Supplement of Atmos. Chem. Phys., 24, 4047–4063, 2024
https://doi.org/10.5194/acp-24-4047-2024-supplement

Atmospheric Chemistry and Physics Open Access

Supplement of

Extending the wind profile beyond the surface layer by combining physical and machine learning approaches

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Table S1. Power law exponent of various terrain.

Terrain type	Power law exponent
Lake, ocean, and smooth hard ground	0.10
Foot high grass on ground level	0.15
Tall crops, hedges, and shrubs	0.20
Wooded country	0.25
Small town with some trees and shrubs	0.30
City area with tall buildings	0.40

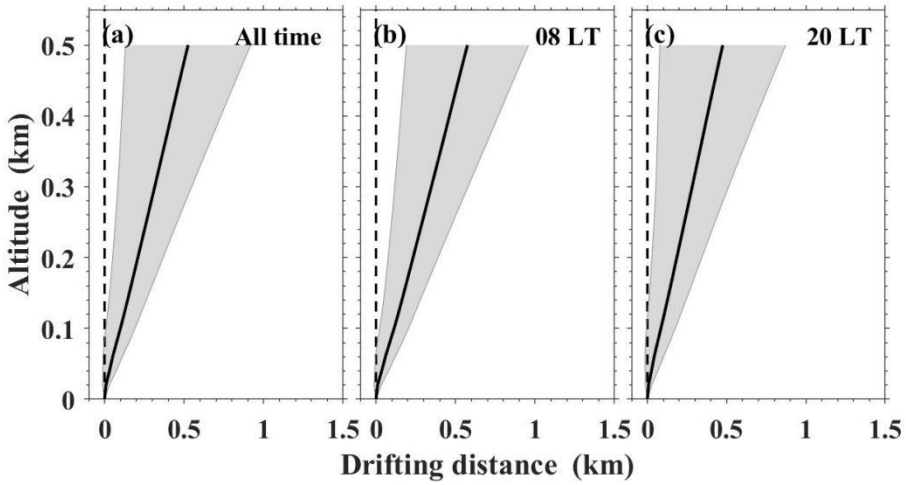

Figure S1. The drifting distance of RS observations over China. Black line represents mean drifting distance between the coordinates of RS and observation stations. Corresponding color shading areas represent the standard deviation.

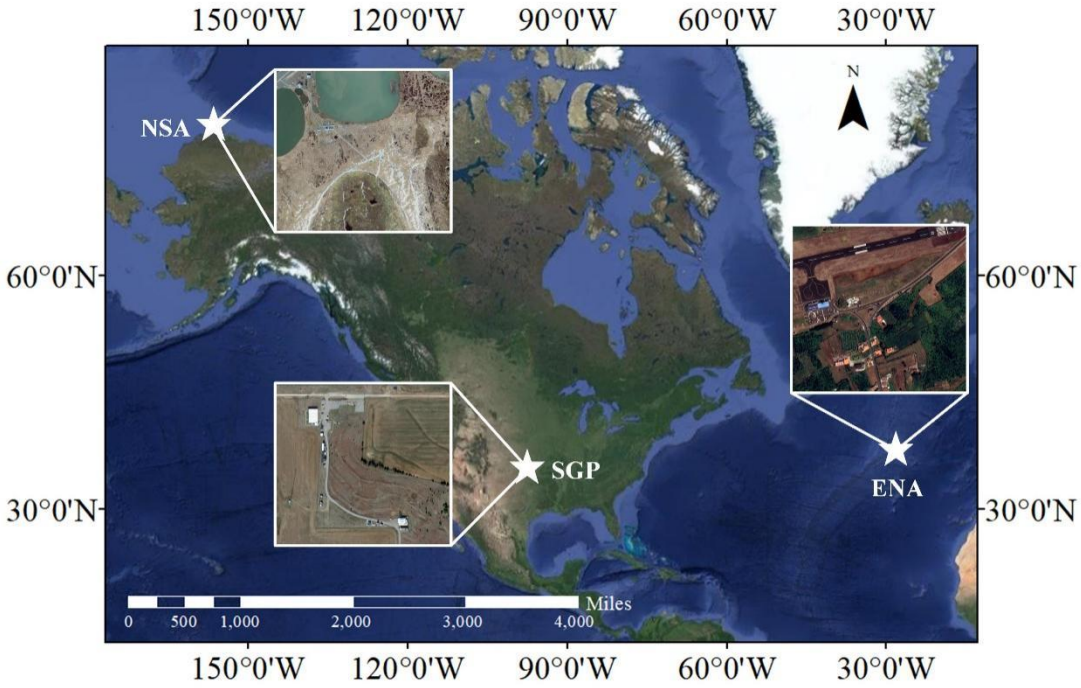

Figure S2. Geographical distribution and surface land cover type of three ARM station. The surface type photo is provided by Google Earth (© Google Maps).

