Paleoclimatic reconstructions

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-Proxy data

-Tree rings

-Ice cores

-Example: astronomic forcing

Proxy data

Radio-activity

Biological

-tree rings,
-sub-fossil pollen,
-corals,
-plankton in lake and ocean sediments

Cross-verification!

Tree rings

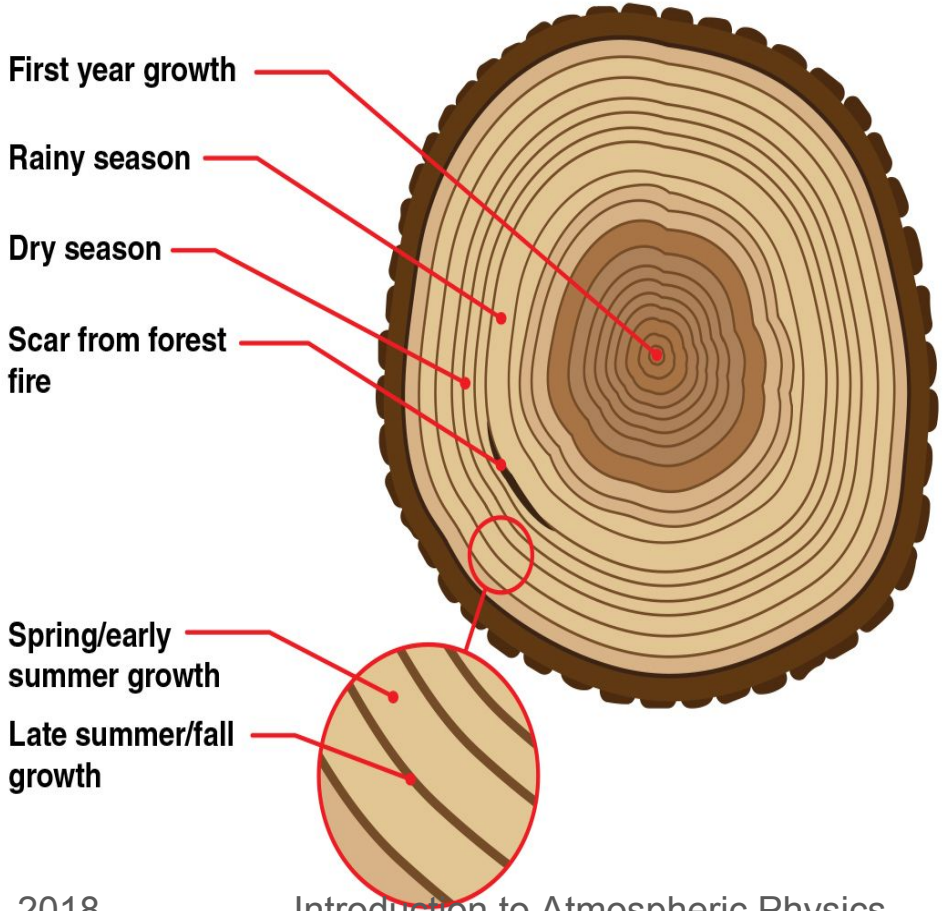
±10 ka

species-dependent

-age of trees

-durability of wood

different factors determine growth



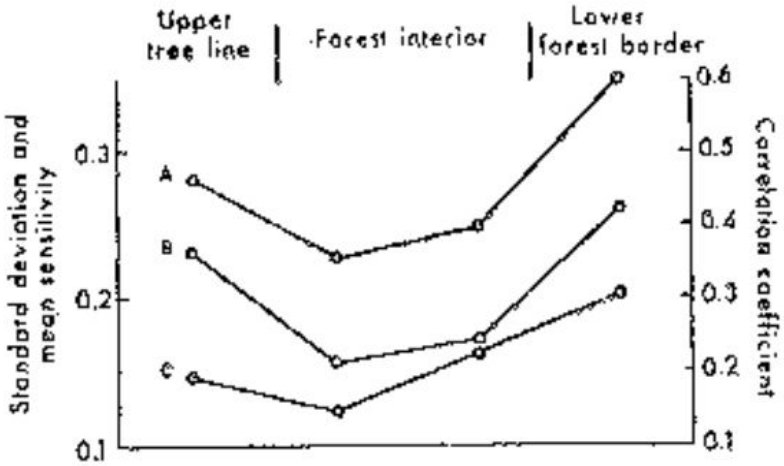


Fig. 1. Tree-ring statistics for bristlecone pines at four sites along an altitudinal gradient. The average correlation between ring-width series from individual radii of different trees at each site (*A*) and the standard deviation (*B*) and mean sensitivity (*C*) of the mean site chronology all indicate increased environmental stress at the lower and upper distributional limits.

