

Supplementary Material for "Disentangling the seasonality effects of malaria transmission in the Brazilian Amazon basin"

S.1 Analysis of notification data and extra results

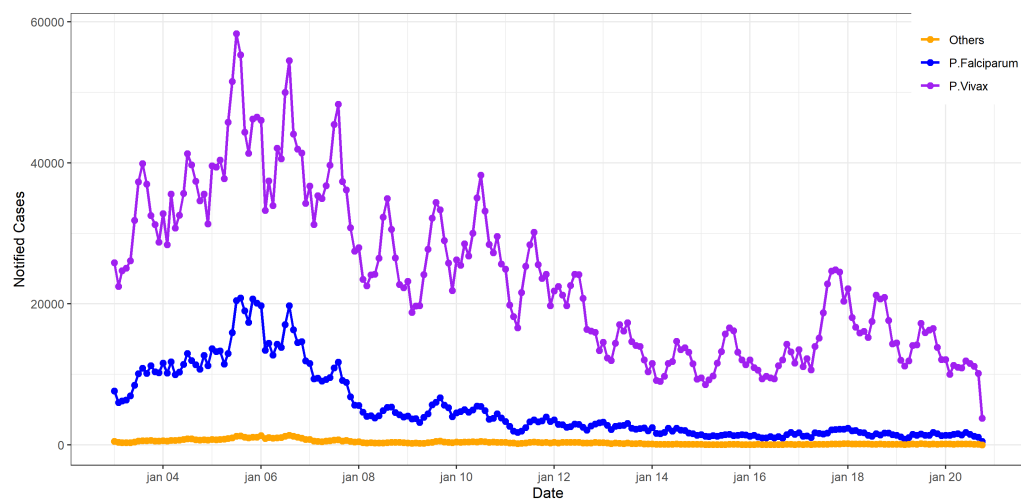
In Fig. S.1a it is clear that the majority of cases through all the analyzed time series refer to *P. vivax* cases, with the *P. falciparum* being the second most parasite present in the amazon region, with other parasites being present in few cases when compared to *P. vivax* (such as *P. malarie* and *P. ovale*).

The age stratification shown in Fig. S.1b marks younger-age groups to be the most affected groups, with an descending order of magnitude parallel to ascending age, that is, older age groups were less affected by malaria through the analyzed time series.

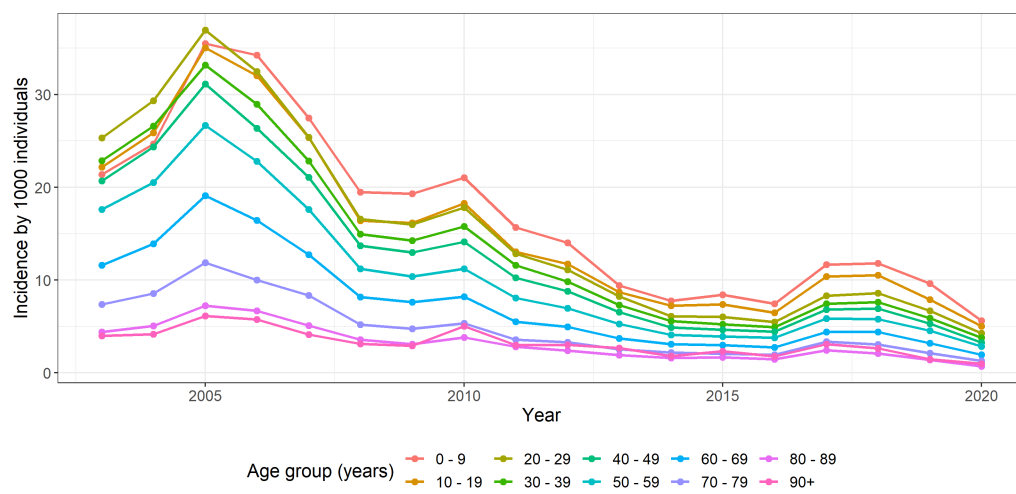
Regarding the higher incidence of individuals of the male sex, this is reported by other authors[1, 2] which point that, as the Amazon region has any extractive activities in the forest region, and the main workers of these activities are of the male sex, it is expected that these individuals will have a higher incidence, therefore, occupational exposure would be an important factor to describe malaria incidence in the Amazon region.

