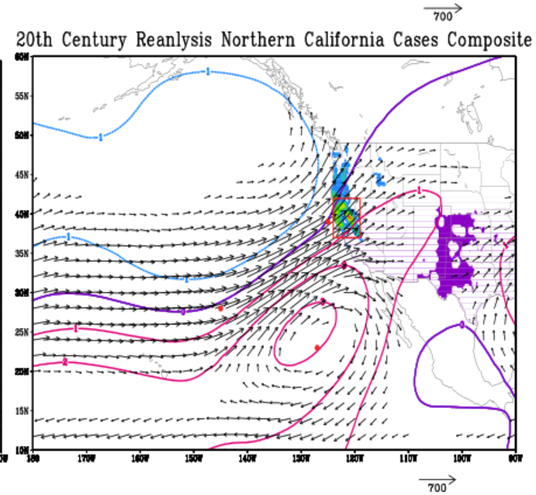
Composite PE events from multiple (6) Reanalyses











PE identification: Procedure

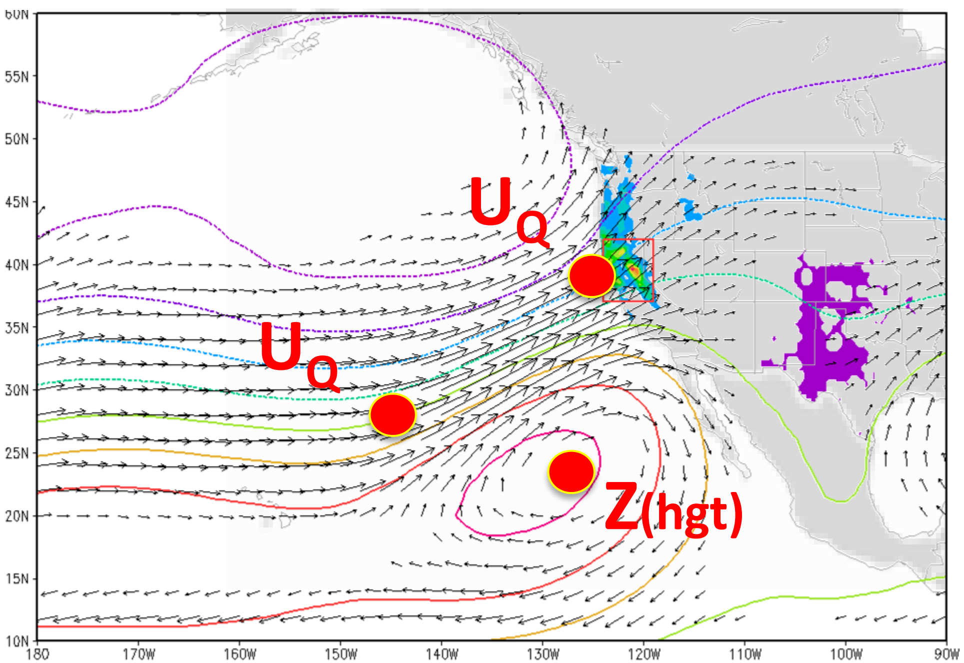
1. PE Index
2. PE pattern

Requisite conditions:

- **(Z-mean>0) ,**
- **(Uq>75, Vq>50), (Uq>75, Vq>0)**

(upstream) (downstream)

