Comparison of uncertainty quantification methods on the example of soil organic carbon (SOC) stock mapping in Hungary

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Research Highlights

- The applied digital soil mapping (DSM) techniques provided different uncertainty models with different performances.
- In point of uncertainty quantification, sequential Gaussian simulation and quantile regression forest outperformed the others.
- We have demonstrated that uncertainty models must be validated.
- Special attention should be paid to the assumptions made in uncertainty modelling.

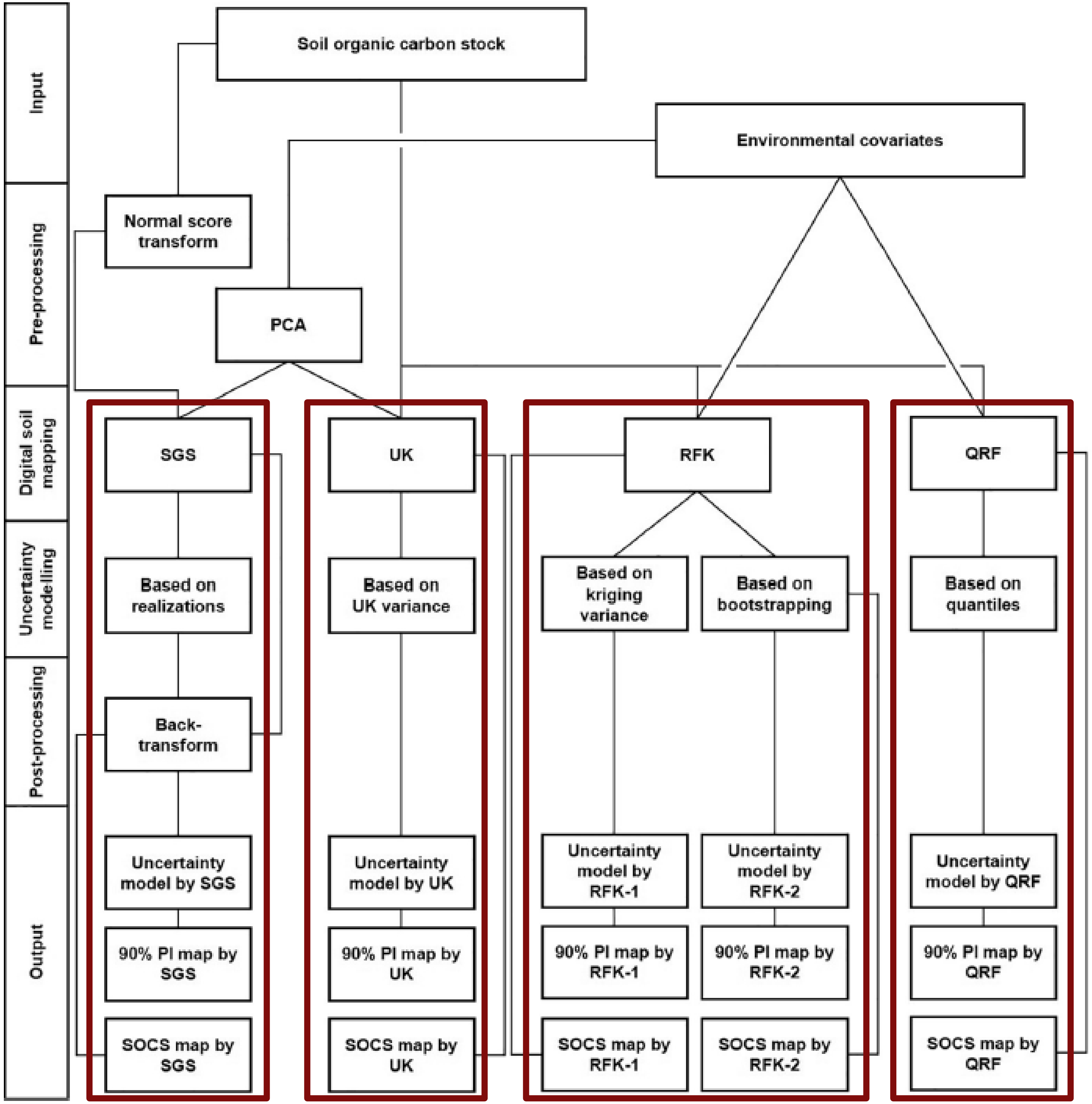
Flowchart

Applied DSM techniques:

1. Sequential Gaussian simulation (SGS)
2. Universal kriging (UK)
3. Random forest + kriging (RFK)
   3.1. Based on kriging variance (RFK-1)
   3.2. Based on bootstrapping (RFK-2)
4. Quantile regression forest (QRF)

Abbreviations:
SOCS: soil organic carbon stock,
PCA: principal component analysis,
PI: prediction interval

Source: Szatmári & Pásztor (2019)
https://doi.org/10.1016/j.geoderma.2018.09.008



SOC stock maps & their uncertainties

Visualization of uncertainty:

The upper and lower limit of the 90% prediction interval are presented. This prediction interval reports the range of values within which the true value is expected to occur 9 times out of 10.

The unit of the maps is **tons · ha^{-1}**

The geometric resolution of the maps is **500 m**

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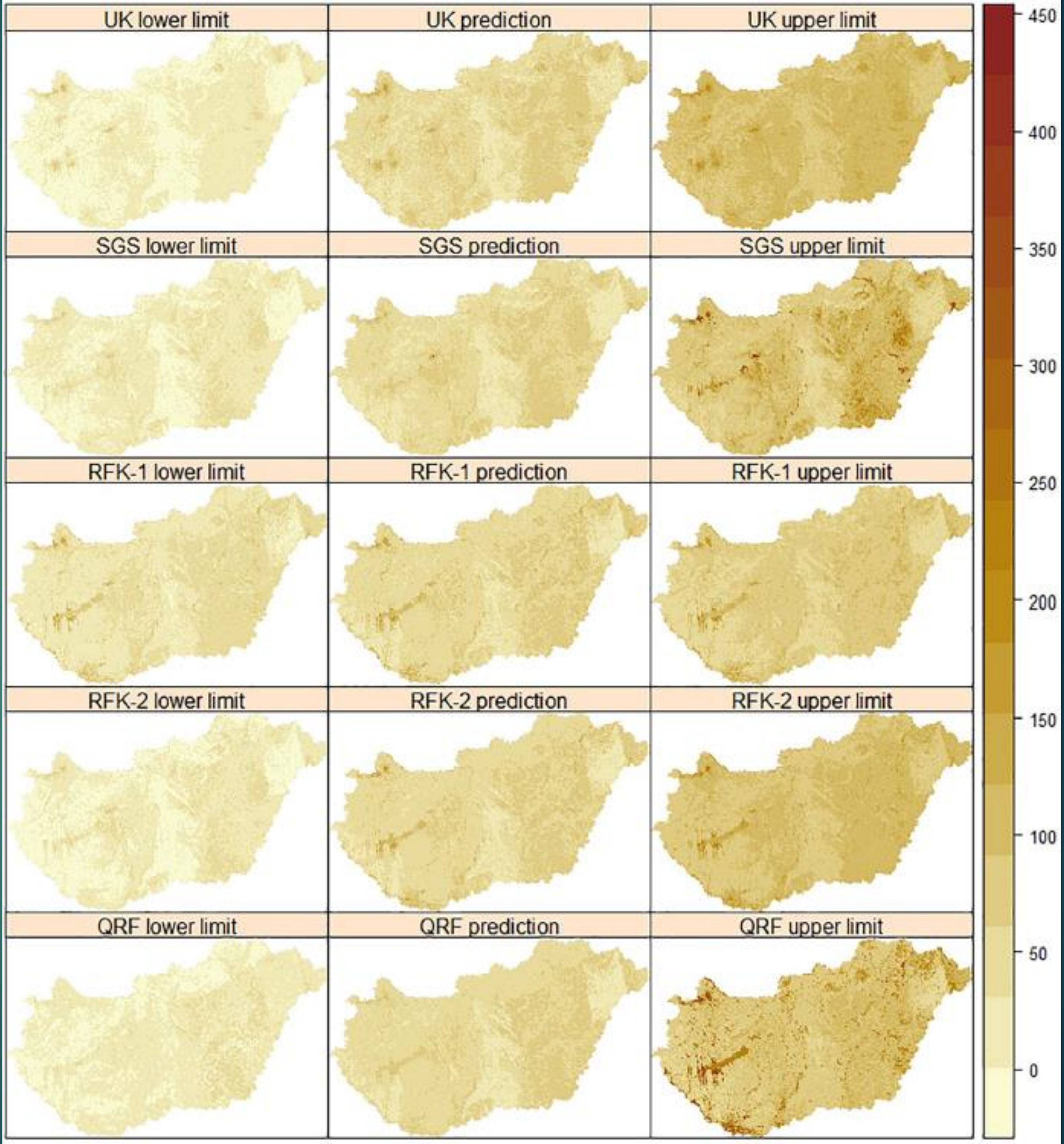


