Augustyn & Company
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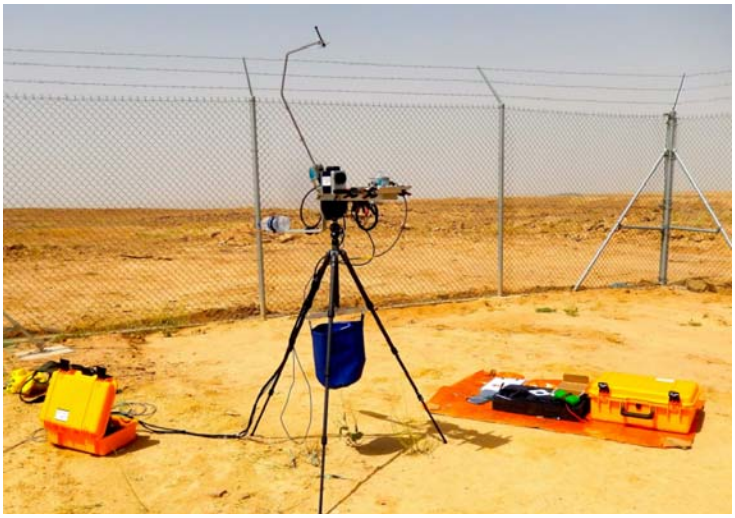
Measuring the Sun since 1983

Field Reference Irradiance Measurement System (FRIMS)

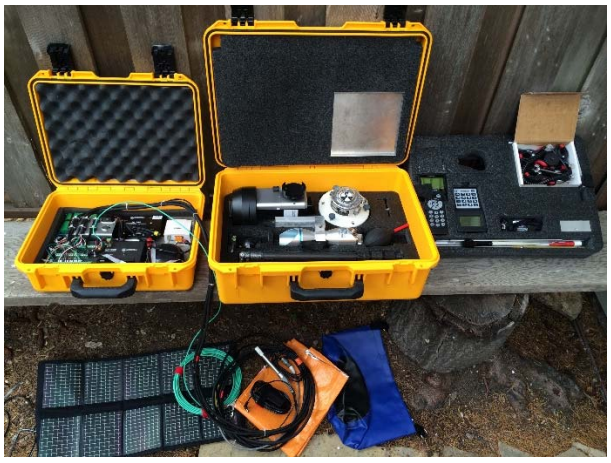
The FRIMS is a light-weight, easily transportable solar radiation measurement system providing the lowest practically attainable field irradiance measurement uncertainties of direct beam and horizontal diffuse for in-situ, field validation and calibration of operating solar measurement stations. It measures the two basic components of broadband solar radiation: direct beam and diffuse on a horizontal surface, from which total horizontal irradiance can be readily and most accurately derived.

The FRIMS was developed in the process of validating and calibrating measurements from over 135 solar measurement stations installed by Augustyn & Company world-wide since 2007. NREL recommended its use to validate the measurement accuracy of the 70+ stations of Saudi Arabia's RRMM solar measurement network developed and operated by King Adbullah City for Atomic and Renewable Energy.

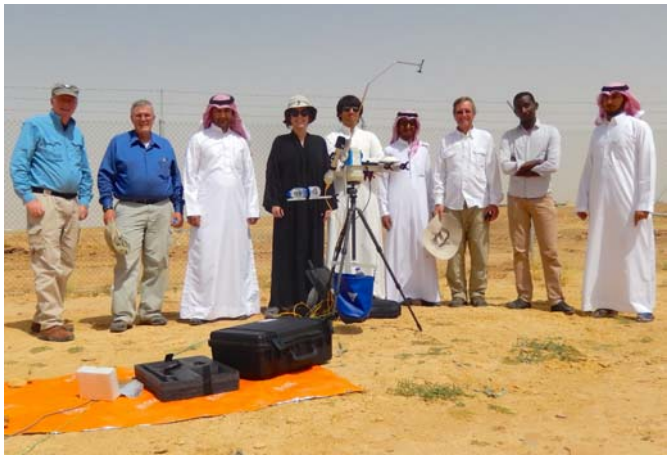
The system comes in two rugged carrying cases weighing under 5.9 and 11.3 kg respectively. The larger case measures 54 x 40 x 22 cm externally, and contains the reference irradiance sensors, mounts and tracking components. The smaller case measures 42 x 32 x 17 cm and contains the pre-programmed measurement and control unit with attached cabling and mounted GPS communication, meteorological sensors and control components. It can be unpacked and placed in operation in less than 30 minutes by a practiced technician.



