

Weather Effects on the Efficiency of Photovoltaic Systems in Medellín, Colombia

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November 22, 2022

Abstract

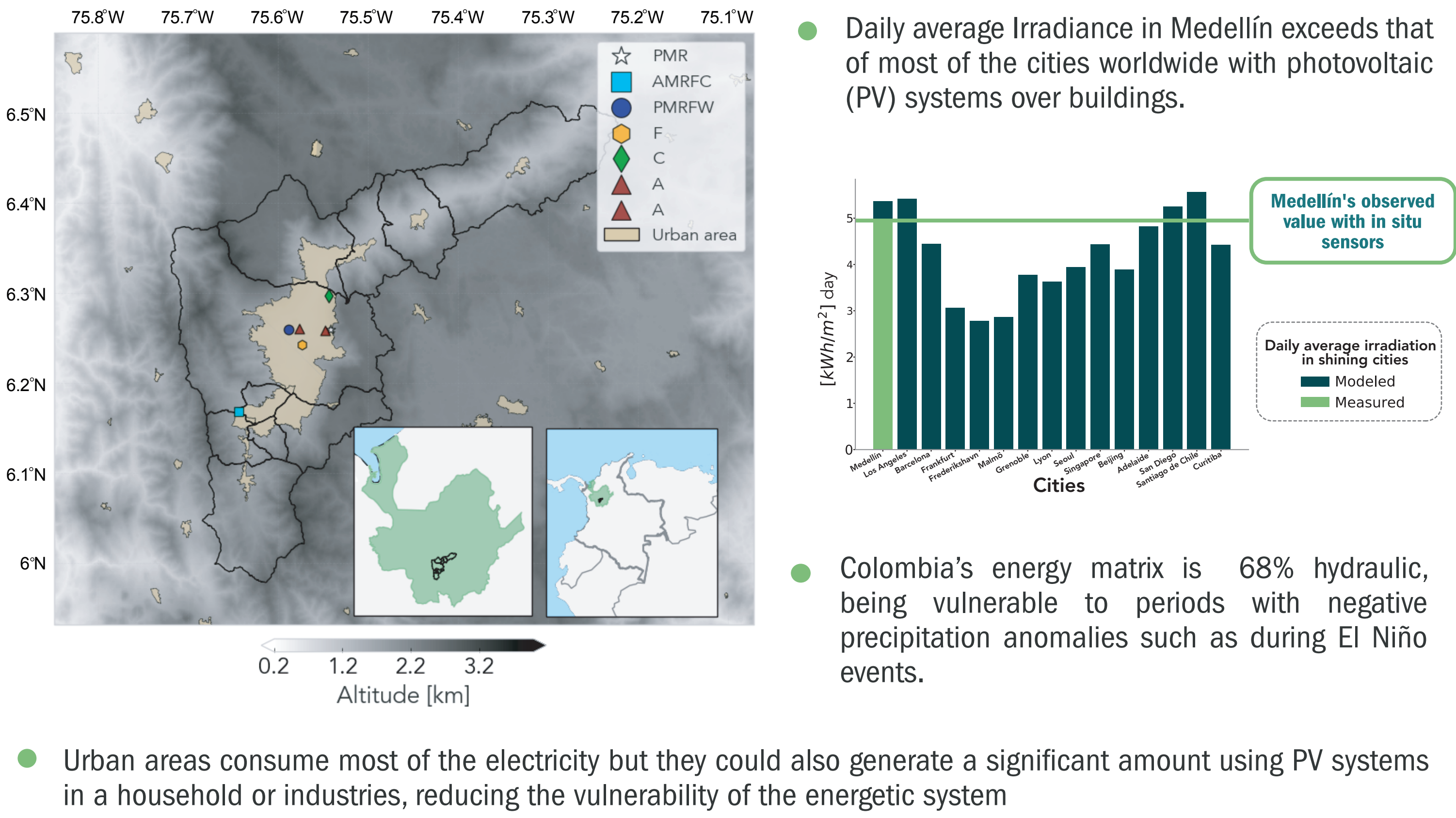
Shortages of electricity in Colombia associated with droughts during El Niño-Southern Oscillation warm events lead government to seek diversification of the electricity matrix, which is mainly hydro (66%). Additionally, clean technologies like wind and solar power are alternatives to climate change. Potentially, solar radiation is high year-round in Colombia due to its low latitude, but clouds are the most critical limiting factor. In this paper, we measure and analyze the variations in efficiency resulting from different weather variables. Toward that end, we measure three photovoltaic systems located in three different zones of the valley. Simultaneously, we analyzed some of the limiting factors which influence solar radiation. For that, we consider radiation from 3 pyranometers, air temperature and relative humidity from meteorological sensors, water vapor density, liquid and solid water content from a microwave radiometer, reflectances as a proxy of clouds from GOES 16 satellite visible band 2. To identify clouds, we estimated radiance thresholds for the GOES information in the three locations of interest from changes in the surface radiation data. These thresholds provide identification of the most sensible hours for radiation based on the anomalies of the radiation under cloudiness conditions. Lastly, the efficiencies on each location were calculated considering the power data, as a proportion of the horizontal global radiation and the area of each solar panel.