FOR 2 OR MORE CONSECUTIVE DAYS



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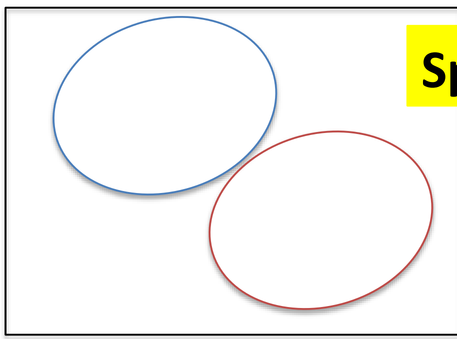
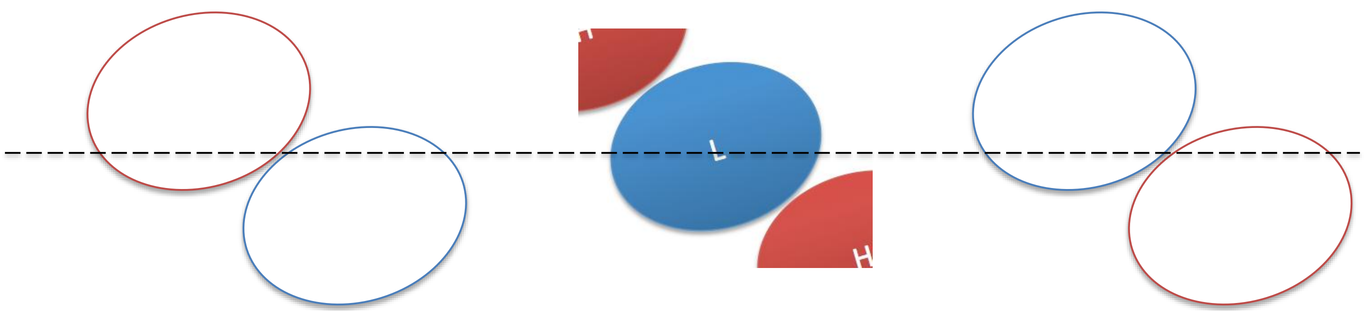
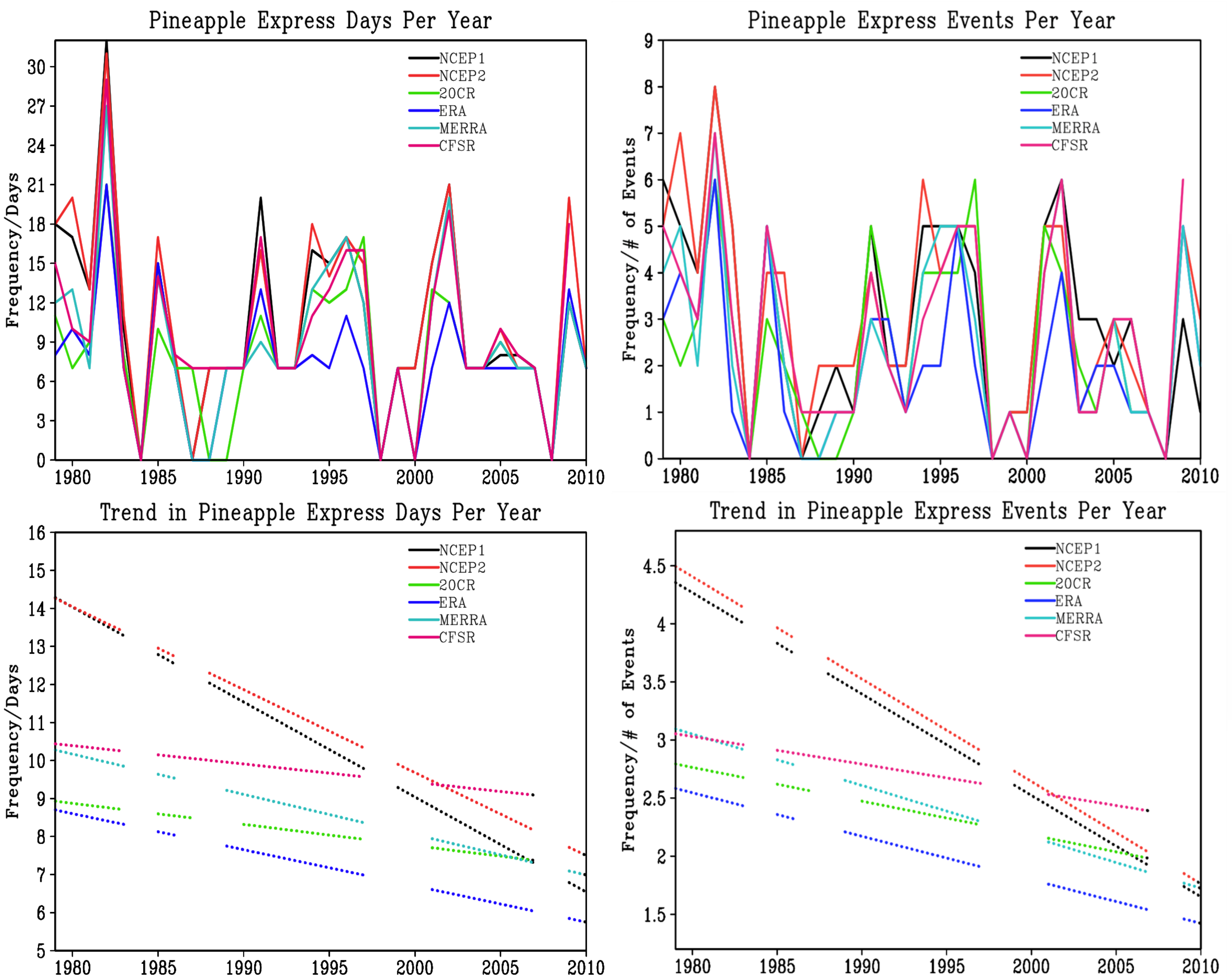


