

Why Arizona?

Understanding benchmark outdoor weathering testing in a Desert environment

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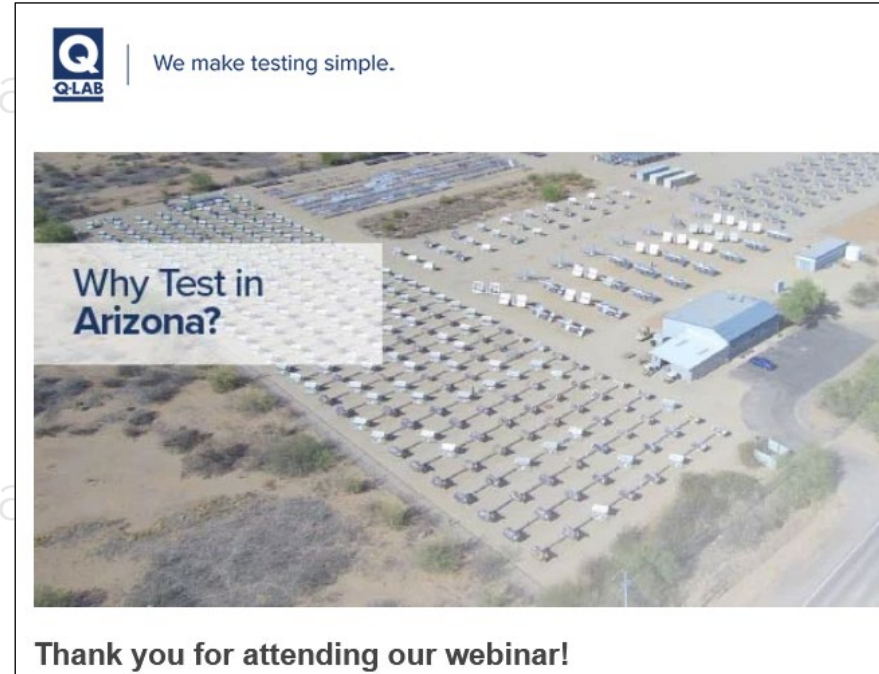
Q-Lab's Natural Outdoor Testing Webinar Series

- Today is the second of our two-part webinar series on benchmark outdoor testing locations.
- Our upcoming and complete archive of past webinars, available on demand, are hosted at: q-lab.com/webinars

Date	Topic
13 Aug	Why Florida?
20 Aug	Why Arizona?

Presentation materials, Q&A

- You'll receive a follow-up email from info@email.q-lab.com with links to a survey, registration for future webinars, and to download the slides
- Use the Q&A feature in Zoom to ask us questions today! We'll stay on after the presentation is completed to answer all questions



Introduction

- Florida is the primary benchmark weathering location
 - For normal, moderate climates
 - Used for wet climates
- Arizona is the Benchmark for dry climates
 - Cannot use Florida to test for arid climates

Plastics Failure Types Differ by Climate

Wet Climate

- Biological
- Chalking
- Ductile failures
- Warping
- Color changes
- Checking

Dry Climate

- Yellowing, Browning
 - Not a color change
- Brittle failures
- Cracking
- Crumbling

Dry Climates are Important

Major Cities in Dry parts
of U.S.A

- Phoenix
- Las Vegas
- Salt Lake City
- Denver

Major Cities in Dry Parts
of Rest of World

- Dubai
- Mexico City
- Cairo

How the Weather Affects Degradation

- Solar radiation, especially UV, is the energy source required to break the bonds in the chemical structure of the material
 - Go/No-Go
- Temperature affects the rate of chemical reactions
 - Fast or Slow
- Moisture changes the failure mode
 - “This or That” Result



Benchmark Climate Comparison

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Parameter	Miami, Florida	Phoenix, Arizona
Total Solar Energy (MJ/m ²)	6500	8200
TUV (MJ/m ²)	320	360
Average Temp (°C)	30	30
Annual rainfall	1,600	250
Average RH (%)	80	30
Annual wet time	4,500	200

