New streamflow reconstructions for the Rio Grande basin

David Meko

Laboratory of Tree-Ring Research, University of Arizona

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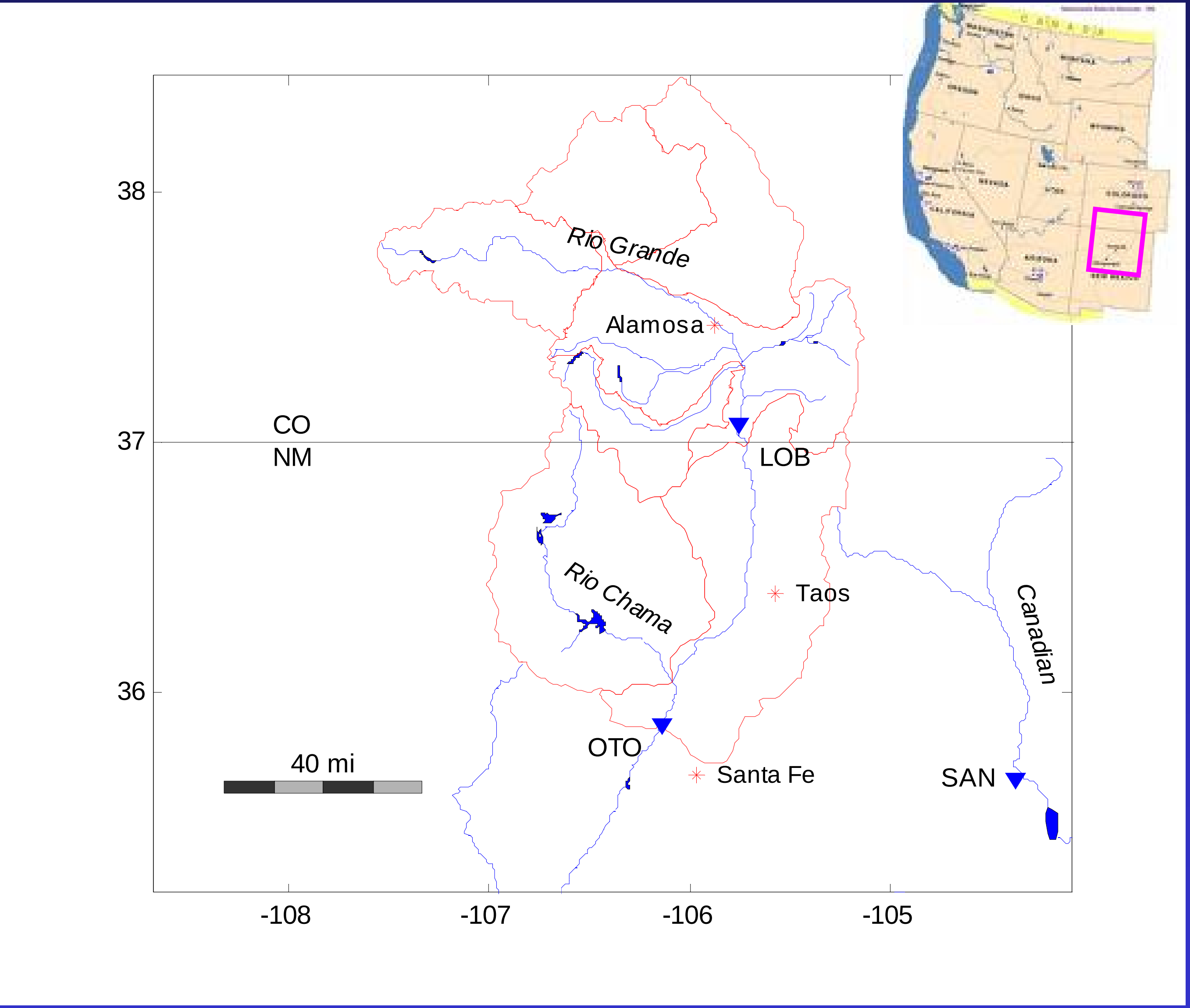
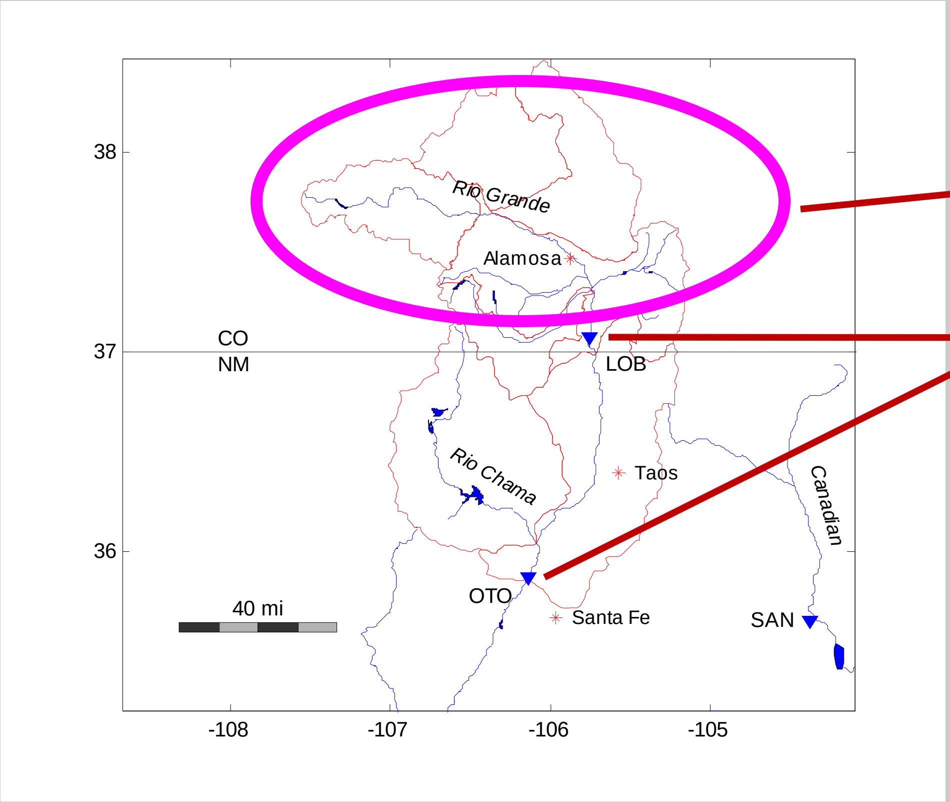
River System



