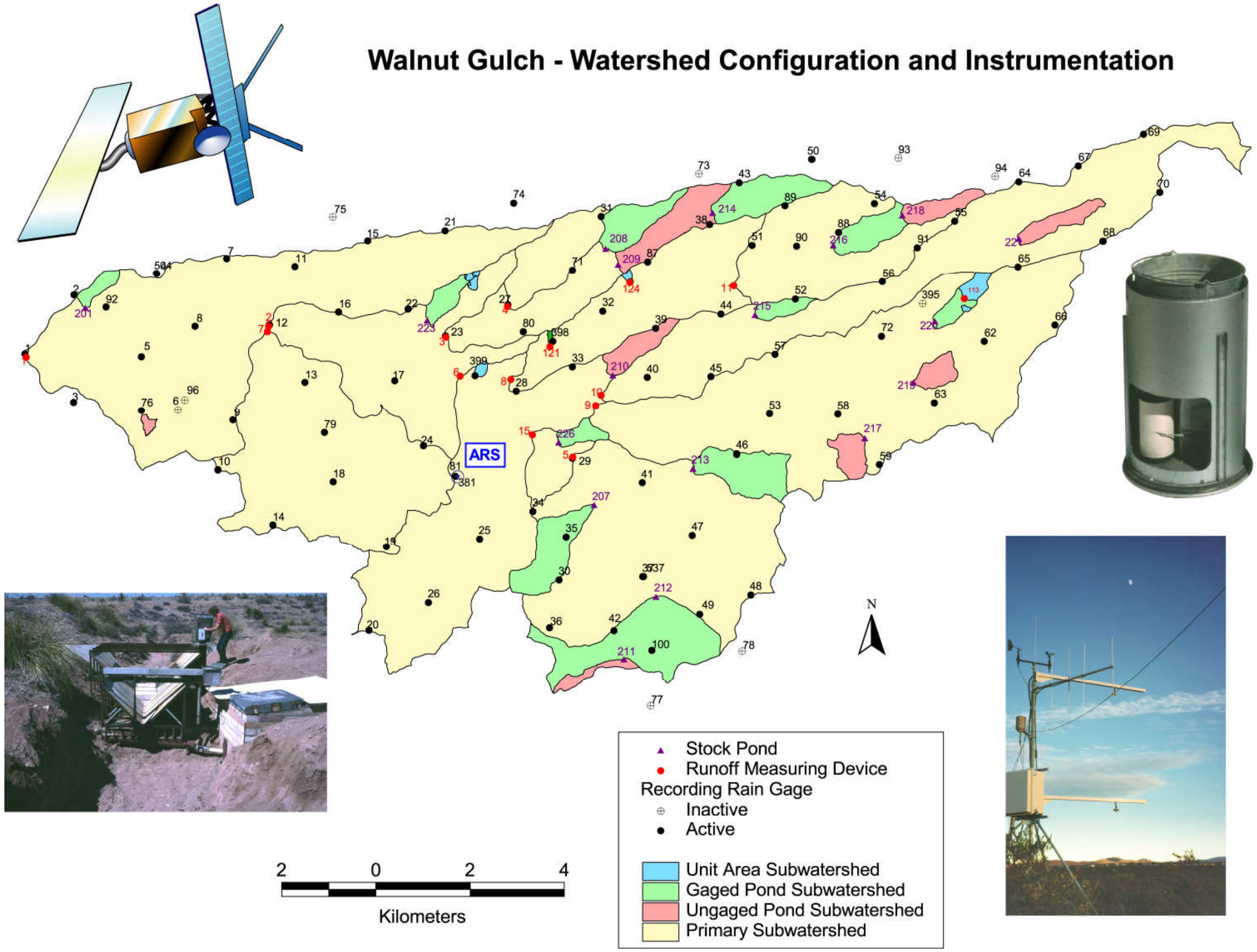
Event to Multi-decadal Persistence in Spatial Rainfall and Runoff as a ƒ(Spatial & Temporal Scales)



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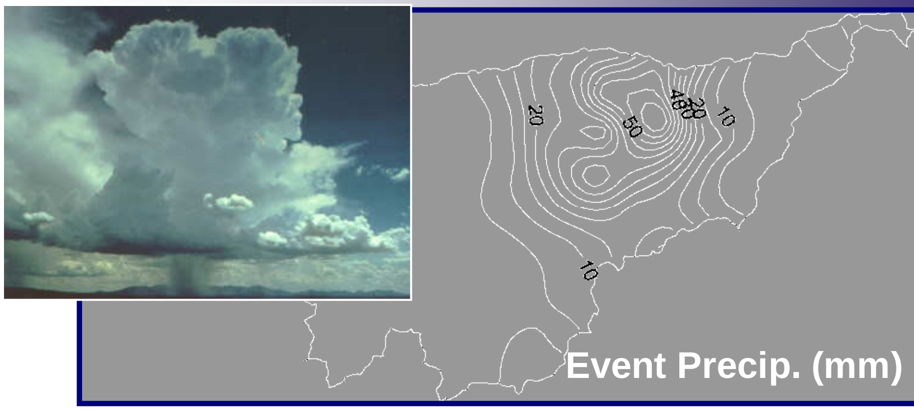
Mary Nichols, Jeff Stone, Lainie Levick, Russ Scott

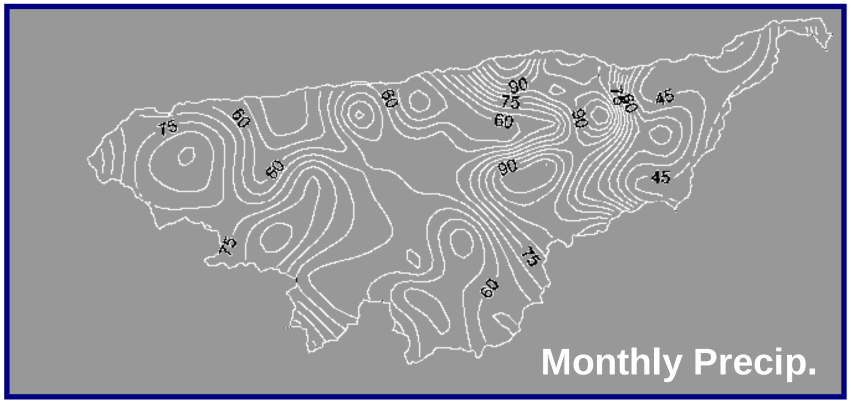
Overview

- Background
- Objectives
- Methods
- Results
- Conclusions

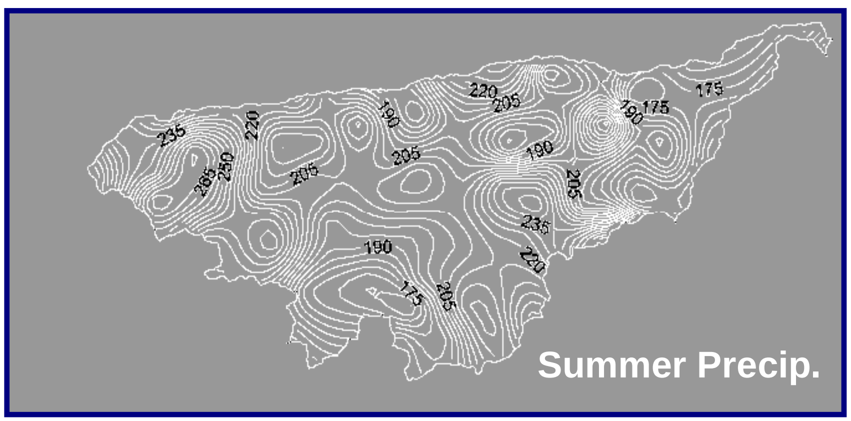
Persistence of Spatial Rainfall Variability



Event Precip. (mm)



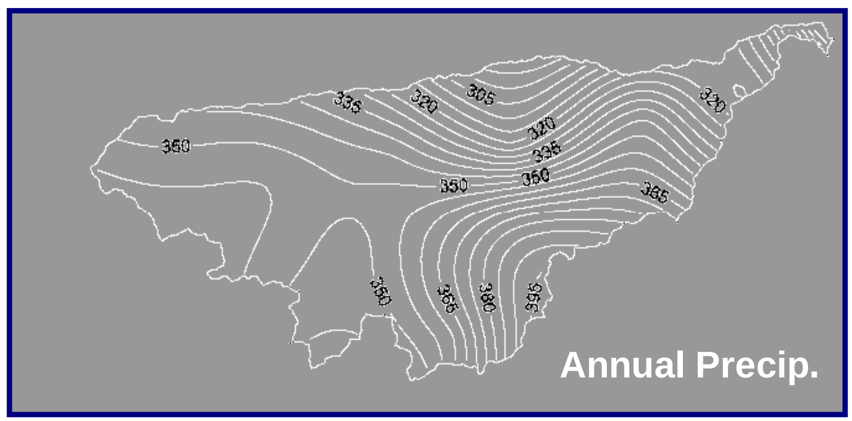
Monthly Precip.



Summer Precip.

