S2S-Forecasting of Central European Winter Temperature Based on Quantile Random Forests

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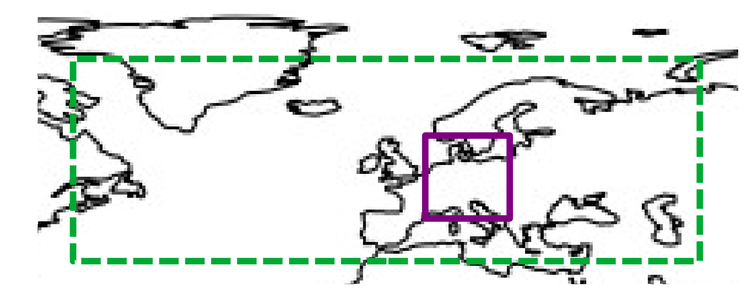
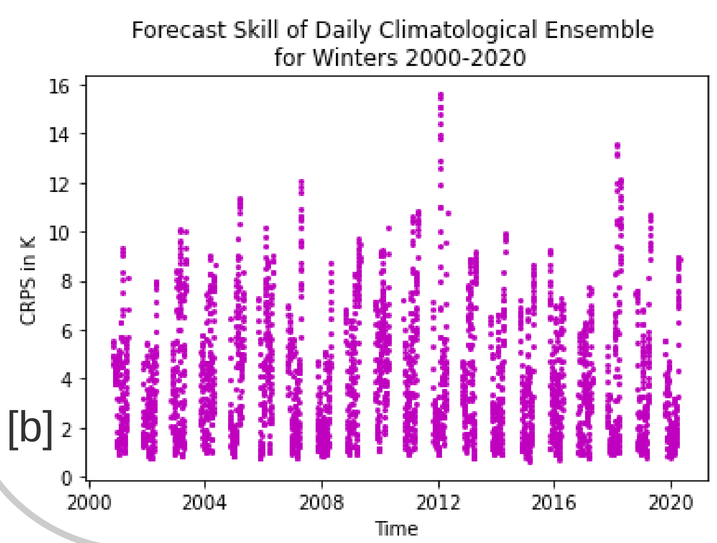
A skillful forecast of climate extremes on subseasonal- to seasonal timescales (S2S) is crucial for planning in many socio-economic sectors. But forecasting on these timescales with traditional methods is particularly challenging. Therefore, a novel method based on Quantile Random Forests (QRFs) is developed to obtain skillful probabilistic forecasts of Central European mean 2-meter temperature in winter. The chosen predictor fields for the machine learning model are known to potentially affect Central European surface weather in winter.

Methodology and Benchmarking



Ground Truth:
E-OBS V23.1e [1]

Predictors:
ERA-5 reanalysis [2]



Climatological Ensemble:
Ground truth data from 1970 – 1999, each year serves as one ensemble member

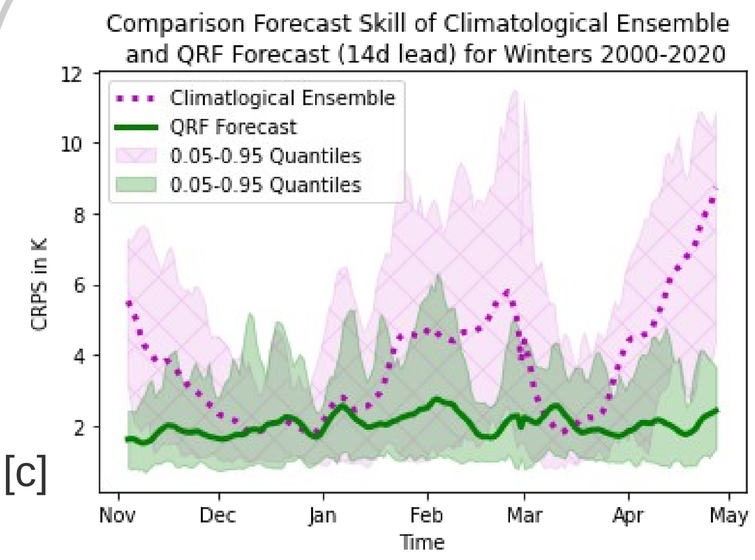
Aim: Prediction of daily mean 2-meter temperature with a lead time of 14 days, target region shown on fig. [a]

