Supplement of Atmos. Chem. Phys., 20, 3439–3458, 2020
https://doi.org/10.5194/acp-20-3439-2020-supplement

Atmospheric Chemistry and Physics
Open Access
EGU

Supplement of

Characterization of the radiative impact of aerosols on CO_2 and energy fluxes in the Amazon deforestation arch using artificial neural networks

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Supplement material

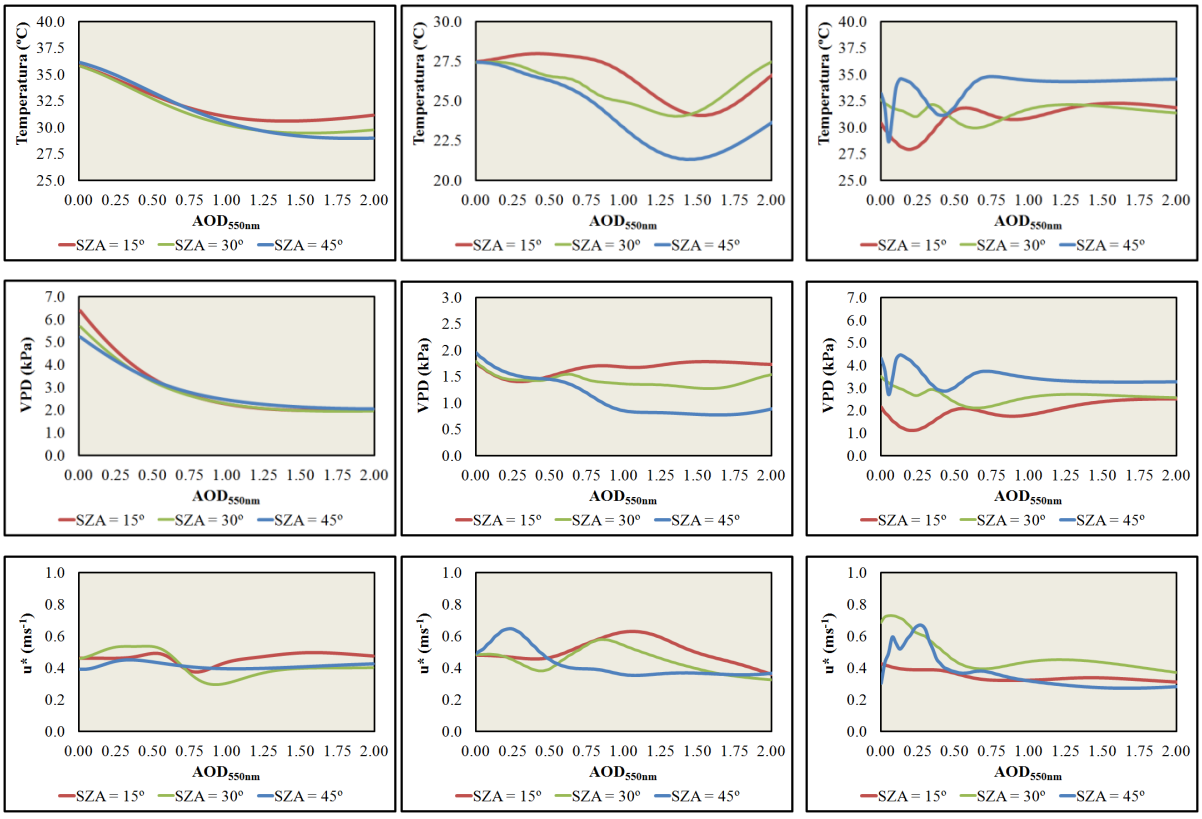

Figure 1: Temperature (ºC), VPD (kPa), and friction velocity (u*, ms-1) calculated through ANNs varying with AOD_{550nm}. ANNs were used with values of PAR_i, PAR_{dif} generated by libRadtran, for three SZAs (15º, 30º, and 45°), for all three study sites.