Spatial correlation: Pattern recognition

Criteria: scorr > 0.85



-1.0 0.0 1.0


Pineapple Express Days Per Year
Frequency/Days
NCEP1
NCEP2
20CR
ERA
MERRA
CFSR
0 3 6 9 12 15 18 21 24 27 30
1980 1985 1990 1995 2000 2005 2010
Pineapple Express Events Per Year
Frequency/# of Events
NCEP1
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Frequency/# of Events
NCEP1
NCEP2
20CR
ERA
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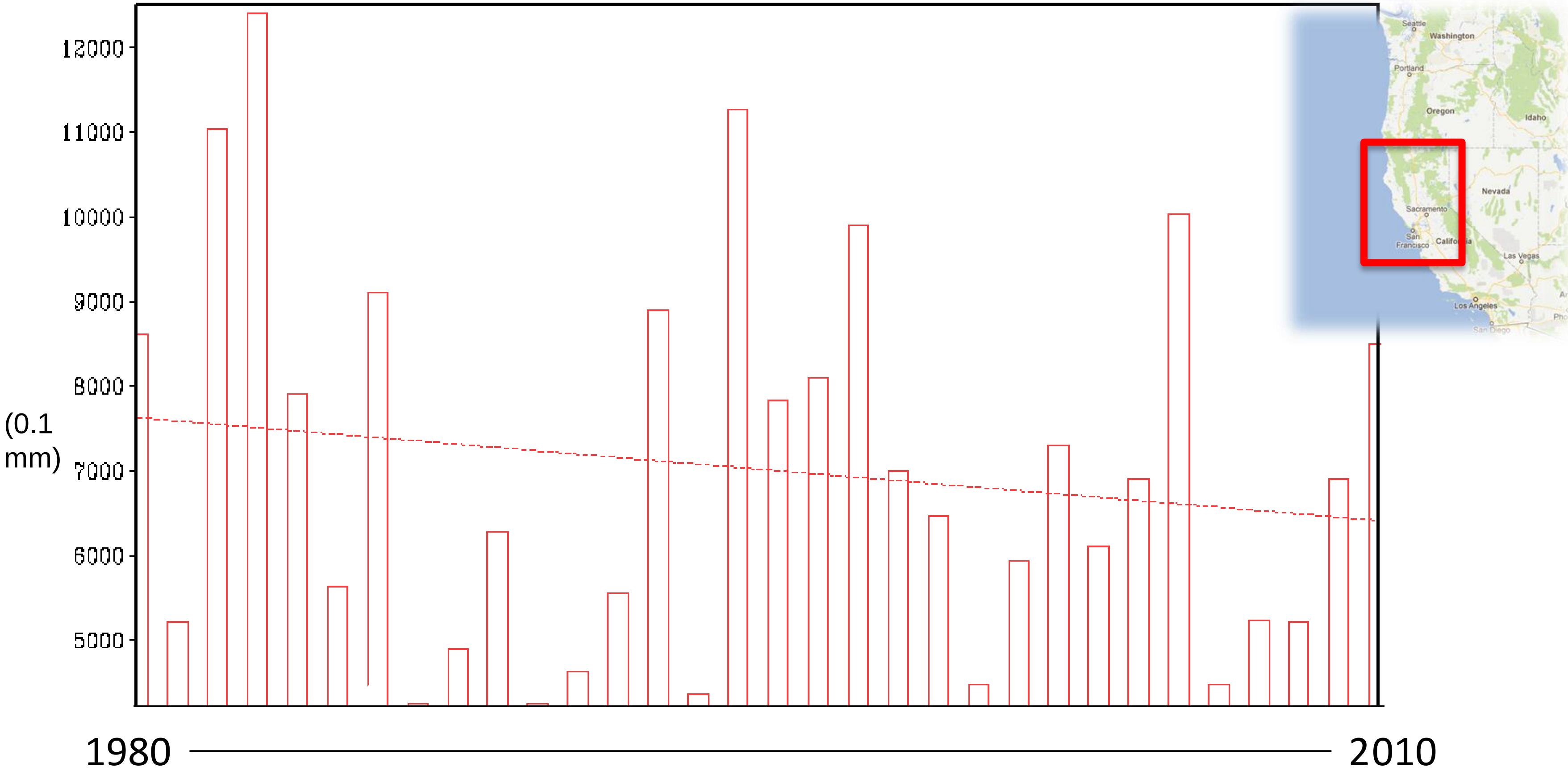
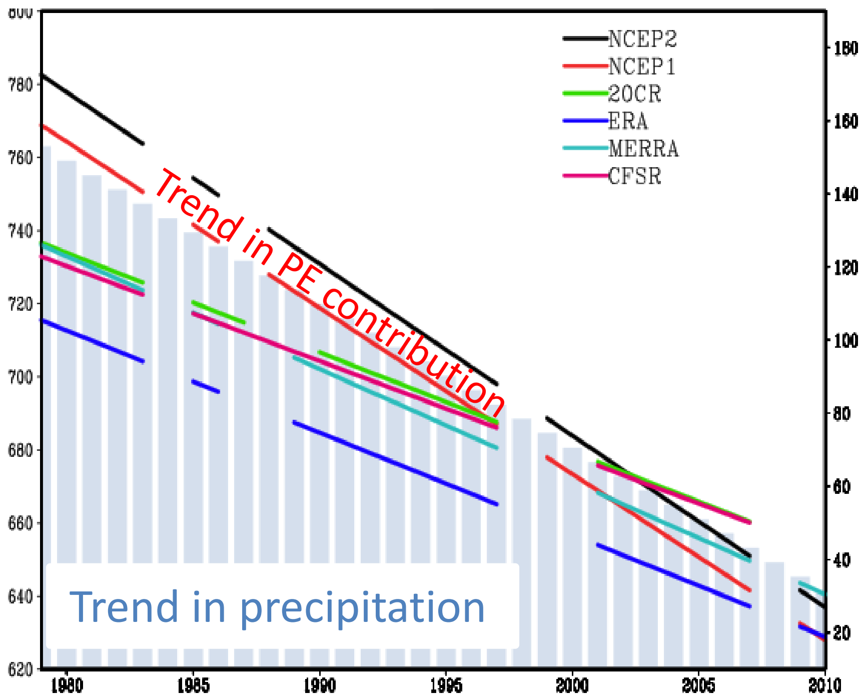
CFSR
1.5 2 2.5 3 3.5 4 4.5
1980 1985 1990 1995 2000 2005 2010

Winter Mean Precipitation Trend in Northern California (Oct-Apr)



