The Role of Localized Circulations in Driving Spatial Variability in Deep Tropical Convection

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Work In Progress

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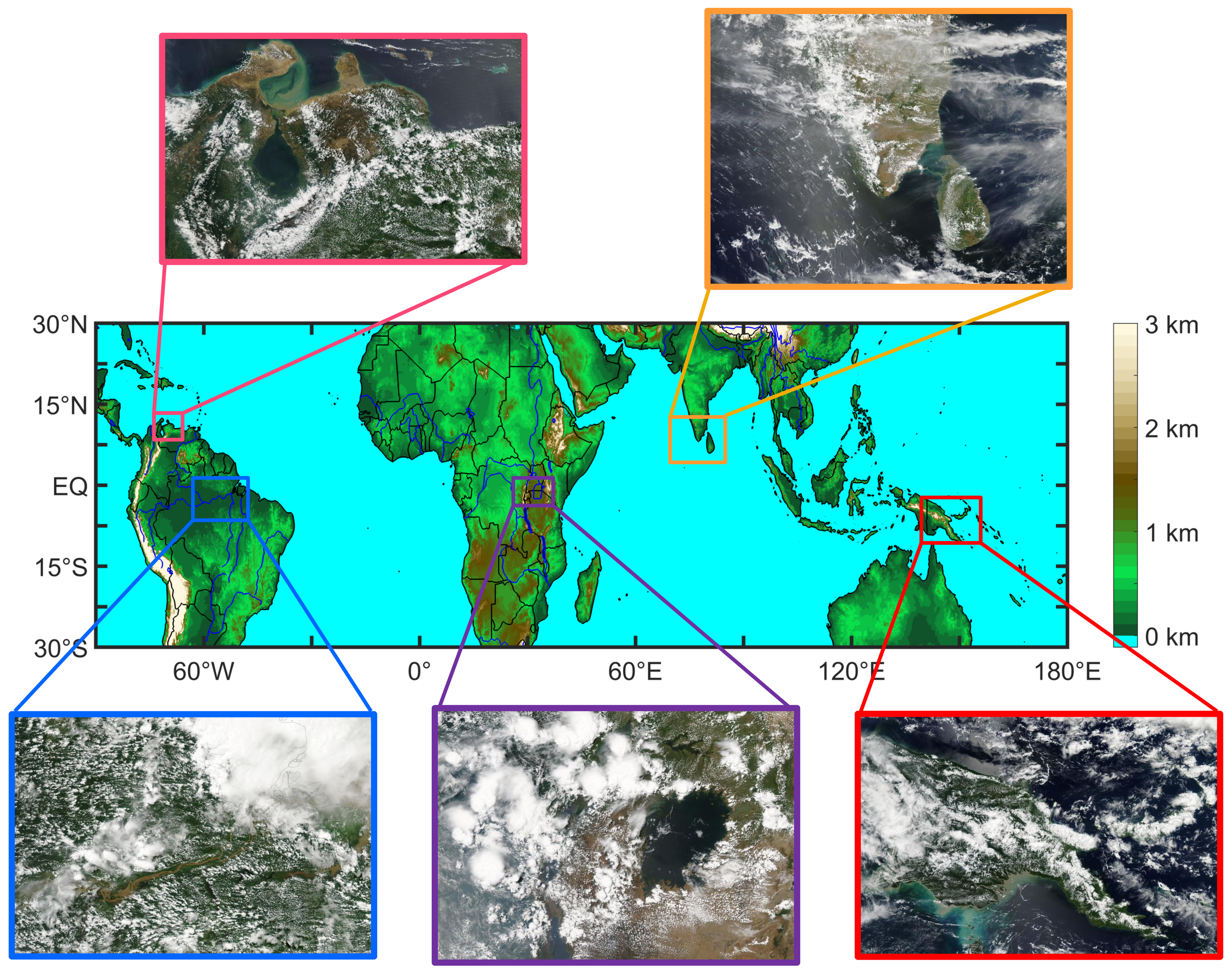
Introduction