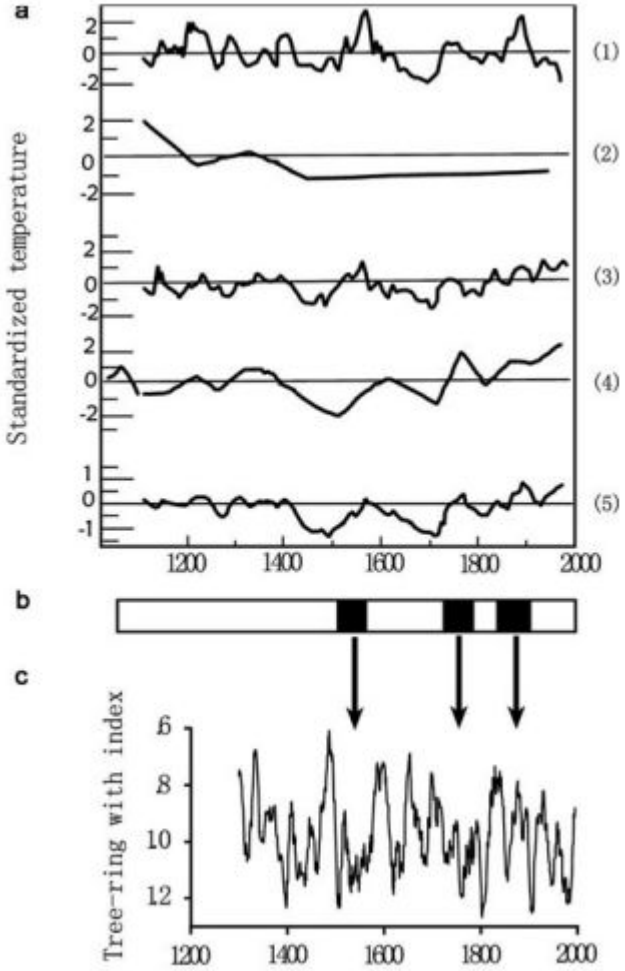
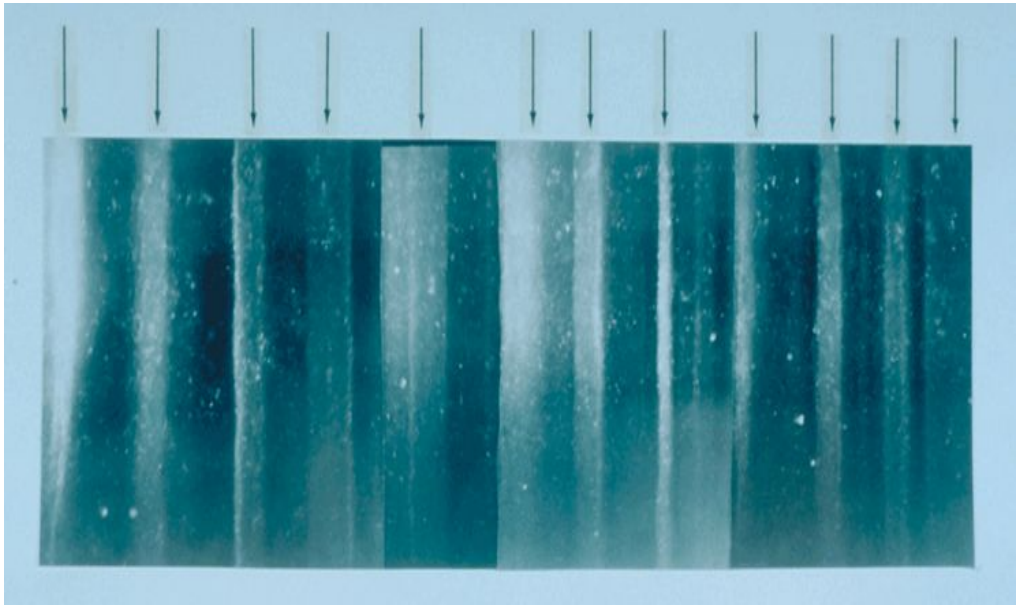


