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Simulation of Spatial Temperature-Precipitation Compound Events with Circulation-Conditioned Weather Generator

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Introduction

SPAGETTA is a stochastic **multi-variate** spatial weather generator (WG) applicable at **various spatial and temporal scales**, for both **present and future climates**. The first version was presented at AGU-2017 [1]. In our experiments presented at AGU-2018 [2], the WG was run with daily step at ~100 km resolution for eight European regions, and its performance in reproducing the temperature-precipitation compound events was compared with CORDEX RCMs (EUR-44 domain); employment of compound weather indices allows to include inter-variable correlations into the validation process. After implementing wind speed and humidity into the generator, it was run at finer resolution (using weather stations data from Czechia and Sardinia) and validated in terms of spatial wildfire-prone weather spells [3]. The first paper on SPAGETTA was published in 2019 [4].

Our present activities aim mainly at (a) going into finer spatial and temporal scales, and (b) conditioning the surface weather generator on larger scale circulation simulated by circulation weather generator run at coarser resolution.

This poster

focuses on the WG's ability to reproduce **spatial temperature-precipitation spells & conditioning the SPAGETTA generator on larger-scale CIRKULATOR generator**

SPAGETTA weather generator

was created by spatialising parametric single-site **M&Rfi generator**

PREC occurrence ~ Markov chain
PREC amount ~ Gamma distribution
non-PREC variables (including TEMPerature) ~ AR(1) model
spatialisation (~Wilks 2009)**: 2 parallel multivariate AR models** control the spatial coherence of PREC and non-PREC variables

SPAGETTA is calibrated using data from multiple weather stations or grid-points. It is optionally conditioned (similarly to RCM being driven by GCM) on larger scale CIRKULATOR generator.

CIRKULATOR (= larger-scale gridded circulation WG):

resolution: 2.5 deg. grid (identical with the NCEP-NCAR reanalysis);1 CIRKULATOR gridbox = 625 E-OBS gridboxes)

5 variables:

- vorticity and (x,y) wind components derived from Mean Sea Level Pressure (based on NCEP-NCAR reanalysis)
- average temperature + average precipitation amount + fraction of grids with PREC > 1mm (derived from E-OBS-v20, 0.1° version

Modelling approach: similar to the one used to model surface weather characteristics in SPAGETTA

References

[1] poster at AGU-2017

[2] poster at AGU-2018

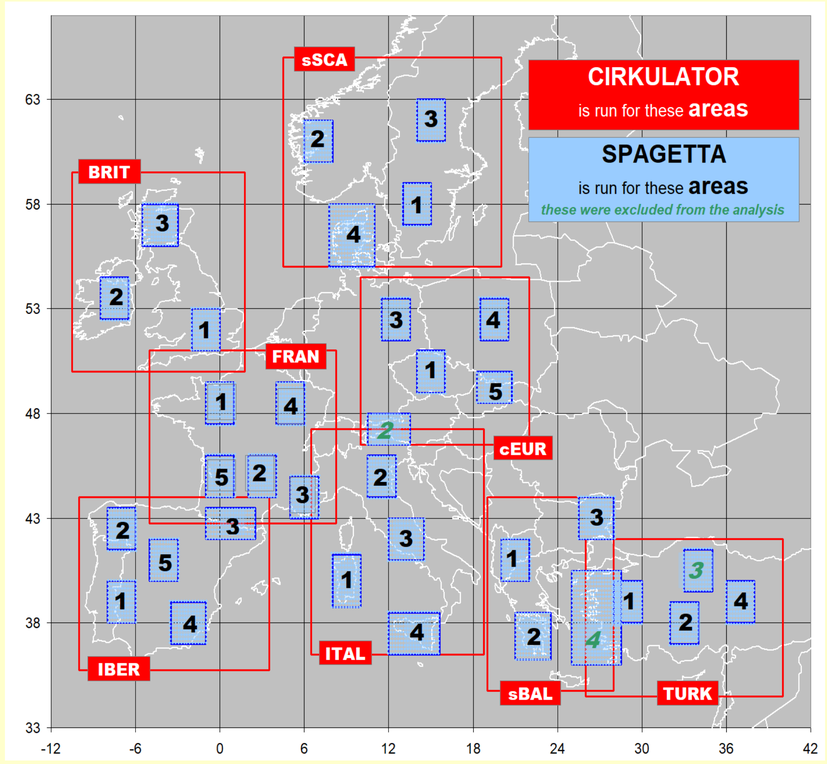
[3] poster at WildFires meeting Marseille 2019

