THE CURRENT DROUGHT IN CONTEXT: A TREE-RING BASED EVALUATION OF WATER SUPPLY VARIABILITY FOR THE SALT-VERDE RIVER BASIN

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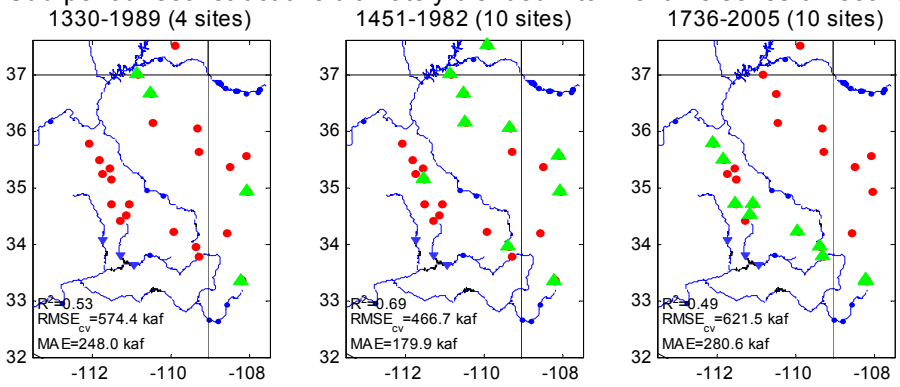
Objective -- To update the tree-ring reconstructions of annual streamflow of the Salt-Verde-Tonto Basin through the period of the most recent drought and place it into a long-term, historical context linked to climatic variability

Main Project Activities

1. **UPDATING TREE-RING CHRONOLOGIES** – Field collections and laboratory analysis to develop chronologies in the Salt-Verde basin with data through growth year 2005
2. **NEW STREAMFLOW RECONSTRUCTION** – Analysis of the new tree-ring chronologies to place the most recent drought in a long-term context
3. **EW-LW EVALUATION** – Exploration of the seasonal precipitation signal in separate measurement of earlywood and latewood width measurements
4. C**LIMATIC ANALYSES** – Synoptic dendro-climatology studies of observed record to better interpret the reconstructed record

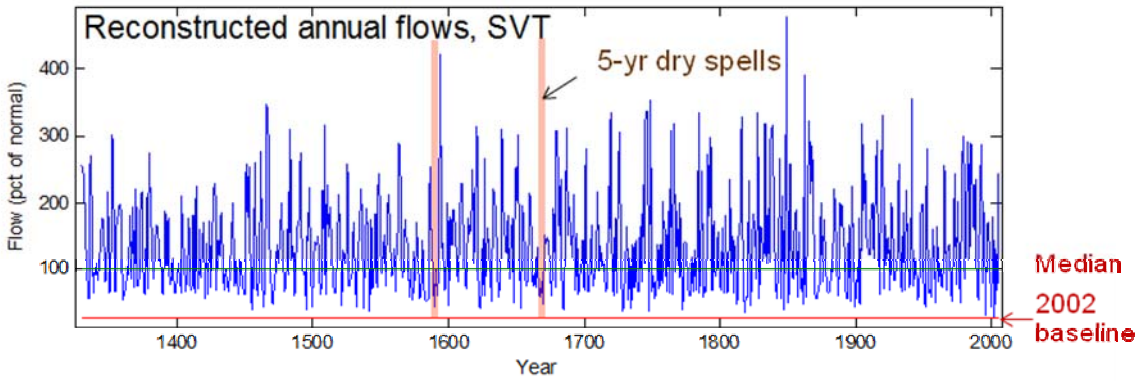
Reconstruction Models

- Tree-ring sites have variable time coverage
- Uniform time coverage required for a model => 3 reconstruction models
- 3 Sub-period reconstructions ultimately blended into final time series of reconstructed streamflow



Results of Reconstruction

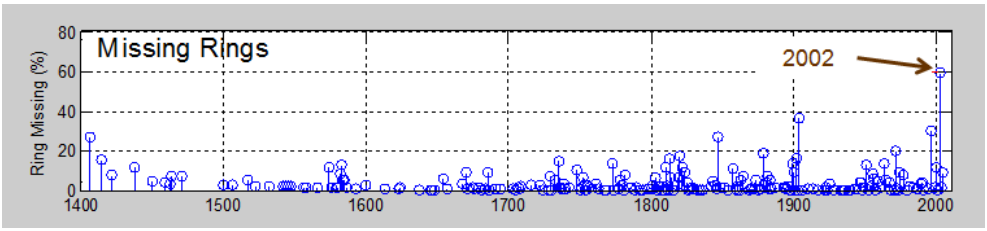
Plotted as % of normal* *normal = defined as 1914-2006 median of observed flows



