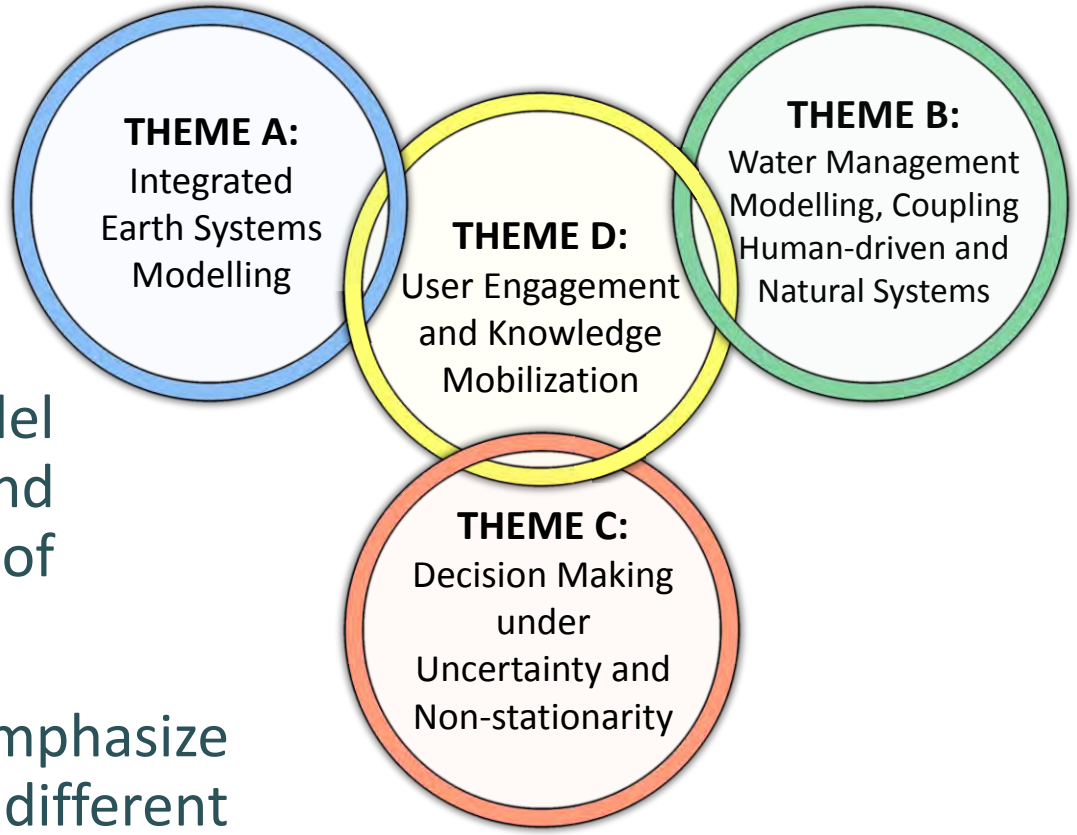
# IMPC THEME A7:
# Characterization and Communication of Uncertainty

Saman Razavi, September 15, 2017

GLOBAL WATER FUTURES
INTEGRATED MODELLING PROGRAM FOR CANADA

# Objective

The overarching goal is to characterize and communicate model uncertainties across all program themes:



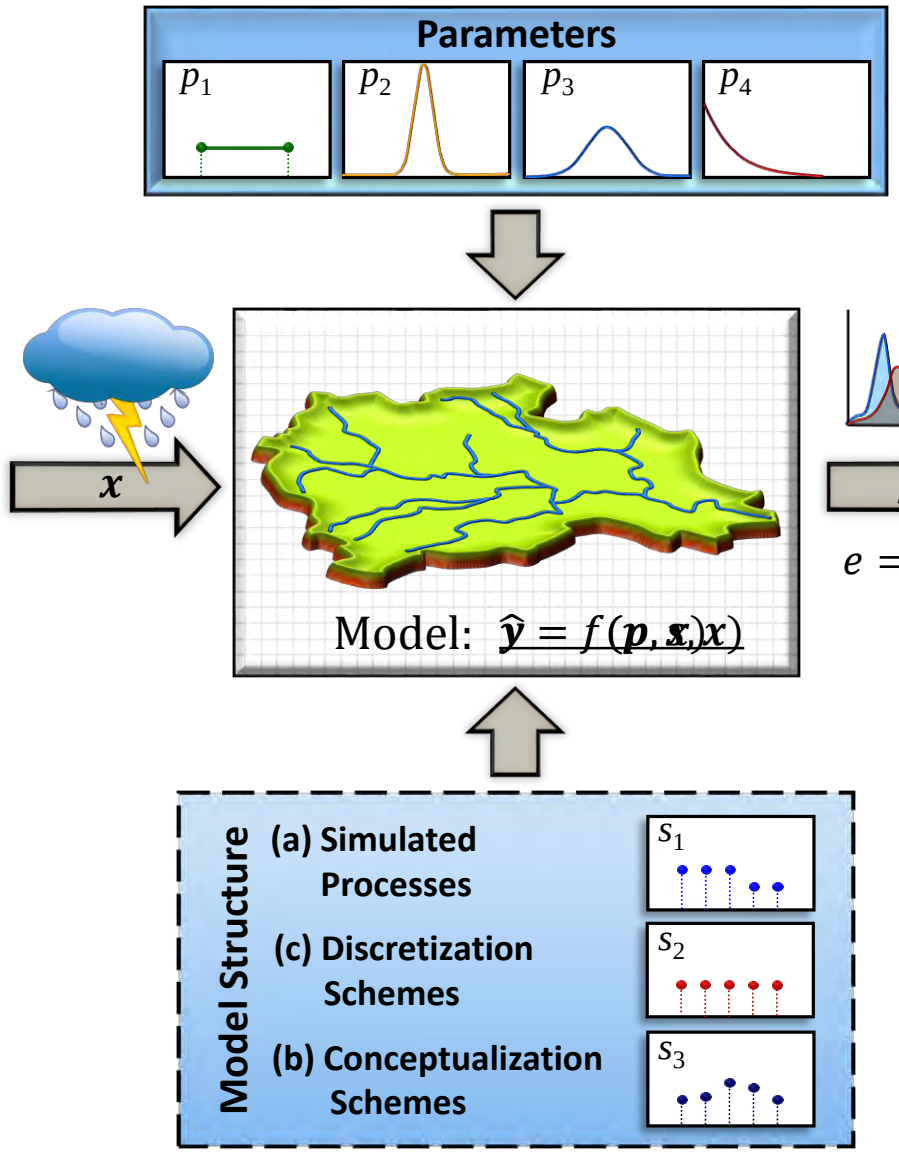

- For Themes A, this will support model development, including diagnostic testing and the identification of major sources of uncertainty.
- For Themes B, C and D, this will emphasize characterizing the predictive uncertainty in different variables of interest such as streamflows, water quality indices, and water resources system performance metrics, and apportioning that uncertainty to different contributing sources.
- A major focus will be on the communication of uncertainty within the Decision Making Under Uncertainty process (Themes C and D).

# Uncertainty is intrinsic to all aspects and components of the current generation of Earth system models.

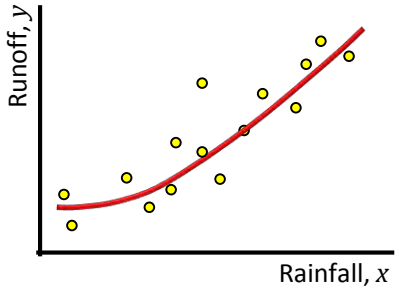


- Some sources of uncertainty in modelling can be ‘adequately’ characterized and incorporated into subsequent analyses, via probability theory.

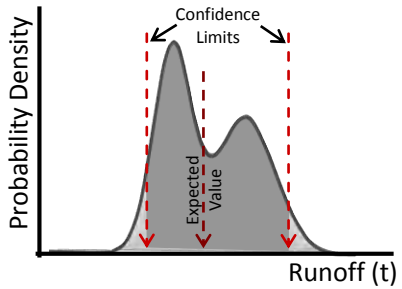
- Adequate characterization of uncertainty and its representation in any decision problem formulation is essential.



