Table 1. The geographical locations and associated annual climatic parameters

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<th>Latitude</th>
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The unit of $R_g$, $T_a$, $P_a$, $W_s$ and $E_p$ are MJ $m^{-2}$, °C, hPa, $ms^{-1}$ and mm/day, respectively; $x_{\text{mean}}$, $S_x$, $C_x$, $C_x$, $x_{\text{min}}$ and $x_{\text{max}}$ denote the mean, standard deviation, variation coefficient, skewness, minimum and maximum values, respectively.

Table 3. The input combinations for different artificial intelligence techniques.
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<td>0.972</td>
<td>0.912</td>
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<td>0.806</td>
<td>1.390</td>
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Table 4. Comparisons of different models for predicting $E_P$ at HEB station.
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<th>MAE</th>
<th>RMSE</th>
<th>$R^2$</th>
<th>E</th>
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Table 5. Comparisons of different models for predicting $E_p$ at ALT station.
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<th>RMSE</th>
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<td>0.810</td>
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Table 6. Comparisons of different models for predicting $E_p$ at MQ station.
<p>| Model | FG6  | FG7  | FG8  | FG9  | GRNN1 | GRNN2 | GRNN3 | GRNN4 | GRNN5 | GRNN6 | GRNN7 | GRNN8 | GRNN9 | LSSVM1 | LSSVM2 | LSSVM3 | LSSVM4 | LSSVM5 | LSSVM6 | LSSVM7 | LSSVM8 | LSSVM9 | MARS1 | MARS2 | MARS3 | MARS4 | MARS5 | MARS6 | MARS7 | MARS8 | MARS9 | MLP1 | MLP2 | MLP3 | MLP4 | MLP5 | MLP6 | MLP7 | MLP8 | MLP9 | SS   | MLR  |
|-------|------|------|------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|
|       | 0.828| 0.795| 0.608| 0.456| 1.289 | 1.225 | 2.441 | 3.845 | 3.379 | 0.686 | 0.508 | 0.178 | 0.055 | 1.295 | 1.259 | 2.713 | 3.861 | 3.242 | 0.841 | 0.911 | 0.982 | 0.549 | 1.352 | 1.076 | 2.419 | 3.829 | 3.225 | 0.804 | 0.807 | 0.668 | 0.546 | 1.297 | 1.057 | 1.139 | 3.833 | 3.179 | 0.724 | 0.742 | 0.933 | 0.938 | 0.968 | 0.983 | 0.988 | 0.986 | 0.986 | 0.729 | 0.922 | 0.77  |</p>
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Table 8. Comparisons of different models for predicting $EP$ at LSA station.
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Table 9. Comparisons of different models for predicting $Ep$ at CQ station.
| Method | FG6 | FG7 | FG8 | FG9 | GRNN1 | GRNN2 | GRNN3 | GRNN4 | GRNN5 | GRNN6 | GRNN7 | GRNN8 | GRNN9 | LSSSV1 | LSSSV2 | LSSSV3 | LSSSV4 | LSSSV5 | LSSSV6 | LSSSV7 | LSSSV8 | LSSSV9 | MARS1 | MARS2 | MARS3 | MARS4 | MARS5 | MARS6 | MARS7 | MARS8 | MARS9 | MLP1 | MLP2 | MLP3 | MLP4 | MLP5 | MLP6 | MLP7 | MLP8 | MLP9 | SS | MLR |
|--------|-----|-----|-----|-----|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
|        | 0.385 | 0.704 | 0.876 | 0.876 | 0.303 | 0.384 | 0.96 | 0.957  
|        | 0.396 | 0.572 | 0.918 | 0.918 | 0.294 | 0.385 | 0.958 | 0.956  
