Supplementary material to:

Exploring Hybrid Forecasting Frameworks for Subseasonal Low Flow Predictions in the European Alps

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Parameter	Value
Learning Rate	0.001
Hidden Size	128
LSTM Layers	2
Attention Head Size	2
Dropout	0.1
Hidden Continuous Size	8
Output Size	7 (Number of quantiles)
Loss Function	QuantileLoss()
Logging Frequency	Every 10 batches
Reduce on Plateau Patience	4

Table S1. Model Architecture for all Temporal Fusion Transformer models trained in this study
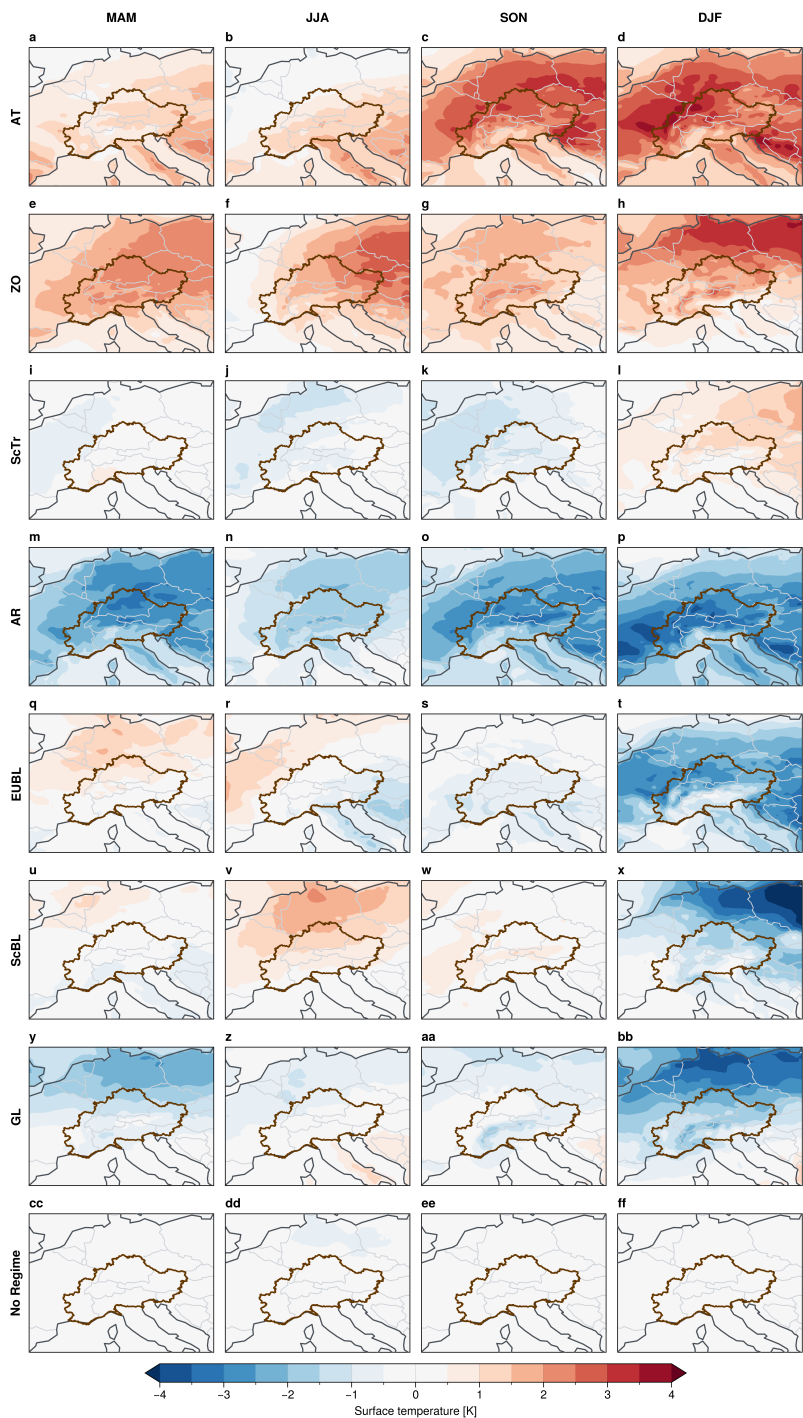
Figure S1. ERA5 Temperature anomalies associated with each of the seven weather regimes plus the no-regime. Anomalies computed with respect to climatology between the years 1999 - 2018. AT - Atlantic Trough, ZO - Zonal, ScTr - Scandinavian Trough, AR - Atlantic Ridge, EUBL - European Blocking, ScBL - Scandinavian Blocking, GL - Greenland Blocking.
