V.3.3-API-HAR HARRISBURG (MARFC) API-RUNOFF OPERATION

Identifier: API-HAR

Application: All Programs

Description: This Operation calculates Antecedent Precipitation Indices (API), Antecedent Evapotranspiration Indices (AEI), Final Indices (FI) and runoff amounts for a given runoff zone.

The data time interval of these variables can be 1, 2, 3, 4, 6, 8, 12 and 24 hours depending on the data time interval specified when the Operation is initialized. Input data are zonal potential evapotranspiration and zonal rain/melt.

Special provisions of this Operation include:

1. The minimum period for which the Operation can be executed is 1 day. Operationally the day ends at 12Z.

2. The data time interval for rain/melt and runoff can be 1, 2, 3, 4, 6, 8, 12 and 24 hours and is specified by the user when the Operation is initialized.

3. Input values of zonal potential evapotranspiration are daily values.

4. Initial carryover values may be specified by the user when the Operation is initialized for a runoff zone. These variables are: 12Z API, 12Z AEI, 12Z FI, 12Z storm API, 12Z storm AEI, 12Z storm FI, rain/melt of current storm, runoff from current storm, 24 hour rain/melt, 24 hour runoff and rain/melt for each period in the new storm window (up to 24 values).

5. The option is available to allow the user to request output time series containing storm API, storm AEI and storm FI values, with all three time series possessing the same data time interval as the rain/melt and runoff time series.

Developed by: Middle Atlantic River Forecast Center

Allowable Data Time Intervals: 1, 2, 3, 4, 6, 8, 12 and 24 hours

Time Series Used: Time series used in this Operation are as follows:

General Type	Dimn	Units	Use	Required	Form of Output T.S.	Data Time Interval	Missing Values Allowed
Rain/melt	L	MM	I	yes	N/A	variable	no

Potential ET	L	MM	I	yes	N/A	24	no
Runoff	L	MM	O	yes	replaces	variable	no
Storm FI	DLES	R	O	no	replaces	variable	no
Storm API	L	MM	O	no	replaces	variable	no
Storm AEI	L	MM	O	no	replaces	variable	no

Input Summary: The card input for this Operation is as follows:

Card	Format	Columns	Contents
1	2A4	1-8	Runoff zone identifier
	6X,5A4	15-34	Runoff zone name
	5X,I4	40-43	Runoff zone number; not used by Operation - for external use only; range is 0 through 1000
	6X,F5.2	50-54	Latitude (units of decimal degrees) of the centroid of the runoff zone; not used by Operation - for external use only; range is 36.00 through 43.50
	5X,F5.2	60-64	Longitude (units of decimal degrees) of the centroid of the runoff zone; not used by Operation - for external use only; range is 73.50 through 83.50
2	F5.3	1-5	Zone runoff adjustment factor; range is 0.00 through 5.00
	F5.3	6-10	24 hour API recession factor; range is 0.75 through 0.99
	F5.3	11-15	New storm rain/melt limit (units of IN); range is 0.00 through 1.00
	F5.2	16-20	Upper limit for AEI (winter curve); highest allowed value is 11.00 IN
	F5.2	21-25	Bottom limit for AEI (winter curve); lowest allowed value is 1.00 IN
	F5.2	26-30	Upper limit for AEI (summer curve); highest allowed value is 11.00 IN
	F5.2	31-35	Bottom limit for AEI (summer curve); lowest allowed value is 1.00 IN
3	I5	1-5	API/AEI/FI curve number; range is 1-20

Card	Format	Columns	Contents
	I5	6-10	Data time interval of rainfall/melt and runoff time series and of the FI, API and AEI time series if requested (units of HR)
	I5	11-15	New storm window (units of HR); range is 1-24 and must be a multiple of the basic data time interval
	I5	16-20	Indicator if to save FI, API and AEI time series: 0 = no - do not save 1 = yes save
	I5	21-25	Indicator if to read initial carryover values: 0 = no - do not read 1 = yes - read
4	2A4	1-8	Internal identifier of rain/melt time series
	3X,A4	12-15	Data type code of rain/melt time series
	4X,2A4	20-27	Internal identifier of potential evapotranspiration time series
	3X,A4	31-34	Data type code of potential evapotranspiration time series
	5X,2A4	40-47	Internal identifier of runoff time series
	3X,A4	51-54	Data type code of runoff time series

Card 5 is needed if FI, API and AEI time series are to be generated. The API/AEI/FI time series output indicator (columns 16-20 of card 3) must contain a positive non-zero value if card 5 is to be read.