|        | 0.287 | 0.38 | 0.964 | 0.964 | 0.229 | 0.299 | 0.974 | 0.973  
|        | 0.195 | 0.25 | 0.984 | 0.984 | 0.182 | 0.280 | 0.981 | 0.979  
|        | 0.437 | 0.746 | 0.861 | 0.86 | 0.284 | 0.374 | 0.963 | 0.958  
|        | 0.574 | 0.845 | 0.823 | 0.821 | 0.507 | 0.651 | 0.883 | 0.874  
|        | 0.453 | 0.652 | 0.893 | 0.893 | 0.473 | 0.610 | 0.902 | 0.889  
|        | 1.212 | 1.475 | 0.562 | 0.453 | 1.158 | 1.330 | 0.557 | 0.474  
|        | 1.318 | 1.617 | 0.354 | 0.342 | 1.253 | 1.548 | 0.395 | 0.287  
|        | 0.306 | 0.598 | 0.911 | 0.91 | 0.279 | 0.384 | 0.959 | 0.956  
|        | 0.197 | 0.278 | 0.981 | 0.981 | 0.243 | 0.328 | 0.968 | 0.968  
|        | 0.145 | 0.203 | 0.99 | 0.99 | 0.177 | 0.240 | 0.983 | 0.983  
|        | 0.227 | 0.308 | 0.977 | 0.977 | 0.234 | 0.297 | 0.975 | 0.974  
|        | 0.449 | 0.758 | 0.856 | 0.856 | 0.282 | 0.377 | 0.961 | 0.958  
|        | 0.552 | 0.825 | 0.829 | 0.829 | 0.503 | 0.650 | 0.888 | 0.874  
|        | 0.687 | 0.862 | 0.887 | 0.813 | 0.625 | 0.765 | 0.906 | 0.826  
|        | 1.07 | 1.345 | 0.548 | 0.545 | 1.003 | 1.222 | 0.556 | 0.555  
|        | 1.305 | 1.626 | 0.336 | 0.335 | 1.233 | 1.543 | 0.406 | 0.292  
|        | 0.399 | 0.741 | 0.864 | 0.862 | 0.322 | 0.399 | 0.960 | 0.953  
|        | 0.391 | 0.586 | 0.918 | 0.914 | 0.266 | 0.355 | 0.966 | 0.962  
|        | 0.407 | 0.634 | 0.916 | 0.899 | 0.284 | 0.392 | 0.968 | 0.954  
|        | 0.313 | 0.482 | 0.944 | 0.941 | 0.219 | 0.290 | 0.976 | 0.975  
|        | 0.5 | 0.753 | 0.858 | 0.858 | 0.274 | 0.357 | 0.964 | 0.962  
|        | 0.559 | 0.806 | 0.837 | 0.837 | 0.509 | 0.653 | 0.888 | 0.873  
|        | 0.453 | 0.664 | 0.889 | 0.889 | 0.466 | 0.599 | 0.904 | 0.904  
|        | 0.974 | 1.234 | 0.617 | 0.617 | 1.09 | 1.38 | 0.466 | 0.433  
|        | 1.236 | 1.51 | 0.427 | 0.427 | 1.321 | 1.741 | 0.277 | 0.10  
|        | 0.354 | 0.617 | 0.904 | 0.904 | 0.333 | 0.444 | 0.949 | 0.941  
|        | 0.336 | 0.48 | 0.942 | 0.942 | 0.292 | 0.372 | 0.959 | 0.959  
|        | 0.273 | 0.426 | 0.954 | 0.954 | 0.221 | 0.300 | 0.973 | 0.973  
|        | 0.267 | 0.417 | 0.956 | 0.956 | 0.25 | 0.323 | 0.970 | 0.969  
|        | 0.419 | 0.733 | 0.865 | 0.865 | 0.27 | 0.371 | 0.96 | 0.959  
|        | 0.55 | 0.81 | 0.835 | 0.835 | 0.509 | 0.658 | 0.887 | 0.872  
|        | 0.568 | 0.845 | 0.82 | 0.82 | 0.502 | 0.637 | 0.893 | 0.877  
|        | 1.052 | 1.338 | 0.55 | 0.55 | 0.999 | 1.231 | 0.55 | 0.549  
|        | 1.299 | 1.61 | 0.348 | 0.348 | 1.263 | 1.591 | 0.381 | 0.247  
|        | 0.334 | 0.65 | 0.894 | 0.894 | 0.266 | 0.355 | 0.966 | 0.947  
|        | 0.252 | 0.348 | 0.97 | 0.969 | 0.218 | 0.296 | 0.975 | 0.971  
|        | 0.185 | 0.239 | 0.986 | 0.986 | 0.167 | 0.230 | 0.985 | 0.984  
|        | 0.161 | 0.211 | 0.989 | 0.989 | 0.189 | 0.265 | 0.985 | 0.979  
|        | 0.379 | 0.786 | 0.847 | 0.847 | 0.226 | 0.307 | 0.973 | 0.971  
|        | 0.389 | 0.534 | 0.928 | 0.928 | 0.317 | 0.398 | 0.955 | 0.955  