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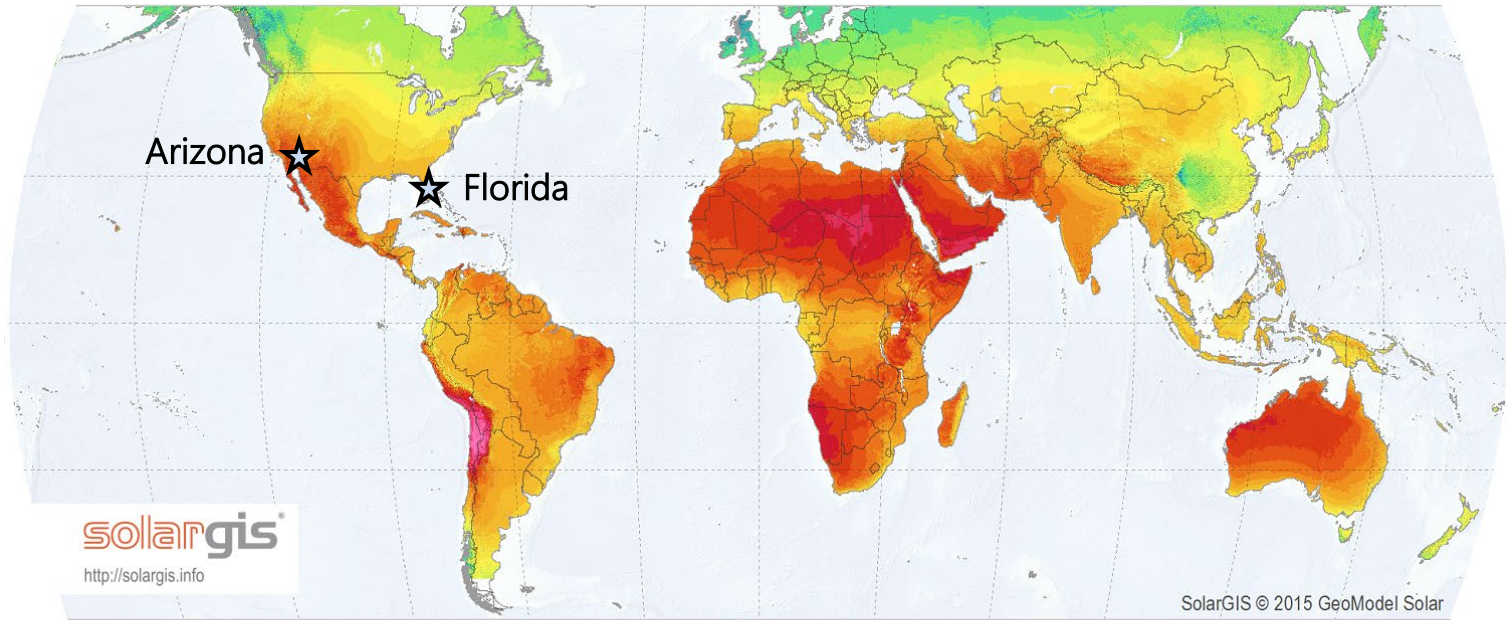
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Florida and Arizona: Solar Energy

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Annual Solar Radiant Energy



Summer Benchmark Comparison

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Summer Day	Miami, Florida	Phoenix, Arizona
Irradiance (W/m ²)	1000	1200
TUV (MJ/m ²)	1.1	1.5
Rainfall	Afternoon storm	No rain
Air temp. (°C)	32	45
Black panel temp (°C)	55	65
Humidity range (%)	70-100	5-20

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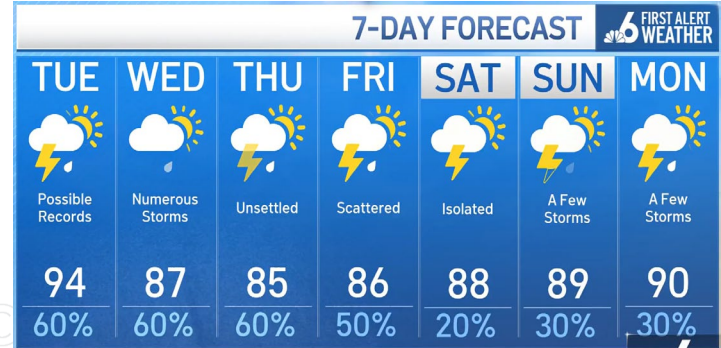
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Why not just always test in Florida?

