

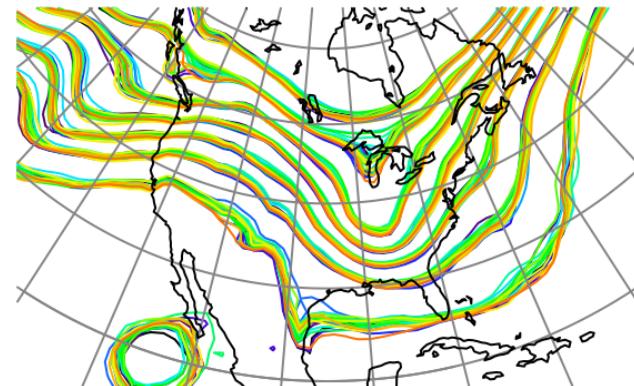
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DART_LAB Tutorial Section 4: Other Updates for an Observed Variable.



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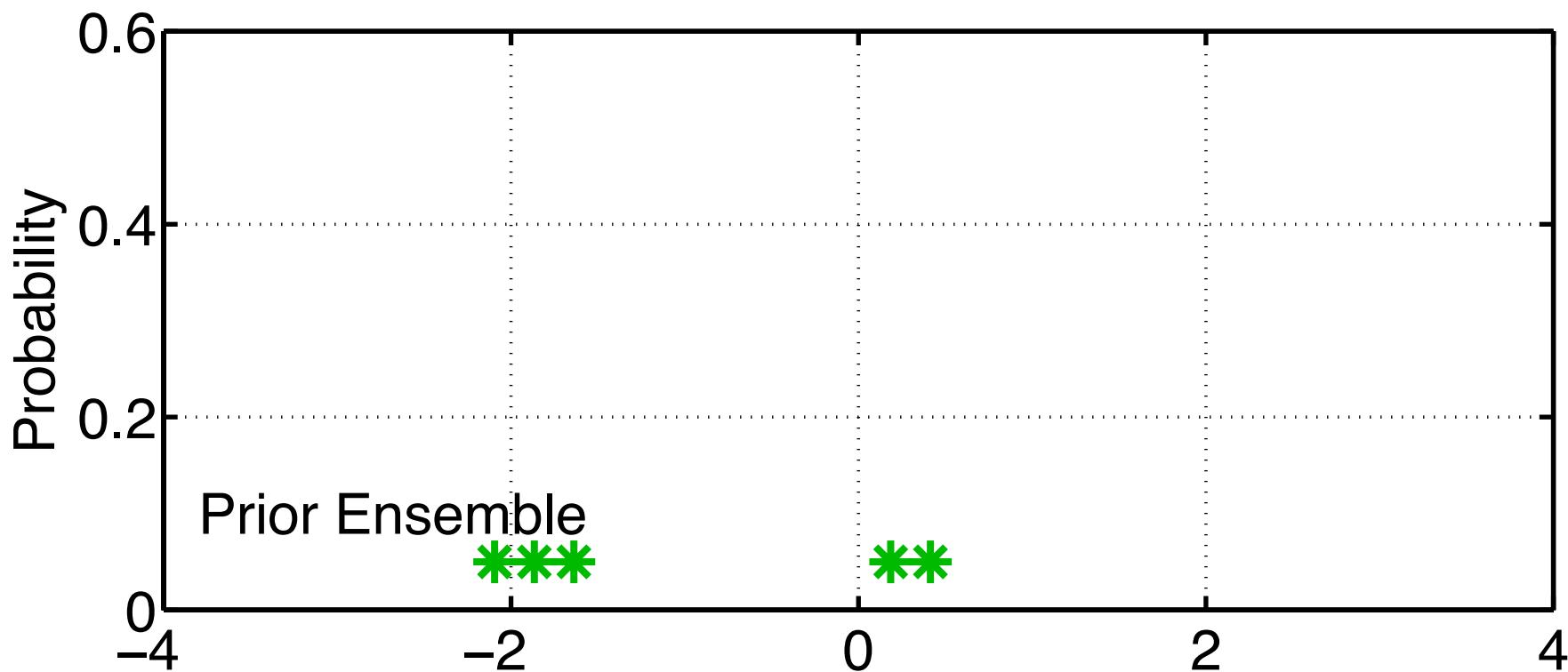
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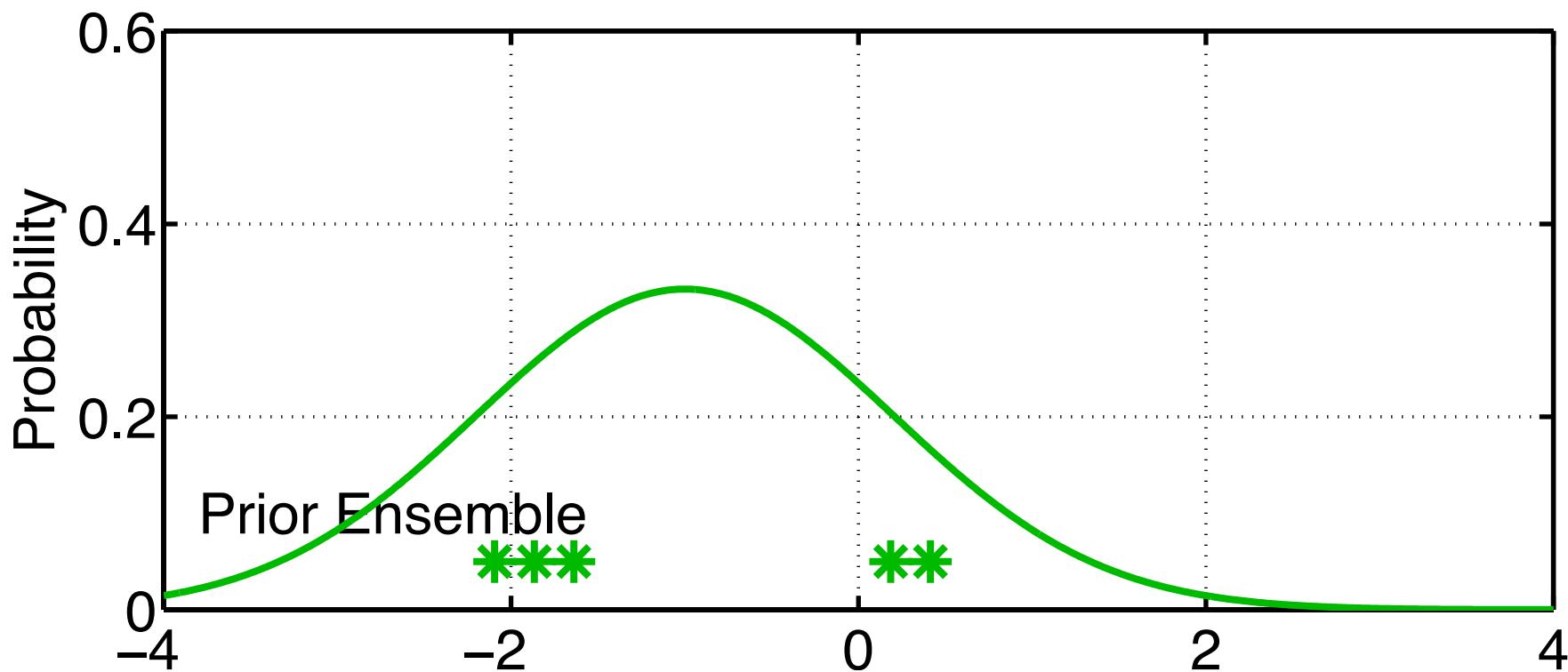
The Ensemble Kalman Filter (Perturbed Observations)

