Supplement of

Assessing the performance of various fire weather indices for wildfire occurrence in Northern Switzerland

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1 Assessment of fire weather indices using AUC

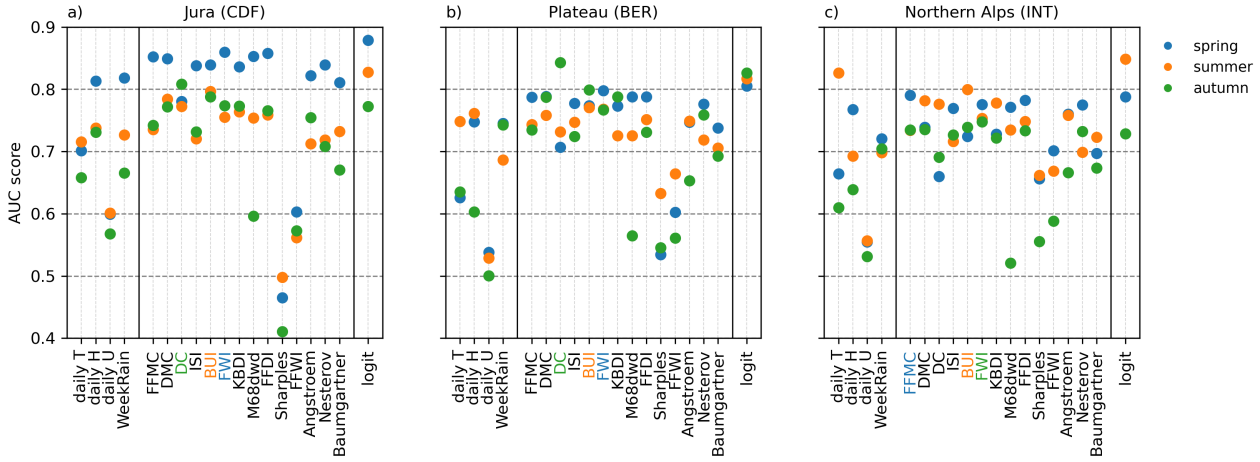

Figure S1. The mean k-fold AUC score for the different fire weather indices, meteorological variables and logistic regression (using daily means as input) for the three ecoregions of the canton of Bern. a) Jura, b) Plateau and c) Northern Alps. The colors indicate the season.

2 Probability density distribution

Since the ranked percentile score evaluates how extreme the index values are during fire days compared to non-fire days, we have a closer look at the probability density function (PDF) of the best-performing index and its input components. An index is most efficient and has a high percentile score if the PDF of fire days and non-fire days are clearly separated, i.e. if the overlap between the PDFs is small. Comparing the PDFs can be further used to find appropriate thresholds for the warning levels (low, moderate, high fire danger) depending on the risk appetite of the local fire management agencies, for example only allowing 5% of the summer days to have high fire danger level (de Jong et al., 2016). As an example, Figure S2 shows the PDFs of daily index values (FFMC for spring, BUI for summer and DC for autumn) computed over fire days (orange) and over non-fire days (blue) for the ecoregion Plateau from 1981 to 2020, and in addition we show the PDFs of the meteorological variables and the logit model. During fire days, the index values are higher than during non-fire days and we obtain statistically significant difference (using a 5% significance level) from applying the non-parametric Mann-Whitney-U-Test (Mann and Whitney, 1947) comparing the PDFs between fire and non-fire days ($p = 0.000$). However, the PDFs also highlight that there is a large overlap and that most fires occurred at days with a moderate index value (dimensionless). Comparing the PDFs of the meteorological input variables highlights their relative importance in determining the severity of the indices and logit, with daily T the most important variable in summer, daily H the most important variable in spring, and WeekRain and daily U in autumn. During fire days in spring (Figure S2a), the weather was significantly drier, and there was a higher probability for no rain during the past week (all p-values < 0.05). During summer Figure S2b), the weather was significantly warmer and drier. During autumn Figure S2c), the weather was significantly drier and windier. Interestingly, there is no significant difference in daily T during fire and non-fire days in spring and autumn ($p > 0.05$). However, the highest frequencies of fire occurred not during extreme weather conditions, but rather during mild conditions with no rain, though fires also occurred during days with considerable amount of rain during the past week ($>$ 50mm per week). The PDFs show that fires are found to ignite under a wide range of weather conditions, owing to the fact that human activities may provide enough initial energy for igniting even when fuel moisture level is not extremely low. PDFs highlight the results obtained with the ranked percentile score for Plateau (see again Figure 3b) and further demonstrate the overall difficulty in distinguishing fire days from non-fire days using only meteorological information. The normalized Wasserstein distance "d" (Ramdas et al., 2015) calculated between the PDFs of fire and non-fire days shows that the logit has the largest distance ($d > 0.3$), therefore it yields the clearest distinction between fire and non-fire days and a better predictive power of fire occurrence than the best-performing indices (except DC in autumn, which we can also see in Figure 3b) or single meteorological input variables.

