On extracting information from closure parameter convergence tests using OpenIFS

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Introduction

- Huge desire to automatize laborious manual tuning of NWP models
- Some algorithmic tuning experiments done without checking properties of the parameter convergence itself (e.g. Ollinaho et al. 2013)
- Some convergence tests done for a specific purpose (Schirber et al. 2013, Aksoy et al. 2006)
- Evaluation of the process itself has not been done thoroughly → this poster shows a rigorous inspection of performance and reliability of convergence tests
- Aspects to consider when designing convergence tests:

1. What optimisation target to use?
2. Which the level of realism to choose for convergence tests?
3. Which test set-up is the most informative?
4. What kinds of problems are likely to be encountered?
5. Can one trust algorithic tuning?

Experiment set-ups and tools

- Closure parameters of the convection scheme
- OpenEPS ensemble prediction system workflow manager
- Tuning algorithms embedded into OpenEPS: EPPES (Järvinen et al. 2011, Laine et al. 2012) and DE (Shemyakin and Haario 2018)
- Optimisation targets: RMS error of Z850 ($RMSE_{Z850}$), Moist total energy norm ΔE_m:

$$\langle \vec{x}', C_{TE}\vec{x}' \rangle = \frac{1}{2}\iint \left[u'^2 + v'^2 + \frac{c_p}{T_r}T'^2 + c_q \frac{L^2}{c_p T_r} q'^2 \right] d\Sigma \frac{\partial p_r}{\partial \eta} d\eta + \frac{1}{2}\int \left[R\frac{T_r}{p_r} \ln p_s'^2 \right] d\Sigma$$

- Fair CRPS (Leutbecher 2018) for measuring the convergence

$$CRPS_{part\ 1} = \frac{1}{M}\sum_{j=1}^{M} |x_j - y| \ ; \ CRPS_{part\ 2} = \frac{1}{2M(M-1)}\sum_{j=1}^{M}\sum_{k=1}^{M} |x_j - x_k|$$

Table 1. Convergence tests with increasing degree of realism; step by step towards genuine model tuning.

	Number of parameters	Different initial conditions	Stochastic physics (SPPT)
Level 0	2	No	No
Level 1	2	Yes	No
Level 2	2	Yes	Yes
Level 3	5	Yes	Yes

References

Aksoy et al. 2006, doi:10.1175/MWR3224.1
Järvinen et al. 2011, doi:10.1002/qj.923
Laine et al. 2012, doi:10.1002/qj.922
Leutbecher 2018, doi: 10.1002/qj.3387
Ollinaho et al. 2013, doi:10.5194/npg-20-1001-2013
Schirber et al. 2013, doi:10.1029/2012MS000167
Shemyakin and Haario 2018, doi:10.1007/s11071-018-4239-5

Results

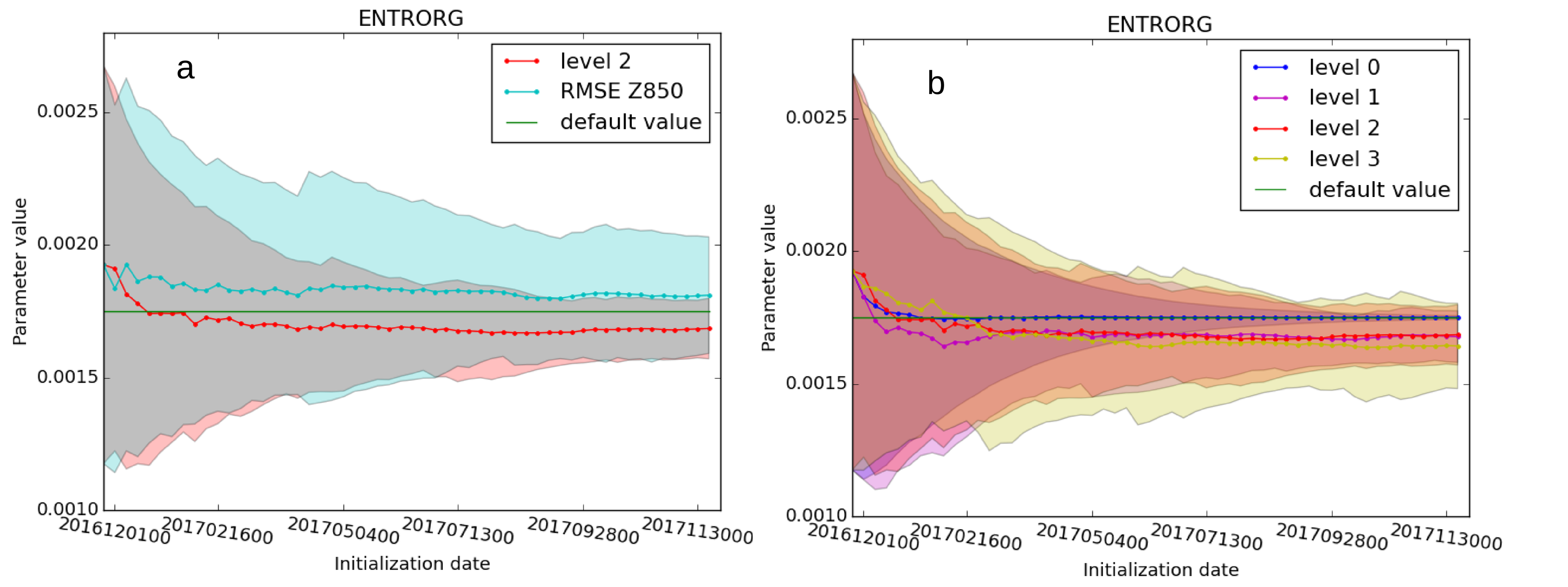

Figure 1. Examples of various convergence tests with EPPES for parameter controlling ENTRainment of deep ORGanized convection. Panel (a) shows effect of different optimisation targets. Otherwise the two experiments are identical. Panel (b) shows effect of increasing degree of realism as in table 1. X-axes refer to the initialization dates of the ensemble forecasts. Default value refers to the control model with fixed parameter values.

