The Community Land Model, version 5: Parameter Perturbation Experiment

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Key Points:

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Abstract

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1 Introduction

2 Experiment description

2.1 Sparse grid

Multivariate spatiotemporal clustering

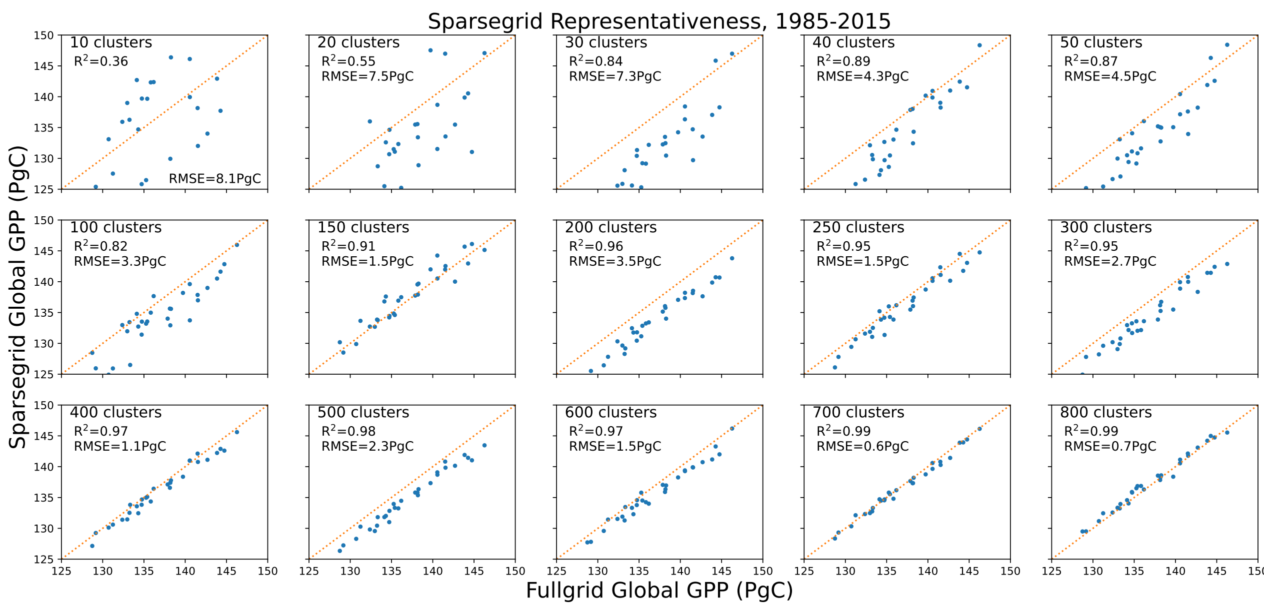

Figure 1. Sparsegrid vs fullgrid (2° resolution) global annual GPP across the last thirty years of a transient CLM5.1 simulation. We opted for 400 clusters (i.e. 400 sparse gridcells) to balance computational cost against representativeness. For reference there are 22,648 and 5,666 land gridcells in standard 1° and 2° CLM simulations, respectively.

2.2 Forcing Scenarios

Table 1. Forcing Scenarios

Name	Meteorology	CO_2 (ppmv)	N addition	Description
CTL2010	2005-2014	367	-	control experiment
C285	2005-2014	285	-	low CO_2
C867	2005-2014	867	-	high CO_2
AF1855	1851-1860	367	-	pre-industrial climate
AF2095	2091-2100	367	-	late century climate (SSP3-7.0)
NDEP	2005-2014	367	$5 g/m^2$	enhanced nitrogen deposition

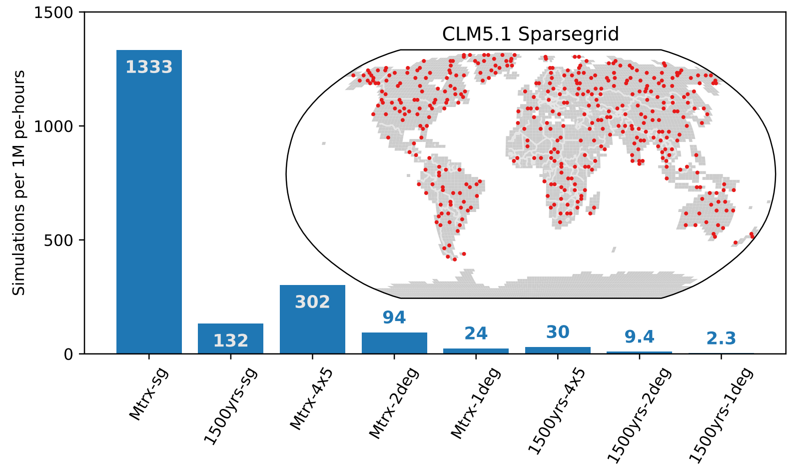

Figure 2. A standard 1-degree CLM-BGC simulation with 1500 years of spinup is prohibitively expensive (∼400k pe-hours) for exhaustive parameter sensitivity testing. Utilizing the Matrix-CN spinup method and our sparsegrid configuration yields approximately 1300 simulations per million pe-hours.

