# The University of Oregon Solar Radiation Monitoring Lab

## Where We've Been and Where We're Going

Josh Peterson
Frank Vignola
Rich Kessler

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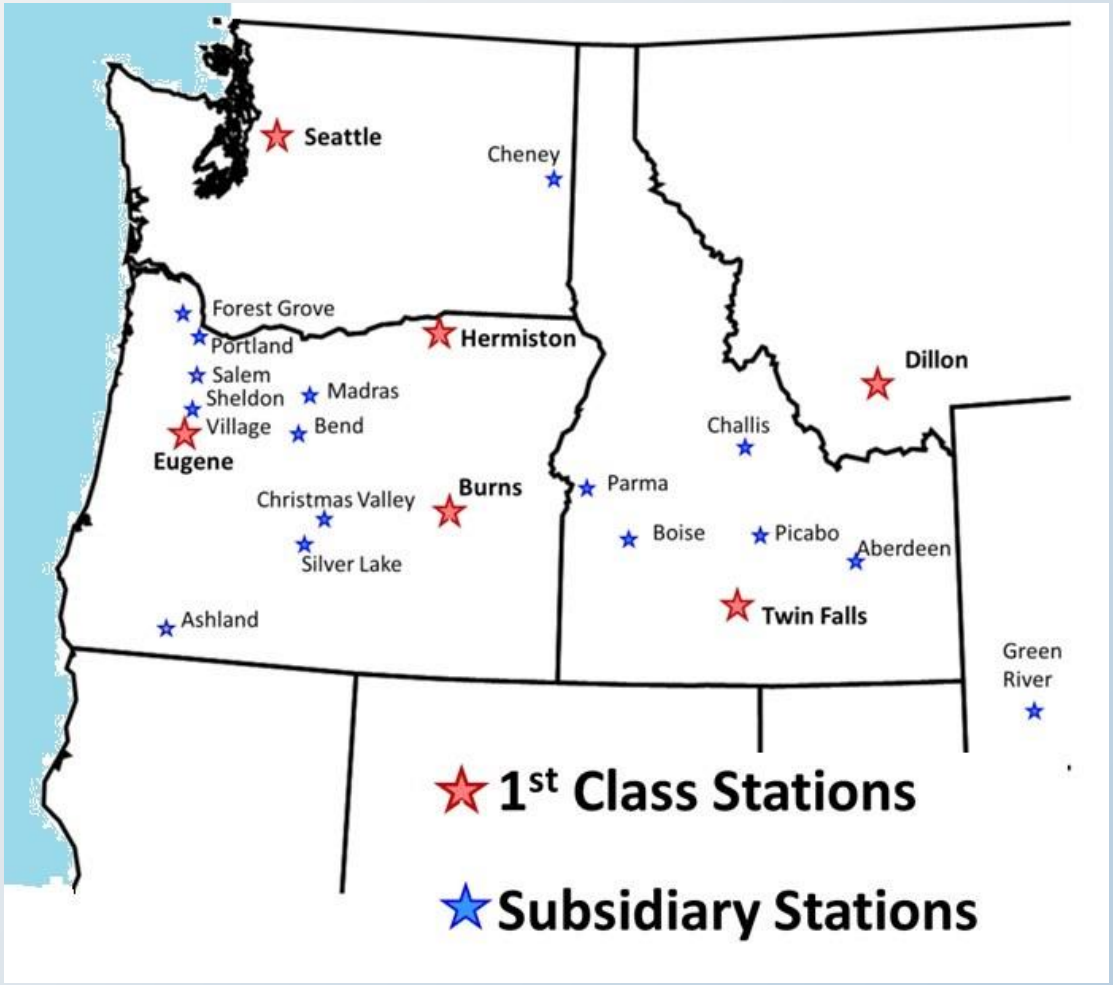
# Outline of talk

- Overview of the SRML
- Description of the Eugene monitoring station
- Available data
- A few studies over the past 40 years
- Current activities and future plans

