Domain knowledge-guided UNet approach for spatial downscaling of GDAPS model's air temperature forecast in summer

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A reliable early forecast of extreme air temperature is important to effectively mitigate for damage such as heat-related mortality and excessive electricity demand caused by heat wave and tropical night. To forecast the air temperature, numerical weather prediction (NWP) models have been used in practice. However, NWP uses the smoothed topography, which cause the systematic error and decrease the air temperature forecast accuracy. In addition, NWP models are required a lot of computational cost for high spatial resolution as the forecasting system is complex. Therefore, the objective of this study is to develop the deep learning-based spatial downscaling approach. Global Data Assmilation and Prediction System (GDAPS) model's forecast data, 1 km all-sky land surface temperature and elevation information were used for spatial downscaling in this study. The domain knowledge-guided multi-task learning-based Unet approach was adopted. As the domain knowledge guided spatial information of air temperature, spatially interpolated air temperature was used based on the stacking ensemble technique. The study period is summer season (i.e., June to Auguest) from 2018 to 2021, and hindcast validation was conducted to evaluate the suggested model. When compared our suggested model with GDAPS, Local Data Assimilation and Prediction System (LDAPS) and SVR-based statistical downscaling model, domain knowledge-guided Unet model showed a higher spatial correlation than others by using the surrounding information. From this result, the our developed model suggested the possibility of improving spatial downscaling accuracy of NWP model accuracy. In addition, It is expected that bias-corrected high-spatial resolution air temperature forecasts with an extended lead time can be produced through the technique developed in this study.

Key words: Heatwave forecast, Statistical downscaling, Maching leanring, Deep learning, Multi-task learning