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- The major difference is the water content (Condensation, humidity, rainfall)
- The UV dosage is only slightly higher
- The average temperature is the same
 - The highs are a bit higher in Arizona
 - The lows are a bit lower in Arizona



Test Materials

- Volatile Organic Compounds (VOCs)
 - *A broad class of carbon-based chemicals that easily evaporate into the air at room temperature. They are found in thousands of everyday products—like paints, cleaners, and fuels—and are notorious for "off-gassing" indoors, where concentrations can be up to ten times higher than outdoors.*
- Plasticizers
 - *Chemical additives incorporated into polymers—primarily PVC—to increase flexibility, softness, and workability. By inserting themselves between polymer chains, they reduce internal friction, allowing the material to bend and stretch without breaking. They make up 10% to 70% of the final product's weight.*

Source: Wikipedia A.I.

Effects of Dry Climate on VOCs

- **Accelerated Off-Gassing:** Unlike humid environments that can slow evaporation, dry and hot climates raise surface and air temperatures. This causes formaldehyde, benzene, and toluene to vaporize faster from carpets, pressed-wood furniture, and glues.
- **Intense Sunlight & Ozone:** VOCs react with sunlight and nitrogen oxides in the atmosphere to form toxic ground-level ozone. Dry climates often experience abundant sunshine, supercharging these photochemical reactions.
- **Low Humidity Effects:** Very low humidity can also dry out household materials like paints and finishes, causing them to crack and emit higher concentrations of VOCs into the air.

Source: Wikipedia A.I.

Effects of Dry Climate on Plasticizers

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The environmental conditions where plastic products live — like hot, arid regions near Phoenix, AZ — significantly impact the behavior of plasticizers.

- **Lower Migration Rates:** Because water acts as a carrier and creates pathways for plasticizer molecules to travel through materials like PVC, dry climates actually reduce the rate of plasticizer migration and leaching.
- **Evaporation Risk:** While the lack of moisture limits leaching, low humidity combined with high heat causes plasticizers to evaporate more quickly into the surrounding air. This eventually results in stiffer, more brittle materials.
- **Internal Plasticization Loss:** Certain materials, like nylons, rely on absorbed environmental moisture to act as a natural plasticizer. In a dry climate, this natural moisture evaporates, causing the nylon to shrink, lose flexibility, and potentially crack.

Source: Wikipedia A.I.

Materials Must Be Tested in a Proper Climate

- Simply put, materials age differently in dry climates versus wet climates
 - A Florida test will not give accurate results for a dry end-use
 - An Arizona test will not give accurate results for a wet end-use
- Conclusion is wrong if a different failure is the result
 - Affects new material research, new market development, and warranties
 - Acceleration rate is irrelevant if the incorrect failure occurs

