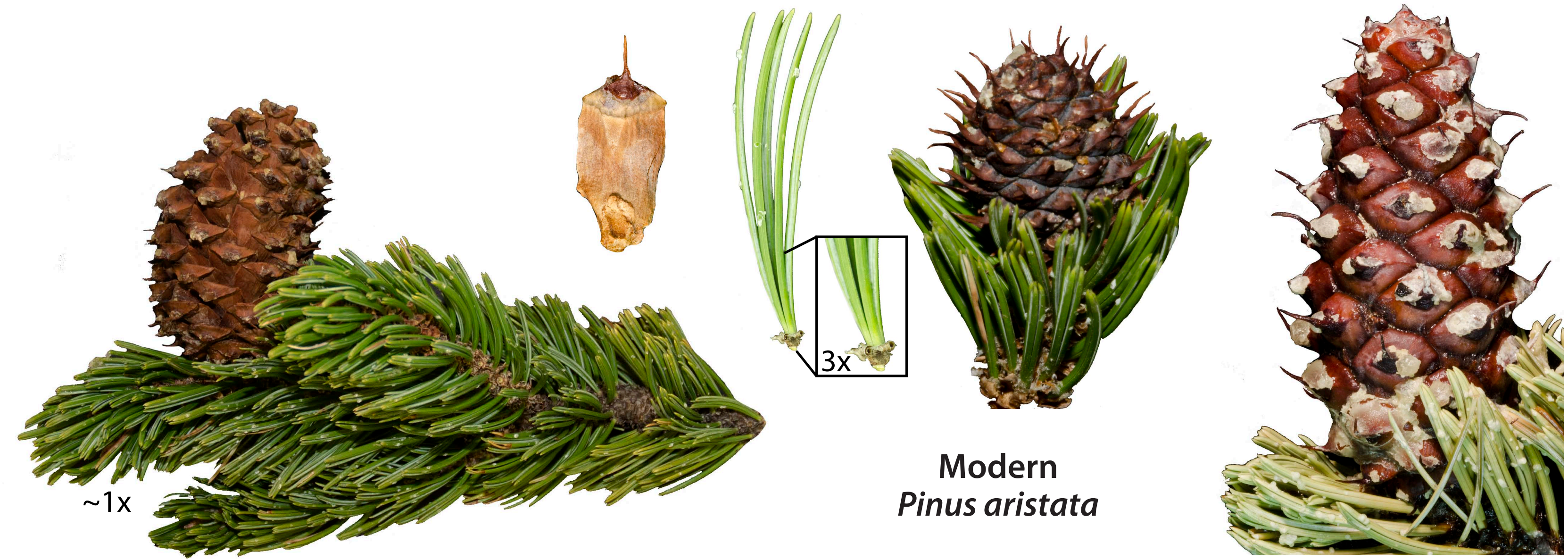




White Mountains, California, U.S.A.  