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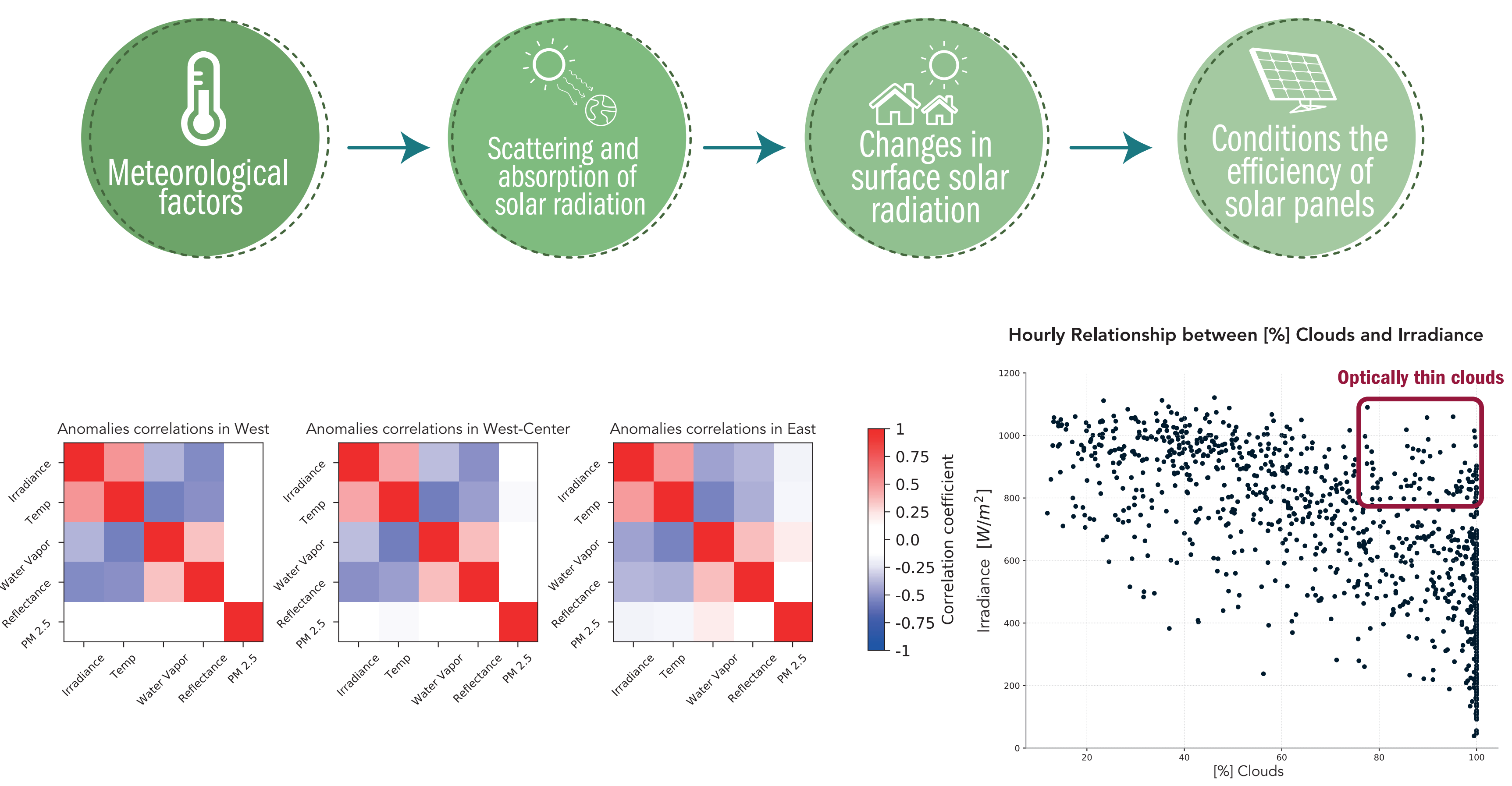
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1.Sistema de Alerta Temprana de Medellín y el Valle de Aburrá2.Universidad Nacional de Colombia, sede Medellín

