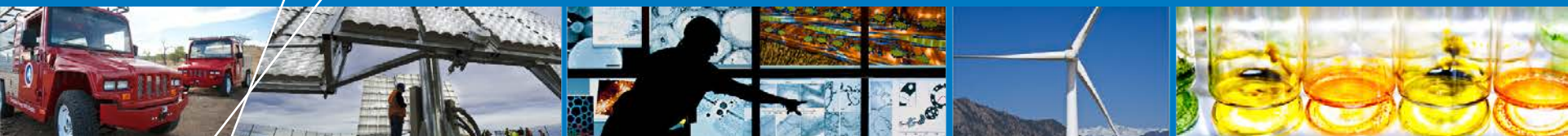


Deployment of BORCAL Procedure at SGP for Pyrgometer Calibration



2015 ASR Science Team Meeting

by

Ibrahim Reda, Afshin Andreas, Mark Kutchenreiter, Craig Webb, Manajit Sengupta, Mike Dooraghi

March 16, 2015

Purpose

Start scheduling calibration for ARM/ASR's pyrgeometers with traceability to the interim World InfraRed Standard Group (WISG) to:

- Provide homogeneous atmospheric IR data for consistency with the international community**
- Complete ECO-00781: pyrgeometers operated at SIRS, SKYRAD, and GNDRAD stations.**