# Overview of the SRML

The SMRL is the Pacific Northwest's regional solar radiation data center




**Support** for the lab comes from regional utilities with assistance from NREL and other entities.

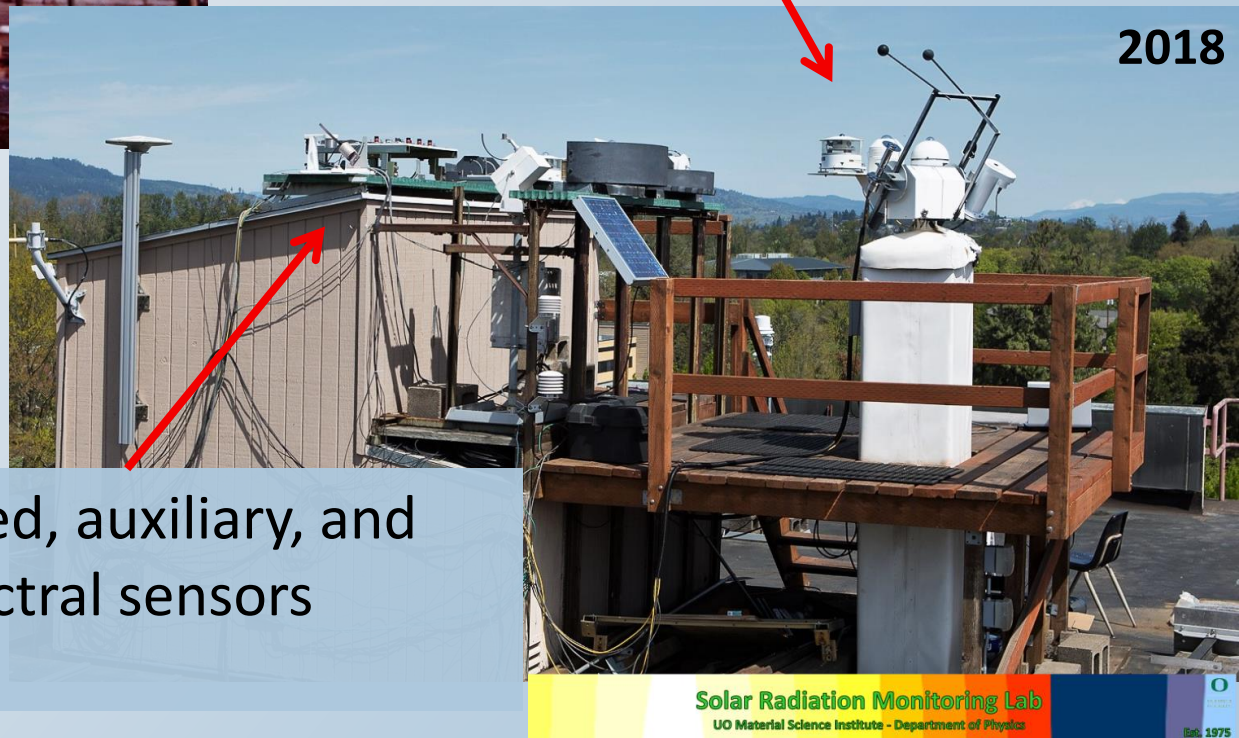
# The Eugene Monitoring Station

- Data collection started at the University of Oregon in Eugene with global horizontal irradiance measurements in 1975. Direct normal irradiance measurements were added in 1977.
- The Eugene station is also our primary research facility used to characterize and evaluate solar monitoring equipment and to calibrate our instruments.

# Eugene monitoring station, then and now


Roughly 10 years after inception

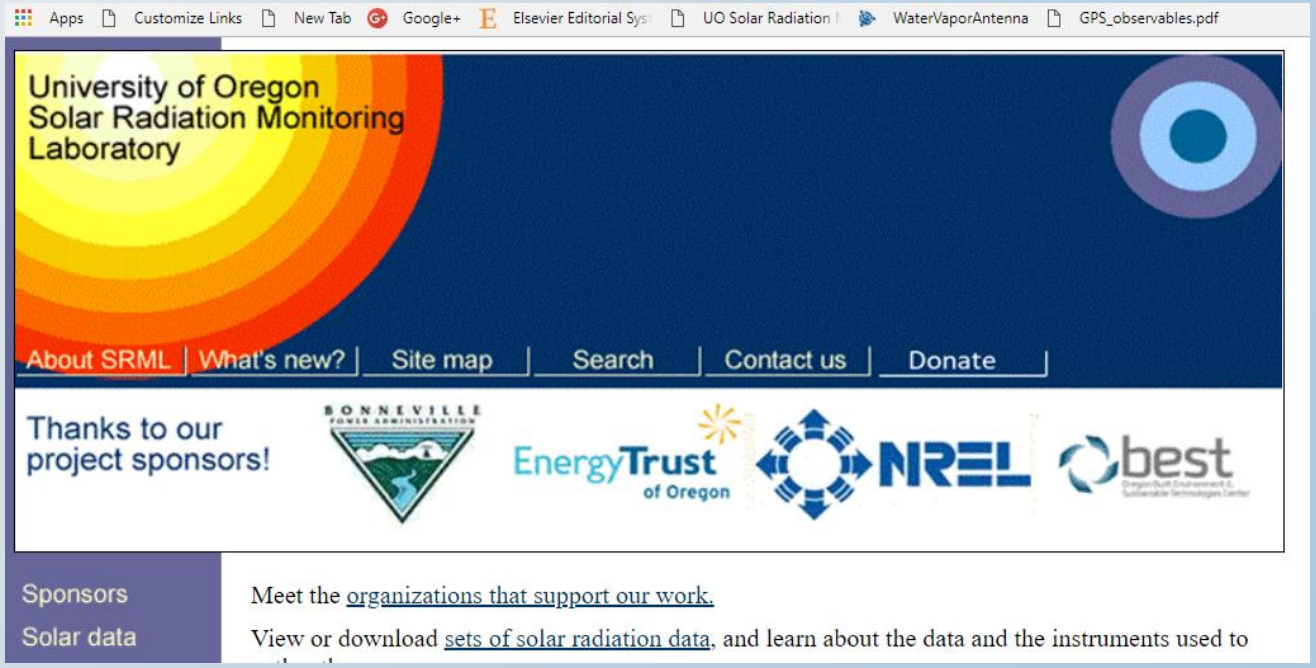
The GHI, DNI, DHI sensors, and pyrgeometer are on the automatic tracker




Tilted, auxiliary, and spectral sensors

# Key features of the SRML website

- Data - Irradiance and Metrological
  - All data is publicly available
  - http://solardata.uoregon.edu
- Stations in the network
- Publications
- Sponsors
- Educational Information



# Available data files

- **Station data files**
  - One-minute to hourly interval data from stations in monthly blocks.

