

## Introduction

Computer models have become a crucial tool in engineering and environmental sciences for simulating the behaviour of complex static and dynamic systems. However, while many models are deterministic the uncertainty in their predictions needs to be estimated before they are used for decision support.

Presently, advances in uncertainty propagation analysis have been paralleled by a growing number of software tools for uncertainty analysis, but none has gained recognition for a universal applicability, including case studies with spatial models and spatial model inputs.

Due to the growing popularity and applicability of the open source R programming language we undertook a project to develop an R package that facilitates uncertainty propagation analysis in spatial environmental modelling.

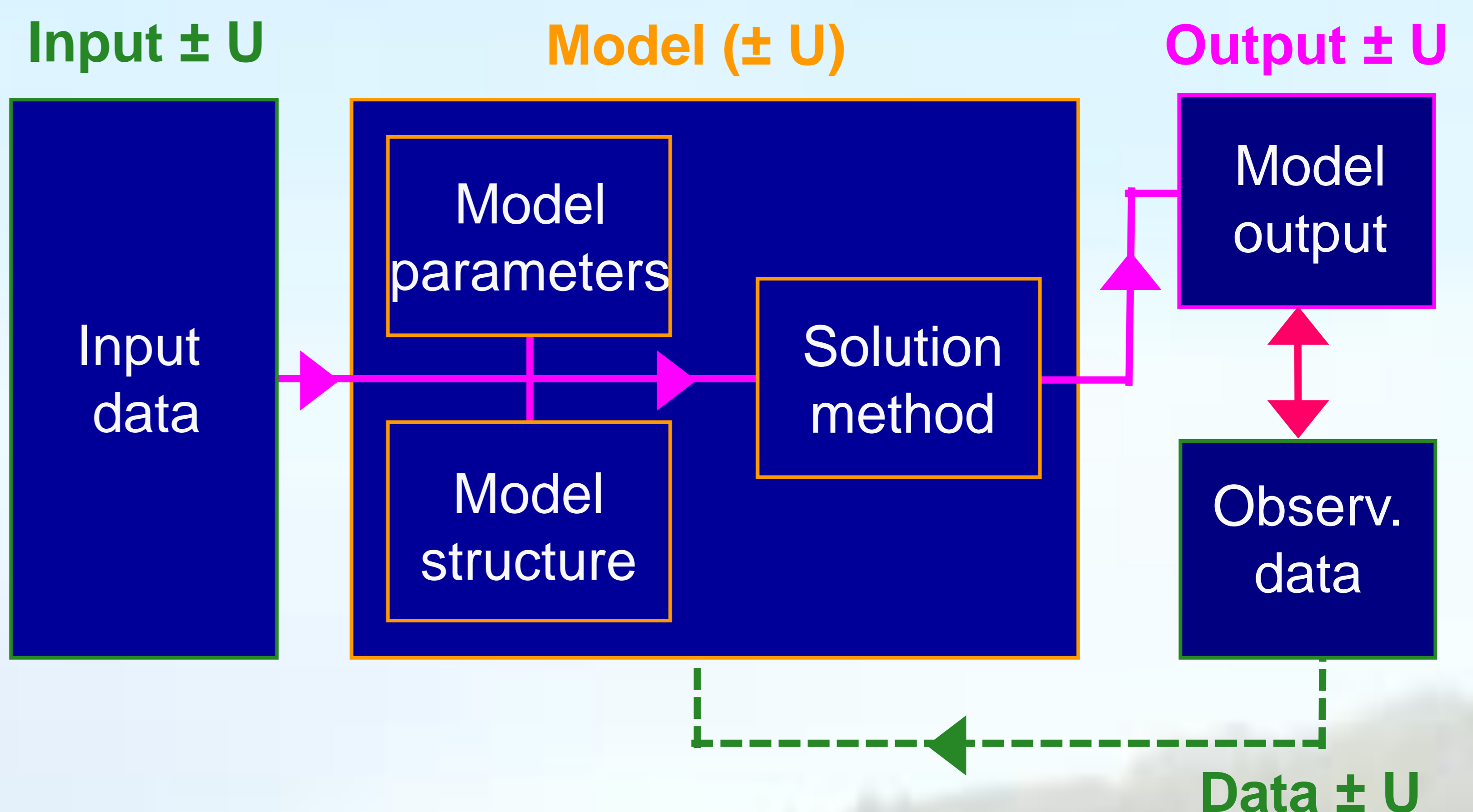
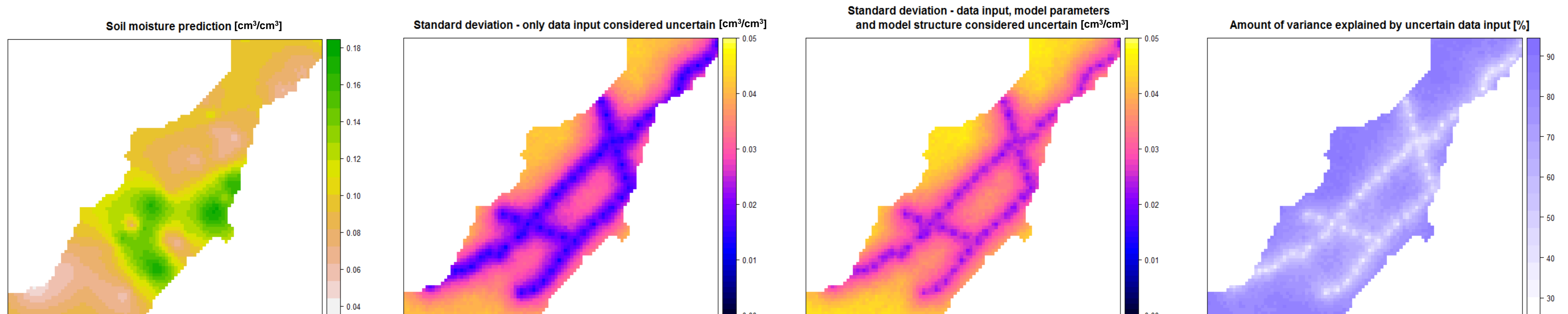


