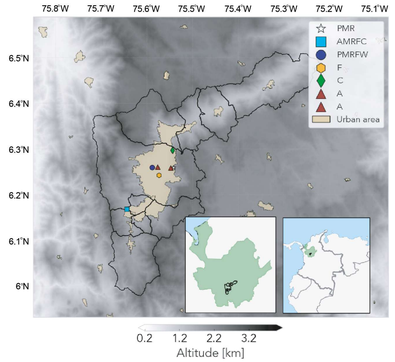
Weather Effects on the Efficiency of Photovoltaic Systems in Medellín, Colombia

Nathalia Correa Sánchez [1,2], Oscar J. Mesa Sánchez [2], Carlos D. Hoyos Ortíz [1,2]

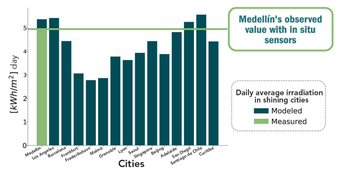
1.Sistema de Alerta Temprana de Medellín y el Valle de Aburrá

2.Universidad Nacional de Colombia, sede Medellín

Introduction



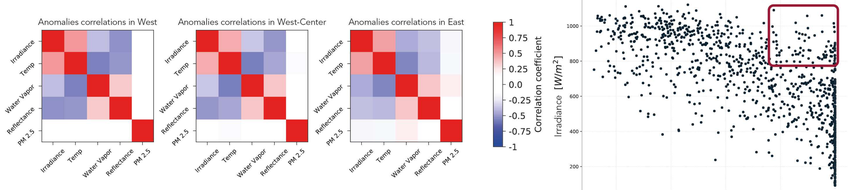
- Daily average Irradiance in Medellín exceeds that of most of the cities worldwide with photovoltaic (PV) systems over buildings.



- Colombia's energy matrix is 68% hydraulic, being vulnerable to periods with negative precipitation anomalies such as during El Niño events.

- Urban areas consume most of the electricity but they could also generate a significant amount using PV systems in a household or industries, reducing the vulnerability of the energetic system

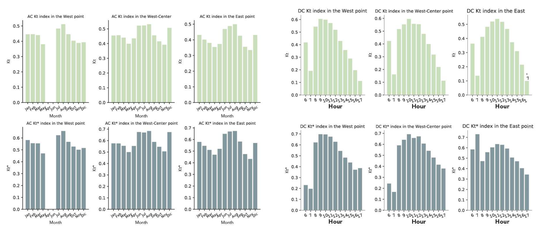
Reduction of surface solar radiation



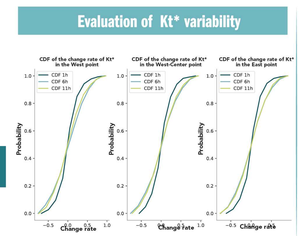
Clearness (Kt) & clear sky (Kt*) indexes

$Kt = \frac{\text{Measured Global Radiation}}{\text{Top Atmospheric Radiation}}$

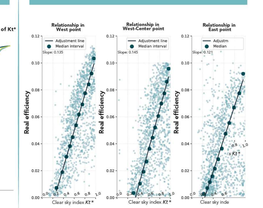
$Kt^* = \frac{\text{Measured Global Radiation}}{\text{Theoretical radiation in clear sky conditions}}$



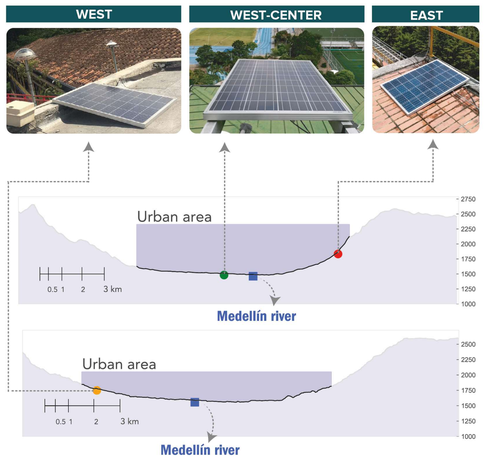
Evaluation of Kt* variability

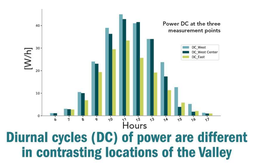


Experimental efficiency of the panels



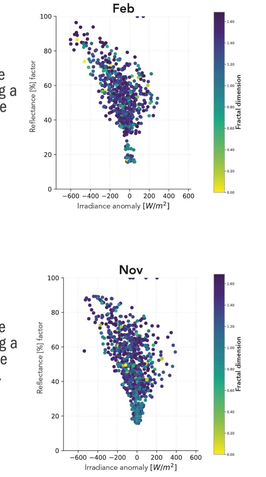
Data & methods





Diurnal cycles (DC) of power are different in contrasting locations of the Valley

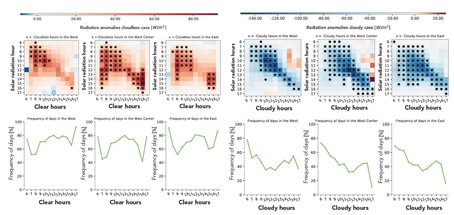
Clouds and irradiance anomalies

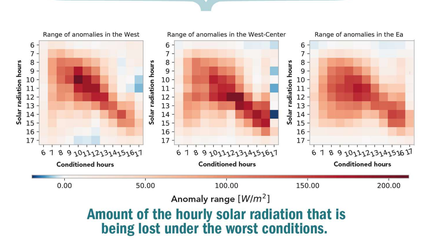


Cloud-Irradiance relationship during a month during the ***dry season***.

Cloud-Irradiance relationship during a month during the ***wet season***.

Irradiance anomalies composites



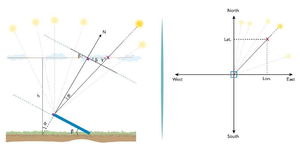


Amount of the hourly solar radiation that is being lost under the worst conditions.

Conclusions

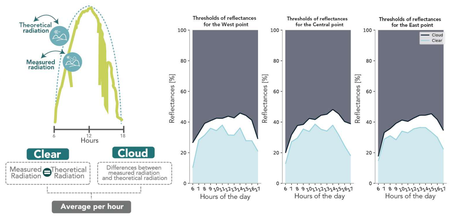
- Clouds are the main limiting factor for solar radiation and are more frequent during April and May in the morning hours. The typical cloud forcing magnitude is approximately 200 W/m2.
- The slope of the adjustment line represents the efficiency of the solar panels at each point; according to this, 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.

GOES Band 2 Pixel Selection

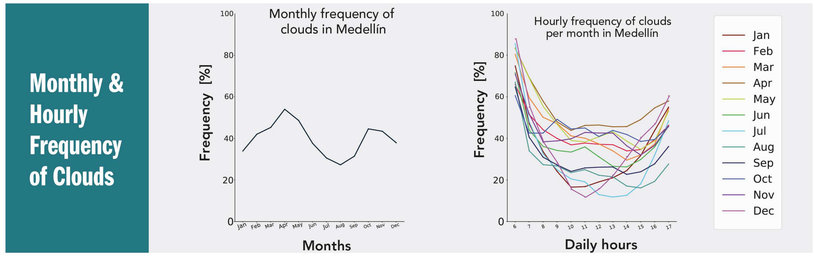


Pixels of the GOES image are selected considering the hourly solar incidence and average cloud height for each hour.

Reflectances Thresholds



Monthly & Hourly Frequency of Clouds



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

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Contact

Nathalia Correa

nacorreasa@unal.edu.co

ncorreas.siata@gmail.com