Deployment Steps

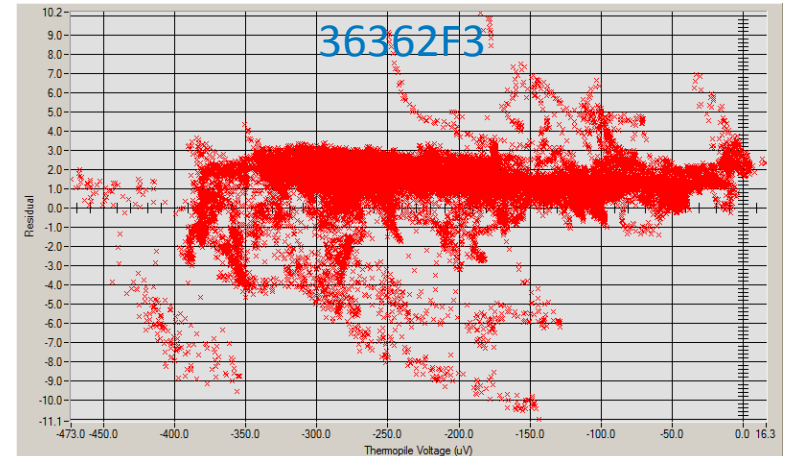
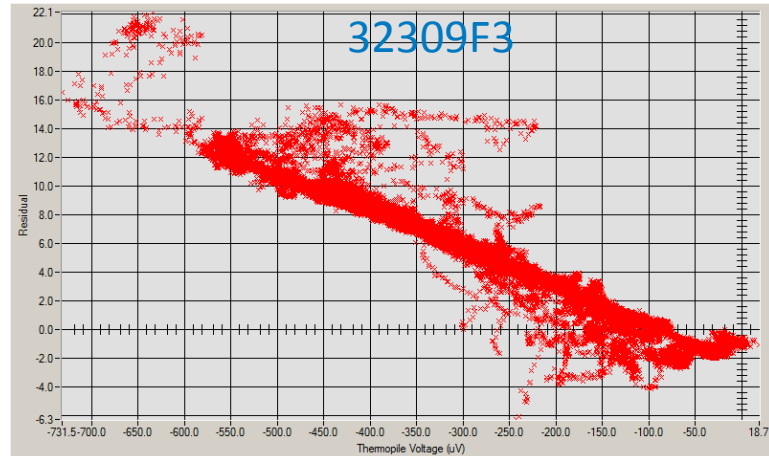
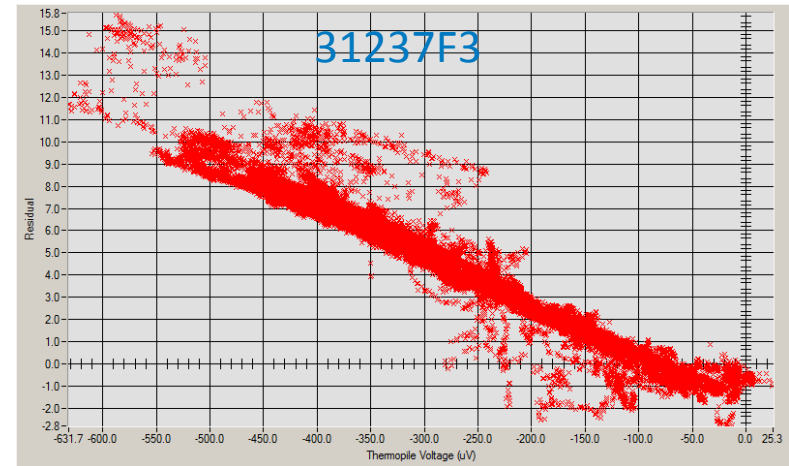
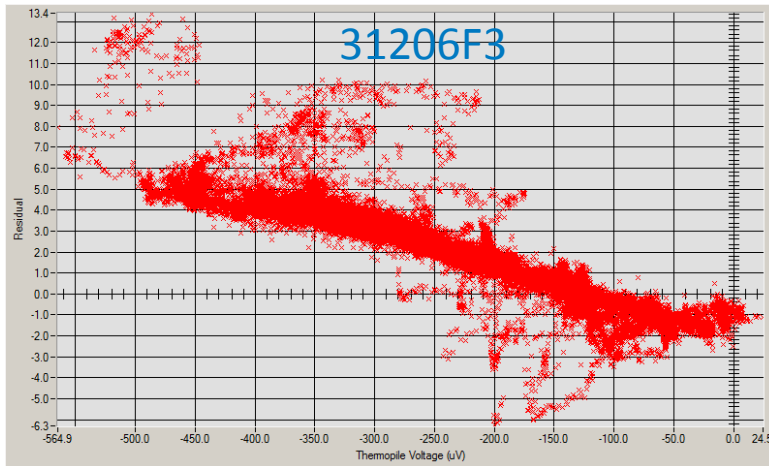
- **Modified RCC software to include pyrgeometer calibration, now it runs in two modes: BORCAL-SW (daytime) and BORCAL-LW (night time)**
- **Calibrated four test pyrgeometers at NREL/SRRL using two standard pyrgeometers with traceability to WISG**
- **Added hardware to accommodate for SGP-BORCAL-LW**
- **Deployed the new RCC at SGP and re-calibrated the same four test pyrgeometers with the same standard pyrgeometers**
- **Compared NREL and SGP calibration results for verification and acceptance.**

