



The Effect of Rainfall Gradients on Gross Primary Productivity (GPP) across the Isthmus of Panama

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Abstract

The Functionally-Assembled Terrestrial Ecosystem Simulator (FATES) model, developed at Berkeley Lab, represents carbon cycle and ecosystem dynamics of tropical forests under different environmental regimes. In this analysis, we characterized climate data measured from three sites (Parque Nacional Metropolitano (PNM), Barro Colorado Island (BCI), and Parque Nacional San Lorenzo (SLZ)) occurring along a rainfall gradient in Panama. We used FATES to examined the effect different rainfall regimes has on predictions of gross primary productivity (GPP) and above ground biomass (AGB). We found as precipitation increased GPP increased between the three sites, and we found no differences in wet season GPP per leaf area across sites, indicating solar radiation (SR) is driving differences in GPP across the rainfall gradients sites. We also found canopy biomass was highest at SLZ, BCI then PNM during the wet season. However, understory biomass had a declining effect across all sites in the wet season. This work assists in the development and evaluation of the FATES model and aids in predicting the impacts of climate change on tropical forest ecosystem processes and functions.

Background

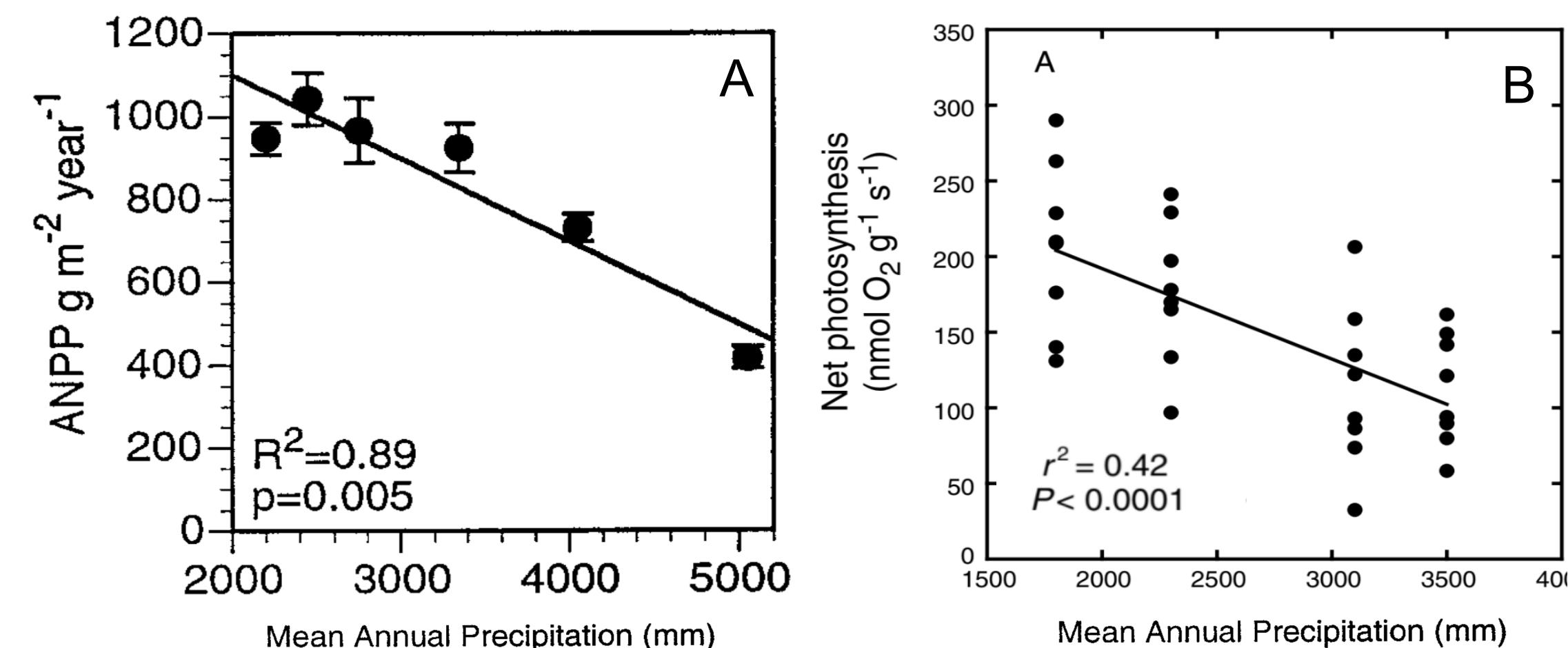


Figure 1: (A) Schuur & Mason, 2001 *Oecologia* indicated that as a Hawaiian rainfall gradient increased, ANPP decreased. (B) Santiago & Mulkey, 2005 *Trees* similarly indicated that as a Panama rainfall gradient increased, net photosynthesis decreased.

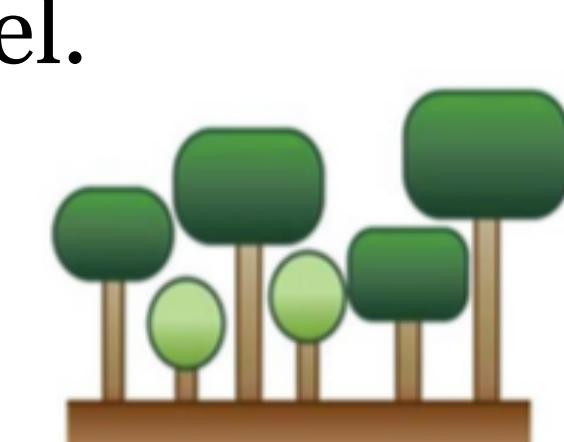
Table 1: Annual rainfall from the 3 rainfall gradient sites in Panama, data provided by the Smithsonian Tropical Research Institute, 2007.

Sites	Annual Rainfall (mm y^{-1})	Abbreviation
Parque Nacional Metropolitano	1800	PNM
Barro Colorado Island	2600	BCI
San Lorenzo	3000	SLZ

Methods

For all sites:

- Describe locally observed meteorological data (Smithsonian Tropical Research Institute, Panama)
- Simulate GPP with the FATES model.



FATES simulates structured forests comprised of functionally different tree species.