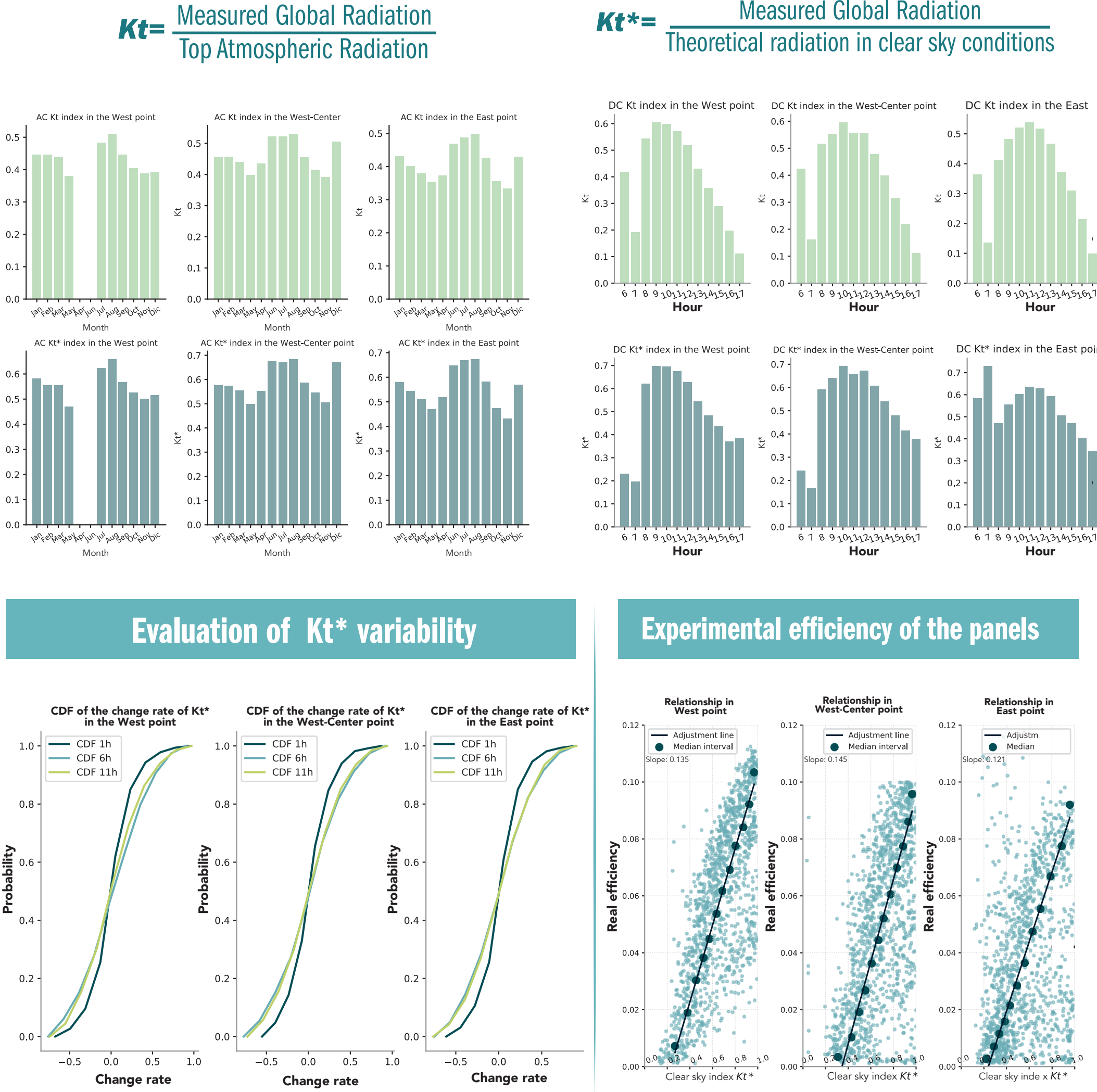
Introduction



