Supplement to the article

Weather Type Reconstruction using Machine Learning Approaches

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S.1 Predictor correlations

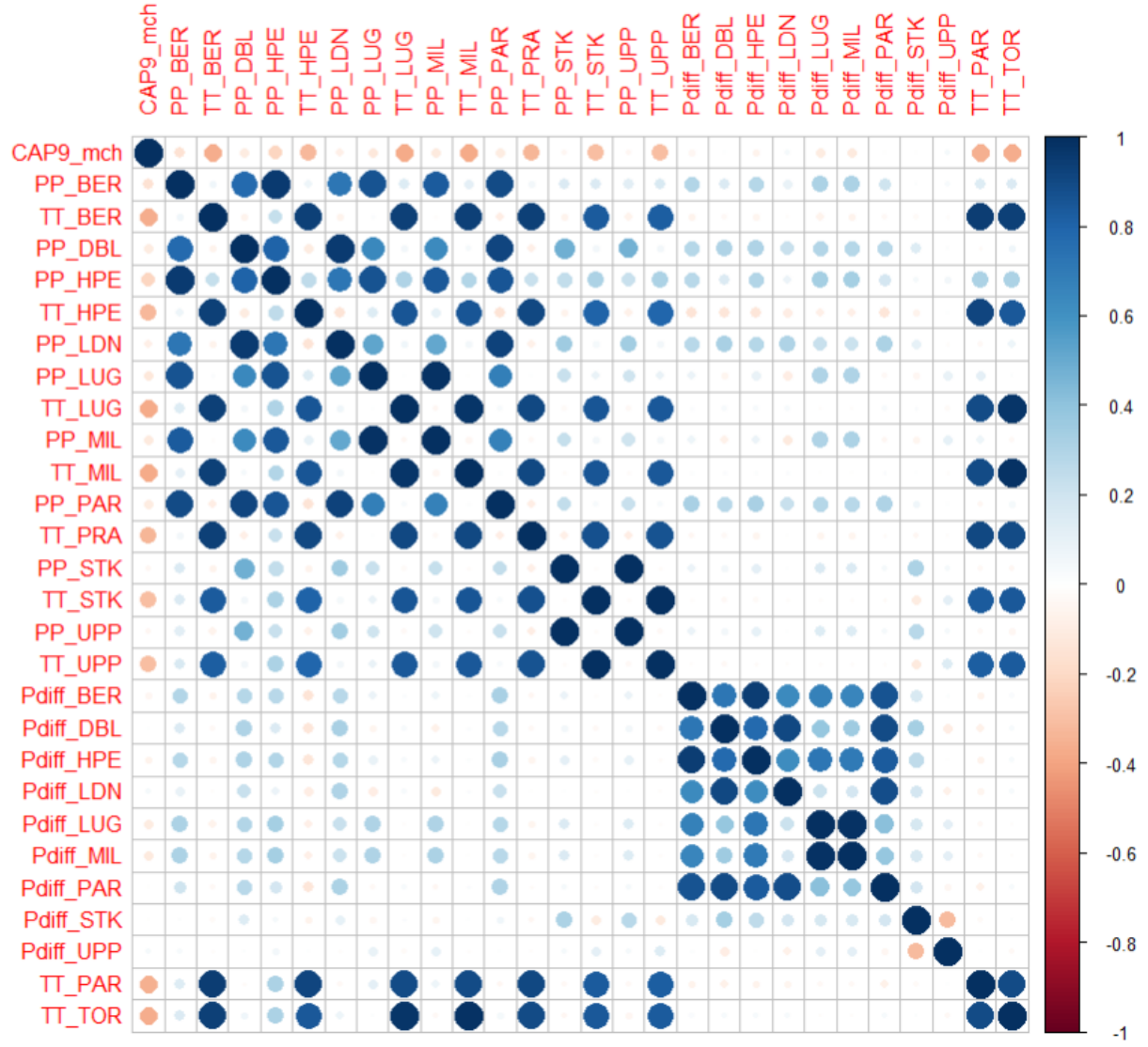

Figure S1.1*: Correlations between variables used for the model comparison including the weather types (CAP9_mch). Shown are pearson correlations for the SMD station set with 11 stations as used by Schwander et al. (2017)*

S.2 Multinomial logistic regression (MLG) model coefficients and fitted relationships

***Table S2.1**: Coefficients β_n of the six MLG predictands (PP_MIL, PP_PAR, TT_PRA, TT_STK, Pdiff_MIL and Pdiff_STK) for each CAP9 class. Class one is taken as reference. All predictands are highly significant (not shown).*

Class	Intercept	PP_MIL	PP_PAR	TT_PRA	TT_STK	Pdiff_MIL	Pdiff_STK
2	686.3291	-0.0633	-0.6142	0.1239	-0.1066	-0.0765	-0.0810
3	-998.7799	1.0667	-0.0846	-0.0116	-0.0506	-0.0334	-0.0330
4	-1352.5444	0.9168	0.4126	-0.2003	0.1352	0.0356	0.0510
5	-2597.8647	2.0411	0.5076	-0.3536	0.1913	0.0164	0.0499
6	1334.6536	-0.9174	-0.4009	0.0436	-0.0416	-0.0270	-0.0285
7	2034.2208	-0.9707	-1.0427	0.2170	-0.1497	-0.1160	-0.1034
8	-4061.5719	2.9962	0.9768	-0.6759	0.3139	0.0585	0.0834
9	2957.1726	-1.7344	-1.1998	0.2361	-0.1795	-0.0607	-0.0881

