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Evaluation of DC Ventilator Fans Proposed for Pyranometer Measurements in the ARM Program

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Abstract

The Atmospheric Radiation Measurement (ARM) program provides high quality radiometric data traceable to International System of Units (SI). The National Renewable Energy Laboratory (NREL) and ARM, through the Radiometer Calibration Facility (RCF) at the Southern Great Plains (SGP), provide calibration of broadband radiometers deployed in the SKYRAD, GNDRAD, and SIRS instrument platforms. Both NREL and ARM continue to improve radiometric measurement through the introduction of new methods. This poster presents the results of recent work that reduces the thermal offset that exists in the broadband global hemispheric irradiance, measured by the Eppley Precision Spectral Pyranometer (PSP), by replacing the original AC ventilator fans with higher flow DC fans. NREL results show that up to 30% reduction in IR loss errors, as well as reduced scatter in the raw signal, can be achieved by using higher flow DC fans. This is consistent with previous recommendations and investigations [1]. These results are used to select the best performing DC ventilator fan that will replace all Eppley AC fans currently used in the ARM network. This includes Eppley pyranometers (PSP), diffuse pyranometers (8-48), and prygeometers (PIR). Transition to the DC fans is planned to begin at the RCF prior to the start of the 2014 Broadband Outdoor Radiometer Calibration (BORCAL) activities, followed by fan replacements at each of the ARM sites equipped with SIRS and SKYRAD-GNDRAD radiometers.

Method

Test setup at NREL's SRRL consisted of five Eppley PSPs installed in ventilators (Model: VEN) along with thermopile and housing temperature measurements. Net Infrared (Net IR) irradiance is measured from a co-located PIR.

Nighttime data was collected from two sets of three DC fans during January and February, 2014. Two AC fans were installed as controls for the entire test period. DC fans were chosen to meet general requirements outlined in [1] (12 VDC and rated ~50 cfm).

Fans Under Test

Fan Manufacturer	Part Number	Type	Test Designation
Delta Electronics	QFR0812SH-F00	12VDC	A
Sunon	PMD1208PKB1-A.(2).GN	12VDC	B
Delta Electronics	FFB0812VH	12VDC	C
Delta Electronics	FFB0812VHE-F00	12VDC	D
Delta Electronics	FFB0812VH-T500	12VDC	E
Pelonis	K8038L12BPLB2-7	12VDC	F
Sanyo Denki	109-043UL	115VAC Present Eppley	G
Comair Rotron	SUZA1 "Sprite"	115VAC Original Eppley	H

Installation Configuration

Ventilator	Set 1 1/9/2014 to 1/25/2014 Fan Designation	Set 2 1/25/2014 to 2/22/2014 Fan Designation
1	H	H
2	E	C
3	B	A
4	D	F
5	G	G

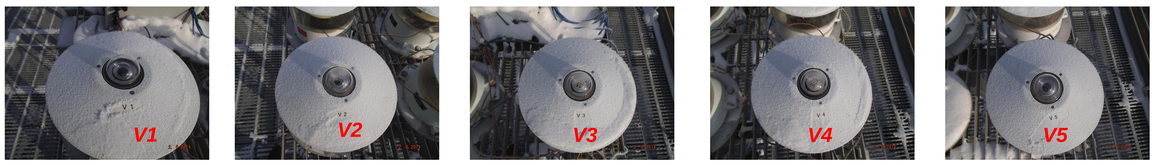
Results

Measured Fan Flow Characteristics

Test Designation	Measured Volumetric Flow Rate (cfm)	Measured Static Pressure (in H_2O)	Measured Electrical Power (W)	Overall Rank Based on Flow Characteristics
A	5.6	0.25	2.5	2
B	5.9	0.29	3.8	1
C	5.0	0.23	3.1	5
D	5.5	0.27	3.4	3
E	4.9	0.21	3.0	6
F	5.1	0.24	2.6	4
G (present Eppley)	4.1	0.13	8.6	7