- Thorough inspection of level 2 experiments with ENTRORG:

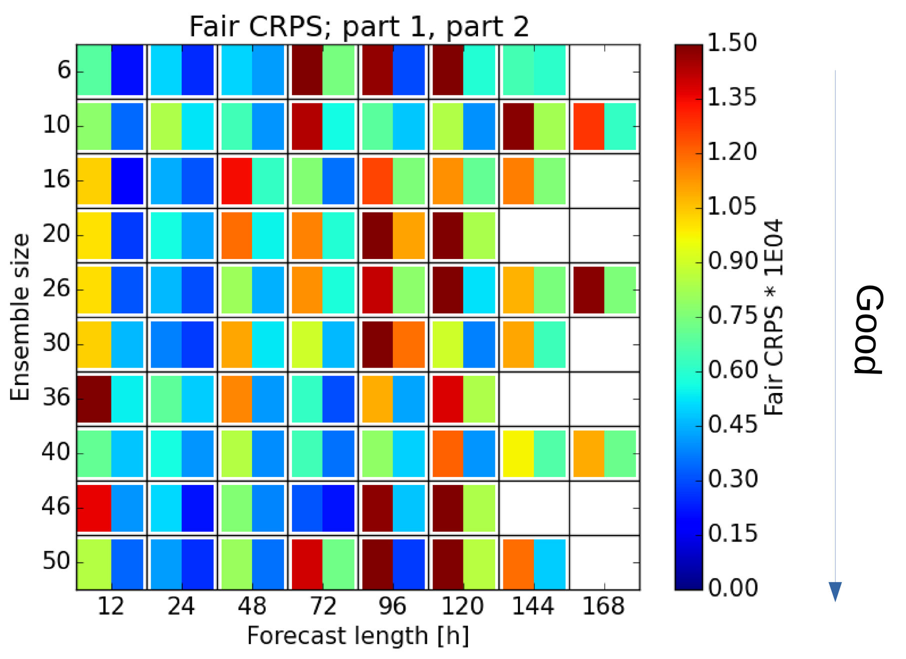

Figure 2. Mean value (left) and spread (right) related components of fair CRPS from the last iteration. Part 1 = distance of mean from default, part 2 = spread of the ensemble. White boxes mean that those experiments have not been done.

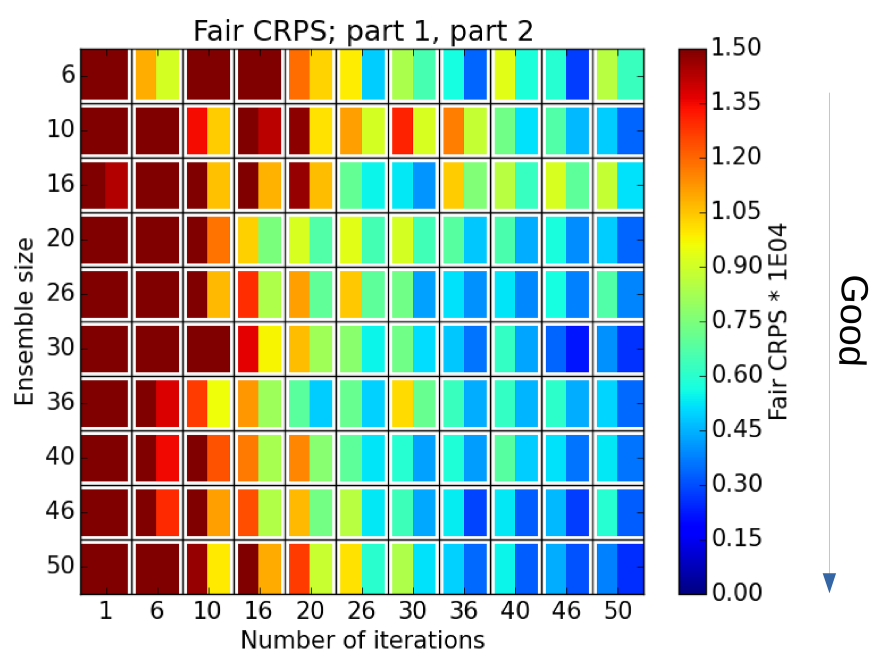

Figure 3. Evolution of convergence tests with the best forecast length of 24 hours. Besides the evolution, this figure also gives information about the best ways to use computational resources.

Conclusions

- Testing with different levels of realism gives information about suitability of the optimisation target to the parameters at hand. Here ΔE_m is more suitable than $RMSE_{Z850}$ (Figure 1). Use as comprehensive optimization target as possible.
- The best forecast length for the chosen 2 convective parameters is 24 hours (Figure 2).
- Convergence with small ensembles may be unstable or parameters may even diverge. Safe but efficient option for 2 parameters is to use ensembles of ~20 members (Figures 2 and 3).
- Problems: convergence can occur in wrong value even with ΔE_m (Figures 1 and 2), and this cannot be easily avoided with different algorithms.
- Based on our results we recommend to be cautious when using algorithmic tuning without supervision. However, we think that it is still able to extract information from parameter space.

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