Yucca Mountain Climate: Past, Present, and Future

Presented to:
U.S. Nuclear Waste Technical Review Board Panel on the Natural System

Presented by:
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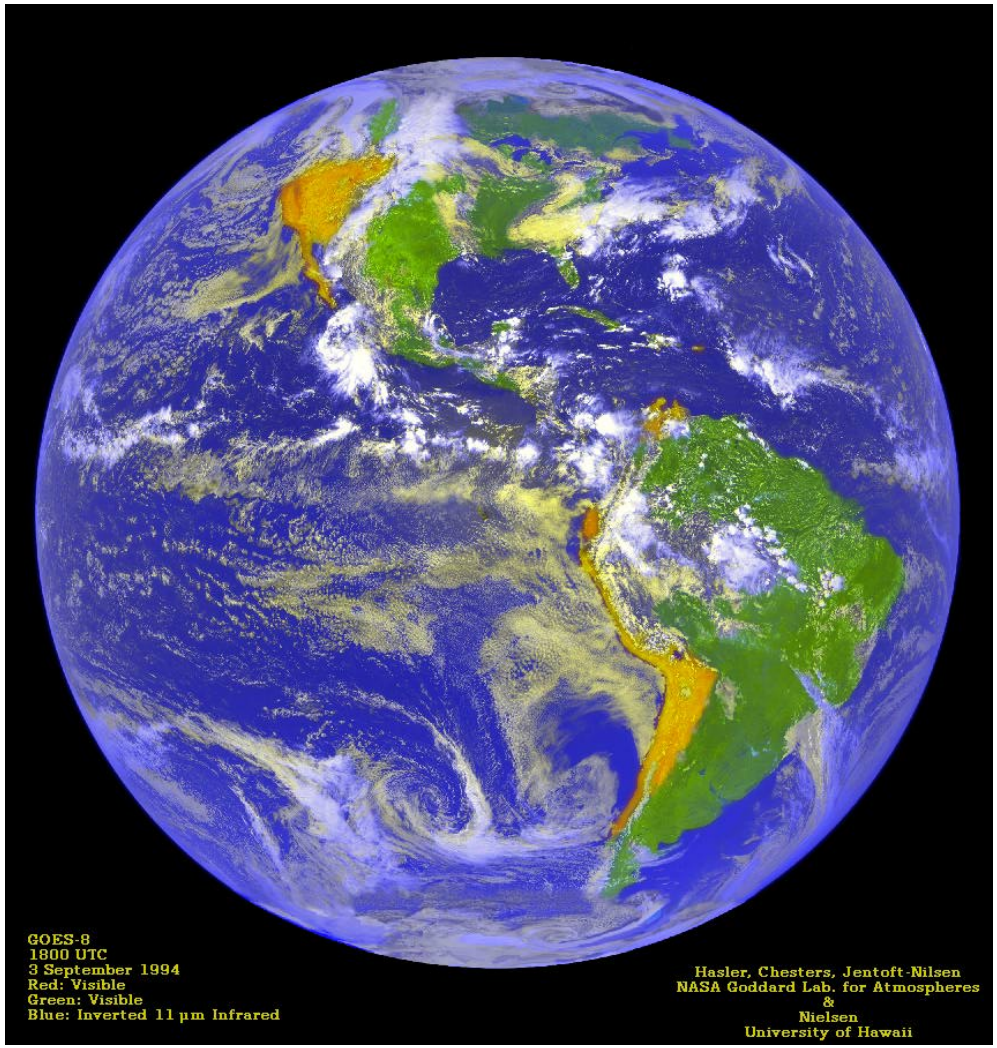
Present the Rationale for Past Climate Being the Key to Future Climate



Long-Term Climate: The Last 400,000 Years

- **Encompassed higher, sometimes much higher, effective moisture relative to today. Greater effective moisture can mean increased precipitation or decreased temperature or both**
- **Precipitation was often higher and/or temperature lower in the past because tropical moisture-laden air was coupled with colder air masses over the Yucca Mountain area**
- **Infiltration was commonly higher relative to today because water is stored more readily during periods of greater effective moisture**