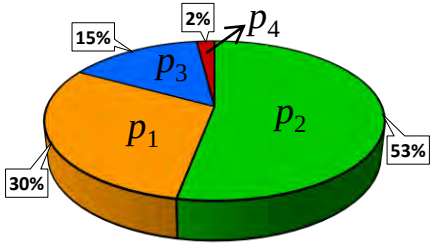

**Optimization**




**Uncertainty Analysis**

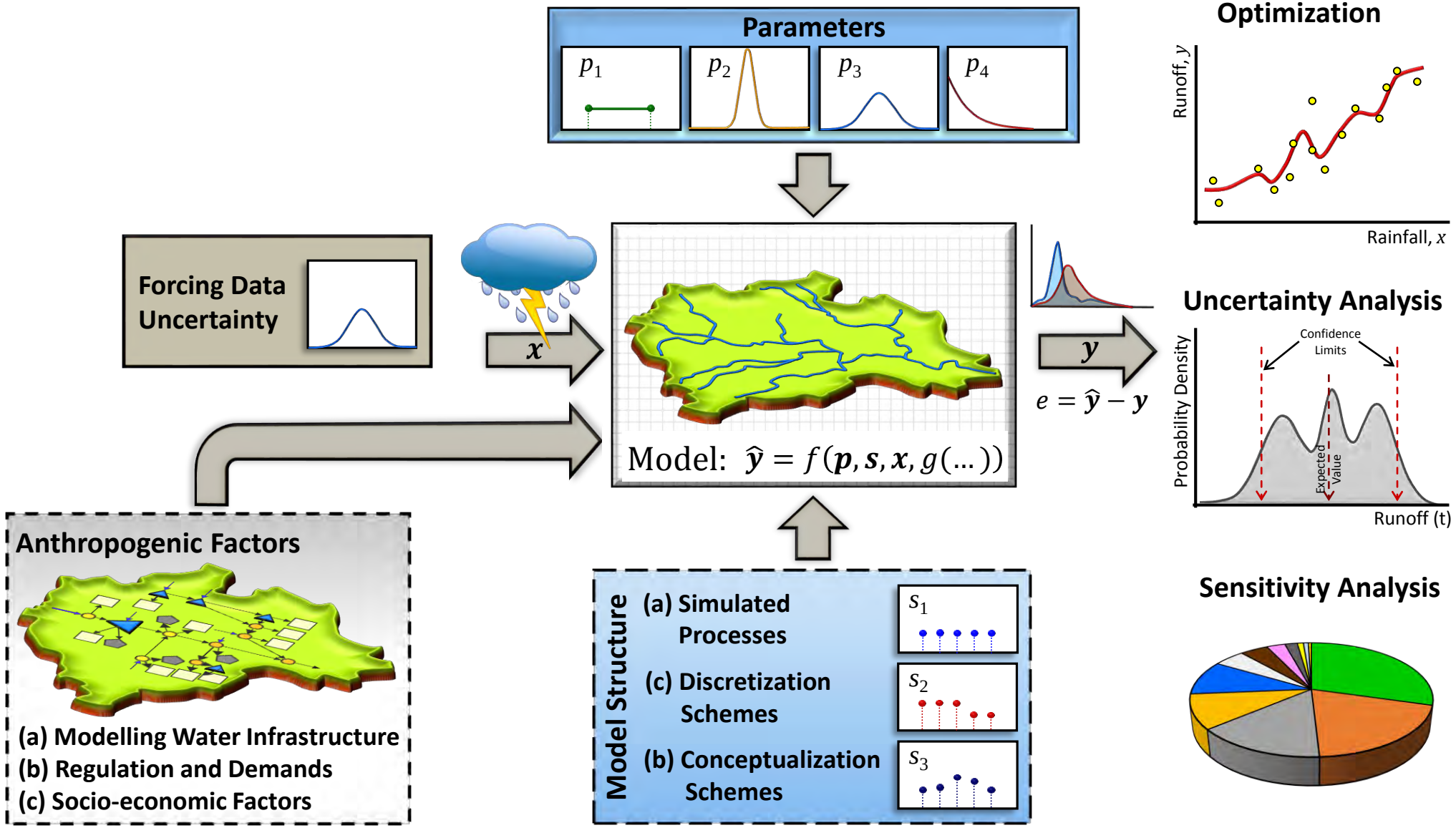



**Sensitivity Analysis**



# Some Factors are "Deeply Uncertain" and Probability Theory is of No/Limited Help

GLOBAL WATER FUTURES
INTEGRATED MODELLING PROGRAM FOR CANADA