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



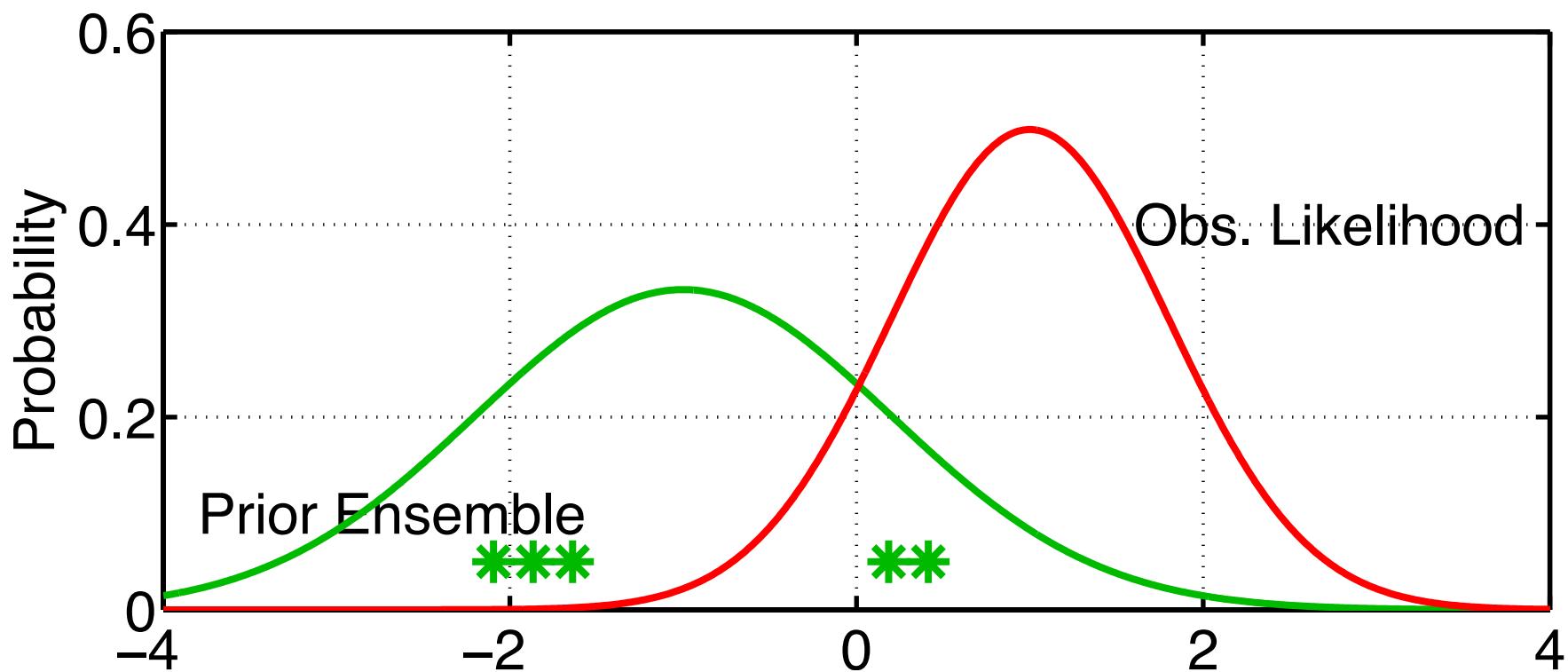
The Ensemble Kalman Filter (Perturbed Observations)

First, fit a gaussian to the ensemble sample.



The Ensemble Kalman Filter (Perturbed Observations)

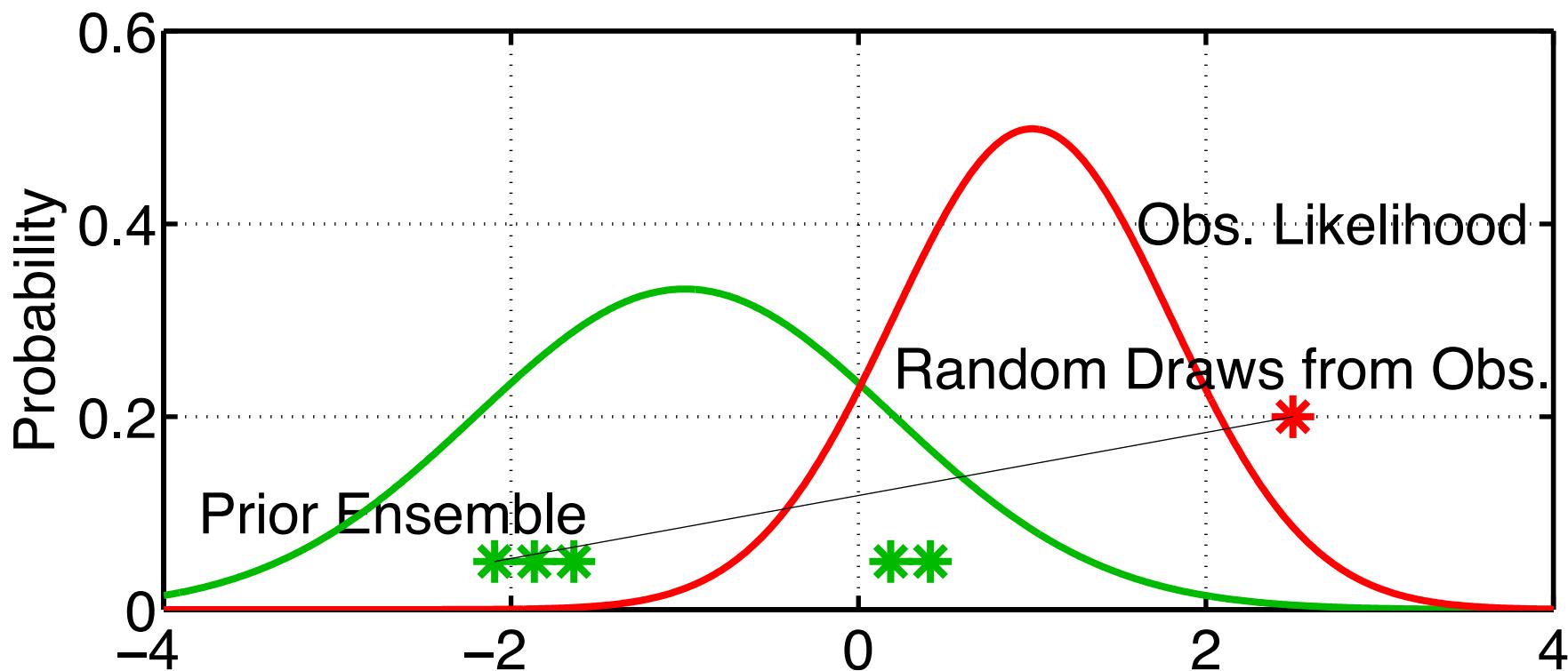
Obtain observation and observation error distribution.



The Ensemble Kalman Filter (Perturbed Observations)

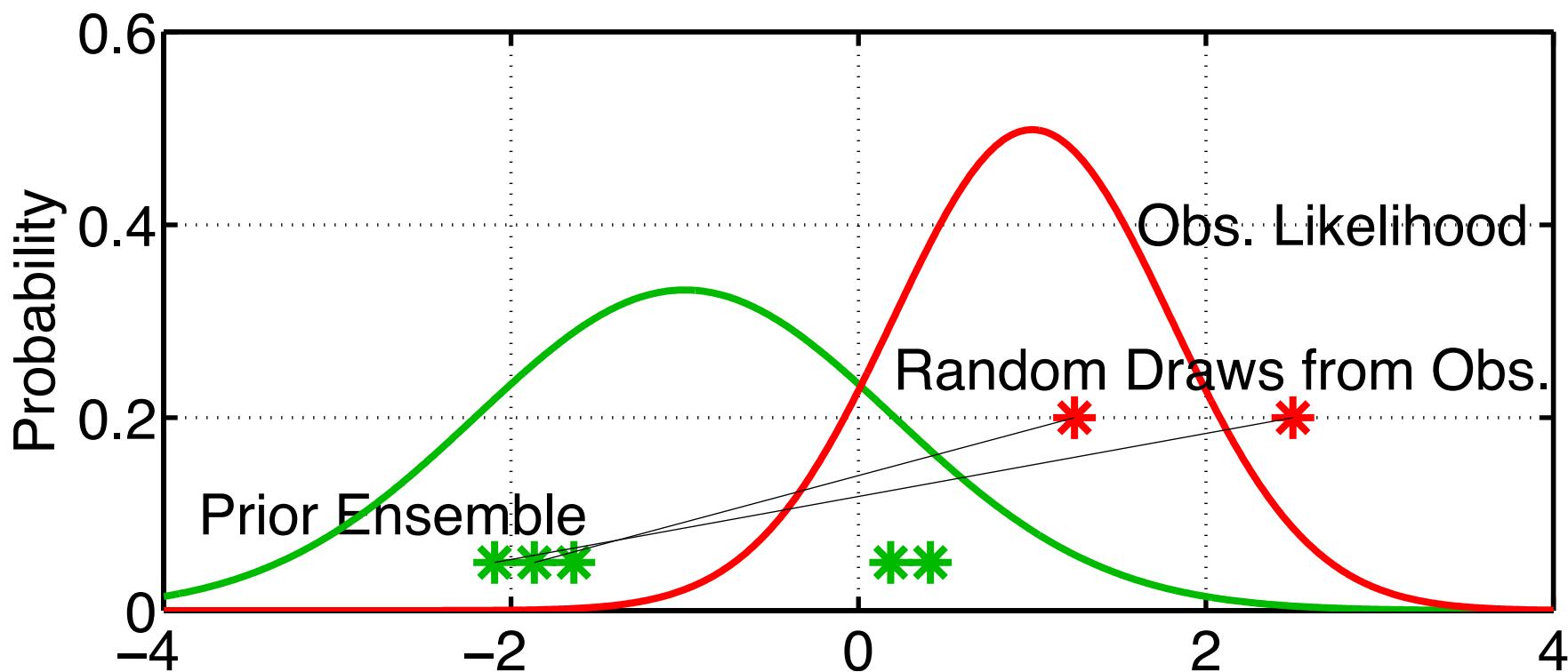
Generate a random draw from the observation likelihood.