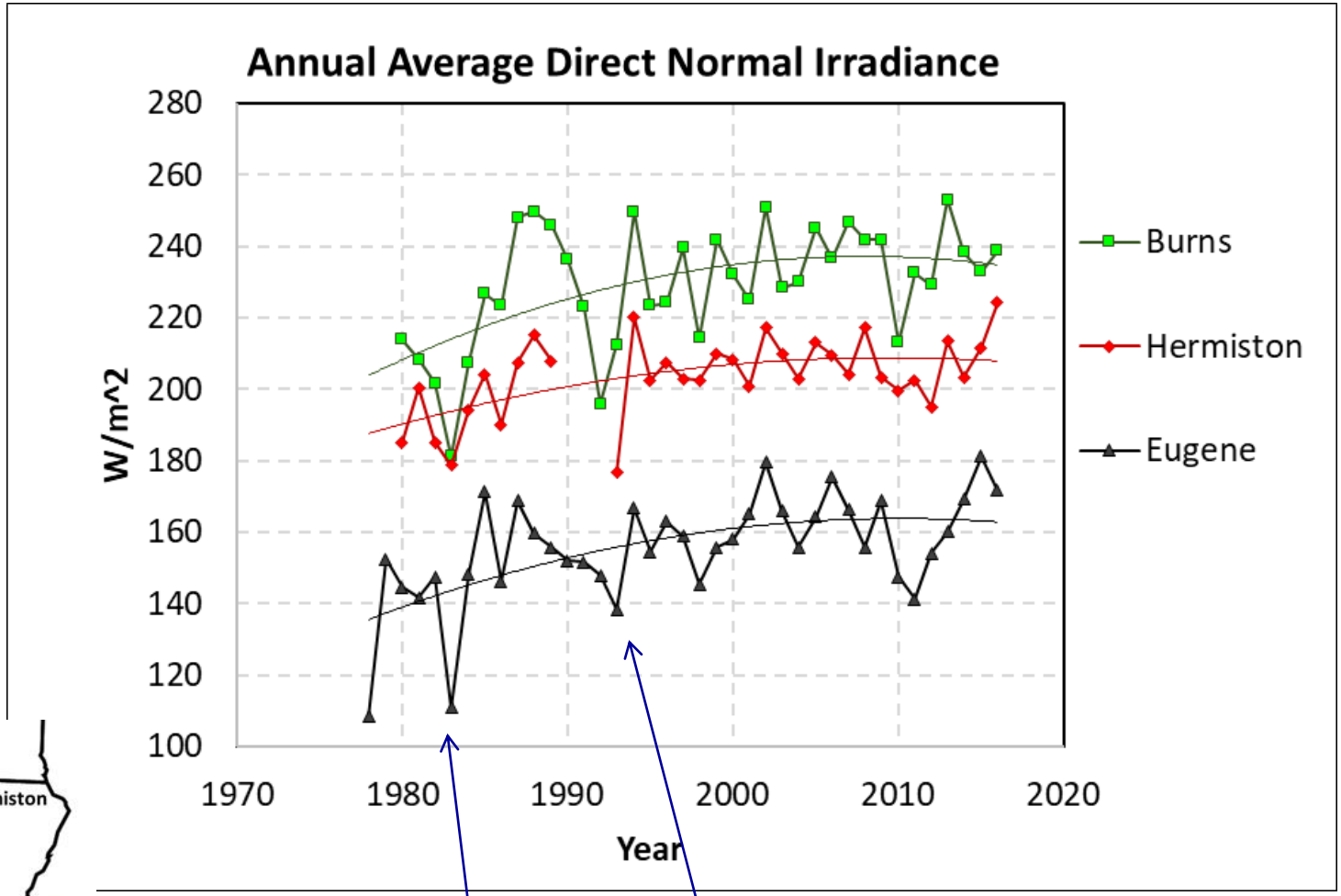
    *http://solardata.uoregon.edu/SelectArchival.html*

- **Spectral data files:** Yankee MFRSR and EKO Spectroradiometer files
  - EKO spectral data comes with corresponding broadband and other metrological information