The table shows the performance metrics for various ML models, including LSSVM, MARS, GRNN, MLP, and MLR, with values for different metrics such as accuracy and precision.
<table>
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<th>Model</th>
<th>MAE</th>
<th>RMSE</th>
<th>$R^2$</th>
<th>E</th>
<th>MAE</th>
<th>RMSE</th>
<th>$R^2$</th>
<th>E</th>
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<td>Testing $R^2$</td>
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Table 11. Comparisons of different models for predicting $E_p$ at HK station.
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<th>0.578</th>
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<td>0.856</td>
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<td>0.603</td>
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<tr>
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<td>1.500</td>
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<td>0.899</td>
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<tr>
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<td>0.882</td>
<td>0.536</td>
<td>0.691</td>
<td>0.891</td>
<td>0.797</td>
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<tr>
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<td>0.895</td>
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<td>0.932</td>
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<td>0.823</td>
<td>0.657</td>
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<td>0.822</td>
<td>0.979</td>
<td>0.792</td>
<td>0.591</td>
</tr>
<tr>
<td>MLP3</td>
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<td>0.903</td>
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<td>0.679</td>
<td>0.821</td>
<td>0.973</td>
<td>0.797</td>
<td>0.626</td>
</tr>
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<td>0.325</td>
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<td>1.459</td>
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<td>0.005</td>
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<td>0.779</td>
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<td>0.884</td>
<td>0.485</td>
<td>0.594</td>
<td>0.897</td>
<td>0.847</td>
</tr>
<tr>
<td>MLP8</td>
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<td>0.554</td>
<td>0.88</td>
<td>0.879</td>
<td>0.671</td>
<td>0.786</td>
<td>0.916</td>
<td>0.736</td>
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<td>0.386</td>
<td>0.491</td>
<td>0.930</td>
<td>0.897</td>
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<td>0.64</td>
<td>0.773</td>
<td>0.823</td>
<td>0.822</td>
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Table 12. Accuracy ranks * of the soft computing models in estimating $E_p$.

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<th>Stations</th>
<th>ANFIS-GP</th>
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<th>GRNN</th>
<th>LSSV</th>
<th>MARS</th>
<th>MLP</th>
<th>MLR</th>
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<td>6</td>
<td>2</td>
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<td>1</td>
<td>7</td>
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<td>4</td>
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<tr>
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<td>2</td>
<td>5</td>
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<td>1</td>
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<tr>
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<td><strong>27</strong></td>
<td><strong>37</strong></td>
<td><strong>43</strong></td>
<td><strong>10</strong></td>
<td><strong>57</strong></td>
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</table>

*Accuracy ranks were determined according to the RMSE, MAE, $E$ and $R^2$ criteria. For the HEB, for example, MLP has the highest accuracy (1st model) while the MLR has the lowest accuracy (7th model).
Table 13. Comparisons of different models for predicting $Ep$ at all stations.

<table>
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<th>Model</th>
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<th>RMSE</th>
<th>$R^2$</th>
<th>$E$</th>
<th>Testing MAE</th>
<th>RMSE</th>
<th>$R^2$</th>
<th>$E$</th>
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<td>1.204</td>
<td>1.681</td>
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<td>0.739</td>
<td>1.022</td>
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<tr>
<td>ANFIS-GP2</td>
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<td>0.412</td>
<td>0.412</td>
<td>1.768</td>
<td>2.345</td>
<td>0.437</td>
<td>0.431</td>
</tr>
<tr>
<td>ANFIS-GP3</td>
<td>1.913</td>
<td>2.377</td>
<td>0.478</td>
<td>0.478</td>
<td>1.877</td>
<td>2.262</td>
<td>0.475</td>
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<td>0.171</td>
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<td>1.490</td>
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<td>ANFIS-GP5</td>
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<td>0.001</td>
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<td>0.417</td>
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<td>FG4</td>
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<td>0.733</td>
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<td>GRNN7</td>
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<td>0.425</td>
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<td>1.667</td>
<td>0.743</td>
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<td>1.371</td>
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<td>0.425</td>
<td>1.703</td>
<td>2.312</td>
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<td>0.447</td>
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<td>1.858</td>
<td>2.215</td>
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<tr>
<td>LSSVM4</td>
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<td>1.333</td>
<td>0.301</td>
<td>0.301</td>
<td>1.151</td>
<td>1.469</td>
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<td>LSSVM5</td>
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<td>1.588</td>
<td>0.009</td>
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<td>1.349</td>
<td>1.611</td>
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<tr>
<td>LSSVM6</td>
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<td>1.386</td>
<td>0.823</td>
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<td>0.806</td>
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<td>0.866</td>
<td>0.864</td>
</tr>
<tr>
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<td>0.827</td>
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<td>LSSVM8</td>
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<td>0.952</td>
<td>0.476</td>
<td>0.657</td>
<td>0.958</td>
<td>0.955</td>
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<td>MARS1</td>
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<td>1.666</td>
<td>0.744</td>
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<td>1.373</td>
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<td>MARS2</td>
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<td>0.455</td>
<td>0.455</td>
<td>1.676</td>
<td>2.268</td>
<td>0.476</td>
<td>0.468</td>
</tr>
<tr>
<td>MARS3</td>
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<td>0.55</td>
<td>0.55</td>
<td>1.77</td>
<td>2.125</td>
<td>0.534</td>
<td>0.533</td>
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<tr>
<td>MARS4</td>
<td>1.084</td>
<td>1.315</td>
<td>0.319</td>
<td>0.319</td>
<td>1.185</td>
<td>1.500</td>
<td>0.243</td>
<td>0.040</td>
</tr>
<tr>
<td>MARS5</td>
<td>1.268</td>
<td>1.561</td>
<td>0.04</td>
<td>0.04</td>
<td>1.386</td>
<td>1.677</td>
<td>0.012</td>
<td>-0.199</td>
</tr>
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Table 14. Evaluation of the optimal models by training with testing dataset and testing with training dataset