As observed at the tropical ARM sites, thermally-driven circulations (e.g., sea breezes, river breezes, and mountain-valley breezes) can trigger deep convection by creating areas of convergence associated with permanent topographic features. These potentially important thermal circulations occur on spatial scales that are subgrid in current GCMs, but may be partially resolved in the next generation (Δx ~10's of km). Deep convection parameterizations often assume that clouds are uniformly distributed over a grid box and lack mechanisms to trigger deep convection in response to the convergence of localized circulations. In this work we attempt to quantify the influence of local circulations over land using satellite data and statistical regressions.



Science Questions

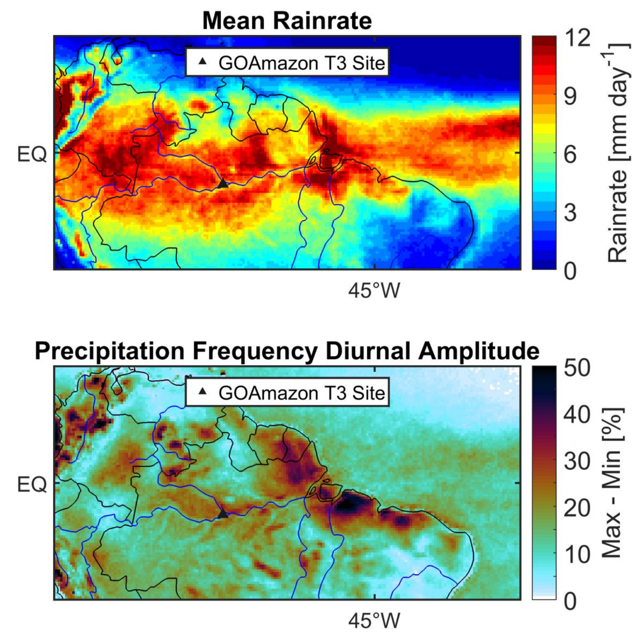
- *Now:* What are the relative roles of topography, distance to water, and stochasticity in determining the spatial variance of tropical convection over land?
- *Future:* How does the variance explained by localized-circulations vary across tropical regions, seasons, and different modes of organized convection?
- *Future:* How much information is a coarse-grid climate model missing by failing to capture these circulations?

Datasets

- *Now:* Precipitation from TRMM 3B42 dataset (0.25°, 3 hr, 17 yrs)
- *Future:* IR data from NASA merged-IR dataset (4 km, 30 min, 16+ yrs)

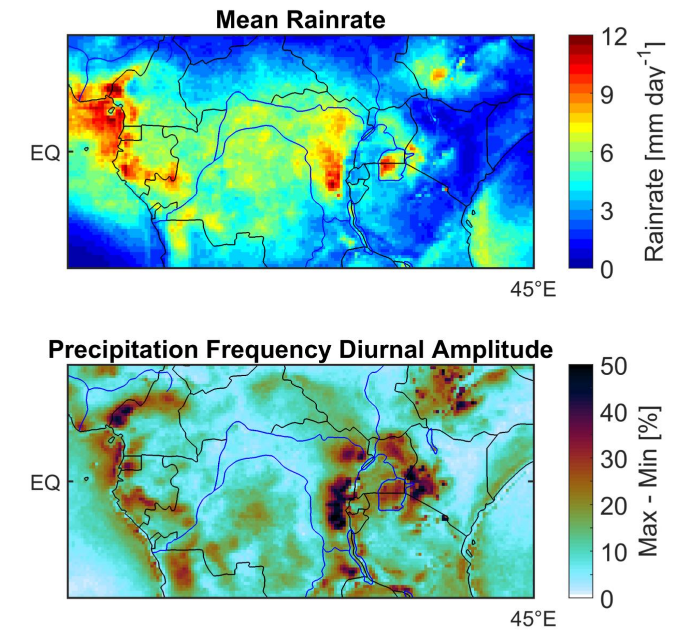
Diurnal Cycle Characteristics in Different Tropical Regions for March-April-May