Validation of uncertainty quantifications

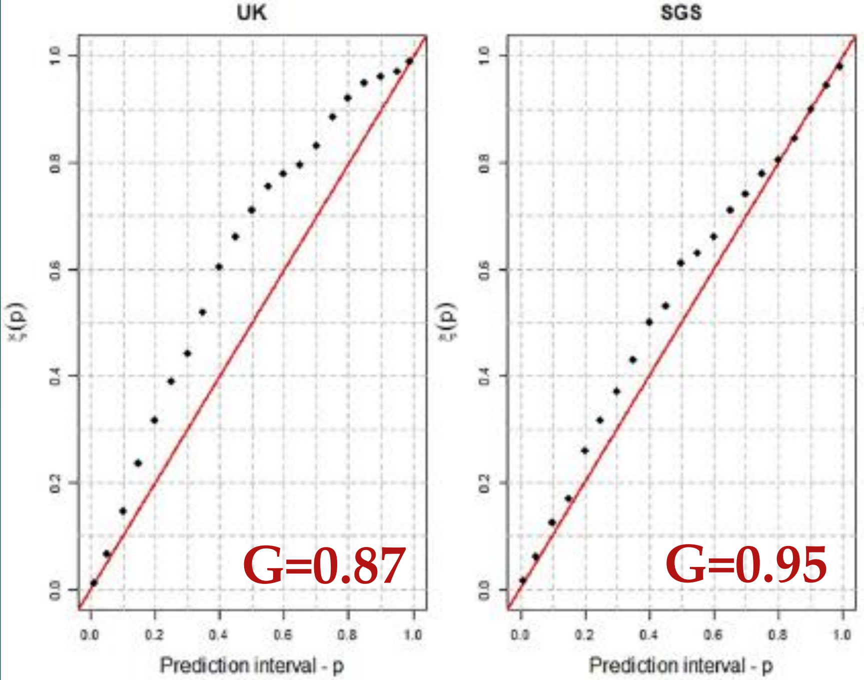
Validation was carried out by using 200 independent SOC stock observations

