



#BrenProjects

UNDERSTANDING THE INFLUENCE OF PARAMETER VALUE UNCERTAINTY ON CLIMATE MODEL OUTPUTS: DEVELOPING AN INTERACTIVE DASHBOARD

Heather Childers, Sofia Ingersoll, Sujan Bhattacharai

Faculty advisor: Daniel Kennedy

National Center of Atmospheric Research – Climate & Global
Dynamics Lab, UCSB

Final Presentation
Bren School of Environmental Science & Management
May 31, 2024

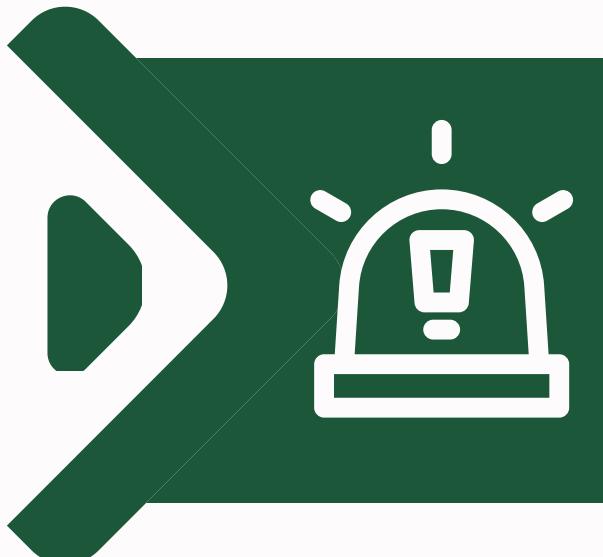


Context



Climate Change is a
real and threatening
problem

Context

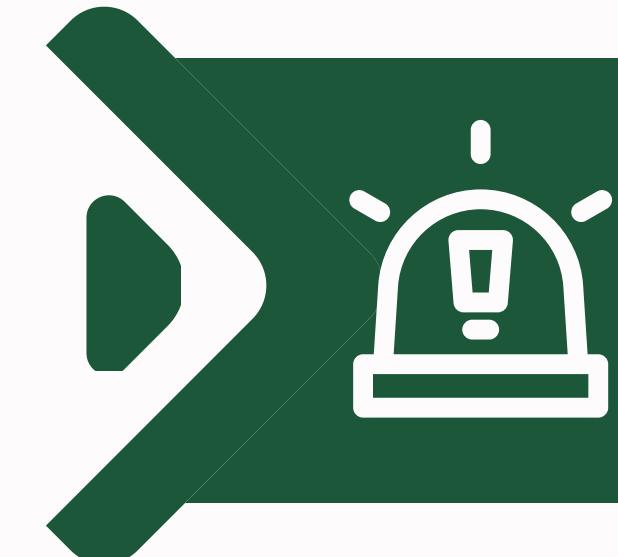


Climate Change is a
real and threatening
problem

Climate models are an
invaluable tool to
quantify potential
impacts



Context



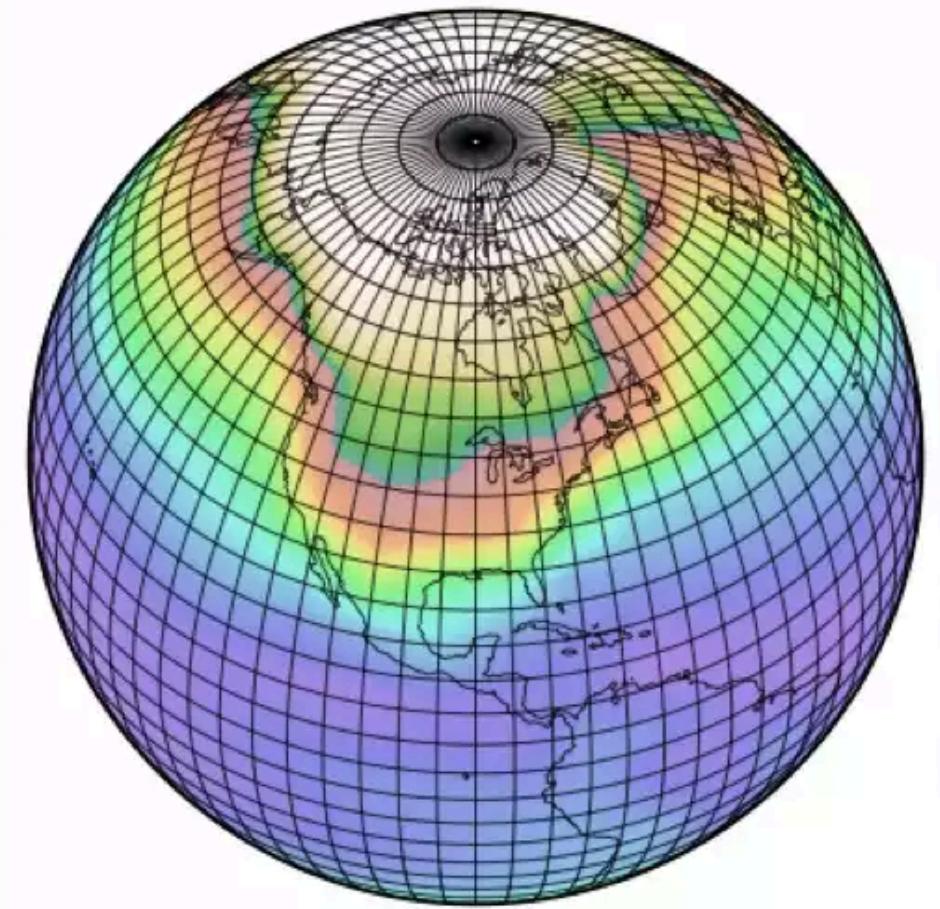
Climate Change is a real and threatening problem

Climate models are an invaluable tool to quantify potential impacts



Climate model outputs are difficult to interpret

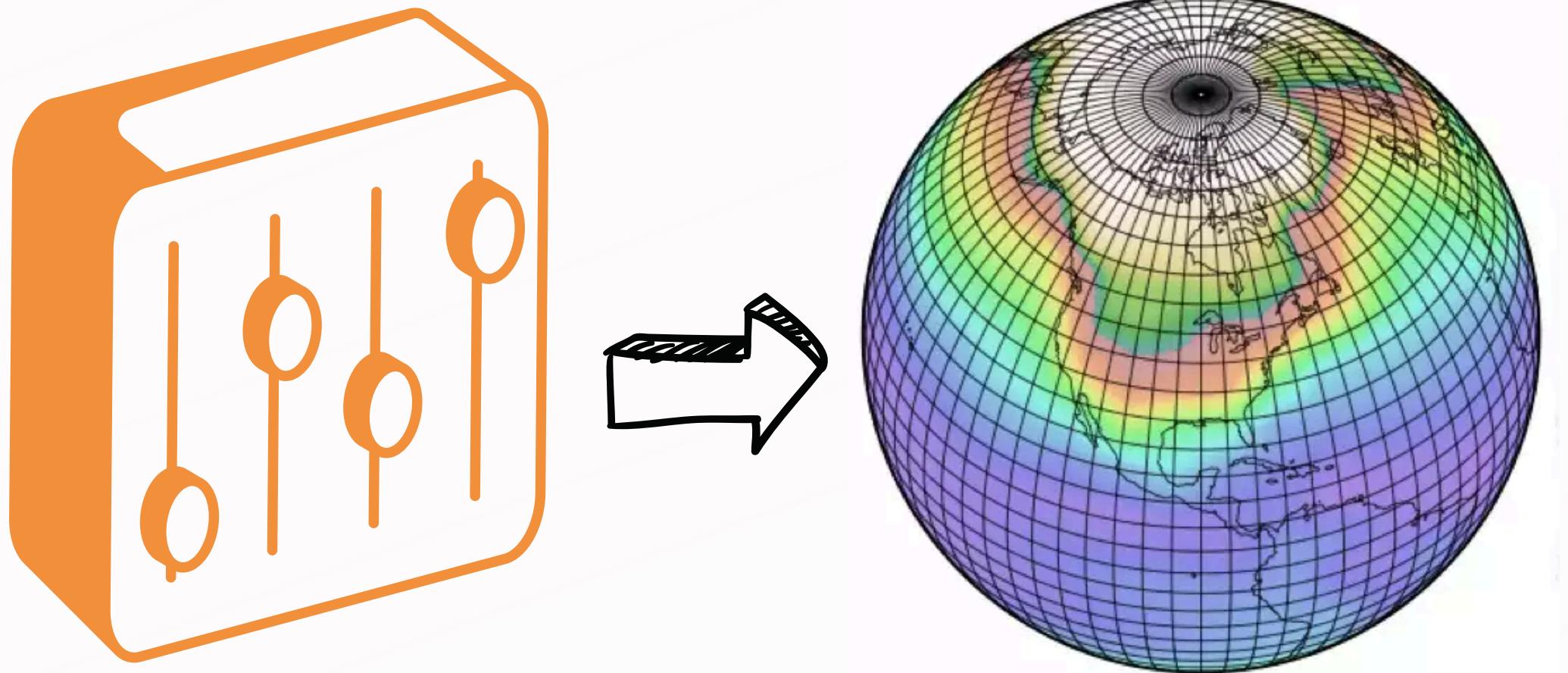
WHAT IS A CLIMATE MODEL?



