

Why Florida?

A commonsense approach to understanding
Florida Outdoor Testing

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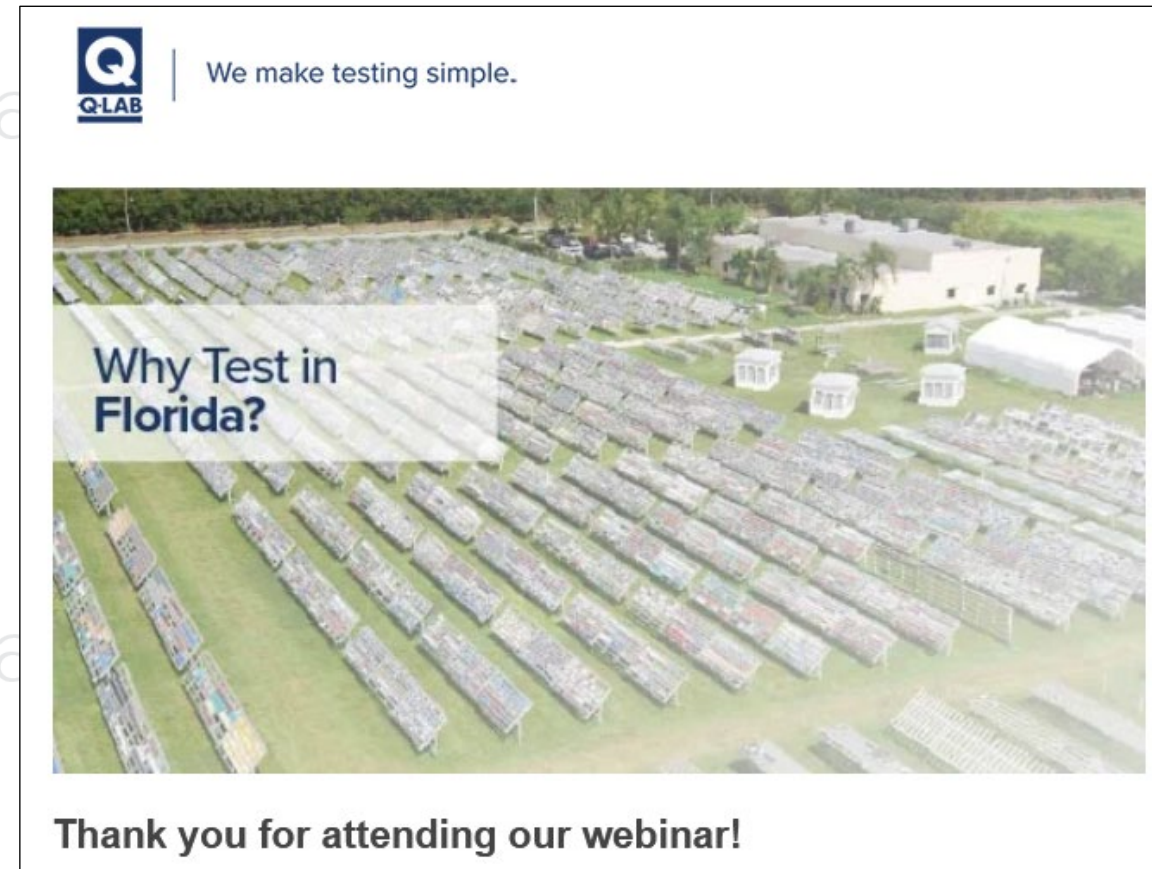
Q-Lab's Natural Outdoor Testing Webinar Series

- Today is the first 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

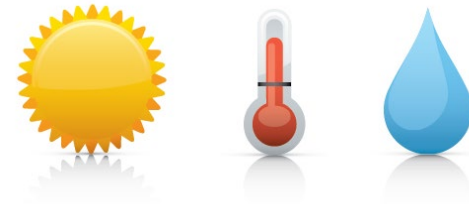


Outdoor Weathering

- Best way to get accurate results, but
- Every location could produce different results
- Time to completion is too long
- A reference location is needed to compare results
 - A location that is fast, relevant, and repeatable

Different Climates = Different Results

- Different ratios and times for the three “Forces of Weathering”
- 3 Levels of 3 factors in 3 combinations = 27 total possible
 - Sunlight (Low, Medium, High)
 - Temperature (Low, Medium, High)
 - Moisture (Low, Medium, High)
- Imagine all the other combinations in between
- Plus pollution, biodeterioration, salt spray, and other factors
- Not possible to test all materials in all conditions
- We must choose from a limited set of benchmarks



World Climate Benchmark Locations

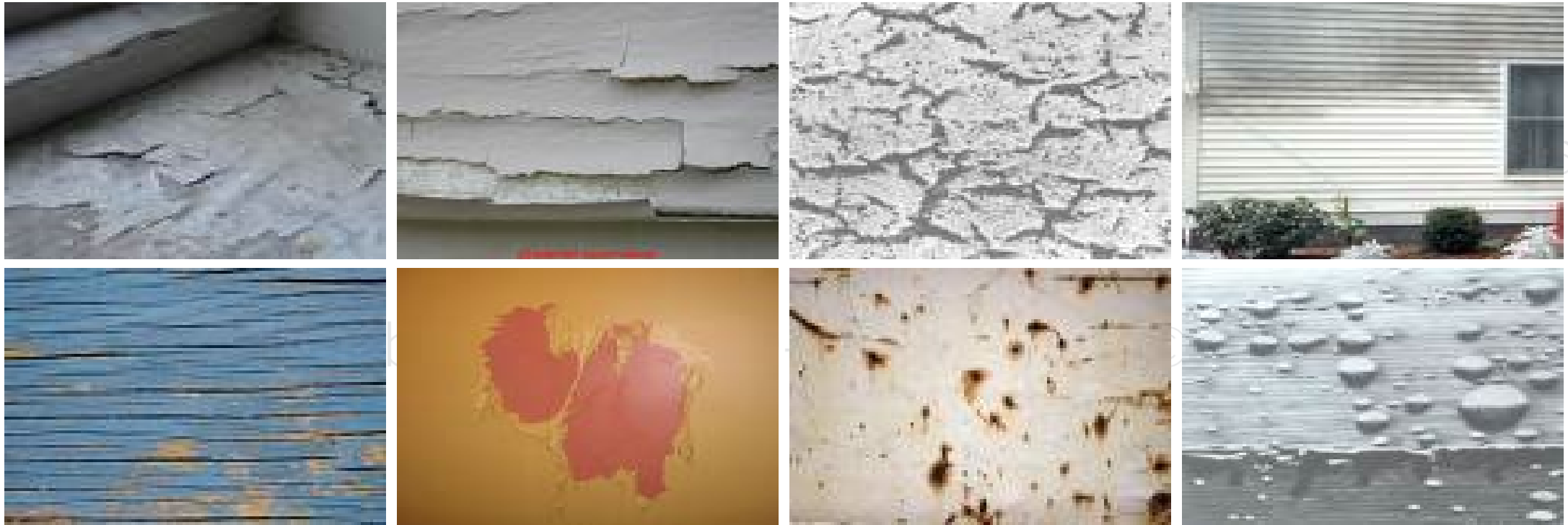
- Major Weathering
 - Subtropical (Florida)
 - Hot, Dry, Desert (Arizona)
 - Temperate (Standard) [but not accelerated]
- Specialized Environments
 - Arctic (Extreme Cold)
 - Continental (Extreme Temp Range)
 - Marine Atmosphere (Combined Corrosion Weathering)
 - Tropical (Constant High Temp and Moisture)
 - Alpine (High Altitude)
 - Industrial (Pollution)
 - Rain Forest (Mold)

Florida is the Primary Location

- Florida is the benchmark by which all other tests are compared
 - Florida has been the primary outdoor testing location since 1926
- Almost all the test cycles in ASTM G155 relate to Florida
- All automotive OEM test specifications require Florida
- Required by SAE, VSI, CRRC, AAMA, Federal, and Military standards
- But "WHY?"
 - Because it works!

