

Supplementary Material

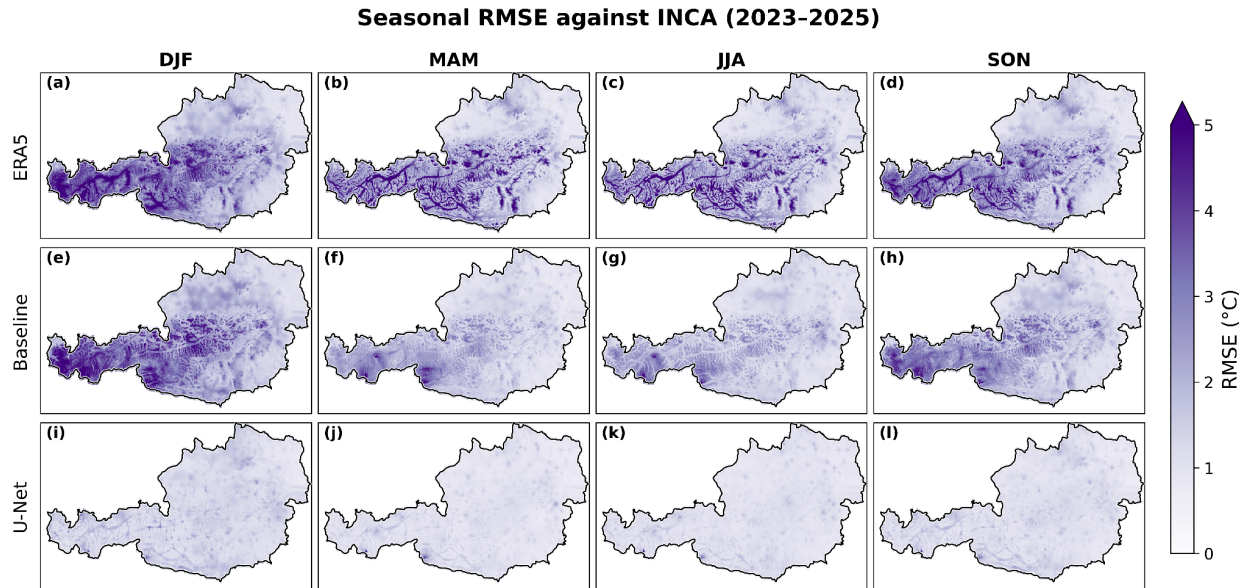


Figure S1: Seasonal grid-cell RMSE against INCA for the 2023–2025 evaluation period. Columns show DJF, MAM, JJA, and SON; rows show (a–d) interpolated ERA5, (e–h) the lapse rate baseline, and (i–l) the residual U-Net.

