PAST ENVIRONMENTAL CHANGE IN THE FOUR CORNERS AND ADJACENT REGIONS

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SOMEWHAT DIFFERENT PERSPECTIVE ON PAST CLIMATE RECONSTRUCTION

Not focused primarily on understanding climate or weather.

Rather, directed toward understanding effects of past environmental (including climate) stability, variation, and change on past, present, and future human behavior.

COMPLEX INTERACTIONS AMONG DIFFERENT CLASSES OF VARIABLE

ENVIRONMENT (INCLUDING CLIMATE BUT MANY OTHER FACTORS)

HUMAN DEMOGRAPHY

HUMAN BEHAVIOR

ENVIRONMENT CONSIDERED IN DETAIL LATER

Important to note here that reconstructed environmental factors have to defined in ways that make them relatable to human behavior.

In other words, to what aspects of the environment do human societies react most closely?

HUMAN DEMOGRAPHY

Effects differ depending on how closely the extant population is to carrying capacity. Crowding reduces options.

HUMAN BEHAVIOR

Effects differ from H-G to farmers; concerned here with the latter.

Effects differ between lowland floodplain farmers and upland dry farmers.

Effects differ depending on the complexity of the affected societies.

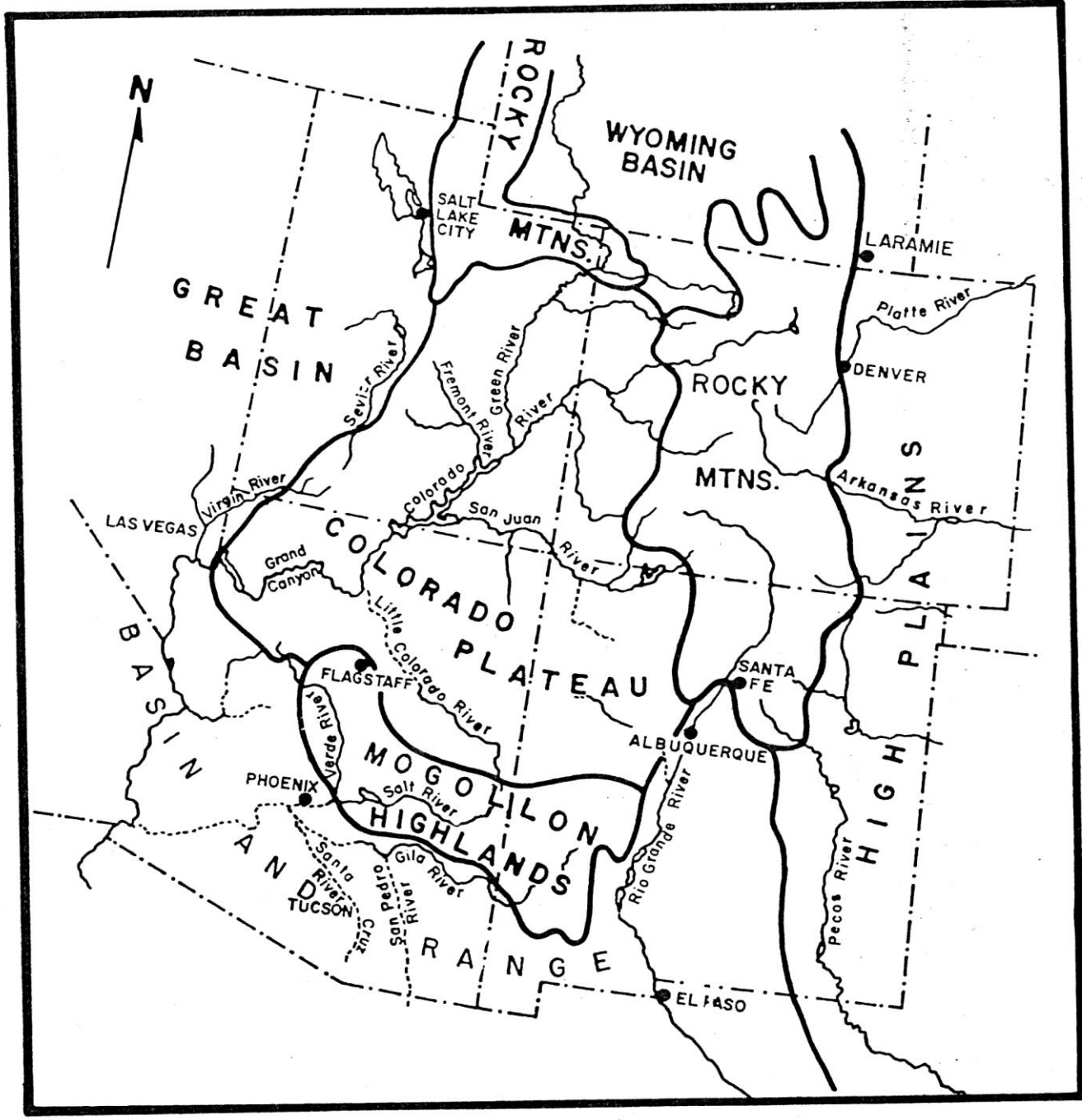
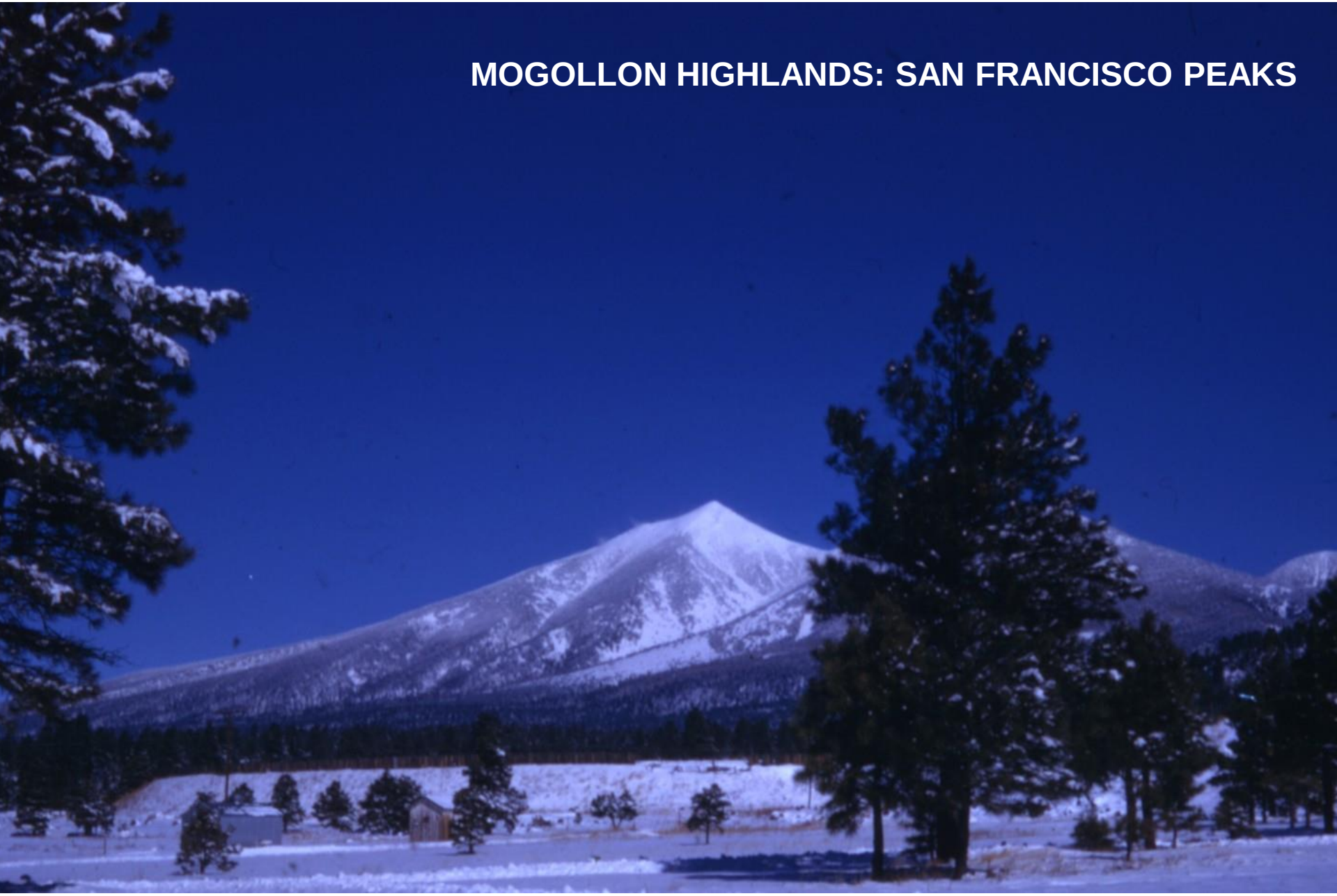


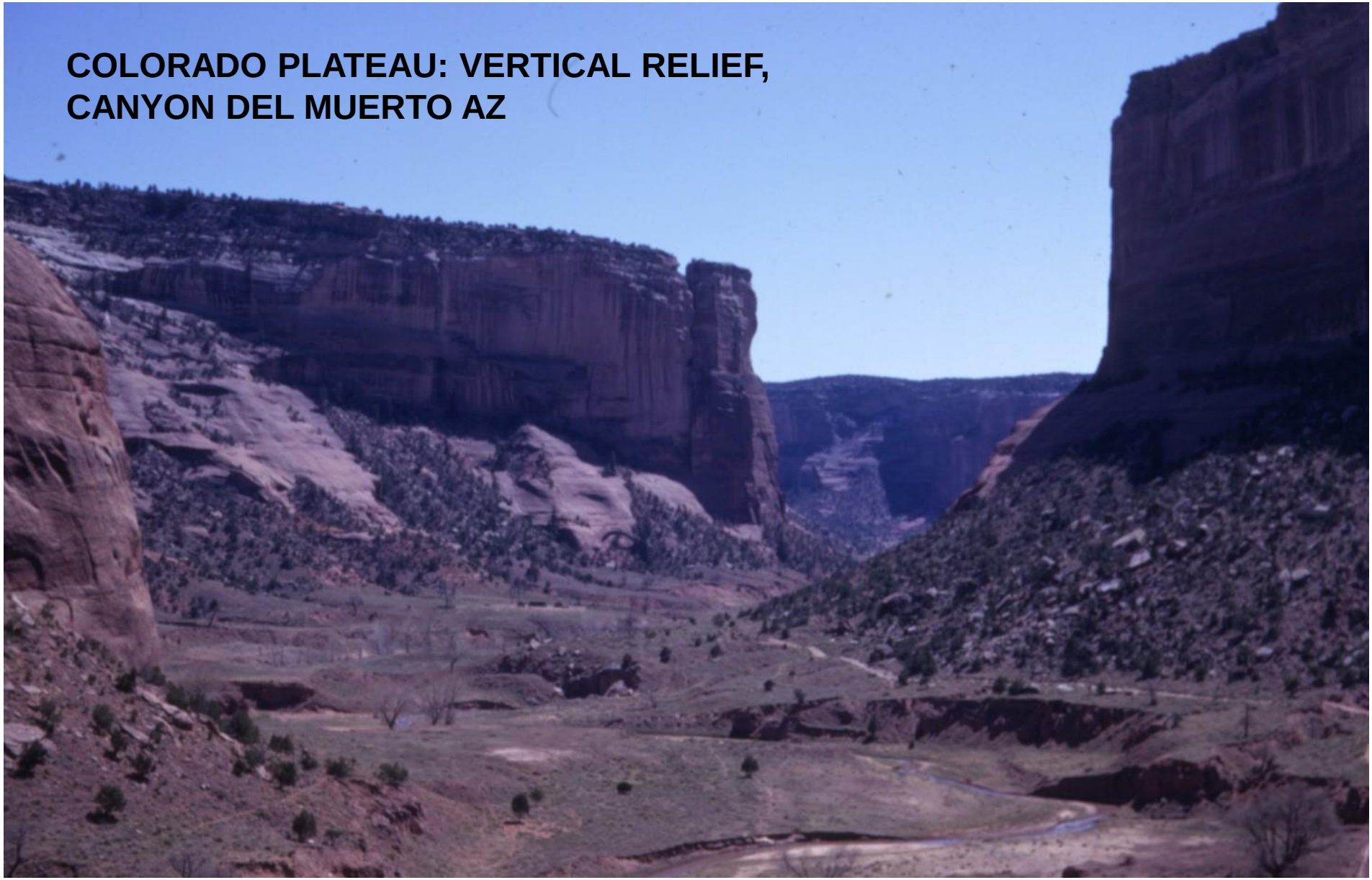
FIGURE 8.1
Southwestern geographic regions.