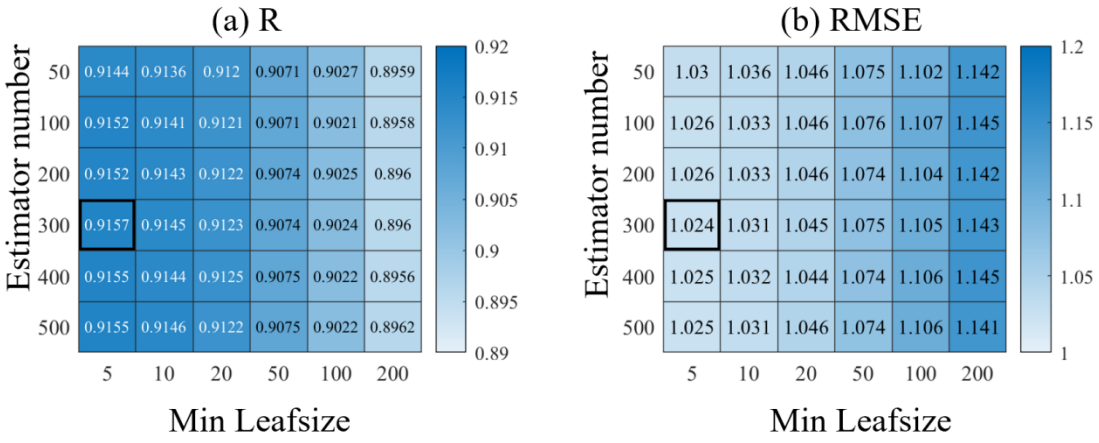

Figure S3. The (a) R and (b) RMSE distribution of RF with different parameters.

