2008 International Meeting on Controlled Environment Agriculture

Thank You!

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Tools for Research

- Percival Scientific, Inc. – Controlled Environment Manufacturer
- Current methods for growing plants in a Percival Environmental Chamber
  - Static Settings
  - Diurnal Program (2 program steps)
  - Multi-step programs (more than 2 steps)
  - Multi-step programs linked in a sequence
  - Ramping and Non-ramping
- What if a research project required, or could benefit from the use of a realistic weather model for growing plants?
- No all-encompassing tool is currently available which can accurately simulate all the major weather variables used for growing plants
- Percival now has a product to meet this need

Percival Scientific Introduces…

WeatherEze

The Next Generation of Environmental Control

A Collaborative Effort…

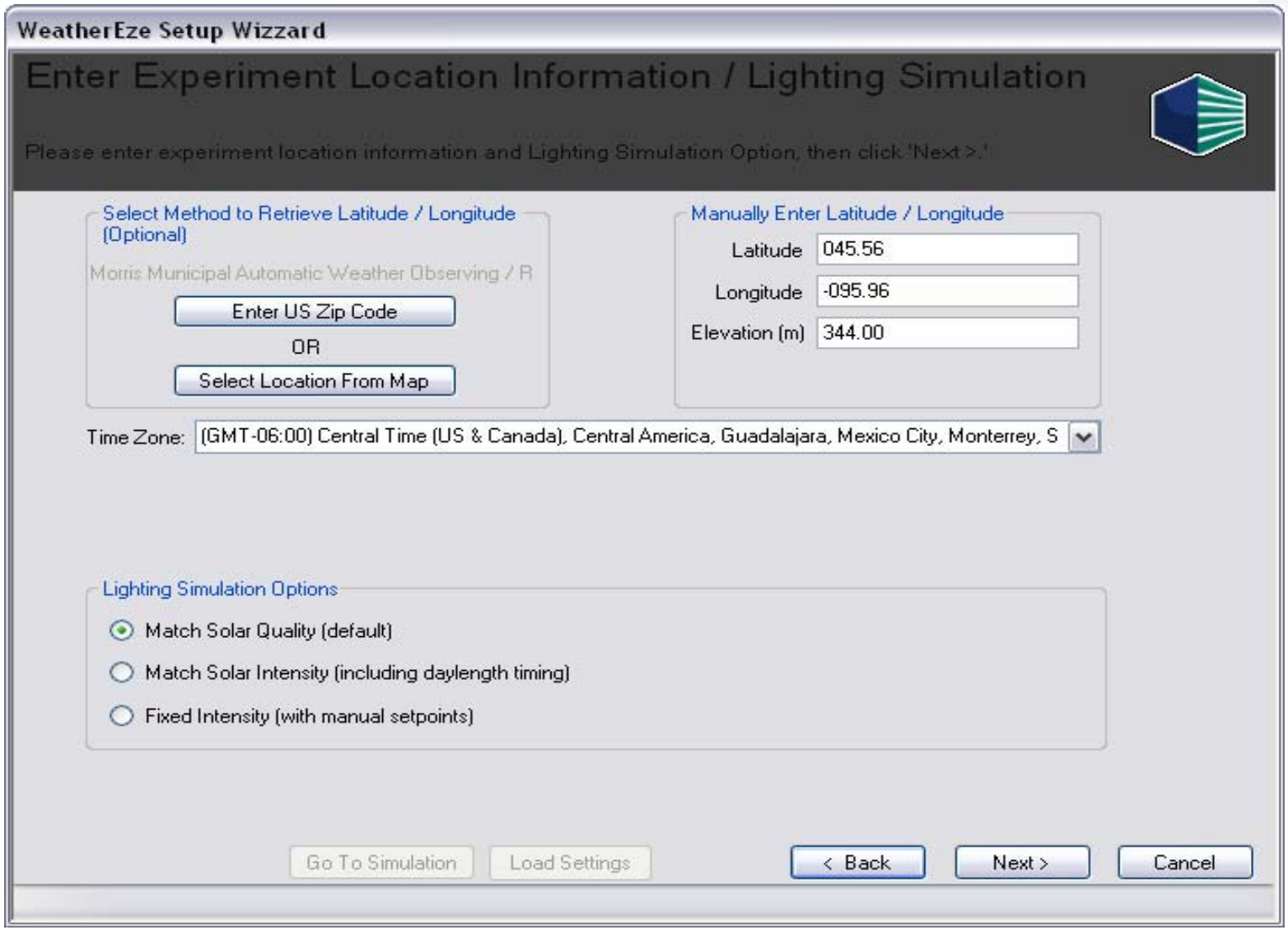
- WeatherEze is a result of a cooperative research and development agreement (CRADA) with the United States Department of Agriculture-Agricultural Research Service.
- Neither this CRADA nor the results of this CRADA are an endorsement by USDA-ARS of Percival's products or services, including this software.