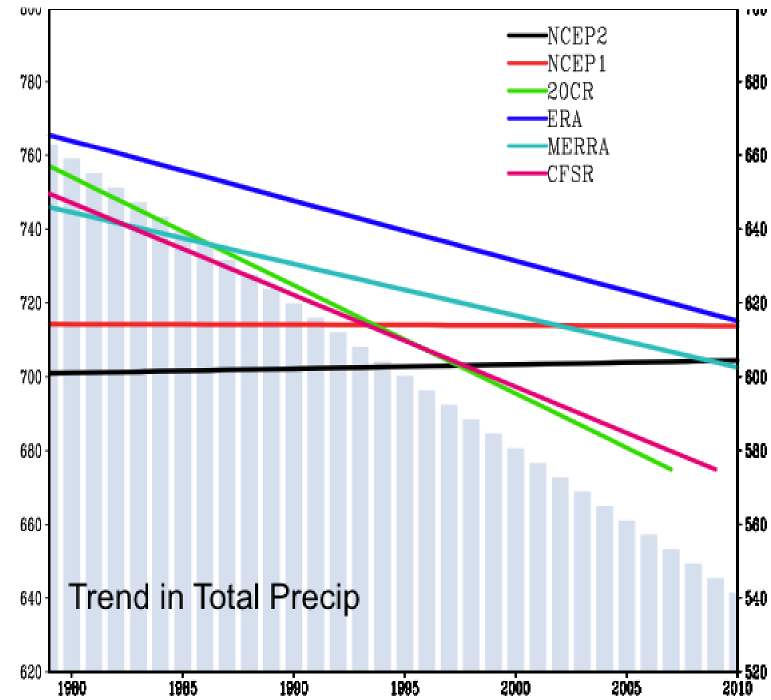
Declining Trend in Winter Precipitation (N.CA)

PE contribution to winter precip



(mm)

Residual winter precip



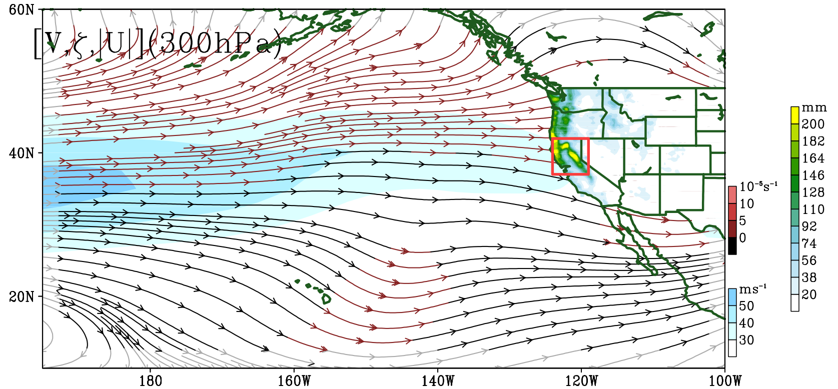
What accounts for the residual?

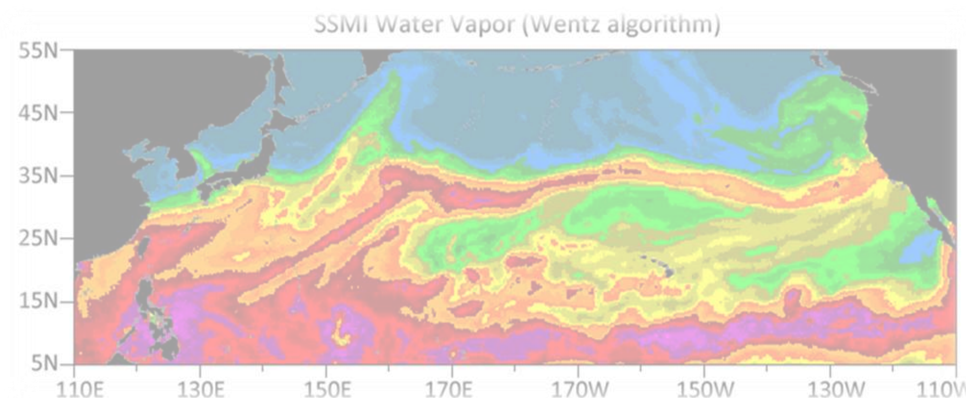
* Precip came from USMEX based on reanalysis "dates"

