

## Research Article

### A Model for Regional Climate Simulation

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**Abstract:** This study in detail introduced a climate model for regional climate simulation-Statistical Regional Climate Model (Abbrev. Star Model). It explained the scheme and the application of the Statistical Regional Climate Model. The regional simulation was used with respect to “Temperature of 2 m” and “Precipitation” as the characteristic variables of regional climate in the study, the model was calculated and tested by taking Huailai climate station of China in Hebei province as practical example.

**Keywords:** Regional climate simulation, statistical regional climate model, temperature

#### INTRODUCTION

Star model was built and developed by the scientists of Potsdam Institute for Climate Impact Research. The study introduces the basis and scheme of Star Model, but more details about Star model can consult the literatures of Orłowski *et al.* (2007). The program of Star Model is open source and consists two parts:

- **Star2.exe:** Which generates a data-to-data mapping
- **Post-process.exe:** Which evaluates the data-to-data mapping

Climate system is nonlinear, so regional climate simulation of future is very limited degree. There are mainly two way to obtain the climate scenarios, regional climate models and statistical models. In the study, Star model, a statistical regional climate model is presented. The simulations of regional climate scenarios are constrained only by the parameters of a linear regression line, for a characteristic climatic variable. The simulated series of regional climate are generated by resampling from segments of observation series. So the simulated series comply with the prescribed regression parameters and possess realistic annual cycles and persistence. The regional climate simulation obtained by the Star model should be considered as an estimation of possibility of future climate. The characteristic variable is to be chosen such that it captures the essential climate variability of the region and temperature is a good choice (Boris, 2007).

In this study, we detail introduced a climate model for regional climate simulation-Statistical Regional Climate Model. It explained the scheme and the application of the Statistical Regional Climate Model. In

general, the average temperature is rising over time while the annual precipitation is decreasing.

#### THE SCHEME OF STATISTICAL REGIONAL CLIMATE MODEL

**Assembling simulated series from segments of observed series:** Inspired by Werner and Gerstengarbe (1997) the simulated series are assembled from segments of the observed series. The approach generates a mapping from dates of a simulation period to dates of the observation period. This mapping is constructed such that the corresponding series yield annual means of the chosen climate variable, which feature the prescribed regression line. Furthermore, a set of heuristic rules makes sure that the simulation series exhibit realistic properties such as annual cycles etc., (Werner and Gerstengarbe, 1997). An illustration of the setting, for which temperature is chosen as the characteristic variable, Fig. 1.

**The data-to-data mapping:** Through the program of Statistical Regional Climate Model, the output that we get the data-to-data mapping from the model looks like this:

Day	Month	Year	-->	Day	Month	Year
11	3	1976	-->	21	2	1961
12	3	1976	-->	22	2	1961
13	3	1976	-->	13	3	1974
14	3	1976	-->	14	3	1974
15	3	1976	-->	15	3	1974
16	3	1976	-->	16	3	1961
17	3	1976	-->	17	3	1961
18	3	1976	-->	18	3	1974

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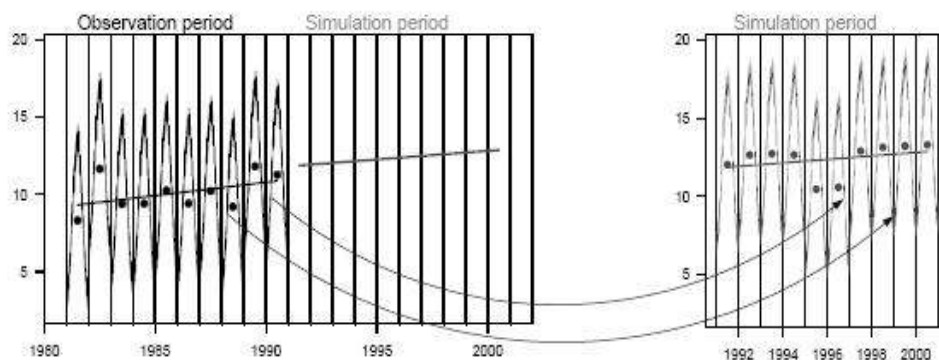


Fig. 1: Assembling simulated series from segments of observed series, corresponding to a prescribed regression line  
 Left: Observation series and prescribed regression line for temperature; Right: Simulated series with annual means (dots), featuring the prescribed regression line