WeatherEze

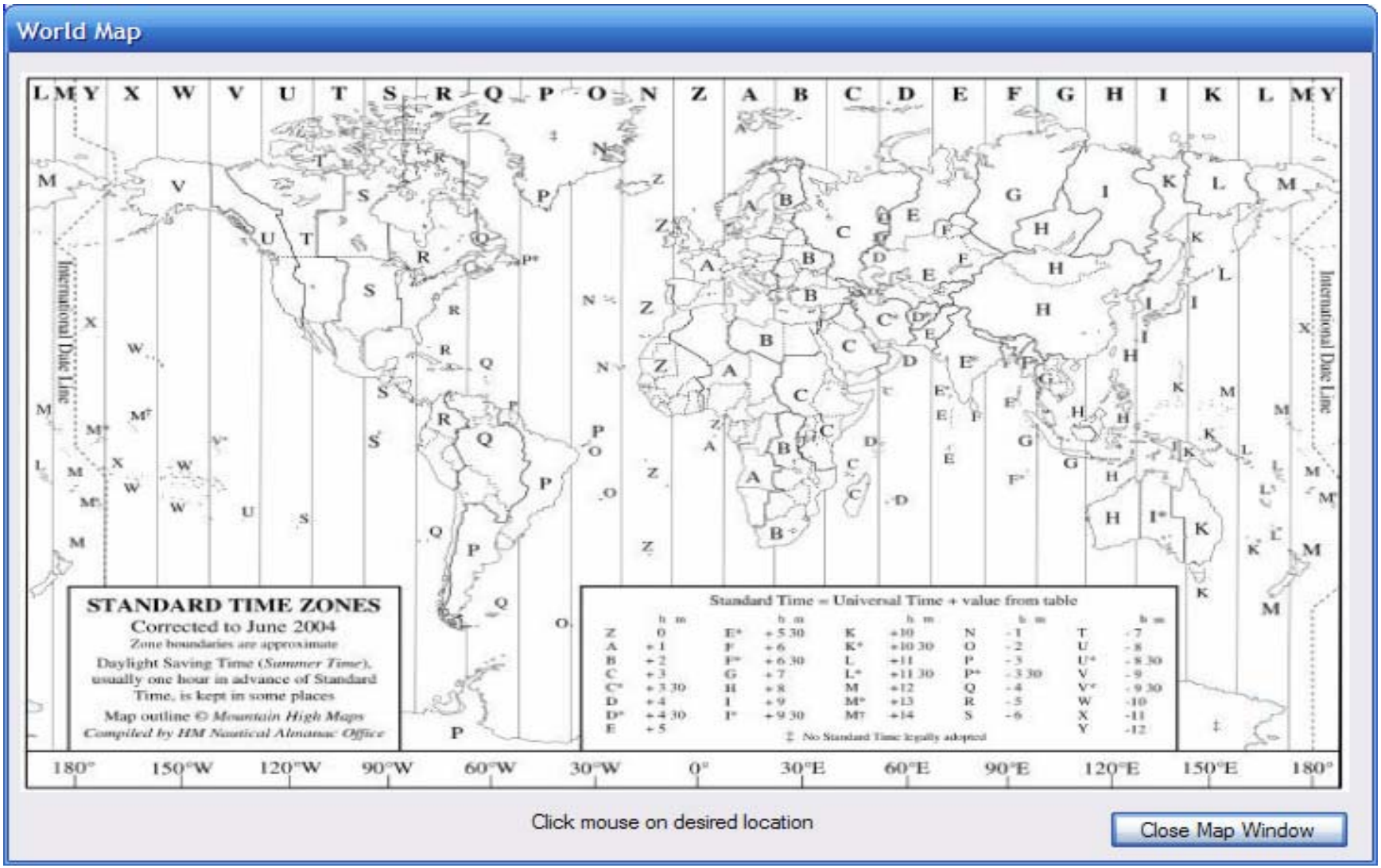
Project Goal

- Create a tool capable of reproducing or simulating natural weather conditions in a Percival Plant Growth Chamber
- Provide a previously unavailable degree of accuracy and control
- Base weather simulations on empirical data
- Keep the system user-friendly and convenient to use
- Allow for user-specific settings
- Provide global coverage