- 2002 and 1996 have the lowest reconstructed annual flows in the entire record (28% and 30% of normal* respectively)
- Maximum number of consecutive years below normal = 5 (in 1590s and 1660s)
- Longest stretch of consecutive years below normal in recent interval of 1914-2005 is 4 years (1950s)

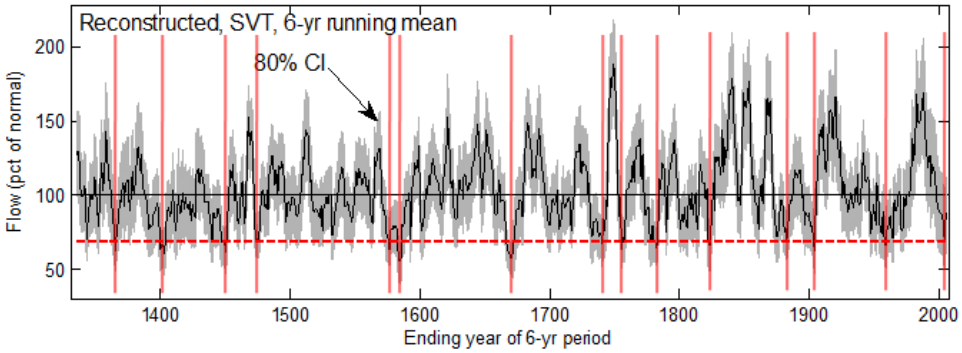
Missing Rings % plotted over time:

2002 was unprecedented for frequency of missing rings



Variations in Time-Averaged Flow

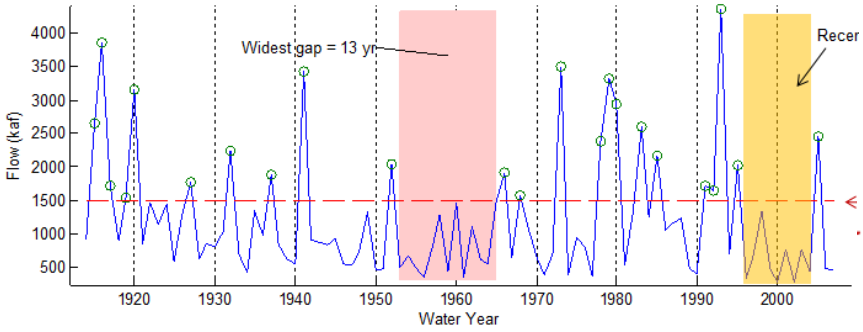
(Plotted as % of normal* *normal =median of all 6-year running means)



- 14 distinct prior occurrences of flow as low as 1999-2004 average
- 1- 3 occurrences in each century
- Most severe conditions at ~1590 and ~1670

Length of Intervals between Wet (High Flow) Years

(Based on Observed Flows, 1914-2007)

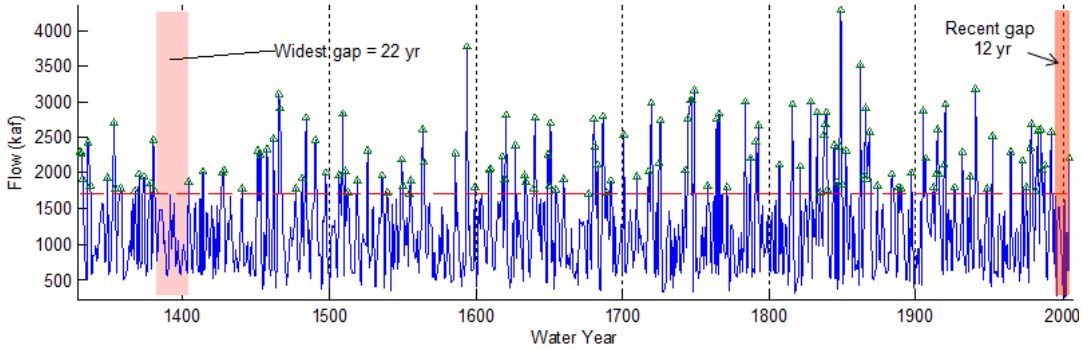


- Interval longer in 1950s than during recent drought period
- If not for mildly wet 1952, the earlier interval would have been 25 years
- Median interval is 2 years in the