*Pinus longaeva*



Black Mountain, Colorado, U.S.A.  
*Pinus aristata*



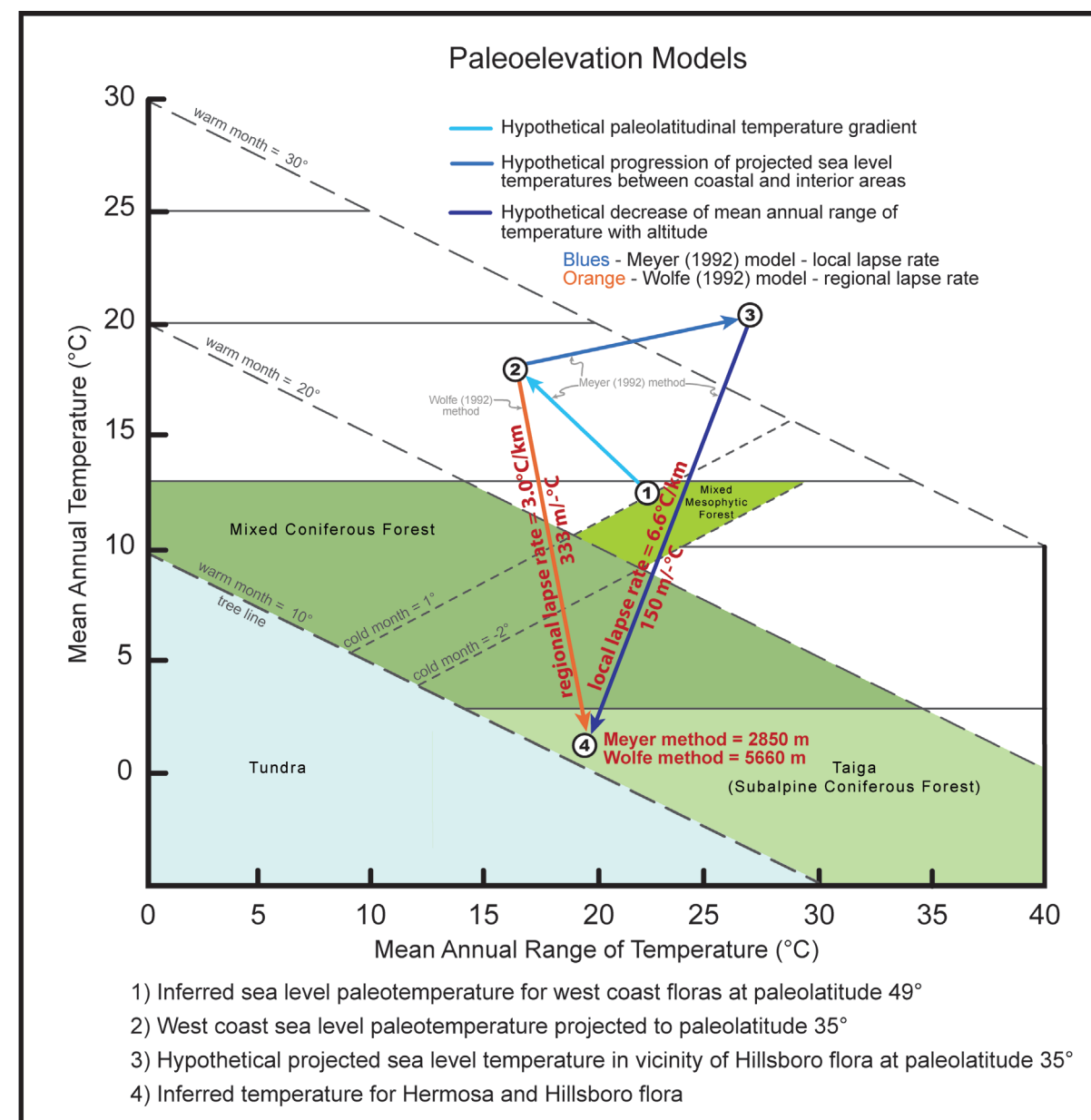
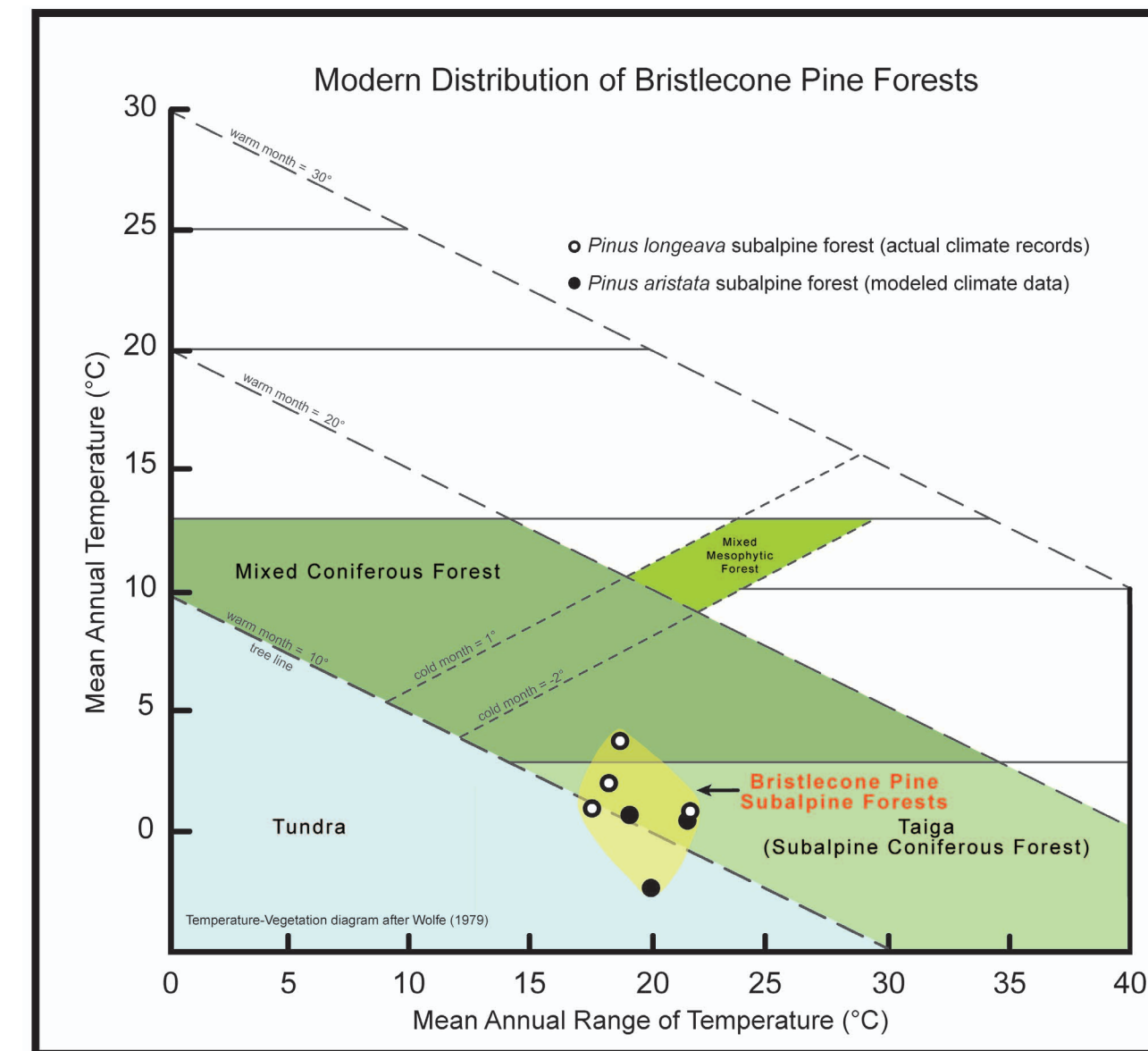
Modern  
*Pinus aristata*

