Center for Western Weather and Water Extremes
SCRIPPS INSTITUTION OF OCEANOGRAPHY AT UC SAN DIEGO

EFO Model Results Using Scaled Flood Events 1986 1997 2006

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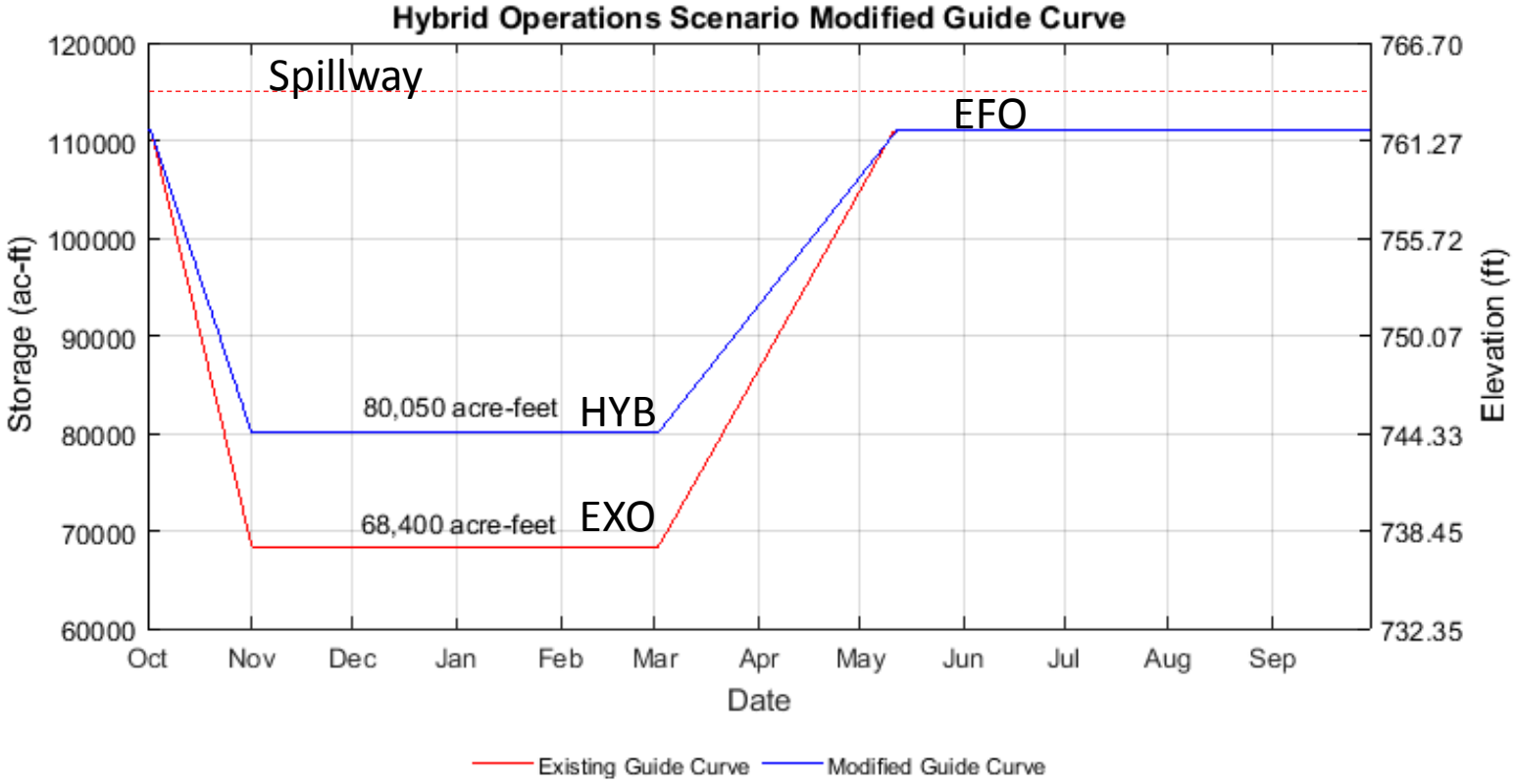
Purpose of Study and Process

- EFO model runs used for the PVA had a limited set of extreme runoff events. – February 1986
- Evaluate the virtual operations of reservoir using the EFO and Hybrid scenarios under more extreme runoff conditions.
- How?
- Scale the three largest events in the hindcast record (Feb 1986, New Year's 1997, and New Year's 2006) to the historical 3-day inflows for Dec 1964 and 200 and 500 yr return period 3-Day inflows to Lake Mendocino – provided by USACE Beth Faber

