Project: **474,** Project title: **Laptev**
Project lead: **Günther Heinemann,** Report period: **2022-01-01 to 2022-10-31**

The project focuses on simulations with the atmospheric climate model COSMO-CLM (CCLM) adapted for the polar regions (Heinemann et al. 2021, Heinemann 2020) with 15km (C15) for the Arctic (C15 being part of Arctic CORDEX). Climate runs with C15 for recent climate and for scenarios the end of the 21st century are nested in AWI-CM CMIP6 runs using sea ice information from the sea-ice/ocean model FESOM of AWI-CM. Sea ice data are available on a variable grid with a resolution of 10-25km for the Arctic. In addition, runs with 5km resolution (C05) for the Laptev Sea were performed covering the YOPP period 2017-2020. Simulations for the MOSAiC drift of Polarstern for the period 2019-2020 have been performed using C15 and C05 with different sea ice data sets.

In the report period, climate runs with C15 were run for the Arctic CORDEX period for 2070-2100 for the SSP3-7.0 scenario as recommended by CORDEX. These runs were nested in AWI-CM CMIP6 runs taking sea ice information at high resolution (10km). We used the data of the MOSAiC drift of Polarstern for the period 2019-2020 to develop and test different parameterization methods. The hindcast simulations with C15 (Arctic) and C05 (domain MOSAiC drift) were nested in ERA5 (Heinemann et al. 2022a). A verification study with long-term (3 years) of SODAR data at Cape Baranov (Bolshevik Island, Siberia) was completed (Heinemann et al. 2022b).

Fig.1 shows the results of the comparison of C15 simulations and Met City observations near Polarstern during the MOSAiC winter 2019/20. Three C15 runs with different sea ice concentration (SIC) data are shown: The reference run (C15) uses AMSR2 SIC, C15MOD0 uses a lead fraction (LF) map derived from MODIS infrared data (with leads being considered to be ice-free in the initial field for CCLM), and C15MOD0h is like C15MOD0, but only half of the LF area is ice-free in the initial field for CCLM (see (Heinemann et al. 2022a for details). The effect of the different sea ice concentration fields on near-surface temperature and wind is shown in Fig.1. In addition, the results are shown for ERA5 data. The C15MOD0 run improves the temperature bias by more than 1°C. ERA5 data show a relatively large positive bias of more than 2°C. Wind speed for CCLM runs shows very small negative biases of about -0.2 m/s, while ERA5 has a positive bias of around 0.5 m/s. The simulated average temperature amplitude of the CCLM runs is close to the observations, while ERA5 largely underestimates the temperature amplitude by more than 3°C.

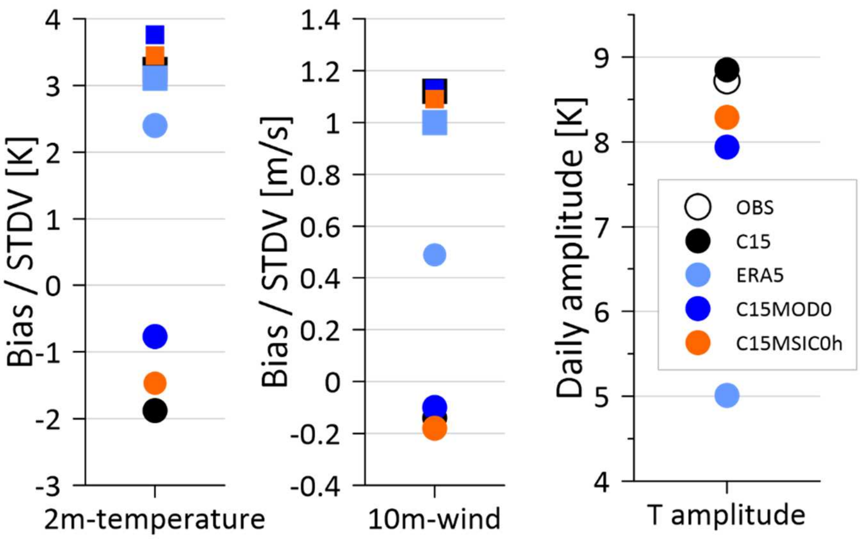

Fig.1: Wintertime (Nov.2019 – April 2020) comparison of C15 simulations and Met City observations. Bias (dots) and STDV (squares) for C15 (black), C15MOD0 (blue), C15MOD0h (orange) and ERA5 (light blue) based on hourly data for 2m-temperature, 10m-wind and daily temperature amplitude (T amplitude). From Heinemann et al. 2022a.