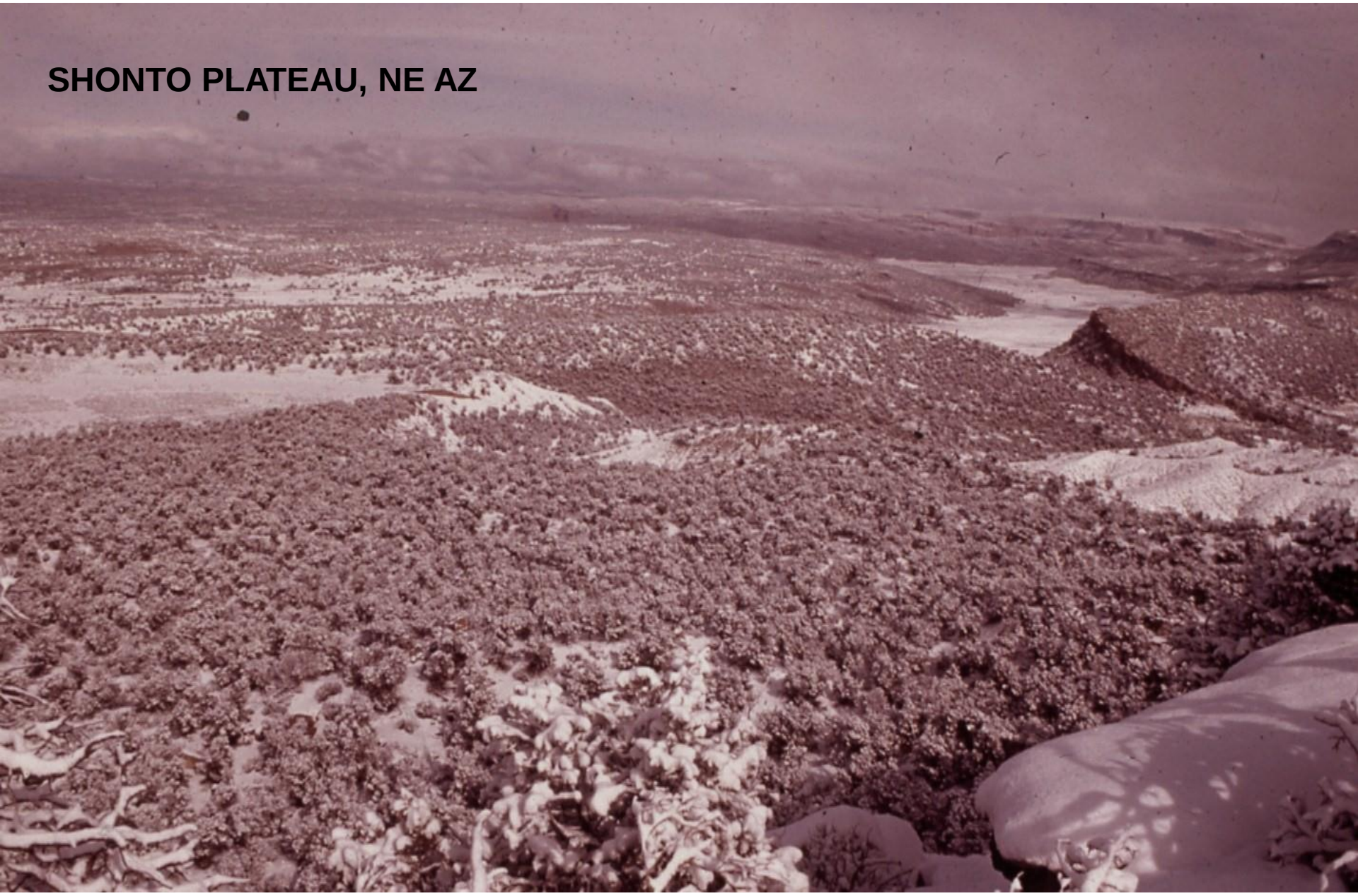
Southern Deserts: San Pedro Valley

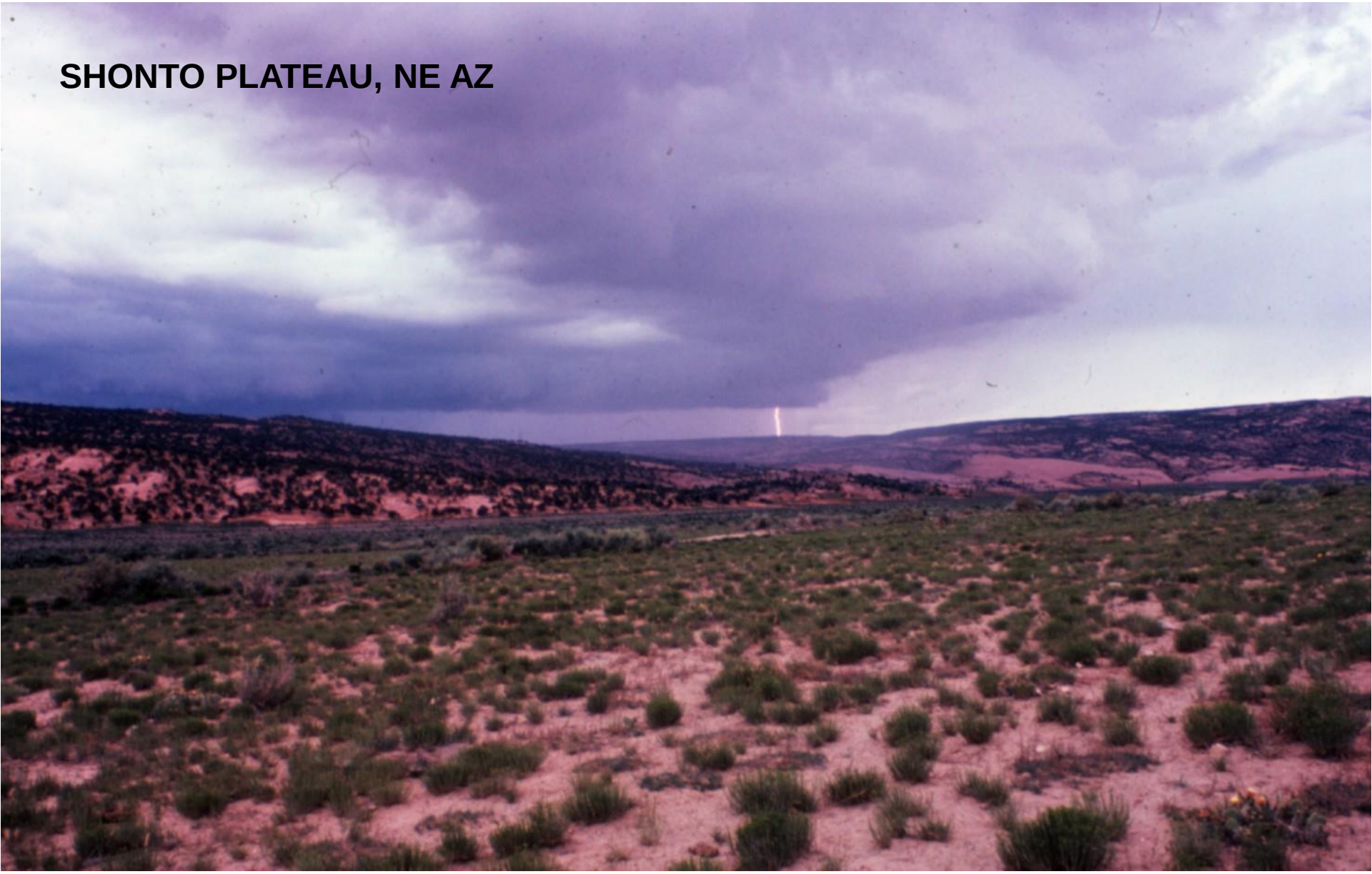

MOGOLLON HIGHLANDS: SAN FRANCISCO PEAKS


RIO GRANDE RIFT VALLEY

COLORADO PLATEAU: VERTICAL RELIEF, STEPPED UPLANDS, CEDAR MESA, ELK RIDGE, ABAJO MOUNTAINS


COLORADO PLATEAU: VERTICAL RELIEF,
CANYON DEL MUERTO AZ


SHONTO PLATEAU, NE AZ


SHONTO PLATEAU, NE AZ


LONG HOUSE VALLEY AZ


SUMMER STORM RUNOFF, MARSH PASS AZ

PAST ENVIRONMENTAL VARIABILITY AND PALEOENVIRONMENTAL RECONSTRUCTION

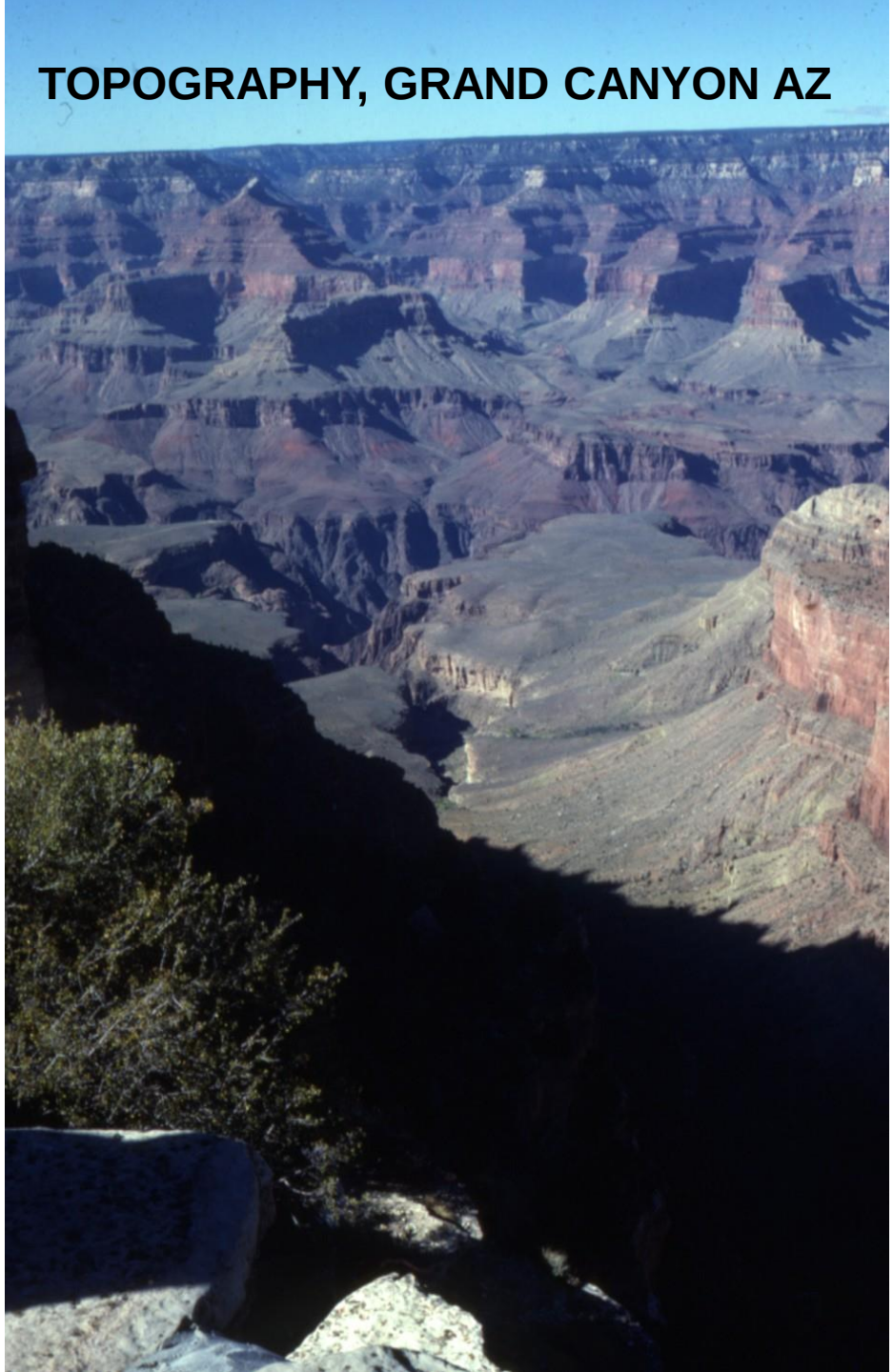
Types of Environmental Variability

- Stable
- Low Frequency
- High Frequency
- Episodic

Stable Factors

- Unchanged over time of interest: Last 4000 Years
- Climate Type
- Topography
- Bedrock Geology
- Elevational Zonation of Plant and Animal Communities
- Three Major Habitats: Desert, Mountains, Plateau
- Others

