



## Met-Ocean Measurements for Wind Energy

Wave Radar, Visibility, Cloud Height, and Structural Monitoring Equipment



Campbell Scientific has a long history of delivering met-ocean measurement solutions used for characterizing atmospheric and ocean conditions. Our meteorological observation solutions also provide critical information used for offshore wind energy resource assess-

ment, plant design, and operational assessment. Ocean atmosphere interactions, structural condition observation, and wind measurement and characterization are common initiatives that use Campbell Scientific Met-Ocean equipment.

## Weather and Climate Monitoring

Met-Ocean equipment designed for marine environments provides operational and research grade accuracy and reliability in any weather and climate scenario. The equipment listed below are easily integrated into any Campbell Scientific datalogger-

based data collection platform (DCP) or meteorological tower. A list of complimentary wind monitoring station is available at:

[www.campbellsci.com/wind-energy](http://www.campbellsci.com/wind-energy)

### SENSORS

		Measurement Description	Accuracy	Operating Temperature
<b>CS475A</b>   Radar Water Level Sensor FCC Approved		Distance for the range of 0.5 to 35 m (1.64 to 114.8 ft)	$\pm 2$ mm ( $\pm 0.0065$ ft)	$-40^{\circ}$ to $80^{\circ}\text{C}$
<b>CS120A</b>   Visibility Sensor High Performance Visibility Measurements		Meteorological observable range (MOR) for fog and snow in the range 10 to 30,000 m.	0 to 10,000 m: $\pm 10\%$ 10,000 to 20,000 m: $\pm 20\%$	$-25^{\circ}$ to $60^{\circ}\text{C}$
<b>CS125</b>   Present Weather Sensor Combines visibility and present weather technology		MOR for fog and snow in the range 10 to 30,000 m and identifies weather type	0 to 10,000 m: $\pm 10\%$ 10,000 to 20,000 m: $\pm 20\%$	$-25^{\circ}$ to $+60^{\circ}\text{C}$
<b>CS135</b>   LIDAR Ceilometer Sensitive, Long Range Cloud Measurement		Cloud height and vertical visibility. Maximum reporting range is 10 km (32,800 ft)	Hard Target Range Accuracy: $\pm 0.25\%$ , $\pm 4.6$ m	$-40^{\circ}$ to $60^{\circ}\text{C}$
<b>CS110</b>   Electric Field Meter Sensor Lifesaving warning before lightning strike		Vertical component of the atmospheric electric field at the earth's surface used to assess the local lightning hazard	Parallel-Plate Configuration: $\pm 1\%$ of reading + $60$ V $\text{m}^{-1}$ offset  2 m Tripod Configuration: $\pm 5\%$ of reading + $8$ V $\text{m}^{-1}$ offset	$-25^{\circ}$ to $50^{\circ}\text{C}$ standard, $-40^{\circ}$ to $+85^{\circ}\text{C}$ extended

More info: 435.227.9120

[campbellsci.com/wind-energy](http://campbellsci.com/wind-energy)



# Structural Health Monitoring

Campbell Scientific data acquisition system's versatile capabilities make them ideal for structural health monitoring.



## VSPECT Spectral Analysis Technology



Our VSPECT spectral analysis technology is ideal for monitoring applications ranging from simple beam fatigue analysis, to structural mechanics research, to continuous monitoring of large, complex structures. Structural measurement equipment can be deployed as a stand-alone system or integrated into any existing Campbell Scientific datalogger based weather observations system.

VSPECT is an innovative patented technology that delivers the most accurate measurement (0.001 Hz resolution) for vibrating wire sensors. VSPECT observes the incoming sensor signal, performs a Fourier transform and a spectral analysis (transforming the Time Series into individual sinusoidal components in the frequency Spectrum), and determines the sensor frequency by identifying the largest signal in the acceptable range and disregarding unwanted noise.

## VSPECT PRODUCTS

	Static VW	Dynamic VW	Channel Count	USB Configuration	Ethernet	Multiplexer Capable	Wireless Communications
<b>CR6</b>   Fully Functional Datalogger with Onboard Vibrating-Wire Measurements 	Yes	with CDM-VW300 Series	12 universal	Yes	Yes	Yes	Wi-Fi and radio options available soon
<b>CRVW3</b>   3-Channel Stand-Alone Vibrating-Wire Datalogger 	Yes	No	3 vibrating wire	Yes	No	No	Radio options
<b>VWAnalyzer</b>   Vibrating-Wire Analyzer 	Yes	No	1 vibrating wire	Yes	No	No	No
<b>CDM-VW300-Series</b>   Dynamic Vibrating-Wire Interface 	Yes	Yes	2 or 8 vibrating-wire (depends on the model)	Yes	No	Other CDMs	No
<b>AVW200-Series</b>   Vibrating-Wire Interface 	Yes	No	2 vibrating-wire	No	No	Yes	Radio options