Virtual Scenarios Used

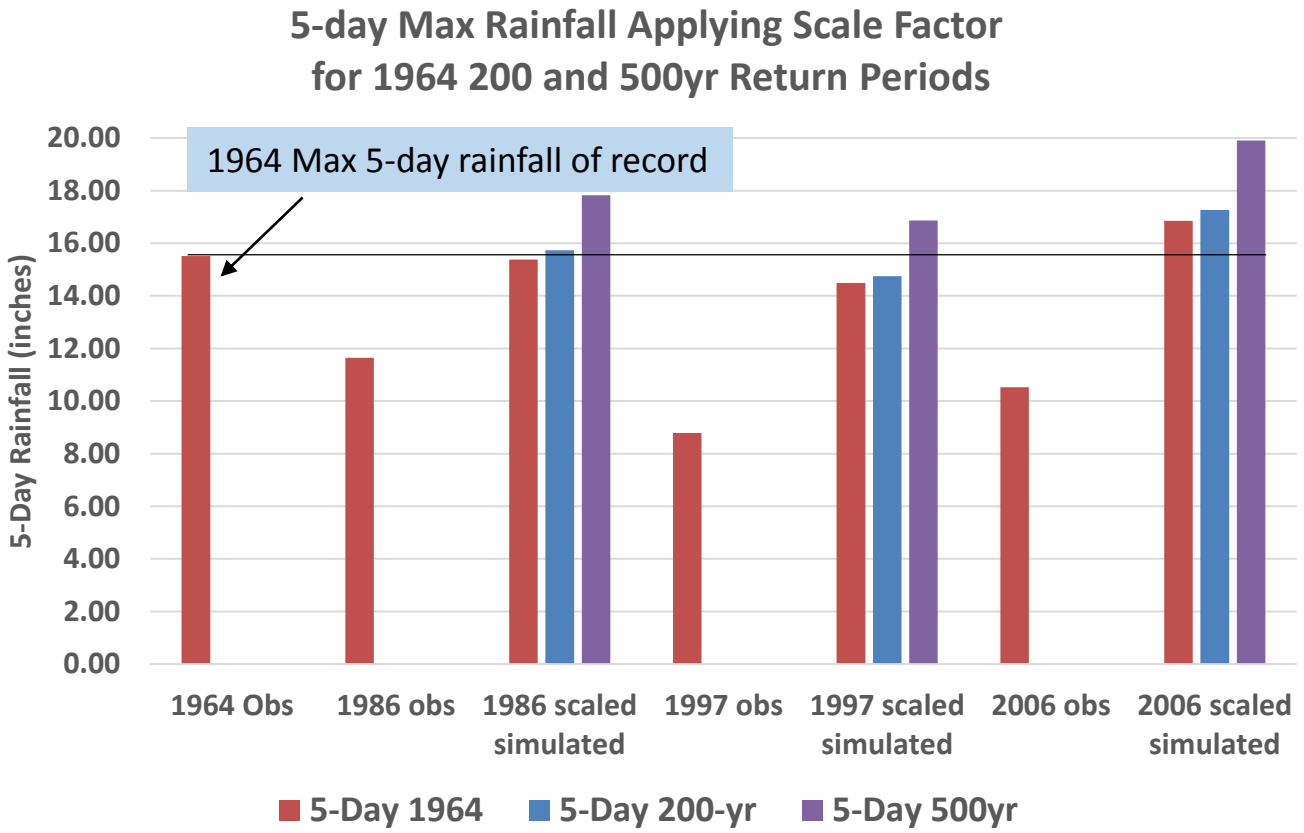


Scaling Factors Applied

Little Difference

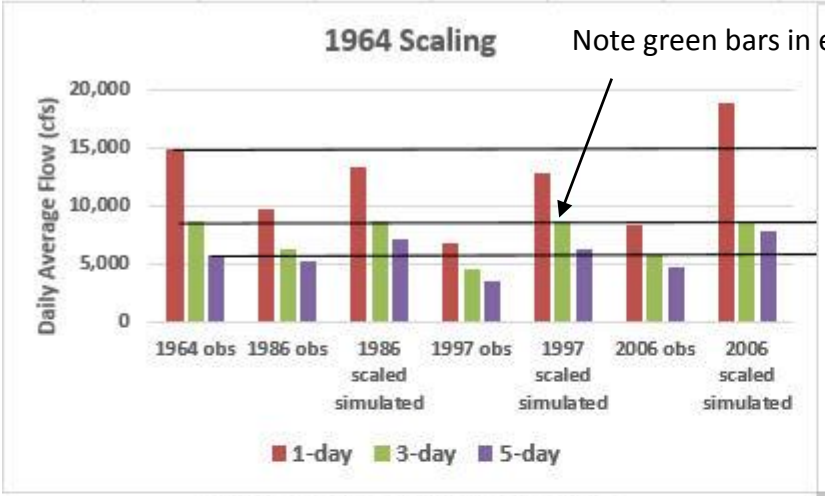
	Scaling Factor per Event		
1964 obs	1986 scaled simulated	1997 scaled simulated	2006 scaled simulated
scale factor	1.32	1.65	1.6
200yr USACE	1986 scaled simulated	1997 scaled simulated	2006 scaled simulated
scale factor	1.35	1.68	1.64
500yr USACE	1986 scaled simulated	1997 scaled simulated	2006 scaled simulated
scale factor	1.53	1.92	1.89

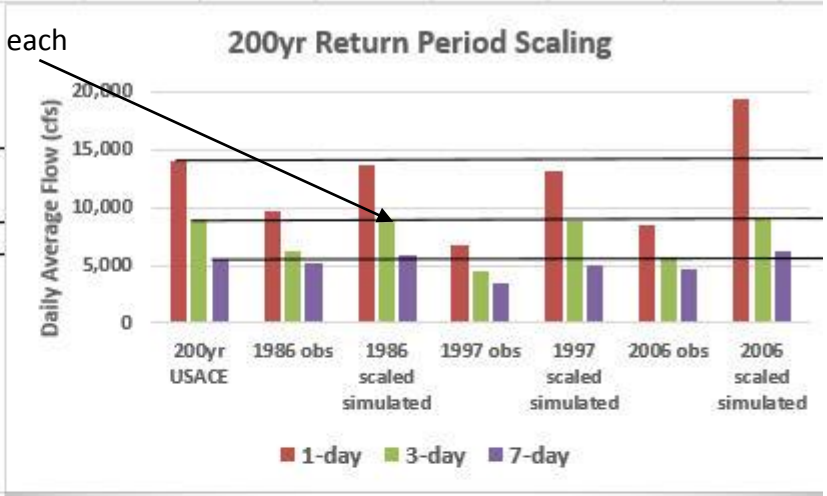
Scale 5-day MAP (Mean Areal Rainfall) to achieve 3-Day desired Inflows

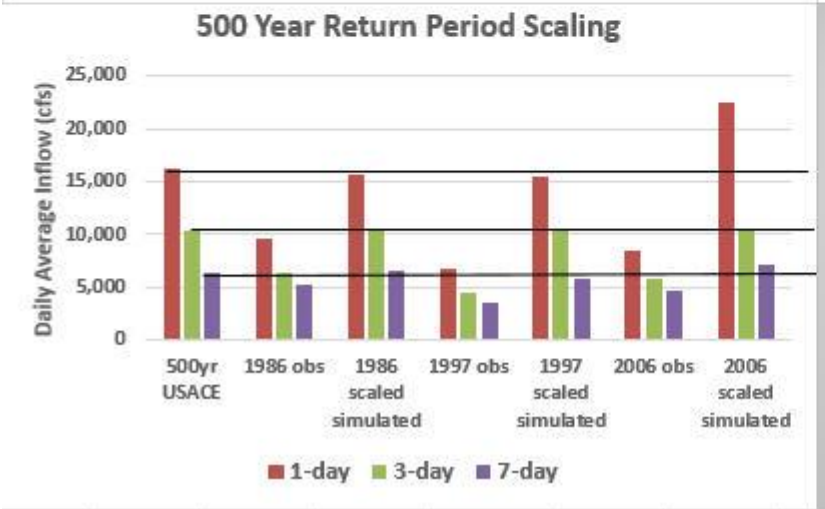


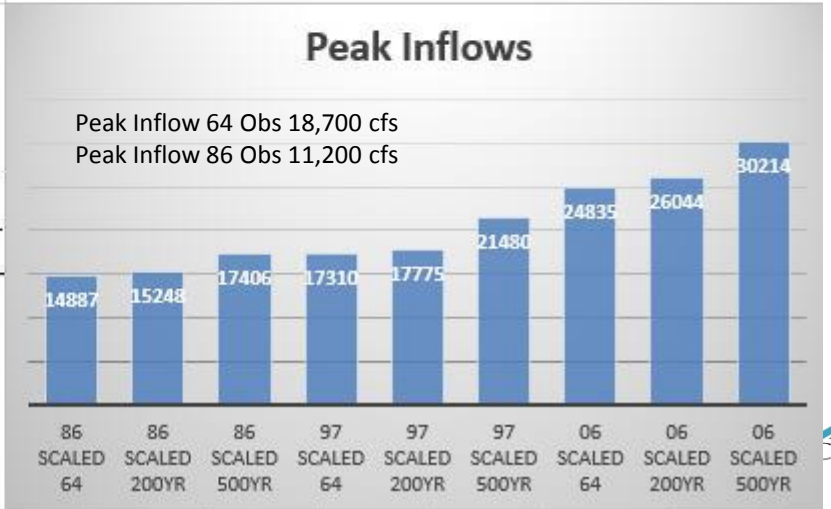
Note all 2006 scaled MAPs above record 64 5-day Obs