Accumulate total precipitation
Surrounding the storm above
Aug. 27, 1982

Interval	Min	Max	Max/Min
Event	0	68	---
Month	35	102	2.9
Summer	165	275	1.7
Year	260	395	1.5



Annual Precip.

Questions

– How long will it take for the cumulative rainfall totals to become “uniform” ?
  - Relevant to cumulative plant and biomass production
– How will the spatial variability of high intensity, runoff producing rainfall, persist ?
  - Relevant to spatial patterns of erosion and possibly long-term landscape evolution
– With higher-resolution WGEW data can we test the finding of Thomas and Pool (2006) who noted a decrease in runoff in the San Pedro beyond what could be explained by decreasing trends in precipitation ?

Objectives

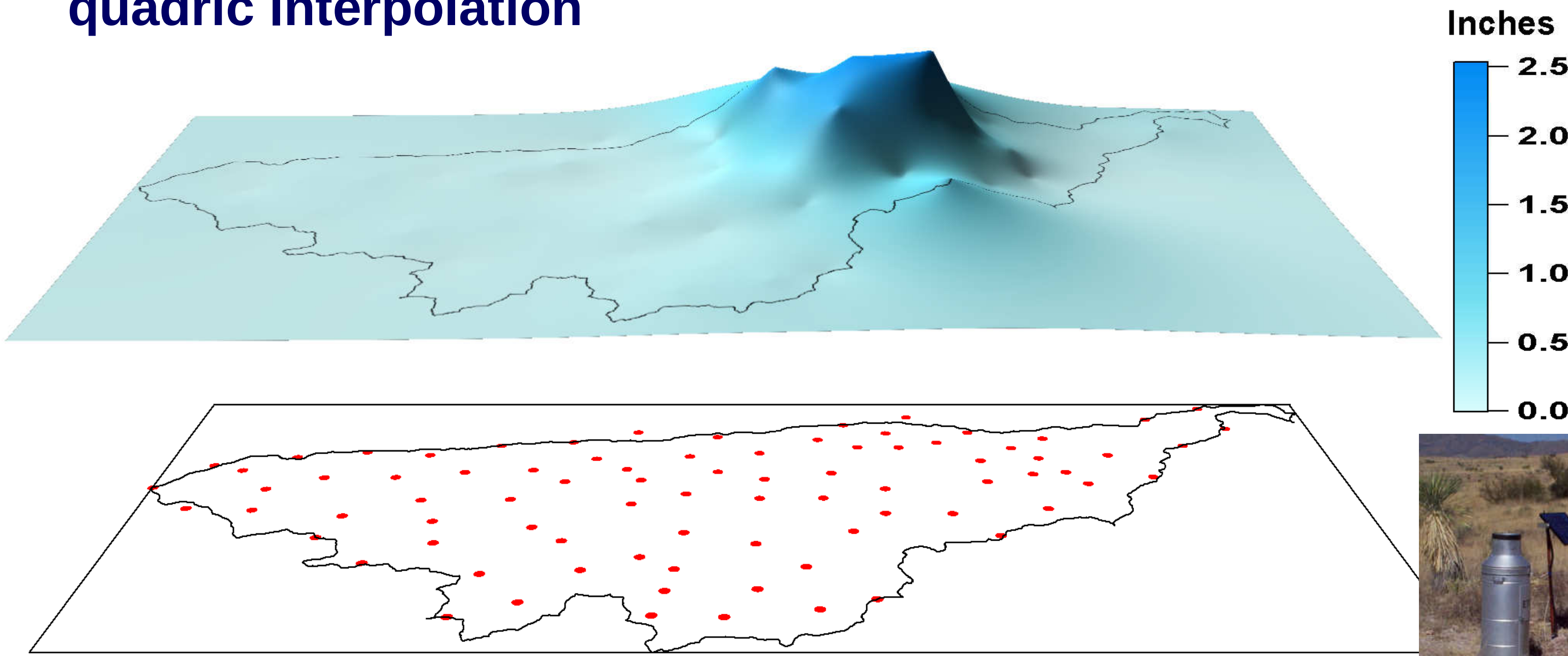
– Assess the spatial uniformity of precipitation (Ppt) and its intensity over the WGEW

– Assess the temporal and spatial trends of Ppt and its intensity and whether ENSO teleconnections are related to the variations in Ppt and intensity at the watershed scale

– Relate watershed-wide Ppt characteristics to runoff over a range of watershed scales

Methods

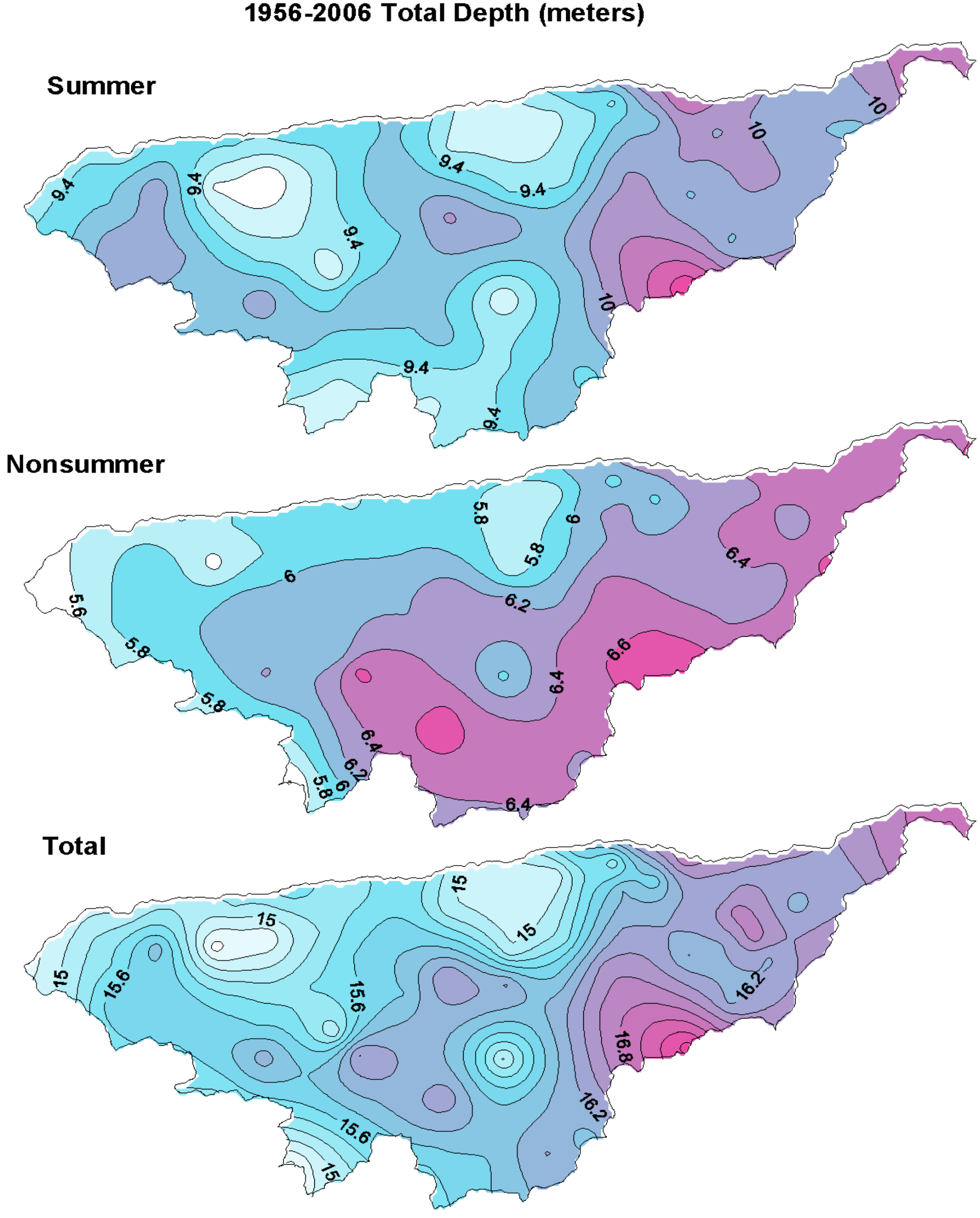
– **Interpolate daily rain gage totals onto a 100 X100 m grid covering the entire Walnut Gulch Experimental Watershed (WGEW) for all days from 1956-2006 using Bi-harmonic Multi-quadric Interpolation**



