Project: 958 **Title**: **Weddell Sea Ice**

Project lead: **Günther Heinemann,** Report period: **2022-01-01 to 2022-10-31**

The regional climate model COSMO-CLM (CCLM) is used with a horizontal resolution of 15km the whole Antarctic continent. CCLM is run with a new turbulence parametrization for the stable boundary layer (Zentek and Heinemann 2020) and a new sea ice model (Heinemann et al. 2021). CCLM is nested in AWI-CM (100km resolution for the atmosphere) and uses the AWI-CM sea ice data (10km resolution). CCLM data are used to drive the sea ice/ocean model FESOM for these periods.

In the report period, simulations have been performed for two time slices for the SSP3-7.0 scenario (2036-2050 and 2086-2100). The climate change signals were determined with respect to the historical run for 2000-2015. The focus lies on the atmospheric boundary layer and low-level jets (LLJs). Comparisons of the historical run are made with a hindcast run for 2002-2016 driven by ERA-I, but only for the Weddell Sea area.

Historical run 2000 – 2015 versus ERA5

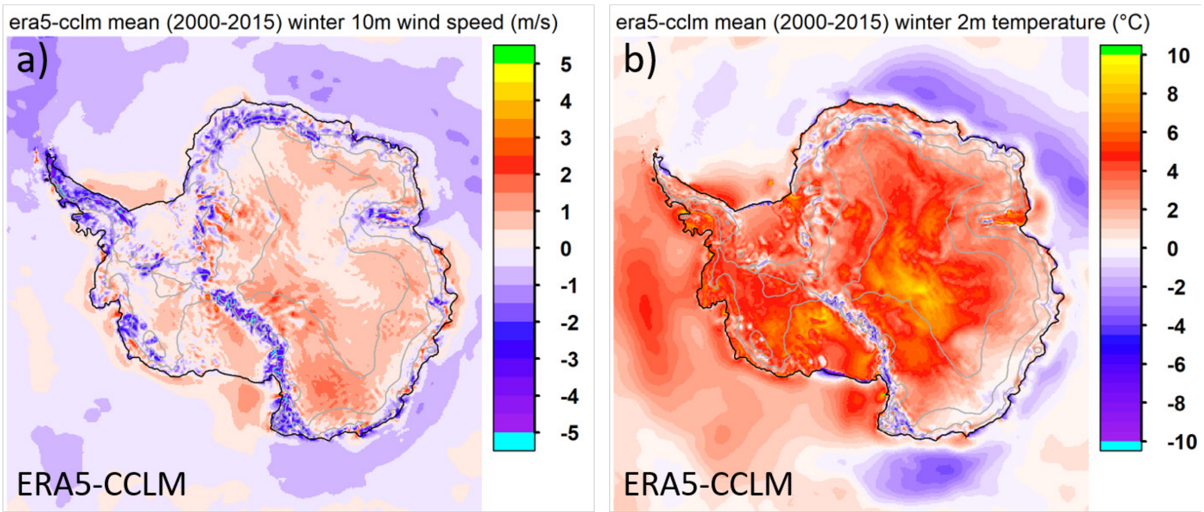

Fig. 1: Evaluation of the historical CCLM run against ERA5 for the winter (April-Sept.) 2000-2015 for(a) the 10m-wind speed (in m/s) and (b) the 2m-temperature (in °C) as differences ERA5-CCLM.

Historical run 2000 – 2015 versus ECHAM6 (AWI-CM)

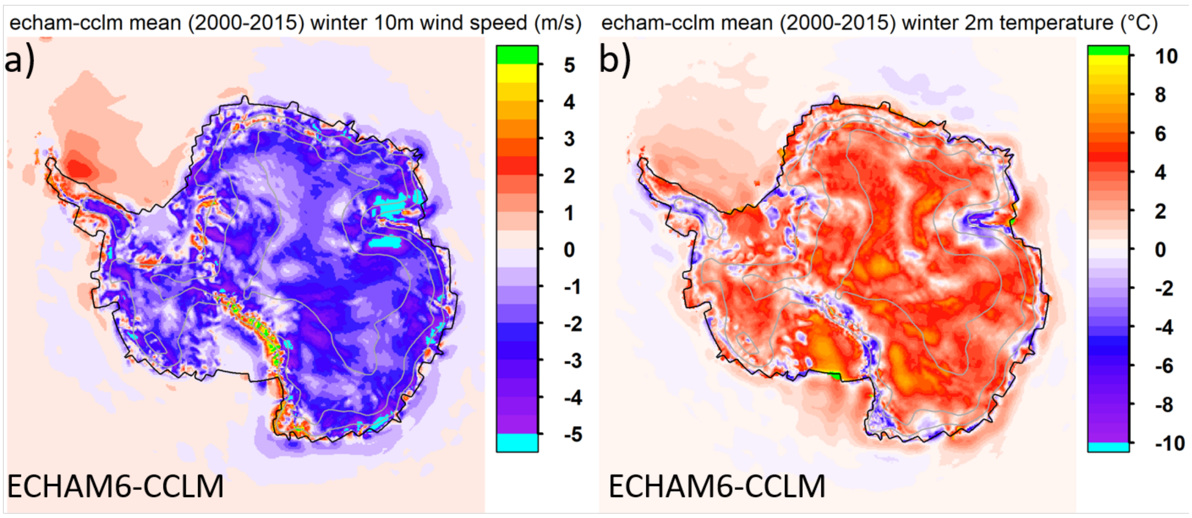

Fig. 2: as Fig.1, but for the historical ECHAM6 run as differences ECHAM6-CCLM.