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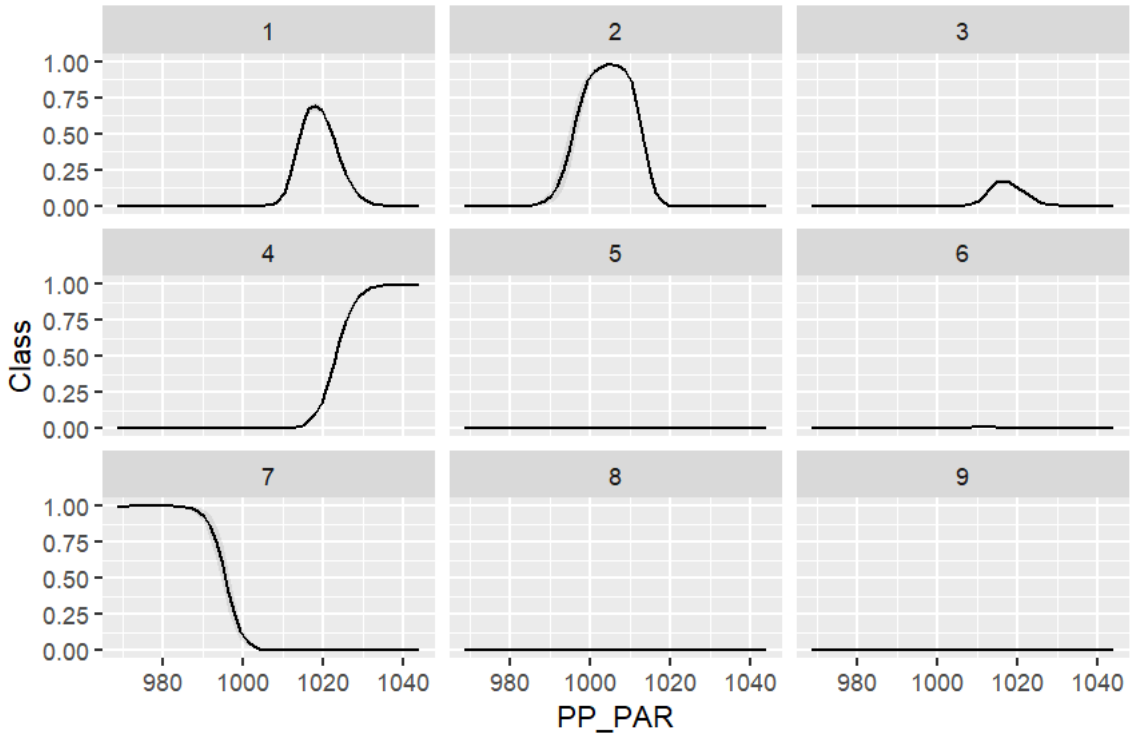


***Figure S2.1**: Fitted model relationships of the predictand PP_PAR per CAP9 class. The probability of the respective class (y-axes) is plotted against the values of PP_PAR in hPa (x-axes).*

