Distances from meteorological model points to meteorological station

```
         lat       lon  lat_st  lon_st  distance
0  42.881499 -8.432536  42.898  -8.418      2.18
1  42.917389 -8.429225  42.898  -8.418      2.34
2  42.879064 -8.383559  42.898  -8.418      3.51
3  42.914952 -8.380220  42.898  -8.418      3.61
4  42.883913 -8.481517  42.898  -8.418      5.40
```

All meteorological model variables:

```
 ['dir0' 'snow_prec0' 'snowlevel0' 'mod0' 'wind_gust0' 'mslp0' 'temp0'
 'rh0' 'visibility0' 'lhflx0' 'lwflx0' 'conv_prec0' 'prec0' 'swflx0'
 'shflx0' 'cape0' 'cin0' 'cfh0' 'cfl0' 'cfm0' 'cft0' 'HGT5000'
'HGT8500'
 'T5000' 'T8500' 'dir1' 'snow_prec1' 'snowlevel1' 'mod1' 'wind_gust1'
 'mslp1' 'temp1' 'rh1' 'visibility1' 'lhflx1' 'lwflx1' 'conv_prec1'
 'prec1' 'swflx1' 'shflx1' 'cape1' 'cin1' 'cfh1' 'cfl1' 'cfm1' 'cft1'
 'HGT5001' 'HGT8501' 'T5001' 'T8501' 'dir2' 'snow_prec2' 'snowlevel2'
 'mod2' 'wind_gust2' 'mslp2' 'temp2' 'rh2' 'visibility2' 'lhflx2'
'lwflx2'
 'conv_prec2' 'prec2' 'swflx2' 'shflx2' 'cape2' 'cin2' 'cfh2' 'cfl2'
 'cfm2' 'cft2' 'HGT5002' 'HGT8502' 'T5002' 'T8502' 'dir3' 'snow_prec3'
 'snowlevel3' 'mod3' 'wind_gust3' 'mslp3' 'temp3' 'rh3' 'visibility3'
 'lhflx3' 'lwflx3' 'conv_prec3' 'prec3' 'swflx3' 'shflx3' 'cape3'
'cin3'
 'cfh3' 'cfl3' 'cfm3' 'cft3' 'HGT5003' 'HGT8503' 'T5003' 'T8503'
'dir4'
 'snow_prec4' 'snowlevel4' 'mod4' 'wind_gust4' 'mslp4' 'temp4' 'rh4'
 'visibility4' 'lhflx4' 'lwflx4' 'conv_prec4' 'prec4' 'swflx4'
'shflx4'
 'cape4' 'cin4' 'cfh4' 'cfl4' 'cfm4' 'cft4' 'HGT5004' 'HGT8504'
'T5004'
 'T8504']
```