Rio Grande Natural Flow Index



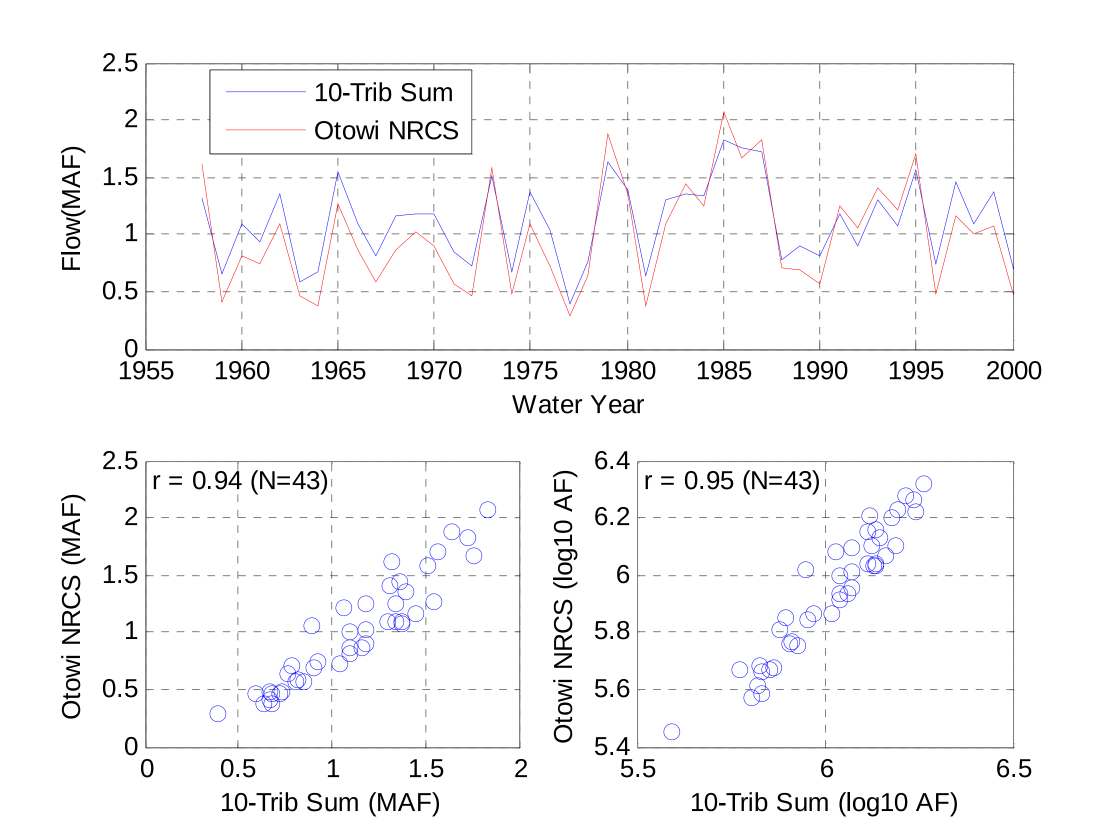
$$Q_1 = \text{ sum of flow at 10 gages in Colorado}$$

$$\Delta Q = Q_{\mathrm{OTO}} - Q_{\mathrm{Lobatos}}$$

$$I = Q_1 + \Delta Q$$

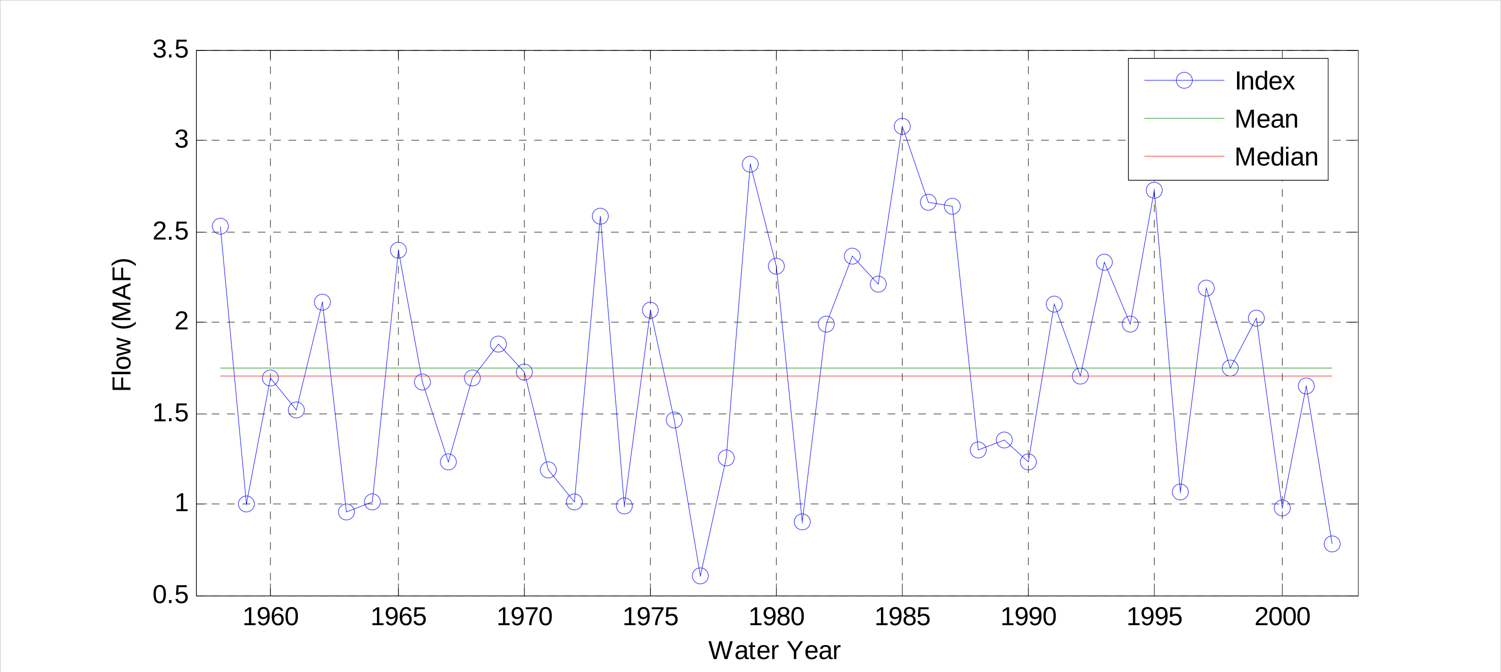
- Q_{OTO} is NRCS
- $Q_{lobatos}$ is gaged