Climate Model

Computer models capable
of simulating the
processes that occur on
Earth

HOW DO CLIMATE MODELS WORK?



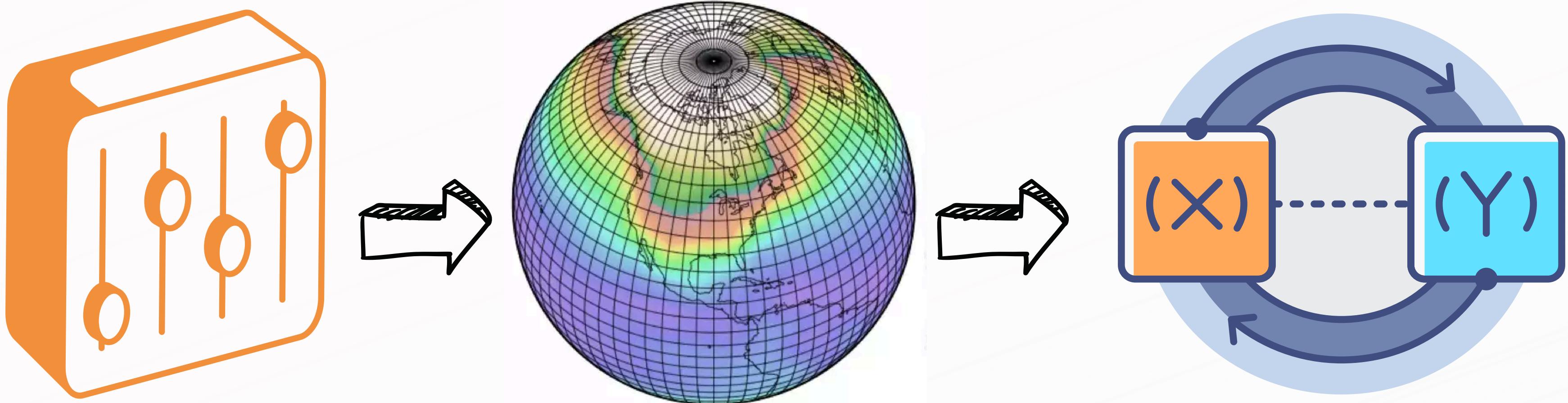
Parameter

- Parameters are Climate Model **Inputs**
- Parameters have inherent uncertainty

Climate Model

Computer models capable of simulating the processes that occur on Earth

HOW DO CLIMATE MODELS WORK?



Parameter

- Parameters are Climate Model **Inputs**
- Parameters have inherent uncertainty

Climate Model

Computer models capable of simulating the processes that occur on Earth

Climate Variable

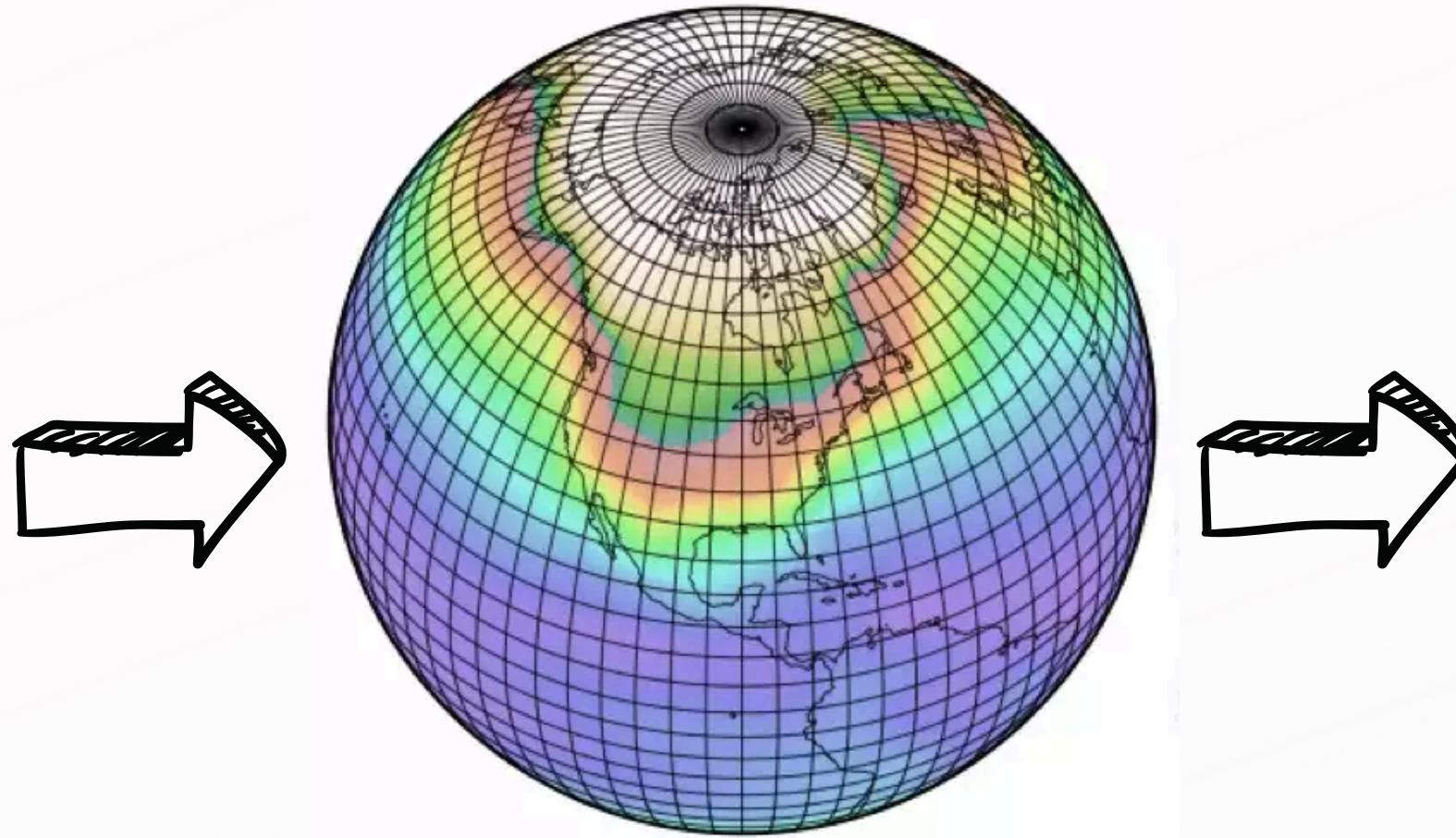
- Variables are Climate Model **Outputs**
- These are the values we are interested in predicting

HOW DO CLIMATE MODELS WORK?