1964 and 200-500yr Return Period Scaling Inflows



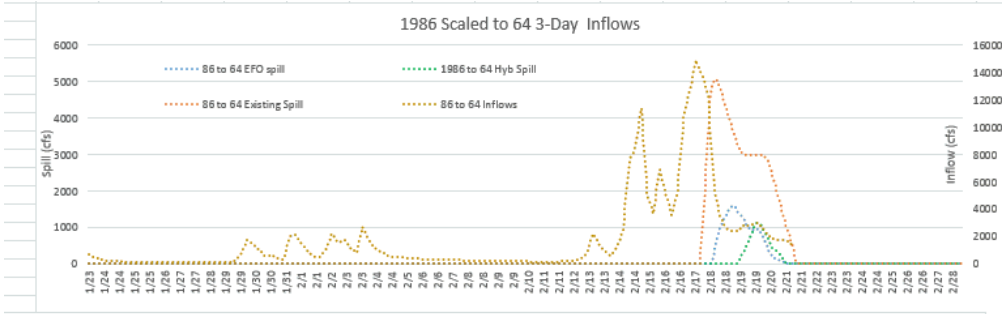






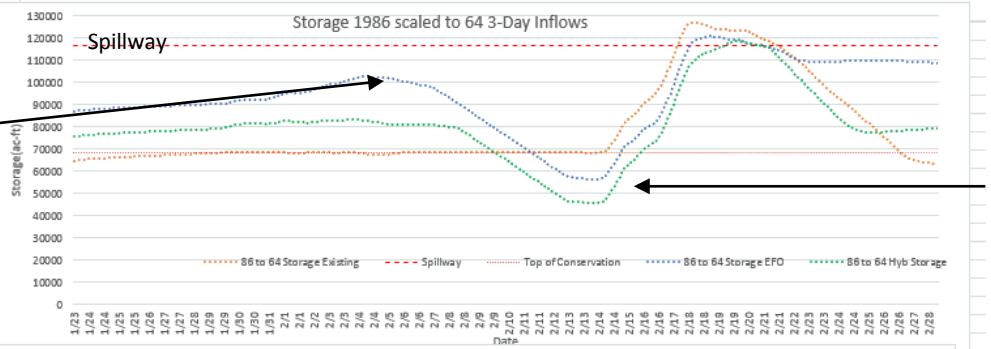
CNRFC scaled to 3-day volumes but daily inflows may not scale as well. Note 2006

1986 scaled to 1964

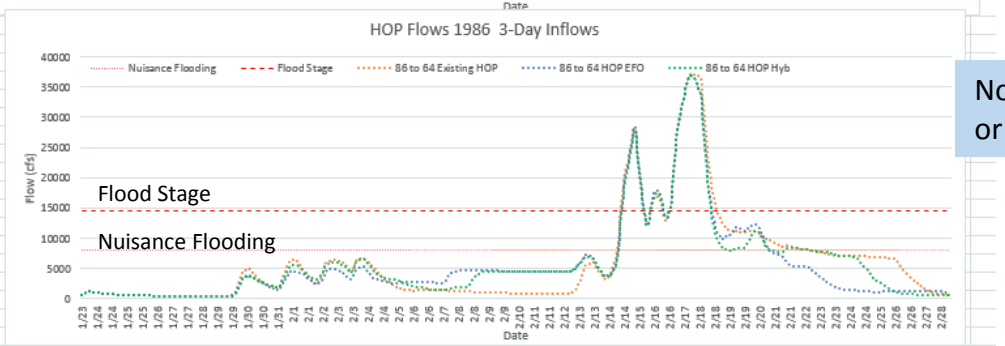


Existing Orange
EFO Blue
HYB Green
Inflows Yellow
64 dotted lines
200yr solid lines
500yr dashed lines

Note EFO simulation releases begin about 10 days before peak inflows

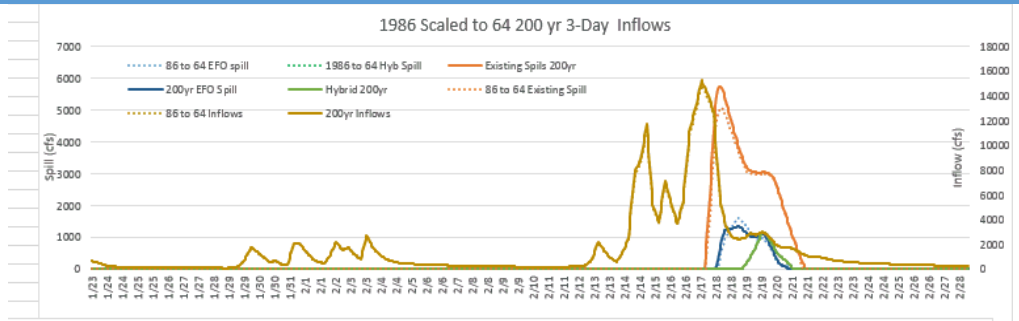


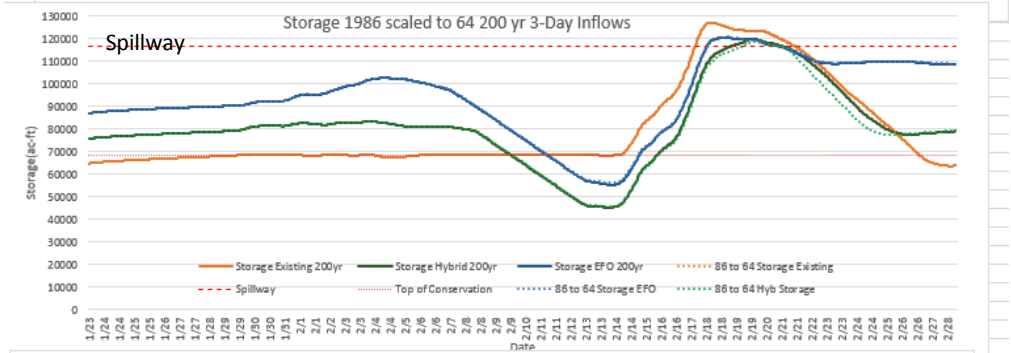
Storage dips well into EXO conservation pool for EFO and HYB

