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Scaling Input Distributions for Probabilistic Models

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Background

Input distribution goal: to capture plausible values consistent with the current state of knowledge

Why scale input distributions?

- Uncertain inputs that are constant over time
- Incorporate information about spatial and temporal scales into input distributions
- Focus on temporal scales in this work

Methods

Develop a GoldSim model in the context of a radwaste performance assessment model to compare temporal scaling of

- simple linear model: y = (c * w) * X
- multiplicative model: y = c * W * X
- non-linear quadratic model: y = (c * w) * X^2
- non-linear square root model: y = (c * w) * $X^{1/2}$

Two scenarios:

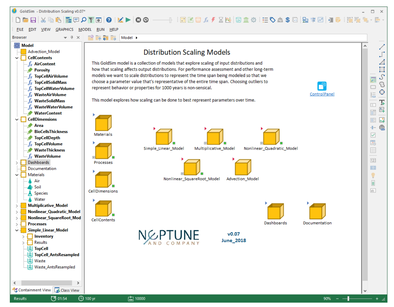
(1) resampled every year for 100 yr

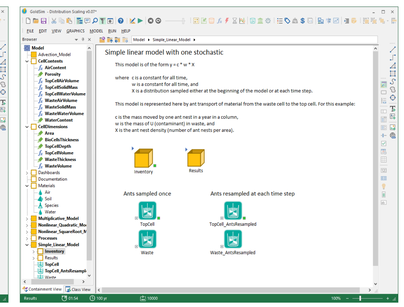
$$X \sim N(\mu_1 = 30, \sigma_1 = 5), \quad x \in R, \mu \in R, \sigma > 0$$

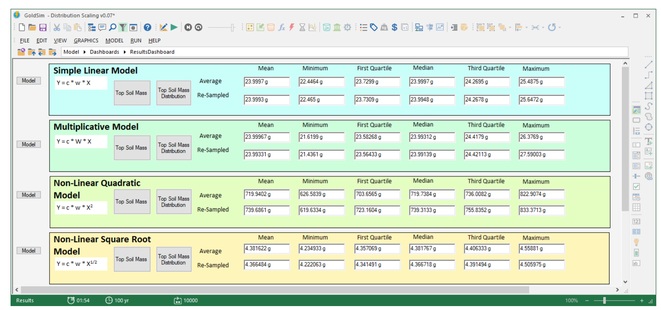
(2) sampled only at beginning of simulation

$$Z_{100} \sim N\left(\mu_{100} = \mu_1 = 30, \sigma_{100} = \frac{\sigma_1}{\sqrt{100}} = 0.5\right)$$

Compare GoldSim model results of ants moving material to surface to similar models derived using mathematical statistics and created in R©.







GIGO…What is Garbage?

→

The art is beautiful but does not justify the garbage on the beach. Better to get art supplies from a recycling center!

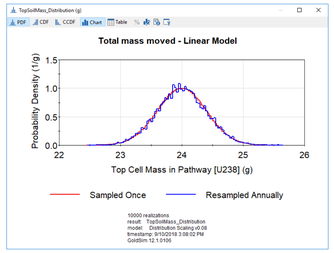
Art to Save the Sea
https://washedashore.org/

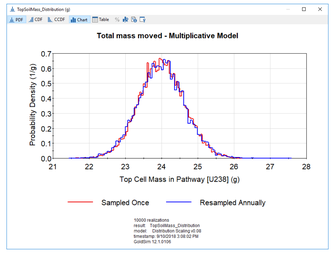
Key: Interdisciplinary team (i.e., subject matter experts and statisticians) works together to develop appropriate input distributions.

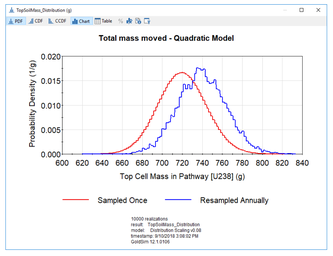
Results

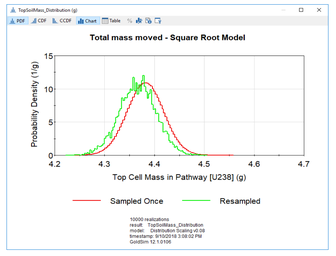
Analytical mathematical solutions, GoldSim modeling and R© modeling agree.

Output from GoldSim model illustrates the agreement between linear model scenarios, and near agreement with multiplicative and non-linear square root scenarios. Non-linear quadratic model results diverge most.









Conclusions

Upscaling is straightforward with an additive model, assuming linearity and stationarity (homogeneous in time and space).

If non-linear but if the linear term is dominant, still may take a straightforward approach to scaling.

Large deviations from linearity will require considerable thought on how to upscale correctly.