Trend and Variability of Pineapple Express Events Depicted by Six Reanalysis Datasets

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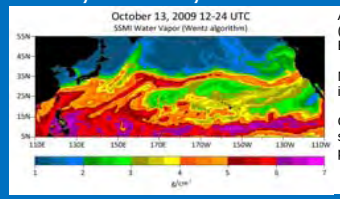
Reanalysis Datasets Used

1. **NCEP/NCAR Reanalysis I**
2. **NCEP/DOE Reanalysis II**
3. **NOAA-CIRES 20th Century Reanalysis V2 (20CR)**
4. **ECMWF Interim Reanalysis (ERA-Interim)**
5. **NASA Modern Era Reanalysis for Research and Applications (MERRA)**
6. **NCEP Climate Forecast System Reanalysis (CFSR)**
7. **US/Mexico Precip (1°x1°) Climate Prediction Center (NOAA)**



Atmospheric River (Non - Pineapple Express)

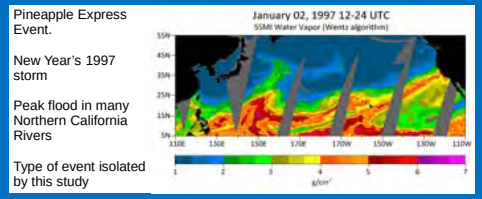
Not of primary interest to this study

Generally does not sustain a consistent pattern

Methods

To determine the conditions leading to P.E. events, we first created a composite representing 12 "classic days" from 4 storms corresponding to literature coverage. We then created an index to define PE events by considering:
1)The southerly and westerly components of column integrated water vapor flux (**Q**) at 2 locations downstream of the region of interest. **2)** 850 mb geopotential height (**Z**) in the subtropical region off the west coast of Mexico. **3)** The spatial correlation of **|Q|** fields relative to the 'classic case' composites.
Requisite conditions:
(Z-mean>0) , (Uq>75, Vq>50), (Uq>75, Vq>0)
(upstream) (downstream)
(scorr|Uq|>0.85)
FOR 2 OR MORE CONSECUTIVE DAYS

- Precipitation was excluded as a variable in the index.
- From this definition, a list of dates meeting the criteria were isolated and analyzed using 6 reanalysis datasets.

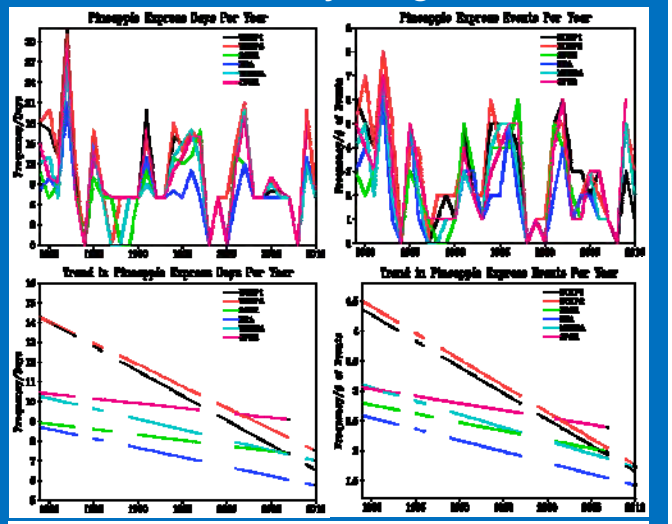


Pineapple Express Event.

New Year's 1997 storm

Peak flood in many Northern California Rivers

Type of event isolated by this study



4 Panel plot showing the frequency and linear trends in the number of Pineapple Express days per year and the number of Pineapple Express events per year. All days meet criteria set out in PE Index

