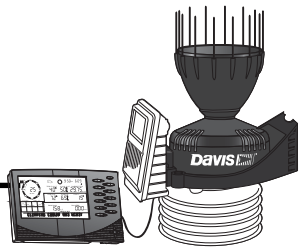
Cabled Vantage Pro2™ & Vantage Pro2 Plus™ Stations



6152C
6162C

Vantage Pro2™

Vantage Pro2™ cabled weather stations include two components: the sensor suite and the console. The sensor suite contains the sensor interface, rain collector, anemometer, temperature and humidity sensors in a passive or aspirated radiation shield. The Vantage Pro2 Plus (6162C) includes two additional sensors that are optional on the Vantage Pro2 and purchased separately: the UV Sensor and the Solar Radiation Sensor.The 6152C and 6162C models rely on passive shielding to reduce solar-radiation induced temperature errors in the outside temperature sensor readings. Cabled GroWeather stations include a solar radiation sensor and either a passive radiation shield (6820C), a Daytime Fan Aspirated Radiation Shield (6334C) or a 24-Hour Fan-Aspirated Radiation Shield (6825C).

The Vantage Pro2 console contains the barometer, inside temperature and humidity sensors and provides the user interface, data display, and calculations. The console and sensor suite are powered by an AC-power adapter connected to the console. Batteries can be installed in the console to provide a backup power supply.

Use with an EnviroMonitor Gateway or WeatherLink® data loggers to let your weather station interface with a computer, log data, and upload weather information to the Internet.

Sensor Suite

Operating Temperature	-40° to +150°F (-40° to +65°C)
Non-operating Temperature	-40° to +158°F (-40° to +70°C)
Current Draw	5 mA (average) at 4 to 6 VDC for ISS only. 10 mA average for both console and ISS
Connectors, Sensor	Modular RJ-11
Cable Type	4-conductor, 26 AWG
Cable Length, Anemometer	40’ (12 m) (included); 240’ (73 m) (maximum recommended)

Note: Maximum displayable wind decreases as the length of cable increases. at 140’ (42 m) of cable, the maximum wind speed displayed is 135 mph (60 m/s); at 240’ (73 m), the maximum wind speed displayed is 100 mph (34 m/s).

Wind Speed Sensor	Solid state magnetic sensor
Wind Direction Sensor	Wind vane with potentiometer
Rain Collector Type	Tipping spoon, 0.01" or 0.2 mm per tip, 33.2 in^2 (214 cm^2) collection area
Temperature Sensor Type	PN Junction Silicon Diode
Relative Humidity Sensor Type	Film capacitor element
Housing Material	UV-resistant ABS, polypropylene
Sensor Inputs	
RF Filtering	RC low-pass filter on each signal line

Sensor suite dimensions(not including anemometer or bird spikes):

Vantage Pro2 with Standard Rad Shield	14.0" x 9.4" x 14.5" (356 mm x 239 mm x 368 mm)
Vantage Pro2 with Fan-Asprated Rad Shield	20.8" x 9.4" x 16.0" (528 mm x 239 mm x 406 mm)
Vantage Pro2 Plus with Standard Rad Shield	14.3" x 9.7" x 14.5" (363 mm x 246 mm x 368 mm)
Vantage Pro2 Plus with Fan-Aspirated Rad Shield	21.1" x 9.7" x 16.0" (536 mm x 246 mm x 406 mm)

Console

Console Operating Temperature	+32° to +140°F (0° to +60°C)
Non-Operating (Storage) Temperature	+14° to +158°F (-10° to +70°C)
Current Draw	5 mA average for console only, 10 mA average for both console and ISS
AC Power Adapter	5 VDC, 300 mA, regulated
Battery Backup	3 C-cells
Battery Life (no AC power)	1 month (approximately)
Connectors	Modular RJ-11
Cable Type	4-conductor, 26 AWG
Cable Length, Console	100’ (30 m) (included); 1000’ (300 m) (maximum recommended)
Housing Material	UV-resistant ABS plastic
Console Display Type	LCD Transflective
Display Backlight	LEDs
Dimensions (console: length x width x height, display length x height)	
Console	9.63" x 6.125" x 1.625" (245 mm x 156 mm x 41 mm)
Display	5.94" x 3.375" (151 mm x 86 mm)
Weight (with batteries)	1.88 lbs. (.85 kg)

Data Displayed on Console

Data display categories are listed with General first, then in alphabetical order.