    *http://solardat.uoregon.edu/SelectMFR.html*

    *http://solardat.uoregon.edu/SelectEKO.html*

# 38 plus years of DNI data





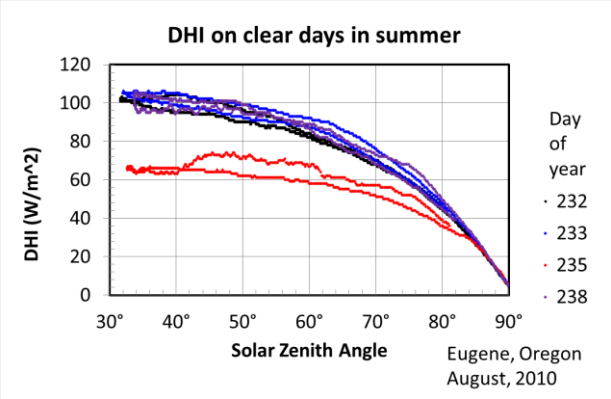
1982 Eruption of
El Chichòn (Mexico)

1991 Eruption of
Mt. Pinatubo (Philippines)

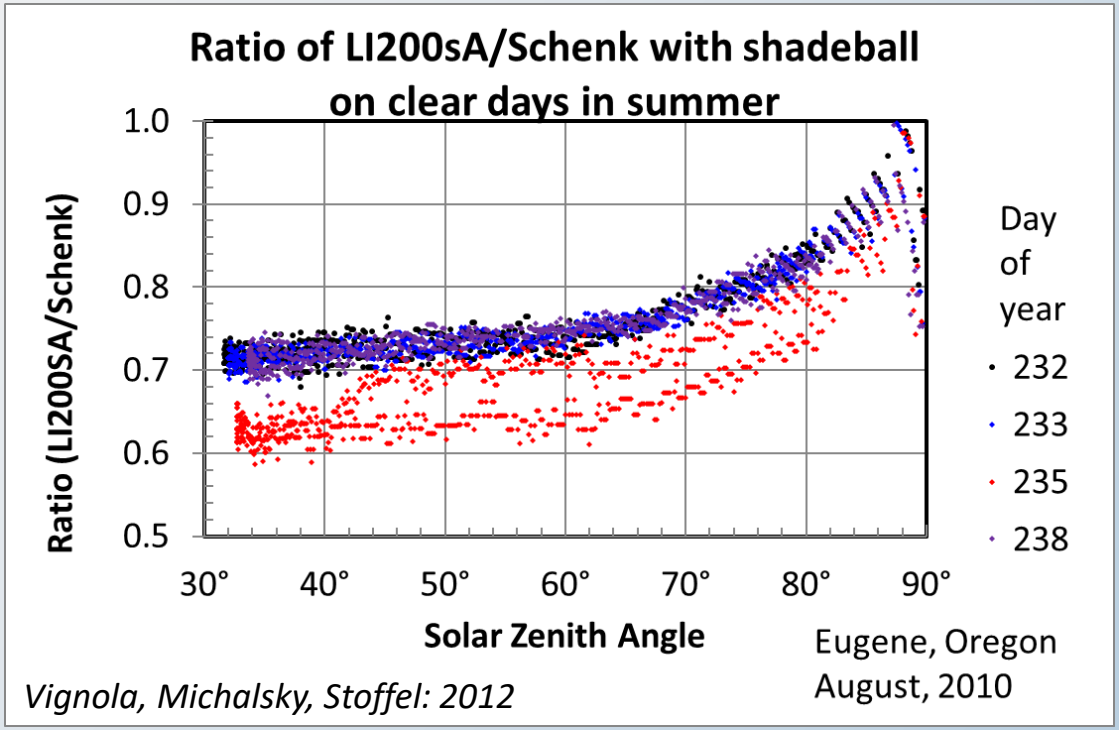
# A few of the SRML studies

1. Spectral biases of a photodiode pyranometers
2. Deviation for lambert cosine response
3. Thermal offset effects

# Spectral biases of a LI-200SA Pyranometer




- Comparison of two DHI sensors
  - **Photodiode**: A LI200SA with a rotating shadowband
  - **Thermopile**: A Schenk Star pyranometer with a shadeball



