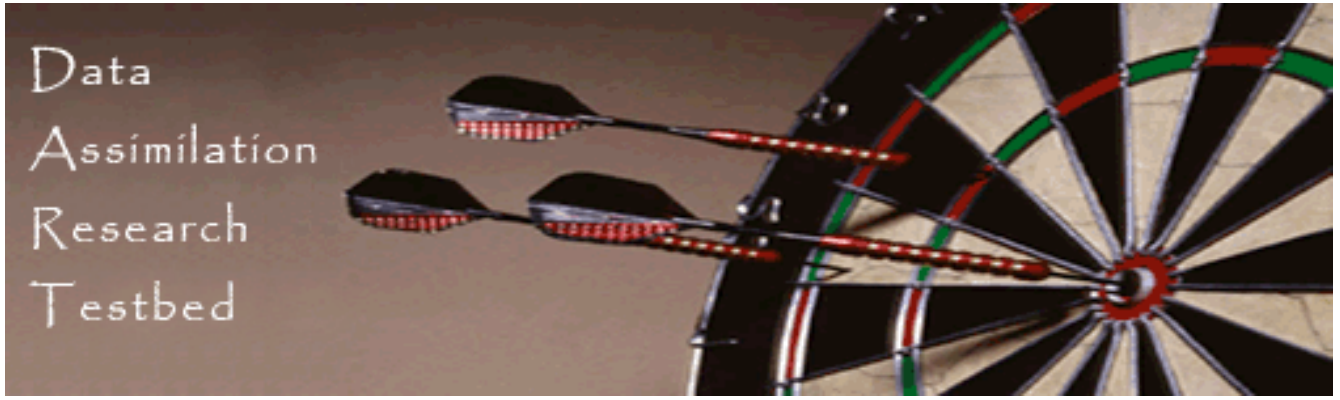
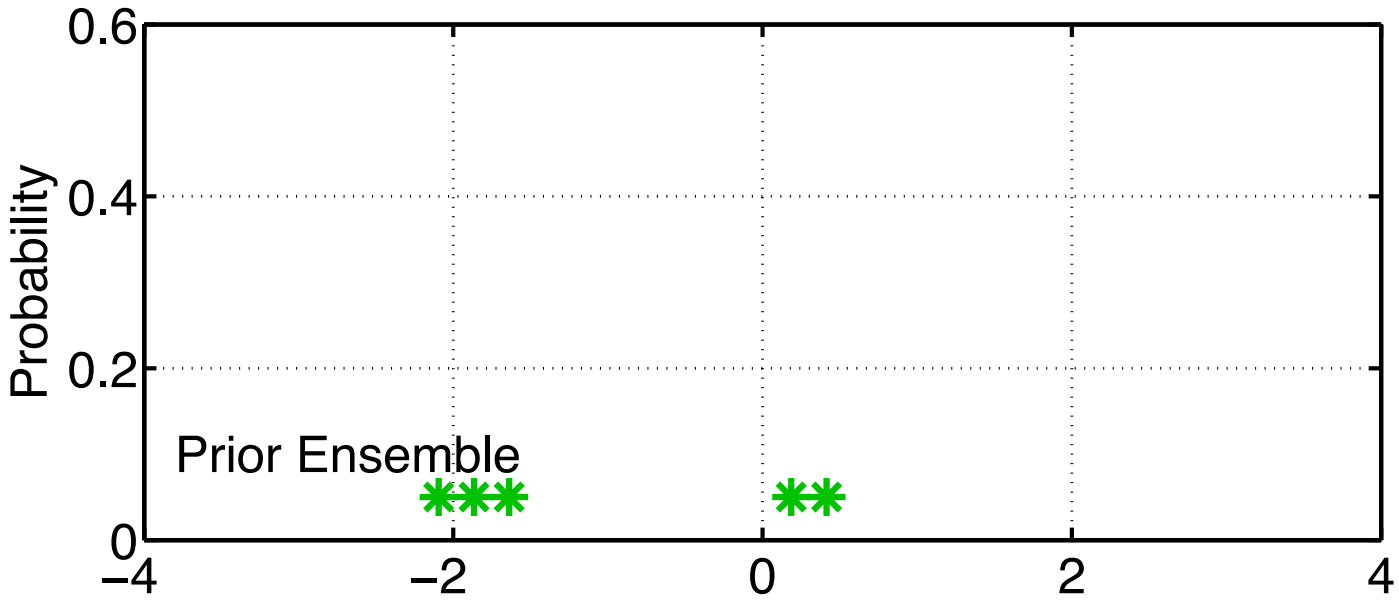
Data Assimilation Research Testbed Tutorial



Section 4: Other Updates for an Observed Variable.

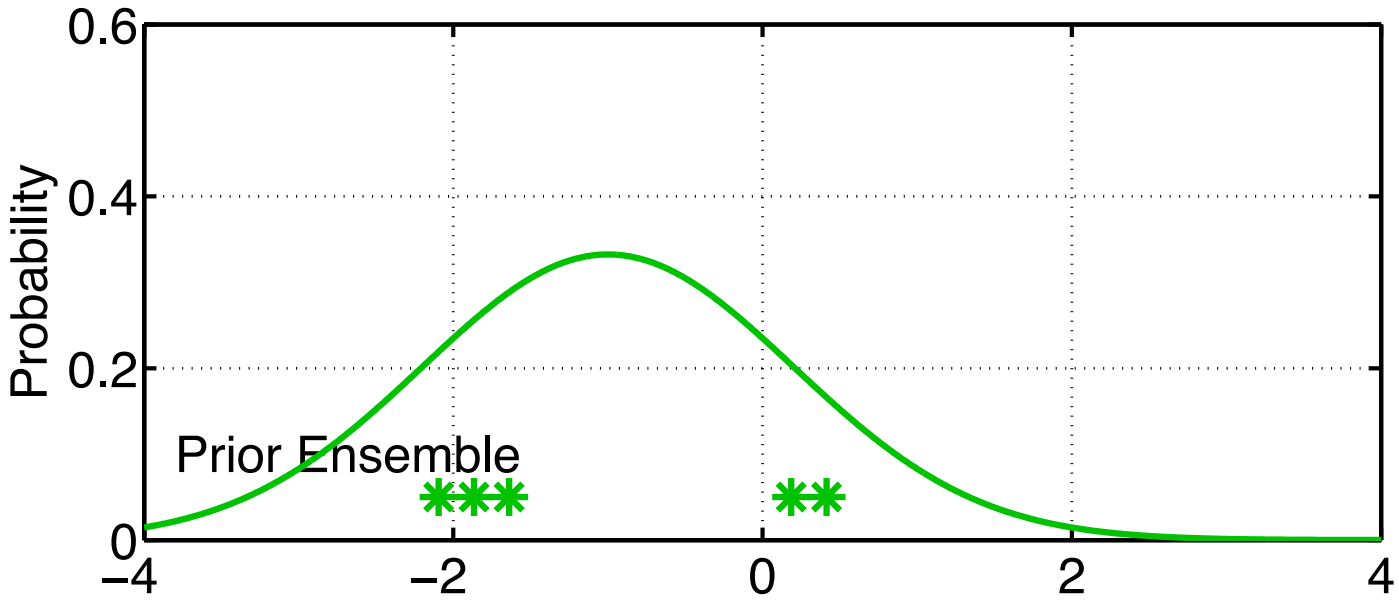
The Ensemble Kalman Filter (Perturbed Observations)

'Classical' Monte Carlo algorithm by Evensen.
Note: earliest references have error, use caution.