General

Historical Graph Data	Includes the past 24 values listed unless otherwise noted; all can be cleared and all totals reset
Daily Data	Includes the earliest time of occurrence of highs and lows; period begins/ends at 12:00 am
Monthly Data	Period begins/ends at 12:00 am on the first of the month
Yearly Data	Period begins/ends at 12:00 am on the first of January unless otherwise noted
Current Display Data	Current display data describes the current reading for each weather variable. In most cases, the variable lists the most recently updated reading or calculation. Some current variable displays can be adjusted so there is an offset for the reading.
Current Graph Data	Current data appears in the right most column in the console graph and represents the latest value within the last period on the graph; totals can be set or reset. Display intervals vary. Examples include: Instant, 15-min., and Hourly Reading; Daily, Monthly, High and Low
Graph Time Interval	1 min., 10 min., 15 min., 1 hour, 1 day, 1 month, 1 year (user-selectable, availability depends upon variable selected)
Graph Time Span	24 Intervals + Current Interval (see Graph Intervals to determine time span)
Graph Variable Span (Vertical Scale)	Automatic (varies depending upon data range); Maximum and Minimum value in range appear in ticker
Alarm Indication	Alarms sound for only 2 minutes (time alarm is always 1 minute) if operating on battery power. Alarm message is displayed in ticker as long as threshold is met or exceeded. Alarms can be silenced (but not cleared) by pressing the DONE key.
Update Interval	Varies with sensor - see individual sensor specifications

Barometric Pressure

Resolution and Units	0.01" Hg, 0.1 mm Hg, 0.1 hPa/mb (user-selectable)
Range	16.00" to 32.50" Hg, 410 to 820 mm Hg, 540 to 1100 hPa/mb
Elevation Range	-999' to +15,000' (-600 m to 4570 m) (Note that console screen limits entry of lower elevation to -999' when using feet as elevation unit.)
Uncorrected Reading Accuracy	±0.03" Hg (±0.8 mm Hg, ±1.0 hPa/mb) (at room temperature)
Sea-Level Reduction Equation Used	United States Method employed prior to use of current "R Factor" method
Equation Source	Smithsonian Meteorological Tables
Equation Accuracy	±0.01" Hg (±0.3 mm Hg, ±0.3 hPa/mb)
Elevation Accuracy Required	±10' (3m) to meet equation accuracy specification
Overall Accuracy	±0.03" Hg (±0.8 mm Hg, ±1.0 hPa/mb)
Trend (change in 3 hours)	Change 0.06" (2 hPa/mb, 1.5 mm Hg) = Rapidly Change 0.02" (.7hPa/mb,.5 mm Hg)= Slowly
Trend Indication	5 position arrow: Rising (rapidly or slowly), Steady, or Falling (rapidly or slowly)
Update Interval	1 minute or when console BAR key is pressed twice
Current Display Data	Instant
Current Graph Data	Instant, 15-min., and Hourly Reading; Daily, Monthly, High and Low
Historical Graph Data	15-min. and Hourly Reading; Daily, Monthly Highs and Lows
Alarms	High Threshold from Current Trend for Storm Clearing (Rising Trend Low Threshold from Current Trend for Storm Warning (Falling Trend)
Range for Rising and Falling Trend Alarms	0.01 to 0.25" Hg (0.1 to 6.4 mm Hg, 0.1 to 8.5 hPa/mb)

Clock

Resolution	1 minute
Units	Time: 12 or 24 hour format (user-selectable)
Date	US or International format (user-selectable)
Accuracy	±8 seconds/month
Adjustments	Time: Automatic Daylight Savings Time (for users in North America and Europe that observe it in AUTO mode, MANUAL setting available for all other areas) Date: Automatic Leap Year
Alarms	Once per day at set time when active

Dewpoint (calculated)

Resolution and Units	1°F or 1°C (user-selectable) °C is converted from °F rounded to nearest 1°C
Range	-105° to +130°F (-76° to +54°C)
Accuracy	±2°F (±1°C) (typical)
Update Interval	10 to 12 seconds
Source	World Meteorological Organization (WMO)
Equation Used	WMO Equation with respect to saturation of moist air over water
Variables Used	Instant Outside Temperature and Instant Outside Relative Humidity
Current Display Data	Instant Calculation
Current Graph Data	Instant Calculation; Daily, Monthly High and Low
Historical Graph Data	Hourly Calculations; Daily, Monthly Highs and Lows
Alarms	High and Low Threshold from Instant Calculation

Evapotranspiration (calculated, requires solar radiation sensor)

Resolution and Units	0.01" or 0.1 mm (user-selectable) °C is converted from °F rounded to nearest 1°C
Range	Daily to 32.67" (832.2 mm); Monthly & Yearly to 199.99" (1999.9 mm)
Accuracy	Greater of 0.01" (0.25 mm) or ±5%, Reference: side-by-side comparison against a CIMIS ET weather station
Update Interval	1 hour
Calculation and Source	Modified Penman Equation as implemented by CIMIS (California Irrigation Management Information System) including Net Radiation calculation
Current Display Data	Latest Hourly Total Calculation
Current Graph Data	Latest Hourly Total Calculation, Daily, Monthly, Yearly Total
Historical Graph Data	Hourly, Daily, Monthly, Yearly Totals
Alarm	High Threshold from Latest Daily Total Calculation

Forecast

Variables Used	Barometric Reading & Trend, Wind Speed & Direction, Rainfall, Temperature, Humidity, Latitude & Longitude, Time of Year
Update Interval	1 hour
Display Format	Icons on top center of display; detailed message in ticker at bottom
Variables Predicted	Sky Condition, Precipitation, Temperature Changes, Wind Direction and Speed

Heat Index (calculated)

