A parameter sensitivity study of the NCAR-NEON CLM simulation tool in the Southeastern United States

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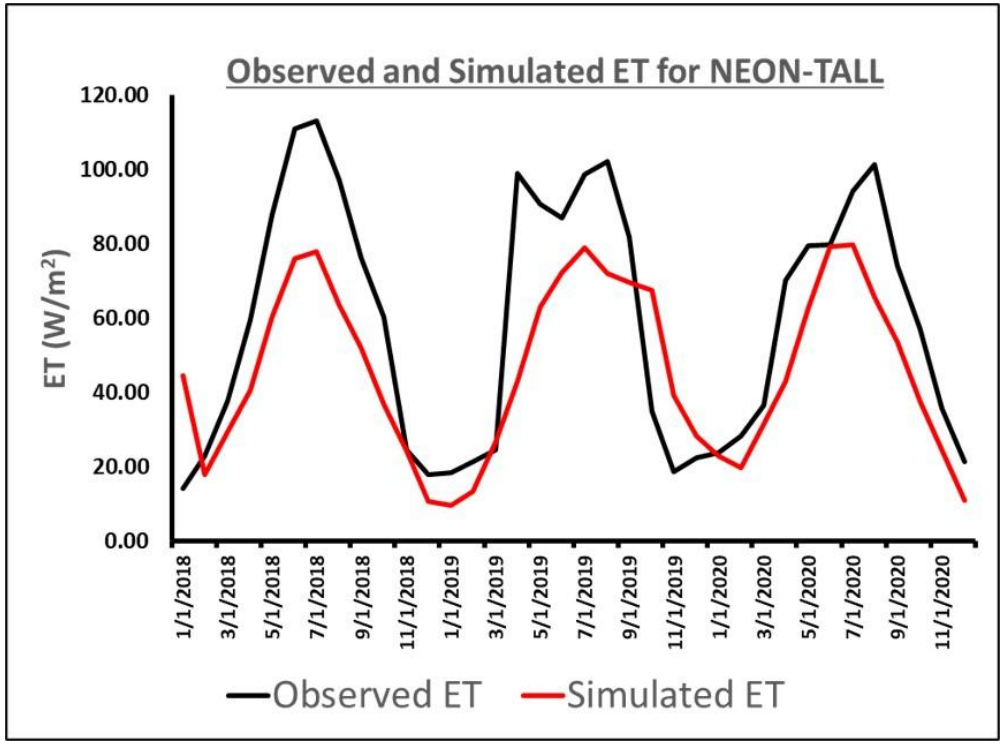
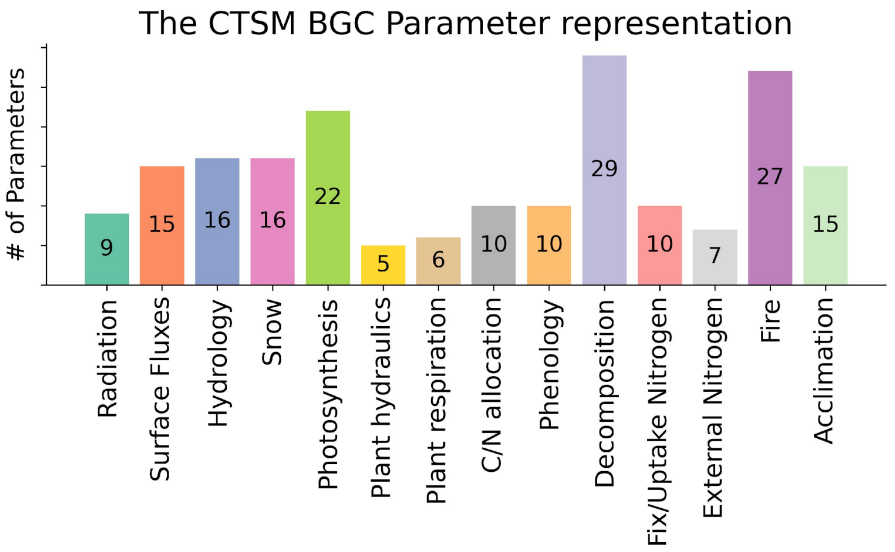
INTRODUCTION

- Estimates of change (e.g., ET) are key for understanding the terrestrial hydrological cycle under changing environments.
- Increasing complexity and comprehensiveness of LSMs - more uncertainty
- Significant biases when estimating water-carbon cycle processes



