Project: **763 (old DKRZ project id 763, 775, 800)**

Project title: **MiKlip II Module E – Evaluation of the MiKlip Decadal Prediction System**

Project lead: **Marc Schröder, Thomas Spangehl, Wolfgang Müller, Ingo Kirchner, Henning Rust, Uwe Ulbrich**

Report period: **1.1.2014 - 31.12.2015**

Reporter: Thomas Spangehl, Marc Schröder, Kathrin Graw, Andreas Hense, Frank Sienz, Wolfgang Müller, Ines Höschel, Ingo Kirchner

WP1 (WPE-8 PROVESIMAC, formerly VECAP, DKRZ project id 763)

Old project title: **Verification, Calibration and Assessment of Predictability of medium-range climate predictions using satellite data**

Project lead: **Marc Schröder**

Report period: **1.1.2014 - 31.12.2015**

Reporter: Thomas Spangehl, Kathrin Graw, Marc Schröder, Andreas Hense

Description of Work and Summary of Results

The VeCAP project focuses on the evaluation of the decadal climate prediction system developed within MiKlip (research programme funded by Federal Ministry of Education and Research in Germany, BMBF, http://www.fona-miklip.de/) utilizing satellite data. Satellite simulators for usage with MPI-ESM have been developed for the Topical Rainfall Measuring Mission precipitation radar (TRMM PR) and for the Infrared Atmospheric Sounding Interferometer (IASI) utilizing the CFMIP Observation Simulator Package (COSP, Bodas-Salcedo et al., 2011). The simulators were applied to MiKlip hindcast simulations. Additionally, the ISCCP simulator has been used to facilitate the evaluation of clouds in the MiKlip system (results published in Spangehl et al., 2015). The required model output for the application of the TRMM PR simulator to the MiKlip prototype system was provided by MiKlip Module D (DKRZ project id 826). Results for TRMM PR were presented on the AGU Fall Meeting 2014 and on the 26th International Union of Geodesy and Geophysics (IUGG) General Assembly 2015. Moreover, MPI-ESM was used to generate model output on satellite curtains (i.e. satellite orbit tracks projected onto the model grid) required to apply the IASI simulator to a subset of the MiKlip baseline-1 hindcasts. The simulator itself was run on the MiKlip server, i.e. no granted resources were required to run the simulator. Results for the brightness temperature (TB) of the 11.1 µm window channel indicate that the simulator captures the main structure of the observed geographical structure such as the low temperatures over the ice sheets and the maximum TBs in the sub-tropical to tropical area (Fig. 1a, b).

Overview of Experiments performed by WP 1

Description	Model configuration	Number of years	CPU h
MiKlip Baseline-1-LR hindcast ensemble start year 2008	MPI-ESM-LR with COSP module for IASI	50	18500
MiKlip Baseline-0 and Baseline-1-LR test simulations	MPI-ESM-LR with COSP module for IASI	~40	13500
MiKlip Baseline-1-LR, extension of ensemble simulations performed in 2013 and post-processing	MPI-ESM-LR with COSP module for TRMM-PR and ISCCP simulator	~130	30000
			Total: 62000

Table 1: Overview of simulations performed by WP 1.