"Wet Year" = flow above 75th percentile

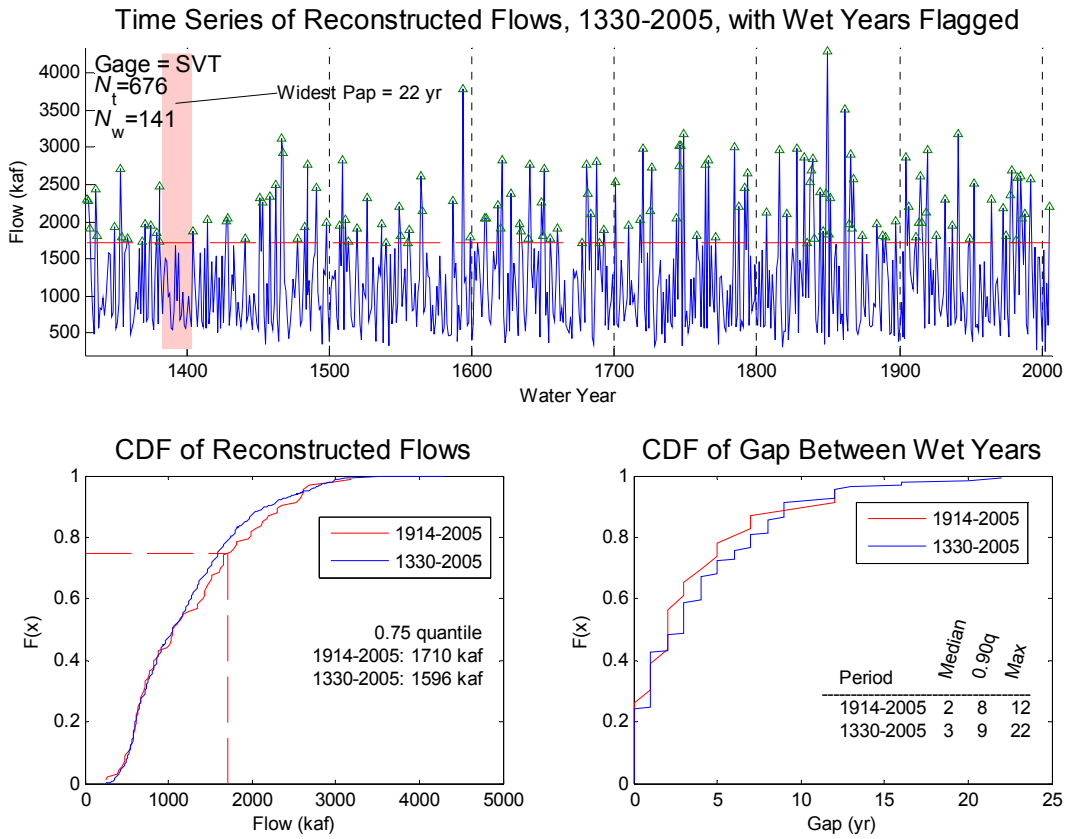
Length of Intervals between Wet (High Flow) Years

(Based on Reconstructed Flows, 1330-2005)



Longest = 22 yrs (1382-1403)
Recent = 12 yrs (1993-2004)
1950s = 12 yrs (1953-1964)
10 intervals ≥ 12 yrs
Median interval is 3 yrs