Associate it with the first sample of the prior ensemble.



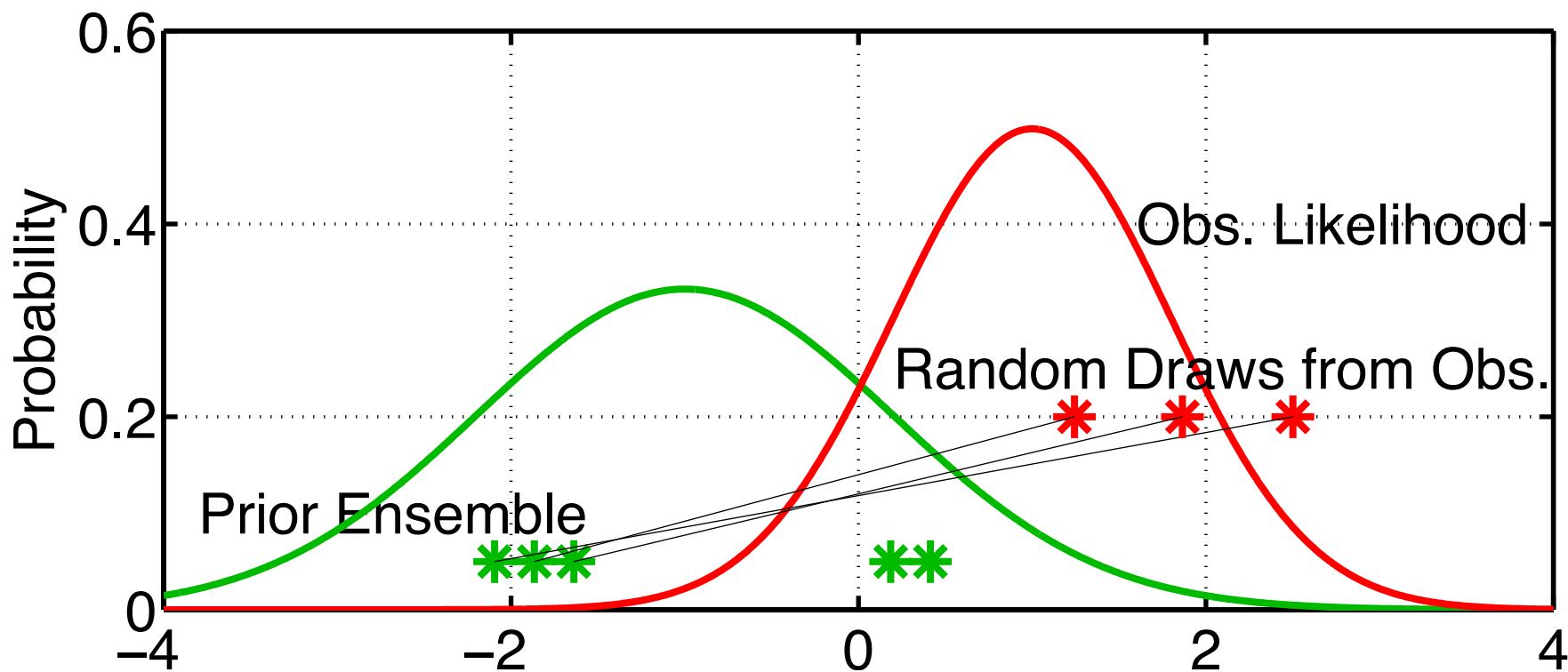
The Ensemble Kalman Filter (Perturbed Observations)