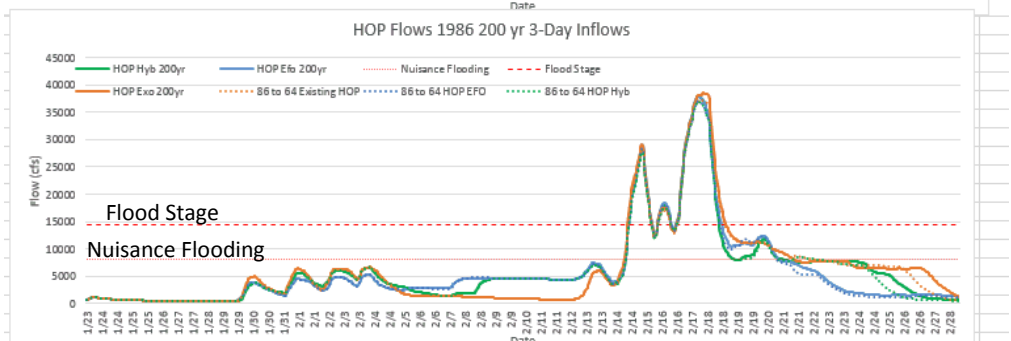


No increase in flood peak or nuisance flooding

1986 to 64 and 200yr Return Period

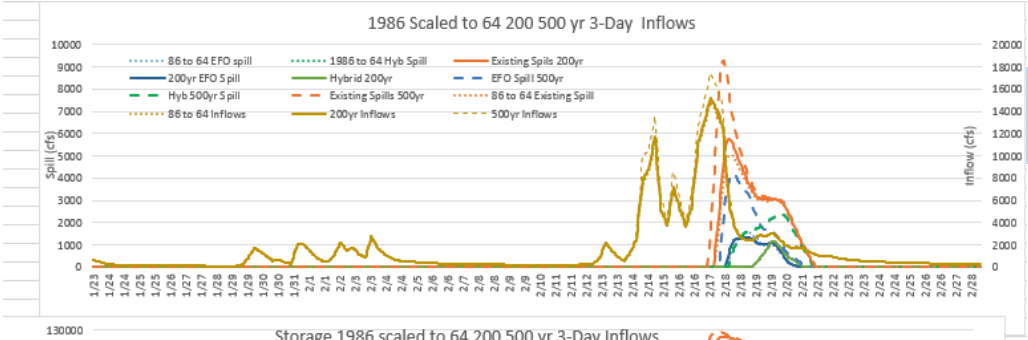




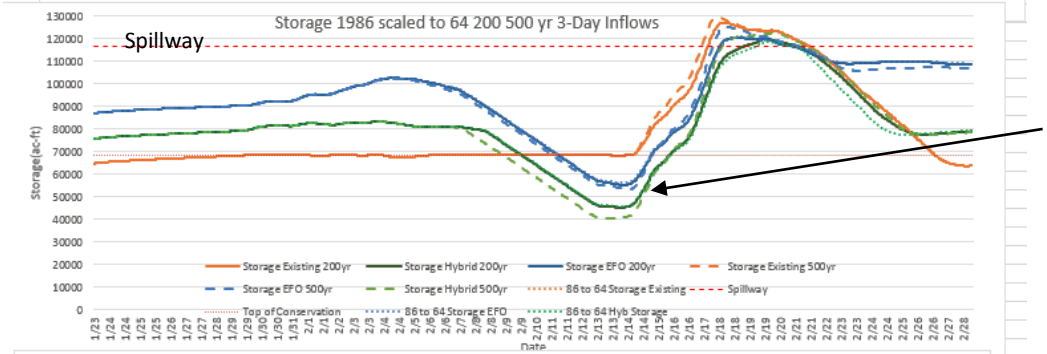


Very little difference between 64 and 200 yr scaling results

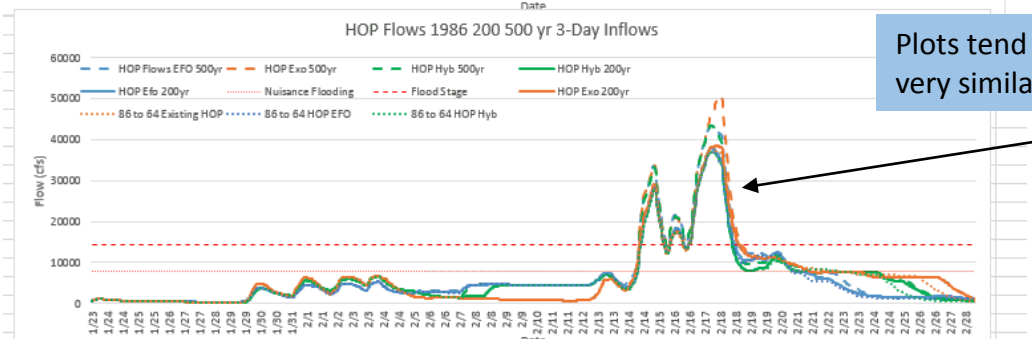
1986 scaled to 64 and 200 and 500yr Return Periods



Spill volumes reduced
For EFO and HYB vs EXO



EFO and HYB dip well into conservation pool

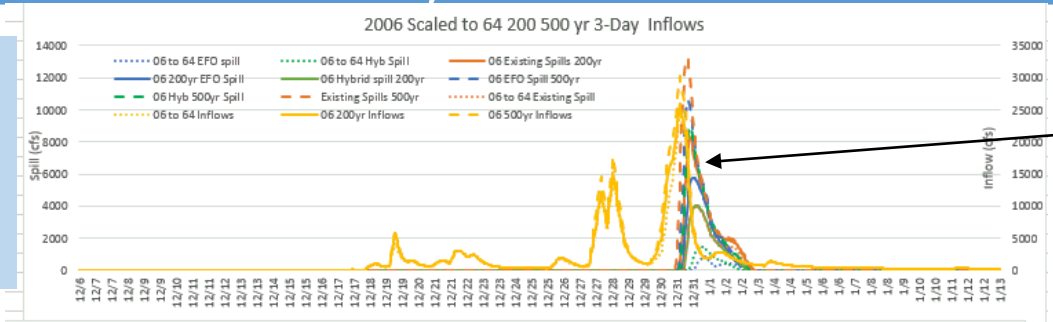


Plots tend to overlay as flows at HOP
very similar for EFO and HYB but less than EXO