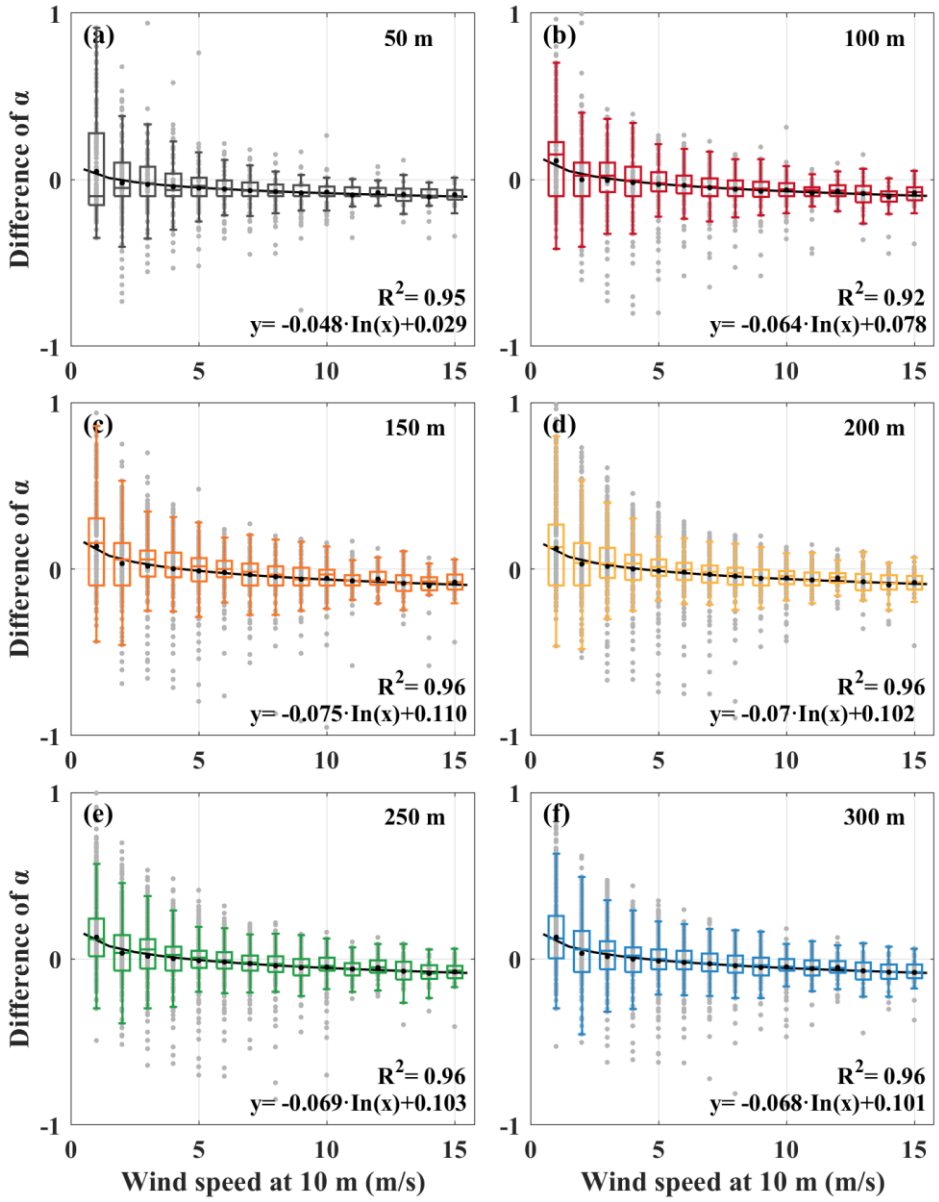

Figure S4. The α bias (assumed value minus observed value) as a function of surface wind speed at (a) 50 m, (b) 100 m, (c) 150 m, (d) 200 m, (e) 250 m, and (f) 300 m.

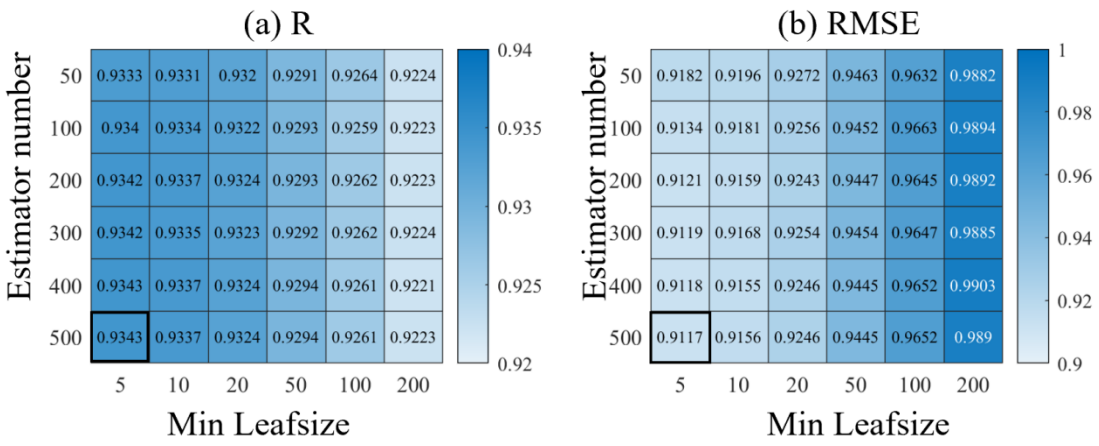

Figure S5. The (a) R and (b) RMSE distribution of PLM-RF with different parameters.

