A Study on Spatial Variation of Summer Precipitation over Huaihe River Basin

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1.Introduction

In the surface hydrological pararmeterization of general circulation models (GCMs), it is commonly assumed that the precipitation processes are homogeneous over a GCM grid square and the the Precipitation intensity is uniformly distributed. A few researchers have explored thatt the precipitation is exponentially distributed. The analysis of historical precipitation over Huaihe river basin explored that neither the uniform nor the exponential distribution assumption may be properly at the grid scale and, that instead, the spatial variability in precipitation is characterized by statistical patterns that are inhomogeneous. A stochastic precipitation disaggregation scheme(proposed by Gao and Sorooshi) is utilized to statistical and generate spatial distribution of the precipitation.

2..Data

By use of intensify hourly data over Huaihe basin during 1998-2003 summer, a analysis is made to study areal spatial distribution of precipitation over this area.

The square is located in the Huaihe river basin with a scope of 31 ˚-36 ˚N，112 ˚-121 ˚E. The paper use 32 gauge site observation. FIG.1 show the gauge scope and location.

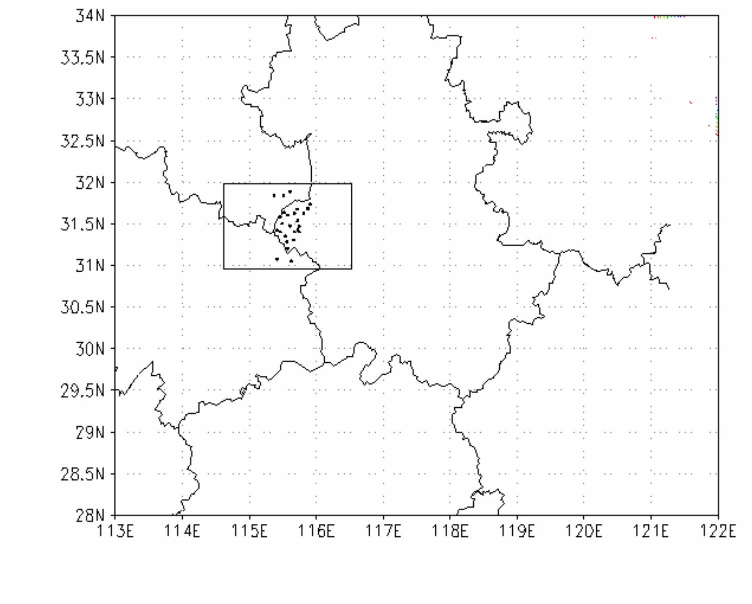
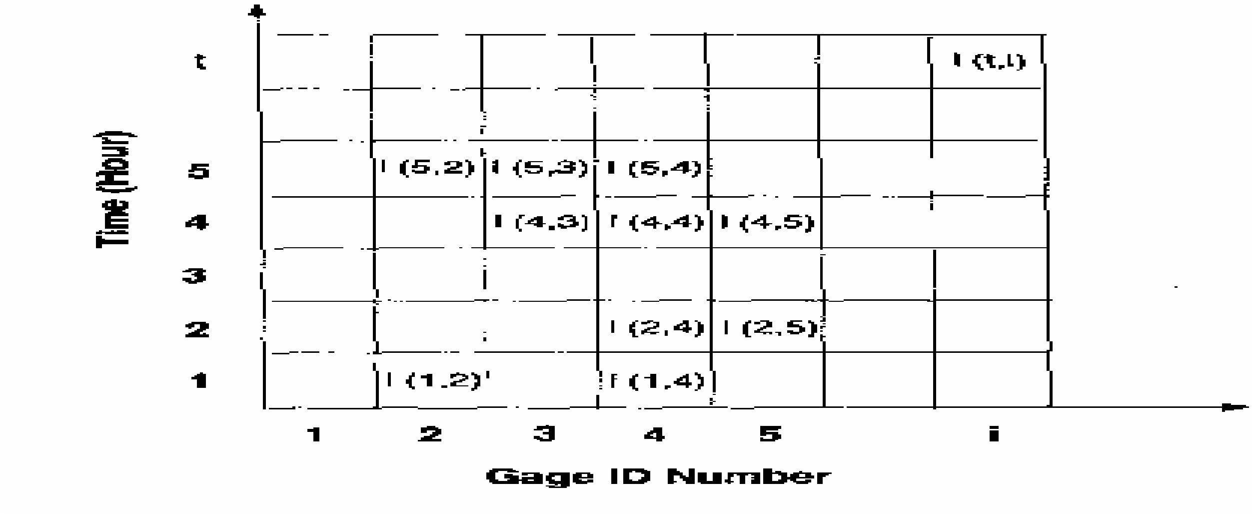


FIG.1 Location of the selected grid.