[4] **paper in TAC (**Dubrovsky et al 2019)

(send email to get PDF)

Experiment: ● simulation of spatial TEMPERATURE-PRECIPITATION compound spells by SPAGETTA
● standalone SPAGETTA vs. SPAGETTA driven by the larger-scale CIRKULATOR generator

Target Regions



Comments

- **SPAGETTA vs. EOBS:** SPAGETTA reasonably well reproduces both frequency of "Days" and annual longest "Spells" (though, e.g., SPAGETTA underestimates frequencies of dry and wet spells)
- **SPAGETTA driven by CIRKULATOR** (SPAGETTA_CIRK series in the graphs)**:** the performance is significantly worse compared to standalone SPAGETTA. As the present results are based on the **first version of the CIRKULATOR**, the reasons are probably related to non-optimal settings of the CIRKULATOR, or to the way, in which SPAGETTA is conditioned on CIRKULATOR (or, maybe even due to bugs in the code)…

→ **<u>improvements of the CIRKULATOR are needed</u>**

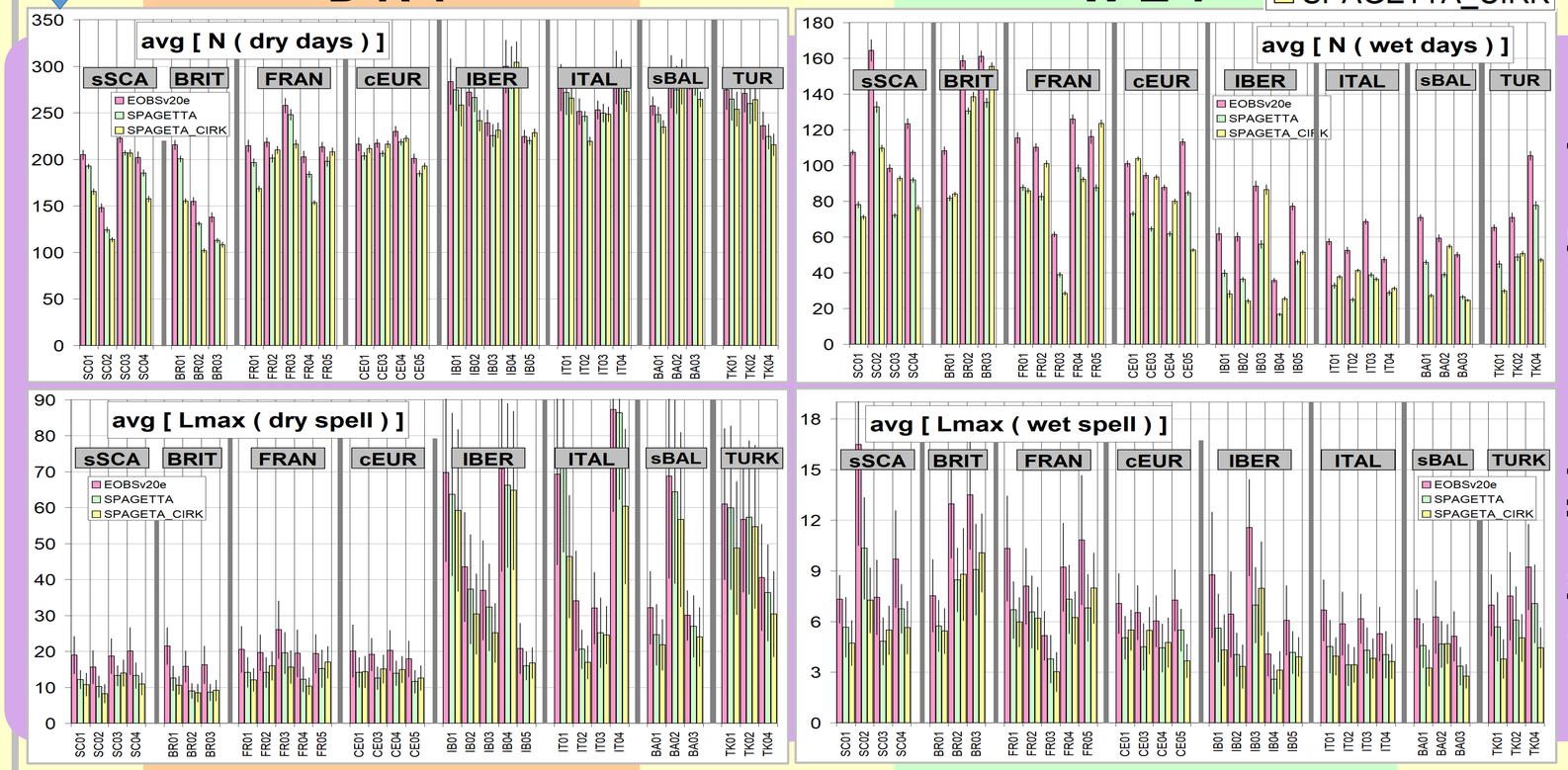
Experiment

(i) **Calibration of SPAGETTA** with E-OBS data (for 31 regions shown in the map as blue rectangles)
