Meteorologische Zeitschrift, Vol. 25, No. 6, 629–630

Editorial

Verification and process oriented validation of the MiKlip decadal prediction system

Frank Kaspar[1*], Henning W. Rust[2], Uwe Ulbrich[2] and Paul Becker[1]

[1]Deutscher Wetterdienst, Geschäftsbereich Klima und Umwelt, Germany
[2]Institut für Meteorologie, Freie Universität Berlin, Germany

Abstract

Decadal prediction systems are designed to become a valuable tool for decision making in different sectors of economy, administration or politics. Progress in decadal predictions is also expected to improve our scientific understanding of the climate system. The German Federal Ministry for Education and Research (BMBF) therefore funds the German national research project MiKlip (Mittelfristige Klimaprognosen). A network of German research institutions contributes to the development of the system by conducting individual research projects. This special issue presents a collection of papers with results of the evaluation activities within the first phase of MiKlip. They document the improvements of the MiKlip decadal prediction system which were achieved during the first phase. Key aspects are the role of initialization strategies, model resolution or ensemble size. Additional topics are the evaluation of specific weather parameters in selected regions and the use of specific observational datasets for the evaluation.

Editorial

Decadal predictions of climate operate at time scales between seasonal forecasts and the centennial scale climate scenario computations. They are designed to become a valuable tool for decision making in different sectors of economy, administration or politics. From a natural science viewpoint, progress in decadal predictions is expected to improve our understanding of the climate system, and its realization in numerical models. The German Ministry for Education and Research (BMBF) therefore funds the German national research project MiKlip (Mittelfristige Klimaprognosen), running over two funding periods (2011–2015 and 2015–2019). The initiative is organized in 5 modules: Initialisation (A), Processes and Modelling (B), Regionalisation (C), Synthesis (D) and Evaluation (E). A network of German research institutions contributes to the development of the system by conducting individual research projects under the module-umbrellas. Using the Earth System Model of the Max-Planck-Institute for Meteorology (MPI-ESM) as a basis, a system suitable for operational use under the auspices of Germany's national meteorological service DWD is the ultimate goal.

This special issue presents a collection of papers with results of the evaluation activities conducted within the first phase of the MiKlip project, while a summary of the scientific, strategic, and structural lessons learned is provided in an overview paper by Marotzke et al. (2016). They aim at a comprehensive assessment of the quality of the system's predictions, which is a prerequisite for its operational application. This quality is assessed by performing retrospective predictions (so-called hindcasts) and by evaluating them against the observed climate evolution. The module was structured into the following main pillars: i) generation of observational data sets and their use for an improved validation of hindcasts, ii) hindcast verification, i.e. the development and implementation of procedures for a quantitative estimation of forecast quality, and iii) process-oriented validation to enhance the understanding and thus the credibility of the prediction system and its products.

Within the first phase of MiKlip three generations of the prediction systems with alternative initialization procedures have been developed and tested. The later generations showed an improvement in hindcast skill for surface temperature (Marotzke et al., 2016). Several papers in this special issue evaluate the improvement in prediction skill between these three generations. Further overarching topics of the contributions to this issue are the impact of model resolution and ensemble size on the predictive skill:

Kadow et al. (2015) evaluate temperature and precipitation forecasts with respect to ensemble mean and ensemble spread proposing an extension to the verification framework from Goddard et al. (2013). They show that initialization improves the forecast skill compared to the so-called historical runs, simulating climate development under prescribed greenhouse gas and aerosol forcings, but with an arbitrary initial state of the ocean. At the same time, they show an improvement of skill with increased ensemble size. Sienz et al. (2016) demonstrate that small sample sizes hamper the detection of predictive skill and provide recommendations on the sample size. Stolzenberger et al. (2015) apply probabilistic measures for the evaluation of decadal predictions and compare the impact of the initialization strategies for predictability of a set of selected three-dimensional atmospheric variables.

*Corresponding author: Frank Kaspar, Deutscher Wetterdienst, Frankfurter Str. 135, 63067 Offenbach, Germany, frank.kaspar@dwd.de

DOI 10.1127/metz/2016/0831
Gebrüder Borntraeger Science Publishers, Stuttgart, www.borntraeger-cramer.com

Four papers of this issue focus on the use of specific observational datasets for the evaluation of the MiKlip system: Schmidt et al. (2015) use GPS radio occultations to validate the simulated temperatures in the upper troposphere and lower stratosphere region. Using these datasets, they also confirm an improvement in skill in the initialized hindcasts when compared to uninitialized climate simulations. Another non-standard dataset of particular relevance to decadal climate changes is developed and applied by Zhang et al. (2015). They compute terrestrial water storage derived from time-variations in the gravity field as observed by the GRACE mission, comparing the results with those from the prediction system. Spangehl et al. (2015) use satellite-derived cloud parameters and find evidence for the predictability of the total cloud cover, e.g. for parts of the equatorial to mid-latitudinal North Atlantic. Pattantyús-Ábrahám et al. (2016) use quality controlled and homogenized radiosonde observations over Europe. They find evidence for small improvements in hindcasted tropospheric temperatures when comparing the alternative initialization strategies.

Some of the papers consider specific weather parameters in selected regions: Kruschke et al. (2015) evaluate the prediction skill regarding Northern Hemispheric winter storms using a modification of the rank probability skill score accounting for small ensemble sizes. Haas et al. (2015) apply a statistical-dynamical downscaling approach to the hindcasts and analyze the predictability of regional-scale peak winds over Europe. Pistotnik et al. (2016) validate convective parameters over Europe. Babian et al. (2016) evaluate to what extent the Antarctic Oscillation and related precipitation is represented in the model. Kothe et al. (2016) analyze the impact of soil initialization strategies for the regionalisation component of MiKlip by assessing the predictions against 2-meter-temperature and precipitation observations. They show that decadal climate predictions systems with sophisticated soil initialization schemes have the potential to make use of the soil's long term memory.