Observed labeled variable results

	Total	Percentage
> 1000 m	64917	98%
<= 1000 m	1650	2%

Compare meteorological model variables forecasted with observed variables

```
Model point: 0
 > 1000 m     0.908048
<= 1000 m    0.091952
Name: visibility0_1, dtype: float64
```

```
Confusion matrix
 visibility0_l  <= 1000 m  > 1000 m    All
var_o_l
<= 1000 m            732       918   1650
> 1000 m            5389     59528  64917
All                 6121     60446  66567
Heidke Skill Score: 0.16

Precision and entropy meteorologic model
 visibility0_l        <= 1000 m  > 1000 m  Climatology
<= 1000 m             0.119588  0.015187     0.024787
> 1000 m              0.880412  0.984813     0.975213
entropy/entropy.max   0.528176  0.113489     0.167534

Quality report meteorologic model
               precision    recall  f1-score       support
<= 1000 m      0.119588  0.443636  0.188393   1650.000000
> 1000 m       0.984813  0.916986  0.949690  64917.000000
accuracy       0.905253  0.905253  0.905253      0.905253
macro avg      0.552201  0.680311  0.569041  66567.000000
weighted avg   0.963367  0.905253  0.930820  66567.000000
************************************************************

Model point: 1
 > 1000 m     0.914282
<= 1000 m    0.085718
Name: visibility1_l, dtype: float64

Confusion matrix
 visibility1_l  <= 1000 m  > 1000 m    All
var_o_l
<= 1000 m            749       901   1650
> 1000 m            4957     59960  64917
All                 5706     60861  66567
Heidke Skill Score: 0.17

Precision and entropy meteorologic model
 visibility1_l        <= 1000 m  > 1000 m  Climatology
<= 1000 m             0.131265  0.014804     0.024787
> 1000 m              0.868735  0.985196     0.975213
entropy/entropy.max   0.560898  0.111177     0.167534

Quality report meteorologic model
               precision    recall  f1-score       support
<= 1000 m      0.131265  0.453939  0.203643   1650.000000
> 1000 m       0.985196  0.923641  0.953426  64917.000000
accuracy       0.911998  0.911998  0.911998      0.911998
macro avg      0.558231  0.688790  0.578535  66567.000000
weighted avg   0.964029  0.911998  0.934841  66567.000000
************************************************************

Model point: 2
 > 1000 m     0.940887
<= 1000 m    0.059113
Name: visibility2_l, dtype: float64
```

```
Confusion matrix
 visibility2_l  <= 1000 m  > 1000 m    All
var_o_l
<= 1000 m            561      1089   1650
> 1000 m            3374     61543  64917
All                 3935     62632  66567
Heidke Skill Score: 0.17

Precision and entropy meteorologic model
 visibility2_l        <= 1000 m  > 1000 m  Climatology
<= 1000 m             0.142567  0.017387     0.024787
> 1000 m              0.857433  0.982613     0.975213
entropy/entropy.max   0.590922  0.126508     0.167534

Quality report meteorologic model
               precision    recall  f1-score       support
<= 1000 m      0.142567  0.340000  0.200895   1650.000000
> 1000 m       0.982613  0.948026  0.965010  64917.000000
accuracy       0.932955  0.932955  0.932955      0.932955
macro avg      0.562590  0.644013  0.582952  66567.000000
weighted avg   0.961790  0.932955  0.946069  66567.000000
************************************************************

Model point: 3
 > 1000 m     0.924347
<= 1000 m    0.075653
Name: visibility3_l, dtype: float64

Confusion matrix
 visibility3_l  <= 1000 m  > 1000 m    All
var_o_l
<= 1000 m            676       974   1650
> 1000 m            4360     60557  64917
All                 5036     61531  66567
Heidke Skill Score: 0.17

Precision and entropy meteorologic model
 visibility3_l        <= 1000 m  > 1000 m  Climatology
<= 1000 m             0.134234  0.015829     0.024787
> 1000 m              0.865766  0.984171     0.975213
entropy/entropy.max   0.568935  0.117335     0.167534

Quality report meteorologic model
               precision    recall  f1-score      support
<= 1000 m      0.134234  0.409697  0.202214   1650.00000
> 1000 m       0.984171  0.932837  0.957817  64917.00000
accuracy       0.919870  0.919870  0.919870      0.91987
macro avg      0.559202  0.671267  0.580015  66567.00000
weighted avg   0.963103  0.919870  0.939087  66567.00000
************************************************************

Model point: 4
 > 1000 m     0.897952
<= 1000 m    0.102048
Name: visibility4_l, dtype: float64
```

```
Confusion matrix
 visibility4_l  <= 1000 m  > 1000 m    All
var_o_l
<= 1000 m            760       890   1650
> 1000 m            6033     58884  64917
All                 6793     59774  66567
Heidke Skill Score: 0.15

Precision and entropy meteorologic model
 visibility4_l        <= 1000 m  > 1000 m  Climatology
<= 1000 m             0.11188  0.014889     0.024787
> 1000 m              0.88812  0.985111     0.975213
entropy/entropy.max   0.50556  0.111693     0.167534

Quality report meteorologic model
               precision    recall  f1-score    support
<= 1000 m      0.111880  0.460606  0.180031   1650.000
> 1000 m       0.985111  0.907066  0.944479  64917.000
accuracy       0.896000  0.896000  0.896000      0.896
macro avg      0.548495  0.683836  0.562255  66567.000
weighted avg   0.963466  0.896000  0.925530  66567.000
```