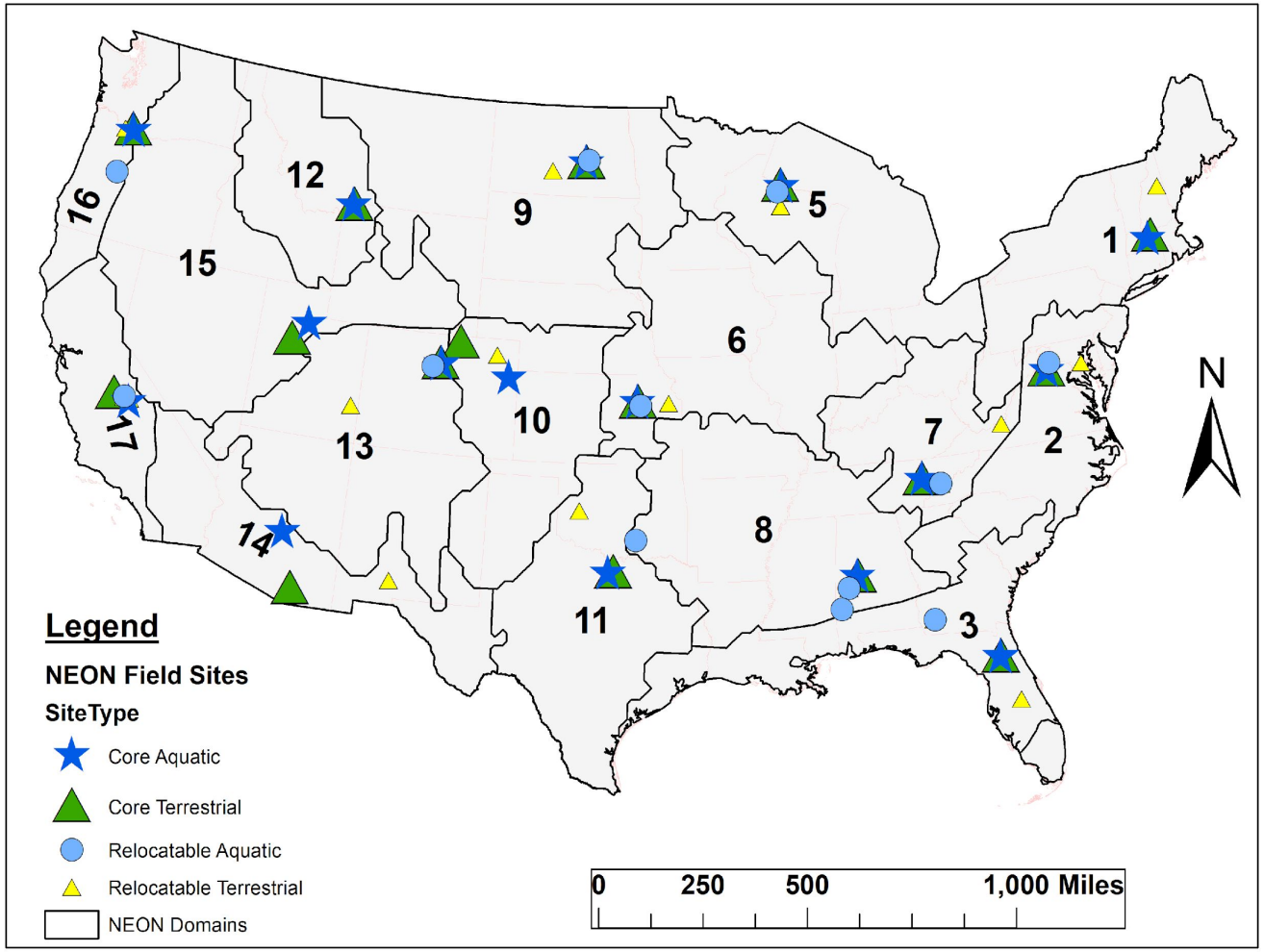
Motivation

- **Growing Complexity and Uncertainty:**
  - Land models increasingly complex and comprehensive (CTSM5, includes over 200 parameters)
  - Increasing number of uncertain parameters poses challenges in accurate simulations.
- **Unquantified Parameter Uncertainty:**
  - The contribution of parameter uncertainty to overall uncertainty is expected to be substantial.
  - However, the extent of this uncertainty remains largely unquantified.
  - This hinders a comprehensive understanding of the model's reliability.
- **Systematic Parameter Calibration for Actionable Science:**
  - Implementing a systematic parameter calibration approach is crucial
  - It enhances the accuracy of simulations within land models like CTSM.
  - The improved accuracy increases the suitability and accessibility of CTSM for actionable science applications.



Methods and Data

- NEON Data Integration in CLM-5:
  - Climate data to drive CLM-5 simulations
  - Land use data to initialize and constrain model parameters
  - Enhancement of model performance and fidelity in simulating real-world ecosystems



