# Sensitivity analysis

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June 2016

# Qualitative Sensitivity Analysis Methods

| Theory | Method | Characteristics | Advantages | Disadvantages |
|---|---|---|---|---|
| Sampling-based | OAT, MCS, QMC, LHS, OAS | Explore the parameter space with random sampling | Simple to implement and interpret | May require large computation cost to fully explore the space; no consider interactions between parameters; |
| Regression-based | PEAR, SPEA, PCC, PRCC, DT | PEAR, SPEA, PCC, PRCC is for linear model while DT is non-linear model | Easy to implement and understand | Assumption required; no interaction effect |
| Screening | Morris | After MOAT sampling, individual effect and interaction effect are calculated based on derivative information | Suitable for large number of parameters; model free | Not suitable for uncertainty anaysis |

# Quantitative Sensitivity Analysis Methods

| Property | Derivate based | Variance based | EVPI based | Entropy based | Distribution based |
|---|---|---|---|---|---|
| global | ✓ | ✓ | ✓ | ✓ | ✓ |
| Handles nonlinearities | ✓ | ✓ | ✓ | ✓ | ✓ |
| Handles dependencies | ✗ | ✗ | ✓ | ✓ | ✓ |
| Information require is prior(Y) | ✓ | ✓ | ✗ | ✗ | ✓ |
| Scale invariant | ✗ | ✗ | ✗ | ✓ | ✓ |

Cost expensive

$$f(X) = f_0 + \sum_{i=1}^{n} f_i(x_i) + \sum_{1 \le i < j \le n} f_{ij}(x_i, x_j) + \ldots + f_{12\ldots n}(x_1, x_2, \ldots, x_n)$$

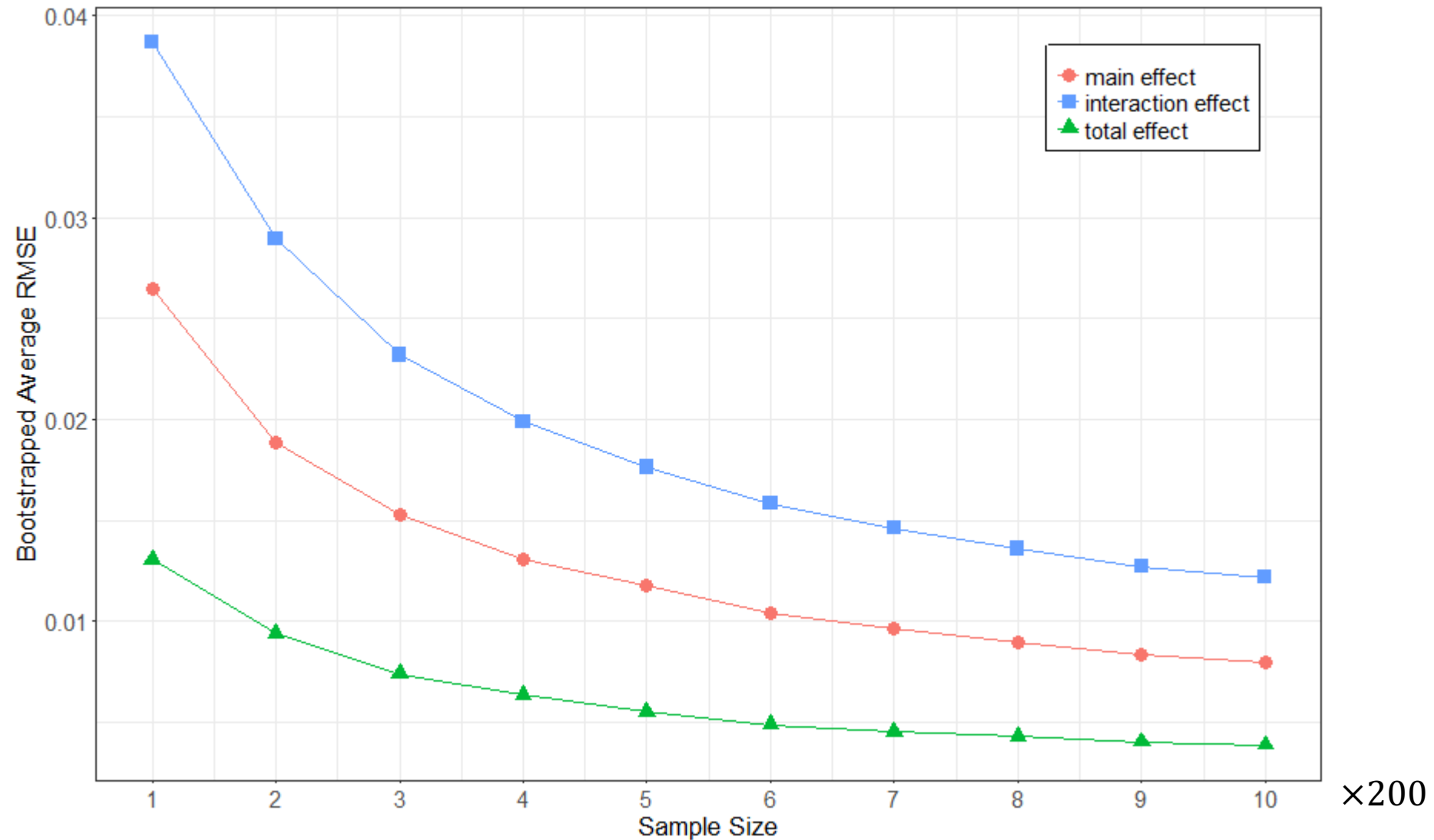$$V = \sum_{i=1}^{n} V_i + \sum_{1 \le i < j \le n} V_{ij} + \ldots + V_{12\ldots n}$$