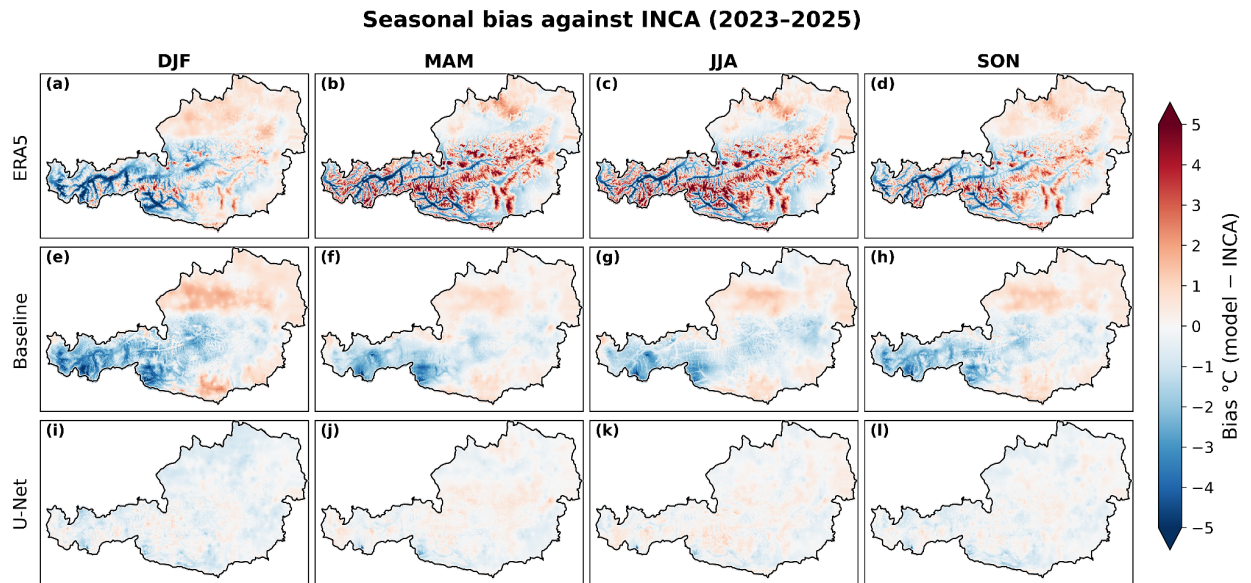


Figure S2: Seasonal grid-cell mean bias against INCA for the 2023–2025 evaluation period. Columns show DJF, MAM, JJA, and SON; rows show (a–d) interpolated ERA5, (e–h) the lapse rate baseline, and (i–l) the residual U-Net.

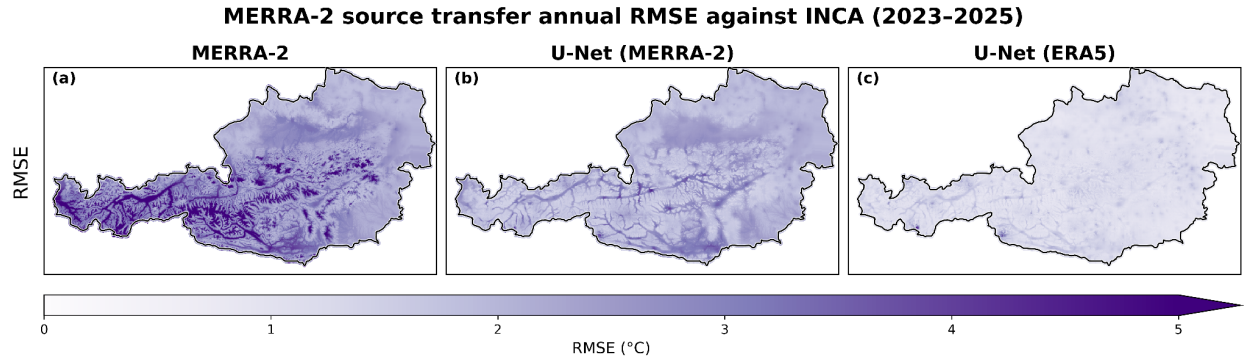


Figure S3: Annual grid-cell RMSE against INCA for the MERRA-2 source-transfer experiment over the 2023–2025 evaluation period. Panels show (a) MERRA-2 interpolated, (b) the ERA5-trained U-Net driven by MERRA-2 predictors, and (c) the standard ERA5-driven U-Net.

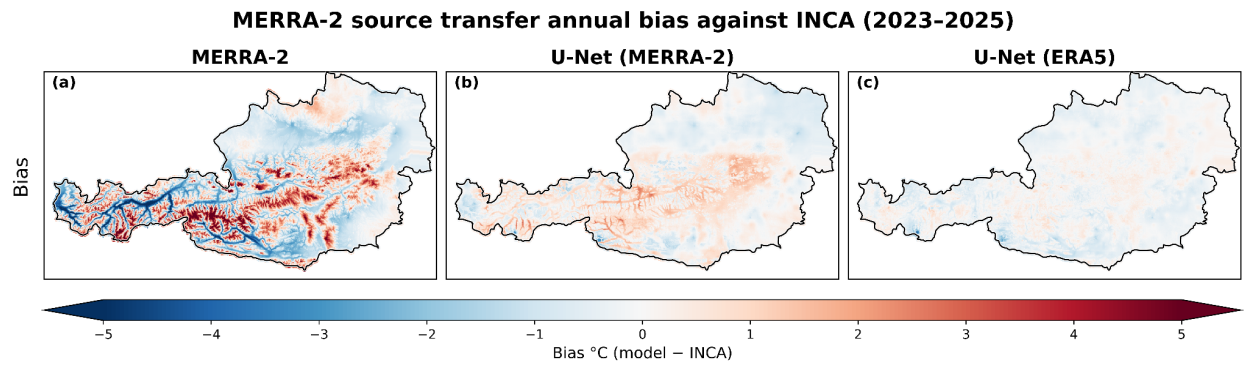


Figure S4: Annual grid-cell mean bias against INCA for the MERRA-2 source-transfer experiment over the 2023–2025 evaluation period. Panels show (a) MERRA-2 interpolated, (b) the ERA5-trained U-Net driven by MERRA-2 predictors, and (c) the standard ERA5-driven U-Net.

