Glossary of important terms for GW1876

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Parameters Variable input values for models, typically representing system properties and forcings. Values to be estimated in the history matching process. Typically identified as k, p, or x ($\mathbf{k}$, $\mathbf{p}$ or $\mathbf{x}$ for multiple parameters in a vector).

Observation Measured system state values. These values are used to compare with model outputs collocated in space and time. The term is often used to mean *both* field measurements and outputs from the model. When referring to a measured value, observations are typically identified by the variables y or o ($\mathbf{y}$ or $\mathbf{o}$ for multiple parameters in a vector)

Modeled Equivalent A modeled value collocated in time and space with an observation. There are various ways to identify a single or multiple modeled equivalent values (and, to make things confusing, they are often *also* called "observations"!)

Single values

1. $f(x)$
2. $X(\beta)$
3. $M(p)$

Multiple values

1. $\mathbf{X}\beta$
2. $\mathbf{Mp}$
3. **NOBS** Number of observations/simulated equivalents in the inverse model setup
4. **NPAR** Number of adjustable input parameters in the inverse model setup

Forecasts Model outputs for which field observations are not available. Typically these values are simulated under an uncertain future condition.

Phi Objective function, defined as the weighted sum of squares of residuals. Phi (aka $\mathbf{\Phi}$) is typically calculated as

$$\Phi = \sum_{i=1}^{n}\left(\frac{y_i - f(x_i)}{w_i}\right)^2 \quad or \quad \Phi = (\mathbf{y}-\mathbf{Jx})^T\,\mathbf{Q}^{-1}\,(\mathbf{y}-\mathbf{Jx}) \tag{1}$$

Residuals The difference between observation values and modeled equivalents $r_i = y_i - f(x_i)$

Sensitivity The incremental change of an observation (modeled equivalent, actually) due to an incremental change in a parameter. Typically expressed as a finite-difference approximation of a partial derivative: $\frac{\partial y}{\partial x}$

Jacobian Matrix A matrix of the sensitivity of all observations in an inverse model to all parameters. This is often shown as a matrix by various names $\mathbf{X}$, $\mathbf{J}$, or $\mathbf{H}$. Each element of the matrix is a single sensitivity value $\frac{\partial y_i}{\partial x_j}$ for $i \in NOBS$, $j \in NPAR$

FOSM

Gaussian (multivariate)

Weight

Weight Covariance matrix (correlation matrix)

Parametric uncertainty

Measurement noise

Structural (model) error

Monte Carlo Ensemble

Bayes' Theorem

Posterior (multivariate distribution)

Schur Complement

Prior (multivariate distribution)

Likelihood (multivariate distribution)