Pyrgeometers Set-Up at SGP

Reference
Pyrgeometers



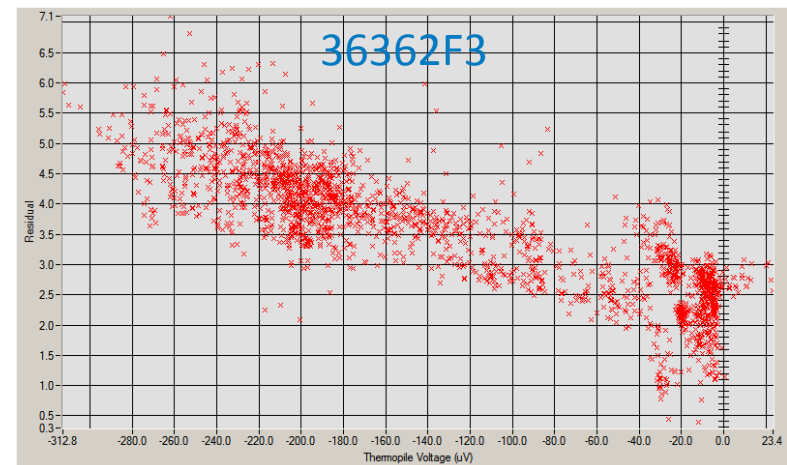
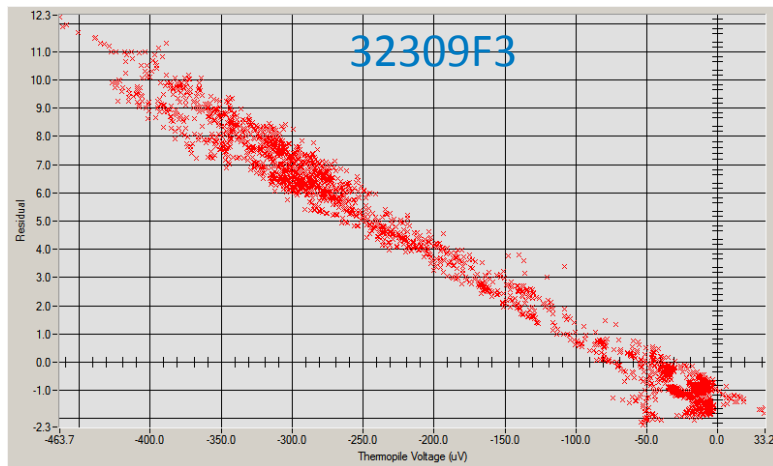
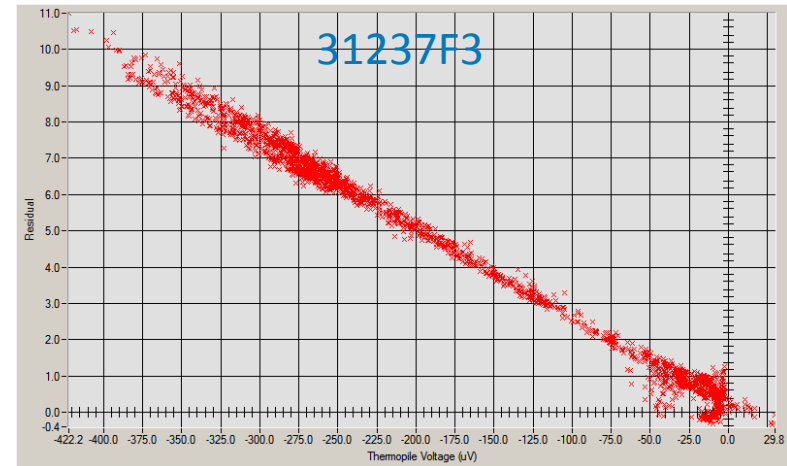
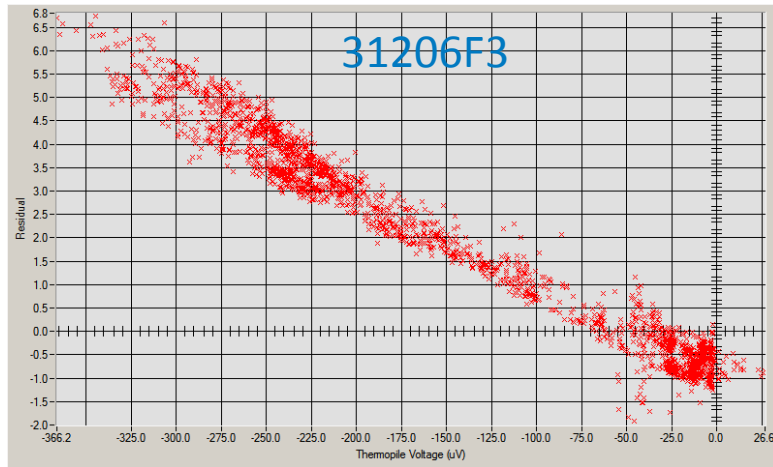
Residuals Using Manufacture Calibration at NREL