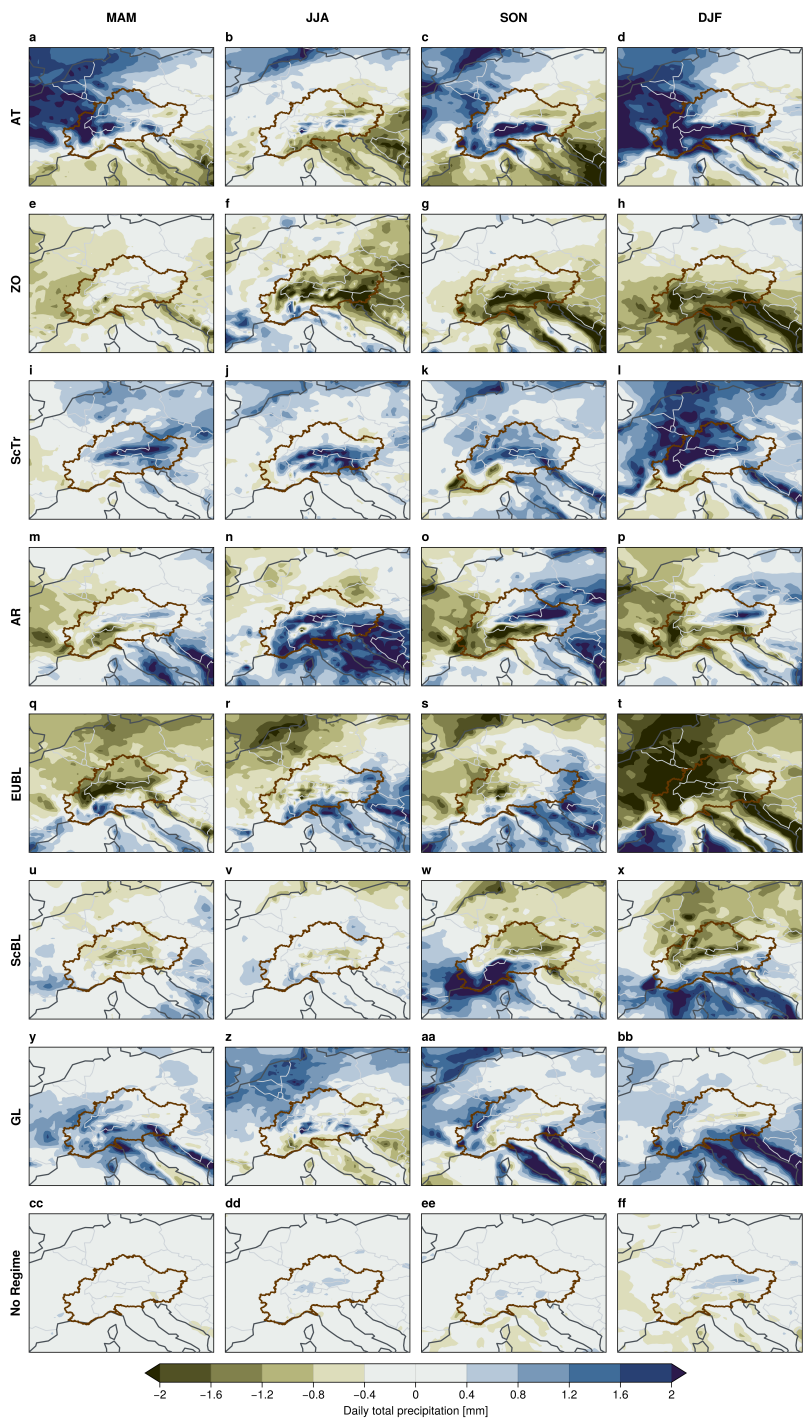
Figure S2. ERA5 total precipitation anomalies for each season associated with each of the seven weather regimes plus the no-regime. Anomalies computed with respect to climatology between the years 1999 - 2018. AT - Atlantic Trough, ZO - Zonal, ScTr - Scandinavian Trough, AR - Atlantic Ridge, EUBL - European Blocking, ScBL - Scandinavian Blocking, GL - Greenland Blocking
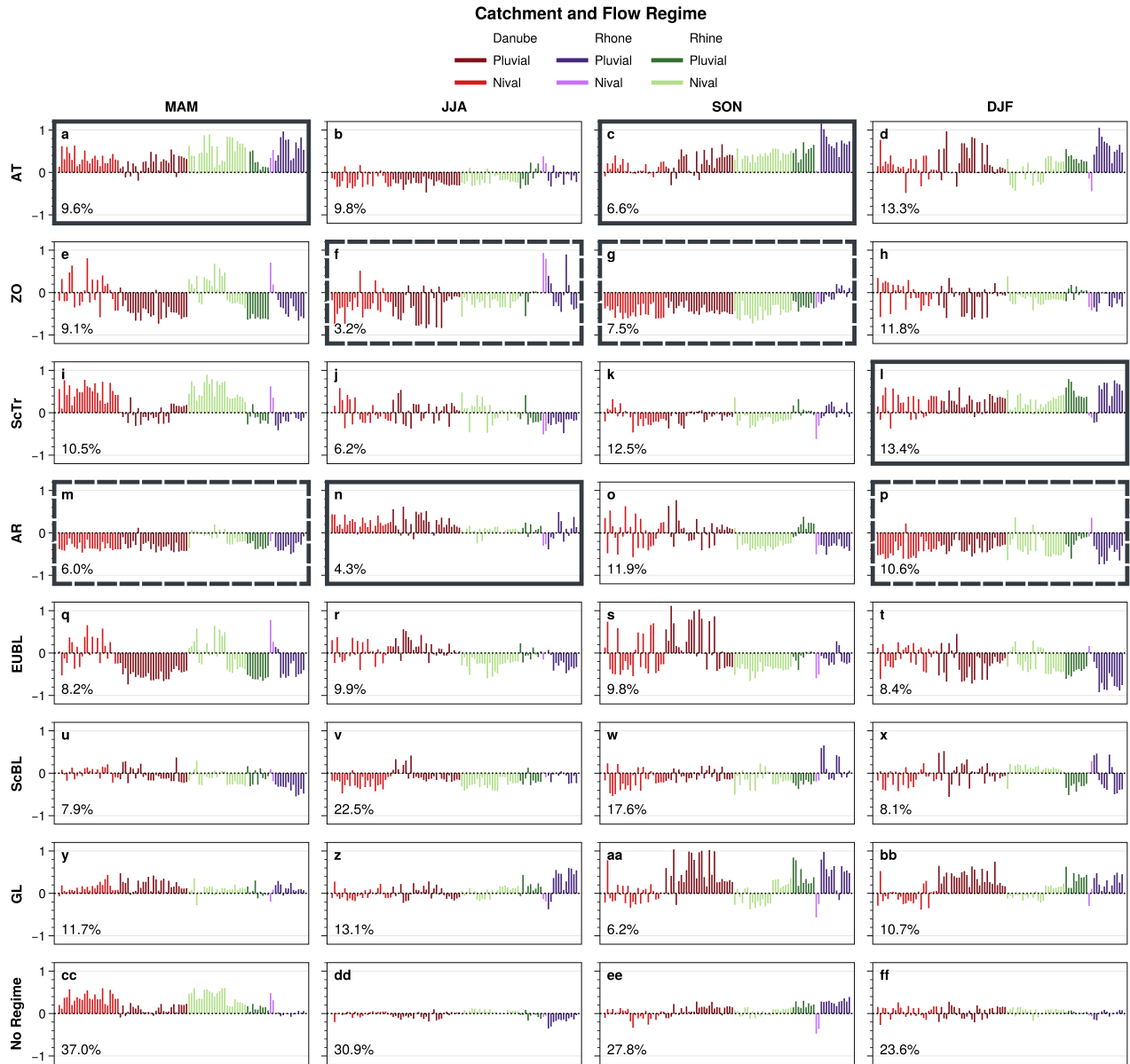
Figure S3. Standardized streamflow anomalies associated with seven weather regimes and a no-regime regime, sorted by season. Each line within the panels represents