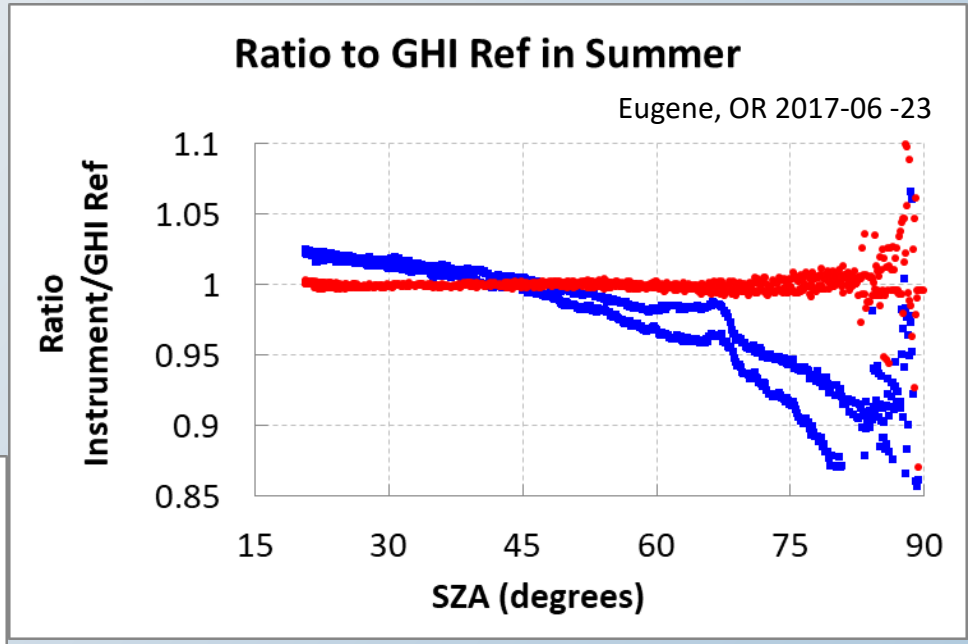

*Vignola, Michalsky, Stoffel: 2012*

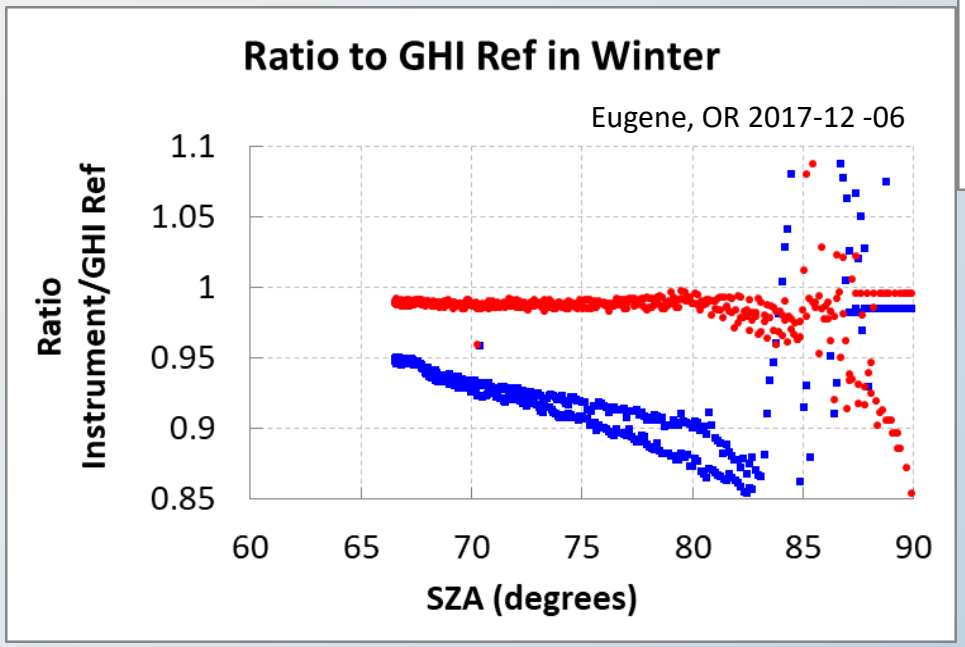
- The LI-200SA responsivity depends on the spectral composition of incident radiation that changes over the day. The DHI dependence is significant for the LI-200SA ~30%.
- The Schenk does not have a spectral dependence