5	2A4	1- 8	Internal identifier of FI time series
	3X,A4	12-15	Data type code of FI time series
	4X,2A4	20-27	Internal identifier of API time series
	3X,A4	31-34	Data type code of API time series
	5X,2A4	40-47	Internal identifier of AEI time series
	3X,A4	51-54	Data type code of AEI time series

Cards 6 and 7 are needed if actual carryover values are to be input. The input carryover indicator (columns 21-25 of card 3)

Card	Format	Columns	Contents
			must contain a positive non-zero value if these cards are to be read. If any values are entered all must be entered. If initial carryover values are not read default values are used. Defaults are 1.0 for API values, 5.0 for AEI values, 2.6 for FI values and 0.0 for all other values.
6	F5.2	1- 5	12Z API value (units of IN); range is 0.10 through 60.00
	F5.2	6-10	12Z AEI value (units of IN); range is 1.00 through 11.00
	F5.2	11-15	12Z FI value; range is 0.10 through 10.00
	F5.2	16-20	12Z storm API (units of IN); range is 0.10 through 60.00
	F5.2	21-25	12Z storm AEI (units of IN); range is 1.00 through 11.00.
	F5.2	26-30	12Z storm FI; range is 0.10 through 10.00
	F5.2	31-35	Rain/melt in current storm (units of IN); range is 0.00 through 60.00
	F5.2	36-40	Runoff in current storm (units of IN); range is 0.00 through 60.00
	F5.2	41-45	24 hour rain/melt (units of IN)
	F5.2	46-50	24 hour runoff (units of IN)
7	12F5.2	1-60	Rain/melt for each period in the new storm window (units of IN); number of values needed is equal to the new storm window divided by the basic data time interval; if more than 12 values needed repeat card 7

Sample Input and Output: Sample input is shown in Figure 1. Sample output from the parameter print routine is shown in Figure 2. There is no execution routine output.

Error and Warning Messages: The error and warning messages generated by this Operation and the corrective action to take when they occur are as follows:

1. ** ERROR **
   ILLEGAL ZONE RUNOFF FACTOR: X.XX
   LIMITS ARE 0.00 THROUGH 5.00

A VALUE OF 0.00 MEANS NO ADJUSTMENTS TO API - HAR COMPUTED RUNOFF.

Action: Change the zone runoff adjustment factor on card 2.

2. ** ERROR **
ILLEGAL 24-HOUR API RECESSION FACTOR : X.XX
LIMITS ARE 0.75 THROUGH 0.99.

Action: Change the 24 hour API recession factor on card 2.

3. ** ERROR **
ILLEGAL NEW STORM RAIN/MELT LIMIT : X.XX
LIMITS ARE 0.00 THROUGH 1.00 INCHES.

Action: Change the new storm rain/melt limit on card 2.

4. ** ERROR **
ILLEGAL UPPER LIMIT FOR AEI (WINTER CURVE) : XX.XX
LIMITS ARE 9.50 THROUGH 11.00 INCHES.

Action: Change AEI upper limit on card 2.

5. ** ERROR **
ILLEGAL LOWER LIMIT FOR AEI (WINTER CURVE) : X.XX
LIMITS ARE 1.00 THROUGH 1.90 INCHES.

Action: Change AEI lower limit on card 2.

6. ** ERROR **
ILLEGAL UPPER LIMIT FOR AEI (SUMMER CURVE) : XX.XX
LIMITS ARE 9.50 THROUGH 11.00 INCHES.

Action: Change AEI upper limit on card 2.

7. ** ERROR **
ILLEGAL LOWER LIMIT FOR AEI (SUMMER CURVE) : X.XX
LIMITS ARE 1.00 THROUGH 2.00 INCHES.

Action: Change AEI lower limit on card 2.

8. ** ERROR **
ILLEGAL API/AEI/FI CURVE NUMBER : XX
LIMITS ARE 1 THROUGH 21.

Action: Change the API/AEI/FI curve number on card 3.