Assumptions

- **Climate is cyclical, the past is the key to the future**
- **Relation exists between the timing of long-term climate change and orbital parameters**
- **Relation exists between the characteristics of past climates and the sequences of those climates**
- **Long-term, earth-based climate forcing functions have remained relatively unchanged for the last 500,000 years and should remain relatively unchanged for the next several hundred thousand years**

Forecasting the Next 400,000 Years

1. **Compare the relation of the Devils Hole record to calculated orbital parameters to identify past climate pattern**
2. **Project this pattern into the future to establish the timing of future climate regimes**
3. **Identify the magnitude and nature of past climate states - Interglacial (modern), Intermediate, Monsoon, Glacial**
4. **Select present-day meteorological stations to represent those past climate states**

Devils Hole, Nevada

Comparison of Proxy Records for Glacial and Interglacial Climate

a) Landwehr et al. 1997

b) Smith et al. 1997

c) Jannik et al. 1991

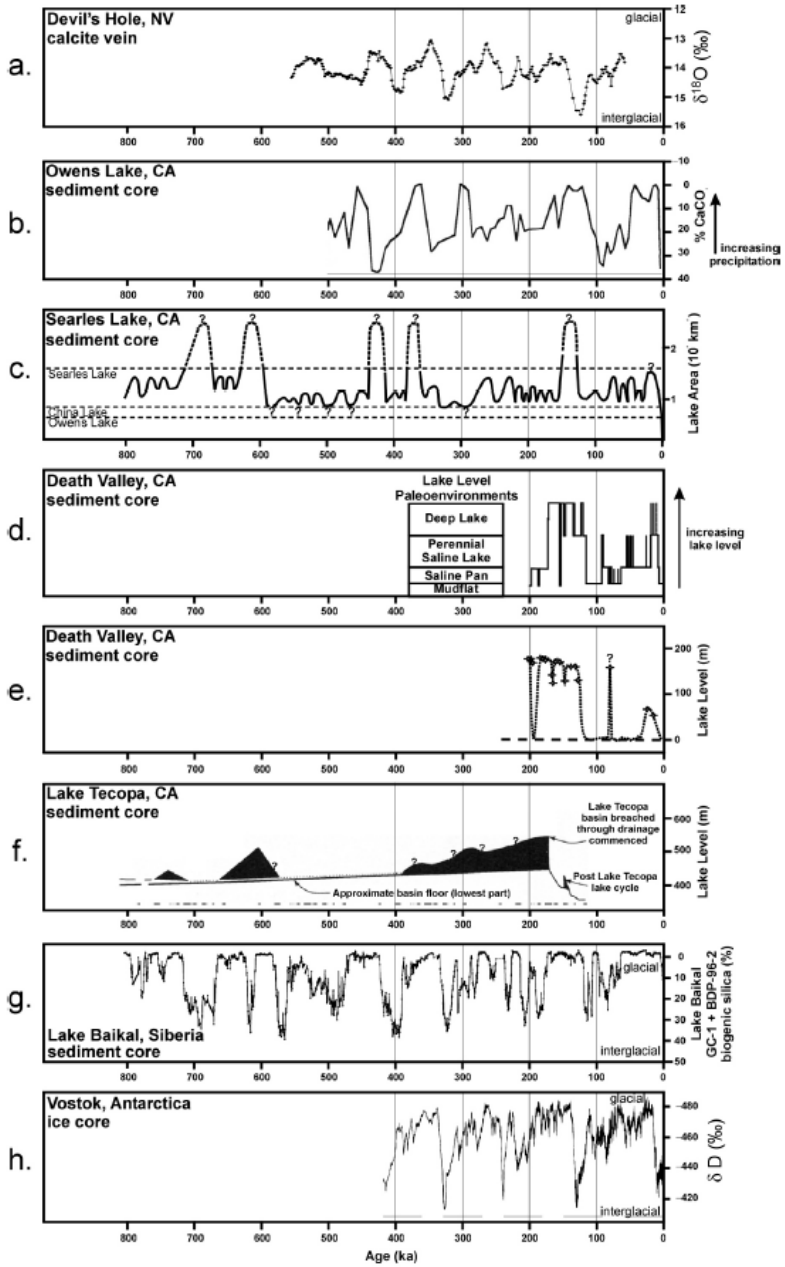
d) Lowenstein et al. 1999

e) Ku et al. 1998

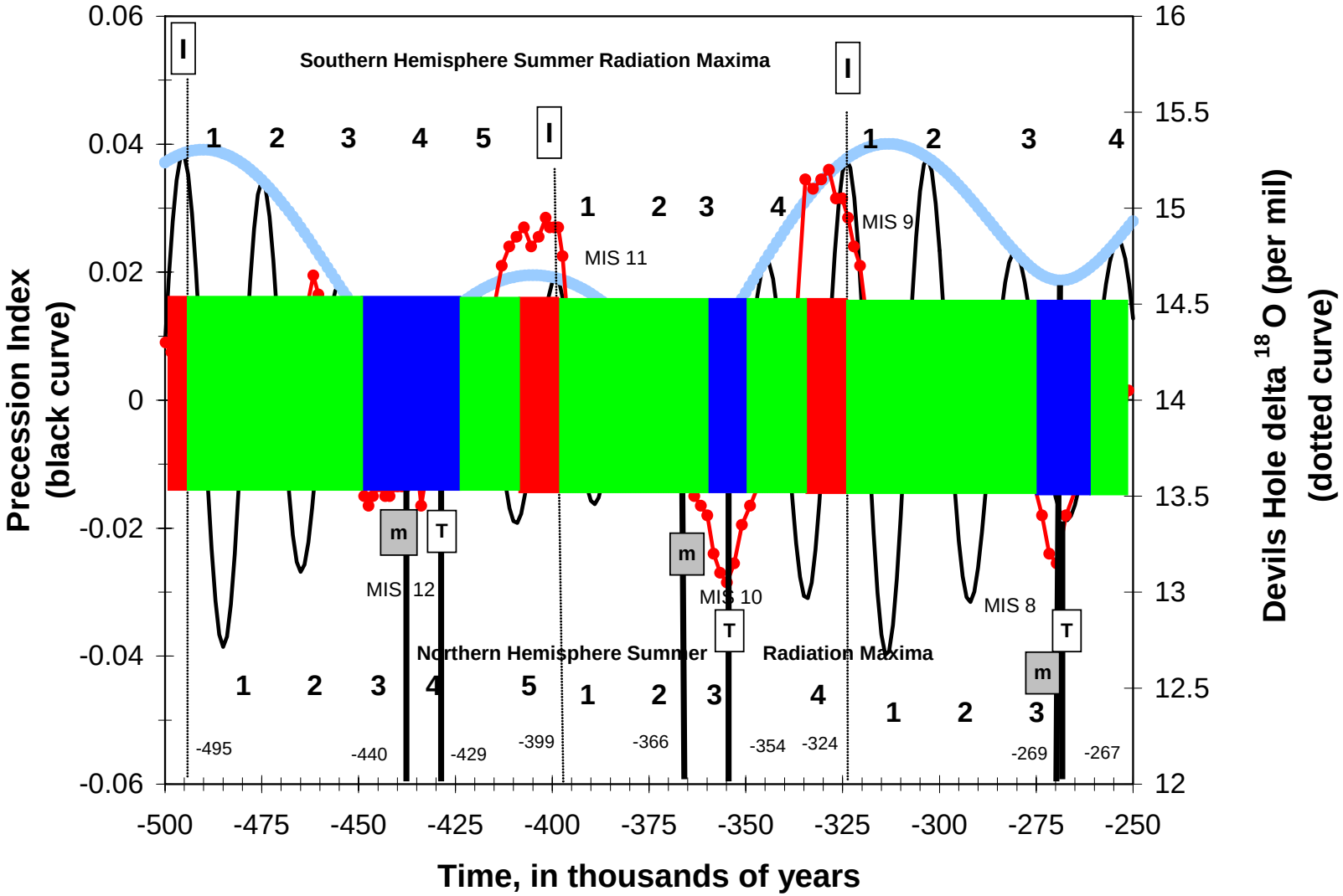
f) Morrison 1999

g) Prokopenko et al. 2001

h) Petit et al. 1999



Chronology: Devils Hole and Orbital Parameters



Chronology: Devils Hole and Orbital Parameters

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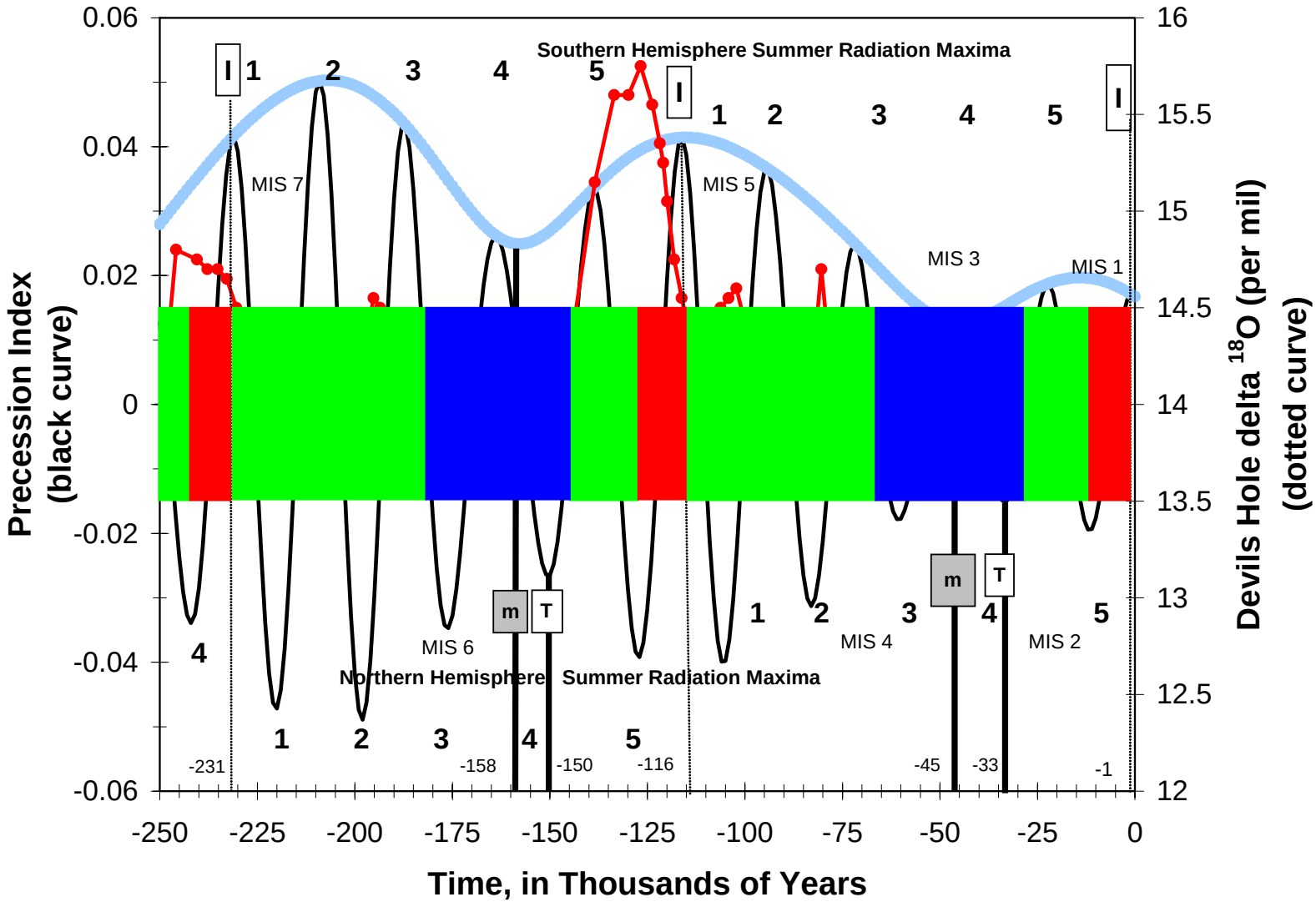