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



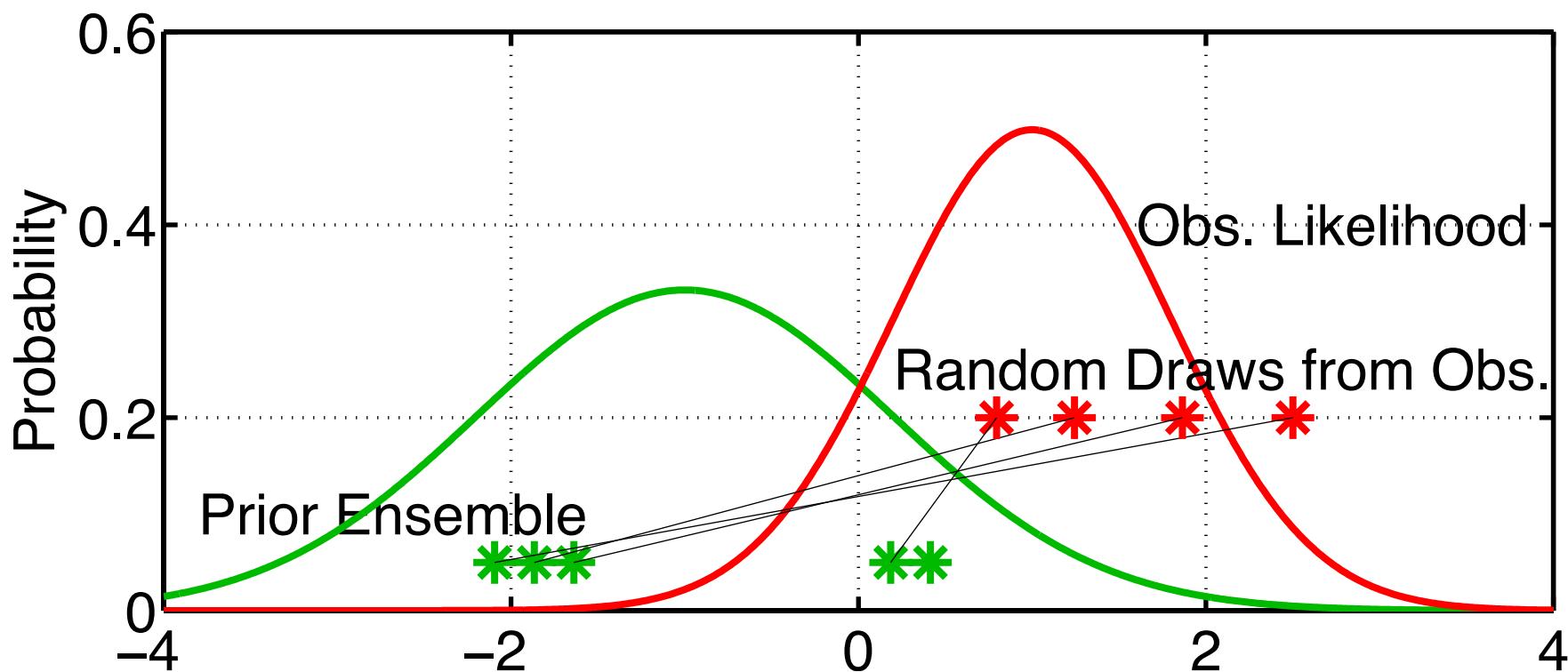
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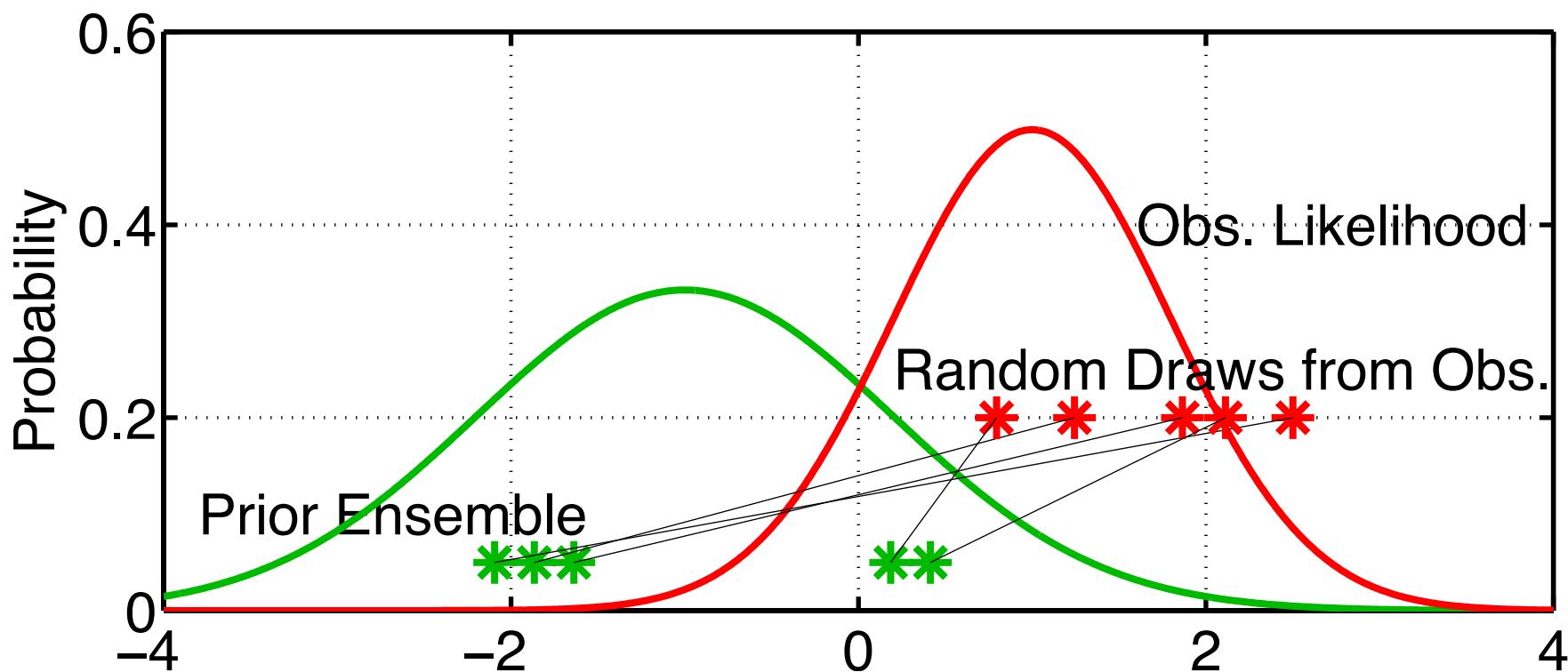
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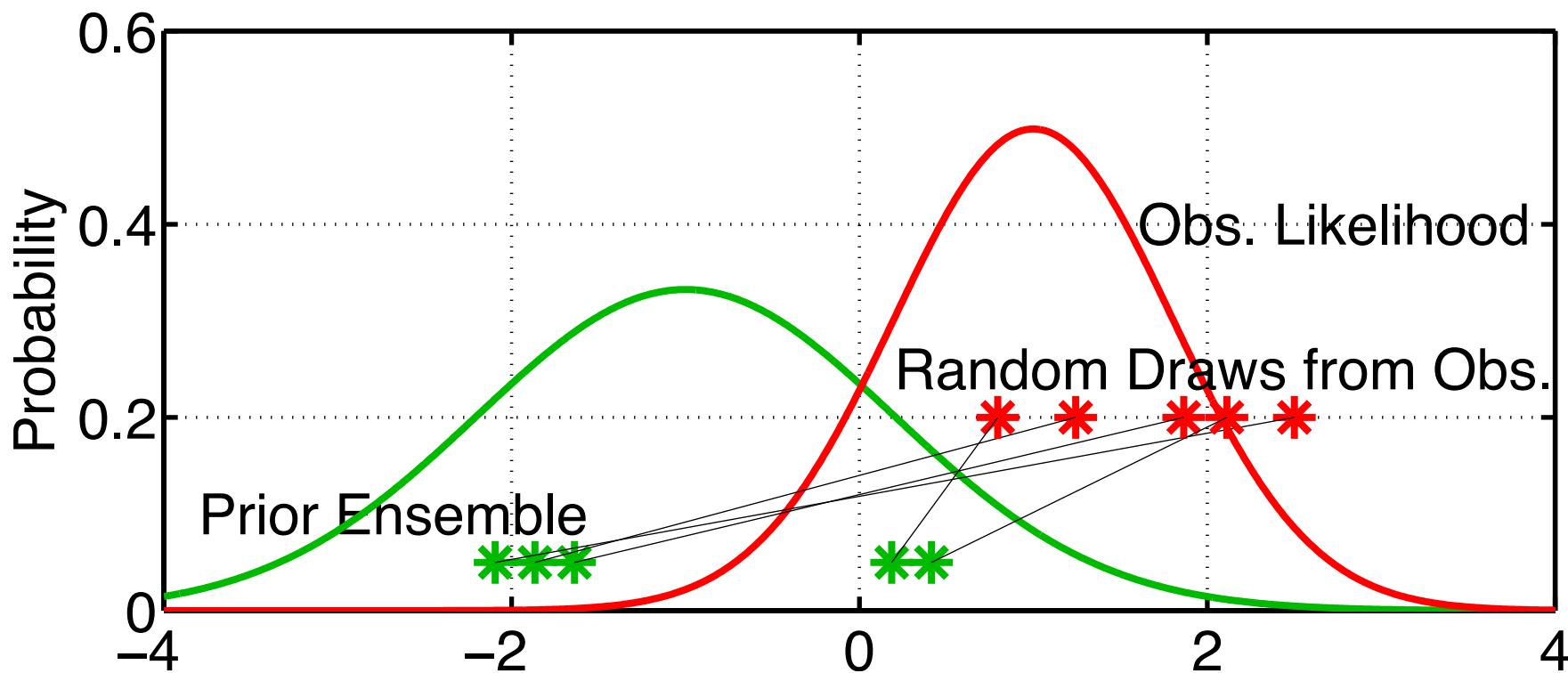
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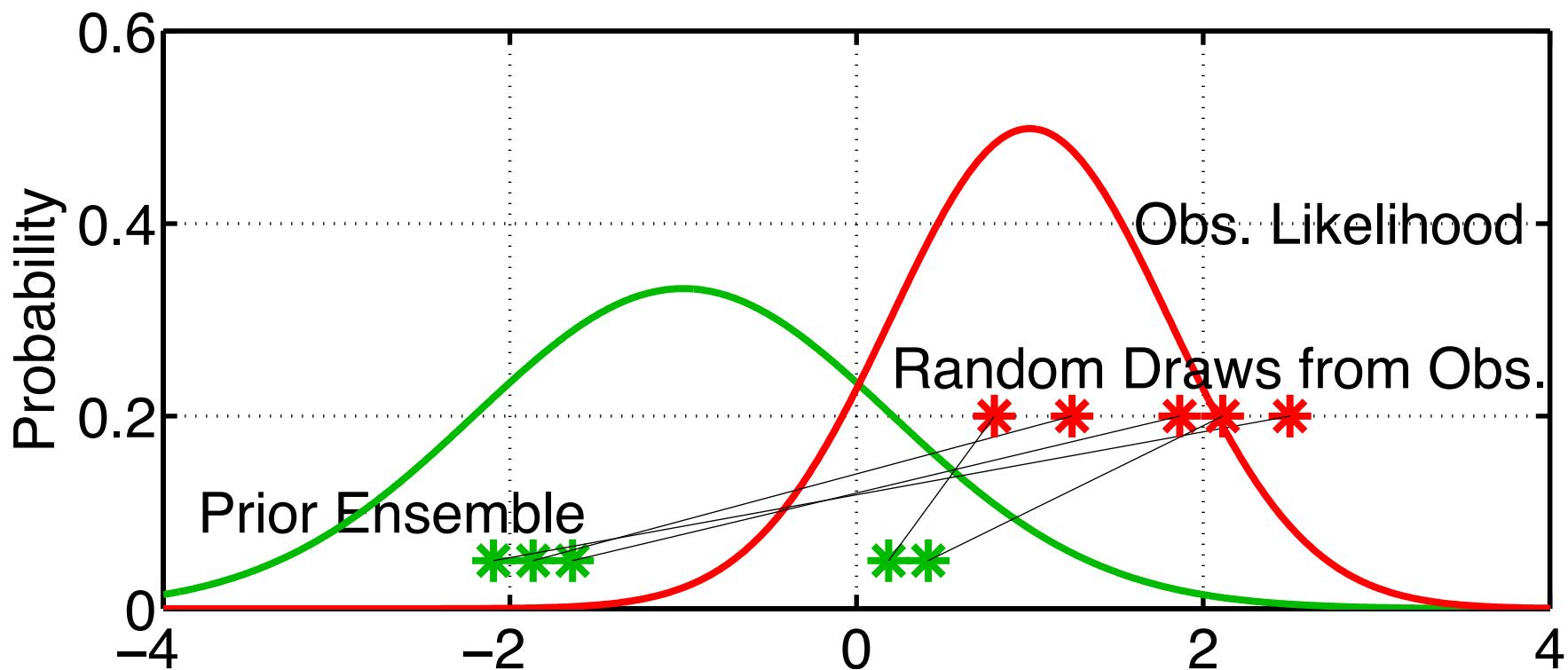
The Ensemble Kalman Filter (Perturbed Observations)

We now have a sample of the joint distribution of the prior mean and observation.