TOPOGRAPHY, GRAND CANYON AZ

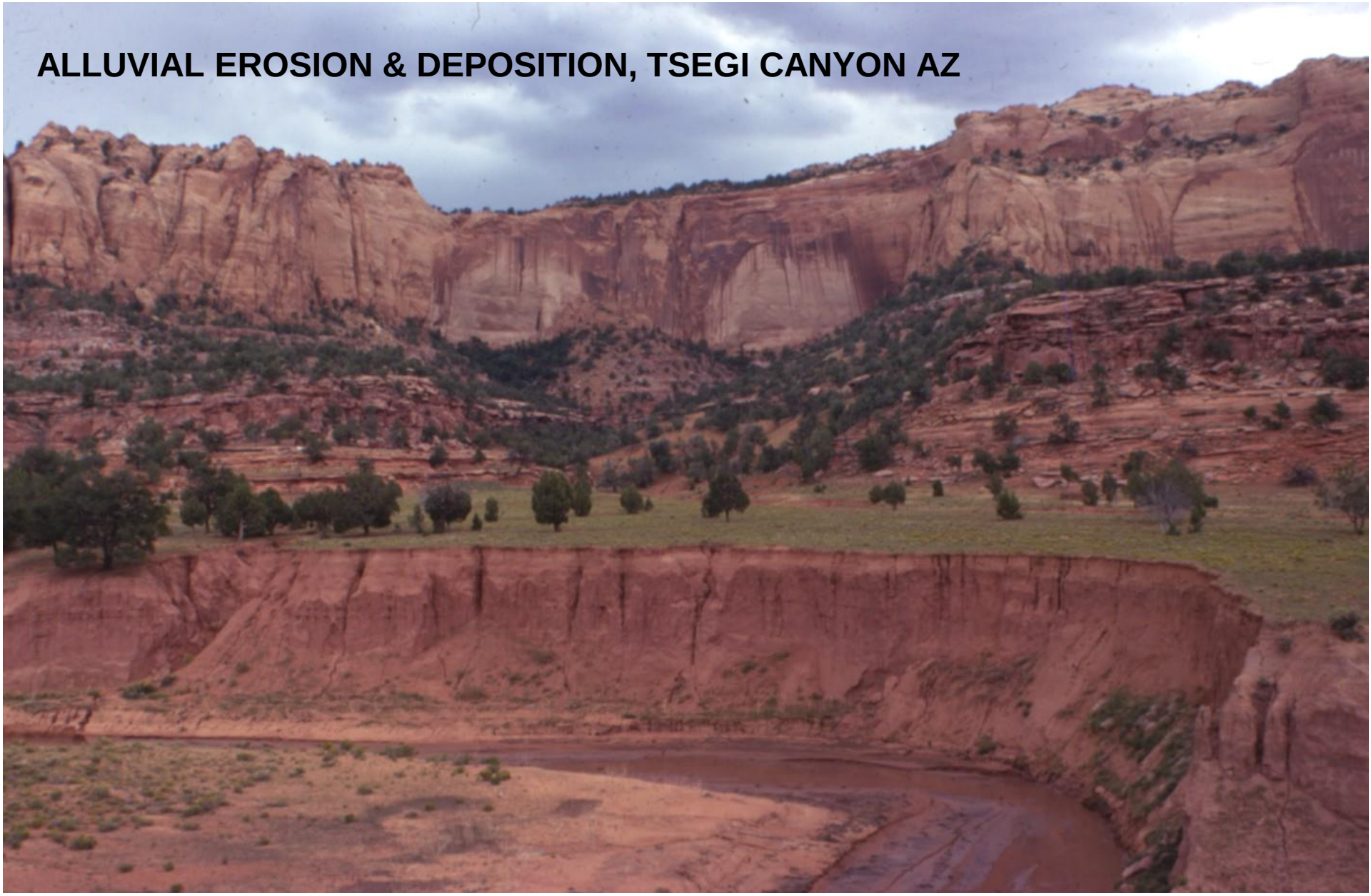



ELEVATIONAL ZONATION OF PLANT COMMUNITIES, NAVAJO MOUNTAIN UT

Low Frequency Variability

- Has cycles of change longer than 25 years
- Rise and fall of alluvial water tables
- Deposition and erosion of floodplain sediments
- Forest and range fires
- Climate

ALLUVIAL EROSION & DEPOSITION, TSEGI CANYON AZ



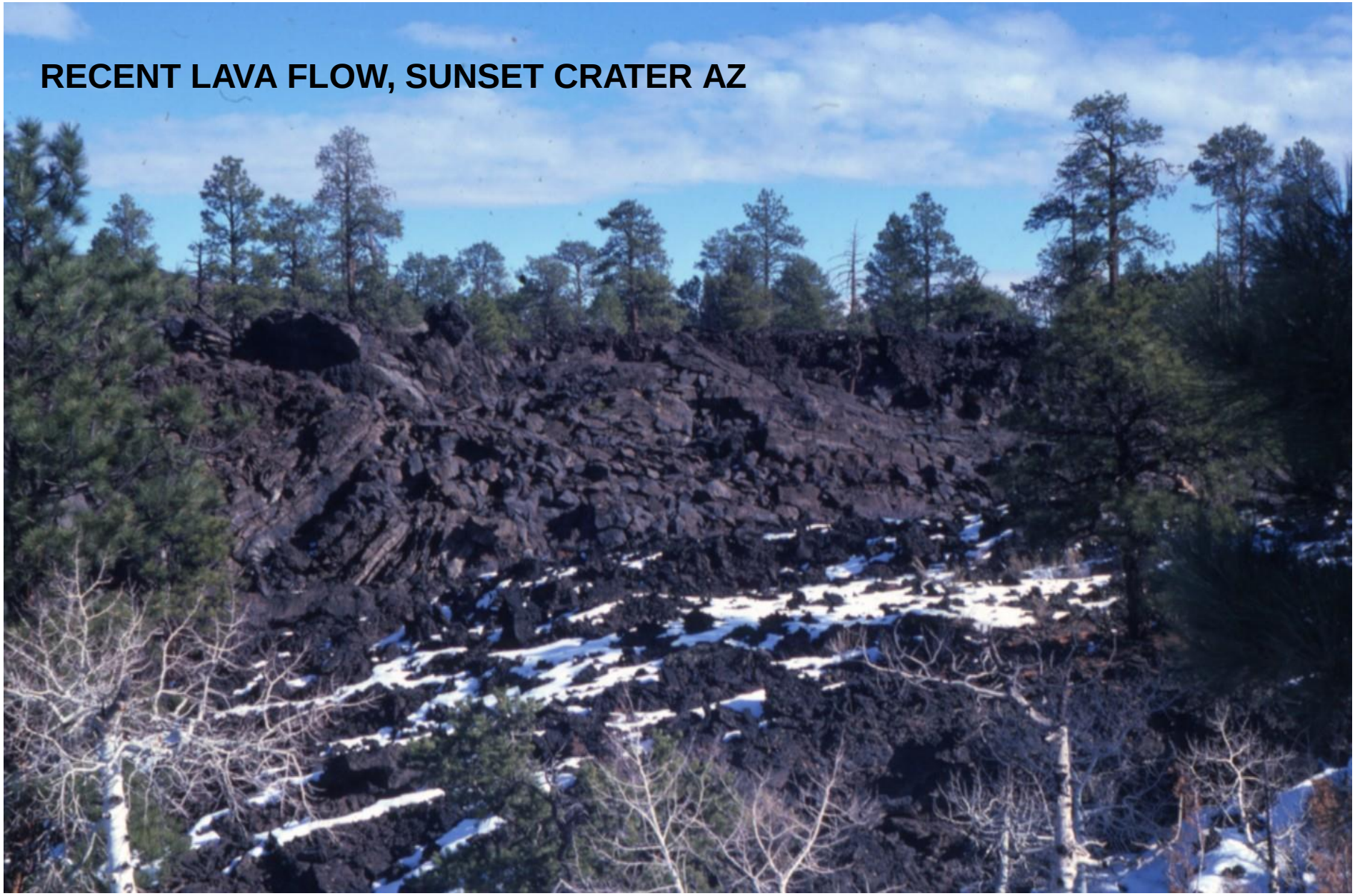
High Frequency Variability

- Has cycles of change less than or equal to 25 years
- Forest and Range Fires
- Primarily climate


SUMMER STORM, SE UT

Episodic Factors

- No (known) regular cycles
- Earthquakes
- Landslides
- Volcanic eruptions
- Floods
- Killing frosts
- Insect outbreaks
- Hailstorms
- Many others


RECENT LAVA FLOW, SUNSET CRATER AZ

Reconstructing Past Environmental Variability

- Needn’t reconstruct stable factors because they haven’t changed appreciably over the study period
- Must reconstruct low and high frequency variability and episodic factors because they change at frequencies shorter than the study period