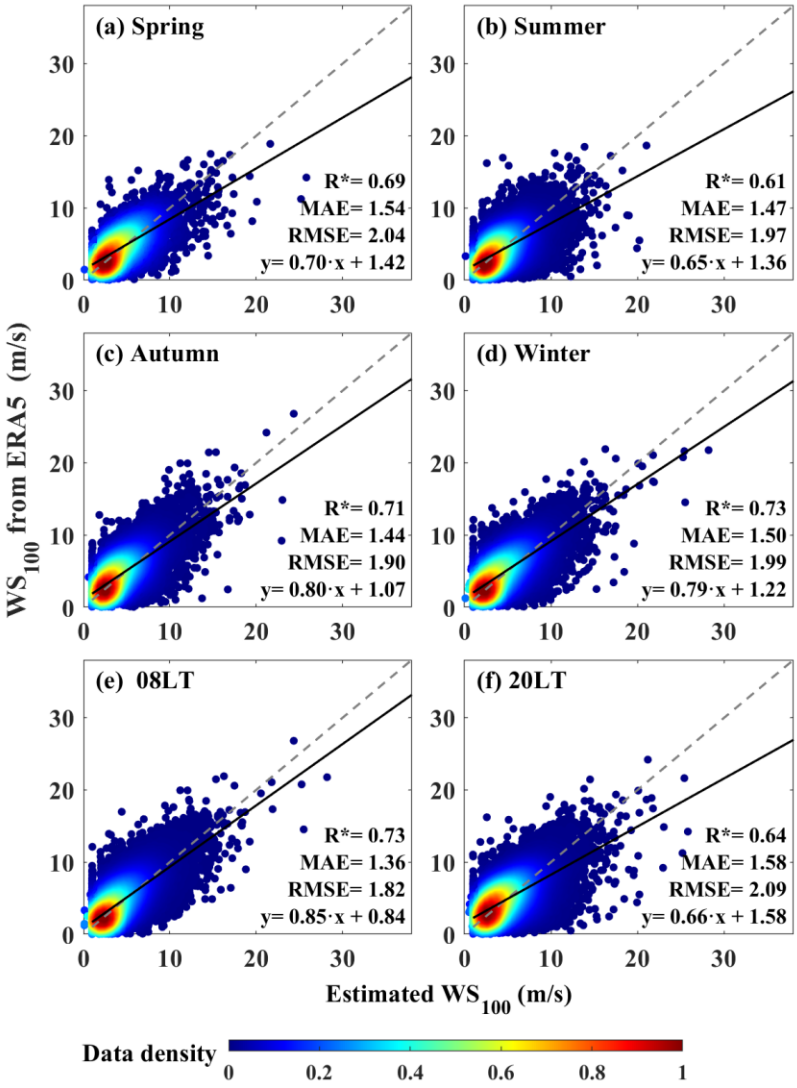

Figure S6. Comparisons between the WS_{100} from ERA5 and from PLM-RF model in (a) spring, (b) summer, (c) autumn, (d) winter, (e) 0800 LT, and (f) 2000 LT.