| MainEffect(ME) | $S_i = \dfrac{V_i}{V}$ | The effect of $x_i$ on y averaging all other parameters |
|---|---|---|
| InterEffect(IE) | $S_T - S_i = \dfrac{\sum V_{i.}}{V}$ | The effect of cooperate parameters |
| TotalEffect(TE) | $S_{T_i} = \dfrac{\sum V_{i.}}{V}$ | The sum of ME and TE |

# Sensitivity analysis for GAMIL atmospheric model

4 parameters are identified as important according to Morris method
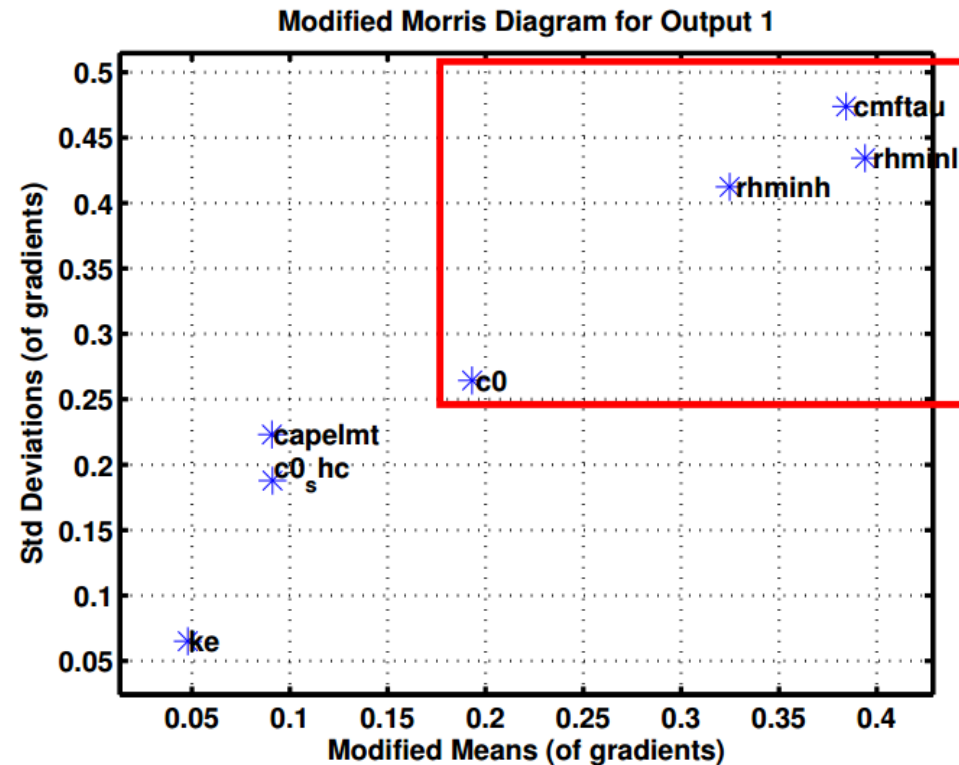
# Convergence of sensitivity indices

# Conclusions

- We use Morris for parameter screening and validate it by Sobol' method

- 4 out of 7 parameters are screened out as important in GAMIL model

- This quantitative sensitivity indices are converged with 1,000 samples

# Thanks