Modelling Present and Future Wildfire Risk with Use of Fire Weather Index, Spatial Weather Generator and Regional Climate Models

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1. Abstract

We assess present and future wildfire risk in Czechia and Sardinia in terms of Fire Weather Index (FWI), whose characteristics are derived from 1) weather station data, 2) meteorological data produced by RCMs available from CORDEX database (EUR11 domain & RCP85 emissions), and 3) parametric stochastic weather generator SPAGETTA (always under development), which is calibrated using available data (both weather station observations and RCM simulations) and then it is used to produce synthetic 100-year spatially coherent multi-site multi-variate weather data having the statistical structure similar to the input calibration data.

The experiment had 2 main aims: (1) Validation of RCMs and WG for their ability to reproduce observed FWI characteristics; we focus on the 90th percentile of FWI, occurrences of “spatial Fire Weather Days” and “spatial Fire Weather Spells”. (2) Assessing the impact of the future climate change on the FWI characteristics.

2. Data & Target Regions

OBS (observations): 85 stations representing Czechia + 15 stations representing Sardinia

RCMs: 8 RCM simulations (historical & RCP85, EUR-11 domain; CORDEX database; conditioned on availability of the four variables: Tmax, Prec, RelHum, Wind). BASELINE = 1971-2000; FUTURE = 2070-99. For Czechia, both raw and bias-corrected versions of RCMs were available.

To allow more conclusive comparisons, we made adjustments to the density of RCM grid-points (in Sardinia) and cropped original target region (Czechia), so that (a) number of grid-points is not so large (SPAGETTA may crash for larger number of grid-points), and (b) number of RCM grid-points is about the same as number of available weather stations.

3. SPAGETTA weather generator (WG)

Is based on our single-site M&Rfi generator.

| Prec occurrence | Markov chain |
| Prec amount     | Gamma distribution |
| Non-Prec variables | AutoRegressive(1) model |

Wilks' approach is used to spatialize M&Rfi: two parallel multivariate AR models control the spatial coherence of precipitation and non-precipitation variables, respectively. SPAGETTA is calibrated using weather data from a set of sites distributed either regularly (grids) or irregularly (stations) in space.

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4. Present experiment

(i) Deriving FWI characteristics from OBS & RCMs:

FWI-90p = 90th percentile of FWI (across all months and stations/grid-points)

sFWdays = “Spatial FireWeather Days” (= days when FWI exceeds FWI-90p at more than 30% of stations/gridpoints in the region)

sFWspell = “Spatial FireWeather Spell” (= uninterrupted sequence of FireWeather Days).

(ii) Calibration of SPAGETTA with both observed & RCM-simulated series

(iii) Generation of 100-year synthetic series (SYNTH) representing both OBS and RCM weather

(iv) Deriving FWI characteristics from SYNTH

Graphs show FWI-90p, frequency of sFWdays and means of annual longest sFWspell.

5. Results

6. Conclusions

a) Regional Climate Models:

- large inter-RCMs variability in FWI-90p as well as in climate change signal
- RCMs imply smaller FWI-90p, even if bias-corrected
- if RCM-based FWI-90p is used, RCMs imply frequency of spatial FW days similar to observations.
- RCMs overestimate length of annual longest spatial FW spells
- RAW and CORR versions of RCMs imply similar magnitudes of climate change signal

b) Weather Generator:

- slightly overestimate FWI-90p from calibration data
- perfectly fits frequency of sFW days in calibr. data
- significantly underestimate length of annual longest FW spells \(\rightarrow\) improvements in model or code of the generator are desirable

Characteristics were derived from:

a) RCMs & WG calibrated with RCM outputs
b) Observed weather data & WG calibrated with them