(ii) **Calibration of CIRKULATOR** with data based on reanalysis & E-OBS for 8 larger areas (red rectangles in the map)
(iii.1) **Generation of synthetic weather series with SPAGETTA** for the 31 small regions [→ SPAGETTA series]
(iii.2) **Generation of synthetic weather series with CIRKULATOR** for all 8 large regions
(iii.3) **Generation of synthetic weather series with SPAGETTA driven by CIRKULATOR** [SPAGETTA_CIRK series]
(iv) **Analysing observed and synthetic series** for the **"Days"** and **"Spells",** which are defined as:

Wet/Dry Day = day with **PREC ≥ 0.05 mm** / **PREC < 0.05 mm** in N>50% of gridpoints
Hot/Cold Day = day with $T \geq T_{hi}$ / $T \leq T_{lo}$ in N>*33* % of gridpoints ($T_{hi} = A + 1.282 \times S$, $T_{lo} = A - 1.282 \times S$; *A* & *S* are baseline-climate mean & std of *T* for a given day of the year; T_{lo} and T_{hi} are 10th and 90th percentiles of N(A,S) distribution
***xxx* Spell** = continuous sequence of *xxx* days

GRAPHS compare statistics from EOBS, SPAGETTA and SPAGETTA-CIRK for 31 subregions of 8 large regions:

- means ± std of **annual counts of *xxx* days**
- means ± std of **annual longest *xxx* spell**