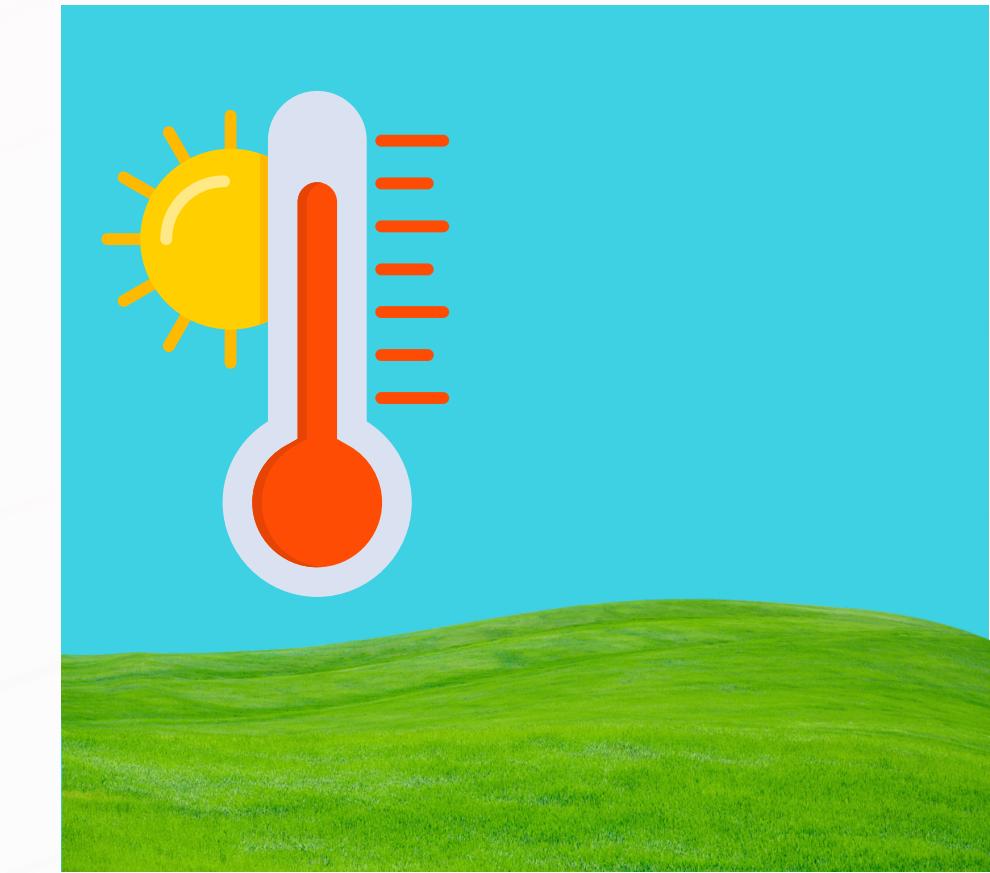
Parameter

Example: Soil Texture



Climate Model

Computer models capable
of simulating the
processes that occur on
Earth

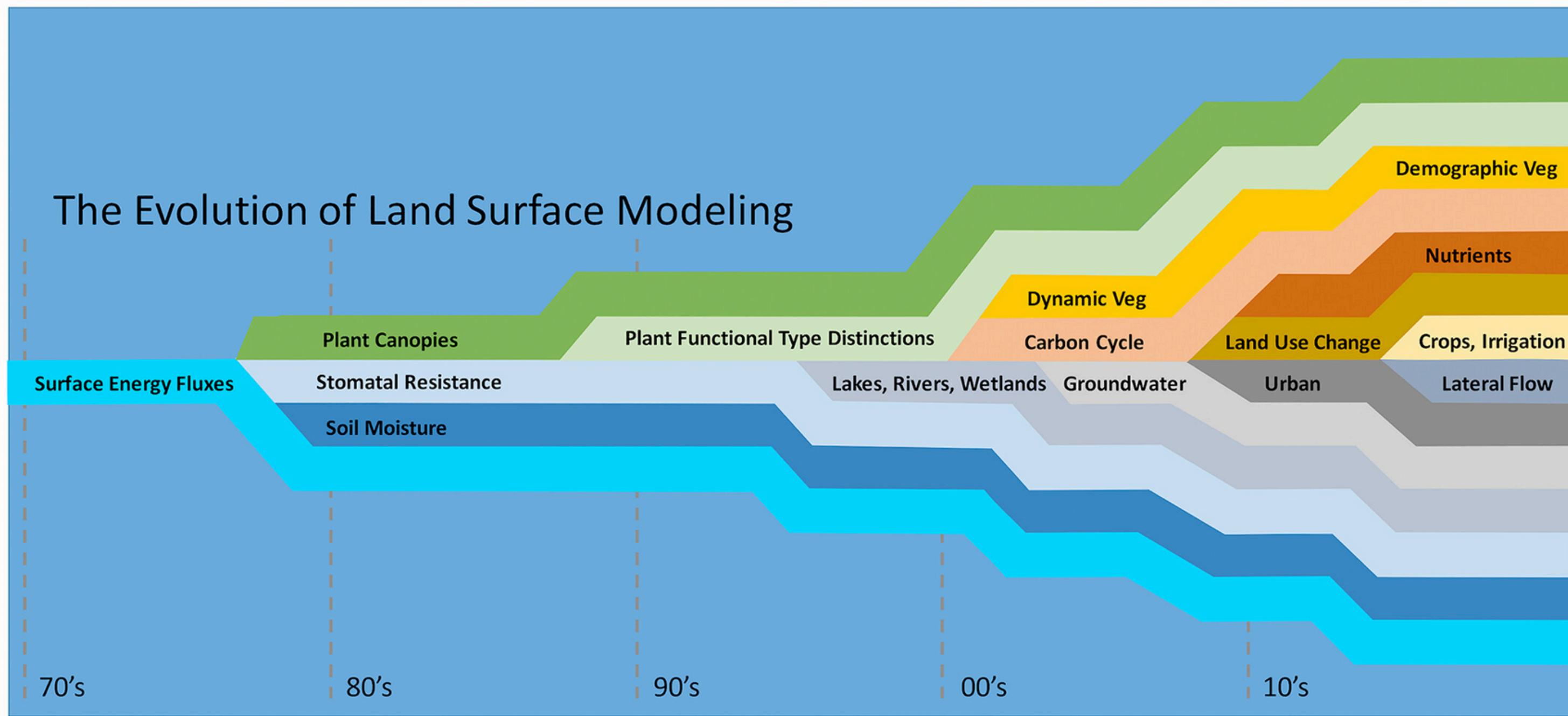


Climate Variable

Example: Surface
Temperature

Motivation

Climate models in the last 20 years have become extremely complex



Fisher and Koven (2020)

Who is NCAR?

The National Center for Atmospheric Research promotes and facilitates innovative research in atmospheric and Earth-Sun sciences.

They make climate models!



Who is NCAR?

They make climate models!

Parameter Perturbation Experiment

Parameter = Input

Perturbation = Changing

Experiment = Test

Translation: A test to see how climate variables respond to changing inputs



Who is NCAR?

They make climate models!

Parameter Perturbation Experiment

Translation: A test to see how climate variables respond to changing inputs

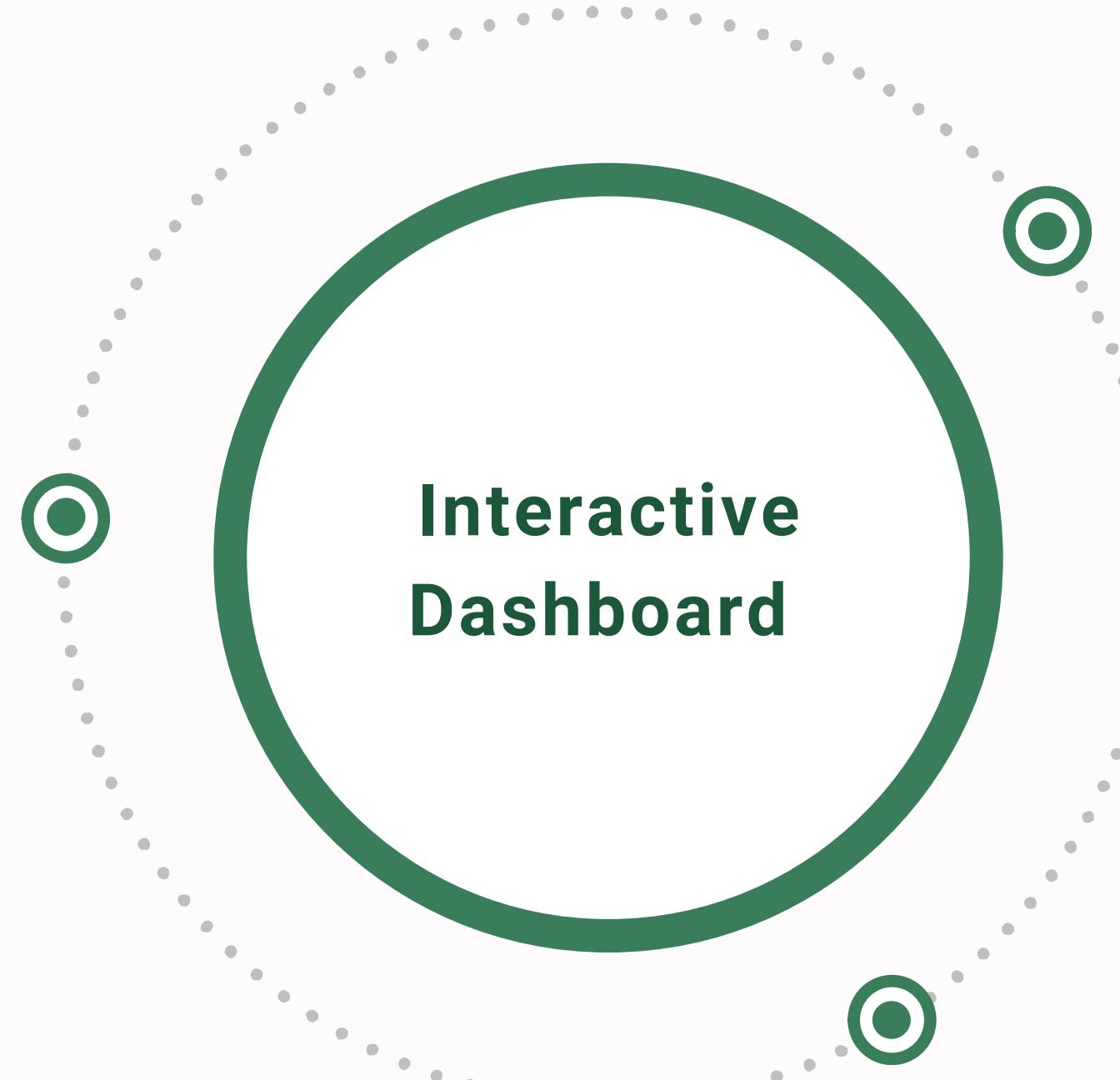
This experiment produced 15TB of climate model output data



THE GOAL

Create an interactive dashboard to
make insightful visualizations and
documentation for the results of the
Parameter Perturbation Experiment

