# Modelling with uncertainty in the Magic Model

A simple overview

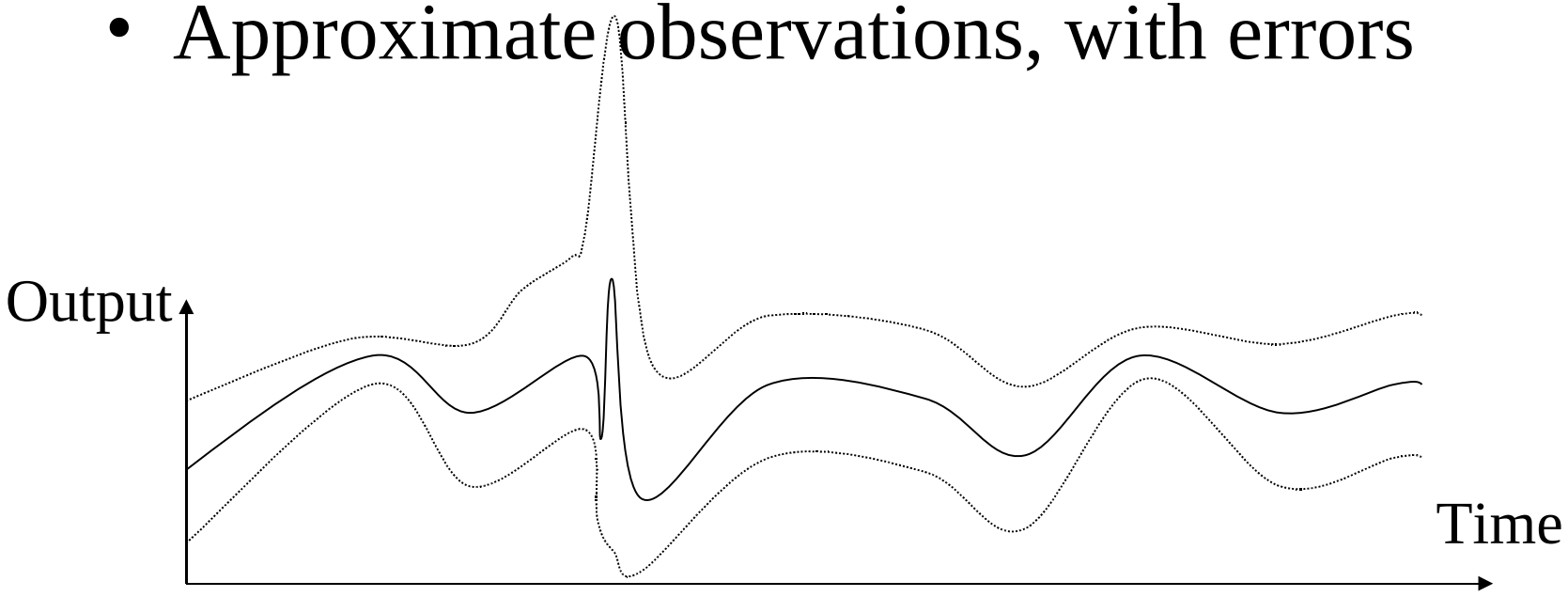
# What we know:

- Approximate parameter values, with errors

*Soil depth = 5m ± 1.2m*

*Soil porosity = 45% ± 10%*

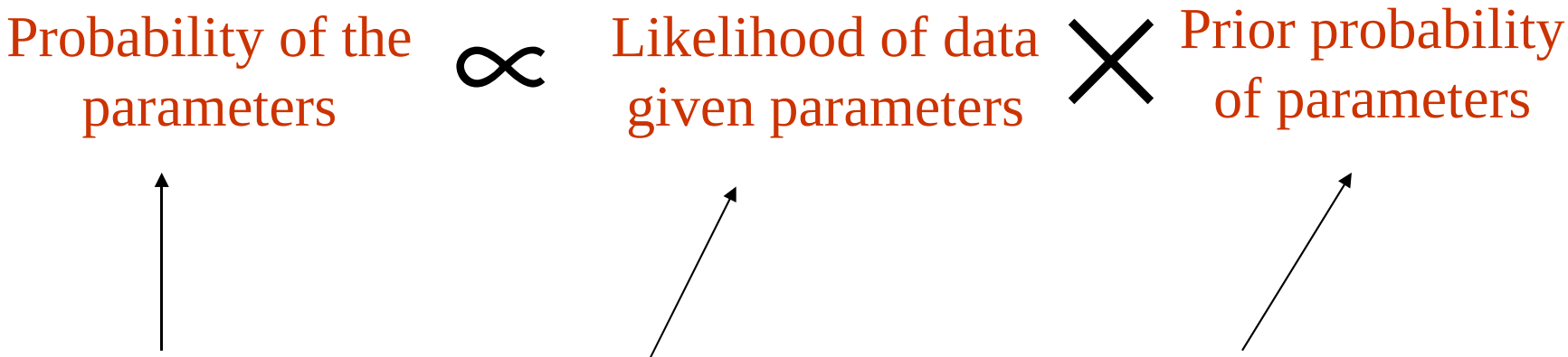
- Approximate observations, with errors



# What we *want* to know:

- Predictions and hindcasting of various catchment properties (e.g. nitrogen deposition)
- Estimates for certainty in those predictions
- Hence we need to know both the errors in the *parameters* and resulting *predictions* for the model