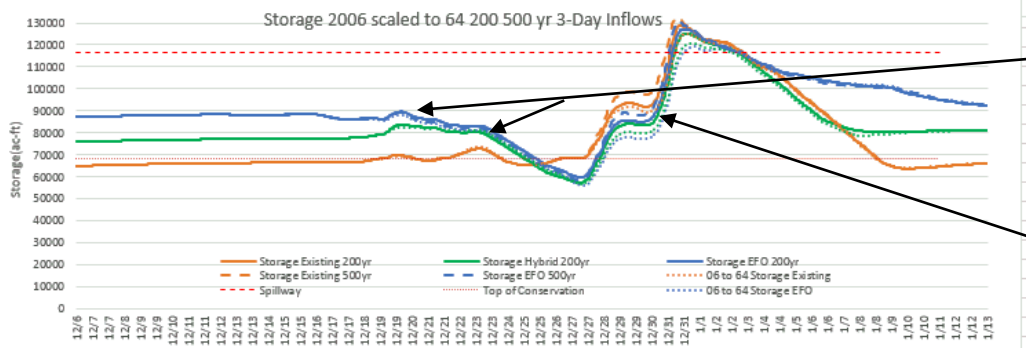
06 Scaled to 64 200 500 yr Events

Volume and duration of spills highest of all simulations

Based on simulated HOP flows the 2006 event constitutes worst case scenario of three cases