Material Failures caused by Weathering

These are common failure types found everywhere



What causes Weathering?

Sunlight



Temperature



Moisture



Basically.... The Weather



Principles of Accelerated Weathering

- A good accelerated test must meet two principles:
 1. Produces the same results as end-use environment
 - Ranking, Direct Comparison, Versus Reference
 2. Results are faster than end-use environment
 - The faster the better, as long as rule 1 is obeyed
- Test must be performed in controlled conditions
- Factors of influence must be known and measured
- Results must be confirmed statistically

Laboratory Accelerated Testing Strategy

- Use a test cycle that simulates outdoor weathering factors
 - Same light, temperature, and moisture time periods
- Increase the level of each factor
 - Higher irradiance, not shorter wavelengths
 - Higher temperatures, or greater temperature swings
 - Longer wet time, or more equal wet and dry times
 - More cycles, faster ramp times (care needed here)
- Limiting factor is quality of simulation and material response

Alternative Plan

- Outdoor weathering is always more accurate, but almost always slower
- There are accelerated outdoor tests, such as solar concentrator
 - These tests have some of the same acceleration concerns
 - Super-accelerated tests have correlation concerns
 - Must always be confirmed with an outdoor test
- Solution might be found with a faster natural outdoor test
 - **Primary benchmark location**

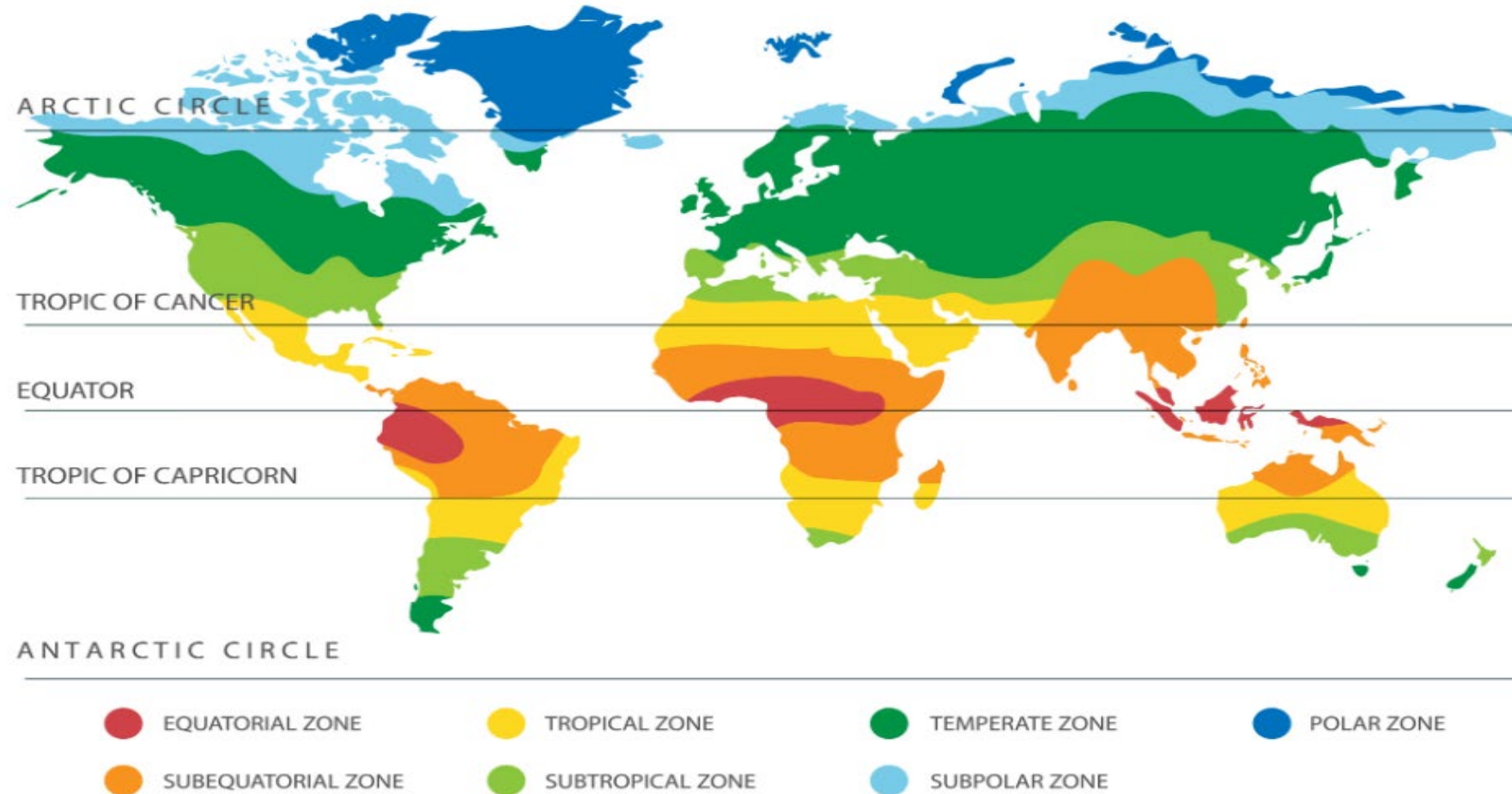
Natural Outdoor Test Strategy

- To get the same results
 - You must have the **same** weather
- To get faster results
 - You must have **more** weather
- To get the same results but faster
 - You must have **more** of the **same** weather

Outdoor Test Solution

- The best **accelerated** test might be an **outdoor** test that produces the same results but faster
- The outdoor test must be performed in a climate that has more of the same weathering characteristics
 - Provides the same results but with a reasonable amount of acceleration
- What locations can be used to perform faster outdoor tests?
 - Somewhere with the same weather, but more of it!

