

# Seasonal, not annual precipitation drives community productivity across ecosystems

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## Introduction

Understanding drivers of aboveground net primary production (ANPP) has long been a goal of ecology. Decades of investigation have shown total annual precipitation to be an important determinant of ANPP within and across ecosystems. However recent individual site studies have shown precipitation during specific seasons of the year can more effectively predict ANPP. We evaluated whether seasonal or total precipitation better predicted ANPP across a range of terrestrial ecosystems, from deserts to forests.

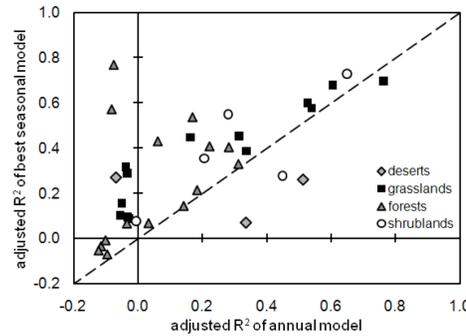
## Methods

We constructed 17 models that used precipitation during different periods of the year and combination of those periods to explain variation in ANPP and used AIC to determine which models were best supported. We also determined whether ANPP responses were dependent on ecosystem type or plant functional group.

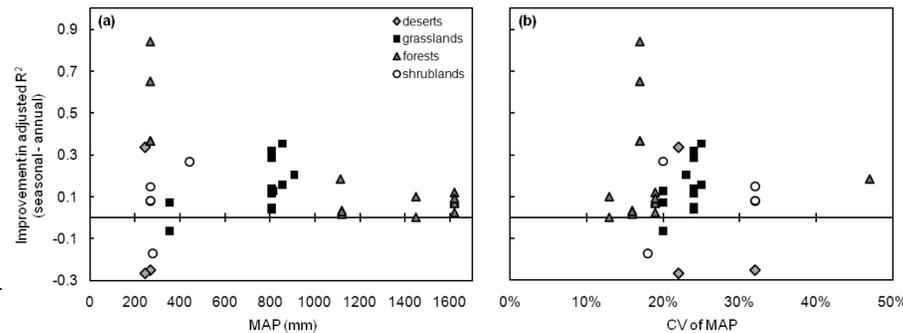
#	Model	Description
1	ANPP=p1	pre-season only
2	ANPP=p2	early growing season only
3	ANPP=p3	mid-growing season only
4	ANPP=p4	late growing season only
5	ANPP=p2+p3	early & mid-season
5a	ANPP=p2+p3+p2*p3	early & mid-season, plus interaction
6	ANPP=p3+p4	mid- & late growing season
6a	ANPP=p3+p4+p3*p4	mid- & late season, plus interaction
7	ANPP=p1+p2	pre-season & early growing season
7a	ANPP=p1+p2+p1*p2	pre-season & early season & interaction
8	ANPP=p0	dormant season only
9	ANPP=p2+p3+p4	all 3 segments of the growing season
9a	ANPP=p2+p3+p4+p2*p3+p3*p4	all 3 segments of the season, & interactions
10	ANPP=p0+p1+p2+p3+p4	all 5 segments of the year
10a	ANPP=p0+p1+p2+p3+p4+p1*p2+p2*p3+p3*p4	all 5 segments of the year, plus interactions
11	ANPP=pt	total yearly precipitation
12	ANPP=pg	total growing season precipitation

## Results

We found that seasonal precipitation generally explained ANPP better than total precipitation, but that responsiveness to seasonal precipitation was not correlated with ecosystem type or plant functional group. Precipitation in multiple parts of the growing season often correlated with ANPP, but rarely interacted with each other.



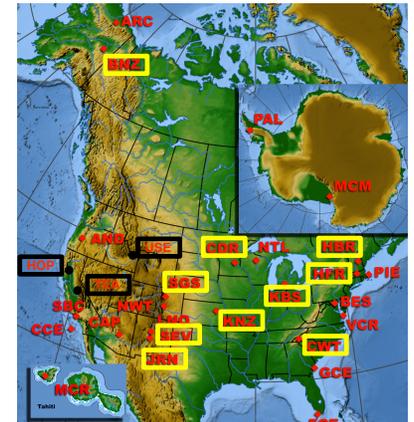
Comparison of the performance of the best seasonal model with a model that uses only total annual precipitation to predict ANPP. Dashed line indicates the 1:1 line, above which ANPP is better predicted by seasonal precipitation and below which ANPP is better predicted by total annual precipitation.



Improvement across all communities of the best seasonal model over the model including only total annual precipitation in predicting ANPP versus (a) mean annual precipitation and (b) the CV of annual precipitation. ANPP in communities with positive improvement values are best predicted by seasonal precipitation while ANPP in communities with negative improvement values are best predicted by total annual precipitation.

## Synthesis

Examining seasonal precipitation can significantly improve ANPP predictions across a broad range of ecosystems and plant types, with implications for understanding current and future ANPP variation. Further work examining precipitation timing relative to species phenology may further improve climate change predictions.



Sites used in the analyses. Yellow boxes denote LTER sites, black boxes indicate other data sources.

### Acknowledgements

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