V.3.3-DELTA-TS RATE OF CHANGE OF TIME SERIES OPERATION

Identifier: DELTA-TS

Application: All programs

Description: This Operation computes rate of change of values per time interval for a time series. The most common use of this Operation is to compute the change in reservoir storage (dS) per time interval from an observed reservoir storage time series.

If mean outflow data are available in addition to storage values, an estimate of reservoir inflows can be computed using the DELTA-TS and ADD/SUB Operations based on the continuity equation. Besides computing dS values, the Operation can be used with any other type of data.

The equation for this Operation is:

$$dVi = Vi - Vi\text{-}1$$

where Vi is the value of the input time series at time step i
Vi-1 is the value of the input time series at time step i-1
dVi is the rate of change value (output time series) at time step i

The following rules and options apply to this Operation:

1. The rate of change time series data type (output time series) must have the same dimension and units as the input time series data type from which rate of change is computed.

2. If the data type for the input time series allows missing values then the output time series data type must also allow missing values.

3. The time interval for the input and output time series must be the same.

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
Input time series	any	1/	I	yes	n/a	any	yes
Output time	2/	2/	O	yes	Replaces	any 3/	yes 4/

General Type	Dimn	Units Use Required	Form of Output T.S.	Data Time Interval	Missing Values Allowed
series					

1/ Standard units for data type.

2/ Same as input time series.

3/ The data time interval for output time series must be the same as the data time interval for the input time series.

4/ If input time series allows missing values the output time series must allow missing values.

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

Card	Format	Columns	Contents
1	2X,2A4	3-10	Internal identifier for the input time series from which the rate of change values are computed
	1X,A4	12-15	Data type code for input time series
	3X,I2	19-20	Data time interval in hours for input and output time series
	2X,2A4	23-30	Internal identifier for the output time series where the rate of change values are stored
	1X,A4	32-35	Data type code for the output time series
	2X,A3	38-40	Read carryover indicator; enter 'YES' if carryover is to be read; default is to assume that the value at time zero is the same as the first value encountered (i.e., rate of change is zero for the initial time interval)
	F10.0	41-50	Carryover value; previous value of input time series (default to standard metric units)
	1X,A4	52-55	Carryover units; enter 'XUNT' to indicate that a non-standard unit, such as acre-feet, thousand cubic meter, etc., is used in the input time series

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:

A. Messages that can occur during setup:

1. **ERROR** INPUT AND RATE OF CHANGE TIME SERIES DO NOT HAVE THE SAME UNITS (XXXX AND XXXX)

   Action: Make sure both time series have the same dimensions and the same units.

2. **ERROR** THE INPUT TIME SERIES ALLOWS MISSING DATA. THEREFORE, RATE OF CHANGE TIME SERIES MUST ALSO ALLOW MISSING DATA.

   Action: Use a data type for the time series that allows missing data.

B. Messages that can occur during execution: None

Carryover Transfer Rules: The rules for carryover transfer are:

1. If the time series dimensions and units remain the same then initial value remains the same.

2. If the new definition of the Operation has time series with different dimensions and units than the old definition then the user specified carryover is used.

Punched Card Limitations: None

Figure 1. Sample Card Input For Operation DELTA-TS

```
                                    - Column -
    5   10   15   20   25   30   35   40   45   50   55   60   65   70   75   80
----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+
DELTA-TS    BMDWE
  BMDWE    RSTO   24  BMDWE    CSTO
```

Figure 2. Sample Output From Operation DELTA-TS Print Parameter Routine

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DELTA-TS OPERATION     NAME=BMDWE        PREVIOUS NAME=

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          INPUT TIME SERIES (I.D.=BMDWE      TYPE=RSTO   TIME INTERVAL=24 HOURS).
          RATE OF CHANGE TIME SERIES (I.D.=BMDWE      TYPE=CSTO   TIME INTERVAL=24 HOURS).

          CARRYOVER SET TO DEFAULT VALUE (-989.) SO THAT INITIAL RATE OF CHANGE VALUE= 0.0
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