17 # 3 Results

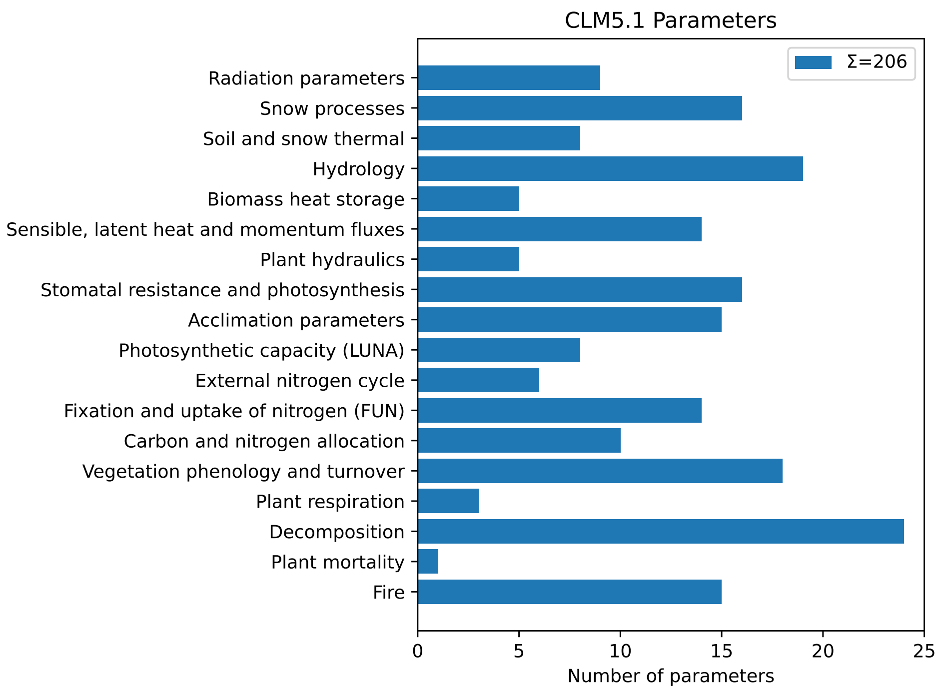

Figure 3. 206 parameters were identified and perturbed across the various domains of the land model.

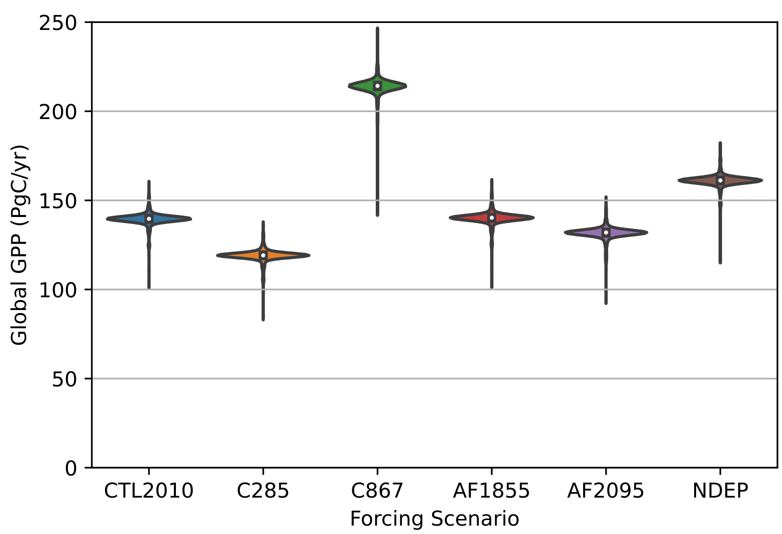

Figure 4. Distributions of global annual GPP across the six forcing scenarios. See Section **??** for scenario descriptions.