Results of the comparison of CCLM of the historical run with ERA5 and the driving ECHAM6 model are shown in Fig.1 and Fig.2 for 2m-temperature and 10m-wind for the winter period. ERA5 simulates larger wind speed over the Antarctic plateau and lower speed in the coastal katabatic wind areas, but differences are in the range of ±2 m/s. Larger differences occur for the 2m-temperature, where CCLM is typically 4-5K colder than ERA5. The comparison with measurements at the South Pole (Amundsen-Scott Station) show a bias of +0.8K for CCLM, but +4.1K for ERA5. This shows the improvements of the new turbulence parametrization for the stable boundary layer in CCLM. The comparison with the driving model ECHAM6 (Fig.2) shows a similar result (warm bias of ECHAM6 of +4.2K). In contrast to ERA5, ECHAM6 simulates lower wind speeds than CCLM over the continent.

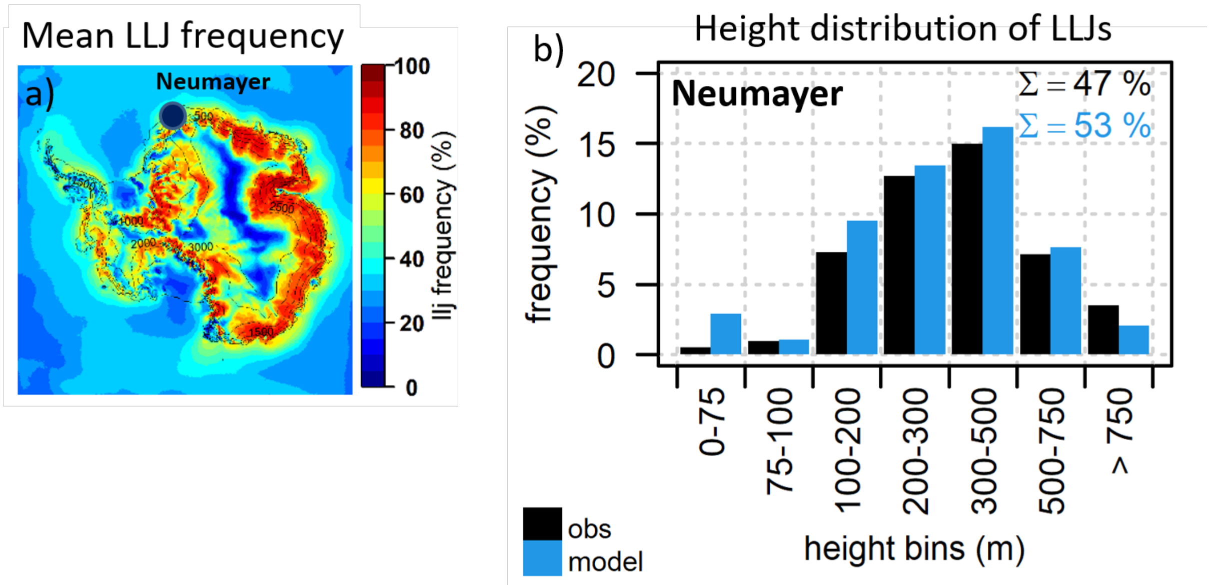

Fig. 3: LLJ frequency (a) and evaluation of the height distribution of LLJs (b) from radiosondes at Neumayer and the historical CCLM run for 2000-2015. The numbers in the upper right corner show the total frequency of LLJs (black: observations, blue: CCLM).

The statistics of LLJs were analysed for the hindcast run (Heinemann and Zentek 2021) and also for the climate runs. Fig.3 shows the map of LLJ frequency and the comparison for the LLJ analysis from radiosondes at Neumayer station 2000-2015 and the historical CCLM run. The highest LLJ frequencies occur in the katabatic wind areas with typically 80-90% (Fig.3a). The overall simulated LLJ frequency and the height distribution of LLJs (Fig.3b) agree very well with the observations.

References

Heinemann, G., Willmes, S., Schefczyk, L., Makshtas, A., Kustov V., Makhotina, I., 2021: Observations and simulations of meteorological conditions over Arctic thick sea ice in late winter during the Transarktika 2019 expedition. Atmosphere 12(2), 174, doi: 10.3390/atmos12020174.

Heinemann, G., Zentek, R., 2021: A model-based climatology of low-level jets in the Weddell Sea region of the Antarctic. Atmosphere 12, 1635; doi: 10.3390/atmos12121635.

Zentek, R. and Heinemann, G., 2020: Verification of the regional atmospheric model CCLM v5.0 with conventional data and lidar measurements in Antarctica, Geosci. Model Dev., 13, 1809–1825, doi: 10.5194/gmd-13-1809-2020.