Regarding the higher incidence in younger age groups, similar patterns are present in other regions. One of the possible hypothesis to explain this pattern is the development of clinical immunity through ageing [3].

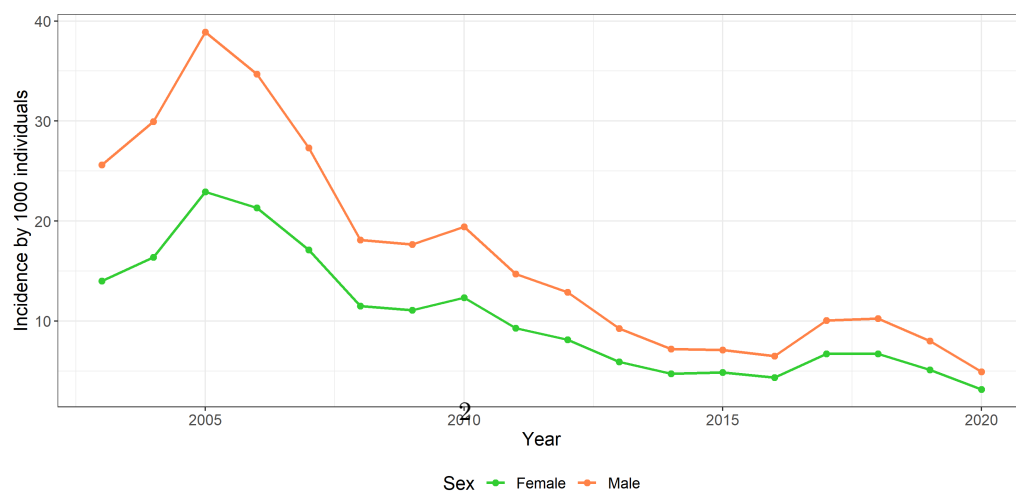
S.6 shows for Macapá and Manaus that Rainfall is mostly out-of-phase in relation to notification data, and that the Mean Temperature is mostly in-phase. However, for Cruzeiro do Sul, it is shown that this difference is not so pronounced regarding Rainfall and Mean Temperature. Although there are different patters regarding the in-phase/out-of-phase relations between climactic variables and notification data in the brazilian amazon region, the mean average phase difference across the analyzed cities regarding rainfall and notification data for all the analyzed period is 0.51 with a mean standard deviation of 0.93, while the mean average phase difference regarding temperature is -0.14, with a mean standard deviation of 0.69. This result shows that, despite the heterogeneity, rainfall, in the brazilian amazon region, when considering only the capitolos of the states within it, is more out-of-phase with notification data



(a)

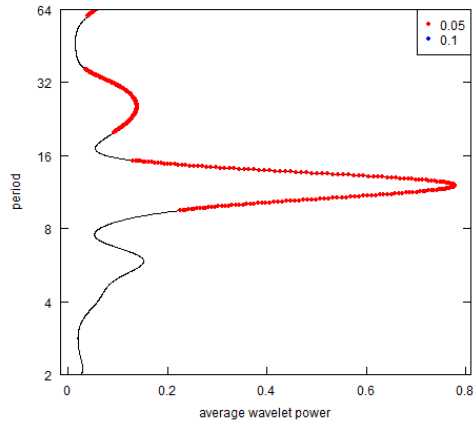


(b)

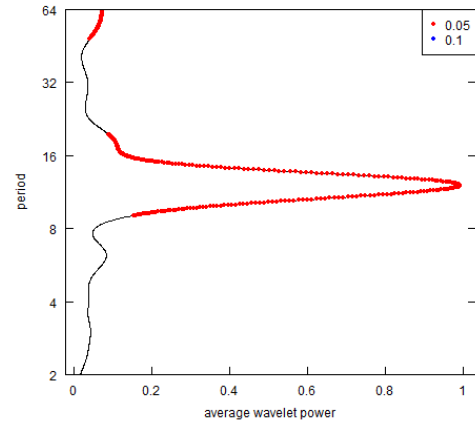


(c)