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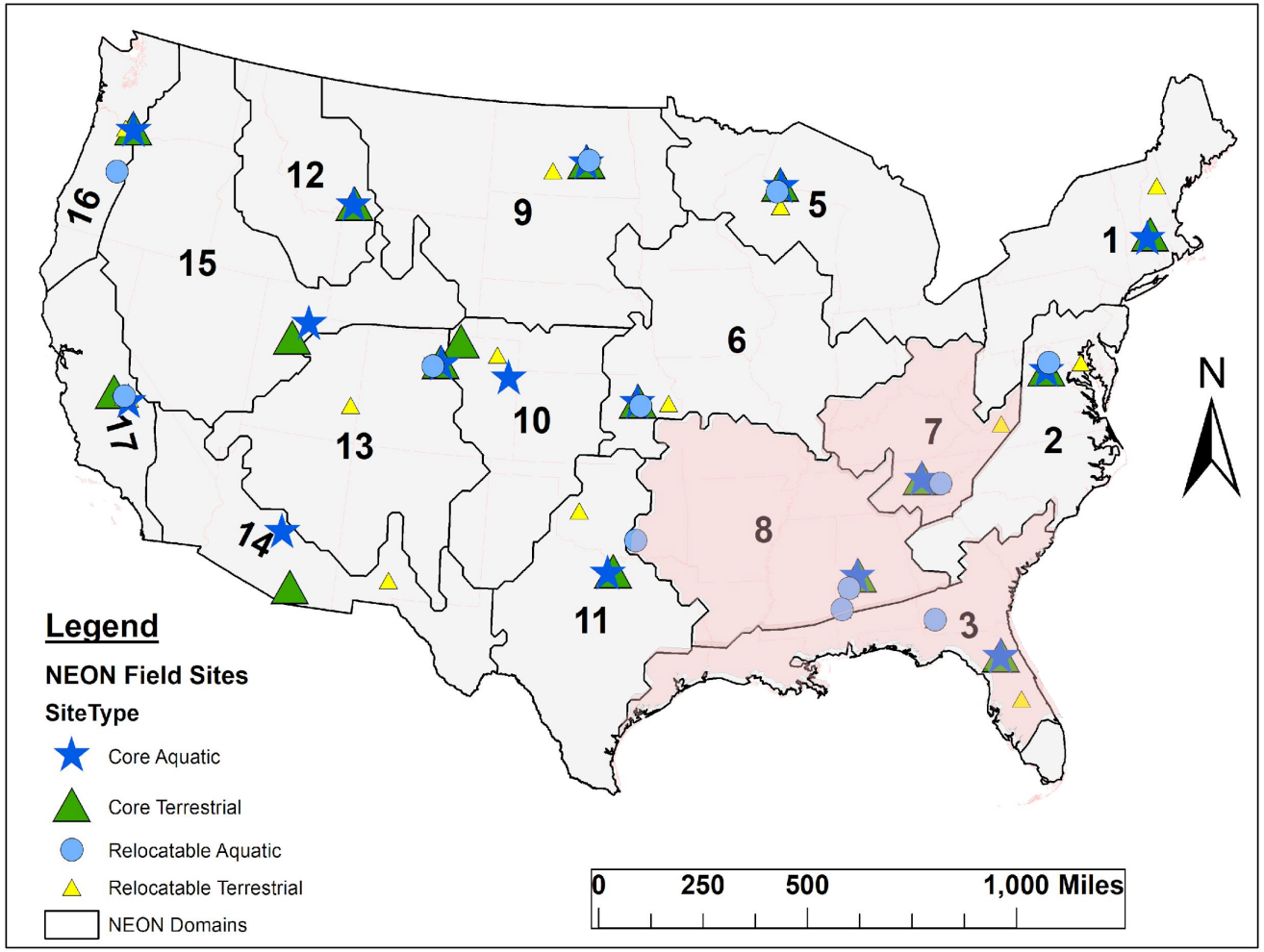
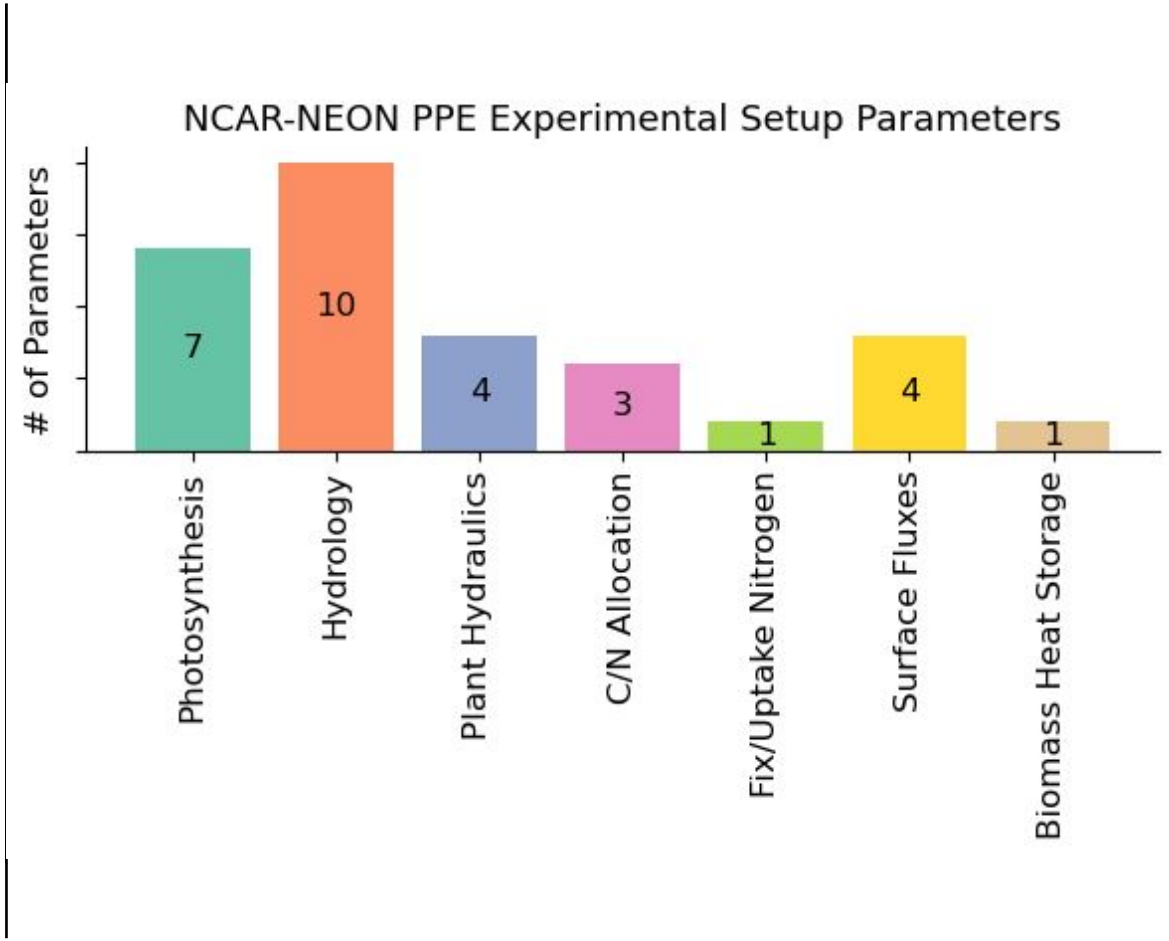


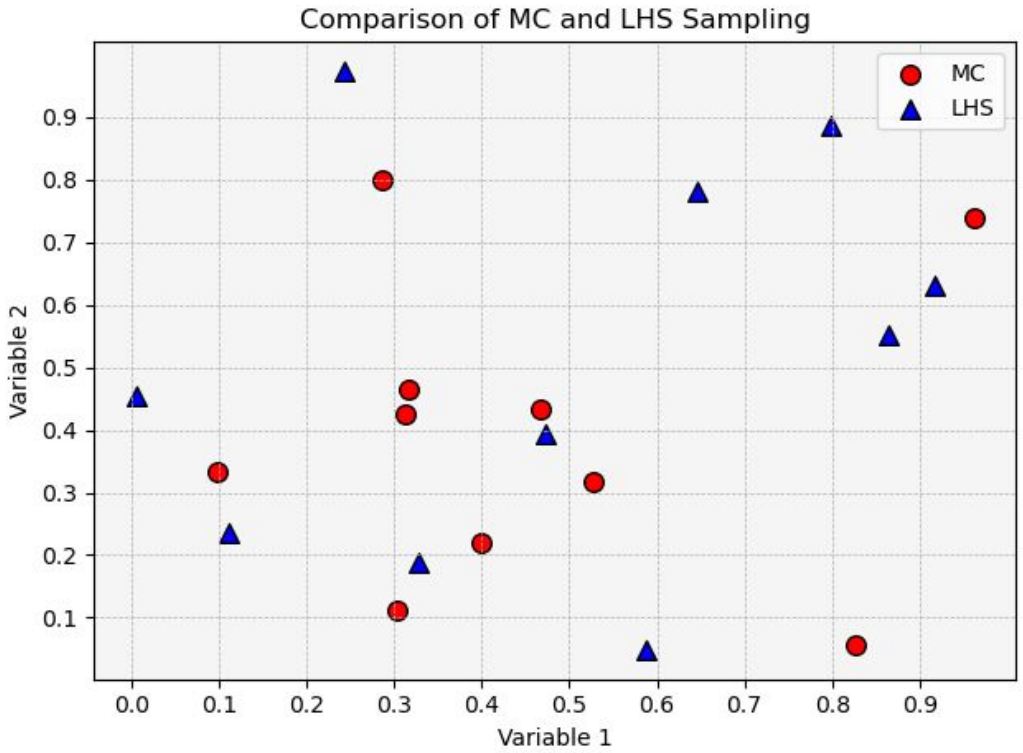
NEON-NCAR Sensitivity Experiment Setup

- 30 parameters affecting various processes
- Includes, plant functional types (pft), namelist and hard-coded parameters
- Obtained from Literature review and ongoing experiments
- Sampled using Latin Hypercube