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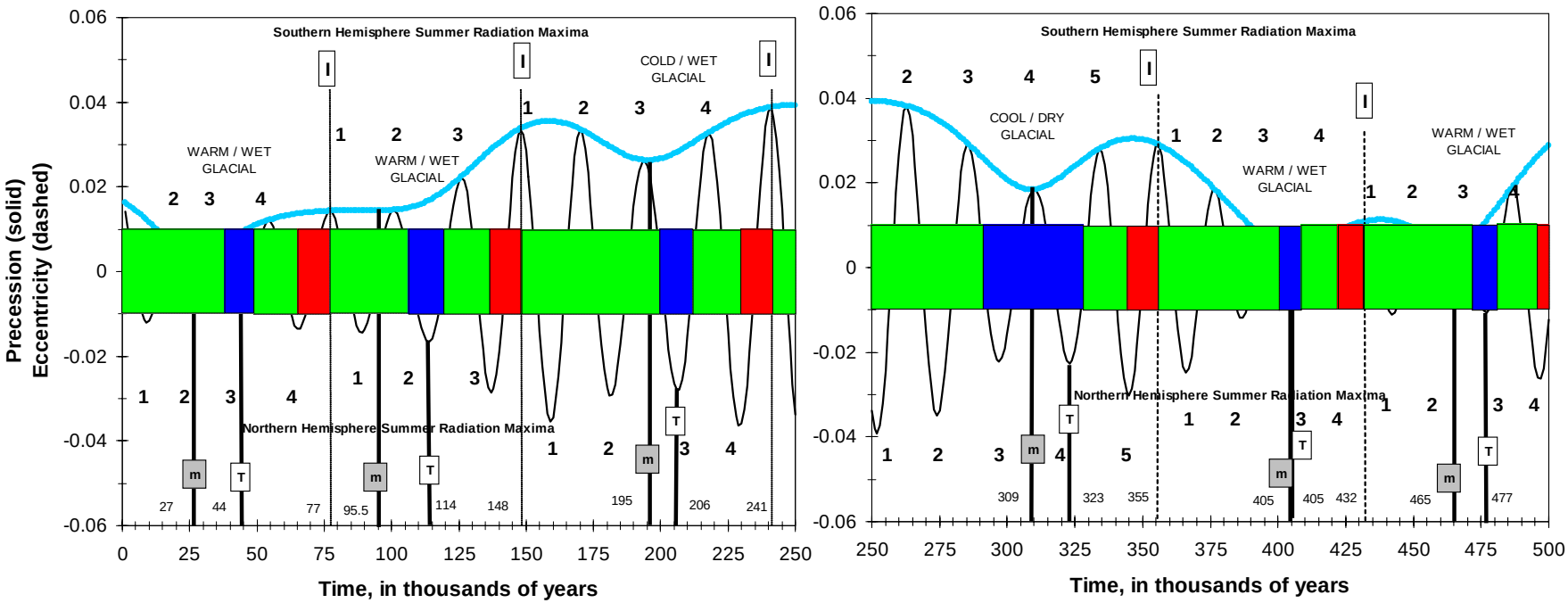