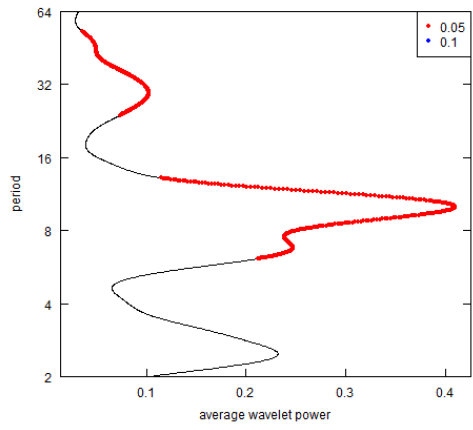
Figure S.1: Analysis of malaria notification data.



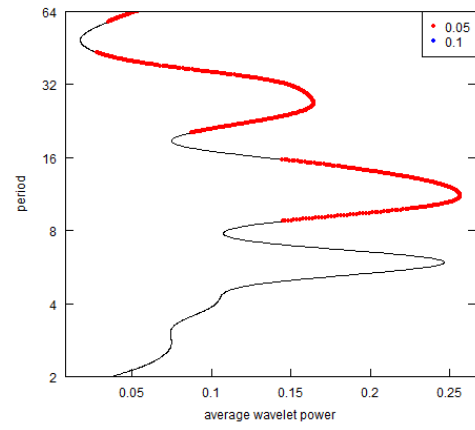
(a) Amazonas



(b) Amapá



(c) Tocantins



(d) Mato Grosso

Figure S.2: Monthly Average Power Spectra for four different states of the Amazon region