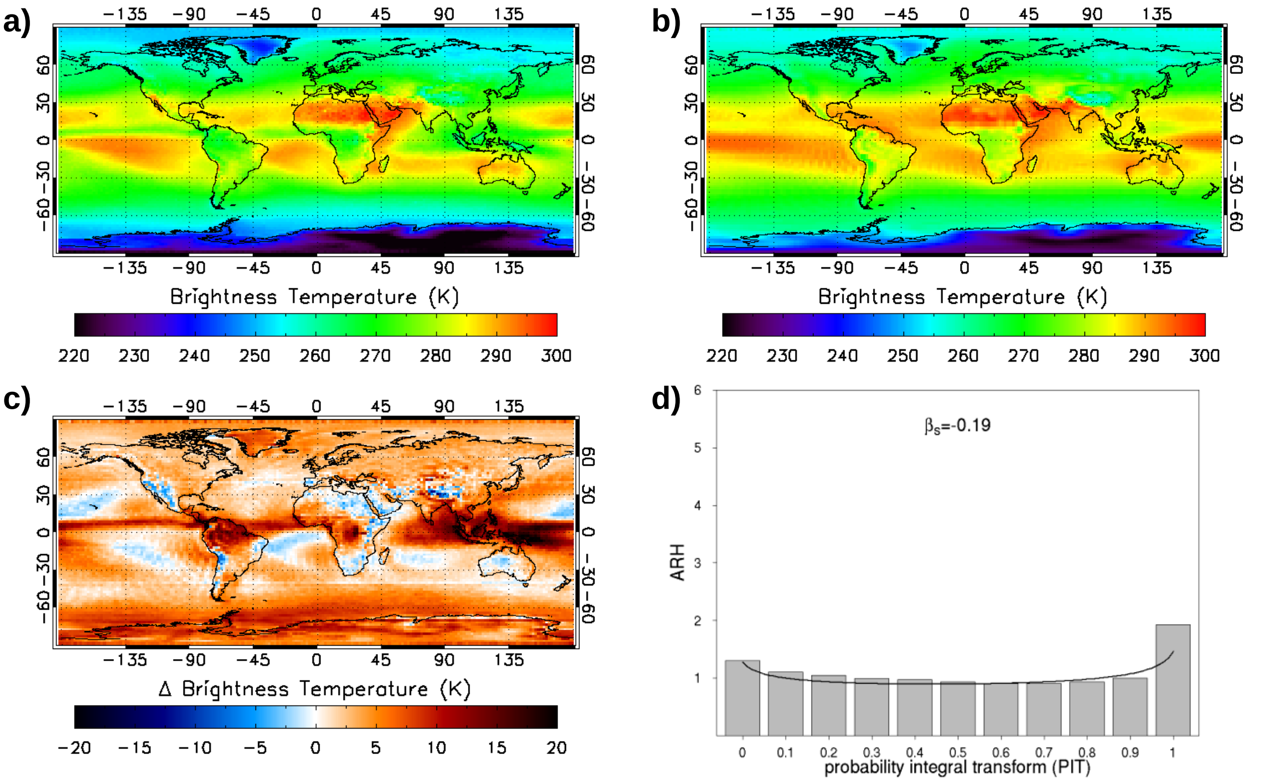

Figure 1: IASI brightness temperature of the 11.1 µm channel covering the period 2008-2012 for (a) observations, (b) COSP IASI satellite simulator (c) difference between simulator and observations and (d) ß-score after Keller and Hense (2011). The COSP IASI satellite simulator results are based on a 10 member ensemble initialized in 2008 constituting a small subset of the MiKlip baseline-1 hindcasts.

The global mean difference between the simulator and the observations for the 11.1 µm channel is 3.8 K. Smaller global mean differences are found for other channels such as -1.0 K for the 15.1 µm channel and 1.3 K for the 7.6 µm channel. Larger deviations are found on the regional scale where maximum deviations of up to 25 K stick out in the tropics for the 11.1 µm channel (Fig. 1c). These higher modelled TBs in the tropics compared to the IASI observations can imply that either the clouds are simulated too low, too thin or too few by the model. Ensemble evaluation for lead years 1-5 covering the period 2008 - 2012 using the ß-score (Keller and Hense, 2011) indicate that the ensemble is slightly underdispersive w.r.t. the TB of the 11.1 µm channel (Fig. 1d), i.e. the negative ß-score suggests that the ensemble spread is too low compared to observations.

References

Bodas-Salcedo, A., and Coauthos, 2011: COSP: Satellite simulation software for model assessment. Bull. Amer. Meteor. Soc., 92, 1023-1043, doi: http://dx.doi.org/10.1175/2011BAMS2856.1.