Amazon



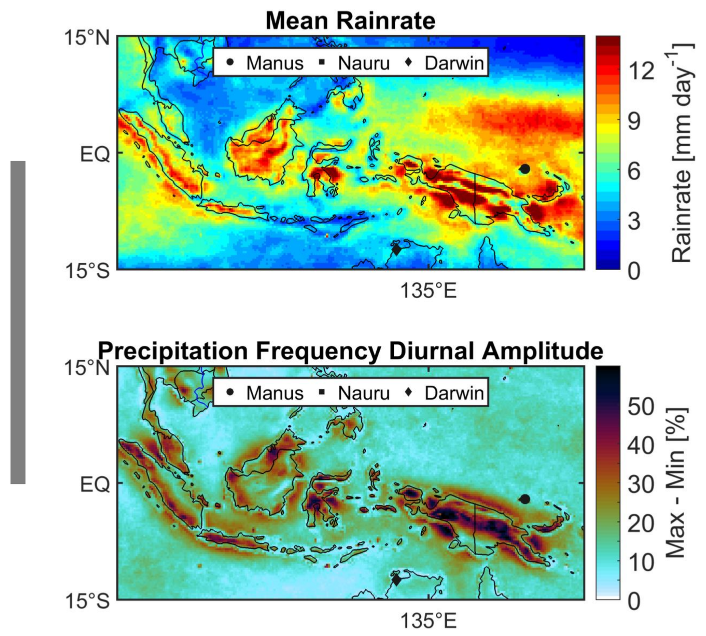
- Inland propagation of sea-breeze front creates bimodal diurnal cycle at many longitudes
- Storms are often triggered around rivers and small hills

Lake Victoria



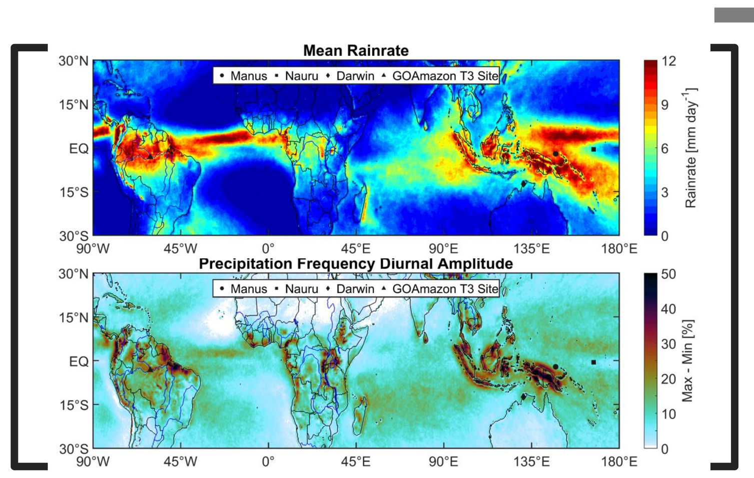
- Storms form over land during the day and over water at night
- Interaction of the lake-breeze and trade winds creates east/west hot spots in precipitation

Maritime Continent

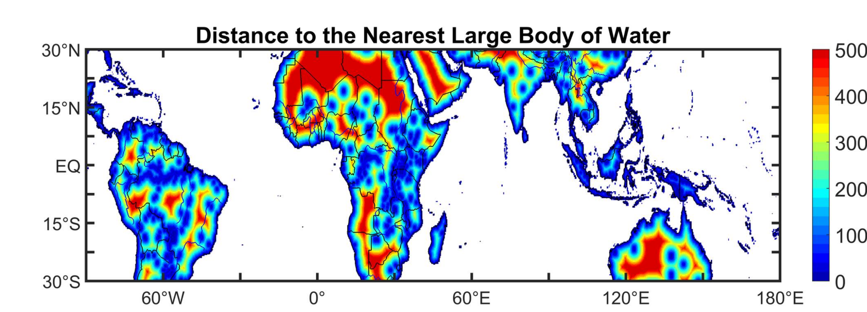


- Large diurnal cycles over and around islands of all sizes
- Terrain on islands further enhances convective frequency