3. Stochastic precipitation disaggregation scheme

Gao and Sorooshi(1994) proposed a stochastic precipitation disaggregation scheme for GCM applications.



Event 1: $N(1) = W_2 + W_4$, $Z(1) = I(1,2)\times W_2 + I(1,4)\times W_4$

Event 2: $N(2) = W_4 + W_5$, $Z(2) = I(2,4)\times W_4 + I(2,5)\times W_5$

Event 4: $N(4) = W_3 + W_4 + W_5$, $Z(4) = I(4,3)\times W_3 + I(4,4)\times W_4 + I(4,5)\times W_5$

Event 5: $N(5) = W_2 + W_3 + W_4$, $Z(5) = I(5,2)\times W_2 + I(5,3)\times W_3 + I(5,4)\times W_4$

FIG.2. conceptual representation of hourly rainfall records on the time and gauge identification number plane.

The hourly precipitation data are distributed in a time-space plane as illustrated in FIG..2. The vertical axis represents time with an increment of one hour. The horizontal axis represents the raingage ID number. The whole dataset constitutes a matrix on the time-space plane. The nonzero elements in the matrix indicate precipitation intensity I(t,i).

The intragrid spatial variability of precipitation is examined through the statistical features of precipitation events. We divide the grid square into polygons. The precipitation volume per-hour ,V, and its coverage area, S, can be represented as:

$$S(t) = \sum_{i=1}^{n(t)} Si = A\sum_{i=1}^{n(t)} Si/A = A\sum_{i=1}^{n(t)} Wi \qquad (1)$$

$$V(t) = \sum_{i=1}^{n(t)} \left[I(t,i)Si\right] = A\sum_{i=1}^{n(t)} \left[I(t,i)Wi\right] \qquad (2)$$

Where

N(t) number of gauges receiving precipitation at events t

A the area of the grid square,

Wi(=Si/A) the areal correction weight for gauge i.

We define two variables to characterize a precipitation event:

$$N(t)=\sum_{i=1}^{n(t)}Wi=S(t)/A \tag{3}$$

$$Z(t)=\sum_{i=1}^{n(t)}\left[I(t,i)Wi\right] \tag{4}$$

We can get $V(t)/S(t)=Z(t)/N(t)$. （5）

Therefor, the relationship between V and S is similar to the relationship between Z and N. After the relationship between Z and N is extracted from the available dataset, it will be used to determine S form the V predicted by a GCM.

4. Statistics over precipitation events

To get the statistical relationship between Z and N, a large number of events is required. By use of the 32 gauge site data in Huai river basin. We get some relationship like that the relationship between mean Z and N and rainfall event with different N(FIG. miss). All the lines are close to each other in the two pictures. So we can get the a set of probability distribution of N according to the subranges of Z by Stochasticing the data.(only show a part of FIG..)