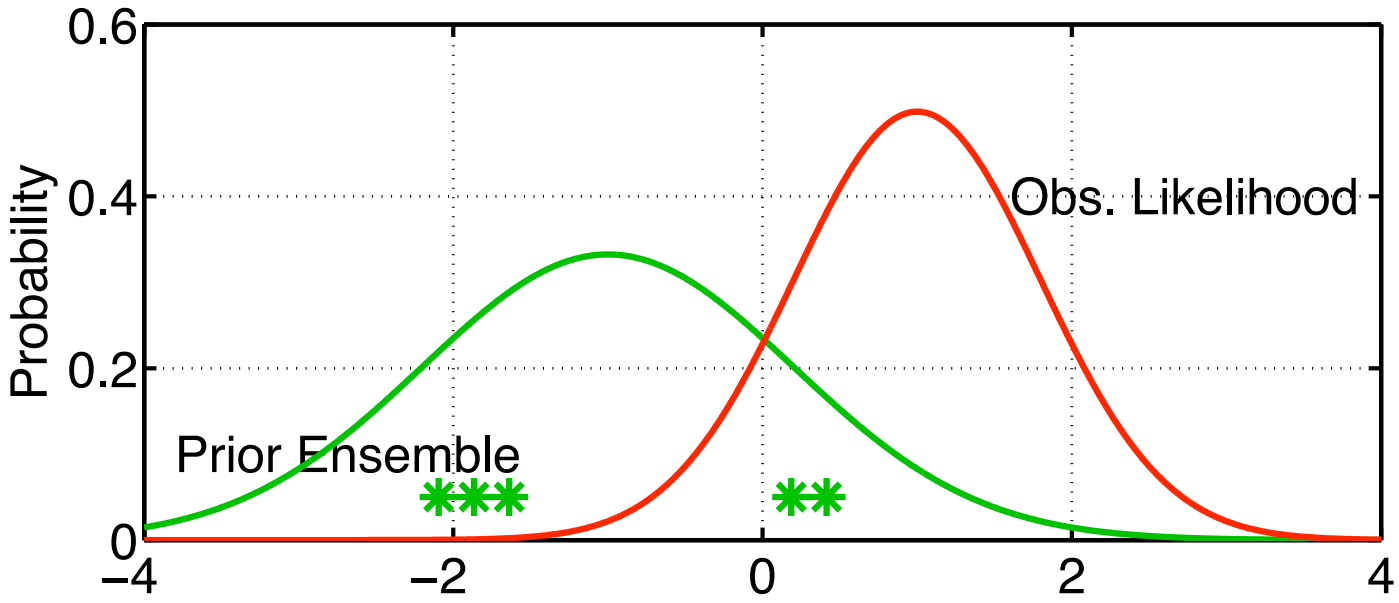
The Ensemble Kalman Filter (Perturbed Observations)

First fit a gaussian to ensemble sample.



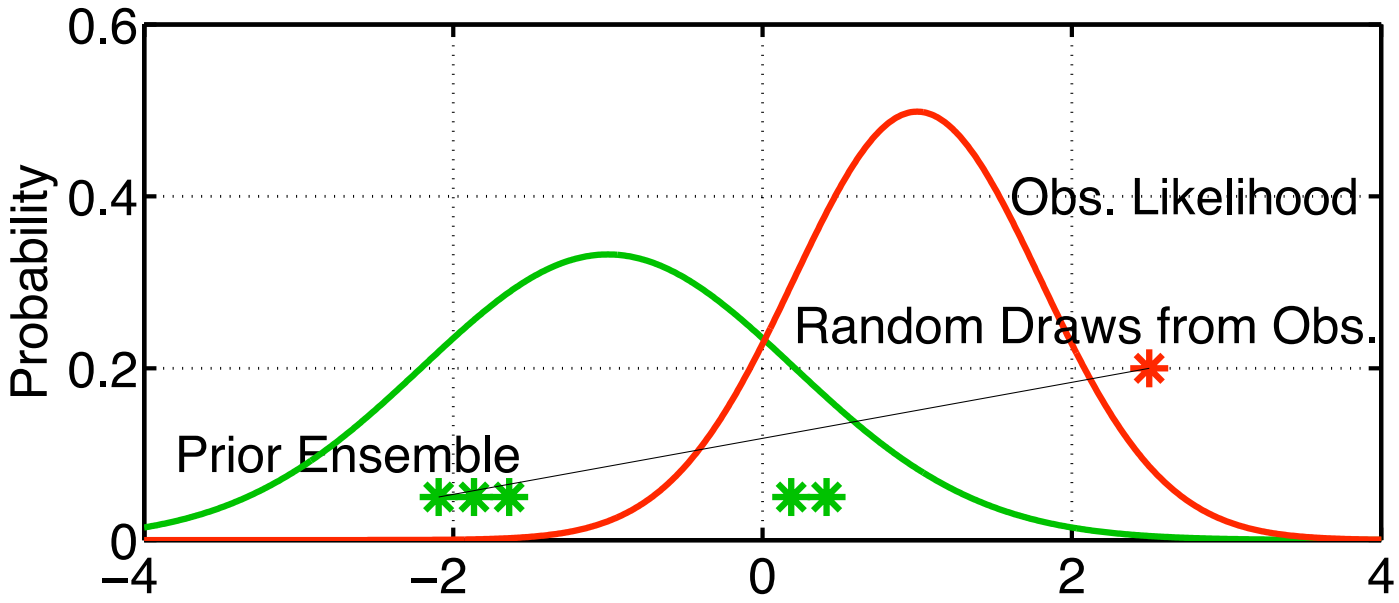
The Ensemble Kalman Filter (Perturbed Observations)

Obtain observation and observational error distribution.



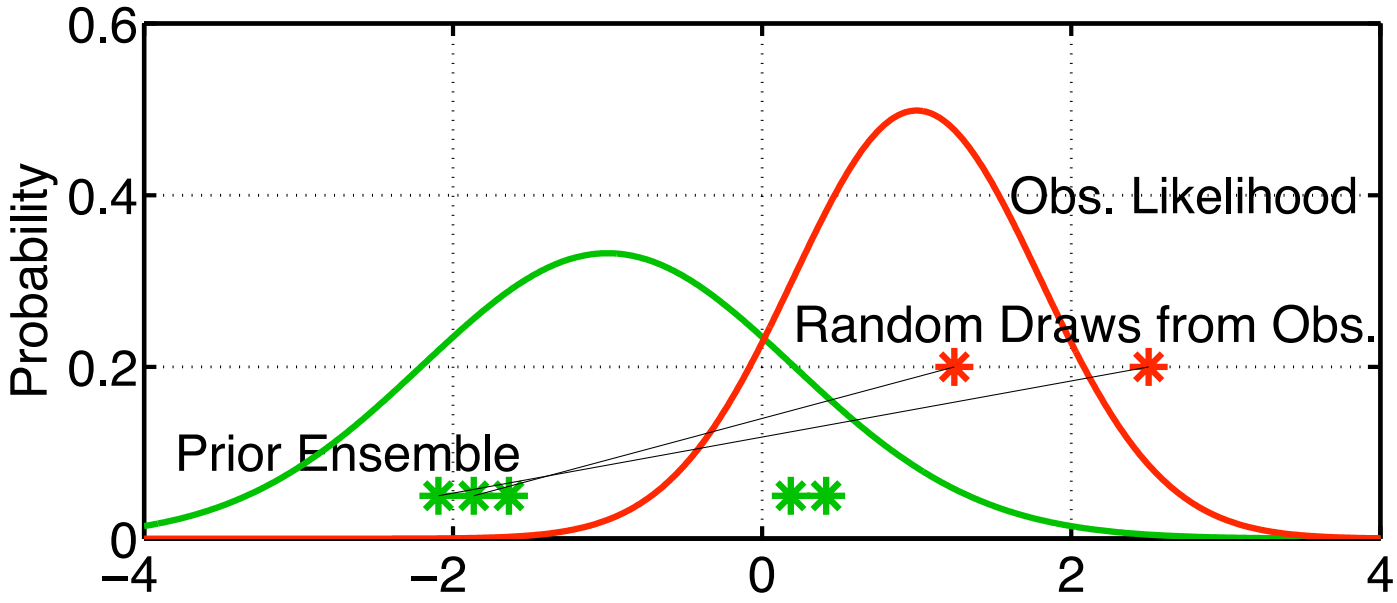
The Ensemble Kalman Filter (Perturbed Observations)