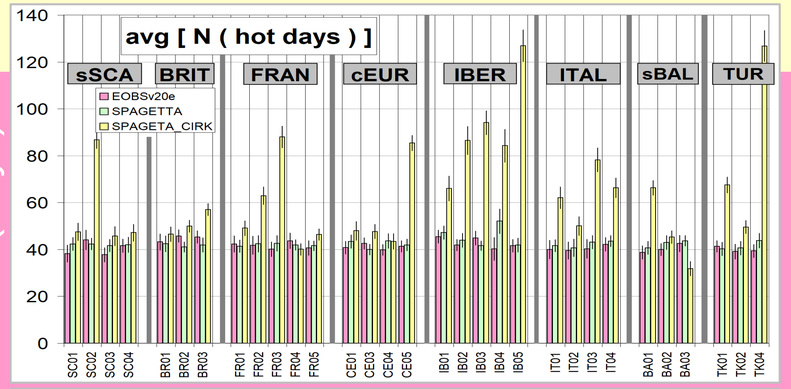


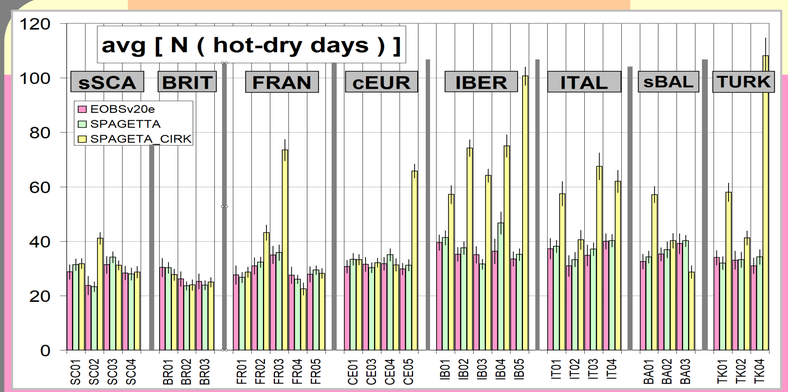
HOT #(Days)

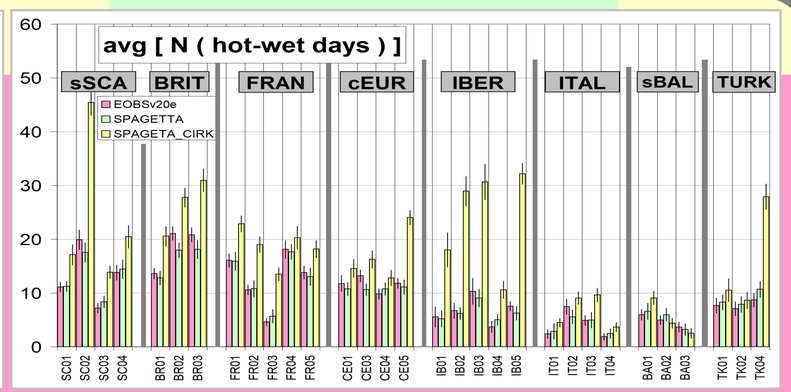
COLD #(Days)

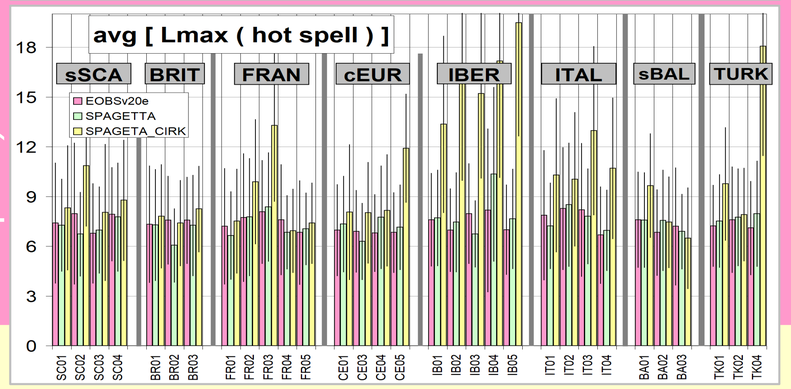
LSpells)