a station, grouped by river basins, which are color-coded (excluding the river Po due to limited data). Within each basin, stations are further divided by flow regime and ordered by catchment area (smallest to largest). A positive streamflow anomaly indicates higher-than-climatology flow, while a negative streamflow anomaly indicates lower-than-climatology flow. For each season, the regimes with the strongest positive and negative anomalies are highlighted with bold and dashed thick borders, respectively. The percentage in the lower-left corner of each panel shows the occurrence frequency of the respective weather regime in the corresponding season. AT - Atlantic Trough, ZO - Zonal, ScTr - Scandinavian Trough, AR - Atlantic Ridge, EUBL - European Blocking, ScBL - Scandinavian Blocking, GL - Greenland Blocking
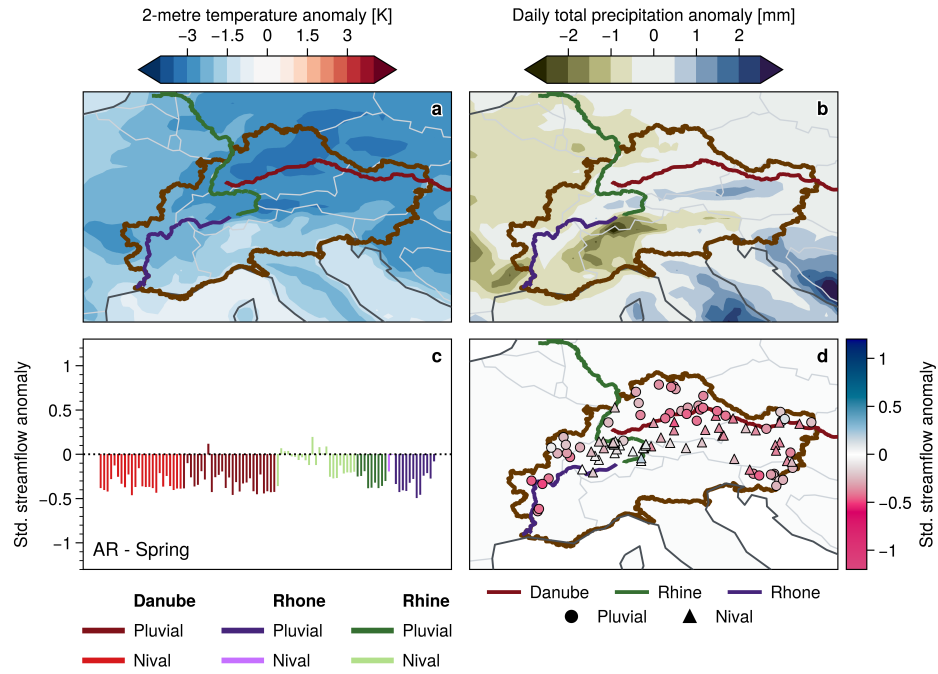
Figure S4. Composite of surface weather anomalies and streamflow anomalies during Atlantic Ridge (AR) regime days in spring (March-April-May). Shown in surface temperature (a), daily accumulated total precipitation (b), standardized streamflow anomaly for different stations (c), and standardized streamflow anomalies displayed on a map of the study area. (d).