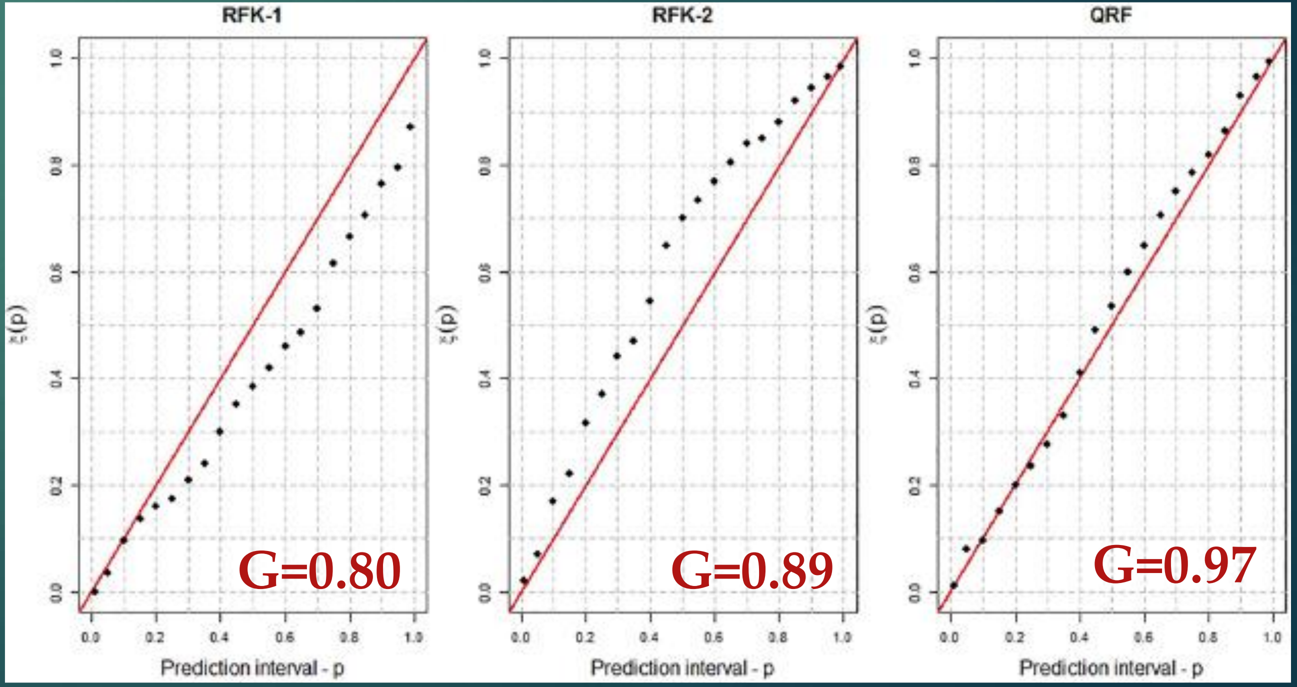
<u>Rank of the applied DSM techniques (from best to worst):</u>

QRF, SGS, RFK-2, UK, RFK-1

Accuracy plot graphically shows the actual fraction of true values falling within symmetric prediction intervals of varying width.

The value of G shows the closeness of the actual and expected fractions. Ideally, G is equal to 1.