Interpolated Rainfall Depth for 27 August 1982

Methods

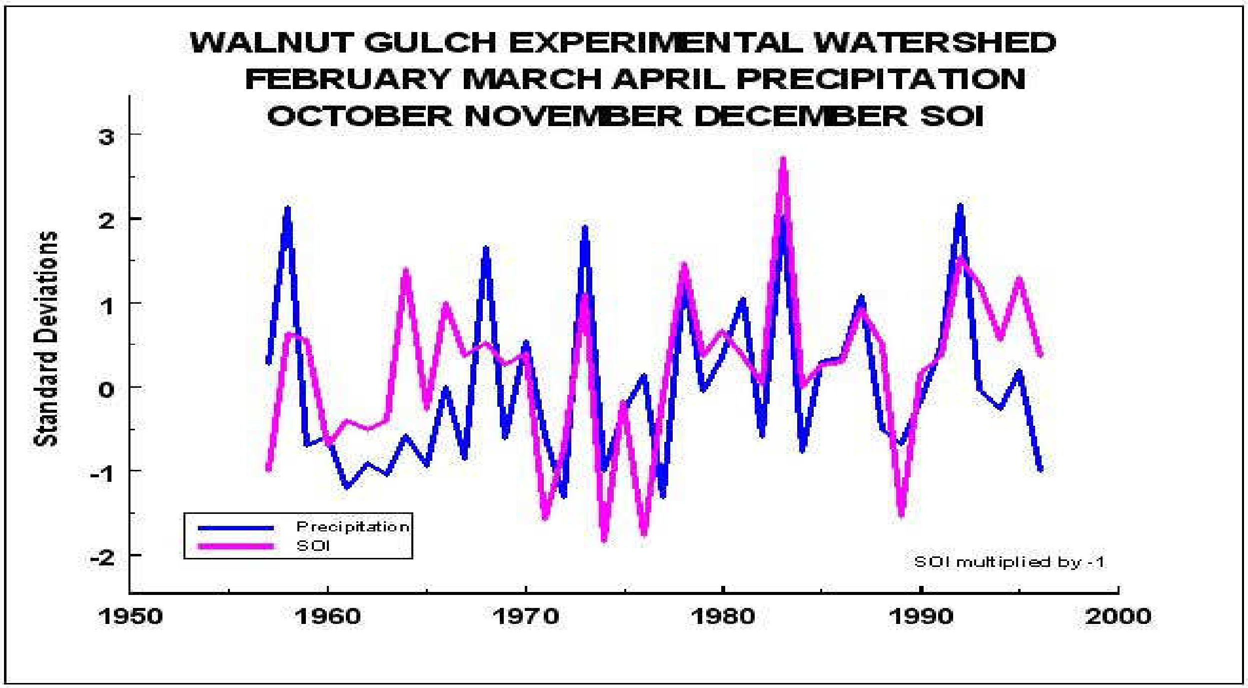
- Accumulate totals for seasons, years, and the entire period of record
- Compute spatial statistics over the WGEW for moving windows over increasing periods of time



Methods - Trends and Teleconnections

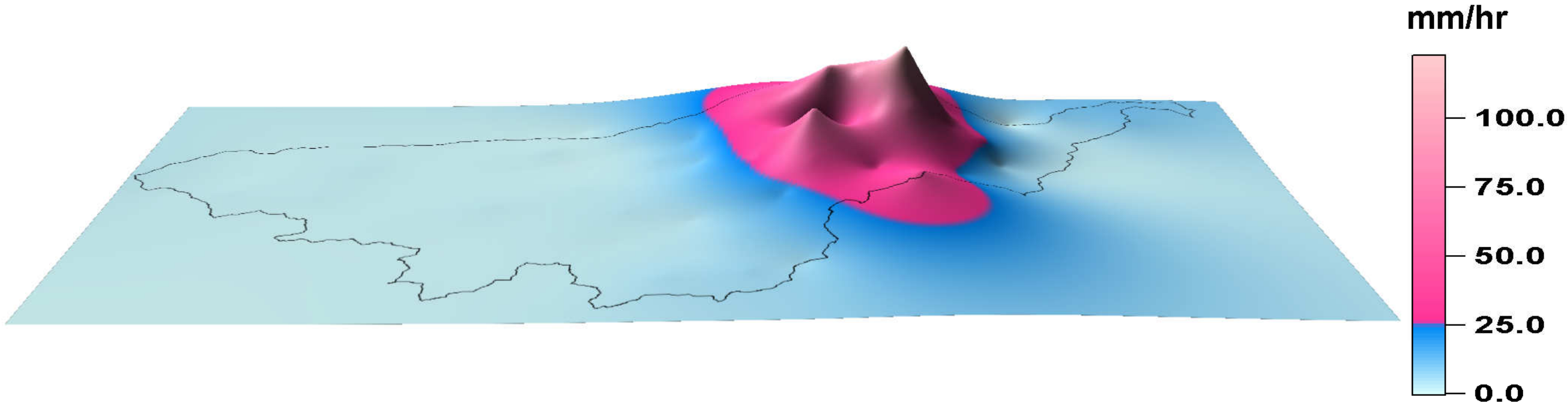
– Extend trend analysis of Nichols et al. (2002) from 6 rain gages to entire watershed with 10 additional years of data

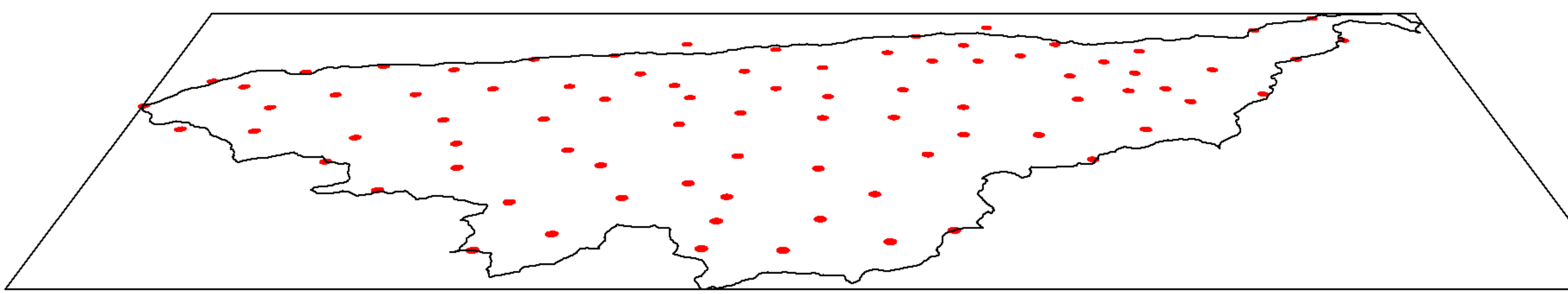
– Test correlation between teleconnection indicies (SOI) to basin wide Ppt values ?



Methods

– **Interpolate the daily maximum 30 min rainfall intensity from each rain gage**