# Errors in the parameters:



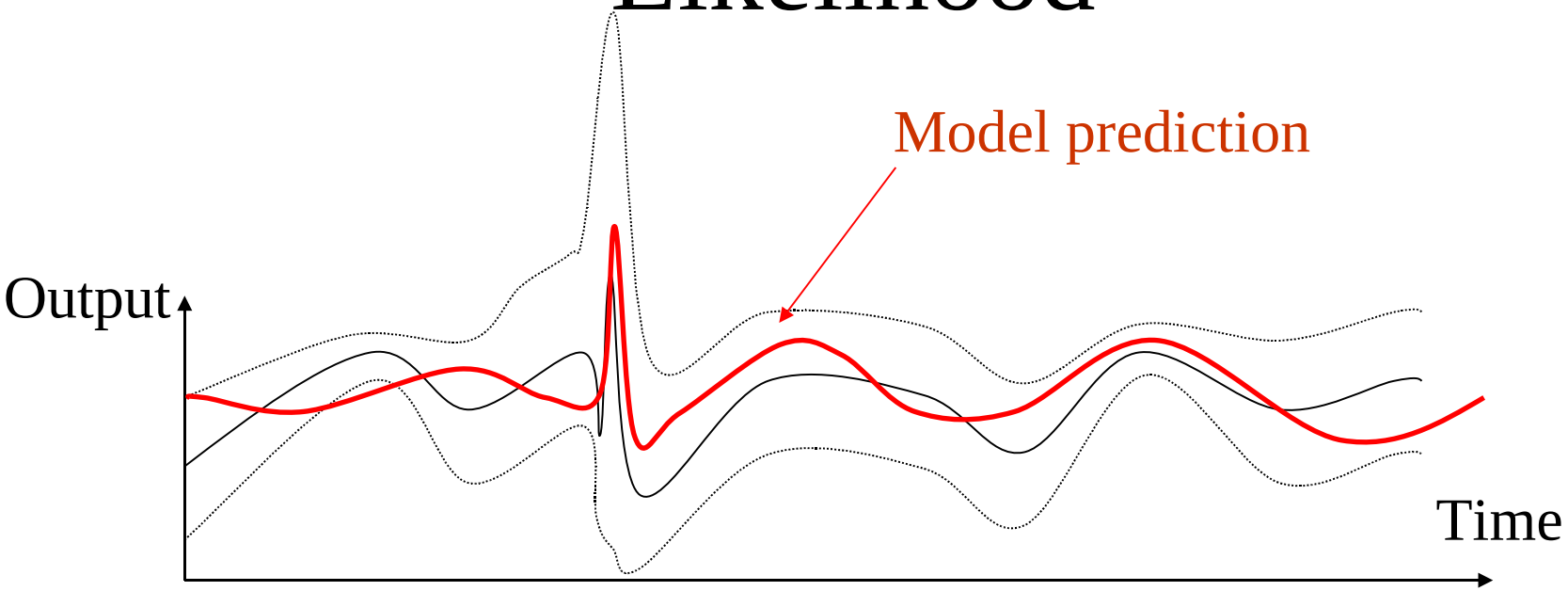

The ***Posterior***; What we want to estimate

Calculate from the output data

Calculate from the parameter errors

*This is (Bayes Formula)*

# Likelihood

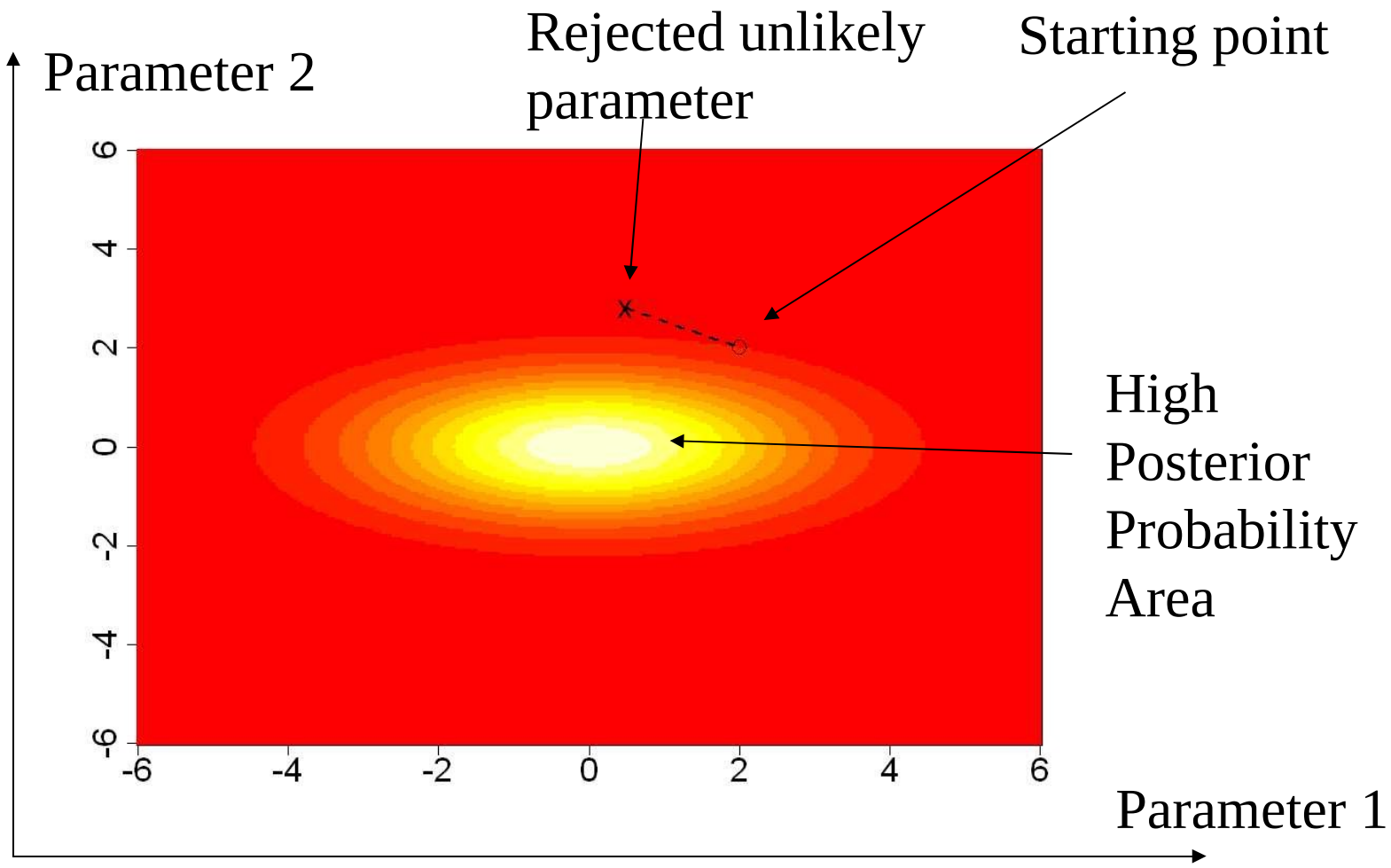



- Likelihood is just the “distance” of the simulation prediction from the data
- Errors define what a big or small distance means