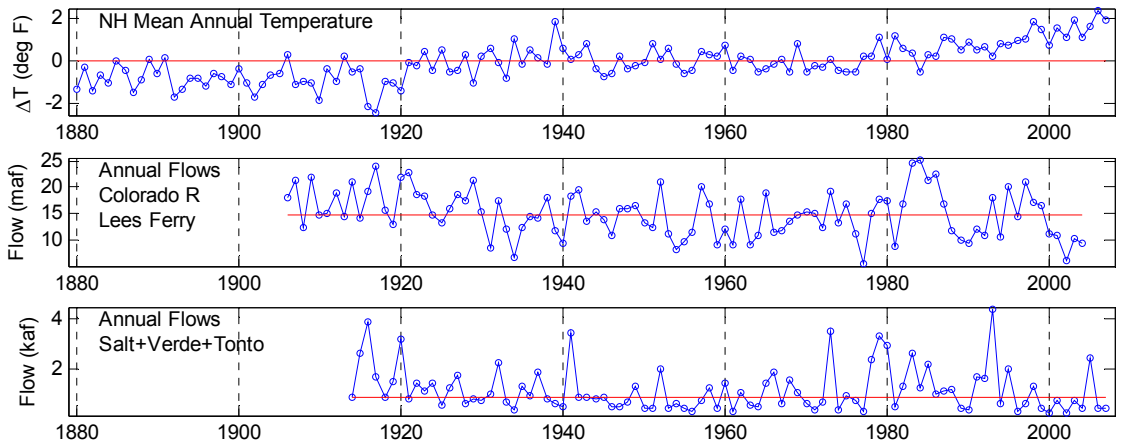
"Wet Year" = flow above 75th percentile



Testing for Latewood Signal of Summer Rainfall

- Total width had signal for annual precipitation, but no signal for summer precipitation
- Latewood width had a weak but significant signal for summer precipitation
- Results encouraging, but summer precipitation signal in partial ring widths is too weak to expect useful reconstruction of summer monsoon variability from this limited site coverage

The Climatic Context of Recent Droughts & High Flow Episodes – "Global Climate Context"



NH Temperature Data from NASA/GISS; data are departures from 1951-80 mean based on GHCN met stations

