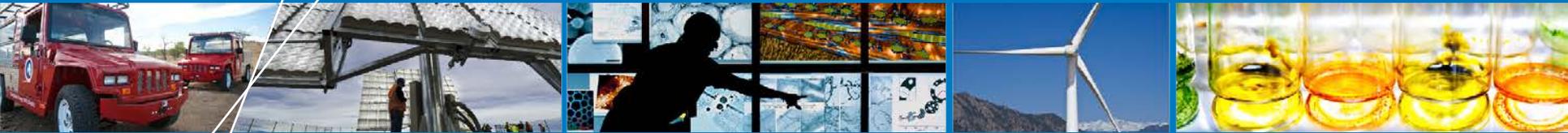


# ARM Radiometer Ventilator Fan Upgrade Status

## Single Radiometer Configuration

### Radiometer Upgrade Evaluations



## 2016 ASR Science Team Meeting

by

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# Topics Overview

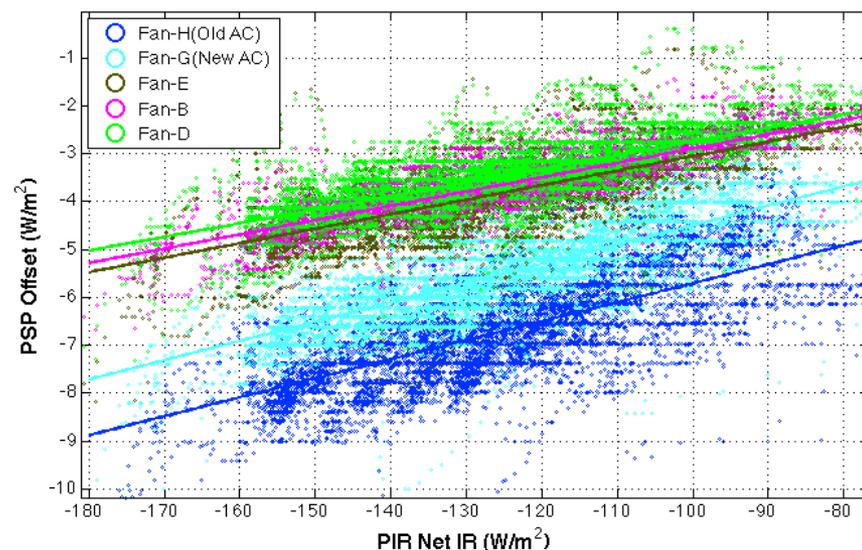
- Review of previous results of DC fan upgrades.
- Status of DC fan upgrade deployments.
- Review of tracker plate modification testing.
- **Single Radiometer Configuration.**
- **Proposed evaluations of radiometers for system upgrades.**



# Initial Testing of Candidate 12VDC Fans

- Six 12VDC fans with 50-60cfm rating were evaluated at NREL, with original model AC reference fans during January and February 2014.
- PSP night time offsets vs. netIR from NREL collocated PIR demonstrated offset improvements of  $\sim 2.5 - 3.0 \text{ W/m}^2$ .
- All of the DC fans tested provided higher flows and generally equivalent IR loss reduction.
- Delta Electronics Model FFB0812VH-T500 was selected based on design characteristics.