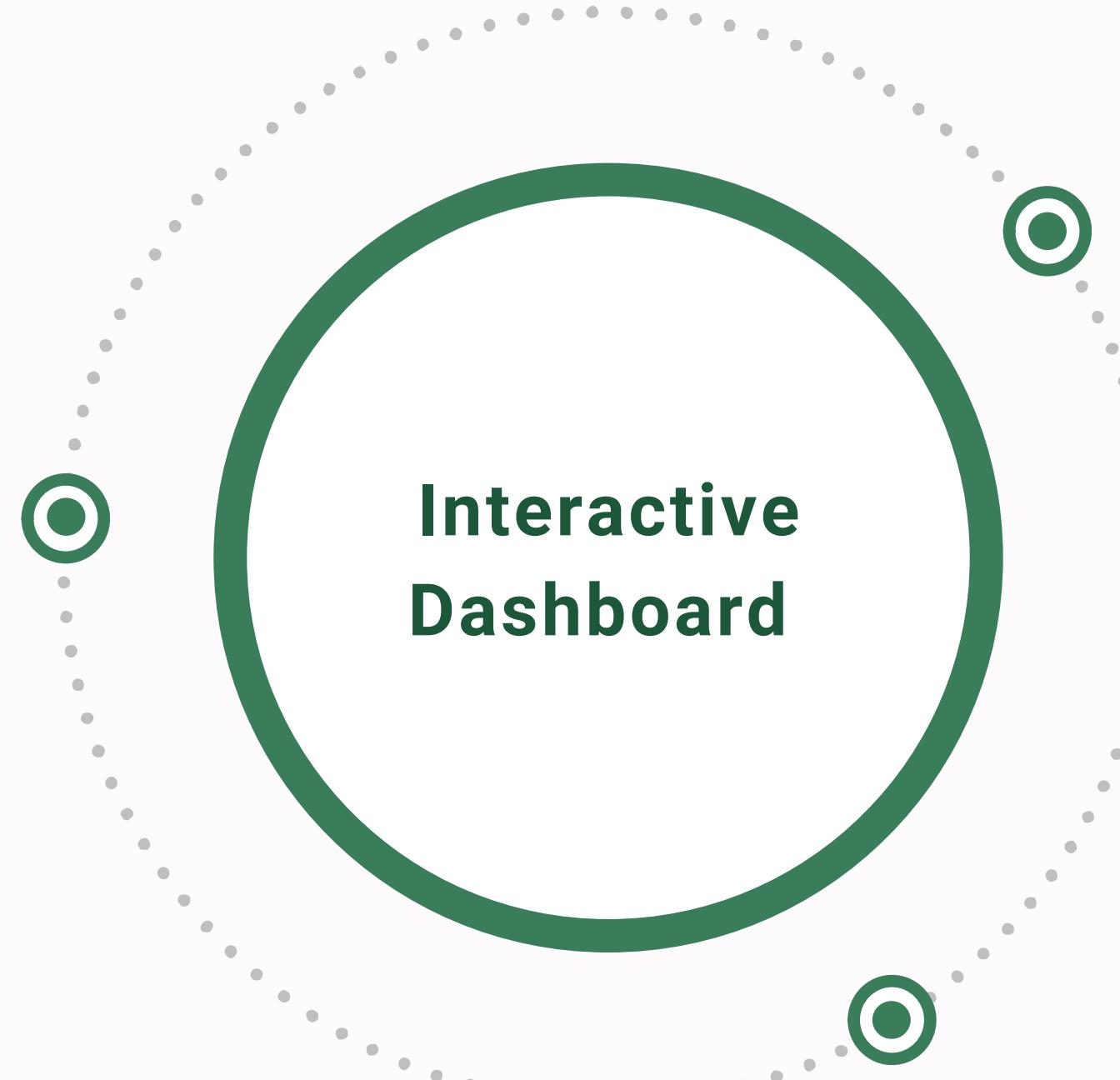
Objectives



Interactive
Dashboard

Objectives

Interpret Results
using an Emulator



Interactive
Dashboard

Objectives

Interpret Results
using an Emulator

Interactive
Dashboard

Create
Visualizations

Objectives

Interpret Results
using an Emulator

Interactive
Dashboard

Create
Visualizations

Add
Documentation

Objectives

Interpret Results
using an Emulator

Interactive
Dashboard

Create
Visualizations

Add
Documentation

How does our emulator work?



How does our emulator work?



How does our emulator work?



How does our emulator work?



How does our emulator work?