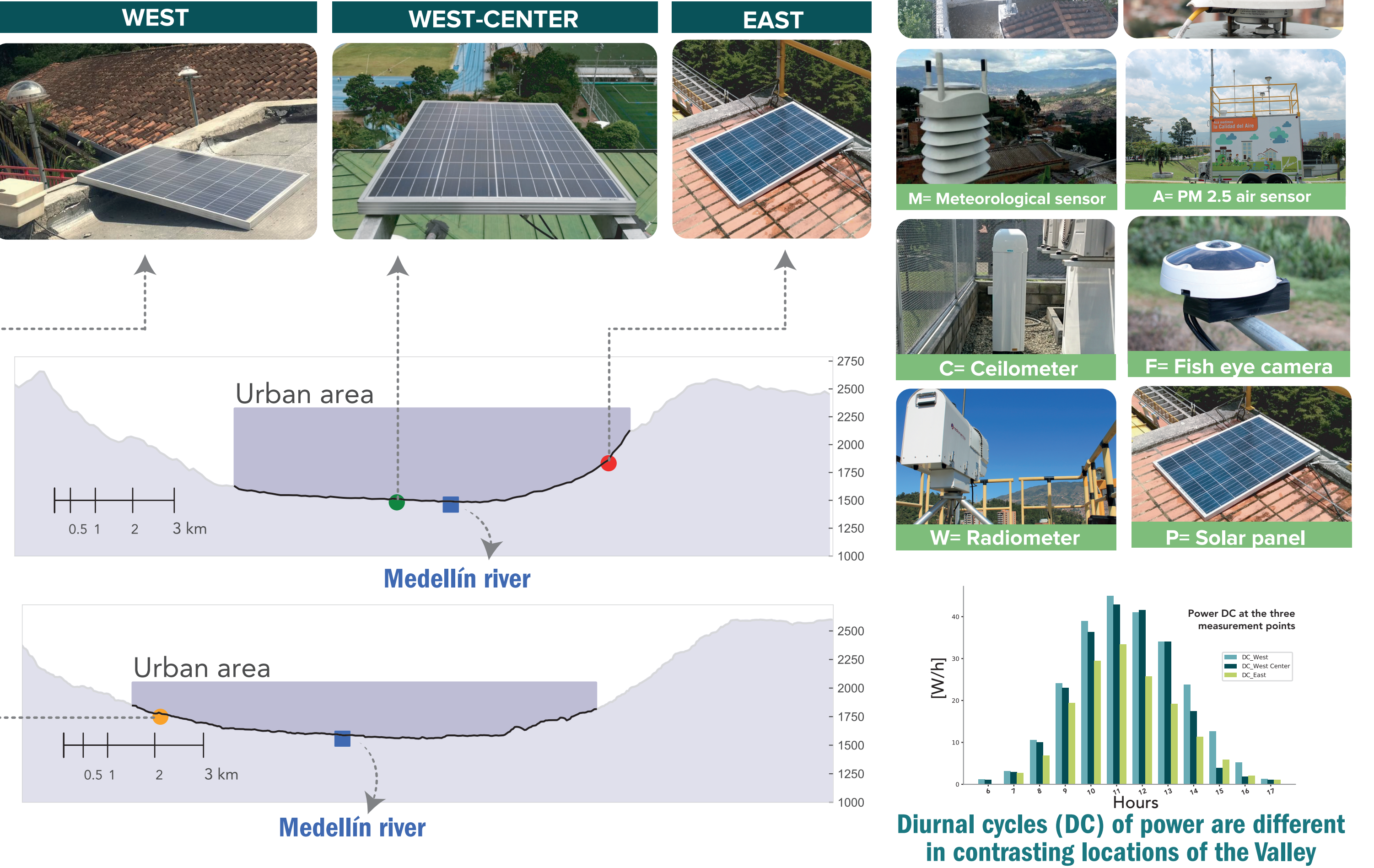
Reduction of surface solar radiation