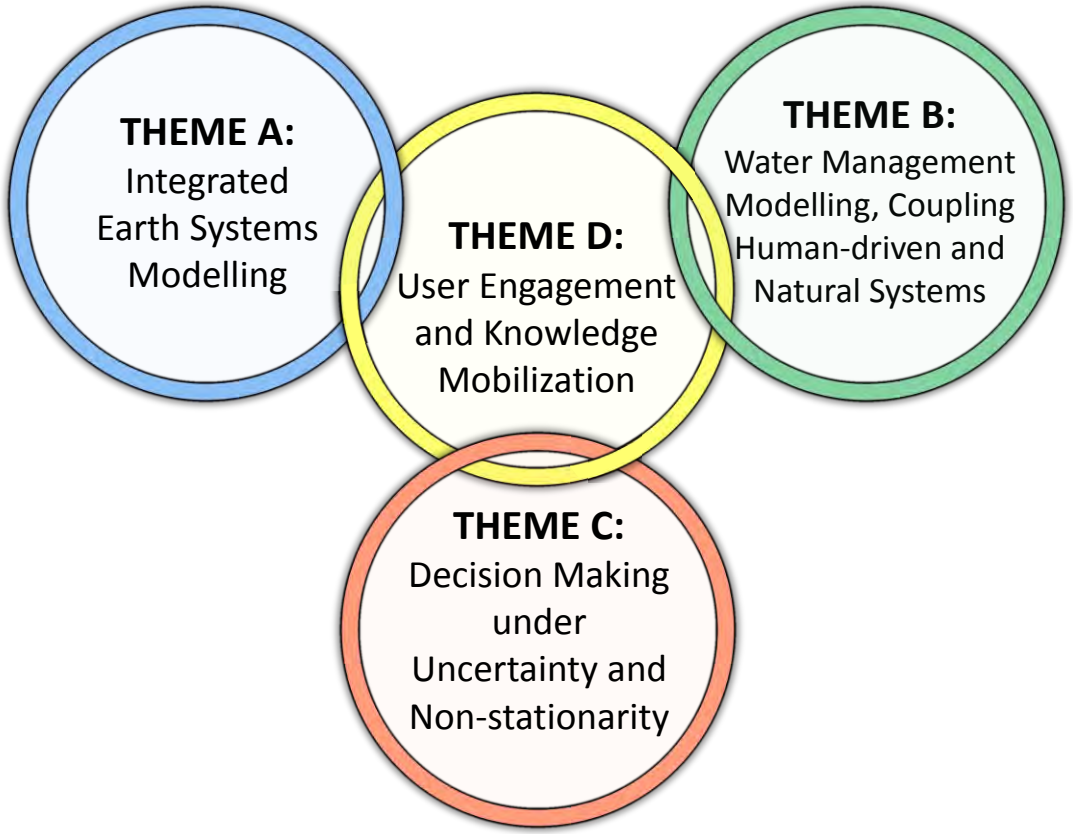
GLOBAL WATER FUTURES
INTEGRATED MODELLING PROGRAM FOR CANADA

# What To Do ...

As a team, we need to be consistent with the approaches used and how we communicate uncertainty with modelling results.

Characterizing predictive uncertainty is critically important for Decision Making Under Uncertainty.