Keller, J. D., and A. Hense, 2011: A new non-Gaussian evaluation method for ensemble forecasts based on analysis rank histograms. Meteorol. Z., 20, 107-119, doi: 10.1127/0941-2948/2011/0217.

Related own Publications and Contributions to Conferences

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

Contributions to Conferences:

Spangehl, T., M. Schröder, A. Bodas-Salcedo, S. Stolzenberger, K. Graw, R. Glowienka-Hense, A. Hense, R. Hollmann, 2015: Evaluation of decadal predictions using a satellite simulator for the Tropical Rainfall Measuring Mission precipitation radar. 26th IUGG General Assembly 2015, *Prague, Czech Republic, June 22 – July 2 2015,* #IUGG-4389.

Spangehl, T., M. Schröder, A. Bodas-Salcedo, 2014: Climate Model Evaluation Using a Satellite Simulator for TRMM PR. AGU Fall Meeting, *San Francisco, USA, 15-19 December, 2014,* FM14-A42E-03.

WP2 (WPE-6, DROUGHTCLIP, formerly DROUGHTCLIP, DKRZ project id 775)

Old project title: **Prediction of Multi-year Droughts**

Project lead: **Wolfgang Müller**

Report period: **1.1.2014 - 31.12.2015**

Reporter: Frank Sienz, Wolfgang Müller

Principal aim

The basic deliverable for DroughtClip is the preparation of extended hindcast experiments covering the time period of the entire 20th century. These experiments enable the predictive skill analysis of historical climate events. Special emphasis is the potential prediction of long-term historical droughts, including the Dust Bowl in the central US during the 1930s. Additionally, the extended range hindcast experiments contribute to a better understanding about necessary hindcast sample size requirements for robust skill estimation. Therewith, the outcomes serve the development of validation strategies and further provide benchmarks and minimal requirements for the decadal prediction system.
For a more detailed description we refer to our application for resources for the year 2013 and the project reports 2012 and 2013.

Benchmarks achieved during the first phase of MiKlip (2012-2015)

For the first time, retrospective predictions back to 1901 have been performed with a dynamical model. Until now, three hindcast experiments are completed with a yearly initialisation from 1901 to 2010. The model runs are made available to all MIKLIP members and to the EU FP7 project SPECS.
The oceanic starting conditions are obtained by forcing the MPIOM ocean model with the NOAA/OAR/ESRL PSD 20th century reanalysis (20CR; Compo et al. (2011)). The resulting salinity and temperature fields are assimilated subsequently into MPI-ESM-LR (Müller et al. 2014a). The results demonstrate the successfull extension of the hindcast time period. The initialised year 2 to 5 predictions of the North-Atlanic SST outperform the unitialised runs in their ability to reproduce the higher temperatures in 1930s and 1940s, as well as the cold phase during the 1970s. This closer correspondence is accompanied by higher skill scores, not only present for years 2 to 5, but also for higher lead times (Müller et al., 2014b). A comparison between the extended hindcast and the reduced time period from 1960 to 2010 reveals an enlargement of surface temperature correlations. Therefore the longer time period can help to establish a better represention of regions with predictive skill. Finally, the predictions capture the 1920s climate variation and its impact for the North Atlantic and European summer temperatures (Müller et al., 2014b).

References

Compo, G. P. et al., 2011: The twentieth century reanalysis project. Q. J. R. Meteorol. Soc., 137, 1-28.

Müller W. A., D. Matei, M. Bersch, J. H. Jungclaus, H. Haak, K. Lohmann,G. P. Compo, and J. Marotzke, 2014a: A 20th-century reanalysis forced ocean model to reconstruct North Atlantic climate variation during the 1920s. Climate Dynamics. doi:10.1007/s00382-014-2267-5

Müller, W. A., H. Pohlmann, F. Sienz, D. Smith, 2014b: Decadal climate predictions for the period 1901-2010 with a coupled climate model. Geophys. Res. Lett., 41, 2100-2107. doi:10.1002/2014GL059259.