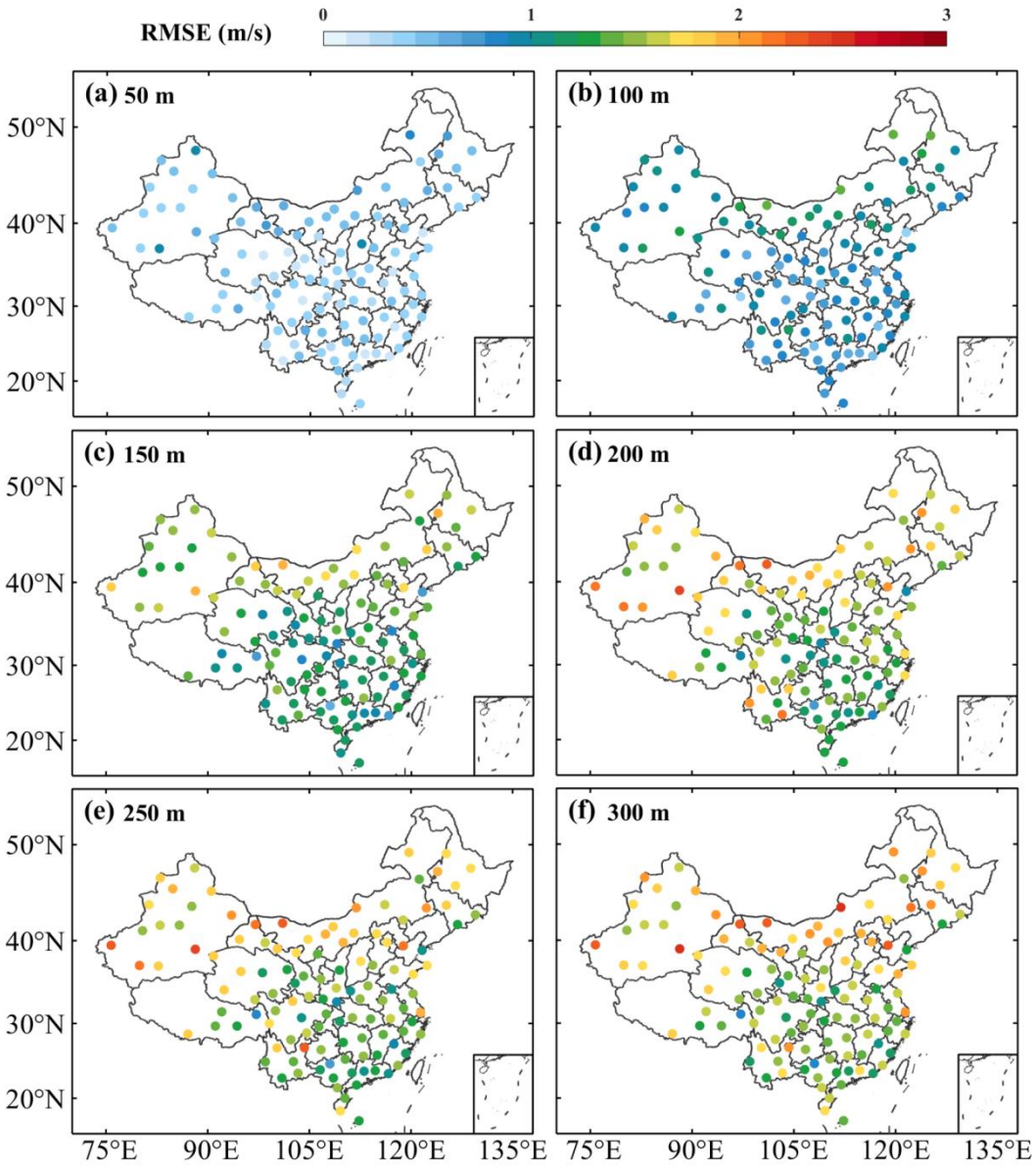

Figure S7. The spatial distributions of the RMSE between the estimated wind speed and observed wind speed for the PLM-RF model over 120 radiosonde stations in China at different heights: (a) 50 m, (b) 100 m, (c) 150 m, (d) 200 m, (e) 250 m, (f) 300 m.