Fig. Temperature series and glacier advances in the northeastern TP. (a) Standardized decadal-scale proxy records reflecting surface air temperature for sites in the northeastern TP and 50 year means of regionally averaged temperature anomalies (after Yang, 2003): **(1) tree-ring width** chronology from Tianjun, Qilian Shan; (2) water temperature in Qinghai lake; **(3) tree-ring widths** from Dulan Qinghai; (4) d18O of Dunde ice core; (5) regionally averaged temperature. (b) Glacier advances (black bars) in northeastern Tibet (after Zheng and others, 1990; Wang, 1991). (c) Tree-ring width index reconstructed from the Animaqin mountains, which is negatively correlated with summer maximum temperatures. The y axis of the tree-ring width index has been reversed.

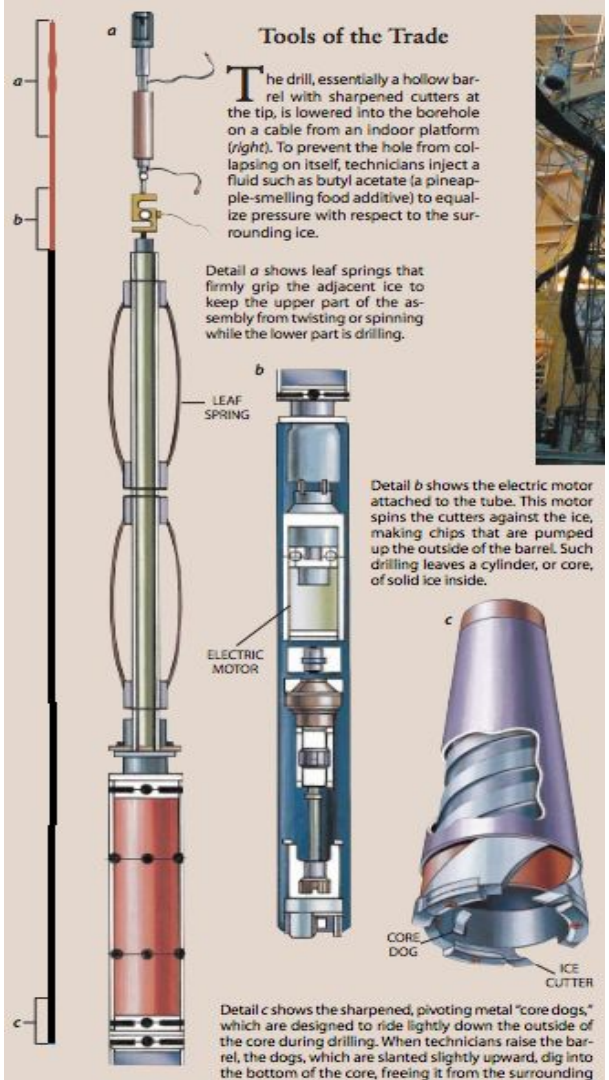
Ice cores

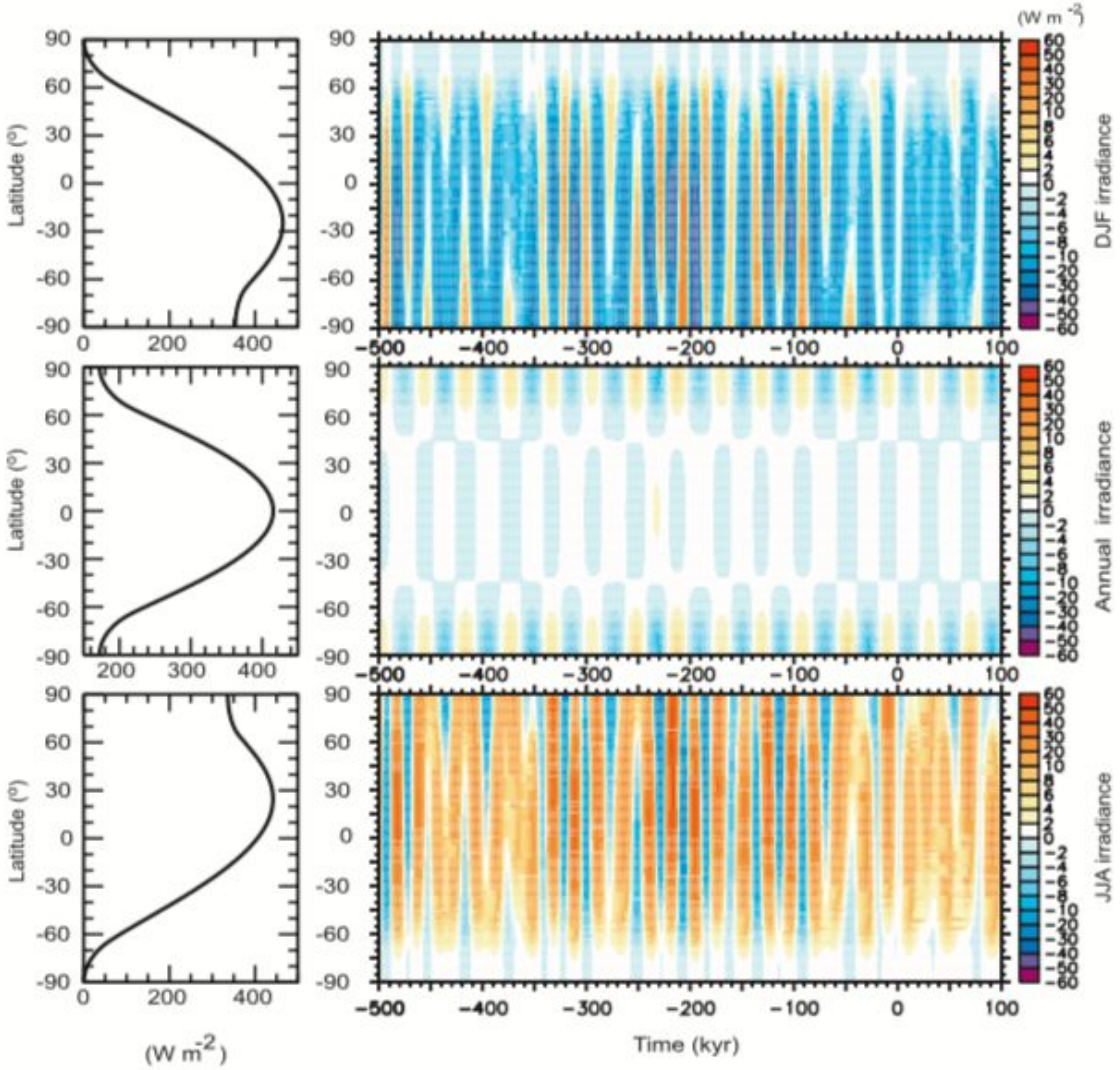


-130 ka (Greenland) to 800 ka (Antarctica)

-bubbles contain samples of atmosphere

-forcing effects: vulcanic, solar, and astronomical





(Left) December to February (top), annual mean (middle) and June to August (bottom) latitu- dinal distribution of present-day (year 1950) incoming mean solar radiation (W m–2). (Right) Deviations with respect to the present of December to February (top), annual mean (middle) and June to August (bottom) latitudinal distribution of incoming mean solar radiation (W m–2) from the past 500 kyr to the future 100 kyr (Berger and Loutre, 1991; Loutre et al., 2004).