Resolution and Units	1°F or 1°C (user-selectable) °C is converted from °F rounded to nearest 1°C
Range	-40° to +165°F (-40° to +74°C)
Accuracy	±2°F (±1°C) (typical)
Update Interval	10 to 12 seconds
Source	United States National Weather Service (NWS)/NOAA
Formulation Used	Steadman (1979) modified by US NWS/NOAA and Davis Instruments to increase range of use
Variables Used	Instant Outside Temperature and Instant Outside Relative Humidity
Current Display Data	Instant Calculation
Current Graph Data	Instant Calculation; Daily, Monthly High
Historical Graph Data	Hourly Calculations; Daily, Monthly Highs
Alarm	High Threshold from Instant Calculation

Humidity

Inside Relative Humidity (sensor located in console)

Resolution and Units	1%
Range	1 to 100% RH
Accuracy	±2%
Update Interval	1 minute
Current Display Data	Instant (user-adjustable offset available)
Current Graph Data	Instant; Hourly Reading; Daily, Monthly High and Low
Historical Graph Data	Hourly Readings; Daily, Monthly Highs and Lows
Alarms	High and Low Threshold from Instant Reading

Outside Relative Humidity (sensor located in ISS)

Resolution and Units	1%
Range	1 to 100% RH
Accuracy	±2%
Drift	<0.25% per year
Update Interval	50 seconds to 1 minute
Current Display Data	Instant (user-adjustable offset available)
Current Graph Data	Instant and Hourly Reading; Daily, Monthly High and Low
Historical Graph Data	Hourly Readings; Daily, Monthly Highs and Lows
Alarms	High and Low Threshold from Instant Reading

Moon Phase

Console Resolution	1/8 (12.5%) of a lunar cycle, 1/4 (25%) of lighted face on console
WeatherLink Resolution	0.09% of a lunar cycle, 0.18% of lighted face maximum (depends on screen resolution)
Range	New Moon, Waxing Crescent, First Quarter, Waxing Gibbous, Full Moon, Waning Gibbous, Last Quarter, Waning Crescent
Accuracy	±38 minutes

Rainfall

Resolution and Units	0.01" or 0.2 mm (user-selectable) (1 mm at totals ≥ 2000 mm)
Daily/Storm Rainfall Range	0 to 99.99" (0 to 999.8 mm)
Monthly/Yearly/Total Rainfall Range	0 to 199.99" (0 to 6553 mm)
Accuracy	For rain rates up to 10"/hr (250 mm/hr): ±3% of total or ± one tip of the spoon (0.01"/0.2mm), whichever is grater.
Update Interval	20 to 24 seconds
Storm Determination Method	0.02" (0.4 mm) begins a storm event, 24 hours without further accumulation ends a storm event
Current Display Data	Totals for Past 15-min
Current Graph Data	Totals for Past 15-min, Past 24-hour, Daily, Monthly, Yearly (start date user-selectable) and Storm (with begin date); Umbrella is displayed when 15-minute total exceeds zero
Historical Graph Data	Totals for 15-min, Daily, Monthly, Yearly (start date user-selectable) and Storm (with begin and end dates)
Alarms	High Threshold from Latest Flash Flood (15-min. total, default is 0.50", 12.7 mm), 24-Hour Total, Storm Total,
Range for Rain Alarms	0 to 99.99" (0 to 999.7 mm)

Rain Rate

Resolution and Units	0.01" or 0.1 mm (user-selectable) (See Figure 1 on page 8)
Range	0, 0.4"/hr (1 mm/hr) 0 to 30"/hr (0 to 762 mm/hr)
Accuracy	±5% for rain rates up to 10"/hr (250 mm/hr)
Update Interval	20 to 24 seconds
Calculation Method	Measures time between successive tips of spoon. Elapsed time greater than 15 minutes or only one tip of the rain collector constitutes a rain rate of zero.
Current Display Data	Instant
Current Graph Data	Instant and 1-min. Reading; Hourly, Daily, Monthly and Yearly High
Historical Graph Data	1-min Reading; Hourly, Daily, Monthly and Yearly Highs
Alarm	High Threshold from Instant Reading

Solar Radiation (requires solar radiation sensor)

Resolution and Units	1 W/m^2
Range	0 to 1800 W/m^2
Accuracy	±5% of full scale (Reference: Eppley PSP at 1000 W/m^2)
Drift	up to ±2% per year
Cosine Response	±3% for angle of incidence from 0° to 75°
Temperature Coefficient	-0.067% per °F (-0.12% per °C); reference temperature = 77°F (25 °C)
Update Interval	50 seconds to 1 minute (5 minutes when dark)
Current Graph Data	Instant Reading and Hourly Average; Daily, Monthly High
Historical Graph Data	Hourly Average, Daily, Monthly Highs
Alarm	High Threshold from Instant Reading

Sunrise and Sunset

Resolution	1 minute
Accuracy	±1 minute
Reference	United States Naval Observatory

Temperature

Inside Temperature (sensor located in console)