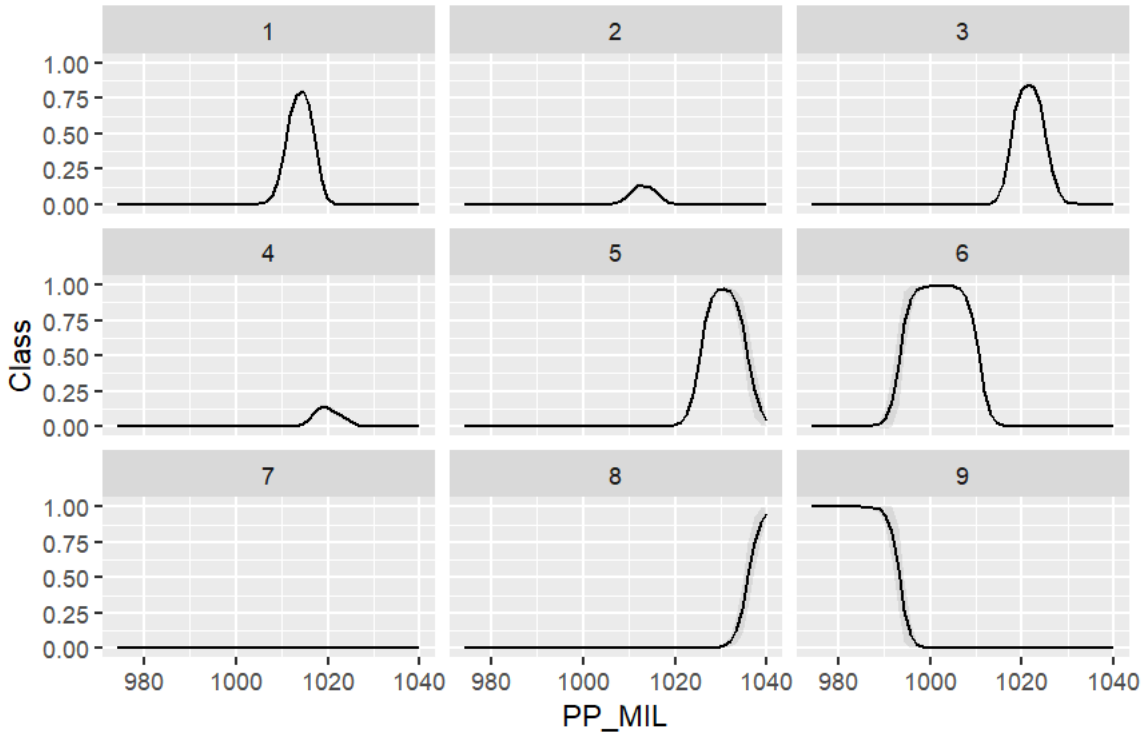


***Figure S2.2**: As figure S2.1, but for PP_MIL.*

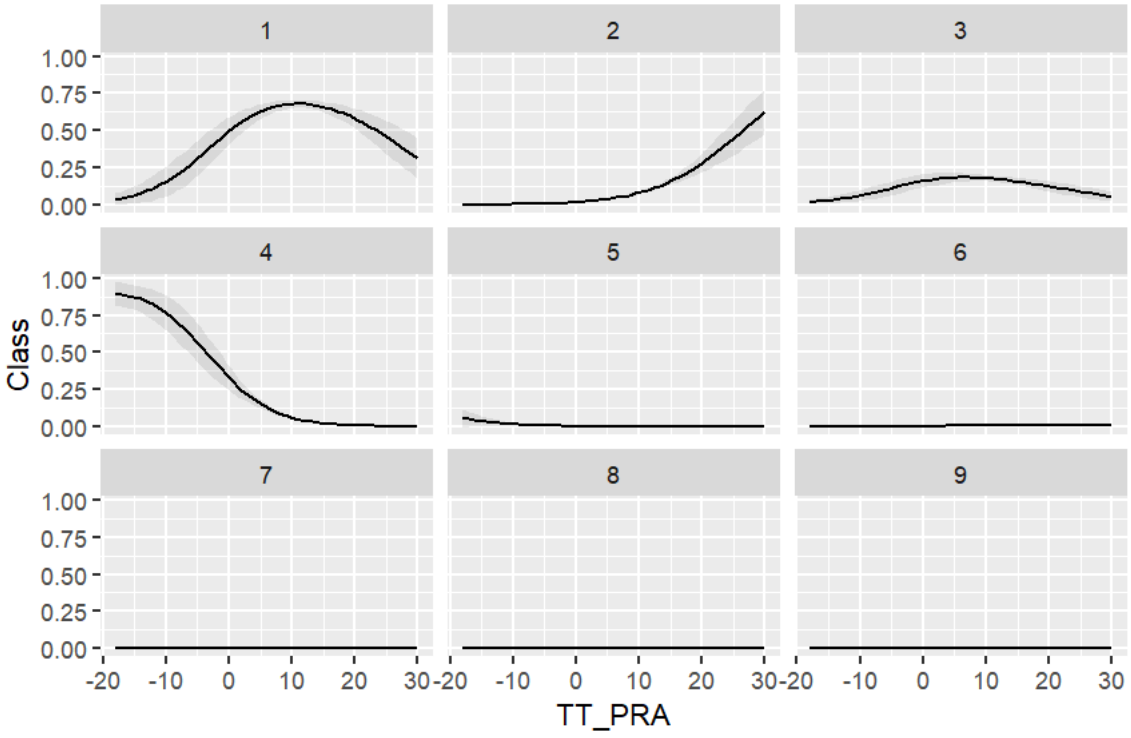


***Figure S2.3**: As figure S2.1, but for TT_PRA.