Correlation observed variable and meterological model threshold: 0.3

```
             visibility_o
cfl2            -0.387654
cfl0            -0.387489
cfl1            -0.386692
cfl3            -0.384712
cfl4            -0.383594
rh4             -0.354194
rh3             -0.353213
rh2             -0.351426
rh0             -0.347093
rh1             -0.345263
cft4            -0.342895
cft0            -0.342222
cft1            -0.341597
cft3            -0.338966
cft2            -0.336875
visibility2      0.344923
visibility3      0.357524
visibility1      0.365982
visibility0      0.382084
visibility4      0.407318
```

AI results

```
Confusion matrix
 col_0      <= 1000 m  > 1000 m   All
row_0
<= 1000 m         79       105   184
> 1000 m         207      6266  6473
All               286      6371  6657
************************************
```

```
Precision and entropy AI
 col_0                <= 1000 m  > 1000 m  Climatology
<= 1000 m             0.276224  0.016481     0.027640
> 1000 m              0.723776  0.983519     0.972360
entropy/entropy.max   0.850254  0.121197     0.182415
Heidke Skill Score: 0.31
************************************
```

```
Quality report AI
               precision    recall  f1-score      support
<= 1000 m      0.276224  0.429348  0.336170   184.000000
> 1000 m       0.983519  0.968021  0.975709  6473.000000
accuracy       0.953132  0.953132  0.953132     0.953132
macro avg      0.629871  0.698684  0.655939  6657.000000
weighted avg   0.963969  0.953132  0.958032  6657.000000
```

meteorological model variables selected:

```
 ['dir0' 'snow_prec0' 'snowlevel0' 'mod0' 'wind_gust0' 'mslp0'
'temp0'
 'rh0' 'visibility0' 'lhflx0' 'lwflx0' 'conv_prec0' 'prec0'
'swflx0'
 'shflx0' 'cape0' 'cin0' 'cfh0' 'cfl0' 'cfm0' 'cft0' 'HGT5000'
'HGT8500'
 'T5000' 'T8500' 'dir1' 'snow_prec1' 'snowlevel1' 'mod1'
'wind_gust1'
 'mslp1' 'temp1' 'rh1' 'visibility1' 'lhflx1' 'lwflx1' 'conv_prec1'
 'prec1' 'swflx1' 'shflx1' 'cape1' 'cin1' 'cfh1' 'cfl1' 'cfm1'
'cft1'
 'HGT5001' 'HGT8501' 'T5001' 'T8501' 'dir2' 'snow_prec2'
'snowlevel2'
 'mod2' 'wind_gust2' 'mslp2' 'temp2' 'rh2' 'visibility2' 'lhflx2'
'lwflx2'
 'conv_prec2' 'prec2' 'swflx2' 'shflx2' 'cape2' 'cin2' 'cfh2'
'cfl2'
 'cfm2' 'cft2' 'HGT5002' 'HGT8502' 'T5002' 'T8502' 'dir3'
'snow_prec3'
 'snowlevel3' 'mod3' 'wind_gust3' 'mslp3' 'temp3' 'rh3'
'visibility3'
 'lhflx3' 'lwflx3' 'conv_prec3' 'prec3' 'swflx3' 'shflx3' 'cape3'
'cin3'
 'cfh3' 'cfl3' 'cfm3' 'cft3' 'HGT5003' 'HGT8503' 'T5003' 'T8503'
'dir4'
 'snow_prec4' 'snowlevel4' 'mod4' 'wind_gust4' 'mslp4' 'temp4'
'rh4'
 'visibility4' 'lhflx4' 'lwflx4' 'conv_prec4' 'prec4' 'swflx4'
'shflx4'
 'cape4' 'cin4' 'cfh4' 'cfl4' 'cfm4' 'cft4' 'HGT5004' 'HGT8504'
'T5004'
 'T8504']
```

