Karthaus Summer School 2008

Inverse modelling

Bayesian Priors in an ice stream model

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Contents

- Review: Bayesian Priors
- Model set up
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Interpreting Bayesian Inference

"Beliefs" are represented as probability distributions.

$$P(x|y) = \frac{P(y|x)P(x)}{P(y)}$$

Prior Belief

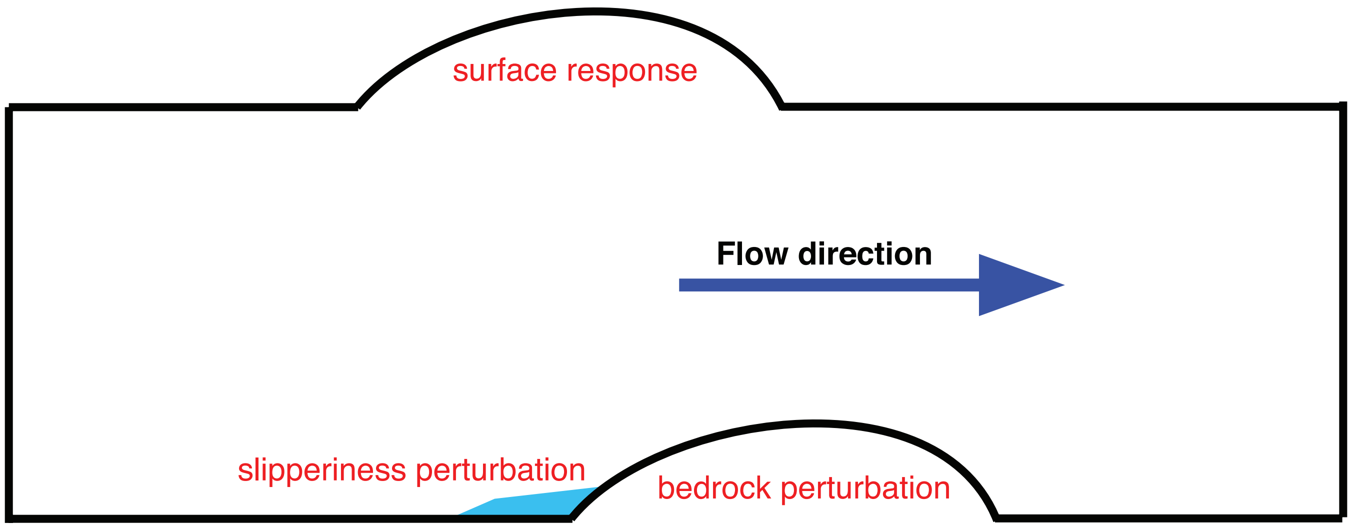
- Created by:
  - Past general knowledge or rules
  - Past inference
  - Prejudice or "gut feeling"

- Represented as a probability distribution (pdf) with a covariance matrix $\boldsymbol{C_p}$ representing belief strength.

- A strong prior has a narrow distribution (low variance); a weak prior has a wide one (high variance).