World Climate Regions

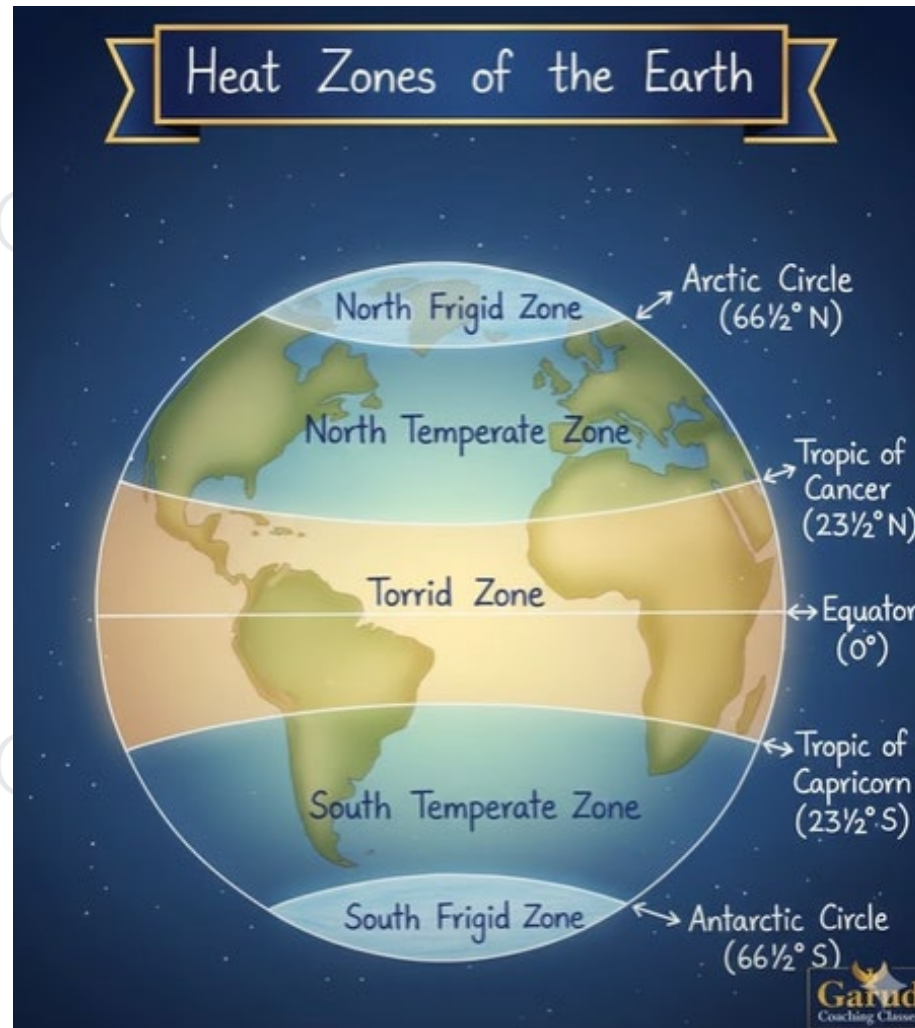


Actual regions vary sometimes based on local geography

The Temperate Zone (TZ)

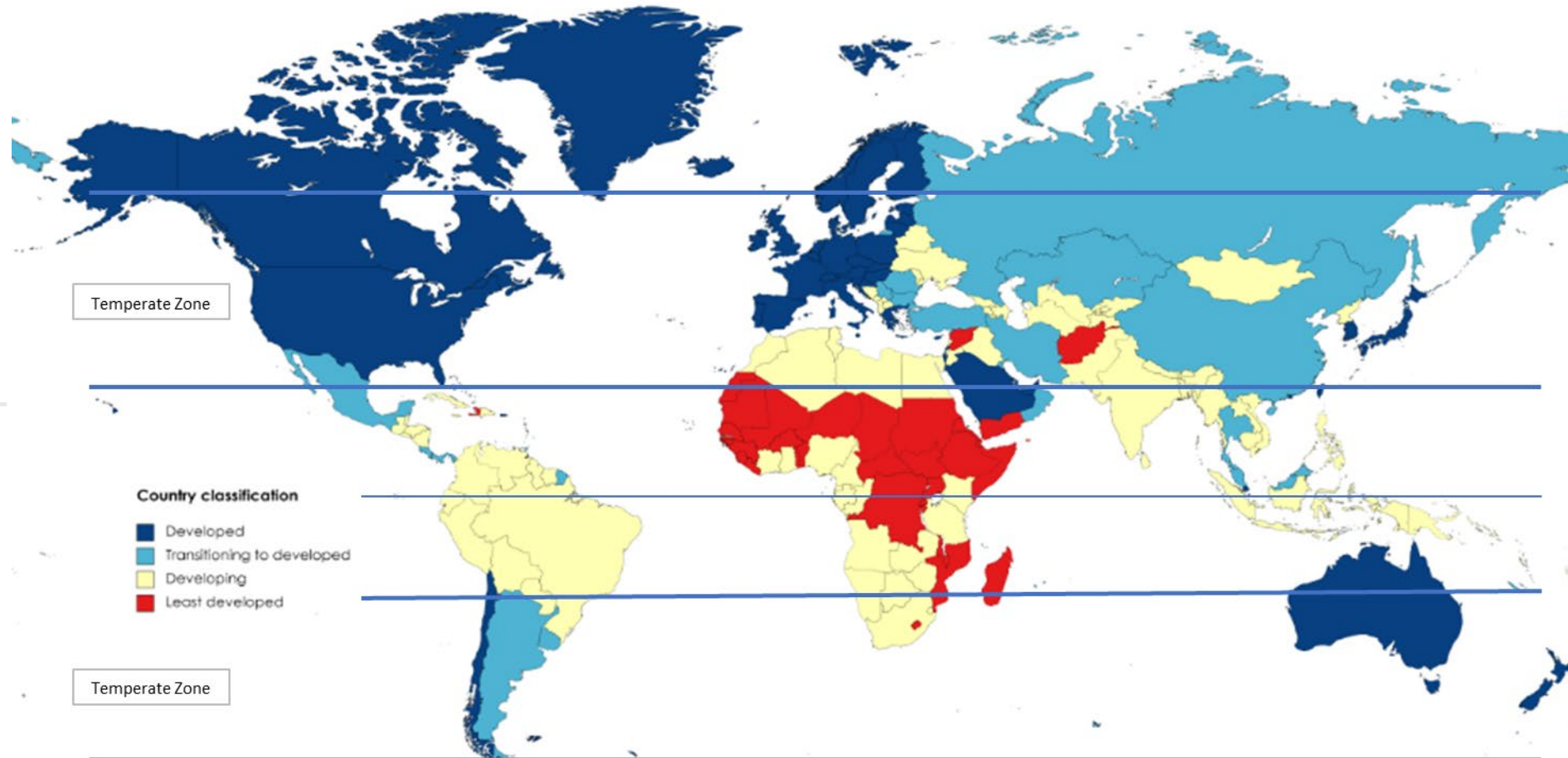
Examples

USA
Southern Canada
Europe
East Asia
Southern Australia
New Zealand
Southern S.
America
South Africa