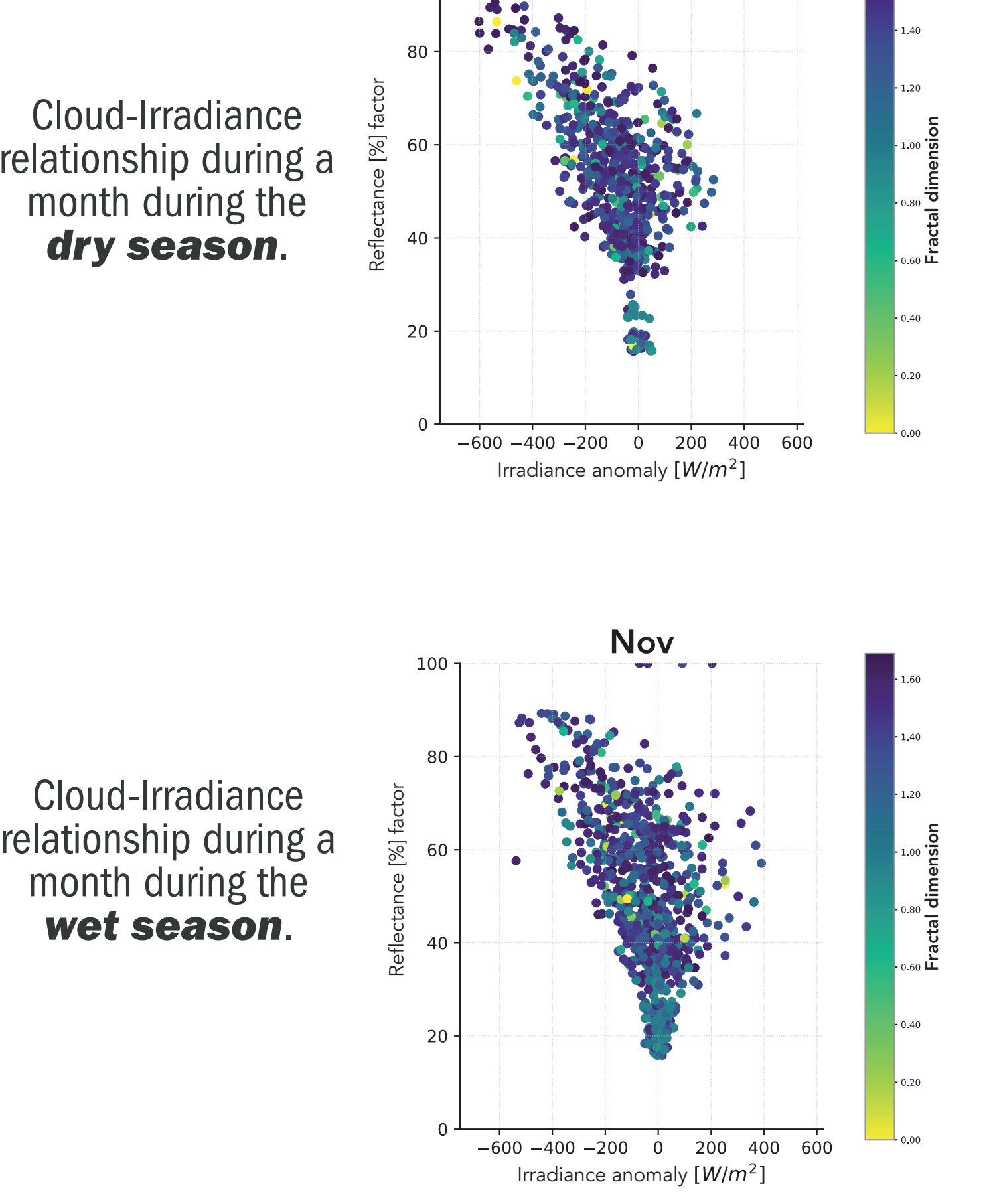
Clearness (Kt) & clear sky (Kt*) indexes