## Flora & Vegetation

- Modern bristlecone and foxtail pines are endemic to the western U.S. This group typically inhabits cold climates at high elevations, and includes some of the world's longest living organisms, which can reach ages >4000 years.
- Dominance of this pine in the Hermosa and Hillsboro floras indicates a depauperate, cold, subalpine (physiognomically taiga-like) forest.
- *Mahonia* and *Crataegus* were understory shrubs
- Pollen flora dominated by Pinaceae and *Sarcobatus*, with several minor angiosperms
  - Pinaceae substantiates macrofloral evidence for pine dominance
  - *Sarcobatus* and *Ephedra* indicate dry habitats (at lower elevations?) within the region and regional aridity
  - Juglandaceae and Ulmaceae indicate moist habitat (at lower elevations?) more distant from the depositional basin

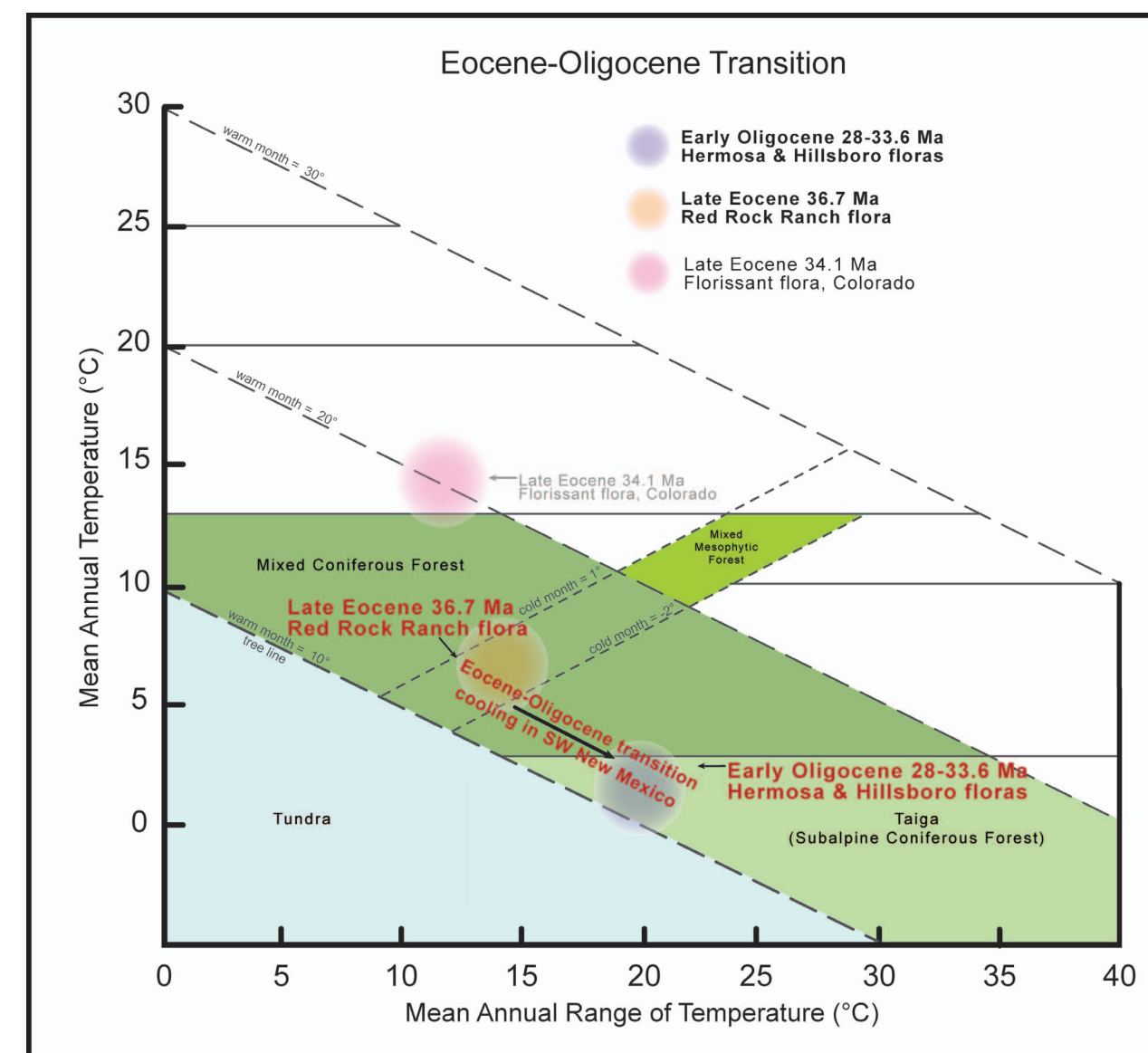
## Climate

- Mean annual temperature (MAT) estimate:  $1^{\circ}\text{C} \pm 2^{\circ}$
- Supported by both physiognomic and nearest-living-relative methods
  - Physiognomic
    - Modern bristlecone pine subalpine forest MAT:  $-2$  to  $+3^{\circ}\text{C}$  (see diagram)
    - Taiga
  - NLRs
    - *Pinus aristata* (MAT:  $-4$  to  $+3^{\circ}\text{C}$ )
    - *Pinus longaeva* (MAT:  $-2$  to  $+12^{\circ}\text{C}$ )
- Caldera topography may have resulted in cold-air drainage into the basin



## Paleoelevation

- Estimates are based on comparison with coeval early Oligocene sea level floras and inferred lapse rates
- Estimated paleoelevation
  - Meyer local lapse rate method: 2850 meters
  - Wolfe regional lapse rate method: 5660 meters



## Response to Eocene-Oligocene Transition

- The floras indicate that a very cold climate developed locally in the interior uplands of the American Southwest during the global climatic cooling of the Eocene-Oligocene transition
- Increase in mean annual range of temperature (MART) during the Eocene-Oligocene transition was probably prerequisite to development of taiga-like subalpine coniferous forest ("pure" bristlecone pine forest) in this region
- The late Eocene Red Rock Ranch flora of this region represents cool mixed coniferous forest with some hardwoods
  - Warmer climate (MAT  $5-9^{\circ}\text{C}$ ) than the Hermosa and Hillsboro floras
    - Climate change?
    - Elevation difference?
- More northern floras of Colorado (Antero and Florissant) indicate warmer conditions than New Mexico during the Eocene-Oligocene transition, probably due to differences in elevation