# Cosine response of a first class and secondary standard pyranometer

GHI Ref = DNI * Cos(SZA) + DHI
DNI = CHP1
DHI = Schenk with shadeball

■ PSP / GHI Ref  ● CMP22 / GHI Ref

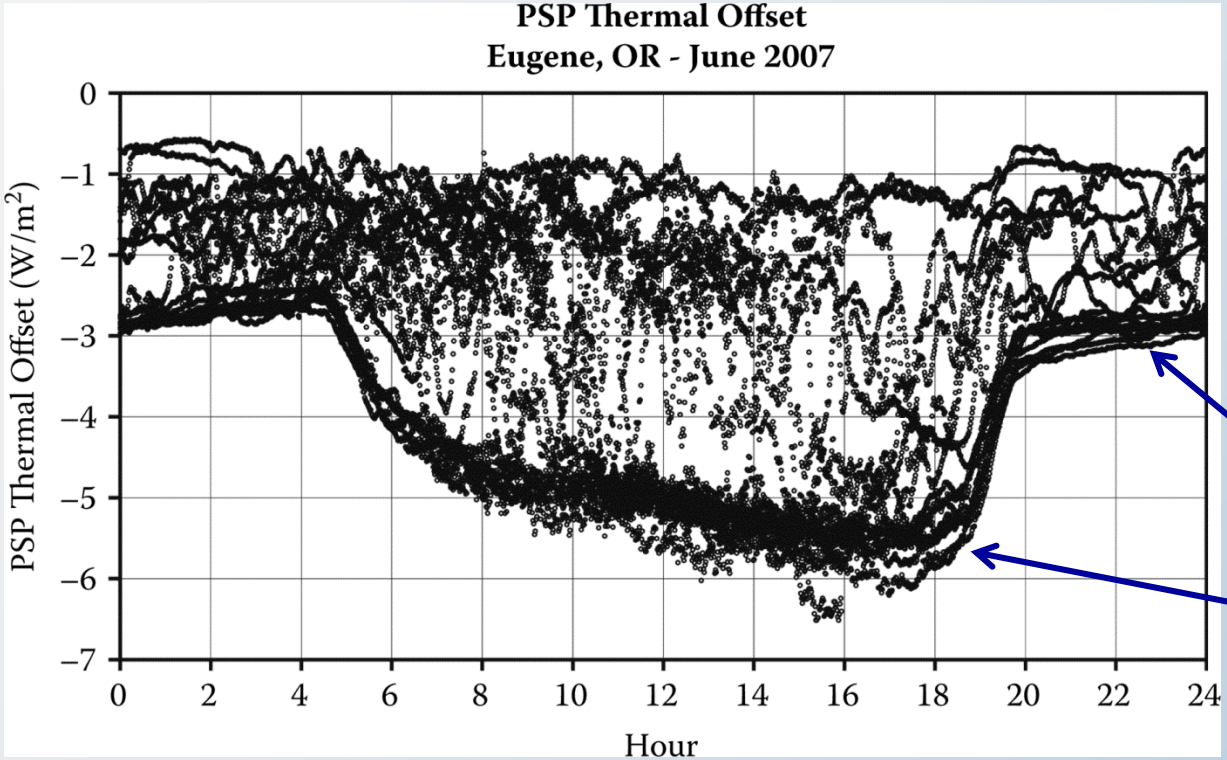



Note the SZA scale of the winter plot

The responsivity of the PSP has a large cosine response.
What is its uncertainty?

# Thermal Offset of an Eppley PSP




Overcast skies

Clear nighttime skies

Clear daytime skies

- Pyrgeometer data was used to calculate the thermal offset.
- The most negative values are obtained during clear sky periods.
- Larger offsets in the afternoon than in the morning.

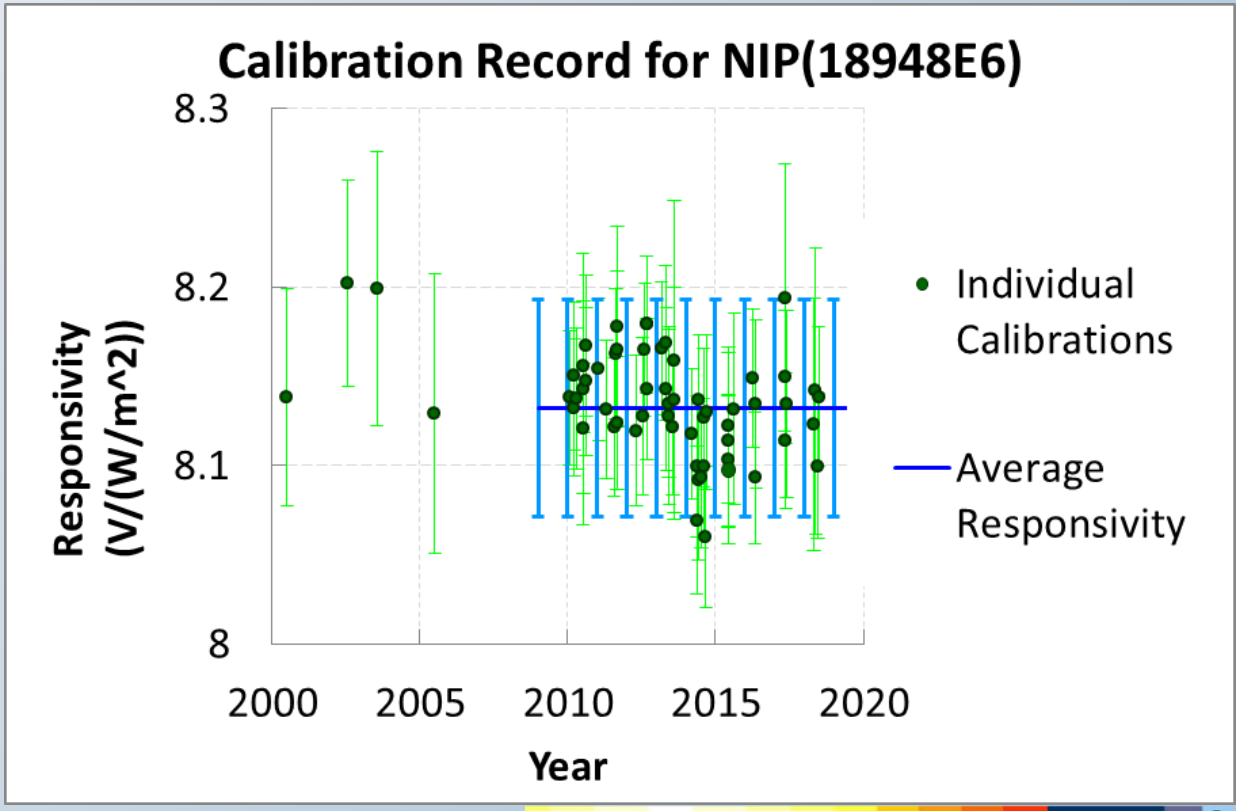
*Younkin and Long: 2003*
*Vignola, Michalsky, Stoffel: 2012, Figure 5.6*