Plastic Products Affected by Dry Climate

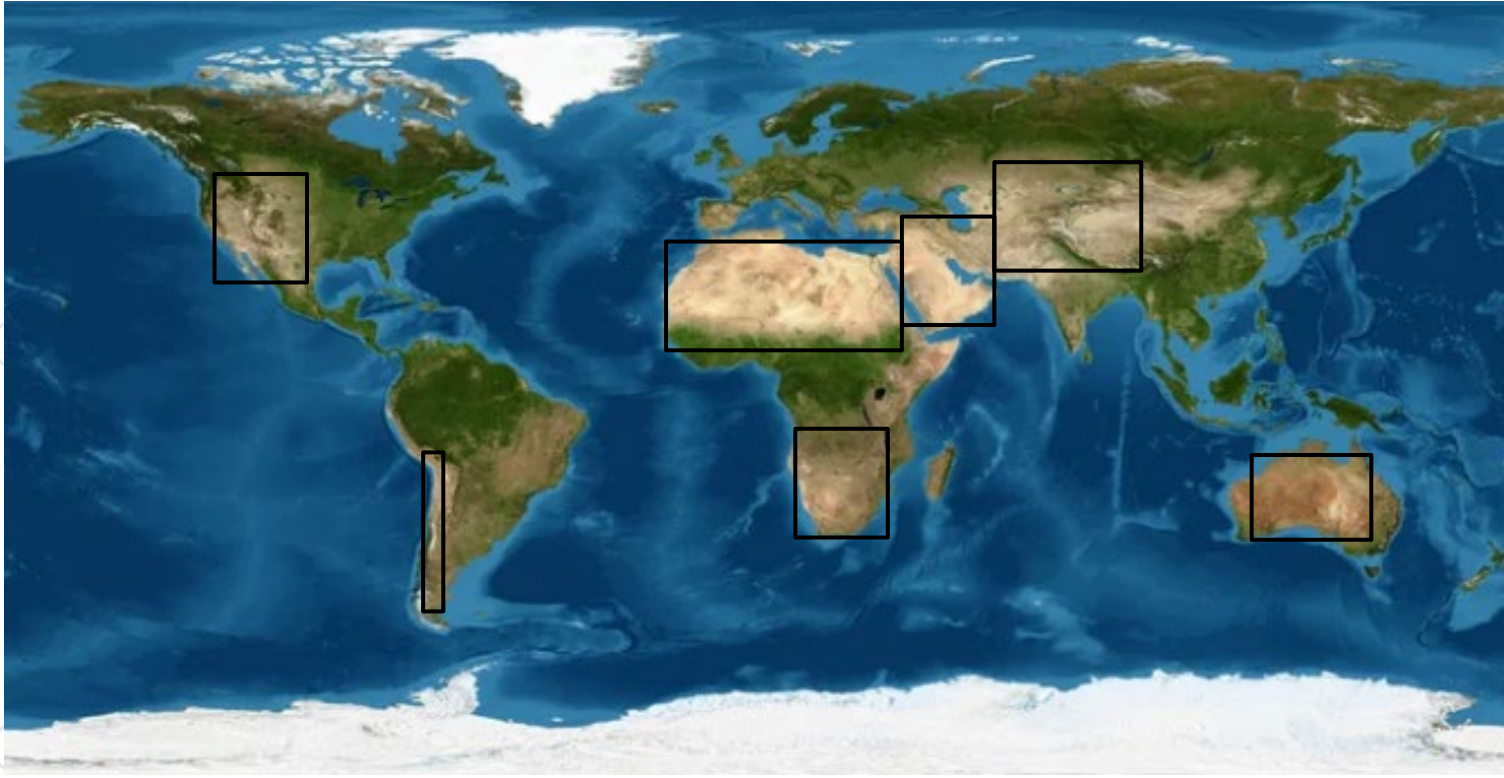
- Roofing Materials
 - Bituminous, Shingles, Underlay
- Plastic Building Products
 - Window and Doors
 - Siding
 - Gutters
- Outdoor Furniture
- Automotive Trim



World's Dry Locations

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List of Dry Locations

- Western USA
 - North Africa
 - Middle East
 - Arabian Peninsula
 - Central Asia
 - South Africa
 - Interior Australia
 - Western S. America
- For accurate data, you should test in a dry benchmark climate for products intended to be used in these locations.
 - For the best accelerated test, you need the sunniest, hottest, driest location that is easily accessible and ISO 17025 accredited

Why Arizona

Central Arizona is the primary world benchmark test location for dry climate testing



Arizona is the Desert Benchmark

- Arizona has been the Benchmark for dry climate testing since 1950
- Maximum solar radiation annually 8200 MJ/m²
 - High % of this is UV energy: 360 MJ/m²
- Maximum ambient air temperatures up to 50 °C
 - Extremely high black panel temperatures > 70 °C
- Extremely Dry
 - Less than 250 mm rain, summertime humidity 5 to 10%
- Accessible location with great infrastructure

Arizona as an Accelerated Test

- Arizona's climate may seem harsh, but it is not too different from temperate zones
- Summer conditions in other locations approach Arizona
- Same weather but more:
 - Sunlight
 - Temperature
 - Dryness