*

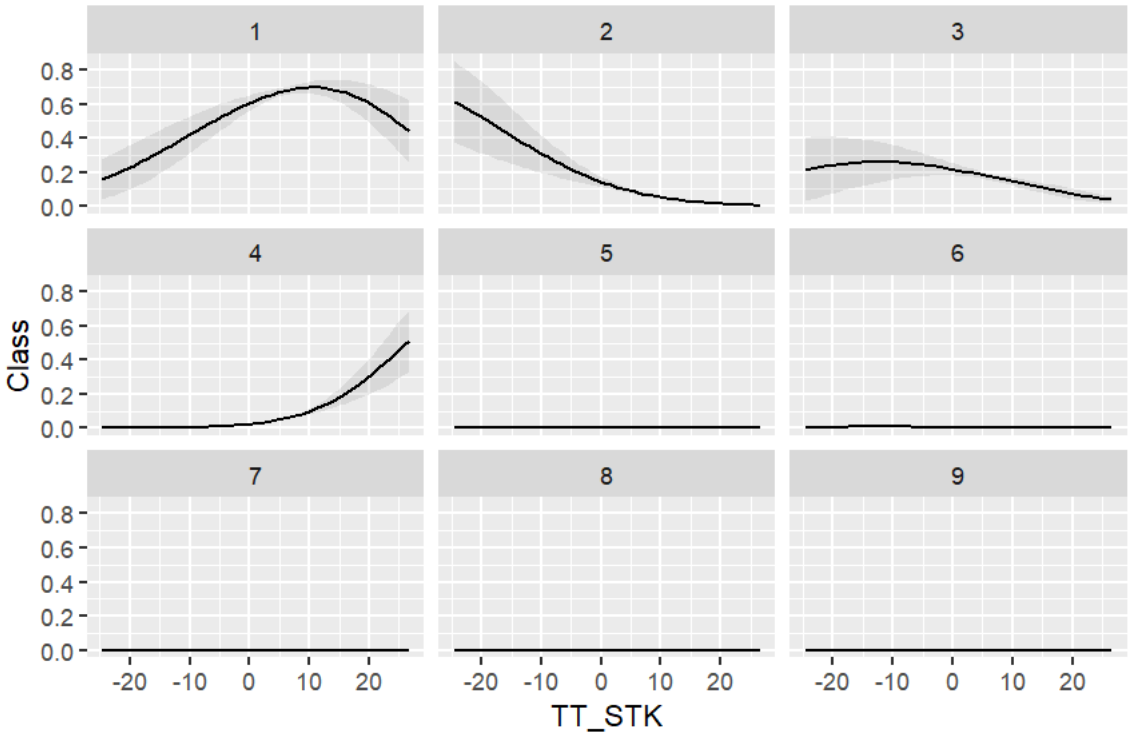


***Figure S2.4**: As figure S2.1, but for TT_STK.*

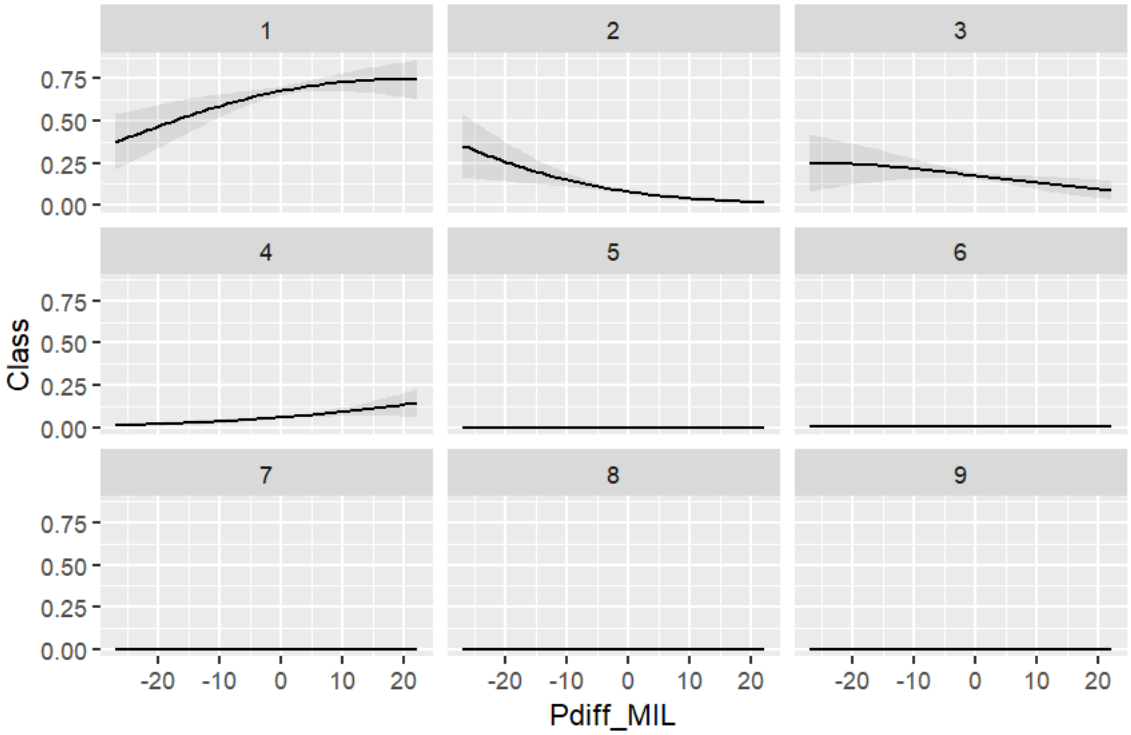


***Figure S2.5**: As figure S2.1, but for Pdiff_MIL.