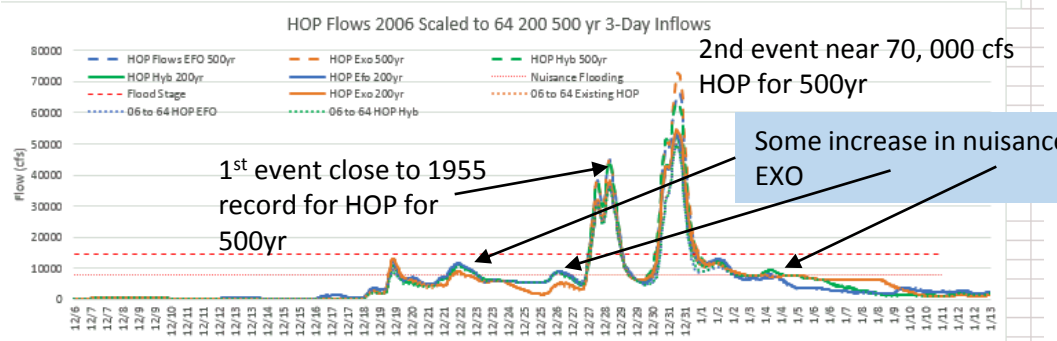


Spill volumes reduced for EFO and HYB virtual operations



Pre-releases begin some 9 days ahead of each of 2 events

Some flood releases made between events

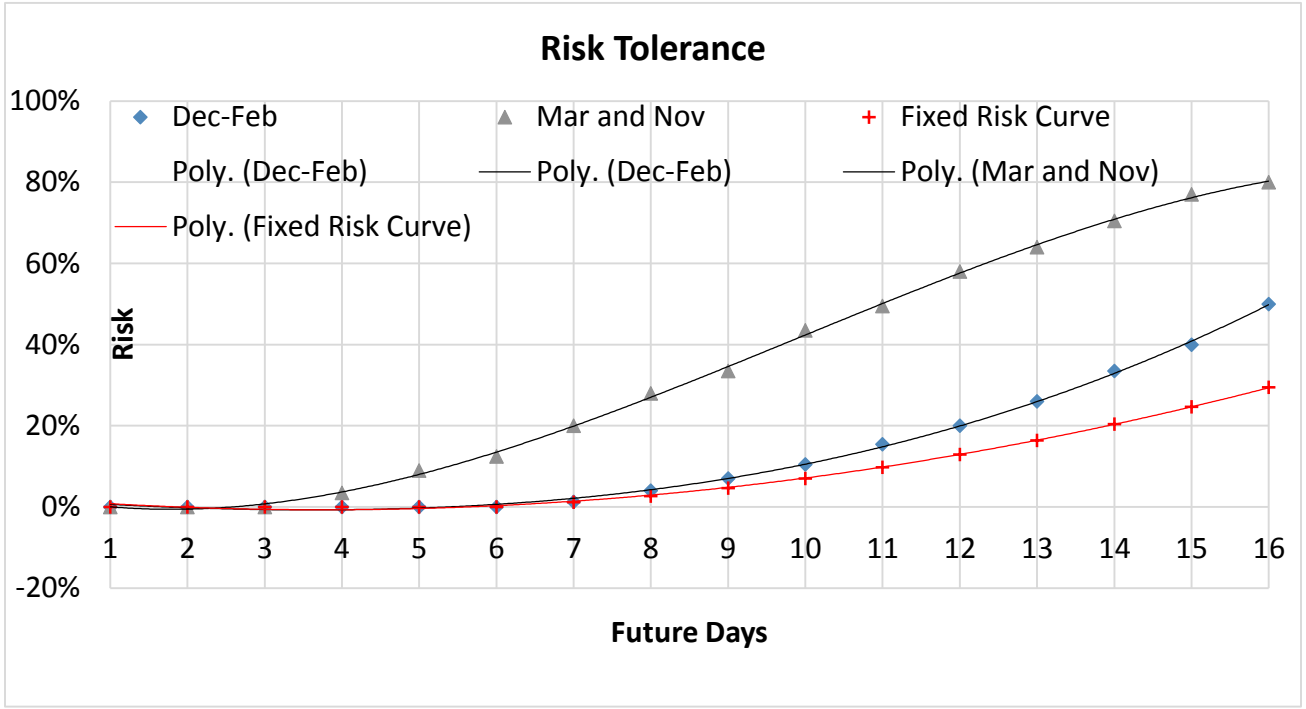


2nd event near 70, 000 cfs HOP for 500yr

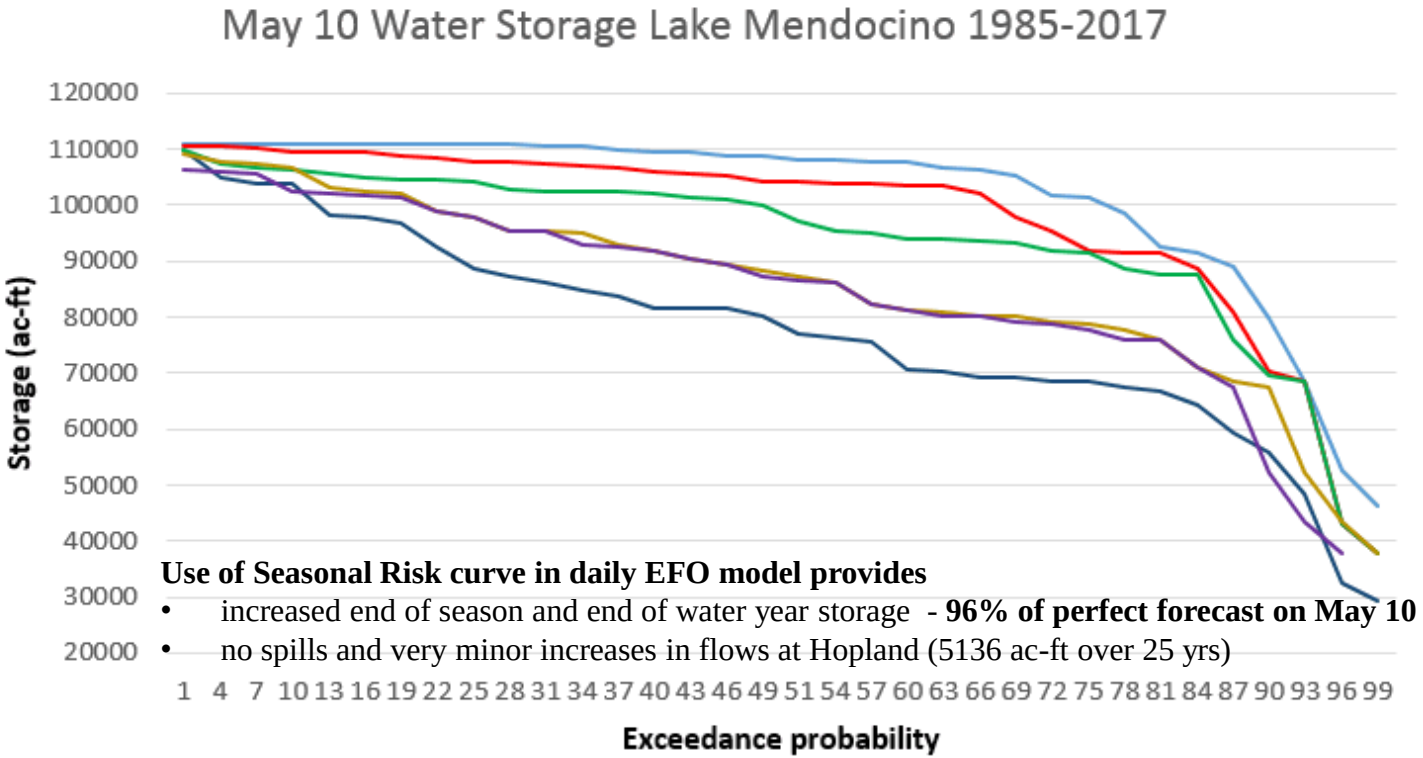
Some increase in nuisance flooding vs EXO

1st event close to 1955 record for HOP for 500yr

Variable vs Fixed Risk Tolerance



Exceedance Probability Variable vs Fixed Risk Curve



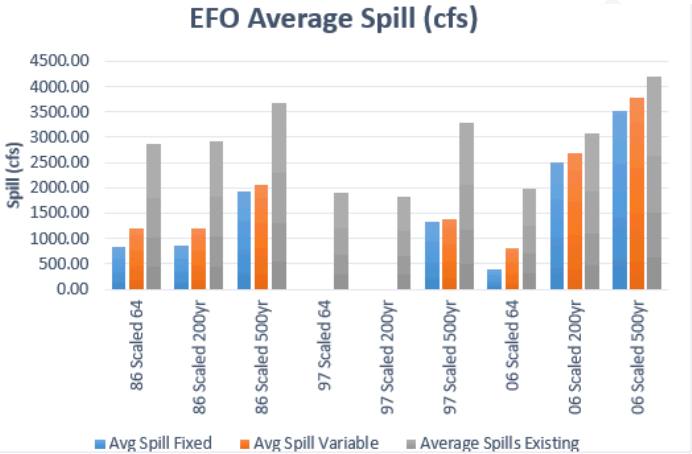
Use of Seasonal Risk curve in daily EFO model provides

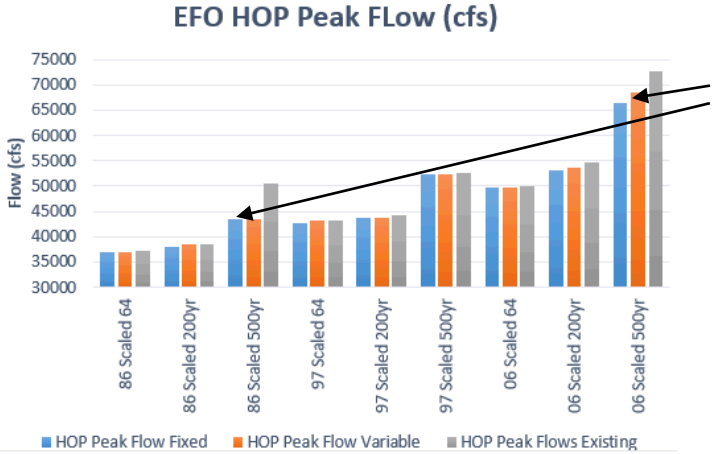
- increased end of season and end of water year storage - **96% of perfect forecast on May 10**
- no spills and very minor increases in flows at Hopland (5136 ac-ft over 25 yrs)