Forces of Weathering in Arizona

Arizona Climate Summary

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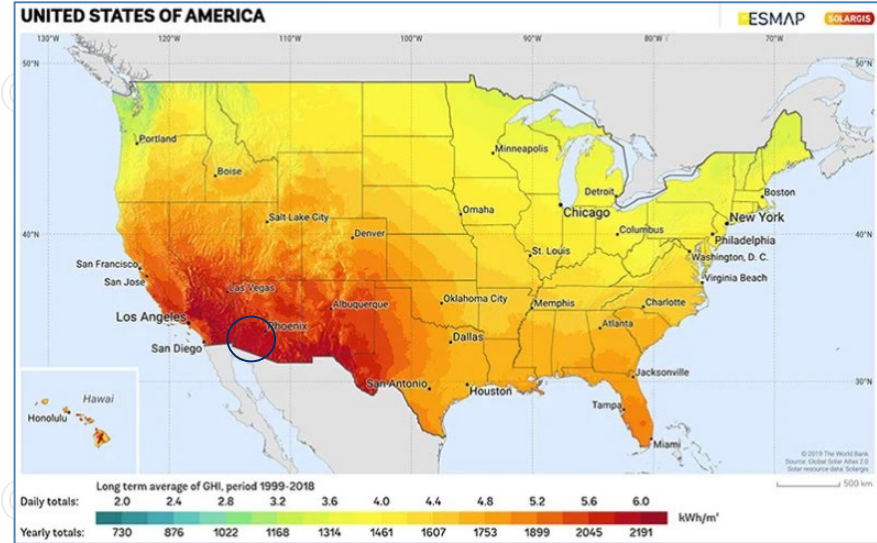
Phoenix	January	February	March	April	May	June	July	August	September	October	November	December
Avg. Temperature °C	11.7	13.6	18.1	22.4	27.4	33.2	34.9	34	30.7	24	17	11.1
Min. Temperature °C	4.7	6.3	9.6	13.8	18.8	24.6	28.2	27.6	23.5	16.3	9.7	4.6
Max. Temperature °C	19.6	21.4	26.1	30.3	34.9	40.5	41.2	40.3	37.5	31.3	24.5	18.3
Precipitation / Rain mm	34	38	25	8	4	2	22	32	27	20	17	29
Humidity(%)	42%	37%	27%	18%	14%	13%	25%	28%	27%	28%	32%	47%
Rainy days (d)	3	3	2	1	1	0	3	3	2	2	1	3
avg. Sun hours (hrs)	8.7	9.4	10.5	11.6	12.5	12.9	12.6	11.9	11	10	9.2	8.5

Source: <https://en.climate-data.org/>

Denver	January	February	March	April	May	June	July	August	September	October	November	December
Avg. Temperature °C	-3.2	-2	3.1	7.6	12.7	19.5	23.1	21.6	17.3	9.5	2.2	-3.4
Min. Temperature °C	-8.8	-8.2	-4	0.4	5.4	11.5	15.3	14.3	10.1	3.1	-3.6	-8.7
Max. Temperature °C	5.8	7.2	12.5	16.5	20.9	27.7	30.7	29.3	25.7	18.5	11.2	5.3
Precipitation / Rain mm	24	25	51	73	86	55	44	42	38	43	34	23
Humidity(%)	58%	55%	51%	48%	50%	42%	41%	43%	43%	49%	53%	59%
Rainy days (d)	4	4	6	7	9	6	6	5	4	5	4	4
avg. Sun hours (hrs)	7.8	8.4	9.4	10	10.7	12.2	12.5	11.8	10.2	8.7	8.1	7.5

Solar Energy

- US Desert SW has most solar radiation
- Nearly 30% more than Denver or Salt Lake City
- High percent of direct beam energy
 - Increases radiant heating
- High ambient temps plus high radiant energy

