Using global climate model outputs for ecological forecasting at a local scale

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04 January, 2022

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Keywords: keyword1; keyword2; keyword3

Running title: Running Title

# Abstract

Abstract text

# Introduction

1. What are these climate models? General circulation models (GCMs) model the Earth’s climate by modeling ocean, atmospheric, and land as coupled systems. [more]. The Coupled Model Intercomparison Project (CMIP) provides specific starting conditions and “experiments” for these GCMs to run. CMIP is now in its 6th iteration, corresponding with the 6th report of the IPCC. The “experiments” correspond to shared socioeconomic pathways (SSPs) laid out in the IPCC’s 6th report. These SSPs differ from the representative concentration pathways (RCPs) used in the previous IPPC report and in CMIP5 models in that they consider a range of global socioeconomic possibilities ranging from very optimistic elimination of fossil fuel consumption and carbon capture technologies with strong international cooperation, to expansion of fascism and nationalism, continued investment in fossil fuel technologies, and increasing global inequality. These scenarios are then combined with “forcings” comparable to the RCPs of CMIP5. Four combinations of SSPs and radiative forcing levels were decided upon as standard across the model intercomparison project: SSP126, SSP245, SSP370, and SSP585. .

* Something about spatial nature and resolution. Something about uncertainty [ecologists will think pixel-to-pixel variation is ‘made up’ (and maybe it is to some extent)]. How to use uncertainty within and among models to your advantage?

1. Why should ecologists be interested? Ecologists and global change biologists are often interested in the impacts of climate change on natural systems [cite some study about increase in climate change biology over time].

Experiments: scientists devise experiments to test the effects of various aspects of climate change such as warming [citation], drought [citation], or rising CO2 [FACE study], or some combination of variables [BACE, others]. The levels of these variables may be determined from literature that is informed by CMIP or other GCM predictions, but often the treatments are “rough” and correspond to continental or global scale patterns (e.g. 50% and 25% rainfall reduction; 1º, 2º, 3º C warming above ambient). \_\_\_ proposes using model output data from sources such as CMIP6 to obtain more precise predictions. They describe an experimental setup using exactly the daily predicted precipitation from a multi-model mean output to water their plants. By using outputs from two scenarios, they are able to ask questions about the impacts of climate change on a very local level. Ecological forecasting: ….

Difficulties:

1. Understanding CMIP models

* box1 for vocab: “experiment,” “run,” “source,” etc.

1. Accessing data, downloading it

* portals that pre-compute things
* Some portals allow download of multi-model means, but you might want to do that yourself, since some models may be inappropriate for your particular region (discussion below).
* ESGF portal
* programmatic access
* helpful R (and python?) packages

1. Spatial aggregation

* not all models on same spatial scale, so may require re-gridding or downscaling
* If you’re interested in a timeseries for your region, without spatial variation, you will need to aggregate the data spatially
* even if interested in a larger region, aggregation may be useful to simplify quality control (discussed below)

1. Model quality control

* models have errors (link to error database)
* even if not “errors,” some models may be unrealistic for your region
* compare observed data to “historical” experiments. Know that “historical” is not meant to be accurate to the day, but patterns like seasonality and #of droughts should be captured accurately at a decadal scale.
* plots to make, stats to calculate

1. Sources of uncertainty (maybe not necessary since I don’t really know what I’m talking about here yet)

* Some researchers have used the uncertainty among CMIP models as an estimate of climate uncertainty (Duffy et al., 2015).
* Could also use spatial uncertainty?? (like if you aggregate a mean of a region, you can also get SD from it?)

# Acknowledgments

We thank **,** \_, \_\_\_ and \_\_\_ anonymous reviewers for helpful discussions and comments on the manuscript. Financial support was provided by the U.S. National Science Foundation (awards \_\_\_\_, and \_\_\_\_). The authors delcare no conflicts of interest.

# Data Availability Statement

Data and R code used in this study are archived with Zenodo at .

# References

Duffy, P. B., Brando, P., Asner, G. P., & Field, C. B. (2015). Projections of future meteorological drought and wet periods in the Amazon. *Proceedings of the National Academy of Sciences*, *112*(43), 13172–13177. <https://doi.org/10.1073/pnas.1421010112>