*

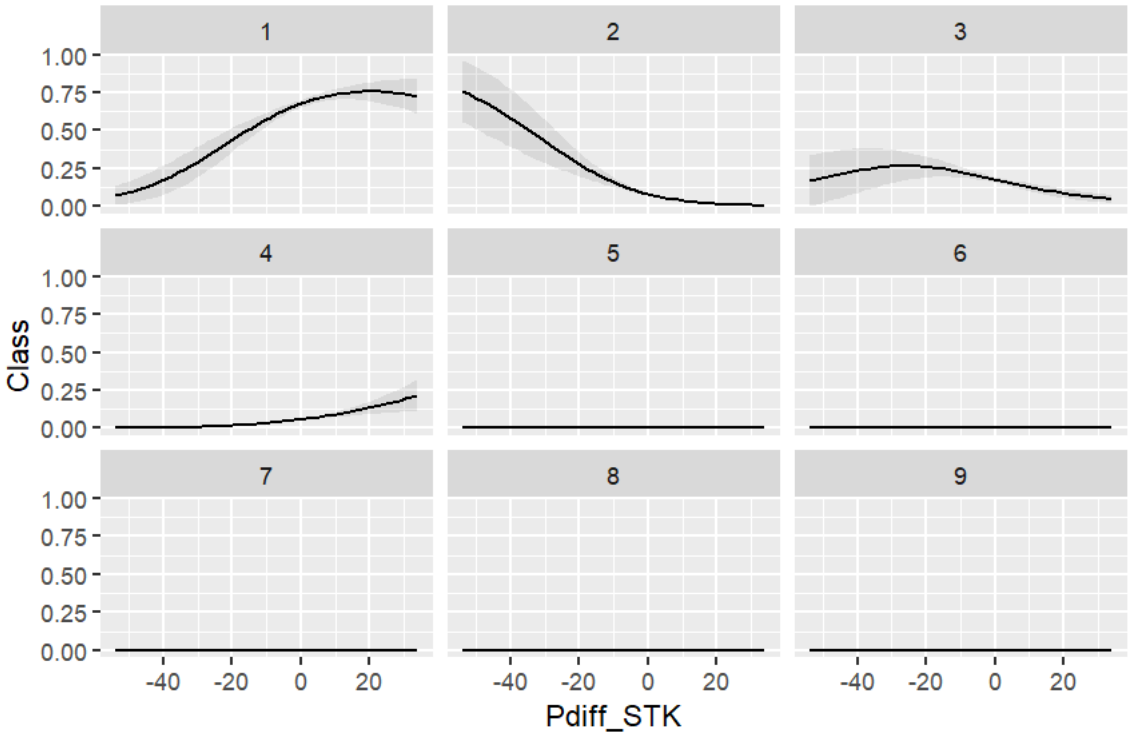


***Figure S2.6**: As figure S2.1, but for Pdiff_STK.*

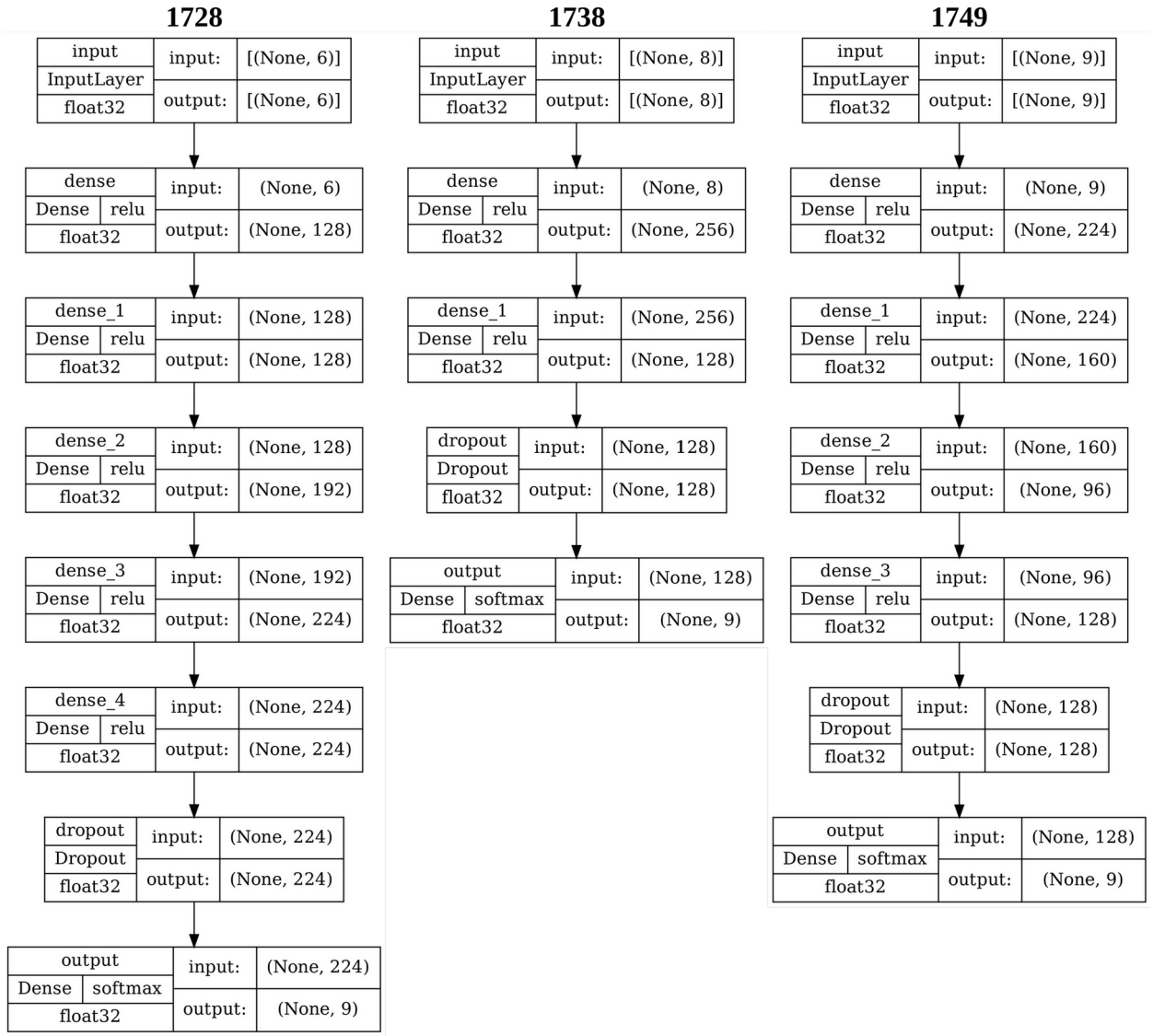
S.3 Random Forests (RF): Feature Importance