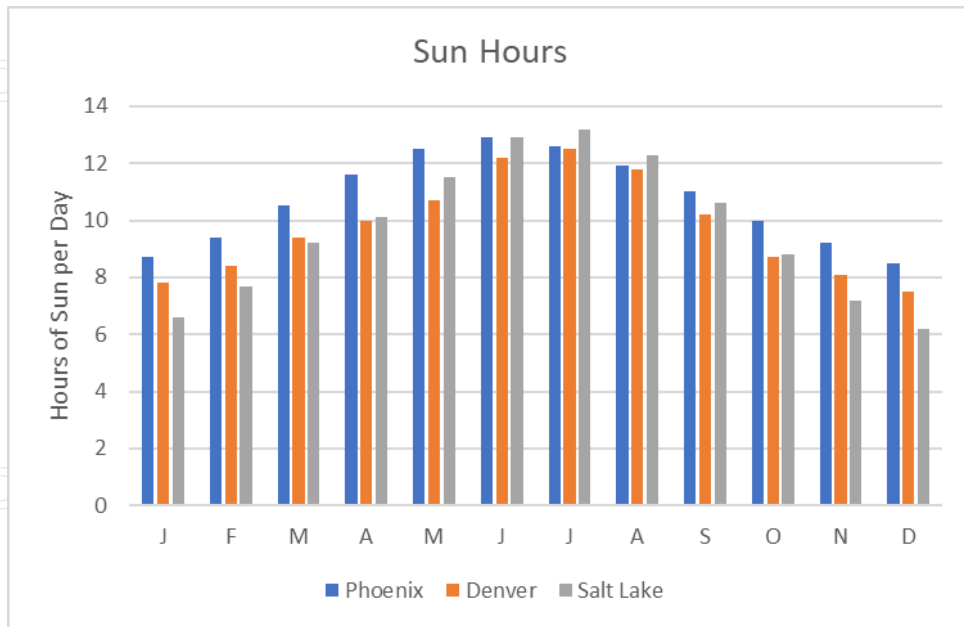


Duration of Sunlight

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- Central Arizona has a similar duration of sunlight as other major cities in U.S. West
- Desert is conducive to clear skies and high UV
- Long durations of actinic UV irradiance
 - Actinic means “effective”



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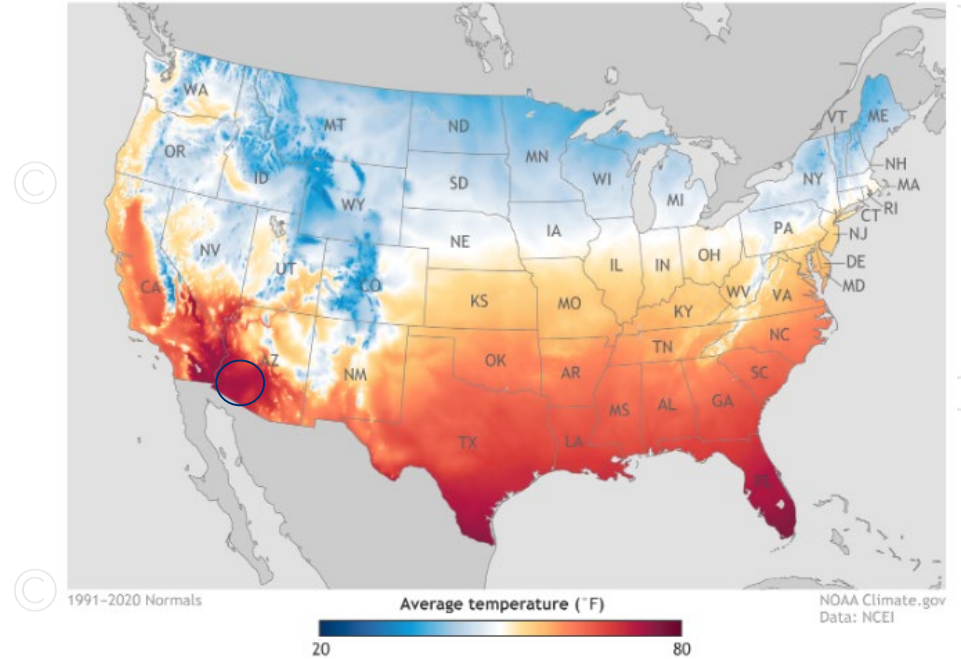
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Temperature

