V.3.3-API-HFD HARTFORD (NERFC) API-RUNOFF OPERATION

Identifier: API-HFD

Application: All Programs

Description: This Operation calculates Antecedent Precipitation Indices (API), Antecedent Temperature Indices (ATI), Final Runoff Indices (RI) and runoff amounts for a given runoff zone.

The time interval of these variables can be 1, 2, 3, 4, 6, 8, 12 or 24 hours depending on the time interval specified when the Operation is initialized.

Input data are average annual basin temperature 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 time interval for rain/melt and runoff can be 1, 2, 3, 4, 6, 8, 12 or 24 hours and is specified by the user when the Operation is initialized.

3. Initial carryover values may be specified by the user when the Operation is initialized for a runoff zone. These variables are: 12Z API, 12Z ATI, 12Z RI, 12Z storm API, 12Z storm ATI, 12Z storm RI, 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).

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

Developed By: Northeast River Forecast Center

Allowable Data Time Intervals: 1, 2, 3, 4, 6, 8, 12 or 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
Runoff	L	MM	O	yes	replaces	variable	no

General Type	Dimn	Units	Use	Required	Form of Output T.S.	Data Time Interval	Missing Values Allowed
Storm API	L	MM	O	yo	replaces	variable	no
Ant Temp Index	TEMP	DEGC	O	no	replaces	24	no
Storm RI	DLES	R	O	no	replaces	Variable	no

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

Card	Field	Format	Columns	Contents
1	1	2A4	1-8	Runoff zone identifier
	2	6X,5A4	15-34	Runoff zone name
	3	5X,I4	40-43	Runoff zone number (used to determine the RI equation); range is 0 through 1000
	4	6X,F5.2	50-54	Latitude (decimal degrees) of the centroid of the runoff zone (not used; for external use only); range is 40.50 through 47.20
	5	5X,F5.2	60-64	Longitude (decimal degrees) of the centroid of the runoff zone (not used; for external use only); range is 67.40 through 78.65
2	1	F6.2	1-6	Zone runoff adjustment factor; range is 0.00 through 5.00
	2	F6.2	7-12	24-hour API recession factor; range is 0.75 through 0.99
	3	F6.2	13-18	New storm rain/melt limit (IN); range is 0.00 through 1.00
	4	F6.1	19-24	Upper limit for ATI (winter curve); highest allowed value is 60.0 DEGF
	5	F6.1	25-30	Bottom limit for ATI (winter curve); lowest allowed value is 33.0 DEGF
	6	F6.1	31-36	Upper limit for ATI (summer curve); highest allowed value is 60.0 DEGF
	7	F6.1	37-42	Bottom limit for ATI (summer

Card	Field	Format	Columns	Contents
				curve); lowest allowed value is 33.0 DEGF
	8	F6.1	43-48	Basin annual temperature; range is 40.0 through 49.0 DEGF
3	1	I6	1-6	Geographical relationship number; valid values are 1, 2 and 3
	2	I6	7-12	Data time interval of rainfall/melt and runoff time series and of the API, ATI and RI time series if requested (HR)
	3	I6	13-18	New storm window (HR); range is 1-24 and must be a multiple of the basic data time interval
	4	I6	19-24	Indicator if API, ATI and RI time series to be saved: 0 = no 1 = yes
	5	I6	25-30	Indicator if to read initial carryover input: 0 = no 1 = yes
4	1	2A4	1-8	Internal identifier of rain/melt time series
	2	3X,A4	12-15	Data type code of rain/melt time series
	3	4X,2A4	20-27	Internal identifier of runoff time series
	4	3X,A4	31-34	Data type code of runoff time series

Card 5 is optional and required only if API, ATI and RI time series are to be generated. The API/ATI/RI time series output flag (field 4 of card 3) must contain a positive non-zero value if card 5 is to be read.