BURIED
JUNIPER,
BLACK MESA
AZ

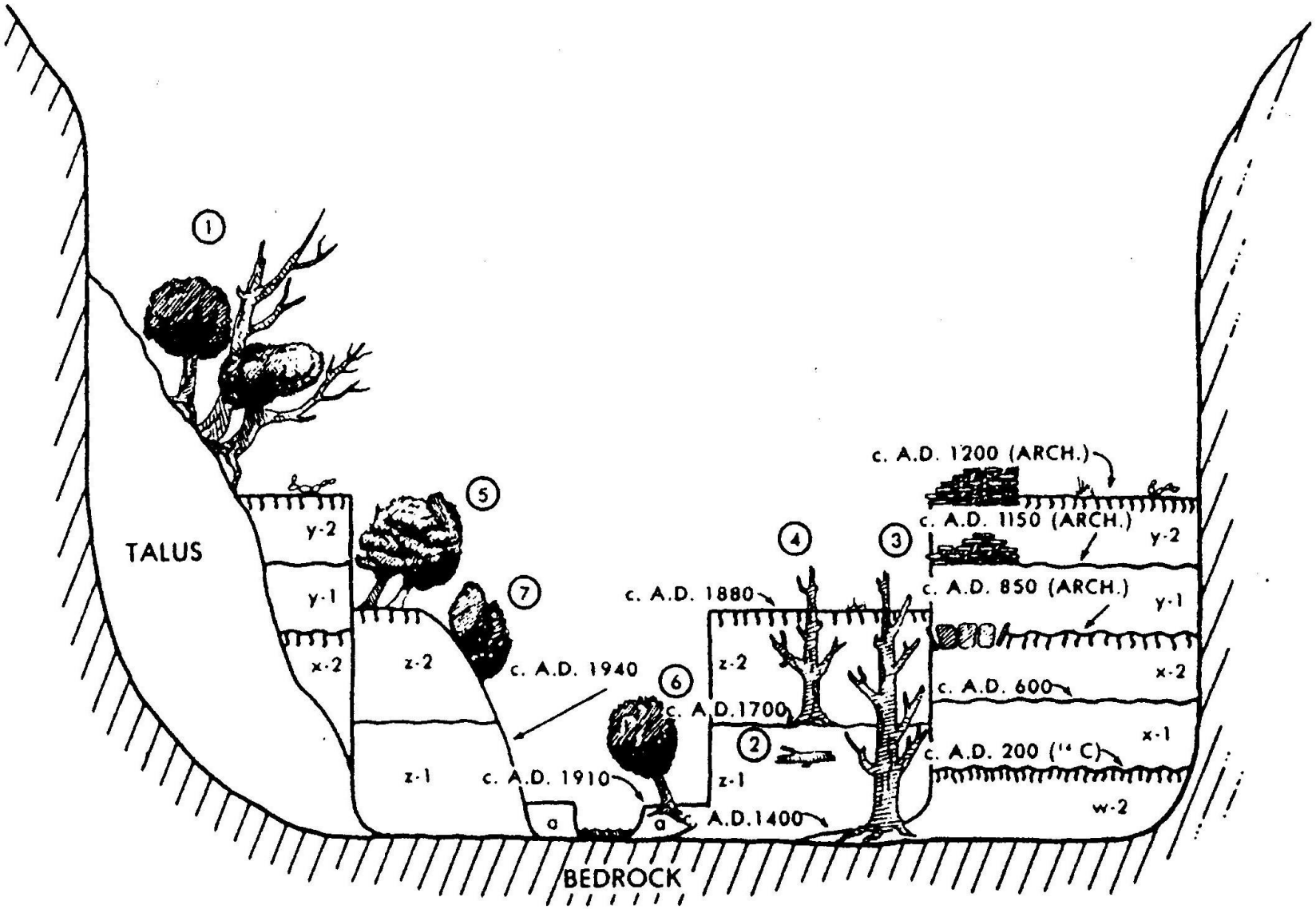


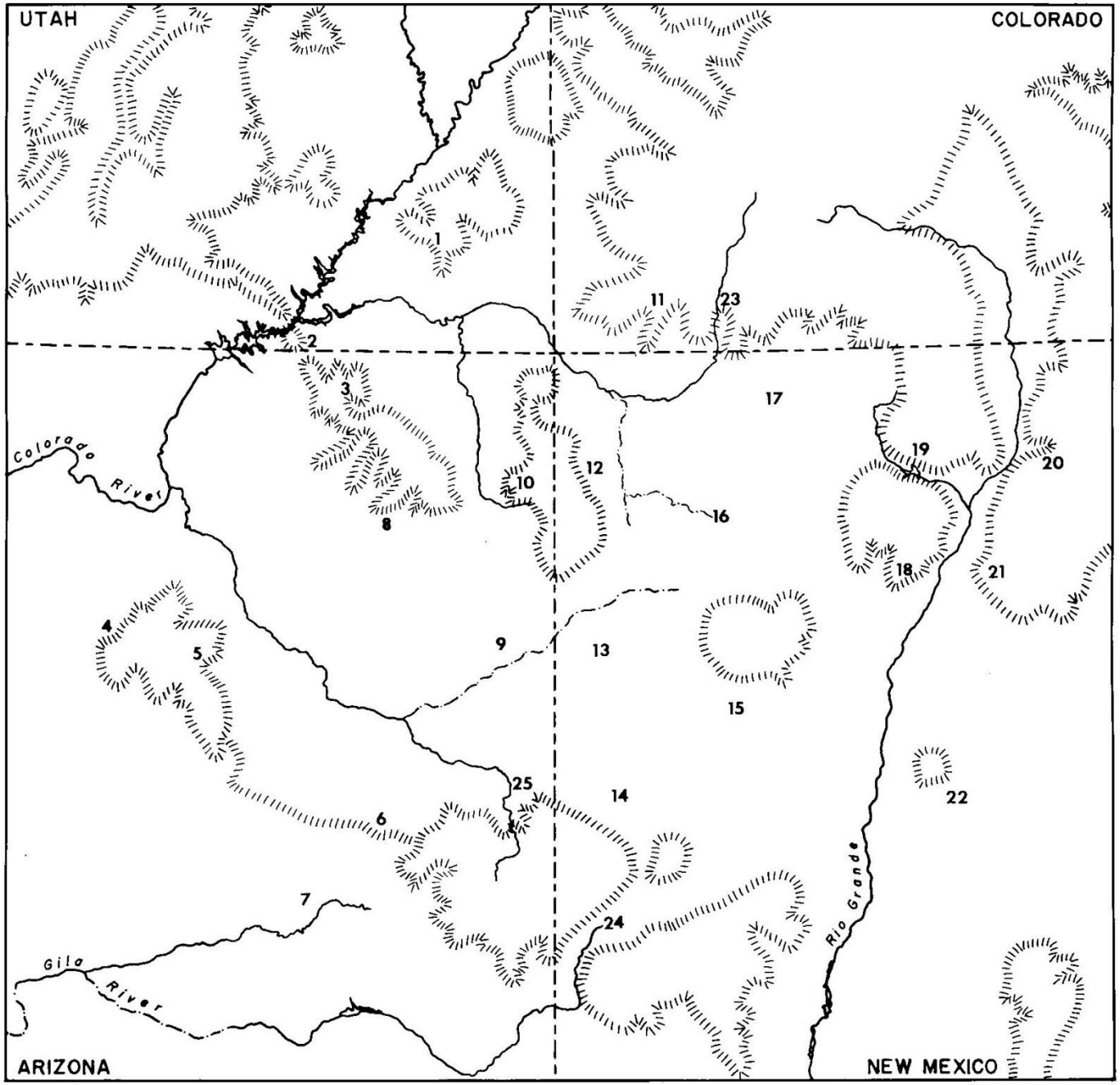
Figure 5.2 Schematic representation of the archaeological and dendrochronological dating of alluvial units in the Black Mesa region.

PACK RAT MIDDEN, CHACO CANYON NM

POLLEN SAMPLING, BLACK MESA AZ

Climate

- Qualitative reconstructions of relative variability in aspects of climate
- Quantitative reconstructions of climate variables in standard units of measurement (inches of precipitation, degrees of temperature, acre-feet of streamflow, drought indices, etc.)


UTAH
COLORADO
ARIZONA
NEW MEXICO
Colorado River
Gila River
Rio Grande
1
2
3
4
5
6
7
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9
10
11
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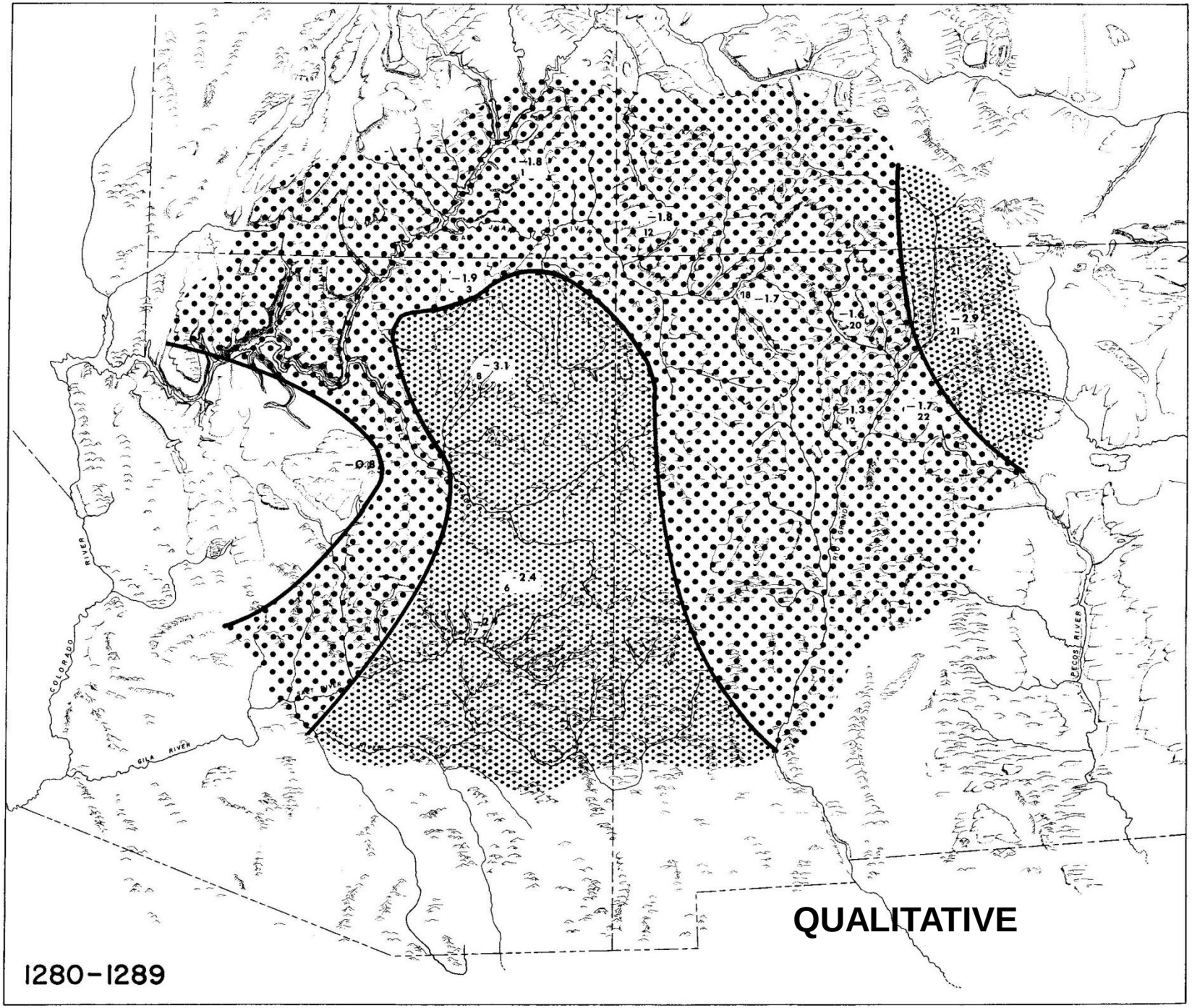
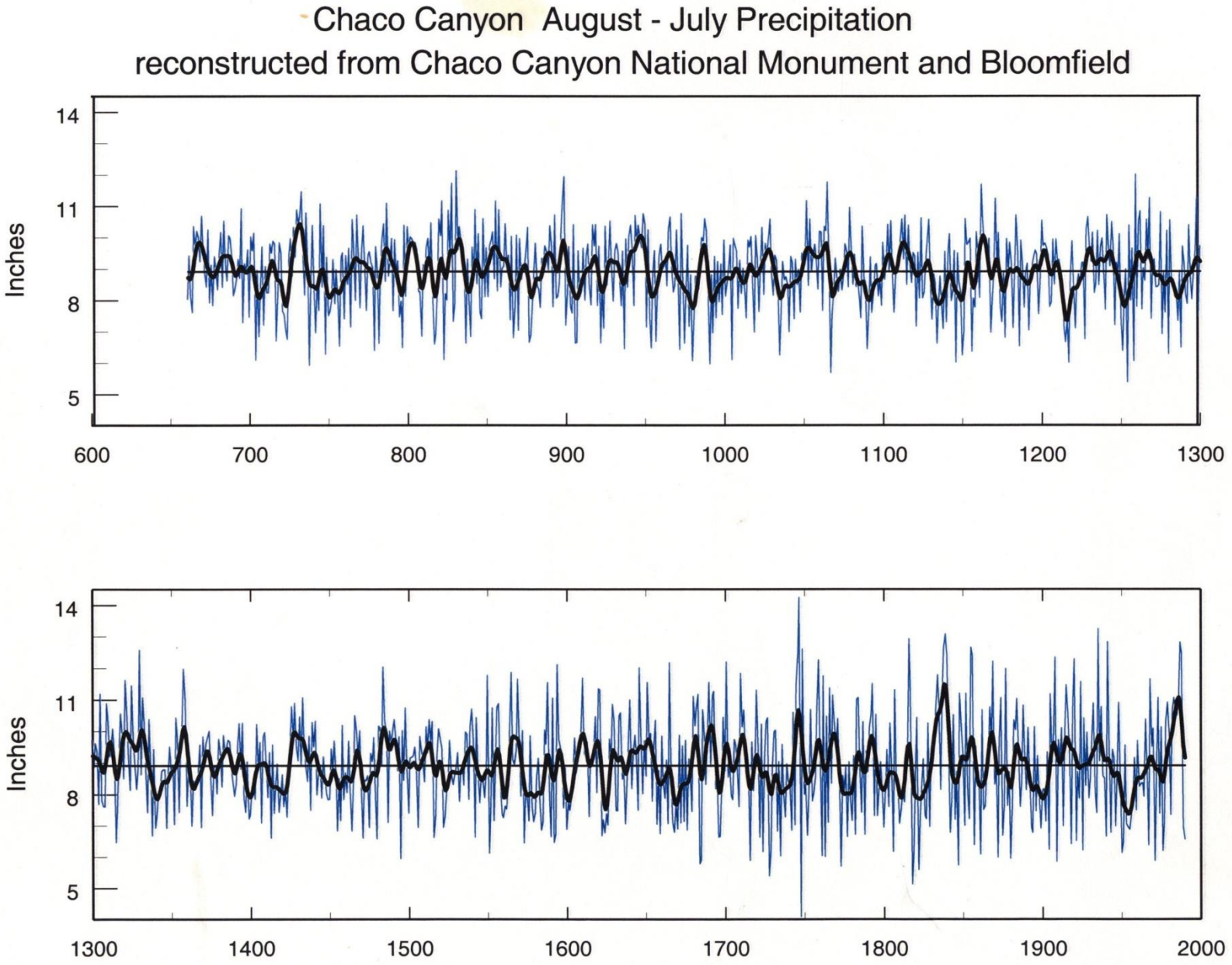
25


-1.8
1
-1.8
12
-1.9
3
18 -1.7
-1.6
20
-2.9
21
-3.1
8
-1.3
19
-1.7
22
-0.8
2.4
6
-2
7
COLORADO RIVER
GILA RIVER
PECOS RIVER
QUALITATIVE
1280-1289


Chaco Canyon August - July Precipitation
reconstructed from Chaco Canyon National Monument and Bloomfield
Inches
14
11
8
5
600
700
800
900
1000
1100
1200
1300
Inches
14
11
8
5
1300
1400
1500
1600
1700
1800
1900
2000

