A deep learning framework for estimating global and diffuse solar irradiances using all-sky images

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Objective

The aim of the presented study is to model the global and diffuse solar irradiances (GHI and DHI) using all-sky images (ASI) and deep learning techniques (Convolutional Neural Network, CNN).

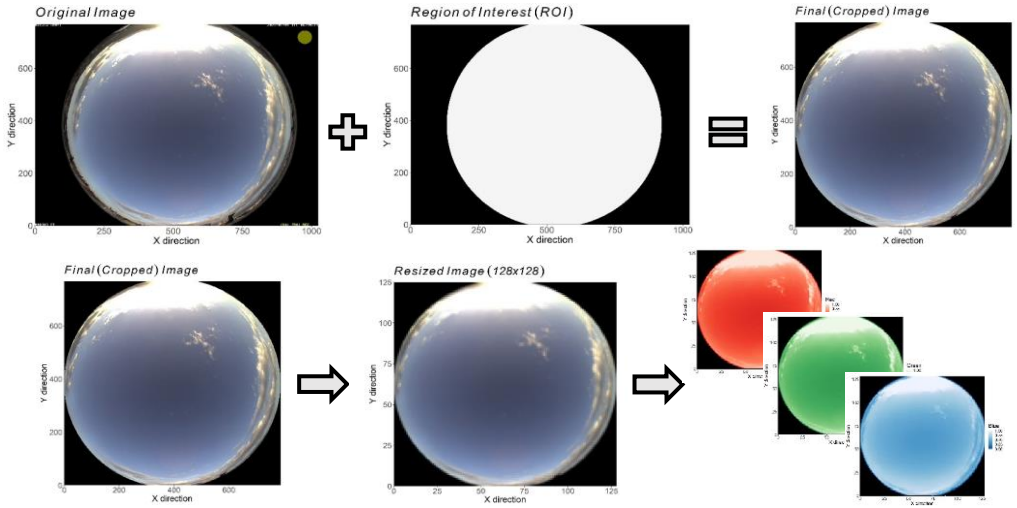
Data & Methodology

Measurement site:
Laboratory of Atmospheric Physics, University of Patras, Greece

Reference instrument:
Kipp & Zonen CMP11 pyranometers

All-sky imager:
Mobotix Q24M model

Model :
CAMS McClear model for clear-sky GHI (GHIc)



- **Data pre-processing**

RGB values are scaled to 0 – 1 by dividing with 255.

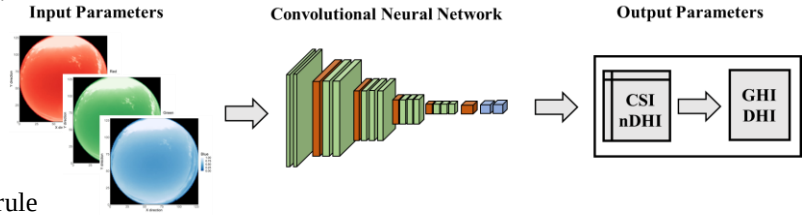
Normalized forms of GHI and DHI.

$$\mathbf{CSI} = \frac{\mathbf{GHI}}{\mathbf{GHIc}} \qquad \mathbf{nDHI} = \frac{\mathbf{DHI} - \mathbf{min(DHI)}}{\mathbf{max(DHI)} - \mathbf{min(DHI)}}$$

- **Data Spitting**

Training and Testing data sets using 70/30 rule

- **Data modelling**



Results

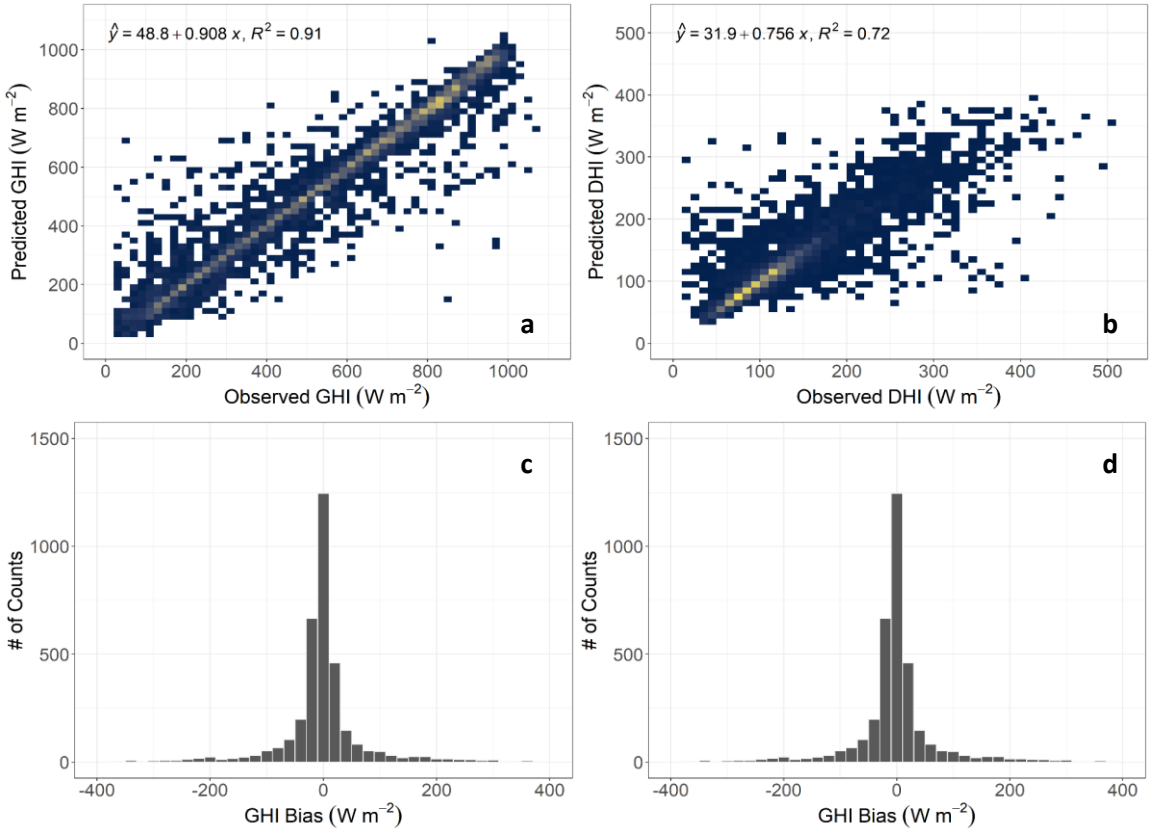


Figure 1: Scatter density plots between the observed and predicted (a) GHI and (b) DHI. Warm colors indicate higher data concentration. Frequency histograms of (c) GHI and (d) DHI differences (model – observations).

- ✓ The (relative) systematic errors are −1.8 W m^{-2} (−0.32%) for GHI and −0.5 W m^{-2} (−0.39%) for DHI.
- ✓ The (relative) dispersion errors are 82.7 W m^{-2} (15%) for GHI and 39.8 W m^{-2} (30%) for DHI.
- ✓ Zero-skewed, strongly peaked distributions of biases with a high concentration of values around zero. The significant number of values at the distribution tails explain the high dispersion errors.

Acknowledgments

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