The papers in this issue clearly document the improvements of the MiKlip decadal prediction system which were achieved during the first phase of the project. They provide hints for setting up an ensemble system and illustrate methodologies for the evaluation against a variety of observational data. The papers collected in this special issue thus provide an insight into how evaluation activities of the German climate research community contribute to the development of the MiKlip system.

References

Babian, S., H.W. Rust, J. Grieger, K. Prömmel, U. Cubasch, 2016: Representation of the Antarctic Oscillation and related precipitation patterns in the MPI Earth System Model. – Meteorol. Z. **25**, 776–774, DOI:10.1127/metz/2016/0661.

Goddard, L., A. Kumar, A. Solomon, D. Smith, G. Boer, P. Gonzalez, V. Kharin, W. Merryfield, C. Deser, S.J. Mason, B.P. Kirtman, R. Msadek, R. Sutton, E. Hawkins, T. Fricker, G. Hegerl, C.A. T. Ferro, D.B. Stephenson, G.A. Meehl, T. Stockdale, R. Burgman, A.M. Greene, Y. Kushnir, M. Newman, J. Carton, I. Fukumori, T. Delworth, 2013: A verification framework for interannual-to-decadal predictions experiments. – Climate Dyn. **40**, 245–272, DOI: 10.1007/s00382-012-1481-2.

Haas, R., M. Reyers, J.G. Pinto, 2015: Decadal predictability of regional-scale peak winds over Europe using the Earth System Model of the Max-Planck-Institute for Meteorology. – Meteorol. Z. **25**, 739–752, DOI:10.1127/metz/2015/0583.

Kadow, C., S. Illing, O. Kunst, H.W. Rust, H. Pohlmann, W.A. Müller, U. Cubasch, 2015: Evaluation of forecasts by accuracy and spread in the MiKlip decadal climate prediction system. – Meteorol. Z. **25**, 631–643, DOI:10.1127/metz/2015/0639.

Kothe, S., J. Tödter, B. Ahrens, 2016: Strategies for soil initialization of regional decadal climate predictions. – Meteorol. Z. **25**, 775–794, DOI:10:1127/metz/2016/0729

Kruschke, T., H.W. Rust, C. Kadow, W.A. Müller, H. Pohlmann, G.C. Leckebusch, U. Ulbrich, 2015: Probabilistic evaluation of decadal prediction skill regarding Northern Hemisphere winter storms. – Meteorol. Z. **25**, 721–738, DOI: 10.1127/metz/2015/0641.

Marotzke, J., W. Müller, F. Vamborg, P. Becker, U. Cubasch, H. Feldmann, F. Kaspar, C. Kottmeier, C. Marini, I. Polkova, K. Prömmel, H. Rust, D. Stammer, U. Ulbrich, C. Kadow, A. Köhl, J. Kröger, T. Kruschke, J. Pinto, H. Pohlmann, M. Reyers, M. Schröder, F. Sienz, C. Timmreck, M. Ziese, 2016: MiKlip – a National Research Project on Decadal Climate Prediction. – Bull. Amer. Meteor. Soc., published online. DOI:10.1175/BAMS-D-15-00184.1.

Pattantyús-Ábrahám, M., C. Kadow, S. Illing, W.A. Müller, H. Pohlmann W. Steinbrecht, 2016: Bias and Drift of the Mid-range Decadal Climate Prediction System (MiKlip) validated by European Radiosonde Data. – Meteorol. Z. **25**, 709–720, DOI:10.1127/metz/2016/0803.

Pistotnik, G., P. Groenemeijer, R. Sausen, 2016: Validation of Convective Parameters in MPI-ESM Decadal Hindcasts (1971–2012) against ERA-Interim Reanalyses. – Meteorol. Z., **25**, 753–766, DOI:10.1127/metz/2016/0649.

Schmidt, T., L. Schoon, H. Dobslaw, K. Matthes, M. Thomas, J. Wickert, 2015: UTLS temperature validation of MPI-ESM decadal hindcast experiments with GPS radio occultations. – Meteorol. Z., **25**, 673–683, DOI:10.1127/metz/2015/0601.

Sienz, F., W.A. Müller, H. Pohlmann, 2016: Ensemble size impact on the decadal predictive skill assessment. Meteor – Meteorol. Z., **25**, 645–655, DOI:10.1127/metz/2016/0670.

Spangehl, T., M. Schröder, S. Stolzenberger, R. Glowienka-Hense, A. Mazurkiewicz, A. Hense, 2015: Evaluation of the MiKlip decadal prediction system using satellite based cloud products. – Meteorol. Z., **25**, 695–707, DOI: 10.1127/metz/2015/0602.

Stolzenberger, S., R. Glowienka-Hense, T. Spangehl, M. Schröder, A. Mazurkiewicz, A. Hense, 2015: Revealing skill of the MiKlip decadal prediction system by three-dimensional probabilistic evaluation. – Meteorol. Z., **25**, 657–671, DOI: 10.1127/metz/2015/0606.

Zhang, L., H. Dobslaw, C. Dahle, I. Sasgen, M. Thomas, 2015: Validation of MPI-ESM Decadal Hindcast Experiments with Terrestrial Water Storage Variations as Observed by the GRACE Satellite Mission. – Meteorol. Z., **25**, 685–694, DOI: 10.1127/metz/2015/0596.