Upper Colorado Flows natural flows for Lees Ferry from USBR

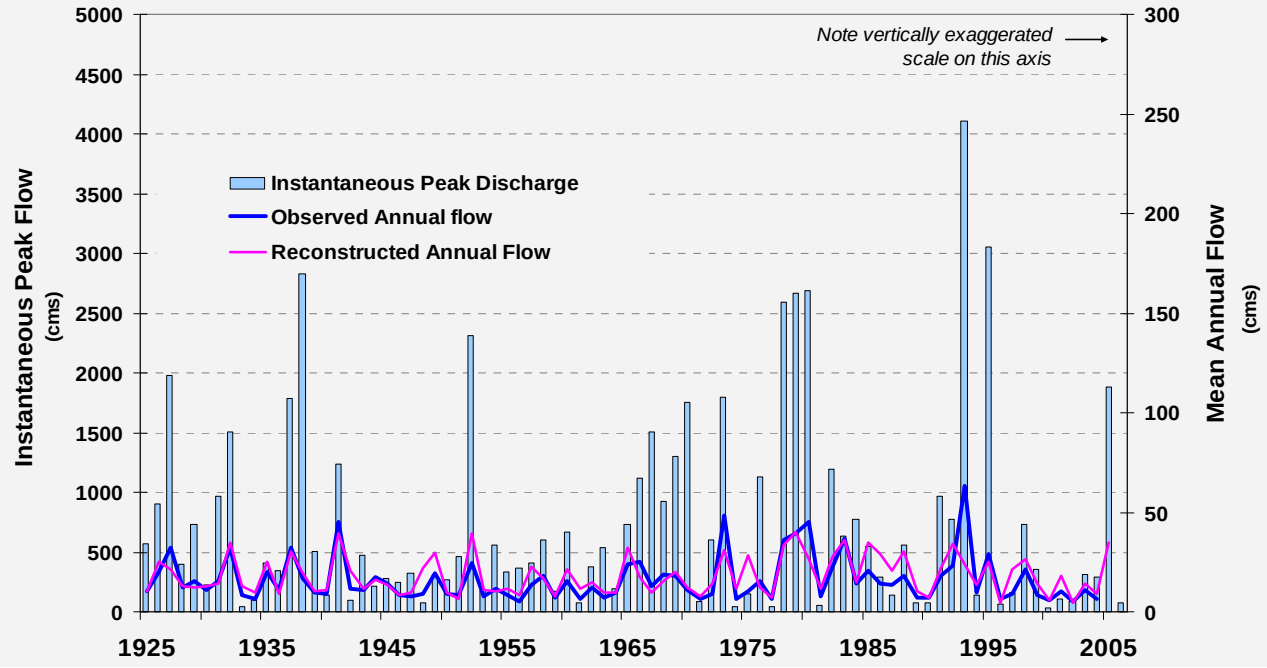
Salt-Verde-Tonto Flows from USGS

Horizontal lines for flows are at medians

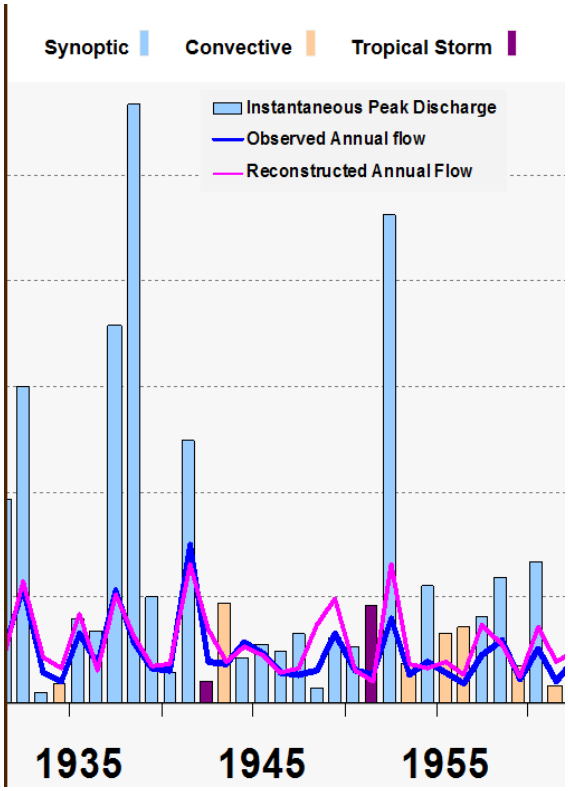
- Recent drought: mean NH temperatures near record highs
- 1950s drought: mean NH temperatures near middle of long-term warming trend
- Wet late 1970s to early 1980s: mean NH temperatures higher
- Wet period 1915-20: mean NH temperatures low
  (not shown here) severe tree-ring drought of 1899-1904:mean NH temperatures very low

The Climatic Context of Recent Droughts & High Flow Episodes -- Floods / High Flows & Reconstructed Flows

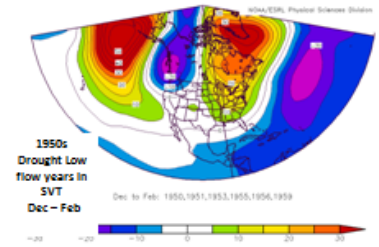
High flow / flood "wet years" are tracked reasonably well by Verde River tree-ring reconstruction



Analyzing the reconstruction synoptically:



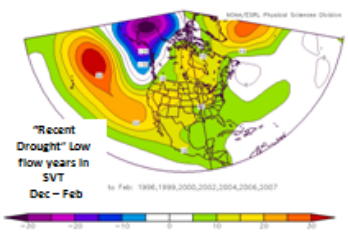
Both reconstructed & observed annual flows track the magnitude of the instantaneous peaks best during SYNOPTIC (winter) events



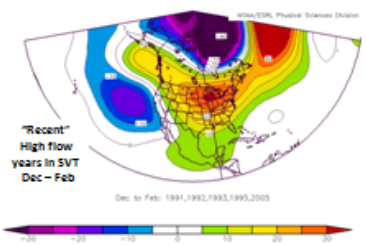
Synoptic Circulation Patterns for SVT

Verde Basin study: tree-ring record is a good indicator of winter storm track activity

