

Background - University of Arizona's Campus Arboretum's Search For Climate-Ready Trees

Continuing and Refining the Search For Climate-Ready Trees!

The University of Arizona Campus Arboretum is a living laboratory promoting stewardship and conservation of urban trees through research, education and outreach. The Campus Arboretum, situated on the roughly 400 acres of The University of Arizona's main campus in Tucson, AZ is home to hundreds of tree and shrub species from arid climates on every continent on earth. These trees have been collected over the University's more than 125-year history, as part of the University's land grant commitment to conducting research relevant to the needs of the state. In the early years, trees were collected and tested on the campus grounds to assess potential as agricultural commodities, while later, during the mid-20th Century, research shifted toward selection of arid-adapted landscape ornamentals in response to urbanization and growing concerns about water conservation. While a growing body of research now supports a significant role for trees mitigating and adapting to global climate change, increases in global temperature will subject our current tree species to temperatures never experienced before. Further, improvements in access to information now allow us to continue the legacy of testing and trying new trees species on campus in a more systematic and inclusive way. In this project, we aim to leverage the availability of climate data, global tree locations, and the access to a large community of experts to cull and refine tree selection best suited for Tucson's aridity, as well as the increasingly hotter and colder temperatures. We hope to arrive ultimately with a ranked list of tree species to test for performance on campus.

A Great Proving Ground for Climate-Ready Trees

The location of the Campus Arboretum arid-adapted tree collection in the Sonoran Desert biome, coupled with intensive warming, population growth rate, and drought being experienced here, create ideal circumstances for continued evaluation of climate-ready tree species. The University of Arizona Campus Arboretum is located in the middle of the Tucson Metropolitan area (MSA). Tucson is home to 1,080,300 residents, experiencing an increase in population of 0.7% between 2022 and 2023, and ranking fourth fastest in population growth out of 12 western Metropolitan areas. Tucson is also among the country's fastest warming cities. It has a hot, desert, climate (Köppen BWh) with two major seasons, a hot summer and mild winter. The mean annual temperature of Tucson, AZ is 70.88°F (21°C). Based on models developed by the Intergovernmental Panel on Climate Change (IPCC), given the assumption of limited emissions (SSP2/RCP4.5), the mean annual temperature of Tucson will be 23.6°C by 2050, and under the business as usual climate change scenario (SSP3/RCP7.0), the MAT of Tucson is predicted to be 26.5°C. Based on data from 1991-2020, January and December are the coldest months in Tucson with the normal cold temperature for January and December, being 66F (18.9°C). The record low temperature of 6°F (-14°C) was recorded on January 7, 1913. Based on data from 1991-2020, June and July are the hottest months of the year with the normal warm temperature for June

and July being 100.7°F (38.17°C). The record high temperature was recorded at 117°F (47.22°C) on June 30, 1990. Tucson averages 10.61 inches (269.5 mm) of precipitation per year, concentrated during the North American Monsoon of summer (~7.97” in June to September) and the Pacific storms of winter (~2.64” in December and January).

Tucson, AZ...More Than Just Another Desert Biome.

A biome is a large area characterized by its vegetation, soil, climate, and wildlife. The main University of Arizona campus in Tucson, AZ is found in a desert biome. Specifically, the Sonoran Desert.