Latin Hypercube Sampling Technique

- Better coverage of the parameter space, resulting in more representative samples and improved accuracy.
- Particularly beneficial when exploring complex systems with high-dimensional input spaces, as it efficiently covers the entire space while minimizing the number of samples required.

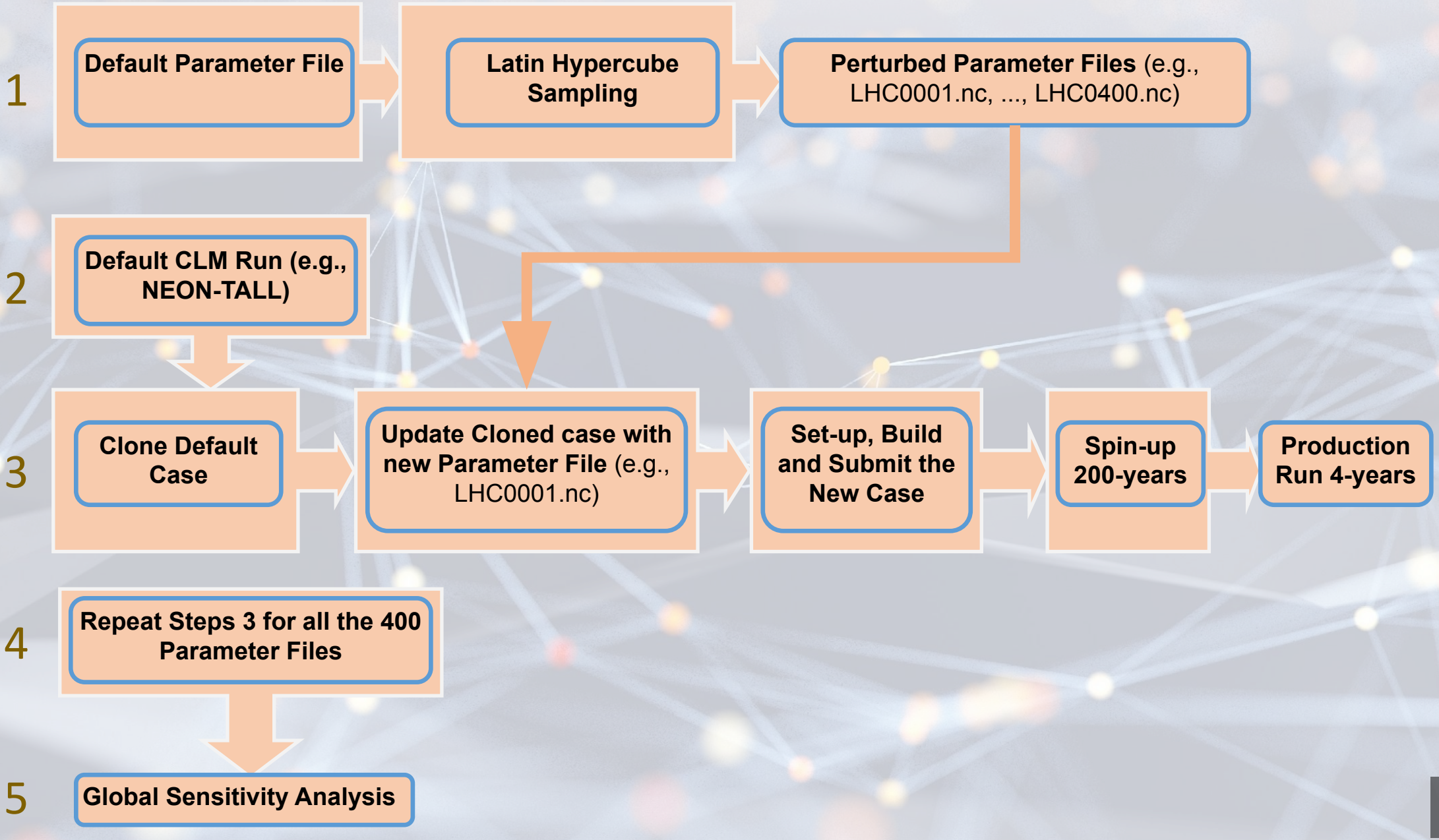


Parameter Sensitivity Analysis - VISCOUS

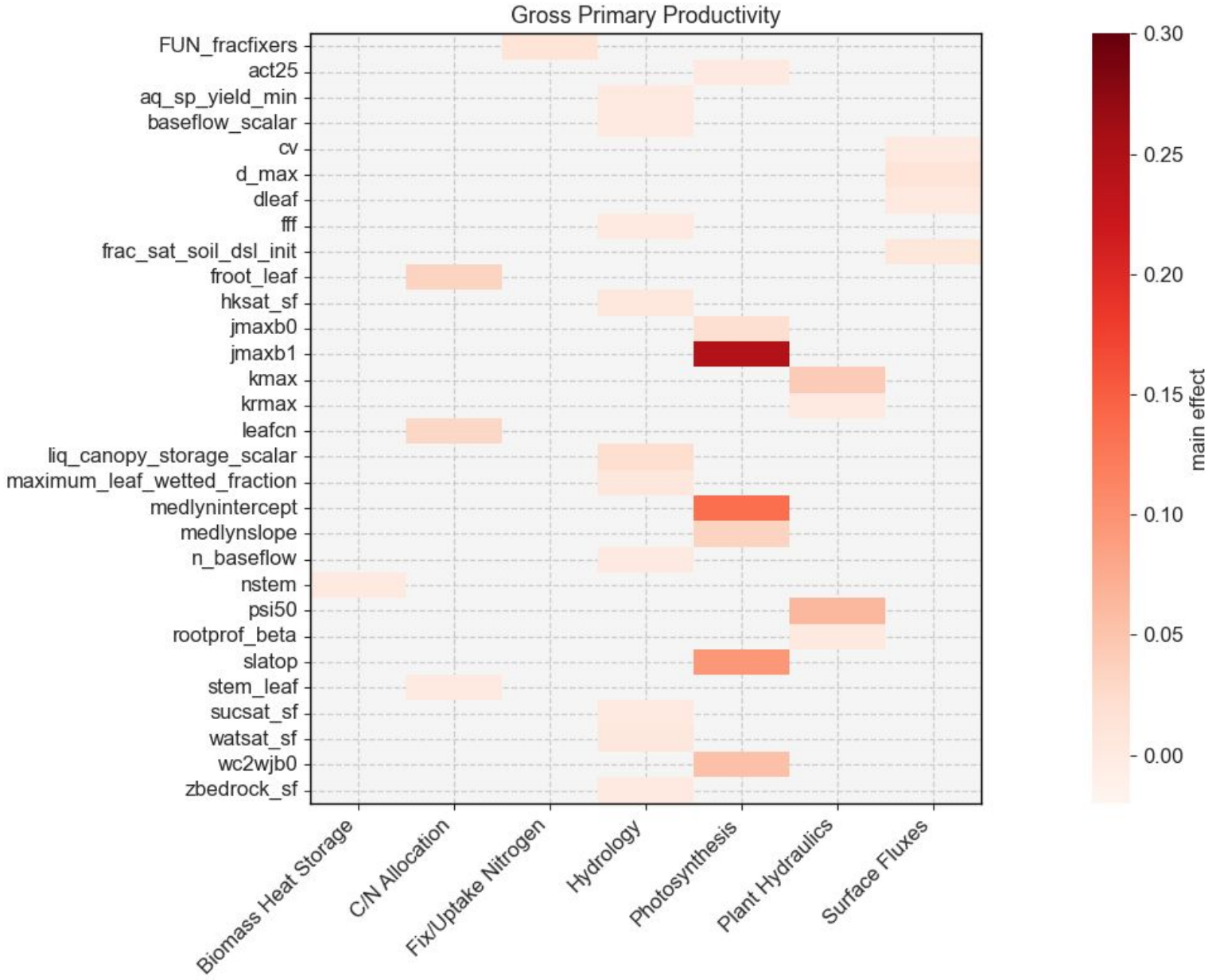
- **Data-driven approach**: Uses existing data to determine the importance of factors without assuming a specific distribution.
- **Joint probability density function**: Analyzes data using a joint probability density function to capture the relationship between input and output variables.
- **Efficient sensitivity analysis**: Calculates sensitivity indices without rerunning the model, providing insights into the relative importance of factors in a computationally efficient manner.

(Razi et al., 2021)