FIXED VS VARIABLE RISK CURVE

All spills reduced or eliminated

Variable risk slightly higher than fixed 86-06

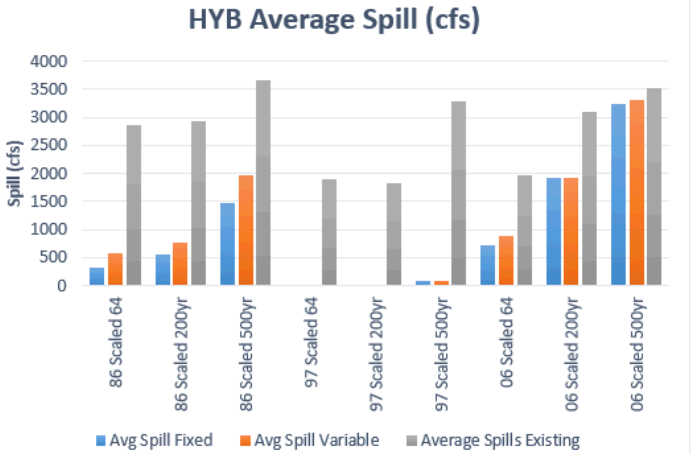


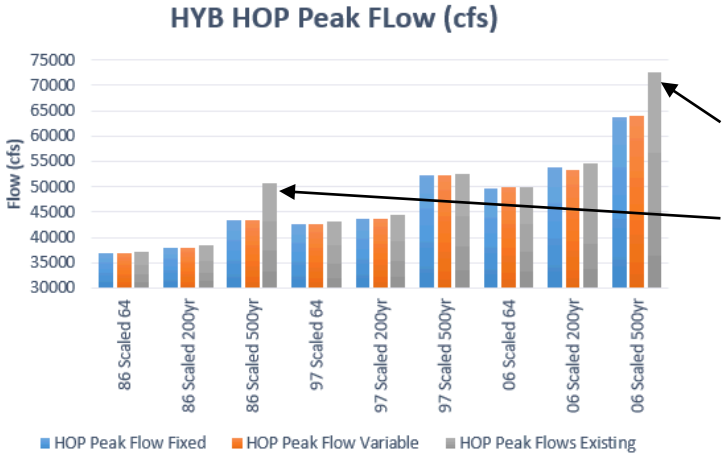


Reduction in flood crest downstream

Variable risk shows minor increases in HOP peak flows for 06 200 500 yr events

All spills reduced or eliminated Variable risk slightly higher than fixed 86-06

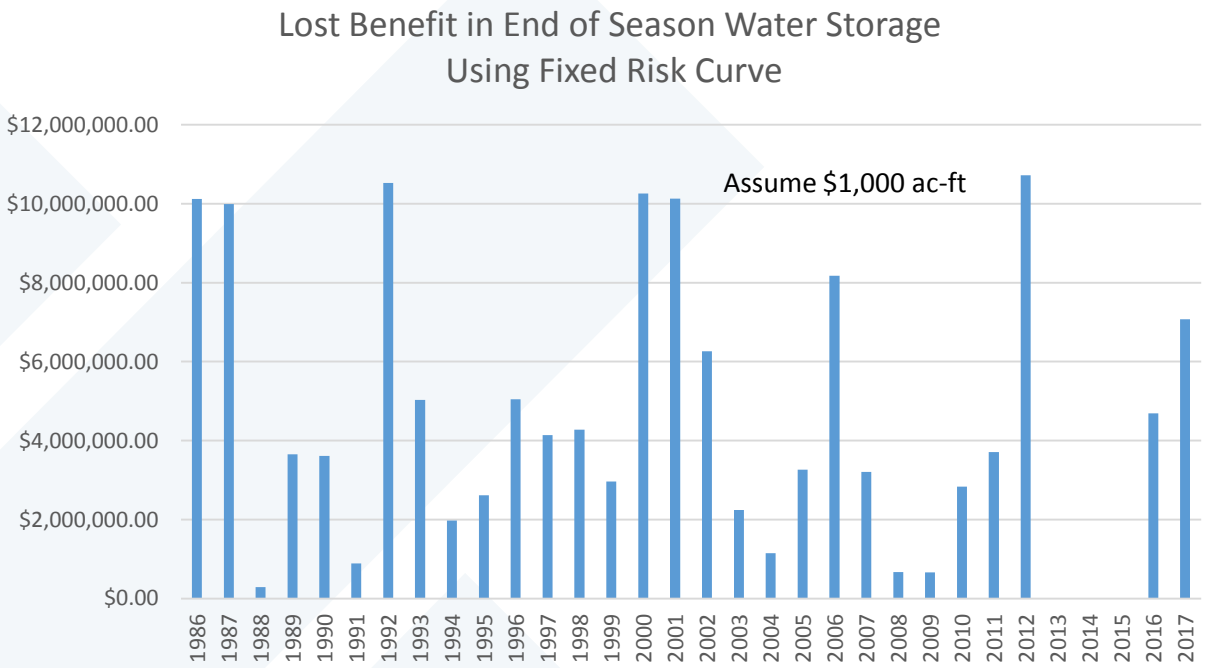




Reduction in flood crest downstream Little difference in peak flows fixed vs variable risk

CIRES

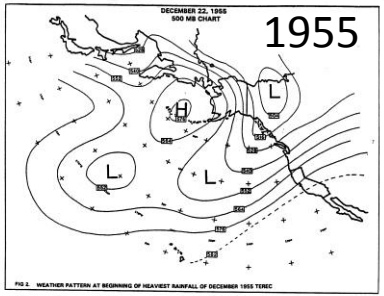
LOST BENEFIT IN END OF SEASON WATER STORAGE WITH FIXED RISK CURVE

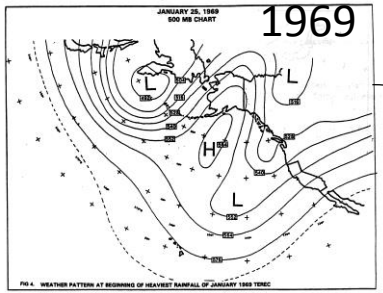


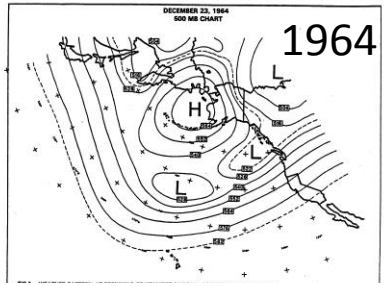
Conclusions

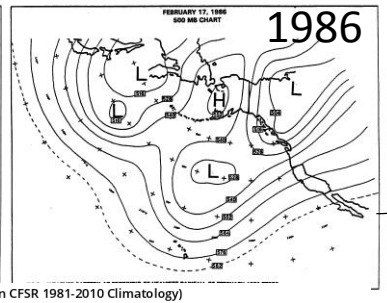
- For each event pre-releases began some 8-10 days prior to peak inflows
- All EFO and HYB simulations for all scaled events show a reduction or even elimination of spills (97 scaled to 64 and 200 yr event) versus existing operations
- There is no increase in flood flows at HOP for any scenario simulated using EFO or HYB virtual operations with fixed or variable risk curves but a reduction in several of the scenarios compared to EXO reservoir operations. (Slight increase in nuisance flooding for 06 scaled event)
- There are some slight increases in spills and minor increases in flows at HOP using variable Dec- Feb risk curve vs current fixed annual risk curve for EFO model. HYB shows little difference.
- Substantial end of season storage increases for EFO operations using variable risk curves
- Question –
  - Do these scaling simulations actually capture the uncertainty (spread) in inflow forecasts as the 3-day inflows increase to 200 or 500 year events?
  - Impacts of flows at Guerneville as model currently does not account for this