Cross validation:

```
Splits number: 5
Test size: 0.1
```

```
f1_weighted: 0.97 (+/- 0.00)
Accuracy: 0.98 (+/- 0.00)

AI model: LGBMClassifier(n_estimators=250)

Library versions

sklearn: 1.0.2
pandas: 1.3.5
numpy: 1.21.6
```

Best AI results

```
Confusion matrix
 col_0      <= 1000 m  > 1000 m   All
row_0
<= 1000 m         71       100   171
> 1000 m          66      6420  6486
All              137      6520  6657
**************************************

Precision and entropy AI
 col_0                <= 1000 m  > 1000 m  Climatology
<= 1000 m             0.518248  0.015337     0.025687
> 1000 m              0.481752  0.984663     0.974313
entropy/entropy.max   0.999039  0.114392     0.172279
Heidke Skill Score: 0.45
**************************************

Quality report AI
               precision    recall  f1-score      support
<= 1000 m      0.518248  0.415205  0.461039   171.000000
> 1000 m       0.984663  0.989824  0.987237  6486.000000
accuracy       0.975064  0.975064  0.975064     0.975064
macro avg      0.751455  0.702514  0.724138  6657.000000
weighted avg   0.972682  0.975064  0.973720  6657.000000


meteorological model variables selected:
 ['dir0' 'snow_prec0' 'snowlevel0' 'mod0' 'wind_gust0' 'mslp0'
'temp0'
 'rh0' 'visibility0' 'lhflx0' 'lwflx0' 'conv_prec0' 'prec0'
'swflx0'
 'shflx0' 'cape0' 'cin0' 'cfh0' 'cfl0' 'cfm0' 'cft0' 'HGT5000'
'HGT8500'
 'T5000' 'T8500' 'dir1' 'snow_prec1' 'snowlevel1' 'mod1'
'wind_gust1'
 'mslp1' 'temp1' 'rh1' 'visibility1' 'lhflx1' 'lwflx1' 'conv_prec1'
 'prec1' 'swflx1' 'shflx1' 'cape1' 'cin1' 'cfh1' 'cfl1' 'cfm1'
'cft1'
 'HGT5001' 'HGT8501' 'T5001' 'T8501' 'dir2' 'snow_prec2'
'snowlevel2'
 'mod2' 'wind_gust2' 'mslp2' 'temp2' 'rh2' 'visibility2' 'lhflx2'
'lwflx2'
 'conv_prec2' 'prec2' 'swflx2' 'shflx2' 'cape2' 'cin2' 'cfh2'
'cfl2'
```

```
 'cfm2' 'cft2' 'HGT5002' 'HGT8502' 'T5002' 'T8502' 'dir3'
'snow_prec3'
 'snowlevel3' 'mod3' 'wind_gust3' 'mslp3' 'temp3' 'rh3'
'visibility3'
 'lhflx3' 'lwflx3' 'conv_prec3' 'prec3' 'swflx3' 'shflx3' 'cape3'
'cin3'
 'cfh3' 'cfl3' 'cfm3' 'cft3' 'HGT5003' 'HGT8503' 'T5003' 'T8503'
'dir4'
 'snow_prec4' 'snowlevel4' 'mod4' 'wind_gust4' 'mslp4' 'temp4'
'rh4'
 'visibility4' 'lhflx4' 'lwflx4' 'conv_prec4' 'prec4' 'swflx4'
'shflx4'
 'cape4' 'cin4' 'cfh4' 'cfl4' 'cfm4' 'cft4' 'HGT5004' 'HGT8504'
'T5004'
 'T8504']

Cross validation:

Splits number: 5
Test size: 0.1

f1_weighted: 0.97 (+/- 0.00)
Accuracy: 0.98 (+/- 0.00)

AI model: ExtraTreesClassifier(n_estimators=200)

Library versions

sklearn: 1.0.2
pandas: 1.3.5
numpy: 1.21.6
```