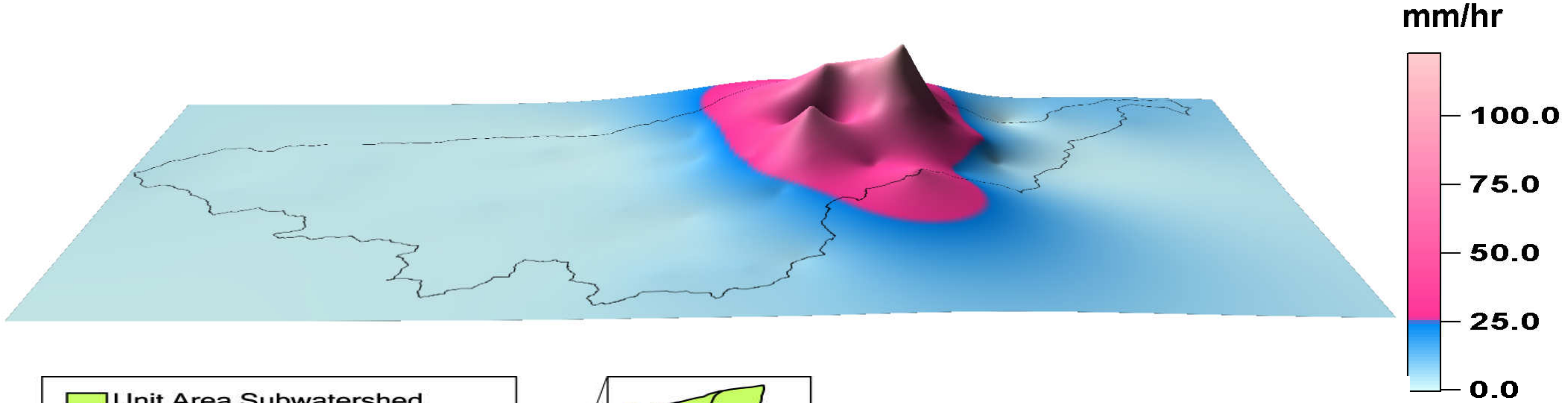


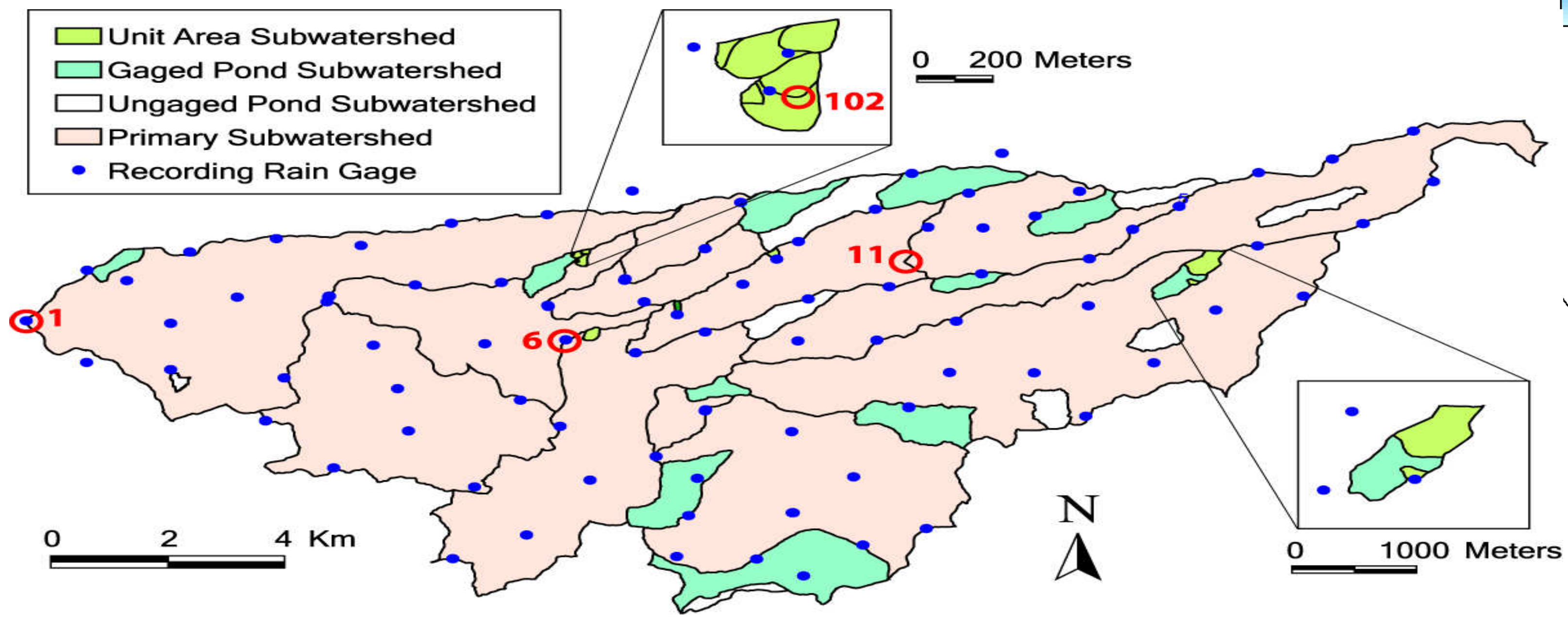


Interpolated Max. I30>25mm/hr for 27 August 1982

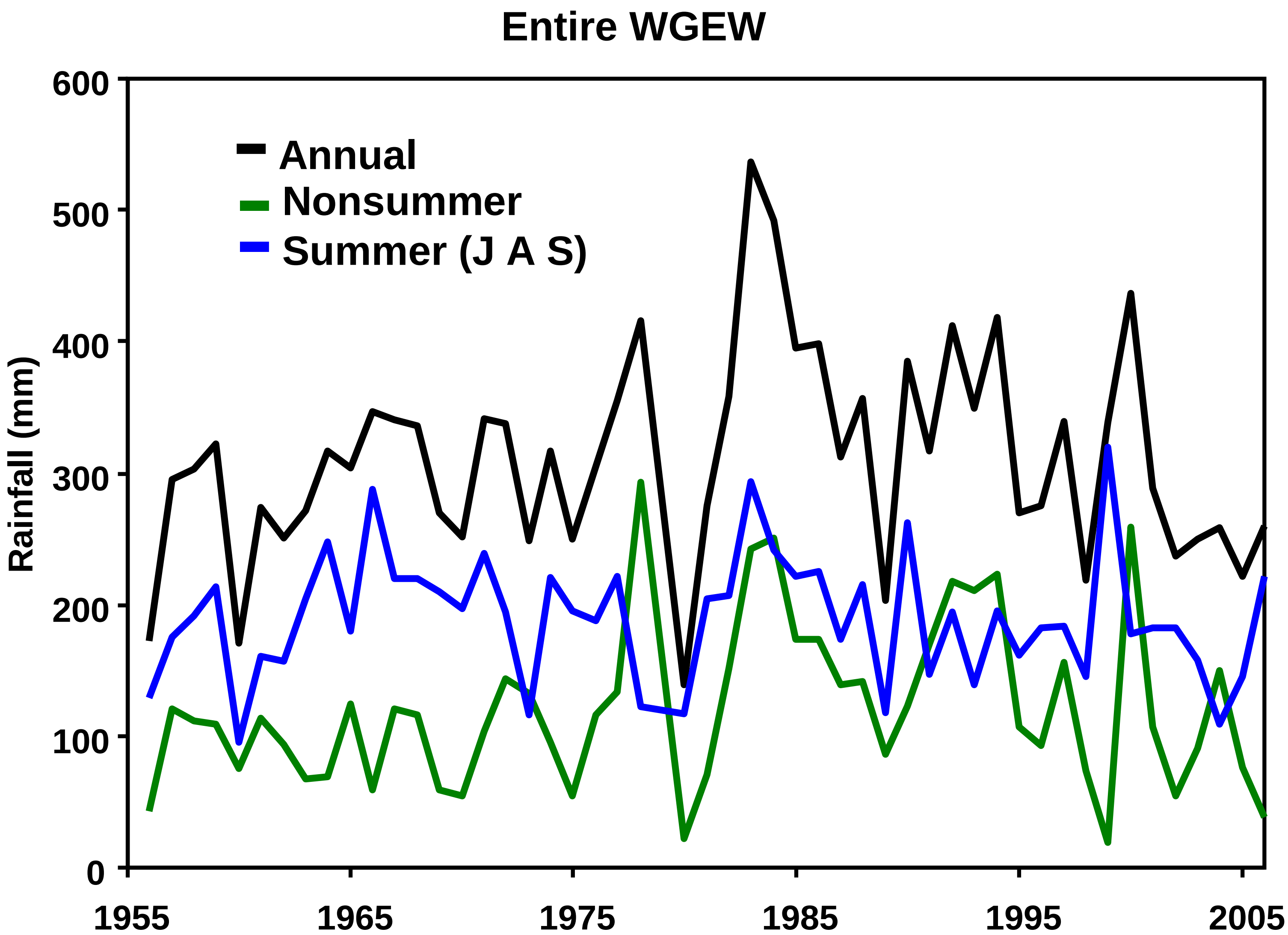
Methods

– **Use sub-watershed masks to relate spatial rainfall characteristics to sub-watershed runoff**