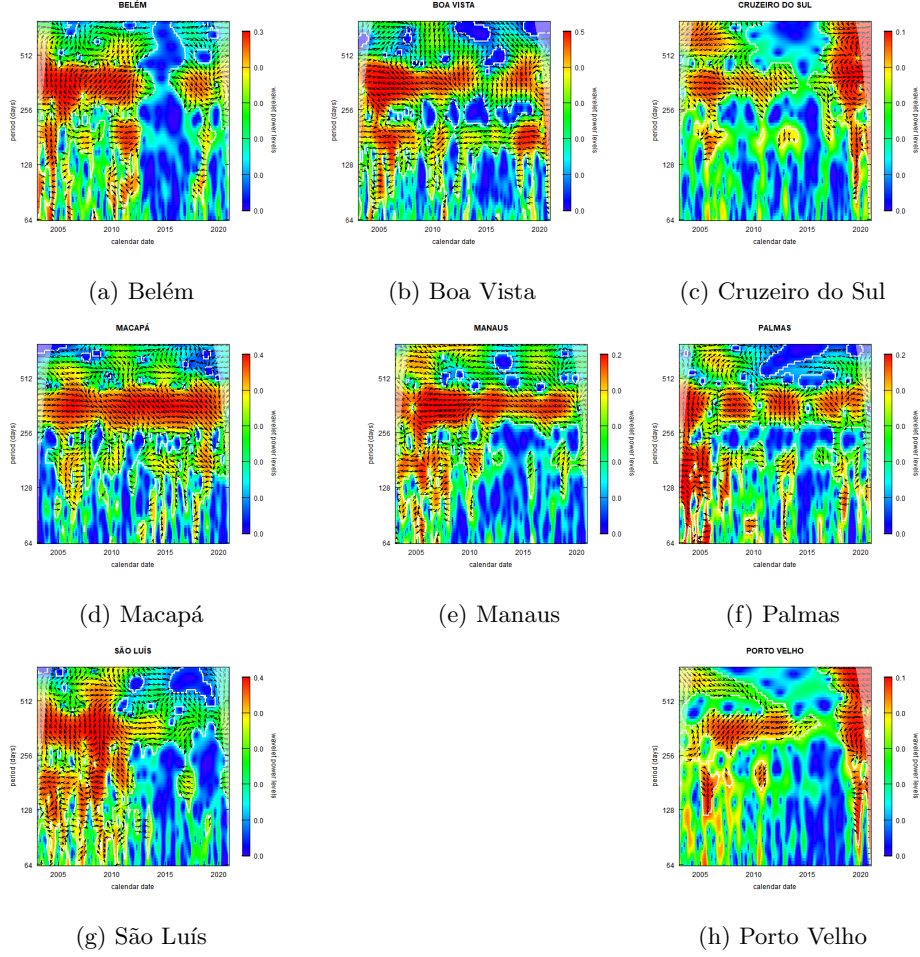


Figure S.3: Wavelet Cross-Power Analysis with daily notification data related to the mean daily temperature for the capitols of each state of the Brazilian Amazon region.

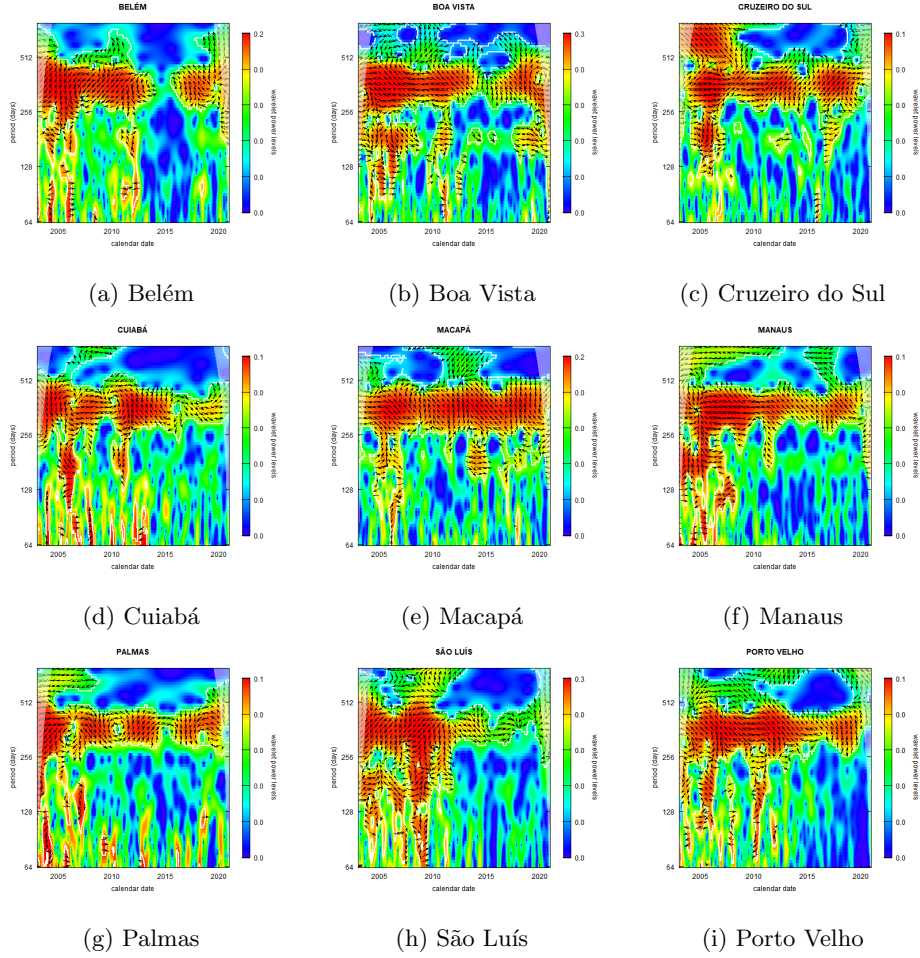


Figure S.4: Wavelet Cross-Power Analysis with daily notification data related to the daily rainfall for the capitols of each state of the Brazilian Amazon region.