WP3 (WPE-4, STOC, formerly VESPA, DKRZ project id 800)

Old project title: **Untersuchungen zur mittelfristigen Vorhersage von Extremereignissen**

Project lead: **Ingo Kirchner**

Report period: **1.1.2014 - 31.12.2015**

Reporter: Ines Höschel, Ingo Kirchner

Project overview

The aim oft the research programme MiKlip (http://www.fona-miklip.de/) which is funded by the Federal Ministry of Education and Research in Germany (BMBF) is the development of a decadal prediction system.
From the end-user's perspective decadal predictions are of relevance since they close the gap between seasonal forecasts and future climate change projections of the 21st century.
The MiKlip subproject VESPA aims at an identification and further analysis of meteorological processes which are relevant for the generation of decadal climate variability in the observations and the MiKlip forecast system. Such processes (e.g. related to AMO, PDO) form the basis for potential predictability on the decadal time-scale. The focus is on the identification of variability and predictability of hydro-meteorological extremes (e.g. winter storms, floods, thunderstorms, hail, droughts) for Central Europe and North Africa.

Summary of work

After adaptation of the planned simulations to the granted computing resources and under consideration of the experiments proposed by CLIVAR Drought Initiative the idealized simulations listed in Table 2 were performed.

AMO-conditions, model resolution	**Model years**	**Boundary conditions**
Boundary conditions cf. Schubert et al. 2009		
Warm, LR + 1 day	40	Fig. 2a) + climatology
Warm, LR + 2 day	40	Fig. 2a) + climatology
Warm, LR + 3 day	40	Fig. 2a) + climatology
Warm, LR + 4 day	40	Fig. 2a) + climatology
Cold, LR + 1 day	40	Fig. 2b) + climatology
Cold, LR + 2 day	40	Fig. 2b) + climatology
Cold, LR + 3 day	40	Fig. 2b) + climatology
Cold, LR + 4 day	40	Fig. 2b) + climatology
Neutral, LR + 1 day	40	Climatology
Neutral, LR + 2 day	40	Climatology
Neutral, LR + 3 day	40	Climatology
Neutral, LR + 4 day	40	Climatology
	Sum: 480	

Table 2 *: Simulations performed by WP 3 at DKRZ in 2014/2015.*

Simulations were performed with the atmosphere model version echam-6.1.02p1 of the MiKlip systems in T63L47(LR) resolution with differing oceanic boundary conditions according to AMV phases.

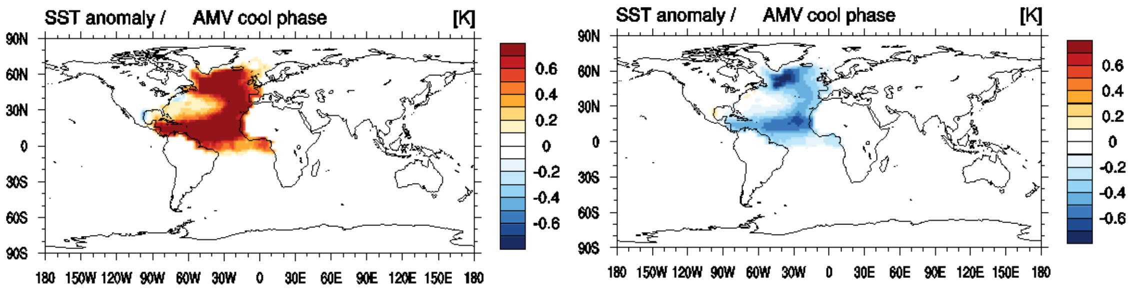

Fig. 2 *:. Surface boundary conditions*: SST; (a) warm phase, (b) cold Phase; (3. rotated EOF of SST from Schubert et al. 2009).

References:

Schubert, S. et al., 2009: CLIVAR Project to Assess and Compare the Responses of Global Climate Models to Drought-Related SST Forcing Patterns: Overview and Results JOC, 2009, 22, 5251-5272.