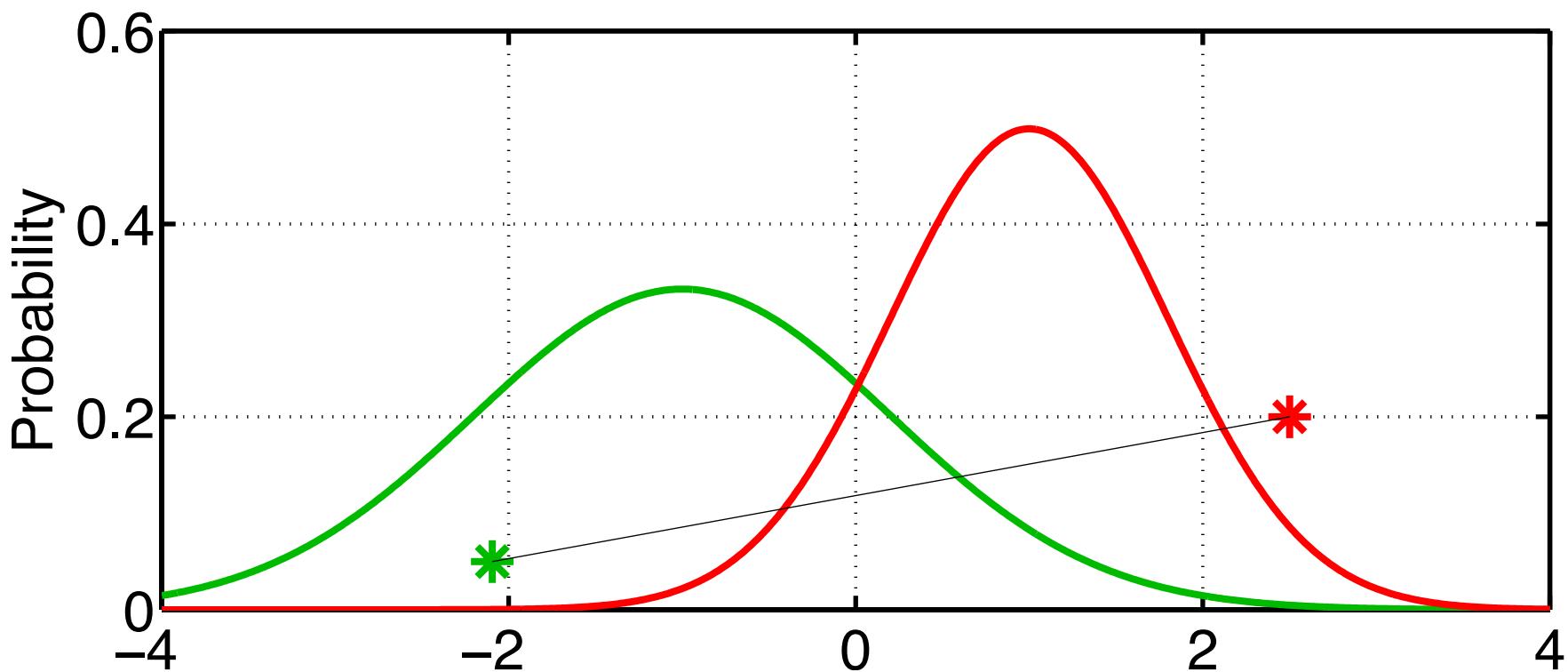
The Ensemble Kalman Filter (Perturbed Observations)

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.



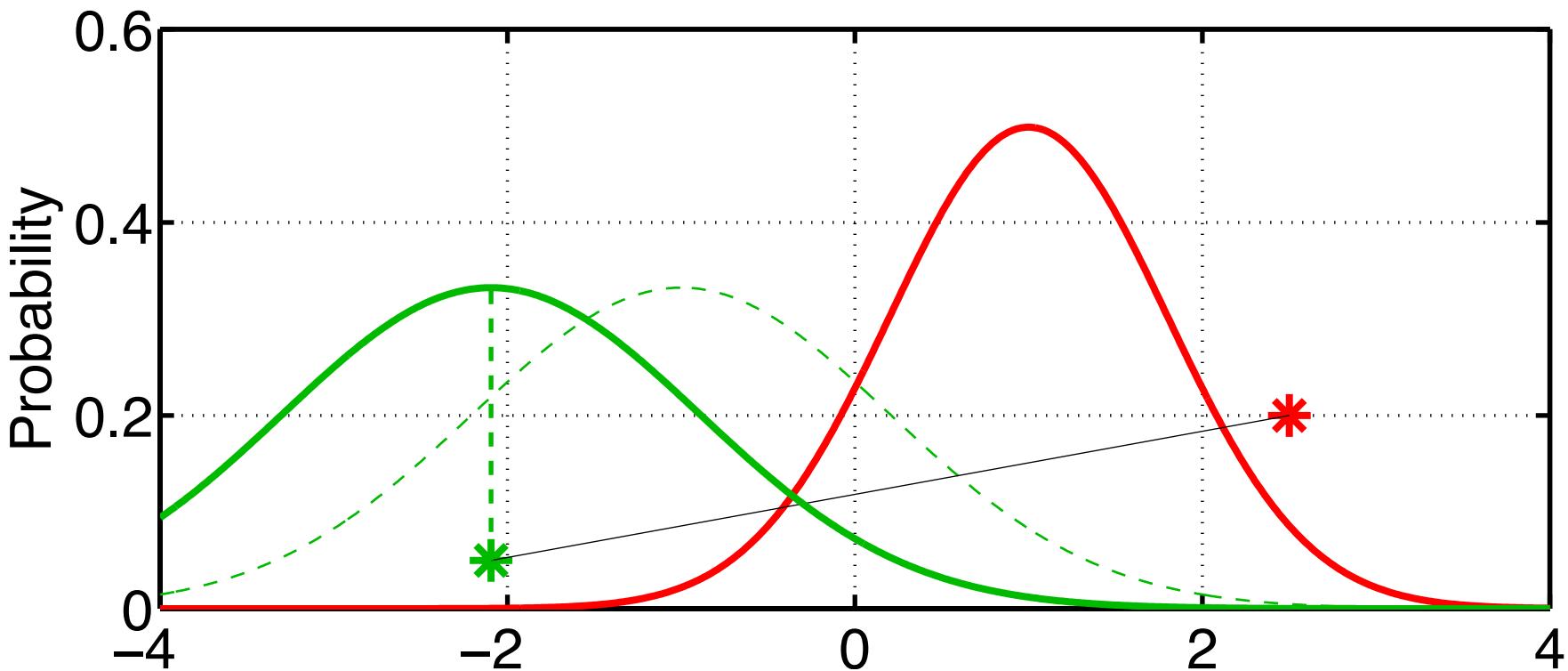
The Ensemble Kalman Filter (Perturbed Observations)

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



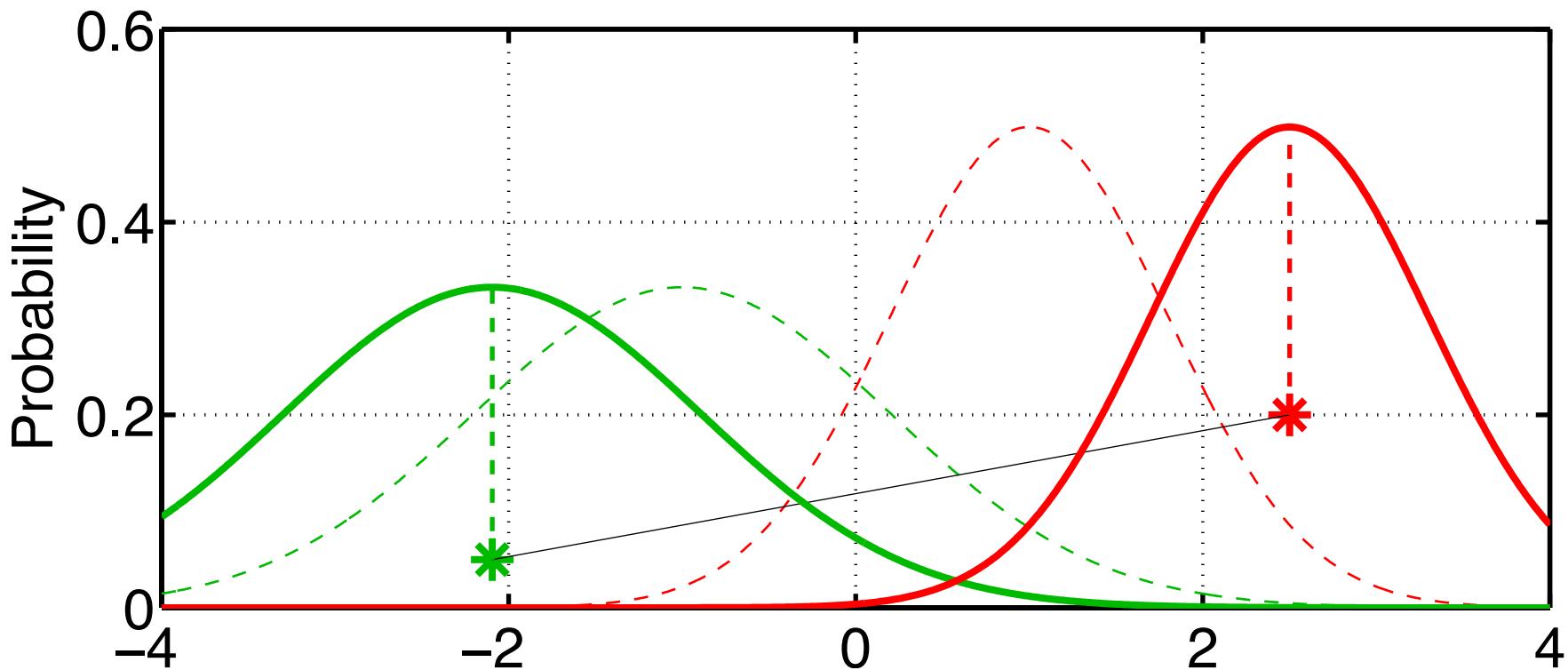
The Ensemble Kalman Filter (Perturbed Observations)