Similarities in 500mb patterns in major floods

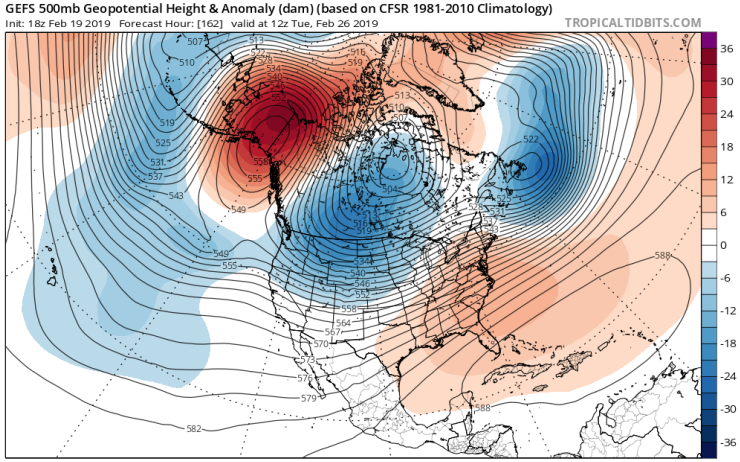








ARKSTORM



Guerneville Peak Stages

1986*	102,000	48.56	Feb 18, 1986
1995*	93,900	48.01	Jan 9, 1995
1965*	93,400	49.60	Dec 23, 1964
1956	90,100	49.70	Dec 23, 1955

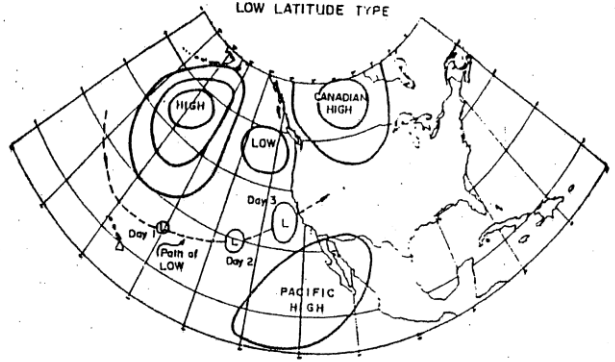
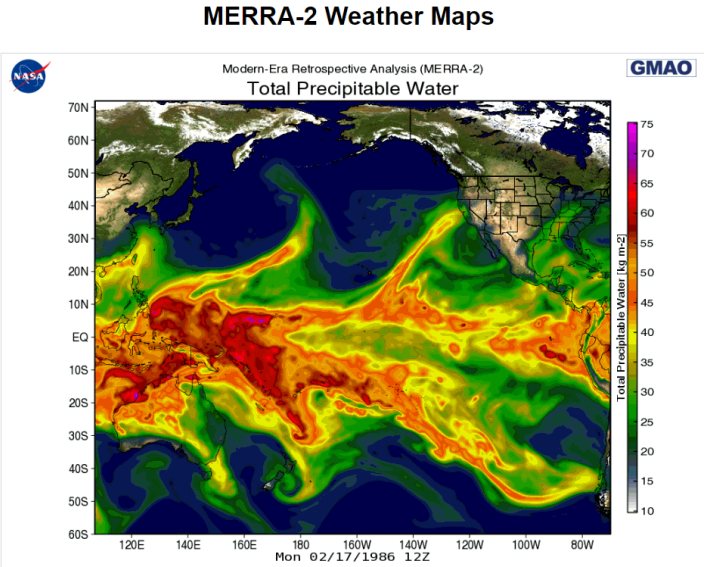


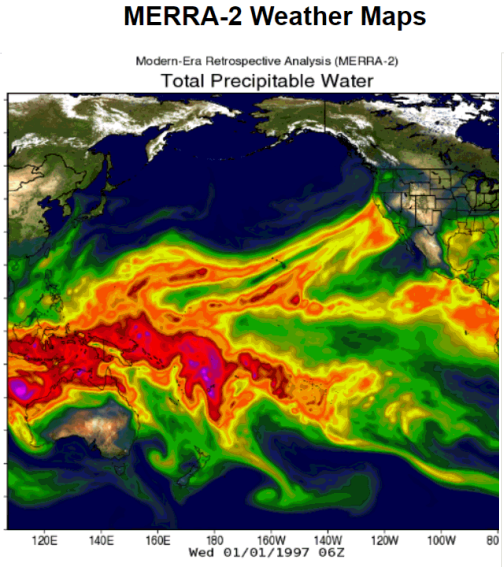
Figure 1. Schematic diagram showing Low Latitude type storm. Blocking in the Gulf of Alaska is an integral feature of this synoptic type. Disturbances pass north and south of the blocking anticyclone with southern breakthrough occurring near Hawaii. A quasi-stationary front with waves at various stages of development extends from the latitude of Hawaii northeastward into California (Monteverdi, 1976).

Diagram based on R. L. Weaver's 1962 U.S. Weather Bureau Report No. 37 Meteorology of Hydrologically Critical Storms in California

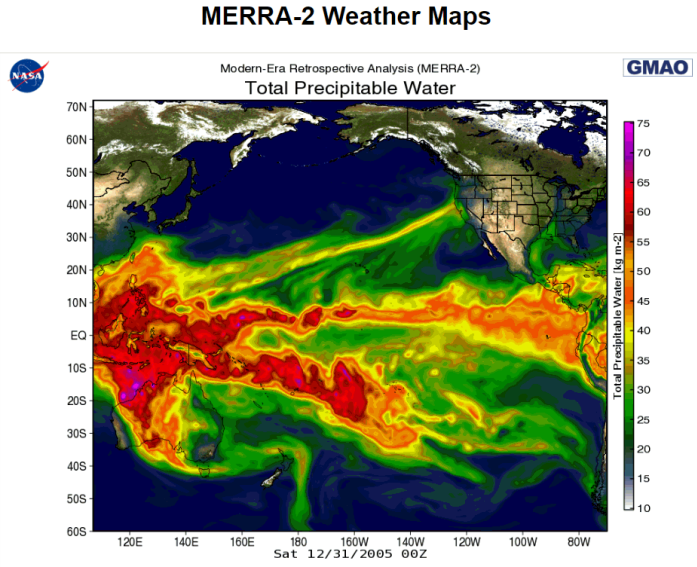
IWV Images centered on main rainfall period for each event



1986



1997



2006

Scaling Flows and Scenarios Run

- Scaled the maximum 5-day precipitation for Lake Mendocino watershed to achieve 3-day inflow volumes matching Dec 1964 and 200 and 500 yr 3-day volumes
  - 37 to 39 days provided for each event (~ 26 days before and 12 days after peak inflow.
- EFO and Hybrid (HYB) scenarios as well as existing (EXO) virtual operations simulated
  - Storage levels at beginning of each simulation based on average for start date for given scenario (EFO,HYB,EXO) based on 1985-2010 hindcasts.
- Used both the fixed risk curve (risk curve used operationally) and a variable risk curve developed to increase end of water year storage
- Used hourly time steps as was used operationally for 2018-19
- Evaluated output for
  - mitigation of downstream flooding at Hopland from pre-releases
  - enhancement of downstream flooding from spills?
  - increase in nuisance flooding at HOP from flood releases versus EXO?