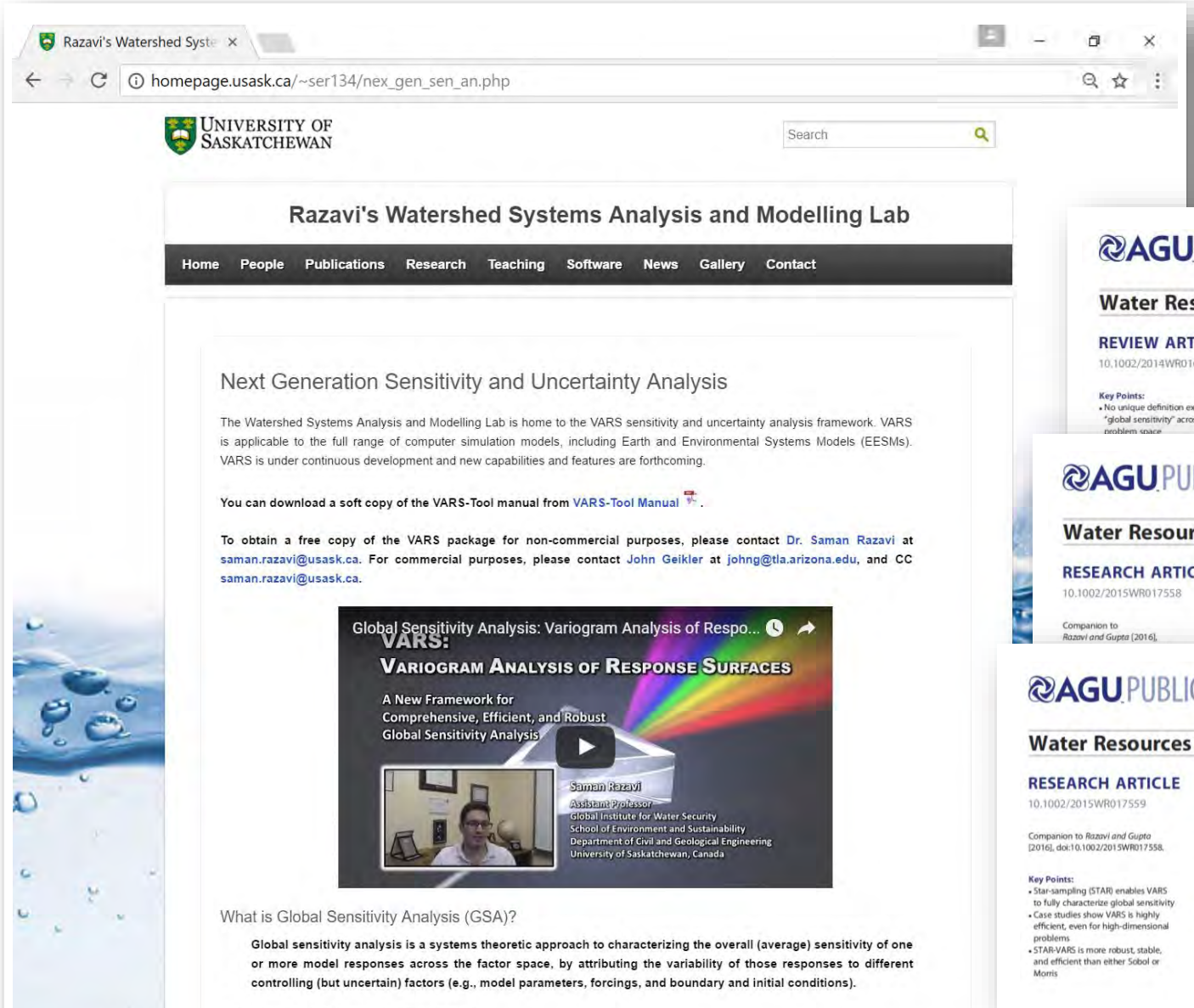
Let's discuss and develop a common plan for characterization and communication of uncertainty.