Generate a random draw from the observation likelihood.
Associate it with the first sample of the prior ensemble.



The Ensemble Kalman Filter (Perturbed Observations)

Associate a random draw from observation likelihood with each prior ensemble member.
This is called generating perturbed observations.



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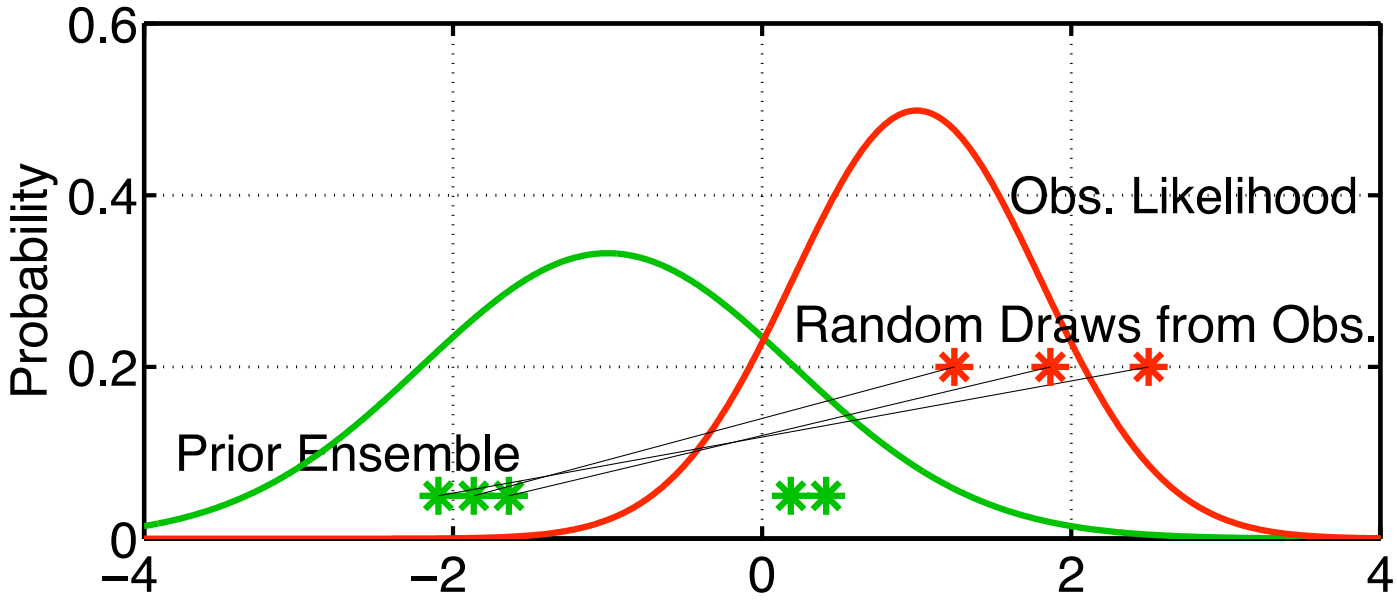

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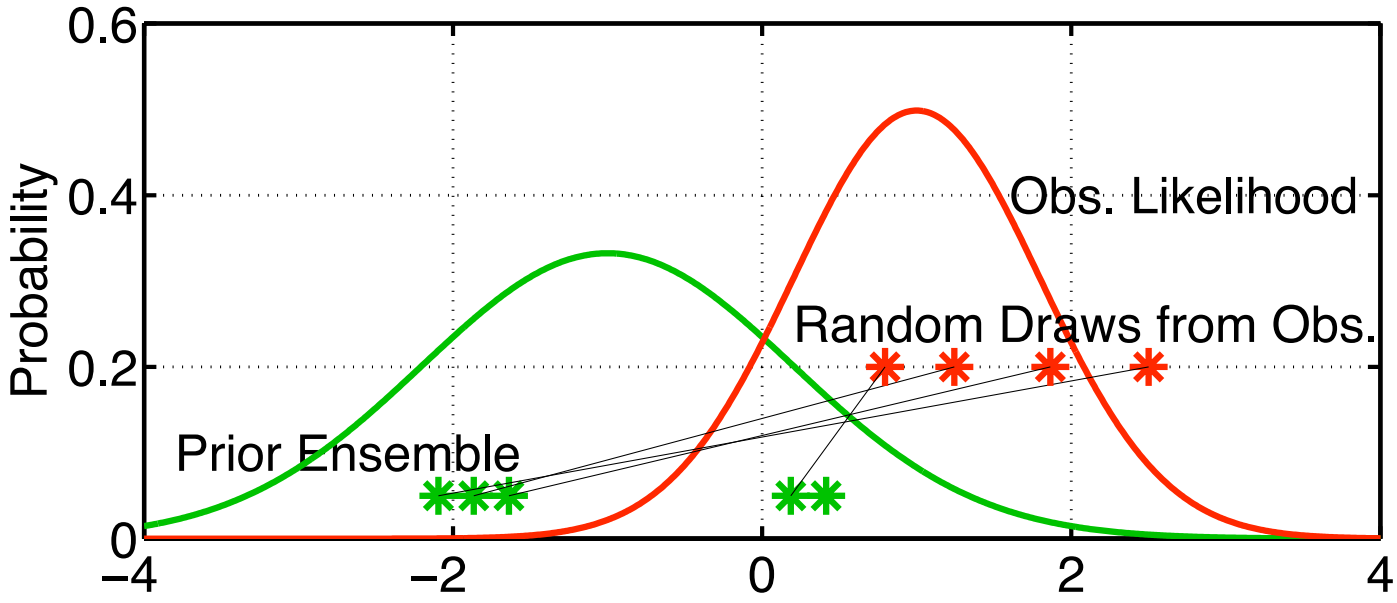