Figure 1. Uncertainty propagation overview.

## An example of uncertainty analysis in spatial environmental modelling

Predicting soil moisture ( $M$ ) along the Allier river in the Limagne rift valley, central France:  $M = \beta_0 + \beta_1 \cdot FC + \beta_2 \cdot SP + \varepsilon$ , where:  $FC$  is field capacity,  $SP$  is soil porosity,  $\beta_0, \beta_1, \beta_2$  are model parameters and  $\varepsilon$  denotes a stochastic residual attributed to lack of model fit and measurement error.



## Employed Monte Carlo approach principle

Monte Carlo simulation uses statistical modelling and random sampling to analyse uncertainty propagation through a model:

1. characterise uncertain model inputs with probability distribution functions (PDFs)
2. repeatedly sample from (spatial) PDFs
3. run model with sampled inputs and store model outputs
4. compute summary statistics of model outputs

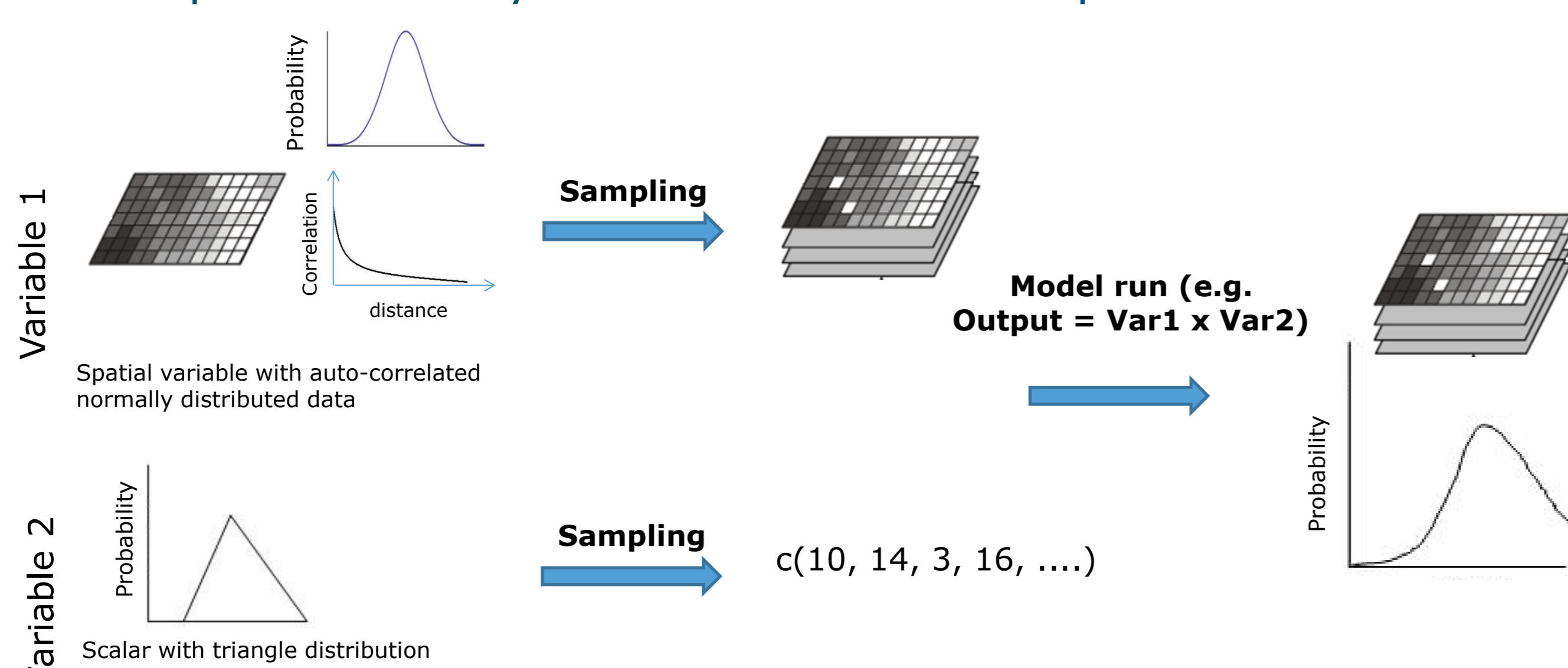
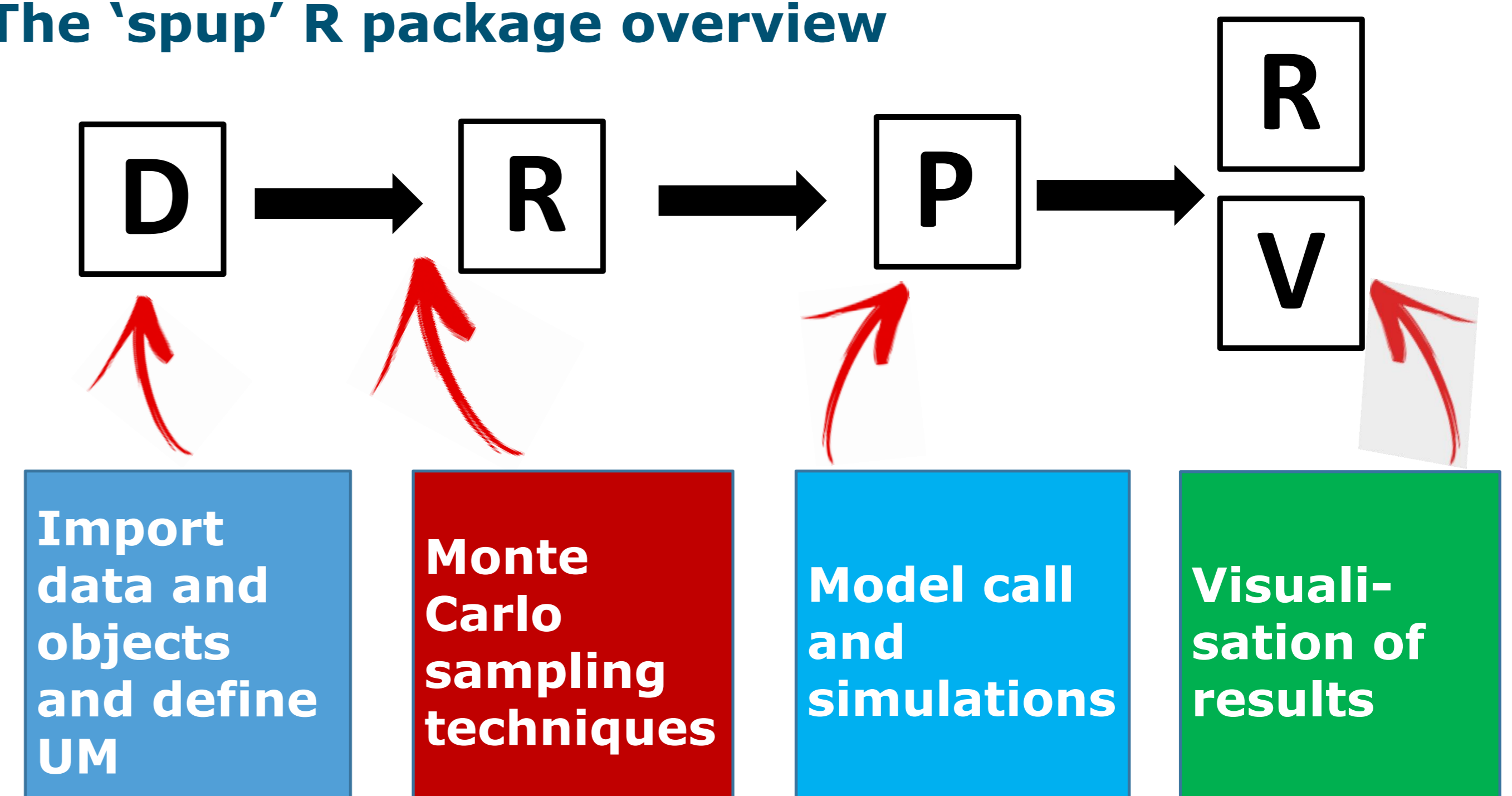


Figure 3. Example of the Monte Carlo algorithm including a spatial variable.

## The 'spup' R package overview



Consequently, the 'spup' R package will include (D) functions that allow user to **define uncertainty model (UM)**, (R+P) functions that **quantify uncertainty propagation** by sampling from uncertain inputs and running the model with sampled realizations, and (R+V) functions that allow user to **save output in a format of data or images**.

## Acknowledgements

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