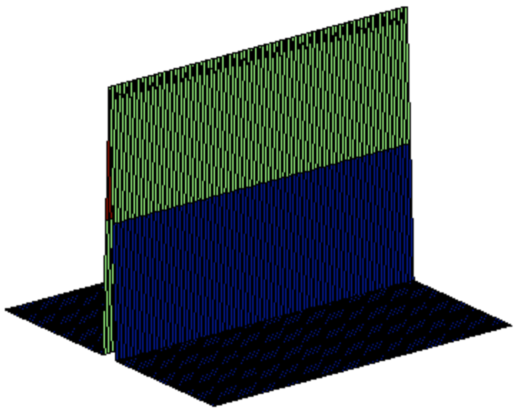
The Ice stream model

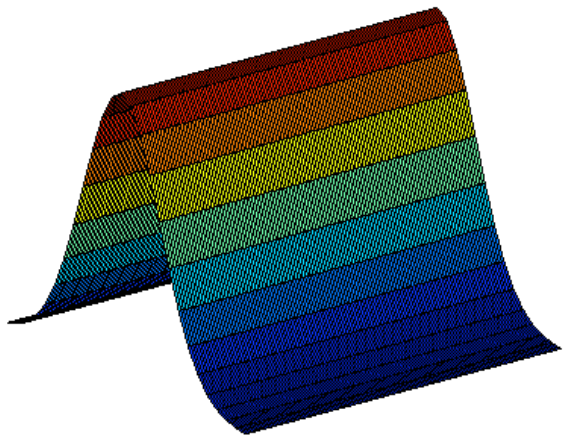
- Observables: surface $\boldsymbol{s}$, velocities $\boldsymbol{u}, \boldsymbol{w}$
- Hidden variables: bedrock $\boldsymbol{b}$, slipperiness $\boldsymbol{c}$
- Need a prior for $\boldsymbol{b}$ and $\boldsymbol{c}$