5	1	2A4	1-8	Internal identifier of API time series
	2	3X,A4	12-15	Data type code of API time series.
	3	4X,2A4	20-27	Internal identifier of ATI time series
	4	3X,A4	31-34	Data type code of ATI time series

Card	Field	Format	Columns	Contents
	5	5x,2A4	40-47	Internal identifier of RI time series
	6	3X,A4	51-54	Data type code of RI time series

Cards 6 and 7 are optional and required only if carryover values are to be input. The input carryover flag (field 5 of card 3) must contain a positive non-zero value if these cards are to be read. If any values are entered then all must be entered. If initial carryover values are not read default values are used.

6	1	F6.2	1-6	12Z API Value (IN); range is 0.1 through 5.00
	2	F6.1	7-12	12Z ATI Value (DEGF); range is 33.0 through 60.0
	3	F6.2	13-18	12Z RI Value; range is 10.00 through 80.00
	4	F6.2	19-24	12Z storm API (IN); range is 0.1 through 5.00
	5	F6.1	25-30	12Z storm ATI (DEGF); range is 33.0 through 60.0.
	6	F6.2	31-36	12Z storm RI; range is 10.00 through 80.00
	7	F6.2	37-42	Rain/melt in current storm (IN); range is 0.00 through 30.00
	8	F6.2	43-48	Runoff in current storm (IN); range is 0.00 through 30.00
	9	F6.2	49-54	24-hour rain/melt (IN)
	10	F6.2	55-60	24-hour runoff (IN)
7	1	12F5.2	1-60	Rain/melt for each period in the new storm window (IN)umber of values needed is equal to the new storm window divided by the basic data time interval; repeat card 7 if more than 12 values are needed
8	1	13(1X,I3)	1-52	Weekly basin temperatures beginning with week number 1 (first week in January) ending with week 13; values read to nearest 0.1 DEGF
9	1	13(1X,I3)	1-52	Weekly basin temperatures beginning with week number 14

Card	Field	Format	Columns	Contents
				(first week in April) ending with week 26; values read to nearest 0.1 DEGF
10	1	13(1X,I3)	1-52	Weekly basin temperatures beginning with week number 27 (first week in July) ending with week 39; values read to nearest 0.1 DEGF
11	1	13(1X,I3)	1-52	Weekly basin temperatures beginning with week number 40 (first week in October) ending with week 52; values read to nearest 0.1 DEGF

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-HFD COMPUTED RUNOFF.

   Action: Correct the zone runoff adjustment factor and change card 2.

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

   Action: Correct the 24-hour API recession factor and change card 2.

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

   Action: Correct the new storm rain/melt limit and change card 2.

4. **ERROR** ILLEGAL UPPER LIMIT FOR ATI (WINTER CURVE) : XX.X
   LIMITS ARE 33.0 THROUGH 60.0 DEGREES.

   Action: Correct ATI upper limit and change card 2.

5. **ERROR** ILLEGAL LOWER LIMIT FOR ATI (WINTER CURVE) : XX.X
   LIMITS ARE 33.0 THROUGH 60.0 DEGREES.

Action: Correct ATI lower limit and change card 2.

6. **ERROR** ILLEGAL UPPER LIMIT FOR ATI (SUMMER CURVE) : XX.X
LIMITS ARE 33.0 THROUGH 60.0 DEGREES.

Action: Correct ATI upper limit and change card 2.

7. **ERROR** ILLEGAL LOWER LIMIT FOR ATI (SUMMER CURVE) : XX.X
LIMITS ARE 33.0 THROUGH 60.0 DEGREES.

Action: Correct ATI lower limit and change card 2.

8. **ERROR** ILLEGAL GEOGRAPHICAL RELATIONSHIP NUMBER : X
LEGAL VALUES ARE 1 THROUGH 3.

Action: Correct the geographical relationship number and change card 3.

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

Action: Correct the time step interval and change card 3.

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

Action: Correct the time step interval and change card 3.