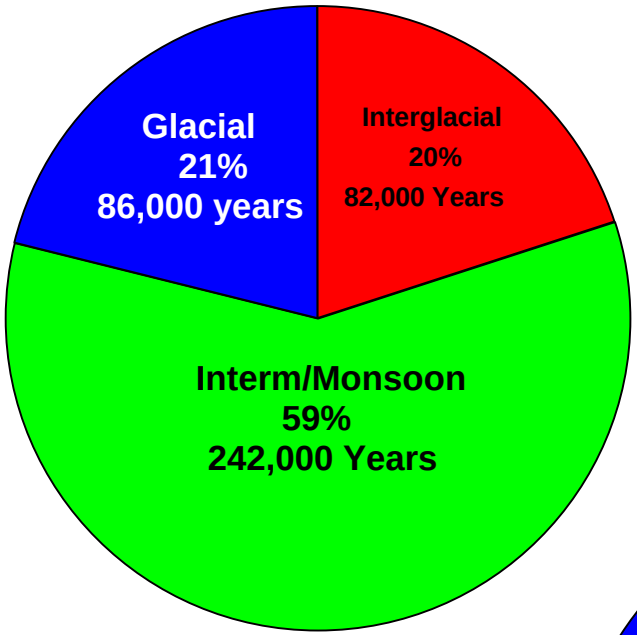
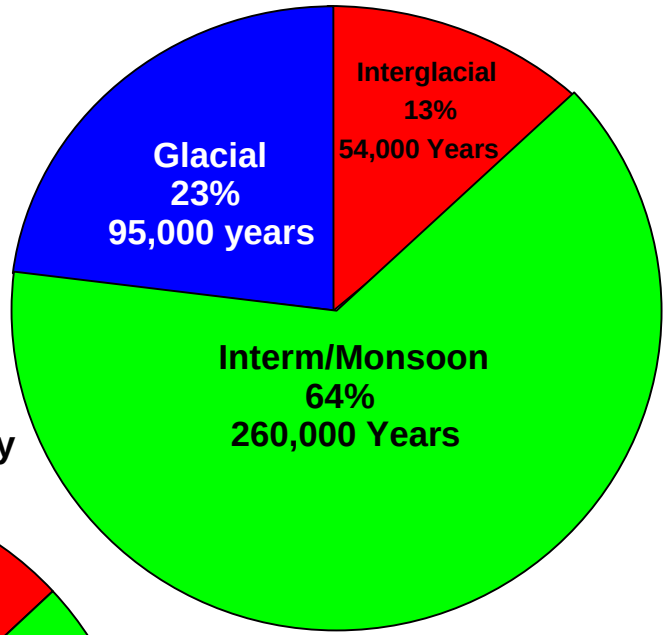
Future Climate and Orbital Parameters