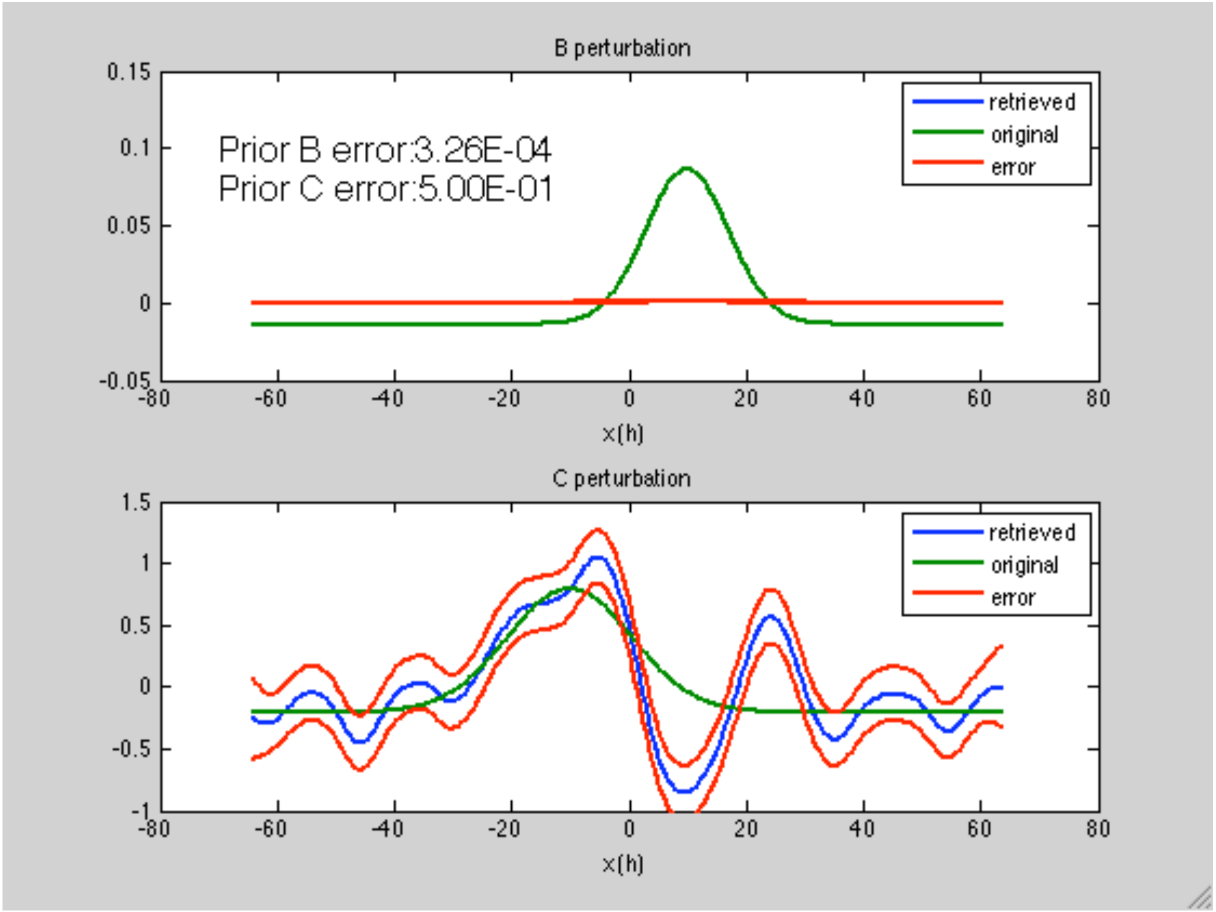
Prior knowledge of b and c

- Physical properties of a bedrock surface (height, slipperiness) will not change drastically across short distances.
- Assume a prior where each b and c value is correlated with its neighbours with a covariance value C, proportional to an *a priori error*.