11. **ERROR** THE NUMBER OF HOURS USED TO DEFINE THE NEW STORM WINDOW IS NOT A POSITIVE, NON-ZERO INTEGER MULTIPLE OF THE COMPUTATIONAL TIME STEP INTERVAL.
THIS MEANS THAT THE TIME INTERVAL OVER WHICH THE API-HFD OPERATION CHECKS FOR A STORM BREAK MAY NOT BE WHAT IS ACTUALLY DESIRED. SUGGESTED REMEDY: ADJUST THE NEW STORM WINDOW AND/OR THE COMPUTATIONAL
TIME STEP INTERVAL. THE RESPECTIVE VALUES OF THESE VARIABLES JUST READ IN ARE XXXXX AND XXXXX.

12. **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 and change card 3.

13. **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 and repunch card 3.

14. **ERROR** ILLEGAL 12Z API VALUE : X.XX
LIMITS ARE 0.10 THROUGH 5.00 INCHES.

Action: Correct the 12Z API value and change card 6.

15. **ERROR** ILLEGAL 12Z ATI VALUE : XX.X
LIMITS ARE 33.0 THROUGH 60.0 DEGREES.

Action: Correct the 12Z ATI value and change card 6.

16. **ERROR** ILLEGAL 12Z RI VALUE : XX.XX
LIMITS ARE 10.00 THROUGH 80.00 INCHES.

Action: Correct the 12Z RI value and change card 6.

17. **ERROR** ILLEGAL 12Z STORM API VALUE : X.XX
LIMITS ARE 0.10 THROUGH 5.00 INCHES.

Action: Correct the 12Z storm API value and change card 6.

18. **ERROR** ILLEGAL 12Z STORM ATI VALUE : XX.X
LIMITS ARE 33.0 THROUGH 60.0 DEGREES.

Action: Correct the 12Z storm ATI value and change card 6.

19. **ERROR** ILLEGAL 12Z STORM RI VALUE : XX.XX
LIMITS ARE 10.00 THROUGH 80.00 INCHES.

Action: Correct the 12Z storm RI value and change card 6.

20. **ERROR** ILLEGAL STORM RAIN/MELT VALUE AT 12Z : XX.XX
LIMITS ARE 0.00 THROUGH 30.00 INCHES.

Action: Correct the storm rain/melt value at 12Z and change card 6.

21. **ERROR** ILLEGAL STORM RUNOFF VALUE AT 12Z : XX.XX
LIMITS ARE 0.00 THROUGH 30.00 INCHES.

Action: Correct the storm runoff value at 12Z and change card 6.

22. **ERROR** ILLEGAL RAIN/MELT TOTAL IN THE NEW STORM WINDOW : XX.XX
LIMITS ARE 0.00 THROUGH 30.00 INCHES.

Action: Correct the rain/melt value for each period within the new storm window and change card 7.

23. **WARNING** ILLEGAL LOWER LIMIT FOR TBAR : XX.X
THE LOWER LIMIT IS 40.0...
TBAR WILL BE RESET TO 40.0 DEGREES.

Action: Correct TBAR lower limit if necessary and change card 2.

24. **WARNING** ILLEGAL UPPER LIMIT FOR TBAR : XX.X
THE UPPER LIMIT IS 49.0...
TBAR WILL BE RESET TO 49.0 DEGREES.

Action: Correct TBAR upper limit if necessary and change card

2.

Carryover Transfer Rules: The following rules apply 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, 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), 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), 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, the API-HFD 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 Rule: The following rules apply when punching input cards for this Operation:

1. The format of punched cards is the same as that described in the Input Summary for this Operation.

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 flag (field 5 of card 3) will correspondingly be punched with a zero value.

