A global sensitivity analysis of biophysical parameters in CABLE

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Why sensitivity analysis?

- Most global LSMs have 5 to 30 different PFTs, each PFT has 20 to 60 parameters.

- Model parameters can be estimated by calibrating against observations

- Studies showed available observations can constraint only a small fraction of model parameters.

- Therefore we need to identify those more sensitive parameters.

What tools are available for global sensitivity analysis?

- For models with several hundred parameters, the key to efficient sensitivity analysis is an efficient sampler in parameter space

- Monte Carlo method (Priodko et al. 2008) (46 parameters, 20,000 simulations, one site)

- Latin Hypercube (Tang and Zhuang, 2009) (35 parameters, 500,000 simulations, one site)

- Morris-Sobol method (Ziehn & Tomlin 2009)

Morris-HDMR method

This method has two steps:

- Step 1 (Morris method): selected parameters with high elementary effects (E_i)

$$E_i = \frac{f(p_1, p_2, \cdots p_i + \Delta, \cdots p_k) - f(p_1, p_2, \cdots p_i, \cdots p_k)}{\Delta}$$

- Step 2: develop a high-dimensional model representation (HDMR) from the simulation results for different combinations of model parameters (sampled using SOBOL sequence). Calculate the contributions of each parameter and its interactions with other parameters to the variance of model output using HDMR. (**contribution -> importance**).
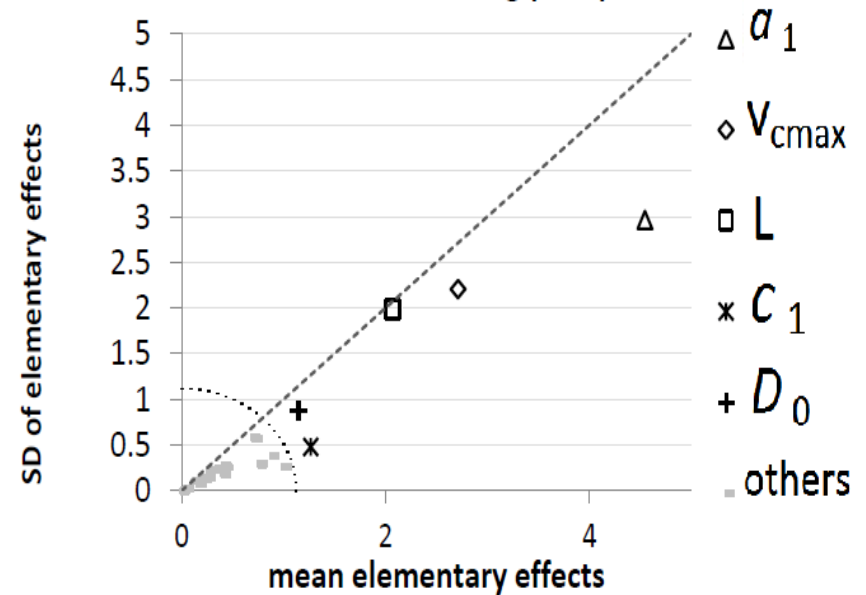
experiment

- 22 biophysical parameters in each PFT are included in this study. (690 simulations)

- 16 in 22 parameters are selected by Morris method to conduct the HDMR analysis. (256 simulations)