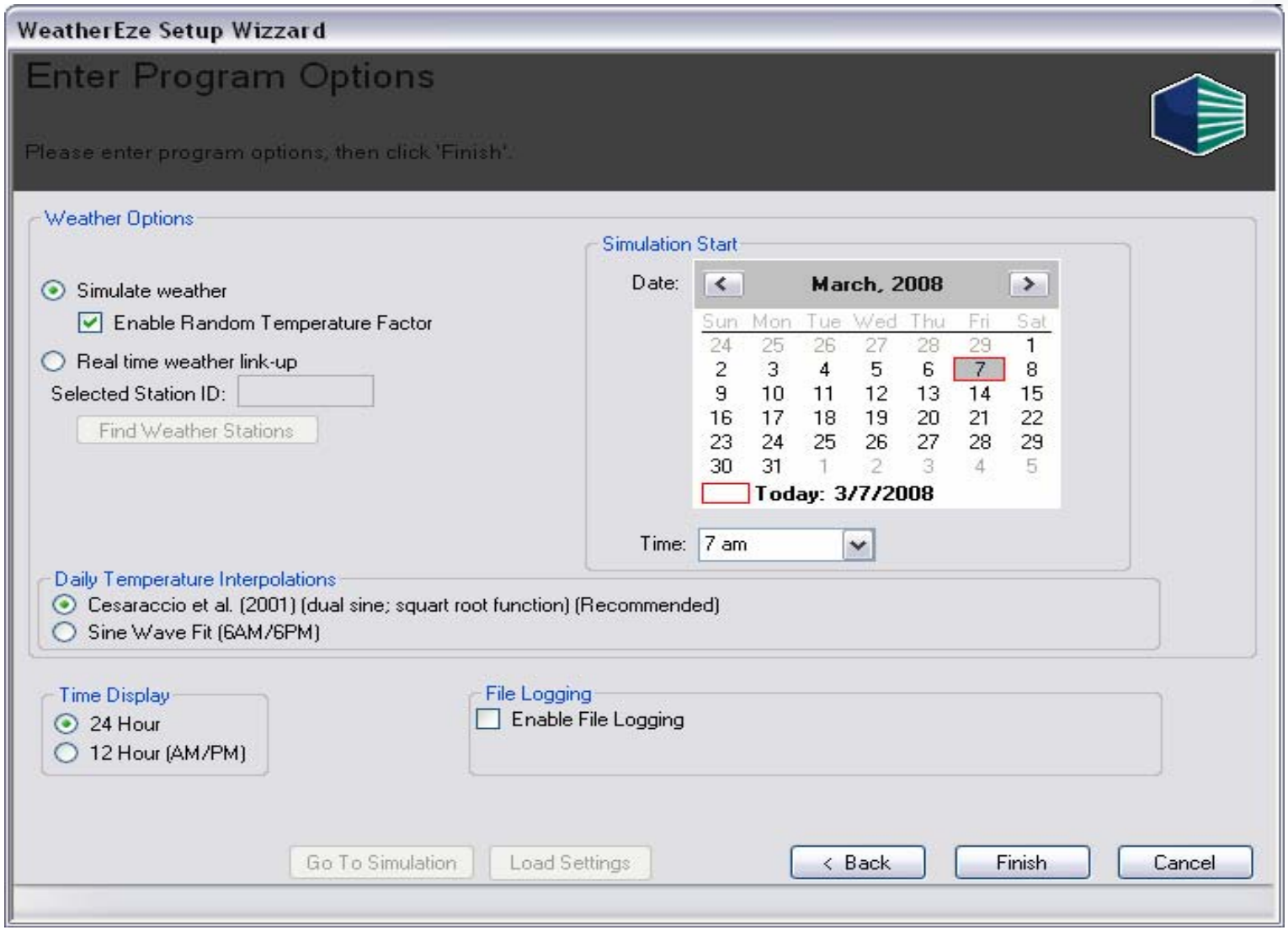
Select a Location



Select a Location – World Map



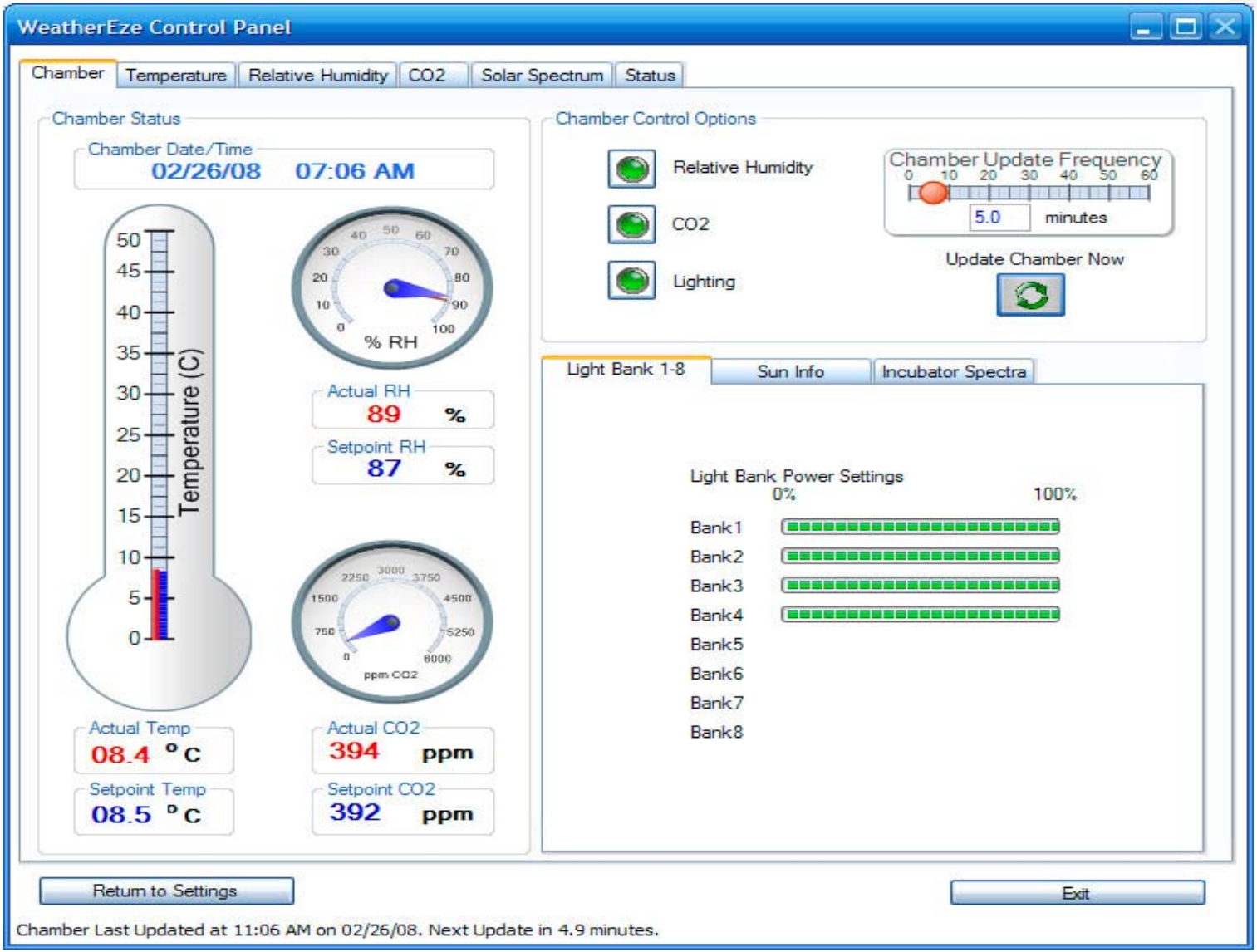
Select a Control Mode



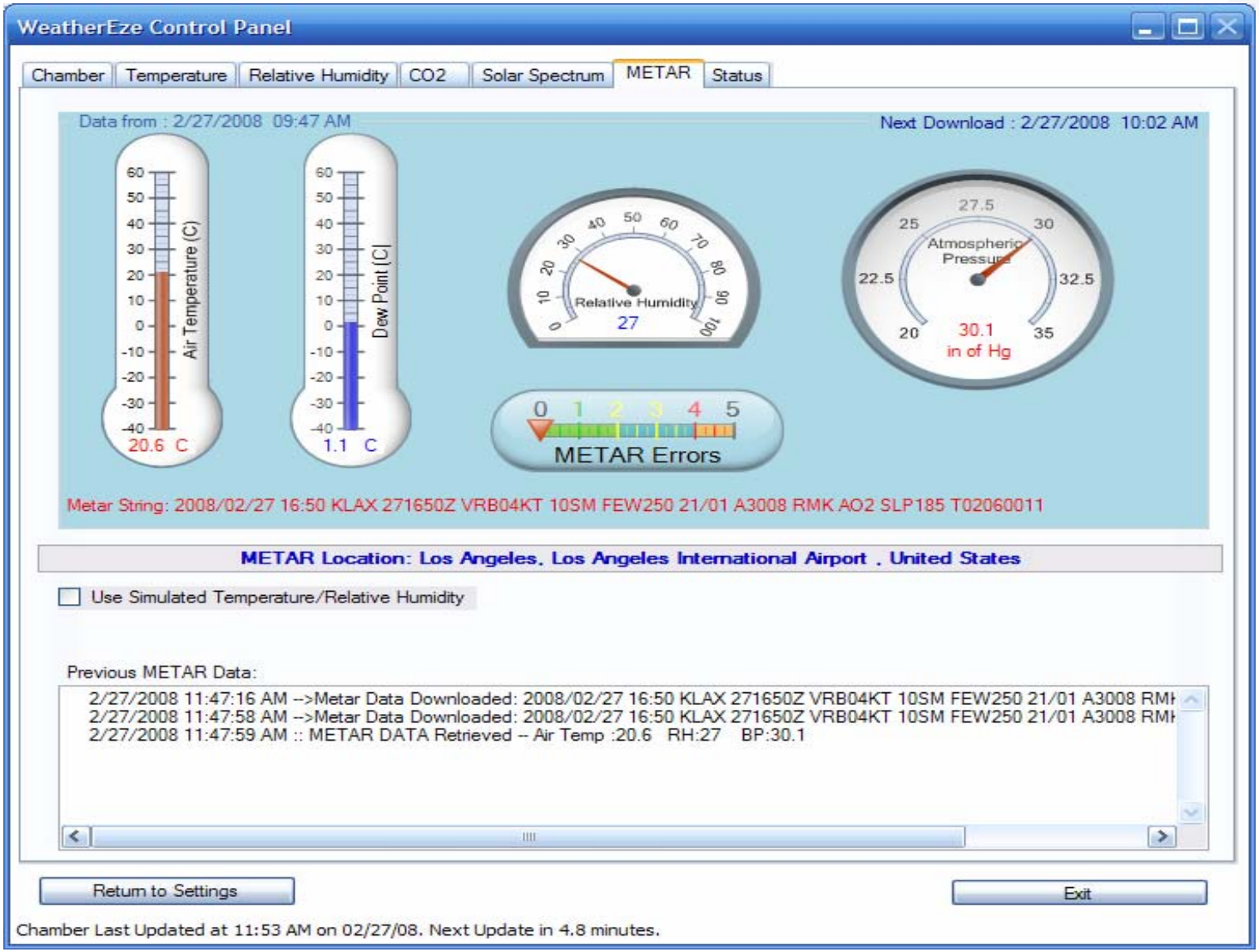
Modes of Control

- Simulation: Allows the user to select any start date at any location on the globe. The program will simulate daily temperature, relative humidity, CO_2 and light conditions and automatically program them into the Intellus Controller on any Percival Environmental Chamber with communications.
- Real-time: Allows the user to recreate weather conditions from any location on the globe where weather data is available in near real-time. The conditions are automatically programmed into the Intellus Controller on any Percival Environmental Chamber with communications.