Feature importance (average reduction of the Gini impurity or entropy in the split classes for each feature (predictor) over all trees) of the random forest input data on the example of the SMD stationset with 11 stations as used by Schwander et al. (2017)

input Variable	feature importance	input Variable	feature importance
PP_LUG	0.1580	**TT_SMA**	0.0106
PP_MIL	0.1434	**TT_TOR**	0.0105
PP_DBL	0.1057	**TT_PAR**	0.0093
PP_BAS	0.0811	**TT_UPP**	0.0077
PP_SMA	0.0804	**TT_STK**	0.0075
PP_HPE	0.0712	**Pdiff_DBL**	0.0069
PP_PAR	0.0606	**Pdiff_HPE**	0.0067
PP_BER	0.0473	**Pdiff_STK**	0.0066
PP_LDN	0.0433	**Pdiff_MIL**	0.0065
PP_STK	0.0139	**Pdiff_LDN**	0.0063
PP_UPP	0.0127	**Pdiff_PAR**	0.0063
TT_PRA	0.0119	**Pdiff_BAS**	0.0061
TT_LUG	0.0118	**Pdiff_BER**	0.0059
TT_HPE	0.0117	**Pdiff_LUG**	0.0058
TT_BER	0.0112	**Pdiff_UPP**	0.0058
TT_MIL	0.0110	**Pdiff_SMA**	0.0057
TT_BAS	0.0108		

S.4 Neural Network (NN) Architectures

Architectures of the best neural network (NN) models for the input data station sets used for the CAP9 reconstructions. They typically contain between 2 and 5 layers (with between 32 and 224 neurons) and (as predefined) a dropout layer. Input and output layers are shown for completeness. The following flowcharts indicate on the left the layer type (in the terminology of the keras library), the activation function (relu or softmax), and the data format, and on the right the size of the input and output of the respective layers. The dimension 'None' represents the variable time dimension.



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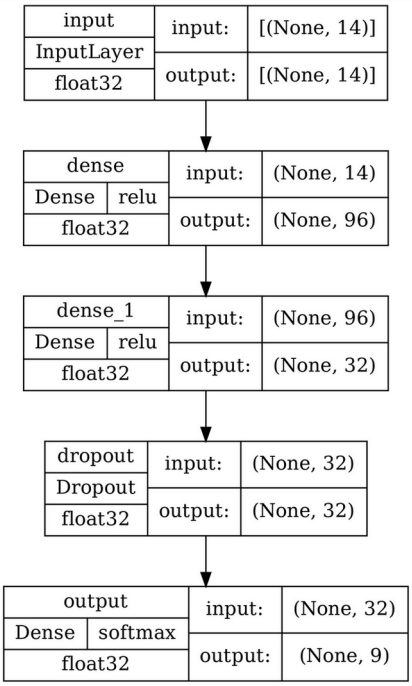

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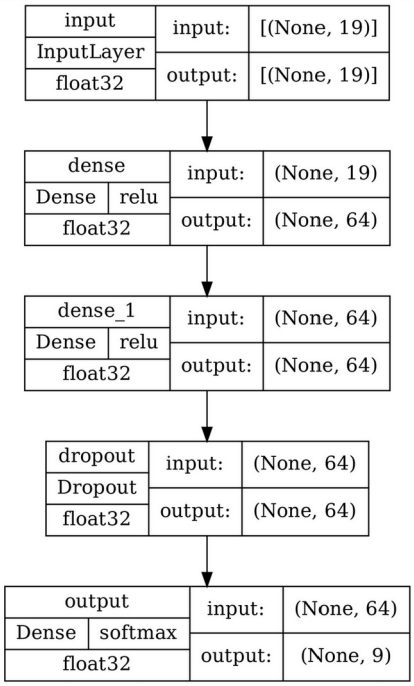

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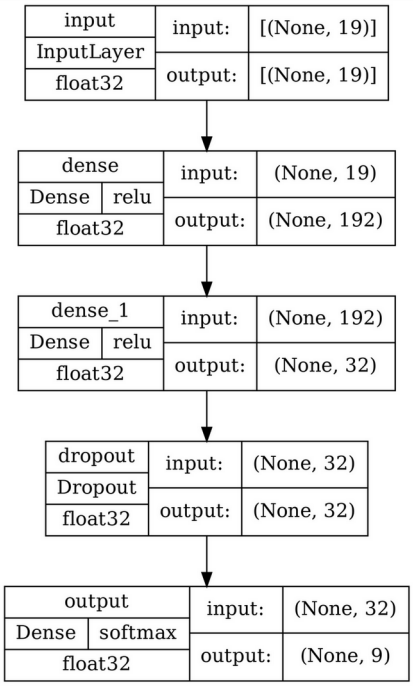

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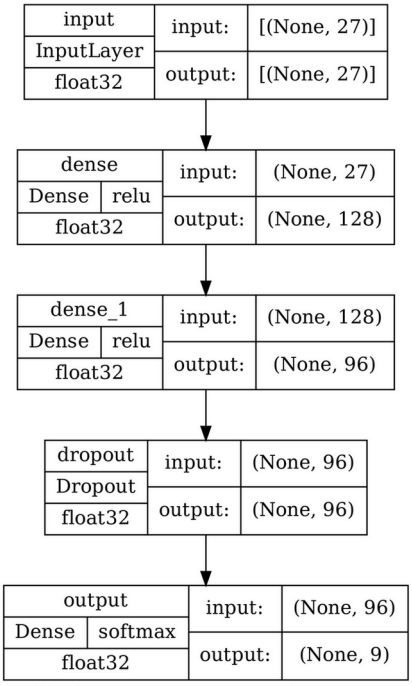