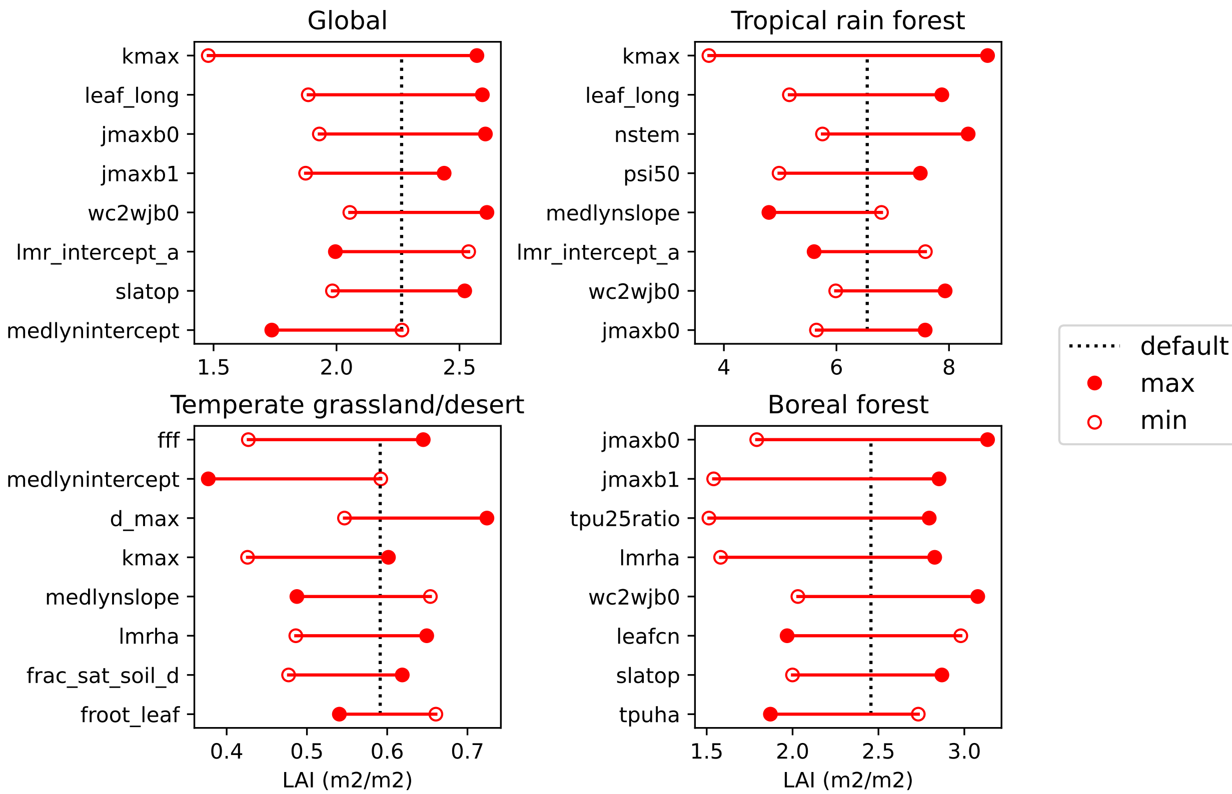

Figure 5. The eight most influential parameters on leaf area index within the CTL2010 ensemble, globally and within three biomes.