Master Status Screen: Simulation Mode



Master Status Screen: Real-Time Mode

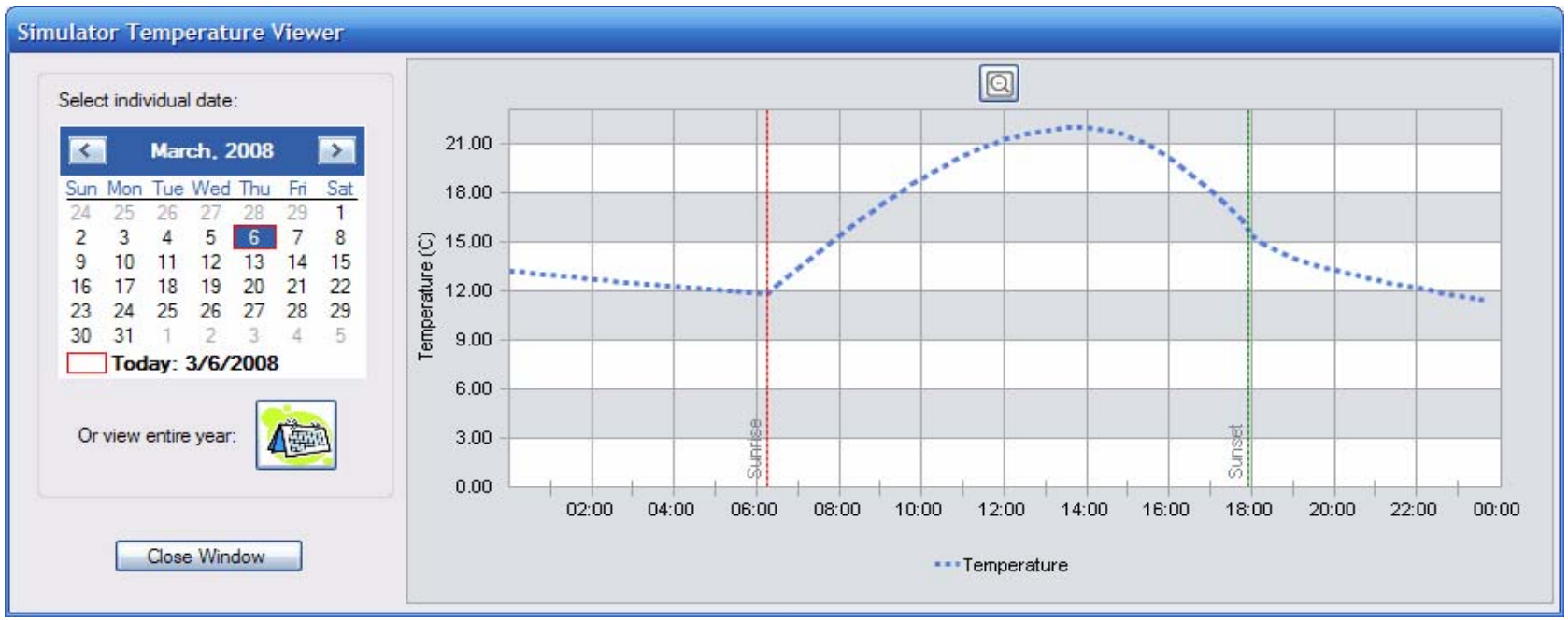


Temperature Control

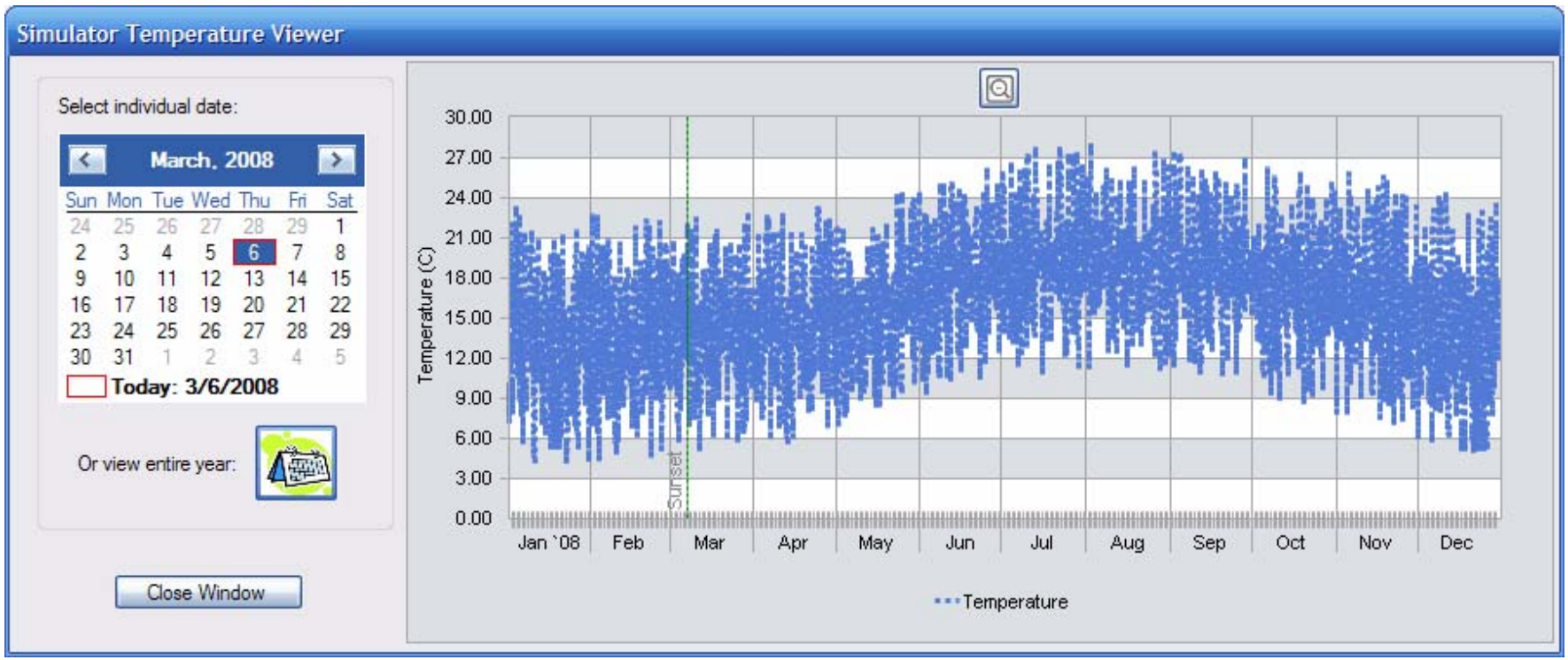
- Simulation:
  - Simulated temperature profiles are averaged values, based on the last 30 years of global climate data
  - Temperature profiles for any point on the globe can be simulated
  - Simulations can be run for past, present and future time periods
  - A random factor can be applied to the annual temperature cycle which simulates diurnal temperature variability
- Real-time Control:
  - Weather data can be acquired in near real-time from any METAR station (which typically update every hour)
  - Requires an internet connection
  - Can automatically switch over to simulated temperature settings if communications are lost