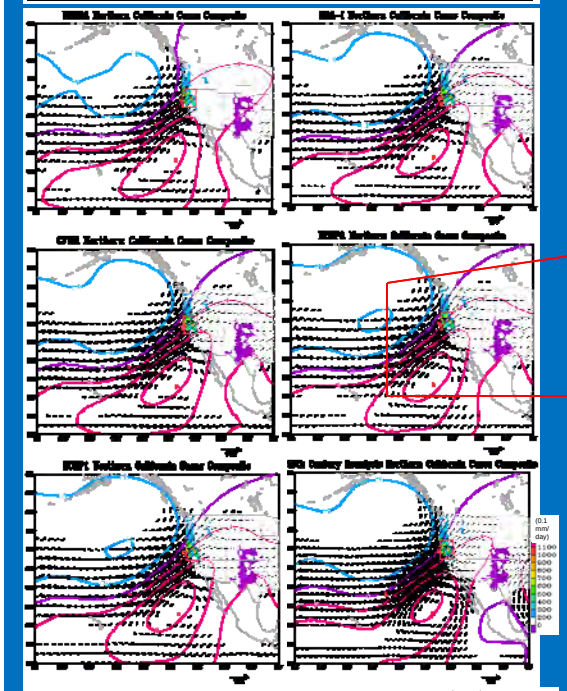
Northern California High-Impact Cases:

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)

All events resulted in significant flooding of Northern California Rivers

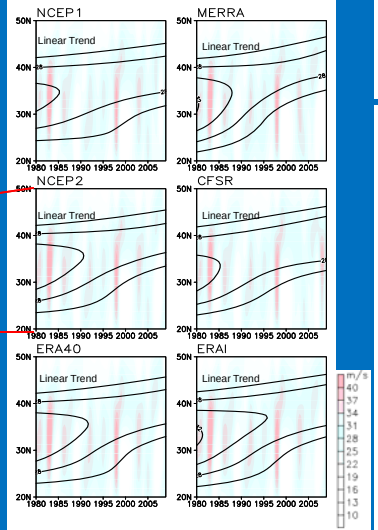
3 days representing 'classic' Pineapple Express conditions were taken from each storm and used to create composites

Composites of PE events from Six Reanalysis Datasets



Vectors show magnitude and direction of water vapor flux (Q) ($kg*m*s^{-1}*kg^{-1}$) from selected high impact days.
Contours show streamfunction or rotation/circulation of water vapor flux (Q) ($m^2*s^{-1}*kg^{-1}$)

Winter U (200mb) 145 ° W Longitude



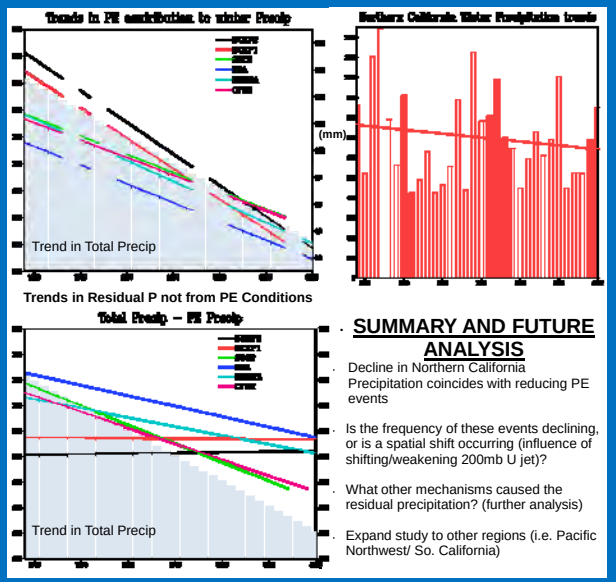
Analysis of winter (Nov-Mar) 200mb U winds reveals a northward shift and weakening in the mid-latitude jet, coinciding with a decrease in winter precipitation over northern California during the same time period.

Observations:

Over 31 years:
Decline in total winter precipitation over northern California was observed.

A decreasing trend in Pineapple Express storms impacting northern California was observed.

Decline in percent contribution to total winter precipitation from PE storms similarly observed.



SUMMARY AND FUTURE ANALYSIS

- Decline in Northern California Precipitation coincides with reducing PE events
- Is the frequency of these events declining, or is a spatial shift occurring (influence of shifting/weakening 200mb U jet)?
- What other mechanisms caused the residual precipitation? (further analysis)
- Expand study to other regions (i.e. Pacific Northwest/ So. California)