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MBRFC METHOD OF COMPUTING FLASH FLOOD INDICES

1 APR 1988

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One of the primary mission requirements of river forecast centers is the preparation of flash flood guidance used by WSFO/WSO's for the issuance of flash flood watches and warnings. MBRFC currently issues guidance products for three types of flash flood areas: state public forecast zones, headwater basins, and counties. Guidance issued for headwater basins is primarily used by WSFO/WSO's to determine actual crest forecasts for the headwater point, but for appropriate basins, the guidance value is also valid for flash flood watch/warning purposes. County guidance is part of a test being conducted in conjunction with AWIPS-90 development.

Guidance values are rainfall amounts which, when exceeded in a period of three hours or less, will cause flash flooding to occur. A single value is issued for each flash flood area. The minimum value allowed is 1.00 inch. The maximum is 5.00 inches for state forecast zones and counties and 6.00 inches for headwater basins. State forecast zone and county guidance is issued daily on AFOS. Headwater guidance products are issued on Mondays and Thursdays, unless hydrometeorological conditions warrant more frequent release.

Calculation of all three types of flash flood indices is based on the same general procedure and types of information. Initially, a "control" file has been created on disk which contains permanent, previously defined information used to calculate guidance values and format AFOS messages. This information is combined with current hydrologic data from the MBRFC runoff model (HYRO) when the flash flood program is executed.

The Missouri Basin has been divided into more than 700 "runoff zones." These are the units of area processed by HYRO for determining soil moisture, mean areal precipitation and snowmelt, and finally runoff. Each flash flood area has been assigned up to five of these runoff zones which are used to determine the soil moisture index of each area. Weights have been assigned to each runoff zone if more than one is used by an area. This information is stored in the control files.

One of the data requirements of the flash flood guidance equations is a three-hour runoff amount (RO) for each flash flood guidance area. These amounts are stored in the control files. To determine the RO values, three-hour runoff values were calculated for all headwater points in the Missouri Basin. They

were based on the flood stage discharge and the three-hour unit-hydrograph peak discharge at the gaging point of each headwater basin. The value of RO for each flash flood area is based on these headwater point three-hour runoff amounts. For headwater areas, RO is directly determined. For state public forecast zones and counties, RO is an average of those headwaters in and close to each area.

The equations used are the reversal of those used in HYRO to calculate runoff.

$$\begin{aligned}P &= ((D+RO)**EN) - (D**EN) ** (1.0/EN) \\EN &= 0.89 + (0.63*AI) \\D &= 0.306 * (AI**1.865)\end{aligned}$$

where: AI is the soil moisture index,
P is the three-hour flash flood rainfall value, and
RO is the three-hour threshold runoff to reach flood stage.

HYRO calculates soil moisture based on the Antecedent Precipitation Index (API) method. The "AI" value is the API value converted for time of year and location of the area. When flash flood indices are generated, the runoff zones assigned to each area are determined from the control files. AI values are retrieved from HYRO files for each of these runoff zones and weighted to get a single AI value for each flash flood area. This method allows flash flood guidance indices to be directly related to daily operational rainfall/runoff calculations. The three-hour runoff value is retrieved from the control files, and the above equations are solved.

The resultant indices are included in AFOS messages formatted for each of the three types of flash flood areas (see Figures 1, 2 and 3).

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AVERAGE 3-HOUR FLASH FLOOD RAINFALL GUIDANCE BY STATE FCST ZONES
RELEASE DATE TUE JAN 19 1988

GENERAL FLASH FLOOD GUIDANCE FOR STEEP TERRAIN AND URBAN AREAS ARE
ONE TO TWO INCHES OR MORE IN ONE TO TWO HOURS OR LESS RESPECTIVELY.
REFERENCE ROML C-40-82 FILED WITH CHAPTER E-13

COLORADO							
11/1.0	12/1.0	13/1.2					
IOWA							
1/2.1	4/1.6	5/2.5	9/1.9	12/1.6	13/1.7		
KANSAS							
1/1.5	2/1.9	4/1.4	5/2.0	7/1.4	8/1.8	10/1.2	11/1.0
13/1.4	14/1.0	15/1.1	16/1.1				
MISSOURI							
1/1.6	2/2.7	4/1.1	5/1.7	6/1.9	8/1.6	9/1.0	10/1.1
13/1.1	14/1.2	15/1.0	16/1.1				
MONTANA							
3/2.0	5/1.9	6/1.3	7/1.4	8/1.6	9/1.6		
NEBRASKA							
1/2.2	2/2.9	3/2.0	4/1.1	5/1.5	6/2.3	7/2.8	8/2.5
9/2.0	10/1.2	11/1.2	12/1.4	13/1.5	14/1.5	15/1.3	16/1.8
17/2.0	18/1.3	19/1.2	20/1.2				
NORTH DAKOTA							
2/1.8	3/1.5	4/1.5	6/1.8	7/1.8	8/1.8	14/1.7	
SOUTH DAKOTA							
1/1.6	2/1.6	3/1.6	4/1.8	5/2.4	6/1.6	7/1.4	8/2.1
9/1.7	10/1.4	11/1.8	12/2.2	13/2.0	14/2.2	15/1.8	16/1.2
17/1.6	18/2.2	19/1.4	20/1.4				
WYOMING							
1/1.1	2/1.0	3/1.1	4/1.0	5/1.3	6/1.3	9/1.0	10/1.4
11/1.5	12/1.4	15/1.2	16/1.1	17/1.0			