Residuals = Reference irradiance - calculated irradiance using manufacturer's Responsivity

K3 = 4

Residuals Using Manufacture Calibration at SGP



Residuals = Reference irradiance - calculated irradiance using manufacturer's Responsivity

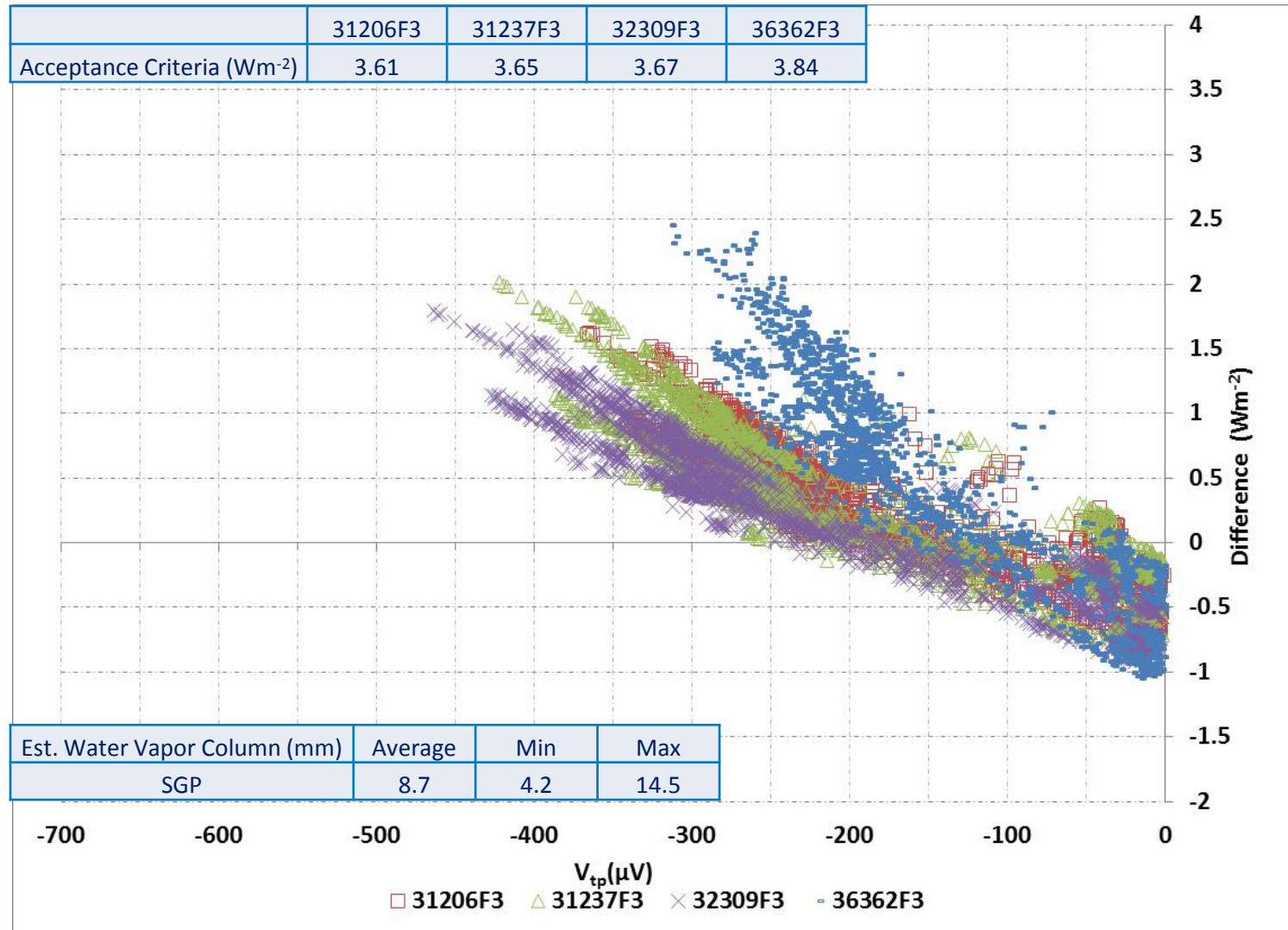
K3 = 4

Validation Process

- Calibrate four test pyrgometers (PIRs) at NREL
- Calibrate the same PIRs at SGP
- Use the calibration coefficients from both sites to calculate the irradiance from the raw data collected at NREL & SGP