## Nighttime Data Evaluation



# ECO-00991 - 12VDC Fan Deployments

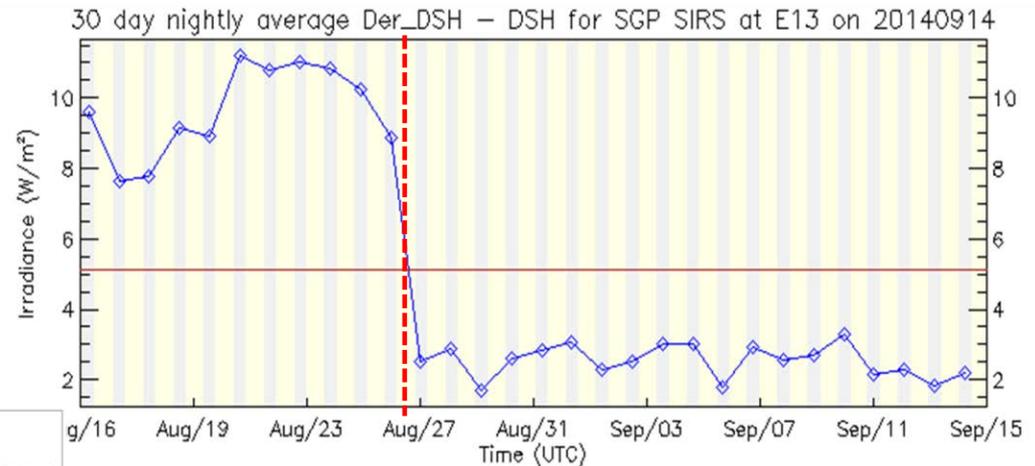
- Procurement information was provided to PNNL.
- SGP RCF BORCAL ventilators were upgraded to the new DC fans before the 2014 BORCAL to maintain proper calibration procedure for all radiometers.
- Ventilator maintenance and flow check addendum was added to SIRS handbook.
- Transition to the 12 volt DC fans at SIRS, BRS, ENA, and TWP C3 sites was performed when the newly calibrated PSP, 8-48, and PIR instruments were installed in 2014.
- PSP, 8-48, and PIR ventilator transitions to DC fans performed:
  - ✓ SGP July-August, 2014
  - ✓ TWP C3 September, 2014
  - ✓ ENA December, 2014
  - ✓ MAO February, 2015
  - ✓ OLI September, 2015
  - ✓ NSA April, 2016

ECO-00991 VENTILATION UPGRADE FAN AND POWER SUPPLY PROCUREMENT				
ARM STATION LOCATIONS	ITEMS AND QUANTITIES			
	80mm 12VDC Fan <sup>1</sup>	12VDC Power Supply <sup>2</sup>	80mm Fan Screen <sup>3,4</sup>	Fastener Sets <sup>5</sup>
SGP BRS	3	1	3	3
SGP C1	3	1	3	3
SGP E9- E38 (15 sites)	45	15	45	45
BRS, C1, E9-38 Spares	12	5	12	12
ENA SKYRAD	4 + 2 Spares	1 + 1 Spare	4 + 4 Spares	4 + 4 Spares
MAO SKYRAD	4 + 4 Spares	1 + 1 Spare	4 + 4 Spares	4 + 4 Spares
NSA SKYRAD	4 + 4 Spares	1 + 1 Spare	4 <sup>4</sup>	4 + 4 Spares
NSA GNDRAD	2 + 2 Spares		2 <sup>4</sup>	2 + 2 Spares
OLI SKYRAD	4 + 4 Spares	1 + 1 Spare	4 <sup>4</sup>	4 + 4 Spares
OLI GNDRAD	2 + 2 Spares	1 + 1 Spare	2 <sup>4</sup>	2 + 2 Spares
TMP SKYRAD	4 + 4 Spares	1 + 1 Spare	4 <sup>4</sup>	4 + 4 Spares
TMP GNDRAD	2 + 2 Spares	1 + 1 Spare	2 <sup>4</sup>	2 + 2 Spares
TWP C3 <sup>5</sup> SKYRAD	4 + 2 Spares	1 + 1 Spare	0 <sup>4</sup>	4 + 4 Spares
<b>TOTALS</b>	119	38	89	