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Fig. 1. Example of flash flood guidance product for state public forecast zones.

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TOPEKA HYDROLOGIC SERVICE AREA

AVERAGE 3-HOUR FLASH FLOOD RAINFALL GUIDANCE BY COUNTIES
RELEASE DATE TUE JAN 19 1988

GENERAL FLASH FLOOD GUIDANCE FOR STEEP TERRAIN AND URBAN AREAS ARE
ONE TO TWO INCHES OR MORE IN ONE TO TWO HOURS OR LESS RESPECTIVELY.
REFERENCE ROML C-40-82 FILED WITH CHAPTER E-13

.B KRF 0119 DH18/PPTCF

:MARSHALL	: KSC058	1.7	, :NEMAHA	: KSC066	1.2
:RILEY	: KSC081	2.0	, :POTTAWATOMIE	: KSC075	1.4
:GEARY	: KSC031	1.4	, :WABAUNSEE	: KSC099	1.1
:BROWN	: KSC007	1.0	, :JACKSON	: KSC043	1.0
:JEFFERSON	: KSC044	1.1	, :SHAWNEE	: KSC089	1.0
:DOUGLAS	: KSC023	1.5	, :OSAGE	: KSC070	1.2
:FRANKLIN	: KSC030	1.3	, :MIAMI	: KSC061	1.3
:ANDERSON	: KSC002	1.0	, :LINN	: KSC054	1.2

.END
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Fig. 2. Example of flash flood guidance product for counties.

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S I O U X F A L L S H Y D R O L O G I C S E R V I C E A R E A

FLASH FLOOD/HEADWATER BASIN CREST STAGE GUIDANCE

RELEASE DATE WED JAN 20 1988

REFERENCE ROML C-40-82 FILED WITH CHAPTER E-13

STREAM	STATION	RAIN	STATE ZONES	RESTRICTION
LITTLE MISSOURI R	CAMP CROOK SD	1.60	SD1 MT4	FF ONLY
GRAND R	LITTLE EAGLE SD 1S	1.80	SD1 2 3	FF ONLY
COLD BROOK CR	COLD BROOK RES SD	1.00	SD7	NOT FOR FF
FALL R	HOT SPRINGS SD #1	3.00	SD7	NOT FOR FF
RAPID CR	RAPID CITY SD #2	2.30	SD7	
BOX ELDER CR	NEMO SD 5SE	1.30	SD7	
SPEARFISH CR	SPEARFISH SD	1.90	SD7 8	
BEAR BUTTE CR	STURGIS/GALENA SD	1.50	SD7	
BAD R	FT PIERRE SD 3S	1.50	SD9 10	FF ONLY
ELM R	WESTPORT SD	2.10	SD4 ND14	
TURTLE CR	REDFIELD SD	1.10	SD10 11	FF ONLY
JAMES R	HURON SD	1.80	SD4 11	FF ONLY
JAMES R	FORESTBURG SD	1.70	SD11	FF ONLY
VERMILLION R	WAKONDA SD	2.40	SD18	FF ONLY
BIG SIOUX R	DELL RAPIDS SD 2SW	2.20	SD12 18 MN17	FF ONLY
BIG SIOUX R	SIOUX FALLS SD 38A	3.00	SD12 18	NOT FOR FF
SKUNK CR	SIOUX FALLS SD	1.80	SD18	
BIG SIOUX R	SUX FALLS SD WSTRN	1.60	SD18	
SPLIT ROCK CR	CORSON SD 1E	2.00	SD18	

UNLESS REQUIRED EARLIER BY HYDROLOGIC CONDITIONS THE NEXT MESSAGE OF THIS TYPE WILL BE ISSUED ON THU JAN 21 1988

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Fig. 3. Example of flash flood guidance product for headwater basins. Note that some points are not to be used for flash flood purposes.