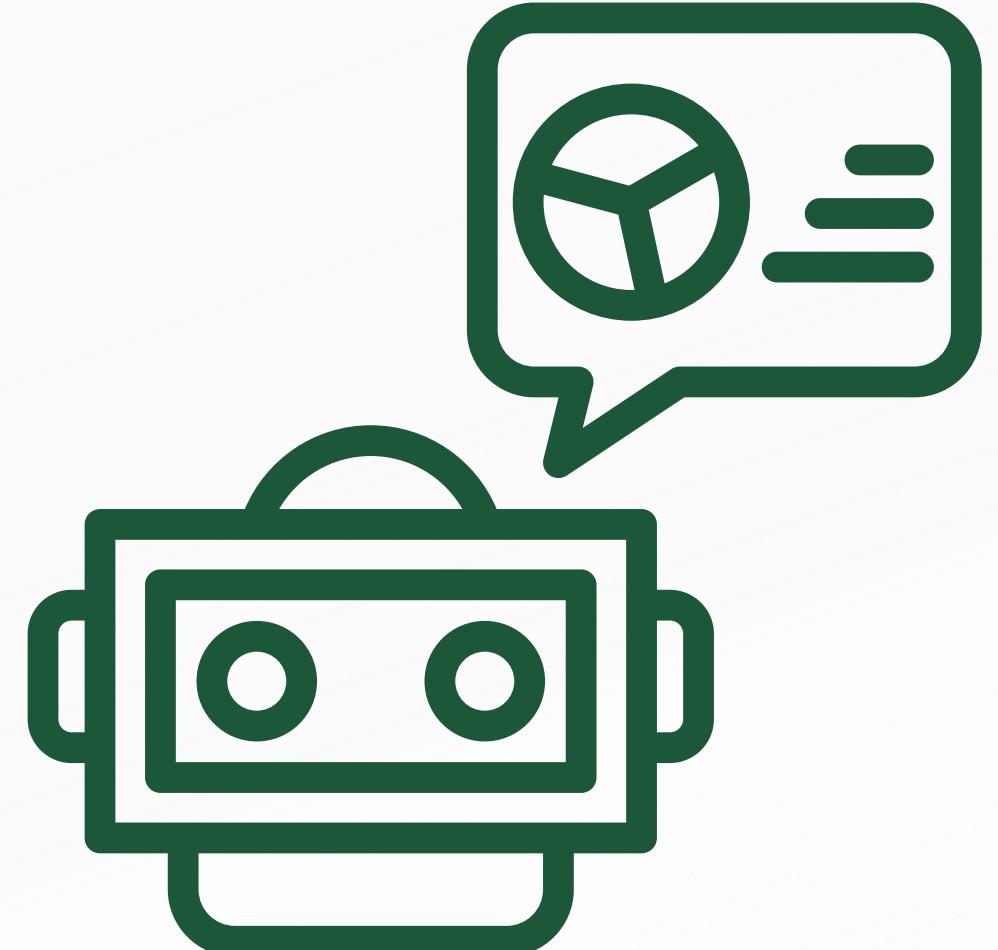
*Preprocessing
Functions*



Identify Relationships



Create Predictions



Objectives

Interpret Results
using an Emulator

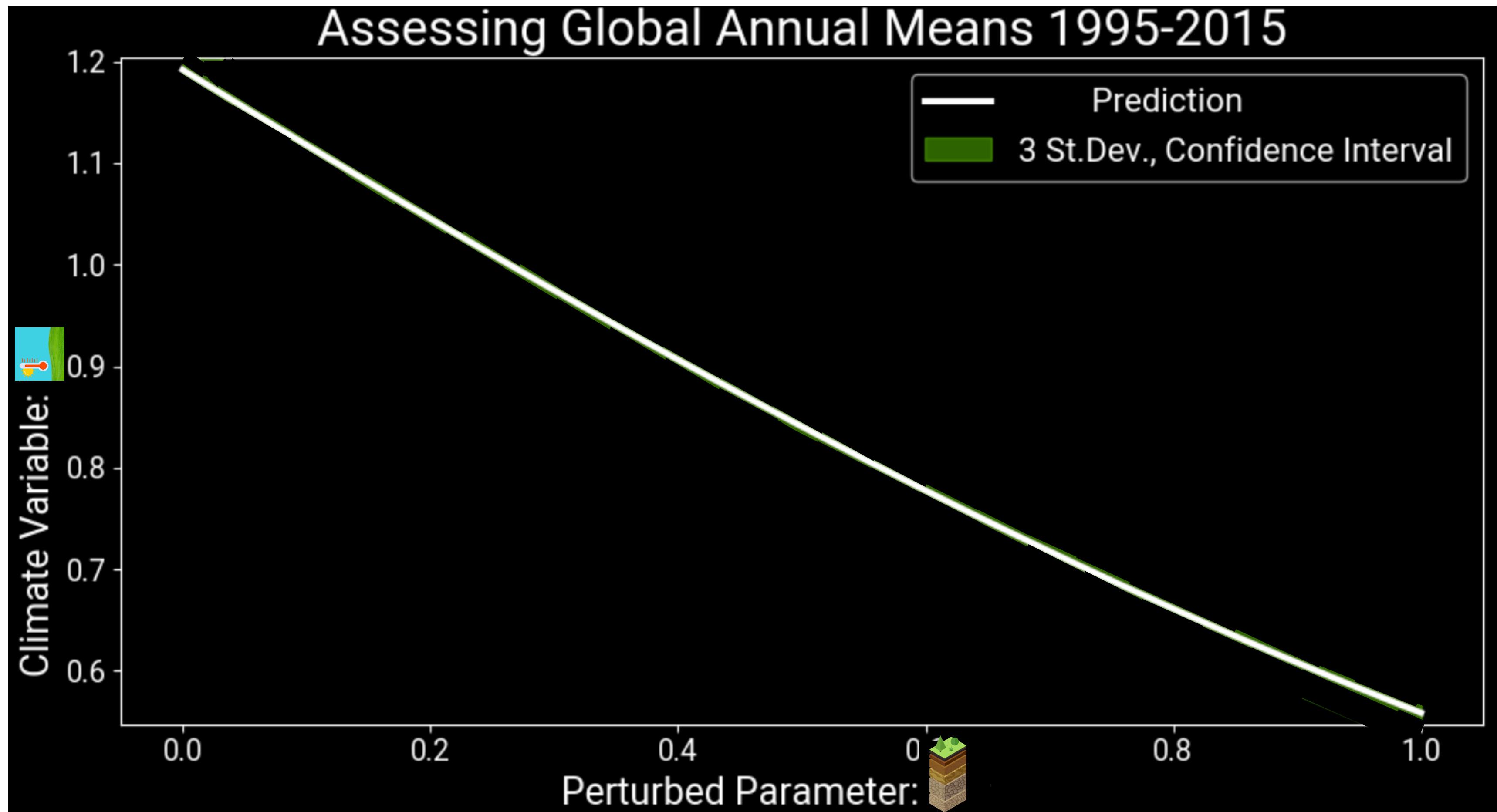
Interactive
Dashboard

Create
Visualizations

Add
Documentation

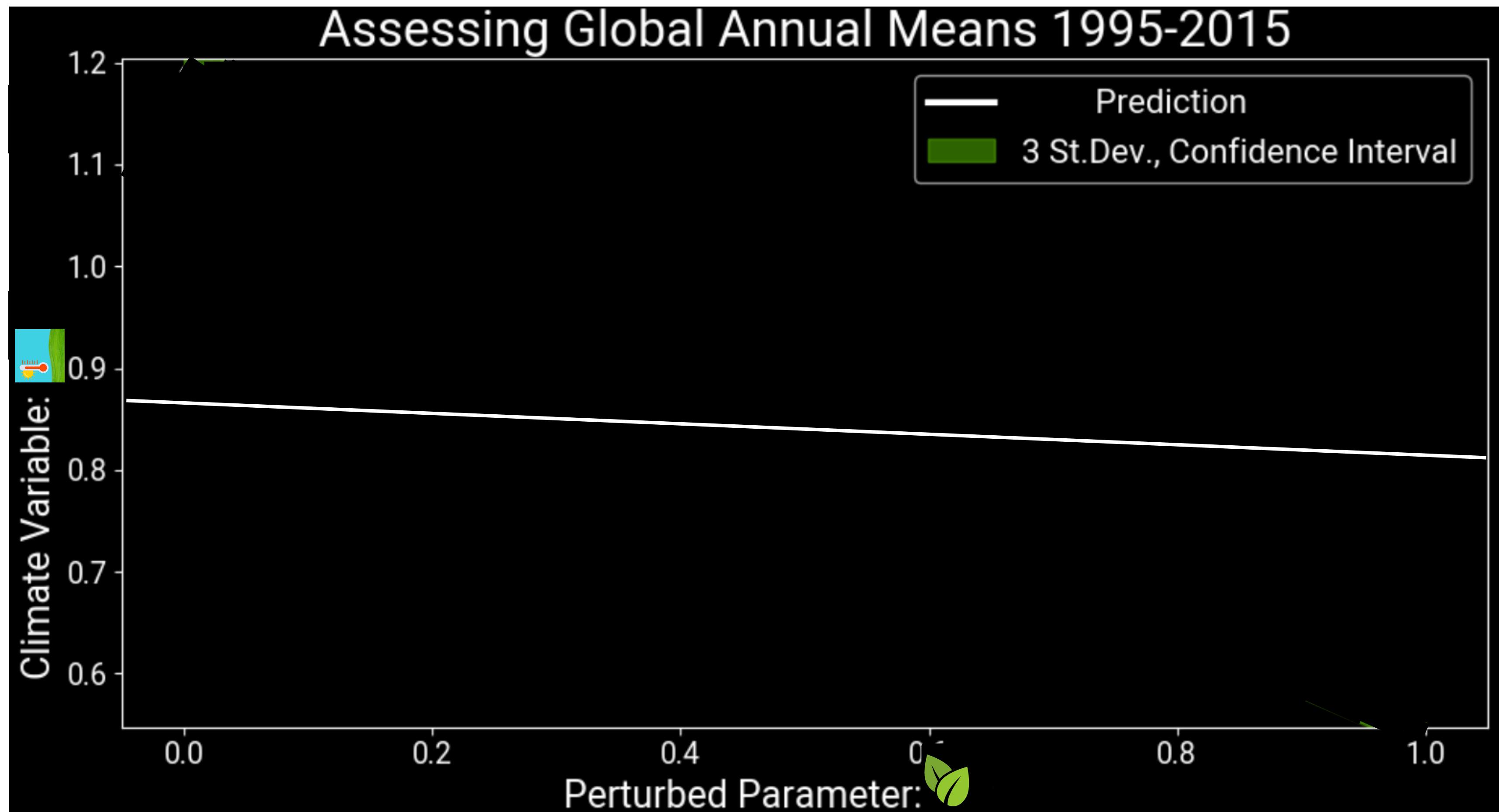


Predictions





Predictions

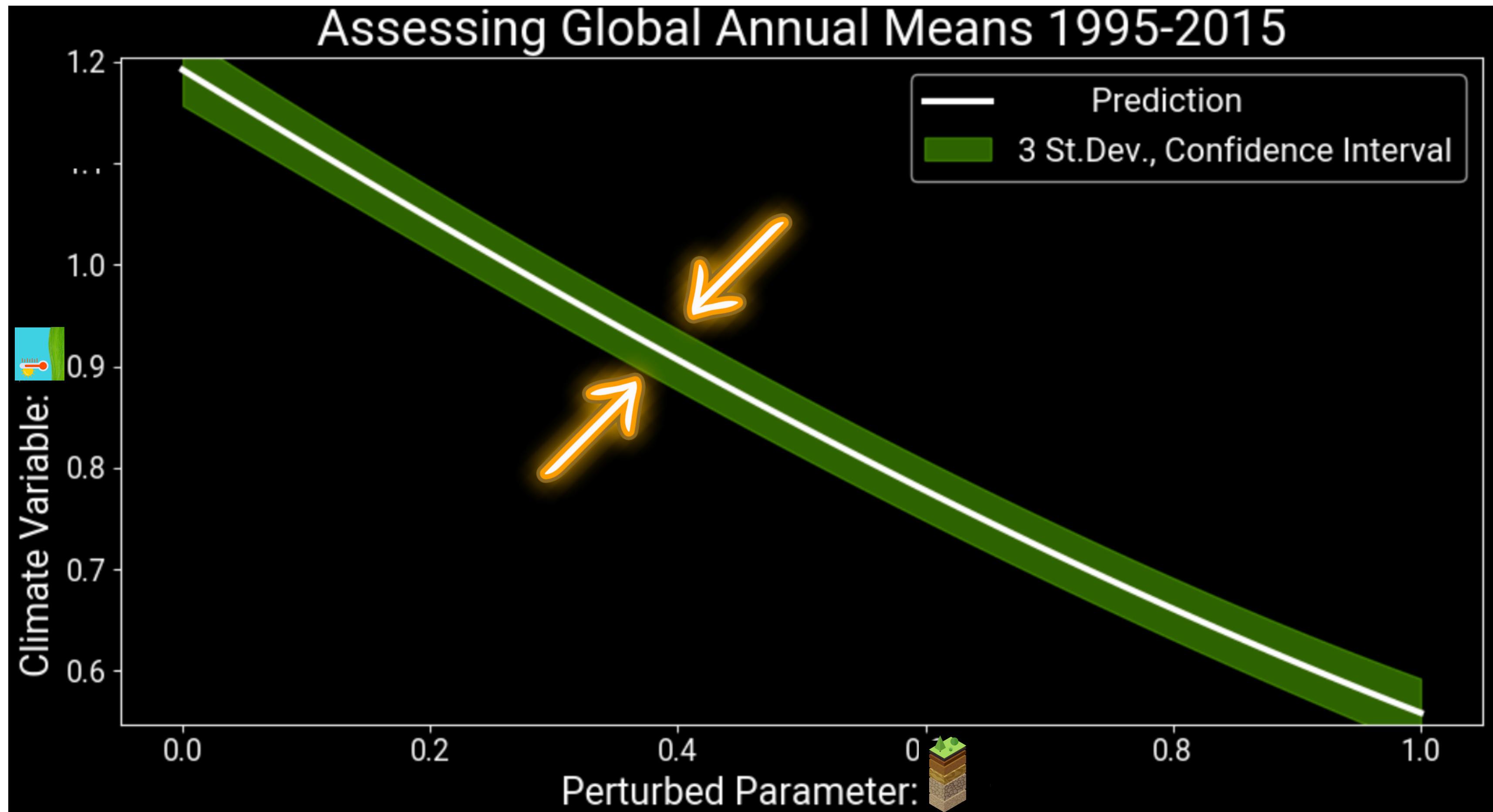




Predictions



Uncertainty

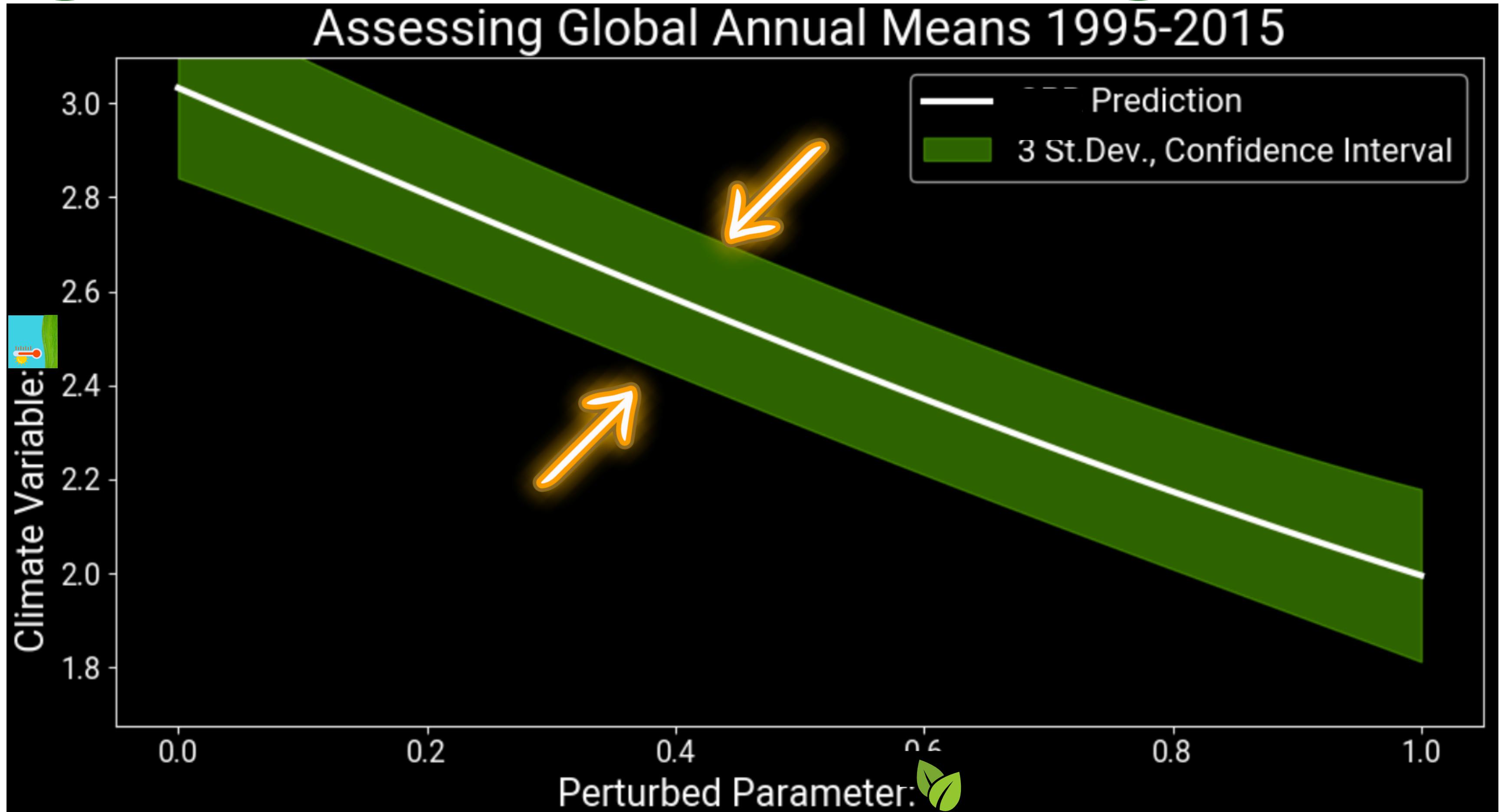




Predictions

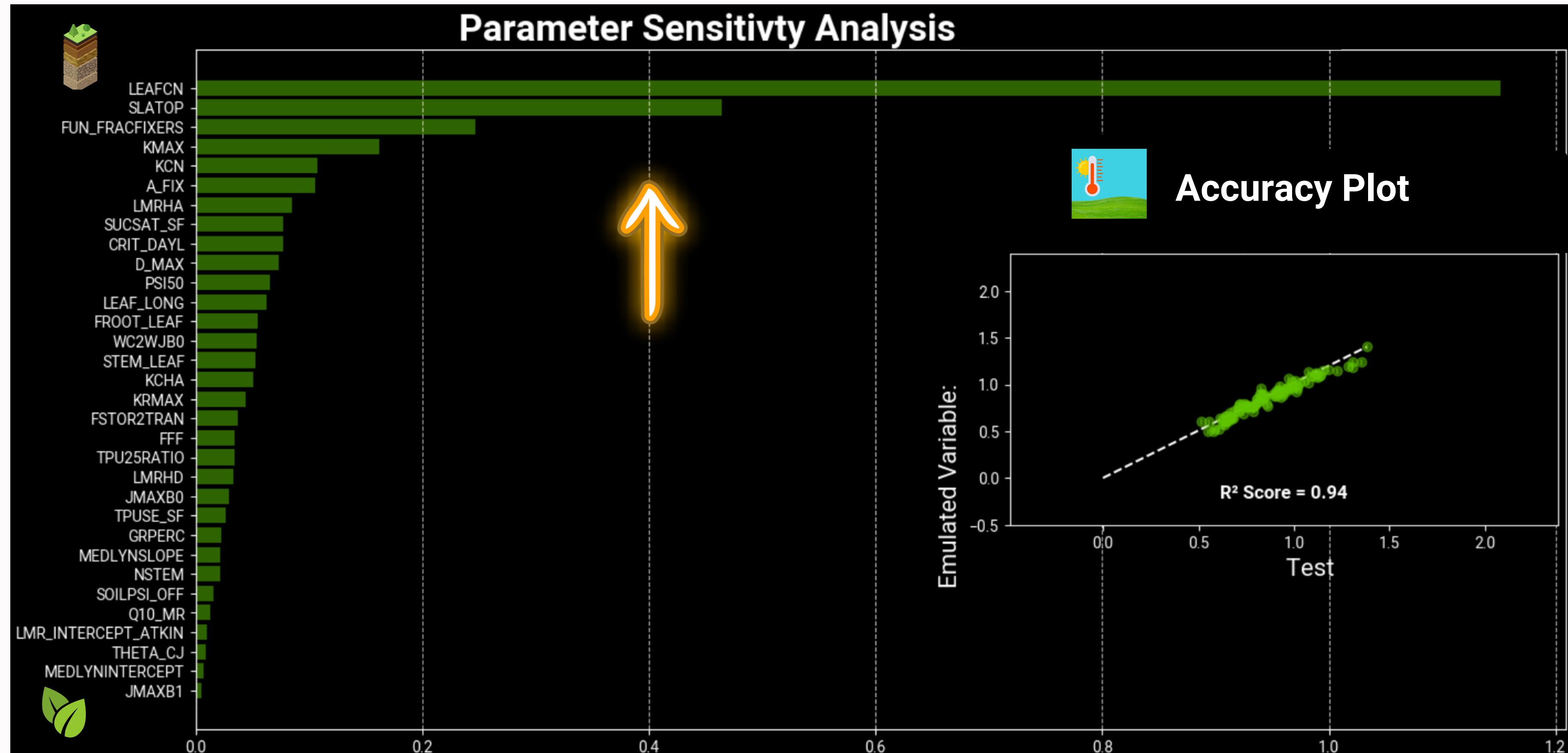


Uncertainty





Sensitivity



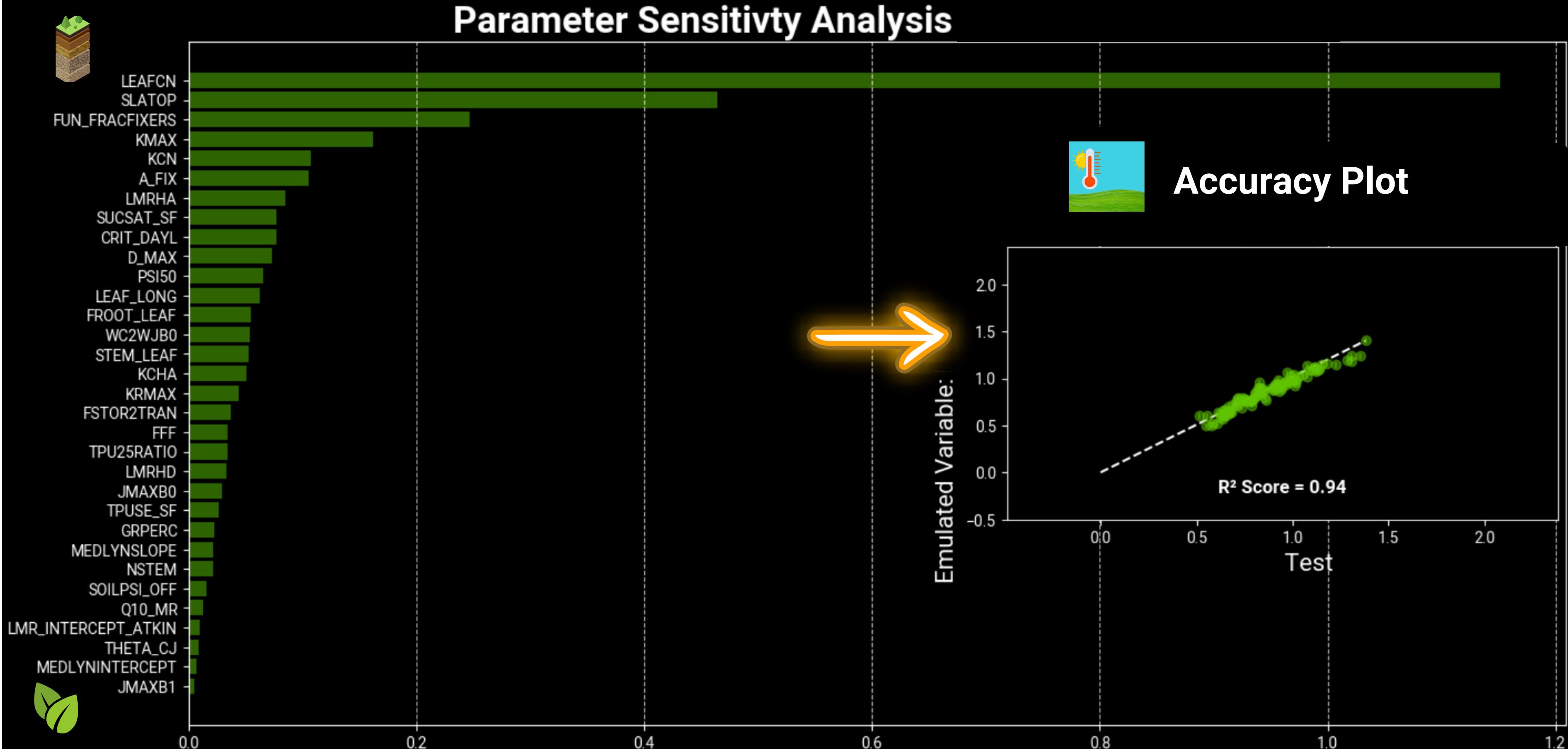


Sensitivity