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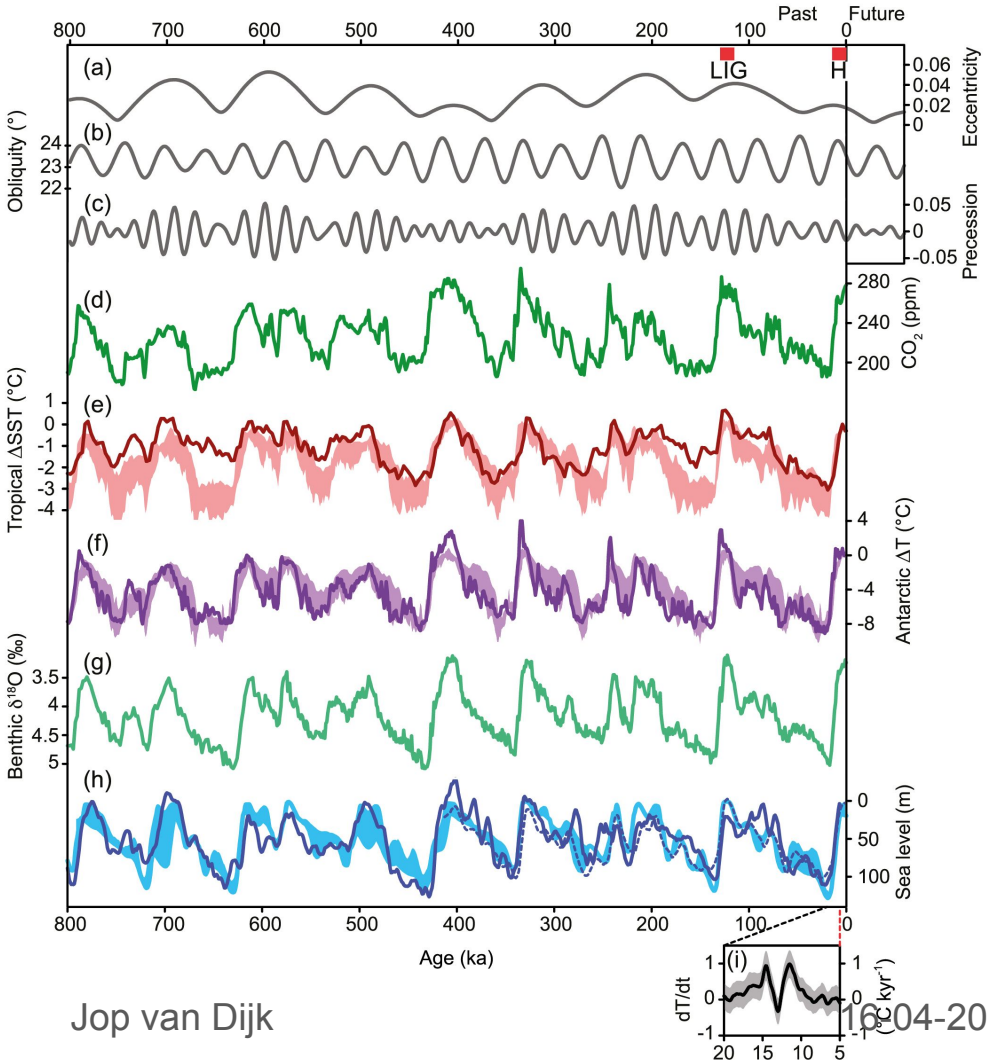

Orbital parameters and proxy records over the past 800 kyr. (a) Eccentricity. (b) Obliquity. (c) Precessional parameter (Berger and Loutre, 1991). (d) Atmospheric concentration of CO2 from Antarctic ice cores (Petit et al., 1999; Siegenthaler et al., 2005; Ahn and Brook, 2008; Lüthi et al., 2008). (e) Tropical sea surface temperature stack (Herbert et al., 2010). (f) Antarctic temperature stack based on up to seven different ice cores (Petit et al., 1999; Blunier and Brook, 2001; Watanabe et al., 2003; European Project for Ice Coring in Antarctica (EPICA) Community Members, 2006; Jouzel et al., 2007; Stenni et al., 2011). (g) Stack of benthic d18O, a proxy for global ice volume and deep-ocean temperature (Lisiecki and Raymo, 2005). (h) Reconstructed sea level (dashed line: Rohling et al., 2010; solid line: Elderfeld et al., 2012

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