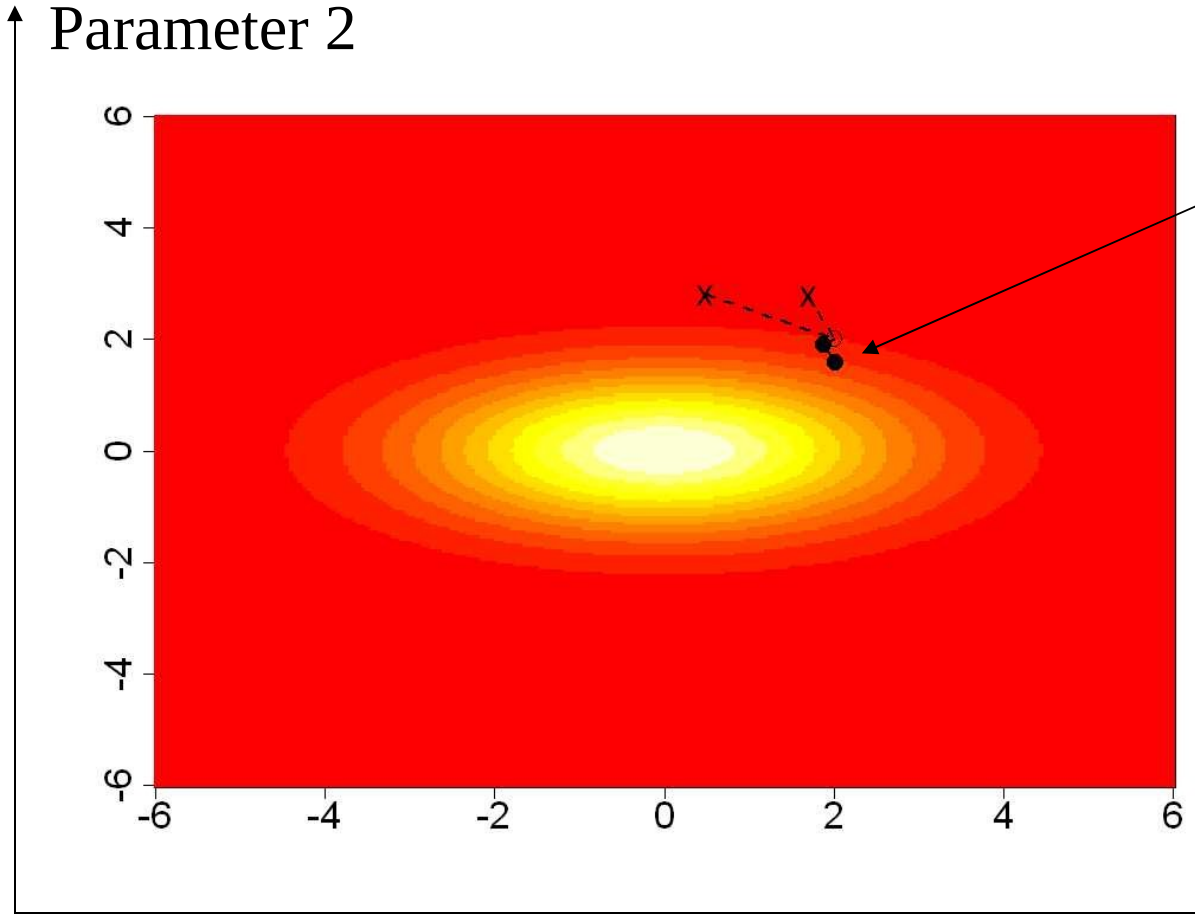
# Choosing new parameter values

- Final task is to sample parameters.
- Can’t solve (too hard!) or do it at random because most parameters are unlikely.
- So use MCMC (Markov-Chain Monte Carlo):
  - Change current parameters by a random small amount
  - Accept the new parameters with probability proportional to posterior