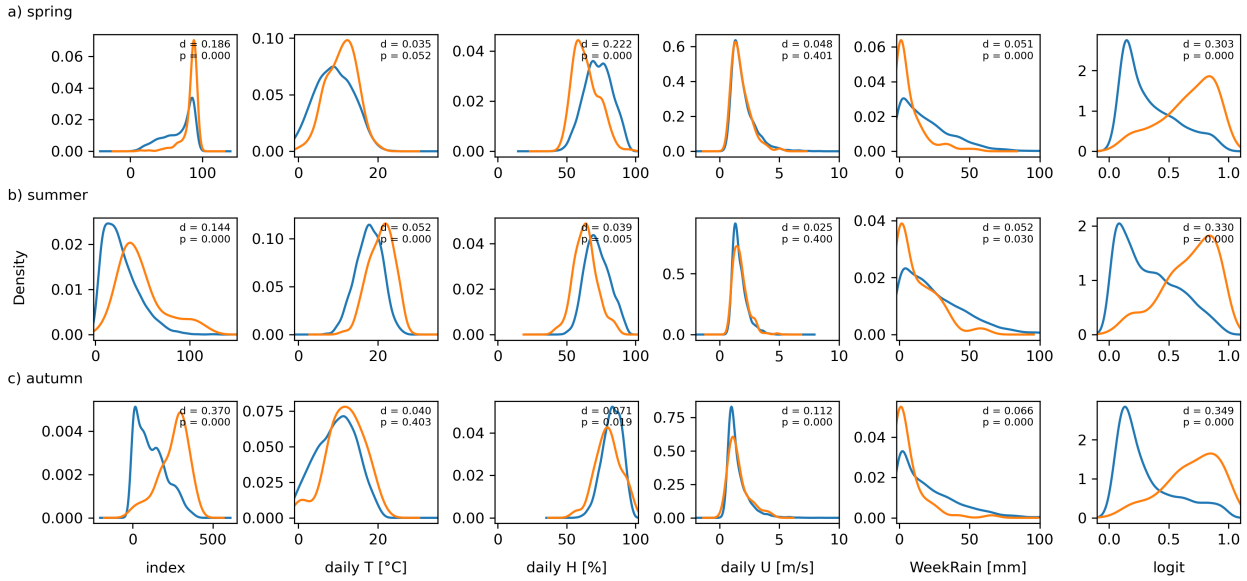

Figure S2. Probability densities of fire days (orange) and non-fire days (blue) for the CFFWIS indices FFMC (spring), BUI (summer) and DC (autumn), the meteorological variables (daily T, H, U, and WeekRain) and logistic regression model for the region Plateau for the seasons a) spring, b) summer and c) autumn. Normalized Weissstein distance "d" and p-value of the Mann-Whitney-U-Test between fire days and non-fire days are indicated.

References

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