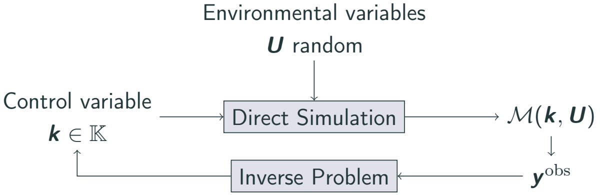
# Parameter control in the presence of uncertainties

- $\boldsymbol{k}$: calibration parameter $\rightarrow$ epistemic uncertainty
- $\boldsymbol{U}$: environmental/uncertain parameter $\rightarrow$ aleatoric uncertainty




The misfit between some observations and the output of the model is $J(\boldsymbol{k}, \boldsymbol{U})$, that needs to be minimized with respect to $\boldsymbol{k}$.

**Robustness under parametric model misspecification**

How to be get an estimate $\hat{\boldsymbol{k}}$ that is robust with respect to the inherent variability of $\boldsymbol{U}$ ?

# Relative regret

Main idea: For each $\boldsymbol{u} \sim \boldsymbol{U}$, *compare* the value of the cost function to its optimal value $J^*(\boldsymbol{u})$ and define $\boldsymbol{k}^*(\boldsymbol{u}) = \arg\min_{\boldsymbol{k}\in\mathbb{K}} J(\boldsymbol{k}, \boldsymbol{u})$:

- Either set $\alpha \geq 1$, and define the probability of being $\alpha$-optimal

$$\Gamma_\alpha(\boldsymbol{k}) = \mathbb{P}_U \left[J(\boldsymbol{k}, \boldsymbol{U}) \leq \alpha J^*(\boldsymbol{U})\right] \tag{1}$$

  and maximize it
- or for a given $0 < p \leq 1$, find the quantile of order $p$ of the r.v. $J(\boldsymbol{k}, \boldsymbol{U})/J^*(\boldsymbol{U})$ and minimize it

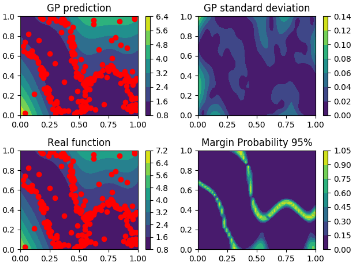
Puts more importance in the estimation in the region where good performances are possible (small $J^*(\boldsymbol{u})$)

# Numerical methods

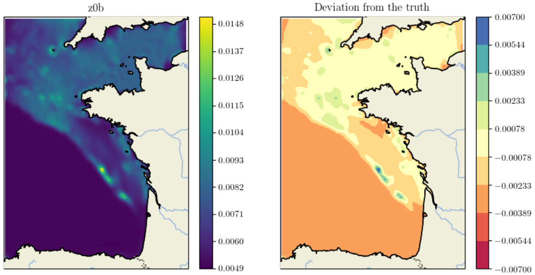
- Computer code is expensive to run
- Even for for a given $\boldsymbol{u}$, getting $J^*(\boldsymbol{u})$ can be tricky

$\rightarrow$ Need for specific methods to

  - gather information on $J(\boldsymbol{k}, \boldsymbol{u})$ prior to the evaluation
  - gather information on $J^*(\boldsymbol{u})$ prior to the optimization
  - improve precision on the estimation of the probability of coverage $\Gamma_\alpha$
  - improve precision on the estimation of the quantiles of $J/J^*$



# Application: estimation of the bottom friction in the Atlantic Ocean




- High-dimensional problem: $\boldsymbol{k} \in \mathbb{R}^{\sim 20000}$: need to reduce dimension
- Sensitivity to the number of number of tides components added