## Structural and Health Monitoring Sensors



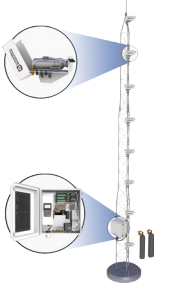
- › Vibrating-wire strain gauges
- › Foil strain gauges
- › Crack and joint sensors
- › Tilt sensors
- › Carlson strain meters
- › Piezoresistive accelerometers
- › Piezoelectric accelerometers
- › Capacitive accelerometers
- › Borehole accelerometer
- › Servo force balance accelerometers

# Surface-Atmosphere Conditions Observation




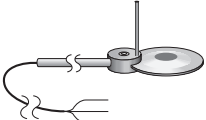
Campbell Scientific eddy-covariance and energy balance solutions observe surface-atmosphere conditions. High precision instrumentation is compact and easy to install on any met-ocean tower or platform. They can be customized with additional sensors or communication peripherals. They use little power and are reliable, requiring little maintenance.

Open and closed path systems for sensible heat flux, momentum flux, and the flux of other scalars between the atmosphere and surface, as well as complete, integrated atmospheric profile systems and core components are listed.

## SYSTEMS

		Measurements	Datalogger	Communication
<b>OPEC</b>   Open-Path Eddy-Covariance System Customizable, Integrated System		CO <sub>2</sub> flux, H <sub>2</sub> O -vapor flux, momentum flux, turbulence intensity, sensible heat flux, 3D wind velocity, sonic temperature, air temperature, barometric pressure	CR3000	CompactFlash cards, remote data collection, including direct (Ethernet, RS-232, shorthaul modem, landline) and wireless (RF, cellular, satellite)
<b>CPEC200</b>   Closed-Path Eddy-Covariance System State of the Art		Long-term monitoring of atmosphere-biosphere exchanges of carbon dioxide, water vapor, heat, and momentum	CR3000	CompactFlash cards, remote data collection, including direct (Ethernet, RS-232, shorthaul modem, landline) and wireless (RF, cellular, satellite)
<b>AP200</b>   CO <sub>2</sub> /H <sub>2</sub> O Atmospheric Profile System Complete, Integrated System with program		Primary: CO <sub>2</sub> concentration at each intake, H <sub>2</sub> O concentration at each intake, system diagnostic word  Secondary: sample flow rate, sample cell pressure, sample cell temperature, other control variables	CR1000	CR1000KD keyboard display, CompactFlash cards, remote data collection, including direct (Ethernet, RS-232, shorthaul modem, landline) and wireless (RF, cellular, satellite)

## CORE COMPONENTS

		Signal Type/Output	Measurement Description	Operating Temperature
<b>CSAT3A</b>   3D Sonic Anemometer, Head Only Used with EC150 and CPEC200		RS-232, analog, SDM	$u_x, u_y, u_z, c$	-50° to 70°C
<b>EC155</b>   CO <sub>2</sub> /H <sub>2</sub> O Closed-Path Gas Analyzer		SDM, RS-485, USB, analog	absolute CO <sub>2</sub> and H <sub>2</sub> O vapor mixing ratio, sample cell temperature and pressure, 3D wind speed and sonic air temperature (requires CSAT3A)	-30° to +50°C
<b>IRGASON</b>   Integrated CO <sub>2</sub> and H <sub>2</sub> O Open-Path Gas Analyzer and 3D Sonic Anemometer		SDM, RS-485, USB, analog	absolute CO <sub>2</sub> and H <sub>2</sub> O vapor mixing ratio, sample cell temperature and pressure, and 3D wind speed and sonic air temperature	-30° to +50°C
<b>NR-LITE2</b>   Net Radiometer PTFE-coated absorbers instead of fragile dome		±25 mV	energy balance between incoming short-wave and long-wave infrared radiation relative to surface-reflected short-wave and outgoing long-wave infrared radiation	-30° to 70°C

# Offshore Wind Resource Assessment and Power

The ZephIR300 is an ideal solution for characterizing offshore wind conditions. It can be used effectively at every stage of project development. Wind measurements are performed down to 10 m, across the entire turbine rotor diameter, and above to 200 m, providing the necessary observations for performing wind shear verification, wind resource assessment, site classification, micro-siting, and wind model verification.

The ZephIR300 is designed for harsh environments, including marine locations. Marine-grade components and a sealed, IP67 rated enclosure to prevent moisture and ingress, make the ZephIR300 ideal for not only pre-planning and development but for permanent operations as the fixed reference.



## LIDAR WIND SENSOR

**ZephIR300** | Remote Sensing Lidar  
Accurate and reliable



<i>Measurements</i>	<i>System Integration</i>	<i>Operating Temperature</i>	<i>Measurement Height Range</i>	<i>Sampling Rate</i>	<i>Accuracy (variation)</i>
horizontal wind speed, vertical wind speed, wind veer, wind shear, turbulence intensity, temperature, relative humidity, barometric pressure, gps location and time	Integrates into any SCADA network and Campbell Scientific datalogger. Same data format options as our datalogger.	-40° to 50°C	10 m to 200 m (10 user configurable heights)	50 Hz	Wind Speed: <0.5% Wind Direction: < 0.5°