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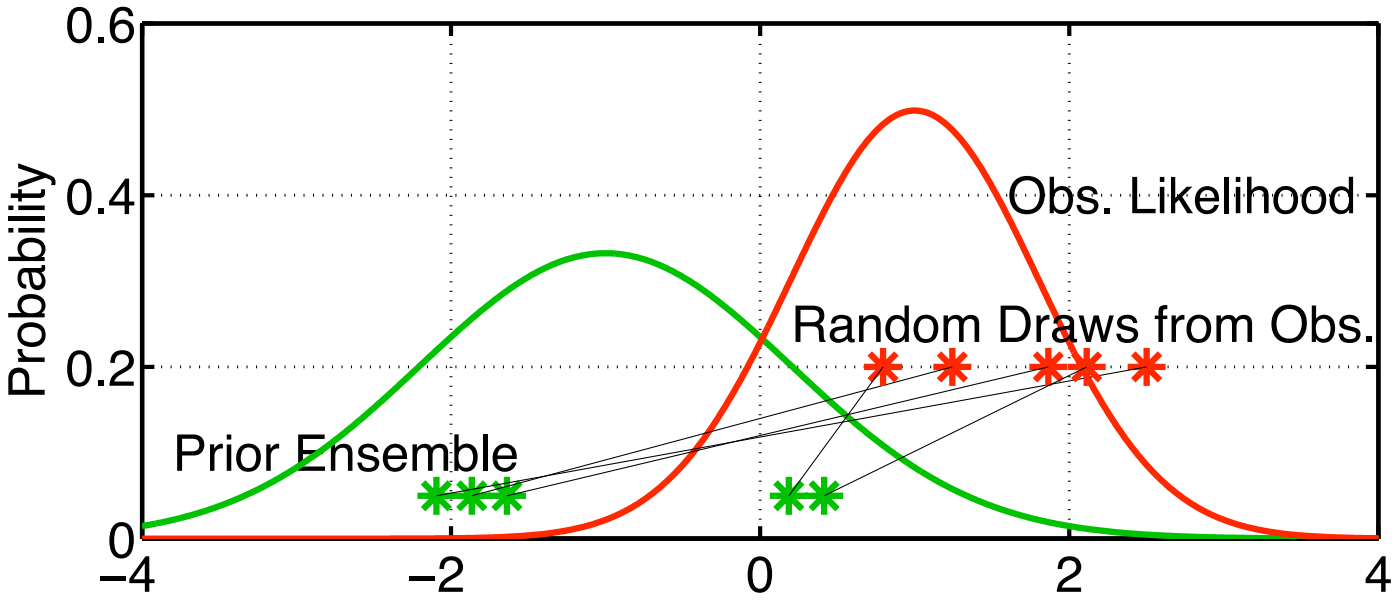
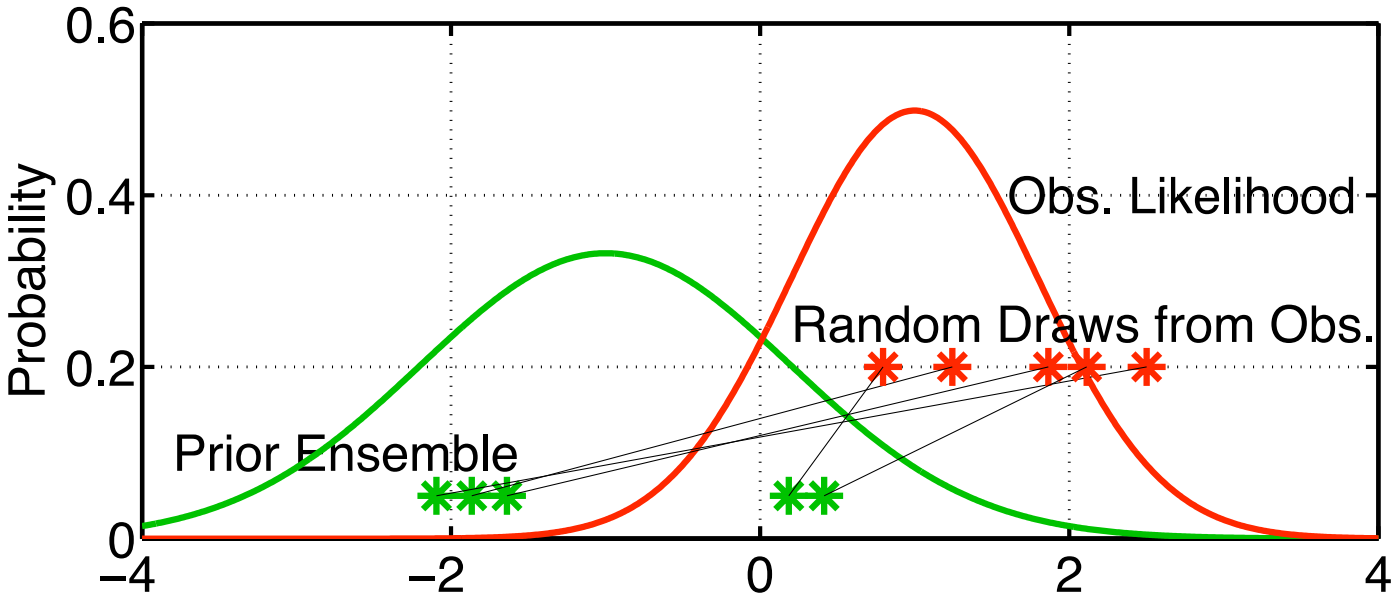


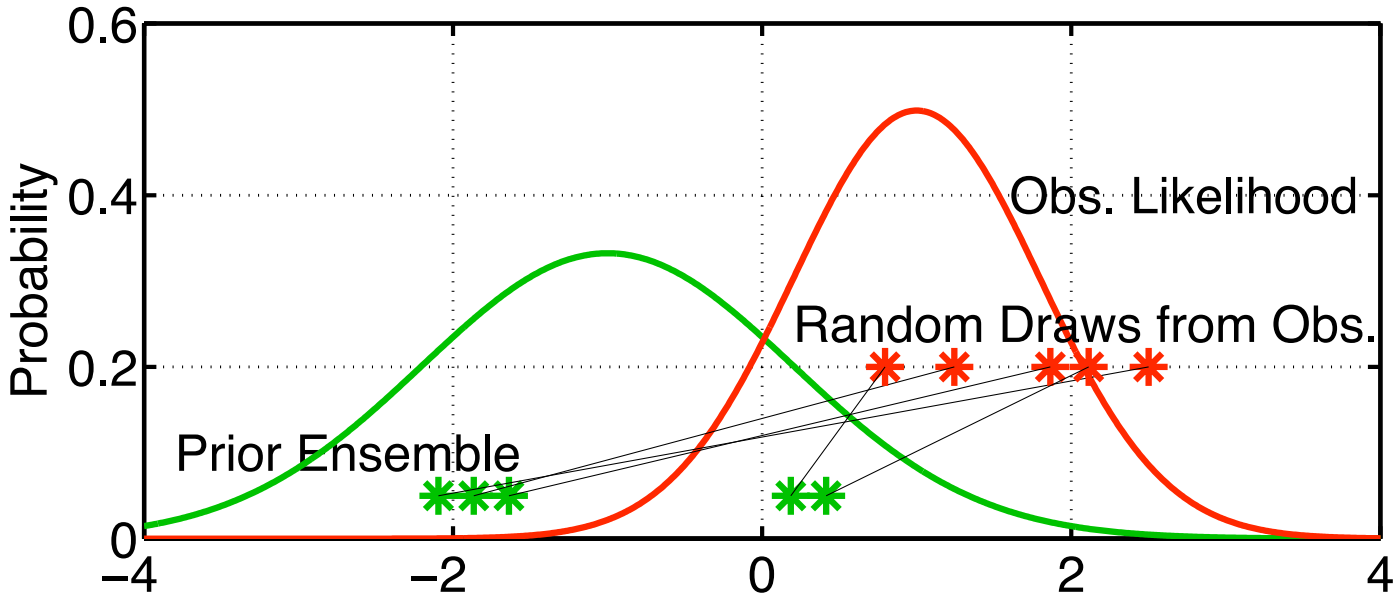
The Ensemble Kalman Filter (Perturbed Observations)

Have sample of joint distribution of prior and mean and observation.



