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LEPTEN
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VALIDATION OF THE BRL DIFFUSE RADIATION MODEL AGAINST BSRN FLO DATA

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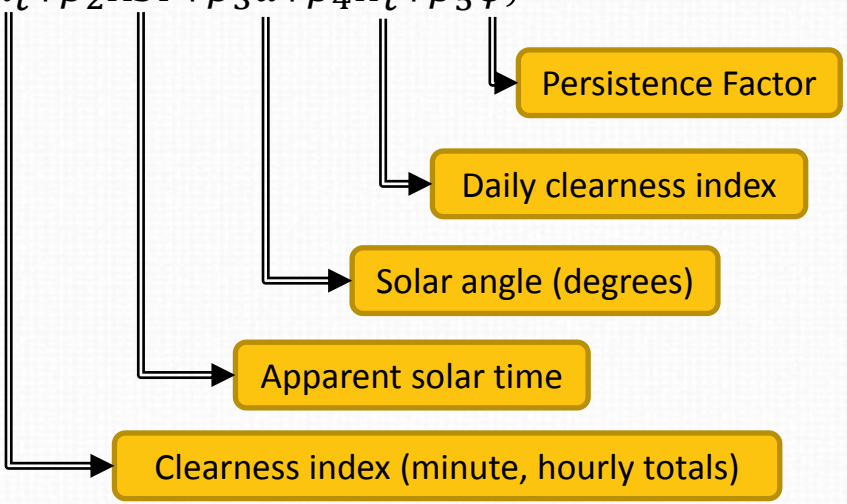
Boland et. al. (2010) developed a model to estimate the diffuse radiation fraction, validated for Australia. A logistic function is proposed instead of a piecewise linear or simple nonlinear functions, as made by Erbs et. al. (1982) and other authors

The present study focuses on the validation of the BRL model, as a first step for building a model for Brazilian conditions

The BRL multiple predictor logistic model

- $$d = \frac{1}{1+e^{(\beta_0+\beta_1 k_t+\beta_2 AST+\beta_3 \alpha+\beta_4 K_t+\beta_5 \psi)}}$$



The BRL multiple predictor logistic model

- Multiple predictors better fit the spread of the data
  - $d = \frac{1}{1+e^{(\beta_0+\beta_1 k_t+\beta_2 AST+\beta_3 \alpha+\beta_4 K_t+\beta_5 \psi)}}$

- AST → asymmetric – differences in the atmosphere between morning and afternoon
- α → altitude angle (path of the sun through the atmosphere)
- K_t → the whole day may have a common characteristic
- ψ → $\psi = \begin{cases} (k_{t-1} + k_{t+1})/2 & sr < t < ss \\ k_{t+1} & t = sunrise \\ k_{t-1} & t = sunset \end{cases}$ the inertia of the atmosphere – lagged clearness index