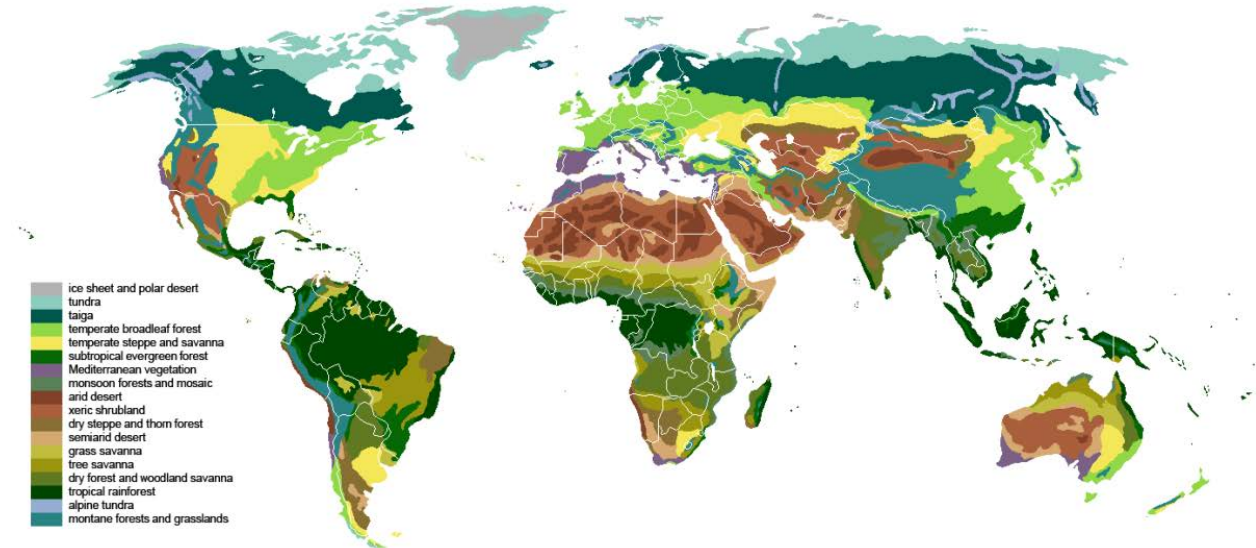


Figure 1 (Left) shows in brown the global locations of deserts.

Source: <https://en.wikipedia.org/wiki/Biome>

Given its status as a Land Grant Institution, the University of Arizona has responsibility to conduct research addressing the needs of the state and to extend university education to the communities of Arizona. As the state of Arizona is situated in a desert biome, early faculty members conducted research and education programs focused on searching for and testing performance of plants from around the world to determine if any could be useful here. As a result of their work many new commodity crops and landscape ornamental plants were introduced into the trade. Because the campus grounds were used as their experiment station, the campus itself became a robust collection of arid-adapted trees and shrubs – sometimes those trees were one of a kind in the state (where they were not adopted commercially), and often they were the first of their kind and the oldest in the state (where they were adopted in production).

These early studies by UArizona faculty members based tree selection on climate similarity to other regions of the world. As such, they arid and semi-arid deserts around for potentially adapted species to test on campus. In large part, the native range of the tree species in the collection maps to other deserts of the world. Clearly, they did their homework as many have stood the test of time! However, deserts are characterized by a variety of factors

affecting performance. They can be hot and dry, semiarid, coastal, or cold. The Sonoran Desert is hot and dry with cold winters and as climate has shifted, the patterns and magnitude of environmental factors has made it increasingly challenging to find species adapted to all the conditions faced by landscape plants in Tucson.

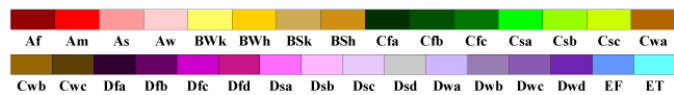
Fortunately, the world is also flooded with new resources to support the process of searching for climate-ready tree species. Climate classification systems, large datasets specifying global observations of tree species, and improved methods for connecting with a global community of horticultural experts may all help to perpetuate the legacy of testing and trying new tree species for the American southwest.

Climate Classification:

By integrating the influence of precipitation and temperature, we can further refine the locations in the world also receiving similar precipitation volume, seasonal patterns, and temperature thresholds and patterns as experienced in Tucson’s current climate. The Köppen climate classification system, does just this. Köppen classifies the Sonoran desert as BWh, meaning it is Arid (B: main climate), has dry winters (W: precipitation) and is hot (h: temperature). More recently, the Trewartha system was developed to better align the middle latitudes with vegetation zoning and genetic climate systems.