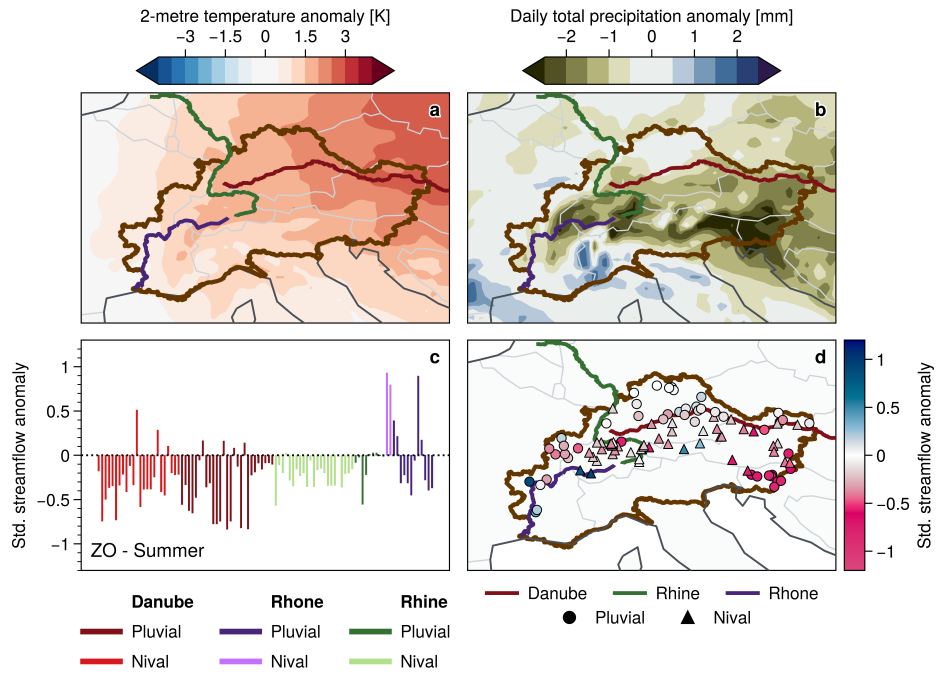
Figure S5. Same as Figure S4, but for Zonal (ZO) regime days in summer (June-July-August).
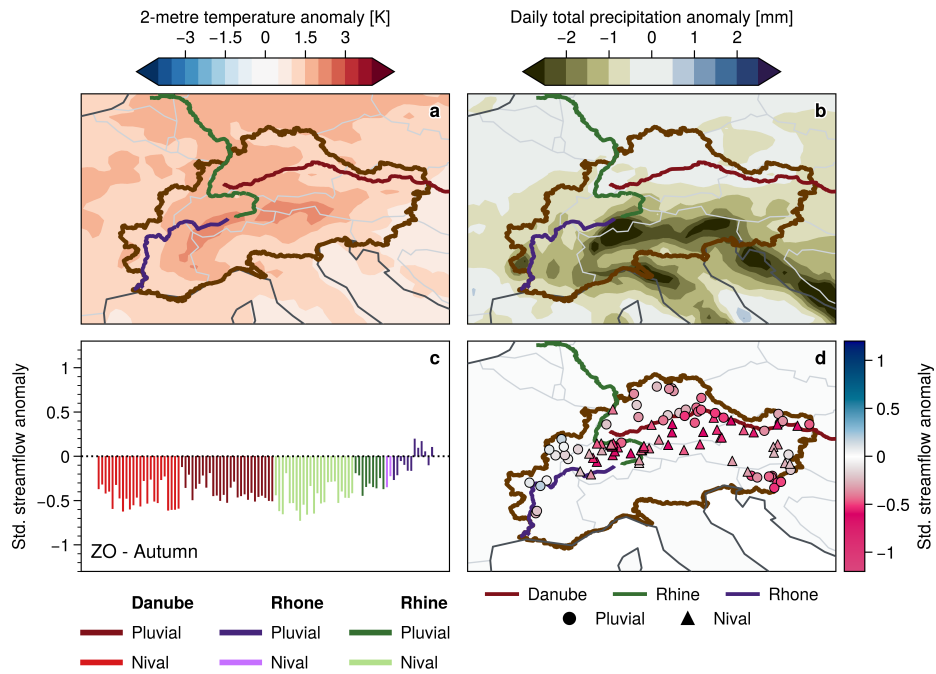
Figure S6. Same as Figure S4, but for Zonal (ZO) regime days in autumn (September-October-November).