# Current Activities

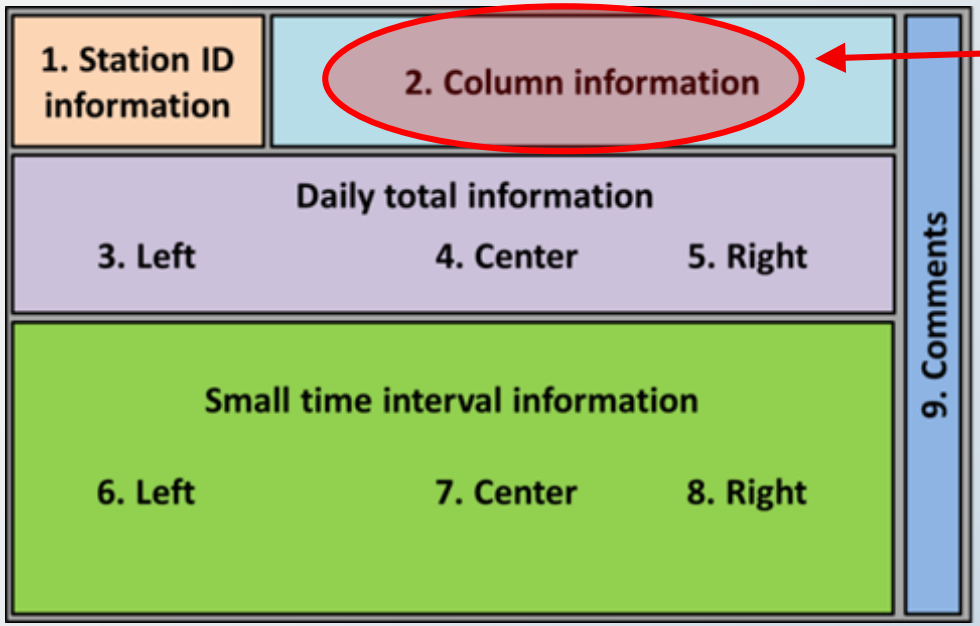
1. Provide calibration information for each instrument on the website
2. Reformat the data files with enhanced information
3. Investigate the effects of spectral data on various systems

# Current Activities - Calibrations

- The SRML performs yearly calibrations of instruments
- Plans are to provide detailed calibration information for each instrument on the website
- The calibration process has been streamlined and formalized with new software
- Absolute Cavity Radiometer obtained in 2010