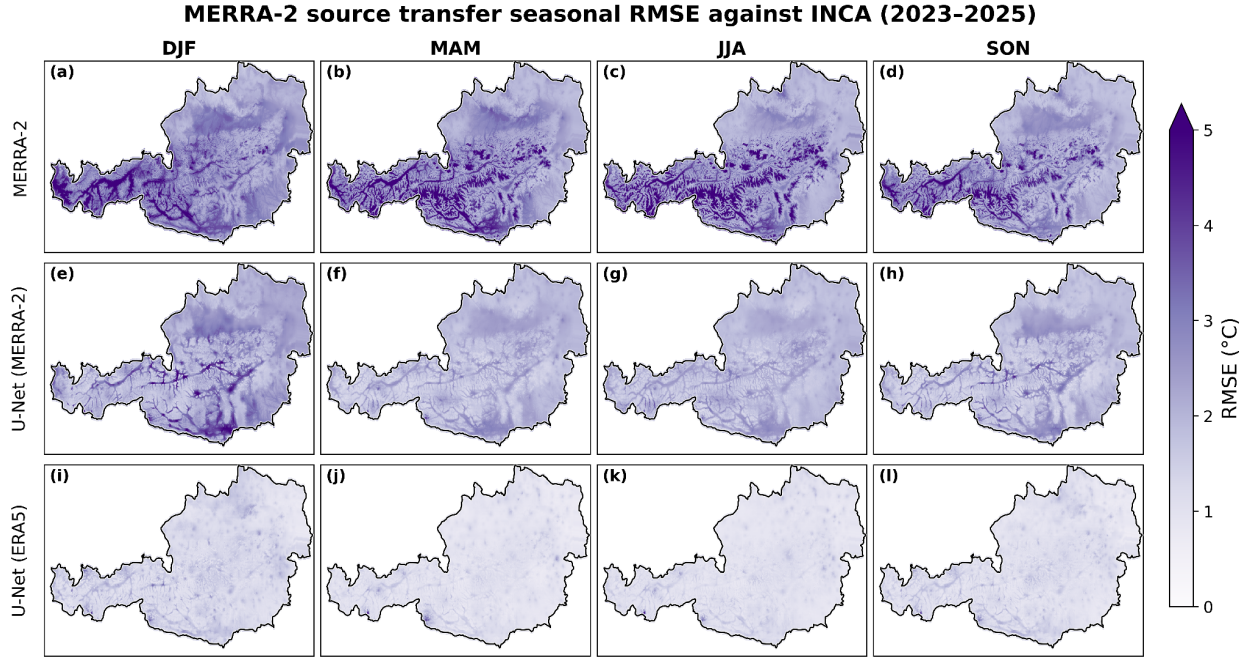


Figure S5: Seasonal grid-cell RMSE against INCA for the MERRA-2 source-transfer experiment over the 2023–2025 evaluation period. Columns show DJF, MAM, JJA, and SON; rows show (a–d) MERRA-2 interpolated, (e–h) the ERA5-trained U-Net driven by MERRA-2 predictors, and (i–l) the standard ERA5-driven U-Net.

