SPECIAL PROJECT FINAL REPORT

All the following mandatory information needs to be provided.

Project Title:	The Impact of Stochastic Parametrisations in Climate Models: EC-EARTH System Development and Application
Computer Project Account:	spgbtpsp
Start Year - End Year :	2015 - 2018
Principal Investigator(s)	Tim Palmer
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Other Researchers (Name/Affiliation):	Kristian Strommen Hannah Christensen Stephan Juricke Dave MacLeod Atmospheric Physics, Oxford.

This template is available at:
http://www.ecmwf.int/en/computing/access-computing-facilities/forms

The following should cover the entire project duration.

Summary of project objectives
(10 lines max)

The aim of the special project was to implement a suite of new stochastic schemes into the EC-EARTH coupled climate model, and then begin to evaluate the impact of these schemes on the model mean state, variability, and further second order diagnostics. The ultimate goal was to introduce a level of stochasticity into each component: atmosphere, land and ocean, thereby creating a fully stochastic climate model.

Summary of problems encountered
(If you encountered any problems of a more technical nature, please describe them here.)

No notable technical hurdles were encountered other than those expected from debugging of our own new code.

Experience with the Special Project framework
(Please let us know about your experience with administrative aspects like the application procedure, progress reporting etc.)

Our experience with the administrative side of the project was excellent. Both application and progress reporting was very transparent and straight forwardly handled. Technical support was outstanding during the entire duration of the project, with swift and thorough communication that was invaluable at critical moments. Great levels of accommodation was shown on issues to do with storage of output on tape, allowing our group as a whole to adopt a unified aproach to handling the large volume of model output. We are overall very happy with our interactions with ECMWF.

Summary of results
(This section should comprise up to 10 pages and can be replaced by a short summary plus an existing scientific report on the project.)

During the course of this project, we implemented several new stochastic schemes in EC-Earth. In the atmosphere, a more flexible version of the already-in-place `SPPT' scheme, dubbed `Independent SPPT' (or ISPPT) was implemented. In the H-TESSEL land-scheme, a stochastic scheme was added which perturbs highly uncertain soil parameters in the model. In the ocean, stochasticity was added to multiple components of the NEMO model used in EC-Earth, including drag processes, ocean mixing and sea-ice parameters. The impact of all of these schemes have been tested in various contexts individually, and were found to have a positive impact on multiple areas.

A unified comparison of the impact of these schemes on the mean-state of EC-Earth is included in the attached scientific report (`Introducing the Probabilistic Earth-System Model'), which includes details on the new schemes and an evaluation on basic mean quantities, the energy budget, the hydrological budget and atmospheric circulation.

This scientific report is submitted for publication and therefore is not currently available publicly. However, the draft paper is available upon request in the meantime (please contact kristian.strommen@physics.ox.ac.uk).

The results from this special project are already being fed into our calibration of the fully stochastic EC-Earth, which will be tested in the context of the upcoming PRIMAVERA project.

List of publications/reports from the project with complete references

Strommen, K., Christensen, H., Juricke, S., MacLeod, D.: Introducing the Probabilistic Earth-System Model, in preparation (2018)

Juricke, S., Palmer, T.N., Zanna, L., Juricke, S., Palmer, T.N., Zanna, L.: Stochastic sub-grid scale ocean mixing: Impacts on low frequency variability. Journal of Climate pp. JCLI–D–16–0539.1 (2017). DOI 10.1175/JCLI-D-16-0539.1

Macleod, D.A., Cloke, H.L., Pappenberger, F., Weisheimer, A.: Improved seasonal prediction of the hot summer of 2003 over Europe through better representation of uncertainty in the land surface. Quarterly Journal of the Royal Meteorological Society 142(694), 79–90 (2016). DOI 10.1002/qj.2631

Christensen, H.M., Lock, S.J., Moroz, I.M., Palmer, T.N.: Introducing independent patterns into the Stochastically Perturbed Parametrization Tendencies (SPPT) scheme. Quarterly Journal of the Royal Meteorological Society 143(706), 2168–2181 (2017). DOI 10.1002/qj.3075

Future plans

(Please let us know of any imminent plans regarding a continuation of this research activity, in particular if they are linked to another/new Special Project.)

This special project has already been continued under the same name. The goal of the next project is to use the results of this completed project to more carefully tune the EC-Earth model in its fully stochastic state, and then evaluate more second-order diagnostic impacts. We aim to in particular focus on the evaluation of North Atlantic regimes, ENSO and the Asian summer monsoon.