Can



be expressed as a function of



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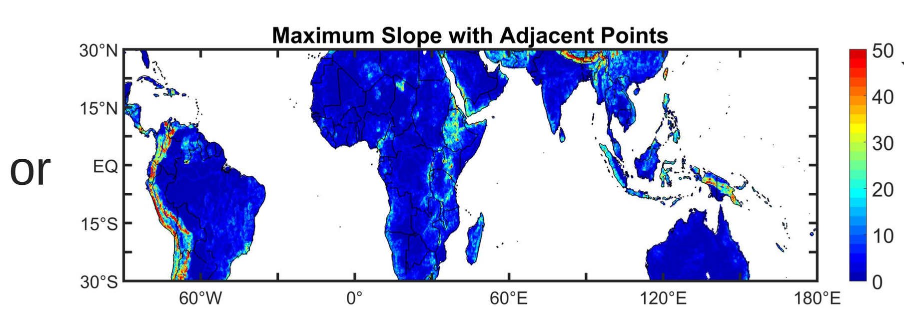

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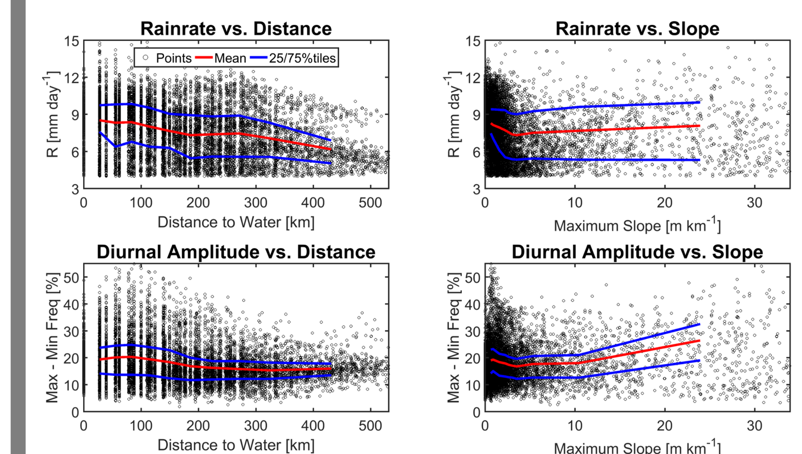
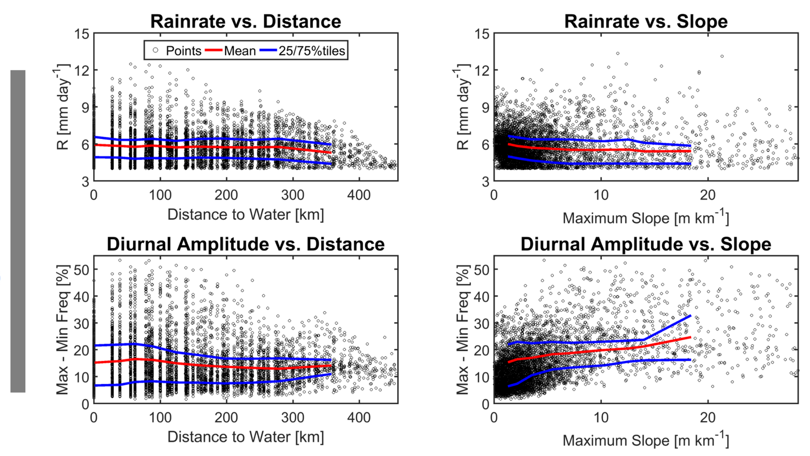
Amazon