Prior sample standard deviation measures uncertainty of prior mean estimate.



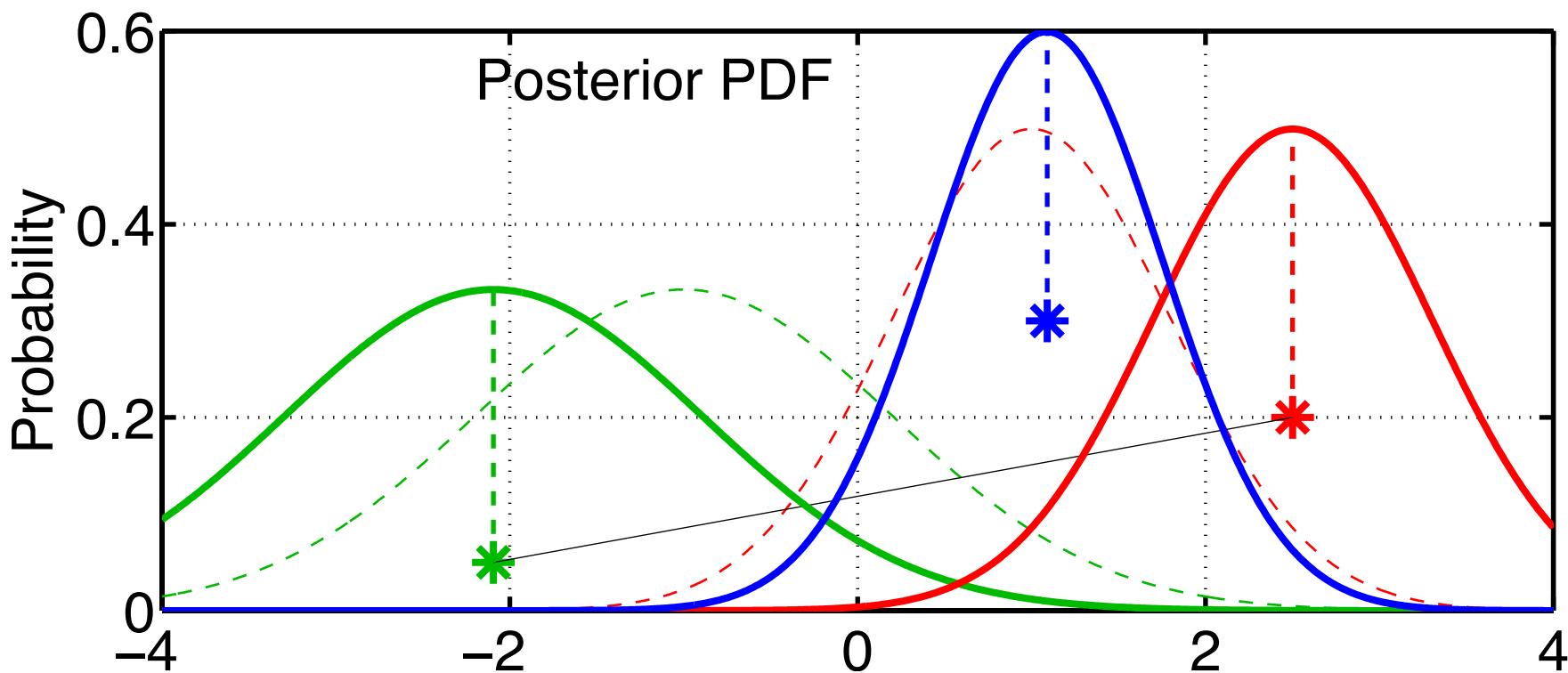
The Ensemble Kalman Filter (Perturbed Observations)

Observation likelihood standard deviation measures the uncertainty of the observation estimate.



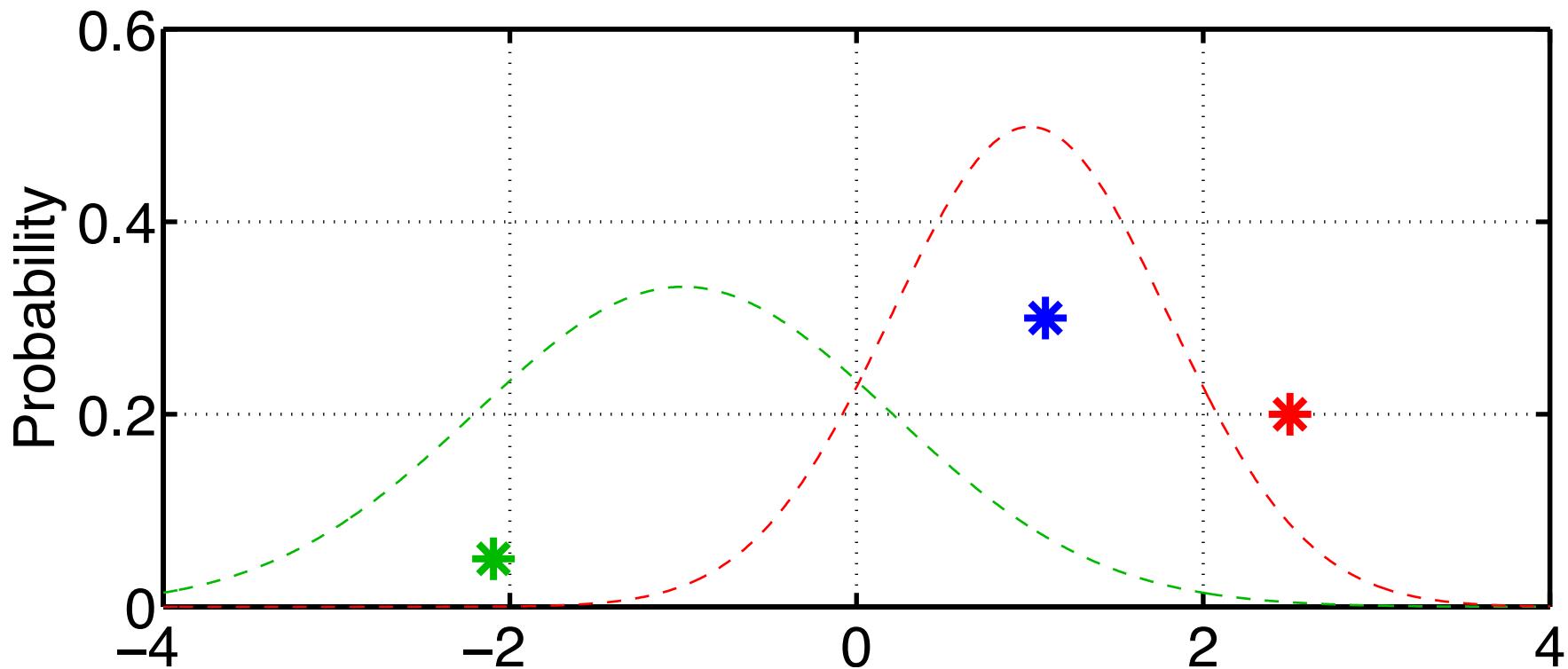
The Ensemble Kalman Filter (Perturbed Observations)