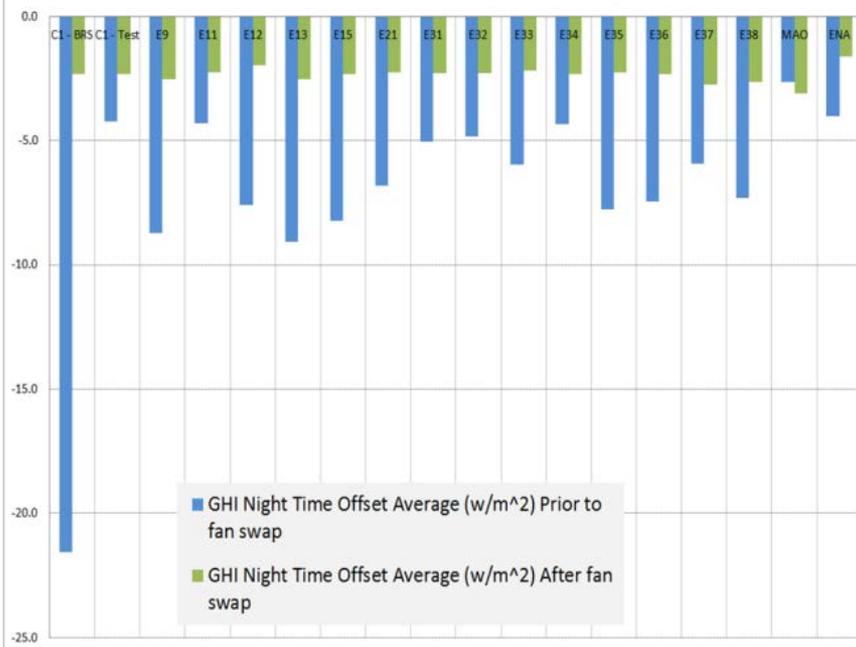
# Results of DC Fan Deployment at Sites

- Transition to the higher flow 12 volt DC fans in ventilators consistently resulted in the reduction of PSP thermal offset responses.
- Average change in nighttime thermal offset for PSPs from the 18 sites was from  $-7.0 \text{ w/m}^2$  prior to the fan change to  $-2.3 \text{ w/m}^2$  after the fan change.

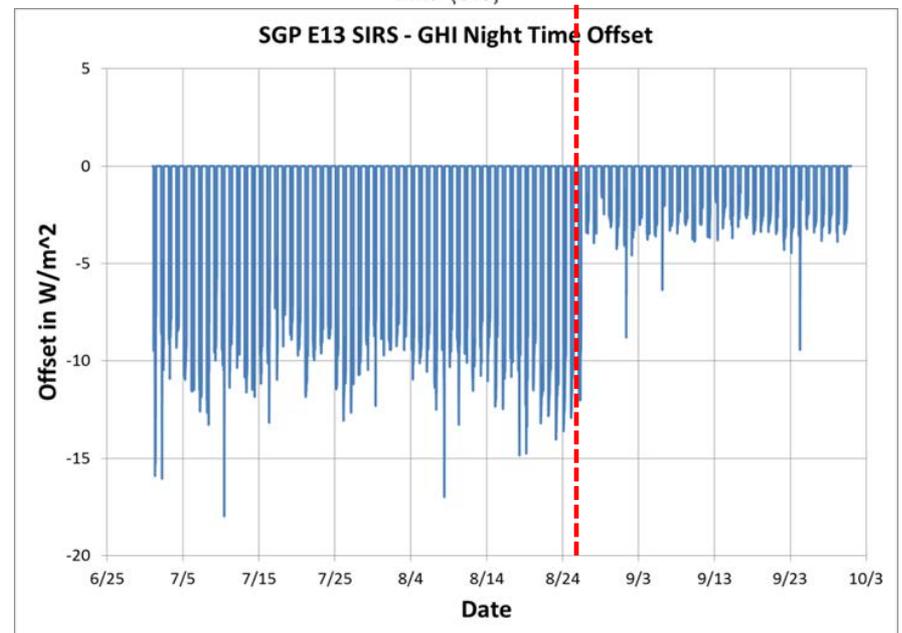
## Daily difference in nighttime PSP offsets