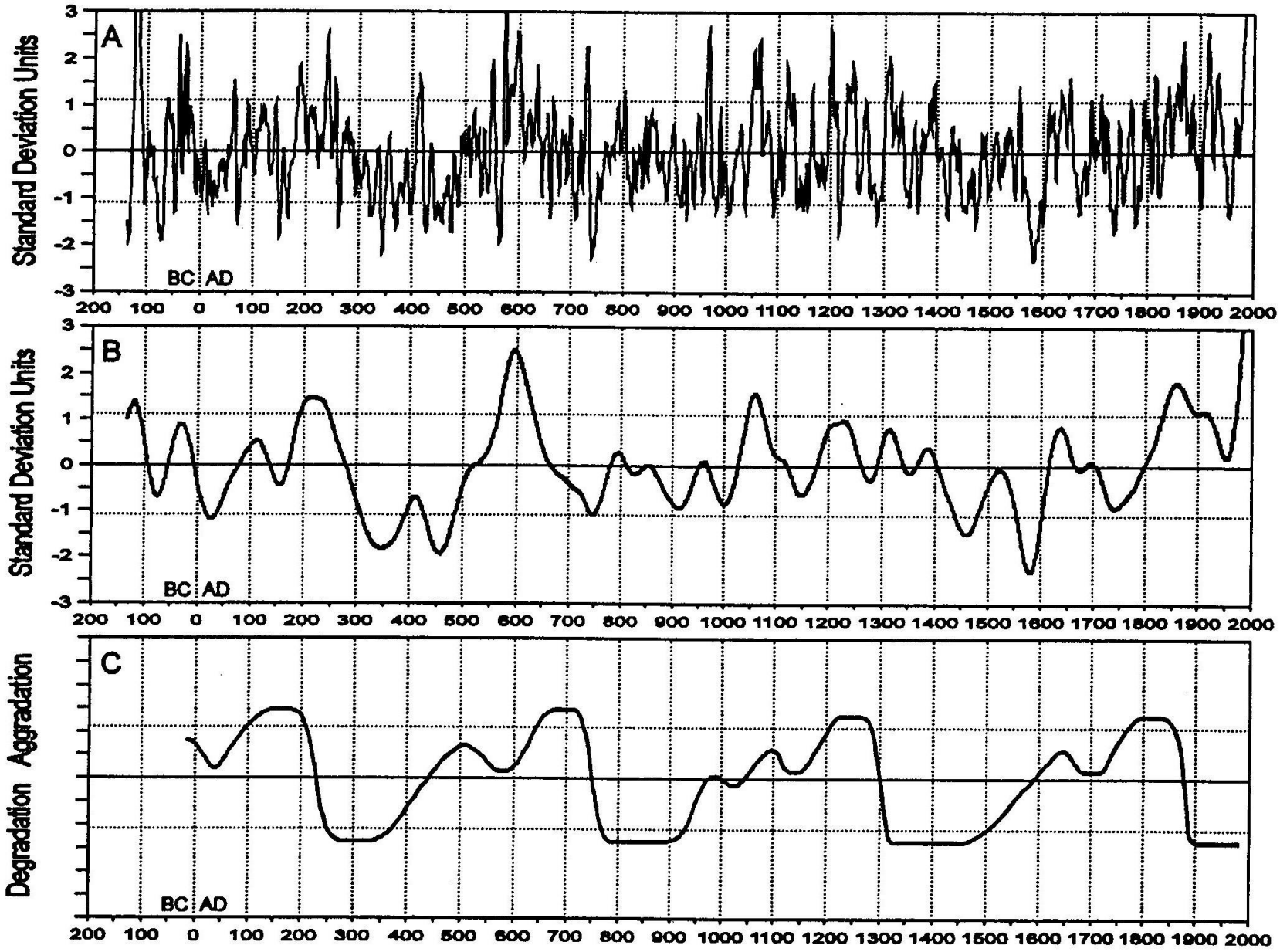


Fig. 4. A. The final reconstruction of annual rainfall (in standard deviation units) reconstructed from the MLC. The curve represents a 10-yr smoothing spline fit through the reconstruction to accentuate short-term (<50 yr) climate episodes. Dashed horizontal lines indicate the ± 1.1 standard deviation thresholds discussed by Dean (1988). B. A 100-yr smoothing spline fit through the reconstruction to accentuate long-term (>100 yr) trends in climate. C. The primary aggradation-degradation curve developed by Euler *et al.* (1979) and Karlstrom (1988) for the Black Mesa area of northeastern Arizona. The curve is relative and therefore dimensionless.

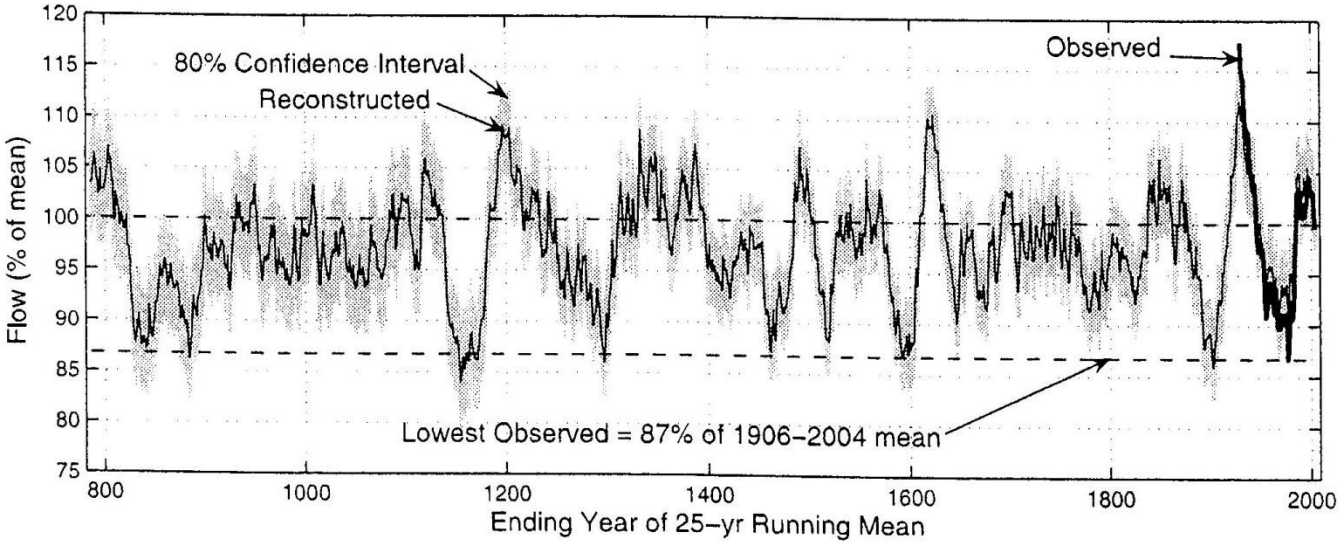
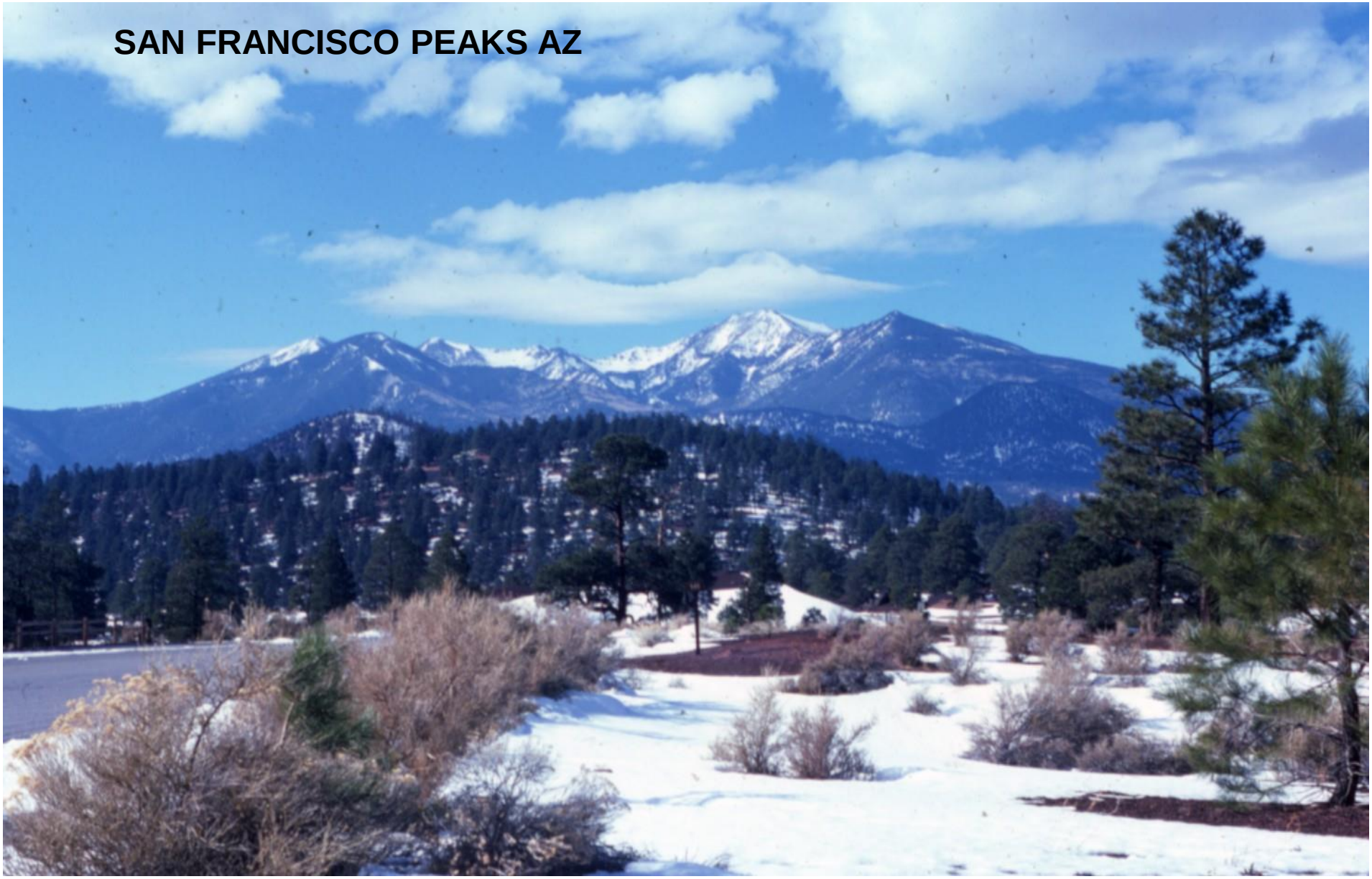
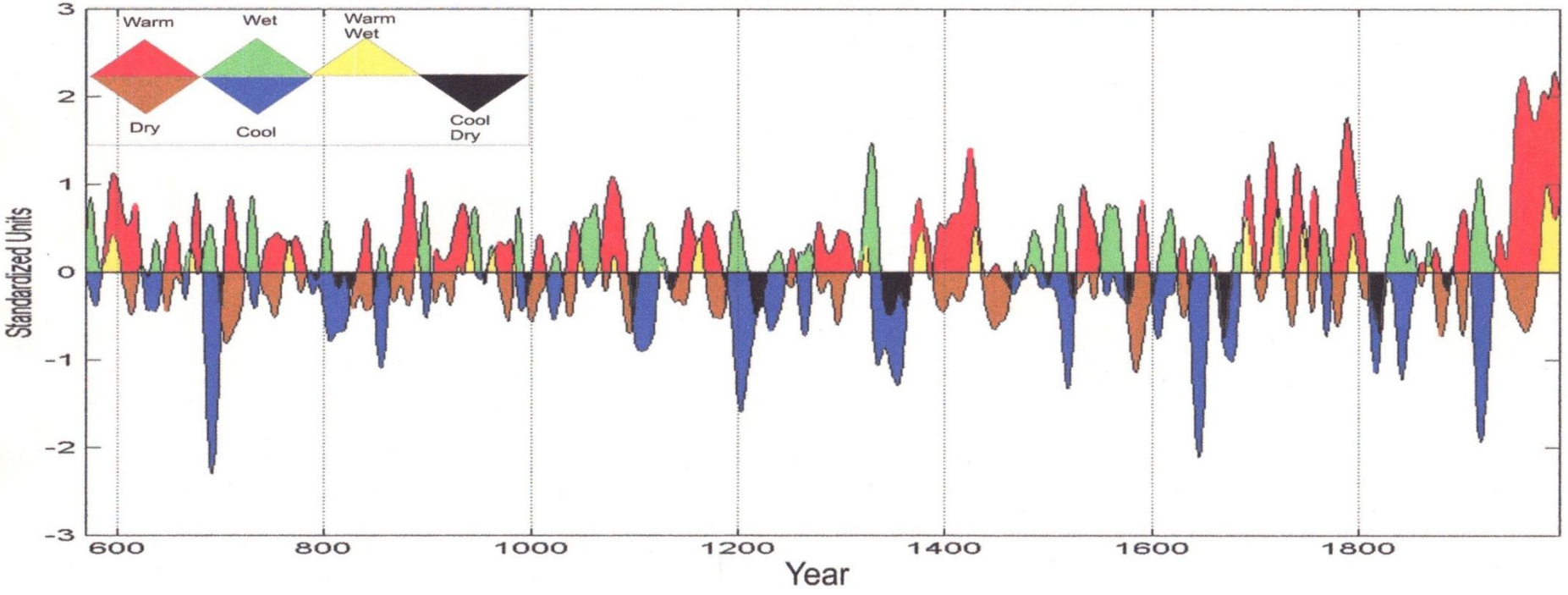
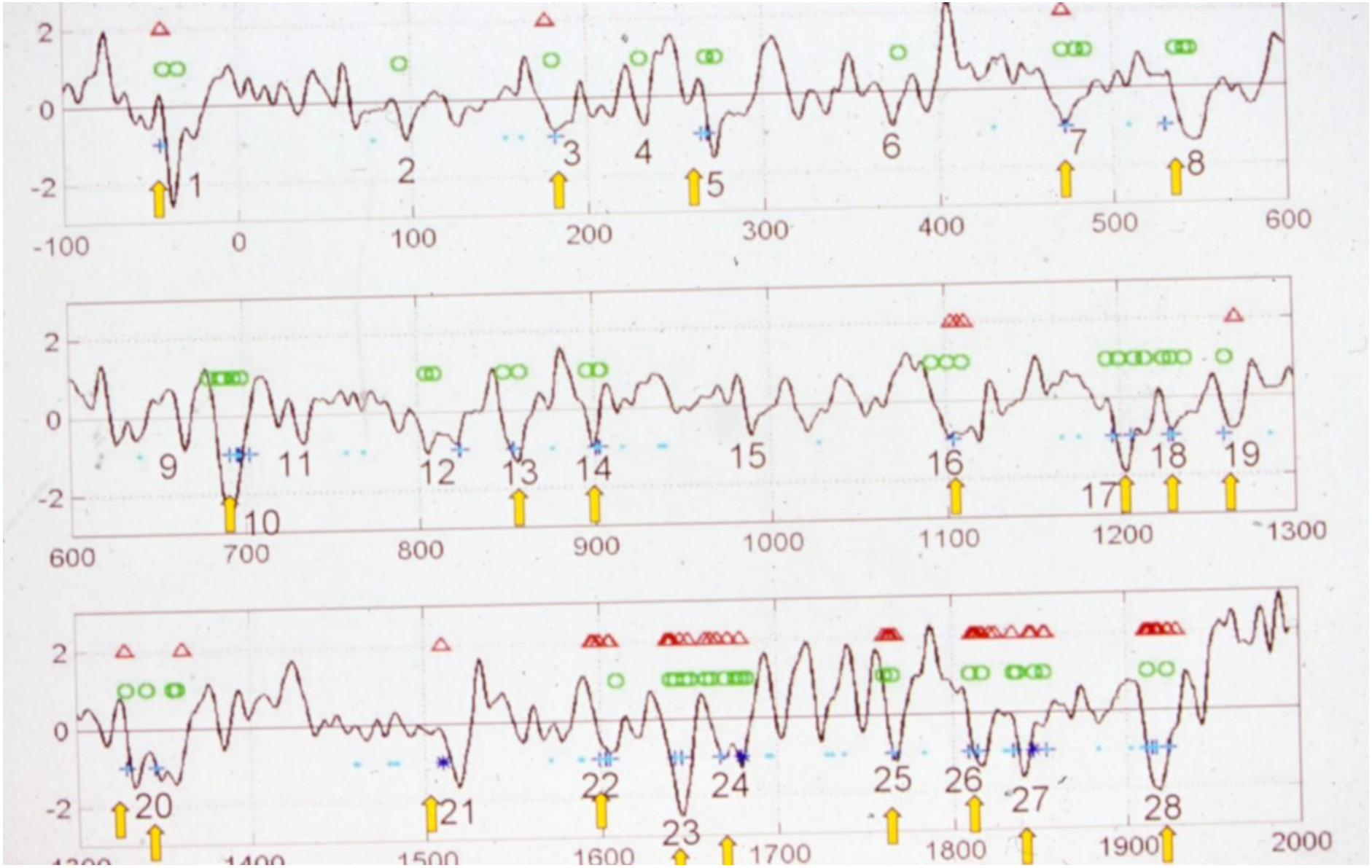