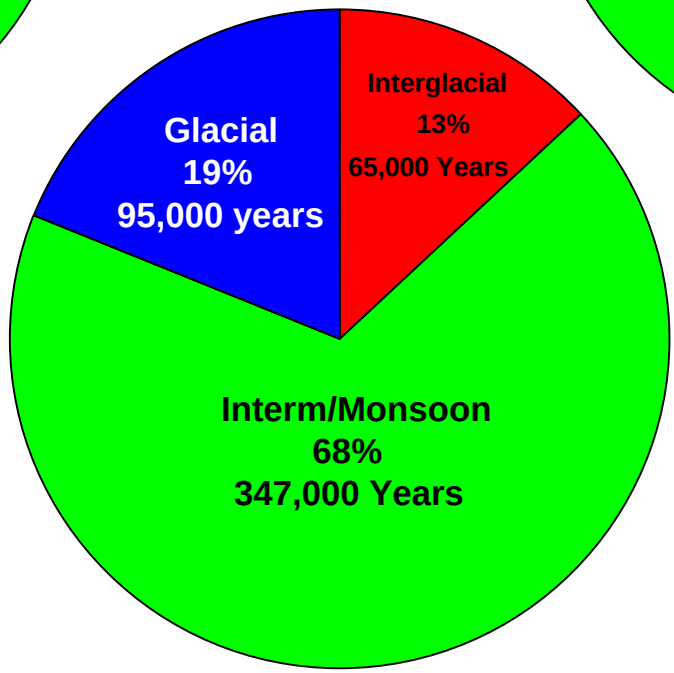
Last 410,000 Years-Owens Lake



Last 409,000 Years-Precession Methodology



Future 507,000 Years-Precession Methodology



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Owens Lake, California

Death Valley, California

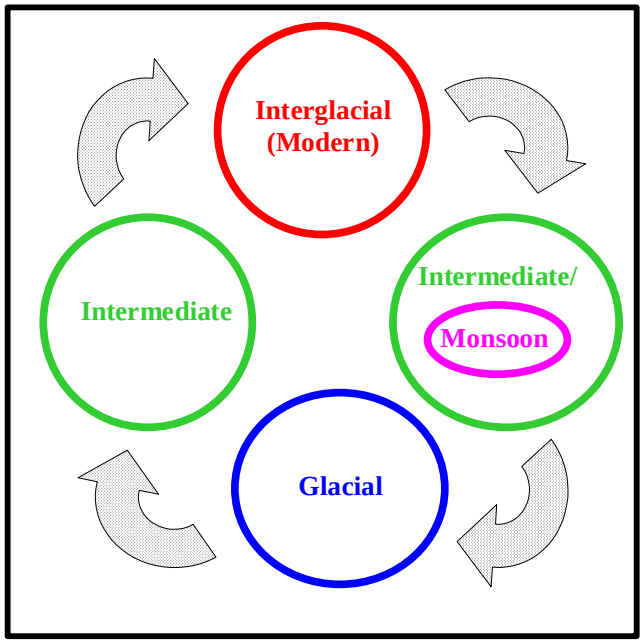
Local Records

Packrat Middens

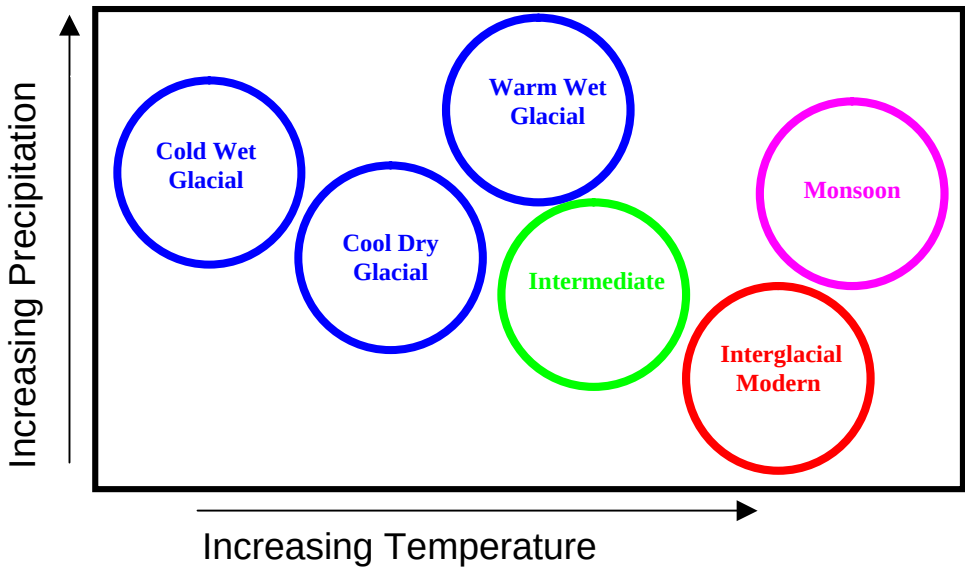
Springs and Wetlands

Climate States Identified and Magnitude of Climate States

Simplified Climate State Sequence



Climate State and Magnitude



Paleoenvironmental data from Owens Lake, packrat middens, Death Valley, and Las Vegas Valley marsh deposits are used to calibrate magnitude.