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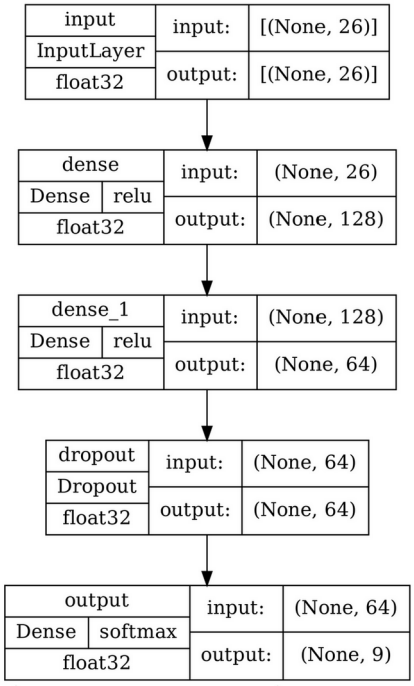

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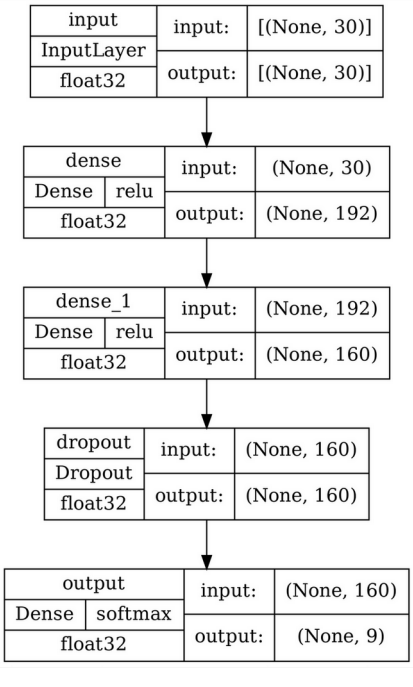
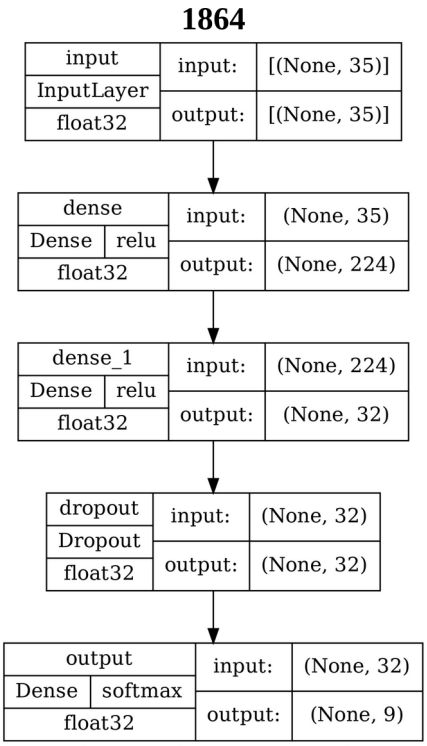
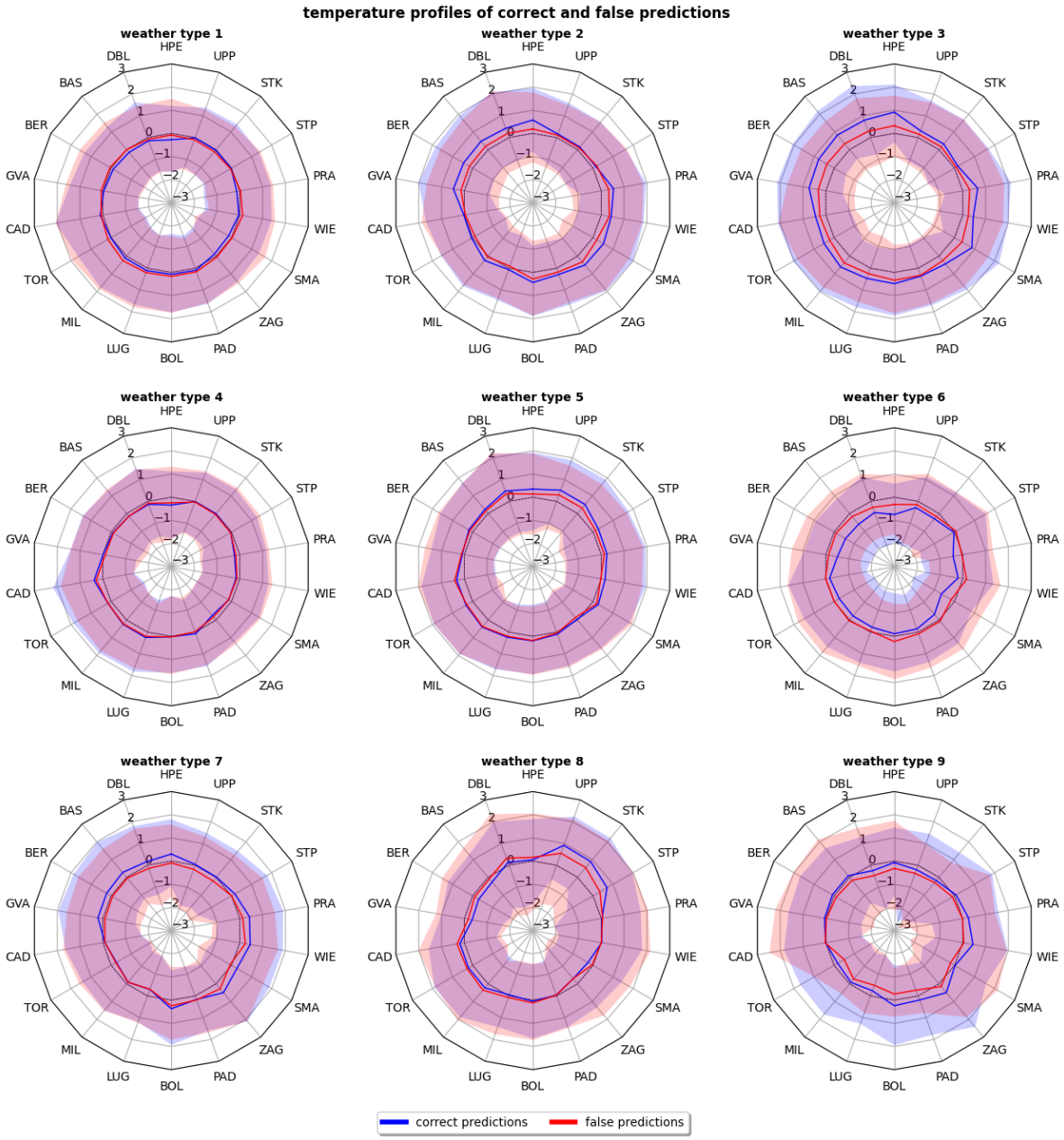