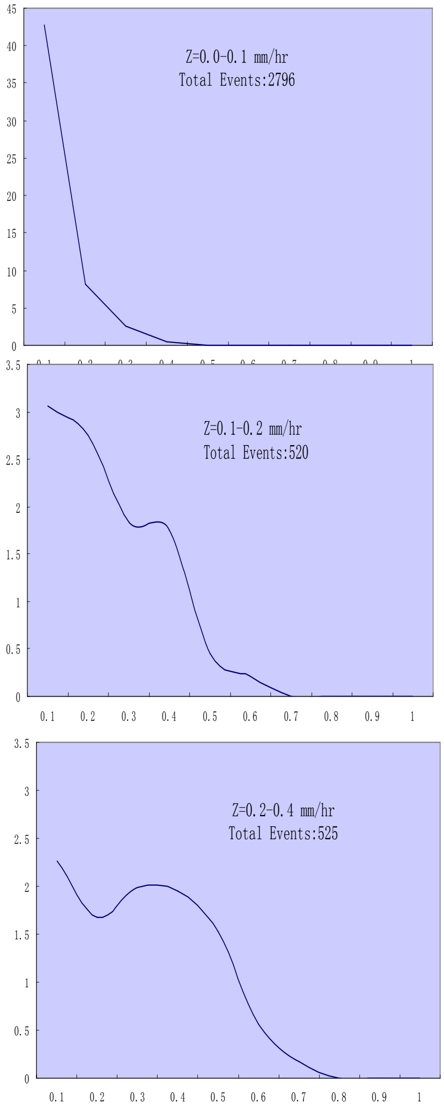
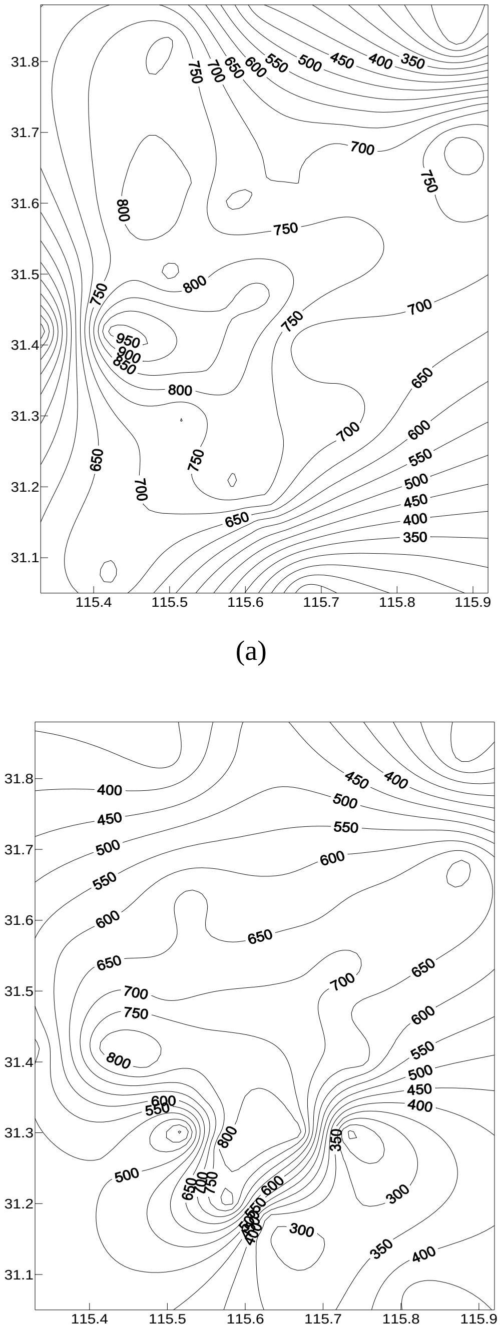


FIG.3 probability distribution functions of N

5.Simulations and summary

To stochastically determine where the hourly precipitation volume will distribute inside the square. According to the value of V, find the PDF curve(FIG.3). Input the curve into a random number generator to determine the corresponding coverage area S. According to the normalized predipitation depth map, the random generator will determine on which subarea the precipitation will fall.

The scheme was tested using data over Huaihe river basin. The simulations will show at FIG.(only show the 1998's simulation)



(a)

(b)

FIG.4 precipitation spatial distribution test, (a)pattern in 1998, (b)simulated pattern in 1998.

Results show that the precipitation spatial distribution is heterogeneous with a close relation between the average precipitation intensity and its coverage area. Statistical evidence suggests that PDF of coverage area and occurrence frequency probably proposed stable mode with properly interval mean rain intensity. The scheme can be used successfully to realize the precipitation disaggregation.

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Reference:

1 Warrilow,D.A.,A.B. Sangster, and A. Slingo, Modeling of land-surface processes and their influence on European Climate, Dyn. Clim. Tech. Note 38,92pp., U.K. Meteorol. Off., Bracknell, Berkshire, England, 1986.

2 Entekhabi, D., and P.S. Eagleson, land surface hydrology parameterization for atmospheric general circulation models including subgrid scale spatial variability. J. Clim., 2,816-831,1989.

3 Pitman, A.J., A. Henderson-Sellers, and Z.L.Yang, Sensitivity of regional climates to localized precipitation in global models, Nature, 346,734-737,1990

4 Wood,E.F., Global scale hydrology:Advances in land surface modeling, U.S. Natl. Rep. Int. Union Geod. Geophys.1987-1990, Rev. Geophys., 29,Suppl., 193-201,1991

5 Liang, X., D.P. Lettenmaier, and E.F. Wood, 1996b: A one-dimensional statistical dynamic representation of subgrid spatial variability of precipitation in the two-layer variable infiltration capacity model. *J. Geophys. Res.*, **101**, D16, 21,403-21,422

6 Andrea N. Hahmann, Representing spatial subgrid-scale precipitation variability in a GCM. Journal of Hydrometeorology, 2003, 4,891-900

7 Pitman,A.J., A. Herderson-sellers, and Z.L.Yand, 1990: Sensitivity of regional climates to localized precipitation in global models. Nature, 364, 734-737.

8 Xiaogang Gao and sorooshi sorooshiian, A stochastic precipitation disaggregation scheme for GCM applications. Journal of climate, 1994,7,238-247.