Forecasting the Next 400,000 Years

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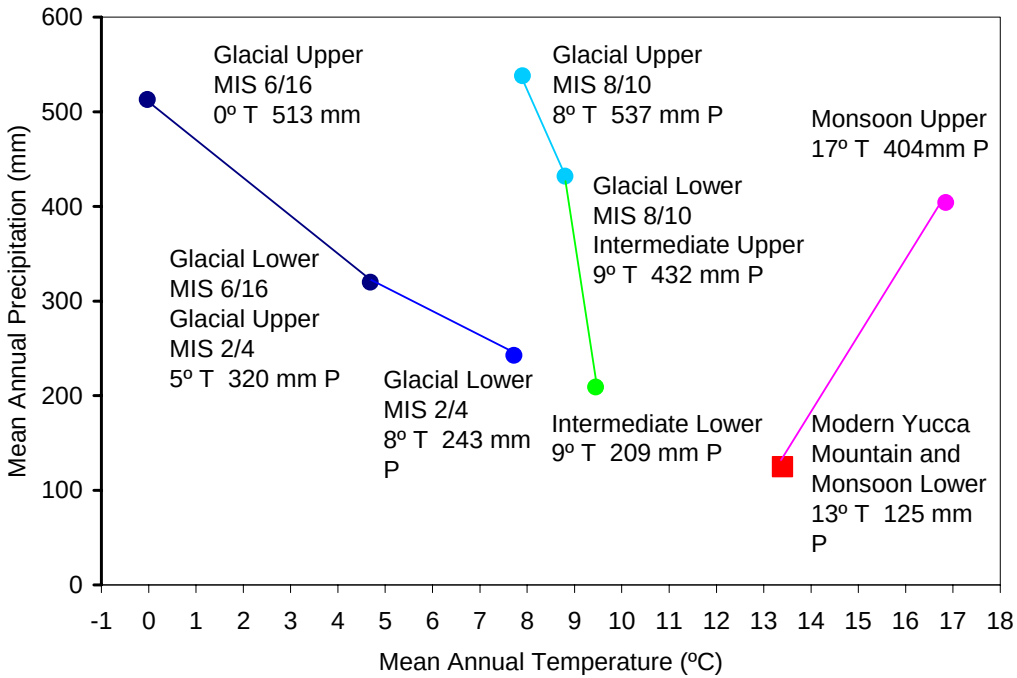
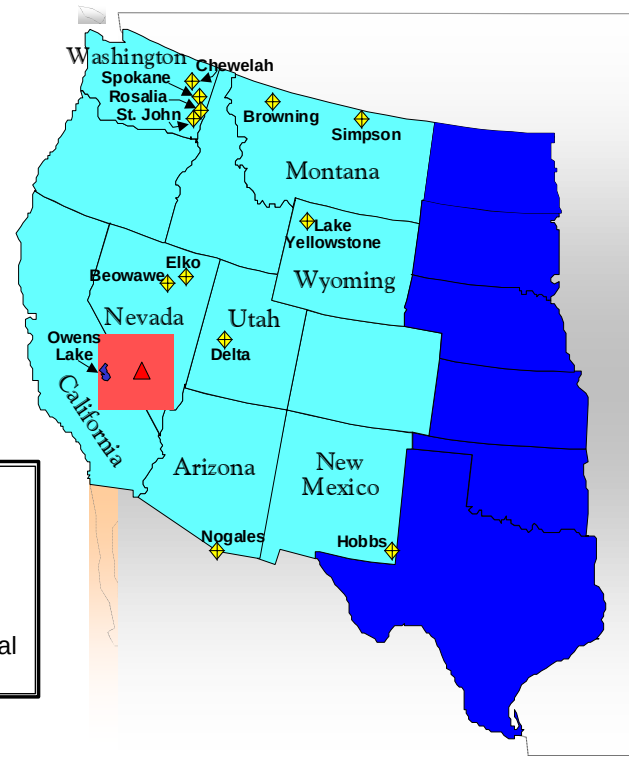
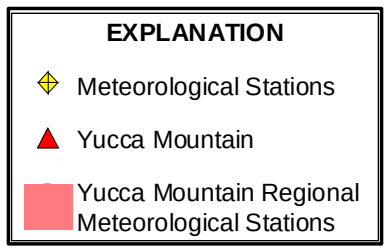
Modern Meteorological Station Temperature and Precipitation







Conclusions

- **Modern climate state estimated to last ~600 more years**
- **Monsoon climate state estimated to occur ~600-2,000 year A.P.**
- **Intermediate climate state estimated to occur ~2,000-30,000 year A.P.**
- **Glacial climate state estimated to occur ~30,000-50,000 year A.P.**
- **Modern climate has less effective moisture and is of shorter duration than the glacial and intermediate climate states**

Conclusions
(Continued)

- Past and future climate may be represented using 4 major climates states
- Close match between Devils Hole and calculated orbital parameters provides the rationale for past climate being the key to future climate
- The nature of future climate is based both on the nature of past climate and the assumption of cyclicity
- The nature of future climate is based on the sequencing and characteristics of past climate