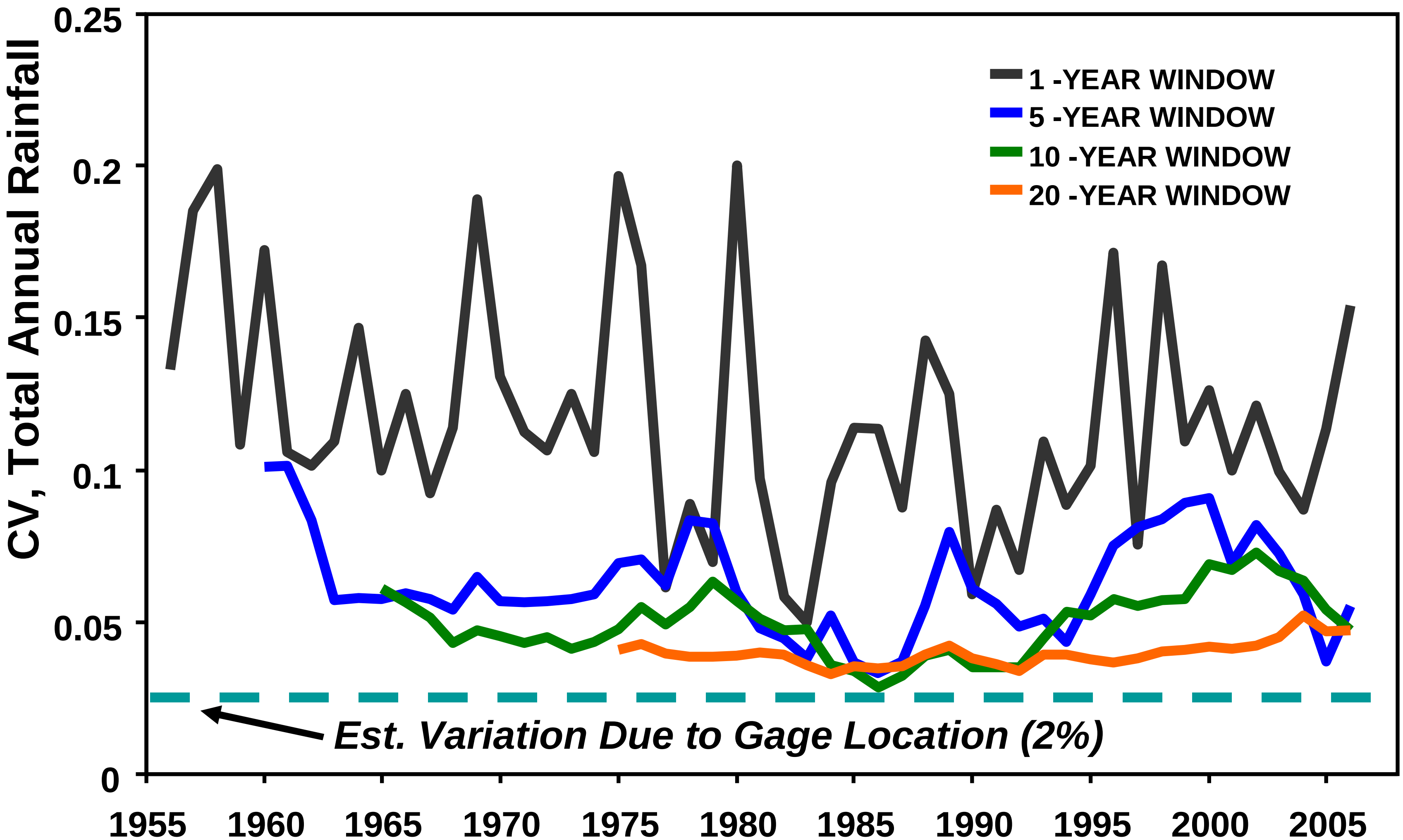


Results – Average Total Ppt over WG



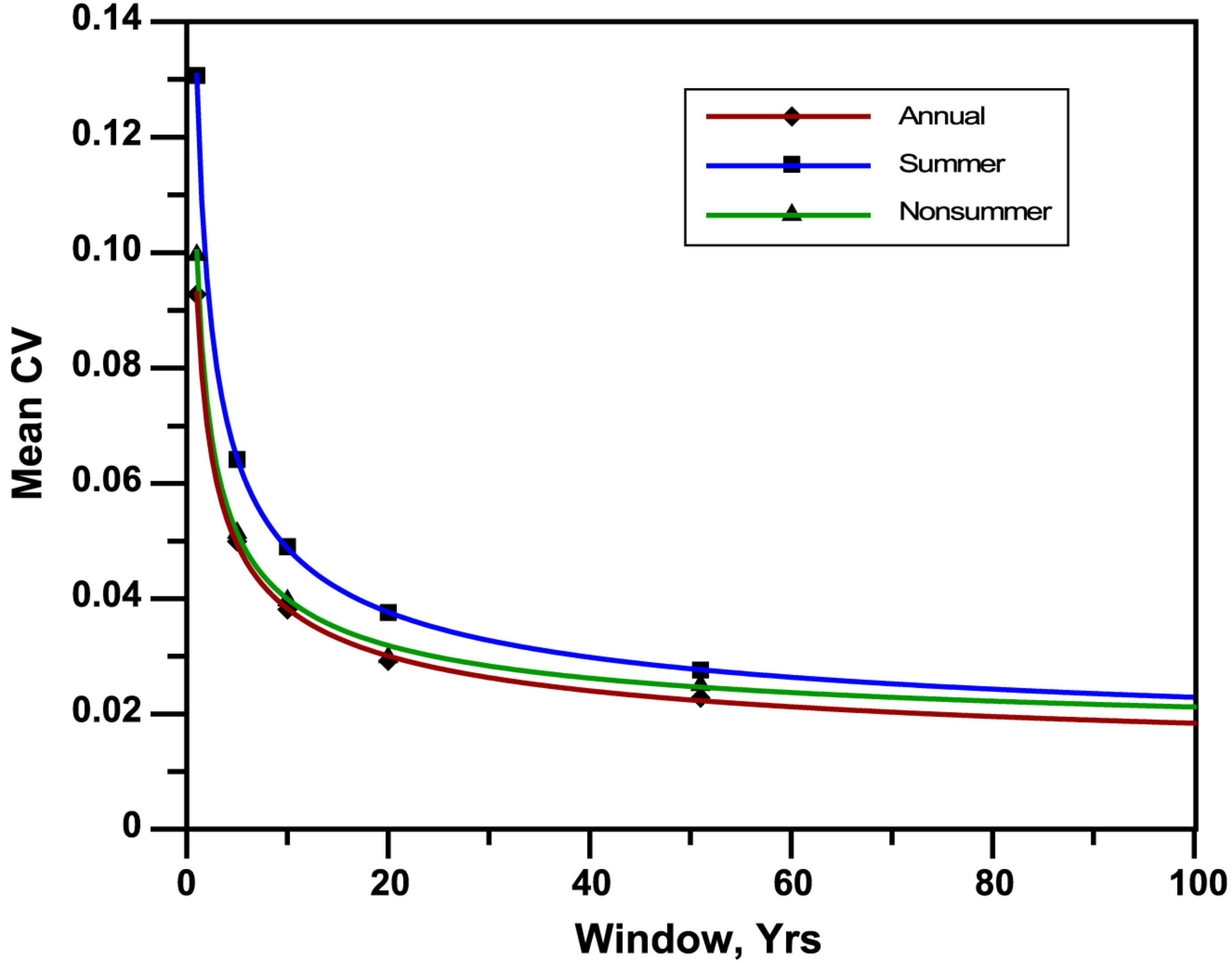
Results – Trends Toward Uniformity

– **Coef. of Variation (CV) of Ppt totals (trends removed)**