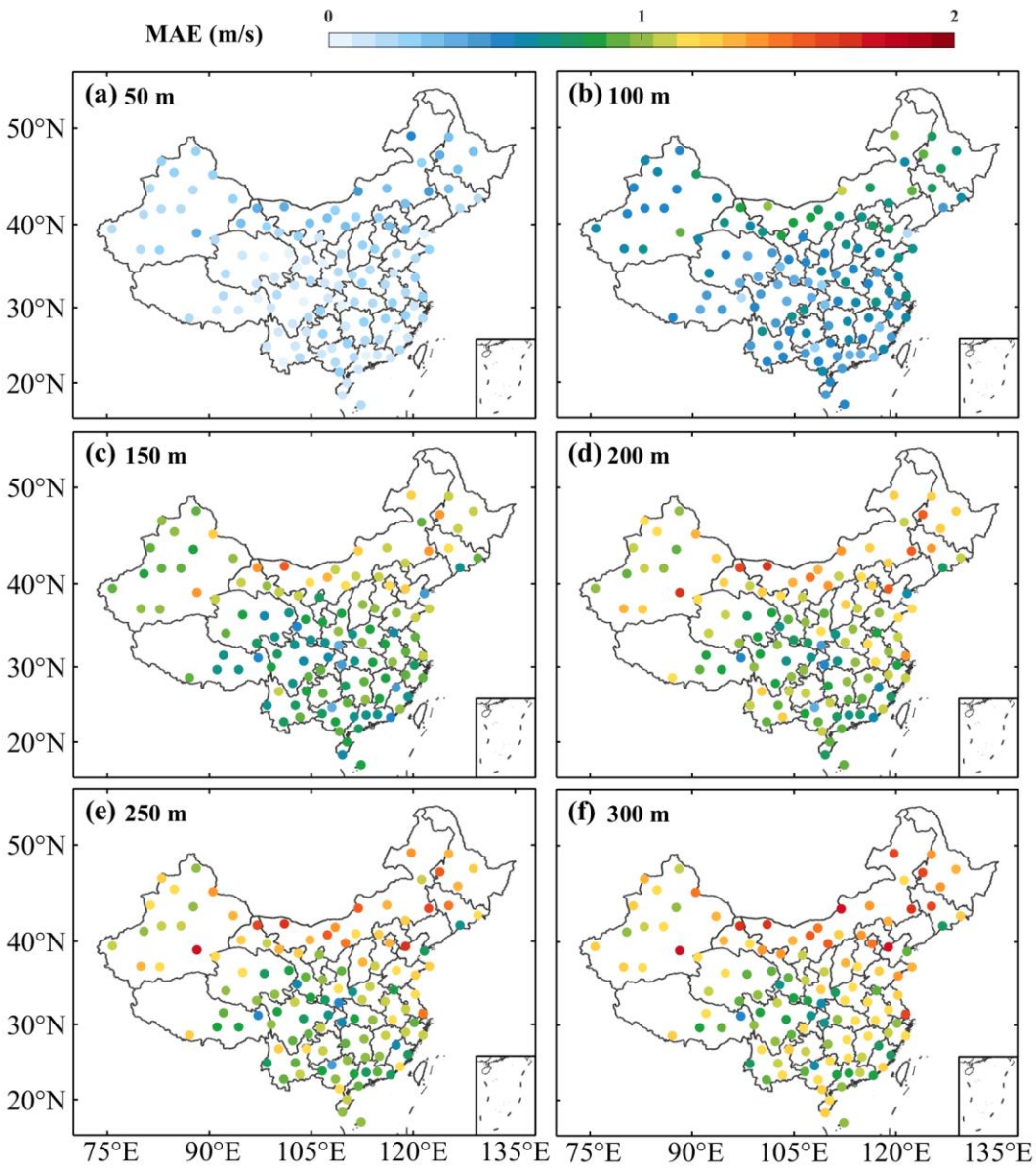

Figure S8. The spatial distributions of the MAE between the estimated wind speed and observed wind speed for the PLM-RF model over 120 radiosonde stations in China at different heights: (a) 50 m, (b) 100 m, (c) 150 m, (d) 200 m, (e) 250 m, (f) 300 m.

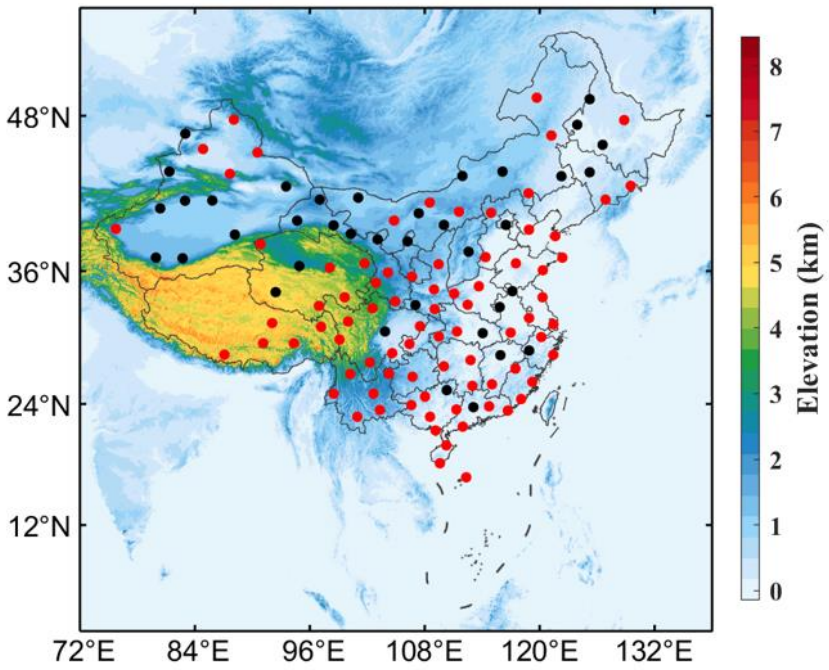

Figure S9. Geographical distribution of the radiosonde stations in China. Color bar represents elevation in kilometers. Red and black dots represent plain and highland sites, respectively.