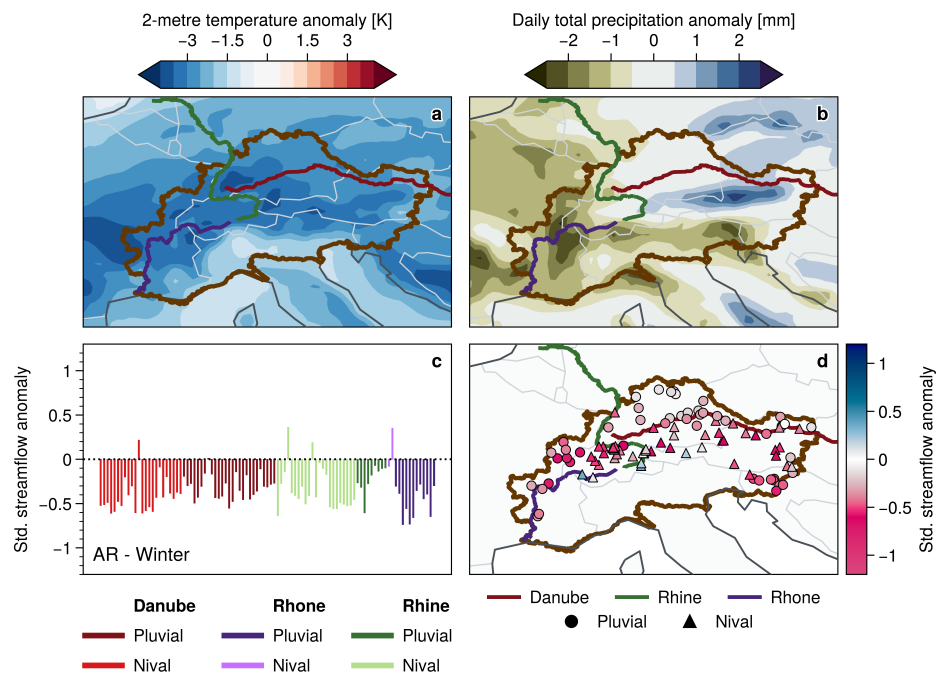
Figure S7. Same as Figure S4, but for winter (December-January-February).
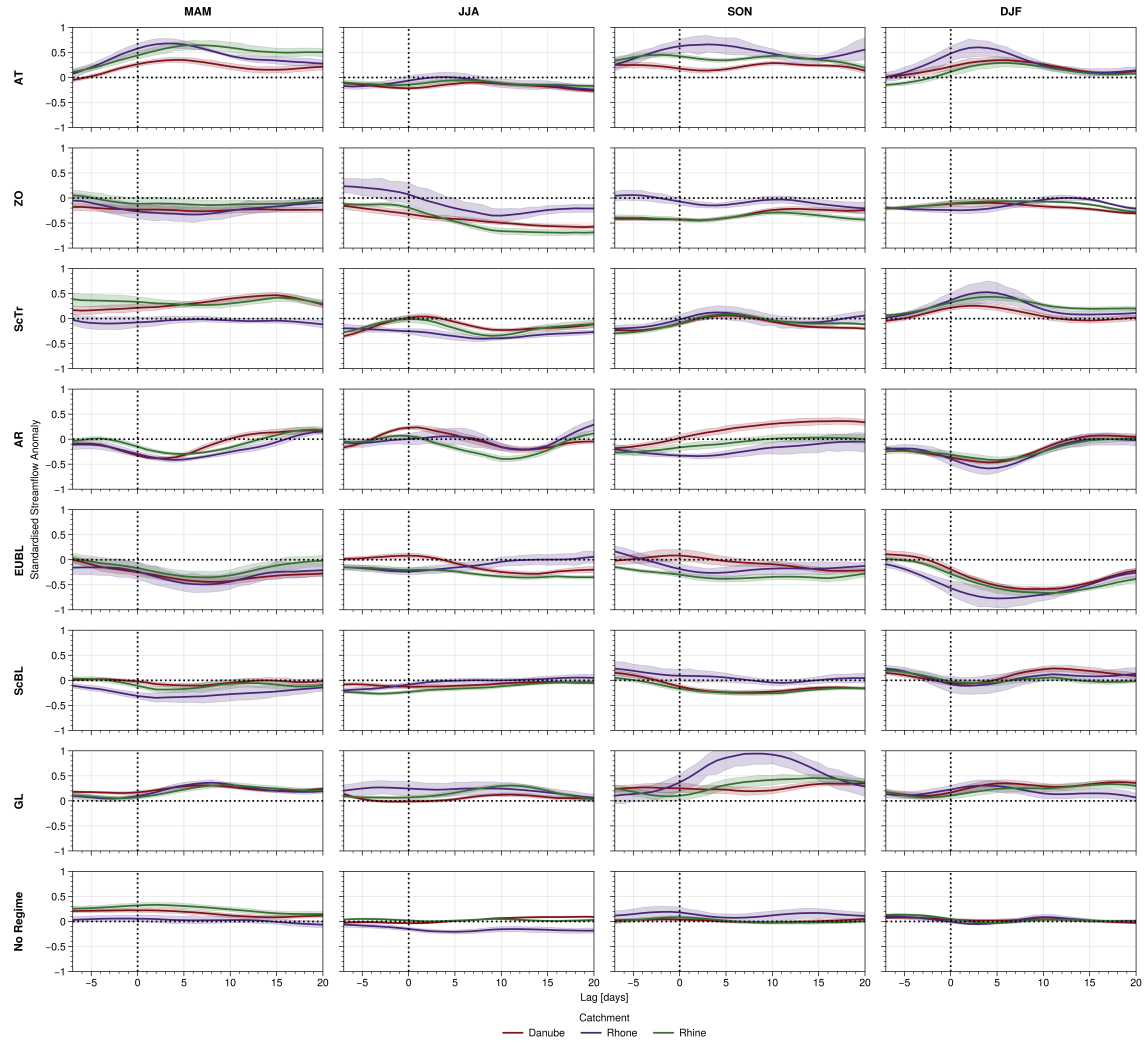
Figure S8. Streamflow anomalies associated with each weather regime type as a function of lag. AT - Atlantic Trough, ZO - Zonal, ScTr - Scandinavian