Otowi flows and Colorado Runoff*



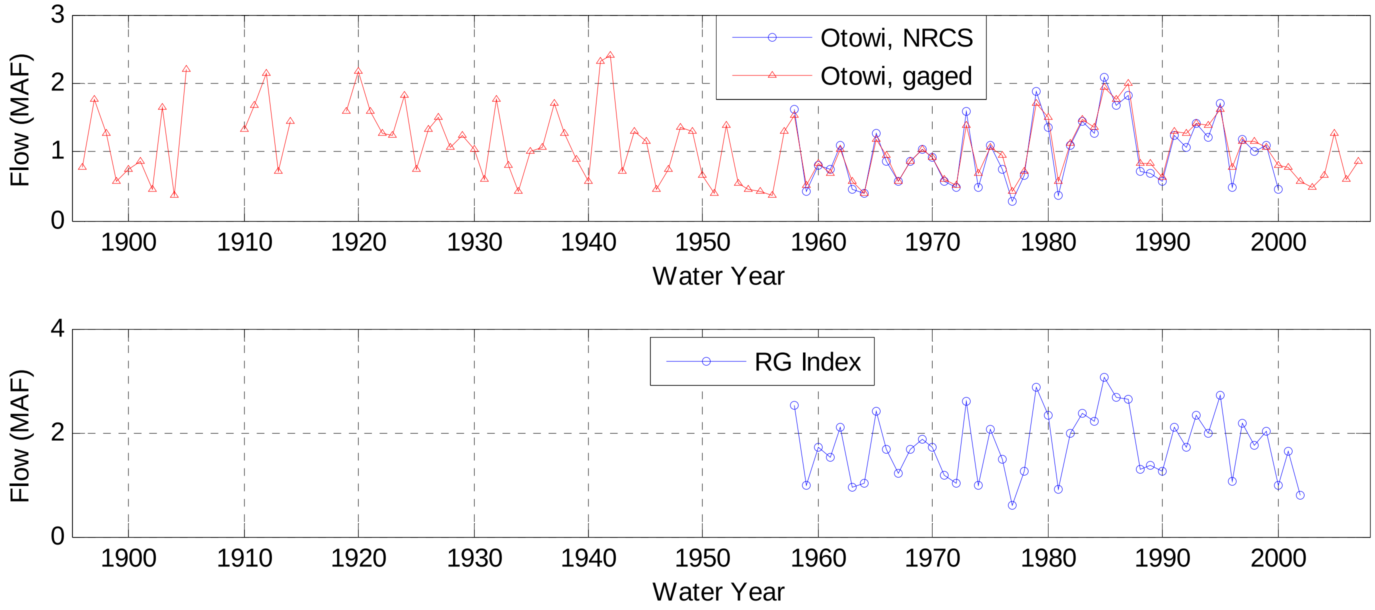
- * Sum of gaged flows of 10 tributaries including Conejos, Trinchera, Los Pinos, Alamosa
- Strong coherence of flow at Otowi Bridge with runoff from mtns in Colorado
- No obvious differential trend

Rio Grande Index – time series



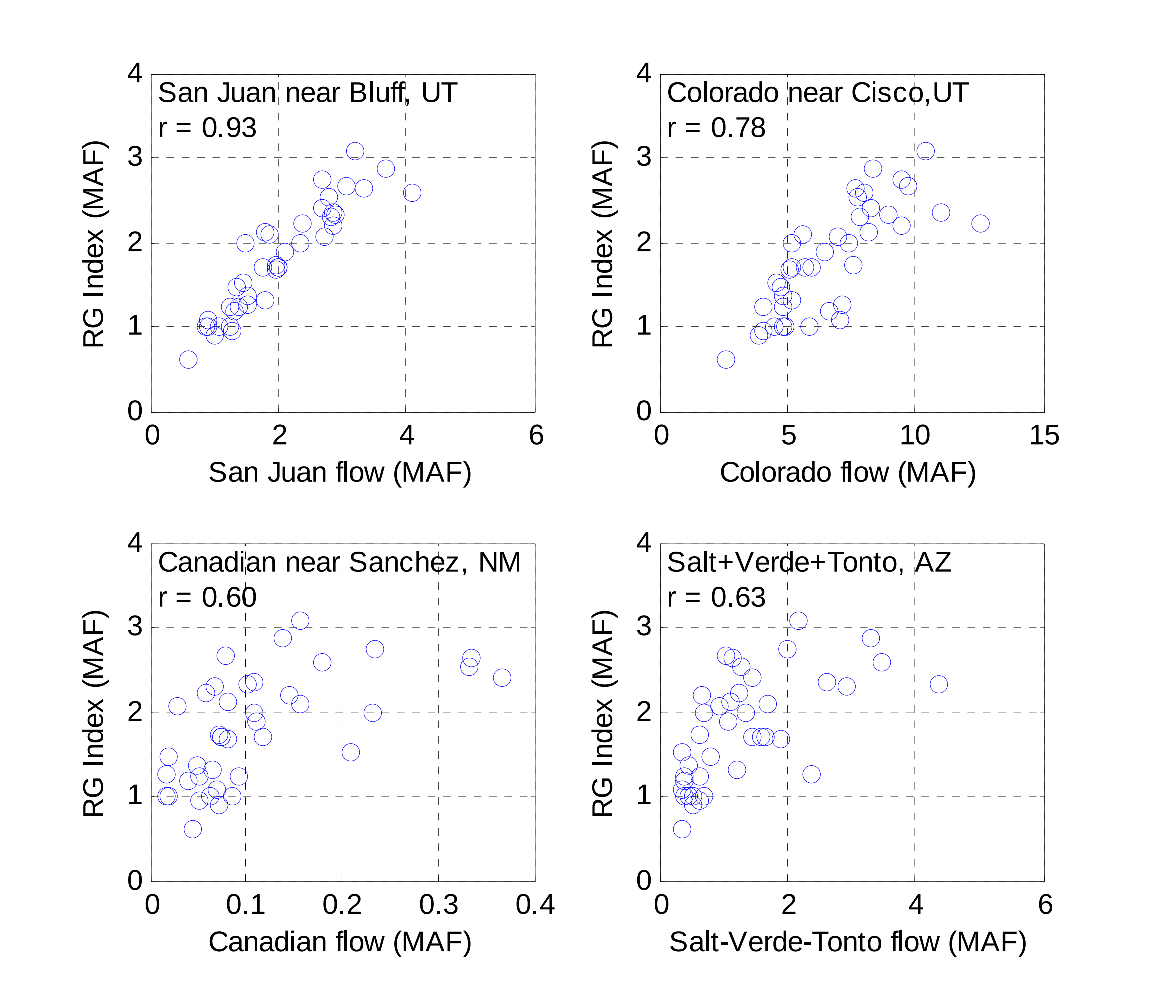
- Low in 1977 is 35 percent of mean, next is 45 percent in 2002
- High in 1985 is 175 percent of mean
- No obvious trend
- Mean is about ¾ MAF higher than mean of Otowi NRCS

Rio Grande Index – long-term context



- Gaged Otowi has scattered data back to late 1800s
- Suggests 1958-2002 representative of lows, but maybe not of highs (e.g., 1941-42)