World Map of Köppen–Geiger Climate Classification

updated with CRU TS 2.1 temperature and VASCLimO v1.1 precipitation data 1951 to 2000



Main climates

- A: equatorial
- B: arid
- C: warm temperate
- D: snow
- E: polar

Precipitation

- W: desert
- S: steppe
- f: fully humid
- s: summer dry
- w: winter dry
- m: monsoonal

Temperature

- h: hot arid
- k: cold arid
- a: hot summer
- b: warm summer
- c: cool summer
- d: extremely continental
- F: polar frost
- T: polar tundra

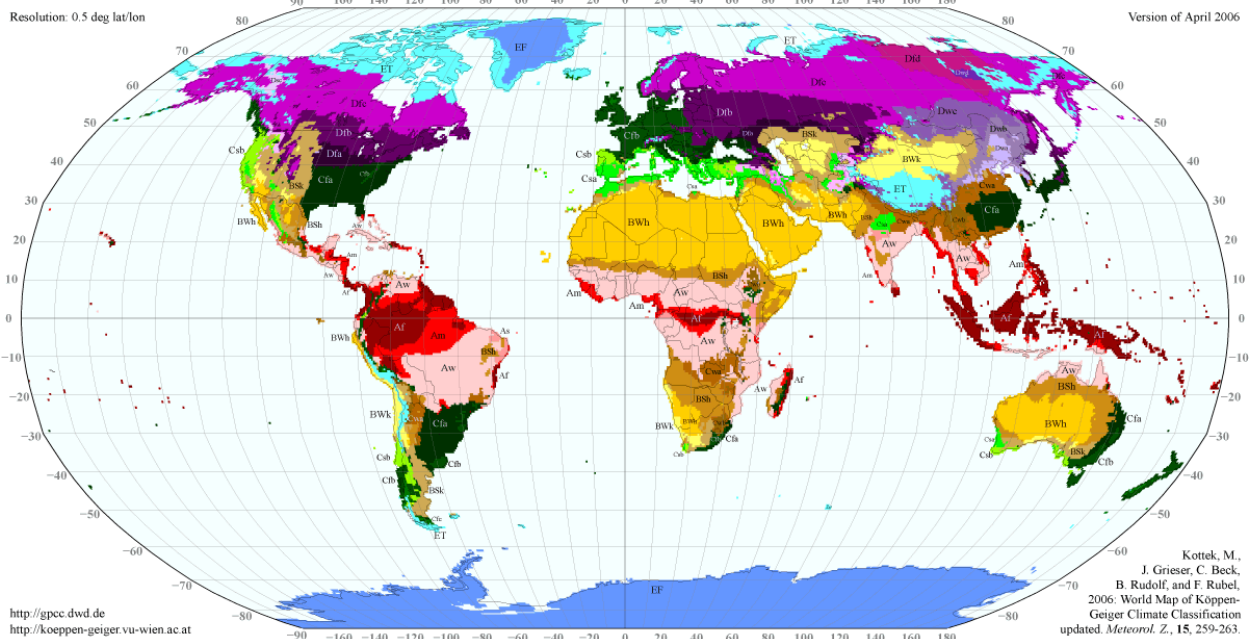


Figure 2. An Example of a Climate Classification Map.

Source: https://koeppen-geiger.vu-wien.ac.at/pics/kottek_et_al_2006.gif

Data and Practitioner Input

In recent decades, we have not only gained access to an unprecedented collection of biogeographical and climate data but also enhanced our ability to connect with a global community of practitioners through the internet. The University of Arizona Campus Arboretum can benefit from searching the [Global Tree Database](#) to understand where tree species have been observed growing. By comparing the climates of those observation locations, we can glean a list of candidate species to explore for their performance in Tucson. The Botanical Garden Conservation International's [Climate Assessment Tool](#) will help us mine the tree climate observation data. Our goal will then be to ranked list of tree species based on temperature thresholds (high and low temperatures) and precipitation limits suited for growth in Tucson, AZ. To learn more about the work and results, visit: <https://arboretum.arizona.edu/research/finding-potential-climate-ready-trees>