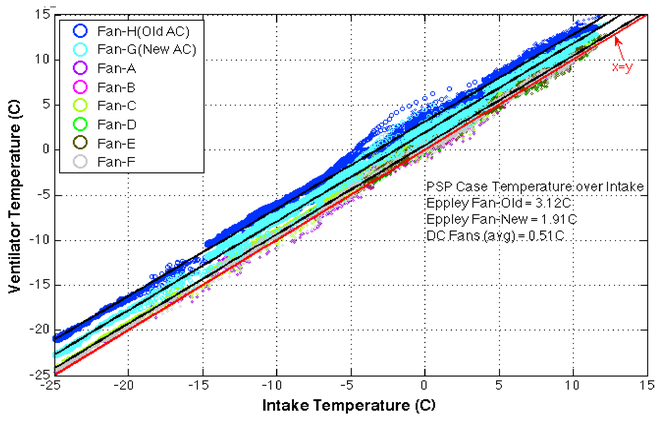
Operational Observations

- **DC fans do not provide the same level of internal heating and thus, do not clear frost as well as AC fans, although flow rates are significantly higher. AC Fan (Ven 1 and Ven 5) and DC fans (Ven 2, 3, and 4) below after cold, calm winter night.**



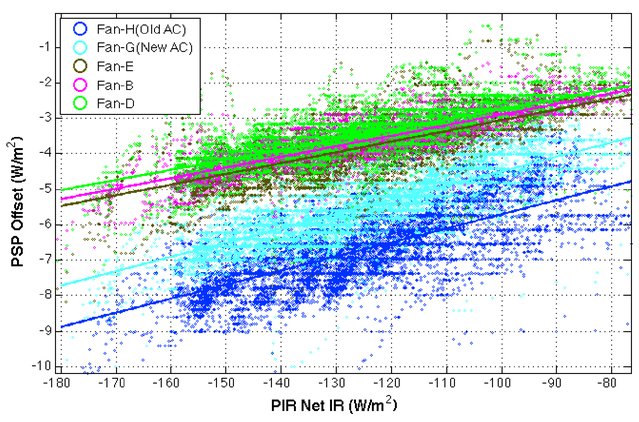
Temperature Characteristics

- **Nighttime data reveals AC fans consistently heat the PSP case to 1.5 – 3°C over intake air temperature. DC fans only average a 0.5°C increase over intake air temperature.**



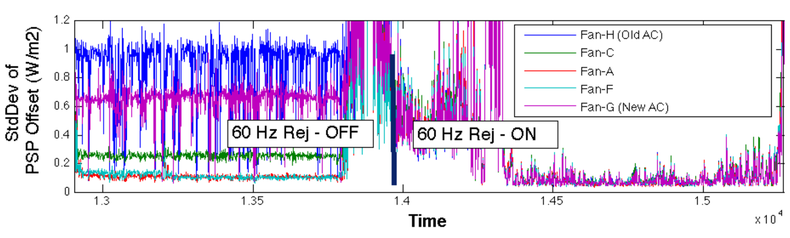
IR Loss Characteristics

- **Nighttime comparison of PSP offset with PIR Net IR shows usual dependence. DC fans show largest improvement in offset (~3 W/m²) compared to old AC fans and a slight decrease in Net IR dependence. Set 1 is shown below. Set 2 is similar.**



60 Hz Rejection Configuration

- **Datalogger AC mains frequency rejection is critical in reducing noise from AC fans.**



Summary

- ***DC powered ventilators may not provide the same level of frost/dew clearing as AC units.***
- ***DC fans in the same flow and power class provide equivalent IR loss reduction.***
- ***DC ventilators could reduce PSP IR loss by up to 35% (site dependent).***
- ***60 Hz rejection eliminates most AC fan induced noise. DC fans will nearly eliminate the issue completely. However, logger frequency rejection should be changed to match local mains frequency.***
- ***Changes will impact VAPs that incorporate IR Loss (e.g. GSWCorr and QCRad1Long [2]).***
- ***All PSPs, 8-48s, and PIRs with AC ventilator fans will be affected.***
- ***Anticipated durability and vendor availability will be incorporated as factors in fan selection.***

References

[1] C.Long, "ARM Radiometer Ventilation Issues: An Appeal for Diligence and Improvement," personal communications, PNNL.
[2] Younkin, K. and C. N. Long, (2004): Improved Correction of IR Loss in Diffuse Shortwave Measurements: An ARM Value Added Product. Atmospheric Radiation Measurement Program Technical Report, ARM TR-009, available online at http://www.arm.gov/publications/tech_reports/arm-tr-009.pdf.

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