Coherence with other Southwest Flow Series

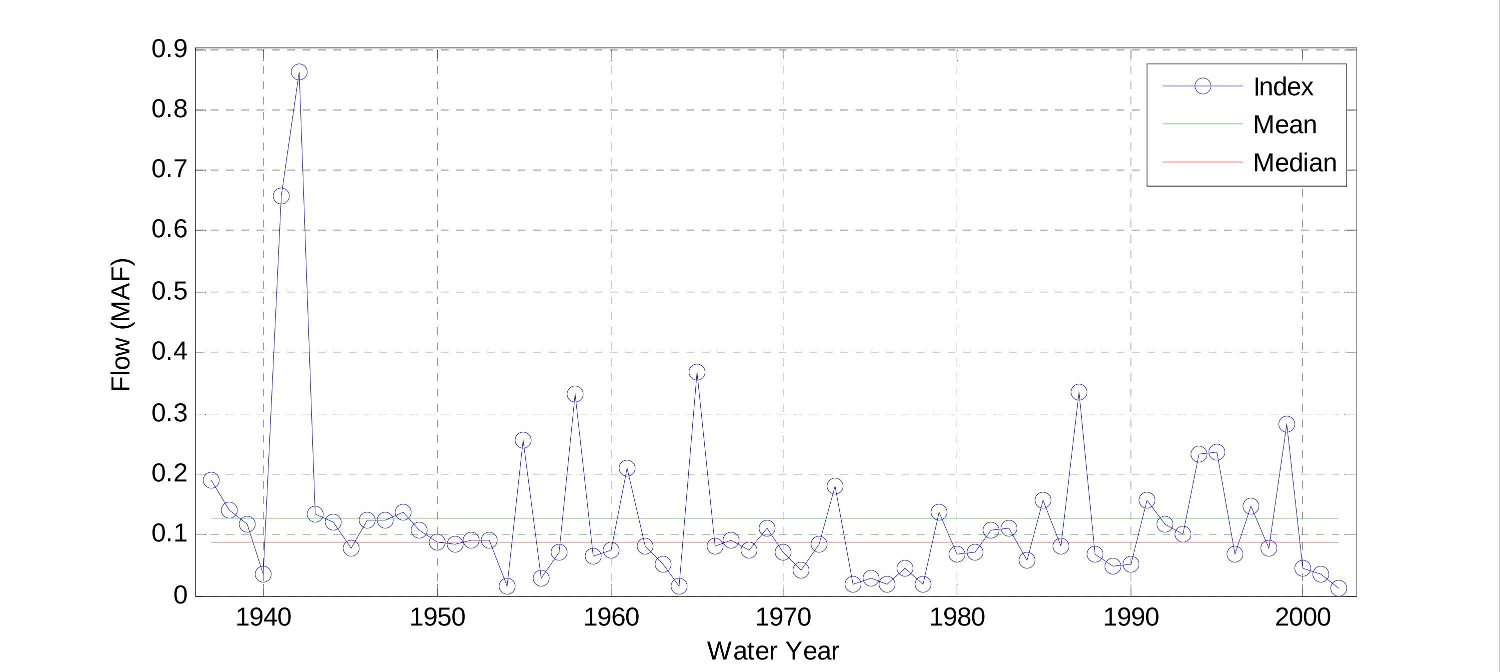


- Closest parallel with San Juan River
- Relationship weakens at high flows

Salt-Verde-Tonto and Canadian near Sanchez are USGS gaged flows; San Juan and Colorado are BOR natural flows

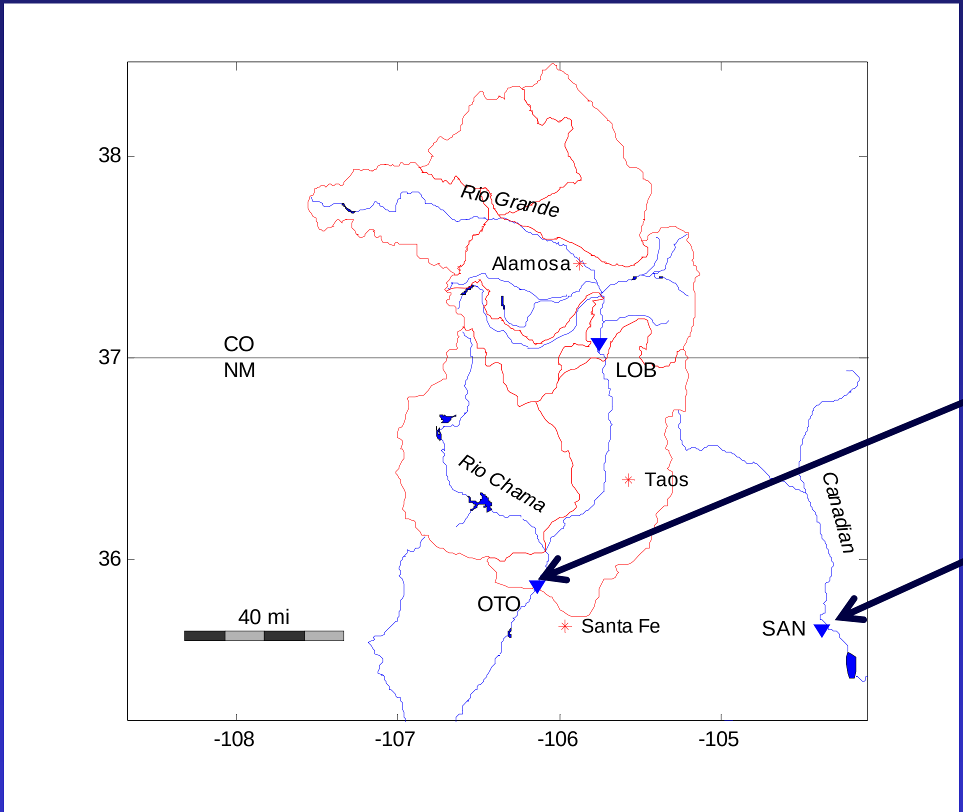
Canadian near Sanchez

(the other gage for reconstruction)



- Flows much lower flows than for Rio Grande at Otowi
- Dominance of 1941-42 high flows
- Lower mean
- No obvious trend