9. ** ERROR **
ILLEGAL TIME STEP INTERVAL : XX
LEGAL VALUES ARE 1,2,3,4,6,8,12 OR 24 HOURS.

Action: Change the time step interval on card 3.

10. ** ERROR **
ILLEGAL NEW STORM WINDOW : XX
LEGAL VALUES ARE 1,2,3,4,6,8,12 OR 24 HOURS.

Action: Change the new storm window on card 3.

11. ** ERROR **
THE NUMBER OF PERIODS CALCULATED FROM THE SPECIFIED NEW STORM WINDOW IS LESS THAN 1.
LIMITS ARE 1 THROUGH 24.

Action: Change the time step interval and/or the new storm window on card 3.

12. ** ERROR **
THE NUMBER OF PERIODS CALCULATED FROM THE SPECIFIED NEW STORM WINDOW IS GREATER THAN 24.

Action: Change the time step interval and/or the new storm window on card 3.

13. ** ERROR **
ILLEGAL 12Z API VALUE : XX.XX
LIMITS ARE 0.10 THROUGH 60.00 INCHES.

Action: Change the 12Z API value on card 6.

14. ** ERROR **
ILLEGAL 12Z AEI VALUE : XX.XX
LIMITS ARE 1.00 THROUGH 11.00 INCHES.

Action: Change the 12Z AEI value on card 6.

15. ** ERROR **
ILLEGAL 12Z FI VALUE : XX.XX
LIMITS ARE 0.00 THROUGH 10.00.

Action: Change the 12Z FI value on card 6.

16. ** ERROR **
ILLEGAL 12Z STORM API VALUE : XX.XX
LIMITS ARE 0.10 THROUGH 60.00 INCHES.

Action: Change the 12Z storm API value on card 6.

17. ** ERROR **
ILLEGAL 12Z STORM AEI VALUE : XX.XX
LIMITS ARE 1.00 THROUGH 11.00 INCHES.

Action: Change the 12Z storm AEI value on card 6.

18. ** ERROR **
ILLEGAL 12Z STORM FI VALUE : XX.XX
LIMITS ARE 0.00 THROUGH 10.00.

Action: Change the 12Z storm FI value on card 6.

19. ** ERROR **
ILLEGAL STORM RAIN/MELT VALUE AT 12Z : XX.XX
LIMITS ARE 0.00 THROUGH 60.00 INCHES.

Action: Change the storm rain/melt value at 12Z on card 6.

20. ** ERROR **
ILLEGAL STORM RUNOFF VALUE AT 12Z : XX.XX
LIMITS ARE 0.00 THROUGH 60.00 INCHES.

Action: Change the storm runoff value at 12Z on card 6.

21. ** ERROR **
ILLEGAL RAIN/MELT TOTAL IN THE NEW STORM WINDOW : XX.XX
LIMITS ARE 0.00 THROUGH 60.00 INCHES.

Action: Change the rain/melt value for each period within the new storm window on card 7.

Carryover Transfer Rules: The following rules are used during the carryover transfer process for this Operation:

1. Checks are made to see if the computational time step interval and the new storm window have been changed:

   a. If the computational time step interval has changed then all rain/melt values in the new storm window are set to zero regardless of what may have happened to the size of the new storm window.

   b. If the new storm window has increased (while the computational time step interval has remained constant) then the existing rain/melt values within the new storm window are padded with zeros.

   c. If the new storm window has decreased (while the computational time step interval has remained constant) then the extraneous rain/melt values within the new storm window are set to zero.

   If changes have been made to either the computational time step interval or the new storm window Operation should be executed for as far back in time as possible to update the carryover.

2. No validity checks or alterations are made to any of the other values during the carryover transfer process.

Punched Card Limitations: The punched card rules for this Operation are as follows:

1. The format of punched cards is identical to those described in the Input Card Summary of this documentation.

2. No checks are made for the validity of the parametric or carryover data during the punching process.

3. Carryover values may be defaulted if desired. In this case, cards 6 and 7 will not be punched for a given runoff zone. The

input carryover indicator (Columns 21-25 of Card 3) will correspondingly be punched with a zero value.

