

Predictability and Ensemble Forecasting with Lorenz-96 systems

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Training Course 2023

- Part 1: The L96 model, chaos, error growth, ensemble forecast experiments (with a perfect model)
- **Part 2:** How to experiment with L96 using scilab, proposed activities
- Part 3: An imperfect forecast model and the representation of model uncertainties
- Part 4: Proposed activities with an imperfect model

Proposed activities for the perfect model scenario

- ① Initial perturbations and reliability
- ② Accuracy of the analyses and probabilistic skill
- ③ RMS errors of perturbed forecasts, control forecast and ensemble mean
- ④ Ensemble size and its impact on verification metrics
- ⑤ Best ensemble configuration for small ensembles

Initial perturbations and reliability

- Run several experiments with different initial perturbation amplitudes (menu: EPS config. → stdev of init. perturbations)
- Look at some of the verification statistics for these experiments
- Are the initial perturbations important for getting a reliable ensemble forecast?
- Which metrics clearly identify ensembles that are unreliable?
- Compare the CRPS of these experiments. Which experiment has the lowest CRPS?

Accuracy of the analyses and probabilistic skill

- Run a couple of experiments for different analysis error standard deviations (menu: analysis error).
- Remember what you need to do in order to get a reliable ensemble forecast for each analysis error standard deviation.
- Check that each experiment looks like a reliable ensemble forecast.
- Now, compare the CRPS of the different experiments.
- How important is the accuracy of the analysis for ensemble forecasts?

RMS errors of perturbed forecasts, control forecast and ensemble mean

- Go to the default settings (menu: L95settings → reset all)
- Increase the number of cases (50 or more in L95settings → EPS config. → number of forecasts)
- Plot the RMS errors of the forecasts (You can select a single experiment; in select scores → rmse)
- Run another experiment with a significantly smaller standard deviation for the initial perturbations
- Plot the RMS errors for this experiment.
- What initial perturbation amplitude would you choose if you wanted to minimize the RMS error of the perturbed forecasts?
- Does this configuration result in better ensemble forecasts?

Ensemble size and its impact on verification metrics

- Run several experiments for different ensemble sizes. Keep everything else the same.
- Compare the CRPS of these experiments. Get an idea how the probabilistic skill changes with ensemble size.
- Now, plot the fair CRPS (fcrps) for the same experiments.
- What do you notice?
- Next, plot the ensemble stdev and the RMS error of the ensemble mean (menu select scores → spread)
- How well do spread and error agree for the different ensemble sizes?

Best ensemble configuration for small ensembles

- Let us try to determine the best ensemble configuration with a 2-member ensemble. In EPS config. set the ensemble size and increase the number of start dates to 90 (EPS config. → number of forecasts)
- Run experiments with slightly different initial perturbation amplitudes.
- Compare the CRPS of these experiments.
- What ensemble configuration is best, with other words has the lowest CRPS?
- Now, compare the fair CRPS (fcrps) of these experiments. Does the ranking of the experiments change?