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Forecasting Diffuse Solar Radiation

John Boland [a]

[a]*Industrial AI Research Centre, Adelaide University, Mawson Lakes, 5095*
Email: john.boland@unisa.edu.au

Abstract:

1 THE BOLAND-RIDLEY-LAURET DIFFUSE IRRADIATION MODEL

The decaying logistic form of the connection between the diffuse fraction and clearness index was described in Boland et al. (2008). The variables involved are defined as

$$d_t = \frac{DHI_t}{GHI_t} \quad (1)$$

$$k_t = \frac{GHI_t}{E_t} \quad (2)$$

In this, d_t is diffuse fraction and k_t is the clearness index at time t, DHI_t is the diffuse radiation on the horizontal plane and GHI_t is similar for global radiation, while E_t is the radiation at the top of the atmosphere at the same time. Additional predictors were added in Ridley et al. (2010), producing the BRL model, enhancing the skill of the model. The additional predictors are Apparent Solar Time (AST), solar altitude, the daily clearness index and a variable that is the mean of the clearness index values at the hour before and hour after. Note that these models were constructed for hourly data. Subsequent studies focused on minute data, where cloud enhancement effects are evident. At this time scale, one can have a clear sky directly above the location, with clouds in the surrounding sky dome, producing a lensing effect that increases the GHI.

When performing resource assessment for tilted collectors, such as in solar farms, or rooftop solar, one needs an estimate of the radiation on that tilted plane. However, the only measured data at meteorological stations is GHI. The chain of steps to get an estimate on a tilted surface follows the algorithm below.

- Use the BRL model to predict the DHI from the GHI.
- Calculate the direct radiation on the horizontal and then use trigonometry to get the direct radiation on the tilted plane.
- Use the Perez et al. (1990) model to obtain the diffuse on the tilted plane and then add that to the direct to get the global on that plane.

However, to forecast the operation of a titled solar array, one can not use the BRL model in this form since it requires knowledge of the diffuse radiation for the whole day and also the clearness index for a time in the future of the time that the prediction is for. This study adjusts the diffuse radiation model to make it usable for forecasting. This is needed since the forecasting tools in the literature only pertain to the GHI, and thus are not usable for forecasting for tilted arrays.

Keywords: *Diffuse irradiation, forecasting, diffuse fraction, clearness index, tilted collectors*

2 Forecasting diffuse radiation

The BRL model for predicting the diffuse fraction from multiple predictors is shown in Figure 1. It is not suitable for forecasting, so we alter it to use lagged values of diffuse predictions and GHI, plus present values of solar altitude and apparent solar time. Note that it would seem that only one of the two latter ones are needed, but since in general the atmosphere for the hours past solar noon are more turbid, the two variables do explain different phenomena. We compare the performance of the model with a model using measured lagged values of diffuse radiation. There are a few sites in Australia where all three components of solar radiation are measured so we use one of these for our test bed.

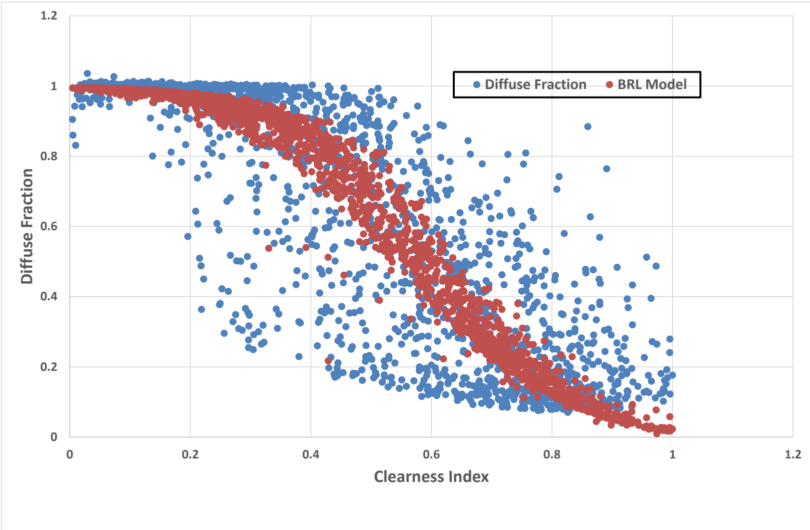

Figure 1. **Boland-Ridlay-Lauret Diffuse Irradiation Model**

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