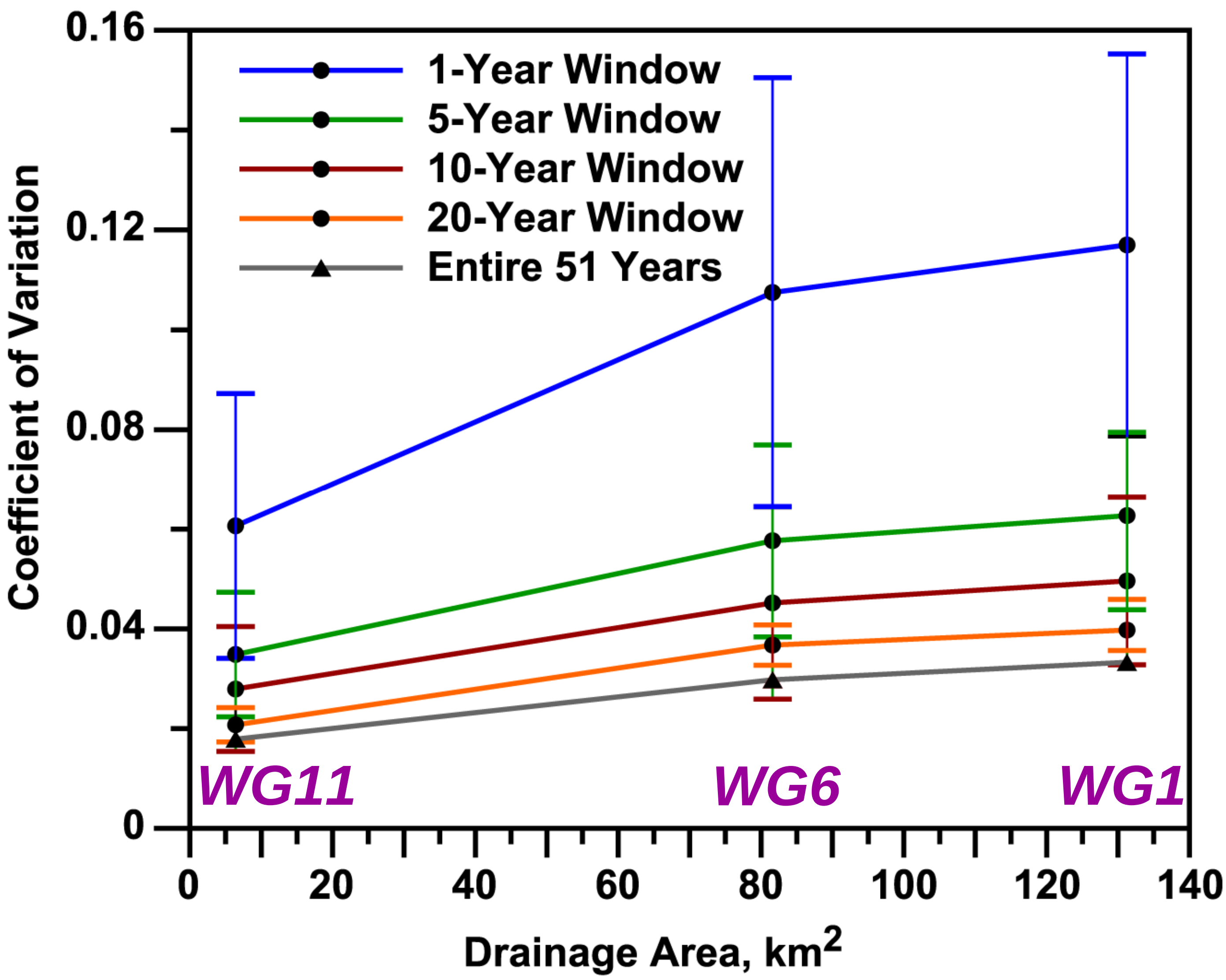
Results – Trends Toward Uniformity

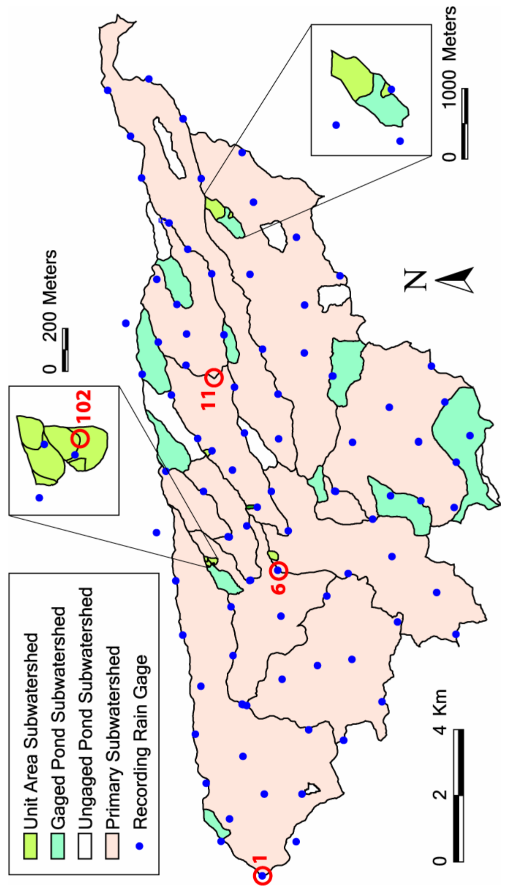
– **Exponential fit to mean CV of Ppt totals**



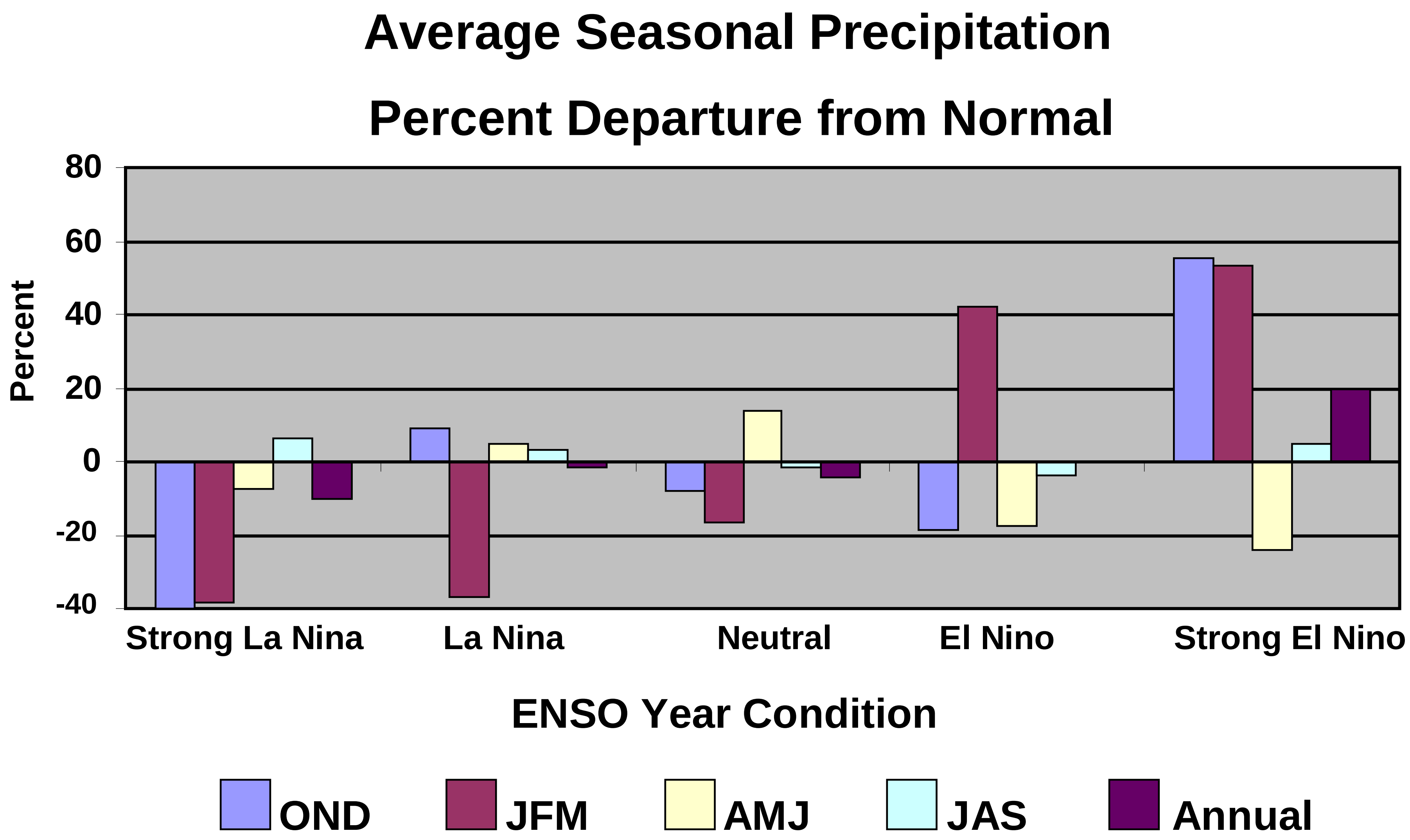
Trends Toward Uniformity across Watershed Scales