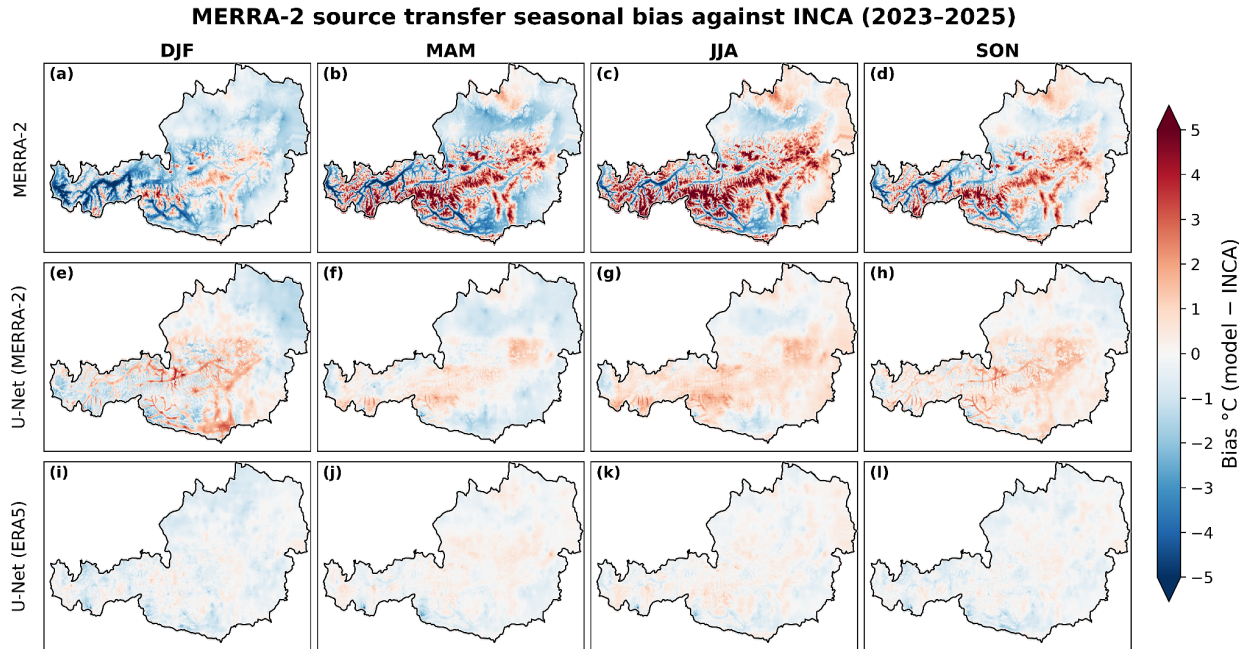


Figure S6: Seasonal grid-cell mean bias against INCA for the MERRA-2 source-transfer experiment over the 2023–2025 evaluation period. Columns show DJF, MAM, JJA, and SON; rows show (a–d) MERRA-2 interpolated, (e–h) the ERA5-trained U-Net driven by MERRA-2 predictors, and (i–l) the standard ERA5-driven U-Net.

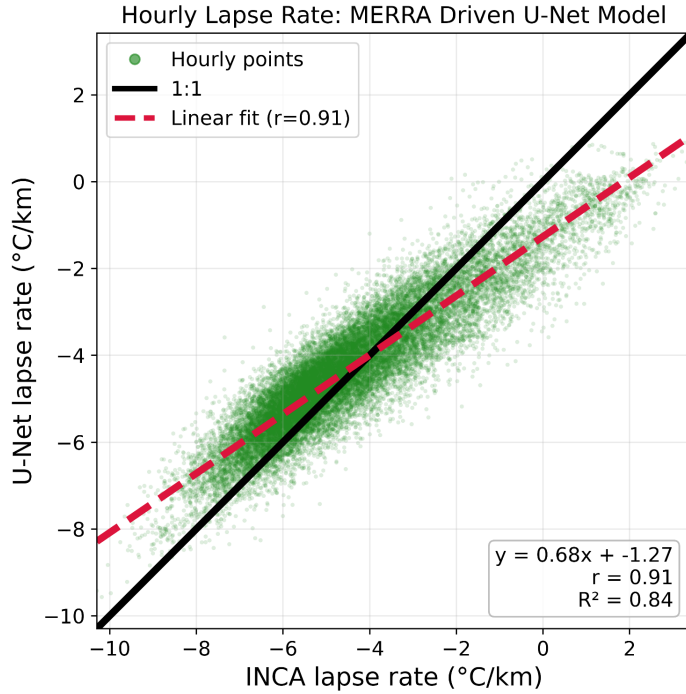


Figure S7: Hourly lapse-rate agreement for the ERA5-trained U-Net driven by MERRA-2 predictors over the 2023–2025 evaluation period. Each point represents one hourly domain-wide temperature–elevation slope, with the MERRA driven U-Net lapse rate plotted against the corresponding INCA lapse rate. The solid black line denotes one-to-one agreement, and the dashed red line denotes the fitted linear regression.