The BRL multiple predictor logistic model

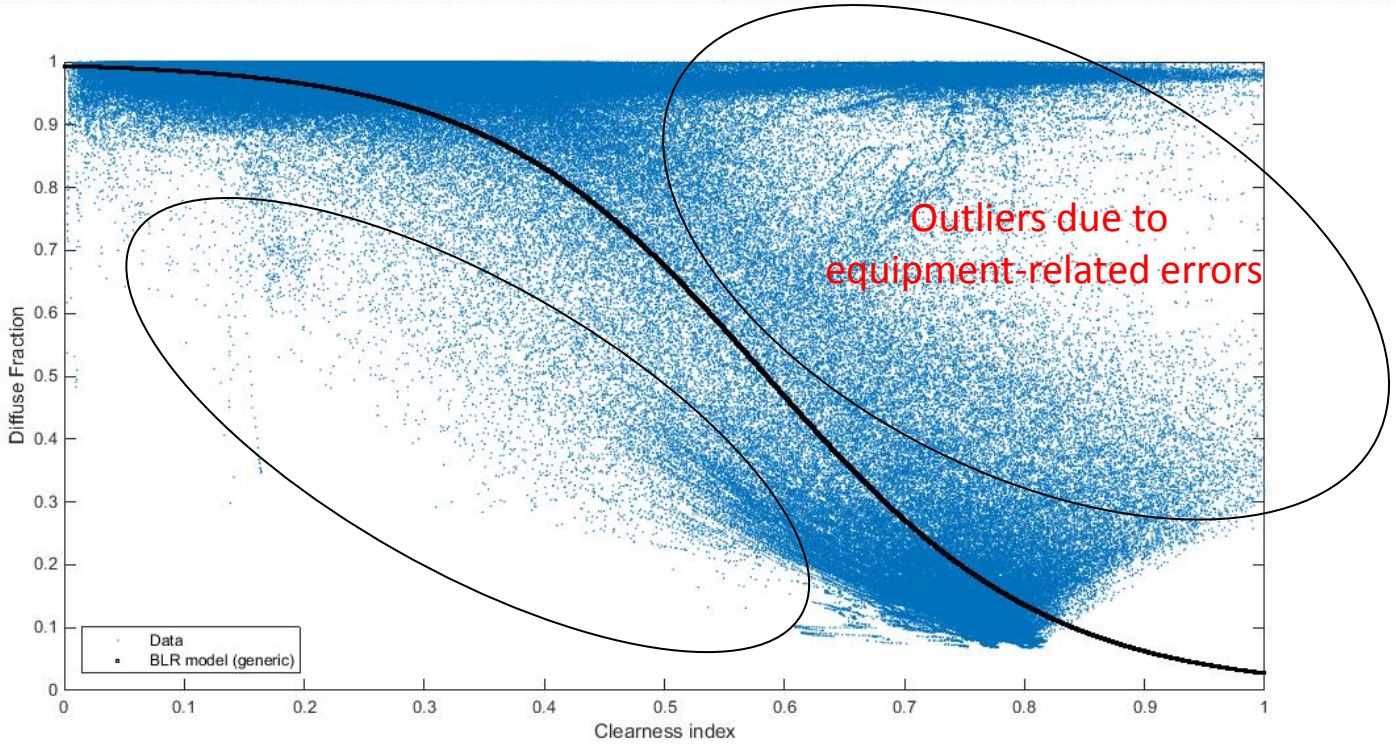
- BRL model → Generic logistic model
- $\beta_0, \beta_1, \beta_2, \beta_3, \beta_4 \; and \; \beta_5$ → calculated from amalgamating data from seven locations (Adelaide, Darwin, Maputo, Backnell, Lisbon, Macau an Uccle)
- $d = \frac{1}{1+e^{(-5.38+6.63k_t+0.006AST-0.007\alpha+1.75K_t+1.31\psi)}}$

BSRN FLO

- Data from:
  - 07/1994 – 04/2002 → Qualified
  - 04/2002 – 09/2013 → Data measured, but under analysis
  - 09/2013 – 03/2016 → Qualified (renewed station)

Results

- Considering all period
- Flagged as Qualified (Quality Control)