FRIMS set up for first KA-CARE site validation near Riyadh



Cases w/ layered, custom-formed foam inserts



KACARE, Battelle, and NREL Marveling at FRIMS

The system provides measurements of direct beam irradiance using an ISO first class (secondary standard) pyrheliometer mounted on a compact two axis astronomical tracker with internal GPS along with a disk-shaded horizontally constructed thermopile pyranometer for diffuse measurement. Traceability to WRR is through manufacturer's sensor and data logger calibrations and/or through additional calibrations such as NREL's BORCAL service if available. As with any measurement system of this kind, even with use of the highest quality components available, its end-use accuracy or measurement uncertainty is strongly a function of operator technique and attention to detail during setup and operation of each validation or calibration event.

The Standard FRIMS Configuration includes:

1. Sensors: one secondary standard first class pyrheliometer (EKO MS56, K&Z CHP1/CH1, or Hux DR02/02), one pyranometer for diffuse horizontal measurements (Eppley 8-48 or K&Z CMP-22), one Campbell Scientific HC2S3 or CS215 sensor for air temperature and relative humidity, and one Campbell Scientific CS106 barometric pressure sensor.
2. Mounting apparatus: Consisting of a light weight, high quality carbon-fiber or aluminum tripod, 12V DC powered automatic astronomical tracker and custom assembly of mounting fixtures, fasteners, and machined parts providing the necessary geometric arrangement and adjustment control to accurately align the pryheliometer and continuously shade the (diffuse) pyranometer.
3. A pre-programmed Campbell Scientific CR6 data logger with integrated WiFi and micro SD storage is mounted in a separate padded water proof carrying case. This data logger is pre-wired, requiring plug-in field connection to only the reference irradiance sensors and an earth ground.
4. Power supply consisting of a small 12VDC rechargeable NiMH battery pack capable of running the FRIMS system for up to 14 hours, along with a matching 240/120VAC 50/60Hz wall charger.
5. GPS Receiver to provide accurate automatic data logger clock time synchronization and location coordinates for solar geometry calculations.
6. A panel mounted push button switch and alarm buzzer are provided to initiate and indicate the start and progress of "Inspection and Adjustment" events during which the operator checks and if necessary adjusts the alignment of the sensors. Generation of output records is paused during these events which typically occur every 30 to 60 minutes throughout the test period to make certain the most accurate reference measurements are being made.
7. Built-in wireless access allows connection to the FRIMS data logger during operation using either a Windows PC running Campbell Scientific LoggerNet communication software, or using a mobile device (iOS or Android) running Campbell Scientific's LoggerLink application.

Options:

A. Calibration documentation can be provided for the sensors and data logger at additional charge.
B. A Campbell CR1000KB keyboard display has been found to be a highly useful addition enabling the simplest and most fool-proof direct-connect data logger control without need for additional powered computers or handheld devices or connecting cables or devices.
C. A small foldable PV module can be added to extend the operating time of the standard power supply, or compensate for an incompletely charged battery pack.
D. A CS I/O-to-USB Flash Memory Drive can be included and used to store and quickly retrieve data records generated by the system under test.
E. A limited number of additional Campbell Scientific CR800/1000 compatible sensors may be added.

The FRIMS is intended for use in short term tests and studies, and not designed for long-term unattended operation. It is typically set up and run for a partial or full day of measurements at a site on a day with clear and stable skies. It was designed to provide a reliable validation of the accuracy of measurements of an operating solar measurement system, but can also be used to perform field calibrations of irradiance sensors and integrated measurement systems is required.

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