Temperature Control

View Any Individual Date



View the Entire Year



Relative Humidity Control

- Simulation:
  - Simulated relative humidity profiles are calculated based on the daily temperature
  - Relative humidity profiles for any point on the globe can be simulated
  - Simulations can be run for past, present and future time periods
- Real-time Control:
  - Relative humidity data can be acquired in near real-time from any METAR station (which typically update every hour)
  - Requires an internet connection
  - Can automatically switch over to simulated temperature settings if communications are lost

Relative Humidity Control

CO_2 Control

- Simulation:
  - Simulated CO_2 profiles are based on geographical and seasonal variations gathered from previous scientific studies
  - Also provides the ability for the user to account for any diurnal fluctuations in CO_2
    - Account for fluctuations resulting from position within a plant canopy
    - Account for ambient levels resulting from location (urban, rural, remote)
  - Simulations can be run for past, present and future time periods
- Real-time Control:
  - These values are typically not available in real-time. All CO_2 control is accomplished though the simulation

CO_2 Control


WeatherEze Control Panel
Chamber
Temperature
Relative Humidity
CO2
Solar Spectrum
Status
Actual
393
ppm
Setpoint
393
ppm
CO2 Concentration (ppm)
420.00
410.00
400.00
390.00
380.00
370.00
360.00
350.00
340.00
330.00
320.00
310.00
300.00
Current Time
02:00
04:00
06:00
08:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
00:00
Time of Day (03/04/08)
Simulated CO2
SetPoint CO2
Actual Chamber CO2
Return to Settings
Exit
Chamber Last Updated at 15:08 on 03/06/08. Next Update in 4.6 minutes.

Lighting Control

- Setup
  - WeatherEze software is easily configured to any specific Percival Controlled Environment
- Quality
  - Solar quality can be simulated at any position and point in time on the globe
  - Takes into account the spectral output of the chamber's lighting system, and matches it as closely as possible to the global solar spectrum
  - This mode is focused on reproducing the actual spectrum in terms of wavelength ratios as opposed to intensity
  - Well suited for single spectrum light sources
- Quantity
  - Solar intensity can be simulated at any position and point in time on the globe
  - Total intensity is matched over the entire solar spectrum
- Custom
  - Allows the user to enter customized lighting periods and bulb outputs
  - Can customize day start, end, and light output during the day cycle