Sensitivity Analysis Experiment Design

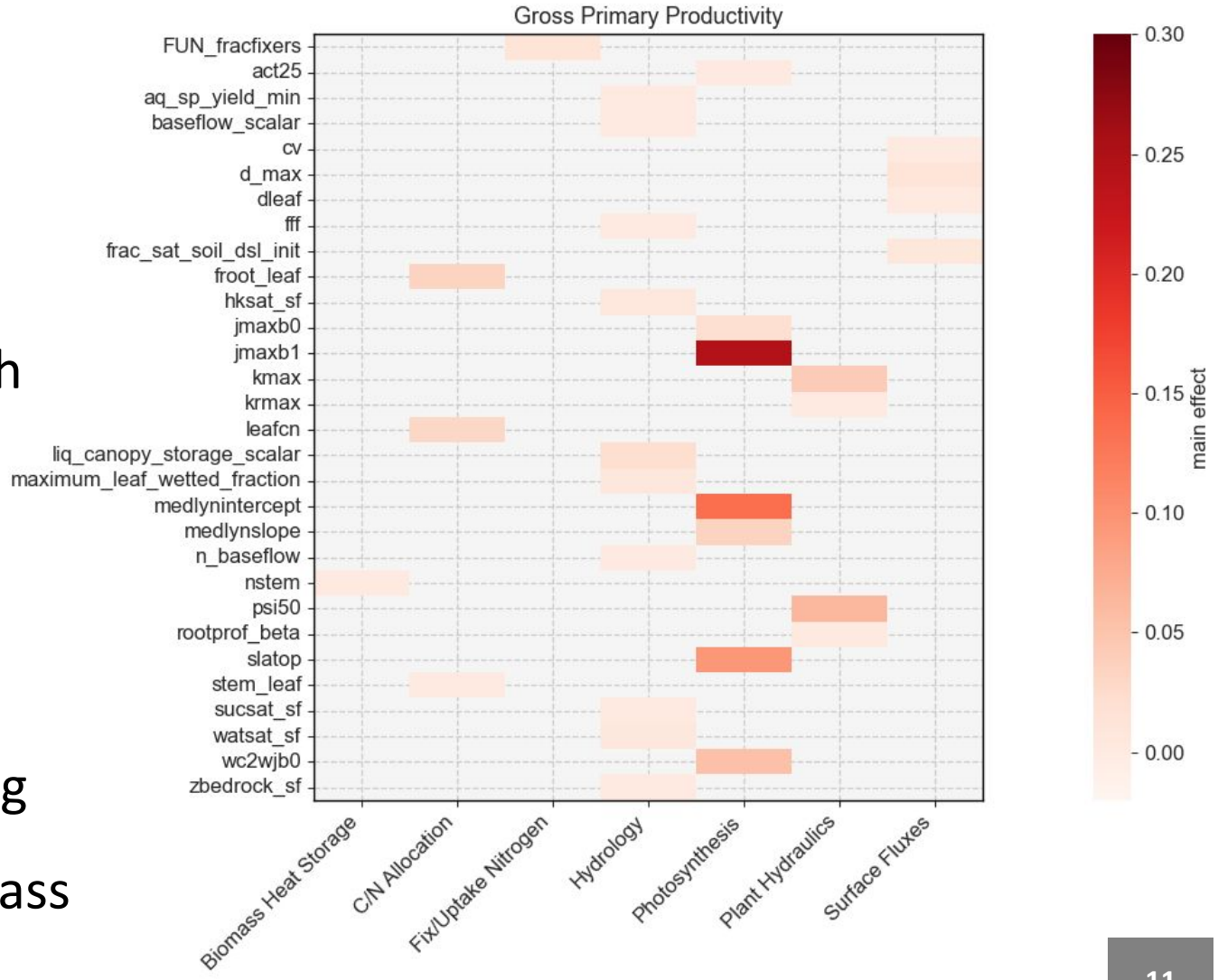


GPP Sensitivity Results

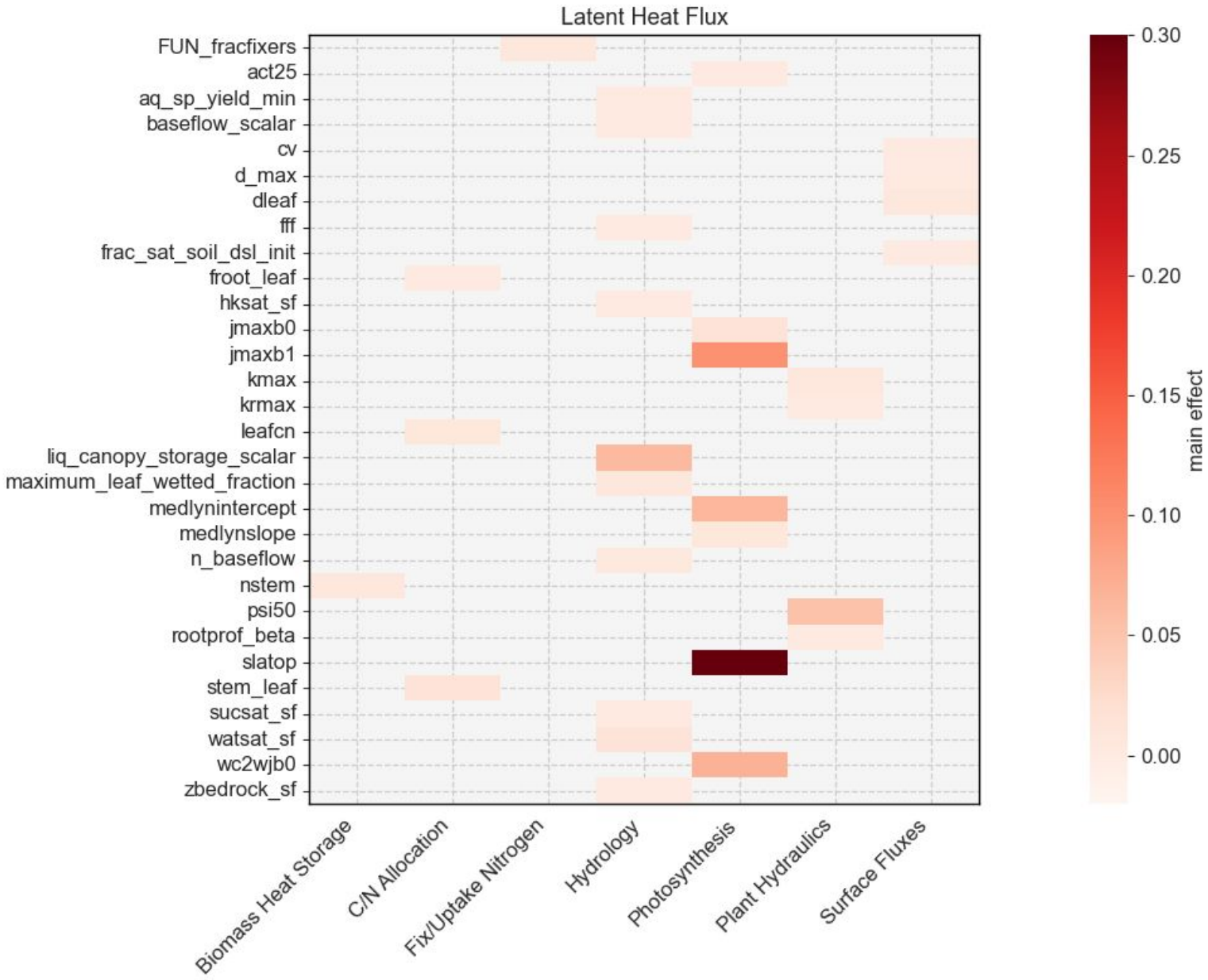


GPP Sensitivity Results

- ***Jmaxb1:*** response of electron transport rate to light absorption
- ***Medlynintercept:*** Sensitivity of stomatal conductance to atmospheric CO2
- ***Psi50:*** Regulates water transport through plants
- ***Kmax:*** Water flow rate through plant segments
- ***Froot-leaf:*** Influences carbon partitioning between above and below-ground biomass