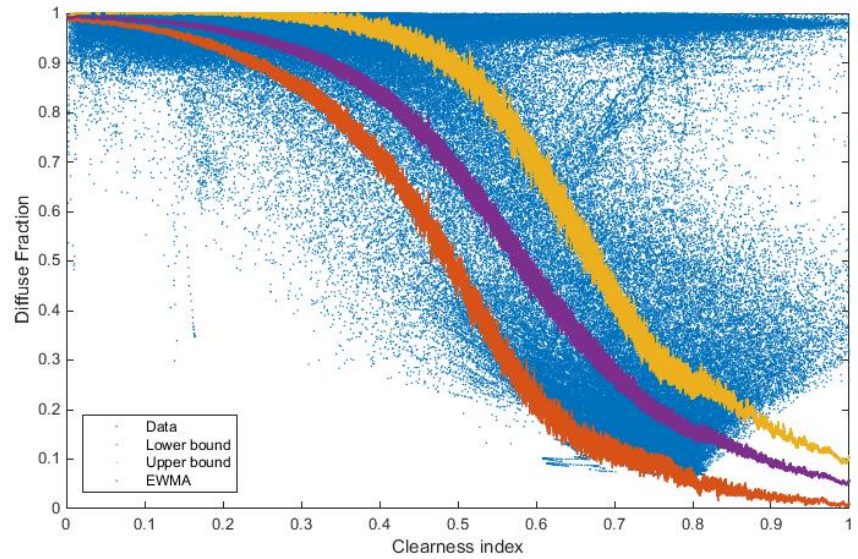


$$d = \frac{1}{1 + e^{-5.0033 + 8.6025 k_t}}$$

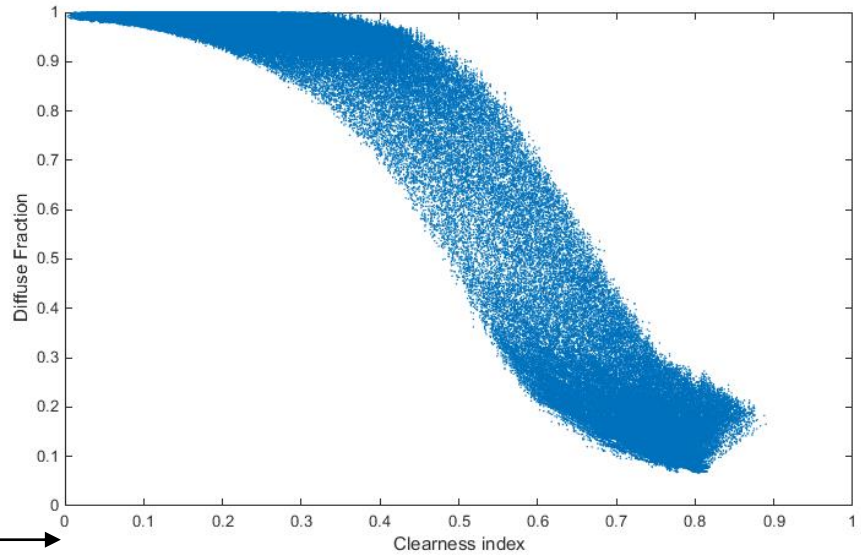
BRL model (generic), Boland et. al. (2008,2010)

Results

- Removing Outliers - “Removing values that may be wrong”
  - Quadratic programming, least squares empirical likelihood Boland et. al. (2008)
    - Unfeasible due the large amount of data
  - As suggested by Boland:
    - Used Exponentially Weighted Moving Average (EWMA) and Exponentially Weighted Moving Variance (EWMV) of the BRL model
    - Calculate the lower and upper bounds of a “Diffuse fraction vs Clearness index Envelope” Younes et. al. (2005)

