Project: **1054**

Project title: **CESM1 (Community Earth System Model) as a new MESSy basemodel: Evaluation based on ESCiMo simulations with ECHAM5/MESSy**

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Report period: **2018-07-01 to 2019-06-30**

In the allocation period 2017/2018, three simulations have been performed in order to evaluate CESM1/MESSy:

simulation	model	horizontal resolution	vertical resolution	period
CMne16L90	CESM1/MESSy	ne16	L90MA	1950 – 2011
CMne30L90	CESM1/MESSy	ne30	L90MA	1990 – 2010
EMACT106L90	EMAC	T106	L90MA	1990 – 2010

Additionally, the respective simulation (RC1-base-07) of the ESCiMo (Earth System Chemistry Integrated Modeling) simulations with EMAC (ECHAM5/MESSy for Atmospheric Chemistry) is used (DKRZ consortial project 853, *Jöckel et al., 2016)* for the analysis.

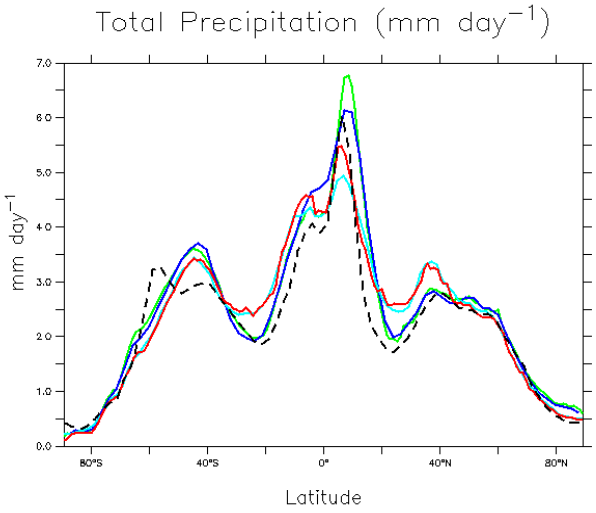

Fig. 1: Zonally and annually averaged total precipitation in [mm/day]. ***GPCP data;*** *EMAC T42L90MA; EMAC T106L90MA , CESM1/MESSy ne16L90MA; CESM1/MESSy ne30L90MA*

Due to a shortage in manpower, the analysis of the data could not start before the second half of the allocation period. First, the dynamical performance of the four simulations was investigated. In the following, this report focuses on global and multi annual means.

Figure 1 shows the zonally and annually averaged precipitation. EMAC in T42 fits the structure shown by GPCP data very well, except for the 2-peak distribution in the southern Extra Tropics, which is not reproduced by none of the four model simulations. EMAC in T106 overestimates the peak in the Tropics, but otherwise is similar to the EMAC T42 results. In contrast to this, both CESM1/MESSy simulations over-estimate precipitation in the region 20° - 40° North and South.

These findings are confirmed when looking at the BIAS and RMSD for precipitation (Fig.2 second row). Precipitation is overestimated in all simulations, but globally averaged, the EMAC simulations show the larger positive BIAS, but the smaller RMSD.

For all simulations the temperature at all displayed pressure levels 5, 30, 200 and 850 hPa compare relatively well to both reanalysis data sets (ERA-Interim and NCEP). With the exception of the EMAC T106L90MA simulations, a cold BIAS is evident for all simulations throughout the atmosphere. The cold BIAS is stronger in the coarser resolved simulations. In contrast to all other simulations EMAC T106L90MA shows a small warm BIAS in the lower troposphere (850 hPa) and at 5 hPa, also displaying the smallest RMSDs. Generally, the CESM1/MESSy simulations show higher RMSDs than the EMAC simulations.