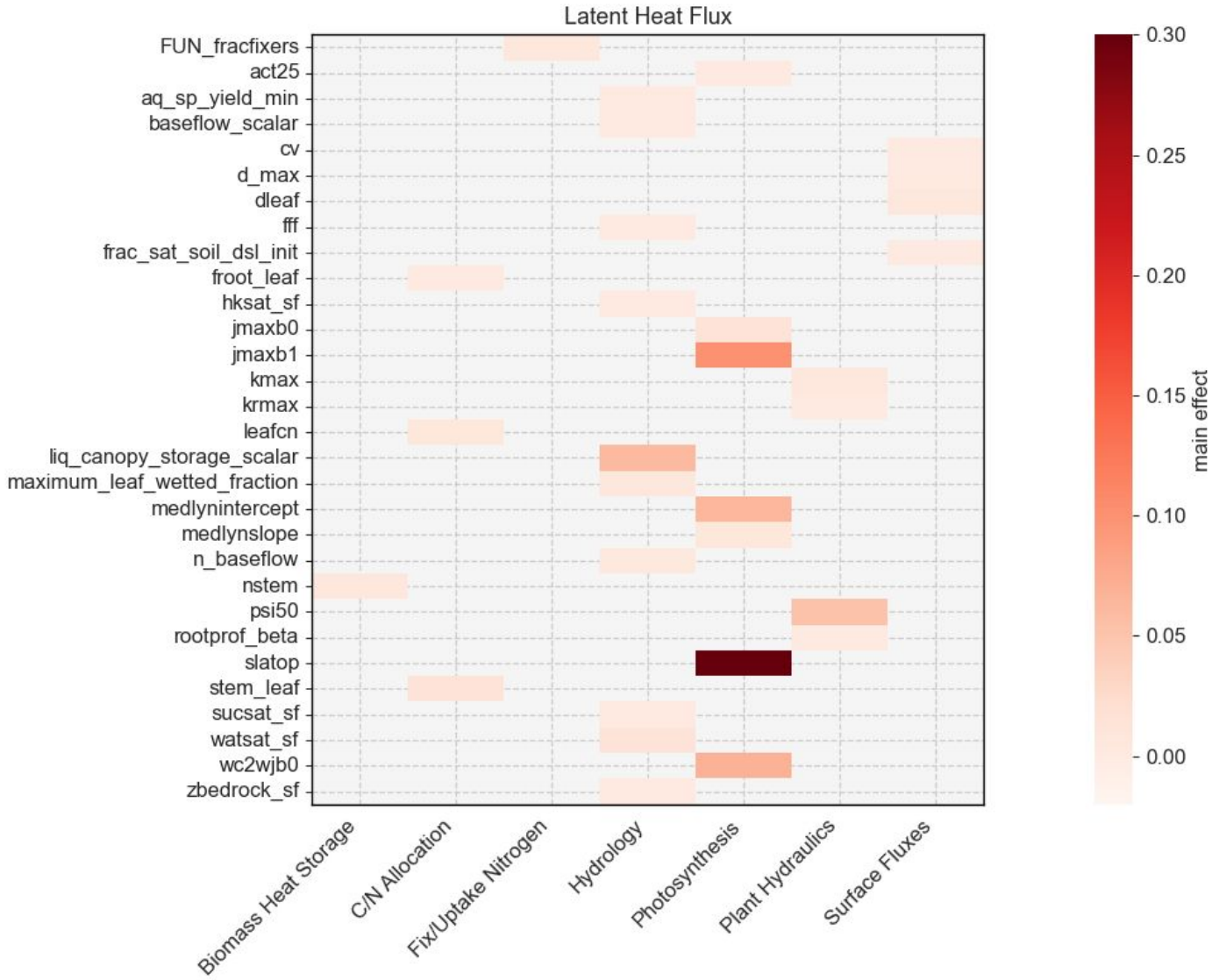


Latent Heat Flux Sensitivity Results

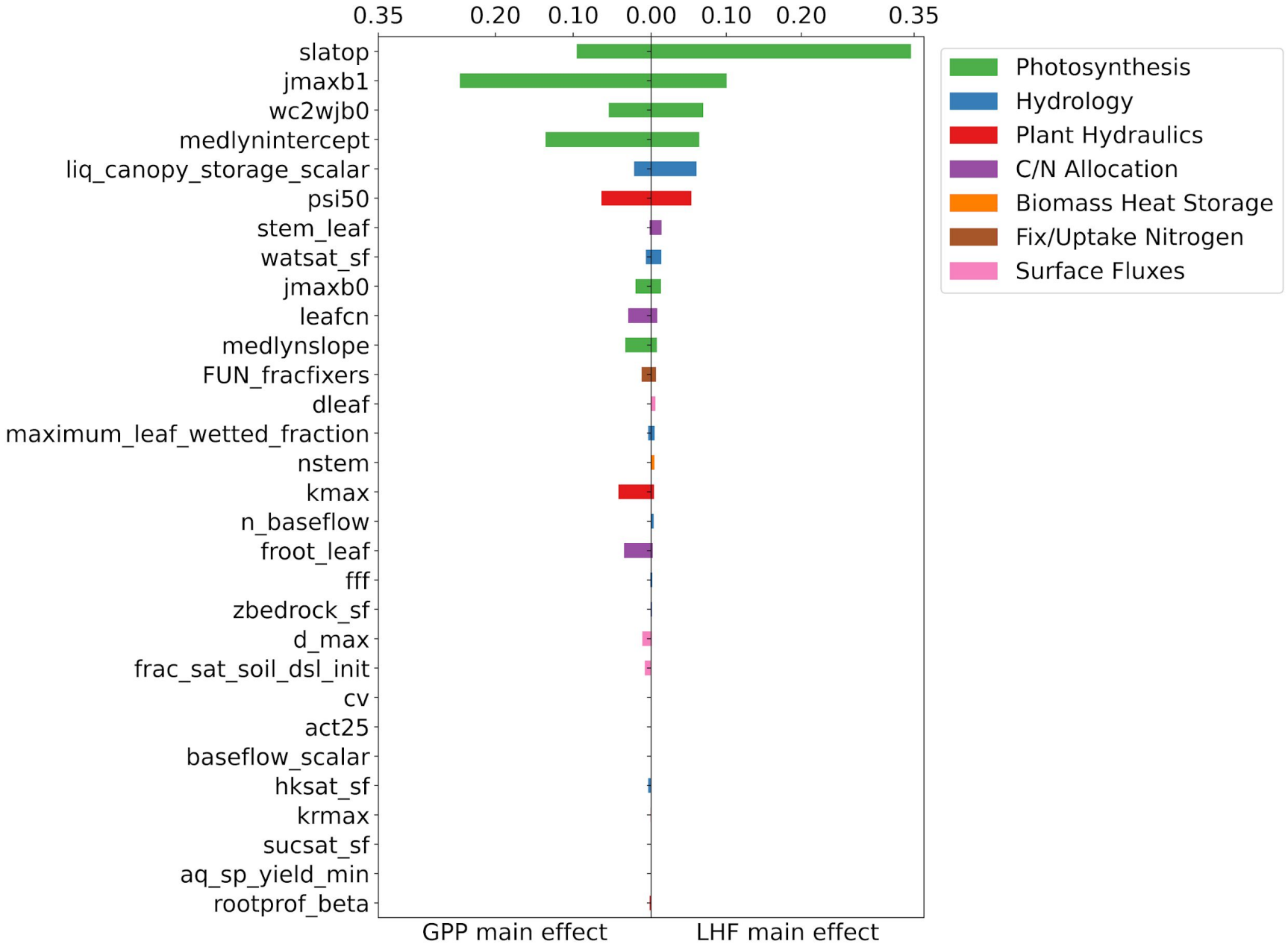


Latent Heat Flux Sensitivity Results

- ***Slatop:*** Relationship between transpiration and absorbed light
- ***Liq_canopy_storage_scalar:*** Canopy water storage
- ***Wcwjb0:*** Simulates the effects of temperature on the balance between Rubisco-limited and light-limited photosynthesis