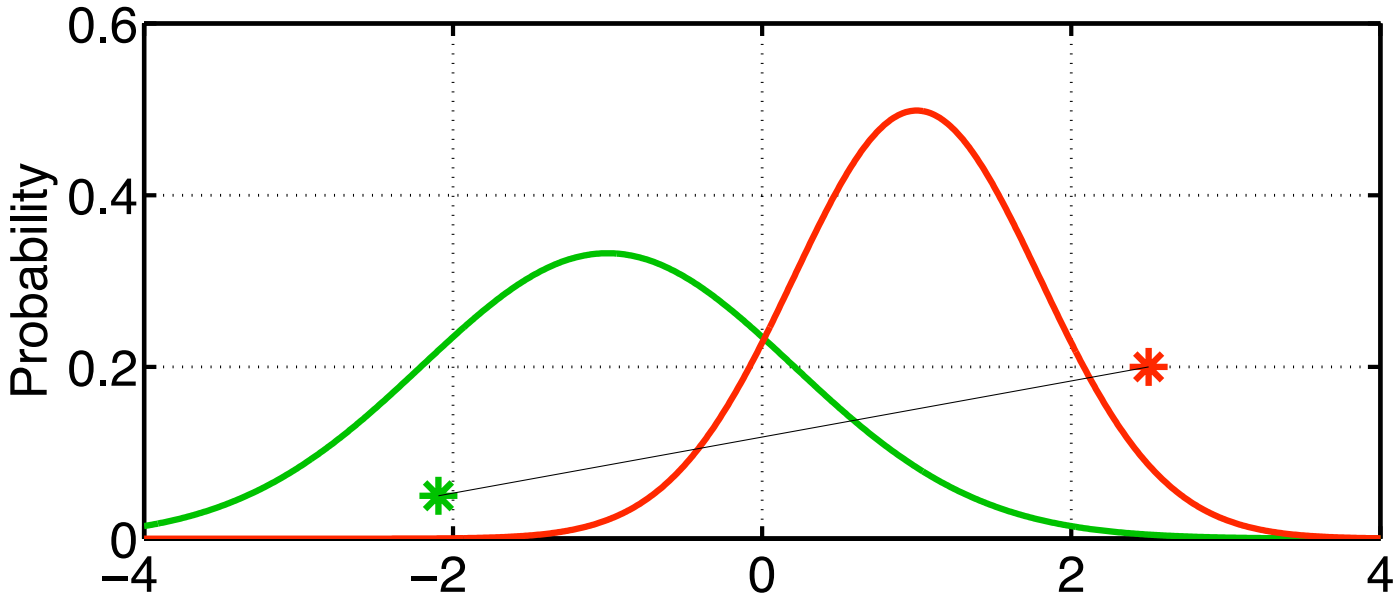
The Ensemble Kalman Filter (Perturbed Observations)

Adjusting the mean of the observation sample helps.
Adjusting the variance to be exact may also help (or not).
Outliers are a potential problem but could be removed.



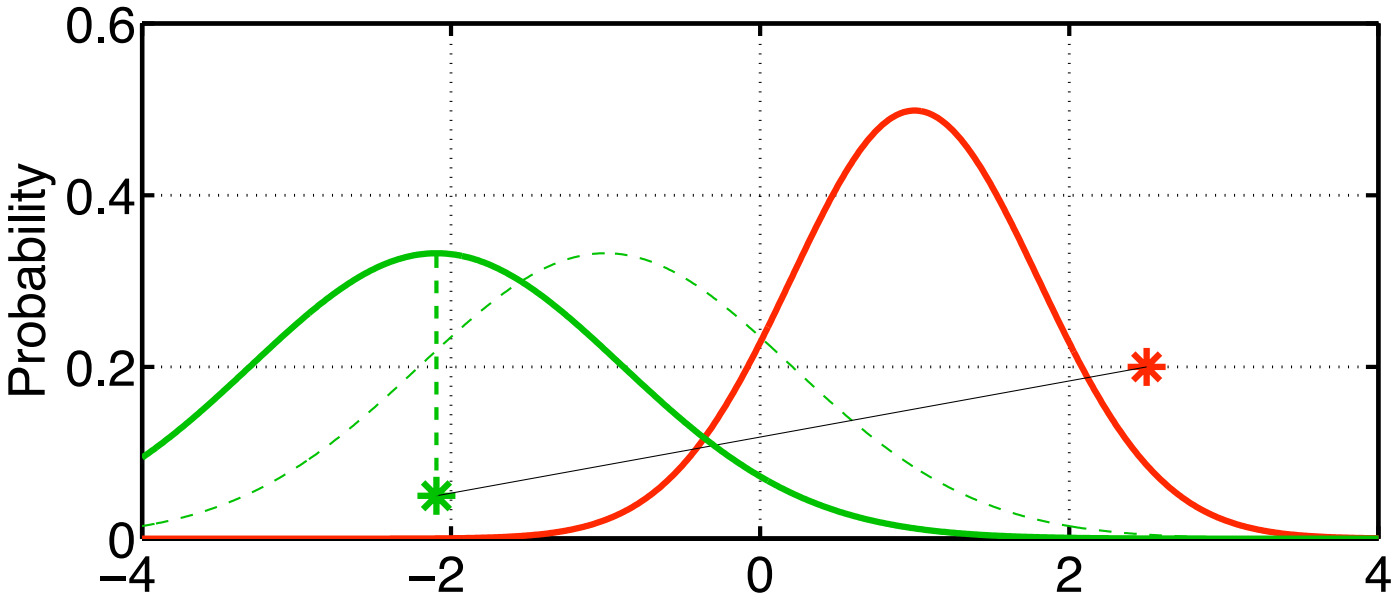
The Ensemble Kalman Filter (Perturbed Observations)

For each prior/observation pair, find mean of posterior distribution.