Trough, AR - Atlantic Ridge, EUBL - European Blocking, ScBL - Scandinavian Blocking, GL - Greenland Blocking.
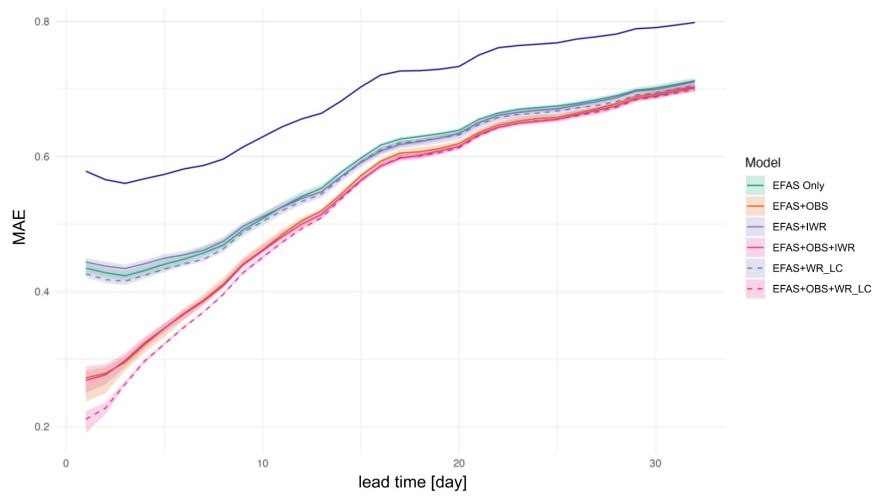
Figure S9. CRPSS value averaged over all stations to demonstrate the uncertainty from random seeds. Each model setup is trained on 11 seeds.