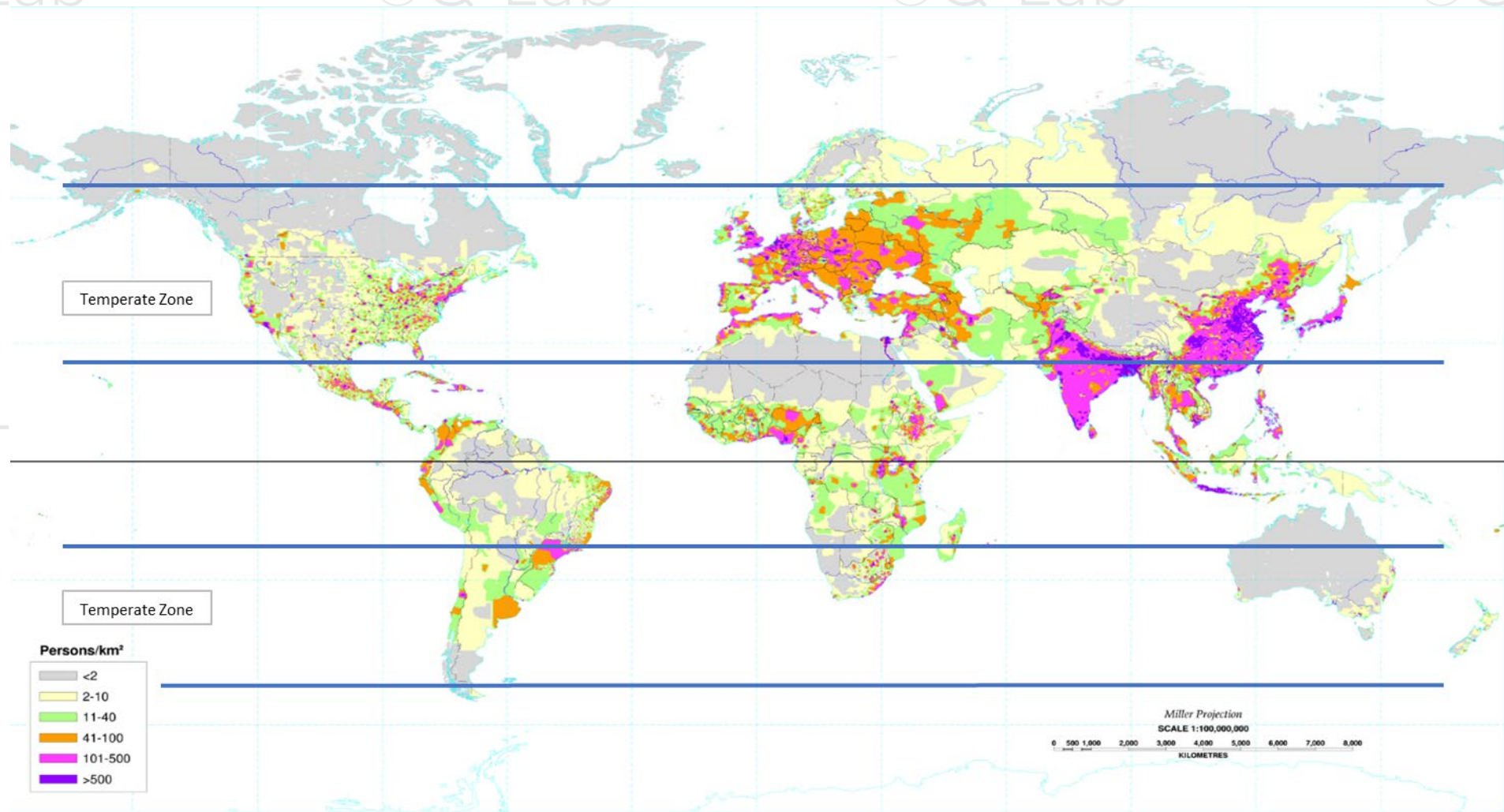


- The Temperate Zone is most areas between 23.5 and 66.5 degrees latitude
- South Florida is at the extreme limit of the temperate region
 - Often described as the only true subtropical region in the United States
- South Florida is the ideal location to test for the TZ

World Industrial Regions



World Population Regions



Florida and the Temperate Zone

- Florida and the TZ are quite similar in the summer
- Florida and the TZ are quite different in the winter
- The TZ's climate in summer is much different than TZ's climate in Winter
- Florida's summer and winter are nearly the same
- The TZ's summer is like Florida average
- A Florida exposure is like summer in the TZ all year round
 - This is the key statement, and why Florida is so important

Seasonal Weathering

- Weathering proceeds in Summer
- Weathering “on hold” in Winter
 - Sunlight too weak, temperatures too low, moisture may not factor
 - Sunlight below 120 W/m² considered too weak to cause photo-degradation
- The weathering factors are greater in the Summer
 - Solar cut-on moves to lower wavelengths
 - Rate of chemical changes doubled if ambient increases 10 °C to 20 °C
 - Rainy season or dry season changes moisture content present

Think of Weathering as a Chemical Reaction

- Sunlight is the energy source
 - Higher irradiances provide more energy, but ...
 - Different wavelengths change the energy effect
- Temperature affects the rate
 - Higher temperatures cause faster rates
- Moisture changes the degradation mode
 - Dry
 - Wet

Why Florida Works: Correlation and Acceleration

The reason why Florida is so good is as simple as 1, 2, 3

1. Florida is accelerated but not extreme
2. Florida's average climate is like summer elsewhere in the TZ

The TZ climate must approximate Florida at some time during the year

3. Acceleration rates depend on the relative "summer" duration

Acceleration is indirectly proportional to the number of months a location in the TZ is in the Florida range.

For a location where 4 months are the same the acceleration is $12/4 = 3$

Florida works for these boundaries

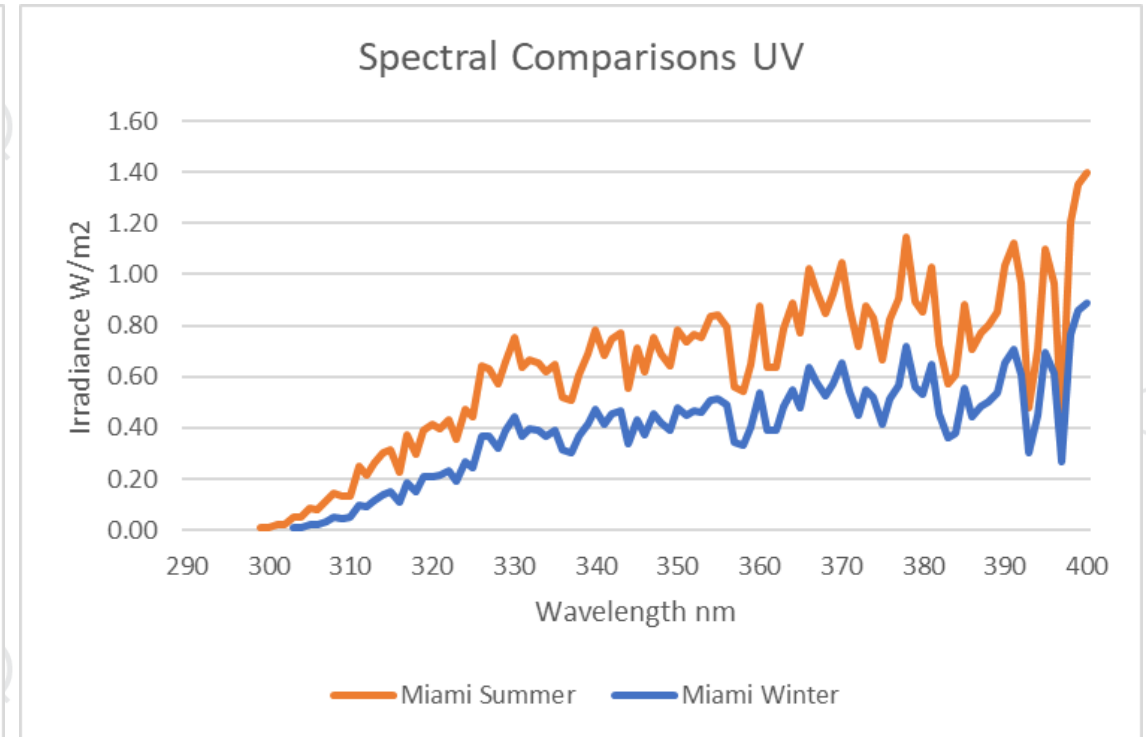
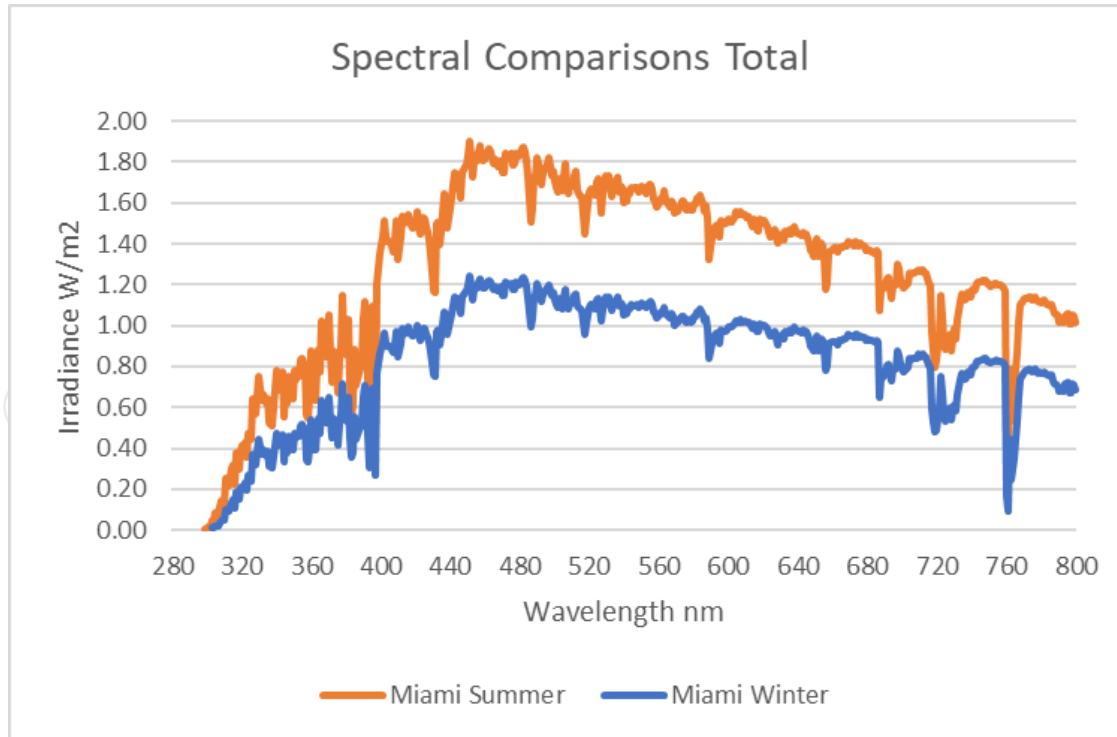