# VARS-TOOL:

## A Toolbox for Sensitivity and Uncertainty Analysis

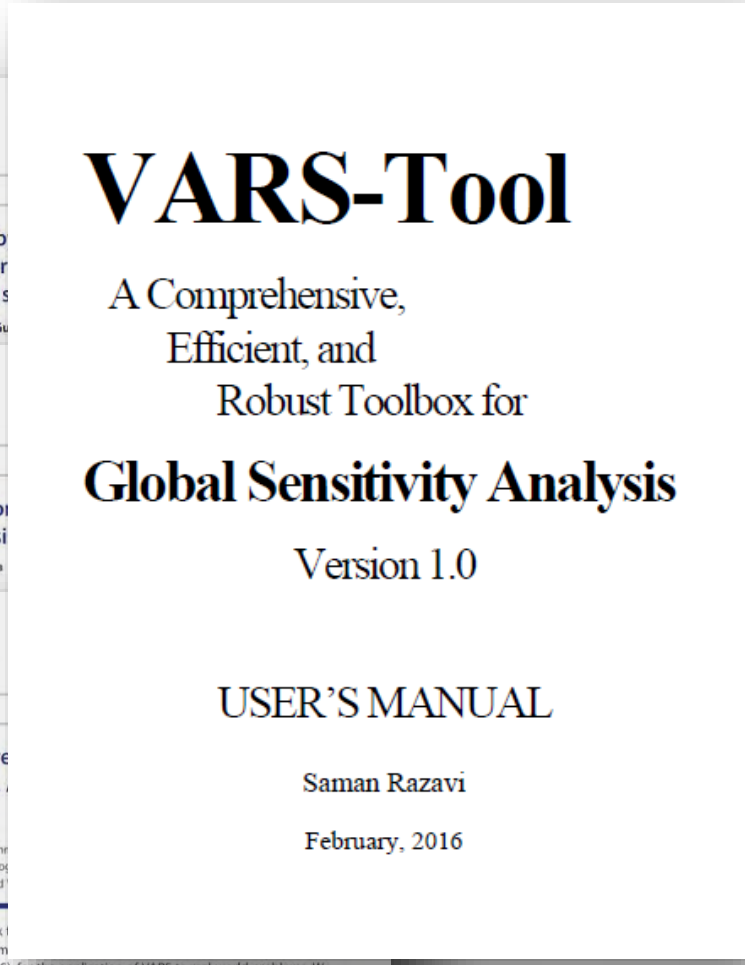
GLOBAL WATER FUTURES
INTEGRATED MODELLING PROGRAM FOR CANADA











# Features of VARS-TOOL

GLOBAL WATER FUTURES
INTEGRATED MODELLING PROGRAM FOR CANADA

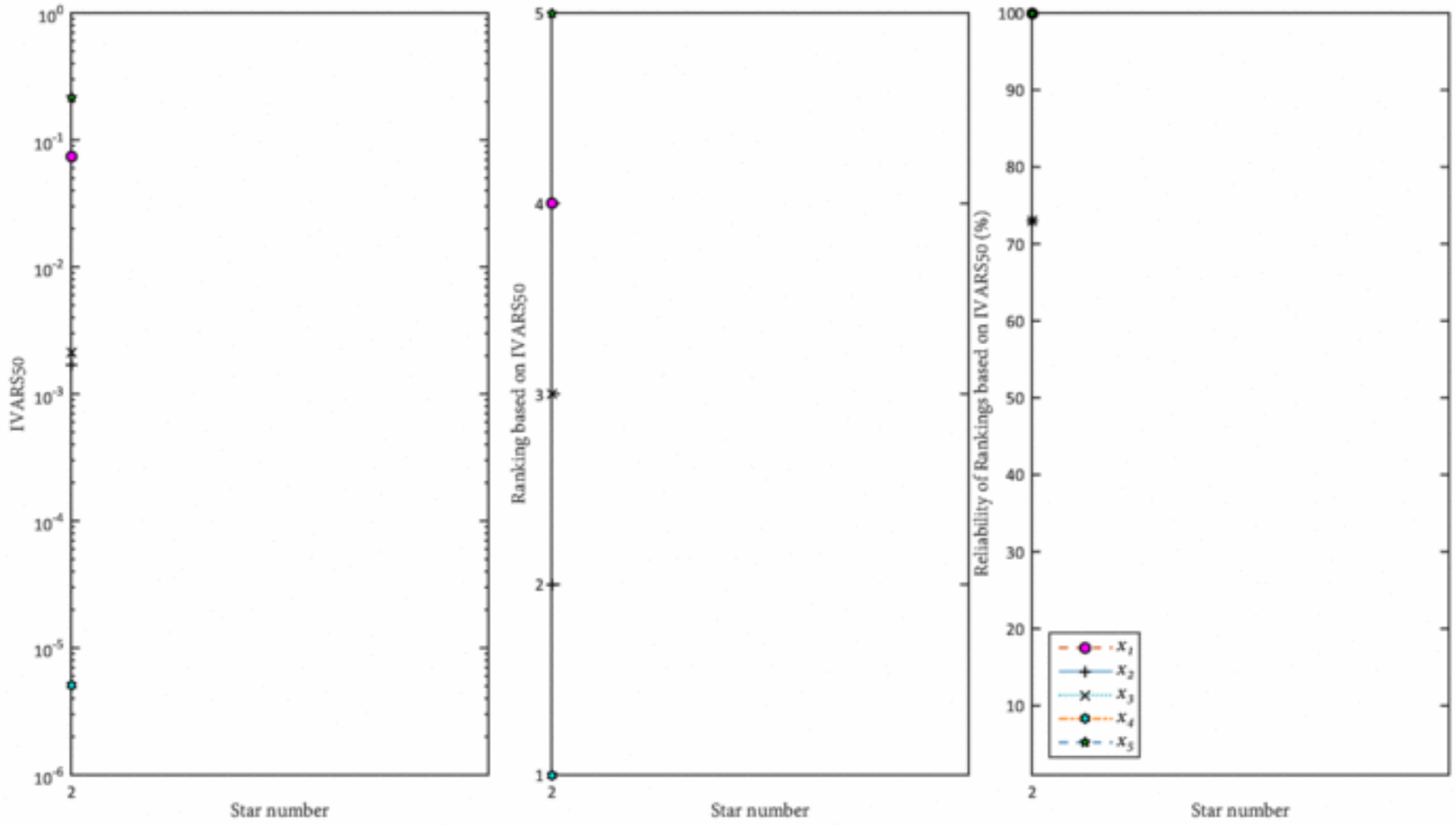
- Multiple Sampling Strategies (NEW)
- Multiple Sensitivity/Uncertainty Analysis Algorithms (NEW)
- Sensitivity Analysis of Dynamical Systems Models (NEW)

- Bootstrapping: Characterizing Confidence and Reliability
- Factor Grouping: Dealing with High-dimensional Problems (NEW)
- Reporting and Visualization: Monitoring Stability and Convergence (NEW)
- Model Emulation: Handling Model Crashes (NEW)
- Beyond MATLAB: Running in any Programming Languages & Operating Systems

- Test Functions (NEW)
- Example Case Studies (NEW)