1864
input
InputLayer
float32
input:
[(None, 35)]
output:
[(None, 35)]
dense
Dense
relu
float32
input:
(None, 35)
output:
(None, 224)
dense_1
Dense
relu
float32
input:
(None, 224)
output:
(None, 32)
dropout
Dropout
float32
input:
(None, 32)
output:
(None, 32)
output
Dense
softmax
float32
input:
(None, 32)
output:
(None, 9)

S.5 Additional Analyses of CAP9 Reconstructions



40 ***Figure S5.1:*** *station observation profiles in standard deviations for correctly and wrongly predicted CAP9 weather types as in Fig. 4, but for temperature.*

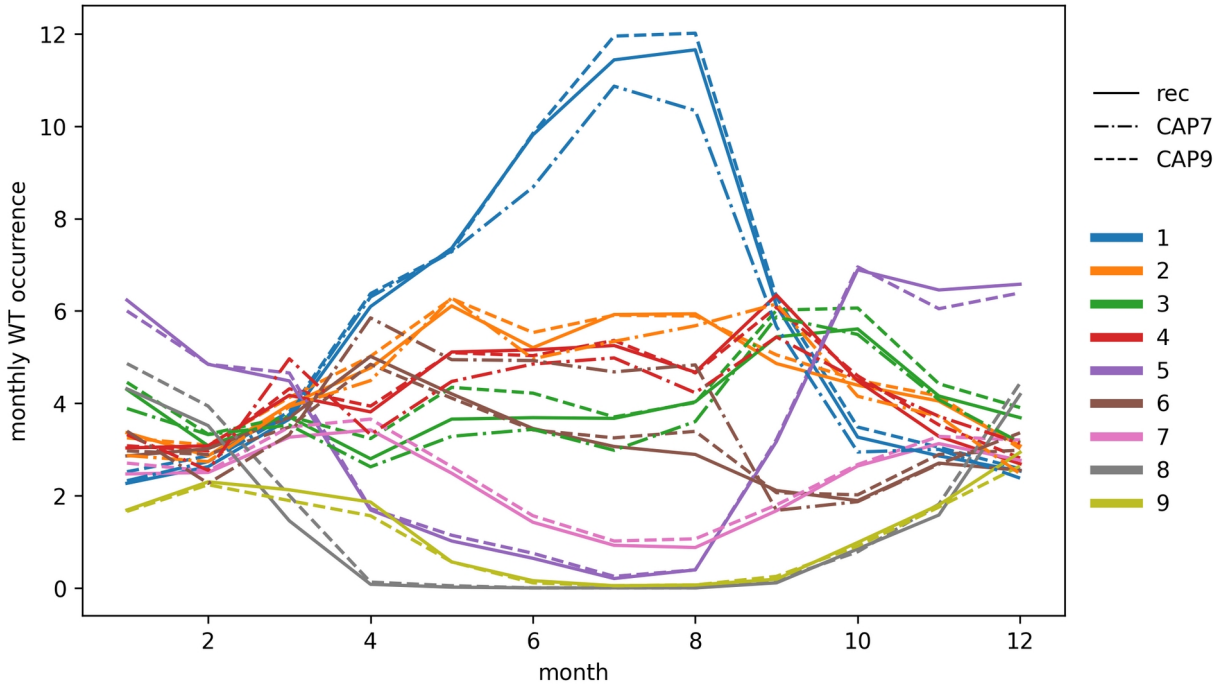


Figure S5.2: *average WT seasonality 1957–2020 for reference CAP9 series (dashed line), CAP9 reconstructions (solid lines), and CAP7 reconstructions (dash-dotted lines, Schwander et al., 2017).*