Resolution and Units	Current Data: 0.1°F or 1°F or 0.1°C or 1°C (user-selectable) °C is converted from °F rounded to nearest 1°C Historical Data and Alarms: 1°F or 1°C (user-selectable)
Range	+32° to +140°F (0° to +60°C)
Sensor Accuracy	±0.5°F (±0.3°C) (typical)
Update Interval	1 minute
Current Display Data	Instant (user-adjustable offset available)
Current Graph Data	Instant Reading; Daily and Monthly High and Low
Historical Graph Data	Hourly Readings; Daily and Monthly Highs and Lows
Alarms	High and Low Thresholds from Instant Reading

Outside Temperature (sensor located in ISS)

Resolution and Units	Current Data: 0.1°F or 1°F or 0.1°C or 1°C (user-selectable) nominal °C is converted from °F rounded to nearest 1°C Historical Data and Alarms: 1°F or 1°C (user-selectable)
Range	-40° to +150°F (-40° to +65°C)
Sensor Accuracy	±0.5°F (±0.3°C) (typical)
Radiation Induced Error (Passive Shield)	+4°F (2°C) at solar noon (insolation = 1040 W/m^2, avg. wind speed ≤ 2 mph (1 m/s)) (reference: RM Young Model 43408 Fan-Aspirated Radiation Shield)
Update Interval	10 to 12 seconds
Current Display Data	Instant (user-adjustable offset available)
Current Graph Data	Instant; Daily, Monthly, Yearly High and Low
Historical Graph Data	Hourly Readings; Daily, Monthly, Yearly Highs and Lows
Alarms	High and Low Thresholds from Instant Reading

Temperature Humidity Sun Wind Index (requires solar radiation sensor)

Resolution and Units	1°F or 1°C (user-selectable) °C is converted from °F rounded to nearest 1°C
Range	-90° to +165°F (-68° to +74°C)
Accuracy	±4°F (±2°C) (typical)
Update Interval	10 to 12 seconds
Sources and Formulation Used	United States National Weather Service (NWS)/NOAA Steadman (1979) modified by US NWS/NOAA and Davis Instruments to increase range of use and allow for cold weather use
Variables Used	Instant Outside Temperature, Instant Outside Relative Humidity, 10-minute Average Wind Speed, 10-minute Average Solar Radiation
Formulation Description	Uses Heat Index as base temperature, affects of wind and solar radiation are either added or subtracted from this base to give an overall effective temperature
Current Graph Data	Instant and Hourly Calculation; Daily, Monthly High
Historical Graph Data	Hourly Calculation; Daily, Monthly Highs
Alarm	High Threshold from Instant Reading

Ultra Violet (UV) Radiation Dose (requires UV sensor)

Resolution and Units	0.1 MEDs to 19.9 MEDs; 1 MED above 19.9 MEDS
Range	0 to 199 MEDs
Accuracy	±5% of daily total
Drift	up to ±2% per year
Update Interval	50 seconds to 1 minute (5 minutes when dark)
Current Graph Data	Latest Daily Total (user resetable at any time from Current Screen)
Historical Graph Data	Hourly, Daily Totals (user reset from Current Screen does not affect these values)
Alarm	High Threshold from Daily Total
Alarm Range	0 to 19.9 MEDs

Ultra Violet (UV) Radiation Index (requires UV sensor)

Resolution and Units	0.1 Index
Range	0 to 16 Index
Accuracy	±5% of full scale (Reference: Yankee UVB-1 at UV index 10 (Extremely High))
Cosine Response	±4% FS (0° to 90° zenith angle)
Update Interval	50 seconds to 1 minute (5 minutes when dark)
Current Graph Data	Instant Reading and Hourly Average; Daily, Monthly High
Historical Graph Data	Hourly Average, Daily, Monthly Highs
Alarm	High Threshold from Instant Calculation

Wind

Wind Chill (Calculated)

Resolution and Units	1°F or 1°C (user-selectable); °C is converted from °F and rounded to the nearest 1°C
Range	-110° to +135°F (-79° to +57°C)
Accuracy	±2°F (±1°C) (typical)
Update Interval	10 to 12 seconds
Source	United States National Weather Service (NWS)/NOAA
Equation Used	Osczevski (1995) (adopted by US NWS in 2001)
Variables Used	Instant Outside Temperature and 10-min. Avg. Wind Speed
Current Display Data	Instant Calculation
Current Graph Data	Instant Calculation; Hourly, Daily and Monthly Low
Historical Graph Data	Hourly, Daily and Monthly Lows
Alarm	Low Threshold from Instant Calculation

Wind Direction

Range	1 - 360°
Display Resolution	16 points (22.5°) on compass rose, 1° in numeric display
Accuracy	±3°
Update Interval	2.5 to 3 seconds
Current Graph Data	Instant Reading (user adjustable); 10-min. Dominant; Hourly, Daily, Monthly Dominant
Historical Graph Data	Past 6 10-min. Dominants on compass rose only; Hourly, Daily, Monthly Dominants