GHI Offset Before and After DC Fan Swap



SGP E13 SIRS - GHI Night Time Offset



# Tracker Plate Modification and Screen Test Configurations

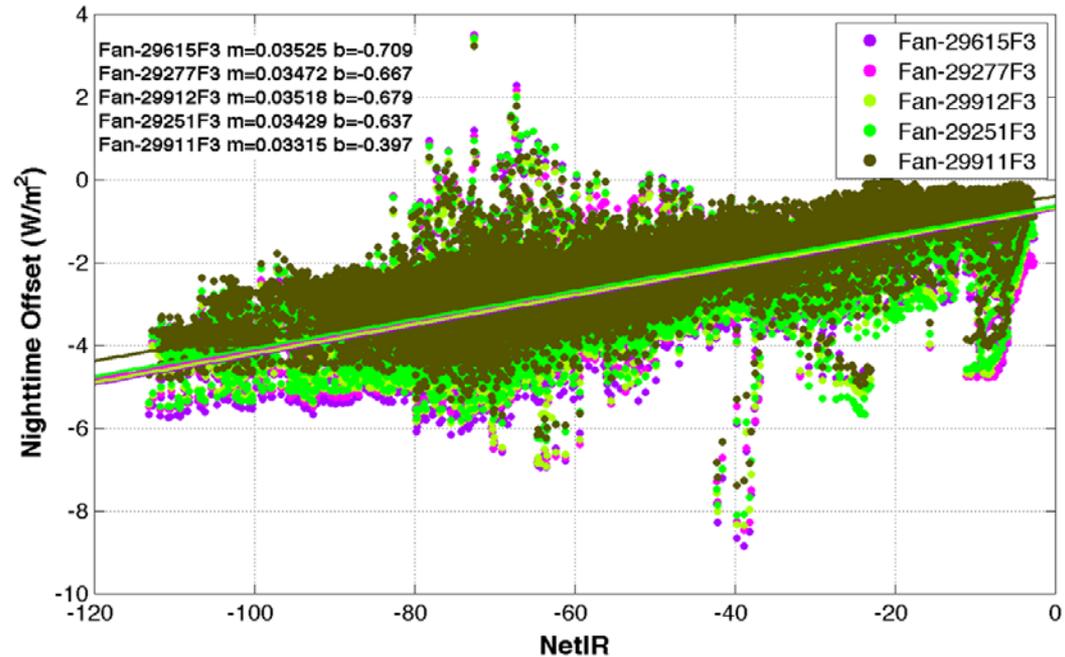
Five configurations of tracker plates and fan air inlet screens were tested at NREL during the 2014-2015 winter period.

EPPLEY VENTILATOR PLATE-SCREEN TEST CONFIGURATION			
VENTILATOR NUMBER	EPPLEY PSP SERIAL NUMBER	SOLAR TRACKER PLATE HOLE SIZE (INCHES)	AIR INTAKE SCREEN SIZE (MM)
V1	29615F3	6	80
V2	29277F3	No Hole	80
V3	29912F3	5	80
V4	29251F3	6.5	120
V5	29911F3	6.5	No Screen



# Test Configuration Nighttime Thermal Offset Comparison

- Analysis of thermopile outputs from the ventilated PSPs, relative to SRRL baseline netIR indicate no significant differences among the V1, V2, V3, V4, and V5 tracker plate and air intake test configurations. The V2 configuration is currently used at ARM sites.
- The reduction of PSP nighttime thermal offsets as achieved in the SIRS and SKYRAD DC fan upgrades under ECO-00991 remained consistent with the performance of the five tracker plate and fan air intake screen configurations used with ventilators in this test.



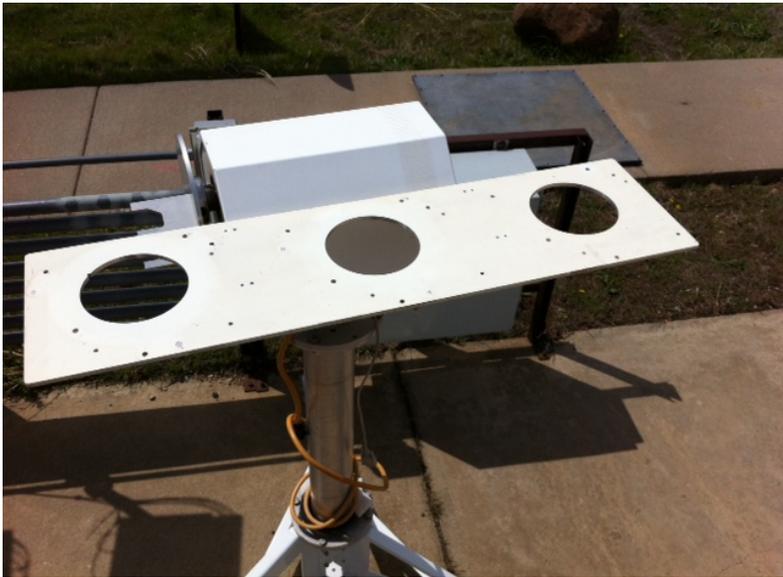
# PSP Dome Snow, Frost, Accumulation Prevention/Reduction

The five ventilator and plate-screen test configurations provided similar performance for prevention/reduction of snow and frost accumulations on PSP domes.