Use Arizona for
anything here

Seasonal and Location Differences in Forces of Weathering: Florida and New York

Florida Sunlight: Seasonal Differences

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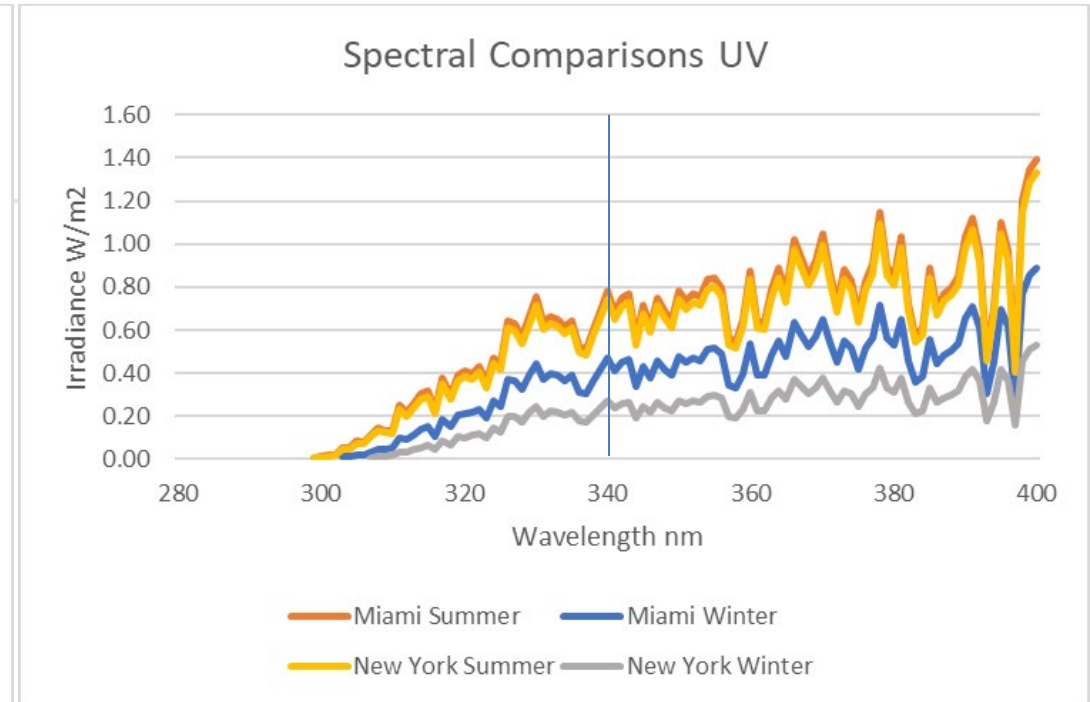
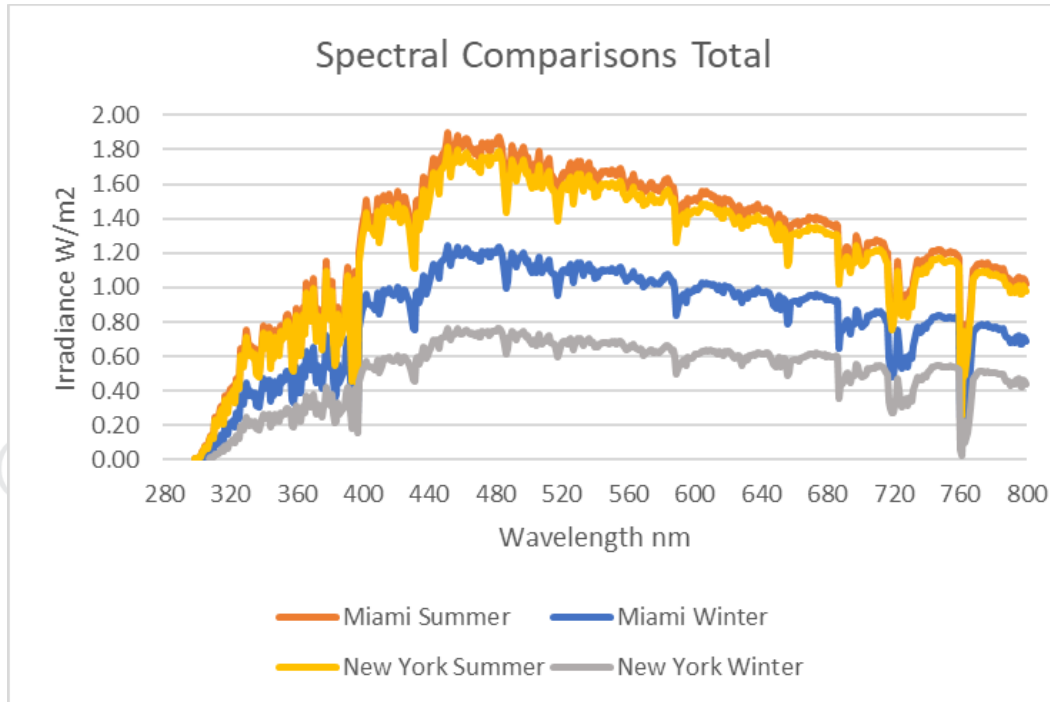
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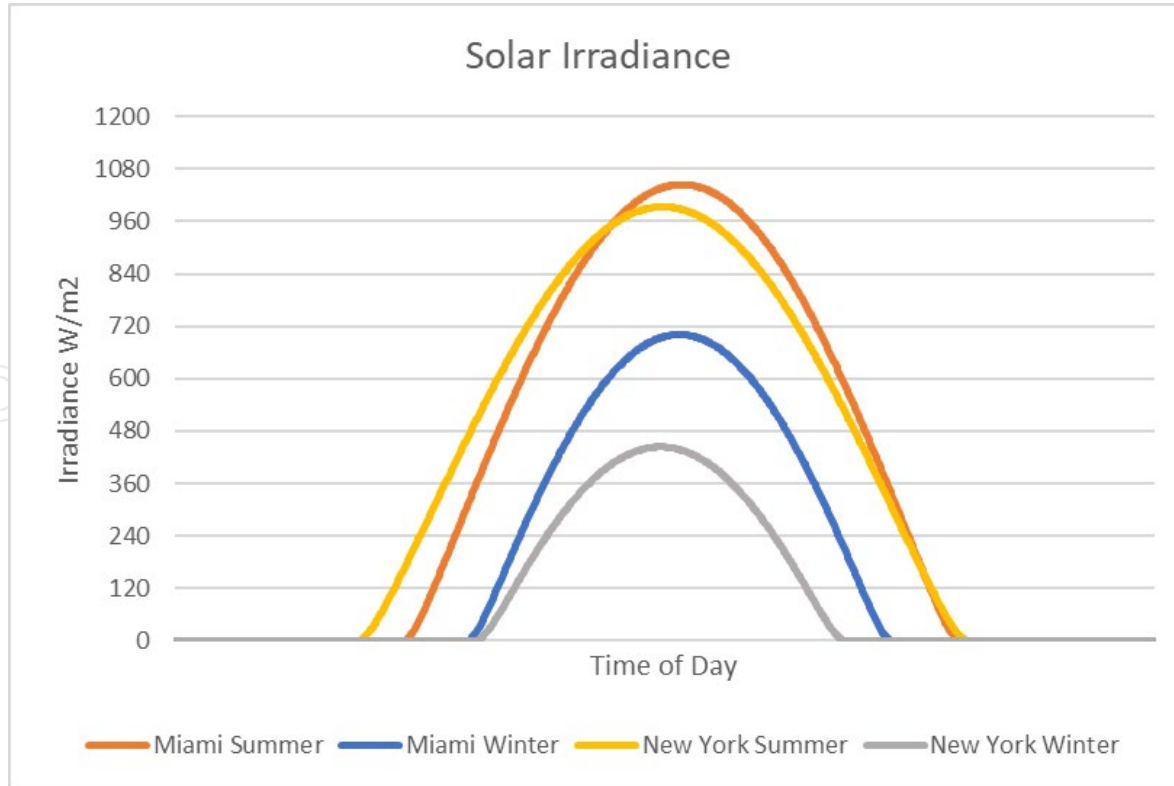
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Spectrum of Sunlight by Season and Location