Identify other synoptic patterns

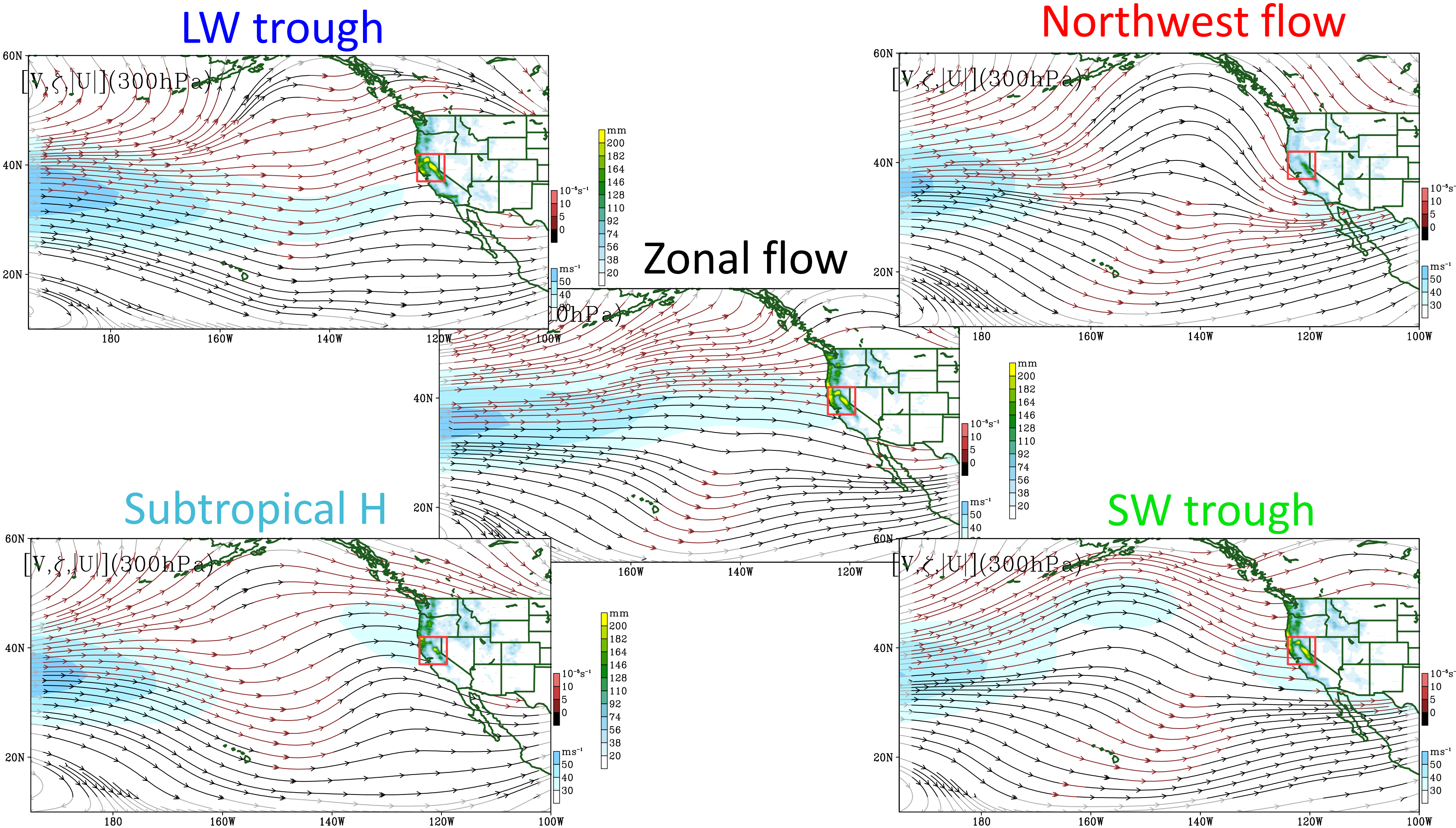
- Used ensemble of six reanalyses, daily means.
- Manual identification for multiple storm types.