The statistics of the comparisons of C05 with SODAR measurements at Cape Baranova for 2017-2020 for the wind speed at different heights is shown in Fig.2. At 50 m height there is a small positive bias of 0.6 m/s, which increases to 1.5 m/s at larger heights. At the same time the number of available

SODAR data decreases largely with height. The number of hourly CCLM data is 25585, that is, only 28% and 15% of the data can be compared for heights of 200 and 300 m, respectively. The C05 simulations were used to study the channeling process in Shokalsky Strait, which is a narrow strait between two islands of the Archipelago Severnaya Zemlya of the Siberian Arctic (with Cape Baranova at the northern exit region of this strait). The composite of the flow during channeling events with a duration ≥ 12 h is shown in Fig.3. The flow enters Shokalsky Strait from the south and accelerates in the strait, where the confluence is supported by downslope winds of the islands. We find about 200 channeling events per year, and channeling events lasting at least 12h occur on about 62 days per year (Heinemann et al 2022b).

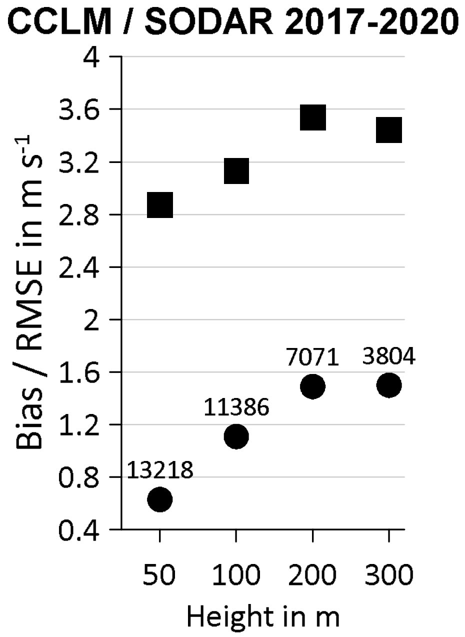

Fig.2: Bias (CCLM-SODAR, dots) and RMSE (squares) for the comparison of the wind speed from SODAR and C05 simulations at different heights (numbers of data points as labels).

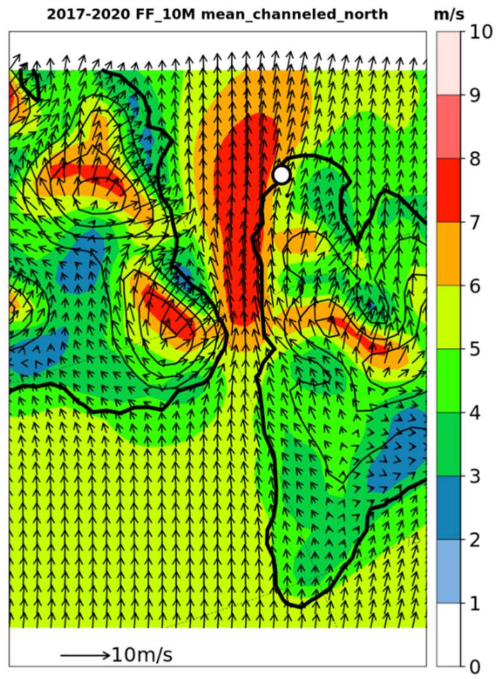

Fig.3: Simulated 10m-wind speed (shaded) and wind vectors (scale at the bottom) for the area of Shokalsky Strait for 2017 –2020 for days with channeling events with a duration ≥12 h at 200 m height at Cape Baranova (marked by a white circle, 190 days in total). Vectors are shown every grid point, topography is shown as isolines every 200 m.

Literature

Heinemann, G., Schefczyk, L., Willmes, S., Shupe, M., 2022a: Evaluation of simulations of near-surface variables using the regional climate model CCLM for the MOSAiC winter period. Elem. Sci. Anth., 10 (1). DOI: 10.1525/elementa.2022.00033.

Heinemann, G., Drüe, C., Makshtas, A., 2022b: A three-years climatology of the wind field structure at Cape Baranova (Severnaya Zemlya, Siberia) from SODAR observations and high-resolution regional climate model simulations during YOPP. Atmosphere 13, 957, doi: 10.3390/atmos13060957.