- Subtract the calculated irradiance using NREL coefficients from the calculated irradiance using SGP coefficients
- If the irradiance difference is within the Acceptance Criteria shown in the table, where U_{95} from NREL & SGP calibrations are added in Wm^{-2} , then the deployment is validated.

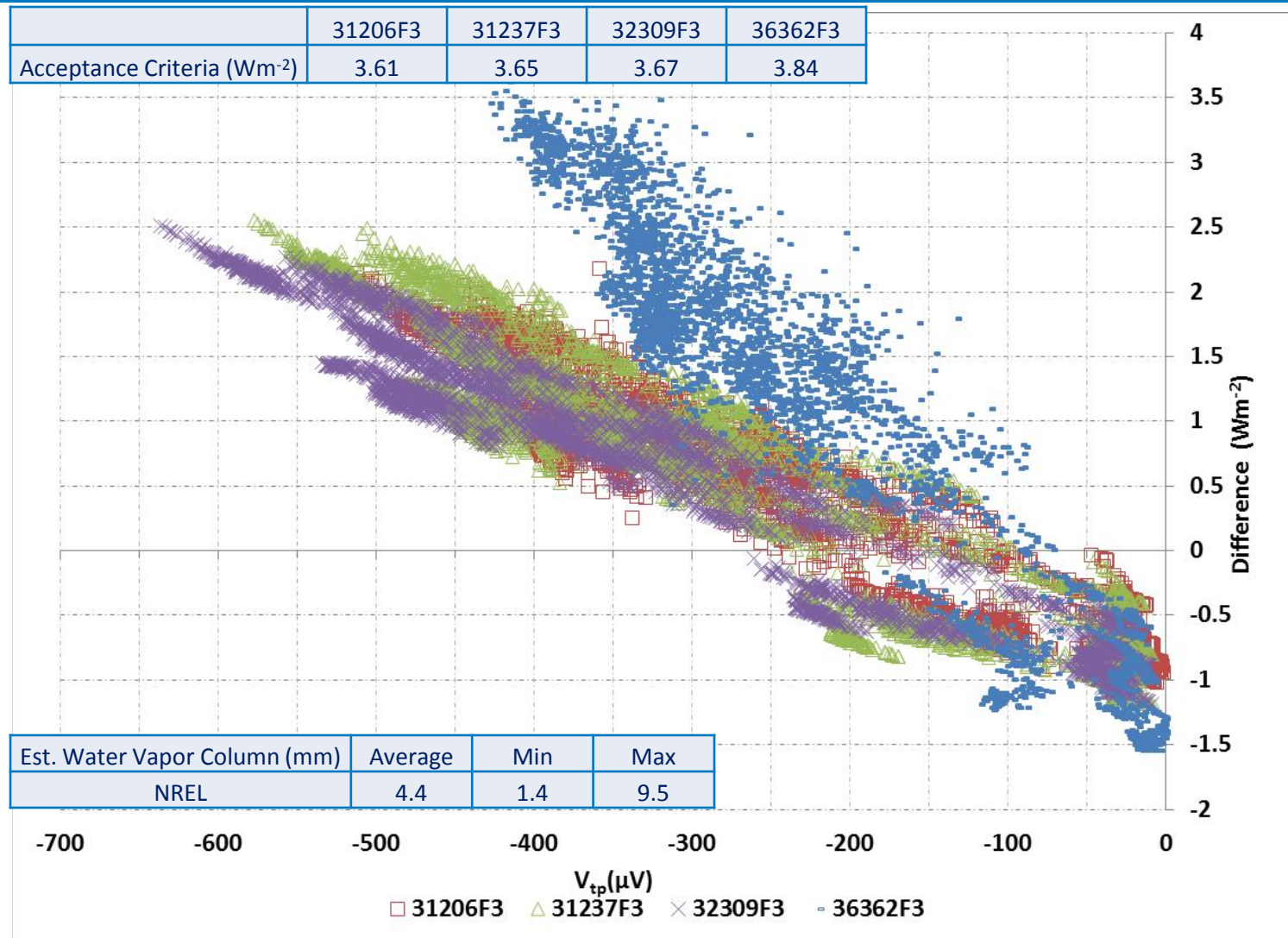
Calibration Site	31206F3	31237F3	32309F3	36362F3
NREL (Wm^{-2})	1.92	1.96	1.98	2.08
SGP (Wm^{-2})	1.69	1.69	1.69	1.76
Acceptance Criteria (Wm^{-2})	3.61	3.65	3.67	3.84