Category	Miami Summer	Miami Winter	New York Summer	New York Winter
W/m ² at 280-800 nm	640	418	611	257
W/m ² at 280-400 nm	65	39	61	22
W/m ² at 340nm	0.78	0.47	0.74	0.27
Cut-on wavelength	299	303	299	307

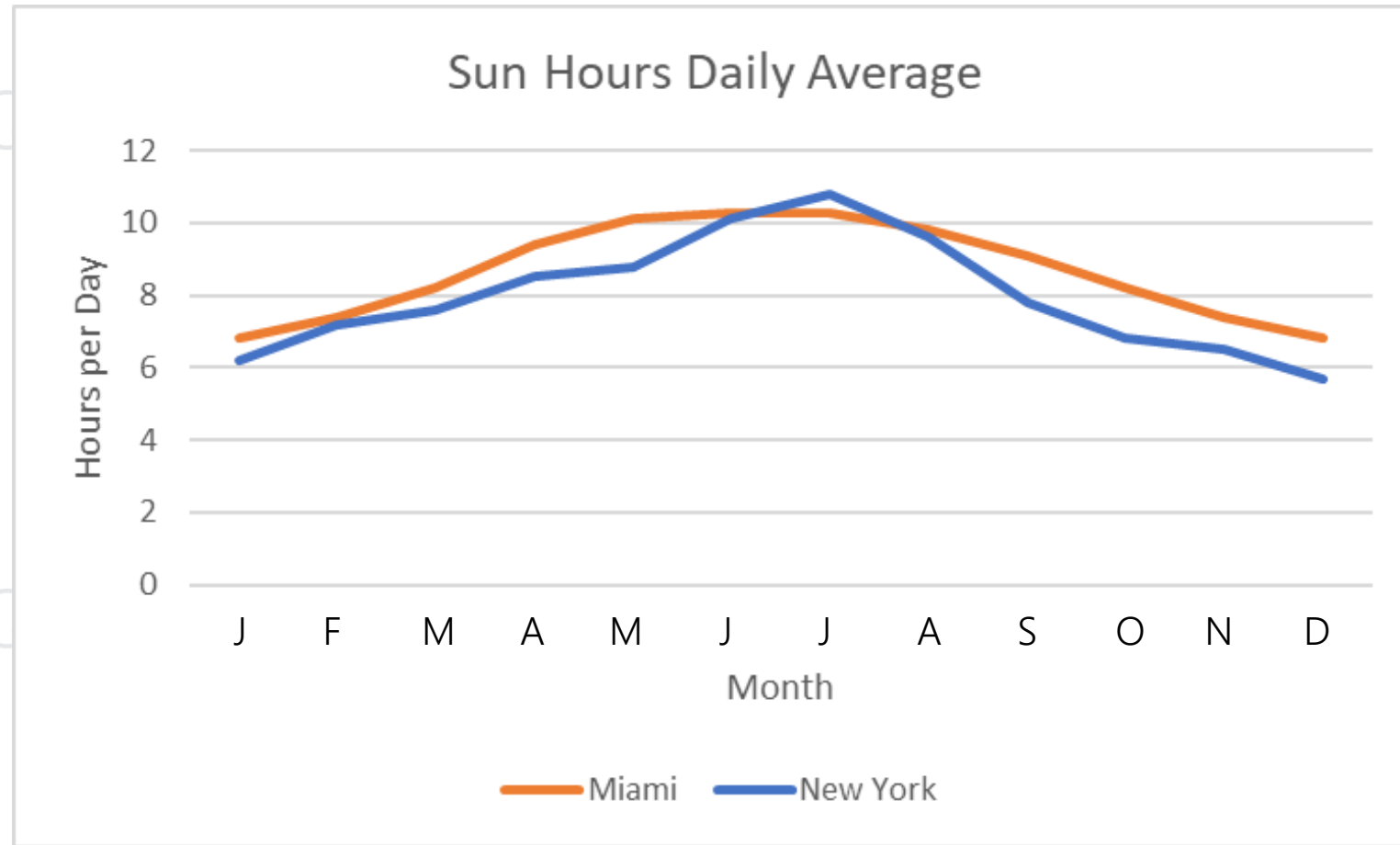
Radiant Energy by Season and Location



- Total Radiant Energy (Summer)
 - Miami: 31.1 MJ
 - New York: 31.1 MJ
- Total Radiant Energy (Winter)
 - Miami: 16.2 MJ
 - New York: 8.9 MJ NY Winter
- Time above a possible irradiance