Results

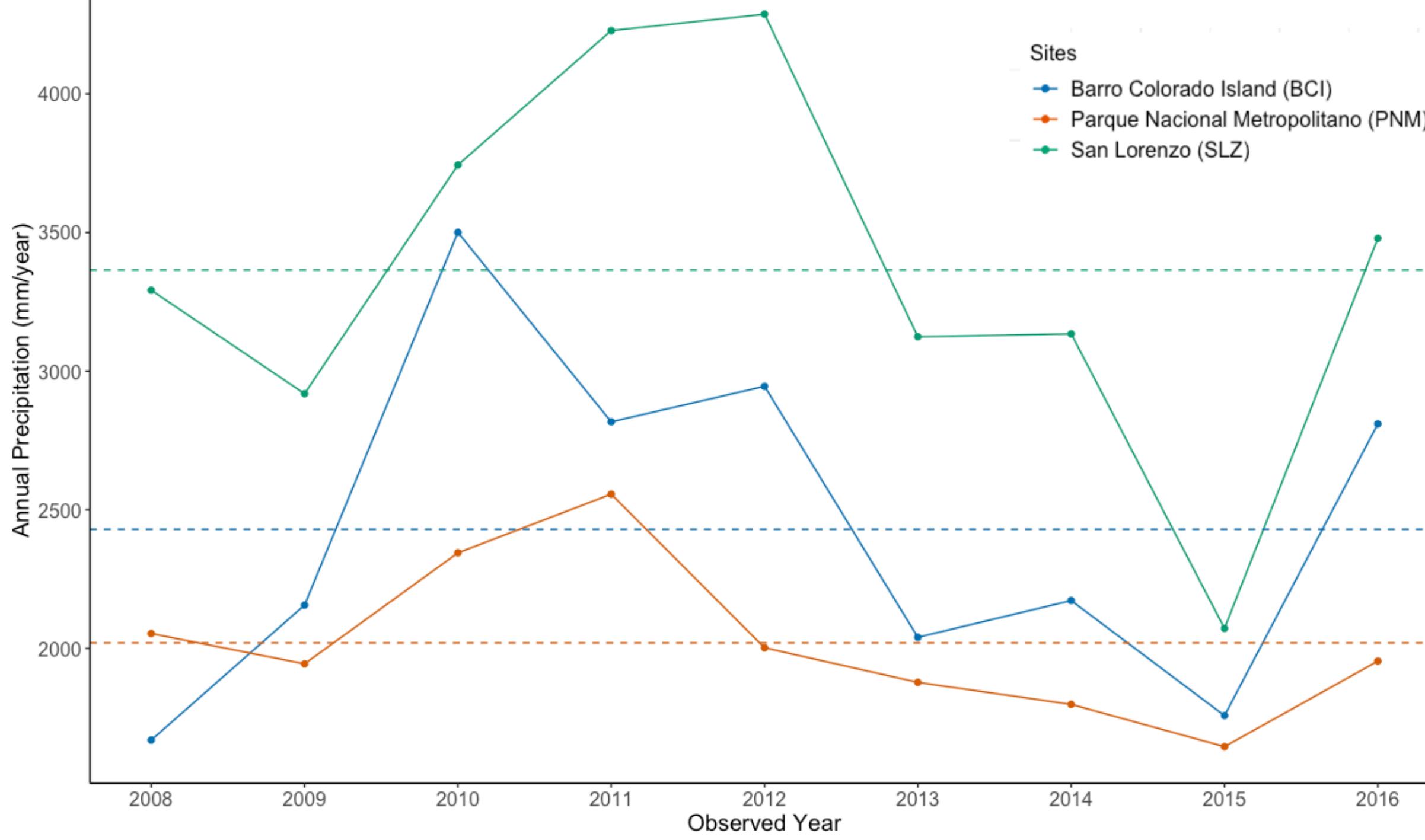


Figure 2: Annual precipitation (mm/year) across the three sites from 2008-2016. Colored dashed line indicates the average precipitation for designated site from 2008-2016.