Wind Speed

Resolution and Units	1 mph, 1 km/h, 0.4 m/s, or 1 knot (user-selectable) Measured in mph; other units are converted from mph and rounded to nearest 1 km/hr, 0.1 m/s, or 1 knot.
Range	0 to 200 mph, 0 to 173 knots, 0 to 89 m/s, 0 to 322 km/h
Update Interval	Instant Reading: 2.5 to 3 seconds, 10-minute Average: 1 minute
Accuracy	±2 mph (2 kts, 3.2 km/h, 0.9 m/s) or ±5%, whichever is greater
Maximum Cable Length	540’ (165 m) (Note that maximum wind speed reading decreases as length of cable from anemometer to ISS increases.)
Current Display Data	Instant
Current Graph Data	Instant Reading; 10-minute and Hourly Average; Hourly High; Daily, Monthly and Yearly High with Direction of High
Historical Graph Data	10-min. and Hourly Averages; Hourly Highs; Daily, Monthly and Yearly Highs with Direction of Highs
Alarms	High Thresholds from Instant Reading and 10-minute Average

Sensor Charts

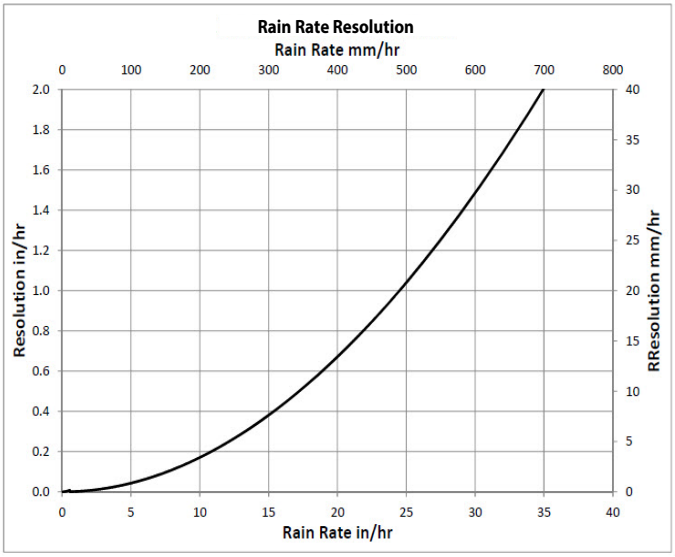


Figure 1: Rain Rate Resolution

Package Dimensions

Product #	Package Dimensions (Length x Width x Height)	Package Weight	UPC Codes
6152C 6152CEU 6152CUK	17.50" x 10.4" x 16.0" (445 mm x 264 mm x 406 mm)	12 lbs. 15 oz. (5.9 kg)	011698 00755 4 011698 00772 1 011698 00773 8
6162C 6162CEU 6162CUK		13 lbs. 4 oz. (6.0 kg)	011698 00756 1 011698 00774 5 011698 00775 2
6322C 6322CM	17.50" x 10.4" x 16.0" (445 mm x 264 mm x 406 mm)	9 lbs.. 1 oz. (4.1 kg)	011698 00777 6 011698 01048 6
6327C 6327CM		11 lbs. 2 oz. (5.0 kg)	011698 00782 0 011698 01049 3

INTERPRETING UV READINGS

Application Note **6**

Vantage Pro2, Vantage VUE, Vantage Pro, and Health EnviroMonitor Systems

Introduction

Ultraviolet (UV) radiation can cause health damage in many ways:

- to the skin: burning, premature aging, and possible skin cancer
- to the eyes: possible cataracts and other disorders
- to the body's immune system.

This Note discusses the interpretation of the Vantage Pro2™, Vantage VUE®, and Health EnviroMonitor® systems' UV readings in terms of possible skin damage. One should, however, be aware of the other hazards and minimize exposure to UV.

> NOTE: The Health EnviroMonitor was discontinued at the end of 2002 and is no longer available.

The UV Spectrum

UV radiation is divided into three spectral regions: UVA, wavelengths of 400 to 320 nanometers (nm); UVB, 320 to 280 nm; and UVC, 280 to 100 nm.

The earth's atmosphere absorbs wavelengths shorter than 290 nm (UVC). UVB rays pose the greatest risk of skin cancer. Some UVA radiation is needed by the human body for the synthesis of vitamin D, but excessive amounts cause aging, wrinkling, and loss of elasticity of the skin, and they contribute to skin cancer and cataracts.

The Erythemal Action Spectrum (EAS) was defined by McKinlay and Diffey (1987) and has been accepted by the Commission Internationale de l'Eclairage (CIE) as the standard representation of the average skin response to UVB and UVA. As shown by the EAS (heavy straight lines) plot in Figure 1, the skin is 100 times more sensitive to radiation at 298 nm than to radiation at 319 nm. The plot with round data points shows the spectral response of a Davis model 7841/7843 UV Sensor. The other curve gives the response of a Yankee Environmental Systems model UVB-1 Ultraviolet Pyranometer.