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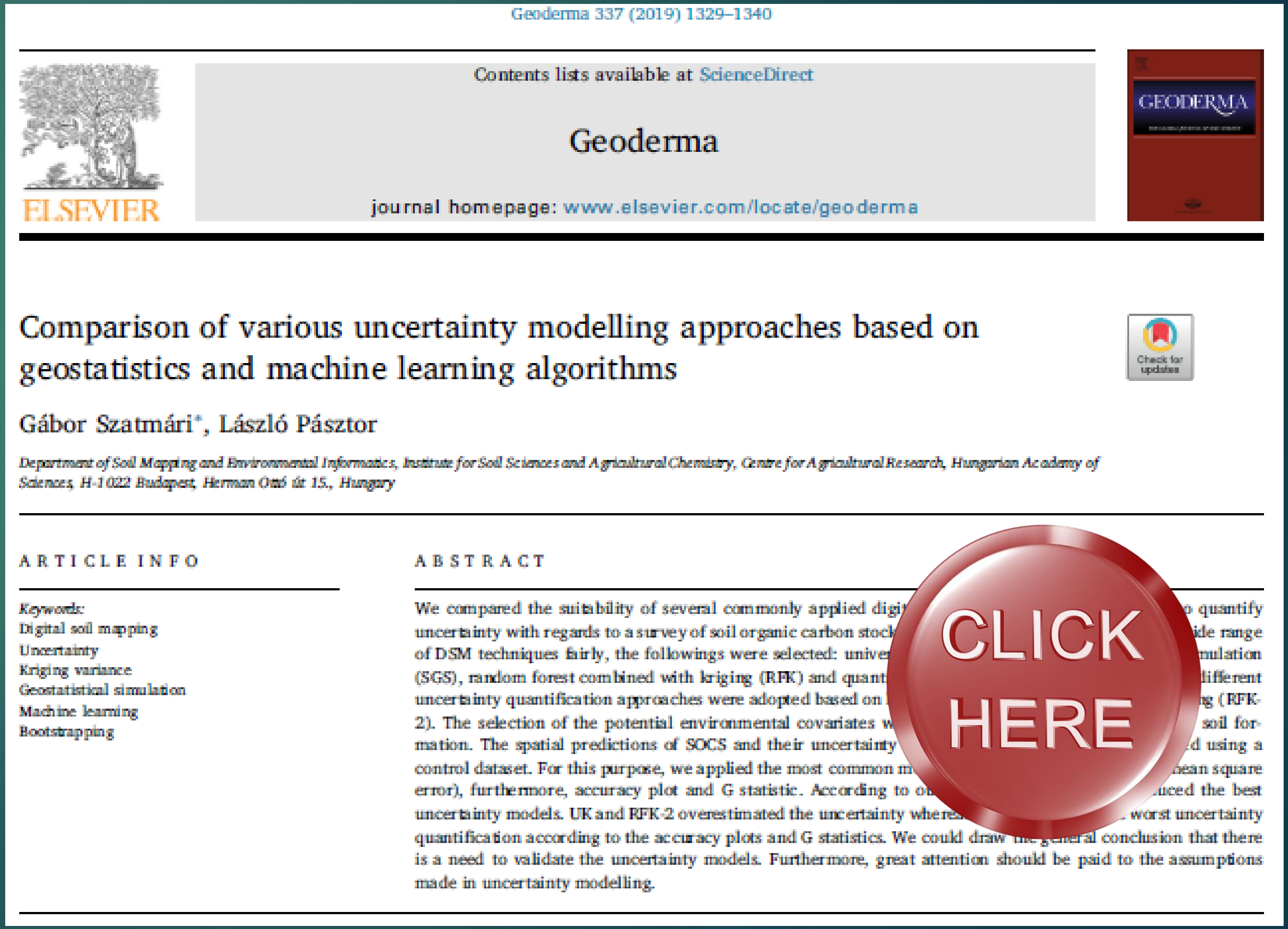
If you want to know more…

…You can take a look at the paper below



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Comparison of various uncertainty modelling approaches based on geostatistics and machine learning algorithms

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ABSTRACT

We compared the suitability of several commonly applied digi … o quantify uncertainty with regards to a survey of soil organic carbon stock … ide range of DSM techniques fairly, the followings were selected: unive … mulation (SGS), random forest combined with kriging (RFK) and quant … different uncertainty quantification approaches were adopted based on … g (RFK-2). The selection of the potential environmental covariates w … soil formation. The spatial predictions of SOCS and their uncertainty … d using a control dataset. For this purpose, we applied the most common m … ean square error), furthermore, accuracy plot and G statistic. According to o … uced the best uncertainty models. UK and RFK-2 overestimated the uncertainty where … worst uncertainty quantification according to the accuracy plots and G statistics. We could draw the general conclusion that there is a need to validate the uncertainty models. Furthermore, great attention should be paid to the assumptions made in uncertainty modelling.

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