Establishing the World Reference for Measuring the Atmospheric Longwave Irradiance with Traceability to the International System of Units

Ibrahim Reda and Manajit Sengupta | National Renewable Energy Laboratory

ABSTRACT

• Advancing climate change research requires accurate and traceable measurement of atmospheric longwave irradiance. Measurement capabilities are limited to an estimated uncertainty of larger than ±6 W/m² using the interim World Infrared Standard Group (WISG).

• Two independently designed and calibrated absolute radiometers measuring downwelling longwave irradiance were compared during five outdoor comparisons in 2013, 2015, and 2017 at the Physikalisch-Meteorologisches Observatorium Davos–World Radiation Center (PMOD/WRC) and the U.S. Department of Energy (DOE) Atmospheric Radiation Measurement Program (ARM) in the Southern Great Plains (SGP). Two Absolute Cavity Pyrgeometers (ACPs) developed by the National Renewable Energy Laboratory (NREL) and four Integrating Sphered Infrared Radiometers (IRISs) developed by PMOD/WRC took part in these intercomparisons.

• From the five comparisons, the difference between the irradiance measured by ACPs and IRISs varied from 0.2 W/m² to 2.5 W/m² based on atmospheric conditions, which is within the combined stated uncertainties of ±3 W/m².

• The irradiance measured by the WISG is lower than the average irradiance measured by ACPs and IRISs. The magnitude of difference varied from 0.2 W/m² to 6.6 W/m² depending on the integrated water vapor.

• A concerted effort to establish a world reference for measuring the atmospheric longwave irradiance with lower uncertainty and with traceability to the International System of Units (SI) by using the ACPs and IRISs as the reference started at the World Meteorological Organization (WMO). The Commission for Instruments and Methods of Observation Commission (CIMO) Task Team on Radiation References (TT) meeting was held in 2017 at the National Physical Laboratory (NPL) in Teddington, United Kingdom to discuss specific recommendation on the traceability of the atmospheric longwave irradiance to the International System of units (SI).

OVERVIEW

• Results presented on five comparisons between ACPs and IRISs.

• Differences between longwave irradiance measured by ACPs and IRISs versus irradiance measured by WISG.

• Longwave irradiance measured by ACPs, IRISs, and AERI versus irradiance measured by WISG.

• Recommend establishing world reference for measuring atmospheric longwave irradiance with traceability to SI.

CONCLUSION

• Difference between the irradiance measured by the ACPs, IRISs, and AERI varied from 0.2 W/m² to 2.5 W/m² based on the atmospheric conditions, which is within the stated uncertainties of ±3 W/m².

• Irradiance measured by the WISG is lower than the average irradiance measured by ACPs and IRISs. The magnitude of the difference varied from 4.4 W/m² to 6.6 W/m² depending on the integrated water vapor.

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