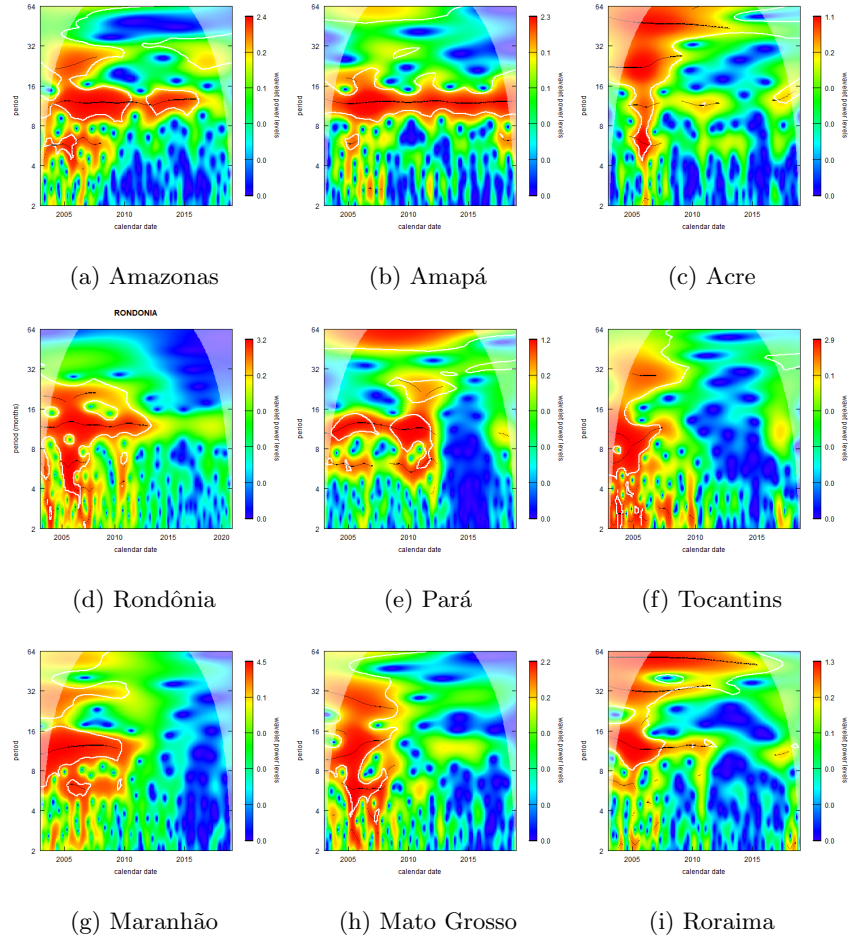
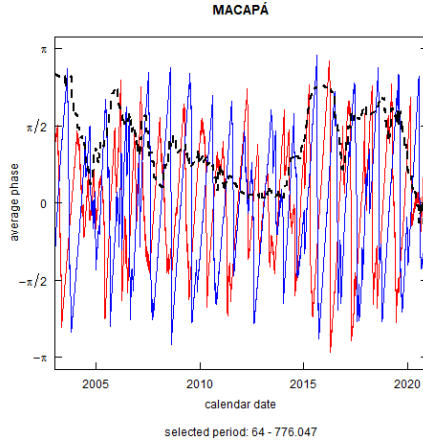
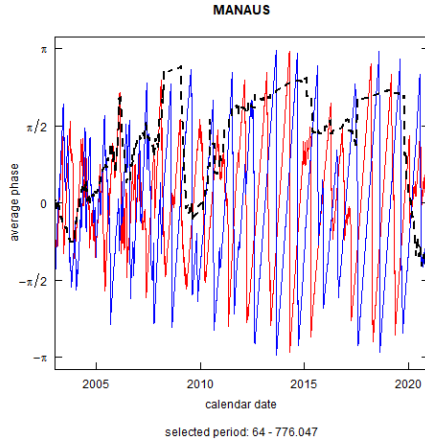