- USA SW Desert is ASHRAE climate zone 1B
- The hottest location in the U.S. for a dry climate
- Average maximum summer temperature over 40 °C

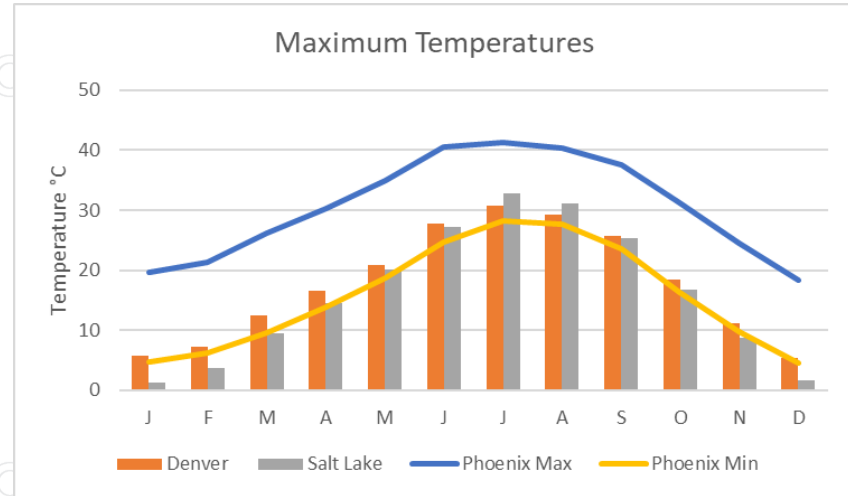


Temperature Comparison

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- Even though AZ temperatures are high, they are not unrealistic
- Summer temperatures in other cities are within the Arizona range



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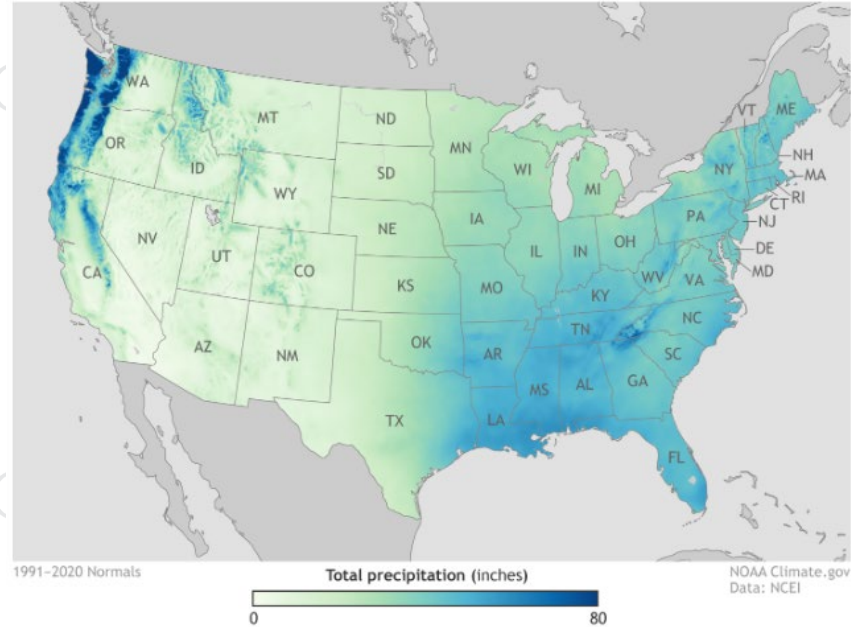
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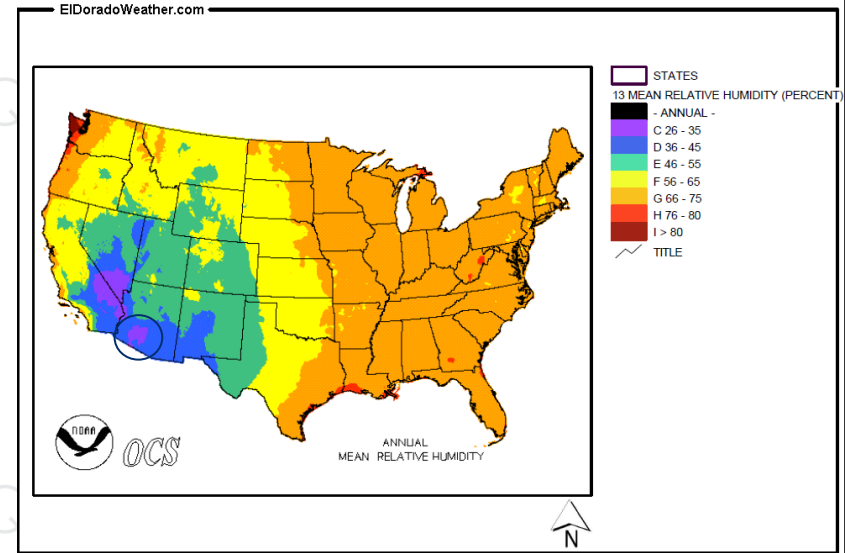
Rainfall