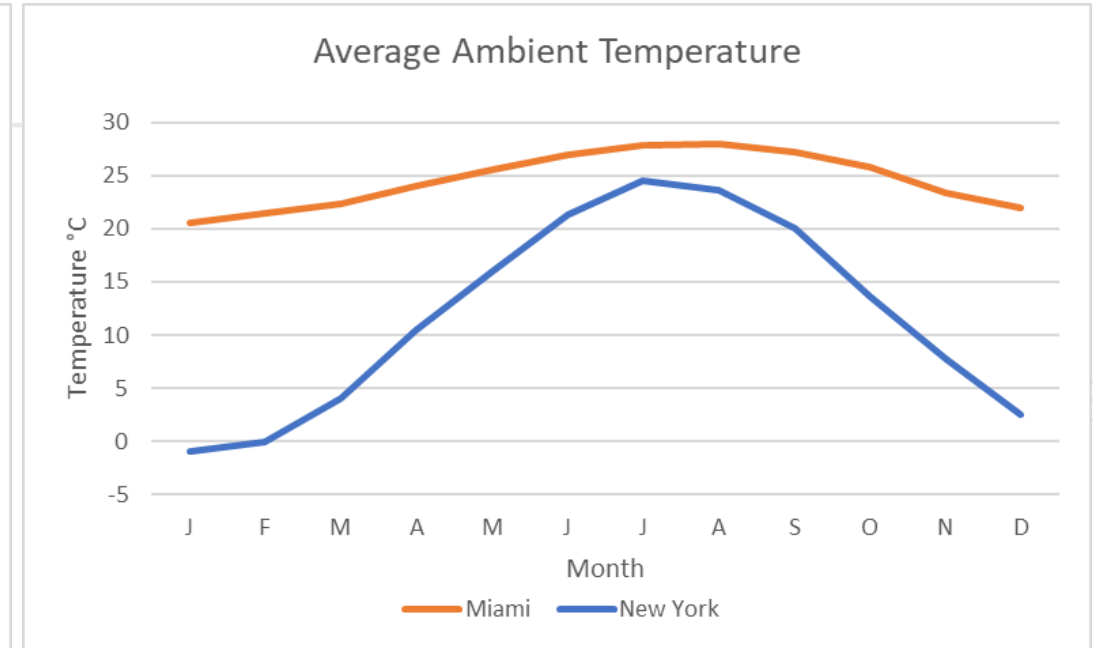
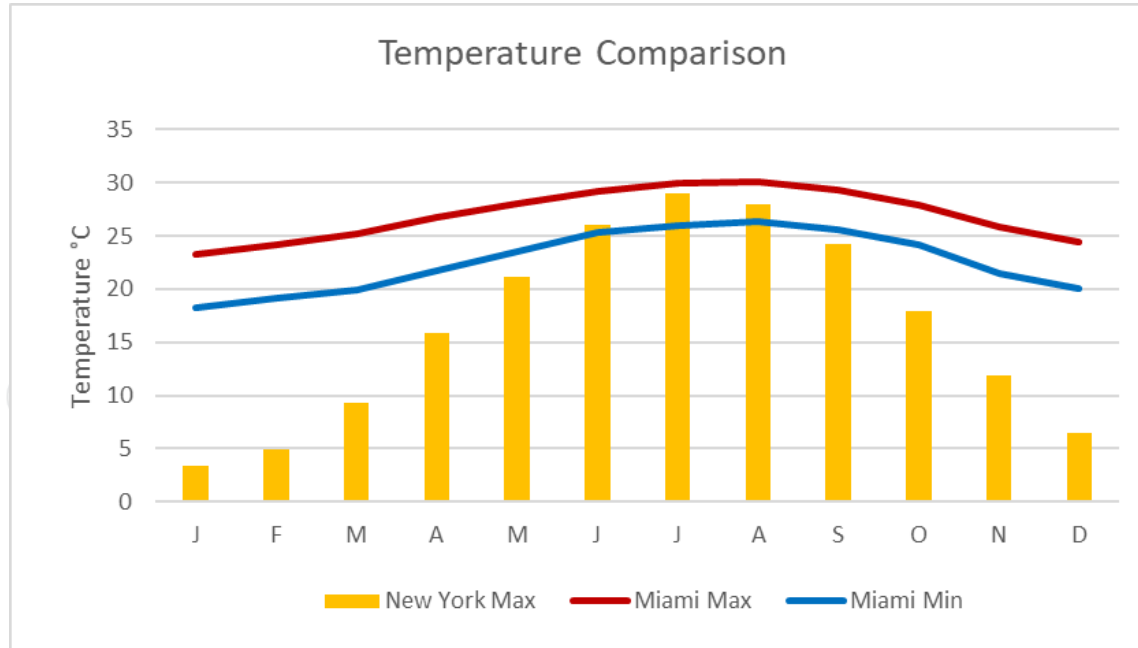
Minutes above 120 W/m^2		
	Miami	New York
Summer	731	790
Winter	536	430