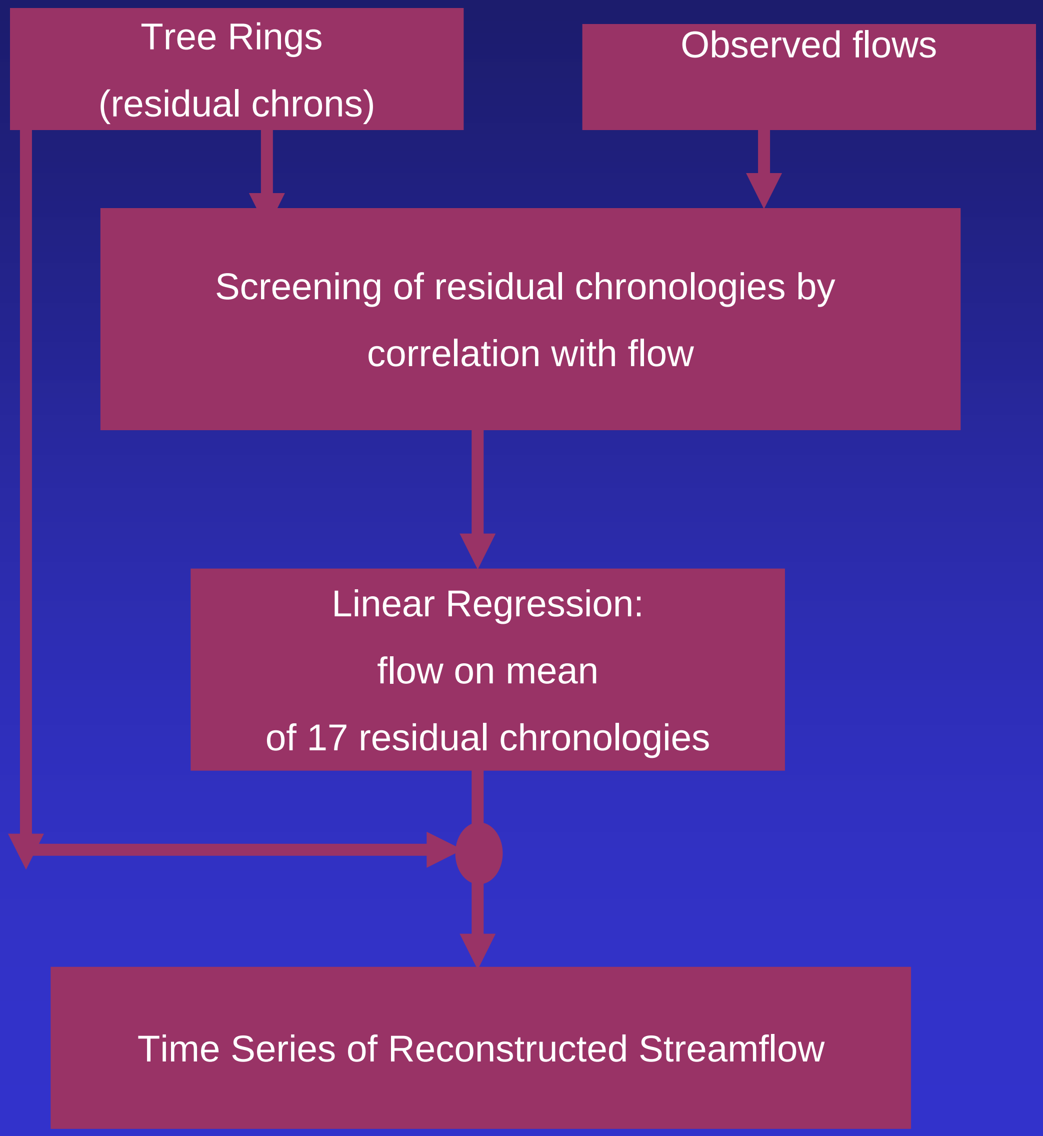
Streamflow Reconstructions



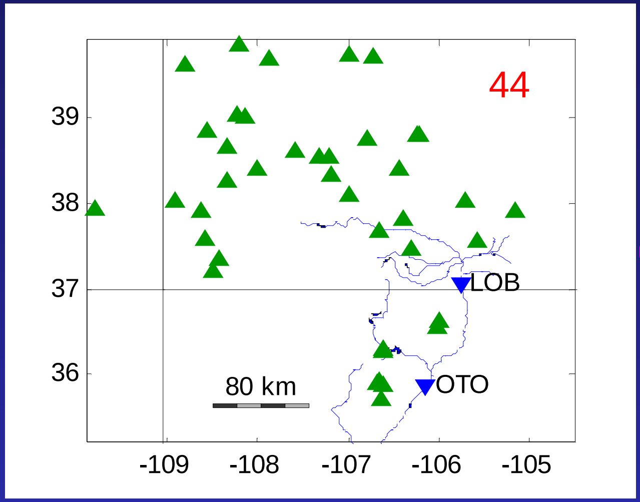
Water-Year Totals

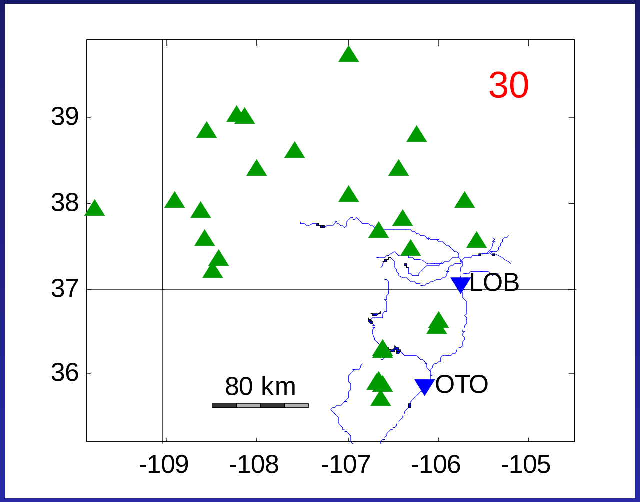
1. Rio Grande Index
2. Otowi NRCS
3. Canadian near Sanchez