Validation using SGP outdoor data



Difference of the calculated irradiance using two sets of calibration coefficients derived during SGP & NREL BORCAL events

Validation using NREL outdoor data



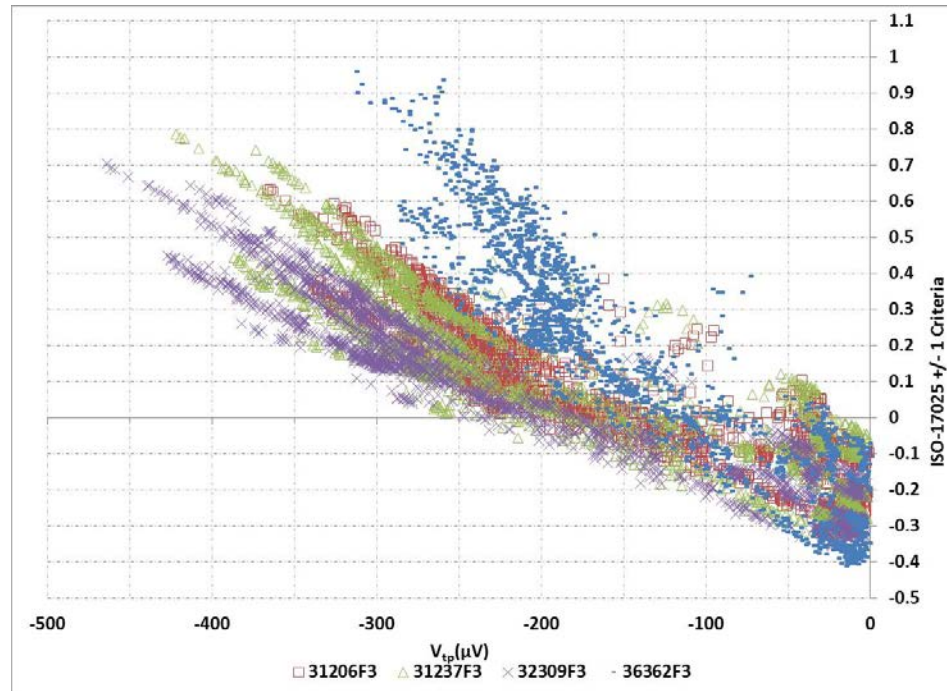
Difference of the calculated irradiance using two sets of calibration coefficients derived during SGP & NREL BORCAL events

ISO-17025 Accreditation Criteria using SGP outdoor data

$$E_n = \frac{W_{SGP} - W_{NREL}}{\sqrt{U_{SGP}^2 + U_{NREL}^2}}$$

Where:

- E_n must be between -1 and 1 for validation
- W_{SGP} and W_{NREL} are the calculated irradiance using SGP and NREL calibration coefficients
- U_{SGP} and U_{NREL} are uncertainties from SGP and NREL calibrations