# VARS-TOOL: New Visualization Tools

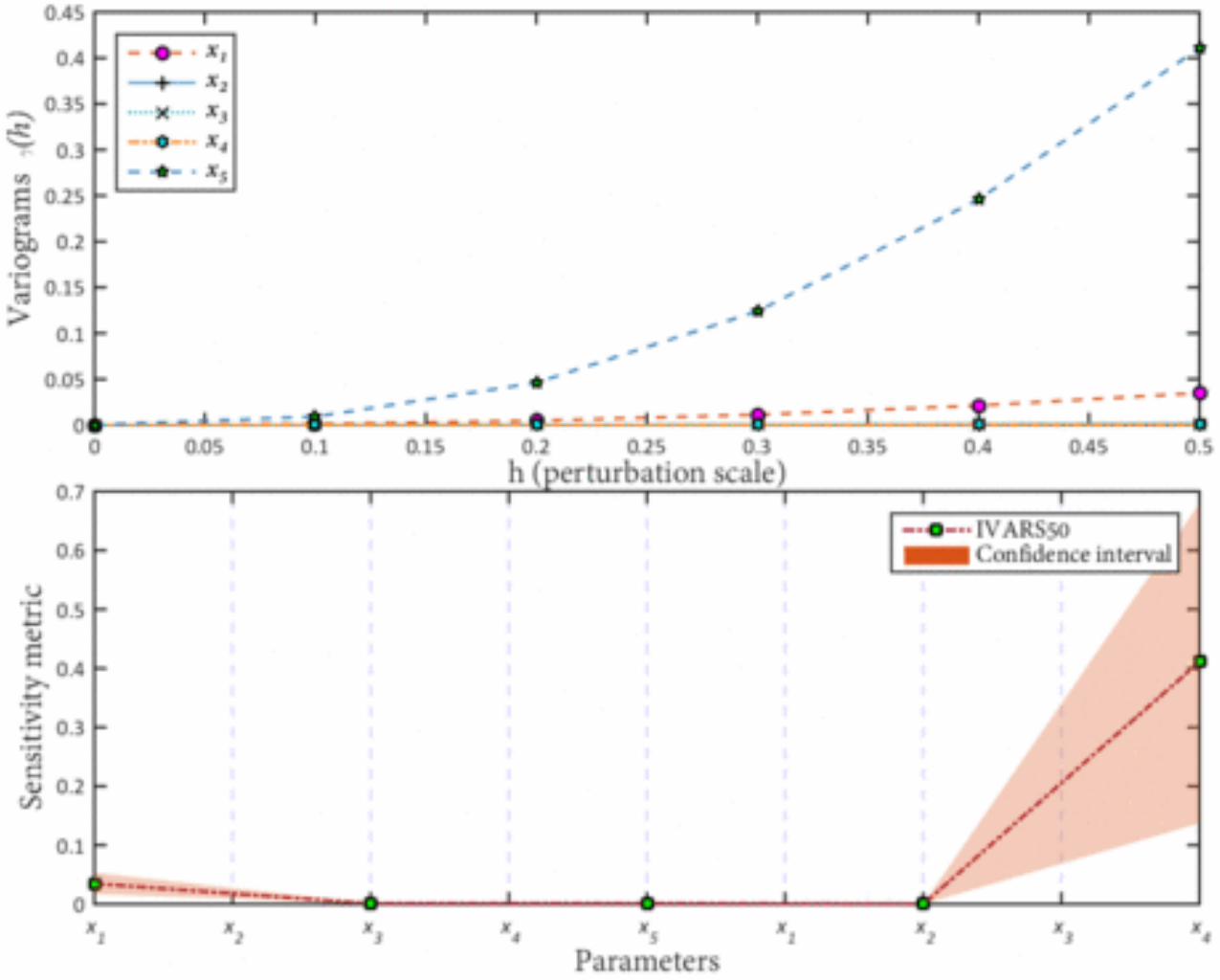
## To Monitor Convergence and Stability …

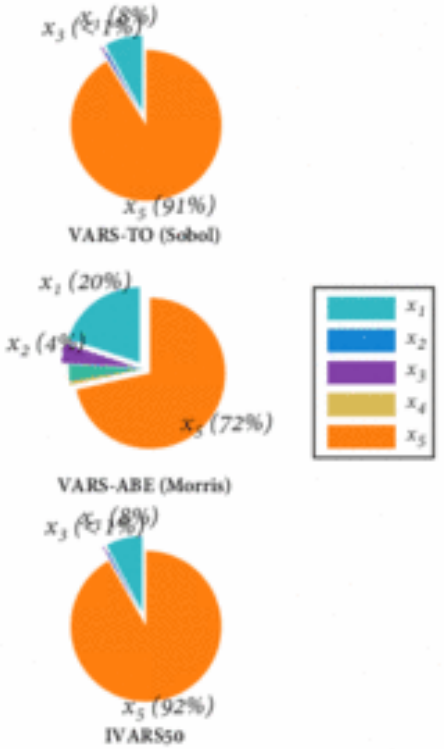


GLOBAL WATER FUTURES
INTEGRATED MODELLING PROGRAM FOR CANADA

# VARS-TOOL: New Visualization Tools

## To Monitor Convergence and Stability …



# Water means the WORLD to Us...

UNIVERSITY OF SASKATCHEWAN
Global Institute for Water Security
USASK.CA/WATER