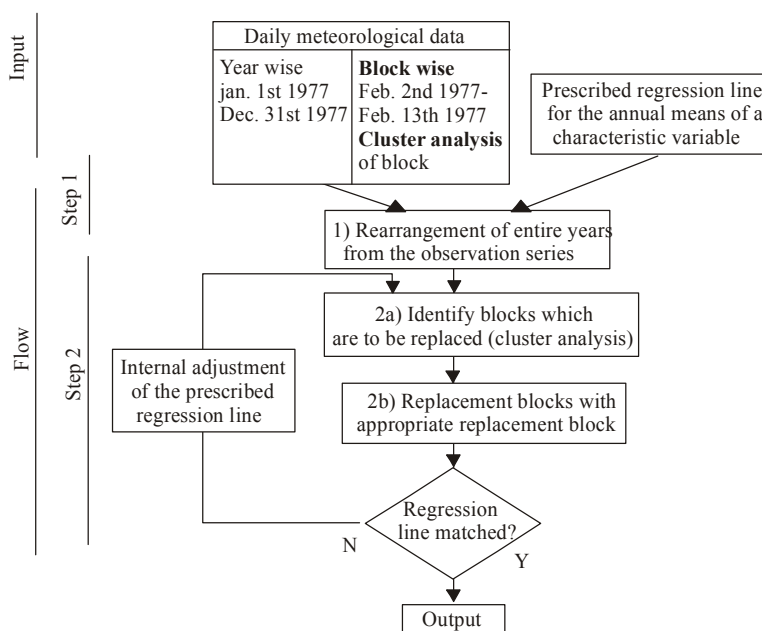


Fig. 2: Summary of the generation of the data-to-data mapping

19	3	1976 -->	19	3	1974
20	3	1976 -->	20	3	1974
21	3	1976 -->	21	2	1961
22	3	1976 -->	22	2	1961
23	3	1976 -->	23	3	1974
24	3	1976 -->	24	3	1974
25	3	1976 -->	30	3	1974
26	3	1976 -->	31	3	1961
27	3	1976 -->	01	4	1961
28	3	1976 -->	02	4	1974

The generation of the data-to-data mapping, illustrated in Fig. 2, comprises two steps operating at different time scale. At first, we can get the first

mapping on the time scale of years and the mapping is a simple rearrangement of entire calendar years from observed data, but its corresponding temperature series is as close as possible to the prescribed regression line (Boris, 2007). Then, the program of Star alters the first data mapping iteratively to find the most suitable simulated series on the shorter time scale of blocks of 12 days. The second step gets the simulation series with blocks of 12 days length. The use of blocks instead of single days makes sure that the weather sequences of the simulated series are realistic at least within the blocks, again simply because they are just copied from actually observed sequences. By experimenting with different block lengths, the length of 12 days is found to

essentially capture the persistence of the observation time series from the Elbe river basin (Orlowsky *et al.*, 2007). For getting more suitable simulation result, it exchanges selected blocks from this series with appropriate blocks in the observation series. This procedure is iteratively repeated until the prescribed regression parameters are reproduced.

### THE APPLICATION OF STATISTICAL REGIONAL CLIMATE MODEL

In order to verify the effectiveness of Statistical Regional Climate Model, we take Huailai climate station (in Hebei Province of China) as an example. For The simulation, observation period is 1961-1980 and simulation period is 1981-2000. Through the model, it can get the simulation situation of temperature and precipitation during the period of 1981 to 2000 of Huailai station. Through comparing the data from simulation and the really measured data of that period as from Fig. 3 to 6 verified the effect of Statistical Regional Climate Model.

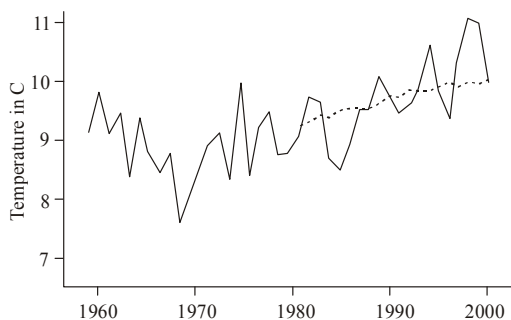


Fig. 3: The annual average value of temperature (solid line is for observation data (from 1960 to 2000) and dotted line is for simulation data (from 1980 to 2000))

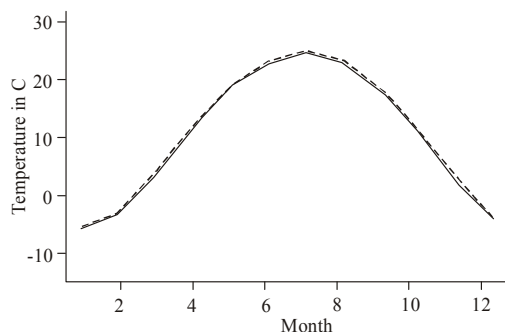


Fig. 4: The monthly average value of temperature (solid line is for observation data and dotted line is for simulation data)

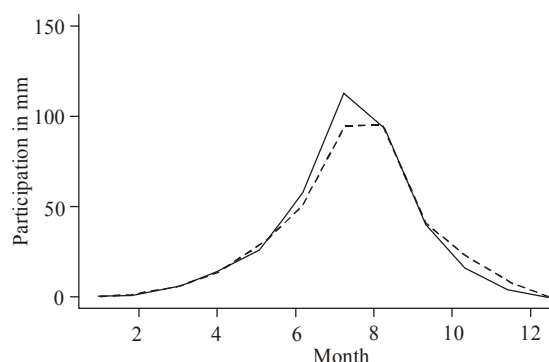


Fig. 5: The annual total value of precipitation (solid line is for observation data (from 1960 to 2000) and the dotted line is for simulation data (from 1980 to 2000))

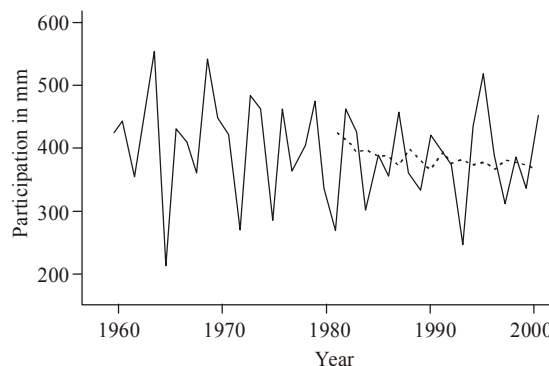


Fig. 6: The monthly average value of precipitation (solid line is for observation data and dotted line is for simulation data)

### CONCLUSION

From the results of Statistical Regional Climate Model, we can see that the simulation data dovetailed nicely with the observation data for Huailai station. In general, the average temperature is rising over time while the annual precipitation is decreasing.

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