# Current Activities - Comprehensive Data Format

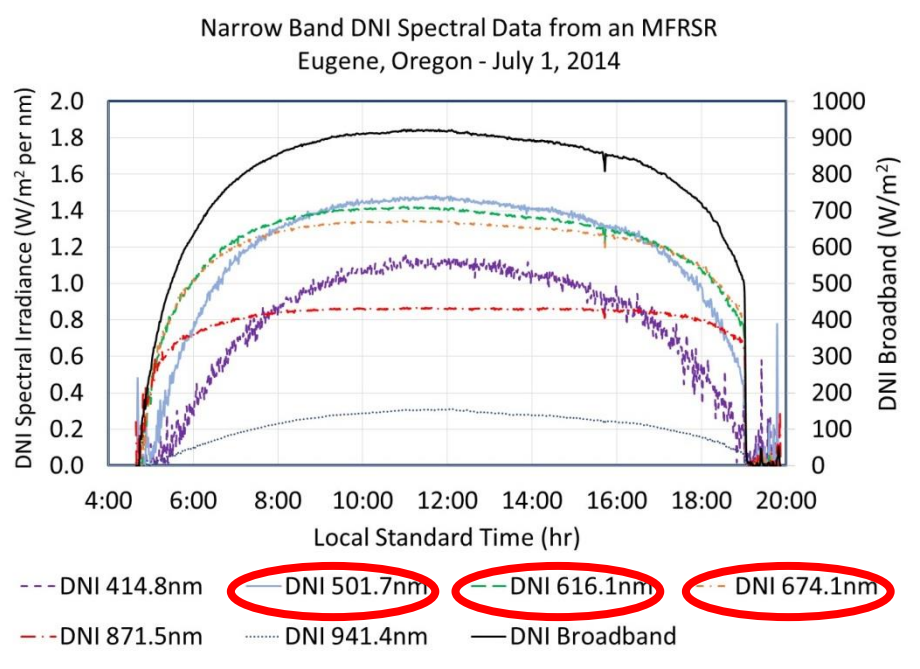


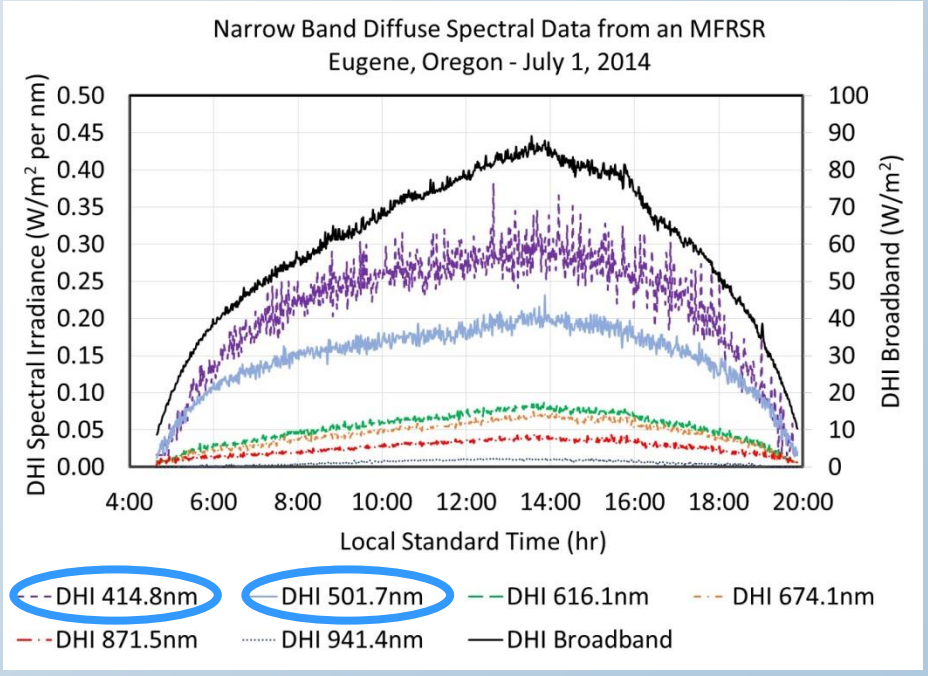

| Sample of Column Information | |
|---|---|
| Row Labels | Instrument 1 |
| Type of Measurement: | GHI |
| Element: | 1000 |
| Instrument Serial Number: | PSP (23973F3) |
| Instrument Shorthand Name: | P23 |
| Responsivity: | 8.6844 $\mu V/W/m^2$ |
| Estimated Uncertainty (U95%): | 3.587 |
| Sample Method: | Avg |
| Units: | $W/m^2$ |
| Column Notes: | Processed |

The new format offers significantly more information about the data contained within each file.

# Current Activities - Spectral Measurements

## Clear sky spectral data from a Multi-Filter Rotating Shadowband Radiometer




Predominate DNI colors are 501 – 674 nm. The Sun is “white”.

Predominate DHI colors are 414 – 501 nm. The sky is “blue”.

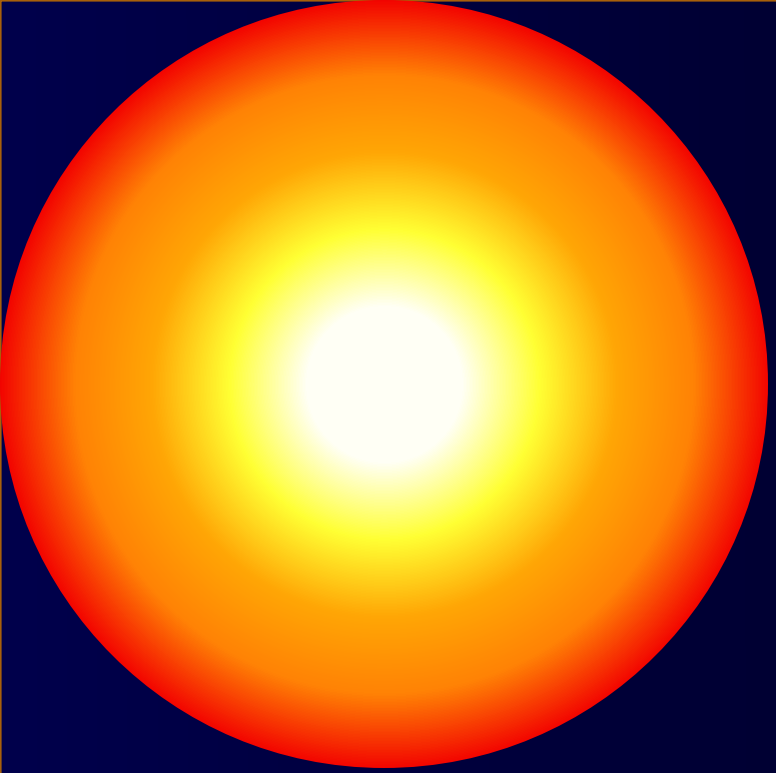
# Conclusions

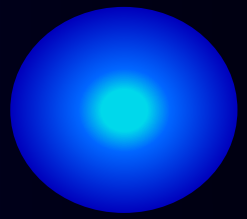
The Solar Radiation Monitoring Lab at the University of Oregon has been making high quality GHI and DNI measurements since the late 1970's.

Characterizing the bias and uncertainties in irradiance measurement is essential. Spectral measurements are becoming increasingly important.

Thank you for your attention!

Contact Information:
Josh Peterson: jpeters4@uoregon.edu
Frank Vignola: fev@uoregon.edu
Web: http://solardata.uoregon.edu





# Measuring the sun every day it rises.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**Solar Radiation Monitoring Lab**
**Materials Science Institute**
**University of Oregon**