Figure 2. Time series plot of 25-year running mean of reconstructed flows. Flows are plotted as percentage of the 1906–2004 mean of observed natural flows (18.53 billion cubic meters, or 15.03 million acre-ft). Confidence interval derived from 0.10 and 0.90 probability points of ensemble of 1000 noise-added reconstructions. Horizontal dashed line is lowest 25-year running mean of observed flows (1953–1977).


SAN FRANCISCO PEAKS AZ


Warm
Wet
Warm
Wet
Dry
Cool
Cool
Dry
Standardized Units
3
2
1
0
-1
-2
-3
600
800
1000
1200
1400
1600
1800
Year


2
0
-2
-100
0
100
200
300
400
500
600
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4
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6
7
8
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0
-2
600
700
800
900
1000
1100
1200
1300
9
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13
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15
16
17
18
19
2
0
-2
1400
1500
1600
1700
1800
1900
2000
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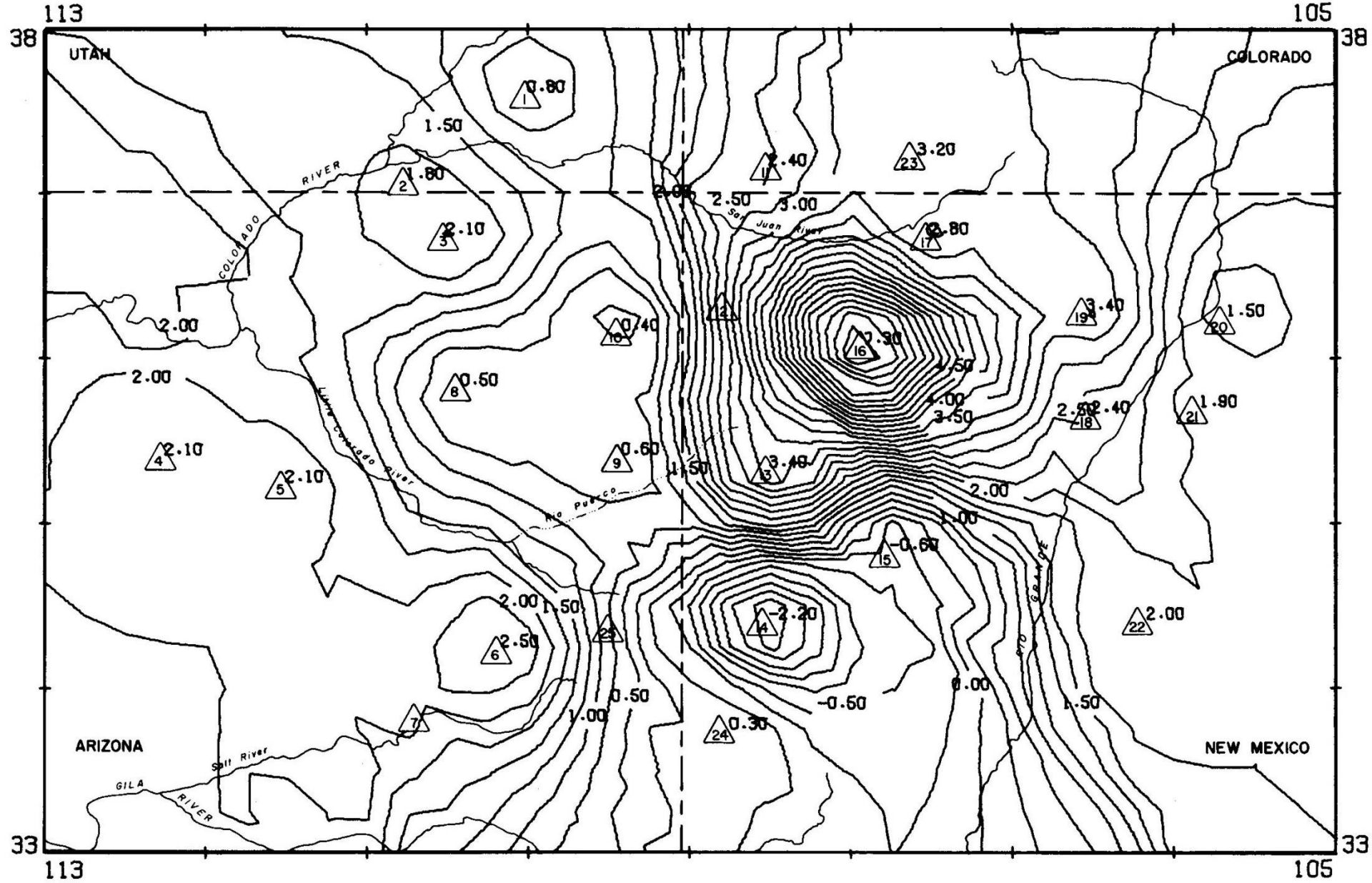
22
23
24
25
26
27
28