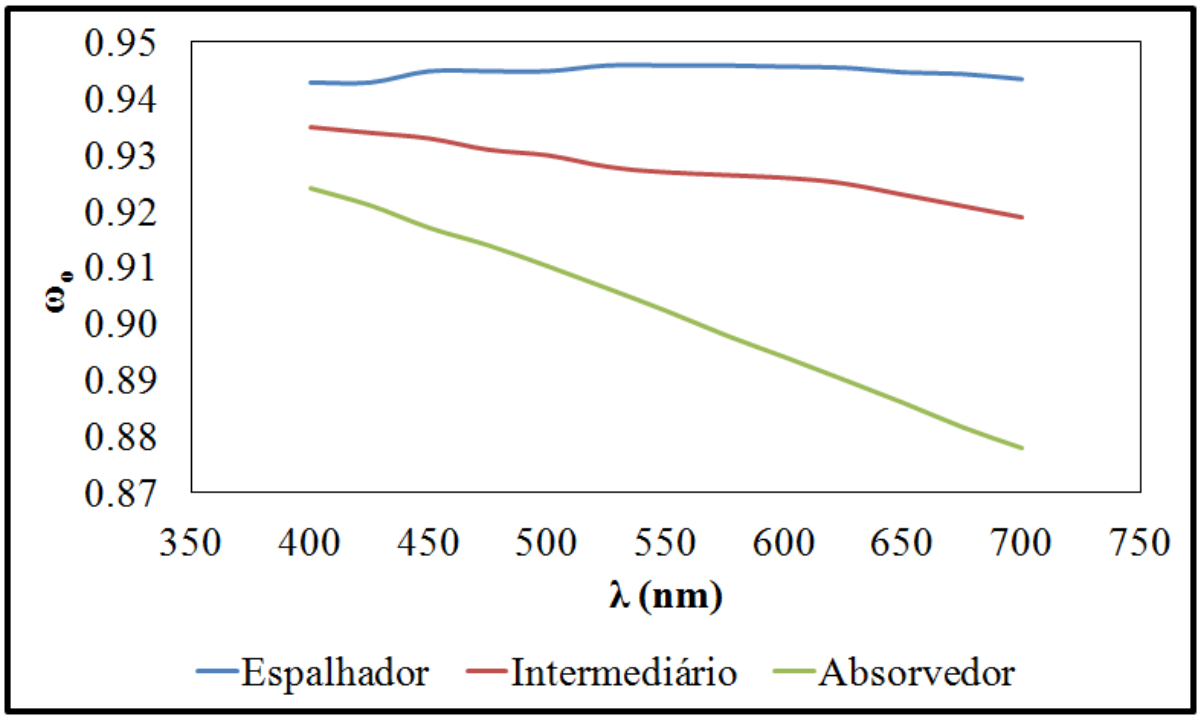

Figure 2: Spectral single scattering albedo (ω_0) as a function of the wavelength λ (nm), in three different types of aerosol: scattering, intermediate, and absorbing. These functions were developed based on the Mie theory from AERONET data for three study sites in the South of the Amazon basin (Rosário et al. (2011)).