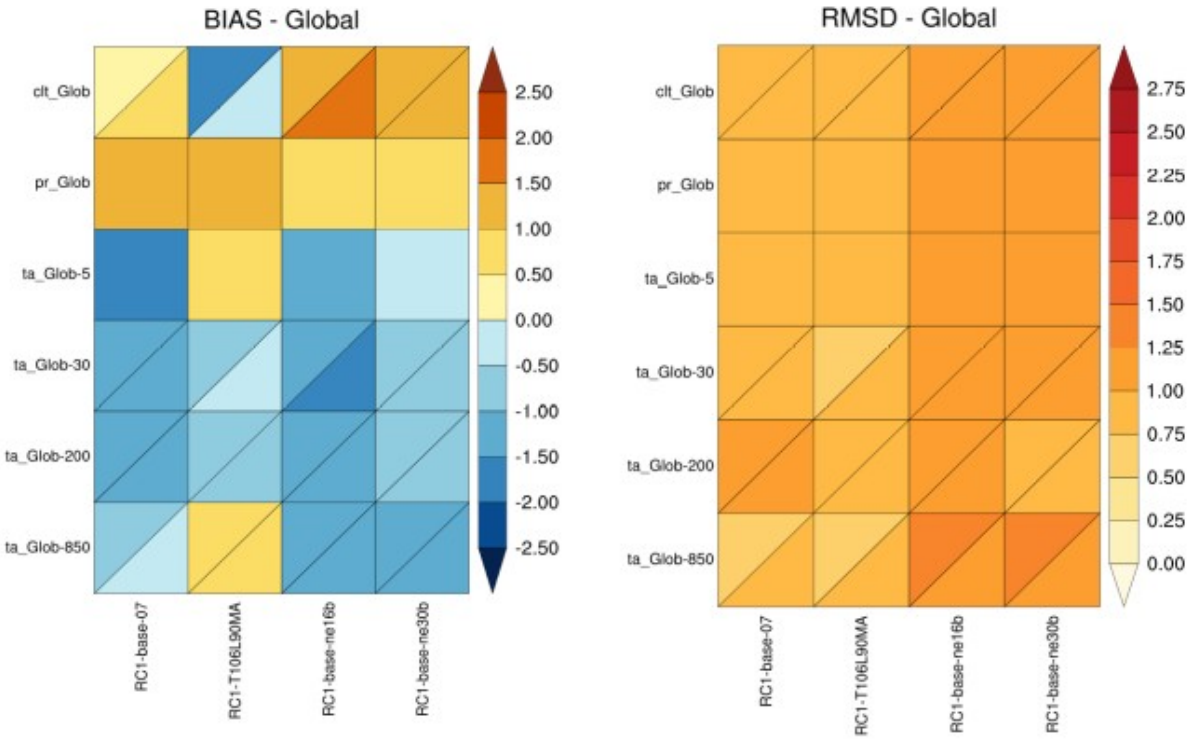

Fig.2: Overall mean BIAS and Root Mean Square Deviation (RMSD) for cloud cover (clt), precipitation (pr) and temperature at 5, 30 ,200 and 850 hPa. Box splits into 2 triangles represent comparisons to two data sets. Temperature: ERA-Interim (bottom) / NCEP (top); precipitation: GPCP ; cloud cover: ESACCI-CLOUD / PATMOS (both satellites).

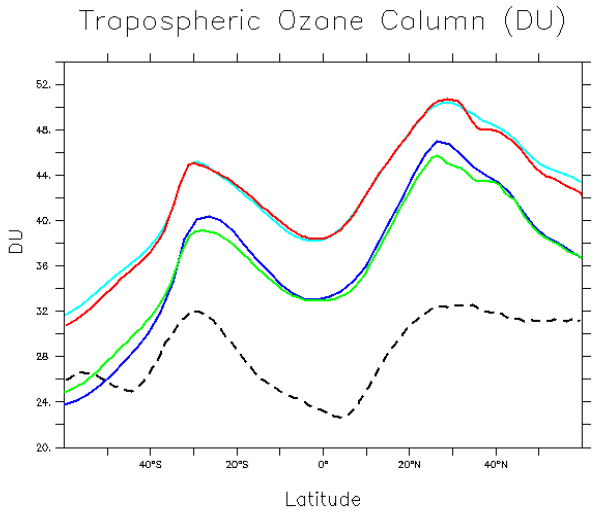

Fig. 3: Zonally averaged Tropospheric Ozone Column (colors as in Fig. 1). Black dashed line: AURA-MLS-OMI satellite data

These differences are also evident, in the tropospheric ozone columns (TOC) shown in Fig. 3. Here all simulations overestimate the TOC, but the EMAC simulations perform slightly better than the CESM1/MESSy simulations.

In the upcoming allocation period, the data of the four simulations will be further analysed to understand the observed differences.

Literature: Jöckel, P., Tost, H., Pozzer, A., Kunze, M., Kirner, O., Brenninkmeijer, C. A. M., Brinkop, S., Cai, D. S., Dyroff, C., Eckstein, J., Frank, F., Garny, H., Gottschaldt, K.-D., Graf, P., Grewe, V., Kerkweg, A., Kern, B., Matthes, S., Mertens, M., Meul, S., Neumaier, M., Nützel, M., Oberländer-Hayn, S., Ruhnke, R., Runde, T., Sander, R., Scharffe, D., & Zahn, A.: Earth System Chemistry integrated Modelling (ESCiMo) with the Modular Earth Submodel System (MESSy) version 2.51, Geoscientific Model Development, 9, 1153–1200, doi: 10.5194/gmd-9-1153-2016, (2016)