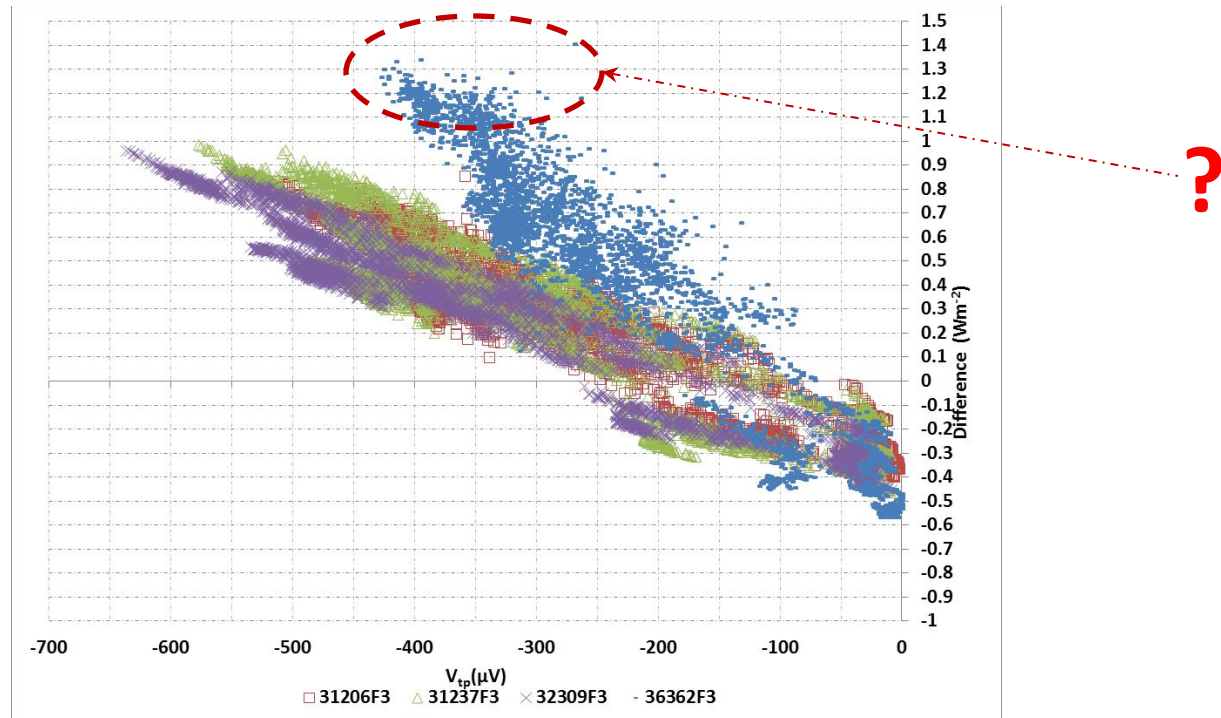


ISO-17025 Accreditation Criteria using NREL outdoor data

$$E_n = \frac{W_{SGP} - W_{NREL}}{\sqrt{U_{SGP}^2 + U_{NREL}^2}}$$

Where:

- E_n must be between -1 and 1 for validation
- W_{SGP} and W_{NREL} are the calculated irradiance using SGP and NREL calibration coefficients
- U_{SGP} and U_{NREL} are uncertainties from SGP and NREL calibrations



Summary

- *The updated BORCAL procedure is successfully installed and validated at SGP*
- *The software is run in SW & LW modes, SW mode during daytime, and LW mode during nighttime (unattended)*
- *Once enough data is collected, the calibration stickers are printed and attached to the radiometers, and the calibration report is printed and distributed to the approved list of PIs.*

Calibration Report

Shown in a separate pdf file

Discussion and Future Investigation

- *When and How IR calibration starts at SGP?*
- *Calibration Cycle?*
- *Principle Investigators list to receive BORCAL certificates?*
- *Calibration site elevation effect?*
- *Water vapor column effect?*