Figure S.5: Monthly Wavelet Power Spectra for different states of the Amazon region

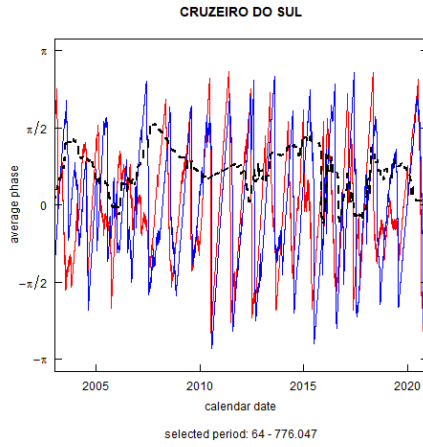
when compared to mean temperature.



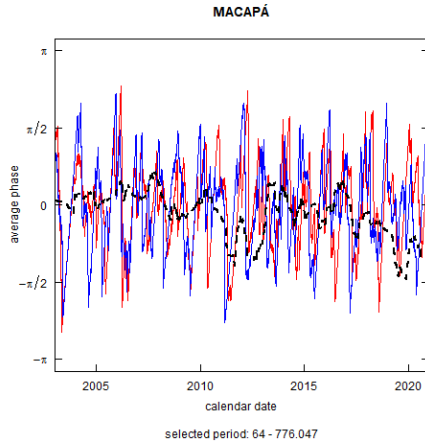
(a) Rainfall / Macapá



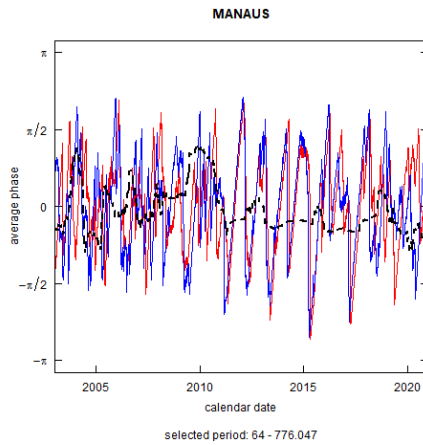
(b) Rainfall / Manaus



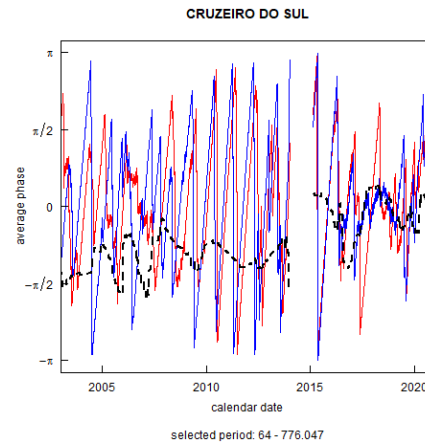
(c) Rainfall / Cruzeiro do Sul



(d) Mean Temperature / Macapá



(e) Mean Temperature / Manaus



(f) Mean Temperature / Cruzeiro do Sul

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Figure S.6: Phase Difference for Rainfall and Notification Data (a,b), and for Mean Temperature and Notification Data (c,d), using daily data in Macapá and Manaus along the analyzed time period.

References

- [1] Souza PF, Xavier DR, Suarez Mutis MC, da Mota JC, Peiter PC, de Matos VP, et al. Spatial spread of malaria and economic frontier expansion in the Brazilian Amazon. *Plos one*. 2019;14(6):e0217615.
- [2] Corder RM, Paula GA, Pincelli A, Ferreira MU. Statistical modeling of surveillance data to identify correlates of urban malaria risk: A population-based study in the Amazon Basin. *PloS one*. 2019;14(8):e0220980.
- [3] Ladeia-Andrade S, Ferreira MU, de Carvalho ME, Curado I, Coura JR. Age-dependent acquisition of protective immunity to malaria in riverine populations of the Amazon Basin of Brazil. *The American journal of tropical medicine and hygiene*. 2009;80(3):452–459.