Figure 1. Sample Card Input For Operation API-HFD

```
                                    - Column -
    5   10   15   20   25   30   35   40   45   50   55   60   65   70   75   80
----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+

API-HFD     WHINE
WHINE          WHITE-W HARTFORD          039      43.88     72.67
  1.02  0.90  0.15  60.0  33.0  60.0  33.0  42.0
     1     6    24     1     1
WHINE       RAIM    WHINE       INFW
WHINE       APIS    WHINE       ATI       WHINE       AIAI
  4.80  37.5 50.00  4.64  35.5 60.00  0.00  0.00  0.00  0.00
 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
 365 350 330 310 300 290 280 270 260 250 250 250 260
 270 280 290 300 310 330 350 365 380 400 420 440 460
 480 500 515 530 540 550 560 570 575 580 580 580 575
 570 565 560 545 530 515 500 485 470 450 430 405 380
```

Figure 2. Sample Output From Operation API-HFD Print Parameter Routine

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 API-HFD  OPERATION     NAME=WHINE        PREVIOUS NAME=

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


              API-HFD PARAMETER VALUES FOR WHITE-W HARTFORD

         INTERNAL
         VARIABLE
           NAME       DESCRIPTION                                  CONTENTS

           VERS ..... API-HFD VERSION NUMBER .................  1.00
           RID   .... 8-LETTER RUNOFF ZONE I.D. ..............  WHINE
           RNAME .... 20-LETTER RUNOFF ZONE NAME .............  WHITE-W HARTFORD
           IRNUM .... RUNOFF ZONE NUMBER .....................    39
           RLAT  .... LATITUDE OF R.O. ZONE CENTROID (DEG DEC)  43.88
           RLNG  .... LONGITUDE OF R.O. ZONE CENTROID (DEG DEC) 72.67
           RFCTR .... BASIN RUNOFF ADJUSTMENT FACTOR .........  1.02
           R24   .... 24-HOUR API RECESSION FACTOR ........... 0.900
           PMAX  .... STORM BREAK RAIN/MELT CRITERION ........  0.15
           ULIMW .... UPPER LIMIT FOR ATI (WINTER CURVE) .....  60.0
           BLIMW .... BOTTOM LIMIT FOR ATI (WINTER CURVE) ....  33.0
           ULIMS .... UPPER LIMIT FOR ATI (SUMMER CURVE) .....  60.0
           BLIMS .... BOTTOM LIMIT FOR ATI (SUMMER CURVE) ....  33.0
           TBAR  .... AVG ANNUAL BASIN TEMP...................  42.0
           NREL  .... GEOGRAPHICAL RELATIONSHIP NUMBER........    1
           IDELTA.... COMPUTATIONAL TIME STEP INTERVAL (HOURS)    6
           NSW   .... NEW STORM WINDOW (HOURS) ...............   24
           NSPER .... NUMBER OF PERIODS IN NSW ...............    4
           IUSEC .... NUMBER OF WORDS USED IN THE CO ARRAY ...   14
           IOFAAA.... I/O FLAG FOR API, ATI & FI TIME SERIES      1
                      (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-HFD OPERATION:

    TS I.D.       TYPE      DESCRIPTION                       TIME INTERVAL
```

WHINE	RAIM	RAINFALL/MELT	6 HOURS
WHINE	INFW	RUNOFF	6 HOURS
WHINE	APIS	STORM API	6 HOURS
WHINE	ATI	ANTECEDENT TEMPERATURE INDEX	24 HOURS
WHINE	AIAI	FINAL INDEX	6 HOURS

WEEKLY BASIN TEMPERATURES:

365 350 330 310 300 290 280 270 260 250 250 250 260
270 280 290 300 310 330 350 365 380 400 420 440 460
480 500 515 530 540 550 560 570 575 580 580 580 575
570 565 560 545 530 515 500 485 470 450 430 405 380

API-HFD CARRYOVER VALUES FOR WHITE-W HARTFORD

INTERNAL VARIABLE NAME	DESCRIPTION	CONTENTS
TAPI	12Z API	4.80
TATI	12Z ATI	37.5
TRI	12Z RI	50.00
SAPI	STORM API AT 12Z	4.64
SATI	STORM ATI AT 12Z	35.5
SRI	STORM RI AT 12Z	60.00
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
0.00
0.00