1950s pattern vs. "Recent Drought" pattern

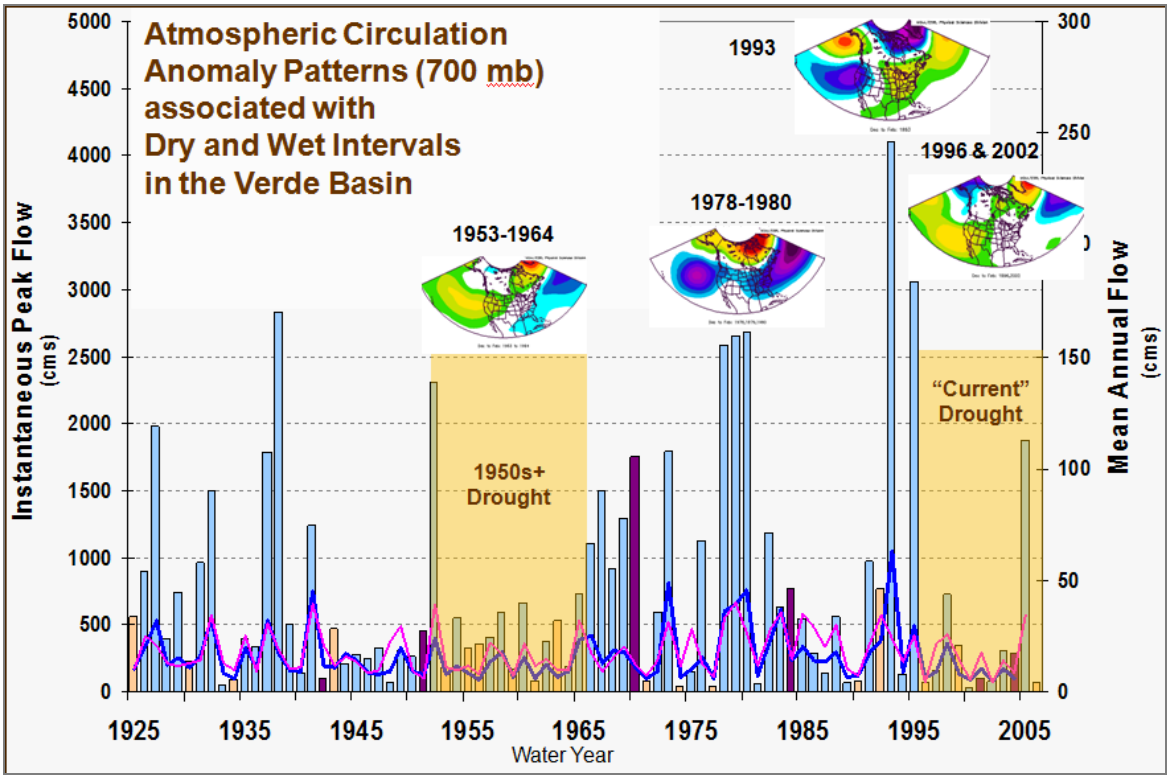


Recent High Flow Year pattern



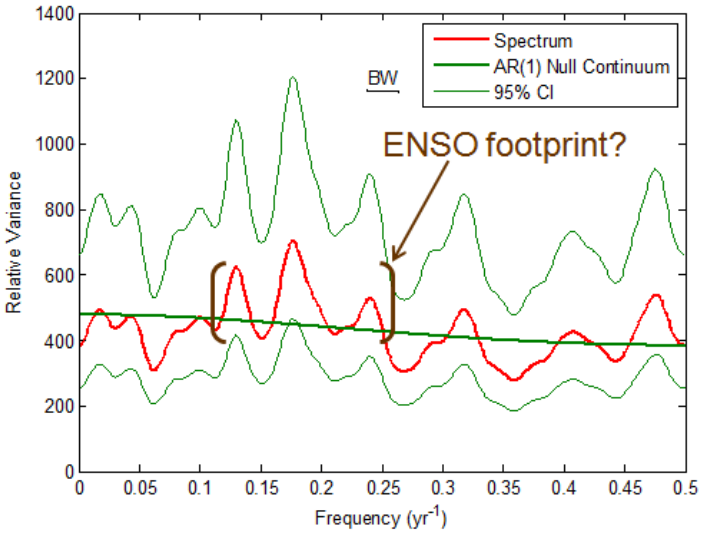
Importance of BLOCKING circulation anomaly patterns: Blocking leads to the PERSISTENCE of circulation features that produce EXTREMES

The Climatic Context of Recent Droughts & High Flow Episodes –
Synoptic Atmospheric Circulation Patterns Linked to Dry and Wet Intervals



Are Streamflow Variations Cyclic?

Spectrum, 1330-2005 Reconstruction



SUMMARY & CONCLUSIONS

Reconstruction Model Summary

- Ring widths of the new collections have a strong annual runoff signal
- Subset models blended together yield a streamflow reconstruction covering 1330-2005
- The reconstruction explains 49- 69% of the variance of the annual flows

Extreme Single-Year Summary

- The reconstructed 1996 value was the 2nd lowest reconstructed flow since 1330
- The reconstructed 2002 value was the LOWEST reconstructed flow since 1330
- From tree's perspective 2002 was a year like no other: 60% of 300+ cores were missing the 2002 ring!

CONCLUSIONS

1) Single-year intensity:
   drought in recent years unsurpassed in long-term tree-ring record (i.e., 1996, 2002)

2) Multi-year intensity:
   14 distinct prior occurrences of flow as low as 1999-2004 average

3) Several intervals between "drought relieving" wet years were longer than any observed in the instrumental record

4) Winter storm track position key factor in drought signature (1950s vs. recent drought)

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MAIN LTRR-SRP WEBSITE: www.ltrr.arizona.edu/srp

Llink to LTRR-SRP-II Project: http://fp.arizona.edu/kkh/srp2.htm

(NOTE: The Final Report will be available at the LTRR-SRP-II website. Stay tuned for an email notification via Jon Skindlov when it is posted.)

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