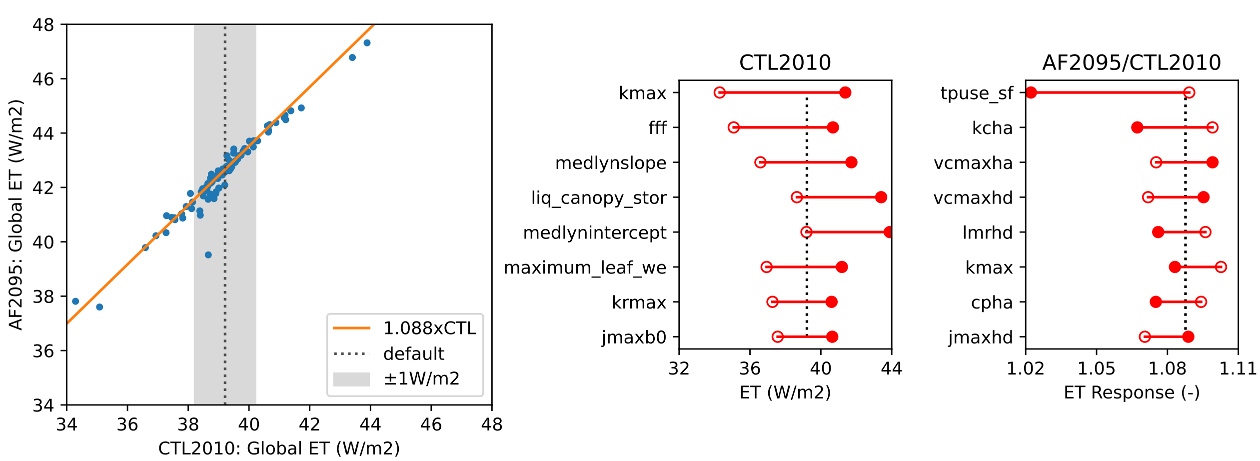

Figure 6. (a) Global evapotranspiration in the warm forcing scenario vs. our control experiment. The default parameterization ET enhancement is +8.8%, as shown with the orange line. The shading spans the CTL2010 default ET, plus or minus 1 W/m2. (b) The top 8 parameters governing global ET in the CTL2010 experiment. (c) The top 8 parameters governing ET response to the future climate anomaly forcing (AF2095). Parameters governing the response to temperature anomalies tend to differ from the parameters controlling present-day ET.

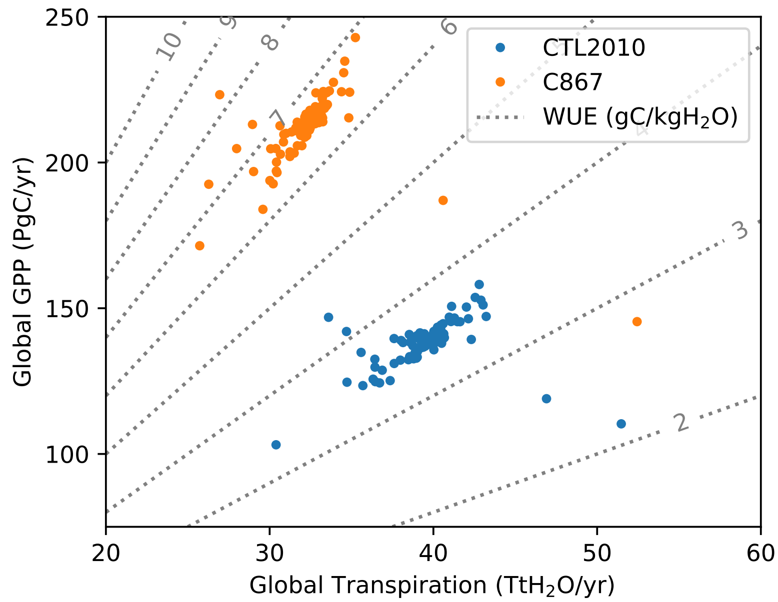

Figure 7. Global photosynthesis vs. transpiration for the control and high CO_2 ensembles. Water use efficiency (in this case defined as GPP/T) contours are drawn for reference. The default parameterization increases GPP by 53% in response to increasing CO_2 from 367 to 867 ppm, made possible by an even larger increase in WUE (+88%).

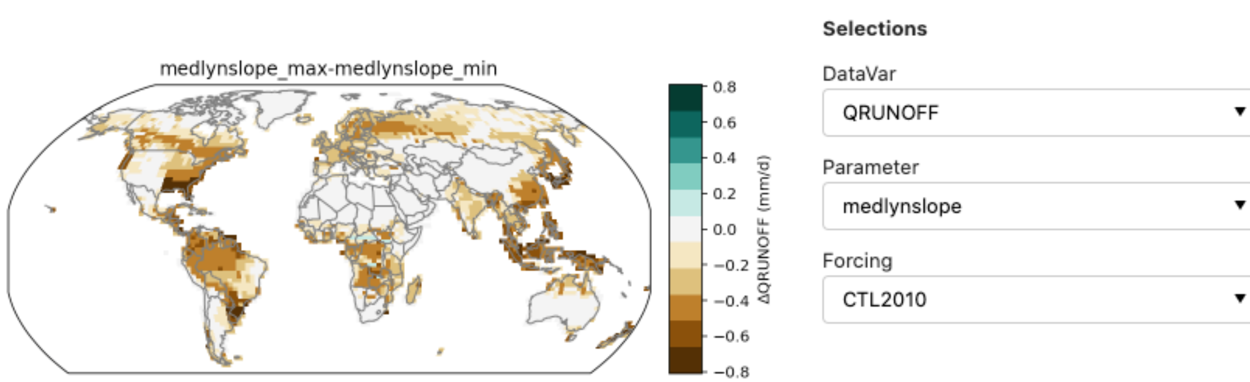

Figure 8. Screenshot of interactive diagnostic for exploring maps of parameter effects. In this case, the effect of medlynslope on runoff within the CTL2010 ensemble. Increasing medlynslope tends to increase transpiration and reduce runoff.