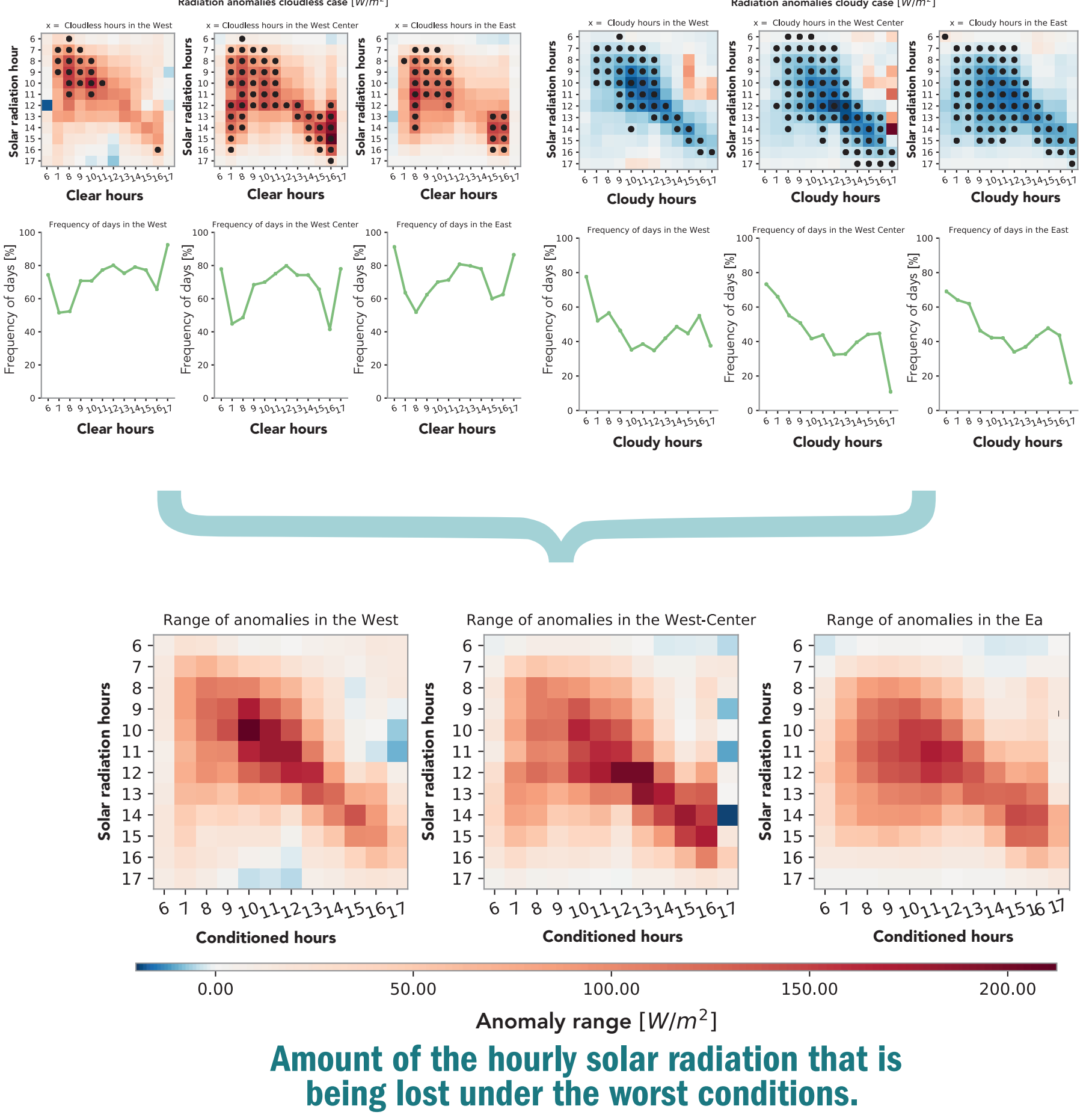
Data & methods



Clouds and irradiance anomalies



Irradiance anomalies composites



Conclusions

- Clouds are the main limiting factor for solar radiation and are more frequent during April and May in the morning hours. The typical cloud forcing magnitude is approximately 200 W/m².
- The slope of the adjustment line represents the efficiency of the solar panels at each point; according to this, the best performance is achieved at the west-center location.
- In all cases, the highest rates of variability of the Kt * index are between 0 and 0.3.

References

- [Data/information/map] obtained from the "Global Solar Atlas 2.0, a free, web-based application is developed and operated by the company Solargis s.r.o. on behalf of the World Bank Group, utilizing Solargis data, with funding provided by the Energy Sector Management Assistance Program (ESMAP). For additional information: <https://globalsolaratlas.info>
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Acknowledgments

This work was supported by Area Metropolitana de Medellín y del Valle de Aburrá, Municipio de Medellín, Grupo EPM, and ISAGEN under the contract CCT504 of 2019. Likewise, the Universidad Nacional de Colombia provided support to this work

Monthly & Hourly Frequency of Clouds