– CV of Ppt totals as a function of window size and drainage area



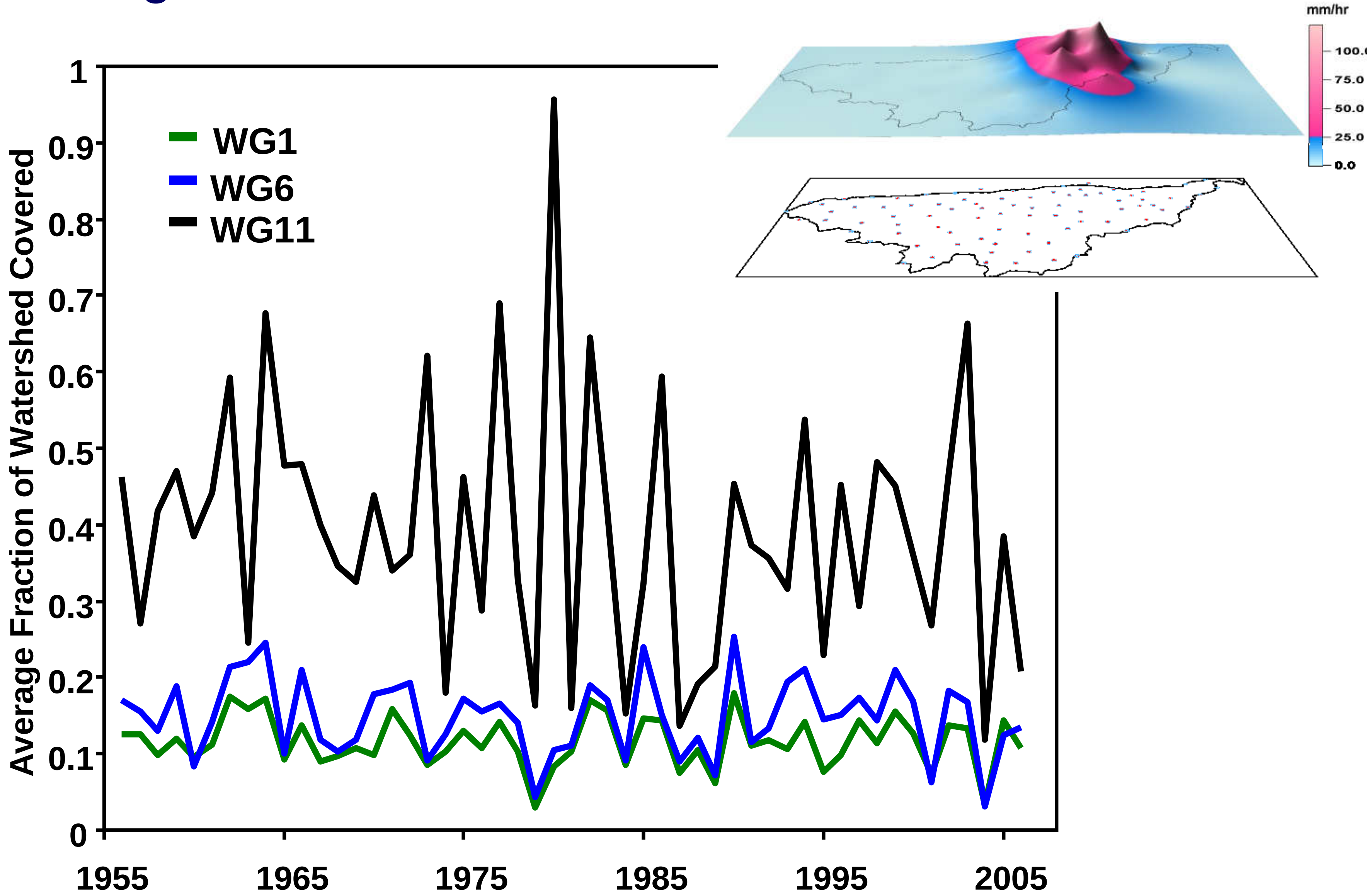


Precipitation in Relation to ENSO Strength



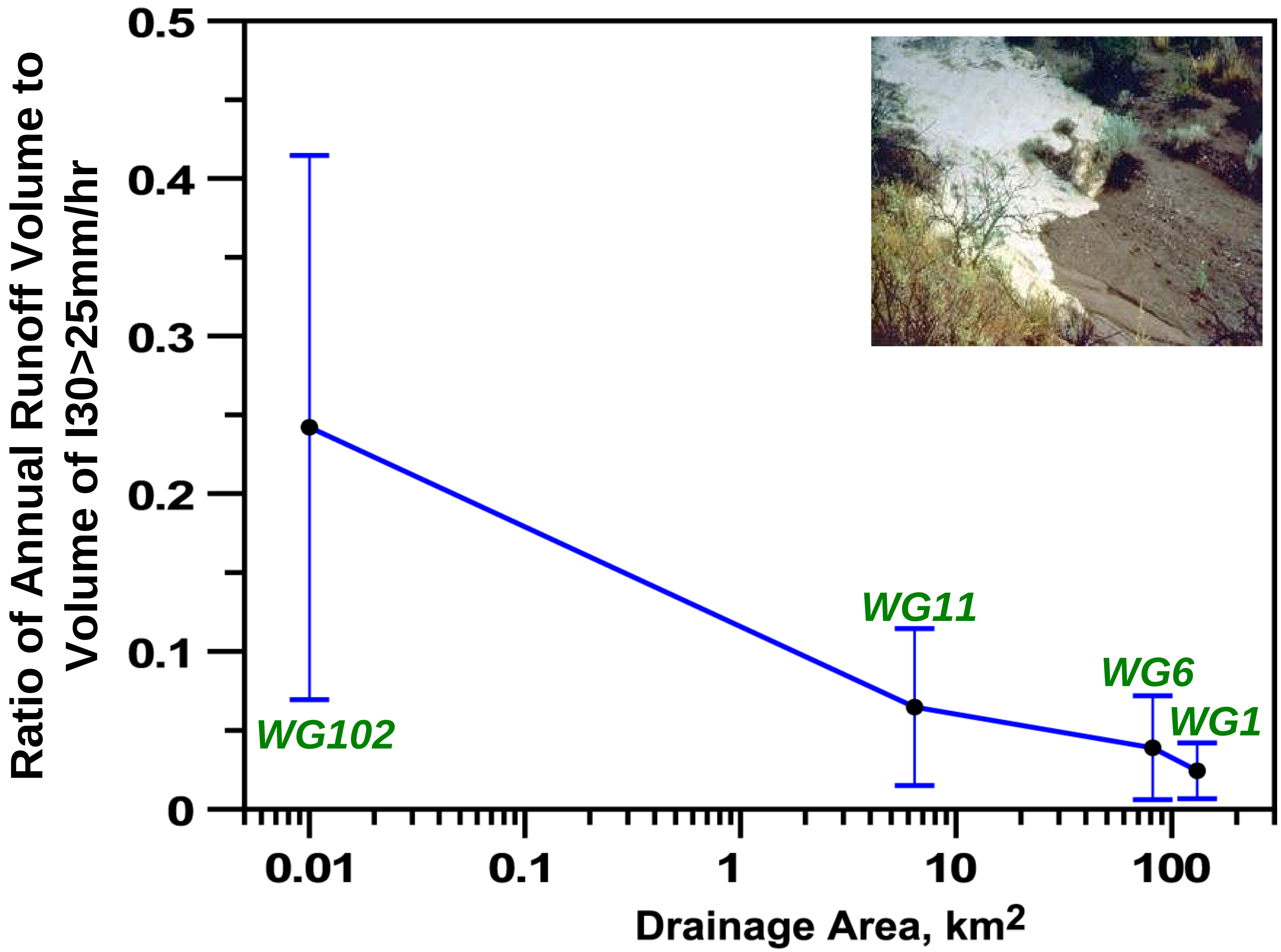
Results – High Ppt Intensity Coverage

Average Fraction of Watershed Covered by I30>25mm/hr



Results – Runoff / Rainfall Ratios

Average Runoff Vol. / High Int. Rainfall Vol. vs Drainage Area



Conclusions (1 of 2)

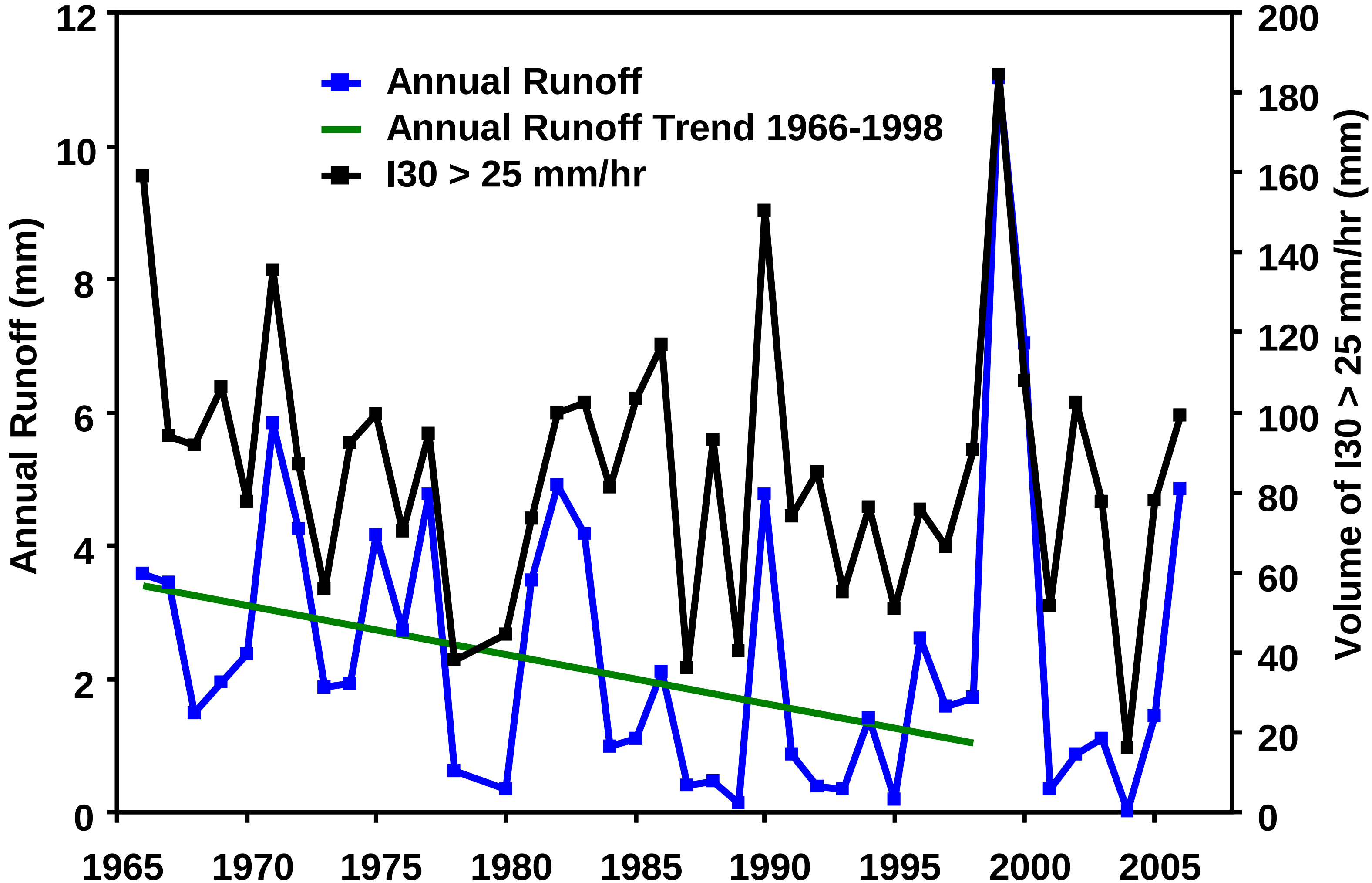
- CV of Ppt depth and Ppt volume with I30 > 25 mm/hr decreased exponentially with longer accumulation periods
  - Most of the decrease within a 20-year period
- For the WGEW (WG1), summer rainfall volume showed a significant decreasing linear trend for the 1956-1996 period but not for 1956-2006
- For teleconnections, January-March precipitation was correlated to ENSO variations, and thus no influence on runoff

What is Causing Decrease in Runoff

- For the San Pedro Thomas & Pool (2006) noted a decrease in runoff beyond what could be explained by decreasing trends in precipitation ?
- They tested for
  - Changes in air temperature
  - Watershed changes (riparian / upland vegetation, channel morphology)
  - Human activity (e.g GW pumping, urbanization, detention pond construction, and grazing)
  - Changes in seasonal distribution of flow between the river and storage in channel banks and the alluvial aquifer.
- They concluded changes in vegetation and increases in near steam pumping were the most likely causes

Results – Runoff & High Int. Rainfall Vol.