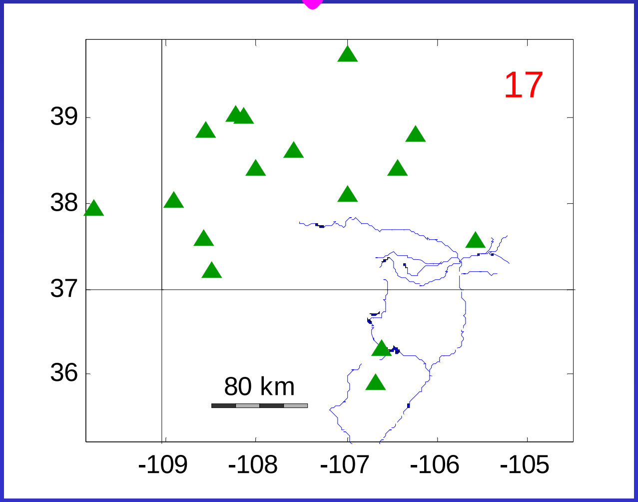
Reconstruction Method--Rio Grande Index



Tree-Ring Network – RG Index Reconstruction



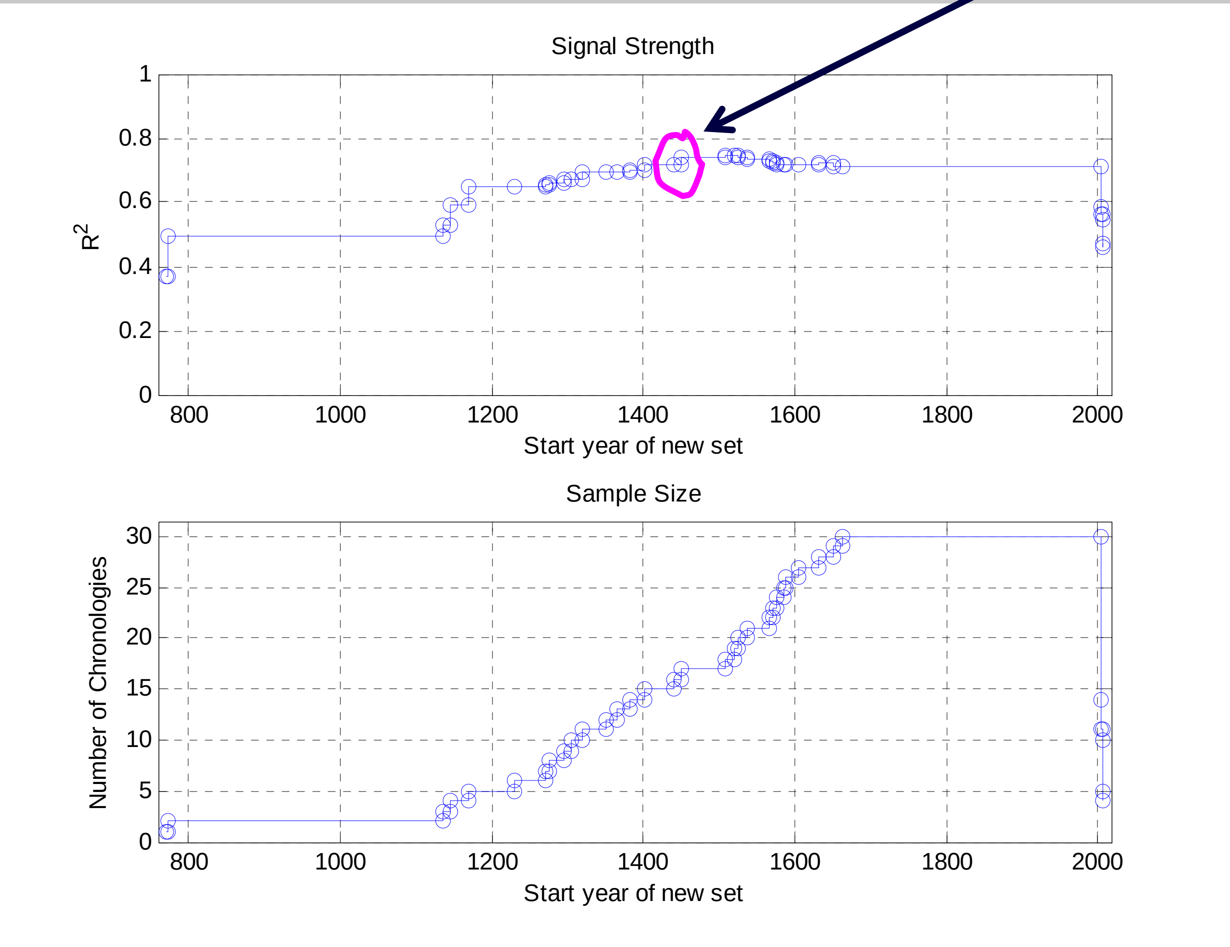




- 44 initial chronologies
- 30 complete through year 2002
- 17 complete 1450-2002
- (Same network also used in reconstruction of Otowi NRCS)

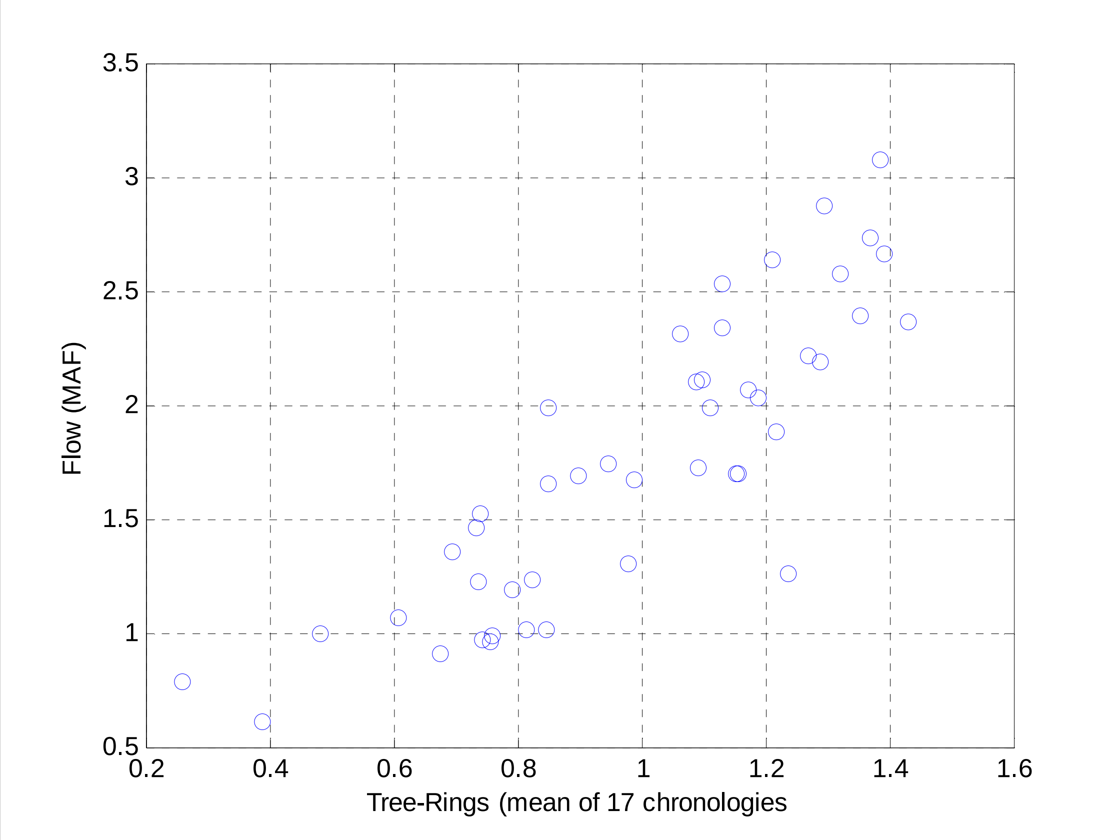
Why the 1450 start?