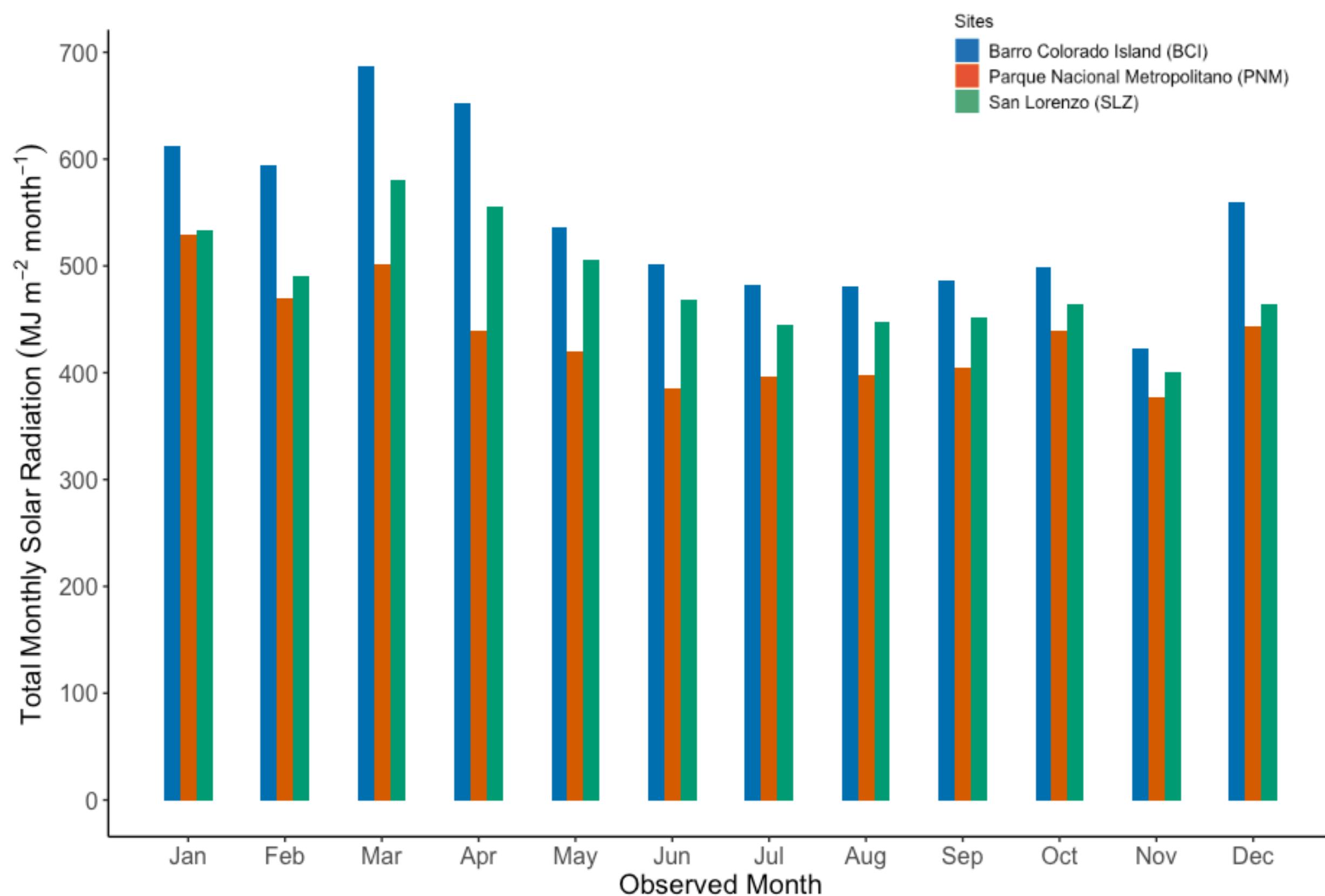


Figure 3: Total monthly solar radiation ($MJ m^{-2} month^{-1}$) across the three sites from 2008-2016.



Figure 4: Interannual variability of GPP from 2008 -2016 from FATES model output

Discussion/Conclusion

Climatology Across Sites

- Average annual precipitation was 2020, 2430 and 3365 mm/year for PNM, BCI and SLZ, respectively (2008-2016).
- BCI had greatest count of small rainfall events and SLZ had more larger rainfall events
- PNM = highest maximum interannual temperatures and SLZ = lowest maximum interannual temperatures
- Annual SR: BCI > SLZ > PNM from 2008-2016. Cloud cover or SR sensor error at PNM?

FATES Model Output

- Annual GPP: SLZ > BCI > PNM
- No differences in wet season GPP per unit leaf area across sites (Fig. 5)
- Canopy biomass : SLZ > BCI > PNM during the wet season
- Understory biomass had declining effect across all sites in the wet season.