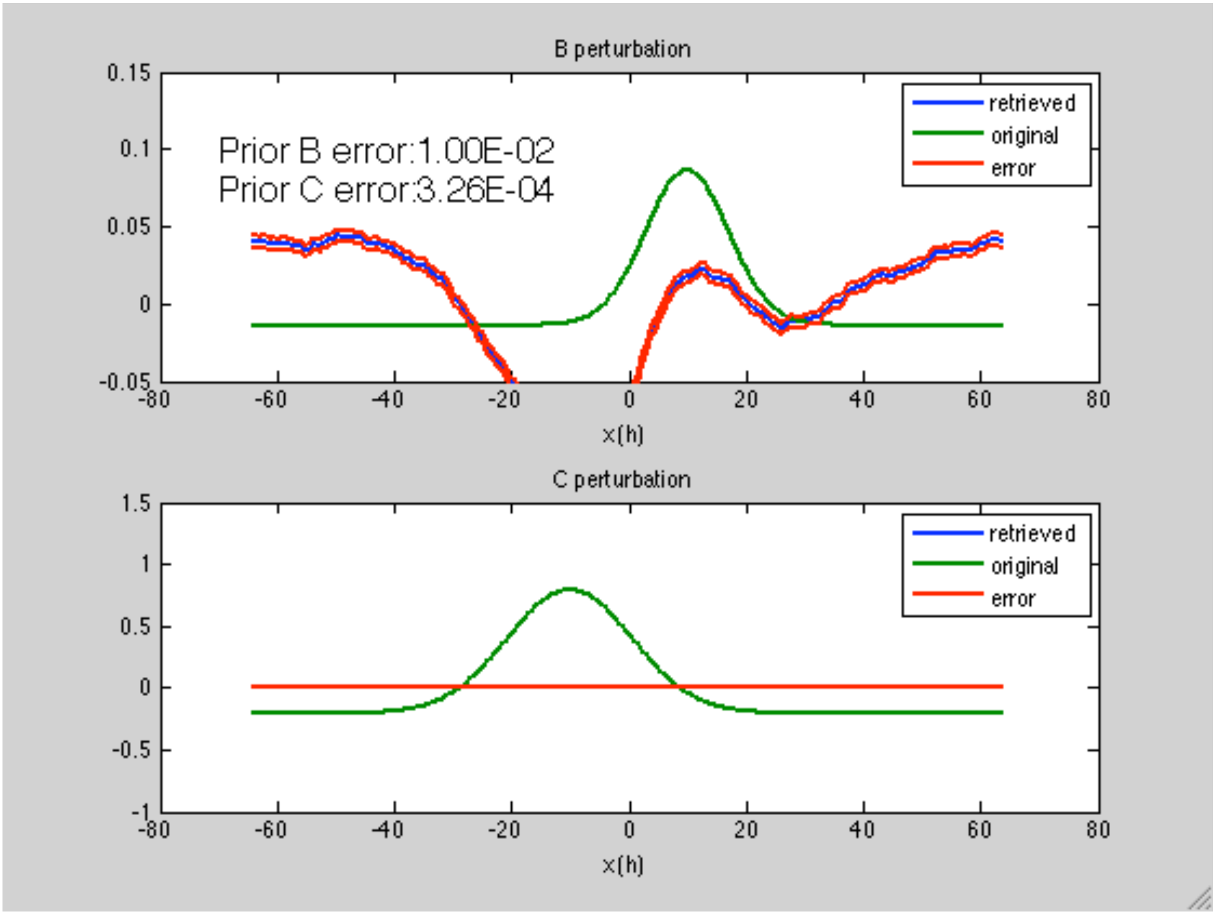




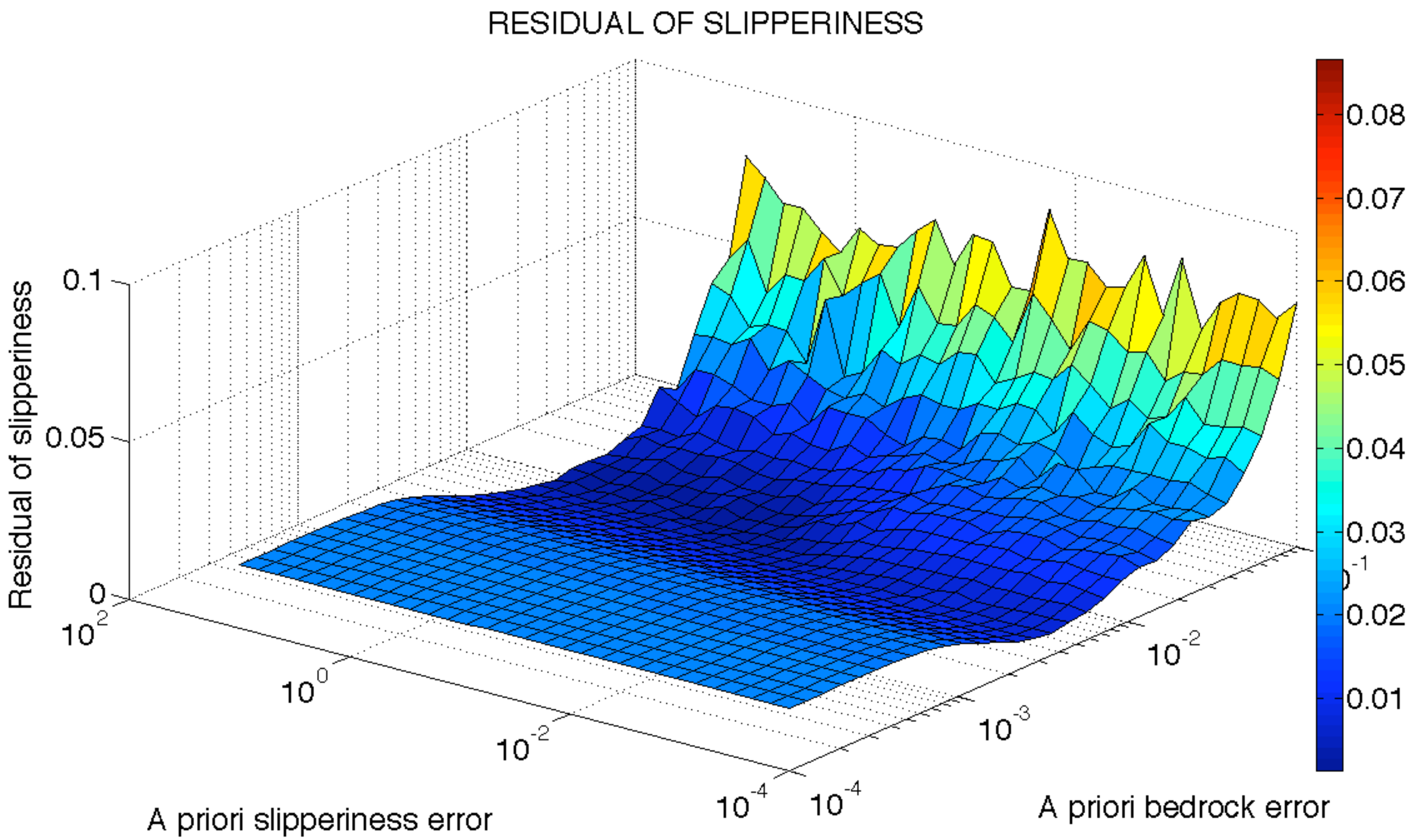
Examining the Prior Covariances (1)