By 1450, the network of available chronologies can explain 74% of flow variance with simple regression model



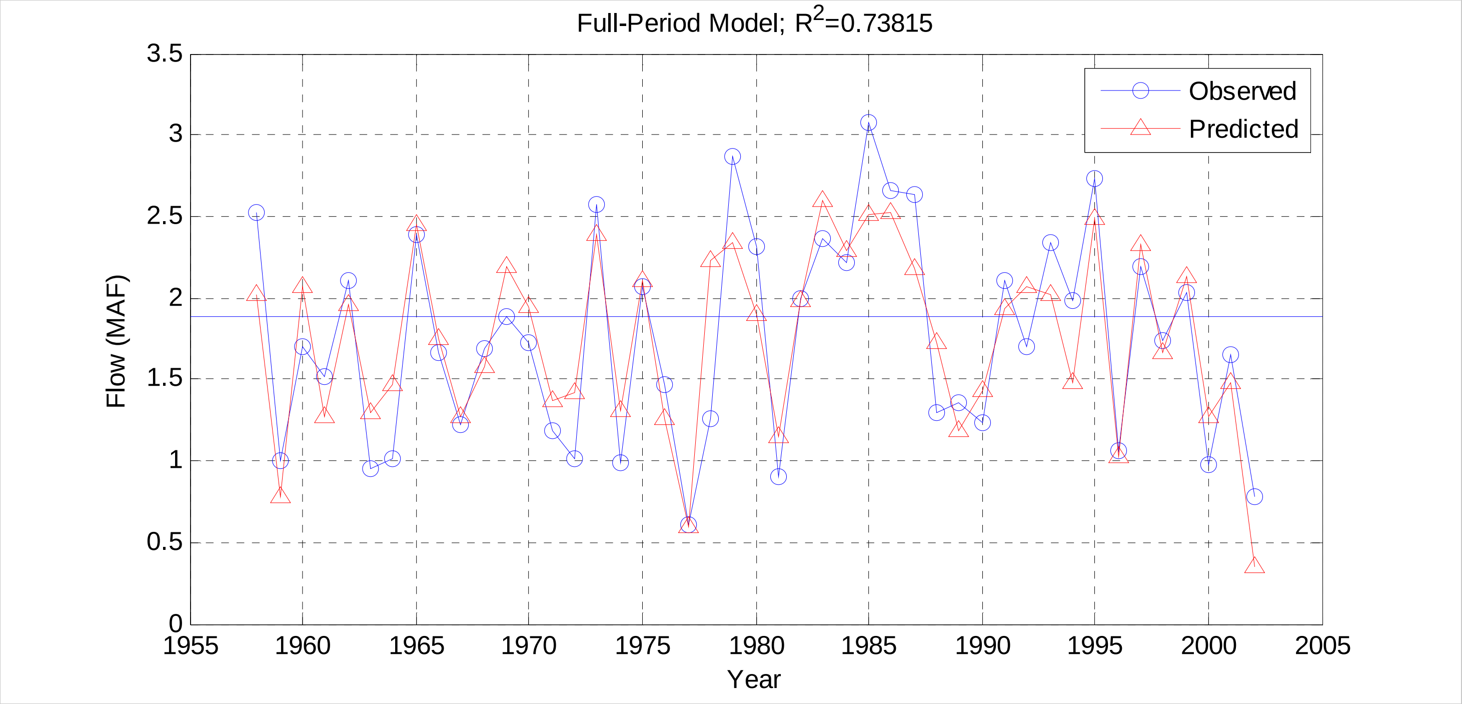
1. Find years the available network of chronologies with data through 2002 changes
2. Repeat regression modeling for each chronology subset with unique period of time-coverage
3. Plot regression variance explained and the number of chronlogies in the m-chronology mean

Flow Transformation?



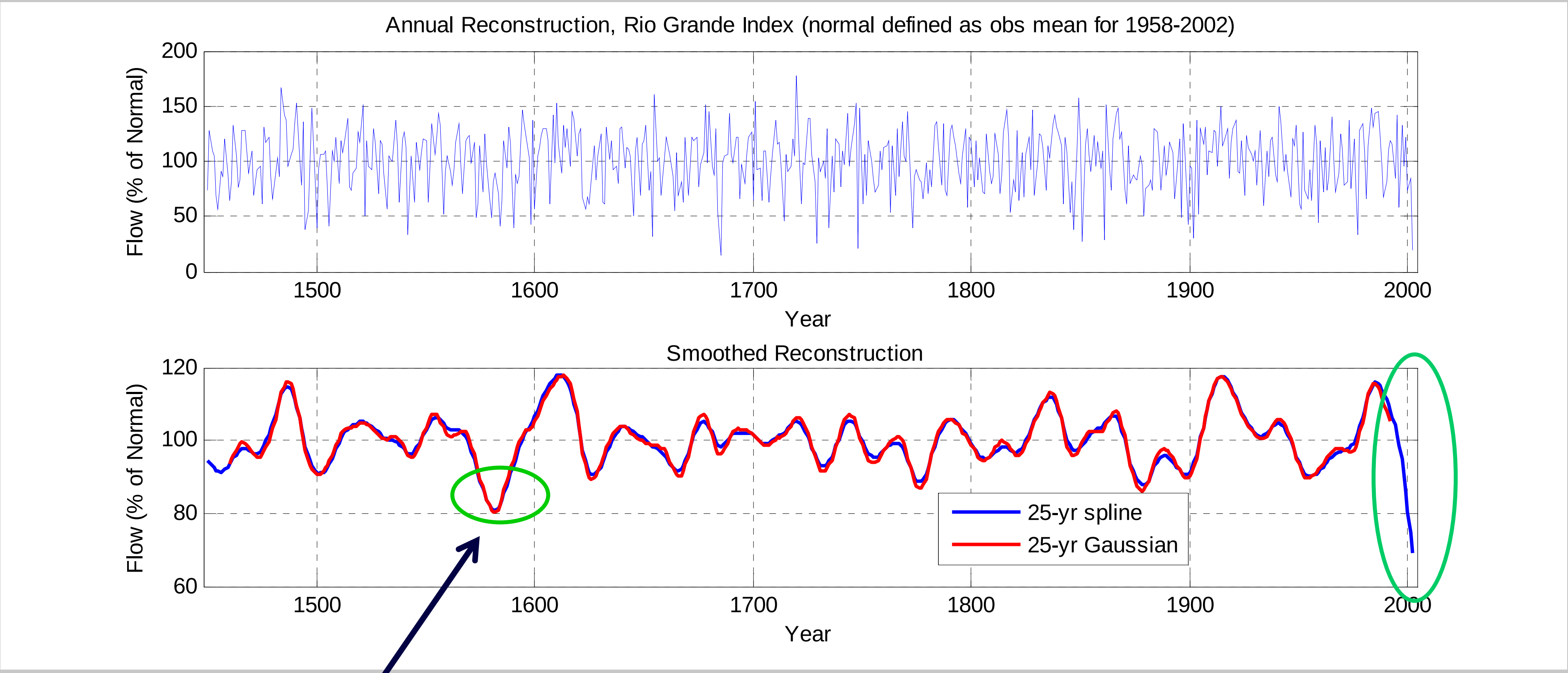
- Rio Grande Index flows vs tree-ring data for 1958-2002
- Relationship ~linear, with no obvious amplification of scatter toward high flows
- Curvature? Possibly, but iffy neglecting the lowest point (corresponds to 2002)
- No flow transformation for this particular reconstruction