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



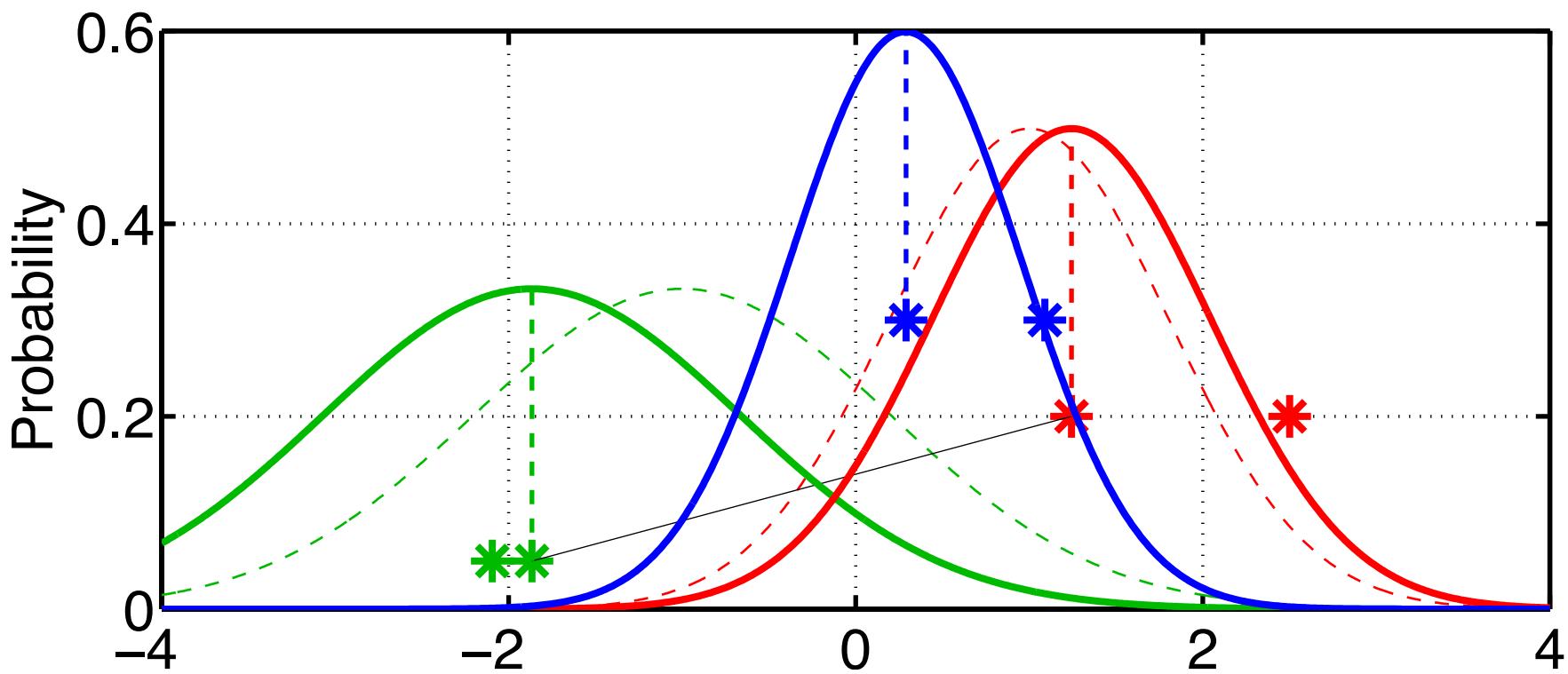
The Ensemble Kalman Filter (Perturbed Observations)

Mean of the product is a random sample of the posterior.
Product of random samples is random sample of product.



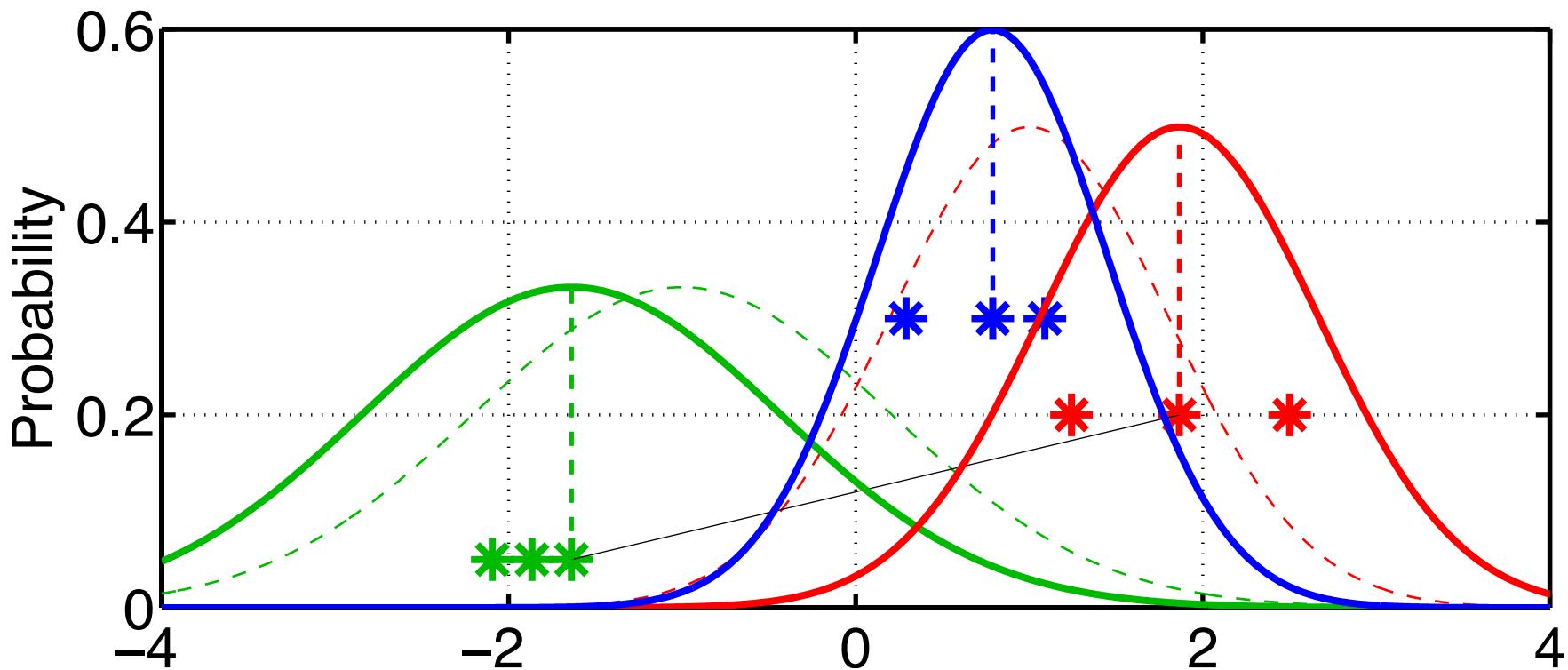
The Ensemble Kalman Filter (Perturbed Observations)

Repeat this operation for every pair of prior and observation.



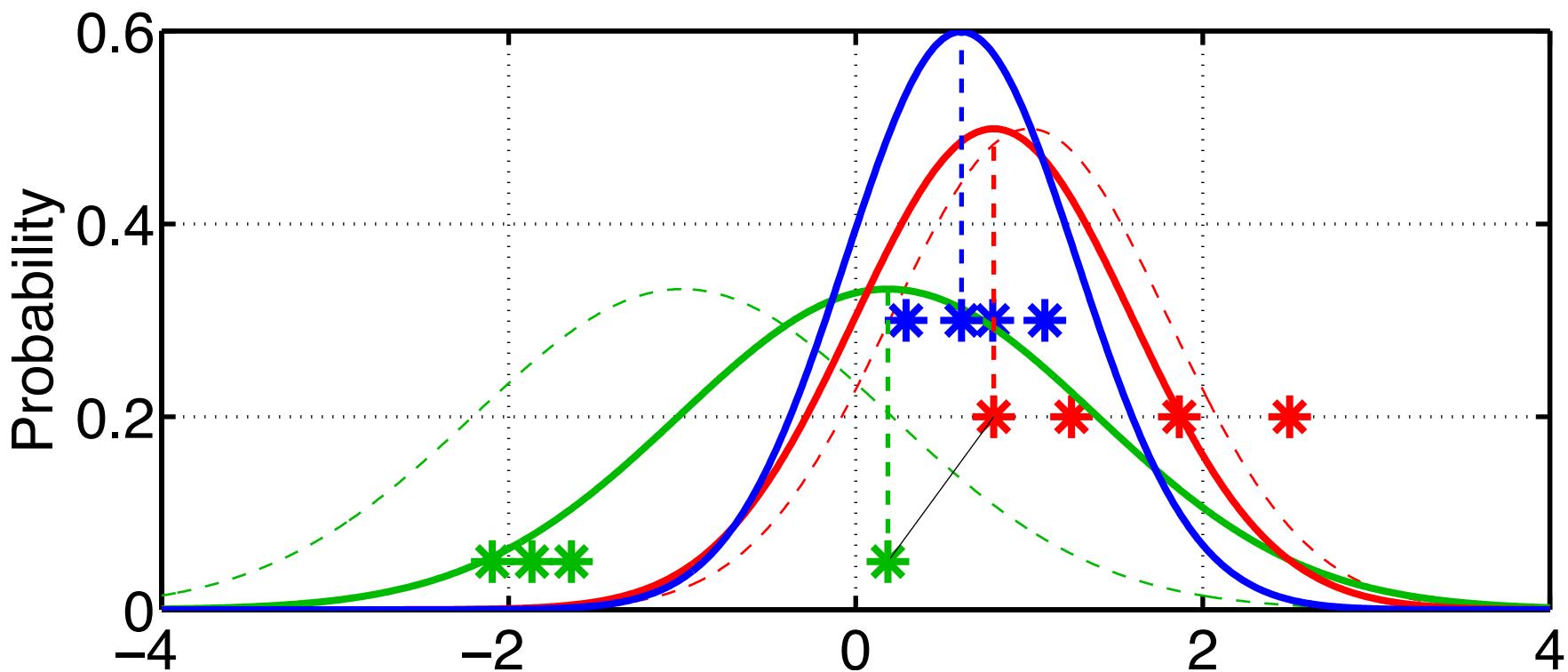
The Ensemble Kalman Filter (Perturbed Observations)