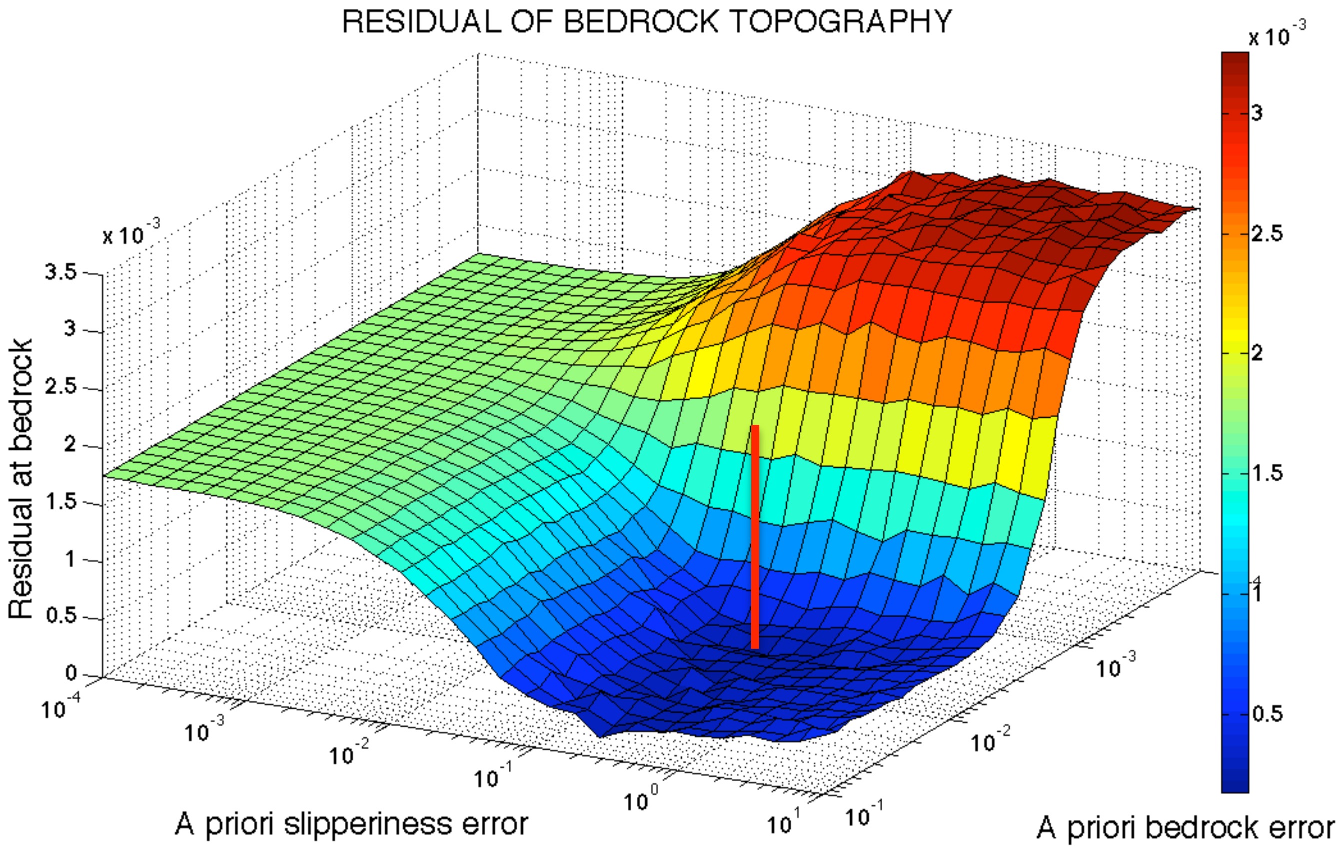
Examining the Prior Covariances (2)