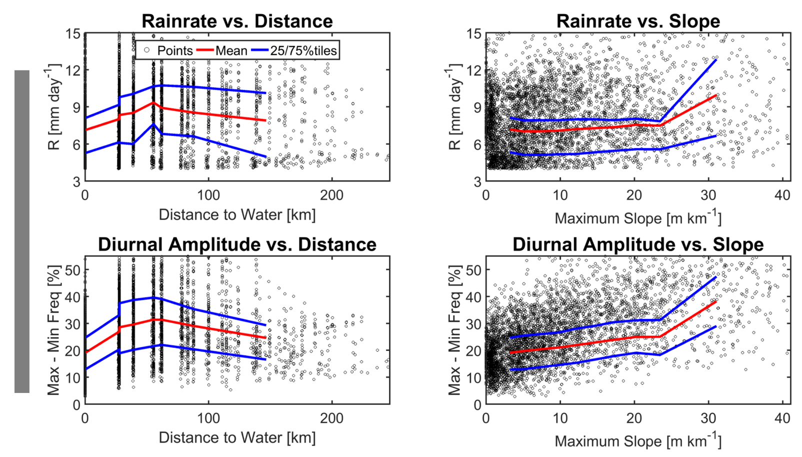
Rainrate and diurnal cycle amplitude both related to distance to water

Lake Victoria



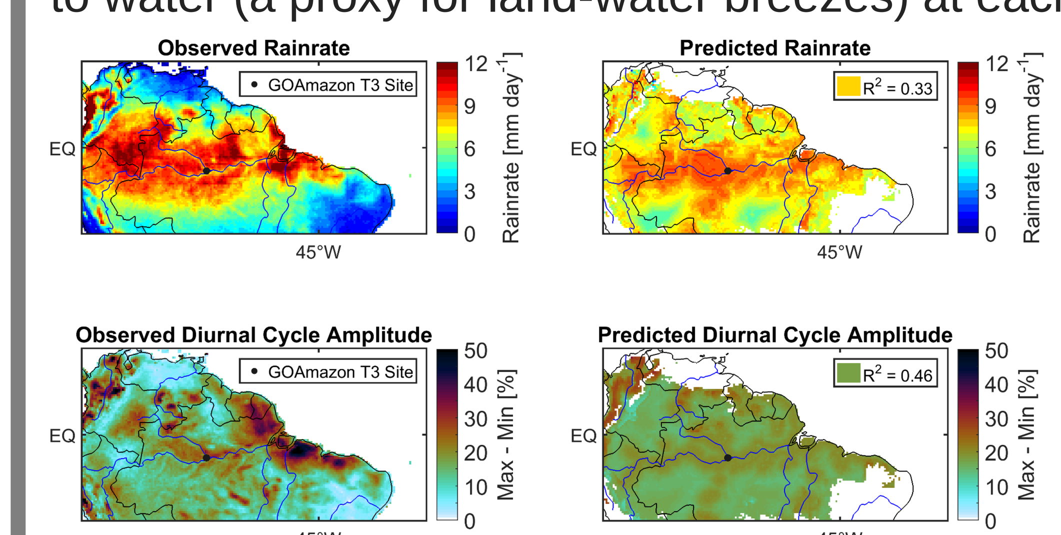
Diurnal cycle amplitude related to both distance to water and slope