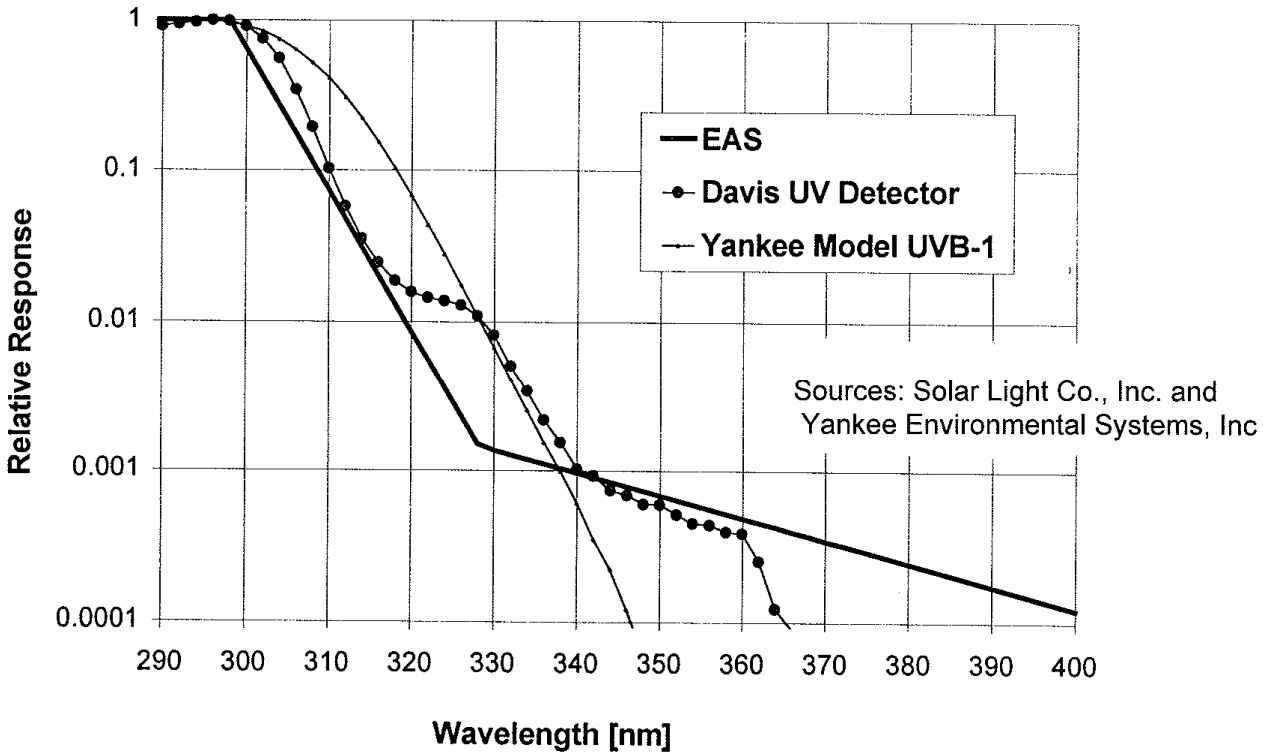


Figure 1. Erythemal Action Spectrum and the UV Sensors' Spectral Responses.

UV Measurements

The Vantage Pro2 and Health EnviroMonitor systems display two types of UV measurement: Intensity, the strength of UV radiation at the moment of measurement, and Dose, the total UV energy measured over a period of time. The Vantage VUE only displays the UV intensity.

Intensity

The UV intensity at a given instant is usually defined in one of three ways:

- The scientific measure of UV irradiance is usually given in units of watts per square meter
- The UV Index has been defined to give a more easily remembered set of units, ranging from 1 to 15
- The intensity may also be defined as a Dose-rate, MEDs per hour

The Vantage Pro2 and Vantage VUE calculate and display the Index. The Health EnviroMonitor calculates and displays the Index and Dose-rate.

It should be noted that when the UV sensor is not aligned with the direct solar irradiance, measurements may understate the UV intensity at surfaces normal to the sun's rays. In other words, if the sensor is aligned with the sun at solar noon, at times other than solar noon, the readings may be less than the actual intensity on the portions of an individual's body that are normal to the sun's rays.

UV Index. The Index was first defined by Environment Canada and has since been adopted by the World Meteorological Organization. In the U.S. the Environmental Protection Agency (EPA) has categorized the Index values as follows:

- 0 to 2, Minimal
- 3 to 4, Low
- 5 to 6, Moderate
- 7 to 9, High
- 10 and higher, Very High

The Index is equal to the EAS-weighted irradiance (in watts/m²) x 40. An Index of 10 is equivalent to an EAS-weighted irradiance of 0.25 W/m². The relationship between Index value and estimated time for sunburn is discussed below.

The Index value published by the U.S. National Weather Service is a forecast of the next day's noontime UV intensity (see Long, et al). The Index value displayed by the Vantage Pro2, Vantage VUE and Health EnviroMonitor is the result of a real-time measurement.

Dose-rate. The Dose-rate is expressed in MEDs per hour, where a MED is the Minimum Erythemal Dose, the amount of sun exposure which causes barely perceptible skin sunburn redness (erythema). The MED and its scale factor are discussed below under DOSE.

For a MED scale factor of 1.0 (the base, or default, value) a Dose-rate of 4.3 MEDs per hour is equivalent to an Index of 10. Stated another way, the base MED rate is 3/7 of the Index value.