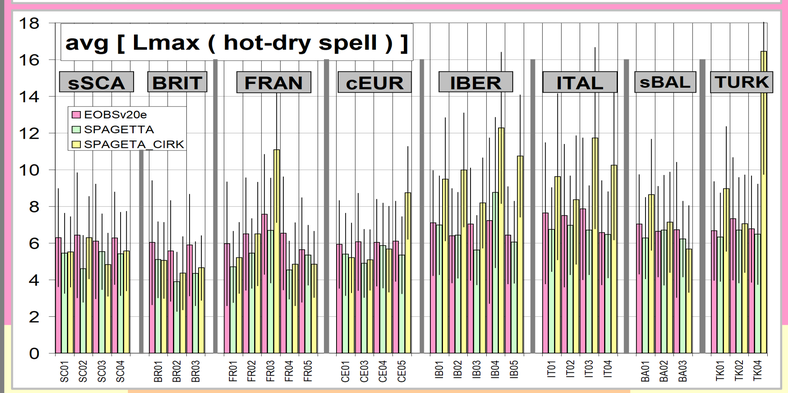
L(Spells)

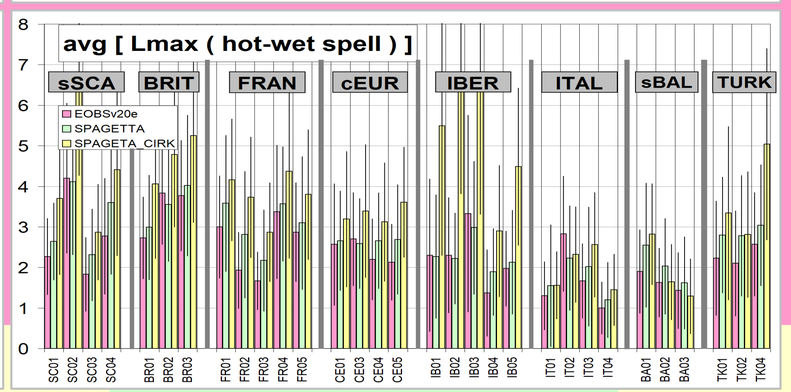


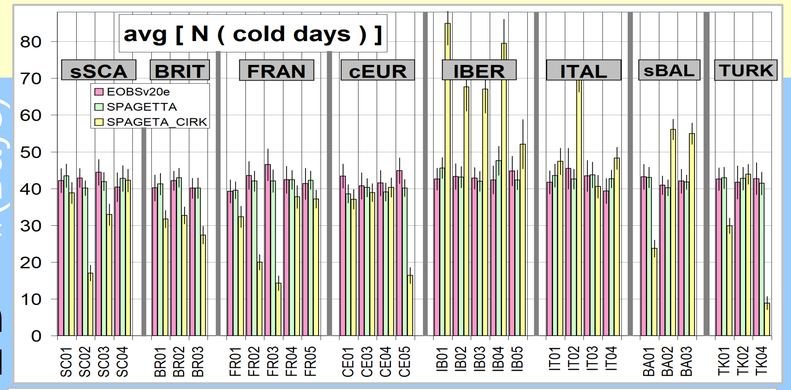


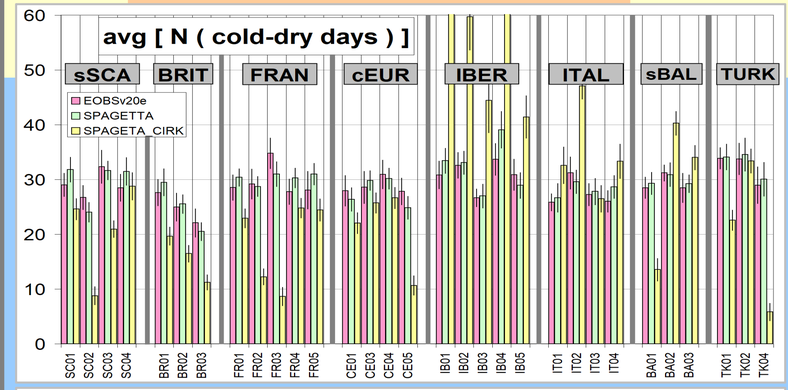