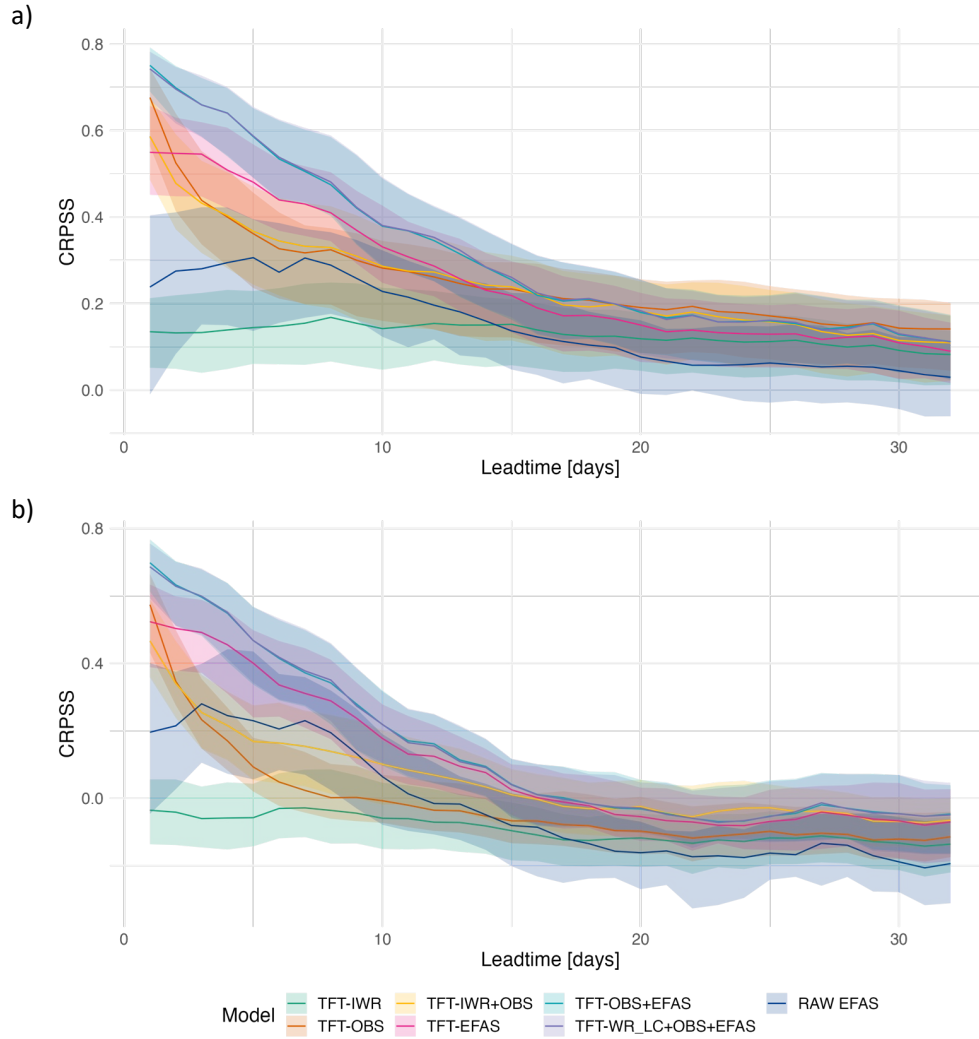
Figure S10. Comparison of CRPSS over a 32-day lead time for selected models with various input features. Information on model setup can be found in Table **??**. The raw EFAS output, shown in blue, serves as a baseline. The shaded regions represent the interquartile range of CRPSS values across different stations and seeds during the testing period (July 1, 2015 - December 28, 2018). Panel (a) presents results for all initialization days across all stations, while Panel (b) focuses on high flow days only.