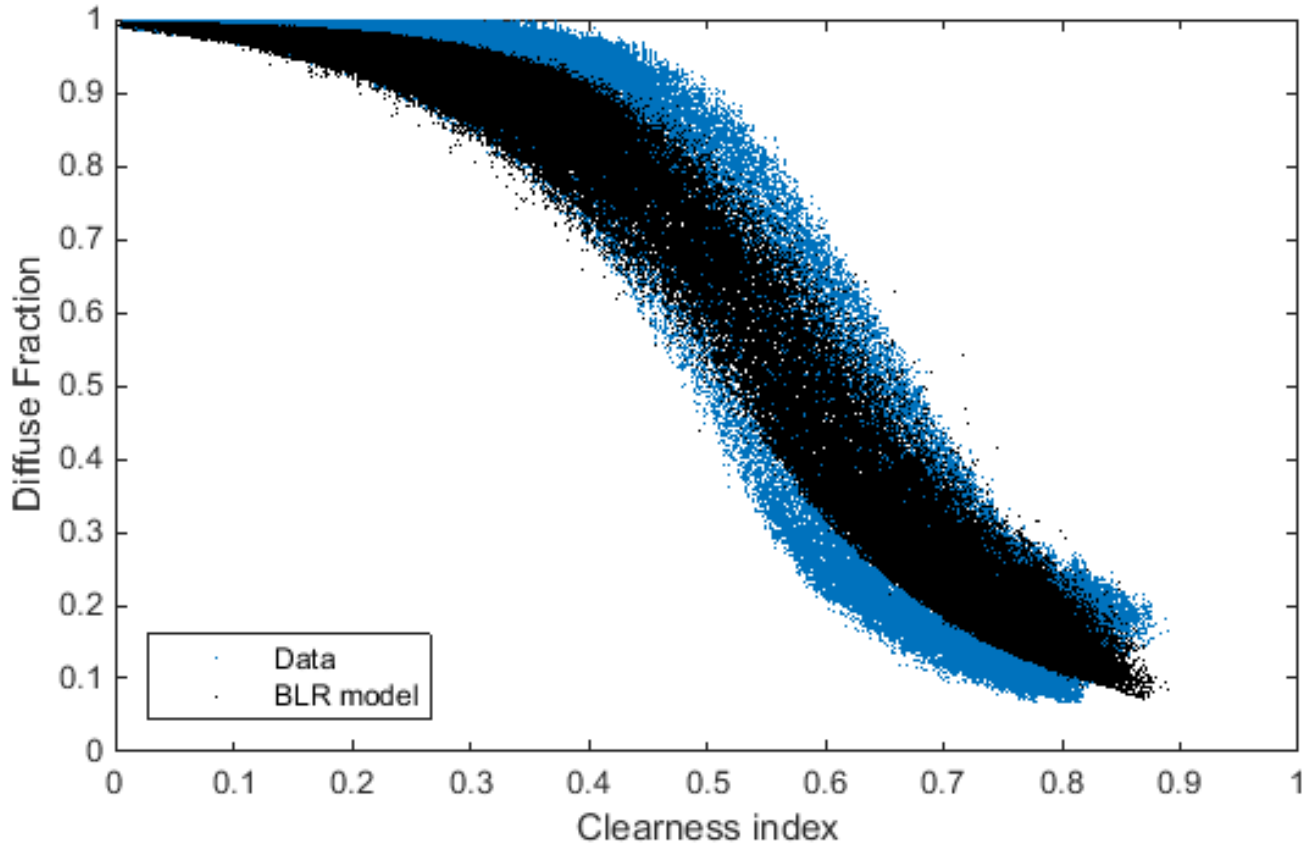


Removing the outliers



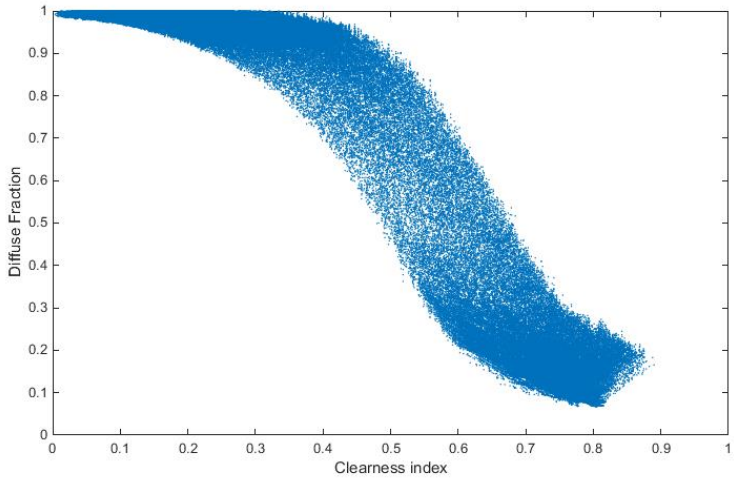
Results

- Results using the validated BRL model



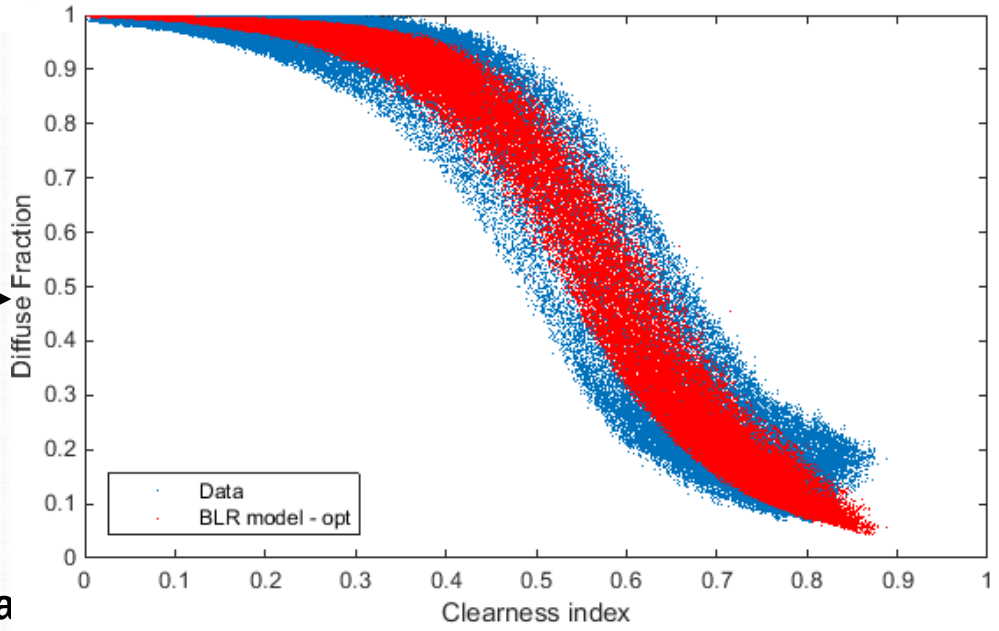
Results

- Puling 2/3 of data to calibrate the model (random choice)