Figure 1. Sample card input for Operation API-HAR

```
                                    - Column -
    5   10   15   20   25   30   35   40   45   50   55   60   65   70   75   80
----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+
API-HAR     PORSE
PORSE          BLUERIDGE-PT OF ROCK      106       39.5     77.48
0.0000.9000.10011.00 1.5011.00 2.00
   20    6   12    0    1
PORSE      RAIM    MSY        MAPE     PORSE      INFW
1.00 3.50 1.70 0.10 1.00 0.10 0.00 0.00 0.00 0.00
  0.0  0.0
```

Figure 2. Sample output from Operation API-HAR print parameter routine

```
 ********************

 API-HAR  OPERATION     NAME=PORSE        PREVIOUS NAME=

 ********************

                          API - HAR PARAMETER VALUES FOR BLUERIDGE-PT OF ROCK

                      INTERNAL
                      VARIABLE
                        NAME       DESCRIPTION                                CONTENTS

                        IVERS .... API - HAR VERSION NUMBER ..............    1
                        RID   .... 8-LETTER RUNOFF ZONE I.D. ..............  PORSE
                        RNAME .... 20-LETTER RUNOFF ZONE NAME .............  BLUERIDGE-PT OF ROCK
                        IRNUM .... RUNOFF ZONE NUMBER .....................  106
                        RLAT  .... LATITUDE OF R.O. ZONE CENTROID (DEG DEC)  39.50
                        RLNG  .... LONGITUDE OF R.O. ZONE CENTROID (DEG DEC) 77.48
                        RFCTR .... BASIN RUNOFF ADJUSTMENT FACTOR .........  0.00
                        R24   .... 24-HOUR API RECESSION FACTOR ...........  0.900
                        PMAX  .... STORM BREAK RAIN/MELT CRITERION ........  0.10
                        ULIMW .... UPPER LIMIT FOR AEI (WINTER CURVE) .....  11.00
                        BLIMW .... BOTTOM LIMIT FOR AEI (WINTER CURVE) ....  1.50
                        ULIMS .... UPPER LIMIT FOR AEI (SUMMER CURVE) .....  11.00
                        BLIMS .... BOTTOM LIMIT FOR AEI (SUMMER CURVE) ....  2.00
                        KURV  .... API/AEI/FI CURVE NUMBER ................    20
                        IDELTA.... COMPUTATIONAL TIME STEP INTERVAL (HOURS)    6
                        NSW   .... NEW STORM WINDOW (HOURS) ...............    12
                        NSPER .... NUMBER OF PERIODS IN NSW ...............     2
                        IUSEC .... NUMBER OF WORDS USED IN THE CO ARRAY ...    12
                        IOFAAA.... I/O FLAG FOR API, AEI & FI TIME SERIES      0
                                   (0 = DON‹T SAVE AS TS, 1 = SAVE AS TS)
                        ICOF  .... CARRYOVER INPUT FLAG ...................    1
                                   (0 = USE DEFAULTS, 1 = READ INPUT)

                             TIME SERIES USED BY THE API - HAR OPERATION:

                   TS I.D.       TYPE      DESCRIPTION                      TIME INTERVAL

                   PORSE         RAIM      RAINFALL/MELT                      6 HOURS
                   MSY           MAPE      POTENTIAL EVAPOTRANSPIRATION      24 HOURS
                   PORSE         INFW      RUNOFF                             6 HOURS

                              API - HAR CARRYOVER VALUES FOR BLUERIDGE-PT OF ROCK

                             INTERNAL
                             VARIABLE
                               NAME       DESCRIPTION                  CONTENTS

                               TAPI  .... 12Z API ......................  1.00

                               TAEI  .... 12Z AEI ......................  3.50
```

TFI	....	12Z FI	1.70
SAPI	....	STORM API AT 12Z	0.10
SAEI	....	STORM AEI AT 12Z	1.00
SFI	....	STORM FI AT 12Z	0.10
SRAIM	....	STORM RAIN/MELT AS OF 12Z	0.00
SRO	....	STORM RUNOFF AS OF 12Z	0.00
DRAIM	....	24-HOUR RAIN/MELT ENDING 12Z ..	0.00
DRO	....	24-HOUR RUNOFF ENDING 12Z	0.00

RAIN/MELT FOR EACH PERIOD WITHIN THE NEW STORM WINDOW (OLDEST PERIOD IS FIRST):

0.00
0.00