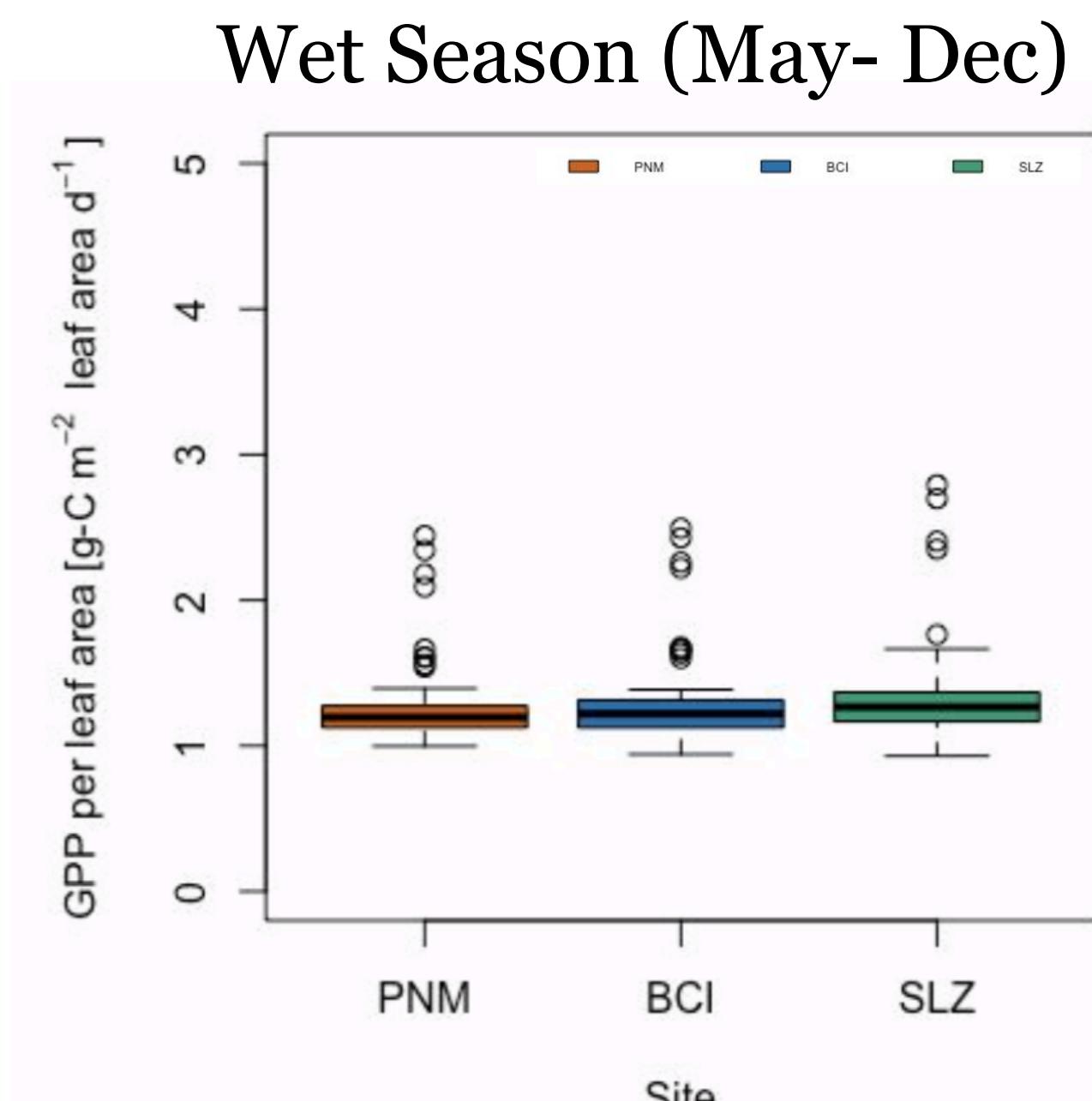
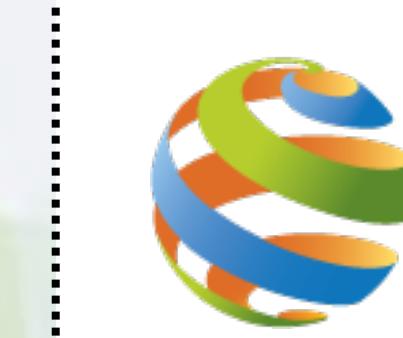


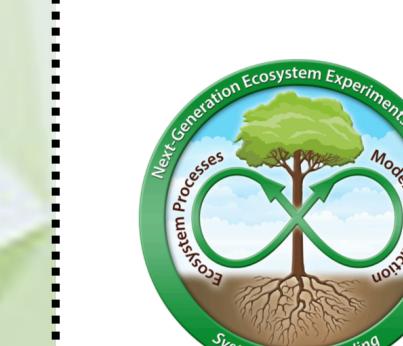
Figure 5: GPP per unit leaf area ($g\text{-C m}^{-2} \text{leaf area d}^{-1}$) across the three sites

Acknowledgements

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