Annual Runoff Vol. and High Int. Rainfall Vol. – entire WG

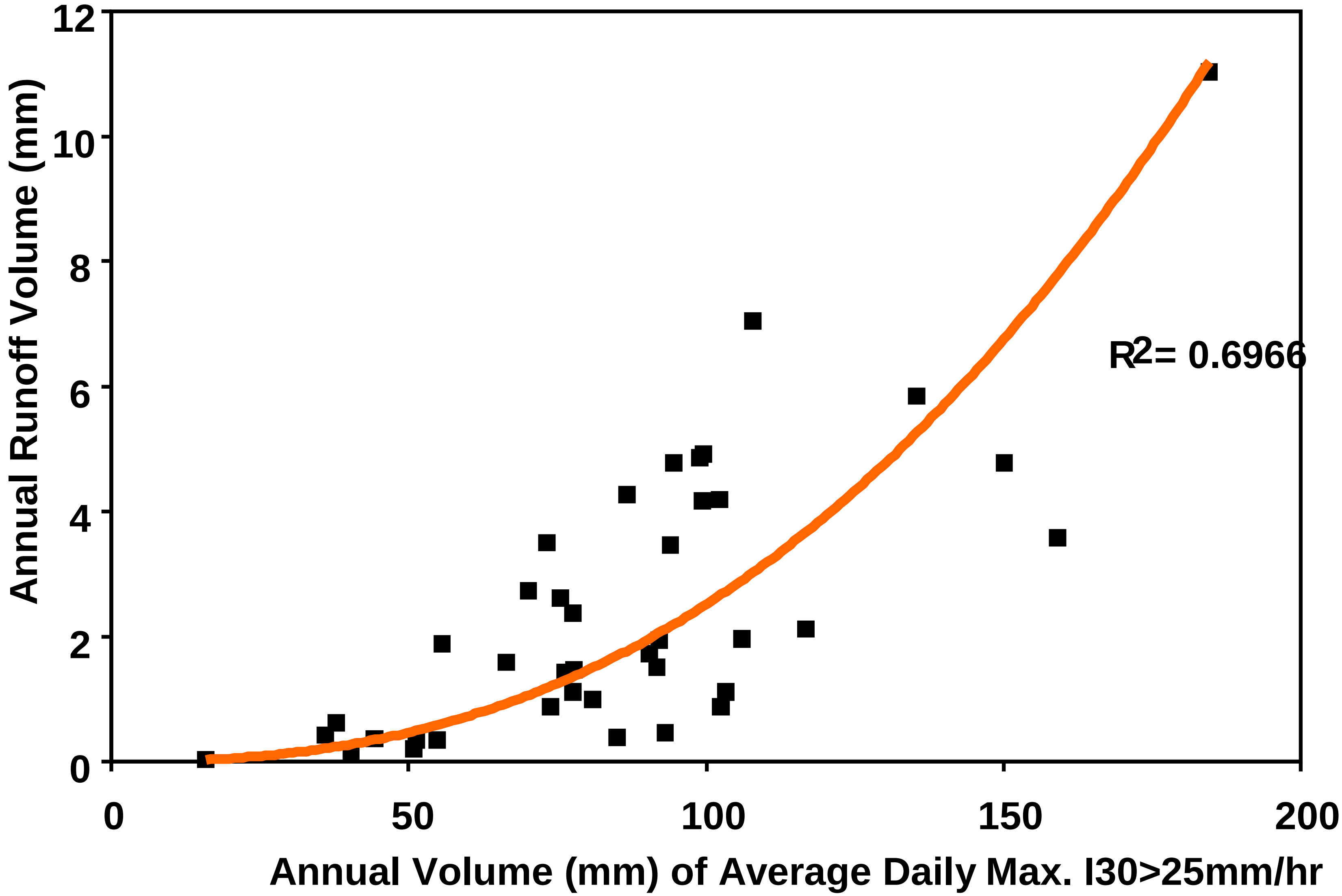


Runoff Trend Sig. from '66-'98

Runoff Trend NOT Sig. from '66-'06

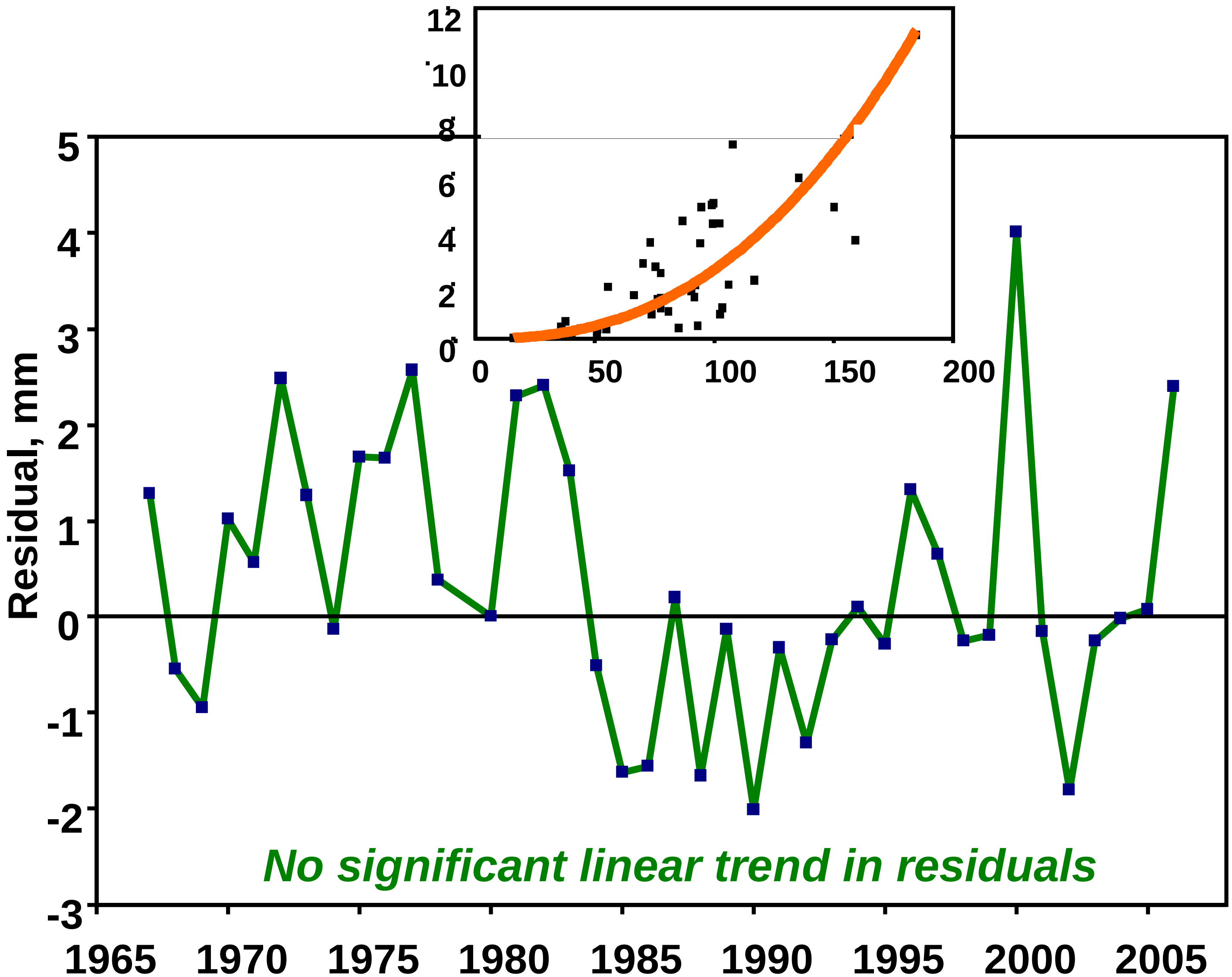
Results – Runoff & High Int. Rainfall Vol.

Annual Runoff Vol. regressed on High Int. Rainfall Vol. – entire WG



Results – Runoff & High Int. Rainfall Vol.

Residual of Runoff Vol. vs Rainfall Vol. as *f* (time)



Conclusions (2 of 2)

- What caused decrease in runoff in WGEW ?
- Ruled out land cover / vegetation change
- No trend in residuals => changes in Ppt are likely causing decrease in runoff
- Supports ruling out tributary watershed change in reducing San Pedro flows and points to other factors noted by Thomas & Pool (e.g. GW pumping or increases in riparian veg.)
- ***HOWEVER:*** Nichols et al., found aggradation of sediment / veg. in main channels of WGEW
- Could a period of small flood flows (aggrading channel sediment, vegetation colonization) set up a positive feedback of increasing channel transmission losses and a decline of annual runoff ??

Stay Tuned – RISE '08