Zonal case composite

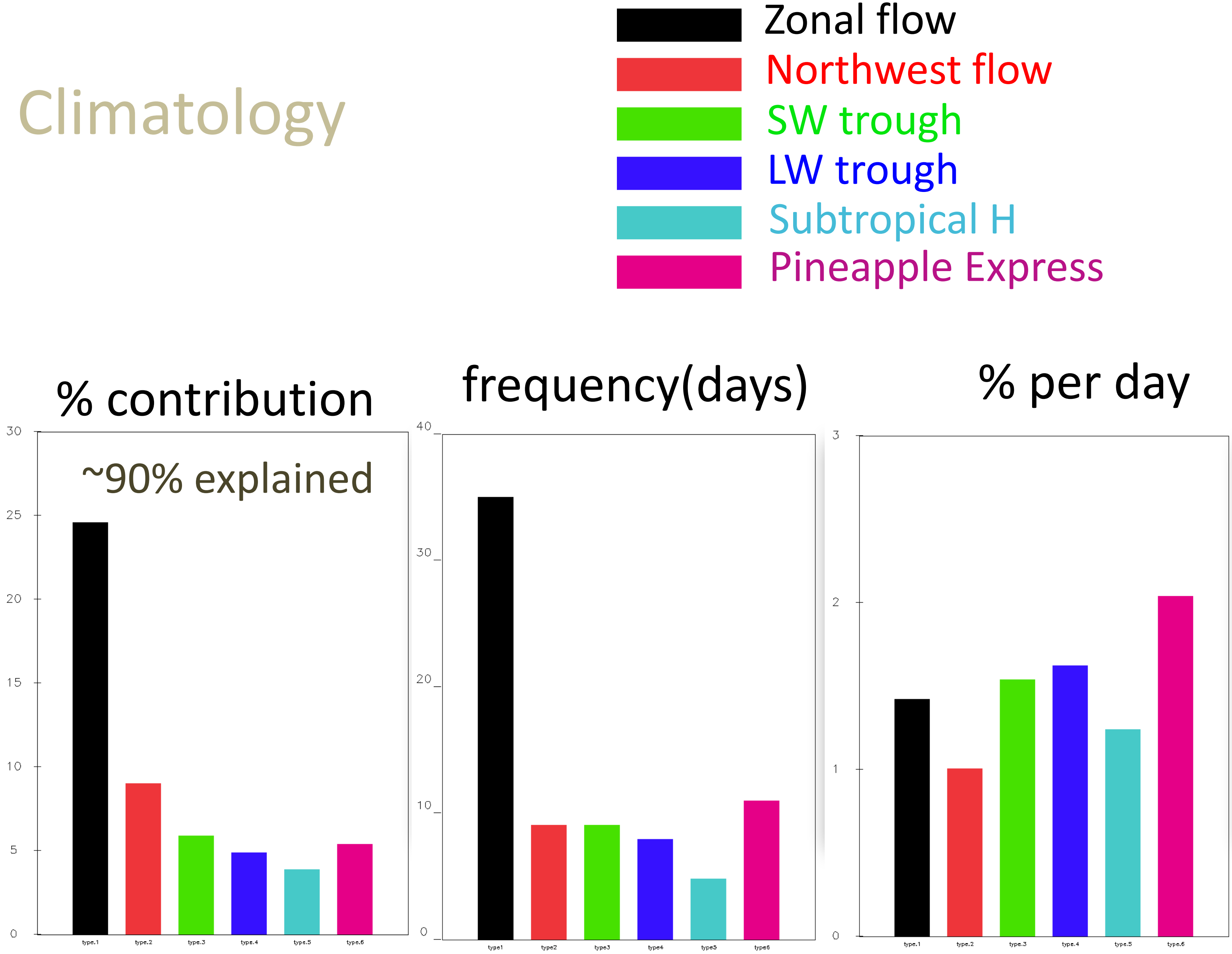




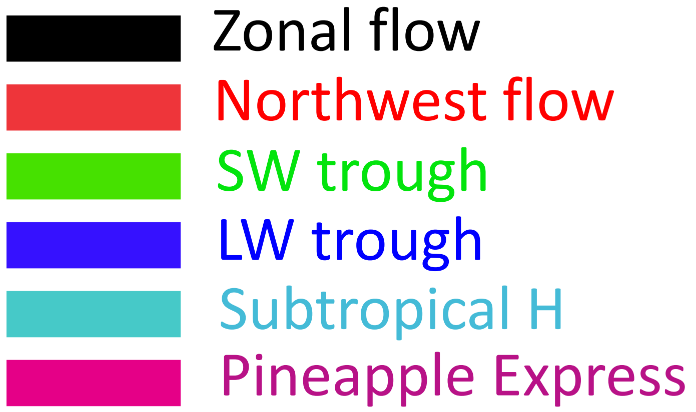
Identify other synoptic patterns



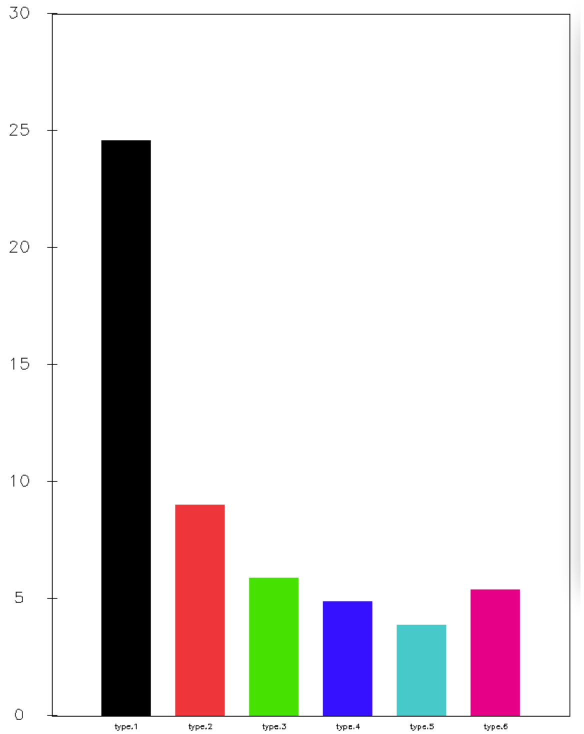
Climatology



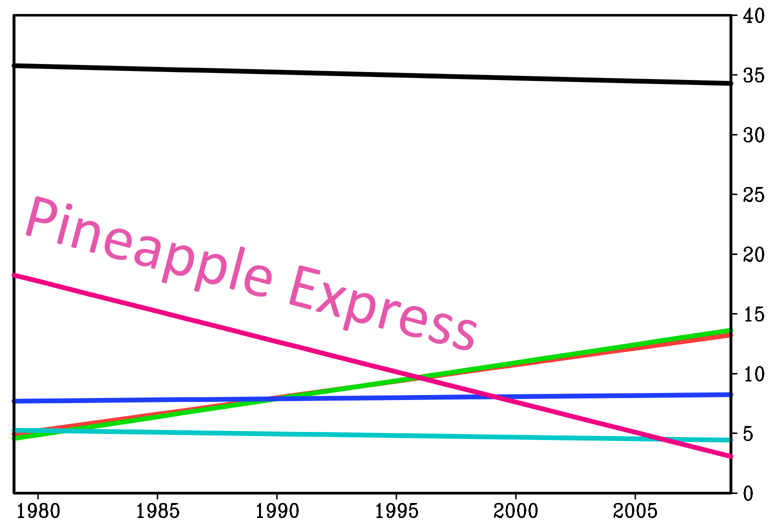
Trends: 1979-2010