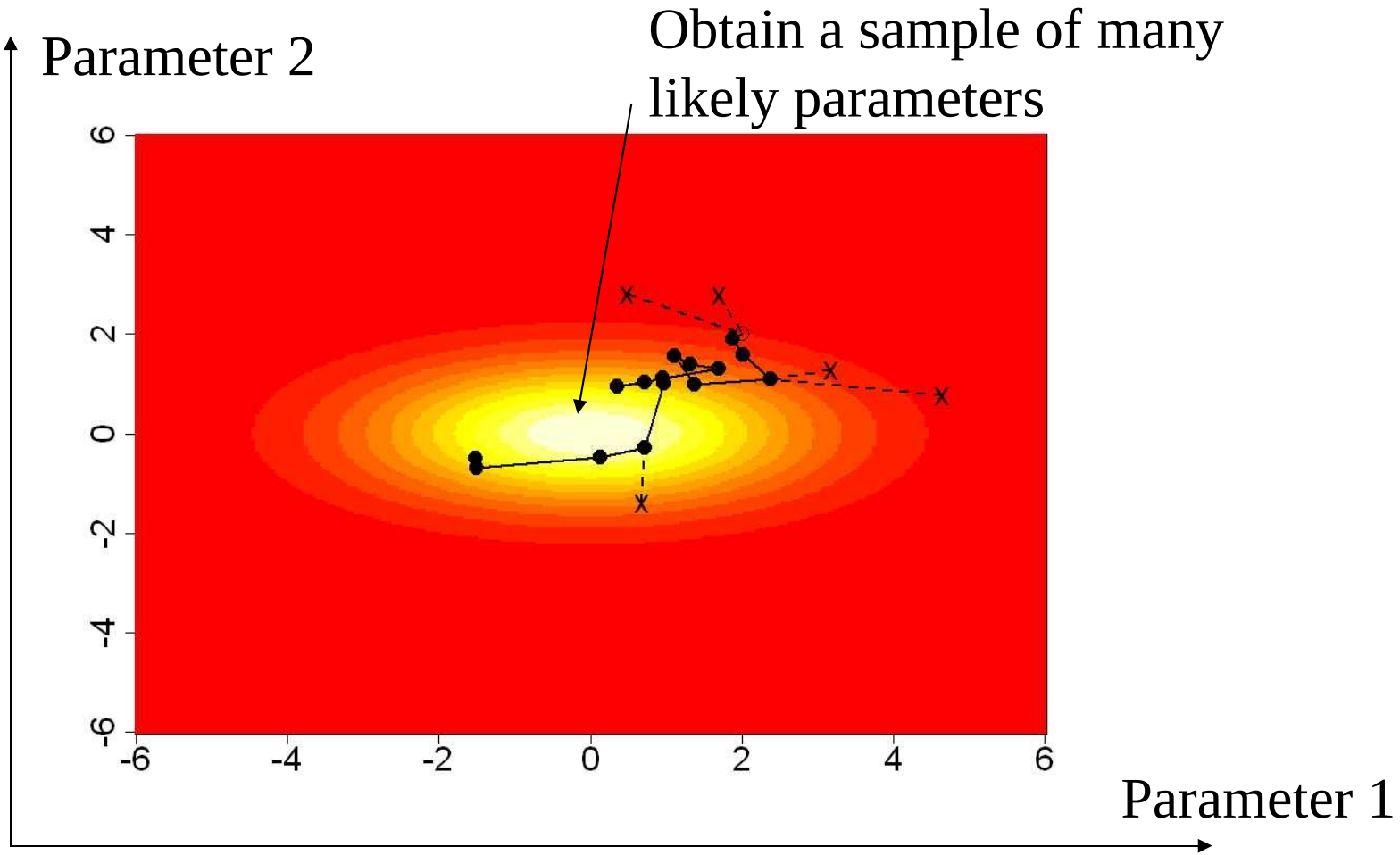
# Example MCMC



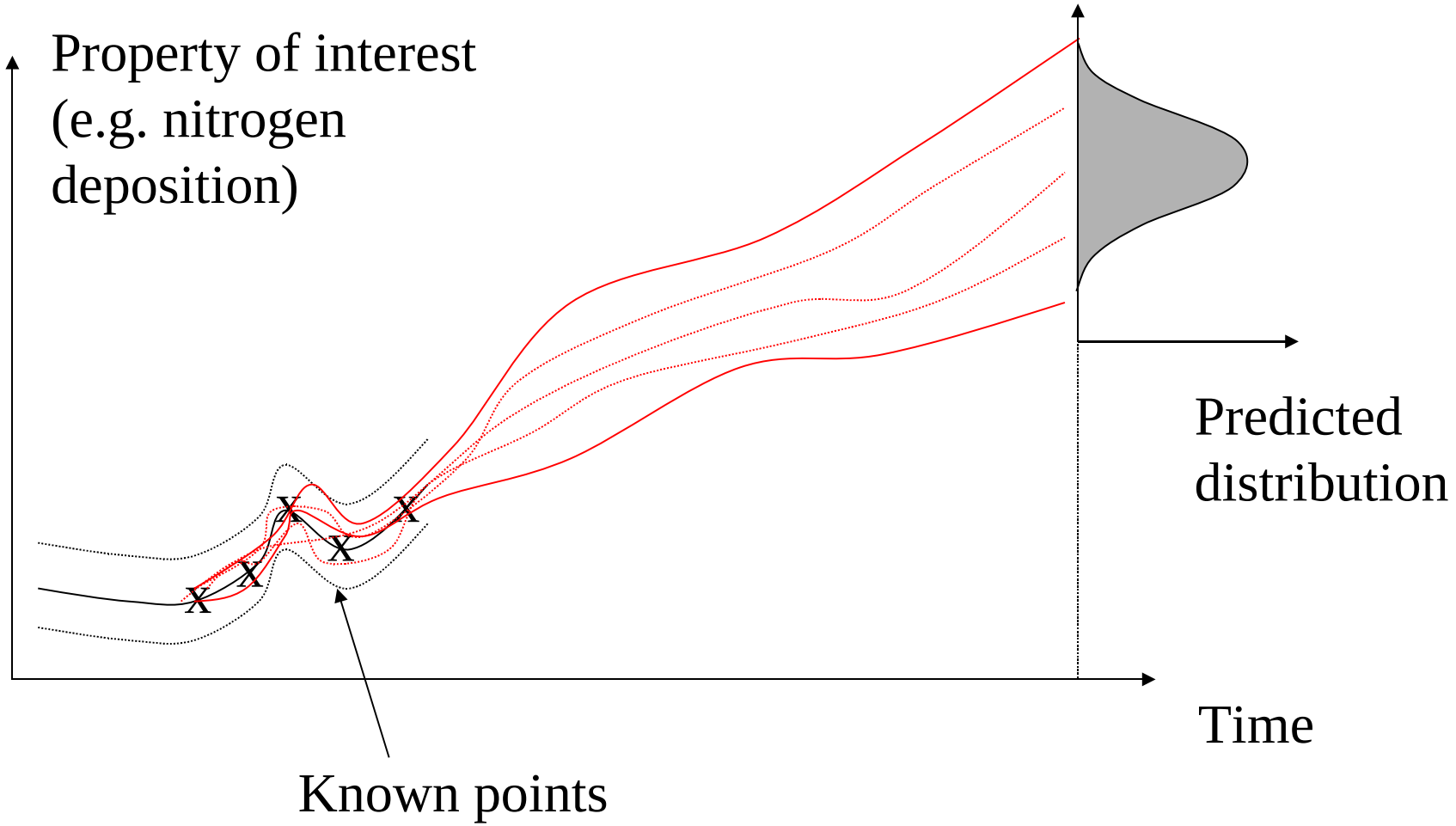
# Example MCMC



# Example MCMC



# Prediction using the parameter distribution



# Work within the project

- Apply method to local sites
- Extend method to allow missing data
- Use regional scale data to make predictions
  - Compare certainty from fine scale land data to lower quality data
  - Methods for well studied catchments to inform lower data quality catchments (such as correlations between neighbours)

# People

Rachel Helliwell – *Project Leader*

Nikki Bagaley – *Catchement*

Martyn Futter – *Catchement*

Daniel Lawson – *Statistics*

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