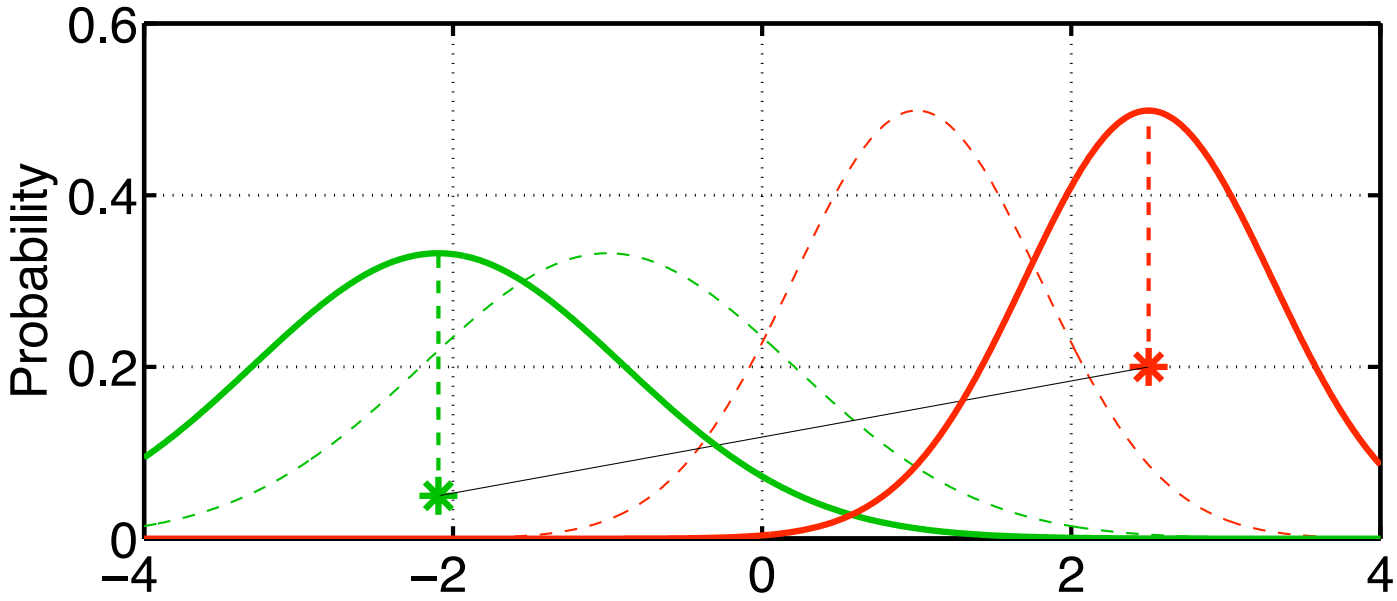
The Ensemble Kalman Filter (Perturbed Observations)

Prior sample standard deviation measures uncertainty of prior mean estimate.



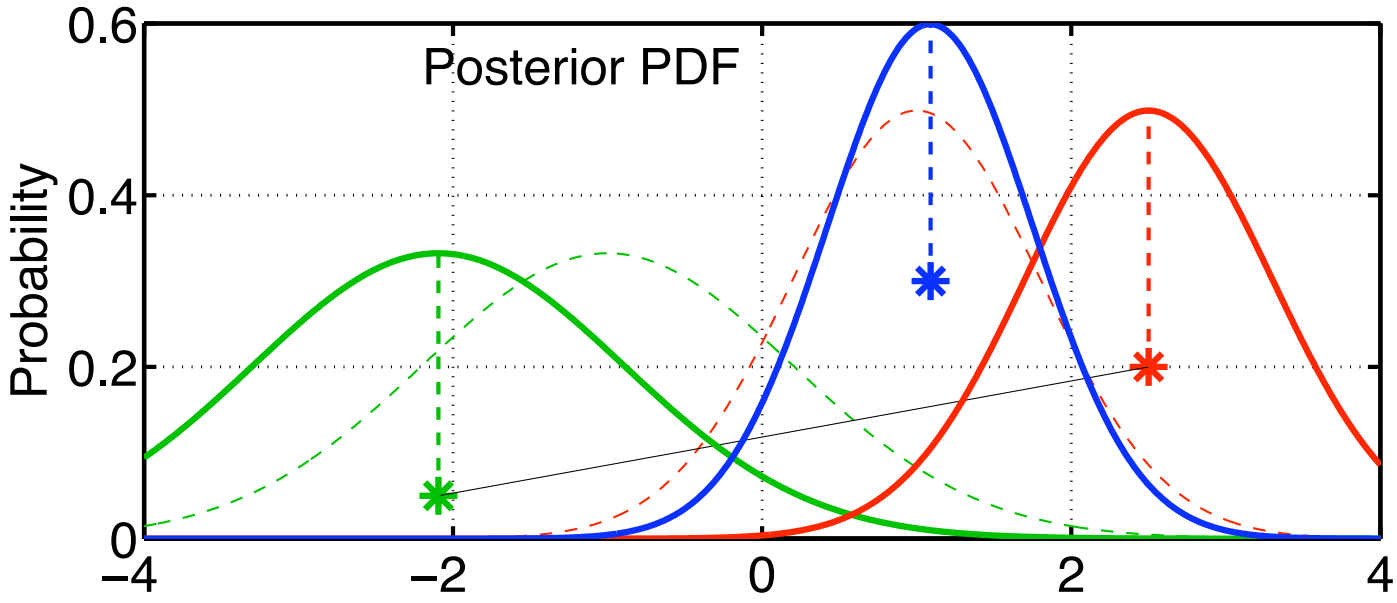
The Ensemble Kalman Filter (Perturbed Observations)

Observation likelihood standard deviation measures uncertainty of observation estimate.



The Ensemble Kalman Filter (Perturbed Observations)

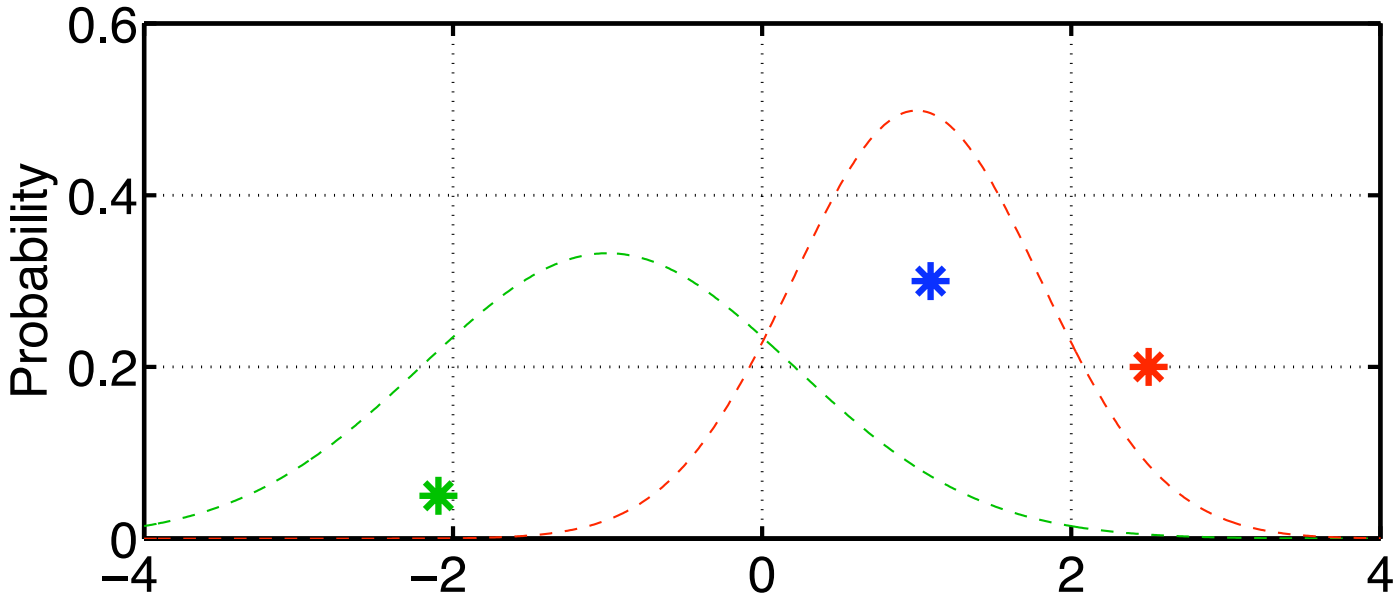
Take product of the prior and observation distributions for the first sample
This is a standard product of gaussians.