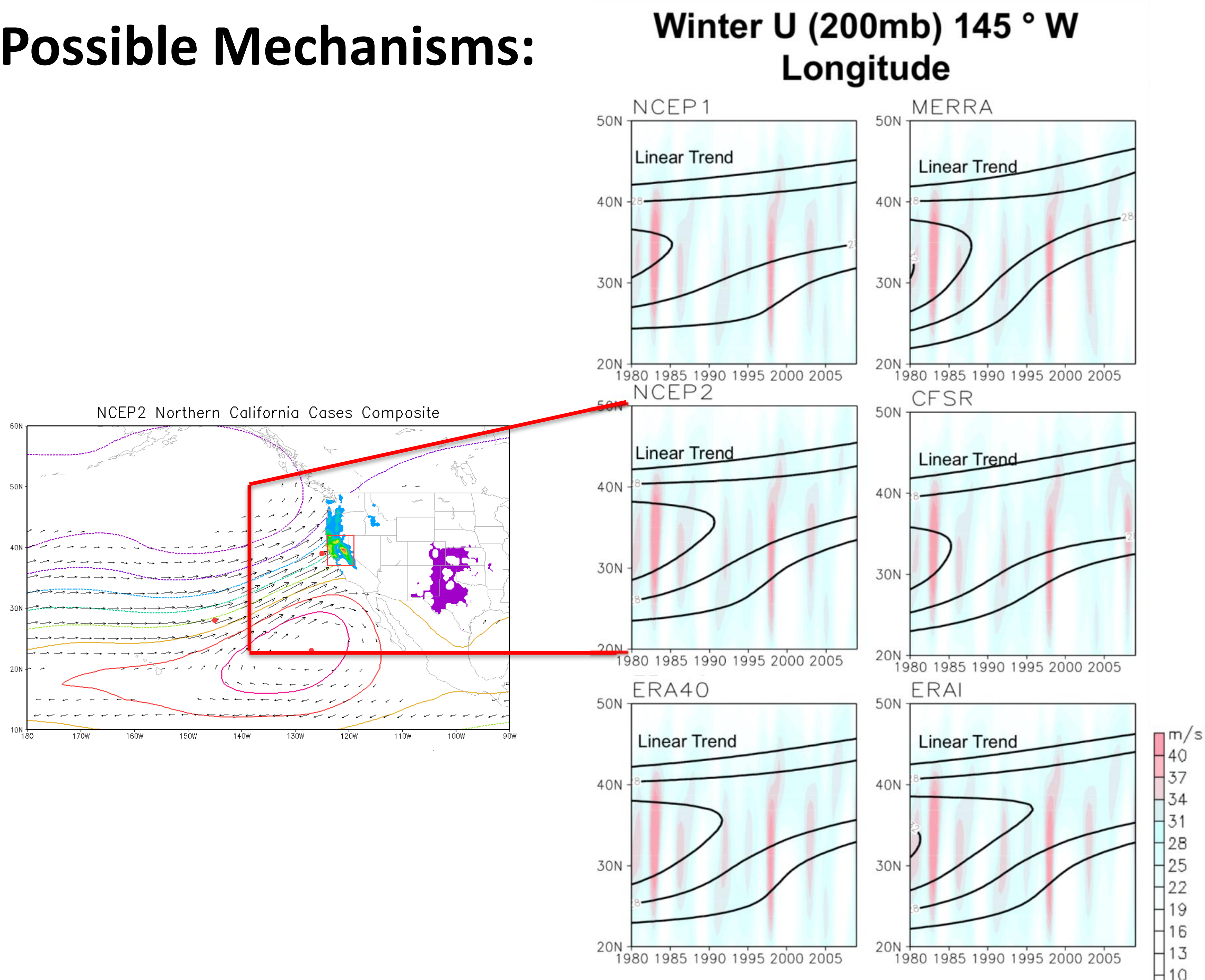
% contribution



Trend in storm type (%)



Possible Mechanisms:



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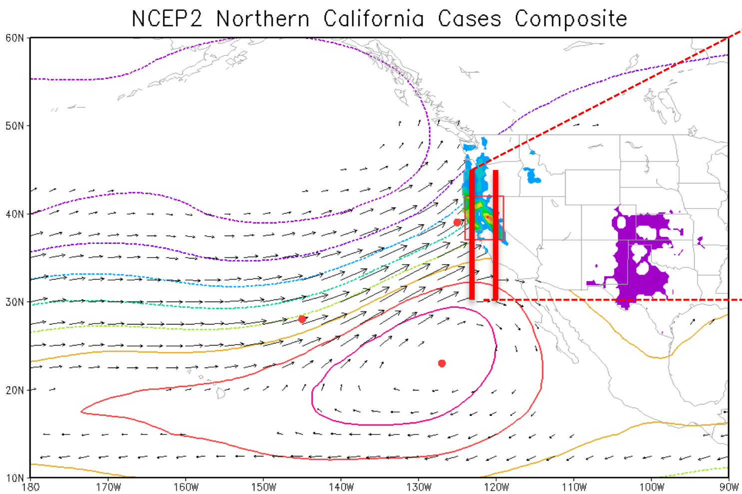
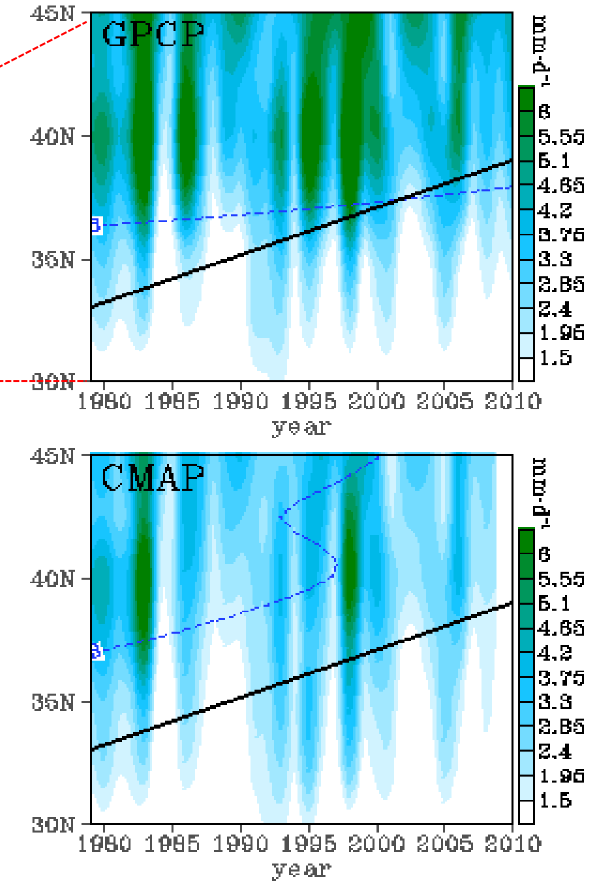


