How might tree-rings inform us about changes in climate?

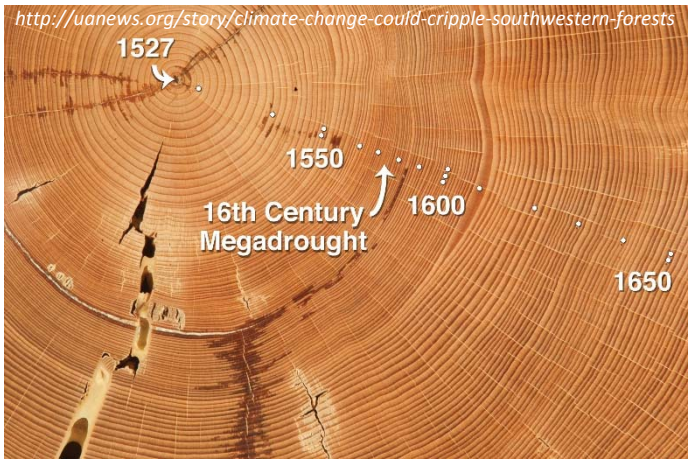
Climate versus Weather

Climate: Regional, longer time scales, multi-decadal, multi-century or longer

Weather: Local, shorter time scales, daily, weekly, monthly

Tree-ring Record and Climate Change Connections

- Tree-ring widths vary by environmental conditions.
- Water and temperature are the most limiting factors, however other variables such as soil nutrient uptake, photosynthesis and evapotranspiration are also important factors to consider.
- Tree-ring records provide a series of annual rings that record physical and chemical changes in tree growth over time. In some cases Dendrochronologists may even be able to identify changes within a particular season by examining physical and chemical changes within the cells of earlywood, latewood and cambium tissue.
- Tree-ring records assist climate researchers in identifying patterns of temperature and precipitation in a specific regions (e.g. cold, arid, high altitude slopes of the Sierra Nevada Range where bristlecone pine trees grow).
- Tree-ring records are <u>not</u> going to tell us if it is going to rain tomorrow, but it may for example inform us about drought over the next few decades and further into the century.



- Tree-ring records may be compared to other climate change "proxies" that record physical and chemical changes over time such as ice, sediment, and coral cores. Combined data from such sources contribute to future climate change projections. In other words, if we can identify what nature is doing now or has done in the past, and then consider human interactions, we can then make informed decisions about how current human behaviors will impact the environment and climate.
- Atmospheric particulates (also called **aerosols**) are microscopic particles of solids or liquids that are suspended in a gas. There are many natural sources of atmospheric particulates: dust blown into the air by the wind, salts splashed into the air by sea spray, and soot from volcanoes and forest fires. These particulates are recorded in tree-rings.

Future Climate Change Projections consider several factors, here are just a few examples:

- Ecosystem/Biological Cycles
- Anthropogenic (human) behaviors such as development, industry, irrigation, and population trends
- Geographic, Topographic, Latitudinal and Longitudinal elements that equate to each climate zone (e.g. hot dry vs cold dry , tropics vs. poles, coastal vs. inland, oceanic vs, terrestrial)
- Global Circulations (e.g. ocean currents, winds, high and low pressure cells)
- Atmospheric Exchanges and Interactions ($C0_2$, O_2, O_3)
- Albedo or reflectivity of a surface such as sunlight reflected back to space by clouds

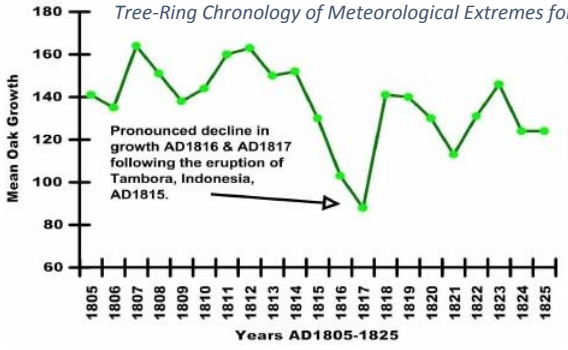
Examples of Climate Change Research using tree-rings

- Correlating tree-ring data to past El Niño events
- Frequency and Intensity of forest fires over time – when trees burn they release the carbon they have stored back in to the environment. Fluxes in carbon dioxide are a major factor in assessing climate change at a regional and global scale.
- Carbon isotope analysis assists researchers in understanding pre and post human industrial era CO_2 levels. Depending on the type of analysis, shifts in recent and distant (paleo-climate) climate changes may be identified.
- Pre-hurricane and post-hurricane growth analysis where tree-rings are used to build chronologies of past hurricanes beyond the existing meteorological records to determine the spatial significance and intensity of such storms. Studying Hurricanes Carmen, Andrew and Katrina helps us to answer questions such as will future hurricanes be more/less frequent and more/less intense?

Extreme Geological Event Analysis using Tree-Rings

Extreme geological events such as volcanic eruptions are indirectly related to climate change and appear in the tree-ring record. For example tree growth may change due to colder or drier periods related to aerosols released by a volcanic eruption. Dendrochronologists use tree-rings to connect geological extreme events to climate change indicators such as prolonged cooling or warming, and wet or dry periods.

Tree-Ring Chronology of Meteorological Extremes for Ireland_AD425-1650 Ludlow, 2014



- This graphic illustrates how oak trees in Ireland responded to aerosols released during a volcanic eruption that occurred in Indonesia.