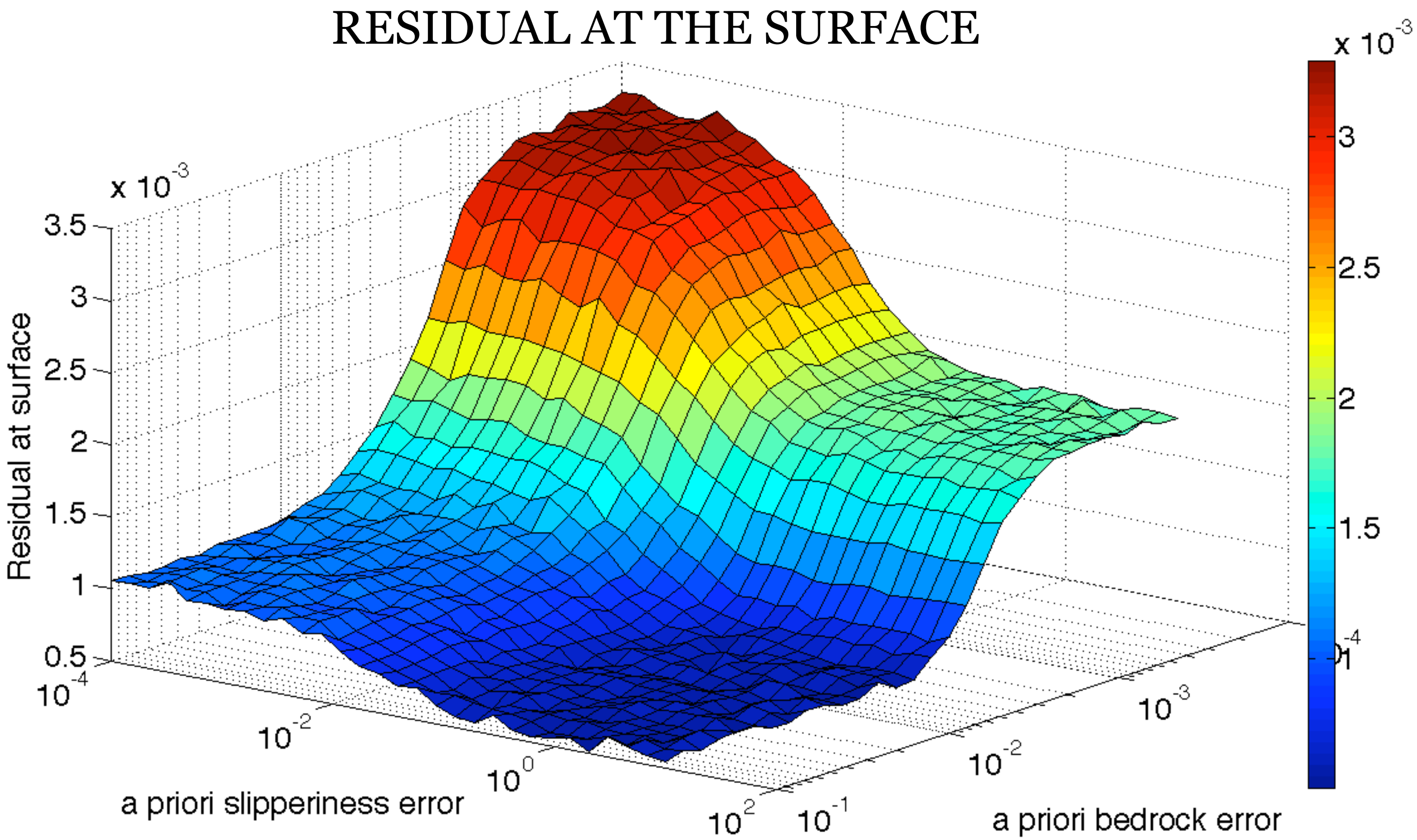
Examining the Prior Covariances (3)