Lighting Control

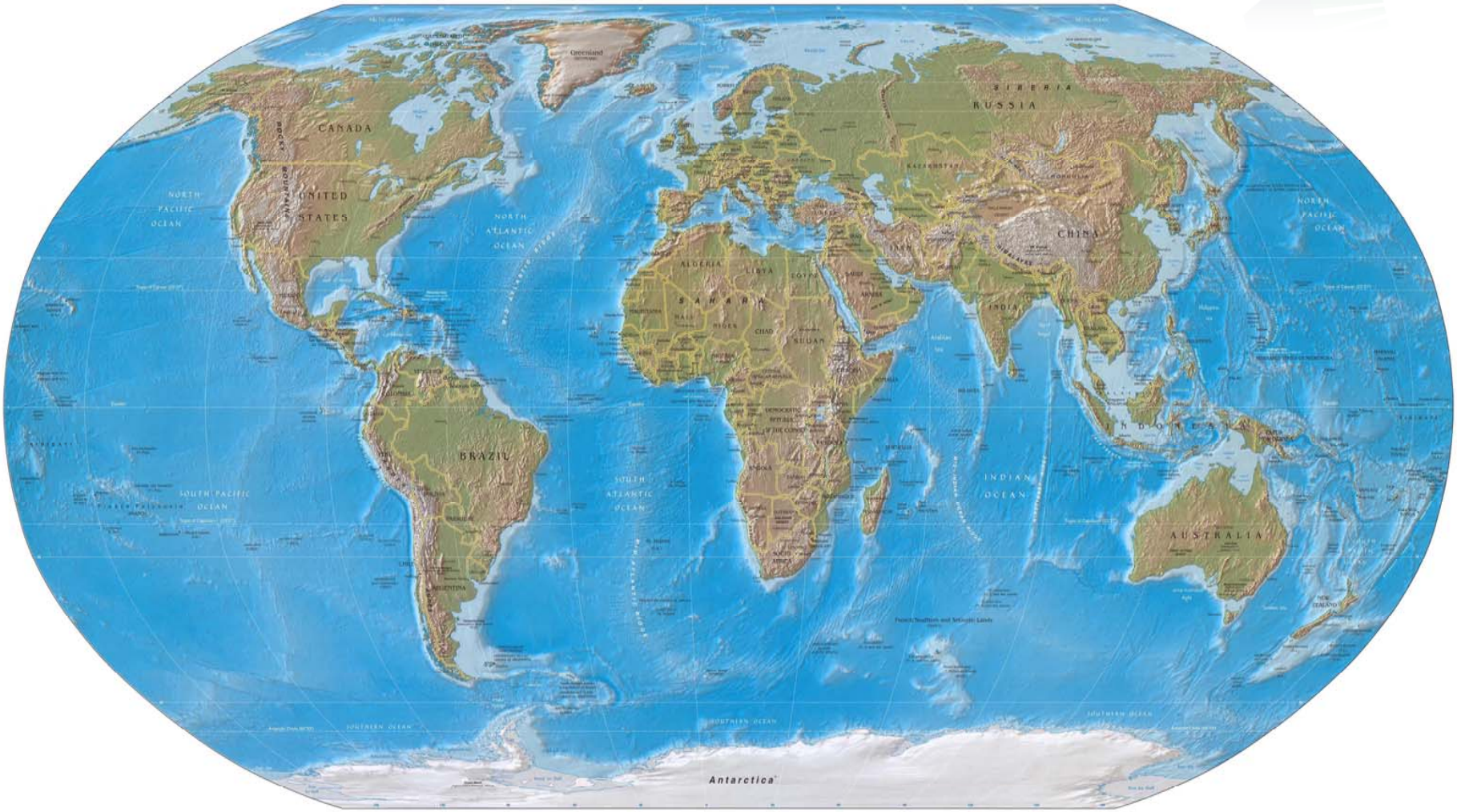
WeatherEze

Key Features

- Offers more realism than more conventional static or ramping environmental control profiles
- Quickly and easily configures to any Percival Environmental Chamber equipped with communications
- Easy to use for beginners, highly configurable for advanced use
- Once a control mode is started, the software will control a chamber without requiring any further user intervention
- All values from both control modes are automatically relayed and entered into the Intellus Controller as set points
- Software outputs and chamber status can be checked in real-time on the master status screen
- Automatic data logging of all chamber set points (simulated or real-time) and actual chamber values
- Sunrise & Sunset times can be overlaid on most graphs

WeatherEze

Global Coverage



Pushing Chamber Technology Forward

- Currently provides a level of control that our chambers cannot currently achieve
  - Cannot reproduce the sun inside a chamber
  - Dew points
  - Rapid temperature cycles
  - Daily minimum and maximum values
- We believe a control system should be at least as accurate as the device its controlling
  - Key to maximizing performance and avoiding under-utilization of current environmental chambers
  - Promotes and enhances a natural progression of current product refinement and new product development
- A plant growth chamber capable of reproducing actual weather conditions is now ultimately within reach
- WeatherEze software and Intellus Ultra with communicaionts has the potential to revolutionize plant growth research

Future Software Enhancements

- Lighting Control
  - Revised functionality
  - Additional modes of control
  - Increased library of bulb spectra
- Plant Growing Guidelines
  - Quick reference
  - Chamber configuration & optimization
- Precipitation values and automatic watering