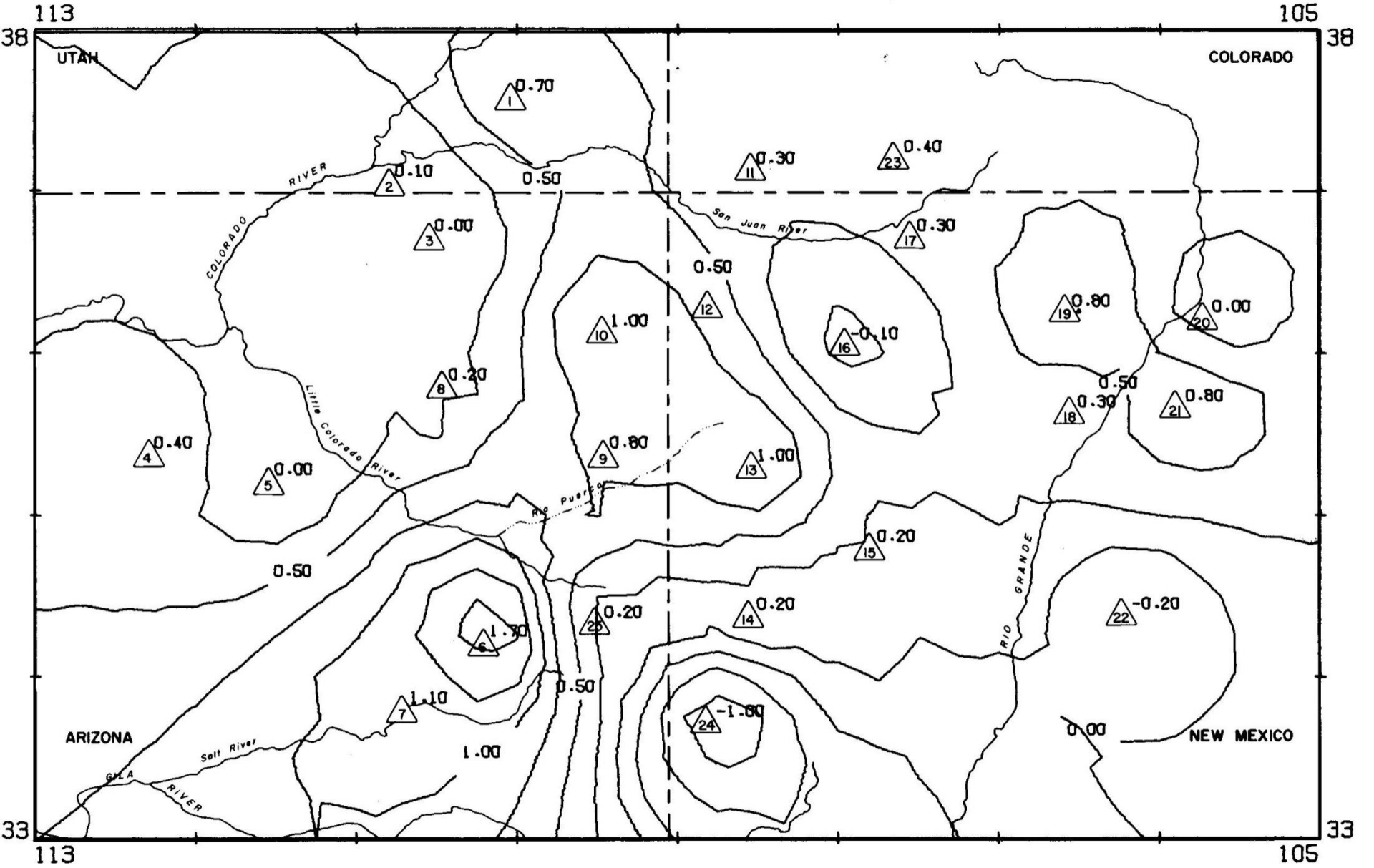
OTHER HFP ASPECTS OF CLIMATE

SPATIAL VARIABILITY

HIGH SPTIAL VARIABILITY



LOW SPATIAL VARIABILITY



1860-1869

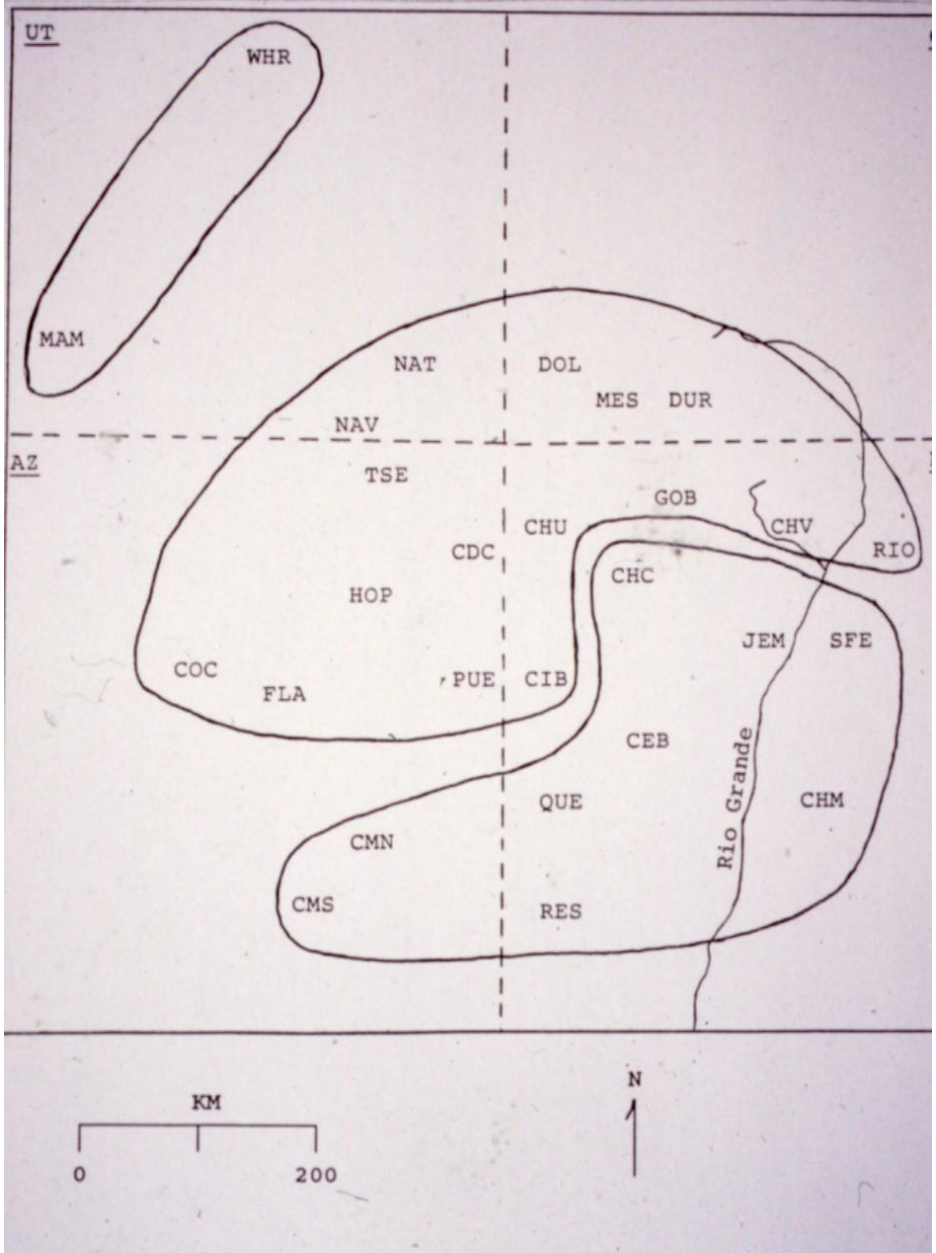
OTHER HFP ASPECTS OF CLIMATE

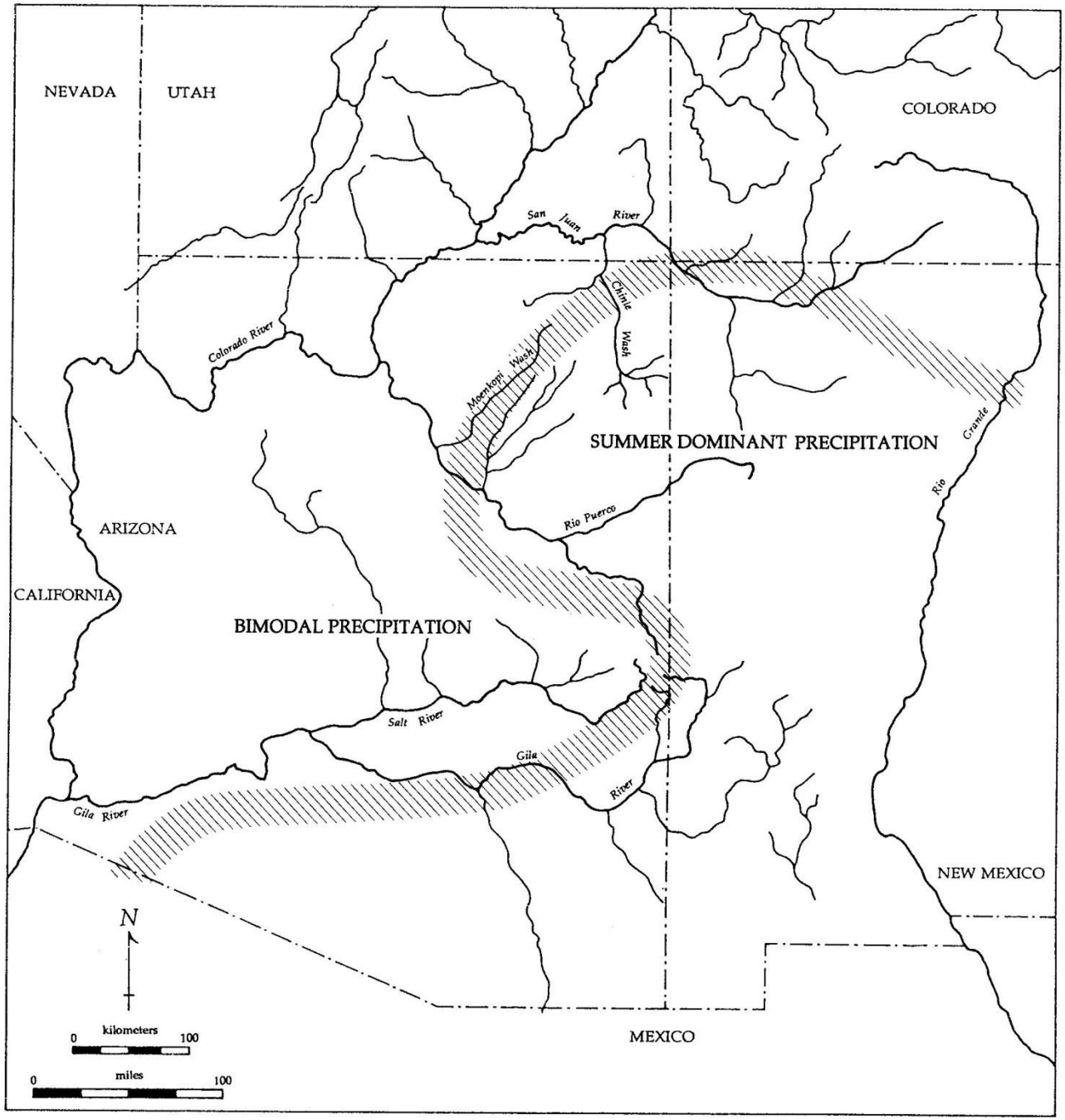
TEMPORAL VARIABILITY

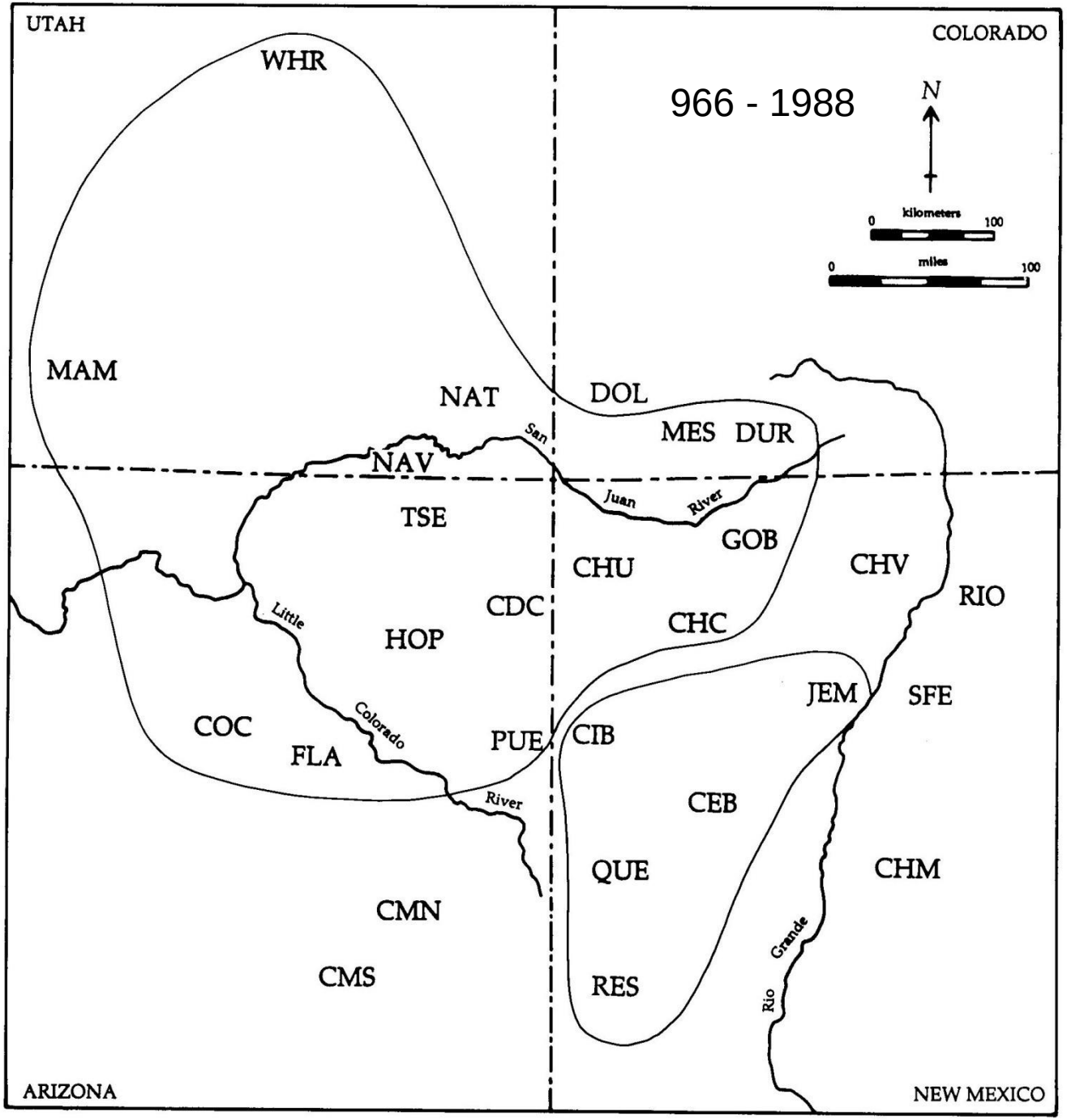
OTHER ASPECTS OF CLIMATE

SEASONAL DISTRIBUTION OF PRECIPITATION

SPATIAL GROUPINGS OF PRINCIPAL COMPONENTS OF TREE GROWTH
FOR THE SOUTHWESTERN PALEOCLIMATE TREE-RING NETWORK, 1889-1988




NEVADA
UTAH
COLORADO
San Juan River
Chinle Wash
Moenkopi Wash
Colorado River
SUMMER DOMINANT PRECIPITATION
Rio Grande
Rio Puerco
ARIZONA
CALIFORNIA
BIMODAL PRECIPITATION
Salt River
Gila River
Gila River
NEW MEXICO
N
0
kilometers
100
0
miles
100
MEXICO