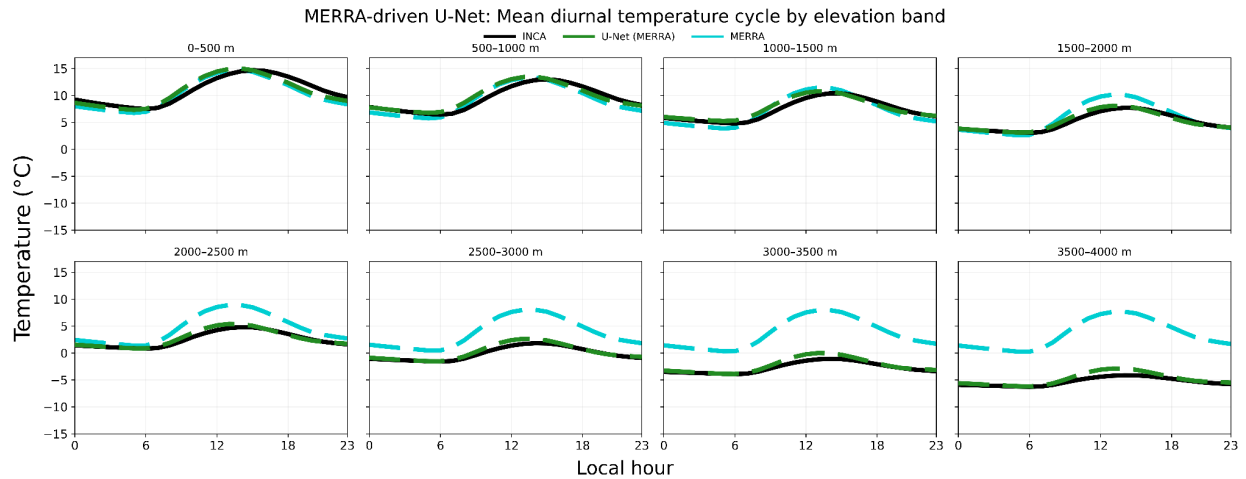


Figure S8: Mean diurnal cycle of 2 m temperature by elevation band for the MERRA-2 source-transfer experiment over the 2023–2025 evaluation period. Black lines show INCA, cyan dashed lines show MERRA-2 interpolated to the INCA grid, and green dashed lines show the ERA5-trained U-Net driven by MERRA-2 predictors.