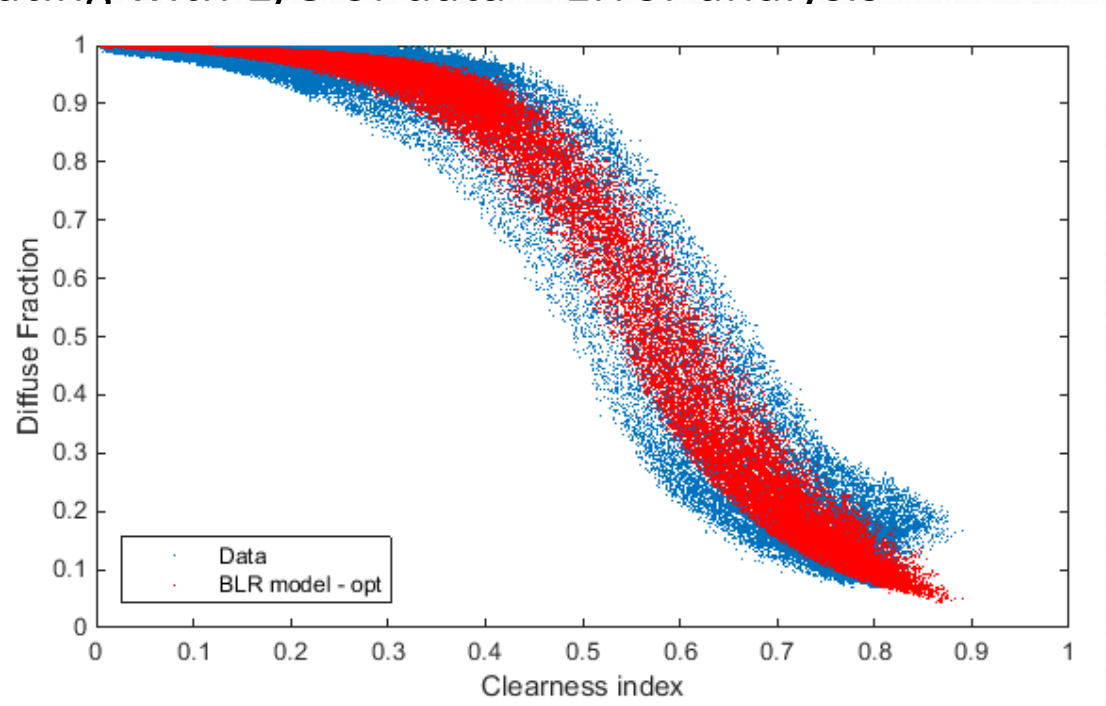
	BRL model	Model parameters for Florianopolis
β_0	-5.3796	-6.7025
β_1	6.6316	9.2319
β_2	0.006	0.0085
β_3	-0.0077	-0.0082
β_4	1.75	1.8263
β_5	1.3066	0.7875

Calculating $\beta_0, \beta_1, \beta_2, \beta_3, \beta_4$ *and* β_5 With **Nonlinear least-squares solver** (with 2/3 of data)



Results

- Validating with 1/3 of data – Error analysis



	BRL Model	BRL - FLO	
MAD (-)	0.31734	0.34343	Mean absolute deviation
MBE (-)	-0.00643	-0.0002	Mean bias error
MeAPE (%)	5.517	3.3777	Median absolute percentage error
nRMSE (%)	9.589	8.1754	Normalized root mean square error

References

- Ridley, B., Boland, J., and Lauret, P., 2010, "Modelling of diffuse solar fraction with multiple predictors," Renew. Energy, **35**(2), pp. 478–483.
- Erbs, D. G., Klein, S. A., and Duffie, J. A., 1982, "Estimation of the diffuse radiation fraction for hourly, daily and monthly-average global radiation," Sol. Energy, **28**(4), pp. 293–302.
- Boland, J., and Ridley, B., 2008, "Models of diffuse solar fraction," Model. Sol. Radiat. Earth's Surf. Recent Adv., **33**, pp. 193–219.
- Younes, S., Claywell, R., and Muneer, T., 2005, "Quality control of solar radiation data: Present status and proposed new approaches," Energy, **30**(9 SPEC. ISS.), pp. 1533–1549.

THANK YOU !

Sunset at Ribeirão da Ilha – Florianópolis - SC