Accuracy

Parameter Sensitivty Analysis



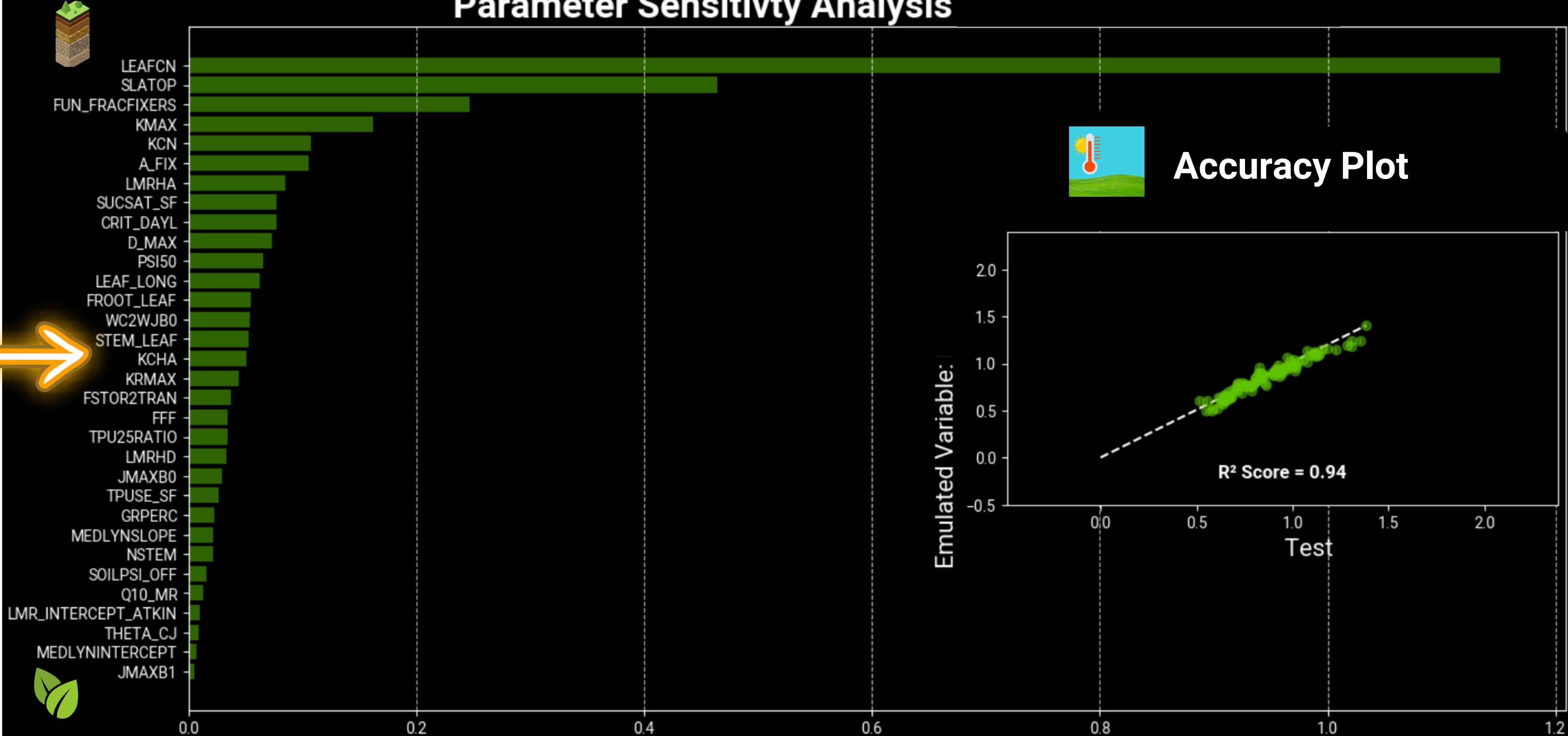


Sensitivity



Accuracy

Parameter Sensitivty Analysis



Objectives

Interpret Results
using an Emulator

Interactive
Dashboard

Create
Visualizations

Add
Documentation

Documentation Page

Introduction to Parameters

Here are 32 parameters categorized into different domains such as Biogeochemistry, Hydrology, Biophysics, and Stomatal Conductance & Photosynthesis.

All Parameters

Search for...

Parameter	Full Name	Category
FUN_FRACFIXERS	The maximum fraction of assimilated carbon that can be used to pay for N fixation	Biogeochemistry
KCN	Nitrogen uptake cost	Biogeochemistry
A_FIX	Parameter 'a' of temp response of N fixation (Houlton et al. 2008)	Biogeochemistry
CRIT_DAYL	Critical day length for senescence	Biogeochemistry
D_MAX	Dry surface layer parameter	Hydrology
FFF	Decay factor for fractional saturated area	Hydrology
FROOT_LEAF	Allocation parameter: new fine root C per new leaf C	Biogeochemistry
FSTOR2TRAN	Fraction of storage to move to transfer for each onset	Biogeochemistry
GRPERC	Growth respiration factor	Biogeochemistry
JMAXB0	Baseline proportion of nitrogen allocated for electron	Stomatal Conductance & Photosynthesis