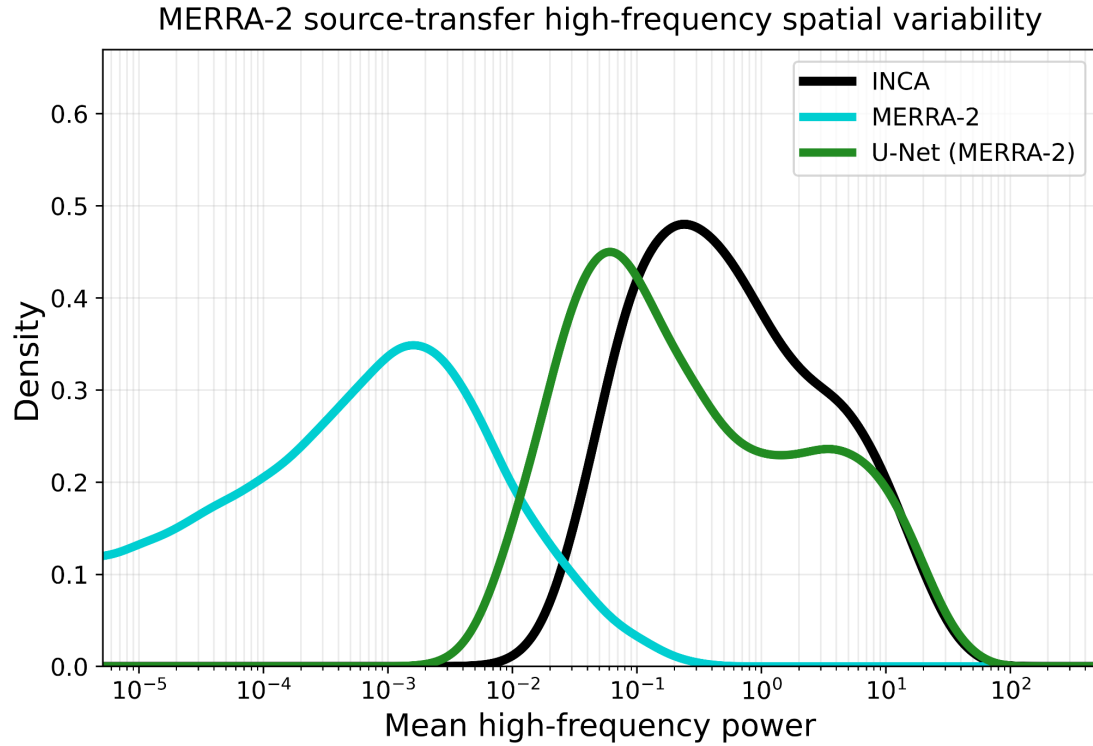


Figure S9: Kernel density estimates of the spatial distribution of time-mean high-frequency temperature power for INCA (black), MERRA-2 interpolated to the INCA grid (cyan), and the ERA5-trained U-Net driven by MERRA-2 predictors (green). High-frequency power is computed from the high-pass temperature component after subtracting a Gaussian-smoothed field with $\sigma=8$ grid cells, corresponding to approximately 8 km on the INCA grid.

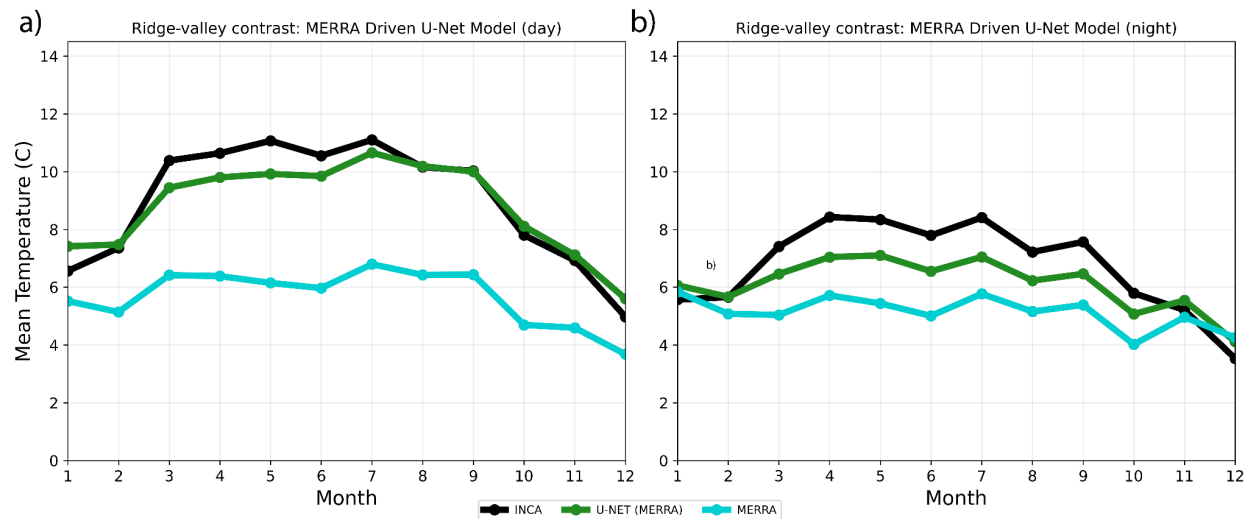


Figure S10: Monthly ridge–valley temperature contrast for the MERRA-2 source-transfer experiment over the 2023–2025 evaluation period, shown separately for (a) daytime and (b) nighttime conditions. Black lines show INCA, cyan lines show MERRA-2 interpolated to the INCA grid, and green lines show the ERA5-trained U-Net driven by MERRA-2 predictors.