Predictors: 10hPa zonal wind, 100hPa and 250hPa geopotential height, latitude, longitude, month of winter (October – April), input region shown on fig. [a]

Forecast Skill of Climatological Ensemble:

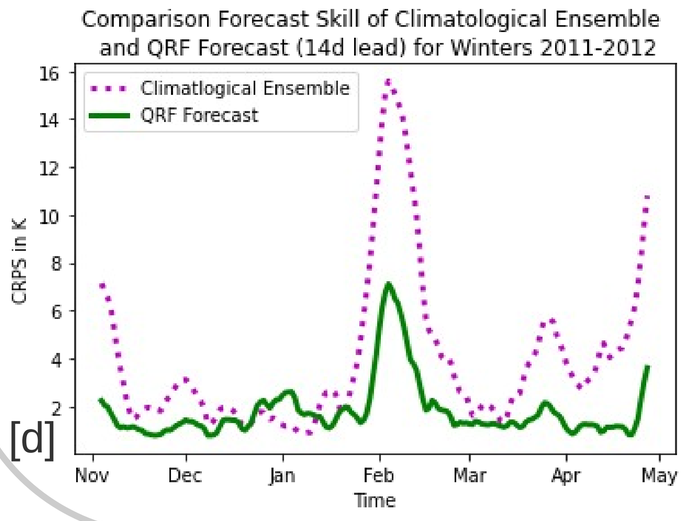
- skill of climatological ensemble varies greatly between the different winters in the period of 2000 – 2020 (fig. [b])
- best predicted winter: 2016/2017
- worst predicted winter: 2011/2012

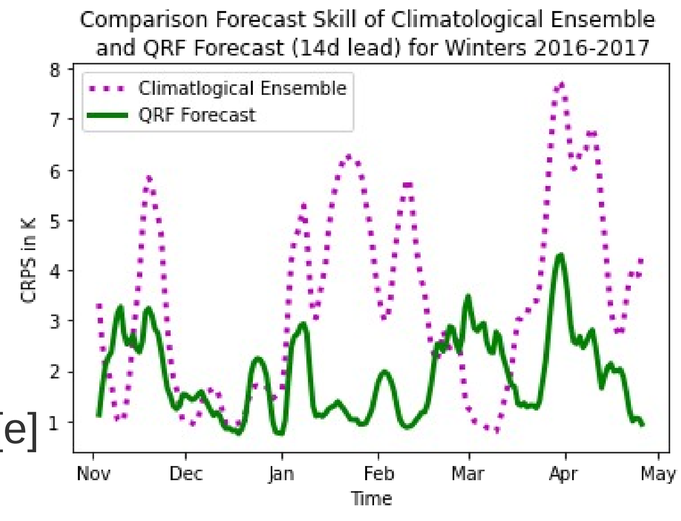
Comparing QRF with Climatological Ensemble



QRF [3] Training:
1950 – 2020, Oct – Apr, the validated winter left out, 100 trees, 100 equidistant quantiles

QRF Validation:
winters of 2000 – 2020





Forecast Skill of QRF Forecasts:

- on most days of winters in the period of 2000 - 2020 the QRF shows a better skill than the climatological ensemble (fig. [c])
- the variability range of the QRF forecast skill is lower than for the climatological ensemble for most days of these Winters (fig. [c])
- between different winters, the forecast skill varies largely, shown here for the winters 2011/2012 and 2016/2017, (fig. [d] and fig. [e])

References:
[1] doi.org/10.1029/2017JD028200
[2] e.g. doi.org/10.24381/cds.bd0915c6
[3] http://jmlr.org/papers/v7/meinshausen06a.html

In general, the QRF model is able to obtain skillful probabilistic forecasts of Central European mean wintertime temperatures at a lead time of 14 days for the winters of 2000/2001 until 2019/2020.

As a next step, categorical forecasts for above/below normal temperatures over Central Europe (fig. [a]) will be created. To gain meteorological insights about relations learned by the QRF model, a feature importance will be performed to determine the most important predictors for the model.