Precipitation (Oct-Apr)



Big Picture

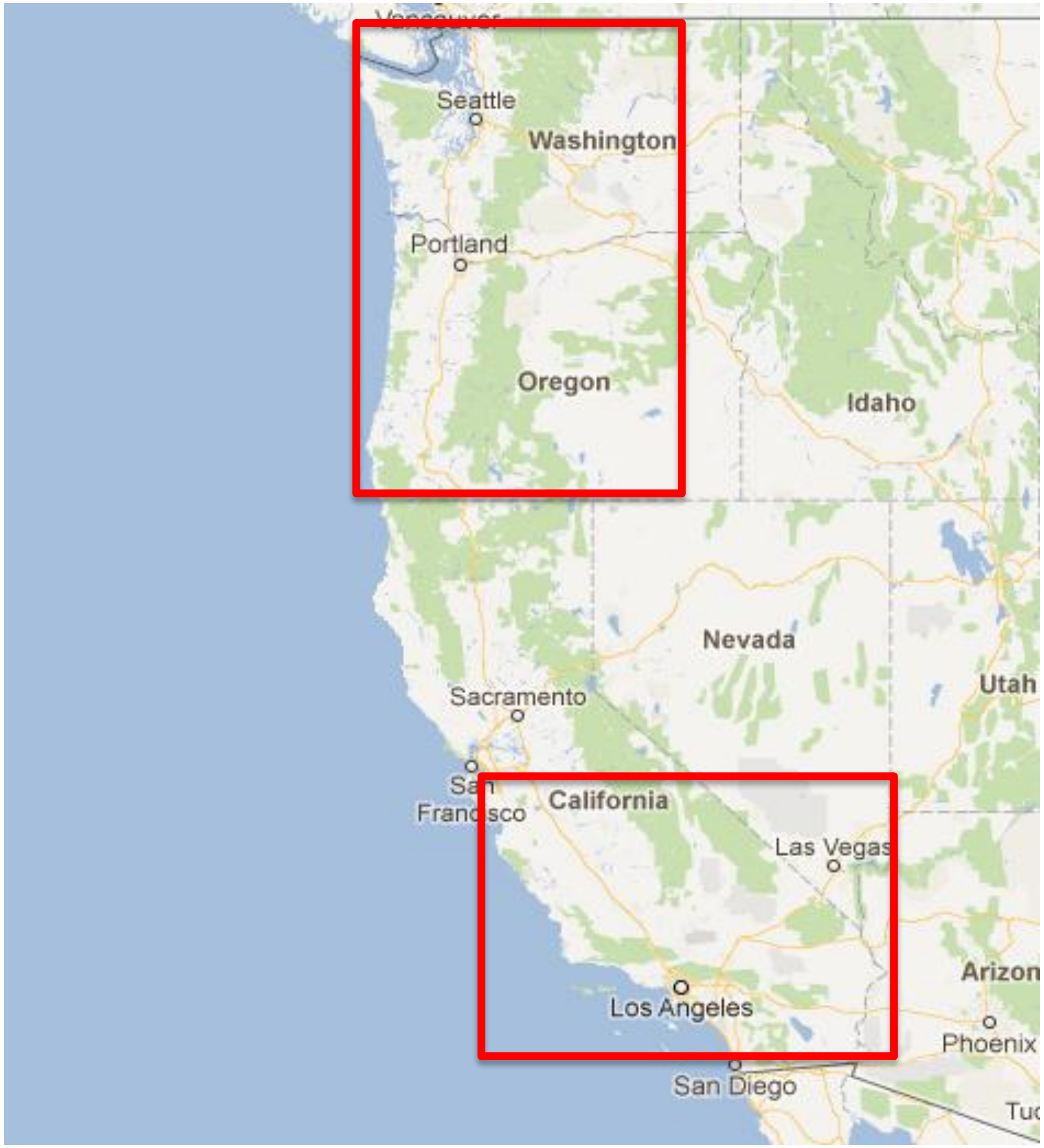
- The widening of the tropical moisture band may lead to an increase in moisture availability for Pineapple Express storms.

- However, this does not translate into an increase in precipitation from Pineapple Express storms. Contrarily, precipitation linked to these storms is decreasing over northern California

- A northerly shift in the upper-level winter jet over the flux region coincides with the decrease in Pineapple Express storms and total winter precipitation in northern California.

Future Work

- Identify what effect the northerly shift and weakening of the winter jet may have on Pineapple Express contributions in southern California and the Pacific Northwest.



Thank You!
QUESTIONS?

References:

Leung L. R, and Y. Qian, 2009. Atmospheric rivers induced heavy precipitation and flooding in the Western U.S. simulated by the WRF regional climate model. *Geophys. Res. Lett.*, 36, L03820, doi:10.1029/2008GL036445.

Galewsky, J., A. Sobel, 2005: Moist dynamics and orographic precipitation in northern and central California during the New Year's Flood of 1997. *Mon. Wea. Rev.*, 133, 1594-1612, doi:10.1175/MWR2943.1.

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Dettinger, M. (2011), Climate Change, Atmospheric Rivers, and Floods in California – A Multimodel Analysis of Storm Frequency and Magnitude Changes. JAWRA Journal of the American Water Resources Association, 47: 514–523. doi: 10.1111/j.1752-1688.2011.00546.x