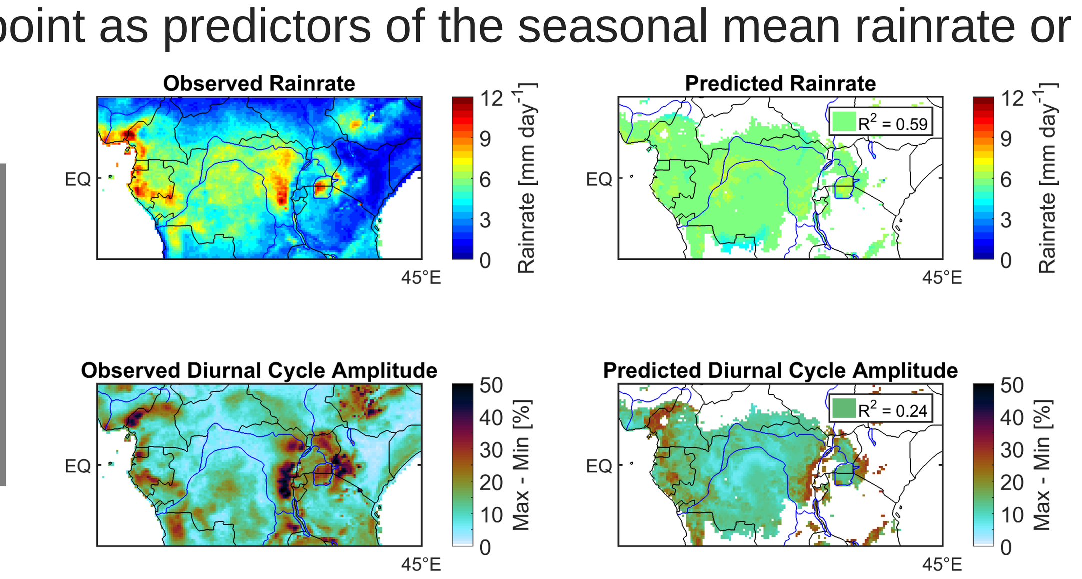
Maritime Continent

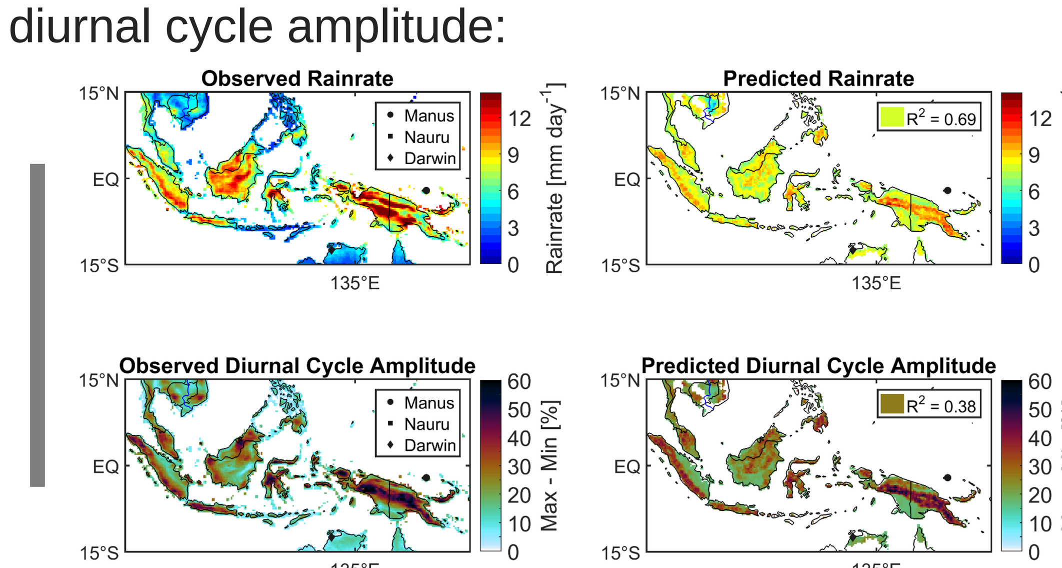


Rainrate and diurnal cycle amplitude both related to distance to water and slope

We derived regional regression relationships using only the slope of the terrain (a proxy for orographic lifting and mountain-valley breezes) and distance to water (a proxy for land-water breezes) at each point as predictors of the seasonal mean rainrate or diurnal cycle amplitude:







Our overly-simplistic statistical model reproduces many features of the spatial variability, particularly around the Maritime Continent and the Amazon river. Moving forward we want to (1) explore adding additional variables to the model such as wind speed orthogonal to terrain, (2) compare and contrast the regional statistical models with a global model, and (3) examine the strength of these relationships in ACME as a metric of model performance.