UTAH
COLORADO
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kilometers
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CHC
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HOP
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SFE
COC
Colorado
PUE
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CMS
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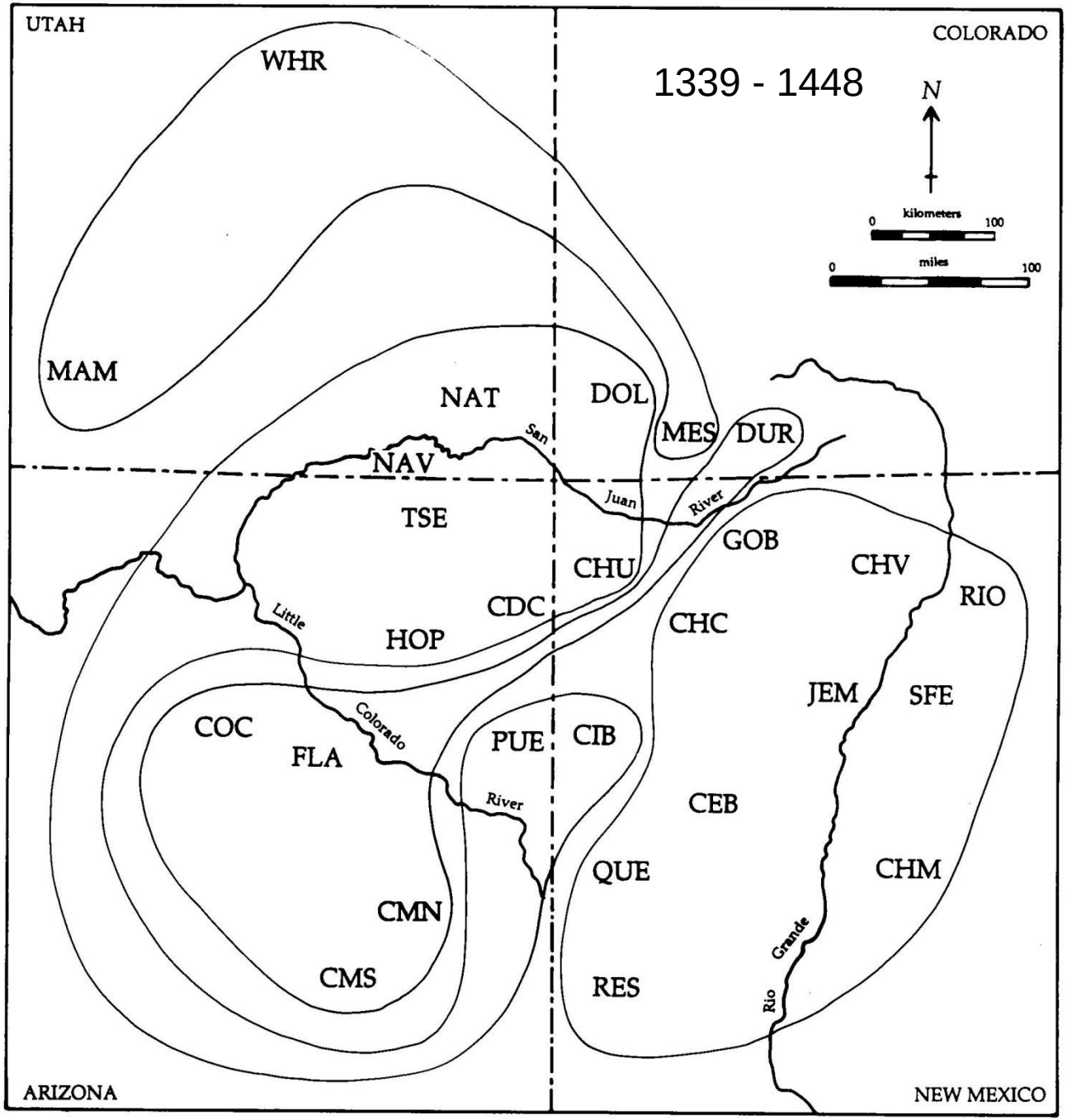
ARIZONA
NEW MEXICO


UTAH
COLORADO
1339 - 1448
N
kilometers
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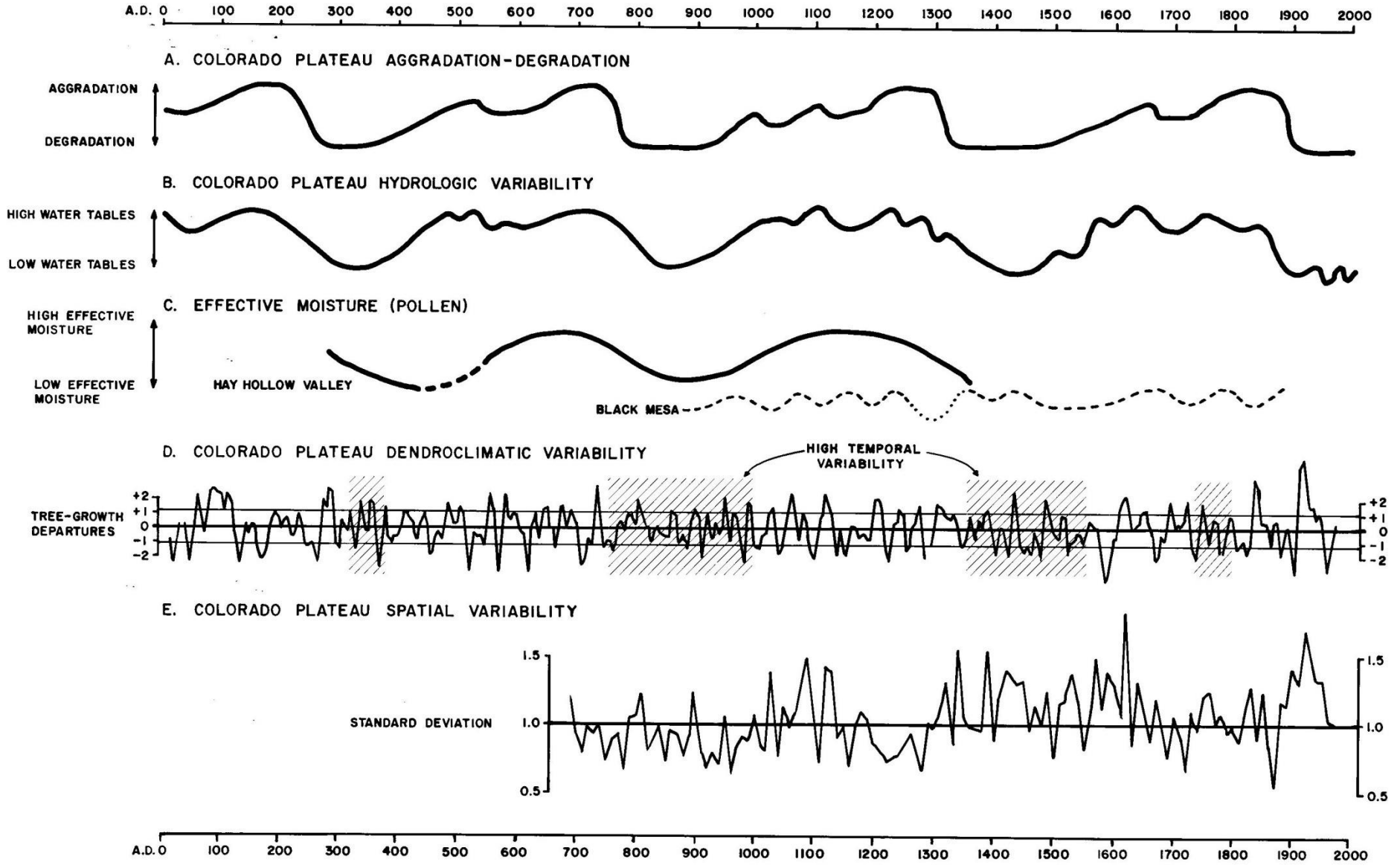
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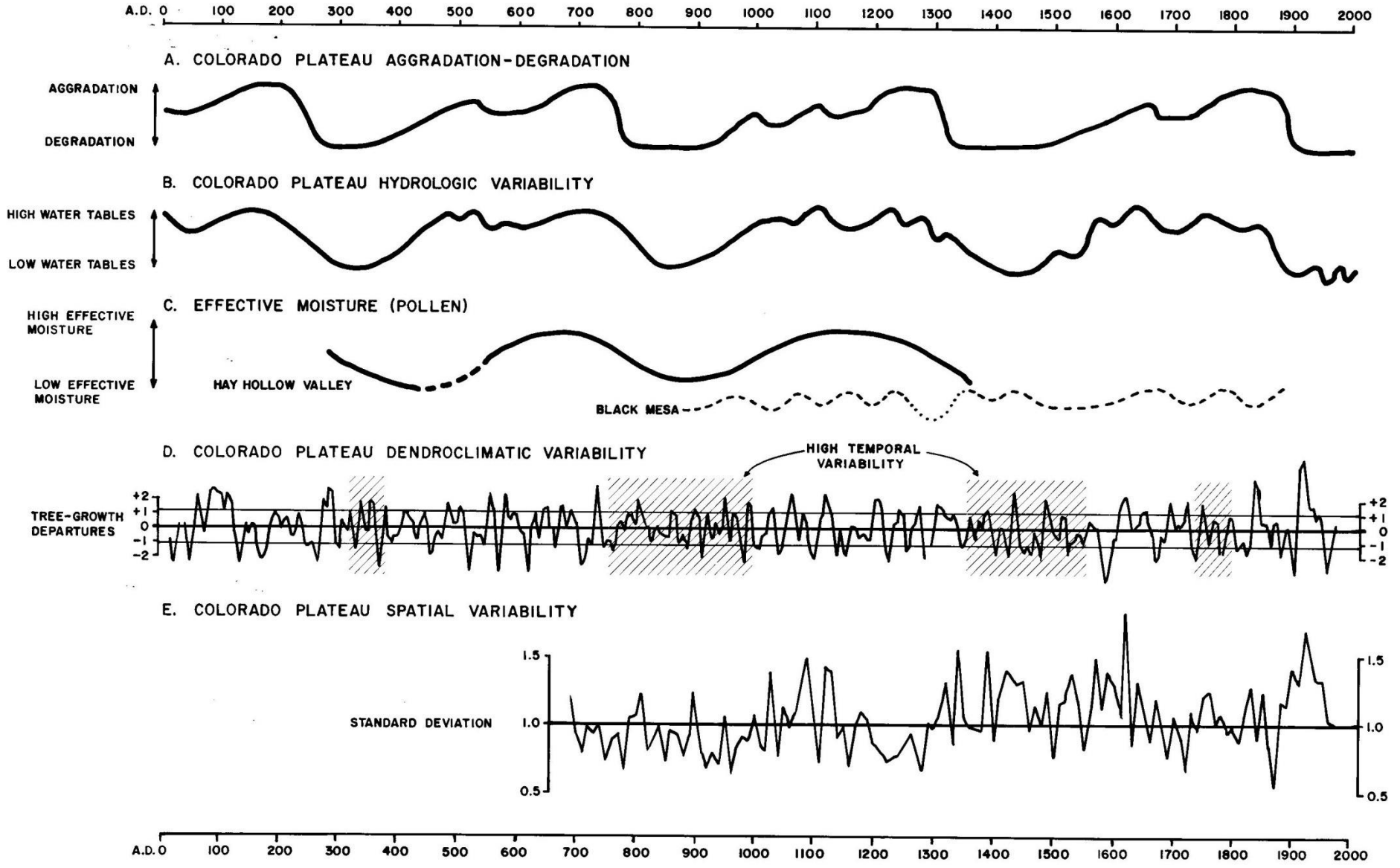
A. COLORADO PLATEAU AGGRADATION-DEGRADATION
AGGRADATION
DEGRADATION
B. COLORADO PLATEAU HYDROLOGIC VARIABILITY
HIGH WATER TABLES
LOW WATER TABLES
C. EFFECTIVE MOISTURE (POLLEN)
HIGH EFFECTIVE MOISTURE
LOW EFFECTIVE MOISTURE
HAY HOLLOW VALLEY
BLACK MESA
D. COLORADO PLATEAU DENDROCLIMATIC VARIABILITY
HIGH TEMPORAL VARIABILITY
TREE-GROWTH DEPARTURES
+2
+1
0
-1
-2
E. COLORADO PLATEAU SPATIAL VARIABILITY
STANDARD DEVIATION
1.5
1.0
0.5
A.D. 0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500 1600 1700 1800 1900 2000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HIGH TEMPORAL VARIABILITY
TREE-GROWTH DEPARTURES
+2
+1
0
-1
-2
E. COLORADO PLATEAU SPATIAL VARIABILITY
STANDARD DEVIATION
1.5
1.0
0.5
A.D. 0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500 1600 1700 1800 1900 2000

EXPECTATIONS

QUESTIONS