The Ensemble Kalman Filter (Perturbed Observations)

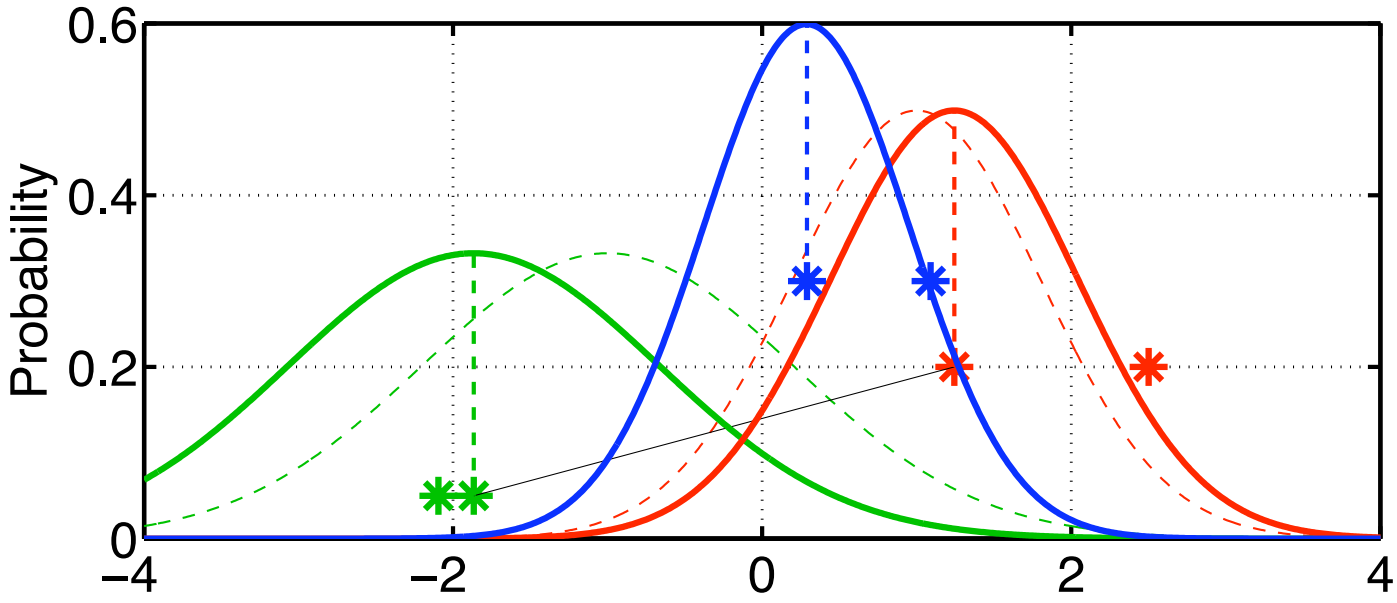
Mean of product is random sample of posterior.

Product of random samples is random sample of product.



The Ensemble Kalman Filter (Perturbed Observations)

Repeat this operation for every pair of prior and observation.



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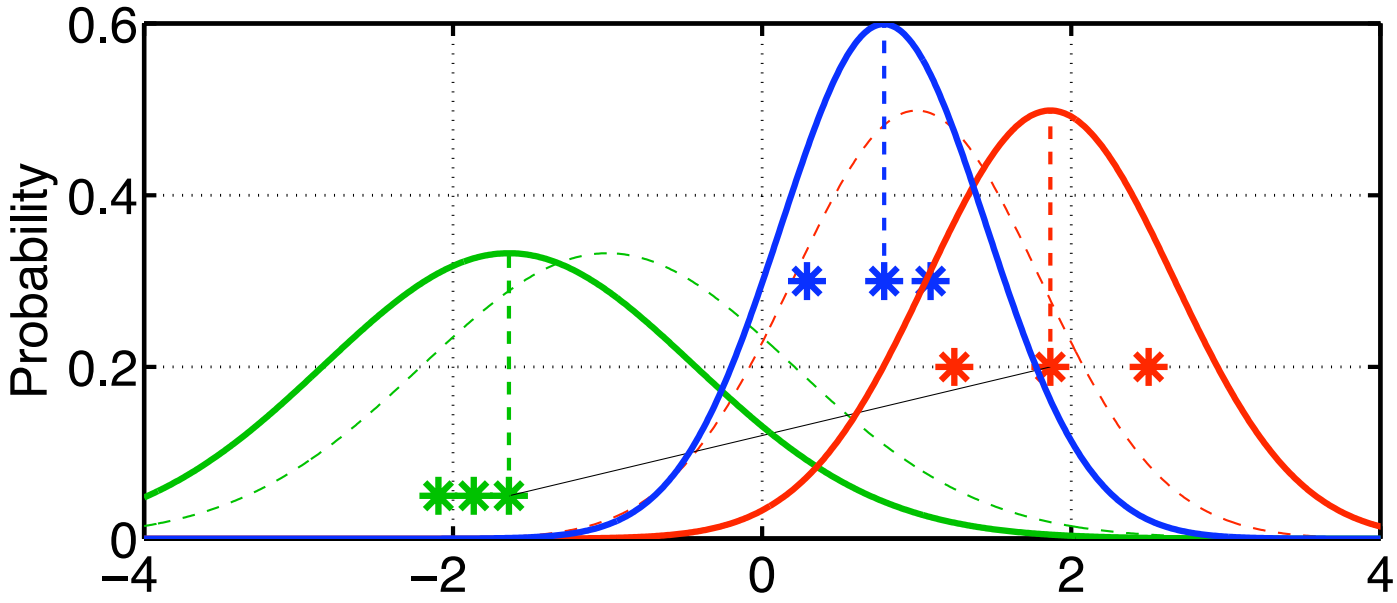

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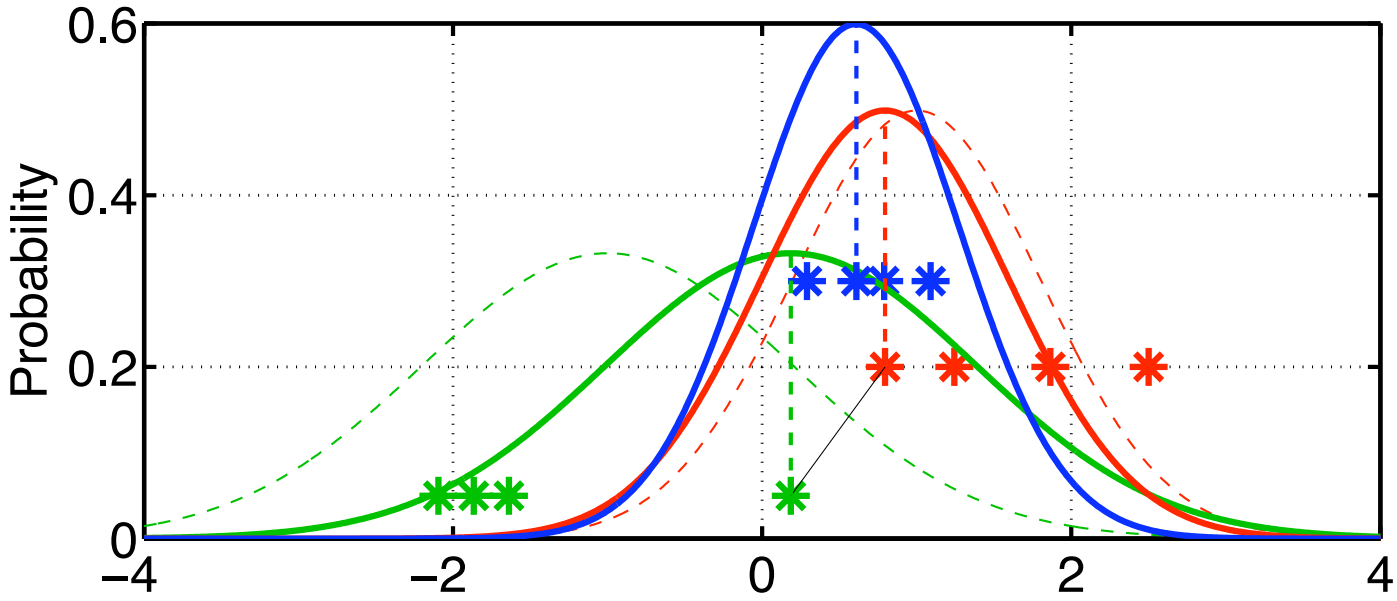