Objectives

Interpret Results
using an Emulator

Interactive
Dashboard

Create
Visualizations

Add
Documentation

Parameter Perturbation Experimental Results

Documentation

Selections

Parameter

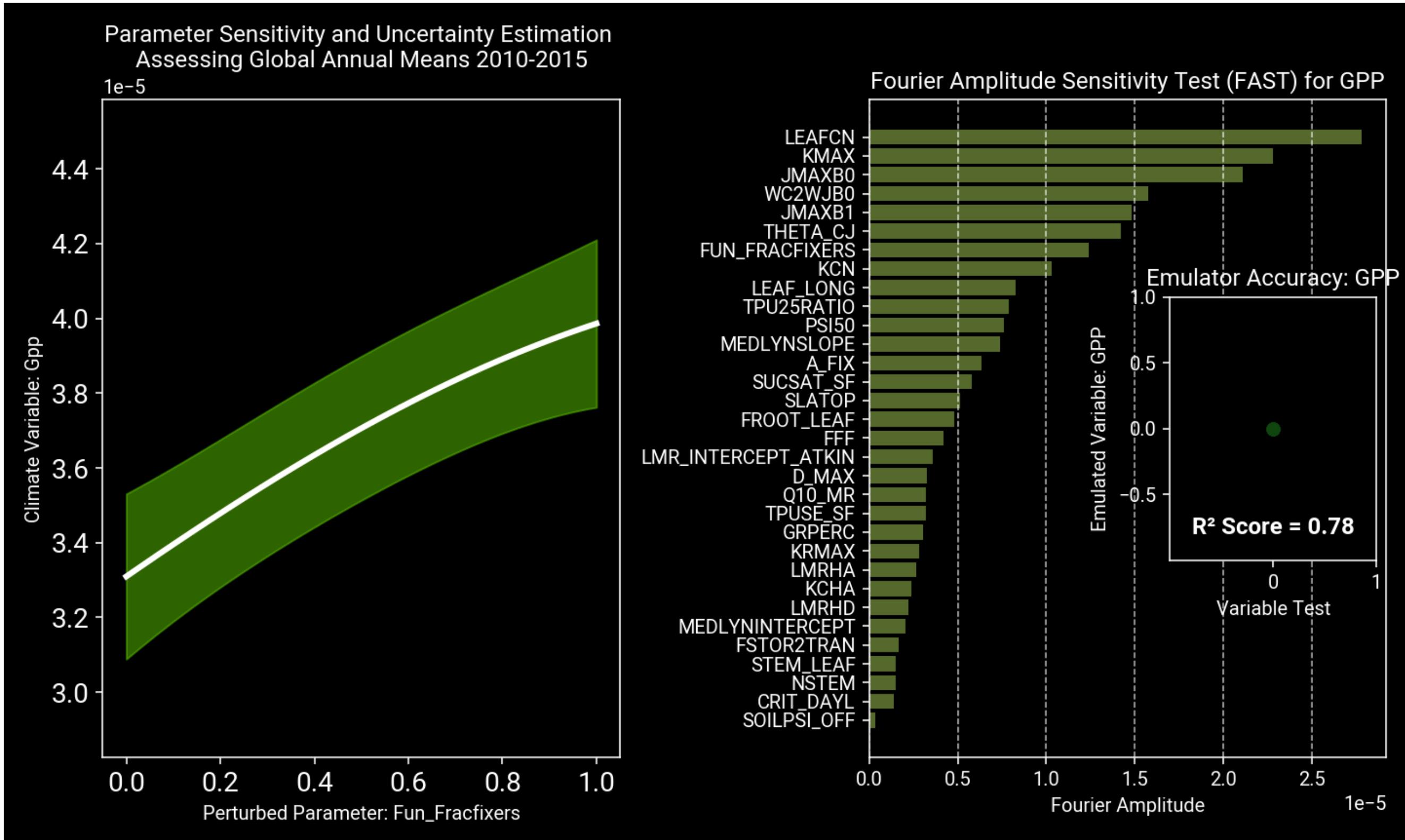
FUN_fracfixers

Variable

GPP

Time selection

2010-2015



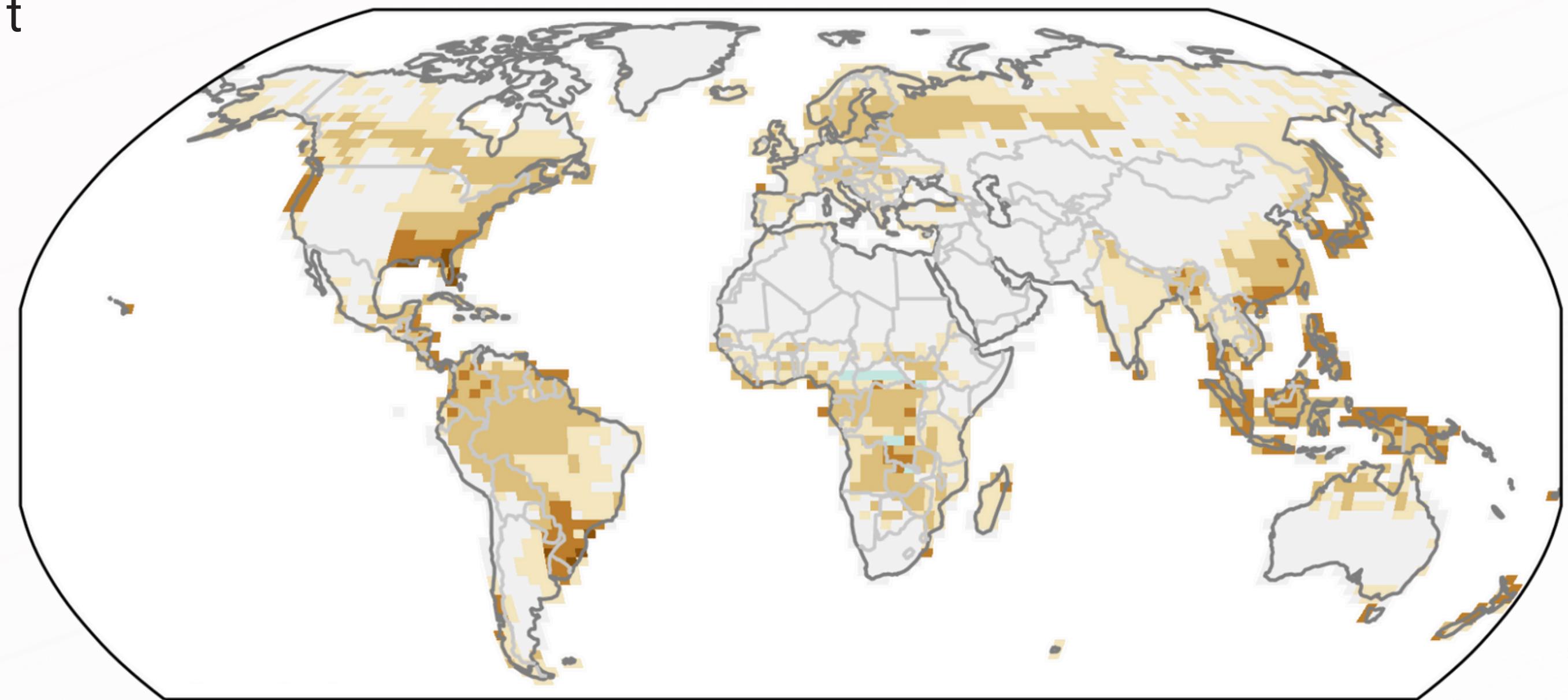
Possible Expansions

01

Public Deployment

02

Global Mapping



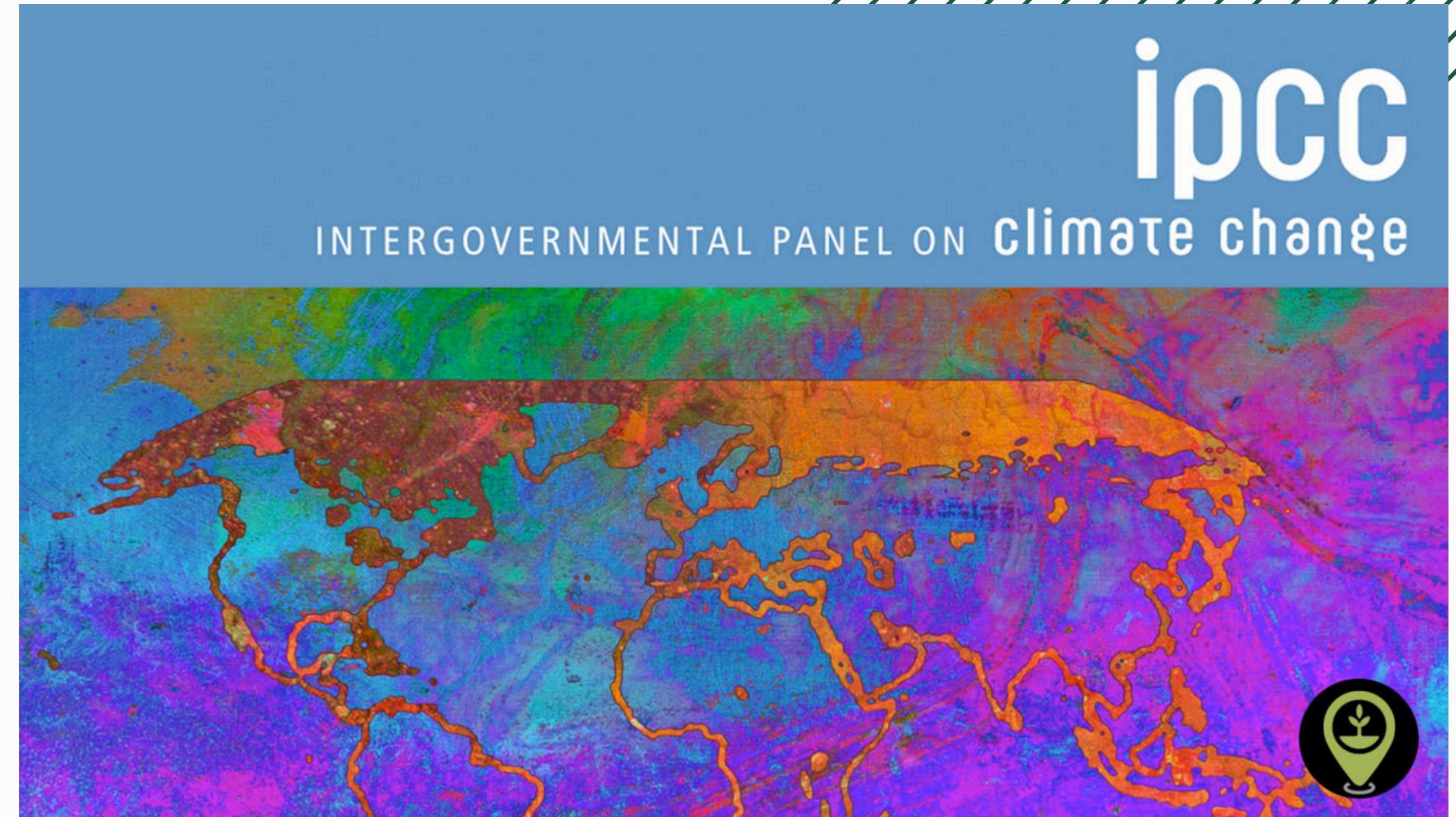
The Big Picture



Parameter Perturbation
Experiment (PPE)

NCAR's Climate Model

IPCC's Assessment Report



As insights are made at the lowest-level,
these insights influence Global Policy!

THANK YOU

DR. DANIEL KENNEDY,
DR. CARMEN GALAZ GARCÍA,
DR. LINNIA HAWKINS, NICK COTE,
&
THE MEDS TEAM FOR THEIR TIME
AND SUPPORT!



