Ensemble generation and evaluation

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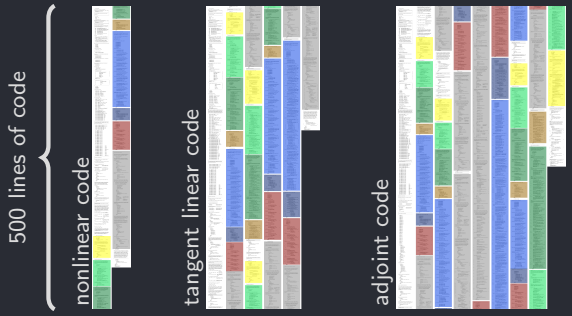
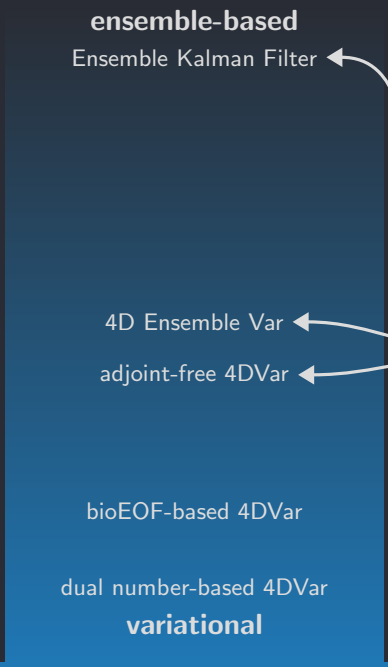
motivation: 4DVar physical+biogeochemical data assimilation for the NEMURO model

- We have successfully applied 4DVar-based data assimilation to the medium complexity (11 variable) NEMURO model and would like to use data assimilation for our regional (37 variable) Darwin model.
- But 4DVar data assimilation requires tangent linear and adjoint code which is difficult and cumbersome to create and maintain:



- We don't want to create adjoint code for Darwin by hand.

a spectrum of data assimilation techniques



- We have been experimenting with a few hybrid data assimilation techniques that combine elements of variational and ensemble-based data assimilation.
- Most of them require ensembles.
- What are good ways to generate ensembles? How can we easily evaluate the quality of an ensemble?

ensembles for data assimilation and beyond

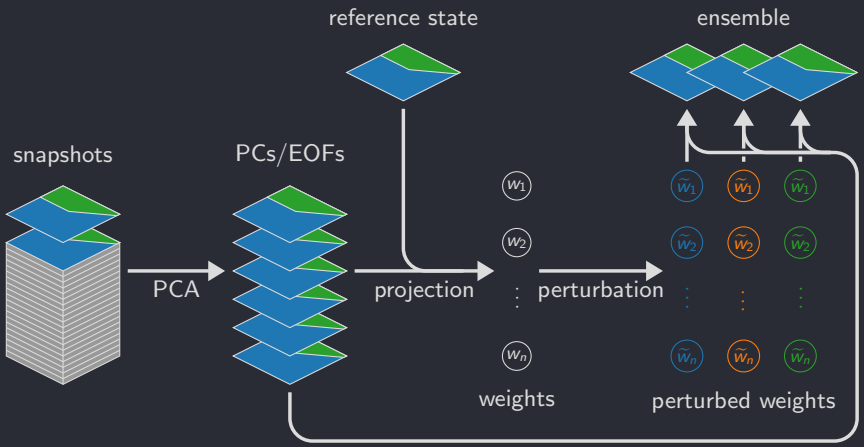
Because ensembles can provide an estimate of model statistics and model uncertainty, ensembles are useful for data assimilation and other applications such as uncertainty analyses.

- While ensembles are easy to generate, creating *good* ensembles can be difficult.
- Reliable estimates of model statistics and hence our data assimilation results rely on *good* ensembles (ensemble quality is dependent on the application).
- We are very interested to learn more about ensemble generation and evaluation: how to generate ensembles and how to assess their quality.

Here, we are mostly interested in ...

- Ensembles for the same model, no multi-model ensembles like those used by the IPCC.
- State estimation, i.e. generating ensembles by varying the initial conditions (and not model parameters, physical forcing, boundary conditions, etc.).

our current approach: PCA-based ensemble generation



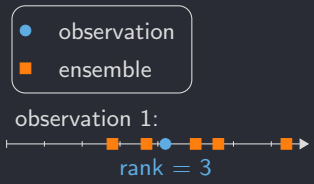
implementation details:

- The snapshots are generated from a long, non-assimilative run.
- The perturbation of weights is based on multiplication with pseudo-random numbers with different distributions (uniform, piece-wise uniform, normal; a positive minimum value is applied to remove negative values).
- Currently we are using 25 leading PCs to generate 25 ensemble members.

ensemble evaluation: rank histograms

- So far, we are mainly using rank histograms to evaluate our ensembles.

ensemble evaluation: rank histograms



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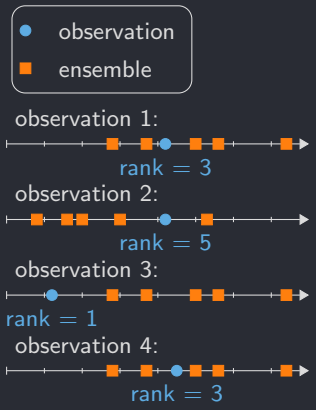

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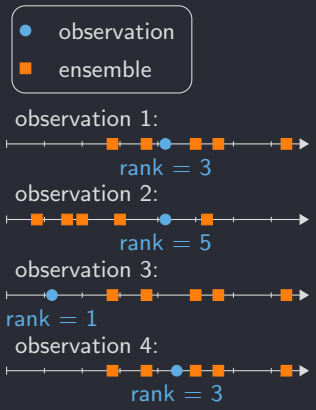

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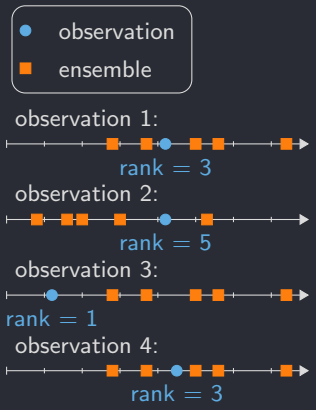

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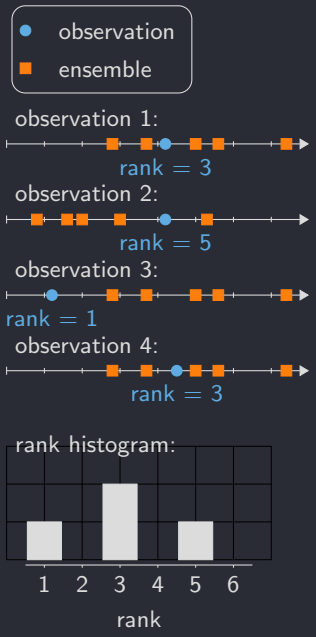

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