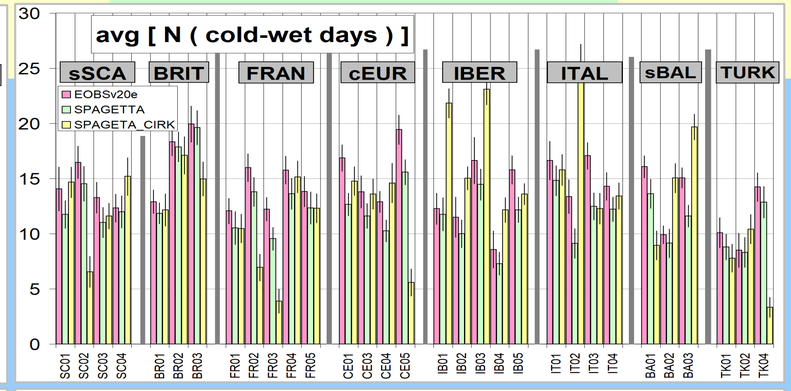


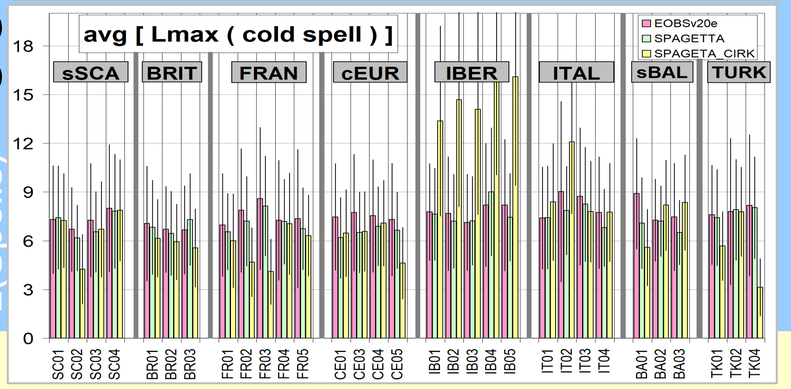


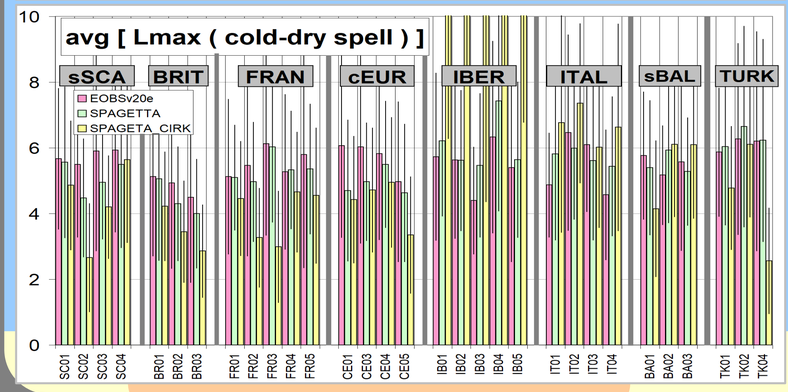


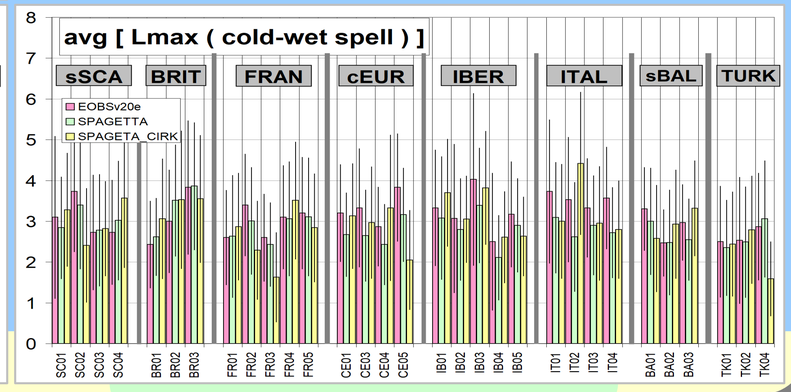












events

compound