Reconstruction Accuracy



- Model validated well in split-sample validation
- No problems in residuals analysis
- Reversal of 1977 and 2002 as extreme dry years in observed vs reconstructed

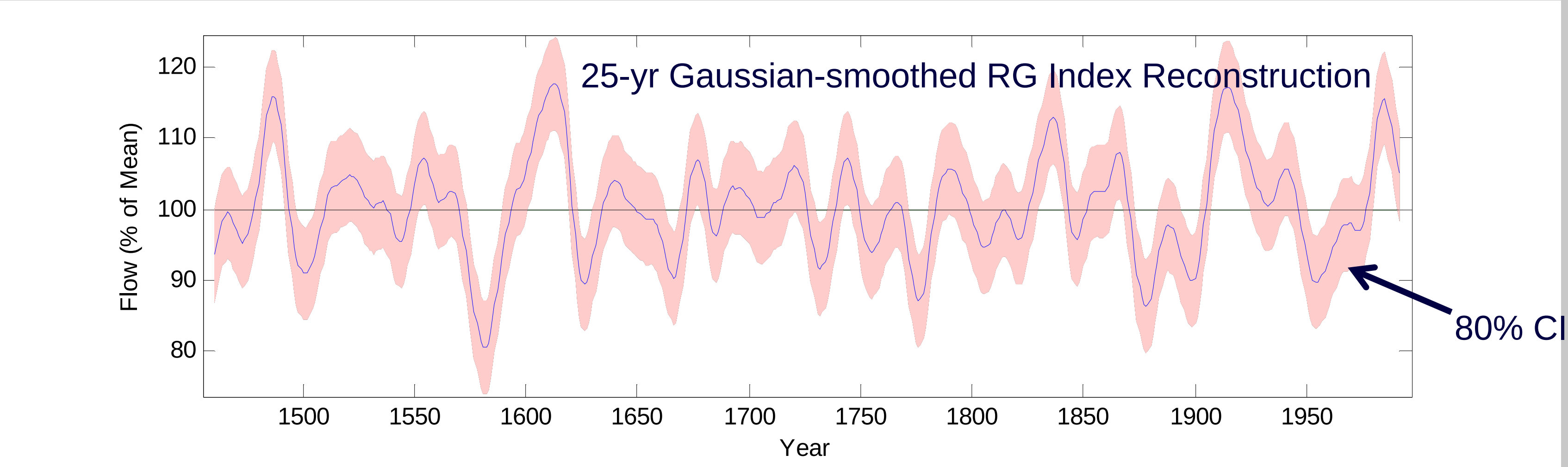
Reconstructed Flows, 1450-2002



1500s “megadrought”

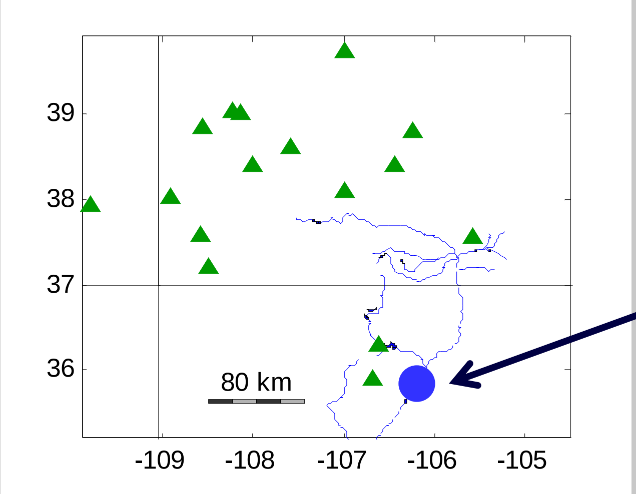
Spline smoothed version depends on extrapolation beyond existing data (end-effects)

Uncertainty



- Uncertainty, for this smoothing, is about ±5 percent of the long-term mean
- Assumption here is that the model is correct
- Width of CI depends on RMSE of annual flows, the smoothing function and assumptions on the distribution of reconstruction errors

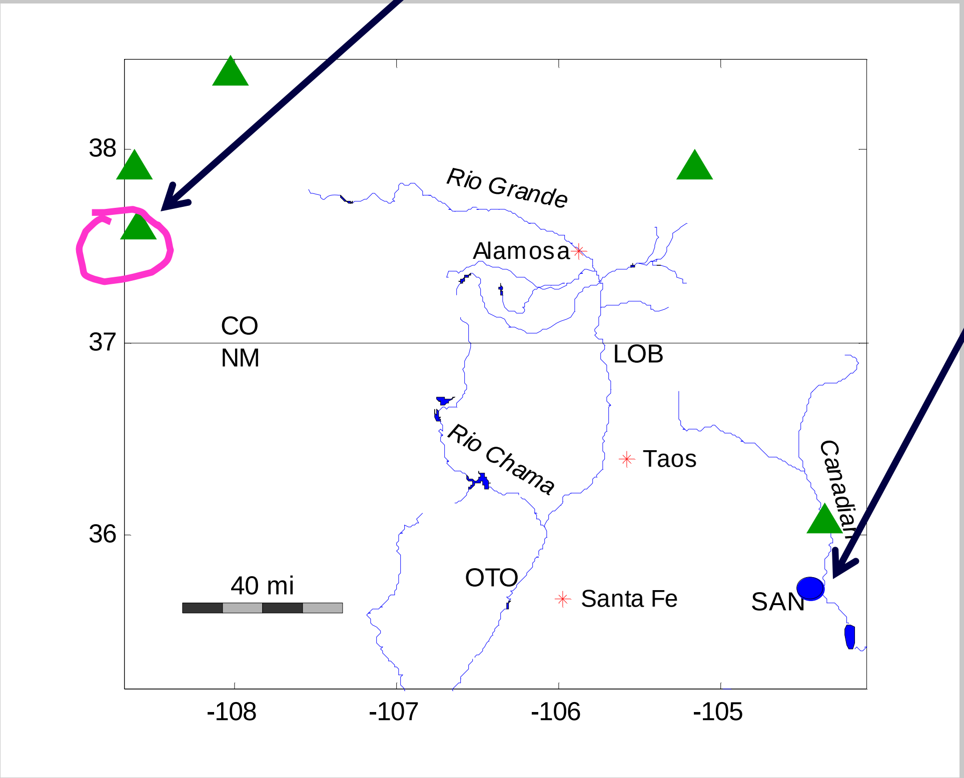
Otowi NRCS Reconstructon



- Same predictor as RG Index reconstruction
- Flows log-transformed before reconstruction
- Slightly weaker tree-ring signal for this flow series than for RG Index
- Long-term reconstruction similar to that for RG Index, as both reconstructions are monotonic re-scalings of same tree-ring series

Canadian River Reconstruction

Negative coefficient on this site



- Log transformation of flows
- 5-predictor model, selected stepwise
- Tree-rings allow 1604-1997 reconstruction
- Variance explained of log10 flows = 61%