- Most of the Western U.S. is a dry zone
 - Except coastal zone
- Moisture content is reduced in all outdoor materials



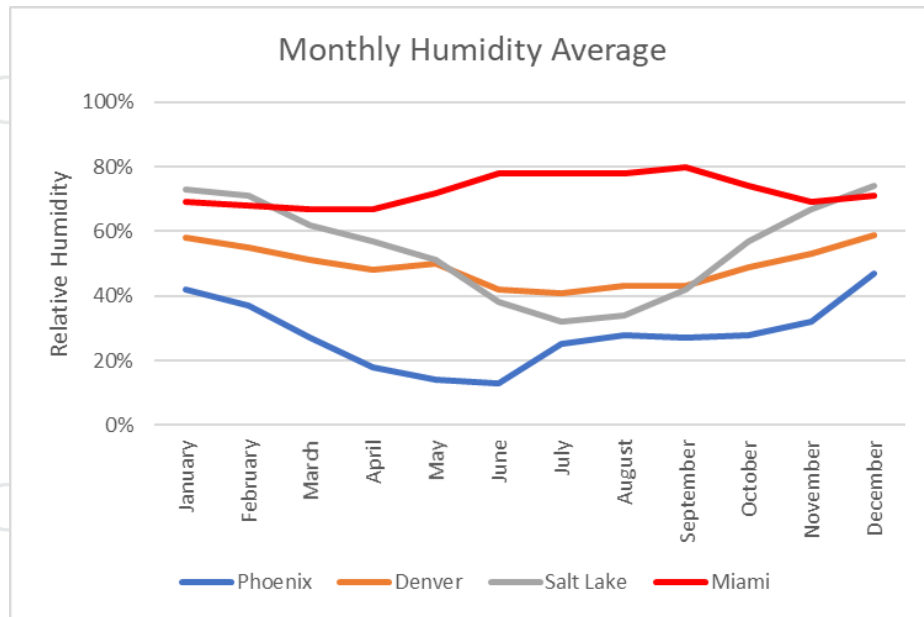
Humidity

- Extremely low ambient humidity
- Essentially the same as a hot desiccator



Big RH Differences between Wet and Dry

- All dry locations have a similar pattern for Relative Humidity
 - Daily average RH below 40% in summer
- Much different from our Miami benchmark



Practical Considerations

Accredited Locations

Independent 3rd Party Weathering Testing Facilities

- Arizona ISO 17025 locations
 - 2 sites
- Rest of World ISO 17025 locations
 - 0 sites
- Arizona test sites are continuously occupied
 - Full-time staff on-site 7 days per week
- Arizona test sites are full-service

Conclusions

- Central Arizona provides the best options for testing materials intended for a dry climate
- Representative:
 - Similar weather numbers for parts of the year
 - Similar weather yields similar results
- Accelerated:
 - Extreme limits of a dry region for all important parameters
 - Sunlight, UV, High Temperature, Dryness
 - More weather yields faster results

Thank you for your time.

Questions?
info@q-lab.com

We make testing simple. |