Sunshine by Location and Month

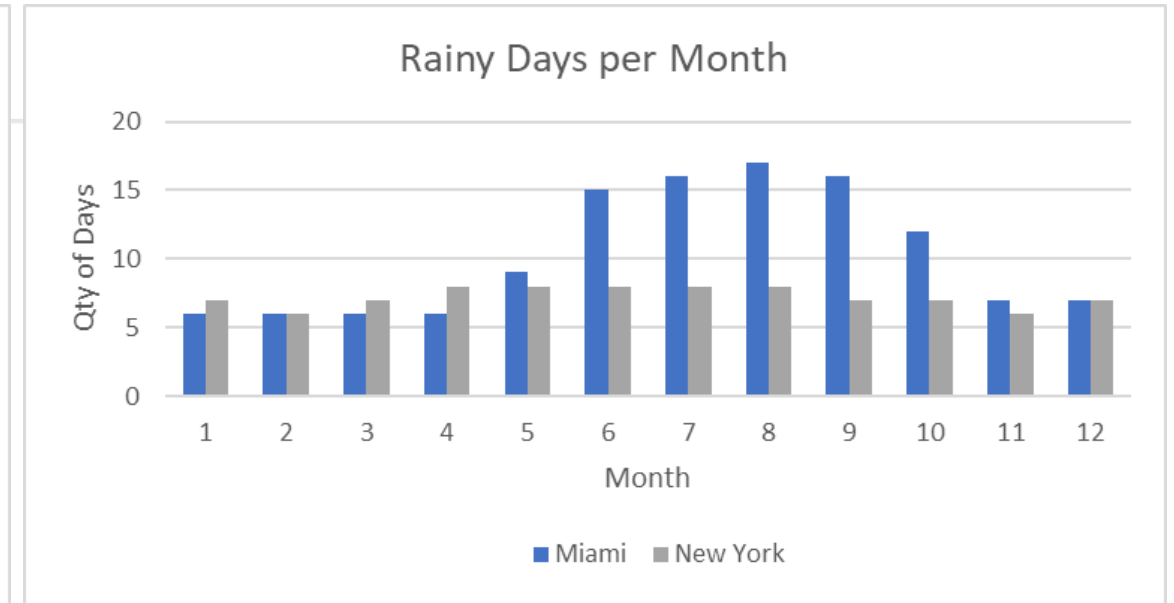
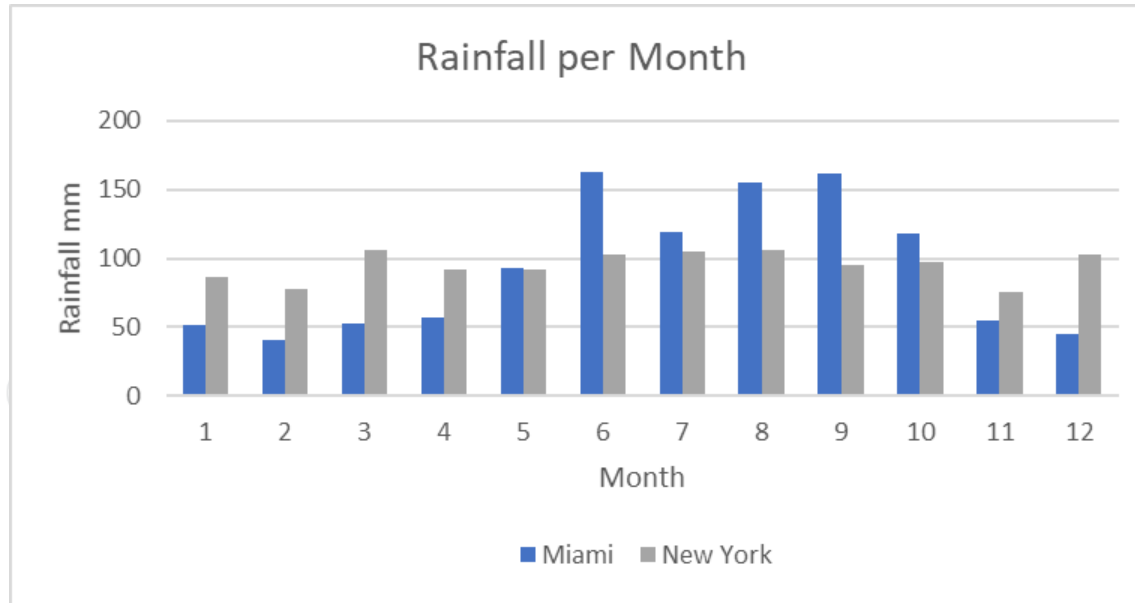


Temperatures by Location and Month

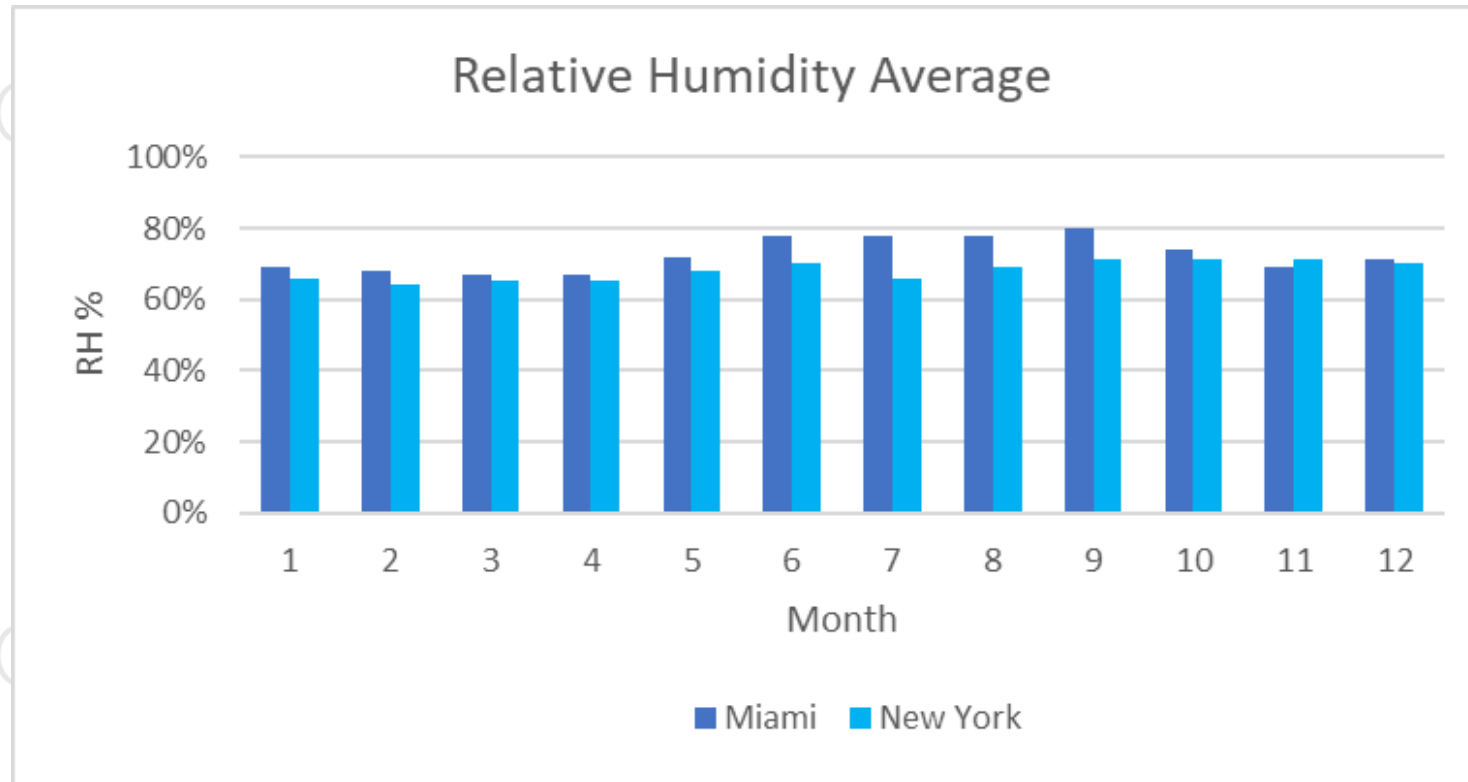
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Rainfall by Month and Location



Moisture in the Air



Comparing Locations

- Other items to consider when comparing two locations
- Critical Thresholds
 - How do these compare to South Florida, for example ...
 - Time that temperature is above 20 °C
 - Total Wet Time approaching 50%
 - Duration of Solar Radiation above 120 W/m²
- Adding all the inputs together (synergistic effect)
 - Time above 20 °C, and the wet/dry is in flux, and sun greater than 120 W/m²

Acceleration

- Comparing a temperate location to Florida
- The amount of time in one location (?) that has the same weather as the other location (FL)
- Acceleration in Florida depends on the climate of the location being compared
 - When does the sun get strong enough, for long enough
 - When do the temperatures climb above FL minimums
 - How long is the warm weather lasting

Why Florida?

- If your location is like Florida for part of the year, the type of weathering will be the same as Florida
- The acceleration factor depends on how long your location has the same weather as Florida
 - These conclusions explain the many reports of 2 to 4 times acceleration when testing in Florida
- These conclusions explain why Florida has been accepted as the world's primary benchmark for 100 years

Thank you for your time.

We make testing simple. |