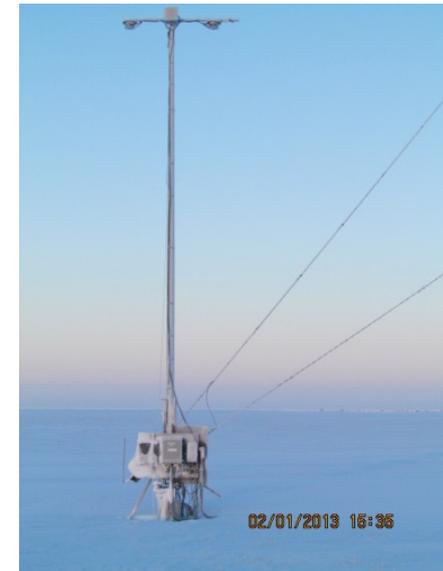
# Modified Solar Tracker Plate Example

- Tracker plate modified with 5 inch holes for three ventilator positions.
- Can be modified for two ventilator positions.



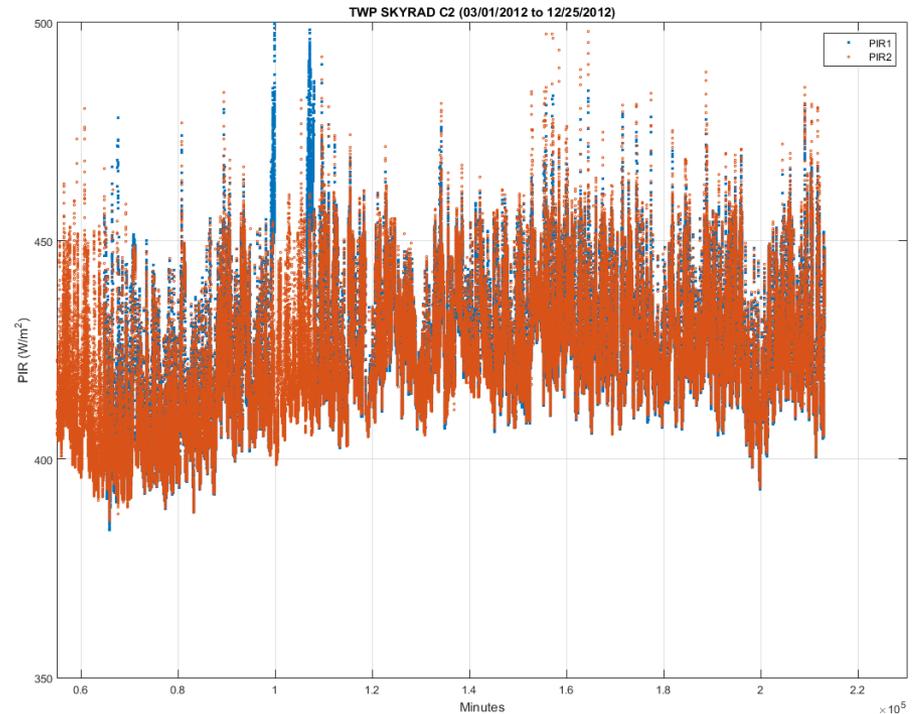
# Single Radiometer Configuration

- Confirm Single Radiometer Configuration viability for all sites.
- Select PIR options:  
Option A- one PIR (~\$12K)  
Option B- two PIRs (~\$155K)
- Preparation of ECR for combined Single Radiometer Configuration and plate modification for SIRS and SKYRAD sites would include:
  - Modify SIRS and SKYRAD tracker plates with holes under ventilators.
  - Operate SKYRAD and GNDRAD on single logger
  - Determine 'single logger' approach for OLI and NSA extended distance to upwelling instruments tower location.
  - Separate IRTs under ECO-00990.



# Comparison of Two Pyrgometers

- Plot of two PIRs for TWP Skyrad C2 site for 2012.
- Very minor difference between the two when both are correctly operating, the average is  $2 \text{ W/m}^2$  for 03/01/2012 to 12/25/2012 period.



# PROPOSED ARM PROGRAM RADIOMETER UPGRADE EVALUATIONS

- Evaluate newer radiometers to reduce the uncertainty in radiometric measurements.
- Evaluate prospective instruments at a few ARM locations to provide the rationale for potential future upgrades.
- Evaluate a direct instrument (e.g. Eppley sNIP), a global instrument (e.g. Kipp and Zonen CMP22) and an infrared instrument (e.g. Kipp and Zonen CGR4), or other potential candidate instruments.



# CVF4 Ventilator Example

- The CVF4 ventilator inlet is raised above and away from the supporting surface.
- Tracker plate can be used without modification.



# Thank You

- Questions?