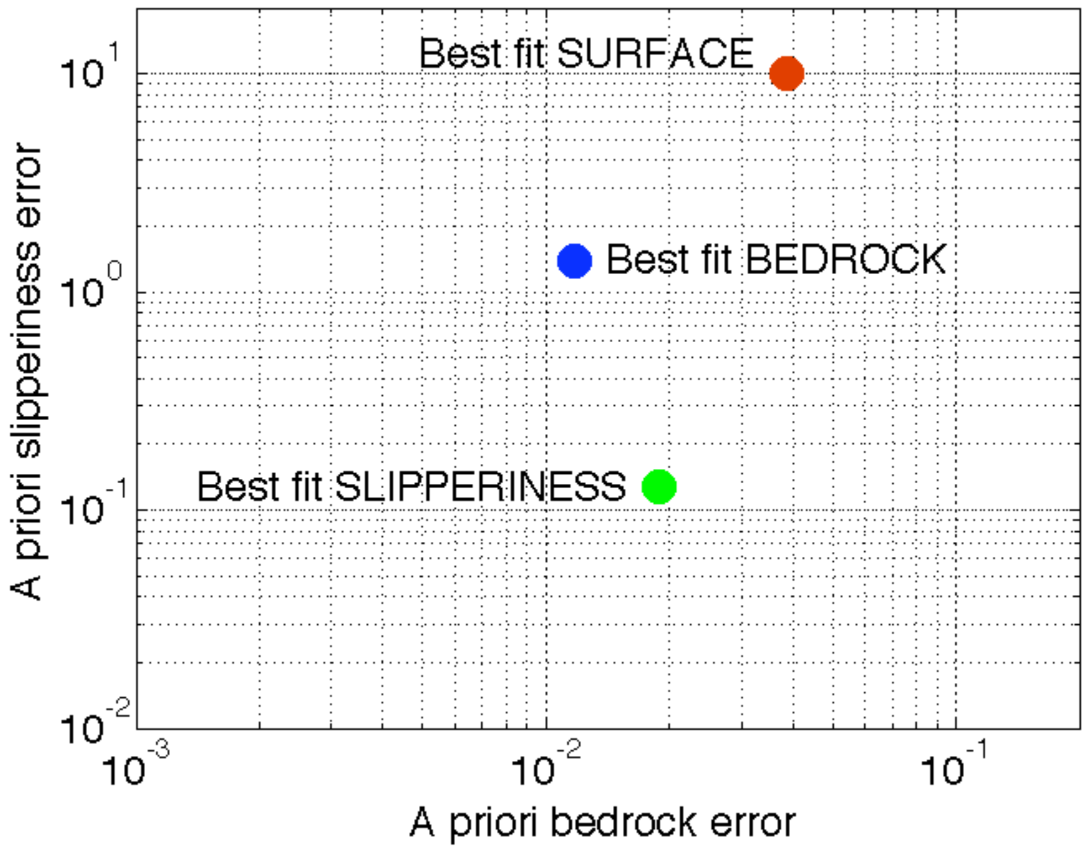
Examining the Prior Covariances (4)



Examining the Prior Covariances (5)



Best fit for the variables



Best fit = Minimum(MSE)

Generalizing Prior Probabilities

- Values calculated in previous slides are *specific to this toy problem*.
- Such values may be cautiously generalized to areas of similar topography – requires a sensitivity analysis.
- May use *hyperpriors* to pick priors using geology data and a Bayesian framework!

Thanks!