tions and large areas and those of short durations and small areas. They should be differentiated and analysed by area size of the design watershed. For example, if the area size of the design watershed is large, storms with long durations and large areas are selected. Differences between these two storm types are also large in terms of design duration and storm point area relationship. These characteristics should be taken into account when deducing the storm model and qualitative characteristics.

(c) Local thunderstorms receive small effects from the topography and elevation and therefore have large transposable areas. According to some studies, they are usually transposable within an elevation difference of 1 500 m.

(d) Both moisture and efficiency maximization should be carefully considered. Some extraordinary storms may be believed to have approached their highest efficiencies and only moisture maximization be needed. Individual storms on the enveloping curve of worldwide storms with the same duration need to be studied carefully to see if maximization is needed. In addition, the actual storm duration should be adopted instead of the standard duration when calculating the efficiency (Wang Y. and Wang W., 2000).

7.5 COMBINATION MODEL STORM METHOD

7.5.1 Applicable conditions

This method is applicable to cases where data on a number of observed large storms are available for the design watershed.

In this method, two or more storms are reasonably combined under principles of synoptic climatology and weather forecast experience to form a new sequence of ideal extraordinary storms, which are then used as typical storms to determine PMP.

The mode of combination is typically temporal, but may also be spatial when necessary, or both temporal and spatial. By temporal combination, rainfall processes of two or more storms are realistically linked together. While combining, a reasonable interval should be kept to enable the previous weather process to evolve into the next one. By spatial combination, isohyetal maps of two or more storms are reasonably pieced together. During the sequencing, a reasonable amount of time should be kept between storm events. The combined events should appear possible.

The key to the combination model method is that the combination sequence definition and its rationale should be plausible.. To do this correctly, it is necessary to be familiar with general climatic characteristics and abnormal climatic conditions in the studied watershed, as well as theories and experience in mid- to long-term evolvement of weather processes. Therefore, it is important to get recommendations from local meteorological organizations (Ministry of Water Resources, 1980; Zhan and Zhou, 1983; Wang G., 1999).

7.5.2 Combination methods

The storm time (temporal) combination method is introduced here. This method includes the similar process substitution method and the evolvement trend analysis method.

7.5.2.1 Similar process substitution method

7.5.2.1.1 *Basic concept*

The similar process substitution method uses an extraordinary (or large) storm that features persistent extremely (or relatively) abnormal precipitation as a typical process. One or more precipitations in the typical process with small rainfalls are substituted with one or more storm processes with very similar circulation types – almost the same weather systems – and large rainfalls, thereby forming a new storm sequence.

For example, the original typical storm process is $A \rightarrow B \rightarrow C$. A serious storm process M, which has a circulation type and a storm weather system similar to those of B, may be used to substitute B, forming a storm process $A \rightarrow M \rightarrow C$.

The key factors in this method are the selection of the typical process and the determination of the principles of similar process substitution.

7.5.2.1.2 *Selection of the typical process*

The selection of the typical process is performed based on observed flood processes. Generally, the storms selected as typical processes feature:

(a) flood durations that correspond to the storm design time interval;
(b) high peaks;
(c) large volumes;
(d) serious floods in the lower to upper reaches;
(e) similar circulations and storm weather systems;
(f) good hydrometeorological data. Those typical storm processes are formulated into a process sequence with units of 24 hours (or 12 hours).