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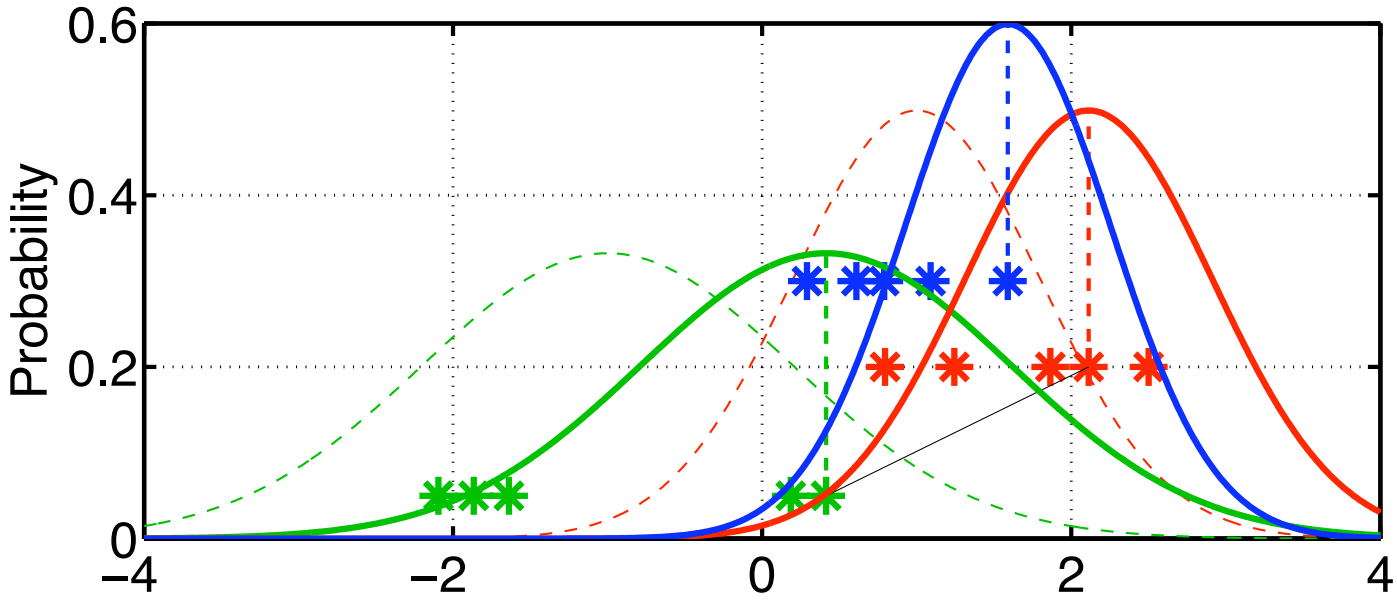
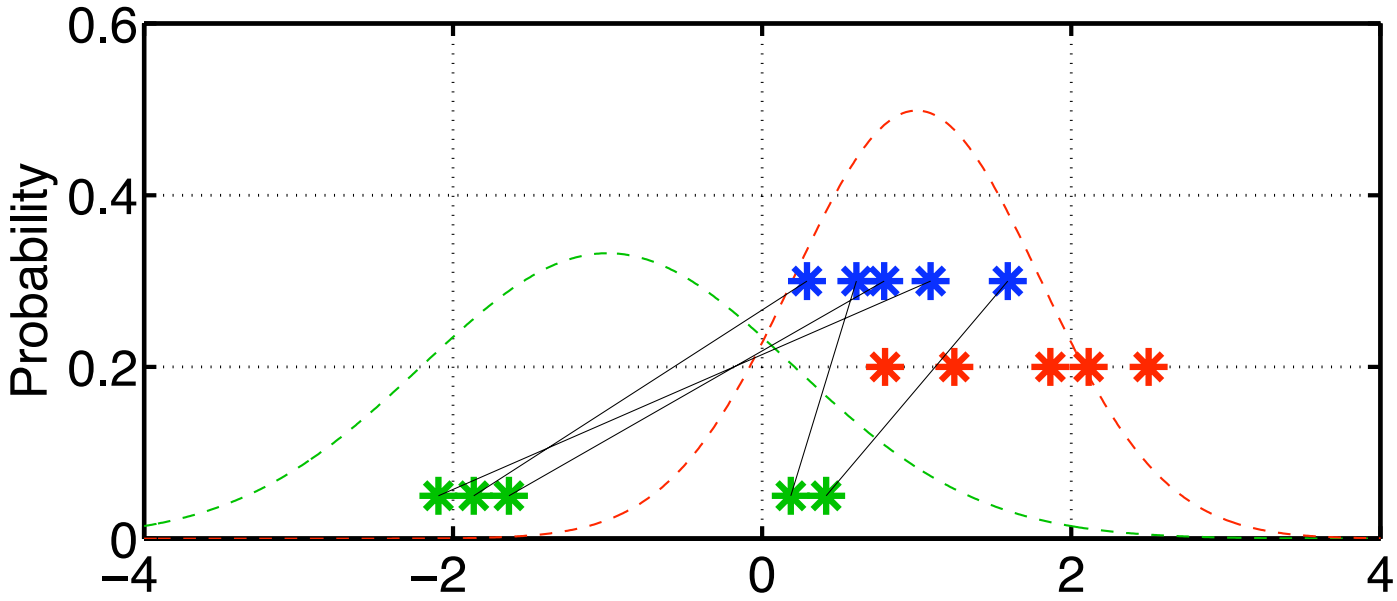


The Ensemble Kalman Filter (Perturbed Observations)

Posterior sample retains much of prior samples structure; this is more apparent for larger ensembles.
Posterior sample mean and variance converge as function of ensemble size.



The Ensemble Kalman Filter (Perturbed Observations)

Matlab exercises oned_ensemble, twod_ensemble, oned_model, run_lorenz_63 and run_lorenz_96 all allow selection of EnKF for assimilation.

In oned_ensemble and twod_ensemble, be sure to try the EnKF repeatedly. It's a stochastic algorithm so produces a different answer each time.