Conclusion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psi50
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watsat_sf
jmaxb0
leafcn
medlynslope
FUN_fracfixers
dleaf
maximum_leaf_wetted_fraction
nstem
kmax
n_baseflow
froot_leaf
fff
zbedrock_sf
d_max
frac_sat_soil_dsl_init
cv
act25
baseflow_scalar
hksat_sf
krmax
sucsat_sf
aq_sp_yield_min
rootprof_beta
GPP main effect
LHF main effect
Photosynthesis
Hydrology
Plant Hydraulics
C/N Allocation
Biomass Heat Storage
Fix/Uptake Nitrogen
Surface Fluxes

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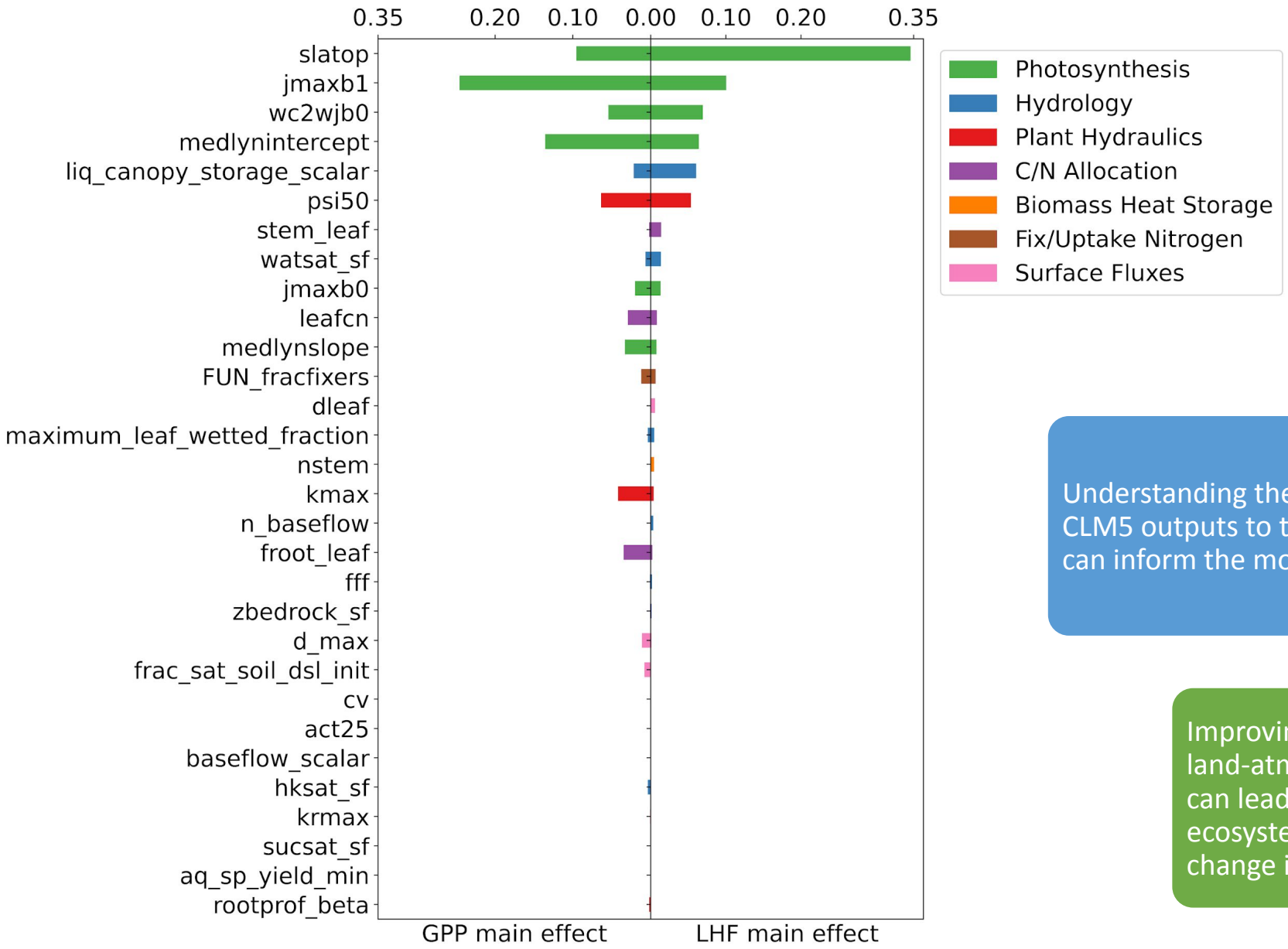
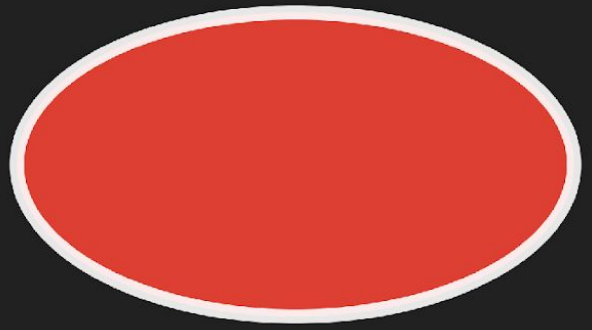


Understanding the sensitivity of CLM5 outputs to these parameters can inform the model calibration

Improving our understanding of land-atmosphere interactions can lead to better predictions of ecosystem function and climate change impact.

Thanks for listening!



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