Dose

As mentioned above, the MED, or Minimum Erythemal Dose, is the integral, or summation, of UV intensity over a period of time; it is the amount of EAS-weighted energy which causes barely perceptible redness to appear within 24 hours in previously unexposed skin. The Vantage Pro2 and Health EnviroMonitor calculate the dose by performing a real-time integration of EAS-weighted intensity.

The base MED is equal to 21 mJ/cm² of EAS-weighted UV energy.

It's obvious that not all skin types have the same sensitivity to sunlight. The following sections discuss the interpretation of dose information for various skin types.

Skin Types

The EPA has defined four skin phototypes to help individuals interpret UV data for their own sensitivities; these definitions are shown in Table 1a. Within each skin type a range of sensitivities will be found; some people will experience sunburn more quickly than others of the same phototype. Environment Canada has defined six skin types, as defined in Table 1b.

Skin Phototype		Skin Color In Unexposed Area	Tanning History
1	Never Tans, Always Burns	Pale or milky white; alabaster	Develops red sunburn; painful swelling; skin peels
2	Sometimes Tans, Usually Burns	Very light brown; sometimes freckles	Usually burns; pinkish or red coloring appears; can gradually develop light brown tan.
3	Usually Tans, Sometimes Burns	Light tan, brown, or olive; distinctly pigmented	Rarely burns; shows moderately rapid tanning response.
4	Always Tans, Rarely Burns	Brown, dark brown, or black	Rarely burns; shows very rapid tanning response.

Table 1a. Description of Four Skin Phototypes (Source: EPA -017)

Skin Type	Characteristics	Tanning History
I	Blond hair, blue or green eyes, very light skin.	Always burns easily, never tans
II	Light to medium hair, eyes, and skin.	Always burns easily, tans minimally.
III	Medium hair, dark eyes, medium skin.	Burns moderately, tans gradually.
IV	Dark hair and eyes, light brown skin.	Burns minimally, always tans well.
V	Dark hair and eyes, very dark skin.	Rarely burns, tans profusely.
VI	Dark hair and eyes, very dark skin.	Never burns, deeply pigmented.

Table 1b. Description of Six Skin Types

Dose to Burn

Figure 2 attempts to show the UV dose that will cause sunburning of various skin types. The four EPA skin phototype ranges are shown on the left vertical axis; the six Environment Canada types are on the right axis. The data points and curve at the left edge of the shaded region are values suggested by Environment Canada as the doses at which the most sensitive people of each skin type will begin to burn. The horizontal bars are the ranges suggested by the EPA as the ranges of sensitivity for each of their four skin phototypes. UV Dose is shown in two sets of units: base MEDs and milliJoules per square centimeter.

In summary: at the UV dose represented by the left edge of the shaded region some individuals of that skin phototype will experience sunburn; at the right-edge dosage everyone of that type will be burned. The “Minutes to Burn” calculation of the WeatherLink® and Health EnviroMonitor Link software gives the time to reach minimum sunburn based on the six Environment Canada dose values.

It must be remembered that reflected UV can play a large role in sunburning, and the UV sensor may not be in a position to measure all the reflected radiation to which an individual—one sitting beside a swimming pool, for example—might be exposed. That person, then, could be receiving a larger dose than the weather station's measurement would indicate.

MED Scale Factor. The WeatherLink software and Health EnviroMonitor includes provisions for applying a scale factor to the MEDs readings, enabling the MED value to be adjusted for each skin phototype. This adjustment can be made such that 1 MED will be the approximate minimal-burn dose for the desired skin phototype. Table 2a lists suggested ranges of scale factors for each of the four EPA skin phototypes. Table 2b lists suggested ranges for the Environment Canada skin types.

