Project: **1141**

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Large metropolitan cities are growing worldwide and already 75 % of all German citizens live in urban areas. For that reason, profound knowledge about urban climate in an overall changing climate is of high importance. Appropriate tools need to be developed to design climate adapted and sustainable city quarters according to the SDG No. 11 ("Make cities inclusive, safe, resilient and sustainable, United Nations, 2015).

The novel PALM-4U model (Maronga et al., 2019) provides Large Eddy resolved simulations at the urban scale considering buildings and urban characteristics like street canyons. The requested computational resources have been and shall be used in the next period for an overarching evaluation of the PALM-4U model with special focus on new features like the realistic forcing with numerical weather prediction simulations. Physical consistency and information about the accuracy of the model are fundamental prerequisites for a physical meaningful application of the tool for urban climate studies and city planning. The evaluation results are of a great value for the model users and developers to know about the chances and challenges to be tackled.

Two different domains, one around the Wettermast Hamburg supersite in the outskirts of Hamburg, and another at the inner-city location of the Geomatikum building are used for the evaluation of the model. Numerous experimental setups and simulations were performed to find an appropriate setup for the planned long-term run of daily urban LES hindcast simulations at the urban scale. Several technical challenges and model issues (PALM bug tracker) have been found and solved during the testing. There are still some further challenges to be solved before running the long-term evaluation runs. The issues, especially found at the new implemented features of the PALM-4U model, are of a great value for the ongoing design and development of the model.

Various domain sizes, grid resolutions with and without nesting and model parameters were analysed to find an appropriate model setup for the first PALM-4U hindcast simulations. The operational COSMO-D2 analyses are used for the large scale forcing. A domain size of 6400 x 6400 x 2400 m around the Wettermast Hamburg with a grid resolution of 10 m in all directions seems to be well-suited for the evaluation. The domain should be large enough for an inner-domain development of local atmospheric processes like boundary layer stratification and turbulence.

A comprehensive bottom-up evaluation, as proposed by Heinze et al. (2017), was adapted to the PALM-4U urban scale simulations. The different levels of atmospheric parameters like wind, temperature, humidity and fluxes are evaluated of the first prototype simulations. A first case study simulation for 23 August 2020 was conducted (Fig. 1) and compared with the Wettermast Hamburg observational data. The wind profile within the boundary layer and diurnal cycle is well represented at the different heights of the boundary layer tower, seen by first preliminary results (Fig. 1). Nevertheless, there are still some challenges as for example at the right representation of the incoming solar radiation due to problems at the simulations of clouds (not shown). These issues will be investigated in more detail together with the resulting effects on the surface energy budget.

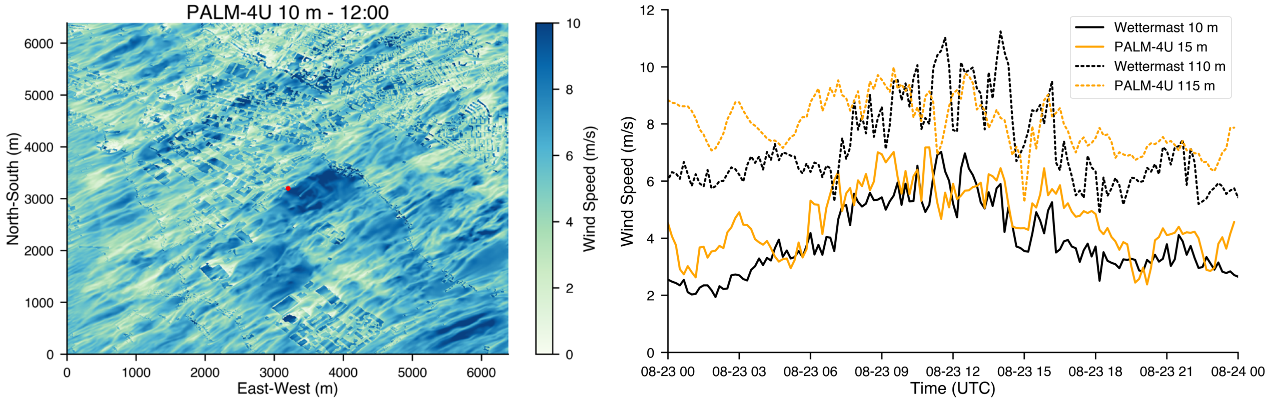

Figure 1: Wind speed at 10 m height of Wettermast domain (red dot – location of Wettermast Hamburg supersite) at 12:00 UTC (left) and diurnal cycle of observed wind speed time series with corresponding simulation output for case study of 23 August 2020.

Several sensitivity studies and experimental setups were performed in 2020 on the Mistral machine as preparation for the upcoming long-term runs in 2021. The technical and model issues slowed down the progress of the simulations which is reason why not all planned runs have yet been simulated. Nevertheless, a first 10-day period of daily PALM-4U LES runs for the Wettermast domain was successfully accomplished. The detailed evaluation is currently ongoing as the next steps towards the strived long-term evaluation of the PALM-4U model. For these simulations, we apply for the computational resources for 2021.

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