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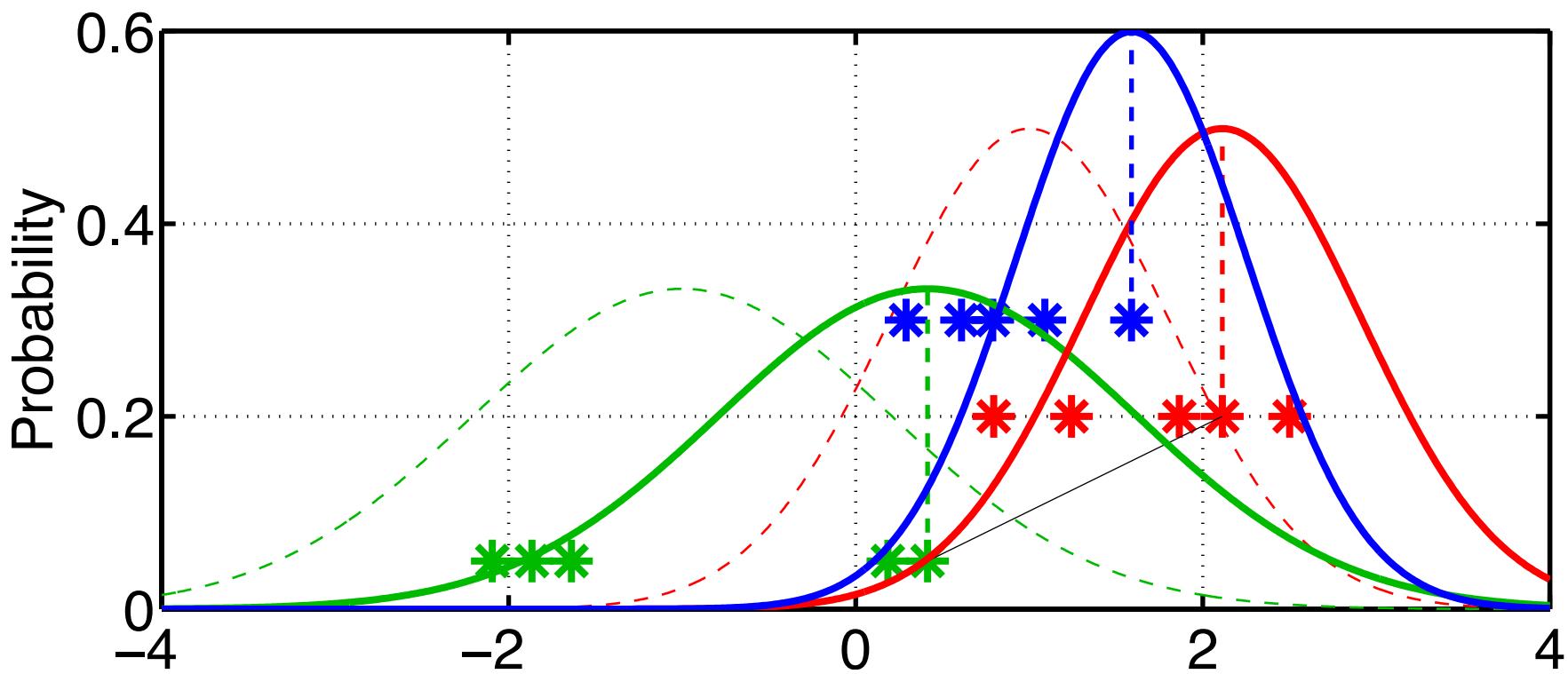
The Ensemble Kalman Filter (Perturbed Observations)

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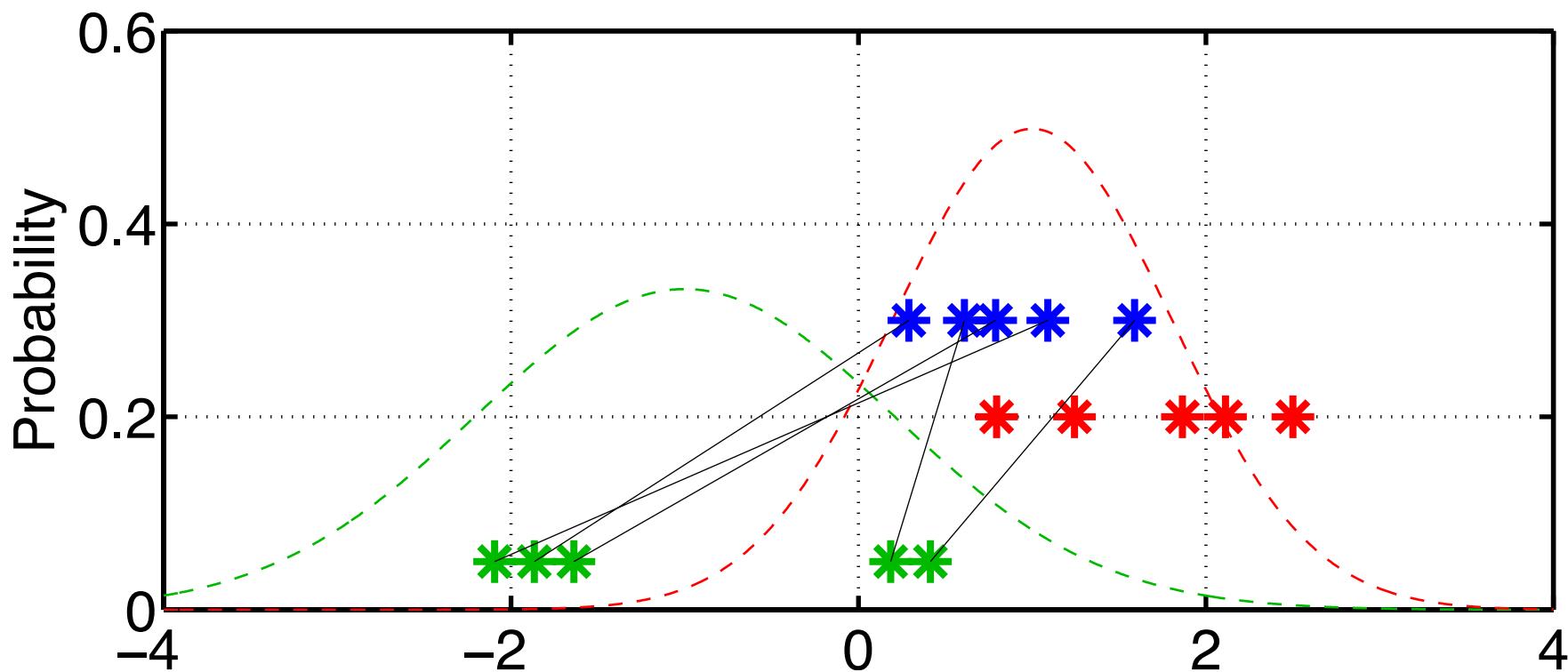
The Ensemble Kalman Filter (Perturbed Observations)

Repeat this operation for every pair of prior and observation.



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 a function of the 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 it produces a different answer each time.