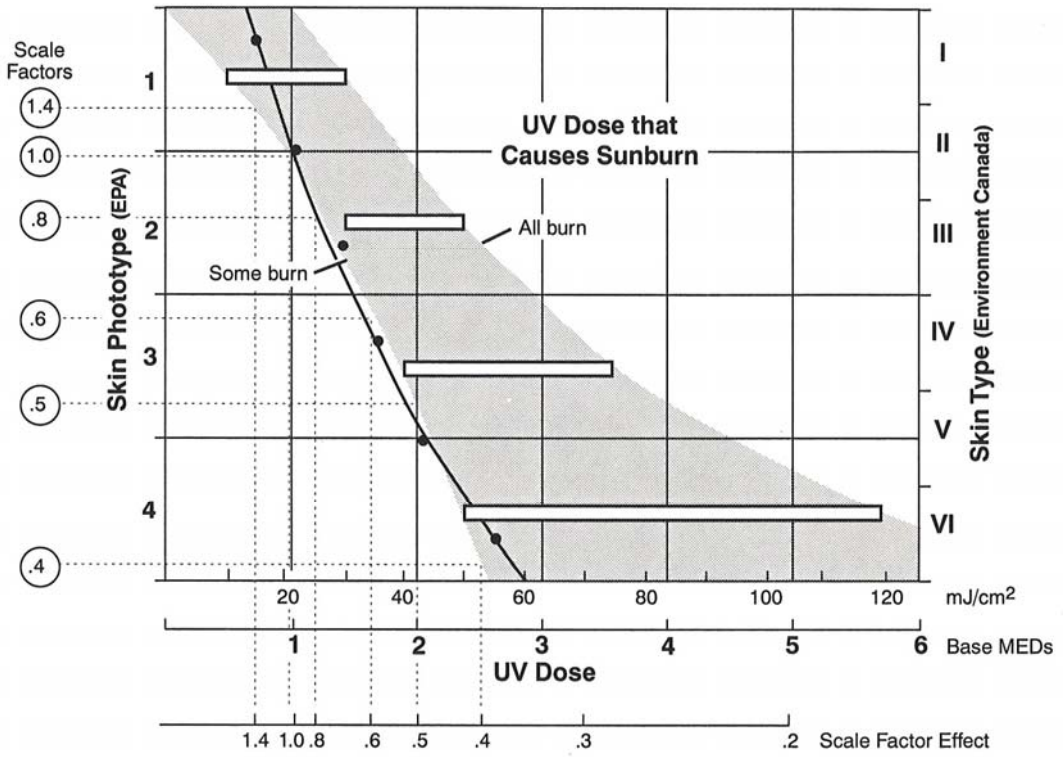


Figure 2. UV Dose That Causes Sunburn (Sources: EPA and Environment Canada)

The scale at the bottom of Figure 2 shows graphically how the MED scale will be altered by the application of the scale factor: when the scale factor is 1.0, a measured dose of 21 mJ/cm2 will cause the display to read 1 MED; when the scale factor is set at 0.5, it takes a measurement of 42 mJ/cm2 to cause the display to read 1 MED. The circled numbers at the left of the figure show where a scaled value of one MED intersects the left edge of the shaded area.

Skin Phototype (EPA)		Scale Factors
1	Never Tans, Always Burns	1.0 to 1.4
2	Sometimes Tans, Usually Burns	0.7 to 1.0
3	Usually Tans, Sometimes Burns	0.5 to 0.7
4	Always Tans, Rarely Burns	0.3 to 0.5

Table 2a. Suggested MED Scale Factor Ranges (four skin types)

Skin Type (Environment Canada)		Scale Factor
I	Always burns easily, never tans	1.4
II	Always burns easily, tans minimally	1.0
III	Burns moderately, tans gradually	0.7
IV	Burns minimally, always tans well	0.6
V	Rarely burns, tans profusely.	0.5
VI	Never burns, deeply pigmented.	0.4

Table 2b. Description of Six Skin Types (Source: Environment Canada)

An individual has two alternative ways to use the data of Figure 2 and the Vantage Pro2, Vantage VUE, WeatherLink software and Health EnviroMonitor system's UV measurements to monitor and anticipate the UV dose that will cause sunburn:

Leave the Scale Factor at 1.0 (or use the Vantage Pro2 or Vantage VUE display value). One can look at Figure 2 and decide on the base MED dose that seems appropriate. A person with Type 1 skin might choose 0.5 MED as the maximum for the day; a person with Type 4 skin might consider 3 MEDs a reasonable dose for the day. This method will probably be the more suitable one when people of different skin types wish to use the data. It also has the benefit of providing better resolution and a wider range for the setting of dose limits. Consult the appropriate weather station's console manual on how to set a UV Dose alarm.

Set a Scale Factor. From either Figure 2 or Table 2 one can choose a scale factor such that a dose of approximately one MED is the appropriate dose. After this is entered, all MEDs dose readings and MEDs/hour dose-rate readings will be scaled accordingly. Note: This can only be done in the WeatherLink software for a Vantage Pro2 or Vantage VUE system.

Time to Burn

To estimate the length of exposure time that will cause sunburn one can divide the Dose to Burn by the current Dose Rate. For example: 0.8 MEDs ÷ 3.2 MEDs/hour = 0.25 hour = 15 minutes. This method is correct for all settings of the MED scale factor. The WeatherLink software will perform this calculation for

the six skin types defined by Environment Canada (Table 1b) in the Sunburn Risk window. Consult the WeatherLink Help file for more details.

The above Time to Burn equation must be used with caution. The Dose Rate can be expected to change during the dose period, so the Time to Burn will change. If, for example, the dose period is begun before solar noon the Dose Rate will probably increase during the period, so the Time to Burn will be shortened.

Similarly, if the initial Dose Rate is observed during a period of cloudiness or overcast, the subsequent Dose Rates and Time to Burn will be quite different if the sky clears.

References

1. Environmental Protection Agency, 1994: Experimental UV Index. EPA 430-F-94-017, -018, and -019.
2. Long, C. S., et al: Ultraviolet Index Forecasts Issued by the National Weather Service. Bulletin of the American Meteorological Society, April 1996.
3. McKinlay, A. F., and B. L. Diffey, 1987: A reference spectrum for ultraviolet-induced erythema in human skin. Human Exposure to Ultraviolet Radiation: Risks and Regulations. W. F. Passchier and B. F. Bosnajakovic, eds., Elsevier, 83-87.

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