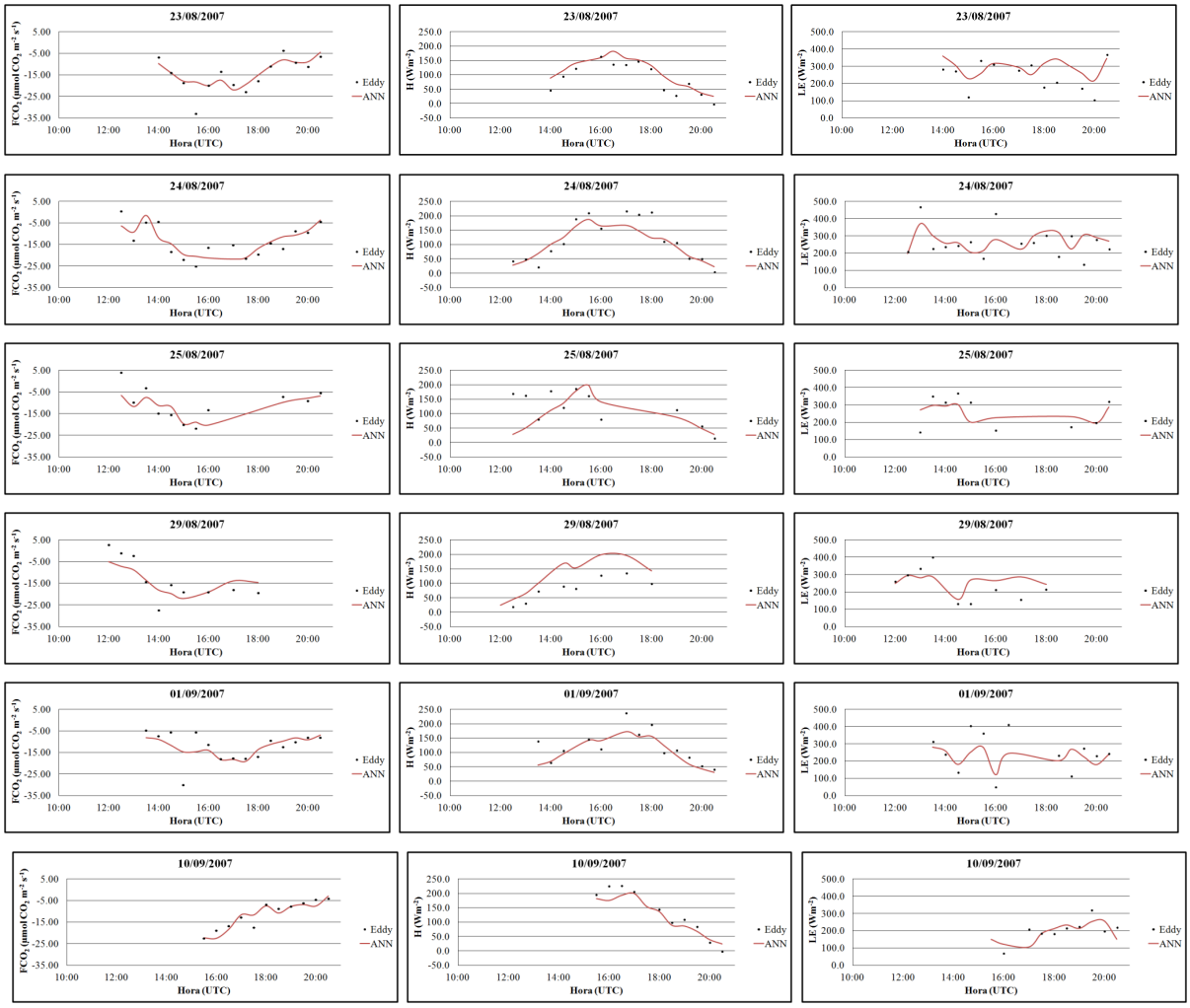

Figure 3: Diurnal cycle of FCO_2 (μmol CO_2 $m^{-2}s^{-1}$), H (W/m²), and LE (W/m²) calculated from flux tower data through eddy covariance (black dots) and modelled by ANNs (red line) for 6 days (23rd Aug, 24th Aug, 25th Aug, 29th Aug, 01st Sep, and 10th Sep) over the dry season of 2007 in Rebio Jaru.

Table 1: Statistical indices generated from the comparison between observed variables T, VPD and u* (validation group) and the modelled ones by the ANNs, for all three experimental sites.

	Bananal Island - TO			Rebio Jaru - RO			Sinop - MT		
	T	**VPD**	**u***	**T**	**VPD**	**u***	**T**	**VPD**	**u***
Pearson coefficient	0.57	0.92	0.49	0.68	0.93	0.57	0.47	0.91	0.64
RMSE	2.11	0.39	0.15	1.76	0.21	0.12	2.33	0.42	0.14
MAE	1.70	0.34	0.13	1.41	0.17	0.10	1.73	0.37	0.11
Relative deviation	0.07%	1.19%	0.65%	0,22%	0.22%	2.09%	0.07%	0.13%	0.02%

Table 2: FCO_2 generated from ANNs for the three study sites and respective errors associated with the validation data.

	Ilha do Bananal - TO	Rebio Jaru - RO	Sinop - MT
Number of *Inputs*	330	162	237
		Data	
Mean	-7.1	-12.4	-17.3
Standard deviation	2.4	5.0	3.7
Maximum value	-1.2	0.7	-9.7
Minimum value	-14.3	-22.5	-28.3
		Coefficients	
Pearson	0.57	0.82	0.58
RMSE	3.20	4.29	5.69
MAE	2.43	3.62	4.78

Table 3: ANNs for the three experimental sites with output variable, the type of ANN (MPL vs. RBF) and the number of input – intermediate – output variables, training method, error function, intermediate function, and output function

Site	Output variable	ANN	Training	Error	Intermediate	Output
Bananal Island	FCO_2	RBF 7-30-1	RBFT	SOS1	Gaussian	Identity
	T	MLP 3-3-1	BFGS2 22	SOS	Seno	Tanh
	VPD	MLP 4-3-1	BFGS 17	SOS	Tanh	Exponential
	u*	RBF 5-30-1	RBFT	SOS	Gaussian	Identity
Rebio Jaru	FCO_2	RBF 7-19-1	RBFT	SOS	Gaussian	Identity
	T	MLP 3-3-1	BFGS 38	SOS	Tanh	Tanh
	VPD	RBF 4-27-1	RBFT	SOS	Gaussian	Identity
	u*	RBF 5-27-1	RBFT	SOS	Gaussian	Identity
Sinop	FCO_2	RBF 7-21-1	RBFT	SOS	Gaussian	Identity
	T	RBF 3-30-1	RBFT	SOS	Gaussian	Identity
	VPD	MLP 4-8-1	BFGS 93	SOS	Exponential	Identity
	u*	RBF 5-30-1	RBFT	SOS	Gaussian	Identity

[1] SOS stands for "*Sum-of-Squares*", which is the sum of squares of the error, to all output units.

[2] BFGS stands for "*Broyden-Fletcher-Goldfarb-Shanno*", which is a second order training algorithm with very fast convergence and high memory demand.