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<tr>
<th>Model</th>
<th>MAE</th>
<th>RMSE</th>
<th>$R^2$</th>
<th>EMAE</th>
<th>MAE</th>
<th>RMSE</th>
<th>$R^2$</th>
<th>$E$</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANFIS-GP9</td>
<td>0.447</td>
<td>0.631</td>
<td>0.959</td>
<td>0.959</td>
<td>0.526</td>
<td>0.792</td>
<td>0.945</td>
<td>0.942</td>
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<tr>
<td>FG9</td>
<td>0.476</td>
<td>0.686</td>
<td>0.951</td>
<td>0.951</td>
<td>0.591</td>
<td>0.864</td>
<td>0.934</td>
<td>0.931</td>
</tr>
<tr>
<td>GRNN9</td>
<td>0.230</td>
<td>0.331</td>
<td>0.989</td>
<td>0.989</td>
<td>0.493</td>
<td>0.820</td>
<td>0.941</td>
<td>0.927</td>
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<td>LSSVM9</td>
<td>0.703</td>
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<td>0.907</td>
<td>0.784</td>
<td>1.170</td>
<td>0.882</td>
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<td>MARS9</td>
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<td>0.937</td>
<td>0.937</td>
<td>0.691</td>
<td>0.968</td>
<td>0.916</td>
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<tr>
<td>MLP9</td>
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<td>0.970</td>
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<td>0.481</td>
<td>0.735</td>
<td>0.953</td>
<td>0.950</td>
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</table>

Table 15. The MLP model performances tested at different stations with full weather inputs

<table>
<thead>
<tr>
<th>Station</th>
<th>MAE</th>
<th>RMSE</th>
<th>$R^2$</th>
<th>$E$</th>
<th>MAE</th>
<th>RMSE</th>
<th>$R^2$</th>
<th>$E$</th>
</tr>
</thead>
<tbody>
<tr>
<td>HEB</td>
<td>0.150</td>
<td>0.197</td>
<td>0.996</td>
<td>0.996</td>
<td>0.498</td>
<td>0.687</td>
<td>0.970</td>
<td>0.956</td>
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<tr>
<td>ALT</td>
<td>0.193</td>
<td>0.255</td>
<td>0.994</td>
<td>0.994</td>
<td>0.524</td>
<td>0.831</td>
<td>0.980</td>
<td>0.957</td>
</tr>
<tr>
<td>MQ</td>
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<td>0.542</td>
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<td>0.983</td>
<td>0.693</td>
<td>0.908</td>
<td>0.974</td>
<td>0.960</td>
</tr>
<tr>
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<td>0.992</td>
<td>0.468</td>
<td>0.813</td>
<td>0.930</td>
<td>0.921</td>
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<tr>
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<td>0.976</td>
<td>0.976</td>
<td>0.636</td>
<td>0.788</td>
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<td>0.876</td>
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<td>0.992</td>
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<td>0.934</td>
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<td>0.548</td>
<td>0.922</td>
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</table>