- Output: GPP and LE (globally and PFT-averaged)
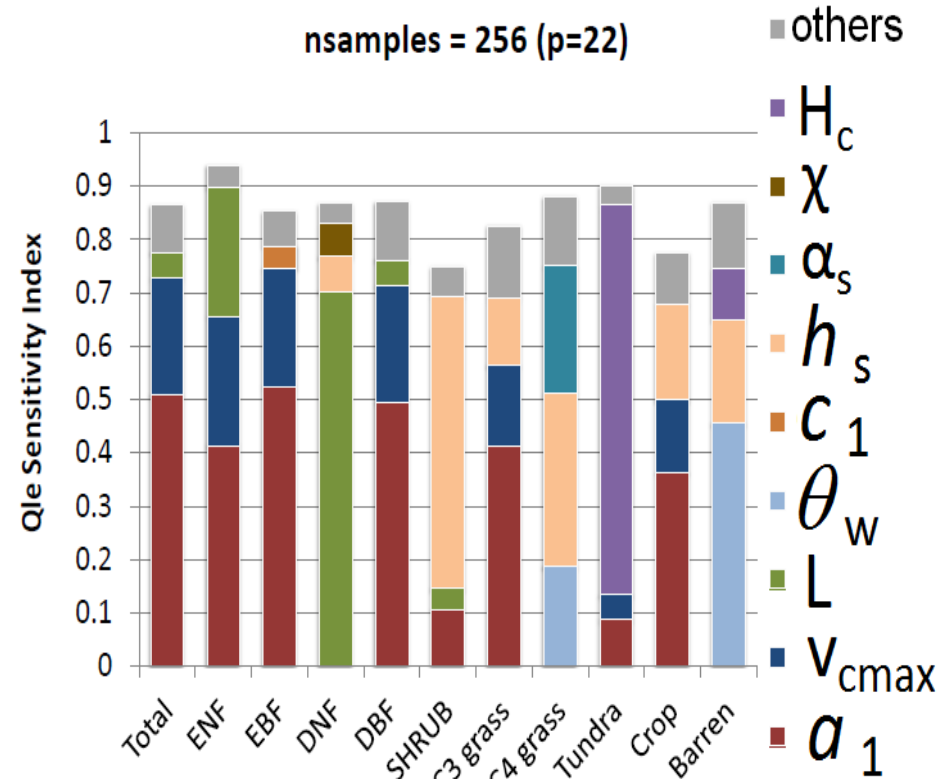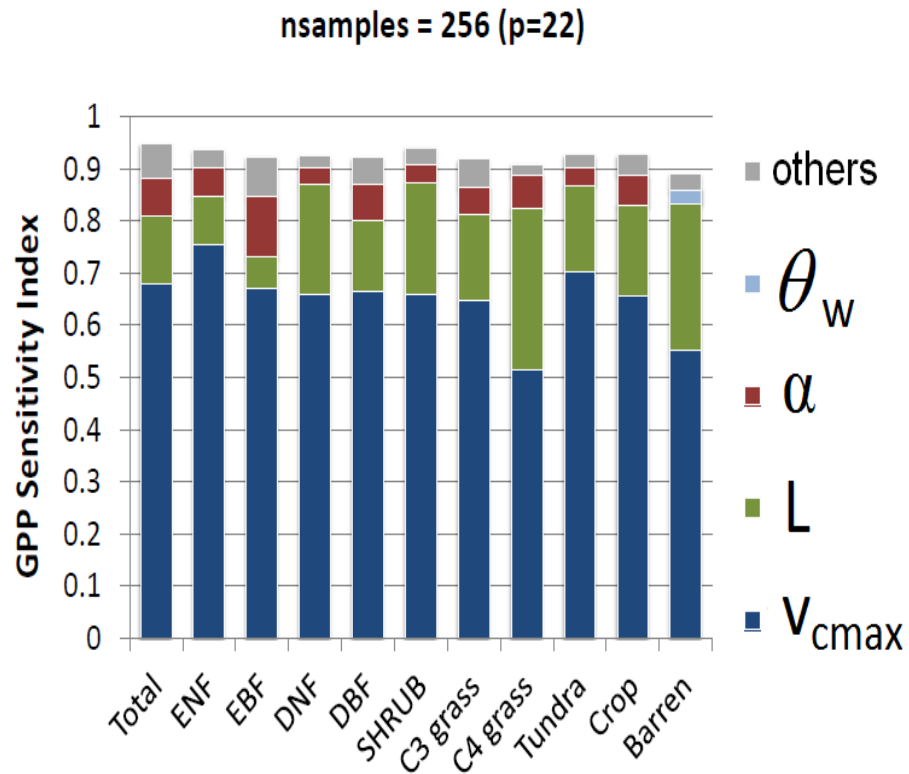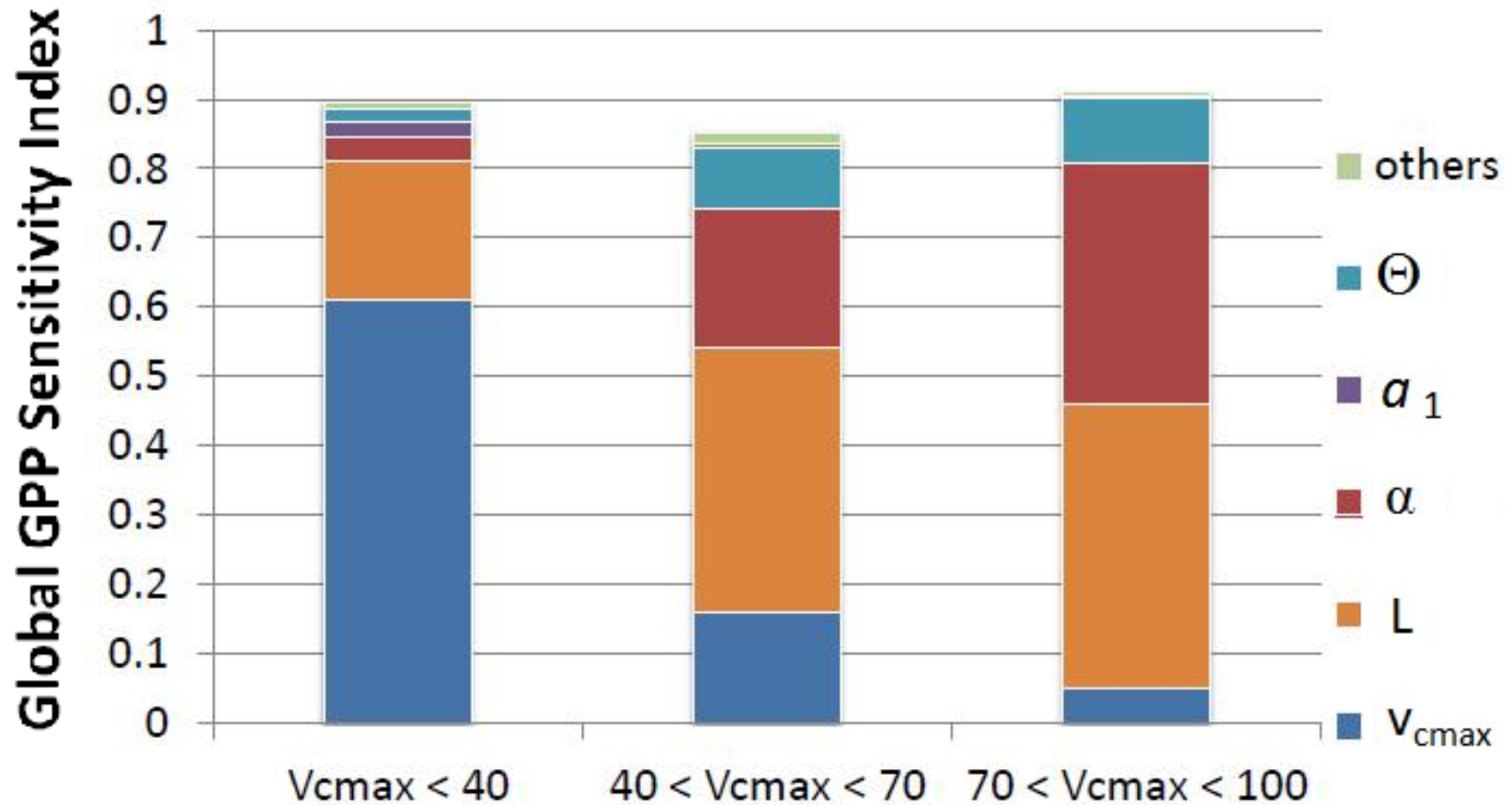
Mean and SD of elementary effects
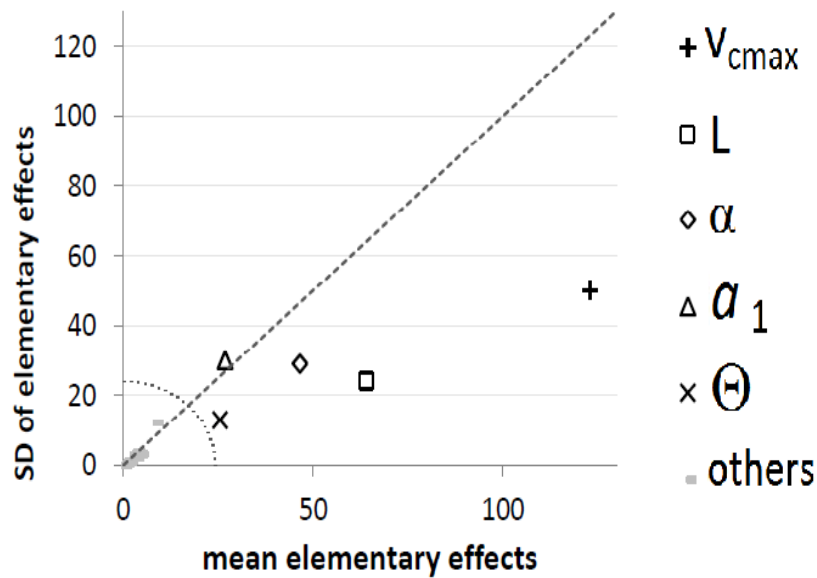
Sensitivity index of GPP and LE

Nonlinearity effects on ranking

Future application

- Model calibration/key observations to constrain model parameters, processes
  - Identify the key plant traits for each PFT
  - How can observations from manipulated experiments be used to constrain model predictions for the future?

- Use the HDMR/meta model as a tool
  - to derive first derivatives for efficient parameter inversions (computing: month to < hour)
  - To study model structural errors